Costs and Risks of Low Stabilisation Scenarios

Lessons from the Innovation Modelling Comparison Project (IMCP)

Low Stabilisation Scenarios – Strategies, Technologies and Costs

Workshop 16 – 17 March 2006 in Potsdam

PIK

Dr. Ottmar Edenhofer / Kai Lessmann

Content

1. The IMCP Project
2. Mitigation Costs
3. Mitigation Strategies
4. Economic Risks of Mitigation
5. Conclusion

Content

SPECIAL REPORT

The costs of global warming

Efforts to forecast how Earth's future climate will affect us must consider the economic growth of both rich and poor nations. But there are doubts over the theories being used, as **Quirin Schiermeier** explains.

Discussions of climate change tend to involve uncertainties, and most climate researchers have come to accept the inherent unknowns of their business. After all, the climate models they use to project the course of global warming are generally seen as the best that science can offer. But there is a growing feeling that the economic assumptions on which their work is based are outdated and unreliable. And this could have serious implications for assessments of climate change.

The Intergovernmental Panel on Climate Change (IPCC), which coordinates efforts to predict the effects of global warming, is currently finalizing its fourth assessment report. It has asked 15 climate groups to run their models using output from a range of different 'scenarios', representing various assumptions about energy use, economic development reflect how lifestyle and energy demand in both rich and poor countries are likely to change.

Climate researchers are familiar with the problem. "Some emissions scenarios are perhaps already demonstrably wrong," says Erich Roeckner, a climate modeller at the Max Planck Institute for Meteorology in Hamburg, Germany, who has modelled three of them for the IPCC (see "Early results"). "It is possible that all of them are wrong." But most feel that economics is a field they are not qualified to assess.

Ridiculous assumption?

One key criticism is the assumption that the economies of poor countries will quickly catch up with those of rich nations. "It is ridiculous to assume, as the IPCC does, that rich and poor countries will economically converge as rapidly as the European Union has done over the past

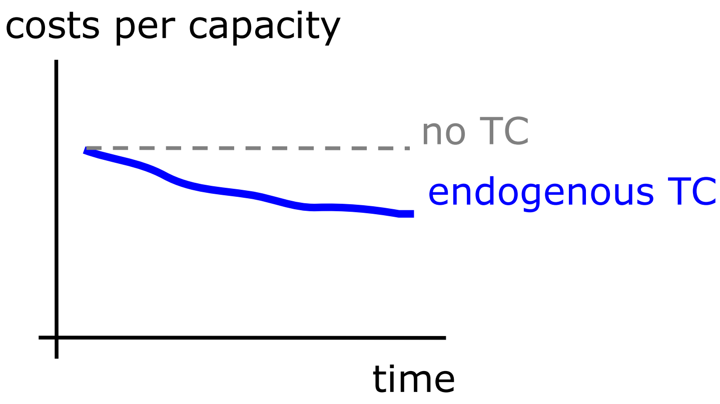
Translating temperature changes into impacts on society is beset with unknowns.

Models in the IMCP

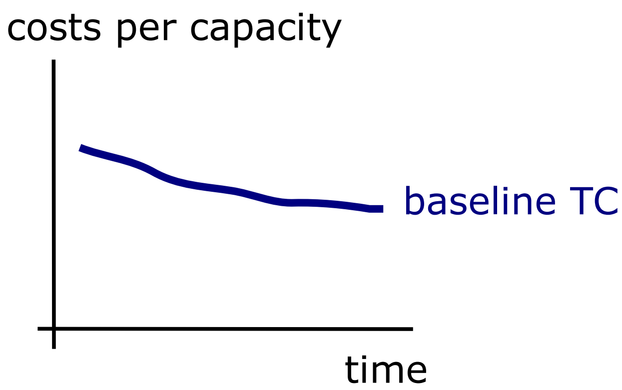
	Technological detail	
Calculus	*Top Down*	*Bottom Up*
Welfare maximization	Optimal growth models ENTICE-BR FEEM-RICE DEMETER-1CCS AIM/Dynamic-Global MIND 1.1	
Cost minimization		Energy system models MESSAGE-MACRO GET-LFL DNE21+
Initial value problems	Simulation models E3MG	
Static equilibrium + recursive dynamics	Computational general equilibrium models (CGE) IMACLIM-R	

