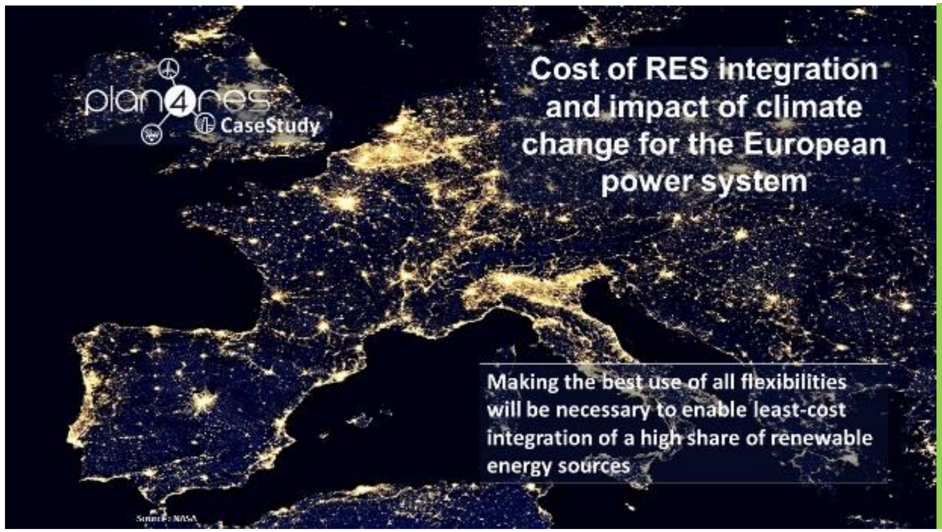

Case Study 3:
Assessing Feasibility of Scenarios, cost of Renewable integration and value of flexibilities for the European electricity system

by S. Charousset, 20 May ’21;

Joint work of:

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- Antonio Frangioni, Rafael Lobato, Ali Ghezelsoflu, Nicollo Iardella (Pisa)
- Utz-Uwe Haus, Alfio Lazzaro (HPE)

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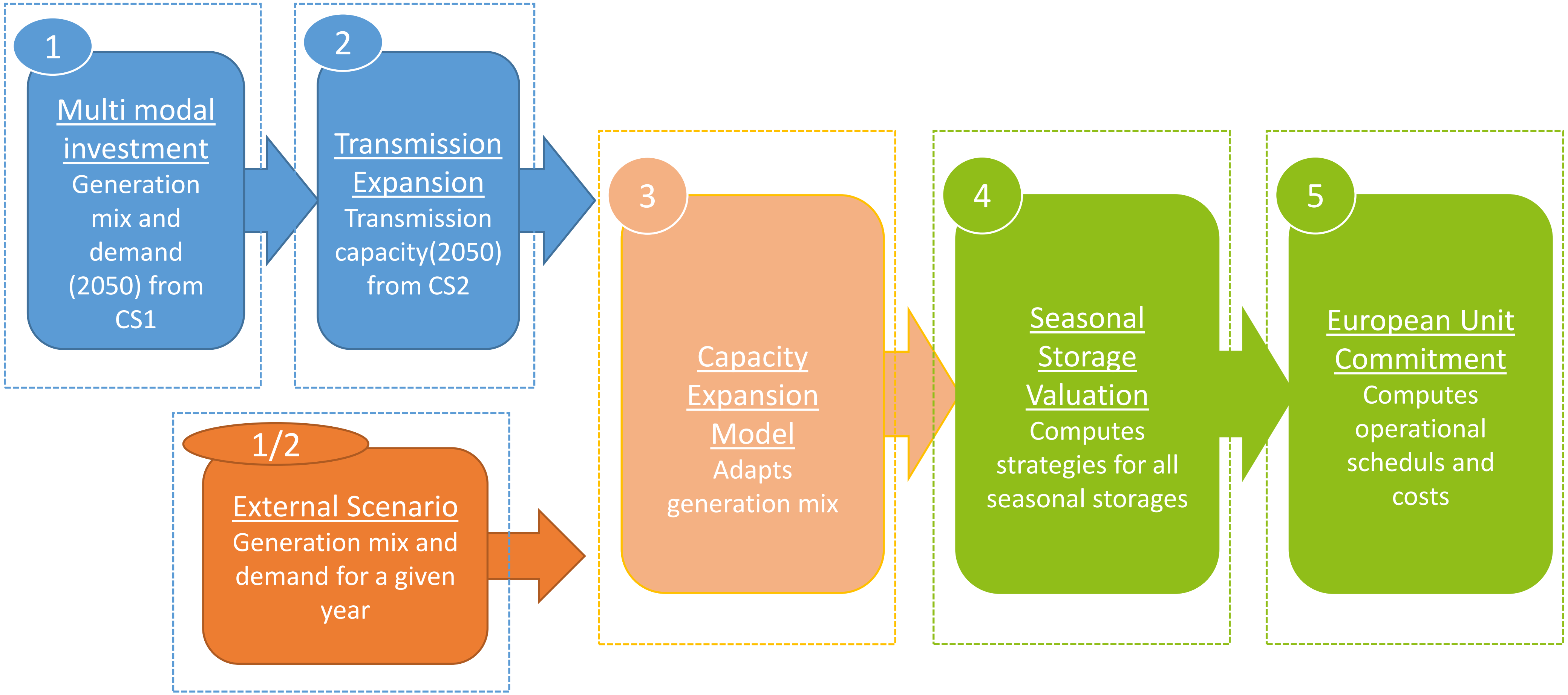
CS3 - Objectives

