

# The Judgement of Paris

Jae Edmonds, Allen Fawcett, and Haewon McJeon

November 05, 2015



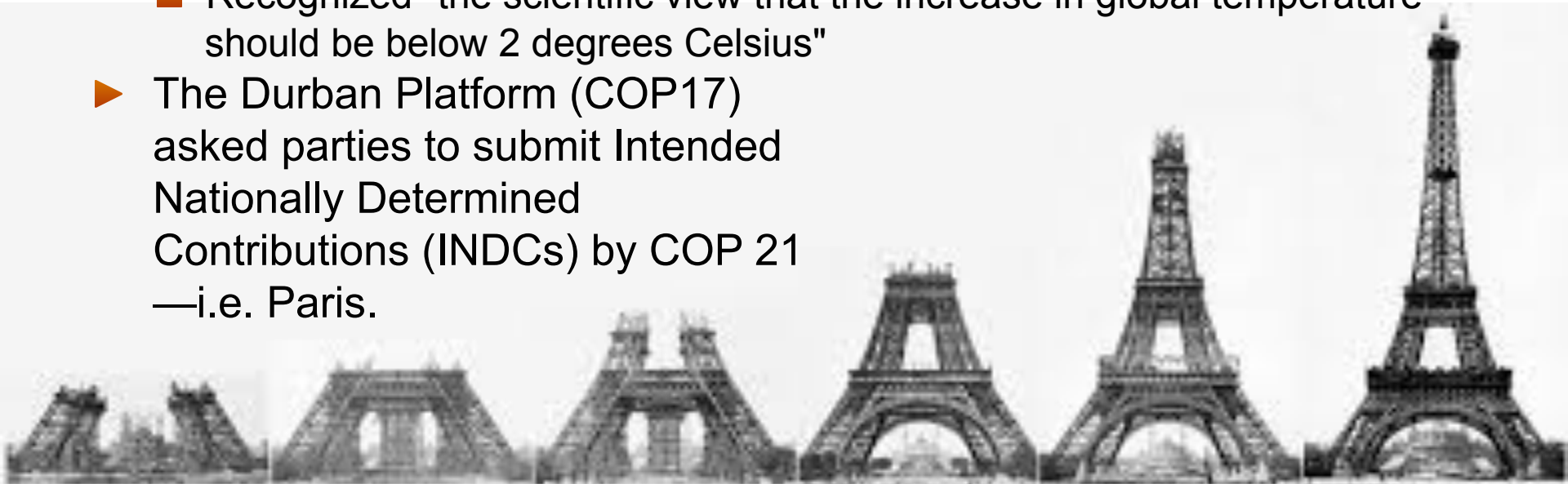
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# Paris INDC process and the U.S. INDC

## **COP 21 in Paris - December 2015**

- ▶ Part of the UNFCCC, originally negotiated and opened for ratification in 1992, entered into force 1994 (196 parties).
- ▶ Set the goal of avoiding “dangerous anthropogenic interference with the climate” (Article 2),
- ▶ The Kyoto Protocol COP3 (1997) established the first international emissions limitation program.
- ▶ The 2009 Copenhagen Accord that emerged from COP15
  - Established a new international approach to emissions limitation,
  - Recognized "the scientific view that the increase in global temperature should be below 2 degrees Celsius"
- ▶ The Durban Platform (COP17) asked parties to submit Intended Nationally Determined Contributions (INDCs) by COP 21 —i.e. Paris.



# Paris and the INDCs

- ▶ The new international architecture that will emerge from Paris will be substantially different than the architecture created by the Kyoto Protocol.
  - Based on cap and trade
  - Capped emissions in Annex I parties
  - Included non-Annex I parties only through CDM
- ▶ The heart of the new international emissions limitation architecture is the **INDC (Intended Nationally Determined Contribution)**.
  - The INDCs are the contributions parties are making towards meeting the goals of the agreement in light of their national circumstances.
- ▶ Paris is also creating a durable framework for Parties' to update INDCs over time in a way that represents a progression that reflects Parties' differentiated responsibilities and commitments under the Convention.



# U.S. & China Joint Announcement and the INDC development process

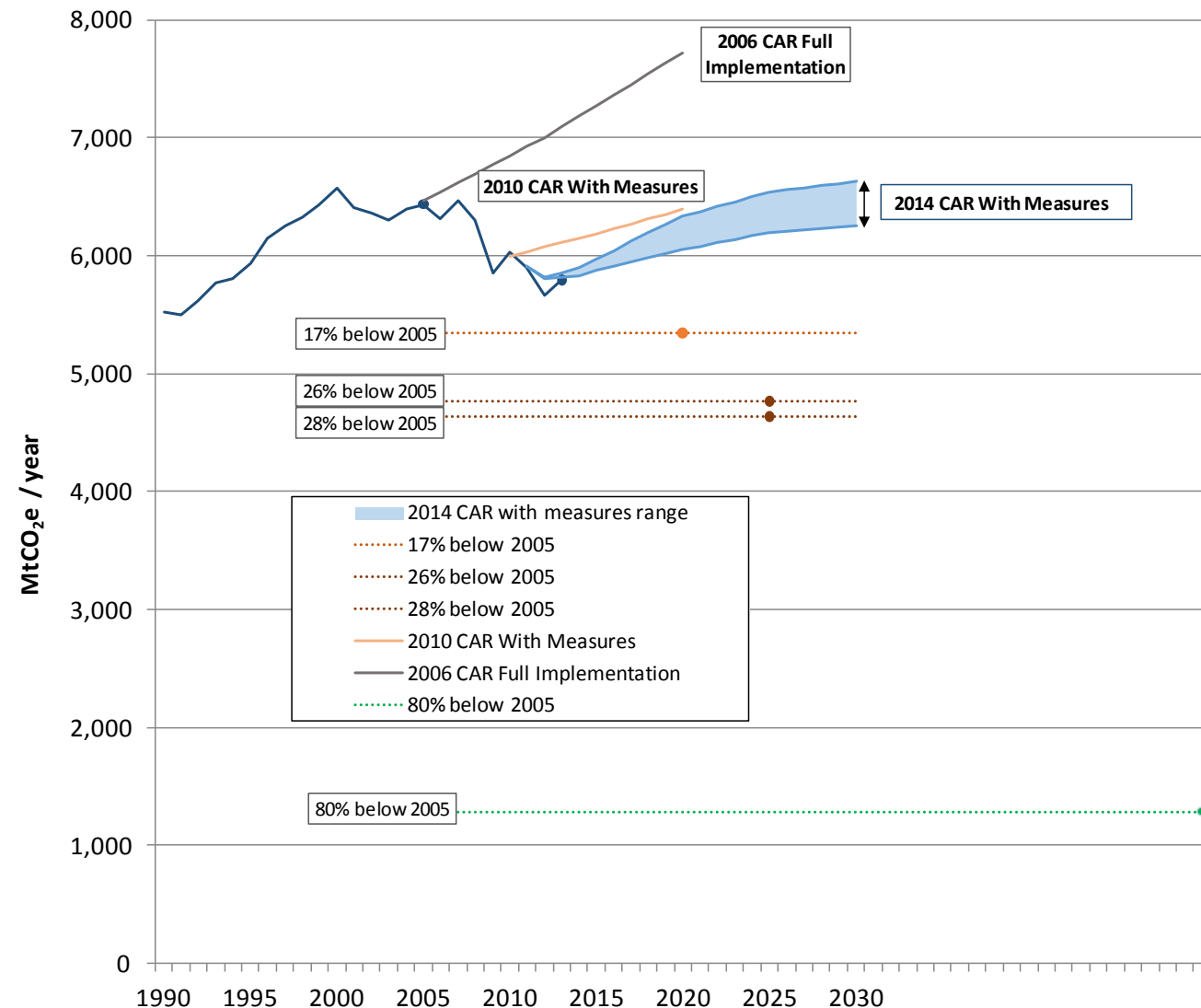
- ▶ “Today, the Presidents of the United States and China announced their respective post-2020 actions on climate change, recognizing that these actions are part of the longer range effort to transition to low-carbon economies, mindful of the global temperature goal of 2°C.”
  - ▶ “The United States and China hope that by announcing these targets now, they can inject momentum into the global climate negotiations and inspire other countries to join in coming forward with ambitious actions as soon as possible, preferably by the first quarter of 2015.”
- 
- ▶ The U.S. & China jointly announced the goals that would form the basis for their INDCs in November 2014.
  - ▶ This commitment to action from the world’s two largest emitters, representing both old Annex 1 and non-Annex 1 parties, kicked off the INDC development process.

## Intended nationally determined contribution

The United States intends to achieve an economy-wide target of reducing its greenhouse gas emissions by 26%-28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%.

- ▶ The target is fair and ambitious.
  - Additional action to achieve the 2025 target represents a substantial acceleration of the current pace of greenhouse gas emission reductions.
- ▶ The 2025 target is consistent with a path to deep decarbonization.
  - This target is consistent with a straight line emission reduction pathway from 2020 to deep, economy-wide emission reductions of 80% or more by 2050.
  - The target is part of a longer range, collective effort to transition to a low-carbon global economy as rapidly as possible.
- ▶ The target reflects a planning process that examined opportunities under existing regulatory authorities to reduce emissions in 2025 of all greenhouse gases from all sources in every economic sector.

