



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Die Rolle der Atomkraft für den Klimaschutz: Ergebnisse der EMF27 Studie und ein Blick auf die INDCs

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B-SEC, DIW, 5. November 2015

EMF27 Studie (Climatic Change 123(3-4), 2014)

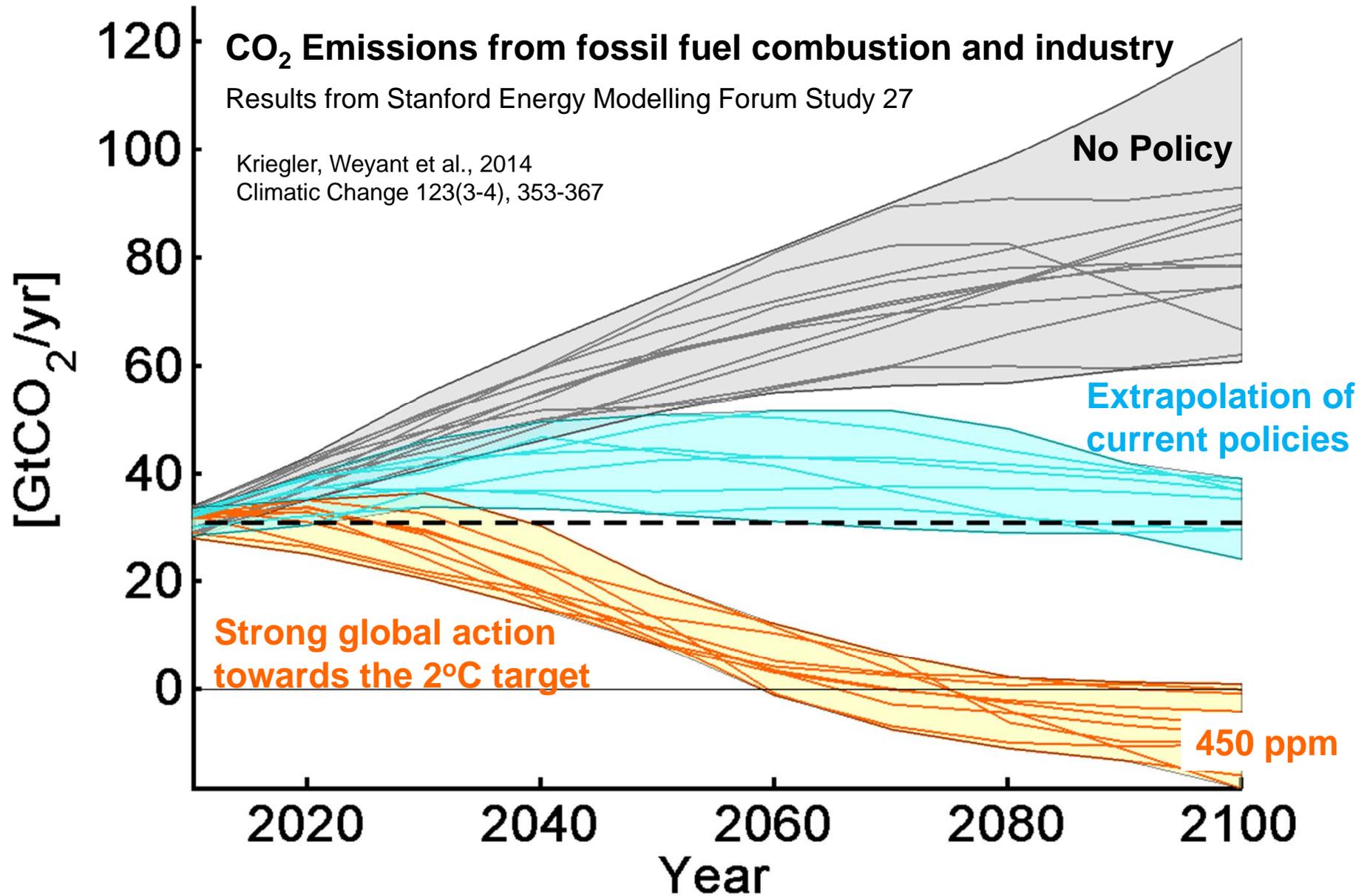
Forschungsfragen:

1. Was sind robuste Eigenschaften des Dekarbonisierungsprozesses zur Erreichung von Klimaschutzzielen?
2. Was ist die Rolle einzelner Low-Carbon Technologien für den Klimaschutz?

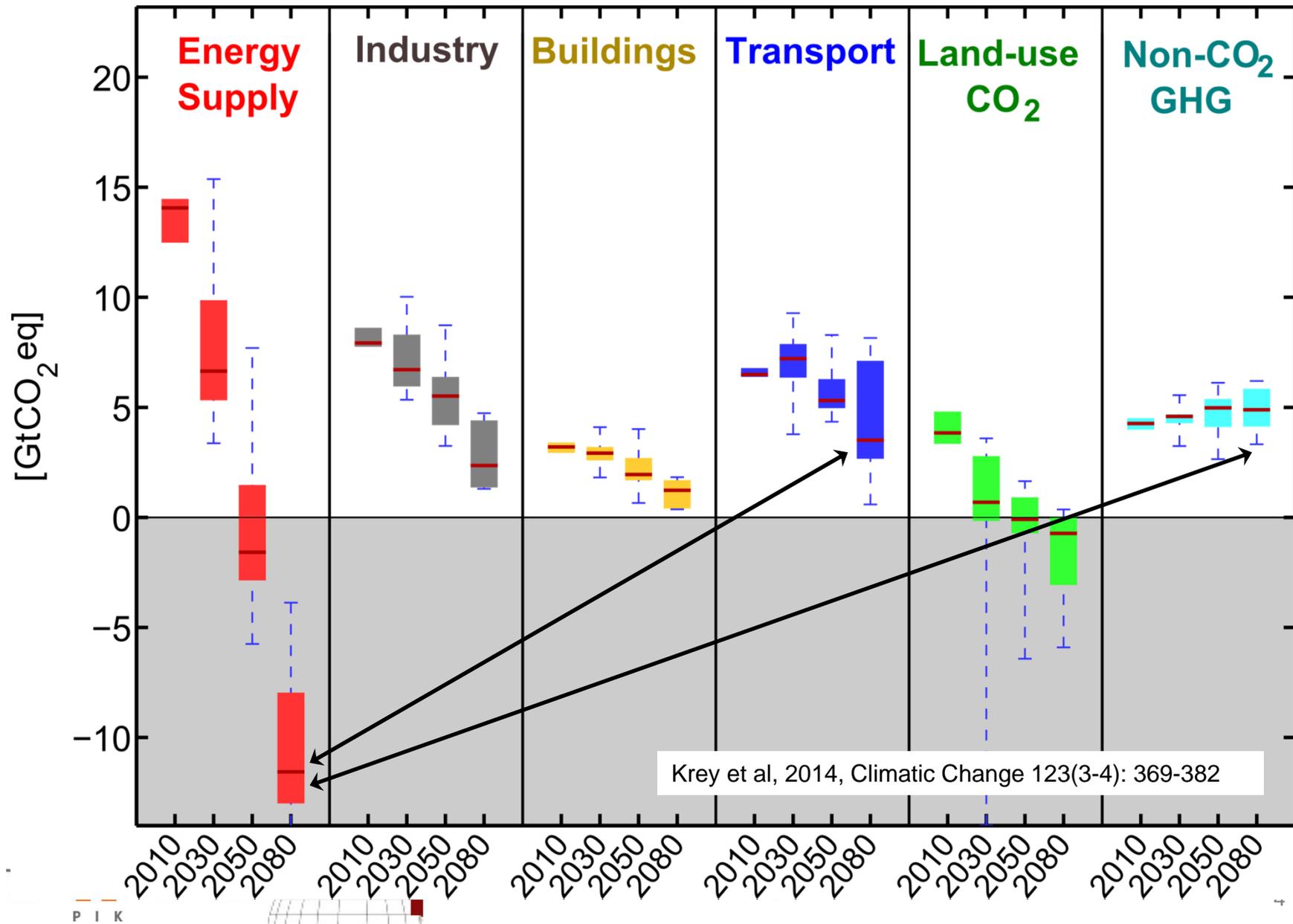
18 Modelle (17 x global, 1 x Indien)

