The Value of Article 6

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The Paris Agreement of 2015

- Adopted by consensus on 12 December 2015; (Entered into force 4 November 2016)

- The goal: *"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"*

- The key feature was the (Intended) Nationally Determined Contributions (NDCs)

Heterogeneous Commitments

- **United States** will reduce its net greenhouse gas emissions by 26-28 percent below its 2005 level in 2025.
- **EU** will impose a binding target of a 40 percent domestic reduction in greenhouse gas emissions by 2030 compared to 1990 to be fulfilled jointly.
- **India** will reduce emissions intensity 33-35% by 2030, compared to 2005 levels.
  - Also pledges to achieve 40% of cumulative electricity installed capacity from non-fossil fuel based resources by 2030.
  - Will also increase tree cover, 2.5 to 3 billion tonnes of CO2 equivalent by 2030.
- **China** will achieve the
  - Peaking of carbon dioxide emissions around 2030 with best efforts to peak early;
  - Lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level;
  - Increase the share of non-fossil fuels in primary energy consumption to around 20%; and
  - Increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.

Article 6

- Allows countries to work together to meet their NDC goals

- But, DO NOT DOUBLE COUNT

How Valuable is Article 6?

*What is the **potential** economic value of implementing Article 6?*

- What is the **potential** size of the carbon market?
- Who would be the sellers and who would be the buyers?
- How much could costs be reduced?

How much additional ambition could be enabled?

Source: https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf

How Valuable is Article 6?

- Article 6 holds significant potential to reduce cost and enhance ambition
  - 2030 ~$250 billion 2015 US$
- Some countries would benefit more, but everyone could be better off through collaboration.

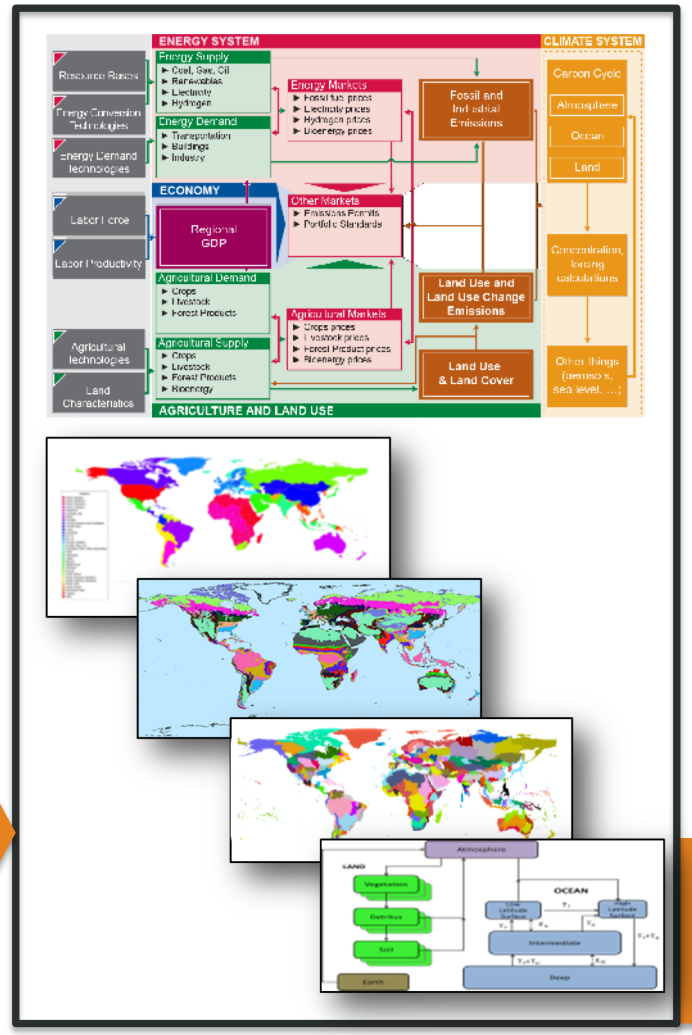
If we interpret the cost of achieving each country's NDC independently as a willingness to pay, 5 $GtCO_2$/year additional mitigation could be enabled in 2030.

- Realizing this potential is a real-world challenge
  - Near-term: Translating NDCs to Internationally Transferred Mitigation Outcomes (ITMOs); Writing the rules to preserve emissions mitigation—do no harm. (Ensuring that no "hot air" is created.)
  - Long-term: It could take any number of forms including NDC coalitions, ratchet mechanisms, or other novel approaches.

The Global Change Assessment Model (GCAM)

Scenario Assumptions

- **Socioeconomic assumptions** (population, GDP)
- Energy, land use, and water **technologies**
- **Policies, company actions and preferences**
- **Resources**



Scenario Outputs

- **Prices and production quantities**:
  - Energy sectors
  - Transportation
  - Primary energy resources
  - Agricultural products
- **Land use**
  - Crops (by type)
  - Pasture
  - Unmanaged
- **Water demand**
  - Raw demand by sector
  - Response to scarcity
- **Atmosphere-Climate**
- **Economic indicators**
  - Economic losses
  - Income transfer

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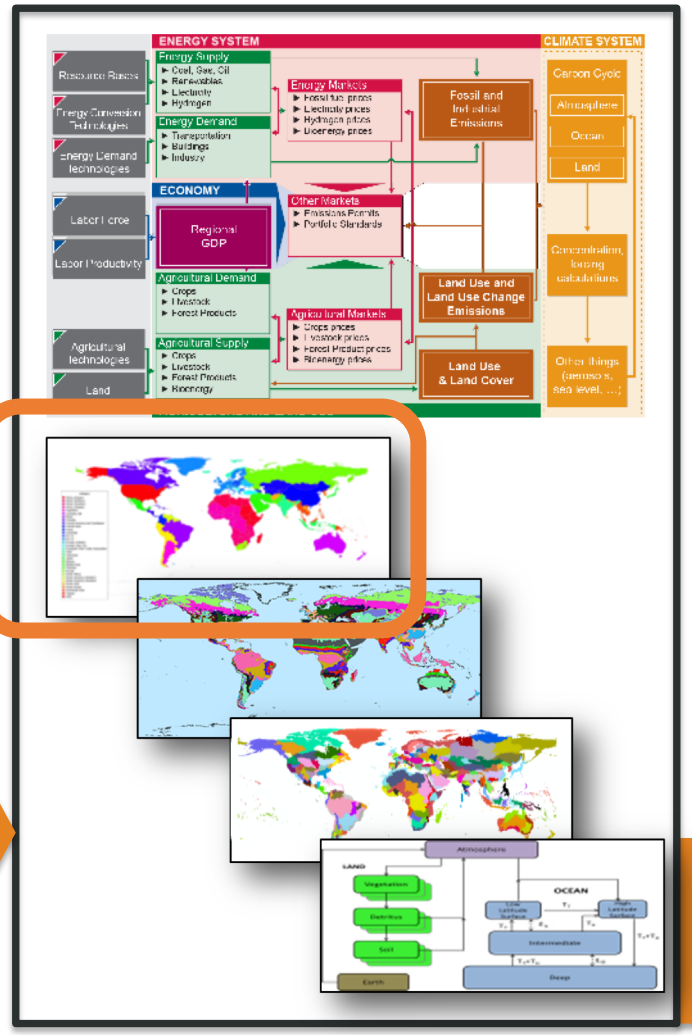
32 Geopolitical Regions



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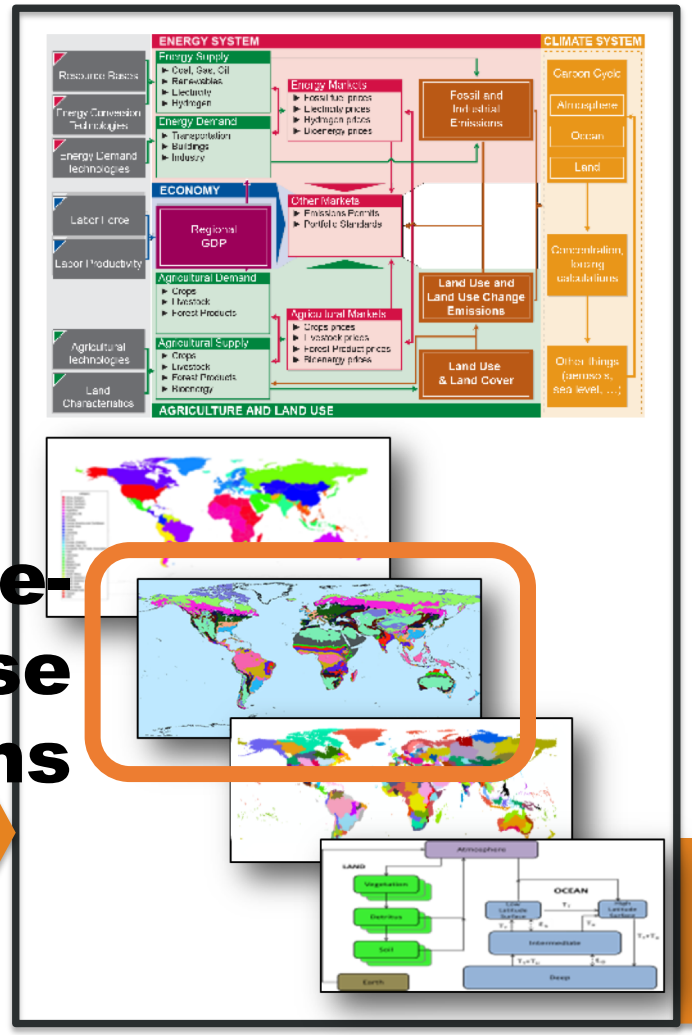
283 Agriculture-Land Use Regions



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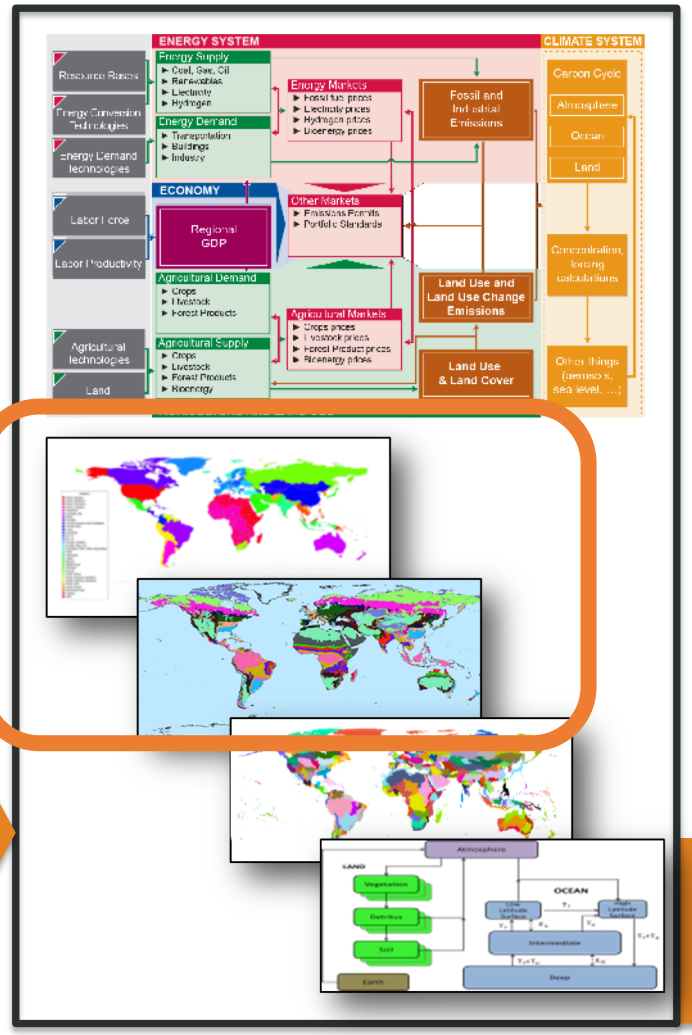
Focus on Carbon Emissions



