



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Low Mitigation Scenarios in Second-Best Worlds

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Snowmass



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



Working Group III
Mitigation of Climate Change



Technische Universität Berlin

Outline



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- 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	
	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



	UNITED NATIONS	
	Framework Convention on Climate Change	Distr. LIMITED
		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.

Draft Decision 7/CP.15

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,

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The Scientific Arena



Table 3.10: Properties of emissions pathways for alternative ranges of CO₂ and CO₂-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/m ²)	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 2°C –4.5°C, 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

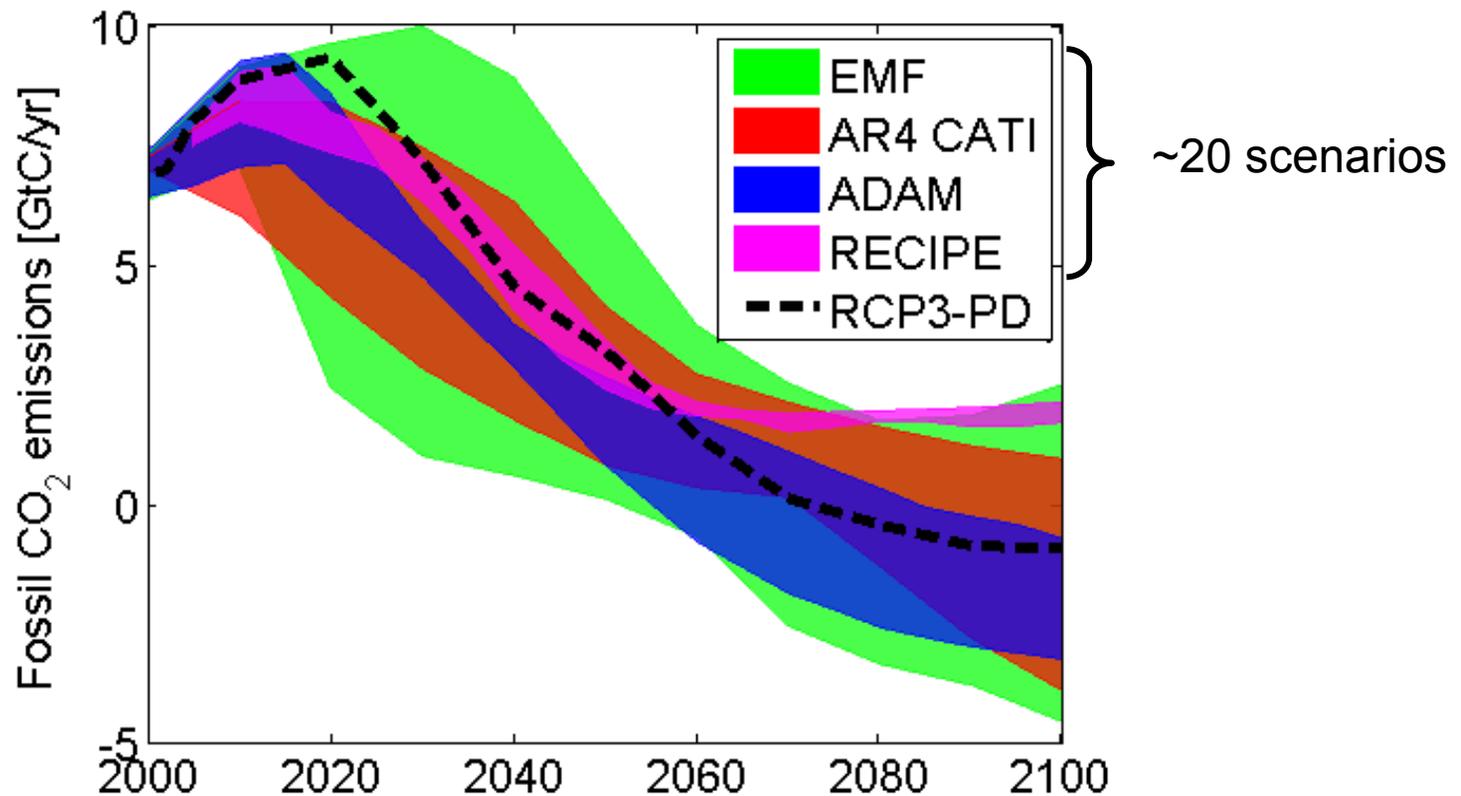
Fisher et al. (2007), AR4

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



Outline

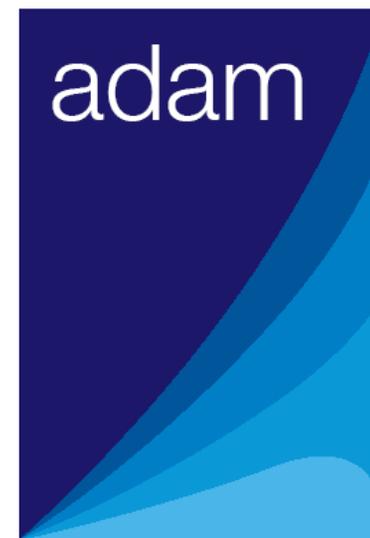


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Low Stabilization Pathways: Economic and Technical Feasibility



ADAM Model Comparison



Members:

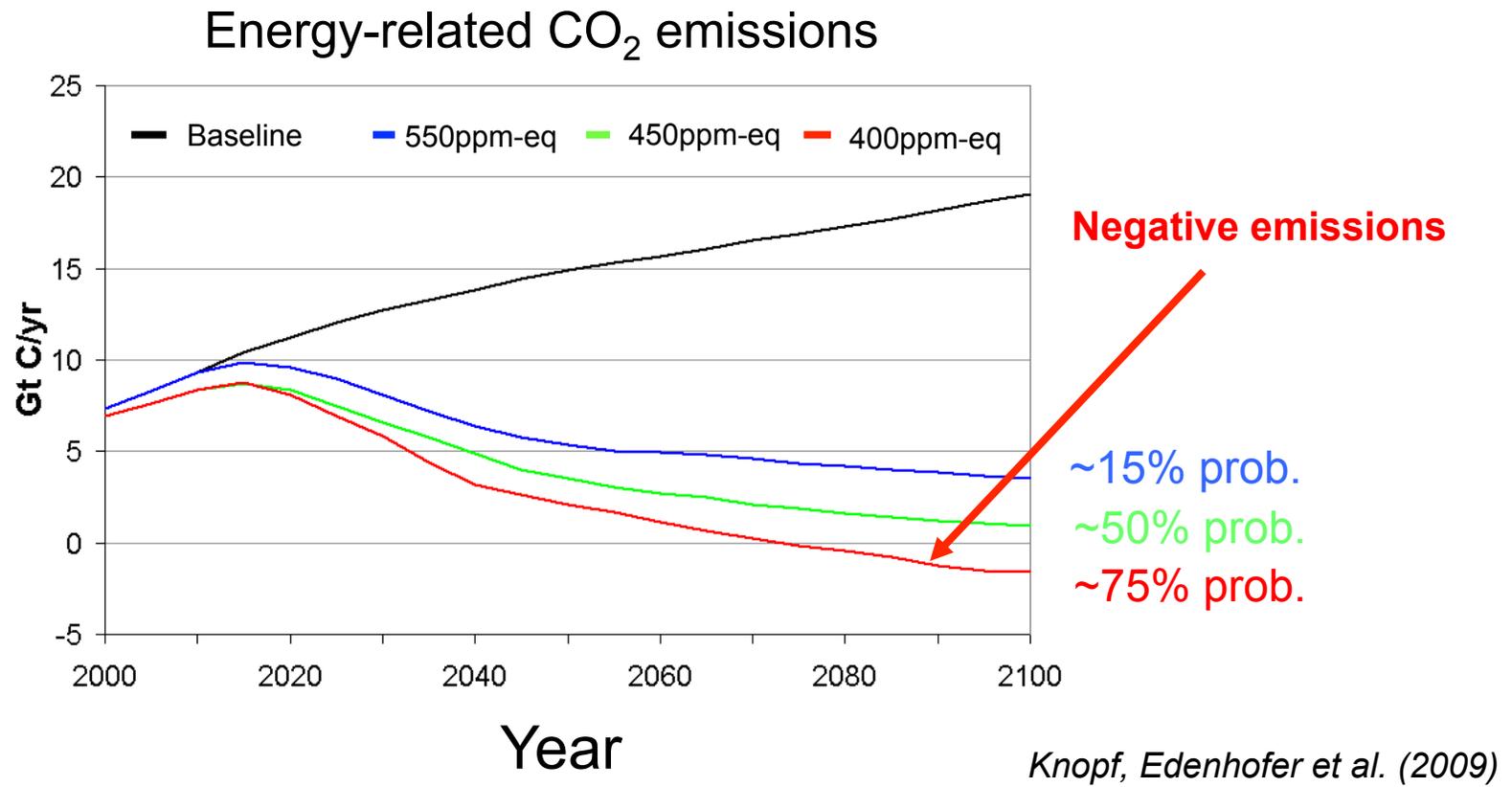
PIK (REMIND model):	O. Edenhofer, M. Leimbach, L. Baumstark, B. Knopf
PSI (MERGE model):	T. Hal, S. Kypreos, B. Magné
U Cambridge (E3MG model):	T. Barker, S. Scriciu
ENERDATA (POLES model):	A. Kitous, E. Bellevrat, B. Chateau, P. Criqui
PBL (TIMER):	D. van Vuuren, M. Isaac
Compilation of comparison: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