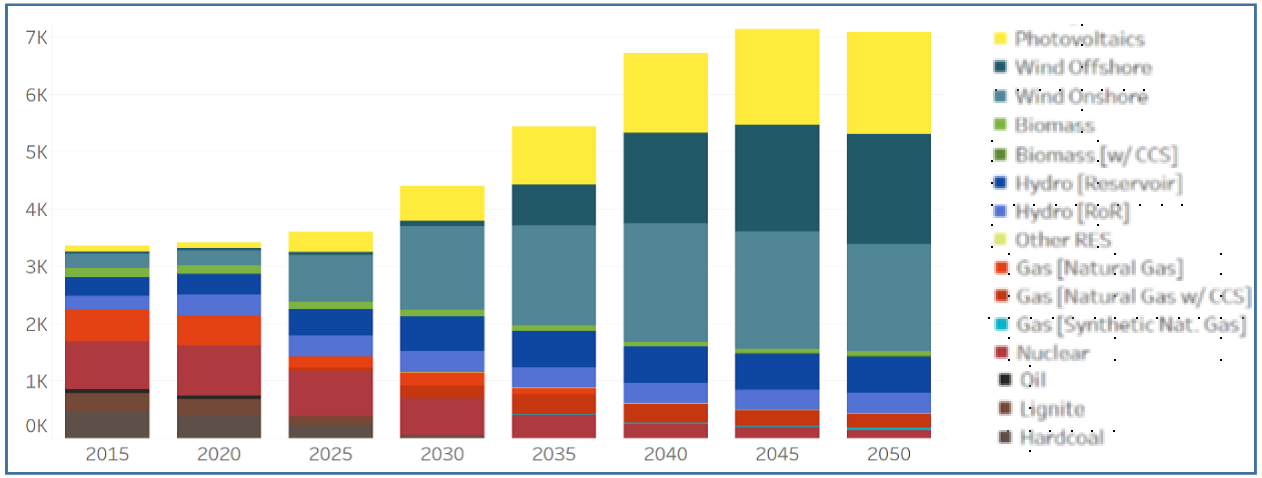
- Case study 3 focuses on the Pan-European electricity sector in 2050
- **The objective of this case study is to assess the plan4res tool's ability to capture**
  - **The feasibility of a given (external) Scenario for the electricity system**
    - With uncertainties
    - Taking into account technical constraints, including dynamic robustness
  - **The Impact of different levels of RES integration on the European system costs**
    - Electricity generation cost
    - Cost to ensure the dynamic robustness of the system (Reserves, Inertia)
  - **The Value of different flexibility services: system cost reduction coming from using the flexibility potentials of the different system assets.**
    - Examples from
      - Storage
      - Interconnections
      - Thermal generation

