POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

Low Mitigation Scenarios in Second-Best Worlds

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Snowmass

PIK

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
WMO
Working Group III
Mitigation of Climate Change
UNEP

Technische Universität Berlin

Outline

- How to overcome the discrepancy between political ambition and scientific underpinning?
- Low mitigation scenarios in a first-best world
- Low mitigation scenarios in second-best worlds
- Exploring the „feasibility frontier“ for AR5

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The Policy Arena: The Copenhagen Accord

UNITED
NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
LIMITED

FCCC/CP/2009/L.7
18 December 2009

Original : ENGLISH

2. We agree that deep cuts in global emissions are required […] to hold the increase in global temperature below 2 degrees Celsius, …

Proposal by the President

Copenhagen Accord

The Heads of State, Heads of Government, Ministers, and other heads of delegation present at the United Nations Climate Change Conference 2009 in Copenhagen,

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Being guided by the principles and provisions of the Convention.

The Policy Arena: The Copenhagen Accord

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Distr.
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FCCC/CP/2009/L.7
18 December 2009

Original : ENGLISH

12. We call for an assessment [that] would include consideration of strengthening the long-term goal […] including […] temperature rises of 1.5 degrees Celsius.

Proposal by the President

Copenhagen Accord

The Heads of State, Heads of Government, Ministers, and other heads of delegation present at the United Nations Climate Change Conference 2009 in Copenhagen,

In pursuit of the ultimate objective of the Convention as stated in its Article 2,

Being guided by the principles and provisions of the Convention.

The Scientific Arena

Table 3.10: *Properties of emissions pathways for alternative ranges of CO_2 and CO_2-eq stabilization targets. Post-TAR stabilization scenarios in the scenario database (see also Sections 3.2 and 3.3); data source: after Nakicenovic et al., 2006 and Hanaoka et al., 2006)*

Class	Anthropogenic addition to radiative forcing at stabilization (W/m²)	Multi-gas concentration level (ppmv CO_2-eq)	Stabilization level for CO_2 only, consistent with multi-gas level (ppmv CO_2)	Number of scenario studies	Global mean temperature C increase above pre-industrial at equilibrium, using best estimate of climate sensitivity[c)]	Likely range of global mean temperature C increase above pre-industrial at equilibrium[a)]	Peaking year for CO_2 emissions[b)]	Change in global emissions in 2050 (% of 2000 emissions)[b)]
I	2.5-3.0	445-490	350-400	6	2.0-2.4	1.4-3.6	2000-2015	-85 to -50
II	3.0-3.5	490-535	400-440	18	2.4-2.8	1.6-4.2	2000-2020	-60 to -30
III	3.5-4.0	535-590	440-485	21	2.8-3.2	1.9-4.9	2010-2030	-30 to +5
IV	4.0-5.0	590-710	485-570	118	3.2-4.0	2.2-6.1	2020-2060	+10 to +60
V	5.0-6.0	710-855	570-660	9	4.0-4.9	2.7-7.3	2050-2080	+25 to +85
VI	6.0-7.5	855-1130	660-790	5	4.9-6.1	3.2-8.5	2060-2090	+90 to +140

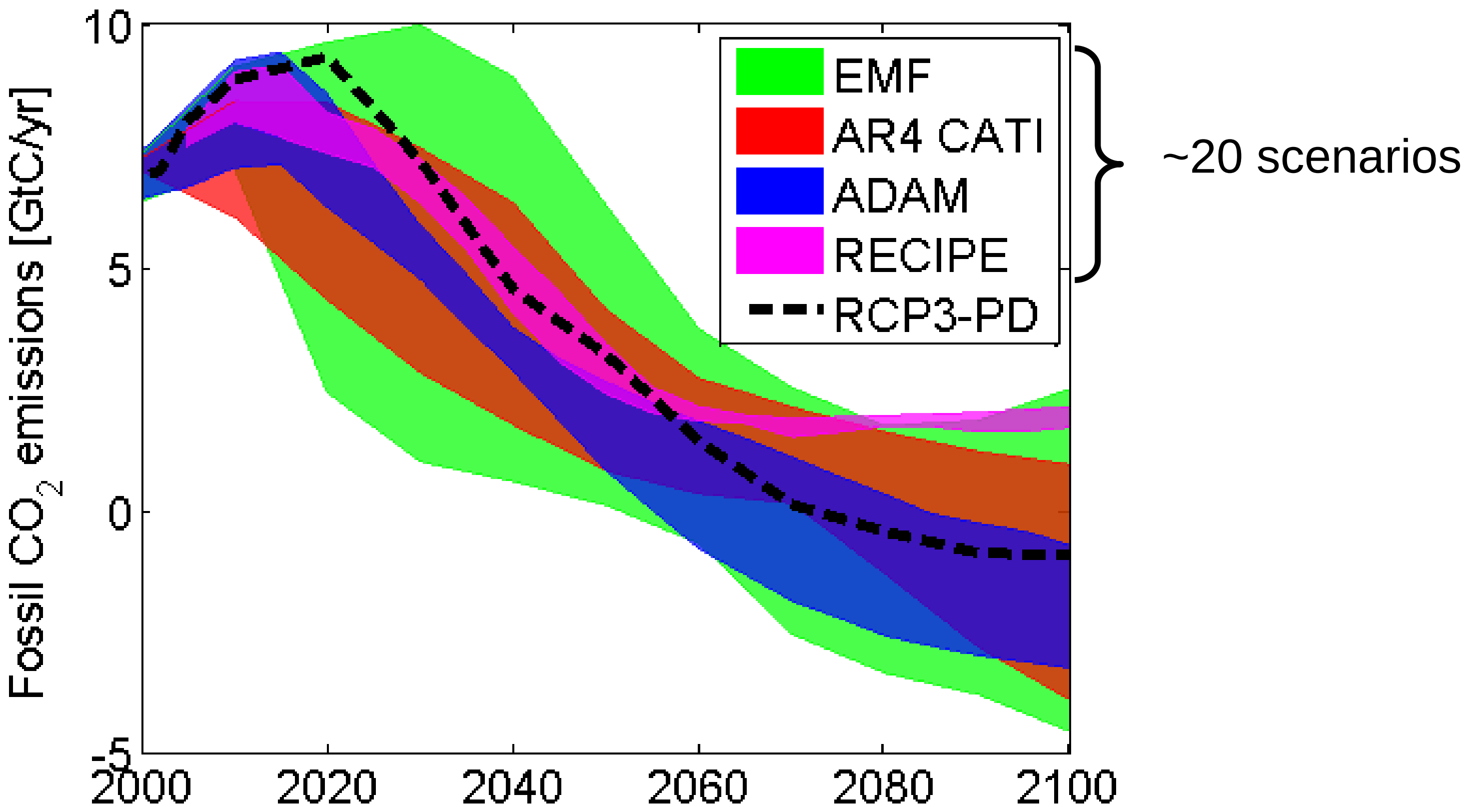
Notes:
a. Warming for each stabilization class is calculated based on the variation of climate sensitivity between 2ºC –4.5ºC, which corresponds to the likely range of climate sensitivity as defined by Meehl *et al.* (2007,Chapter 10).
b. Ranges correspond to the 70% percentile of the post-TAR scenario distribution.
c. 'Best estimate' refers to the most likely value of climate sensitivity, i.e. the mode (see Meehl *et al.* (2007,Chapter 10) and Table 3.9

Fisher et al. (2007), AR4

Only 6 scenarios from 3 models in the lowest category…

Low Mitigation Scenarios Beyond AR4

- …but already many more available for AR5
- Exploration of RCP3-PD within the scenario process



Knopf/Luderer/Edenhofer, subm.

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Low Stabilization Pathways: Economic and Technical Feasibility

ADAM Model Comparison

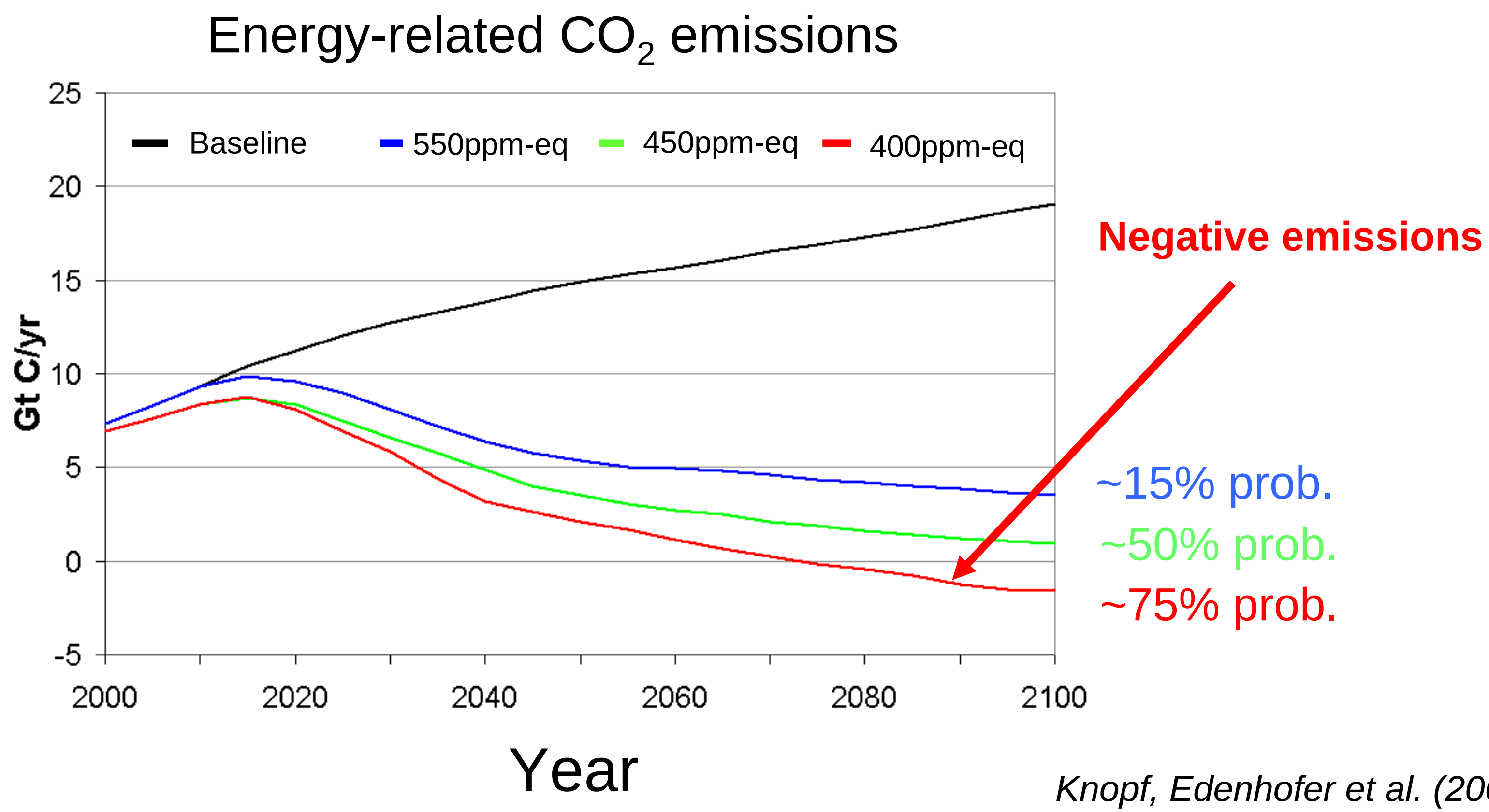
Members:

