

## **Delayed Participation of LDC in Climate Policy: a Reason to Postpone Abatement in the US and EU ?**

“Modeling Technology Oriented RD&D Strategic Cooperation for Climate Change Mitigation: Methodological Issues and Alternative Policy Scenario

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## Motivation

- Differentiated responsibilities, equity issues
- Free riding
  
- » Slow progress towards IEA
- » Uncertainty on participation

## Focus of the paper

- Cost effective analysis of stabilization policy
- Delayed vs immediate participation of NA1 countries
- Role of uncertainty
  
- » Implication of second best solutions on
  - abatement, policy costs
  - role of carbon trading

WITCH: [www.feem-web.it/WITCH](http://www.feem-web.it/WITCH)

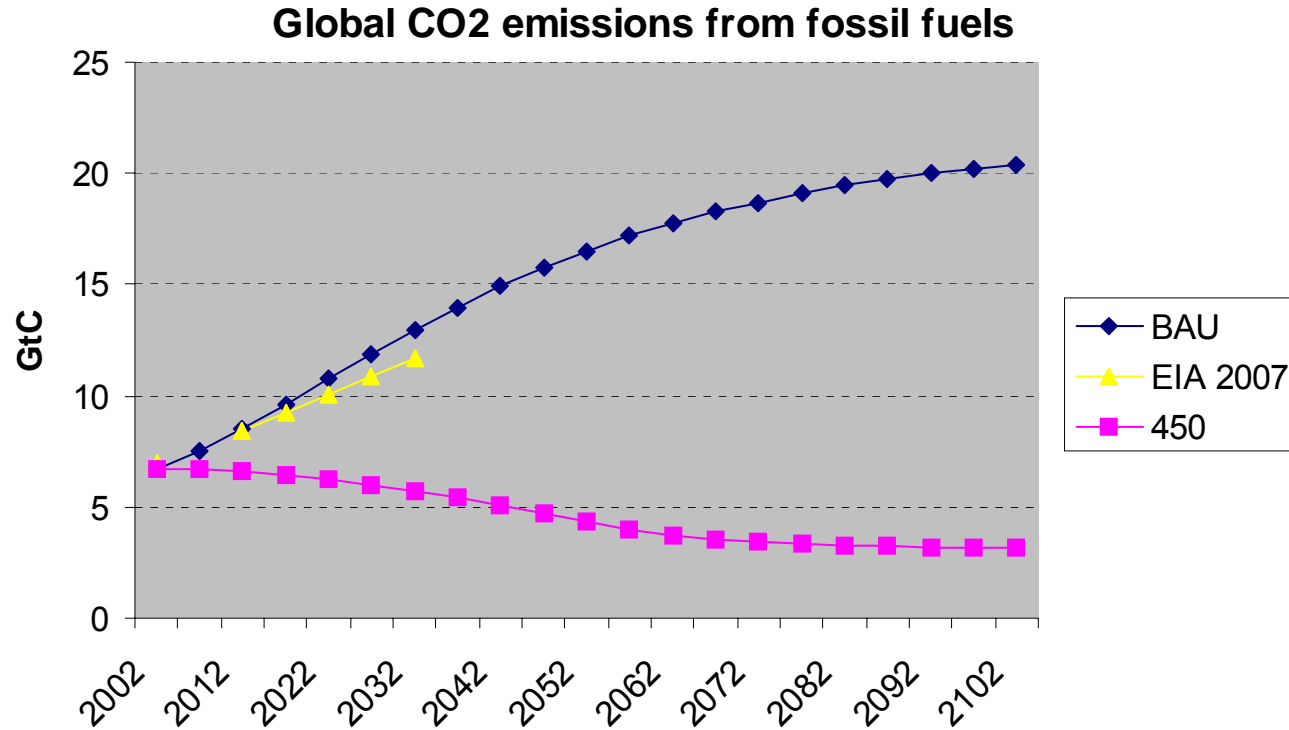
- a hybrid **energy-economy-climate model**.
  - Global, 12 regions
  - **Economy**: Ramsey-type neo-classical optimal growth (dynamic, perfect foresight)
  - **Energy Sector**
    - Electric and non electric energy use
    - 6 Fuels types (Oil, Gas, Coal, Uranium, Trad. Biofuels, Adv. Biofuels)
    - 7 Technologies for electricity generation
  - **Climate**: damage feedback
  - The three modules are **hard-linked**
  - **ETC** (LbD, LbR)
  - **Game theoretical set up**

## Stochastic programming version:

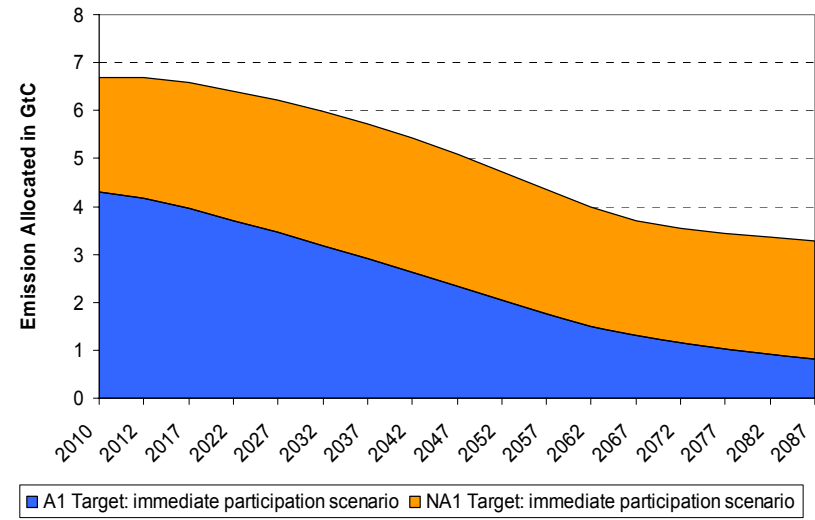
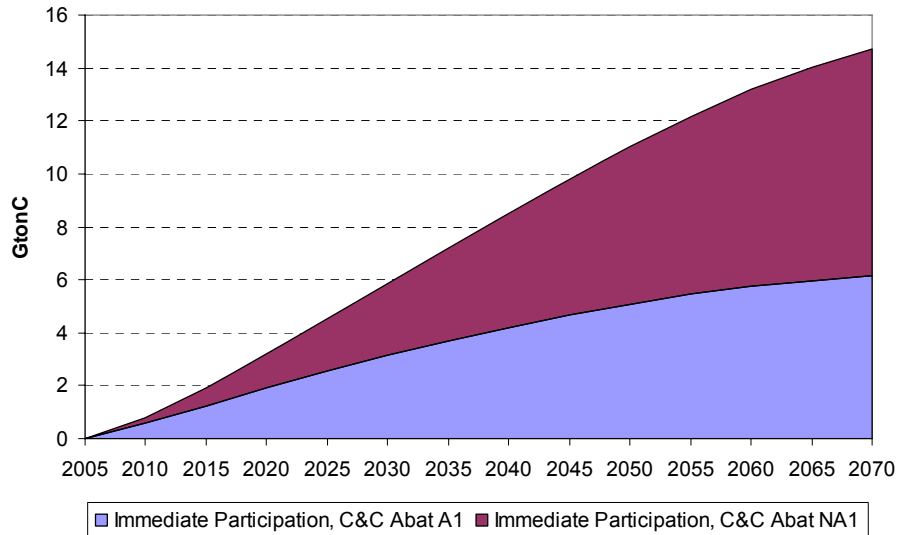
Implicit formulation: non-anticipativity is implicitly defined through characterization of predecessor/successor relationships among nodes.

