



Fondazione
Eni
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Présidence française de l'Union Européenne

“Social sciences and humanities facing the climate change challenges”/“L'Homme et la Société face aux défis des changements climatiques”

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**Climate Change and
Sustainable Development.
Long-term Goals, Short-term Strategies**

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University of Venice, CMCC and FEEM



High public awareness of climate change problem
Post-2012 climate policy now entering a crucial phase
(=> Copenhagen 2010)

Perception (from Stern Review, IPCC 4ar WGIII) is that effective policy is affordable. Ballpark figure is 1% GWP one-off loss to achieve the 450 ppm CO₂ only target

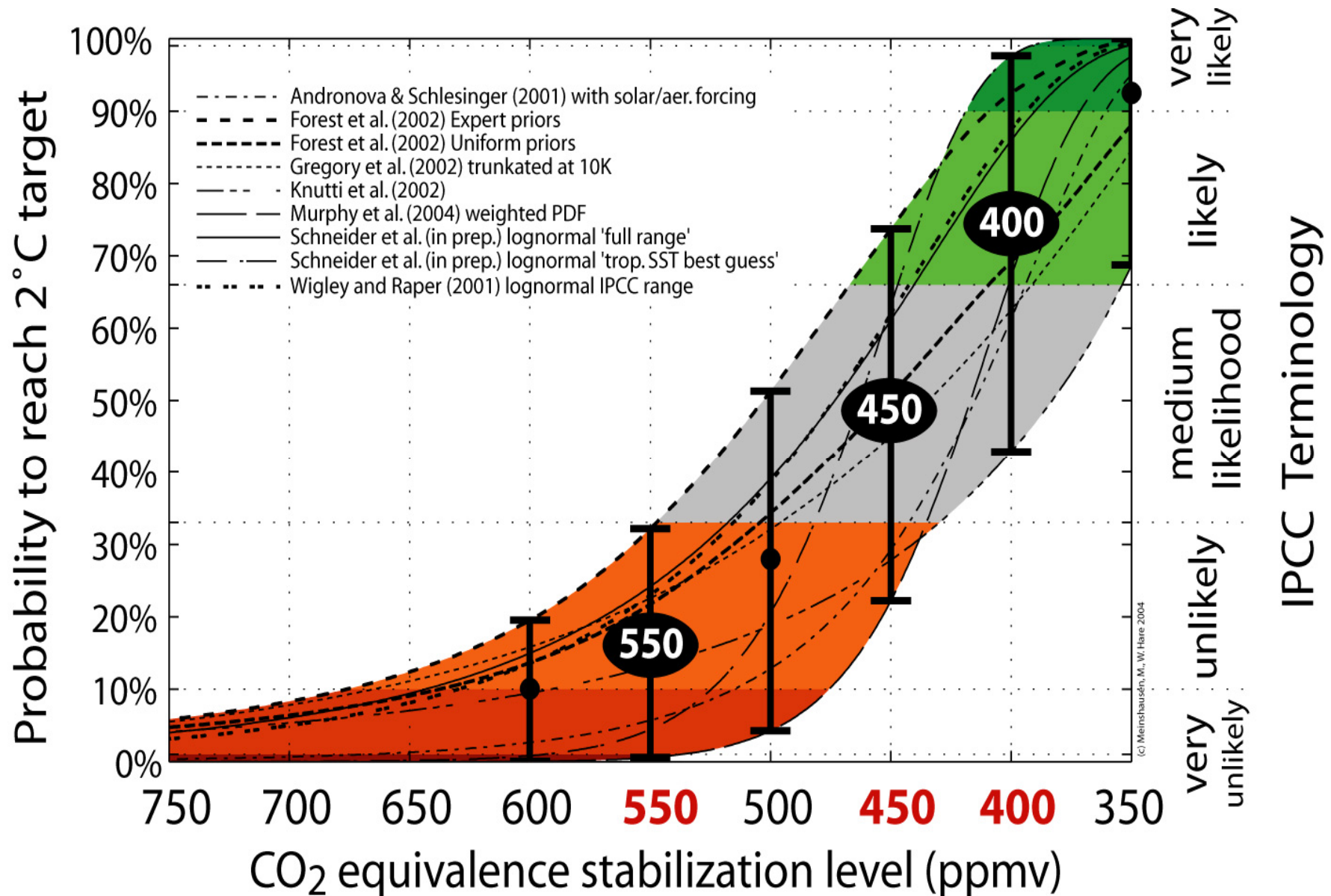
However, a series of obstacles might raise the bill:

- Technology deployment/technical change may be insufficient
- Fragmented/delayed participation by developing countries
- Global delay in taking action
- Uncertainty on future target

Outline

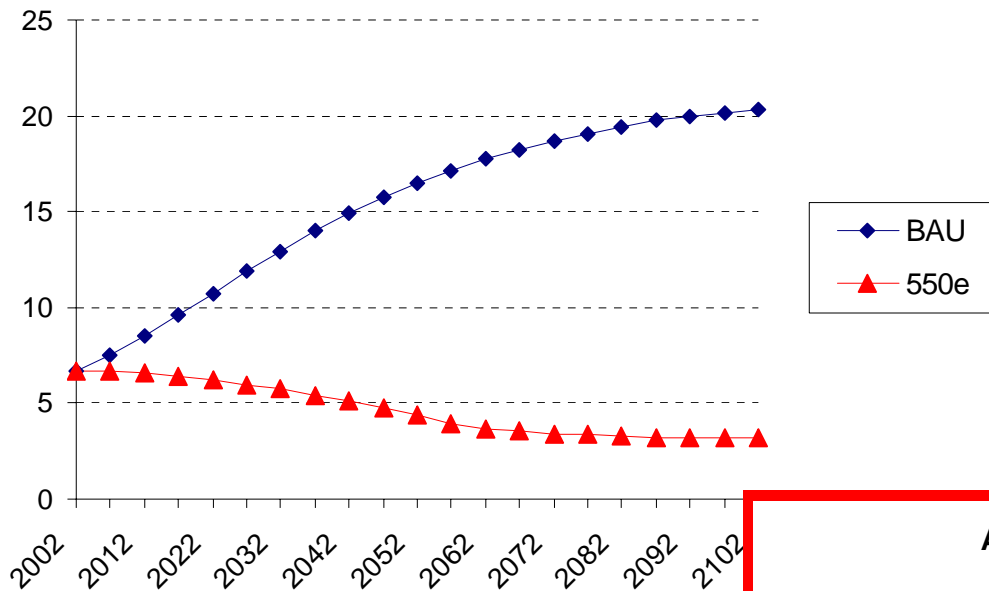
- Set the long-term stabilization target for sustainable development
- Identify the short-term policy measures to achieve it:
 - Energy investments/technological portfolio
 - Innovation/R&D Investments
 - Policy induced price signals/carbon price
- Assess the policy costs
- Quantify additional costs induced by delays and policy obstacles

Stabilization Target for Sustainable Development



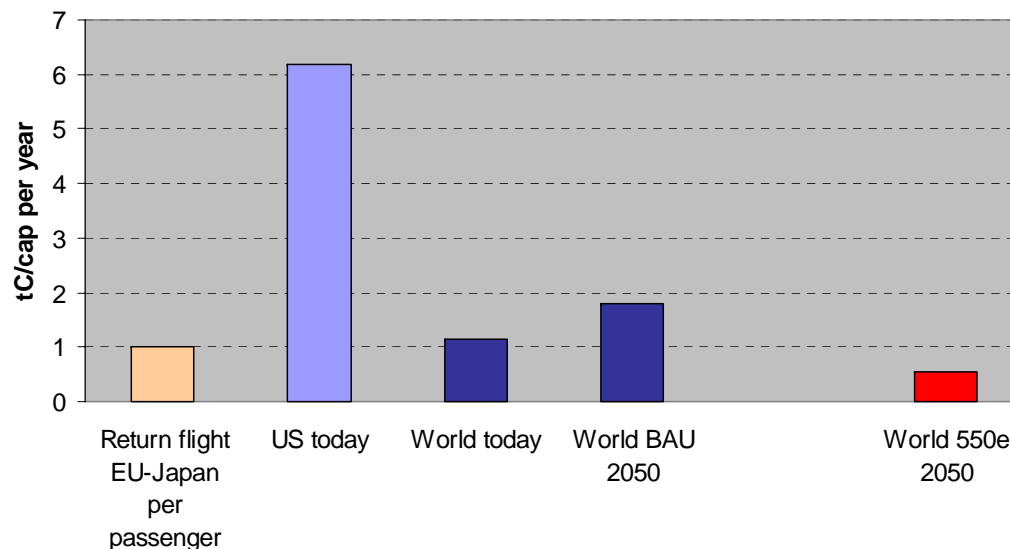
Emission Target (450 ppm CO2 only)

World Industrial Carbon Emissions (GtC)



