IPCC Report

Global Warming of 1.5 ^{o}C

October 6 2018

Why 1.5°C?

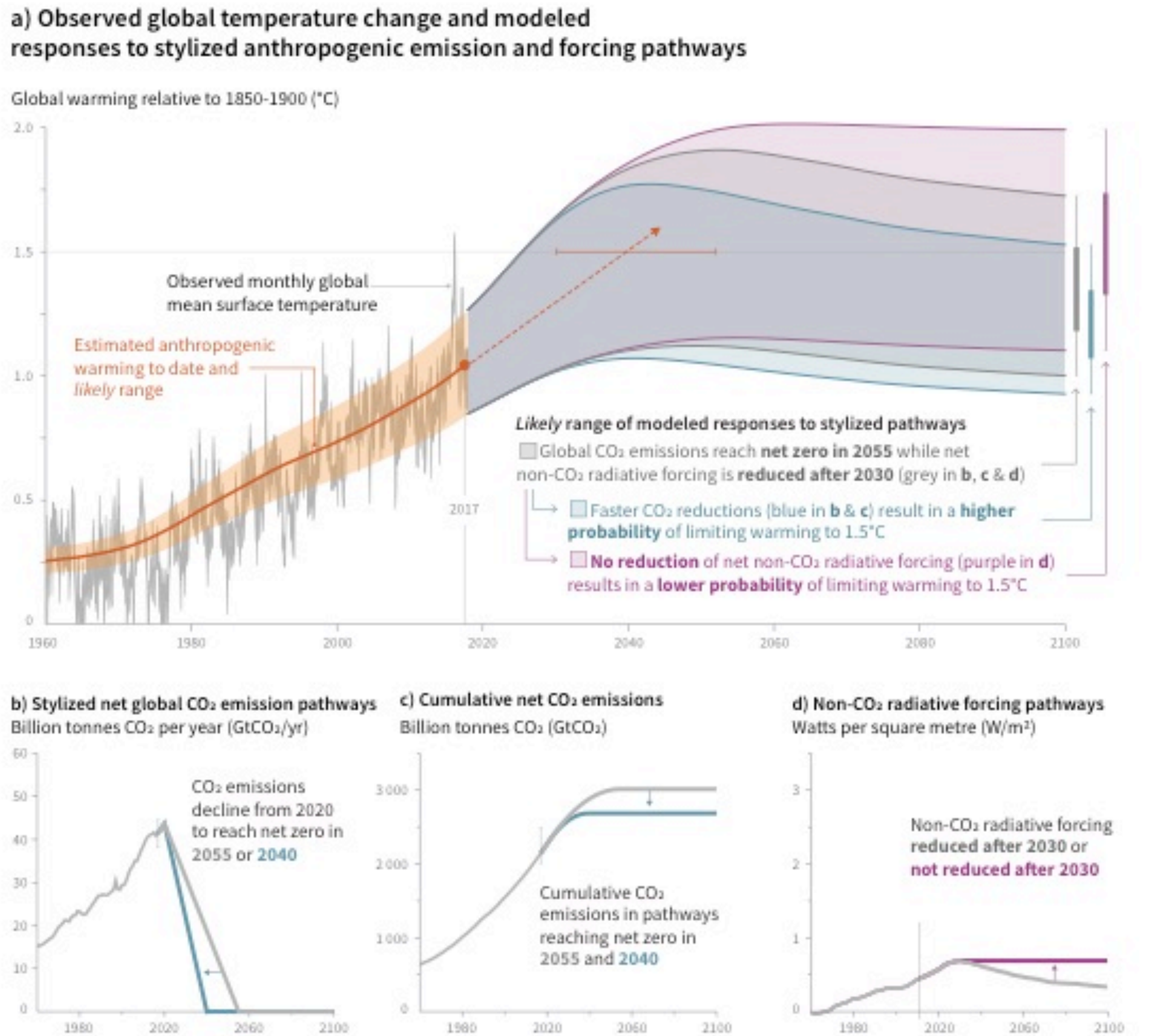
- It is very likely that global mean surface temperatures (GMST) will increase by 1.5°C
- It may be possible to hold GMST increases to 1.5°C
- Increases in GMST by more than 2°C will have larger impacts

The Paris Agreements focused on limiting ΔT to less than 1.5°C

Headlines. I.

