POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

AMPERE

Assessment of Climate Change Mitigation Pathways and Evaluation of the Robustness of Mitigation Cost Estimates

Model Diagnostics

(& Validation ➔ See talk by Jana Schwanitz tomorrow)

Elmar Kriegler

IAMC Meeting

Utrecht, November 2012

Leibniz Gemeinschaft

SEVENTH FRAMEWORK PROGRAMME

Model diagnostics – motivation

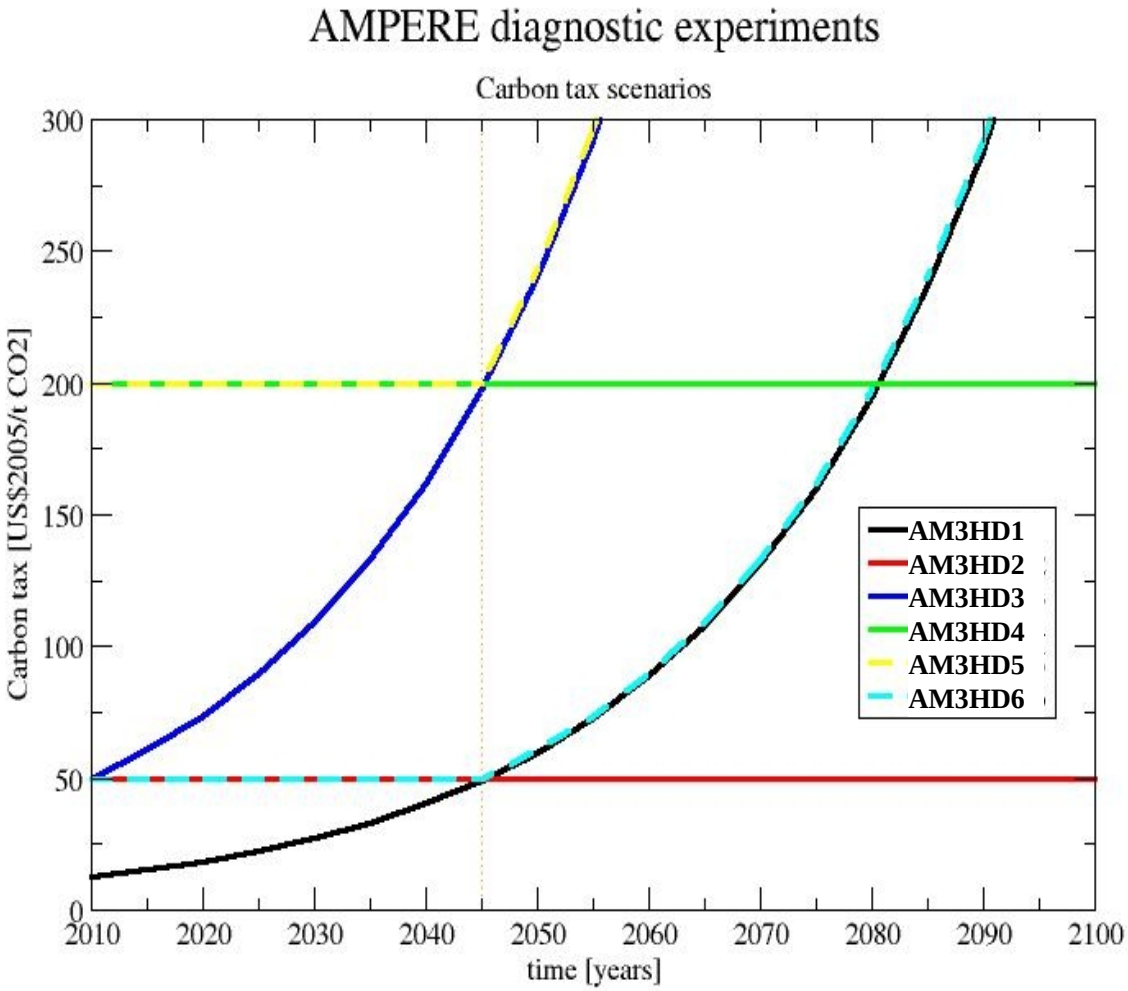
- Contrast the behavior of models relative to each other
- Renewed interest in diagnostics of integrated assessment models (IAMs) – example: PIAMDDI

Goals:

- Identify indicators of model behaviour that help to explain the spread of model results in key quantities (e.g. mitigation costs, decarbonization rates)
- Develop rough model classification scheme that can assist the comparative analysis of model results
- Develop standardized diagnostic experiments that can be used to deduce such model indicators

Model diagnostics experiment

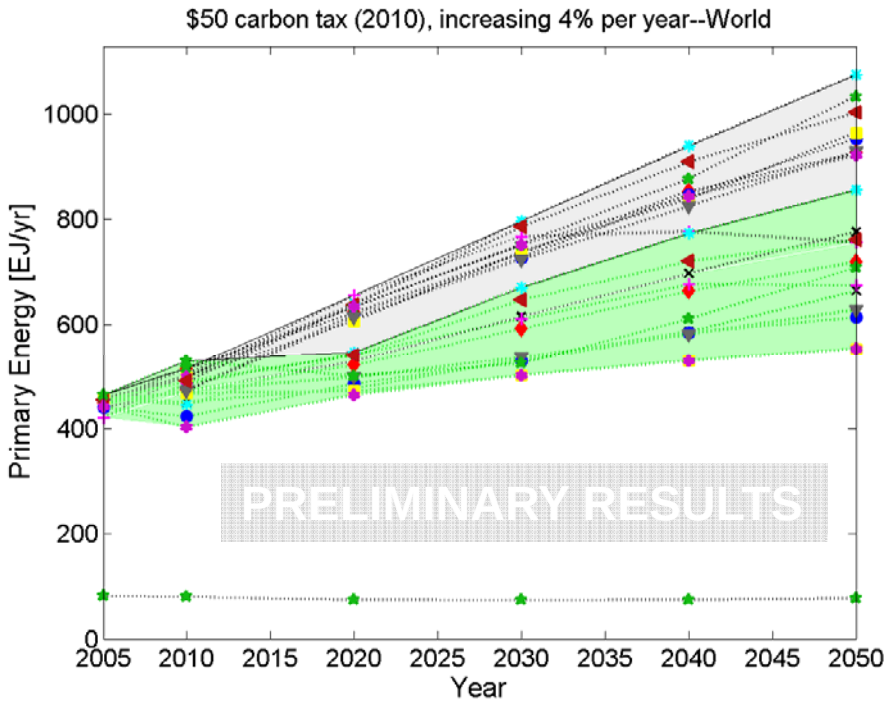
- Globally harmonized carbon tax scenarios
- Harmonized population and GDP
- For diagnostic purposes only, not intended to be policy-relevant

