Technology Assessment and Climate Policy

(IAM, WP4.1, NCCR-Climate)

Alexander Wokaun (PI), Socrates Kypreos (Co-PI), Leonardo Barreto, Peter Rafaj, Daniel Krzyzanowski, Hal Turton

Energy Economics Group

General Energy Research Department (ENE)

Paul Scherrer Institute (PSI)

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Outline

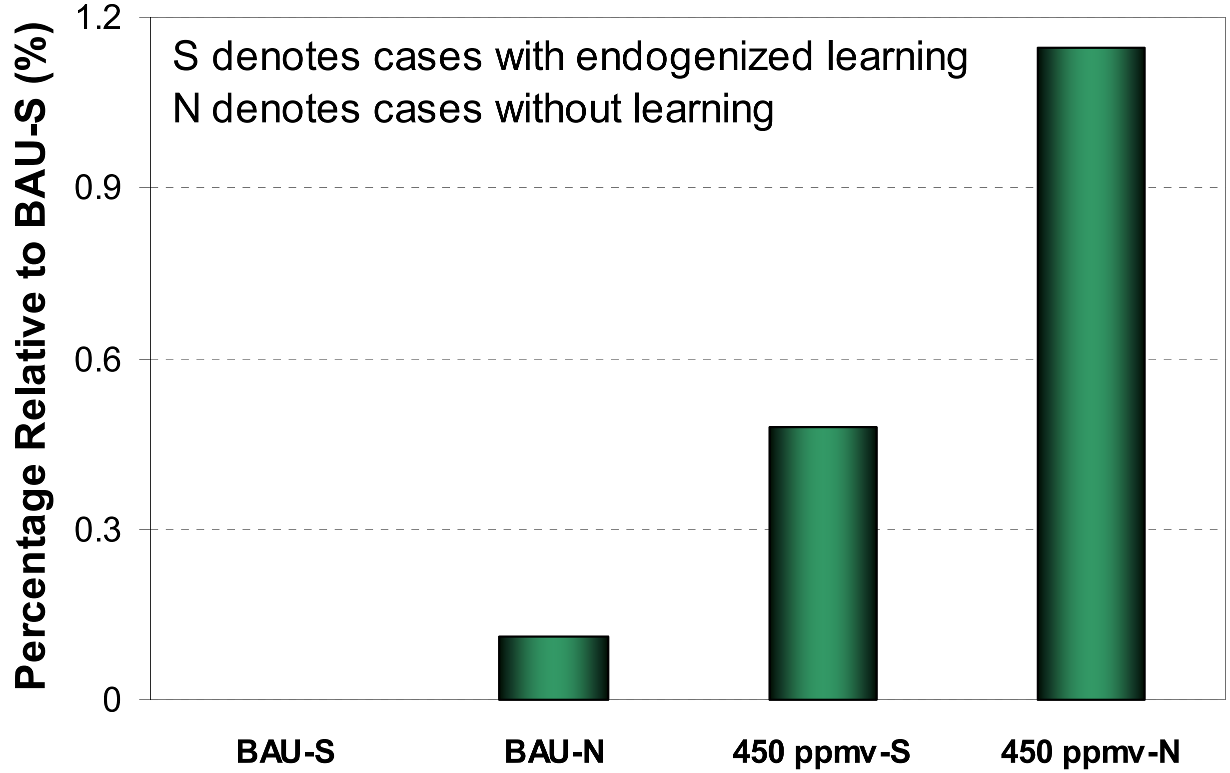
- Integrated assessment models
- The impact of endogenized technological learning
- Flexible climate policy instruments
- Stimulating technological learning
- Fuel cells and hydrogen in the automobile sector
- Conclusions

Integrated Assessment Models (IAM)

- Two overarching questions:
  - Which policy mix will insure that the most efficient options are selected and promoted?
  - What is the portfolio of efficient technological and other options to mitigate climate change?
- In order to answer these two questions an adequate representation of technology dynamics within the IAM framework was developed (MERGE-ETL, GMM, ERIS) and alternative policy instruments that could enhance the flexibility of climate policies were examined.

