

# Guide to the Science of Climate Change in the 21<sup>st</sup> Century

## Chapter 21 Sixth Assessment Report – AR6

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<https://climatescenarios.org/primer/mitigation/>

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## Chapter 21.0 Sixth Assessment Report – AR6

### 21.1 Introduction

Preparation of the Sixth Assessment Report began immediately, if not before, the AR5 was published. The recommendations from AR5 were clear as to the global temperature targets for 2100 – between 1-2°C above pre-industrial. If current emission rates continue it is considered likely that 1.5°C will be reached between 2030 and 2050 – much sooner than 2100.

At the 21st Conference of the Parties (COP21) in December 2015, 195 nations adopted the Paris Agreement (<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>). The first instrument of its kind, the landmark agreement includes the aim to strengthen the global response to the threat of climate change by ‘holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels’.

In 2016 the IPCC accepted an invitation from the United Nations Framework on Climate Change to prepare a ‘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; Special Report on greenhouse gas (GHG) fluxes in land-based ecosystems, land use and sustainable land management in relation to climate change adaptation and mitigation, desertification, land degradation and food security; and, on Special Report on the ocean and the cryosphere in a changing climate.’ The Special Reports are intended to provide guidance as to which mitigation strategy to choose (possible) to achieve the emission objective.

The Special Report Global Warming of 1.5°C was approved by the IPCC on October 8, 2018 <https://www.ipcc.ch/sr15/>. The special report uses shared socioeconomic pathways, SSPs, described in Tables 21.1 and 21.2, used to select workable representative concentration pathways, RCPs, (original four plus three as shown in Figure 21.1). CMIP5 models were used to perform simulations.

The Special Report Climate Change and Land was published August 8, 2019 <https://www.ipcc.ch/srccl/>. The special report uses shared socioeconomic pathways, SSPs, described in Tables 21.1 and 21.2 used to select workable representative concentration pathways, RCPs, (original four plus three) as shown in Figure 21.1. CMIP5 models were used to perform simulations. The report was prepared by the Working Groups 1, 2 and 3 in collaboration with the Task Force on National Greenhouse Gas Inventories.

The Special Report Ocean and the Cryosphere was published September 24, 2019, <https://www.ipcc.ch/srocc/>. The special report uses RCP2.6 and RCP8.5. CMIP5 models were used to perform simulations.

## 21.2 Outcomes of note from Special Reports

1. Achieving a temperature increase of 1.5°C or less above pre-industrial levels in 2100, carbon neutrality or net zero emissions must be realized by 2050.
2. A decrease in CO<sub>2</sub> emissions of about 45% from 2010 levels (9.995 GtC see <https://www.co2.earth/global-co2-emissions>) is required by 2030.
3. Some form of carbon dioxide removal will be required.

In order to meet their commitments to the Paris Agreement countries must declare their 'nationally determined contributions' (NDCs). These are likely similar to decreases in CO<sub>2</sub> emissions of about 45% from 2010 levels by 2030 and carbon neutrality by 2050. Progress toward meeting these commitments is reviewed every five years.

## 21.3 AR6 simulations

All AR6 simulations will be performed using CMIP6 models and the SSPs and RCPs discussed in the Special Reports. Attention will be given to the United Nations Sustainable Development Goals.

The reports from the different working groups will be available as follows:

- AR6 Climate Change 2021: The Physical Science Basis is expected to be available April 2021.
- AR6 Climate Change 2021: Mitigation of Climate Change is expected to be available July 2021.
- AR6 Climate Change 2021: Impacts, Adaptation and Vulnerability is expected to be available October 2021.
- AR6 Synthesis Report: Climate Change 2022 is expected to be available June 2022.

## 21.4 Shared socio-economic pathways, SSPs

Tables 20.1 and 20.2 explain what is meant by the five SSPs. These are combined with the representative concentration pathways that will work with the desired SSPs as shown in Figure 20.1.

## Box SPM. 1 | Shared Socio-economic Pathways (SSPs)

In this report the implications of future socio-economic development on climate change mitigation, adaptation and land-use are explored using shared socio-economic pathways (SSPs). The SSPs span a range of challenges to climate change mitigation and adaptation.