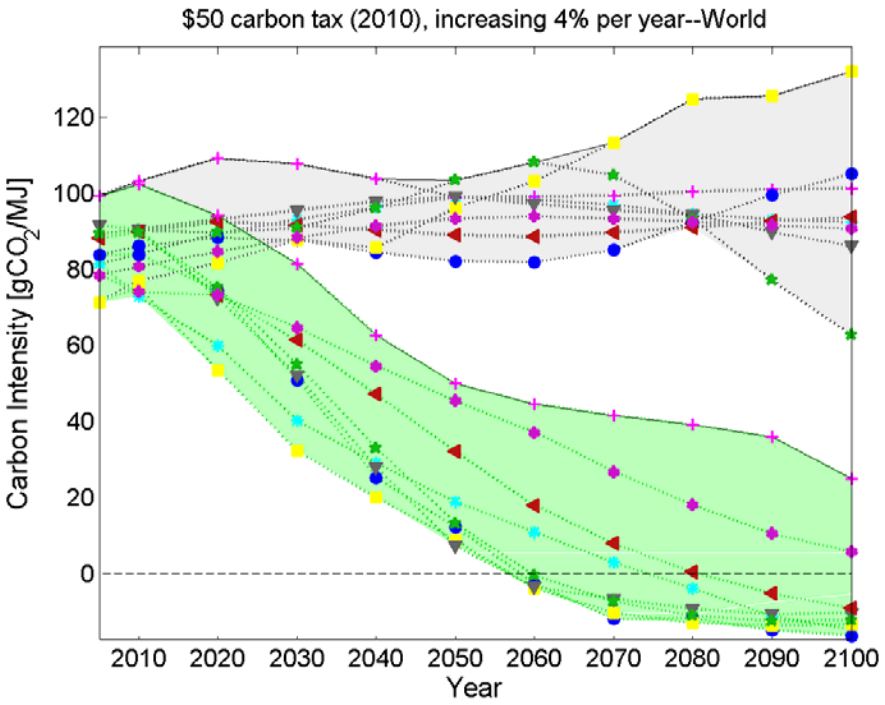


Participating models

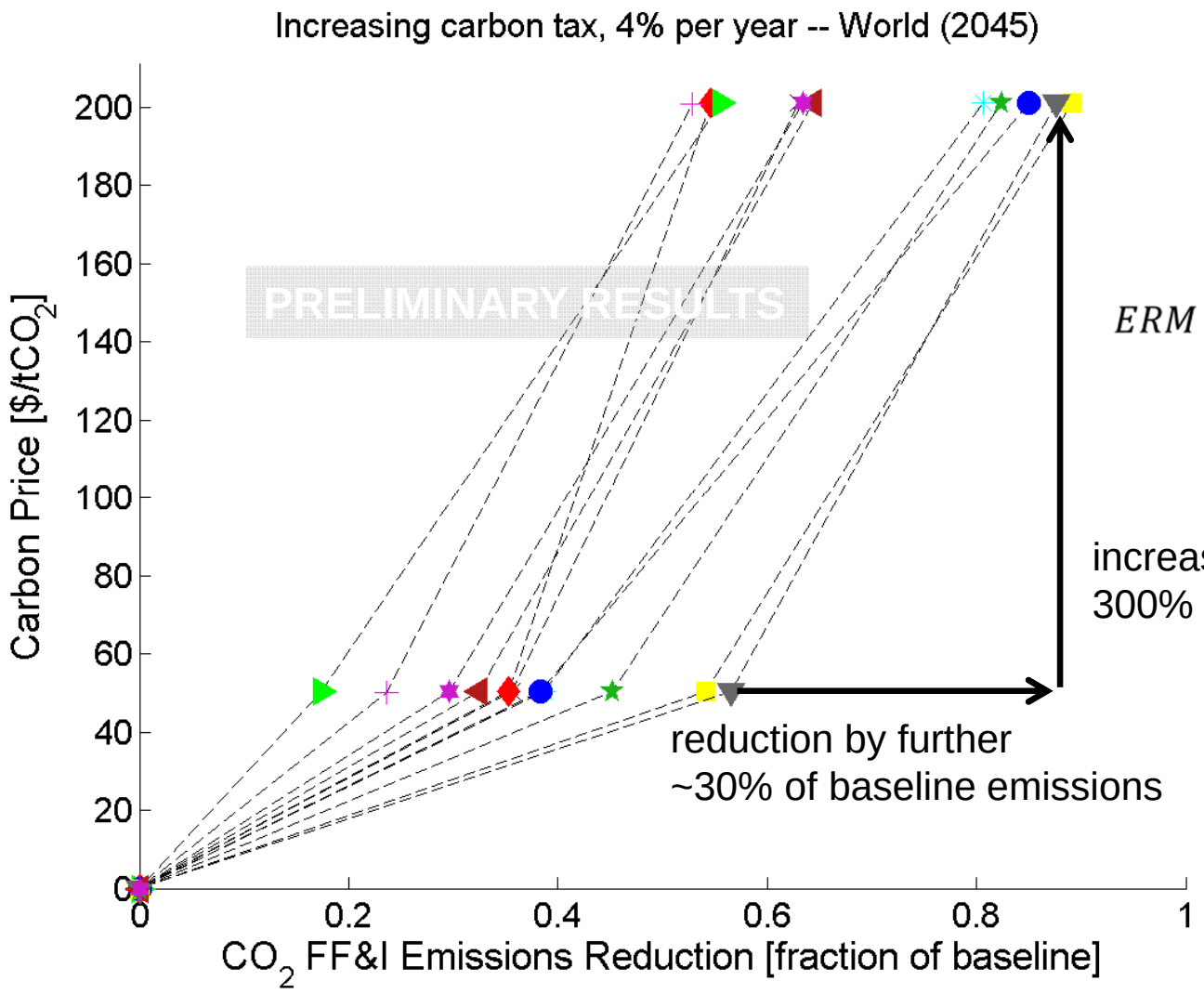
Model name	Model category	Scale
AIM-Enduse	Integrated assessment model	Global
DNE21+	Energy system model	Global
GCAM	Partial Equilibrium	Global
GEM-E3	Recursive computational general equilibrium	Global, EU27
IMACLIM	Recursive computational general equilibrium	Global
IMAGE/TIMER	Partial Equilibrium	Global
MERGE-ETL	Intertemporal general equilibrium	Global
MESSAGE-MACRO	Intertemporal general equilibrium	Global
POLES	Partial Equilibrium	Global
REMIND	Intertemporal general equilibrium	Global
WITCH	Intertemporal general equilibrium	Global
WorldScan	Recursive computational general equilibrium	Global, EU27 detail
PRIMES	Partial Equilibrium	EU27