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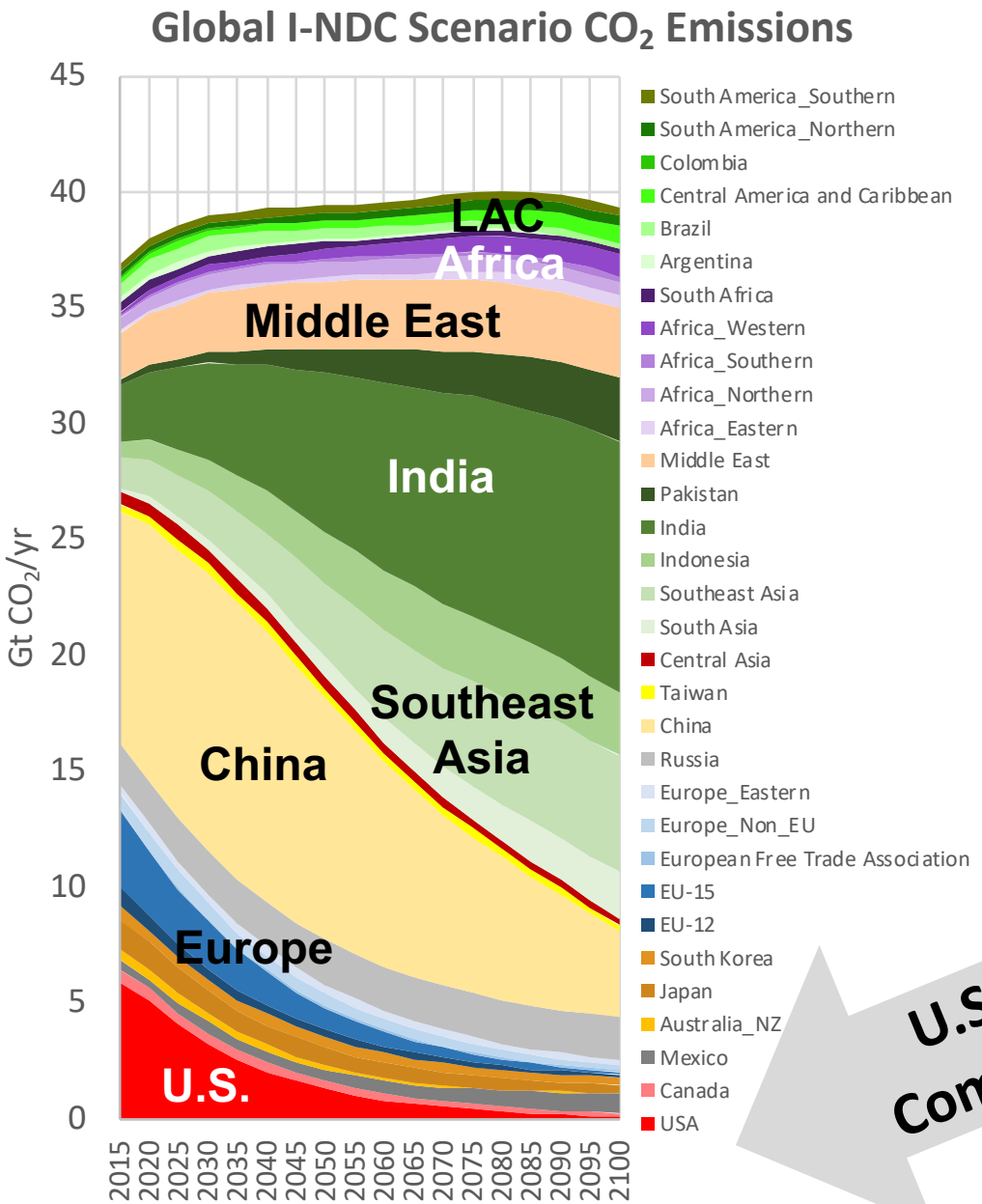
NDC Emissions: Independent Implementation



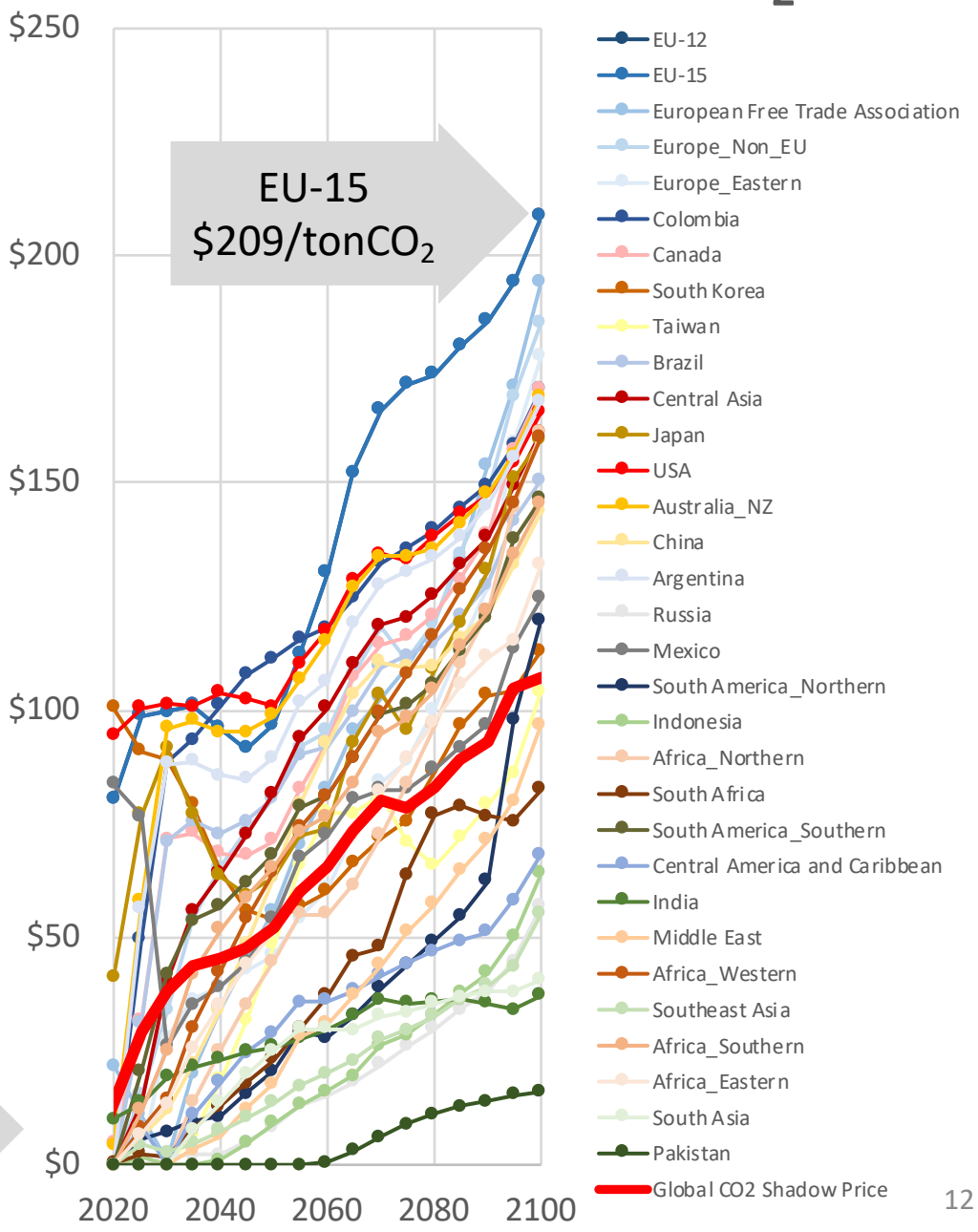
- **Nationally Determined Contributions (NDCs)**
  - Taken from country submissions
  - Post-2030 projections extend trends
  - Used the same method as in the Fawcett, et al. (2015) *Science* paper
- Significant decline in emissions
- The level of emissions reduction varies by country

U.S. 2015 Commitment

NDC Shadow Prices: Independent Implementation

- Wide range in shadow prices

	2030	2050	2100
I-NDC Range	\$0 to \$101/tonCO_2	\$0 to \$111/tonCO_2	\$16 to \$209/tonCO_2