Two solutions:

- **Cooperative** (first best)
- **Non-cooperative** (Nash open loop), interactions among regions on:
  - Environmental externality (carbon)
  - Exhaustible resources (oil, gas, coal, uranium)
  - Technological spillovers
  - Trade of emission permits

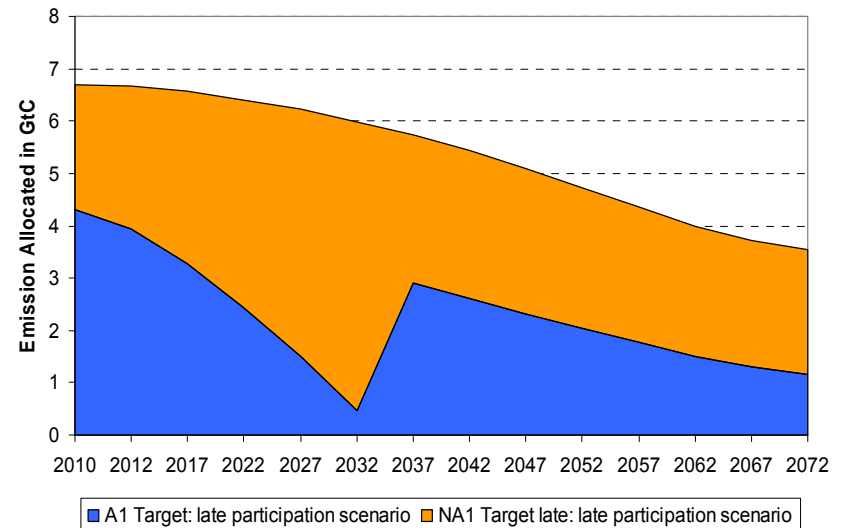
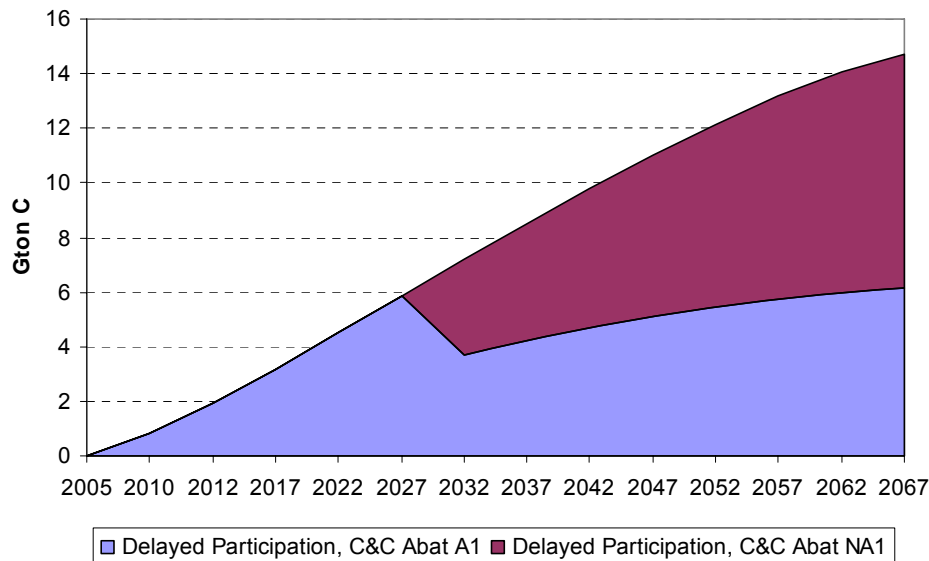


# Target and abatement with immediate participation



“Contraction and convergence” burden sharing rule  
NA1 allocated roughly constant emissions

# Target and abatement with delayed participation



Maintain the same overall abatement but  
A1 bear all abatement. Reach zero target in only 30 yrs.

## General set up:

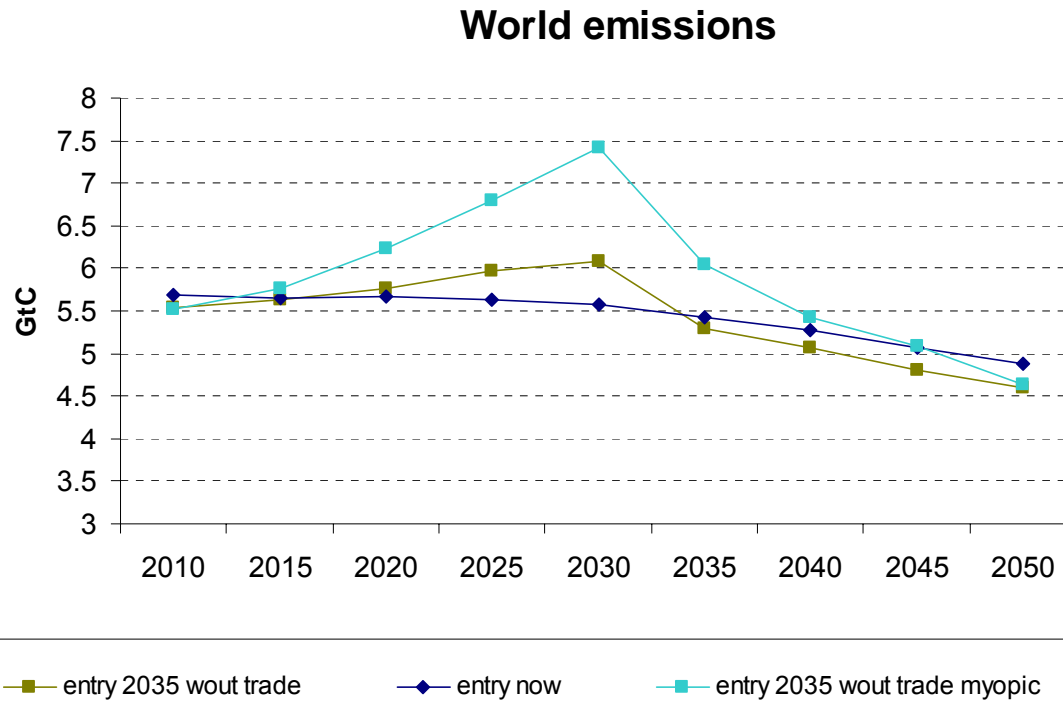
- » Non-cooperative solution
- » Emission path consistent with 450 ppm CO2 only
- » Burden sharing rule based on “contraction and convergence” for participatory countries (non-participatory countries allocated their BaU)
- » Allow banking (partial “when” flexibility, no borrowing, no speculation)

