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Transition Scenarios

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What Scenarios Should We be Considering?

- Many long-term, global scenarios have assumed efficient carbon regimes: all countries participate fully in mitigation from the outset.
- Reality is unlikely meet this ideal.
- Strategy must consider the more likely possibility of a less coordinated and efficient future.
  - What policy structures are possible or likely?
  - What might these policy structures imply for the costs and burdens of stabilization?
  - What might they imply for strategic decisions such as technology development and deployment?

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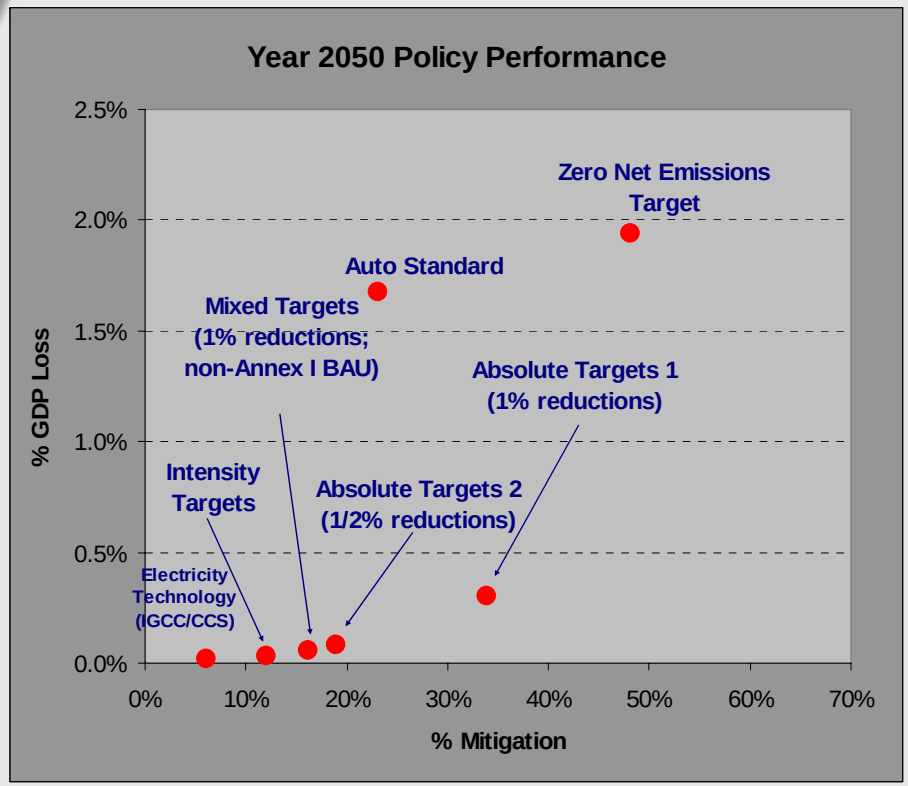
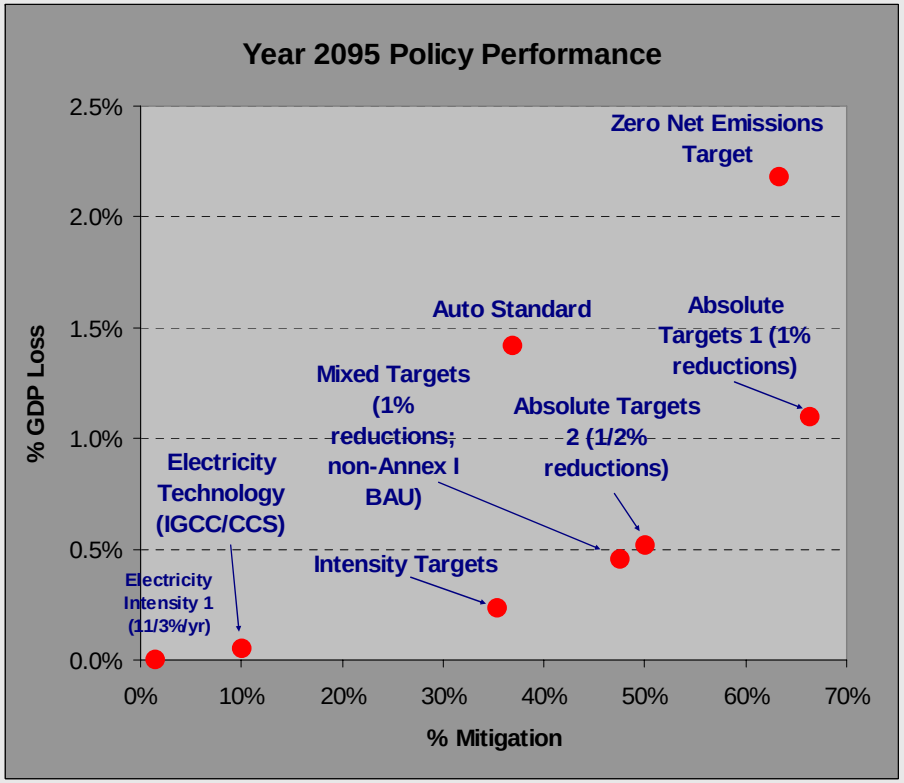
The Pocantico Process

A look at specific policy proposals.





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Outline of this Research: Second-Best Paths to Stabilization

- Consider stabilization at four levels: 450 ppm, 550 ppm, 650 ppm, and 750 ppm.
- Consider four stabilization regimes:
  - Set 1: Idealized—perfect global where and when flexibility.
  - Set 2: Add graduated accession—some countries wait to participate.
  - Set 3: Add regionally differentiated regimes—participating countries face differentiated carbon prices.
  - Set 4:Add sectorally differentiated regimes—sectors face differentiated carbon prices.
- We will talk about the first three of these today.

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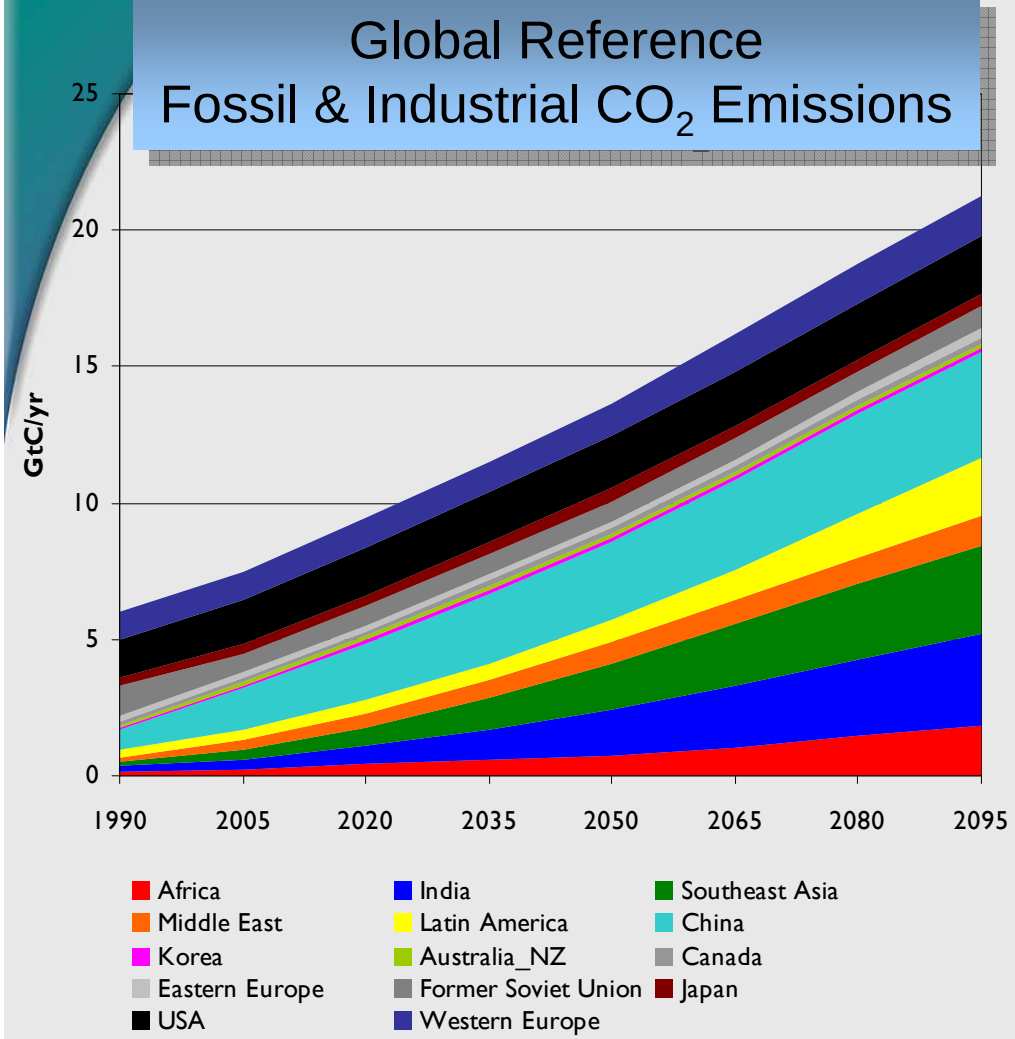
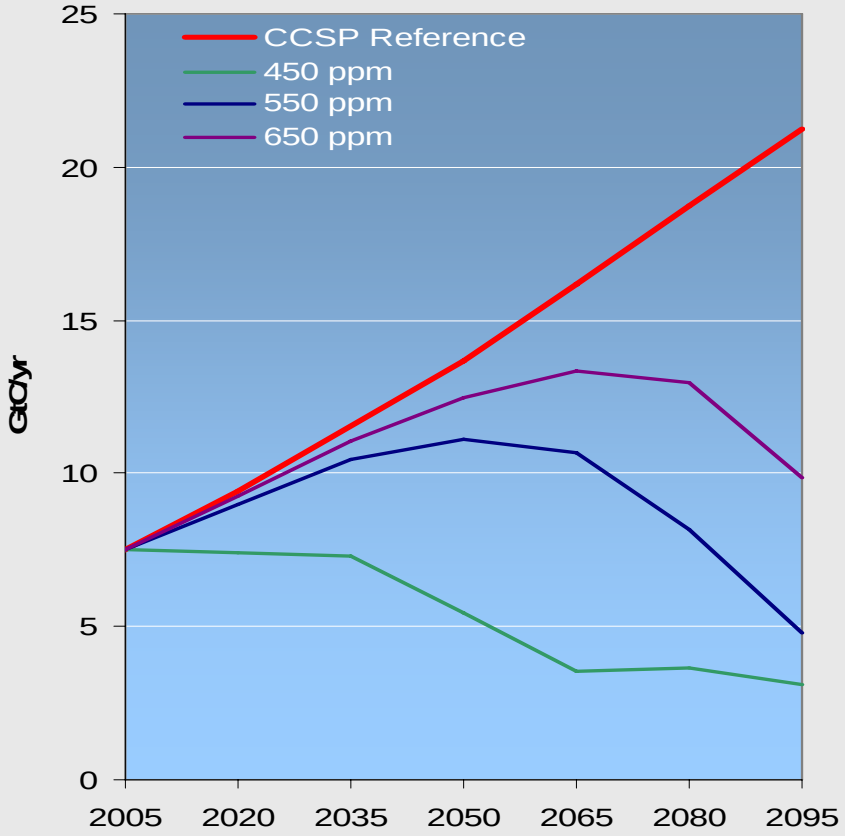
The Reference Scenario

