HELMHOLTZ ASSOCIATION

Alliance ENERGY-TRANS

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

ZEW Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

Energy Transition in Germany: External Perspectives and EU-Integration

Technical and economic effects of the European power system integration

Yvonne Scholz, Frieder Borggrefe, Felix Cebulla (DLR-S)
Dominik Schober, Oliver Woll, Nikolas Wölfing (ZEW)

Germany lies in the centre of Europe and its energy and especially power supply has physical as well as financial and legal interdependencies with the surrounding states: market liberalisation meets limited interconnector capacities; market power can be used for raised supply bids at stock markets and can be a mover for firm expansion plans. This project has three sub-projects which aim at investigating the German-European interdependencies.

Objectives

- Analysing medium to long term **power and money flows** to and from Germany with a high temporal and spatial resolution energy system model (DLR-S).
- Applying methods of **functional data analysis to Actual Supply & Demand Curves** from European power exchanges (ZEW).
- Analysing the effect of European market integration on **Merger & Acquisition activities** of firms (ZEW).

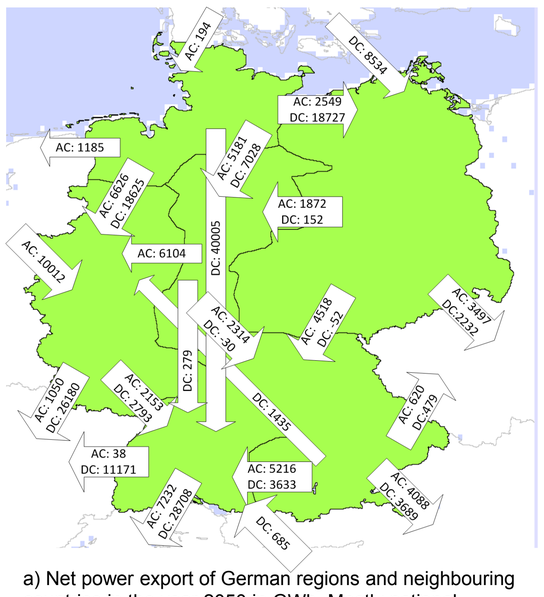
This poster focuses on the **power and money flows** to and from Germany in different scenarios of the European energy system development.

Method

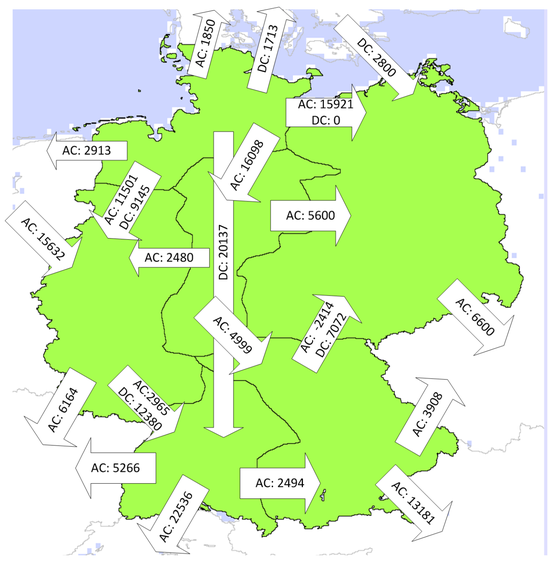
1) Scenario definition (installed power generation capacities)
2) Develop a method to derive cross-border money flows from REMix model results (see box on the right hand side)
3) Linear optimisation model application:
   1) power plant dispatch → marginal costs → money flows
   2) Storage dispatch (and dimensioning)
   3) Transmission (dimensioning and) dispatch → power flows
4) Sensitivity to parameter variations related to socio-technical scenarios

Exemplary results

Two descriptors from the socio-technical scenarios developed as a cross-cutting cooperation within ENERGY-TRANS that have major influence on the power and money flows in and over the borders of Germany are a) Development of the power grid (in Germany) and b) International integration of power grids. The figures below show two REMix results in which these influencing factors have been varied. Annual power flow balances for Germany are shown for two scenarios of the European power supply with high renewable energy shares.



a) Net power export of German regions and neighbouring countries in the year 2050 in GWh. Mostly national, fluctuating renewables in European countries. (Scenario described in [1]).



b) Net power export of German regions and neighbouring countries in the year 2050 in GWh. National renewables combined with power from CSP plants in North Africa. (Scenario described in [1]).

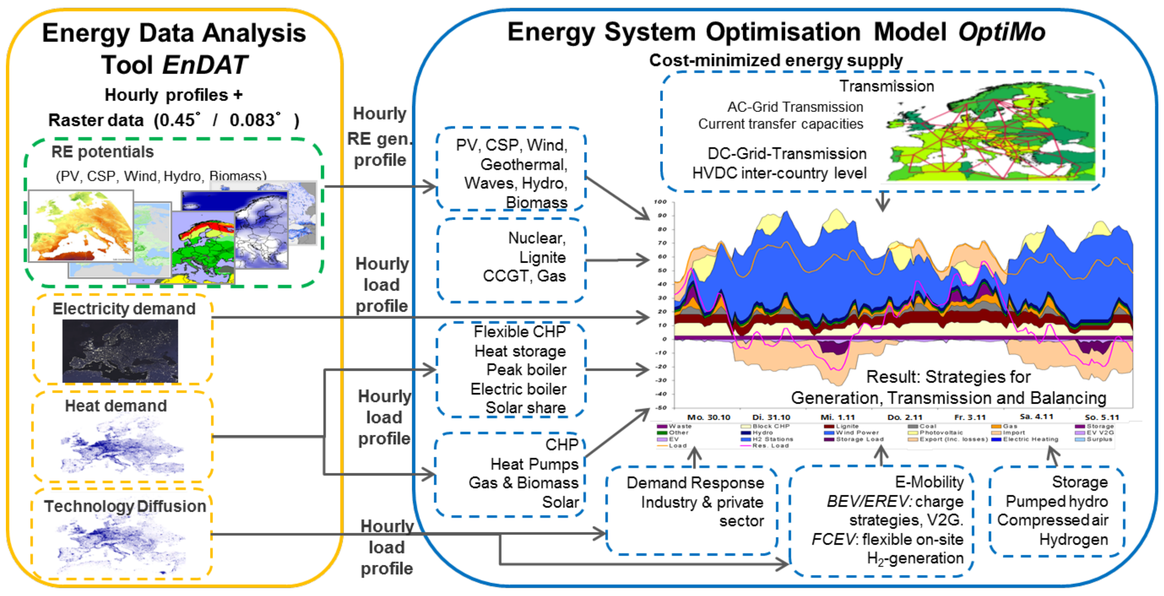
a) Net export from Germany in both scenarios.
b) CSP import → less wind power in Germany → reduced export.