IMCP Scenario Definitions

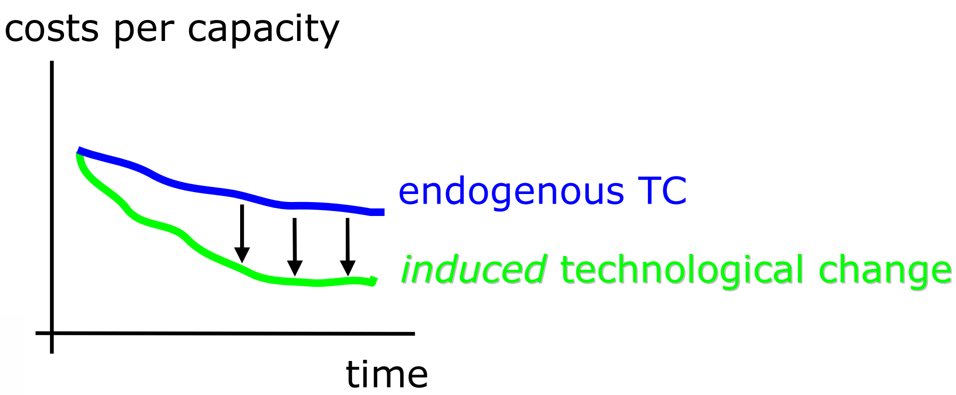
Baseline



Policy Scenario without ITC



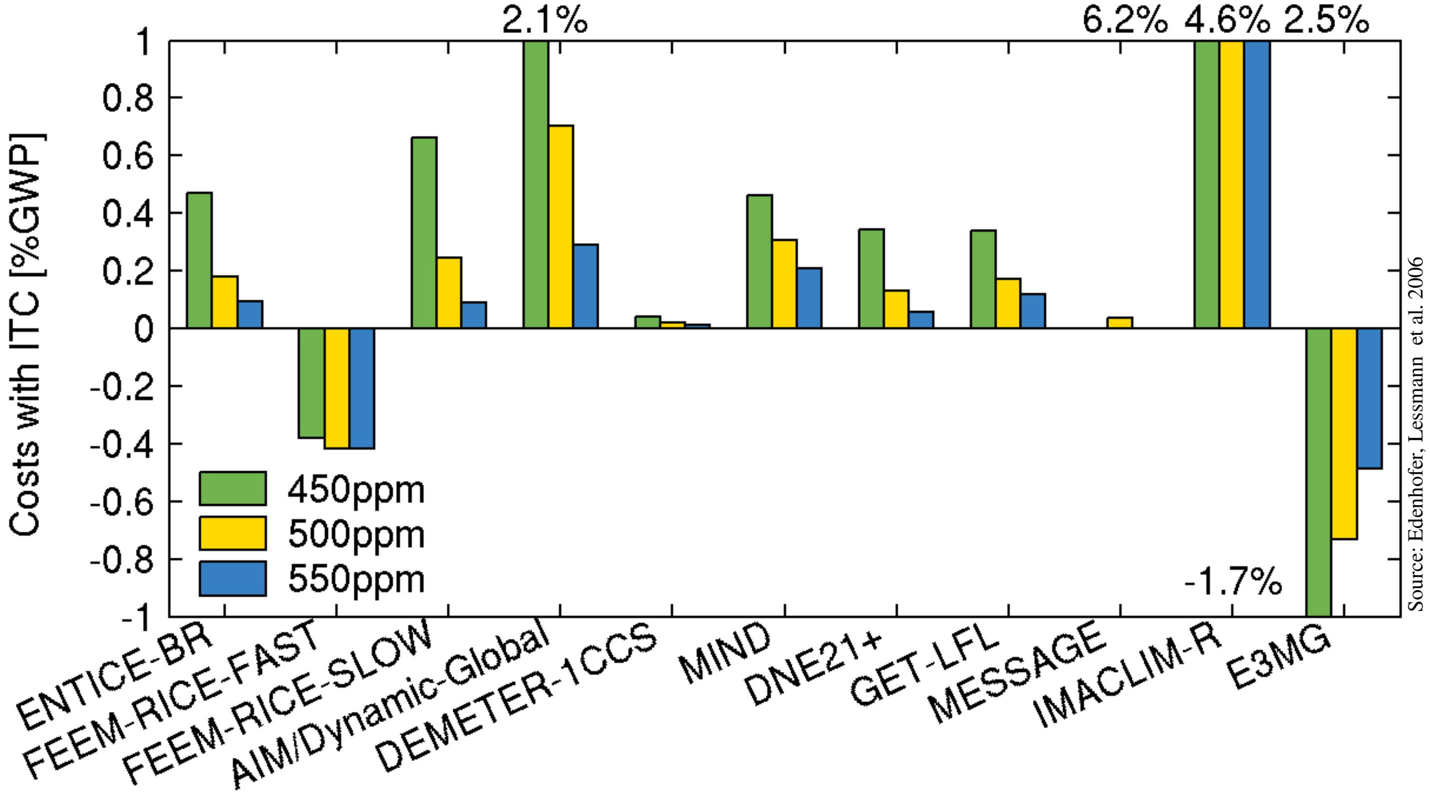
Policy Scenario with ITC



Content

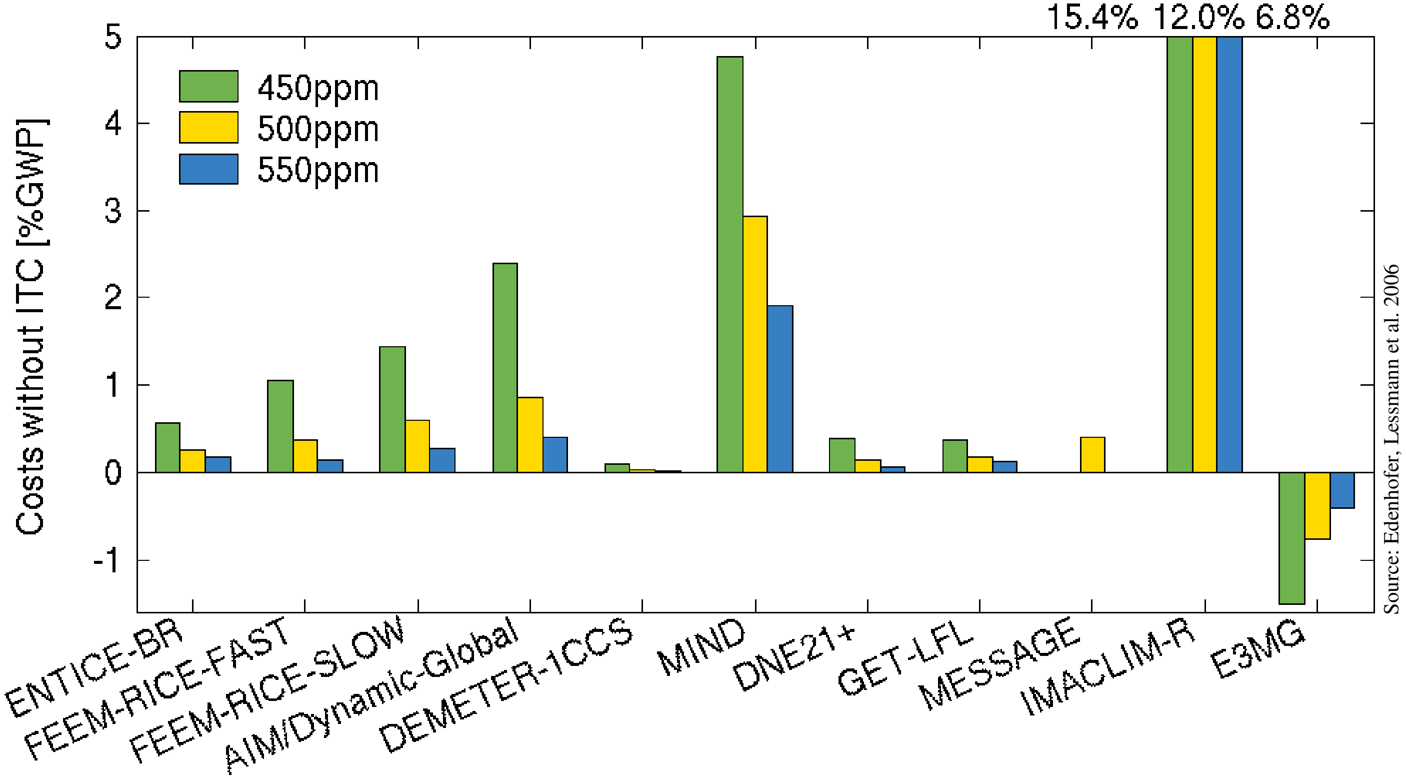
1. The IMCP Project
2. Mitigation Costs
3. Mitigation Strategies
4. Economic Risks of Mitigation
5. Conclusion

Mitigation Costs with ITC

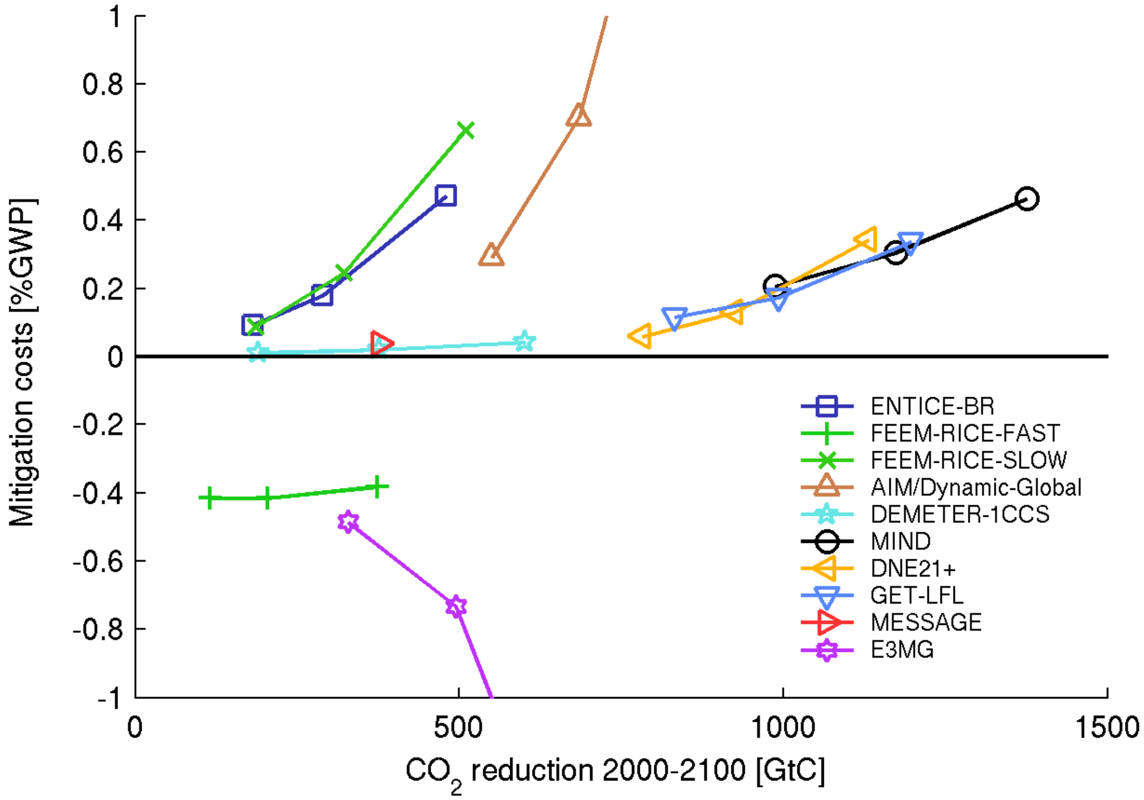


P I K

Mitigation Costs without ITC



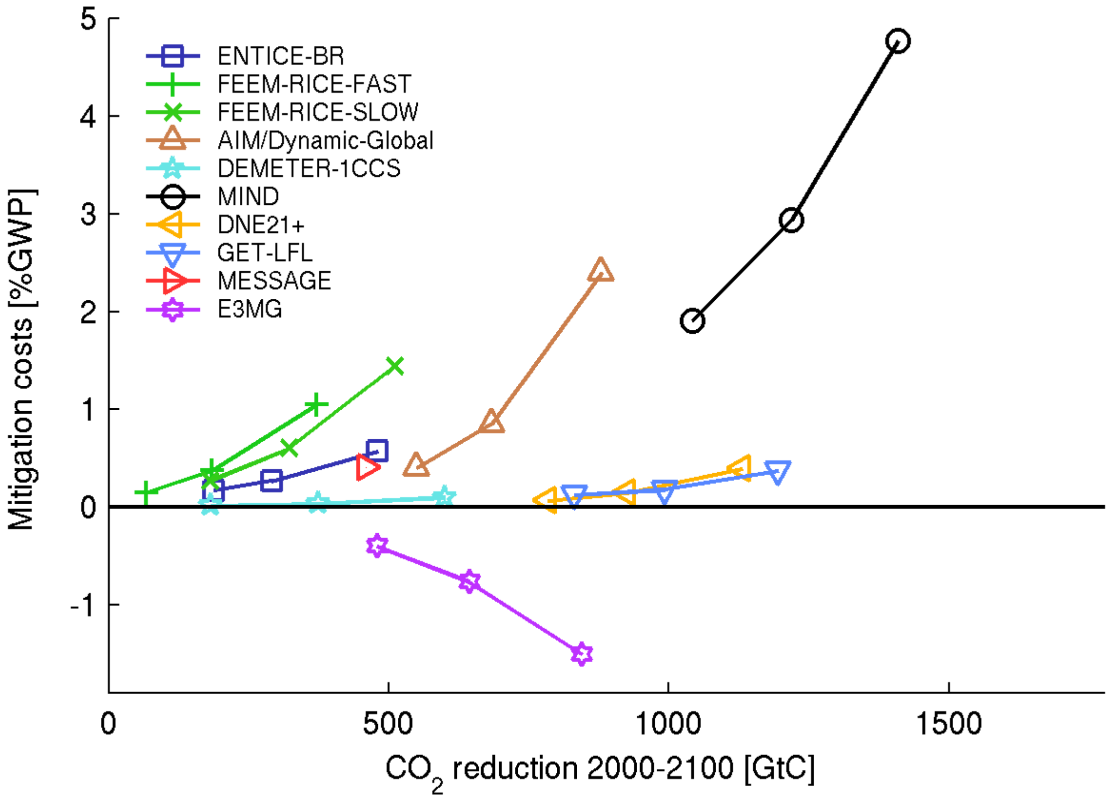
Mitigation Costs as a Function of Cumulative CO_2 Reduction



Source: Edenhofer, Lessmann et al. 2006

P I K

Mitigation Costs without ITC relative to corresponding CO_2 reductions



Source: Edenhofer, Lessmann et al. 2006

Stabilisation at 400ppm CO_2

Table 4. Mitigation Costs for 400ppm Stabilization

	Mitigation costs [%GWP]	
Model Name	**With ITC**	**Without ITC**
DEMETER-1CCS	0.07	0.17
FEEM-RICE-FAST	0.01	3.1
FEEM-RICE-SLOW	2.0	3.7
MIND	0.76	8.9
GET-LFL	0.62	0.67