Primary energy and carbon intensity response



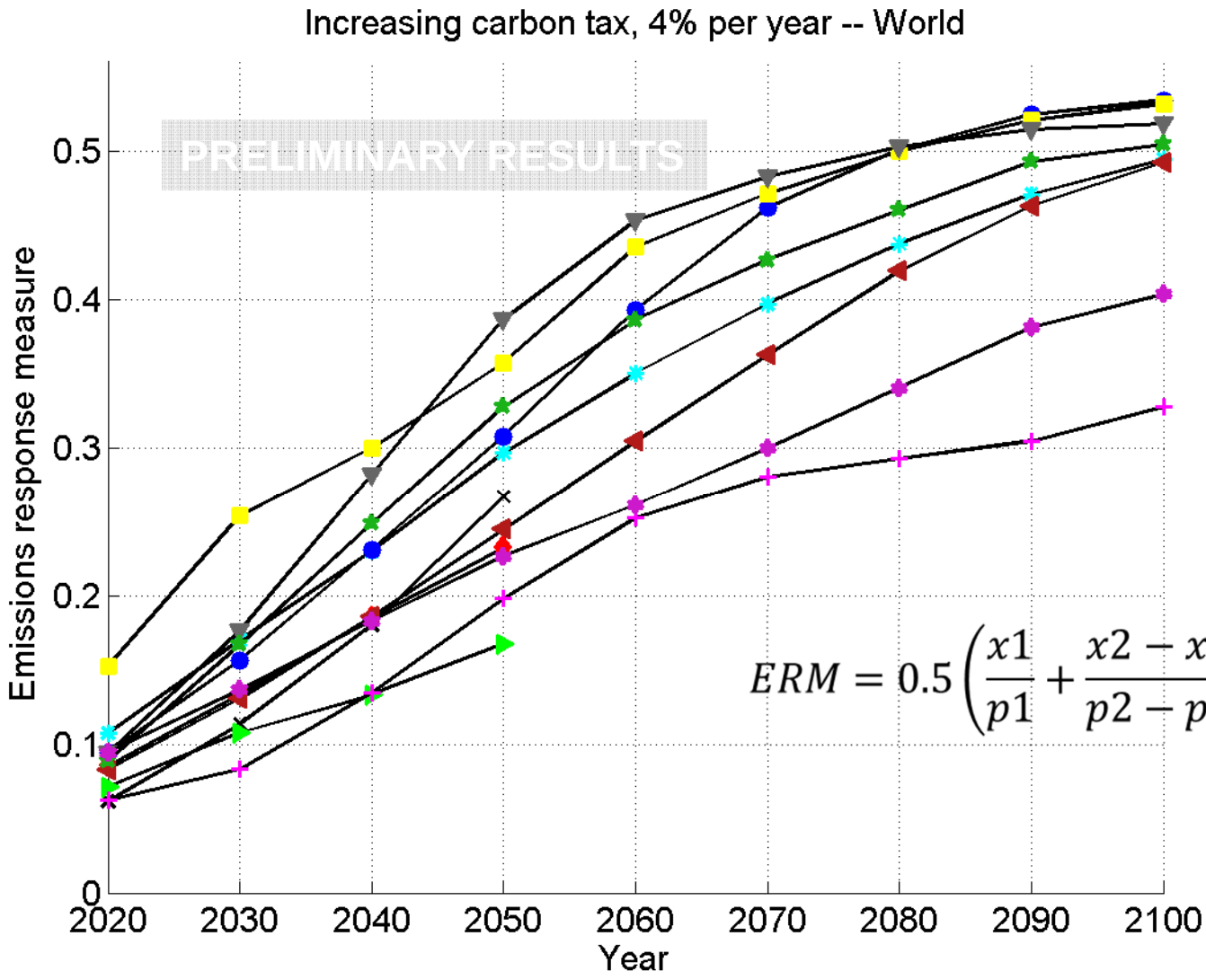


Marginal abatement cost (2045)