# U.S. INDC

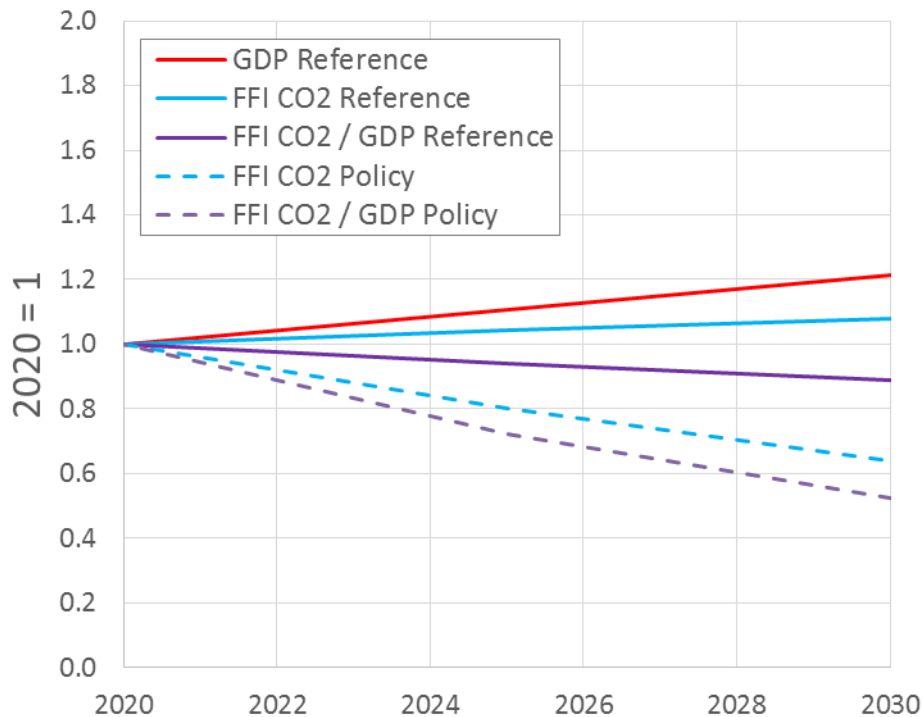


“On closer scrutiny, though, some of the pledges look less impressive. America is already most of the way to reaching its new target.”

- *The Economist*,  
“It’s Getting Hotter,”  
October 3<sup>rd</sup> 2015

# U.S. INDC, Decarbonization Rates, and CO<sub>2</sub> Projections

USA - GDP and CO<sub>2</sub>



► In the GCAM baseline scenario for the U.S., from 2020 to 2030:

- GDP increases 21%
  - 2.0% annual growth rate
- FFI CO<sub>2</sub> increases 8%
  - 0.8% annual growth rate
- FFI CO<sub>2</sub>/GDP falls 11%
  - 1.2% annual decarbonization rate

► In the GCAM policy scenario that meets the U.S. INDC goal,\* from 2020 to 2030:

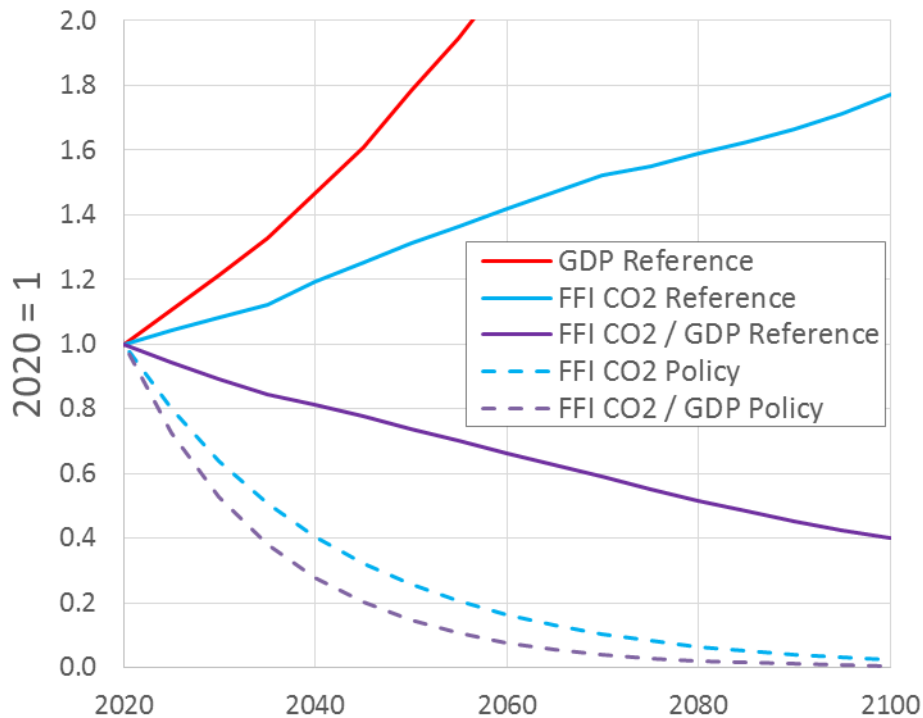
- GDP increases 21%
  - 2.0% annual growth rate
- FFI CO<sub>2</sub> decreases 36%
  - -4.4% annual growth rate
- FFI CO<sub>2</sub>/GDP falls 47%
  - 6.2% annual decarbonization rate

\* Using the straight line path from the 2020 17% target, through the 28% 2025 goal, to a 80% reduction in 2050 as discussed in the U.S. INDC.



# U.S. INDC, Decarbonization Rates, and CO<sub>2</sub> Projections

USA - GDP and CO<sub>2</sub>



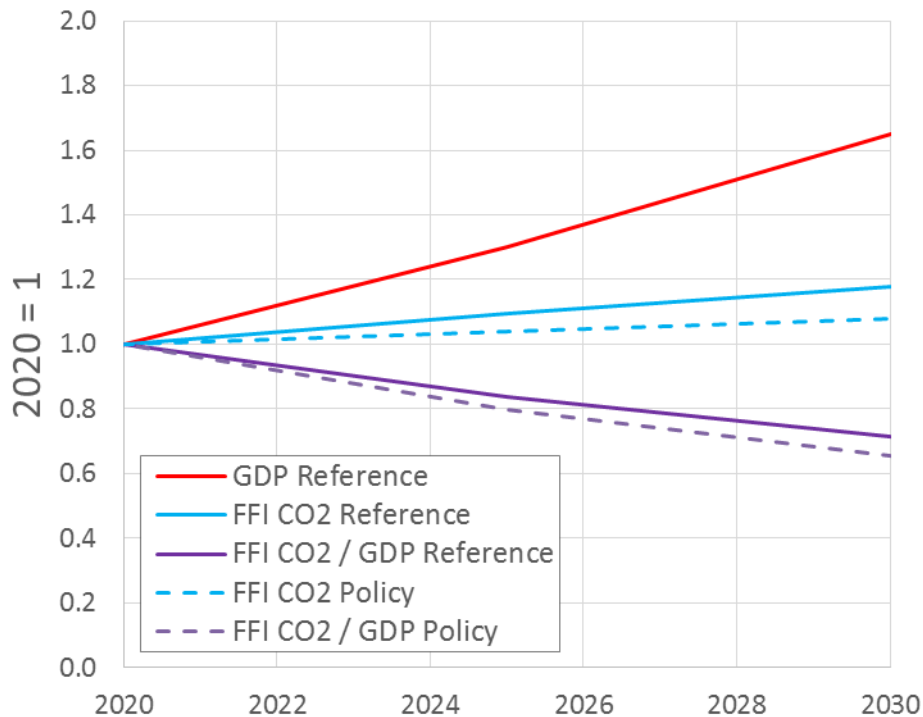
- ▶ If the U.S. maintains the decarbonization rate required to meet the INDC goal.
- ▶ In the GCAM baseline scenario for the U.S., from 2020 to 2100:
  - GDP increases 343%
    - 1.9% annual growth rate
  - FFI CO<sub>2</sub> increases 77%
    - 0.7% annual growth rate
  - FFI CO<sub>2</sub>/GDP falls 60%
    - 1.1% annual decarbonization rate
- ▶ In the GCAM policy scenario that extends the INDC decarbonization rate, from 2020 to 2100:
  - GDP increases 343%
    - 1.9% annual growth rate
  - FFI CO<sub>2</sub> decreases 97%
    - -4.5% annual growth rate
  - FFI CO<sub>2</sub>/GDP falls 99%
    - 6.2% annual decarbonization rate

## Intended nationally determined contribution

- To achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early;
- To lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level;
- To increase the share of non-fossil fuels in primary energy consumption to around 20%; and
- To increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.

# China INDC, Decarbonization Rates, and CO<sub>2</sub> Projections

China - GDP and CO<sub>2</sub>



► In the GCAM baseline scenario for the China, from 2020 to 2030:

- GDP increases 65%
  - 5.1% annual growth rate
- FFI CO2 increases 18%
  - 1.7% annual growth rate
- FFI CO2/GDP falls 29%
  - 3.3% annual decarbonization rate

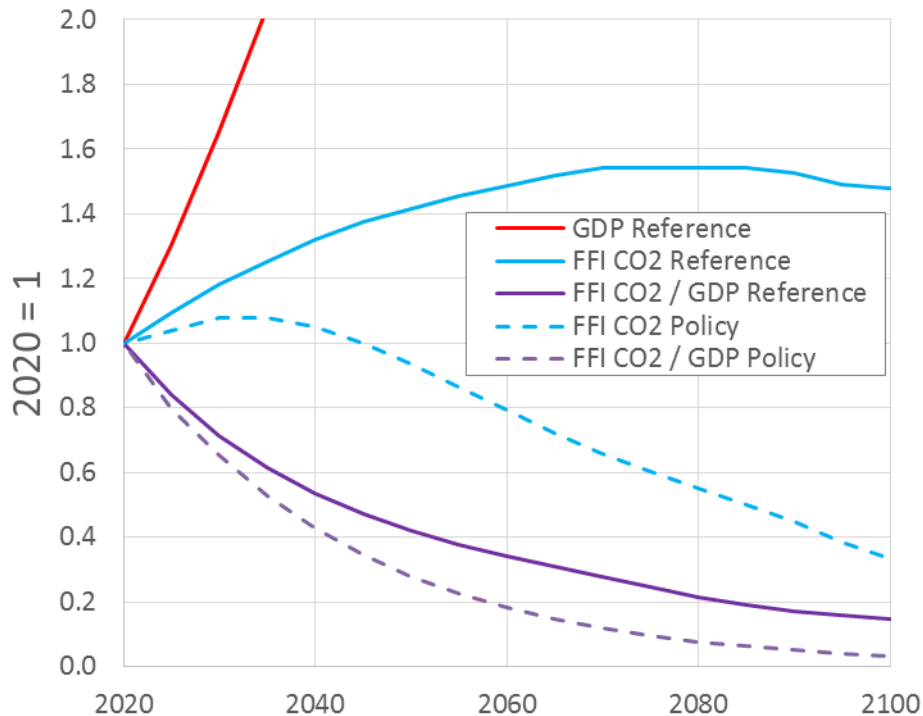
► In the GCAM policy scenario that meets the China INDC goal,\* from 2020 to 2030:

- GDP increases 65%
  - 5.1% annual growth rate
- FFI CO2 increases 8%
  - 0.8% annual growth rate
- FFI CO2/GDP falls 35%
  - 4.2% annual decarbonization rate

\* The peak by 2030 and the 20% non-fossil share of primary energy are both considered in this GCAM scenario.