PIK (REMIND model):	O. Edenhofer, M. Leimbach. L. Baumstark, B. Knopf
PSI (MERGE model):	T. Hal, S. Kypreos, B. Magné
U Cambridge (E3MG model):	T. Barker, S. Scrieciu
ENERDATA (POLES model):	A. Kitous, E. Bellevrat, B. Chateau, P. Criqui
PBL (TIMER):	D. van Vuuren, M. Isaac
Compilation of comparison:	B. Knopf

The Economics of Atmospheric Stabilisation

ADAM model comparison:

Analysis of 3 stabilisation targets with different probabilities to reach the 2° target: 550ppm-eq, 450ppm-eq, 400ppm-eq

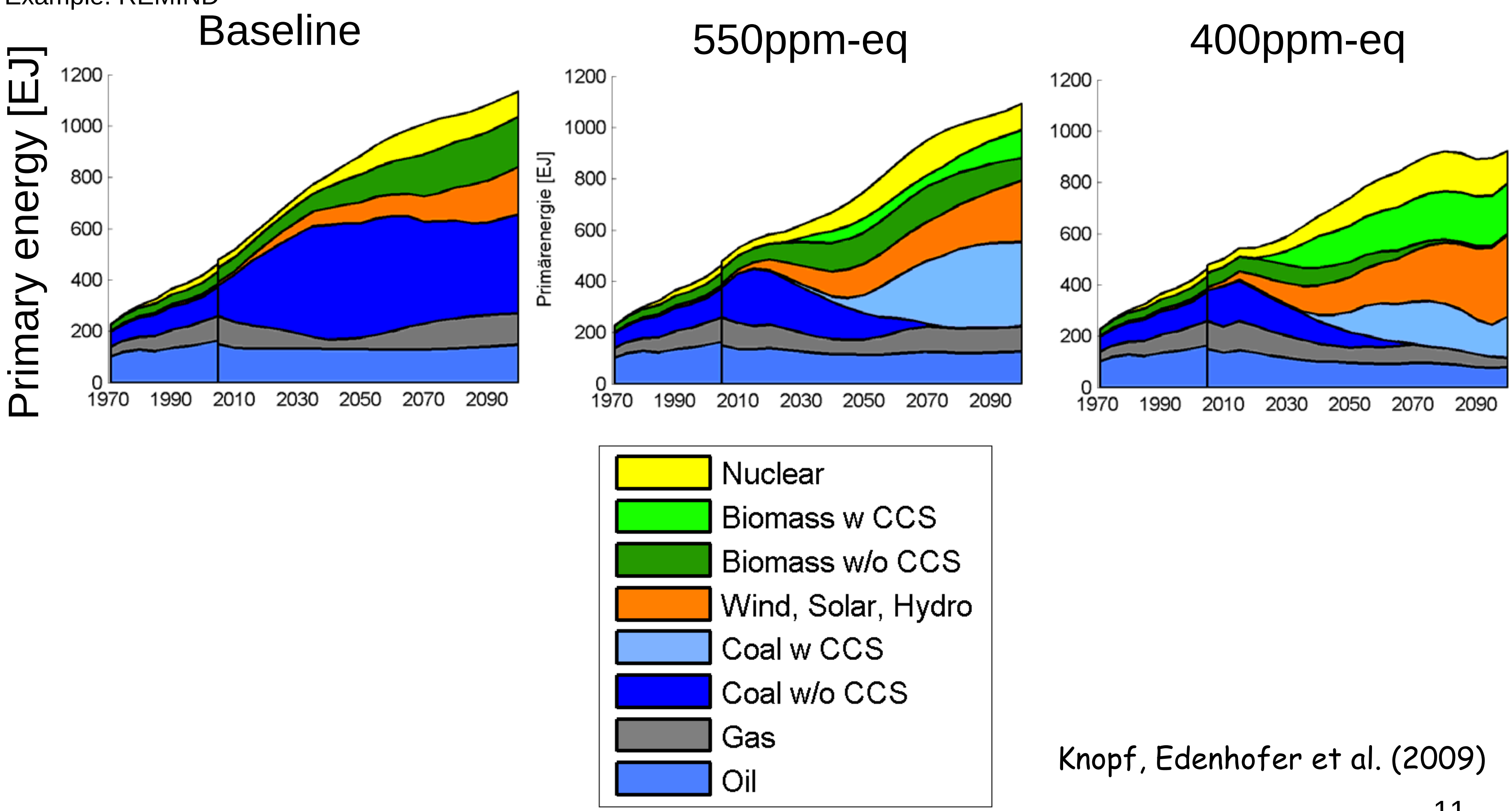


Knopf, Edenhofer et al. (2009)

Transformation of the Energy System

The historical challenge

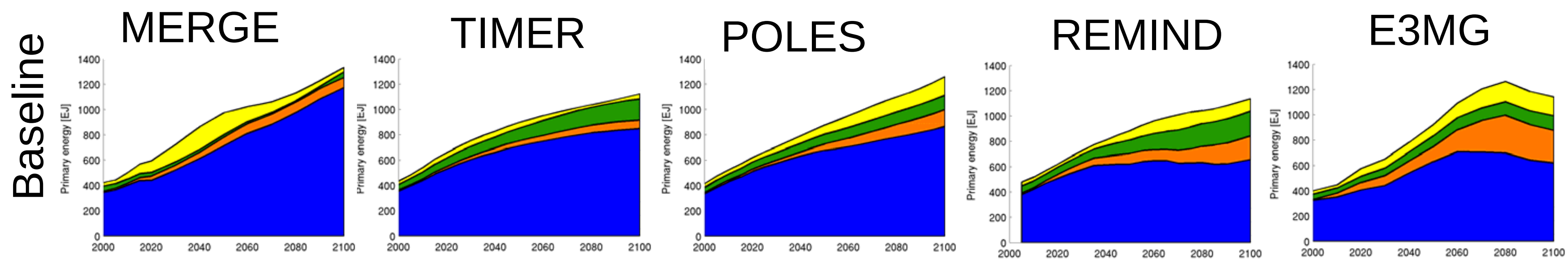
Example: REMIND



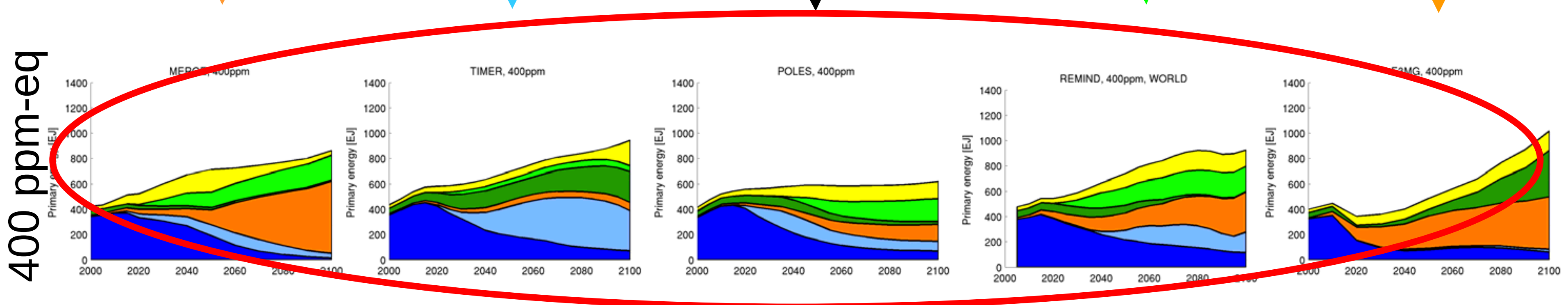
Knopf, Edenhofer et al. (2009)

