

The Global Energy Transition and the 1.5 Degree Target

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United Nations



Framework Convention
on Climate Change



Article 2

(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels,....

Article 4: In order to achieve the long-term temperature goal set out in Article 2, Parties aim to [...], achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

Courtesy: Jan Sigurd Fuglestad



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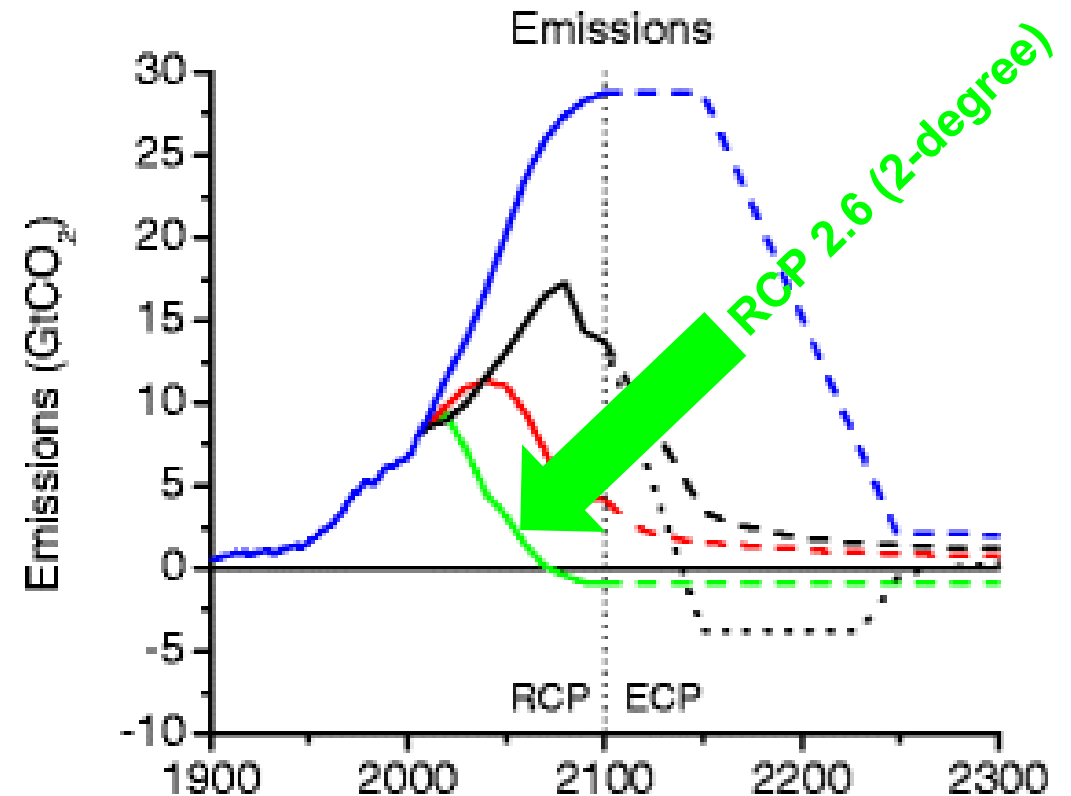


PARIS 2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

- When the Paris Agreement was negotiated no scenario pathways had been developed that showed that 1.5 was possible.
- That literature has grown rapidly since.

All CO₂ emissions scenarios are alike—They all end at zero

- Cumulative emissions of CO₂ will determine climate CO₂ climate forcing—and climate—for the next century.
- Non-CO₂ emissions will become more important as CO₂ emissions decline to zero
- CO₂ has no atmospheric sink—it doesn't disappear
- Carbon that was removed from the atmosphere over millions of years, can only be partitioned between atmosphere, ocean and land
 - Atmosphere (~20% on average will remain permanently)
 - Oceans (~80% on average will end up in oceans)