CS3 - Methodology



Scenario : openENTRANCE technoFriendly 1.0

- Power Sector:
  - Decarbonized
  - Steady increase of Wind and PV
  - Significant reduction of Fossil (oil & gas)
  - CCS
- Demand:
  - Electrification of heat
  - Reduction of gas
  - Increase of elec transport



Electricity Generation (TWh)

Source: openEntrance D3.1, D7.1

www.openentrance.eu

Climatic data: Copernicus C3S Energy

- Scenarised hourly time series over 1 year for:
  - Electricity demand per region
  - Load factors per region:
    - PV Power
    - Onshore WindPower
    - Offshore WindPower
  - Inflows to reservoirs per countries

opernicus
Europe's eyes on Earth

Climate
Change Service

https://climate.copernicus.eu/operational-service-energy-sector

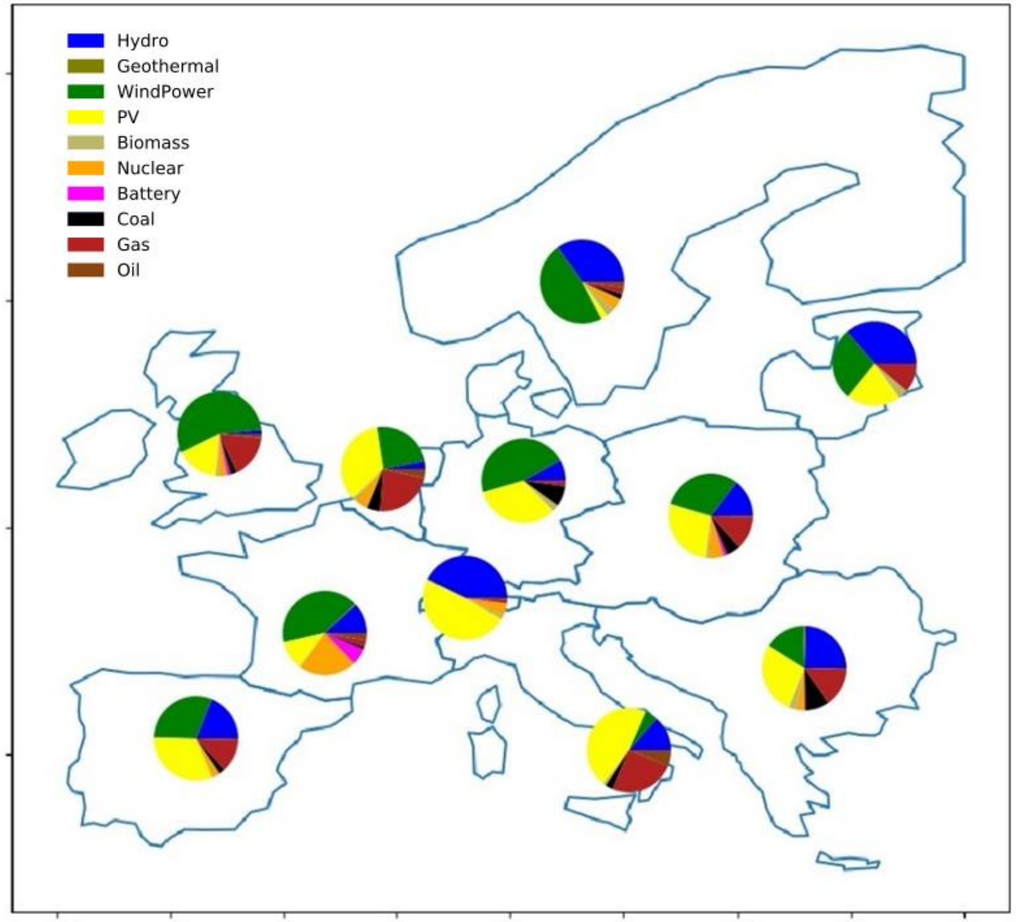
plan4res

The dataset used

❑ openENTRANCE technoFriendly 1.0, 2030

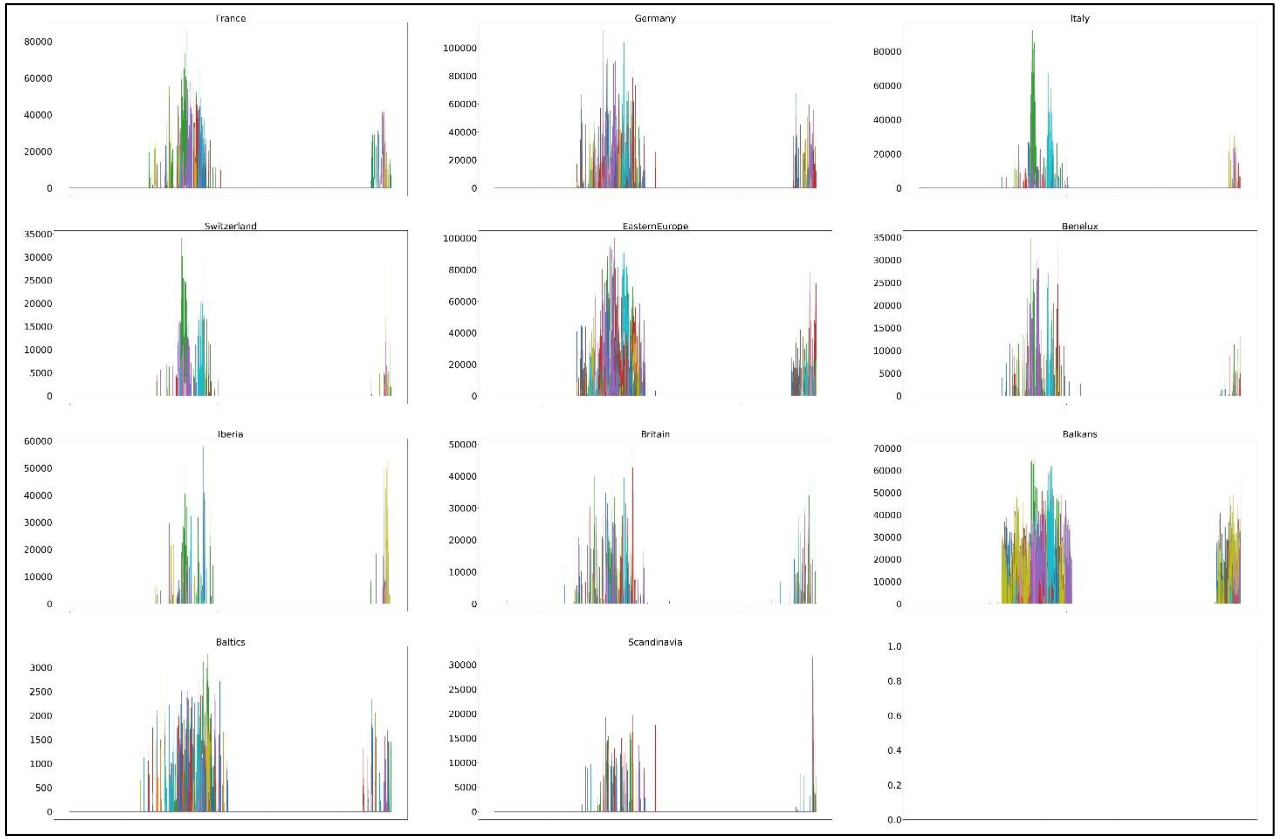
Regions :

