ZOFNASS PROGRAM
FOR SUSTAINABLE INFRASTRUCTURE

RESEARCH

Assessment of Projects for a. mitigation and adaptation to climate change and b. attractiveness to investments

Prof. Spiro N. Pollalis

Evgenia Chatzistavrou

Angela Kouveli

Eleonora Marinou

Judith Rodriguez

Olga Tzioti

June 15, 2021

ACKNOWLEDGEMENTS

The authors would like to thank for their contribution:

EXECUTIVE SUMMARY

The present Zofnass Program research “Assessment of Projects for (a) mitigation and adaptation to climate change and (b) attractiveness to investments” aims to assist the Envision framework in adapting and contributing to the ongoing global discourse and research on climate change and the urgency of channeling investments in climate action projects.

Departing from an extensive literature review on climate change and the investors’ demand for climate action, key areas of related research are highlighted and current climate-related goals are identified. The analysis of selected established ESG standards – the main tool for investor knowledge on companies’ sustainable performance- and climate-related reporting frameworks like the Taskforce for Climate-related Financial Disclosures (TCFD) Recommendations, provides additional insight on how climate-related performance is defined and communicated as relevant to investors.

Based on the findings of the literature review and the ESG systems analysis key criteria for assessing climate-related performance are identified and used for a targeted review of Envision. The review focuses on how Envision assesses project performance in climate change mitigation and adaptation, if Envision is in line with current trends and methods and if the climate-related risks and opportunities of projects for investors are adequately captured.

The review is performed directly using the Envision manual and an Envision-based tool, the Lifecycle Sustainability tool, developed as part of a recent research in collaboration with the National Research Council of Canada (NRCC).

The findings of the review process are synthesized in:

- identified gaps in Envision’s climate-related assessment of projects and guidance to project teams
- potential recommendations to Envision on how to address the identified gaps and enhance its climate-related assessment and guidance and
- identification of prioritization Envision credits to assist in selection of the right projects for climate action, critical in the current climate emergency.

Finally, two Envision verified projects are presented and analyzed to provide insight in sector- and project-specific approaches to climate change mitigation and adaptation.

INTRODUCTION

This report presents the research on assessing projects for mitigating or adapting to climate change and the financial attractiveness of such projects. The scope of the research is described in the Research proposal shared with the Sustainability Industry Advisory Board (SIAB) on November 14, 2020, following the discussion of November 10, 2020, with the SIAB members,[1] where input was requested on a potential research direction (Appendix A).

[1] Participants: Spiro Pollalis (ZPH), Chris Barron (Bentley), Andreas Georgoulias (EFCG), Anthony Kane (ISI), Tom Lewis (WSP), Cris B. Liban (LA Metro), Loren Labovitch (Stantec), Roberto Mezzalama (Golder), Linda Reardon (NV5), Deepa Sathiaram (En3), Brian Swett (ARUP), Paul Zofnass (EFCG)

Since its original launch in 2012, Envision® has demonstrated an ability to address industry changes, concretized into two updated versions of Envision until today. The industry understanding of resilience in 2015 motivated an expansion of the Envision to incorporate a more advanced appreciation and understanding of resilience by updating and reviewing resilience-related credits. Moreover, there is a growing demand for ESG investing, motivating Envision to incorporate an evaluation of sustainable infrastructure projects' economics. Presently, the SDGs gain global momentum due to the urgency of climate action and the ongoing COVID-19 pandemic crisis, the recovery from which can speed up the transition to a better paradigm.

During the November discussion, a shared view among the SIAB members was the anticipated availability of funds in the US to support the restart of the global economy in a post-COVID era. Therefore, investment in infrastructure projects constitutes an opportunity and makes more urgent to prioritize the "right projects." For Envision to be strategic, two areas of focus emerged to be studied as part of the Envision® framework:

- assess projects centered on climate change mitigation and adaptation, and
- evaluate sustainable projects for their financial opportunities, which can easier attract financing

Moreover, a discussion on what approach should be adopted in terms of climate change action, mitigation vs. adaptation, was initiated that should be further explored.

1. RESEARCH STATEMENT

The proposed research aims to assist the Envision framework in adapting and contributing to the ongoing global discourse and research on (a) climate change and (b) investments in climate action projects.

The Envision® framework, as a set of criteria for the sustainable performance of infrastructure projects, is proposed to serve as the basis for the research on the prioritization of projects to be funded. This may lead to <u>prioritizing selected Envision criteria over other criteria</u>. Such a task complements the importance of all criteria that collectively ensure an infrastructure project's sustainable performance. Envision® is a triple bottom line sustainability certification system essential for ensuring a sustainable project regarding social, environmental, and economic performance. None of the three dimensions should be ignored or underrated. Envision can ensure if 'we are doing the project right in terms of sustainable performance,' while the present research is focused on how Envision can assist in the selection of 'the right project' in conditions of climate urgency.

1.1. Scope of Research

The research focus for the Zofnass Program for 2020-2021 consists of research that can support investors for funding projects that address climate change through mitigation and adaptation projects. A dual approach to address the importance of climate change mitigation and adaptation while supporting investors on decision-making or selecting projects to invest in.

The research will build upon the Envision V3 framework and study how Envision can respond to the current urgency and investors' demand for climate-friendly projects. To bring out these high-priority criteria, a specific 'filtering' of Envision is required. Therefore, it is essential to research and define what the specific right filtering should be. The research follows a recent methodology that has led to the development of the Lifecycle Sustainability tool as part of research in collaboration with the National Research Council of Canada (NRCC), applicable during the early decision-making process.

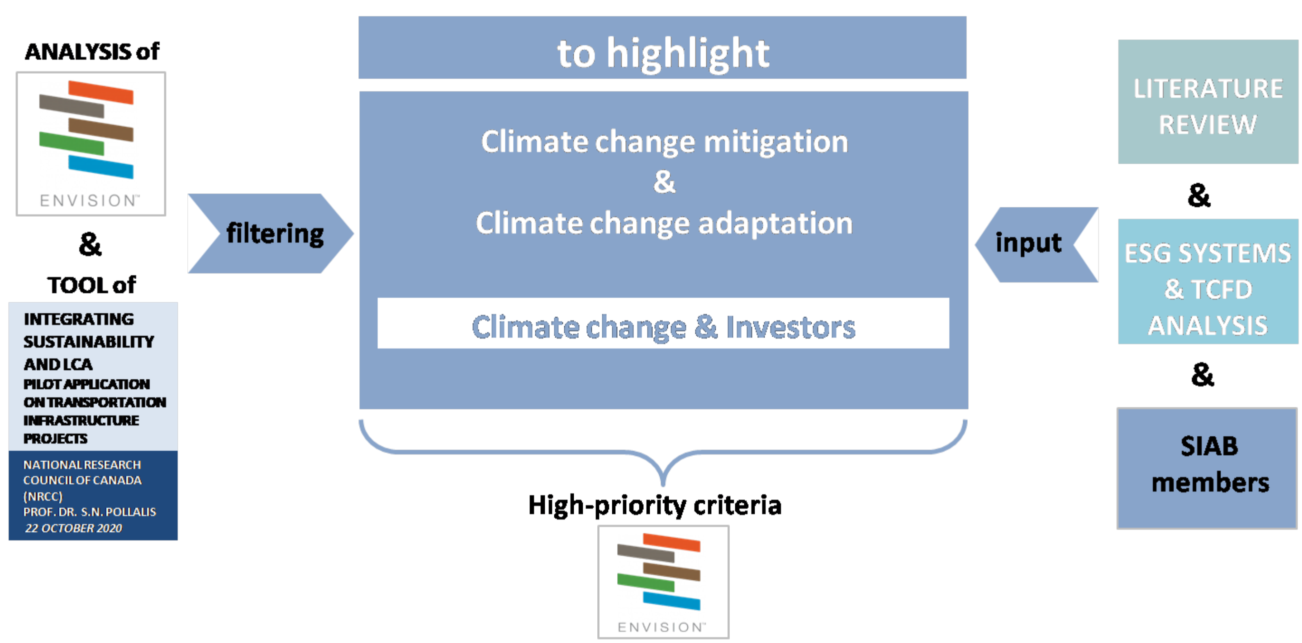
It is worth highlighting that the research's focus on climate change and investors does not suggest a mono-criteria or two-or-three criteria analysis of projects. Priority credits and strategies will be considered across the full extent of their related impacts to provide a stronger case of why investors should choose to fund these projects and the multiple benefits and trade-offs of such decisions.

1.2. Initial Research Questions

A series of research questions emerge to support the research's scope and define the research objectives.

- Why is it critical to prioritize projects that mitigate and/or adapt to climate change?
- Are all infrastructure projects climate-related? What baseline requirements do they have to meet?
- Climate change mitigation VS. climate change adaptation
- What are the risks and opportunities of investing in climate projects?
- Is support for climate change action a priority for investors?
- How can Envision contribute to the prioritization of the right projects?
- How can Envision provide evidence to investors of the climate risks addressed by the project and evidence of the opportunities it presents based on investment imperatives?

2. RESEARCH METHODOLOGY



A. Literature review

A1. Literature review on climate change-related topics and recent trends, climate change mitigation and adaptation goals and on how mitigation and adaptation definitions have evolved over the last decades. The objective is to highlight why it is critical to prioritize projects that mitigate and/or adapt to climate change and which actions the global scientific community suggests towards that direction.

A2. Literature review on investors' position on the need for climate action. The review captures how investors' demand has evolved through the evolution of Environmental Social Governance (ESG) reporting systems - the main tool for investors for accounting of the sustainability performance of their portfolios-, demonstrating a recent trend on 'climate-first' approach.

B. ESG and Climate-related reporting systems analysis

Analysis and cross-examination of selected established ESG and climate-related reporting frameworks and standards to identify the current approach to climate change-related reporting. This analysis allows identifying climate-related data that are relevant to investors and guide their investment decisions. Specific focus is given on the analysis of the Taskforce for Climate Financial Disclosures (TCFD) Recommendations that mainstreamed climate change as financial risk, by connecting it to potential financial impacts for companies.

C. Identification of key criteria for defining climate action project performance

Extraction of key takeaways from the literature review and analysis of ESG systems and the TCFD Recommendations generate questions and provide insight on key criteria that define climate action and financial materiality, on which a targeted review of Envision is based.

D. Use of the Lifecycle Sustainability tool to track selected key climate action criteria within Envision

In order to assist an Envision review based on the identified key climate action criteria an Envision-based tool is used, the Lifecycle Sustainability tool, developed as a recent research in collaboration with the National Research Council of Canada (NRCC). The tool entered the Envision® manual in a computer model (in Excel format), maintaining the Envision structure, transforming it into a searchable and filterable format, enabling and facilitating targeted analyses. The LC Sustainability tool and its add-ons to Envision are presented as part of this report.

E. Enhancement of the LC Sustainability tool for a climate-focused analysis of Envision

Enhancement of the LC Sustainability tool based on the input from literature review and TCFD and ESG systems analysis to match the climate-focus of the Envision analysis. This required the addition of new parameters in the existing tool and review of its definitions of climate-related risks/ opportunities.

F. Review of Envision

Review of Envision regarding the assessment of climate-related risks and opportunities to identify potential gaps as compared to ESG reporting systems and the climate-related TCFD Recommendations. Exploration of Envision's alignment to TCFD is an important part of this review process.

The review is performed through:

- The Envision Manual (evaluation criteria, documentation)
- The Life Cycle Sustainability tool

Due to Envision's twofold purpose, as both an assessment tool for sustainable project performance and as a guidance tool for project teams to optimize project performance, the review refers to both uses of the Envision manual.

G. Gap identification and initial recommendations to be considered as part of the development of the next Envision manual update.

H. Use of Case studies

Selection and analysis of two Envision verified projects as case studies to provide insight in sector- and project-specific approaches to climate change mitigation and adaptation. The first is the California High-speed Rail program (Phase I), a project conceived to contribute to climate change mitigation, and the second is Santa Monica Clean Beaches, a multi-benefit project that incorporates adaptation strategies that at the same time contribute to mitigation. Both projects are in California, a state that has demonstrated leadership in climate change action.

PART1: LITERATURE REVIEW

Literature Review methodology

Considering the broad field and multiple concepts, keywords, and scientific research related to climate change mitigation, adaptation, resilience, impacts, urgent actions, risks and opportunities to investors, priorities, hidden costs, etc. the literature review methodology will be based on:

- Briefly documenting the milestones of the actions and goals towards climate change mitigation and adaptation and identify their relationships. For example, the 2030 Agenda for Sustainable Development refers to the Global indicator framework for the Sustainable Development Goals (SDGs), the Paris Agreement, and targets. When did the global discussion on SDGs and climate action become more intense and urgent? These milestones, events, discussions, and concepts are related to International organizations, Programs, Funds, Agencies, Conventions, Panels, Reports, Projects, and documents. It is part of this literature review to go through and examine those that serve the research purpose.
- Examination of recent reports, platforms, and initiatives will provide an overview of the progress towards the goals today.
- Research on ESG and Climate-related reporting frameworks that represent the basic tool of investor knowledge for company performance concerning sustainability
- Research on recent or ongoing developments in the ESG landscape to identify current trends that shape investors understanding of sustainability and climate-related risk and determine their response to sustainable and climate action goals

1. LITERATURE REVIEW ON GOALS FOR CLIMATE CHANGE

One of the two areas of focus to be studied in the proposed research and as part of the Envision® framework is to rate projects explicitly on climate change mitigation and adaptation.

As part of the literature review, we try to identify milestones in the ongoing global discourse on Climate change and the gradual evolution of the science of climate change through Institutions, organizations, and agencies that analyze, explore and highlight the need and lately the urgency for a sustainable development of the world's environment. These milestones are presented and organized throughout text , in relation with key themes (see following diagram) and significant issues for the scientific community and the Climate Change discussion over the last 4 decades such as:

- Emissions categories
- Greenhouse gas Inventories and accounting
- temperature limits
- scenarios' types, evolution and their alignment to new 1.5°C and net-zero by 2050 targets
- parallel action towards sustainable development

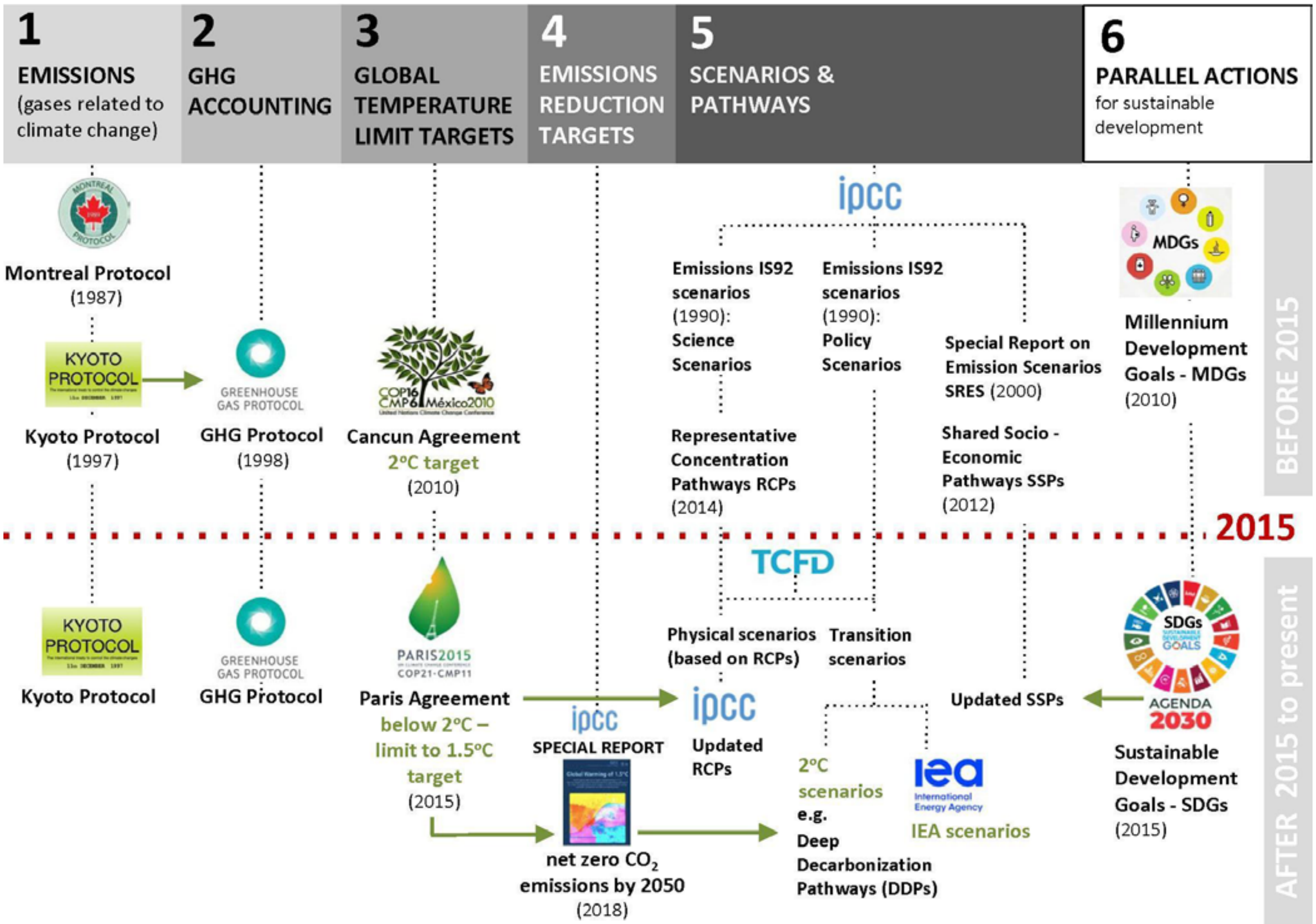


Fig. 1: Overview of the key themes explored and their evolution before and after the landmark year 2015

In the timeline presented below, it is evident that for almost five decades since its establishment, the United Nations Environment Program is the voice for the environment, its protection, and proper use at a global scale. The World Bank, the Organization for Economic Co-operation and Development (OECD)[2], the World Economic Forum (WEF) and the International Energy Agency (IEA), the UN Environmental Programme (UNEP), the Intergovernmental Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change (UNFCCC) are only some of the major institution which their research, since 1990, projects, reports and scientific information, provided a solid base for this part of the literature review. The significant agreements towards climate change such as the Kyoto Protocol and the Paris Agreement that focused attention on the impacts of climate change and the urgency for GHG mitigation, the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) as a parallel action to mitigation and adaptation, will all be presented in this chapter with the aim to provide a strong base to understand the current uncertainty in investment decision making and the strategies needed be adopted. However the whole spectrum of multiple initiatives, funds and

2 'In September 1961 the Organization for European Economic Co-operation (OEEC) was superseded by the Organization for Economic Co-operation and Development (OECD), a worldwide body. In 1961, the OECD consisted of the European founder countries of the OEEC plus the United States and Canada', OECD, https://www.oecd.org/general/organisationforeuropeaneconomicco-operation.htm

programs that during the last decades support the global response to climate change cannot be extensively explored within the research's limited boundaries.

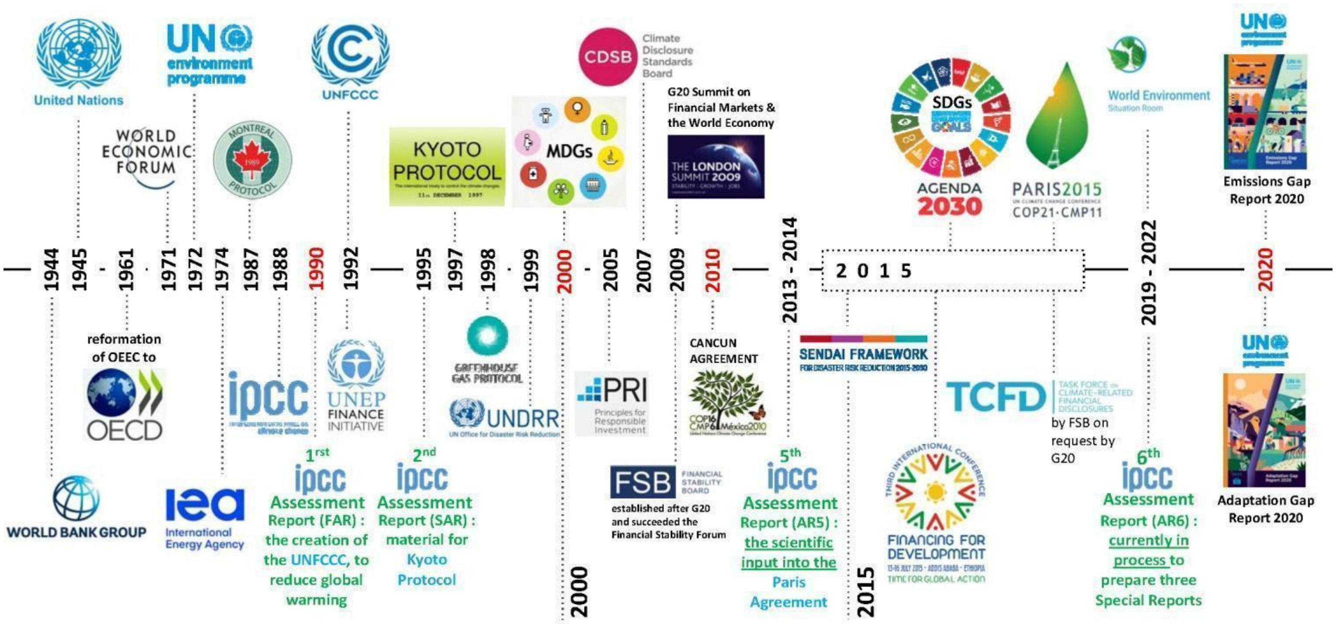


Fig. 2: A timeline documenting selected milestones and international institutions, panels, reports, and more involved in the development of Kyoto Protocol (1997) and Paris Agreement (2015).

Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC) and the Conference of Parties (COP)

A milestone in climate change was the creation, in 1988, of the Intergovernmental Panel on Climate Change (IPCC), an independent body funded by World Meteorological (WMO) and the United Nations Environmental Programme (UNEP). IPCC's objective is to provide governments at all levels with scientific information that they can use to develop climate policies[3] and to provide policymakers with regular scientific assessments on climate change, its implications, and potential future risks, as well as to put forward adaptation and mitigation options.[4] Since 1990 IPCC has published five Assessment Reports, each one of which has paved the way for significant steps towards global warming reduction.

More specifically, the scientific evidence brought up by the first IPCC Assessment Report (FAR, 1990) underlined the importance of climate change as a challenge requiring international cooperation to tackle its consequences. It therefore played a decisive role in leading to another significant milestone in climate change, the creation of the United Nations Framework Convention on Climate Change (UNFCCC), the key international treaty to reduce

---

[3] About the Intergovernmental Panel on Climate Change IPCC, https://www.ipcc.ch/about/

[4] The IPCC does not conduct its own research. Through its assessments, the IPCC determines the state of knowledge on climate change. It identifies where there is agreement in the scientific community on topics related to climate change, and where further research is needed. The reports are drafted and reviewed in several stages, thus guaranteeing objectivity and transparency. https://www.ipcc.ch/

global warming and cope with the consequences of climate change.[5] In the aftermath of UNFCCC creation the cooperation with IPCC has been strengthened with the latter providing information on scientific and technical matters requested from the Convention and particularity from the supreme decision-making body of the Convention, the Conference of Parties, known as COP[6]. The first COP (COP1) meeting was held in 1995, while the latest COP25 in 2019 and by the end of 2021 the COP26 (that was postponed due to Covid-19 outbreak) is expected to discuss matters related to Paris Agreement progress and targets and the impacts of the pandemic crisis[7].

The IPCC 1995 Second Assessment Report (SAR) stimulated many governments into intensifying negotiations on what was to become the Kyoto Protocol. The United Nations Framework Convention on Climate Change and the Kyoto Protocol which was adopted in 1997, marked the importance to limit or reduce greenhouse gas emissions, set binding targets for developed countries and established innovative mechanisms to assist these Parties in meeting their emissions commitments.[8]

The IPCC Third Assessment Report (TAR), released in 2001, confirmed the findings of the Second Assessment Report, providing new and stronger evidence of a warming world. More specifically, TAR provided conclusions about mitigation options that take into account factors such as the Kyoto Protocol and its findings have reinforced adaptation as a critical issue, underscoring the need for adaptation strategies at national and local levels to complement mitigation efforts[9]. The IPCC Fourth Assessment Report (AR4), released in 2007, laid the ground work for a post-Kyoto agreement, focusing on limiting warming to 2°C [10]. The Fifth Assessment Report (AR5), finalized in October 2014, informs the negotiations and policy formulation towards the Paris Agreement,[11] a legally binding international treaty on climate change that was adopted by 196 Parties at COP21 in Paris in 2015. It is considered a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects[12].

---

5 History, The Intergovernmental Panel on Climate Change (IPCC), https://archive.ipcc.ch/organization/organization_history.shtml

6 All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements. A key task for the COP is to review the national communications and emission inventories submitted by Parties. The COP meets every year, unless the Parties decide otherwise. https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop

7 Patricia Espinosa Outlines the Four Keys to Success at COP26, https://unfccc.int/news/patricia-espinosa-outlines-the-four-keys-to-success-at-cop26

8 Kyoto Protocol Reference Manual – On accounting of emissions and assigned amount, UNFCCC, Foreword, p.4 https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

9 Third Assessment Report of the International Panel on Climate Change (IPCC), Submissions from Parties, UNFCCC, 2002, https://unfccc.int/resource/docs/2002/sbsta/misc05.pdf

10 The Reports, History of the IPCC, https://www.ipcc.ch/about/history/

11 Background - Cooperation with the IPCC, United Nation Climate Change, https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/background-cooperation-with-the-ipcc

12 The Paris Agreement, United Nations Climate Change, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

It is essential to understand that the IPCC does not carry out original research, nor does it monitor climate or related phenomena itself. Rather, it assesses published literature, including peer-reviewed and non-peer-reviewed sources.[13] In this context for the preparation of the Assessment Reports the IPCC has structured the work among three Working Groups, a Task Force and a Task Group. While the role of Task Force is focused on overseeing the IPCC National Greenhouse Gas Inventories Program (IPCC-NGGIP), each Working Group role is[14]:

1. The IPCC Working Group I (WGI) aims at assessing the physical scientific basis of the climate system and examines the physical science underpinning past, present, and future climate change.
2. Working Group II assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change and options for adapting to it.
3. WG III, Mitigation of Climate Change focuses on climate change mitigation, assessing methods for reducing greenhouse gas emissions, and removing greenhouse gases from the atmosphere. Climate change mitigation involves actions that reduce the rate of climate change and impacts.

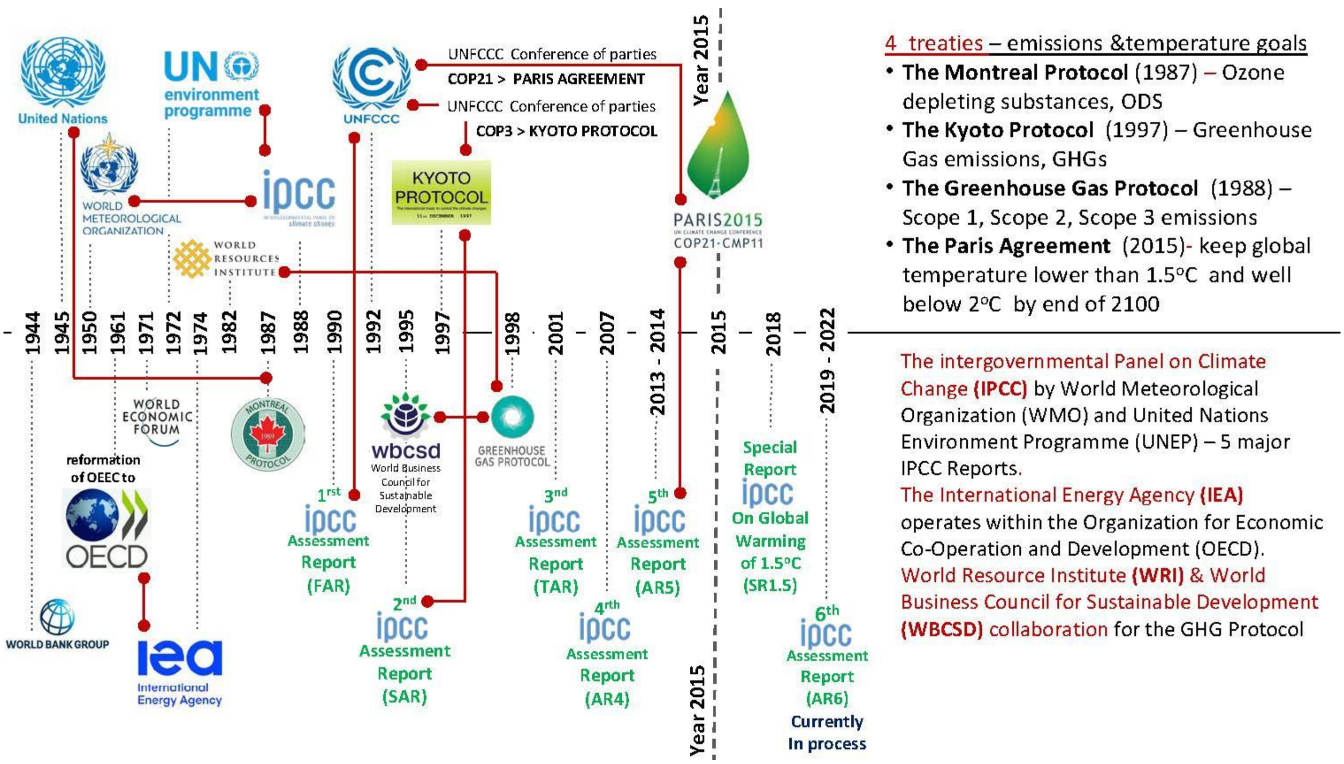


Fig. 3: A timeline documenting 4 major treaties and their relation to the main organizations (e.g. IPCC and its Assessments Reports)

Climate Change Impacts

13 Intergovernmental Panel on Climate Change, https://en.wikipedia.org/wiki/Intergovernmental_Panel_on_Climate_Change#cite_note-Appendix_A_to_the_Principles_Governing_IPCC_Work-9

14 Working Groups, https://www.ipcc.ch/working-groups/

As described in Envision® Version 3 'Climate change is a serious threat to global development and security for current and future generations. Increased temperatures are increasing glacier loss and rising sea levels. Many low-lying coastal areas are directly at risk, with others facing devastating erosion. Inland areas dependent on snowmelt for freshwater have seen consistent decreases in water availability, and many mountains around the world, once perpetually snowcapped, are now seasonal. Entire permafrost ecosystems collapse as they shift into freeze-and-thaw cycles. Ocean temperatures influence the entire global weather system, and as temperature rises, the frequency, intensity, and pattern of storm systems change and become more unpredictable. The extent of climate change impacts is far-reaching and not entirely understood. Many impacts exacerbate each other; for example, increased storm intensity and rising sea levels compound to make storm surges even more devastating to coastal communities'[15].

The "Climate change 2014: Impacts, Adaptation, and Vulnerability"[16] report, part of IPCC's AR5, underlines that 'with the impacts that have already occurred and with the risks of future impacts, especially the way those risks change with the amount of climate change that occurs, the investments in adaptation to climate changes cannot be avoided. Human influence on the climate system is clear and the warming of the climate system is unequivocal since the 1950s'.

1.1. Main objectives and goals until 2015

A. Emissions

Two significant agreements set the ground for what is known now as Greenhouse Gas Emissions, the need for their mitigation, emissions reduction commitments, emission trading, carbon accounting and pricing.

1.1.1. The Montreal Protocol

Prior to the United Nations Framework Convention on Climate Change (UNFCCC) first Conference of Parties (COP1) proposal in 1995 for the need of a protocol to the Convention on greenhouse gas emissions reduction[17], a landmark multilateral environmental agreement that regulates the production and consumption of nearly 100 man-made chemicals referred to as ozone depleting substances (ODS), was initiated with the Montreal Protocol. When released to the atmosphere, those chemicals damage the stratospheric ozone layer, Earth's protective shield that protects humans and the environment from harmful levels of ultraviolet radiation from the sun. Adopted on 15 September 1987, the Protocol is to date the only UN treaty ever that has been ratified by every country on Earth - all 198 UN Member States.[18] Even more encouraging regarding the effectiveness of

---

15 CR 2.2 Assess Climate Change Vulnerability, Description, Envision V3, p.170

16 Climate Change 2014: Impacts, Adaptation, and Vulnerability is the second volume of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) — Climate Change 2013/20142014— and was prepared by its Working Group II. The volume focuses on why climate change matters and is organized into two parts, devoted respectively to human and natural systems and regional aspects, incorporating results from the reports of Working Groups I and III. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf

17 'Report of the conference of the parties on its first session, held at Berlin (28 March-7 April 1995) https://unfccc.int/cop4/resource/docs/cop1/07.htm

18 The Montreal Protocol, https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

the protocol is that today the parties to the Protocol have phased out 98 per cent of their ozone-depleting substances.[19] The substances controlled by the treaty are[20]:

1. Chlorofluorocarbons CFCs[21], halons (a group of organohalogen compounds containing bromine and fluorine and one or two carbons)
2. Fully halogenated CFCs, carbon tetrachloride, methyl chloroform),
3. Hydrochlorofluorocarbons HCFCs
4. Methyl bromide CH_3Br
5. Hydrofluorocarbons HFCs.

Regarding HFCs it is important to highlight that in the aftermath the Montreal Protocol entered into force (1989), where it was decided by many states[22] to phase out the CFC's, the use of HFCs developed as a replacement. HFC also destroys the ozone layer, although its effect is 20 times less than that of the CFC. In 2006, the CFC was banned worldwide, while very recently it was discovered that HFC is a dangerous greenhouse gas, with a global warming potential much greater than that of carbon dioxide.

A further step or an evolution of Montreal Protocol, was the Kigali Amendment[23] which in 2016 declared the phase-down of hydrofluorocarbons (HFCs) by cutting their production and consumption. The amendment entered into force on 1 January 2019 with the goal to achieve over 80% reduction in HFC consumption by 2047. The impact of the amendment will avoid up to 0.5 °C increase in global temperature by the end of the century. More specifically, if fully supported by governments, the private sector and citizens, the amendment will substantially contribute to the goals of the Paris Agreement[24].

1.1.2. The Kyoto Protocol

The Kyoto Protocol is the international agreement, which was adopted in 1997 and entered into force as an international law in 2005. 192 Parties/Nations committed to reduce their greenhouse gas emissions by an

[19] Meaning, an estimated number of two million people have been saved from skin cancer every year. 'Thirty years on, what is the Montreal Protocol doing to protect the ozone?', UNEP 2019, https://www.unep.org/news-and-stories/story/thirty-years-what-montreal-protocol-doing-protect-ozone

[20] The Montreal Protocol, https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

[21] CFCs are gases used in refrigerators, air conditioners and atomizer thrusters, 'Short history of the Montreal Protocol and holes in the ozone layer', https://sgkplanet.com/en/short-history-of-the-montreal-protocol-and-holes-in-the-ozone-layer/

[22] The twelve countries of the European Community banned the use of CFC, 'Short history of the Montreal Protocol and holes in the ozone layer', https://sgkplanet.com/en/short-history-of-the-montreal-protocol-and-holes-in-the-ozone-layer/

[23] The Montreal Protocol evolves to fight climate change, United Nations Industrial Development Organization (UNIDO) https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/montreal-protocol-evolves-fight-climate-change

[24] 'Kigali Amendment implementation begins', UNEP-Ozone Secretariat, 3 January 2019, https://ozone.unep.org/kigali-amendment-implementation-begins

average of 5.2% over the five years 2008–2012[25], which would represent about 29% of the world's total emissions.[26]

The Kyoto protocol, an extension or product of the United Nations Framework Convention on Climate Change (UNFCCC)[27], set binding emission reduction targets for 37 industrialized countries, for economies in transition and for the European Union to **limit and reduce greenhouse gases (GHG) emissions following an agreement of individual targets.**[28] The first time a treaty asks developed countries **to adopt policies and measures on mitigation** and report periodically, underlying this way the historical responsibility of rich countries for emitting greenhouse gases. The Kyoto Protocol made concrete how big emitters should take the lead in slowing climate change.[29]

An important consideration in the Kyoto Protocol was that targets to limit or reduce greenhouse gas emissions were binding for the developed countries, known as the "Annex I Parties"[30], separating thus the developed (the 37 industrialized nations plus the EU) from the developing nations. The emission limits were applied to the first group, while the developing countries were asked to comply voluntarily. However, more than 100 developing countries, including China and India, were exempted from the treaty.[31]

GHG emissions

The core commitment under the Kyoto Protocol[32], requires each Annex I Party to ensure that its total emissions from GHG sources listed in Annex A (as presented in the figure below) to the Kyoto Protocol over the commitment period do not exceed its allowable level of emissions. In figure 3[33], the Table 1 presents the six Greenhouse gases and Table 2 demonstrates the GHG emissions from sources, sectors such as the energy, industrial processes, solvent and other product use, agriculture and waste sectors as described in the Annex A of the Protocol.

However for each of the developed countries (Annex I Party) the allowable level of emissions is different. In the Protocol this level is called the Party's assigned amount and each country/Party has a specific emissions target[34] which is set relative to its emissions of GHGs in its base year. The quantity of the initial assigned amount is

---

25 2008-2012 was the first commitment period addressed in Kyoto agreement, Article 3, Paragraph1, Kyoto Protocol, United Nations Framework Convention on Climate Change, https://unfccc.int/kyoto_protocol

26 Countries that ratified the Kyoto Protocol were assigned maximum carbon emission levels for specific periods and participated in carbon credit trading. If a country emitted more than its assigned limit, then it would receive a lower emissions limit in the following period, https://earth.org/the-kyoto-protocol/

27 The UNFCCC is also the parent treaty of the 1997 Kyoto Protocol, https://unfccc.int/about-us/about-the-secretariat

28 https://unfccc.int/kyoto_protocol

29 https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473

30 Kyoto Protocol Reference Manual – On accounting of emissions and assigned amount, UNFCCC, Foreword, p.4 https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

31 https://earth.org/the-kyoto-protocol/

32 Article 3, paragraph 1, Kyoto Protocol, United Nations Framework Convention on Climate Change, https://unfccc.int/resource/docs/convkp/kpeng.html

33 Appendices, I. Annex A Emissions and resources, Kyoto Protocol Reference Manual – On accounting of emissions and assigned amount, UNFCCC, Foreword, p.106 https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf https://unfccc.int/resource/docs/convkp/kpeng.html

34 Inscribed in Annex B to the Kyoto Protocol, https://unfccc.int/resource/docs/convkp/kpeng.html

denominated in individual units, called assigned amount units (AAUs), each of which represents an allowance to emit one metric tonne of carbon dioxide equivalent (tCO2 eq).[35]

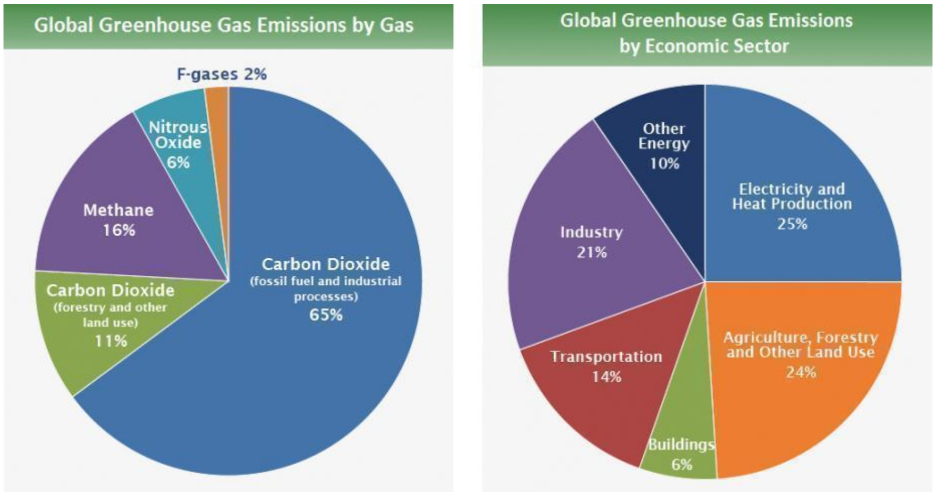


Fig.4: Percentages of GHG emissions by Gas and By Economic sector, based on global emissions from 2010[36]

---

[35] 21 Emission targets and initial assigned amount, Kyoto Protocol Reference Manual – On accounting of emissions and assigned amount, UNFCCC, p.13 https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

[36] Images Source: IPCC (2014), Details about the sources included in these estimates can be found in the Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Global Greenhouse Gas Emissions Data, United Stated Environmental Protection Agency (EPA), https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

I. ANNEX A EMISSIONS AND SOURCES

Table 1 Greenhouse gases

Carbon dioxide	CO_2
Methane	CH_4
Nitrous oxide	N_2O
Hydrofluorocarbons	HFCs
Perfluorocarbons	PFCs
Sulphur hexafluoride	SF_6

Table 2 Sectors/source categories

Energy	Fuel combustion • Energy industires • Manufacturing industries and construction • Transport • Other sectors • Other
	Fugitive emissions from fuels • Solid fuels • Oil and natural gas • Other
Industrial processes	Mineral products
	Chemical industry
	Metal production
	Other production
	Production of halocarbons and sulphur hexafluoride
	Consumption of halocarbons and sulphur hexafluoride
	Other
Solvent and other product use	
Agriculture	Enteric fermentation
	Manure management
	Rice cultivation
	Agricultural soils
	Prescribed burning of savannas
	Field burning of agricultural residues
	Other
Waste	Solid waste disposal on land
	Wastewater handling
	Waste incineration
	Other

Fig. 5: Emissions and resources based on Annex A of Kyoto Protocol[37]

The Kyoto mechanisms

By recognizing these two groups of countries, the Kyoto Protocol introduced **flexible market mechanisms based on the trade of emissions permits**[38]**,** which offered to the countries – which their priority is to meet their

[37] Appendices, I. Annex A Emissions and resources, Kyoto Protocol Reference Manual – On accounting of emissions and assigned amount, UNFCCC, Foreword, p.106 https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

[38] These mechanisms ideally encourage GHG abatement to start where it is most cost-effective, for example, in the developing world, https://unfccc.int/kyoto_protocol

targets primarily through national measures - an additional means to meet their targets. The Kyoto mechanisms' role is, firstly to stimulate sustainable development through technology transfer and investment, secondly, to help countries with Kyoto commitments to meet their targets by reducing emissions or removing carbon from the atmosphere in other countries in a cost-effective way and finally to encourage the private sector and developing countries to contribute to emission reduction efforts.[39] The three market-based mechanisms are:

(a) International Emissions Trading (IET),
(b) Clean Development Mechanism (CDM) and
(c) Joint Implementation (JI).

Clean Development Mechanism (CDM) and Joint Implementation (JI) are the two project-based mechanisms which feed the carbon market[40]. The CDM refers to the developing countries and involves investment in emission reduction or removal enhancement projects that contribute to their sustainable development, while JI refers to the developed countries enabling them to carry out emission reduction or removal enhancement projects in other developed countries.[41]

On the other hand, International Emissions Trading[42] allows for countries that have emission units to spare - emissions permitted them but not "used" - to sell this excess capacity to countries that are over their targets. By investing in projects with lower emissions, a country earns credits that could be exchanged, traded, or sold to a country with high carbon emissions. This meant countries that did not meet reduction targets could "buy" the right to extra emissions from the budgets of less-polluting countries. Although a criticism over this mechanism is that trading carbon at the end allows for the developed countries to continue emitting GHGs, it is the first time CO_2 had been given a price.[43]

Trading units

The **trading units** in Kyoto Protocol are an important component of the "carbon-pricing" mechanism and carbon market. The targets for limiting or reducing emissions are expressed as levels of allowed emissions[44], or assigned amounts. The allowed emissions are divided into Assigned Amount Units (AAUs). Other trading units in the carbon market that can be traded and sold under the Kyoto Protocols emissions trading scheme[45], equal to one tonne of CO_2, as mentioned earlier, and may be in the form of:

39 Mechanisms under the Kyoto Protocol, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms

40 Thus, a new commodity was created in the form of emission reductions or removals. Carbon is now tracked and traded like any other commodity. This is known as the "carbon market.", 'Greenhouse gas emissions a new commodity', Emissions Trading, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

41 Mechanisms under the Kyoto Protocol, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms

42 Emissions Trading, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

43 https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473

44 The allowed emissions in Kyoto Protocol refer to the 2008-2012 commitment period, Emissions Trading, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

45 Emissions trading schemes may be established as climate policy instruments at the national level and the regional level. Under such schemes, governments set emissions obligations to be reached by the participating entities. The

- a Removal Unit (RMU) on the basis of land use, land-use change and forestry (LULUCF) activities such as reforestation
- an Emission Reduction Unit (ERU) generated by a joint implementation (JI) project
- a Certified Emission Reduction (CER) generated from a clean development mechanism (CDM) project activity

The International Emissions Trading IET can be implemented through the monitoring emission targets/trading units system and transfers and acquisitions are tracked and recorded through the registry systems under the Kyoto Protocol. An international transaction log ensures secure transfer of emission reduction units between countries.[46] This ensured transparency and hold Parties to account. Under the Protocol, countries' actual emissions have to be monitored, and precise records have to be kept of the trades carried out.[47]

An example of well-known Emissions Trading System (ETS) that was set up within the European regional boundaries and is considered the world's first international emissions trading system is the EU ETS[48] that was established in 2005. As stated the EU ETS is 'a cornerstone of the EU's policy to combat climate change and its key tool for reducing greenhouse gas emissions cost-effectively'. With respect to Annex A, Kyoto's Protocol, Greenhouse gases and GHG emissions from sources and sectors, the EU ETS covers the following sectors and gases, focusing on emissions that can be measured, reported and verified with a high level of accuracy:

- carbon dioxide (CO_2) from (i) electricity and heat generation, (ii) energy-intensive industry sectors including oil refineries, steel works, and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals, and (iii) commercial aviation within the European Economic Area
- nitrous oxide (N_2O) from production of nitric, adipic and glyoxylic acids and glyoxal;
- perfluorocarbons (PFCs) from production of aluminium.

Adaptation Fund

Although Kyoto Protocol is mostly known for its mitigation goals, another element introduced by the protocol is related to increasing resilience with the establishment of an Adaptation Fund, as part of recognizing the inevitable impacts of climate change. The role of the Adaptation Fund is through the financing of projects and programs to help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views, and priorities. Under the Clean Development Mechanism (CDM), emission-reduction projects in developing countries can earn certified emission reduction (CER) credits. These credits can be traded

European Union emissions trading scheme is the largest in operation."Emissions Trading, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

46 Emissions Trading, UNFCCC, https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

47 https://unfccc.int/kyoto_protocol

48 EU Emissions Trading System (EU ETS), https://ec.europa.eu/clima/policies/ets_en

and sold by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. Financing for the Adaptation Fund comes mainly from sales of certified emission reductions.[49]

The Doha Amendment[50] to the Kyoto Protocol focused on the extension of the first 5 years period (2008-2012) and the parties' commitments review; therefore a second commitment period 2013 until 2020 was proposed. Nevertheless despite the new commitments for the parties to follow during that new period and the revising of the list of GHG emissions, the results, and targets were not reached. Key factors to missing the targets and commitments were the withdrawal of the U.S. formally in 2001[51] and Canada in 2011. Without the two largest carbon dioxide emitters — the U.S. and China — in the treaty, any progress made by the remaining countries, was considered by many, as less significant on a global scale.[52]

B. Greenhouse Gas Inventories and Greenhouse Gas Accounting

Further to the list of GHG emissions that should not exceed the allowable levels, to the commitment period and to the trading units, another element that provides eligibility for each Annex I Party to participate to the Kyoto Mechanism Kyoto is to maintain a national system for the estimation of GHG emissions and removals. A national system refers to the institutional, legal and procedural arrangements necessary for the planning, preparation, reporting and archiving of inventory information[53]. The national systems or national emission inventories are also essential in developing policies and in monitoring the impact of those policies, providing invaluable information related to climate change and air pollution"[54].

The information registered in the inventory is the outcome of a process that measures how much GHG is emitted by an organization or a corporation and is called Greenhouse gas accounting or Carbon accounting. More specifically, the GHG accounting quantifies the total amount of GHG emissions produced and describes the way to inventory and audit GHG emissions. Understanding a country's, organization's or a corporate's carbon footprint is the basis for managing climate change impacts, that is why GHG accounting is considered an important business tool. On a national level, the Intergovernmental Panel on Climate Change (IPCC) supports nations and gives guidance for the development of National Greenhouse Gas Inventories. On the other hand on a corporate and organizations level, GHG accounting and emission reduction projects is provided by the World

49 Adaptation Fund-Helping developing countries build resilience and adapt to climate change, Governance & Resources https://www.adaptation-fund.org/about/

50 Doha Amendment was held in 2012, https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment

51 "When the US — responsible for a large part of historic CO2 emissions — withdrew from the agreement in 2001, and Canada in 2011, many observers thought the Kyoto Protocol had failed. But by 2012, the emissions of the industrialized countries had dropped 20% from 1990 levels — five times the Kyoto targets of the remaining nations. The EU cut emissions by 19%, and Germany by 23%. Over the same period, however, global emissions rose by around 38%", https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473

52 Andrew Wong, "Even without the US, the Paris climate agreement can succeed where its predecessor failed", Published in 2018, https://www.cnbc.com/2018/02/11/unlike-the-kyoto-protocol-the-paris-agreement-can-still-succeed.html

53 Kyoto Protocol Reference Manual, On accounting of Emissions and assigned account, UNFCCC, 2008, https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

54 2006 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC, IGES, October 2007, https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) and their Greenhouse gas Protocol framework[55]. Accounting supports consistent tracking either of countries' or corporate and organization's progress towards the target they set, which actually helps to check if they are on track, and if any changes are needed.

Finally the GHG accounting methods are distinguished into two main categories[56]:

- the Production-based/territorial CO_2 emissions and
- Demand-based /Consumption CO_2 emissions

Reliable carbon emissions statistics are essential for formulating responses to climate change and to inform global negotiations such as those concluded in Kyoto in 1997 or recently in Paris at COP21. Typically, emissions statistics are compiled according to production-based or territorial emission accounting methods: measuring emissions occurring within sovereign borders. However, these estimates do not reflect production chains which extend across borders. Emissions associated with the production of a given good and or service may arise in many countries.

1.1.3. National GHG Inventories

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories summarizes the basic approach for inventory development, and provides guidance on their use. The 2006 Guidelines provide methodologies for making estimates of national anthropogenic emissions and removals of specified gases[57] from all categories and sectors from a given area during a specified time frame.

National inventories include in general GHG emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction. They contain estimates for the calendar year during which the emissions to (or removals from) the atmosphere occur.[58] Greenhouse gas emission and removal estimates are divided into main sectors, which are groupings of related processes, sources and sinks: Energy; Industrial Processes, Solvents and Other product use; Agriculture, Land use, Land-use change and Forestry and Waste[59]. The quality of emission inventory relies on the integrity of the methodologies used, the completeness of reporting, and the procedures for compilation of data[60], meaning a combination of guidance per sector and a

---

55 GHG Protocol arose when WRI and WBCSD recognized the need for an international standard for corporate GHG accounting and reporting in the late 1990s. https://ghgprotocol.org/about-us

56 'OECD CO_2 emissions embodied in consumption' https://www.oecd.org/sti/ind/EmbodiedCO2_Flyer.pdf

57 As specified gases are considered the anthropogenic emissions and removals of greenhouse gases which are not controlled by the Montreal Protocol: CO_2, methane (CH_4), nitrousoxide (N_2O), HFCs, PFCs and SF_6. 2006 IPCC Guidelines for national greenhouse gas inventories, IPCC – IGES, 2008 https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

58 Using the 2006 guidelines, 2006 IPCC Guidelines for national greenhouse gas inventories, IPCC – IGES, 2008 https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

59 Kyoto Protocol Reference manual on accounting of emissions and assigned amount, UNFCCC, November 2008, https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

60 Methodological issues relating to fluorinated gases , UNFCCC, https://unfccc.int/process-and-meetings/transparency-and-reporting/methods-for-climate-change-transparency/methodological-issues-relating-to-fluorinated-gases

more general guidance and steps that should be followed during the reporting process, as illustrated in the following graph.

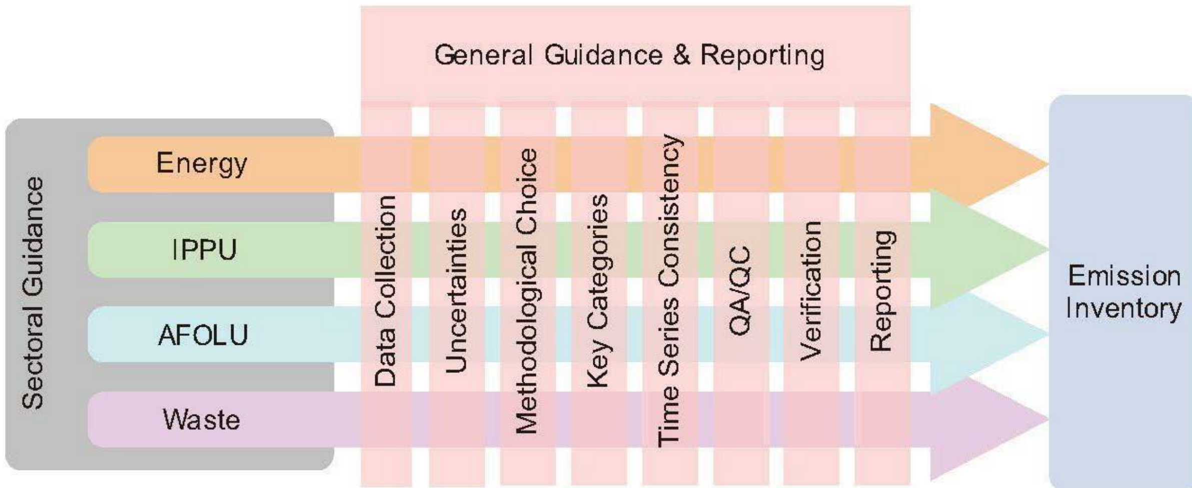


Fig.6: Relationship between general and sectoral guidance[61]

The recent "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories"[62], aligned with the Paris Agreement on issues regarding the improvement plan on transparency, requests from countries to regularly and transparently report how they add or subtract various emissions estimates to come up with a national total. Other points of the refinement include:

- New guidance which provides suggestions for integrating GHG emissions reported from private facilities into national GHG inventories, as companies already have started providing data and reducing their carbon footprints.
- Improvement of the quality of measurements, reporting and verification (MRV) in the various sectors of the economy and in several areas. This includes measuring fugitive emissions from oil and natural gas systems; countries' ability to measure efforts to comply with the Montreal Protocol to reduce ozone pollution; and estimation of carbon emissions and removals from the agricultural, land use and forestry sector.
- Clear mitigation targets that can be understood in comparable terms, following transparent methodologies and calculations, therefore countries have to disclose on which methodologies they use and how they account for traded emissions.

---

61 Image source: 2006 IPCC Guidelines for national greenhouse gas inventories, IPCC – IGES, 2008, https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

62 'INSIDER: The IPCC Updated its Emissions Guidance for the First Time in 13 Years. Here's Why That Matters', By Yamide Dagnet, May 17, 2019 World Resources Institute (WRI), https://www.wri.org/insights/insider-ipcc-updated-its-emissions-guidance-first-time-13-years-heres-why-matters

1.1.4. The Greenhouse Gas Protocol

Similar to the IPCC National GHG Inventories, the Corporate GHG inventories quantify the amount of GHGs a company emits into the atmosphere and are critical management tools for companies of all sizes and sectors [63]. The companies can start developing a GHG inventory, by firstly choosing a methodology that follows accounting standards. The GHG Protocol Corporate Standard comes with WRI and WBCSD recognition that there is a need for an international standard for corporate GHG accounting and reporting in the late 1990s, however the first edition of the Corporate Standard, published in 2001[64].

In its first revised version in 2004 it is clarified that: 'This standard is written primarily from the perspective of a business developing a GHG inventory, however, it applies equally to other types of organizations with operations that give rise to GHG emissions. The GHG Protocol Corporate Standard has been designed to be program or policy neutral, nevertheless many existing GHG programs use it for their own accounting and reporting requirements and it is compatible with most of them[65]. The GHG Protocol Corporate Standard focuses only on the accounting and reporting of emissions. It does not require emissions information to be reported to WRI or WBCSD'.

The most innovative about the Greenhouse Gas Protocol is that it has classified emissions into the following categories, scopes[66]:

- Scope 1 emissions must be accounted for and reported from all companies. Scope 1 emissions are considered the direct emissions from sources that the company owns or controls.
- Scope 2 emissions are the indirect GHG emission from the generation of purchased energy (electricity, steam, or heat) consumed by the facilities or equipment that the company owns or controls. The GHG Corporate Standard requires that companies account for and report all scope 2 emissions.
- Scope 3 emissions. It is optional whether and how to account for scope 3 emissions. They are considered indirect GHG emissions from other sources the company does not own or control. This may include waste disposal, leased/outsourced activities, or emissions such as those related to business travel and employee commuting and occur in a company's value chain. Scope 3 emissions can represent the largest source of emissions for companies and present the most significant opportunities to influence GHG reductions and achieve a variety of GHG-related business objectives.

63 Bottom Line on Corporate GHG Inventories, Author Eliot Metzger, March 6, 2008, https://www.wri.org/research/bottom-line-corporate-ghg-inventories

64 What is GHG Protocol?, Greenhouse Gas Protocol, https://ghgprotocol.org/about-us

65 'Some of them are: Voluntary GHG reduction programs like WWF, U.S. Environmental Protection Agency (EPA) etc., GHG registries like World Economic Forum Global GHG Registry, GHG trading programs like European Union Greenhouse Gas Emissions Allowance Trading Scheme (EU ETS) etc.', Relationship to other GHG programs, The Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard - Revised edition, World Resources Institute and World Business Council for Sustainable Development, March 2004, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

66 Chapter 1.3 Relationship to the GHG Protocol Corporate Standard, Corporate Value Chain (Scope 3) Accounting and Reporting Standard - Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, World Resources Institute and World Business Council for Sustainable Development, September 2011, p.5, https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

As presented in the following figure, among Scope1, 2 and 3, the Scope 3 emissions further divided into upstream and downstream emissions[67]. The distinction is based on the financial transactions of the reporting company.

1. Upstream emissions are indirect GHG emissions related to purchased or acquired goods and services. In the case of goods purchased or sold by the reporting company, upstream emissions occur up to the point of receipt by the reporting company.
2. Downstream emissions are indirect GHG emissions related to sold goods and services. Downstream emissions also include emissions from products that are distributed but not sold (i.e., without receiving payment.) Downstream emissions occur subsequent to their sale by the reporting company and transfer of control from the reporting company to another entity (e.g., a customer)

Emissions from activities under the ownership or control of the reporting company (i.e., direct emissions) are neither upstream nor downstream.

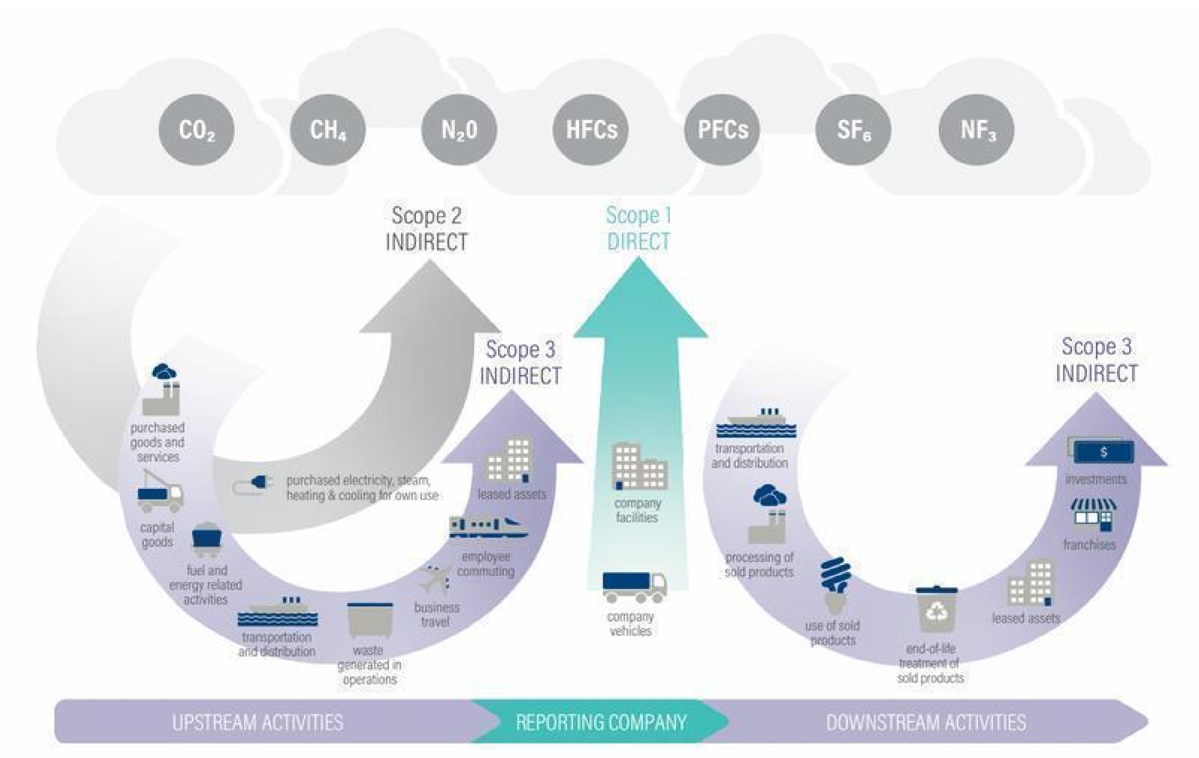


Fig. 7: Overview of GHG Protocol scopes and emissions across the value chain [68]

[67] Chapter 5.3 Upstream and downstream scope 3 emissions, Corporate Value Chain (Scope 3) Accounting and Reporting Standard - Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, WRI and WBCSD, September 2011, p.29, https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

[68] Image source: Greenhouse Gas Protocol, World Resources Institute WRI, https://www.wri.org/initiatives/greenhouse-gas-protocol,

It is important to underline that Scope1, 2 and 3 emissions assist in creating the company's inventory as they enable comparisons of a company's GHG emissions over time. For comparisons between companies based on their scope1, 2 or 3 emissions additional measures are needed. Such 'measures include consistency in methodology and data used to calculate the inventory, and reporting of additional information such as intensity ratios or performance metrics. Additional consistency can be provided through GHG reporting programs or sector-specific guidance'[69].

Finally in the GHG Protocol the methodologies and calculating tools used are the outcome of a range of generic and sector-specific sources and processes. 'Where applicable, these tools are based on and consistent with IPCC methodologies, tailored for use at the corporate level and the tools contain default emission factors from IPCC, International Energy Agency (IEA), U.S. Environmental Protection Agency (EPA) and other relevant sources.[70]

C. Temperature limits

The temperature limits are now well-established with Paris agreement and are known as keeping global warming lower to the 1.5^{0}C or well below 2°C. The rising GHG emissions and their dangerous effects causing the global warming is of the utmost importance for the uncertainty of the magnitude and the precise timing these effects will take place. To start with, the 2^{0}C target was introduced well before the Paris Agreement, which today guides the national or private policies and strategies worldwide. At the same time the uncertainty of the climate change effects and their potentials at a national level has been extensively analyzed since the 1990's with the scientific analysis of various climate models and more precisely with the presentation of various emissions and temperature scenarios, meaning alternative plausible future states under a given set of assumptions and constraints[71]. The evolution of these scenarios is part of this chapter scope and will be presented in relation to the benchmark year 2015.

1.1.5. The Cancun Protocol (The 2^{o}C target)

For the Conference of Parties (COP), the emissions reduction targets, either at national or corporate level, are reviewed, monitored and remain one of the most significant topics since the 1997 COP3 where Kyoto Agreement was ratified. Almost 10 years after, discussion and negotiations on a successor to the Kyoto Protocol, an agreement that would be politically and binding was the primary focus of the conference[72]. Another milestone before the ratification of Paris Agreement was the 2010 COP16 that took place in Cancun,

---

69 Chapter 1.5 Scope of the standard, Corporate Value Chain (Scope 3) Accounting and Reporting Standard - Supplement to the GHG Protocol Corporate Accounting and Reporting Standard, WRI and WBCSD, September 2011, p.29, https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

70 Bottom Line on Corporate GHG Inventories, Author Eliot Metzger, March 6, 2008, https://www.wri.org/research/bottom-line-corporate-ghg-inventories https://www.wri.org/research/bottom-line-corporate-ghg-inventories

71 'Why is a scenario useful?', Technical Supplement:"The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", Task Force on Climate-Related Financial Disclosures, June 2017, p.2 https://www.tcfdhub.org/scenario-analysis/

72 Conference of the Parties 14 (COP 14/CMP 4) that took place on December 2008 in Poznań, Poland, Down To Earth-Climate Change, Conference of the Parties List, https://www.downtoearth.org.in/climate-change/coplist

which concluded significant agreements and commitments among all countries. The ultimate conclusion and goal is that all efforts should be put form nations worldwide to reduce emissions, avoid further warming and keep the global average temperature rise below two degrees Celsius (2°C). In this regard and in order to start implementing the 2°C goal, the Cancun Agreements also included a timely schedule for nations to review the progress they make towards this global temperature goal**,** on the basis of the best scientific knowledge available.[73]

In the timeline of 2°C, shown in the following Figure 6, it is evident that the alarming global warming has risen as an issue in the global discussion well before the Cancun Agreements in 2010. In fact, already in the 1990's Hansen's public statement 'that rising emissions could have a dangerous impact and that human-caused emissions were responsible for the warming' and Stockholm Environment Institute (SEI) report[74], have initiated the discussion on which measures to limit climate change would be more efficient globally and weather the limit should be set at two degrees. 'The European Council of environment ministers, in 1996, became the first political body to lend formal support and declared that "global average temperatures should not exceed 2 degrees above pre-industrial level", however that was not a binding goal to the countries. Nor was it even a year after with the ratification of the first binding agreement to cut emissions, the Kyoto Protocol, as the two degrees goal is not mentioned in the treaty'[75].

Nevertheless, the significance of two degrees agreement commitment, lays in its simplicity. "The power of the 2°C target is that it is pragmatic, simple and straightforward to understand and communicate all important elements when science is brought to policymakers."[76]

---

73 'Intro to Cancun Agreements', UNFCCC, https://unfccc.int/process/conferences/the-big-picture/milestones/the-cancun-agreements.

74 'Two degrees: The history of climate change's speed limit', International Policy, Authors: Carbon Brief Staff, Carbon Brief, 8 December 2014, https://www.carbonbrief.org/two-degrees-the-history-of-climate-changes-speed-limit

75 Woven into the fabric of climate policy, International Policy, Authors: Carbon Brief Staff, Carbon Brief, 8 December 2014, https://www.carbonbrief.org/two-degrees-the-history-of-climate-changes-speed-limit

76 As mentioned from the IPCC's co-chair, Thomas Stocker to the Carbon Brief, 'A simple speed limit', International Policy, Authors: Carbon Brief Staff, Carbon Brief, 8 December 2014, https://www.carbonbrief.org/two-degrees-the-history-of-climate-changes-speed-limit

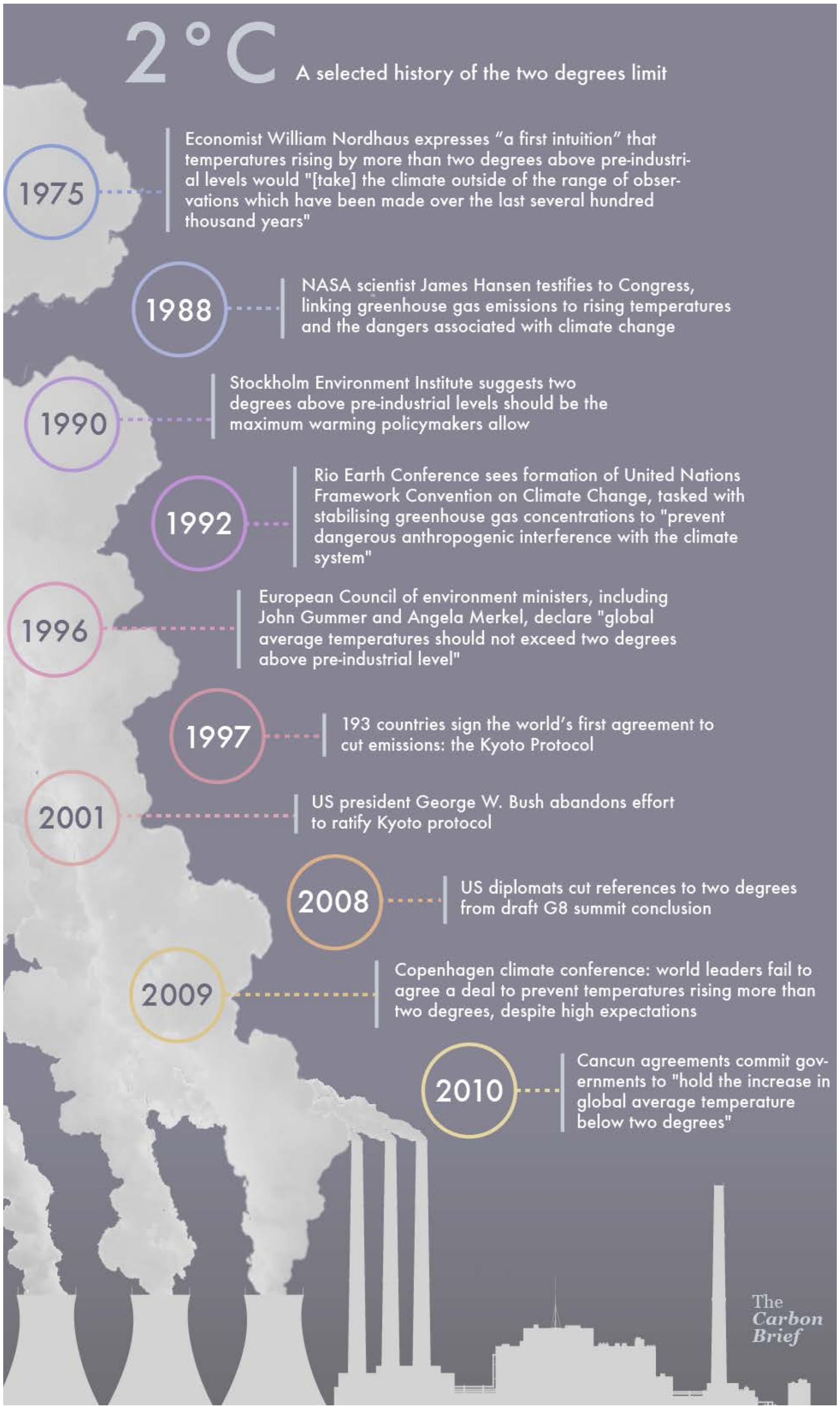

2°C A selected history of the two degrees limit
1975
Economist William Nordhaus expresses "a first intuition" that temperatures rising by more than two degrees above pre-industrial levels would "[take] the climate outside of the range of observations which have been made over the last several hundred thousand years"
1988
NASA scientist James Hansen testifies to Congress, linking greenhouse gas emissions to rising temperatures and the dangers associated with climate change
1990
Stockholm Environment Institute suggests two degrees above pre-industrial levels should be the maximum warming policymakers allow
1992
Rio Earth Conference sees formation of United Nations Framework Convention on Climate Change, tasked with stabilising greenhouse gas concentrations to "prevent dangerous anthropogenic interference with the climate system"
1996
European Council of environment ministers, including John Gummer and Angela Merkel, declare "global average temperatures should not exceed two degrees above pre-industrial level"
1997
193 countries sign the world's first agreement to cut emissions: the Kyoto Protocol
2001
US president George W. Bush abandons effort to ratify Kyoto protocol
2008
US diplomats cut references to two degrees from draft G8 summit conclusion
2009
Copenhagen climate conference: world leaders fail to agree a deal to prevent temperatures rising more than two degrees, despite high expectations
2010
Cancun agreements commit governments to "hold the increase in global average temperature below two degrees"
The Carbon Brief

Fig. 8: Two degrees: A selected history of climate change's speed limit[77]

1.1.6. Scenarios and Pathways

According to the current literature and scientific discourse, 'a scenario describes a path of development leading to a particular outcome'[78]. This means that they do not present a full description of the future, but 'highlight specific elements of a possible future' outcomes and identify which are the key drivers of these potential future developments. Since scenarios are only 'hypothetical constructs', with the aim to shift from the current thinking and explore alternative assumptions beyond the "business-as-usual" practice, they cannot be considered either predictions or forecasts.

To understand climate-related scenarios currently followed, it is significant to highlight specific milestones that lead to the most known scenarios and pathways. As mentioned, each of the IPCC's reports was the compilation of the results produced by the three IPCC's three Working Groups. In 1990, 'The IPCC Scientific Assessment' was the report prepared by Working Group I (WGI), a strongly supported statement on climate change that has ever been made by the international scientific community. The issues introduced included (i) global warming, (ii) GHGs, (iii) the greenhouse effect, (iv) sea level changes, (v) forcing of climate and (vi) the history of Earth's changing climate'[79]. The second Working Group II (WGII) published the 'The IPCC Impacts Assessment' focusing on the impacts of climate change'[80]. Finally the Working Group III (WGIII) delivered the Response Strategies Working Group (RSWG), which analyzed issues 'addressed in each subgroup or topic area'[81].

a. Emissions Scenarios (science and policy scenarios) - IS92 scenarios (1990)[82]

The first category of emission scenarios was generated by IPCC WGIII and represented a <u>broad range of possible controls and policies to limit the emissions of greenhouse gases</u>, **hence these scenarios are known as policy scenarios**. The second category of scenarios was prepared by WGI to illustrate <u>the way in which the atmosphere and climate would respond to changes in emissions</u> and are considered as **science scenarios**.

Science Scenarios

77 Image source: Rosamund Pearce for Carbon Brief. https://www.carbonbrief.org/two-degrees-the-history-of-climate-changes-speed-limit

78 'What is a Scenario?', Technical Supplement:"The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", Task Force on Climate-Related Financial Disclosures, June 2017, p.2 https://www.tcfdhub.org/scenario-analysis/

79 'Climate change - The IPCC Scientific Assessment', p.ii https://www.ipcc.ch/report/ar1/wg1/

80 Covering topics regarding 'agriculture and forestry, natural terrestrial ecosystems, hydrology and water resources, human settlement and socioeconomic activities, oceans and coastal zones and the cryosphere' . 'Climate Change - The IPCC Impacts Assessment', The final Report of Working Group II of the Intergovernmental Panel on Climate Change, sponsored jointly by the World Meteorological Organization and the United Nations Environment Programme, IPCC, October 1990, p.i https://www.ipcc.ch/report/ar1/wg2/

81 Note to the Reader, 'Climate Change - The IPCC Response Strategies', The final Report of Working Group III of the Intergovernmental Panel on Climate Change, sponsored jointly by the World Meteorological Organization and the United Nations Environment Programme, IPCC, June 1990, p.vii https://www.ipcc.ch/report/ar1/wg3/

82 For a more detailed description of scenarios see 'Appendix B'

This category of the four emissions scenarios relates each one of them with the type of emissions that are expected to be controlled and with an estimation of the impact to the temperature levels over the next decades. The WGI scenarios cover the emissions of carbon dioxide (CO_2) methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), carbon monoxide (CO) and nitrogen oxides (NO_x) from the present (1990) up to the year 2100[83] and are defined as:

1. S1 **or Scenario A (or Business-as-Usual Scenario**). **The assumption is that the energy supply is coal intensive**
2. S2 **or Scenario B.** In this case, **the energy supply mix shifts towards lower carbon fuels**, notably natural gas
3. S3 **or Scenario C** goes a step further suggesting **a shift towards renewables and nuclear energy** which takes place in the second half of next century (meaning in 2050)
4. S4 **or Scenario D**. In these scenarios the key factors are the shift to renewables and nuclear energy in the first half of 2050, which reduces the emissions of CO_2, initially, stabilizing emissions in the industrialized countries

Policy Scenarios[84]

In the WGIII report in 1990 it is stated that: 'the longer emissions continue at present-day rates, the greater reductions would have to be for concentrations to stabilize at a given level. The long-lived gases would require immediate reductions in emissions from human activities of over 60 percent to stabilize their concentrations at today's levels'[85].

The key factors[86] expected to influence future changes in emissions of GHGs, included: (i) population growth, (ii) economic growth, (iii) the costs of technology used to convert energy from one form to another, (iv)end-use efficiency, (v) deforestation rates, (vi) CFC emissions, and (vii) agricultural emissions. Each of the following scenarios[87] presents different ways 'future emissions of GHG[88] might evolve over the next century highlights the types of changes needed to stabilize emissions'. They are categorized as follows:

---

83 Growth of the economy and population estimations was taken common for all scenarios 'Emissions scenarios from Working group III of IPCC', Climate Change - The IPCC Scientific Assessment, Annex p.xxxiv, https://www.ipcc.ch/report/ar1/wg2/

84 The two categories of scenarios, the 'policy scenarios' and the 'science scenarios' are defined in chapter "Climatic consequences of emissions", Climate Change - The IPCC Scientific Assessment report, ANNEX p.331 https://www.ipcc.ch/report/ar1/wg1/

85 Policymakers Summary 'Climate Change - The IPCC Response Strategies' report Working Group, IPCC, 1990, p.xxv https://www.ipcc.ch/report/ar1/wg3/

86 Chapter 2.3.2 'Demographic, economic and Technological change', FAR Climate Change: The IPCC Response Strategies, IPCC 1990, p.20 https://www.ipcc.ch/report/ar1/wg3/

87 The categories of scenarios are extensively presented in Chapter 2. 'Emissions Scenarios', FAR Climate Change: The IPCC Response Strategies, IPCC 1990, p.12-20 https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc_far_wg_III_full_report.pdf

88 'The hypothetical future patterns of GHG emissions and the cumulative effect of these emissions on the atmosphere were calculated using the concept of equivalent CO_2 concentrations. Equivalent CO_2 concentration, or the concentration equivalent to a specified atmospheric concentration of CO_2, is defined as the concentration of CO_2

1. The **2030 High Emissions** scenarios or **"Business as Usual"**, assume that few or no steps are taken to reduce GHG emissions. Continued population and economic growth produces increases in the use of energy and in the rate of clearing of tropical forests.
2. The **2060 Low Emissions** scenarios portray a world in which a number of environmental and economic concerns result in GHG emissions reduction. Energy efficiency improves due to efficiency standards and technology transfer, supported by governments, and to emissions controls adopted globally.
3. The **Control Policies** scenarios reflect futures where concern over global climate change and other environmental issues, such as ozone depletion, motivate technological development, agricultural policies and government efforts to rapid penetrations of renewable energy sources after 2050.
4. The **Accelerated Policies** scenarios are similar to the Control Policies; however they assume much more rapid development and penetration of renewable energy sources encouraged by global adoption of carbon fees. The ' **Alternative Accelerated Policies Scenarios'** differed only in CO_2 emissions reductions in the short-run and assumes a political climate that stresses the urgency of rapidly slowing down the rate of climate change, and immediate declining of CO_2 emissions by the end of 2100.

Regarding the measures and types of changes needed to stabilize emissions, Policy Scenarios introduced: firstly '**Short-term strategies**[89], related to **limitation** (mitigation) including actions in: (i) improving energy efficiency to reduce emissions of CO_2, (ii) using of cleaner energy sources and technologies, (iii) improving forest management, (iv) phasing-out of CFCs to protect the stratospheric ozone layer etc. Short-term strategies related to **adaptation** involved actions with regard to (a) developing emergency and disaster preparedness policies and programs, (b) assessing areas at risk from sea level rise, (c) developing comprehensive management plans for future vulnerability reduction and (d) improving the efficiency of natural resource use, research on control measures for desertification etc. Secondly, **the long-term measures** urged governments for more intensive actions such as (1) accelerating and coordinated research programs, to reduce scientific and socio-economic uncertainties, (2) developing new technologies in the fields of energy, industry, and agriculture, (3) reviewing planning in the fields of energy, industry, transportation, urban areas, coastal zones etc., (4) supporting behavioral and structural changes and (5) expanding of the global ocean observing and monitoring systems.

b. Special Report on Emissions Scenarios[90] - SRES (2000)

---

that, by itself, would produce the increase in direct radiative forcing (Rf) produced by all of the greenhouse gases. It derives by first estimating the increase, over pre-industrial levels, in direct radiative forcing from all of the GHG and then calculating the concentration of CO_2 that would produce the same increase, assuming atmospheric concentrations of all other GHG stayed at pre-industrial levels. The equivalent CO_2 Concentration is greater than the atmospheric concentration of CO_2 as long as the concentrations of other gases such as methane (CH_4) and nitrous oxide (N_20) are equal to or greater than pre-industrial levels.' Chapter 2.2.2 'Specifications of Scenarios', FAR Climate Change: The IPCC Response Strategies, IPCC 1990, p.18 https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc_far_wg_III_full_report.pdf

89 Response strategies for addressing global climate change, Policymakers Summary chapter, 'Climate Change - The IPCC Response Strategies' report Working Group, IPCC, 1990, p.xxxiv, p.xxvii https://www.ipcc.ch/report/ar1/wg3/

90 The SRES report was conducted on request for scientific and technical advice from the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and its bodies, 'Preface' chapter, 2000 https://www.ipcc.ch/report/emissions-scenarios/

The IPCC's GHG emissions IS92 scenarios were groundbreaking, as they were the first global scenarios to provide estimates for the full suite of GHGs. During 1995 the IPCC proceeded to their evaluation and review and thereafter in 2000 published a new set of scenarios the "IPCC Special Report Emissions Scenarios (SRES)". The SRES introduced 'narrative descriptions of the scenarios and inclusion of information on the availability of energy technologies'[91]. In relation to the IS92 scenarios, none of the SRES included any future policies that explicitly address climate change[92]. However they were aligned with all previous 'Policy Scenarios' in the 'key factors', the 'driving forces' considered influential to future changes in GHGs emissions. 'The SRES four narrative storylines[93] described the relationships between emission driving forces[94] and their evolution'.

1. The **A1 storyline and scenario family** describes a future world of very rapid economic growth, global population that peaks in 2050, and of rapid introduction of new, efficient technologies.
2. The **A2 storyline and scenario family** assumes a very heterogeneous world based on self-reliance and preservation of local identities, with regional economic development, fragmented and slower economic growth and technological change.
3. The **B1 storyline and scenario family** describes a world with the same global population as in the A1, with rapid changes in economic structures toward a service and information economy, with the introduction of clean and resource-efficient technologies, but without additional climate initiatives.
4. The **B2 storyline and scenario family** considers a world with emphasis on local economic, social, and environmental sustainability solutions, increasing global population (lower than A2), with intermediate economic development, and less rapid and more diverse technological change (than B1 and A1).

These scenarios were developed to be potentially used both for climate modeling, assessment of impacts, vulnerability, mitigation, and adaptation options and for policy analysis. For analysis at the national or regional scale, the most appropriate scenarios may be those that best reflect specific circumstances and perspectives. 'The important uncertainties ranging from driving forces to emissions may be different in different applications. On that account, the driving forces and emissions of each SRES scenario should be used together and components of SRES scenarios should not be mixed, in order to avoid internal inconsistencies'[95].

c. The complementary Shared Socio-Economic Pathways - SSPs (2012) and Representative Concentration Pathways - RCPs (2013)

In 2007, the IPCC requested from the scientific community to develop a new set of climate scenarios for the 2014 IPCC Fifth Assessment Report (AR5). The new 'scenarios needed to describe different climate futures, but

[91] IPCC Special Report on Emissions Scenarios SRES, 2000 https://www.ipcc.ch/report/emissions-scenarios/ , https://www.ipcc.ch/site/assets/uploads/2018/03/emissions_scenarios-1.pdf

[92] Preface, Special report on Emissions Scenarios, IPCC UNEP and WMO, 2000

[93] For a more detailed description of SRES scenarios see 'Appendix B'

[94] like the different demo-graphic, social, economic, technological, and environmental developments, 'Emissions Scenarios - A Special Report of IPCC Working Group III', IPCC 2000 https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf

[95] 'How can scenarios be used?', 'Emissions Scenarios - A Special Report of IPCC Working Group III', IPCC 2000 https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf

ideally also cover different possible and internally consistent socioeconomic developments'[96]. 'Researchers from different modeling groups[97] around the world created 'a new framework which included integrated scenarios based on combinations of climate model projections, socioeconomic conditions, and assumptions about climate policies'[98] . More specifically. one group of researchers developed four "Representative Concentration Pathways" (RCPs), describing 'different levels of GHGs and other radiative forcings that might occur in the future, as will be explained in this chapter. The second group prepared models in order to understand the implications of socioeconomic factors such as population, economic growth, education, urbanization and the rate of technological development. 'The five "Shared Socioeconomic Pathways" (SSPs) proposed by the second team provided different ways in which the world might evolve in the absence of climate policy and suggested different levels of climate change mitigation when the SSPs and the RCPs mitigation targets are combined'.

Shared Socio-Economic Pathways, SSPs[99]

The five Shared Socio-Economic Pathways (SSPs), published a decade after the IPCC SRES socio-economic scenarios[100], were the outcome of a collaborative work of 'three key groups involved in climate science research: (1)the climate modelers (CM), (2)the integrated assessment modelers (IAM), and (3) the impacts, adaptation, and vulnerability community (IAV)'[101]. As presented in the following figure, the SSPs are based on five narratives which are briefly described as[102]:

96 'The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview', Volume 42, January 2017, https://www.sciencedirect.com/science/article/pii/S0959378016300681

97 One group developed the RCP and the other the SSPs, 'Explainer: How 'Shared Socioeconomic Pathways' explore future climate change', Carbon Brief, 19 April 2018 https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

98 'A new scenario framework for climate change research: the concept of shared socioeconomic pathways', van Vuuren et al. (2013) https://link.springer.com/article/10.1007/s10584-013-0905-2

99 For a more detailed description of SSPs scenarios see 'Appendix B'

100 'The "SRES" scenarios, which looked at four different possible future trajectories of population, economic growth and greenhouse gas emissions, were becoming dated and lacked some large changes to society and the global economy that have occurred over the past 20 years.', Article: ''Explainer: How 'Shared Socioeconomic Pathways' explore future climate change', Carbon Brief, 19 April 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

101 'The SSP-RCP scenarios and their use for forest sector outlooks' by Nicklas Forsell International Institute for Applied Systems Analysis (IIASA), https://unece.org/fileadmin/DAM/timber/meetings/20161212/12-similar-shared-socioeconomic-pathways-for-economic-developments.pdf

102 'Explainer: How 'Shared Socioeconomic Pathways' explore future climate change', Carbon Brief, 19 April 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

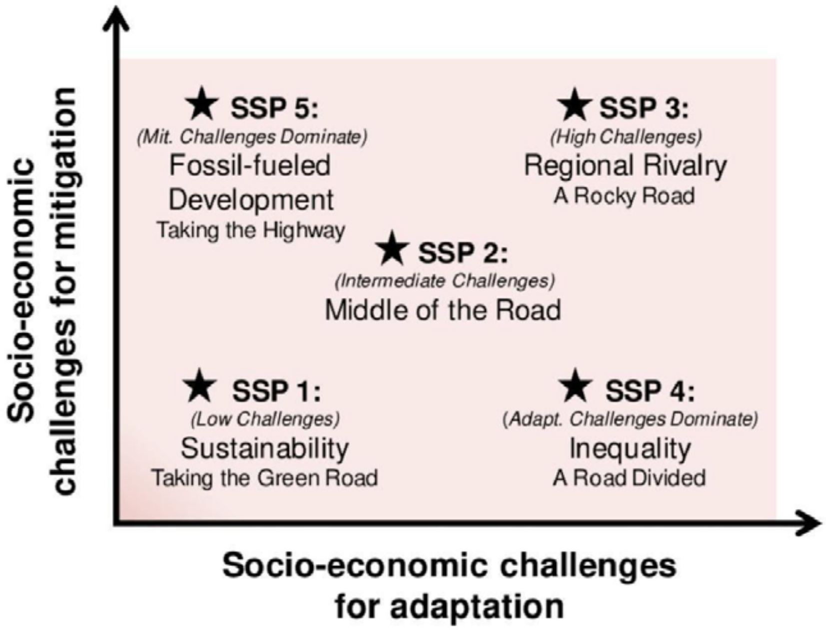


Fig.9: Overview of SSPs [103]

SSP1: 'Sustainability – Taking the Green Road'. Gradual shift toward a more sustainable path. Emphasis on economic growth shifts toward human well-being. Low material growth and lower resource and energy intensity.

SSP2: Middle of the Road. Social, economic, and technological trends do not shift from historical patterns. Only some countries are making relatively good progress. Income inequality improves slowly. Environmental systems degrade. Resource and energy use intensity declines.

SSP3: Regional Rivalry – A Rocky Road. Resurgent nationalism and regional conflicts push countries' focus on domestic issues and national or regional security policies. Low international priority for environmental concerns. Environmental degradation. Focus on local energy and food security goals. Material-intensive consumption.

SSP4: Inequality – A Road Divided. Highly unequal investments in human capital, economic opportunity and political power. Fragmented lower-income societies versus high-tech economies and countries leads to social degradation. Mostly local environmental policies. Energy sector diversifies from carbon-intensive fuels (coal), to low-carbon energy sources.

SSP5: Fossil-fueled Development – Taking the Highway. Rapid technological progress and development of human capital. Rapid growth of the global economy. Local environmental problems, social and ecological systems successfully managed. Abundant fossil fuel resources exploitation. Resource and energy intensive lifestyles globally.

[103] Source: Narratives in O'Neill et.al.,2016,GlobEnvChange, online first, https://unfccc.int/sites/default/files/part1_iiasa_rogelj_ssp_poster.pdf

SSPs consist of (i) a qualitative description, meaning a narrative that outlines broad characteristics and patterns of the global future development and (ii) a set of various quantitative elements like the country-level population, the national GDP, the urbanization projections, the education and the technology. What SSPs do not include are the typical scenarios' model output such as emissions, land use, climate change policy (for mitigation or adaptation) and were not designed as being influenced by climate change. The SSPs only reflected worlds in which mitigation and adaptation challenges vary from low to very high, instead[104].

Representative Concentration Pathways, RCPs

To complete the set of new scenarios requested by IPCC, the scientific community created 'a framework in the form of a matrix, whose dimensions represent key determinants of uncertainty in outcomes'. The SSPs described, through different pathways, the first determinant of uncertainty in outcomes which is related to socio-economic development, where societies vary widely in their capacities to mitigate emissions or undertake adaptation measures. The second determinant of uncertainties in outcomes is related to climate change. In this case the 'required mitigation effort and adaptation needs depend strongly on the outcomes each policy aspires'. These determinants were reflected in the denoted four 'Representative Concentration Pathways', the 4 RCPs prepared for the IPCC's Fifth Assessment Report (AR5)[105]. These RCPs were used for the new climate model simulations carried out under the framework of the Coupled Model Inter-comparison Project Phase 5 (CMIP5)[106] of the World Climate Research Program[107].

'Climate change projections required information about future emissions or concentrations of GHGs, aerosols and other climate drivers. Therefore the new scenarios used in the AR5 report have focused on anthropogenic emissions and did not include changes in natural drivers such as solar or volcanic forcing or natural emissions, for example, of CH_4 and N_2O. Representative Concentration Pathways (RCPs) provided time-dependent projections of atmospheric GHG concentrations, both a specific long-term concentration outcome and the

104 'Explainer: How 'Shared Socioeconomic Pathways' explore future climate change', Carbon Brief, 19 April 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

105 Was published in 2014 (the next Assessment Report, AR6 will be published in 2022). Working Group I, Working Group II, and Working Group III reports were approved in 2013 and 2014. The Synthesis Report was finalized in October 2014., https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/the-fifth-assessment-report-of-the-ipcc

106 'The fifth phase of the Coupled Model Intercomparison Project (CMIP5) will produce a state-of-the- art multi-model dataset designed to advance our knowledge of climate variability and climate change. Researchers worldwide are analyzing the model output and will produce results likely to underlie the forthcoming (2015)Fifth Assessment Report (AR5) by the Intergovernmental Panel on Climate Change, IPCC. CMIP5 includes "long term" simulations of twentieth-century climate and projections for the twenty-first century and beyond and calls for an entirely new suite of "near term" simulations focusing on recent decades and the future to year 2035'. Bulletin of the American Meteorological Society, 'An Overview of CMIP5 and the Experiment Design' article, https://journals.ametsoc.org/view/journals/bams/93/4/bams-d-11-00094.1.xml

107 'In 2008 the WCRP Working Group on Coupled Modelling (WGCM), endorsed the CMIP5 protocol, which defined a set of 35 climate model experiments designed to be useful in 1) assessing the mechanisms responsible for model differences in poorly understood feedbacks associated with the carbon cycle and with clouds, 2) examining climate "predictability" and exploring the ability of models to predict climate on decadal time scales, and, more generally, 3) determining why similarly forced models produce a range of responses.', https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip5

trajectory that is taken over time to reach that outcome'[108]. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing (rf)[109] characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome.

According to the following figure x, the RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios[110]. They covered a broad range of forcing in 2100 and are:

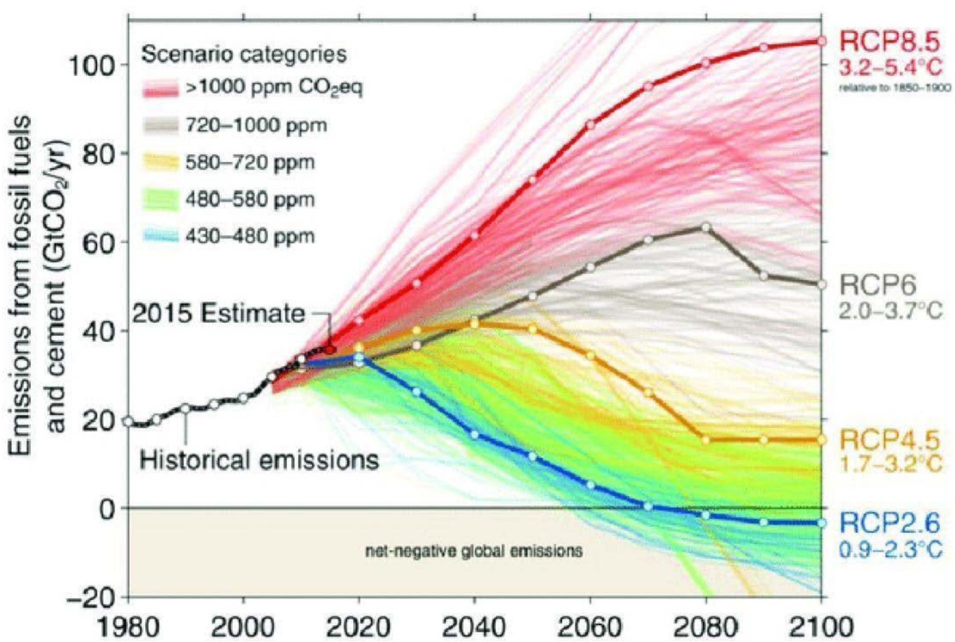


Fig. 10: The four RCP trajectories[111]

108 'Appendix 1: IEA and IPCC Climate Scenarios', Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities TCFD 2017, p.12

109 'Natural and anthropogenic substances and processes that alter the Earth's energy budget are drivers of climate change. Radiative forcing (RF) quantifies the change in energy fluxes caused by changes in these drivers for 2011 relative to 1750. Positive RF leads to surface warming, negative RF leads to surface cooling. The emission-based RF of a compound can be reported, which provides a more direct link to human activities', Summary for Policy makers chapter, C. Drivers of Climate Change sub-chapter, 'Climate Change 2013 The Physical Science Basis' Report, 2013-IPCC, https://www.ipcc.ch/site/assets/uploads/2018/03/WG1AR5_SummaryVolume_FINAL.pdf
'Radiative Forcings**:** Radiative forcing is the difference between incoming and outgoing energy in the Earth's climate. When increased greenhouse gases result in incoming energy being greater than outgoing energy, the planet will warm due to increased radiative forcing. Some forcings are positive while others, such as those from volcanoes or human-emitted aerosols, are negative', https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

110 Glossary chapter, Climate Change 2013 The Physical Science Basis' Report, 2013- IPCC

111 Original source: Fuss et al. 2014. 'Betting on negative emissions. Nature Climate Chang'. Image found in https://unece.org/fileadmin/DAM/timber/meetings/20161212/12-similar-shared-socioeconomic-pathways-for-economic-developments.pdf

- **RCP2.6** One pathway where radiative forcing (rf) peaks at approximately 3 W/m2 (watts per meter squared) before 2100 and then declines Additionally, the RCP 2.6 assumes that global annual GHG emissions (measured in CO2-equivalents) peak between 2010-2020, with emissions declining substantially thereafter;
- **RCP4.5** An intermediate stabilization pathway in which rf is stabilized at approximately 4.5 W/m2 after 2100. The RCP 4.5 assumes that emissions peak around 2040, then decline;
- **RCP6.0** Another intermediate stabilization pathway where rf stabilizes at approximately 6.0 W/m2 after 2100. RCP 2.6 assumes that global annual GHG emissions (measured in CO2-equivalents) peak around 2080, then decline.
- **RCP8.5** One high pathway for which radiative forcing (rf) reaches greater than 8.5 W/m2 by 2100 and continues to rise for some amount of time The RCP8.5 assumes that emissions continue to rise throughout the 21st century[112]

In a wider perspective, it is evident in the previous graph (figure 8) that the sooner the CO_2 emissions reach the peak and the less they are by that point, the less extreme and uncertain climate-related impacts and risks, stemming from the rising temperature, will have to be avoided and managed. In the case of the RCP2.6 scenario the highest level of GHG emissions are estimated to peak at around 2015-2020 and then decline on a linear path, becoming net-negative by before 2100.

D. Actions towards sustainable development

1.1.7. The Millennium Development Goals (2000-2015)

An almost parallel to the Kyoto Protocol on Climate change action was the historic United Nations Millennium Declaration. It was signed in September 2000 by world leaders of 189 countries and United Nations, committing their nations **to a new global partnership to reduce extreme poverty** and setting out a series of time-bound targets - with a deadline of 2015 - that have become known as the **Millennium Development Goals (MDGs).** The eight (8) MDGs were revolutionary in providing a common language to reach global agreement among all the world's countries and the entire world's leading development institutions.[113]

112 "Towards new Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies," September, 2007. IPCC Expert Meeting Report).' see Appendix 1: IEA and IPCC Climate Scenarios', Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities TCFD 2017, p.12.

113 The MDGs were realistic and easy to communicate and were structured with a clear measurement / monitoring mechanism, https://www.un.org/millenniumgoals/bkgd.shtml

Fig.11: The 8 Millennium Development Goals – MDGs that originated from the UN Millennium Declaration

More specifically, the eight (8) MDGs are

- MDG 1 "Eradicate extreme poverty."
- MDG 2 "Achieve universal primary education."
- MDG 3 "Promote gender equality and empower women."
- MDG 4 "Reduce child mortality."
- MDG 5 "Improve maternal health."
- MDG 6 "Combat HIV/AIDS and other diseases."
- MDG 7 "Ensure environmental sustainability."
- MDG 8 "Global Partnership for Development"

Regarding the "new global partnership" part of the commitment and the respective responsibilities shared by both developed and developing countries, within the MDGs framework for the first time, rich countries acknowledged and agreed that:

- Developing countries cannot achieve the goal unless rich countries increase their aid's effectiveness and change trade rules to foster development.
- Donors are part of the problem and, as such, are willing to become part of the solution, allowing recipient countries to take on their responsibilities. **This is what the MDGs are about: an agreement between rich and** developing **countries, each of which must be held accountable by their respective citizens.** [114]

As for the MDGs' ultimate goal of reducing extreme poverty, increasing living standards, and improving the well-being in the developing world, the MDGs emphasized three intertwined areas: **the human capital, the infrastructure, and human rights** (social, economic, and political).

The Goals for hunger and disease are part of human capital. The Goals for water and sanitation and slum dwellers are part of the infrastructure. The Goal for environmental sustainability is part of natural capital. The first Goal for income poverty is part of economic growth. And because meeting the Goals for hunger, education,

[114] https://www.un.org/en/chronicle/article/millennium-campaign-successes-and-challenges-mobilizing-support-mdgs

gender equality, environment, and health is vital for overall economic growth and development; it is a mistake to talk simply about the rate of economic growth needed to achieve the Goals in a country. It is more helpful, particularly for the poorest countries caught in economic stagnation, to describe the range and levels of investments needed to achieve the Goals and support overall economic growth.[115] This means that although the goals are global, they need to be adapted to the local conditions, priorities, and needs, which have to be locally determined. **The most important aid reform realizes that donors do not develop; developing countries must develop themselves**.[116]

Although ambitious and with a global involvement, a decade after the MDGs adoption, the achievements seemed uneven. The main lessons learned from the eight goals[117] formed the base for the next steps and new goals that succeeded the MDGs. Indicative points to be taken into consideration are the following :

- MDGs acceleration depends on the timeliness and effectiveness of policy instruments
- Strong government involvement ensures the greatest impact of MDG-related interventions
- Lack of quality data and analysis poses a serious constraint to timely monitoring, policy development, and the ability to target the most interventions~~.~~
- Communities mobilization are central to achieving development results
- Achieving long-term development requires bridging the humanitarian and development agendas
- Operating under a normative framework, the UN system needs to push for the inclusion of issues that may have been deprioritized at the country level.

Simultaneously, a discussion of a post-2015 agenda had started and was focusing on building a sustainable world where environmental sustainability, social inclusion, and economic development are equally valued.[118] Hence the MDGs have been superseded by the Sustainable Development Goals, the SDGs.

115 UN Millenium project, "Investing in Development-A practical Plan to achieve the MDGs", 2005, Overview p.5 https://www.who.int/hdp/publications/4b.pdf

116 https://www.un.org/en/chronicle/article/millennium-campaign-successes-and-challenges-mobilizing-support-mdgs

117 The ten key points from the lessons learned during the MDGs adoption are presented in the 'Transitioning from the MDGs to the SDGs' report, by the UN System Chief Executives Board for Coordination (CEB) 2015, https://reliefweb.int/sites/reliefweb.int/files/resources/Transitioning%20from%20the%20MDGs%20to%20the%20SDGs.pdf

118 'From MDGs to SDGs' , The SDG Fund, https://www.sdgfund.org/mdgs-sdgs

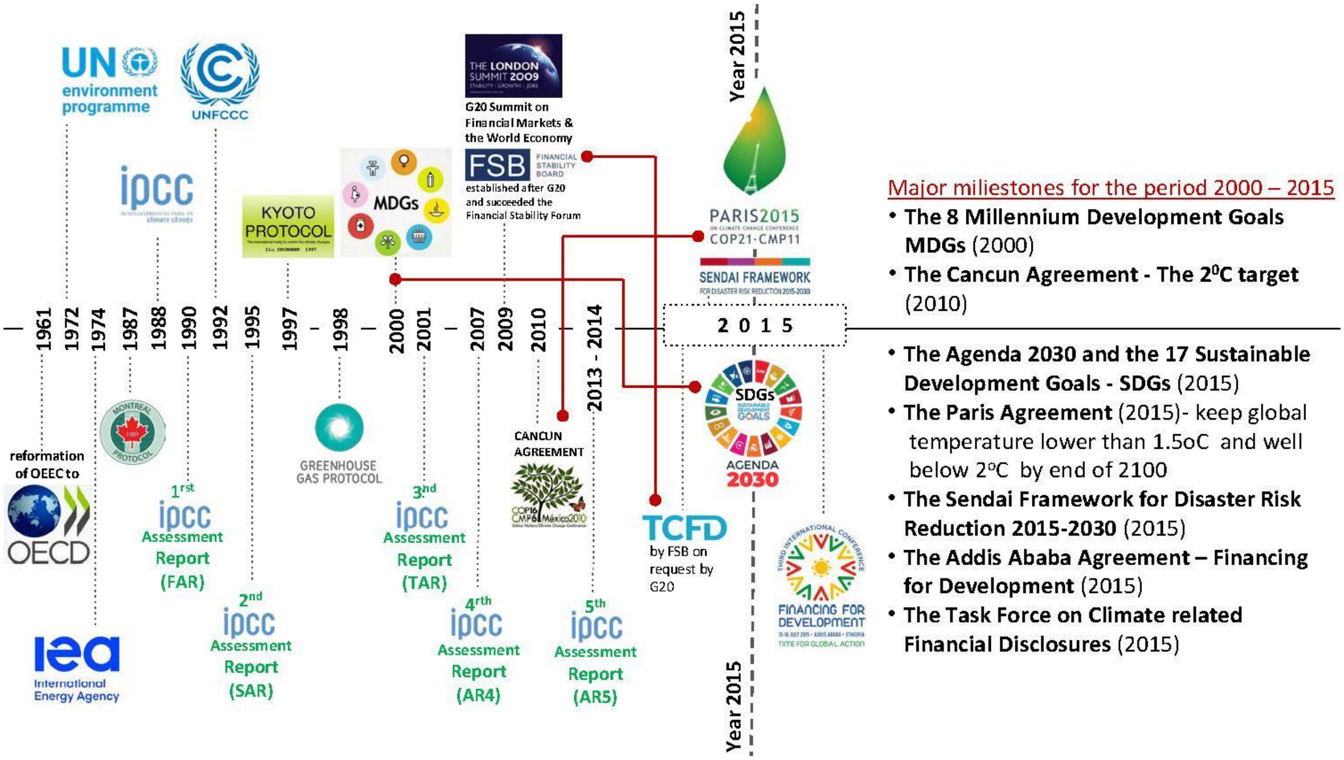


Fig. 12: A timeline documenting milestones between 2000 and the landmark year 2015 and treaty, the Paris Agreement.

1.2. The Year 2015

'Climate change presents the single biggest threat to sustainable development everywhere, and its widespread, unprecedented impacts disproportionately burden the poorest and most vulnerable'. [119]

2015 was a landmark year for multilateralism and international policy shaping. Major agreements were adopted,[120] raising issues on climate risks mitigation, the need for domestic finance mobilization, creating a common set of new sustainable global goals, and the urgency for a new CO_2 mitigation target. The four frameworks for climate change signed within 2015 are, in a chronological order, as follows:

1. **The Sendai Framework for Disaster Risk Reduction**, *signed in March 2015,* was the foundation for sustainable, low-carbon, and resilient development under a changing climate, a transition towards zero emissions.
2. **The Addis Ababa Action Agenda on Financing for Development** which was adopted in July 2015.[121]
3. **The 2030 Agenda for Sustainable Development** calling for urgent action to halt climate change and deal with its impacts and setting new goals (building on the MDGs), the Sustainable Development Goals (SDGs) was signed in September 2015.
4. **The Paris Agreement**, a historic agreement reached in December 2015 at the COP21 Paris Climate Conference.

119 https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs
120 https://sdgs.un.org/goals
121 https://sdgs.un.org/goals

As these agreements were adopted by the majority of nations almost simultaneously, they provide a solid set of common standards and achievable targets to reduce carbon emissions, manage the risks of climate change and natural disasters, and build back better after a crisis. [122]

For a better understanding of the interrelation between the four frameworks' main concepts, they will be presented in an alternative order as follows:

1.2.1. The 2030 Agenda and the Sustainable Development Goals – SDGs (2015-2030)

At the "Rio+20" Conference on Sustainable Development, governments decided to develop global Sustainable Development Goals, including natural resources management, sustainable consumption and production, effective institutions, good governance, the law rule, and peaceful societies.

Some of the most important characteristics of the 2030 Agenda are:[123]

a) **The set of the 17 Sustainable Development Goals** and 169 targets
b) **Its scale, ambition, and approach**. For example, the SDGs are global in nature and applicability, taking into account national realities, capacities, development levels, and specific challenges. All countries have a shared responsibility to achieve the SDGs and a meaningful role to play locally, nationally, and on the global scale
c) **The integration of the three dimensions of sustainable development – economic, social, and environmental**. It must be implemented in an integrated manner, as the various goals and targets are closely interlinked.
d) **The concept of global partnership**, supported by a comprehensive approach to the mobilization of all means of implementation[124]. To ensure progress and long-term accountability, the 2030 Agenda includes a strong follow-up and review mechanism which will allow all partners to assess the impact of their actions.

In contrast to the MDGs, the SDGs seek to complete what the first set of goals did not achieve, applying to all countries from the Global South to the Global North and recognizing that local needs and priorities are different and variable. Moreover, adding to economic and social goals, the SDGs explicitly address ecological sustainability challenges.

122 http://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html
123 https://ec.europa.eu/environment/sustainable-development/SDGs/index_en.htm
124 The implementation of the 2030 Agenda is complemented by the Addis Ababa Action Agenda, which is an integral part.

Fig. 13: The 17 Sustainable Development Goals SDGs

Analyzing further the relationships between the predecessors of SDGs, the MDGs, and the new Sustainable Development Goals, as illustrated in the following graph, some of the MDGs topics were developed into two SDGs as in the case of MDG 1. In contrast, others were grouped to form a new goal, for example, the MDG 4, MDG 5, MDG 6 now form the SDG 3.

Fig. 14: The evolution from MDGs to SDGs[125]

More specifically:

- MDG 1 “Eradicate extreme poverty”’ goal became more specific in both SDG 1, “No poverty” and SDG 2, “Zero hunger.”
- The MDG 2 “Achieve universal primary education” evolved into SDG 4, “Quality education.”
- Similarly, the MDG 3 “Promote gender equality and empower women” goal is now compatible with SDG 5 “Gender quality.”
- MDG 4 “Reduce child mortality,” MDG 5 “Improve maternal health” and MDG 6 “Combat HIV/AIDS and other diseases” were grouped and form the new SDG 3, “Good Health and Well-being.”
- The MDG 7 “Ensure environmental sustainability” topic became more elaborated and resulted directly into SDG 13 “Climate Action,” SDG 14 “Life below water,” and SDG 15 “Life on land.”
- Finally, the MDG 8 “Global Partnership for Development” was transformed into SDG 17, “Partnerships for the goals.”