Source: Edenhofer, Lessmann et al. 2006

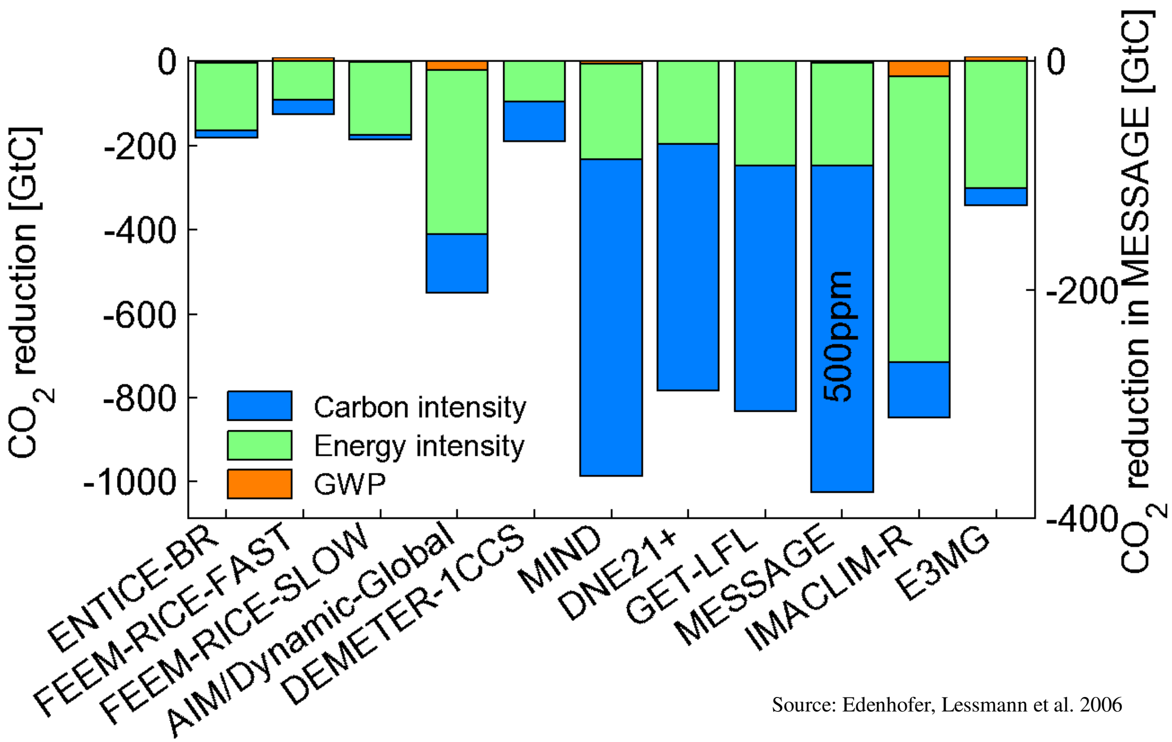
Mitigation Costs – Result I

- Induced Technological Change reduces the mitigation costs
- Mitigation costs increase with stabilisation levels despite ITC
- The “typical” IMCP model derives mitigation costs below 1 % of gross world product for stabilisation scenarios of 450 - 550ppm CO_2.

Content

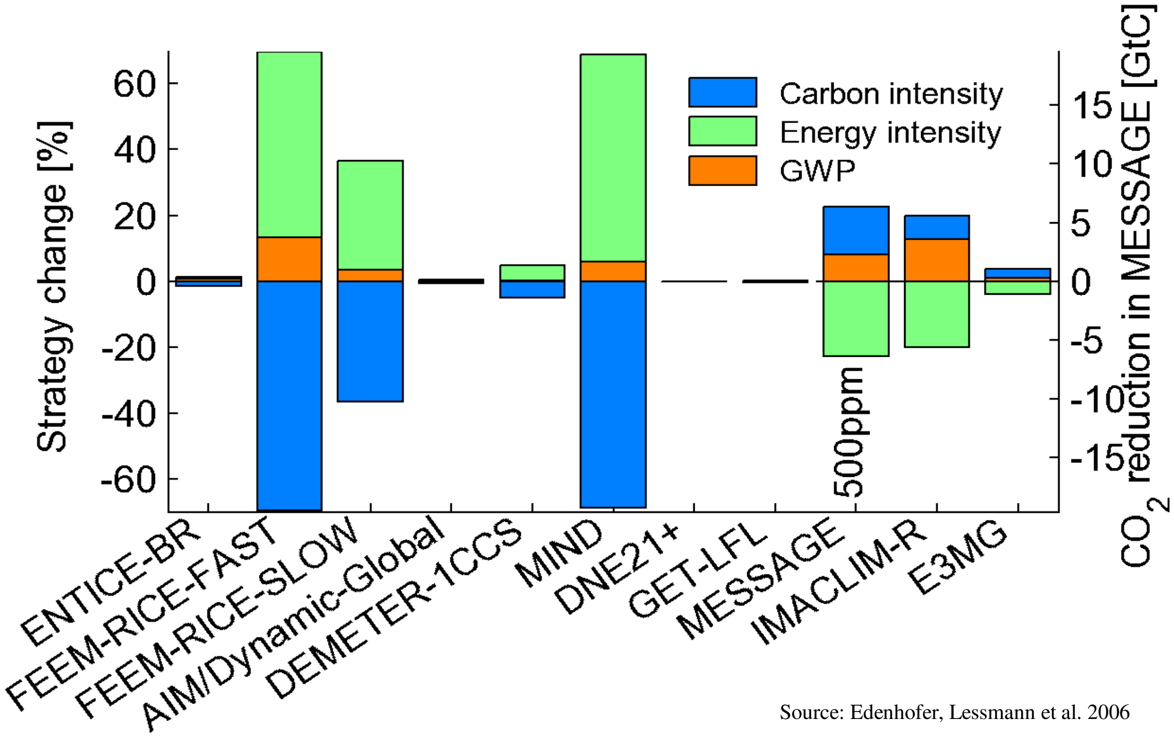
1. The IMCP Project
2. Mitigation Costs
3. Mitigation Strategies
4. Economic Risks of Mitigation
5. Conclusion