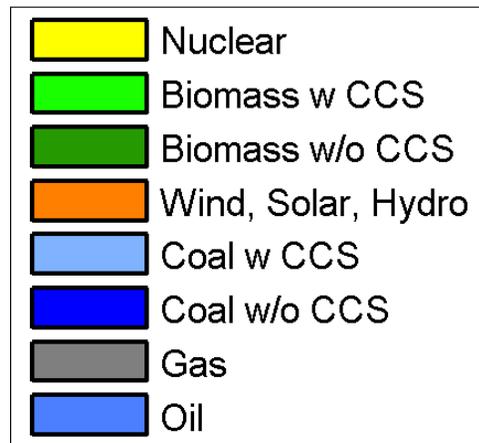
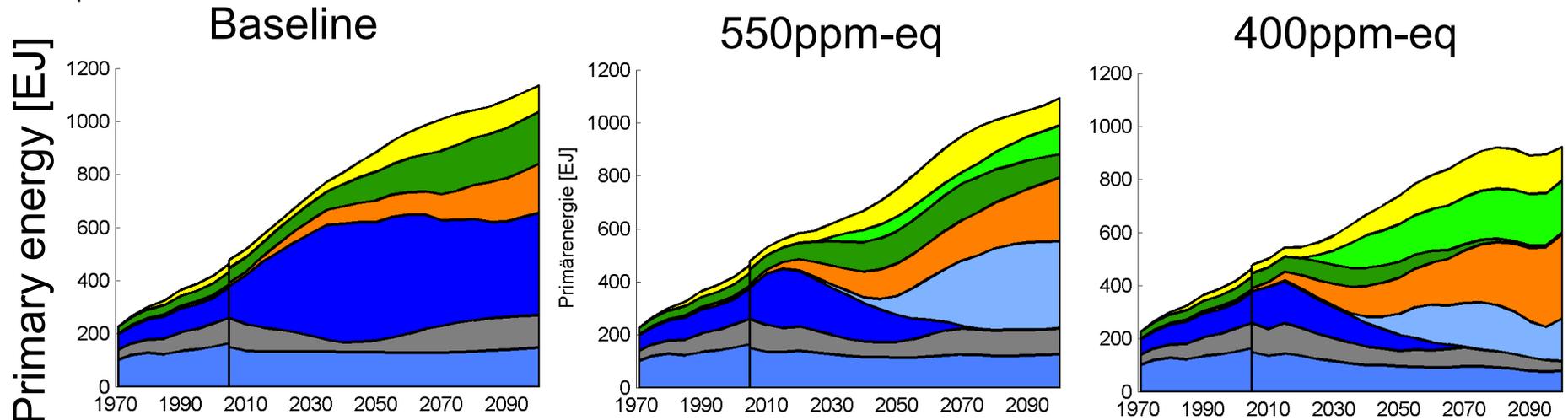


Transformation of the Energy System



The historical challenge

Example: REMIND

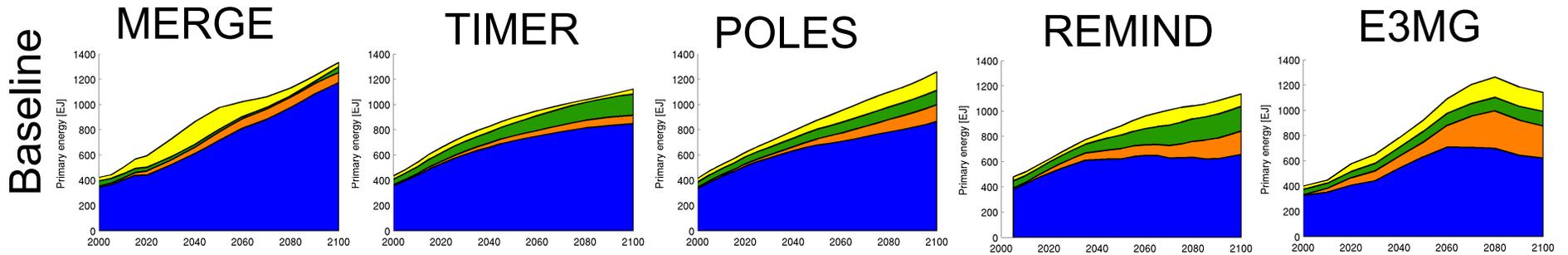


Knopf, Edenhofer et al. (2009)

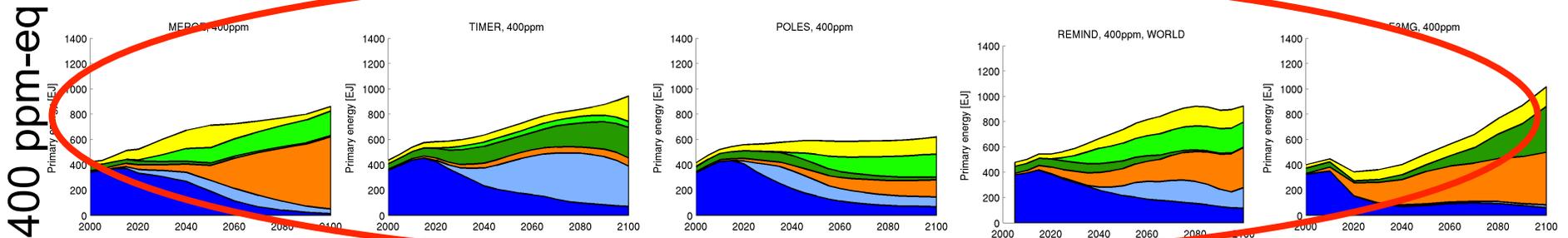
Transformation of the Energy System



models →



Many different pathways to transform the energy system

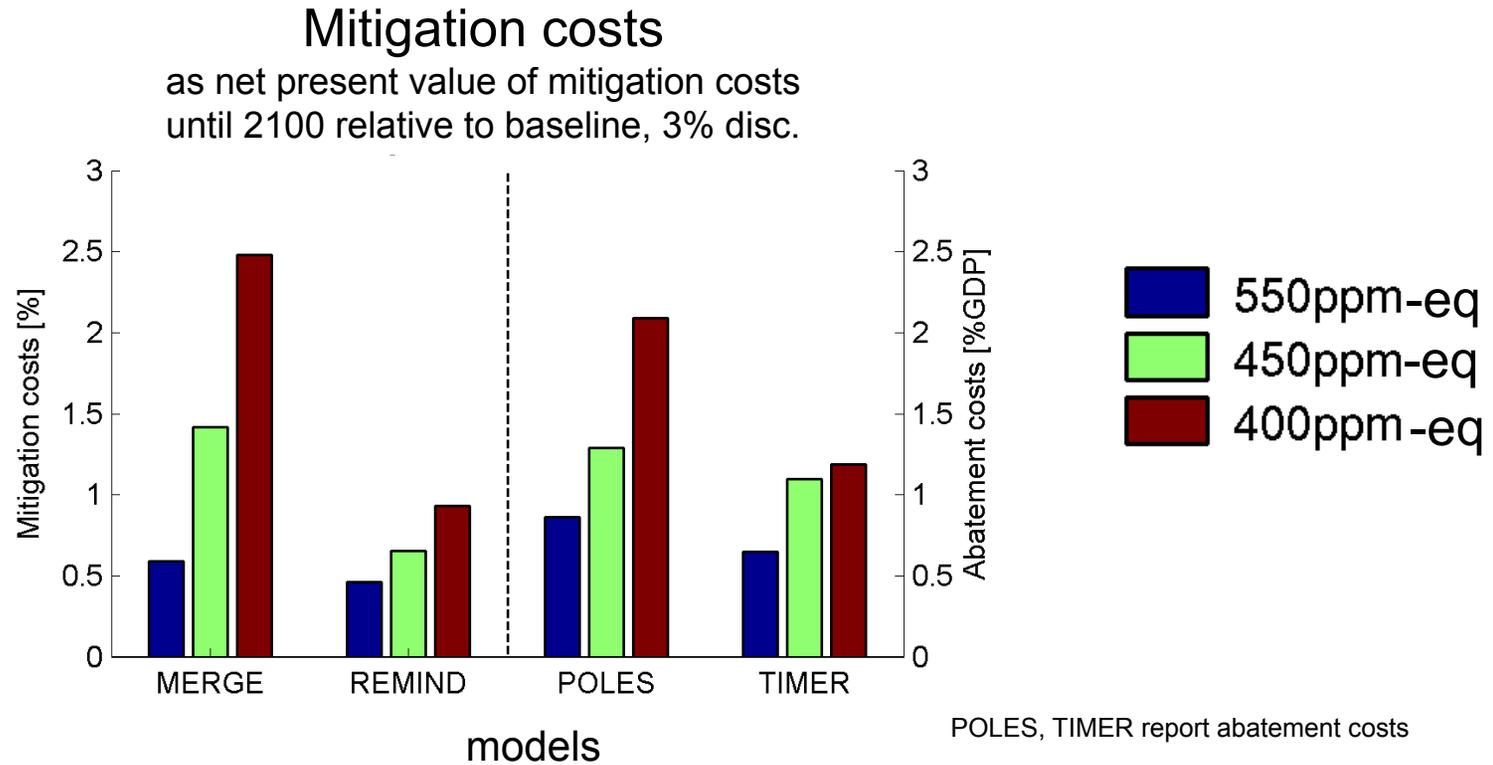


➔ Different possibilities to reach low stabilisation

➔ 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)