At the same time, the eight completely new goals added to form the total 17 SDGs of the 2030 Agenda framework, such as SDG 6 “Clean Water and Sanitation,” SDG 7 “Affordable and clean energy,” SDG 8 “Decent work and economic growth,” SDG 9 “Industry, innovation and infrastructure,” SDG 10 “Reduced Inequalities,” SDG 11 “Sustainable cities and communities,” SDG 12 “Responsible consumption and production” and SDG 16 “Peace, justice and strong institutions,” reveal the broad spectrum of targets required *to shift the world onto a more sustainable path.* [126]

---

[125] Image taken from the paper by Stefan Zagelmeyer and Rudolf R Sinkovics, “MNEs, Human Rights and the SDGs – The Moderating Role of Business and Human Rights Governance”, 2019, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3624076

[126] http://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html

Fig. 15: The MDG no.7, "Ensure Environmental Sustainability," resulted in 6 new SDGs[127]

However, considering the new topics introduced in the eight entirely new SDGs, it is worth noticing that the MDG 7 "Ensure Environmental Sustainability" is related to six new SDGs rather than three as mentioned earlier. To "ensure environmental sustainability" (MDG 7), the "clean water and sanitation" (SDG 6), "affordable and clean energy" (SDG 7) and "responsible consumption and production" (SDG 12) are prerequisites, "climate action" (SDG 13) is urgent and "Life below water" (SDG 14) and "Life and land" (SDG 15) have to be protected. In the Appendix B, a full description of each of the six SDGs' targets and the estimated implementation year, is provided. In broader perspective, the targets related to the environment can be found in other SDGs and not only in those explicitly referring on the environment, as shown in the following table, which shows the interrelation of all SDGs and the integrated approach needed when aiming at a sustainable development.

Table 1: The 2030 Agenda calls for a more integrated approach, as illustrated by the SDGs that explicitly focus on the environment and the environment-related targets included in the other SDGs[128]

[127] http://muslimpoliticians.blogspot.com/2018/02/dari-mdgs-ke-sdgs-transformasinya-dan.html

[128] Original image source: (Elder and Olsen, 2019[81]), The design of environmental priorities in the SDGs, https://doi.org/10.1111/1758-5899.12596, found in 'Strengthening Climate Resilience : Guidance for Governments and Development Co-operation', Chapter '2.3.3. Environmental and social sustainability', OECD Library, https://www.oecd-ilibrary.org/sites/c1fa7176-en/index.html?itemId=/content/component/c1fa7176-en

SDG targets related to the environment			
SDGs' TARGET No.	Content related to environment	SDGs' TARGET No.	Content related to environment
1.5	Resilience to climate and environmental, shocks and disasters	7.b	**Infrastructure and technology**
2.4	**Sustainable food production systems**	8.4	**Resource efficiency and decoupling economic growth from envirnmental degradation**
2.5	Genetic diversity	8.8	Labour rights and safe working environment
3.3	Death and ilness from pollution	8.9	**Sustainable tourism**
3.9	Water-borne diseases	9.1	**Sustainable and resilient infrastructure**
4.7	**Education for sustainable development**	9.2	**Sustainable industrialisation**
5.a	**Women's equal rigths to economic resources, property, natural resources**	9.4	**Sustainability upgrading and resource efficiency**
6.1	Access, safe water	9.a	**Financial, technical and technological support for sustainable and resilient infrastructure**
6.2	**Sanitation**	11.1	Adequate, safe, affordable housing
6.3	**Water quality**	11.2	**Sustainable transport**
6.4	**Use-efficiency, scarcity**	11.3	**Inclusive and sustainable urbanization**
6.5	**Integrated water management**	11.4	Protect and safeguard cultural and natural heritage
6.6	Ecosystmes	11.6	Environmental impact, air quality, **waste management**
6.a	**Capacity building**	11.7	Green and public spaces
6.7	**Local participation**	11.a	**National and regional development planning**
7.2	**Renewable energy**	11.b	**Integrated policis on inclusion, resource efficiency, climate mitigation and adaptation, resilience, disaster risk management**
7.3	**Energy efficiency**	11.c	**Support for sustainable and resilient building**
7.a	**Related investment**	12-15	**All except 14.a**

Notes:

Grey box: environmental condition to be improved

Bold text: means to improve the environment.

Grey box & bold text: the target combines the environmental condition to be improved with means to improve it.

Normal text: ends which benefit from an improvement

1.2.2. The Paris Agreement

Some climate data:

- The earth is now 1.1°C warmer than it was at the start of the industrial revolution. We are not on track to meet the agreed targets in the 2015 Paris Agreement on climate change, which stipulated keeping global temperature increase well below 2°C or at 1.5°C above pre-industrial levels.
- 2010-2019 is the warmest decade on record. On the current path of carbon dioxide emissions, the global temperature is expected to increase by 3°C to 5°C by the end of the century.[129]

In 2015, in Paris, UNFCCC parties reached a landmark agreement to combat climate change and accelerate and **intensify the actions and investments needed for a sustainable low carbon future.** [130] It is considered a milestone *in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.* **The** Paris Agreement's central aim is to cut GHG emissions to ***keep a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels while taking steps to limit this to 1.5 degrees***. [131]
The origin of the 1.5°C Paris Agreement limit derived from the concern amongst the vulnerable countries about the adverse consequences of a 2°C warming level. [132]
The warming limit of 2°C as a "guardrail" was found not safe, and governments should aim for 1.5°C instead.[133]
The mechanism for implementing the Agreement is **Nationally Determined Contributions (NDCs),**[134] requesting each signatory country to submit their plan for climate action, in line with the overall targets and dates. *In their NDCs, countries communicate*

- Actions they will take to reduce their Greenhouse Gas emissions to reach the goals of the Agreement. Climate finance is needed for mitigation because large-scale investments are required to reduce emissions significantly [135]. It is equally important to direct finance flows to projects which align with lower GHG emissions[136] It is worth noting that the definition of climate change mitigation, used by the European Union, has been adapted to the goals set by the Paris Agreement."[137]
- Actions they will take to **build resilience to adapt** to the impacts of rising temperatures. Climate finance is equally important **for adaptation** (Article 7)[138], as significant financial resources are needed to adapt to the adverse effects and reduce the impacts of a changing climate.

129 https://news.un.org/en/story/2020/12/1078612
130 https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement
131 https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
132 https://climateactiontracker.org/methodology/paris-temperature-goal/
133 http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf
134 "Intended Nationally Determined Contribution (INDC): Submissions by Parties which identify actions each national government intends to take under the future UNFCCC climate agreement, negotiated in Paris in December 2015. INDCs are, in effect, the basis of post-2020 global emission reduction commitments that will be included in the future climate agreement. While Nationally determined Contribution (NDC): Actions that, by ratifying the Paris Agreement, each party to the UNFCCC binds itself to pursuing."Emissions Gap Report 2017, https://www.unep.org/resources/emissions-gap-report-2017
135 https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
136 https://earth.org/what-is-the-paris-agreement/
137 E.U. Environmental Social Governance (ESG) Regulations Guide, 2020
138 New elements and dimensions of adaptation under the Paris Agreement, https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/new-elements-and-dimensions-of-adaptation-under-the-paris-agreement-article-7

Additional supportive tools[139] referred in the Paris Agreement for countries to reach these ambitious goals are:

- New technology framework and enhanced capacity-building. Since not all developing countries have sufficient capacity to deal with the many challenges of climate change, it is requested from all developed countries to enhance their support for capacity-building of the developing and most vulnerable countries, *in line with their national objectives.*
- New tracking progress through *transparency, implementation, and compliance*[140] framework. In this context, the Agreement requires, in addition to reporting information on mitigation, adaptation, and support, that the information submitted by each Party undergoes international technical expert review. The Global Stocktake (Article 14) is an essential monitoring mechanism as it "periodically takes stock of the implementation of the Paris Agreement and assesses collective progress towards achieving the purpose of the Agreement and its long-term goals." This process, called the global stocktake[141], will link the NDCs implementation status to the Paris Agreement goals.

1.2.3. The Sendai Framework for Disaster Risk Reduction 2015-2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 was the first major agreement of the post-2015 development agenda and provides the Member States with concrete actions to protect development gains from disaster risk.

The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters.

It works hand in hand with the 2030 Agenda agreement, the Paris Agreement on Climate Change, the Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda, and ultimately the Sustainable Development Goals, and it advocates for 'the substantial reduction of disaster risk and losses in lives, livelihoods, and health and the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries. **It recognizes that the State has the primary role in reducing disaster risk, but that responsibility should be shared with other stakeholders, including local government, the private sector, and other stakeholders**'[142].

To support the assessment of global progress in achieving the Expected outcome and goal[143], **seven global targets have been agreed upon**:

(a) Substantially reduce global disaster mortality by 2030.

[139] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[140] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement

[141] The first Global Stocktake will take place in 2023, https://www.ipcc.ch/2020/02/24/ipcc-opens-meeting-in-paris-to-consider-2022-climate-change-report-outline/

[142] https://www.undrr.org/implementing-sendai-framework/what-sendai-framework

[143] According to the "Sendai Framework for Disaster Risk Reduction2015-2030 report the Expected outcome and goal" to achieve and realize the goal the Framework advocates for, over the next 15 years, a strong commitment and involvement of political leadership in every country at all levels in the implementation, a follow-up of the present Framework (...) https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030 .pdf

(b) Substantially reduce the number of affected people globally by 2030.
(c) Reduce direct disaster economic loss to the global gross domestic product (GDP) by 2030.
(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services by 2030.
(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020.
(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions to implement the present Framework by 2030.
(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.[144]

Fig. 16: The seven targets of Sendai Framework

‘Risk is increasingly systemic. If we want to reduce risk, we must also be increasingly joined in our approaches: working cross-sectors, between and within institutions, and ensuring harmony from policy through activity.

[144] https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

Both the Sendai Framework and the Sustainable Development Goals (SDGs) outcomes result from interconnected social and economic processes. As such, there is a lot of synergy between the two policy instruments'[145]. There is recognition in the proposals for both the SDGs and the Sendai Framework that their desired outcomes are a product of complex and interconnected social and economic processes with overlap across the two agendas.

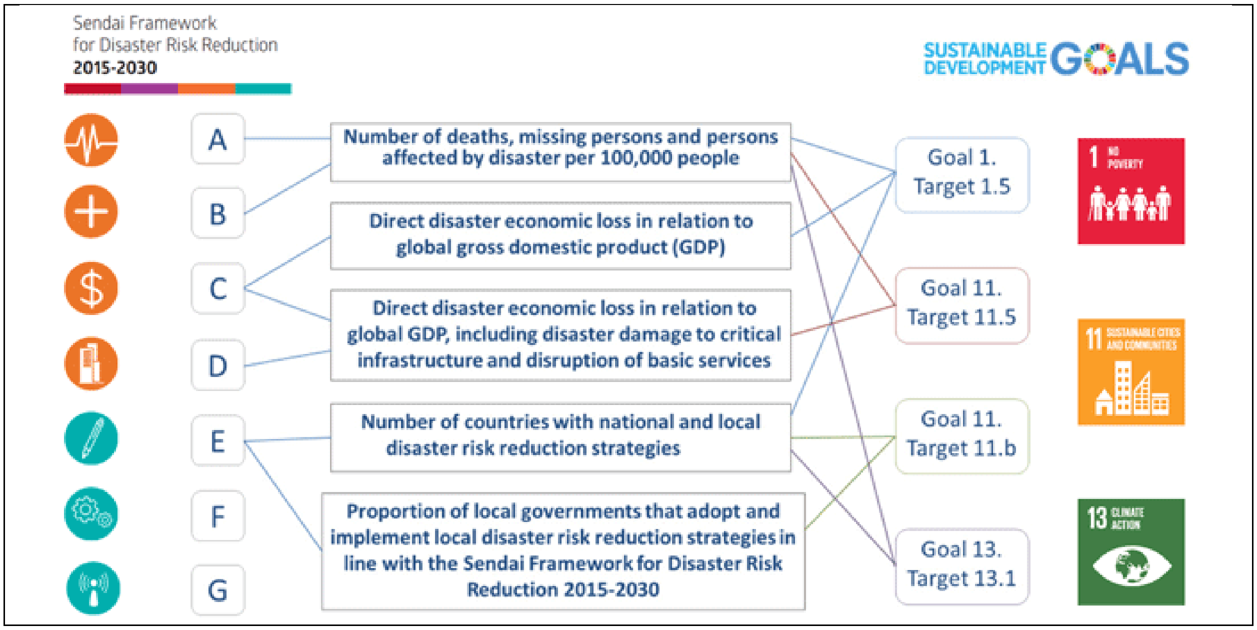


Fig.17: Integrated monitoring of the global targets of the Sendai Framework and the Sustainable Development Goals[146]

1.2.4. The Addis Ababa Action Agenda on Financing for Development

In July 2015, some months before the UN transformative post-2015 development agenda "Agenda 2030", which included the SDG goals, and the Paris Agreement declaration[147], the Addis Ababa Action Agenda (AAAA), which was the outcome of the Third International Conference on Financing for Development (FfD), established a holistic and forward-looking framework[148] to commit to new concrete actions.

The importance of the AAAA is described in the Agenda 2030, as it is stated that "the means of implementation targets under Goal 17 and under each SDG are key to realising Agenda 2030 and are of equal importance with the other Goals and targets. The Agenda, including the SDGs, can be met within the framework of a revitalized global partnership for sustainable development, supported by the concrete policies and actions as outlined in

---

145 https://www.undrr.org/implementing-sendai-framework/sf-and-sdgs

146 https://www.preventionweb.net/sendai-framework/sendai-framework-monitor/common-indicators

147 "The Conference is the first of three crucial events this year that can set the world on an unprecedented path to a prosperous and sustainable future. Its outcome provides a strong foundation for countries to finance and adopt the proposed sustainable development agenda in New York in September, and to reach a binding agreement at the UN climate negotiations in Paris in December that will reduce global carbon emissions." https://www.un.org/esa/ffd/ffd3/press-release/countries-reach-historic-agreement.html

148 Addis Ababa Action Agenda on Financing for Development report, UN, https://sustainabledevelopment.un.org/content/documents/2051AAAA_Outcome.pdf

the outcome document of the Third International Conference on Financing for Development, held in Addis Ababa from 13-16 July 2015. We welcome the endorsement by the General Assembly of the Addis Ababa Action Agenda, which is an integral part of the 2030 Agenda for Sustainable Development. We recognize that the full implementation of the Addis Ababa Action Agenda is critical for the realization of the Sustainable Development Goals and targets."[149]

The Addis Ababa Action Agenda, building upon the commitments made in the two previous[150] "Conferences on FfD" set, presented seven Areas of Action to further strengthen the framework for financing sustainable development and suggested a "Data, monitoring and follow-up process"[151] to ensure that these actions would be implemented and reviewed in an appropriate, inclusive, timely and transparent manner.

Domestic resource mobilization was central to the agenda. Nevertheless, while reviewing the global framework for financing development post-2015, the agenda's report **"**identified a range of cross-cutting areas, that build on synergies, outlined in the following seven points: (1) delivering social protection and essential public services for all (including developing and least developing countries, (2) scaling up efforts to end hunger and malnutrition, (3) establishing a new forum to bridge the infrastructure gap, (4) promoting inclusive and sustainable industrialization (5) generating full and productive employment and decent work for all and promoting micro, small and medium-sized enterprises, (6) protecting our ecosystems for all and (7) promoting peaceful and inclusive societies."[152]

The above synergies framed concrete policies and the seven actions areas[153] towards a revitalized global partnership for sustainable development, as presented below:

A. Domestic public resources
B. Domestic and international private business and finance
C. International development cooperation
D. International trade as an engine for development
E. Debt and debt sustainability
F. Addressing systemic issues
G. Science, technology, innovation and capacity-building

149 Means of Implementation, https://sdgs.un.org/2030agenda

150 The Third conference built upon the main six key areas that were presented in the First Conference on Financing for Development (held in Monterrey, Mexico in 2002), which had the mandate to promote international cooperation. The six areas were: (1) mobilizing domestic resources, (2) increasing private international investment, (3) strengthening official development assistance (ODA), (4) increasing market access and ensuring fair trade, (5) solving the debt burden, and improving the coherence of global and regional financial structures and (6) promoting fair representation of developing countries in global decision-making. The Second Conference FfD (held in Doha, Qatar in 2008) was actually a follow-up of the First Conference with the aim to review the implementation of Monterrey's decisions and determine the new initiatives that would be necessary to meet the increasingly compromised Millennium Development Goals (MDGs). https://www.un.org/press/en/2002/dev2376.doc.htm, https://www.un.org/en/development/devagenda/financial.shtml

151 Chapter III, Addis Ababa Action Agenda report https://sustainabledevelopment.un.org/content/documents/2051AAAA_Outcome.pdf

152 Chapter I, Addis Ababa Action Agenda report

153 Chapter II, Addis Ababa Action Agenda report

To implement the above actions and goals, the parties/countries of the Agenda also agreed to several new initiatives[154], such as: establishing a Technology Facilitation Mechanism and a Global Infrastructure Forum, providing social protection systems, strengthening health, developing the International Labor Organization Global Jobs Pact by 2020, setting new foreign aid targets, creating a package of measures for least developed countries, engaging with the Economic and Social Council and with the UN International Cooperation in Tax Matters to improve taxation and finally, about Climate Change, engaging developed countries to implement the goal of jointly mobilizing USD100 billion per year, by 2020, and phase out inefficient fossil fuel.

1.3. Main objectives and goals after 2015

The 2030 Agenda, the SDGs, the Paris Agreement targets and the Sendai Framework for Disaster Risk Reduction constitute the new blueprints against climate change and towards sustainability. In the following paragraphs the current trends, based on the aforementioned agreements, and the new goals will be presented, emphasizing the urgent need for countries, organizations, policymakers, scientific community, stakeholders, private sector, local societies and individuals to recognize that effective responses to climate change require a global collective effort.

1.3.1. Net-Zero by 2050 target

a. IPCC report on Global Warming of 1.5°C

While all countries committed under the Paris Agreement to limit global temperature rise to 1.5°C-2°C (2.7°F-3.6°F)it remains a question how the world can achieve this temperature goal and what happens if the target is not met. The scientists participating in the IPCC report on ‘Global Warming of 1.5°C’[155], published in 2018, explained the efforts needed to achieve the Paris Agreement goals and the potential impacts related to the temperature limits to reach these goals. The following points[156] are some of the main topics addressed in the IPCC report:

- Limiting warming to 1.5°C requires major and **immediate transformation.** Indicatively, transformations **r**egarding global emissions reduction have to be about around 25-30 GtCO2e/yr on average by 2030, regarding the use of renewable, they have to supply 70-85 percent of electricity by 2050 and regarding energy demand a change in dietary choices and reducing food loss and waste will be a significant contribute.
- **An unprecedented scale** of low-carbon transition will be required across energy, land, industrial, urban and other systems, as well as across technologies and geographies. To proceed to this widespread,

[154] “Countries reach historic agreement to generate financing for new sustainable development agenda” https://www.un.org/esa/ffd/ffd3/press-release/countries-reach-historic-agreement.html

[155] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty https://www.ipcc.ch/sr15/download/#full

[156] ‘8 Things You Need to Know About the IPCC 1.5˚C Report’, By Kelly Levin, World Resources Institute (WRI), October 7, 2018, https://www.wri.org/insights/8-things-you-need-know-about-ipcc-15c-report

rapid shift, substantial new investments in low-carbon energy technology and energy efficiency will need to increase by roughly a factor of five by 2050 compared to 2015 levels.

- **The various interpretations and results** of "Limiting warming to 1.5°C". In the example of ecosystems, exceeding 1.5°C for years might result in irreversible impacts, such as species extinction, but this can also happen if it doesn't get higher than 1.5°C. While the 1.5°C goal refers to the *global* average temperature increase at the local level, the resultant impacts might be slightly different depending on the specific characteristics of each location.
- **The estimated climate-related risks at 1.5**°C **and 2**°C**.** In the World Resources Institute following graph it is highlighted how much higher are the estimated physical risks in a 2°C global temperature than in 1.5°C, according to the 2018 IPCC ' Global Warming of 1.5°C' report.

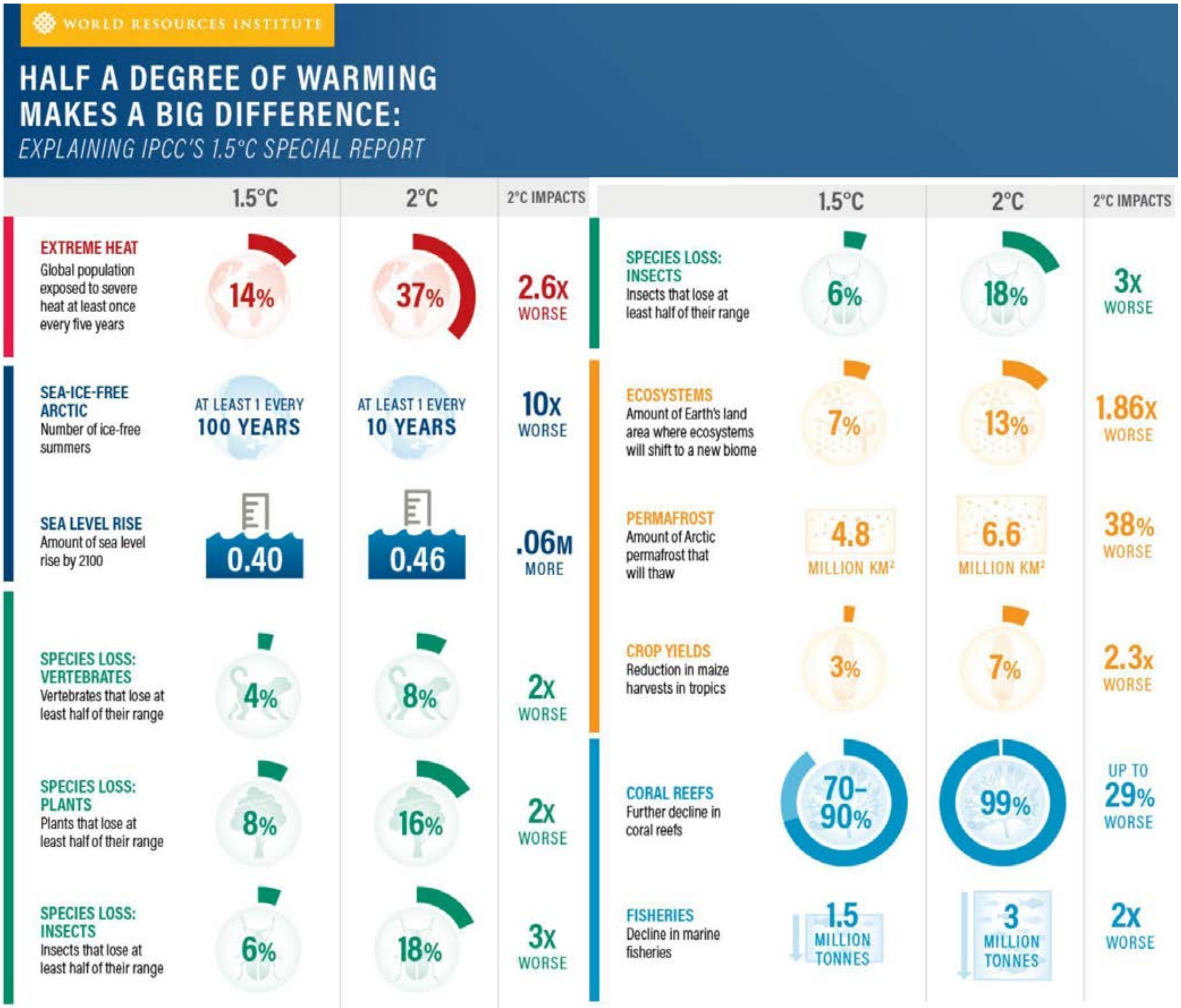


Fig. 18: A breakdown of the differences between a 1.5°C and a 2°C world[157]

- **Emissions need to reach net-zero by around 2050.** In addition to large emissions cuts, net CO2 emissions will need to be reduced to zero by 2050, actually the sooner emissions peak before 2030, the less the challenges will be. It is estimated that if the date of reaching net-zero emissions is brought forward one decade to 2040 the chance of limiting warming to 1.5°C is considerably higher.
- **All 1.5**°C **emissions pathways rely upon carbon removal to some extent.** 'Efforts should focus not only on reducing emissions, but also removing and storing carbon from the atmosphere. Carbon removal is necessary for both moving to net-zero emissions and for producing net-negative emissions to compensate for any overshoot of 1.5°C. The pathways studied in the report rely on different levels of

157 'Half a Degree and a World Apart: The Difference in Climate Impacts Between 1.5°C and 2°C of Warming', By Kelly Levin, World Resources Institute (WRI), October 7, 2018, https://www.wri.org/insights/half-degree-and-world-apart-difference-climate-impacts-between-15c-and-2c-warming

carbon removal, but all rely on it to some extent. However carbon removal deployed at such a scale is unproven, and is a major risk to our ability to limit warming to 1.5°C. The feasibility of carbon removal could be enhanced if a portfolio of carbon-removal approaches is pursued'[158].

- **Actions required without delay at countries, cities, the private sector and individuals level.** All Countries have to achieve their goals described in their INDCs and make deep emissions cuts after 2030. Non-state actors also need to strengthen their contributions without delay. Transformation in society with the aim to limit warming to 1.5°C is a prerequisite, otherwise achieving sustainable development will be exceedingly difficult, if not impossible.

b. Net-zero emissions and net-zero CO_2 emissions, carbon removal, carbon budget and Carbon Capture and Storage (CCS)

In the previous paragraph, the key-role of the Carbon Dioxide removal (CDR), in order to reach net-zero by 2050 and not exceed the global temperature limit, was considered a prerequisite in almost all 1.5˚C emissions pathways. However at this point, it is important to create a common understanding between various concepts of the scientific literature, such as net-zero emissions or net-zero CO2 emissions target, becoming carbon or climate neutral, carbon removal in carbon budget and Carbon Capture and Storage (CCS) technology. These concepts are essential when used for comparing goals and assessing strategies among different sectors, organizations and companies[159].

'Net-zero emissions will be achieved when all GHG emissions released by humans are counterbalanced by **removing GHGs from the atmosphere** in a process known as carbon removal'[160]. In an effort to decode this quote it is important to clarify the following [161]:

- **'Net-zero emissions** are achieved when anthropogenic emissions of GHGs to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple GHGs are involved, the quantification of net-zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon)'. Reaching net-zero emissions is akin to achieving "climate neutrality"[162], while

[158] '8 Things You Need to Know About the IPCC 1.5˚C Report', By Kelly Levin, World Resources Institute (WRI), October 7, 2018, https://www.wri.org/insights/8-things-you-need-know-about-ipcc-15c-report

[159] 'Foundations for Science-based net-zero target setting in the corporate sector' report, Science Based Targets Initiative, by CDP Disclosure Insight Action, September 2020, https://sciencebasedtargets.org/resources/legacy/2020/09/foundations-for-net-zero-full-paper.pdf

[160] 'Box SPM.1:Core Concepts Central to this Special Report', Summary for Policymakers, IPCC Special Report on 'Global warming of 1.5°C', https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf#%5B%7B%22num%22%3A585%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22FitH%22%7D%2C792%5D

[161] 'Glossary', IPCC report 'Special Report: Global Warming of 1.5 ºC', 2018, https://www.ipcc.ch/sr15/chapter/glossary/

[162] 'What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered', By Kelly Levin, Taryn Fransen, Clea Schumer and Chantal Davis, September 17, 2019, https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

- **'Net-zero CO_2 emissions** are achieved when anthropogenic CO_2 emissions (human-caused emissions such as those from fossil-fueled vehicles and factories) are balanced globally by anthropogenic CO_2 removals over a specified period. Net zero CO_2 emissions are also referred to as carbon neutrality.'

Carbon Dioxide Removal (CDR)

The CO_2 and other GHGs in the atmosphere 'are not driven only by energy, industrial and agricultural processes, but also by the loss of carbon contained in soils and in terrestrial ecosystems and this loss can cause further accumulation of carbon in the atmosphere and decrease in the ability of our natural systems to reduce atmospheric carbon concentrations'[163].In this regard, carbon dioxide can be removed through natural processes and through reducing the anthropogenic CO_2 emissions to net-zero. Nevertheless 'natural processes are so slow that almost all remaining anthropogenic CO_2 emissions must be compensated for by an equal rate of anthropogenic Carbon Dioxide Removal (CDR)'[164]

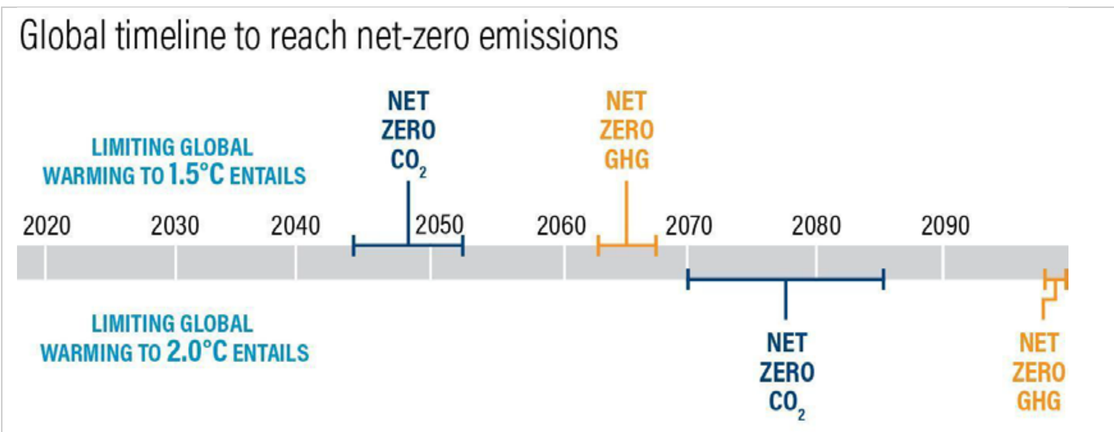


Fig. 19: The different time frame for reaching net-zero emissions for CO_2 alone versus for CO_2 plus other GHGs like methane, nitrous oxide and fluorinated gases[165]

The graph highlights another important parameter in the carbon removal process, 'the time frame for reaching net-zero emissions which is different for CO_2 alone and for CO_2 plus other GHGs' and at the same time both (CO2 alone or all GHGs) are estimated to be reached in a different time-span when the target is 1.5 degrees Celsius and 2°C limit. 'For non-CO2 emissions, the net-zero date is later because models suggest that some of

163 'The IPCC has determined that up to 13% of anthropogenic emissions are due to deforestation and land-use change', 'Foundations for Science-based net-zero target setting in the corporate sector' report, Science Based Targets Initiative, by CDP Disclosure Insight Action, September 2020, p.7, https://sciencebasedtargets.org/resources/legacy/2020/09/foundations-for-net-zero-full-paper.pdf

164 'Cross-Chapter Box 2 - Measuring Progress to Net Zero Emissions Combining Long-Lived and Short-Lived Climate Forcers', Chapter 1, Framing and Context, IPCC Special Report on 'Global warming of 1.5°C', https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf#%5B%7B%22num%22%3A585%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22FitH%22%7D%2C792%5D

165 'What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered', By Kelly Levin, Taryn Fransen, Clea Schumer and Chantal Davis, September 17, 2019, https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

these emissions (like methane from agricultural sources) are more difficult to phase out'[166]. Therefore it should be clearly mentioned from countries, organizations or companies whether their net-zero targets cover CO_2 only or all GHGs.

Carbon budget

"Global emissions budget"[167]is a threshold set by scientists, to calculate the current total accumulated emissions to avoid a particular level of temperature increase such as 1.5^{0}C and identify those emissions that remain. Since 1997 and the Kyoto Protocol ratification, CO_2 constitutes more than 65% of the GHGs and therefore is considered 'the most important among the GHGs leading to human-induced climate change'[168].In this context 'limiting global warming requires limiting the total cumulative global anthropogenic emissions of CO_2 since the pre-industrial period that is, staying within a total carbon budget'[169].As such, the carbon budget refers to 'the budget of all emissions and removals of CO_2' and the following image illustrates the relation of both 'the direct emission from the combustion of fossil fuels (coal, oil, gas and some from the production of cement) and the indirect ones coming from the land use change (eg. deforestation), with the CO_2 that is removed by the CO_2 sinks on land (vegetation uptake through photosynthesis) and oceans (through diffusion) within the last decade (2010-2019). That is why is so important we monitor, understand, and predict the evolution of the CO_2 sinks so we know how fast climate change will occur and by how much'[170].

166 'What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered', By Kelly Levin, Taryn Fransen, Clea Schumer and Chantal Davis, September 17, 2019, https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

167 Glossary, 'Foundations for Science-based net-zero target setting in the corporate sector' report, Science Based Targets Initiative, by CDP Disclosure Insight Action, September 2020, https://sciencebasedtargets.org/resources/legacy/2020/09/foundations-for-net-zero-full-paper.pdf

168 'Although other GHGs are more powerful per molecule in warming the planet than CO_2, the sheer amount of CO_2 emissions from human activities and the fact that some of the emissions stay in the atmosphere for hundreds to thousands of years, makes CO_2 the biggest challenge in combating climate change', Global Carbon Project, http://www.globalcarbonatlas.org/en/content/global-carbon-budget

169 'Emission Pathways and System Transitions Consistent with 1.5°C Global Warming', Summary for Policymakers, IPCC Special Report on 'Global warming of 1.5°C', https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf#%5B%7B%22num%22%3A585%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22FitH%22%7D%2C792%5D

170 Global Carbon Project, http://www.globalcarbonatlas.org/en/content/global-carbon-budget

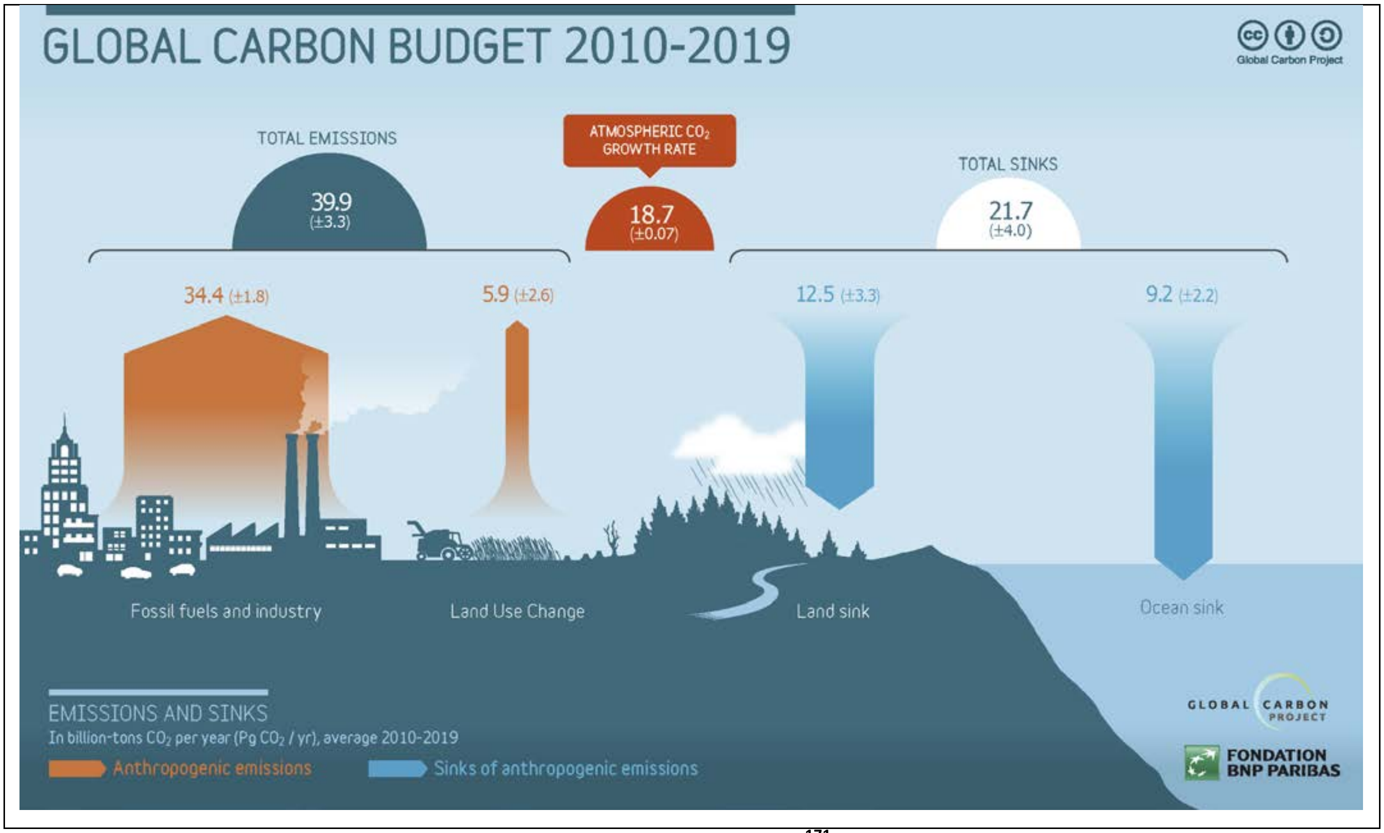


Fig. 20: Anthropogenic emissions and Sinks of anthropogenic emissions[171]

Carbon Capture and storage

Regarding the technologies available for removing CO_2 from the atmosphere, according to the International Energy Agency (IEA), broadly fall into three[172] broad categories:

1. Nature-based solutions including afforestation and reforestation[173]
2. Enhanced natural processes including land management approaches to increase the carbon content in soil through modern farming methods and less developed approaches like adding very fine mineral silicate rocks to soils or ocean fertilization and
3. Technology solutions including bio-energy with carbon capture and storage[174] (BECCS) and direct air capture, which involves the capture of CO_2 directly from the atmosphere' as shown in the following graph.

[171] Source: 'Friedlingstein et al. 2020 Global Carbon Budget 2020. Earth System Science Data', Global Carbon Project, http://www.globalcarbonatlas.org/en/content/global-carbon-budget

[172] 'Going carbon negative: What are the technology options?', by Sara Budinis, 31 January 2020, https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

[173] 'The repurposing of land use by growing forests where there was none before (afforestation) or re-establishing a forest where there was one in the past (reforestation)' 'Going carbon negative: What are the technology options?', by Sara Budinis, 31 January 2020, https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

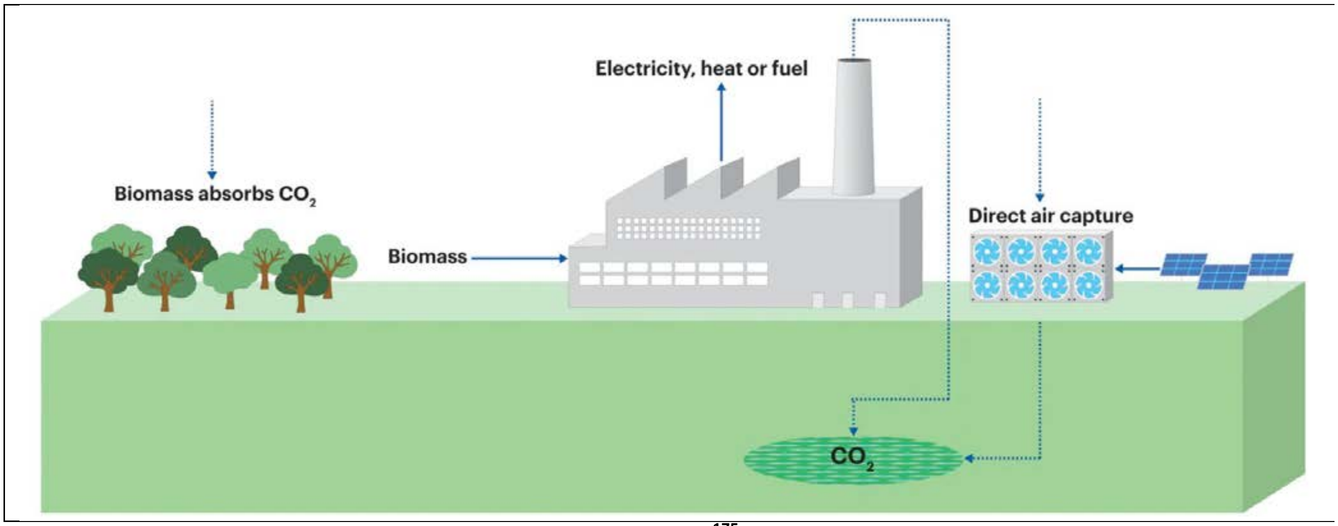


Fig.21: BECCS is one of the most mature carbon removal options[175]

'All the scenarios for keeping global temperature rise to 2^0C require "negative emissions"[176] - removing CO_2 from the atmosphere and storing it on land, underground or in the oceans. Although plenty of negative emissions technologies have been proposed, none are ready to be rolled out around the world, or, in some cases, even demonstrated to work at scale. No one single technology can solve climate change, but many have been proposed that could contribute to reducing atmospheric CO_2'[177].

1.3.2. Current Scenarios and Pathways

Scientists, policymakers and analysts, that have been long using climate-related scenarios to assess future vulnerability to climate change, after the Paris Agreement and the countries' commitments towards the new goal to limit the temperature levels to 1.5°C and keep global warming well below 2°C, started updating models, tools and methods so that the scenarios are consistent the COP21 and the net-zero targets.

174 'BECCS involves the capture and permanent storage of CO2 from processes where biomass is burned to generate energy. This can include power plants using biomass (or a mix of biomass and fossil fuels); pulp mills for paper production; lime kilns for cement production; and refineries producing biofuels through fermentation (ethanol) or gasification (biogas) of biomass. BECCS enables carbon removal because biomass absorbs CO2 as it grows, and this CO2 is not re-released when it is burned. Instead, it is captured and injected into deep geological formations, removing it from the natural carbon cycle', https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

175 Image source: https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

176

177

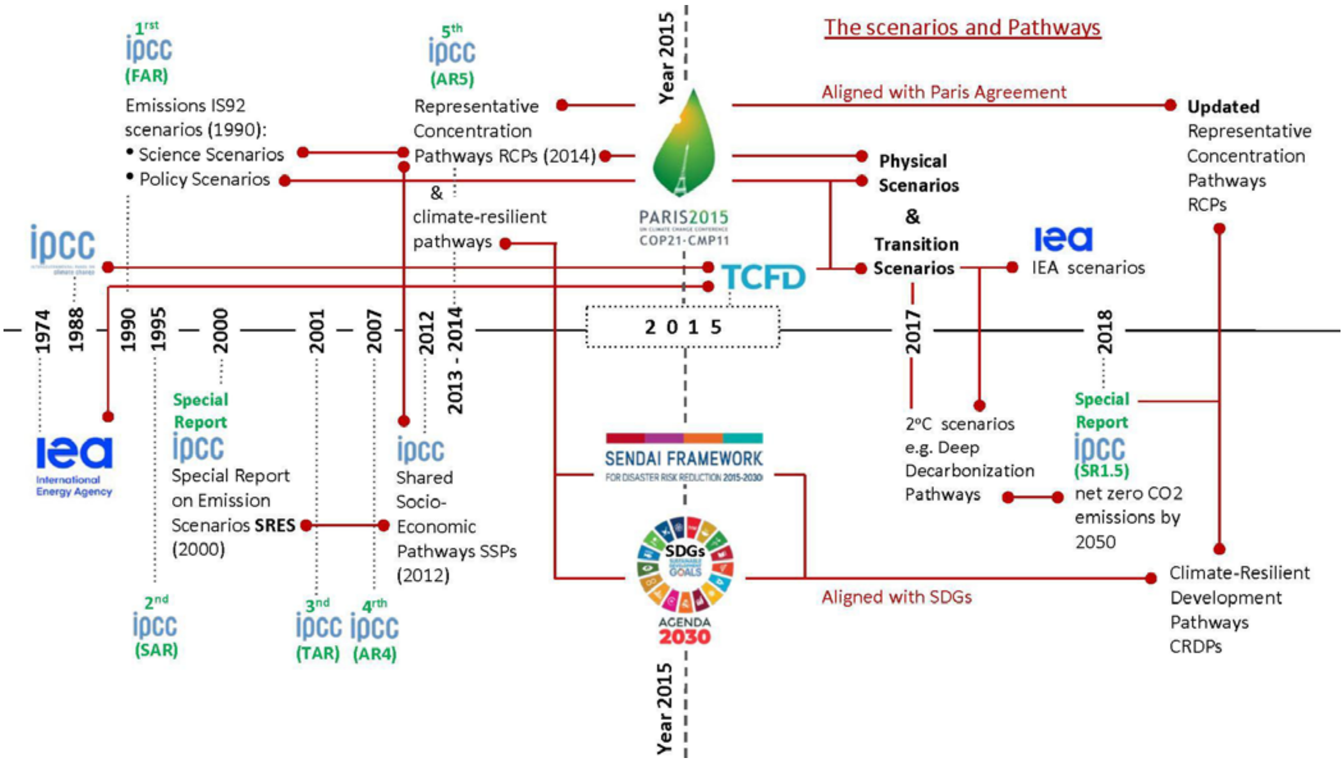


Fig. 22: A timeline illustrating the evolution of most-known scenarios and pathways, before and after the 2015 Paris Agreement

a. Aligned with SDGs - Climate-Resilient Development Pathways (CRDPs)

The Paris Agreement and the Sendai Framework for Disaster Risk Reduction 'recognize the need to collectively limit global temperature increase (mitigation) and the importance to enhance resilience across sectors and scales (adaptation). At the same time, both the Sendai Framework and the Sustainable Development Goals (SDGs) outcomes result from interconnected social and economic processes[178]. The Shared Socio-Economic Pathways (SSPs) are analyzed based on sustain

able development. 'They constitute an important first step in providing a framework for the integrated assessment of adaptation and mitigation and their climate–development linkages. However, in all SSPs, no pathway integrates or achieves all 17 SDGs'[179].

---

178 'Strengthening Climate Resilience: Guidance for Governments and Development Co-operation', https://www.oecd-ilibrary.org/sites/4b08b7be-en/1/3/2/index.html?itemId=/content/publication/4b08b7be-en&_csp_=c6f3f519f231a3bb752ee0777d54c922&itemIGO=oecd&itemContentType=book

179 Chapter 5, IPCC, 2018: 'Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty', https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter5_Low_Res.pdf

Nevertheless the Climate-Resilient Development Pathways (CRDPs) responses involve 'a range of strategies and actions to mitigate greenhouse gas (GHG) emissions and to strengthen climate resilience to achieve the Sustainable Development Goals (SDGs)'[180]. When firstly introduced in the IPCC AR5 report as "climate-resilient pathways", they were grouped into two main categories of responses[181]:

1. **Actions to reduce human-induced climate change and its impacts**, including both mitigation and adaptation toward achieving sustainable development (currently achieving the SDGs)
2. **Actions to ensure that effective institutions, strategies, and choices for risk management** will be identified, implemented, and sustained as an integrated part of achieving sustainable development.

'Because climate change challenges are significant for many areas, systems, and populations, **climate-resilient pathways will generally require transformations—beyond incremental or business-as-usual approaches**—in order to ensure sustainable development. The business-as-usual responses to climate change address immediate and anticipated threats based on current practices, management approaches, or technical strategies. The transformative responses, in contrast, involve innovations that contribute to systemic changes by challenging some of the assumptions that underlie business-as-usual approaches'[182].

The synergies and trade-offs of adaptation and mitigation options in different scales, countries and levels of development with targets to achieve sustainable development and the SDGs and towards a 1.5°C warmer world are described through the Climate-Resilient Development Pathways (CRDPs) in the following figure. It is also significant to highlight that the global pathways that emerge are accumulations of these local and national choices.

In the diagram, 'CRDPs in green arrows take as a starting point today's world (A) and lead to future worlds that range from climate-resilient (bottom) to unsustainable (top) (D). The CRDPs involve societal transformation rather than business-as-usual approaches, and all pathways involve adaptation and mitigation choices and trade-offs (B). Pathways that achieve the Sustainable Development Goals by 2030 and beyond, strive for net zero emissions around mid-21st century, and stay within the global 1.5°C warming target by the end of the 21st century, while ensuring equity and well-being for all, are best positioned to achieve climate-resilient futures (C)'[183].

---

[180] 'Strengthening Climate Resilience: Guidance for Governments and Development Co-operation', https://www.oecd-ilibrary.org/sites/4b08b7be-en/1/3/2/index.html?itemId=/content/publication/4b08b7be-en&_csp_=c6f3f519f231a3bb752ee0777d54c922&itemIGO=oecd&itemContentType=book

[181] Chapter 20, 'Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the IPCC', https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap20_FINAL.pdf

[182] Chapter 20, IPCC AR5, https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap20_FINAL.pdf

[183] Chapter 5, IPCC Special Report 'Global Warming of 1.5°C', IPCC, 2018, https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter5_Low_Res.pdf

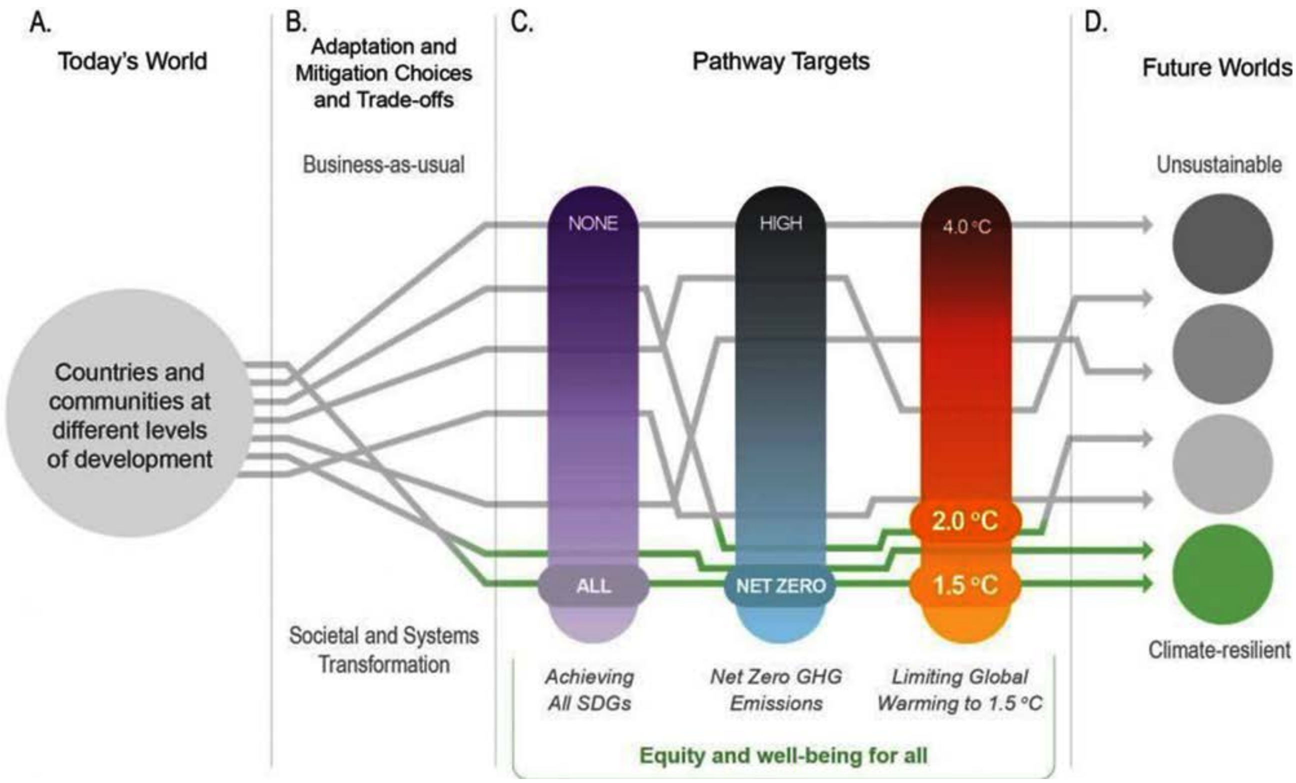


Fig. 23: Climate-resilient development pathways - CRDPs[184]

It is evident, that failing in achieving SDGs, net-zero GHG emissions by 2050, and limiting to 1.5°C global temperature, as in the case of overshooting[185] 1.5°C and reach 2°C instead, means that the CRDPs and other sustainable trajectories will be more difficult to be achieved and the future worlds impacts can be hardly estimated. 'Threats to sustainable development are greater if climate change is substantial rather than moderate. Similarly, opportunities for sustainable development are greater if climate change is moderate rather than substantial'[186].

b. Aligned with 1.5^{0}C or 2^{0}C targets - Updated RCPs and SSPs

With the release of the SSPs, modelers have expanded the range of mitigation targets. The IPCC AR5 (2014) report focused on RCP2.6, RCP4.5, RCP6.0 and the no-mitigation RCP8.5 pathway. As mentioned, each SSP looks at how each different RCPs could be achieved within the context of the underlying socioeconomic characteristics and shared policy assumptions of that world. However not all the previous SSPs were compatible with the RCPs limiting warming to 1.5^{0}C or 2^{0}C. After the Paris Agreement, in the framework of the SSPs and

184 Original image source: Source: (IPCC, 2018[12]), Global warming of 1.5°C, https://www.ipcc.ch/sr15/, found in https://www.oecd-ilibrary.org/sites/4b08b7be-en/1/3/2/index.html?itemId=/content/publication/4b08b7be-en&_csp_=c6f3f519f231a3bb752ee0777d54c922&itemIGO=oecd&itemContentType=book

185 'Temperature overshoot: The temporary exceedance of a specified level of global warming' Box SPM.1: Core Concepts Central to this Special Report', Summary for Policymakers, 'Global warming of 1.5°C, An IPCC Special Report, 2018, p.27, https://www.ipcc.ch/site/assets/uploads/2018/10/SR15_SPM_version_stand_alone_LR.pdf

186 Chapter 20, IPCC AR5, https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap20_FINAL.pdf

RCPs, new mitigation targets have been added. As shown in the following figure the new **radiative forcings by 2100 are 6.0, 4.5, 3.4, 2.6 and 1.9 watts/m2 corresponding to** RCP1.9, RCP3.4 while an RCP7.0 is planned to be added as well’[187].

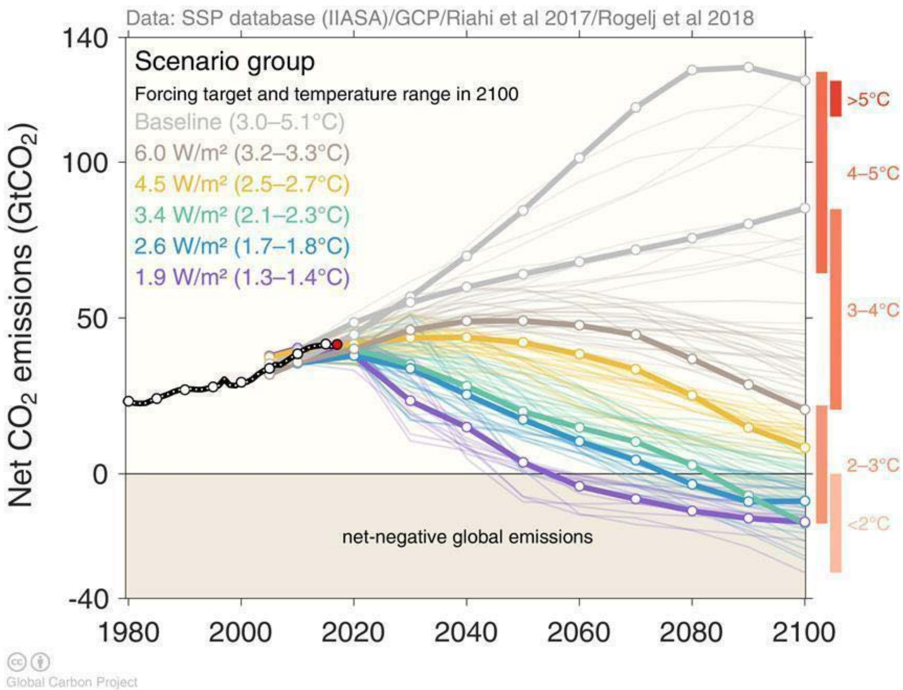


Fig.24: The new radiative forcings in 2100 are limited to 6.0, 4.5, 3.4, 2.6 and 1.9 watts per m2 (colored lines)[188]

- **RCP1.9** is a new pathway that focuses on limiting warming to below 1.5^{0}C, the aspirational goal of the Paris Agreement. Pre-Paris, the research community was focused on limiting warming to 2^{0}C as the most ambitious climate outcome. However, after the adoption of the Paris Agreement and the inclusion of 1.5^{0}C in its long-term temperature goal, there was a need to clearly understand the implications of this more ambitious target.
- **RCP3.4**, on the other hand, represents an intermediate pathway between the “very stringent” RCP2.6 and less stringent mitigation efforts associated with RCP4.5. It provides an alternative to explore given “recent discussions about the attainability of the 2^{0}C objective”. A variant of RCP3.4 is also being explored where forcings “substantially overshoot” the target mid-century and are brought back down by 2100 through the use of large amounts of negative emissions later in the century.

187 Combining SSPs and mitigation targets**,** ‘Explainer: How ‘Shared Socioeconomic Pathways’ explore future climate change’, Carbon Brief, 19 April 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

188 SSP no-climate-policy baseline scenarios are shown grey, while the various mitigation targets are shown in colour. Bold lines indicate the subset of scenarios chosen as a focus for running CMIP6 climate model simulations. Chart produced for Carbon Brief by Glen Peters and Robbie Andrews from the Global Carbon Project. https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

- **RCP7.0** will represent the medium-to-high end of the range of future emissions and warming, and is a baseline outcome rather than a mitigation target. It will fill an important gap by providing a pathway similar to the SSP2 "middle of the road" baseline, and may provide a compelling alternative or complement to the commonly used RCP8.5 for studies comparing mitigation and "business-as-usual" scenarios.

It is important to highlight that 'the RCPs are not new, fully integrated scenarios. They are consistent sets of projections of only the components of radiative forcing that are meant to serve as input for climate modeling, pattern scaling, and atmospheric chemistry modeling'[189]. They are the starting point for the scenario development taking also into consideration the 'key factors', the 'driving forces' that impact various futures and provide 'a consistent analytical thread across communities'.

On the other hand, each of SSPs questions whether near-term mitigation targets can be achieved. More specifically, 'while SSP1-'Sustainability–Taking the Green Road' and SSP4-'Inequality–A Road Divided' (see Appendix B) allow for quick global action in reducing emissions beyond those already agreed to in the nationally determined contributions (NDCs) under the Paris Agreement, other scenarios, such as SSP3-'Regional Rivalry–A Rocky Road' and SSP5-'Fossil-fueled Development–Taking the Highway', find that even these existing commitments are challenging to achieve in full'[190].

c. Transition and Physical Scenarios

After the 2015 international agreements, the scenarios explored so far, regarding mitigation, are the SSPs and the RCPs which have set new mitigation targets in order to be compatible with limiting warming to 1.5^{0}C or 2^{0}C temperatures. Those related to adaptation and to sustainable development are the Climate-Resilient Development Pathways (CRDPs), providing strategies and actions to strengthen climate resilience to achieve the Sustainable Development Goals (SDGs) and to mitigate greenhouse gas (GHG) emissions.

This paragraph analyzes this set of climate-related scenarios that should be considered at the organizations level, in order to 'understand how the physical and transition risks and opportunities of climate change might impact organizations business over time'[191]. The Financial Stability Board (FSB) and the recommendations by the Task Force on Climate-related Financial Disclosures[192] with the aim to assist and motivate organizations

189 'Description of the RCPs', RCP Database, 2009, International Institute for Applied Systems Analysis, https://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=about#citation

190 'Explainer: How 'Shared Socioeconomic Pathways' explore future climate change', Carbon Brief, 19 April 2018, https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

191 'Section B', "Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017, p.2, https://www.tcfdhub.org/scenario-analysis/

192 TCFD – Task Force on Climate-related Financial Disclosures, UNEP-Finance Initiative, https://www.unepfi.org/climate-change/tcfd/

incorporating scenario analysis in their business plans and strategies, broadly assigned climate-related scenarios into two categories[193]:

1. 'Transition scenarios', which refer to '**different policy outcomes and the energy and economic pathways that would result**, with some probability, i**n achieving temperature increases around the desired outcome**'. Most known scenarios and broadly used in this category are those prepared by The International Energy Agency (IEA), the International Renewable Energy Agency (IRENA) REmap, the Greenpeace Advanced Energy [R]evolution and the Deep Decarbonization Pathways Project (DDPP).
2. 'Physical scenarios' that '**start with a range of atmospheric GHG concentration and articulate the likely resulting temperature ranges'**. In this category the most well-known and used are the IPCC RCPs

In this regard, each organization can choose over a range of publicly available scenarios or develop new ones, taking into consideration 'the different combination of key factors, the message and the structure that each scenario should have'. Nevertheless, following the 2015 agreed international climate change commitments, among the scenarios used for strategic planning it is a prerequisite for an organization to take into account a scenario in line with a 2°C pathway, firstly because not all transition scenarios proposed in the TCFD report are aligned with Paris Agreement targets. Secondly a 2°C scenario 'provides a common reference point that will support the evaluation, by analysts and investors, of the potential magnitude and timing of transition-related implications for individual organizations, across different organizations within a sector, and across different sectors'[194].

Transition Scenarios

'Transition scenarios typically present assumptions about the development of climate policies and the transition to and deployment of "climate-friendly" technologies to limit GHG emissions'[195]. Since the transition scenarios depend on the key policies that affect the rate of change - either short or long-term transition to low-carbon technologies and economy - they include all policy scenarios mentioned in previous chapters and new ones developed to be consistent with the current policies and climate targets as shown in the table 2 below.

193 The categories are extensively analyzed in the 'Appendix 1: IEA and IPCC Climate Scenarios', "Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017, p.2, https://www.tcfdhub.org/scenario-analysis/

194 'c. NDCs and the Importance of 2°C Scenarios, TCFD, June 2017, p.19, https://www.tcfdhub.org/scenario-analysis/

195 Appendix 1: IEA and IPCC climate scenarios, TCFD, June 2017, p.19, https://www.tcfdhub.org/scenario-analysis/

Table 2: Publicly available, current and well-known transition and physical scenarios[196]

SCENARIOS A scenario describes a path of development leading to a particular outcome Doesn't represent a full description of the future, highlights central elements of a possible future and the key factors that will drive future developments.			PARIS AGREEMENT 2°C LIMIT/1.5°C alignment	TIMEFRAME	DESCRIPTION
TRANSITION SCENARIOS	International Energy Agency - **IEA Scenarios**	**IEA WEO Current Policies** Scenario (projected to generate warming of 6°C)	NO NEW MEASURES	-	**IEA Scenarios**: widely used and reviewed for transition to a low carbon economy. The IEA **data and scenarios capture the entire energy chain,** but not "non-energy" sectors such as land use/land use change/forestry (LULUCF) and process emissions from industry that do not involve fuel combustion. They can be **used to qualitatively assess risks associated with different pathways,** but are not suited to producing precise estimates
		IEA WEO New Policies Scenario (projected to generate warming of 4°C)	NEW MEASURES BUT 4°C WARMING	-	
		IEA INDC Paris Agreement Scenario (projected to limit warming to 2.6°C)	BASED ON INDCs PARIS AGREEMENT	2012-2030	
		IEA Bridge Scenario (keeps world on path to 2°C limit to 2025, but more needed after 2025)	NOT ITSELF A 2°C PATHWAY	2012-2025	
		IEA WEO 450ppm Scenario (projected to limit warming to 2°C)	YES	2012-2040	
		IEA ETP 2DS Scenario (projected to limit warming to 2°C)	YES	2013-2050	
	2 degrees Celsius Scenarios - **2°C Scenarios**	**International Renewable Energy Agency** (IRENA) **REmap** (2016) - analysis of 40 countries representing 80% of global energy use & focus on possible technology pathways	YES	2012-2030	**A so-called 2°C scenario** lays out a pathway and an emissions trajectory consistent with limiting the average global temperature increase to a temperature range around 2°C. The four examples of publicly available 2°C scenarios are: **(1)** used, referenced, and issued by an independent body; **(2)** supported by publicly available data sets; **(3)** updated and peer-reviewed on a regular basis; and **(4)** linked to functional tools (e.g., visualizers, calculators, and mapping tools) that can be applied by organizations.
		Greenpeace Advanced Energy [R]evolution (5th Edition) - faster introduction of technologies for complete decarbonization	YES	2010-2050	
		Deep Decarbonization Pathways Project (DDPP) - what is required to reduce emissions sector by sector and over time, for each physical infrastructure of the 16 largest GHG-emitting countries	YES	2010-2050	
		IPCC RCP 2.6 (i) sector decarbonization by 2050 (ii) electrifying energy services (iii) bioenergy substitutes fossil fuel in transport, buildings, industry (iv) negative emissions in carbon sinks by 2100	YES	peak around 2020 - net negative before 2100	
PHYSICAL SCENARIOS	**IPCC** Representative Concentration Pathway **(RCP)** Scenarios	**RCP8.5 :** (i) **high-emissions scenario** (ii) with a future with no policy changes to reduce emissions (iii) increasing GHG emissions and high atmospheric GHG concentrations - **Business-As-Usual Scenario**	NO NEW POLICIES	-	The **IPCC's four RCPs scenarios (1)** describe the **climate impacts of a range of possible future GHG emissions and consequent trajectories** of atmospheric GHG concentrations **(2)** They fix the amount of GHG concentration in the atmosphere and analyze the resulting changes in global temperatures at various future points i.e. out to 2035, mid-century and end of century **(3)** Their climate outcomes such as global temperature are highly comparable across the models **(4) Downscaling these global climate models** to local impacts (from global climate models to assess new infrastructure projects) is a work **in progress.**
		RCP6.0 : (i) **high-to-intermediate** emissions scenario (ii) GHG emissions peak at around 2060	2.0-3.7°C WARMING	GHG emissions peak at 2060	
		RCP4.5 : (i) **intermediate-emissions** scenario (ii) with a future with emissions reductions and GHG emissions decline at 2040 (iii) falls short of the 2°C limit/1.5°C goal (iv) aligned with the GHG emissions from implementation of the 2015 NDCs (out to 2030)	1.7-3.2°C WARMING	2015-2030	
		RCP2.6 : (i) **in line with the Paris Agreement's** (ii) consistent with ambitious reduction of GHG emissions (iii) GHG emissions with peak around 2020, then decline on a linear path (iv) become **net negative before 2100.**	YES	peak around 2020 - net negative before 2100	

Each scenario starts with different assumptions regarding the timing that policy changes will take place, the technology adoption, the required changes in energy mix, and other factors to achieve a climate-friendly

196 The information in the table is based on the report "Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017, https://www.tcfdhub.org/scenario-analysis/

economy[197].In this regard, one way to identify which of the publicly available transition scenarios is applicable to the organization's strategic planning; a comparison among the scenarios is provided and is based on the following various key drivers[198].

- Policy and Demand, such as Energy Demand, CO_2 Price and Energy efficiency
- Emerging technologies, like Solar Photovoltaic (PV) Deployment, Electric Vehicles (EV) Deployment, Carbon Capture Systems (CCS) Deployment and Bio-energy, and
- Energy mix, more specifically the percentages of the Renewables adopted and Nuclear capacity expected
- Outcomes referring to the CO_2 emissions reductions measured in Gt and the estimated year of achievement.

As presented in table 2, the IEA scenarios and data capture the entire energy chain, but not "non-energy" sectors such as land use/land use change/forestry (LULUCF) and process emissions from industry that do not involve fuel combustion. They can be used to qualitatively assess risks associated with different pathways, but are not suited to producing precise estimates. While a so-called 2°C scenario lays out a pathway and an emissions trajectory consistent with limiting the average global temperature increase to a temperature range around 2°C. The four examples of publicly available 2°C scenarios are: (1) used, referenced, and issued by an independent body; (2) supported by publicly available data sets; (3) updated and peer-reviewed on a regular basis; and (4) linked to functional tools (e.g., visualizers, calculators, and mapping tools) that can be applied by organizations.

From the transition scenarios presented, the Deep Decarbonization Pathways (DDPs) is the most relevant to the research's topics. (i) Firstly because 'DDPproject fills a gap in the climate policy dialogue by providing a clear and tangible understanding of what will be required for countries to reduce emissions, consistent with the 2°C limit'. (ii) It also provides guidelines for change, 'sector by sector and over time, for each physical infrastructure' from the countries analyzed, relating them to the technological and cost requirements and to each country's emissions reduction goal. (iii) 'Finally the DDPs begin with an emissions target in 2050 and determine the steps required to get there. This tool therefore allows the user to create any number of 2°C pathways'[199].

Deep Decarbonization Pathway Project[200]

Consisted with keeping global warming well below 2°C and with the goal to lead economies towards a carbon neutral world by 2050, the Deep Decarbonization Pathways Project (DDPP) initiative consists of research teams

---

197 '1.Transition scenarios', TCFD, June 2017, p.15, https://www.tcfdhub.org/scenario-analysis/

198 'd. Comparisons of Relevant Parameters and Signposts', TCFD, June 2017, p.15, https://www.tcfdhub.org/scenario-analysis/

199 'Box A2, Other Scenarios', TCFD, June 2017, p.18, https://www.tcfdhub.org/scenario-analysis/

200 The DDP initiative is led by IDDRI (Institute for Sustainable Development and International Relations, (French: Institut du Développement Durable et des Relations Internationales) which met the the Sustainable Development Solutions Network (SDSN) and formed the secretariat of the Deep Decarbonization Pathways Project (DDPP) platform, https://ddpinitiative.org/about/, https://www.iddri.org/en/project/deep-decarbonization-pathways-project

from 16 countries[201], which represent more than 70% of current global CO2 emissions from energy. As presented in the following figure 21, the DDP countries emissions trajectories present a peak of emissions around 2030 with the ambition, by 2050, the aggregate emissions to be 57% below 2010 levels.

The research teams from the 16 courtiers create practical pathways to deep greenhouse gas emissions reductions using country-based energy research. More specifically they develop 'deep decarbonization pathways (DDPs) and sector-by-sector blueprints of changes over time for each physical infrastructure of the 16 courtiers such as: power plants, vehicles, buildings, and industrial equipment—that inform decision makers about the technology requirements and costs of different options for reducing emissions'[202]. In this context the Deep Decarbonization Pathways cannot be considered as forecasts of future or predictions. They simply 'start with an emissions target in 2050 and determine the steps required to get there' by answering the questions:

- how can changes towards sectors' and infrastructures' de-carbonization be achieved,
- how can the specific context and development objectives of each country be taken into account and
- what policies are needed, both at the local and international levels?[203]

All deep decarbonization pathways incorporate "three pillars" [204] of energy system transformation:

- Energy efficiency and conservation: Greatly improved energy efficiency in all energy end-use sectors including: (1) passenger and goods transportation, through improved vehicle technologies, smart urban design, and optimized value chains; (2) residential and commercial buildings, through improved end-use equipment, architectural design, building practices, and construction materials; and (3) industry, through improved equipment, production processes, material efficiency, and re-use of waste heat.
- Low-carbon electricity: Decarbonization of electricity generation through the replacement of existing fossil-fuel-based generation with renewable energy (e.g. hydro, wind, solar, and geothermal), nuclear power, and/or fossil fuels (coal, gas) with carbon capture and storage.
- Fuel Switching: Switching end-use energy supplies from highly carbon-intensive fossil fuels in transportation, buildings, and industry to lower carbon fuels, including low-carbon electricity, other low-carbon energy carriers synthesized from electricity generation or sustainable biomass, or lower-carbon fossil fuels.

---

201 Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Africa, South Korea, the United Kingdom, and the United States.

202 'Pathways to deep decarbonization - 2015 Report Executive Summary' report, IDDRI https://www.iddri.org/sites/default/files/import/publications/ddpp_exesum.pdf

203 IDDRI, https://www.iddri.org/en/project/deep-decarbonization-pathways-project

204 GSDR 2015 Brief, 'Brief Pathways to Deep Decarbonization, a Problem Solving Approach for a 2°C Society' By the SDSN/IDDRI Deep Decarbonization Pathways Project Team Henri WAISMAN (IDDRI), Carl MAS (SDSN) and Emmanuel GUERIN (SDSN) https://sustainabledevelopment.un.org/content/documents/6474Pathways%20to%20deep%20decarbonizations,%20a%20problem%20solving%20approach%20for%20a%202%20degree%20society.pdf

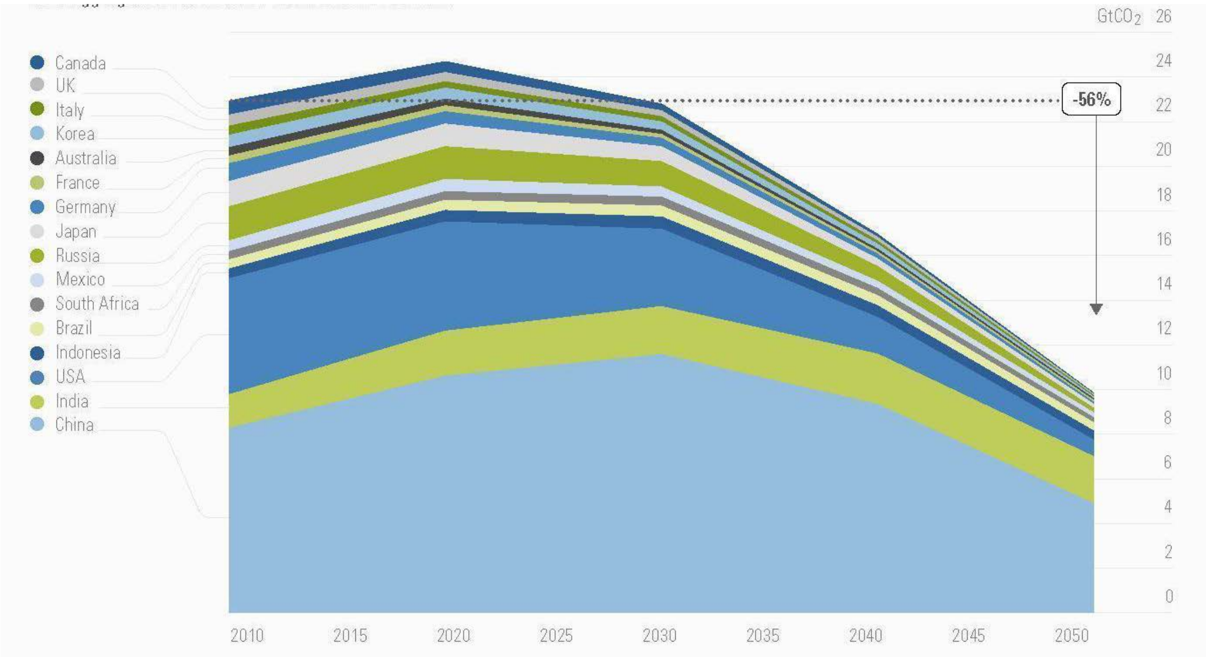


Fig. 25: Emissions trajectories for energy CO_2, 2010-2050, showing most ambitious reduction scenarios for all DDPP countries [205]

'The DDPs show multiple ways of implementing the three pillars, with country-specific strategies, technology mixes, and sequences of action. However, because of the interactive effects between them -for example, using low-carbon electricity in combination with the electrification of vehicles- deep decarbonization cannot be achieved if any of the pillars is absent or implemented at insufficient scale.'[206] To avoid conflicts or lack of implementation of all the pillars, since different sectors and organizations are involved, one way to scale-up deep decarbonization, would be the enhancement of 'low-carbon technology public private partnerships (PPPs) to accelerate research, development, demonstration and deployment (RDD&D)'[207]. In a way, a partnership between private and public sector is partially achieved through the Paris Agreement Nationally Determined Contributions NDCs, because 'the DDP initiative invites countries to communicate "long-term low emission development strategies" in the revised NDCs that portray countries' official commitments. Finally it supports the efforts of the Carbon Neutrality Coalition that brings together national and local governments, as well as private companies committed to a decarbonization path.'[208]

Physical scenarios

205 Source: 'Pathways to deep decarbonization-2015 executive summary' report, IDDRI, p.4 https://www.iddri.org/sites/default/files/import/publications/ddpp_exesum.pdf

206 'Pathways to deep decarbonization - 2015 Report Executive Summary' report, IDDRI https://www.iddri.org/sites/default/files/import/publications/ddpp_exesum.pdf

207 GSDR 2015 Brief, https://sustainabledevelopment.un.org/content/documents/6474Pathways%20to%20deep%20decarbonizations,%20a%20problem%20solving%20approach%20for%20a%202%20degree%20society.pdf

208 https://ddpinitiative.org/about/

'The patterns of physical impacts attributable to climate change can be termed "**physical climate scenarios**." Physical climate scenarios typically present the results of global climate models (referred to as "general circulation models") that show the response of the Earth's climate to changes in atmospheric GHG concentrations'[209].

As explored in the previous chapters, the scenarios used for climate change model simulations - carried out under the framework of the Coupled Model Inter-comparison Project Phase 5 (CMIP5) and the World Climate Research Program - were the IPCC's Representative Concentration Pathways (RCPs)[210] and in this regard they are considered examples of physical climate change scenarios as explained in Table 2. In a wider perspective the 'first Science Scenarios' prepared by WGI in 1990 which illustrate the way in which the atmosphere and climate would respond to changes in emissions can be also considered as physical scenarios.

What remains challenging though is the downscaling of global climate models to local impacts. Still, 'several governments and international financial institutions are now using "downscaled" data from global climate models to assess new infrastructure projects despite the difficulties in projecting accurately extreme weather events at local levels (e.g., floods, precipitation patterns, and droughts)'[211].Physical risk scenarios assist organizations in exploring questions such as:

- What type of physical impacts might there be?
- What if the physical consequences of climate change become more severe?
- When, where, to whom, and to what degree might they be felt?

Using the data and outcomes of climate modeling available in CMIP5, for key factors such as surface temperature change, precipitation, water supply and demand, Sea level change, floods, drought etc. allows for comparisons across different scenarios.[212]

Transitional and Physical impacts and Transitional and Physical scenarios

The synergies and trade-offs of adaptation and mitigation options in different scales, countries and levels of development with targets to achieve sustainable development towards less than 1.5°C warmer world are more evident in the case of the organizations' level. 'While some organizations will likely be more affected by transition risk (e.g., fossil fuel and energy-intensive manufacturers), others will be more affected by physical climate risk (e.g., those reliant upon agriculture or long-lived infrastructure)'. Both transition risks and physical

---

209 Appendix 1: IEA and IPCC climate scenarios, TCFD, June 2017, p.19, https://www.tcfdhub.org/scenario-analysis/

210 'The RCP scenarios fix the amount of GHG concentration in the atmosphere and analyze the resulting changes in global temperatures (and other variables such as precipitation) at various future points (i.e., out to 2035, mid-century [2046-65], and end of century [2081-2100]) relative to pre-industrial levels', paragraph 'a. Publicly Available Scenarios,' TCFD, June 2017, p.24, https://www.tcfdhub.org/scenario-analysis/

211 '2. Physical Scenarios', TCFD, June 2017, p.24, https://www.tcfdhub.org/scenario-analysis/

212 'Figure A7, Comparison of Relevant Sign posts within Physical Climate Scenarios', TCFD, June 2017, p.27, https://www.tcfdhub.org/scenario-analysis/

risks have to be taken into consideration as they are complementary and both are 'required in understanding the full implications of climate change and the resilience of organizations to those implications'[213]

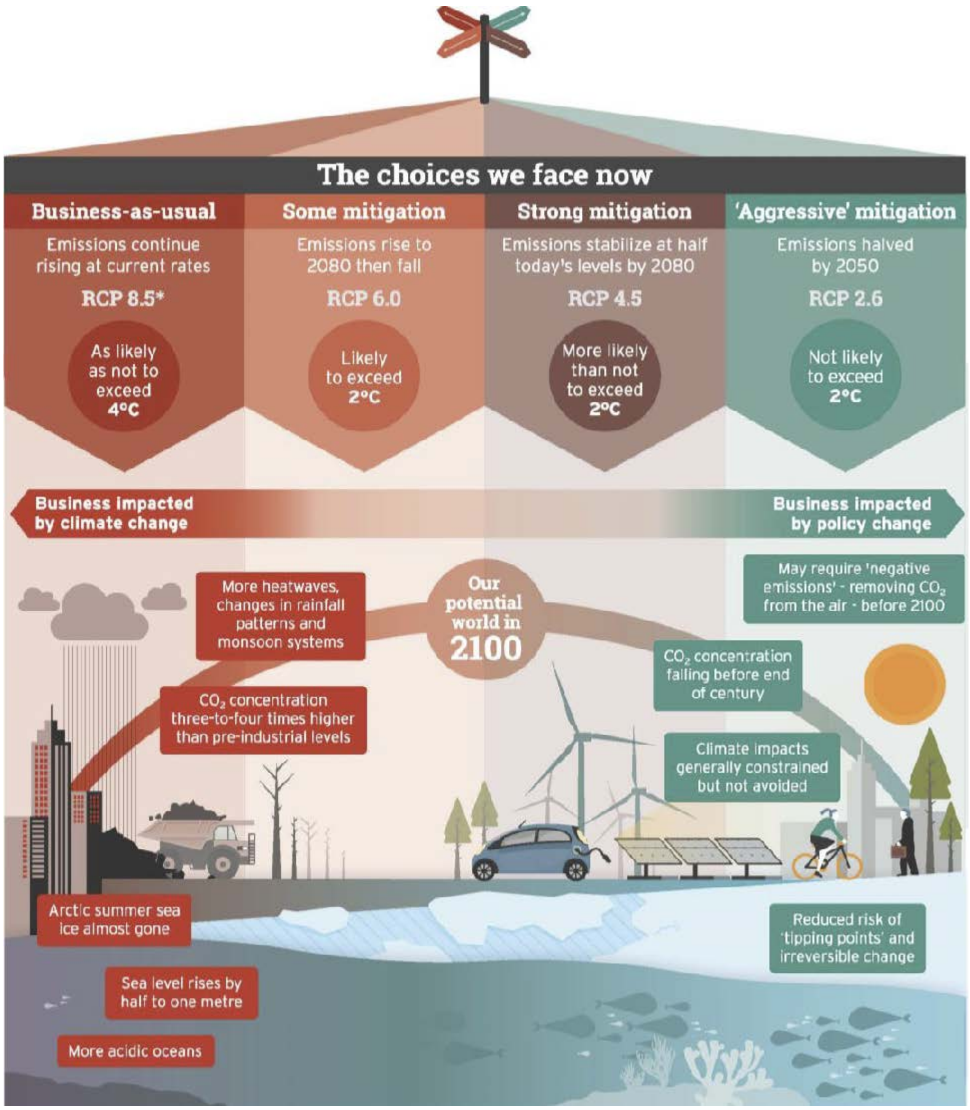


Fig. 26: The Carbon Crossroads[214]

As shown in the previous figure xx the interplay between transition and physical impacts in different scenarios will impact businesses differently. Lower transition risk might result in higher levels of physical risk from climate change in a business. In this context, 'organizations need to use scenarios that allow them to consider a range

[213] 'Appendix 1: IEA and IPCC climate scenarios', TCFD 2017, p.13, https://www.tcfdhub.org/scenario-analysis/

[214] Image original Source: Intergovernmental Panel on Climate Change, Fifth Assessment Report (AR5), Climate Change: Action, Trends, and Implications for Business, Cambridge University Press (2013), presented as Figure A2: 'Interplay between Transition and Physical Impacts' in the 'Technical Supplement - The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities' report, TCFD 2017, p.14

of potential transition and physical effects on their strategy and financial planning and how these effects compare to various publicly available scenarios and national goals'[215]

1.4. On Urgency, "Climate Action" goal beyond 2020

"Despite clear emission reduction objectives agreed in the 2015 Paris Agreement on Climate Change, global greenhouse emissions have continued to climb until 2019, where they flatlined. There is now scientific consensus[216] that global emissions must drop by 50% over the next decade for the world to have a chance of staying at 1.5 degrees of global warming and thus avoid the most catastrophic consequences of climate change. This has clear and immediate implications for businesses."[217]

The impacts of climate change are now inevitable and apparent, with signs that several alarming tipping points will be reached, particularly in excessive air pollution, water stress, and biodiversity loss that undermines ecosystems.

"The message on the urgency of environmental and climate risks is getting through. In its 15th Global Risks Report published in January 2020, the World Economic Forum (WEF) found that, for the first time in the report's history, **all of the "top long-term risks by likelihood" are environmental, and climate change is rated as the biggest global threat**."[218]

One of the main questions that the proposed research explores is if supporting climate change is a priority for investors?

Governments and businesses should use the lessons learned and opportunities arising from this crisis to accelerate the transitions needed to achieve the Paris Agreement and the Sendai Framework for Disaster Risk Reduction 2015–2030, ***redefine our relationship with the environment, and make systemic shifts and transformational changes t****o become low-greenhouse-gas emission and climate-resilient economies and societies.*[219]

In this context, many existing ESG regimes, as the EU ESG regime, are being redeveloped to align with the 17 SDGs due to their commitment to the UN 2030 Agenda.

"Of the SDGs, the goal of combating climate change (SDG 13) has been identified by the EU political institutions as the most pressing, after adopting the UN Paris Climate Change Agreement."[220]

215 'Figure A2', TCFD 2017, p.13, https://www.tcfdhub.org/scenario-analysis/

216 Point C1 of the Summary for Policy Makers of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5ºC, https://www.ipcc.ch/sr15/ (Source: EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020)

217 EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020

218 WEF Global Risks Report 2020, https://www.weforum.org/reports/the-global-risks-report-2020 ((Source: EU Technical Expert Group on Sustainable Finance, Taxonomy: Final report of the Technical Expert Group on Sustainable Finance, March 2020)

219 SDG 13"Climate Action", https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf

220 E.U. Environmental Social Governance (ESG) Regulations Guide, 2020

Sustainable Development Goal 13 "Climate action" targets

5 Targets linked to climate action:[221]

- Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- Target 13.2: Integrate climate change measures into national policies, strategies, and planning
- Target 13.3: Improve education, awareness-raising, and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning
- Target 13.a: Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible
- Target 13.b: Promote mechanisms for raising capacity for effective climate change-related planning and management in the least developed countries and small island developing States, including focusing on women, youth, and local and marginalized communities

[221] https://www.unenvironment.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-13

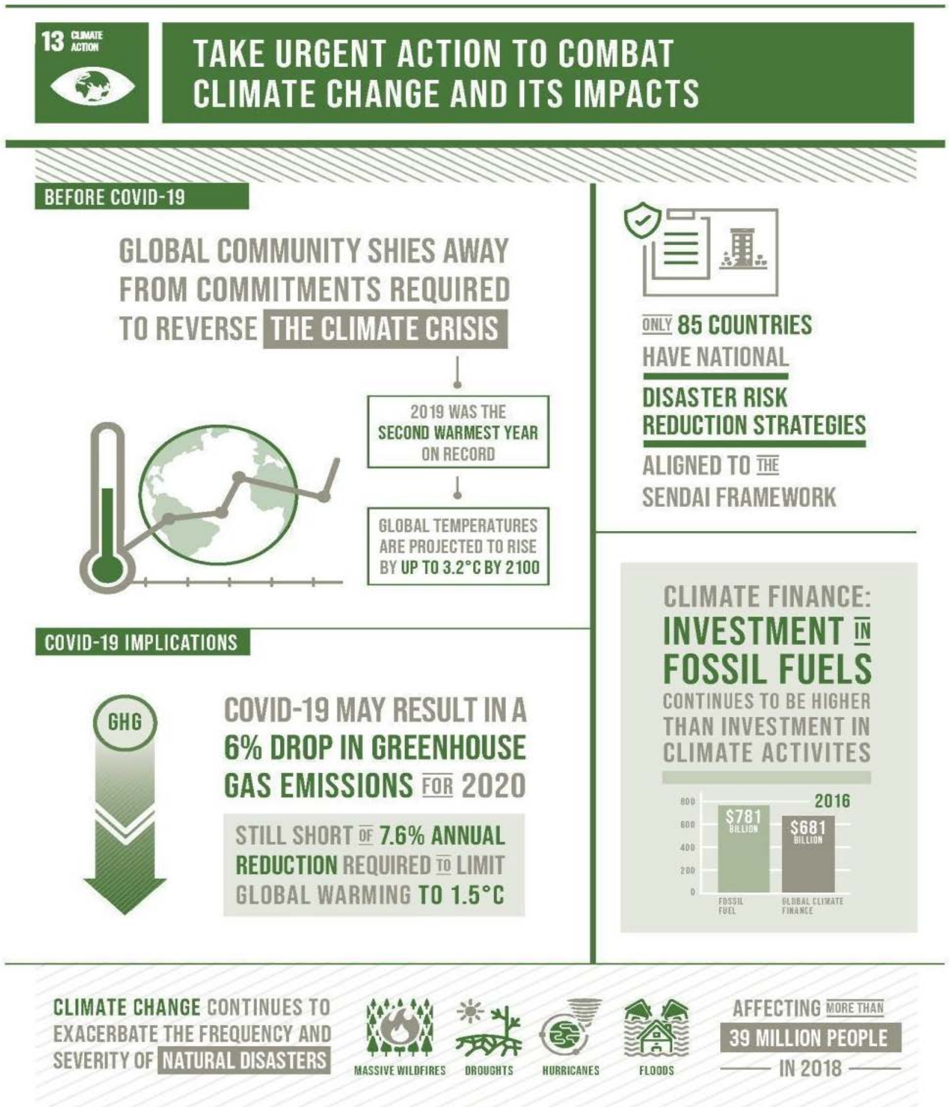


Fig. 27: SDG No.13." Climate Action" concerning Covid-19 Implications, as presented in the Sustainable Development Goals Report 2020 [222]

In the Sustainable Development Goals Report 2020 regarding Climate Action SDG 13,[223] some indicators highlight existing trends to the prioritization of projects:

- **Financing for climate action has increased substantially, but it continues to be surpassed by investments in fossil fuels.** Global climate-related financial flows saw a 17 percent rise from 2013–2014 to 2015–2016, from $584 billion to $681 billion. The spurt in growth was largely due to high levels of new private investment in renewable energy, representing the largest segment in total climate-related flows. However, investments in climate activities across sectors continued to surpass those related to

[222] https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf
[223] Climate Action, https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf

fossil fuels in the energy sector, which totaled $781 billion in 2016. To achieve a low-carbon, climate-resilient transition, a much greater scale of annual investment is required. Climate-related financing provided by developed countries to developing countries increased by 14 percent in 2016, reaching nearly $38 billion. **Climate change mitigation remained the predominant focus, at $24.3 billion, followed by climate change adaptation ($5.6 billion) and cross-cutting issues ($5.1 billion).**

- **Most developing countries have begun to formulate plans to strengthen resilience and adapt to climate change.** National adaptation plans (NAPs) help countries achieve the global goal of adaptation under the Paris Agreement – namely, to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change. In 2019, at least 120 of the 153 developing countries had undertaken activities to formulate and implement NAPs, an increase of 29 countries over the previous year. Eighteen countries, including five Least Developed Countries LDCs and four small-island developing States, have completed and submitted their NAPs to the United Nations Framework Convention on Climate Change Secretariat. Many others are at various stages in the process.
- **Despite its glaring relevance, progress in meeting the 2020 disaster risk reduction** target **has been slow.** The Sendai Framework for Disaster Risk Reduction 2015–2030 aims to reduce existing – and prevent new – disaster risk through clear targets and priorities for action, following the 2030 Agenda for Sustainable Development. Target (e) of the Sendai Framework, which focuses on establishing national and local disaster risk reduction strategies, has a 2020 deadline. As of April 2020, 85 countries – slightly over 40 percent – reported that they have national disaster risk reduction strategies aligned, to some extent, to the Sendai Framework, with six of the countries reporting fully aligned national strategies.

1.5. Progress against climate goals

The scope of this chapter is to highlight the documentation of the progress towards the goals after 2015 through some of the most recent reports, tracking progress platforms and initiatives. The selected literature of this chapter is indicative and applies to the context and the purpose of this research.

1.5.1 Emissions gap and Adaptation gap reports 2020

Emissions gap reports (EGR) are issued on an annual basis for over a decade, “assessing the gap between countries’ pledges on greenhouse gas emissions reductions and the reductions required to deliver a global temperature increase of below 2°C by the end of this century.”[224] On the other hand, the latest Adaptation gap report 2020 (AGR20)[225] is the 5th edition of a series of reports that presented adaptation gaps since the first release in 2014. The AGR14 was prepared “for the twentieth session of the Conference of the Parties (COP 20,

224 UN Environment Emissions Gap Report, https://unepdtu.org/project/un-environment-emissions-gap-report/

225 The fifth edition of the UNEP Adaptation Gap Report looks at progress in planning for, financing and implementing adaptation – with a focus on nature-based solutions, UNEP, UNEP DTU Partnership, Adaptation Gap Report 2020, 14 January 2021, https://www.unenvironment.org/resources/adaptation-gap-report-2020?_ga=2.25128506.1422488007.1611823088-1674895308.1609656262

in Lima), in response to requests by UNFCCC Parties for an assessment on adaptation, complementary to the annual Emissions Gap Report"[226].

The 11th Emissions Gap report was released on December 9, 2020, while a month later, on January 14, 2021, the Adaptation Gap report was published, meaning that the data, topics, and conclusions of each report have been produced during the year of Covid-19 crisis which has been the primary issue of all nations, International Institutions and private and public funds, putting their effort to overcome the social and economic difficulties and disruption caused worldwide.

Emissions gap report 2020

As per the latest report (2020): "the gap between estimated future global GHG emissions, if countries implement their climate mitigation pledges, and the global emission levels from least-cost pathways that are aligned with achieving the Paris Agreement goal of limiting global warming to well below 2°C and pursuing 1.5°C, meaning the difference between where we will likely be and where we need to be is known as the 'emissions gap'".

The lessons[227] learned from the emissions gap assessments between 2009-2019 indicate that the continuously growing GHG emissions are synonymous with a decade lost with no significant change in the global emissions trend. Secondly, the emissions gap has been larger than ever. The previous Emissions gap reports concluded that the gap could still be bridged if immediate action was taken. Key parameters to transformational change were considered: the decarbonizing energy supply and transport, the balanced transition needed in the coal phasing process, and the Nature-based Solutions (NbS), introduced for CO2 reduction. Finally, since 2015 the non-State and sub-national actors, innovation, and new solutions were highlighted as important factors for long-term carbon neutrality (net-zero emissions).

However, this year's Emissions Gap report differentiates from the previous reports, trying to assess the impacts of the Covid-19 pandemic and reveal the rescue and recovery measures that have been taken. The main topics are structured on the analysis of (i) Global emissions trends and G20 status and outlook, (ii) the 2030 emissions gap[228], (iii) bridging the gap exploring the implications of current Covid-19 fiscal rescue and recovery measures

[226] UN Environment Adaptation Gap Report 2020, https://www.unep.org/resources/adaptation-gap-report-2020

[227] "Lessons from a decade of emissions gap assessments" report published in 2019, UN Environment, https://wedocs.unep.org/bitstream/handle/20.500.11822/30022/EGR10.pdf

[228] The 2030 emissions gap is another 10 years expansion, a shift from 2020 to 2030 of the pledges of 85 countries to reduce their emissions. The initial target year 2020 was set in the Copenhagen Accord 2009 (The 15th session of the COP to the UNFCCC) and the Cancun Agreement 2010, where the pledges and temperatures of the Copenhagen Accord were formalized a year later at the 2010 United Nations Climate Change Conference in Cancun. The set of significant decisions of Cancun Agreement are outlined as: (i) Mitigation, (ii) Transparency of actions, (iii) Technology, (iv) Finance, (v) Adaptation, (vi) Forests and (vii) Capacity building. With the Paris Agreement, the focus of the gap assessment shifted from 2020 to 2030 as the new target year and started to include the 1.5°C limit of the agreement. https://unfccc.int/process-and-meetings/conferences/past-conferences/copenhagen-climate-change-conference-december-2009/copenhagen-climate-change-conference-december-2009, https://unfccc.int/process/conferences/the-big-picture/milestones/the-cancun-agreements https://wedocs.unep.org/bitstream/handle/20.500.11822/30022/EGR10.pdf

(iv) bridging the gap and the role of international shipping and aviation[229] (v) bridging the gap and the role of equitable low-carbon lifestyles.

Despite the disappointing recognition that the efforts over the last years are not on track to bridge the gap, the ERG20 states that "the most significant and encouraging development in terms of climate policy in 2020 is the growing number of countries that have committed to achieving net-zero emissions goals by around mid-century, consistent with the Paris Agreement temperature goal".[230] Some of the main findings[231] highlighting the progress towards the goals so far can be outlined in the following points:

- GHG emissions up to 2019

GHG emissions continued to grow for the third consecutive year in 2019**,** indicating that the 7 percent decrease in 2020 compared with 2019 emission levels due to COVID-19 offers only a short-term reduction in global emissions, while at the same time, atmospheric concentrations of GHGs continue to rise.

For the shipping and aviation sectors examined within the 2020 report, domestic and international shipping and aviation emissions (currently account for around 5 percent of global CO2 emissions) are projected to increase significantly. Current policy frameworks to address emissions in these sectors have been identified as weak.

This year's findings also revealed that "around two-thirds of global emissions are linked to private household activities according to consumption-based accounting." Nevertheless, average consumption emissions vary substantially between countries. For example, current per capita consumption emissions in the United States of America are approximately 17.6 tons CO2e per capita, around ten times that of India at 1.7 tons per capita. By contrast, the European Union and the United Kingdom together have an average footprint of approximately 7.9 tons per capita."[232]

- Countries' commitments and current policies

The number of countries committing to net-zero emissions goals has grown during 2020. These commitments, however, must be reflected in the new NDCs expected to be delivered in COP26 and need to be translated into near-term policies and action to be strongly effective. Most of the G20 members[233], that account for about 78

229 This year's report examines aviation and shipping, mainly because they were closely related to the pandemic, and most importantly because both need to reduce emissions, but as theirs are considered as international emissions and not national ones they are not included in NDCs, an issue that has to be tackled.

230 Emissions Gap Report 2020, https://www.unep.org/emissions-gap-report-2020

231 Within the Executive summary the findings of the EGR20 are presented in 14 points, https://www.unep.org/emissions-gap-report-2020

232 A range of estimates point to a strong correlation between income and emissions, with a highly unequal global distribution of consumption emissions, "6.1 The consumption problem and why lifestyles are critical to tackling climate change", Emissions Gap Report 2020

233 The G20 members are: Argentina, Australia, Brazil, Canada, China, France, Germany, Japan, India, Indonesia, Italy, Mexico, Russia, South Africa, Saudi Arabia, South Korea, Turkey, the United Kingdom, the United States, and the European Union. Spain is also invited as a permanent guest. Collectively they constitute almost 60% of the world's population, account for 80% of global GDP and in terms of trade they hold 75% of global exports. https://www.g20.org/about-the-g20.html

percent of global emissions, have only made marginal progress in shifting their future emissions trajectories downward, with several others not even on track to meet their NDCs. Moreover, by 2030, annual emissions need to be 15 GtCO2e[234] lower than current unconditional NDCs[235] for a 2°C goal and 32 GtCO2e lower for the 1.5°C goal.

"Collectively, current policies fall short 3 GtCO2e of meeting the level associated with full implementation of the unconditional NDCs. Current NDCs remain inadequate to achieve the climate goals of the Paris Agreement and would lead to a temperature increase of at least 3°C by the end of the century. The net-zero emissions goals could reduce this by about 0.5°C, provided that short-term NDCs and corresponding policies are made consistent with the net-zero goals[236]".

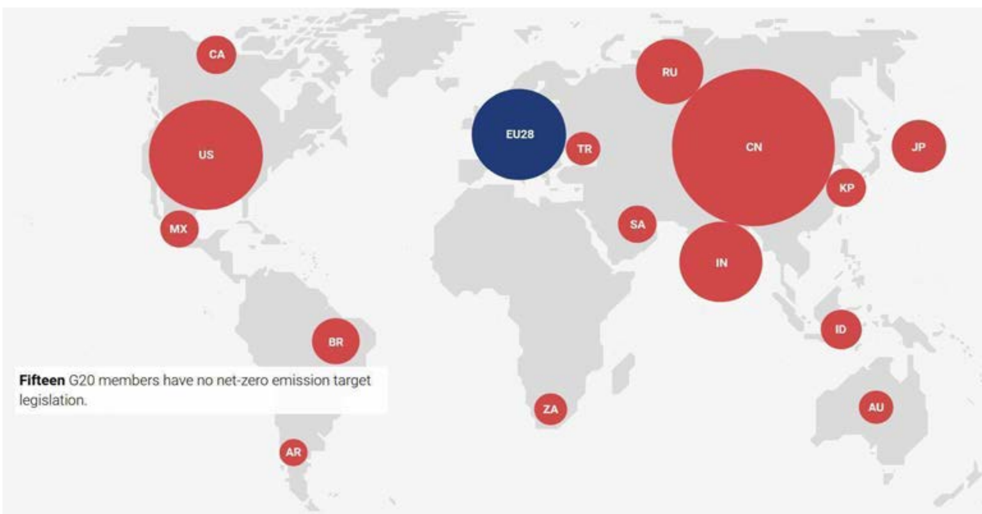


Fig.28: Map illustrating the progress until 2019 regarding the G20 members' net-zero emission target legislation process.[237]

- The emissions gap

---

234 $GtCO_2e$ stands for gigatone CO_2 equivalent. Indicative is that "one gigatonne is roughly equivalent to the emissions generated by transport in the European Union (including aviation) over a year". https://www.un.org/sustainabledevelopment/blog/2016/11/report-world-must-cut-further-25-from-predicted-2030-emissions/, EGR17, https://www.unep.org/r7esources/emissions-gap-report-2017

235 " Conditional NDC: NDC proposed by some countries that are contingent on a range of possible conditions, such as the ability of national legislatures to enact the necessary laws, ambitious action from other countries, realization of finance and technical support, or other factors, On the other hand Unconditional NDCs: NDCs proposed by countries without conditions attached.", Emissions Gap Report 2018, https://www.unep.org/resources/emissions-gap-report-2018

236 Emissions Gap Report 2020, https://www.unep.org/emissions-gap-report-2020

237 "Are governments doing enough? To date (2019), 71 countries and 11 regions, accounting for about 15% of global GHG emissions in total. Countries representing the remaining 85% of global GHG emissions will make similar commitments. The G20 (a group of 19 countries, plus the EU) account for 78% of all emissions. Theirs is the biggest opportunity to lead the world into a thriving, renewable future." https://www.unep.org/interactive/emissions-gap-report/2019/

The 2020 report updates the assessment of the emissions gap for 2030, which is defined as the difference between global total GHG emissions from least-cost scenarios that keep global warming to below 2°C, 1.8°C, or 1.5°C (mitigation scenarios consistent with the Paris Agreement)[238] with varying levels of likelihood, and the estimated global GHG emissions resulting from a full implementation of the NDCs."[239]

The emissions gap is unchanged compared with 2019. The reasons for this are that until November 2019, none of the major emitters provided new NDCs with scenarios adjusted to the NDC targets for 2030. Also, no new 1.5°C, 1.8°C, and 2.0°C scenarios have been added to the assessment since 2019. Nevertheless, the connection of current policies and NDCs scenarios with the parallel actions towards the net-zero emissions goals is really important. In the report, it is mentioned that: "Achieving the long-term temperature goals (to reach net-zero GHG emissions in the second half of this century) of the Paris Agreement to limit global warming to well below 2°C and pursue 1.5°C depends strongly on implementing near-term mitigation action by 2030."

Finally, the implications of the Covid-19 pandemic in the emissions gap 2030 and global emissions towards meeting the temperature goals of the Paris Agreement are highly uncertain, and only assumptions and *explorative calculations* can be presented as they depend on the epidemics and lockdowns evolution on a national level. "Similarly, it is uncertain how oil market prices will evolve and how oil exporters and producers will adapt to price changes of fossil resources."[240]

- Bridging the gap

According to EGR20, bridging the gap is related to the implications of current Covid-19 fiscal rescue and recovery measures, the role of international shipping and aviation, and equitable low-carbon lifestyles.

"So far, the opening to use rescue and recovery measures to support a low-carbon transition has largely been missed," since the majority of emergency funding addressed health priorities. A way to mitigate the continued rise of GHG emissions (pre-COVID-19) by 2030 is to use Covid-19 economic recovery as the vehicle towards decarbonization. This means "more ambitious new or updated nationally determined contributions (NDCs) and the major long-term sectoral transformations to reach net-zero GHG emissions globally."

---

238 "In order to obtain climate change projections, the climate models (mathematical representations of processes important in the Earth's climate system) use information described in scenarios of GHG and air pollutant emissions and land use patterns. The standard set of scenarios used in the AR5 is called Representative Concentration Pathways (RCPs)." "Each RCP provides a plausible description of the future, based on socio-economic scenarios of how the global society grows, develops, and uses land and energy."“The Representative Concentration Pathways (RCPs) describe four different 21st century pathways of greenhouse gas (GHG) emissions and atmospheric concentrations, air pollutant emissions and land use: a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0), and one scenario with very high GHG emissions (RCP8.5). Global surface temperature change for the end of the 21st century (2081–2100) is projected to likely exceed 1.5°C for RCP4.5, RCP6.0 and RCP8.5 (high confidence). Warming is likely to exceed 2°C for RCP6.0 and RCP8.5 (high confidence), more likely than not to exceed 2°C for RCP4.5 (medium confidence), but unlikely to exceed 2°C for RCP2.6 (medium confidence)., https://ar5-syr.ipcc.ch/topic_futurechanges.php , https://www.carbonbrief.org/analysis-four-years-left-one-point-five-carbon-budget

239 "The emissions gap",Chapter 3, Emissions Gap Report 2020, https://www.unep.org/emissions-gap-report-2020

240 "3.4 Implications of the COVID-19 pandemic and associated rescue and recovery measures on GHG emissions by 2030" Emissions Gap Report 2020, https://www.unep.org/emissions-gap-report-2020

Governments through certain rescue and recovery measures and regulatory options that take into account medium-to-long-term economic, environmental and social indicators can "support a rapid, employment-intensive and economically cost-effective economic recovery and a low-carbon transition. Such measures include i) support to low-carbon and renewable energy, low-carbon transport, zero-energy buildings, and low-carbon industry; ii) support to research and development of zero-emissions technologies; iii) fiscal reforms of fossil fuel subsidies; and iv) nature-based solutions, including large-scale landscape restoration and reforestation."[241]

Similarly, in the international aviation and shipping sectors, "additional policies are required to bridge the gap between the sectors' current business-as-usual (BAU) trajectories and GHG pathways consistent with the Paris Agreement temperature goals." These policies need to motivate both sectors into new or improved technologies and support their transition far from fossil fuel by incentivizing the use of alternative fuels[242] (such as biofuels, hydrogen, and ammonia, etc.).

Finally, reducing emissions produced through the current and transition of lifestyle depends on policy changes, awareness, and individual efforts. "The International Energy Agency (IEA 2020) concluded that behavior change is an integral part of emissions reduction strategies that accomplish net-zero emissions by 2050, taking into account that emissions from mobility, residential energy use, and food comprising approximately 17 percent, 19 percent and 20 percent of lifestyle emissions respectively."[243] The lessons learned from Covid-19 revealed how lifestyles could change rapidly. Governments' recovery measures from the pandemic could establish opportunities towards low-carbon mobility, a low-carbon residential sector, and low-carbon diets; however, they need the support of "actors and groups across civil society to ensure this happens in a way that preserves people's well-being."

Adaptation gap report 2020

The first Adaptation Gap report in 2014[244]proposed the definition of the adaptation gap as "the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts, and reflecting resource limitations and competing priorities. It provided a preliminary framework for assessing adaptation gaps and proposed three dimensions: (i) the funding gap, (ii) the technology gap, and (iii) the knowledge gap".

The lessons learned from the previous Adaptation Gap Reports[245] highlighted that the in-depth assessment of the adaptation finance gap (examining estimates of the costs of adaptation and availability of financing), the

---

241 "4. Bridging the gap – implications of current COVID-19 fiscal rescue and recovery measures" Emissions Gap Report 2020

242 "5.3.3. Alternative fuels", Emissions Gap Report 2020

243 "6. Bridging the gap – the role of equitable low-carbon lifestyles" Emissions Gap Report 2020

244 Executive summary, UNEP Adaptation Gap Report 2014, p.xii, https://www.unep.org/resources/adaptation-gap-report-2014

245 Main goals of the second AGR in 2016, third AGR in 2017 and fourth AGR 2018 are presented in Box 1.1. Overview of past Adaptation Gap Reports UNEP Adaptation Gap Report 2020, https://www.unep.org/resources/adaptation-gap-report-2020

identification of methodological issues in assessing global adaptation progress, and the introduction of focusing topics (e.g., the adaptation gap in the health sector), have structured a strong framework that brought the discussions on adaptation gap at a global level. However, the ARG20 recognized that the Covid-19 pandemic has affected the adaptation process. More specifically, "the acute need to manage the direct public health impacts of the virus and the subsequent economic fallout, has seen adaptation fall down the political agenda at all levels of governance and resources for adaptation planning, finance and implementation have been reallocated to combat the pandemic."