Endogenized Technological Learning

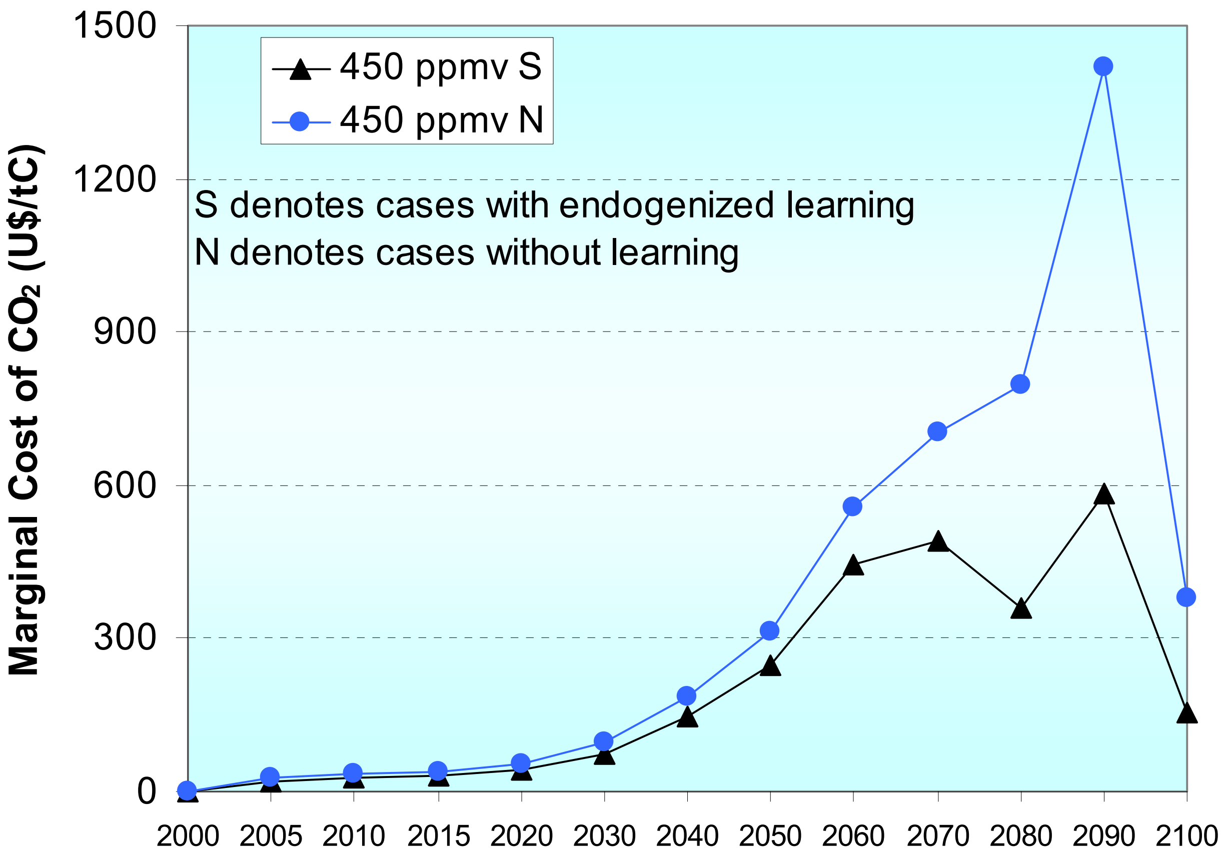
Cumulative Undiscounted GWP Losses in a 450 ppmv case relative to BaU Case with Learning (BAU-S)



Source: Kypreos, 2005: Optimal Economic Growth under Climate Threats. Kluwer Publishers (submitted)

Endogenized Technological Learning

CO_2 Marginal Cost for a 450 ppmv Target



Source: Kypreos, 2005: Optimal Economic Growth under Climate Threats. Kluwer Publishers (submitted)

