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?
The Pocantico Process

A look at specific policy proposals.

Year 2050 Policy Performance

Year 2095 Policy Performance

- Zero Net Emissions Target
- Auto Standard
- Absolute Targets 1 (1% reductions)
- Absolute Targets 2 (1/2% reductions)
- Mixed Targets (1% reductions; non-Annex I BAU)
- Intensity Targets
- Electricity Technology (IGCC/CCS)
- Electricity Intensity 1 (1/3%/yr)
- Intensity Targets
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.
The Reference Scenario
The GTSP Reference Scenario

The Importance of Participation

Global Reference Fossil & Industrial CO₂ Emissions

Global Emissions in Reference & Stabilization

- Africa
- Middle East
- Korea
- Eastern Europe
- USA
- India
- Latin America
- Australia_NZ
- China
- Canada
- Former Soviet Union
- Japan
- Southeast Asia
- Western Europe

CCSP Reference
450 ppm
550 ppm
650 ppm

Years: 1990, 2005, 2020, 2035, 2050, 2065, 2080, 2095

GtC yr⁻¹
Stabilization Set 1
Full Participation
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.

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.
450 ppm has fundamentally different near-term implications than 550 ppm and above.
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.
- Staggered accession based on per capita income.
  - Alternative accession cases—first group enters: 2020-2035, 2035-2050, 2050-2065

Notes:
- We assume that all Annex 1 nations participate in an international protocol by 2020 and that others join at different times based on per capita income. Non-Annex 1 participation is keyed to China’s entry date.
### Order of Regional Participation

(1<sup>st</sup> NA1 Group Enters 2020-2035)

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NA1 1st Group Enters 2020-2035
Order of Regional Participation
(1st NA1 Group Enters 2035-2050)

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### Order of Regional Participation

(1st NA1 Group Enters 2050-2065)

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**Note that India comes in one period after China.**

NA1 1st Group Enters 2050-2065
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 CO₂ Emissions

Global

USA

India

Carbon leakage

Late accession means precipitous drop in emissions
Scenario Set 2, 450 ppm
Scenario Set 2, 450 ppm
Global Carbon Price

- Set 1: 450 ppm
- Set 2: 1st Accession 2020-35
- Set 2: 1st Accession 2035-50

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 CO₂ Emissions

Global

USA

India

CCSP Reference
Set 1: 450 ppm
Set 2: 1st Accession 2020-35
Set 2: 1st Accession 2035-50

Global USA India
Scenario Set 2, 450 ppm
Fossil & Industrial CO₂ Emissions

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 CO₂ Emissions

Global

USA

India

Negative emissions are the result of biomass energy being used indirectly with CCS or in non-energy uses.
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.
Stabilization Set 3
Graduated Accession
+ Differentiated Prices
Stabilization Scenario Set 3
Graduated Accession + Differentiated Prices

Stabilize CO₂ concentrations

- 450 ppm, 550 ppm, 650 ppm.
- Sectoral carbon prices—All EQUAL.
- Regional carbon prices—each region separate.
- Time path of carbon prices
  - Annex 1 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
Scenario Set 3, 450 ppm
Scenario Set 3, 450 ppm
Carbon Prices by Region

Highly differentiated pricing between Annex I and non-Annex I

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.
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.
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?
END