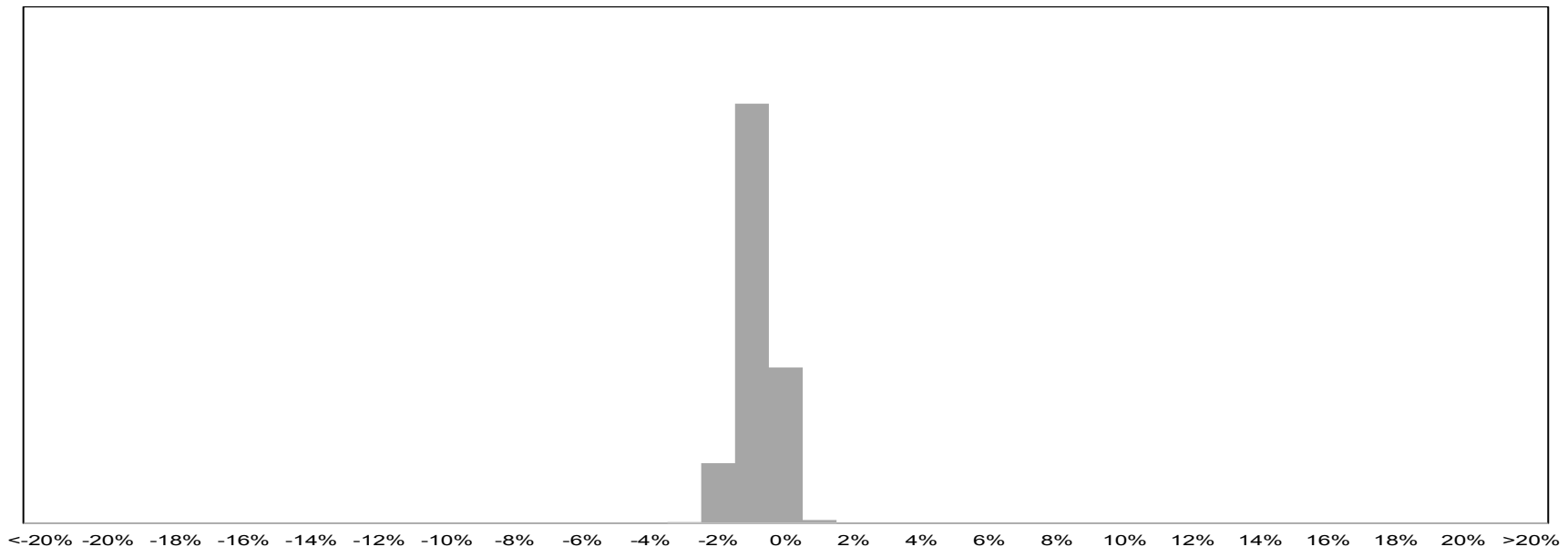
# China INDC, Decarbonization Rates, and CO<sub>2</sub> Projections

China - GDP and CO<sub>2</sub>



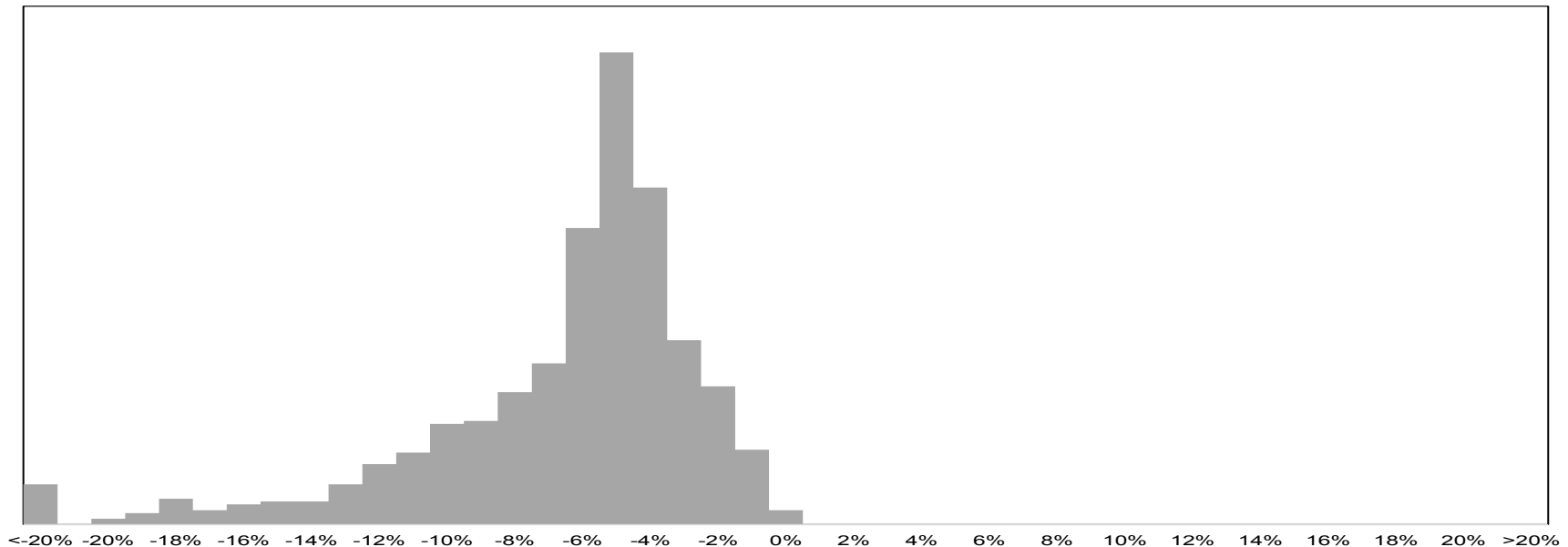
- ▶ If China maintains the decarbonization rate required to meet the INDC goal.
- ▶ In the GCAM baseline scenario for the China, from 2020 to 2100:
  - GDP increases 912%
    - 2.9% annual growth rate
  - FFI CO<sub>2</sub> increases 48%
    - 0.5% annual growth rate
  - FFI CO<sub>2</sub>/GDP falls 85%
    - 2.4% annual decarbonization rate
- ▶ In the GCAM policy scenario that extends the INDC decarbonization rate, from 2020 to 2100:
  - GDP increases 912%
    - 2.9% annual growth rate
  - FFI CO<sub>2</sub> decreases 67%
    - -1.4% annual growth rate
  - FFI CO<sub>2</sub>/GDP falls 98%
    - 4.2% annual decarbonization rate

# Decarbonization Rates – Ambition & Feasibility



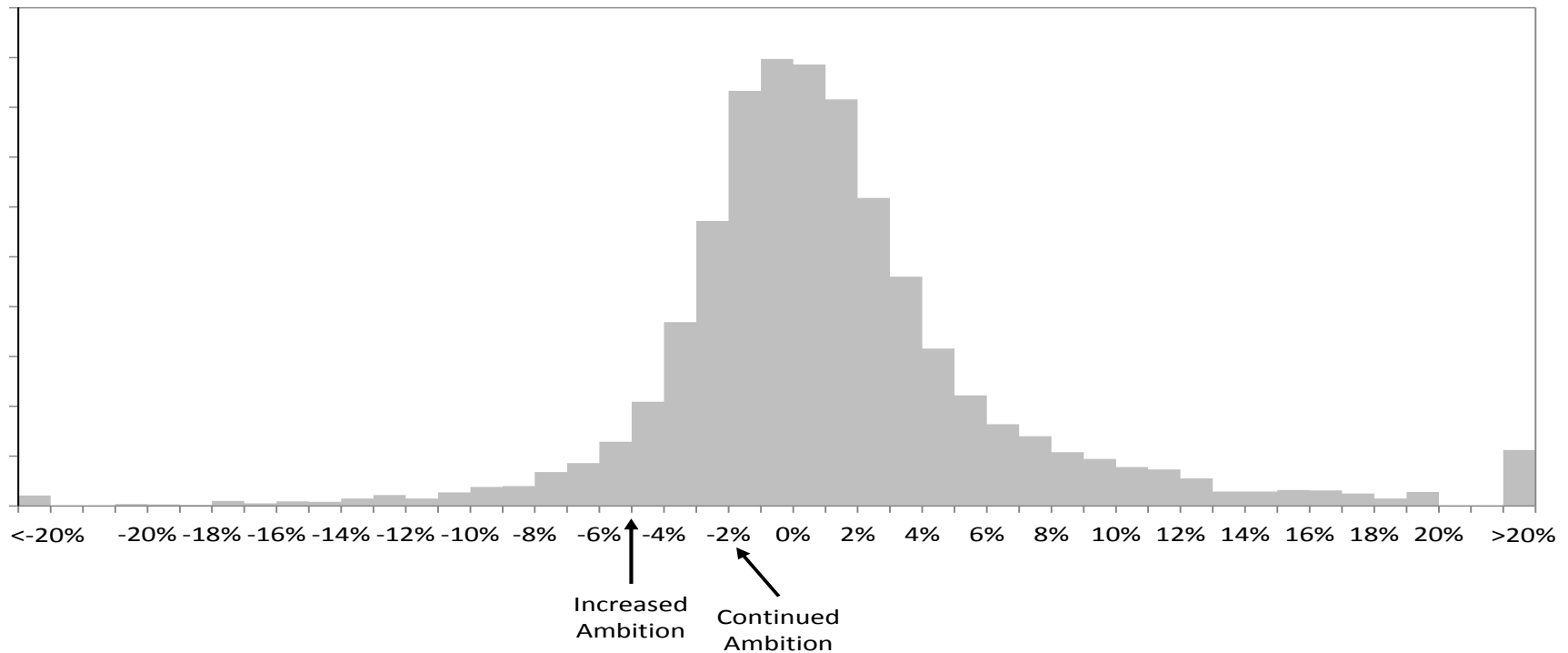
- ▶ Distribution of 10-year running average of global rates of change in CO<sub>2</sub>/GDP (change in global CO<sub>2</sub>/global GDP) from 2020 to 2100 in baseline scenarios (that is, scenarios with no new GHG mitigation policies) from the IPCC's Fifth Assessment Report.
- ▶ Negative rates of change are referred to as “decarbonization rates”.