Nevertheless, the encouraging news is that "almost three-quarters of countries have adopted at least one national-level adaptation planning instrument. Most developing countries are working on national adaptation plans (NAPs). There are also a growing number of adaptation actions. Since 2006, multilateral climate funds have initiated around 400 adaptation projects in developing countries, with their size and scope growing".[246]

"From the outset of the first AGR14, it was clear that assessing the adaptation gap was going to be a very different and methodologically more challenging exercise than that of assessing the emissions gap.[247]

- There is a specific target of limiting temperature increases for tracking mitigation progress, according to the Paris Agreement ("well below" +2°C) and an associated CO_2 emissions/concentration target based on available warming scenarios. However, a similar metric "that could be used to convert the global goal on adaptation into a measurable target at the global level does not exist so far."
- Additionally, there is no universal, agreed-upon assessment framework, and the progress towards adaptation goals, to date, cannot readily be compared across countries or other actors (private sector, subnational level, etc.)
- Moreover, there is a data challenge as currently no central data repository, documenting delivered adaptation outputs, exists."[248]

Taking these challenges into account, the 2020 AGR primarily focuses on establishing a future Adaptation Gap Reports baseline. In alignment with the Global Stocktake in 2023[249], the report addresses three important questions:

1. What are we doing today to adapt?
2. To what extent are we currently reducing climate risks?

246 Foreword message by Inger Andersen, Executive Director of UNEP, Adaptation Gap Report 2020,

247 "Box 1.1. Overview of past Adaptation Gap Reports", UNEP Adaptation Gap Report 2020

248 "While it is comparatively easy to track large-scale projects delivered by international donors (due to centrally available data sources), as well as national-level adaptation (due to these being well captured through reporting under the UNFCCC enhanced transparency framework), subnational, non-state actor and local (often autonomous) adaptation efforts can go largely undocumented, despite being major factors in reducing climate risks locally.", 2.3.2 Barriers in tracking adaptation outcomes, UNEP Adaptation Gap Report 2020

249 The report has sought to provide negotiators of the UNFCCC Member States, the broader UNFCCC constituency and the general public with scientifically based assessments of global adaptation gaps and to inform on the status and results of global adaptation efforts. The objective of the AGR process as a whole is therefore closely aligned with that of the Global Stocktake, while remaining an independent assessment". 1.1 Context, UNEP Adaptation Gap Report 2020

3. To what extent will our adaptation trajectory help us reduce future climate risks?

Building upon these questions, the AGR20 is structured on three parts:[250] "(i) The regular assessment of progress in planning, financing and implementation processes (ii) This year's focusing topic/sector, the Nature-based Solutions (NbS), assessing it through the three elements of progress mentioned above and (iii) The synthesis of findings from previous parts into a status of global progress of adaptation, including the outlook on future developments. Finally, this year's report features several innovative elements that are directly relevant to the Global Stocktake, firstly, evaluation criteria for adaptation planning, secondly, mechanisms for financial sustainability, thirdly the status of implementation, and lastly, the analysis of nature-based solutions for adaptation."

- Assessing adaptation progress - Climate Risks

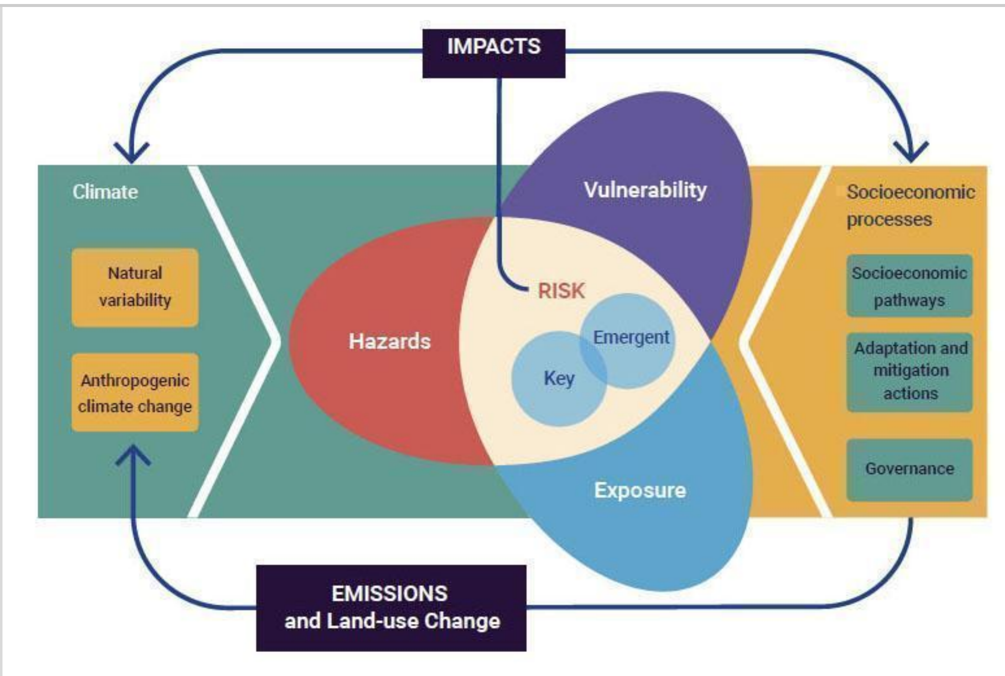


Fig. 29: Schematic of the interaction among physical climate system, exposure, and vulnerability producing risk[251]

Answering the question what climate risk is and furthermore which is the relationship of hazards, probability, and exposures, the AGR20 emphasized that[252] "Risk is the probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk framing focuses on the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values." As is illustrated in figure 25 above, risks from climate change impacts arise from the interaction between hazard (triggered by an event or trend related to climate change), vulnerability (susceptibility to harm), and exposure (people, assets, or ecosystems at risk). Hazards include processes that

250 Chapter 1.2 The 2020 Adaptation Gap Report, UNEP Adaptation Gap Report 2020

251 The original source: Figure 19-1 from Oppenheimer et. al.(2014) UNEP Adaptation Gap Report 2020, https://www.unep.org/resources/adaptation-gap-report-2020

252 Box 2.2. What is climate risk? 2.3 Understanding progress in adaptation, UNEP Adaptation Gap Report 2020

range from brief events, such as severe storms, to slow trends, such as multi-decade droughts or multi-century sea level rise. Vulnerability and exposure are sensitive to a wide range of social and economic processes, with possible increases or decreases depending on development pathways.[253]

'Considering that climate risks are rising as climate change leads to increases in global temperatures, sea-level rise, and many extreme events, including heatwaves, droughts, and floods, **adaptation is a process by which levels of risk are reduced at any given temperature level'[254]. It is uncertain that climate risks can be avoided at all. Therefore, mitigation measures and their implementation are urgently considered the only way to avoid severe impacts.**

To further develop the framework for assessing adaptation, the AGR20 highlighted this strong relationship between mitigation and adaptation by introducing "the current and future risk levels against which to assess adaptation progress, and the extent to which ambitious adaptation could reduce climate risks[255]. At the same time, "adaptation is place-and context-specific, with no single approach for reducing risks (their nature and level) appropriate across all settings"[256]. In this regard, how can adaptation progress be assessed in the context of climate risks? Acknowledging this challenge, the IPCC Fifth Assessment Report[257] developed a climate risk framework with an assessment of eight key risks that are considered representative of the range of critical climate risks to global society, across all latitudes, levels of development, and types of climate hazards:

1. risk to lives
2. land-based food security
3. ocean-based food security
4. water security
5. urban systems
6. critical infrastructure and networks
7. terrestrial biodiversity
8. ocean biodiversity.

- Assessing adaptation progress - Adaptation outputs Vs. Adaptation outcomes

253 The definitions of Risk, Vulnerability, Hazards and Exposure are described in the AR5 (IPCC), Glossary, Climate Change 2014 Synthesis Report, https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

254 "With increasing climate change, the efforts – and costs – required to avoid or limit the resulting impacts continue to grow, and there is residual risk, whereby some level of damages can no longer be avoided at all," 2.2.1 Climate risks in the context of adaptation and mitigation, UNEP Adaptation Gap Report 2020

255 Chapter 2. Framing the Adaptation Gap Report, UNEP Adaptation Gap Report 2020

256 Climate Change 2014 Synthesis Report, https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

257 The IPCC Special Report on Global Warming of 1.5°C updated the five integrated 'reasons for concern' (i) Risks to unique and threatened systems (ii) risks associated with extreme weather events (iii) risks associated with uneven distribution of impacts (iv)risks associated with global aggregate impacts and (v) risks associated with large-scale singular events to encompass a wider range of both natural and social systems., 2.2 Framing the climate risks context, UNEP AGR20

Furthermore, the process for assessing adaptation is related to another question: Against which current and future risk levels should adaptation progress be assessed? The concept of current and future risks and the activities involved, according to the AGR20, are defined as follows:[258]

1. Adaptation <u>outputs</u> refer to the sum of <u>activities engaged on the ground</u> and address the question: what are we doing today to adapt?
2. Adaptation <u>outcomes</u> refer to <u>the results of those activities in terms of reducing risk today</u> (observed outcomes) <u>and in the future</u> (expected outcomes), addressing the question: To what extent our adaptation trajectory will help us reduce future climate risks?

However, today's assessment of adaptation progress cannot give the full spectrum of adaptation outputs and outcomes. The reason is that, since there is a lack of central data repository, documenting, discussing, and delivering adaptation outputs, to date, the data regarding outputs and outcomes will be only at a national and international level. This paves the way for the next AGRs to come since a global perspective of the adaptation outputs is expected after the Global Stocktake in 2023. Therefore, this year's report in terms of adaptation can respond only to what we are doing today to adapt by examining outputs and not on the outcomes.

"Assessing progress on outcomes is generally more difficult to do than tracking outputs, for many reasons including the lack of scientific understanding of the effects of adaptation-related responses on risk levels and the absence of a clear singular metric for adaptation. These issues mean that assessing outcomes will, by necessity, have to be rather qualitative".[259]

- Global progress on planning, financing, and implementing adaptation

The progress towards global adaptation is the result of three main processes: (a) planning the actions needed for adaptation, (b) identifying the means of implementing these actions, such as the financing instruments, the technology required, and the capacity-building to collect further information for effective actions. (c) Finally, the Implementation process is usually based on insights from existing projects, proposals, and scientific literature.

(a) Global progress on adaptation planning.[260]

On a global level, the Paris Agreement provided each country/party the only mechanism for planning adaptation, the National Adaptation Plans (NAP,) where national strategies and selected actions per sectors, etc., to respond to the impacts of climate change, are presented. The status regarding NAP progress is that "125 developing countries have initiated and launched the process to formulate and implement NAPs as of November 2020, 20 of which have already been submitted."[261] On a local, site-specific level, adaptation

[258] 2.2. Framing the climate risk context, UNEP Adaptation Gap Report 2020
[259] 2.3 Understanding progress in adaptation, UNEP Adaptation Gap Report 2020
[260] Chapter 3. Assessing global progress on adaptation planning, UNEP Adaptation Gap Report 2020
[261] 3.3 Progress on adaptation planning, UNEP Adaptation Gap Report 2020

planning aims to motivate public and private actors, investors, and stakeholders to prepare and respond to climate change; therefore, policies, laws, and regulations must be aligned with this endeavor.

As mentioned from the very beginning of this chapter, to date, due to the lack of common methodologies or consensus on definitions for assessing adaptation planning progress, it is difficult to evaluate if the planning adopted is effective and adequate. Nevertheless, the AGR20 introduced and proposed five criteria and indicators[262] consistent with the Paris Agreement goals. The purpose of these criteria was to analyze 20 NAPs and 139 NDCs with adaptation components of developing countries and 42 Seventh National Communications[263] of developed countries. The results of this analysis are illustrated in fig.11 concerning the criteria: (1) Comprehensiveness, (2) Inclusiveness, (3) Implementability, (4) Integration and monitoring, and (5) Monitoring and evaluation.

[262] 3.2 Methodology (for assessing global progress on adaptation planning), UNEP Adaptation Gap Report 2020

[263] Seventh National Communications can be consulted here: https://unfccc.int/NC7.

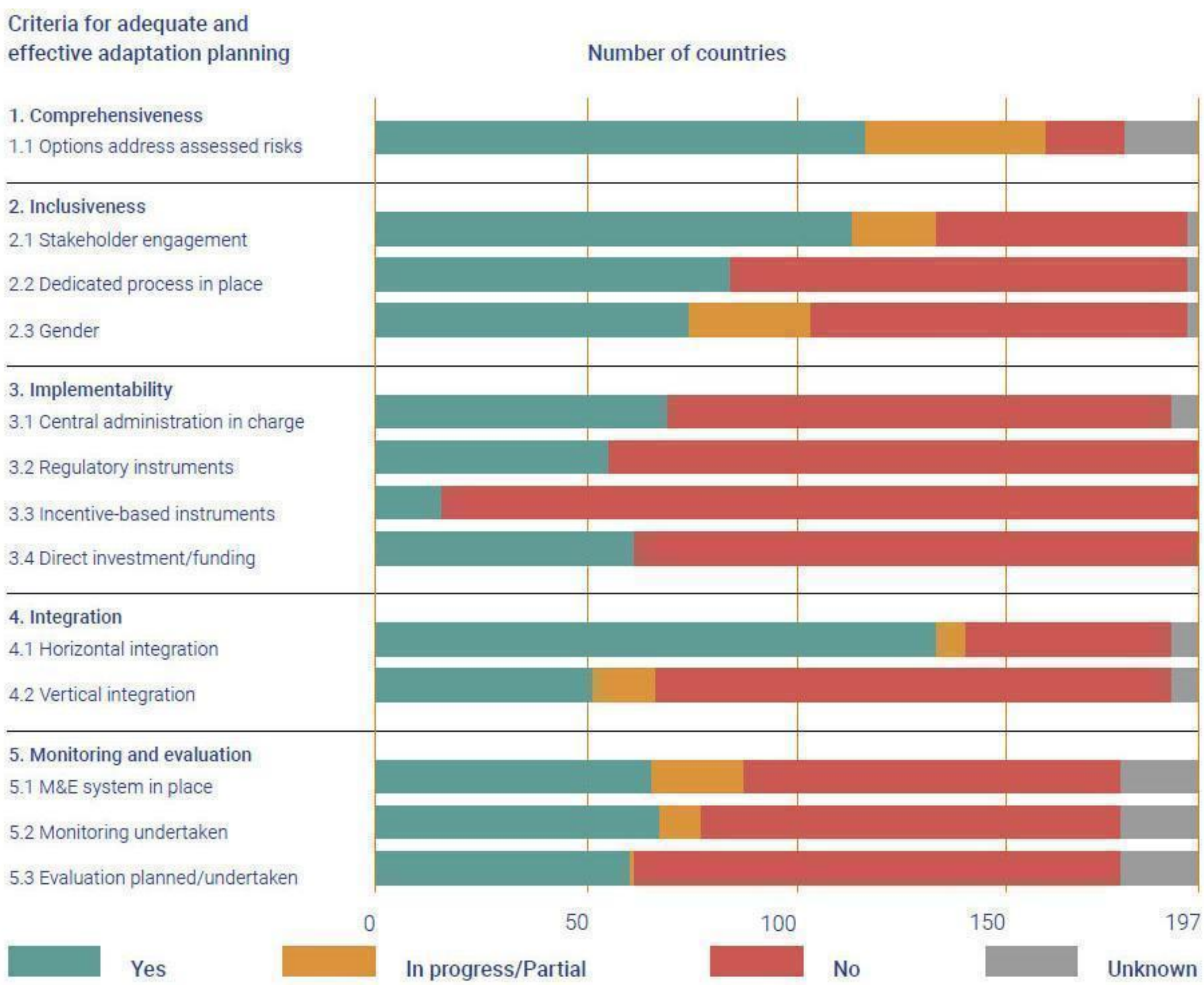


Fig. 15: Assessing the adequacy and effectiveness of adaptation planning worldwide [264]

(b) Global progress on financing for adaptation.

The latest update regarding financing adaptation is that “in Paris Agreement developed countries pledged[265] to mobilize US$100 billion annually by 2020 to support developing countries with mitigation and adaptation and also agreed to set a new collective quantified goal before 2025, using the US$100 billion as a floor.” The question, if this goal has been met, remains unanswered mainly because “developed countries are not required to report their climate finance data for 2020 to the UNFCCC before January 2022”. At the same time the AGR20 reports that another critical parameter in financing adaptation is that adaptation funding “is often most needed in non-market sectors or is focused on public goods that benefit many stakeholders, which makes it challenging to mobilize private finance.”

[264] “3.3 Progress on adaptation planning” UNEP Adaptation Gap Report 2020, https://www.unep.org/resources/adaptation-gap-report-2020

[265] This was actually a reiteration of the Copenhagen Accord in 2009, where the commitment to mobilize US$100 billion was firstly pledged. 4.1 Financing of adaptation, UNEP Adaptation Gap Report 2020,

However, since the Paris Agreement pledge, the encouraging news is that "the Global finance flows for adaptation have increased by 35 percent since 2015– 2016. This constitutes 5 percent of total tracked flows, a percentage that is similar to the 2015-2016 period. The majority of adaptation finance arises from public finance channels.[266]" At the same time, there has been a significant evolution in the "adaptation finance modalities[267] of bilateral and multilateral support." These modalities are important as they support the creation of sustainable financial systems,[268] a prerequisite for scaling up adaptation financing, monitoring of investments as well as making financial flows consistent with the Paris Agreement goal "towards climate-resilient development."[269]

Nevertheless, the financial mechanisms alone are not enough, even more so as there is "a growing understanding that both physical risks resulting from climate change and risks caused by transitioning to a low-carbon economy may destabilize the financial system." The need for new regulation, policies, and evaluation systems related to climate change has led to a "fast-evolving sustainable finance policy landscape."

(c) Global progress in implementing adaptation.

"Since 2006, the United Nations Framework Convention on Climate Change (UNFCCC) climate funds have financed close to 400 projects with the primary aim of adaptation."[270] What is interesting is the outcomes from the evaluation of these projects. As it is stated in the AGR20:

1. The most frequently addressed sectors by projects under UNFCCC climate funds align with two of the three sectoral priorities for adaptation mentioned in the first round of nationally determined contributions (NDCs), namely agriculture and water.
2. Health as the third priority is seldom the primary subject of adaptation projects in developing countries.
3. However, evidence from scientific articles shows that extreme heat is the fourth most-targeted climate hazard globally.
4. The top three climate hazards addressed by adaptation projects under UNFCCC climate funds and by actions documented in the literature are drought, rainfall variability, and flooding.

However, as mentioned earlier, the adaptation outcomes are strongly related to the local context, social realities, and environmental particularities, which have multiple levels of vulnerability. Therefore, the adaptation outcomes measuring remains challenging, specifically for funds, investors, and project developers. Another concern in adaptation's implementation progress outlook is that "continued high amounts of global

266 4.2.1 Global climate-related finance, UNEP Adaptation Gap Report 2020,

267 "Grant modalities are increasingly bolstered by a broader range of instruments, actors and approaches. While this trend is visible among many funds and funders, such as the Green Climate Fund (GCF)"., 4.3 New trends in the financing of adaptation, UNEP Adaptation Gap Report 2020

268 "Sustainable finance can be defined in a narrow sense as taking "due account of environmental and social considerations in investment decision-making" (European Commission 2018)", 4.3.2 Sustainable finance, AGR20.

269 Article 2.1c of the Paris Agreement, 4.3.2 Sustainable finance, AGR20.

270 Chapter 5 Progress in implementing adaptation, UNEP Adaptation Gap Report 2020

greenhouse gas emissions imply rising levels of climate risk.[271] The adaptation gap is therefore inextricably linked to the emissions gap."

Nature-based Solutions (NbS)[272] for adaptation. Selected points, resulting from this year's focusing topic/sector, the Nature-based Solutions (NbS), and its assessment through the three elements of progress planning, financing, and implementing are outlined as follows:

- NbS for adaptation can cost less than hard engineered approaches for addressing climate hazards and generate substantial economic benefits.
- When well-designed and implemented, they have the potential to generate larger returns (in a broad economic, rather than financial, sense) because of the multiple societal benefits they deliver in addition to reducing climate risk
- A challenge is that as adaptation is highly context-specific, there can be some uncertainty around how effective individual NbS will be for addressing hazards of varying severity or in different locations.
- Progress in scaling up NbS depends on more concrete incorporation of NbS into planning for adaptation across scales and sectors, through the NAP process and beyond, including recognition of, and explicit planning for, the links and co-benefits between NbS for mitigation and NbS for adaptation.
- Before the early 2000s, NbS were only considered in the context of mitigation – if at all – and are therefore not represented here. Between 2005 and 2015, there was an exponential increase in activities when integrating across the entire data set.

To summarize, the Adaptation Gap Report 2020 has highlighted the progress made in enhancing national-level adaptation worldwide over the last decade, has acknowledged the importance of adaptation policy to accelerate action at the international and national levels as well as the emerging policies and strategies to guide how to operationalize adaptation and has underlined aspects of adaptation progress: (i) adaptation finance (ii) Monitoring and evaluation, (iii) Knock-on effects, (iv) Effectiveness of climate risk reduction and (v) Gender issues, that need to be further tackled at the national level.

Ultimately, the Emissions Gap Report 2020[273] and the Adaptation Gap Report 2020, both address the importance of commitments from countries to the mitigation goals, the urgency of financing projects concerning mitigation and adaptation planning, and the *new tools needed, such as sustainability investment criteria, climate-related disclosure principles and mainstreaming of climate risks into investment decisions can stimulate investments in climate resilience.*

---

271 Intergovernmental Panel on Climate Change [IPCC] 2018; UNEP 2020), 5.5 Outlook AGR20.

272 Nature-based solutions (NbS), a term that has been increasingly used in recent years, is most commonly defined as: "Actions to protect, sustainably manage and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (International Union for Conservation of Nature [IUCN] 2020), Chapter 6 Nature-based solutions for adaptation, AGR20

273 For over a decade, the UNEP Emissions Gap Report has provided a yearly review of the difference between where greenhouse emissions are predicted to be in 2030 and where they should be to avoid the worst impacts of climate change, UNEP, UNEP DTU Partnership, Emissions Gap Report 2020, 9 December 2020, https://www.unenvironment.org/emissions-gap-report-2020

1.5.2 Tracking progress platforms

Tracking progress platforms that aim to increase transparency, build knowledge and share data on the progress made towards the climate change mitigation and adaptation goals have intensified their projects, especially in the aftermath of the Paris Agreement and the countries' effort to combat climate change. The selected platforms presented in this chapter track the progress of climate change mitigation and adaptation. They are presented by the topic they address and are structured according to the two main climate-related categories:

Tracking progress on Climate change mitigation

- Climate targets Status of the 2020 NDC update process

In the example of CAT Climate Target Update Tracker[274], the interactive world map provides an overview of the 2020 NDC update progress. The countries that have published or not their nationally determined contributions are highlighted in different colors, representing various levels of their NDC targets.

274 https://climateactiontracker.org/climate-target-update-tracker/

Fig. 30: An overview on a global level of the status of the 2020 NDC process

As mentioned in the online platform, the data collected to present the status of submitted NDCs, to date, are based on "*the governments' acknowledgment that their national climate targets collectively would not meet the goal of limiting warming to 1.5˚C. So, they undertook the first update of their 2030 targets which are part of a country's (NDC) by 2020, backed by the IPCC Special Report on 1.5˚C, which was completed in October 2018.*

The Climate Action Tracker is tracking these updated targets. For the 36 countries we analyze, we will provide a detailed analysis on how much of an improvement each updated target is and how much it is aligned to the goals of the Paris Agreement. Countries that are not part of the 36 CAT countries and put forward or propose updated targets for 2030 will be listed but not analyzed.

The most important mitigation element of an updated target, in our view, is the emission levels in the target year because this is "what the atmosphere sees." To be viewed as making progress, an updated NDC must lower emission levels than the previous one. Under the Paris Agreement, governments have universally agreed that successive NDCs should reflect a country's highest possible ambition and represent a progression beyond the current NDC and contribute toward meeting the Paris Agreement's 1.5˚C warming limit."[275]

- Net-Zero target progress

The Net-Zero tracker platform created by Climate Watch[276] illustrates which countries have adopted a net-zero target or not, as shown in the first image below. Each country's profile and data related to the country's historical GHG emissions data are further analyzed separately and appears only after clicking on the country in the interactive world map. The creators of the platform state that *"To avoid the worst climate impacts, global greenhouse gas (GHG) emissions must be slashed in half during the next decade and reach net-zero early in the second half of the century. Given this need, a growing number of Parties to the Paris Agreement are adopting net-zero emissions targets. This tracker presents the net-zero targets that have been communicated in a Party's nationally determined contribution (NDC), long-term low GHG emissions development strategy (LTS), domestic law, policy, or high-level political pledge such as head of state commitment."*

---

275 The Climate Action Tracker is an independent scientific analysis that tracks government climate action and measures it against the globally agreed Paris Agreement aim of "holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C." A collaboration of two organisations, Climate Analytics and New Climate Institute, the CAT has been providing this independent analysis to policymakers since 2009. https://climateactiontracker.org/climate-target-update-tracker/

276 Climate Watch is an online platform designed to empower policymakers, researchers, media and other stakeholders with the open climate data, visualizations and resources they need to gather insights on national and global progress on climate change. Climate Watch brings together dozens of datasets for the first time to let users analyze and compare the Nationally Determined Contributions (NDCs) under the Paris Agreement, access historical emissions data, discover how countries can leverage their climate goals to achieve their sustainable development objectives, and use models to map new pathways to a lower carbon, prosperous future. This free platform enables users to create and share custom data visualizations and comparisons of national climate commitments. https://www.climatewatchdata.org/about/description


CLIMATEWATCH
COUNTRIES
SECTORS
COMMITMENTS
GHG EMISSIONS
PATHWAYS
ABOUT
DOWNLOAD & VISUALIZE
Net-Zero Tracker
To avoid the worst climate impacts, global greenhouse gas (GHG) emissions must be slashed in half during the next decade and reach net-zero early in the second half of the century. Given this need, a growing number of Parties to the Paris Agreement are adopting net-zero emissions targets. This tracker presents the net-zero targets that have been communicated in a Party's nationally determined contribution (NDC), long-term low GHG emissions development strategy (LTS), domestic law, policy, or high-level political pledge such as head of state commitment.
Category
Target Description
Indicator
Net-zero Target Status
Share
The map reflects latest communication of each country. Explore which countries have adopted a net-zero target below and click on a country to see its climate profile.
48
Parties, representing 59 countries and 54% of global GHG emissions, have communicated a net-zero target
3.5 % of global emissions.
Net-zero Target in Law
6 Parties
Net-zero Target in Policy Document
27 Parties
Net-zero Target in Political Pledge
15 Parties
No Document Submitted
149 Parties
Visualize individual targets of EU Members on the map
Country
Net-zero Target Status (Current selection)
Net-zero Target Source
Net-zero Target Status
Share of Global GHG Emissions
Andorra
In Policy Document
Andorra Updated First NDC (5/19/2020)
In Policy Document
0.00%
Argentina
In Political Pledge
Climate Ambition Summit 2020 (12/12/2020)
In Political Pledge
0.81%
Austria
In Policy Document
Long-Term Strategy 2050 - Austria (11/12/2020); Integrated National Energy and Climate Plan for Austria (2020)
In Policy Document
0.14%

Fig.31: An overview on a global level of the net-zero tracking process

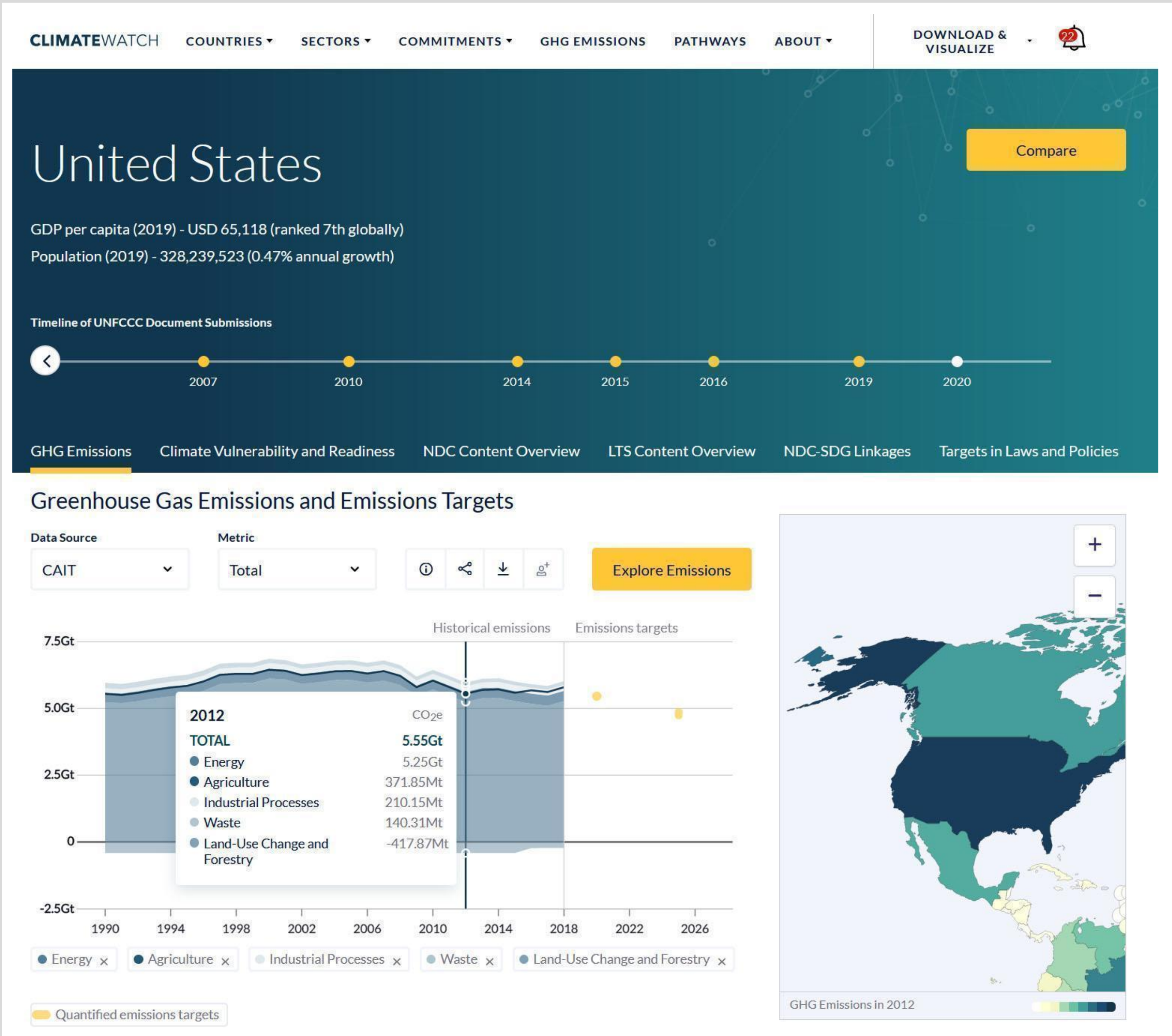


Fig. 32: The example of US profile GHG emissions targets with an interactive timeline provides data for the country's GHG historical emissions

- Number of coal power plants worldwide

This online platform Carbon Brief – clear on Climate[277] dots on an interactive world map, the counties' coal power plants. The plants' status means how many are now operating, which are the new ones, those that are

---

277 Carbon Brief is a UK-based website covering the latest developments in climate science, climate policy and energy policy, specializing in clear, data-driven articles and graphics to help improve the understanding of climate change, both in terms of the science and the policy response. The platform is supported by the European Climate Foundation, which provides our funding. In the spirit of transparency, https://www.carbonbrief.org/mapped-worlds-coal-power-plants

under construction, which are closed, and where and how many are planned coal plants, are illustrated in different colors. Another feature provided is the timeline, where the world's coal power plants are documented since the year 2000. As shown in the figure below, the world's coal plants are captured in two different years, 2000 and 2019. It is worth mentioning that new and operating plants are concentrated in Asia within the last decade. In the US from 2000 until two years ago, a significant number of coal power plants have stopped operating.

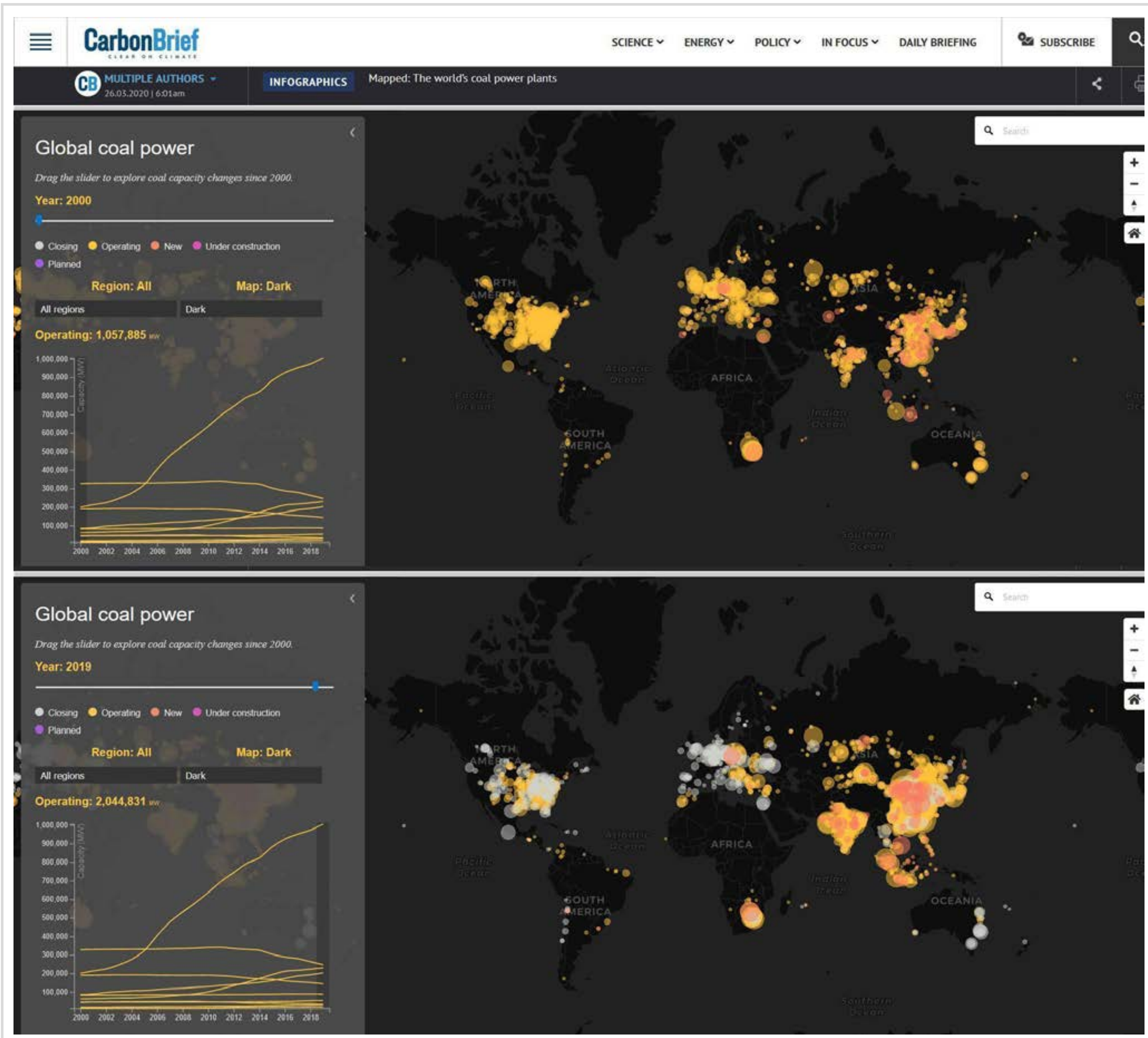


Fig. 33: The world's coal power plants in the years 2009 and 2019. The different colors represent operating, new, under construction, closing, and planned coal plants.

In the next figure that is a focus / a closer view of a chosen country (in the image is the US), the platform enables the user to retrieve information regarding each country's power plant. The same information regarding the capacity, coal type, technology, CO_2 emissions, country, Year opened, and age is provided for all the power plants.

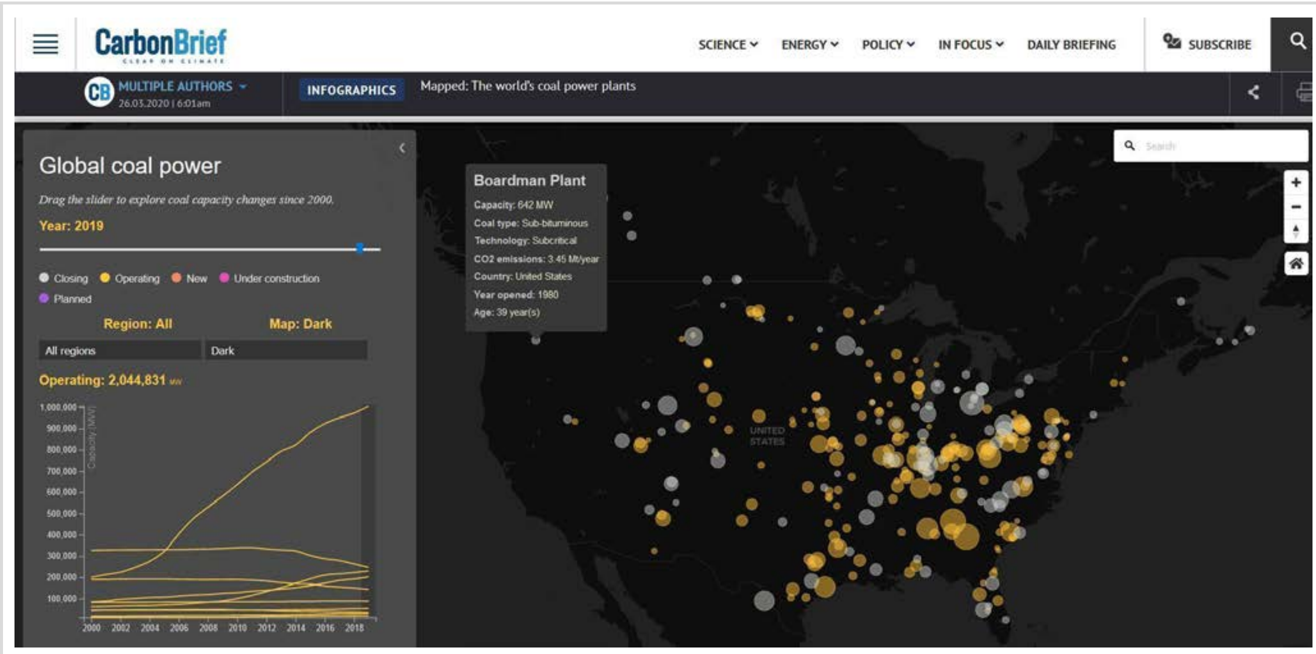


Fig.34: The US coal power plants in the year 2019. The different colors represent operating, new, under construction, closing, and planned coal plants.

Tracking progress on Climate change adaptation

- Adaptation actions

The Climate Analytics[278] platform provides a series of online interactive tools focusing on actions towards climate change adaptation. The adaptation map presented in the figure below, according to its creators: *"provides an overview of adaptation actions in 11 countries in West Africa and the Member States of the Caribbean Community (CARICOM) since 2010. Its main purpose is to act as a library, fostering inter-regional learning on adaptation action. The map includes policies, strategies, programs, and projects. Adaptation actions are categorized by country (regional actions are also included) and by sector".*[279]

By choosing a specific country and outline with data regarding the sectors included in the analysis, is provided like in the case of the Bahamas, where three sectors, two in Coastal and Marine resources sector and one in the Climate-Induced Disaster, are further examined.

278 Climate Analytics is a multidisciplinary and culturally diverse team composed of experts in climate science and impacts, including authors of the IPCC, experts in climate finance, adaptation, climate negotiation, mitigation policies and climate policy analysis and provides state-of-the-art solutions to global and national climate change policy challenges., https://climateanalytics.org/about-us/team/

279 http://adaptationmap.climateanalytics.org/index.html?

Fig.35: Mapping adaptation actions. Among the 11 countries that have been mapped, this image shows how the selected (Bahamas) are illustrated.

- Sea Level Rise projections

The local Sea Level Rise (SLR)[280] tool *"allows users to see how much sea levels are projected to rise worldwide at different levels of warming. The projections are available at the local level."* In the selected area of Key West, a U.S. island city, part of the Florida Keys archipelago, the data provided in graphs and tables focus on the *"Local sea-level projections for different global warming trajectories."* The SLR map is based on various literature references and the Antarctic and Greenland ice sheets based on IPCC AR5.

280 Created by Climate Analytics, http://localslr.climateanalytics.org/location/Key%20West

local SLR About

Local Sea-Level Projections

Oceanic processes, gravitational effects and local processes like land subsidence lead to substantial **regional differences in sea-level projections**. This website allows you to browse through local sea-level projections provided by Kopp et al. (2014), extended by data based on Rasmussen et al. (2018) and Bamber et al. (2019).

Search for a tide gauge station: Key West

You can also select a tide gauge station on the zoomable map below:

At locations where no tide gauge station is available, gridded sea-level projections can be selected (yellow squares). Gridded sea-level projections come with substantially higher uncertainties. Therefore, **we strongly recommend to use projections for tide gauge stations** whenever possible!

Sea-level projections are presented for three **scenarios** leading to different increases in global mean temperature above pre-industrial levels:

- A scenario staying below 2°C of warming at the end of the century without a further temperature increase beyond 2100. (RCP26)
- A scenario reaching a warming of around 2.5°C at the end of the century (RCP45)
- A scenario exceeding a warming of 4°C at the end of the century (RCP85)

Above scenarios are based on different greenhouse gas emissions from 2006 onwards, clear differences in future sea-level rise, however, only materialise in the second half of the 21st century due to the time-lagged sea-level response to greenhouse gas forcings. For more information on the underlying emission scenarios and the resulting warming trajectories, please see Meinshausen et al. (2011).

A key source of uncertainty in projections of future sea-level rise relates to the contribution of the Antarctic ice sheet. To provide a more comprehensive representation of this component, we also include sea-level projections for selected scenarios with a revised Antarctic ice-sheet contribution based on expert judgement presented in Bamber et al. (2019).

References

get pdf

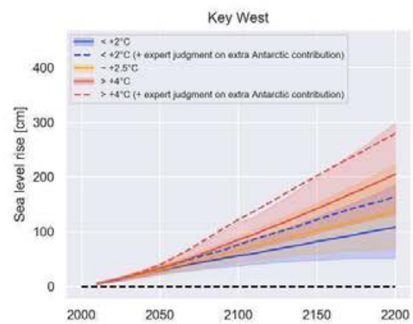


Figure: Local sea-level projections at Key West for different global warming trajectories. The solid lines represent multi-model medians, the shaded areas capture the 66% uncertainty range. Dashed lines show median sea-level projections including revised Antarctic ice-sheet contributions from Bamber et al. (2019).

Local Sea Level Rise [cm]

year	median	uncertainty ranges 66%	90%
2030	17 [17] 17 18 [19]	13-21 [12-23] 12-21 13-22 [14-25]	10-25 [7-27] 9-25 10-26 [10-30]
2050	29 [32] 30 33 [39]	22-37 [23-44] 22-38 25-42 [29-53]	18-44 [16-55] 17-45 19-50 [22-68]
2100	56 [76] 66 85 [122]	37-80 [51-107] 44-91 58-117 [82-184]	24-106 [34-140] 30-117 40-148 [59-264]
2150	82 [122] 102 142 [202]	48-127 [78-179] 60-152 97-198 [136-321]	31-181 [48-238] 36-209 71-259 [97-609]
2200	108 [164] 138 205 [279]	51-185 [101-252] 70-222 132-299 [189-447]	23-283 [60-343] 33-321 93-406 [133-975]

Table: Local sea-level projections at Key West for global warming trajectories shown in Figure above. The second column shows the multi-model median, column three shows the 66% uncertainty range, and column four shows the 90% uncertainty range. Shown in brackets are sea-level projections including revised Antarctic ice-sheet contributions from Bamber et al. (2019).

Fig.36: Map of the world's local sea-level rise projections- selected area: Key West.

Nature-based solutions could provide one third of net reductions in greenhouse gas emissions required to meet Paris Agreement goals.

Tracking progress on SDGs – SDGs today

'The United Nations Sustainable Development Solutions Network (SDSN), in partnership with Esri and the National Geographic Society, launched "SDGs Today: The Global Hub for Real-Time SDG Data" in July 2020. SDGs Today aims to advance the production and use of real-time and geo-referenced data for the SDGs with a one-of-a-kind data platform, and education and training resources. The initiative encourages countries, institutions, and civil society members to produce, share and engage with the data to help ensure that we meet the Global Goals by 2030. The data featured in SDGs Today are not the official datasets for SDG monitoring. They are timely measures, updated regularly, at least once a year'[281].

As shown in the two following figures the initiative's effort is to map progress of each of the 17 SDGs and present the status of issues today in relation with the data provided by major organizations. For example in the SDG 6 'Clean Water and Sanitation' data regarding the different water stress level of countries in relation with their population are presented in the 'Water Stress' map[282], in the case of SDG 7 'Affordable and Clean Energy' the topic 'Population without electricity'[283] illustrates the electricity access in Sub-Saharan Africa and in SDG 15 'Life on Land' information about the Global Analysis and Discovery (GLAD) alerts[284], the Area of Deforestation and the Change in Carbon Loss, updated on a weekly basis, monitor forests and highlight the significant threat to biodiversity and the future of sustainable development[285].

Finally the SDG 13 'Climate actions' apart from the progress tracked in the following issues such as the 'Arctic Sea Ice', the 'Drought and Precipitation', the 'Global Temperature Change' and the 'Carbon Dioxide Emissions', provides additional information with ratings of a country's performance on the SDG 13 which is supported by the 'Sustainable Development Report platform'[286] (see figure 34).

---

281 https://sdgstoday.org/about

282 In collaboration with the ISciences, TRenNDS, May 2020-April 2021, https://sdgstoday.org/dataset/water-stress-1613245443098x520531199547182400

283 In collaboration with the FEEM and IIASA, last updated information on Population without electricity in 2020, https://sdgstoday.org/dataset/population-without-electricity

284 The GLAD alert system devised by the University of Maryland's Global Analysis and Discovery (GLAD) lab uses satellite imagery to collect weekly data on deforestation across the tropics. 'GLAD Deforestation Alerts, Explained', Global Forest Watch, September 2020, https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/

285 In collaboration with the World Resource Institute (WRI) https://sdgstoday.org/dataset/deforestation-1613578011005x673172345249617400

286 https://dashboards.sdgindex.org/map/goals/sdg13

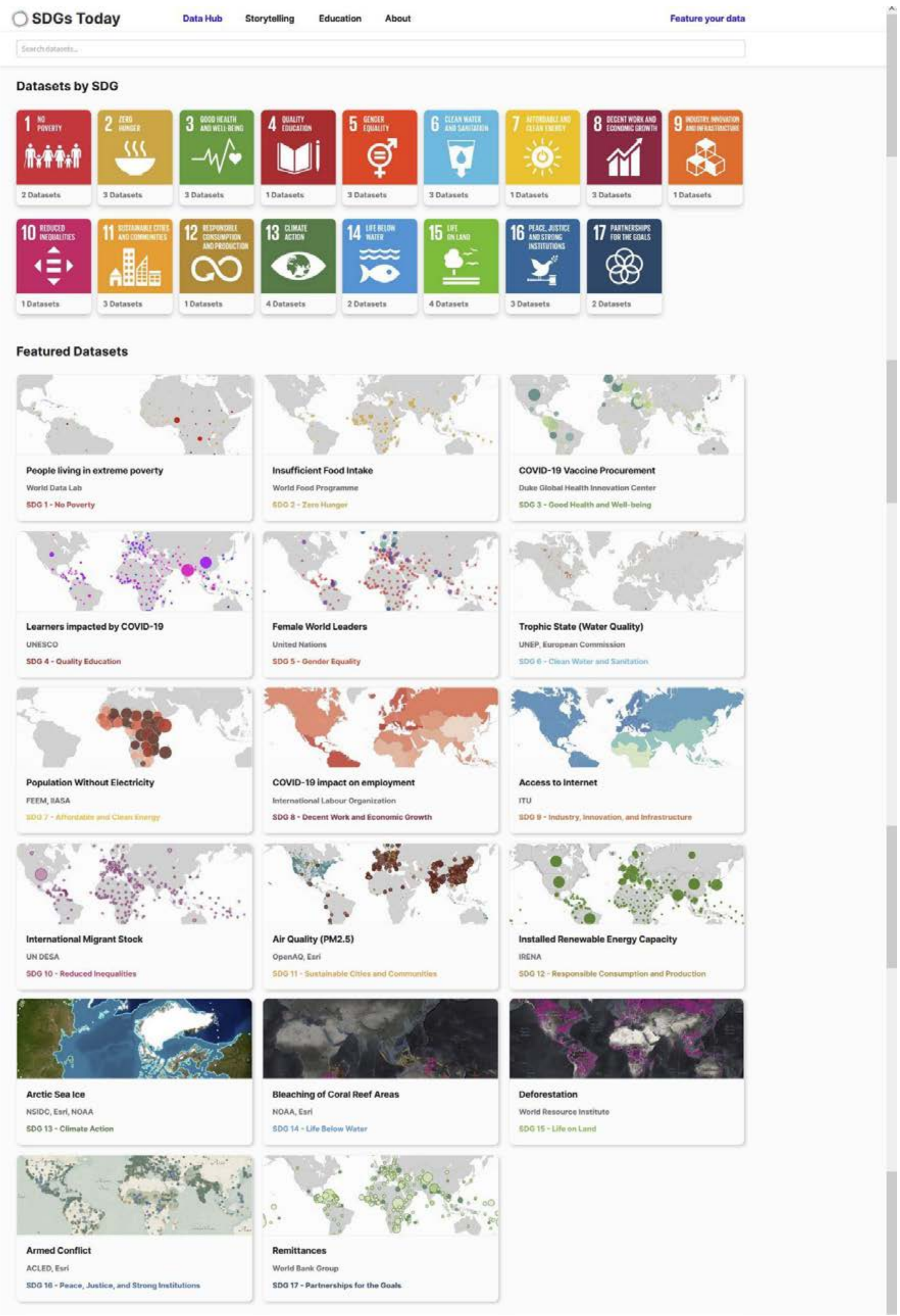


Fig. 37: The 17 SDGs various topics mapped worldwide

Fig.38: Map highlighting the progress of the SDG 13 'Climate Action" across countries

1.5.3 New goals expected in the COP26 UN Climate Change Conference[287] - 2021

"Today, we are at 1.2 degrees of warming and already witnessing unprecedented climate extremes and volatility in every region and on every continent"[288]. "Governments are nowhere close to the level of ambition needed to limit climate change to 1.5 degrees and meet the goals of the Paris Agreement"[289]. "Every fraction of

287 The Conference of Parties (COP26) was expected to be held in November 2020, however was delayed because of the Covid-19 pandemic outbreak, https://unfccc.int/process-and-meetings/conferences/glasgow-climate-change-conference

288 Quote by UN Secretary-General António Guterres, 'Secretary-General's address at Columbia University: "The State of the Planet", December 02, 2020 https://www.un.org/sg/en/content/sg/speeches/2020-12-02/address-columbia-university-the-state-of-the-planet

289 Quote by UN Secretary-General António Guterres, 'Greater Climate Ambition Urged as Initial NDC Synthesis Report Is Published', Feb 26, 2021 https://unfccc.int/news/greater-climate-ambition-urged-as-initial-ndc-synthesis-report-is-published

a degree matters"[290]. "If this task was urgent before, it's crucial now"[291]. The aforementioned statements describe in few words where the world stands now and call for significant actions to be made worldwide immediately.

The central objective of the United Nations for 2021 is to build a truly Global Coalition for Carbon Neutrality and in this sense 2021 can be a new kind of leap year — the year of a quantum leap[292] towards carbon neutrality. The 26th UN Climate Change Conference (COP26) which marks the fifth anniversary of the Paris Agreement and will take place in Glasgow in November 2021 is a great opportunity to review the progress so far and to agree to global action that is significantly overdue. The UK and Italian governments, which are co-hosting COP26, have set four goals[293] for the the 2021 event:

- Agreeing a step change in commitments to emissions reduction
- Strengthening adaptation to climate change impacts
- Getting finance flowing for climate action
- Enhancing international collaboration on energy transition, clean road transport and nature.

Emissions reduction

In the United Nation Climate Change campaign[294] Race to Zero' it is stated that 'now that 63% of global emissions are covered by a net zero goal, countries must translate national commitments into credible policies, while every sector must undergo an exponential transformation. Even in the face of COVID-19, net zero commitments roughly doubled in 2020. At a national level, new countries have also stepped up, with Japan, South Korea, and China – and now the US – joining the EU, UK, South Africa, Chile and others mobilizing around the shared guiding star of net zero emissions. To deliver the transformation that we need, across the more than

290 Quote by Swedish climate activist Greta Thunberg, https://www.weforum.org/agenda/2021/05/cop26-un-climate-change-summit/ , Greta Thunberg UN Climate Change Conference Speech Transcript, December 11, 2019, https://www.rev.com/blog/transcripts/greta-thunberg-un-climate-change-conference-speech-transcript

291 Quote by the head of the UNFCCC Patricia Espinosa, 'UN climate report a 'red alert' for the planet: Guterres', February 26 2021, https://news.un.org/en/story/2021/02/1085812

292 UN chief Antonio Guterres warned "the planet is broken", calling for a "quantum leap" on getting to net zero emissions in 2021, article published on 02/12/2020, https://www.climatechangenews.com/2020/12/02/guterres-un-will-build-global-coalition-carbon-neutrality-2021/

293 'Climate change: What is COP26 and why does it matter?', by Douglas Broom, 10 May 2021, https://www.weforum.org/agenda/2021/05/cop26-un-climate-change-summit/

294 'Race To Zero is a global campaign to rally leadership and support from businesses, cities, regions, investors for a healthy, resilient, zero carbon recovery that prevents future threats, creates decent jobs, and unlocks inclusive, sustainable growth. It mobilizes a coalition of leading net zero initiatives, representing 733 cities, 31 regions, 3,067 businesses, 173 of the biggest investors, and 622 Higher Education Institutions. These 'real economy' actors join 120 countries in the largest ever alliance committed to achieving net zero carbon emissions by 2050 at the latest. Collectively these actors now cover nearly 25% global CO2 emissions and over 50% GDP', https://unfccc.int/climate-action/race-to-zero-campaign

20 sectors that make up the global economy, the UN High-Level Champions call on all leaders to work in partnership and commit their skills, ingenuity, and resources to achieving these Breakthroughs'[295].

Similarly the International Energy Agency (IEA) at the IEA-COP26 Net Zero Summit, held on 31 March 2021 identifies the following principles for implementing Net Zero[296]:

- Sustainable recoveries can provide a once-in-a-generation down payment toward net zero,
- Clear, ambitious and implementable net-zero-aligned roadmaps to 2030 and beyond are critical,
- Transitions will go faster when learning is shared,
- Net zero sectors and innovation are essential to achieve global net zero,
- Mobilizing, tracking and benchmarking public and private investment can be the fuel to achieve net zero,
- People-centered transitions are morally required and politically necessary and
- Net zero energy systems also need to be sustainable, secure, affordable and resilient

Investors, Markets and Finance Ministers towards carbon neutrality

Further to actions towards emissions reduction, adaptation and resilience, the United Nations Secretary-General António Guterres in a speech held in 2020 at Columbia University[297]**highlighted the importance to '**align all public and private financial flows behind the Paris Agreement 1.5 degrees C aim (2.7 degrees F) and the Sustainable Development Goals. In this context it is an urgent call for 'all governments to translate these pledges into policies, plans and targets with specific timelines and for multilateral, regional and national development institutions, and private banks, to all commit to align their lending to the global net zero objective. This will provide certainty and confidence for businesses and the financial sector to invest for net zero'. However to reach this goal he argued that 'it is time to:

- put a price on carbon
- phase out fossil fuel finance and end fossil fuel subsidies
- stop building new coal power plants -- and halt coal power financing domestically and overseas
- shift the tax burden from income to carbon, and from taxpayers to polluters
- integrate the goal of carbon neutrality into all economic and fiscal policies and decisions
- make climate-related financial risk disclosures mandatory.'

At the same according to the UN chief the effort should be common and worldwide therefore 'all asset owners and managers have to decarbonize their portfolios, companies need to adjust their business models, investors need to demand information from companies on the resilience of those models and developed countries have

295 'Transforming our systems together - A global challenge to accelerate sector breakthroughs for COP26 – and beyond' UNFCCC 'Race To Zero', https://racetozero.unfccc.int/wp-content/uploads/2021/02/Race-to-Zero-Breakthroughs-Transforming-Our-Systems-Together.pdf

296 Seven Key Principles for Implementing Net Zero, IEA, 28 April 2021https://www.iea.org/news/seven-key-principles-for-implementing-net-zero

297 'Secretary-General's address at Columbia University: "The State of the Planet"', 02 December 2020, https://www.un.org/sg/en/content/sg/speeches/2020-12-02/address-columbia-university-the-state-of-the-planet

to fulfill their long-standing promise to provide $100 billion dollars annually to support developing countries in reaching our shared climate goals.'

Adaptation and Resilience

According to the World Economic Forum's 'Global Risks Report 2021'[298], despite the pandemic outbreak, 'the global leaders still rate extreme weather events caused by climate change and human environmental damage as among the top 10 clear and present dangers to the world'. In his speech[299] the United Nations Secretary-General António Guterres highlighted the equal importance and need for a breakthrough on adaptation and resilience, acknowledging that 'until now, adaptation represents only 20 percent of climate finance, reaching $30 billion on average in 2017 and 2018. This hinders our essential work for disaster risk reduction. It also isn't smart.' In this regard, before COP26, he called for 'all donors and the Multilateral and National Development Banks should commit to increase the share of adaptation and resilience finance to at least 50 per cent of their climate finance support. Early warning systems, climate-resilient infrastructure, improved dry land agriculture, mangrove protection and other steps can give the world a double dividend:

- avoiding future losses and
- generating economic gains and other benefits'.

He underlined the importance of 'moving to large-scale, preventive and systematic adaptation support, especially urgent for small island developing states, which face an existential threat, bringing attention to what is already mentioned in this report, that everything is interlinked. Therefore 'the race to resilience is as important as the race to net zero'. In an even wider perspective 'there can be no separating climate action from the larger planetary picture' and in his statement he stressed the need for 'a post-2020 biodiversity framework to halt the extinction crisis and put the world on a pathway to living in harmony with nature' as the world has not met any of the global biodiversity targets set for 2020'.

Vulnerable countries' expectations[300]

Finally, the vulnerable nations are less responsible for the climate change compared to the developed countries. Nevertheless they mostly face the climate-related impacts. In this context and in view of the COP26 summit, 'the new Allied for Climate Transformation by 2025 (ACT2025)[301] consortium will explore ways to

[298] https://www.weforum.org/agenda/2021/05/cop26-un-climate-change-summit/

[299] 'Secretary-General's address at Columbia University: "The State of the Planet"', 02 December 2020, https://www.un.org/sg/en/content/sg/speeches/2020-12-02/address-columbia-university-the-state-of-the-planet

[300] '5 things climate-vulnerable countries need from the COP26 summit' article that is part of the 'Climate Breakthroughs: The Road to COP26 and Beyond' (https://www.weforum.org/events/climate-breakthroughs-the-road-to-cop26-2021), published in collaboration with the World Resources Institute, by Yamide Dagnet, Jemima Marie Mendoza and Molly Bergen, 12 May 2021, https://www.weforum.org/agenda/2021/05/4-things-climate-vulnerable-countries-need-from-the-cop26-summit/

[301] The consortium includes local and global organizations based in Africa, Asia, the Caribbean and Latin America.' https://www.weforum.org/events/climate-breakthroughs-the-road-to-cop26-2021, https://www.wri.org/initiatives/allied-climate-transformation-act2025

rebuild trust and foster cooperation to advance an ambitious and just outcome at COP26 and beyond' The ACT2025 members believe, climate-vulnerable nations need from COP26:

- Ambitious emissions-reduction targets in line with 1.5 degrees C temperature rise
- Scaled up and accessible finance for vulnerable countries
- More support for adaptation efforts
- Increased action and support for loss and damage
- Finalized rules and architecture for the Paris agreement

1.6. Key takeaways

- The 2015 Paris Agreement 1.5°C aim and well below 2°C target, SDGs and Agenda 2030 are the blueprints of guidelines that all the participating nations have committed to follow in the battle against Climate Change
- The urgency for 'climate action today' lies on the fact that nations overall have not met the 2015 targets and the current global temperature reached 1.1°C, leading thus to the extreme climate-related effects occurring now worldwide.
- Severe impacts could be avoided if nations act fast, meaning that as long as the world reaches the peak of CO_2 emissions the earliest possible, the occurrence of acute physical events will be less and adaptation to climate-related effects will be easier in the long-term. This highlights a critical focus on mitigation.
- GHG accounting is critical for setting and planning climate action. Significant tools towards climate change mitigation like the National GHG emissions inventories and GHG protocol are longtime available and allow for GHG accounting at the national scale and at companies' scale.
- The GHG Protocol's emissions categorization into Scope 1, 2 and 3 emissions, assists creating inventories and monitoring GHG emission evolution in the long term, but most importantly allows for aggregation and comparability.
- The development of various climate models, scenarios and pathways is an essential part of the science of climate change and crucial for global decision making against the inherent uncertainty of climate change as they provide alternative plausible future states under a given set of assumptions and constraints.
- Since 1990 two main categories of scenarios have emerged and evolved until today. The first group explores the range of policies to limit the GHGs emissions (policies scenarios) or the way in which the atmosphere and climate responds to changes in emissions (science scenarios in 1992 and RCPs in 2013). The second group focused on models to understand the implications of socioeconomic factors such as population, economic growth, education, urbanization and the rate of technology as the driving forces of emissions (SRES in 2000 and SSPs in 2012 are the most known).
- The Sustainable Development Goals-developed in parallel to the Paris Agreement with the aim to be achieved by 2030. Under this global partnership the three dimensions of sustainable development- economic, social and environmental are integrated. The SDGs take into account national realities, different capacities, variable development levels, specific needs, priorities and challenges and are applicable to all countries.
- Commitment to the UN 2030 Agenda and alignment to the 17 SDGs is required both at a national and regional level and also at organizational and companies' level. The EU has already embraced all the SDGs in its regulatory framework and has identified the SDG13 goal 'climate action' as the most pressing.

- To achieve the net-zero targets (net-zero CO_2 or net-zero GHG) by 2050, the following steps are needed: (i) immediate transformation on global emissions (ii) low-carbon transition across all scales, sectors, technologies and geographies (iii) interpretations of the global goal to “Limiting warming to 1.5˚C” at local levels. (iv) identification of the estimated climate-related risks at 1.5˚C and 2˚C respectively (v) emissions to reach net-zero by around 2050 (vi) carbon removal and aligned to 1.5˚C emissions pathways (vii) actions without delay at countries, cities, private sector and individuals level
- Business-as-Usual Scenarios have to gradually phase-out and nations, organizations, sectors and private companies should consider including the 2°C scenarios that meet the Paris Agreement goals.
- One of the most known aligned to 2°C scenarios is Deep-Decarbonization Pathways (DDPs). All DDPs incorporate 3 pillars of energy system transformation, (a) the ‘Energy efficiency and conservation’ in all end-use sectors, (b) the ‘Low-carbon electricity’ meaning the decarbonization of electricity generation through replacement with renewable energy and (c) the ‘Fuel Switching’ meaning the switching end-use energy supplies from highly carbon-intensive fossil fuels to lower carbon fuels, including low-carbon electricity.
- The categorization of Transition and Physical scenarios is an effort by TCFD to incorporate scenario analysis as a basic component related to the transition and physical risks of companies. Transition scenarios can be developed in accordance to the current policies which enable transition to low-carbon. Physical scenarios build upon the RCPs emissions and temperatures trajectories and explore the acute or chronic events a company may face in the short or long-term and therefore should be taken into consideration in their strategies and business planning.
- Assessing the 2020 emissions gap between countries, meaning the reductions necessary to deliver a global temperature increase of below 2°C by 2100, identified that the gap has been larger than ever.
- Bridging the adaptation gap in 2020 has slowed down due to Covid-19, which was the primary issue in all countries political agenda. Assessing the adaptation gap still stumbles in the lack of specific metric target like the Paris Agreement 1.5°C goal, of a universal agreed-upon assessment framework and of a central data repository, documenting delivered adaptation outputs.

2. LITERATURE REVIEW ON INVESTORS' RESPONSE TO CLIMATE CHANGE AND SUSTAINABILITY

The goals described in the previous sections can be categorized into climate change-related goals and wider sustainable development-related goals, which share the common global nature and the significant amount of investment to be implemented. This consecutive goal setting has been embraced by investors who gradually recognized both the risks of no action and the opportunities entailed in taking action. Investors' commitment to achieving the set goals was translated into demand for:

1. the governments to enable a policy framework for investment; and
2. companies to provide evidence for their performance against these goals.

As described in the following section, investors' demand for an enabling regulatory context is mainly reflected in collective global investor statements. Demand for companies' accountability is reflected in increased demand for corporate reporting on sustainability issues (ESG frameworks and standards).

'Investors' include "existing and potential investors, lenders and other creditors that make decisions about providing resources to the entity," based on the definition of International Accounting Standards Board (IASB), a definition equivalent to the "providers of financial capital" of the International Integrated Reporting Council (IIRC).

2.1. Investors' role and response to Climate Action

The ~~ongoing~~ literature review[302] highlights the urgency for climate action, mainly driven by the Paris Agreement commitments and goals. This action implicates a transition towards a low-carbon economy.

It is widely accepted that investors have a crucial role in accomplishing the goals set through new investment in low-carbon technologies and energy efficiency and by reducing investments in high-emitting sectors and activities, including the extraction and use of fossil fuels. In 2018, the Intergovernmental Panel on Climate Change (IPCC) announced that the world should invest an average of US $2.4 trillion in clean energy every year through 2035 to prevent global temperature increases from exceeding 1.5°C.[303] Private investment is critical to close the climate investment gap generated by the insufficient governments' financial commitments.
A representative example of the private sector's crucial contribution in accomplishing climate goals is the EU Green Deal of 2019, showing the scale of the required investment and the investment gap for the EU to implement its action plan for becoming net-zero by 2050.

Investors response to Climate Action

The investor community has already taken steps to help ensure that the world's largest corporate greenhouse gas emitters act on climate change. Climate Action 100+, launched in 2017, is now the largest ever investor engagement initiative on climate change. The initiative focuses investor engagements on 160 global companies

302 ~~The literature review continues until the completion of the final report.~~

303 https://theinvestoragenda.org/focus-areas/investment/

that are high-emitters and/or are critical to the net-zero emissions transition. By engaging with these focus companies, signatory investors to Climate Action 100+ are helping to accelerate the business transition to a net-zero emissions future and ensure that global economies are more resilient to climate change. Its 2020 Progress report presents a surge in net-zero announcements by companies, with many of these commitments driven through investor engagement.[304]

Another investor-driven initiative is the Investor Agenda launched in 2018,[305] also urging investors for low-carbon investments and commitments, including phasing out high-emitting investments and integrating climate change into their long-term investment decision-making process and portfolio analysis. Since 2009 institutional investors have been taking a position regarding climate change action through joint statements, the annual Global Investor Statement on Climate Change, used to engage with government leaders and policymakers 'to apply finance tools that lower risks, and thus enable much greater amounts of private investment in climate mitigation and adaptation' and commit to dialogue with the investor community.[306]

In the 2010 Global Investor Statement on Climate Change, investors were already expressing their concerns about the climate change risks and their interest in the opportunities of the low-carbon transition:
"Investors are concerned with the risks presented by climate change to regional and global economies and individual assets. At the same time, investors are interested in the large potential economic opportunities that the transition to a low-carbon economy presents. Investors have a fiduciary responsibility that requires them to seek optimal risk-adjusted returns on their investments. At present, in the absence of strong and stable policy frameworks, many low-carbon investment opportunities do not currently pass this test. Private investment will only flow at the scale and pace necessary if it is supported by clear, credible, and long-term policy frameworks that shift the risk-reward balance in favor of less carbon-intensive investment."[307]

---

304 In 2020, the initiative developed the Climate Action 100+ Net Zero Company Benchmark, which will be used to publicly benchmark focus companies. The Benchmark includes indicators which cover:

- Net zero by 2050 ambition.
- Targets and goals for greenhouse gas (GHG) emissions reduction in the short, medium and long-term and whether targets align with a 1.5°C climate scenario
- Decarburization strategy
- Capital allocation alignment
- Climate policy engagement
- Governance, including executive remuneration linked to climate targets
- Just transition
- Task Force on Climate related Financial Disclosures (TCFD) reporting, including scenario analysis.

305 The Investor Agenda has been developed by seven Founding Partner investor groups: Asia Investor Group on Climate Change, CDP, Ceres, Investor Group on Climate Change, Institutional Investors Group on Climate Change, Principles for Responsible Investment and UNEP Finance Initiative.

306 Global Investor Statement on Climate Change: Reducing Risks, Seizing Opportunities & Closing the Climate Investment Gap, November 2010. The Statement was signed by 268 investors – both asset owners and asset managers – that collectively represent assets of over US$15 trillion.

307 Global Investor Statement on Climate Change: Reducing Risks, Seizing Opportunities & Closing the Climate Investment Gap, November 2010. The Statement was signed by 268 investors – both asset owners and asset managers – that collectively represent assets of over US$15 trillion.

Since 2015 the statement has highlighted the need to implement effective policies and regulations to achieve the goals of the Paris Agreement. Institutional investors reiterated their full support for the Paris Agreement and "strongly urged all governments to implement the actions that are needed to achieve the goals of the Agreement, with the utmost urgency." The 2019 Statement has been launched ahead of the COP 25 climate negotiations in December 2019 and was signed by 631 investors representing over $37 trillion in assets.[308] The statement restated investors' commitment to action on climate change through significant ongoing investments into the low carbon transition across a range of asset classes, incorporating climate change scenarios and climate risk management strategies into their investment processes, and engagement with high-emitting companies. However, investors also expressed their concerns that the implementation of the Paris Agreement was falling short of the agreed goal, leading to an "unacceptably high-temperature increase that would cause substantial negative economic impacts."

"It is vital for our long-term planning and asset allocation decisions that governments work closely with investors to incorporate Paris-aligned climate scenarios into their policy frameworks and energy transition pathways. The statement called on global leaders to:

- Achieve the Paris Agreement's goals.
- Update and strengthen nationally-determined contributions to meet the emissions reduction goal of the Paris Agreement, starting the process now and completing it no later than 2020, and focusing swiftly on implementation.
- Formulate and communicate long-term emission reduction strategies.
- Align all climate-related policy frameworks holistically with the goals of the Paris Agreement.
- Support a just transition to a low carbon economy.
- Accelerate private sector investment into the low carbon transition.
- Incorporate Paris-aligned climate scenarios into all relevant policy frameworks and energy transition pathways.
- Put a meaningful price on carbon.
- Phase-out fossil fuel subsidies by set deadlines.
- Phase-out thermal coal power worldwide by set deadlines.

Also, investors expressed the need for companies to "report reliable and decision-useful climate-related financial information to price climate-related risks and opportunities effectively."[309]

2.2. TCFD as a catalyst for awareness of climate change as a financial risk

A major milestone for raising investors' awareness of climate change as a financial risk was the Task Force's work for Climate-related Financial Disclosures (TCFD) on climate-related reporting. The TCFD was formed in 2015 by the Financial Stability Board, upon request by the G20 Finance Ministers and Central Bank Governors, to review how the financial sector can understand and take account of climate-related issues and identify the information needed to assess and price climate-related risks. In June 2017, TCFD published its Recommendations on Climate-related Financial Disclosures and an Implementation guide for companies,

[308] https://www.iigcc.org/download/global-investor-statement/?wpdmdl=2600&masterkey=5dea880180e04
[309] 2019 Global Investor Statement on Climate Change

including example metrics. TCFD's work acted as a catalyst for bringing climate risk to the mainstream for the financial sector. "The work of the Task Force has resulted in increasing investor scrutiny of corporate disclosures on the topic and growing momentum towards mandatory climate risk disclosure in many jurisdictions around the world."[310]

The large-scale and long-term nature of climate change makes it uniquely challenging, especially in economic decision-making. The TCFD recommendations guide all market participants on the disclosure of information on the financial implications of climate-related risks and opportunities so that they can be integrated into business and investment decisions.

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

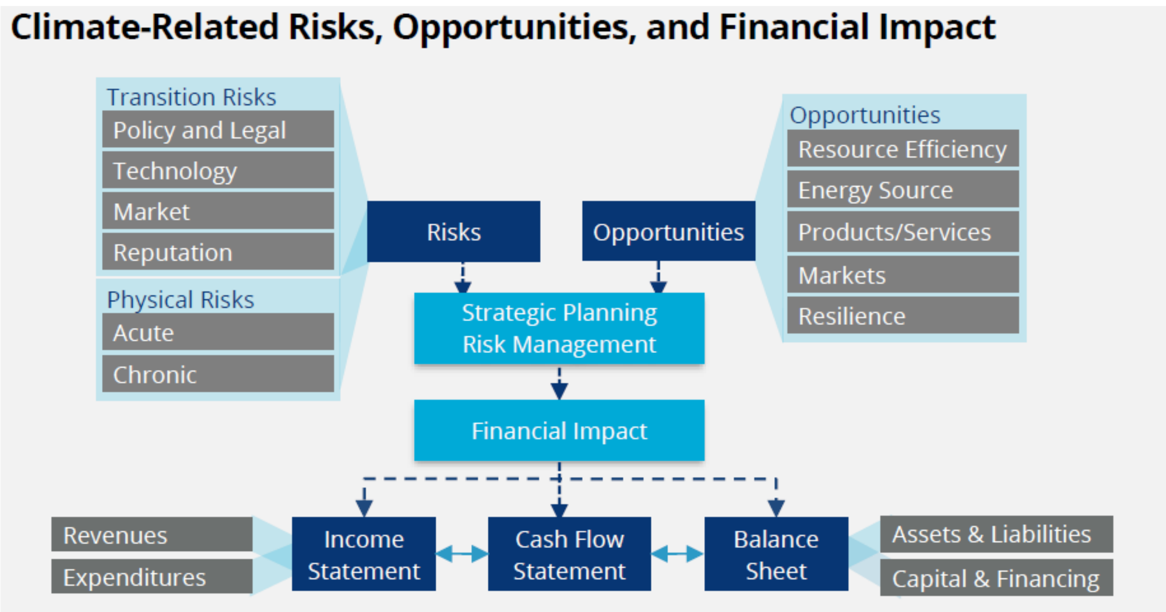


Fig. 39:: TCFD Climate change risks & opportunities and financial impacts[311]

The final recommendations were published in 2017,[312] and they have been gaining momentum ever since, counting more than 1,500 supporters in 70 countries.[313] It has been growingly adopted by major organizations who seek to align with its framework.

---

[310] KPMG IMPACT (December 2020) "The time has come. The KPMG Survey of Sustainability Reporting 2020." https://assets.kpmg/content/dam/kpmg/be/pdf/2020/12/The_Time_Has_Come_KPMG_Survey_of_Sustainability_Reporting_2020.pdf

[311] Recommendations of the Task Force on Climate-related disclosures (June 2017).

[312] TCFD. (June 2017) "Final Report Recommendation of the Task Force on Climate-related Financial Disclosures."

[313] TCFD. (October 2020) "2020 Status Report."

The TCFD recommendations were welcomed by the investor community as reflected in their Global investor statements, with investors committing to "take practical steps to assist their implementation around the world" and urging governments to commit to improving climate-related financial reporting standards by publicly supporting the adoption of the TCFD recommendations, to ensure TCFD's effectiveness."
More specifically, they called on government leaders to:

- Commit to improve climate-related financial reporting.
- Publicly support the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) recommendations.
- Commit to implement the TCFD recommendations in their jurisdictions no later than 2020.
- Request the FSB incorporate the TCFD recommendations into its guidelines.
- Request international standard-setting bodies incorporate the TCFD recommendations into their standards.[314]

The European Commission's Climate Reporting Guidelines integrate all of the recommendations of the TCFD. In September 2020, New Zealand became the first country to mandate climate risk reporting in line with the TCFD recommendations, followed by the UK in November 2020 and Hong Kong in December 2020,[315] indicating that the area of influence of TCFD grows on regulators and is expected to further expand.

At the same time, TCFD has published a Technical Supplement as part of the initial report with the aim to support individual companies to understand the potential effects of climate change in their businesses. These potential effects are not certain when exactly they will emerge, over the long term or short term, and it is unknown to what extent and under which condition they will affect the companies' financial performance. Therefore the TCFD suggests that one way to assess such implications is through the use of scenario analysis[316]. Although climate-related scenarios, as mentioned in previous chapters, have been available since 1990, 'the use of scenario analysis for assessing climate-related risks and opportunities and their potential business implications, however, is relatively recent'.

The Task Force encourages organizations/companies to:

- Use a scenario analysis as part of their strategic planning and/or enterprise risk management processes[317], highlighting its usefulness and the benefits both for companies and investors,
- Start considering ways to build, beginning with qualitative scenario analysis and if possible proceed to quantitative approaches. They should also examine the nature of the climate-related risks they may face as well as their assets, customers, key stakeholders and markets.

314 2019 Global Investor Statement on Climate Change
315 CDP, CDSB, GRI, IIRC and SASB. (December 2020) "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard."
316 TCFD. (June 2017), Technical Supplement - The use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities. https://www.tcfdhub.org/scenario-analysis/
317 Section 'C. Developing and Applying Scenario Analysis', Technical Supplement, TCFD. (June 2017) p.4,

- Identify the analytical choices in scenario analysis, such as the parameters used, the assumptions made and the choice of scenarios (types of climate-related scenarios that are publicly available), time horizons, supporting data and models etc for the analysis development.[318]

As shown in the figure below, the Task Force presents a series of steps that could be followed by the organizations/companies in order to develop and use a climate-related scenario analysis and support the disclosures consistent with the Recommendations on Climate-related Financial Disclosures.

Nevertheless it is evident that the scenarios are infinite, therefore each organization should focus, select and use only those scenarios that will highlight the future exposure of their businesses into transition and physical climate-related risks and opportunities and that will work best for their needs, resources and capabilities. **In this regard, the Task Force recommendations to organizations is to use , at a minimum, a 2°Celsius (2°C) scenario** and consider using other scenarios most relevant to the organization's circumstances, such as scenarios related to Nationally Determined Contributions (NDCs), business-as-usual (greater than 2°C) scenarios, physical climate risk scenarios, or other challenging scenarios'[319]

[318] The Task Force proposes as publicly available scenarios to be used, those from International Energy Agency (IEA), the Intergovernmental Panel on Climate Change (IPCC) and others that can provide context and a basis for company, industry or sector scenarios, Section C.2. Analytical Choices in Scenario Analysis, Technical Supplement, TCFD. (June 2017), p.8 , https://www.tcfdhub.org/scenario-analysis/

[319] Section 'B. Scenario Analysis', Technical Supplement, TCFD. (June 2017), p.2, https://www.tcfdhub.org/scenario-analysis/

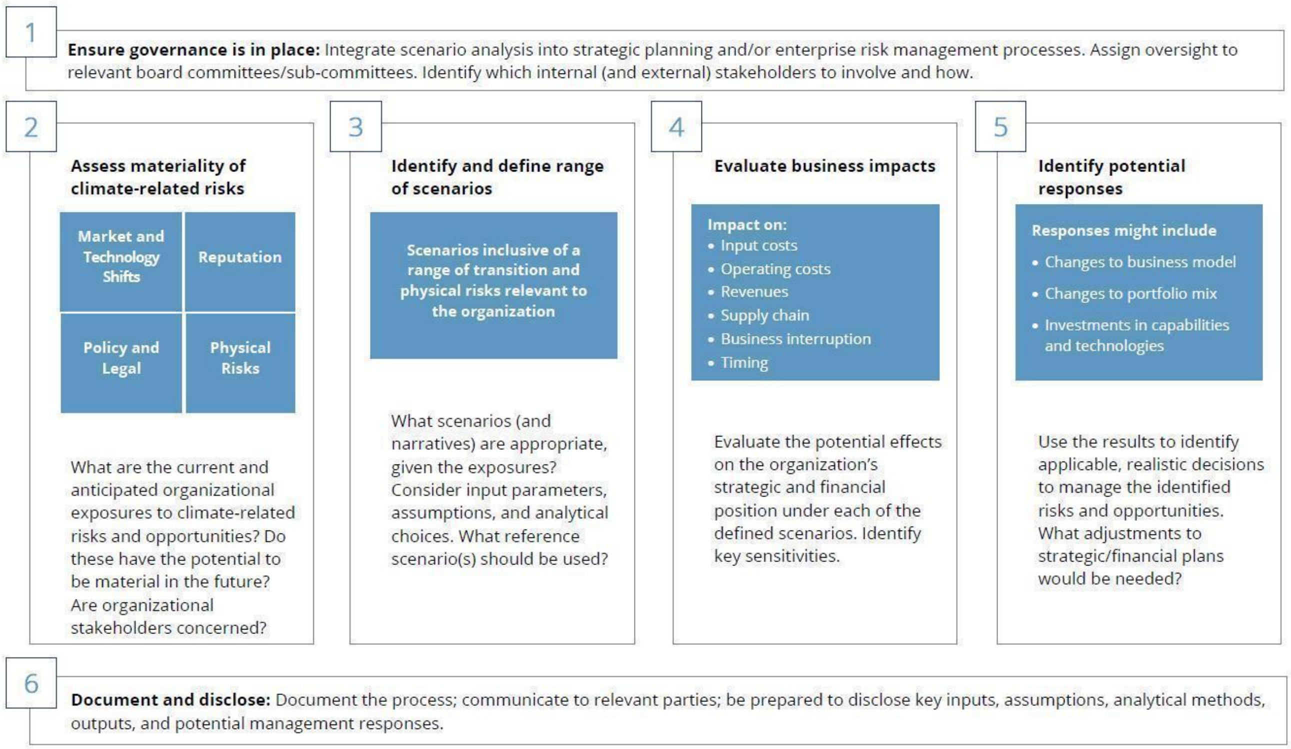


Fig. 40: TCFD's indicative process for applying climate-related scenario analysis to Climate-Related Risks and Opportunities[320]

Finally, 'to support the evaluation, by analysts and investors, of the organizations' strategies across a range of plausible impacts, thereby supporting better risk and capital allocation decisions, transparency around key parameters, assumptions, and analytical choices'[321], is critical. Disclosing and sharing information will provide 'comparability of results between different scenarios used by an organization and across organizations'.

The above highlights the importance of climate-related financial reporting for investors. However, this does not indicate a unique focus for investors, but rather a **'climate first' approach** that pertains to a wider demand for sustainable development, further explained in the following sections.

2.3. Corporate Reporting as a Tool for Investor Knowledge

An indispensable topic in the discussion of investors and climate change and sustainable development – or, in other words, the intersection between climate change and/or sustainability and enterprise value, is corporate reporting. Corporate reporting is "a means by which stakeholders, including investors, can understand, evaluate and monitor companies' performance, in the same way, companies use information internally to inform

320 Section 'C. Developing and Applying Scenario Analysis' TCFD. (June 2017), Technical Supplement - The use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities, p.7, https://www.tcfdhub.org/scenario-analysis/

321 Section C.2. Analytical Choices in Scenario Analysis, Technical Supplement, TCFD. (June 2017), p.8

decision-making,"[322] and the key instrument through which investors decide on which companies to allocate financial capital in. Corporate reporting is broadly categorized into financial reporting and non-financial reporting (or sustainability reporting).

Fig.41: Corporate reporting

The investors' primary interest is to understand enterprise value. Financial reporting provides the necessary financial information about the company to existing and potential investors, lenders, and other creditors. Mainstream financial reports are the annual reporting packages in which companies are required to deliver their audited financial results under corporate, compliance, or securities laws of the country in which they operate. Mainstream reports usually are publicly available, providing information to existing and prospective investors about the organization's financial position and financial performance. Though the exact provisions under which companies are required to deliver mainstream financial reports differ internationally, they generally contain financial statements, other financial reporting, including governance statements and management commentary.[323]

The primary focus of financial market participants is to price risk to support informed, efficient capital-allocation decisions. Accurate and timely disclosure of current and past operating and financial results is fundamental to this function. Still, it is increasingly important to understand the governance and risk management context in which financial results are achieved. This has resulted in increased demand for transparency from organizations on their governance structures, strategies, and risk management practices. Without the correct information, investors and others may incorrectly price or value assets, leading to a misallocation of capital.[324]

Moreover, a company's business model can positively and negatively impact stakeholders, such as customers or employees and natural resources. These stakeholders, along with the external environment in which the

---

[322] CDP, CDSB, GRI, IIRC and SASB. (September 2020) "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting."

[323] CDSB Framework

[324] TCFD (June 2017) Final Report Recommendations of the Task Force on Climate-related Financial Disclosures

company operates, can also positively or negatively affect the company's business model and therefore create or erode its enterprise value and financial returns to providers of financial capital.[325]

Some of these effects on enterprise value are already included in the projections of cash flows that support valuations and estimates of future cash flows and are represented as monetary amounts recognized in financial statements. However, this type of reporting that relates directly to monetary amounts in financial statements addresses the narrowest range of sustainability matters, the positive or negative externalities that companies generate that are considered sufficiently likely to influence enterprise value.[326]

Sustainability reporting reflects all significant impacts a company's activities have and typically addresses the broadest range of sustainability matters. Therefore, it is directed to a broader audience of various users with various objectives- from the providers of financial capital that need to make economic decisions to the stakeholders that are affected by a company's activities, the community- who want to understand the enterprise's positive and negative contributions to sustainable development.

Reporting on sustainability matters has become a well-established part of corporate practice and societal expectation;[327] however, it is not as well matured as financial reporting, where internationally acknowledged and accepted accounting standards exist. Sustainability reporting is still a dynamic field due to its "more complex" nature.

Companies opt to disclose ESG reporting data through a variety of channels, including annual reports to shareholders, integrated reports, sustainability reports, stand-alone ESG reports, and investor relations websites.[328]

2.4. Evolution of ESG systems based on investors' demand

2.4.1. ESG investing

Sustainability is high on many investors' agendas, as evidenced by a fast-growing interest in sustainable investments. The principal motivations of such interest are:

- Some sustainability-related impacts have known consequences on the present value of investments, e.g., an infrastructure company that pollutes will be fined in most jurisdictions. This knowledge is priced by investors and already reflected in asset values

---

325 CDP, CDSB, GRI, IIRC and SASB. (December 2020) "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard."

326 CDP, CDSB, GRI, IIRC and SASB. (December 2020) "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard."

327 CDP, CDSB, GRI, IIRC and SASB. (December 2020) "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard."

328 https://www.sasb.org/implementation-primer/

- The belief that sustainability matters, even if not currently priced by markets or regulators, are likely to become priced because of regulatory changes, such as a carbon tax, or systematic changes of attitude amongst consumers, etc.
- The aim to 'do good' and meet non-financial objectives irrespective of their impact on asset values. This could include excluding certain countries, sectors, or assets from a portfolio, regardless of the likelihood of an impact on asset values or its potential magnitude.[329]

Moreover, it has been gradually proven that investments' returns, and sustainability are not mutually exclusive and that sustainable companies perform better financially in the long term. Therefore, a need to ensure investors that their capital is channeled into genuinely sustainable activities emerged.

The main barrier to the transparency of companies' sustainable performance is the lack of reliable, comparable, and relevant non-financial data from companies. From their side, companies face challenges in identifying what information to disclose to what audience for what purpose and struggle to meet the needs of multiple audiences efficiently and cost-effectively. Disclosure frameworks and standards are essential tools to address these challenges.

Reporting information about businesses' performance on sustainability topics started as a stakeholder-driven accountability initiative over 30 years ago.[330] Today, sustainability disclosure (also called ESG disclosure – environmental, social, and governance – or non-financial reporting) is more relevant than ever for a wide range of audiences, including policymakers, consumers, employees, investors, and civil society organizations. Leading companies and their boards, who carry the responsibility for all corporate reporting, are now aiming not just to be accountable to shareholders but also to define their purpose and benefit to all stakeholders.[331]

329 EDHEC Infrastructure Institute. (March 2021) "Towards a Scientific Approach to ESG for Infrastructure Investors: Approaching ESG & Infrastructure within the Portfolio."

330 Many consider as defining marker the publication of the paper "Our common future" by the World Commission on Environment and Development in 1987, also known as the Brundtland Report. (source: 5ISS. (September 2020) "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting."

331 CDP, CDSB, GRI, IIRC and SASB. (September 2020) "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting."

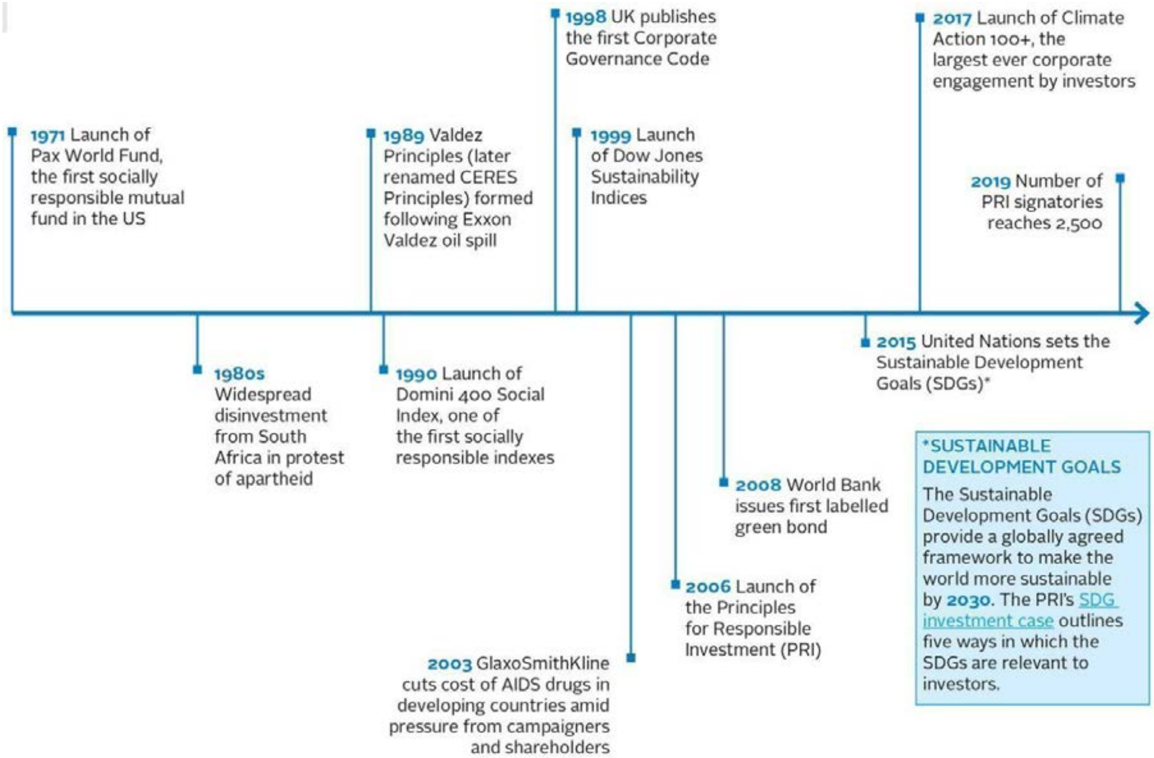


Fig.42: Milestones in the evolution of responsible investment[332]

Across the asset-management world, interest in environmental, social, and governance (ESG) has increased since the Principles for Responsible Investments (PRI) in 2006. The PRI defines responsible investment as a strategy and practice to incorporate environmental, social, and governance factors in investment decisions and active ownership.

ESG is about risk-based investing, which evaluates, in equal measure, all potential risks and drivers of long-term enterprise value, and assesses whether those risks are priced in. In other words, ESG emerged from the recognition that non-financial information was necessary for investors to have a clear picture of the issues that are likely to impact a company's financial condition of assets directly. Investment managers need to be able to measure and understand the risk to manage it. This led to increasing demand for transparency on the sustainable performance of companies through the ESG standards, ratings, and reporting.

ESG investing is an approach that seeks to incorporate environmental, social, and governance factors into asset allocation and risk decisions to generate sustainable, long-term financial returns. Recent industry and academic studies suggest that ESG investing can help improve risk management and lead to returns that are not inferior to returns from traditional financial investments, demonstrating the superiority of sustainable infrastructure, including better risk-adjusted returns, improved revenue stability, and decreased insurance premiums.

The recognition of ESG risks and opportunities had, as a result, the significant growth of the number of investment portfolios that had integrated key elements of ESG, especially in the last decade. Moreover, the

332 https://www.unpri.org/an-introduction-to-responsible-investment/what-is-responsible-investment/4780.article

products and services related to ESG ratings, indices, and standards have multiplied to such a degree that led to market fragmentation, often confusing investors concerning which approach to follow and not be misled investing capital into activities they believe are sustainable, while they are not.

Currently, numerous ESG actors shape the ESG ecosystem:

- Non-governmental, voluntary ESG Disclosure Framework and standards developers and providers
- Standard-setters, including the United Nations (UN), the Organization for Economic Co-operation and Development (OECD), the International Organization for Standardization (ISO) among other organizations), the International Financial Reporting Standards (IFRS),
- Policy drivers (such as the EU) that publish ESG regulations and various oversight authorities assess ESG taxonomies and disclosure.
- Private agencies that provide ESG ratings, issuing ESG Risk Rating Licenses for companies who want to assure their investors that they finance green or social projects

Among the most widely used and established voluntary ESG Frameworks and standards that will be referenced in the following sections are:

- the Global Reporting Initiative (GRI), the most commonly used standard, developed in 1997.
- the Sustainability Accounting Standards Board (SASB), one of the most widely used standards along with GRI, published in November 2018.[333]
- the International Integrated Reporting Council (IIRC)'s Integrating Reporting <IR> Framework, initially published in 2013.

Climate-related financial reporting frameworks

- the Taskforce on Climate-related Financial Disclosures (TCFD)'s Framework, published in 2017.
- the Climate Disclosure Standards Board's (CDSB) Framework, initially published in 2010.

It is worth mentioning that all frameworks and standards have been developed after a long period of research, key stakeholders' engagement, and market consultation processes to seek feedback on the relevance and decision-usefulness of their reporting approaches, as well as the feasibility of their implementation. The systems are continuously revised or updated to keep track of the emerging market, technology trends, and regulatory changes. Before every major update or revised a public consultation is held on 'exposure draft' papers, and received feedback shapes the final published outcome. This is one of the reasons they manage to capture, among others, investment priorities.

2.4.2. SDG investing

Since 2015, when the 2030 Agenda for Sustainable Development was adopted, establishing the Sustainable Development Goals (SDGs) as a globally accepted set of overarching goals, the 'alignment with values' to guide investors to redirect capital has acquired an additional new global definition. Therefore, it is the transition to an ESG-aligned world that shapes investors' perception of risks and opportunities and the transition to an SDG-aligned world, resulting in an urgent investors' demand for ESG sustainable and SDG - aligned

[333] SASB published Provisional Standards for a set of 79 Industry Standards across 10 sectors - published sequentially by sector- between July 2013-March 2016. The provisional Standards were published to seek feedback from stakeholders on the relevance and decision-usefulness of the Standards and the feasibility and cost-effectiveness of their implementation.

projects/companies. The shift from ESG to SDG investing showcases a trend of moving **from a company agenda to a global agenda**.

Soon after the SDGs were launched, the first initiatives for responsible and SDG-aligned investment funds started. The UN embraced these initiatives, as many governments and private investments need to achieve the SDGs. Increasingly more and more companies are reporting on their SDGs performance, creating an opportunity for investors to invest based on SDG. The UN SDG framework can potentially guide companies and responsible investors to aim their effort. However, SDG investing by private parties is still relatively smaller than ESG investing.

It is essential to highlight that ESGs do not exclude SDGs. On the contrary, the alignment with SDGs is a common approach for most ESG frameworks and a driver of the current work-in-progress on ESG standards to establish generally accepted corporate accounting and reporting principles. The SDGs provide a common language for reporting. Their common framework for sustainable development holds the potential to prioritize the reporting narrative and the type of performance disclosures a company makes on its sustainable development performance. At the same time, corporate reporting can illustrate the relevant SDGs to a company's business model, enabling both companies and investors to focus on those SDGs most likely to impact the financial performance of specific entities.[334] In other words, the key standard setters and framework developers that have a significant international influence on the corporate reporting landscape can provide specific tools that monitor the achievement of the SDGs and make the goals actionable. Aligning a company's reporting and communication with the SDGs means discussing performance in the context of the SDGs' expectations and aligning disclosures with the language of the SDGs to ensure a common dialog among stakeholders.

Fig. 43: Examples of SDG implementation guidance

There have been various individual efforts for addressing the SDGs:

[334] Corporate Reporting Dialogue. (February 2019) "The Sustainable Development Goals and the future of corporate reporting." Report developed by the participants of the Corporate Reporting Dialogue: CDP, Climate Disclosure Standards Board, Global Reporting Initiative, International Accounting Standards Board, International Integrated Reporting Council, International Organization for Standardization, Sustainability Accounting Standards Board. The US-based Financial Accounting Standards Board participates as an observer to the Corporate Reporting Dialogue.

- The SDG Compass: The guide for business action on the SDGs[335]- launched in 2015 by the Global Reporting Initiative (GRI) together with the UN Global Compact and the World Business Council for Sustainable Development- to support companies in aligning their strategies with the SDGs and measuring and managing their contribution.
- The International Integrated Reporting Council's (IIRC) reports on the implementation of integrated reporting while taking account of the SDGs and how integrated thinking and integrated reporting can be applied in the context of the SDGs.
- 'Reporting on SDGs Action Platform' developed by GRI and the UN Global Compact; an initiative to accelerate corporate reporting on the Global Goals. The Analysis of Goals and Targets offers a menu of illustrative actions businesses can take to contribute to each SDG target and maps possible disclosures (including indicators) that businesses can use to report against the SDG targets. The disclosures and indicators – both qualitative and quantitative – are taken from globally accepted disclosure frameworks for businesses, such as GRI Standards or CDP.
- Other frameworks and standards, such as the CDP, the Climate Disclosure Standards Board (CDSB), and the International Organization for Standardization, were asked to demonstrate their alignment with the SDGs, so they outlined the SDGs that are covered by their respective frameworks.
- Several organizations have mapped the Sustainability Accounting Standards Board (SASB) standards to the SDGs, using the SASB standards to help identify which SDGs are most relevant to financial performance in specific industries.[336]

The work-in-progress on ESG standards is gaining global momentum due to the increasing popularity of SDGs and the ongoing COVID-19 pandemic crisis, the recovery from which becomes an opportunity to speed up the transition to a better environmental, climate, and social paradigm. Several recent or under-development initiatives are in this direction.

[335] https://sdgcompass.org/

[336] Corporate Reporting Dialogue. (February 2019) "The Sustainable Development Goals and the future of corporate reporting."

Table 3: ESG systems alignment with SDGs.[337]

SUSTAINABLE DEVELOPMENT GOALS	CDP	CDSB	GRI	ISO	SASB	IR
1 NO POVERTY			✔	✔		
2 ZERO HUNGER			✔	✔		
3 GOOD HEALTH AND WELL-BEING			✔	✔		
4 QUALITY EDUCATION			✔	✔		
5 GENDER EQUALITY			✔	✔		
6 CLEAN WATER AND SANITATION	✔	✔	✔	✔		
7 AFFORDABLE AND CLEAN ENERGY	✔	✔	✔	✔		
8 DECENT WORK AND ECONOMIC GROWTH			✔	✔		
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE			✔	✔		
10 REDUCED INEQUALITIES			✔	✔		
11 SUSTAINABLE CITIES AND COMMUNITIES	✔	✔	✔	✔		
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	✔	✔	✔	✔		
13 CLIMATE ACTION	✔	✔	✔	✔		
14 LIFE BELOW WATER		✔	✔	✔		
15 LIFE ON LAND	✔	✔	✔	✔		
16 PEACE, JUSTICE AND STRONG INSTITUTIONS			✔	✔		
17 PARTNERSHIPS FOR THE GOALS			✔			

This mapping was developed as part of the Corporate Reporting Dialogue Initiative and its Better alignment project that took a position on the future of corporate reporting. The mapping of systems participating in the initiative indicates the full SDG alignment of GRI and ISO Standards. The partial alignment of CDP and CDSB is due to the two systems' scope, focused on environmental and climate issues. In the case of SASB, metrics would be relevant for specific SDGs for selected industries. Finally, Integrated Reporting (IR) follows a principle-based approach and does not prescribe specifics; however, it indirectly supports all SDGs.

2.4.3. TCFD Alignment of ESG Systems

Since 2015, the established ESG standards and frameworks have gradually demonstrated their support to the TCFD recommendations and initiated an effort to align with its approach both individually and collectively. A key driver for TCFD alignment was investors' explicit request for "international standard-setting bodies to incorporate the TCFD recommendations into their standards," as already mentioned. This request resides in the fact that TCFD is a framework, and as such, offers a set of principles and guidance for 'how' a report should be structured,' therefore is open to interpretation. On the other hand, a standard has specific, replicable, and detailed requirements for 'what' should be reported for a particular topic. In short, standards make frameworks

337 Corporate Reporting Dialogue (February 2019) The Sustainable Development Goals and the future of corporate reporting

actionable, ensuring comparable, consistent, and reliable disclosure. Moreover, standards facilitate disclosure that an independent third party can assure.[338]

One representative example of the work on TCFD alignment is the Corporate Reporting Dialogue's Better Alignment Project of 2019 with participants from some internationally leading framework- and standard-setting institutions, CDP, CDSB, GRI, IIRC, and SASB. As its name indicates, the project focused on assessing the participating standard-setters alignment on the TCFD's disclosure principles, recommendations, and illustrative example metrics.

The Corporate Reporting Dialogue initiative further evolved to the 'group of five' collaboration, announced in September 2020 through their joint Statement of Intent, according to CDP, CDSB, IIRC, GRI, and SASB committed to working together towards comprehensive corporate reporting. As reflected in their progress published in December 2020, the group of five shows how specific components of their current frameworks and standards, along with the recommendations set out by TCFD, can provide a starting point for the development of global standards for sustainability-related financial disclosure. All of TCFD's 11 final recommendations[339] have been included, but the scope has been widened from climate-related risks and opportunities to sustainability-related financial risks and opportunities. According to the 'group of five', the four pillars of the TCFD provide a helpful structure for organizing the presentation of climate and other sustainability-related financial information. The four pillars of the TCFD: Governance, Strategy, Risk Management, and Metrics & Targets represent core elements of how organizations operate.

It is worth noting that TCFD refers to most of the group of five systems as part of its supplementary implementation guidance. More specifically, TCFD presents how CDP covers its recommended disclosures, GRI and CDSB, and provides example metrics for non-financial sectors based on the CDP, GRI, and SASB metrics. TCFD recommendations are integrated into the climate change-related disclosures of ESG systems' reviews and updates, or recent efforts mentioned in the next paragraph.

2.4.4. Recent and ongoing efforts in ESG reporting

ESG standards are still considered a field under development. There is no agreed-upon approach for what metrics related to ESG approaches are sufficient to enhance the shareholders' value. ESG investing has been motivated by shifts in investor's demand, driven by their needs and the search for better long-term financial value and pursuit of better alignment with finances. To a great extent, the inability of a single framework or standard to effectively stand on its own is a function of the heterogeneity of users and audiences, including investors, corporate professionals, civil society organizations, and policymakers. SASB highlights that its experience in reporting shows that "even investors are not a monolith," with each having their unique investment strategy, risk tolerance, and time horizon, for example.[340]

338 CDP, CDSB, GRI, IIRC and SASB. (September 2020) "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting."

339 The 11 recommendations are structured across the four pillars of TCFD.

340 Response of the Sustainability Accounting Standards Board to the Public Consultation on the Revision of the Non-Financial Reporting Directive.

In recent years, momentum has grown behind increased coalescence of the major non-financial reporting standards. Investors have started to join the discussion, and reporting businesses have expressed frustration over the lack of harmonized standards for non-financial reporting.[341] Moreover, efforts also focus on comprehensive corporate reporting systems that integrate both financial and non-financial reporting. A representative example is the already mentioned 'group of five' collaboration. The five institutions, in their joint Statement of intent to work together, state that there is value in standard-setting systems that achieve two objectives:[342]

- to establish a globally agreed set of sustainability topics and related disclosure requirements based on evidence of demand among various stakeholders for a disclosure solution
- to acknowledge the specific user whose primary objective is economic decision-making. This includes identifying those topics that are reasonably likely to affect a typical company's financial condition (e.g., its balance sheet), operating performance (e.g., its income statement), or risk profile (e.g., its market valuation and cost of capital) in different industries. These topics are the relevant or **material topics for enterprise value creation.**

Part of the work carried out by the 'group of five'[343] is to show how the current systems and standards can be used together. They highlight the complementarity of the five frameworks and standards and the potential of building upon their existing work for a comprehensive system that provides connectivity between financial and non-financial reporting. They consider that non-financial reporting comprises of three "building blocks"[344]:

- Block 1: The first block of information addresses significant sustainability-related impacts that affect a company's financial performance or risk profile, thereby driving enterprise value over the short, medium, and long term. This information, which they term "sustainability-related financial disclosure," is primarily relevant to economic decision-making by users such as investors and other providers of financial capital.
- Block 2: The second block of information covers all of a company's significant sustainability impacts—i.e., on the economy, environment, and people—and their importance to its key stakeholders. The resulting information, which is often referred to as "sustainability reporting," thereby provides a comprehensive picture of a company's positive and negative contributions to sustainable development and can serve a broad range of users and objectives.
- Block 3: The third building block represents information related to specific jurisdictional requirements intended to support local public accountability and public policy objectives, insofar as they are not addressed via the first and second building blocks.

341 The KPMG Survey of Sustainability Reporting 2020.

342 CDP, CDSB, GRI, IIRC and SASB. (September 2020) "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting."

343 The work is facilitated by the Impact Management Project, World Economic Forum and Deloitte*. The five collaborating organizations form part of the IMP Structured Network*. https://impactmanagementproject.com/impact-management/structured-network/

344 SASB's response to preliminary proposals resulting from the European Commission's ad personam mandate on non-financial reporting standard setting, January 2021

Their suggested approach aims at a type of reporting distinct from sustainability reporting, which is designed to illuminate a company's most significant impacts on the environment, people, and economy. They use the term 'Sustainability-related financial disclosure standards,' which would enable the disclosure of how sustainability matters act as value drivers that create or erode enterprise value. They support that sustainability reporting and sustainability-related financial disclosure must be seen as interrelated reporting concepts, <u>with shared methodologies wherever appropriate</u>, regardless of their distinct aims.[345] Finally, they recognize the importance of jurisdiction-level overlays, which can ensure that global standards are complemented by any additional disclosure requirements needed to achieve specific policy objectives—for example, those related to the EU Taxonomy Regulation, a core element of EU's new ESG regulations.[346]

Moreover, the group of five expressed its support with the announcement of the International Financial Reporting Standards[347] (IFRS)'s intention to be involved in the process of developing a global standard for sustainability reporting: "With its experience in international standard-setting and publicly accountable governance architecture, the Foundation is ideally positioned to establish authority and legitimacy around sustainability disclosure standards for capital markets, just as it did for financial reporting."[348]

Apart from the 'group of five' initiative and the IFRS's consultation, other ongoing efforts by ESG systems are summarized below:

- The World Economic Forum and International Business Council (IBC) launched a project to develop a common set of baseline ESG metrics for consistent reporting for sustainable value creation. They released their paper defining 21 core metrics in September 2020.
- ISO formed in 2018 the ISO/TC 322, a technical committee on Sustainable Finance to establish a framework under which new standards may be developed to define and guide certain sustainable finance activities.[349] A Supporting statement to ISO/TC 322 scope was released in September 2019, and the ISO/TC 322 Strategic Business Plan v1 became publicly available in April 2020. The underdevelopment work is estimated to be completed in a 4 to 8 years period.
- The IFRS Foundation issued a consultation from September 2020 to the end of December 2020 to calibrate market views globally for sustainability reporting. Though the consultation results are not yet

[345] CDP, CDSB, GRI, IIRC and SASB. (December 2020) "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard."

[346] EU Taxonomy will be further explained in Part 2: 2.7.' The paradigm of the EU ESG Regime' section of this report.

[347] International Financial Reporting Standards are accounting standards issued by the IFRS Foundation and the International Accounting Standards Board (IASB). They constitute a standardized way of describing the company's financial performance and position so that company financial statements are understandable and comparable internationally. IFRS have replaced many different national accounting standards around the world. The announced involvement of IFRS in the field of non-financial reporting has received extensive support and it is considered as a major event from ESG systems and financial market participants.

[348] https://www.sasb.org/blog/ifrs-foundation-aims-for-coherence-not-complexity/

[349] ISO/TC 322 will seek contributions from other ISO/TCs (several of which already have directly applicable standards; for example, supporting management and reporting) and from external stakeholders and organizations. More specifically, TC 322 has close cooperation with TC 68 in the field of financial services, TC 207 in the field of environmental management, TC 251 in the field of asset management and TC 309 in the field of governance of organizations. (https://www.iso.org/committee/7203746.html)

published, it has received strong support from other organizations, like IOSCO (International Organization of Securities Commissions).

- In October 2020, TCFD published Guidance on Scenario Analysis for Non-Financial Companies and realized a consultation during October 2020- January 2021 to determine whether further TCFD financial sector guidance on forward-looking metrics is needed. [350]
- In March 2018, the EU Commission issued its Action plan on Financing Sustainable Growth, also known as the 'Action Plan.' The plan includes ten action points, three regulations in taxonomy, disclosure, and low carbon benchmark. One of the ten actions of the Plan EU commits to review the EU Non-financial Reporting Directive (NFRD). In June 2019, Supplemental Guidelines were published on reporting climate-related information, and in 2020 the EU launched two public consultations on the revision of NFRD. Based on the results of the consultations, the European Commission is expected to publish a legislative proposal by the end of the year.

2.4.5. The Climate-first Approach

As already mentioned, climate change has been identified as one of the top risks, and SDG 13 for climate action is the most pressing among the sustainable development goals. Specific focus was given on climate-related reporting. This is reflected in the practices of major ESG organizations updating or supplementing their disclosure requirements for climate-related topics.

In the case of the IFRS Foundation's consultation on sustainability disclosure, the consultation paper concludes that climate-related information has been prioritized for early consideration. Following the Task Force's research that indicates that developing global sustainability reporting standards for climate-related information is the most pressing concern, IFRS recommends a "climate-first" approach. Climate risk is a financial risk of growing importance to investors and prudential regulators, primarily because of public policy initiatives by major jurisdictions globally. The immediacy of climate-related demand guided any initial work undertaken by IFRS to focus on climate-related information. However, "what is meant by 'climate-related information' is open to interpretation. That information could focus specifically on climate change and greenhouse gas emissions or take into consideration wider environmental factors and the associated financial risks."[351]

The 'group of five' collaboration followed a similar approach. Though their work is still under development, the first component they presented as progress was a prototype climate-related financial disclosure standard.[352]

[350] On December 4, 2015, the Financial Stability Board (FSB) established the industry-led Task Force on Climate-related Financial Disclosures (TCFD) with mission to develop voluntary, consistent, climate-related financial disclosures for use by companies in providing information to lenders, insurers, investors and other stakeholders, which were published in the TCFD Recommendations Report on June 29, 2017.