4 Representative Concentration Pathways and Extensions

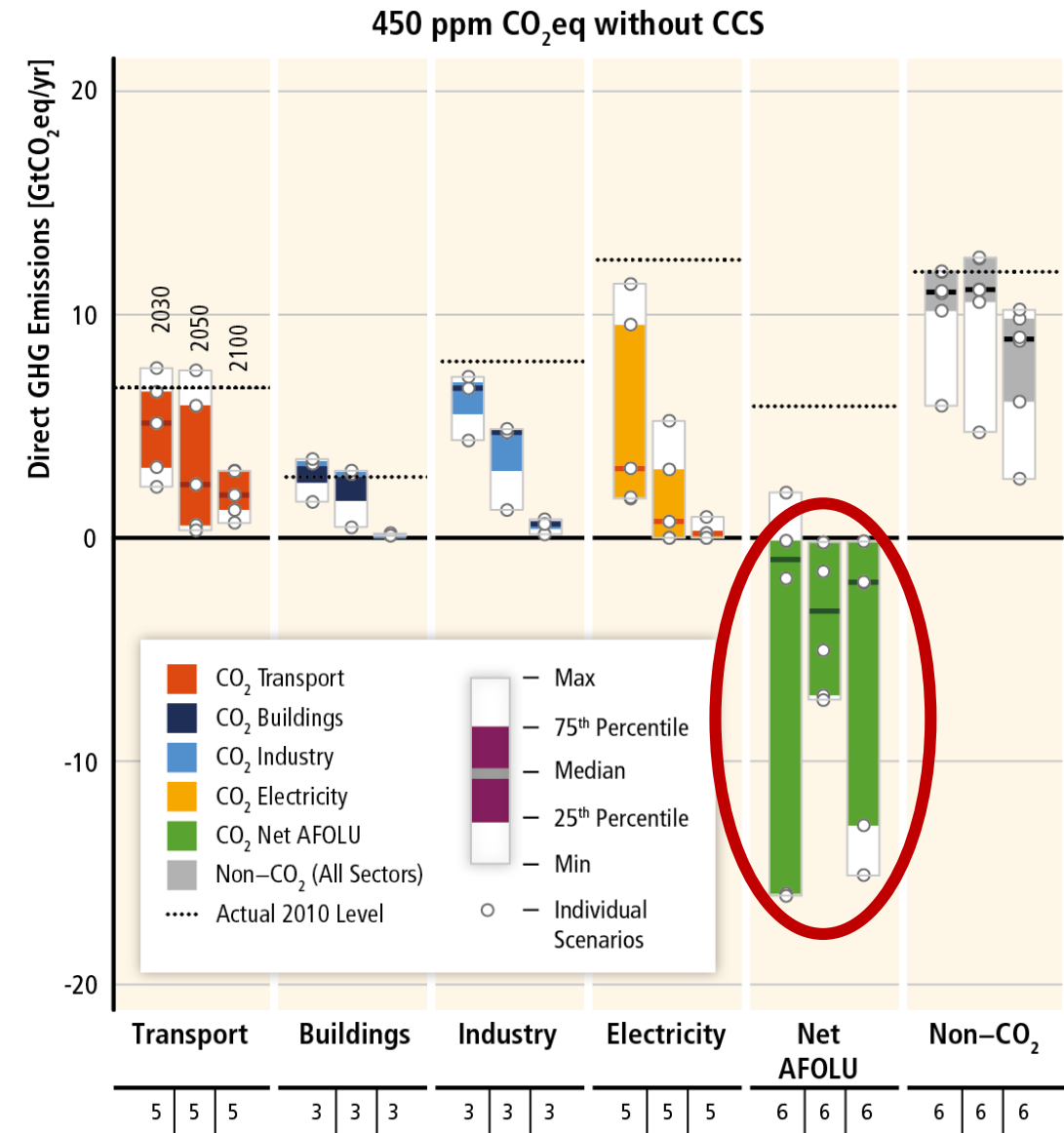