- In 2017, global temperatures are $1.0 \pm 0.2^{\circ}C$ above pre-industrial average.
- Global temperatures are increasing $0.2 \pm 0.1^{\circ}C$ every decade.
- Warming is expected to exceed $1.5^{\circ}C$ between 2030 and 2052.
- Warming over land exceeds ocean warming; 20-40% of population lives where ΔT exceeds $1.5^{\circ}C$ already.
- Past greenhouse gas emission unlikely to cause global ΔT to exceed $1.5^{\circ}C$.
- Current warming will persist, and have effects for centuries to millennia.

Cumulative emissions of CO_2 and future non-CO_2 radiative forcing determine the probability of limiting warming to 1.5°C



Faster immediate CO_2 emission reductions limit cumulative CO_2 emissions shown in panel **(c)**.

Maximum temperature rise is determined by cumulative net CO_2 emissions and net non-CO_2 radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.

Source: IPCC Special Report on Global Warming of 1.5°C

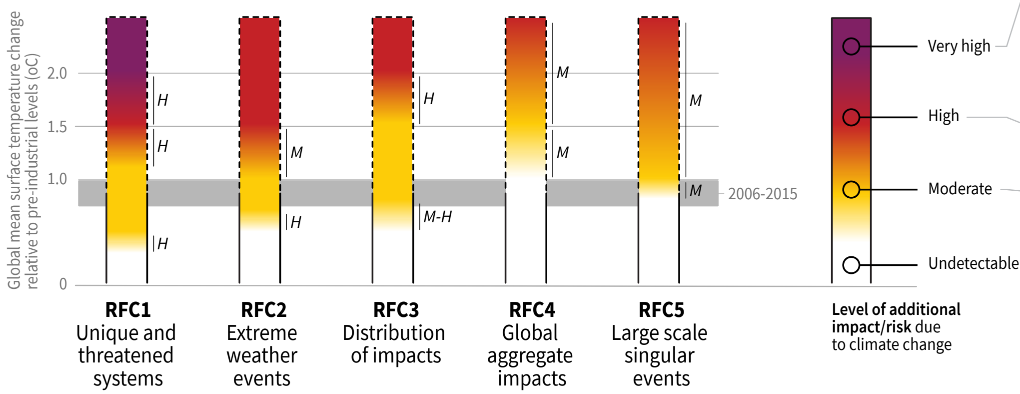
Headlines. II.

- Mitigation of climate change falls disproportionately on the poor. There will be ethical concerns in any mitigation effort.
- “Climate adaptation is more likely to contribute to sustainable development when polices align with mitigation and poverty eradication goals”.
- “Ambitious mitigation actions are indispensable to limit warming to 1.5°C while achieving sustainable development and poverty eradication”.
- “There is no single answer to the question of whether it is feasible to limit warming to 1.5°C and adapt to the consequences”

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



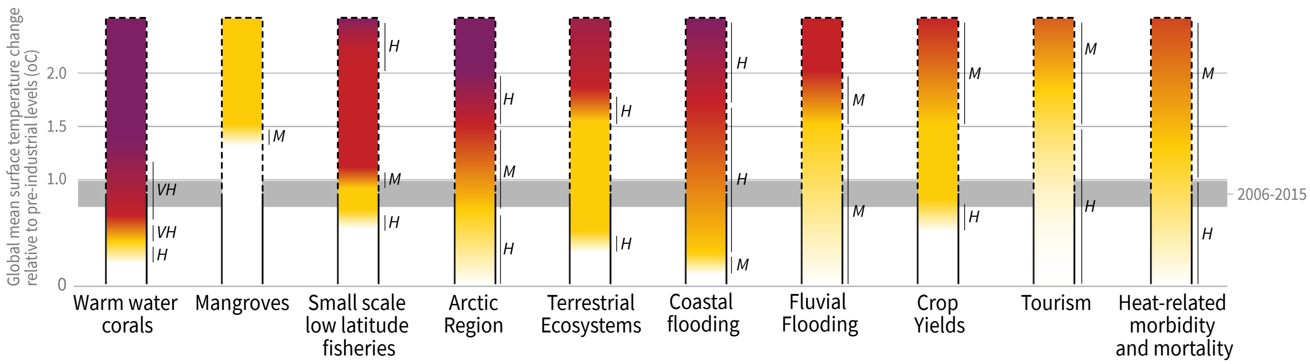
Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.