Flexible Climate Policy Instruments

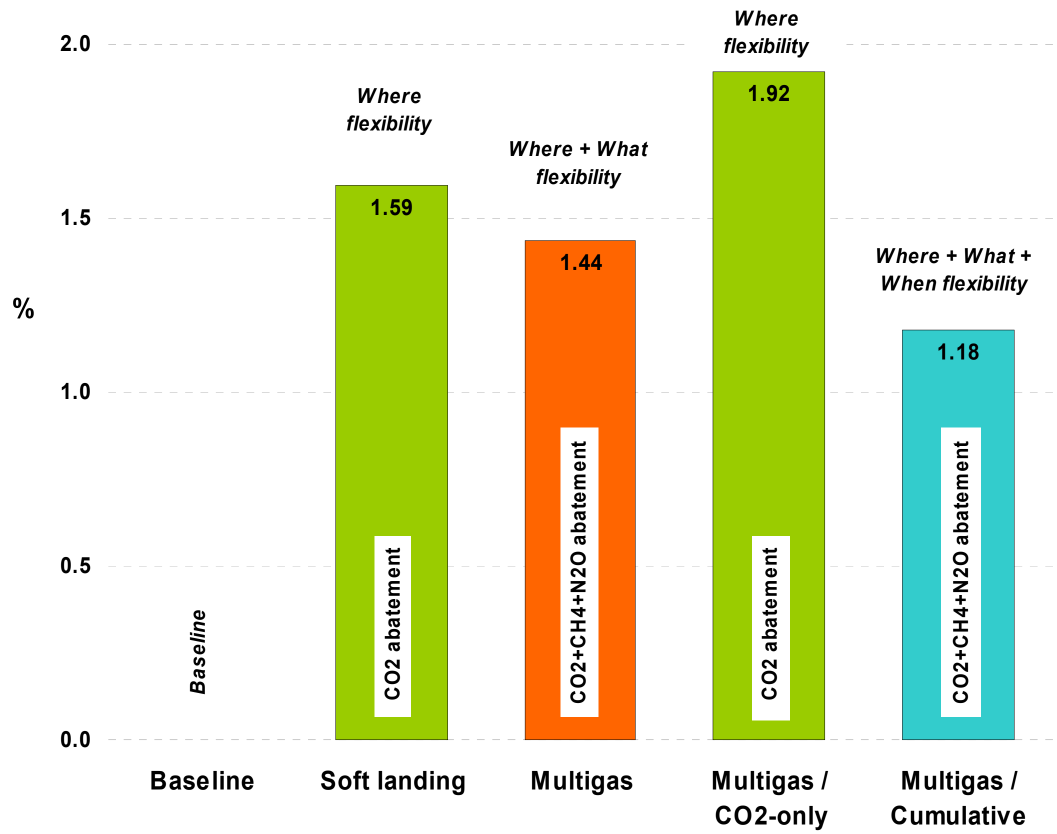
- Climate policy should exploit a combination of "where", "when", "what" and technology-related flexibilities.
- A combination of policy instruments may help exploiting potential synergies
- Policy instruments must be designed to stimulate technological change in the long run

Multi-GHG Mitigation Strategies

- Consideration of non-CO_2 GHGs (e.g. CH_4, N_2O) leads to noticeable cost reductions and changes in the composition of mitigation strategies
- The “what” flexibility in climate policy could shift the introduction of capital-intensive technologies into the future
- But, in the long term, CO_2 reduction must remain at the core of GHG mitigation efforts

Multi-GHG Mitigation Strategies

Change in Cumulative Discounted Energy System Cost and Welfare Loss relative to the Baseline Scenario