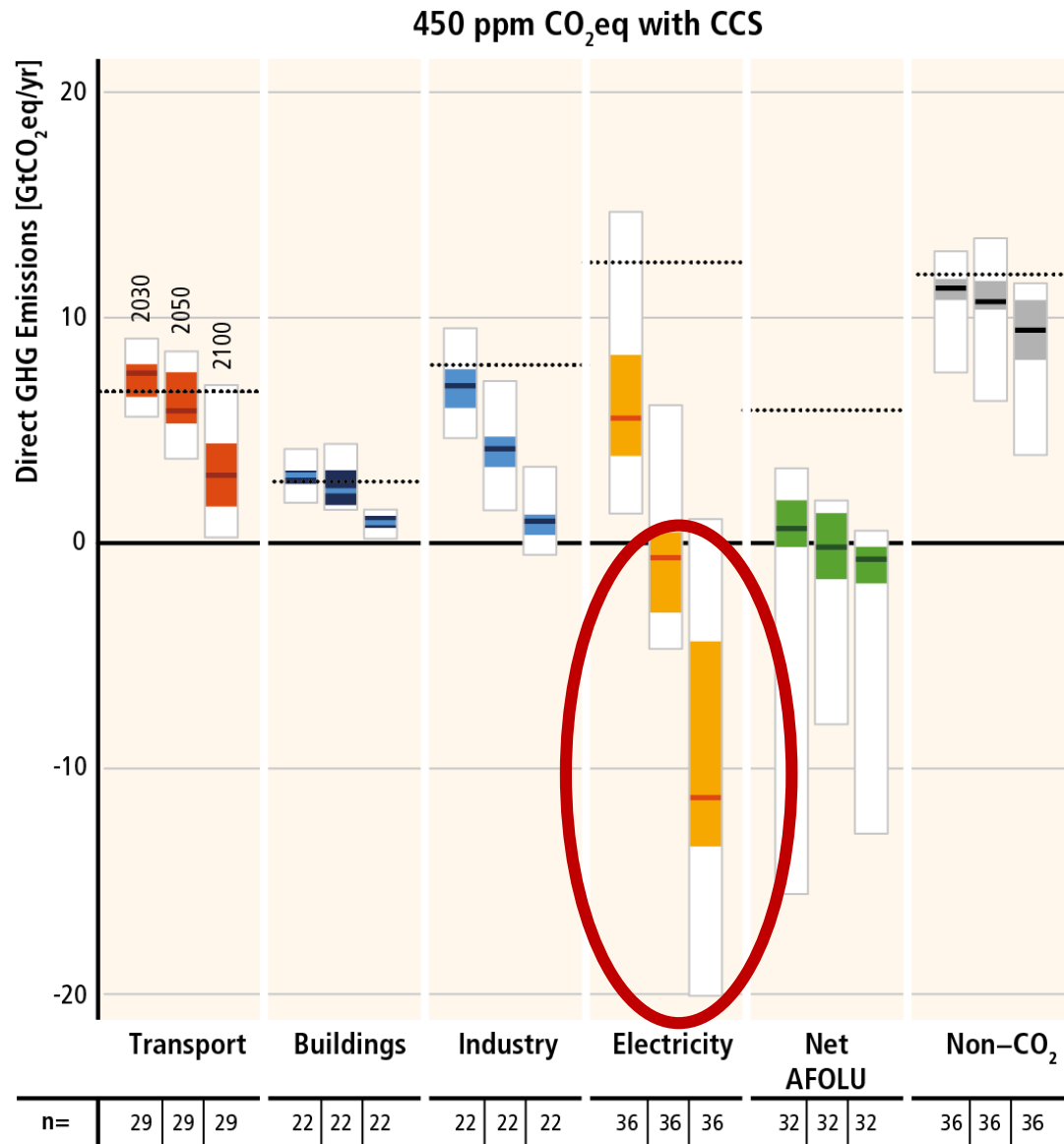
Getting to Zero—Five strategy elements