Red indicates severe and widespread impacts/risks.

Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.

White indicates that no impacts are detectable and attributable to climate change.

Impacts and risks for selected natural, managed and human systems



Confidence level for transition: *L*=Low, *M*=Medium, *H*=High and *VH*=Very high

Source: IPCC Special Report on Global Warming of 1.5°C

Headlines. III.

The difference between a 1.5°C and 2°C rise:

- More extreme weather (temperatures, droughts, storms)
- 0.1m of sea-level rise
- Fewer impacts to coastal ecosystems
- Lower ocean acidity; less anoxia
- Less species loss/extinction
- Less cost to economy

Pathways to Limiting ΔT

$\Delta T = 1.5°C$

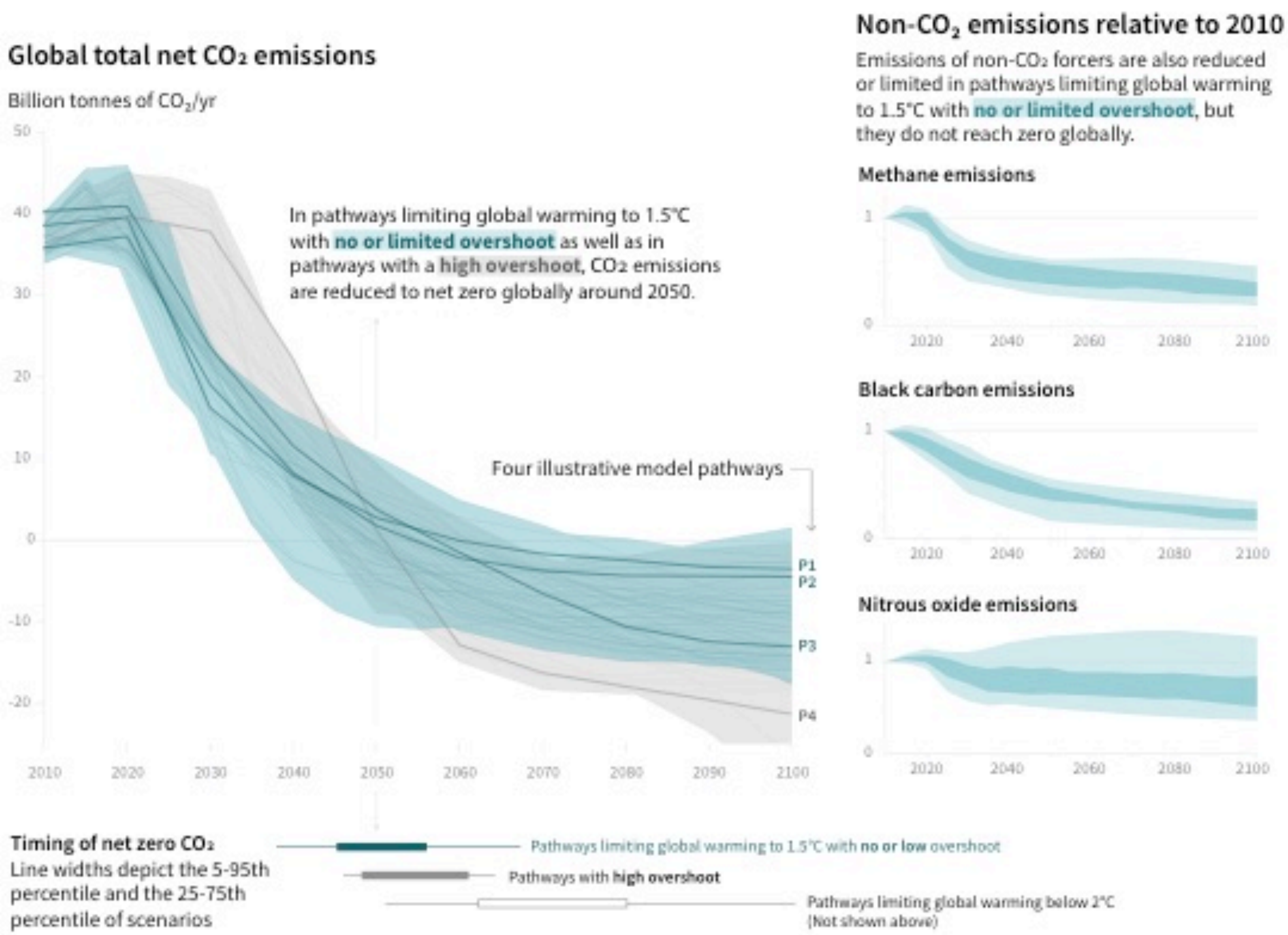
- CO_2 emissions must decrease 45% by 2030 (from 2010 levels)
- Net CO_2 emission = 0 by 2050
- CO_2 removal of 100-1000 Gt CO_2 by 2100
- Non CO_2 greenhouse gases must be reduced