Transformation of the Energy System

models →



Many different pathways to transform the energy system

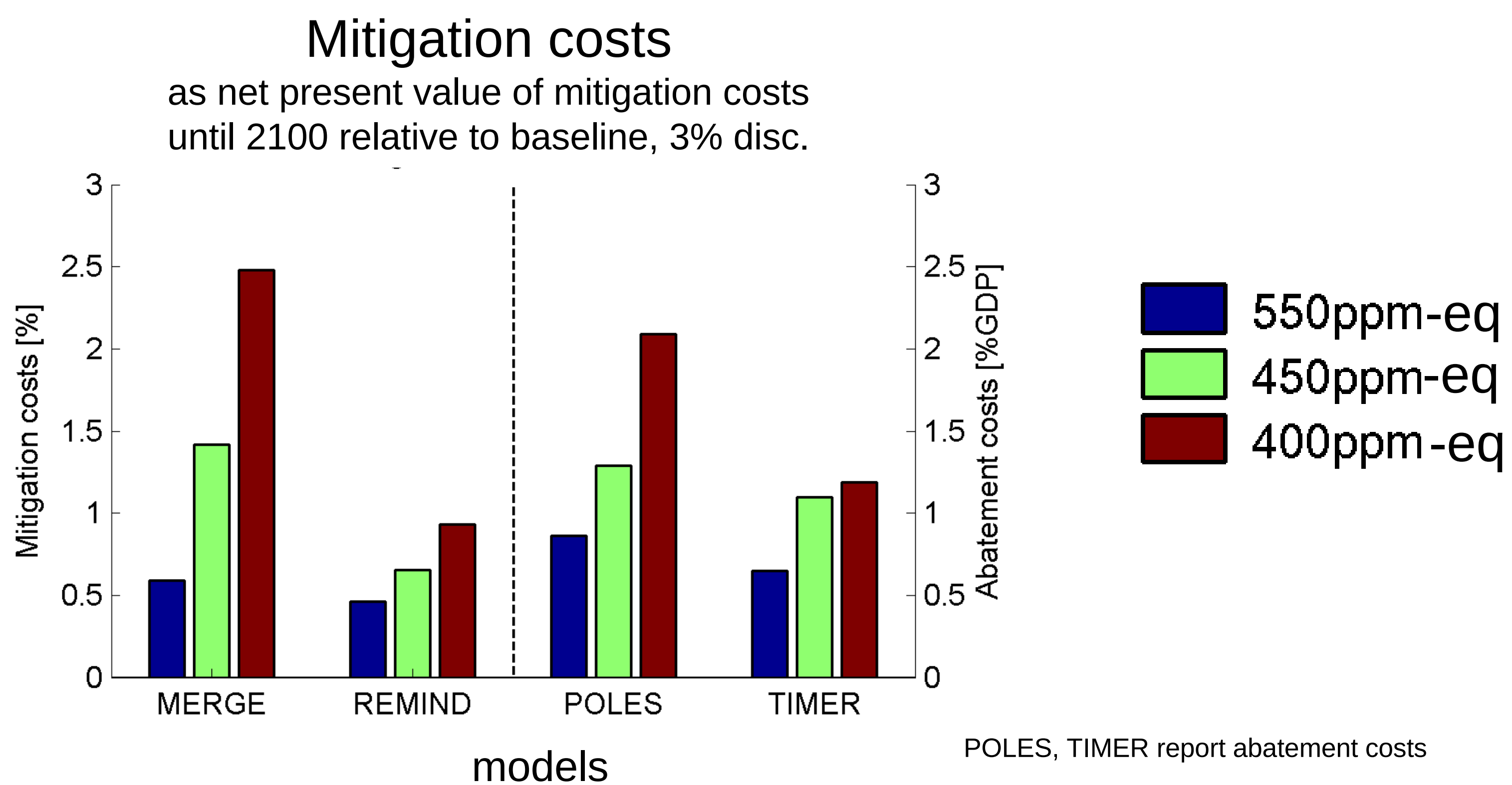


➔ Different possibilities to reach low stabilisation

➔ 400ppm can be achieved by all models

Knopf, Edenhofer et al. (2009)

Costs of Low Stabilisation



➔ Global costs are below 2.5% GDP losses for low stabilisation

➔ One model reports gains as it assumes inefficiencies in the baseline

Knopf, Edenhofer et al. (2009)

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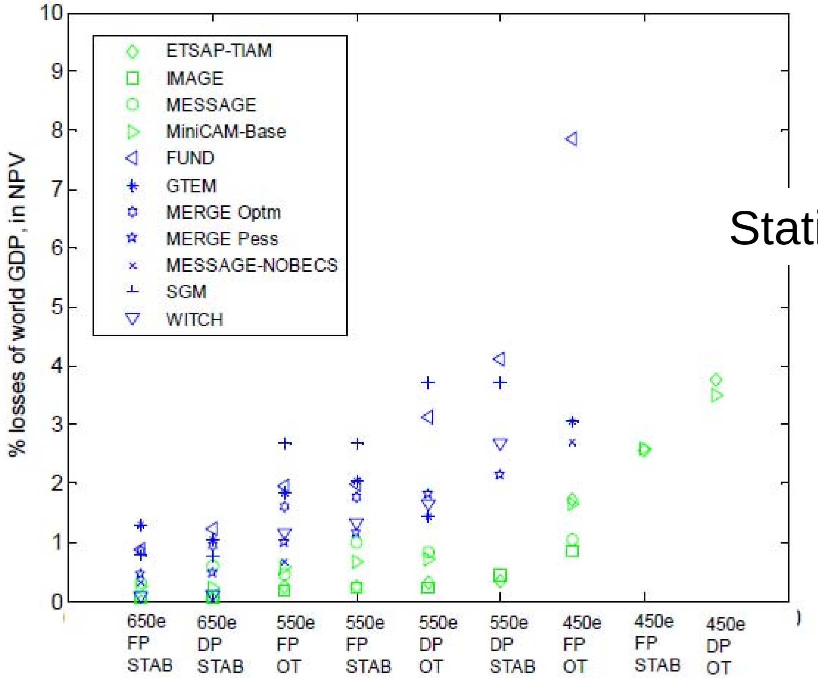
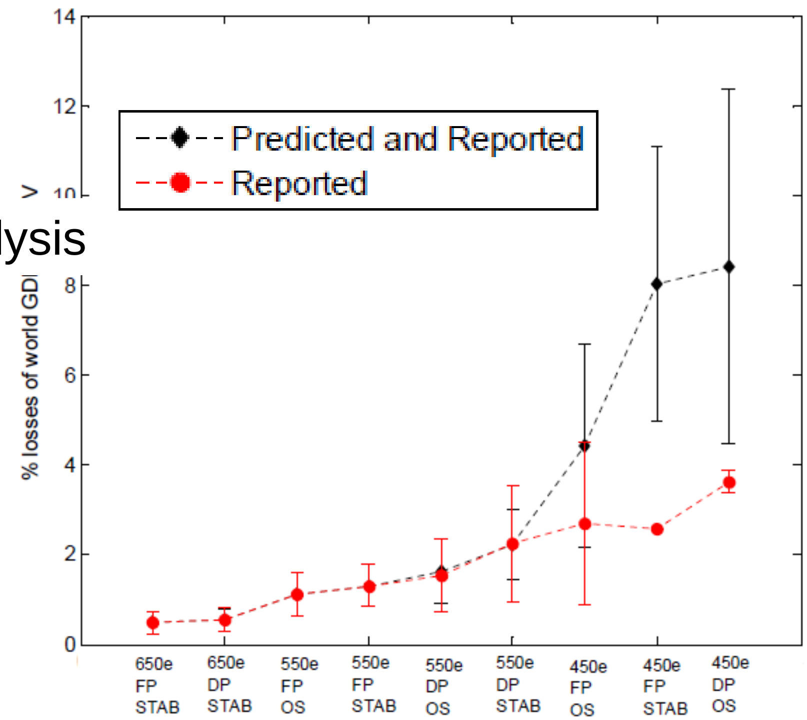
Statistical Analysis for Assessing Second Best Worlds