Cumulative CO_2 Reduction for 550ppm Stabilization Scenario



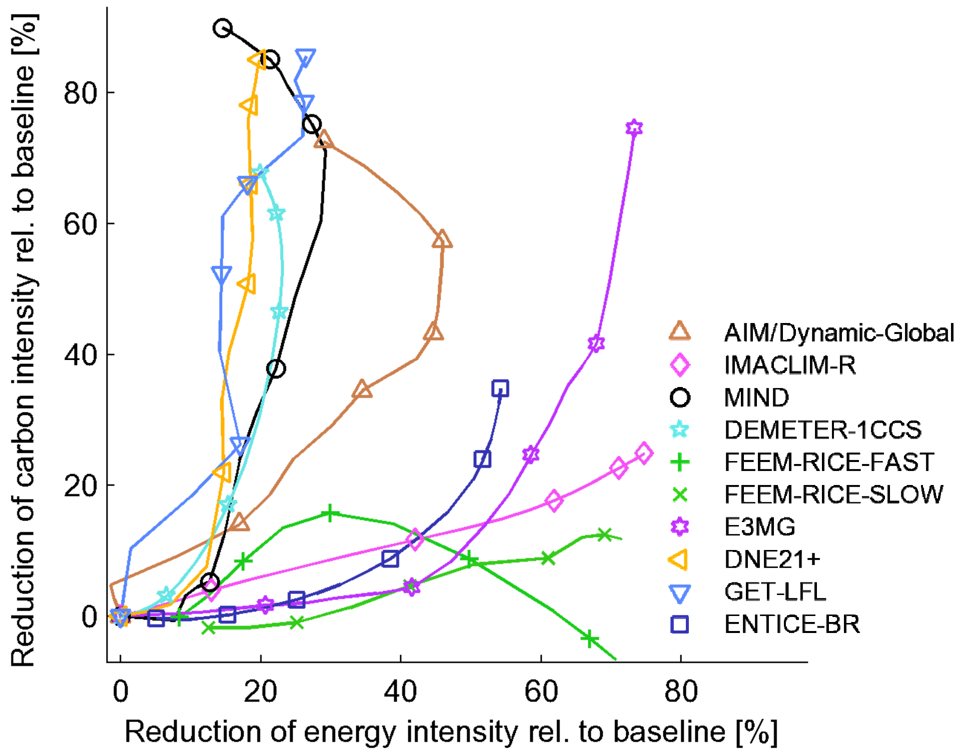
Source: Edenhofer, Lessmann et al. 2006

Change of the Mitigation Strategy when ITC is Disabled in the 550ppm Scenario



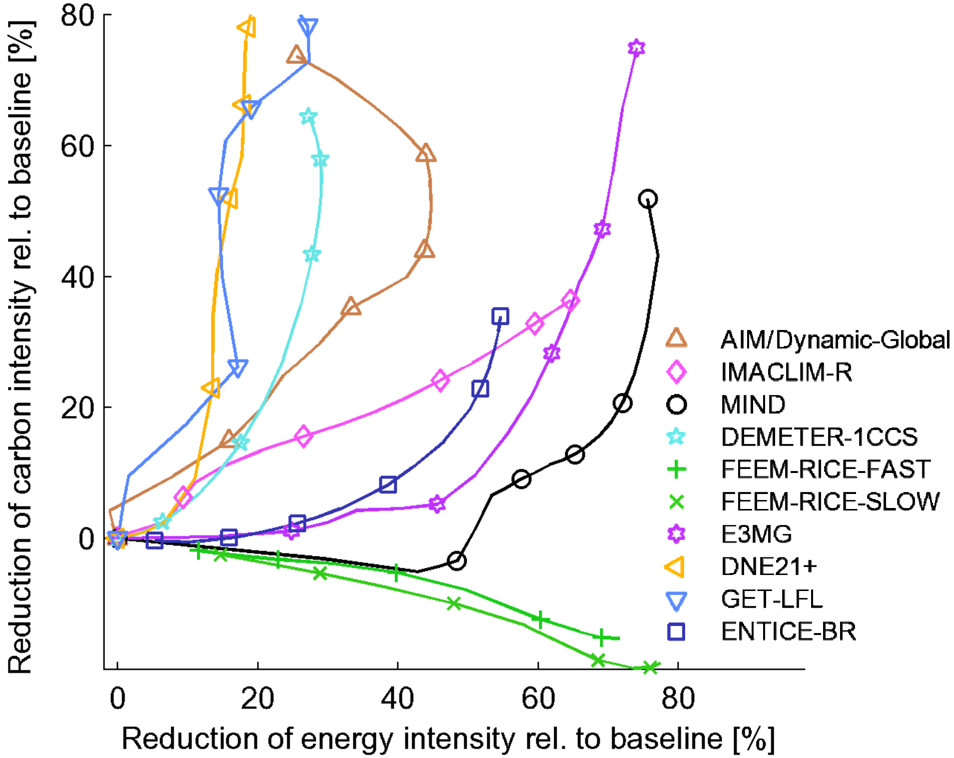
Source: Edenhofer, Lessmann et al. 2006

Energy Intensity/Carbon Intensity with ITC



Source: Edenhofer, Lessmann et al. 2006

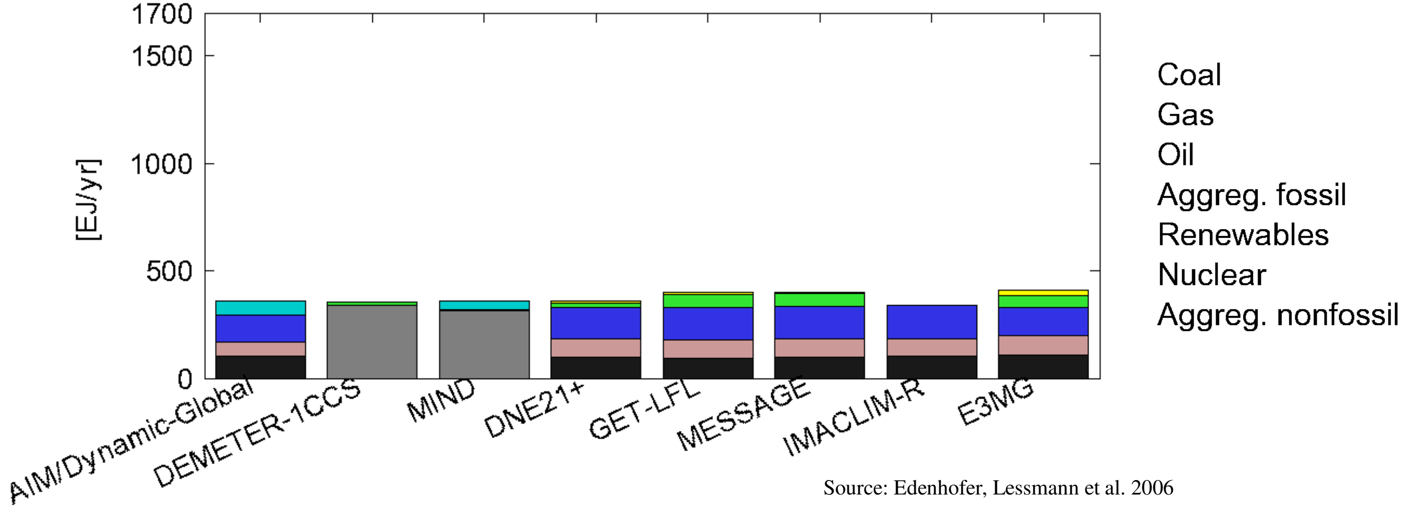
Energy Intensity/Carbon Intensity without ITC