The GTSP Reference Scenario
The Importance of Participation

Global Reference
Fossil & Industrial CO_2 Emissions





Global Emissions in Reference & Stabilization

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Stabilization Set I Full Participation

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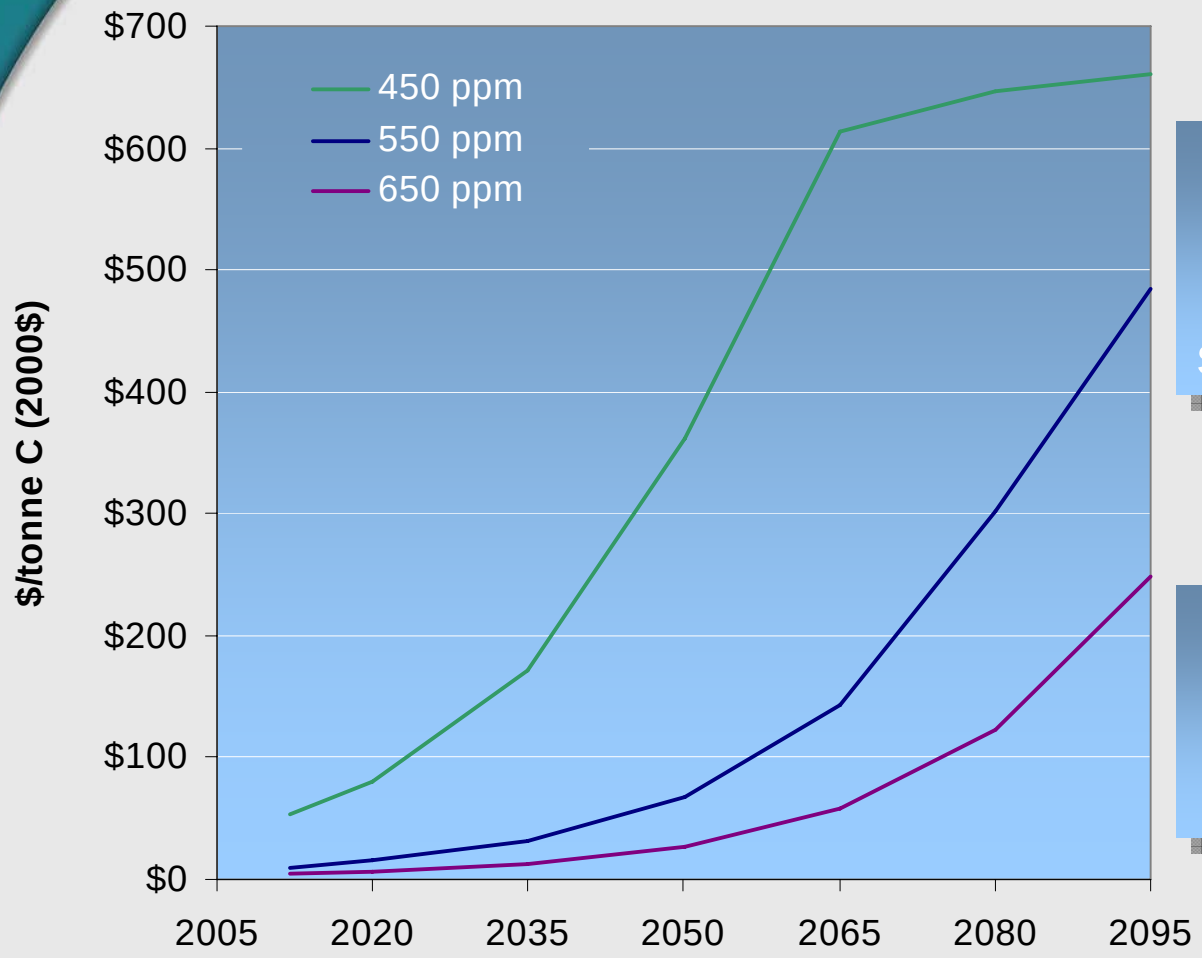
Scenario Set 1: Full Participation

- Stabilize CO_2 concentrations
  - 450 ppm, 550 ppm, 650 ppm.
  - Sectoral carbon prices—All EQUAL.
  - Regional carbon prices—All EQUAL.
  - Time path of carbon prices—Peck-Wan-Hotelling.
- Notes:
  - We have chosen CO_2 rather than radiative forcing for simplicity. We have further simplified the analysis by assuming a fixed agriculture-land-use emissions path. Unmanaged ecosystem extent and composition is fixed.
  - This case sets an economically efficient benchmark for comparison with other cases.

