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

How climate services will contribute to energy system simulations

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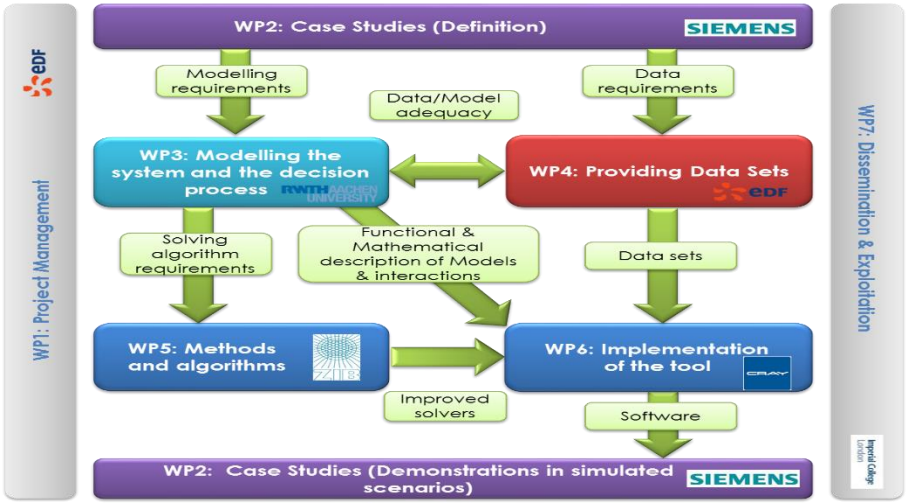
plan4res Consortium

H2020 project
Nov 1, 2017 – Oct 31, 2020



- 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)

European objectives

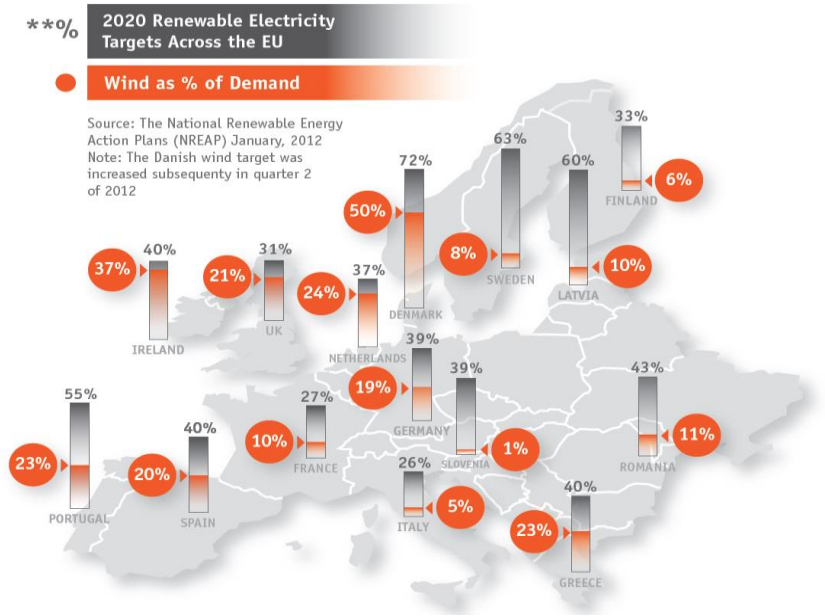
2030 and 2050 EU's carbon reduction targets

⇒ High share of Renewable energy

At least 27% RES-E

40% Reduction in GHG emission

27% increase in energy efficiency



Criteria for the European Energy System in 2050:

- ✓ **Sustainability**
- ✓ **Security of supply**
- ✓ **Competitiveness**

EVOLUTION OF RES INTEGRATION IN EUROPE

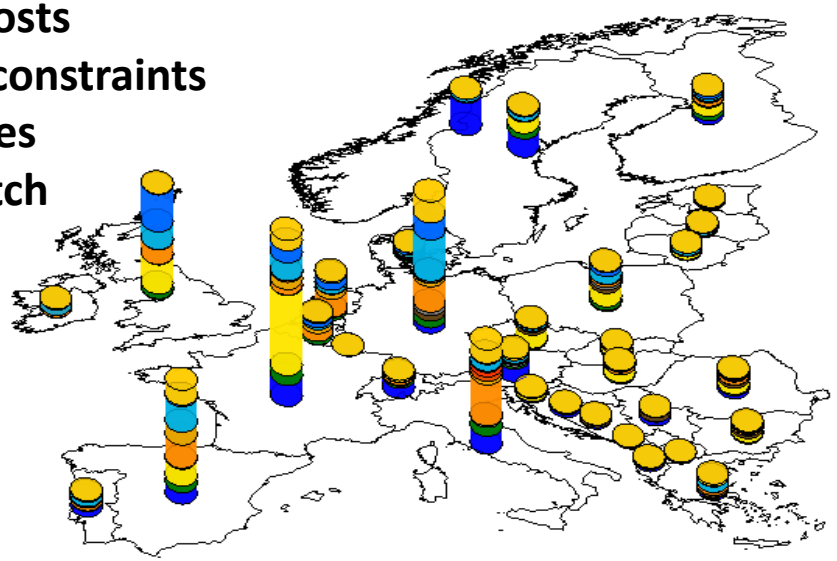
plan4res objectives

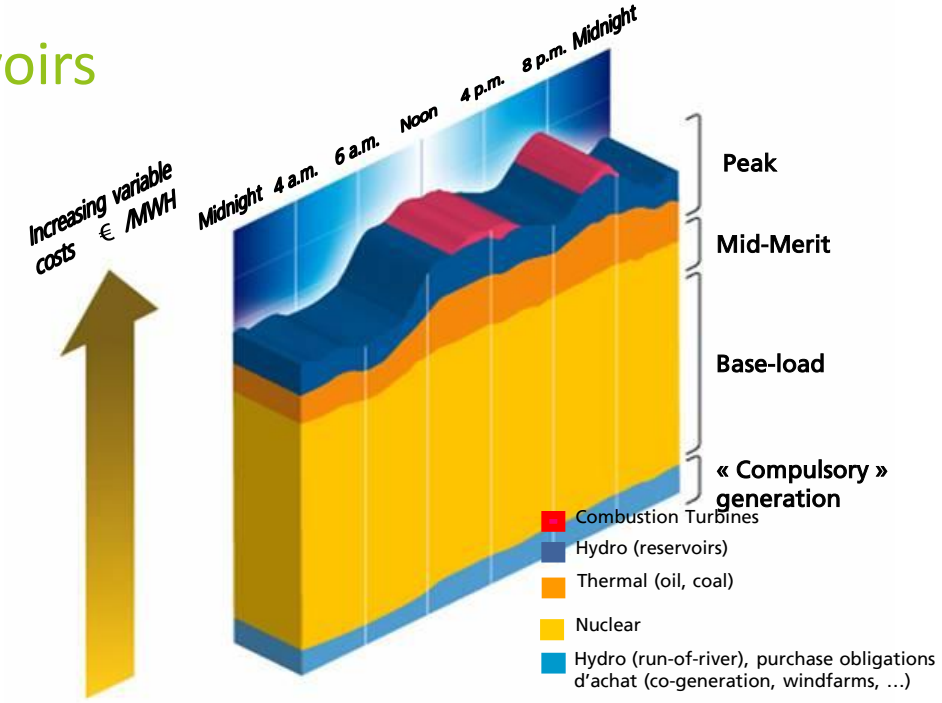
- **End-to-end planning and operation tool for the Plan-European Energy System**
  - ***Focused on the Electricity European System, with its interactions with other energy vectors : electricity, gas, heat, cold, mobility***
  - ***Realistic representation of the system operation : dynamics, operationnal constraints, interconnections…***
  - ***Variable renewable integration***
  - ***uncertainties modelling, especially related to climate***
  - ***End-to-end : from generation to consumption***

Energy Management tools

❑**Operation** : What are the optimal schedules for all generating plants ? What is the best strategy for reservoirs management in Europe?

- ➢**Satisfying the equilibrium between Generation and Demand**
- ➢**In each area, taking care of the interconnection constraints**
- ➢**Minimising generation costs**
- ➢**Respecting all technical constraints**
- ➢**Dealing with uncertainties**
- ➢**Reserve provision Dispatch**





Merit order of generation means
Example of a high consumption on a winter day, in France

Energy Management tools

- **Planning**: What is the optimal energy mix?
  - **Generation Assets**
  - **Storage**
  - **Demand response**
  - **Transmission Grid expansion**
  - **Distribution network reinforcement**
  - **Location**