## Simulations:

- » **entry now**: immediate global participation
- » **entry 2035**: NA1 join in 2035
  - **wout trade**: carbon trading only among participatory
  - **wout trade myopic**: carbon trading only among participatory, no anticipation of future commitment
  - **with trade**: NA1 allocated their BAU
- » **stoch entry**: 50% in 2035, 50% in 2050

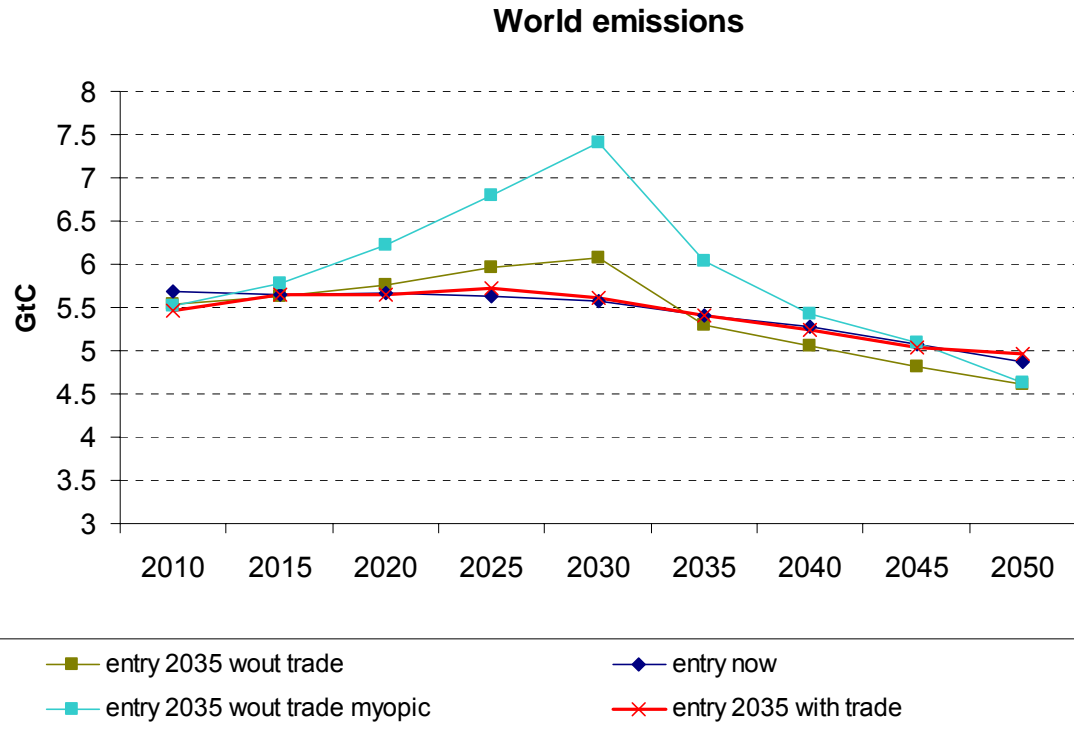
# Delayed participation: effects on climate

