EUROPEAN COMMISSION
DIRECTORATE-GENERAL
JOINT RESEARCH CENTRE
Directorate A – Strategy and Work Programme Coordination

CDP Theme

Energy and Transport Modelling

Background on the JRC research

The European Commission makes extensive use of modelling capacity to prepare its policies. To assess the impact of energy, transport and climate change policies, it applies extensive models.

The JRC has accumulated over the last 5 years a considerable experience and expertise in the conceptual development, maintenance and exploitation of economic/energy and transport models that can project energy consumption, air pollutants and greenhouse gas (GHG) emissions, covering in particular detail sectors such as transport and energy supply on a global scale as well as on a Member States level. Furthermore, the JRC is using macroeconomic modelling tools to look at the economic impacts of policies and climate change, see footnote.

In order to insure the highest quality in terms of inputs and methodologies applied, the modelling tools are constantly undergoing revision, updates and enhancements. To this end research is needed that can successfully contribute to the improvement of the models and the analytic capability of the JRC. This consequently will contribute to enhance the quality of the impact assessments of European energy, transport and climate change related policies.

The models in use at the JRC range from detailed energy system models for the EU (POTEnCIA) over global energy models including global fuel markets and resources as well as covering global greenhouse gas emissions (POLES) or emissions due to the use of specific fuels or vehicles (Well-to-Wheels), to macroeconomic computable general equilibrium models (GEM-E3).

Ongoing key projects and research

With regard to energy modelling, the JRC is active at different scale levels, from the level of the EU28 energy system to questions related to the integration of individual assets.

Furthermore JRC can model the interaction of the energy sector with other sectors with an impact on energy (e.g. global energy system and macroeconomic, dispatch, energy systems integration, *Note: There are many examples where quantitative analysis has been used to prepare specific EU policy Communications, e.g.: Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020 (COM(2008) 16, COM(2008) 17, COM(2008) 19), A Roadmap for moving to a competitive low carbon economy in 2050 (COM(2011) 112 final). Furthermore EU policy preparation in the context of international negotiations also requires modelling input, e.g.: Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond (COM(2007) 2 final), Towards a comprehensive climate change agreement in Copenhagen (COM(2009) 39 final), The Paris Protocol – A blueprint for tackling global climate change beyond 2020 (COM(2015) 81 final).*

transmission-distribution grid for electricity and gas, transport models , energy market, energy consumer/prosumer, smart grid interoperability, grid interoperability, energy efficiency (general and in buildings), renewable energy, biomass, advanced traffic, etc.)

With regard to transport modelling, the work of JRC covers traffic simulation, vehicle simulation, fleet impact models, technology innovation models, models that can capture the relation between alternative fuels infrastructure and vehicles, vehicle-to-grid aspects, GHG emissions and air quality impact modelling, vehicle/traffic modelling, application of big data techniques. Modelling is carried out at different scales, from the activity/behaviour of the single vehicle/driver, to the detailed analysis of urban/regional scale contexts, to the application of large scale modelling tools for the long-term planning in the transportation sector.

The energy and transport models are complemented by other models used for studying specific questions such as price taker models for assessing the value of generation or storage in real market situations and meteorological and statistical models for understanding the behaviour of renewable energy.

Together the energy and transport sectors generate a large proportion of EU emissions of atmospheric pollutants. As a number of recent studies (WHO, OECD, UNECE) have indicated poor air quality is the biggest environmental cause of premature mortality, as well as having non-negligible effects on vegetation (agriculture) and climate. As these costs are not always fully factored into energy and transport modelling assessments, a fruitful sub-topic for the Energy and Transport heading is the improvement of the linkages between energy and transport modelling, emissions and the resulting impacts of the emissions on air quality. JRC has developed tools at the global scale: the EDGAR emissions database and TM5-FASST scenario screening tool, as well as at the urban-regional scale: SHERPA. The 40 year time-series of EDGAR permit analysis of possible global impacts of European air quality improvements in different industrial sectors. The EDGAR database also includes both air pollutants and also greenhouse gases. Greenhouse gas inventories are evaluated with in-situ atmospheric measurements making use of atmospheric transport models to provide independent verification of climate policies both within the EU28 and also globally. Coupled with the FASST tool swift and ad-hoc impact assessment of air pollutant emissions in a regional - global framework are possible. At the urban-regional scales, the SHERPA screening tool is designed to support policy makers in assessing the impact of emission abatement plans (transport, housing, agriculture.) on air quality. A particular application of these tools is in support of EU macro-regional-strategies, such as the EU Strategy of the Danube Region, which includes states with some of the greatest difficulties with air pollution in Europe, as well as states that have among the most effective air pollution control strategies. Pilot studies on the contributions to air pollution from different sectors, and how to abate them, are being undertaken together with the local scientists. The Directorate has supervised in the last 5 years 6 PhD's in related fields.