- **Japan:** AIM-Enduse, BET, DNE21+, GRAPE
- **Indien:** GCAM-IIM
- **Europa:** ENV-Linkages, IMACLIM, IMAGE, MESSAGE, POLES , REMIND-MAGPIE, WITCH
- **USA / Kanada:** GCAM, EC-IAM, FARM, MERGE, Phoenix, TIAM-World

The scope of the mitigation challenge



Emissions reductions by sectors

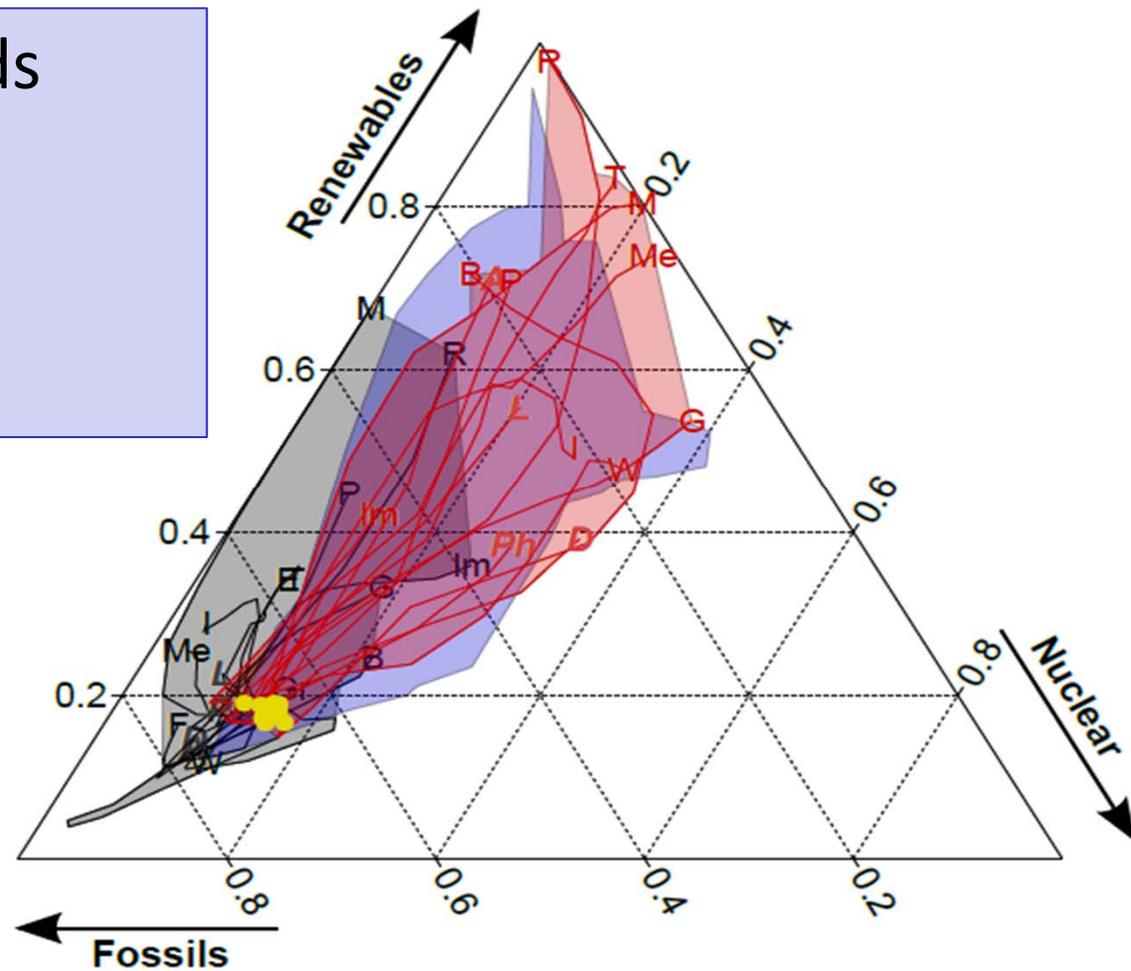


Decarbonization of electricity sector

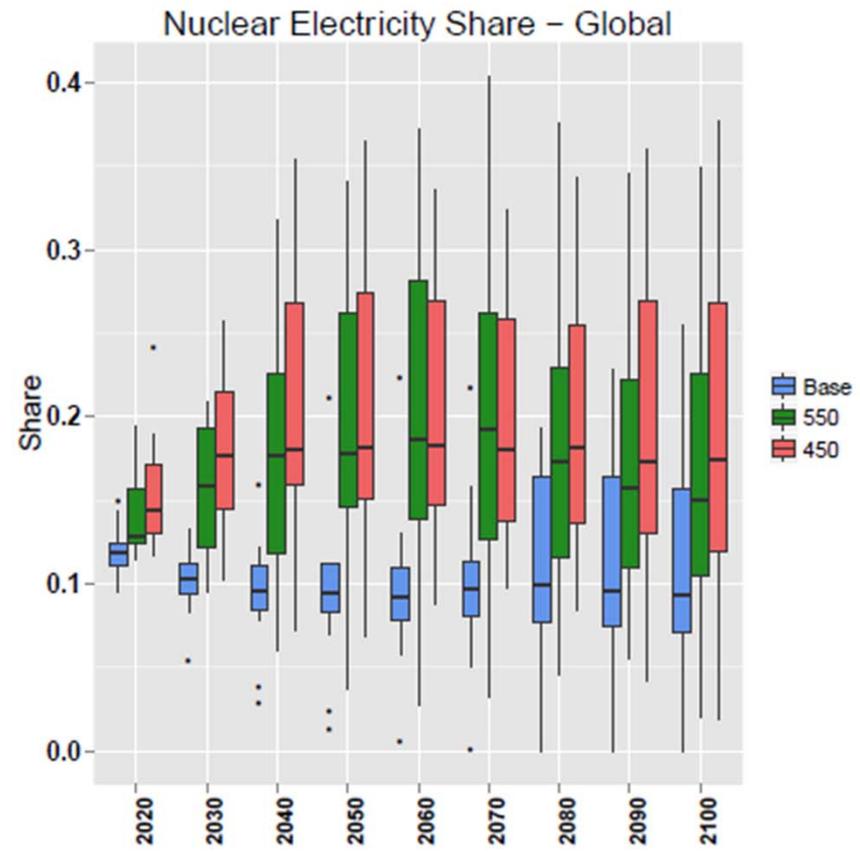
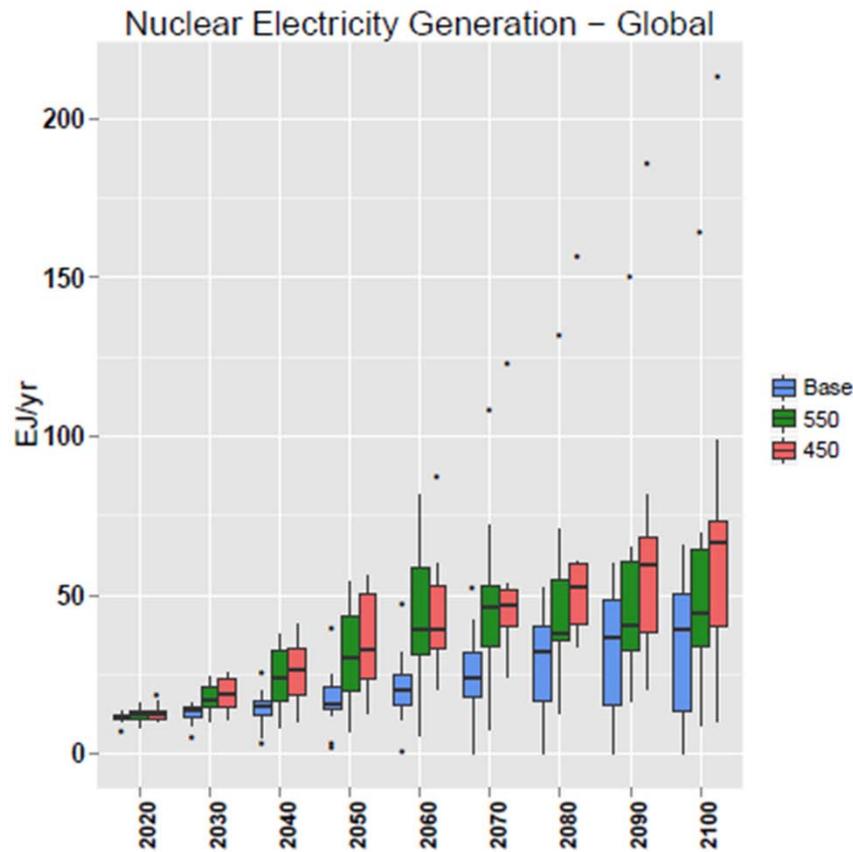
Largest shift towards renewables