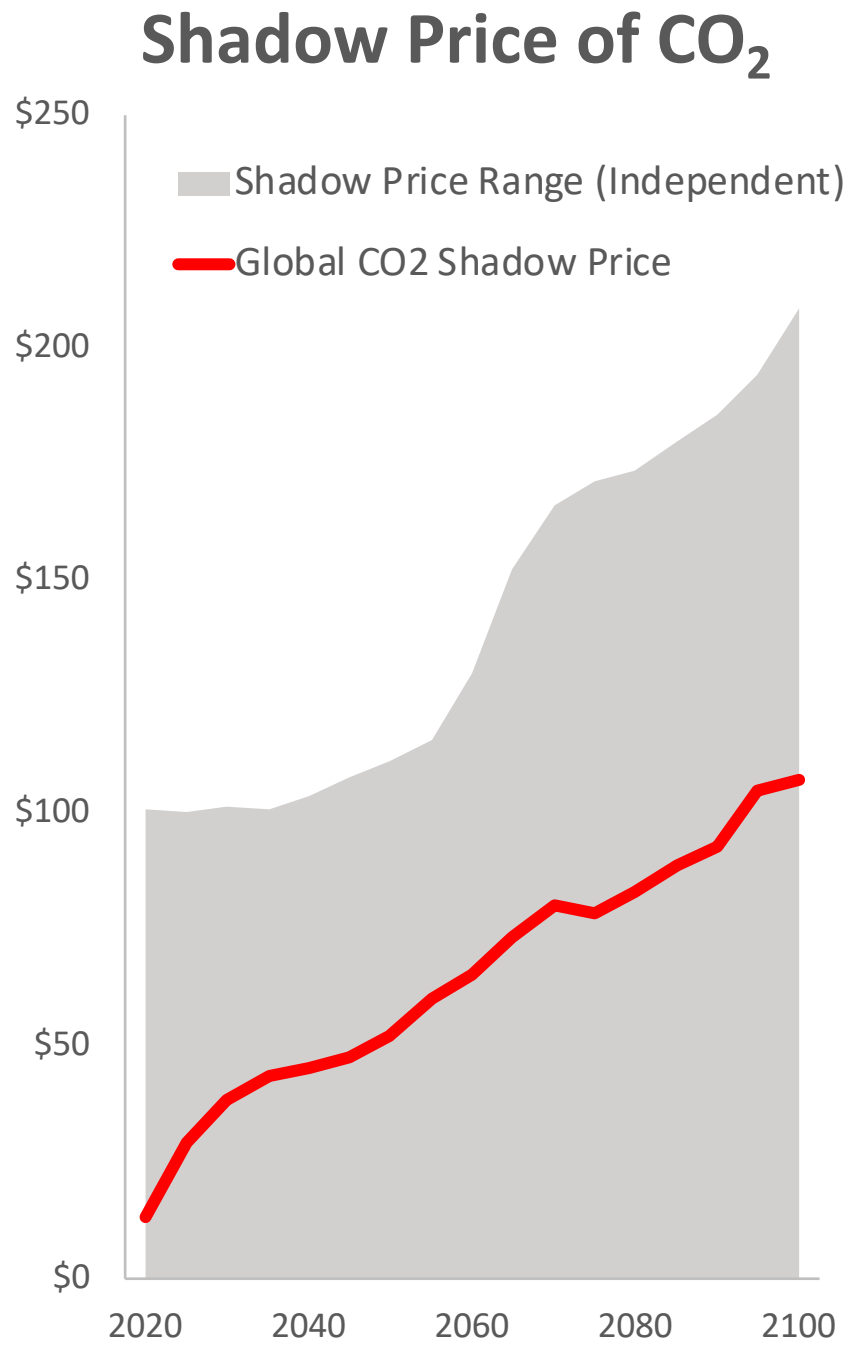


Reducing Cost

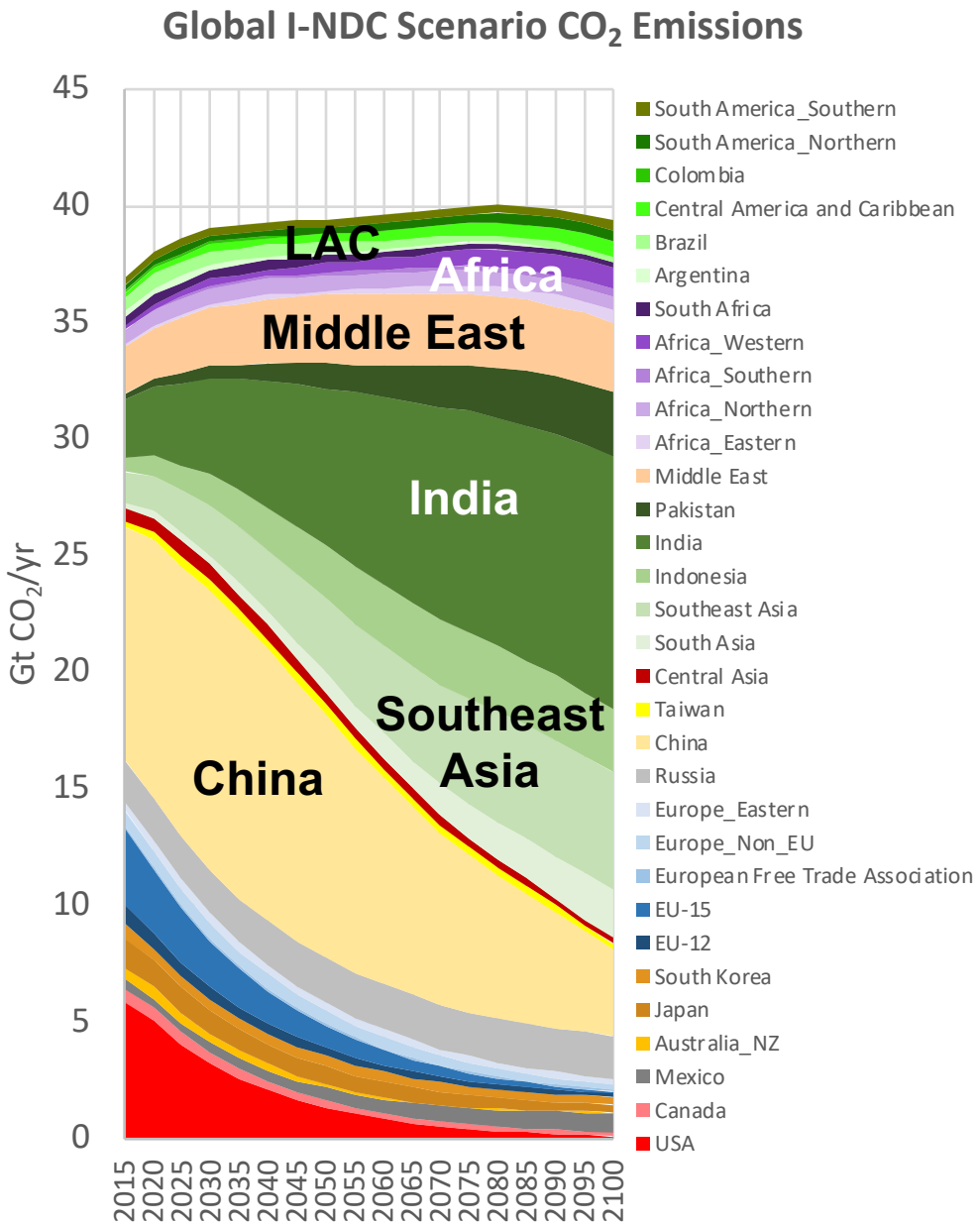
NDC Shadow Prices: Independent vs. Joint Implementation

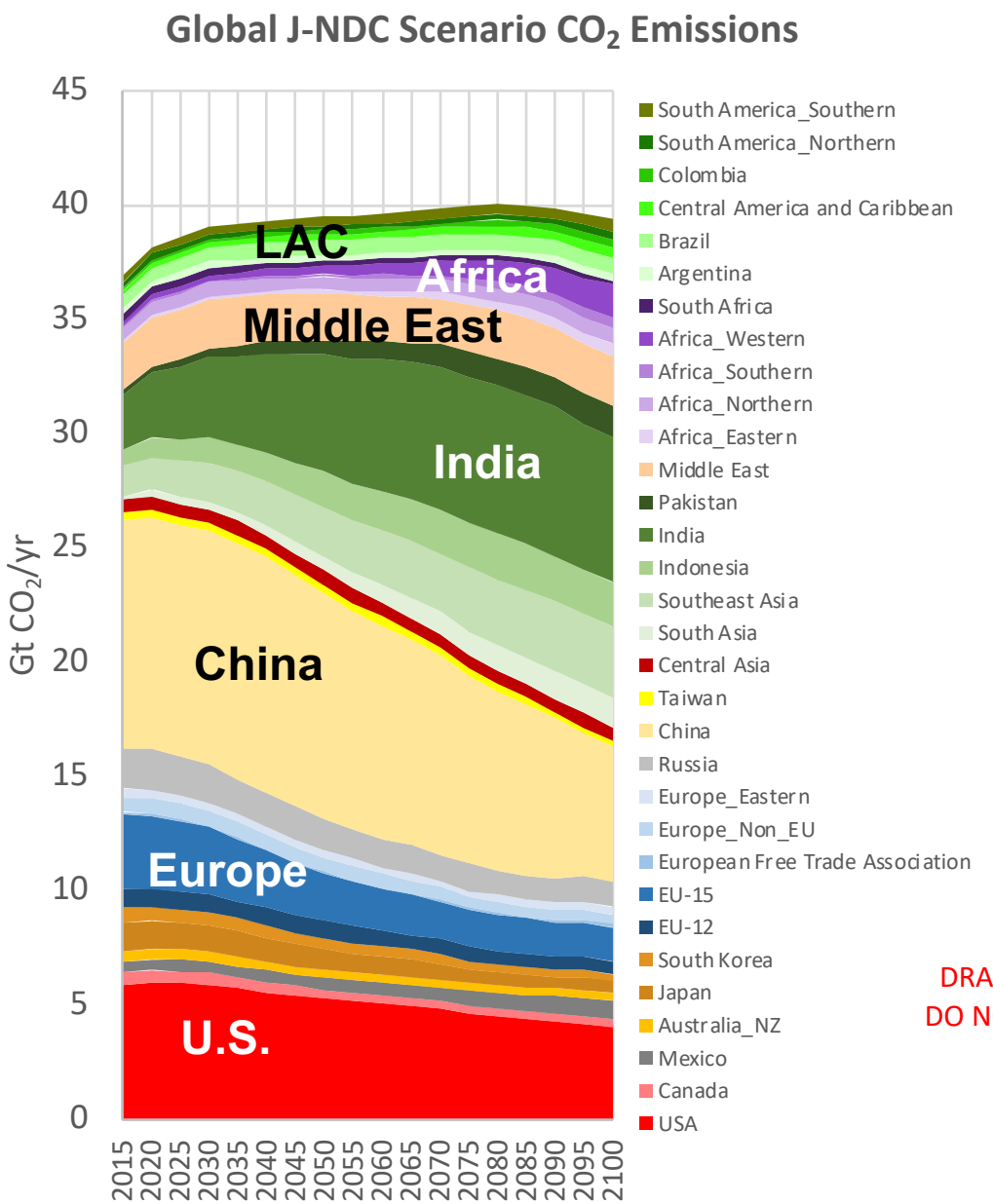
- Joint implementation shadow price lies between high and low prices of independent implementation

	2030	2050	2100
I-NDC Range	\$0 to \$101/tonCO_2	\$0 to \$111/tonCO_2	\$16 to \$209/tonCO_2
J-NDC	**\$38/tonCO_2**	**\$52/tonCO_2**	**\$107/tonCO_2**



NDC Emissions: Independent vs. Joint Implementation





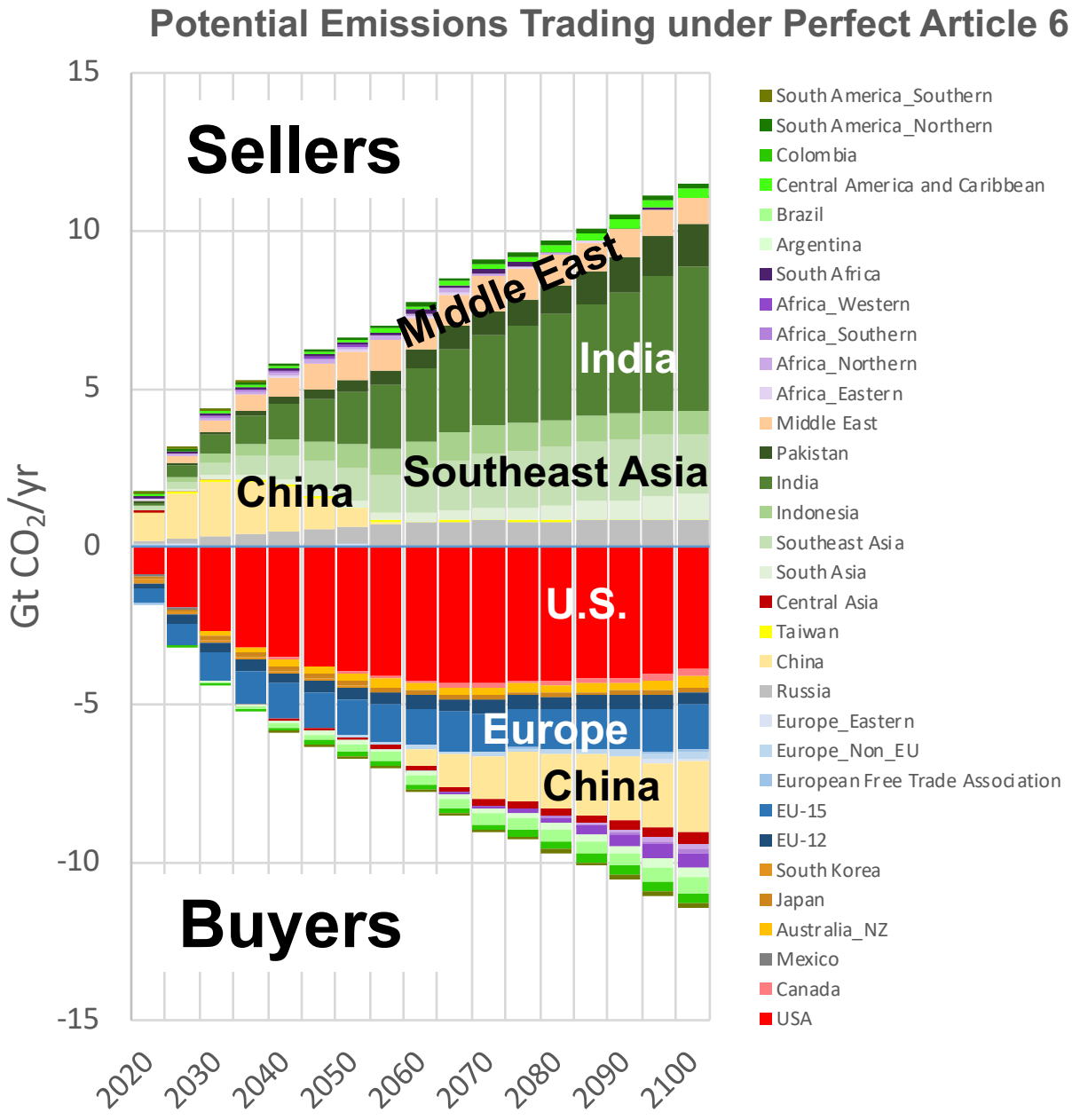
DRAFT PRESENTATION—
DO NOT QUOTE, SUBJECT
TO CHANGE

Potential changes in emissions—CO_2

- Seller (11 regions)
- Buyer (4 regions)
- Seller to buyer

  (15 regions)
- Buyer to seller

  (2 regions)