The focus of the research is to understand the global energy system by modelling at different scales and different degree of granularity. Many detailed areas of research can be mentioned:

- The implications of technology innovation on future transport decarbonisation pathways
- The system impact of renewable energy and the integration of intermittent resources.
- Study effectiveness of policy measures for decarbonisation
- Shift towards alternative fuels (incl. electro-mobility)
- The role of flexibility and storage technologies (e.g. decentralised storage) within a future decarbonised power system with high shares of renewable energy.
- The role of heating and cooling technologies in the decarbonisation of the energy system
- The use of Energy grids models (electricity and gas) in the definition of infrastructure investments, risk and emergency plans, and wholesale market provisions
- The interactions between the retail market, the distribution operators, new market actors and the consumers/prosumers
- Interoperability in smart grids and with other energy and transport systems
- Impacts of transport technology transitions and intelligent/autonomous road transport on traffic, air quality, and EU energy target achievement (e.g. decarbonisation, security, etc.)
- Assessment of cost, energy and GHG saving due to the use of alternative fuels.
- Comprehensive assessment of electro-mobility related aspects
- Assessment of PV resources and their cost-effective conversion via geospatial renewable information tool
- Assessment of PV electricity self-consumption by household and industrial consumers with and without battery storage
- Study opportunities provided by Renewable energies for the low carbon society will be assessed by means of geographical analysis (GIS) and technological insights (EU and global).
- Developing and updating the European Energy Efficiency Platform (E3P), the open web platform that will provide the energy efficiency community with an EU one-stop-shop delivering data and analysis on energy efficiency policies and technologies

Selected output for science and policy

Policy reports:

Climate Impacts in Europe. The JRC PESETA II Project EUR, 26586 EN

Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014. Efficiency Trends of Energy-related Products and Energy Consumption in the EU-28. EUR 27972 EN

Supporting the deployment of selected low-carbon technologies in Europe, Implications of techno-economic assumptions. An energy system perspective with the JRC-EU-TIMES model, EUR 27608 EN

Well-to-Wheel Analysis of Future Automotive fuels and Powertrains in the European Context, Well-to-Wheels - Version 4.a

Peer reviewed papers:

A. Moro, E. Helmers, A new hybrid method for reducing the gap between WTW and LCA in the carbon footprint assessment of electric vehicles, *The International Journal of Life Cycle Assessment*, 2017, 22: 4–14. http://dx.doi.org/10.1007/s11367-015-0954-z.

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I. González-Aparicio, A. Zucker, Impact of wind power uncertainty forecasting on the market integration of wind energy in Spain, *Applied Energy*, 2015, 159: 334-349, http://dx.doi.org/10.1016/j.apenergy.2015.08.104.

S. Quoilin, K. Kavvadias, A. Mercier, I. Pappone, A. Zucker, Quantifying self-consumption linked to solar home battery systems: Statistical analysis and economic assessment, *Applied Energy*, 2016, 182: 58-67, http://dx.doi.org/10.1016/j.apenergy.2016.08.077.

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S. Simoes, W. Nijs, P. Ruiz, A. Sgobbi, C. Thiel, Comparing policy routes for low-carbon power technology deployment in EU – an energy system analysis, *Energy Policy*, 2016, in press, http://dx.doi.org/10.1016/j.enpol.2016.10.006.

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Hosting Directorate

Directorate: Energy, Transport and Climate (DIR C)