Scenario Set 1
The Global Carbon Price

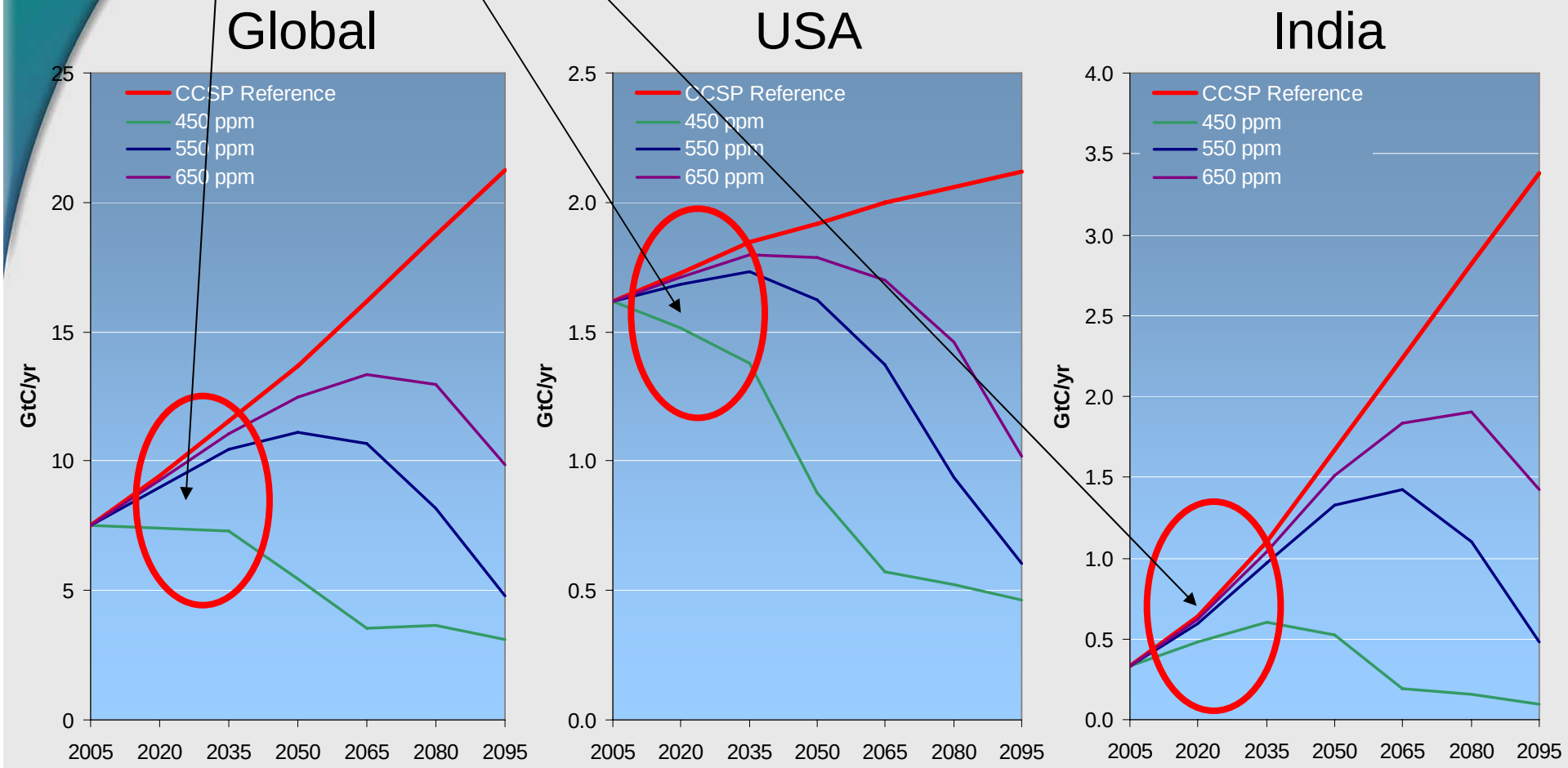


The carbon price rises at roughly the rate of interest until stabilization is reached.

Today's price depends on tomorrow's technology

Scenario Set I
Industrial CO_2 Emissions

450 ppm has fundamentally different near-term implications than 550 ppm and above



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Stabilization Set 2 Graduated Accession

Stabilization Scenario Set 2
Graduated Accession

- Stabilize CO2 concentrations
  - 450 ppm, 550 ppm, 650 ppm.
  - Sectoral carbon prices—All EQUAL.
  - Regional carbon prices—All EQUAL.
  - Time path of carbon prices—Peck-Wan-Hotelling.
  - Staggered accession based on per capita income.
    - Alternative accession cases—first group enters: 2020-2035, 2035-2050, 2050-2065

Countries come in at the global market price of carbon

- Notes:
  - We assume that all Annex I nations participate in an international protocol by 2020 and that others join at different times based on per capita income. Non-Annex I participation is keyed to China's entry date.

Order of Regional Participation
(1st NA1 Group Enters 2020-2035)

2005-2020	2020-2035	2035-2050	2050-2065	2065-2080	2080-2095
USA	USA	USA	USA	USA	USA
Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ
Canada	Canada	Canada	Canada	Canada	Canada
W. Europe	W. Europe	W. Europe	W. Europe	W. Europe	W. Europe
E. Europe	E. Europe	E. Europe	E. Europe	E. Europe	E. Europe
Japan	Japan	Japan	Japan	Japan	Japan
FSU	FSU	FSU	FSU	FSU	FSU
	Korea	Korea	Korea	Korea	Korea
	China	China	China	China	China
	Latin America	Latin America	Latin America	Latin America	Latin America
	Mideast	Mideast	Mideast	Mideast	Mideast
		Other SE Asia	Other SE Asia	Other SE Asia	Other SE Asia
		India	India	India	India
			Africa	Africa	Africa

NA1 1st Group Enters 2020-2035

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Order of Regional Participation
(1st NA1 Group Enters 2035-2050)

2005-2020	2020-2035	2035-2050	2050-2065	2065-2080	2080-2095
USA	USA	USA	USA	USA	USA
Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ
Canada	Canada	Canada	Canada	Canada	Canada
W. Europe	W. Europe	W. Europe	W. Europe	W. Europe	W. Europe
E. Europe	E. Europe	E. Europe	E. Europe	E. Europe	E. Europe
Japan	Japan	Japan	Japan	Japan	Japan
FSU	FSU	FSU	FSU	FSU	FSU
		Korea	Korea	Korea	Korea
		China	China	China	China
		Latin America	Latin America	Latin America	Latin America
		Mideast	Mideast	Mideast	Mideast
			Other SE Asia	Other SE Asia	Other SE Asia
			India	India	India
				Africa	Africa

NA1 1st Group Enters 2035-2050

Order of Regional Participation
(1st NA1 Group Enters 2050-2065)

2005-2020	2020-2035	2035-2050	2050-2065	2065-2080	2080-2095
USA	USA	USA	USA	USA	USA
Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ	Australia & NZ
Canada	Canada	Canada	Canada	Canada	Canada
W. Europe	W. Europe	W. Europe	W. Europe	W. Europe	W. Europe
E. Europe	E. Europe	E. Europe	E. Europe	E. Europe	E. Europe
Japan	Japan	Japan	Japan	Japan	Japan
FSU	FSU	FSU	FSU	FSU	FSU
			Korea	Korea	Korea
			China	China	China
			Latin America	Latin America	Latin America
			Mideast	Mideast	Mideast
				Other SE Asia	Other SE Asia
				India	India
					Africa

