PACTA for Investors

Scenario supporting document

PACTA
Paris Agreement Capital Transition Assessment

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1. Introduction

The Paris Agreement Capital Transition Assessment (PACTA) is a climate scenario analysis methodology. It measures the alignment of financial portfolios to climate change scenarios, including Paris-aligned scenarios, across climate critical sectors. PACTA aims to inform alignment and potential transition risk with the ultimate goal of driving emissions reductions in the real economy.

On the **Transition Monitor platform**, individual users can perform a PACTA analysis of their portfolios. It is important to bear in mind that the tool will be able to perform the analysis on the financial assets that the tool for investors covers, such as long positions in listed equity, corporate bonds, and funds. PACTA bases its assessment of portfolio alignment to a climate scenario on forward-looking production values, which are measured in economic units of output in the real economy. It is thus distinguished from carbon accounting frameworks, which are often based on historic data. For additional information on the PACTA methodology, please refer to the PACTA for Investors methodology document.

Measuring alignment requires scenarios that explain what needs to happen in a sector to decarbonize. While climate change scenarios don't predict the future, they provide essential information to understand climate change and the pathways to reach specific goals. It is important to note that climate scenarios are built using a range of different assumptions and, therefore can propose different courses of action to achieve climate targets, so it is important to compare and contrast them. Not all scenarios cover all sectors, as such different sectors might also be analyzed using different scenarios.

This document is intended to serve as a guide for PACTA users to explain some of the basic concepts associated with climate change scenarios, and aspects that should be taken into account when analyzing the results. Note that this document should be read in conjunction with the PACTA for Investors methodology document. There’s also a wide range of literature about climate change scenarios, how they are developed, and how they can be used. We recommend further familiarizing yourself with the guidance available and recommendations on how scenarios can be used. Lastly, while we include a brief explanation of the scenarios that are embedded in the online tool, for detailed information concerning their methodology or assumptions we recommend getting in contact with the scenario provider.

2. What are Decarbonization Scenarios?

In the efforts to tackle climate change, it is critical to understand what can happen and what should happen in a future that, although uncertain, can be planned for with the aid of the foresight provided by scenarios. Climate change scenarios incorporate scientific, technical, and socio-economic assumptions to depict a range of views of what may happen in the future and constitute a powerful tool that allows society to understand the challenges of climate change and the consequences of not taking action today. In other words, scenarios are the outcome and descriptions of possible futures that arise from the research and analysis.

A first common reference point for understanding scenarios are the indicative pathways developed by United Nation's **Intergovernmental Panel on Climate Change (IPCC),** whose regular reviews and updates of the latest climate science form the basis for international policy making. The IPCC maintains a global database of models and over 2,000 scenarios that it reviews and aggregates in order to create a set of climate scenario categories and illustrative pathways to different average global mean temperature rises in 2100, together with their associated probability and what they imply in terms of the techno-economic and social change required. Their latest and 6th review, published in February 2022, defined eight broad categories of climate scenarios and from these a set of Illustrative Mitigation Pathways (IMPs) and Share Socio-economic Pathways (SSPs) for policymakers to consider at a global level (see figure 1).

