



POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH



How do Energy-Economy Model Responses to Carbon Pricing Compare? First Insights from the ADVANCE Open Community Model Diagnostics Study

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Model Diagnostics – Motivation

- **Understand model characteristics and differences**
 - **Bottom-up: compare model structure and assumptions**
 - **Top-down: compare model response characteristics in diagnostic model runs**
- **Classify models according to their response and structural characteristics**
- **Establish standard diagnostic experiments to benchmark models**



Model Diagnostics – Recent Work

- **AMPERE work on model diagnostics**
- **Identified indicators of model behaviour**
- **Developed preliminary model classification scheme**

- **Selection criteria for diagnostic indicators**

- **identification of heterogeneity in model responses**
- **relevance for climate policy analysis**
- **applicability to diverse models**
- **accessibility and ease of use**

- **PIAMDDI work on model diagnostics**
- **U.S. IAM diagnostics (Wilkerson et al., Energy Policy, 2015)**
- **Studies on technology impact, system elasticities, hindcasting**

AMPERE Diagnostic Indicators

Model	Relative Abatement Index	CoEI Indicator	Transformation Index (primary energy)	Cost per Abatement Value	Model type	Classification
...	PE or GE	...

Characterize system response to emissions price
 → Low system response leads to high carbon price for fixed emissions reduction

X

Characterizes cost response to emissions price = Magnitude of mitigation costs

Kriegler et al., 2015, Diagnostic indicators for integrated assessment models of climate policy. *Technological Forecasting and Social Change 90A: 45-61*

AMPERE Model Classification („fingerprints“)

Model	Relative Abatement Index	CoEI Indicator	Transformation Index (primary energy)	Cost per Abatement Value	Classification
AIM-Enduse	Low	Mixed	Mixed	TBD	PE – med response
DNE21+	Low	High	Low	Mixed	PE – low response
GCAM	High	Low	High	Medium	PE – high response
GEM-E3	Low	High	TBD	Medium	GE – low response
IMACLIM	Low	High	Mixed	High	GE – low response
IMAGE	High	Low	Mixed	Low	PE – high response
MERGE-ETL	High	Low	High	Low	GE – high response
MESSAGE	High	Low	High	Low	GE – high response
POLES	Mixed	Mixed	Low	Low	PE – med response
REMIND	High	Low	High	Medium	GE – high response
WITCH	Low	High	Low	Medium	GE – low response