- Energy efficiency—reduce demand for energy as much as economical
- Decarbonize power generation
 - Fossil fuel with CCS
 - Renewable power
 - Nuclear power
 - Bioenergy
 - Bioenergy with CCS
- Electrify Buildings and Industry as much as economical
- Decarbonize transport
 - Electrify
 - Biofuels
 - H2
- Halt deforestation/afforestation and continue improving crop yields



Source: <http://www.energy.gov/science-innovation/energy-sources/renewable-energy/wind>

Getting to zero—ALL sectors need to get close to zero or less

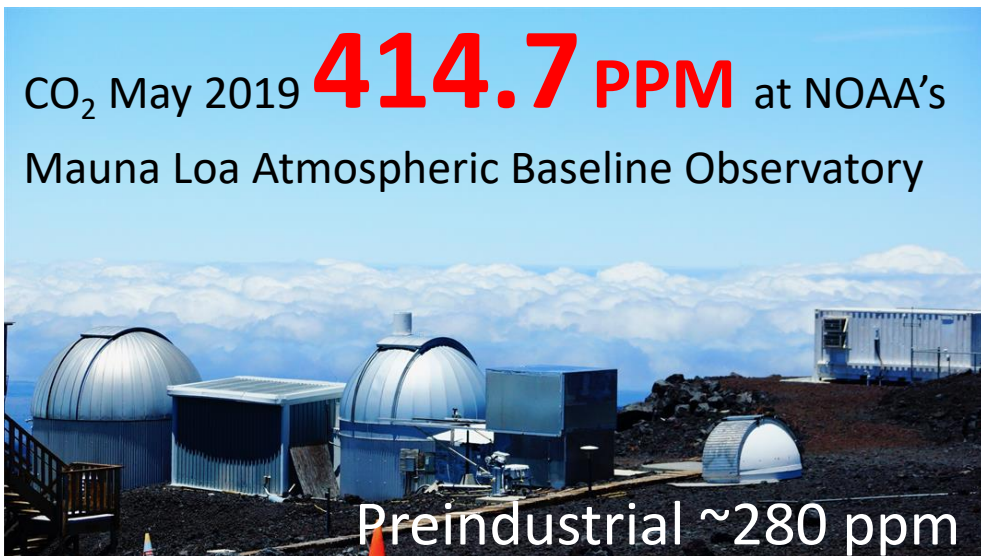


Source: IPCC, AR5, SPM

DRAFT PRESENTATION—COMMENTS WELCOME

The Challenge of Getting to 1.5

- CO₂ is measured in both tons of CO₂ and tons of C
- 3.667 ton CO₂ = 1 tons C
- \$1/tCO₂ = \$3.67/tC



CO ₂ -equivalent (ppm)	Radiative Forcing (W/m ²)	Avg. Global Temp. Change Long-term (ΔT)*
1360	8.5 (RCP)	6.8 °C
1030	7.0	5.6 °C
850	6.0 (RCP)	4.8 °C
650	4.5 (RCP)	3.6 °C
550	3.7	2.9 °C
450	2.6 (RCP)	2.1 °C
400	1.9	1.5 °C

* Assumes a climate sensitivity of 3°C. Climate sensitivity is the number of degrees the planet would warm in the long term if the concentration of CO₂ doubled.



Remaining Carbon Budget

- By the end of 2017, 2200 ± 320 GtCO₂ has been emitted by human activities
- **Currently, emitting 42 ± 3 GtCO₂/yr**

Choice of the measure of global temperature affects the estimated remaining carbon budget

Using global mean surface air temperature, as in IPCC AR5:

580 GtCO₂ left (50% chance of 1.5 °C)

420 GtCO₂ left (66% chance of 1.5 °C)

Using global mean surface temperature (GMST)

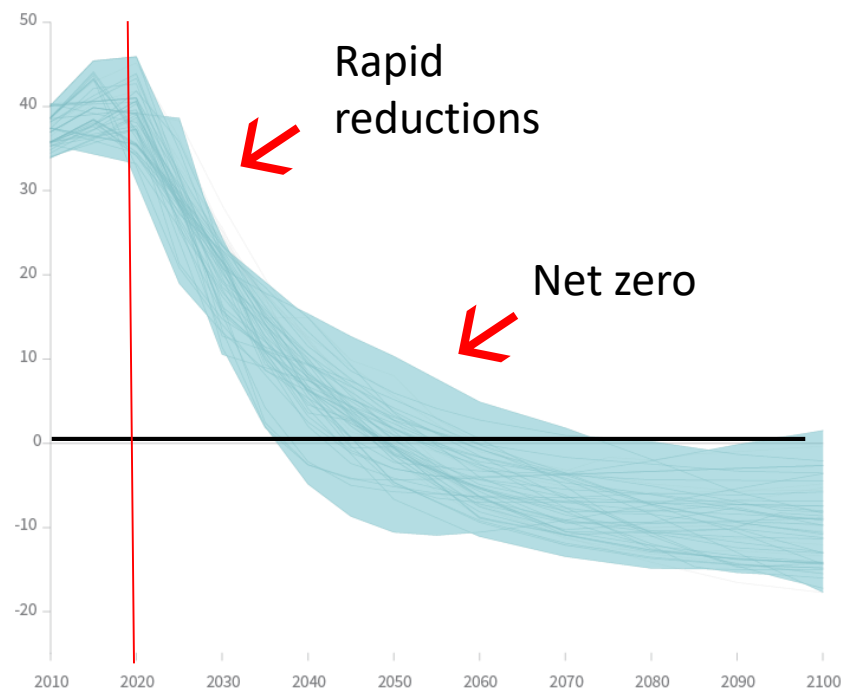
770 GtCO₂ left (50% chance of 1.5 °C)

570 GtCO₂ left (66% chance of 1.5 °C)

Global emissions pathway characteristics

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



Timing of net zero CO₂
Line widths depict the 5-95th
percentile and the 25-75th
percentile of scenarios