# Decarbonization Rates – Ambition & Feasibility



- ▶ Distribution of 10-year running average of global rates of change in CO<sub>2</sub>/GDP (change in global CO<sub>2</sub>/global GDP) from 2020 to 2100 in scenarios that limit global temperature change to less than 2°C with at least 50% chance from the IPCC's Fifth Assessment Report.
- ▶ Negative rates of change are referred to as “decarbonization rates”.
- ▶ Periods with negative emissions are excluded from the distribution.
  - This exclusion might bias the distribution towards low decarbonization rates since the negative emissions scenarios will be the ones with the lower rates initially.

# Decarbonization Rates – Ambition & Feasibility



- ▶ Historical distribution of 10 year running average of country level rates of change in CO<sub>2</sub>/GDP (1900-2008)
- ▶ Negative rates of change are referred to as “decarbonization rates”.
- ▶ Rates with absolute values larger than 20% are associated with newly established countries and countries that ceased to exist.

# INDC Commitments



- ▶ As of mid-November 164 countries representing ~90% of current global GHG emissions have submitted INDCs.





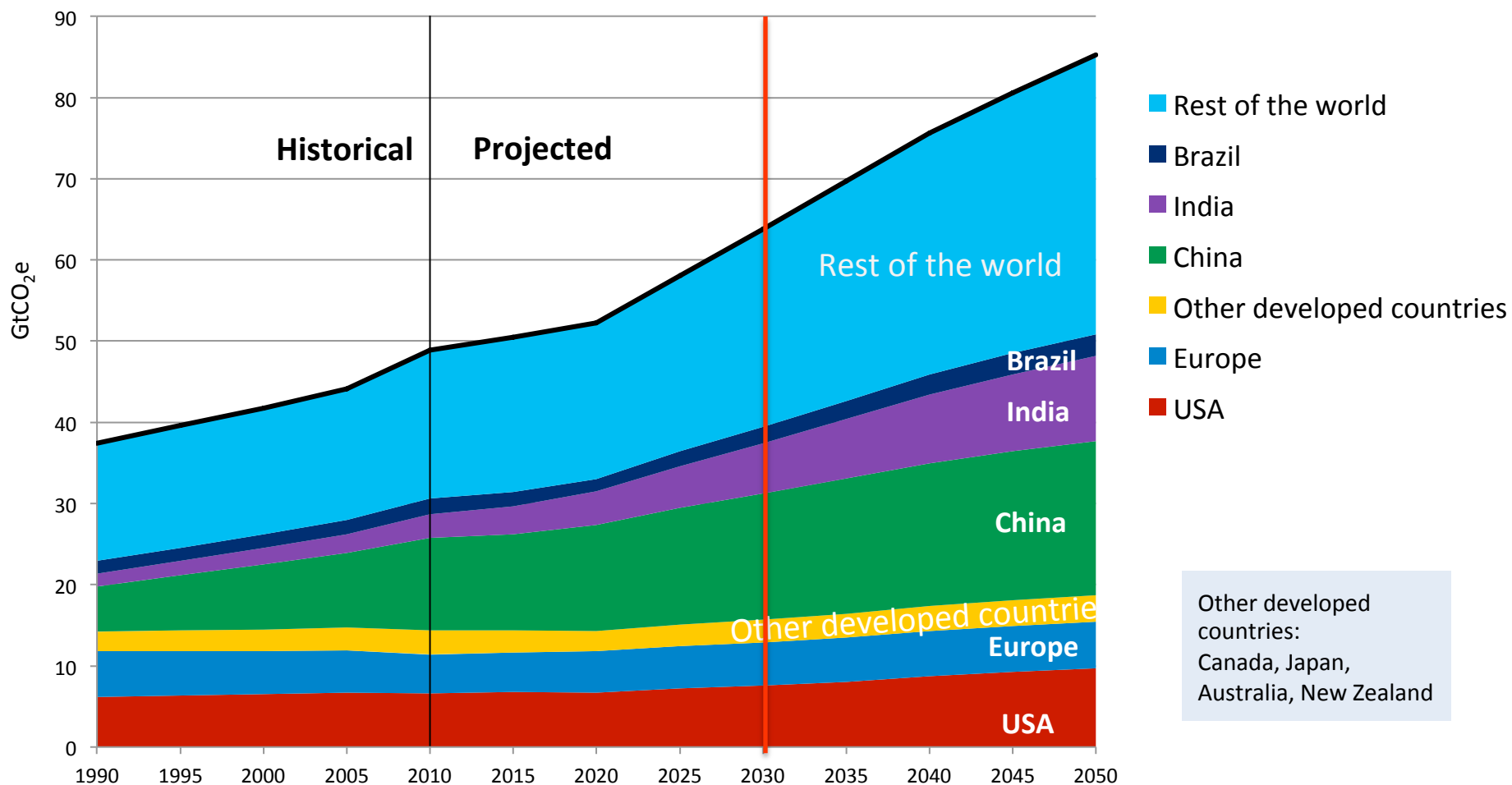
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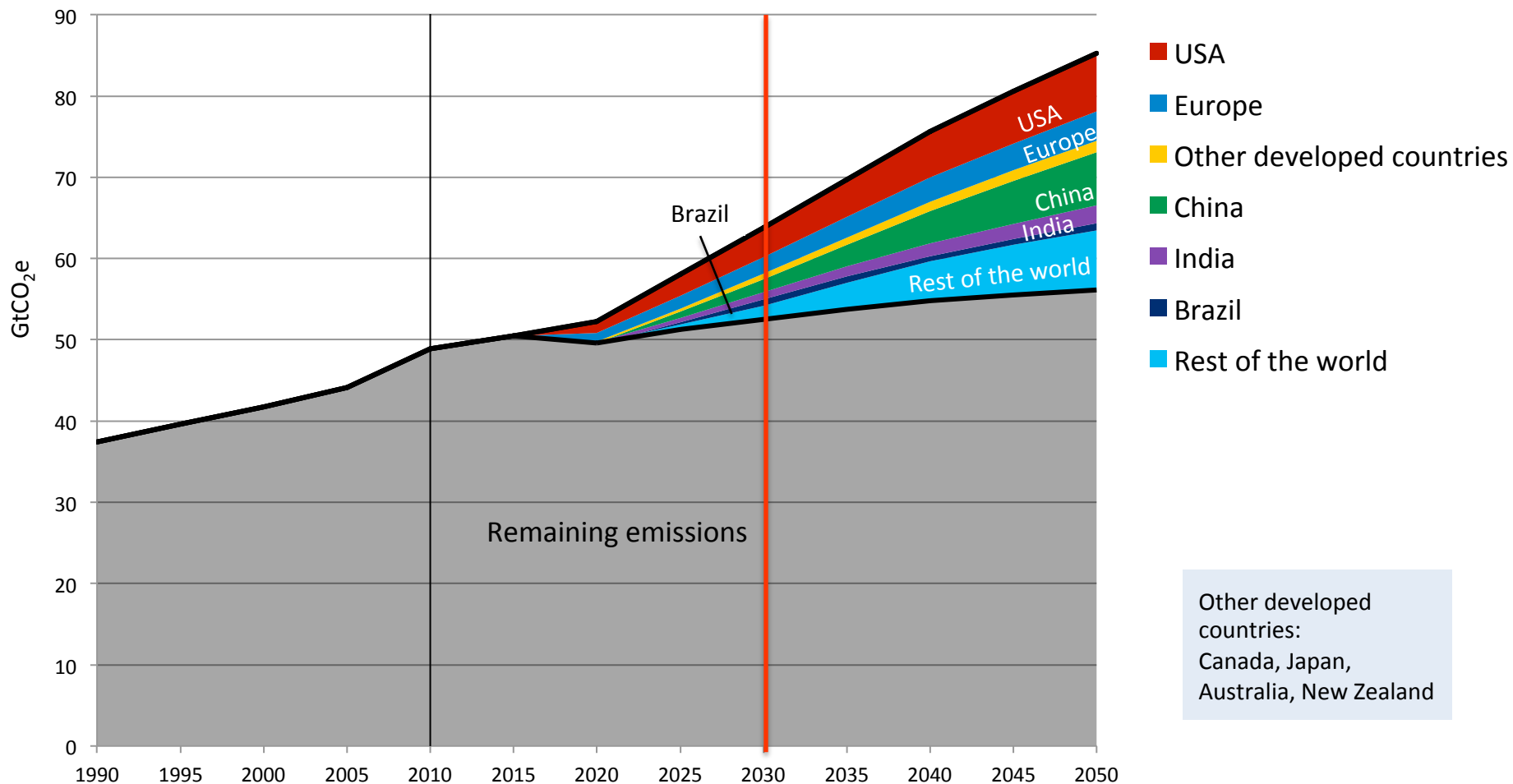
# How do INDCs add up globally?