$\Delta T = 2°C$

- CO_2 emissions must decrease 20% by 2030 (from 2010 levels)
- Net CO_2 emission = 0 by 2070
- Non CO_2 greenhouse gases must be reduced

Global emissions pathway characteristics

General characteristics of the evolution of anthropogenic net emissions of CO_2, and total emissions of methane, black carbon, and nitrous oxide in model pathways that limit global warming to 1.5°C with no or limited overshoot. Net emissions are defined as anthropogenic emissions reduced by anthropogenic removals. Reductions in net emissions can be achieved through different portfolios of mitigation measures illustrated in Figure SPM3B.

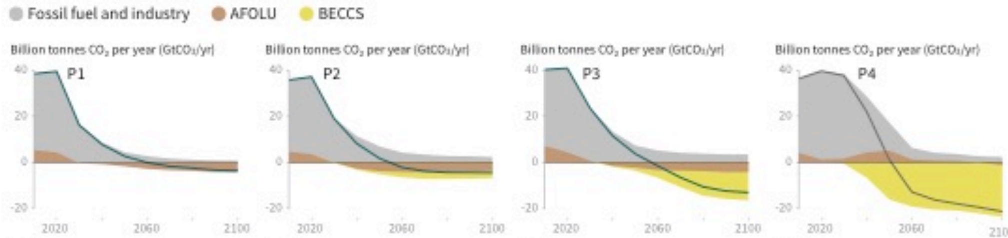


Source: IPCC Special Report on Global Warming of 1.5°C

Characteristics of four illustrative model pathways

Different mitigation strategies can achieve the net emissions reductions that would be required to follow a pathway that limit global warming to 1.5°C with no or limited overshoot. All pathways use Carbon Dioxide Removal (CDR), but the amount varies across pathways, as do the relative contributions of Bioenergy with Carbon Capture and Storage (BECCS) and removals in the Agriculture, Forestry and Other Land Use (AFOLU) sector. This has implications for the emissions and several other pathway characteristics.