450 ppm CO2 only is roughly equivalent to 550 ppm all greenhouse gases included

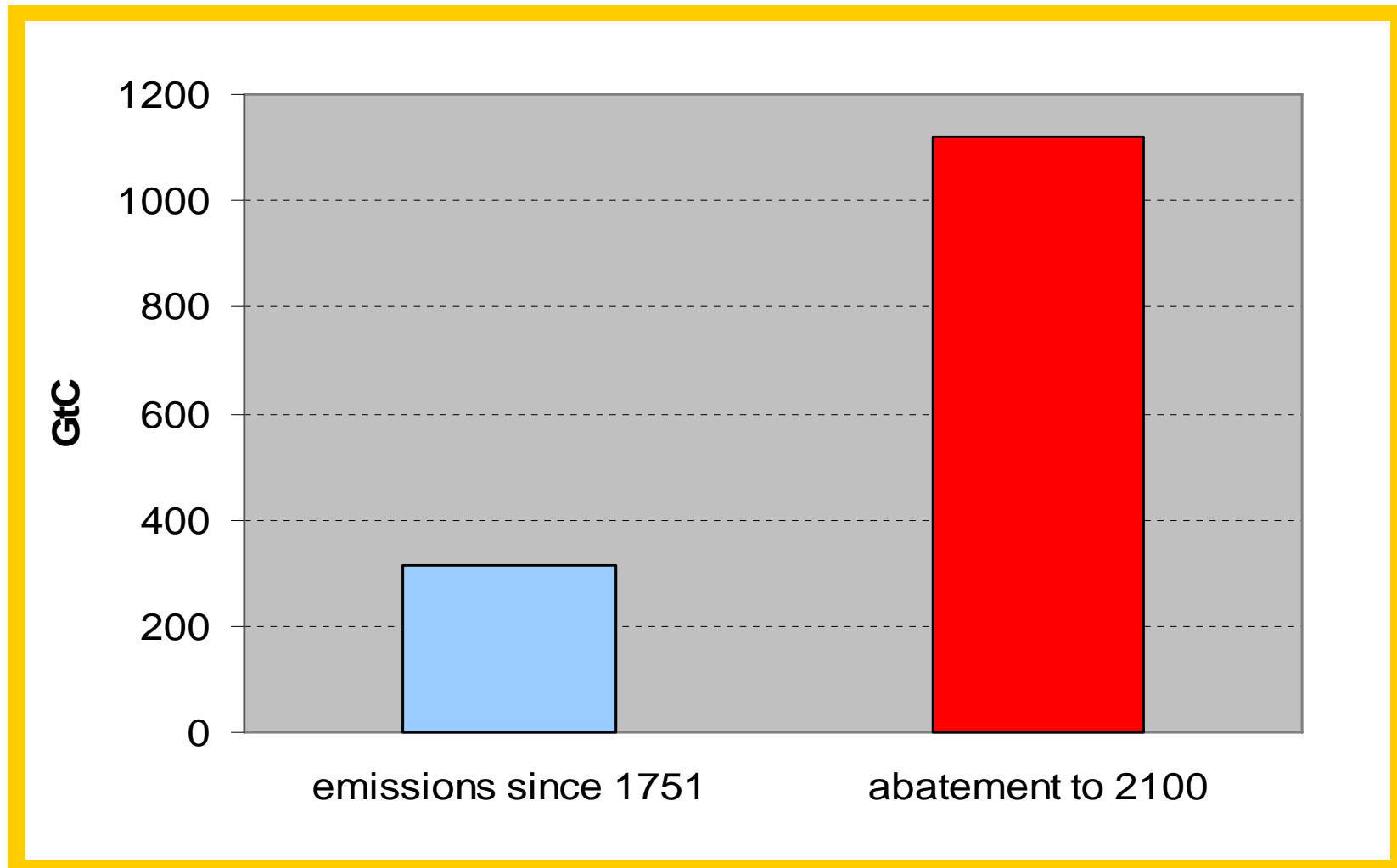
Average per capita emissions across scenarios



Required emission reductions

	BAU	450ppmCO2	% reduction
2005	7.8	7.8	
2030	13.0	8.0	38%
2050	17.0	4.9	71%
2100	23.6	3.6	85%

Required emission reductions



A different world

- Given the projected dynamics of world population, the objective of limiting temperature increase below 2°C implies that average per capita emissions in the second half of this century are to be reduced **from about 2 to about 0.3 tC** per year.
- In other words, the world will have to emit not more than today's India average – quite a significant reduction for most industrialised countries (US average per capita emissions are about 6 tC) and for countries that aim at similar lifestyle standards.
- Just to provide another benchmark, 0.3 tC is the amount of GHGs emitted by an individual flying – one way – from the EU to the US East coast!

Main questions

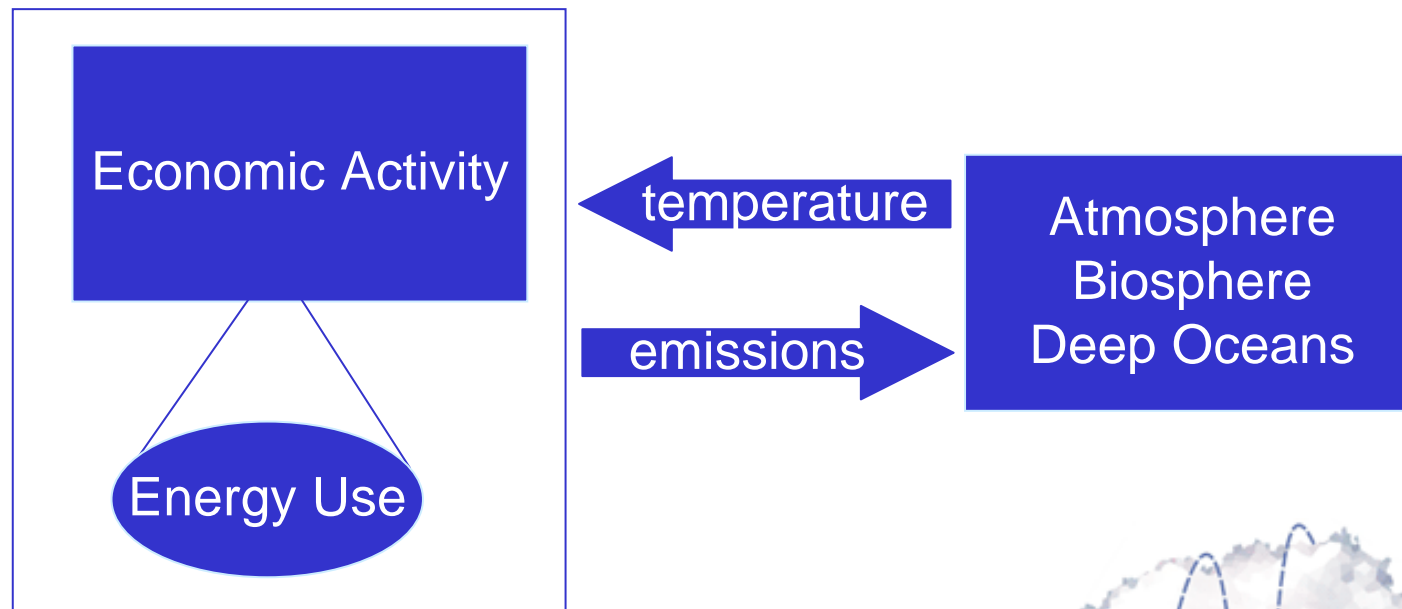
- Is a world in which per capita emissions are about 0.3tC feasible?
- What changes in the energy sector and in energy technologies are necessary?
- What are the required investments (including R&D Investments)?
- What policies can drive the change to a different world?
- How much will all this cost?

The WITCH Integrated Assessment Model

WITCH: World Induced Technical Change Hybrid model

Hybrid I.A.M.:

- **Economy**: Ramsey-type optimal growth (inter-temporal)
- **Energy**: Energy sector detail (technology portfolio)
- **Climate**: Damage feedback (global variable)



