Advanced Model Development and Validation for the Improved Analysis of Costs and Impacts of Mitigation Policies

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How to establish credibility? Evaluation and transparency of energy-economy models

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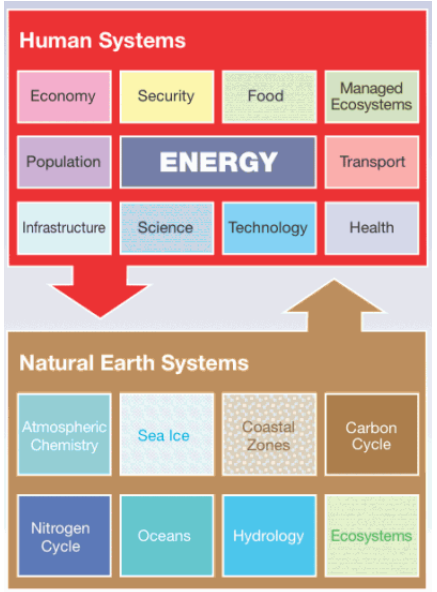
What is the purpose of IAMs?

Exploring the option space

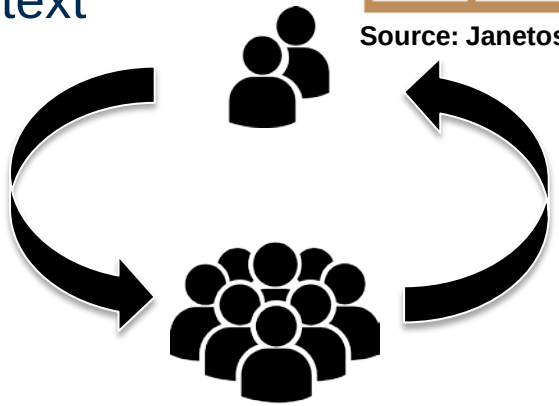
- Develop scenarios for future emissions
- Explore strategies for climate stabilization
- Analyze co-benefits and adverse side effects of mitigation measures
- Explore broader sustainability issues (e.g., water-energy-land nexus) in a climate change context



Source: Janetos, 2009

Use of IAMs as a reasoning tool

- Problem setting and objectives
- Analysis framing
- Model analysis
- Result evaluation



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IAM evaluation is an open-ended process of testing, learning & improving a model and its performance

Evaluation criteria for IAMs

appropriateness	**is model purpose and design consistent with the research question?**
interpretability	**are model results clearly interpretable in light of model structure and parameterisation?**
verifiability	**are model results repeatable or is model structure accessible to 3rd parties?**
credibility	**is model seen as good enough for its intended purpose by both users and modellers?**
usefulness	**do model insights help understand uncertainties, trade-offs, alternatives?**

Each evaluation method has strengths & weaknesses … and contributes more to certain evaluation criteria

evaluation method	*appropriateness*	*interpretability*	*verifiability*	*credibility*	*usefulness*
historical simulations	✔	~		✔	
generalisable historical patterns	✔	~		✔	
model intercomparisons		✔		✔	✔
diagnostic indicators	✔	✔		~	
sensitivity analysis		✔		~	✔
documentation/open access	~	~	✔	✔	

+ …

Harmonized Model Documentation

ADVANCE documentation specification

Objective

harmonized documentation for larger set of models with two levels of detail

Structure

- Highly structured **Reference Cards** consisting mostly of tables with predefined categories (~2 pages)
- **Full documentation** based on standardized outline which is adaptable to model type (~30-40 pages)
- Optional **appendices** with details on mathematical formulation and input data (or links to existing material)

Implementation

- Utilizes **Wiki** platform to allow continuous updating (incl. versioning)
- First Wiki release (hosted by UCL, public since 2015) referenced in ~10 publications