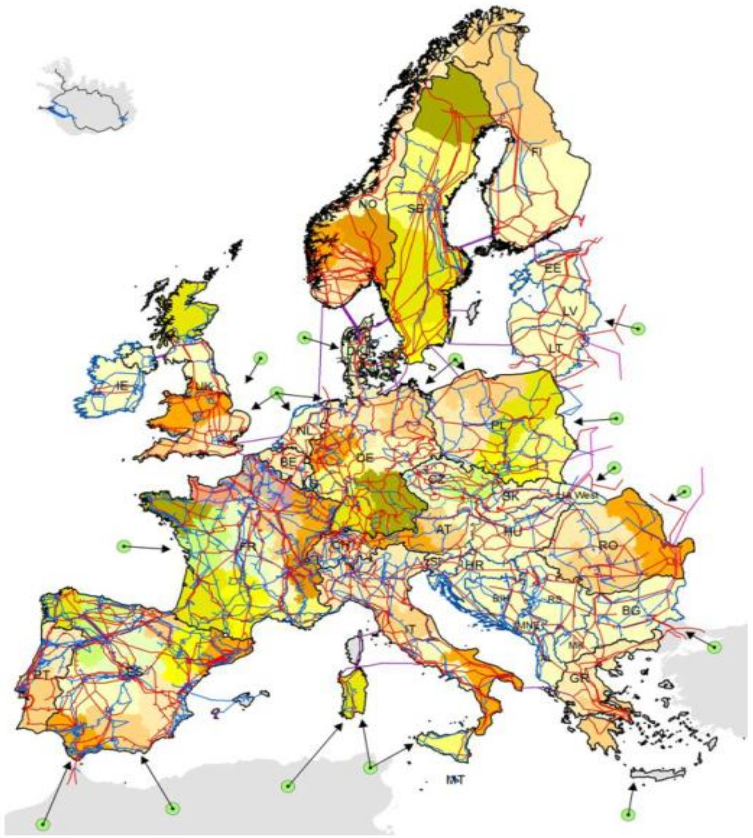


Figure 20: Geographic clustering

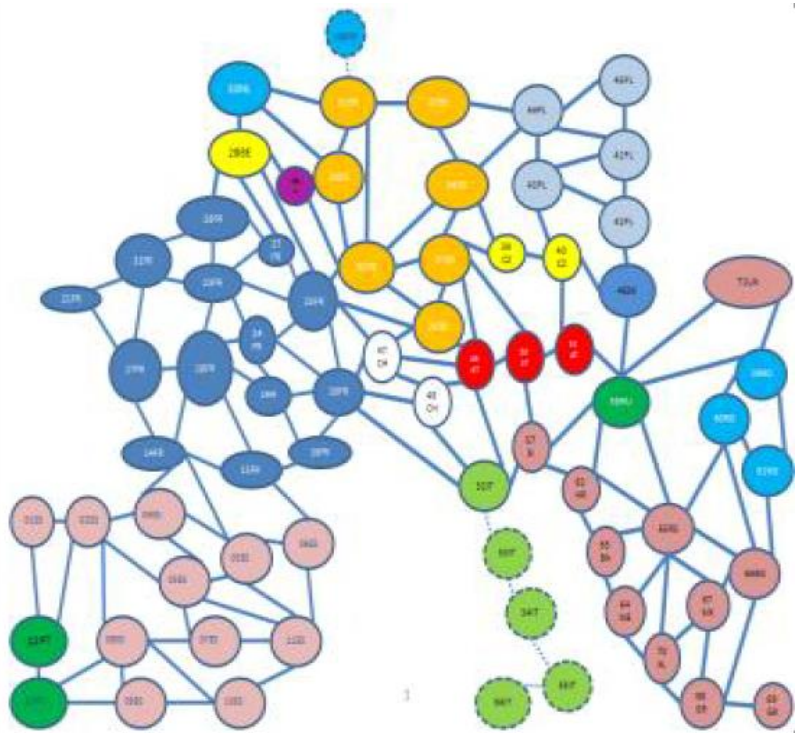


Figure 21: Cluster model for continental Europe

Why do we need new planning tools?

- **High share of Renewable (RES)**
  - **Unpredictable (or less predictable)**
  - **Intermittent**

  ⇒ Increased need for flexibility and flexibility sharing in europe
  ⇒ Grid and Generation/Storage assets will evolve towards a system designed to maximise its capacity to host such amounts of RES.