- SSP1 includes a peak and decline in population (~7 billion in 2100), high income and reduced inequalities, effective land-use regulation, less resource intensive consumption, including food produced in low-GHG emission systems and lower food waste, free trade and environmentally-friendly technologies and lifestyles. Relative to other pathways, SSP1 has low challenges to mitigation and low challenges to adaptation (i.e., high adaptive capacity)
- SSP2 includes medium population growth (~9 billion in 2100), medium income, technological progress, production and consumption patterns are a continuation of past trends, and only a gradual reduction in inequality occurs. Relative to other pathways, SSP2 has medium challenges to mitigation and medium challenges to adaptation (i.e., medium adaptive capacity).
- SSP3 includes high population growth (~13 billion in 2100), low income and continued inequalities, material-intensive consumption and production, barriers to trade, and slow rates of technological change. Relative to other pathways, SSP3 has high challenges to mitigation and high challenges to adaptation (i.e., low adaptive capacity).
- SSP4 includes medium population growth (~9 billion in 2100), medium income, but significant inequality within and across regions. Relative to other pathways, SSP4 has low challenges to mitigation, but high challenges to adaptation (i.e., low adaptive capacity).
- SSP5 includes a peak and decline in population (~7 billion in 2100), high income, reduced inequalities, and free trade. This pathway includes resource-intensive production, consumption and lifestyles. Relative to other pathways, SSP5 has high challenges to mitigation, but low challenges to adaptation (i.e., high adaptive capacity).
- The SSPs can be combined with Representative Concentration Pathways (RCPs) which imply different levels of mitigation, with implications for adaptation. Therefore, SSPs can be consistent with different levels of global mean surface temperature rise as projected by different SSP-RCP combinations. However, some SSP-RCP combinations are not possible; for instance RCP2.6 and lower levels of future global mean surface temperature rise (e.g., 1.5°C) are not possible in SSP3 in modelled pathways. {1.2.2, 6.1.4, Cross-Chapter Box 1 in Chapter 1, Cross-Chapter Box 9 in Chapter 6}

Table 21.1 Description of Shared Socio-economic Pathways (SSPs) taken from Summary for Policymakers, Special Report Climate Change and Land. <https://www.ipcc.ch/srccl/>

Socio-Economic Challenges to Mitigation	Socio-Economic Challenges to Adaptation		
	Low	Medium	High
<b>High</b>	<b>SSP5: Fossil-fuelled development</b> <ul style="list-style-type: none"> <li>• low population</li> <li>• very high economic growth per capita</li> <li>• high human development</li> <li>• high technological progress</li> <li>• ample fossil fuel resources</li> <li>• very resource intensive lifestyles</li> <li>• high energy and food demand per capita</li> <li>• economic convergence and global cooperation</li> </ul>		<b>SSP3: Regional rivalry</b> <ul style="list-style-type: none"> <li>• high population</li> <li>• low economic growth per capita</li> <li>• low human development</li> <li>• low technological progress</li> <li>• resource-intensive lifestyles</li> <li>• resource-constrained energy and food demand per capita</li> <li>• focus on regional food and energy security</li> <li>• regionalization and lack of global cooperation</li> </ul>
<b>Medium</b>		<b>SSP2: Middle of the road</b> <ul style="list-style-type: none"> <li>• medium population</li> <li>• medium and uneven economic growth</li> <li>• medium and uneven human development</li> <li>• medium and uneven technological progress</li> <li>• resource-intensive lifestyles</li> <li>• medium and uneven energy and food demand per capita</li> <li>• limited global cooperation and economic convergence</li> </ul>	
<b>Low</b>	<b>SSP1: Sustainable development</b> <ul style="list-style-type: none"> <li>• low population</li> <li>• high economic growth per capita</li> <li>• high human development</li> <li>• high technological progress</li> <li>• environmentally oriented technological and behavioural change</li> <li>• resource-efficient lifestyles</li> <li>• low energy and food demand per capita</li> <li>• economic convergence and global cooperation</li> </ul>		<b>SSP4: Inequality</b> <ul style="list-style-type: none"> <li>• Medium to high population</li> <li>• Unequal low to medium economic growth per capita</li> <li>• Unequal low to medium human development</li> <li>• unequal technological progress: high in globalized high-tech sectors, slow in domestic sectors</li> <li>• unequal lifestyles and energy /food consumption: resource intensity depending on income</li> <li>• Globally connected elite, disconnected domestic work forces</li> </ul>