ADVANCE Diagnostics Exercise - Motivation

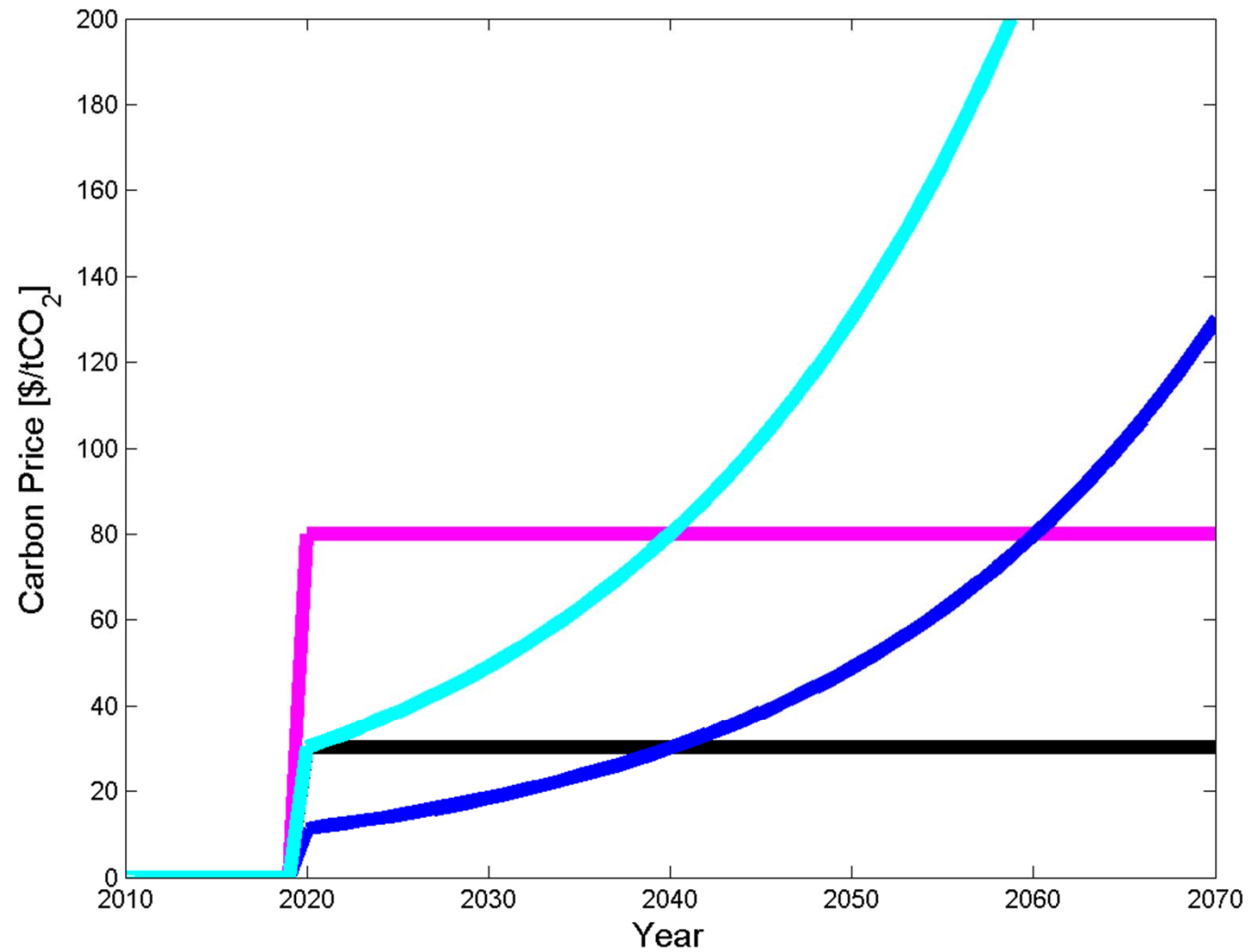
- **Establish community database of diagnostic runs**
- **Test validity of model fingerprints identified in AMPERE on a larger set of models**
- **Explore new diagnostic indicators to characterize broader set of model behaviour**
- **Further integrate information on model structure and input assumptions with model response characteristics to improve understanding of model differences**



ADVANCE Diagnostics Exercise - Design

Mandatory runs:

- 1 baseline
- 4 x CO2 price



ADVANCE Diagnostics Exercise - Design

Mandatory runs:

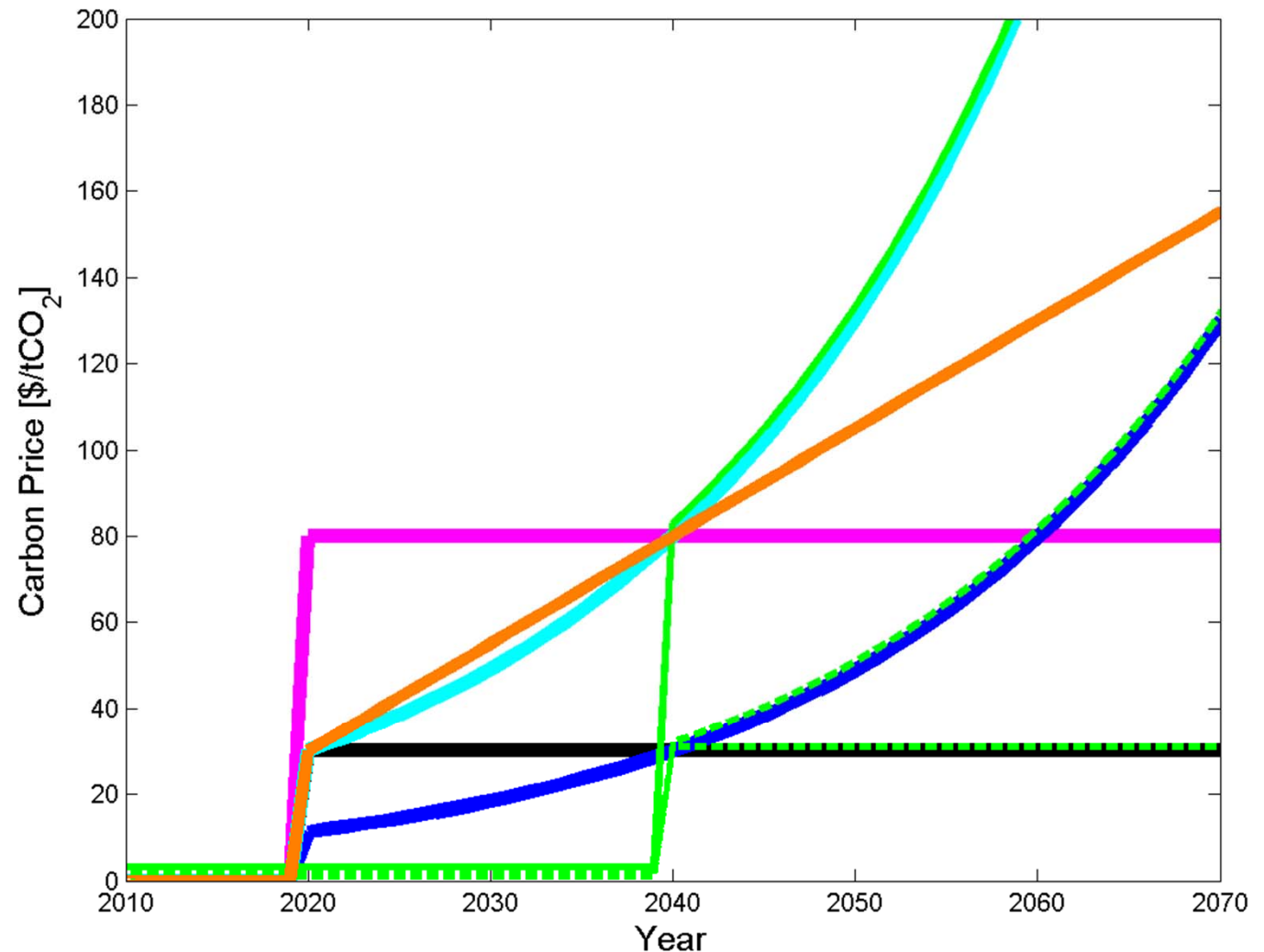
- 1 baseline
- 4 x CO2 price

6 Recommended runs:

- 4 x CO2 price
- 2 x CO2 budget

7 Optional runs:

- Add reference
- Anticipation
- Late shocks
- Higher budgets
- Hybrid



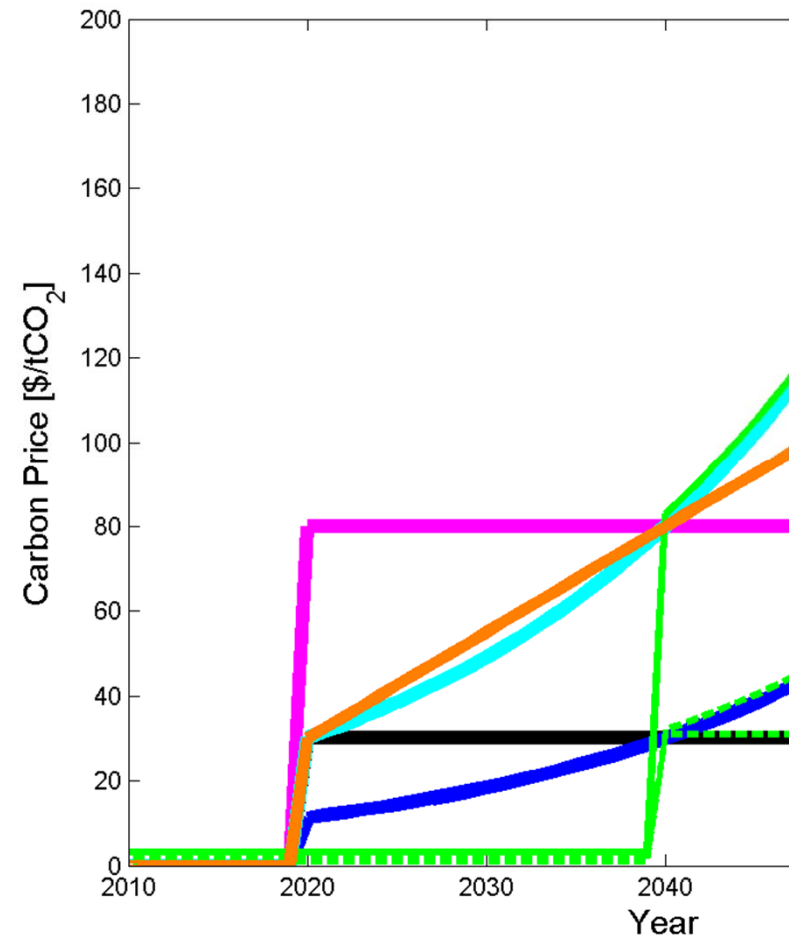
Participating models (open for newcomers)

DR CGE, Intertemporal GE, **Dyn-rec PE**, Intertemporal PE

	Solution Concept	Solution Method
AIM/CGE	GE (closed economy)	Recursive-dynamic (myopic)
DNE21+	PE	Inter-temporal (foresight)
EPPA	GE (closed economy)	Recursive-dynamic (myopic)
FARM	GE (global CGE)	Recursive-dynamic (myopic)
GEM-E3	GE (closed economy)	Recursive-dynamic (myopic)
IMACLIM	GE (closed economy)	Recursive-dynamic (myopic)
IMAGE	PE (price elastic demand)	Recursive-dynamic (myopic)
iPETS	GE (closed economy)	Inter-temporal (foresight)
KEI-Linkages	GE (closed economy)	Recursive-dynamic (myopic)
MESSAGE	GE (closed economy)	Inter-temporal (foresight)
POLES	PE (price elastic demand)	Recursive-dynamic (myopic)
REMIND	GE (closed economy)	Inter-temporal (foresight)
TIAM-UCL	PE (price elastic demand)	Inter-temporal (foresight)