A World Induced Technical Change Hybrid Model



A World Induced Technical Change Hybrid Model

Model Framework

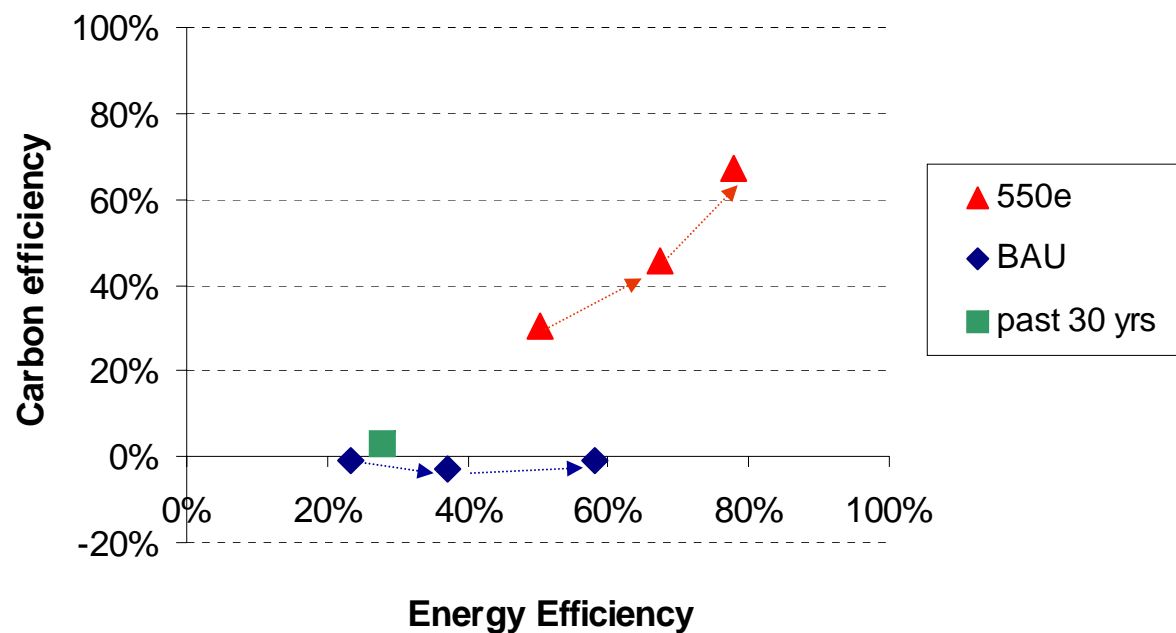
- 12 regions playing open loop noncooperative strategies
- A strategy is a path for all control variables (investments, R&D, capacity of different energy technologies) that maximizes the intertemporal regional utility function
- Regions **interact** through global energy markets, climate damage, LbD in wind and solar and bio masses, R&D spillovers, and a worldwide emissions trading scheme
- **Global climate damage** feedbacks back into each regional economy, reducing final output (fully integrated model)
- Open loop Nash equilibrium is computed numerically
- Output is “optimal” path to sustainable development

Sustainable development requires:

- Improvement of energy efficiency (even though this is short-term option with decreasing returns)
- Decarbonisation of the energy sector, in particular power and transport sectors
- Large investments in the deployment of (quasi) carbon free technologies (wind&solar, nuclear, CCS)
- Four fold increase in energy R&D expenditure
- Immediate action, at least a moderate one
- Global cooperative effort (including at least major developing countries)
- Adoption of economic mechanisms to minimize costs

Changes in Energy and Carbon Intensities

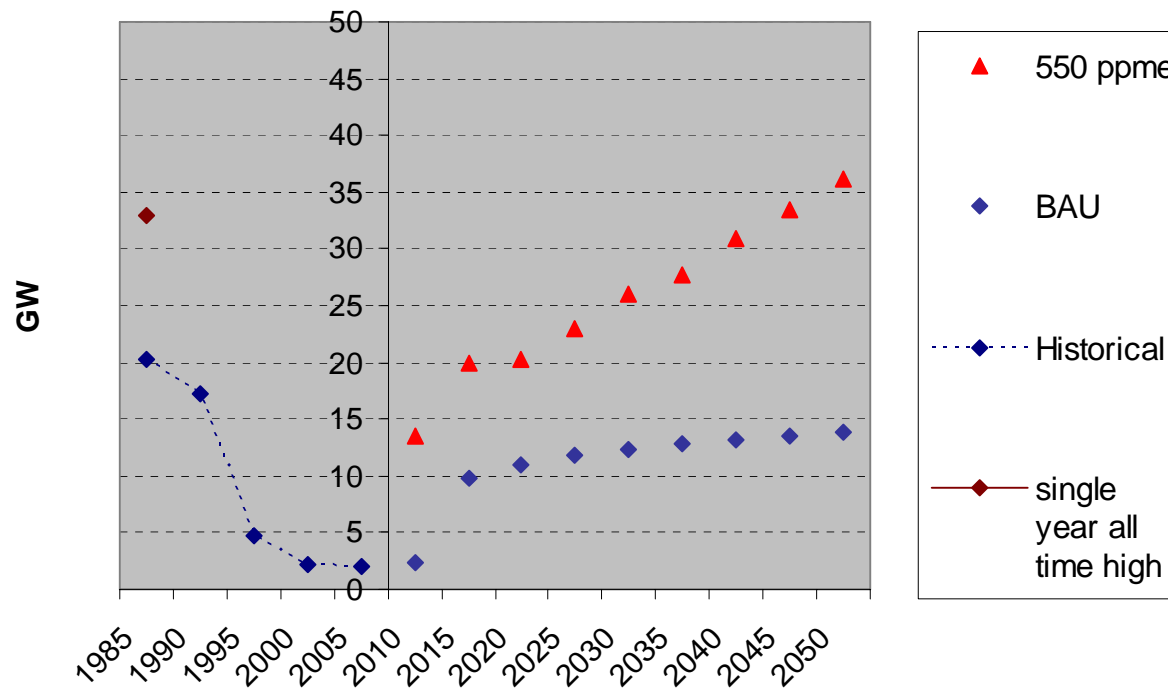
Trajectories in the energy intensity/carbon intensity:
next 30, 50 and 100 yrs



Energy savings and efficiency should be pursued vigorously in the short term, but decarbonisation is essential from 2030 onwards already.

Nuclear power

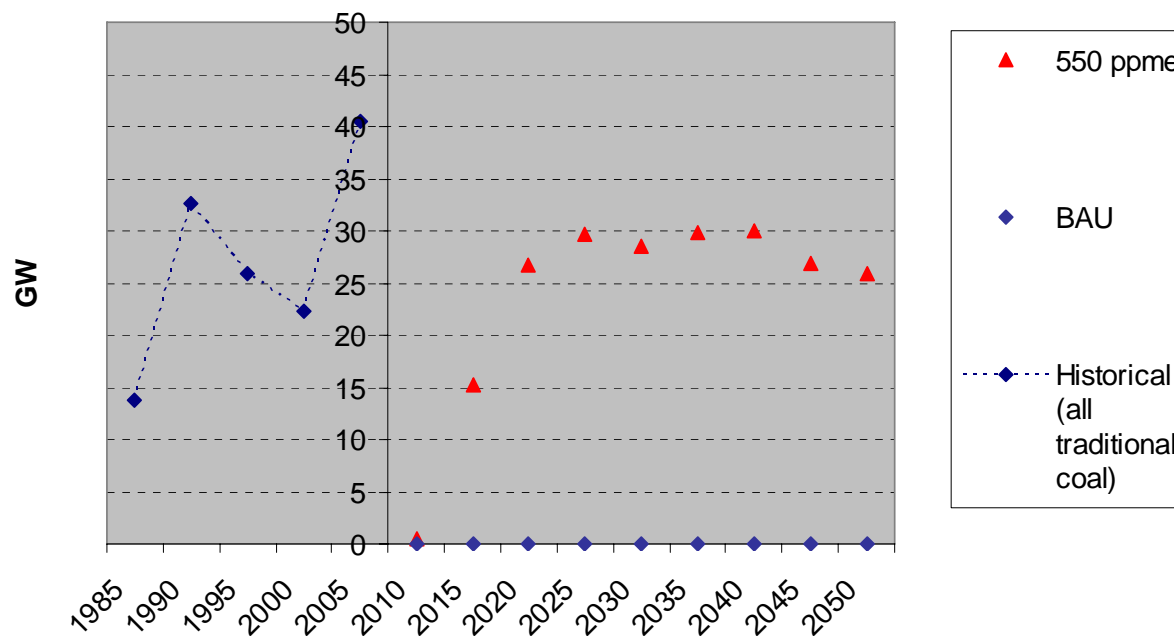
Nuclear power capacity additions (yearly, 5 year averages)



Strong carbon signal would make nuclear extremely competitive (back to the '80s).

Risks (proliferation, international coordination, waste etc.) ?

IGCC + CCS capacity additions (yearly, 5 year average)



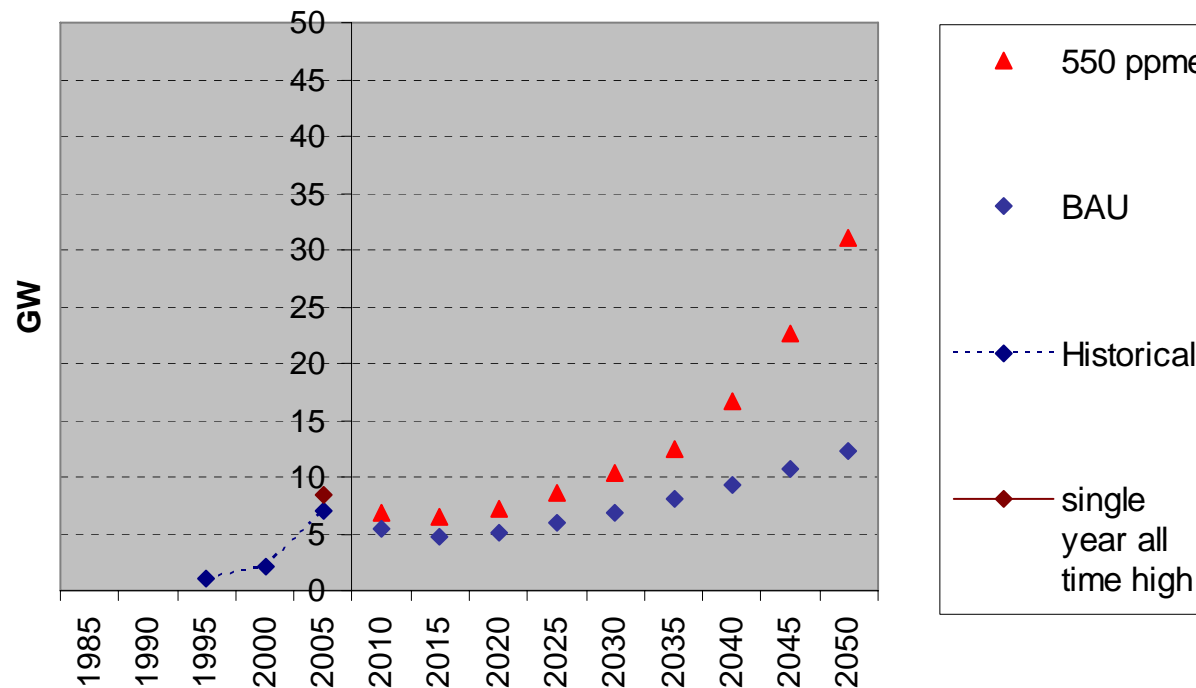
CCS could provide a climate+coal scenario.