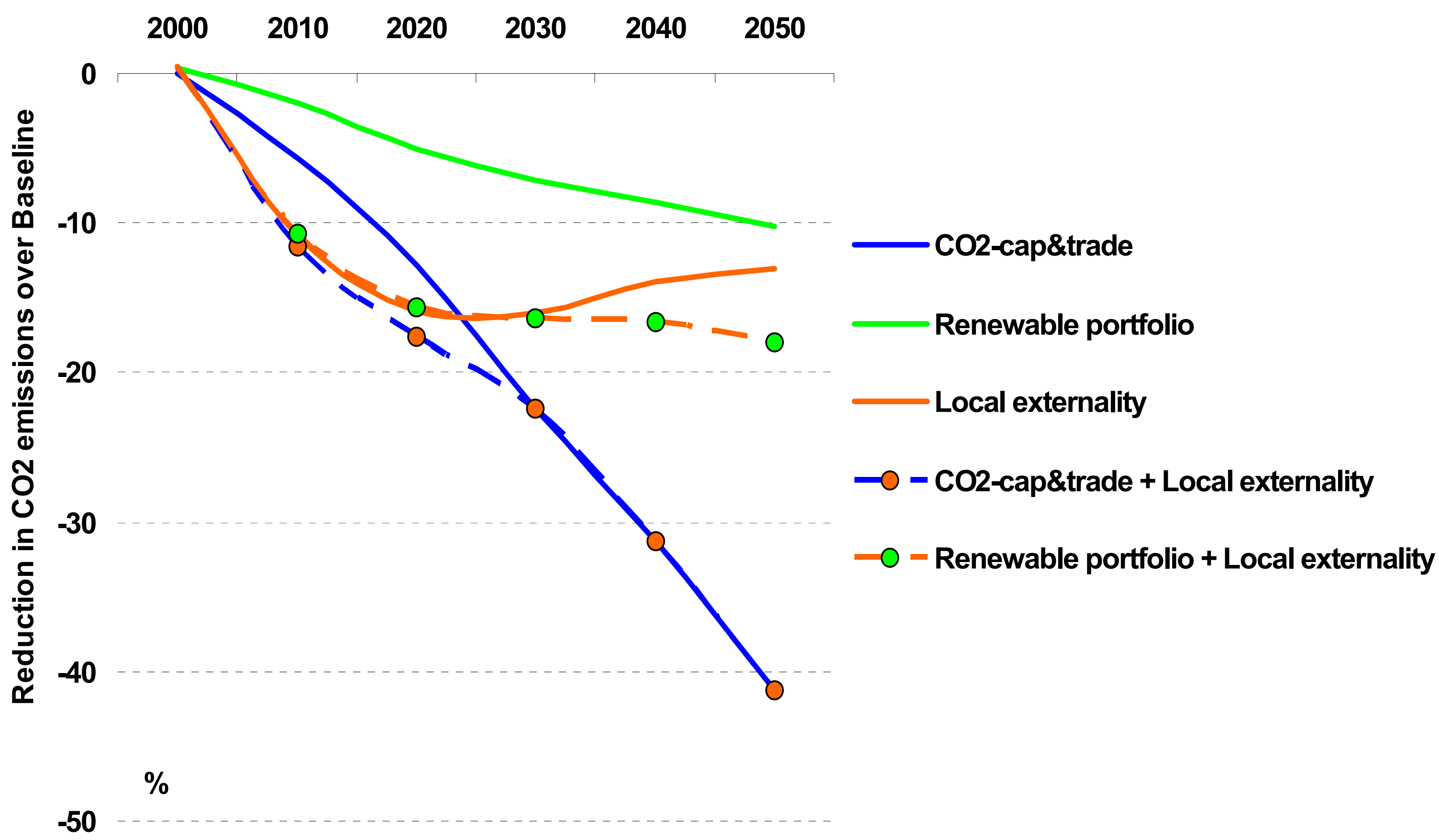
Source: Rafaj, Barreto, Kypreos 2005: The Role of Non-CO_2 Gases in Flexible Climate Policy (submitted)

Combining Policy Instruments:

CO_2 Reduction, Renewable Portfolio, Local Externalities

- It is necessary to examine the effects of combining climate-change policy instruments with measures in other policy domains
- Synergies between CO_2 reduction, renewable portfolio standards and policies to curb air pollution could be exploited