NA1 1st Group Enters 2050-2065

Note that India comes in one period after China

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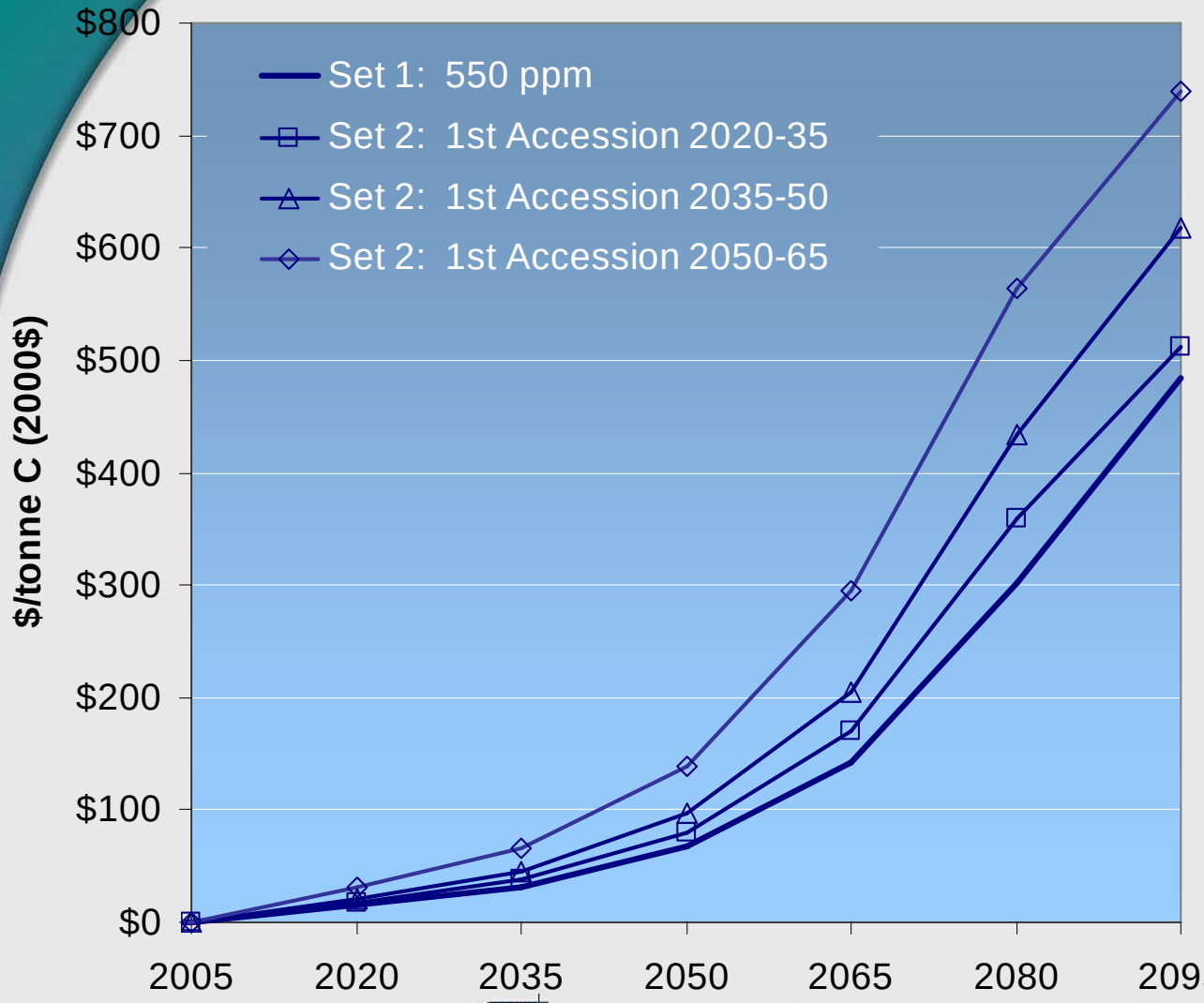
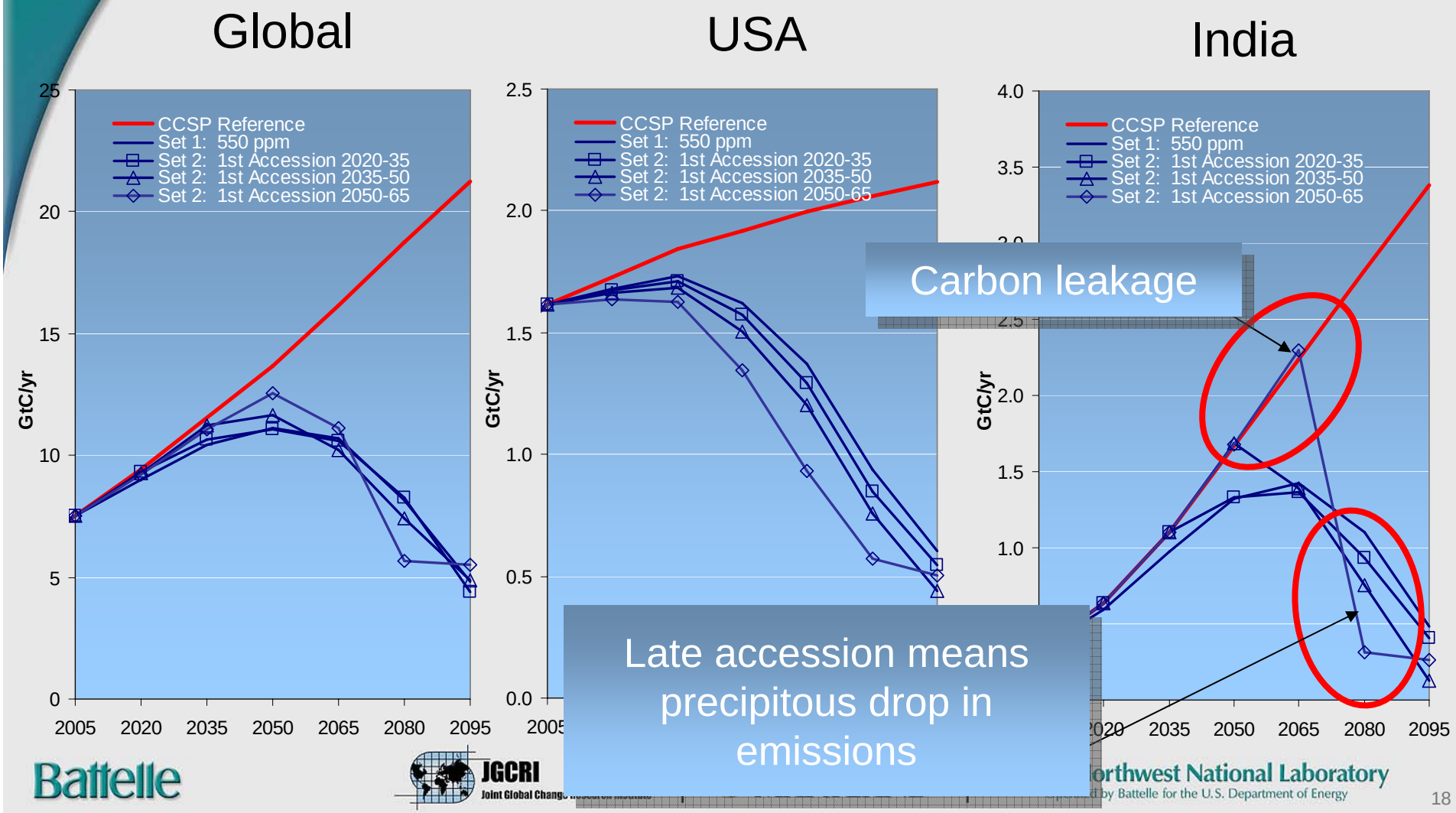
Scenario Set 2, 550 ppm

Scenario Set 2, 550 ppm Global Carbon Price



Effect on carbon prices is not extreme in the 550 scenario

Scenario Set 2, 550 ppm
Fossil & Industrial CO_2 Emissions



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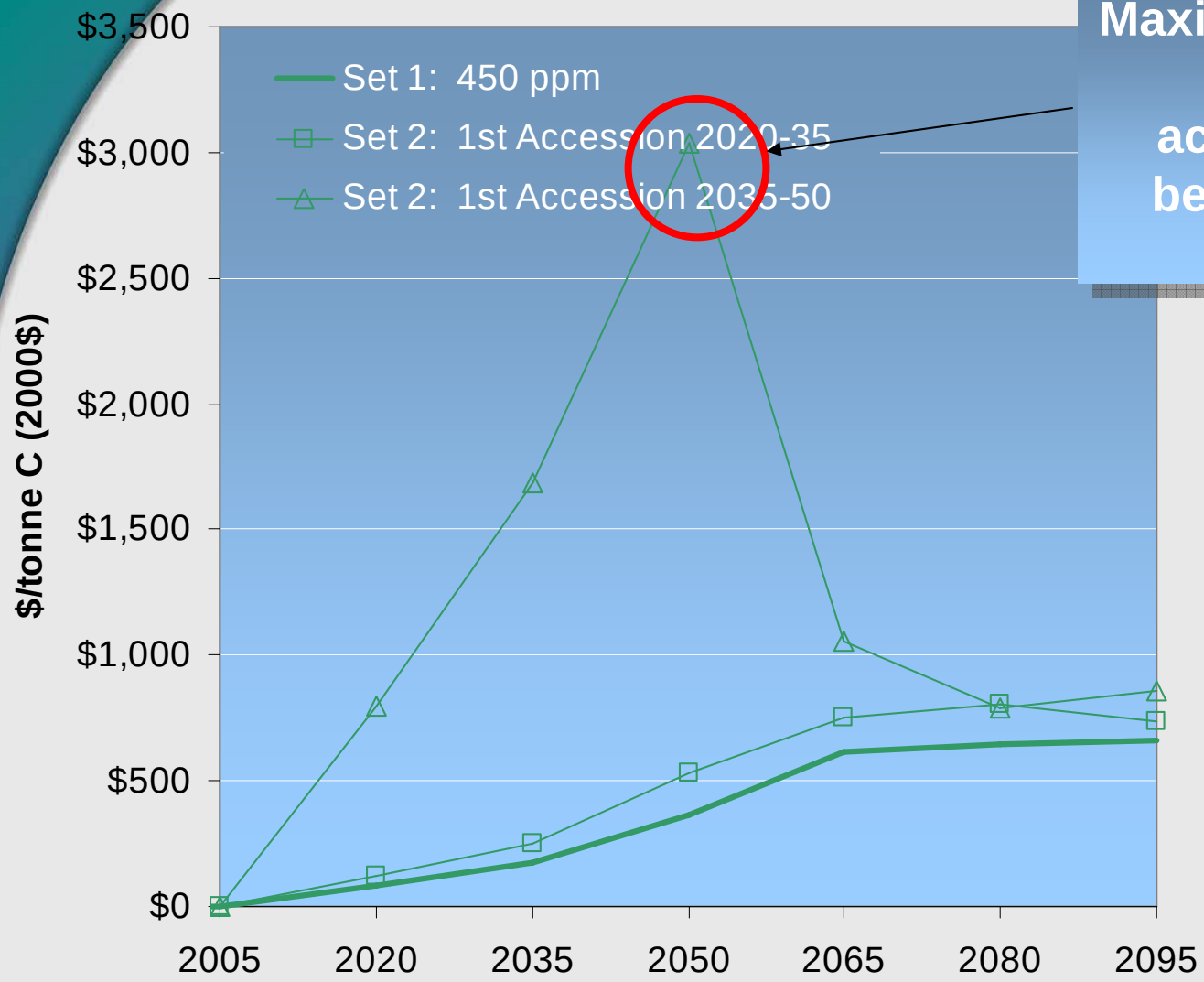
Scenario Set 2, 450 ppm