Capturing technology ? Sites availability and acceptance ?

Energy penalty ?

Wind & Solar

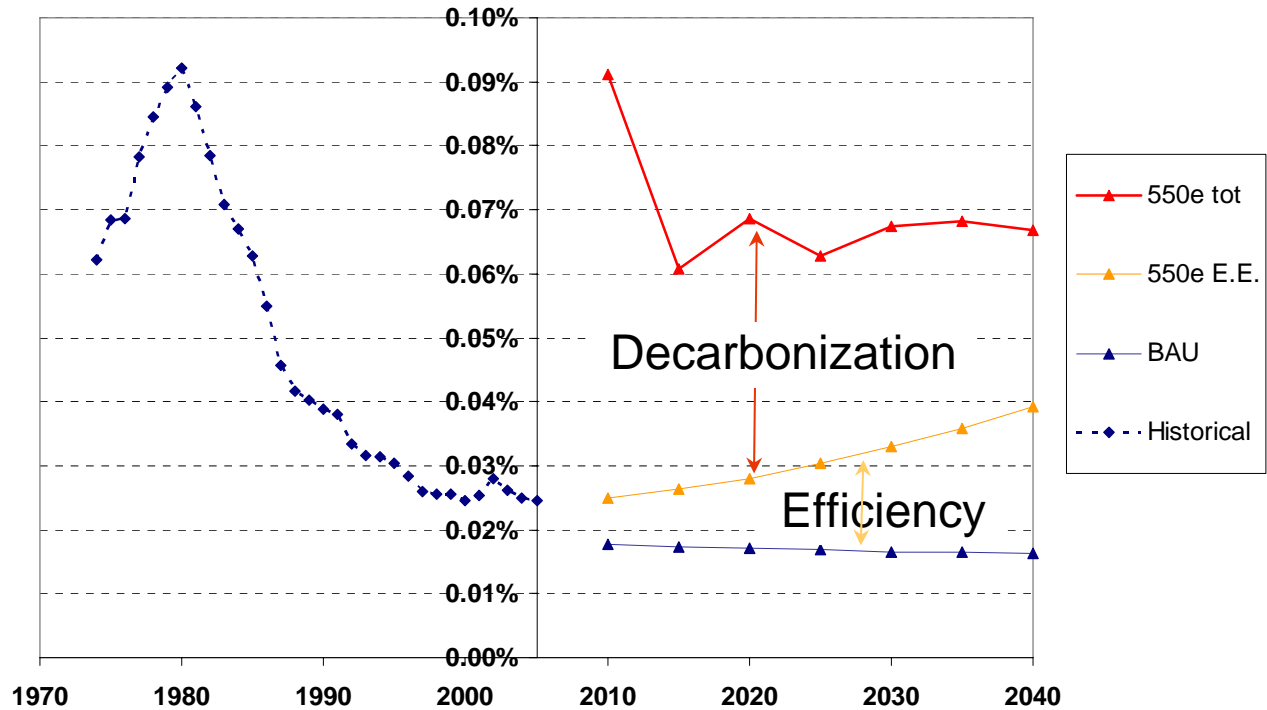
W&S power capacity additions (yearly, 5 year averages)



W&S contribute significantly in the mid term.

Intermittency ? Operability ?

Public Energy R&D over GDP

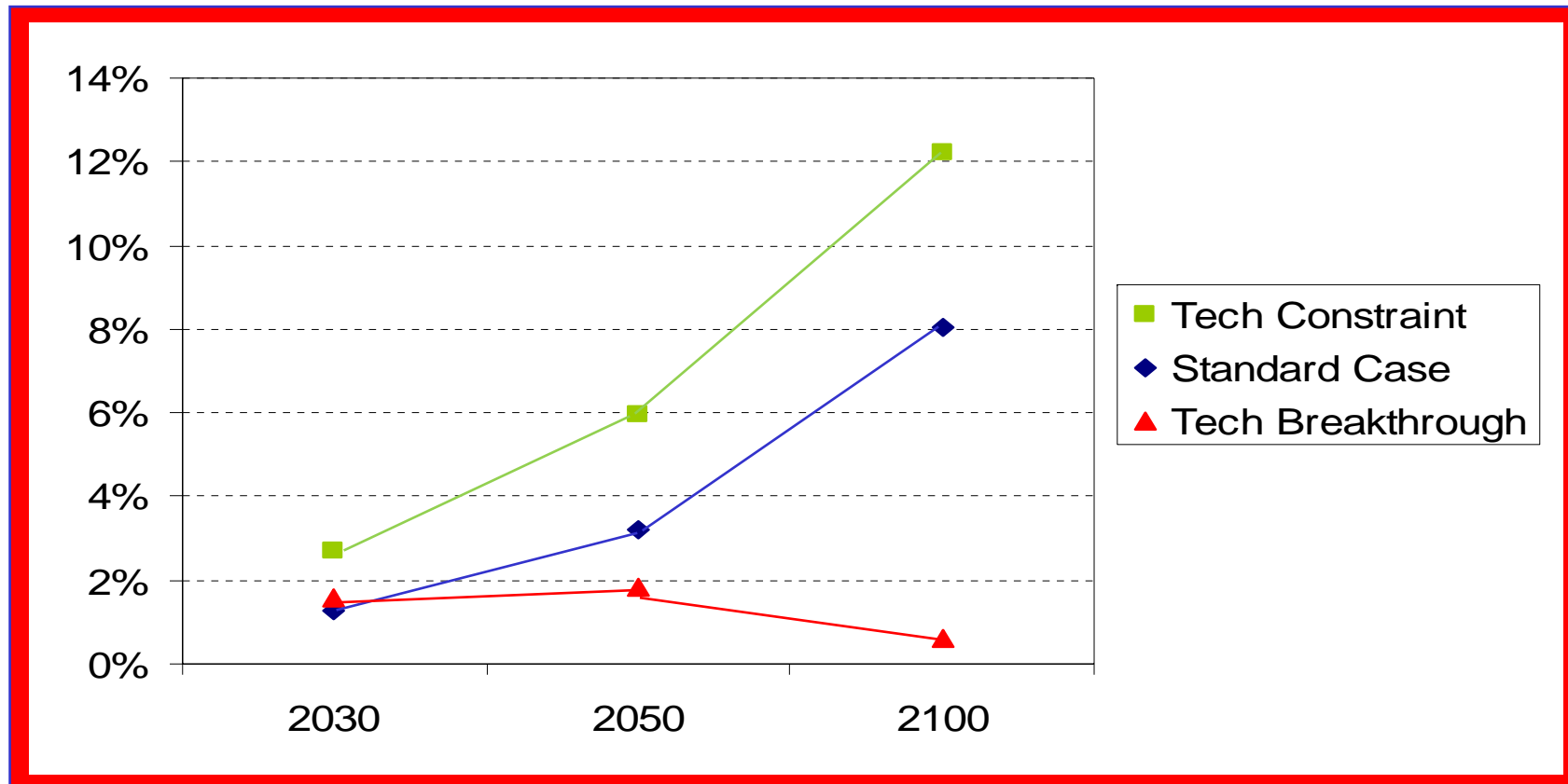


4 fold increase in public energy R&D investments needed (roughly 40 Billions/yr).

Return to 1980s figures (yet 2 order of magnitude smaller than physical investments in commercial technologies -> cheap insurance policy).