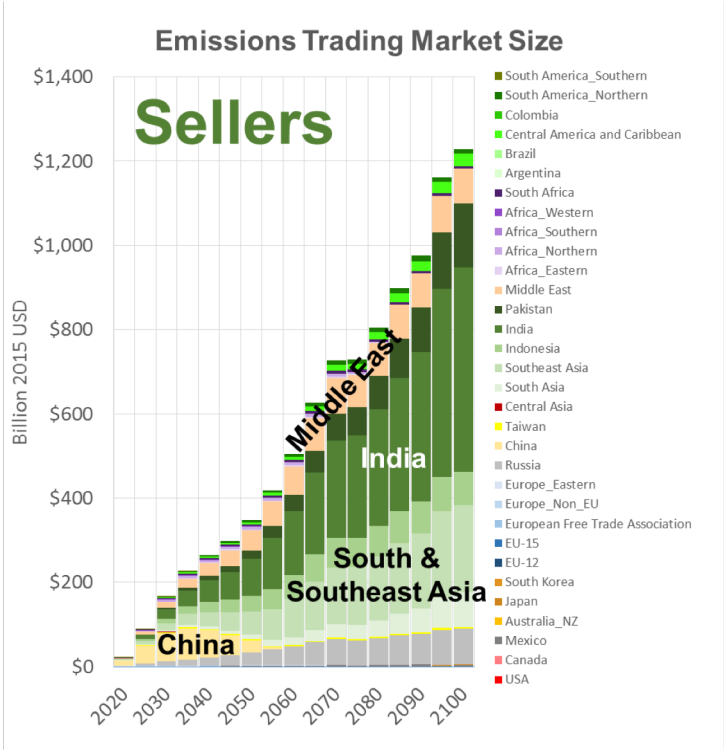


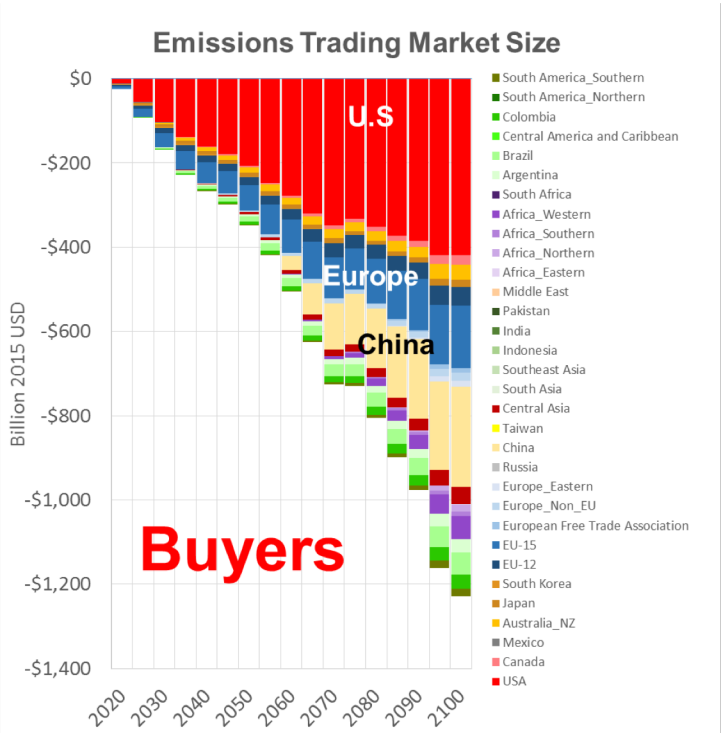
Potential changes in emissions—CO_2

Year	Change emissions distribution
2030	4.3 $GtCO_2$/yr (11% of emissions redistributed in 2030)
2050	6.6 $GtCO_2$/yr (17% of emissions redistributed in 2050)
2100	11.4 $GtCO_2$/yr (29% of emissions redistributed in 2100)

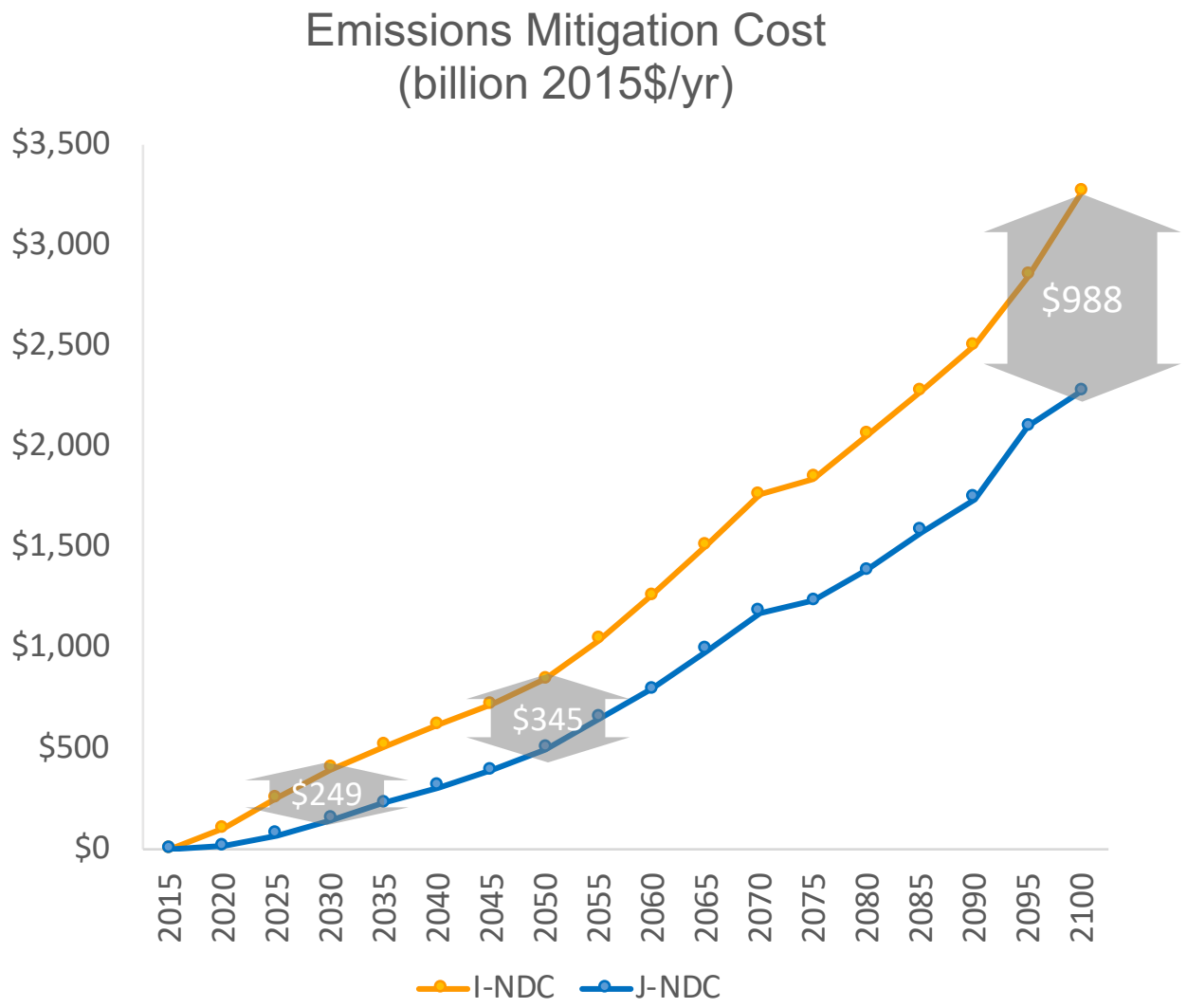
Potential Market Size—Billion of 2015 US$

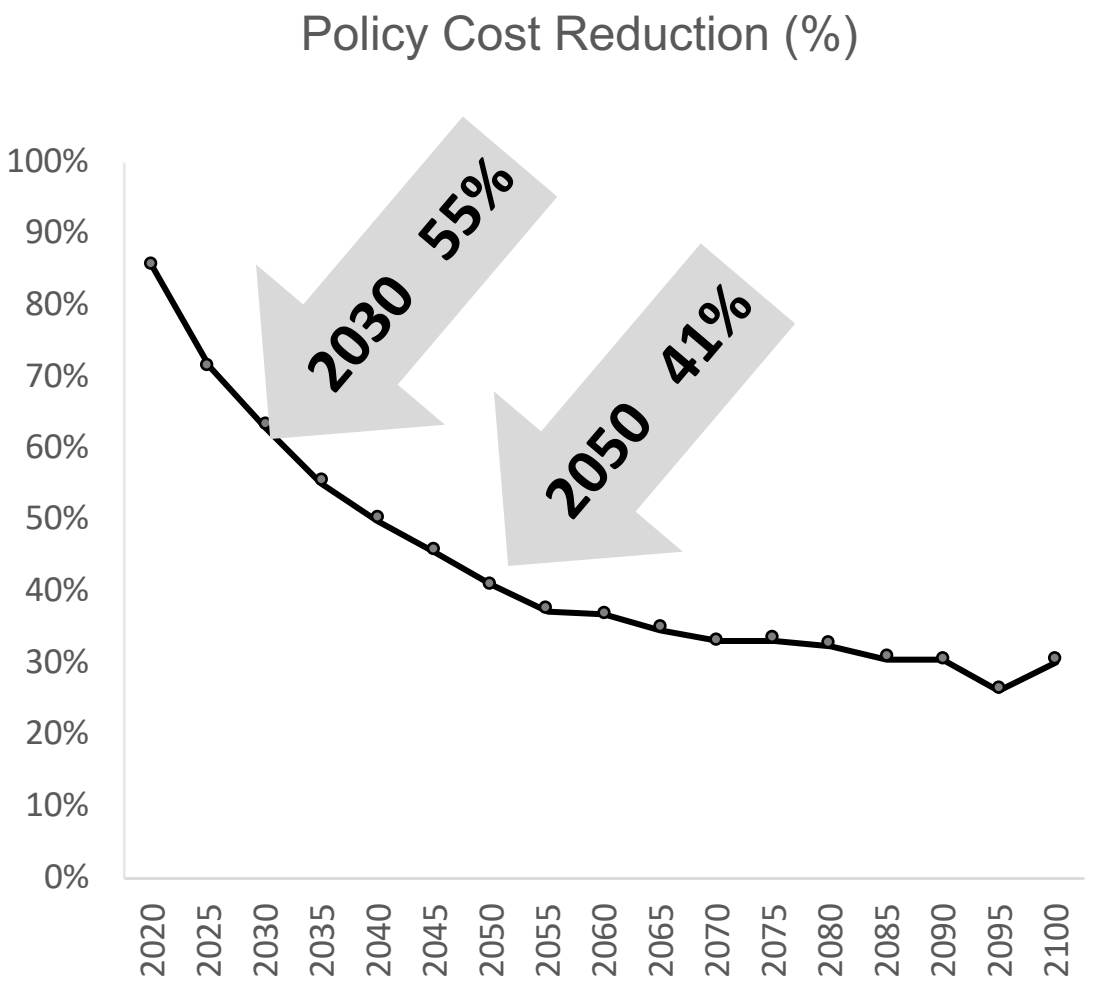
Year	Market Size (Billion 2015 US$)
2030	$167
2050	$347
2100	$1,229