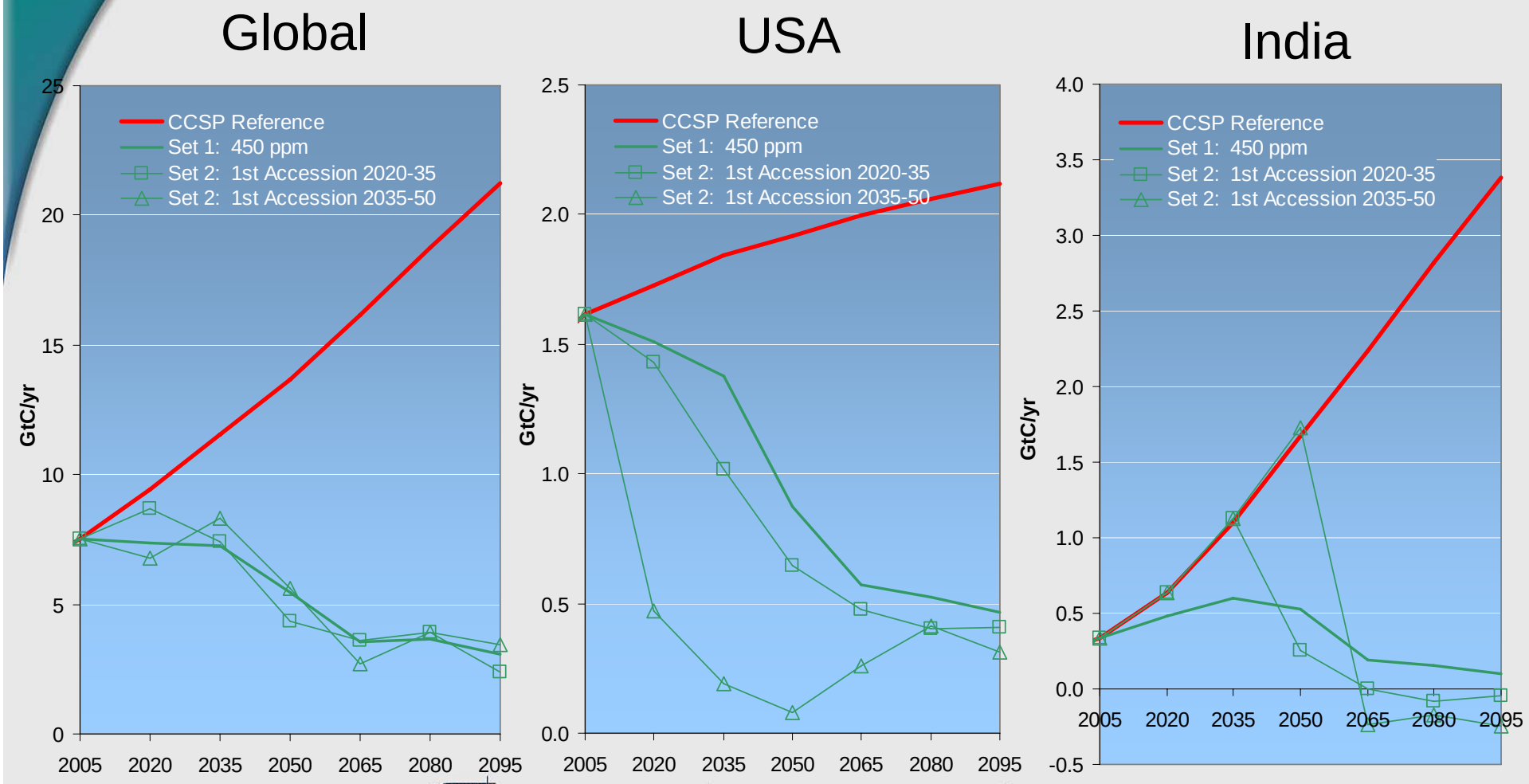
Scenario Set 2, 450 ppm Global Carbon Price



Maximum price just as Non-annex 1 accession begins between 2035 and 2050

Set 2 1st Accession 2050-65 is infeasible!

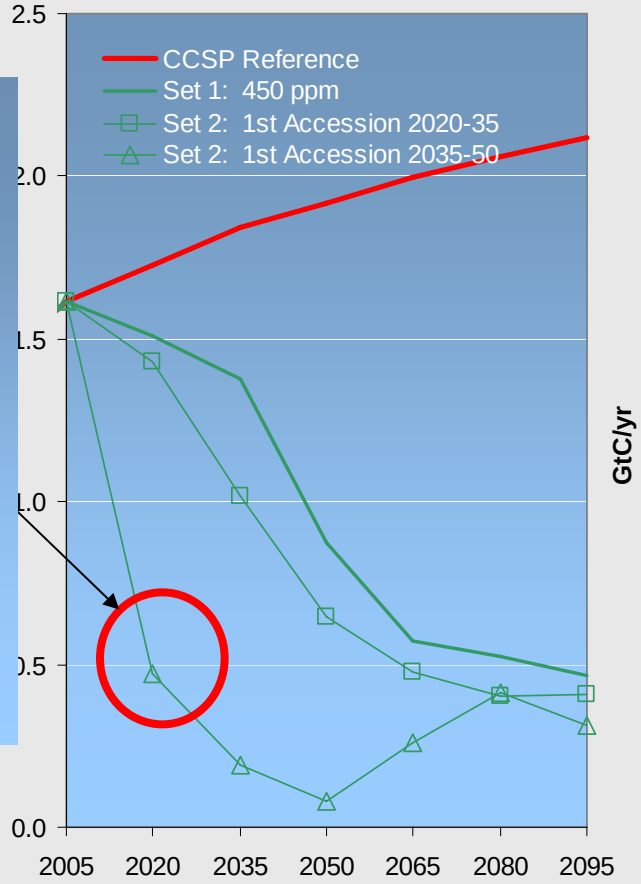
Scenario Set 2, 450 ppm
Fossil & Industrial CO_2 Emissions



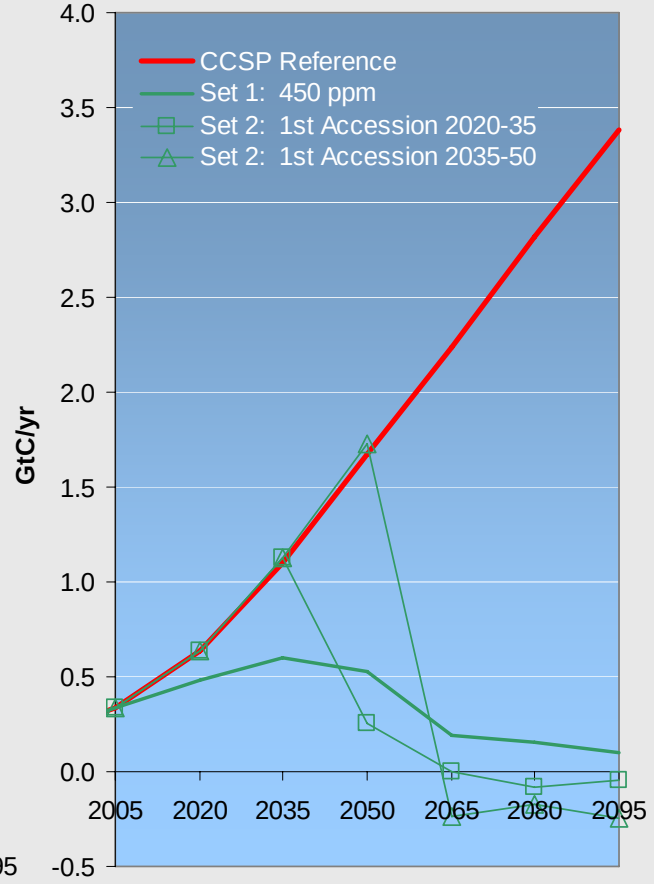
Scenario Set 2, 450 ppm
Fossil & Industrial CO_2 Emissions