- **France**
- **Germany**
- **Italy**
- **Switzerland**
- **Benelux**
- **Iberia**= Spain+Portugal
- **Britain**= United Kingdom + Ireland
- **Eastern Europe**= Austria+Czech Republic+Hungary+Poland+Slovakia
- **Benelux** = Belgium+Luxembourg+Netherlands
- **Baltics** = Estonia+Latvia+Lithuania
- **Scandinavia**= Denmark+Finland+Sweden+Norway
- **Balkans**= Non EU Balkans+Bulgaria+Croatia+Greece+Romania+Slovenia

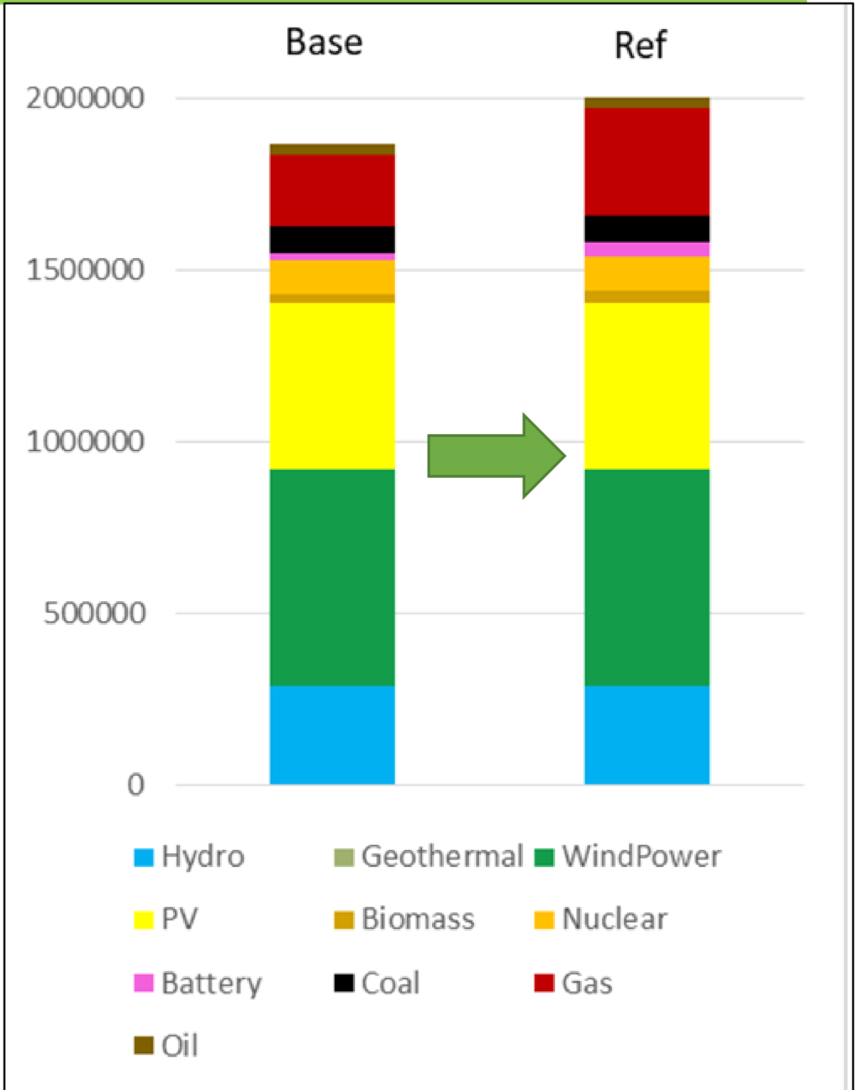


Installed electricity Generation mix

First Step: Generation mix Adaptation



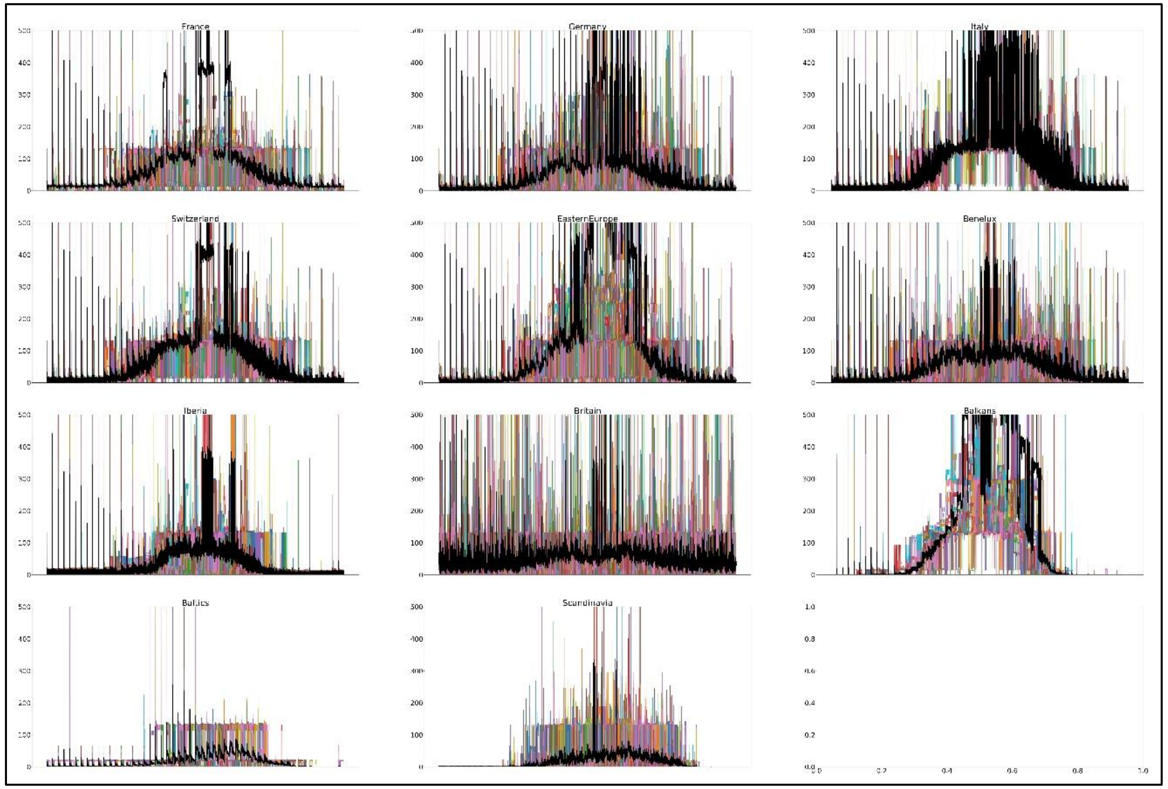
Non served electricity per country / climatic scenario