Source: Edenhofer, Lessmann et al. 2006

Energy System

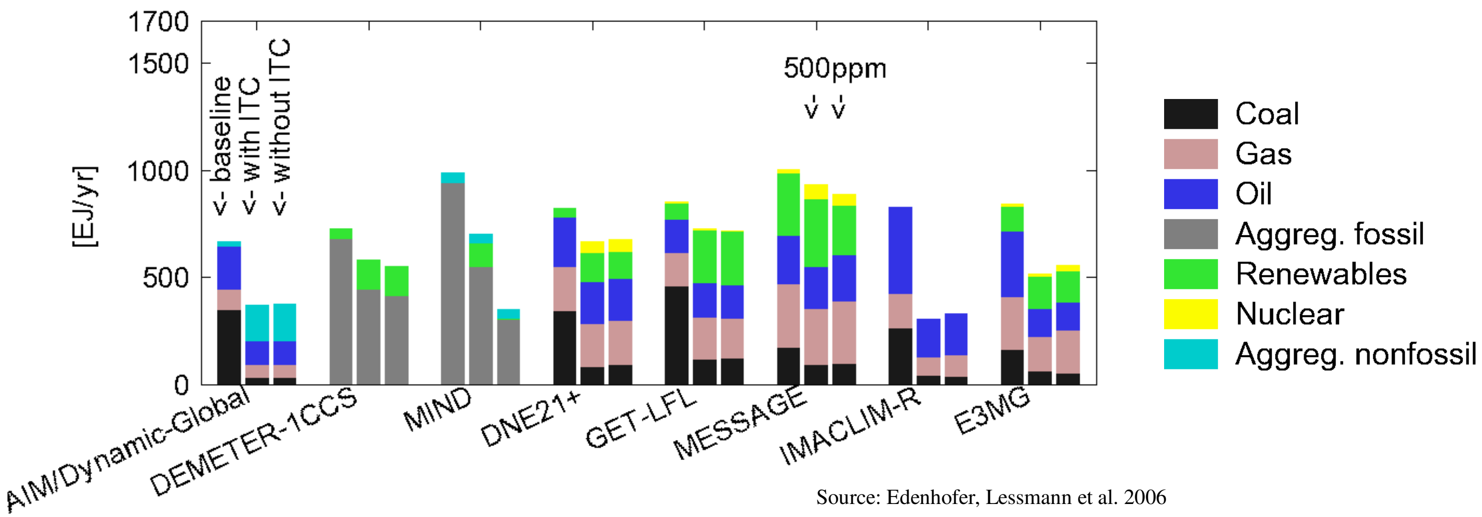
2000



Source: Edenhofer, Lessmann et al. 2006

Energy System

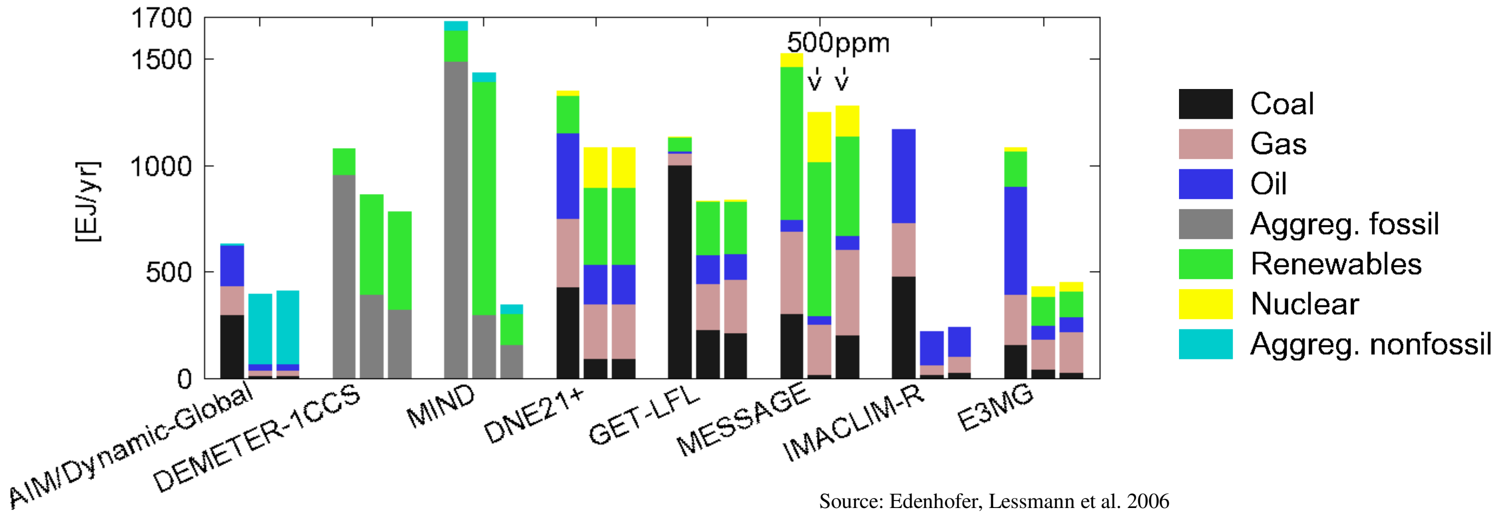
2050



Source: Edenhofer, Lessmann et al. 2006

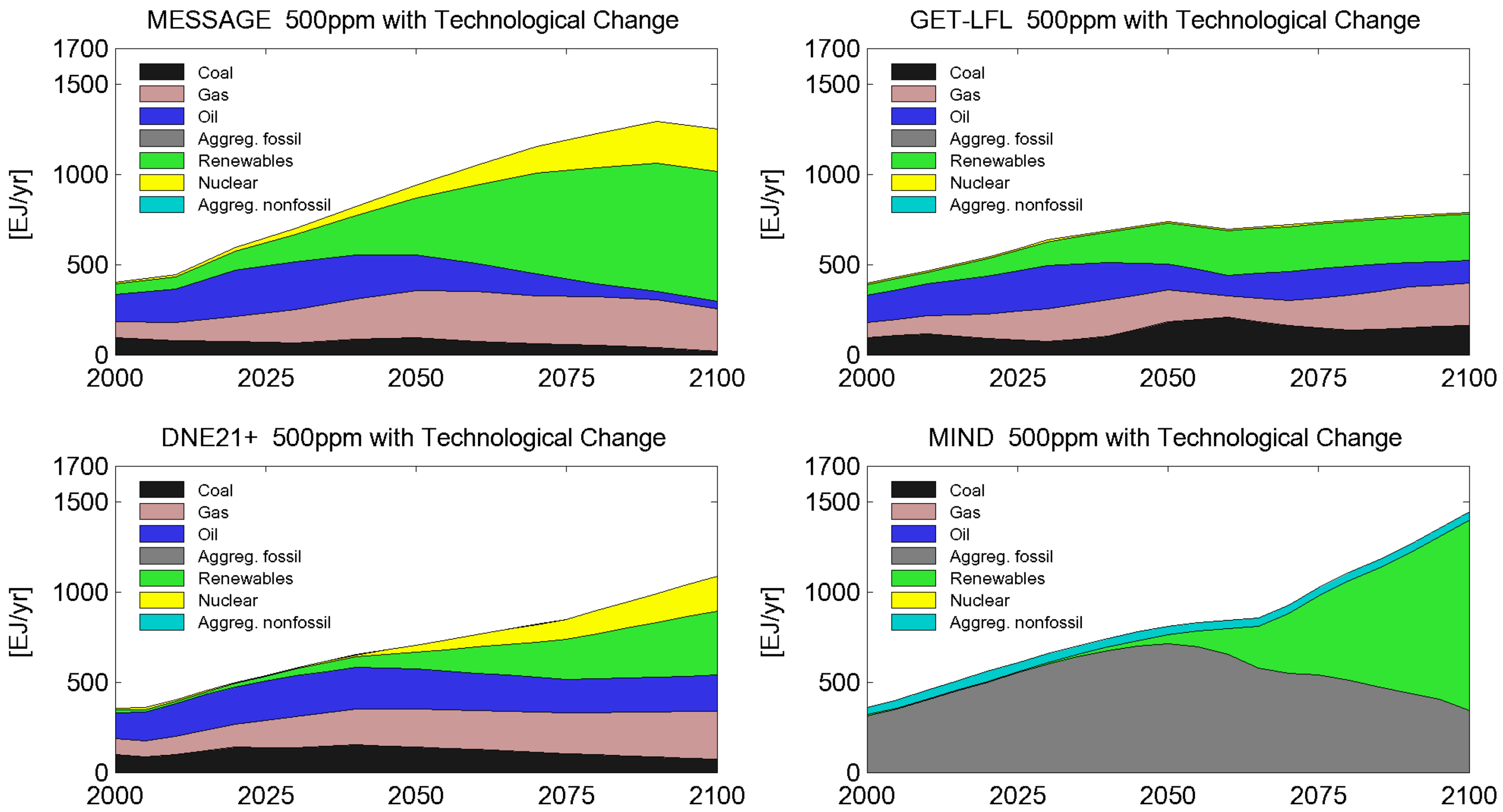
Energy System

2100



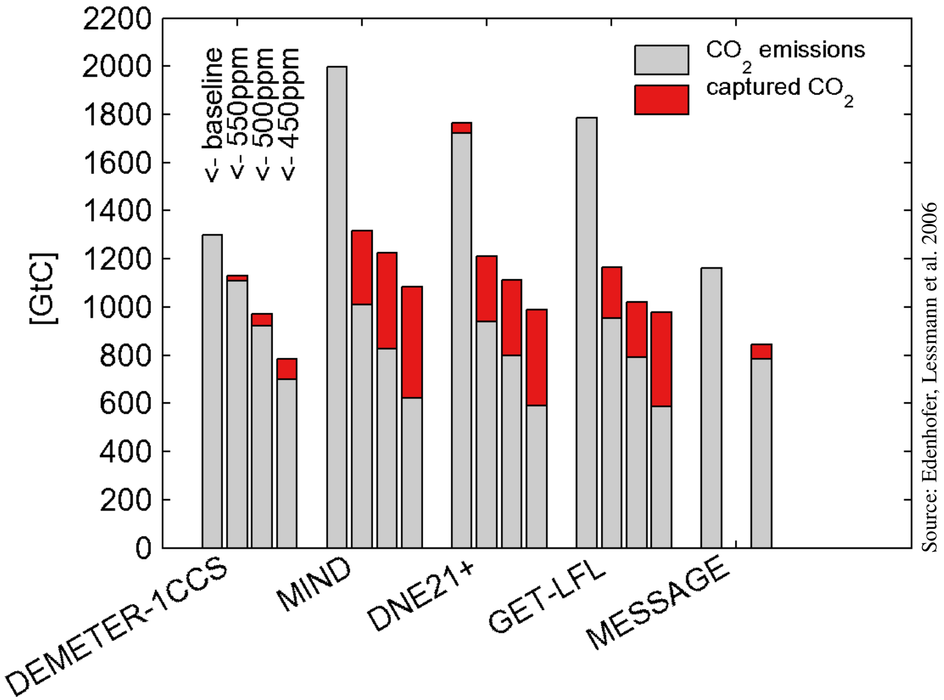
Source: Edenhofer, Lessmann et al. 2006

Energy System and Hybrid Models

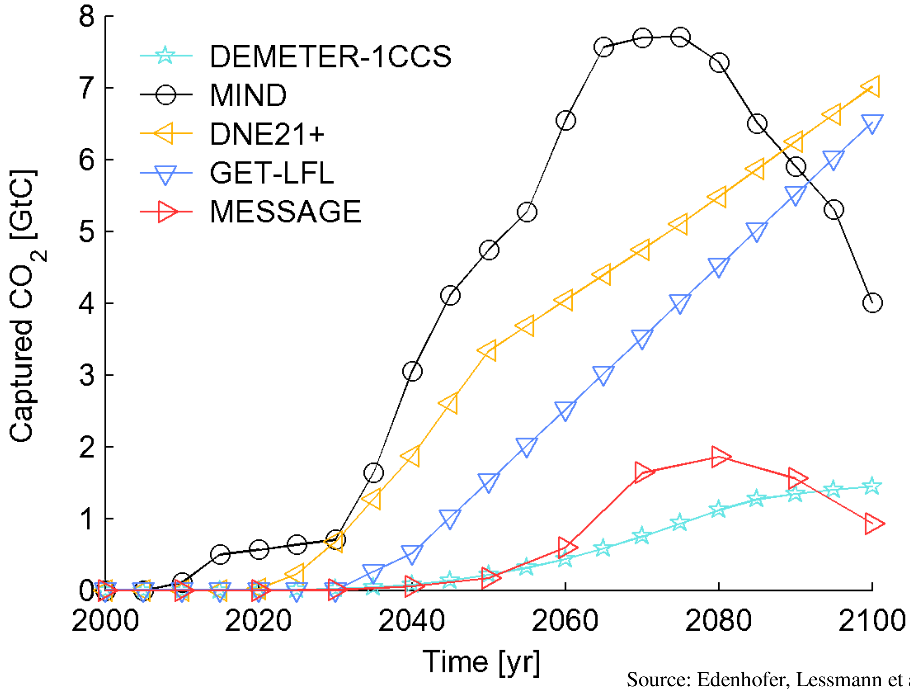


Department of Global Change & Social Systems

Captured CO_2 and Total CO_2 Emissions



Carbon Capturing and Sequestration over the course of the century

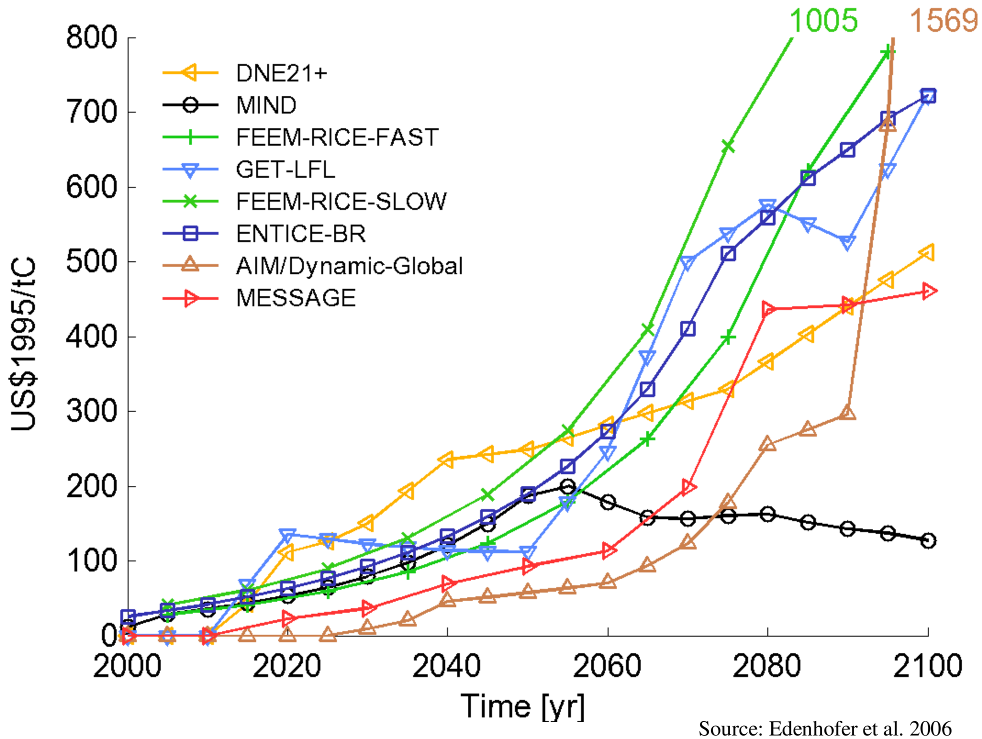