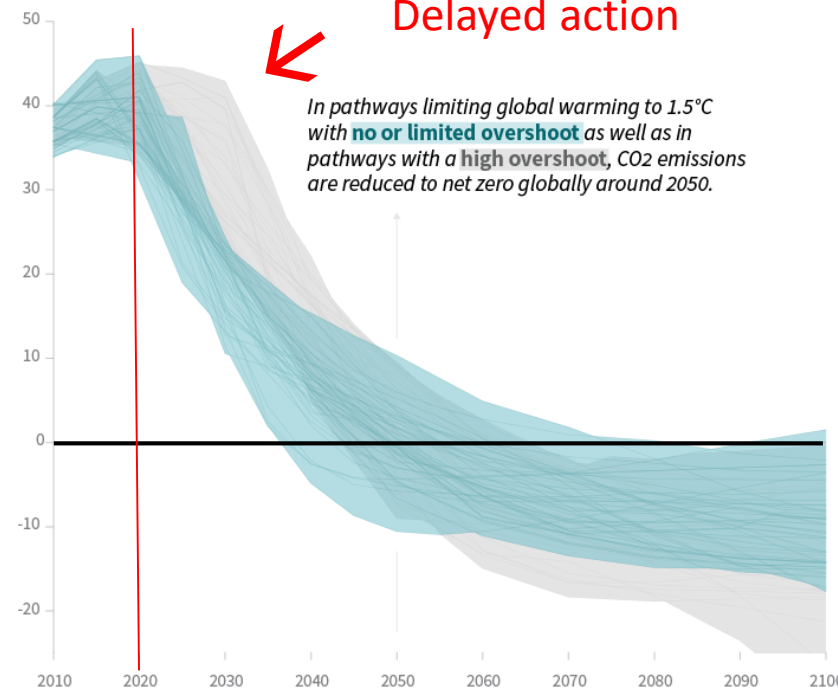
Pathways limiting global warming to 1.5°C with no or low overshoot

← Negative emissions

Global emissions pathway characteristics

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



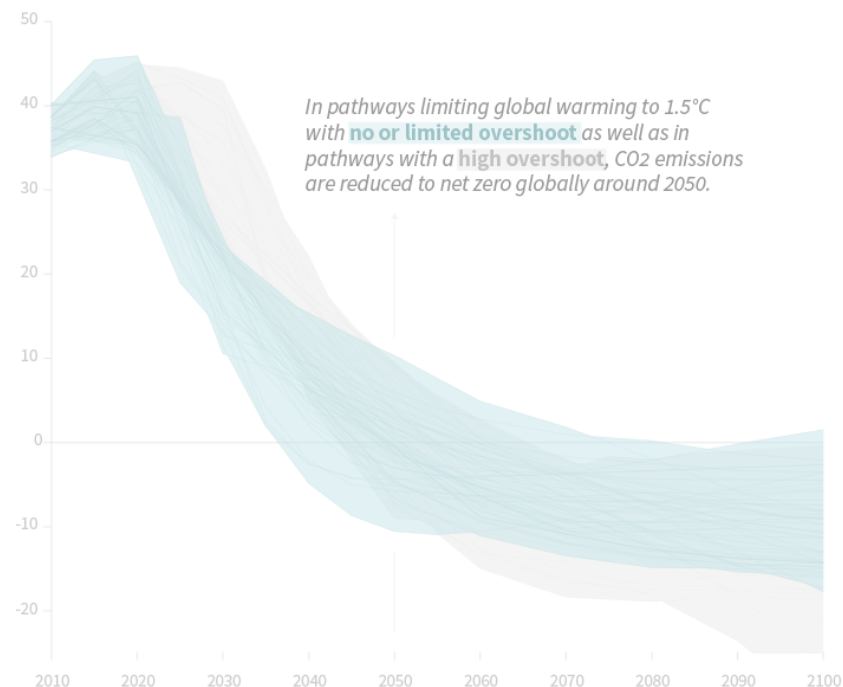
Timing of net zero CO₂
Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios

Pathways limiting global warming to 1.5°C with no or low overshoot
Pathways with high overshoot
Pathways limiting global warming below 2°C (Not shown above)

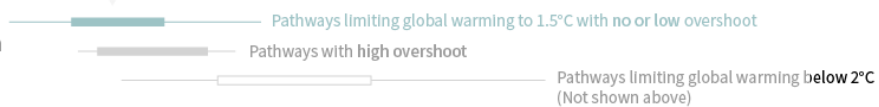
Global emissions pathway characteristics

