ADVANCE

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

newsletter

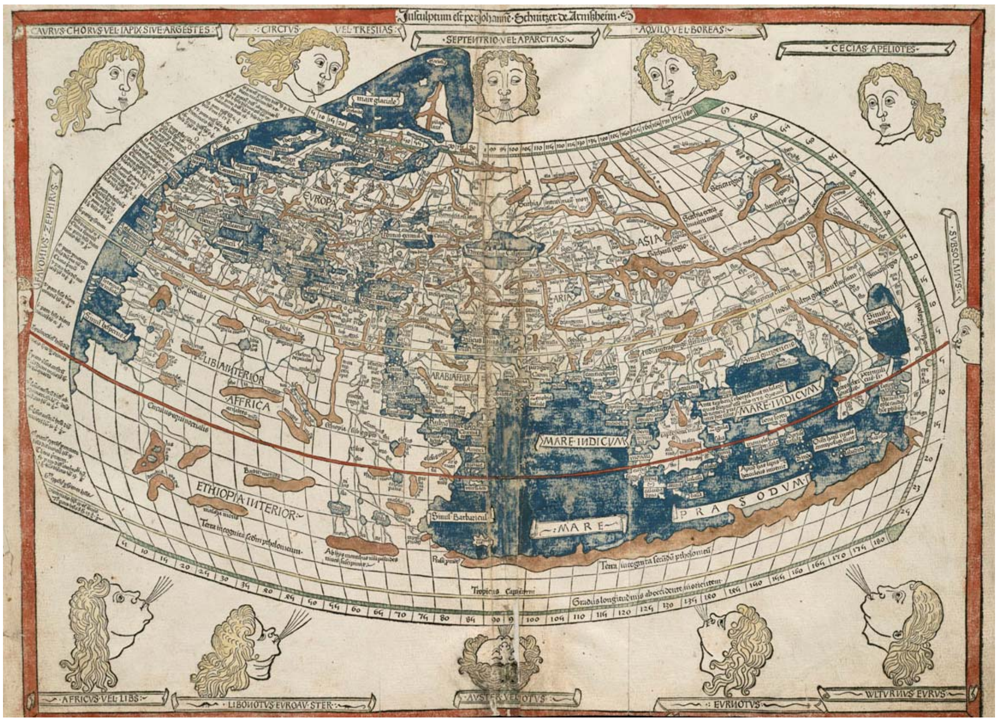
December - 2014

The ADVANCE project: insights into first project findings

The ADVANCE project is half way through its lifetime. Over the past 2 years the consortium has put forces together to improve energy-economy and integrated assessment modelling tools with the overall aim to better inform policy makers on different climate mitigation options and their impacts. At the end of the project, in late 2016, improved models shall be applied to assess EU climate policy in the framework of policy impact assessments.

ADVANCE shall offer policy makers a map of different paths available within the “solution space”. Policy makers may use the map to navigate through this space.

We are pleased to present some highlights of the joint work conducted so far in the areas of energy demand, technological change and systems integration of energy supply. We also present our activities on model validation and diagnostics, which includes a web-based model tool for standardized testing of Integrated Assessment Models (IAM). Finally, we report on past and upcoming exchanges with international experts on main ADVANCE research areas.



Modellers offer a map of different paths available within the “solution space”. Photo: Norman B. Leventhal Map Center at the BPL, CC BY 2.0

ADVANCE

newsletter

Removal of fossil fuel subsidies: impacts on energy supply and demand, greenhouse gas emissions and climate change, and the wider economy