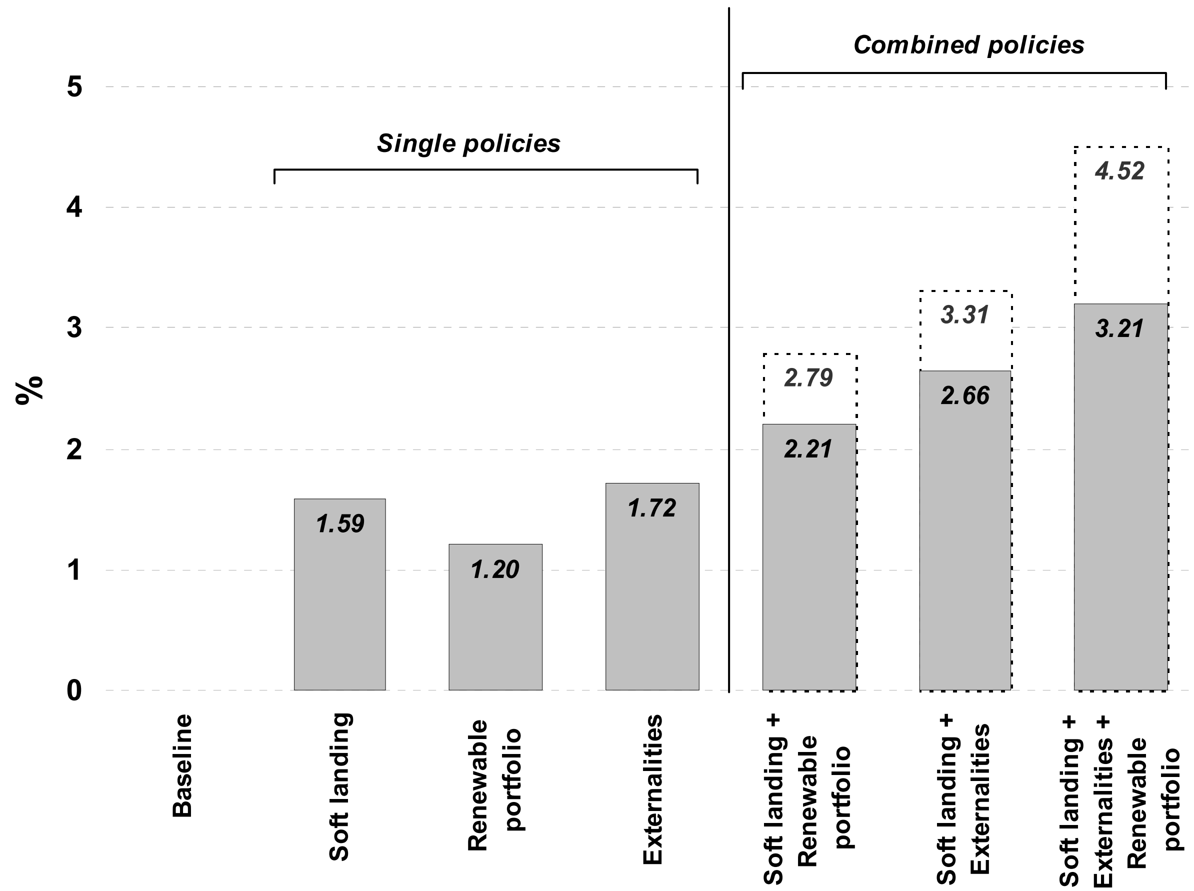
Combining Policy Instruments:
CO_2 Reduction, Renewable Portfolio, Local Externalities



Source: Rafaj, Barreto, Kypreos, 2005: Combining Policy Instruments for Sustainable Energy Systems

Combining Policy Instruments:

Change in Cumulative Discounted Energy System Cost relative to the Baseline Scenario