ADVANCE Wiki Features

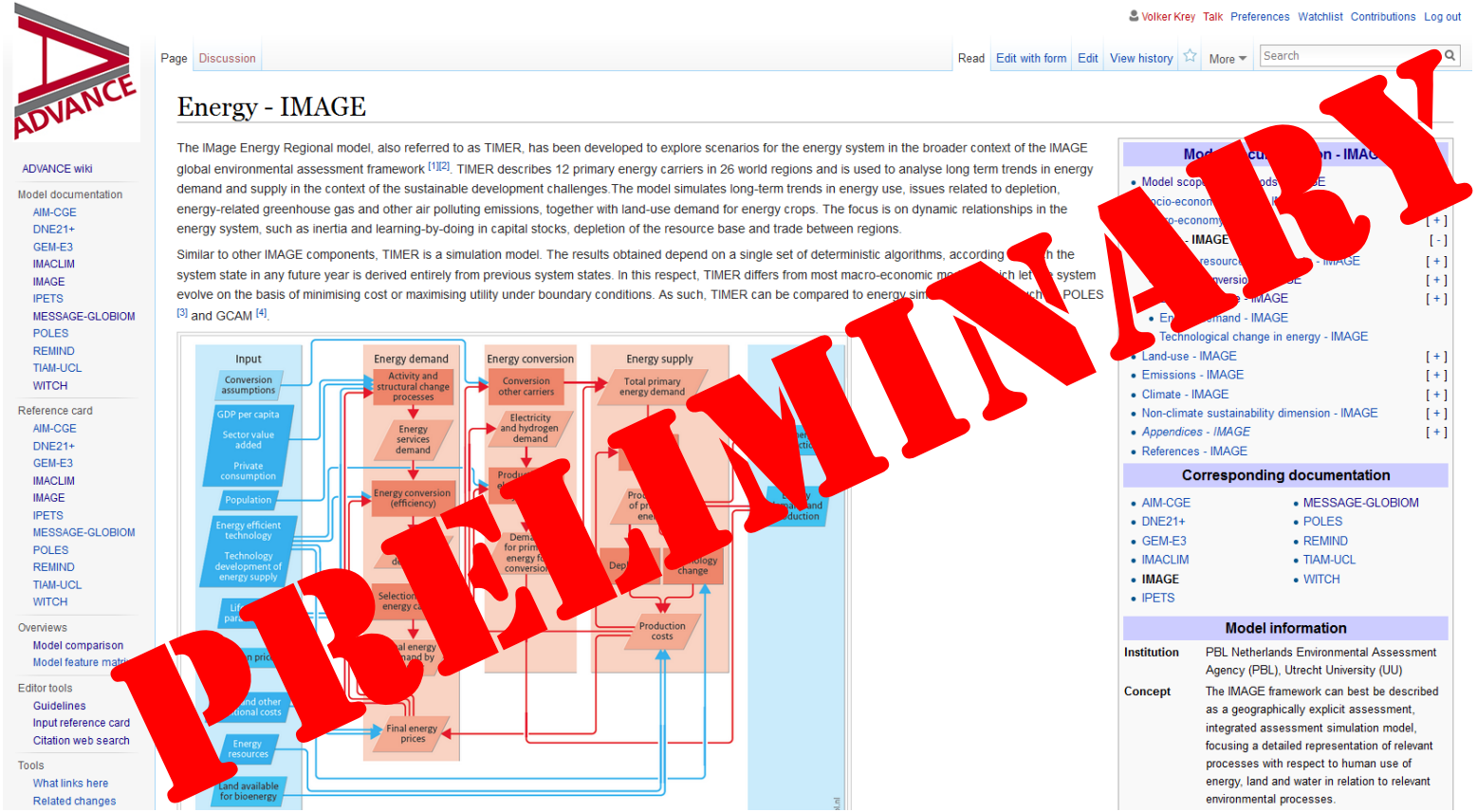
Standardized Outline

- Model scope and methods
- Socio-economic drivers
- Macro-economy [optional]
- Energy
- Land-use [optional]
- Emissions
- Climate [optional]
- Non-climate sustainability dimension [optional]
- Appendices [optional]

Value added

- One stop repository for model documentation
  (with links to publications and other documentation)
- Cross-linkages to similar material for other models
- Comparison tables for References Card features
- Public review (2015) highlighted need for improvements along various dimensions

ADVANCE Wiki Documentation



PRELIMINARY

ADVANCE Wiki hosted by PBL: http://themasites.pbl.nl/models/advance/index.php

IAM Diagnostics

Model Diagnostics

Objective

- Provide methodologies to evaluate IAMs and energy-economic models (global and national) and promote use of diagnostics