# Global GHG Emissions: BAU



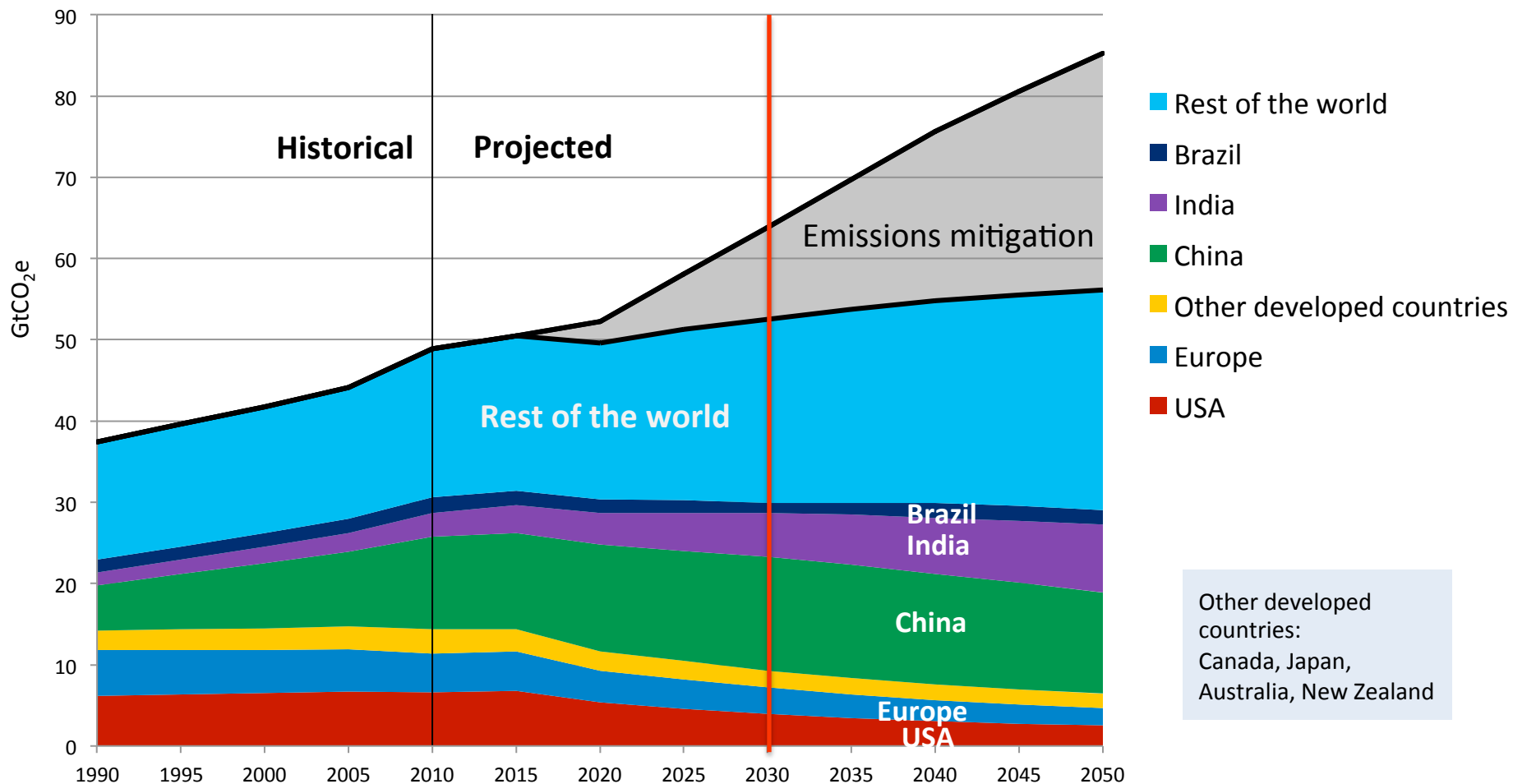
\* LUC emissions are reported in 10 year running average.

# Global GHG Mitigation



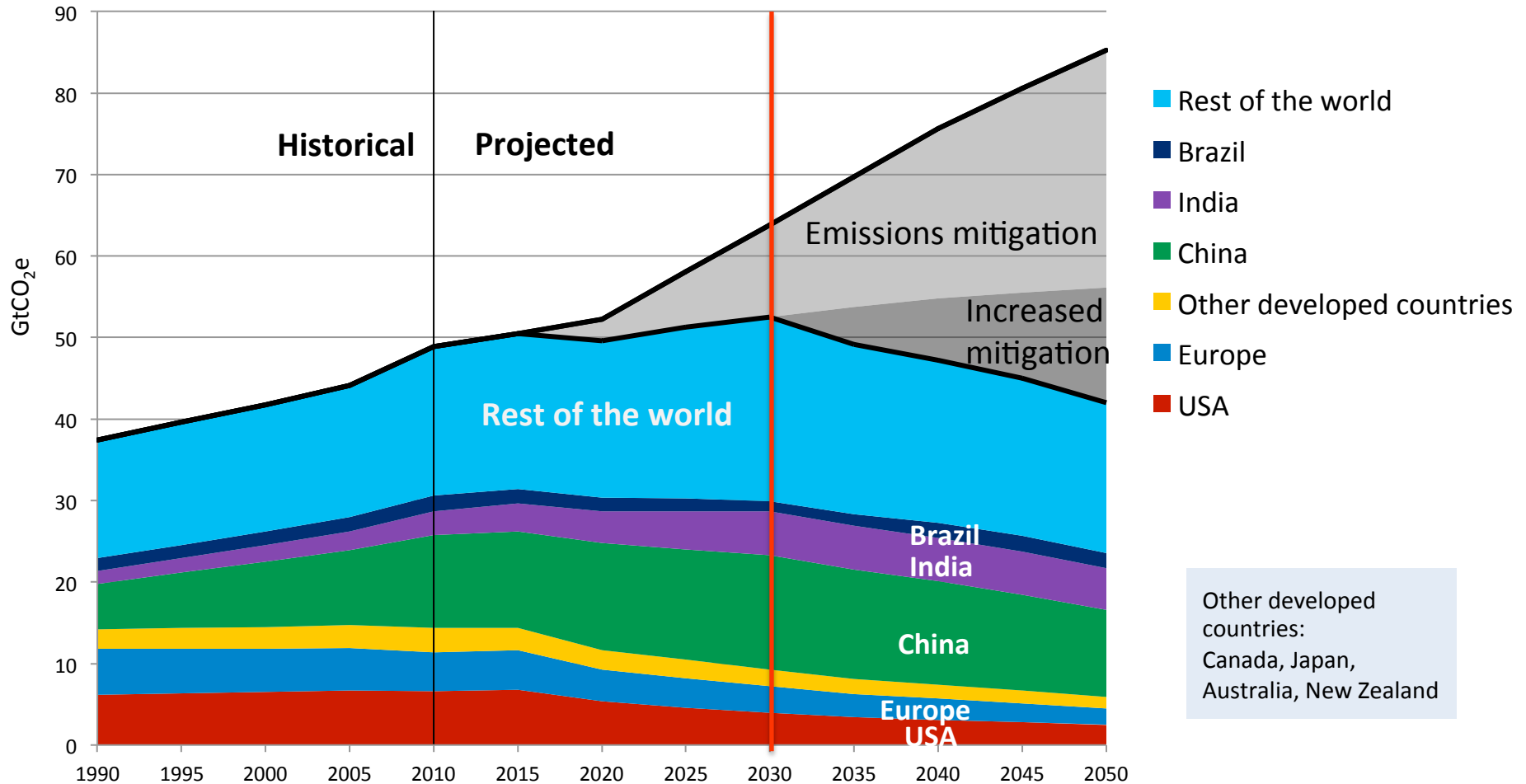
\* LUC emissions are reported in 10 year running average.

# Global GHG: remaining emissions



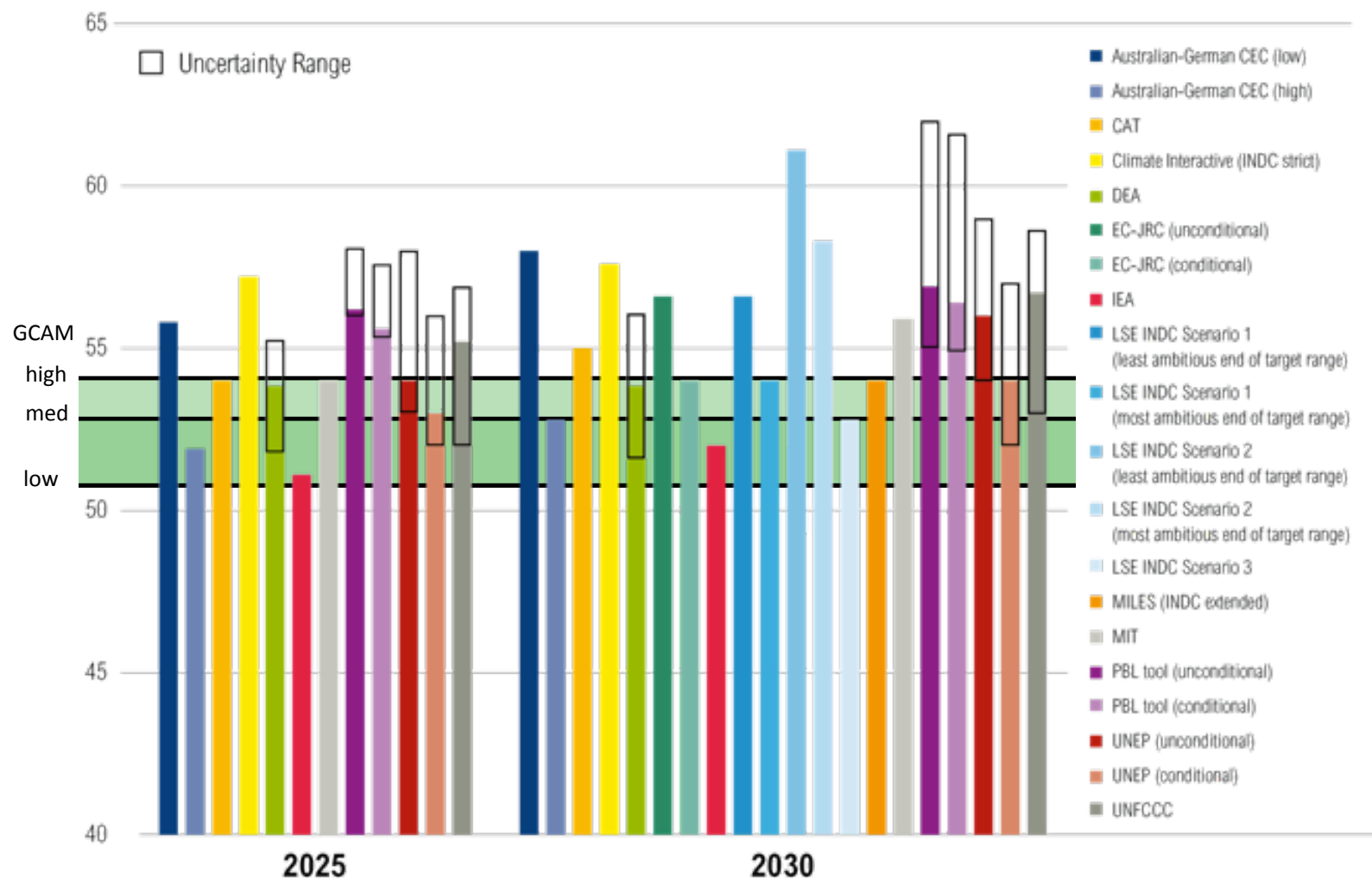
\* LUC emissions are reported in 10 year running average.