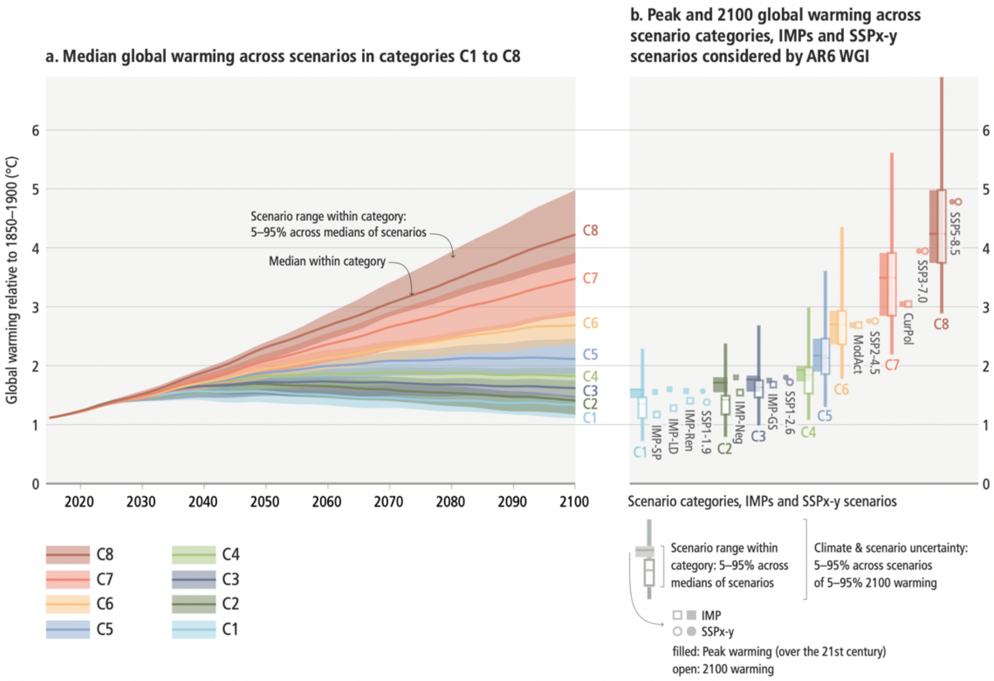

Figure 1. the IPCC's eight indicative pathways to the year 2100, published in their AR6 (2022) review

The Shared Socio-Economic Pathways (SSPs) describe different future worlds with contrasting socio-economic conditions and driving forces, including different population growth forecasts. The five pathways comprise:

- SSP1 ´Sustainability´
- SSP2 ´Middle of the road´
- SSP3 ´Regional rivalry´
- SSP4 ´Inequality´
- SSP5 ´Rapid growth / fossil fuelled development´

Only SSPs 1 and 2 are modelled to achieve a below 2°C (SSP2) or below 1.5°C (SSP1) world. SSPs 3, 4 and 5 are associated with global warming of below 4°C (SSP3), below 2.5°C (SSP4) and above 4°C (SSP5). The new Illustrative Mitigation Pathways introduced in 2021 are illustrated in Figure 2. They explore different technology transitions, including renewable energy (IMP-Ren), CO_2 removal technology (IMP-Neg) and greater resource efficiency (IMP-LD), as well as a gradual strengthening of mitigation measures (IMP-GS) and sustainable development with a focus on reducing global inequality (IMP-SP).