Development of new diagnostic test

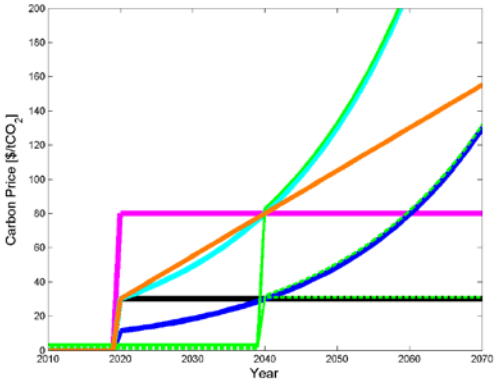
- Path dependence
- Sectoral dynamics (electricity, industry, buildings, transport)
- Macro-economy (focus on CGEs)
- Standardized climate model (MAGICC6)
  (utilized in several MIPs including ADVANCE, SSPs, EMF)
- Linking documentation (structure and data) with diagnostic indicators

Implementation

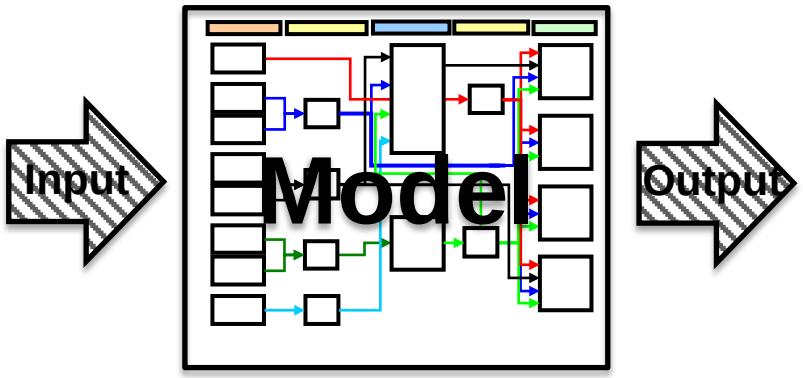
- Development of an automated web-tool for IAM diagnostics, allowing application to a larger set of models

ADVANCE Diagnostics Exercise

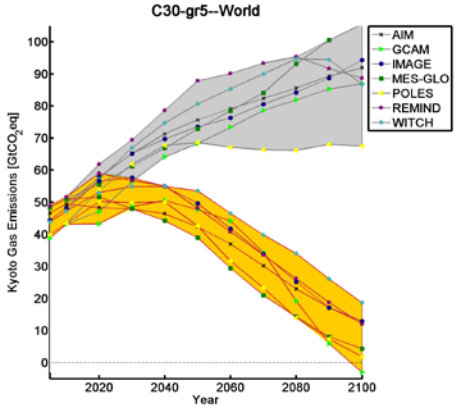
Simple Scenario Design
5 mandatory, 6 recommended,
7 optional model runs