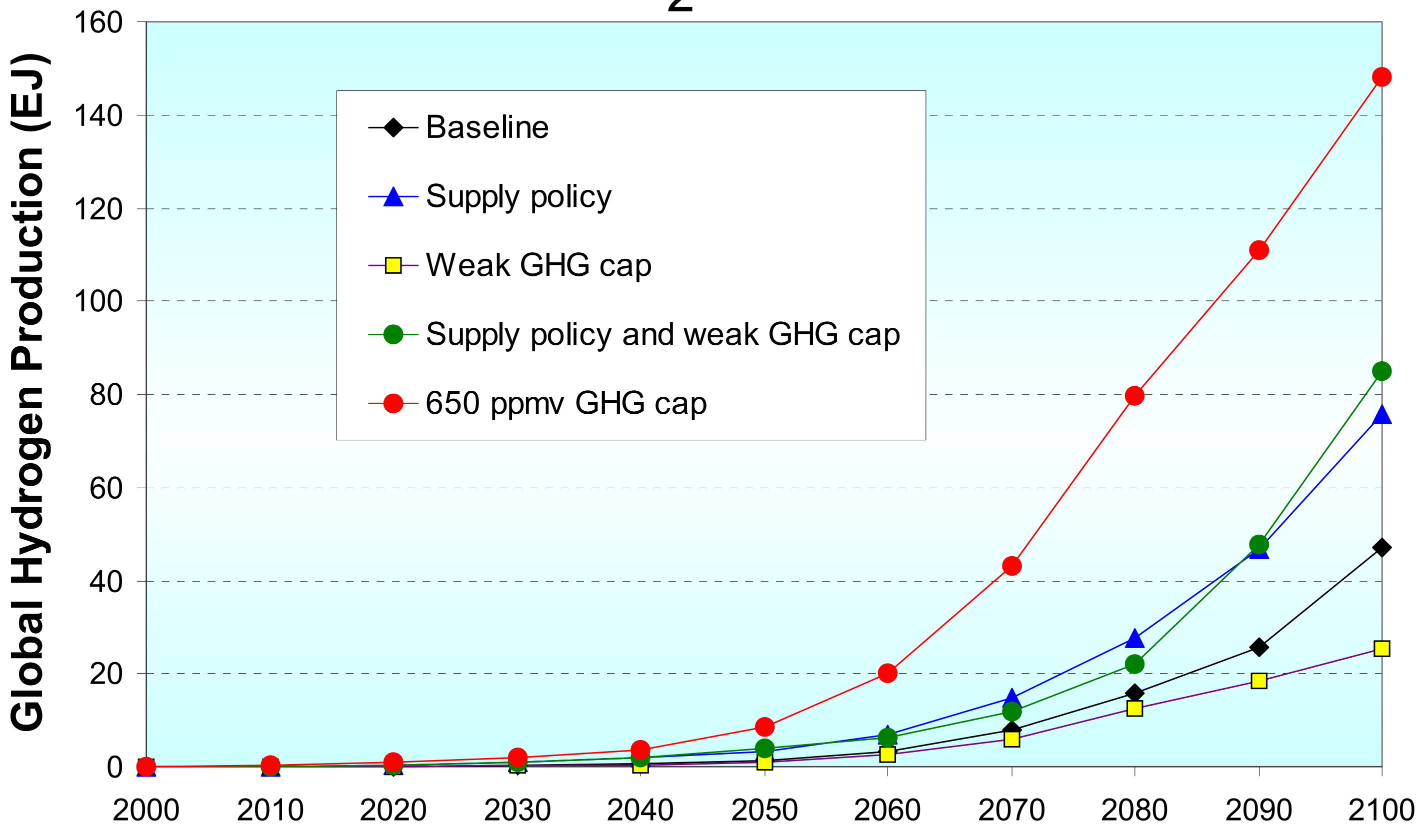
Source: Rafaj, Kypreos, Barreto, 2005: Combining Policy Instruments for Sustainable Energy Systems

Combining Security of Energy Supply and Climate Change Policies

- Climate change and energy supply disruptions are two major risks linked to the energy system
- Both important to long-term energy sustainability
- There may be synergies and trade-offs between pursuing GHG abatement and security of supply -> possible shift to H_2 economy
- Both are affected by technological change

