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

FP7-Cooperation-ENV
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Meta-database of technical description of newly developed methods

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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ADVANCE Toolbox

Technical description of newly developed methods in ADVANCE
available as online source at www.fp7-advance.eu

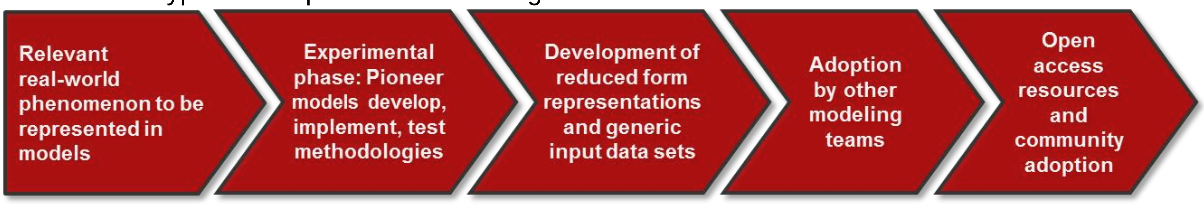
Toolbox aims

The ADVANCE modelling toolbox collects detailed descriptions of the methodologies developed in the project. The toolbox responds to the widespread need in the modelling community to share methodologies and input data for the further improvement of integrated assessment and energy-economy modelling.

Toolbox development and quality insurance

Methodological improvements were generated based on a peer-review process. In a first phase a core group of 1-3 “pioneer” modelling teams developed, implemented and tested innovative modelling approaches. Based on the results of the pioneer group, suitable reduced-form representations for use in other models were developed. In a second phase, the other teams participating in the task adopted and implement the modelling approaches in their models. Selected model algorithms and relevant generic input data sets that were used to parameterize individual IAMs are now made available to the entire modelling community via the ADVANCE project website. The selection of tools was based on the criteria of relevance for the wider modelling community, successful adoption by ADVANCE modelling teams in the course of the project as well as easy applicability by external modelling teams.

Illustration of typical work plan for methodological innovations



Toolbox structure and contents

The toolbox includes new model components, mathematical formulae, algorithmic approaches, examples of model code, and generic input datasets. Each methodology is accompanied by a manual providing instruction for implementation. Overall 13 tools are made available online as open access resource.

1) Modelling guideline for the cement industry

The guideline helps less detailed models to separately model the cement industry. The main advantage of modelling each industrial sub-sector separately is that industry specific information, such as production technologies and energy saving measures, allow for a better representation of the industrial sector and therefore lead to more accurate model results. The guideline contains industry details, such as the breakdown of the technologies used for cement making in the different world regions and all key parameters, such as fuel and electricity intensities, clinker to cement ratios, and simple functions that can be used to estimate the regional energy use and GHG emissions (including process emissions). The guideline also includes a list with measures for energy and material efficiency improvements as well as methods to incorporate them in the models.

2) Service sector end use model

The service sector end-use model captures sector specific dynamics. The inclusion of this detail has several advantages: end-use demand can be related to climate conditions and thus capture regional differences; moreover, end-use specific efficiency and fuel switching opportunities as well as structural change can be accounted for. The toolbox provides an extensive description of a bottom up approach to model the service sector end use demand and provides related demand functions.

3) Residential sector end use model

The residential sector end-use model (REMG) captures sector specific dynamics. The inclusion of this detail has several advantages: end-use demand can be related to climate conditions and thus capture regional differences; moreover, end-use specific efficiency and fuel switching opportunities as well as structural change can be accounted for. The toolbox provides input data as well as a description of the REMG model with related functions.

4) Transport infrastructure module

The transport infrastructure module aims to allow IAM groups to implement a bottom-up estimation of the costs and impacts on service demand, energy demand, and carbon emissions of the deployment and maintenance of transport infrastructure such as roads, railways and airports. The module provides input data on (i) costs for deployment and maintenance of road, public transport and air travel infrastructure for 12 Global Regions for 2010, and (ii) regional data on construction capacity, vehicle road occupancy, land area, density limit and size of parking space. It also provides detailed description of variables and relationships used in modelling deployment of transport from reference to target year. This involves a calculation of total cost and the influence of service demand, and some physical and economic constraints on the deployment of road, public transport and airport infrastructure.

5) Subsidy and energy tax dataset

The subsidy-tax dataset aims to enable IAM teams to better calibrate end-use fuel prices to real-world values and depict energy tax rates and fossil fuel subsidies. The data set contains three elements: (i) a compilation of average prices of natural gas, oil, coal and electricity for residential/commercial and industry and for oil used in transport, (ii) a compilation of tax rates on natural gas, oil, coal and electricity used in residential/commercial and industry as well as for oil products used in transport, (iii) 3. a compilation of fossil fuel energy subsidies on natural gas, oil, coal and electricity.