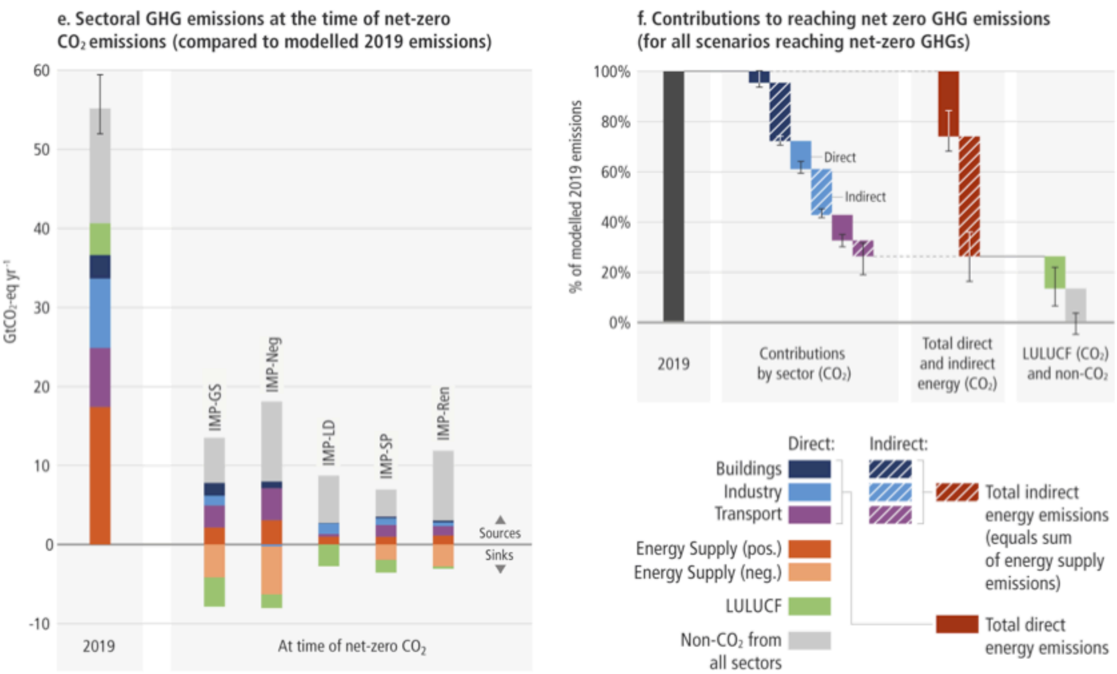

Figure 2. the IPCC's five Illustrative Mitigation Pathways (IMPs) to the year 2100, published in their AR6 (2022) review

Whilst useful to understand the headline scale of change and investment required, the IPCC SSP and IMP pathways are in general not granular enough to use at sector level in PACTA. Amongst the scenarios accepted within the IPCC database are so-called Integrated Assessment Models (IAM) and these are the type that PACTA can run on. They tend to be built up from much more granular information on what needs to happen at sectoral level, including scenarios of the kind developed by the IEA, the European Commission, and other organisations such as the Institute for Sustainable Futures (ISF) and International Institute for Applied Systems Analysis (IASA).

Like the high-level IPCC pathways, these decarbonization scenarios are generally developed to meet specific carbon budgets and climate mitigation objectives, although they can also serve to illustrate the outcome of different combinations of political and economic actions that can be taken. Various of these scenarios exist that can potentially be used in PACTA, and although some of them may have the same climate targets, it is relevant to further evaluate the assumptions that the scenario provider has brought together in order to reach the target or targets.

The scenarios that are of particular interest for implementing PACTA are those that come as a set, reflecting different levels of ambition and, importantly, the sectoral decarbonization pathways contained within the main scenarios, which tell us how the different technologies will shift within a sector or how the emissions intensity will change as a result of implementing different measures over time. Some of the factors to bear in mind that can differ from the modelling of one scenario to the other can include:

- The speed at which decarbonization occurs;
- Availability and maturity of technologies, their scalability, and cost;
- Favouring or ruling out different technologies (e.g. reduce role for nuclear in the OECM scenario, more prominent use of CCUS in the SDS and B2DS scenarios);
- Level of ambition for decarbonization (resulting in varying probabilities of limiting the global average global rise in temperature to <2°C);
- Levels of granularity (time, geography, etc.).

Figure 3 illustrates the types of assumptions and technological changes that may inform different sectoral pathways within a scenario (as indicated by the different colours) and on what timescale.

