Science update 1.5°C

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“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 (..)”

What are the required emissions reductions?

What are the implications for policy makers?

What are the implications for different sectors?

How to get onto a 1.5°C pathway?
Is the 1.5°C limit out of reach?

- Long-term temperature limits are always understood as annual averages of at least 20 years to account for natural variability, consistent with IPCC climate & impact projections & assessments.
  
  - The 1.5°C limit in the Paris Agreement refers to a global average annual increase in the temperature above pre-industrial average over 20 years.

- Observed 2016 temperatures do not call into question feasibility of 1.5°C warming limit.

- Natural variability can lead to individual years (or months) exceeding 1.5°C.

- Observed extreme temperatures are a very strong warning of potential large scale damage well before an average annual warming of 1.5°C is reached.

![Graph showing temperature increase over years](image-url)
The three stages of the 1.5°C compatible pathway.

- Peak global GHGs emissions around 2020
- Rapid decline of CO₂ emissions to zero before 2050
- Deployment of negative emissions at scale from early 2030s
Paris Agreement 1.5°C limit requires more ambition than 2°C scenarios – AR5 scenarios

Schleussner et al: "Science and policy characteristics of the Paris Agreement temperature goal" Nature CC 2016
New feasible 1.5°C emissions scenarios

- Lowest scenarios in IPCC AR5 context had peak warming of around 1.6°C mid century and below 1.5°C by 2100 (RCP2.6 peaks at about 1.6°C)
- New research is exploring RCP1.9 (peaks around 1.5°C, declines to about 1.3°C by 2100)
- Scenarios tend to focus on 2100, do not explicitly look at limiting peak warming
- On-going research is exploring new RCP1.9 for a variety of socioeconomic contexts
**CLIMATE ACTION TRACKER**

- **No new coal power plants & reduce emissions from current coal plants by at least 30% by 2025**
- **Sustaining the growth rate of renewables and other zero and low carbon power until 2025 to reach 100% by 2050**
- **All new installations in emission-intensive sectors are low-carbon after 2020 and maximise material efficiency towards circular economy**
- **Last fossil fuel car sold before 2035**
- **Develop and get agree on a 1.5°C compatible vision**
- **Increase building renovation rates from <1% in 2015 to 5% by 2020**
- **All new buildings fossil-free and near zero energy by 2020**
- **Keep emissions at or below current levels, establish and disseminate regional best practice**
- **Reduce emissions from forestry and other land uses to 95% below 2010 by 2030**
- **Sop net deforestation by the 2020s**
The achievement of the PA goal requires a much faster and decisive action.

The quicker the phase-out of unabated coal, the lower the need and costs of negative emissions in the second half of the century.

Source: IASA/Joeri Rogelj, GCPT, own calculations
Three areas for transformative action in the near- to mid-term

**Coal phase-out**
Elimination of 10 GtCO2 of emissions annually would decrease pressure on the carbon budget.
Relatively low cost further decreased by co-benefits and decreasing price of alternatives.

**Low-carbon modes of transport**
Oil combustion a close second emissions source.
Transport sector notoriously hard re breaking upward trends.
There are solutions - modal changes and E-mobility may offer the largest contributions, but require parallel decarbonisation of the power sector.

**Energy efficiency of the building stock**
We have the technology but we’re not using it eg. net-zero emissions buildings.
Long legacy of stock make transformation urgent.
Energy demand is set to increase two to three fold by 2050 without intervention.
Two areas to keep on the radar

- **Land use, land-use change and forestry (LULUCF)**
  - Reductions of emissions need to happen simultaneously with decarbonisation of energy & industry sectors, never in place of
  - Limited potential that needs to be utilized carefully

- **Challenging sectors**
  - Difficult to reduce GHGs emissions due to technological limits (e.g. steel, cement, aviation, agriculture)
  - Improved technologies and behavioral changes are necessary
  - Long-term impact possible if action (e.g. investment in R&D) is taken in the short term
What is required to get from 2°C to 1.5°C? Long-term perspective