Outline

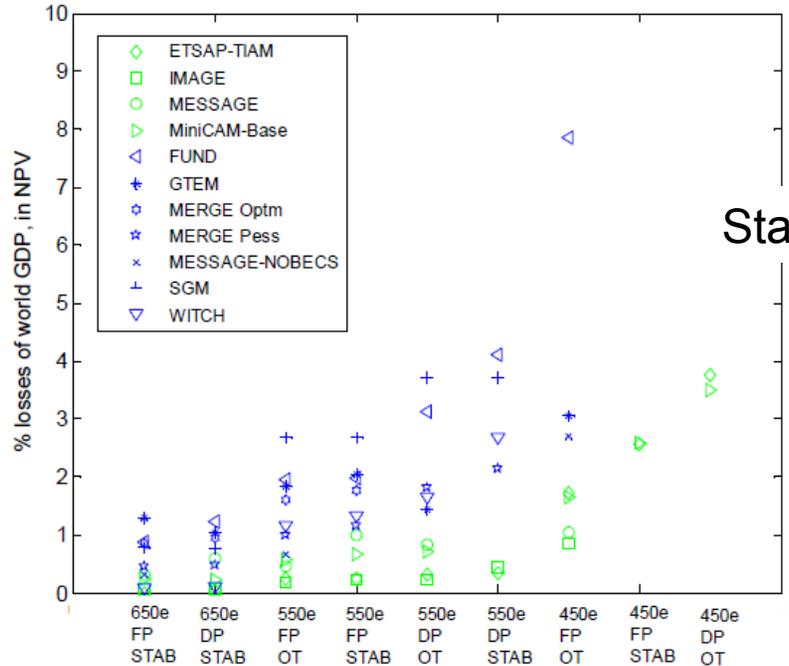


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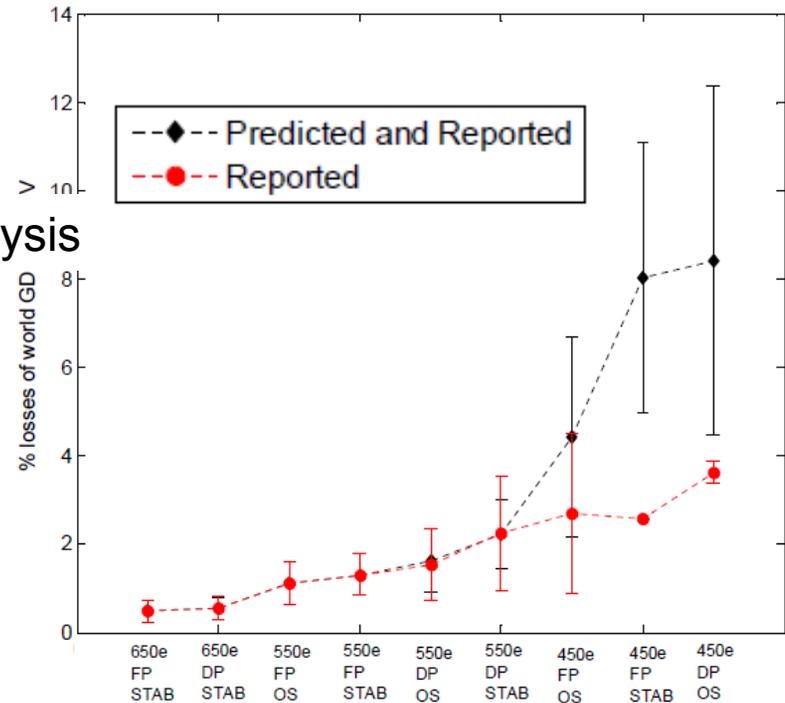
Statistical Analysis for Assessing Second Best Worlds

Green: with BECS

Blue: w/o BECS



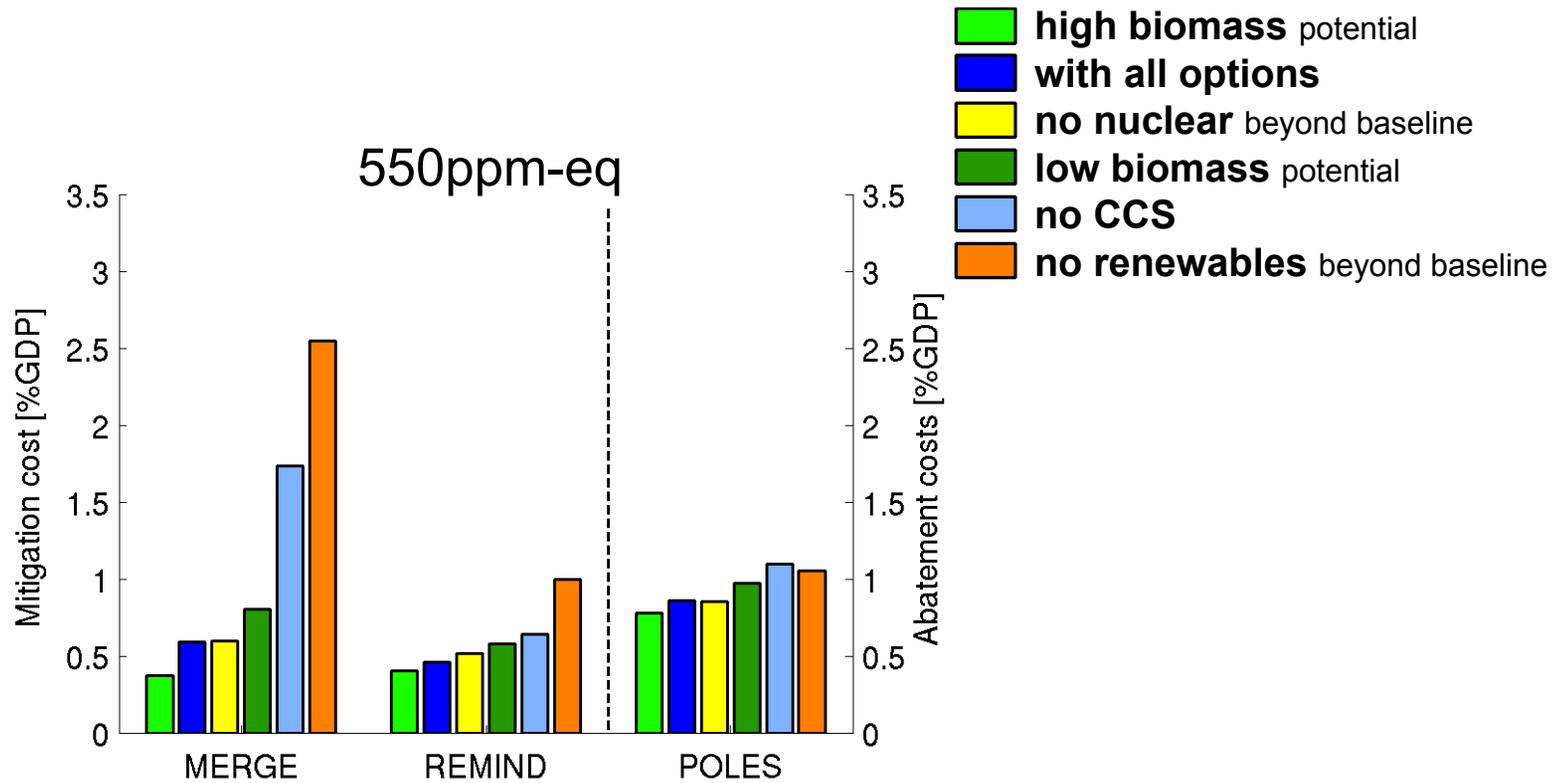
Statistical Analysis



Increasing strictness of target

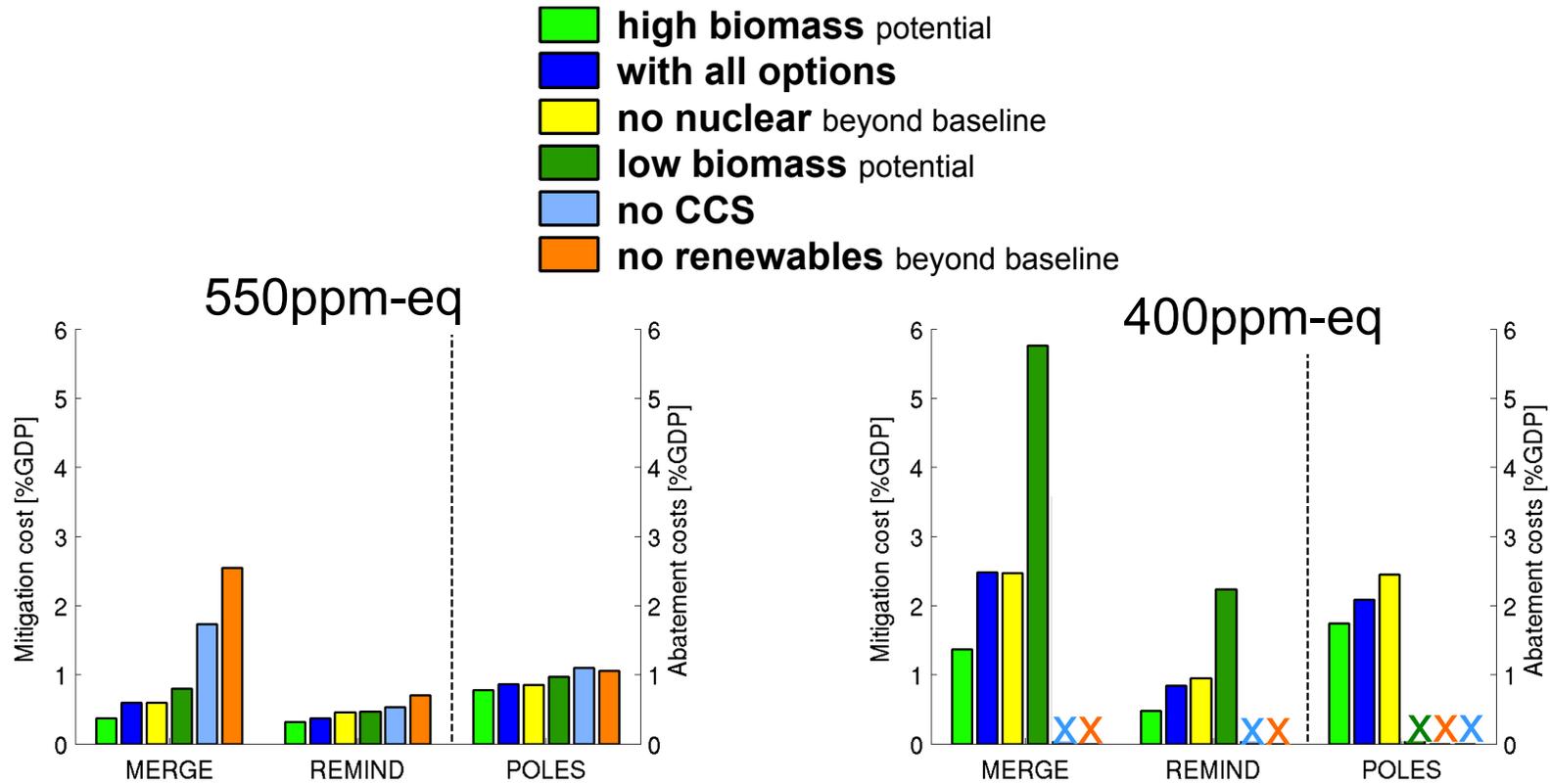
Increasing strictness of target

Mitigation Costs: Technology Options, 550ppm



Knopf, Edenhofer et al. (2009)