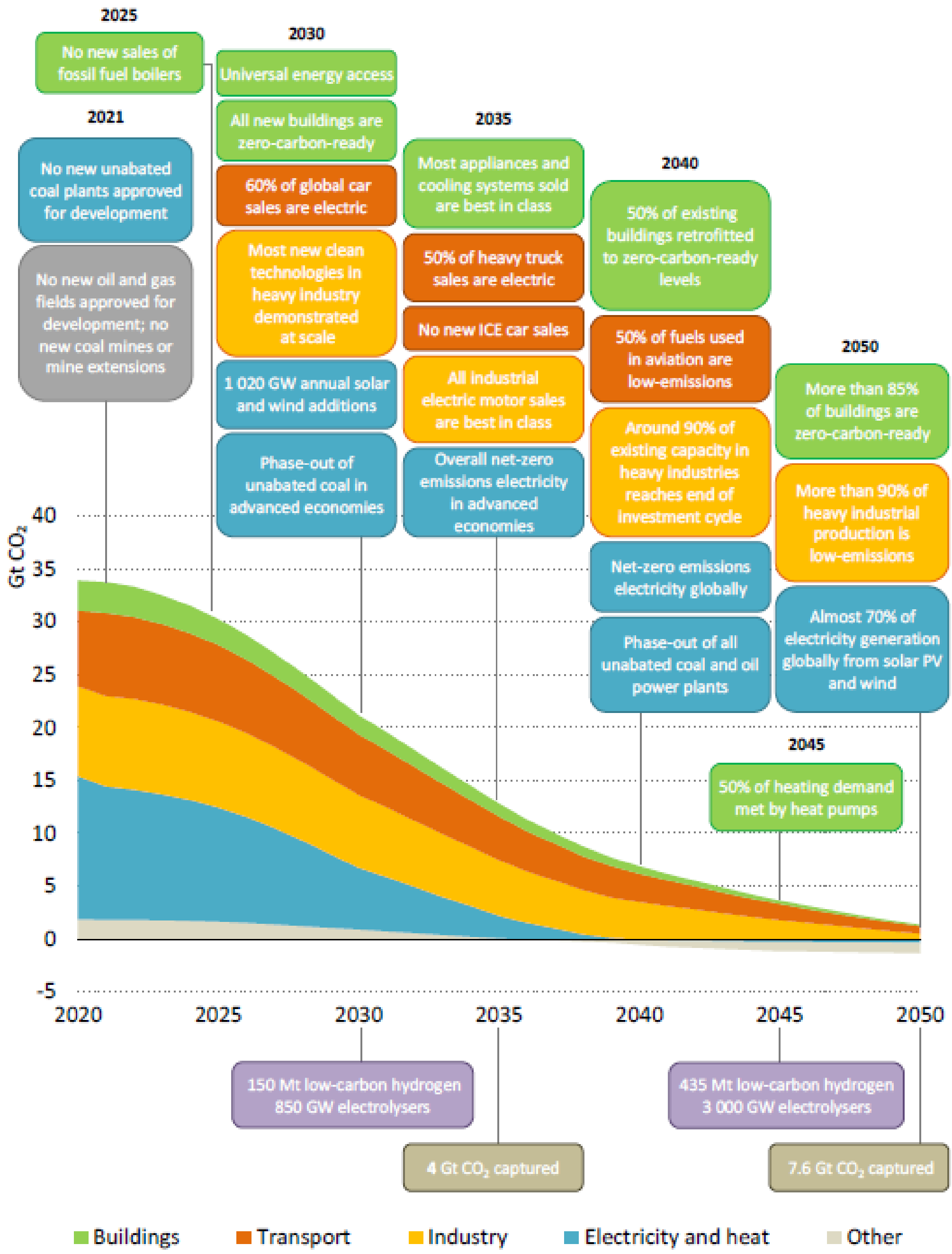

Figure 3. Technological changes along six pathways of the IEA Net Zero scenario (courtesy of IEA 2021)

Suggested reading on scenarios

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

I4CE, *Understanding transition scenarios – eight steps for reading and interpreting these scenarios*, November 2019

Institut Louis Bachelier et al. (2020) *Alignment cookbook on choosing one or several scenarios and associated trajectories.*

TCFD, *Technical supplement: The Use of Scenario Analysis in Disclosure of Climate-Related Risks and*

Opportunities, June 2017

TCFD, *The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*, https://www.tcfdhub.org/scenario-analysis/

3. Limitations and Assumptions of scenarios

As we have already emphasized, scenarios and their sectoral pathways are still only depictions and models of possible futures. When conducting scenario analysis on a portfolio it is therefore important to understand the following limitations and assumptions:

3.1 PROBABILITY OF ACHIEVING THE STATED GOALS

The estimated degree Celsius number connected to climate scenarios is usually accompanied by the probability of stabilizing global warming at the degrees Celsius target above pre-industrial levels by 2100. Thus, aligning with a 2°C scenario may represent, for example, a 50% chance and thus doesn't necessarily lead to the limiting of global warming to 2°C. Table 1 compares the overall global warming goals and probabilities of four scenarios included in PACTA.

The use of a given scenario (B2DS, SDS, NPS, CPS) does not constitute an assumption that this scenario is more likely to prevail than others, but the assumptions made about the market maturity of the different technologies in the pathways can provide an overall indication of the degree of uncertainty (see section 3.2). Note also that the choice of IEA scenarios or other providers should not be interpreted as an endorsement of the underlying assumptions by RMI.