Green: with BECS
Blue: w/o BECS



Increasing strictness of target

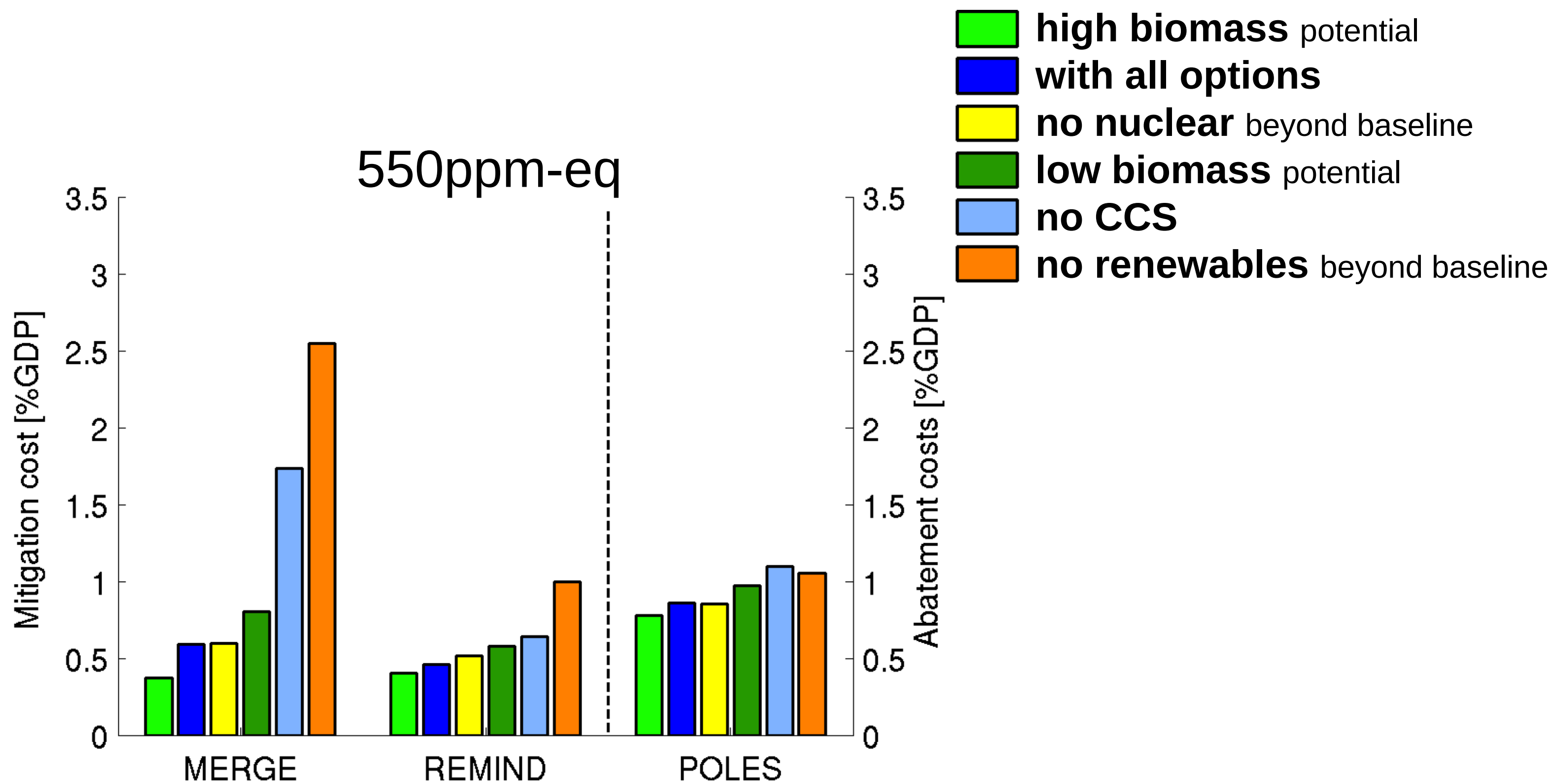
Statistical Analysis



Increasing strictness of target

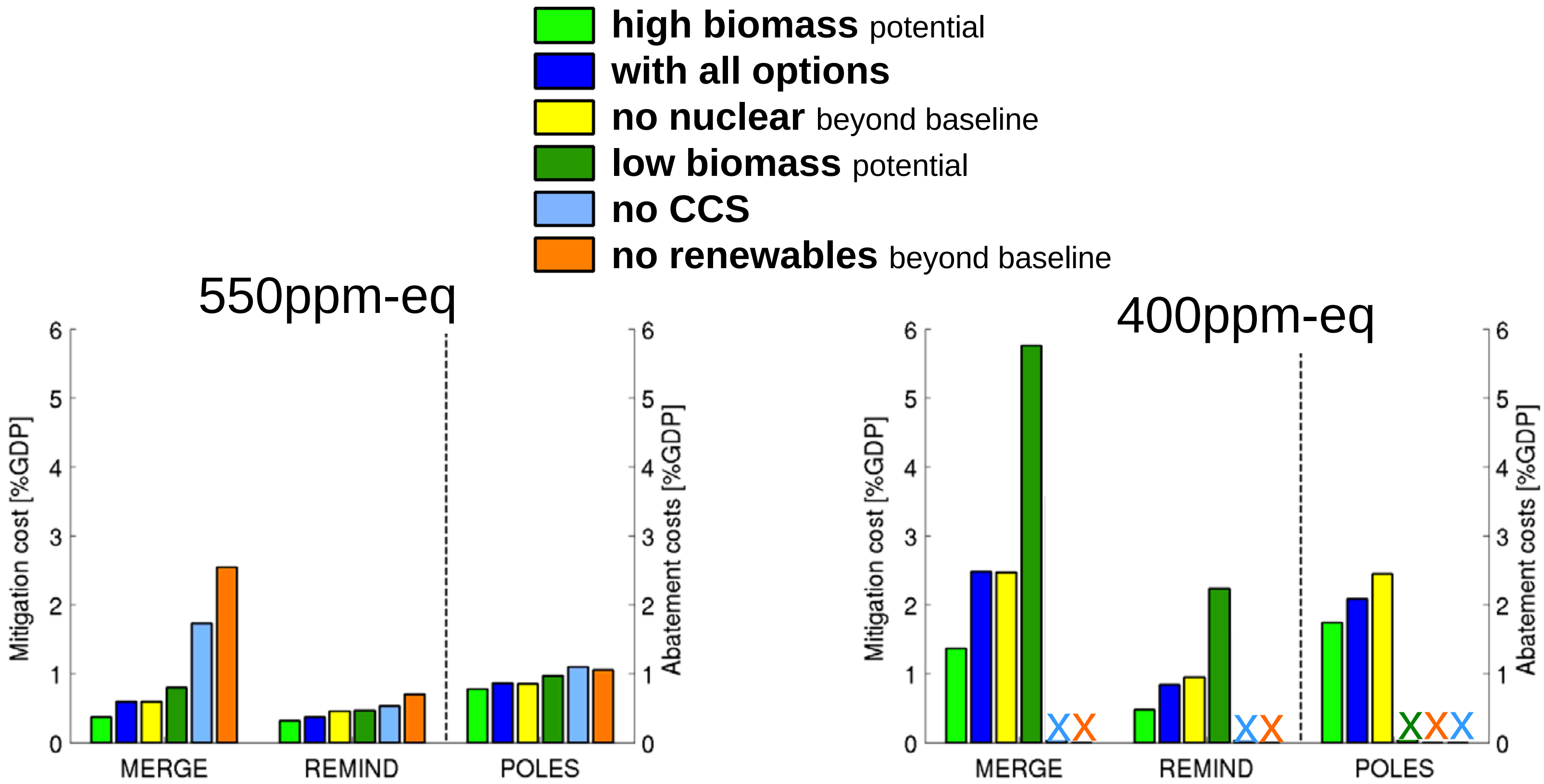
Tavoni and Tol (2010)

Mitigation Costs: Technology Options, 550ppm



Knopf, Edenhofer et al. (2009)

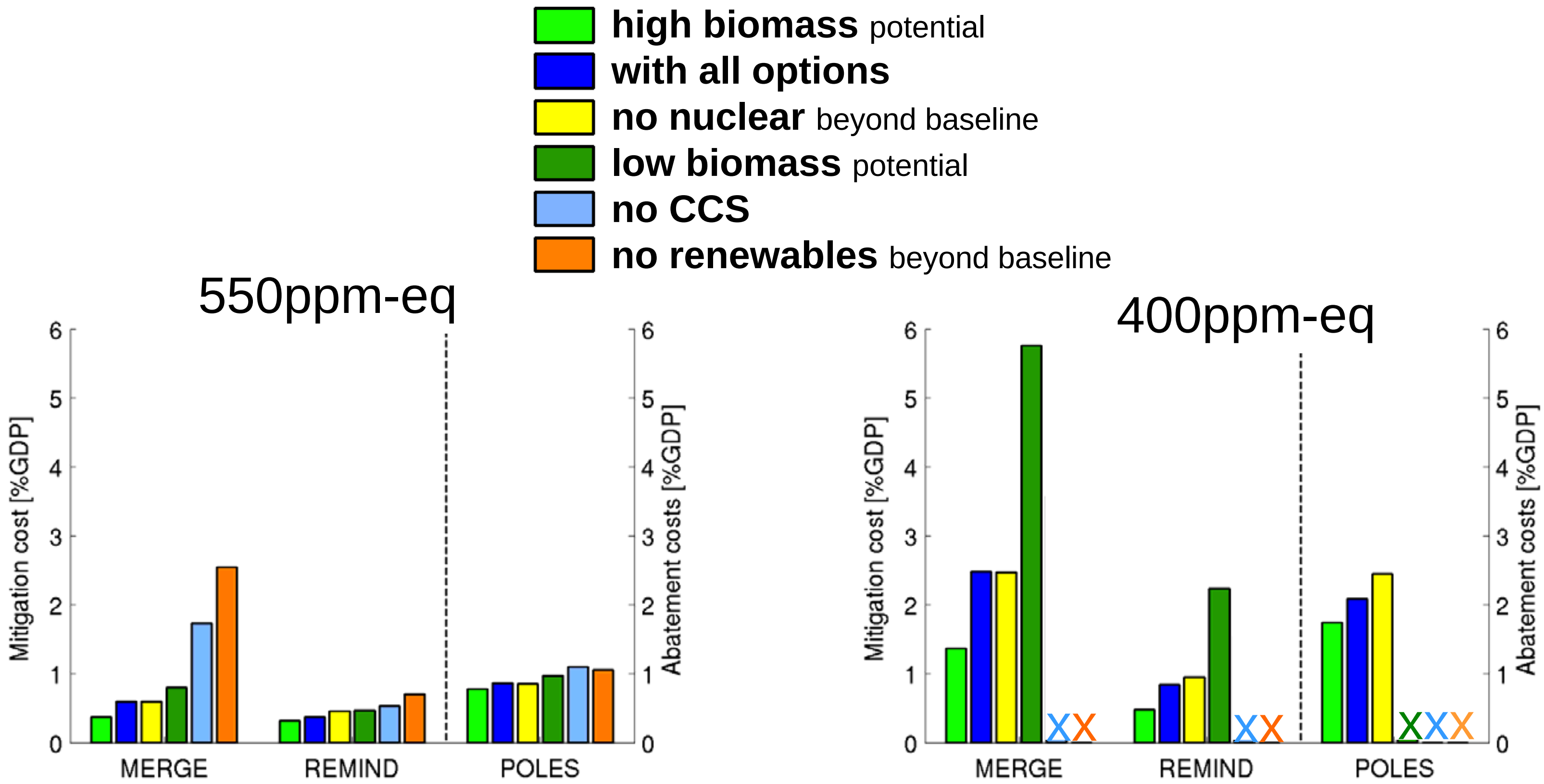
Technology Options for Low Stabilisation



➔ Robust ranking of options

Knopf, Edenhofer et al. (2009)