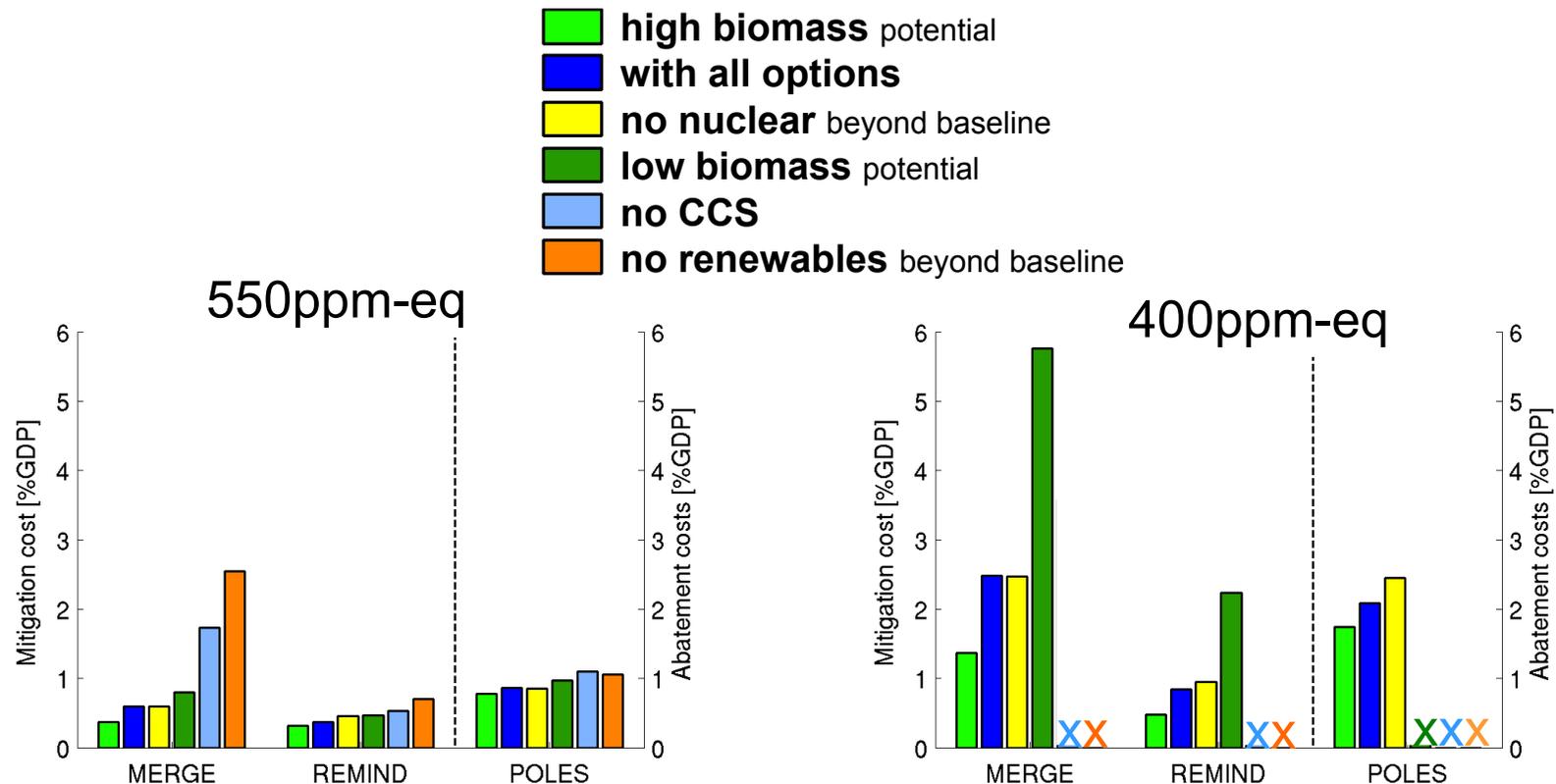
Technology Options for Low Stabilisation



➔ Robust ranking of options

Knopf, Edenhofer et al. (2009)

Technology Options for Low Stabilisation



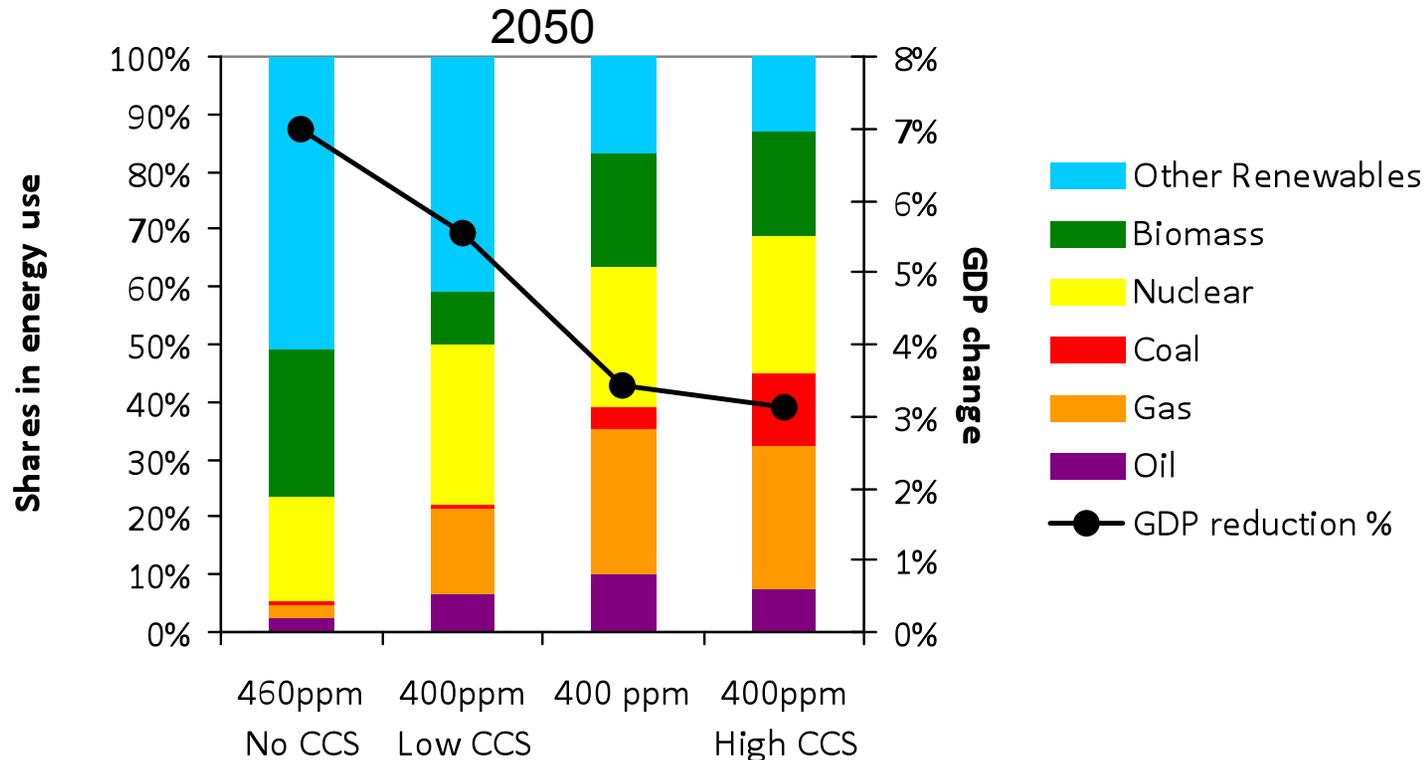
- ➔ Mitigation potential of nuclear is limited (but high use in the baseline)
- ➔ 400 ppm neither achievable without CCS nor without extension of renew
- ➔ Biomass potential dominates the mitigation costs of low stabilisation