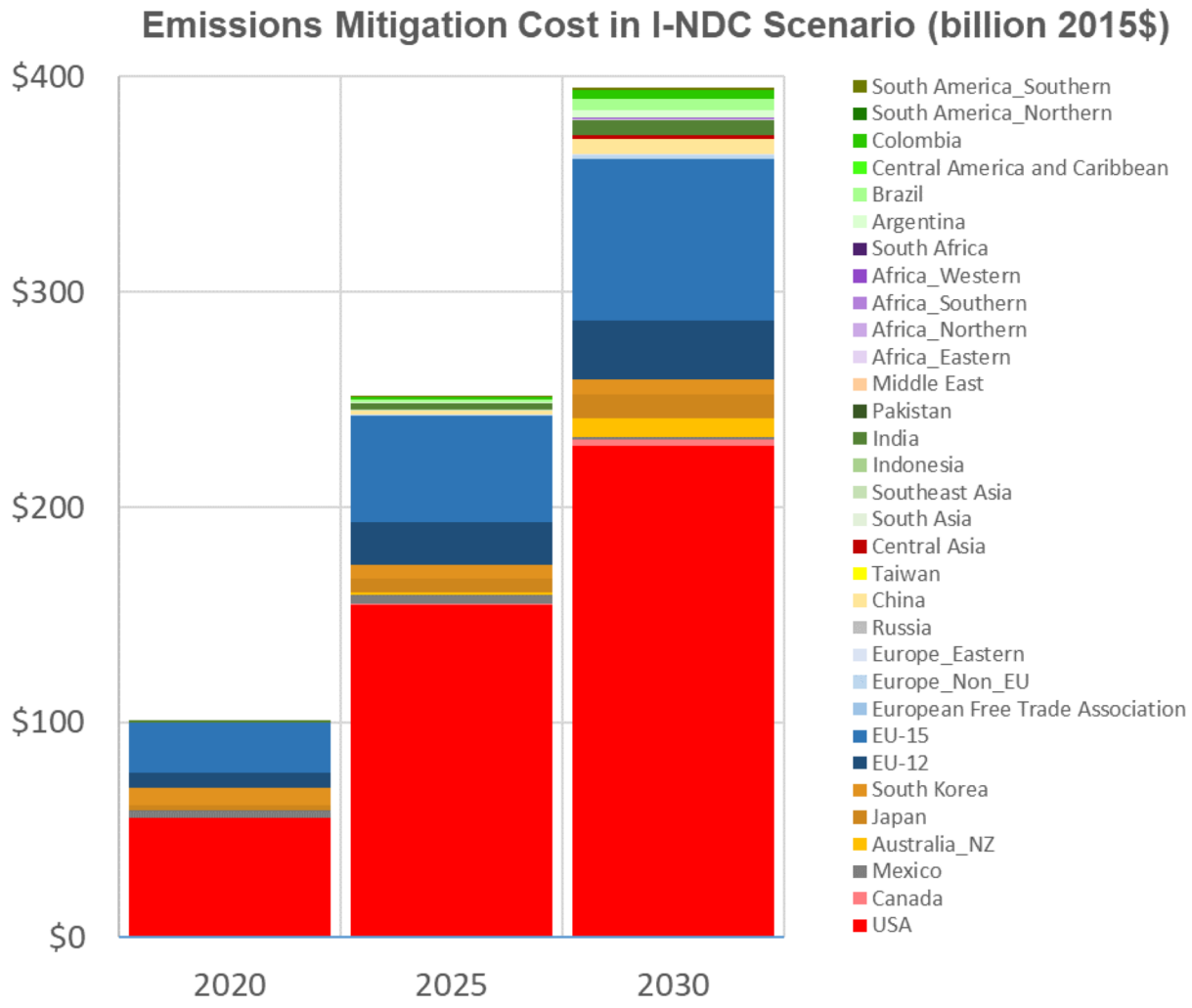


Emissions Mitigation Cost: Independent vs. Joint Implementation





Potential Cost Reductions

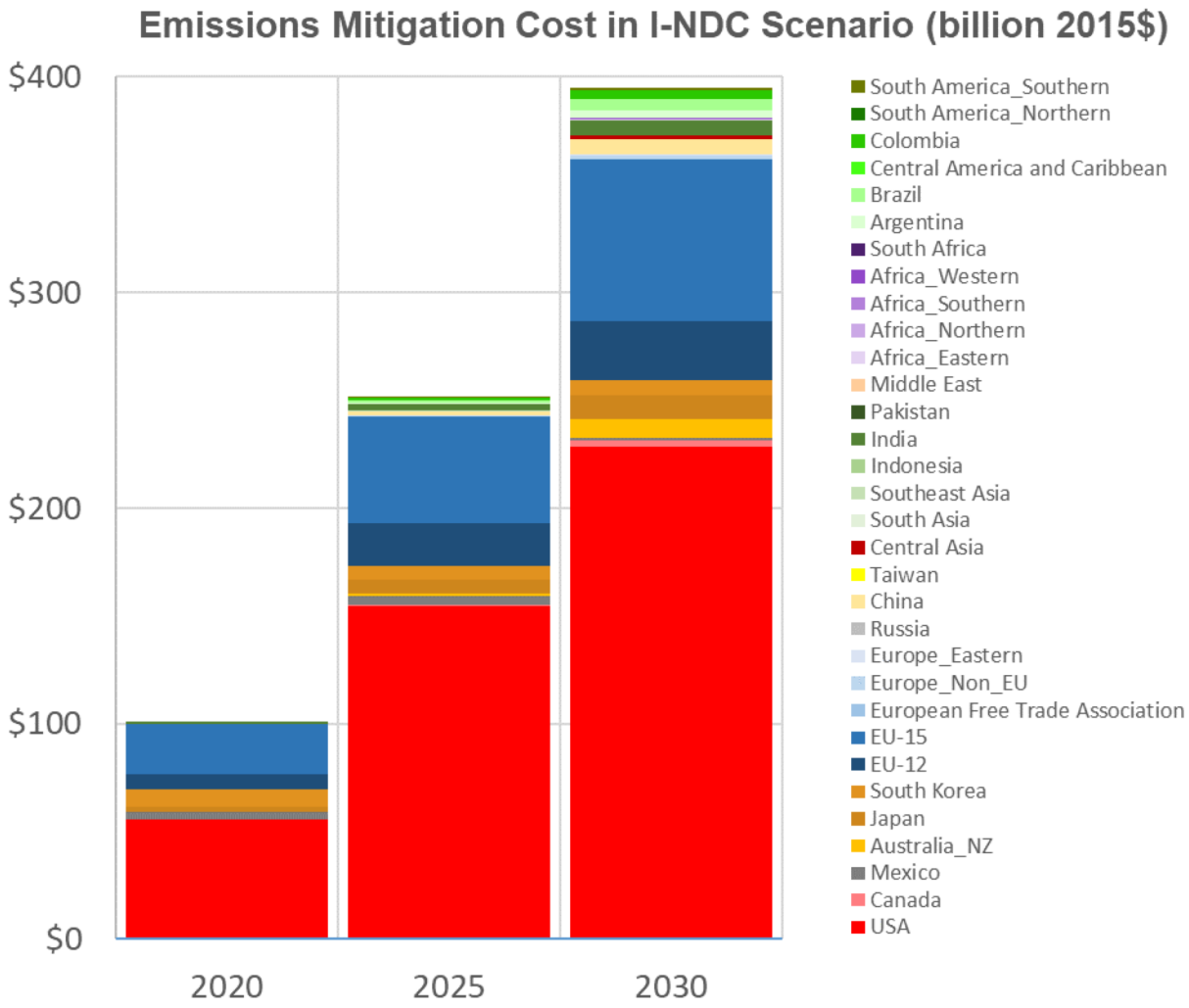


Enhancing Ambition

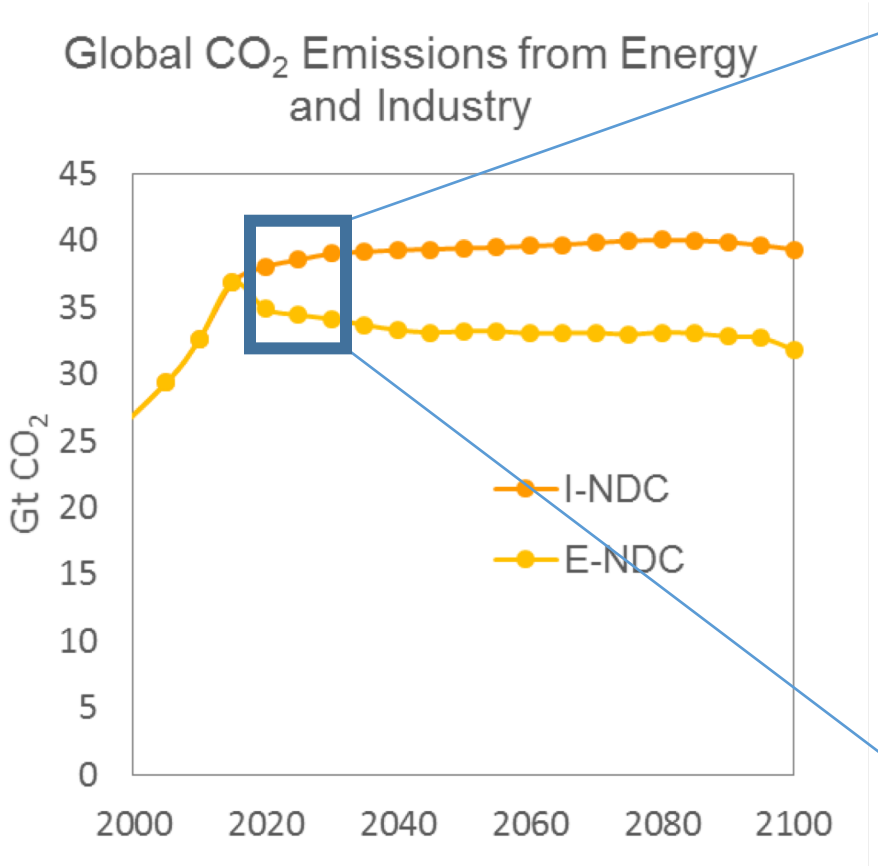
Potential Enhanced Ambition

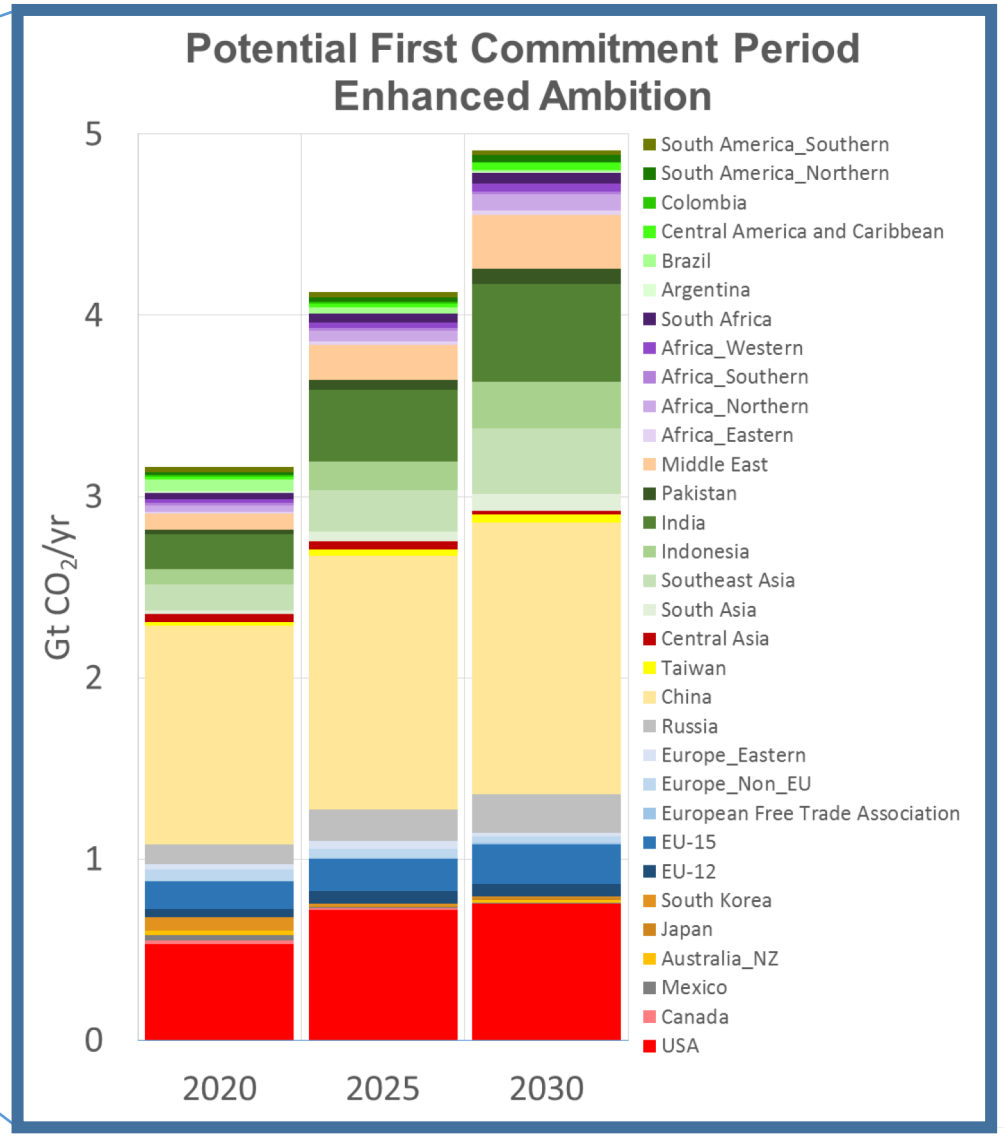
Interpret the cost of achieving each country's NDC as a willingness to pay.

- Apply each country's savings from employing Article 6 to jointly achieving additional mitigation.
- Total cost will be the same as in the I-NDC scenario
- Emissions mitigation will increase.