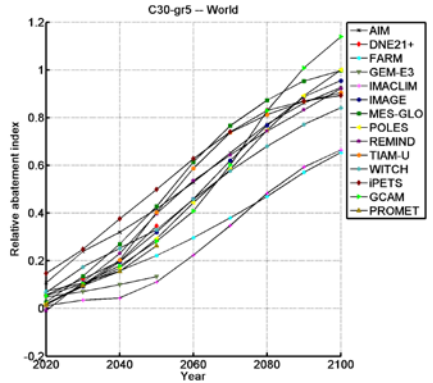


Model Runs and Submission



Diagnostic Indicators
GHG emissions response,
Relative Abatement Index, …





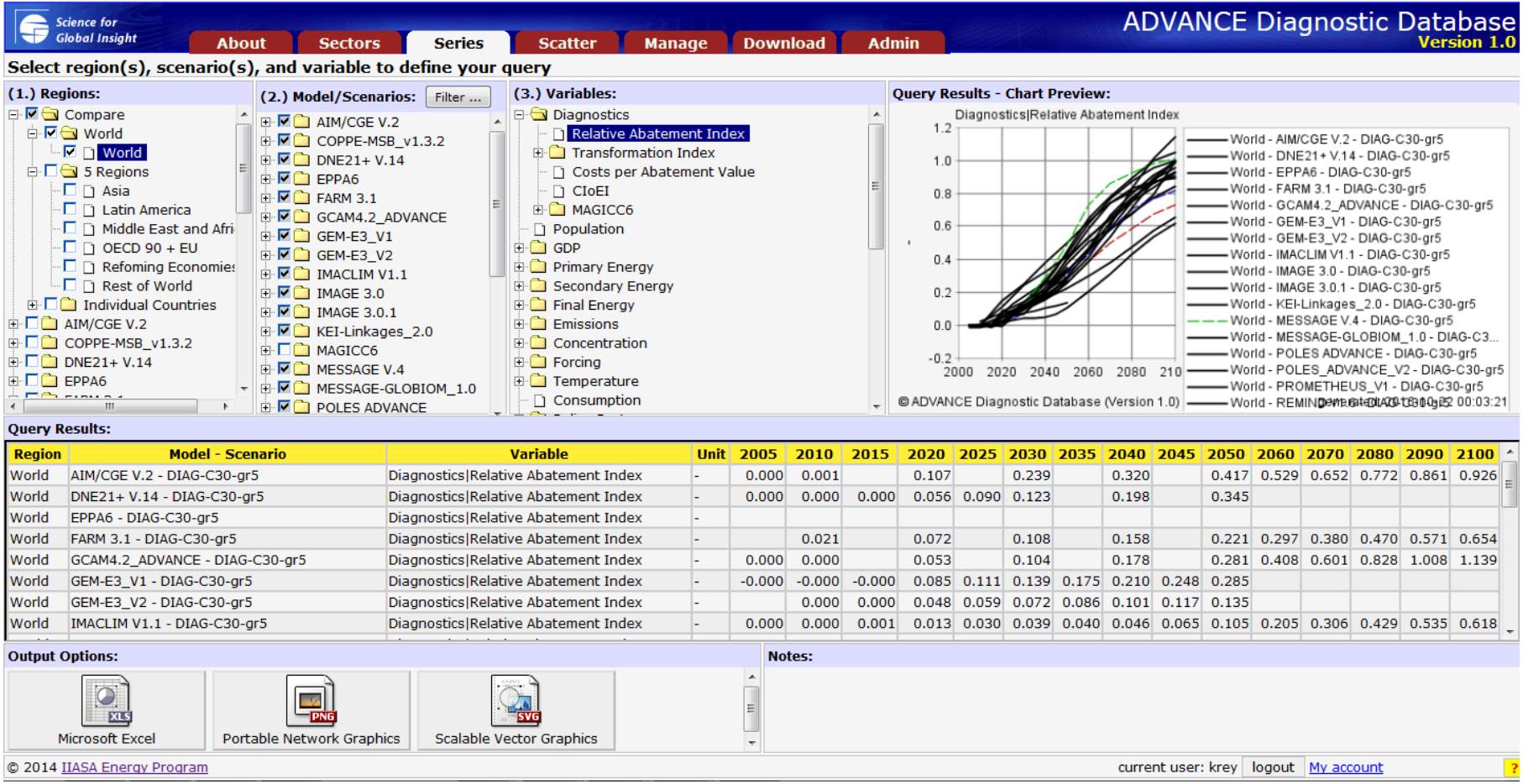
Model Classification („fingerprint“)

Table 2
Qualitative description of indicator values across individual models and diagnostic indicators. TBD (To be defined) is shown in places where model data was not available to calculate the particular indicator. A preliminary classification of models based on the combination of indicator values is shown in the rightmost column.

Model	Relative abatement index	CoEI indicator	Transformation index (primary energy)	Cost per abatement value	Classification
AIM-Enduse	Low	Mixed	Mixed	TBD	PE – medium 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 – medium response
REMIND	High	Low	High	Medium	GE – high response
WITCH	Low	High	Low	Medium	GE – low response

Source: Kriegler et al. 2015

Automated IAM Diagnostics Web-Tool



Diagnostics Web-Tool hosted by IIASA: https://tntcat.iiasa.ac.at/ADVANCEWP1DB/

Conclusions

- Significant step forward in terms of providing transparent information on IAMs
- Integration of different approaches to enhance model evaluation is important (e.g., linking documentation with diagnostics)
- Ongoing effort to engage the IAM community beyond the ADVANCE consortium partners
  - Documentation: 8 ADVANCE models + 3 external partners
  - Diagnostics: 8 ADVANCE models + 4 external partners + 3 models from wider community
- Continuous, systematic & more prominent evaluation effort is needed to strengthen and maintain confidence in IAMs

Thanks!

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