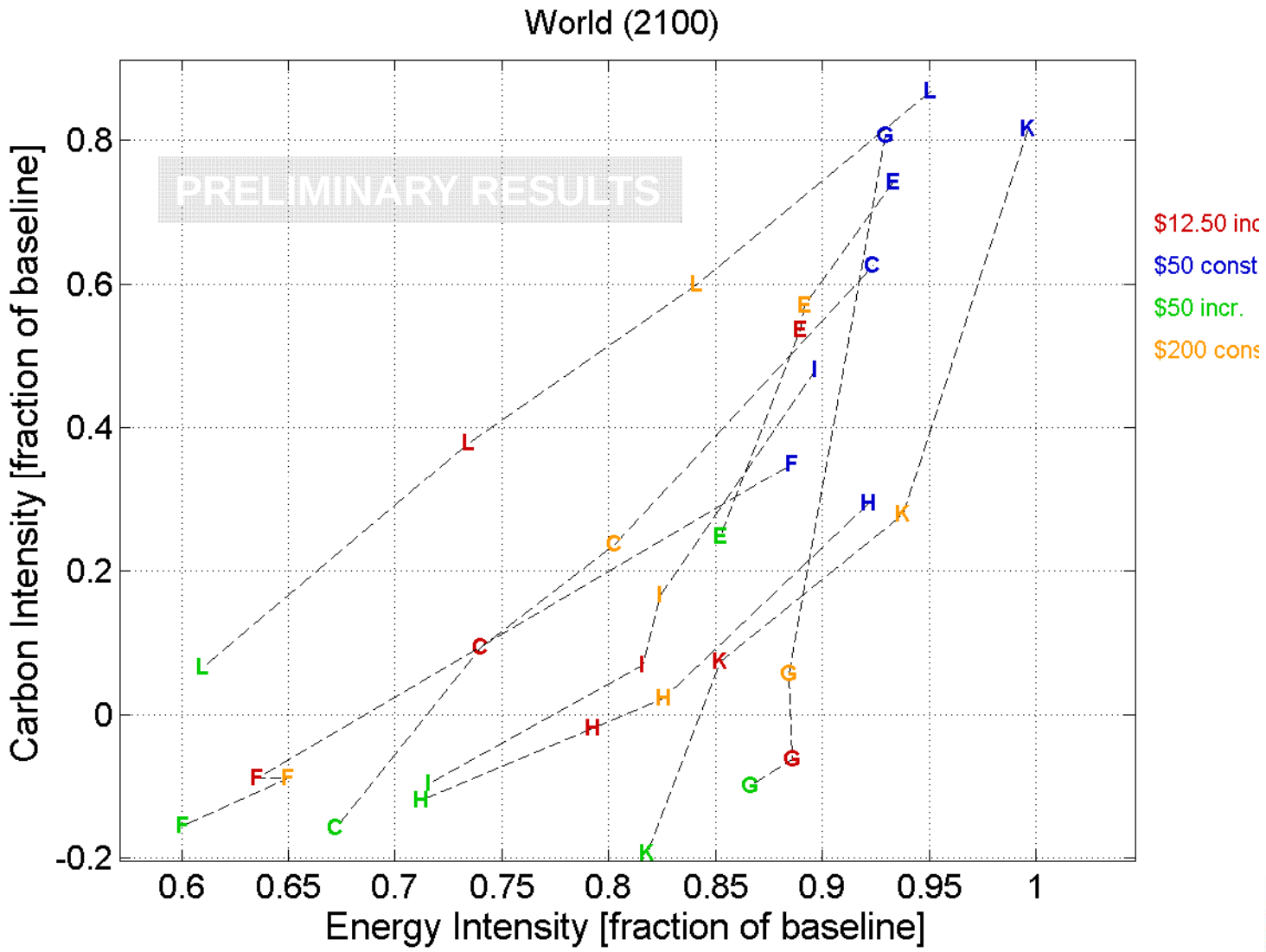


$$ERM = 0.5\left(\frac{x1}{p1} + \frac{x2 - x1}{p2 - p1}\right) * p1$$

Emissions response measure

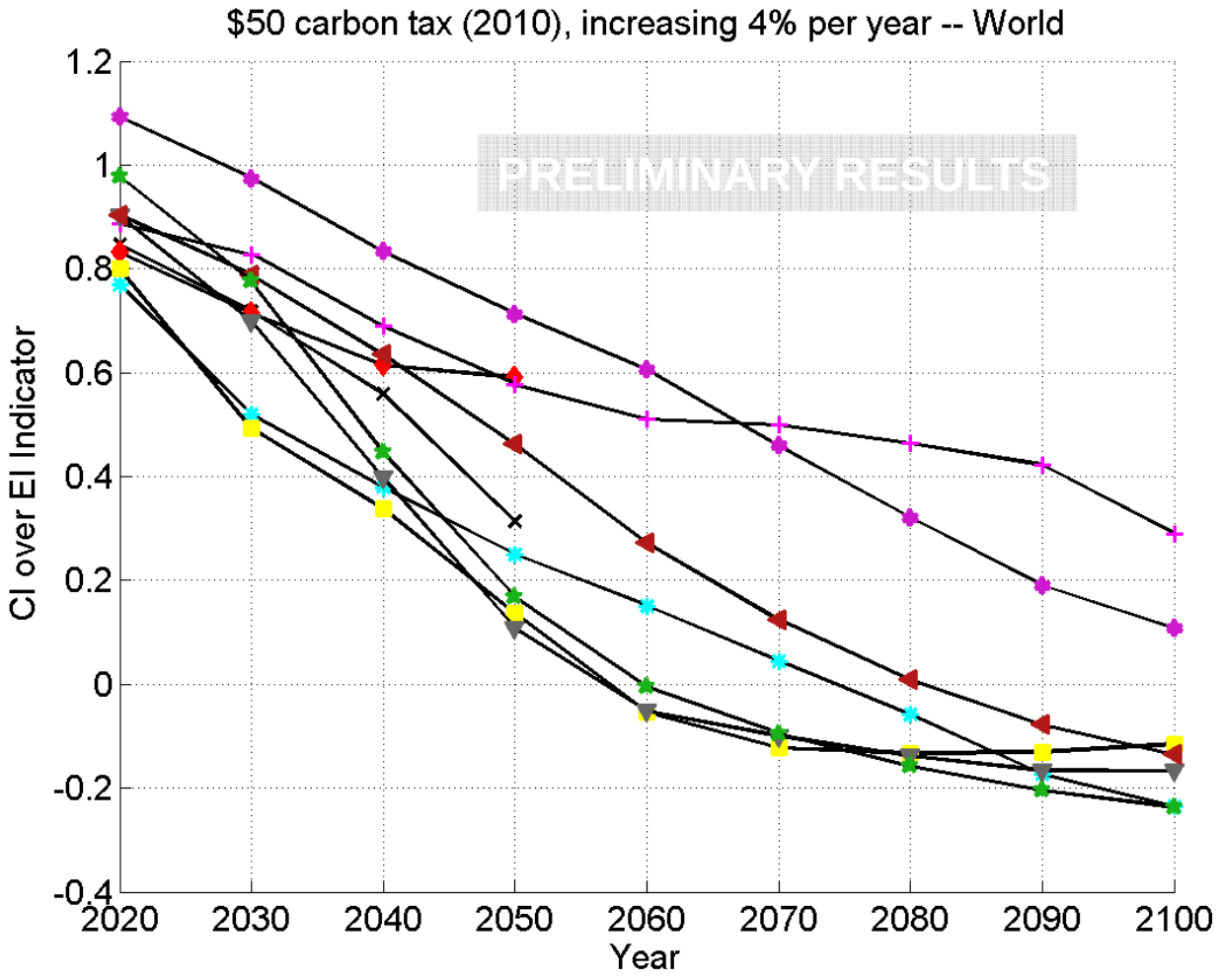


Reducing carbon vs. energy intensity

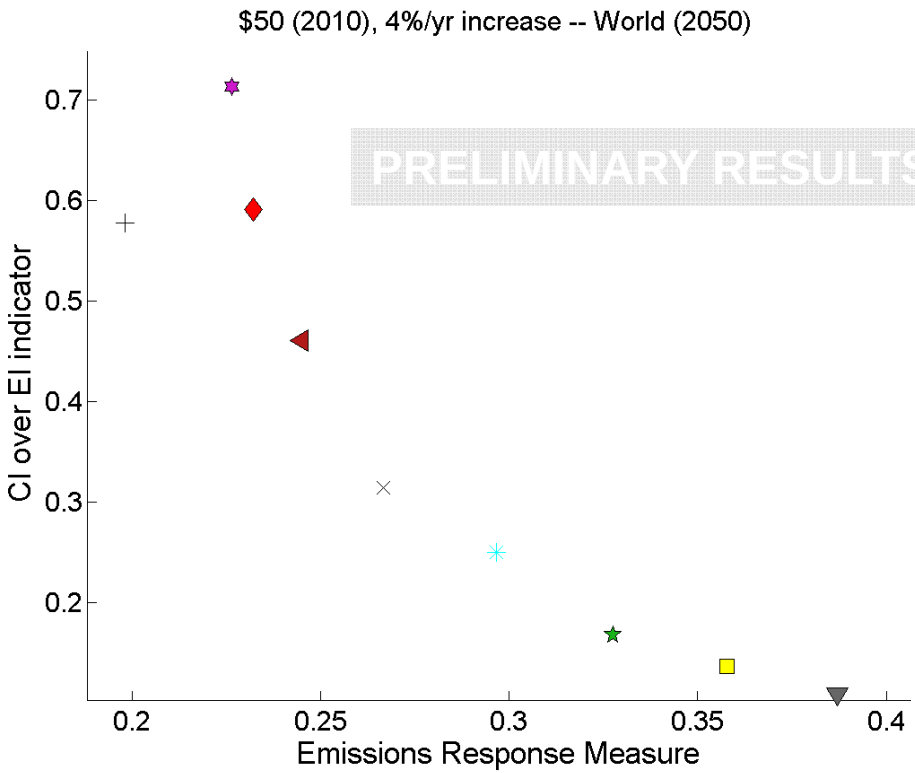


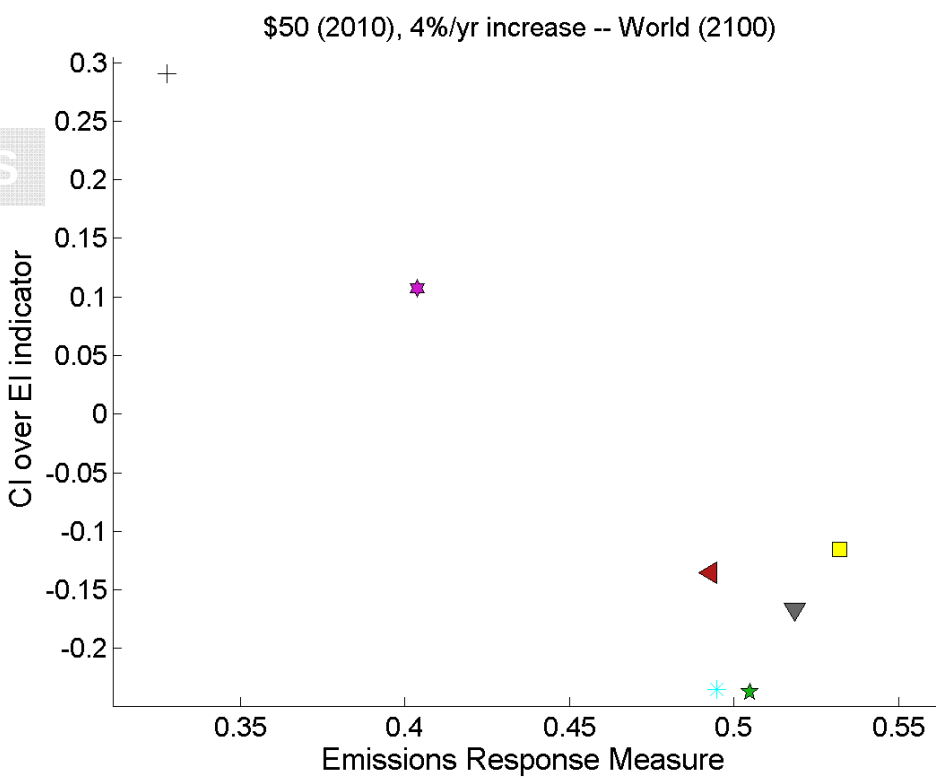