# Global GHG: increased ambition



\* LUC emissions are reported in 10 year running average.

# Emissions levels in 2025 and 2030 with INDCs



<http://bit.ly/indc-temp>



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# What is the aggregate impact of the INDCs?

CLIMATE POLICY

# *Can Paris pledges avert severe climate change?*

Reducing risks of severe outcomes and improving chances of limiting warming to 2°C

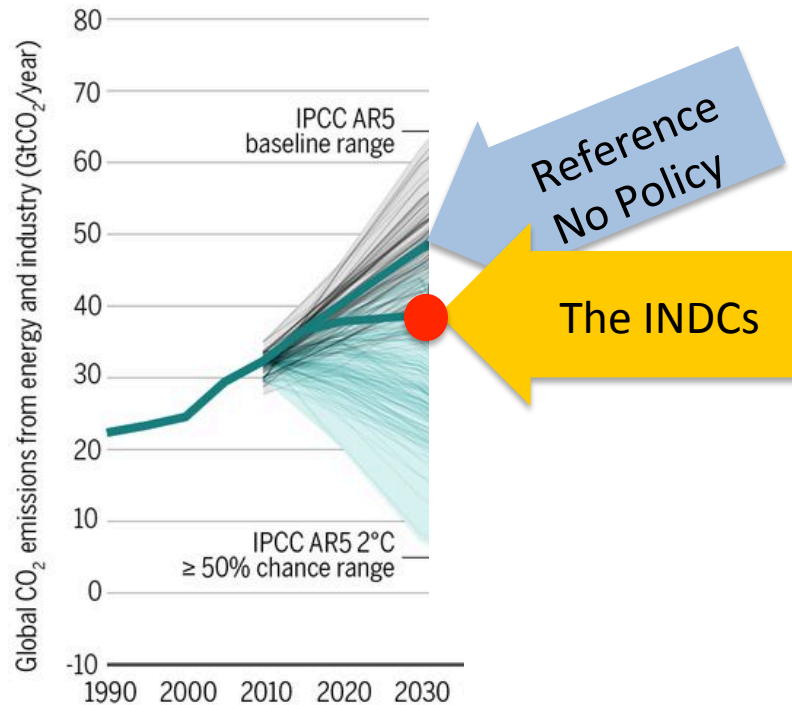
By Allen A. Fawcett,<sup>1</sup> Gokul C. Iyer,<sup>2\*</sup> Leon E. Clarke,<sup>2</sup> James A. Edmonds,<sup>2</sup> Nathan E. Hultman,<sup>3</sup> Haewon C. McJeon,<sup>2</sup> Joeri Rogelj,<sup>4</sup> Reed Schuler,<sup>5</sup> Jameel Alsalam,<sup>1</sup> Ghassem R. Asrar,<sup>2</sup> Jared Creason,<sup>1</sup> Minji Jeong,<sup>2</sup> James McFarland,<sup>1</sup> Anupriya Mundra,<sup>2</sup> Wenjing Shi<sup>2</sup>

- ▶ A multi-year effort by a team from PNNL, EPA, UMD, State, and IIASA supporting the INDC process in the lead up to Paris.
- ▶ We analyze Paris from a risk management perspective and pose two key questions:
  - How much does Paris and the INDCs reduce the probability of the highest levels of temperature change?
  - How much do they improve the odds of achieving the international goal of limiting temperature change to 2°C?
- ▶ In order to answer these questions we need to:
  - Estimate what emissions would look like without Paris
  - Assess the emissions reductions that would be driven by the INDCs
  - Project a range of futures that are enabled by Paris and the INDCs
  - Estimate probabilistic temperature outcomes over the 21<sup>st</sup> century for this range of scenarios with and without Paris and the INDCs



# “The Judgement of Paris” a New Analysis

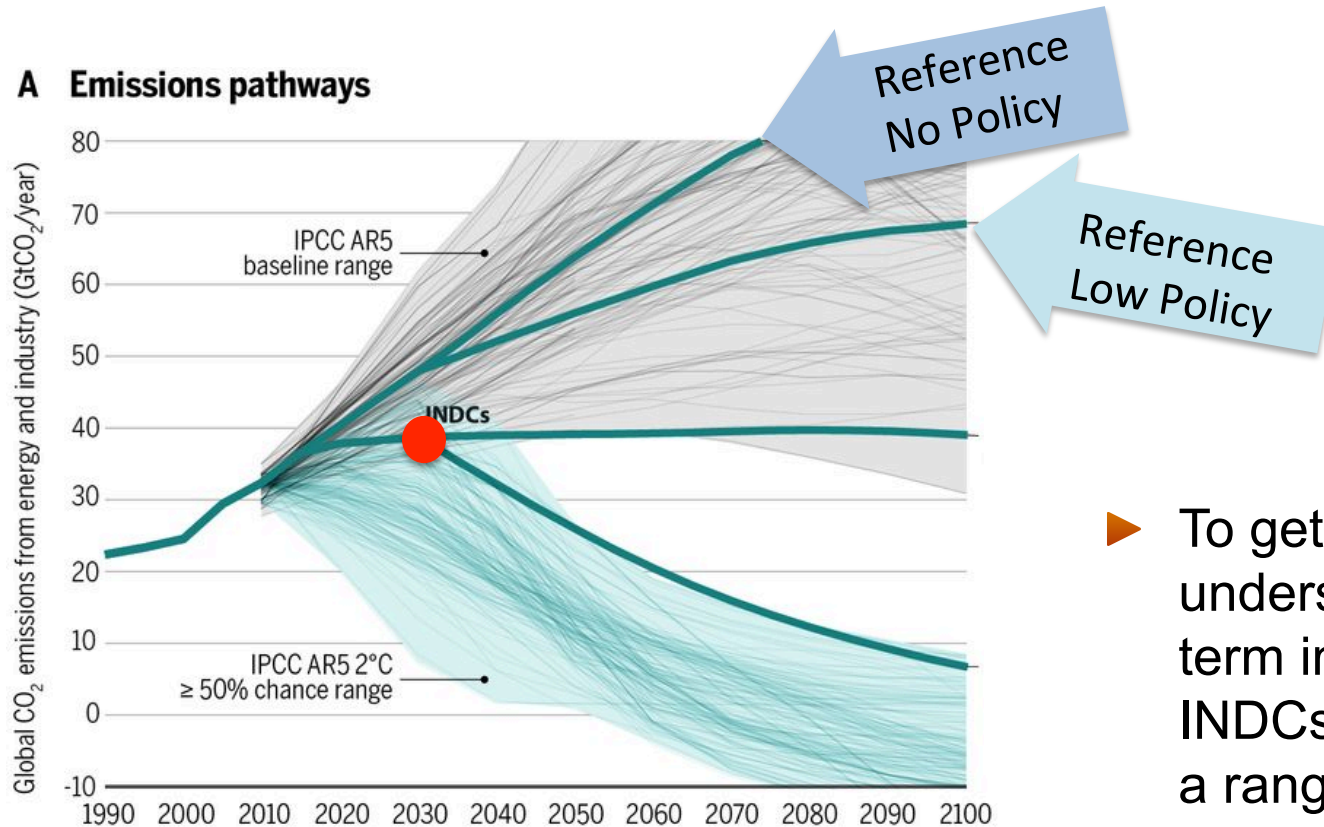
## A Emissions pathways



- ▶ The INDCs are defined no further than the year 2030 (e.g. U.S. INDC goes to 2025)
- ▶ Yet, a major question that is being asked is, what are the climate implications of the INDCs?
- ▶ That answer depends on the next 70 or more years.

Allen A. Fawcett et al. Science 2015;science.aad5761

# “The Judgement of Paris” a New Analysis

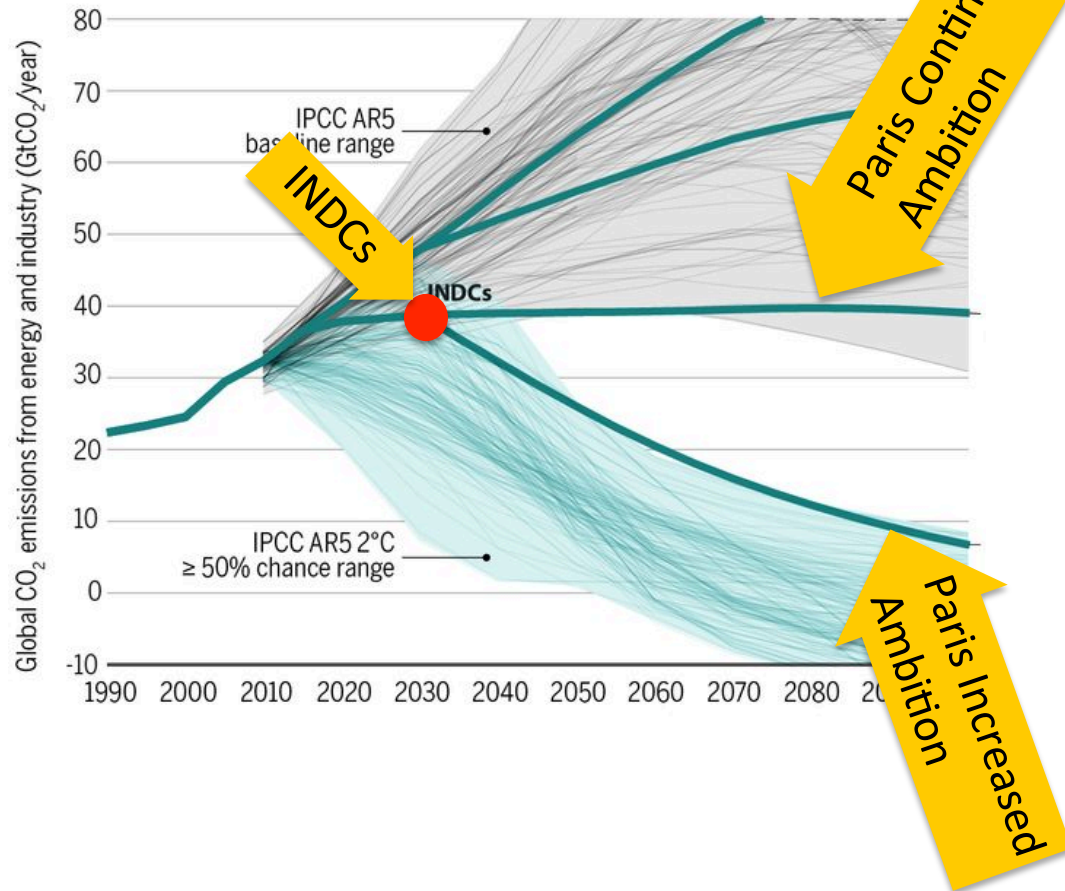


- ▶ To get a better understanding of the long term implications of the INDCs we need to consider a range of scenarios that could occur in the period between 2030 and 2100.