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



Reference:
200 EJ/yr

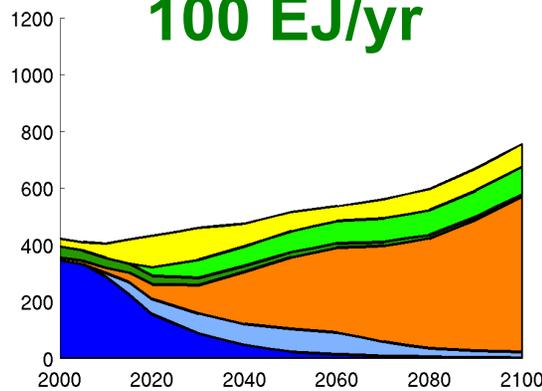
100 EJ/yr

400 EJ/yr

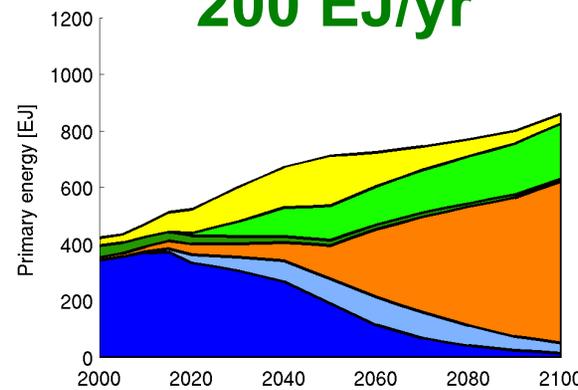
Primary energy [EJ]

MERGE

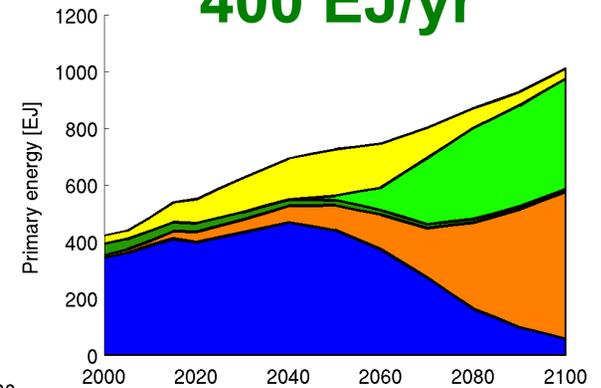
REMIND



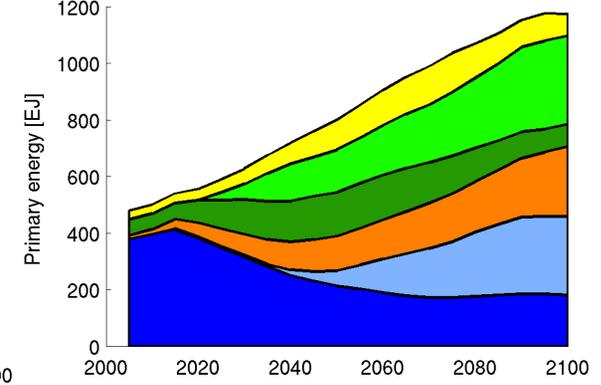
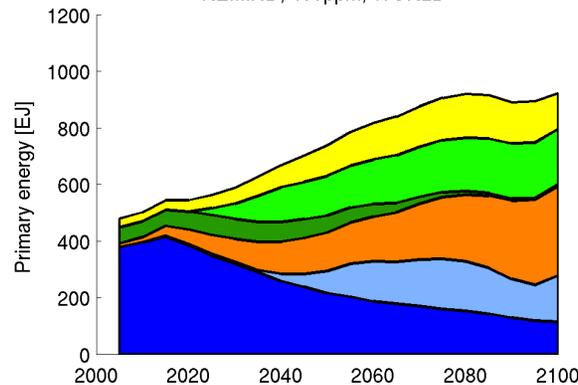
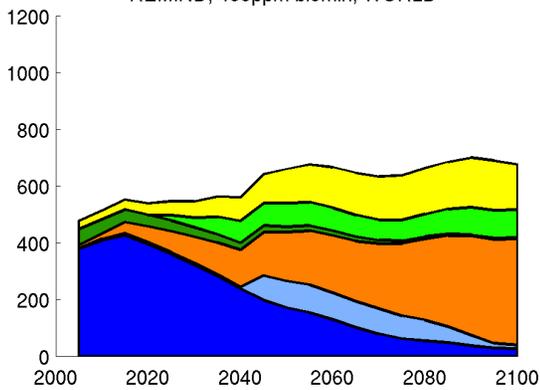
REMIND, 400ppm biomin, WORLD



REMIND, 400ppm, WORLD



REMIND, 400ppm biomax, WORLD



- ➔ Competition between biomass+CCS with other renewables
- ➔ Longer use of fossil energy with higher biomass potential

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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^b International Institute for Applied Systems Analysis (IIASA), Austria

^c Electric Power Research Institute (EPRI), USA

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^f Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), Italy

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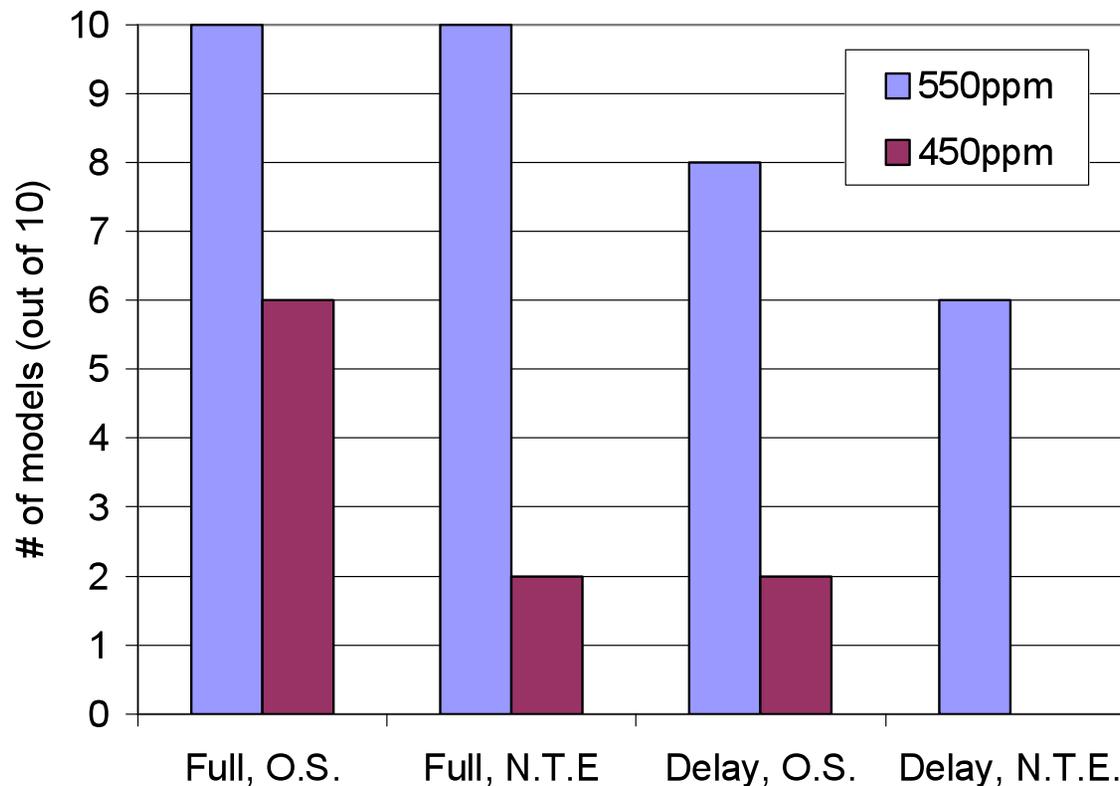
ABSTRACT

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 CO₂-equivalent (CO₂-e)

EMF 22: Overshoot or „Not to exceed“

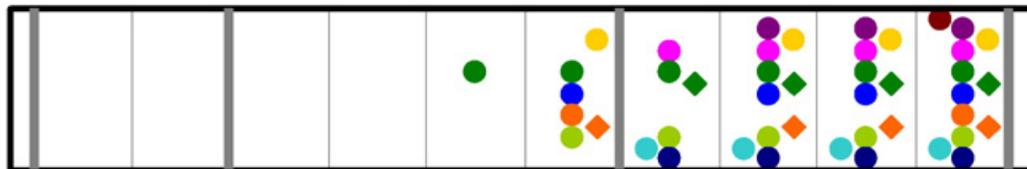
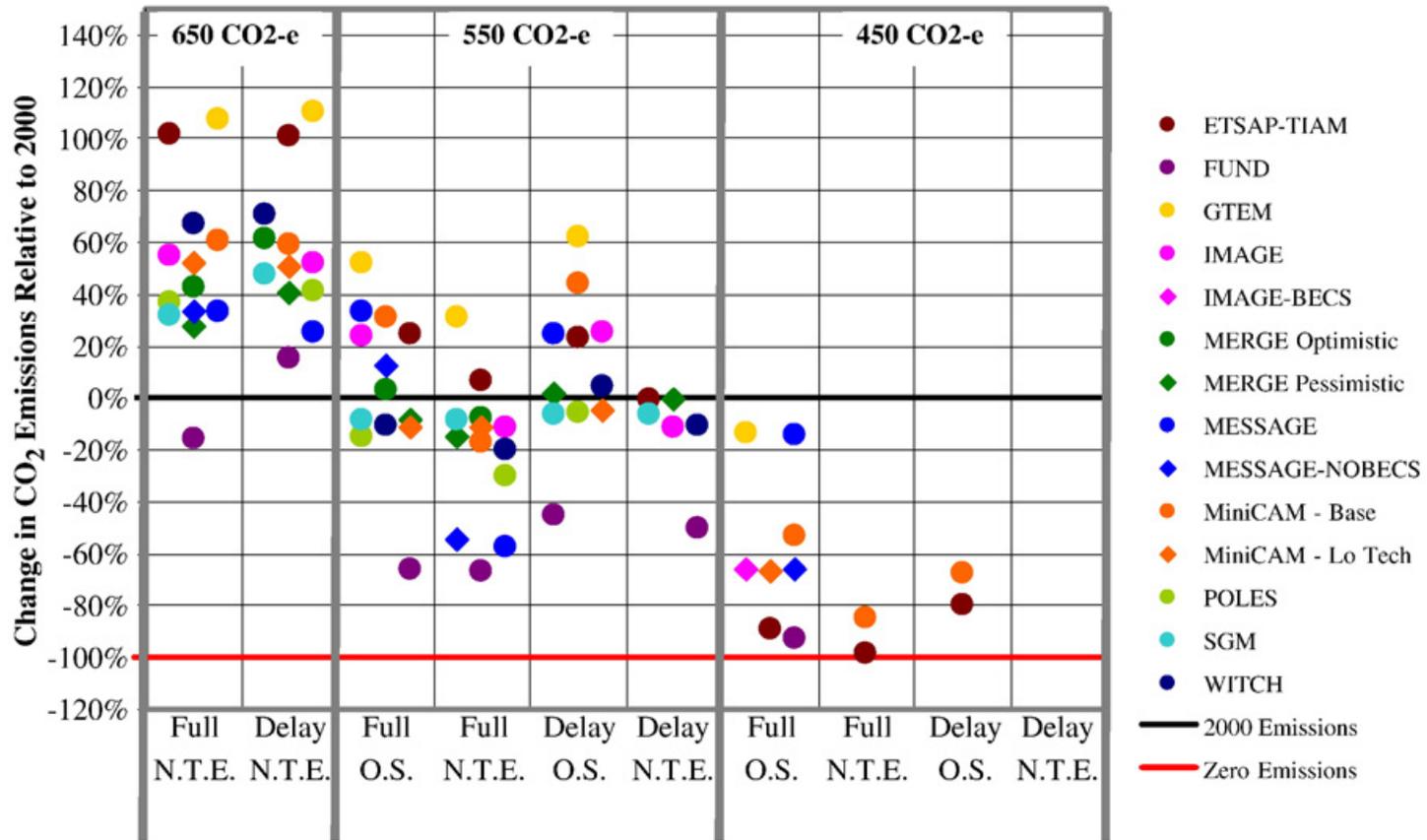