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways



P1: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Global indicators	P1	P2	P3	P4	**Interquartile range**
Pathway classification	No or low overshoot	No or low overshoot	No or low overshoot	High overshoot	No or low overshoot
CO_2 emission change in 2030 (% rel to 2010)	-58	-47	-41	4	(-59,-40)
└ in 2050 (% rel to 2010)	-93	-95	-91	-97	(-104,-91)
Kyoto-GHG emissions in 2030 (% rel to 2010)*	-50	-49	-35	-2	(-55,-38)
└ in 2050 (% rel to 2010)	-82	-89	-78	-80	(-93,-81)
*Final energy demand** in 2030 (% rel to 2010)*	-15	-5	17	39	(-12, 7)
└ in 2050 (% rel to 2010)	-32	2	21	44	(-11, 22)
Renewable share in electricity in 2030 (%)	60	58	48	25	(47, 65)
└ in 2050 (%)	77	81	63	70	(69, 87)
Primary energy from coal in 2030 (% rel to 2010)	-78	-61	-75	-59	(-78, -59)
└ in 2050 (% rel to 2010)	-97	-77	-73	-97	(-95, -74)
from oil in 2030 (% rel to 2010)	-37	-13	-3	86	(-34,3)
└ in 2050 (% rel to 2010)	-87	-50	-81	-32	(-78,-31)
from gas in 2030 (% rel to 2010)	-25	-20	33	37	(-26,21)
└ in 2050 (% rel to 2010)	-74	-53	21	-48	(-56,6)
from nuclear in 2030 (% rel to 2010)	59	83	98	106	(44,102)
└ in 2050 (% rel to 2010)	150	98	501	468	(91,190)
from biomass in 2030 (% rel to 2010)	-11	0	36	-1	(29,80)
└ in 2050 (% rel to 2010)	-16	49	121	418	(123,261)
from non-biomass renewables in 2030 (% rel to 2010)	430	470	315	110	(243,438)
└ in 2050 (% rel to 2010)	832	1327	878	1137	(575,1300)
Cumulative CCS until 2100 ($GtCO_2$)	0	348	687	1218	(550, 1017)
└ of which BECCS ($GtCO_2$)	0	151	414	1191	(364, 662)
Land area of bioenergy crops in 2050 (million hectare)	22	93	283	724	(151, 320)
Agricultural CH_4 emissions in 2030 (% rel to 2010)	-24	-48	1	14	(-30,-11)
in 2050 (% rel to 2010)	-33	-69	-23	2	(-46,-23)
Agricultural N_2O emissions in 2030 (% rel to 2010)	5	-26	15	3	(-21,4)
in 2050 (% rel to 2010)	6	-26	0	39	(-26,1)

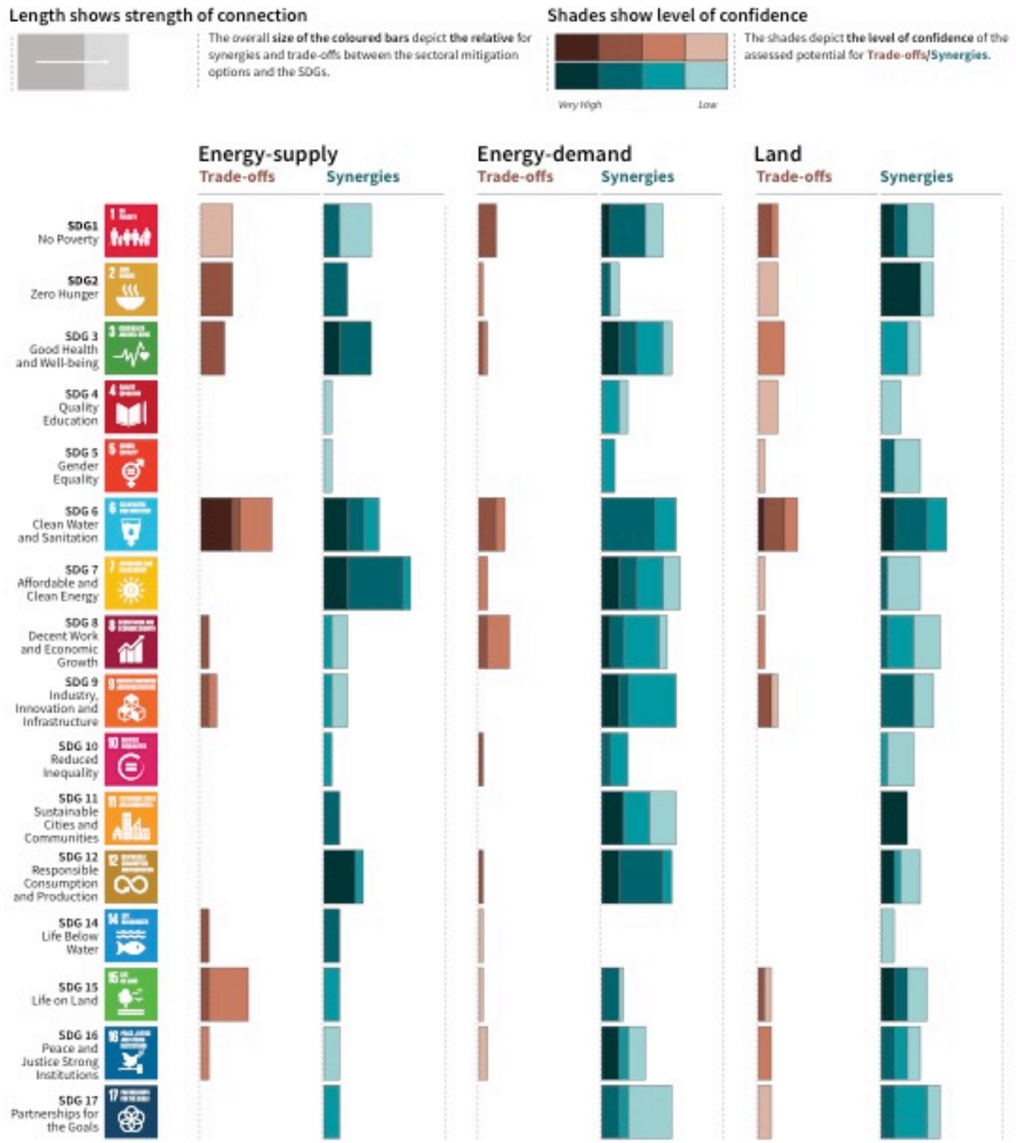
NOTE: Indicators have been selected to show global trends identified by the Chapter 2 assessment. National and sectoral characteristics can differ substantially from the global trends shown above.