Outlook

- Further sensitivities of conventional power plant models
- selection and parameterisation of a conventional power plant model
- Definition of scenario variations related to socio-technical scenario descriptors
- Analysis of power and money flows in selected scenario variations

REMix model enhancement

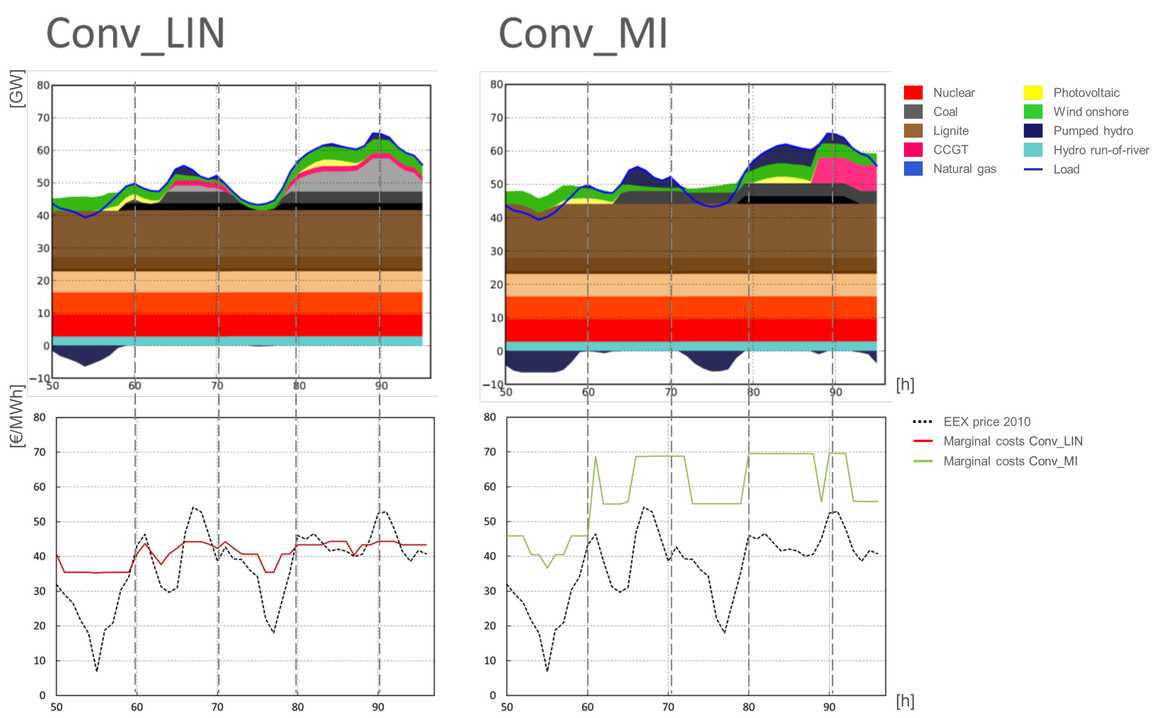
F. Cebulla, Ph.D candidate, Helmholtz Research School on Energy Scenarios.
In collaboration with Dominik Schober, Oliver Woll (ZEW).



Scheme of the energy system model REMix (Renewable Energy Mix for sustainable Energy Supply)

Cross-border money flows can be calculated from REMix power flow and marginal cost times series, if modelled marginal costs can significantly be related to stock market prices.
Aim: Relate marginal power cost (REMix results) to stock market prices.
Approach: Model adaptation and comparison of marginal costs (model results) with stock market prices. Performance index: EEX spot market prices

I. 'Conv_MI': mixed integer modelling → uptime, downtime, ramping constraints, ambient temperature influenced efficiency, part-load behaviour- and efficiencies for power plant units or classes
II. 'Conv_LIN': parameter variations with the current, linear model



Interim results

a) Detailed model of conventional power plants 'Conv_MI' implemented and operational
b) Conv_LIN does not 'see' cost/price valleys; it operates conventional power plants continuously in order to prevent ramping costs
c) Minimum granularity of power plant classes for mixed integer modelling not yet met by Conv_MI, → overestimation of marginal costs, too big 'cost jumps'.

Contact: yvonne.scholz@dlr.de

References: [1] Scholz, Y., Gils, H.C. et al. 2014: 'Möglichkeiten und Grenzen des Lastausgleichs durch Energiespeicher, verschiebbare Lasten und stromgeführte KWK bei hohem Anteil fluktuierender erneuerbarer Stromerzeugung', BMWi, http://opac.tib.uni-hannover.de/DB=1/SET=2/TTL=1/MAT=/NOMAT=T/CLK?IKT=12&TRM=792483081