NON-A1 can't trade reductions from BAU

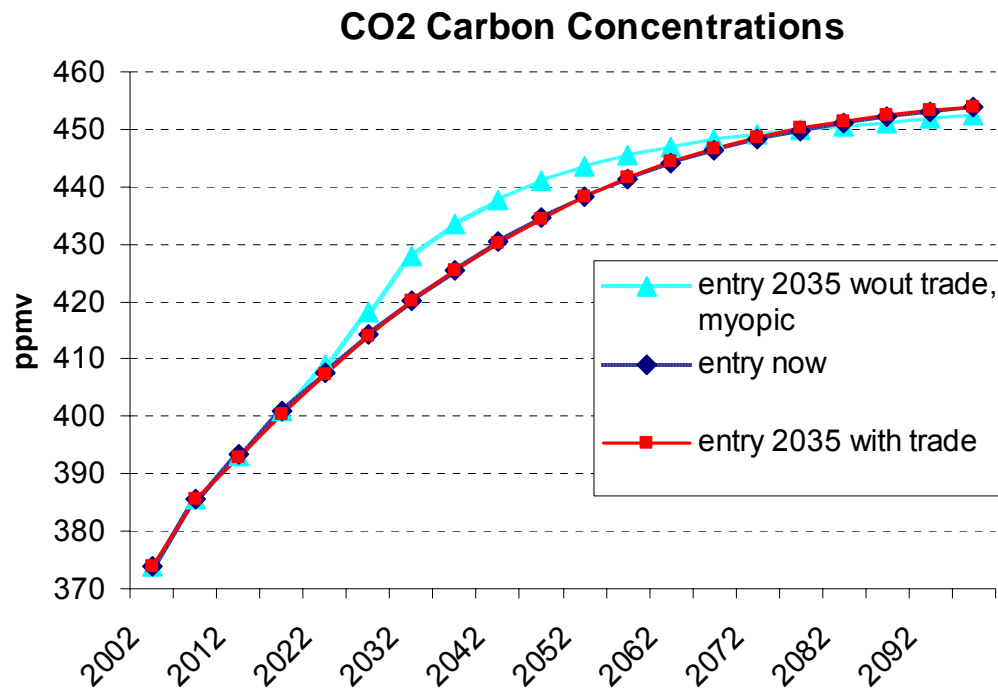


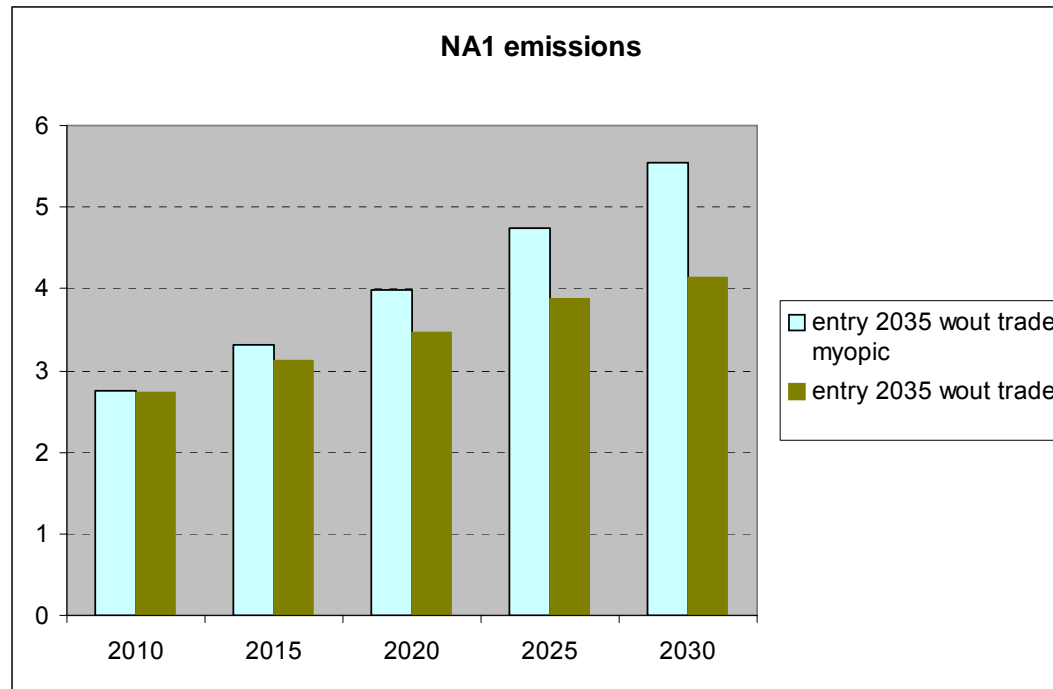
Later participation of NA1 countries implies higher global initial emissions, lower emissions in second half of century

## NON-A1 can trade



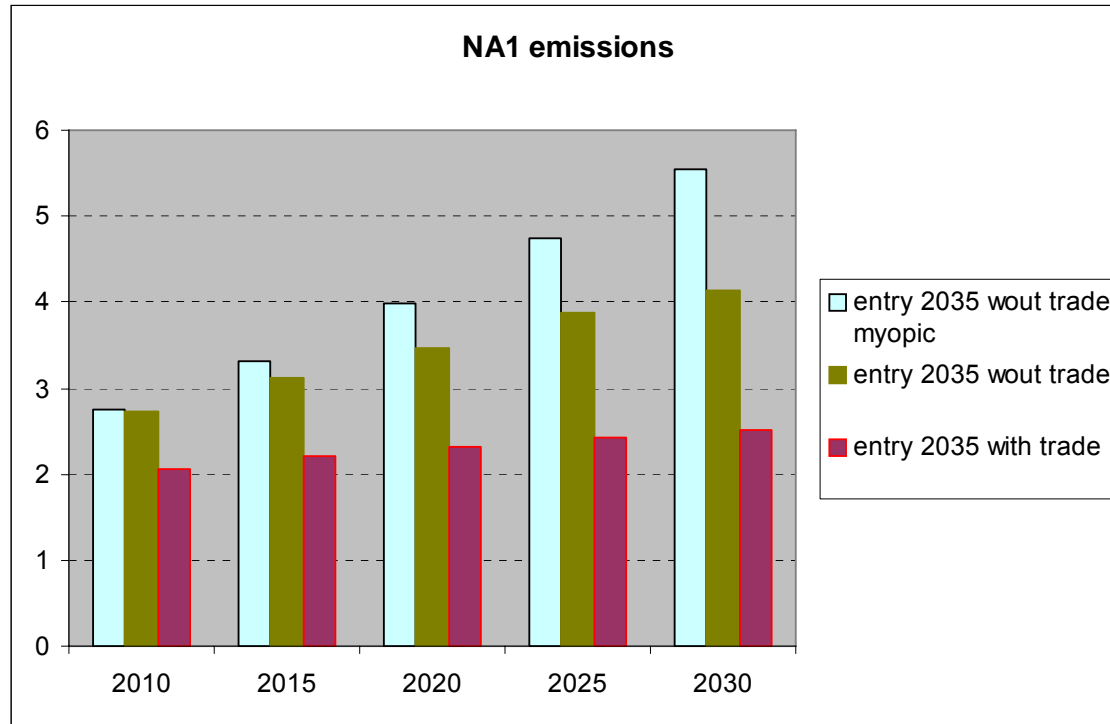
Allowing non-participatory countries to trade offsets abatement postponement