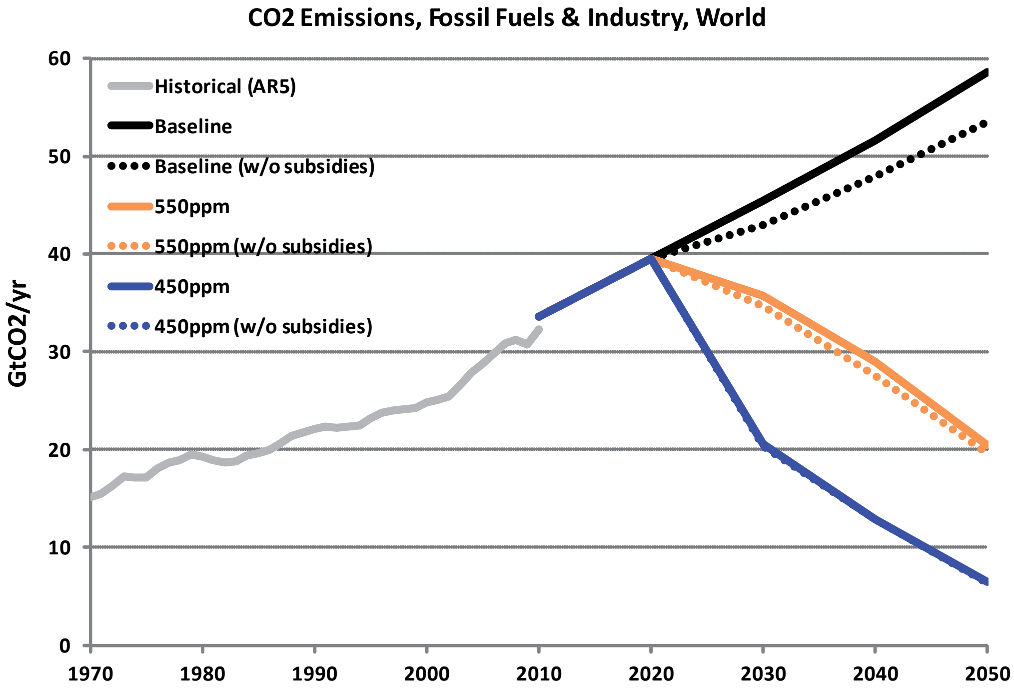
The year 2014 has shown first results in the analysis of energy subsidies and taxes. Subsidies sustain the supply and demand of fossil fuels and thereby represent one of the obstacles to a low-carbon transformation of the energy system. In ADVANCE, modelling teams seek to better understand the impact of such subsidies on the energy system, related GHG emissions and the cost of climate change mitigation – in brief: what would be the impacts on the energy mix and cost of climate mitigation if fossil-fuel subsidies were phased out?

To answer this question a multi-model comparison is under way, which involves the IAMs MESSAGE, GEM-E3, IMAGE, REMIND, TIAM-UCL and WITCH. Still in the model development phase, teams are currently in the process of integrating data on energy prices, subsidies and taxes, with plans to soon implement two initial scenario pairings. Two baselines and two climate policy scenarios (e.g., 550 ppm CO2-eq) will be run by all models, for a total of four scenarios. In both cases, the plan is to explore scenarios where present-day subsidy rates are either retained throughout the century or fully phased-out by 2020 and kept that way until 2100. After this initial implementation phase, other policy-relevant variants of the subsidy phase-out scenarios will be analysed.

First results[1] from the scenarios are already available from the MESSAGE team, which has been tasked with the "pioneering model implementation" of this activity. Several notable insights have emerged from the scenarios where subsidies are removed globally in 2020. In baseline scenarios, without any climate policies from 2010 onward, subsidy-removal promotes a shift in energy supply from highly-subsidized fuels such as gas, oil and electricity to renewables and nuclear. However, a limitation of the subsidy removal is that energy supply from coal, which is less subsidized, remains steady and even gains economic attractiveness. This might lead to greater coal demand in regions where it is not used heavily today (e.g. Middle East). On the demand side, one of the main findings is that energy end-use is reduced substantially in regions with previously high subsidies, as there is a much greater incentive to slow energy demand growth through efficiency and conservation efforts. Regarding the impacts of subsidy-removal policies on climate change mitigation, the results are less promising: even though removing subsidies reduces greenhouse gas emissions, the levels are still considerably higher than today and, thus, insufficient to reach long-term low-temperature targets like 2 or 2.5 degrees. These findings show that the removal of subsidies, while valuable, is no substitute for stringent climate policies. If a framework for the latter is in place, then scenario results indicate that subsidy-removal policies could be a valuable complement to climate policies, providing

1 Results are documented in J. Jewell, et al. 2014. Report on improving the representation of existing energy policies in IAMs. ADVANCE Project Deliverable No. 3.1. (http://www.fp7-advance.eu/content/project-deliverables)

an incremental boost to those efforts. Subsidy-removal motivates additional energy efficiency and conservation at the end-use level, on top of that already induced by stringent climate policy measures. These actions help to modestly reduce carbon prices, because with reduced demands a lower carbon price is needed to motivate the same level of emissions reduction.