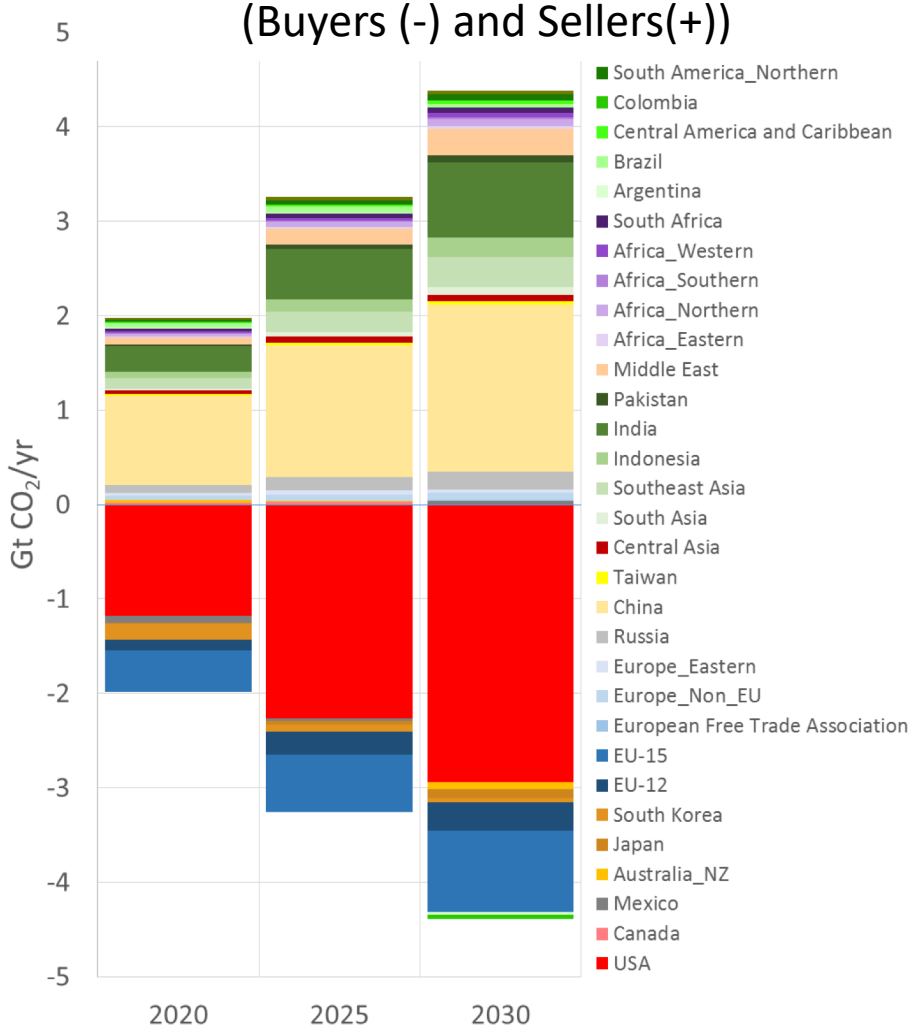
Enhanced Ambition Enabled by Article 6



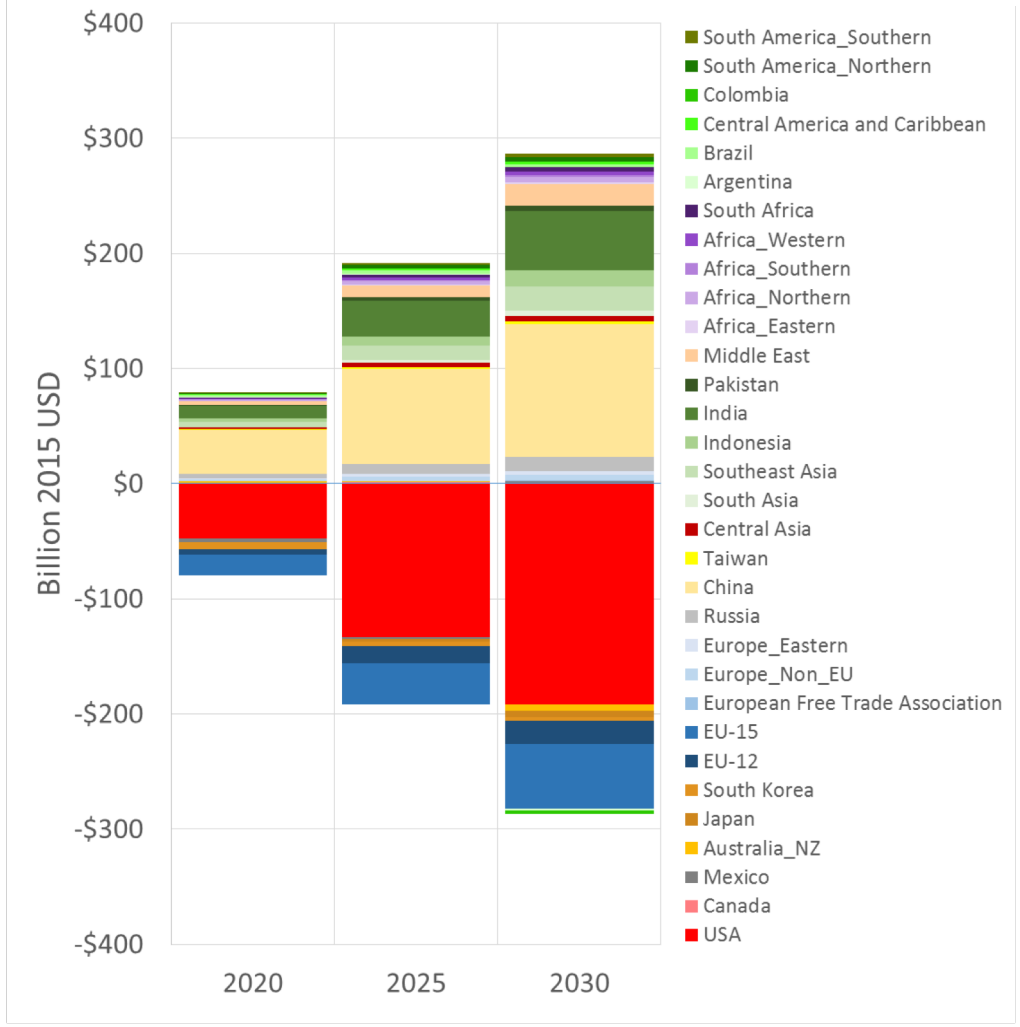


Potential Market Size with Enhanced Ambition

Physical Trades with Enhanced Ambition
(Buyers (-) and Sellers(+))



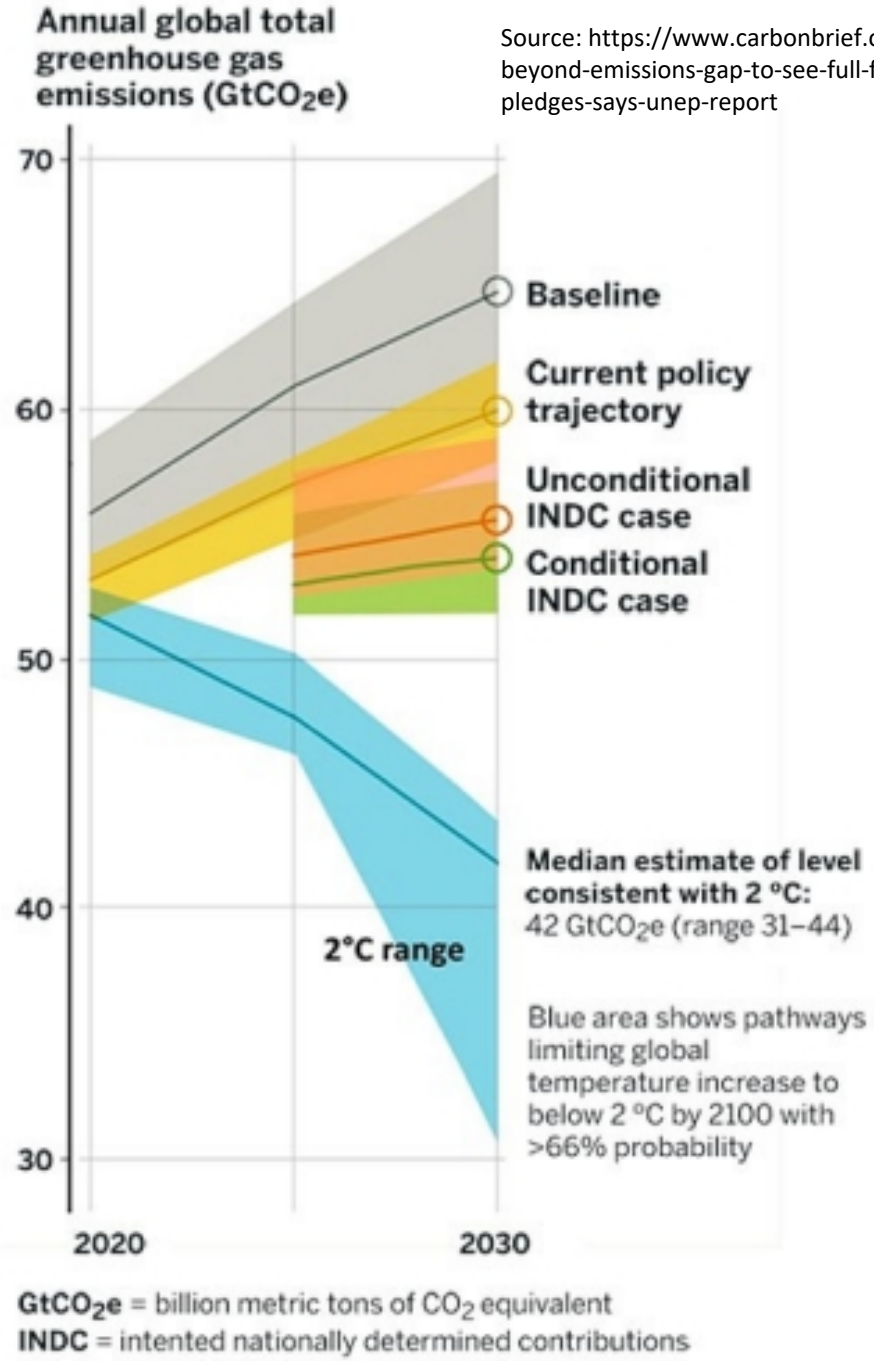
Financial Transactions with Enhanced Ambition
(Buyers (-) and Sellers(+))



How Valuable is Article 6?

Article 6 holds significant potential to reduce cost and enhance ambition

- Everyone could be better off through collaboration
- Estimated potential
  - 2030 ~$250 billion 2015 US$
  - 2050 ~$350 billion 2015 US$
  - 2100 ~$990 billion 2015 US$
- Mitigation could be enhanced by 5$GtCO_2$/year in 2030



Source: https://www.carbonbrief.org/look-beyond-emissions-gap-to-see-full-force-of-climate-pledges-says-unep-report

The Challenges

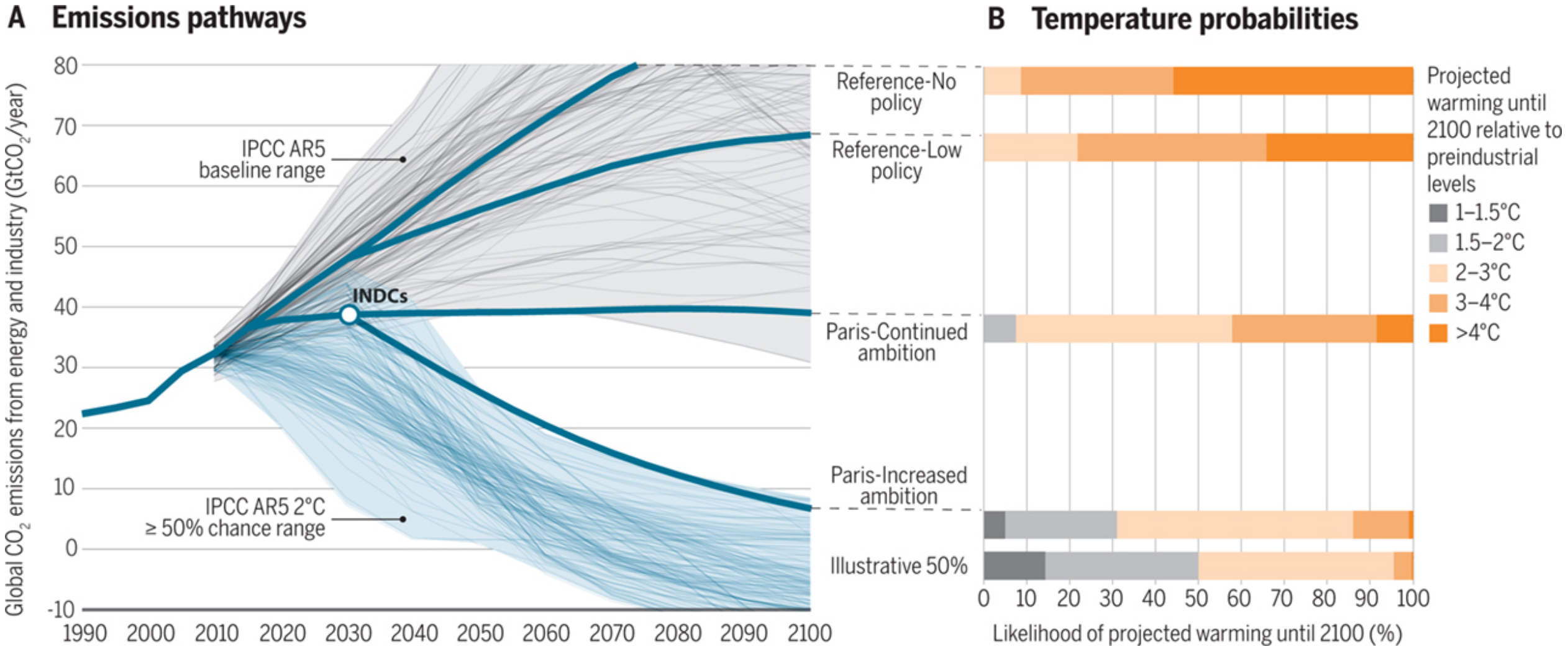
- **Near-term challenges**:
  - How to translate heterogeneous NDCs into Internationally Transferred Mitigation Outcomes (ITMOs)?
  - Ensure that rules prevent “hot air”
    - Calvin, et al. showed that seemingly air-tight rules for CDM-types of emissions trading can have perverse macro-outcomes.
  - Can clubs collaborate to extract the benefits without a formal trading regime?
- **Longer-term challenges:**
  - How to create incentives to increase ambition?
  - Can dynamic incentives be developed to increase ambition?