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



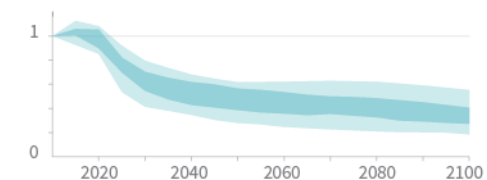
Timing of net zero CO₂
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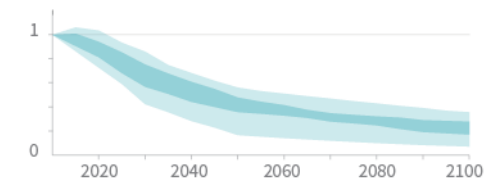
Non-CO₂ emissions relative to 2010

Emissions of non-CO₂ forcers are also reduced or limited in pathways limiting global warming to 1.5°C with **no or limited overshoot**, but they do not reach zero globally.

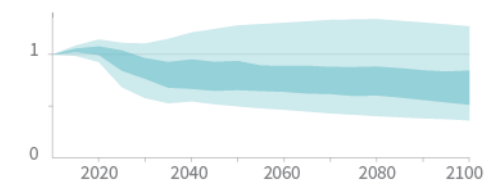
Methane emissions



Black carbon emissions



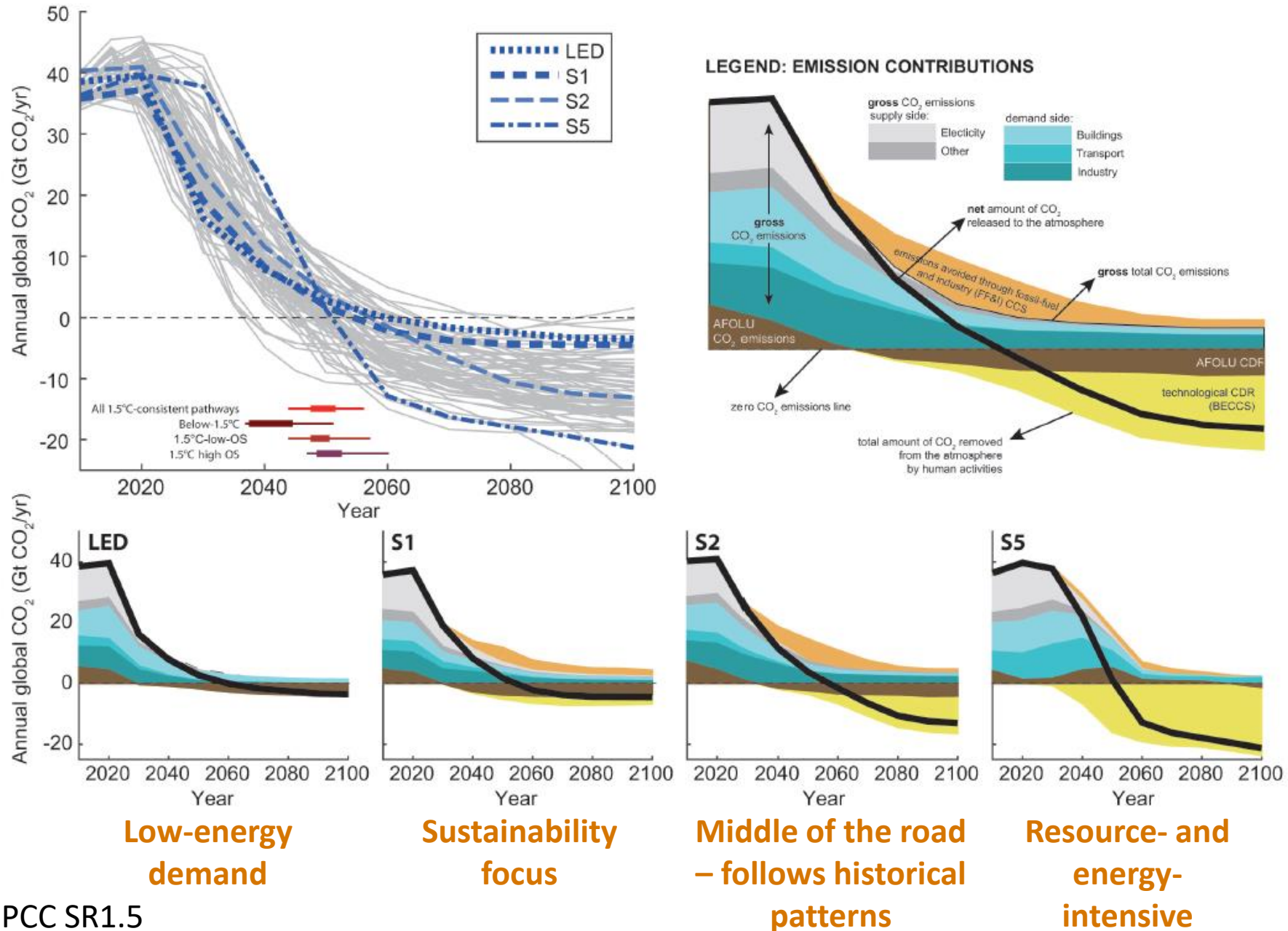
Nitrous oxide emissions