- EMF 22: assessment of
 - Different targets
 - Overshoot (O.S.) or Not-to-exceed (N.T.E.) scenarios
 - Delayed participation



Based on Clarke et al (2009)²²

EMF22: Delayed Participation



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)

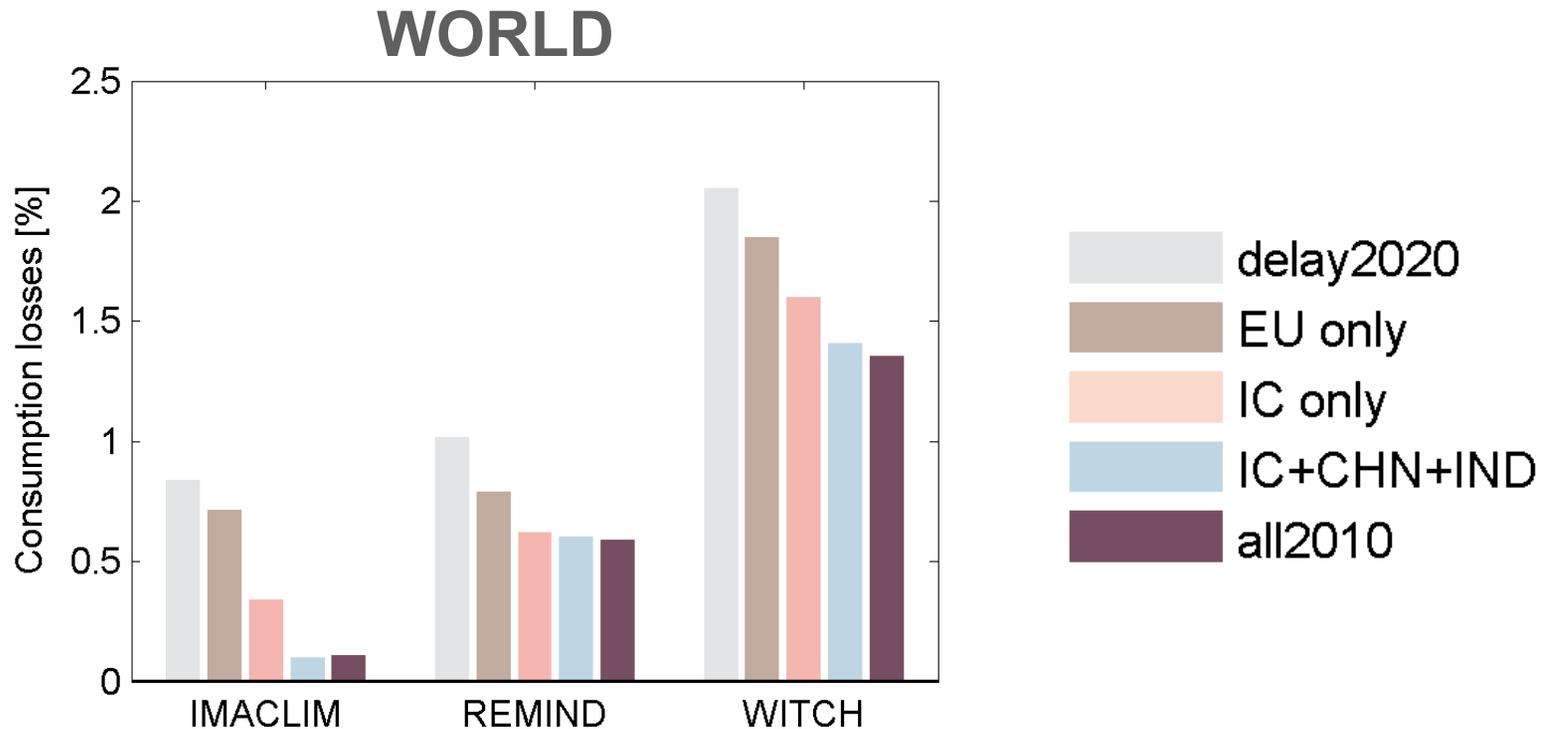
Green: Higher priority optional scenarios (12)

Yellow: Lower priority optional scenarios (14)

Second-Best Scenarios – Insights From RECIPE



RECIPE: The Costs of Delay



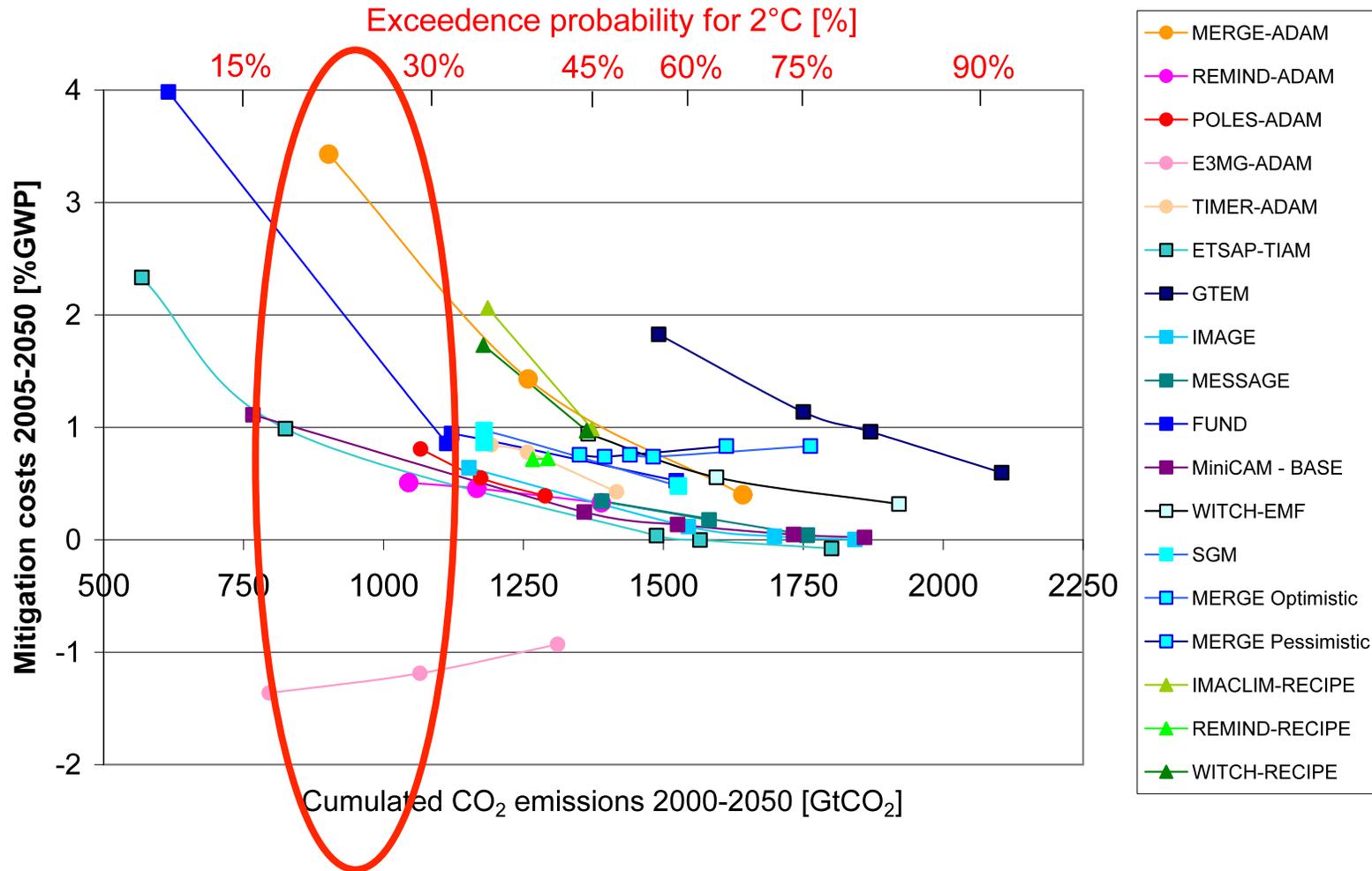
- ➔ If global climate agreement is delayed until 2030, stabilization at 450 ppm CO₂ or below becomes infeasible
- ➔ If global climate agreement is delayed until 2020, costs are projected to increase by at least 46%