Table 1. Comparison of the global warming goals of four scenarios included in PACTA

Scenario parameters	**IEA WEO 2021 SDS scenario**	**IEA Net Zero by 2050 scenario**	**ISF (NZAOA) Net Zero scenario**	**JRC GECO 1.5°C Unified scenario**
Average global temperature target in 2100	1.6°C	1.4°C	1.5°C	1.5°C

Probability of achieving warming goal by 2100	50%	50%	66%	50%

3.2 UNDERSTANDING THE ASSUMPTIONS AROUND AVAILABLE TECHNOLOGIES

Some scenarios rely on technologies which are still in the development phase and hence may not be available at the speed and scale that the scenario requires. For example, the IEA 2°C scenario relies on a significant portion of BECS (Bio energy with Carbon Storage) after 2050, but there are still open questions regarding its technological feasibility.

On the other hand, past IEA scenarios have been quite conservative. They have underestimated both energy efficiency developments and renewable deployment rates (as a result of accelerated reductions in the cost of technologies). This means that the scenarios might not be ambitious enough (compared to what is feasible) and that there is a need for more ambitious scenarios that lead to higher probabilities to limit global warming to well below 2°C, one of the main goals of the Paris agreement.

Table 2 summarises some of the main sources of uncertainty related to technology assumptions for four scenarios included in PACTA, as identified by the scenario developers, as well their main assumptions on technological maturity of solutions.

Table 2. Comparison of the uncertainty factors and technology assumptions of four scenarios included in PACTA

Scenario parameters	**IEA WEO 2021 SDS scenario**	**IEA Net Zero by 2050 scenario**	**ISF Net Zero scenario**	**JRC GECO 1.5°C Unified scenario**
Main identified sources of model uncertainty	Covid uncertainties, behavioral changes, CCUS for fossil fuels	Behavioral change, bioenergy, CCUS for fossil fuels	Behavioral change, large-scale deployment of renewables[4]	Carbon price and mitigation policies

Main assumptions on technology maturity	60-65% of required CO_2 reductions are from technologies currently commercially deployed.	50-60% of required CO_2 reductions are from technologies currently at demonstration or prototype stage.	Only considers theoretical technologies that have demonstrated proof of concept.	A technology learning-curve approach is applied.

3.3 DIFFERENT SCENARIOS ARE UNDERPINNED BY DIFFERENT MODELING ASSUMPTIONS

Scenarios are not future projections, they are estimations and are based on numerous indicators and assumptions, which might not all hold true and will depend on the beliefs of the publishers of the scenarios. Hence, it is important to understand the underlying assumptions behind the scenarios being used. Table 3 compares some these assumptions for four scenarios included in PACTA – including energy demand, fossil fuel use, renewable energy and carbon capture.

Table 3. Comparison of the major technology assumptions of four scenarios included in PACTA

Scenario parameters	**IEA WEO 2021 SDS scenario**	**IEA Net Zero by 2050 scenario**	**ISF Net Zero scenario**	**JRC GECO 1.5°C Unified scenario**
Primary Energy demand reduction	17% less in 2030 compared to 2019	7% less in 2050 compared to 2020	8% less in 2050 compared to 2020	7% less in 2050 compared to 2020
Fossil fuel use and exploitation	Fossil fuel share in the primary energy mix falls around 70% by 2030	No new development or exploitation from 2020 onwards.	Emissions from fossil fuel must decline by more than half by 2030.	Fossil fuel share in the primary energy mix falls around 70% by 2050
The role of renewable energy	Renewable energy generation share increases from 30% in 2019 to 40% in 2030	Renewable energy generation is 60% of global power	Renewable energy generation share increases from 30% in	Renewable energy accounts for 78% of global power

		generation by 2030	2019 to 40% in 2025	generation in 2050.
The role of nuclear energy	36% growth in nuclear capacity by 2040	76% growth in nuclear capacity by 2040	No new nuclear power stations	337% growth in nuclear capacity by 2040.
The role of carbon capture utilization and storage	2.9 Gt CO_2 after 2050	7.6 Gt CO_2 in 2050	No use of the technology	4.6 Gt CO_2 in 2050
Use of nature-based solutions as offsets [7]	80-240 Gt CO_2 in 2050	No offsets assumed	152 Gt CO_2 in 2050	Use of forest management to mitigate emissions.

3.4 SECTORAL ALIGNMENT TO A SCENARIO

Considering that scenarios are built taking into account a specific remaining carbon budget that is intended to limit global warming to a certain temperature rise, it is recommended to make the PACTA analysis using the same scenario to analyse multiple sectors. This means that in order to claim to be aligned with a specific scenario, all the technologies of the analyzed sector must be aligned with this scenario or with a stricter one from the same scenario set or publication.