[351] IFRS Consultation

[352] CDP, CDSB, GRI, SASB and <IR>. (December 2020) Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard.

2.5. Enterprise Value Creation, Preservation, or Erosion

One core concept of corporate reporting is enterprise value. The International Integrated Reporting Council's <IR> framework[353] provides a comprehensive definition of value creation, preservation, or erosion for a company, adding important connectivity between financial and non-financial reporting. "Value created, preserved, or eroded by an organization over time manifests itself in increases, decreases or transformations of the capitals caused by the organization's business activities and outputs. According to <IR>, enterprise value is a stock of a mix of capitals a company's success depends upon: financial, manufactured, intellectual, human, social and relationship, and natural capitals. Not all capitals are equally relevant; however, most organizations interact with all capitals to some extent, therefore <IR> guides companies to consider all the forms of capital they use or affect.

Financial capital: The pool of funds available to an organization for use in the production of goods or provision of services and/or obtained through financing, such as debt, equity, or grants, or generated through operations or investments.

Manufactured capital: Manufactured physical objects, assets (as distinct from natural physical objects) available to an organization for use in producing goods or providing services, such as buildings, equipment, and infrastructure.

Intellectual capital: Organizational, knowledge-based intangibles, such as intellectual property (patents, copyrights, software, rights, and licenses) and 'Organizational capital,' such as tacit knowledge, systems, procedures, and protocols.

Human capital: People's competencies, capabilities and experience, and their motivations to innovate, including their alignment with and support for an organization's governance framework, risk management approach, and ethical values; ability to understand, develop and implement an organization's strategy; and loyalties and motivations for improving processes, goods, and services, including their ability to lead, manage and collaborate.

Social and relationship capital: The institutions and the relationships within and between communities, groups of stakeholders, and other networks, and the ability to share information to enhance individual and collective well-being. It includes shared norms, and common values and behaviors; key stakeholder relationships, and the trust and willingness to engage that an organization has developed and strives to build and protect with external stakeholders'; intangibles associated with the brand and reputation that an organization has developed; as well as an organization's social license to operate.

---

[353] The IIRC is a global coalition of regulators, investors, companies, standard setters, the accounting profession and NGOs. Its mission is to establish integrated thinking and reporting within mainstream business practice as the norm in the public and private sectors. Its vision is to align capital allocation and corporate behavior to wider goals of financial stability and sustainable development through the cycle of integrated thinking and reporting.

An integrated report is a concise communication about how an organization's strategy, governance, performance and prospects, in the context of its external environment, lead to the creation of value over the short, medium and long term. The International <IR> Framework sets out seven guiding principles and eight content elements to govern the overall content of an integrated report, as well as providing organizations with additional general guidance relating to fundamental concepts of integrated reporting.

The IIRC recognizes the increasing importance of climate change to the ability of all organizations to create value over time and, therefore, the need to address climate-related risks and opportunities in an integrated report.

Natural capital: All renewable and non-renewable environmental resources and processes that provide goods or services that support the past, current, or future prosperity of an organization, including air, water, land, minerals, and forests, and biodiversity and ecosystem health.
The capitals are stocks of value that are increased, decreased, or transformed through the activities and outputs of the organization. The overall stock of capital is not fixed over time, but instead, there is a constant flow between them because of business activities. For example, through employee training, financial capital is transformed into human capital.

Although organizations aim to create value overall, this can involve the erosion of value stored in some capitals, resulting in a net decrease to the overall stock of capitals (i.e., value is eroded). In many cases, whether the net effect is an increase or decrease (or when value is preserved) will depend on the perspective chosen.

The <IR> defined capitals, except the financial capital, are **value drivers** that create or erode enterprise value. <IR> distinguishes value in two interrelated aspects:

- Value for the organization itself, which affects financial returns to the providers of financial capital.
- Value for others (i.e., stakeholders and society at large).

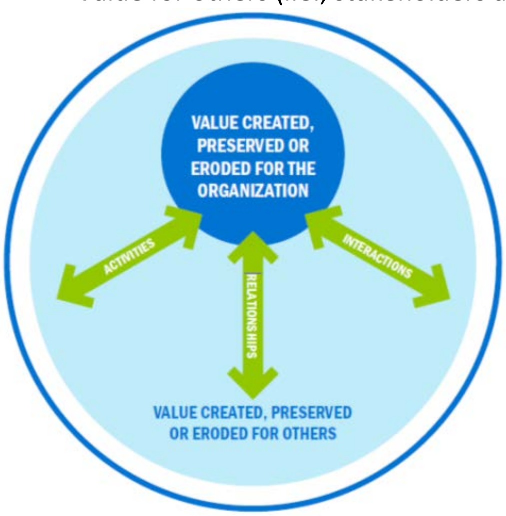


Fig. 44: Value created, preserved, or eroded for the organization and others, according to <IR>

Providers of financial capital are interested in the value an organization creates for itself. The value the organization creates for others is of their interest when it affects the ability of the organization to create value for itself or relates to a stated objective of the organization (e.g., an explicit social purpose) that affects their assessments.

The ability of an organization to create value for itself is linked to the value it creates for others through a wide range of activities, interactions, and relationships in addition to those, such as sales to customers, that are directly associated with changes in financial capital. These include:

- the effects of the organization's business activities and outputs on customer satisfaction
- suppliers' willingness to trade with the organization and the terms and conditions upon which they do so
- the initiatives that business partners agree to undertake with the organization

- the organization's reputation
- conditions imposed on the organization's social license to operate, and
- the imposition of supply chain conditions or legal requirements.

In other words, these interactions, activities, and relationships are material to the organization's ability to create value for itself. This includes considering the extent to which effects on the capitals have been externalized (i.e., the costs or other effects on capitals that the organization does not own).
Because value is created over different time horizons and for different stakeholders through various capitals, it is unlikely to be made through the maximization of one capital while disregarding or at the expense of the others.

The process through which value is created, preserved or eroded (according to <IR>)
Although organizations aim to create value, the stock of capitals can either undergo a net decrease or experience no net change. In such cases, value is eroded or preserved. The process through which value is created, preserved, or eroded is depicted in the figure:

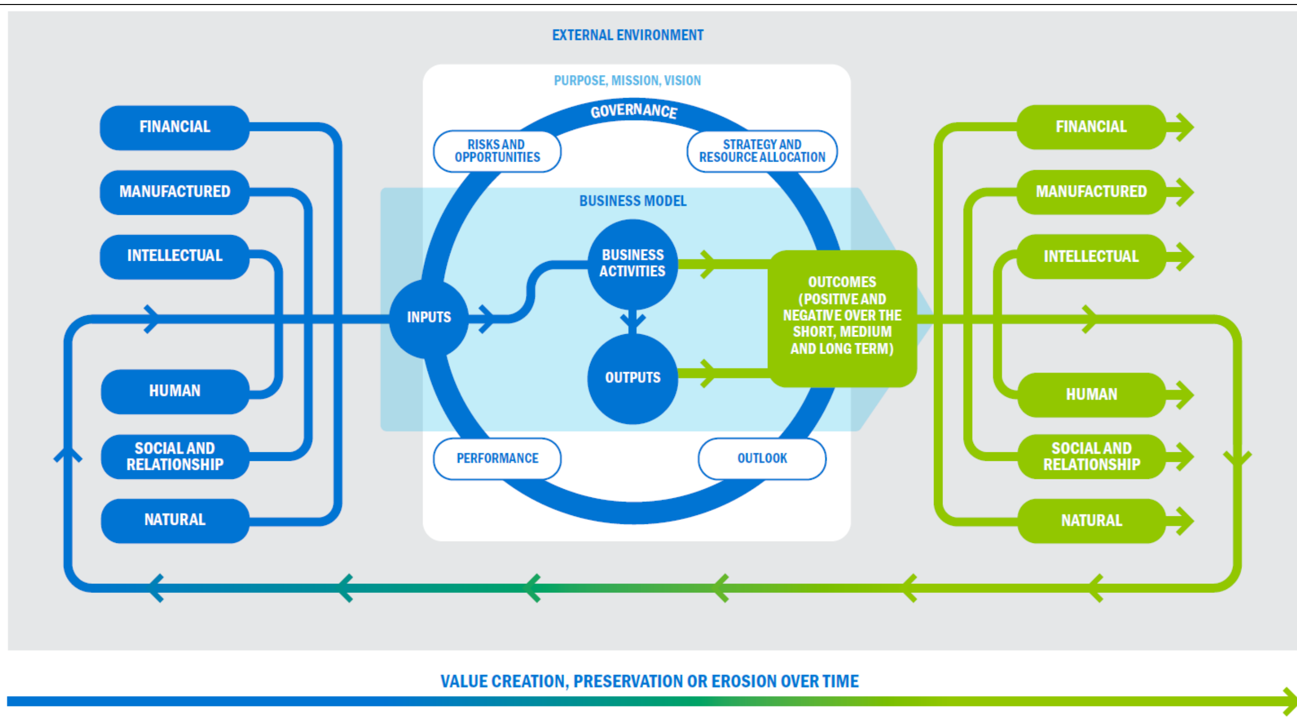


Fig. 45: Process through which value is created, preserved, or eroded, according to <IR>

According to the above diagram, the process through which value is created, preserved, or eroded is a function of various factors:

- the stock of the multiple capitals that function as inputs for the company's production of products or provision of services
- the external environment (economic conditions, technological change, societal issues, and environmental challenges)
- the purpose, mission, and vision of the company

- the company's governance
- the company's business model
- the company's strategy and resource allocation plans
- the company's performance, which involves setting up measurement and monitoring systems for information on performance
- the company's outlook, which includes the uncertainties it is likely to encounter in pursuing its strategy and the potential implications they may have for its business model and future performance
- the company's business activities (planning, design, and manufacture of products or the deployment of specialized skills and knowledge in the provision of services)
- the company's outputs (products, services, by-products, and waste).
- The outcomes, the internal and external consequences (positive and negative) for the capitals, result from an organization's business activities and outputs.

The external environment sets the context within which the organization operates. The purpose, mission, and vision encompass the whole organization, identifying its intention in clear, concise terms. Those charged with governance are responsible for creating an appropriate oversight structure to support the ability of the organization to create value. The company's business model draws on various capitals as inputs and converts them to outputs through its business activities.

The organization's business activities and outputs lead to outcomes in terms of effects on the capitals. The capacity of the business model to adapt to changes (e.g., in the availability, quality, and affordability of inputs) can affect the organization's longer-term viability. Encouraging a culture of innovation is often a key business activity in generating new products and services that anticipate customer demand, introducing efficiencies and better use of technology, substituting inputs to minimize adverse social or environmental effects, and finding alternative uses for outputs.

Continuous monitoring and analysis of the external environment in the context of the organization's purpose, mission, and vision identifies risks and opportunities relevant to the organization, its strategy, and its business model. The organization's strategy identifies how it intends to mitigate or manage risks and maximize opportunities. It sets out strategic objectives and strategies to achieve them, which are implemented through resource allocation plans.

The value creation, preservation, or erosion process is not static; regular review of each component and its interactions with other components, and a focus on the organization's outlook, lead to revision and refinement to improve all the components.

2.6. ESG Materiality to Investors

A company is faced with a wide range of topics, which can report. Relevant topics, which should potentially be communicated to stakeholders, are those that can reasonably be considered important for reflecting the company's economic, environmental, and social impacts[354] or influencing the decisions of stakeholders. A topic can be relevant – and so potentially material – based on only one of these dimensions.[355]

In financial reporting, materiality is commonly thought of as a threshold for influencing the economic decisions of those using a company's financial statements, investors in particular. More specifically, the IFRS Foundation defines 'material information' as the information that '*if omitting, misstating or obscuring it could reasonably be expected to influence the decisions that the primary users of general-purpose financial statements make based on those financial statements, which provide financial information about a specific reporting entity*.'[356]

Financially material information is the one that is necessary for an understanding of the development, performance, and position of a company, and this is typical of most interest to investors.

Environmental and social materiality is necessary for understanding the external impacts of the company's activities and concerns a broader range of impacts and a wider range of stakeholders. This is typical of most interest to citizens, consumers, employees, business partners, communities, and civil society organizations.
In sustainability reporting, materiality is the principle that determines which relevant topics are sufficiently important that it is essential to report on them. Not all material topics are of equal importance, and the emphasis within a report is expected to reflect their relative priority. When assessing whether a topic is material, a combination of internal and external factors can be considered. These include the organization's overall mission and competitive strategy and the concerns expressed directly by stakeholders. Materiality can also be determined by broader societal expectations and by the organization's influence on upstream entities, such as suppliers, or downstream entities, such as customers. Assessments of materiality are also expected to consider the expectations expressed in international standards and agreements with which the organization is expected to comply. These internal and external factors are considered when evaluating the importance of information for reflecting significant economic, environmental, and/or social impacts or stakeholders' decision-making. Various methodologies can be used to assess the significance of impacts. In general, 'significant impacts' are a subject of established concern for expert communities or identified using established tools, such as impact assessment methodologies or life cycle assessments. Impacts that are considered important enough to require active management or engagement by the organization are likely to be considered significant.

Materiality, in other words, entails a prioritization of ESG topics that have to be communicated internally and externally. Sustainable investing is about materiality. A company that aspires to address every conceivable environmental, social, and governance (ESG) issue will likely see its financial performance suffer. In contrast, **companies that focus on material issues tend to outperform those that do not**.[357]

Each ESG system has a distinct approach to materiality, focusing on either financial materiality or environmental and social materiality, or both. This is represented in selecting ESG topics they list as part of their guidance for

[354] Impact refers to the effect a company has on the economy, the environment, and/or society (positive or negative)
[355] GRI Standards
[356] https://www.ifrs.org/news-and-events/2018/10/iasb-clarifies-its-definition-of-material/
[357] The Investor Revolution: Shareholders are getting serious about sustainability. by Robert G. Eccles and Svetlana Klimenko From the Harvard Business Review Magazine (May–June 2019)

companies to disclose information about. They call companies to assess which topics they consider the material for their business model and context, as materiality varies by industry. They provide the necessary guidance to assist the user (reporting company) in assessing the materiality of topics. Therefore, it is the preparer of the report that ultimately decides on its exact content.

The SASB Standards, an industry-specific standard, supports that 'when evaluating the financial materiality of environmental and social issues, **industry-specificity is critical** because such issues often manifest in unique ways in the context of specific business models."[358]

The term 'double materiality' was first introduced by the EU Commission as part of the Non-Binding Guidelines on Non-Financial Reporting Directive (NFRD)'s supplement on climate-related disclosures in 2019, highlighting that risks and opportunities can be material from both a financial and non-financial perspective. In other words, issues or information related to environmental and social objectives can have financial consequences over time. These two risk perspectives already overlap in some cases and are increasingly likely to do so in the future. Climate change is a prime example of that.

An increasing number of investors need to know about the climate impacts of investee companies to better understand and measure the climate impacts of their investment portfolios.[359] For example, as markets and public policies evolve in response to climate change, the positive and/or negative impacts of a company on the climate will increasingly translate into business opportunities and/or risks that are financially material. In other words, materiality is a dynamic concept, and issues that are not financially material today may become relevant for enterprise value over time.

The materiality perspective of the NFRD and the EU ESG Regime in general covers both financial materiality and environmental and social materiality, whereas the TCFD has a financial materiality perspective only. Companies are required "to set out the risks to a product or portfolio by ESG phenomena, and the risks a product or portfolio presents to ESG factors" and aim at ensuring economic resilience in the face of ESG risks to assess such exposures to the products they manufacture or distribute, the services they provide and the exposure of their firm."[360]

358 Response of the Sustainability Accounting Standards Board to the Public Consultation on the Revision of the Non-Financial Reporting Directive

359 European Commission. (2019) Guidelines on reporting climate-related information https://ec.europa.eu/info/publications/non-financial-reporting-guidelines_en#climate

360 E.U. Environmental Social Governance Regulations Guide, 2020.

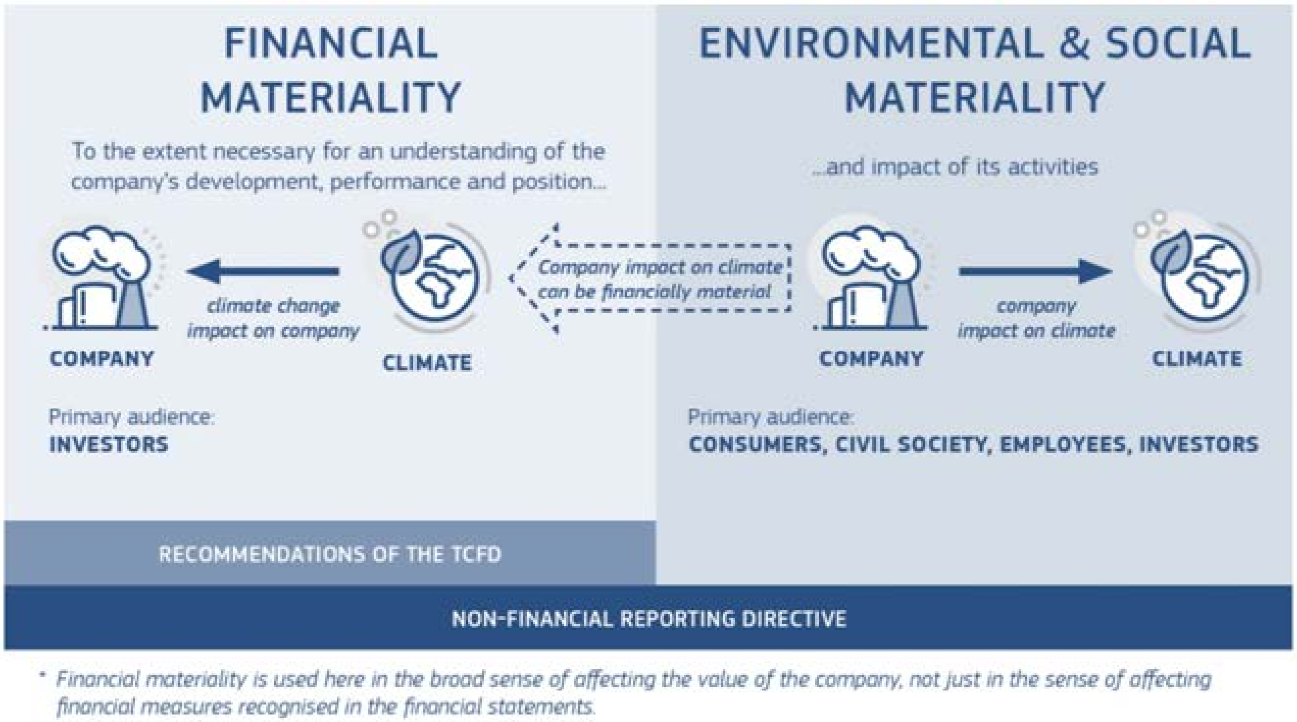


Fig. 46: The double materiality perspective in the case of climate change according to the European Commission's Guidelines on reporting climate-related information, 2019

The 'building blocks' approach of the 'group of five' collaboration effort for its new global standard, described earlier, Recent initiatives, embraces the EU's double materiality perspective.

2.7. The Paradigm of the EU ESG Regime

The European Commission has demonstrated leadership in establishing a coherent, comprehensive corporate reporting system through its nascent ESG regime. It responds to the proliferation of voluntary, non-governmental standards that filled the gap left by an absence of regulation. An entire ESG data and analytics industry emerged to serve the needs of the investment community, however leading to market fragmentation, opacity, and heterogeneity in quality among voluntary standards and their offerings.

"To overcome this fragmentation, EU policy drivers have developed a single set of regulatory standards that require investment firms to demonstrate their provenance in their ESG claims with robust data and analytic disclosures. The disclosures are designed to facilitate meaningful comparisons between investments to enable informed decisions and channeling of private investment into legitimate, sustainable economic activities. The regulatory measures also seek to address the growing risks ESG factors pose to investments (and investment firms), and the risks investments present to ESG factors."

The EU ESG regulations are part of a broader plan, the EU Action Plan for sustainable finance, also known as the 'Action Plan,' released in March 2018. The plan includes ten action points, three regulations in taxonomy, disclosure, and low carbon benchmark. The ten actions of the Action plan:

Actions for reorienting capital flows towards sustainable investment to achieve sustainable and inclusive growth:

1. Establishing an EU classification system for sustainability activities
2. Creating standards and labels for green financial products
3. Fostering investment in sustainable projects
4. Incorporating sustainability when providing investment advice
5. Developing sustainability benchmarks

Actions for mainstreaming sustainability into risk management:

6. Better integrating sustainability in ratings and research
7. Clarifying institutional investors and asset managers' duties
8. Incorporating sustainability in prudential requirements

Actions for fostering transparency and long viability in financial and economic activity:

9. Strengthening sustainability disclosure and accounting rule-making
10. Fostering sustainable corporate governance and attenuating short-termism in capital markets

As part of one of the Plan actions, the EU commits to review the EU Non-financial Reporting Directive (NFRD) of 2017 that requires large EU 'public interest' corporates to publish annual ESG related disclosures on the impact of their activities have on ESG factors. The most pressing ESG rules for investment firms are those set out in:

- The Non-financial Reporting Directive (NFRD
- The Sustainable Finance Disclosure Regulation (SFDR) and
- The Taxonomy regulation

The interconnection of these ESG rules is shown in the graph below:

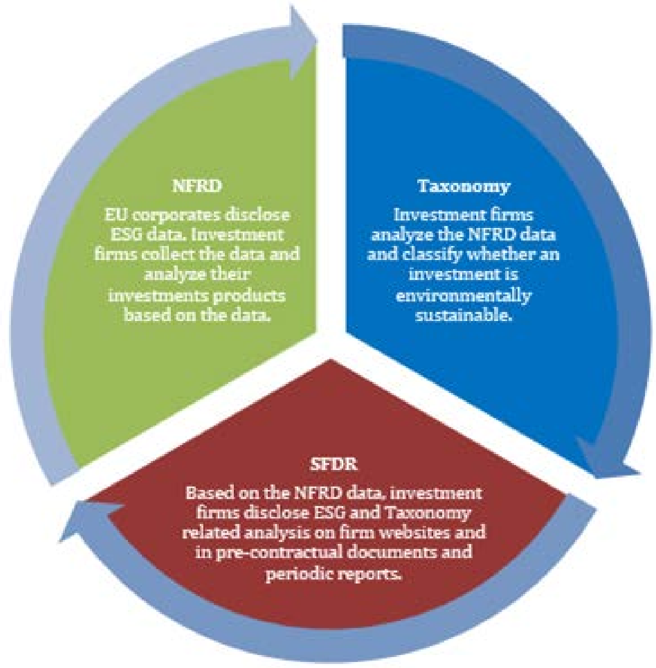


Fig. 47: Interconnections between the EU Taxonomy, SFDR, and NFRD Regulations[361]

In large part, the driver for the nascent EU ESG Regime is the EU's commitment to the UN 2030 Agenda and the 17 SDGs. The EU has embraced all the SDGs to varying degrees in its regulatory framework and has identified the goal of combating climate change as the most pressing.

In December 2019, the EU Green Deal was presented with new rules for countries, sectors, companies, financial markets & institutions, and consumers: *"The European Green Deal provides a roadmap with actions to boost the efficient use of resources by moving to a clean, circular economy and stop climate change, revert biodiversity loss and cut pollution. It outlines investments needed and financing tools available and explains how to ensure a just and inclusive transition."*

The EU takes a leading global role in climate action committing to becoming the first climate-neutral continent by 2050. The first main climate target has been set in the EU's first-ever Climate Law: to reduce greenhouse gas emissions by at least 55% by 2030. To support this sustainable transition within the EU, at least €100 billion has been mobilized for sustainable investments over 2021-2027.

EU Taxonomy

EU Taxonomy is a classification system at the European Union level to clarify which economic activities qualify as 'green' or 'environmentally sustainable.' It is aimed at investors, companies, and financial institutions to

361 Barrie C. Ingman**.** (July 2020) 'The EU Taxonomy Regulation: An Overview'. https://insight.factset.com/eu-taxonomy-regulation

define the environmental performance of economic activities across a wide range of industries and sets requirements corporate activities must meet to be considered sustainable.

It is built upon the six EU Green Deal environmental objectives:

- Climate Change mitigation
- Climate Change adaptation
- Protection of water and marine resources
- Transition to a circular economy
- Pollution prevention and control
- Protection and restoration of biodiversity and ecosystems

The six environmental objectives are aligned with SDGs and more specifically:

- SDG6 “Ensure availability and sustainable management of water and sanitation for all” targets
- SDG7 “Ensure access to affordable, reliable, sustainable and modern energy for all” targets
- SDG13 “Climate action” targets
- SDG12 “Ensure sustainable consumption and production patterns” targets
- SDG14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development” targets; and
- SDG15 “Protect, restore and promote sustainable use of terrestrial” targets

The Taxonomy sets performance thresholds (referred to as ‘technical screening criteria’) for economic activities, which:

- make a substantive contribution to one of six environmental objectives,
- do no significant harm (DNSH) to the other five objectives, and
- meet minimum social and governance safeguards (e.g., OECD Guidelines on Multinational Enterprises and the UN Guiding Principles on Business and Human Rights).[362]

[362] EU. (March 2020) “Taxonomy: Final report of the Technical Expert Group on Sustainable Finance”.

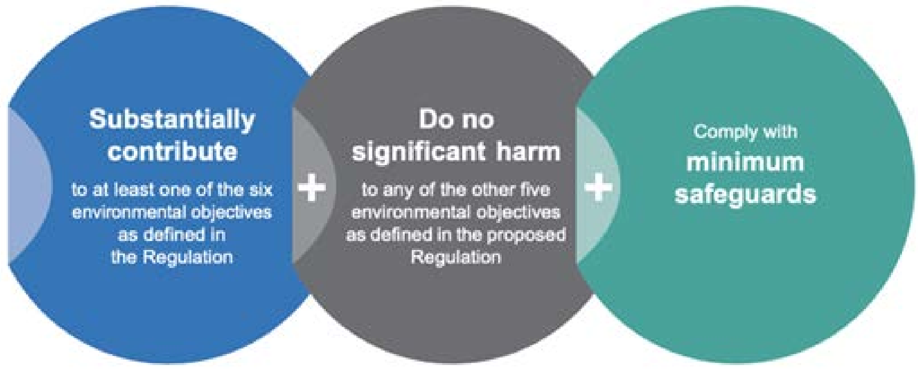


Fig. 48: The 3 Taxonomy's performance thresholds (referred to as 'technical screening criteria') for economic activities

For each environmental objective, the Taxonomy Regulation recognizes two distinct types of substantial contribution that can be considered Taxonomy-aligned:

- Economic activities that make a substantial contribution based on their performance: For example, economic activities performed environmentally sustainable.
- Enabling activities: Economic activities that will allow a substantial contribution to other activities by providing their products or services. For example, an economic activity that manufactures a component that improves the environmental performance of another activity.

Up to date, the 1st Phase of the Taxonomy has been published and enables the categorization of economic activities/sectors that play key roles in climate change mitigation and adaptation.[363] The Taxonomy will be expanded to include adequate consideration of the other four objectives by the end of 2021.

Specifically for the climate change mitigation objective, the Taxonomy's basis for establishing thresholds is the 50–55% reduction by 2030 and net-zero emissions by 2050 of the EU Green Deal, consistent with the EU's commitment the Paris Agreement. It will be tightened over the period to 2050, e.g., in the case of CO2 intensity limits.

The EU Taxonomy is indispensable in making the EU climate targets implementable in practice and widely seen as a first and essential enabling step in the overall effort to channel investments into sustainable activities. It's intended as a "tool for financing the transition to a more sustainable economy, that it incentivizes capital to flow towards improvements in environmental performance (and resilience) of all sectors of the economy which do not directly undermine environmental goals."[364] Economic activities will have to prove they are Taxonomy-aligned. "The EU Taxonomy is one of the most significant developments in sustainable finance and will have wide-ranging implications for investors and issuers working in the EU, and beyond." The performance

363 The European Commission established a Technical Expert Group (TEG) on Sustainable Finance, which was tasked with developing recommendations on a range of topics, including what the Taxonomy technical screening criteria should be for the objectives of climate change mitigation and adaptation. The TEG has received input from all parts of the investment chain, industry sector representatives, academia, environmental experts, civil society and public bodies.

364 EU. (March 2020) "Taxonomy: Final report of the Technical Expert Group on Sustainable Finance".

thresholds will help companies, project promoters, and issuers access green financing to improve their environmental performance, as well as helping to identify which activities are already environmentally friendly. In doing so, it will help to grow low-carbon sectors and decarbonize high-carbon sectors.[365]

The Taxonomy Regulation requires companies to disclose the proportion of their turnover derived from products or services associated with environmentally sustainable economic activities and the proportion of their capital and operating expenditure related to assets or processes associated with such activities. It can be expected that financial market actors will look much more closely at the activities they are financing and investing in.[366] Although the main workload for implementation will be for financial institutions and other capital providers, companies will still need data points to deliver to their capital providers. It is estimated that more than 20.000 companies in the EU are likely to be asked for these data points soon- as the implementation date for financial institutions is December 31st, 2021.

2.8. Key takeaways

- The findings of the second part of the Literature Review reaffirm the initial research hypothesis that support for climate action is a priority for investors and investment decisions.
- ESG systems provide a representative overview of the ESG topics that are material (relevant) to investors, given that are the primary tool for investors to monitor a company's sustainable performance.
- <IR> framework's definition of value creation or erosion is instructive for understanding the range of topics that can be material to investors. Enterprise value is defined as a stock of a mix of capitals: financial, manufactured, intellectual, human, social and relationship, and natural capitals that a company's success depends upon.
- ESG systems respond to investors' increasing demand for disclosure of companies' performance across a range of sustainability topics (and by extension project performance in the case of infrastructure companies). In this sense Envision as an assessment tool has a role to play in the prioritization of the right projects, by requesting and/or guiding on the collection of the right type of data of project performance that is material to investors' decisions.
- ESG reporting on climate-related issues is rapidly evolving in response to increasing interest from investors and regulators. Apart from climate-focused systems, there are cases of under=-development new standards that adopt a climate-first approach, prioritizing publication of climate-related components of ESG reporting.
- The TCFD Recommendations have acted as a catalyst for bringing climate risk to the mainstream for the financial sector by linking it to its potential financial impacts for a company.
- TCFD alignment has grown to an investors' demand for ESG systems and evidence of alignment is pursued by ESG systems as part of recent update efforts
- ESG systems have a different approach to materiality, focusing on either financial materiality or environmental and social materiality, or both. Regulators and emerging ESG systems seek to address double materiality, which could indicate a new direction of investors' demand.

[365] EU. (March 2020) "Taxonomy: Final report of the Technical Expert Group on Sustainable Finance".
[366] https://home.kpmg/fi/fi/home/Pinnalla/2019/08/eu-sustainable-finance-explained-part-ii-taxonomy.html

- SASB Standards, an industry-specific standard, supports that 'when evaluating the financial materiality of environmental and social issues, **industry-specificity is critical** because such issues often manifest in unique ways in the context of specific business models. This view is supported by other standards that apart from industry-agnostic guidance, provide sector-specific guidance as a supplement.

PART 2: RESEARCH TOOLS

This part provides an overview of the main tools used for the research:

- The Envision rating system's approach to climate change mitigation, adaptation and financial materiality
- The LC Sustainability tool, an Envision-based tool that adds certain new data and capabilities to Envision
- Selected established ESG and climate-related reporting frameworks and standards

The ESG systems are analyzed and cross-examined to identify the current trends of climate change-related reporting. This analysis allows for identifying climate-related data that are relevant to investors and guide their investment decisions. Specific focus is given on the analysis of the Taskforce for Climate Financial Disclosures (TCFD) Recommendations that mainstreamed climate change as financial risk, by connecting it to potential financial impacts for companies.

1. ENVISION®

1.1. Evolution of Envision® from V2 to V3

The Envision® framework evolution from version 2 to version 3 was triggered by industry advances in understanding resilience due to the growing evidence of climate change adverse effects that made the need for climate change mitigation and adaptation actions even more urgent. The Envision V2 Climate & Risk Category was renamed to Climate & Resilience, and resilience credits were reviewed and updated. Moreover, credits were expanded to integrate construction activities (activities with short-term and recurrent impacts and the project's life, given that rehabilitation or replacement of assets involves construction works). Finally, as a response to a growing interest in linking non-financial sustainability performance with financial performance to strengthen the business case of sustainable projects, ISI identified the need to place greater emphasis on evaluating the economics of infrastructure projects.[367]

As presented in the following tables, the new credits added the new sub-categories: Mobility in the Quality of life, Economy in Leadership, Conservation and Ecology in Natural World and the enhancement of the Climate &

[367] As part of the release of the 3rd version of the Envision in 2018: "The industry understanding of resilience has grown tremendously, especially in the wake of major natural disasters in recent years (e.g., hurricane Sandy); therefore, ISI identified the need to expand the framework to incorporate a more advanced appreciation and understanding of resilience. Also, ISI identified the need to place greater emphasis on evaluating the economics of infrastructure projects, as well as the need to extend the framework to more specifically include construction related sustainability aspects."

Resilience category and the emphasis placed in Leadership regarding the Economics of infrastructure, developed in Envision V3. These changes illustrate the importance and urgency of the topics in the proposed research.

Table 4: Overview of changes between Envision V2 and V3, highlighting (i) the New subcategories, (ii) the main credits changes related to Climate and the Resilience and Leadership (i, ii), and the New credits.


ENVISION V2 TO ENVISION V3
CHANGES AND REORGANIZATION
TABLE KEY
Rewritten Credits
Minimal Changes
New credits
Moved to Innovation
Credits moved to other or new categories
ENVISION V2
Quality of Life
Purpose
QL1.1 Improve Community Quality of Life
QL1.2 Stimulate Sustainable Growth and Development
QL1.3 Develop Local Skills and Capabilities
Wellbeing
QL2.1 Enhance Public Health and Safety
QL2.2 Minimize Noise and Vibration
QL2.3 Minimize Light Pollution
QL2.4 Improve Community Mobility and Access
QL2.5 Encourage Alternative Modes of Transportation
QL2.6 Improve Site Accessibility, Safety and Wayfinding
Community
QL3.1 Preserve Historic & Cultural Resources
QL3.2 Preserve Views & Local Character
QL3.3 Enhance Public Space
Leadership
Collaboration
LD1.1 Provide Effective Leadership & Commitment
LD1.2 Establish a Sustainability Management System
LD1.3 Foster Collaboration and Teamwork
LD1.4 Provide for Stakeholder Involvement
Management
LD2.1 Pursue By-Product Synergy Opportunities
LD2.2 Improve Infrastructure Integration
Planning
LD3.1 Plan for Long-Term Monitoring and Maintenance
LD3.2 Address Conflicting Regulations and Policies
LD3.3 Extend Useful Life
Resource Allocation
Materials
RA1.1 Reduce Net Embodied Energy
RA1.2 Support Sustainable Procurement Practices
RA1.3 Use Recycled Materials
RA1.4 Use Regional Materials
RA1.5 Divert Waste From landfills
RA1.6 Reduce Excavated Materials Taken Off Site
RA1.7 Provide for Deconstruction and Recycling
Energy
RA2.1 Reduce Energy Consumption
RA2.2 Use Renewable Energy
RA2.3 Commission and Monitor Energy Systems
Water
RA3.1 Protect Fresh Water Availability
RA3.2 Reduce Potable Water Consumption
RA3.3 Monitor Water Systems
Natural World
Siting
NW1.1 Preserve Prime Habitat
NW1.2 Protect Wetlands and Surface Water
NW1.3 Preserve Prime Farmland
NW1.4 Avoid Adverse Geology
NW1.5 Preserve Floodplain Functions
NW1.6 Avoid unsuitable Development on Steep Slopes
NW1.7 Preserve Greenfields
Land + Water
NW2.1 Manage Stormwater
NW2.2 Reduce Pesticide and Fertilizer Impacts
NW2.3 Prevent Surface and Groundwater Contamination
Biodiversity
NW3.1 Preserve Species Biodiversity
NW3.2 Control Invasive Species
NW3.3 Restore Disturbed Soils
NW3.4 Maintain Wetland and Surface Water Functions
Climate and Risk
Emissions
CR1.1 Reduce Greenhouse Gas Emissions
CR1.2 Reduce Air Pollutant Emissions
Resilience
CR2.1 Assess Climate Threat
CR2.2 Avoid traps and Vulnerabilities
CR2.3 Prepare for Long-Term Adaptability
CR2.4 Prepare for Short-Term Hazards
CR2.5 Manage Heat Islands Effects
ENVISION V3
QL1.1 Improve Community Quality of Life
QL1.2 Enhance Public Health & Safety
QL1.3 Improve Construction Safety
QL1.4 Minimize Noise & Vibration
QL1.5 Minimize Light Pollution
QL1.6 Minimize Construction Impacts
Wellbeing
QL2.1 Improve Community Mobility
QL2.2 Encourage Sustainable Transportation
QL2.3 Improve Access & Wayfinding
Mobility
NEW
QL3.1 Advance Equity & Social Justice
QL3.2 Preserve Historic & Cultural Resources
QL3.3 Enhance Views & Local Character
QL3.4 Enhance Public Space & Amenities
Community
Quality of Life
LD1.1 Provide Effective Leadership & Commitment
LD1.2 Foster Collaboration & Teamwork
LD1.3 Provide for Stakeholder Involvement
LD1.4 Pursue Byproduct Synergies
Collaboration
LD2.1 Establish a Sustainability Management Plan
LD2.2 Plan for Sustainable Communities
LD2.3 Plan for Long-Term Monitoring & Maintenance
LD2.4 Plan for End-of-Life
Planning
LD3.1 Stimulate Economic Prosperity & Development
LD3.2 Develop Local Skills & Capabilities
LD3.3 Conduct a Life-Cycle Economic Evaluation
Economy
NEW
Leadership
RA1.1 Support Sustainable Procurement Practices
RA1.2 Use Recycled Materials
RA1.3 Reduce Operational Waste
RA1.4 Reduce Construction Waste
RA1.5 Balance Earthwork On Site
Materials
RA2.1 Reduce Operational Energy Consumption
RA2.2 Reduce Construction Energy Consumption
RA2.3 Use Renewable Energy
RA2.4 Commission & Monitor Energy Systems
Energy
RA3.1 Preserve Water Resources
RA3.2 Reduce Operational Water Consumption
RA3.3 Reduce Construction Water Consumption
RA3.4 Monitor Water Systems
Water
Resource Allocation
NW1.1 Preserve Sites of High Ecological Value
NW1.2 Provide Wetland & Surface Water Buffers
NW1.3 Preserve Prime Farmland
NW1.4 Preserve Undeveloped Land
Siting
NW2.1 Reclaim Brownfields
NW2.2 Manage Stormwater
NW2.3 Reduce Pesticide & Fertilizer Impacts
NW2.4 Protect Surface & Groundwater Quality
Conservation
NEW
NW3.1 Enhance Functional Habitats
NW3.2 Enhance Wetland & Surface Water Functions
NW3.3 Maintain Floodplain Functions
NW3.4 Control Invasive Species
NW3.5 Protect Soil Health
Ecology
NEW
Natural World
CR1.1 Reduce Net Embodied Carbon
CR1.2 Reduce Greenhouse Gas Emissions
CR1.3 Reduce Air Pollutant Emissions
Emissions
CR2.1 Avoid Unsuitable Development
CR2.2 Assess Climate Change Vulnerability
CR2.3 Evaluate Risk and Resilience
CR2.4 Establish Resilience Goals and Strategies
CR2.5 Maximize Resilience
CR2.6 Improve Infrastructure Integration
Resilience
Climate and Resilience

Table 5: The enhancement of Climate & Resilience category and the emphasis on evaluating infrastructure projects ' economics through the new subcategory "economy" in the Leadership category

Envision V2	THE ENVISION™ RATING SYSTEM				Envision V3			
categories	sub-categories	criretia			categories	sub-categories	criretia	
	Purpose	QL1.2	Stimulate Sustainable Growth and Development	→		Economy	LD3.1	Stimulate Economic Prosperity & Development
		QL1.3	Develop Local Skills and Capabilities	→			LD3.2	Develop Local Skills & Capabilities
	Planning	LD3.3	Extend Useful Life	→		Planning	LD2.4	Plan for End-of-Life
	Materials	RA1.7	Provide for Deconstruction and Recycling					
	Management	LD2.2	Improve Infrastructure Integration	→		Resilience	CR2.6	Improve Infrastructure Integration
	Materials	RA1.1	Reduce Net Embodied Energy	→		Emissions	CR1.1	Reduce Net Embodied Carbon
		RA1.4	Use Regional Materials					
	Siting	NW1.4	Avoid Adverse Geology	→		Resilience	CR2.1	Avoid Unsuitable Development
		NW1.6	Avoid unsuitable Development on Steep Slopes					
	Resilience	CR2.2	Avoid traps and Vulnerabilities	→			CR2.5	Maximize Resilience
		CR2.3	Prepare for Long-Term Adaptability					
		CR2.4	Prepare for Short-Term Hazards					

1.2. Envision Analysis on Climate Mitigation vs. Adaptation

The question to explore is, "Are climate change mitigation and climate change adaptation equally weighted in the Envision rating system?"[368] The first step for answering this question is based on the credits that explicitly refer to climate mitigation or adaptation.

Table 6: Envision credits that explicitly refer to/ assess climate change mitigation strategies:

Credit		Points per level of achievement				
		Improved	Enhanced	Superior	Conserving	Restorative
RA2.1	Reduce Operational Energy Consumption	6	12	18	26	-
RA2.2	Reduce Construction Energy Consumption	1	4	8	12	-
RA2.3	Use Renewable Energy	5	10	15	20	24
RA2.4	Commission & Monitor Energy Systems	3	6	12	14	-
CR1.1	Reduce Net Embodied Carbon	5	10	15	20	-
CR1.2	Reduce Greenhouse Emissions	8	13	18	22	26
	total	28	55	86	114	50

What percentage of the overall scoring does mitigation and adaptation assessment constitute?

The maximum total points in Envision V3 framework : 1000

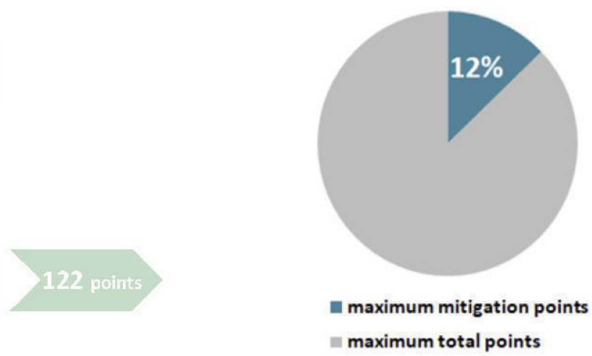
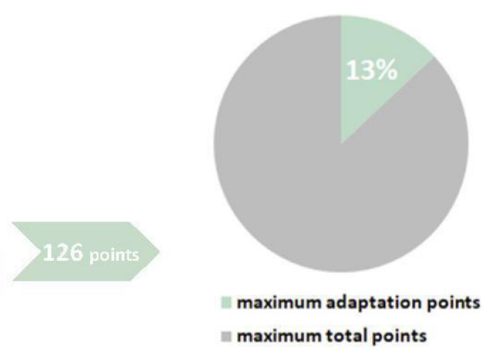


Table 7:: Envision credits that explicitly refer to/assess climate change adaptation strategies

Credit		Points per level of achievement				
		Improved	Enhanced	Superior	Conserving	Restorative
CR2.1	Avoid Unsuitable Development	3	6	8	12	16
CR2.2	Assess Climate Change Vulnerability	8	14	18	20	-
CR2.3	Evaluate Risk and Resilience	11	18	24	26	-
CR2.4	Establish Resilience Goals and Strategies	-	8	14	20	-
CR2.5	Maximize Resilience	11	15	20	26	-
CR2.6	Improve Infrastructure Integration	2	5	9	13	18
	total	35	66	93	107	34

What percentage of the overall scoring does mitigation and adaptation assessment constitute?

The maximum total points in Envision V3 framework : 1000



368 Climate change adaptation is the process of adjusting to current and/or expected climate change and its impact. Climate change mitigation refers to any actions or efforts taken to reduce or prevent the long-term risks of climate change on human life and property by reducing the sources or enhancing the sinks of greenhouse gases emissions.

1.3. Envision analysis in terms of economics

An initial step for this analysis will be based on credits that explicitly refer to / assess economically sustainable performance. Through the Leadership's subcategory 'Economy,' Envision assesses the economic sustainability of the project with three credits:

LD3.1	Stimulate Economic Prosperity & Development
LD3.2	Develop Local Skills & Capabilities
LD3.3	Conduct a Lifecycle Economic Evaluation

Credits LD3.1 and LD3.2 encourage project teams to extend their assessment to account for socio-economic sustainability. Credit LD3.3 assesses the financial impacts of a project for the owner/ manager. The credit encourages the development of a Lifecycle Economic Evaluation and as part of evaluating higher levels of performance, Credit LD3.3 requires:

- mapping and quantification of the social and environmental impacts of the project, and
- quantification and measurement of the project's broader financial, social, and environmental benefits, using triple bottom line cost-benefit analysis (TBL-CBA) or sustainable return on investment (SROI).

To further guide users on mapping the social and environmental impacts, the credit's evaluation criteria provide a list of potential impacts.

In the above review of Envision **only** those credits that explicitly refer to/assess climate change mitigation or adaptation and economic sustainability were presented. However, there are inherent relations/ synergies between credits as highlighted within the Envision manual, the 'Related Envision Credits' included in each credit's description. Therefore, questions that emerge and are subject of the research are:

- Which **credits <u>indirectly</u>** contribute to mitigation or adaptation to climate change?
- Which **credits <u>indirectly</u>** contribute to the economic costs/benefits for the infrastructure project owner/ manager?

1.4. Performance of Envision awarded projects in RA and C&R Categories

Loren Labovitch of Stantec,[369] member of the Zofnass Industry Advisory Board, suggested "to analyze the average score in the Climate and Resilience category for all Envision Gold and Platinum-certified projects to date," to provide insight on "how some projects focus on reducing their carbon footprint relative to other sustainability criteria while others simply choose not to measure their carbon reductions for various reasons, including the complexity and cost."

Labovitch further suggested that "maybe one-day Envision could institute a "Platinum Plus" or "Gold Plus" type of rating that distinguishes projects which not only meet the highest criteria for sustainability overall but also rank high in the climate category specifically. Added incentive to increase the focus on climate change without disregarding the inherent interrelationships between climate mitigation and other sustainability criteria."

[369] Feedback on the 1st presentation to SIAB members on the 2020-21 Zofnass Research Framework.

Roberto Mezzalama of Golder, now WSP, member of the Zofnass Industry Advisory Board, suggested prioritizing climate change and biodiversity conservation of infrastructure projects (both positive and negative) related to Envision criteria and beyond.

Table 8: Overview of scoring per Envision Category of the 18 of 94[370] Envision verified projects that have been publicly announced as of February 4, 2021

	PROJECT	SECTOR	YEAR	AWARD LEVEL	SCORE (%)				
					QL	LD	RA	NW	C&R
1	Snow Creek Stream Environment Zone Restoration Project, Placer County, CA	Land/Environment	2013	**Platinum**	77%	48%	34%	92%	45%
2	South Los Angeles Wetland Park, Los Angeles, CA	Water	2014	**Platinum**	57%	56%	43%	92%	21%
3	Sun Valley Watershed Multi-Benefit Project, Los Angeles, CA	Water	2014	**Platinum**	75%	85%	39%	86%	55%
4	Low-Level Road, North Vancouver, BC	Transportation	2015	**Platinum**	78%	61%	21%	54%	66%
5	Kansas City Streetcar, Kansas City, MO	Transportation	2016	**Platinum**	91%	62%	27%	25%	43%
6	Ohio River Bridges - East End Crossing, Jeffersonville, IN	Transportation	2016	**Platinum**	92%	79%	13%	46%	57%
7	Nutrient Management Facility, Alexandria, VA	Wastewater	2016	**Platinum**	53%	59%	49%	75%	40%
8	Highway (I-4 Ultimate), Orlando, FL	Transportation	2017	**Platinum**	81%	79%	26%	44%	23%
9	CIP 2406 - Digester Gas Utilization Project, Los Angeles, CA	Energy	2018	**Platinum**	47%	56%	55%	85%	48%
10	TIWRP - Advanced Water Purification Facility, Los Angeles, CA	Wastewater	2018	**Platinum**	52%	56%	48%	62%	61%
11	California High-Speed Rail Program (Phase I), Sacramento, CA	Transportation	2020	**Platinum**	80%	75%	61%	25%	93%
12	William Jack Hernandez Sport Fish Hatchery, Anchorage, AK	Land/Environment	2013	**Gold**	50%	64%	32%	57%	18%

370 The list of the 94 Envision verified projects that have been publicly announced as of February 4, 2021 is available in ISI's Envision project awards directory: https://sustainableinfrastructure.org/project-awards/
The scores per category for the 18 projects, presented in the table, have been provided through contacting project owners, through presentations and developed Envision Case studies.

13	Ridgewood View Reservoir and Pump Station, Portland, OR	Water	2016	**Gold**	58%	70%	36%	40%	57%
14	Santa Monica Clean Beaches Project, Santa Monica, CA	Water	2019	**Gold**	34%	47%	51%	55%	43%
15	Starlight Park - Phase II, Bronx, NY	Land/Environment	2021	**Gold**	87%	48%	22%	61%	5%
16	26th Ward WWTP, New York, NY	Wastewater	2015	**Silver**	28%	66%	14%	26%	42%
17	Sheldon Avenue, New York, NY	Water	2017	**Silver**	31%	43%	5%	36%	49%
18	Blower Foul Air Clean-up System, Los Angeles, CA	Wastewater	2018	**Silver**	26%	18%	34%	79%	47%
19	Itinerario ferroviario Napoli-Bari. Tratta Apice – Orsara, 1° Lotto Funzionale Apice – Hirpinia	Transportation	2020	**Platinum**	97%	64%	18%	41%	65%
		overall	**avg score**		**63%**	**60%**	**33%**	**57%**	**46%**
			mean score		**58%**	**61%**	**34%**	**55%**	**47%**
			max. score		**97%**	**85%**	**61%**	**92%**	**93%**

Table 9: Findings for Platinum award projects per category:

	QL	LD	RA	NW	C&R
Average score	73%	65%	36%	61%	51%
Mean score:	77.5%	61.5%	36.5%	58%	51.5%
Maximum score	97%	85%	61%	92%	93%
Minimum score	47%	48%	13%	25%	21%

Table 10: Findings for Gold award projects:

	QL	LD	RA	NW	C&R
Average score	57%	57%	35%	53%	31%
Mean score:	54%	56%	34%	56%	31%
Maximum score	87%	70%	51%	61%	57%

Minimum score	34%	47%	22%	40%	5%

It is obvious that the majority of ENV projects score lower in the Climate and Resilience and Resource Allocation categories mainly because they do not conduct Life Cycle Assessment studies (for carbon, energy etc.).

The LC SustainabilityTool as will be explained in the following section provides an add-on to Envision. Through its capability to identify and map all implemented strategies which generate or avoid emissions and involve use of materials (embodied carbon), could serve in assisting project teams to estimate their lifecycle GHG emissions and carbon of materials through providing 'a calculator'.

2. LIFE CYCLE SUSTAINABILITY TOOL

2.1. Life Cycle Sustainability Tool Overview

As mentioned earlier, it is proposed to use a recent research methodology that led to the development of the Sustainability Lifecycle tool by Prof. Pollalis in collaboration with the National Research Council of Canada (NRCC). The research and developed tool are presented in the report entitled "Integrating Sustainability and LCA, Pilot application on transportation infrastructure projects" of September 2020, already shared confidentially with the SIAB.

In the Sustainability Lifecycle tool, the research objective was to develop a tool that integrates sustainability assessment and lifecycle assessment to be used in transportation projects. The analysis for the development of the tool was based on:

- A review of the ISO Lifecycle Assessment (LCA) of infrastructure in the triple bottom line (TBL).
- A review of three widely used sustainability assessment systems for a project's lifecycle, Envision®, CEEQUAL®, and ISCA®.
- The analysis of a transportation infrastructure project of a typical bridge replacement project by the Ontario's Ministry of Transportation West Region Bridge Office.

A sustainability assessment system was chosen to be the basis of the proposed tool instead of the ISO LCA methodology since:

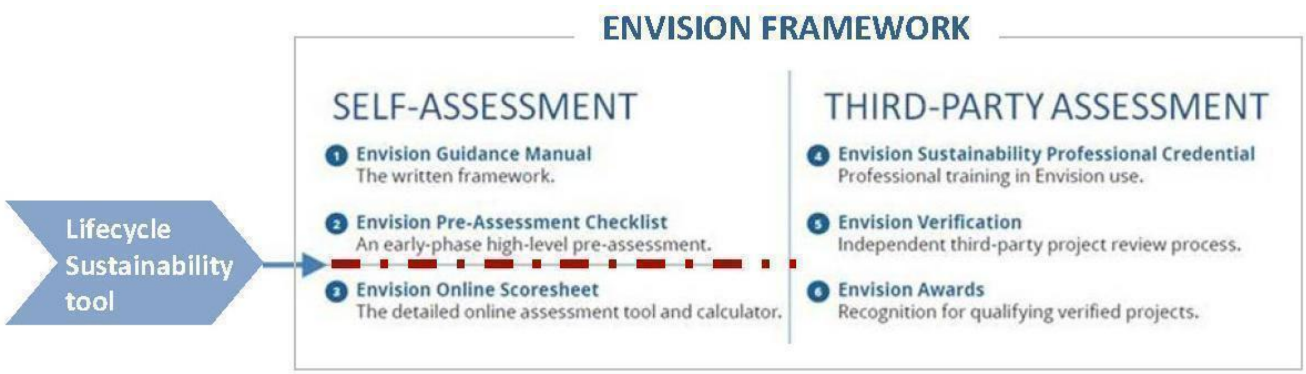
- A sustainability assessment framework, by definition, considers the environmental, social, and economic aspects of a project. In contrast, the ISO LCA accounts for either environmental or economic impacts.
- A sustainability assessment considers the entire lifecycle of a project.
- The ISO LCA follows a highly technical and labor- and data-intensive process. Capacity building is necessary for agencies to perform LCAs in-house, which has been a constraint in its use.

Among the three analyzed systems, the Envision® framework was selected to be used as the basis of the proposed model to address life cycle sustainability and further link it with the ISO LCA. A result is a self-assessment tool that assesses project performance:

- per lifecycle stage (design and material production, construction, operation, maintenance, and end-of-life)
- concerning specific triple bottom line impacts (environmental, social, and economic).

The Sustainability Lifecycle tool uses the Envision methodology, approach, and structure**.** It is an interpretation of the Envision Manual, extracting and highlighting selective information within the Envision credits. The tool is based on an extensive background table (in XLS format), structured according to Envision's five impact categories and credits, which contains multiple levels of information for each Envision credit:

- performance indicators & associated metrics
- lifecycle stage
- TBL impacts



The '**performance indicators'** are consistent with the Envision evaluation criteria requiring evidence and documentation. Same with Envision evaluation criteria, the indicators include both qualitative and quantitative requirements (metrics). However, while the evaluation criteria are framed as questions, the performance indicators are more focused and straightforwardly formulated, aiming to assist in high-level evaluations of sustainability features and decision-making strategies.

The list of performance indicators functions as a set of guidelines or strategies and will be referred to as strategies in the tool's presentation.

The '**lifecycle stage'** indicates the stage of the project that the credits and their related strategies refer to (as a boundary of the credit's assessment).

The '**TBL impact'** links credits with the type of impact they assess. Moreover, the various strategies within a credit are connected with their specific impacts. An impact can be negative or positive, direct or indirect (indirect benefit, trade-off, and incremental impact).

2.2. Add-ons to the Envision Manual

The proposed add-ons to the Envision Manual can be summarized as:

1. Direct connection of related strategies to credits (as described within the Envision Manual) with the 'TBL impacts,' the type of impacts they mitigate (positive impact) or contribute to (negative).
2. Connection of indirect impacts to strategies.
3. The lifecycle dimension of the impacts.
4. The key credits.

2.2.1. Envision in XLS format

The Envision® manual was entered in a computer model (in Excel format), maintaining the five categories and credits structure.

A new coding was applied to each performance indicator focused on Lifecycle stages and Triple Bottom Line (TBL) impacts based on the Envision manual's information. Thus, the manual was transformed into a searchable and filterable format, enabling and facilitating targeted analyses. The capability of the LC Sustainability tool that is more useful for the research is filtering all Envision credits based on a selected impact or impacts**. It can be used as a filtering tool to highlight how Envision already addresses or not the research questions. The tool is based on an extensive background table (in XLS format), structured according to Envision's five impact categories and credits, which contains multiple levels of information for each Envision credit.**

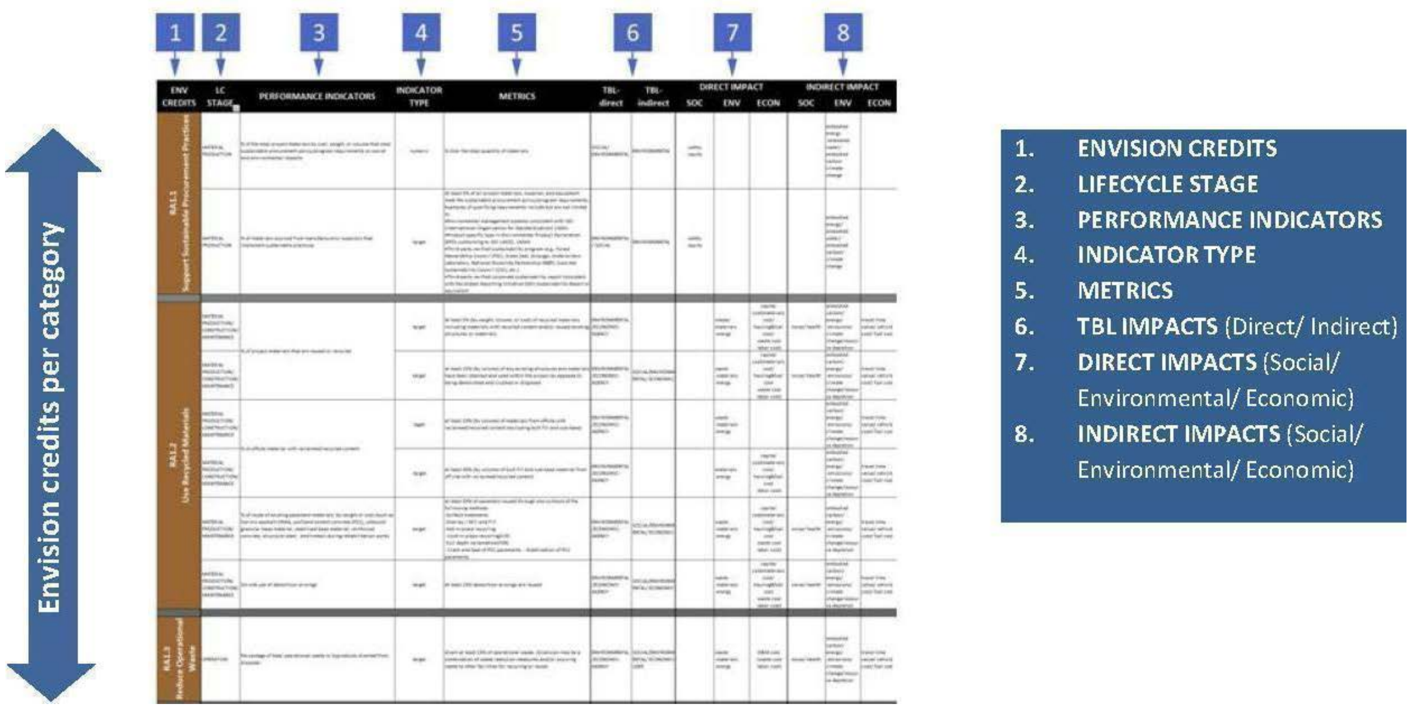
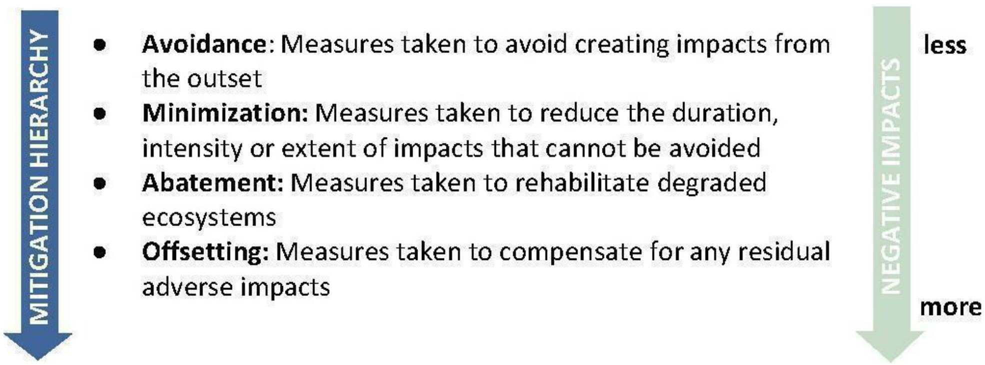


Fig. 49: A partial view of the extensive background table (an Excel spreadsheet) of the LC Sustainability tool

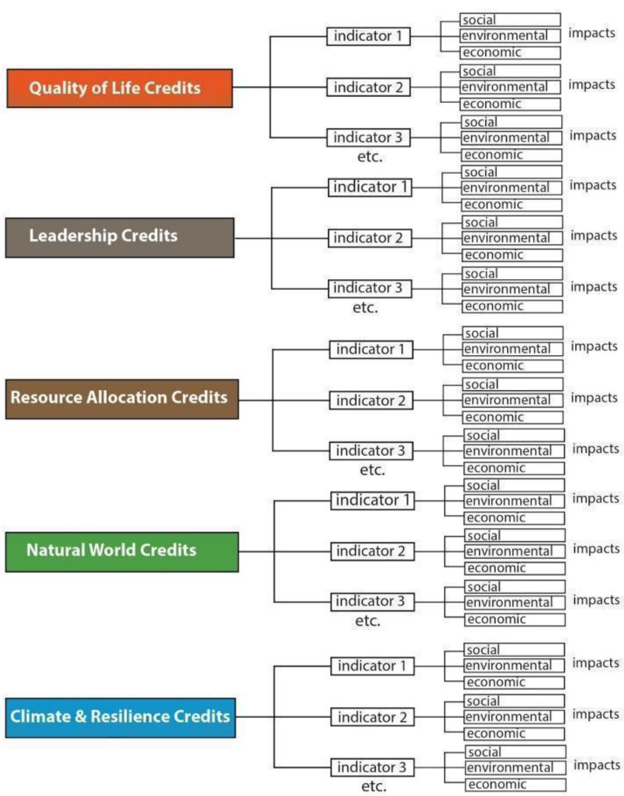
The tool is in line with Envision's mitigation hierarchy that prioritizes sustainability actions based on impacts: first, avoid negative impacts rather than compensate.

Win-win strategies can be identified through the impacts related to strategies.



2.2.2 Tool Structure

The tool offers two ways of reading, as presented in the following diagram:

The basic structure of the LC Sustainability tool
1. Connection of credits' related strategies with the 'TBL impacts

2. The lifecycle dimension of the impacts

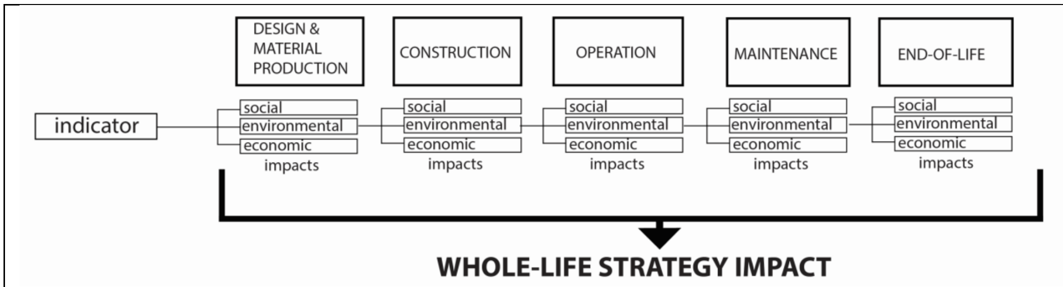


Fig.50: The basic structure of the LC Sustainability tool and its two potential readings

Linking Envision credits and their related strategies with impacts across the life cycle stages allows a decision-maker to have a holistic understanding of a sustainable strategy and prioritize accordingly.

2.2.3. Impacts for filtering

A core capability of the LC Sustainability tool tha**t it can perform a** filtering of all Envision credits based on a selected impact or impacts.
Central in this filtering process is the list of 'IMPACTS,' determining which impacts can be accounted for.

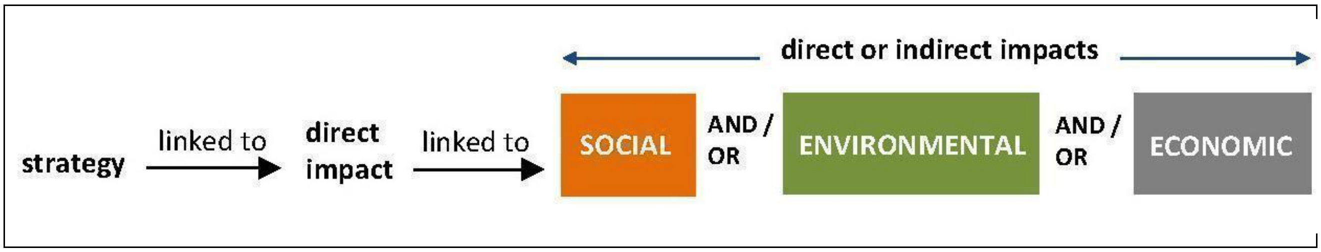
Table 11: The list of the Triple bottom line impacts accounted in the LC Sustainability tool

SOCIAL	ENVIRONMENTAL	ECONOMIC	
		AGENCY	USER
Access Safety Health Noise Light pollution Community satisfaction Inclusivity Equity Sense of place Wellbeing Livability Integration Capacity building Social resilience	Materials Energy Embodied energy Water Water quality Embodied water Air quality Waste Soil quality Emissions Embodied carbon Ecosystem quality Resource depletion Land occupation Climate change Ecological Resilience	Capital (initial)cost O&M cost Rehabilitation cost Replacement cost Residual value Revenues Delay cost Liability claim/Compliance cost Noise cost Restoration cost Resilience value Ecosystem services value	Travel time value Vehicle cost Fuel cost Fare cost Accident cost Health cost Job creation Economic prosperity Resilience value Ecosystem services value

The exact definitions of the above impacts are presented in the NRCC research report

The impact list summarizes the potential filterings per impact that can be performed across all credit categories. For example, climate change is already included in the list of impacts of the LC Sustainability tool. It represents an indirect impact of various strategies across various ENV Categories of credits <u>and not only of the credits of the Climate & Resilience category or the Resource Allocation's Energy subcategory.</u>

The LC Sustainability tool links Envision credits with the type of impact they assess. Each strategy, depending on the Envision credit, has direct environmental, social, or economic impacts. The tool identifies indirect benefits, trade-offs, and incremental impacts. This provides the additional advantage of awareness of every strategy across all Envision categories that may contribute to climate change or mitigates or adapts to its adverse effects.



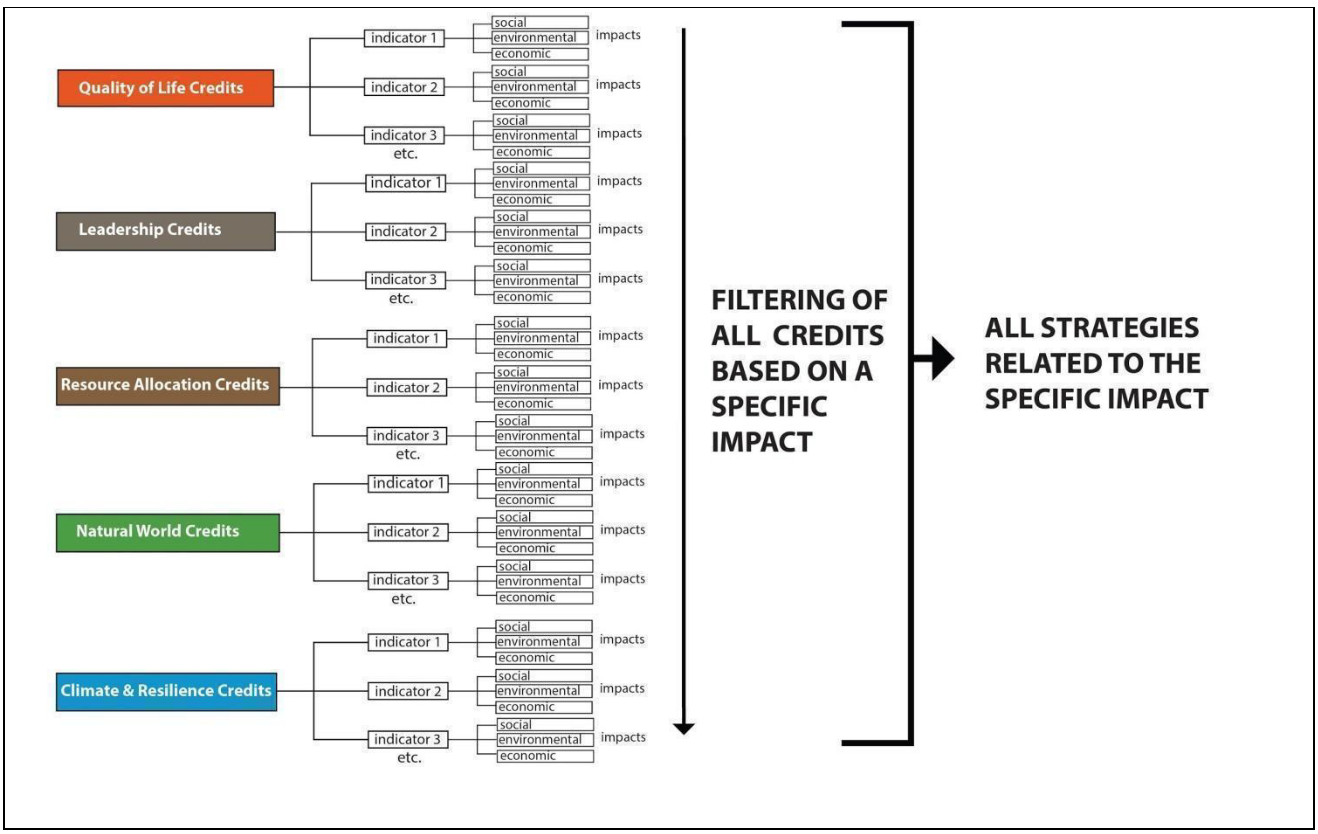


Fig. 51: Filtering across all credit categories per impact

Interconnections of impacts

It is worth highlighting the existing inherent connections between the listed impacts; in other words, highlighting the underlying assumptions and rules that govern the assignment of impacts to each strategy to ensure consistent use across strategies.

A strategy designed to address a specific direct (primary), e.g., environmental impact, has been examined across the other TBL categories and lifecycle stages to identify its parallel social or economic impacts and its indirect impacts across all categories, initial or future, short-term, and long-term. There are some recurring connections, 'packages of impacts' formed and used based on a strategy's direct impact.

Providing an overview of the interconnected impacts is a starting point for identifying the spectrum of strategies an investment has to consider for minimizing or avoiding some or the entire primary and associated impacts of an infrastructure development project. This can be applied in a project that aims to focus on climate change mitigation and adaptation.

The example of relationships between impacts with climate change mitigation and adaptation are shown in the table below:

Table 12: Connection between impacts (as included in the Lifecycle Sustainability tool)

Connections between impacts (as included in LC Sustainability tool)

	Impact of a strategy of the project on:	DIRECT				INDIRECT			
		SOC	ENV	ECON agency	ECON user	SOC	ENV	ECON agency	ECON user
ENVIRONMENTAL IMPACTS	**energy use**		**energy** (use)	O&M cost			emissions **climate change**		
	emissions		**emissions**	capital cost		health	**climate change**	penalty cost	
	embodied carbon		**embodied carbon**	O&M cost Revenues		health	**climate change**	penalty cost	
	materials use	access	**materials** (use)	capital cost rehabilitation cost replacement cost	travel time value vehicle cost fuel cost accident cost	noise	energy (fuel from private vehicles) embodied energy embodied water embodied carbon **climate change** resource depletion		economic prosperity
	water use		**water** (use)	capital cost OR O&M cost			resource depletion ecosystem quality **ecological resilience**	**resilience value** ecosystem services value	**resilience value** ecosystem services value
	water quality		**water quality**			health	ecosystem quality **ecological resilience**	penalty cost restoration cost **resilience value** ecosystem services value	health cost ecosystem services value
	waste (generation)	access	**waste** land occupation	capital cost OR O&M cost	travel time value vehicle cost fuel cost accident cost	noise	energy (fuel from private vehicles) emissions embodied energy embodied water embodied carbon **climate change** water quality ecosystem quality **ecological resilience**	ecosystem services value	ecosystem services value
	ecosystem quality		**ecosystem quality**				**ecological resilience**	ecosystem services value	ecosystem services value
SOCIAL IMPACTS	**access (disruption or enhancement)**	**access**		rehabilitation cost residual value	travel time value vehicle cost fuel cost accident cost	wellbeing noise	energy (fuel from private vehicles) emissions **climate change**		economic prosperity
	integration	**integration**	materials	capital cost rehabilitation cost replacement cost	travel time value vehicle cost fuel cost accident cost	noise	embodied energy embodied water embodied carbon **climate change** resource depletion	**resilience value**	resilience value

Another recurrent 'package of impacts' is the so-called "construction works' impacts". To capture a strategy's implications across the life of a project, the Life Cycle Sustainability tool accounts for the impacts of additional or avoided initial or future construction works resulting from a specific strategy (see an indicative example in Appendix). This feature goes beyond Envision's credits that refer to construction activities (credits QL1.3, QL1.6, RA1.4, RA2.2, and RA3.3) and incorporate construction works' impacts to all credits.

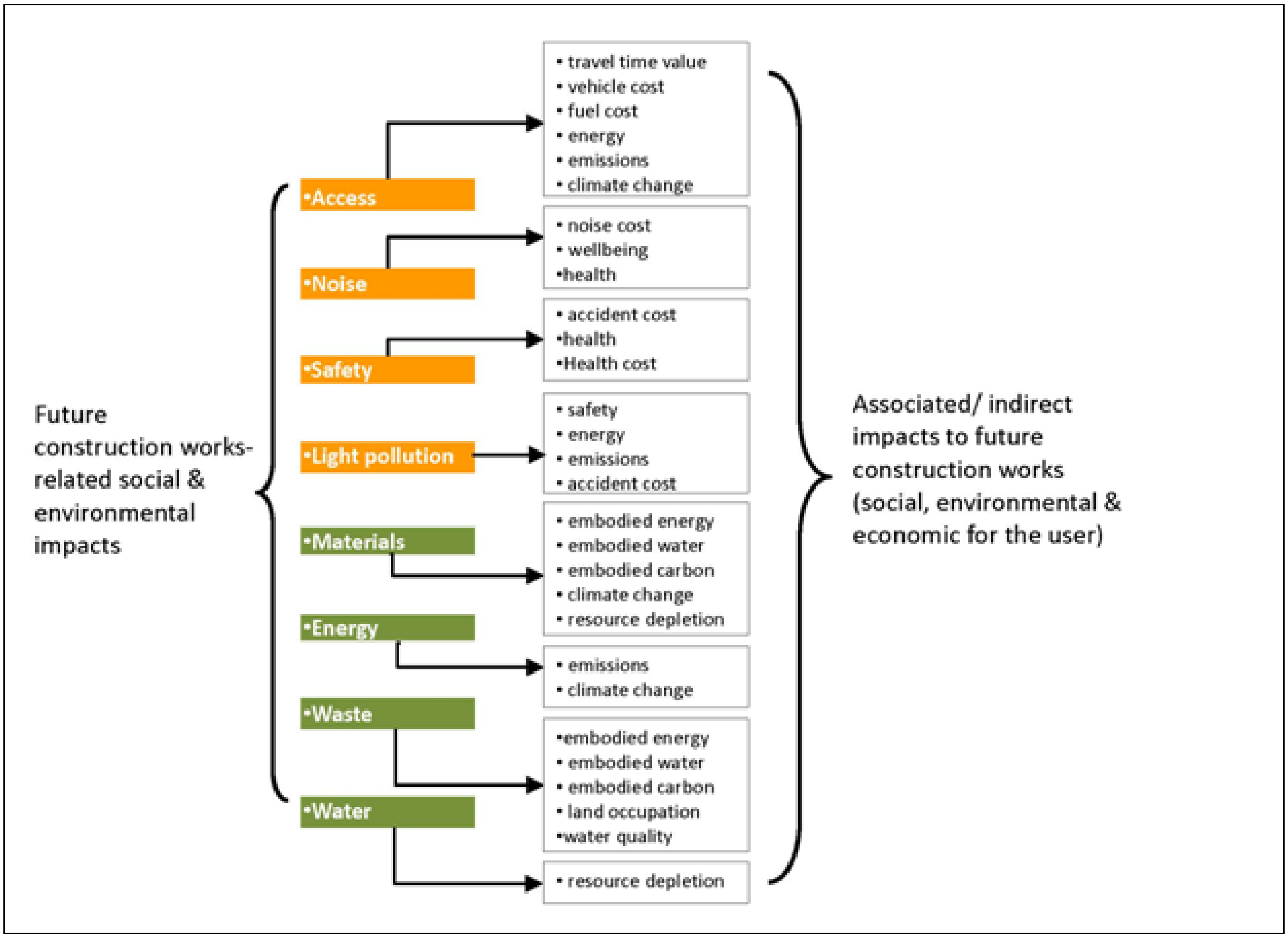


Fig. 52: Construction work-related impacts

2.3. Filtering capability

The tool demarcates a set of Envision credits as 'key credits.' The six key credits within the Sustainability Lifecycle Tool are the following:

- LD1.3 Provide for Stakeholder Engagement
- LD3.1 Stimulate Economic Prosperity
- LD3.3 Conduct a Lifecycle Economic Evaluation
- CR1.1 Reduce net Embodied Carbon
- CR2.2 Reduce GHG Emissions
- CR2.5 Maximize Resilience

The key credits include indicators that request input from other Envision credits. The credits which provide input are identified through search/filtering based on specific impacts.

Overall, the key credits explicitly refer to core impacts, which are at the center of the research and aim to provide a basis for their quantification: impact on the community, cost, climate change, and resilience against future uncertainty.

Table 13: Overview of impacts captured by the six key credits

KEY CREDITS	TBL CATEGORY	TYPE OF IMPACT FOR FILTERING	IMPACT FOR FILTERING
LD1.3 Provide For Stakeholder Engagement	SOCIAL	'DIRECT SOCIAL IMPACT'	COMMUNITY SATISFACTION
LD3.1 Stimulate Economic Prosperity	ECONOMIC	INDIRECT ECONOMIC IMPACT'	ECONOMIC PROSPERITY
	ECONOMIC	INDIRECT ECONOMIC IMPACT for USER	TRAVEL TIME VALUE
LD3.3 Conduct A Lifecycle Economic Evaluation	ECONOMIC	'DIRECT ECONOMIC IMPACT for 'AGENCY'	ALL
	ECONOMIC	DIRECT ECONOMIC IMPACT' for 'AGENCY' & 'DIRECT ECONOMIC IMPACT" for 'USER'	ALL
	ECONOMIC	DIRECT' & 'INDIRECT' 'ECONOMIC IMPACT' for 'AGENCY' and 'USER'	ALL
CR1.1 Reduce net embodied carbon	ENVIRONMENTA L	INDIRECT ENVIRONMENTAL IMPACT	EMBODIED CARBON
CR2.2 Reduce GHG Emissions	ENVIRONMENTA L	INDIRECT ENVIRONMENTAL IMPACT'	EMISSIONS
CR2.5 Maximize Resilience	ECONOMIC	INDIRECT ECONOMIC IMPACT'	RESILIENCE VALUE

The key credits aim to familiarize the user with the LC Sustainability tool's core capability and perform filtering of the various impacts linked to credits and related strategies. Thus, the user decision-maker has the option to include his additional indicators, customized based on his needs: e.g., 'Identify all indicators/strategies with a positive impact on 'climate change.' Therefore, the user can focus on certain areas of interest.

2.4. Usefulness of the Tool for the research purposes

The lifecycle sustainability tool's framework has several uses, combined with the Envision rating system methodology:

- as a Lifecycle self-assessment tool,

- multiple criteria, decision-making tool,
- guidelines to enhance sustainable performance,
- as an educational manual for lifecycle sustainability, and
- as evidence-based documentation of project decisions.

However, the capability that is most useful is that it **can be used as a filtering tool of** all Envision credits based on a selected impact or impacts, to highlight how Envision already addresses or not the research questions.

As seen in the table below and the example of key credits that were mentioned in Part 2. Section2.3 “Filtering capability,” an ‘impact filtering’ can easily identify all strategies (indicators) across various credits that address or contribute to the specific impact and highlights the usefulness of the tool in prioritizing the criteria.

Table 14: Life Cycle Sustainability tool filtering in the case of key credits

			FILTERINGS PER IMPACT	FILTERING RESULT: NO.of performance indicators	FILTERING RESULT: CREDITS within which the resulting performance indicators
			impact filtered		
KEY CREDIT FILTERINGS	LD1.3		Community satisfaction	12 indicators	QL1.1 QL1.4 QL1.6 QL2.1 QL3.1 QL3.2 QL3.3 QL3.4
KEY CREDIT FILTERINGS	LD3.1		Economic prosperity	92 indicators	QL1.1 QL2.1 QL2.2 QL2.3 QL3.1 QL3.4 LD1.1 LD1.3 LD1.4 LD3.1 LD3.2 LD3.3 RA1.1 RA2.3 NW1.3 NW1.4 NW2.1 NW3.2 NW3.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	LD3.1		Travel time value	56 indicators	QL1.3 QL1.6 QL2.1 QL2.2 QL2.3 LD2.3 LD3.1 LD3.3 RA1.2 RA1.3 RA1.4 RA1.5 RA2.2 RA3.3 NW2.4
KEY CREDIT FILTERINGS	LD3.3	agency costs	Capital cost	142 indicators	QL1.3 QL1.4 QL1.5 QL2.1 QL2.2 QL2.3 QL3.3 QL3.4 LD1.2 LD2.3 LD2.4 LD3.3 RA1.1 RA1.2 RA1.4 RA1.5 RA2.1 RA2.2 RA2.3 RA2.4 RA3.2 RA3.3 RA3.4 NW1.1 NW1.3 NW2.1 NW2.2 NW2.3 NW3.1 NW3.2 NW3.4 NW3.5 CR1.2 CR1.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	LD3.3	agency costs	O&M cost	86 indicators	QL1.5 QL2.1 QL2.2 QL2.3 QL3.4 LD1.2 LD1.4 LD2.3 LD3.3 RA1.3 RA2.1 RA2.3 RA2.4 RA3.2 RA3.4 NW2.2 NW2.3 NW3.1 NW3.2 NW3.4 CR1.1 CR2.5 CR2.6
KEY CREDIT FILTERINGS	LD3.3	agency costs	Major rehabilitation cost	58 indicators	QL1.4 QL2.1 QL2.2 QL2.3 QL3.4 LD1.2 LD2.3 LD3.3 RA1.2 NW3.1 NW3.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	LD3.3	agency costs	Replacement cost	64 indicators	QL1.4 QL2.1 QL2.2 QL2.3 QL3.4 LD1.2 LD2.3 LD2.4 LD3.3 RA1.2 RA2.4 NW3.1 NW3.2 NW3.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	LD3.3	agency costs	End-of-life cost	3 indicators	LD2.4
KEY CREDIT FILTERINGS	LD3.3	agency costs	Residual value	48 indicators	QL2.1 QL2.2 QL2.3 QL3.4 LD1.2 LD2.3 LD2.4 LD3.3 RA1.2 NW3.1 NW3.3 CR2.5
KEY CREDIT FILTERINGS	LD3.3	agency costs	Revenues	27 indicators	QL2.1 QL2.2 QL3.1 LD3.3 CR1.1 CR2.6
KEY CREDIT FILTERINGS	LD3.3	agency costs	Delay cost	28 indicators	QL1.1 QL1.4 QL1.6 QL2.1 QL3.2 QL3.3 LD1.3 LD3.3 NW2.4 NW3.5 NW3.1 NW3.5 CR2.5
KEY CREDIT FILTERINGS	LD3.3	agency costs	Liability claim cost	12 indicators	QL1.2 QL1.6 QL3.3 LD3.3
KEY CREDIT FILTERINGS	LD3.3	agency costs	Penalty cost	31 indicators	QL1.6 LD3.3 RA3.1 RA3.4 NW1.2 NW2.1 NW2.2 CR1.1 CR1.2 CR1.3
KEY CREDIT FILTERINGS	LD3.3	agency costs	Noise cost	19 indicators	QL1.4 QL1.6 LD1.4 LD2.3 LD3.3
KEY CREDIT FILTERINGS	LD3.3	agency costs	Restoration cost	31 indicators	QL1.3 QL1.6 QL3.3 LD3.3 RA3.1 RA3.4 NW1.3 NW2.4 NW3.1 NW3.2 NW3.5
KEY CREDIT FILTERINGS	LD3.3	user costs	Travel time value	56 indicators	QL1.3 QL1.6 QL2.1 QL2.2 QL2.3 LD2.3 LD3.1 LD3.3 RA1.2 RA1.3 RA1.4 RA1.5 RA2.2 RA3.3 NW2.4
KEY CREDIT FILTERINGS	LD3.3	user costs	Vehicle cost	49 indicators	QL1.3 QL1.6 QL2.1 QL2.2 QL2.3 LD2.3 LD2.4 LD2.3 RA1.2 RA1.3 RA1.4 RA1.5 RA2.2 RA3.3 NW2.4 NW3.1
KEY CREDIT FILTERINGS	LD3.3	user costs	Fuel cost	48 indicators	QL1.3 QL1.6 QL2.1 QL2.2 QL2.3 LD2.3 LD2.4 LD3.3 RA1.2 RA1.3 RA1.4 RA1.5 RA2.2 RA3.3 NW2.4
KEY CREDIT FILTERINGS	LD3.3	user costs	Fare cost	4 indicators	QL2.1 QL2.2 QL3.1
KEY CREDIT FILTERINGS	LD3.3	user costs	Accident cost	65 indicators	QL1.2 QL1.3 QL1.5 QL1.6 QL2.1 QL2.2 QL2.3 LD2.3 LD3.3 RA1.4 RA2.1 RA2.2 NW1.4 NW2.2 NW3.1
KEY CREDIT FILTERINGS	LD3.3	user costs	Health cost	104 indicators	QL1.2 QL1.3 QL1.4 QL1.5 QL1.6 QL2.1 QL2.2 QL2.3 LD1.4 LD2.3 LD3.3 RA2.1 RA3.3 RA3.4 NW2.1 NW2.2 NW2.3 NW2.4 NW3.1 NW3.2 NW3.3 NW3.4
KEY CREDIT FILTERINGS	LD3.3	user costs	Job creation	22 indicators	QL2.1 QL2.2 LD3.2 LD3.3 NW1.4 NW2.1
KEY CREDIT FILTERINGS	LD3.3	user costs	Economic prosperity	92 indicators	QL1.1 QL2.1 QL2.2 QL2.3 QL3.1 QL3.4 LD1.1 LD1.3 LD1.4 LD3.1 LD3.2 LD3.3 RA1.1 RA2.3 NW1.3 NW1.4 NW2.1 NW3.2 NW3.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	CR1.1		Embodied carbon	85 indicators	QL1.3 QL1.4 QL1.5 QL1.6 QL2.1 QL2.2 QL2.3 QL3.4 LD1.2 LD1.4 LD2.3 LD2.4 RA1.1 RA1.2 RA1.3 RA1.4 RA1.5 RA2.2 RA2.3 RA2.4 RA3.3 NW1.4 NW2.3 NW3.1 NW3.3 NW3.4 NW3.5 CR2.5 CR2.6
KEY CREDIT FILTERINGS	CR1.2		Emissions	94 indicators	QL1.3 QL1.4 QL1.5 QL1.6 QL2.1 QL2.2 QL2.3 LD1.2 LD1.4 LD2.3 LD2.4 RA1.4 RA1.5 RA2.1 RA2.2 RA2.3 RA2.4 RA3.3 NW2.4 NW3.3 CR2.6
KEY CREDIT FILTERINGS	CR2.5		Resilience value (agency)	108 indicators	QL2.1 QL2.2 QL2.3 LD1.2 LD1.4 LD2.3 LD2.4 LD3.1 LD3.2 LD3.3 RA2.1 RA2.3 RA3.1 RA3.2 RA3.4 NW2.2 NW2.3 NW3.1 NW3.2 NW3.3 NW3.4 CR1.3 CR2.5 CR2.6
KEY CREDIT FILTERINGS	CR2.5		Resilience value (user)	88 indicators	QL2.1 QL2.2 QL2.3 LD1.2 LD2.3 LD2.4 LD3.1 LD3.2 LD3.3 RA2.3 RA3.1 RA3.2 NW2.2 NW2.3 NW3.2 NW3.4 CR1.1 CR1.2 CR2.5 CR2.6

Similarly, this feature enables all mitigation and adaptation performance strategies to be accounted, improving the overall project contribution.

An analysis of Envision in terms of climate change has already been performed as part of the LC Sustainability research. It has linked Envision credits (and their related strategies) with a positive or negative impact on:

- direct contributors to climate change, such as 'energy,' emissions, and embodied carbon (**mitigation**) and
- 'resilience value,' 'ecological resilience,' 'social resilience.' (**adaptation**)

Therefore, the LC Tool enables identifying the credits that incorporate strategies that contribute to climate change mitigation, and answering two key questions of the present research:

- Which **Envision credits** **indirectly** contribute to mitigation or adaptation to climate change?
- Which **Envision credits** **indirectly** contribute to the economic costs/benefits?

However, the extent to which the initial list of 'impacts' of the LC Tool addresses the research questions in is to be further examined to identify potential gaps and the need for potential further additions. This process entails the performance of relevant filtering and a review of the result in cross examination with literature review findings and other systems approach.

3. SELECTED ESG AND CLIMATE-RELATED FINANCIAL FRAMEWORKS AND STANDARDS

3.1. Overview of selected ESG and Climate-related Reporting Frameworks and Standards

A more focused and targeted study of selected ESG and climate-related reporting frameworks and standards will provide insight on key research questions. The approach of widely used and well-established sustainability reporting and sustainability- and climate-related financial reporting frameworks and standards will contribute to a needed input on:

- How are climate change mitigation and adaptation and climate risk accounted for by the various systems?
- Which sustainability topics are considered relevant and material to investors?
- What Envision's approach to materiality is and/or should be? As a sustainability rating tool, it covers the impacts of a project on the environment, society, and economy. Is the project's impact on the company itself (financial materiality) sufficiently accounted for?

ESG frameworks and Standards studied as part of the research:

TCFD Climate-related Financial Disclosure Recommendations: TCFD, as already explained, has acted as a catalyst for mainstreaming climate change as financial risk. Therefore, as part of this analysis it is used to provide input on climate risk, opportunities and financial impacts & Climate-related risk management.

Climate Disclosure Standards Board's (CDSB) Framework: environmental focus reflects the intrinsic interconnection between climate and other environmental matters.

GRI Standards: The Global Reporting Initiative (GRI) is the most widely used ESG standard and one of the most comprehensive tools for reporting the impacts of a company on the environment, society, and economy, therefore captures the environmental and social materiality. The GRI Standards are structured as a set of interrelated, modular standards, three universal Standards that apply to every organization preparing a sustainability report. An organization further selects from the set of topic-specific standards for reporting on its material topics. These standards are organized into three series – economic, environmental, and social.

The GRI Standards contain several topic-specific standards for organizations to use to report climate change where they identify it as a material topic, i.e., GRI 305: Emissions 2016; GRI 302: Energy 2016; GRI 303: Water and Effluents 2018; and GRI 201: Economic Performance 2016, Disclosure 201-2 (related to financial implications and other risks and opportunities due to climate change).

GRI focuses on social and environmental materiality. According to the GRI Materiality "a sustainability report should include information that "reflects the organization's significant economic, environmental, and social impacts" or "substantively influence[s] the assessments and decisions of stakeholders." This emphasis on external impacts and a broad set of stakeholders differs from the definition of materiality typically used to guide financial reporting.[371]

Moreover, GRI defines impact in a way consistent with how the LC Sustainability tool approaches impact.

"*In the GRI Standards, impact refers to the effect an organization has or could have on the economy, environment, or people, including on human rights, as a result of its activities or business relationships*[372]*. These impacts can be actual or potential, negative or positive, short-term or long-term, intended or unintended, and reversible or irreversible. These impacts indicate the organization's contribution, negative or positive, to sustainable development.*"

WEF IBC Reporting Metrics and Disclosure Standards: the recently developed World Economic Forum's (WEF) and the International Business Council (IBC) ESG Reporting Metrics and Disclosure Standards. The WEF project has scanned the many hundreds of ESG metrics available and highlighted just 21 core metrics that are well-established, universal, industry-agnostic that considers being material to sustainable value creation. It includes 34 additional metrics and disclosures, called expanded, that tend to be less established in existing practice and which have a broader value chain scope or convey impact in a more sophisticated or tangible way, such as in monetary terms. WEF's work is a core set of "Stakeholder Capitalism Metrics" (SCM) and disclosures that companies can use to align their mainstream reporting on performance against environmental, social, and governance (ESG) indicators and track their contributions towards the SDGs consistently.

---

[371] GRI Universal Standards. (June 2020) "GRI 101, GRI 102, and GRI 103 Exposure Draft"

[372] The organization's impacts on the economy refer to the impacts on economic systems at local, national, and global levels. An organization can impact the economy through, for example, its taxes and payments to governments, its procurement practices, or its competition practices. The organization's impacts on the environment refer to the impacts on living and non-living natural systems, including land, air, water, and ecosystems. An organization can impact the environment through, for example, its use of water, energy, land, and other natural resources. The organization's impacts on people refer to the impacts on individuals and groups. Individuals or groups that have interests that are, or could be, affected by the organization's activities and decisions are referred to as stakeholders. An organization can impact people through, for example, its employment practices (such as the wages it pays to employees), its supply chain (such as the working conditions of workers making the organization's products), and its products and services (such as their safety or affordability). The most acute impacts an organization can have on people are those that negatively affect their human rights. (Source: GRI Universal Standards. (June 2020) "GRI 101, GRI 102, and GRI 103 Exposure Draft".)

SASB Accounting Standards: The SASB Foundation has established an independent standard-setting arm, the Sustainability Accounting Standards Board, that sets sustainability disclosure standards that are industry-specific[373] and tied to the concept of materiality to investors. SASB'S definition of materiality is the one typically used to guide financial reporting, focused on financial impacts of interest to investors. The standards are intended to capture financially material sustainability matters–reasonably likely to have a material impact on financial performance or condition.

SASB is comprised of 77 Industry standards that provide disclosure topics and accounting metrics tailored in different industries' needs. However, organizes its disclosure topics also in 'General Issue Categories' represent 26 broad sustainability-related business issues that allow for cross-industry comparisons of closely related industry-specific disclosure topics. Every Disclosure topic is mapped to one General Issue Category but the latter may encompass more than one Disclosure topic in an industry.

Climate risk is nearly ubiquitous, appearing in 69 of the 77 SASB Standards, but it manifests in industry-specific ways. SASB Standards enable TCFD disclosure by providing industry-specific metrics to evaluate company exposure and manage climate-related risks and opportunities.

EDHECinfra ESG taxonomy is part of the EDHEC's Infrastructure Institute recently presented as part of the March 2021 publication "Towards a Scientific Approach to ESG for Infrastructure Investors Approaching ESG & Infrastructure within the Portfolio." The publication presents research relevant to the study purposes as it refers to infrastructure assets ESG impacts and risks.

It is worth highlighting that ESG frameworks and standards refer to and aim to capture a company's performance, while Envision refers to and assesses project performance. Moreover, the ESG systems are not infrastructure-specific but rather infrastructure-relevant. Therefore, it is expected that their company-level approach is not completely comparable with Envision's project-level approach. Additionally, in SASB standards, the proposed topics and metrics are industry-specific and not cross-industry, as in Envision. For the above reasons, input from the various ESG will have to be 'filtered' for their relevance to infrastructure projects and their cross-industry relevance.

3.2. Systems Approach to Mitigation and Adaptation

3.2.1. TCFD Recommendations for climate –related disclosures

The TCFD recommendations are already established as the primary framework for disclosure of information on the management of climate-related risks and opportunities in main annual filings.

The recommendations are structured around four thematic areas that represent core elements of how organizations operate: governance, climate strategy, risk management and metrics and targets. As part of their risk management, companies must identify and measure the financial implications of the material risks and

[373] SASB developed the Sustainable Industry Classification System® (SICS®) in 2012, its industry classification system that groups like industries based on their sustainability profiles. SICS groups companies into 77 industries across 11 thematic sectors based on their shared sustainability challenges.

opportunities under at least two widely recognized scenarios. The structure of the recommendations is shown in the following table.

Table 15: TCFD Recommendations and Supporting Recommended Disclosures

TCFD Recommendations and Supporting Recommended Disclosures		
GOVERNANCE	Disclose the organization's governance around climate-related risks and opportunities.	a) Describe the board's oversight of climate-related risks and opportunities.
		b) Describe management's role in assessing and managing climate-related risks and opportunities.
STRATEGY	Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.
		b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.
		c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.
RISK MANAGEMENT	Disclose how the organization identifies, assesses, and manages climate-related risks	a) Describe the organization's processes for identifying and assessing climate-related risks.
		b) Describe the organization's processes for managing climate-related risks.
		c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.
METRICS AND TARGETS	Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.	a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.
		b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.
		c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.

As observed in the table above TCFD as part of its recommendation for metrics and targets used to assess and manage relevant climate-related risks and opportunities, explicitly guides for disclosure of Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks, calculated in line with the GHG Protocol methodology to allow for aggregation and comparability.

Moreover, TCFD guides for "including metrics[374] on climate-related risks associated with water, energy, land use, and waste management where relevant and applicable." Especially, in the case of energy and water TCFD refers to their disclosure as evidence of 'energy and water dependencies' (especially in water-stressed regions).

---

[374] TCFD developed supplemental guidance for non-financial industries that account for the largest proportion of GHG emissions, energy usage, and water usage. These industries were organized into four groups based on similarity of risk: 1. Energy; 2. Materials and Buildings; 3. Transportation; 4. Agriculture, Food, and Forest Products. As part of this

Among other recommended metrics "organizations should provide their internal carbon prices", as well as climate-related financial metrics such as Capex, Opex for low-carbon alternatives, and opportunity metrics such as revenue from products and services designed for a lower-carbon economy.

Finally, it is worth highlighting the importance of the use of internal carbon price (or shadow carbon price), an internally developed estimated cost of carbon emissions. According to TCFD, "internal carbon pricing can be used as a planning tool to help identify revenue opportunities and risks, as an incentive to drive energy efficiencies to reduce costs, and guide capital investment decisions".[375]

3.2.2. Climate-related risks and opportunities in TCFD Recommendations

As part of the TCFD recommendations report, climate-related risks and opportunities for companies are listed. Climate-related risks are divided into two major categories:

1. **Transition risks** are considered the risks related to the transition to a lower-carbon economy, affecting most economic sectors and industries. The transition risks are organized into four groups (i) Policy and legal, (ii) Technological risks, (iii) Market risks, and (iv) reputation risks. Moreover, within each of the four groups, potential financial impacts are presented next to the climate-related risks, as shown in Table 16.
2. **Physical risks**: are considered the risks related to the physical impacts of climate change, event-driven (acute) or longer-term shifts (chronic) in climate patterns. They are particularly relevant for infrastructure companies that by definition have long-lived, fixed assets and based on their:
   - locations or operations in climate-sensitive regions (e.g., coastal and flood zones);
   - reliance on availability of water; and
   - value chains exposed to the above.

   Potential financial impacts are presented next to the climate-related risks, as shown in Table 17.

Table 16: Examples of Climate-related Transition Risks and Potential Financial Impacts

TYPE	CLIMATE-RELATED RISKS	POTENTIAL FINANCIAL IMPACTS
TRANSITION RISKS	POLICY AND LEGAL	
	1. Increased pricing of GHG emissions 2. Enhanced emissions-reporting obligations 3. Mandates on and regulation of existing products and services 4. Exposure to litigation	1. Increased operating costs (e.g., higher compliance costs, increased insurance premiums) 2. Write-offs, asset impairment, and early retirement of existing assets due to policy changes 3. Reduced demand for products and services resulting judgments (due to fines) 4. Increased costs from fines
	TECHNOLOGY	

guidance TCFD provided example metrics, selection of which is presented in the tables in the following Section '3.2.4. Other ESG systems approach to climate change mitigation and adaptation'.

375 TCFD. (June 2017) Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) Final report

	1. Substitution of existing products and services with lower emissions options 2. Unsuccessful investment in new technologies 3. Costs to transition to lower emissions technology	1. Write-offs and early retirement of existing assets 2. Reduced demand for products and services 3. Research and development (R&D) expenditures in new and alternative technologies 4. Capital investments in technology development 5. Costs to adopt/deploy new practices and processes
	MARKET	
	1. Changing customer behavior 2. Uncertainty in the market signals 3. The increased cost of raw materials	1. Reduced demand for goods and services due to shifting in consumer preferences 2. Increased production costs due to changing input prices (e.g., energy, water) and output requirements (e.g., waste treatment) 3. Abrupt and unexpected shifts in energy costs 4. Change in revenue mix and sources, resulting in decreased revenues 5. Repricing of assets (e.g., fossil fuel reserves, land valuations, securities valuations)
	REPUTATION	
	1. Shifts in consumer preferences 2. Stigmatization of sector 3. Increased stakeholder concern or negative stakeholder feedback	1. Reduced revenue from decreased demand for goods/services 2. Reduced revenue from decreased production capacity (e.g., delayed planning approvals, supply chain interruptions) 3. Reduced revenue from negative impacts on workforce management and planning (e.g., employee attraction and retention) 4. Reduction in capital availability

Table 17: Examples of Climate-related Physical Risks and Potential Financial Impacts

TYPE	CLIMATE-RELATED RISKS	POTENTIAL FINANCIAL IMPACTS
PHYSICAL RISKS	**ACUTE RISKS**	1. Reduced revenue from decreased production capacity (e.g., transport difficulties, supply chain interruptions) 2. Reduced revenue and higher costs from negative impacts on the workforce (e.g., health, safety, absenteeism) 3. Write-offs and early retirement of existing assets (e.g., damage to property and assets in "high-risk" locations) 4. Increased operating costs (e.g., inadequate water supply for hydroelectric plants or to cool nuclear & fossil fuel plants) 5. Increased capital costs (e.g., damage to facilities) 6. Reduced revenues from lower sales/output 7. Increased insurance premiums and potential for reduced availability of insurance on assets in "high-risk" locations
	1. Increased severity of extreme weather events such as cyclones and floods	
	CHRONIC RISKS	
	1. Changes in precipitation patterns and extreme variability in weather patterns 2. Rising mean temperatures 3. Rising sea levels	

While changes associated with a transition to a lower-carbon economy present a significant risk, they also create significant opportunities for organizations focused on climate change mitigation and adaptation solutions. The climate-related opportunities and the potential financial impacts are organized into five groups: (i) resource efficiency, (ii) energy resource, (iii) products and services, (iv) markets, and (v) resilience, as presented in Table 16.

Table 18: Examples of Climate-related Opportunities and Potential Financial Impacts

TYPE	CLIMATE-RELATED OPPORTUNITIES	POTENTIAL FINANCIAL IMPACTS
RESOURCE EFFICIENCY	1. Use of more efficient modes of transport 2. Use of more efficient production and distribution processes 3. Use of recycling 4. Move to more efficient buildings 5. Reduced water usage and consumption	1. Reduced operating costs (e.g., through efficiency gains and cost reductions) 2. Increased production capacity, resulting in increased revenues 3. Increased value of fixed assets (e.g., highly rated energy-efficient buildings) 4. Benefits to workforce management and planning (e.g., improved health and safety, employee satisfaction) resulting in lower costs
ENERGY RESOURCE	1. Use of lower-emission sources of energy 2. Use of supportive policy incentives 3. Use of new technologies 4. Participation in the carbon market 5. A shift toward decentralized energy generation	1. Reduced operational costs (e.g., through use of lowest cost abatement) 2. Reduced exposure to future fossil fuel price increases 3. Reduced exposure to GHG emissions and therefore less sensitivity to changes in the cost of carbon 4. Returns on investment in low-emission technology 5. Increased capital availability (e.g., as more investors favor lower-emissions producers) 6. Reputational benefits resulting in increased demand for goods/services
PRODUCTS AND SERVICES	1. Development and/or expansion of low emission goods and services 2. Development of climate adaptation and insurance risk solutions 3. Development of new products or services through R&D and innovation 4. Ability to diversify business activities 5. A shift in consumer preferences	1. Increased revenue through demand for lower emissions products and services 2. Increased revenue through new solutions to adaptation needs (e.g., insurance risk transfer products and services) 3. Better competitive position to reflect shifting consumer preferences, resulting in increased revenues
MARKETS	1. Access to new markets 2. Use of public-sector incentives 3. Access to new assets and locations needing insurance coverage	1. Increased revenues through access to new and emerging markets (e.g., partnerships with governments, development banks) 2. Increased diversification of financial assets (e.g., green bonds and infrastructure)
RESILIENCE	1. Participation in renewable energy programs and adoption of energy efficiency measures	1. Increased market valuation through resilience planning (e.g., infrastructure, land, buildings) 2. Increased reliability of supply chain and ability to

	2. Resource substitutes/diversification	operate under various conditions 3. Increased revenue through new products and services related to ensuring resilience

Further information to support the decision making of investors, lenders, and insurance underwriters, is presented in Table 19, where the Task Force has identified four major financial categories, through which climate-related risks and opportunities may affect an organization's current and future financial positions, as reflected in its income statement and balance sheet.

Table 19: Major categories of potential climate-related financial Impacts related to the organization's Income statement and Balance sheet

Major Categories of Financial Impact	
Income Statement	**Balance Sheet**
Revenues Transition and physical risks may affect demand for products and services. Organizations should consider the potential impact on revenues and identify potential opportunities for enhancing or developing new revenues. In particular, given the emergence and likely growth of carbon pricing as a mechanism to regulate emissions, it is important for affected industries to consider the potential impacts of such pricing on business revenues. **Expenditures** An organization's response to climate-related risks and opportunities may depend, in part, on the organization's cost structure. Lowercost suppliers may be more resilient to changes in cost resulting from climate-related issues and more flexible in their ability to address such issues. By providing an indication of their cost structure and flexibility to adapt, organizations can better inform investors about their investment potential. It is also helpful for investors to understand capital expenditure plans and the level of debt or equity needed to fund these plans. The resilience of such plans should be considered bearing in mind organizations' flexibility to shift capital and the willingness of capital markets to fund organizations exposed to significant levels of climate-relatedrisks. Transparency of these plans may provide greater access to capital markets or improved financing terms.	**Assets and Liabilities** Supply and demand changes from changes in policies, technology, and market dynamics related to climate change could affect the valuation of organizations' assets and liabilities. Use of long-lived assets and, where relevant, reserves may be particularly affected by climate-related issues. It is important for organizations to provide an indication of the potential climate-related impact on their assets and liabilities, particularly long-lived assets. This should focus on existing and committed future activities and decisions requiring new investment, restructuring, writedowns, or impairment. **Capital and Financing.** Climate-related risks and opportunities may change the profile of an organization's debt and equity structure, either by increasing debt levels to compensate for reduced operating cash flows or for new capital expenditures or R&D. It may also affect the ability to raise new debt or refinance existing debt, or reduce the tenor of borrowing available to the organization. There could also be changes to capital and reserves from operating losses, asset write-downs, or the need to raise new equity to meet investment.

3.2.3. Climate-related risks and opportunities in CDSB Framework

The Climate Disclosure Standards Board (CDSB) was formed at the World Economic Forum's annual meeting in 2007 as a new international consortium of business and environmental NGOs with a mission to create a generally accepted framework for climate risk reporting by corporations.[376]

CDSB's mission is to create the enabling conditions for material climate change and environmental information to be integrated into mainstream reports. This facilitates the assessment of the relationship between specific environmental matters and the organization's strategy and financial performance for the benefit of investors. CDSB does this by offering companies the CDSB Framework for reporting natural capital and environmental information with the same rigor as financial information. The CDSB Framework helps companies provide investors with decision-useful environmental information via mainstream corporate reports, enhancing the efficient allocation of financial capital to support sustainable and climate-resilient economies. Regulators also benefit from the compliance-ready materials that CDSB produces.

The first CDSB Framework, the Climate Change Reporting Framework, released in 2010, focused on the risks and opportunities that climate change presents to an organization's strategy, financial performance, and condition. Climate change was the reason CDSB was set up. Still, the market and regulators were becoming aware that climate is only one of the many elements of natural capital that affect business value. So, in 2013 CDSB's Board agreed to expand the framework's scope beyond climate change to encompass environmental information and natural capital (the wider "E" of ESG) in mainstream reporting.[377]

In 2018, the CDSB Framework was amended to further meet user needs around climate risks and opportunities. In light of changing market demands, the CDSB Framework has been refined and updated to ensure universal applicability in 2019.

The framework consists of 12 reporting requirements, among which one for reporting material environmental risks and opportunities. According to CDSB, environmental risks and opportunities are potentially wide-ranging, direct or indirect (for example, affecting markets or supply chain) and can include:

- **Regulatory risks and opportunities from current and/or expected regulatory requirements, including known or anticipated effects of:**
  - GHG and non-GHG emissions limits.
  - Energy efficiency, water, and forest standards.
  - Taxation of environmental resources and sources of environmental impact.
  - Process and product standards.
  - Participation in GHG emissions trading schemes.
- **Physical risks including the known or expected effects of:**

[376] CDSB builds on the activities of CDSB Board members, including CDP; Ceres; The Climate Registry; The International Emissions Trading Association (IETA); The Sustainability Accounting Standards Board (SASB); The World Business Council for Sustainable Development (WBCSD); The World Economic Forum (WEF); and The World Resources Institute (WRI).