Technology Options for Low Stabilisation

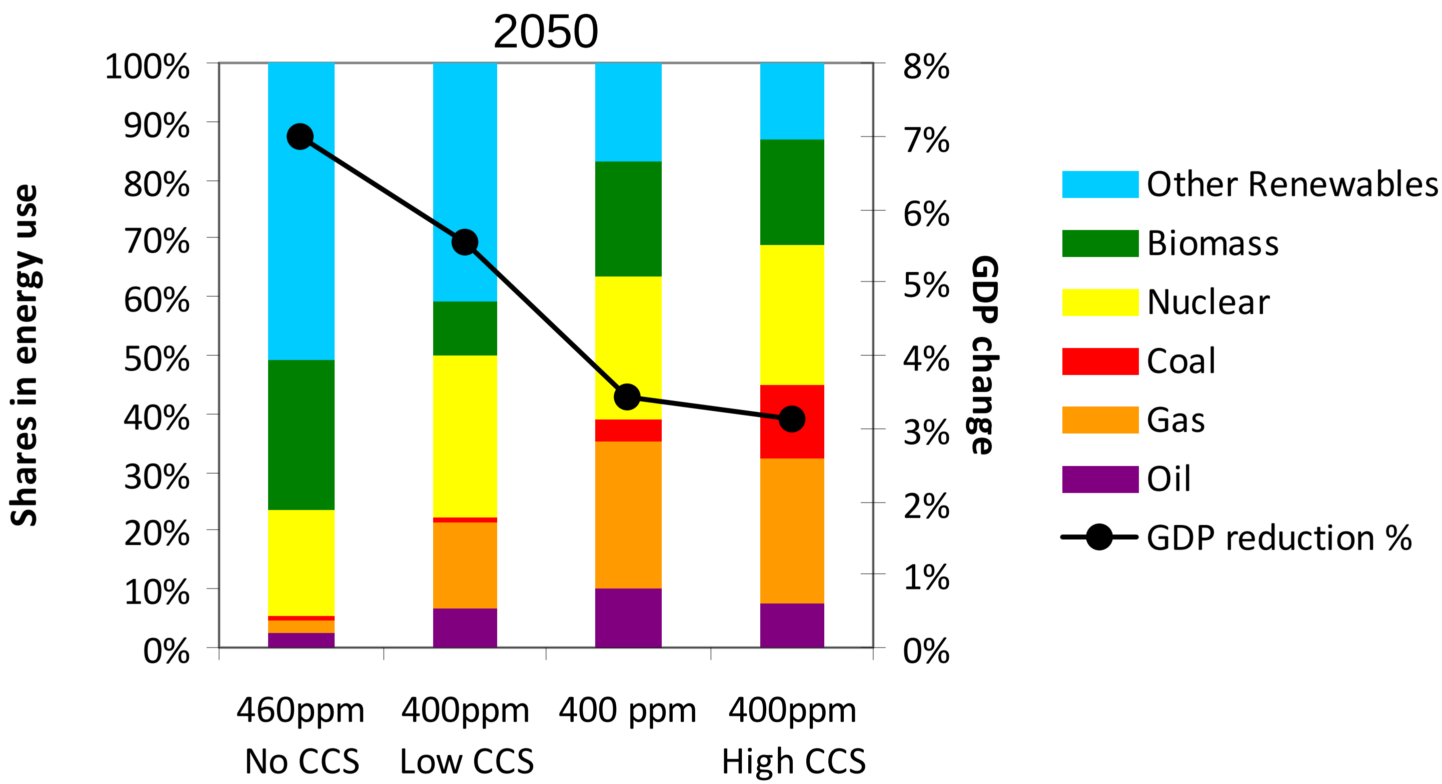


➔ Mitigation potential of nuclear is limited (but high use in the baseline)
➔ 400 ppm neither achievable without CCS nor without extension of renew
➔ Biomass potential dominates the mitigation costs of low stabilisation

Knopf, Edenhofer et al. (2009)

Influence of the CCS Potential

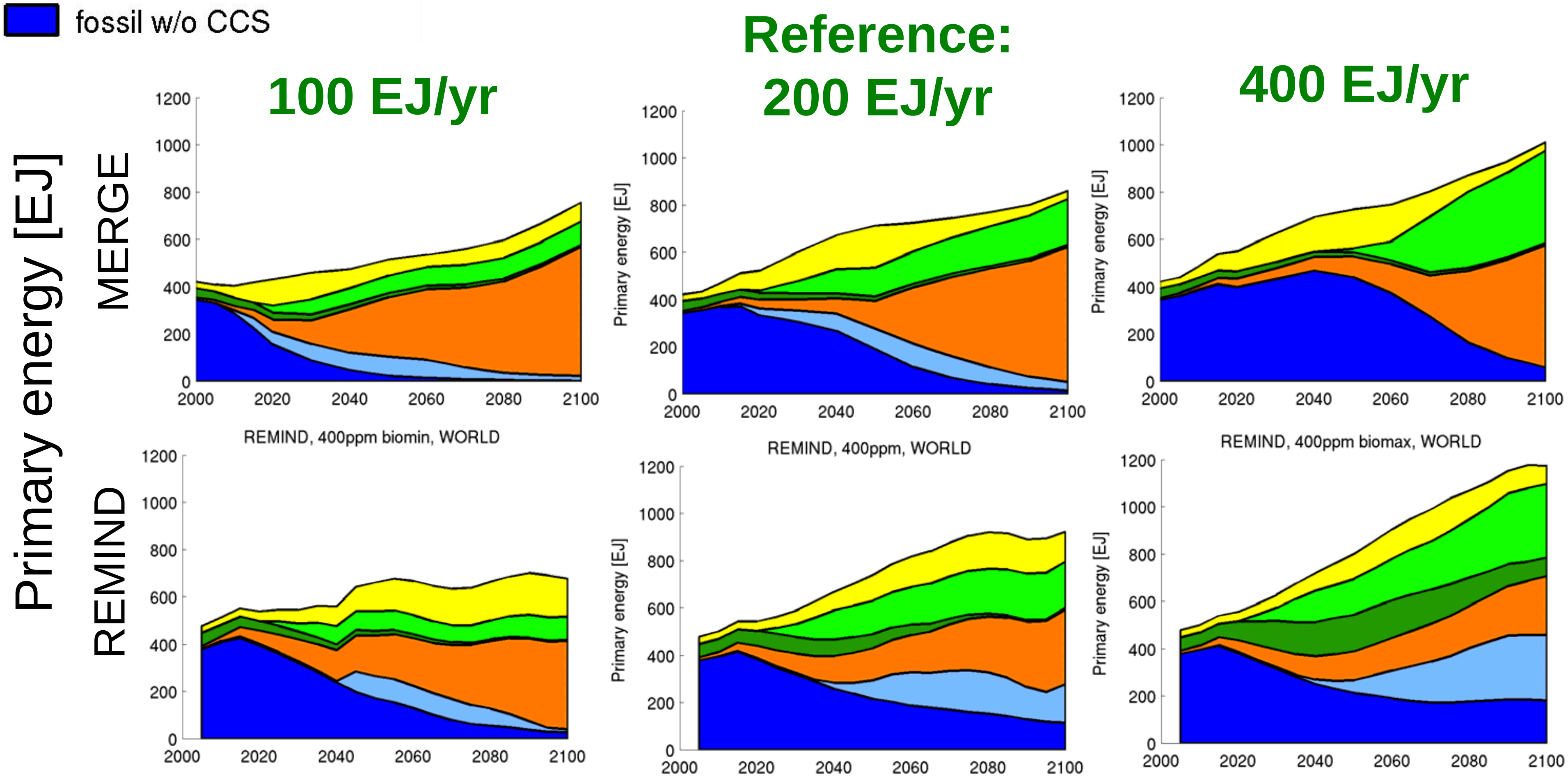
MERGE-ETL



➔ CCS potential does not only affect the costs, but also the strategy in the energy system

Magné, Kypreos, Turton (2010)

Influence of the Biomass Potential



➔ Competition between biomass+CCS with other renewables

➔ Longer use of fossil energy with higher biomass potential

Knopf, Edenhofer et al. (2009)

EMF 22 – International Scenarios

Energy Economics 31 (2009) S64–S81

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International climate policy architectures: Overview of the EMF 22 International Scenarios

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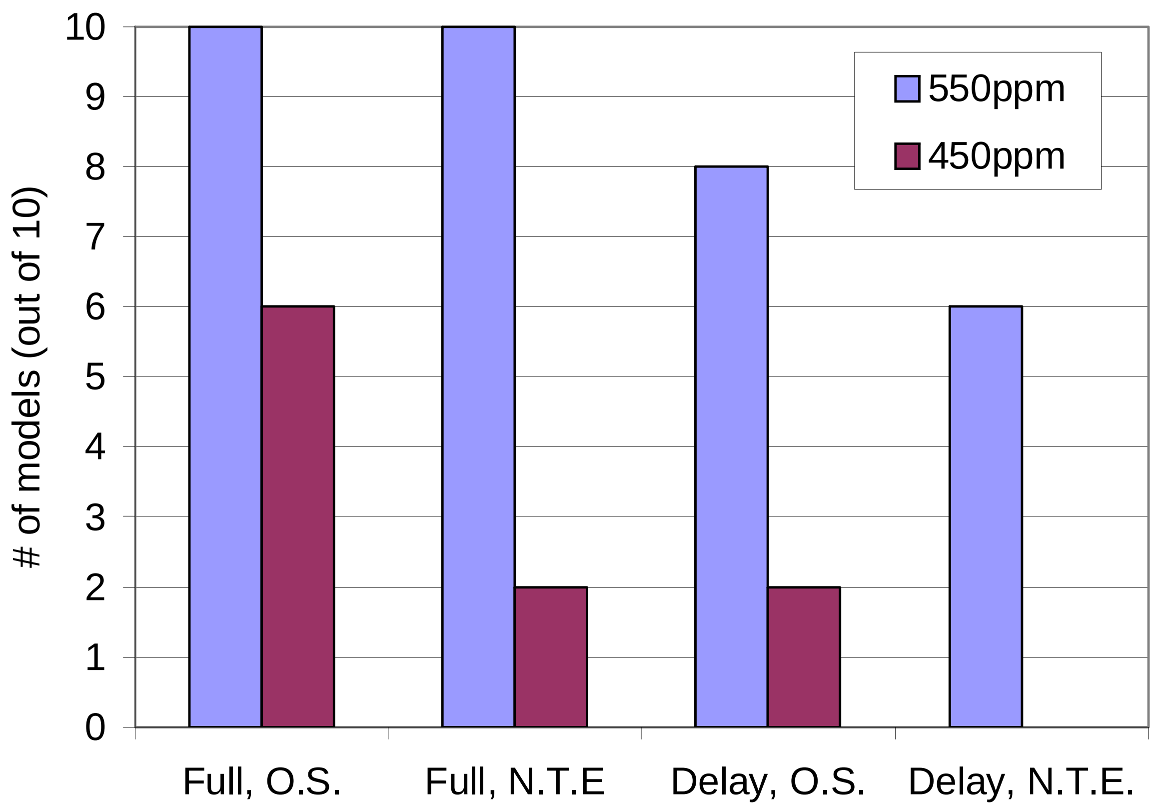
ABSTRACT

This paper presents an overview of the study design for, and the results of, the EMF 22 International Scenarios. The EMF 22 International Scenarios engaged ten of the world's leading integrated assessment (IA) models to focus on the combined implications of three factors integral to international climate negotiations: (1) the long-term climate-related target, expressed in this study in terms of the CO_2-equivalent (CO_2-e)