Source: Edenhofer, Lessmann et al. 2006

Mitigation Strategies – Result II

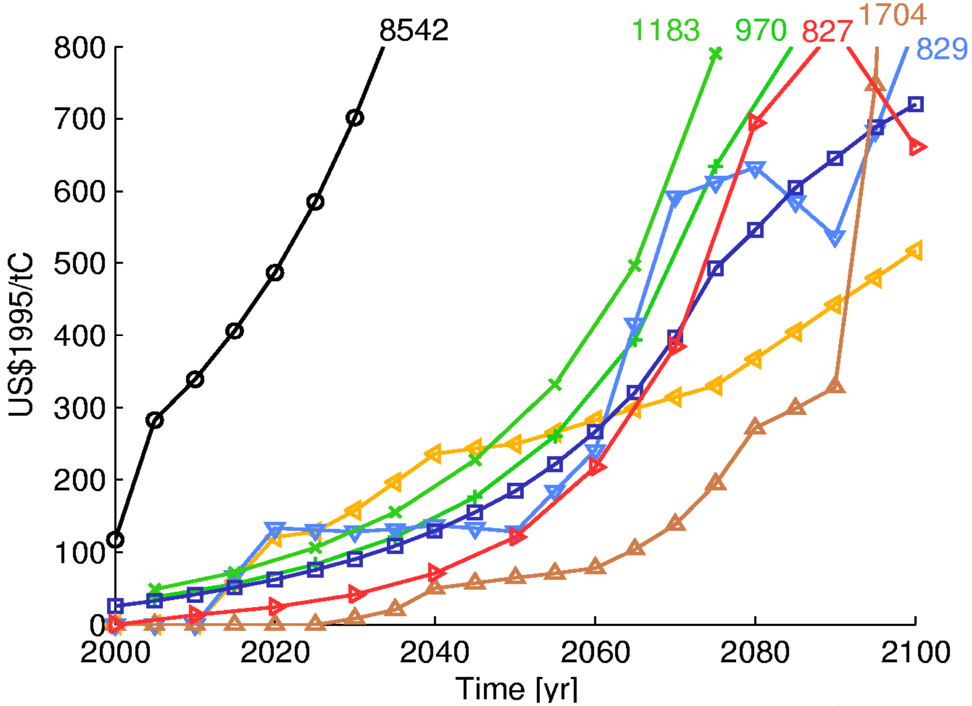
- Induced technological change works more towards decarbonisation of energy rather than reducing energy intensity of output.
- Backstop Technologies (mostly modelled as renewable energy technologies) are crucial for achieving low emissions at low costs.
- Some models show extensive use of Carbon Capturing and Sequestration (CCS) as temporary solution. CCS as an end-of-pipe technology allows postponing the introduction of the backstop technology in some models.
- Some models with backstop technologies and CCS show path dependent behaviour.