Cumulative CO₂ storage in 1.5°C and 2°C scenarios. Values are rounded to the nearest 5 GtCO₂. Based on: Rogelj et al. (2015)

<table>
<thead>
<tr>
<th></th>
<th>Until 2050 GtCO₂</th>
<th>Until 2100 GtCO₂</th>
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<tbody>
<tr>
<td><strong>Total cumulative CO₂ storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returning warming to below 1.5°C by 2100 with 50% chance</td>
<td>135 (100-235)</td>
<td>790 (420-1070)</td>
</tr>
<tr>
<td>Holding warming to below 2°C during the 21st century with 66% chance</td>
<td>105 (75-170)</td>
<td>790 (555-990)</td>
</tr>
<tr>
<td><strong>Cumulative storage for CO₂ from biomass energy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returning warming to below 1.5°C by 2100 with 50% chance</td>
<td>45 (5-165)</td>
<td>520 (155-955)</td>
</tr>
<tr>
<td>Holding warming to below 2°C during the 21st century with 66% chance</td>
<td>22 (5-75)</td>
<td>440 (155-780)</td>
</tr>
</tbody>
</table>

- Use of CCS (fossil fuel and bioenergy) typical in these scenarios
- **Accelerated deployment of renewables, 100% RES, and higher efficiency would limit or avoid fossil CCS, but will not avoid need for negative CO₂ emissions.**
  - Total CO₂ storage in 1.5 and 2°C scenarios is comparable
  - Larger part of total storage needed for BECCS in 1.5°C scenarios, instead of fossil fuels, but still substantial role for fossil fuel CCS
Current insights from 1.5°C and 2°C scenarios

- Remaining non-CO$_2$ and CO$_2$ emissions in some sectors or countries
- Total negative CO$_2$ emissions result from both increased net-uptake in the land-use sector and from BECCS in these scenarios
  - The scale of negative emissions technologies needed for 1.5°C is similar to 2°C, but needs to be deployed a few years sooner
- Less negative emissions are needed if stronger non-CO$_2$ emissions reductions, or more uptake in the land-use sector are achieved
- In 1.5°C scenarios, improved energy efficiency and other demand side measures need to be deployed 5-10 years sooner than in 2°C
  - Additional mitigation efforts in the industry, buildings and transport sectors lead to significantly lower emissions from these sectors by mid-century in 1.5°C scenarios
Very real differences in impacts between 1.5°C and 2°C
Benefits and Opportunities of the 1.5°C temperature limit

The economic benefits of keeping warming to a minimum are tremendous!

Climate Action will benefit public health, agriculture and save lives

Deploying and maintaining renewables creates jobs and improves employment circumstances

Low-emission development improves economic stability and energy independence for most economies

Renewables grew to 90% of new electricity generation in 2015, showing that declining renewable costs, and cooperation on technological transfer across different nations could significantly lower the cost of mitigation
Very real differences in impacts between 1.5°C and 2°C

<table>
<thead>
<tr>
<th>Category</th>
<th>1.5°C WORLD</th>
<th>2°C WORLD</th>
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</thead>
<tbody>
<tr>
<td>HEATWAVES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropics</td>
<td>2 months</td>
<td>3 months</td>
</tr>
<tr>
<td>ANNUAL WATER AVAILABILITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central America</td>
<td>20% reduction</td>
<td>30% reduction</td>
</tr>
<tr>
<td>EXTREME PRECIPITATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South East Asia</td>
<td>7% increase</td>
<td>10% increase</td>
</tr>
<tr>
<td>SEA LEVEL RISE BY 2100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Islands in the South Pacific and Caribbean and South East Asia</td>
<td>40 cm</td>
<td>50 cm</td>
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</tbody>
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**WHEAT YIELDS - RISK OF REDUCTIONS UP TO**