Increase in nuclear power limited

Baseline
550ppm
450ppm
Base year



Significant variation in nuclear electricity shares reflects differences in technology choice behavior, technology assumptions and competitiveness of low carbon technologies. Greater clarification of nuclear fuel cycle issues and risk factors are necessary (Kim et al.)



Investigating the role of individual technologies

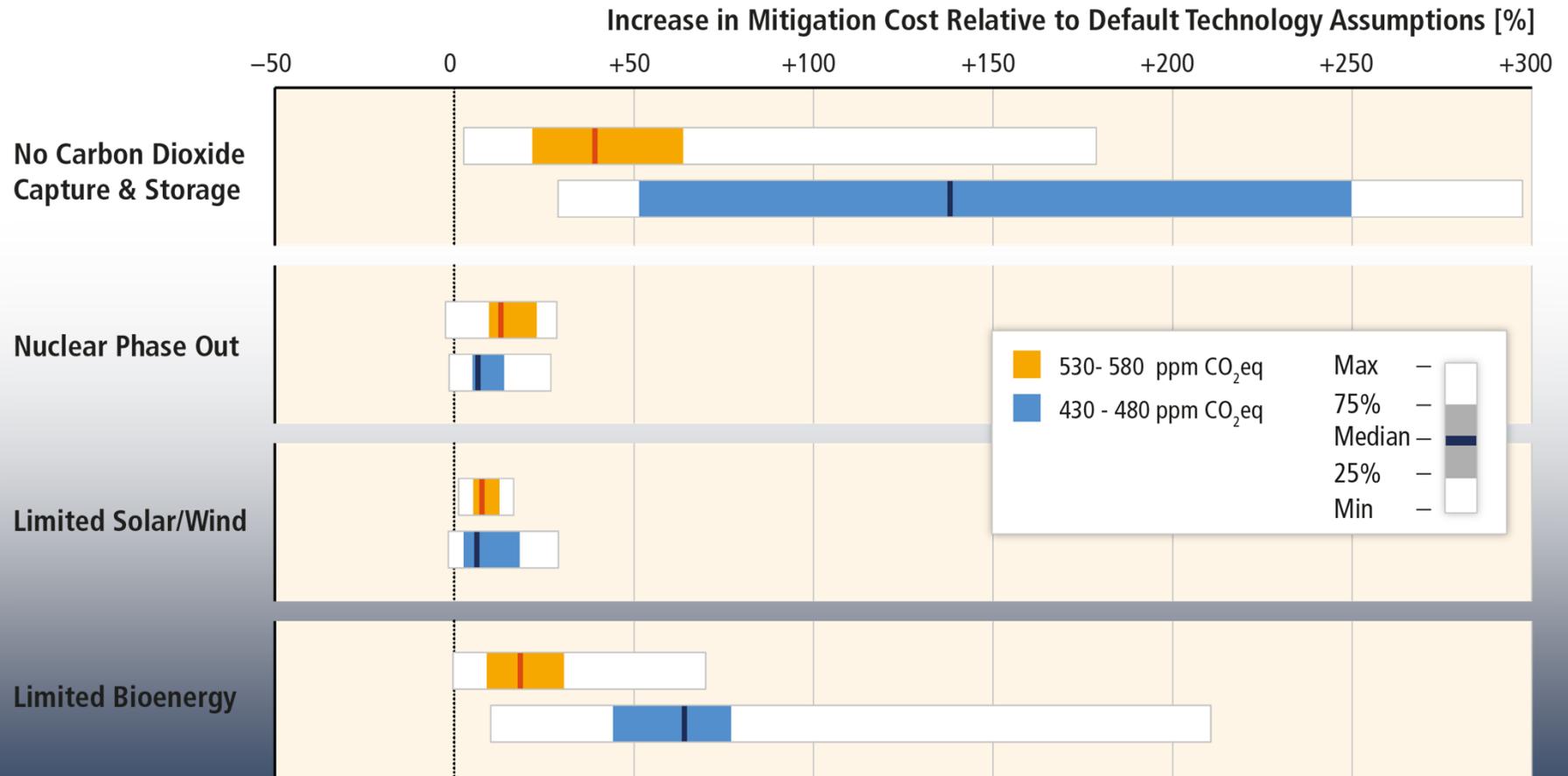
Compare mitigation strategies with different availability of low carbon technologies:

- **LowEI:** 35-45% lower global energy demand in 2100
- **NoCCS:** no deployment of CCS technologies globally
- **NucOff:** global nuclear phase out
- **LimSW:** share of solar & wind electricity < 20% globally
- **LimBio:** global modern bio-energy supply < 100 EJ/yr
- **LimTech:** NoCCS + NucOff + LimSW + LimBio

	FullTech	LowEI	NoCCS	NucOff	LimSW	LimBio	LimTech
Baseline	13/13	13/13		11/11	11/11	13/13	11/11
550 ppm	13/13	13/13	12/12	11/11	11/11	13/13	6/9
450 ppm	10/11	9/10	4/11	9/10	9/10	9/11	0/10

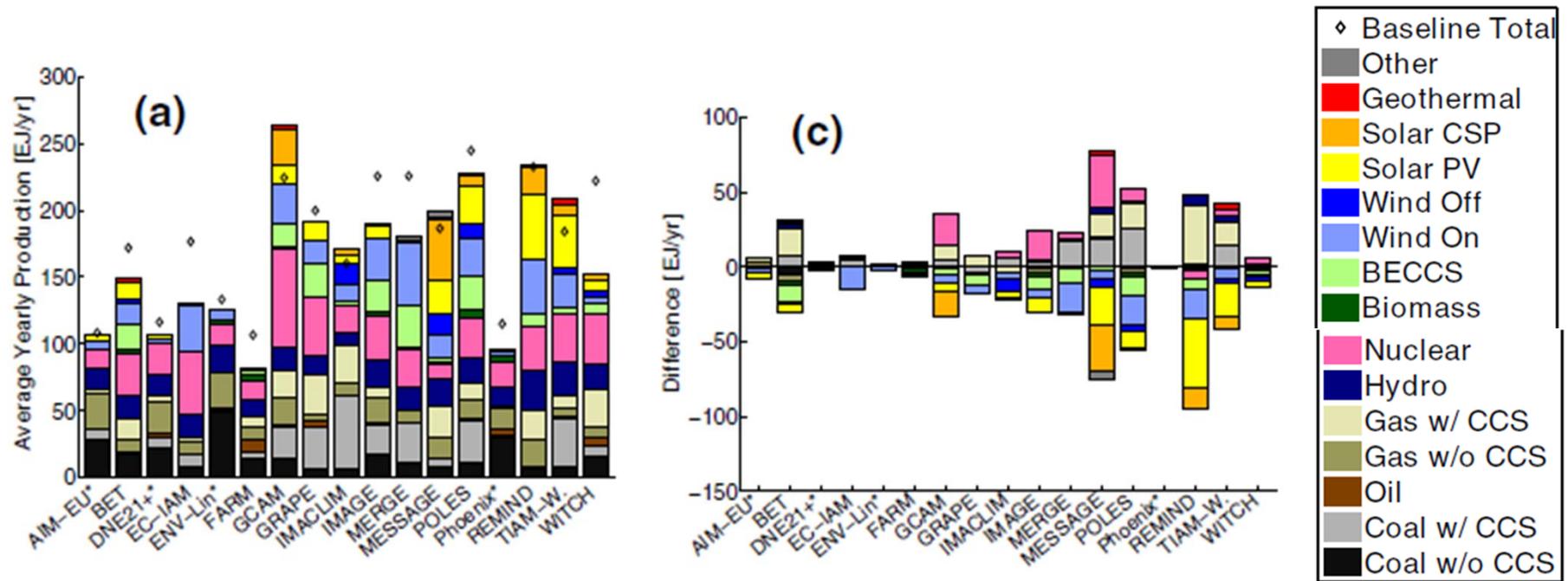
models producing scenario / # models that tried

Availability of technology greatly influence mitigation costs.



Technology options in the electricity system

Avg. 2010-2100 electricity production, 550 ppm policy



FullTech

Difference w/
pessimistic renewables

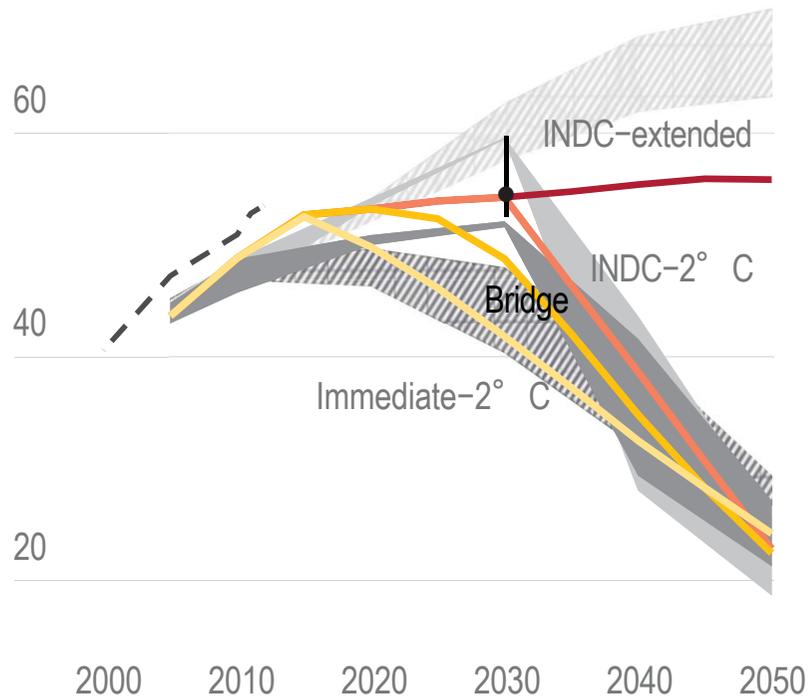
Luderer et al.



Key message: Paris Agreement needs to include strengthening mechanisms to build bridge from INDCs to staying below 2°C