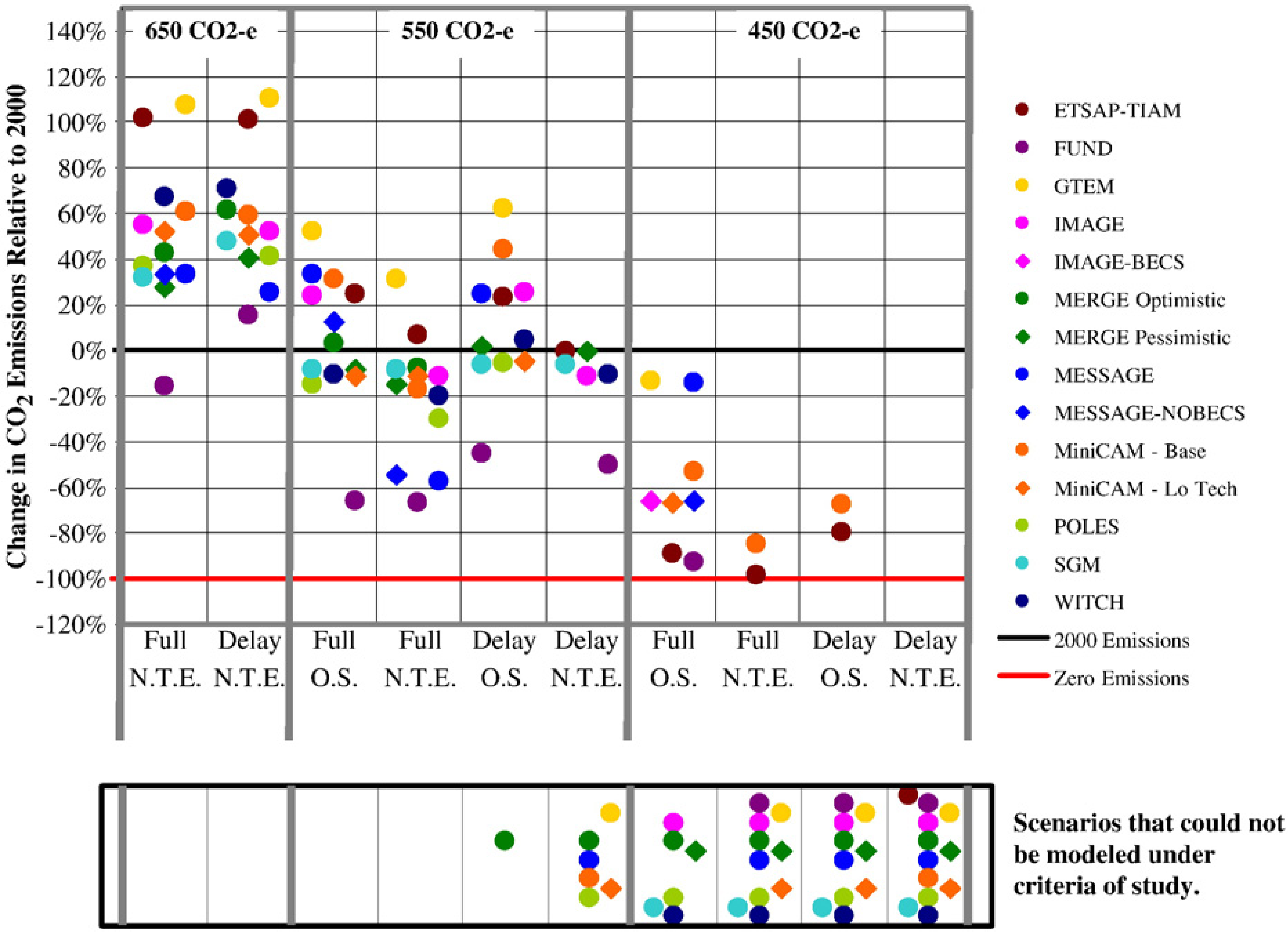
EMF 22: Overshoot or „Not to exceed“

- EMF 22: assessment of
  - Differnt targets
  - Overshoot (O.S.) or Not-to-exceed (N.T.E.) scenarios
  - Delayed participation



Based on Clarke et al (2009)

EMF22: Delayed Participation



Clarke et al (2009)

Proposal: EMF 24 Scenarios

Technology Dimension								
Energy intensity	Ref		Low		Ref		Low	
CCS	On	Off	On	Off	On	Off	On	Off
Nuclear energy	On	Off	On	Off	On	Off	On	Off
Renewable energy	Opt	Opt	Opt	Opt	Pess	Pess	Pess	Pess
Dimension 2								
Baseline	1	2	3	4	15	16	27	28
450 CO2e	33	34	5	17	18	19	35	36
550 CO2e	6	7	8	9	20	21	29	30
Idealized G8	37	38	10	22	23	24	39	40
Muddling through	11	12	13	14	25	26	31	32

Purple: Required scenarios for participation (14)
Green: Higher priority optional scenarios (12)
Yellow: Lower priority optional scenarios (14)

Second-Best Scenarios – Insights From RECIPE

REPORT ON ENERGY AND CLIMATE POLICY IN EUROPE

RECIPE

THE ECONOMICS OF DECARBONIZATION

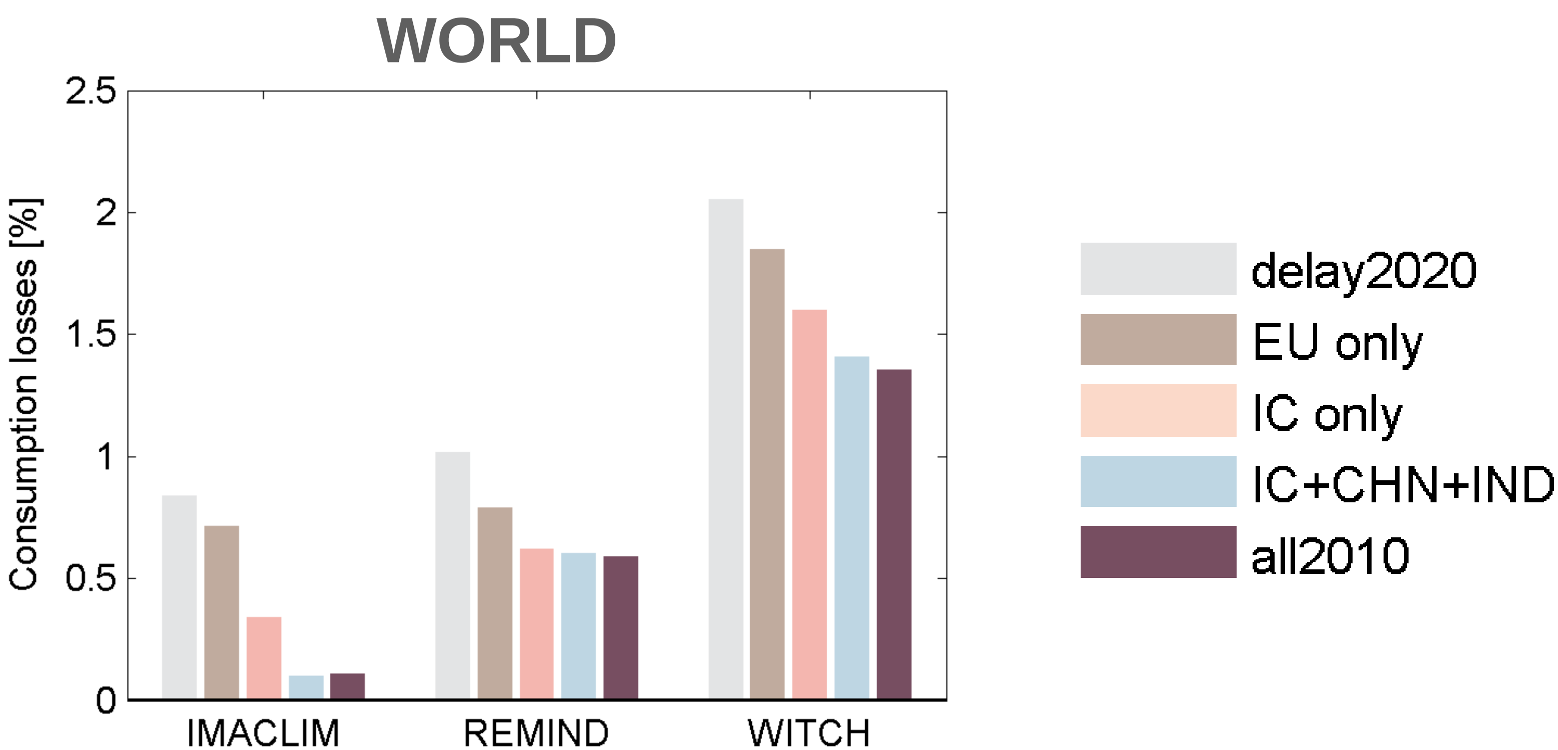
PIK

CMCC
Centro Euro-Mediterraneo per i Cambiamenti Climatici

CIRED

UNIVERSITY OF CAMBRIDGE | Electricity Policy Research Group

RECIPE: The Costs of Delay



➔ If global climate agreement is delayed until 2030, stabilization at 450 ppm CO2 or below becomes infeasible

➔ If global climate agreement is delayed until 2020, costs are projected to increase by at least 46%