[377] Mardi McBrien. (April 2018) "Looking back at 10 years of CDSB."

  - Changes to resource quality or availability, particularly in the organization's natural capital dependencies.
  - Changing weather patterns.
  - Sea level rise.
  - Shifts in species distribution.
  - Changes in water availability and quality.
  - Change in temperature.
  - Variation in agricultural yield and growing seasons.

- **Reputational risks and opportunities; and**
- **Litigation risks and opportunities."**[378]

3.2.4. Other ESG systems approach to climate change mitigation and adaptation

ESG reporting frameworks and standards are representative of investors' demand and reflect this demand in the content of the ESG reports they deliver for companies. The following section explores if and how they integrate climate-related information.

Regarding emissions:
Emissions are a prime driver of rising global temperatures and, as such, are a key focal point of policy, regulatory, market, and technology responses to limit climate change. As a result, organizations with significant emissions are likely to be impacted more significantly by transition risk than other organizations.
When referring to GHG emissions, the majority of the systems require evidence on Scope 1, 2 & 3 emissions. SASB has adopted a different approach. It requires the disclosure of direct emissions (Scope 1) and accounts for indirect emissions by capturing operational and/or strategic factors that give rise to such emissions: 'Energy Management' (Scope 2) and 'Product Design & Lifecycle Management', 'Supply Chain Management & Materials Sourcing & Efficiency' (Scope 3). According to SASB "these factors are the actionable "levers" that company management is likely to pull to reduce Scope 2 and 3 emissions. Reporting on these "levers" enables investors to evaluate **whether a company is adapting its business operations and strategy to mitigate climate-related risks, realize climate-related opportunities, and enable achievement of society's GHG emission targets.**"[379]

So, SASB includes metrics that capture information about the energy consumed by the reporting entity as a surrogate for Scope 2 emissions and similarly, rather than calling for Scope 3 emissions disclosure—which relates to issues beyond the control of reporting entities—SASB calls for the disclosure of industry-specific metrics related to the direct risks and opportunities companies face which drive Scope 3 emissions both up and down the value chain.[380]

Table 20: GHG emissions- related indicators (or disclosures) /metrics

[378] CDSB. (December 2019) "CDSB Framework for reporting environmental & climate change information: Advancing and aligning disclosure of environmental information in mainstream reports."
[379] Sustainability Accounting Standards Board. (September 2020) SASB Implementation Supplement: Greenhouse Gas Emissions and SASB Standards.
[380] Ibid.

WEF	**Greenhouse gas (GHG) emissions**	For all relevant greenhouse gases (e.g. carbon dioxide, methane, nitrous oxide, F-gases etc.), report in metric tonnes of carbon dioxide equivalent (tCO2e) GHG Protocol Scope 1 and Scope 2 emissions. Estimate and report material upstream and downstream (GHG Protocol Scope 3) emissions where appropriate.
	TCFD implementation	Fully implement the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). If necessary, disclose a timeline of at most three years for full implementation. Disclose whether you have set, or have committed to set, GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C – and to achieve net-zero emissions before 2050.
	Paris-aligned GHG emissions targets	Define and report progress against time-bound science-based GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C. This should include defining a date before 2050 by which you will achieve net-zero greenhouse gas emissions, and interim reduction targets based on the methodologies provided by the Science Based Targets initiative, if applicable. If an alternative approach is taken, disclose the methodology used to calculate the targets and the basis on which they deliver on the goals of the Paris Agreement.
	Impact of GHG emissions	Report wherever material along the value chain (GHG Protocol Scope 1, 2 & 3) the valued impact of greenhouse gas emissions. Disclose the estimate of the **societal cost of carbon** used and the source or basis for this estimate.
GRI	**305-1 Direct (Scope 1) GHG emissions**	a. Gross direct (Scope 1) GHG emissions in metric tons of CO2 equivalent.
	305-2 Energy indirect (Scope 2) GHG emissions	a. Gross location-based energy indirect (Scope 2) GHG emissions in metric tons of CO2 equivalent.
	305-3 Other indirect (Scope 3) GHG emissions	a. Gross other indirect (Scope 3) GHG emissions in metric tons of CO2 equivalent.
	For scope 1,2 & 3 emissions also requests disclosure on: b. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. c. Biogenic CO2 emissions in metric tons of CO2 equivalent. d. Base year for the calculation, if applicable, including: i. the rationale for choosing it; ii. emissions in the base year; iii. the context for any significant changes in emissions that triggered recalculations of base year emissions. e. Source of the emission factors and the global warming potential (GWP) rates used, or a reference to the GWP source. f. Consolidation approach for emissions; whether equity share, financial control, or operational control. g. Standards, methodologies, assumptions, and/or calculation tools used.	
	305-4 GHG emissions intensity	a. GHG emissions intensity ratio for the organization. b. Organization-specific metric (the denominator) chosen to calculate the ratio. c. Types of GHG emissions included in the intensity ratio; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). d. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all.
	305-5 Reduction of GHG emissions	a. GHG emissions reduced as a direct result of reduction initiatives, in metric tons of CO2 equivalent. b. Gases included in the calculation; whether CO2, CH4, N2O, HFCs, PFCs, SF6, NF3, or all. c. Base year or baseline, including the rationale for choosing it. d. Scopes in which reductions took place; whether direct (Scope 1), energy indirect (Scope 2), and/or other indirect (Scope 3). e. Standards, methodologies, assumptions, and/or calculation tools used.
SASB	**Greenhouse emissions**	Gross global Scope 1 emissions and percentage of Scope 1 emissions emitted in areas that are subject to emissions-limiting or emissions-reporting regulation

		[in cases also] Percentage of Scope 1 emissions associated with the emission of a specific (per industry) substance
		Discussion of long-term and short-term strategy or plan to manage Scope 1 and lifecycle emissions, emissions reduction targets, and an analysis of performance against those targets
		(1) Total landfill gas generated (2) percentage flared (3) percentage used for energy
	Emissions Reduction Services & Fuels management	Discussion of strategies or plans to address air-emissions related risks, opportunities and impacts
		Percentage of engines in service that meet Tier 4 compliance for non-road diesel engine emissions
TCFD	**GHG Emissions**	Amount of gross global Scope 1 emissions from: (1) combustion, (2) flared hydrocarbons, (3) process emissions, (4) directly vented releases, and (5) fugitive emissions/leaks
		Estimated Scope 3 emissions, including methodologies and emission factors used
		[for Road vehicles] Geographic breakdown of GHG emissions: emissions and/or emission intensity of products for key geographies against regulatory requirements/targets
		Life cycle reporting of GHG emissions of Transportation products (air, ship, rail, truck, auto)
		Describe current carbon price or range of prices used
		GHG emissions intensity from buildings (by occupants or square area) and from new construction and redevelopment

It is worth highlighting, the WEF-IBC standards' selected metrics & disclosures for the theme 'climate change'[381]:

- Greenhouse gas (GHG) emissions
- TCFD Implementation
- Paris-aligned GHG emissions targets
- Impact of GHG emissions

On one hand, WEF IBC requests companies to fully implement the TCFD Recommendations within three years at a maximum, and "disclose whether the company have set, or have committed to set, GHG emissions targets that are in line with the goals of the Paris Agreement and to achieve net-zero emissions before 2050." Therefore, though all ESG standards request disclosure of GHG emission targets, WEF-IBC specifically refers to Paris alignment of targets. Moreover, as part of the 'Paris-aligned GHG emissions targets' disclosure requests "reporting of progress against time-bound science-based GHG emissions targets that are in line with the goals of the Paris Agreement", and adds that "this should include defining a date before 2050 by which you will achieve net-zero greenhouse gas emissions, and interim reduction targets based on the methodologies provided by the Science Based Targets initiative, if applicable." Finally, it has included 'the impact of GHG emissions' disclosure which requests disclosure of 'the valued impact of greenhouse gas emissions'. According to WEF, "reporting valued impact in monetary terms provides a meaningful indication of the scale of impacts in units that can be readily understood by executives and compared across impact areas and with financial figures.

381 See full set of WEF-IBC selected themes and disclosures and metrics in the Appendix F.

Valuation of environmental impacts is increasingly recognized as the most efficient and effective way of incorporating as much relevant contextual information as possible to provide estimates of actual impact, rather than simply measures of output as is the case with most quantitative environmental metrics."[382]

In general, WEF IBC, a recently launched standard -that was based on existing standards, such as GRI, SASB, ISO and CDSB for its development and aligned to TCFD -has incorporated metrics that are "not well-established in existing practice and standards and have a wider value chain scope or convey impact in a more sophisticated or tangible way, such as in monetary terms".

Regarding Climate physical risk

ESG systems cover climate-related risk management both against the physical risks of climate change and the exposure to the risks of the transition to a low-carbon economy.

Table 21: Climate risk-related indicators/metrics

WEF	**TCFD implementation**	**Fully implement the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). If necessary, disclose a timeline of at most three years for full implementation.** Disclose whether you have set, or have committed to set, GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit warming to 1.5°C – and to achieve net-zero emissions before 2050.
GRI	**201-2 Financial implications and other risks and opportunities due to climate change**	a. Risks and opportunities posed by climate change that have the potential to generate substantive changes in operations, revenue, or expenditure, including: i. a description of the risk or opportunity and its classification as either physical, regulatory, or other; ii. a description of the impact associated with the risk or opportunity; **iii. the financial implications of the risk or opportunity before action is taken;** iv. the methods used to manage the risk or opportunity; **v. the costs of actions taken to manage the risk or opportunity.**
SASB	**Climate impacts of business mix**	Amount of backlog for (1) cancellation associated with hydrocarbon-related projects and (2) renewable energy projects
		Amount of backlog for non-energy projects associated with climate change mitigation
	Management of Energy Infrastructure Integration & Related Regulations	Description of risks associated with integration of solar energy into existing energy infrastructure and discussion of efforts to manage those risks
		Description of risks and opportunities associated with energy policy and its impact on the integration of solar energy into existing energy infrastructure
	(Systemic Risk Management) Grid Resiliency	(1) System Average Interruption Duration Index (SAIDI), (2) System Average Interruption Frequency Index (SAIFI), and (3) Customer Average Interruption Duration Index (CAIDI), inclusive of major event days
	Managing Systemic Risks from	(1) System average interruption frequency and (2) customer average interruption duration

382 World Economic Forum. (September 2020) "Measuring Stakeholder Capitalism towards Common Metrics and Consistent Reporting of Sustainable Value Creation".

	Technology Interruptions	Discussion of systems to provide unimpeded service during service interruptions
TCFD	**Risk Adaptation & Mitigation**	Revenues/savings from investments in low-carbon alternatives (e.g., R&D, equipment, products or services)
		Expenditures (OpEx) for low carbon alternatives (e.g., R&D, equipment, products, or services)
		Proportion of capital allocation to long-lived assets versus short-term assets
		Capital payback periods or return on capital deployed
	Location	Area of buildings, plants or properties located in designated flood hazard areas

Regarding Energy

All the analyzed ESG systems include disclosures of energy management and request information on energy consumption savings as well as energy reduction targets, efficiency targets or considerations.

Table 22: Energy-related Indicators/ metrics

GRI	**302-3 Energy intensity**	a. Energy intensity ratio for the organization. b. Organization-specific metric chosen to calculate the ratio. c. Types of energy included in the intensity ratio; whether fuel, electricity, heating, cooling, steam, or all. d. Whether the ratio uses energy consumption within the organization, outside of it, or both.
	302-4 Reduction of energy consumption	a. Amount of reductions in energy consumption achieved as a direct result of conservation and efficiency initiatives, in joules or multiples. b. Types of energy included in the reductions; whether fuel, electricity, heating, cooling, steam, or all. c. Basis for calculating reductions in energy consumption, such as base year or baseline, including the rationale for choosing it. d. Standards, methodologies, assumptions, and/or calculation tools used.
	302-5 Reduction in energy requirements of products and services	a. Reductions in energy requirements of sold products and services achieved during the reporting period, in joules or multiples. b. Basis for calculating reductions in energy consumption, such as base year or baseline, including the rationale for choosing it. c. Standards, methodologies, assumptions, and/or calculation tools used.
SASB	**Lifecycle Impacts of Buildings & Infrastructure**	Discussion of process to incorporate operational-phase energy and water efficiency considerations into project planning and design (engineering & construction services)
	Energy management	Percentage of eligible portfolio that (1) has an energy rating and (2) is certified to ENERGY STAR, by property subsector
	Fleet fuel management	Percentage of alternative fuel vehicles in fleet
TCFD	**Energy/Fuel**	Indicative costs of supply for current and committed future projects (e.g., through a cost curve or indicative price range. This could be broken down by product, asset, or geography)
		Sales-weighted average fleet fuel economy, by region and weight/number of people transported
		Total energy intensity—by tons of product, amount of sales, number of products depending on informational value

		Building energy intensity (by occupants or square area)

Regarding water (quantity and quality)

ESG systems approach to capture sustainable water management in quantity and quality is reflected in freshwater consumption and withdrawal and its impacts and effluent quality.

Table 23: Water-related Indicators/ metrics

WEF	**Water consumption and withdrawal in water-stressed areas**	Report for operations where material: megalitres of water withdrawn, megalitres of water consumed and the percentage of each in regions with high or extremely high baseline water stress, according to WRI Aqueduct water risk atlas tool. Estimate and report the same information for the full value chain (upstream and downstream) where appropriate.
	Impact of freshwater consumption and withdrawal	Report wherever material along the value chain: the valued impact of freshwater consumption and withdrawal.
GRI	**303-1 Interactions with water as a shared resource**	a. A description of how the organization interacts with water, including how and where water is withdrawn, consumed, and discharged, and the water-related impacts caused or contributed to, or directly linked to the organization's activities, products or services by a business relationship (e.g., impacts caused by runoff). b. A description of the approach used to identify water-related impacts, including the scope of assessments, their timeframe, and any tools or methodologies used. c. A description of how water-related impacts are addressed, including how the organization works with stakeholders to steward water as a shared resource, and how it engages with suppliers or customers with significant water-related impacts. d. An explanation of the process for setting any water-related goals and targets that are part of the organization's management approach, and how they relate to public policy and the local context of each area with water stress.
SASB	**Water Supply Resilience**	Discussion of strategies to manage risks associated with the quality and availability of water resources
		Volume of recycled water delivered to customers
	Lifecycle Impacts of Buildings & Infrastructure	Discussion of process to incorporate operational-phase energy and water efficiency considerations into project planning and design (engineering & construction services)
	Effluent Quality Management	Number of incidents of non-compliance associated with water effluent quality permits, standards, and regulations
	Distribution Network Efficiency	Water main replacement rate
		Volume of non-revenue real water losses
TCFD	**Water**	Percent water withdrawn in regions with high or extremely high baseline water stress
		Assets committed in regions with high or extremely high baseline water stress
		Building water intensity (by occupants or square area)

Finally, it is worth adding that apart from key climate-related topics presented in the tables above, all ESG systems also cover lifecycle consideration for materials, resource availability, supply chain and human capital (workforce) related issues, that related to climate risk. (See Appendix F)

3.4. Key Takeaways

- TCFD Recommendations explicitly guides for disclosure of Scope 1, Scope 2, and, if appropriate, Scope 3 GHG emissions, calculated in line with the GHG Protocol methodology to allow for aggregation and comparability.
- TCFD identifies two types of climate-related risks (and opportunities): **transition risks**, the risks related to the transition to a lower-carbon economy and physical risks, the risks related to the physical impacts of climate change.
- Use of an internal carbon price (or shadow price) is a useful planning tool for companies to quantify risks related to GHG emissions.
- All ESG systems despite deviations in terminology or degree of comprehensiveness consider as materials to investors ESG topics that cover: the environment, social capital, human capital, leadership and governance.
- Apart from ESG systems alignment to the TCFD, the recently launched WEF-IBC standard includes 'TCFD alignment' as one of its climate change disclosures.
- The majority of the ESG systems request reporting of scope 1 and 2 emissions, and scope 3 emissions (if appropriate) in line with the GHG Protocol and TCFD Recommendations.
- ESG systems request reporting of GHG emission reduction targets and WEF-IBC explicitly requests disclosure of "progress against time-bound science-based GHG emissions targets that are in line with the goals of the Paris Agreement".
- All ESG systems include indicators/disclosures that are climate-related:
    - Energy management
    - 'Freshwater availability' particularly in water-stressed locations.
    - Resource availability
    - Supply chain
    - Human capital (workforce)

PART 3: ENVISION REVIEW - PRIORITIZING CRITERIA

Due to Envision's twofold purpose, as both an assessment tool for sustainable project performance and as a guidance tool for project teams to optimize project performance, the review and recommendations refer to both uses of the Envision manual.

Envision as an infrastructure project assessment tool should assist in the on-going global efforts to create the right pipeline of projects for investment that help close the mitigation and adaptation gap, by setting those criteria that enable prioritization of the right 'climate –first' infrastructure projects. Envision as a guidance tool should provide examples of strategies that contribute to a net positive effect on climate, assist companies to avoid the use of lock-in technologies and highlight the opportunities of climate-related strategies.

For the review of the assessment process, the Envision manual is mainly used to ensure that Envision requirements and the boundary of assessment reflect current practice, while the review as guidance tool utilizes the LC Sustainability tool to highlight indirect connections already existing within Envision.

1. METHODOLOGY FOR REVIEW

The Envision review regarding mitigation and adaptation is based on targeted questions generated from the key takeaways of the literature review and the analysis of ESG systems.

RESEARCH QUESTIONS FOR ENVISION REVIEW

1. Does Envision request GHG accounting as part of projects' performance assessment? Does this GHG accounting encompasses:
    a. the full life cycle of a project
    b. the scope categorization as defined by GHG Protocol
    c. what is the boundary of Envision's assessment? Is it limited to the project's own performance or extends to account for end user emissions during the use phase of the project?)
2. Envisions refers to emissions as direct and indirect and also refers to the embodied carbon of materials. Should it consider using the terminology established by GHG Protocol to allow for aggregation and comparability?
3. Envision as an assessment tool has to align its performance requirements with recent climate research findings. Should Envision seek to align its emission reduction targets that determine different levels of performance with international or national GHG emission targets? Does Envision request projects to report alignment to international or national goals?
4. In a period that urgent climate action is needed, should additional project requirements or guidance on strategies be provided by Envision in line with deep decarbonization pathways?
5. Envision rewards innovative approaches and practices through the 'Innovate or exceed requirements' credits that provide 'bonus' points to projects for exceeding requirements. Given the core role of innovation in achieving the aggressive GHG reduction targets that are necessary for transition to a low-carbon paradigm, a question that emerges is if Envision should incorporate innovative processes and technologies in its guidance and requirements within relevant credits of at least Resource Allocation and Climate & Resilience credits, to underline their significance?
6. Is Envision's climate-related risk evaluation and assessment aligned with the TCFD Recommendations?
7. Envision includes performance targets regarding GHG emissions reduction, net embodied carbon reduction, energy consumed, share of renewable energy sources, use of recycled materials, reduction of waste, water consumption etc. Are these performance targets in line with recent transition and physical scenarios?
8. The Envision review regarding climate-change financial materiality to investors is also based on targeted questions generated from previous parts of the report.
9. Which climate-related topics, covered by Envision credits, are material to investors and should be considered by companies?
10. Should Envision include Transition and physical risks and their potential financial impacts as evidence of climate project performance?

1.1. Envision Filtering through LC Tool

In order to bring to surface the credits that contribute to climate change mitigation or adaptation, the LC Sustainability tool will be used to filter Envision. Three filterings are required:

1. Mitigation
2. Adaptation
3. Financial materiality

1) The filtering for mitigation takes into consideration the following impacts:
   - **Emissions**= GHG emissions; depending on the credit, they could refer to emissions by the project's operations or emissions by on-site energy use during construction works emissions refer directly to 'Climate change.' Emissions also refer to emissions by private vehicles (e.g., from congestion created by the project).
   - **Embodied carbon**= embodied carbon of materials, equipment, and fleet vehicles (from cradle to gate), including emissions during material extraction and production; equipment/vehicle manufacture; fuel production; supply chain.
   - **Energy**= fuel & electricity use during operation and construction (energy used on the construction site); Energy, when labeled as an indirect impact, refers to fuel use of equipment/ vehicles. It is worth highlighting that Envision does not require documentation or estimates of private vehicle fuel consumption; however, it is identified as an indirect impact on certain credits.
   - **Embodied energy**= embodied energy of materials, equipment, and fleet vehicles (from cradle to gate)

Table 24: Filtering for climate change mitigation – Direct contributors to climate change

IMPACT FILTERED	FILTERING RESULT													
Emissions / Energy	QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	QL3.4	LD2.3	LD2.4				
	RA1.2	RA2.1	RA2.2	RA2.3	RA2.4	RA3.3	NW2.4	NW3.1	NW3.3					
	CR1.2	CR2.5	CR2.6											
Embodied carbon/ embodied energy	QL1.3	QL1.4	QL1.5	QL1.6	QL2.1	QL2.2	QL2.3	QL3.4	LD1.4	LD2.3	LD2.4			
	RA1.1	RA1.2	RA1.3	RA1.4	RA1.5	RA2.2	RA2.3	NW2.1	NW2.3	NW2.4	NW3.3	NW3.4	NW3.5	
	CR1.1	CR2.5	CR2.6											
Emissions (user)	QL1.3	QL2.1	QL2.2	QL2.3	QL3.4	LD2.3	LD2.4	RA1.2	RA1.3	RA1.4	RA1.5	NW2.2	NW2.3	NW3.3
	CR1.1	CR2.5	CR2.6											

Note: filtering energy overlaps with impact emissions; and impact embodied carbon with 'embodied energy'

This filtering isolates all mitigation strategies included in Envision credits.

2) The filtering for climate change adaptation takes into consideration the following impacts:

   - **Resiliency Value (for the Agency/ Infrastructure Owner)**: the value of protection from the effects of future/repeat disasters or enhanced reliability, such as avoided future cost of damage, displacement, or cost of loss of service that may create a financial downturn or slowdown for the organization. [383]

Table 25: Filtering for climate change adaptation – Resilience

IMPACT FILTERED	FILTERING RESULT													
Resilience value	QL1.3	QL1.4	QL2.1	QL2.2	QL2.3	QL3.4	LD1.1	LD1.2	LD1.3	LD1.4	LD2.1	LD2.2	LD2.3	LD2.4
	LD3.1	LD3.2	RA1.1	RA1.2	RA1.3	RA1.4	RA1.5	RA2.1	RA2.3	RA2.4	RA3.1	RA3.2	RA3.3	RA3.4
	NW1.1	NW1.2	NW1.3	NW1.4	NW2.1	NW2.2	NW2.3	NW2.4	NW3.1	NW3.2	NW3.3	NW3.4	NW3.5	
	CR2.1	CR2.2	CR2.3	CR2.4	CR2.5	CR2.6								

This filtering isolates all adaptation strategies included in the Envision credits.

The two filterings regarding mitigation and adaptation impacts presented above complement the Envision analysis presented in Part 2: Section 1.2. 'Envision analysis in terms of climate change mitigation vs. adaptation' that focused only on credits that explicitly refer to mitigation and adaptation. The filterings highlight the strong interconnectivity of credits since credits from all categories are identified as relevant to either mitigation or adaptation. At the same time, it is worth mentioning that some credits apply for both mitigation and adaptation.

As Labovitch observes, "the data seems to reinforce the inter-relationships between 'climate-friendly projects and broader sustainability, ESG objectives. It may also reflect how difficult it is to isolate a metric or small set of metrics for measuring or defining a 'climate friendly' project.

Table 26: Overview table of Envision credits that contribute to mitigation and/or adaptation

ENVISION CREDITS	CREDITS RELATED TO MITIGATION	CREDITS RELATED TO ADAPTATION
QL1.1 Improve Community Quality of Life		
QL1.2 Enhance Public Health & Safety		
QL1.3 Improve Construction Safety	Y	Y
QL1.4 Minimize Noise and Vibration	Y	
QL1.5 Minimize Light Pollution	Y	Y
QL1.6 Minimize Construction Impacts	Y	Y
QL2.1 Improve Community Mobility & Access	Y	Y
QL2.2. Encourage Sustainable Transportation	Y	Y
QL2.3. Improve Access & Wayfinding	Y	Y
QL3.1 Advance Equity and Social Justice		
QL3.2 Preserve Historic and Cultural Resources		
QL3.3 Enhance Views & Local Character		
QL3.4 Enhance Public Space and Amenities	Y	Y

383 In the LC Tool the term resilience is used, social resilience, ecological resilience, as well as resilience value for the user. However, this encompasses resilience in a wider sense and not specifically to climate change. The impact 'Resilience value' for the infrastructure owner is the most related to climate change adaptation and was used for the filtering.

LD1.1 Provide Effective Leadership & Commitment	Y	Y	ENABLING
LD1.2 Foster Collaboration & Teamwork	Y	Y	ENABLING
LD1.3 Provide for Stakeholder Involvement	Y	Y	ENABLING
LD1.4 Pursue Byproduct Synergies	Y	Y	
LD2.1 Establish a Sustainability Management Plan	Y	Y	ENABLING
LD2.2 Plan for Sustainable Communities	Y	Y	ENABLING
LD2.3 Plan for Long-Term Monitoring and Maintenance	Y	Y	
LD2.4 Plan for end-of-life	Y	Y	
LD3.1 Stimulate Economic Prosperity & Development	Y	Y	
LD3.2 Develop Local Skills & Capabilities	Y	Y	
LD3.3 Conduct a Life-Cycle Economic Evaluation			
RA1.1 Support Sustainable Procurement Practices	Y	Y	
RA1.2 Use Recycled Materials	Y	Y	
RA1.3 Reduce Operational Waste	Y	Y	
RA1.4 Reduce Construction Waste	Y	Y	
RA1.5 Balance Earthwork On Site	Y	Y	
RA2.1 Reduce Operational Energy Consumption	Y	Y	
RA2.2 Reduce Construction Energy Consumption	Y		
RA2.3 Use Renewable Energy	Y	Y	
RA2.4 Commission & Monitor Energy Systems	Y	Y	
RA3.1 Preserve Water Resources		Y	
RA3.2 Reduce Operational Water Consumption	Y	Y	
RA3.3 Reduce Construction Water Consumption	Y	Y	
RA3.4 Monitor Water Systems		Y	
NW1.1 Preserve Sites of High Ecological Value	Y	Y	
NW1.2 Provide Wetland & Surface Water Buffers	Y	Y	
NW1.3 Preserve Prime Farmland	Y	Y	
NW1.4 Preserve Undeveloped Land	Y	Y	
NW2.1 Reclaim Brownfields	Y	Y	
NW2.2 Manage Stormwater	Y	Y	
NW2.3 Reduce Pesticide & Fertilizer Impacts	Y	Y	
NW2.4 Protect Surface and Groundwater Quality	Y	Y	
NW3.1 Enhance Functional Habitats	Y	Y	
NW3.2 Enhance Wetland & Surface Water Functions	Y	Y	
NW3.3 Maintain Floodplain Functions	Y	Y	
NW3.4 Control Invasive Species	Y	Y	
NW3.5 Protect Soil Health	Y	Y	
CR1.1 Reduce Net Embodied Carbon	Y	Y	
CR1.2 Reduce Greenhouse Gas Emissions	Y	Y	
CR1.3 Reduce Air Pollutant Emissions			
CR2.1 Avoid Unsuitable Development		Y	
CR2.2 Assess Climate Change Vulnerability		Y	
CR2.3 Evaluate Risk and Resilience		Y	
CR2.4 Establish Resilience Goals and Strategies		Y	
CR2.5 Maximize Resilience	Y	Y	
CR2.6 Improve Infrastructure Integration	Y	Y	

As observed in the table above the majority of credits relate to both climate change mitigation and adaptation.

In the case of credits of the LD category, that are more related to governance and management practices, some credits depending on the specific practices they will encompass have the potential of enabling mitigation and/or adaptation.

In the case of credits of NW category, all credits have the potential to contribute to both mitigation and adaptation based on the ‘landscape as infrastructure’ approach.

At this point it is worth highlighting that ‘ecological resilience’ and ‘ecosystem services value’ are also considered as related to both climate change adaptation and mitigation. In general the Natural world credits by referring to habitat and biodiversity protection, preservation and enhancement contribute to the preservation and enhancement of ‘natural capital’ with value both for the infrastructure owner, manager and the community. Landscape has the singularity of a solution to climate change and recipient of direct pressure by its impacts.
The contribution to climate change mitigation and adaptation is better understood through the approach of ‘landscape as infrastructure’ that Envision supports. This approach was presented and documented in the Zofnass program publication ‘Prof. S.N. Pollalis (2016) Planning Sustainable Cities: An infrastructure-based approach.” Landscape was analyzed in terms of the provision of services (ecosystem services).
“Landscape supports specific infrastructural services, offering biological solutions to technical problems, especially if planned in synergy with other infrastructure systems and as high-performance landscape. The landscape services can be summarized in six main functions as habitat, source, sink, conduit, filter, and barrier.”

Table 27: Ecosystems services

Provisioning services	Regulating services	Supporting services	Cultural services
• Food (nutrition/ animal feeding) • Freshwater • Fiber, timber (raw materials) • Genetic resources • Biochemicals • Fuel (energy resources)	• Water filtration/ purification • Water regulation (rainwater management/ flood control/ natural hazard protection) • Erosion regulation • Climate regulation • Carbon sequestration and storage • Regulation of atmospheric composition • Crop pollination • Pest regulation (biological control) • Disease control and suppression of pathogens • Waste decomposition • Contaminants control	• Primary production/ nutrient cycling • Soil formation and retention • biomass production • production of atmospheric oxygen • water cycling • provisioning of habitat	• Spiritual and religious values • Aesthetic values • Recreation • Knowledge systems and educational values

Landscape’s function **as source** and the related provisioning services are directly related to resource availability and by extension to adaptation. Due to its function **as sink** and the associated regulating services it provides is related to climate change adaptation to climate variability e.g. more frequent extreme weather events, increased average temperatures, heat waves (through rainwater management, natural hazard protection, climate regulation), as well as climate change mitigation (carbon storage).

Due to the extent and the complexity of the topic the research does not focus on nature-based solutions against climate change mitigation and adaptation.

3) A final filtering is performed to identify credits that are material to investors. Envision assesses primarily external impacts of the project (on the environment, society and economy) and includes one credit LD3.3. Conduct a Life-cycle Economic Evaluation to account for internal impacts on an infrastructure company. The LC Tool provides an add-on to Envision by connecting strategies with economic impacts for the infrastructure owner. The financial impacts that are considered as material for investors are:
   - Financial impacts that are reported in income statements
   - Financial impacts that are typically included in balance sheets
   - ESG-related financial impacts that are included in ESG reporting for investment decisions in sustainability

According to EDHECinfra,[384] the ESG-related financial impacts represent risks to the value of the firm arising from physical damage, access to resources, social acceptability, workforce availability (external factors), and organizational failure and staff failure (internal risks).

<u>The filtering for agency/ infrastructure owner costs takes into consideration the following impacts:</u>

Financial impacts included in Income Statements:

- **O&M cost**[385]= recurring operational & routine maintenance cost
- **Revenues**= streams of income due to service provision, pricing schemes in place, by-product synergies with external groups, carbon credits trade.

Financial impacts typically included in Balance sheets:

- **Capital cost**= initial capital/ investment cost (including preliminary engineering, contract administration, initial construction, construction supervision & administrative costs)
- **Rehabilitation cost**= cost or avoided costs of major rehabilitation
- **Replacement cost** = cost or avoided costs of replacement of the project/ end-of-life cost
- **Residual value** = (also known as salvage value) is the estimated value of an asset at the end of its lease term or useful life.

---

[384] "Towards a Scientific Approach to ESG for Infrastructure Investors. A Publication of the EDHEC Infrastructure Institute." published on March 3, 2021

[385] O&M, capital, rehabilitation, and replacement costs include the following types of costs:

- Land acquisition cost (e.g., for temporary staging area)
- Materials acquisition cost
- Labor cost (or workforce-related cost)
- Schedule efficiency cost (avoided cost through optimized work completion)
- Hauling & fuel cost
- Waste cost

Additionally, as indirect financial impacts to infrastructure owners are included:

- **Delay cost**= Less exposure to potential cost due to delays in project delivery due to public opposition, or extended approval processes
- **Liability claim/ Compliance cost**= Less exposure to potential cost of liability claims (e.g., in the case of an accident) and cost of potential penalties for exceedance of regulation limits (e.g., noise, air quality, water quality, etc.)
- **Resiliency value**= value of protection from the effects of future/repeat disasters, such as avoided future cost of repair, of displacement, or cost of loss of service that may create a financial downturn or slowdown for the organization
- **Ecosystem services value**= Less exposure to impact on natural capital and costs for substituting natural control processes (availability of clean air, freshwater, reduced risk of flooding or drought) with engineered controls

Resilience value is a term included in the Envision manual as part of LD3.3 credit's evaluation criteria and documentation guidance for scoring higher levels of achievement by quantifying and measuring the broader financial, social, and environmental benefits of the project, using triple bottom line cost-benefit analysis (TBL-CBA) or sustainable return on investment.

Table 28: Filtering for costs or cost savings to infrastructure owners/ managers

IMPACT FILTERED	FILTERING RESULT														
Capital cost	QL1.3	QL1.4	QL1.5	QL2.1	QL2.2	QL2.3	QL3.3	QL3.4	LD1.2	LD1.4	LD2.3	LD2.4	LD3.3		
	RA1.1	RA1.2	RA1.4	RA1.5	RA2.1	RA2.2	RA2.3	RA2.4	RA3.2	RA3.3	RA3.4				
	NW1.1	NW1.3	NW2.1	NW2.2	NW2.3	NW3.1	NW3.2	NW3.4	NW3.5	CR1.1	CR1.2	CR1.3	CR2.5	CR2.6	
O&M cost	QL1.5	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD3.3	RA1.3	RA2.1	RA2.3	RA2.4	RA3.2	RA3.4
	NW2.2	NW2.3	NW3.1	NW3.2	NW3.4	CR1.1	CR1.2	CR2.5	CR2.6						
Rehabilitation cost	QL1.4	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD3.3	RA1.2	NW3.1	NW3.3	CR2.5	CR2.6	
Replacement cost	QL1.4	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD2.4	LD3.3	RA1.2	NW3.1	NW3.3	CR2.5	CR2.6
Residual value	QL2.1	QL2.2	QL2.3	QL3.4	CR2.5	CR2.6									
Revenues	QL2.1	QL2.2	QL2.3	QL3.4	LD1.2	LD1.4	LD2.3	LD3.3	RA1.1	CR1.1	CR1.2	CR2.5	CR2.6		
Delay cost	QL1.1	QL1.4	QL1.6	QL2.1	QL3.2	QL3.3	QL3.3	LD1.3	LD3.3	NW2.4	NW3.1	NW3.5	CR2.5		
Liability/ compliance cost	QL1.2	QL1.6	QL3.3	LD1.4	LD3.3	RA1.1	RA3.1	RA3.4	NW1.2	NW2.1	NW2.2	CR1.1	CR1.2	CR1.3	
Resilience value	QL2.1	QL2.2	QL2.3	LD1.2	LD1.4	LD2.3	LD2.4	LD3.1	LD3.2	LD3.3	RA1.1	RA1.2	RA2.1	RA3.1	RA3.2
	RA3.4	NW2.2	NW2.3	NW3.1	NW3.2	NW3.3	NW3.4	CR1.3	CR2.1	CR2.2	CR2.3	CR2.4	CR2.5	CR2.6	

1.2. Additional Parameters to the LC Tool

1.2.1 New filters

The key takeaways from the literature review and ESG systems analysis and the generated questions for Envision review required **add-ons (additional parameters)** to the LC Tool in order to enable more targeted filterings of Envision as part of its review for climate change. The additions to the LC Tool are:

For climate change mitigation:

- The impact 'emissions' is further explained and categorized (1) as scope 1, 2 or 3 emissions and (2) as initial vs. future/ short-term vs. long-term emissions.
- A climate-related risk was attributed to the impact 'emissions', the '**transition risk'**, as defined by TCFD to highlight less or more exposure to related potential financial impacts.

For climate change adaptation:

Impact 'resilience value' is further explained and categorized as:

- physical asset risk
- service continuity risk
- resource availability risk (water, materials, land, workforce)
- supply chain continuity risk

Based on TCFD and analyzed ESG systems these climate-related risks for a company's / project's adaptation capacity have been identified. These risks connect strategies with less or more exposure to potential financial impacts as described by TCFD.

1.2.2. Reviewed and Enhanced Definitions

Regarding climate-related financial materiality:

In the existing LC Sustainability tool, climate change-related financial materiality is accounted for through the 'resilience value' economic impact to the infrastructure owner, referring to the exposure to risks of climate change, in other words, in climate change adaptation:

Resiliency value= value of protection from the effects of future/repeat disasters or enhanced reliability, such as avoided future cost of damage, displacement, or cost of loss of service that may create a financial downturn or slowdown for the organization.

On one hand, the above definition encompasses a wide variety of issues that, due to the present research's specific focus and the input from ESG and Climate-related Financial Reporting frameworks and standards, should be expanded.

On the other hand, the risks related to climate change mitigation (transition risk) for an infrastructure owner were not accounted for.

By introducing the TCFD-based climate-related 'transition risk' and 'physical risk', as already mentioned, strategies within credits are connected to basic categories of financial impact as seen in the section 3.2.2. Climate-related risks and opportunities in TCFD Recommendations of Part 2 of this report. These potential financial impacts were categorized into different types of cost relevant to LC tool's terms. As seen in the table resilience value encompasses increased or decreased revenues, capital cost, O&M, rehabilitation, replacement cost, residual value, liability/compliance cost (with impact on O&M) and delay cost (with impact on revenues).

Table 29: Climate change mitigation (transition risk/ opportunities) financial impacts:

	Transition Risks	Transition Opportunities
Revenues	**(-)Revenues from reduced demand due to:** ● Judgments for fines resulting from mandates and regulation on existing products and services ● Stakeholder concern or negative stakeholder feedback ● shift in consumer demand/ preferences away from heavy emissions options ● Change in revenue mix and sources due to uncertainty of market signals	**(+)Revenues from increased demand due to:** ● Reputational benefits ● shift in consumer demand/ preferences for lower emissions products and services ● Better competitive position to reflect shifting consumer preferences through R&D and innovation ● Access to new and emerging markets (e.g., partnerships with governments, development banks)
	(-) Revenues from reduced production capacity due to: ● Negative impacts on workforce management and planning, e.g., employee attraction and retention because of stigmatization of sector ● e.g., delayed planning approvals, supply chain interruptions because of stigmatization of sector ● Unsuccessful investment in new technologies	**(+) Revenues from increased production capacity due to:** ● more efficient processes
O&M cost	(-)**O&M cost from/due to:** ● Higher compliance costs ● increased insurance premiums for GHG emissions ● Changing input prices/increased cost of raw materials (e.g., energy, water) and output requirements (e.g., waste treatment) ● Abrupt and unexpected shifts in energy costs ● Increased pricing of GHG emissions (carbon cost)	**(+) O&M cost from:** ● efficiency gains due to efficient processes ● Benefits to workforce management and planning (e.g., improved health and safety, employee satisfaction ● use of lowest cost abatement through efficient transport modes, efficient production and distribution processes ● Reduced exposure to GHG emissions and therefore less sensitivity to changes in cost of carbon ● Reduced exposure to future fossil fuel price increases
Capital cost	**(-) Capital cost from/due to:** ● Required investment in research and development (R&D) in new and	

	alternative technologies ● Required investment in technology development ● Adoption/deployment of new practices and processes ● Unsuccessful investment in new technologies	
Liability/ Compliance cost	**(-)Liability/ Compliance cost from/due to:** ● Enhanced emissions-reporting obligations ● Mandates on and regulation on products/ services	
Replacement cost / Residual value	**(-) Replacement cost /(-) Residual value from/ due to:** ● Re-pricing of assets (e.g., fossil fuel reserves, land valuations, securities valuations) ● Write-offs, early retirement of assets because of policy changes ● Write-offs, early retirement of assets because of substitution with lower emissions options	**(+) Residual value from:** ● Value of energy-efficient assets

Table 25: Climate change adaptation (physical risk/ opportunities) financial impacts:

	Physical risks	**Resilience opportunities**
Revenues	**(-) Revenues from reduced production due to:** ● Transport difficulties, supply chain interruptions due to acute risks. ● Negative impacts on workforce management and planning (health, safety, absenteeism due to acute risks. ● Lower sales due to acute risks or chronic risks. ● Lower output (production capacity) due to acute risks or chronic risks.	**(+) Revenues through:** ● new solutions to adaptation needs (e.g., insurance risk transfer products and services) ● through new products and services related to ensuring resiliency ● Increased reliability of supply chain and ability to operate under various conditions due to resource substitutes/ diversification
O&M cost	**(-) O&M cost due to:** ● Increased insurance premiums on assets in “high-risk” locations (for acute or chronic risks) ● e.g., inadequate water supply for hydroelectric plants or to cool nuclear & fossil fuel plants	

Rehabilitation/ Replacement cost Residual value	**(-) Rehabilitation/** **(-) Replacement cost** **(-) Residual value due to:** ● Damage to facilities in high-risk locations from acute or chronic risks.	● Increased market valuation through resilience planning

2. ENVISION REVIEW - ASSESSMENT OF CLIMATE RISKS

The review on transition and physical risks is performed on a credit by credit basis, for all credits identified as relevant and explores each related credit's boundary of assessment, performance requirements and required evidence.[386]

2.1. Assessment of performance in climate change mitigation

The review of Envision in terms of assessment of climate mitigation is based on the following criteria that were identified through the literature review and the analysis if the selected ESG systems as key for climate action:

- GHG accounting during all life cycles of a project
- Energy efficiency
- Electricity decarbonization through the use of renewable energy sources
- Electrification (replacement of use of fossil fuels with electricity)
- Carbon capture and sequestration for the hard-to- electrify portions of systems

2.1.1. GHG accounting in Envision Credits

A first step of Envision's review in terms of climate change mitigation is to ensure that it accounts for the **GHG emissions** of an infrastructure project, the prime driver of global rising temperatures. Proper accounting of GHG emissions results in less uncertainty about impact on emissions and by extension the required transition to a lower carbon paradigm. Based on the findings of the literature review and the analysis of ESG systems reporting of GHG emissions must cover:

- The full life of the project
- The full GHG emissions scope categories: scope 1, 2 and 3.

Life cycle performance of a project is necessary in order to determine the net effect on GHG emissions. Therefore, a first focus of review is to explore if the whole-life GHG emissions of a project are requested to be

[386] Envision's evaluation criteria include both qualitative and quantitative requirements. Examples of evaluation criteria are:

- Yes/No: An action taken or an outcome achieved.
- Target: A specified outcome with discrete quantifiable levels.
- Execution: A process conducted or a commitment made to accomplish a stated objective.
- Accomplishment: A process conducted with a general or unspecified result. (source: Envision Manual Version 3)

reported and are being assessed. Accordingly to ESG systems and TCFD recommendations GHG emissions accounting in Envision will be reviewed based on their scope categorization.

Table 30: Credits that account for project's performance regarding scope 1, 2 and 3 emissions along the project life

GHG EMISSION SCOPE CATEGORY	LIFE CYCLE STAGES[387]				
	DESIGN & MATERIAL PRODUCTION	CONSTRUCTION	OPERATION	MAINTENANCE	END-OF-LIFE
Scope 1 emissions		RA2.2	CR1.2		
Scope 2 emissions		RA2.2	CR1.2		
Scope 3 emissions	CR1.1	CR1.1/RA2.2	CR1.1	CR1.1	

Credits that account for project's performance regarding scope 1, 2 emissions along construction, operation and maintenance

DURING OPERATION

CR1.2 Reduce Greenhouse Gas emissions

INTENT

Reduce greenhouse gas emissions during the operation of the project, reducing project contribution to climate change

METRIC

Percentage of reduction in operational greenhouse gas emissions

As noted in the table above scope 1 & 2 emissions are reported in credit **CR1.2 Reduce Greenhouse Gas emissions.** The intent of this credit is to "reduce greenhouse gas emissions during the operation of the project, reducing project contribution to climate change"; and the metric "percentage of reduction in operational greenhouse gas emissions." Therefore, the credit **assesses operational scope 1 and 2 GHG emissions** along the project's useful life. But what about the scope 1 and 2 emissions released during a project's construction and maintenance phase?

[387] The lifecycle stages are:

- Design & Material Production. In ISO- LCA methodology, the first stage of the product life cycle is 'Material Production.' Given that Envision is oriented to infrastructure projects, the stage is converted to 'Design & Material Production' to also account for all design-led strategies with impact on materials production, such as optimizing the use of materials through project sizing, material selection, etc.
- Construction
- Operation (including routine recurring maintenance, upkeeping)
- Maintenance (including minor and major rehabilitation). This stage does not include routine recurring maintenance, which is accounted for in Operation (O&M), but rather minor or major rehabilitation that involves significant construction works.
- End-of-life (replacement/decommissioning & deconstruction). Given that in many infrastructure projects (e.g. transportation projects) it is not common to decommission and deconstruct a project, end-of-life in some cases mainly refers to project replacement at the end of its useful life.

The type of evaluation criteria in the CR1.1 credit is **target**. The different levels of achievement are defined based on targets and points are assigned as follows:

Table 31: Credit CR1.1. Levels of achievement and corresponding score

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE	
points	% reduction	points	% reduction	points	% reduction	points	% reduction	points	% reduction
8	**At least 10%**	**13**	**At least 25%**	**18**	**At least 50%**	**22**	**100%**	**26**	**Carbon negative**

DURING CONSTRUCTION

According to the description of the credit within the Envision manual, "Emission of greenhouse gases during construction is addressed in credit **RA2.2 Reduce Construction Energy Consumption**. Therefore we will analyze RA2.2 in conjunction to credit CR1.2.

RA2.2 Reduce Construction Energy Consumption

INTENT

Conserve resources and reduce greenhouse emissions by reducing energy consumption during construction

METRIC

The number of strategies implemented on the project during construction that reduce consumption and emissions

Credit RA2.2 assesses the level of performance of a project based on the number of energy reduction strategies implemented during construction and presents a list of strategies that meet the credit requirements as follows:

Table 32: Credit RA2.2. Levels of achievement and corresponding score

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE
points	No. of Reduction strategies	points	No. of Reduction strategies	points	No. of Reduction strategies	points	No. of Reduction strategies	Not available
1	**Identify reduction opportunities**	**4**	**At least two reduction strategies**	**8**	**At least four reduction strategies**	**12**	**At least six reduction strategies**	

Table 33: Credit RA2.2. List of energy reduction strategies highlighting the related scope category of emissions

Strategy 1	*Tier IV construction equipment or Tier III with Best Available Technology (BAT)* ***for at least 75% of non-road equipment fleet greater than 50 horsepower;***	NOx and PMs emissions[388] (air pollutants)
Strategy 2	*Alternative fuels in heavy equipment such as biodiesel* ***for at least 5% of total fuel consumption***	Scope 1 emissions
Strategy 3	*Hybrid or fully electric project vehicles for* ***at least 50% of fleet***	Scope 1 &2 emissions
Strategy 4	*Electrified equipment for* ***at least 20% of equipment*** *(vs. gas or diesel*	Scope 1 emissions

388 Not part of Kyoto Protocol's GHG emissions definition.

	engines)	
Strategy 5	*Employee commuting programs with incentives (shuttles to transit, ride-share programs, biking facilities, etc.)*	Scope 3 emissions
Strategy 6	*Reduce purchased energy for workstations (construction trailer/office energy**) by 30%** for two of the following: (1) lighting; (2) HVAC; (3) plug loads;*	Scope 2 emissions
Strategy 7	*Purchase green power (RECs) for 30% of workstation energy consumption*	Scope 2 emissions
Strategy 8	*Offset electrical consumption **by generating 5% renewable energy on site** (e.g., solar panels on trailer complex, solar-powered temporary light plant, solar-powered cameras and variable message sign boards);*	Scope 2 emissions
Strategy 9	*Reduce overall fuel consumption **by 10%** through improved planning and logistics. Strategies may include the below listed:*	
9.1	*Reduce number of deliveries*	Scope 3 emissions
9.2	*Reduce idle times*	Scope 1 emissions
9.3	*On-site reuse of soils or other materials to decrease truck traffic to and from site (ties into Reduced Excavated Material taken off site)*	Scope 3 emissions
9.4	*Reduce on-site trucking – proper logistics planning such as staging material in close proximity to installation location*	Scope 3 emissions
9.5	*Schedule acceleration without additional resource consumption*	Scope 1 &2 emissions
9.6	*Waterborne/rail transportation of materials versus trucking (third-party distribution or logistics);*	Scope 3 emissions
9.7	*On-site plants (concrete plant/asphalt plant) in lieu of trucking material to the site*	Scope 3 emissions
9.8	*Prefabrication of design elements*	Scope 1 &2 emissions

As part of the credit's review the scope category of emissions for each strategy has been explored. As highlighted in the table above among the list of recommended strategies, Strategy 5 and various potential practices under Strategy 9 are related with reduction of scope 3 emissions that are accounted for in credit **CR1.1 Reduce Net Embodied Carbon**.

RA2.2 credit's description states: *"This credit addresses the important need to reduce construction energy consumption. As construction energy use is closely linked to emissions, many actions in this credit address energy efficiency, energy reduction, renewable energy use, and reduced emissions. Therefore, in addition to other Resource Allocation credits, RA2.2 Reduce Construction Energy Consumption is also connected to CR1.1 Reduce Net Embodied Carbon, and CR1.2 Reduce Greenhouse Gas Emissions."*

However CR1.2 credit's stated intent as described earlier is to: *"Reduce greenhouse gas emissions during the operation of the project, reducing project contribution to climate change"* and the associated metric is the *"Percentage of reduction in operational greenhouse gas emissions."*

Therefore the construction-related scope 1&2 emissions are not accounted for and reported as part of credit CR1.2.

GAP IDENTIFIED IN ENVISION: Where are construction-related scope 1 & 2 emissions reported?
Envision's credit RA2.2 Reduce Construction Energy Consumption assesses implementation of a range of energy management strategies that result in scope 1, 2 & 3 emissions, however does not request an overall reduction of scope 1&2 emissions as result of implemented strategies. Rather it refers to a connection with credit CR1.2 Reduce Greenhouse Gas Emissions, while CR1.2 is accounting for operational GHG scope 1& 2 emissions only.

DURING MAINTENANCE

Similarly the scope 1 and 2 emissions during the maintenance phase (minor or major rehabilitation) that involve significant construction works are not reported as part of the Envision assessment.

Considerations for sustainable performance in the maintenance stage are present in Envision, mainly as part of credits '**LD2.3 Plan for Long-term Monitoring and Maintenance' and 'CR2.5 Maximize Resilience'.**

Credit LD2.3 assesses if the project team has plans and processes in place to ensure long-term and reduced-impact maintenance. The improved level of performance requires 'reduced maintenance' through implementation of strategies such as better design and durable longer-lasting materials. Credit CR2.5 also assesses among other practices if the project is designed as durable and if it is well-constructed. However, the scope 1 and 2 emissions of avoided maintenance works are not accounted for.

GAP IDENTIFIED IN ENVISION: Where are maintenance-related scope 1 & 2 emissions reported?
The relevant to maintenance Envision credits 'LD2.3 Plan for Long-term Monitoring and Maintenance' and 'CR2.5 Maximize Resilience' do not request reporting estimates on scope 1, 2 emissions reductions through more efficient planning for reduced maintenance needs. (maintenance-related scope 3 emissions are reported as part of credit CR1.1)

Credits that account for project's performance regarding scope 3 emissions along all life cycle stages

Scope 3 emissions of materials are assessed in credit CR1.1 Reduce Embodied Carbon'.

CR1.1 Reduce embodied carbon

INTENT	METRIC
Reduce the impacts of material extraction, refinement/ manufacture, and transport over the project life	Percentage of reduction in net embodied carbon of materials

Envision in this credit requires reporting of reductions in the net embodied carbon of materials. More specifically, requires evidence that the project team makes an inventory of primary materials to be used over the life of the project including construction and operation, as well as replacement, repair, or refurbishment of materials over the life of the project. Requires the team to "determine which materials are the primary contributors to net embodied carbon (collectively >80%)"

According to the Envision manual "Embodied carbon is calculated, or acquired by a validated source, for the primary materials identified as primary contributors to net embodied carbon. Calculations include:

- Embodied carbon of production, including raw material extraction, refinement, and manufacture.
- Embodied carbon of transporting materials to the project site."

Moreover, provides **guidance on strategies** that reduce net embodied carbon: "These may include but are not limited to:

Table 34: Credit CR1.1. List of energy reduction strategies highlighting the LC stage each strategy corresponds to

		LC STAGE
Strategy a	*Sizing the project to require less material;*	Design & Material Production Construction Maintenance End-of-Life
Strategy b	*Designing the project to use less material;*	Design & Material Production Construction Maintenance End-of-Life
Strategy c	*Choosing materials that have lower embodied carbon;*	Design & Material Production
Strategy d	*Reducing material needed for repair and maintenance;*	Maintenance
Strategy e	*Reducing material waste during construction;*	Construction
Strategy f	*Reducing material waste during operation;*	Operation
Strategy g	*Sourcing local materials to reduce transportation emissions;*	Construction Operation Maintenance
Strategy h	*Utilizing lower-carbon transportation modes.*	Operation

The embodied carbon of materials is part of scope 3 emissions (upstream) 'from cradle-to-site' and (downstream) in the case of generated waste, 'from site-to-grave'.[389]

The CR1.1 credit accounts for the scope 3 emissions of the materials used in the project, including materials used in construction and operation, and highlighting that*: 'Note that operations materials may need to be multiplied by the frequency of use over the project life. Material estimates should include anticipated repairs/upkeep (e.g. road resurfacing).* Therefore CR1.1 accounts for maintenance-related carbon of materials.

The type of evaluation criteria in the CR1.1 credit is target. The different levels of achievement are defined based on targets and points are assigned as follows:

389 Based on the GHG Protocol there are 15 categories under the scope 3 category of emissions for which minimum boundaries are set. Not all are relevant to infrastructure. The 15 categories are presented in the Appendix. (source: Greenhouse Gas Protocol, Technical Guidance for Calculating Scope 3 Emissions)

Table 35: Credit CR1.1 Levels of achievement and corresponding scores

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE	
points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources
5	**At least 5%**	**10**	**At least 15%**	**15**	**At least 30%**	**20**	**At least 50%**	**24**	**Net positive**

It is worth highlighting that among the topics evaluated in credit 'RA1.1 Support Procurement Practices', for material and equipment sourcing, is reduced embodied carbon. For example, the Product-specific type III Environmental Product Declarations (EPDs) are related to the carbon footprint of products, and provide input to CR1.1.

2.1.2. Assessment of GHG emissions reduction strategies in Envision Credits

This review explores, on one hand, if Envision assesses project performance based on strategies that are common in various decarbonization pathways and transition scenarios[390]. The most current 'transition scenarios' describe pathways and emissions trajectories consistent with limiting the average global temperature increase to a range around 2°C, given the agreed international climate change commitment. [391]

As part of the literature review four strategies have been identified as key for achieving net zero projects:

- Energy efficiency
- Electricity decarbonization through the use of renewable energy sources
- Electrification (the process of replacing use of fossil fuels with electricity as a source of energy)
- Carbon capture and sequestration for the hard-to- electrify portions of systems

At the same time, each of these decarbonization strategies complements the others and efforts must be made in all four to efficiently reach a net-zero outcome.[392,393]

---

390 Emerging technologies, such as Solar Photovoltaic (PV) Deployment, Electric Vehicles (EV) Deployment, Carbon Capture Systems (CCS) Deployment and Bio-energy, as well as Energy mix, such as % Renewables and Nuclear are considered common parameters/key drivers for the analysis of various transition scenarios, 'Technical Supplement - The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities', TCFD 2017, p.22-23, https://www.tcfdhub.org/scenario-analysis/

391 'Organizations should include scenario analysis as part of their strategic planning and/or enterprise risk management processes by (i) identifying and defining a range of scenarios, including a 2°C scenario, that provide a reasonable diversity of potential future climate states; (ii) evaluating the potential resiliency of their strategic plans to the range of scenarios; and (iii) using this assessment, identify options for increasing the organization's strategic and business resiliency to plausible climate-related risks and opportunities through adjustments to strategic and financial plans', "Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017, p.3,4 https://www.tcfdhub.org/scenario-analysis/

392 For example, the DDPP/EER team research for the United States shows that the most cost-effective pathway to reach net-zero emissions by 2050 requires the United States to reduce electric power sector emissions per capita by 95 percent while reducing per-capita final energy demand by 40 percent through energy efficiency improvements. At the same time, electricity's share of final energy demand should increase from 20 percent to 60 percent of final energy demand and the country should be capturing 400 million tons of CO_2 per year by 2050. The basic idea is that

Energy efficiency is assessed through the credits 'RA2.1 Reduce Operational Energy Consumption' and 'RA2.2 Reduce Construction Energy Consumption', as well as in credit 'RA2.4 Commission & Monitor Energy Systems' given that commissioning of energy systems ensure proper implementation and optimized function of energy efficiency measures and integrated monitoring enables identification of efficiency loss and increases the likelihood that projects maintain high levels of energy efficiency throughout their useful life.

DURING OPERATION

RA2.1 Reduce Operational Energy Consumption

INTENT	METRIC
Conserve energy by reducing overall operational energy consumption throughout the project life	Percentage of operational energy reductions achieved.

Table 36: Credit RA2.1 Levels of achievement and corresponding scores

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE
points	% of Operational energy reduction	points	No. of Reduction strategies	points	No. of Reduction strategies	points	No. of Reduction strategies	Not available
6	**At least 10%**	**12**	**At least 30%**	**18**	**At least 50%**	**26**	**At least 70%**	

DURING CONSTRUCTION

RA2.2 Reduce Construction Energy Consumption

INTENT	METRIC
Conserve resources and reduce greenhouse emissions by reducing energy consumption during construction	The number of strategies implemented on the project during construction that reduce consumption and emissions

Credit RA2.2 assesses the level of performance of a project based on the number of energy reduction strategies implemented during construction and presents a list of strategies that meet the credit requirements as follows:

Table 37: Credit RA2.2 Levels of achievement and corresponding scores

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE
points	No. of Reduction	points	No. of Reduction	points	No. of Reduction	points	No. of Reduction	Not available

the electric power systems must decarbonize, energy production and consumption must become more efficient, the economy must more deeply electrify, and the CO_2 from the hard-to- electrify portions of the energy systems must be captured. (source: https://www.csis.org/analysis/climate-solutions-series-deep-decarbonization-pathways)

[393] https://www.csis.org/analysis/climate-solutions-series-deep-decarbonization-pathways

	strategies		strategies		strategies		strategies	
1	**Identify reduction opportunities**	**4**	**At least two reduction strategies**	**8**	**At least four reduction strategies**	**12**	**At least six reduction strategies**	

Table 38: Credit RA2.2. List of strategies (reviewed for energy efficiency)

Strategy 1	*Tier IV construction equipment or Tier III with Best Available Technology (BAT)* ***for at least 75% of non-road equipment fleet greater than 50 horsepower;***	
Strategy 2	*Alternative fuels in heavy equipment such as biodiesel* ***for at least 5% of total fuel consumption***	Decarbonization of fuel
Strategy 3	*Hybrid or fully electric project vehicles for* ***at least 50% of fleet***	Decarbonization of fleet Electrification of fleet
Strategy 4	*Electrified equipment for* ***at least 20% of equipment*** *(vs. gas or diesel engines)*	Electrification of equipment
Strategy 5	*Employee commuting programs with incentives (shuttles to transit, ride-share programs, biking facilities, etc.)*	Fuel efficiency
Strategy 6	*Reduce purchased energy for workstations (construction trailer/office energy)* ***by 30%*** *for two of the following: (1) lighting; (2) HVAC; (3) plug loads;*	Electricity efficiency
Strategy 7	*Purchase green power (RECs) for 30% of workstation energy consumption*	Decarbonization of electricity through Renewable energy sources
Strategy 8	*Offset electrical consumption* ***by generating 5% renewable energy on site*** *(e.g., solar panels on trailer complex, solar-powered temporary light plant, solar-powered cameras and variable message sign boards);*	Decarbonization of electricity through Renewable energy sources
Strategy 9	*Reduce overall fuel consumption* ***by 10%*** *through improved planning and logistics. Strategies may include the below listed:*	
9.1	*Reduce number of deliveries*	Fuel efficiency
9.2	*Reduce idle times;*	Fuel efficiency
9.3	*On-site reuse of soils or other materials to decrease truck traffic to and from site (ties into Reduced Excavated Material taken off site)*	Fuel efficiency
9.4	*Reduce on-site trucking – proper logistics planning such as staging material in close proximity to installation location*	Fuel efficiency
9.5	*Schedule acceleration without additional resource consumption*	Electricity & fuel efficiency
9.6	*Waterborne/rail transportation of materials versus trucking (third-party distribution or logistics);*	Fuel efficiency
9.7	*On-site plants (concrete plant/asphalt plant) in lieu of trucking material to the site*	Fuel efficiency

9.8	*Prefabrication of design elements*	Electricity & fuel efficiency

DURING OPERATION

RA2.4 Commission and Monitor Energy Systems

INTENT

Ensure efficient functioning and extend useful life by specifying commissioning and monitoring of energy systems.

METRIC

The inclusion of monitoring equipment and software, the extent of commissioning, and the commissioning agent's independence from the project.

Table 39: Credit RA2.4 Levels of achievement and corresponding scores

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE
points	% of energy use/ consumption commissioned & monitored	points	% of energy use/ consumption commissioned & monitored	points	% of energy use/ consumption commissioned & monitored	points	% of energy use/ consumption commissioned & monitored	Not available
3	**At least 50%**	**6**	**At least 75%**	**12**	**At least 90%**	**14**	**At least 90%**	

DURING OPERATION

Use of renewable energy sources for electricity decarbonization is assessed in the credit 'RA2.3 Use Renewable energy'.

RA2.3 Use Renewable Energy

INTENT

Meet operational energy needs through renewable energy sources.

METRIC

Extent to which renewable energy sources are incorporated.

The credit assesses the extent to which renewable sources are incorporated in project and the percentage of energy needs (electricity and fuel) met by these sources, the share of renewables. Envision assesses project performance in terms of:

- On-site Renewable Energy generation
- Purchase of renewable fuels
- Purchase of RECs

The type of evaluation criteria in the RA2.3 credit is target. The different levels of achievement are defined based on targets and points are assigned as follows:

Table 40: Credit RA2.3 Levels of achievement and corresponding scores

IMPROVED		ENHANCED		SUPERIOR		CONSERVING		RESTORATIVE	
points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources	points	% of energy needs from renewable sources
5	**At least 5%**	**10**	**At least 15%**	**15**	**At least 30%**	**20**	**At least 50%**	**24**	**Net positive**

DURING CONSTRUCTION

Also, offset of energy needs by renewable, on-site generation or purchase of RECs is part of the strategies that assess performance in credit RA2.2 Reduce construction energy consumption:

- Strategy 7: *Purchase green power (RECs) for 30% of workstation energy consumption;*
- Strategy 8: *Offset electrical consumption by generating 5% renewable energy on site (e.g., solar panels on trailer complex, solar-powered temporary light plant, solar-powered cameras and variable message sign boards)*

The use of renewable energy generation sources has additional impacts and risks that are sector-specific and/or technology specific. A common, however, observation for renewable technologies such as wind, or solar power, is the inherent production capacity risk, as the volume of electricity produced is weather-related, resulting in reliability issues. Envision doesnot request any documentation or evidence of how production capacity risk is mitigated and if energy storage solutions are in place.

GAP IDENTIFIED: The management of renewable energy regeneration's production capacity risk.
The use of renewable energy generation sources has additional impacts and risks that are sector-specific and/or technology specific. A common, however, observation for renewable technologies such as wind, or solar power, is the inherent production capacity risk, as the volume of electricity produced is weather-related, resulting in reliability issues. Envision doesnot request any documentation or evidence of how production capacity risk is mitigated and if energy storage solutions are in place.

Electrification is not directly assessed within the Envision process, but as part of the 'RA2.3 Use Renewable energy' credit and the 'RA2.2 Reduce construction energy consumption' credit.

DURING OPERATION

In the case of the RA2.3 credit, electrification of fleet used for operation is among the requested breakdown by type of renewable energy sources electric vehicle use is included:

'Breakdown of renewable energy sources by type. Renewable energy may include:

- *solar energy (thermal heating, both active and passive, and photovoltaic);*
- *wind (electricity generation);*
- *water (hydro or tidal for electricity generation);*
- *biomass (electricity generation or as fuels);*
- *geothermal (electricity generation or heating and cooling); and*
- *hydrogen/fuel cells (used as a fuel).*

- *renewable transportation fuel or **electric vehicle use.***

DURING CONSTRUCTION

In the case of the RA2.2 credit, electrification of fleet and equipment during construction is between the strategies:
Strategy 3: Hybrid or fully electric project vehicles for at least 50% of fleet;
Strategy 4: Electrified equipment for at least 20% of equipment (vs. gas or diesel engines);

Finally, **carbon capture and sequestration** is accounted for in the credit CR1.2. More specifically, Envision indicates that the calculation on GHG emissions reduction "*should include any natural or mechanical methods of carbon sequestration", as well as "purchased carbon offsets".* Moreover, the higher level of achievement for the credit refers to '**carbon negative'** projects, performance that is achieved through removal of GHG emissions from the atmosphere. Also, as part of 'CR0.0 Innovate or Exceed Credit Requirements' credit, Envision rewards with bonus points "
Projects that go beyond carbon negative to become large-scale carbon sinks for greenhouse gas emissions".

GAP IDENTIFIED: Carbon capture & storage
Given that all 1.5°C emissions pathways rely upon carbon removal to some extent and **c**arbon removal is necessary for both moving to net-zero emissions and for producing net-negative emissions to compensate for any overshoot of 1.5°C, Envision could refer more on carbon removal and request more information on the adopted carbon-removal approaches.
Moreover, Envision refers to carbon capture and storage during operations, however it is emerging as an approach during construction as well (net zero-carbon construction sites).

GAP IDENTIFIED: The combined outcome of GHG reduction strategies
The decarbonization strategies are assessed by the Envision process in separate relevant credits. Envision includes performance targets for energy consumed, share of renewable energy sources.
However, the supplementary role of GHG emission reduction strategies in transition scenarios that through their combination enable reaching an overall emission reduction target towards a projected temperature limit, raises the question how Envision, apart from the separate assessment of incorporation of these strategies, could assess them regarding the overall outcome? Additionally, should Envision request commitment to GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C and pursue efforts to limit warming to 1.5°C – and to achieve net-zero emissions before 2050?

2.1.3. GHG emissions out of Envision's boundary of assessment

The LC Sustainability tool is used to identify GHG emissions that are not being accounted as part of the Envision process. The additional capacity as compared to the review of the Envision manual is that the tool enables mapping all credits that contribute to scope 1, 2 and 3 emissions based on the strategies they include. This part of the review focuses on those credits where GHG emissions are not subject of the Envision assessment process (credits reviewed in section 2.1.1 of the Review). Rather it focuses on credits with indirect emissions; credits that either generate emissions as unintended impacts (trade-offs) or contribute to emissions reductions as indirect benefit.

Table 41: Credits that contribute positively or negatively to scope 1 &2 emissions

SCOPE 1 & 2 EMISSIONS

ENVISION CREDITS	INITIAL SHORT-TERM (CONSTRUCTION)		FUTURE SHORTTERM RECURRENT (MAINTENANCE)		FUTURE LONGTERM (OPERATION)	
	scope		scope		scope	
	1	2	1	2	1	2
QL1.3 Improve Construction Safety	(+-)	(+-)				
QL1.4 Minimize Noise and Vibration			(-)	(-)		
QL1.6 Minimize Construction Impacts	(+-)	(+-)				
QL2.1 Improve Community Mobility & Access	(-)	(-)	(+-)	(+-)	(+-)	(+-)
QL2.2. Encourage Sustainable Transportation	(-)	(-)	(+-)	(+-)	(+)	(-)
QL2.3. Improve Access & Wayfinding	(-)	(-)	(+-)	(+-)		
QL3.4 Enhance Public Space and Amenities	(-)	(-)				(-)
LD2.3 Plan for Long-Term Monitoring and Maintenance	(-)	(-)	(+-)	(+-)		
LD2.4 Plan for end-of-life			(+)	(+)		
RA1.2 Use Recycled Materials			(-)	(-)		
NW2.2 Manage Stormwater	(+)	(+)	(+)	(+)		
NW2.4 Protect Surface and Groundwater Quality	(-)	(-)	(-)	(-)		
NW3.3 Maintain Floodplain Functions			(+)	(+)		
CR2.5 Maximize Resilience			(+)	(+)		
CR2.6 Improve Infrastructure Integration	(+)	(+)	(+)	(+)		

Table 42: Credits that contribute positively or negatively to scope 3 emissions

SCOPE 3 EMISSIONS

ENVISION CREDITS	INITIAL SHORT-TERM (CONSTRUCTION)		FUTURE SHORTTERM RECURRENT (MAINTENANCE)		FUTURE LONGTERM (OPERATION)	
	3 up	3 down	3 up	3 down	3 up	3 down
QL1.3 Improve Construction Safety	(-)	(-)	(+)	(+)		(+)
QL1.4 Minimize Noise and Vibration	(-)		(-)			
QL1.6 Minimize Construction Impacts	(+-)	(+-)				
QL2.1 Improve Community Mobility & Access	(-)	(-)	(+-)	(+-)		(+-)
QL2.2. Encourage Sustainable Transportation	(-)	(+)	(+-)	(+-)		(+-)
QL2.3. Improve Access & Wayfinding	(+-)		(+-)			(+)
QL3.4 Enhance Public Space and Amenities	(-)		(-)	(+)		
LD1.4 Pursue Byproduct Synergies			(+)	(+)	(+)	(+)
LD2.3 Plan for Long-Term Monitoring and Maintenance	(-)		(+-)			(+)

LD2.4 Plan for end-of-life			(+)	(+)		
RA1.1 Support Sustainable Procurement Practices	(+)					
RA1.2 Use Recycled Materials	(+)	(+)	(-)	(-)		
RA1.3 Reduce Operational Waste						(+)
RA1.4 Reduce Construction Waste		(+)				
RA1.5 Balance Earthwork On Site	(+)	(+)				
NW1.4 Preserve Undeveloped Land	(+)	(+)				
NW2.1 Reclaim Brownfields	(+)	(+)				
NW2.3 Reduce Pesticide & Fertilizer Impacts	(+)		(+)		(+)	
NW2.4 Protect Surface and Groundwater Quality						(-)
NW3.3 Maintain Floodplain Functions			(+)	(+)		(+)
NW3.4 Control Invasive Species					(+)	
NW3.5 Protect Soil Health	(+)	(+)	(+)	(+)		
CR2.5 Maximize Resilience			(+)	(+)		(+)
CR2.6 Improve Infrastructure Integration	(+)	(+)	(+)	(+)		

The above tables introduce the duration and the life cycle stage the GHG emissions occur:

- Initial short-term emissions are the GHG emissions during the initial project **construction works.**
- Future short-term, recurrent emissions are those during planned **maintenance works,** such as minor or major rehabilitations necessary to keep the project in a state of good repair; and
- Future long-term emissions are those during the **operation** of the project covering its planned useful life.

In terms of scope category, scope 3 emissions are broken down into those related to the materials used in the project (upstream emissions) and those related to the waste generated by the project -during construction works or operation (downstream emissions).

The tables 41 and 42 summarize the positive or negative impact on GHG emissions of various strategies that are referred to as examples per each Envision credit. Not all credits have equal significance in GHG emissions, but rather may contain at least one strategy that has negative or positive impacts on emissions[394]. (The full tables are presented as part of the Appendix K). Envision presents in each credit examples of a range of strategies that address the topic of the credit, however a project team will eventually have to implement a selection of those strategies, therefore **the net effect on GHG emissions** per credit is result of the final selection or combination of strategies.

394 For example, in the case of 'QL1.4 Minimize Noise and Vibration' the negative impact on scope 1, 2 & 3 emissions is in the case that the project does not avoid through siting noise disturbance on community and implements use of noise barriers or use of quiet pavements. In the case of the quiet pavements, the noise abatement capability of the pavements typically reduces earlier than a conventional pavement replacement cycle thus requiring earlier replacement works.

The tables aim to indicate cases of credits that though they aim to address an impact have parallel trade-offs on GHG emissions. According to the US Federal Highway Administration (FHWA) an agency with extensive research on highway and bridge projects: "*almost all GHG mitigation strategies produce some emissions as a side effect, in addition to reducing emissions as intended.* ***These net effects must be analyzed to know the true measure of a strategy's effectiveness in mitigating emissions***."[395] Moreover, Envision should indicate those cases of strategies with trade-offs and potentially guide on bundles of strategies that can counterbalance negative impacts.

Overall, negative future short-term recurrent scope 1, 2 and 3 emissions, indicate additional maintenance works related to a credit. These scope 1 and 2 emissions are out of the boundary of Envision's assessment, however are result of various credit strategies, as seen in the table above.

GAP IDENTIFIED: This analysis reaffirms and visualizes the gap identified as part of the assessment in section 2.1.1 that maintenance works related scope 1 & 2 emissions are not accounted as part of the Envision assessment.

<u>User-related scope 3 emissions</u>

Scope 3 emissions are presented separately from scope 1 & 2, given that according to TCFD, the disclosure of scope 3 is provisional and "should be accounted if they are significant compared to scope 1 and scope 2 emissions". Envision has already a clear approach towards the reporting of material-related scope 3 emissions, but a question that is raised is if Envision should assess user-related emissions. This is a valid question especially in the case of transportation projects, such as highways or bridges, where scope 1 and 2 emissions of the project per se are insignificant as compared to the emissions of the private vehicles that are going to use the road.

QL2.1 and QL2.2 Envision credits are representative examples of the above issue. In these credits Envision assesses the ability of a transportation project to improve mobility and access and encourage sustainable transportation, respectively, that both have a positive end effect on user generated emissions. However, Envision does not request disclosure of the estimated amount of avoided emissions through the implemented strategies.

Moreover, some of the strategies under the two credits produce unintended emissions e.g. due to capacity expansion that requires additional initial construction and future maintenance works. Additionally, they don't account for the risk of these strategies potentially inducing demand. Envision when providing examples of strategies should underline these potential risks and provide additional guidance for compatible strategies that don't counteract each other or suggest bundles of strategies that reduce the risk for induced demand.[396]

---

[395] US Department of Transportation Federal Highway Administration (US DOT FHWA), Reference Sourcebook for reducing greenhouse gas emissions from transportation sources, February 2012

[396] US Department of Transportation Federal Highway Administration (US DOT FHWA), Reference Sourcebook for reducing greenhouse gas emissions from transportation sources, February 2012

One of the add-ons of the LC Tool, is that it captures user-related emissions. These emissions represent avoided emissions from less private vehicle trips and/ or less vehicle miles driven through strategies that introduce active transportation modes; that reduce disruption of access due to construction works or maintenance works; that reduce congestion; or relate to proper road surface conditions etc.

Table 43: Credits related to user-related scope 3 emissions

ENVISION CREDITS	USER-RELATED SCOPE 3 EMISSIONS		
	INITIAL SHORTTERM	FUTURE SHORTTERM RECURRENT	FUTURE LONGTERM
	3 down	3 down	3 down
QL1.3 Improve Construction Safety	(-)	(+)	(+)
QL2.1 Improve Community Mobility & Access	(-)	(+-)	(+-)
QL2.2. Encourage Sustainable Transportation	(+)	(+-)	(+-)
QL2.3. Improve Access & Wayfinding			(+)
QL3.4 Enhance Public Space and Amenities	(-)	(-)	
LD2.3 Plan for Long-Term Monitoring and Maintenance			(+)
LD2.4 Plan for end-of-life		(+)	
RA1.2 Use Recycled Materials	(+)	(+-)	
RA1.3 Reduce Operational Waste			(+)
RA1.4 Reduce Construction Waste	(+)	(+)	
RA1.5 Balance Earthwork On Site	(+)	(+)	
NW2.2 Manage Stormwater		(+)	(+)
NW2.4 Protect Surface and Groundwater Quality	(-)	(-)	
NW3.3 Maintain Floodplain Functions		(+)	(+)
CR1.1 Reduce Net Embodied Carbon	(+)	(+)	(+)
CR2.5 Maximize Resilience		(+)	(+)
CR2.6 Improve Infrastructure Integration	(+)	(+)	

GAP INDENTIFIED: User-related scope 3 emissions are not accounted as part of the Envision assessment. These emissions are particularly significant- as compared to operational scope 1 & 2 emissions- especially in the case of transportation projects.

Moreover, User-related scope 3 emissions are also produced during construction & maintenance stages and not accounted within relevant Envision credits, such as QL1.6 Minimize Construction Impacts and LD2.3 Plan for Long-term Monitoring and Maintenance.

2.2. Assessment of performance in climate change adaptation

The review of Envision in terms of assessment of physical risks is based on the following identified key criteria for projects:

- Alignment with TCFD recommended disclosures for climate-related strategy and risk management, that report risk evaluation and risk management process
- Inclusion of disclosures/ metrics that refer on climate-related risk types (identified through the literature review and the analysis of TCFD and selected ESG systems) and consist of:

- physical asset risk
- service continuity risk
- resource availability risk (water, materials, land, workforce)
- supply chain continuity risk

● Consideration of physical climate scenarios (or physical risks scenarios) analysis.

Climate change adaptation is assessed by Envision as part of the 'Resilience' subcategory of the Climate and Resilience category, though the category includes a broader range of hazards (e.g. geophysical events like earthquakes). Given that climate change adaptation is context- and location-specific the Envision assessment of adaptation focuses on risk evaluation and risk management.

As stated in the Envision Manual, the majority of the credits of this subcategory have a strong correlation that is worth highlighting.

Resilience	**CR2.1 Avoid Unsuitable Development** **CR2.2 Assess Climate Change Vulnerability;** [397] **CR2.3 Evaluate Risk and Resilience;**	Risk Evaluation process
	CR2.4 Establish Resilience Goals and Strategies; **CR2.5 Maximize Resilience; and** **CR2.6 Improve Infrastructure Integration**	Risk management process

Climate change threats and hazards are specifically part of credit CR2.2 Assess Climate Change Vulnerability, however given that climate change is an overarching threat to projects, CR2.2 can be considered subcomponent of the broader credit CR2.3, just as credit CR2.1. Furthermore, credit CR2.3 forms the foundation (and a requisite) for credits CR2.4 and CR2.5. Therefore, credits CR2.2-CR2.4 establish consecutive steps of risk evaluation towards maximized resilience against climate change threats/hazards among other hazards.

Given that the above credits are not standalone credits, but part of Envision's assessment of a risk evaluation and management process, credits CR2.1-CR2.5 will be all reviewed against the TCFD recommended relevant recommendations categorized as 'Risk Management' and 'Strategy'. Moreover, given that TCFD addresses apart from physical risks, also transition risks (related to mitigation) the review <u>will focus on physical risk management</u>.

Table 44: Selection of TCFD Recommended Disclosures that relate to climate risk evaluation and management.

[397] Hazards/threats are events that have the potential to cause damage or harm, whether naturally occurring (hazards) or human-induced (threats). Vulnerability is a condition whereby a threat has the potential to disrupt or damage a project or system. Risk is the probability of a threat exploiting a vulnerability and the associated impacts and consequences. For example, flooding might be a threat to a project, critical systems located below flood levels would be vulnerable to that threat, and risk would be an evaluation of the probability and severity of a flood event as a factor of the associated losses if the critical systems were flooded. (source: Envision Manual)

TCFD Recommendations and Supporting Recommended Disclosures			
STRATEGY	Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	Risk Evaluation
		b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	Risk Evaluation
		c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	Risk Management
RISK MANAGEMENT	Disclose how the organization identifies, assesses, and manages climate-related risks	a) Describe the organization's processes for identifying and assessing climate-related risks.	Risk Evaluation
		b) Describe the organization's processes for managing climate-related risks.	Risk Management
		c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	Risk Evaluation/ Risk Management

Finally, it is worth mentioning that TCFD apart from climate-related risks refers to climate-related opportunities. The review will explore the evaluation of such opportunities within the Envision process.

2.2.1. Assessment of climate physical risk evaluation in Envision credits

Envision credits CR2.2 and CR2.3 suggest a standard methodology for risk evaluation to be used:

- Establish the boundary and scope of the assessment
- Understanding of objectives and performance goals of the project and related systems.
- Identification of natural hazards and human-induced threats (acute shocks and chronic stressors) that have the potential to
- Vulnerability assessment: Identification of vulnerabilities of the critical functions and dependencies of the asset and its primary components that are essential for meeting objectives and performance goals
- Evaluation of risk by determining the likelihood/probability of a threat/hazard occurring and determining associated consequences/impact in each category of social, environmental and economic.

In addition to rewarding the development or not of a comprehensive risk evaluation, Envision rewards the extent of the scope and the comprehensiveness of the assessment:

- only project and site assessment
- expansion to system assessment: interdependencies of the project and its associated/connected infrastructure system/network
- expansion to community risk assessment: interdependencies of the project, its associated/ connected infrastructure system/network, and broader community.

Table 45: Risk Evaluation in TCFD Recommendations

	Recommended Disclosures	Guidance on Disclosures

STRATEGY	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	Organizations should provide the following information: – a description of what they consider to be the relevant short-, medium-, and long-term time horizons, taking into consideration the useful life of the organization's assets or infrastructure and the fact that climate-related issues often manifest themselves over the medium and longer terms, – a description of the specific climate-related issues for each time horizon (short, medium, and long term) that could have a material financial impact on the organization, and – a description of the process(es) used to determine which risks and opportunities could have a material financial impact on the organization. Organizations should consider providing a description of their risks and opportunities by sector and/or geography, as appropriate.
	b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	Organizations should discuss how identified climate-related issues have affected their businesses, strategy, and financial planning in the following areas: – Products and services – Supply chain and/or value chain – Adaptation activities – Investment in research and development – Operations (types of operations and location of facilities) Organizations should describe how climate-related issues serve as an input to their financial planning process, the time period(s) used, and how these risks and opportunities are prioritized. Organizations' disclosures should reflect a holistic picture of the interdependencies among the factors that affect their ability to create value over time. If climate-related scenarios were used to inform the organization's strategy and financial planning, such scenarios should be described.
RISK MANAGEMENT	a) Describe the organization's processes for identifying and assessing climate-related risks.	Organizations should describe their risk management processes for identifying and assessing climate-related risks and how they determine the relative significance of climate-related risks in relation to other risks. Organizations should also consider disclosing the following: – processes for assessing the potential size and scope of identified climate-related risks and – definitions of risk terminology used or references to existing risk classification frameworks used.
	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	Organizations should describe how their processes for identifying, assessing, and managing climate-related risks are integrated into their overall risk management.

The above review indicates that Envision through the risk evaluation process that crosscuts the CR2.1-CR2.3 credits aligns with TCFD Recommendations for climate-related physical risk evaluation.

GAP IDENTIFIED: Reference to physical risk scenarios[398] and associated time horizon(s) considered

[398] Physical risk scenarios generally identify extreme weather threats of moderate or higher risk before 2030 and a larger number and range of physical threats between 2030 and 2050. Although most climate models deliver scenario results for physical impacts beyond 2050, organizations typically focus on the consequences of physical risk scenarios over

The Envision does not request as part of climate-related risk evaluation any reference to physical risk scenarios. The physical scenarios also take into consideration the anticipated physical impacts and the specific localities.[399] Additionally, reference to a physical scenario in line with the Paris Agreement 2^{o}C limit/1.5^{o}C aim, which suggests ambitious reductions of GHGs emissions and GHGs peak at around 2020 and net-negative emissions before 2100, implies less physical impacts and risks in the long-term. Contrariwise higher temperature limits are expected to result in an increase of acute climate impacts and highly uncertain risks.

and

GAP IDENTIFIED: Assessment of how companies' processes for identifying, assessing, and managing climate-related risks are integrated into their overall risk management.
Envision should guide projects teams to integrate climate change risk into their risk management plans, such as Safety and Security management plans or Health and Safety Plans, Risk assessments.
For example, in the case of CA High Speed rail, climate change risk was integrated in Safety and Security Management Plan.

2.2.2. Assessment of climate physical risk management in Envision credits

Credit CR2.4 assesses the development of risk management strategies (based on results of a risk evaluation in CR2.3) that meet project performance goals and the prioritization of strategies according to their risk reduction potential and any extenuating factors (cost, availability, reliability, effectiveness, etc.).

Resilience strategies prioritization:

- **Vulnerability Reduction**
  - **Eliminate/Avoid:** The project eliminates or avoids the potential threat.
  - **Accommodate**: The project is designed to overcome the threat.
    - Durability/Robustness
    - Adaptability/Flexibility
- **Impact/Consequence Reduction**
  - **Minimize**: The project is designed to minimize the impact of a failure.
    - Redundancy/Diversity
    - Preparedness
  - **Restore**: The project is designed to quickly or more easily recover from losses.
    - Recovery/Response
- **No Action**
  - **Accept**: The likelihood and impacts are deemed an acceptable risk.

---

shorter time frames that reflect the lifetimes of their respective assets or liabilities, which vary across sectors and organizations. (Source: TCFD)

399 The steps of such analysis start with the identification of the atmospheric GHG concentration range (high, intermediate or low emissions), then estimate the likely resulting temperature ranges at various future time frames and points (peaks), additionally attempt to downscale the data from global climate models to local levels and finally assess the projects' exposure to risks, resilience and overall performance in relation to the anticipated physical impacts and the given localities."Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017, https://www.tcfdhub.org/scenario-analysis/

It is worth highlighting that avoidance (e.g. through the initial project siting) is first in Envision's hierarchy of strategies and crosscuts many credits.

Finally, credit 'CR2.6 Improve Infrastructure Integration' completes the overall risk reduction of the Resilience subcategory credits by assessing how 'Integration strategies' increase resilience and reduce the risk of systemic or cascading failures.

Table 46: Risk Management in TCFD Recommendations

STRATEGY	c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios.	Organizations should describe how resilient their strategies are to climate-related risks and opportunities, taking into consideration **scenarios consistent with increased physical climate-related risks.** Organizations should consider discussing: – where they believe their strategies may be affected by climate-related risks and opportunities; – how their strategies might change to address such potential risks and opportunities; and – the climate-related scenarios and associated time horizon(s) considered.
RISK MANAGEMENT	b) Describe the organization's processes for managing climate-related risks.	Organizations should describe their processes for managing climate-related risks, including how they make decisions to mitigate, transfer, accept, or control those risks. In addition, organizations should describe their processes for prioritizing climate-related risks, including how materiality determinations are made within their organizations.
	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	Organizations should describe how their processes for identifying, assessing, and managing climate-related risks are integrated into their overall risk management.

2.2.3. Envision credits contributing to climate change adaptation

As already mentioned, the climate change adaptation capacity of a project is defined as less exposure to:

- physical asset risk
- service continuity risk
- **resource availability risk** (water, materials, land, workforce)
- supply chain continuity risk

The following table connects credits with contribution to climate change adaptation by reducing exposure to the above risks. However, the below listed credits are not assessed by the Envision process for their performance in terms of climate change adaptation capacity. Rather indicate credits with indirect contribution to adaptation related risks.

Table 47: Credits related to physical risk

ENVISION CREDITS	SERVICE CONTINUITY RISK	PHYSICAL ASSET RISK	RESOURCE AVAILABILITY RISK (reduction in quantity or deterioration of quality)	SUPPLY CHAIN CONTINUITY

			water	materials	land	workforce	RISK
QL1.3 Improve Construction Safety							
QL1.4 Minimize Noise & Vibration							
QL 1.5 Minimize Light Poluution							
QL 1.6 Minimize Construction Impacts							
QL2.1 Improve Community Mobility & Access							
QL2.2. Encourage Sustainable Transportation							
QL2.3. Improve Access & Wayfinding							
LD1.1 Provide Effective Leadership & Commitment	ENABLING ADAPTATION						
LD1.2 Foster Collaboration & Teamwork	ENABLING ADAPTATION						
LD1.4 Pursue Byproduct Synergies							
LD2.1 Establish a Sustainability Management Plan	ENABLING ADAPTATION						
LD2.2 Plan for Sustainable Communities	ENABLING ADAPTATION						
LD2.3 Plan for Long-Term Monitoring & Maintenance							
LD2.4 Plan for end-of-life							
LD3.1 Stimulate Economic Prosperity & Development							
LD3.2 Develop Local Skills & Capabilities							
RA1.1 Support Sustainable Procurement Practices							
RA1.2 Use Recycled Materials							
RA1.3 Reduce Operational Waste							
RA1.4 Reduce Construction Waste							
RA1.5 Balance Earthwork On Site							
RA2.1 Reduce Operational Energy Consumption							
RA2.3 Use Renewable Energy							
RA2.4 Commission & Monitor Energy Systems							
RA3.1 Preserve Water Resources							
RA3.2 Reduce Operational Water Consumption							
RA3.3 Reduce Construction Water Consumption							
RA3.4 Monitor Water Systems							
NW1.1 Preserve Sites of High Ecological Value							
NW1.2 Provide Wetland & Surface Water Buffers							
NW1.3 Preserve Prime Farmland							
NW1.4 Preserve Undeveloped Land							
NW2.1 Reclaim Brownfields							
NW2.2 Manage Stormwater							
NW2.3 Reduce Pesticide & Fertilizer Impacts							
NW2.4 Protect Surface and Groundwater Quality							
NW3.1 Enhance Functional Habitats							
NW3.2 Enhance Wetland & Surface Water							

Functions							
NW3.3 Maintain Floodplain Functions							
NW3.4 Control Invasive Species							
NW3.5 Protect Soil Health							
CR1.1 Reduce Net Embodied Carbon							

It is worth highlighting freshwater withdrawal, one of the example metrics TCFD provided as part of its supplemental guidance, and one of other ESG systems indicators (see Part 2. Section 3.2.4. Other ESG systems approach to climate change mitigation and adaptation). TCFD suggests the use of the metric '*Percent water withdrawn in regions with high or extremely high baseline water stress*' against the risk of limited water availability.

Envision through its RA subcategory 'Water' addresses sustainable use of water as a resource during operation and construction (credits RA3.2, RA3.3), and assesses impact on freshwater availability, quantity and quality at a watershed scale to ensure regional scale water resources (credit RA 3.1).

2.3. Scoring of climate change mitigation and adaptation in Envision

The weighting methodology used in Envision assessment process offers insights on an intended prioritization of credits in terms of significance. Envision credits have been sorted based on maximum and minimum points achieved per credits.

Table 48: Envision Credits sorted by score (from higher to lower value)

ENVISION CREDITS	SCORE PER LEVEL OF ACHIEVEMENT				
	Improved	Enhanced	Superior	Conserving	Restorative
CR2.3 Evaluate Risk and Resilience	**11**	**18**	**24**	**26**	
CR2.5 Maximize Resilience	**11**	**15**	**20**	**26**	
CR1.2 Reduce Greenhouse Gas Emissions	**8**	**13**	**18**	**22**	**26**
RA2.1 Reduce Operational Energy Consumption	**6**	**12**	**18**	**26**	
QL1.1 Improve Community Quality of Life	2	5	10	20	**26**
RA2.3 Use Renewable Energy	5	10	15	20	**24**
NW2.2 Manage Stormwater	2	4	9	17	**24**
NW2.1 Reclaim Brownfields	**11**	**13**	**16**	**19**	**22**
RA3.2 Reduce Operational Water Consumption	4	9	13	17	**22**
NW1.1 Preserve Sites of High Ecological Value	2	6	12	16	**22**
CR2.2 Assess Climate Change Vulnerability	8	14	18	20	
CR1.1 Reduce Net Embodied Carbon	5	10	15	20	
CR2.4 Establish Resilience Goals and Strategies		8	14	20	
QL1.2 Enhance Public Health & Safety	2	7	12	16	20
NW1.4 Preserve Undeveloped Land	3	8	12	18	20
NW3.2 Enhance Wetland & Surface Water Functions	3	7	12	18	20
LD3.1 Stimulate Economic Prosperity & Development	3	6	12	20	

NW1.2 Provide Wetland & Surface Water Buffers	2	5	10	16	20
NW2.4 Protect Surface and Groundwater Quality	2	5	9	14	20
LD2.1 Establish a Sustainability Management Plan	4	7	12	18	
LD1.4 Pursue Byproduct Synergies	3	6	12	14	18
QL3.1 Advance Equity and Social Justice	3	6	10	14	18
LD1.3 Provide for Stakeholder Involvement	3	6	9	14	18
LD1.1 Provide Effective Leadership & Commitment	2	5	12	18	
LD1.2 Foster Collaboration & Teamwork	2	5	12	18	
NW3.1 Enhance Functional Habitats	2	5	9	15	18
CR1.3 Reduce Air Pollutant Emissions	2	4	9	14	18
CR2.6 Improve Infrastructure Integration	2	5	9	13	18
QL3.2 Preserve Historic and Cultural Resources		2	7	12	18
RA1.4 Reduce Construction Waste	4	7	10	16	
LD2.2 Plan for Sustainable Communities	4	6	9	12	16
RA1.2 Use Recycled Materials	4	6	9	16	
CR2.1 Avoid Unsuitable Development	3	6	8	12	16
QL2.2. Encourage Sustainable Transportation		5	8	12	16
LD3.2 Develop Local Skills & Capabilities	2	4	8	12	16
NW1.3 Preserve Prime Farmland		2	8	12	16
LD3.3 Conduct a Life-Cycle Economic Evaluation	5	7	10	12	14
RA1.3 Reduce Operational Waste	4	7	10	14	
RA2.4 Commission & Monitor Energy Systems	3	6	12	14	
QL1.3 Improve Construction Safety	2	5	10	14	
LD2.4 Plan for end-of-life	2	5	8	14	
QL2.3. Improve Access & Wayfinding	1	5	9	14	
NW3.3 Maintain Floodplain Functions	1	3	7	11	14
QL2.1 Improve Community Mobility & Access	1	3	7	11	14
QL3.3 Enhance Views & Local Character	1	3	7	11	14
QL3.4 Enhance Public Space and Amenities	1	3	7	11	14
RA1.1 Support Sustainable Procurement Practices	3	6	9	12	
RA3.1 Preserve Water Resources	3	5	7	9	12
LD2.3 Plan for Long-Term Monitoring and Maintenance	2	5	8	12	
QL1.4 Minimize Noise and Vibration	1	3	6	10	12
QL1.5 Minimize Light Pollution	1	3	6	10	12
NW2.3 Reduce Pesticide & Fertilizer Impacts	1	2	5	9	12
NW3.4 Control Invasive Species	1	2	6	9	12
RA2.2 Reduce Construction Energy Consumption	1	4	8	12	
RA3.4 Monitor Water Systems	1	3	6	12	
RA1.5 Balance Earthwork On Site	2	4	6	8	
RA3.3 Reduce Construction Water Consumption	1	3	5	8	
NW3.5 Protect Soil Health		3	4	6	8
QL1.6 Minimize Construction Impacts	1	2	4	8	

As seen in the table above the majority of the credits reviewed as part of section 3 of this part are among the most highly weighted credits (26-20 points):

- CR2.3 Evaluate Risk and Resilience
- CR2.5 Maximize Resilience
- CR1.2 Reduce Greenhouse Gas Emissions
- RA2.1 Reduce Operational Energy Consumption
- RA2.3 Use Renewable Energy
- NW2.2 Manage Stormwater
- NW2.1 Reclaim Brownfields
- RA3.2 Reduce Operational Water Consumption
- CR2.2 Assess Climate Change Vulnerability
- CR1.1 Reduce Net Embodied Carbon
- CR2.4 Establish Resilience Goals and Strategies
- NW1.4 Preserve Undeveloped Land
- NW3.2 Enhance Wetland & Surface Water Functions
- NW2.4 Protect Surface and Groundwater Quality

As made evident by the relevant scores, the impacts during construction works are less weighted than impacts during operation, due to the shorter duration of impact (e.g. RA2.2 Reduce Construction Energy Consumption).

3. ENVISION REVIEW - GUIDANCE ON CLIMATE OPPORTUNITIES

This section focuses on Envision's use as a guidance to direct project teams into strategies selection for an optimized performance in terms of climate change mitigation and adaptation. It highlights how response and action against climate change risks presents opportunities for infrastructure owners that extend the net effect on climate per se. In other words, the review identifies climate-related opportunities within the Envision manual.

The review departs from the core principles of resilience that Envision identifies as qualities of projects that represent opportunities primarily against physical climate risk (physical opportunities). As a next step, the core principles are linked to specific examples of strategies that address them, as presented by Envision. Through the use of the LC Tool the indirect impacts of strategies can be identified to highlight their parallel potential as opportunities against transition risk (transition opportunities). Focus will be given in (1) climate change mitigation contribution and (2) potential financial impacts.

3.1. Climate-related Physical Opportunities in Envision credits/ Core Principles of Resilient systems

The climate–related opportunities for an infrastructure company are well captured through the CR2.5 Maximize Resilience, one of the higher score credits in the Envision assessment process. More specifically, as part of the documentation guidance of the CR2.5 credit, it is requested that project teams explain how the implemented resilience strategies address one or more of the core principles of resilient systems:

- *Resource efficient, creative*
- *Durable, well constructed*
- *Adaptable (flexible, changeable)*
- *Redundant (diverse, fault tolerant)*
- *Integrated (diverse systems, institutions, and people)*
- *Reflective (learning and improving)*
- *Inclusive (shared action and responsibilities)*

These core principles will be used for a final review of Envision that aims to highlight **why** incorporating these principles into a project represents opportunities both against climate physical and transition risk.

Envision assesses if "the project team has established methods for measuring/quantifying the benefits of resilience strategies implemented (e.g. monetary savings from avoided damage or service loss, accelerated recovery time)", thus linking them with financial materiality. The review will make evident these benefits.

3.1.1. Resource efficiency in Envision credits

Resource Efficiency is the ability to deliver greater value with less input, reducing pressure on limited natural resources. It counts alternative practices that treat the byproducts of processes as a valuable resource. It is worth highlighting that it is one of the climate-related opportunities identified by TCFD.

In Envision it is subject of assessment of credits:

(for materials)

MATERIALS	● RA1.1 Support Sustainable Procurement Practices ● RA1.2 Use of recycled materials ● RA1.3 Reduce Operational Waste ● RA1.4 Reduce Construction Waste ● RA1.5 Balance Earthwork On-Site
EMISSIONS	● CR1.1 Reduce embodied carbon

(for water)

WATER	● RA3.1 Preserve Water Resources ● RA3.2 Reduce Operational Water Consumption ● RA3.3 Reduce Construction Water Consumption ● RA3.4 Monitor Water Systems
CONSERVATIO N	● NW2.2 Manage Stormwater

(for land)

- NW2.1 Reclaim Brownfields

Finally credit 'LD1.4 Pursue Byproduct Synergies' encompasses all the above categories of resources. It refers to identifying opportunities for direct exchange of excess resources from one project to another for beneficial reuse, eliminating waste and reducing dependence on external sources, thus contributing to a circular economy.

The review will focus on materials efficiency, given that the Manufacturing Sector is one of the high-emitting sectors. 'Minimizing the total impact of material use should be a primary consideration for infrastructure projects'[400] as they consume a significant amount of materials along their entire life cycle. Cement, for example, is one of the biggest carbon footprint products.

<u>Resource efficiency strategies in Envision credits</u>

- Sizing the project to require less material (CR1.1)
- Designing the project to use less material (e.g. through use of high performance materials, including many variations of high performance concrete, steel or use of prefabricated components with high strength and enhanced durability) (CR1.1)
- Reducing material needed for repair and maintenance (CR1.1)
- Use of recycled materials (on-site reuse of materials or recycled content materials) (RA1.2)

3.1.2. Durability in Envision credits

Durability is the ability to withstand an extreme event, but also the ability to resist long-term wear and decay associated with project operations, therefore implying a longer useful life, reducing the need for maintenance and replacement. Material degradation is accentuated by exposure to chronic stressors, such extreme heat or precipitation or flooding, a result of climate change.

The use of durable longer-lasting materials apart from the CR2.5 credit is also a strategy in credits:

- LD2.3 Plan for Long-Term Monitoring and Maintenance
- CR1.1 Reduce Net Embodied Carbon
- LD2.4 Plan for End-of-Life (given that repurposing of components requires durability so that at the end of the project's useful life they are still proper for reuse)

<u>Durability Strategies in Envision credits</u>

- Exceedance of minimum specifications, regulations, or industry norms for project durability for materials, structure, construction quality (CR2.5)
- Maximized durability for project elements where failures or degradation are most likely to occur. (taking into consideration anticipated impacts on durability by future demand, loads up until project's end-of-life) (CR2.5)
- (May also include) maintaining a state of good repair (e.g. through predictive-proactive maintenance) (LD2.3)

Examples from literature potentially to be added to Envision as strategies

[400] Envision Manual

- Use of materials with crack healing properties, such as self-healing asphalt and self-healing bioconcrete, for improved mechanical properties and durability
- Improved construction quality through increased use of prefabrication, modular assembly, and offsite construction (manufacturing in a controlled environment rather than a construction site enables enhanced construction quality, therefore durability).
- Improved construction quality through intelligent construction systems, machines and technologies with real-time monitoring of material placement and compaction (e.g. using electromagnetic technologies like infrared)[401]
- Pre-stressed concrete slab technology for increased durability and better crack control

3.1.3. Adaptability in Envision credits

Adaptability is the ability of increased operational tolerance for adaptation to long-term changes, enabling reliability, as well as increased physical flexibility, easy reconfiguration and refurbishment. This ability increases the possibilities for repurposing to alternative future uses, and as a result allows the system to extend its useful life. Increased operational tolerance requires expansion of the range of conditions in which a system can function, grow or be configured. Adaptability is highly connected with redundancy (possibly from backup systems or distributed networks that maintain functionality) and reflective capabilities, systems to learn or change over time to be more prepared to deal with altered conditions.

Adaptability is also a recommended strategy in the credit 'LD2.4 Plan for End-of-Life'.

The LD2.4 credit also encourages the provision for opportunities to extend the project's useful life by giving emphasis to recyclability, up-cycling of materials and components, ease and efficiency in disassembly or replacement (e.g. components or materials that can be easily separated for recycling or reuse[402]), as well as opportunities for future expansion to address future increasing demands, loads or other requirements.

Adaptability Strategies in Envision credits

- Use of modular structures and materials that are easily adaptable for changing configurations (LD2.4)
- Use of prefabricated components that can be easily separated for recycling or reuse. (LD2.4)
- Use of decentralized systems, distributed networks (CR2.5)
- Use of intelligent systems that can or change over time (CR2.5)
- Provision of alternative supply options (alternative methods and locations) for resources that are important for the project (CR2.5)
- Use of natural systems that are self-regulating and self-repairing systems (e.g. wetlands to treat stormwater) (CR2.5)

[401] National Academies of Sciences, Engineering, and Medicine 2020. Strategic Issues Facing Transportation, Volume 7: Preservation, Maintenance, and Renewal of Highway Infrastructure. Washington, DC: The National Academies Press.

[402] Structures and components that can be easily dismantled will yield more materials for high-grade reclamation. Minimizing the use of composite forms will avoid the need to process the components to separate the materials for reuse.
Examples of suitable material types may include bricks, blocks, stone and concrete, untreated timber, glass, different types of plastic, metal, paper, and cardboard.

3.1.4. Redundancy in Envision credits

Redundancy, or diversity refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfill a particular function, therefore 'spreading risk' from a single reliance point to multiple. Redundancy is intentional and not the result of inefficient design, such as oversizing of structures or systems. This quality is also the subject of credit 'CR2.6 Improve Infrastructure Integration', as well as credits 'QL2.1 Improve Community Mobility & Access' and 'QL2.2 Encourage Sustainable Transportation'. Redundancy in the case of transportation projects is also provision of multiple transport mode options as alternatives to private vehicle use, increased system capacity to reduce congestion, as well as system capacity to address projected growth in demand.

Redundancy strategies in Envision

- Use of decentralized systems, distributed networks (CR2.6)
- Provision of alternative supply options (alternative methods and locations) for resources that are important for the project (CR2.6)
- System capacity planning addresses projected growth in commercial, industrial, and/or residential demand (QL2.1)
- Availability of multiple options of transportation modes (QL2.1)
- Increased system capacity to reduce congestion (QL2.1)
- Increased pedestrian proximity and accessibility to active, shared, and/or mass transportation (QL2.2)
- Extended network of active transportation (QL2.2)

3.1.5. Integration in Envision credits

Integration is a quality within and between systems and across different scales of operation that improves overall resilience and system performance. Integration reduces the risk of systemic and cascading failures, while promoting efficiency by leveraging co-benefits, thus avoiding duplication of components and/or system diversity without the need for redundant backups. Integration is the subject of credit CR2.6 Improve Infrastructure Integration. The credit assesses 'the degree to which the project is functionally integrated into connected systems, where beneficial and appropriate, in order to increase resilience and systems performance'. The first level is integration of internal systems within the project, the next level is integration with external infrastructure systems and optimal performance is integration at the community level. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops.

Integration strategies in Envision

- Increased integration of internal systems within the project to achieve efficiency and redundancy (e.g through multi-function components) (CR2.6)
- Identification and management of critical failure points to reduce risk of cascading failures (CR2.6)
- Use of smart technologies for monitoring and data gathering systems to improve operational performance (CR2.6)

3.1.6. Reflective capability in Envision credits

Reflective systems are accepting of the inherent uncertainty and change in today's conditions, particularly relevant for the long-lived infrastructure projects. They have mechanisms in place to continuously evolve, plan-do-check-act systems, revisiting plans and modifying standards or norms based on emerging evidence, rather than seeking permanent solutions. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making, as well as can capture new opportunities as they arise. The reflective quality is integrated in various Envision credits, such as:

- LD2.1 Establish a Sustainability Plan
- LD2.4 Plan for Long-term Monitoring & Maintenance
- RA2.4 Commission & Monitor Energy Systems
- RA3.4 Monitor Water Systems

<u>Reflective Capability Strategies in Envision credits</u>

- Development of a robust plan-do-check methodology to identify priorities, evaluate progress, and make adjustments to continually improve performance. (LD2.1)
- Development of operations and management plan that establishes a plan-do-check-act systems that learn and continually improve resilience capabilities. (CR2.5)
- Integration of data or monitoring systems with reporting or preparedness systems in order to learn and improve performance over time. (CR2.6)
- Incorporation of equipment or software in the design to allow for detailed monitoring, or real-time monitoring of all primary project functions. (RA2.4)
- Development of a plan for using monitoring data to improve water quality and efficiency, reduce leakage, and/ or conserve water. (RA3.4)
- A schedule is developed for future re-evaluation and modification of the maintenance plan based on monitored data. (LD2.4)

3.1.7. Inclusivity in Envision credits

Inclusivity is the ability of establishing shared action and responsibilities, as well as knowledge sharing. It is particularly critical in order to deal with multidisciplinary issues like climate change, disaster risk reduction or emergency response through coordination. Often individuals from diverse backgrounds, skill sets can add value by bringing attention to threats and vulnerabilities that might "Inclusivity emphasizes the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience."[403] Inclusivity is the focus or an integral component of various credits assessment:

- LD1.2 Foster Collaboration & Teamwork
- LD1.3 Provide for Stakeholder Involvement
- QL1.1 Improve Community of Life

[403] City Resilience Framework - The Rockefeller Foundation

- QL3.1 Advance Equity & Social Justice
- LD2.4 Plan for End-of-life
- LD3.2 Develop Local skills & Capabilities
- CR2.3 Evaluate Risk & Resilience

Inclusivity Strategies in Envision credits

- Interdisciplinary collaboration and integrated design process, including stakeholders from later construction, operations, and/or maintenance phases (LD1.2)
- Participation of owner and key stakeholders in the risk evaluation process (CR2.3)
- Work with academic or research organization as part of project development and publication of research outcomes to advance general knowledge of the profession (CR0.0)
- Development of proactive stakeholder engagement plans (LD1.3)
- Incorporation of end-of-life options into the stakeholder engagement process (LD2.4)
- Community education and awareness training (LD3.2)

3.2. Core Principles of Resilient systems as transition opportunities

The seven core principles of resilient systems have inherent interconnections. Envision highlights their common outcome, the ability to extend the useful life of an infrastructure project. In this shared objective the core principles act in a supplementary manner.

Durability facilitates resource efficiency (materials), enabling downsizing of structures with equivalent structural performance through high performance or quality.

Integration is enabling redundancy eliminating the risk of oversizing systems or duplicated components, thus increasing resource input requirements.

Redundancy in turn is supporting adaptability by reducing over-reliance on a single asset. And finally, the reflective capacity and inclusivity act as enablers for the rest of core principles, through new knowledge and shared action and responsibilities.

However, it is worth highlighting that resilience principles have to be properly balanced based on project needs and goals to deliver opportunities. For example, if the adaptability strategy sets as goal the 'up-cycling of end-of-life project components and materials, it may require the use of additional materials to remain in a useful state. Therefore, designing for materials reuse and up-cycling may run counter to objectives for reducing materials' intensity.'[404]

The high interdependence of the seven principles is made evident by the overlapping of various of the strategies that address them, as shown in previous sections. Their common objective of extension of useful life translates into longer maintenance or replacement cycles, a significant component of resource consumption and cost. In the following table the shared opportunities against transition risk are summarized for all resilient strategies and linked to their potential financial benefits.