Greenhouse gas emissions

80 GtCO₂eq/yr



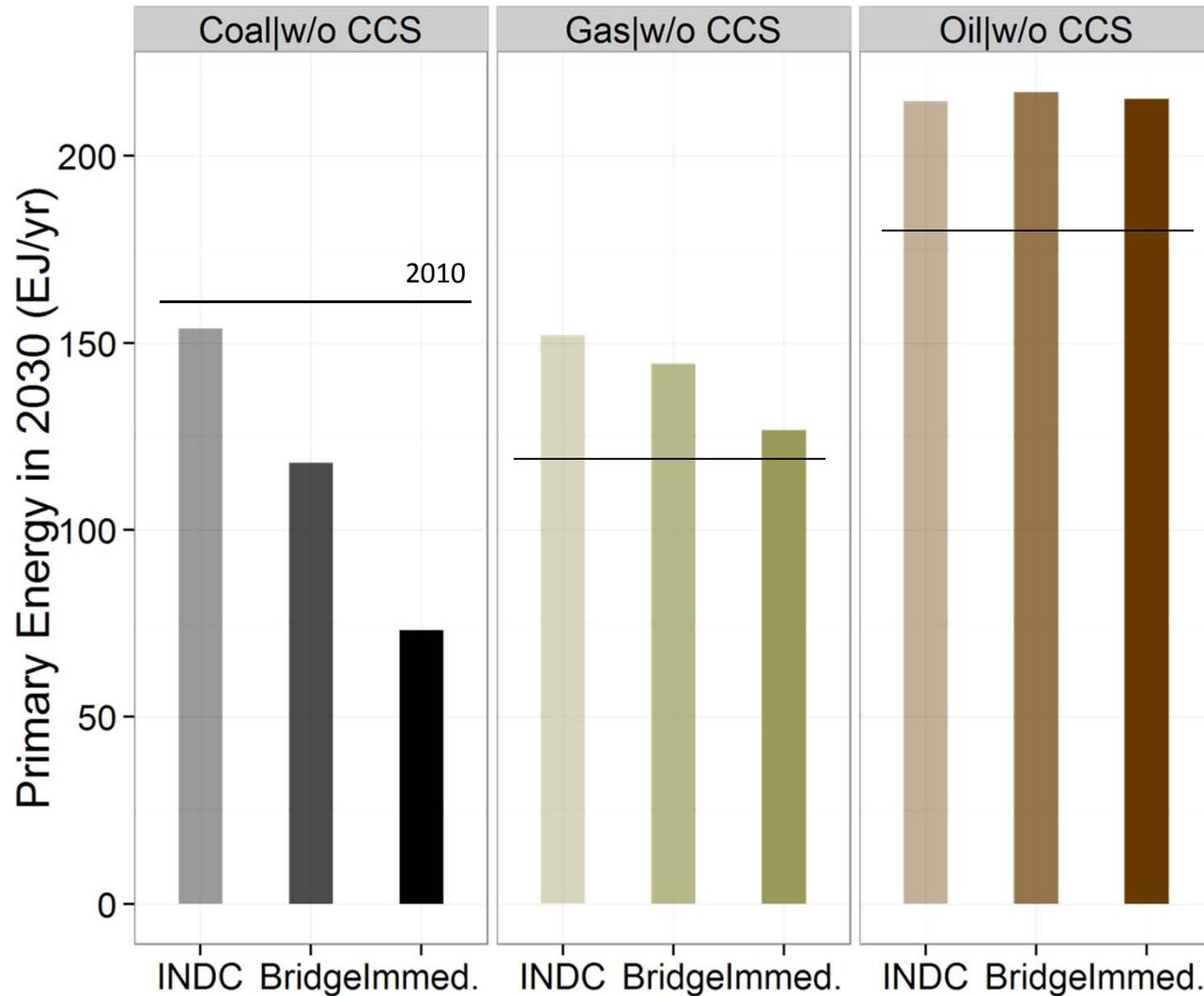
Source: REMIND model calculations, EDGAR (JRC/PBL, historical emissions), PBL INDC Tool calculations (www.pbl.nl/indc INDC range and best estimate, vertical black line and circle) and IPCC AR5 scenario database

- INDCs are significant deviation from current trends and policies
- But not sufficient to keep below 2° C goal in reach as freely emitting fossil fuel infrastructure is not reduced until 2030
- Mechanisms for rapid strengthening can send signal of commitment to long term goal to investors.
- Early restructuring of investments can shave additional 5 GtCO₂eq off trajectory in 2030 and reduce the risk of disruptive, rapid, costly change
- The Paris Agreement must establish this early and regular ratchet

Results from the MILES project. Report at:

<http://www.iddri.org/Publications/Beyond-the-numbers-Understanding-the-transformation-induced-by-INDCs>

Residual coal & gas use without CCS in 2030



Coal is primary fossil fuel to be reduced (by >50% in 2030)

INDC scenario is not sufficient to initiate reduction in coal use

Conventional oil industry would be maintained until 2050 and gradually reduced thereafter



Diskussion

EMF 27 global technology and GHG mitigation scenario matrix

Policy Dimension	Technology Dimension								
	Base FullTech	Base LowEI		Base NucOff	Base LimSW	Base LimBio	Base Conv	Base EERE	Base LimTech
Baseline	Base FullTech	Base LowEI		Base NucOff	Base LimSW	Base LimBio	Base Conv	Base EERE	Base LimTech
450 CO ₂ e	450 FullTech	450 LowEI	450 NoCCS	450 NucOff	450 LimSW	450 LimBio	450 Conv	450 EERE	450 LimTech
550 CO ₂ e	550 FullTech	550 LowEI	550 NoCCS	550 NucOff	550 LimSW	550 LimBio	550 Conv	550 EERE	550 LimTech
Modified G8 scenario	G8 FullTech							G8 EERE	
Fragmented Policy	FP FullTech							FP EERE	

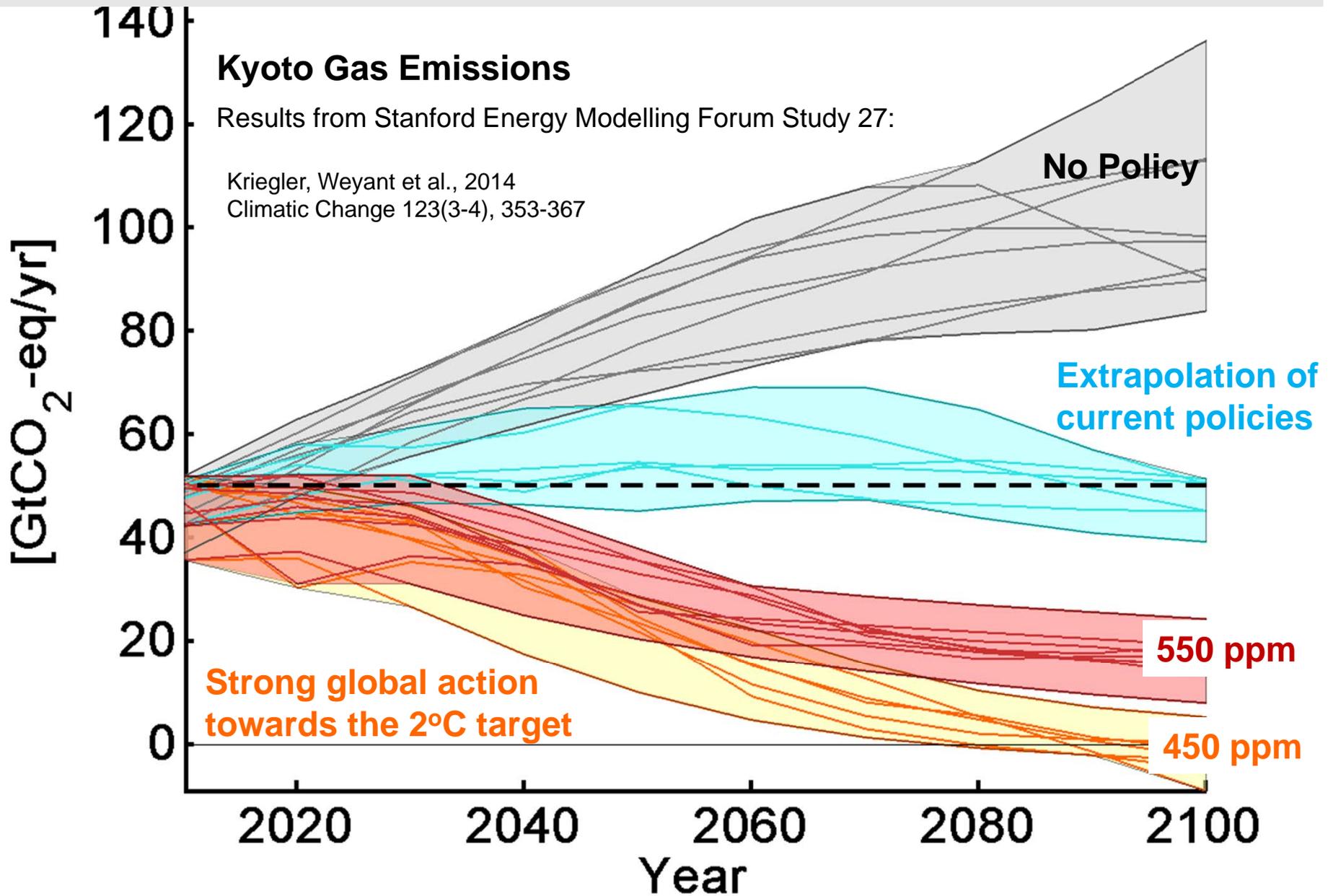
550 CO ₂ e	550 CO ₂ e concentration in 2100 (3.7 W/m ²), pathway not to exceed target
450 CO ₂ e	450 CO ₂ e concentration in 2100 (2.8 W/m ²), pathway can overshoot target
Modified G8	G8 targets for participants, fossil fuel exporters not participating (inc. Russia)
Fragmented Policy	Annex 1 (except Russia) 50% reductions by 2050 wrt 2005, non-Annex 1 Copenhagen pledges then slow reduction increases, fossil fuel exporters not participating (inc. Russia)



