Synergistic approach of Multi-Energy Models for a European Optimal Energy System Management Tool

Sandrine Charousset (EDF, plan4res Coordinator)
plan4res Consortium

- ÉLECTRICITÉ DE FRANCE SA (EDF)
- IMPERIAL COLLEGE LONDON (IMPERIAL)
- SIEMENS AG, CORPORATE TECHNOLOGY (SIEMENS)
- CRAY COMPUTER GMBH (CRAY)
- ZUSE INSTITUTE BERLIN (ZIB)
- RWTH AACHEN UNIVERSITY (RWTH)
- CONSORZIO INTERUNIVERSITARIO PER L’OPTTIMIZZAZIONE E LA RICERCA OPERATIVA (ICOOR)
Context of the project: European objectives

2050 EU’s carbon reduction targets ⇒ High share of Renewable Energy

Criteria for the European Energy System in 2050:
✔ Sustainability
✔ Security of supply
✔ Competitiveness

Source: Decarbonization Project Team; http://www.electricitymap.org/
What did the H2020 Call required?

- **The Challenge**: contribute to targets for the reduction of emissions by creating tools that will help enhancing the flexibility of the energy system.

- “A Novel European grid and end-to-end energy system planning tools, including foreseeable features such as storage, aggregation, demand-response and integrating cost aspects”
  - End-to-end: from generation to consumption, via transport and distribution
  - Focused on the electricity system.... and coupling with other energies (gas, heat)
  - Tools for planning, integration and operation
plan4res storyline

Facing European targets for reduction of greenhouse gas emissions while maintaining high quality of supply and low cost

⇒ Electricity: Increase Share of renewable
⇒ Other Energies: move uses to low emission energy sources

⇒ Maximise the grid capacity to host renewable by optimising the best balance between infrastructure investments and optimum use of all assets
⇒ Maximise the use of all available flexibilities including traditional (generation plants...) and emerging (distributed assets, multi energy synergies...)

plan4res assumption: an integrated representation of the system is necessary in order to achieve the objectives with the lowest cost

Net CO₂ by point of emission (Gt CO₂ p.a.)
What plan4res will deliver:

- An end-to-end planning and operation tool, composed of a set of optimization models based on an integrated modelling of the pan-European Energy System;

- An IT platform for providing seamless access to data and high performance computing resources, catering for flexible models (easily replacing submodels and the corresponding efficient solution algorithms) and workflows;

- A database of public data

- 3 case studies highlighting the tool’s adequacy and relevance.
Investment

Multimodal Investment Model
(Along pathway considering sector coupling)

Capacity Investment Model
(Stochastic investment planning with transport)

Transmission Grid Expansion Model
(Stochastic expansion planning)

European Unit Commitment Model
(Aggregated Modelling of Transmission grid
Electricity + MultiEnergy assets contributing to electricity grid flexibility services)

Clustering Transmission Grid

Scenario Valuation

- Reservoirs Mid-Term Management
- "Water values"

- Energy Mix / new clustered grid
- Aggregated Grid

- Energy Cell Generation
- Heat Submodel
- E-Mobility Submodel

- Marginal costs

- Schedules

Schedules, Dispatch Constraints

Transmission Grid Operation Model

Transmission Grid expansion measures

Gas Network Model
plan4res Case Studies

- **Strategic development of pan-European network without perfect foresight** and considering long-term uncertainties

- **Cost of RES integration and impact of climate change for the European Electricity System** in a future world with high shares of renewable energy sources

- **Multi-modal European energy concept for achieving COP 21 goal** with perfect foresight, considering sector coupling of electricity, gas, heat and transport demand
Thank you