Source: https://unfccc.int/files/focus/long-term_strategies/application/pdf/mid_century_strategy_report-final_red.pdf

DISCUSSION

BACKUP SLIDES

Global CO_2 emissions and probabilistic temperature outcomes of Paris



Source: Allen A. Fawcett, Gokul C. Iyer, Leon E. Clarke, James A. Edmonds, Nathan E. Hultman, Haewon C. McJeon, Joeri Rogelj, Reed Schuler, Jameel Alsalam, Ghassem R. Asrar, Jared Creason, Minji Jeong, James McFarland, Anupriya Mundra, Wenjing Shi. 2015. Can Paris pledges avert severe climate change? Science 350(6266):1168-9.

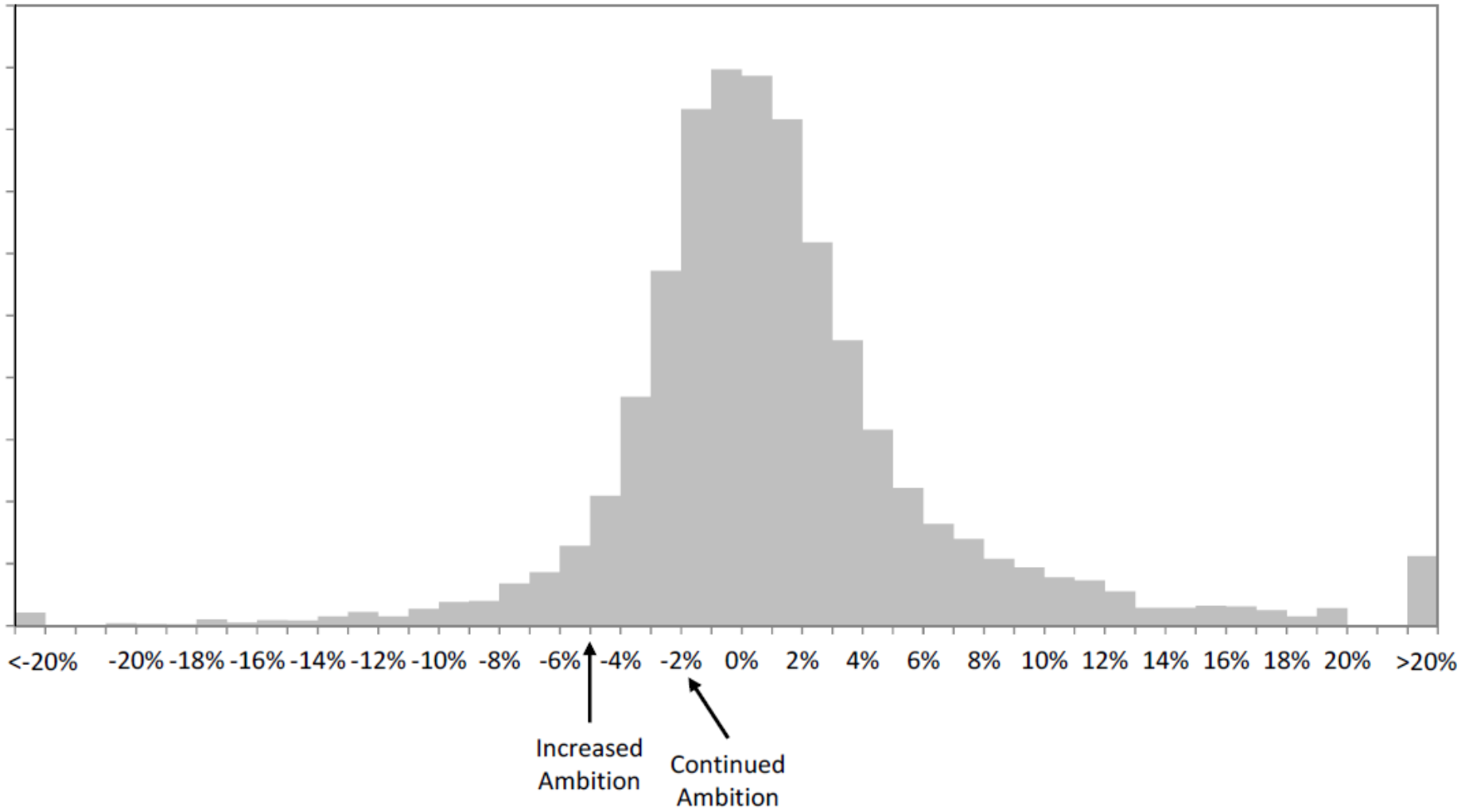


Fig. S2. Historical distribution of 10 year running average of country level rates of change in CO_2/GDP (1900-2008) (*54, 55*). Negative rates of change are referred to as "decarbonization rates". Rates with absolute values larger than 20% are associated with newly established countries and countries that ceased to exist.

Source: Allen A. Fawcett, Gokul C. Iyer, Leon E. Clarke, James A. Edmonds, Nathan E. Hultman, Haewon C. McJeon, Joeri Rogelj, Reed Schuler, Jameel Alsalam, Ghassem R. Asrar, Jared Creason, Minji Jeong, James McFarland, Anupriya Mundra, Wenjing Shi. 2015. Can Paris pledges avert severe climate change? Science 350(6266):1168-9.

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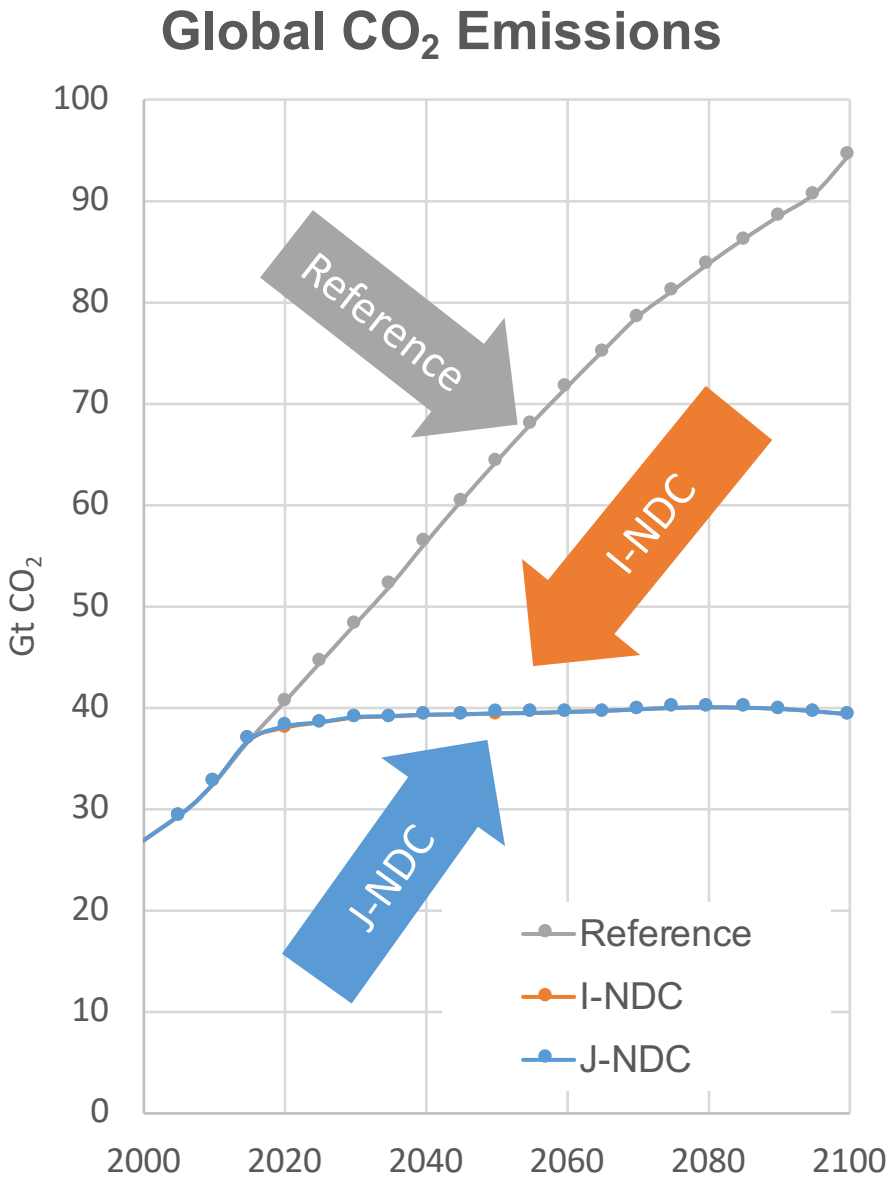
Our Approach: 3 Scenarios

- **Reference** scenario—no emissions mitigation—GCAM SSP2.
- NDCs implemented independently **(I-NDC).**
- NDCs are implemented jointly with Article 6 **(J-NDC).**



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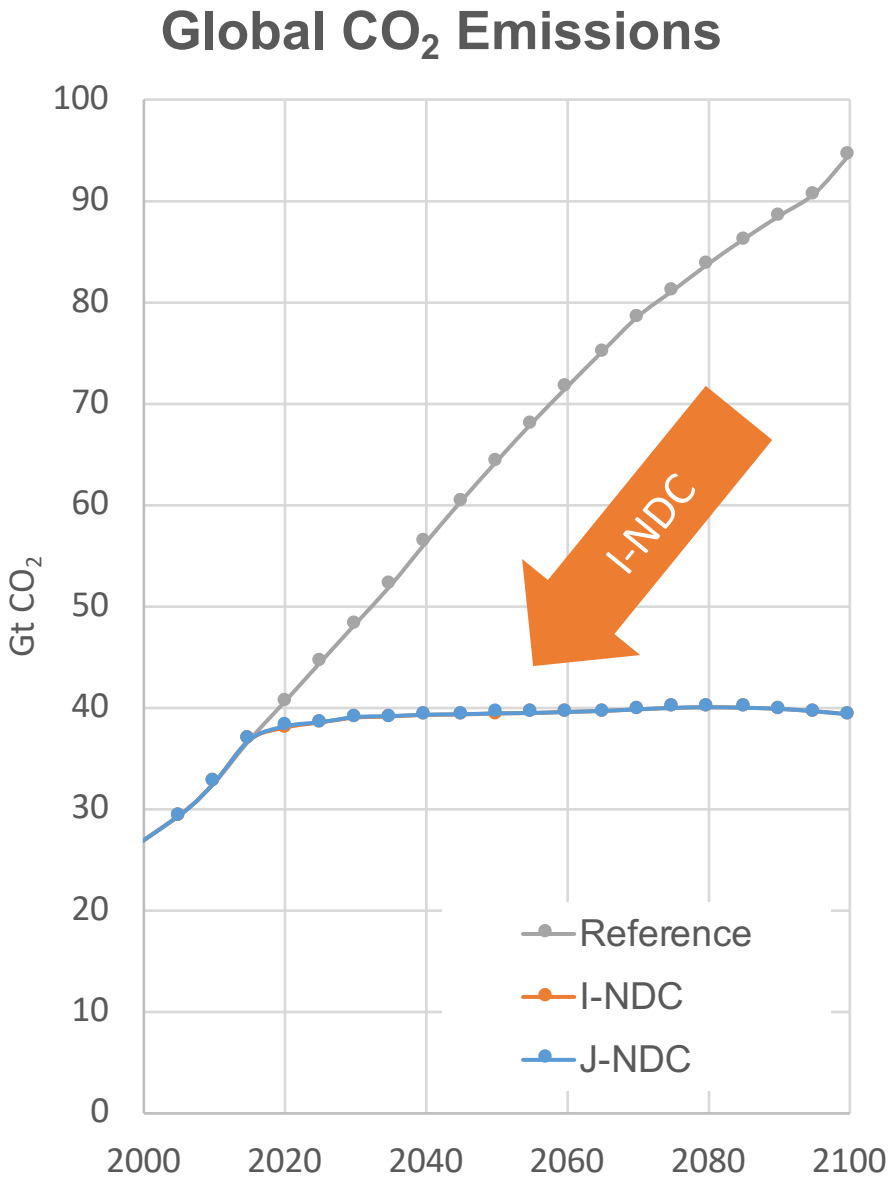
The I-NDC Scenario

- We transform each NDC into an absolute emissions limit.
  - We use Fawcett, et al. (2015)*
- Each country implements its NDC in a cost-effective manner
  - This assumption is an important simplification.
  - Since countries are using heterogeneous approaches, national mitigation costs will be higher.
  - Thus, our estimate of economic value is an **underestimate** of the potential value of Article 6.