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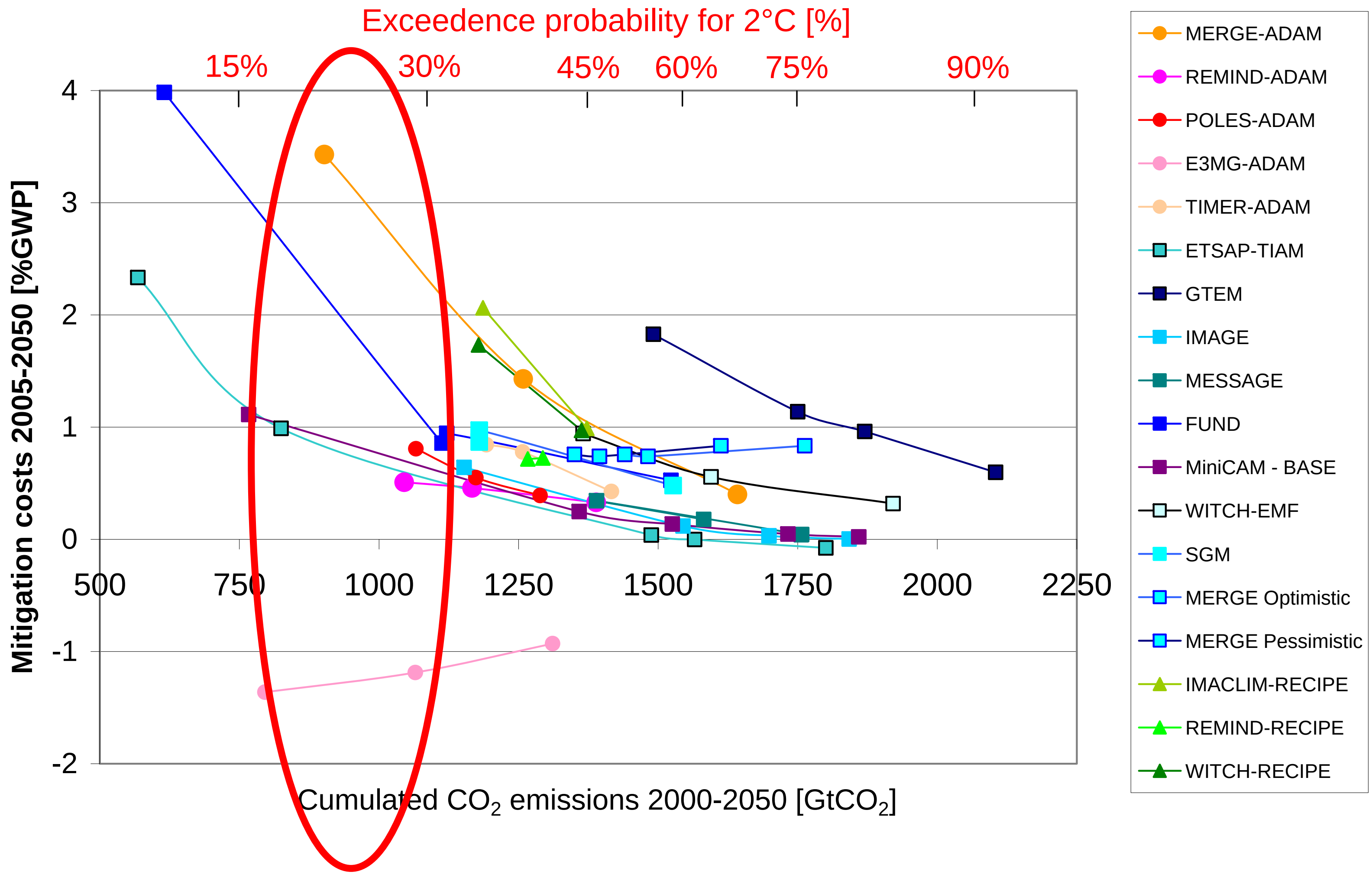
Costs of Low Mitigation Scenarios

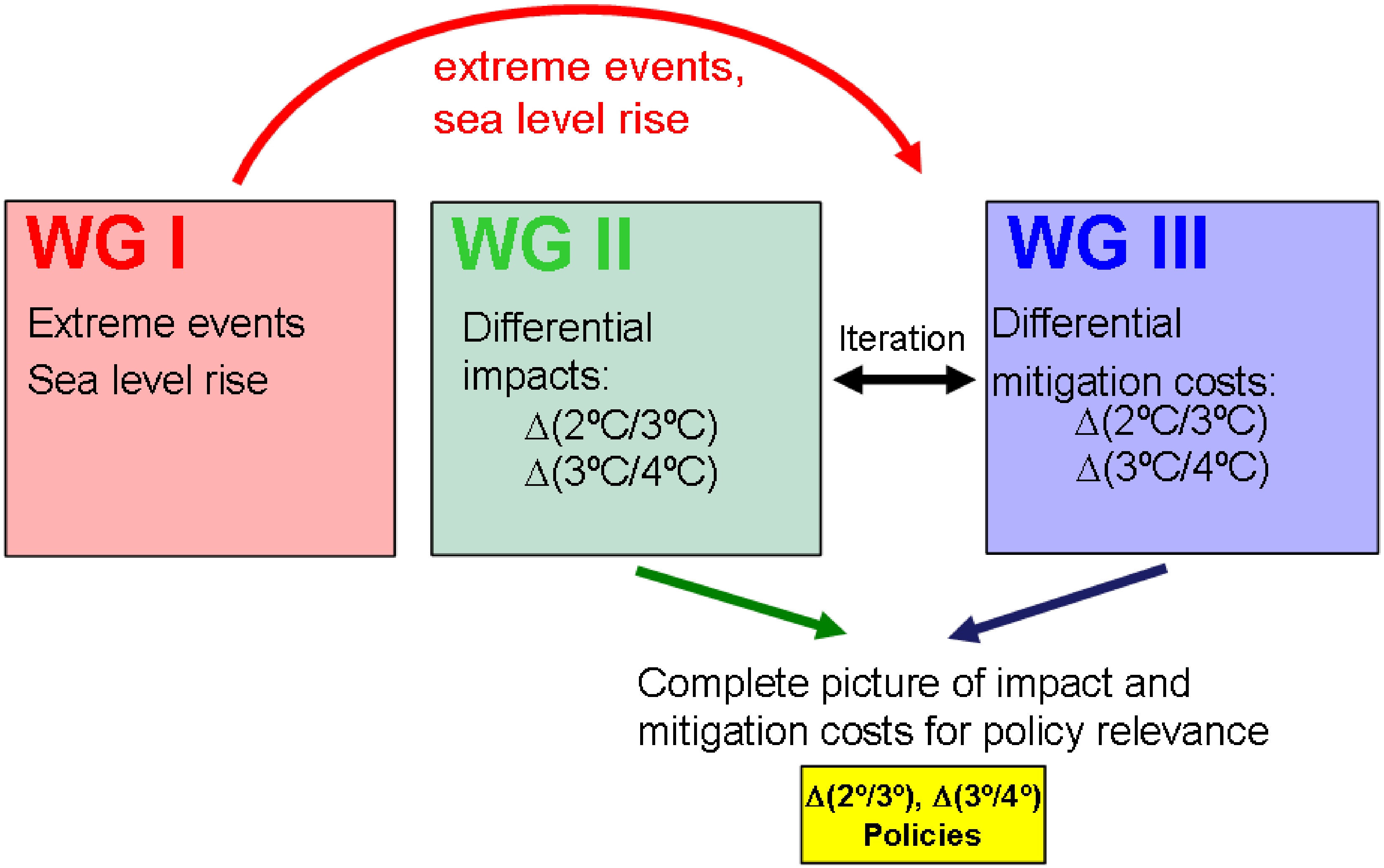


Somewhere here starts the (model dependent) feasibility frontier

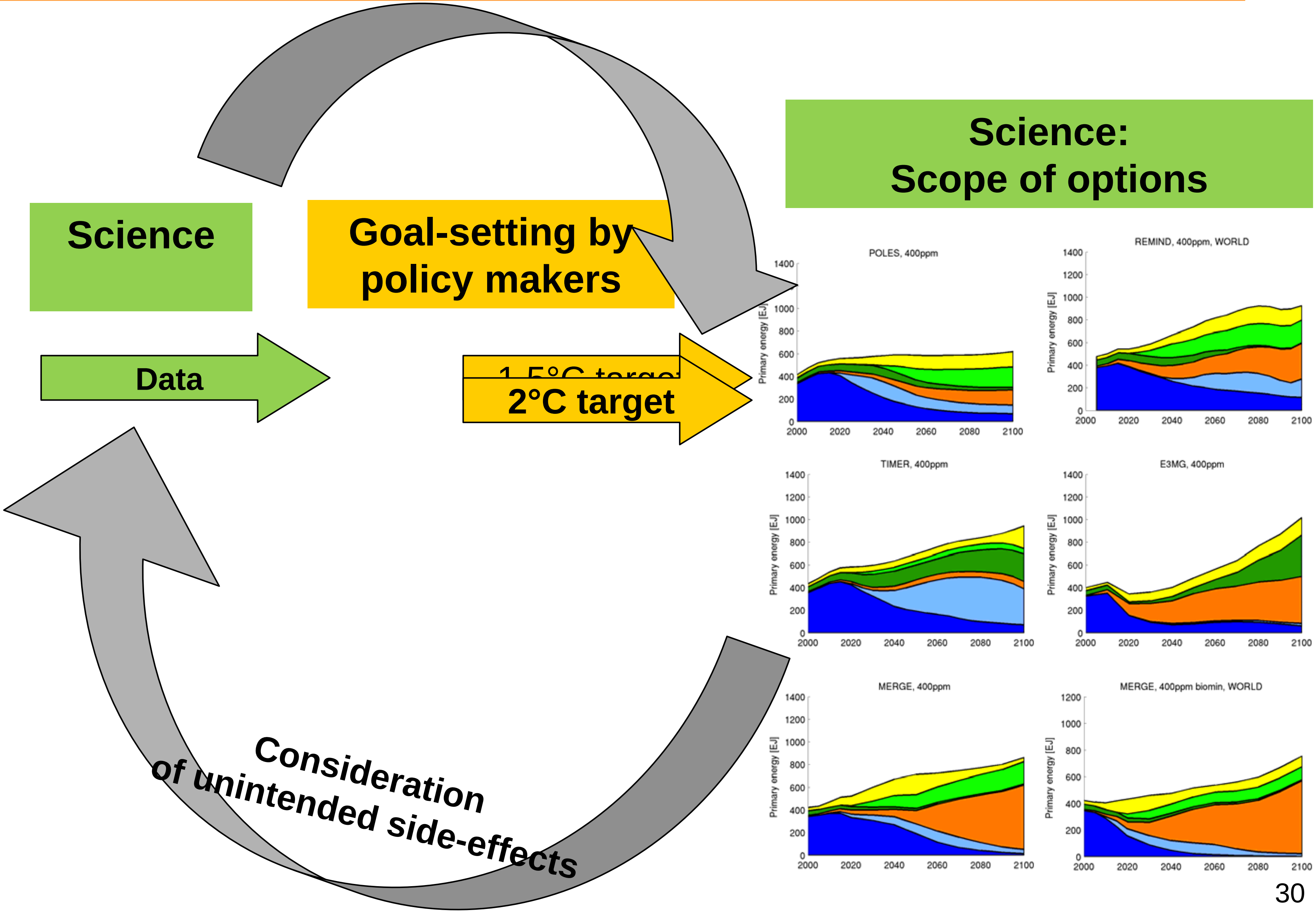
Knopf/Luderer/Edenhofer, subm.