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Costs of Low Mitigation Scenarios

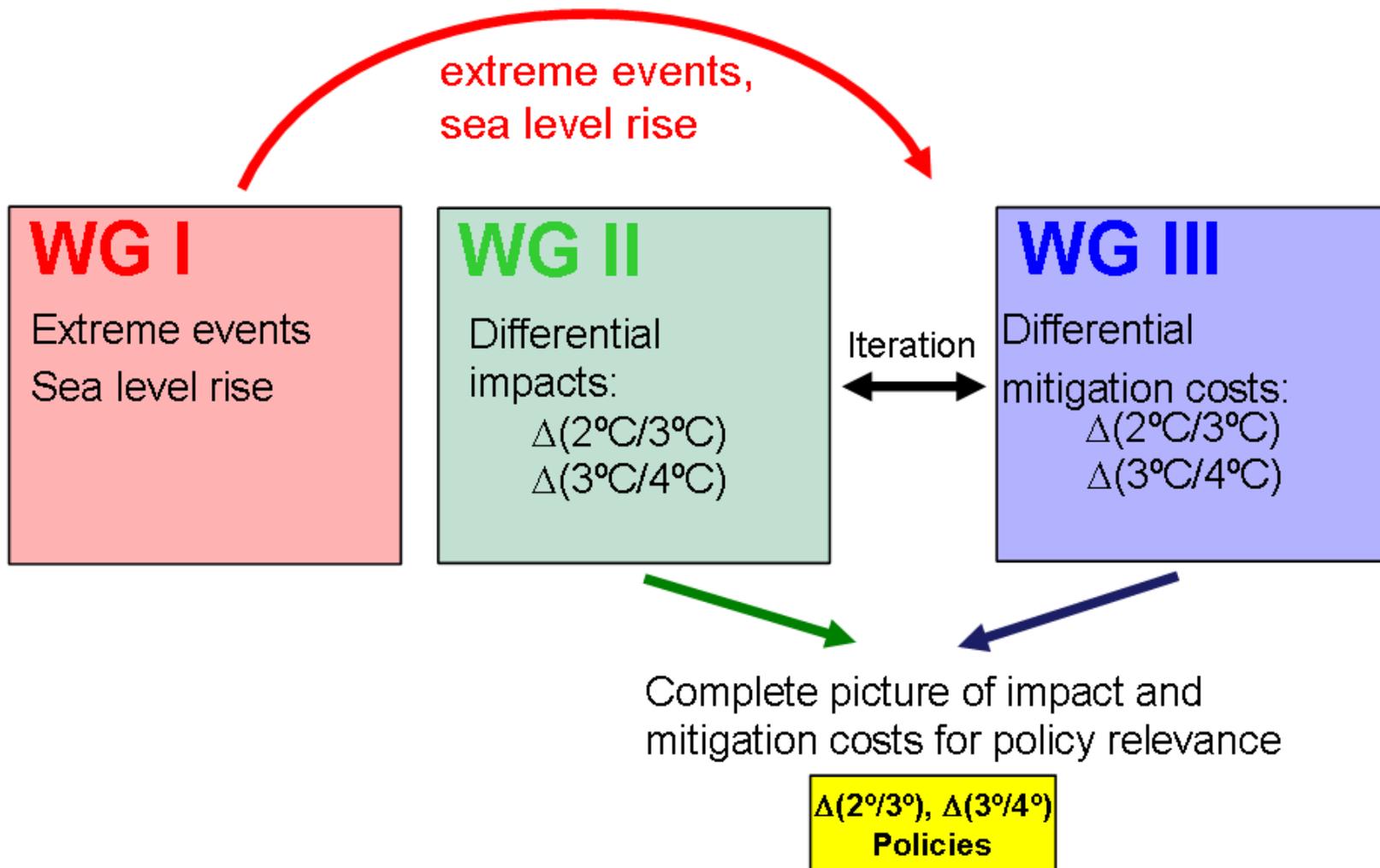


Somewhere here starts the (model dependent) feasibility frontier

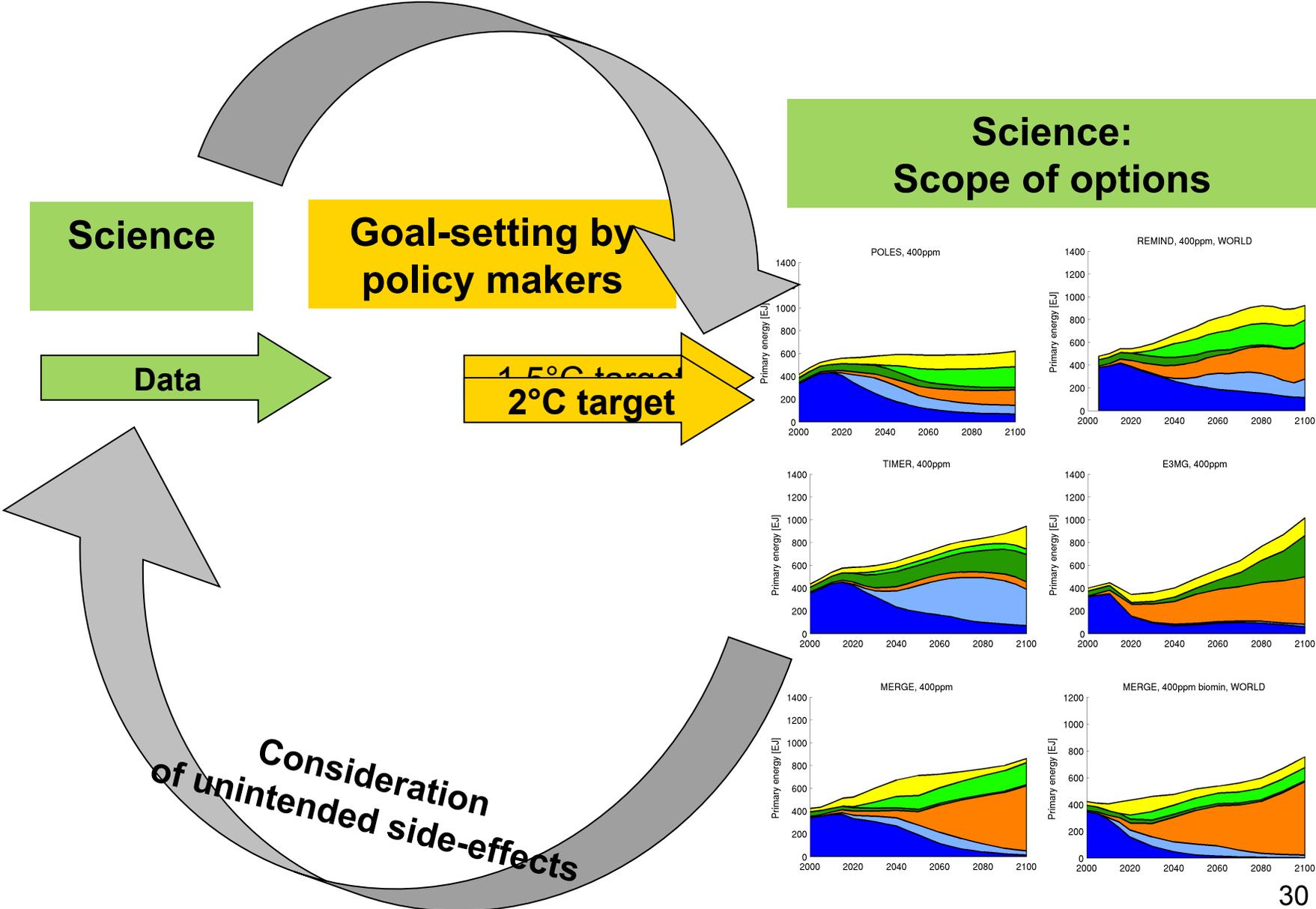
Assessment of Differential Impacts



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



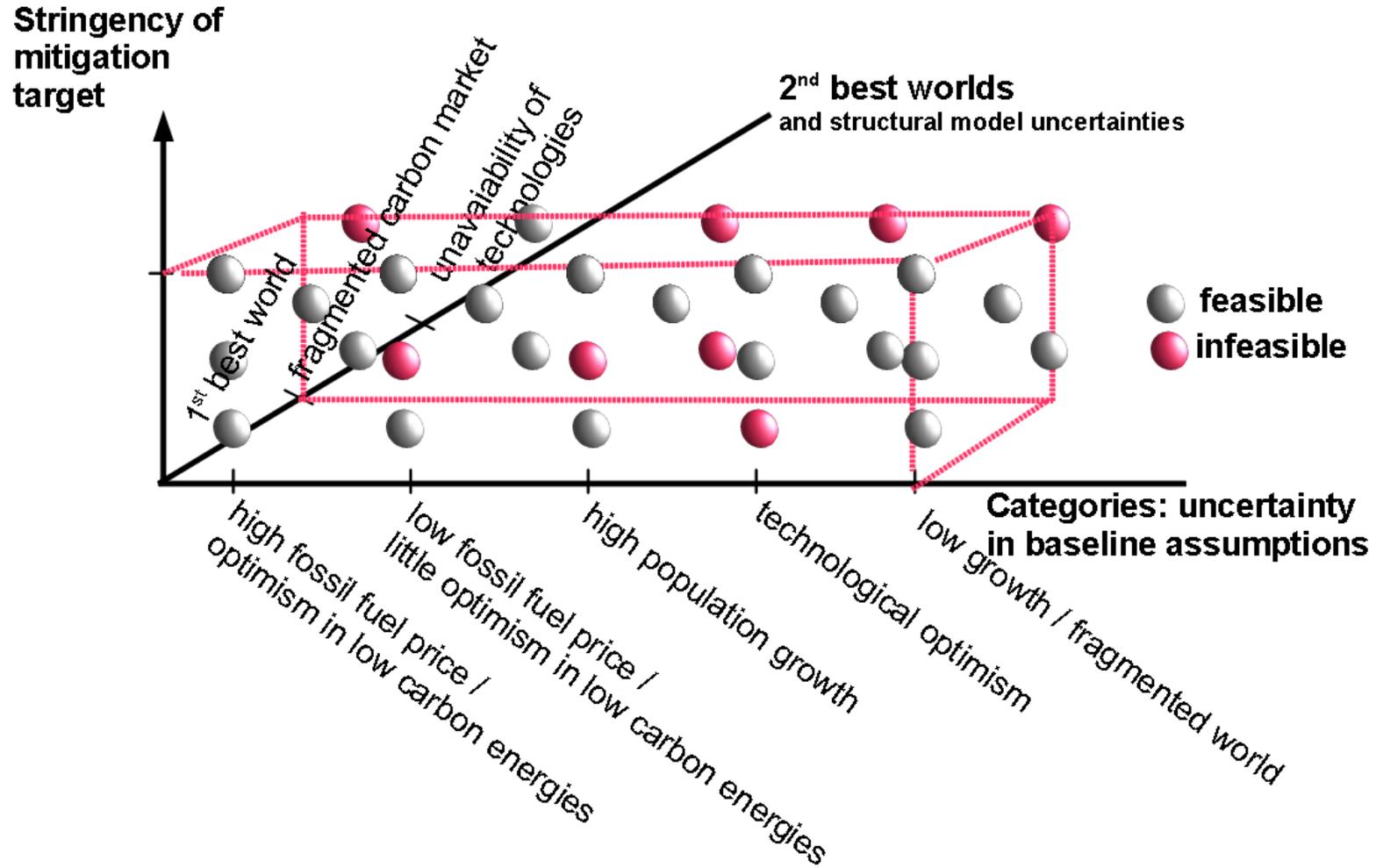
Iteration Between Targets and Measures