Combining Security of Energy Supply and Climate Change Policies

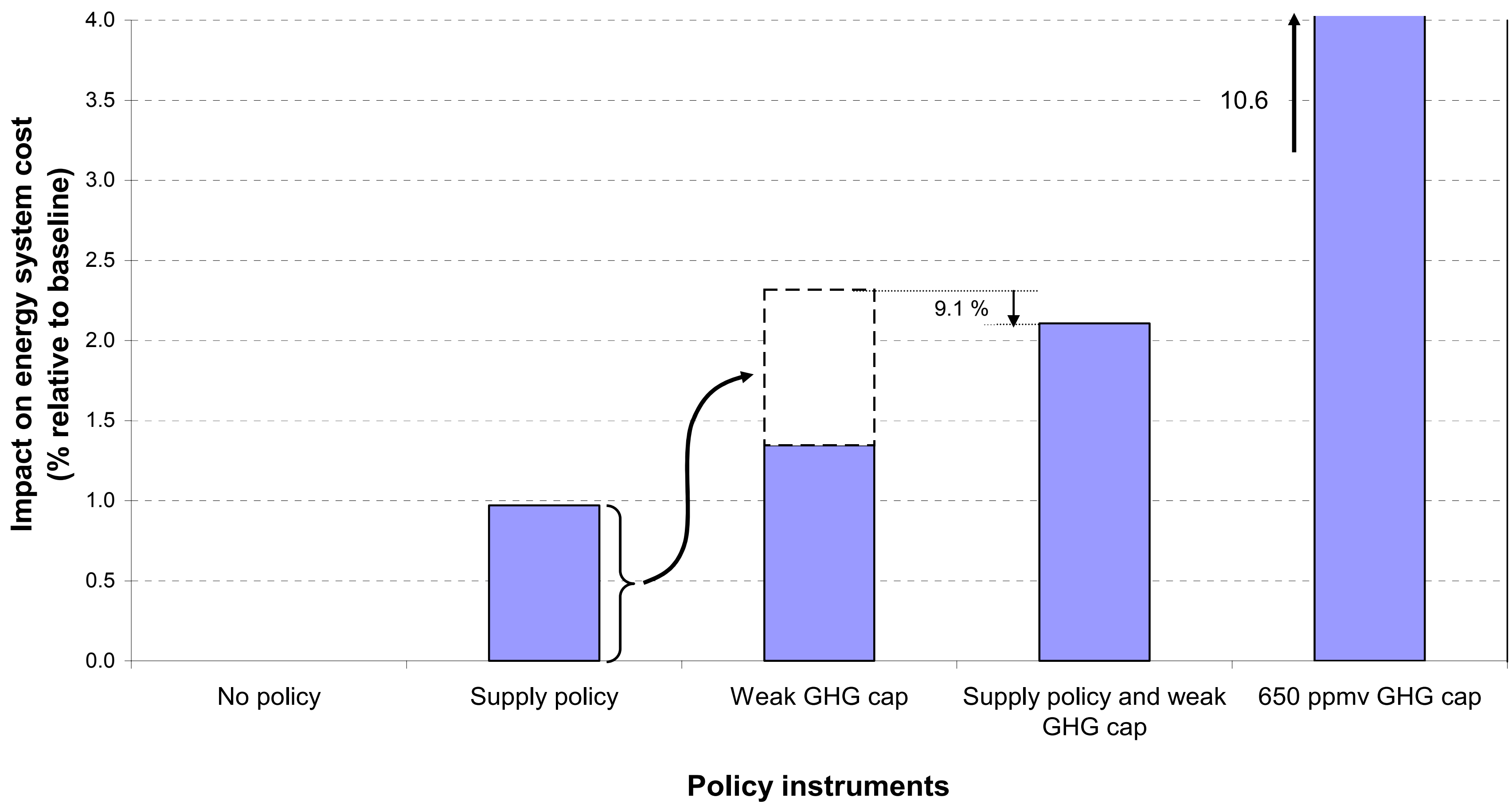
Global H_2 Production



Source: Turton and Barreto (2005), Long-term security of energy supply and climate change

Security of Supply and Climate Change

Policy Impact on Energy System Cost



Source: Turton and Barreto (2005), Long-term security of energy supply and climate change