Assessment of Differential Impacts

- Exploration of the feasibility frontier has to come from both sides: including impacts and limits of adaptive capacity

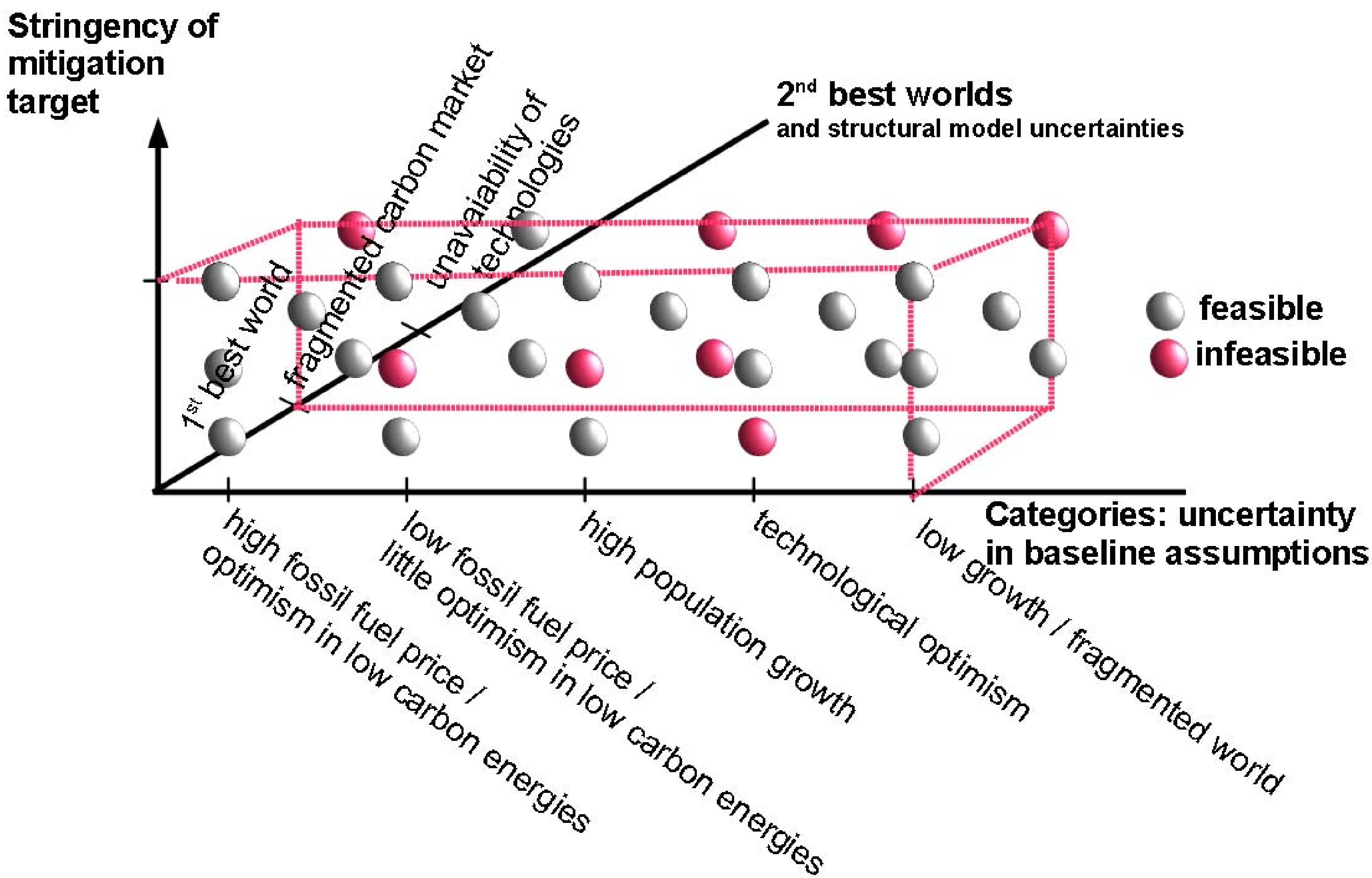


Iteration Between Targets and Measures



Exploring the Feasibility Frontier

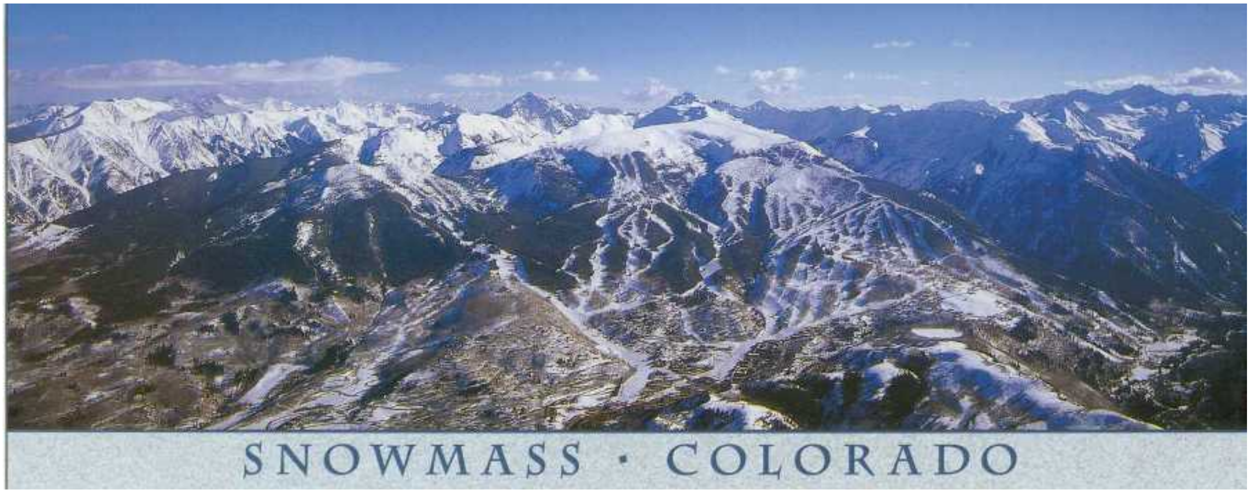
3D assessment space for each model



Knopf/Luderer/Edenhofer, subm.

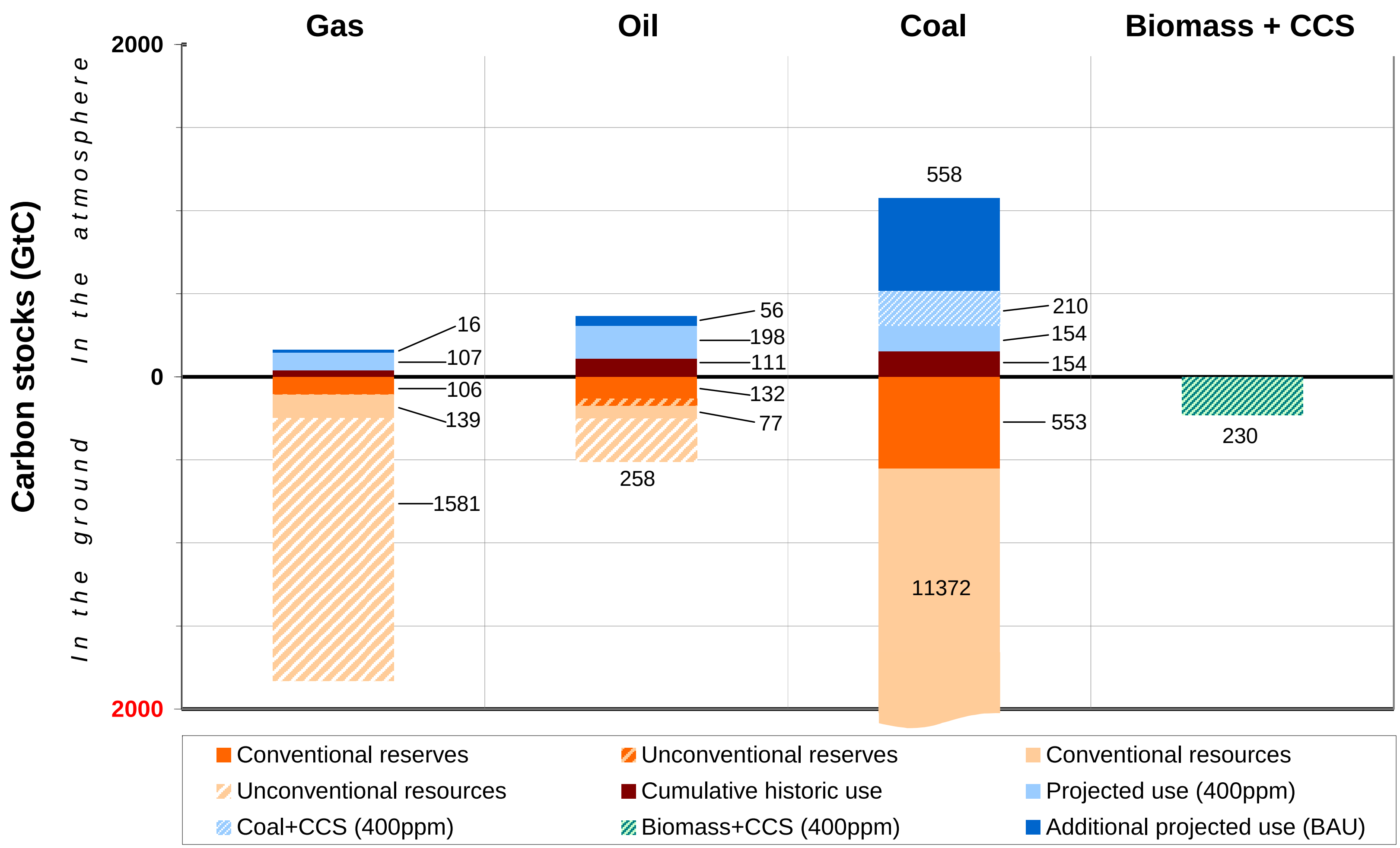
Conclusion

Potsdam is the first-best place in the World…



…but Snowmass is definitely the second-best place

The Supply-side of Global Warming



Cumulative historic carbon consumption (1750-2004), estimated carbon stocks in the ground, and estimated future consumption (2005-2100) for business-as-usual (BAU) and ambitious 400-ppm-CO_2-eq. scenario

Source: Kalkuhl, Edenhofer and Lessmann, 2009