4. Scenarios available on the Transition Monitor Platform

PACTA as a methodology is scenario agnostic, however, the methodology requires data with sufficient technological and regional breakdowns; i.e. it should cover the same sectors and ideally provide pathways at a country or regional granularity. The PACTA analysis can be performed through the Transition Monitor Platform. The process to upload a portfolio and execute the analysis is described in the PACTA For Investors guide. A short description of the scenarios that are currently available in the online tool is provided below.

4.1 ENERGY TECHNOLOGY PERSPECTIVE (ETP) 2020

This update of the ETP modelling scenario has been extended from 2060 to 2070 compared to the 2017 version of it. The modelling incorporates updated assumptions for gross domestic product (GDP) and energy prices to reflect the effects of the global Covid-19 pandemic. The baseline scenario was changed to the Stated Policies Scenario and the two Paris aligned scenarios replaced by the Sustainable Development Scenario (SDS) also used in the WEO2019.

Sustainable Development Scenarios (SDS): This scenario aims to meet stricter sustainable development goals. This requires rapid and widespread changes across all parts of the energy system. It is aligned with the goals set out in the Paris Agreement, with a 50% chance of limiting global temperature rise to 1.65°C by the end of the century, as well as objectives related to universal energy access and cleaner air. These efforts are shared amongst multiple fuels and technologies.

IEA, Energy Technology Perspective (2020)

4.2 WORLD ENERGY OUTLOOK (WEO) 2021

Stated Policies Scenario (STEPS): This scenario incorporates policies declared as of 2019 with the goal of assessing what the world may look like in the future based on policies that have currently been announced. In the STEPS energy demand rises by 1% per year until 2040. More than half of this growth in demand is met by solar photovoltaics (PV) while natural gas enabled by trade in liquefied natural gas (LNG) accounts for a third. Oil demand plateaus in 2030. Despite this, the global economic and population growth means that there is no peak in global emissions ahead of 2040 and hence globally shared sustainability goals (like that set out in the Paris Agreement) are missed.

Announced Pledges Scenario (APS): This scenario models the new commitments and pledges to meet net-zero emissions targets made by countries in the run-up to COP26. This is equivalent to a warming of 2.1°C at the end of the century. This scenario assumes that countries will implement their plans in time and in full. The projections evidence a decrease in global CO2 emissions driven by the capacity additions of low emission power generation sources in the period to 2030, which generates a decline in coal consumption in the power sector. Announced pledges save around 20% of the gap in emissions until 2030 from the Net Zero Scenario to the Stated Policies Scenario.

Sustainable Development Scenario (SDS): This scenario aims to meet stricter sustainable development goals. This requires rapid and widespread changes across all parts of the energy system. It is aligned with the goals set out in the Paris Agreement, with a 50% chance of limiting global temperature rise to below 1.65°C by the end of the century, as well as objectives relate to universal energy access and cleaner air. These efforts are shared amongst multiple fuels and technologies.

Net Zero Emissions by 2050 (NZE): This scenario extends the SDS scenario to target net-zero emissions. The scenario responds to the increasing number of countries and companies that have made commitments to reach net zero emissions earlier, combined with the aim of limiting the rise in global temperatures to 1.5°C by the end of the century (with a 50% probability). In particular, it explores the actions needed in the period to 2030 to be on track to achieve net zero emissions by 2050, including the need to end new fossil fuel exploitation from 2021 onwards and to avoid stranded assets across sectors. The original May 2021 documentation is provided below, as many of the scenario and sectoral pathway assumptios remain unchanged.

IEA, World Energy Outlook (2021)

IEA, Net Zero by 2050 (2021)

4.3 GLOBAL ENERGY AND CLIMATE OUTLOOK (GECO) 2021

This edition of the GECO scenario takes stock of the potential impact of policy updates made by G20 countries ahead and during the 2021 United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP) in Glasgow, including nationally determined contributions (NDCs) and long-term net-zero emission targets. The time horizon extends to 2070. The focus on G20 emitters is accompanied by detailed modelling and analysis of how each country can achieve its climate goals.