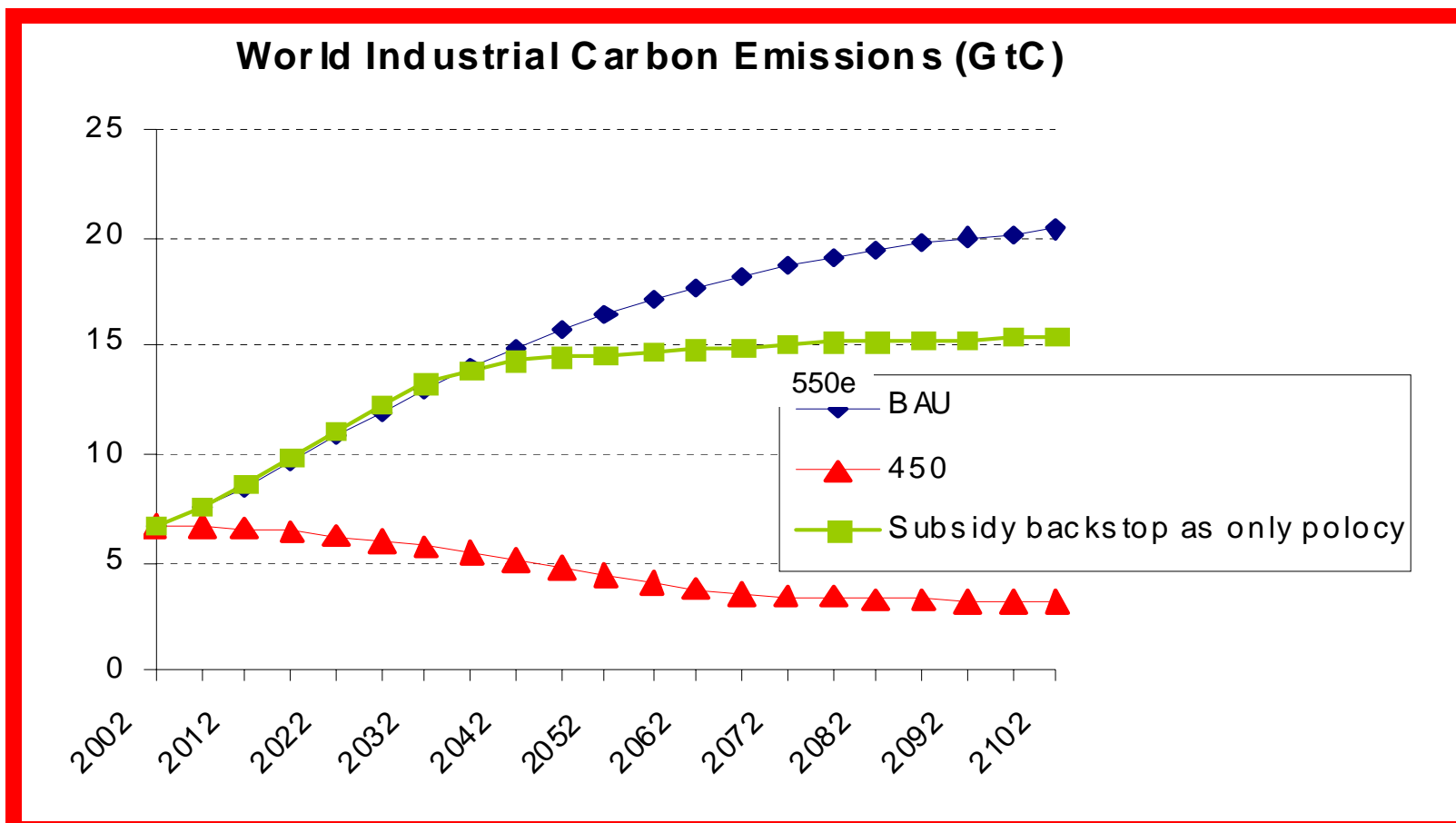
Focus on both improving efficiency but mostly on innovation in low carbon technologies.

Cost of Stabilization Policy



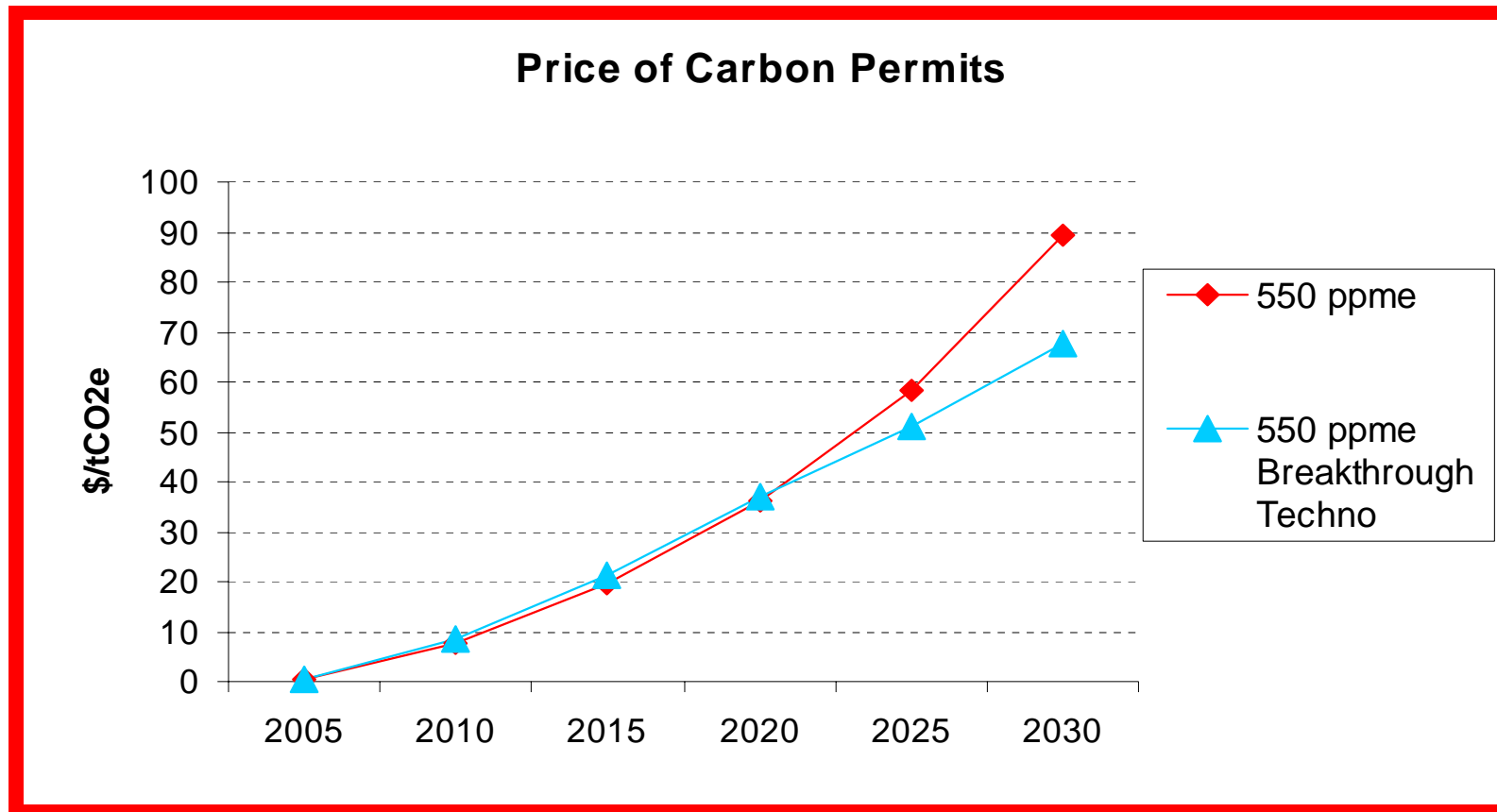
- With constraints on CCS-renewables-nuclear climate policy bill increases significantly;
- Innovation is key to decoupling economic activity and climate protection but requires initial investments.