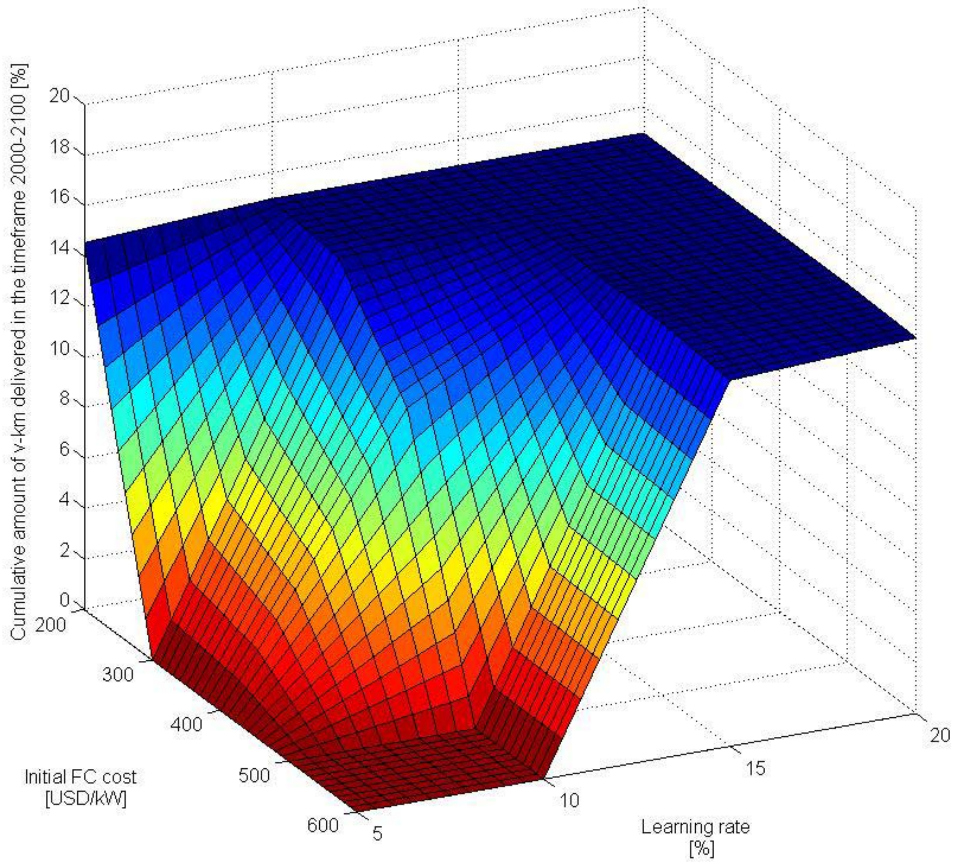
Stimulating Technological Learning

- The portfolio of policy instruments must include R&D and demonstration and deployment (D&D) programs in order to stimulate technological learning of clean emerging technologies
- "No silver bullet": a broad portfolio of technologies is needed to achieve long-term climate policy goals. Options range from renewable and nuclear energy to efficiency improvements along the whole chain and CO_2 capture and storage

Fuel Cells and Hydrogen in the Passenger Car Sector

- Fuel-cell vehicles and hydrogen could be promising options to satisfy energy needs in the long term but require targeted and consistent support in the form of R&D, demonstration and deployment (D&D) programs, adequate CO_2 price signals and targeted measures, among others

Influence of Fuel Cell Cost (USD/kW) and Learning Rates in Market Share of H_2 Fuel Cell Cars



Source: Krzyzanowski, Kypreos, Barreto (2005): Assessment of Market Penetration Potential of Fuel Cell Vehicles

Conclusions - 1

- An affordable CO_2 mitigation policy requires:
  - Combination of “where”, “when”, “what” and technology-related flexibilities
  - Exploitation of synergies with other policy domains (air pollution, promotion of renewable energy, security of energy supply, etc)
  - Adequate and sufficiently funded R&D and demonstration and deployment (D&D) programs to stimulate technological learning of cleaner emerging technologies
  - Technologies that build a bridge to low-emissions energy systems are essential

Conclusions - 2

- A “hydrogen+electricity” economy could be attractive in the long run, provided a number of hurdles are surmounted and environmentally compatible pathways can be implemented
- Climate policy solutions require combining knowledge in science, policy, economics and technology, implemented under societal constraints