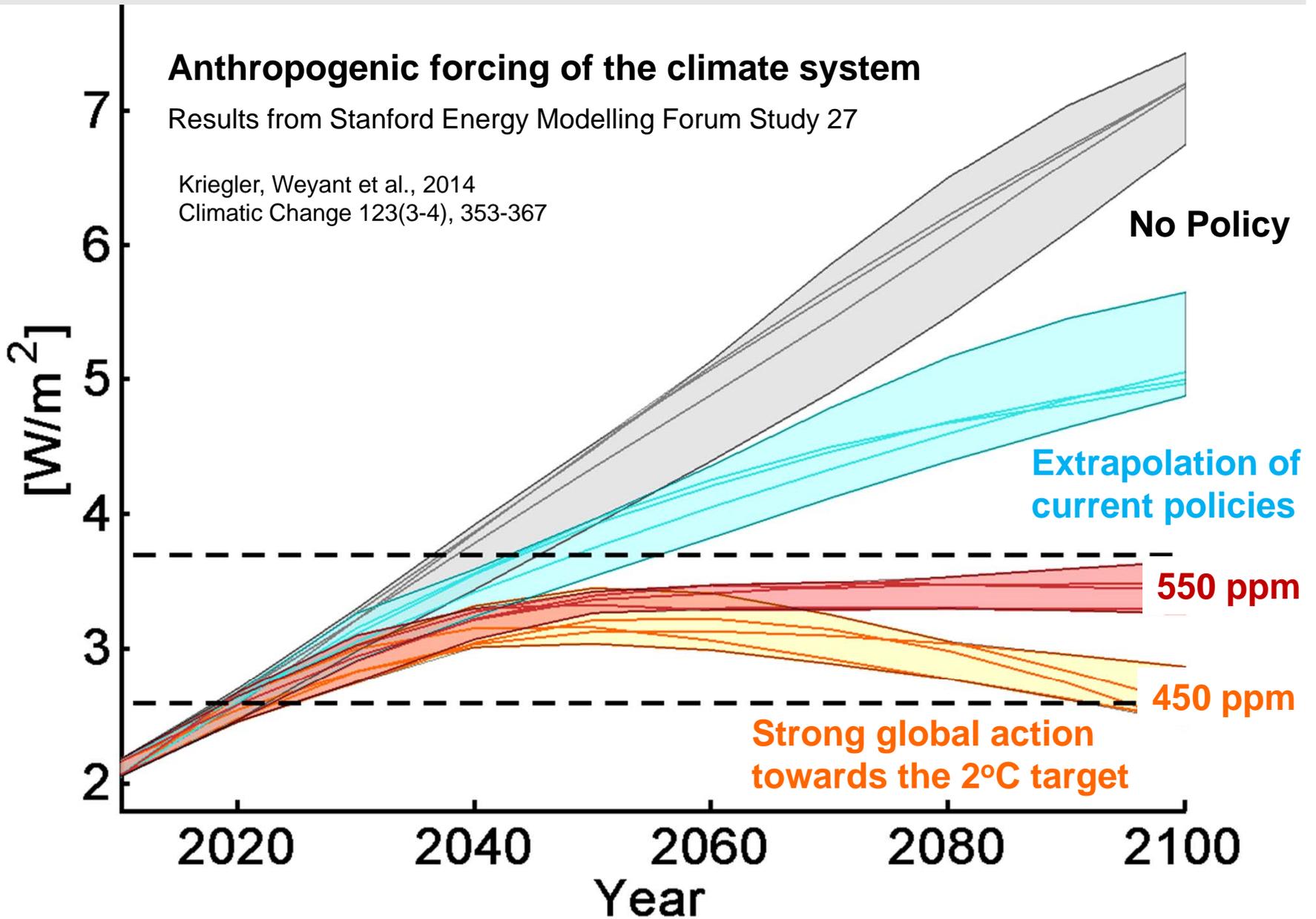
Technology scenarios

Definition of technology variations	
FullTech	include all technologies represented in models, reference energy intensity improvements
LowEI	low energy intensity: 20-30% lower final energy demand in 2050 and 35-45% in 2100 compared to the reference case
NoCCS	carbon capture and storage excluded from technology portfolio in all sectors
NucOff	phase out of nuclear energy with no new nuclear power plants built beyond those under construction; existing plants operated until end of their technical lifetime
LimSW	share of electricity production from intermittent solar and wind technologies (wind, solar PV and CSP) limited to 20%
LimBio	global primary bio-energy supply – including purpose grown crops, residues and municipal solid waste, but excluding traditional biomass – limited to 100 EJ/yr
Conv	Combined LimSW & LimBio
EERE	Combined LowEI & NoCCS & NucOff
LimTech	Combined NoCCS & NucOff & LimSW & LimBio