[404] Envision manual

Table 49: Durability – Adaptability- Redundancy – Integration strategies related opportunities

ENVIRONMENTAL IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	INITIAL (CONSTRUCTION)	OPERATION	FUTURE (MAINTENANCE)
(+) materials	(+) scope 3 upstream emissions (+) embodied water (+) climate change (+) resource depletion	Reduced material use due to optimizing the size of structures due to the redundant corrosion system/ premium materials	Short-term		
		Reduced use of materials (permanent) due to avoided replacement works through design, longer-lived materials			Recurring short-term
		Reduced use of temporary material for replacement works (equipment, safety barriers/ temporary signage, noise barriers, etc.)			Recurring short-term
		Reduced scope 3 upstream emissions and embodied water of materials due to avoided maintenance needs; avoided hauling routes			Recurring short-term
(+) energy	(+) scope 1 & 2 emissions (+) climate change	Avoided construction worksite energy consumption and associated emissions			Recurring short-term
(+) waste	(+) scope 3 downstream emissions (+) embodied water (+) land occupation (+) water quality	Reduced construction waste due to avoided rehabilitation or replacement works			Recurring short-term
		Reduced scope 3 downstream emissions and embodied water of construction waste Reduced land occupation for landfilling Improved water quality			Recurring short-term
(+) water	(+) resource depletion	Avoided construction water consumption Reduced contribution to depletion of water resources			Recurring short-term
ECONOMIC IMPACT	**ASSOCIATED IMPACT**	**IMPACT DESCRIPTION**	**INITIAL (construction)**		**FUTURE (maintenance)**
(+-) capital cost		Added capital cost for more durable materials (premium) and structures	Short-term		
		Reduced capital cost for acquisition of materials due to downsizing			
		Reduced capital cost for labor or transport of components (downsized, less-weight structures)	Short-term		
(+) rehabilitation cost		Avoided future rehabilitation cost due to longer-lived structures and materials			Recurring short-term
(+) replacement cost		Avoided future replacement cost due to longer-lived structures and materials			Short-term
(+) residual value		Increased residual value			future
(+)transition risk		Less exposure to transition risk and related financial impacts (See table 51) due to reduction of overall GHG emissions (scope 1, 2 and 3)	Short-term	Long-term	Recurring short-term

(+)physical risk		Less exposure to physical risk (physical asset risk, service risk, resource availability risk and supply chain continuity risk) and associated financial impacts(See table 52) due to maximized resilience through incorporation of strategies that address the resilient system's core principles	Short-term	Long-term	Recurring short-term

Table 50: User-related opportunities due to avoided maintenance works

ENVIRONMENTAL IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	INITIAL (CONSTRUCTION)	OPERATION	FUTURE (MAINTENANCE)
(+) access	(+) travel time value (+) vehicle cost (+) fuel cost (+) energy (+) scope 3 downstream emissions (user-related) (+) climate change	Avoided disruptions of access/ closure due to reduced maintenance needs; avoided construction traffic Avoided additional fuel consumption by private vehicles due to construction traffic (stop-and-go traffic flow during congestion results in excess fuel consumption) or detouring and associated scope 3 emissions Avoided cost of lost productivity, vehicle operating costs, and fuel costs due to avoided disruption of access and construction traffic			Recurring for the period of works
(+)energy	(+)scope 3 emissions	Avoided excess fuel consumption by private vehicles from surface roughness and deflection of the road surface (which is a function of design and maintenance) due to state of good repair		Long-term future	
(+)physical risk		Avoided cost of productivity for the community due to failure of systems; lost operating time; avoided cost of damage loss of property			

It is worth highlighting that modular structures and prefabricated units (strategies for both durability and adaptability) have the additional potential of accelerating construction duration, thus reducing construction site energy consumption, and associated scope 1& 2 emissions, as well as capital cost, given that allow for better work sequencing.

The use of recycled materials (on-site reuse of materials or recycled content materials), presents similar initial construction opportunities to the above listed, however differentiates from the above strategies due to durability concerns. Recycled-content materials tend to have shorter useful life as compared to primary materials. Therefore, are expected to require shorter maintenance or replacement cycles.

Research and Development has a significant role to play in enhancing the net climate effect of resilient strategies. There is an active area of research **on substitute materials** and technologies that increase durability, reparability, upgradability or reusability of products, while resulting in less embodied carbon. Examples include:

- Recovered materials as high-quality secondary raw material input, such as ultra-high performance concrete from waste materials of excavation works
- Graphene-enhanced concrete for downsizing of structures with equivalent structural performance (grapheme may come from old tyres)
- Nanotechnology-based construction materials for improved mechanical properties and durability
- Composites for reinforcement of roadway structures to improve mechanical properties, and durability, such as carbon and glass fiber reinforced polymers
- lightweight fill for embankments (e.g., geofoam, low-density cementitious fill, and expanded shale)
- CO2 reuse for cement or production of carbon fibre with high strength, low weight to strength ratio and high temperature resistance
- Green cement from steel waste materials (waste products during the conversion of iron to steel)

GAP IDENTIFIED: The use of substitute materials
Substitute materials constitute an active area of research aiming to improve material properties :
- Improved durability with downsized materials
- Improved durability of recycled-content materials
- Increased resistance in high temperatures or corrosion from increased exposure to flooding
- Less/ zero carbon content of materials

Research in this area can counterbalance some of the negative impacts of materials mentioned (e.g. recycled-content materials, quiet pavements etc.).

Tables 49 and 50 highlight **a net positive impact on transition risk** through GHG emissions reductions across the life cycle of the project that if combined with GHG emission reduction strategies (energy efficiency, decarbonization, electrification and carbon storage and sequestration) during the operation and construction of the project can result to a low carbon, net zero project or even carbon negative project.

Transition risk, as already described, is linked to financial impacts:

Table 51: Linking transition opportunities to financial benefits based on TCFD

Financial benefit of transition	Examples of Financial benefits
(+)Revenues	**Increased revenues from increased demand due to:** ● Reputational benefits ● shift in consumer demand/ preferences for lower emissions services ● Better competitive position to reflect shifting consumer preferences through R&D and innovation ● Access new and emerging markets (e.g., partnerships with governments, development banks)

	Increased revenues from increased production capacity due to: ● more efficient processes ● Increased employee attraction and retention ● Avoided delayed planning approvals ● Avoided supply chain interruptions
(+) O&M cost[405]	**Reduced O&M cost from:** Apart from the efficiency gains due to efficient production and distribution processes mentioned in table 49, also: ● Benefits to workforce management and planning (e.g., improved health and safety, employee satisfaction ● Less exposure to higher compliance costs ● Less exposure to increased insurance premiums for GHG emissions ● Less exposure to increased pricing of GHG emissions (carbon cost) ● Less exposure to changing input prices/increased cost of raw materials (e.g. abrupt and unexpected shifts in energy, water costs) and output requirements (e.g., waste treatment) ● Reduced exposure to GHG emissions-related pricing and therefore less sensitivity to changes in cost of carbon ● Reduced exposure to future fossil fuel price increases
(+-) Capital cost	Apart from increased capital cost for more durable materials and cost savings from downsizing structures there are potential increased technology-related capital cost due to: ● Required investment in research and development (R&D) in new and alternative technologies ● Required investment in technology development ● Adoption/deployment of new practices and processes ● Unsuccessful investment in new technologies
(+) Liability/ Compliance cost	**Reduced Liability/ Compliance cost due to:** ● Less exposure to future enhanced emissions-reporting obligations ● Less exposure to future mandates on and regulation on services
(+) Replacement cost **(+) Residual value**	**Reduced Replacement cost due to:** ● Less exposure to write-offs, early retirement of assets because of policy changes ● Less exposure to write-offs, early retirement of assets because of substitution with lower emissions options **Increased Residual value** of energy-efficient assets

Table 52: Linking physical opportunities to financial benefits based on TCFD

405 Moreover, a further breakdown of capital, O&M, rehabilitation, and replacement costs is provided for additional and more specific data on the source of cost:

- Land acquisition cost (e.g., for temporary staging area)
- Materials acquisition cost
- Labor cost (or workforce-related cost)
- Schedule efficiency cost (avoided cost through optimized work completion)
- Hauling & fuel cost
- Waste cost

Financial Benefits of Physical opportunities	Examples of Financial benefits
(+) Revenues	**(+) Revenues through:** ● new solutions to adaptation needs (e.g., insurance risk transfer products and services) ● Less exposure to input resources shortage ● Increased reliability of supply chain and ability to operate under various conditions due to resource substitutes/ diversification (less exposure to transport difficulties, supply chain interruptions) Less exposure to reduced production capacity ● Disruption of production processes due to acute risks ● Less exposure to negative impacts on workforce management and planning (health, safety, absenteeism due to acute risks.
(+) O&M cost	**(+) O&M cost due to:** ● Less exposure to increased insurance premiums on assets in “high-risk” locations (for acute or chronic risks)
(+) Rehabilitation/ Replacement cost Residual value	● Increased market valuation through resilience planning **(+) Rehabilitation/** **(+) Replacement cost** **(+) Residual value due to:** ● Less exposure to damage to facilities in high-risk locations from acute or chronic risks.

PART 4: SYNTHESIS OF FINDINGS AND INITIAL RECOMMENDATIONS

1. SYNTHESIS OF FINDINGS

This part presents a synthesis of findings of the performed Envision review.

1) The performed filtering through the LC Sustainability tool to identify credits indirectly related to (1) climate change mitigation, (2) adaptation and (3) financial materiality highlighted that the majority of Envision credits are related to both mitigation and adaptation and coincide with topics that have financial materiality.

2) The review of the Envision manual in terms of assessment of climate risks, demonstrated that Envision includes key criteria defined as critical for contributing to climate change mitigation or adaptation. The key criteria were identified through the literature review and the analysis of TCFD and selected ESG systems) and consist of:

   For assessment of transition risks:
   - GHG accounting during all life cycles of a project
   - Energy efficiency
   - Electricity decarbonization through the use of renewable energy sources
   - Electrification (replacement of use of fossil fuels with electricity)
   - Carbon capture and sequestration for the hard-to- electrify portions of systems

   For assessment of physical risks:
   - Alignment with TCFD recommended disclosures for climate-related strategy and risk management, that report risk evaluation and risk management process
   - Inclusion of disclosures/ metrics that refer on climate-related risk types (identified through the literature review and the analysis of TCFD and selected ESG systems) and consist of:
     - physical asset risk
     - service continuity risk
     - resource availability risk (water, materials, land, workforce)
     - supply chain continuity risk

   The review on transition and physical risks was performed on a credit by credit basis, exploring each related credit's boundary of assessment and performance requirements. The identified gaps and corresponding recommendations to address them are presented in the following section.

3) The review based on the seven core principles of resilient systems highlighted, strategies related to
   - Resource efficiency;
   - Durability;
   - Adaptability;
   - Redundancy;

- Integration;
- Reflective capacity; and
- Inclusivity,

were identified in various credits beyond the Climate & Resilience category's credits CR2.5, where mentioned. Among these credits are ones that were identified as related to transition risks. This is evidence of the potential of strategies that respond to physical risks, to simultaneously address transition risks, and more specifically contribute to GHG emissions reduction. This strengthens the case that the seven core principles represent climate-related opportunities.

The findings in terms of:

- Envision's assessment of climate-related transition risks (mitigation) and physical risks (adaptation); and
- Envision's guidance on climate-related physical opportunities and their connection with transition opportunities and financial impacts;

are summarized in a matrix that connects Envision credits with climate-related risk and opportunities. (See Table 53).

Table 53: Envision Credits in relation to the key criteria that define climate-related performance

	CLIMATE TRANSITION RISKS								CLIMATE PHYSICAL RISKS							CLIMATE PHYSICAL OPPORTUNITIES						
											resource availability											
ENVISION CREDITS	GHG scope 1	GHG scope 2	GHG scope 3	GHG scope 3 user	energy efficiency	decarbonization	electrification	carbon capture & storage	service continuity	physical asset	water	materials	land	workforce	supply chain continuity	resource efficiency	durability	adaptability	redundancy	integration	reflective capability	inclusivity
QL1.1 Improve Community Quality of Life																						
QL1.2 Enhance Public Health & Safety																						
QL1.3 Improve Construction Safety																						
QL1.4 Minimize Noise and Vibration																						
QL1.5 Minimize Light Pollution																						
QL1.6 Minimize Construction Impacts																						
QL2.1 Improve Community Mobility & Access																						
QL2.2. Encourage Sustainable Transportation																						
QL2.3. Improve Access & Wayfinding																						
QL3.1 Advance Equity and Social Justice																						
QL3.2 Preserve Historic and Cultural Resources																						
QL3.3 Enhance Views & Local Character																						
QL3.4 Enhance Public Space and Amenities																						
LD1.1 Provide Effective Leadership & Commitment																						
LD1.2 Foster Collaboration & Teamwork																						
LD1.3 Provide for Stakeholder Involvement																						
LD1.4 Pursue Byproduct Synergies																						
LD2.1 Establish a Sustainability Management Plan																						
LD2.2 Plan for Sustainable Communities																						
LD2.3 Plan for Long-Term Monitoring and Maintenance																						
LD2.4 Plan for end-of-life																						
LD3.1 Stimulate Economic Prosperity & Development																						
LD3.2 Develop Local Skills & Capabilities																						
LD3.3 Conduct a Life-Cycle Economic Evaluation																						
RA1.1 Support Sustainable Procurement Practices																						
RA1.2 Use Recycled Materials																						
RA1.3 Reduce Operational Waste																						
RA1.4 Reduce Construction Waste																						
RA1.5 Balance Earthwork On Site																						
RA2.1 Reduce Operational Energy Consumption																						
RA2.2 Reduce Construction Energy Consumption																						
RA2.3 Use Renewable Energy																						

RA2.4 Commission & Monitor Energy Systems																						
RA3.1 Preserve Water Resources																						
RA3.2 Reduce Operational Water Consumption																						
RA3.3 Reduce Construction Water Consumption																						
RA3.4 Monitor Water Systems																						
NW1.1 Preserve Sites of High Ecological Value																						
NW1.2 Provide Wetland & Surface Water Buffers																						
NW1.3 Preserve Prime Farmland																						
NW1.4 Preserve Undeveloped Land																						
NW2.1 Reclaim Brownfields																						
NW2.2 Manage Stormwater																						
NW2.3 Reduce Pesticide & Fertilizer Impacts																						
NW2.4 Protect Surface and Groundwater Quality																						
NW3.1 Enhance Functional Habitats																						
NW3.2 Enhance Wetland & Surface Water Functions																						
NW3.3 Maintain Floodplain Functions																						
NW3.4 Control Invasive Species																						
NW3.5 Protect Soil Health																						
CR1.1 Reduce Net Embodied Carbon																						
CR1.2 Reduce Greenhouse Gas Emissions																						
CR1.3 Reduce Air Pollutant Emissions																						
CR2.1 Avoid Unsuitable Development																						
CR2.2 Assess Climate Change Vulnerability																						
CR2.3 Evaluate Risk and Resilience																						
CR2.4 Establish Resilience Goals and Strategies																						
CR2.5 Maximize Resilience																						
CR2.6 Improve Infrastructure Integration																						

Note: Grey color indicates the potential of credits to enable addressing risks and providing opportunities

The matrix makes evident that 26 credits of the Climate & Resilience, Resource Allocation, Leadership Category and Natural World relate to multiple of the key criteria for climate change mitigation and adaptation. More specifically:

Table 54: Selected Envision credits to serve for prioritization of climate action projects

Category	Subcategory	Credit
CLIMATE & RESILIENCE	Emissions	CR1.1 Reduce Net Embodied Carbon
		CR1.2 Reduce Greenhouse Gas Emissions
	Resilience	CR2.1 Avoid Unsuitable Development
		CR2.2 Assess Climate Change Vulnerability
		CR2.3 Evaluate Risk and Resilience
		CR2.4 Establish Resilience Goals and Strategies
		CR2.5 Maximize Resilience
		CR2.6 Improve Infrastructure Integration
RESOURCE ALLOCATION	Materials	RA1.1 Support Sustainable Procurement Practices
		RA1.2 Use Recycled Materials
		RA1.3 Reduce Operational Waste
		RA1.4 Reduce Construction Waste
	Energy	RA2.1 Reduce Operational Energy Consumption
		RA2.2 Reduce Construction Energy Consumption
		RA2.3 Use Renewable Energy
		RA2.4 Commission & Monitor Energy Systems
	Water	RA3.1 Preserve Water Resources
		RA3.2 Reduce Operational Water Consumption
		RA3.3 Reduce Construction Water Consumption
		RA3.4 Monitor Water Systems
LEADERSHIP	Collaboration	LD1.4 Pursue Byproduct Synergies
	Planning	LD2.3 Plan for Long-Term Monitoring and Maintenance
		LD2.4 Plan for end-of-life
	Economy	LD3.3 Conduct a Life-Cycle Economic Evaluation
NATURAL WORLD	Conservation	NW2.2 Manage Stormwater
	Ecology	NW3.3 Maintain Floodplain Functions

These credits could be used as prioritization criteria for identifying the right climate action projects. Moreover, the mapping of their multiple benefits along with the transition and physical opportunities' financial benefits (Tables 51, 52) can serve as evidence for investors of financial materiality. The financial materiality of the selected credits is presented in the table below

Table 55: Financial Materiality of prioritization Envision credits

Prioritization Envision Credits	Financial Materiality
CR1.1 Reduce Net Embodied Carbon	Capital cost/ O&M cost/ Revenues/ Liability/ compliance cost/ Transition risk-related financial impacts
CR1.2 Reduce Greenhouse Gas Emissions	Capital cost/ O&M cost/ Revenues/ Liability/ compliance cost/ Transition risk--related financial impacts
CR2.1 Avoid Unsuitable Development	Physical risk-related financial impacts
CR2.2 Assess Climate Change Vulnerability	Physical risk-related financial impacts
CR2.3 Evaluate Risk and Resilience	Physical risk-related financial impacts
CR2.4 Establish Resilience Goals and Strategies	Physical risk-related financial impacts

CR2.5 Maximize Resilience	Capital cost/ O&M cost/ Revenues/ Rehabilitation cost / Replacement cost/ Residual value/ Delay cost/ Transition risk/ Physical risk-related financial impacts
CR2.6 Improve Infrastructure Integration	Capital cost/ O&M cost/ Revenues/ Rehabilitation cost / Replacement cost/ Residual value/ Transition risk/ Physical risk--related financial impacts
RA1.1 Support Sustainable Procurement Practices	Capital cost/ Revenues/ Liability/ compliance cost/ Transition risk/ Physical risk--related financial impacts
RA1.2 Use Recycled Materials	Capital cost/ Rehabilitation cost / Replacement cost/ Residual value/ Transition risk/ Physical risk-related financial impacts
RA1.3 Reduce Operational Waste	O&M cost/ Transition risk/ Physical risk-related financial impacts
RA1.4 Reduce Construction Waste	Capital cost/ Transition risk/ Physical risk-related financial impacts
RA2.1 Reduce Operational Energy Consumption	Capital cost/ O&M cost/ Transition risk-related financial impacts
RA2.2 Reduce Construction Energy Consumption	Capital cost/ Transition risk/ Physical risk-related financial impacts
RA2.3 Use Renewable Energy	Capital cost/ Transition risk-related financial impacts
RA2.4 Commission & Monitor Energy Systems	Capital cost/ O&M cost/ Transition risk-related financial impacts
RA3.1 Preserve Water Resources	Liability/ Compliance cost/ Transition risk/ Physical risk-related financial impacts
RA3.2 Reduce Operational Water Consumption	Capital cost/ O&M cost/ Physical risk-related financial impacts
RA3.3 Reduce Construction Water Consumption	Capital cost/ Physical risk-related financial impacts
RA3.4 Monitor Water Systems	Capital cost/ O&M cost/ Physical risk-related financial impacts
LD1.4 Pursue Byproduct Synergies	Capital cost/ O&M cost/ Revenues/ Rehabilitation/ Replacement cost/ Residual value/ Transition risk/ Physical risk-related financial impacts
LD2.3 Plan for Long-Term Monitoring and Maintenance	Capital cost/ O&M cost/ Rehabilitation cost / Replacement cost/ Residual value/ Revenues/ Transition risk/ Physical risk
LD2.4 Plan for end-of-life	Replacement cost/ Residual value/ Transition risk/ Physical risk-related financial impacts
LD3.3 Conduct a Life-Cycle Economic Evaluation	All types of cost
NW2.2 Manage Stormwater	Capital cost/ O&M cost/ Liability/ Compliance cost/ Transition risk/ Physical risk-related financial impacts
NW3.3 Maintain Floodplain Functions	Capital cost/ O&M cost/ Rehabilitation/ Replacement cost/ Residual value/ Transition risk/ Physical risk--related financial impacts

It is worth highlighting the case of Quality of Life credits that also cover multiple of the key criteria for climate change mitigation and adaptation:

- QL1.6 Minimize Construction Impacts
- QL2.1 Improve Community Mobility
- QL2.2 Encourage Sustainable Transportation
- Ql2.3 Improve Access & Wayfinding

These credits are distinguished from the rest of identified credits for being more relevant to transportation projects.

Redundancy in the case of transportation projects is also provision of multiple transport modes, system capacity and physical characteristics. Though the strategies of QL2.1, QL2.2 and QL2.3 credits assess mobility, pedestrian/driver safety, system efficiency, congestion, travel time etc. they are connected to GHG emissions reduction. GHG emissions are dependent of vehicle miles driven, vehicle speed, stop-and-go driving due to congestion, causing aggressive acceleration and deceleration, and excess idling all of which reduce fuel efficiency and increase GHG emissions.[406] Moreover, the roadway surface condition, roughness also reduces fuel efficiency and increases GHG emissions.

Table 53 however indicates potential negative impacts on materials, land, water. These impacts correspond to those strategies within these credits that refer to system capacity expansion, therefore require more resources, greater scale of construction works and additional maintenance works. Additionally, capacity expansion may also result in induced demand, given that increased fuel efficiency reduces the cost of driving for the user and may encourage increased use of private vehicles.

Credit QL1.6 Minimize Construction Impacts, though related to all infrastructure projects is also prioritized for transportation projects, because the strategies with more impact on GHG emissions are mainly those related to partial or full closure, typically used in construction or replacement of highways and bridges.

A question which is raised is whether the climate-related priority of the identified credits (presented in Table 54) is also reflected in their scoring within the Envision rating process?

In order to provide a better understanding of the weight of the selected credits a sorting was performed based on their score in the Envision rating process, from the highest to the lowest score, and presented in the table below:

Table 56: Prioritization Envision credits sorted based on their score (from highest to lowest)

PRIORITIZATION ENVISION CREDITS	Position based on sorting of scores (from higher to lower)	SCORE PER LEVEL OF ACHIEVEMENT				
		Improved	Enhanced	Superior	Conserving	Restorative
CR2.3 Evaluate Risk and Resilience	1	**11**	**18**	**24**	**26**	
CR2.5 Maximize Resilience	2	**11**	**15**	**20**	**26**	
CR1.2 Reduce Greenhouse Gas Emissions	3	**8**	**13**	**18**	**22**	**26**
RA2.1 Reduce Operational Energy Consumption	4	**6**	**12**	**18**	**26**	
RA2.3 Use Renewable Energy	6	5	10	15	20	**24**
NW2.2 Manage Stormwater	7	2	4	9	17	**24**
RA3.2 Reduce Operational Water Consumption	9	4	9	13	17	**22**
CR2.2 Assess Climate Change Vulnerability	11	8	14	18	20	
CR1.1 Reduce Net Embodied Carbon	12	5	10	15	20	
CR2.4 Establish Resilience Goals and Strategies	13		8	14	20	
LD1.4 Pursue Byproduct Synergies	21	3	6	12	14	18
CR2.6 Improve Infrastructure Integration	28	2	5	9	13	18
RA1.4 Reduce Construction Waste	30	4	7	10	16	
RA1.2 Use Recycled Materials	32	4	6	9	16	
CR2.1 Avoid Unsuitable Development	33	3	6	8	12	16
LD3.3 Conduct a Life-Cycle Economic Evaluation	37	5	7	10	12	14
RA1.3 Reduce Operational Waste	38	4	7	10	14	

[406] FHWA

RA2.4 Commission & Monitor Energy Systems	39	3	6	12	14	
LD2.4 Plan for end-of-life	41	2	5	8	14	
NW3.3 Maintain Floodplain Functions	43	1	3	7	11	14
RA1.1 Support Sustainable Procurement Practices	47	3	6	9	12	
RA3.1 Preserve Water Resources	48	3	5	7	9	12
LD2.3 Plan for Long-Term Monitoring & Maintenance	49	2	5	8	12	
RA2.2 Reduce Construction Energy Consumption	54	1	4	8	12	
RA3.4 Monitor Water Systems	55	1	3	6	12	
RA3.3 Reduce Construction Water Consumption	57	1	3	5	8	

Based on the opportunities that credits present as identified in performed review, one recommendation for Envision is to revisit the weighting of the following credits:

- LD2.3 Plan for Long-Term Monitoring & Maintenance
- RA2.2 Reduce Construction Energy Consumption

2. IDENTIFIED GAPS AND INITIAL RECOMMENDATIONS

In the following tables the gaps identified during the Envision review process are summarized and initial recommendations to address them are presented:

Table 57: Identified gaps & Recommendation regarding GHG accounting across project life cycle stages

Risk type	IDENTIFIED GAPS	RECOMMENDATIONS
Scope 1 & 2 GHG emissions	**Where are construction-related scope 1 & 2 emissions reported?** Envision's credit RA2.2 Reduce Construction Energy Consumption assesses implementation of a range of energy management strategies that result in scope 1, 2 & 3 emissions, however does not request an overall reduction of scope 1&2 emissions as result of implemented strategies. Rather it refers to a connection with credit CR1.2 Reduce Greenhouse Gas Emissions, while CR1.2 is accounting for operational GHG scope 1& 2 emissions only.	**RA2.2 credit** should request apart from evidence of the number of energy management strategies implemented during construction, also the overall reduction of scope 1&2 emissions during construction, result of the implemented strategies.
Scope 1 & 2 GHG emissions	**Where are maintenance-related scope 1 & 2 emissions reported?** The relevant to maintenance Envision credits 'LD2.3 Plan for Long-term Monitoring and Maintenance' and 'CR2.5 Maximize Resilience' do not request reporting estimates on scope 1, 2 emissions reductions through more efficient planning for reduced maintenance needs. (maintenance-related scope 3 emissions are	**LD2.3 credit** should request an estimate of the overall reduction of scope 1&2 emissions during the expected minor and major rehabilitation works over the project's estimated service life

	reported as part of credit CR1.1)	
User-related scope 3 emissions	**User-related scope 3 emissions are not accounted as part of the Envision assessment. These emissions are particularly significant- as compared to operational scope 1 & 2 emissions- especially in the case of transportation projects.**	Consideration of extending Envision's boundary of assessment to account for end-user's scope 3 emissions, particularly in the case of transportation projects, in credits **QL2.1, QL2.2 and QL2.3.**
	User-related scope 3 emissions are also produced during construction & maintenance stages and not accounted within relevant Envision credits, such as QL1.6 Minimize Construction Impacts and LD2.3 Plan for Long-term Monitoring and Maintenance.	**Credits QL1.6 and LD2.3** should consider if requesting estimations of end-user's scope 3 emissions due to construction works-related closures, detouring, or avoided end-user's scope 3 emissions through accelerated construction duration etc.
An overall recommendation is to revisit 'targets' evaluation criteria in credits CR1.1 & CR1.2 that assess reduction of GHG emissions (scope 1, 2 & 3). Envision should request commitment to GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C and pursue efforts to limit warming to 1.5°C – and to achieve net-zero emissions before 2050.		
Envision does not incorporate transition risk as part of climate-related risk assessment and management. As already explained evaluation and management of transition risk is part of the TCFD recommended disclosures, along with physical risk. For the appropriate evaluation of the climate-related impacts in a project, which result from transition or physical risks, TCFD suggests also analysis and identification of various transition and physical scenarios.		

Table 58: Identified gaps & Recommendation regarding assessment of GHG emission reduction strategies

Risk type	IDENTIFIED GAPS	RECOMMENDATIONS
Energy efficiency		Revisit 'targets' in evaluation criteria in **credits RA2.1 and RA2.2**
Decarbonization of electricity through use of renewable energy sources	**The management of renewable energy regeneration's production capacity risk.** The use of renewable energy generation sources has additional impacts and risks that are sector-specific and/or technology specific. A common, however, observation for renewable technologies such as wind, or solar power, is the inherent production capacity risk, as the volume of electricity produced is weather-related, resulting in reliability issues. Envision doesnot request any documentation or evidence of how production capacity risk is mitigated and if energy storage solutions are in place.	**RA2.3 credit** could account for the risk of renewable energy production and request evidence on risk management such as provision of energy storage solutions.
Electrification	-	-

Carbon Capture & storage	**GAP IDENTIFIED: Carbon capture & storage** Given that all 1.5°C emissions pathways rely upon carbon removal to some extent and **c**arbon removal is necessary for both moving to net-zero emissions and for producing net-negative emissions to compensate for any overshoot of 1.5°C, Envision could refer more on carbon removal and request more information on the adopted carbon-removal approaches. Moreover, Envision refers to carbon capture and storage during operations, however it is emerging as an approach during construction as well (net zero-carbon construction sites).	Envision could refer more on carbon removal and request more information on the adopted carbon-removal approaches both for operations and construction.
An overall recommendation is to revisit 'targets' in evaluation criteria in credits RA2.1, RA2.2 & RA2.3 that assess: - Reduction in operational energy consumption - Reduction in construction energy consumption - Share of renewable energy sources **Moreover,** the decarbonization strategies are assessed by the Envision process in separate relevant credits. Envision includes performance targets for energy consumed, share of renewable energy sources. However, the supplementary role of GHG emission reduction strategies in transition scenarios that through their combination enable reaching an overall emission reduction target towards a projected temperature limit, raises the question how Envision, apart from the separate assessment of incorporation of these strategies, could assess them regarding the overall outcome? Envision should request evidence on commitment to GHG emissions targets that are in line with the goals of the Paris Agreement – to limit global warming to well below 2°C and pursue efforts to limit warming to 1.5°C – and to achieve net-zero emissions before 2050, **as part of credits CR1.1 and CR1.2.**		

Table 59: Identified gaps & Recommendation regarding assessment of physical risk evaluation & management

Risk type	**IDENTIFIED GAPS**	**RECOMMENDATIONS**
Service continuity/ physical asset risk/ Resource availability/ Supply chain continuity	**Reference to physical risk scenarios and associated time horizon(s) considered.** The Envision does not request as part of climate-related risk evaluation any reference to physical risk scenarios. The physical scenarios also take into consideration the anticipated physical impacts and the specific localities.[407]	Envision should request reference to physical risk scenarios for anticipated physical impacts in the project's specific locality in higher or lower temperature limits, as part of climate-related risk evaluation. Also, Envision as part of its assessment of risk evaluation should make clear that impacts on the project's durability should be accounted, such as accelerated degradation from extreme heat

407 The steps of such analysis start with the identification of the atmospheric GHG concentration range (high, intermediate or low emissions), then estimate the likely resulting temperature ranges at various future time frames and points (peaks), additionally attempt to downscale the data from global climate models to local levels and finally

	Additionally, reference to a physical scenario in line with the Paris Agreement 2°C limit/1.5°C aim, which suggests ambitious reductions of GHGs emissions and GHGs peak at around 2020 and net-negative emissions before 2100, implies less physical impacts and risks in the long-term. Contrariwise higher temperature limits are expected to result in an increase of acute climate impacts and highly uncertain risks.	waves, or corrosion due to increased flooding (not all materials have adequate properties to withstand extreme weather conditions)
Service continuity/ physical asset risk/ Resource availability/ Supply chain continuity	**Assessment of how infrastructure companies' processes for identifying, assessing, and managing climate-related risks are integrated into their overall risk management.**	Envision should guide projects teams to integrate climate change risk into their overall risk management plans, such as Safety and Security management plans or Health and Safety Plans, Risk assessments. For example, in the case of CA High Speed rail, climate change risk was integrated in Safety and Security Management Plan (See relevant section of the report).

Table 60: Identified gaps & Recommendation regarding guidance on climate-related opportunities

Core principle	IDENTIFIED GAPS	RECOMMENDATIONS
Resource Efficiency (materials)/ **Durability**	**Use of substitute materials** Substitute materials constitute an active area of research aiming to: - Improved durability with downsized materials - Increased resistance in high temperatures or - Less/ zero carbon content of materials	In the Resource Allocation category, Envision apart from suggesting recycled-content materials as alternative to the of use primary resources should assess the use of innovative resources
Resource Efficiency (materials)/ **Durability/ Adaptabilit y**	**Credit LD1.4 Pursue Byproduct synergies presents the potential of resource efficiency, however circularity can potentially present more opportunities.** This is evident through the possibilities of 'material passports'.	**Credit LD1.4** could make reference to materials passport as an opportunity for a company to identify the value of its own excess materials and/or identify opportunities in the excess materials of other companies. Materials passports are digital datasets that optimize the value recovery from materials by connecting data to physical products, make this

assess the projects' exposure to risks, resilience and overall performance in relation to the anticipated physical impacts and the given localities."Technical Supplement-The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities", TCFD, June 2017,
https://www.tcfdhub.org/scenario-analysis/

		information more easily accessible and applicable to the supply chain, thus facilitating efficient material flows. Digital passports enable: ● circularity (durability, repairability, spare parts, recycled content, recyclability, dismantability, etc); ● value chain cooperation: designing – assembling – selling – using – reusing – collecting - sorting – recycling; ● Footprinting and emissions data; ● Supporting information for green claims[408]
Durability	**Provide more examples of strategies that contribute to durability quality as guidance for project teams.**	Examples of strategies that could be added for increased durability ● Use of materials with crack healing properties, such as self-healing asphalt and self-healing bio-concrete, for improved mechanical properties and durability ● Improved construction quality through increased use of prefabrication, modular assembly, and offsite construction (manufacturing in a controlled environment rather than a construction site enables enhanced construction quality, therefore durability). ● Improved construction quality through intelligent construction systems, machines and technologies with real-time monitoring of material placement and compaction (e.g. using electromagnetic technologies like infrared)[409] ● Pre-stressed concrete slab technology for increased durability and better crack control
	Enhancing durability definition within credit CR2.5.	Durability also includes resistance to extreme heat waves, increased anti-corrosion protection due to increased flooding.(e.g. materials that withstand extreme weather conditions)

A general comment is regarding how innovation is assessed and rewarded in Envision. Envision rewards innovative approaches and practices through the 'Innovate or exceed requirements' credits that provide 'bonus' points to projects for exceeding requirements or using innovative methods, resources, technologies or processes. Given the core role of innovation in achieving the aggressive GHG reduction targets that are necessary for transition to a low-carbon paradigm, a question that emerges is if Envision should incorporate

408 https://www.betterworldsolutions.eu/eu-materials-passport-platform/

409 National Academies of Sciences, Engineering, and Medicine 2020. *Strategic Issues Facing Transportation, Volume 7: Preservation, Maintenance, and Renewal of Highway Infrastructure*. Washington, DC: The National Academies Press.

innovation in its guidance and requirements within relevant credits of at least Resource Allocation and Climate & Resilience credits, to underline their significance.

PART 5: EXAMPLES OF MITIGATION & ADAPTATION PROJECTS

1. PROJECT SELECTION

Two projects were selected and analyzed (a) to provide insight on how climate change risks and opportunities are addressed on a project level and (b) to provide representative examples of projects that could be prioritized by Envision.

1.1. Criteria for project selection

The ISI's Database of Envision awarded projects was used for identification of representative projects.

Part of the criteria for selection can be the project's award (Platinum or Gold) and the specific scores in the Resource Allocation and Climate and Resilience categories, and the year of project completion, most preferably after 2015. Scores per category have been attained for 19 projects, listed below.

Table 61: List of 18 Envision awarded projects with performance scores per category

	PROJECT	SECTOR	YEAR	AWARD LEVEL	SCORE (%)				
					QL	LD	RA	NW	C&R
1	Snow Creek Stream Environment Zone Restoration Project, Placer County, CA	Land/Environment	2013	**Platinum**	77%	48%	34%	92%	45%
2	South Los Angeles Wetland Park, Los Angeles, CA	Water	2014	**Platinum**	57%	56%	43%	92%	21%
3	Sun Valley Watershed Multi-Benefit Project, Los Angeles, CA	Water	2014	**Platinum**	75%	85%	39%	86%	55%
4	Low-Level Road, North Vancouver, BC	Transportation	2015	**Platinum**	78%	61%	21%	54%	66%
5	Kansas City Streetcar, Kansas City, MO	Transportation	2016	**Platinum**	91%	62%	27%	25%	43%
6	Ohio River Bridges - East End Crossing, Jeffersonville, IN	Transportation	2016	**Platinum**	92%	79%	13%	46%	57%
7	Nutrient Management Facility, Alexandria, VA	Wastewater	2016	**Platinum**	53%	59%	49%	75%	40%
8	Highway (I-4 Ultimate), Orlando, FL	Transportation	2017	**Platinum**	81%	79%	26%	44%	23%
9	CIP 2406 - Digester Gas Utilization Project, Los Angeles, CA	Energy	2018	**Platinum**	47%	56%	55%	85%	48%

10	TIWRP - Advanced Water Purification Facility, Los Angeles, CA	Wastewater	2018	**Platinum**	52%	56%	48%	62%	61%
11	California High-Speed Rail Program, Sacramento, CA	Transportation	2020	**Platinum**	80%	75%	61%	25%	93%
12	William Jack Hernandez Sport Fish Hatchery, Anchorage, AK	Land/Environment	2013	**Gold**	50%	64%	32%	57%	18%
13	Ridgewood View Reservoir and Pump Station, Portland, OR	Water	2016	**Gold**	58%	70%	36%	40%	57%
14	Santa Monica Clean Beaches Project, Santa Monica, CA	Water	2019	**Gold**	34%	47%	51%	55%	43%
15	Starlight Park - Phase II, Bronx, NY	Land/Environment	2021	**Gold**	87%	48%	22%	61%	5%
16	26th Ward WWTP, New York, NY	Wastewater	2015	**Silver**	28%	66%	14%	26%	42%
17	Sheldon Avenue, New York, NY	Water	2017	**Silver**	31%	43%	5%	36%	49%
18	Blower Foul Air Clean-up System, Los Angeles, CA	Wastewater	2018	**Silver**	26%	18%	34%	79%	47%
19	Itinerario ferroviario Napoli-Bari. Tratta Apice – Orsara, 1° Lotto Funzionale Apice – Hirpinia	Transportation	2020	**Platinum**	97%	64%	18%	41%	65%
		overall	**avg score**		**63%**	**60%**	**33%**	**57%**	**46%**
			mean score		**58%**	**61%**	**34%**	**55%**	**47%**
			max. score		**97%**	**85%**	**61%**	**92%**	**93%**

The two selected projects are:

- The California High-Speed Rail Program (Phase I), in Sacramento, CA
- The Santa Monica Clean Beaches Project, Santa Monica, CA

Both projects are located in California, a US state with a legacy of climate leadership that seeks to align with global climate efforts and a high exposure to the adverse impacts of climate change, already evident.

The first project is an exemplary climate change mitigation project that has the higher score in both RA and C&R categories. Moreover, it is the largest scale project that has ever been rated by Envision. The project is a representative example of how a project aligns to state-level and global level emission reduction targets.
The second project is a multi-benefit project of an underground water harvesting tank in Santa Monica that mainly includes sustainable strategies for climate adaptation but it has parallel benefits in climate mitigation as

well as in other sustainability aspects (social, financial). The project is representative of how adaptation and mitigation can be integral part of a project without being the project's core objective in the first place.

Work on the analysis of these projects will continue based on expected additional information to be provided by the project teams.

1.2. California's Exposure and Response to Climate Change Impacts

1.2.1. California's Climate-related acute risks and chronic stressors

Fig.53: Climate Impacts California is facing. (Source: Safeguarding-california-plan-2018-update)

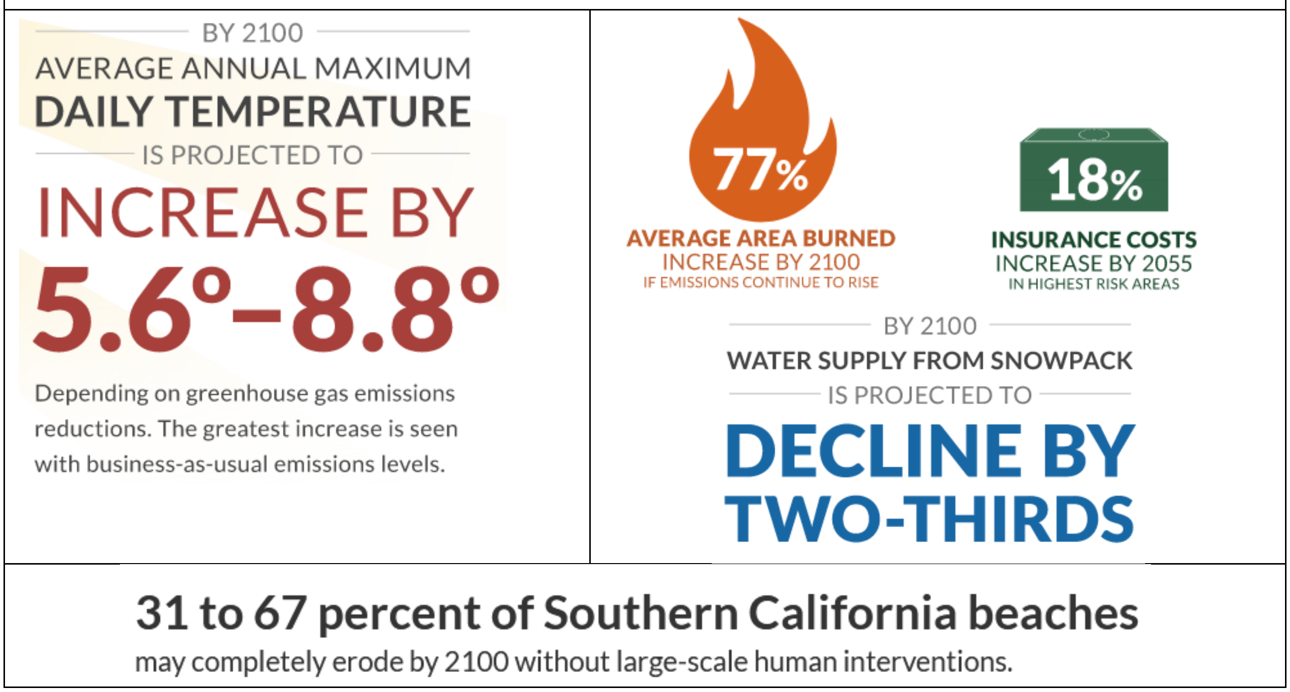
In California, there are several areas of impact from climate change. Increased air pollution, deforestation, ocean acidification, more wildfires, droughts, heat waves and sea-level rise are becoming more common, snow is melting earlier in spring—and in southern California, less rain is falling as well. In the coming decades, the changing climate is likely to further decrease the supply of water, increase the risk of wildfires, and threaten coastal development and ecosystems.

The Paris Agreement brought, for the first time, all nations of the world together around the common cause of limiting global average temperature warming to 2°C [3.6˚F] or less (1.5°C [2.7˚F]) above pre-industrial levels.

The Fourth Assessment study reports estimated climate impacts to California assuming global compliance with the Paris goals, finding that impacts in California would be substantially reduced. However, California still needs to prepare, at a minimum, for significant unavoidable impacts that would occur even if global average temperature rise is limited to 1.5°C, and adopt precautionary adaptation policy to protect against impacts from higher emissions scenarios. While most of these trends have been generally understood and expected since before California's First Climate Change Assessment in 2006, the Fourth Assessment provides new quantitative tools to understand and address these impacts. The updated results from the suite of Fourth Assessment models and analyses demonstrate the importance of achieving global reductions in greenhouse gas emissions.[410]

Here are the climate predictions from the fourth climate change assessment[411]:

If greenhouse gas emissions…	are reduced at a moderate rate…	**then California will experience average daily high temperatures that are warmer than the historical average by…**	**2.5°F** from 2006 to 2039.	**4.4°F** from 2040 to 2069.	**5.6°F** from 2070 to 2100.
	continue at current rates…		**2.7°F** from 2006 to 2039.	**5.8°F** from 2040 to 2069.	**8.8°F** from 2070 to 2100.



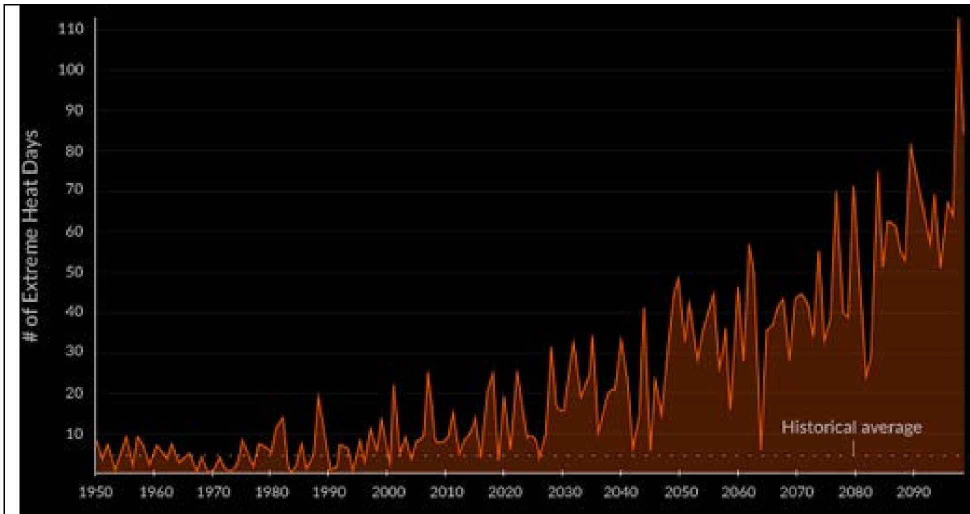
Increased temperature

California is one of the most "climate-challenged" regions of North America; its historical climate is extremely variable, and climate change is making extreme conditions more frequent and severe. California's temperatures are already warming, heat waves are more frequent. While the averages of daily maximum temperatures over

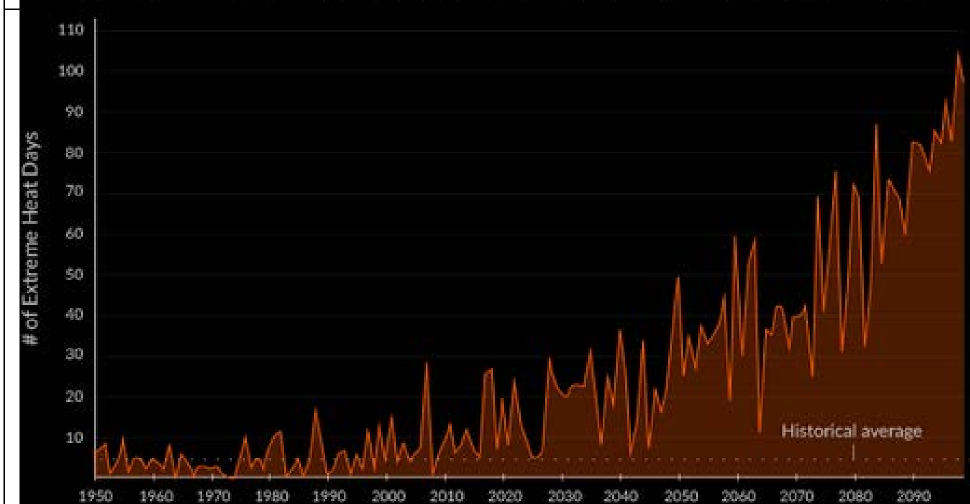
[410] For more information about how the state is already experiencing climate change, the Office of Environmental Health Hazard Assessment presents 36 trends in the Indicators of Climate Change in California report. To understand future impacts, the Cal-Adapt.org web portal is at the forefront of resources for specific communities to understand how climate change will raise temperatures and exacerbate extreme heat events, drought, snowpack loss, wildfire, and coastal flooding. In August 2018, the Fourth Climate Change Assessment was released with several reports detailing the vulnerabilities to climate change across multiple regions and sectors.

[411] Source: California's Fourth Climate Change Assessment Summary

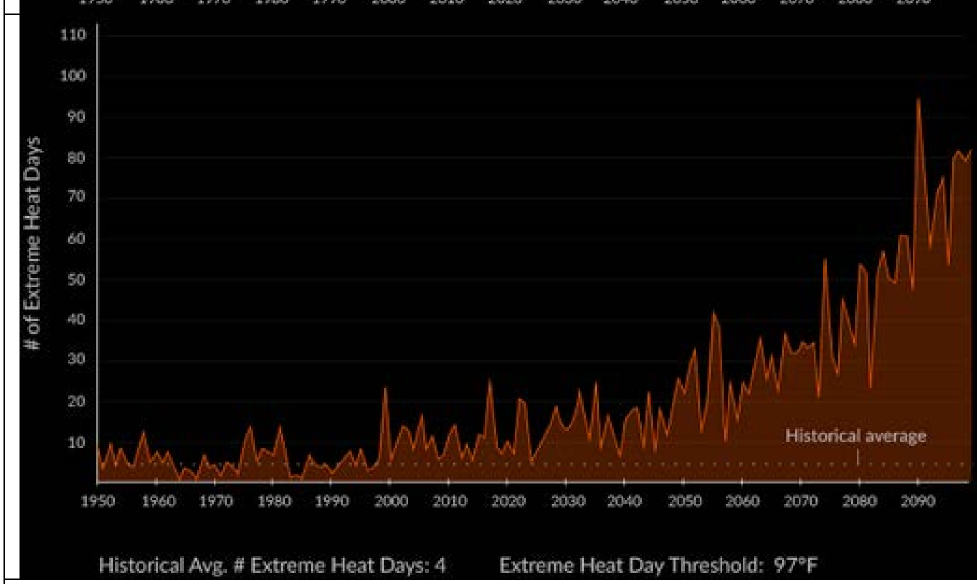
an entire year are easily understood, in many ways this indicator obscures the risks from extreme weather events due to changing climate. For example, the number of extreme heat days will increase exponentially in many areas.



Los Angeles



San Diego



San Francisco

Fig. 54, 55 & 56: number of extreme heat days for the period of 1950-2090 in three CA urban centers:[412]

---

412 Source: https://www.energyupgradeca.org/climate-change/

Rising sea levels

"Approximately 85% of California's population live and work in coastal counties. The sea level along California's coasts has risen nearly 8 inches in the past century and is projected to rise by as much as 20 to 55 inches by the end of the century. A 55-inch sea level rise could put nearly half a million people at risk of flooding by 2100, and threaten $100 billion in property and infrastructure."[413]

"Sea level is likely to rise between one and four feet in the next century. Even a 16-inch rise could threaten coastal highways, bridges, and the San Francisco and Oakland airports. A rise of three feet would increase the number of Californians living in places that are flooded by a 100-year storm from about 250,000 today to about 400,000. Along some ocean shores, homes will fall into the water as beaches, bluffs, and cliffs erode; but along shores where seawalls protect shorefront homes from erosion, beaches may erode up to the seawall and then vanish. The sea could also submerge wetlands in San Francisco Bay and other estuaries, which would harm local fisheries and potentially remove key intertidal feeding habitat for migratory birds."[414]

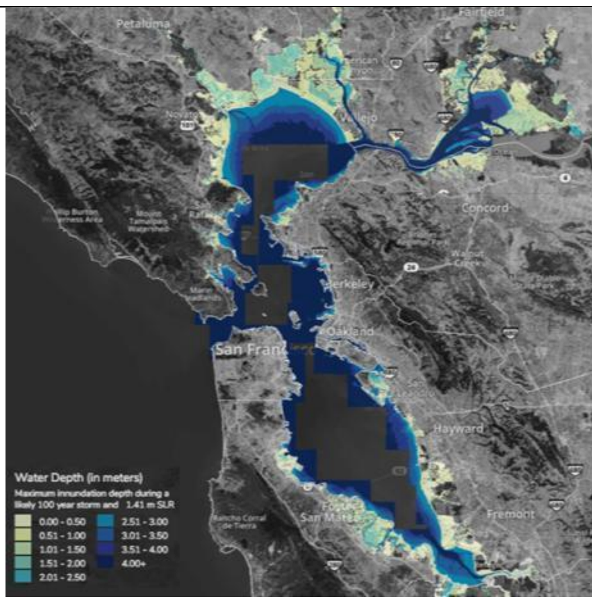


Fig. 57: San Francisco Bay area – no rise

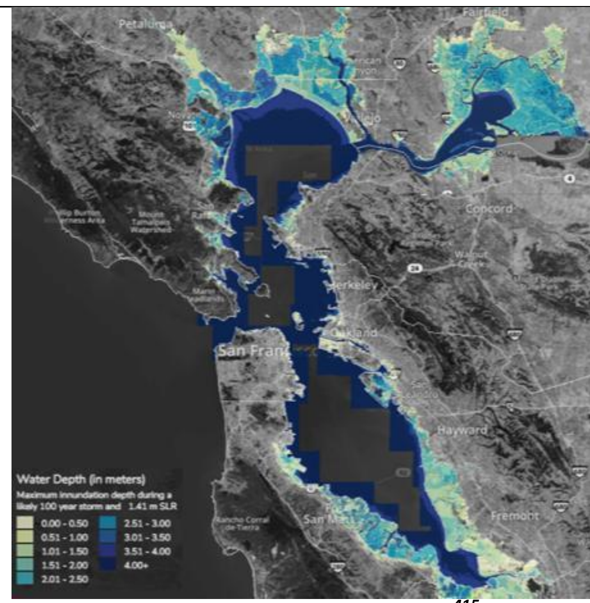


Fig. 58: San Francisco Bay area – rise of 1m[415]

Wildfires and drought events

"Forest and rangelands cover over 80% of California's 100 million acres. Climate change will affect tree survival and growth, reducing these lands' productivity and changing their habitats. In addition, climate change makes forests more vulnerable to fires."[416]

"Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires. On average, 4% of the land in California has burned per decade since 1984. The combination of more fires and drier conditions may expand deserts and otherwise change parts of California's landscape. Many plants and animals

413 https://oag.ca.gov/environment/impact
414 Source: "What Climate Change Means for California". EPA August 2016.
415 Source: https://www.energyupgradeca.org/climate-change/
416 https://oag.ca.gov/environment/impact

living in arid lands are already near their tolerance limits. A warmer and drier climate would generally expand the geographic ranges of the Sonoran, Mojave, and Great Basin deserts. In some cases, native vegetation may persist and delay or prevent expansion of the desert. In other cases, fires or livestock grazing may accelerate the conversion of grassland to desert in response to a changing climate. For similar reasons, some forests may change to desert or grassland."[417]

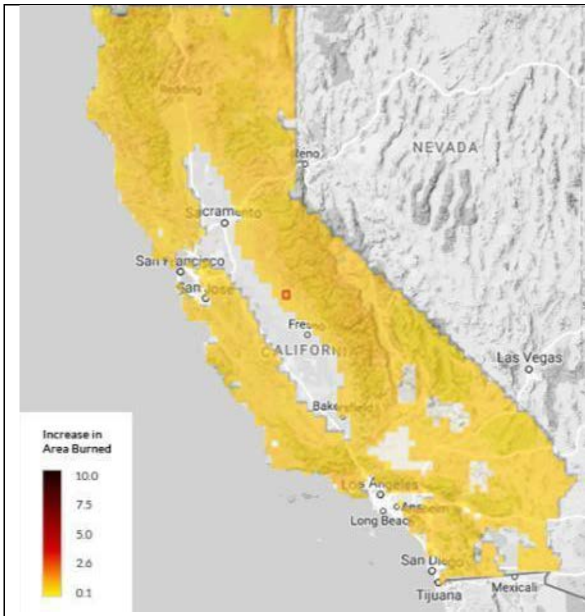


Fig. 59: 2020 Increase in area burned

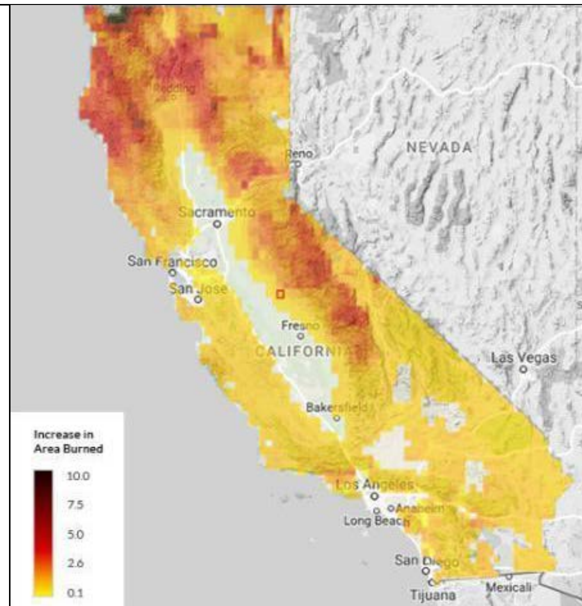


Fig. 60: 2085 Increase in area burned[418]

Warm temperatures are affecting drought impacts. The last 20 years California has experienced the 5-year event of 2012-2016, and other notable historical droughts included 2007-09 and 1987-92. Provisions of California's Emergency Services Act have been used to declare a statewide drought emergency for only two of our droughts, the 2012 to 2016 event and its immediate predecessor in 2007-09. Public health and safety impacts are primarily associated with catastrophic wildfire risks and drinking water shortage risks.

417 Source: "What Climate Change Means for California". EPA August 2016.

418 Source: https://www.energyupgradeca.org/climate-change/

1.2.2. California's Climate Initiatives

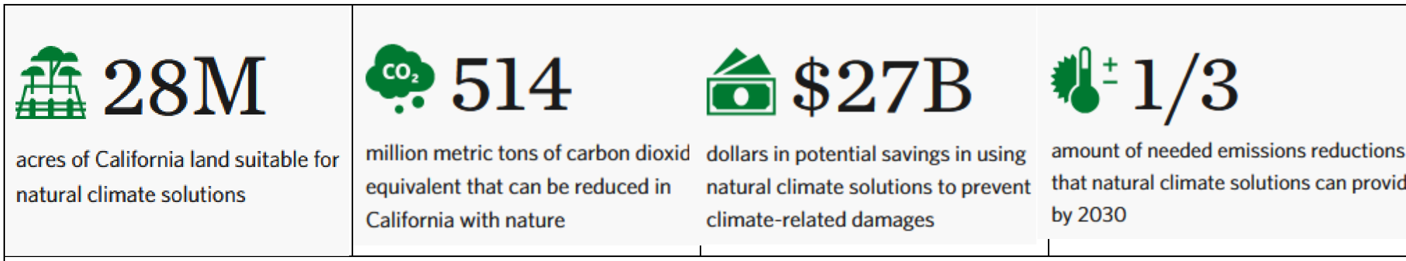


Fig. 61: CA climate opportunities in numbers. (Source: The Nature Conservancy website)

California has a legacy of climate leadership. California's policies set a national tone on climate change, developing clean energy, curbing greenhouse gas emissions, benefiting disadvantaged communities, protecting endangered species and valuable agricultural lands, and transitioning to a sustainable, low-carbon future. Consequently, California must invest in projects that reduce pollution for communities and deliver short- and long-term GHG emissions reductions. The State has also clearly set itself on the path to carbon neutrality earning a leading position globally.

California Climate Investments are administered by state and local agencies for a variety of greenhouse-gas cutting programs, including energy efficiency, public transit, low-carbon transportation and affordable housing. Guidelines written by the California Air Resources Board (ARB)[419] help these agencies develop programs that meet statutory requirements for reducing emissions while maximizing the benefits to disadvantaged communities.

Preparing for future conditions and designing resilient infrastructure is also important to the State of California and its communities. In 2015 a landmark Executive Order (EO B-30-15) required state agencies to account for climate change impacts in investment decisions. This legislation was followed by others and a statewide guidance document, "Planning and Investing for a Resilient California," which provides recommendations for how state agencies can begin to evaluate climate change impacts and develop adaptation responses.

California's Global Warming Solutions Act of 2006 (AB 32), landmark legislation, set an absolute statewide limit on GHG emissions, and confirmed California's commitment to transition to a sustainable, clean energy economy. In 2016 California extended and strengthened the limit on GHG emissions with the passage of SB 32, raising its **goal to 40% below 1990 levels by 2030.**

"California is now demonstrating impressive outcomes from the implementation of its climate policies. After the first decade of AB32 implementation, California's economy is growing while carbon pollution is declining. With innovative advancements in clean energy and energy efficiency, the state is well on the way to meeting its renewable energy target. More recently, the state is seriously considering an opportunity to leverage its cap-and-trade program to protect rainforests around the world via its proposed California Tropical Forest Standard.

[419] CARB is charged with protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change. From requirements for clean cars and fuels to adopting innovative solutions to reduce greenhouse gas emissions, California has pioneered a range of effective approaches that have set the standard for effective air and climate programs for the nation, and the world.

The proposal sets out comprehensive requirements for large-scale programs to reduce emissions from tropical deforestation to be considered for crediting in future compliance markets worldwide."[420]

By taking bold action California is a leader on climate change at the subnational level. The State has a climate and energy portfolio with an excellent foundation from which to grow, aligning with climate policies around the world. The 2018 Update to the Safeguarding California Plan is a roadmap showing how California's state government is taking action to respond to climate change. Over 1,000 ongoing actions and next steps, organized by 76 policy recommendations across 11 policy sectors, were developed through the scientific and policy expertise of staff from 38 state agencies.

2. CALIFORNIA HIGH-SPEED RAIL PROGRAM (Phase I)

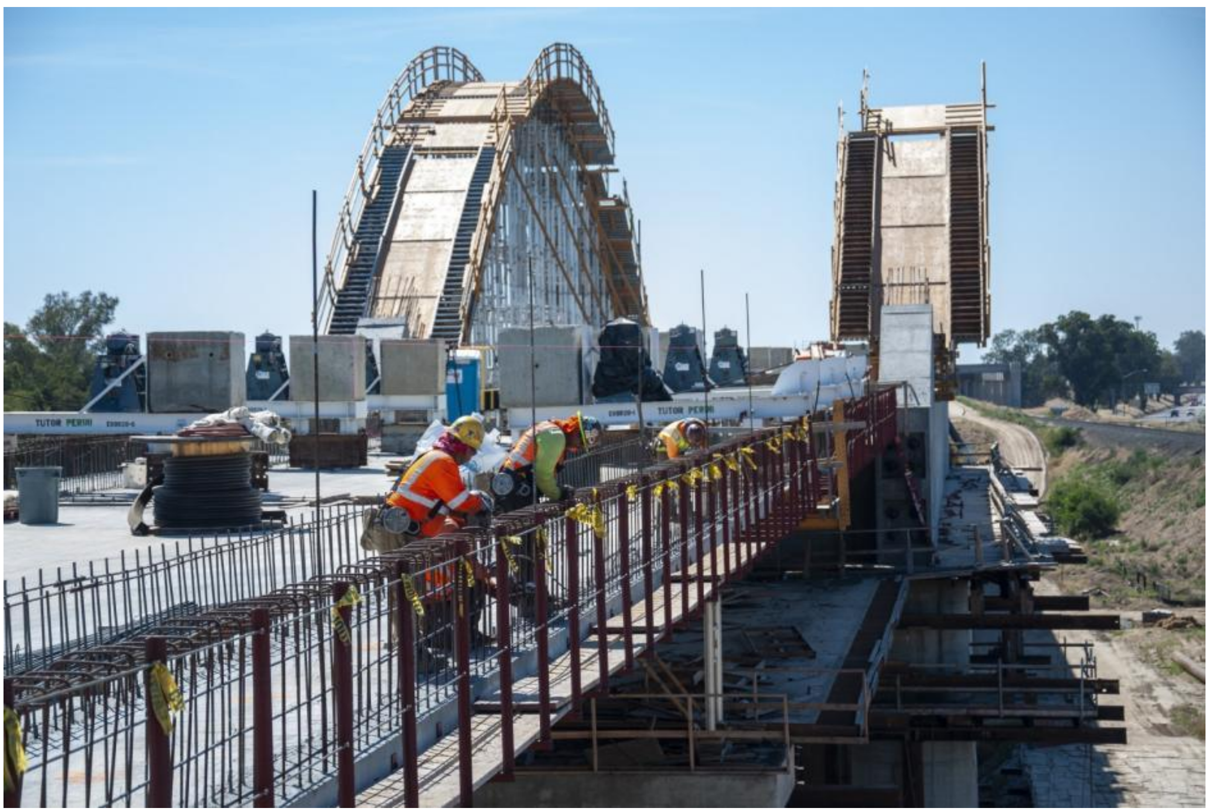


Fig. 62: San Joaquin river viaduct

The California High Speed Rail (CHSR) is considered as one of the leading climate mitigation projects in California. It is estimated that the project will reduce emissions by more than 100 million metric tons of CO2e ($MTCO_2e$) from operations and 47 million from associated projects. This case study concerns the climate change mitigation efforts and strategies associated with the implementation of the CHSR program. The project has been awarded with the Envision platinum award and the findings of this report are based on its assessment and

420 https://www.edf.org/climate/california-leads-fight-curb-climate-change

verification. The most significant volume in climate mitigation is the contribution from high-speed electrified rail network and using 100% renewable energy in its operation. For climate adaptation the project reduces heat island effects by implementing vegetative shading, green roofs, and choosing materials with high SRI values at all rail stations and operations and maintenance facilities, and it has conducted a comprehensive, multi-hazard climate change risk and resilience evaluation. The focus of this section is to synthesize and shed light on the CHSR mitigation and efforts along the project lifecycle, to understand what each of the actions entails, how these would be implemented, and by which stakeholder, as well as understanding the impacts along the transit corridor.

Fig. 63: ***Cedar Viaduct on April 2021***[421]

2.1. Project Description

421 Image source: https://www.buildhsr.com/construction_update/

QUICK FACTS

- ✓ Over 800 miles of rail & up to 24 stations.
- ✓ The project has been broken into ten separate sections.
- ✓ The Envision awarded in December 2020 the first Phase that refers to the 520 mile San Francisco/Merced to Los Angeles/Anaheim section of the program, approved by California voters in Proposition 1A in 2008.
- ✓ The whole project will be powered by electricity generated from renewable energy sources.
- ✓ Its construction started in 2016[1] and it has an estimated completion in 2033.
- ✓ Total cost for phase 1: $77.3 billion
- ✓ It is funded from both state and federal sources.
- ✓ Project owner/manager: California High Speed Rail Authority

LENGTH	LESS THAN	SPEED
1288 km	3 hours	350 km/h

The CHSR program's main goal is to not only deliver a high-speed rail system that will contribute significantly to a more sustainable California, but also to employ leading methods during construction to make the country's largest infrastructure program a model for sustainable delivery. To meet these commitments, the project has defined five key sustainable infrastructure principles to guide the system's design, construction and operation:

- Net-Zero Greenhouse Gas and Criteria Pollutant Emissions in Construction
- All electric
- Use of 100%renewable energy for system operation.
- Delivering LEED® Platinum/Net Zero Facilities by overseeing design and contract specifications[422].
- Integrating climate adaptation and resilience principles into the design, construction and operation of the system.
- Making a priority lifecycle performance of components, systems and materials.

2.1.1. The California High Speed Rail (CHSR) Program

The California High Speed Rail (CHSR) is the first high speed rail project in the US (CHSRA, 2021). The project is a 800-mile rail line, with speeds above 200 miles per hour and is estimated to take at least 14 years to complete.

422 For example, the Anaheim Regional Transportation Intermodal Center (ARTIC) stop, which opened for service in December 2014, is currently the premier transportation hub for Southern California. A state of the art site, it includes dining, retail, and entertainment options alongside a variety of transportation services, including OCTA, Metrolink, and Amtrak. The 67,000 square-foot hub, designed by HOK, will join 24 other locations in being a part of the massive speed-rail line along California. With achieved Platinum LEED status, the site includes sustainable features such as photovoltaic shade structures in the parking lot, a radiant flooring system, and managed to keep ninety-five percent of the construction waste diverted from landfills. Source: https://www.architectmagazine.com/design/buildings/california-officials-break-ground-on-high-speed-rail_o

It is a publicly funded system that is managed by the CHSR Authority (CHSRA) that was established by an act of the CA State Legislature.

The first phase of the project links San Francisco with Los Angeles and Anaheim and is approximately 520 miles long with completion expected in 2029. The line will connect the San Francisco basin to the Los Angeles basin in less than 3 hours. In this phase the line will run through Anaheim up to Burbank, Palmdale, Bakersfield, and Fresno; then west to Gilroy, San Jose and into San Francisco. In Phase 2, the route is planned to be extended north from the Central Valley to Merced, Modesto, Stockton, and Sacramento and south to Riverside, Escondido and San Diego. Upon completion the total system will have a total of 24 stations.

As illustrated in the following figure 60, the CHSR network will connect cities and economic regions within northern and southern California. It will be built in the following segments:

Table 62: Project segments[423]

Central Valley: Bakersfield – Fresno – Merced	Under Construction
Caltrain Electrification: San Francisco – San Jose	Under Construction
Los Angeles Urban Mobility Corridor: Burbank – Los Angeles – Anaheim	Environmental approval underway
Pacheco Pass, closing the northern gap: San Jose – Merced	Environmental approval underway
Tehachapi Crossing, closing the southern gap: Bakersfield – Palmdale	Environmental approval underway
Antelope Valley: Palmdale – Burbank	Environmental approval underway
Virgin Rail: Las Vegas – Victorville	Ready for construction
Virgin Rail: Victorville – Palmdale	Design work & environmental docs underway
Inland Empire: Los Angeles – San Diego	The California High Speed Rail Authority will begin designing new high-speed line as construction wraps up on the Los Angeles – San Francisco trunk.
Sacramento – Stockton	
Stockton – Merced	

The timing of those segments is driven in large part by mountain ranges and funding availability. The Central Valley and Silicon Valley segments are under construction. The planning and environmental documents for the remaining segments are expected to be approved this year.[424] Then, the state can seek additional funds to expedite construction of the remaining sections. The line will eventually operate on dedicated, grade-separated tracks for almost the entirety of its route. The San Francisco–San Jose and Los Angeles–Anaheim sections will be shared with local trains in a "blended system".

423 https://www.hsrail.org/californias-high-speed-rail-phasing-plan
424 https://www.hsrail.org/californias-high-speed-rail-phasing-plan

Fig. 64: CHSR project status (April 2021) and project phases. Source: CHSRA, 2021

2.1.2. Project scale and significance

The CHSR project is both large in scope and in high-profile areas. It is the backbone of California's greater innovative state rail plan and the greenest infrastructure project in the nation, both in construction and operations. It is considered as one of the leading infrastructure projects in North America and is part of the state's solution to reduce transportation GHG emissions by shifting travel away from automobiles and short-haul air travel. It sets important emissions reduction targets since its early planning stages.

In 2008, the California Air Resources Board included the high-speed rail system as one of the measures to achieve the required greenhouse gas emissions reductions to comply with AB32. The high speed rail system has been included in subsequent scoping plan updates, including the latest update which emphasized its role as the spine of electrified mass transportation that, uniquely, reduces air travel. "The average annual greenhouse gas emissions savings of the system, as much as 2 million metric tons of carbon dioxide equivalent, would be equal to taking 400,000 passenger vehicles off the road every year – roughly all of the cars registered in San Francisco County."[425]

It has been certified and awarded by several sustainability benchmarks:

- LEED, and Envision platinum award in 2020 for phase I.
- The GRESB Infrastructure Assessment top sustainable rail infrastructure project in North America with five stars and fourth among all global participating infrastructure assets in 2016, in the GRESB Infrastructure Assessment.[426] This achievement validates its leading position against environmental, social and governance measures at North American and international scales.

2.1.3. California's public transportation network

The HSR segments will be added to the state's already robust network of trains and buses over time. California has an extensive network of feeder buses that are timed to meet the state's three Amtrak routes (shown in the following map) at many stations, with passengers using a single ticket for both parts of the trip. Commuter rail and local bus networks extend the reach to most of the state. At the state level, the CHSRA is working with regional partners, such as Caltrain and others, to implement a rail modernization plan and electrification (CHSRA, 2021). This innovative state rail plan is being used to coordinate actions of the CHSRA and many transit agencies as each part of the plan is developed. As a coordinated network, every segment, high-speed, conventional and bus, will see a big boost in ridership, transforming the travel throughout the state. Individual segments of high-speed line are designed to take advantage of and enhance this network. High-speed rail stations will be built to make transferring between high-speed trains, conventional trains and feeder buses quick and easy.

425 CHSRA 2021. "Good for the Environment" document.

426 The GRESB Infrastructure Assessment is a globally consistent, voluntary framework that benchmarks the environmental, social and governance performance of infrastructure assets and funds. It ranked the CHSR in relation to its peers and provided useful insight into the integrity of the sustainability policies, practices and performance. Source: CHSR Sustainability Report 2018.

Fig. 65: California Amtrak and Feeder Bus Network. Source: https://www.hsrail.org/californias-high-speed-rail-phasing-plan

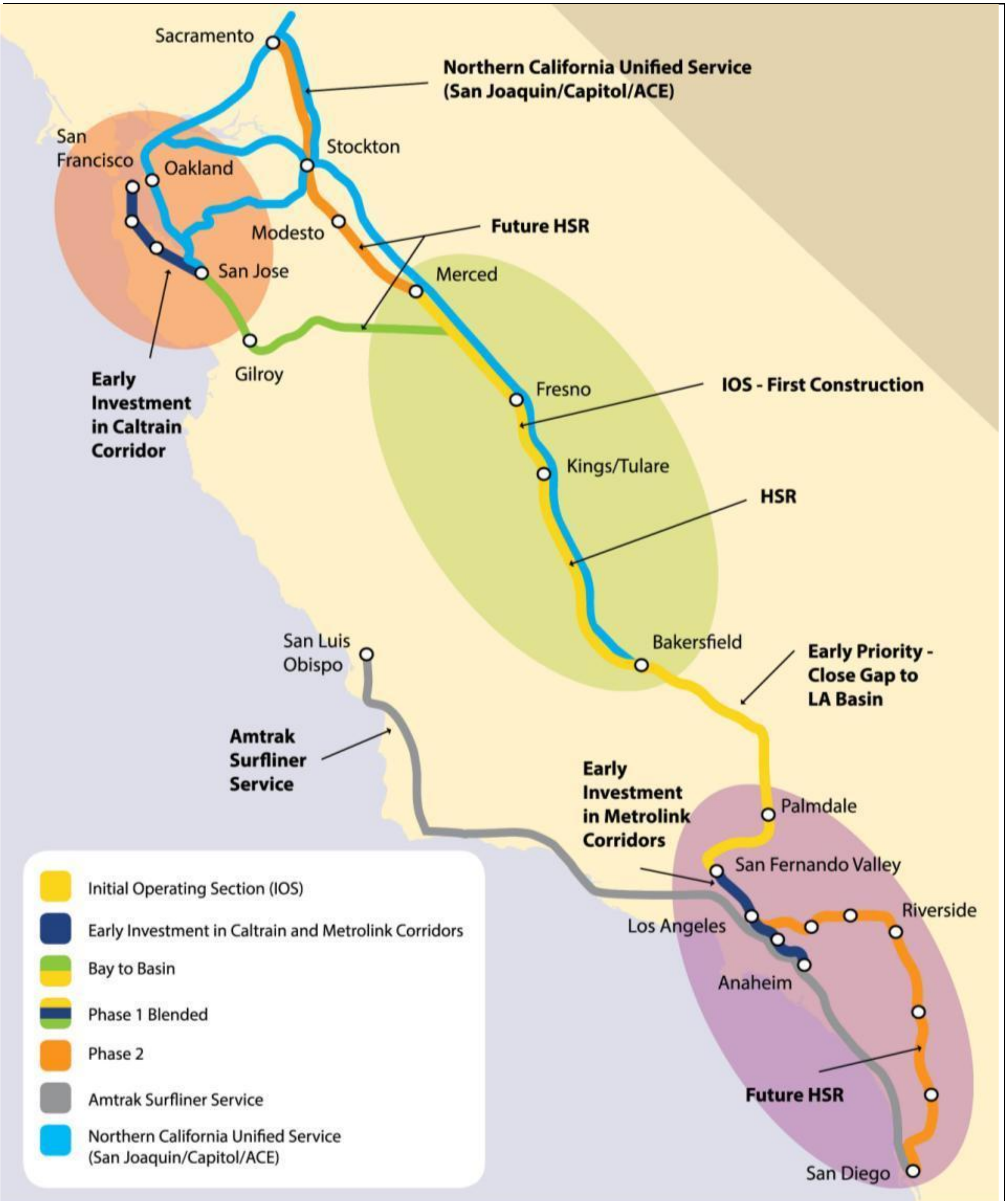


Fig. 66: Statewide Rail Modernization. Source: CHSRA 2013.

2.1.4. Project cost and funding

"One of the biggest challenges the Authority faces is securing full funding for delivering the system. To date, the California High-Speed Rail Authority (Authority) has secured significant funds from both state and federal sources. These funds are being used to deliver the Central Valley Segment and complete environmental planning and other early work for the entire Phase 1 System, consistent with federal grant agreements. The cost of CHSR Phase I is estimated at $77.3 billion with a completion schedule of 2033 (CHSRA, 2021).

CHSR is a long term investment for the future of California. Over the last 10 years, the Authority has secured approximately one-third of the funds needed to complete the current estimated cost of the system."[427] As of June 30, 2020, the Authority has received:

- Commitments of $3.5 billion from the federal government
- $929 million in additional funding authorized though a Fiscal Year (FY10) Transportation, Housing and Urban Development grant;
- $2.5 billion from the American Recovery and Reinvestment Act of 2009 (ARRA) in 2009
- $9.0 billion from Proposition 1A bonds ($8.5 billion for capital outlay expenditures)
- 25% of annual Cap-and-Trade proceeds on a continuous basis since 2014, plus one-time appropriations, facilitated by CARB programs. has been updated in 2017 to continue through 2030 (CHSR, 2021). Through December 2017, the Authority received $1.7 billion in Cap-and-Trade proceeds for high-speed rail (CHSRA 2018) and through June 2020, nearly $3.3 billion. (CHSRA 2020)

Table 63: Funding and Investment ($ In Billions), Source: CHSR Sustainability Report 2020

Funding and Investments	2015	2016	2017	2018	2019
Total Invested	-	$2.3	$3.5	$5	$5.7
Investment in California Firms/ Workers	-	94%	97%	97%	98%
Federally Funded Investment	-	70%	70%	73%	73%*

* The Authority has received $2.55 billion of the $3.5 billion in federal funds anticipated for the project. The remaining $928 million FY10 grant agreement is unexpended at this time and was terminated by FRA on March 4, 2019. The termination is now subject to a legal suit filed by the State of California on behalf of the Authority on May 21, 2019.

The project's participation in the GRESB Infrastructure Assessment is of value for ways to attract private investment. The assessment was developed at the behest of major institutional investors, including CalPERS, PGGM Investments, AIMCo and others collectively representing more than 17 trillion dollars in institutional capital, to evaluate consistent sustainability information concerning the infrastructure investments within their portfolios. Anticipating the information that major investors could seek, helps the project align the reporting efforts with what investors find most important.

The Authority is taking a "building block" approach to funding and delivering the program in order to mitigate funding challenges. In 2017, the Board of Directors conducted a comprehensive review of the current Central Valley construction contracts and cost estimates for the Silicon Valley to Central Valley Line and the complete Phase 1 System. The review resulted in these findings:

[427] Capital Costs & Funding - California High Speed Rail

- A Central Valley Segment estimate-at-completion of $10.6 billion which will be received from federal and state funding, including $3.1 billion from the federal government, $2.8 billion from Proposition 1A bond proceeds and $4.7 billion in current and future Cap-and-Trade proceeds. (CHSRA 2018)
- An updated Silicon Valley to Central Valley Line estimate of $29.5 billion which also reflects an extended completion schedule of 2029

The following statutes guide CHSRA's financial decision-making:

- Assembly Bill 115 (Com. on Budget, Chapter 38, Statutes of 2011): Budget Act of 2011
- Senate Bill 1029 (Com. on Budget, Chapter 152, Statutes of 2012): Budget Act 2012
- Senate Bill 852 (Leno, Chapter 25, Statues of 2014): Budget Act of 2014
- As an investment, when its planning begun in 2008, the California senate bill *SB-862 Greenhouse gases: emissions reduction,* established the Greenhouse Gas Reduction Fund was created. It identified the high-speed rail system **as a high priority project** for greenhouse gas reductions in the state and established the CHSRA. $400 million in funds were allocated for the initial phase of the project (Senate Bill No. 862). Also, the project receives about 25% of all the cap-and-trade[428] funds generated each year, which **is the largest from all the California Climate Investments (CCI) funded projects** (CHSRA, 2020).[429]
- The project's 2019 Equivalent Capacity Analysis Report estimates what it would take and cost to add the equivalent of the high-speed rail system's people-carrying capacity to the state transportation network using highways and airports. The report's key finding shows that California would need to construct approximately 4,200 highway lane-miles, add 91 airport gates and build two new airport runways to provide capacity equivalent to the Los Angeles/Anaheim to San Francisco high-speed rail system. As shown in the following figure, **the equivalent roadway and airport capacity would cost about twice as much as high-speed rail and would not advance California's climate goals.**

---

428 The program is central to meeting California's ambitious goals to reduce greenhouse gas emissions to 1990 levels by 2020 (which it met in 2016), 40 percent below 1990 levels by 2030, and 80 percent below 1990 levels by 2050. California also has additional goals of achieving 100 percent carbon-free electricity by 2045 and economy-wide carbon neutrality by 2045. The California Air Resources Board (CARB) implements and enforces the program.

429 In addition to California's regulatory and market-based programs aimed at reducing GHG emissions, investments from various sources provide incentives for companies to reduce emissions. Combining strategic financial investments with policy support can accelerate market transitions to cleaner technologies. One important source of funding is the Greenhouse Gas Reduction Fund (GGRF), which will be used to fund a variety of projects that will provide long-term reductions in GHG emissions. Funding for the GGRF comes from auction proceeds that are part of CARB's Cap-and-Trade program. As directed by legislation, CARB's Investment Plan evaluates opportunities for GHG reductions and identifies priority investments in the state to help achieve emission goals and realize important co-benefits. Source: https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006

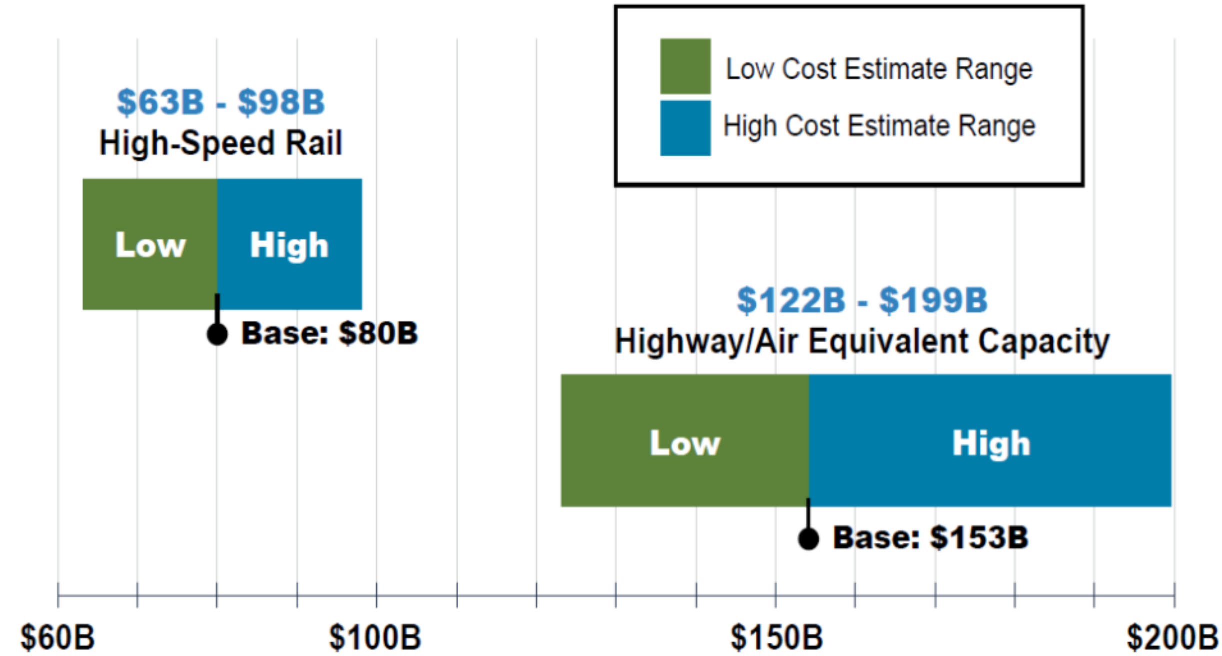


Fig. 67: Cost of Phase 1 High-Speed Rail Compared to Equivalent Cost in Highway/Airport Capacity (Source: 2019 Equivalent Capacity Analysis Report)

2.2. Envision Performance

Table 64: Project score per Envision category

CATEGORY	SCORE
QUALITY OF LIFE	80%
LEADERSHIP	75%
RESOURCE ALLOCATION	61%
NATURAL WORLD	25%
CLIMATE AND RESILIENCE	93%

> *POLICY STATEMENT:*
> *"The Authority will deliver a sustainable high-speed rail system for California that serves as a model for sustainable rail infrastructure. The Authority has developed and will continue to implement sustainability practices that inform and affect the planning, siting, designing, construction, mitigation, operation, and maintenance of the high-speed rail system."*
> *Source: CHSR Sustainability Report 2018*

In the Climate and Resilience (CR) category of Envision, the CHSR received a 93% score and in the Resource Allocation (RA) category a 61% score. Both are the highest scores in the respective categories of all Envision awarded projects until today. Additionally, CHSR is the largest transportation program both in terms of capital investment and geographic area to earn an Envision award for sustainable infrastructure to date. The Platinum Envision award achieved by the California High-Speed Rail (Authority) and its program partners in 2020, demonstrates that sustainability is achievable across large-scale and complex transportation systems. It received high scores in all Envision categories.

The project has the potential to contribute to the Sustainable Development Goals, for instance in SDG 13 for Climate Action, the project clearly contributes to the indicator 13.2.1, on the establishment and operationalization of the CHSR system in lowering the greenhouse gas emissions. (UN, 2021).

According to ISI, the purpose of the CHSR project is to provide a backbone of a safe, fast and reliable high-speed electrified train network that will connect the megaregions of the state, contribute to economic development and a cleaner environment, create jobs and preserve agricultural and protected lands (ISI, 2020; CHSRA. 2021).

The CHSR will reduce emissions, provide sustainable rapid transportation, and will connect the largest metropolitan areas of California, the north and the south. The benefits from the CHSR are anticipated to increase over time as the project is completed. The implementation of the CHSR system incorporates along its corridor a series of sub-projects and developments, expected to increase the sustainability and resilience of the communities it connects and serves, and contribute to a cleaner environment.

The key sustainability achievements of the project include:

- Net reduction in air pollution emissions during system operations compared to the baseline (the existing systems the high-speed rail system will replace), and eliminating pollutant sources in the design of the system.
- Exceptional performance in achieving greenhouse gas emissions reductions (more than 100,000,000 $MTCO_2e$ due to mode shift from automobiles and planes) and preparing for climate change.
- Leadership and commitment to sustainability and social equity and justice: the project's executive sponsors and all firms involved in this project are deeply committed to sustainability and have strategies in place to ensure pay equity, fair and equitable work environments, and to attract and retain diverse workforces

- Use of renewable energy: traction power will rely on renewable energy. Stations, as well as other facilities to support the high-speed rail system will be zero-net energy, and in many cases will supply more than 100% of annual energy needs with on-site renewable energy
- Stimulating economic prosperity and development across the state, by providing nearly 3,000 full time jobs, with an emphasis on job creation for people living in historically disadvantaged communities and an emphasis on small business participation.

Climate and Resilience Category

In the Emissions subcategory, the project demonstrated an excellent performance, which was defined by receiving an innovative credit, as well as an enhanced score in reducing embodied carbon (CR1.1), and two restorative scores, one for reducing greenhouse gas emissions (CR1.2), and the other for reducing air pollutant emissions (CR1.3) (CHSRA, 2020).

Table 65: Climate and Resilience Category Scores

CLIMATE AND RESILIENCE: 93%		
CREDIT	LEVEL OF ACHIEVEMENT	POINTS
CR1.1 Reduce Net Embodied Carbon	**Enhanced** At Least 15% Reduction	10
CR1.2 Reduce Greenhouse Gas Emissions	**Restorative** Carbon Negative	26
CR1.3 Reduce Air Pollutant Emissions	**Restorative** Air Quality Improvement	18
CR2.1 Avoid Unsuitable Development	**Enhanced** Risk Mitigation	6
CR2.2 Assess Climate Change Vulnerability	**Conserving** Knowledge Sharing	20
CR2.3 Evaluate Risk and Resilience	**Superior** Community Evaluation	24
CR2.4 Establish Resilience Goals and Strategies	**Conserving** Shared Community Goals	20
CR2.5 Maximize Resilience	**Conserving** Quantifying Improvement	26
CR2.6 Improve Infrastructure Integration	**Restorative** Information Integration	18
CR0.0 Innovate or Exceed Credit Requirements		10

Innovation[430]

The CHSR project innovates through several of its practices, in this extra Envision innovation credit the team presented ten practices or processes where the project overcome significant barriers, or propose scalable and transferable solutions. Among the practices listed by the project team are:

1) Net Zero Energy Stations and Zero Emission Vehicles;
2) Caltrans Electrification Project;
3) Climate-Safe Infrastructure Working Group participation;
4) Climate Change Risk in Safety and Security Management Plan;
5) Heat Island Reduction at Station Facilities;
6) CHSRA-led Resilience White Paper;
7) Wildfire Analysis;
8) Temperature Exposure Analysis;
9) Innovative Future Ready Design Criteria;
10) Construction Emissions reduction strategies.

Specifically for the last innovative strategy, the project addresses **construction emissions that are not currently addressed by the Envision system.** They occur throughout the construction period (2014-2022), and can be divided into the following two main sources:

A. upstream emissions from materials, and
B. construction activities.

Multiple, innovative and stringent requirements in the procurement, relate to greenhouse gas reductions and climate change resiliency. As it is shown in the following figure.

Table 66: Summary of the notable contractor requirements

Greenhouse Gas Emission Reduction	Resilience and Climate Adaptation
Financial incentive for the Contractors to emit less than the allotted site-specific construction carbon dioxide budgets, and financial penalties if the budget is exceeded (**17. Track and Systems – General Provisions**, p.183).	Inclusion of defensible space (of 100 feet) around the HSR centerline, or facilities in wildfire risk areas such as forest, grass and bush covered lands (**18. Track and Systems – Design Criteria Manuel**, p.11).
The use of renewable diesel for all diesel fueled equipment (**17. Track and Systems – General Provisions**, p. 184).	Provision of emergency care supplies (including first aid kits, and automated external defibrillators) in HSR stations, operations and maintenance facilities, and rolling stock for occupants in case of disaster and/or emergency (**18. Track and Systems – Design Criteria Manuel**, p.11; **19. ReLi 2.0 Rating Guidelines for Resilient Design + Construction**, p.18-20).
	Provision 10 days worth of food and water for at least double the expected occupancy for in HSR stations, operations and maintenance facilities, and rolling stock in case of disaster and/or emergency (**18. Track and Systems – Design Criteria Manuel**, p.11; **19. ReLi 2.0 Rating Guidelines for Resilient Design + Construction**, p. 26).
	Maintenance of rail Zero Stress Temperatures with future temperature rise (**17. Track and Systems – General Provisions**, p.183).

430 Envision Credit Cover Sheet for CR0.0 Innovate or Exceed Credit Requirements. Provided by ISI. More information of innovative strategies for emissions reduction will be analyzed later in this section of the report.

The emissions are broken down into the three categories of the Greenhouse Gas Protocol outlined in ISO 14064-2 in efforts to better stand the source of the emissions. A summary of these categories can be seen in the table below.

Table 67: Scope categorization of emissions during project activities

EMISSIONS CATEGORY	ACTIVITIES INCLUDED IN THE EMISSION CALCULATION
SCOPE 1 – DIRECT EMISSIONS	- Emissions related to the construction of the rail system - Estimated emissions related to the operations of the rail system
SCOPE 2 – INDIRECT EMISSIONS ASSOCIATED WITH AUTHORITY ACTIVITES	- Electricity consumption for the Authority's office operations
SCOPE 3 - INDIRECT EMISSIONS ASSOCIATED WITH CONSTRACTOR ACTIVITES	- Contractor vehicle emissions - Contractors office energy consumption (both electricity & fuel consumption)

2.3. Climate Change Mitigation Milestones & Commitments

2.3.1. Milestones set for GHG emissions reduction

The climate mitigation efforts from this infrastructure project can be summarized as an aim to reduce the source greenhouse gases and pollutants from transportation, through avoiding burning fossil fuels, reducing vehicle miles, construction emissions, using clean energy for its operation, and from enhancing sinks by accumulating and storing greenhouse gas on trees and soil through preservation and conservation of vegetated areas along its corridor.

The CHSR system has been designed to significantly reduce greenhouse gas emissions and air pollutants. From 2022 to 2079 it will reduce its emissions by more than 100 million metric tons of CO2e ($MTCO_2e$) from its own operations and 47 million from cumulative emissions from projects associated with CHSR, such as energy efficiency and waste diversion (Cederoth, 2020; CHSR, 2020). Throughout the construction, the CHSRA already requires that the contractors use the cleanest equipment, resulting in the project's construction sites being 50 to 60% cleaner than typical California construction sites, with 97% of all construction waste recycled to date. CHSR will also use fleets that also reduce air pollutant emissions of more than 50% in several criteria pollutants, when compared to regular construction fleets. During operations, the CHSR will run on 100% electricity that will be generated from 100% renewables. The stations and other high-speed rail related facilities will be energy net-positive, increasing environmental benefits and reinforcing California's commitment to renewable energy, and the CHSR program will also contemplate producing green energy onsite, as well as battery storage, which will increase its resilience. Finally the CHSR associated projects sequester CO2 through habitat preservation and restoration activities in 3,750 acres; and through agricultural land preservation of 1,250 acres (Cederoth, 2020). Moreover, CHSRA has planted more than 6,000 trees in the Central Valley and elsewhere in the state to balance out the remaining emissions produced through construction.

2.3.2. GHG emissions reduction commitments

Among its sustainability milestones are the commitments and targets toward emissions reduction. In 2008 the California Air Resources Board supported the implementation of a high speed rail system, listing the project as an emissions reduction measure with 1.0 MMTCO2e for its 1st year of operation of phase 1, that would use 100% renewable energy for its operations, and have long term potential for emissions reductions in the transportation, as well as from low impact transit oriented development (CRB, 2008).

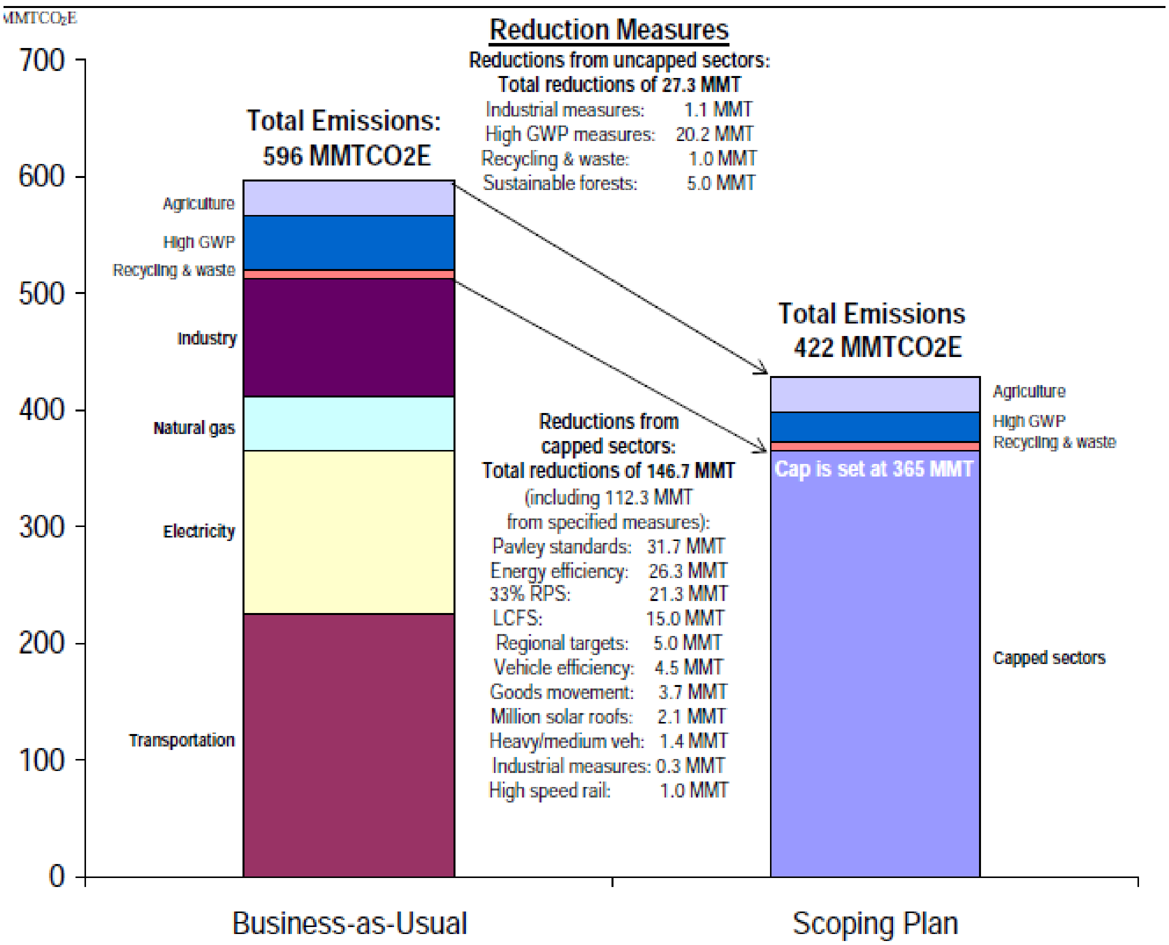


Fig. 68: CA Greenhouse Gas Emissions in 2020 and Recommended Reduction Measures. Source: CA Climate Change Scoping Plan 2008 (CARB 2008).

In 2011, the CHSR was also incorporated in the Scoping Plan for Assembly Bill 32. In 2012, the commitments for net zero emissions were set, such as net zero direct greenhouse gas emissions for construction, net-zero air quality emissions for construction, and proactive construction requirements, such as the use of Tier 4 vehicles and 100% recycling.

In 2014 CHSR becomes the first infrastructure project to require emissions disclosure on major materials as informed AB 262 Buy Clean California Act. For this purpose, the CHSR Authority developed EMMA (Environmental Mitigation Management Application), a customized, web-based tool to enhance data collection, review and analysis that is used by the CHSR and its Project Construction Managers (PCM) to ensure that design-build contractors' submittals demonstrate contract compliance (CHSR, 2019). In 2016, the Board adopted a Sustainability Policy, and in 2017 the project was incorporated in ARB's Scoping Plan update (Cederoth, 2020).

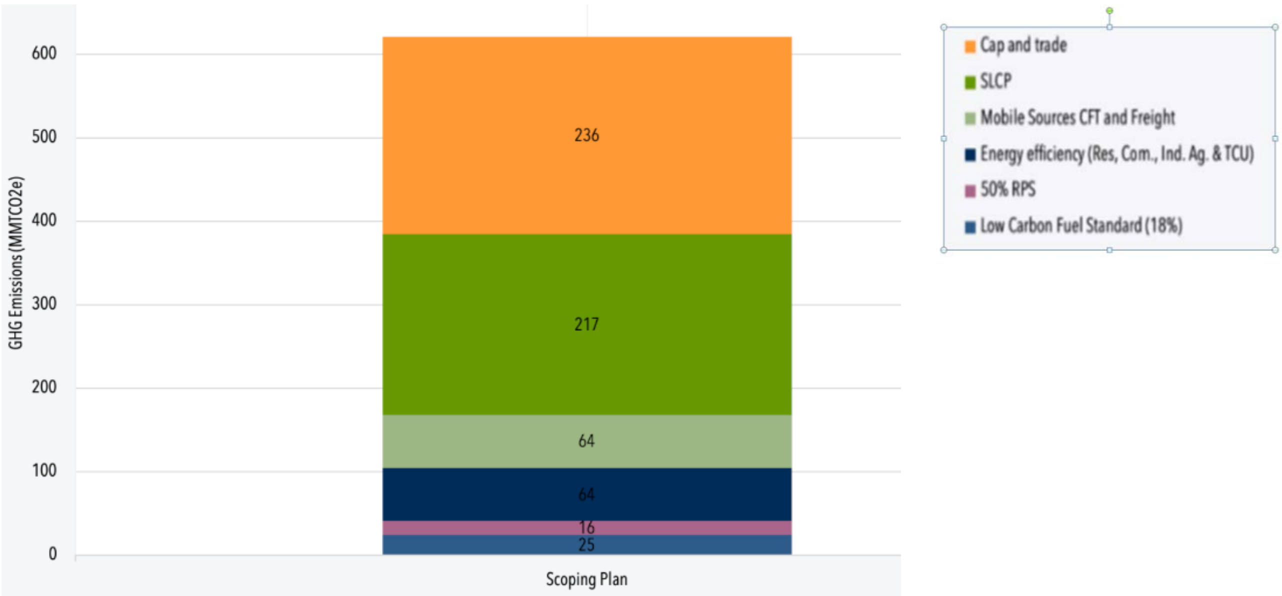
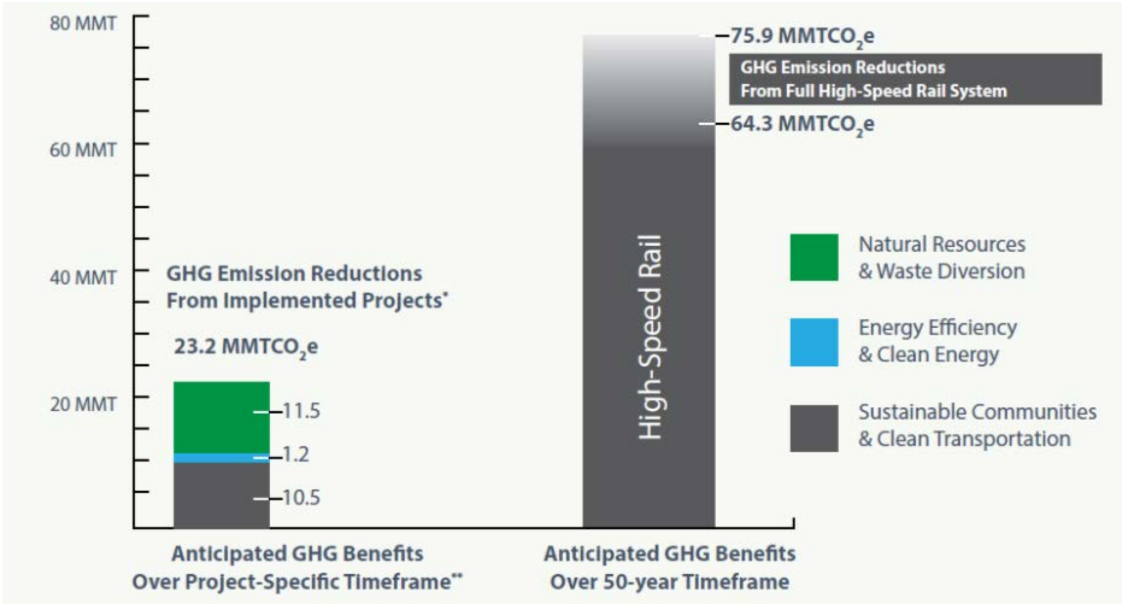


Fig. 69: Projected Cumulative Reductions by Measure (2021–2030).[431]

[431] Source: CA Climate Change Scoping Plan (CARB, 2017)



*Estimates for California Climate Investments implemented through 2016 & 2017; does not include benefits from High-Speed Rail Project.
**https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2018_cci_annual_report.pdf

Fig.70: CA Climate Investments and Greenhouse Gas Emissions Reductions (MMTCO2e=million metric tons of carbon dioxide equivalent) [432]

In 2019, the CHSRA established performance targets requirements for embodied energy in concrete and steel, zero emissions fleet vehicles in 25% of the on road fleet for contractors, and a GHG emissions target for construction, which can lead to a bonus or a penalty. For example, contractors can receive a financial incentive if emitting less than the CO2 budget allotted in a site, and incur into a penalty if the budget is exceeded (CHSRA, 2020). Additionally, the CHSR Authority General Provisions include the use of renewable diesel for all diesel fueled equipment.

Considering the deep impacts from climate change effects in California, climate mitigation is great importance to avoid or reduce significant human interference with the climate system, and to stabilize greenhouse gas levels. The state's Cap-and-Trade Program is one of the key funding mechanisms for the CHSR.[433] Several climate laws, such as the California Global Warming Solutions Act of 2006 (Assembly Bill 32),[434] set the goal for

432 Source: CHSR Sustainability Report 2018

433 Revenues that California receives from the program are deposited into the state's Greenhouse Gas Reduction Fund and then the California Legislature appropriates these funds to state agencies to administer programs that further reduce emissions. A pair of 2012 laws (AB 1532 & SB 535) established guidelines on how this annual revenue is disbursed. The two laws do not identify specific programs that would benefit from the revenue, but they provide a framework for how the state invests cap-and-trade revenue into local projects. AB 1532, requires that the auction revenue be spent for environmental purposes, with an emphasis on improving air quality. Source: https://www.c2es.org/content/california-cap-and-trade/

434 In 2006, the Legislature passed the California Global Warming Solutions Act of 2006 [Assembly Bill 32 (AB 32)], which created a comprehensive, multi-year program to reduce greenhouse gas emissions in California. AB 32 required the California Air Resources Board (CARB or Board) to develop a Scoping Plan that describes the approach California will take to reduce GHGs to achieve the goal of reducing emissions to 1990 levels by 2020. Each of the Scoping Plans have

the state to reduce emissions to the 1990 levels by 2020. In 2016 the Senate Bill 32 GHG emissions reduction target was updated to 40% below the 1990 levels by 2030,[435] and set a deeper reduction of 80% by 2050 (CHSRA, 2019). In 2017, the Assembly Bill 398 bolstered and extended the horizon the Cap-and-Trade Program to ensure its operation until the end of 2030.

To meet the above, the Authority works closely with:

- the California Energy Commission,
- the California Public Utilities Commission (CPUC),
- the California Independent System Operator (ISO), and
- local utilities.

2.4. Climate Change Mitigation Strategies

The CHSR Project, will be a carbon negative, net-zero transportation infrastructure project. This will be achieved through the following key mitigation strategies:

1. **LC GHG Emissions Reduction**
2. **LC Energy Efficiency**
3. **Embodied Carbon Reduction**

2.4.1. Lifecycle GHG emissions reduction- Aiming for carbon negative

Carbon Negative

Emissions reduction:
100,000,000 tCO2e

Carbon sequestration:
46,000,000 tCO2e

The Authority tracks GHG emissions across emissions scopes per the GHG Protocol and with reference to ISO 14064-2:

- Scope 1: Direct emissions from sources owned by the Authority;

- Scope 2: Indirect emissions associated with electricity purchased for Authority activities;

- Scope 3: Indirect emissions associated with contractor vehicles.

**Scope 2 market-based emissions are quantified to be the same as location-based emissions. At this time, the Authority does not procure electricity with known attributes*

---

included a suite of policies to help the State achieve its GHG targets .Source: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan
The full implementation of AB 32 will help mitigate risks associated with climate change, while improving energy efficiency, expanding the use of renewable energy resources, cleaner transportation, and reducing waste. Source: https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006

435 The 2030 target reflects the same science that informs the agreement reached in Paris by the 2015 Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at keeping the global temperature increase below 2 degrees Celsius (°C). The California 2030 target represents the most ambitious GHG reduction goal for North America. Based on the emissions reductions directed by SB 32, the annual 2030 statewide target emissions level for California is 260 million metric tons of carbon dioxide equivalent (MMTCO2e). Source: Scoping Plan 2017. Chapter 1: Introduction. Page 2.

that differ from the grid average.

The following strategies will produce significant emissions reductions that place the project in the carbon negative status. According to CHSRA (2020), the operation of the CHSR will result in a cumulative reduction of 198% in GHG emissions (–99,732,605 tCO2e), when compared to the baseline emissions (102,144,701 tCO2e) for the period 2022 and 2079.

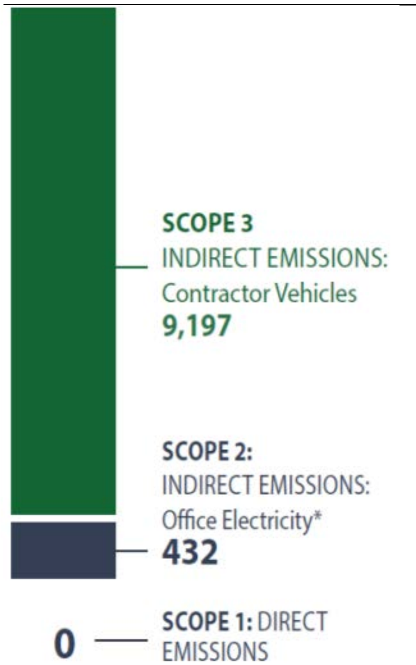


Fig. 71: 2019 annual GHG Emissions (in MMTCO2e)

1. ***Modal shift from airplane and car travel to high speed rail***
2. ***Decarbonization and Electrification strategies***
3. ***Carbon sequestration***
4. ***Construction Emissions Reduction Strategies***

Modal shift from airplane and car travel to high speed rail

The high-speed rail system was planned to shift travel away from automobiles and short-haul air travel and to play a crucial role in California's ambitious plan to reduce statewide GHG emissions to 40% below 1990 levels by 2030.

Projected avoided emissions reflect riders shifting from automobile and air travel to 100% renewable energy powered high-speed rail based on the ridership on ramped up models for the high-speed rail.

From its first year of operation, high-speed rail will contribute to reducing GHG emissions in the state. Every mile traveled on high-speed rail is a mile of avoided travel by automobile or airplane.[436] The emissions associated with these less-efficient forms of travel will be significantly avoided by travelling on the high-speed rail. On average, annual GHG emissions reductions are projected to be 2 million metric tons of carbon dioxide equivalent (MMTCO2e).