Current Policy Scenario (CPS):
This scenario models at the macro-economic level the effect of enacting current policies that have already been adopted up until 2019. If there are NDC targets at national level but no policies, then these are not taken into account. Macro-economic projections for GDP and population growth are combined with the modelled effects of policies on energy prices and technology development and deployment in order to then make projections for changes in energy systems and CO2 emissions. The effects of the Covid-19 pandemic on the energy system are factored into the modelling of growth and in particular on the transport sector. The global temperature outcome of the scenario is not specifically stated in the scenario literature, but the charts indicate greater than 3°C.[1]

[1] See Figure 3 on page 13 of Keramidas et al, *Global Energy and Climate Outlook 2021: Advancing towards climate neutrality*, EUR 30861 EN, Publications Office of the European Union, Luxembourg, 2021,

Natonally Determined Contributions – Long Term low GHG emission development Strategies (NDC-LTC):

This scenario includes the country and NDC pledges updated at COP26. It is expected an implied temperature rise of about 1.8°C by 2100. To achieve the target, additional policies need to be put in place, as current policies would stabilize emissions by 2035 -2040. Power sector also play's an important role to achieve this scenario target, specially by the reduction of coal power generation. The NDCs cover around 50% of the ambition gap to 1.5°C in 2030. (JRC, 2021)

1.5ºC Unified (Unif):

This scenario represents an economically efficient pathway to achieving 1.5oC. The scenario assumes low overshoot by 2050 (1.7oC) with global net-zero GHG emissions reached before 2070. It assumes application of a single global carbon price from 2021 onwards and relies on it as the main policy driver. The 1.5° Unified scenario has a limited reliance on carbon capture and storage technologies and does not consider financial transfers between countries to implement mitigation measures. If all the targets are achieved as specified by the scenario there would be at least a 50% chance of limiting global temperature rise to 1.5°C by 2100.

JRC, Global Energy and Climate Outlook (2021)

4.4 INSTITUTE FOR SUSTAINABLE FUTURES 2020

Sectoral pathways to Net Zero emissions:

This scenario was created upon the request of the Net Zero Asset Owners Alliance (NZAOA). It presents a contrasting net zero scenario to that of the IEA, with a focus on existing, mature technologies, the exclusion of carbon capture technologies to achieve net zero and greater overall investment in renewable energy and demand-side efficiency. The scenario is an output of the One Earth Climate Model (OECM). The main scenario assumptions are documented in Table 4. If all the targets are achieved as set out by this scenario there would be at least a 66% chance of limiting global temperature rise to 1.5°C by 2100. Users of this scenario are encouraged to look at the ISF NZ scenario documentation.

ISF, Sectoral Pathways to Net Zero Emissions (2020)

Summary of scenarios included in the PACTA for Investors online tool (Transition Monitor Platform)

Scenario	Sectors Covered	Global Average Temperature rise in 2100	Probability	Publication	Abbreviation
Net Zero by 2050	Oil and Gas, Coal, Power, Automotive, Steel, Cement	1.5°C	50%	IEA, NZE report	NZE_2050
Sustainable Development Scenario	Oil and Gas, Coal, Power	1.65°C	50%	IEA, WEO 2021	SDS
Announced Pledges Scenario	Oil and Gas, Coal, Power	2.1°C	50%	IEA, WEO 2021	ADS
Stated Policy Scenario	Oil and Gas, Coal, Power	2.7°C	50%	IEA, WEO 2021	STEPS
Sustainable Development Scenario	Power, Oil & Gas, Coal	1.6°C	50%	IEA, ETP 2020	ETP_SDS
Baseline	Power, Automotive, Oil & Gas	1.5°C	50%	JRC, GECO 2021 Baseline	
NDC LTS	Power, Automotive, Oil & Gas, Coal	1.8°C	50%	JRC GECO 2021, NDC LTS	
1.5C Unified	Power, Automotive, Oil & Gas, Coal, Aviation	>3°C	50%	JRC GECO 2021, 1.5C Unif	
ISF Net Zero Scenario	Power, Coal, Oil & Gas	1.5°C	66%	ISF 2020, Sectoral Pathways to Net Zero Emissions	ISF_NZ