Allen A. Fawcett et al. Science 2015;science.aad5761

# “The Judgement of Paris” a New Analysis

## A Emissions pathways



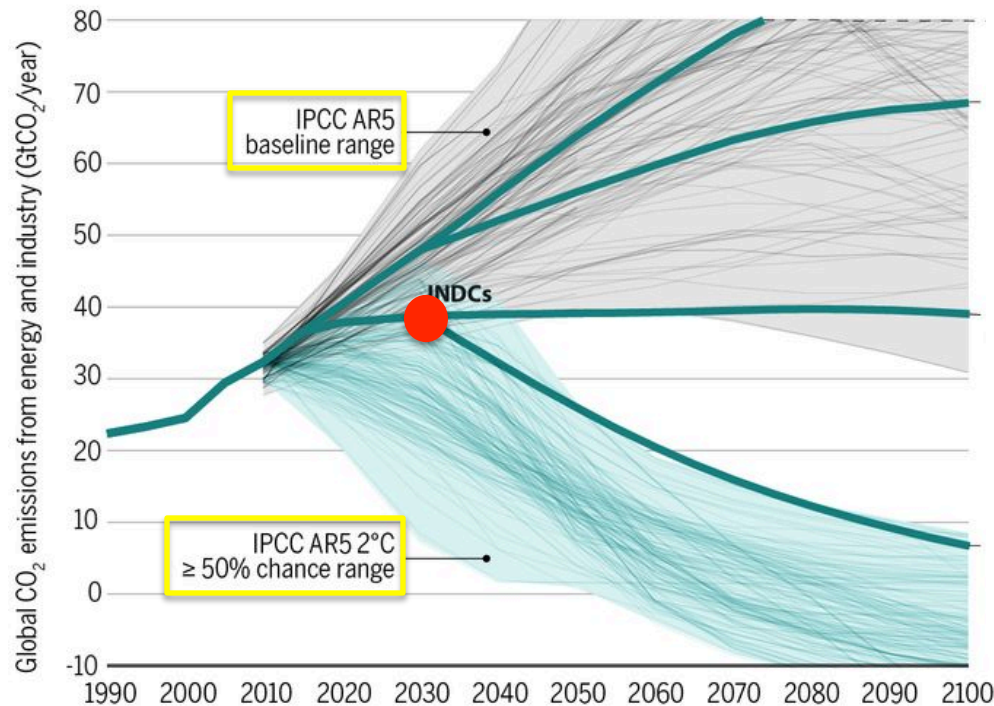
Allen A. Fawcett et al. Science 2015;science.aad5761



- ▶ We extend the INDCs under two alternative assumptions:
  - Paris - Continued Ambition
  - Paris - Increased Ambition
- ▶ To extend the INDCs, we assume that countries continue to decarbonize their economies after 2030 (reduce CO<sub>2</sub>/GDP) at the pace required to meet their INDC goals in 2030.
- ▶ The range between our two scenarios is generated by varying the minimum decarbonization rate that countries are assumed to achieve after 2030 from 2% in the continued ambition scenario to 5% in the increased ambition scenario.

# “The Judgement of Paris” a New Analysis

## A Emissions pathways

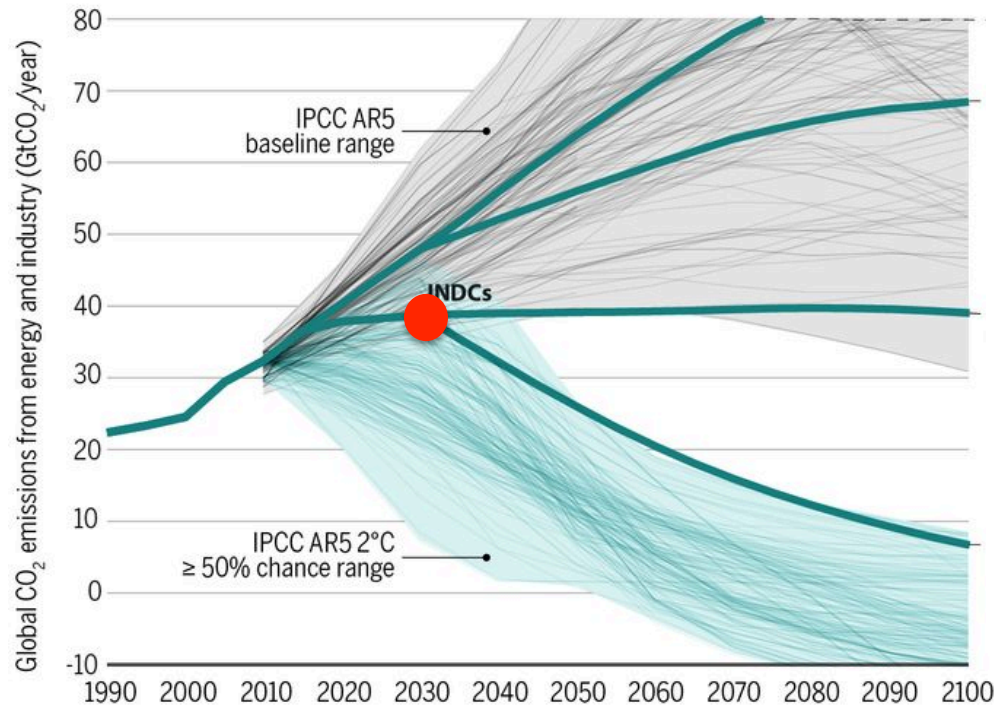


- ▶ We contrast our baseline scenarios with the range of baseline scenarios from the IPCC AR5 database
- ▶ We contrast our Paris scenarios with the range of scenarios from the IPCC AR5 database that have at least a 50% chance of limiting global mean surface temperature change to 2°C above pre-industrial time.

Allen A. Fawcett et al. Science 2015;science.aad5761

# “The Judgement of Paris” a New Analysis

## A Emissions pathways



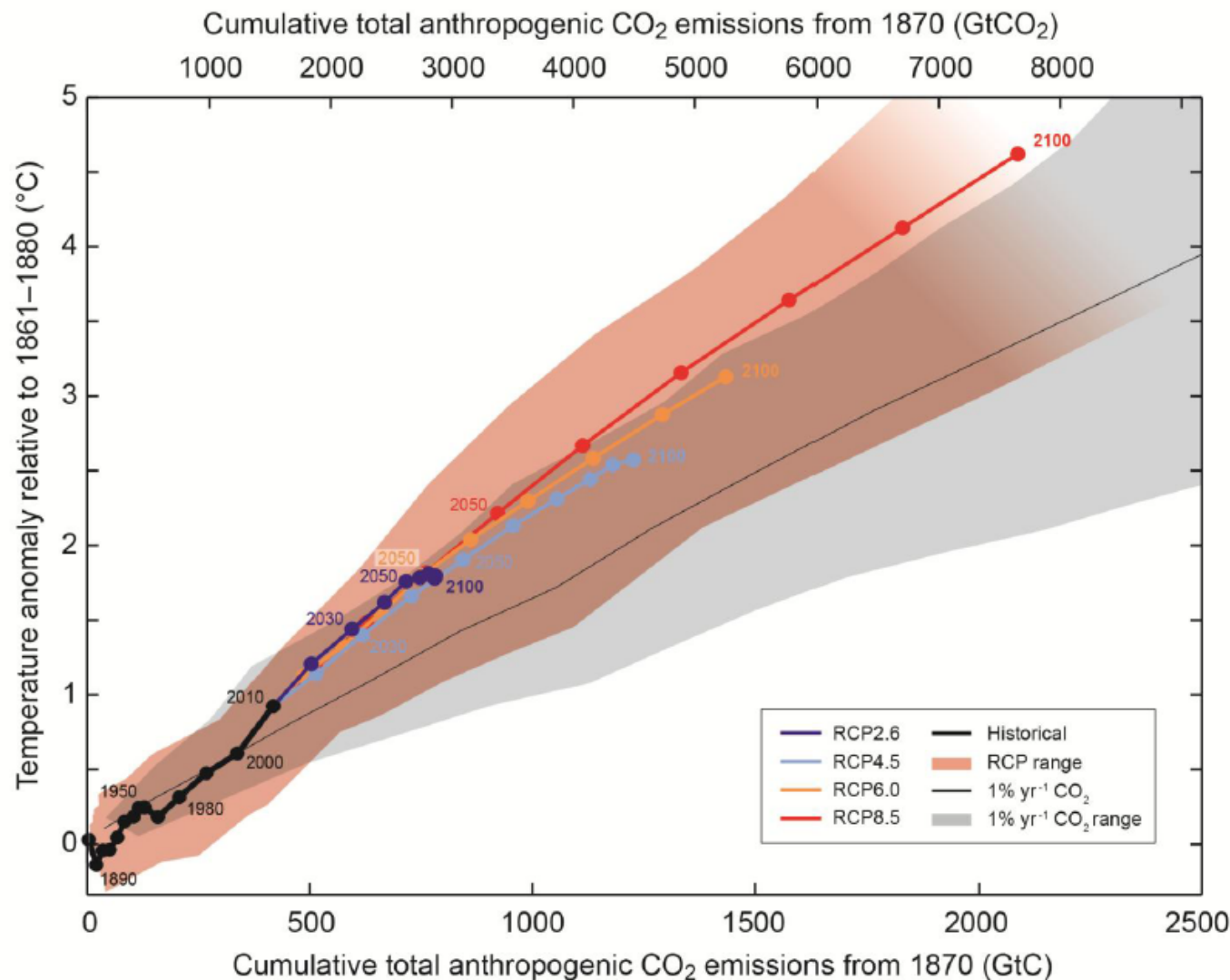
Allen A. Fawcett et al. Science 2015;science.aad5761



- ▶ Our 4 deterministic emissions scenarios are run with GCAM
  - GCAM generates the no-policy reference scenario
  - GCAM fills in non-fossil fuel CO<sub>2</sub> emissions and generates the non-CO<sub>2</sub> emissions paths.
- ▶ We run each of our scenarios through a probabilistic version of MAGICC, a reduced form physical Earth system model, using a Monte Carlo simulation to get the distribution of temperature probabilities.