Table 21.2 Shared socio-economic pathways explained in Special Report Global Warming of 1.5°C.  
[https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15\\_Chapter2\\_Low\\_Res.pdf](https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_Chapter2_Low_Res.pdf)

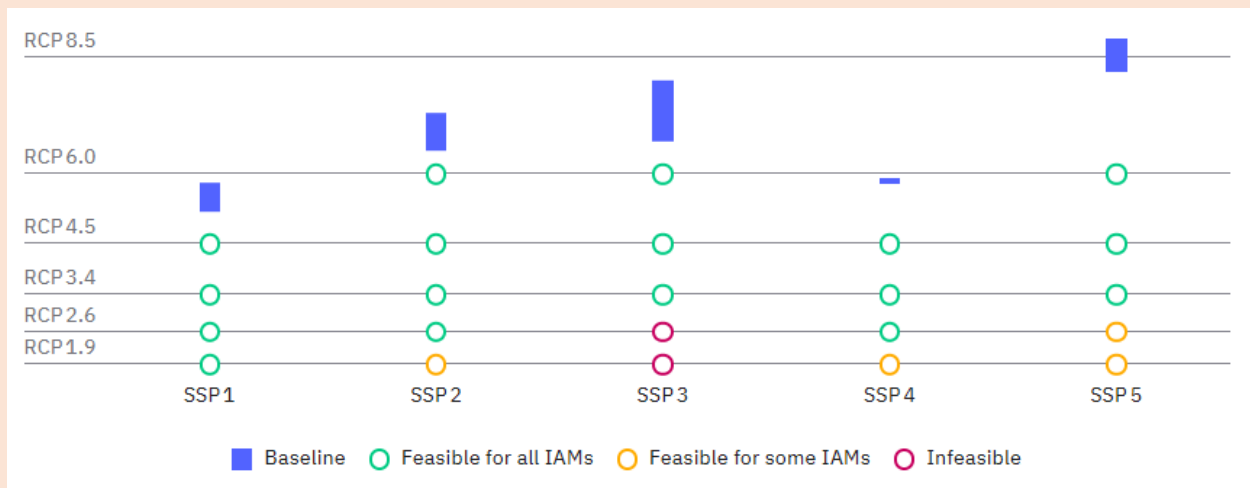


Figure 21.1 Climate change scenarios to be used in AR6.  
<https://climatescenarios.org/primer/mitigation/>

## 21.4 Information support

### Key web sites:

1. Paris Agreement, COP21, <https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement>
2. Global emissions. <https://www.co2.earth/global-co2-emissions>
3. IPCC Sixth Assessment Report. <https://www.ipcc.ch/assessment-report/ar6/>
4. IPCC special report, global warming 1.5 degrees C. <https://www.ipcc.ch/sr15/>
5. IPCC special report, climate change and land. <https://www.ipcc.ch/srccl/>
6. IPCC special report, ocean and the cryosphere in a changing climate. <https://www.ipcc.ch/srocc/>
7. IPCC special report, ocean and the cryosphere, supplementary material. [https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/SROCC\\_FinalDraft\\_Chapter1-SM.pdf](https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/SROCC_FinalDraft_Chapter1-SM.pdf)
8. A new scenario framework for climate change research: scenario matrix architecture. <https://link.springer.com/article/10.1007/s10584-013-0906-1>
9. Discussion of representative concentration pathways used in AR6. <https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change>
10. Climate change scenarios to be used in AR6. <https://climatescenarios.org/primer/mitigation/>