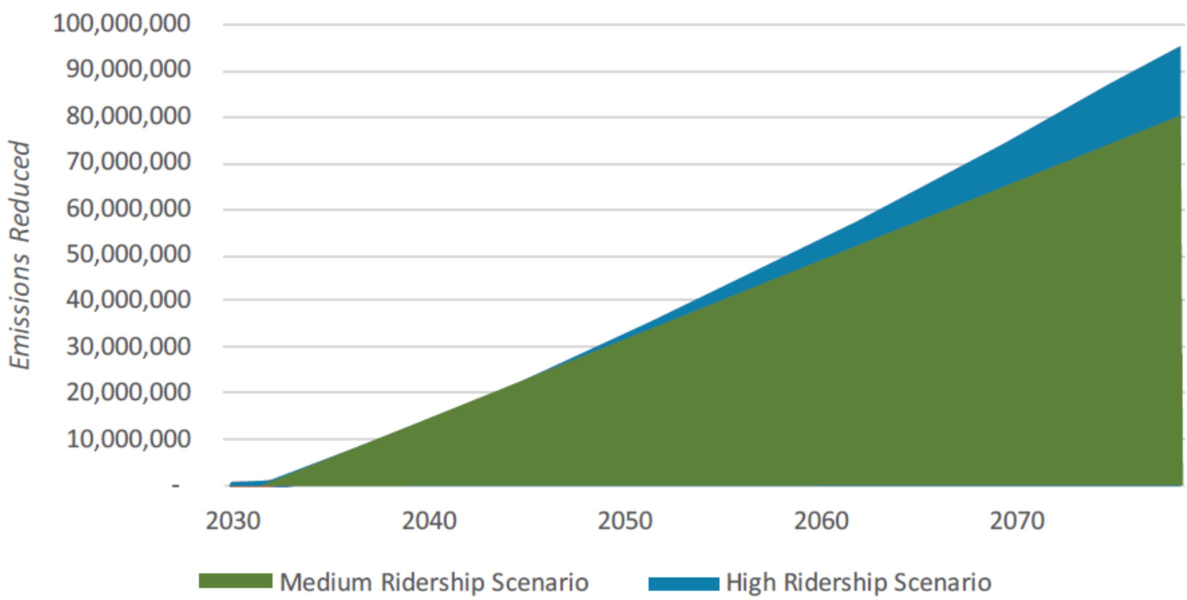


Fig. 72: Projected Cumulative GHG Reductions by 2040, 2050 and by 2079 (MTCO2e). Source: 2020 Business Plan.

Over the first 50 years of operation, as shown above, the cumulative reductions of tailpipe emissions are projected to be between 65 and 79 million metric tons of carbon dioxide avoided. The GHG emissions reduction scenarios reflect the ridership range expressed in the 2020 Business Plan. Ridership is expressed as both a medium case and as a 75th percentile, which provides the medium and high emissions scenarios. This projection informs the baseline case in California's Scoping Plan.

The model[437] provides a range of scenarios depending on train ticket cost, compared against a baseline scenario, and updated every 2 years. The baseline represents a "business-as-usual" scenario, where the transportation modes consist of intrastate vehicle and air travel trips. The model use forecasts of mode shift to

436 The project will reduce travel time in half, by connecting San Francisco to Los Angeles in less than 3 hours, which is expected to reduce vehicle and plane trips, traffic congestion, and improve air quality. The San Francisco to Los Angeles flight route is considered to be the most congested short-haul market in the U.S. The project is expected to reduce congestion and reduce emissions associated with this route. In addition, the project aims to reduce highway congestion in six of the cities that would be connected by the CHSR, which are currently among the top 30 congested urban areas in the U.S.

437 The CHSRA has determined the appropriate quantification methodology to report the annual GHG emissions and air pollutant reductions, which is in conformance with the methodology of the California Air Resources Board (CARB). The bulk of the GHG reductions is based on the diverted automobile and airplane trips, which also are an output of the CHSRA ridership model that is used in its business plans that forecast ridership and revenues.

high-speed rail service in combination with emissions factors for gasoline, diesel and jet fuel that are limited to the tailpipe emissions. The model is subjected to external reviews by the US Government Accountability Office and a third party, an independent financial advisory firm that specializes in infrastructure projects (CHSRA, 2020). As the following table 68 shows, the cumulative reductions of tailpipe emissions are projected to be between 65 and 79 million metric tons of carbon dioxide avoided. This projection informs the baseline case in California's Scoping Plan.

In table 69, the results illustrate the full set of life cycle emissions that can be avoided through mode shift to high-speed rail over the first 50 years—between 83 and 102 MMTCO2e. In the third figure, the results illustrate the full set of life cycle emissions that can be avoided annually through mode shift to high-speed rail for the Phase 1 system—between 2.201 and 2.681 MMTCO2e.

Table 68: Projected cumulative GHG emissions avoided for phase 1: Tailpipe (in MMTCO2e)

Year	Medium	High
2030	0.121	0.121
2040	8.6	10.5
2050	21.3	25.9
2079	65.9	79.9

Table 69: Projected cumulative GHG emissions avoided: Well to Wheels (in MMTCO2e)

Year	Medium	High
2030	0.15	0.15
2040	10.9	13.3
2050	27.1	33.1
2079	83	102

Table 70: Projected cumulative GHG emissions avoided for phase 1: Well to Wheels (in MMTCO2e)

Year	Medium	High
2030	0.075	0.077
2040	1.540	1.875
2050	1.693	2.062
2079	2.201	2.681

Source: CHSRA Sustainability Plan 2020.

Additionally, the project analyzes the avoided emissions by assigning an emissions factor that illustrates the full life cycle impacts of the fuels used for transportation: electricity, gas, diesel and jet fuel. Using this analytic technique enables all fuel types to be evaluated on equal terms. In the above figures, the "well-to-wheels" emissions factors were obtained from the Argonne Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET) and applied to the fossil fuel auto and air fleet. A life cycle emissions factor was also applied to the electricity required for system operation.

Fig.73: Avoided emissions due to modal shift enabled by the project (Source: CHSRA 2021. "Good for the Environment" document)

Decarbonization and Electrification Strategies

CHSRA's commitment is to operate on 100% electricity that comes from renewable energy generated on site (Authority-owned land). The Authority continues to work with state partners, such as the California Energy Commission, to better understand the use and availability of renewable energy to supply the whole system's needs over the project's life. According to an Energy Commission analysis of state renewable energy data and trends, California's renewable energy resources provide more than enough capacity to meet the relatively small demands of the high-speed rail system. (CHSRA, 2020)

In terms of the actual emissions generated by the operation of the CHSR, most of the emissions are expected from the operation of the rolling stock propulsion, maintenance facilities, vehicles, and stations. The direct emissions of the rolling stock are assumed to be zero. The rest of the CHSR operations will be also powered by a renewable energy supply chain, which according to consultations with CARB, will also be considered as zero (CHSRA, 2020). The other direct GHG emissions are considered to be limited, as these refer to on-track maintenance activities using small diesel-fueled equipment. The indirect emissions from the use of potable water and generation of waste water in stations are considered to be limited (CHSRA, 2020).

Cost-efficiency and reliability are critical to successful operation. CHSRA mitigates risks to the system's power supply through energy generation on site (Authority-owned land) matched with battery storage. Staff are further refining the steps for power generation and renewable power purchases. In 2016, the Authority signed a renewable energy Memorandum of Understanding with the California Energy Commission. The agreement detailed the strategy and implementation plan for achieving the renewable energy goals and to work cooperatively with the Energy Commission to expand the use of renewable energy, net-zero energy buildings and zero-emission vehicles, including electric-vehicle charging and hydrogen-fueling infrastructure at rail stations.

An important strategy of the project is the electrification of the Caltrain line. The CHSRA was having trouble identifying a route from San Jose to San Francisco. A "blended" plan was proposed, with CHSRA to partially fund the Caltrain's electrification with high-speed rail money in return for allowing high-speed rail trains to share tracks in the future. In March 2012, Caltrain and other local agencies signed a memorandum of understanding with the CHSRA that detailed the blended plan, which received approval from the Metropolitan Transportation Commission a week later.[438]

CHSRA committed $714 million to Caltrain'c Peninsula Corridor Electrification Project, nearly 40% of the total $2 billion cost. This investment will increase Caltrain service, reduce emissions by 97% from today's diesel service, and allow passengers to experience travel up and down the Peninsula in new electric trains. An electrified Caltrain corridor is a critical element for bringing high-speed rail services to the Bay Area, enabling high-speed trains to reach San Francisco, by sharing tracks with Caltrain.[439]

Carbon Sequestration

The CHSR has been implementing several carbon sequestration initiatives that range from conservation and preservation, to reforestation strategies. It is estimated that around 45 million tCO2e will be sequestered by action of these initiatives.

Conservation & Preservation: "The Authority has worked with the Department of Conservation (DOC) since 2012 to preserve agricultural land with two DOC programs. The Agricultural Land Mitigation Program (ALMP) and the California Farmland Conservancy Program (CFCP). The DOC routinely reports on the benefits of conservation projects that protect land from development; specifically, the DOC quantifies the greenhouse gas (GHG) emissions reductions that are created these conservation projects. Typically, the DOC estimates the three factors of vehicle miles traveled (VMT) that are avoided by limiting development in a given area, the avoided energy use from buildings; and the avoided soil disturbance caused by housing construction. Out of the 1,250 acres protected by the ALMP on behalf of the Authority, the DOC estimates that 1,162 acres would have been subject to development risk. The DOC estimates that 104 houses were eliminated as a result of this conservation effort, resulting in an estimated 36,654 metric tons of CO2e in GHG emissions being avoided."[440]

Reforestation: "The California Department of Forestry and Fire Protection, in partnership with the Authority, awarded $2.5 million in tree-planting grants to date to offset GHG emissions associated with construction of the

[438] Caltrain 2012 and https://www.sfgate.com/news/article/MTC-approves-Caltrain-electrification-plan-3442745.php

[439] https://hsr.ca.gov/high-speed-rail-in-california/northern-california/

[440] The DOC excluded soil carbon sequestration benefits, under the assumption that equal amounts of soil carbon was disturbed during the high-speed rail alignment's construction. Source: CHSRA Sustainability report 2020.

first portion of the high-speed rail system. These grants fund tree planting projects to reduce GHG levels; arrest the decline of urban forests and improve their structure and function; increase climate change resilience; and improve the quality of the environment in urban areas. The Urban Forestry program focuses on the communities that are near the rail system, with special emphasis on providing benefits to disadvantaged communities. The first phase of urban tree planting at West Fresno Middle School kicked off on May 25, 2018, when nearly 200 trees were planted, and this effort was complemented with additional tree planting in the fall. Tree planting continued in 2019 throughout California. An estimated 180,000 tCO2e will be sequestered by planted trees over their lifetime (CCI, 2021). The CHSRA has already planted more than 6,000 trees along the transit corridor, and since January 2016 it has completed more than 2,200 acres of rural conservation projects."[441]

Construction Emissions Reduction Strategies

Fig.74: 2019 annual avoided emissions from recycling

The construction emissions, which are to occur throughout the construction period (2014-2022), can be divided into the following two main sources: upstream emissions from materials, and construction activities. These emissions are mitigated by offset activities to ensure zero net direct construction GHG emissions. The Authority has relied on industry and public policy leading practices to manage and reduce GHG emissions in construction. For example, construction recycling is being monitored, recorded and reported. Construction recycling has decreased from previous years due to the construction phase transitioning from demolition of roadways and buildings to constructing. The 97% (183,290 tons) of all construction waste to date is being recycled, sending only 3% (4,973 tons) to landfills.

Additionally, the CHSRA requires all contractors to abide by the signed contract, and to monitor and report their material use, energy consumption, electricity purchase from the grid and renewable sources, water consumption, waste generation volumes by type, waste management streams by volume and type for each type of waste, types of on- and off- road equipment, and hours of miles of operation. The Authority uses this data to measure performance and for setting data-driven policy and strategies. The measures to decrease the indirect emissions associated with construction contractors, material and waste are the following:

Table 71: Scope 3 emissions reduction measures

SCOPE 3 EMISSIONS REDUCTION MEASURES

441 Source: CHSRA Sustainability report 2020.

Minimizing GHG emissions through design requirements;
Achieving net-zero tailpipe GHG emissions in construction through carbon sequestration projects;
Requiring Environmental Product Declarations (EPD) for construction materials, including steel products and concrete mix designs, to improve disclosure of materials information and allowing for the selection of more sustainable products;
Requiring performance thresholds for global warming potential for major materials while maintaining durability and quality requirements;
Adapting existing structures and facilities for reuse whenever feasible; and
Integrating climate adaptation and resilience principles into the design, construction and operation of the system.

Finally the Authority uses the Carbon Tool that calculates emissions based on each construction package for each construction section, while the quarterly emission reductions status reports for construction packages capture all emissions and identify offset requirements. The Authority calculates the GHG emissions emitted during construction as a result of activities from both the sub-contractors and the Authority and publicly reports this data annually. Calculations are based on activity data as received from sub-contractors of each construction package, with estimates made based on the number of employees the Authority currently hires.

Lifecycle Emissions Scopes

The following figure shows information to date on emissions by scope across the project's first 60 years. It is a combination of modeled and actual emissions and is based on the best available information.

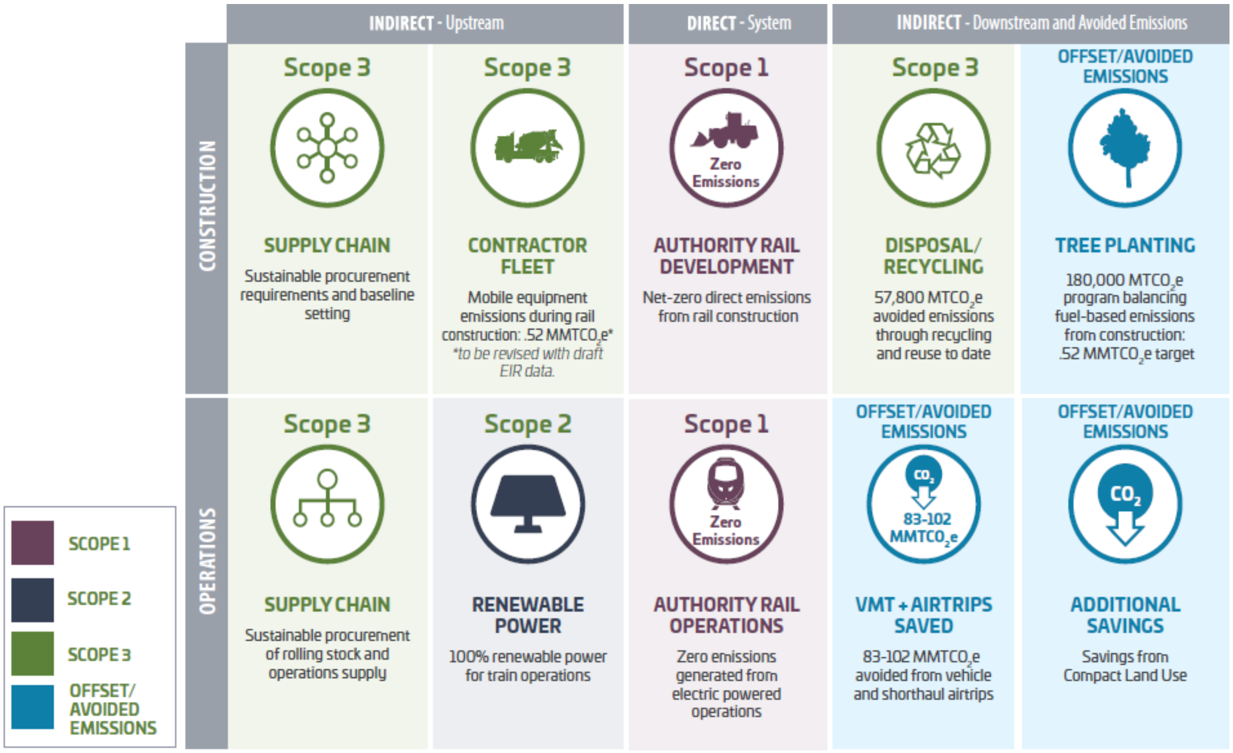


Fig. 75: GHG Emissions by scope for the period 2015-2079. Source: CHSRA Sustainability Report 2020

Since January 2016, approximately 29,737 MTCO2e have been generated during construction. Positively, through more than 4,900 trees planted and more than 2,200 acres of rural projects, approximately 180,000 MTCO2e will be sequestered over the trees' lifecycle. More than 46,000 MTCO2 have been sequestered or avoided through habitat and agricultural land conservation. Finally, more than 57,800 MTCO2e have been avoided through recycling. In 2019, the project will continue to analyze Early Train Operator (ETO) service plans to revise projected emissions for early operations in the Central Valley. These emissions projections are included as part of any study reports.

2.4.2. Energy Efficiency

The project's energy efficiency targets are achieved through:

1. Net Zero Energy Stations
2. Energy efficient offices
3. Monitoring fuels & electricity consumed during construction

Net-zero energy stations

The stations and O&M facilities will achieve net positive energy consumption by supplying 105% of their energy needs through on-site renewable energy generation. The project is developing plans for how this excess energy produced can spur more restorative development in station districts. Working toward net-positive energy facilities includes partnering with adjacent developments and helping local partner communities reach important milestones for renewable energy and sustainability. The capital costs for the construction, O&M of those resources will be undertaken by a private entity engaged through a power-purchase agreement.

Energy efficient offices

In 2019, the electricity consumption for powering the Authority's offices (computers, lights, and heating/cooling systems) remained stable compared to 2018. The office spaces are energy-efficient as multiple initiatives to reduce demand have been implemented (metered lighting, automatic shut-off of computer monitors, etc.).

Monitoring fuels & electricity consumed during construction

During construction, the contractors engaged by the Authority use fuels and electricity, to power their equipment (front-loaders, bulldozers and graders, as well as pick-up trucks and other motor vehicles) and site/field offices. Diesel fuel consumption increased by 68% from 2018, attributable to increased construction activity, while gasoline fuel consumption also increased by 79%. In total, energy consumption of vehicle fuels increased 87% compared to 2018. Since 2015, the construction of the project has consumed approximately 473,757 Gigajoules of energy (electricity). During 2018, approximately 28% of the total kWh that each contractor reported consuming, was sourced from renewable energy.

Table 72: ***Energy Consumption***

Consumption Source	Units	Quantity
Off-Road Diesel Consumption	Gallons	443,935
On-Road Diesel Consumption	Gallons	241,737
On-Road Gasoline Consumption	Gallons	598,208
Energy Content of Fuel Consumed	Gigajoules	178,725
Construction Electricity Consumption	MWh	1,818
Authority Office Electricity Consumption	MWh	1,908*
Construction Renewable electricity	%	28% of total
Energy Content of Electricity Imported	Megajoules	6,552,224

* Authority Office electricity consumption is estimated based on number of Authority and Rail Delivery Partner staff working on the project in 2019.

2.4.3. Net embodied carbon reduction

Reduction in the net embodied carbon of materials used

At least a 15% net embodied carbon reduction

Total embodied carbon:
5,969,861,133 tCO2e

Net embodied carbon
(transportation for construction)
4,979,321 tCO2eq

Reducing embodied carbon is a challenge for projects of large scale, as the impact associated with the materials is difficult to reduce. The project team was able to identify the materials that contribute the most towards embodied carbon using the Embodied Carbon in Construction Calculator (EC3) tool to estimate quantities, and the emission factors were taken from Environmental Product Declarations (EPDs) and Lifecycle Analysis (LCA) databases (CHSRA, 2020). According to the analysis, a total of 83% of total project embodied carbon dioxide equivalent was found in the project, and the materials that contribute the most are structural concrete with 58%, geotextile fabric with 17%, structural steel with 9%, and structural concrete with 4%. The scope of the estimation included a 15% overage on the materials, for anticipated repairs, maintenance and refurbishment. A 15% is also included in the 2018 business plan total maintenance costs in order to support the labor costs.

According to the analysis, a total of 83% of total project embodied carbon dioxide equivalent was found in the project, and the materials that contribute the most are structural concrete with 58%, geotextile fabric with 17%, structural steel with 9%, and structural concrete with 4%. The scope of the estimation included a 15% overage on the materials, for anticipated repairs, maintenance and refurbishment. A 15% is also included in the 2018 business plan total maintenance costs in order to support the labor costs.

The CHSR team calculated which are the primary contributors to the overall embodied carbon that relate to the production of materials, including the extraction, refinement, manufacture, processing, and transporting into the site, for a total of 5,969,861,133 tons of carbon dioxide equivalent (tCO2eq) (CHSRA, 2020). For the emissions factors used in the calculations, the team used the boundary of cradle to gate, derived from EPDs, Gabi or GREET (CHSRA, 2020). In the case where local or regional product emissions intensity data is unavailable, a similar local or regional proxy product is chosen, based on availability, expert opinion, and input from project team engineers.

The total net embodied carbon from transportation for construction and maintenance has been calculated at 4,979,321 tCO2eq (CHSRA, 2020). As Phase I is expected to be completed in 2029 and many segments are still in the planning process, the team made a blanket assumption in the calculation of emissions for the transportation of the materials, using the expected size and loads of the transportation vehicles used, the returning of the empty vehicle, and a 100% local sourcing, acquired from vendors located within a 50-mile radius from each project segment. An extra 15 % overage is included in the calculations to account for maintenance and transportation burden for each material.

As there is a large geographical extent in the CHSR transit corridor for the sourcing of materials and a large quantity of suppliers, the project team has not compiled the distances from each supplier for each project segment. The CHSRA has included several requirements in its Design Criteria Manual to reduce the total embodied carbon of materials to a minimum of 30%, in 80% of the larger materials. For instance, contractors have to provide the costs for all materials, and an embodied carbon lifecycle assessments for 80% of the total construction materials costs (CHSRA, 2020).

The Design Criteria Manual includes specifications to help reduce the embodied carbon of construction materials. For example, several thresholds were determined for concrete, which is a highly used material with high emissions intensity. According to the concrete's minimum specified compressive strength in psi, a maximum global warming potential (GWP) measure in (kg CO2e / m3) must be observed (CHSRA, 2020). For example, for concrete of up to 2,500 psi in specified compressive strength, a maximum GWP of 260 kg CO2e / m3 is allowed.

Table 73: The materials contributing to the largest quantity of embodied carbon dioxide equivalent. Source: Carbon Material Tool

MATERIAL CATEGORY	PERCENTAGE OF TOTAL PROJECT EMBODIED CARBON DIOXIDE EQUIVALENT
STRUCTURAL CONCRETE	58%
GEOTEXTILE FABRIC	17%
STRUCTURAL STEEL	9%
STRUCTURAL CONCRETE	4%
TOTAL	**83%**

Table 74: Maximum global warming potential for concrete specified compressive strength. Source: CHSR, 2020.

Concrete specified compressive strength (psi)	**Maximum global warming potential** (GWP) (kg CO2e / m3)
Up to 2,500 psi	260
3,000 psi	289
4,000 psi	313
5,000 psi	338
6,000 psi	356
7,000 psi	394
$\geq$ 7001 psi	433
Up to 3,000 psi light weight	578
4,000 psi light weight	626
5,000 psi light weight	675

The values listed in the table above correspond to the GWP determined in CHSRA design criteria for concrete. These values are result of a review of the national average results of industry-wide GWP, as described in the Environmental Product Declarations **(**EPD) published by the National Ready-Mix Concrete Association (CHSRA, 2020). According to CHSRA (2020), for the GWP values they use the lowest GWP average result for a compressive strength in psi, and apply a 15% reduction. In the embodied carbon calculations for CHSRA, the team assumed use of 5,000 psi strength concrete for both baseline and project cases using its maximum GWP, which provides a 30% reduction when compared to the NRMA Benchmark Report (CHSRA, 2020).

Likewise, for reinforcement steel a GWP threshold of 0.876 kg CO2e per kg was determined by CHSRA by averaging GWP values in the different EPDs that were received in prior procurement packages, and also applying a 15% reduction (CHSRA, 2020). When comparing the reinforcing steel values of the California-based EPDs with the baseline industry average emission intensity, as listed in the Gabi tool, a 9% reduction was found, and a 0.5% reduction was found for structural steel. Both thresholds will help the CHSR to achieve an approximate 18.2% reduction in embodied carbon of steel.

Further work on embodied carbon by the CHSRA encompasses the making of an inventory of all the materials used for operations in one segment, including the weight, volume, cost and third party verified EPDs that outline the GWP of a product, and scaling it to the system wide operations. The CHSRA is also working on a net embodied carbon emissions analysis through the life cycle analysis (LCA) of the materials that will be used in the operation, including their transportation, and maintenance throughout the lifespan of the project (CHSRA, 2020).

Table 75: Climate change mitigation in relation to the transition risks they address & the lifecycle stage they were implemented

PROJECT MITIGATION STRATEGIES	CLIMATE TRANSITION RISKS									PROJECT LIFECYCLE STAGES				
	GHG Scope 1	GHG Scope 2	GHG Scope 3	GHG Scope 3 user	Energy Efficiency	Decarbonization	Electrification	Carbon Capture & Storage		DESIGN & MATERIAL PRODUCTION	CONSTRUCTION	OPERATION	MAINTENANCE	END OF LIFE

A1	**Avoided emissions through modal shift from airplane and car travel to high speed rail**														
A2	**Decarbonization**														
i.	*100% decarbonization of project electricity needs through renewables (on site & from CA)*														
ii.	*Mitigation of renewable energy production risk through battery electric storage*														
iii.	*Promoting zero emission vehicles through collaboration with state partners to streamline electric-vehicle charging and hydrogen-fueling infrastructure at rail stations.*														
A3	**Electrification**														
i.	*100% electric fleet*														
ii.	*Electrification of the Caltrain line committing $713 million of funding (CHSR) and replacing 75% of Caltrain's diesel service.*														
A4	**Carbon Sequestration**														
i.	*Partnership with the Department of Conservation (DOC) for the Agricultural Land Mitigation Program (ALMP).*														
ii.	*Partnership with the Department of Conservation (DOC) for the California Farmland Conservancy Program (CFCP).*														
iii.	*Reforestation efforts through partnership with the California Department of Forestry and Fire Protection for the Urban Forestry program.*														
A5	**Construction Emissions Reduction**														
i.	*Minimizing GHG emissions through design requirements*														
ii.	*Net-zero tailpipe GHG emissions through carbon sequestration*														
iii.	*Requiring Environmental Product Declarations (EPD) for construction materials*														
iv.	*Requiring performance thresholds for global warming potential for major materials*														
v.	*Adapting existing structures and facilities for reuse whenever feasible*														
vi.	*Integrating climate adaptation and resilience principles into the design, construction and operation of the system*														
vii.	*Tracking, Reporting, and Mitigating Construction Emissions*														

B	**ENERGY EFFICIENCY**														
B1	**Net-zero energy stations**														
B2	**Energy efficient offices**														
B3	**Monitoring fuels & electricity consumed during construction**														
C	**EMBODIED CARBON REDUCTION**														
C1	**Reduction in the net embodied carbon of materials used**														
i.	*Use of the Embodied Carbon in Construction Calculator (EC3) tool*														
ii.	*Requirements for specific embodied carbon thresholds for concrete and reinforcing steel*														
iii.	*Calculation of emissions for the transport of materials*														
iv.	*Making of an inventory of all the materials used for operations (weight, volume, cost and third party verified EPDs)*														

2.4. Climate Change Adaptation Efforts

The Authority's 2018 Materiality Assessment results revealed that resilience and adaptation are of high importance to our stakeholders as well. In 2019, the Authority formed a work group, the Climate Adaptation Implementation Committee (CAIC), focused on developing a climate adaptation plan for the system, in alignment with new state guidance, "Planning and Investing for a Resilient California." The CAIC guided the completion of a systemwide exposure analysis of climate stressors to identify risks and identifying vulnerable elements of the CHSR project (2. CHSR Climate Change Exposure Analysis, p.1). The list of acute and chronic climate change threats that may affect the project is summarized in the table below.

Table 76: Project exposure to acute and chronic threats result of climate change

Acute and chronic climate change threats	Impacts
Sea Level Rise and Storm Surge	California's sea level is predicted to increase by 3 feet by the end of the century, which may cause increased tidal flooding and permanent inundation in vulnerable areas. Further, increased intensity and frequency of storm surges are expected along the California Coast.
Temperature Rise	An average annual temperature increase between 1.8 – 5.4 °F by 2050 is anticipated for the state of California, more frequent and more extreme accompanied heat days. The increase in minimum and maximum temperature are relevant for

	pavement, concrete, wiring, and rail materials and design elements.
Precipitation Changes and Riverine Flooding	An average decrease of 12-35% of annual precipitation is anticipated for the state of California, accompanied by longer dry spells and intermittent extreme heavy rain events.
Wildfire Risk	The rising temperatures and longer dry spells described above increase the wildfire risk across the state of California. Under the A2 emissions scenario defined by the Intergovernmental Panel for Climate Change, (IPCC), the risk of large wildfires is predicted to rise by 55% across the state.
Landslides	The two types of landfills of concern to the CHSR, deep seated and shallow landslides, are affected by precipitation patterns – which are projected to change due to climate change. The projected increased wildfire risk also increases the likelihood of experiencing shallow landslides since wildfire damages the forest canopy, as well as plantings and soil which result in increasing the likelihood of higher volume runoff after intense rainfall or a rapid snowmelt.
Subsidence	The San Joaquin Valley, Antelope, and the Delta islands are sinking primarily due to groundwater depletion. With more frequent and more severe droughts the dependence on groundwater may increase and cause further subsidence.

In 2019, the CAIC discussed adaptation implementation opportunities for the system and worked collaboratively with the Safety and Security team to identify relevant climate risks in the Authority's Risk Management framework. (CHSRA, 2020)[442] This collaboration is ongoing in 2020 and will ultimately lead to the integration of a climate risk evaluation approach into the Authority's Safety and Security Management Plan (SSMP),[443] in an effort to provide a consistent and streamlined way to evaluate climate change impacts to the program.

To ensure resiliency is incorporated into system design, the Authority mandated new climate change adaptation and resiliency requirements in its procurements. The new criteria included in the procurement documents are related to maintaining defensible space, use of fire-resistant and drought tolerant landscaping, proper

442 The risks studied are for the present day and the future of all project assets and include: sea level rise and surge, average and extreme precipitation, average and extreme temperatures, and wildfire.

443 "The preparation of the plan involves defining the severity and frequency of hazards through a hazard analysis process used for risk estimation and mitigation development. development. When developing mitigations, or adaptation strategies, the SSMP requires a benefit-cost comparison to choose the most cost-effective option." Source: CHSR Sustainability Report 2020.

floodplain management, emergency and disaster preparedness at stations, use of passive heating and cooling at stations, and rainwater collection.

Greenhouse gases trap energy in the atmosphere and are the primary driver of climate change and global warming. According to the United Nations Intergovernmental Panel on Climate Change (IPCC), greenhouse gases trap energy in the atmosphere, which contributes to global warming and climate change. Among the seven gases of most concern are: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), fluorocarbons (PFCs), nitrogen trifluoride (NF3) and sulfur hexafluoride (SF6) (IPCC; CHSRA, 2019).

In California, the transportation sector produces the highest source of greenhouse gas emissions (CHSRA, 2019). Climate change effects are already present in California, more and more are extreme events exceeding the standards of the built infrastructure. From 2017 to 2018, a series of disasters ranging from drought, to wildfires, to extreme rain events, to floods, mudslides, and debris flows, had a big impact on communities, as disasters took lives, destroyed homes, cars and transportation networks (CSIWG, 2018). During this period, 52 of the total 58 counties in California declared a state of emergency at least once, and received approximately $3.5 billion in disaster funding (CSIWG, 2018).

Finally, the approach to generate the energy that the project needs on Authority-owned land matched with battery storage, speaks to the importance of system resilience. The system, and its power supply, must operate under any number of future conditions. This solar and storage approach:

- Reduces overall power demands, decreasing operating costs;
- Provides a source of back-up power should the grid unexpectedly shut off, enabling the project to continue service for an extended period;
- Enables the project to cost-effectively meet renewable energy commitments;
- Enables maximizing benefits from the low-carbon fuel standard program; and
- Enables the project to test the battery storage system prior to commercial operation and to identify additional potential capital cost savings.

Table 77: Climate-related risk evaluation and risk management

CLIMATE-RELATED RISK EVALUATION[444]
Participating on the Climate-Safe Infrastructure Working Group
HSR Temperature Exposure Analysis (considerations of public health impacts due to high heat, with a specific focus on HSR riders and employees)
Climate Change Impacts to CP4 Design Criteria Report (for wind, temperature, precipitation, sea level rise, snow)
Conducting a CHSR Climate Change Exposure Analysis (threats of temperature increase, sea level rise, wildfire increase, drought)

444 The table was based on the material received until July 2021. It will be updated.

Conducting a Hydrology and Water Technical Evaluation
Conducting a Geology and Soils Technical Evaluation
Conducting a Water Resources Climate Change Vulnerability Assessment
Conducting a CHSR Vulnerability assessment from chronic and acute climate effects
Asking for Asset based vulnerability assessments from the design teams
Conducting a Temperature Exposure Analysis
Conducting a Wildfire Exposure Analysis
Conducting an Asset Risk Analysis
CLIMATE-RELATED RISK MANAGEMENT STRATEGIES ALONG THE PROJECT LIFECYCLE
Incorporating of climate change risk into existing Authority practices, such as the Safety and Security Management Plan;
Specifying minimum Solar Reflectance Index (SRI) values to minimize the heat island effect at station facilities, meeting LEED v4 BD+D Heat Island Reduction Credit.
Publishing a white paper on climate change resiliency;
Implementing innovative methods in the project design criteria to encourage greenhouse gas reductions and improve climate adaptation and resilience.
Annual CHSR Climate Adaptation Plans
Creation of the CHSR Climate Action Implementation Committee (CAIC)
Conducting a CHSR Climate Activities Plan
Publishing the projects’ climate change vulnerability assessment and adaptation efforts in the Safeguarding California Plan: 2018 Update

3. SANTA MONICA CLEAN BEACHES PROJECT

Fig. : Santa Monica Pier

The “Clean Beaches” project is a multi-benefit project of an underground water harvesting tank in Santa Monica. Santa Monica is facing issues with its water infrastructure both regarding its weak water supply system as well as with its shoreline contamination. As part of the city’s sustainable water management plan towards self-sufficiency and the enhanced water management plan towards beach pollution elimination, the Clean Beaches Project was built in 2018 to address all relevant issues.

Southern California is anticipated to experience longer periods of dry weather, followed by intense winter storms. The project is designed to be resilient towards water scarcity by providing a **new water source** by recycling brackish water and urban runoff after treatment at the existing Santa Monica Urban Runoff Recycling Facility (SMURFF). As such, it contributes in the city’s goal towards self-sufficiency. In addition to climate-related risks resiliency, the project mitigates climate threats by eliminating beach water pollution by capturing the wet-weather runoff from the sub-watershed of downtown Santa Monica.

3.1. Santa Monica’s response to environmental and climate-related risks

3.1.1. Santa Monica's water supply issues

The City of Santa Monica is a beachfront town west of Los Angeles that faces tangible problems with water resources due to the low annual rainfall and the absence of lakes or rivers in the area.

The city has been facing major issues with its water supply since it was founded in 1875 and especially during the early 1900s when the population boomed as many moved to the west coast. In 1928 along with 12 other governments they formed the Metropolitan District (MWD) in order to build the Colorado River Aqueduct to supplement the water supplies of the original founding members.

Fig. . California Aqueducts (source: Zach Pollard lecture, Harvard Graduate School of Design, Cambridge, 2019)

The City continued to purchase MWD water throughout the years to supplement its water supply. In 2011, the town got 51% of its water supply from local wells and 48% bought from MWD. The remaining 1% came mostly from recycling[445].

However, the City was not satisfied because of increasing rates for the wholesale water and the energy-inefficient means of transfer, with few gravity-fed systems. Furthermore, the Colorado River was not a

445 City of Santa Monica. "Sustainable Water Management Plan Update". 2018. Accessed March 30, 2020.https://www.smgov.net/uploadedFiles/Departments/Public_Works/Water/SWMP.pdf

dependable source, with droughts becoming more frequent due to climate change. In 2011–2014, California experienced the driest period in its history which resulted in water supply issues. So the City Council decided to achieve water self-sufficiency by establishing a diverse, sustainable, and drought-resilient local water supply.

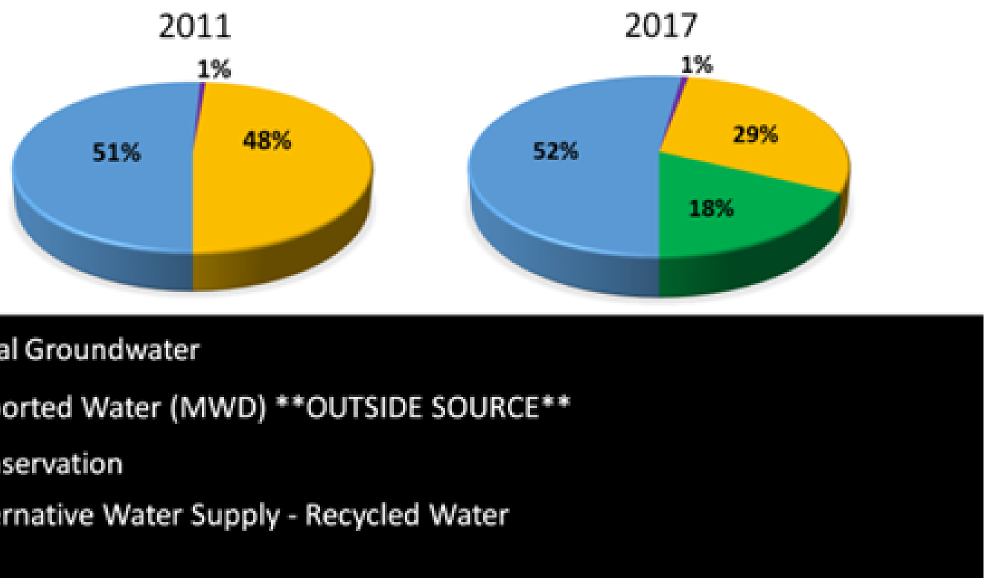


***Fig. .** : Santa Monica Water Source in 2011 and 2017 (source: Zach Pollard lecture, Harvard Graduate School of Design, Cambridge, 2019)*

In October 2014, the City adopted the **Sustainable Water Management Plan (SWMP),** a comprehensive **plan toward water self-sufficiency** by 2020, which, after further studies, was pushed out to 2023.

The pathway to achieve water self-sufficiency consists of three key components:

1) **increasing water conservation** efforts to permanently reduce water demand
2) developing sustainable and drought resilient **alternative water supplies.** These supplies include captured rainwater and municipal wastewater for non-potable uses.
3) **expanding local groundwater** production within sustainable yield limits. [446]

The benefits of water self-sufficiency are:

- Establishment of a diverse, sustainable, drought-resilient local water supply
- Reduction of the energy footprint of the City's water supply[447]

[446] Santa Monica Public Works, Water Resources. «2019 Water/Wastewater Rate Study» Accessed February 25, 2020. https://www.smgov.net/departments/publicworks/water.aspx

[447] Santa Monica Public Works, Water Resources. «2019 Water/Wastewater Rate Study» Accessed February 25, 2020. https://www.smgov.net/departments/publicworks/water.aspx

- Acquisition of long-term cost benefits for water ratepayers (i.e.residents)

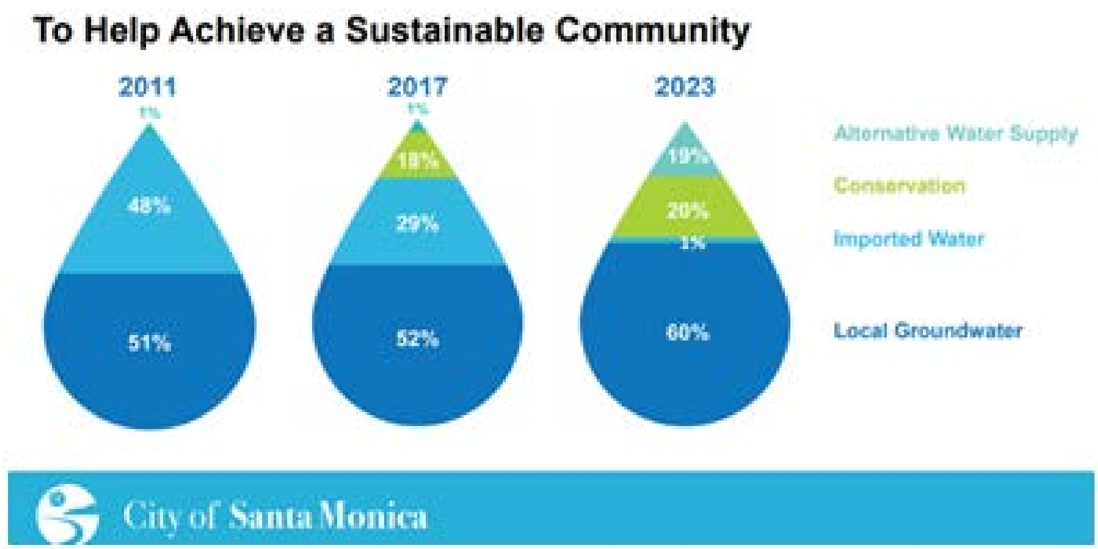


Fig. The City of Santa Monica's water supply plan

3.1.2. Santa Monica's beach water pollution

The City of Santa Monica is a densely populated small beach town along one of the most popular beaches of Santa Monica Bay. The beach is widely accessible from the entire LA County and is considered a main recreational and tourist destination. The urbanization of the natural habitat and landscape of have resulted among others in high water pollution[448]. Stormwater runoff is disposed of in the ocean and according to Curbed LA, "in 2018, for the fifth year in a row, Santa Monica Pier was one of the most contaminated stretches of shoreline in California, in spite of significant efforts by local officials to clean up the water."[449].

---

448 "Discharges of polluted urban runoff result in elevated bacteria levels and increased illness rates among swimmers, and the association between heavy precipitation (leading to increased runoff) and waterborne disease outbreaks is well documented. For instance, a 2012 California study investigated surfers' risk of contracting gastrointestinal illness during dry weather and in post-storm conditions in the coastal waters of Southern California based on enterococcus and fecal coliform concentrations in the water. The researchers found that "at most beaches, there are higher GI risks after rainfall than during dry condition[s]" and that "some beaches have significantly elevated health risks for surfers after a storm event…A large-scale 1995 epidemiological study, also in California, investigated possible adverse health effects of swimming in ocean waters contaminated by urban runoff. The study found an increased risk of illness associated with swimming near flowing storm drain outlets in Santa Monica Bay, compared with swimming more than 400 yards away. Swimmers near storm drains were found to have a 57 percent greater incidence of fever, for instance, than those swimming farther away". (Natural Resources Defense Council. "The Impacts of beach pollution". 2014. Accessed February 25, 2020.
https://www.nrdc.org/sites/default/files/ttw2014_Impacts_of_Beach_Pollution.pdf

449 Elijah Chiland "Santa Monica is still the filthiest beach in L.A." Los Angeles Curbed. June 2018.
https://la.curbed.com/2018/6/8/17440210/santa-monica-pier-beach-safe-to-swim

Santa Monica's 106-acre downtown watershed, with five major storm water outfalls ~~(Fig. 7),~~ is one of the significant sources of pollutants in LA County. **Pollutants are a problem in both wet weather (rain events) and periods of dry weather (runoff from over-irrigation, washing of sidewalks, vehicles, business equipment, and draining of pools).**[450] These pollutants impact the recreational use of the beach.[451]

Faced with this problem, strict pollution reduction regulations for storm drains were enacted by the Los Angeles Regional Water Quality Control Board, the state agency responsible for protecting the beaches and the Santa Monica Bay from stormwater pollution. To preserve and restore the water quality in the Bay, **the City developed an Enhanced Watershed Management Plan** (EWMP) per the requirements driven by the Municipal Separate Storm Sewer System (MS4)[452] Discharge Permit.[453] The City also developed and implemented **regional best management practices (BMPs)**[454] for addressing the water quality goals and for reducing the pollutants and the runoff from the built-out urban environment at Santa Monica Bay.

3.2. The Clean Beaches Project: Stormwater Harvesting Tank

The project was built in order to respond to the described problems of Santa Monica, being developed thus with a dual role:

1. To reduce beach water pollution to the Santa Monica pier:
For this purpose, , the City awarded a Clean Beaches Initiative (CBI) grant to build a regional, multi-benefit project to capture the wet-weather runoff from the sub-watershed of downtown. **In addition, for the purpose of implementing quality improvements in urban runoff water according to the City's Watershed Management Plan of 2006, a property tax raise** was approved by the citizens. The new tax, known as the Clean Beaches and Ocean Parcel Tax or "Measure V," was passed by over two-thirds of

450 Santa Monica Public Works, Civil Engineering. "Why is Measure V needed". Accessed February 25, 2020. "**https://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9573**

451 Recreational use of the beach includes swimming, fishing, drinking water, navigability, and wildlife habitats and reproduction (Santa Monica Public Works (2017) City Council Report :Award Construction Contract for Clean Beaches Project (Agenda Item:3H)

452 The Federal Clean Water Act (CWA section 402) requires the issuance of a permit to regulate municipal stormwater discharges, known as the MS4 permit. EPA defines an MS4 as a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a State (40 CFR 122.26(b)(8)). The MS4 permit defines a Total Maximum Daily Load (TMDL) as the maximum amount of a pollutant that a body of water can receive. Established TMDLs for Santa Monica Bay include coliform bacteria, DDT (pesticide), 9 of 18 PCBs (manufactured organic chemicals), and debris. The SWRCB monitors and enforces the MS4 permit compliance.

453 Selim Eren "Protecting the Santa Monica Bay & Beneficial Use of Stormwater: Santa Monica Clean Beaches Project." (Selim Eren lecture, Harvard Graduate School of Design, Cambridge, November 4, 2019)

454 I Best Management Practices (BMPs) are structural water pollution controls installed on individual parcels or in the public right-of-way in order capture, treat, and infiltrate or use rainwater/stormwater for beneficial use. (City of Santa Monica, Office of Sustainability and the Environment. "Urban Runoff, BMP Reporting". Accessed February 26, 2020) https://www.smgov.net/Departments/OSE/Categories/Urban_Runoff/BMP_Reporting.aspx

voters in the City of Santa Monica.[455] The Clean Beaches Project **improves the water quality by harvesting and treating stormwater**, which used to be discharged untreated into Santa Monica Bay.

2. To contribute to Santa Monica's goal towards water self-sufficiency.
   The Clean Beaches Project not only **improves the water quality by harvesting and treating stormwater**, which was being discharged untreated into Santa Monica Bay, but it also **provides a new water source** by recycling brackish water and urban runoff after treatment at the SMURFF[456].

The Clean Beaches project is the City's new strategy to complement prior efforts with a harvesting tank that supports SMURFF. The diversion structure and pipeline are constructed under Santa Monica Pier, where stormwater from this part of the City is discharged to Santa Monica Bay. The location of the project's tank is directly related to the area's natural topography. Eren explains that "the lowest point of the watershed is the best place that ensures that the runoff from the entire watershed is captured," and therefore the Clean Beaches harvesting tank is located right by Santa Monica Pier, which is the lowest point of the watershed. The underground cistern was constructed in the undeveloped vacant lot north of the existing Beach Maintenance Yard, known as the "Deauville Site," which is developed into a paved public parking lot as an expansion of the existing Lot 1 North.

455 Santa Monica Public Works, Civil Engineering. "Background". 2020. Accessed February 25, 2020. "**https://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9573**

456 SMURFF is the existing Santa Monica Urban Runoff Recycling Facility which treats brackish water that will be collected under the Clean Beaches stormwater harvesting tank. This facility together with a group of other sustainable projects and conservation measures are part of Santa Monica's water self-sufficiency goal for 2023. Due to its limited diversion capacity, the existing SMURRF currently captures and treats dry weather runoff, and only a small amount of wet weather runoff. This has resulted in wet-weather bacterial TMDL exceedances near the Santa Monica Pier Outfall. This Project was modeled in and is consistent with, the EWMP for the Pier drainage basin.

Fig. Project Location

According to the project supervisor Selim Eren, the project team was focusing mainly on wet weather flows which were the most contributing to the beach bacterial pollution. So they tried to completely eliminate this charge while in the meantime they aimed for drought resiliency by collecting brackish groundwater when stormwater is scarce. Regarding the project's multibenefit role, Eren mentions: “the Clean Beaches project is all about protecting the beaches, preserving the environment, and helping the City use the resources efficiently and thoughtfully.

Fig. . Project Diagram (City of Santa Monica, https://socalwater.org/files/9-sm-castle--sw-management-program_00126.pdf)

3.3. Envision Performance

It is evident that due to its dual purpose, the clean beaches project includes strategies both for climate-change adaptation and climate change mitigation. Based on the Envision documentation, the following paragraphs describe climate adaptation and mitigation processes and strategies. Parallel benefits of sustainable strategies are also presented in order to highlight the multi-benefit sustainable performance of the project.

The project used Envision® Version 2 from the early design stages. It achieved the Envision® Gold award, although, according to Santa Monica's City's expectations, it initially aimed for Platinum. Nevertheless, the Gold award is a high score, obtained for the first time by an infrastructure project in Santa Monica. The project's specific scores in each Envision category are shown in the following table

Table 78: Project scoring per Envision category

ENVISION CATEGORY	VALUE
QUALITY OF LIFE	34%
LEADERSHIP	47%
RESOURCE ALLOCATION	51%
NATURAL WORLD	55%
CLIMATE AND RISK	43%

Although the project's sustainability was evaluated by a previous Envision version (V2), the performance of the project in the category "Climate and Risk" is indicative to observe the degree in which the project addressed climate-related issues.

Table 79: Project level of achievement per Climate & Risk category credits

CLIMATE AND RISK (Envision V2)[457]	NONE	IMPROVED	ENHANCED	SUPERIOR	CONSERVING	RESTORATIVE
CR1.1 Reduce Greenhouse Gas Emissions						
CR 1.2 Reduce Air Pollutant Emissions						
CR 2.1 Access Climate Threat						
CR 2.2 Avoid Traps and Vulnerabilities						
CR 2.3 Prepare for Long-Term Adaptability						
CR 2.4 Prepare for Short-Term Hazards						
CR 2.5 Manage Heat Island Effects						

It is evident that due to its dual purpose, the clean beaches project includes strategies both for climate-change adaptation and climate change mitigation. Based on the Envision (V2) documentation, the following paragraphs describe climate adaptation and mitigation processes and strategies. Parallel benefits of sustainable strategies are also presented in order to highlight the multi-benefit sustainable performance of the project.

[457] The updated credits of Envision V3 that correspond to the specific credits of Climate and Risk are from Climate and Resilience category as follows:

- CR1.1 Reduce Greenhouse Gas Emissions is replaced with CR1.2 Reduce Greenhouse Gas Emissions
- CR 1.2 Reduce Air Pollutant Emissions is replaced with CR 1.3 Reduce Air Pollutant Emissions
- CR2.1 Assess Climate Threat is replaced with CR2.2. Assess climate change vulnerability
- CR2.2 Avoid Traps and Vulnerabilities is replaced with CR2.5 Maximize Resilience
- CR2.3 Prepare for Long-Term Adaptability is replaced with CR2.5. Maximize Resilience
- CR2.4 Prepare for Short-Term Hazards is replaced with CR2.5. Maximize Resilience
- CR 2.5 Manage Heat Island Effects is omitted

3.4. Climate change adaptation

As mentioned, the Envision assessment of adaptation focuses on risk evaluation and risk management. Santa Monica's climate-related threats and risks are taken into consideration by the project team in order to propose adaptation strategies.

3.4.1. Climate-related risk evaluation

Based on the "Unincorporated Los Angeles County Community Climate Action Plan 2020" (CCAP) which is composed of State and local actions to reduce GHG emissions within the unincorporated Areas, the project team developed a comprehensive climate impact assessment and adaptation plan. The CCAP identifies that Southern California is anticipated to experience longer periods of dry weather followed by more intense winter storms. During these long periods of dry weather, pollutant material will accumulate, causing higher concentrations in dry flows or first flush scenarios, thus causing increased water pollution. Another risk that is identified is sea level rise which may lead to flooding.

Taking into consideration the CCAP, the project has identified and addressed the climate change risks, thus achieving a conserving level of achievement in the Envision related credit (**CR2.1 Assess Climate Threat)**[458]. The climate change risks are summarized in the following table:

Table 80: Project's exposure to climate change related risks as identified

CLIMATE CHANGE-RELATED ACUTE SHOCKS AND CHRONIC STRESSORS	CLIMATE CHANGE – RELATED RISKS
Longer periods of dry weather and storm water scarcity	Insecure water supply
	During the long periods of dry weather, pollutant material accumulates causing higher concentrations of pollutants in dry flows or first flush scenarios
Dry weather is followed by more intense winter storms	Over flooding of the system during larger storm events
Sea level rise	flooding

In order to identify potential traps and vulnerabilities, the project team described possible changes in key engineering design variables and explained how they accounted for them in the design. The project scored an Enhanced level of achievement at the related Envision credit, (**CR2.2 Avoid Traps and Vulnerabilities**)[459]. The changes in key engineering design variables that the project team identified are the following:

- <u>Shallow Groundwater level:</u>

The groundwater was encountered at depths of approximately 5.8 to 13.8 feet below ground surface during the geotechnical investigation. Historic high groundwater depths range between ground surface and 10 feet. The groundwater level is influenced by tidal fluctuations, rainfall, storm water runoff, ground surface topography,

458 Envision V3 has replaced this credit with CR2.2. Assess climate change vulnerability
459 Envision V3 has replaced this credit with CR2.5 Maximize Resilience

subsurface stratification, groundwater pumping, and irrigation practices. The risk of high groundwater level is that it creates a potential for the underground storage reservoir to float.

- Diverted flow rate:

The diversion structure is only designed to divert dry-weather flows (20 cfs). If the structure floats, the precast modular units could shift and separate, causing leakage. In the event of storms larger than 20 cfs, the system might become overwhelmed and overloaded, leading to equipment failure.

3.4.2. Climate-related risk management

The project team describes in the Envision required documentation how the project alleviates and/or eliminates traps. They describe that the storage tank was designed to resist the buoyant forces of the water table under different storage scenarios. More specifically "A permanent dewatering system was implemented to remove groundwater within the project area and to reduce groundwater impacts. Since care had to be considered for the underground storage reservoir, certain types of storage containers or designs had to be modified or discarded as options since a more robust tank would need to be designed. As such, calculations had to be performed to ensure that the designed tank would be able to resist the buoyant forces of the water table under different storage scenario. The storage facility was designed to be watertight in order to prevent leaking.

With respect to the potential risk of overwhelming and overloading of the system and SMURRF, active controls and actuated valves are set in place to close the system during larger storm events."[460]

In the Envision documentation the project team also demonstrated that the Clean Beaches project is resilient and adaptive in climate-related changes and can function under altered climate conditions, supply shortfalls, or other significant long-term changes in operational or environmental conditions.

Consequently, in the credit **CR2.3 Prepare for Long-Term Adaptability[461],** it managed a conserving level of achievement.

The responses to the climate change risks are summarized in the following table::

Table 81: Project response to identified climate change-related risks

CLIMATE CHANGE - RELATED RISKS	PROJECT'S RESPONSE
Insecure water supply due to longer periods of dry weather and stormwater scarcity	Increased **water reuse opportunity:** The galleries will provide additional sources of irrigation water by recycling water which will save additional fresh water sources for periods of drought.
During the long periods of dry weather,	The project's diversion structure and storage galleries will

460 Source: Envision documentation for credit CR2.2 (provided by the project team)

461 Envision V3 has replaced this credit with CR2.5. Maximize Resilience

pollutant material accumulates causing higher concentrations of pollutants in dry flows or first flush scenarios	be able to contain and settle those higher pollutant loads in order to protect the City's coastal waters.
intense winter storms that may lead to overflooding	Bypass is built into the system to prevent over flooding of the system during larger storm events.
	High insulation of underground facility
Sea level rise	Reviewed sea level rise models, wave runup FEMA flood maps and considered 100-year storms
	Use of cast-in-place storage gallery to resist **buoyant forces** of rising water level.

The siting was also carefully chosen with respect to water supply issues. It was chosen among other options in order to divert stormwater from the pier stormwater outfall and therefore to contribute in the increase of water supply.

The project has considered both natural and human-induced potential hazards and has also incorporated design strategies to safeguard against these hazards. In the Envision documentation the project team describes: **"**To safeguard against earthquakes, proposed improvements are designed in accordance with the California Building Code, which specifically address seismic hazards, and per recommendations of the geotechnical engineer. Structural calculations have been included to show the seismic design of the project.

To prevent issues due to flooding and low groundwater table levels, the tank system and pipes have been designed to resist uplift from buoyant forces. Active controls that include level sensors, flow transmitters, and actuated valves, are included in the design to safeguard the system from large storm events. When level sensors detect the system is full, actuated valves will automatically close. Diversion from the existing storm drain will be closed off and the system will be protected from surcharge. If a spill were to occur, it would be contained onsite since the parking lot is bound with concrete curbs, allowing for cleanup. "

In the related credit (**CR2.4 Prepare for Short-Term Hazards**)[462], the project scored the maximum Envision score achieving the restorative level as it managed to reduce impacts of future short-term disasters to the quality of the ocean. It basically improves water quality through the implementation of diversions and a hydrodynamic separator. By diverting the 85th percentile storm event[463], the project pretreats, stores and pumps the water to SMURFF for recycling. Larger storms will bypass the diversion, continue within the existing storm drain system, and discharge into the ocean. However, the amount of stormwater discharging eventually into the ocean is reduced, thus minimizing the risk of disaster from flood.

Additionally the project provides an extra source of water to be treated by the SMURRF, in order to be used as recycled water for City facilities. As such, it reduces potable water demand.

---

[462] Envision V3 has replaced this credit with CR2.5. Maximize Resilience

[463] To comply with the MS4 permit's requirements set by Los Angeles Regional Water Quality Control Board (LARWQCB) , the project targets capturing the 85th percentile runoff of a 24-hour storm event on the specific site

3.4.3. Project Core Strategies

Both California's Sustainable City Plan and the Climate Action Plan address and manage extreme environmental changes by including strategies towards resilience to extreme events. Some of these strategies are considered and also proposed by the project team such as **storage of water, and reuse of recycled water.** Overall the project reduces the need for importing water, minimizing thus the supply chain continuity risk.

Consistent with the City's guidelines, the legislative framework and requirements, as well as Envision, the project team's efforts toward sustainability and climate change adaptation are reflected in the following core sustainability strategies:[464]

Storage of water

The storage tank is a climate adaptation strategy that responds to water scarcity. It basically harvests and stores water both during dry and wet flow events for future use[465]. A new water source is provided through the stored water which after proper treatment, may be reused for irrigation, saving thus additional fresh water sources for periods of drought

In addition, this strategy contributes to climate mitigation by preventing highly pollutant waters to flow into the ocean. During the long periods of dry weather, pollutant material accumulates causing higher concentrations of pollutants in dry flows or first flush scenarios. The storage tank contains and settles these highly polluted loads in order to protect the city's coastal waters.

Use of Brackish Water

Use of brackish water is also a sustainable strategy for resiliency to drought. it provides a new water source which during long dry-weather conditions, will be the main water source to be treated in SMURFF. As such, it contributes in the City's target of minimizing imported water.

Additionally, the use of brackish water is also a climate change mitigation strategy. By eliminating the amount of imported water, it also **reduces energy use and emissions** associated with importing water and therefore contributes in **reducing the City's carbon footprint**.

Reuse of recycled water

The reuse of recycled water is a strategy that completely serves climate change adaptation. It addresses the resource availability risk that Santa Monica is facing with respect to fresh water availability.

Although the facility does not recycle the water, it was built to allow for water recycling after diverting the water. C) In order to minimize the long-term negative net impact on water sources, the project is implementing

464 The strategies described have been selected among many sustainable strategies of the Clean Beaches project's design and engineering teams, as the most important to mention for the scope of this case study.

465 Using the WIN TR-55 program to estimate onsite run off, the site is expected to produce and capture 1.35 cfs during a two year peak flow event and 3.56 cfs during a 100 year event. Each of which are well below the 20 cfs possible for capture from the existing pier outfall. Thus the facility we greatly exceed 100% storage capacity of the 71 acre site. (source: Envision assessment documentation)

the use of hydrodynamic separators, underground storage galleries and urban water recycling facilities in order to increase local fresh water resources. This is done by offsetting offsite potable water demand through recycled water uses. This will exceed the potable water demand created on site due to irrigation providing a net benefit. [466]

By passes

The project uses bypasses as a strategy to prevent overflooding of the tank **during larger storm events**. The bypasses provide flexibility to the harvesting system by allowing the water to be guided towards the sewage pipes when needed instead of the tank. This strategy is the response of the project towards vulnerabilities and increased risk of climate change threats such as flooding , that may impact the broader community.[467]

According to the project manager Selim Eren, "We put a diversion pump station to be able to switch from pumping into the recycling facility versus sewer. So, when we need to empty the tank, then we basically use our sewer system and put the storm water into the sewers."[468]

Underground Tank

The decision to place the tank underground, right near the Pier, was an unconventional solution with construction challenges, considering that the tank was similar in size to a football field. The project team was motivated by Envision and placed the tank about 15 feet below the initial ground surface, to use gravity for the runoff directed to the tank. The main benefit with respect to climate change mitigation was that the selection of a gravity system instead of a pumped system **reduces energy consumption and lowers greenhouse gas emissions**. Additionally, as a parallel benefit, the O&M costs of the underground tank were lower. However, there were risks involved regarding the stability of the tank and buoyancy from the elevated water table, sea level rise, or flooding. Eren describes: "we designed the tank to be completely submerged … and we assumed that it was empty. We considered that when it is empty, it needs to stay in place." The tank was designed to avoid traps and vulnerabilities, according to Envision.

Long-Term Monitoring

A long-term monitoring system has been introduced in the Clean Beaches project. It is part of the Coordinated Integrated Monitoring Program (CIMP) of a regional collaboration among the City of LA, the County Flood Control, the City of Santa Monica, and the City of El Segundo. The monitoring has a dual role:

- Climate change adaptation target: the real time control systems record and report the amount of water that the infrastructure harvests on a monthly and annual basis. It contributes in maximizing the amount of stored water for reuse, maximizing thus the potential for fresh water saving. This information is also suitable for public engagement to inform people on the amount of water used and treated.

---

[466] Source Envision V2 assessment, NW 2.1 – Manage Stormwater

[467] Refer to Envision V3 CR2.2.

[468] Selim Eren "Protecting the Santa Monica Bay & Beneficial Use of Stormwater: Santa Monica Clean Beaches Project." (Selim Eren lecture, Harvard Graduate School of Design, Cambridge, November 4, 2019)

- Climate change mitigation target: It monitors the water quality throughout Santa Monica Bay and the related watershed in order to contribute in reducing water pollution and reaching regulations targets.

Reuse of excavated soils

According to an earthwork calculation during the design of the project, the anticipated volume of soil to be hauled away from the site was 11,402 cubic yards, which equates to about 15,393 tons. To prevent the project from creating excess waste and to fulfill the California Coastal Commission's criteria for sand, the excess soil was filtered to be used as beach nourishment post construction using geosynthetic textile. [469]

The combination of reusing onsite soils and using recycled materials for the underground storage reservoir qualifies the project for a Superior level of achievement in the relevant Envision credit "RA1.3 Use Recycled Materials"
The described core strategies of the project are linked to Envision credits (V2) as shown in the following table. The relation of strategies with climate adaptation and climate mitigation is also presented:

Table 82: Core strategies in relation to Envision credits (V2) and contribution to adaptation and/or mitigation

STRATEGIES	RELATED ENVISION CREDITS V2	ENV SCORE	MITIGATION / ADAPTATION
Storage of water	CR 2.1 Access Climate Threat	CONSERVING	ADAPTATION MITIGATION
	NW 2.1 Manage Stormwater	RESTORATIVE	
	RA 3.1 Protect Fresh Water Availability	RESTORATIVE	
	NW2.3 -Prevent Surface and Groundwater Contamination	CONSERVING	
Use of brackish water	CR 2.1 Assess Climate Threat	CONSERVING	ADAPTATION MITIGATION
	NW 2.1 Manage Stormwater	RESTORATIVE	
	RA 3.1 Protect Fresh Water Availability	RESTORATIVE	
	RA 2.1 Reduce Energy Consumption	SUPERIOR	
	CR1.1 Reduce Greenhouse Gas Emissions	NONE	
Reuse of recycled water	CR 2.1 Assess Climate Threat	RESTORATIVE	ADAPTATION
	NW 2.1 Manage Stormwater	RESTORATIVE	
	RA 3.1 Protect Fresh Water Availability	RESTORATIVE	
Use of bypasses	CR 2.1 Assess Climate Threat	CONSERVING	ADAPTATION MITIGATION
	NW 2.1 Manage Stormwater	RESTORATIVE	
	NW2.3 - Prevent Surface and Groundwater Contamination	CONSERVING	
	LD2.2 Improve Infrastructure Integration	RESTORATIVE	
	CR2.3. Prepare for long term adaptability	CONSERVING	
Modular Underground	RA 2.1 – Reduce Energy Consumption	SUPERIOR	MITIGATION ADAPTATION
	CR1.1 Reduce Greenhouse Gas Emissions	NONE	
	CR2.2 Avoid Traps and Vulnerabilities	ENHANCED	

469 Source: Envision documentation submitted by the project team for RA1.3 Use Recycled Materials

Tank	LD3.3 Extend useful life	ENHANCED	
	CR2.3. Prepare for long -term adaptability	CONSERVING	
Long-Term Monitoring	NW2.3 - Prevent Surface and Groundwater Contamination	CONSERVING	MITIGATION
	RA2.3 Commission and Monitor Energy Systems	CONSERVING	ADAPTATION
	RA 3.3 – Monitor Water Systems	CONSERVING	
	LD 3.1 Plan for Long-term Monitoring and Maintenance	CONSERVING	
Reuse of excavated soils	RA1.6 Reduce Excavated Materials Taken Off Site	ENHANCED	
	RA 1.3 Use Recycled Materials	SUPERIOR	MITIGATION
	RA 1.5 Divert Waste from Landfills	SUPERIOR	ADAPTATION
	RA 2.1 – Reduce Energy Consumption	SUPERIOR	

The table shows that all core strategies are related to climate-change adaptation. It is also evident that a big percentage of strategies is related to climate change mitigation as well, highlighting the multi-benefit contribution of the project to sustainability.

Although there was no life-cycle carbon assessment performed for the project, it is evident that the project team made efforts to reduce GHG emissions. These are reflected in the following strategies that address climate change mitigation:

- The selection of the gravity system over a pumped system to harvest the water, eliminates the energy consumption and related long-term greenhouse emissions.
- The harvested water which is intended for non-potable uses offsets the energy needed to import water to the city and the associated GHG emissions.
- Towards the end of construction, the excavated sand was filtered and cleaned in order to be used for beach nourishment. This strategy eliminated the emissions associated to trucking the excavated material away from the site.

3.5. Climate-related Opportunities as Parallel Benefits

3.5.1. Emerging opportunities from addressing climate change

The main risks that the project is faced with are the physical asset risk and the resource availability risk (fresh water availability) due to long dry season and intense storms. The table below summarizes the types of risks that are related to each strategy based on the previous analysis. It also reveals opportunities that emerge with the implementation of core strategies towards climate change mitigation and adaptation. However, the table is still in progress, as the strategies towards resilience are yet to be further investigated, through expected input from the project team. The finalization of analysis of project opportunities will be subsequently linked to financial data in order to reveal in more detail the financial benefits of the project.

Table 83: Core strategies in relation to the risks they address and the opportunities they present

CORE STRATEGIES	RELATED ENVISION CREDITS V2	RISKS	OPPORTUNITIES
Storage of water	CR 2.1 – Assess Climate Threat	resource availability risk (water)	-
	NW 2.1 – Manage Stormwater	resource availability risk (water)	Resource efficiency (water)
	RA 3.1 – Protect Fresh Water Availability	resource availability risk (water)	Resource efficiency (water)
	NW2.3 - Prevent Surface and Groundwater Contamination	resource availability risk (water)	Resource efficiency (water)
Use of brackish water	CR 2.1 – Assess Climate Threat	resource availability risk (water)	-
	NW 2.1 – Manage Stormwater	resource availability risk (water)	Resource efficiency (water)
	RA 3.1 – Protect Fresh Water Availability	resource availability risk (water)	Resource efficiency (water)
	RA 2.1 – Reduce Energy Consumption	-	Resource efficiency (water), transition opportunity
	CR1.1 Reduce Greenhouse Gas Emissions	-	transition opportunity
Reuse of recycled water	CR 2.1 – Assess Climate Threat	resource availability risk (water)	-
	NW 2.1 – Manage Stormwater	resource availability risk (water)	Resource efficiency (water)
	RA 3.1 – Protect Fresh Water Availability	resource availability risk (water)	Resource efficiency (water)
Use of bypasses	CR 2.1 – Assess Climate Threat	physical asset risk, resource availability	-
	NW 2.1 – Manage Stormwater	resource availability risk (water)	Resource efficiency (water)
	NW2.3 - Prevent Surface and Groundwater Contamination	resource availability risk (water)	resource efficiency (water)
	LD2.2 Improve Infrastructure Integration	service continuity risk	Redundancy, integration
	CR2.3. Prepare for long term adaptability	service continuity risk	Adaptability
Modular Underground Tank	RA 2.1 – Reduce Energy Consumption	-	Resource efficiency (energy), transition opportunity
	CR1.1 Reduce Greenhouse Gas Emissions	-	transition opportunity
	CR2.2 Avoid Traps and Vulnerabilities	physical asset risk	-
	LD3.3 Extend useful life	resource availability risk (materials)	Durability
	CR2.3. Prepare for long -term adaptability	resource availability risk (materials)	Adaptability

		service continuity risk	
Long-Term Monitoring	NW2.3 - Prevent Surface and Groundwater Contamination	-	Resource efficiency (water)
	RA2.3 Commission and Monitor Energy Systems	resource availability risk (water)	Integration, Adaptability Reflective capability
	RA 3.3 – Monitor Water Systems	resource availability risk (water)	Integration, Adaptability Reflective capability
	LD 3.1 – Plan for Long-term Monitoring and Maintenance	resource availability risk (materials)	Integration, Adaptability Reflective capability
Reuse of excavated soils	RA1.6 Reduce Excavated Materials Taken Off Site	-	transition opportunity
	RA 1.3 – Use Recycled Materials	resource availability risk (materials)	Resource efficiency (materials)
	RA 1.5 – Divert Waste from Landfills	resource availability risk (land)	
	RA 2.1 – Reduce Energy Consumption	-	Resource efficiency (energy),

The project makes efforts to maximize resilience by addressing the climate-related opportunities that are linked with some of the core strategies.
Apart from providing for resource efficiency, the strategy of reusing the excavated soil also eliminates the emissions associated with trucking it away from the site. Therefore, that the project provides **resource efficiency** both in terms of materials but also in terms of energy**.** In addition, resource efficiency (water) is addressed by the project's own scope, as one of its main purposes for its realization was to contribute to water self-sufficiency. The use of brackish water ,the storage of water and the reuse of recycled water are strategies that add to saving water and therefore provide resource efficiency in terms of water.

The strategy of constructing an underground tank, apart from the benefits mentioned earlier, has several risks, such as the rising water level that can affect the tank due to buoyancy forces. This provided an opportunity for the project team to construct a facility with increased **durability**. To prevent issues due to flooding and low groundwater table levels, the tank system and pipes have been designed to resist uplift from buoyant forces. Durable and flexible design was incorporated through the use of a modular underground storage gallery. The modular design allows for easy configuration as needed, can be set up for a variety of uses including infiltration, storage, and treatment, providing thus also **adaptability**. It also allows for the easy installation of various connections, pumps or controls. Precast concrete was chosen over its plastic counterpart due to its better durability against external forces. Additional facilities were designed for the Pico Kenter outfall but not constructed. The design allows for the future expansion of the system by constructing the additional facility, therefore provides adaptability to future additional needs

Adaptability is also evident in the measures taken to address the potential consequences of long-term climate change, such the use of cast in place storage gallery to resist buoyant forces of rising water level and the use of bypasses to prevent overflooding of the tank during larger storm events. The bypasses also act as a backup system **(redundancy)** and **integrate** the project to a broader system as they permit overflows from the tank to be discharged into the existing sanitary sewer system during large storm events.

The strategy of long-term monitoring is linked by default with **integration and reflective capability.** The project has scored a restorative level at the respective credit LD2.2. Improve infrastructure Integration (V2), by restoring existing community infrastructure assets for community-wide infrastructure integration. More specifically it restores an existing storage yard into a new parking lot with 111 new parking spaces open to the public. Removing parking spaces on the Pier reduces some vehicular and pedestrian congestion, creates a safer Pier environment, which improves economic growth by attracting more visitors and businesses to the Pier. Additionally, integration is also evident in the new storm drain system that the project introduces in order to retrofit existing infrastructure to divert flows draining to the Pier outfalls. A hydrodynamic separator will be used for pretreatment before conveying flows into the underground storage gallery. Stormwater collected within the storage gallery will be pumped out via lift station and diverted to the existing storm drain system, which leads to the existing Santa Monica Urban Runoff Recycling Facility (SMURRF).

As for the **reflective capability** of the project, long-term monitoring of the project's performance is covered by the Coordinated Integrated Monitoring Program (CIMP) as part of a regional collaboration between the City of LA, County Flood Control, City of Santa Monica and City of El Segundo. The CIMP monitors the water quality throughout the Santa Monica Bay and its contributing watershed. Testing of the water in the drainage area and ocean will determine if the facility is performing as intended[470].

Regarding the project's inclusivity, it should be highlighted that throughout the project's development the City of Santa Monica has maintained an effort to remain transparent and communicate about its progress, adopting thus an inclusive approach towards the project. Many information bulletins, flyers, website updates, and workshops were created in order to help educate the public about the importance and scope of the project. Also, the project team solicited and assessed stakeholder issues and concerns during the monthly meetings and design milestone review meetings. In addition, during the project's operation, the real time control systems contribute in public engagement as they record and report the amount of water that the infrastructure harvests on a monthly and annual basis. This information is used to inform people on the amount of water used and treated. Santa Monica has thus created a sense of shared ownership or a joint vision to build city resilience and as a result the project has received a large amount of support in terms of community endorsements. It is worth mentioning that a great part of its funding has come from City of Santa Monica's Clean Beaches and Open Parcel Tax, "Measure V". In 2006, Measure V was passed with over two-thirds of the City's voting residents voting in its favor. Residents in Santa Monica agreed to contribute higher taxes to the city government in order to help fund projects – including the Clean Beaches project – that will divert potentially harmful substances from the ocean, improving their local environment.

3.5.2. Indirect Avoided Costs

In addition to the savings from the avoided imported water, other economic benefits could be taken into account, such as indirect costs related to tourism and health impacts caused by the beach's pollution. Coastal

[470] Source: Envision documentation submitted for LD 3.1 – Plan for Long-term Monitoring and Maintenance

tourism generates substantial revenues for state and local governments as well as for businesses. According to Santa Monica's Travel and Tourism,[471] the local tourism industry supports about 13,000 jobs.[472],[473] Economists estimate that a typical swimming person-day is worth approximately $35 to the City. Depending on the number of potential visitors to a beach, the loss of beach days due to health warnings or closures can be quite significant.[474] Even for areas that choose not to monitor the quality of their beaches or not to close them when water quality drops below standards, there are costs related to medical treatments and lost workdays. According to a Southern California study, every year fecal contamination at Los Angeles and Orange County beaches caused between 627,800 and 1,479,200 excess gastrointestinal illnesses, with a public health cost of $21 to $51 million.[475]

Additionally, avoided costs relate to penalties when facilities do not meet regulations for water quality standards. Santa Monica City's website officially states: ***"Santa Monica may be in violation of the new regulations and subject to $10,000 per day fines without construction of new projects that will be funded by Measure V to reduce storm drain pollution."*** (Santa Monica Public Works, Civil engineering, 2020)[476]

Table 84: Overall Santa Monica visitor activity indicators (2017 vs. 2016)[477]

Indicator	2017 Number	2017 % Change	2016
Total Number of Visitors[1]	8,710,468	3.6%	8,408,350
Average Length of Stay (days, all visitors)	1.36	-.7%	1.37
Total Visitor Days	11,852,965	3.2%	11,484,900
Total Annual Visitor Spending	$1.96 billion	5.1%	$1.87 billion
Per-capita Daily Visitor Spending	$166	1.8%	$163
Hotel Tax Revenue to City (from non-local visitors)[2]	$54,353,740	6.7%	$50,938,600
Visitor Retail Sales Tax Revenue to City [2]	$12,176,830	2.5%	$11,883,450
Santa Monica Jobs Supported by Tourism	13,345	.7%	13,256

Source: Lauren Schlau Consulting and CIC Research, Inc. for Santa Monica Travel & Tourism

471 SMTT is a nonprofit organization that promotes Santa Monica as a travel destination.

472 "Santa Monica 2017 Summary Tourism Economic & Fiscal Impacts, Visitor Profile," https://www.santamonica.com/wp-content/uploads/2018/05/2-Page-Econ-Imp-Summary-2017.pdf).

473 To receive the same level of city services Santa Monica residents currently experience, it is estimated that each Santa Monica household would have to pay an additional $1,379 in property taxes to maintain city services if tourism revenues and the TOT (Tax Our Tourists) did not exist. In 2017, visitors spent a record-breaking $1.96 billion in the city of Santa Monica (source: https://www.santamonica.gov/blog/by-the-numbers-tourism-s-economic-impact-in-santa-monica).

474 One study estimated economic losses as a result of closing a Lake Michigan beach due to pollution could be as high as $37,030 per day: https://www.nrdc.org/sites/default/files/ttw2014_Impacts_of_Beach_Pollution.pdf)

475 S. Given et al., "Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches," *Environmental Science and Technology* 40, no. 16 (2006): 4851. (Source: https://www.santamonica.com/wp-content/uploads/2019/05/2-Page-Econ-Imp-Summary-2018.pdf.)

476 https://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9573

477 Source: https://www.santamonica.com/wp-content/uploads/2019/05/2-Page-Econ-Imp-Summary-2018.pdf

3.5.3. Return on Investment[478]

The return on investment (ROI) analysis is based on a 30-year lifecycle, taking into consideration:

- the savings from avoided imported water costs when operating SMURRF at full capacity,
- the maintenance and operation costs of the project,
- the sewer fees associated with use of sewer discharges

Table 85: Summary of year one costs and savings[479]

Construction cost	($14,856,970)
Annual O&M cost	($100,000)
Annual sewer fee	($56,000)
Savings	$568,108

Table 86: Summary of 30 years costs and savings[480]

Construction cost	($14,856,970)
Present value of cumulative annual O&M cost, escalated at 2% for 30 years*	($2,613,553)
Present value of annual sewer fee, escalated at 2% for 30 years*	($1,463,590)
Present value of savings from avoided imported water cost, escalated at 7% for 30 years*	$31,249,245
NET PRESENT VALUE for 30 YEARS*	**$12,315,132**

* discount rate 3% annually

3.5.4. Multiple benefits of the project

The sustainability-oriented leadership of Santa Monica, the availability of funding and the community support provided the context for the project to thrive. The success of the project is reflected in environmental, social and economic benefits related to beach water quality upgrades, health risks minimization and tourism promotion.

This infrastructure project, with its sustainability objectively quantified with Envision® and the resulting Envision Gold award, is a sound business decision for the City of Santa Monica.

Overall, the Clean Beaches project is multi-benefit contributing in various aspects of sustainability such as:

- Protection of freshwater (by preventing pollutant waters to flow in the ocean)
- Water self-sufficiency (by providing new sources of water)

478 Santa Monica Public Works (2017) City Council Report :Award Construction Contract for Clean Beaches Project (Agenda Item:3H)

479 Santa Monica Public Works documents provided by Selim Eren

480 Ibid

- Preservation of the natural environment (protecting beach waters, minimizing emissions related to importing water)
- Ensuring the people's health and safety (by reducing beach water pollution)
- Safeguarding the economic prosperity of the City based on tourism (by upgrading the beachfront of Santa Monica)
- Avoiding costs related to penalties
- Return on investment
- Minimizing the risks of climate change and providing extreme events management (storm water management, providing new sources of water, facing flood risks etc
- Reducing carbon emissions (using gravity instead of pumping and reducing emissions related to importing water)

APPENDIX A

ZOFNASS PROGRAM AT HARVARD
PROPOSED FOCUS OF RESEARCH, 2020-21

DRAFT AND CONFIDENTIAL, November 14, 2020

SIAB members ZOOM call, November 10, 2020

Spiro Pollalis (ZPH)
Evgenia Chatzistavrou (ZPH)
Judith Rodriguez (ZPH)
Chris Barron (Bentley)
Andreas Georgoulias (EFCG)
Anthony Kane (ISI)
Tom Lewis (WSP)
Cris B. Liban (LA Metro)
Loren Labovitch (Stantec)
Roberto Mezzalama (Golder)
Linda Reardon (NV5)
Deepa Sathiaram (En3)
Brian Swett (ARUP)
Paul Zofnass (EFCG)

IDENTIFICATION OF NEED

During the discussion of November 10, 2020, with the Sustainability Industry Advisory Board (SIAB), we requested their input for the 2020-21 research direction of the Zofnass Program. A shared view of the SIAB members focuses on the availability of funds in a post-COVID era to support the necessary restart of the global economy; therefore, investment in infrastructure projects. Along these lines, two areas of focus emerged, to be studied as part of the Envision® framework within the existing framework:

- high-priority to projects, which embrace climate change mitigation and adaptation, and
- project financing and prioritization of projects to ensure the right projects are selected.

RESEARCH PROPOSAL

The Envision® framework, a set of criteria for the sustainable performance of infrastructure projects, serves as the basis for the research on prioritizing projects to be funded. It may lead to prioritizing selected criteria over other criteria. Such a task complements the importance of all criteria that collectively ensure an infrastructure project's sustainable performance. Envision® is a triple bottom line sustainability certification system essential for ensuring a sustainable project regarding social, environmental, and economic performance. None of the three dimensions should be ignored or underrated. However, it may lead to 'we are doing the project right,' rather than respond to the question 'are we doing the right project?' Given the need:

- for prioritizing projects with significant impact on climate change mitigation, zero-carbon projects, etc., and
- for investors to identify which projects are the right projects to proceed, based on their imperatives.

Envision could take a position, a form of 'declaration' on what sustainable projects should principally represent. Moreover, the two needs above are interconnected: investors are interested in projects that address climate change since such projects have lower risks.

The present proposal for the research focus for the Zofnass Program for 2020-2021 consists of research that can support investors for funding climate change mitigation and adaptation projects. It is a dual approach to take a position regarding the importance of climate change mitigation and adaptation while supporting investors in decision-making.

A specific 'filtering' of Envision is required to bring out these high-priority criteria. Therefore, it is essential to research and define <u>what the filtering should be</u>.

In climate change, this is straightforward as the lifecycle of projects could be prioritized based on their contribution, e.g., to conventional energy usage, emissions, and embodied carbon.

In supporting investor-related criteria for choosing a project, the performance across social, economic, and environmental criteria should be considered, including reputational risk, license to operate, etc.

RESOURCES TO BUILD UPON

Apart from building upon the Envision framework, the research suggests using relevant recent research methodology that led to the development of the Sustainability Lifecycle tool developed by Prof. Pollalis as part of research in collaboration with the National Research Council of Canada (NRCC).

<u>A brief overview of the Sustainability Lifecycle Tool</u>

In the Sustainability Lifecycle tool, the research objective was to develop a tool that integrates sustainability assessment and lifecycle assessment. The result is an Envision-based self-assessment tool, an additional proposed tool within the Envision Framework that assesses project performance, which is already present in Envision:

- per lifecycle stage (design and material production, construction, operation, maintenance, and end-of-life)
- concerning specific triple bottom line impacts (environmental, social, and economic).

The Sustainability Lifecycle tool uses the Envision methodology, approach, and structure**.** <u>It is a filtering and interpretation of the Envision Manual, extracting and highlighting selective information within the Envision credits. It adds to the Envision by applying a new coding to each credit focused on **Lifecycle stages** and **Triple**</u>

Bottom Line impacts. In other words, the tool links credits and their related strategies with the lifecycle they refer to (as a boundary of the credit's assessment) and the type of impact they assess and have an indirect benefit, trade-off, and incremental impact.

The list of the Triple bottom line impacts that the tool assesses are shown below:

SOCIAL	ENVIRONMENTAL	ECONOMIC	
		AGENCY	USER
Access Safety Health Noise Light pollution Community satisfaction Inclusivity Equity Sense of place Wellbeing Livability Integration Capacity building Social resilience	Materials Energy Embodied energy Water Water quality Embodied water Air quality Waste Soil quality Emissions Embodied carbon Ecosystem quality Resource depletion Land occupation Climate change Ecological Resilience	Capital (initial)cost O&M cost Rehabilitation cost Replacement cost Residual value Revenues Delay cost Liability claim/ Compliance cost Noise cost Restoration cost Resilience value Ecosystem services value	Travel time value Vehicle cost Fuel cost Fare cost Accident cost Health cost Job creation Economic prosperity Resilience value Ecosystem services value

The connection of the Envision credits with specific impacts, which they address, can serve as a basis for the research on project priority. As highlighted in the table above, an analysis of Envision has already been performed in climate change. It has linked Envision credits (and their related strategies) with a positive or negative impact on direct contributors to climate change, such as energy, emissions, and embodied carbon.

It is worth adding that the Sustainability Lifecycle tool assigns direct and indirect impacts on credits. Therefore, it connects the 'obvious' credits to emissions or embodied carbon and credits that include strategies that indirectly produce emissions, etc. This is essential for a holistic approach to climate change mitigation and adaptation, as it highlights strategies across different categories of impact with a negative or positive contribution.[481]

The impacts finally include the project's lifetime dimension. They can be initial, short-term, but also long-term, or recurring short-term impacts. The tool tries to capture and account for both the initial and future impacts of a project, which is more evident in the direct economic impacts for owners and thus financiers. Credit and strategies correspond to a specific lifecycle stage of the project, i.e., improve sustainable performance during operation. The listed related impacts focus not only on operation but also on other life cycle stages to provide a complete overview of the strategy's implications and enable choosing between alternative strategies. In such a way, a decision-maker that navigates the tool in search of sustainable strategies is informed for strategies that impact future stages of the project.

481 The 'CR1.1 Reduce Net Embodied Carbon' and 'CR1.2 Reduce Greenhouse Gas Emissions' are among a set of credits that are defined as 'key credits' within the Sustainability Lifecycle tool. They provide the capability to map and group all Envision credits and relevant strategies that have a positive or negative impact on embodied carbon and GHG emissions.

The research methodology for the development of the Sustainability Lifecycle tool can be adapted for the proposed research focused on climate change and, at the same time, focused on investment driving factors.

PROPOSED METHODOLOGY

The methodology for the development of the Sustainability Lifecycle tool included a thorough analysis of Envision under the lens of the relevant lifecycle and triple bottom line impacts that each credit and its related strategies address or produce, that was further supported by:

- an extensive literature review on (a) life cycle assessment methodologies and (b) analysis in terms of the triple bottom line (TBL),
- in addition to Envision, an analysis of two widely used sustainability certification systems, CEEQUAL® and ISCA®,
- input from experts on the interrelation of strategies and impacts,
- a detailed analysis of a selected project, which was used as a case study to identify environmental, social, and economic impacts as input for the development of the tool and calibrate the proposed use of the developed tool.

The proposed research methodology for the 2020-2021 research of the Zofnass Program consists of:

- analysis of the priorities of investors (literature review, input from investors),
- analysis of what priority to climate mitigation and adaptation performance of a project means, based on the Sustainability Lifecycle tool,
- input from companies and agencies on climate mitigation and adaptation and use of specific project example(s) to explore multiple benefits or project trade-offs in the social and economic categories of impact,
- input from investors to identify the main 'IMPACTS' to filter the Envision credits,
- analysis of Envision credits in terms of the two priorities (filtering of Envision based on climate change and investor-related criteria) to determine to what extent Envision covers explicitly or implicitly the specific IMPACTS; the Sustainability Lifecycle tool will be the basis for analysis and potential further additions to its list of impacts,
- final selection and compilation of Envision credits that relate to the identified IMPACTS; these credits will form the high-priority criteria for the evaluation of the right projects to proceed,
- analysis of the current weight of the selected criteria and input from SIAB-ZPH members on potential weighing enhancement to reflect the high priority of climate change and investment criteria.

It is worth highlighting that the present proposal does not suggest a mono-criteria or two-or-three criteria analysis of projects. The focus may be on climate change, but priority credits and strategies will be considered across the full extent of their related impacts to provide a stronger case of why investors should choose to fund these projects and the multiple benefits and trade-offs of such decisions.

APPENDIX B

In the Appendix B there is a more detailed description of the scenarios presented in the Part A and Chapter 1. of the Literature Review.

a. Emissions Scenarios - IS92 scenarios -1990

Science Scenarios

1. **S1 or Scenario A (or Business-as-Usual Scenario**). The assumption is that the energy supply is coal intensive and on the demand side only modest efficiency increases are achieved. Carbon monoxide (CO) controls are modest, deforestation continues until the tropical forests are depleted and agricultural emissions of methane and nitrous oxide are uncontrolled. For CFCs the Montreal Protocol is implemented albeit with only partial participation. The aggregation of national projections by IPCC gives higher emissions (10-20%) of carbon dioxide and methane by 2025. S1 scenario as stated in the 'IPCC Scientific Assessment': 'emissions of GHGs are predicted to reach a rate of increase of global mean temperature during the next century of about 0,3°C per decade. This will result in a likely increase in global mean temperature of about 1°C above the present value by 2025 and 3°C before the end of the next century (meaning by 2100).
2. **S2 or Scenario B.** In this case, the energy supply mix shifts towards lower carbon fuels, notably natural gas. Large efficiency increases are achieved. Carbon monoxide (CO) controls are stringent, deforestation is reversed and the Montreal Protocol is implemented with lull participation. The message of S2 scenario is that all emissions will be reduced by 50% in 1990, and will hold constant thereafter. Taking this into consideration it is predicted that GHG emissions will reach rates of increase in global mean temperature of about 0,2°C per decade.
3. **S3 or Scenario C** goes a step further suggesting a shift towards renewables and nuclear energy which takes place in the second half of next century (meaning in 2050). CFCs in this scenario are phased out and agricultural emissions limited and therefore the S3 scenario predicts a decrease in emissions at 2% per year compound from 1990 which is translated in rates of increase in global mean temperature to be expected just above 0,1°C per decade.
4. **S4 or Scenario D**. In this scenarios the key factors are: (i) a shift to renewables and (ii) nuclear in the first half of the next century (until 2050) which reduces the emissions of carbon dioxide, initially more or less stabilizing emissions in the industrialized countries. In S4 scenario Carbon dioxide (CO_2) emissions were expected to be reduced about 50% of 1985 levels (levels which in 1990's reports were considered as the baseline) by the middle of the next century (by 2050). This reduction in the long-term would be reflected as an increase of emissions at 2% per year compound until 2010 and then decrease at 2% per year compound. In S4/Scenario D it is also predicted that the rates of increase in global mean temperature will be of about 0,1 °C per decade'.

Policy Scenarios

1. The **2030 High Emissions** scenarios or **"Business as Usual"**, assumed that few or no steps are taken to reduce GHG emissions in response to concerns about greenhouse warming. According to WGI, under this scenario, the equivalent CO_2 concentrations reach a value double that of pre-industrial atmospheric concentrations of CO_2 by 2030 and continued increase throughout the rest of the century. Continued population and economic growth produces increases in the use of energy and in the rate of clearing of tropical forests. The Montreal Protocol comes into effect, but without strengthening and with less than

100% compliance. Fossil fuels continue to dominate energy supply, with coal taking a much larger share of energy supply in the future.

2. The **2060 Low Emissions** scenarios portray a world in which a number of environmental and economic concerns result in steps to reduce the growth of GHG emissions. The equivalent CO_2 concentrations is estimated to reach a value of double that of pre-industrial atmospheric concentrations of CO_2 around 2060. Energy efficiency improves more rapidly due to such factors as efficiency standards and technology transfer and is possible with government intervention. Emissions controls are adopted globally and the share of the world's primary energy provided by natural gas increases. Full compliance with the Montreal Protocol is achieved, the tropical deforestation is halted and reversed and a global reforestation effort begins. These steps reduce growth in emissions by 50 -75% and significantly slow down the growth in atmospheric concentrations GHGs.
3. The **Control Policies** scenarios reflected futures where concern over global climate change and other environmental issues, such as stratospheric ozone depletion, motivate steps over and above those in the 2060 Low Emissions Scenario to reduce GHG emissions. These emission trends yield increases in atmospheric concentrations. Equivalent CO_2 concentrations reach a value double that of pre-industrial atmospheric concentrations of CO_2 by 2090 and stabilize thereafter. Technological development, commercialization, and government efforts result in rapid penetrations of renewable energy sources in the last half of the next century (2100). Agricultural policies yield reduction in emissions of GHGs from enteric fermentation in domestic animals, from rice paddies, and from fertilizer. The Montreal Protocol is strengthened to include a full phase-out of CFCs and freezes on methyl-chloroform and carbon tetrachloride.
4. The **Accelerated Policies** scenarios were similar to the Control Policies scenarios and assumed that economic, political and technological constraints would prevent any significant reduction in emissions. In the short run Equivalent CO_2 concentrations was estimated to stabilize at a level less than a doubling of pre-industrial atmospheric concentrations of CO_2. Much more rapid development and penetration of renewable energy sources will be encouraged, in part by global adoption of carbon fees. To reduce GHGs emissions actions like the adoption of agricultural policies to reduce emissions from livestock systems, rice paddies, and fertilizers and the further strengthening of the Montreal Protocol will be implemented. Biomass energy will represent 10-25% of primary energy supply by 2025. The group of experts suggested an alternative to this scenario namely 'the **Alternative Accelerated Policies Scenarios'** which differs only in emissions of CO_2 and primarily in the short run however the alternative of the fourth scenario assumes a political climate that <u>stresses the urgency of rapidly slowing down the rate of climate change</u>, and immediate declining of CO_2 emissions which should reach the same levels by the end of the next century (2100). In both scenarios, atmospheric concentrations of GHGs continue to increase, but stabilize by the middle of 2050 at levels 25% greater climate-resilient development pathways (CRDPs) than current levels.

b. Special Report on Emissions Scenarios - SRES - 2000

1. The **A1 storyline and scenario family** describes a future world of <u>very rapid economic growth, global population that peaks in mid-century (2050)</u> and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes were the convergence among regions, the capacity building, and the increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe <u>alternative directions of technological change</u> in the energy system such as: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B)
2. The **A2 storyline and scenario family** describes a very heterogeneous world. The underlying theme was self-reliance and <u>preservation of local identities</u>. Fertility patterns across regions converge very slowly,

which results in continuously increasing global population. Economic development is primarily regionally oriented and per capita economic growth and technological change are more fragmented and slower than in other storylines.

3. The **B1 storyline and scenario family** describes a convergent world with the same global population that peaks in mid-century (2050) and declines thereafter, as in the A1 storyline, but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives
4. The **B2 storyline and scenario family** describes a world in which the emphasis is on local solutions to economic, social, and environmental sustainability. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented toward environmental protection and social equity, it focuses on local and regional levels.

c. The complementary Shared Socio-Economic Pathways - SSPs (2012) and Representative Concentration Pathways - RCPs (2013)

Shared Socio-Economic Pathways, SSPs

SSP1: 'Sustainability – Taking the Green Road'. Gradual shift toward a more sustainable path. (i) Management of the global commons slowly improves, educational and health investments accelerate the demographic transition and the emphasis on economic growth shifts toward human well-being. (ii) With the aim to achieve development goals, inequality is reduced both across and within countries. (iii) Consumption is oriented toward low material growth and lower resource and energy intensity.

SSP2: Middle of the Road. A path in which social, economic, and technological trends do not shift from historical patterns. (i) Development and income growth proceeds unevenly. Some countries are making relatively good progress while others are not. Global population growth is moderate and levels off in around 2050. Income inequality improves slowly. Challenges to reducing societal vulnerability and environmental changes remain. (ii) Global and national institutions make slow progress in achieving sustainable development goals. (iii) Environmental systems degrade, only with some improvements. Resource and energy use intensity declines.

SSP3: Regional Rivalry – A Rocky Road. Resurgent nationalism, competitiveness and security, and regional conflicts push countries to focus on domestic or regional issues. (i) Policies shift toward national and regional security issues. Population growth is low in industrialized countries and high in developing countries. (ii) Low international priority for environmental concerns leads to environmental degradation. Investments in education and technological development decline. (iii) Countries focus on energy and food security goals within their own regions. Slow economic development, consumption is material-intensive, and inequalities remain.

SSP4: Inequality – A Road Divided. Highly unequal investments in human capital, economic opportunity and political power, lead to inequalities across and within countries. (i) Gap widens between an internationally-connected society and capital-intensive sectors of the global economy, (ii) Fragmented lower-income, poorly educated societies working in a labor intensive, low-tech economy leads to social degradation. Environmental policies focus on local issues (iii) Technology development in high-tech economies and sectors. Energy sector diversifies. Investments in carbon-intensive fuels (coal), unconventional oil and low-carbon energy sources.

SSP5: Fossil-fueled Development – Taking the Highway. Increased faith in competitive markets and innovation. Societies grow in rapid technological progress and development of human capital. (i) Global markets are increasingly integrated. Strong investments in health, education, and institutions enhance human and social capital. Global economy rapid growth (ii) Global population peaks and declines in the 21st century. Local environmental problems (like air pollution) are successfully managed. Faith in effectively managing social and ecological systems, including geo-engineering (iii) Push for economic and social development through abundant fossil fuel resources exploitation and resource and energy intensive lifestyles adoption globally.

APPENDIX C

In the following tables the six SDGs related to the predecessor MDG 7 "ensure environmental sustainability" are portrayed in regard with their targets and their estimated implementation year .

Goal 6	Ensure availability and sustainable management of water and sanitation for all	
no	**targets**	**Implemented by**
6.1	Achieve universal and **equitable access to safe and affordable drinking water for all**	2030
6.2	Achieve access to adequate and **equitable sanitation and hygiene for all** and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	2030
6.3	**Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials**, halving the proportion of untreated wastewater and substantially **increasing recycling and safe reuse globally**	2030
6.4	Substantially **increase water-use efficiency across all sectors** and ensure sustainable withdrawals and **supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity**	2030
6.5	Implement **integrated water resources management** at all levels, including through trans-boundary cooperation as appropriate	2030
6.6	**Protect and restore water-related ecosystems**, including mountains, forests, wetlands, rivers, aquifers and lakes	2020
6.a	**Expand international cooperation** and capacity-building support to developing countries in water- and sanitation-related activities and programs, including **water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies**	2030
6.b	Support and strengthen the **participation of local communities in improving water and sanitation management**	-

Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all	
no	**targets**	**Implemented by**
7.1	Ensure universal access to affordable, reliable and modern energy services	2030
7.2	Increase substantially the share of renewable energy in the global energy mix	2030
7.3	Double the global rate of improvement in energy efficiency	2030
7.a	Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and	2030

	advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	
7.b	Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programs of support	2030

Goal 12	**Ensure sustainable consumption and production patterns**	
no	**targets**	**Implemented by**
12.1	Implement the 10-year framework of programs on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	within 10 years since 2015
12.2	Achieve the sustainable management and efficient use of natural resources girls and those in vulnerable situations	2030
12.3	Halve per **capita global food waste** at the retail and consumer levels and **reduce food losses along production and supply chains**, including post-harvest losses	2030
12.4	Achieve the environmentally **sound management of chemicals and all wastes throughout their life cycle**, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	2020
12.5	**Substantially reduce waste generation through prevention, reduction, recycling and reuse**	2030
12.6	**Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle**	-
12.7	Promote public procurement practices that are sustainable, in accordance with national policies and priorities	-
12.8	Ensure that people everywhere have the relevant information and awareness for **sustainable development and lifestyles in harmony with nature**	2030
12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	-
12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and **promotes local culture and products**	-
12.c	**Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption b**y removing market distortions, in accordance with national circumstances, including by **restructuring taxation and phasing out those harmful subsidies, where they exist**, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities	-

Goal 13	Take urgent action to combat climate change and its impacts*	
no	**targets**	**Implemented by**
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	-
13.2	Integrate climate change measures into national policies, strategies and planning	-
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	-
13.a	Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	2020
13.b	Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities	-
* Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.		

Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	
no	**targets**	**Implemented by**
14.1	Prevent and significantly **reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution**	2025
14.2	Sustainably manage and **protect marine and coastal ecosystems** to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	2020
14.3	**Minimize and address the impacts of ocean acidification**, including through enhanced scientific cooperation at all levels	-
14.4	Effectively **regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans**, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	2020
14.5	**Conserve at least 10 per cent of coastal and marine areas**, consistent with national and international law and based on the best available scientific information	2020
14.6	**Prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies**, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral	2020

	part of the World Trade Organization fisheries subsidies negotiation	
14.7	**Increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources**, including through sustainable management of fisheries, aquaculture and tourism	2030
14.a	Increase scientific knowledge, **develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology**, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries**, in particular small island developing States and least developed countries**	-
14.b	**Provide access for small-scale artisanal fishers to marine resources and markets**	-
14.c	**Enhance the conservation and sustainable use of oceans and their resources** by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of The Future We Want	-

Goal 15	Protect, restore and promote sustainable use of terrestrial	
no	**targets**	**Implemented by**
15.1	Ensure the **conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services**, in particular forests, wetlands, mountains and dry-lands, in line with obligations under international agreements	2020
15.2	Promote the implementation of sustainable management of all types of forests, **halt deforestation, restore degraded forests** and substantially increase afforestation and reforestation globally	2020
15.3	**Combat desertification, restore degraded land and soil**, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	2030
15.4	**Ensure the conservation of mountain ecosystems**, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	2030
15.5	Take urgent and significant action **to reduce the degradation of natural habitats, halt the loss of biodiversity and**, by 2020, protect and prevent the extinction of threatened species	2020
15.6	**Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources** and promote appropriate access to such resources, as internationally agreed	-
15.7	Take **urgent action to end poaching and trafficking of protected species of flora and fauna** and address both demand and supply of illegal wildlife products	-
15.8	Introduce measures to **prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems** and control or eradicate the priority species	2020
15.9	**Integrate ecosystem and biodiversity values into national and local planning**, development processes, poverty reduction strategies and accounts	2020

15.a	Mobilize and significantly increase **financial resources from all sources to conserve and sustainably use biodiversity and ecosystems**	-
15.b	Mobilize significant resources from all sources and at all levels to **finance sustainable forest management** and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation	-
15.c	Enhance **global support for efforts to combat poaching and trafficking of protected species,** including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	-

APPENDIX D

LIST OF KEY ORGANIZATIONS AND INSTITUTIONS WORKING ON CLIMATE CHANGE

The **United Nations**, **UN** is an international organization currently made up of 193 Member States. Due to its unique international character, the United Nations can take action on the issues confronting humanity in the 21st century, such as peace and security, climate change, sustainable development, human rights, disarmament, terrorism, humanitarian and health emergencies, gender equality, governance, food production, and more. The main organs of the UN are the General Assembly, the Security Council, the Economic and Social Council, the Trusteeship Council, the International Court of Justice, and the UN Secretariat. All were established in 1945 when the UN was founded. The UN system, also known unofficially as the 'UN family,' comprises the UN itself and many programs, funds, and specialized agencies, all with their leadership and budget. The programs and funds are financed through voluntary rather than assessed contributions. The Specialized Agencies are independent international organizations funded by both voluntary and assessed contributions.[482]

The UNEP - United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system . UNEP acts as a catalyst , advocate, educator, and facilitator to promote the global environment's wise use and sustainable development.[483]

The UNDP - United Nations Development Program works in nearly 170 countries and territories, helping to eradicate poverty, reduce inequalities and build resilience so countries can sustain progress. UNDP plays a critical role in helping countries achieve Sustainable Development Goal as the UN's development agency.[484]

The UNFCCC - United Nations Framework Convention on Climate Change Secretariat - UN Climate Change - was established in 1992 when countries adopted the United Nations Framework Convention on Climate Change (UNFCCC). With the subsequent adoption of the Kyoto Protocol in 1997 and the Paris Agreement in 2015,

[482] https://www.un.org/en/sections/about-un/main-organs/index.html
[483] https://www.un.org/en/sections/about-un/funds-programmes-specialized-agencies-and-others/index.html
[484] Background on the goals : https://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html

Parties to these three agreements have progressively reaffirmed the Secretariat's role as the United Nations entity tasked with supporting the global response to the threat of climate change.[485]

The UNECE - United Nations Economic Commission for Europe was set up in 1947. One of the five regional commissions of the United Nations with a major aim is to promote pan-European economic integration. UNECE includes 56 member States in Europe, North America, and Asia

COP - Conference of the Parties under the UNFCCC - Under the 1992 United Nations Framework Convention on Climate Change, every country on earth is treaty-bound to "avoid dangerous climate change" and find ways to reduce greenhouse gas emissions globally in an equitable way. COP stands for 'Conference of the Parties' under the UNFCCC. The annual meetings have swung between fractious and soporific, interspersed with moments of high drama and the occasional triumph (the Paris agreement in 2015) and disaster (Copenhagen in 2009).[486] A key task for the COP is to review the national communications and emission inventories submitted by the Parties. Based on this information, the COP assesses the effects of the measures taken by the Parties and the progress made in achieving the ultimate objective of the Convention.[487]

UNDRR (formerly UNISDR)-United Nations Office for Disaster Risk oversees the Sendai Framework for Disaster Risk Reduction 2015-2030, supporting countries in its implementation, monitoring & sharing what works in reducing existing risk and preventing the creation of new risk. [488]

The UNSD -United Nations Statistics Division is committed to the advancement of the global statistical system. It aims to compile and disseminate global statistical information, develop standards and norms for statistical activities, and support countries' efforts to strengthen their national statistical systems. Moreover, it facilitates the coordination of international statistical activities and supports the functioning of the United Nations Statistical Commission as the apex entity of the global statistical system.[489]

The Sustainable Development Goals Fund (SDG Fund) is an international multi-donor and multi-agency development mechanism created in 2014 by the United Nations to support sustainable development activities through integrated and multidimensional joint programs. Its main objective is to bring together UN agencies, national governments, academia, civil society, and business to address the challenges of poverty, promote the 2030 Agenda for Sustainable Development and achieve SDGs. Convening public-private partnerships for SDGs is in the SDG Fund's DNA.[490]

IPCC – The **Intergovernmental Panel on Climate Change** was established in 1988 to provide policymakers with regular scientific assessments on the current state of knowledge about climate change. Its initial task was to prepare a comprehensive review and recommendations for the state of knowledge of the science of climate change, the social and economic impact of climate change, and potential response strategies and elements for

[485] https://unfccc.int/about-us/about-the-secretariat
[486] https://www.theguardian.com/news/2019/dec/02/climate-crisis-what-is-cop-and-can-it-save-the-world
[487] https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop
[488] https://www.undrr.org/about-undrr
[489] https://unstats.un.org/home/about/
[490] https://www.sdgfund.org/who-we-are

inclusion in a possible future international convention on climate. Since 1988, the IPCC has had five assessment cycles and delivered five Assessment Reports. It has also produced a range of Methodology Reports, Special Reports, and Technical Papers to request information on specific scientific and technical matters from the United Nations Framework Convention on Climate Change (UNFCCC), governments, and international organizations.[491]

[491] https://www.ipcc.ch/reports/

APPENDIX E

IMPACTS DEFINITION

Social Impacts:

Access=access to key community activities (job, education, healthcare, etc.)

Safety = exposure to the risk of accident (during operations or construction works) for public/ safety for workers; the level of stress for users; premature mortality due to accidents

Health = project's impact on human health (air-, water-, noise- prone diseases and premature mortality)

Noise= community disturbance caused by project-generated noise (operational or during construction and maintenance works)

Light pollution= impact of excessive, misdirected, or obtrusive artificial outdoor light (during operations or construction and maintenance works)

Community satisfaction= Project approval by the affected by the project community as reflected in positive feedback

Inclusivity=inclusion of people who might otherwise be excluded or marginalized (minority groups) and inclusion of all related stakeholders in the decision-making process

Equity=equal and without prejudice treatment of all individuals affected by the project (communities) and involved in the project delivery (project team, workforce), as well as fair distribution of benefits and burdens and funding

Sense of place= heritage & cultural identity

Wellbeing= Given that human wellbeing is a broad concept with numerous interpretations that lacks a universally acceptable definition, as part of this research entails living standards, needs fulfillment, human comfort, freedom of choice, ride quality, visual comfort (removal of eyesores), and workers comfort. Though not a quantifiable impact, it is used to highlight the project's contribution to relevant themes.

Livability=contribution to the creation of livable communities

Integration= operational relationships and functional integration of the project into connected, efficient, and diverse infrastructure systems beyond its boundary

Capacity building= Skill and knowledge expansion (for the workforce, community), awareness building, and behavioral change

Social Resilience= avoided loss of life, loss of health, loss of assets due to acute shocks and chronic stresses and avoided impact on the community due to loss of service, as well as adaptation to demographic shifts

Environmental Impacts:

Materials= use of primary materials

Energy= fuel & electricity use; depending on the credit could refer to fuel use of equipment/ vehicles.

Embodied energy= embodied energy of materials, equipment, and fleet vehicles (from cradle to gate)

Water = quantity of freshwater used during construction works and O&M, as well as embodied water of materials

Water quality= contamination of wetlands, surface water bodies, and groundwater, acidification, eutrophication of water bodies

Embodied water= embodied water of materials, equipment, and fleet vehicles (use of water from cradle to gate)

Air quality= emission of air pollutants: particulate matter (including dust), volatile organic compounds (VOC), etc.

Waste= waste generation during construction or replacement works and project operations

Soil quality= disturbance of soil health and functionality (e.g., water holding capacity, nutrient retention capability, and erosion prevention capability

Emissions= GHG emissions; depending on the credit, they could refer to emissions by the project's operations or emissions by on-site energy use during construction works emissions refer directly to 'Climate change.' Emissions also refer to emissions by private vehicles (e.g., the congestion created by the project).

Embodied carbon= embodied carbon of materials, equipment, and fleet vehicles (from cradle to gate), including emissions during material extraction and production; equipment/vehicle manufacture; fuel production; supply chain.

Ecosystem quality= ecosystem degradation, biodiversity loss, loss of habitat connectivity (and in some cases wildlife-vehicle collisions)

Resource depletion =intensification of raw materials extraction, freshwater (surface and groundwater) as a result of materials, water used by the project

Land occupation= area of land (undeveloped) permanently or temporarily occupied and converted to accommodate the project, or temporary construction works, as well as land to accommodate waste produced (landfill)

Climate change= project's contribution (exacerbation or mitigation) to climate change

Ecological resilience= Project's contribution to the potential degradation of ecosystems

Economic impacts:

Economic impacts are added or reduced costs for/by incorporating a sustainable feature and implementing a sustainable strategy. In line with Lifecycle Costing and Cost-Benefit Analysis, methodologies costs are distinguished in agency and user costs.