Global CO2 emissions from fossil fuels combustion in energy and industry (FF&I) in the reference baseline and in climate change mitigation scenarios resulting in atmospheric concentrations of CO2 (including all forcing agents) of either 550 or 450 ppm CO2-eq in the year 2100. The emissions impact of removing subsidies is similarly shown for each case. Historical CO2 emissions (FF&I) are also displayed for reference; source: IEA (2012a) and JRC/PBL (2013). Graph: International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

Technological change: insights into technology-related learning and energy efficiency improvements and their representation in IAMs

When talking about technological change we generally mean a technological improvement that allows providing more or better goods and services from a given amount of resources. Technological change is considered to be one of the drivers for climate change mitigation and is thus a key element of any carbon strategy. IAMs take technological change into account when picturing possible futures, however - in doing so - they face a high degree of uncertainty which can only partly be overcome. With this in mind, ADVANCE looked into the topic by both analysing technology-related learning effects and energy efficiency improvements[2].

IAMs generally represent technological change endogenously via learning curves, which base on the assumption that each time a unit of a particular technology (e.g. a wind turbine) is produced some learning accumulates which leads to cheaper production of the next unit of

[2] Results are documented in the Report on how to improve the representation of technical change into IAMs. 2014. ADVANCE Project Deliverable No. 4.1. Fondazione Eni Enrico Mattei (FEEM) and Université Pierre-Mendès-France (UPMF) - Economie du développement durable et de l'énergie (EDDEN). (http://www.fp7-advance.eu/content/project-deliverables)

that technology. ADVANCE proposes a new methodology to estimate learning rates with higher precision of results. The new method shows lower learning rates compared to traditional estimates, which implies a smaller response of technology prices to an increase of production and thus higher mitigation costs as previously thought. In addition, ADVANCE shows that there is a relation between learning and spending in Research & Development, even though this relation might be altered due to changes in material prices.

Mitigation efforts strongly rely on an increase in efficiency, as this allows reducing energy consumption without compromising economic growth. So far IAMs did not consider the drivers behind energy saving technological change. ADVANCE shows that an increase of energy expenditure and prices increases the incentives for energy saving innovations and thus energy efficiency improvements. It provides IAMs with a tool that allows estimation of efficiency improvements based on expected energy expenditure.

Integrating Variable Renewable Energies in the energy system: a quantitative analysis of integration challenges via the Residual Load Duration Curve

ADVANCE seeks to understand challenges and effects of integrating Variable Renewable Energies (VRE) into the power system and how to best represent them in IAMs. Especially policy makers might thereby better grasp the potential role of VRE for decarbonisation, as a clear understanding of the parameters determining future deployment of VRE will help understanding the interplay of climate and VRE deployment policies.

VRE differs from conventional power-generating technologies as they are not continuously available, e.g. wind speed and solar irradiation depend on natural variations and can therefore not be supplied on demand. This causes additional costs at the system level, which are usually termed “integration costs”, for example for additionally required distribution and transmission networks, short-term balancing services, more cycling and ramping of conventional plants and provision of firm reserve capacity.

As part of the work on VRE integration, ADVANCE has developed a new tool: the Residual Load Duration Curve (RLDC) allows capturing the relation of the different temporal profiles of wind and solar supply and demand and delivering the relevant economic aspects of major integration challenges.

Wind and solar PV reduce the annual full-load hours (FLH) of dispatchable power plants, such as coal, natural gas, biomass or nuclear; at high shares this is especially true for intermediate and baseload plants. The average utilization and therefore the life-cycle generation per capacity of existing and newly build plants is reduced and thus their specific generation costs (per MWh) increase. An economic evaluation of VRE needs to take a system perspective that accounts for both variability of VRE, but also a potential adaptation of the non-VRE part of the power system. The new method developed in ADVANCE allows to capture these effects, and thus to quantify mitigation challenges more accurately. We further quantify the potential of large scale integration options, such as storage systems or smart grids.

A system perspective is needed to evaluate gains and losses of VRE integration. Photo: © iStock.com/stevotion

Model diagnostics platform up and running

Given the considerable differences in key results across different models, e.g. those regarding technology choice or costs and achievability of mitigation targets, there is an obvious need to improve our understanding of how these results compare to empirical evidence, and how differences in model results relate to different model structures and input assumptions.

To respond to this need, ADVANCE has established a platform for standardised diagnostics of scenarios[3]. The purpose of this system is to provide access to diagnostic indicators characterizing model behaviour and harmonized climate indicators for a large set of energy-economy and integrated assessment models, thereby contributing to the transparency of models and building trust in model results. At present, several established diagnostic indicators are automatically calculated from the submitted scenario information.