Shadow Price with ITC



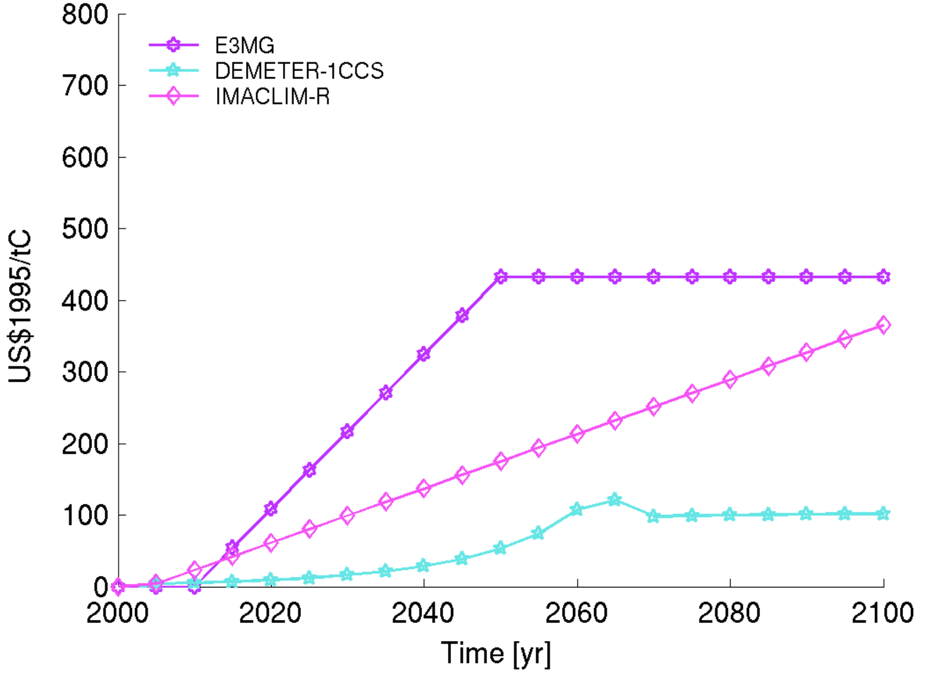
Source: Edenhofer et al. 2006

Shadow Price without ITC



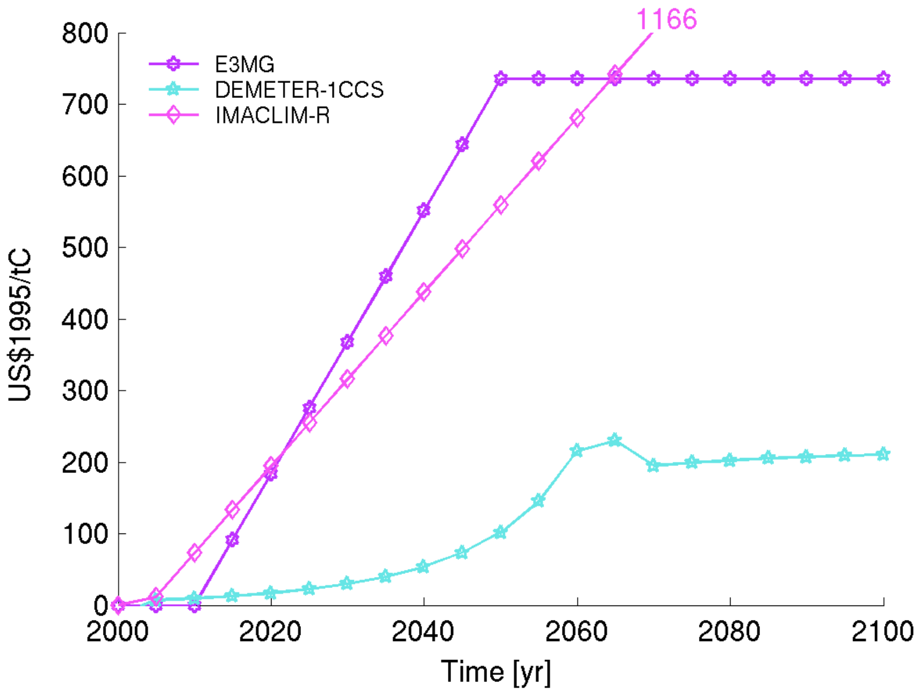
Source: Edenhofer et al. 2006

Carbon Tax with ITC



Source: Edenhofer et al. 2006

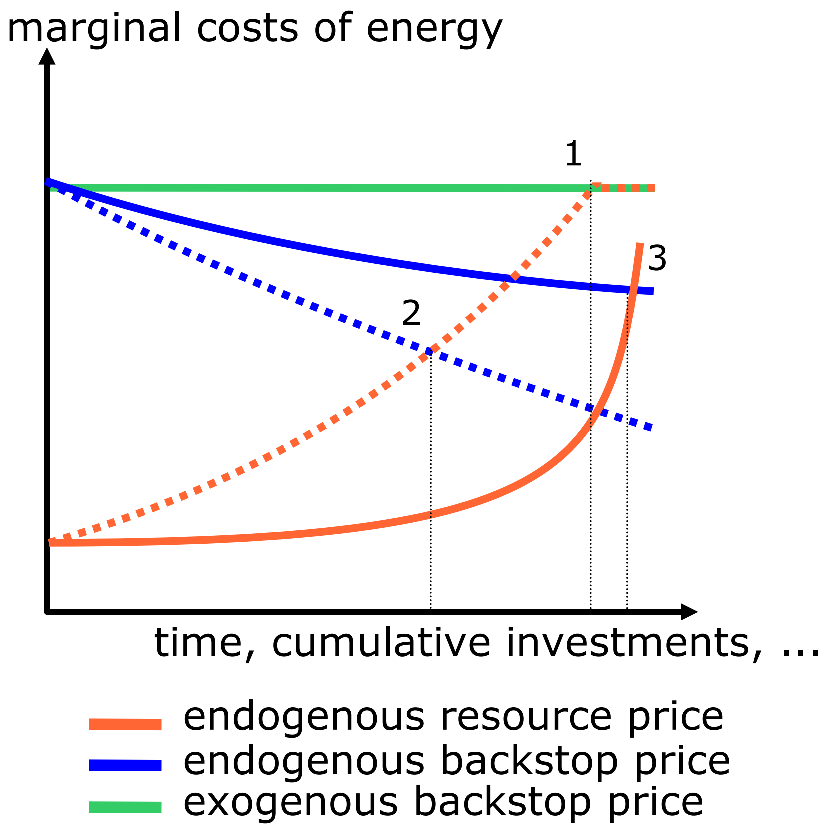
Carbon Tax without ITC



Source: Edenhofer et al. 2006

Content

Different formulatios of backstop technology

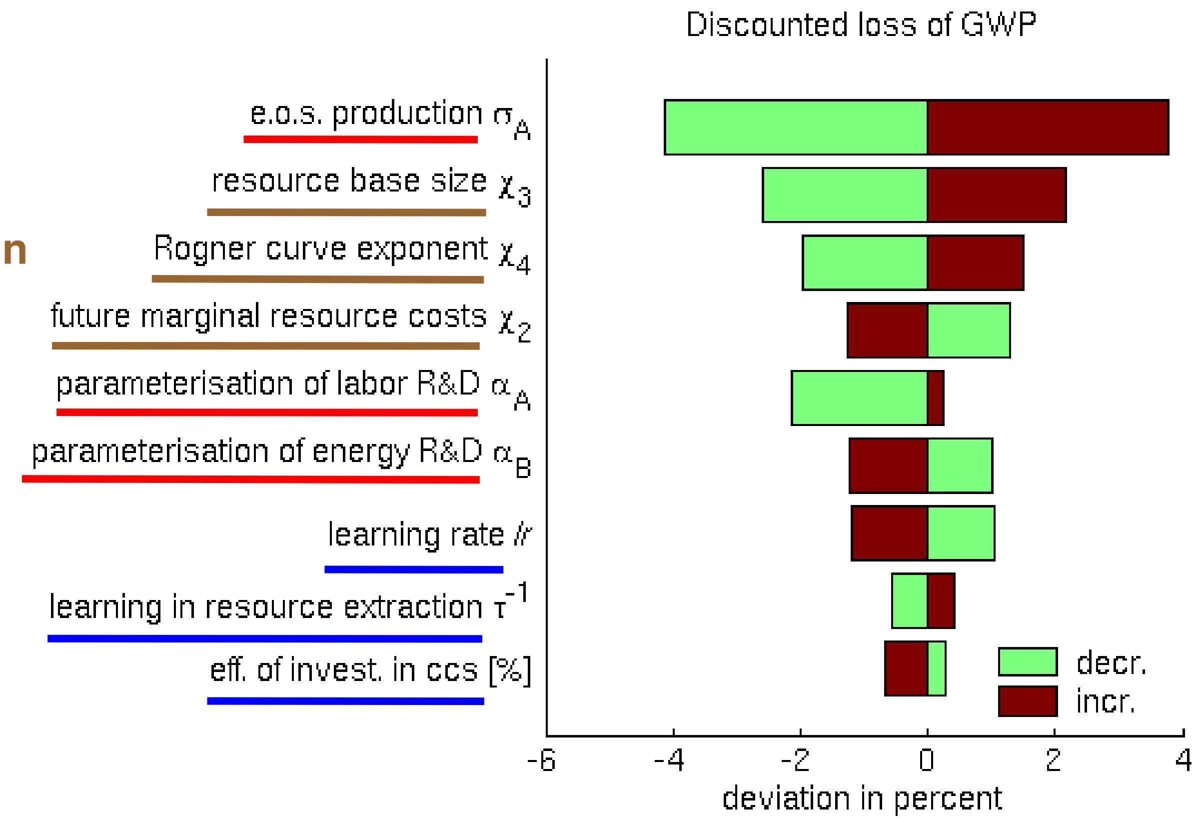


Sensitivity Analysis for MIND – GWP

Macro-economy

Resource extraction

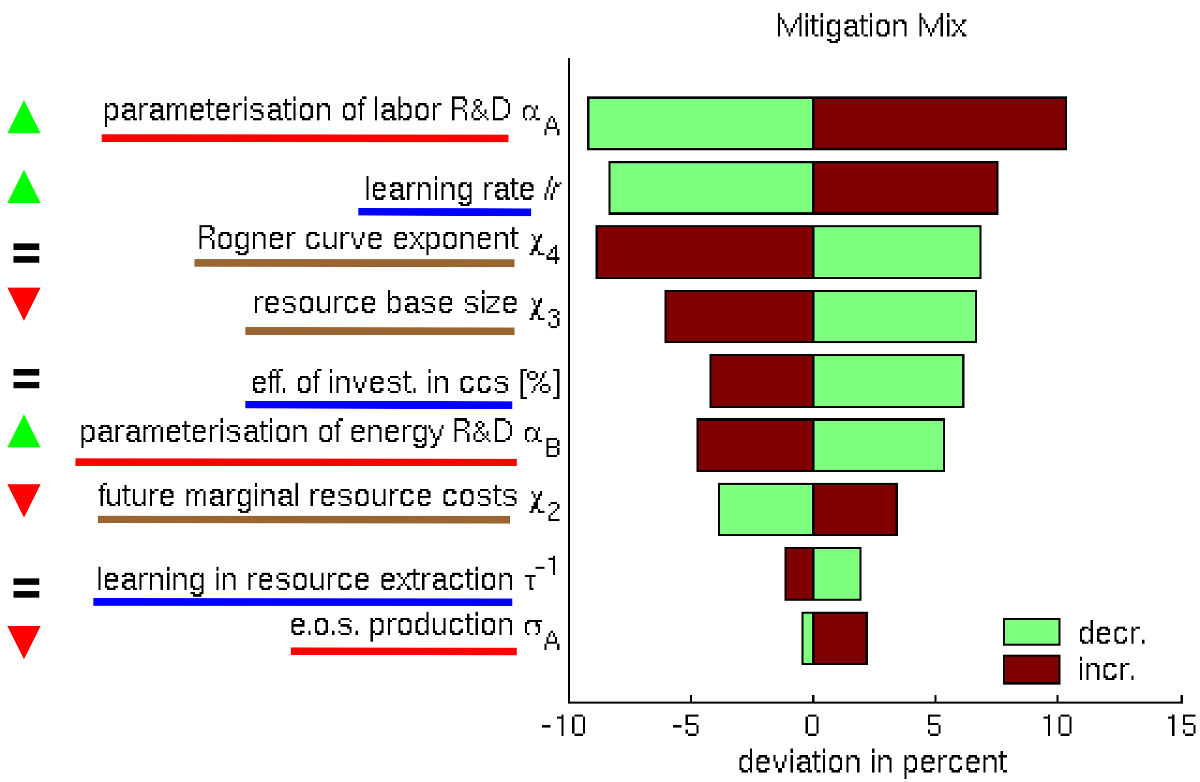
Energy sector



P I K

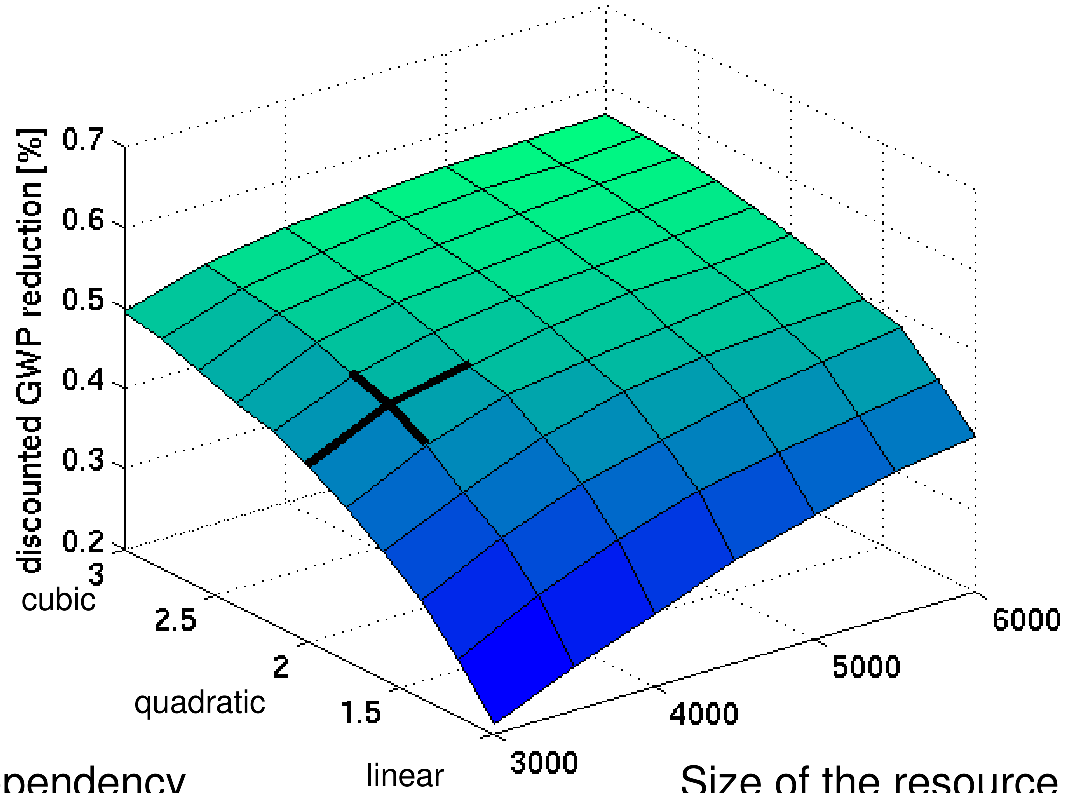
Department of Global Change & Social Systems