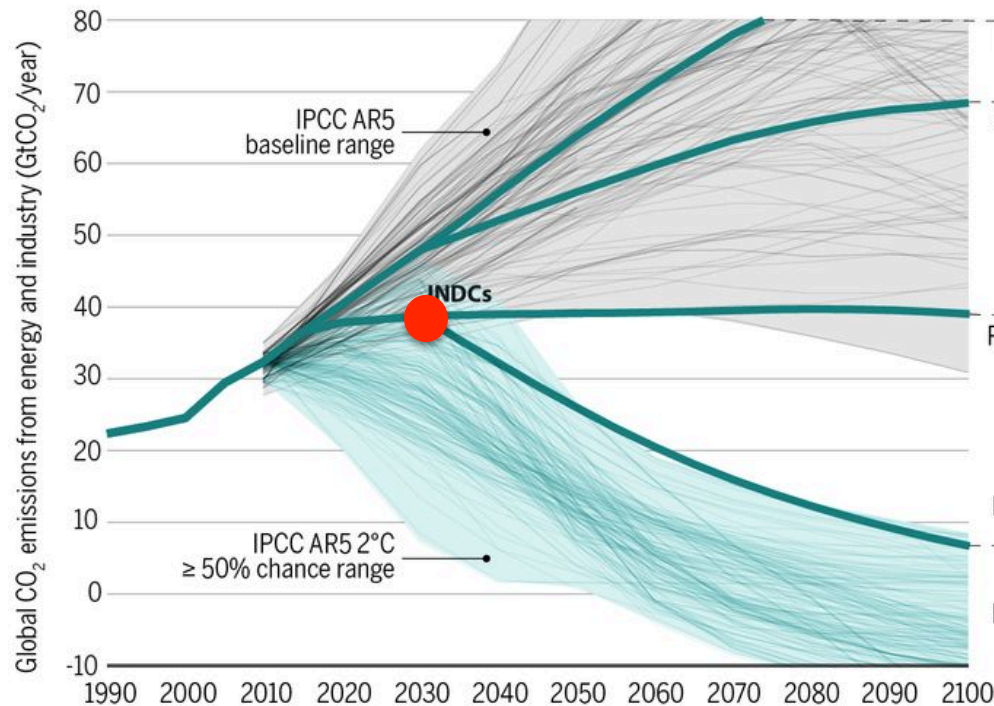
# Cumulative carbon determines warming



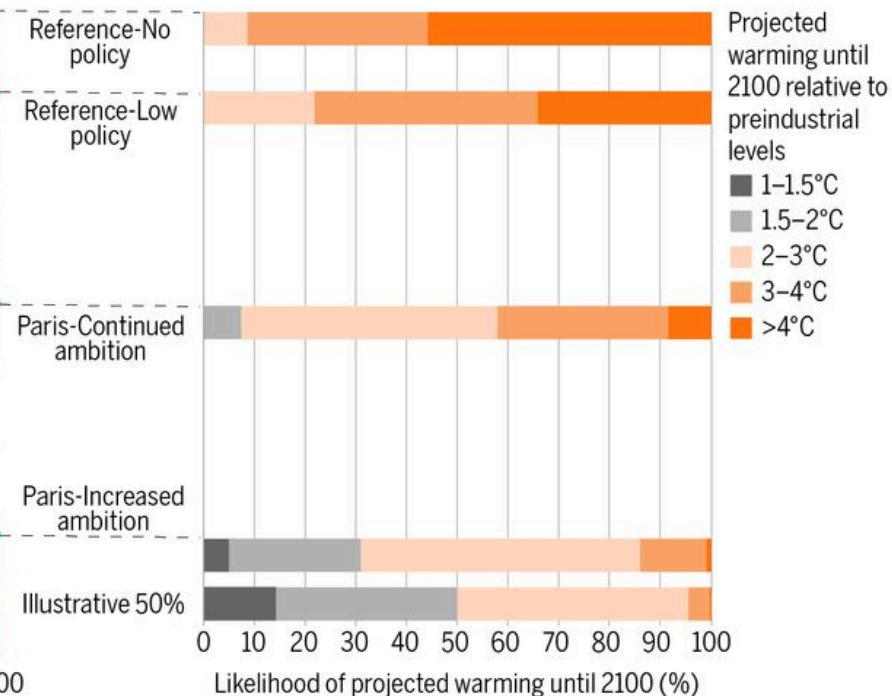
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# “The Judgement of Paris” a New Analysis

## A Emissions pathways



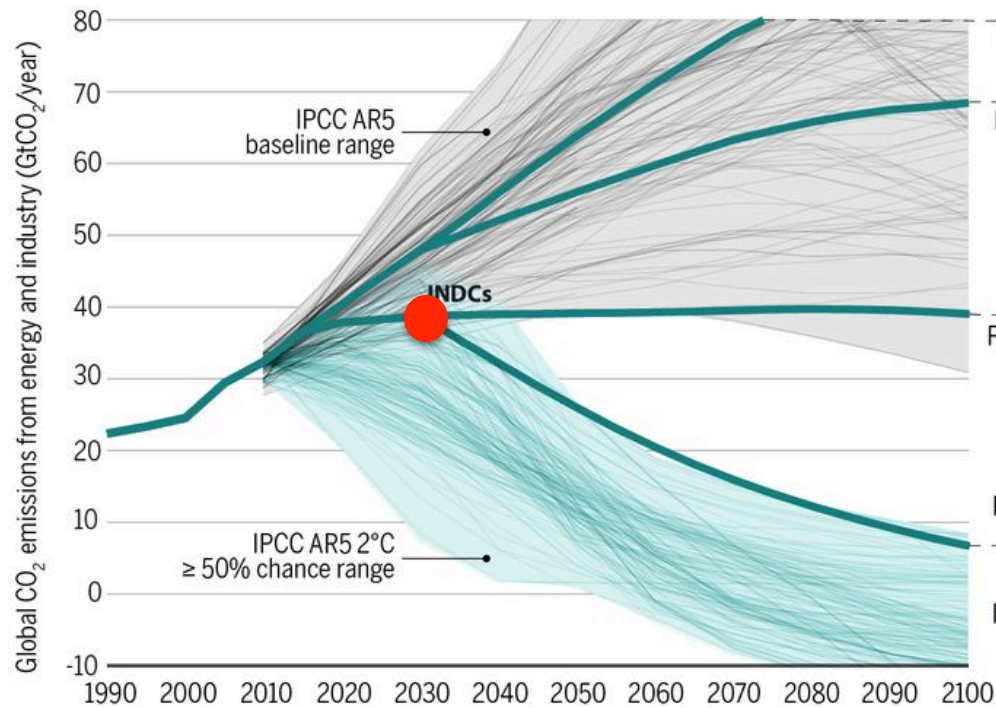
## B Temperature probabilities



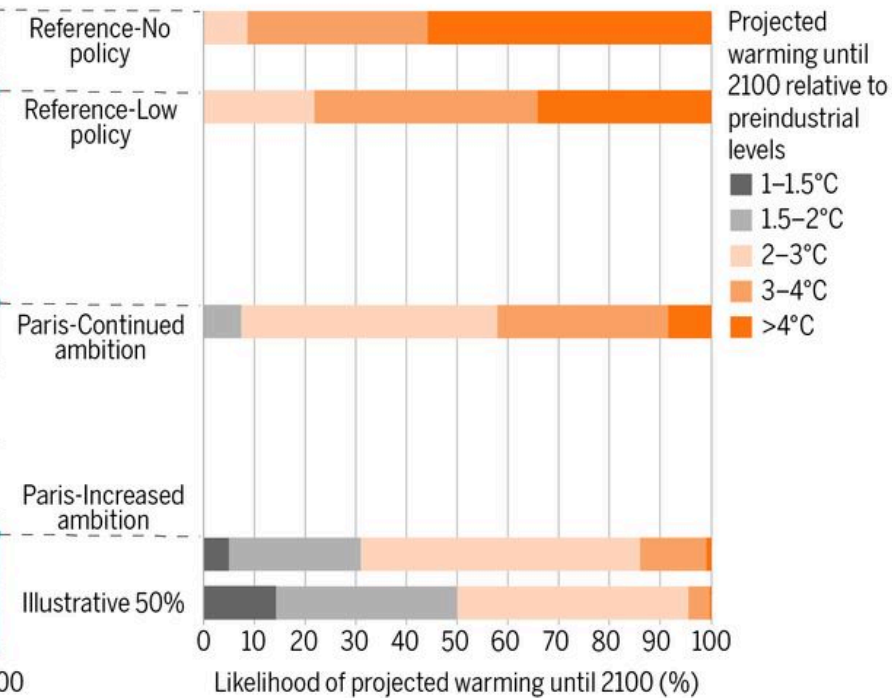
- ▶ While the INDCs are defined no further into the future than 2030, they nonetheless reshape the range of options available to future decision makers.
- ▶ A useful way to think about the climate implications of policy is to consider it as a risk management problem under uncertainty.
- ▶ If the INDCs are followed by similar increases in ambition after 2030, then they could lead to substantial reductions in the likelihood of global average temperature change greater than 4°C.
- ▶ The INDCs also leave the door open to increased ambition which would increase the likelihood climate less than 2°C

# “The Judgement of Paris” a New Analysis

## A Emissions pathways



## B Temperature probabilities



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# The End