A community wide call for participation in the ADVANCE model diagnostics study was published with a deadline for submission of

3 Further information on the newly established database infrastructure can be found in Krey, V. et al. 2014. Interactive public web-database with automated implementation of diagnostic and validation routines. ADVANCE Project Deliverable No. 1.2. (http://www.fp7-advance.eu/content/project-deliverables)

diagnostic scenario runs in March 2015. We hope to obtain diagnostic scenarios from a wide range of models to test the robustness of available diagnostics and to develop further diagnostic tests and indicators. The call was coordinated with the Model Evaluation & Diagnostics Working Group of the Integrated Assessment Modeling Consortium which encouraged its members to participate in the study.

Expert workshop on uncertainty: lessons learned

Major uncertainties are involved in climate change and the formulation of appropriate policy responses and related risk management strategies. To discuss these issues, the ADVANCE consortium invited researchers and experts to a joint workshop on "Uncertainty in climate change modelling and policy" in May 2014 in Milan, Italy.

In recent years, new research has emerged with the potential to improve the representation of uncertainty in the modelling exercise. Advances in decision theory, dynamic and stochastic programming and data availability allow for better accounting of uncertainty than previously possible. Yet, important challenges remain in the applicability of these new methods to large scale Integrated Assessment Models which are routinely used for assessing climate change policies.

The expert workshop provided an opportunity for reviewing the latest developments in uncertainty and risk analysis in climate change and their potential applications to IAMs.

Some of the main conclusions of the workshop include:

- The quantification of uncertainty is essential for climate decision making. Quantification may result out of the assessment of subjective probabilities through expert elicitation, the aggregation of multiple model results or the estimation of confidence intervals.

- New research is underway pointing at alternative decision criteria that go beyond the traditionally used expected utility framework. Decision analysis may base on a comprehensive description of preferences that include ambiguity aversion or inequality aversion, or on a combination of stochastic programming techniques, large IAMs and global sensitivity analysis.

- The aim of uncertainty analysis is threefold: it shall increase credibility, reliability and transparency of IAMs (e.g. via robust sensitivity practices), support decision making on robust and flexible policies (e.g. with decision criteria accounting for unanticipated disruptive events or uncertain/ambiguous physical/economic/technological assumptions), improve the understanding of major socio-economic drivers and their roles in shaping future climate decision making (e.g. by exploring large space of possible future scenarios).

Expert workshop on energy efficiency in buildings: outlook

IAMs tend to focus on energy supply rather than on energy demand. Still, energy demand is a main driver of emissions and, related to this, energy efficiency can form a major part of mitigation strategies. The ADVANCE expert workshop will dig deeper into this topic with a focus on energy efficiency in buildings. It will bring together external experts and stakeholders to discuss technological and behavioural options to increase energy efficiency in buildings as well as demand management options to support grid integration of VRE. The workshop will be held on 20-21 January 2015 in Utrecht, the Netherlands.

ADVANCE consortium

- Potsdam-Institut für Klimafolgenforschung (PIK), DE
- Internationales Institut für angewandte Systemanalyse (IIASA), AT
- Ministerie van Infrastructuur en Milieu (PBL), NL
- Fondazione Eni Enrico Mattei (FEEM), IT
- JRC - Joint Research Centre - European Commission (IPTS), ES
- University College London (UCL), UK
- Société de Mathématiques Appliquées et de Sciences Humaines (SMASH), FR
- University of East Anglia (UEA), UK
- Institute of Communication and Computer Systems (ICCS), GR
- Université Pierre Mendès France (UPMF), FR
- Norges Teknisk-Naturvitenskapelige Universitet (NTNU), NO
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), DE
- Universiteit Utrecht (UU), NL
- Enerdata SA (NRD), FR

Associated collaborators

- Pacific Northwest National Laboratory (PNNL), USA
- National Center for Atmospheric Research (NCAR), USA
- National Institute for Environmental Studies (NIES), JP
- Research Institute of Innovative Technology for the Earth (RITE), JP

ADVANCE contacts

Project coordination
Dr. Gunnar Luderer and Dr. Elmar Kriegler, project leaders
Laura Delsa, project manager

Potsdam Institute for Climate Impact Research
Telegraphenberg A 31
P.O. Box 60 12 03
D-14412 Potsdam

Phone: +49 331 288 25 28
E-mail: delsa@pik-potsdam.de
www.fp7-advance.eu

This research receives funding from the European Union Seventh Framework Programme FP7/2007-2013 under grant agreement n°308329 (ADVANCE). This publication reflects only the view of the ADVANCE consortium and does not represent the opinion of the European Community nor is the European community responsible for any use that might be made of the information/data appearing herein.