- **New distributed (connected to DSO) flexibility resources**

  ⇒ Coordination of centralized and distributed flexibility resources
  ⇒ From a 'country' level to a 'region' level in planning tools
  ⇒ Local resources will provide services to the grid

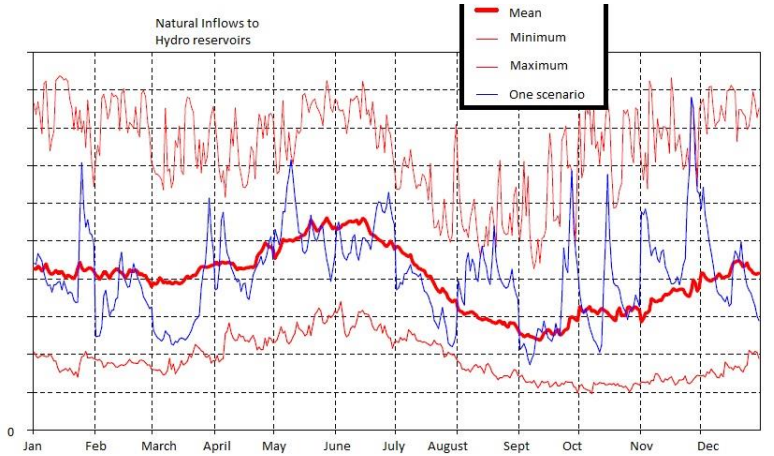
plan4res assumption : an integrated representation of the system is necessary for all the actors of the energy system

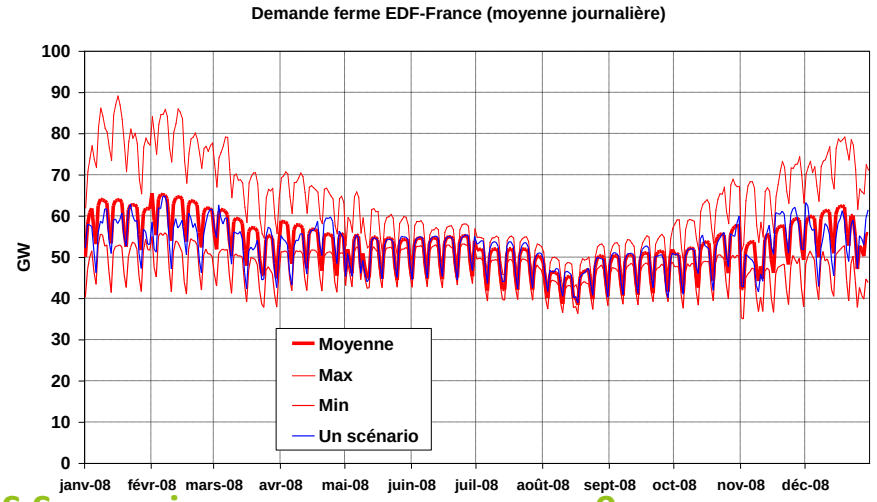
What plan4res will deliver:

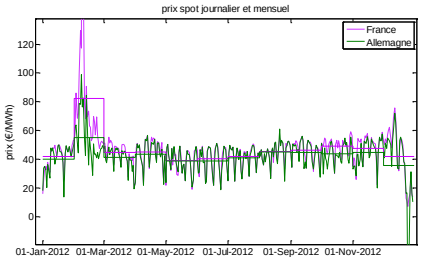
- An end-to-end planning and operation tool, composed of a set of optimization models based on an integrated modelling of the pan-European Energy System;
- An IT platform for providing seamless access to data and high performance computing resources, catering for flexible models (easily replacing submodels and the corresponding efficient solution algorithm) and workflows;
- A database of public data
- 3 case studies highlighting the tool's adequacy and relevance.

Uncertainties and Energy Management

- **Climate uncertainties**
  - Temperature => impact on demand /Generation capacity
  - Wind => windpower generation
  - Sun => PV
  - Natural Inflows to reservoirs => hydroelectricity capacity
- **Technical uncertainties**
- **Market uncertainties**







ECEM for building data sets

Profiles :