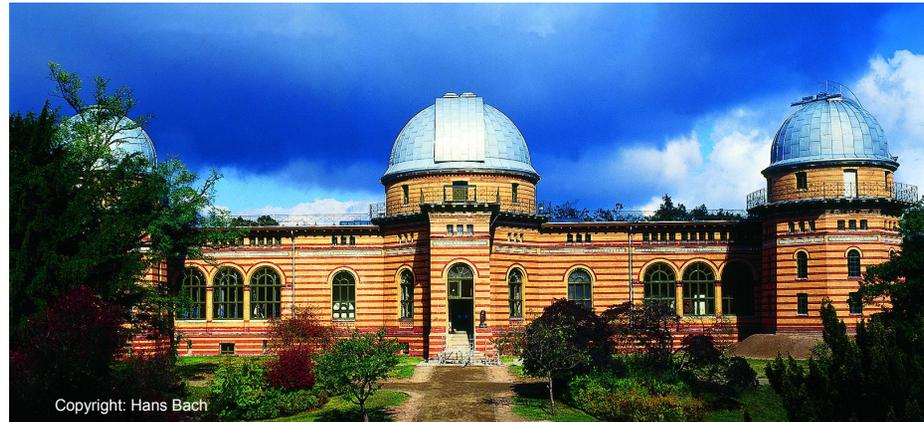
Exploring the Feasibility Frontier



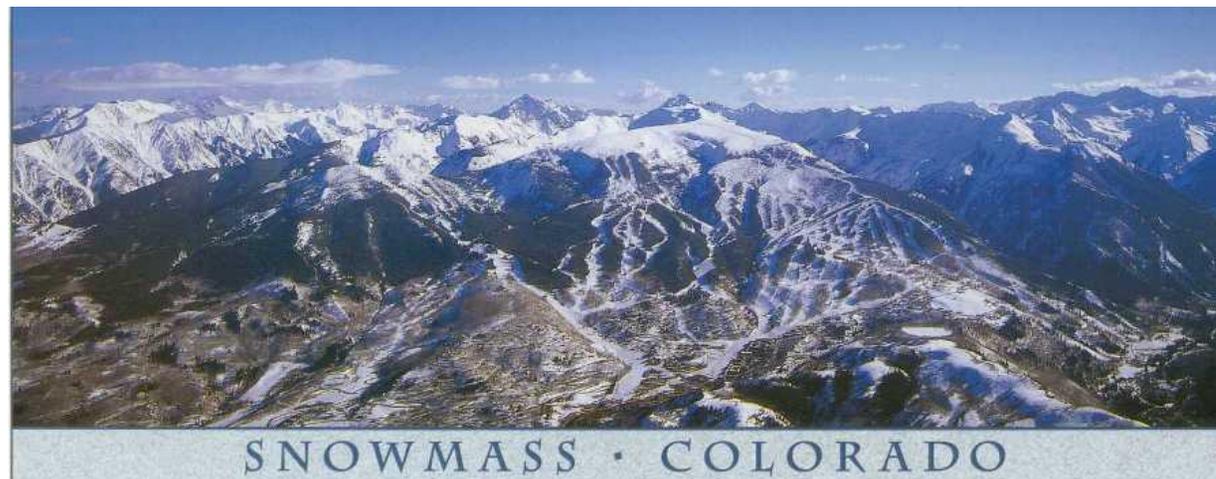
3D assessment space for each model



Conclusion

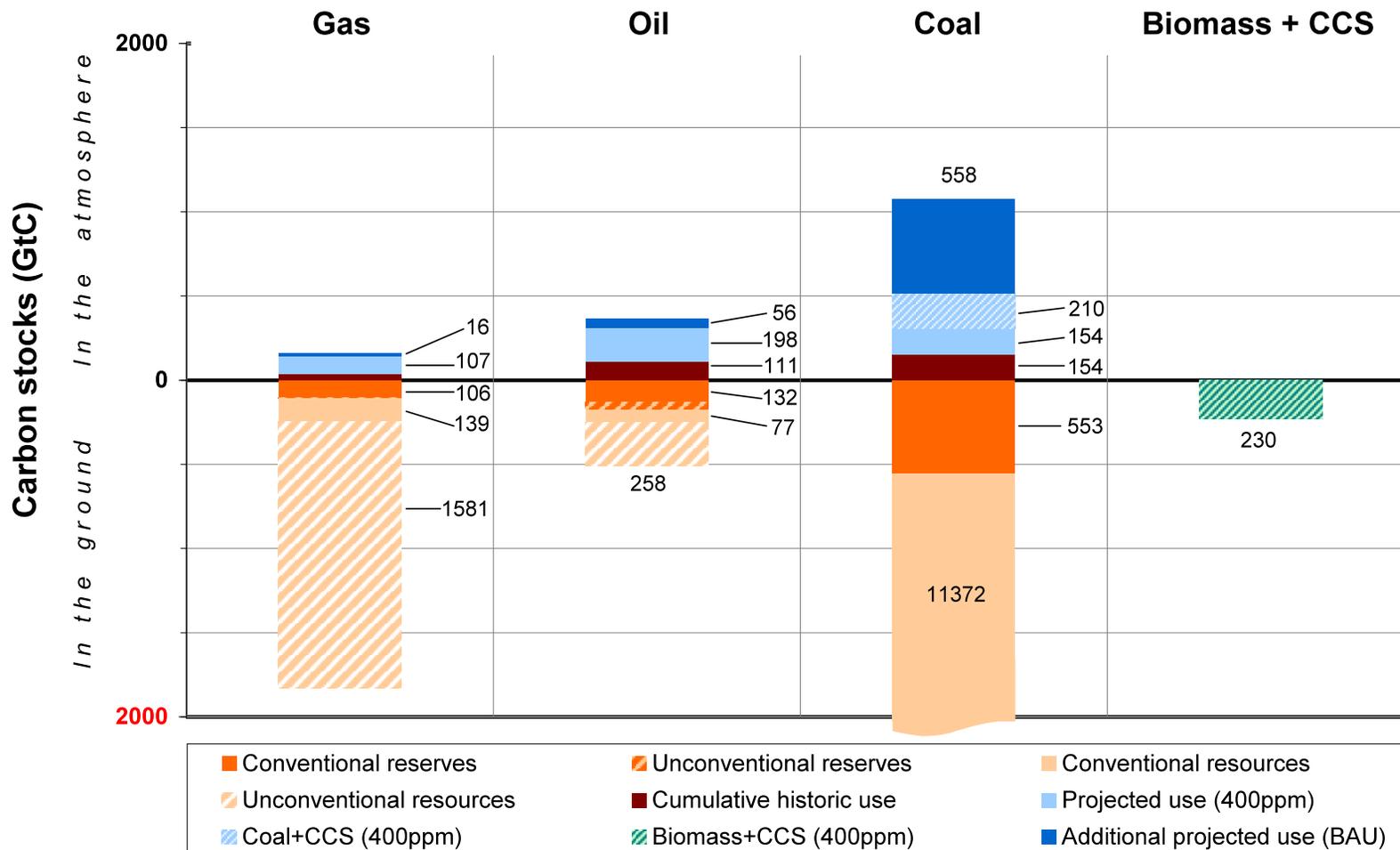


Potsdam is the first-best place in the World...



...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-CO₂-eq. scenario

Source: Kalkuhl, Edenhofer and Lessmann, 2009