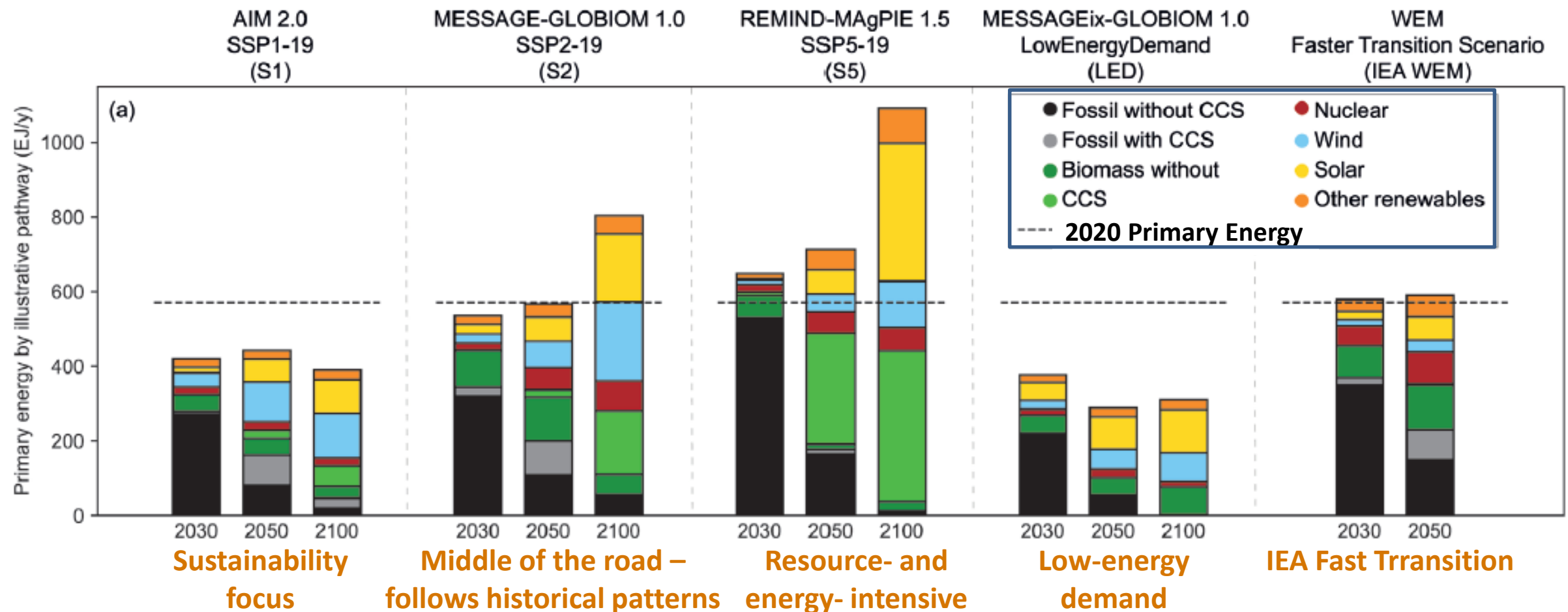
ipcc
climate change



Characteristics of Four Illustrative Pathways

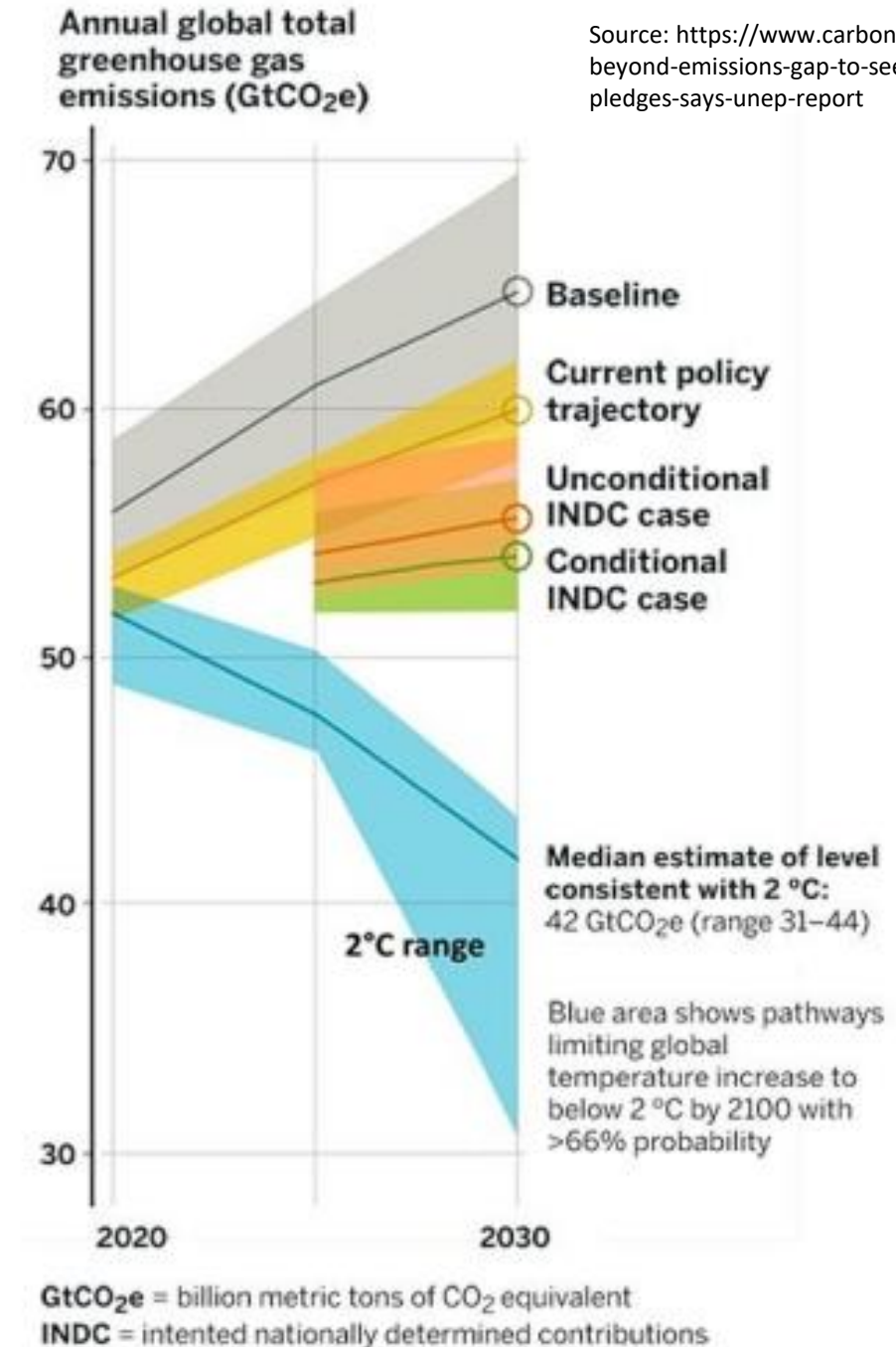


The energy system will need to transform



Progress to Date

- Current policies and measures are not adequate to meet Nationally Determined Contributions (NDC) to Paris Agreement.
- NDCs are inadequate to meeting either 2° or 1.5° long-term stabilization goals.



Final Thoughts

- Limiting climate change to any level involves eventually transitioning to a zero CO₂ emissions world
 - **All sectors** of energy and land systems must also decline toward zero or lower
 - **All regions** of the world must also decline toward zero or lower
- Lower limits of global temperature require faster transitions
- The challenge to achieving the 1.5° goal should not be underestimated.
 - **Global** emissions must begin to decline **before 2030**
 - **Global** carbon emissions must reach **zero around 2050**
 - And then go **negative**.
- Technology, policy and institutions will shape the mix of sectors and fuels.
- The world is currently **NOT** on track to achieve the 1.5° goal.

DISCUSSION