Energy R&D as a stand alone policy



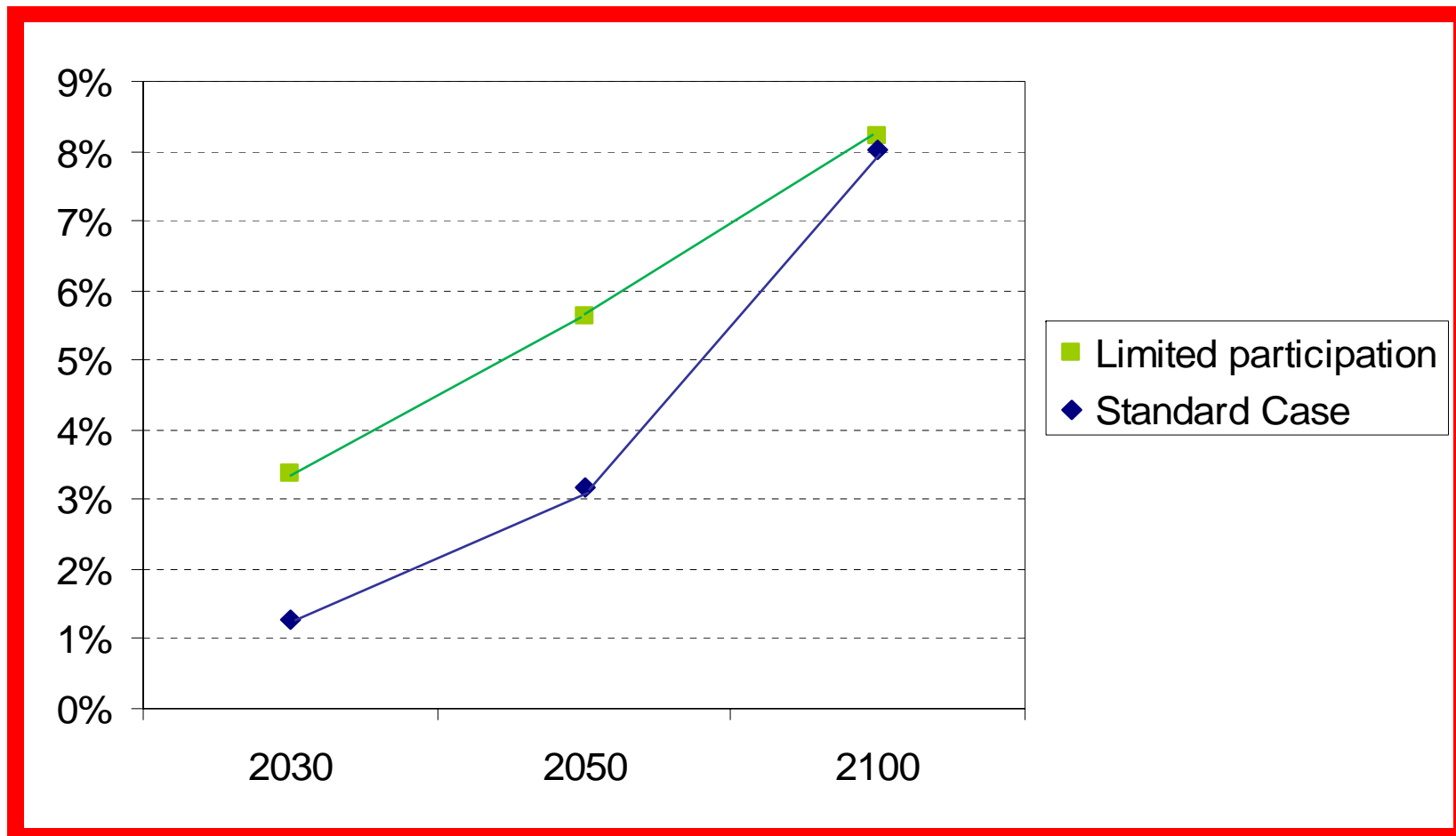
An energy R&D policy alone will not achieve emission reductions needed to stabilize concentrations.

Carbon price signal



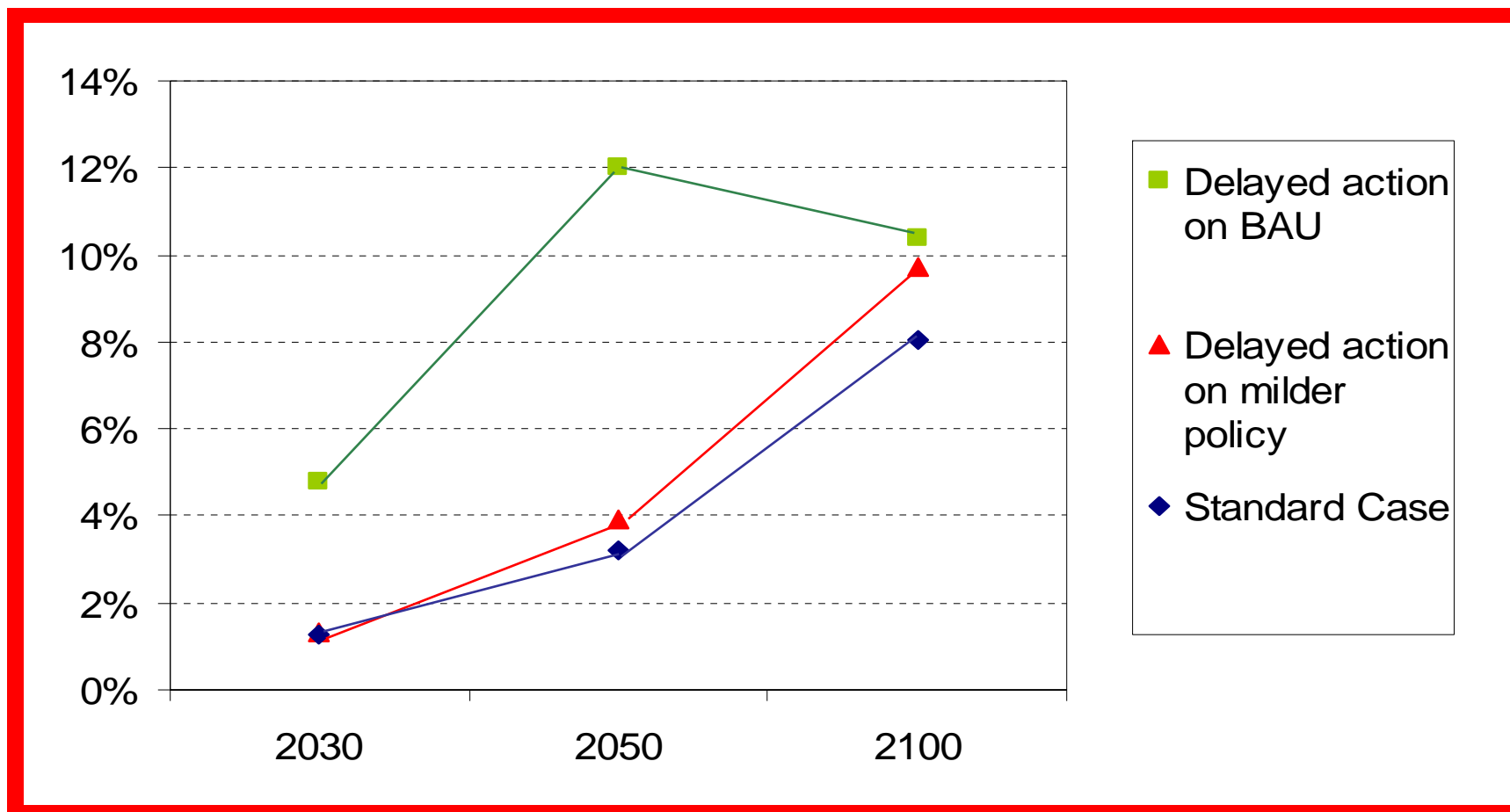
Significant **carbon price signal** is needed to 2030 irrespective of innovation outcome

Costs of developing countries' delayed participation (GWP losses)