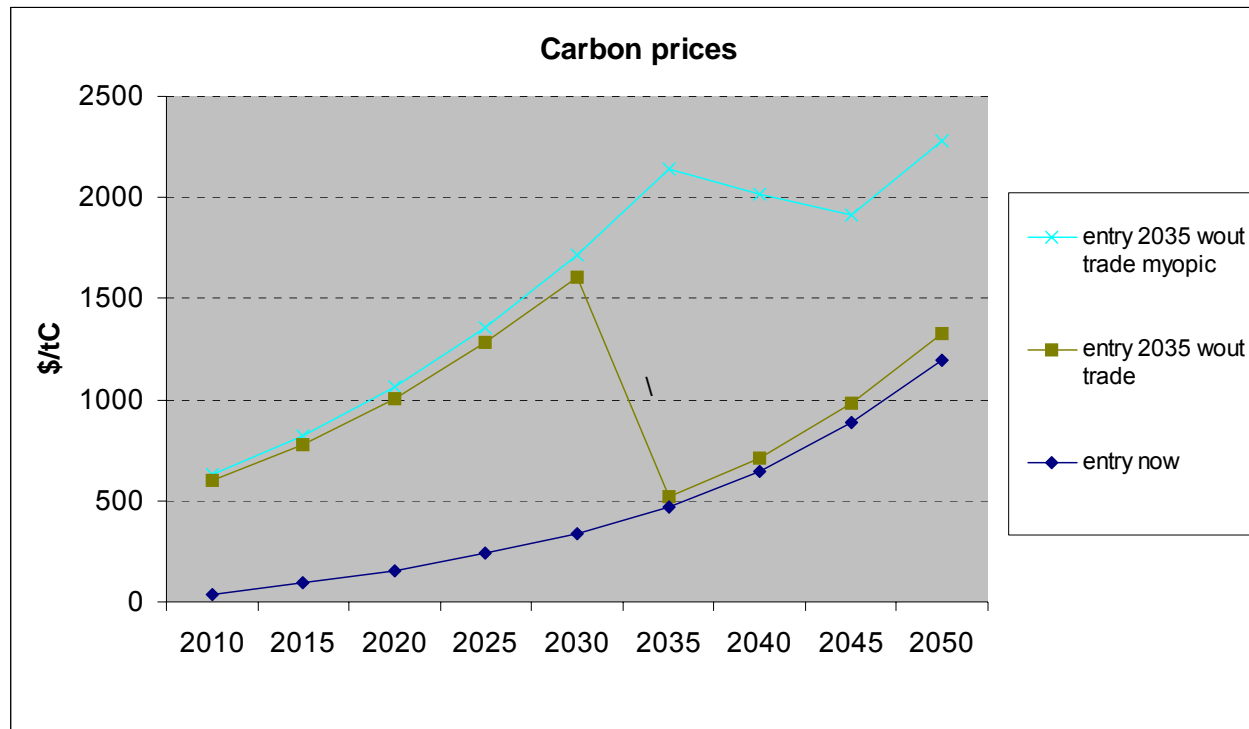
NA1 emissions:

1. A1 policy lowers fossil fuel prices (+)
2. A1 policy fosters technical change in low carb techs (-)
3. Foresee coming target (long lifetime of investments) (-)

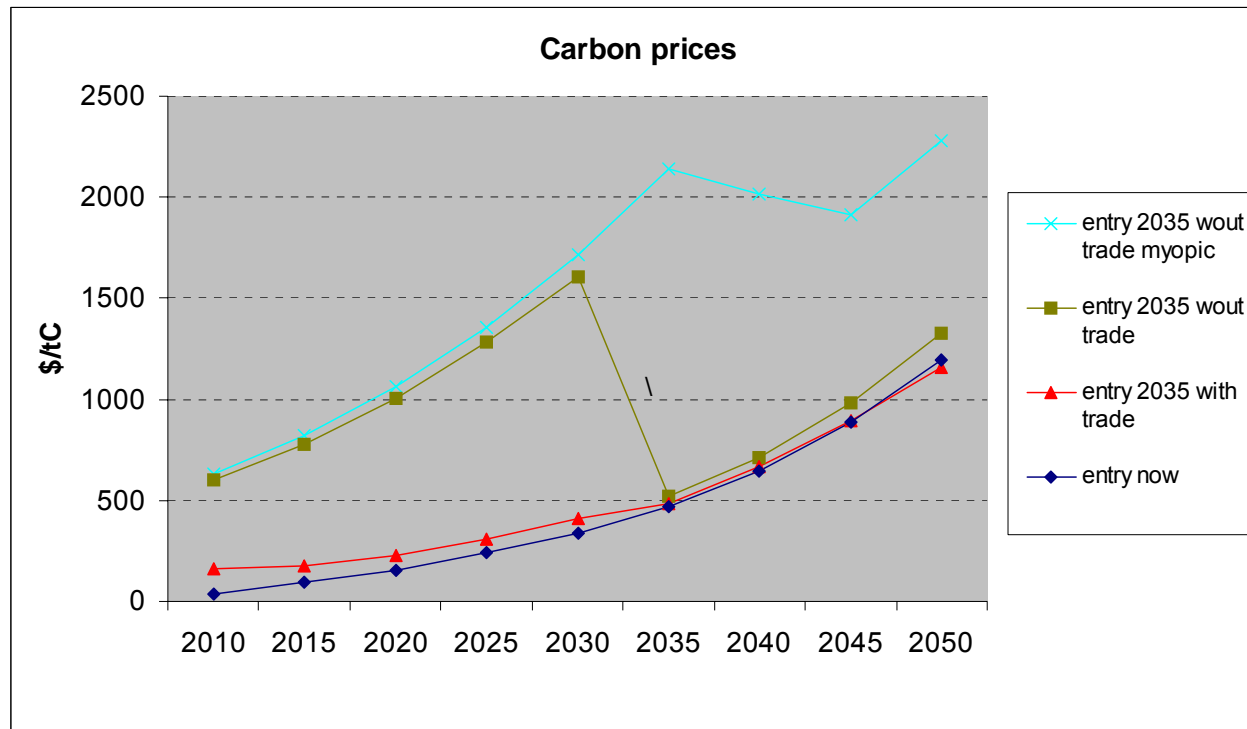


Incentives in lowering emissions with trade

# Delayed participation: economic effects



Carbon prices 3 fold increase with NA1 delay



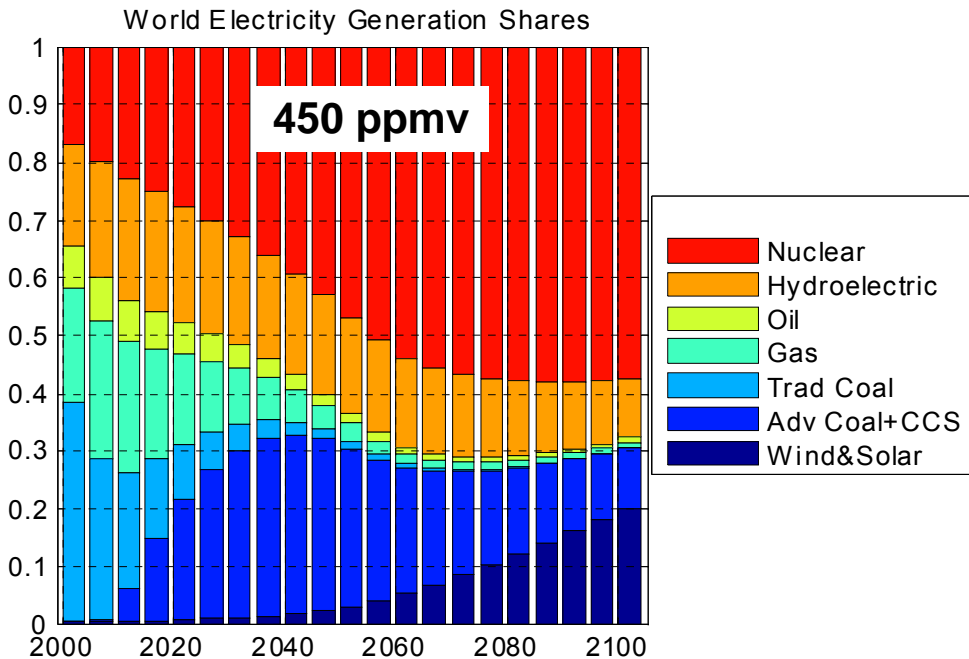
Introducing trade brings back carbon prices close to original values

