Under what assumptions can the climate ambition of the Paris Agreement materialize?

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Joeri Rogelj – 20 June 2016
Outline

- Paris climate ambition
- Emission implications
- Scenario implications
“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”

The Long-Term Temperature Goal
Paris Agreement Article 2
Paris climate ambition

“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”

*The Long-Term Temperature Goal, Paris Agreement Article 2*

“In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach **global peaking** of greenhouse gas emissions **as soon as possible** [...] , and to undertake rapid reductions thereafter in accordance with best available science, so as to **achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**”

*Paris Agreement Article 4*
Emissions implications

Cumulative total anthropogenic CO₂ emissions from 1870 (GtCO₂)

Temperature anomaly relative to 1861-1880 (°C)

- RCP2.6
- Historical
- RCP4.5
- RCP8.5
- 1% yr CO₂
- 1% yr CO₂ range

IPCC AR5 WGI SPM.10
Emissions implications

cumulative total anthropogenic CO\(_2\) emissions from 1870 (GtCO\(_2\))

Temperature anomaly relative to 1861-1880 (°C)

Cumulative total anthropogenic CO\(_2\) emissions from 1870 (PgC)

Peak warming limit (°C)

Consistent cum. total anthropogenic CO\(_2\) emissions given warming by all forcers in RCP8.5 (PgC)

90% of models - 66% of models - 50% of models - 33% of models - 10% of models
Emissions implications

How much remains for 1.5°C and 2°C?

For 2°C >66% (is this “well below”?)
- About 1000 GtCO₂ after 2011 (IPCC AR5 SYR)
- 590–1240 GtCO₂ after 2015 (post-AR5 literature)

For 1.5°C
- 550 GtCO₂ after 2011 (IPCC AR5 SYR)
- 650 GtCO₂ since 2010-2020 average CMIP5 (present-day adjusted)

Context:
- Current annual emissions ~40 GtCO₂/yr
- Until 2011: about 1900 GtCO₂ emitted
Scenario implications

*Internal consistency Paris Agreement*

**IPCC AR5 Scenario Database**

**ex-post temperature characterization**

- medium chance (50-66%) of limiting warming <2°C in 2100
- likely chance (>66%) of limiting warming <2°C in 2100
- >50% chance of returning warming to below 1.5°C in 2100

IPCC AR5 Scenario Database; Rogelj et al (2015) ERL
Scenario implications

Internal consistency Paris Agreement

Consistency between Article 2 & Article 4

*IPCC AR5 Scenario Database; Rogelj et al (2015) ERL*
Scenario implications

1.5°C & 2°C

Rogelj et al (2015) NCC
Scenario implications
1.5°C & 2°C

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1.5°C & 2°C

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Scenario implications
1.5°C & 2°C
What do 1.5°C scenarios look like?

Energy system characteristics

Rogelj et al (2015) NCC
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Energy system characteristics

Rogelj et al (2015) NCC
What do 1.5°C scenarios look like?

Energy supply characteristics – no differences
What do 1.5°C scenarios look like?

Energy supply characteristics – near-term differences

Rogelj et al (2015) NCC
What do 1.5°C scenarios look like?

Energy supply characteristics – medium-term differences

Rogelj et al (2015) NCC
Key mitigation options
What do 1.5°C scenarios look like?

Negative emissions

Rogelj et al (2015) NCC
What do 1.5°C scenarios look like?

Like-with-like comparison
What do 1.5°C scenarios look like?

*Like-with-like comparison*

![Diagram](image_url)

- **CO₂ from fossil-fuel burning and industrial processes (gross)**
- **BECCS**
- **CO₂ LUCF**
- **CH₄ energy**
- **CH₄ land use**
- **CH₄ other**
- **N₂O land use**
- **N₂O other**
- **F-gases**

![Total net Kyoto-GHG emissions](image_url)

![Total net CO₂ emissions](image_url)

Rogelj et al (2015) NCC
Relative difference between scenarios that hold warming to below 2°C during entire 21st century and that return warming to below 1.5°C by 2100

What do 1.5°C scenarios look like?

Like-with-like comparison

Rogelj et al (2015) NCC
What do 1.5°C scenarios look like?

Key differences with 2°C scenarios

- CO₂ → additional GHG reductions, mainly from CO₂
- CO₂ ↓ CO₂ reductions beyond net zero
- CO₂ ⬛ rapid near-term decarbonisation of energy supply
- ⚡ ↓ greater demand side mitigation efforts
- 💡 energy efficiency improvements are crucial
- $↑ higher mitigation costs
- ⌚ comprehensive reductions in the coming decade
Half a decade of 1.5°C science at IIASA

Series of peer-reviewed publications:

2020 emissions levels required to limit warming to below 2 °C
Joeri Rogelj1,2,*, David L. McCo

Probabilistic cost estimates for climate change mitigation
Joeri Rogelj1,2, David L. McCollum3, Andy Rek

Energy system transformations for limiting end-of-century warming to below 1.5 °C
Joeri Rogelj1,2,*, Gunnar Luderer3,*, Robert C. Pietzcker3, Elmar Kriegler3, Michiel Schaeffer4,5, Volker Krey1 and Keywan Riahi1,6
Thank you

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