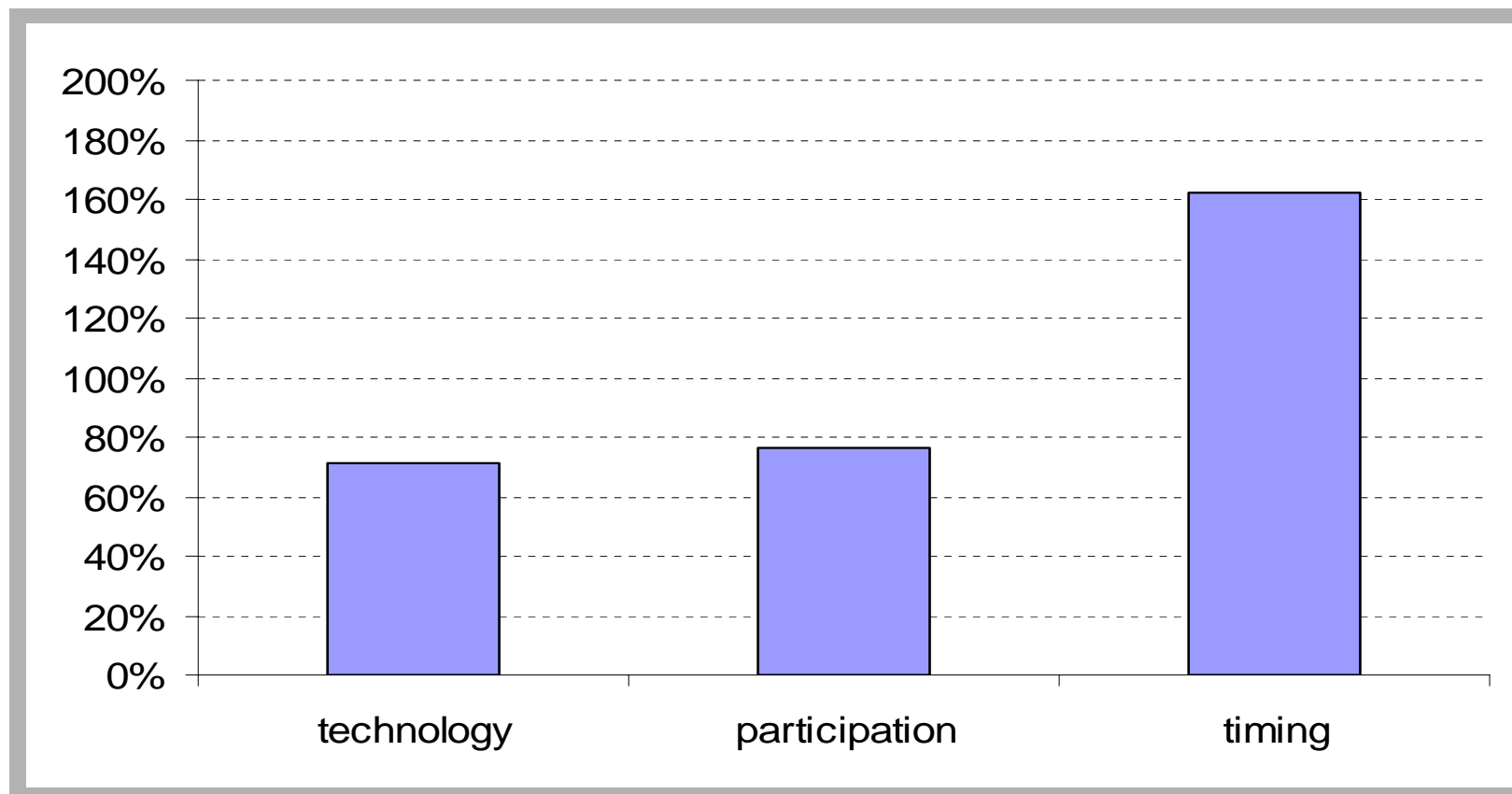


Short run mitigation costs are much larger if developing countries delay participation to a climate agreement by 20 years

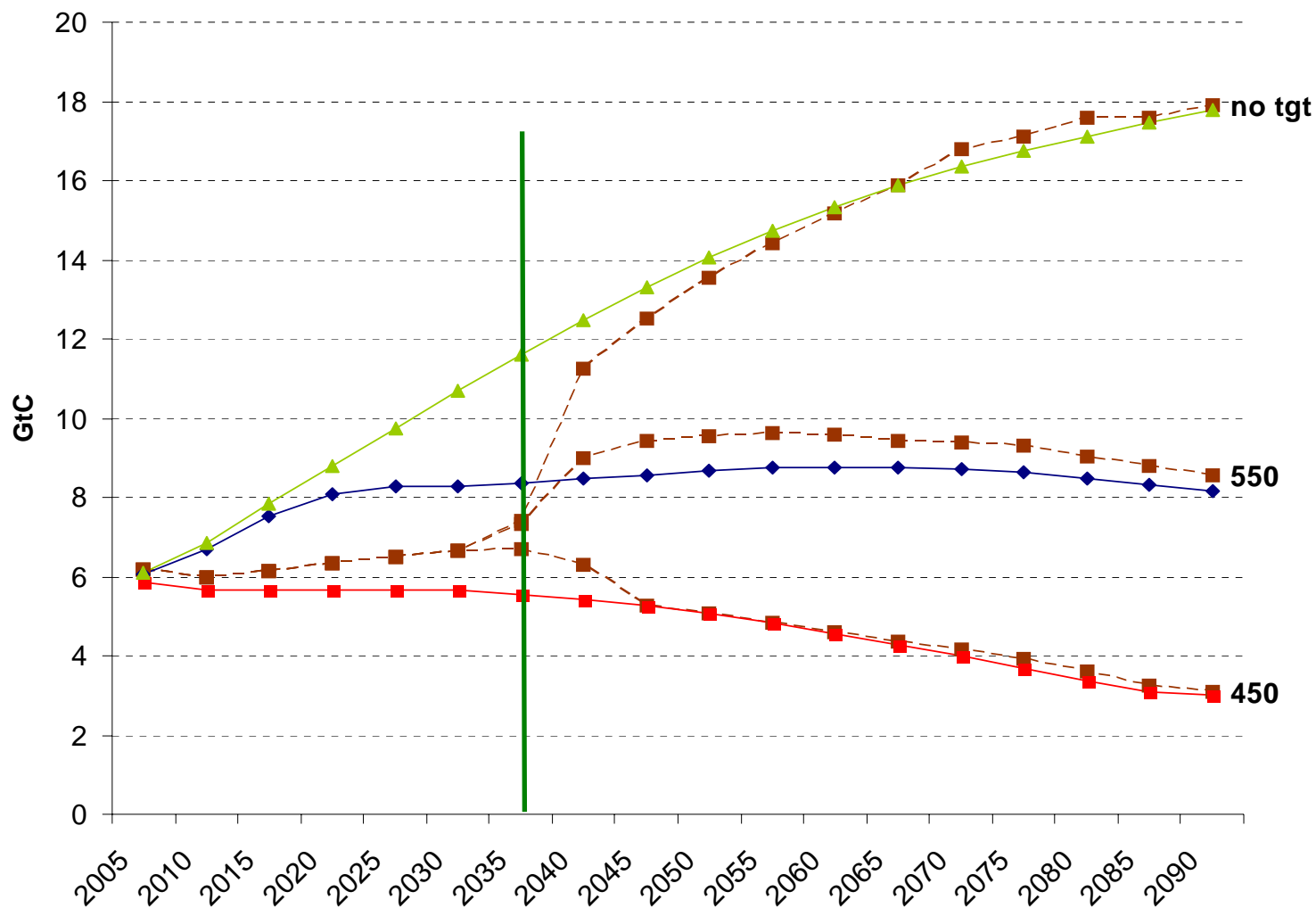
Cost of delayed global action (GWP losses)



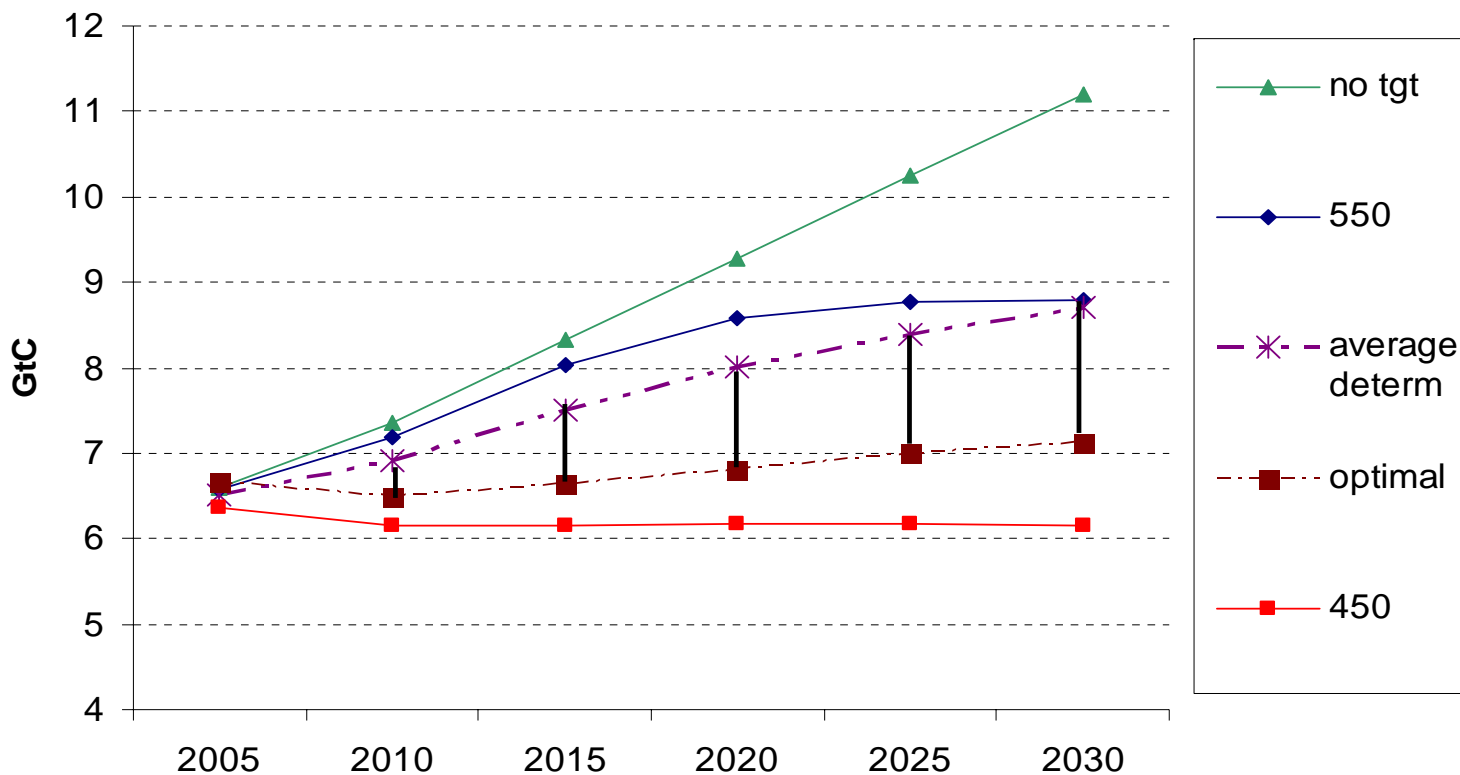
Additional costs from limited technology availability, delayed DC participation, delayed global action



Optimal Strategy under Uncertainty



Optimal Strategy under Uncertainty



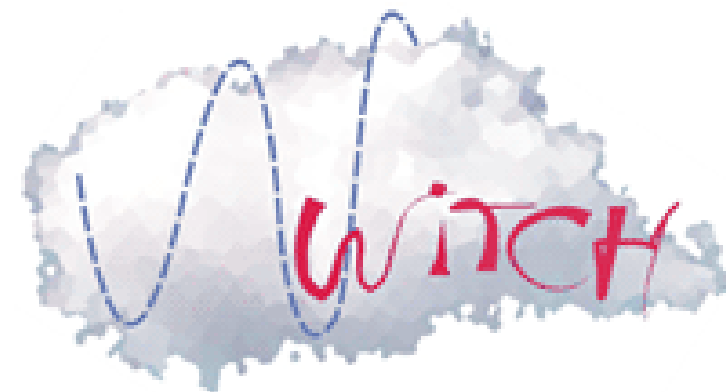
Precautionary principle prevails

Sustainable development requires ... a different world!