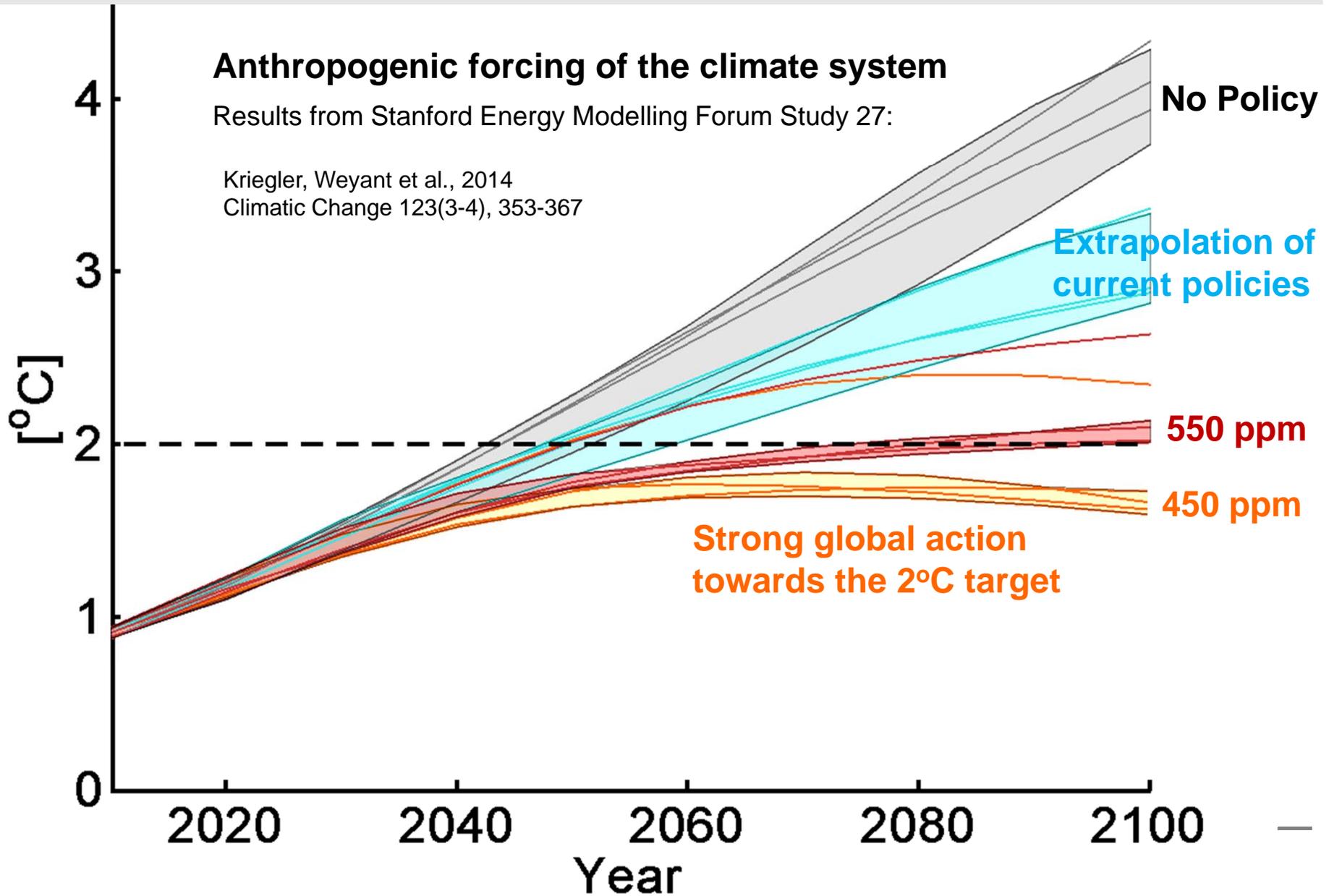
The scope of the mitigation challenge



The scope of the mitigation challenge



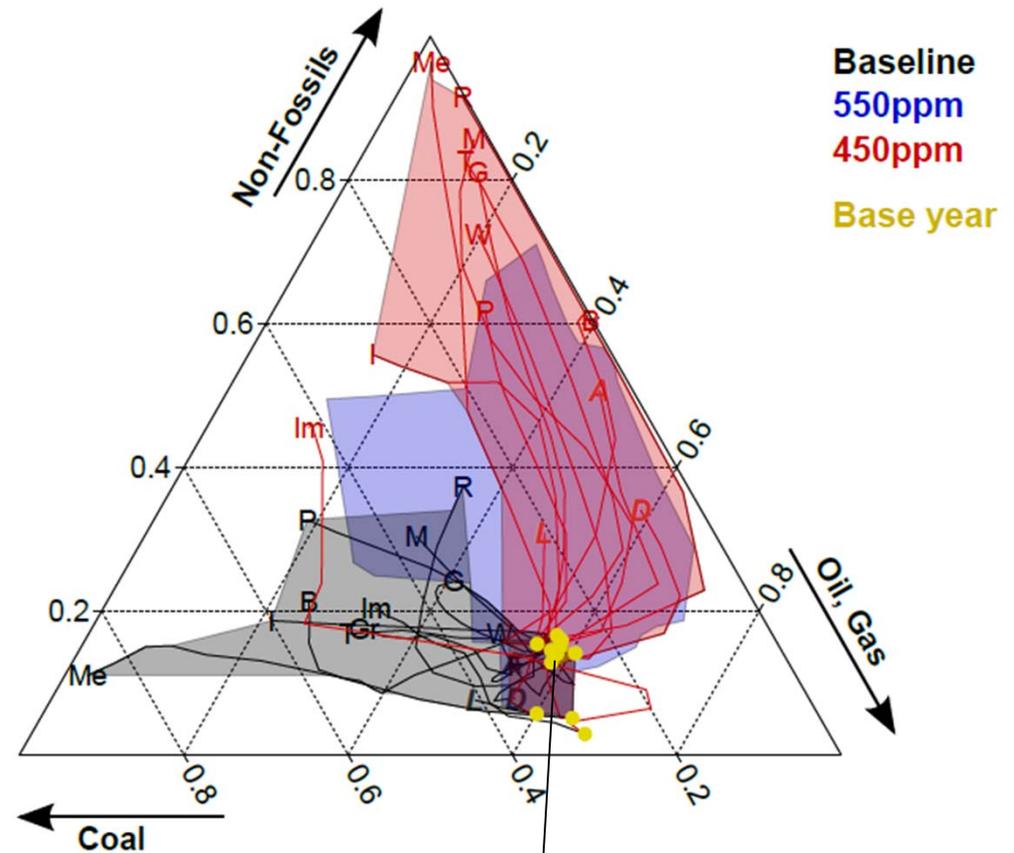
The scope of the mitigation challenge



Global energy system transformation

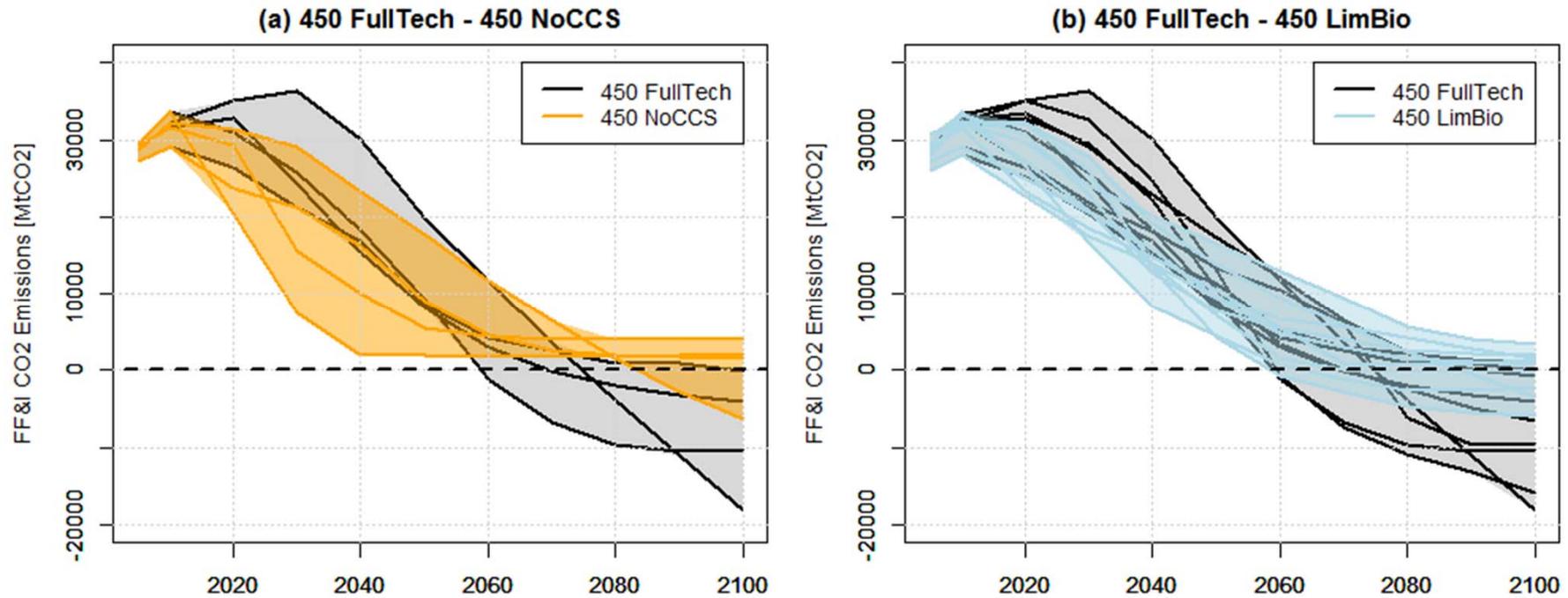
Shifting away from a fossil fuel dominated system – but large variation in speed and endpoint

Kriegler, Weyant et al., 2014,
Krey et al., 2014,
Climatic Change 123 (3-4)



Today: ~ 30% coal, 55% oil&gas, 15% non-fossil

Technology affects emissions profile

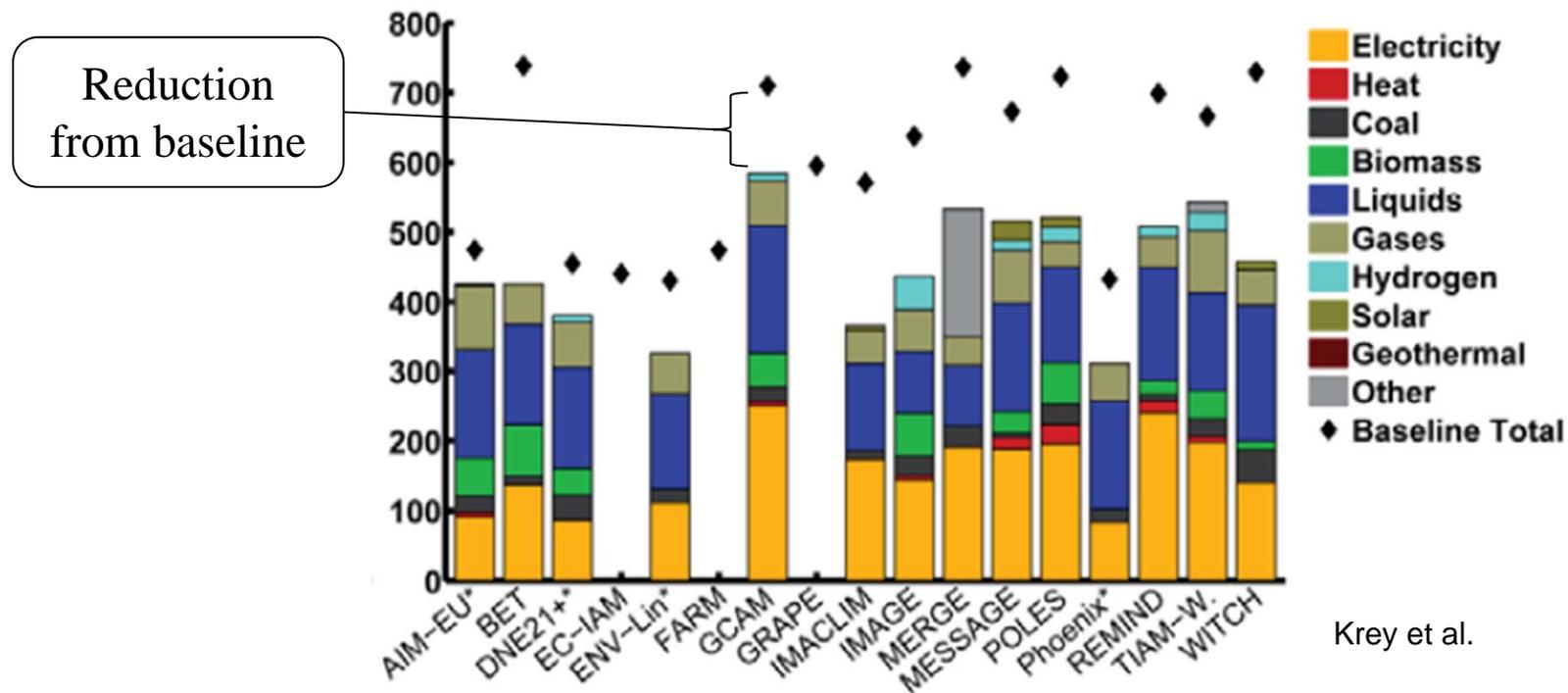


Krey et al.

Biomass with CCS providing “when” reduction flexibility as an overshoot strategy

Global energy system transformation

450 FullTech Final Energy



Smaller energy systems – primarily non-electric sectors

Structure of EMF-27 Special Issue *Climatic Change 123(3-4)*

Overview of Overviews (Kriegler, Weyant et al.)			
Policy Overview (Blanford et al.)		Technology Overview (Krey et al.)	
Subgroups	<u>Resources</u> (McCollum et al.)	<u>Renewables</u> (Luderer et al.)	<u>Bioenergy</u> (Rose et al.)
			<u>Land Use</u> (Popp et al.)
			<u>Nuclear Energy</u> (Kim et al.)
			<u>Energy Efficiency</u> (Sugiyama et al.)
			<u>Carbon Capture & Storage</u> (Koelbl et al.)
Non-Kyoto Forcing (Rose et al.)			
Individual Modeling Team Papers (17)			