NPV GDP loss 2000-2100*	WORLD
Entry now	2.1 %
Entry 2035 wout trade	2.8 % (+11 USDTIn)
Entry 2035 wout trade myopic	3.7% (+24.6 USDTIn)
Entry 2035 with trade	2 % (-0.9 USDTIn)

\*Discounted a 5%

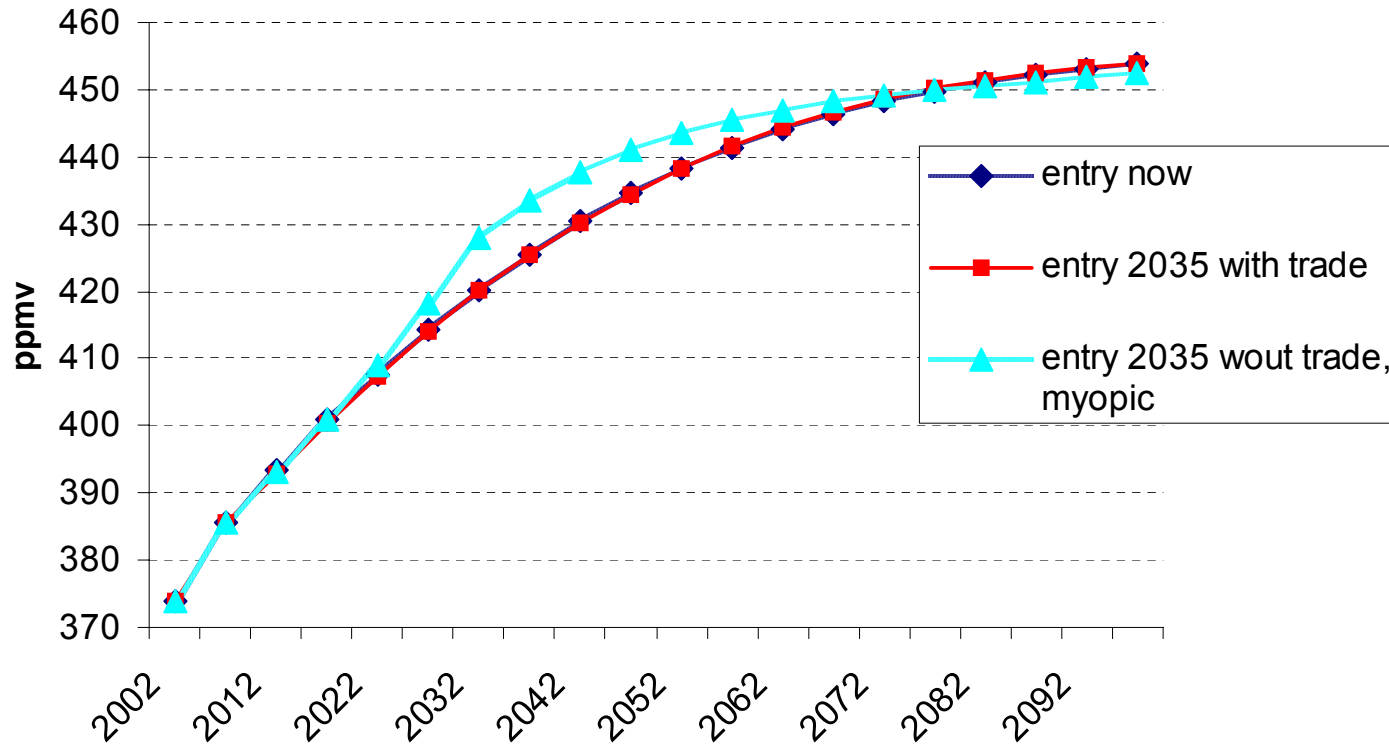
# Delayed participation: technology adoption and technical change