Global

USA



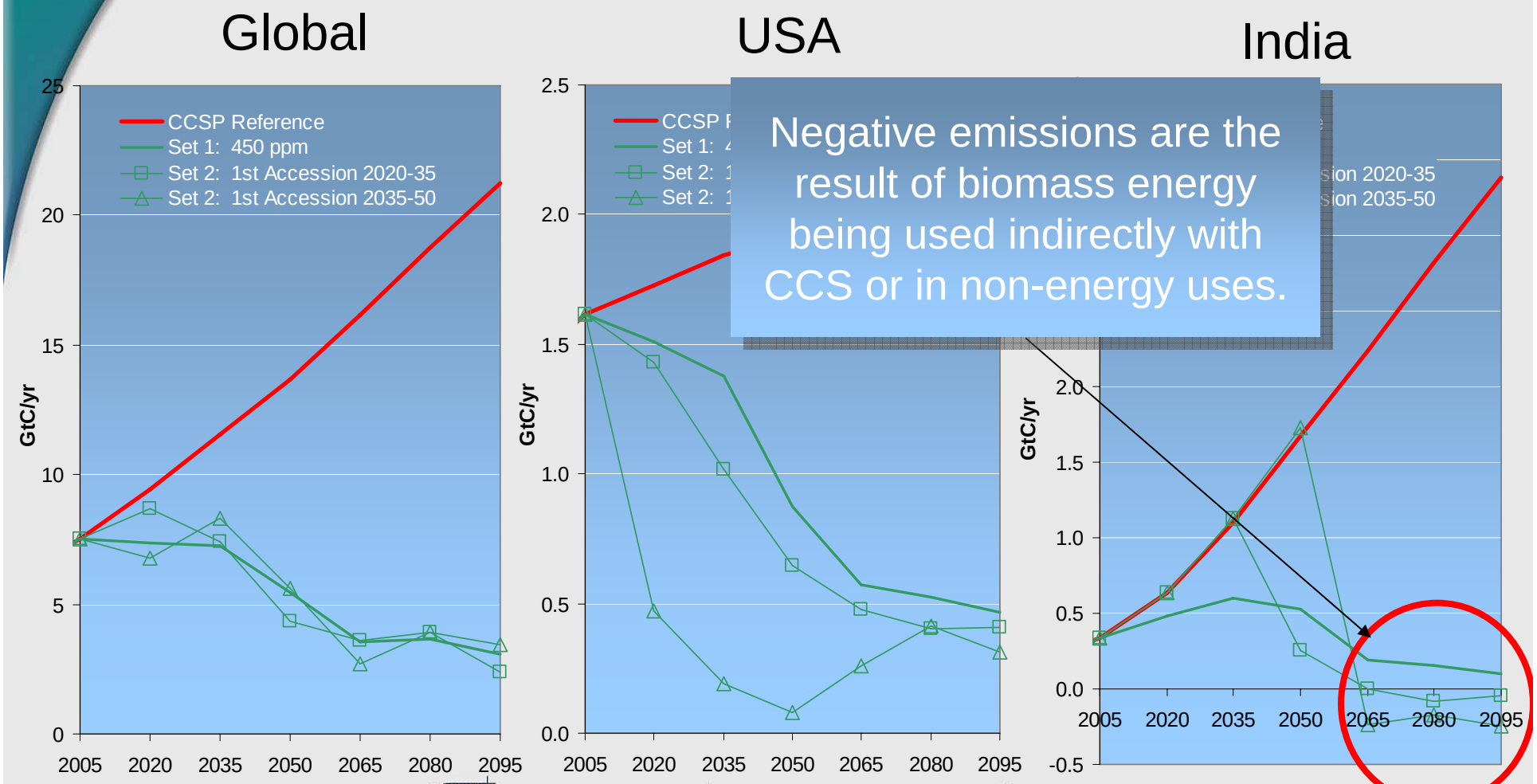
India



Two periods of delay mean 2/3 reduction in US emissions by 2020.

Accession delay past 2050 is totally infeasible for 450 ppm.

Scenario Set 2, 450 ppm
Fossil & Industrial CO_2 Emissions



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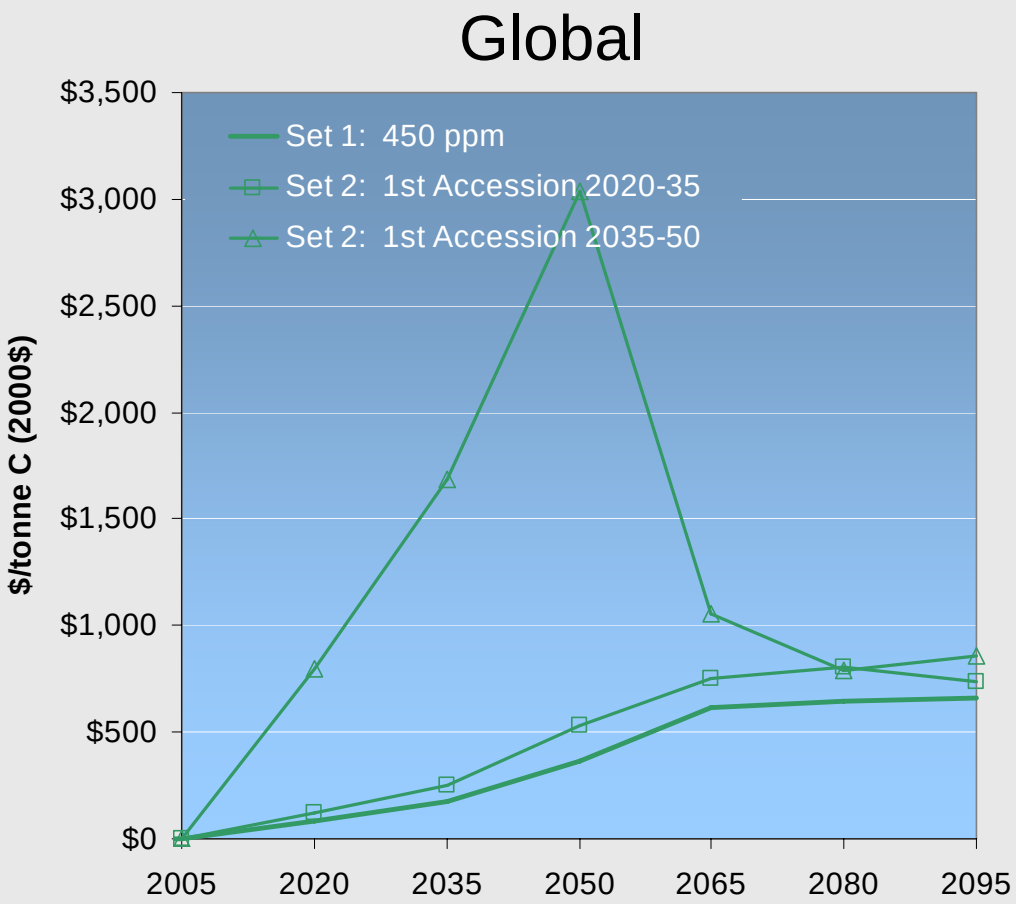
Carbon Prices in the Annex I and Non-Annex I

- Graduated accession or differentiated regimes means different prices in different regions.
  - What does this imply for technology strategy?
- Annex I faces carbon prices of over $1000/tonne C with no abatement in non-Annex I countries.



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Stabilization Set 3 Graduated Accession + Differentiated Prices

Stabilization Scenario Set 3
Graduated Accession
+ Differentiated Prices

- Stabilize CO_2 concentrations
  - 450 ppm, 550 ppm, 650 ppm.
  - Sectoral carbon prices—All EQUAL.
  - Regional carbon prices—each region separate.
  - Time path of carbon prices
    - Annex I follows Peck-Wan-Hotelling.
    - Other regions carbon price proportional to relative per capita income.
  - Staggered accession based on per capita income.
    - Alternative accession cases—first group enters: 2020-2035, 2035-2050, 2050-2065