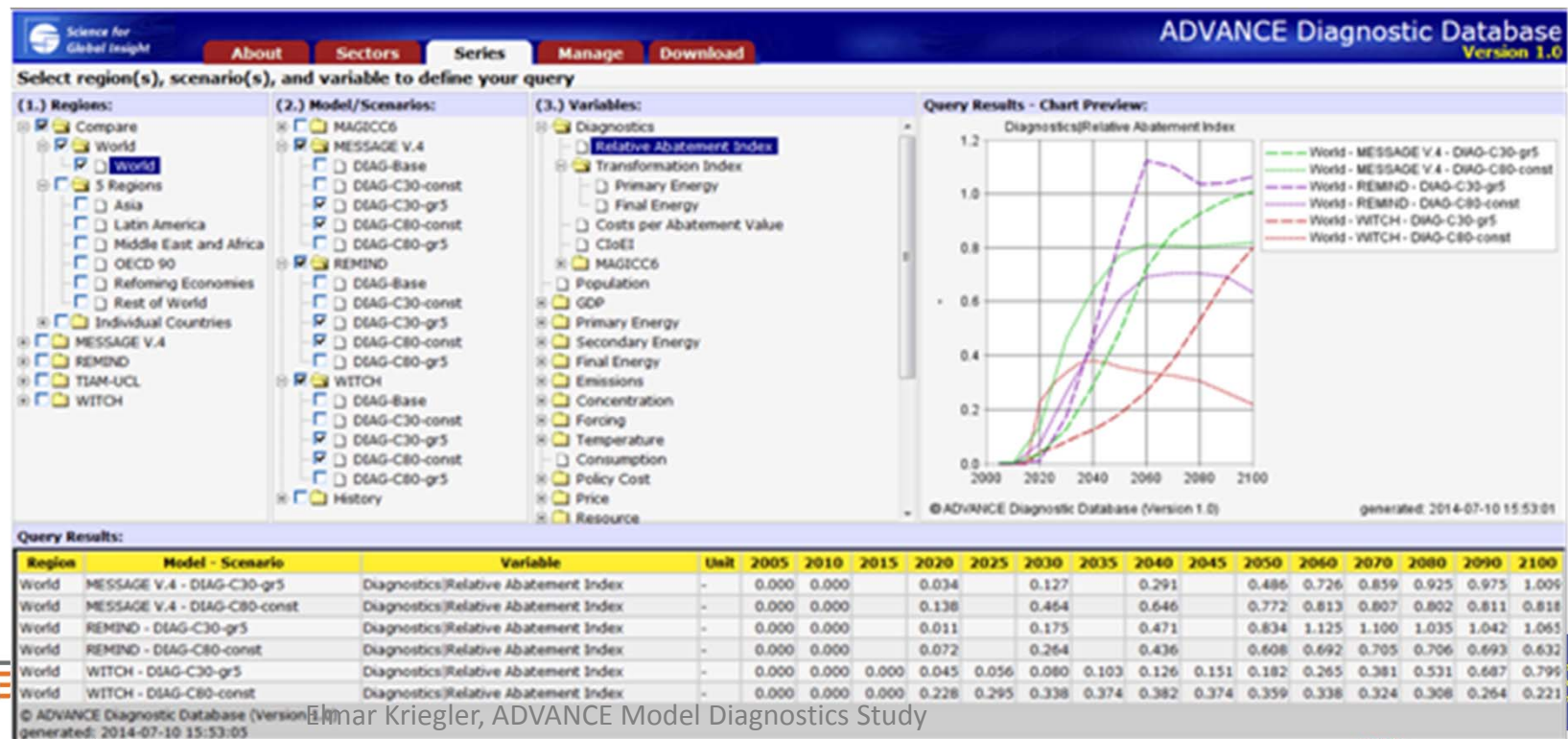
Future Extensions of the Analysis

- Model inertia and path dependency in response to carbon pricing
- Non-CO2 emissions response
- Regional response patterns
- Emissions target vs. carbon pricing response
- Integrating model input and structure information to improve understanding of differences



ADVANCE diagnostics infrastructure

- ADVANCE diagnostics database hosted by IIASA
- Includes automatic calculation of AMPERE diagnostic indicators and climate response (using the latest version of MAGICC)
- Graphical user interface allowing teams to compare results across models



Open to participation ...



Continuous process:

- global, regional or national energy-economy models running until 2050 which can describe emissions response to carbon pricing
- submission of at least five core diagnostic runs
- teams get access to the database GUI after submission (allowing them to compare their results with others).

All information on how to submit: <https://tntcat.iiasa.ac.at/ADVANCEWP1DB>

This analysis:

- Any new submission would need to come well ahead of writing up the analysis (~ end of July)
- Teams will review the interpretation of their results
- Researchers from teams can join the analysis of results on demand.
- Analysed part of the database will be published results with the paper.