# Stabilization Scenario Analysis – 450 ppmv



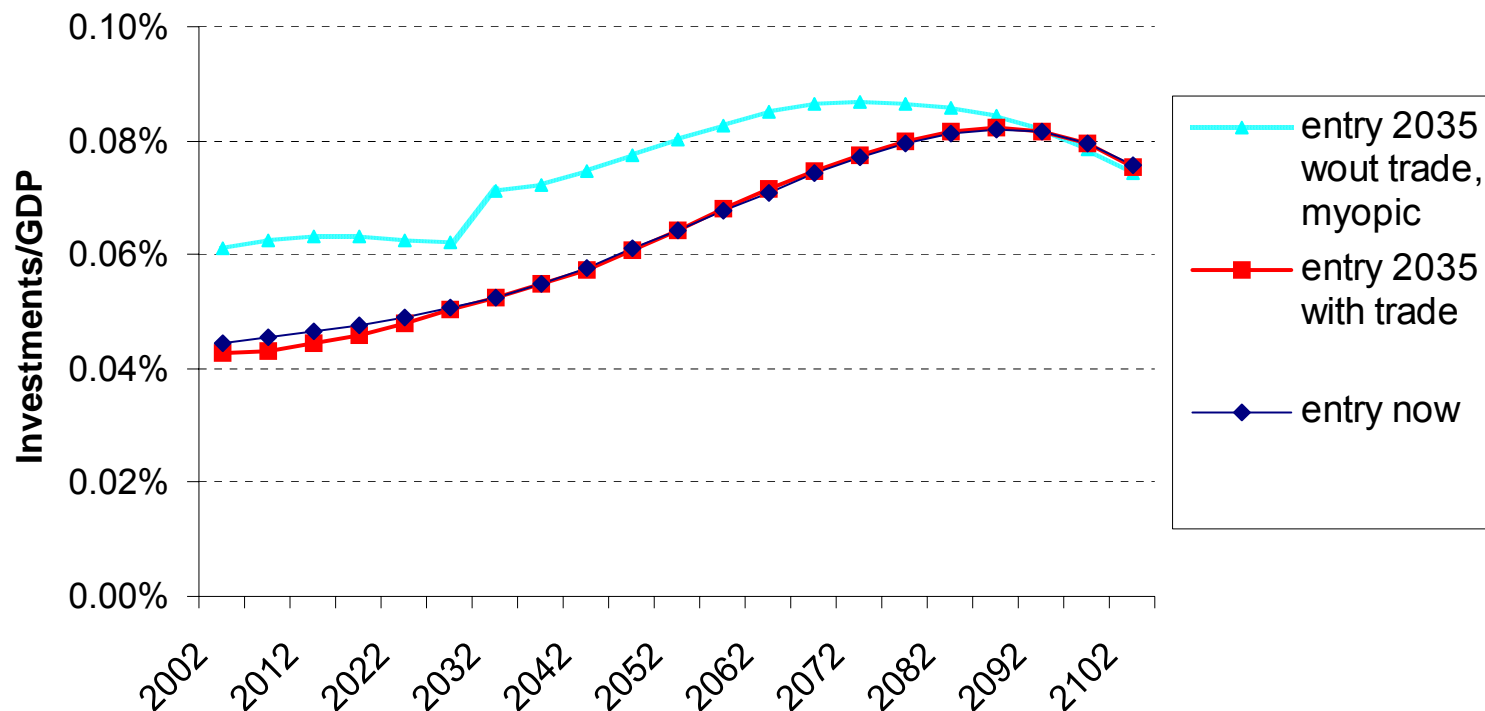
- IGCC CCS reaches the 30% share, then declines in 450ppmv (when emissions are more stringent)
- Nuclear ten-fold expansion in 450ppmv !!!
- Wind&Solar 20% electricity in 2100 in 450. Learning by Doing helps making the technology more competitive

### CO2 Carbon Concentrations



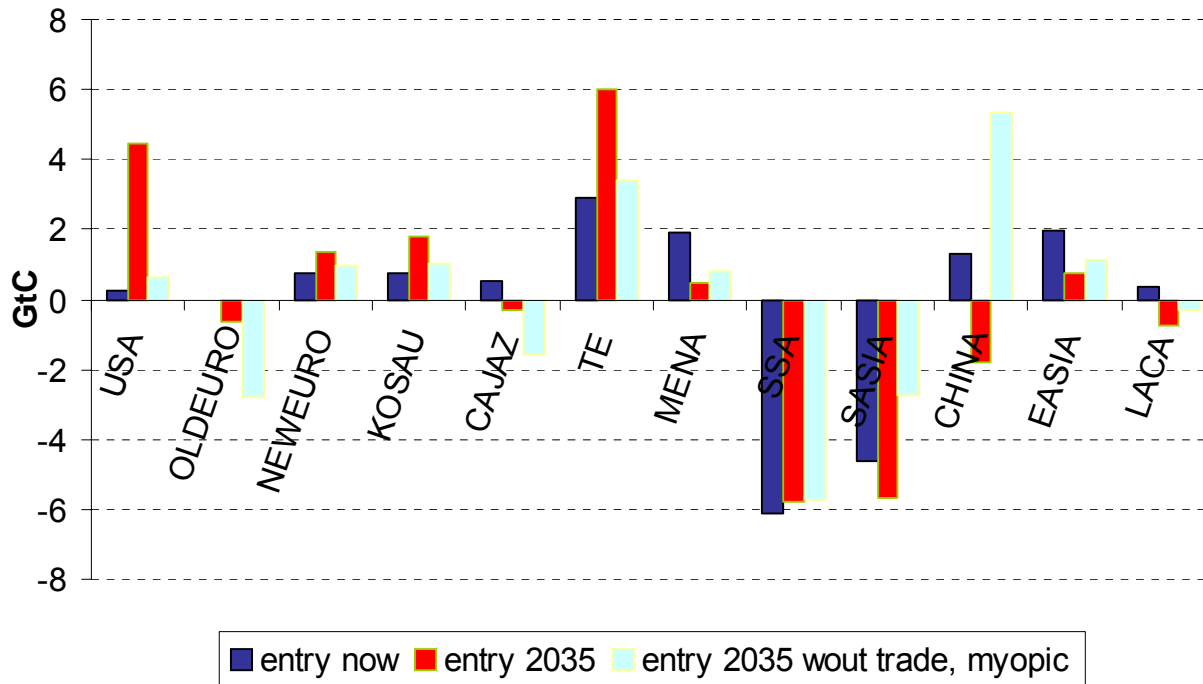
CCS downsized wout trade: non-perfect capture rate acts as a bound late in the century when very low emissions are needed. Delayed deployment exacerbates this.

## Energy Efficiency R&D



R&D increases wout trade as it's mostly carried out in A1 countries.  
Intertemporal and cross country spillovers effects