Carbon intensity over energy intensity

$$CoEI = \frac{Res(CI)}{Res(EI)}$$

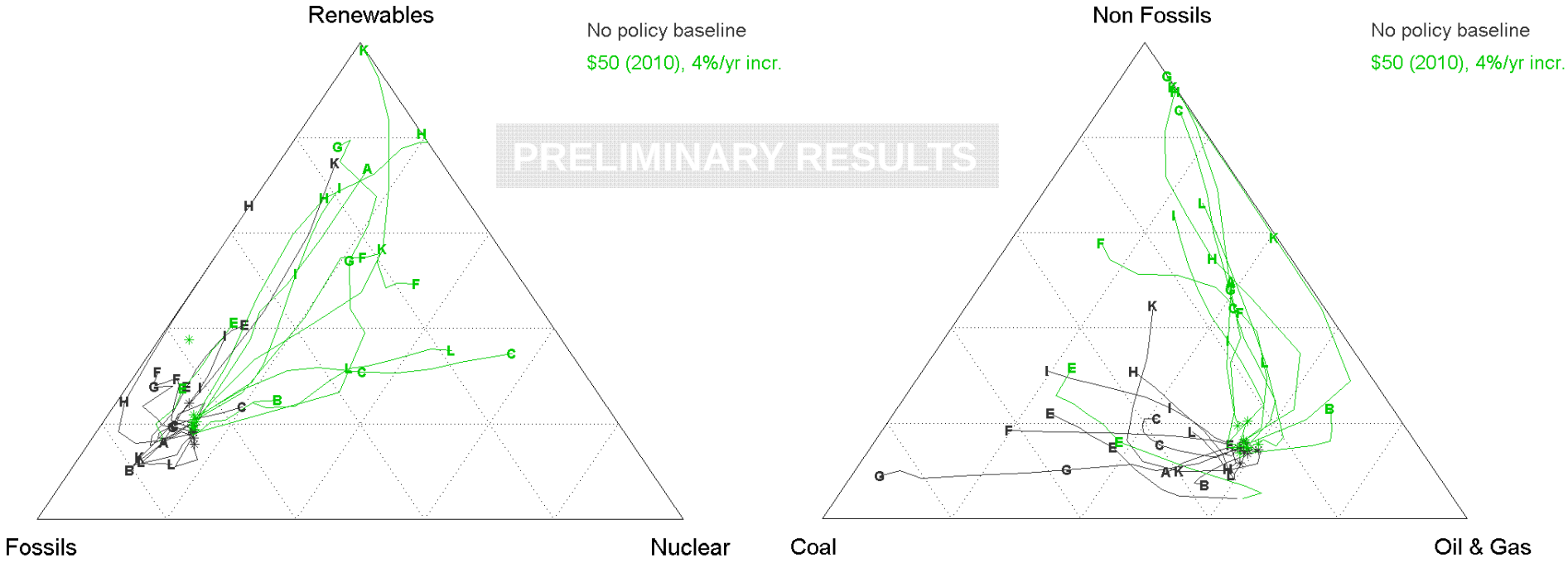


Correlation emissions response measure & CoEI





Transformation of energy mix

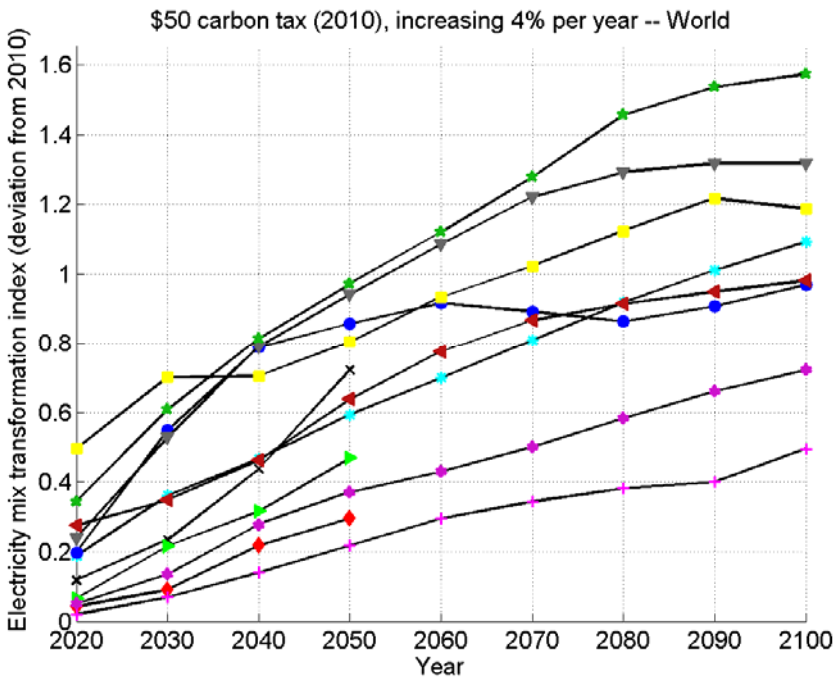


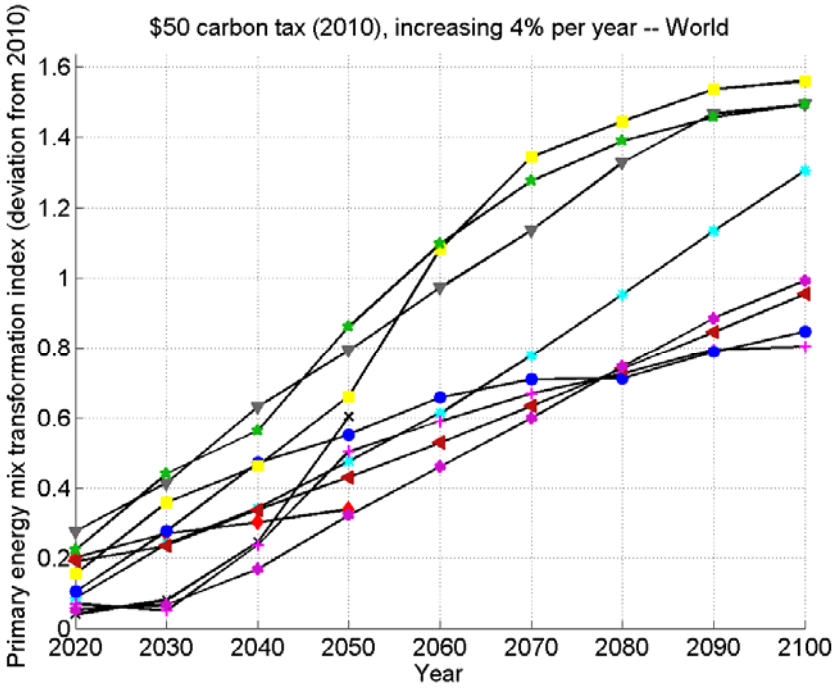