Sensitivity Analysis for MIND Mitigation mix



Macro-economy
Resource extraction
Energy sector

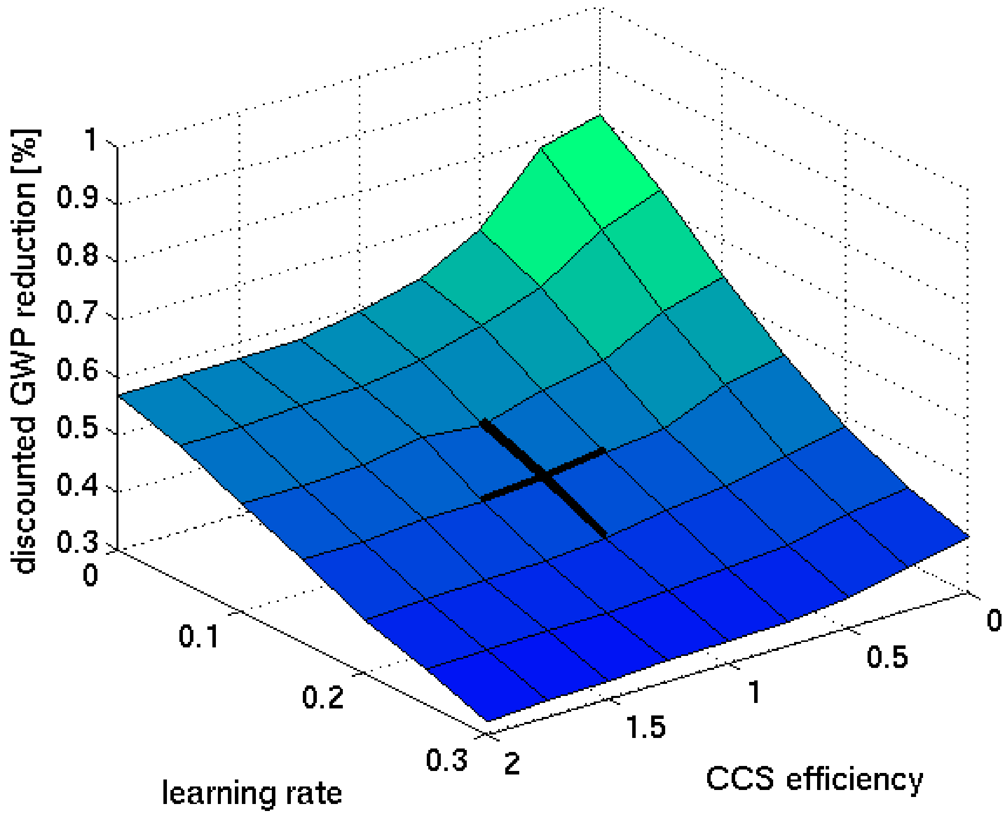
The Role of TC in the Extraction Sector



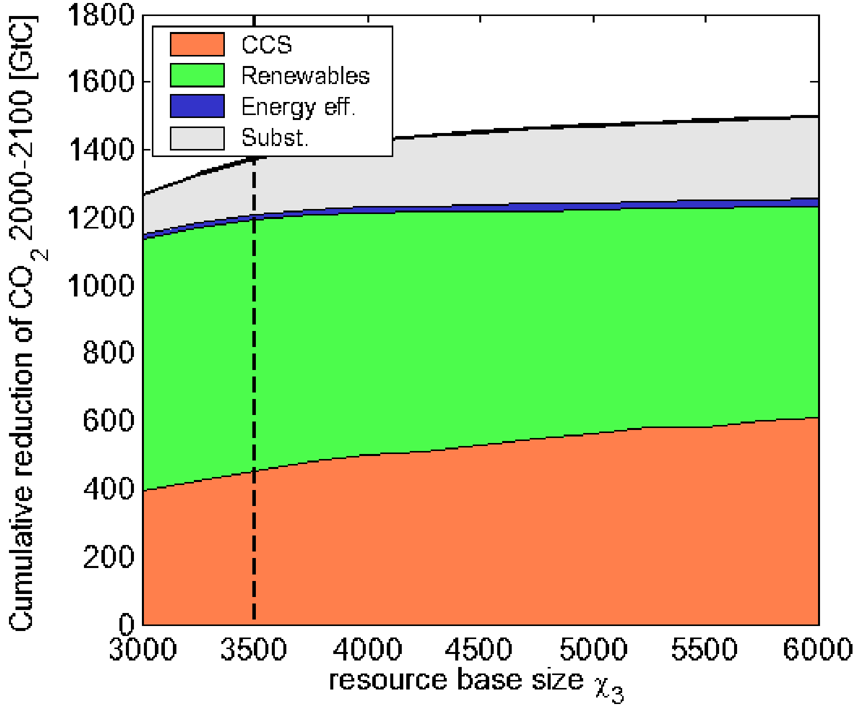
Functional dependency
of cumulative extraction and their costs

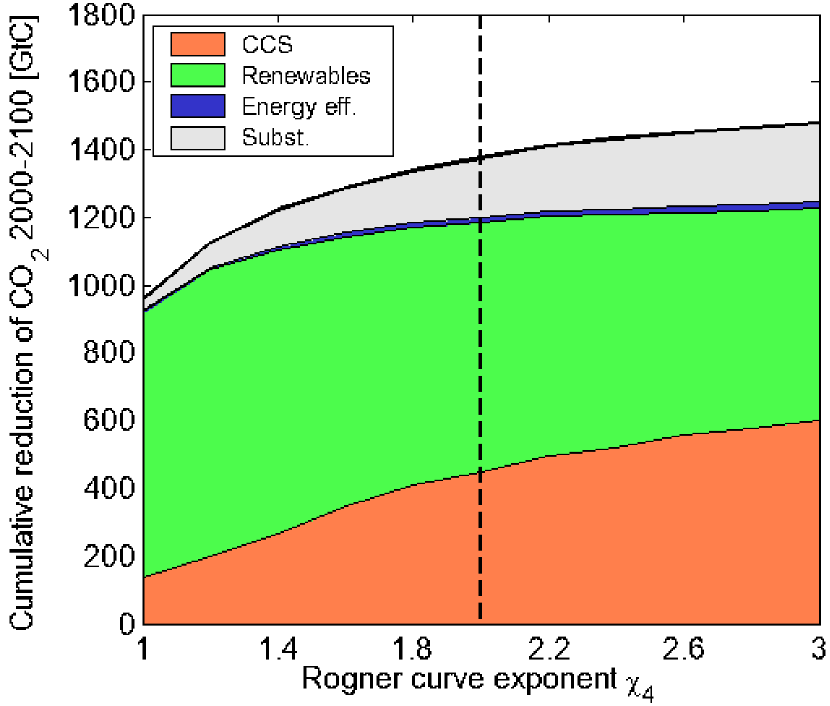
Size of the resource
base [GtC]

End-of-pipe and backstop

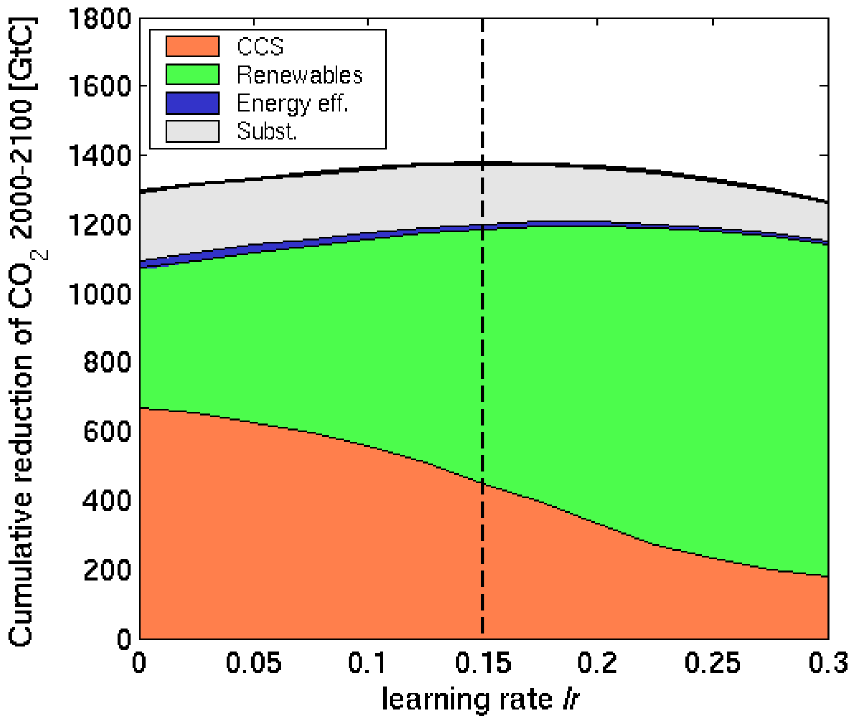


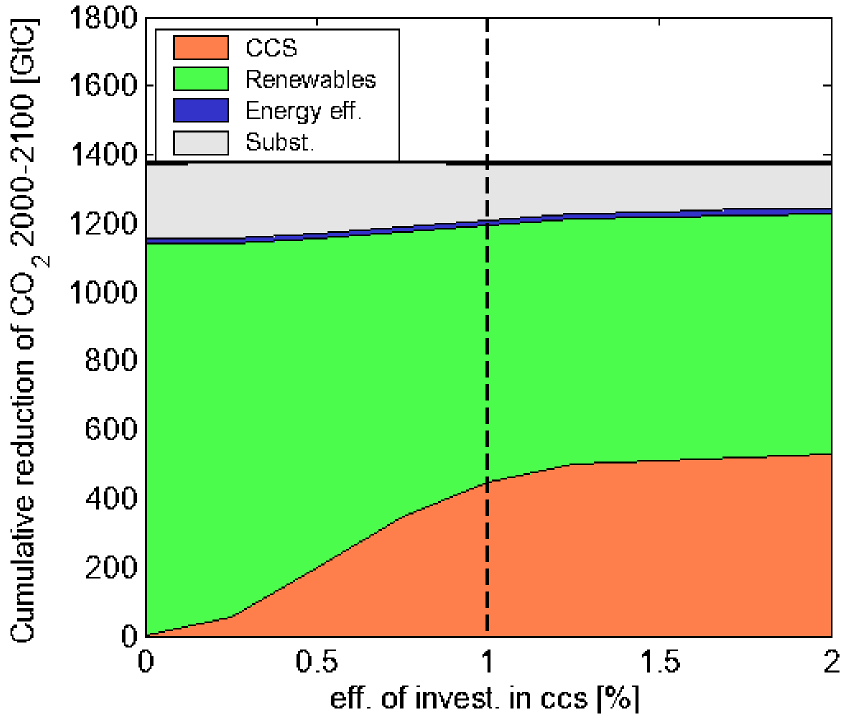
Impact of Resource Extraction





Impact of Energy Sector





Sensitivity Analysis for MIND

- Technological Change in the fossil fuel sector is crucial in determining the opportunity costs of climate protection

- For a realistic estimations of costs and strategies, TC in the following sectors is crucial:
  - Backstop technologies
  - End-of-pipe technologies
  - Extraction and exploration sector

Content

1. The IMCP Project
2. Mitigation Costs
3. Mitigation Strategies
4. Economic Risks of Mitigation
5. Conclusion

Economic Risks of Mitigation

- Expectations about investment decisions
- Backstop technologies
- ETC in the fossil fuel sector
- End-of-the-pipe technologies