<table>
<thead>
<tr>
<th>Region</th>
<th>1.5°C Reduction</th>
<th>2°C Reduction</th>
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</thead>
<tbody>
<tr>
<td>West Africa</td>
<td>45% reduction</td>
<td>60% reduction</td>
</tr>
<tr>
<td>East Africa</td>
<td>25% reduction</td>
<td>35% reduction</td>
</tr>
<tr>
<td>Central America</td>
<td>25% reduction</td>
<td>40% reduction</td>
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**OCEAN ACIDIFICATION AND CORAL REEF LOSS**

<table>
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<th>Region</th>
<th>1.5°C Reduction</th>
<th>2°C Reduction</th>
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<tr>
<td>Small Islands in the South Pacific and Caribbean and South East Asia</td>
<td>90% reduction [50;99]</td>
<td>98% reduction [86;100]</td>
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</table>

The Paris Agreement goal of 2015, the United Nation Framework Convention on Climate Change (UNFCCC) established a review process of the below 2°C goal in 2010. This chapter gives an overview of how the physical impacts of climate change would be reduced at 1.5°C warming, compared to higher levels.

The economic and social effects of observed warming of 0.85°C levels are the highest they have been in millions of years. Regional temperatures and sea levels are rising. Severe implications for marine life, including the effects of CO₂-fertilisation, which remains highly uncertain. Projections not including this effect predict reductions for all crop types of about 10% globally. Crop yield projections are highly uncertain due to biophysical and socioeconomic uncertainties. Here we pursue a risk reduction.
Economic growth is hampered by climate change

- **1.5°C pathway limits risk of economic damages even before 2050** – high warming level risks serious setback for developing countries and developed countries alike.

- **Calculations based on temperature change patterns only** – no adaptation assumed.
Improving employment and productivity through climate action

- The rapid transition to renewables required for 1.5°C would create 68% more energy-related jobs in 2030 compared with current policies.

- High warming, however, leads to deteriorating outdoor work environment, with more than 2% of work hours lost in 10 regions in Asia, Africa, and Latin America by 2030, and the worst affected regions to be South Asia and West Africa.

- As early as 2025, potential lost hours are experienced in Asia and the Pacific region, as well as West Africa. In particular, Pakistan (5%), Cambodia (4%), and India (4%) in Asia; and Burkina Faso (4%) in Africa.
Virtually all countries in the world are renewable energy independent.

- Domestic renewable energy potential 20-80+ greater than current energy consumption levels
- Exceptions: smallest countries – opportunities for regional cooperation
Improving balance of payments and lowering barriers for energy access

- Costs of fuel imports constitute up to a third of the value of all imports in many countries. 1.5°C policies would reduce inflationary risks from fluctuation in fossil fuel prices. They would also improve the trade balance of fossil fuel importing countries.

- 1.5°C policies require high proportions of renewable energy capacity, 60% of which needs to be provided off-grid. Such policies bring the greatest possible contribution towards achieving universal energy access by 2030.
Health and Air Pollution

• 1.5°C policies maximise contributions to reducing air pollution that already kills 7 million people each year worldwide - as many as alcohol or tobacco

• By 2050, 1.5°C policies avoid a 5% reduction in productivity of key food crops, such as rice and wheat, in contrast to the pollution added by the emissions expected under current policies

Globalising Action

• 1.5°C requires global zero CO$_2$ emissions by 2050, with large benefits if 100% renewables in the power sector were achieved

• 1.5°C-compatible policies accelerate access to cheap renewable energy, reducing current costs (2009-10) by as much as five times before mid-century due to increased renewable energy installation capacity worldwide
Climate policies support economic growth and poverty-reduction strategies

- Most cost-benefit analysis fail to factor in non-monetized benefits, but savings associated with welfare risks will offset a large portion of the cost of stronger climate policies.

- An accelerated diffusion of low-carbon technologies would hasten closing the energy access gap in developing countries and speed development progress.

- Lower-warming pathways mean lower needs for adaptation, extending the time-span required for the implementation of the measures to avoid unmanageable damages, and making economies more resilient to unforeseen future warming impacts.
Additional information about climate impacts and feasibility of the 1.5°C limit on our website...

http://climateanalytics.org/hot-topics

Climate change
Science based policy to prevent dangerous climate change

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