## Net Import of Permits (cumulative to 2100)

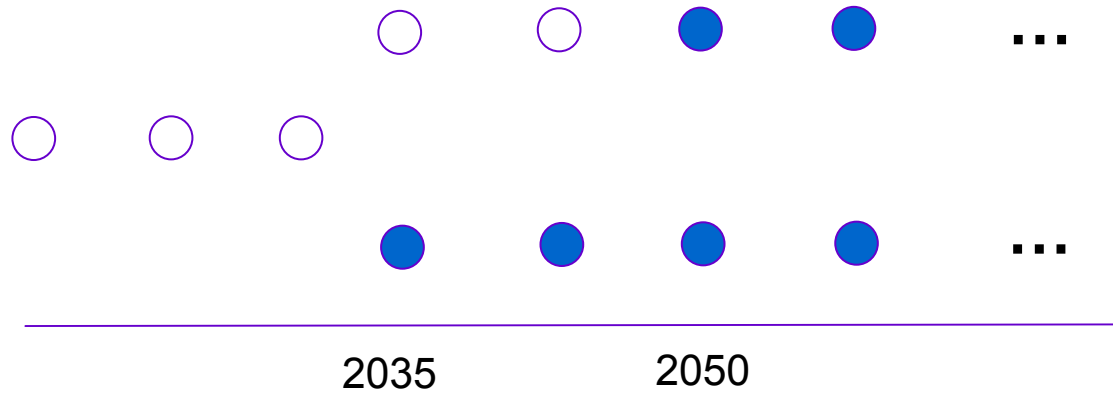


# Uncertain participation

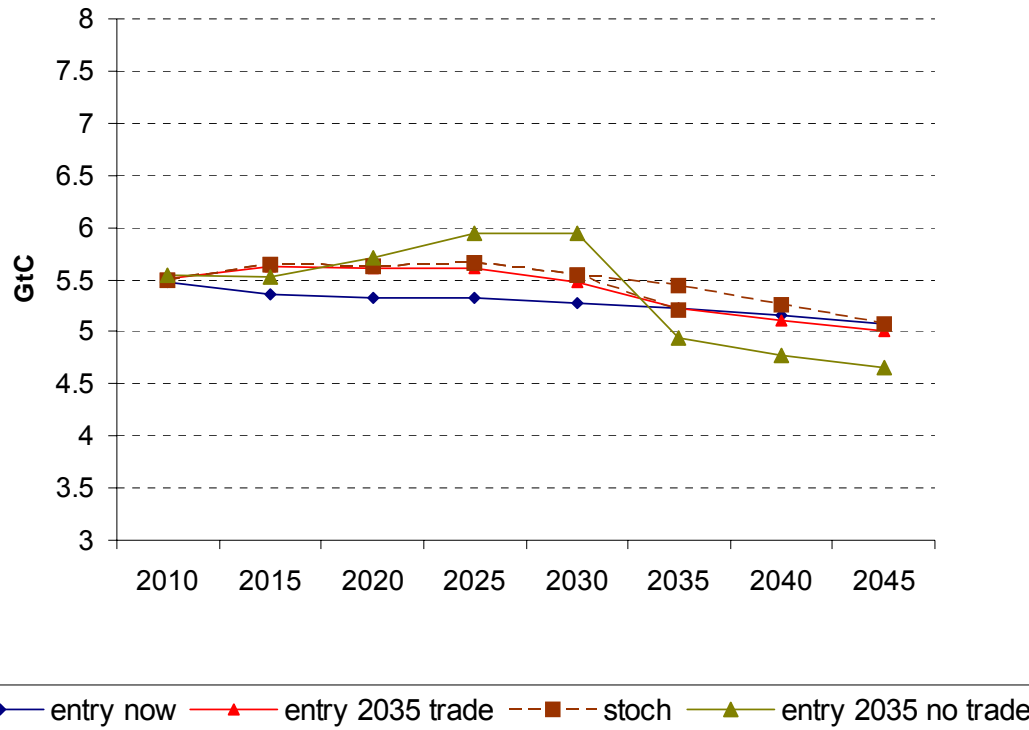
## PARTECIPATING PERIOD: Stochastic analysis

» Entry time of NON-A1 is uncertain

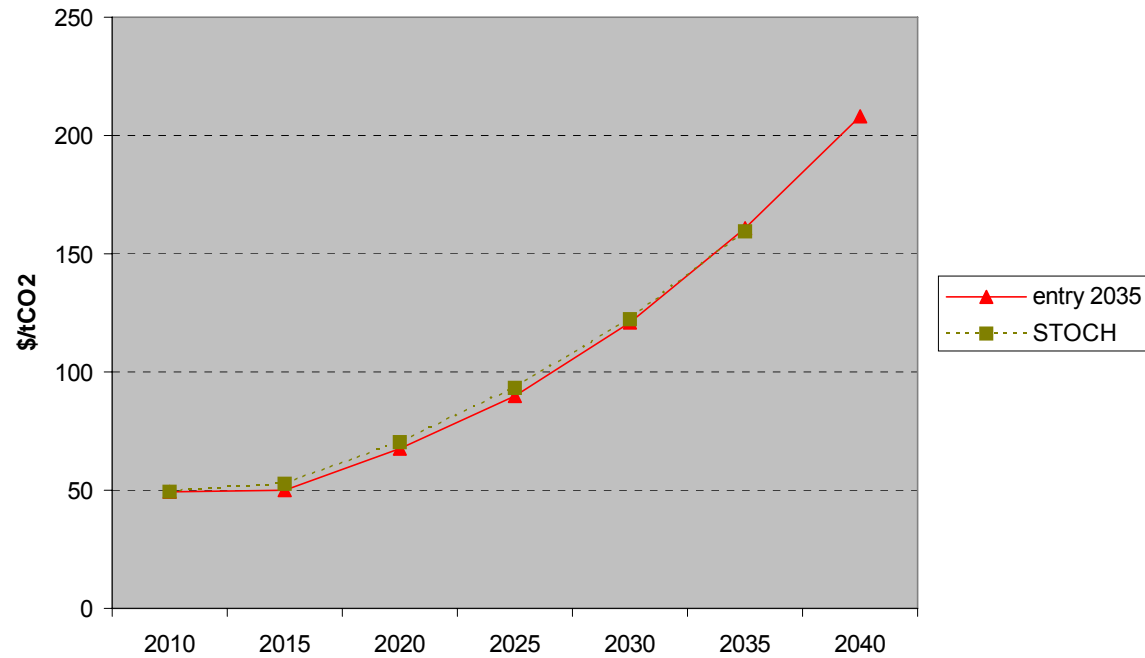
- Global participation
- Partial participation



Trade allowed (otherwise 2050 delay infeasible)



Emission path not significantly affected by uncertainty



Carbon prices not affected by uncertainty

## Partial and uncertain participation

- a. Delayed participation of LDC negative impact on emissions and mostly on costs. Second best inefficiency up to 10-25 TInUSD (different effects on different groups of regions).
- b. However, these two negative effects are almost entirely attributable to limited carbon trading, and wane when non-participatory countries can credit emission reductions from BAU.
- c. Not consenting carbon trade has implications for technology deployment (CCS ↓) and innovation (R&D ↑).
- d. Uncertainty about timing of participation of NONA1 doesn't modify picture, as long as carbon trading is active.

- Include avoided deforestation
- Include non CO<sub>2</sub> GHGs
- More stringent targets
- Gradual participation

**Thank you !**

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$$\begin{aligned}
E^{Early}(W) - E^{Late}(W) &= E^{Early}(A1) + E^{Early}(NA1) - [E^{Late}(A1) + E^{Late}(NA1)] \\
&= E^{450}(W) - S^{Early}(A1) - S^{Early}(NA1) - [E^{450}(W) - S^{Late}(A1) - S^{Late}(NA1)] \\
&= [S^{Late}(A1) - S^{Early}(A1)] + [S^{Late}(NA1) - S^{Early}(NA1)]
\end{aligned}$$