$$TI(2010) = |Sx - Sx(2010)| + |Sy - Sy(2010)| + |Sz - Sz(2010)|$$

Transformation index (TI) – electricity, primary

TI of 0 = no transformation TI of 2 = complete transformation

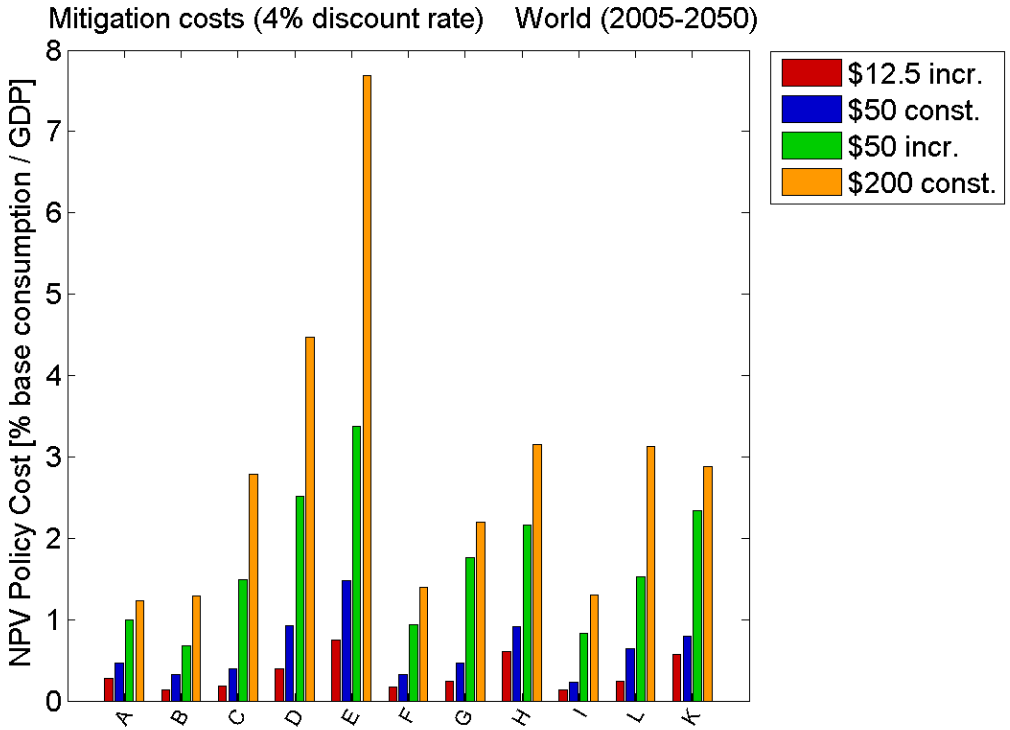
$$TI(2010) = |Sx - Sx(2010)| + |Sy - Sy(2010)| + |Sz - Sz(2010)|$$