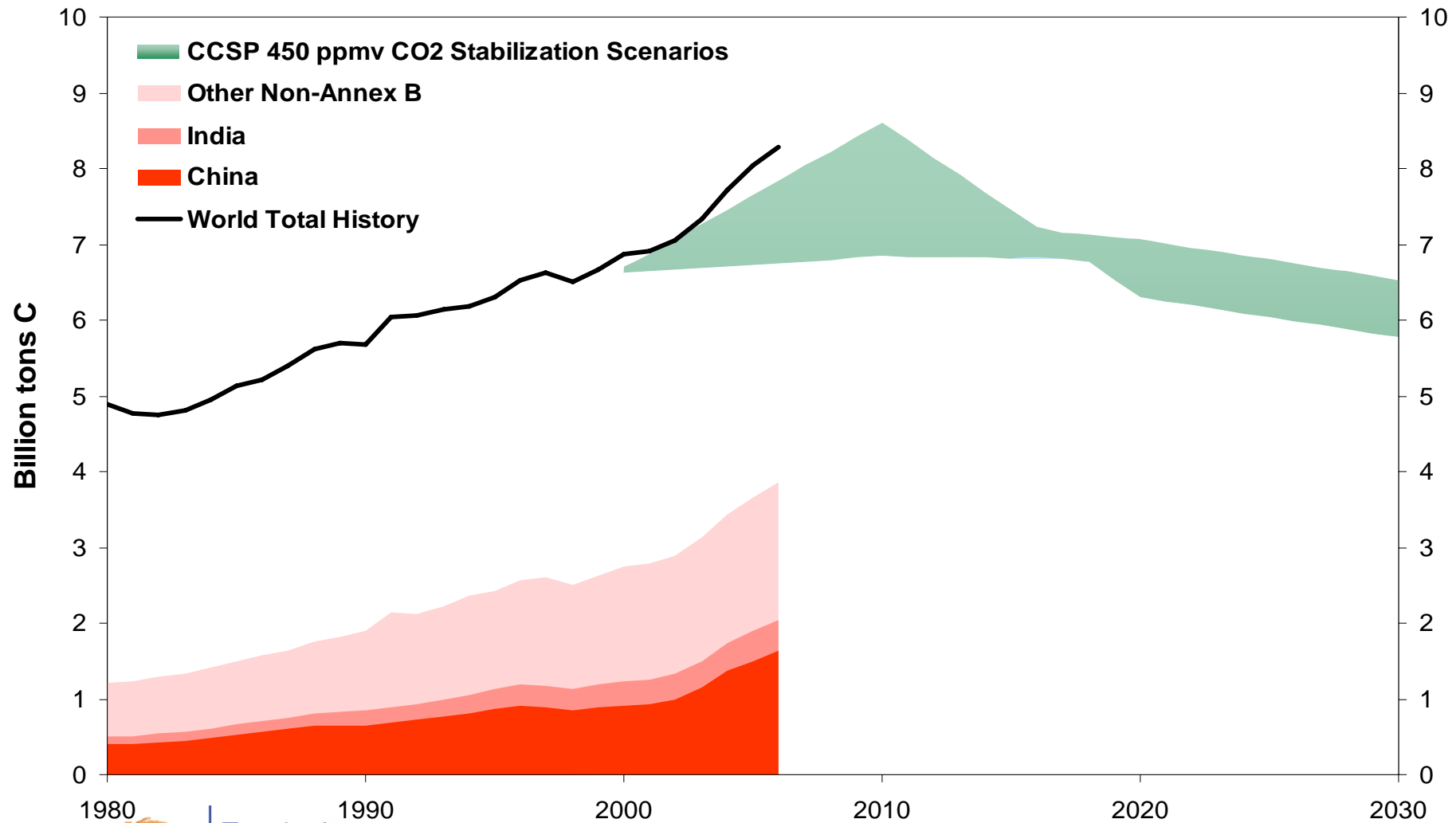
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- Global cooperative effort (including at least major developing countries)
- Adoption of economic mechanisms to minimize costs
- **Large financial resources anyway...**

Thank you!

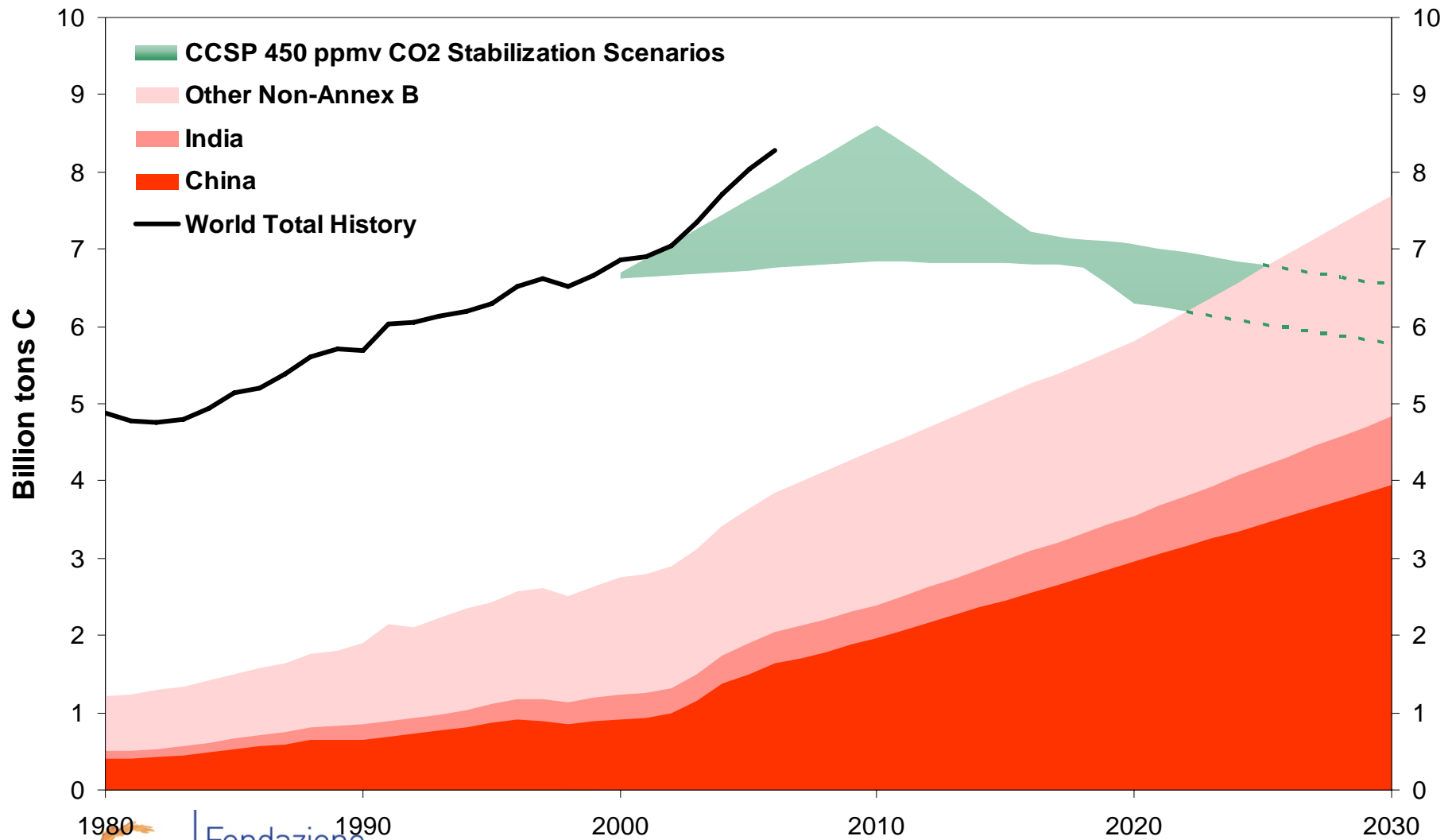
www.feem-web.it/witch



Is 450 (CO₂ only) Feasible?



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