Difference with Set 2

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Scenario Set 3, 450 ppm

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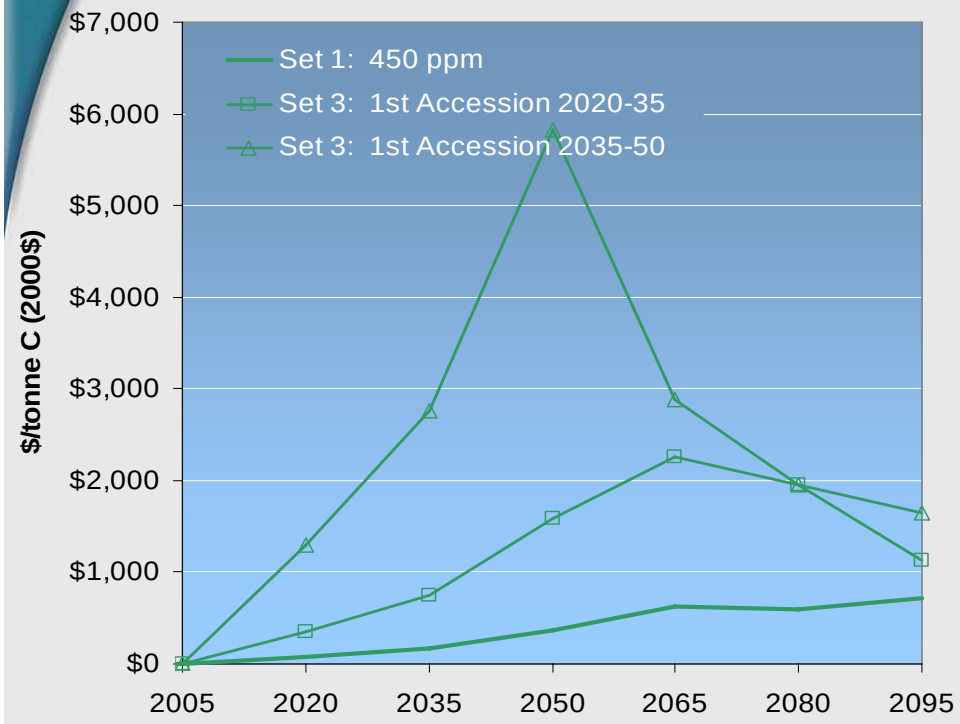
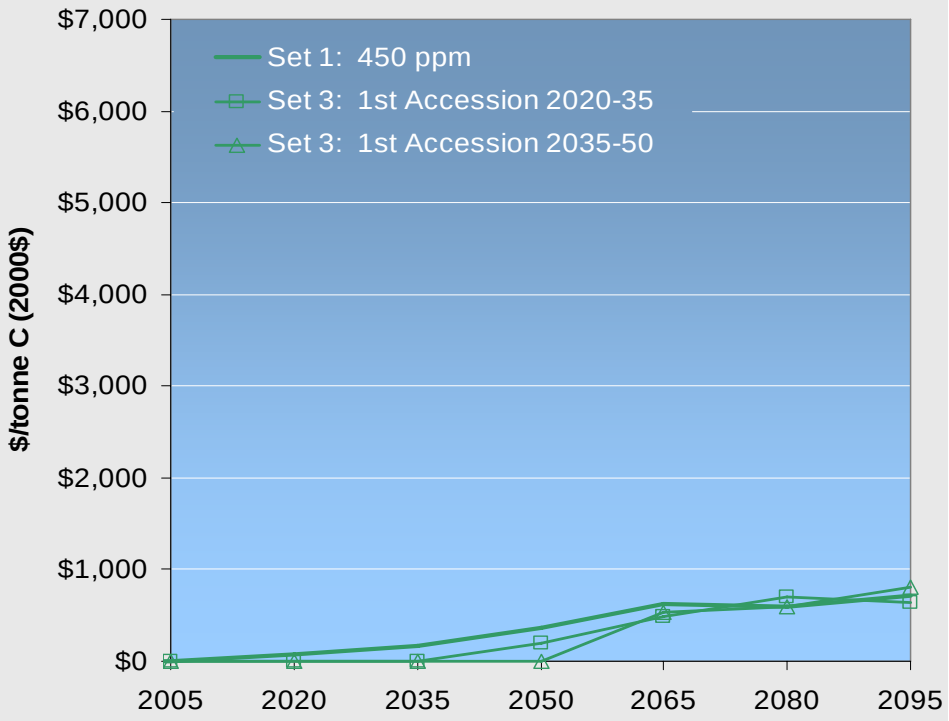
Highly differentiated pricing between Annex I and non-Annex I

Scenario Set 3, 450 ppm Carbon Prices by Region

USA



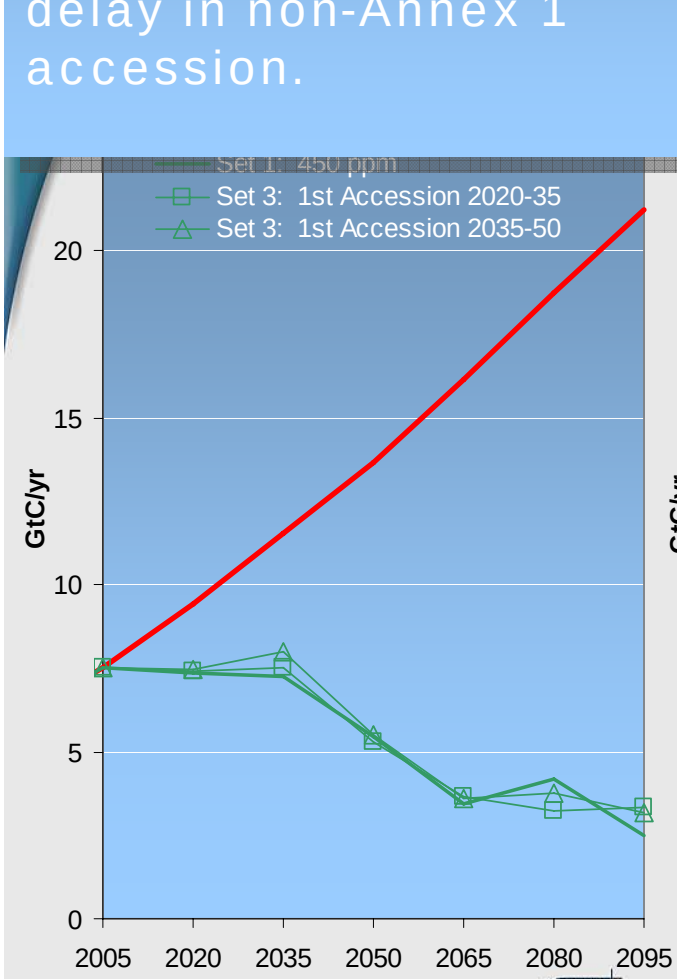
India



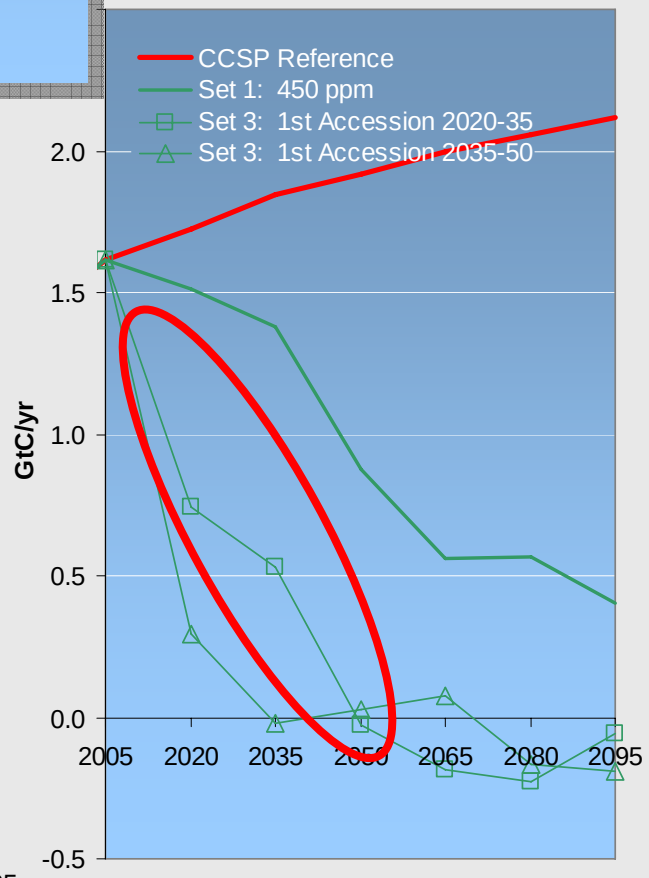
Set 3 1st Accession 2050-65 is infeasible!

There is little difference in the Set 3 global emissions path from Set 1, however USA emissions must be much lower with ANY delay in non-Annex 1 accession.