** Kyoto-gas emissions are based on SAR GWP-100*
*** Changes in energy demand are associated with improvements in energy efficiency and behaviour change*

Source: IPCC Special Report on Global Warming of 1.5°C

Indicative linkages between mitigation options and sustainable development using SDGs (The linkages do not show costs and benefits)

Mitigation options deployed in each sector can be associated with potential positive effects (synergies) or negative effects (trade-offs) with the Sustainable Development Goals (SDGs). The degree to which this potential is realized will depend on the selected portfolio of mitigation options, mitigation policy design, and local circumstances and context. Particularly in the energy-demand sector, the potential for synergies is larger than for trade-offs. The bars group individually assessed options by level of confidence and take into account the relative strength of the assessed mitigation-SDG connections.



Costs of Mitigation

Requires investments in

- Renewable non-carbon-based sources
- CO_2 removal technologies

Requires changes in land use

Estimated cost:

- $900-1800 billion /year 2015-2050 ($\Delta T = 2°C$)
- 12% more for $\Delta T = 1.5°C$

The Point of No Return

Depends on:

- acceptable ΔT
- Growth of renewable energy resources
- Development of carbon-removal (CDR) technologies
- Acceptable probability of success (67%, 95%)

- For $\Delta T<1.5°C$, no new technology, at 95% confidence: it's too late.
- For $\Delta T<2°C$, CDR, at 67% confidence: 2040s.
- IPCC consensus: 2030 ($\Delta T<1.5°C$, CDR, 67% confidence

Trump Administration Action

Using the IPCC estimated carbon budget, as of 2011, approximately 51%, or 515 Gt C (1,890 Gt CO_2), of this budget had already been emitted, leaving a remaining budget of 485 Gt C (1,780 Gt CO_2) (IPCC 2013b). From 2011 to 2015, CO_2 emissions from fossil fuels, cement production, and land-use change totaled approximately 50 Gt C (183 Gt CO_2), leaving a remaining budget from 2016 onwards of 435 Gt C (1595 Gt CO_2) (CDIAC 2016). Under the No Action Alternative, U.S. passenger cars and trucks are projected to emit 23 GtC (83 Gt CO_2) from 2016 to 2100, or 5.2% of the remaining global carbon budget. Under Alternative 1, this projection increases to 25 Gt C (91Gt CO_2) or 5.7% of the remaining budget.

From "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks Draft Environmental Impact Statement", July 2018, Docket No. NHTSA-2017-0069, pg 5-30