For the agency:

Capital cost= initial capital/ investment cost (including preliminary engineering, contract administration, initial construction, construction supervision & administrative costs)

O&M cost= recurring operational & routine maintenance cost

Rehabilitation cost= cost or avoided costs of major rehabilitation

Replacement cost = cost or avoided costs of replacement of the project/ end-of-life cost

Residual value = (also known as salvage value) is the estimated value of an asset at the end of its lease term or useful life.

Revenues= streams of income due to service provision, pricing schemes in place, by-product synergies with external groups, carbon credits trade.

Delay cost= avoided cost due to delays in project delivery due to public opposition, or extended approval processes

Liability claim/ Compliance cost= avoided potential cost of liability claims (e.g., in the case of an accident) and cost of potential penalties for exceedance of regulation limits (e.g., noise, air quality, water quality, etc.)

Noise cost= avoided cost for passive noise mitigation (e.g.) Sound Insulation schemes for affected residences.

Restoration cost= cost of restoration or clean-up of a natural system in the case of an environmental incident during construction and operation.

Resiliency value= value of protection from the effects of future/repeat disasters or enhanced reliability, such as avoided future cost of damage, displacement, or cost of loss of service that may create a financial downturn or slowdown for the organization.

Ecosystem services value= impact on natural capital and avoided costs for substituting natural control processes (availability of clean air, freshwater, reduced risk of flooding or drought) with engineered controls

Moreover, a further breakdown of capital, O&M, rehabilitation, and replacement costs is provided for additional and more specific data on the source of cost:

- Land acquisition cost (for temporary staging area)
- Materials cost (for acquisition)
- Labor cost

- Schedule efficiency cost (avoided cost through optimized work completion)
- Hauling & fuel cost
- Waste cost

In the form of notes, this additional information can provide a better account for trade-offs to consider alternatives (Lifecycle Costing).

For the user:

Travel time value= avoided cost of time spent on transport. It includes costs to businesses when their employees and vehicles spend on travel and costs to consumers of personal (unpaid) time spent on travel. Therefore, it translates time loss, e.g., due to congestion into productivity for individuals and businesses. A person's time value is determined by the average income level and working hours)

Vehicle cost= avoided vehicle operating cost due to increased miles traveled (affected by vehicle type, age, and condition of road surface condition)

Fuel cost= avoided cost of excess fuel consumption due to stop-and-go traffic flow during congestion & due to surface roughness and deflection of the road surface (which is a function of design and maintenance)

Fare cost= the impact of the project on the affordability of service

Accident cost= avoided cost of accidents (vehicle repair or medical cost)

Health cost= avoided medical cost of illness

Job creation= direct or indirect jobs created as a result of the project (construction, O&M, supply chain)

Economic prosperity=project's contribution to socioeconomic conditions of the affected community through attractiveness to businesses, workforce, etc., and user's productivity through increased capacity, improved level of service, etc.

Resiliency value= value of protection from the effects of future/repeat disasters, such as avoided loss of life, loss of health, damage or loss of property; and loss of productivity due to disruption of service

Ecosystem services value=impact on natural capital, a community asset, given that the preservation of ecological functions is necessary for human needs fulfillment (availability of clean air, freshwater, reduced risk of flooding or drought, stabilization of local and regional climates, control on the range and transmission of certain diseases; provisioning of food; visual comfort, recreation, etc.)

APPENDIX F

WEF IBC List of sustainability themes material to investors

PILLARS	THEMES	METRICS & DISCLOSURES
PRINCIPLE OF GOVERNMENT	Governing purpose	Setting purpose
		Purpose-led management
	Quality of governing body	Governance body composition
		Progress against strategic milestones
		Remuneration
	Stakeholder engagement	Material issues impacting stakeholders
	Ethical behavior	Anti-corruption
		Protected ethics advice and reporting mechanisms
		Alignment of strategy and policies to lobbying
		Monetary losses from unethical behavior
	Risk and opportunity oversight	Integrating risk and opportunity into business process
		Economic, environmental and social topics in capital allocation framework
PLANET	Climate change	Greenhouse gas (GHG) emissions
		TCFD Implementation
		Paris-aligned GHG emissions targets
		Impact of GHG emissions
	Nature loss	Land use and ecological sensitivity
		Land use and ecological sensitivity
		Impact of land use and conversion
	Freshwater availability	Water consumption and withdrawal in water-stressed areas
		Impact of freshwater consumption and withdrawal
	Air pollution	Air pollution
		Impact of air pollution
	Water pollution	Nutrients

		Impact of water pollution
	Solid waste	Single-use plastics
		Impact of solid waste disposal
	Resource availability	Resource circularity
PEOPLE	Dignity and equality	Diversity and inclusion
		Pay equality
		Wage level
		Risk for incidents of child, forced, or compulsory labor
		Pay gap
		Discrimination and harassment incidents and the total amount of monetary losses
		Freedom of association and collective bargaining at risk
		Human rights review, grievance impact & modern slavery
		Living wage
	Health and well-being	Health and safety
		Monetized impacts of work-related incidents on organization
		Employee well-being
	Skills for the future	Training provided
		Number of unfilled skilled positions
		Monetized impacts of training – Increased earning capacity as a result of training intervention
PROSPERITY	Employment and wealth generation	Absolute number and rate of employment
		Economic contribution
		Financial investment contribution
		Infrastructure investments and services supported
		Significant indirect economic impacts
	Innovation of better products and services	Total R&D expenses
		The social value generated (%)
		Vitality Index

	Community and social vitality	Total tax paid
		Total Social Investment
		Additional tax remitted
		Total tax paid by the country for significant locations

SASB List of general issue categories

DIMENSION	**GENERAL ISSUE CATEGORY**
ENVIRONMENT	GHG Emissions
	Air Quality
	Energy Management
	Water & Wastewater Management
	Waste & Hazardous Materials Management
	Ecological Impacts
SOCIAL CAPITAL	Human Rights & Community Relations
	Customer Privacy
	Data Security
	Access & Affordability
	Product Quality & Safety
	Customer Welfare
	Selling Practices & Product Labelling
HUMAN CAPITAL	Labor Practices
	Employee Health & Safety
	Employee Engagement, Diversity & Inclusion
BUSINESS MODEL & INNOVATION	Product Design & Lifecycle Management
	Business Model Resilience
	Supply Chain Management
	Materials Sourcing & Efficiency
	Physical Impacts of Climate Change
LEADERSHIP &	Business Ethics

GOVERNANCE	Competitive Behavior
	Management of the Legal & Regulatory Environment
	Critical Incident Risk Management
	Systemic Risk Management

GRI List of disclosure topics

TOPICS		**DISCLOSURE REQUIREMENTS**
ECONOMIC TOPICS	**Economic Performance**	Direct economic value generated and distributed
		Financial implications and other risks and opportunities due to climate change
		Defined benefit plan obligations and other retirement plans
		Financial assistance received from the government
	Market Presence	Ratios of standard entry-level wage by gender compared to local minimum wage
		The proportion of senior management hired from the local community
	Indirect Economic Impacts	Infrastructure investments and services supported
		Significant indirect economic impacts
	Procurement Practices	The proportion of spending on local suppliers
	Anti-corruption	Operations assessed for risks related to corruption
		Communication and training about anti-corruption policies and procedures
		Confirmed incidents of corruption and actions taken
	Anti-competitive Behavior	Legal actions for anti-competitive behavior, anti-trust and monopoly practices
	Tax	Approach to taxation
		Tax governance, control, and risk management
		Stakeholder engagement and management of concerns related to tax
		Country-by-country reporting
ENVIRONMENTAL TOPICS	**Materials**	Materials used by weight or volume
		Recycled input materials used
		Reclaimed products and their packaging materials
	Energy	Energy consumption within the organization

		Energy consumption outside of the organization
		Energy intensity
		Reduction of energy consumption
		Reduction in energy requirements of products and services
	Water and Effluents	Interactions with water as a shared resource
		Management of water discharge-related impacts
		Water withdrawal
		Water discharge
		Water consumption
	Biodiversity	Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas
		Significant impacts of activities, products, and services on biodiversity
		Habitats protected or restored
		IUCN Red List species and national conservation list species with habitats in areas affected by operations
	Emissions	Direct (Scope 1) GHG emissions
		Energy indirect (Scope 2) GHG emissions
		Other indirect (Scope 3) GHG emissions
		GHG emissions intensity
		Reduction of GHG emissions
		Emissions of ozone-depleting substances (ODS)
		Nitrogen oxides (NOX), sulfur oxides (SOX), and other significant air emissions
	Waste	Waste generation and significant waste-related impacts
		Management of significant waste-related impacts
		Waste generated
		Waste diverted from disposal
		Waste directed to disposal
	Environmental Compliance	Non-compliance with environmental laws and regulations
	Supplier	New suppliers that were screened using environmental criteria

	Environmental Assessment	Negative environmental impacts in the supply chain and actions taken
SOCIAL TOPICS	**Employment**	New employee hires and employee turnover
		Benefits provided to full-time employees that are not provided to temporary or part-time employees
		Parental leave
	Labor/Management Relations	Minimum notice periods regarding operational changes
	Occupational Health and Safety	Occupational health and safety management system
		Hazard identification, risk assessment, and incident investigation
		Occupational health services
		Worker participation, consultation, and communication on occupational health and safety
		Worker training on occupational health and safety
		Promotion of worker health
		Prevention and mitigation of occupational health and safety impacts directly linked by business relationships
		Workers covered by an occupational health and safety management system
		Work-related injuries
		Work-related ill-health
	Training and Education	Average hours of training per year per employee
		Programs for upgrading employee skills and transition assistance programs
		Percentage of employees receiving regular performance and career development reviews
	Diversity and Equal Opportunity	Diversity of governance bodies and employees
		The ratio of basic salary and remuneration of women to men
	Non-discrimination	Incidents of discrimination and corrective actions taken
	Freedom of Association and Collective Bargaining	Operations and suppliers in which the right to freedom of association and collective bargaining may be at risk
	Child Labor	Operations and suppliers at significant risk for incidents of child labor

	Forced or Compulsory Labor	Operations and suppliers at significant risk for incidents of forced or compulsory labor
	Security Practices	Security personnel trained in human rights policies or procedures
	Rights of Indigenous Peoples	Incidents of violations involving rights of indigenous peoples
	Human Rights Assessment	Operations that have been subject to human rights reviews or impact assessments
		Employee training on human rights policies or procedures
		Significant investment agreements and contracts that include human rights clauses or that underwent human rights screening
	Local Communities	Operations with local community engagement, impact assessments, and development programs
		Operations with significant actual and potential negative impacts on local communities
	Supplier Social Assessment	New suppliers that were screened using social criteria
		Negative social impacts in the supply chain and actions taken
	Public Policy	Political contributions
	Customer Health and Safety	Assessment of the health and safety impacts of product and service categories
		Incidents of non-compliance concerning the health and safety impacts of products and services
	Marketing and Labeling	Requirements for product and service information and labeling
		Incidents of non-compliance concerning product and service information and labeling
		Incidents of non-compliance concerning marketing communications
	Customer Privacy	Substantiated complaints concerning breaches of customer privacy and losses of customer data
	Socioeconomic Compliance	Non-compliance with laws and regulations in the social and economic area

Material impacts and risks in EDHECinfra ESG taxonomy

The recent publication of the EDHEC/Natixis Research Chair on ESG and infrastructure investment, "Towards a Scientific Approach to ESG for Infrastructure," is consulted as it presents research that focuses on ESG and infrastructure from a financial perspective, in particular, the link between ESG, risk, and infrastructure asset prices.

"To assess the link between ESG risks and infrastructure financial risk and asset prices, the authors conduct a review of 17 existing ESG reporting, and assessment schemes (Envision included) used by infrastructure investors and create a mapping between 4,850 individual disclosures to determine to what extent these schemes can help answer financial questions within the portfolio." The paper finds that the existing reporting and assessing schemes are primarily designed to assess 'impacts,' but much less to understand the ESG risks of infrastructure companies: "are useful to evaluate ESG objectives including impacts but are not a system of knowledge designed to answer financial questions, including how ESG impacts can create risks."

The paper proposes concrete steps to develop science-based ESG reporting, **including a taxonomy of the ESG risks and impacts of infrastructure companies** and materiality profiles for each type of infrastructure asset using objective, consensual measurements that can be documented using artificial intelligence techniques.[492]

The EDHECinfra ESG taxonomy includes four super-classes of impacts and six super-classes of risk

Impacts of the firm's activities on:
1. Natural resources
2. Human wellbeing
3. Economic development
4. Organizational quality

Risks to the value of the firm arising from:
1. Physical damage
2. Access to resources
3. Social acceptability
4. Workforce availability
5. Organizational Failure
6. Staff Failure

EDHECinfra ESG Taxonomy

	SUPERCLASSES	CLASSES	SUBCLASSES
A.1.1 ENVIRONMENTAL IMPACTS	**EI 1 Natural Resources**	EI 1.1 Biodiversity	EI1.1.1 Loss
			EI1.1.2 Disturbance
			EI1.1.3 Restoration
			EI1.1.4 Conservation
			EI1.1.5 Enhancement
		EI1.2 Water Resources	EI1.2.1 Pollution
			EI1.2.2 Depletion

492 EDHECinfra Announcement on "Towards a Scientific Approach to ESG for Infrastructure Investors. A Publication of the EDHEC Infrastructure Institute." published on March 3, 2021. https://edhec.infrastructure.institute/announcement/press-release-new-research-finds-that-esg-reporting-schemes-for-infrastructure-investors-are-not-focused-on-measuring-risks-despite-upcoming-sfdr-requirements-to-do-so/

			EI1.2.3 Diversion
			EI1.2.4 Preservation and protection
			EI1.2.5 Restoration
		EI1.3 Land	EI1.3.1 Pollution
			EI1.3.2 Change in land use
			EI1.3.3 Depletion
			EI1.3.4 Preservation and protection
			EI1.3.5 Restoration
		EI1.4 Atmosphere	EI1.4.1 Air pollution
			EI1.4.2 Climate change
			EI1.4.3 Air quality improvement
A.1.2 ENVIRONMENTAL RISKS	**ER1 Physical risk**	ER1.1 Geophysical events	ER1.1.1 Earthquake risk
			ER1.1.2 Volcanic risk
			ER1.2.3 Mass movement (dry) risk
		ER1.2 Hydrological events	ER1.2.1 Flood risk
			ER1.2.2 Mass movement (wet) risk
		ER1.3 Climatological events	ER1.3.1 Extreme temperature risk
			ER1.3.2 Drought risk
			ER1.3.3 Wildfire risk
		ER1.4 Meteorological Events	ER1.4.1 Storm risk
	ER2 Access to natural resources	ER2.1 Resource loss risk	ER2.1.1 Quality risk
			ER2.1.2 Availability risk
A.2.1 SOCIAL IMPACTS	**SI1 Human wellbeing**	SI1.1 Collective wellbeing	SI1.1.1 Human rights
			SI1.1.2 Public health and safety
			SI1.1.3 Public disturbance
			SI1.1.4 Heritage and culture
		SI1.2 Workforce wellbeing	SI1.2.1 Workforce health and safety

			SI 1.2.2 Working conditions
			SI 1.2.3 Benefits
	SI2 Economic development	SI2.1 Human development	SI2.1.1 Standard of living
			SI2.1.2 Human Capital
			SI2.1.3 Healthy life
		SI2.2 Assets Values	SI2.2.1 Related land value
			SI2.2.2 Related real estate value
			SI 2.2.3 Related business value
			SI2.2.4 Related infrastructure asset value
A.2.2 SOCIAL RISKS	**SR1 Social Acceptability**	SR1.1 Customer	SR1.1.1 Quality of service
			SR1.1.2 Affordability of service
			SR1.1.3 Accessibility of service
		SR1.2 General Public	SR1.2.1 Sector reputation
			SR1.2.2 Privatization perception
			SR1.2.3 Company reputation
		SR1.3 Regulators	SR1.3.1 Ideology
			SR1.3.2 Politics
	SR2 Workforce Availability	SR2.1 Industrial action	SR2.1.1 Strikes and slowdowns
		SR2.2 Labor Market	SR2.2.1 Skill drought
A.3.1 GOVERNANCE IMPACT	**GI1 Organization quality**	GI1.1. Company management	GI1.1.1 Effectiveness
			GI1.1.2 Impact and risk management
		GI1.2 External relationships	GI1.2.1 Transparency
			GI1.2.2 Corporate accountability and responsibility
			GI1.2.3 Stakeholder engagement
			GI1.2.4 Contractor and supplier engagement
A.3.2	**GR1**	GR1.1 Process failure	GR1.1.1 Reporting failure

GOVERNANCE RISKS	**Organization Failure**		GR1.1.2 Compliance failure
		GR1.2 Absence of processes	GR1.2.1 Mandatory processes
			GR1.2.2 Other processes
	GR2 Staff failure	GR2.1 Competency	GR2.1.1 Core activity
			GR2.1.2 Non-core activity
		GR2.2 Integrity	GR2.2.1 Criminal activity
			GR2.2.2 Non-Criminal activity

APPENDIX G

Example of lifecycle impacts of strategies that contribute to minimization/ avoidance of future maintenance needs

SOCIAL IMPACT	ASSOCIATED IMPACT	IMPACT DESCRIPTION	IMMEDIATE/ INITIAL	FUTURE
(+) access	(+) travel time value (+) vehicle cost (+) fuel cost (+) energy (+) emissions (+) climate change	Avoided disruptions of access/ closure due to reduced maintenance needs; avoided construction traffic		Recurring for the period of works
		Avoided fuel consumption by private vehicles due to construction traffic or detouring and associated emissions		
		Avoided cost of lost productivity, vehicle operating costs, and fuel costs due to avoided disruption of access and construction traffic		
(+) safety	(+) health (+) health cost	Increased safety due to durable structures		Long-term
	(+) accident cost	Increased safety due to avoided construction works and related traffic Avoided cost of accidents for public (vehicle repair or medical cost)		Recurring short-term
(+) noise	(+) noise cost (+) wellbeing (+) health (+) ecosystem quality	Avoided construction worksite noise for future maintenance; construction traffic noise		Recurring for the period of works
		Avoided operational noise/ vibration due to state of good repair	Long-term	Long-term
		Avoided cost for passive noise mitigation (e.g.) Sound Insulation schemes for affected residences	Long-term	Long-term
		Avoided potential health impact from increased noise levels Positive impact on habitats as increased noise levels disturb their equilibrium		Long-term
(+) light pollution	(+) safety (+) energy (+) emissions	Avoided energy consumption due to light wastage during nighttime works and associated emissions		Recurring for the period of

	(+) accident cost (+) ecosystem quality	Positive impact on habitats as light pollution disturbs their equilibrium Avoided nighttime works and exposure of drivers to accidents due to intrusive light		works
ENVIRONMENTAL IMPACT	**ASSOCIATED IMPACT**	**IMPACT DESCRIPTION**	**INITIAL/ IMMEDIATE**	**FUTURE**
(+) materials	(+) embodied energy (+) embodied water (+) embodied carbon (+) climate change (+) resource depletion	Reduced material use due to optimizing the size of structures due to the redundant corrosion system/ premium materials	Short-term	
		Reduced use of materials (permanent) due to avoided replacement works through design, longer-lived materials		Recurring short-term
		Reduced use of temporary material for replacement works (equipment, safety barriers/ temporary signage, noise barriers, etc.)		Recurring short-term
		Reduced embodied energy, water, and carbon of materials due to avoided maintenance needs; avoided hauling routes		Recurring short-term
(+) energy	(+) emissions (+) climate change	Avoided construction worksite energy consumption and associated emissions		Recurring short-term
(+) waste	(+) embodied energy (+) embodied water (+) embodied carbon (+) land occupation (+) water quality	Reduced construction waste due to avoided rehabilitation or replacement works		Recurring short-term
		Reduced embodied energy, water, and carbon of construction waste Reduced land occupation for landfilling Improved water quality		
(+) water	(+) resource depletion	Avoided construction water consumption Reduced contribution to depletion of resources		Recurring short-term
ECONOMIC IMPACT	**ASSOCIATED IMPACT**	**IMPACT DESCRIPTION**	**IMMEDIATE/ INITIAL**	**FUTURE**
(-) capital cost		Added capital cost for more durable materials (premium) and structures	Short-term	
		Reduced capital cost for labor or transport of heavier components (for downsized structures)	Short-term	
(+) rehabilitation cost		Avoided future rehabilitation cost due to longer-lived structures and materials		Recurring short-term
(+) replacement cost		Avoided future replacement cost due to longer-lived structures and materials		Recurring short-term
(+) residual value		Increased residual value		future

APPENDIX H

WORKBOOK (February 24, 2021)

During the assessment of projects for (a) mitigation and adaptation to climate change and (b) attractiveness to investments, the main research question emerges: "Is climate change action a priority for investors and agencies?"

1. Current trends and demand in Climate change-related projects

In the November 10, 2020, discussion, a shared view among the SIAB members was the anticipated availability of funds to restart the global economy in a post-COVID era.

- Is there any noticeable increase in requests from the public or private sector?
- Have you noticed shifts in infrastructure investments due to the COVID pandemic or a growing interest in new technologies in infrastructure or the green economy?
- How are these shifts incorporated in your firm's design strategies and planning?
- Can you indicate projects considered climate-related and a high priority to investors? What baseline requirements do they meet? (Your response will help towards selecting projects as case studies for the research.

2. New targets toward global GHG emissions reduction

The Paris Agreement goal of holding the increase in global average temperature to well below 2°C and pursuing efforts to limit it to 1.5°C above pre-industrial levels is incorporated in the definition of climate change mitigation (EU ESG regulations). Zero-carbon solutions aligned to Agreement's global goal to reach net-zero emissions by 2050 are becoming competitive and are noticeable in the power and transportation sectors.[493] National efforts towards low emissions and climate-resilient development are outlined and documented in the NDCs.[494]

- Has investors' interest raised for project portfolios towards low-emission?
- In addition to energy and transport projects, are there any other types of infrastructure projects you have worked for that address a 2°C temperature strategy or net-zero target?
- Do organizations request carbon footprint measuring?
- Do you follow a specific methodology at a project level to ensure that GHG reduction targets are aligned with the 2°C goal?
- Have investors or your clients requested scenarios for addressing climate-related risks and opportunities in projects? Scenarios like a 2°C target, or related to NDCs, or business-as-usual.

3. Resilience and adaptation

[493] The Paris Agreement, United Nations Framework Convention on Climate Change Secretariat (UNFCCC)

[494] Countries submit their plans for climate action known a Nationally Determined Contributions known as NDCs, a Paris Agreement's mechanism for implementing the well below 2°C target, The Paris Agreement, United Nations Framework Convention on Climate Change Secretariat (UNFCCC)

The SDG 13 goal's target 13.1 requires to "strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries."

- Do investors or agencies request to incorporate methodologies or tools for climate resilience evaluation or disaster risk assessment of projects?
- Climate risk adaptation is a context-specific and location-specific challenge. Macro impacts of climate change involve all projects. Which can be considered as "universal" adaptation strategies in projects?

4. Climate change mitigation and/or Climate change adaptation strategies

Considering that the well below 2°C temperature Paris Agreement target has affected investments since 2015, climate-related issues today are viewed as a mainstream business. Emissions are a key focal point of policy, regulatory, market, and technology responses to limit climate change.[495]

- Based on your area of expertise and experience, is there a prioritization on projects that mitigate over projects that adapt to climate change?
- Are there any current methodologies that evaluate climate change mitigation over adaptation projects regarding return on investment (ROI)?

5. Alignment to Environmental, Social and Corporate Governance (ESG) and Sustainable Development Goals (SDG) criteria

ESG rating and reporting are an established means for investors to understand and evaluate companies' sustainability performance for informed decision-making. On the other hand, the SDGs are a globally accepted set of overarching goals, a common language for reporting[496] to guide investors to redirect capital. More specifically, the SDG 13 "Climate action" is considered the most pressing after the UN Paris Agreement adoption.

- Are you involved in projects incorporating ESG criteria? Do companies that award the projects aim for ESG ratings?
- How do ESG criteria and ratings affect project design? Does it require developing new (beyond business-as-usual) documentation?
- Do agencies of your projects align with and report on their SDGs performance today? Have you noticed an interest in reporting on SDG 13?

6. Climate-related Risks and opportunities

The high degree of uncertainty around the timing and magnitude of climate-related risks makes it difficult to determine and disclose the potential impacts with precision.[497] The Task Force on Climate-related Financial Disclosures (TCFD) provides recommendations on how climate-related issues translate into potential financial impacts.

---

[495] Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) Final report (June 2017)
[496] Corporate Reporting Dialogue (February 2019)
[497] Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) Final report (June 2017)

- How do you identify, assess and manage climate-related risks at a project level?
- Are you requested to implement the TCFD recommendations during the project development process?
- Could you suggest a project that provides insight on how climate change and investors' risks and opportunities are addressed at a project level?

APPENDIX I

GHG Protocol Scope 3 emissions categories

category	Category description	Minimum boundary
1. Purchased goods and services	Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 - 8	All upstream (cradle-to-gate) emissions of purchased goods and services
2. Capital goods	Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year	
3. Fuel- and energy-related activities (not included in scope 1 or scope 2)	Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in scope 1 or scope 2, including: **a.** Upstream emissions of purchased fuels (extraction, production, and transportation of fuels consumed by the reporting company) **b.** Upstream emissions of purchased electricity (extraction, production, and transportation of fuels consumed in the generation of electricity, steam, heating, and cooling consumed by the reporting company) **c.** Transmission and distribution (T&D) losses (generation of electricity, steam, heating and cooling that is consumed (i.e., lost) in a T&D system) – reported by end user **d.** Generation of purchased electricity that is sold to end users (generation of electricity, steam, heating, and cooling that is purchased by the reporting company and sold to end users) – reported by utility company or energy retailer	a. For upstream emissions of purchased fuels: All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding combustion) b. For upstream emissions of purchased electricity: All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding, combustion by a power generator) c. For T&D losses: All upstream (cradle-to-gate) emissions of energy consumed in a T&D system, including emissions from combustion d. For generation of purchased electricity that is sold to end users: Emissions from the generation of purchased energy
4. Upstream transportation and distribution	• Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company) • Transportation and distribution services purchased by the reporting company in the	• The scope 1 and scope 2 emissions of transportation and distribution providers that occur during use of vehicles and facilities (e.g., from energy use) **• Optional: The life cycle emissions associated with manufacturing vehicles, facilities, or infrastructure**

	reporting year, including inbound logistics, outbound logistics (e.g., of sold products), and transportation and distribution between a company's own facilities (in vehicles and facilities not owned or controlled by the reporting company)	
5. Waste generated in operations	• Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)	• The scope 1 and scope 2 emissions of waste management suppliers that occur during disposal or treatment **• Optional: Emissions from transportation of waste**
6. Business travel	• Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)	• The scope 1 and scope 2 emissions of transportation carriers that occur during use of vehicles (e.g., from energy use) **• Optional: The life cycle emissions associated with manufacturing vehicles or infrastructure**
7. Employee commuting	• Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)	• The scope 1 and scope 2 emissions of employees and transportation providers that occur during use of vehicles (e.g., from energy use) **• Optional: Emissions from employee teleworking**
8. Upstream leased assets	• Operation of assets leased by the reporting company (lessee) in the reporting year and not included in scope 1 and scope 2 – reported by lessee	• The scope 1 and scope 2 emissions of lessors that occur during the reporting company's operation of leased assets (e.g., from energy use) **• Optional: The life cycle emissions associated with manufacturing or constructing leased assets**
9. Downstream transportation and distribution	• Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company's operations and the end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company)	• The scope 1 and scope 2 emissions of transportation providers, distributors, and retailers that occur during use of vehicles and facilities (e.g., from energy use) **• Optional: The life cycle emissions associated with manufacturing vehicles, facilities, or infrastructure**
10. Processing of sold products	• Processing of intermediate products sold in the reporting year by downstream companies (e.g., manufacturers)	• The scope 1 and scope 2 emissions of downstream companies that occur during processing (e.g., from energy use)
11. Use of sold products	End use of goods and services sold by the reporting company in the reporting year	• The direct use-phase emissions of sold products over their expected lifetime (i.e., the scope 1 and scope 2 emissions of end users that occur from the use of: products that directly consume energy (fuels or electricity) during use; fuels and feedstocks; and GHGs and products that contain or form GHGs that are emitted during use) **• Optional: The indirect use-phase emissions of sold products over their expected lifetime (i.e., emissions from the**

		use of products that indirectly consume energy (fuels or electricity) during use)
12. End-of-life treatment of sold products	• Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life	• The scope 1 and scope 2 emissions of waste management companies that occur during disposal or treatment of sold products
13. Downstream leased assets	not infrastructure project relevant	
14. Franchises		
15. Investments		

APPENDIX K

In this part the complete tables of strategies per credit that support tables 32, 33 and 34 of the Envision Review are presented:

	PERFORMANCE INDICATORS	INITIAL SHORTTERM	FUTURE SHORTTERM RECURRENT	FUTURE LONGTERM
QL1.3	Reduction of workers exposure to street traffic through performance of selected works off-site - use of temporary construction yard (preferably in close proximity to the site) **- use of prefabricated materials**	(-)scope 3 emissions (upstream) (-) scope 3 emissions (downstream)	(+)scope 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
QL1.4	Implementation of noise reduction measures (Measures may include: - siting strategies e.g. relocating noise generation sources away from populated areas - noise abatement at source, e.g through the use of quieter equipment, use of quieter pavement, (in the case of bridges) elimination of bridge expansion joints through structural continuity - receptor abatement (e.g. use of noise barriers/ buffers)	(-)scope 3 emissions (upstream)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	
QL1.5	Lighting pollution reduction through the following strategies as prioritized: a. Avoidance: identifying where lighting may not be needed. b. Minimization: determining the minimum lighting necessary to meet safety and performance requirements. c. Protection: restricting light spillage to sensitive areas or directing light only to where it is needed. d. Offsetting: compensating for lighting in one location by removing lighting in another location.			(+)scope 2 emissions

QL1.5	Establishment of minimum lighting needs to meet safety and energy performance requirements (sufficient light levels and uniformity necessary for human nighttime safety and low-energy and avoidance of light wastage)	(+)scope 3 emissions (upstream)	(+)scope 3 emissions (upstream & downstream)	(+)scope 2 emissions
QL1.5	Reduction of overall existing lighting levels through: - Retrofit of existing luminaires and/or - Removal of excess existing lighting no longer needed	(-)scope 3 emissions (downstream)		(+)scope 2 emissions
QL1.6	Reduced construction noise through noise control strategies, such as: - minimum distance from sensitive receptors, (e.g. site access roads and noisy plant as far as possible from residential areas) - new engine technology (low-noise emitting equipment) - properly sized equipment and plant on-site - **avoided prolonged idling of equipment** and - noise transmission reduction (screening, enclosure or silencing of noise sources)	(+)scope 1/ 2 emissions		
QL1.6	Minimized disruption from construction traffic (delivery trucks for hauling of materials and waste) upon the transport network through improved construction logistics	(+)scope 3 emissions (upstream & downstream)		
QL1.6	Reduced interruption of service (full-closure)	(-)scope 3 emissions (downstream)		
QL1.6	Provision of alternative access during construction works through the minimum possible detour	(-)scope 3 emissions (upstream & downstream)		
QL1.6	Implementation of partial closure of service-staged construction	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream) (+)scope 3 emissions (downstream)		
QL1.6	Reduced construction duration through performance of selected works off-site	(+)scope 1/ 2 emissions (-)scope 3 emissions (upstream) (+)scope 3 emissions (downstream)		

QL1.6	Reduced construction duration through accelerated construction	(+)scope 1/ 2 emissions (+)scope 3 emissions (downstream)		
QL1.6	Control of distracting or intrusive lighting in workzone	(+)scope 2 emissions		
QL2.1	Increased system capacity to reduce congestion	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream & downstream)	(+-)scope 1/ 2 emissions (+-)scope 3 emissions (upstream & downstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Reduced vehicle distance traveled			(+)scope 3 emissions (downstream)
QL2.1	System capacity planning addresses projected growth in commercial, industrial, and/or residential demand	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream & downstream)	(+-)scope 1/ 2 emissions (+-)scope 3 emissions (upstream & downstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Increased coverage of public transportation service	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(+-)scope 1/ 2 emissions (+-)scope 3 emissions (upstream & downstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Multiple options of transportation modes are included			(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Intelligent Transportation Systems are incorporated to increase system efficiency	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream) (-)scope 3 emissions (downstream)	(-)scope 2 emissions (-)scope 3 emissions (upstream & downstream)	(+)scope 1 emissions (-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Improved level of service (reliability)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(+)scope 1/ 2/ 3 emissions (upstream)	(-)scope 1/ 2 emissions (+)scope 3 emissions (downstream)
QL2.1	Incentivized mobility management to shift travel from peak to off-peak (e.g. congestion pricing, dynamic pricing, incorporation of HOV toll lanes)			(+)scope 3 emissions (downstream)
QL2.2	Increased pedestrian proximity and accessibility to active, shared, and/or mass transportation	(+)scope 3 emissions (downstream)		(+)scope 3 emissions (downstream)

QL2.2	Increased proximity between households and jobs	(+)scope 3 emissions (downstream)		(+)scope 3 emissions (downstream)
QL2.2	Increased high-frequency transit routes	(-)scope 2 emissions (-)scope 3 emissions (upstream)		(+)scope 3 emissions (downstream)
QL2.2	Increased pedestrian proximity to high-frequency transit routes			(+)scope 3 emissions (downstream)
QL2.2	Extended network of active transportation	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream) (+)scope 3 emissions (downstream)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(+)scope 3 emissions (downstream)
QL2.2	Enhanced width and condition of bicycle and pedestrian facilities	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream) wider area/ less frequency)	(+)scope 3 emissions (downstream)
QL2.2	Enhanced HOV access within the ROW by incorporating car pool lane for HOV (or HOV toll lanes)	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream) wider area/ less frequency)	(+)scope 3 emissions (downstream)
QL2.2	Enhanced physical characteristics (roadway structure dimensions or form) for mass transportation that provide: - queue jump lanes for transit vehicles; - dedicated transit access within the ROW, such as on-street bus lane - expressway bus lane; - exclusive mass transit access within the ROW, such as at-grade or grade-separated transitways	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream) (wider area/ less frequency)	(+)scope 3 emissions (downstream)
QL2.2	Increased sidewalk connections and bike facility connections	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
QL2.2	Increased transit stops with bicycle parking, bicycle sharing stations, secure bike lockers along a corridor	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
QL2.2	Extended use of shelters in bus stops along a corridor	(-)scope 1/ 2/ 3 (upstream) emissions	(+-)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)

QL2.2	Extended network of well-lit and clearly visible pathways	(-)scope 2 emissions (-)scope 3 emissions (upstream) (+)scope 3 emissions (downstream)		(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.2	Increased access to modeshare			(+)scope 3 emissions (downstream)
QL2.2	Extended use of ITS in transit and HOV facilities		(-)scope 3 emissions (upstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.2	Provision for access to new park&ride lots in strategic locations	(-)scope 1/ 2/ 3 emissions (upstream)	(+-)scope 1/ 2/ 3 emissions (upstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.2	Inclusion of programs that encourage use of mass transportation (Subsidized fare programs, emergency ride home services, coordination with ride-sharing companies, off-board ticketing, real-time arrival information, or mobile apps)			(+)scope 3 emissions (downstream)
QL2.2	Contribution to integrated overall efficiency and level of service of active, shared, or mass transportation network for the community or region (e.g. creation of new connections, rehabilitation/repurpose of unused, underused, or previously disconnected pathways, bikeways, rail, and/or other modes)	(-)scope 1/ 2/ 3 emissions (upstream)	(+-)scope 1/ 2 emissions (+-)scope 3 emissions (upstream & downstream)	(-)scope 2 emissions (+)scope 3 emissions (downstream)
QL2.2	Increased use of lower-carbon transport modes (e.g. electricity-, natural gas- powered)	(+)scope 1 emissions (-)scope 2 emissions		(+)scope 1 emissions (-)scope 2 emissions
QL2.3	Provision of clear wayfinding measures for orientation, route selection, route control and recognition of destination for both regular vehicular or pedestrian traffic	(+)scope 3 emissions (upstream)	(+-)scope 1/ 2 emissions (+-)scope 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
QL2.3	Increased tolerance for error through flexibility in route selection		(+)scope 1/ 2/ 3 emissions (upstream)	(+)scope 3 emissions (downstream)

QL2.3	Clear signage and wayfinding techniques (for access roads, bikeways, or pedestrian paths) to facilitate their proper use		(+)scope 1/ 2/ 3 emissions (upstream)	(+)scope 3 emissions (downstream)
QL2.3	Increased no.of safe and accessible streetcrossing opportunities for pedestrians (universal access curb cuts, pedestrian crossing signs, and high-visibility crosswalks and no.of eliminated at-grade crossings at heavy traffic roads	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(+)scope 3 emissions (downstream)
QL2.3	Improved pedestrian path safety (e.g. physical barriers between sidewalks and street traffic exceeding 40 mph speed)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(+)scope 3 emissions (downstream)
QL3.4	No net loss in quantity or quality (may include offsetting) of existing public amenities (offsets must be of similar or better type and quality and serve the same community)	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(-)scope 3 emissions (upstream)	(-)scope 2 emissions
QL3.4	Net benefit in quantity or quality of existing public amenities through at least one of the following strategies: - Enhancement of existing public amenities - New public amenities (not previously available) added - new assets to community -Restoration of previously degraded or unusable amenities	(-)scope 1/ 2 emissions (-)scope 3 emissions (upstream)	(-)scope 3 emissions (upstream) (+)scope 3 emissions (downstream)	(-)scope 2 emissions
LD1.4	Assessment of the availability and viability of beneficial reuse of excess resources (e.g. waste materials, land area/space, or management/ personnel capacity)	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)
LD1.4	Reuse for project’s waste or excess resources to support natural systems or use of natural systems for processing project waste	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)
LD1.4	Increased collaboration with external groups to find beneficial use of project by-products (project's waste streams or excess resources) off-site or incorporating off-site waste or excess resources into the project	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)
LD1.4	Short-term and/or long-term incorporation of at least one by-product synergy or reuse into the project	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)	(+)scope 3 emissions (upstream& downstream)

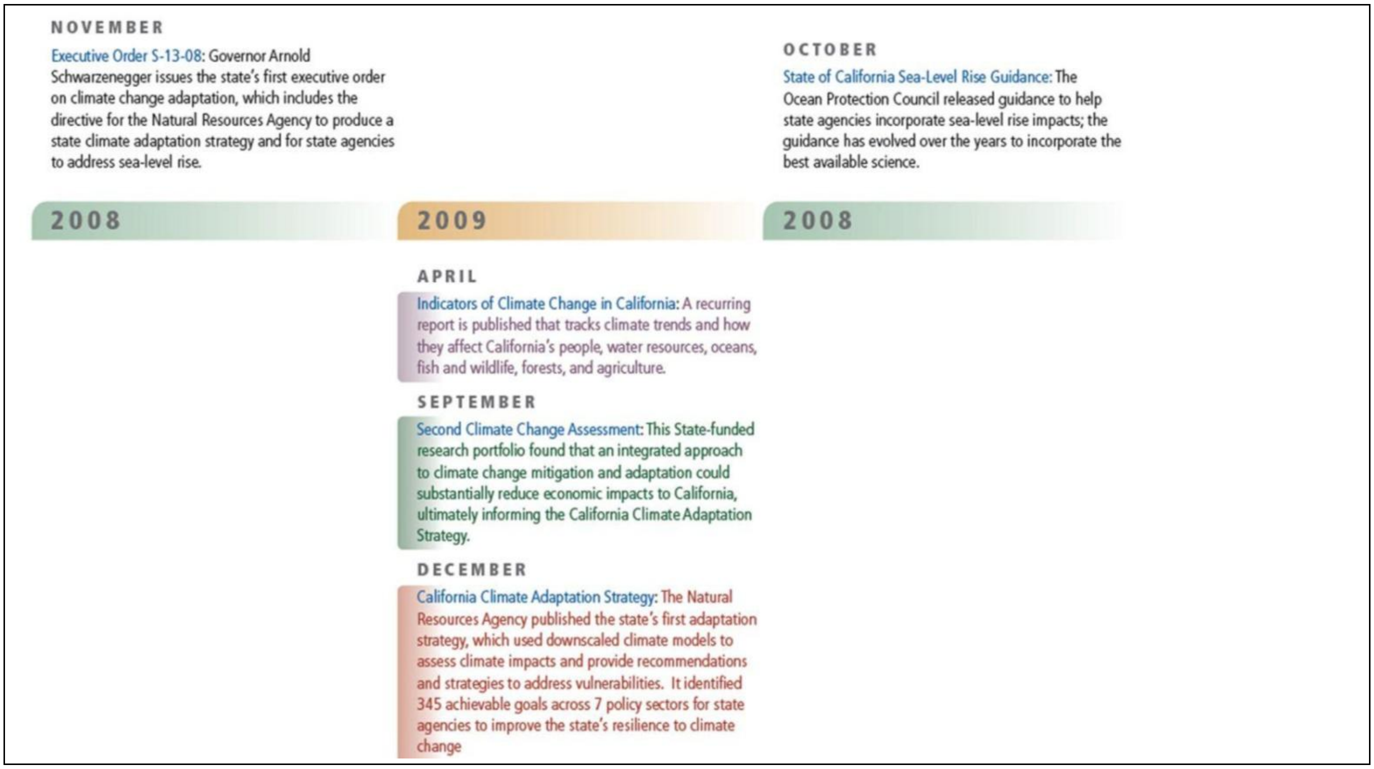
LD2.3	Reduction of maintenance needs through project design (e.g. redundant corrosion protection, use of integral abatement)		(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
LD2.3	Reduction of maintenance needs through the use of durable longer-lasting materials		(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
LD2.3	Contractor's quality process management system for avoidance of early and excessive maitenance and/or early replacement (e.g. inadequate asphalt compaction as a factor for decreased stiffness, reduced fatigue life, accelerated aging/ decreased durability, rutting, raveling, and moisture damage)		(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)
LD2.3	Provision for ease of access for maintenance and repair" (e.g. existence of shoulder to allow repair without disruption)	(-)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 3 emissions (downstream)	(+)scope 3 emissions (downstream)
LD2.4	Extension of project's useful life through durability and state of good repair	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	
LD2.4	Extension of project's useful life by providing flexibility for reconfiguration, future expansion (Relevant future demands, loads, or other requirements on the infrastructure system have to estimated over the anticipated project life)	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	
LD2.4	% by volume of components or prefabricated units that can be easily separated on future disassembly/ de-construction into material types suitable for recycling or reuse		(+) scope 3 emissions (upstream & downstream)	
RA1.1	Increased % of the total project materials by cost, weight, or volume that meet sustainable procurement policy/program requirements on social and environmental impacts.	(+)scope 3 emissions (upstream)		
RA1.1	% of materials sourced from manufacturers/ suppliers that implement sustainable practices	(+)scope 3 emissions (upstream)		
RA1.2	% of project materials that are reused or recycled	(+)scope 3 emissions (upstream & downstream)	(-)scope 1/ 2/ 3 emissions (upstream & downstream)	
RA1.2	% of offsite material with reclaimed/recycled content	(+)scope 3 emissions (upstream & downstream)	(-)scope 1/ 2/ 3 emissions (upstream & downstream)	

PA1.3	Percentage of total operational waste or byproducts diverted from disposal			(+) scope 3 emissions (downstream)
RA1.4	% (by volume) of total construction waste diverted from disposal	(+)scope 3 emissions (upstream & downstream)		
RA1.4	Reduced(by volume) surplus materials (ordered and not used) over the total volume of materials ordered	(+)scope 3 emissions (upstream & downstream)		
RA1.4	% (by volume)of surplus materials beneficially reused	(+)scope 3 emissions (upstream & downstream)		
RA1.5	% of excavated material reused/ retained on-site	(+)scope 3 emissions (upstream & downstream)		
RA1.5	% of excavated material moved off-site / reused to other nearby projects	(+)scope 3 emissions (upstream & downstream)		
RA1.5	Use of locally sourced fill materials and close proximity of destination of excavated materials to site	(+)scope 3 emissions (upstream & downstream)		
NW1.4	% of the project area that is on previously developed land	(+)scope 3 emissions (upstream)	(+)scope 3 emissions (upstream)	
NW 2.2	Increased % of pervious hardscape	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	(+)scope 1/ 2/ 3 emissions (upstream & downstream)	
NW 2.3	Application control of fertilizers or pesticides on site during construction (limited to the eradication of invasive species) and during the initial stage of operation (limited to vegetation establishment)	(+)scope 3 emissions (upstream)		
NW 2.3	Reduced pesticide and fertilizer application rates or no use through the use of soil tolerant and pest resistant plant species, native species			(+)scope 3 emissions (upstream)
NW 2.4	Minimization of potential impacts on surface water and/or groundwater quality through performance of selected works off-site(e.g. demolition of existing structures)	(-)scope 3 emissions (upstream)		
NW 3.3	Maintained or increased floodplain storage capacity		(+)scope 1/ 2/ 3 emissions (upstream & downstream)	

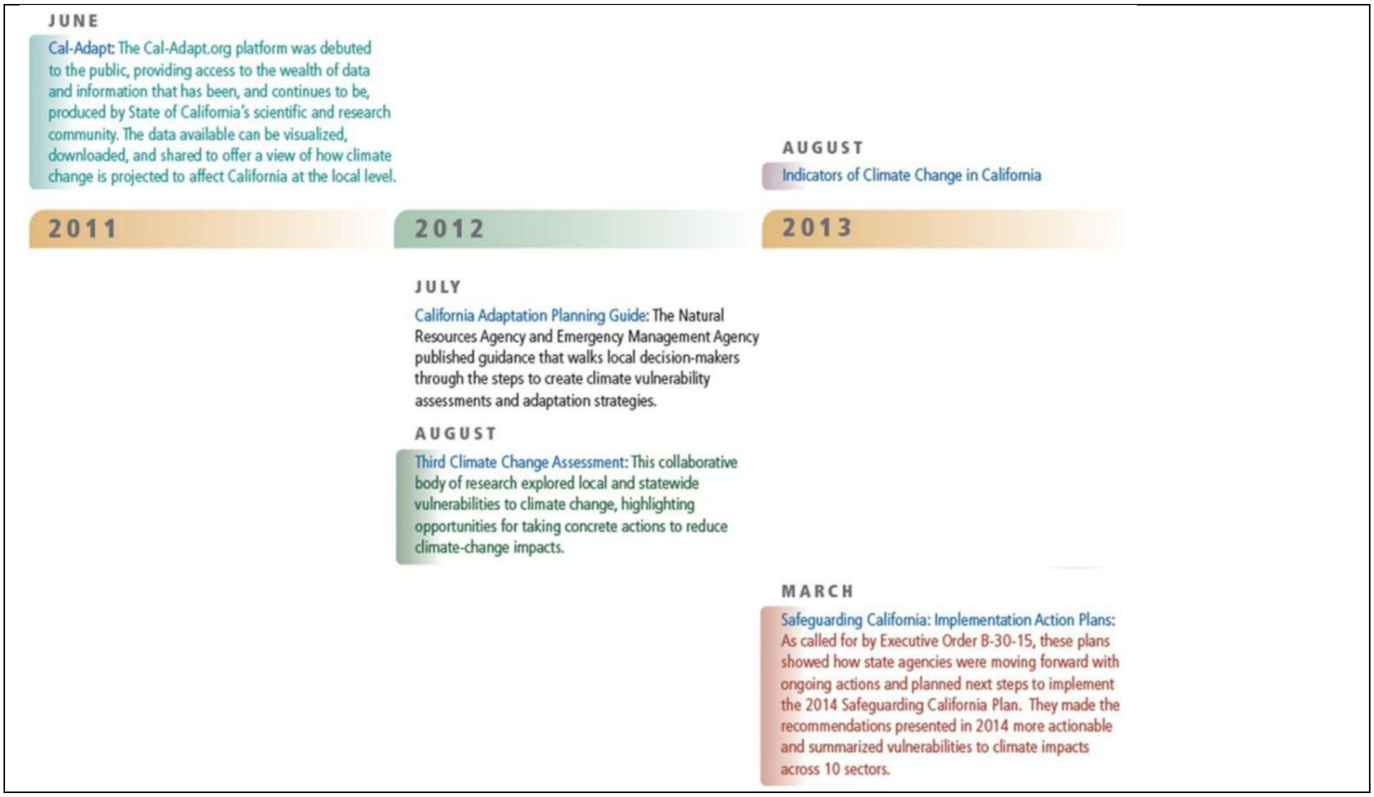
NW 3.3	Maintain pre-development floodplain infiltration		(+)scope 1/ 2/ 3 emissions (upstream & downstream)	

APPENDIX L

Highlights of Climate Policy in California[498]



498 Source: Safeguarding California Plan 2018 Update


JUNE
Cal-Adapt: The Cal-Adapt.org platform was debuted to the public, providing access to the wealth of data and information that has been, and continues to be, produced by State of California's scientific and research community. The data available can be visualized, downloaded, and shared to offer a view of how climate change is projected to affect California at the local level.
AUGUST
Indicators of Climate Change in California
2011
2012
2013
JULY
California Adaptation Planning Guide: The Natural Resources Agency and Emergency Management Agency published guidance that walks local decision-makers through the steps to create climate vulnerability assessments and adaptation strategies.
AUGUST
Third Climate Change Assessment: This collaborative body of research explored local and statewide vulnerabilities to climate change, highlighting opportunities for taking concrete actions to reduce climate-change impacts.
MARCH
Safeguarding California: Implementation Action Plans: As called for by Executive Order B-30-15, these plans showed how state agencies were moving forward with ongoing actions and planned next steps to implement the 2014 Safeguarding California Plan. They made the recommendations presented in 2014 more actionable and summarized vulnerabilities to climate impacts across 10 sectors.

2014

JULY

Safeguarding California Plan: This update to the 2009 California Adaptation Strategy focused on providing policy guidance for state decision-makers across 9 different sectors, providing updated information on climate vulnerabilities and state agency actions to address them.

2015

MARCH

Climate Change Research Plan

APRIL

Executive Order B-30-15: Governor Brown's major Executive Order integrated directives on climate change mitigation and adaptation, providing a powerful framework for action. This order requires all state agencies to take current and future *climate impacts* into account in all planning and investment. It directed the preparation of implementation plans to ensure coordinated progress on the objectives of the Safeguarding California Plan, and emphasized the State's commitment to protecting vulnerable populations and prioritizing flexible, adaptive, and natural infrastructure solutions.

OCTOBER

Climate Adaptation Legislation: A package of three bills was signed into law by Governor Brown to improve California's resilience to climate change:

- SB 246 (Wieckowski): Establishes the Integrated Climate Adaptation and Resiliency Program (ICARP) at the Governor's Office of Planning and Research (OPR) to help coordinate local and regional efforts with state climate adaptation strategies. As part of ICARP, OPR convenes a Technical Advisory Committee of stakeholders and practitioners to provide support for climate adaptation coordination. ICARP also maintains a state Adaptation Clearinghouse that serves as a centralized source of information for resources and guidance.
- SB 379 (Jackson): Requires local jurisdictions to include climate adaptation and resiliency strategies in the safety elements of their general plans.
- AB 1482 (Gordon): Formalizes a three-year update and reporting process for the Safeguarding California Plan.

2016

OCTOBER

AB 2800 (Quirk): In addition to making the requirement for all state agencies to take the current and future impacts of climate change in all aspects of infrastructure planning, investment, and maintenance, this legislation also directed the Natural Resources Agency to convene the Climate-Safe Infrastructure Working Group. This group will examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

2017

JULY

AB 398 (Garcia): As part of the legislation to meet California's 2030 greenhouse gas emissions target through a cap-and-trade system, climate adaptation and resiliency was identified as an ongoing prioritized cap-and-trade auction revenue expenditure category.

AUGUST

General Plan Guidelines Update: The first update to the guidelines since 2003 provides guidance to jurisdictions on how to integrate climate change adaptation and mitigation throughout their general plans.

Cal-Adapt 2.0: In a dramatic expansion of the original 2011 platform, the new Cal-Adapt 2.0 provides new climate projections, more powerful visualizations, improved access to data, a public Applications Programming Interface, and new connections with supporting resources. The website update provides an early look at the new downscaled projections that serve as the foundation to California's Fourth Climate Change Assessment.

NOVEMBER

Planning and Investing for a Resilient California: A Guidebook for State Agencies: This document provides high level guidance on what future climate conditions State agencies should plan for and how State agencies should approach planning differently to adapt to a changing climate.

2018

JANUARY

Indicators of Climate Change Report.

Sea-Level Rise Guidance Document Update: The Ocean Protection Council is releasing a new document based on the best available science to address the needs of state agencies and local governments as they address sea-level rise.

2018 Update to the Safeguarding California Plan:
California's state adaptation strategy is a comprehensive roadmap to over 1000 ongoing actions and next steps that the State is taking to address climate risk and bolster resilience to climate impacts. Its new policy recommendations provide structure and connectivity across 11 sectors, all of which contribute to a holistic climate justice strategy that addresses equity in climate adaptation.

APPENDIX M

EMISSIONS REDUCTION DATA

Energy Consumption

Priority	2015	2016	2017	2018	2019
Office Energy Consumption* (Megawatt hours)	1,036	1,287	1,431	1,908	1,908
Off-Road Diesel Consumption (Gallons)	26,816	172,684	276,556	292,662	443,935
On-Road Diesel Consumption (Gallons)	5,859	26,665	54,524	115,495	241,737
On-Road Gasoline Consumption (Gallons)	116,947	203,304	383,994	333,317	598,208
Energy Content of Fuel Consumed (Gigajoules)	37,000	55,800	98,846	103,385	178,725

* Office energy consumption is estimated for the total number of Authority staff and RDP staff using 2015 average EUI and occupancy rates for LEED office buildings in California. No changes between 2018 & 2019 are recorded as total number of employees and RDP staff is unchanged between the years.

Projected Cumulative GHG Emissions Avoided: Tailpipe ($MMTCO_2e$)*

Year	Low	High
2030	.121	.121
2040	8.6	10.5
2050	21.3	25.9
2079	65.9	79.9

* The greenhouse gas emissions reduction scenarios reflect the ridership range expressed in the 2020 Business Plan. Ridership is expressed as both a medium case, and a 75 % percentile, which provides the medium and high emissions scenarios. The Authority calculates emissions reductions for the initial 50-year span of operation (2029-2079, per the 2020 Business Plan). These reductions are reported at intervals corresponding to state reduction milestones (2030,2050), program milestones (2040), and at year 50 (2079).

Projected Cumulative GHG Emissions Avoided: Well-to-Wheels ($MMTCO_2e$)*

Year	Medium	High
2030	.15	.15
2040	10.9	13.3
2050	27.1	33.1
2079	83	102

Projected Annual GHG Emissions Avoided: Well to Wheels (MMTCO$_2$e)*

Year	Medium	High
2030	.075	.077
2040	1.540	1.875
2050	1.693	2.062
2079	2.201	2.681

* The greenhouse gas emissions reduction scenarios reflect the ridership range expressed in the 2020 Business Plan. Ridership is expressed as both a medium case, and a 75 % percentile, which provides the medium and high emissions scenarios. The Authority calculates emissions reductions for the initial 50-year span of operation for well-to-wheels for Phase 1(2029-2079, per the 2020 Business Plan). These reductions are reported at intervals corresponding to state reduction milestones (2030,2050), program milestones (2040), and at year 50 (2079).

Greenhouse Gas Emissions in Metric Tons of Carbon Dioxide Equivalent (MTCO$_2$e)

Emissions Source	2015	2016	2017	2018	2019
Office Energy Emissions: Scope 2	307	381	344	459	432
Contractor Vehicle Emissions: Scope 3	1,400	4,282	6,795	8,063	9,197

Greenhouse Gas Emissions in Metric Tons of Carbon Dioxide Equivalent (MTCO$_2$e)

Emissions Avoided Source	2015	2016	2017	2018	2019
Recycling	12,000	19,774	7,053.01	15,814.32	3,292
Bookend and Connectivity*	142,519	142,519	142,519	142,519	142,519
Agricultural Conservation Easements (in MTCO2e)					36,654
Habitat Mitigation (in MTCO2)					9,400
Tree Programs (in MTCO2e)					180,000

*Calculated for Caltrain Electrification, Central Subway, Regional Rail Connector, and grade separations in Southern California. Additionally, between 2026 and 2078, Link Union Station's estimated contribution to GHG reductions is estimated to be 13.5 million MT of CO2e. https://media.metro.net/projects_studies/rr/LINKUS_DEIR/3.5_ AirQualityandGlobalClimateChange.pdf

Criteria Air Pollutant Emissions (Construction Fleet) – Emitted and Avoided (In Pounds)

Criteria Air Pollutant	2015 Emissions	2015 Emissions Avoided	2016 Emissions	2016 Emissions Avoided	2017 Emissions	2017 Emissions Avoided	2018 Emissions	2018 Emissions Avoided	2019 Emissions	2019 Emissions Avoided
NOx – Nitrogen Oxide	4,006	-49%	23,024	-51%	20,0944	-70%	27,190	-54%	42,507	-49%
ROG – Reactive Organic Gas	549	-41%	1,715	-58%	2,441	-59%	2,318	-58%	2,802	-65%
PM – Particulate Matter	341	-41%	1,082	-60%	1,467	-61%	1,964	-43%	2,374	-50%
BC – Black Carbon	254	-42%	833	-60%	1,130	-61%	1,513	-43%	1,869	-51%

Voluntary Emissions Reduction Agreements (VERA)

VERA Details	2015	2016	2017	2018	2019
VERA Offsets: Total Lifetime Emissions in tons	26	1,006	1,369	1,375	1,375
VERA Investment – $ million		9	13	13	13
VERA Equipment – Tractors	20	46	82	84	84
VERA Equipment – Trucks		104	161	162	162
VERA Equipment – School Bus			1	1	1

CALCULATION OF GHG EMISSIONS

We take the operational control approach to quantifying GHG emissions, and we have adopted 2015 as the baseline year for reporting on emissions changes over time. GHG emissions are quantified using methodologies consistent with the GHG Protocol Corporate Standard, ISO 14064, California Air Resources Board methodologies and U.S. Environmental Protection Agency (EPA) models. All relevant greenhouse gases are included.

Scope 2 GHG emissions are calculated from annual electricity consumption, and emissions factors sourced from the U.S. EPA (2016) and eGRID for California (CAMX).

Scope 3 emissions from contractor vehicles are calculated using EMFAC2011 emissions rates from the California Air Resources Board.

Scope 3 emissions avoided through materials recycling are calculated using the amount of construction materials recycled and the EPA Waste Reduction Model (WARM).

Anticipated GHG emissions reductions during systems operations are calculated according to the methodology available online at: ***www.arb.ca.gov/cci-resources***.

All greenhouses gases relevant to the activities are included (CO2, CH4, N2O). Reductions are reported relative to a scenario without high-speed rail, rather than relative to a baseline year. Emissions reductions occur as a result of the service provided by high-speed rail, so are classified as scope 3 emissions reductions.

PROJECT COMPLIANCE WITH LEGISLATION

- The Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century (Proposition 1A, 2008)
- AB 32 (Núñez, 2006) Global Warming Solutions Act
- SB 32 (Pavley, 2016) Global Warming Solutions Act, 2006: Emissions Limit
- SB 375 (Steinberg, 2008) Sustainable Communities and Climate Protection Act
- AB 75 (Strom-Martin, 1999) Waste Management for State Agencies
- SB 1029 Budget Act of 2012
- SB 852 Budget Act of 2014
- SB 862 (Senate Budget and Fiscal Review Committee, 2013-2014) Greenhouse Gases: Emissions Reduction

- SB 535 (De León, 2012) Global Warming Solutions Act, 2006: Greenhouse Gas Reduction Fund
- AB 1352 (Pérez, 2012) Global Warming Solutions Act, 2006: Greenhouse Gas Reduction Fund
- AB 262 (Bonata, 2017) Buy Clean California Act
- SB 350 (De León, 2015) Clean Energy and Pollution Reduction Act
- SB 100 (De León, 2018) California Renewables Portfolio Standard Program: emissions of greenhouse gases
- SB 379 (Jackson, 2015) Land Use: General Plan: Safety Element: Climate Adaptation
- Executive Order B-18-12
- Executive Order B-30-15
- Executive Order N-19-19
- 2008 California Long-term Energy Efficiency Strategic Plan
- 2008 Air Resources Board Scoping Plan; 2013 Update
- 2016 California Green Building Standards Code (CalGreen Code) Title 24 Part 11
- AB 1550 (Gomez, 2016) Greenhouse Gases: Investment Plan: Disadvantaged Communities
- AB 398 (Garcia, 2017) Update to Global Warming Solutions Act of 2006: market-based compliance mechanisms

EMISSIONS REGULATORY COMPLIANCE

Reducing GHG emissions is detailed in and governed by the following policies and statutes:

- Assembly Bill 32 (Núñez, 2006), the California Global Warming Solutions Act of 2006;
- Senate Bill 32 (Pavley, 2016), requiring the California Air Resources Board, in adopting rules and regulations, to ensure that statewide GHG emissions are reduced to 40 percent below the 1990 levels by 2030;
- California Air Resources Board 2008 Scoping Plan and 2013 Scoping Plan Update, which identify the high-speed rail system as a measure for GHG reduction;
- Greenhouse Gas Emissions Reduction Fund (Cap-and-Trade Auction Proceeds) Third Investment Plan: Fiscal Years 2019-20 through 2021-22, in which the system plays a key role;
- Senate Bill 862 (Committee on Budget and Fiscal Review, 2013-2014), Greenhouse gases: emissions reduction;
- Assembly Bill 1550 (Gomez, 2016), prescribing GHG reduction fund investment in disadvantaged communities; and
- Assembly Bill 617 (Garcia, 2017), required the California Air Resources Board to establish a Community Air Protection Program to focus on reducing exposure in communities most affected by air pollution.

ENERGY REGULATORY COMPLIANCE

CHSR complied with all the following applicable policies, laws, standards and regulatory guidelines:

- California High-Speed Rail Authority Policy Directive Poli-Plan-03 on Sustainability;
- California 2013 Building Energy Efficiency Standards;

- 2010 California Green Building Standards Code (CalGreen Code) Title 24, Part 11;
- 2008 California Long-term Energy Efficiency Strategic Plan;
- Memorandum of Understanding between the Authority and the California Energy Commission; and
- SB 350 (De León) Clean Energy and Pollution Reduction Act.

BIBLIOGRAPHY

Literature review on climate change

Adaptation Fund. "Governance." https://www.adaptation-fund.org/about/governance/

Broom D. for World Economic Forum (WEF). (May 2021). "Climate change: What is COP26 and why does it matter?" https://www.weforum.org/agenda/2021/05/cop26-un-climate-change-summit/

Budinis S. for International Energy Agency (IEA). (January 2020) "Going carbon negative: What are the technology options?" https://www.iea.org/commentaries/going-carbon-negative-what-are-the-technology-options

Carbon Brief Staff. (December 2014). "Two degrees: The history of climate change's speed limit." Carbon Brief. https://www.carbonbrief.org/two-degrees-the-history-of-climate-changes-speed-limit

Carbon Brief Staff. (April 2016) "Explainer: 10 ways 'negative emissions' could slow climate change." Carbon Brief. https://www.carbonbrief.org/explainer-10-ways-negative-emissions-could-slow-climate-change

Carbon Brief – Clear on Climate. Infographics. (March 2020) "Mapped: The world's coal power plants". https://www.carbonbrief.org/mapped-worlds-coal-power-plants

CDP Disclosure Insight Action (on behalf of the Science Based Targets initiative-SBTi). (September 2020). "Foundations for Science-based net-zero target setting in the corporate sector." https://sciencebasedtargets.org/resources/legacy/2020/09/foundations-for-net-zero-full-paper.pdf

Climate Action Tracker (CAT). "Paris temperature goal." https://climateactiontracker.org/methodology/paris-temperature-goal/

Climate Action Tracker (CAT). "CAT Climate Target Update Tracker." https://climateactiontracker.org/climate-target-update-tracker/

Climate Analytics. "About." https://climateanalytics.org/about-us/team/

Climate Analytics. "Adaptation map of policies, strategies, programs and projects in the Caribbean and West Africa." http://adaptationmap.climateanalytics.org/index.html?

Climate Analytics. "The local Sea Level Rise (SLR) Local Sea-Level Projections." http://localslr.climateanalytics.org/location/Key%20West

Climate Watch. "About-Climate Watch includes." https://www.climatewatchdata.org/about/description

Conference of Parties (COP). https://unfccc.int/process/bodies/supreme-bodies/conference-of-the-parties-cop

Conference of the parties "First Report" (COP1). (28 March-7 April 1995). https://unfccc.int/cop4/resource/docs/cop1/07.htm

Dagnet, Y. (May 2019). "INSIDER: The IPCC Updated its Emissions Guidance for the First Time in 13 Years. Here's Why That Matters." World Resources Institute (WRI). https://www.wri.org/insights/insider-ipcc-updated-its-emissions-guidance-first-time-13-years-heres-why-matters

Dagnet Y., Holt M. and Bergen M. for World Resources Institute (WRI). (May 2021). "What Vulnerable Countries Need from the COP26 Climate Summit." https://www.wri.org/insights/what-vulnerable-countries-need-cop26-climate-summit

Deep Decarbonization Pathways (DDP) Initiative led by IDDRI (Institute for Sustainable Development and International Relations). "Why this initiative." https://ddpinitiative.org/about/

Deep Decarbonization Pathways (DDP) Initiative led by IDDRI (Institute for Sustainable Development and International Relations). (2015). "Pathways to deep decarbonization report - Executive Summary." https://www.iddri.org/sites/default/files/import/publications/ddpp_exesum.pdf

Deep Decarbonization Pathways (DDP) Initiative team: Waisman H. (IDDRI), Carl Mas C. (SDSN) and Guerin E.(SDSN). (2015). "2015 Global Sustainable Development Report (GSDR) Brief: Pathways to Deep Decarbonization, a Problem Solving Approach for a 2°C Society." https://sustainabledevelopment.un.org/content/documents/6474Pathways%20to%20deep%20decarbonizations,%20a%20problem%20solving%20approach%20for%20a%202%20degree%20society.pdf

Down To Earth. "Conference of the Parties List." https://www.downtoearth.org.in/climate-change/coplist

Earth.Org. (May 2020) "What is the Kyoto Protocol?" https://earth.org/the-kyoto-protocol/

Earth.Org. (July 2020). "What is the Paris Climate Agreement?" https://earth.org/what-is-the-paris-agreement/

EPA, United States Environmental Protection Agency. "Greenhouse Gas Emissions - Global Greenhouse Gas Emissions Data." https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

Espinosa, P., head of the UNFCCC. (February, 2021). "Four Keys to Success at COP26." https://unfccc.int/news/patricia-espinosa-outlines-the-four-keys-to-success-at-cop26

European Commission. (2015). "EU Emissions Trading System (EU ETS)." https://ec.europa.eu/clima/policies/ets_en

European Union. (2020). "EU Environmental Social Governance (ESG) Regulations Guide." https://advantage.factset.com/eu-environmental-social-governance-regulations?hsCtaTracking=fa8fcee6-feee-4424-83a1-8e005fe8d39b%7Cdfa5fcf3-6c21-452a-84af-bb063c2d3e2b

European Commission. (March 2020). "Taxonomy: Final report of the Technical Expert Group on Sustainable Finance," Technical annex. Updated methodology & Updated Technical Screening Criteria." https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf

Eurostat. (2017) "Sustainable development in the European Union-Monitoring report on Progress towards the SDGs in an EU context." https://ec.europa.eu/eurostat/documents/3217494/8461633/KS-04-17-780-EN-N.pdf

Farand C. Climate Home News. (December 2020). "Guterres: UN will build global coalition for carbon neutrality in 2021." https://www.climatechangenews.com/2020/12/02/guterres-un-will-build-global-coalition-carbon-neutrality-2021/

Forsell, N. for International Institute for Applied Systems Analysis (IIASA). (December 2016). "The SSP-RCP scenarios and their use for forest sector outlooks'. https://unece.org/fileadmin/DAM/timber/meetings/20161212/12-similar-shared-socioeconomic-pathways-for-economic-developments.pdf

G20. "About the G20." https://www.g20.org/about-the-g20.html

Global Carbon Atlas. (2020) 'Global Carbon Budget." http://www.globalcarbonatlas.org/en/content/global-carbon-budget

Global Climate Forum. "PROVIA: Program of Research on Climate Change Vulnerability, Impacts, and Adaptation)." website accessed in January 2020. https://globalclimateforum.org/portfolio-item/provia/

GHG Protocol Team. (September 2011). "Corporate Value Chain (Scope 3) Accounting and Reporting Standard-Supplement to the GHG Protocol Corporate Accounting and Reporting Standard'. World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf

Guterres António for United Nations Secretary-General. (December 2020). "Secretary-General's address at Columbia University: 'The State of the Planet'." https://www.un.org/sg/en/content/sg/speeches/2020-12-02/address-columbia-university-the-state-of-the-planet

Harvard Political Review. (January 2021). "Who is really to blame for climate change?" https://harvardpolitics.com/climate-change-responsibility/

Hausfather, Z. (April 2018). "Explainer: How 'Shared Socioeconomic Pathways' explore future climate change." Carbon Brief. https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change

Herfkens, E. for United Nations, UN Chronicle. (2002). "The Millennium Campaign: Successes and Challenges in Mobilizing Support for the MDGs." https://www.un.org/en/chronicle/article/millennium-campaign-successes-and-challenges-mobilizing-support-mdgs

Institute for Sustainable Development and International Relations (IDDRI). "Deep Decarbonization Pathways Project (since 2014) - Background and issues." https://www.iddri.org/en/project/deep-decarbonization-pathways-project

International Energy Agency (IEA). (April 2021). "Seven Key Principles for Implementing Net Zero." https://www.iea.org/news/seven-key-principles-for-implementing-net-zero

International Institute for Applied Systems Analysis (IIASA). (2009). "RCP Database -Description of the RCPs." https://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=about#citation

International Panel on Climate Change (IPCC). (2000). "Emissions Scenarios report." https://www.ipcc.ch/report/emissions-scenarios/

International Panel on Climate Change (IPCC), sponsored jointly by the World Meteorological Organization and the United Nations Environment Programme. (2000). "Emissions Scenarios- Summary for Policymakers." https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf

International Panel on Climate Change (IPCC). “History.”
https://archive.ipcc.ch/organization/organization_history.shtml

International Panel on Climate Change (IPCC) reports. https://www.ipcc.ch/

International Panel on Climate Change (IPCC). (2008) ‘2006 IPCC Guidelines for National Greenhouse Gas Inventories – A primer.” Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Miwa K., Srivastava N. and Tanabe K. (eds). Published: Institute for Global Environmental Strategies (IGES), Japan. https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf

Intergovernmental Panel on Climate Change (IPCC). (2014). “The Synthesis Report (SYR) of the Fifth Assessment Report (AR5): Climate Change 2014.” https://www.ipcc.ch/report/ar5/syr/

International Panel on Climate Change (IPCC). (January 2020). “Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Summary for Policymakers.”
https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf

International Panel on Climate Change (IPCC). (2002). “Third Assessment Report (TAR) of the, Submissions from Parties.” https://unfccc.int/resource/docs/2002/sbsta/misc05.pdf

International Panel on Climate Change (IPCC). Working Groups. https://www.ipcc.ch/working-groups/

International Panel on Climate Change (IPCC). Working Group I (WGI). (1990). “Climate change - The IPCC Scientific Assessment.” https://www.ipcc.ch/report/ar1/wg1/

International Panel on Climate Change (IPCC). Working Group II (WGII). (October 1990). “Climate Change - The IPCC Impacts Assessment.” The final Report of Working Group II of the Intergovernmental Panel on Climate Change, sponsored jointly by the World Meteorological Organization and the United Nations Environment Programme. https://www.ipcc.ch/report/ar1/wg2/

International Panel on Climate Change (IPCC). Working Group III (WGIII). (June 1990). “Climate Change - The IPCC Response Strategies.” https://www.ipcc.ch/report/ar1/wg3/,
https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc_far_wg_III_full_report.pdf

International Panel on Climate Change (IPCC). Working Group I (WGI). (2013-2014). “Climate Change 2013: The Physical Science Basis.” www.ipcc.ch/report/ar5/wg1/.
https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/the-fifth-assessment-report-of-the-ipcc

International Panel on Climate Change (IPCC). Working Group II (WGII). (2013-2014). “Climate Change 2014: Impacts, Adaptation, and Vulnerability.” IPCC - Fifth Assessment Report (AR5) ‘Second volume’.
https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf,
https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap20_FINAL.pdf

International Panel on Climate Change (IPCC). Working Group III (WGIII). (2013-2014). “AR5 Climate Change 2014: Mitigation of Climate Change.” https://www.ipcc.ch/report/ar5/wg3

International Panel on Climate Change (IPCC). “IPCC’s Fifth Assessment Report (AR5): Future Climate Changes, Risks and Impacts.” https://ar5-syr.ipcc.ch/topic_futurechanges.php

Intergovernmental Panel on Climate Change (IPCC). https://en.wikipedia.org/wiki/Intergovernmental_Panel_on_Climate_Change#cite_note-Appendix_A_to_the_Principles_Governing_IPCC_Work-9

Intergovernmental Panel on Climate Change (IPCC). (2018). "Global Warming of 1.5°C - an IPCC special report (SR1.5)." https://www.ipcc.ch/sr15/download/ , https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf#%5B%7B%22num%22%3A585%2C%22gen%22%3A0%7D%2C%7B%22name%22%3A%22FitH%22%7D%2C792%5D

International Panel on Climate Change (IPCC) – Newsroom. (February 2021). "IPCC opens meeting in Paris to consider 2022 climate change report outline." https://www.ipcc.ch/2020/02/24/ipcc-opens-meeting-in-paris-to-consider-2022-climate-change-report-outline/

Levin K. for World Resources Institute (WRI). (October 2018). "8 Things you need to know about the IPCC 1.5˚C Report." https://www.wri.org/insights/8-things-you-need-know-about-ipcc-15c-report

Levin K. for World Resources Institute (WRI). (October 2018). "Half a Degree and a World Apart: The Difference in Climate Impacts Between 1.5°C and 2°C of Warming." https://www.wri.org/insights/half-degree-and-world-apart-difference-climate-impacts-between-15c-and-2c-warming

Levin K., Fransen Taryn, Schumer C. and Davis C. for World Resources Institute (WRI). (September 2019). "What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered." https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

Metzger, E. (March 2008) 'Bottom Line on Corporate GHG Inventories." World Resources Institute (WRI). https://www.wri.org/research/bottom-line-corporate-ghg-inventories

Organization for Economic Co-operation and Development (OECD) – Science, Technology and Innovation (sti). (February 2016). "OECD CO2 emissions embodied in consumption." https://www.oecd.org/sti/ind/EmbodiedCO2_Flyer.pdf

Organization for Economic Co-operation and Development (OECD). (December 2019). "OECD work in support of climate action." http://www.oecd.org/env/cc/OECD-work-in-support-of-climate-action.pdf

Organization for Economic Co-operation and Development – OECD Library. (March 2021). "Strengthening Climate Resilience: Guidance for Governments and Development Co-operation – 2. Aspirations for strengthening climate resilience." https://www.oecd-ilibrary.org/sites/4b08b7be-en/1/3/2/index.html?itemId=/content/publication/4b08b7be-en&_csp_=c6f3f519f231a3bb752ee0777d54c922&itemIGO=oecd&itemContentType=book

Organization for Economic Co-operation and Development (OECD). (June 2020). "COVID –19 and the low-carbon transition. Impacts and possible policy responses." https://read.oecd-ilibrary.org/view/?ref=134_134752-qmhlk04mue&title=COVID%E2%80%9319-and-the-low-carbon-transition-Impacts-and-possible-policy-responses

Rev.com (audio and video transcripts). (December 2019). "Greta Thunberg UN Climate Change Conference Speech Transcript." https://www.rev.com/blog/transcripts/greta-thunberg-un-climate-change-conference-speech-transcript

Riahi, K. et.all. (2017). "The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview." Published by Elsevier Ltd. https://www.sciencedirect.com/science/article/pii/S0959378016300681

Sandor A. Gerendas-Kiss. (January 2019). "Short history of the Montreal Protocol and holes in the ozone layer." https://sgkplanet.com/en/short-history-of-the-montreal-protocol-and-holes-in-the-ozone-layer/

Schauenberg, T. (February 2020). "Tackling climate change from Kyoto to Paris and beyond." Article published in Deutsche Welle. https://www.dw.com/en/kyoto-protocol-climate-treaty/a-52375473

Task Force on Climate-related Financial Disclosures (TCFD) Hub. "The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities." https://www.tcfdhub.org/scenario-analysis/

Task Force on Climate-related Financial Disclosures (TCFD). (June 2017). "The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities Technical Supplement." https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Technical-Supplement-062917.pdf

Taylor,K.E., Stouffer, R. J. and Gerald A. Meehl. (April 2012). "An Overview of CMIP5 and the Experiment Design." Bulletin of the American Meteorological Society. https://journals.ametsoc.org/view/journals/bams/93/4/bams-d-11-00094.1.xml

United Nations. (2015). "Addis Ababa Action Agenda of the Third International Conference on Financing for Development (Addis Ababa Action Agenda)." https://sustainabledevelopment.un.org/content/documents/2051AAAA_Outcome.pdf

United Nations. "Millennium Development Goals (MDGs) and Beyond 2015." https://www.un.org/millenniumgoals/bkgd.shtml

United Nations. Meetings Coverage and Press Releases. (March 2002). "First International Conference on financing for development to be held in Monterrey, 18 - 22 March 2002." https://www.un.org/press/en/2002/dev2376.doc.htm

United Nations. "Outcomes on Financing for Development-International Conference on Financing for Development, Monterrey, 18-22 March 2002." https://www.un.org/en/development/devagenda/financial.shtml

United Nations. Third International Conference: 'Financing for Development 13-14 July 2015 -Addis Ababa-Ethiopia Time for global Action'. (2015). "Countries reach historic agreement to generate financing for new sustainable development agenda." https://www.un.org/esa/ffd/ffd3/press-release/countries-reach-historic-agreement.html

United Nations. Sustainable Development Goals. (November 2016). "Goal 13: Climate Action – Report: World must cut further 25% from predicted 2030 emissions." https://www.un.org/sustainabledevelopment/blog/2016/11/report-world-must-cut-further-25-from-predicted-2030-emissions/

United Nations – UN News –Global perspectives Human stories. (February 2021). "UN climate report a 'red alert' for the planet: Guterres." https://news.un.org/en/story/2021/02/1085812

United Nations– UN News –Global perspective Human stories. (December 2020). "The race to zero emissions, and why the world depends on it." https://news.un.org/en/story/2020/12/1078612

United Nations Sustainable Development Solutions Network (SDSN), in partnership with Esri and the National Geographic Society. "About SDGs Today." https://sdgstoday.org/about

United Nations Sustainable Development Solutions Network (SDSN) in collaboration with FEEM, IIASA. "Dataset Hub/ SDG 7: Affordable and Clean Energy - Population without Electricity." https://sdgstoday.org/dataset/population-without-electricity

United Nations Sustainable Development Solutions Network (SDSN) in collaboration with ISciences, TReNDS. "Dataset Hub/SDG 6: Clean Water and Sanitation - Water Stress." https://sdgstoday.org/dataset/water-stress-1613245443098x520531199547182400

United Nations Sustainable Development Solutions Network (SDSN). "SDG 13 Climate Action- Sustainable Development Report." https://dashboards.sdgindex.org/map/goals/sdg13

United Nations Sustainable Development Solutions Network (SDSN), in collaboration with World Resource Institute (WRI). "Dataset Hub / SDG 15: Life on Land –Deforestation." https://sdgstoday.org/dataset/deforestation-1613578011005x673172345249617400

UN Millennium Project. (2005). "Investing in development: A practical plan to achieve the Millennium Development Goals. Overview." Report to the UN Secretary- General. https://www.who.int/hdp/publications/4b.pdf

United Nations Department of Economic and Social Affairs Sustainable Development (UNDESA). "Sustainable Development Goals (SDGs)." Accessed in December 2020. https://sdgs.un.org/goals

United Nations Department of Economic and Social Affairs Sustainable Development (UNDESA). (2015). "Transforming our world: the 2030 Agenda for Sustainable Development." https://sdgs.un.org/2030agenda

United Nations Development Programme (UNDP), Brussels. "Background on the goals." https://www1.undp.org/content/brussels/en/home/sustainable-development-goals/background.html

United Nations. SDG Fund (SDGF). "From MDGs to SDGs." https://www.sdgfund.org/mdgs-sdgs

UNDESA Statistics Division (UNSD). (2018). "SDG Indicators: Global Indicator Framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development. https://unstats.un.org/sdgs/indicators/indicators-list//

UNDESA Statistics Division (UNSD). The Sustainable Development Goals Report: Progress summary for SDG targets with a 2020 deadline." https://unstats.un.org/sdgs/report/2020/progress-summary-for-SDG-targets/

United Nations Office for Disaster Risk Reduction. (2015). "Sendai Framework for Disaster Risk Reduction 2015-2030." https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030, https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

United Nations Office for Disaster Risk Reduction. “The Sendai Framework and the SDGs.” https://www.undrr.org/implementing-sendai-framework/sf-and-sdgs

UNDRR United Nations Office for Disaster Risk Reduction. (2015). “What is the Sendai Framework for Disaster Risk Reduction?” https://www.undrr.org/implementing-sendai-framework/what-sendai-framework

United Nations Environment Programme (UNEP) & Technical University of Denmark (DTU), UNEP DTU Partnership. (January 2021). “Adaptation Gap Report 2020.” https://www.unep.org/resources/adaptation-gap-report-2020

United Nations Environment Programme (UNEP) & Technical University of Denmark (DTU), UNEP DTU Partnership. (2014). “Adaptation Gap Report 2014.” https://www.unep.org/resources/adaptation-gap-report-2014

United Nations Environment Programme (UNEP). (November 2017). “Emissions Gap Report 2017.” https://www.unep.org/resources/emissions-gap-report-2017

United Nations Environment Programme (UNEP). (November 2018). “Emissions Gap Report 2018.” https://www.unep.org/resources/emissions-gap-report-2018

United Nations Environment Programme (UNEP). (2019). “Emissions Gap Report 2019.” https://www.unep.org/interactive/emissions-gap-report/2019/

United Nations Environment Programme (UNEP). (December 2020). “Emissions Gap Report 2020.” https://www.unep.org/emissions-gap-report-2020

United Nations Environment Programme (UNEP). “Why do sustainable development goals matter? - GOAL 13: Climate action- Take urgent action to combat climate change and its impacts.” https://www.unep.org/explore-topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-13

United Nations Environment Programme (UNEP). (2019). “Lessons from a decade of emissions gap assessments.” https://wedocs.unep.org/bitstream/handle/20.500.11822/30022/EGR10.pdf

United Nations Environment Programme (UNEP) & Technical University of Denmark (DTU), UNEP DTU. (2020). “UN Environment Emissions Gap Report.” https://unepdtu.org/project/un-environment-emissions-gap-report/

United Nations Environment Programme (UNEP) & Technical University of Denmark (DTU), UNEP DTU. (2020). “Emissions Gap Report 2020.” https://www.unep.org/emissions-gap-report-2020

United Nations Environment Programme (UNEP). “The Montreal Protocol.” https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

UNEP World Environment Situation Room (WESR). “SDGs and Global Synergies.” website accessed in December 2020. https://wesr.unep.org/synergies

UNEP. (November 2019). “Thirty years on, what is the Montreal Protocol doing to protect the ozone?” https://www.unep.org/news-and-stories/story/thirty-years-what-montreal-protocol-doing-protect-ozone

UNEP Finance Initiative (UNEP FI). “TCFD – Task Force on Climate-related Financial Disclosures.” https://www.unepfi.org/climate-change/tcfd/

UNEP-Ozone Secretariat. (January 2019). "Kigali Amendment implementation begins." https://ozone.unep.org/kigali-amendment-implementation-begins

United Nations Framework Convention Climate Change (UNFCCC). "Action on Climate and SDGs." https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs

United Nations Framework Convention Climate Change (UNFCCC). "Climate Action - Race to Zero Campaign." https://unfccc.int/climate-action/race-to-zero-campaign

United Nations Framework Convention Climate Change (UNFCCC). (2021). "Race to Zero Breakthroughs – Transforming our systems together: A global challenge to accelerate sector breakthroughs for COP26 – and beyond." https://racetozero.unfccc.int/wp-content/uploads/2021/02/Race-to-Zero-Breakthroughs-Transforming-Our-Systems-Together.pdf

United Nations Framework Convention Climate Change (UNFCCC). "COP26 - Glasgow Climate Change Conference." https://unfccc.int/process-and-meetings/conferences/glasgow-climate-change-conference

United Nations Framework Convention Climate Change (UNFCCC) – Process and meetings. "Conference-Copenhagen Climate Change Conference - December 2009." https://unfccc.int/process-and-meetings/conferences/past-conferences/copenhagen-climate-change-conference-december-2009/copenhagen-climate-change-conference-december-2009

United Nations Framework Convention Climate Change (UNFCCC) – Process and meetings. "Seventh National Communications - Annex I." https://unfccc.int/NC7

United Nations Framework Convention Climate Change (UNFCCC). "Intro to Cancun Agreements." https://unfccc.int/process/conferences/the-big-picture/milestones/the-cancun-agreements

United Nations Framework Convention Climate Change (UNFCCC). "Emissions Trading." https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

United Nations Framework Convention Climate Change (UNFCCC). "Key aspects of the Paris Agreement." https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/key-aspects-of-the-paris-agreement

United Nations Framework Convention Climate Change (UNFCCC). (2008). "Kyoto Protocol Reference Manual: On accounting of emissions and assigned amount." https://unfccc.int/sites/default/files/08_unfccc_kp_ref_manual.pdf

United Nations Framework Convention Climate Change (UNFCCC). "Kyoto Protocol to the United nations framework convention on climate change." https://unfccc.int/resource/docs/convkp/kpeng.html

United Nations Framework Convention Climate Change (UNFCCC). "Mechanisms under the Kyoto Protocol." https://unfccc.int/process/the-kyoto-protocol/mechanisms

United Nations Framework Convention Climate Change (UNFCCC). "Methodological issues relating to fluorinated gases." https://unfccc.int/process-and-meetings/transparency-and-reporting/methods-for-climate-change-transparency/methodological-issues-relating-to-fluorinated-gases

United Nations Framework Convention Climate Change (UNFCCC). "New elements and dimensions of adaptation under the Paris Agreement (Article 7)." https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/new-elements-and-dimensions-of-adaptation-under-the-paris-agreement-article-7

United Nations Framework Convention Climate Change (UNFCCC). (December 2012). "The Doha Amendment." https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment

United Nations Framework Convention Climate Change (UNFCCC). "The Paris Agreement." https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

United Nations Framework Convention Climate Change (UNFCCC). "What is the Kyoto Protocol?" https://unfccc.int/kyoto_protocol

United Nation Climate Change. "Background - Cooperation with the IPCC." https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/background-cooperation-with-the-ipcc

United Nations Framework Convention Climate Change (UNFCCC). https://unfccc.int/about-us/about-the-secretariat

United Nations Framework Convention Climate Change (UNFCCC). (May 2015). "Report on the structured expert dialogue on the 2013–2015 review." https://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf

United Nations Framework Convention Climate Change (UNFCCC). (February 2021). "Greater climate ambition urged as initial NDC Synthesis Report is published." https://unfccc.int/news/greater-climate-ambition-urged-as-initial-ndc-synthesis-report-is-published

United Nations Development Programme (UNDP) and the World Bank Group (WBG) endorsed by the UN System Chief Executives Board (CEB). (2015). "Transitioning from the MDGs to the SDGs." https://reliefweb.int/sites/reliefweb.int/files/resources/Transitioning from the MDGs to the SDGs.pdf

United Nations General Assembly. (October 2015). "Resolution adopted by the General Assembly on 25 September 2015: Transforming our world: the 2030 Agenda for Sustainable Development." https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

United Nations Industrial Development Organization (UNIDO). "The Montreal Protocol evolves to fight climate change." https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/montreal-protocol-evolves-fight-climate-change

United Nations. (2020). "The Sustainable Development Goals Report2020." https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf

Van Vuuren et al. (2013). "A new scenario framework for climate change research: the concept of shared socioeconomic pathways." https://link.springer.com/article/10.1007/s10584-013-0905-2

Weisse M. and Pickens A. for Global Forest Watch. (September 2020). "GLAD Deforestation Alerts, Explained." https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/

Wong, A. (February 2018). "Even without the US, the Paris climate agreement can succeed where its predecessor failed." CNBC, https://www.cnbc.com/2018/02/11/unlike-the-kyoto-protocol-the-paris-agreement-can-still-succeed.html

World Economic Forum (WEF). (2020). "WEF Global Risks Report 2020." https://www.weforum.org/reports/the-global-risks-report-2020

World Economic Forum (WEF). (May 2021). "Climate Breakthroughs: The Road to COP26 and Beyond." https://www.weforum.org/events/climate-breakthroughs-the-road-to-cop26-2021

World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) partnership. "Greenhouse Gas Protocol." https://ghgprotocol.org/about-us

World Resources Institute (WRI). "Allied for Climate Transformation By 2025 (ACT2025)." https://www.wri.org/initiatives/allied-climate-transformation-act2025

Working Group on Coupled Modelling (WGCM). (2008). "CMIP Phase 5 (CMIP5)." https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip5

Literature review on climate change and investors / ESG reporting

CDP Disclosure Insight Action (formerly the Carbon Disclosure Project). (2019) "Major Risk or Rosy Opportunity: Are companies ready for climate change? https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/004/588/original/CDP_Climate_Change_report_2019.pdf?1562321876

CDP, CDSB, GRI, IIRC, and SASB. (September 2020). "Statement of Intent to Work Together Towards Comprehensive Corporate Reporting." https://29kjwb3armds2g3gi4lq2sx1-wpengine.netdna-ssl.com/wp-content/uploads/Statement-of-Intent-to-Work-Together-Towards-Comprehensive-Corporate-Reporting.pdf

CDP, CDSB, GRI, IIRC, and SASB. (December 2020). "Reporting on enterprise value: Illustrated with a prototype climate-related financial disclosure standard. Progress towards a comprehensive corporate reporting system". https://29kjwb3armds2g3gi4lq2sx1-wpengine.netdna-ssl.com/wp-content/uploads/Reporting-on-enterprise-value_climate-prototype_Dec20.pdf

Climate Disclosure Standards Board (CDSB). (December 2019). "CDSB Framework for reporting environmental & climate change information: Advancing and aligning disclosure of environmental information in mainstream reports for reporting environmental & climate change information." https://www.cdsb.net/sites/default/files/cdsb_framework_2019_v2.2.pdf

CERES, IIGCC, GIC, Global Investor Coalition on Climate Change, Asia Investor Group on Climate Change. (July 2020). "Portfolio Climate Risk Management: Case Studies on Evolving Best Practices." https://globalinvestorcoalition.org/wp-content/uploads/2020/11/PCRM-Ceres-FINAL-Aug-6.pdf

Center for Strategic & International Studies (CSIS). (March 2020). "Climate Solutions Series: Deep Decarbonization Pathways". https://www.csis.org/analysis/climate-solutions-series-deep-decarbonization-pathways

Climate Action 100+ (Part of IIGCC initiatives and collaborations). (2020). "Climate Action 100+ 2020 Progress report." https://www.climateaction100.org/wp-content/uploads/2020/12/CA100-Progress-Report.pdf

Corporate Reporting Dialogue. (February 2019) "The Sustainable Development Goals and the future of corporate reporting." https://corporatereportingdialogue.com/wp-content/uploads/2019/12/The-Sustainable-Development-Goals-and-the-future-of-corporate-reporting.pdf

Eccles, Robert G. and Klimenko, S. "The Investor Revolution: Shareholders are getting serious about sustainability." Published in the Harvard Business Review Magazine (May–June 2019). https://hbr.org/2019/05/the-investor-revolution

EDHEC Infrastructure Institute. (March 2021). "Towards a Scientific Approach to ESG for Infrastructure Investors: Approaching ESG & Infrastructure within the Portfolio." https://edhec.infrastructure.institute/paper/towards-a-scientific-approach-to-esg-for-infrastructure-investors/

EU European Commission. (2019). "Factsheet: Financing sustainable growth." https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200108-financing-sustainable-growth-factsheet_en.pdf

European Union. (2020). "EU Environmental Social Governance (ESG) Regulations Guide." https://advantage.factset.com/eu-environmental-social-governance-regulations?hsCtaTracking=fa8fcee6-feee-4424-83a1-8e005fe8d39b%7Cdfa5fcf3-6c21-452a-84af-bb063c2d3e2b

European Commission. (March 2020). "Taxonomy: Final report of the Technical Expert Group on Sustainable Finance."https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf

European Commission. (March 2020). "Taxonomy: Final report of the Technical Expert Group on Sustainable Finance," Technical annex. Updated methodology & Updated Technical Screening Criteria." https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

European Commission. (June 2019). "Guidelines on non-financial reporting: Supplement on reporting climate-related information." https://ec.europa.eu/finance/docs/policy/190618-climate-related-information-reporting-guidelines_en.pdf

Gestrin, Michael V. (2019). "The contribution of international business investment to the Sustainable Development Goals: Key actors and recent trends", OECD, Paris. http://www.oecd.org/investment/investment-policy/The-contribution-of-international-business-investment-to-the-sustainable-development-goals.pdf

Global Investor Coalition on Climate Change (GIC), Ceres. (July 2020). "Portfolio Climate Risk Management: Case Studies on Evolving Best Practices." https://globalinvestorcoalition.org/wp-content/uploads/2020/11/PCRM-Ceres-FINAL-Aug-6.pdf

Global Reporting Initiative (GRI). (various dates) "GRI Standards 2020". https://www.globalreporting.org/how-to-use-the-gri-standards/gri-standards-english-language/

Global Reporting Initiative (GRI). (June 2020). "GRI Universal Standards: GRI 101, GRI 102, and GRI 103 – Exposure draft." https://www.globalreporting.org/standards/media/2605/universal-exposure-draft.pdf

International Financial Reporting Standards (IFRS) Foundation. (September 2020). "Consultation Paper on Sustainability Reporting." https://www.ifrs.org/content/dam/ifrs/project/sustainability-reporting/consultation-paper-on-sustainability-reporting.pdf

International Integrated Reporting Council (IIRC). (January 2021). "International <IR> Framework January 2021." https://integratedreporting.org/wp-content/uploads/2021/01/InternationalIntegratedReportingFramework.pdf

Institutional Investors Group on Climate Change (IIGCC). "Investor agenda topics." website accessed in December 2020. https://www.iigcc.org/resources/?resource_topic=investor-agenda

KPMG. "EU Sustainable Finance explained – Taxonomy: Part II - Key Taxonomy-related takeaways". https://home.kpmg/fi/fi/home/Pinnalla/2019/08/eu-sustainable-finance-explained-part-ii-taxonomy.html

KPMG IMPACT (December 2020) "The time has come. The KPMG Survey of Sustainability Reporting 2020." https://assets.kpmg/content/dam/kpmg/be/pdf/2020/12/The_Time_Has_Come_KPMG_Survey_of_Sustainability_Reporting_2020.pdf

McBrien, Mardi. (April 2018). "Looking back at 10 years of CDSB." https://www.cdsb.net/cdsb-framework/796/looking-back-10-years-cdsb

Moret, J., ESG Franklin Templeton Investments. (April 2017) "An integrated approach to managing ESG risks and opportunities." https://www.franklintempleton.co.uk/investor/commentary-details?contentPath=en-gb/blog-posts/An-Integrated-Approach-To-Managing-ESG-Risks-And-Opportunities

Sustainability Accounting Standards Board. SASB Materiality Map®. Interactive table with Disclosure topics & Accounting metrics available at: https://materiality.sasb.org/

Sustainability Accounting Standards Board (SASB). (June 2020) "Response of the Sustainability Accounting Standards Board to the Public Consultation on the Revision of the Non-Financial Reporting Directive."

Sustainability Accounting Standards Board. (September 2020). "SASB Implementation Supplement: Greenhouse Gas Emissions and SASB Standards." https://www.sasb.org/knowledge-hub/sasb-implementation-supplement-greenhouse-gas-emissions-and-sasb-standards/

Task Force on Climate-related Financial Disclosures (TCFD). (June 2017). "Final Report Recommendation of the Task Force on Climate-related Financial Disclosures." https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf

Task Force on Climate-related Financial Disclosures (TCFD). (October 2020). "2020 Status Report." https://www.fsb.org/wp-content/uploads/P291020-1.pdf

Task Force on Climate-related Financial Disclosures (TCFD). (June 2017). "Technical Supplement - The use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities." https://www.tcfdhub.org/scenario-analysis/

UNEP Finance Initiative (UNEPFI) for the Global Commission on Adaptation (GCA). (July 2019) **"**Driving Finance Today for the Climate Resilient Society of Tomorrow for the Global Commission on Adaptation." https://www.unepfi.org/wordpress/wp-content/uploads/2019/07/GCA-Adaptation-Finance.pdf

UN Principles for Responsible Investment (UN PRI). (September 2019) **"**Driving meaningful data: financial materiality, sustainability performance, and sustainability outcomes." https://www.unpri.org/download?ac=11641

UNPRI, ICGN. (October 2018) "Investor Agenda For Corporate ESG Reporting A Discussion Paper By Global Investor Organizations On Corporate ESG Reporting." https://www.unpri.org/download?ac=6181

World Economic Forum. (September 2020) "Measuring Stakeholder Capitalism towards Common Metrics and Consistent Reporting of Sustainable Value Creation. White paper."
http://www3.weforum.org/docs/WEF_IBC_Measuring_Stakeholder_Capitalism_Report_2020.pdf

Full list of Global investor statements:

2019 Global Investor Statement to Governments on Climate Change
2018 (Updated) Global Investor Statement to Governments on Climate Change
2018 Global Investor Statement to Governments on Climate Change
2017 Global Investor Letter to G7 and G20
2016 Global Investor Letter: Global investor groups urge leaders to sign and accede to the Paris Climate Agreement rapidly
2014/2015 Global Investor Statement on Climate Change
2013 Global Investor Survey on Climate Change
2012 Letter from Global Investor Networks to the Governments of the World's Largest Economies
2011 Global Investor Statement on Climate Change
2010 (Updated) Global Investor Statement on Climate Change
2010 Investor Statement on Catalyzing Investment in a Low-Carbon Economy
2009 Investor Statement on the Urgent Need for a Global Agreement on Climate Change

References for Envision Review

EU BAMB (Buildings as Material Banks). (2020) "Materials Passports."
https://www.bamb2020.eu/topics/materials-passports/

Better World Solutions. (October 2020). "EU Materials Passport Platform ready for testing."
https://www.betterworldsolutions.eu/eu-materials-passport-platform/

Institute for Sustainable Infrastructure (ISI). (2018). "Envision Sustainable Infrastructure Framework, Version 3."

Institute for Sustainable Infrastructure (ISI). (2015). "Envision Rating System for Sustainable Infrastructure."

Institute for Sustainable Infrastructure (ISI). (October 2018). "ENVISION V3: What You Need to Know & Frequently Asked Questions."

Institute for Sustainable Infrastructure (ISI). (September 2017). "Envision V3 Draft Credits for Public Review and Comment September 6 - November 1, 2017."

Institute for Sustainable Infrastructure (ISI). "Project awards directory: Envision verified projects that have been publicly announced as of Feb 4, 2021." https://sustainableinfrastructure.org/project-awards/

National Academies of Sciences, Engineering, and Medicine 2020. Strategic Issues Facing Transportation, Volume 7: Preservation, Maintenance, and Renewal of Highway Infrastructure. Washington, DC: The National Academies Press.
https://www.nap.edu/catalog/25757/strategic-issues-facing-transportation-volume-7-preservation-maintenance-and-renewal-of-highway-infrastructure

Prof.S.N.Pollalis. (October 2020). "Integrating Sustainability and LCA: Pilot Application on Transportation Infrastructure Projects". Report prepared for the National Research Council of Canada (NRCC).

Pollalis, S.N. (2016). "Planning Sustainable Cities: An Infrastructure-based Approach." Published by Routledge, New York.

US Department of Transportation Federal Highway Administration (US DOT FHWA). (February 2012). "Reference Sourcebook for reducing greenhouse gas emissions from transportation sources". https://www.fhwa.dot.gov/environment/sustainability/energy/publications/reference_sourcebook/referencesourcebook.pdf

References California's exposure to Climate-related impacts and response

Governor's Office of Planning and Research. (March 2018) "Planning and investing for a resilient California: A guidebook for state agencies". www.opr.ca.gov

Adaptation Clearinghouse. "State of California Executive Order N-19-19". https://www.adaptationclearinghouse.org/resources/state-of-california-executive-order-n-19-19.html

The Equation. (September 2018) "Climate-Safe Infrastructure for All: California Working Group Report Provides Comprehensive Recommendations". https://blog.ucsusa.org/jamesine-rogers-gibson/climate-safe-infrastructure-for-all-california-working-group-report-provides-comprehensive-recommendations/

Energy Upgrade California. "How Is Climate Change Affecting California?" https://www.energyupgradeca.org/climate-change

Office of Governor Gavin Newsom. (October 2020) "Governor Newsom Launches Innovative Strategies to Use California Land to Fight Climate Change, Conserve Biodiversity and Boost Climate Resilience". www.gov.ca.gov

California Public Utilities Plan. "Energy Efficiency Strategic Plan". www.cpuc.ca.gov

California Natural Resources Agency. (January 2018). "Safeguarding California Plan 2018 Update: California's Climate Adaptation Strategy."

State of California's Governor's Office of Planning and Research, State of California's Energy Commission and California Natural Resources Agency. "California's Changing Climate 2018: A Summary of Key Findings from California's Fourth Climate Change Assessment". https://www.energy.ca.gov/sites/default/files/2019-11/20180827_Summary_Brochure_ADA.pdf

References California High Speed Rail Program

California Air Resources Board (CRB). (December 2008). "Climate Change Scoping Plan a framework for change". https://ww2.arb.ca.gov/sites/default/files/classic//cc/scopingplan/document/adopted_scoping_plan.pdf

California Air Resources Board (CRB). (November 2017). "California's 2017 Climate Change Scoping Plan: The strategy for achieving California's 2030 greenhouse gas target". https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan

California Climate Investments (CCI). "2021 Profiles: California High Speed Rail Project, Building Resilience, Central Valley." http://www.caclimateinvestments.ca.gov/2021-profiles/2021/4/26/california-high-speed-rail-project-building-resilience

California High-Speed Rail Authority (CHSRA). (September 2019). "2019 CHSR Sustainability Report: Energizing Economic Revitalization." https://hsr.ca.gov/wp-content/uploads/docs/programs/green_practices/sustainability/Sustainability_Report_2019.pdf

California High-Speed Rail Authority (CHSRA). (October 2020). "2020 Sustainability Report: Building Resilience." https://hsr.ca.gov/programs/green-practices-sustainability/sustainability/

California High-Speed Rail Authority (CHSRA). April 2019. California High-Speed Rail Authority Sustainability Implementation Plan Summary. https://hsr.ca.gov/wp-content/uploads/docs/programs/green_practices/sustainability/Sustainability_implementation_plan_SUMMARY.pdf

California High-Speed Rail Authority (CHSRA). (December 2020). "California High-Speed Rail Program Envision Verification Credit Details: Climate and Resilience Category". https://hsr.ca.gov/2020/12/08/news-release-california-high-speed-rail-receives-national-award-for-sustainability/

Cederoth, M. (2020). "Presentation of the California High-Speed Rail Authority's 2020 Sustainability Report: Building Resilience."

Climate-Safe Infrastructure Working Group (CSIWG). (September 2018). "Paying it forward: The Path toward Climate-Safe Infrastructure in California. Executive Summary." https://resources.ca.gov/CNRALegacyFiles/docs/climate/ab2800/AB2800_ES_FINAL.pdf

High Speed Rail Alliance. "California's High Speed Rail Phasing Plan." https://www.hsrail.org/californias-high-speed-rail-phasing-plan

Institute for Sustainable Infrastructure (ISI). 2020. "The California High-Speed Rail Program earns an Envision platinum award." https://sustainableinfrastructure.org/project-awards/california-high-speed-rail-program/

Institute for Sustainable Infrastructure (ISI). (2018). Envision Sustainable Infrastructure Framework. Version 3.

UN Department of Economic and Social Affairs Sustainable Development. (2021). "Goal 13: Take urgent action to combat climate change and its impacts*. Targets and Indicators". https://sdgs.un.org/goals/goal13

U.S. Global Change Research Program (USGCRP). Fourth U.S. National Climate Assessment (NCA). Ch. 28: Reducing Risks through Adaptation Actions & Ch. 29: Reducing Risks through Emissions Mitigation. https://nca2018.globalc hange.gov/

References Santa Monica Clean Beaches project

Chiland, E. (June 2018). “Santa Monica is still the filthiest beach in L.A.” Los Angeles Curbed. https://la.curbed.com/2018/6/8/17440210/santa-monica-pier-beach-safe-to-swim

City of Santa Monica. (2019). Submission of documentation for the Envision verification process.

City of Santa Monica. (2018) “Sustainable Water Management Plan Update.” Accessed March 30, 2020. https://www.smgov.net/uploadedFiles/Departments/Public_Works/Water/SWMP.pdf

City of Santa Monica, Office of Sustainability and the Environment. (2017). “Urban Runoff, BMP Reporting”. Accessed February 26, 2020) https://www.smgov.net/Departments/OSE/Categories/Urban_Runoff/BMP_Reporting.aspx

City of Santa Monica. (2018). “Santa Monica 2017 Summary Tourism Economic & Fiscal Impacts, Visitor Profile,” https://www.santamonica.com/wp-content/uploads/2018/05/2-Page-Econ-Imp-Summary-2017.pdf).

Eren, S. (November 2019). “Protecting the Santa Monica Bay & Beneficial Use of Stormwater: Santa Monica Clean Beaches Project.” Presentation at Harvard Graduate School of Design, Cambridge, November 4, 2019)

Farrell, C. (August 2018). “By the Numbers: Tourism’s Economic Impact in Santa Monica.”

Given, S. et al. (2006). “Regional Public Health Cost Estimates of Contaminated Coastal Waters: A Case Study of Gastroenteritis at Southern California Beaches,” Environmental Science and Technology 40, no. 16 4851. https://www.santamonica.com/wp-content/uploads/2019/05/2-Page-Econ-Imp-Summary-2018.pdf.

Natural Resources Defense Council. (2014). “The Impacts of beach pollution.” Accessed February 25, 2020. https://www.nrdc.org/sites/default/files/ttw2014_Impacts_of_Beach_Pollution.pdf

Santa Monica Public Works, Water Resources. “2019 Water/Wastewater Rate Study.” Accessed February 25, 2020. https://www.smgov.net/departments/publicworks/water.aspx

Santa Monica Public Works, Civil Engineering. “Why is Measure V needed”. Accessed February 25, 2020. “https://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9573

Santa Monica Public Works. (June 2017). “City Council Report: Award Construction Contract for Clean Beaches Project (Agenda Item:3H).” https://publicdocs.smgov.net/WebLink/edoc/2346079/SR-06-27-2017%203H.pdf?dbid=0&repo=SMGOV

Santa Monica Public Works, Civil Engineering. (2020) “Background”. Accessed February 25, 2020. https://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9573

ABBREVIATIONS

AAUs	Assigned Amount Units
AFOLU	Agriculture, Forestry and Land Use
AGR20	Adaptation Gap Report 2020
AR	Afforestation and reforestation
AR5	Fifth Assessment Report (of IPCC)
BaU (BAU)	Business as Usual
BECCS	Bio-Energy with Carbon Capture and Storage
CAP	Changed Agricultural Practices,
CCS	Carbon Capture and Storage
CDP	Carbon Disclosure Project
CDR	Carbon Dioxide Removal
CER	Certified Emission Reduction
CDM	Clean Development Mechanism
CDSB	Climate Disclosure Standards Board
COP	Conference of the Parties
CR	Climate and Resilience
CRDPs	Climate-Resilient Development Pathways
DAC	Direct air capture
DDPs	Deep-Decarbonization Pathways
DNSH	Do No Significant Harm
EGR20	Emissions Gap Report 2020
EPA	U.S. Environmental Protection Agency
ESG	Environmental, Social, and Corporate Governance
ETS	Emissions Trading System
EU	European Union
EV	Electric Vehicles
EW	Enhanced weathering
FfD	Financing for Development (Forum)
FSB	Financial Sustainability Board
GCMs	Global Climate Models
GHG	Greenhouse Gas

GRI	Global Reporting Initiative
IBS	International Business Council
IEA	International Energy Agency
IET	International Emissions Trading
IFRS	International Financial Reporting Standards
IISD	International Institute for Sustainable Development
INDCs	Intended Nationally Determined Contributions
IOSCO	International Organization of Securities Commissions
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
JI	Joint Implementation
<IR>	Integrated Reporting
ISO	International Organization for Standardization
LC	Life Cycle
LD	Leadership
MDGs	Millennium Development Goals
NAPs	National Adaptation Plans
NbS	Nature-based Solutions
NDCs	Nationally Determined Contributions
NETs	Negative Emissions Technologies
NFRDs	Non-Financial Reporting Directives
NW	Natural World
ODS	Ozone Depleting Substances
OECD	Organization for Economic Co-operation and Development
OF	Ocean fertilisation
O&M	Operation and Maintenance
PPP	Public–private partnership
PRI	Principles for Responsible Investing
PV	Photovoltaic
QL	Quality of Life
RA	Resource Allocation
RCPs	Representative Concentration Pathways

SASB	Sustainability Accounting Standards Board
SDG	Sustainable Development Goals
SFDR	Sustainable Finance Disclosure Regulation
SRES	Special Report on Emissions Scenarios
SSPs	Shared Socio-Economic Pathways
TBL	Triple Bottom Line
TCFD	Task Force on Climate-related Financial Disclosures
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WEF	World Economic Forum
WGI	Working Group I
WMO	World Meteorological Organization
WRI	World Resources Institute