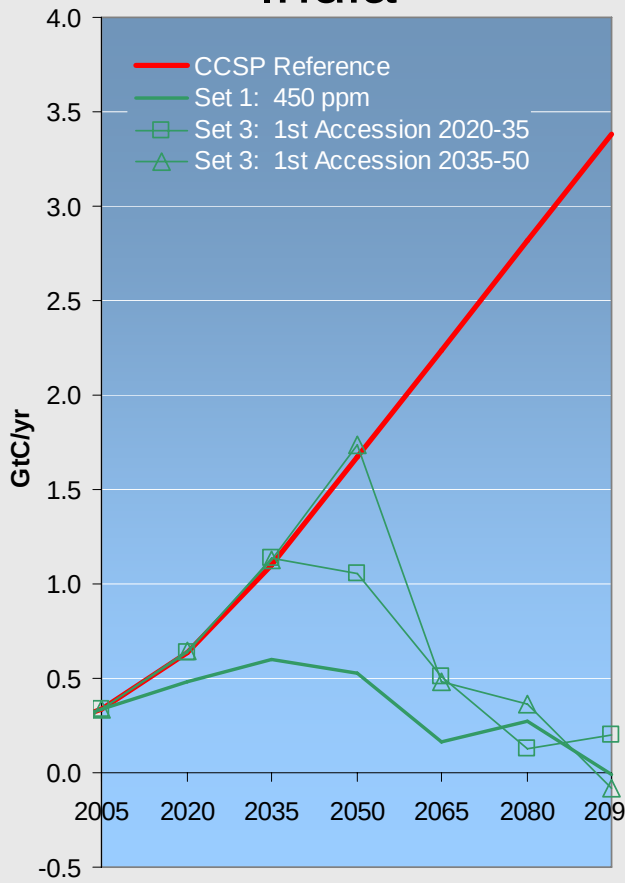
nario Set 3, 450 ppm
Industrial CO_2 Emissions



USA



India



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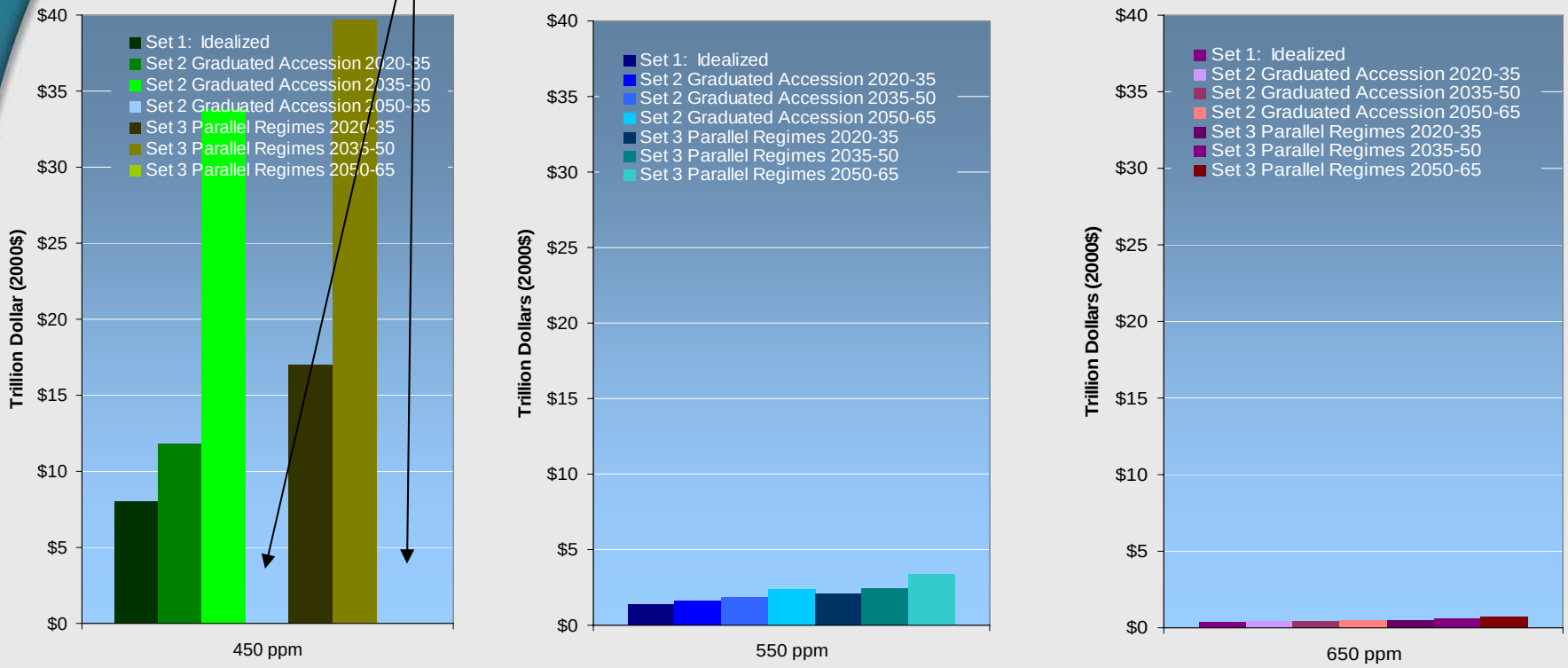
The Costs of Stabilization

Inefficient Participation and the Total Costs of Stabilization

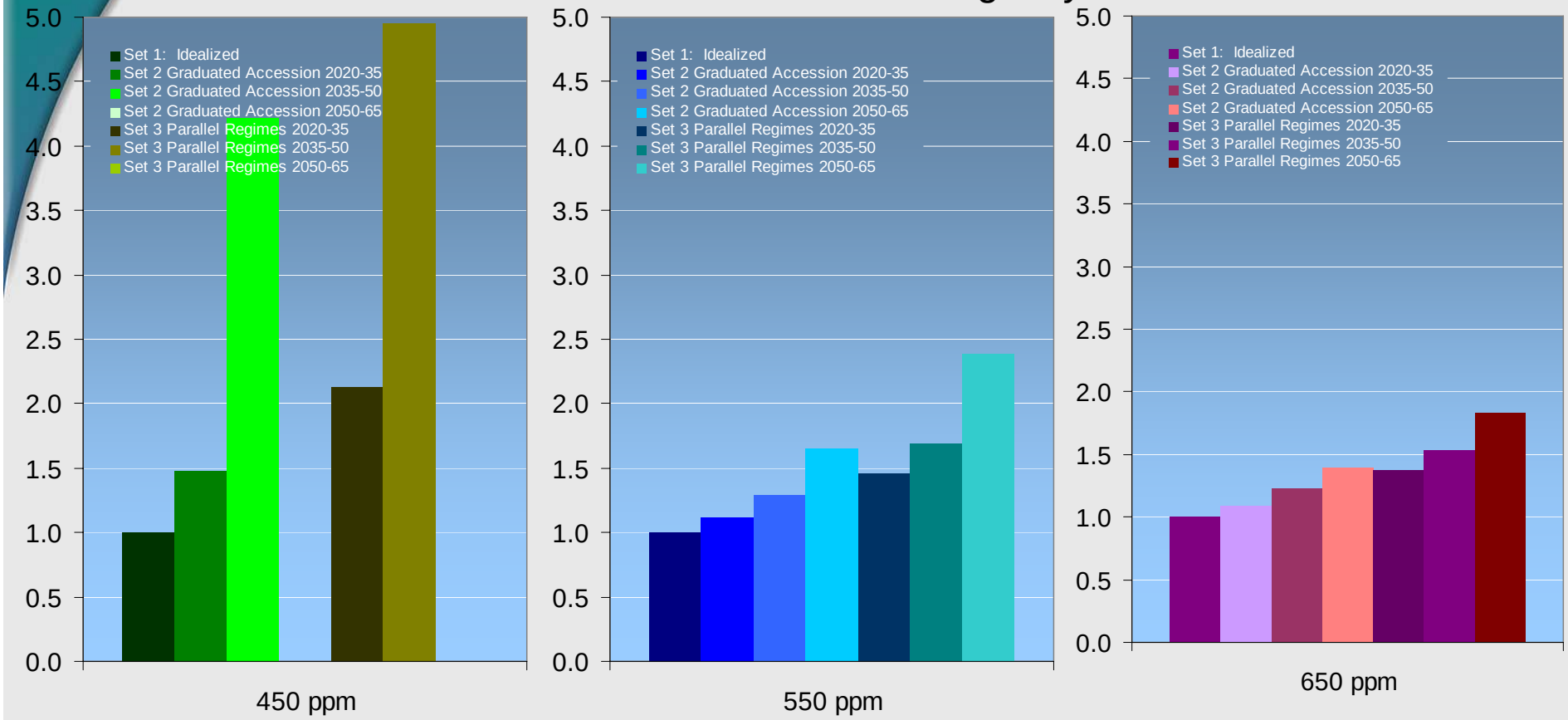
Post 2050 non-Annex 1 accession not possible under the reference assumptions



The dominant determinant of cost is the stabilization level.

Inefficient Participation and the Total Costs of Stabilization

The relative effect on cost increases as the stringency of the limitation rises.



All costs normalized to the idealized cost at the concentration.

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Final Observations

- "Second best" is just that, second best.
- Near-term prices of carbon depend on expectations about the future—including international emissions mitigation architectures and long-term stabilization goal.
  - Inefficiencies matter more for 450 ppm stabilization.
- Prices could vary regionally.
- What does this all mean for technology strategy?

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END