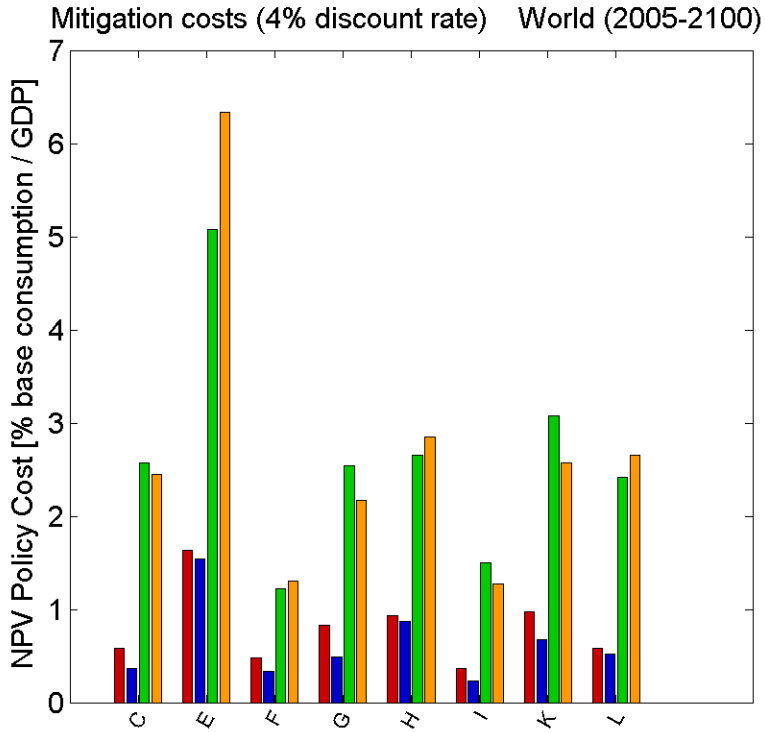




PRELIMINARY RESULTS

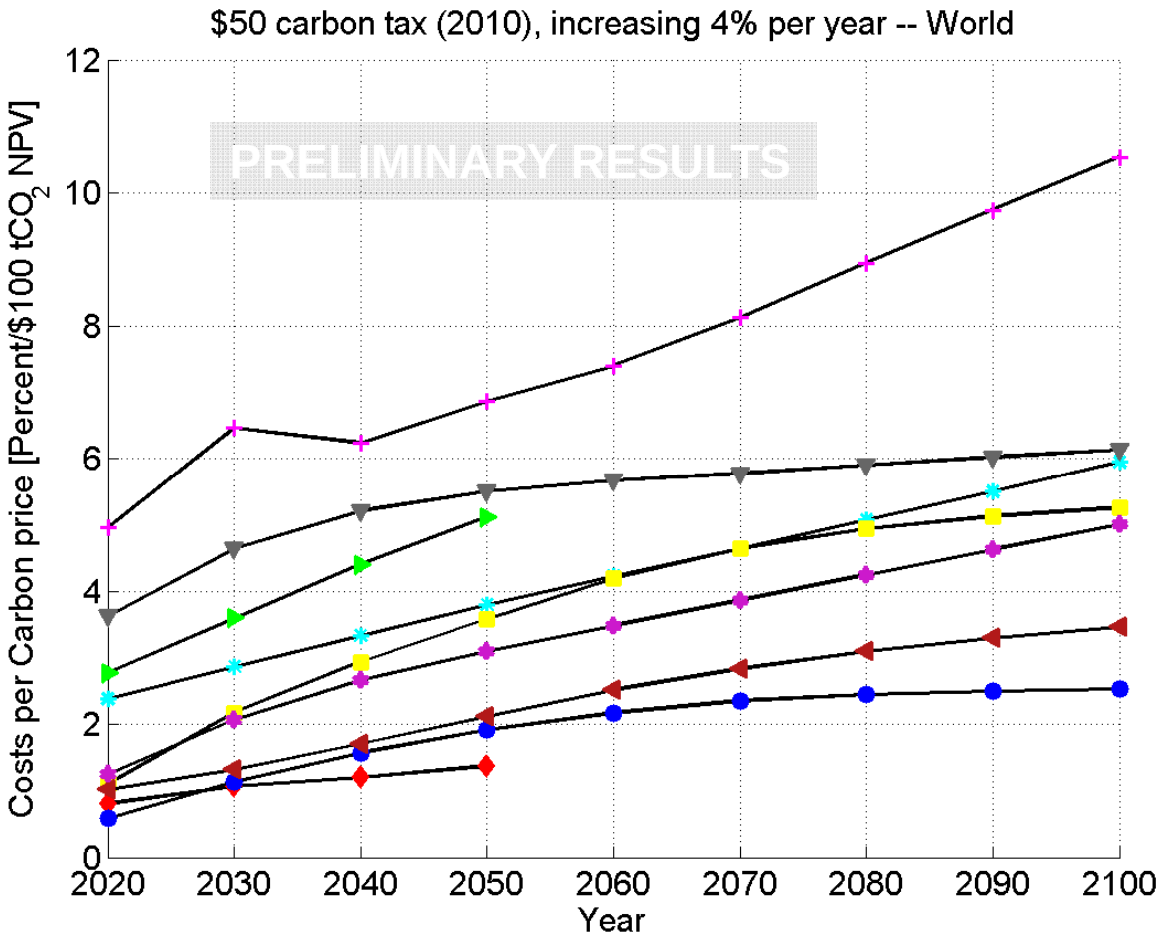
Mitigation cost



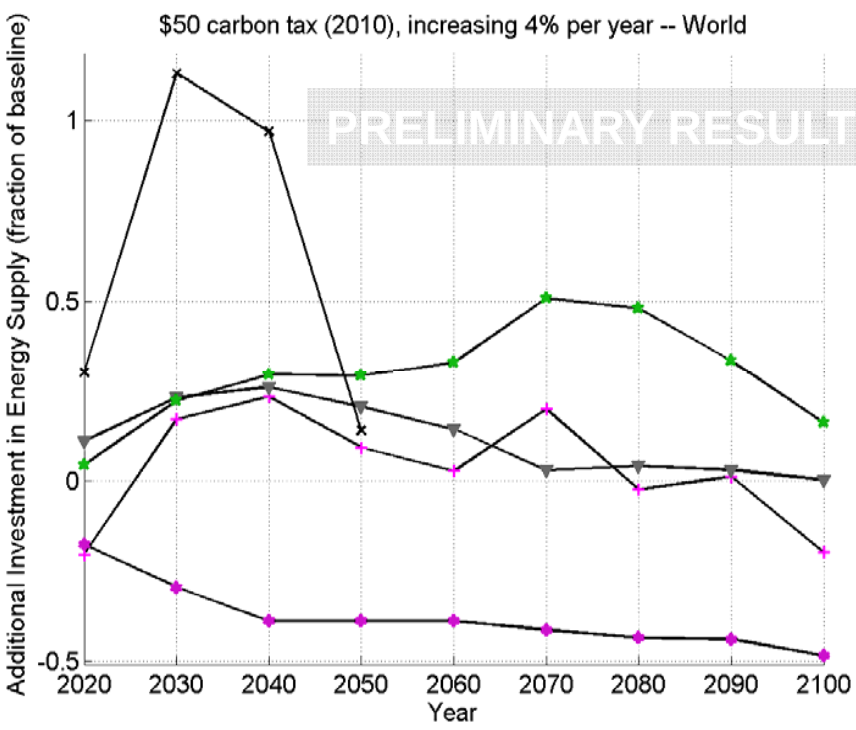


PRELIMINARY RESULTS

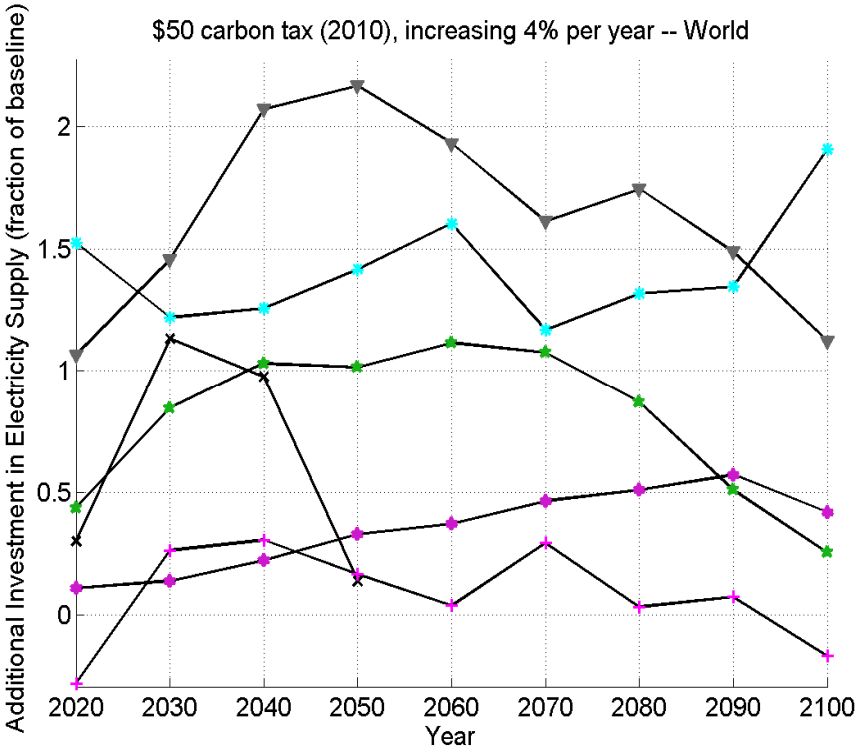
Differential mitigation cost



Energy investment response



Energy supply



Electricity supply

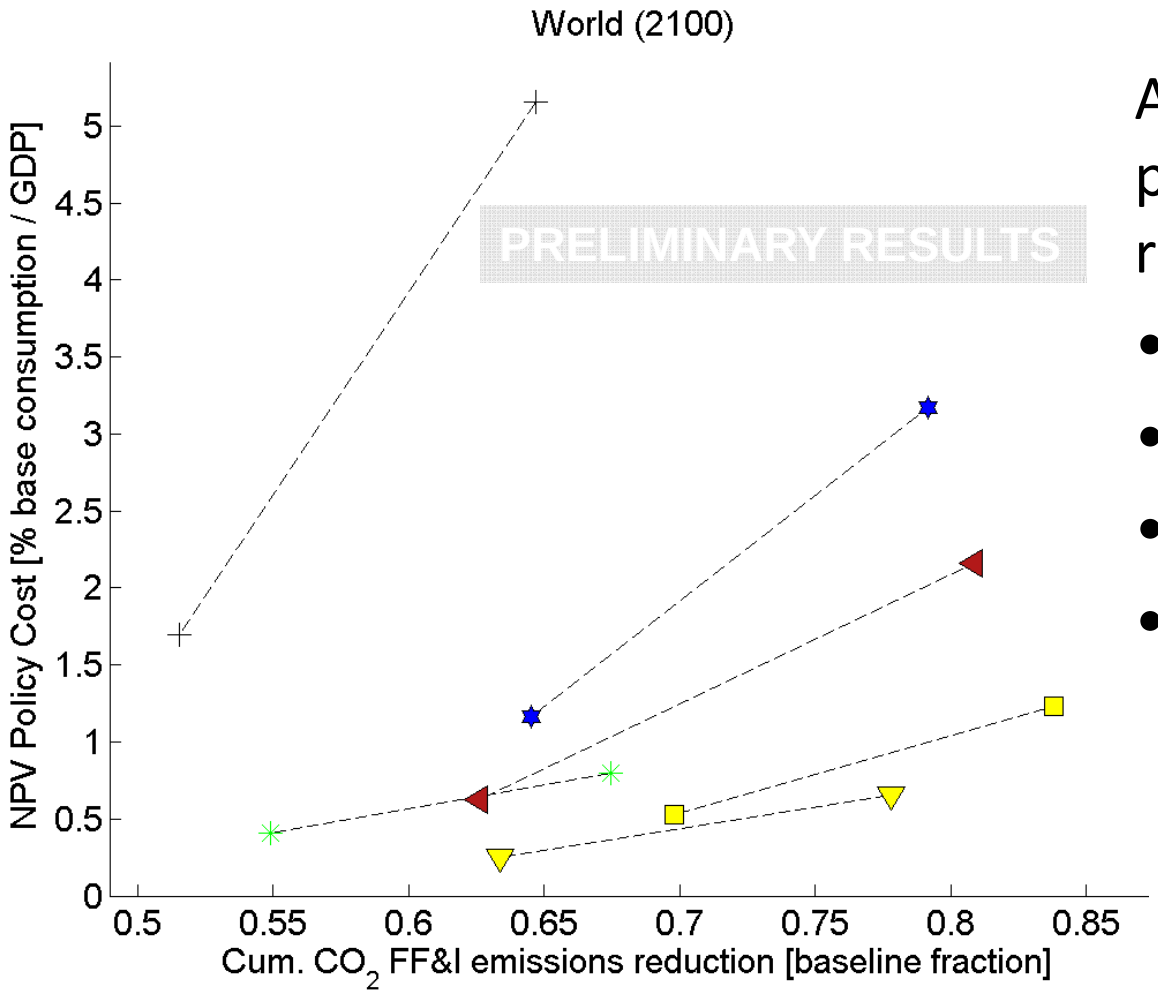
Diagnostic indicators

PRELIMINARY

Model class	Model indicators				
	Emissions Response Measure	CoEI Indicator	Transformation Index	Cost Response Measure	Energy Investment Response
Partial Equilibrium	*Low*	*High*	*Low*	*Low*	*Low/Medium*
	Mixed	*Mixed*	*Mixed*		
	High	*Low*	*High*	*Low*	*Medium/High*
General Equilibrium	*Low*	*High*	*Low*	*Medium/High*	*Low/Medium*
	Mixed	*Mixed*	*Mixed*		
	High	*Low*	*High*	*Medium/High*	*Medium/High*

Indicator value combinations (e.g. low, high, low) shown are combinations observed among participating models

Mitigation costs
vs. cumulated CO_2 FF&I emissions reduction



AMPERE 450 and 550 ppm CO2e stabilization runs

- GE-3: yellow
- PE-3: green
- PE-2: brown
- GE-1: blue

Conclusions

Many models exhibit distinct fingerprint:

- strong abatement response + strong reliance on CI + strong transformation of energy system
- limited abatement response + limited reliance on CI + limited transformation of energy system

Useful model classification to explain differences in model results (e.g. on mitigation costs) may be established

Solidifying and testing the preliminary model classification in applications needed

Aim: Standardized diagnostic experiments that can be run by a large class of energy-economy and integrated assessment models (could be a community activity)

Discussion