*Allen A. Fawcett, Gokul C. Iyer, Leon E. Clarke, James A. Edmonds, Nathan E. Hultman, Haewon C. McJeon, Joeri Rogelj, Reed Schuler, Jameel Alsalam, Ghassem R. Asrar, Jared Creason, Minji Jeong, James McFarland, Anupriya Mundra, Wenjing Shi. 2015. Can Paris pledges avert severe climate change? Science 350(6266):1168-9.

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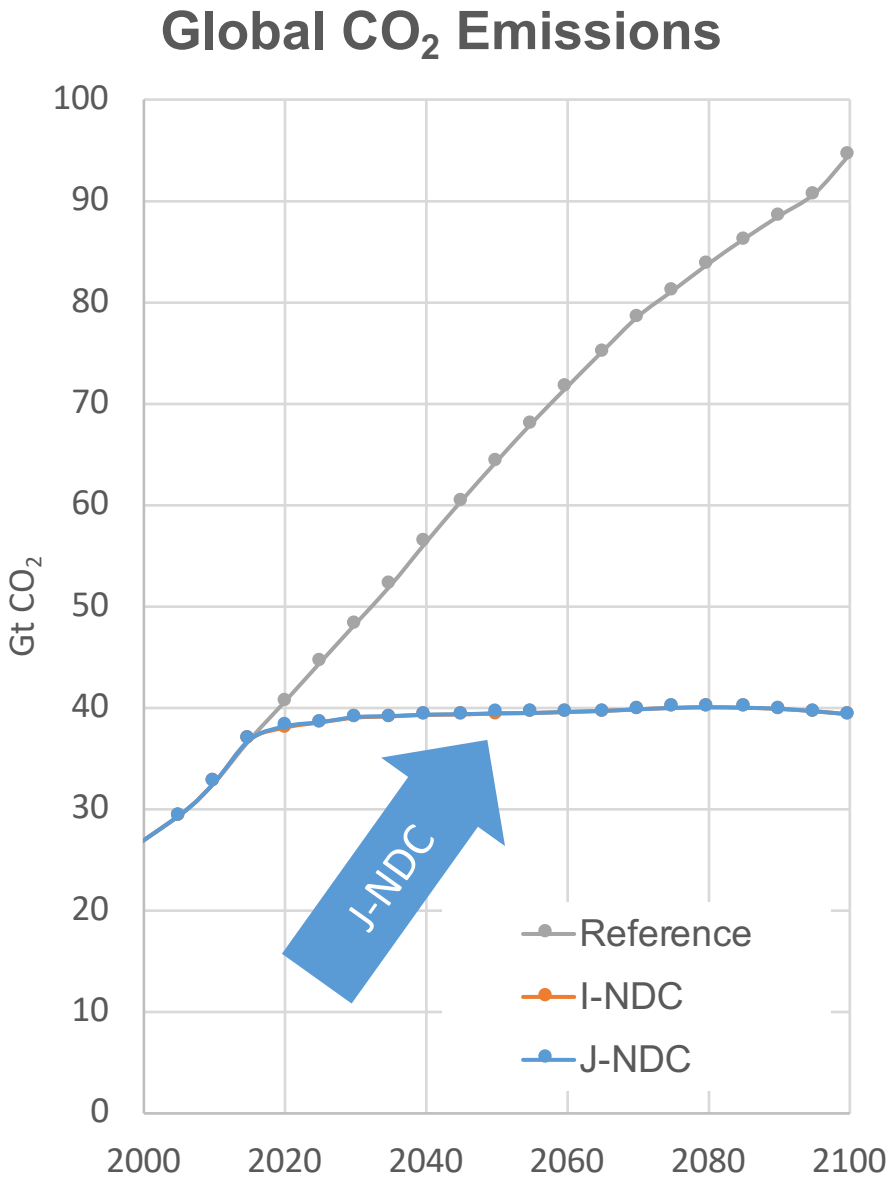
The J-NDC Scenario

- We assume that each country's NDC can be treated as a fixed emissions limit for that country.
- Any additional emissions can be sold into a global emissions mitigation market.
- We recognize that this translation is a major challenge to implementing Article 6 in the real world.
- Our goal is simpler—estimate the **potential** economic value of Article 6.
- If the potential economic value is small the value of the translation step is similarly low.



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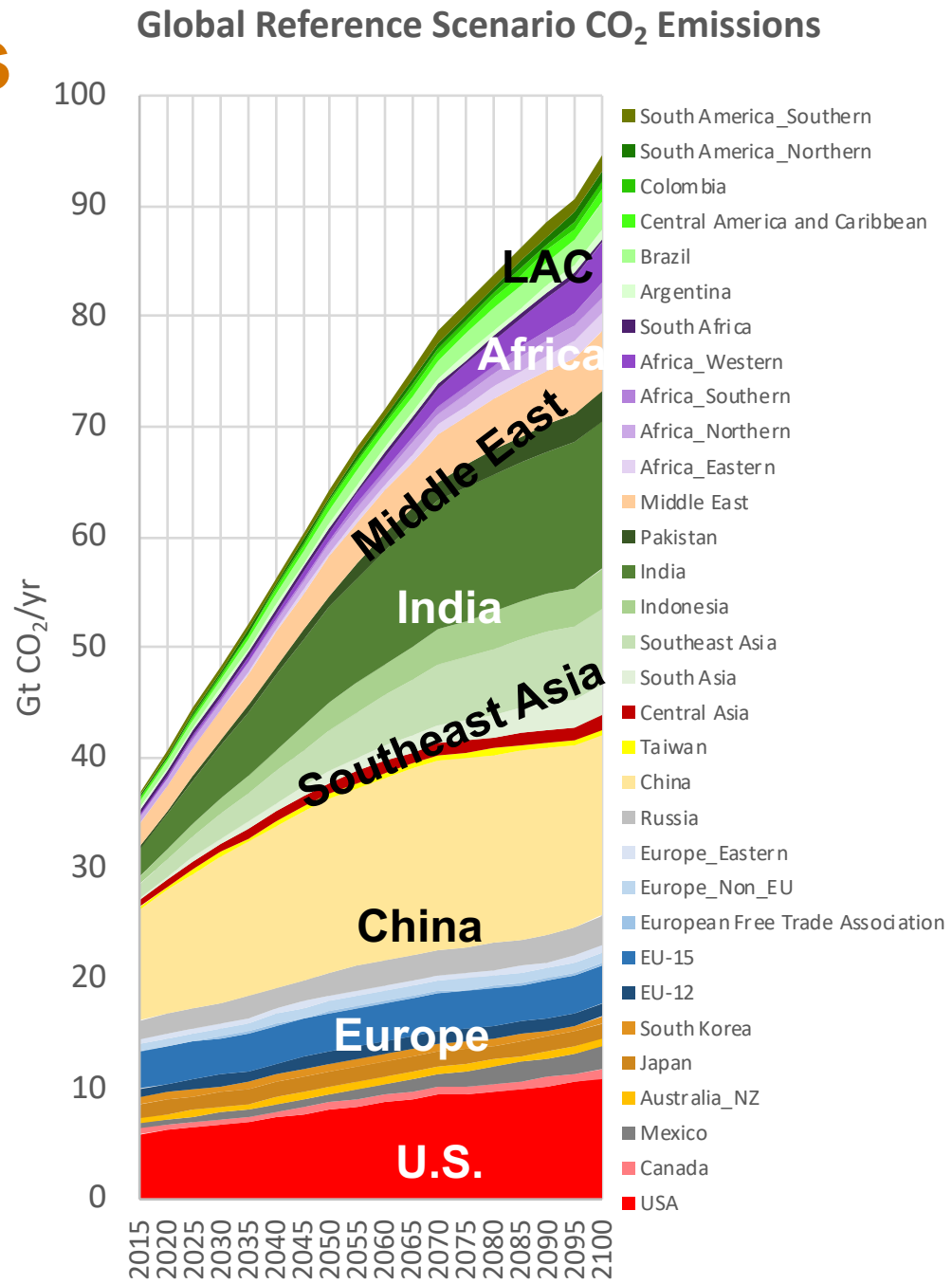
Reference regional emissions

- Global emissions grow
- Geopolitical distribution of emissions evolves over time



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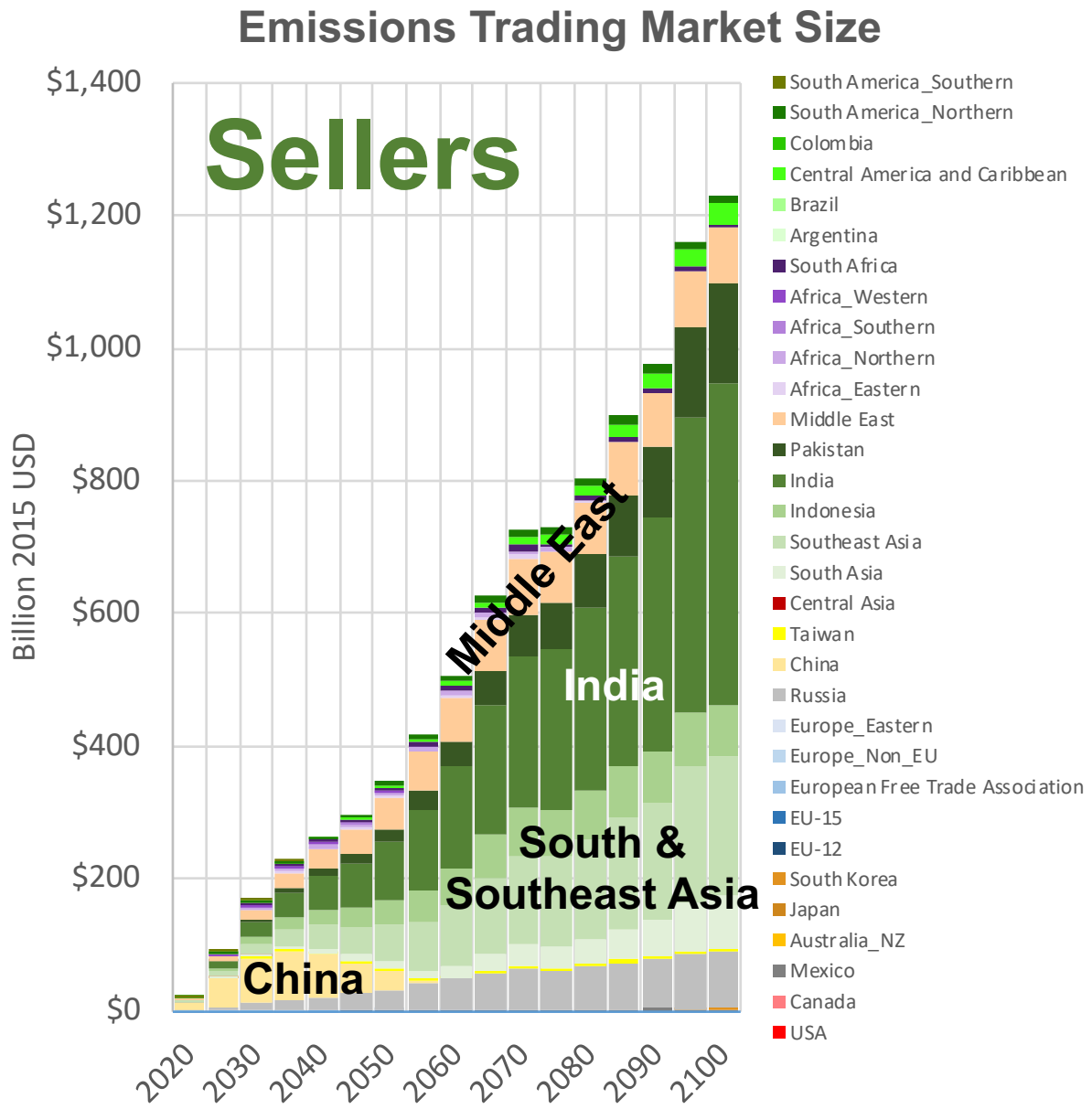

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