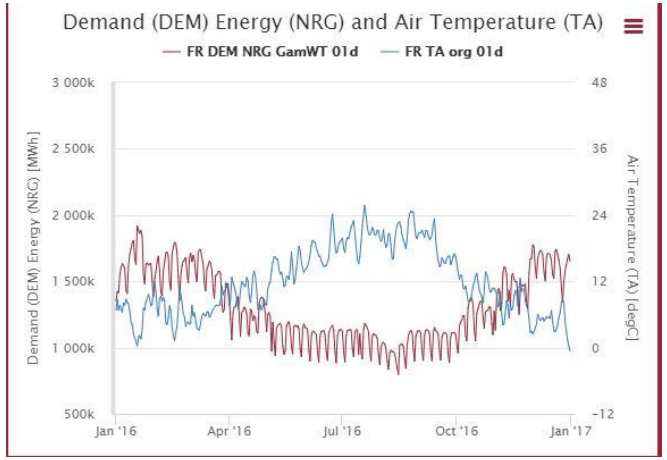
- electricity demand
- Renewable generation (capacity factors)
- Run of river and inflows

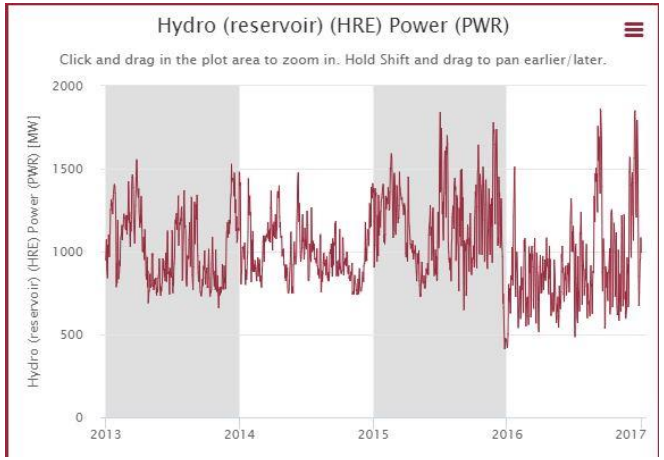
Geographical scale :

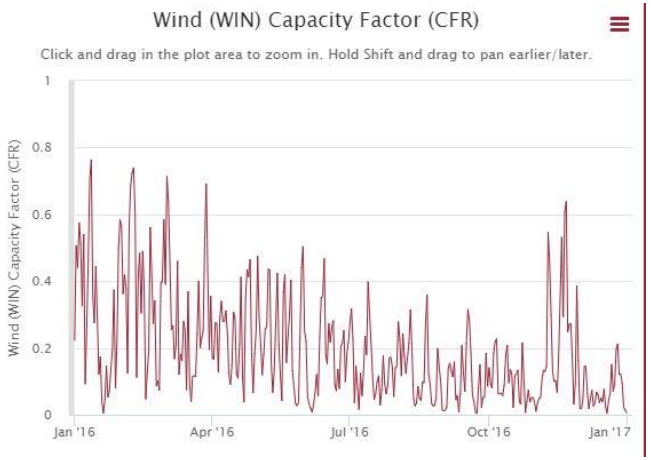
- country
- clusters
- ‘local system’

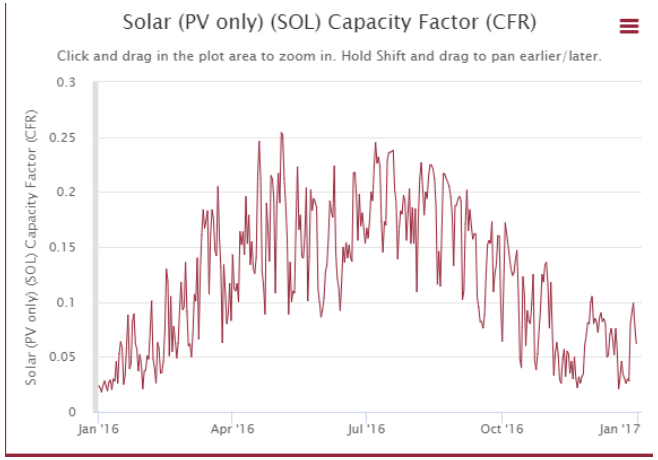
Uncertainties :

- ECEM scenarios
- Statistical models









Example of Case Studies

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

Impacts of climate changes

- **plan4res will use ECEM 2050 projections with/without climate change impact**
  - **Level and variability**
  - **energy demand (e.g. temperature)**
  - **energy generation capacity (wind speed, solar radiation, precipitation …)**
- **What are the impacts of climate change?**
  - **On the 'optimal' energy mix?**
  - **On the operation of the system**
  - **On costs**

To know more

www.plan4res.eu

First Stakeholder Workshop

April 11, 2018, EDF'Lab Paris Saclay

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Thank you

Questions?

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