6) MESSAGE-access model

The MESSAGE-Access Model code provides a method for analysing the climate policy impacts on energy poverty, specifically fuel choice and demand for residential thermal cooking energy, by explicitly considering changes in these choices and demand under alternative climate mitigation policy scenarios for heterogeneous population groups that are not typically distinguished in the models. The model provides all the input data required to calibrate the model in the base year as well as data on future population and income projections by population sub-group that are used as inputs in the model for future scenario analysis. An R script runs the "Access" model using inputs for different climate policy scenarios that are represented in the model as distinct "fuel price inputs". The R-script produces a set of outputs relating to cooking energy demand by fuel and stove type, scenario, population sub-group, and periods.

7) Energy efficiency module

The energy efficiency module enables IAMs to endogenize energy saving technological progress and the rate of Autonomous Energy Efficiency Improvement. It is composed of a set of equations which maps IAM's projections of energy prices into projections of energy intensity. The module provides input data to estimate the parameters of the module as well as Source codes. By running the codes, the user can reproduce the estimates of the parameters of the key equations in the module.

8) Learning rates

The toolbox provides a new procedure for estimating the learning curves which are applied in IAMs. This procedure is more robust to econometric biases than standard methods used previously. The module provides data on electricity and energy prices, indicators for environmental policies and net capacities of wind turbines by country and by year. The users can update the data sets (e.g. by including new observations from last years) or tailor the data set to a particular Integrated Assessment model. The module provides a source code to process the data and run the econometric model. The output is the estimate of the learning rate.

9) Power generation split module

The objective of the module is to allow splitting the aggregate power generation sector usually found in statistical databases to its consisting parts (transmission and distribution, discrete power generation technologies). The method contains the following features: (i) enable the automated split of the aggregated power supply sector with limited manual intervention and (ii) utilise the commonly used energy and economic databases. The module provides input data and source code.

10) Life cycle assessment module

The life cycle assessment module aims at enabling IAM groups to analyse wider life-cycle impacts of power production beyond greenhouse gases and air pollutants and include indirect effects not considered in the models. The module provides a data set of lifecycle impacts differentiated by scenario (baseline or climate policy), region (nine IEA regions), power-sector technology, technology variant (different types of technologies employing the same energy conversion), lifecycle phase (construction, operation, end-of-life) and period (2010, 2030, 2050). Impacts include use of bulk materials (cement, iron/steel, aluminium, copper), transportation services, indirect energy use, land occupation, freshwater and marine eutrophication, human, freshwater and terrestrial toxicity, ionising radiation, land use and land use change emissions (CO_2, CH_4, N_2O). The R script provided with the module combines IAM results with these coefficients to produce impacts differentiated by technology and lifecycle phase for different models, scenarios, regions and periods.

11) Light-Duty Vehicles Intangible Cost Calculator

The LDV Intangible Cost Calculator for light-duty vehicles enables IAM groups to more realistically represent technology choice decisions in the transport sector.

‘Intangible costs’ are related to those aspects of consumer decision making which are not captured by pure techno-economics (e.g., capital, O&M, and fuel costs). They represent additional sources of utility or disutility contributing to consumers’ perceptions of beneficial or costly choice outcomes. Importantly, intangible costs, or non-financial preferences as they are also known, for a given vehicle technology may differ widely among heterogeneous groups of consumers in different countries. In the realm of vehicle choice, these non-financial attributes include vehicle novelty, range, and refueling availability, among others. Using the LDV Intangible Cost Calculator developed in ADVANCE, consumers' unique preferences for these attributes are monetized. The costs and benefits can then be included alongside pure financial costs as extra parameters in IAM equations determining vehicle choice. The intangible costs are derived from a detailed, multinomial logic transport sector model (MA3T). This approach allows consumer heterogeneity and non-financial preferences to be linked to (or derived from) specific IAM scenarios so that narrative storylines, model set-up, and model assumptions are all consistent.

12) Variable Renewable Energy datasets

Datasets on Photovoltaics (PV) and Concentrating Solar Power (CSP) and datasets on wind resources (on- and offshore) allow representation of quality-differentiated resource potentials of wind and solar power at country level.

13) VRE integration module

The VRE integration module provides both data and two different methods to represent key integration challenges of wind and solar power in large-scale energy-economy models. The main idea is that the variable renewable energies wind and solar are challenging to integrate, because they influence key electricity system parameters such as peak residual demand, full-load hours of dispatchable power plants, storage requirements and curtailment.

Residual load duration curves (RLDCs) contain the information on how these key system parameters change depending on the share of wind and solar in electricity generation. Based on this data, the toolbox describes two ways of how to represent this information in an IAM: a) in a mixed-integer formulation suited for a linear model and b) in a polynomial formulation suited for a non-linear model.