Overview - Scope of Case Study 3

Objective of the Horizon2020 project plan4res will provide a well-structured and highly modular modelling framework to enable consistent insights into the different needs of future energy system. Three case studies will highlight the potentials of this framework by dealing with different aspects of a future energy systems (compare [1]).

Overall Objective

Identifying the 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 will be the main focus of case study 3. The objective is to assess the plan4res framework to capture:

- The cost of RES integration
- The value of different flexibility services
- The impact of climate change

Target Users

The use case will be useful for national and European authorities or for electricity utilities to inform critical planning and policy decisions in Europe regarding intermittent RES development.

Detailed Description

Case study 3 will focus on the Pan-European electricity sector in the single year, e.g. 2050 and include the countries which are shown in the figure below. Countries are divided into 'clusters' represented by different colours.

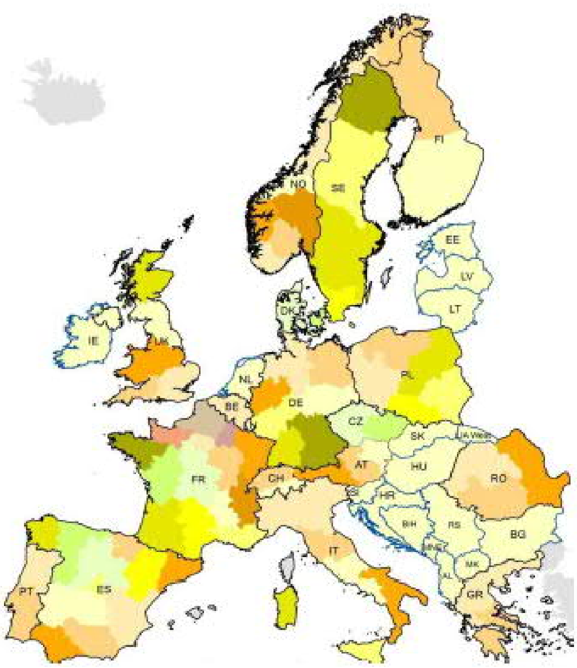

Figure 1. Countries and sub-country clusters (colours) modelled in case study 3.

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In order to obtain the total system costs we have to determine the fixed and variable costs. As we simulate only one single year, we will compute annual costs:

- Annual fixed costs are the annualized investment costs and the annual fixed operational costs
- Variable costs are the annual power plant operational costs (fuel & CO_2 emission price)

To compute these costs several models will be implemented in plan4res:

- ***Capacity expansion model:***

The capacity expansion model will compute a better or ideally optimal set of assets including electric generation plants, storages, interconnection capacities between clusters and distribution grid capacities, for the considered time horizon (the year 2050). Here optimal means, providing the least-cost set of assets, while accounting at best for the modelled constraints.

- ***Scenario valuation layer:***

The Scenario valuation layer will evaluate the investment decisions from the capacity expansion model by means of modelling the operation of the existing assets in the energy system. This layer contains two distinct models, the first model will be referred to as the seasonal storage valuation model and the second model will be the European unit commitment (EUC) model.

The objective of the seasonal storage valuation model is to provide an accurate account of "the value" that seasonal storage can bring to the system. Indeed, such seasonal storage (e.g., cascaded reservoir systems) can be used to store energy over large spans of time and use this "stored" energy when most needed.

The EUC model will compute an optimal (or near optimal) schedule for all the system assets satisfying the set of constraints:

- Supply power demand and ancillary services
- Minimal inertia in the system
- Maximum transmission and distribution capacities between clusters
- Technical constraints of all assets

Expected results

We expect the following results:

- Impact of different levels of RES integration on the European system costs broken-down by categories: total, generation (investment and operational), transmission and distribution
- Value of flexibility: system cost reduction coming from using the flexibility potentials of the different system assets. This will be computed by simulating different configurations:
    - RES can be represented as non-flexible, i.e. all generation is 'fatal' or we can account for their ability to be curtailed or to contribute to ancillary services
    - flexibilities from storages and additional storages can be represented

- different demand response flexibilities can be modelled
- Impact of climate change on system costs

Scope of Technologies

Case study 3 only deals with the electricity sector:

- Nuclear and thermal (coal, lignite, gas …) power plants
- Renewable generation (Wind, PV, biomass, hydro …)
- Electric transmission and distribution grid
- Storages: including batteries and e-mobility

Methodology

The results will be obtained by comparing several scenarios:

- For assessing the costs of RES integration, the model will be run without optimising the RES share, but using given levels of RES generation
    - High share of RES (reference scenario)
    - Low share of RES (sensitivity analysis, for example using 0%, 25%, 50% and 75% of the levels in the e-Highway2050 'Large-scale RES' scenario)
- For assessing value of flexibility :
    - 'No flexibility' in the initial scenario (no additional flexibility from, e.g. batteries, demand response, etc.)
    - Addition of flexibilities individually, and collectively among different kinds of storages (2 types: hydro and battery) and demand response (2 types: load shifting and load curtailment)
- For assessing the impact of climate change :
    - Simulation with present climate variables (temperature, hydro inflows and PV and wind power generation profiles)
    - Simulation with projected future climate variables (temperature, hydro inflows and RES generation profiles in 2050)

References

[1] Horizon 2020 project plan4res ,2018, "Deliverable D2.1 Definition and requirements of three case studies"; pdf downloadable at www.plan4res.eu