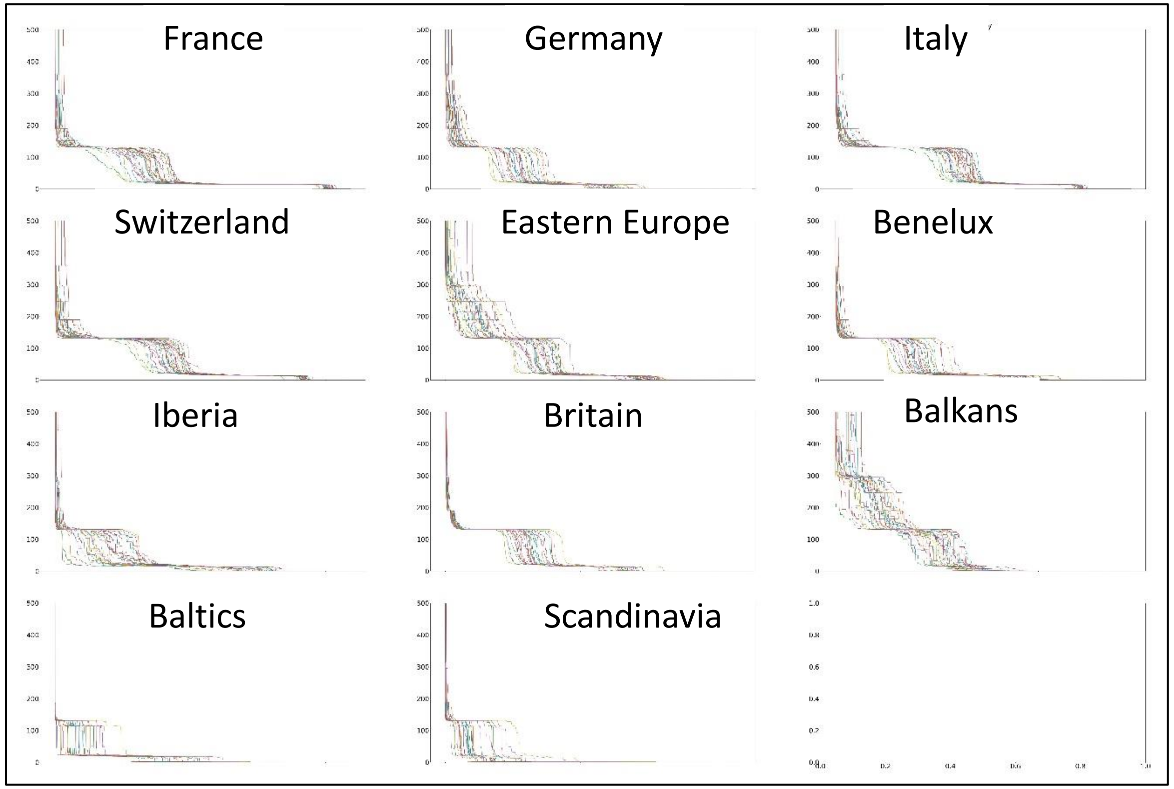


Scenario Assessment

Marginal Costs of Electricity

From Jul 1 to June 30

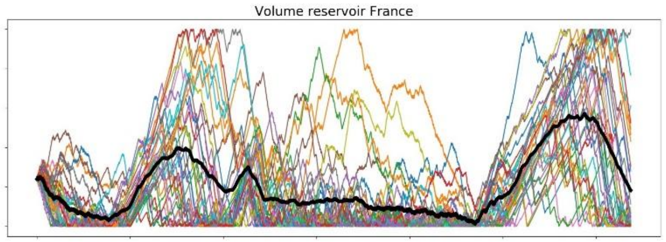


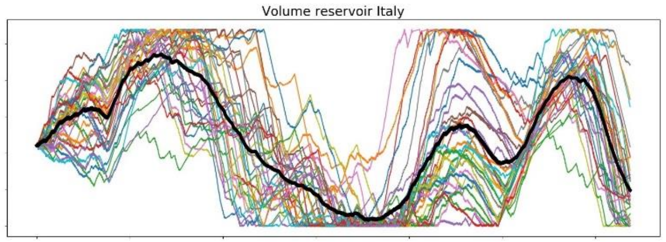


Storage in Hydro (Aggregated) Reservoirs

From Jul 1 to June 30

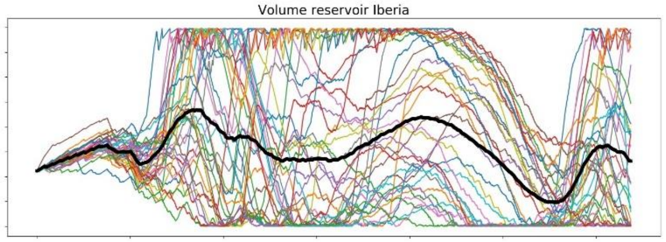
France

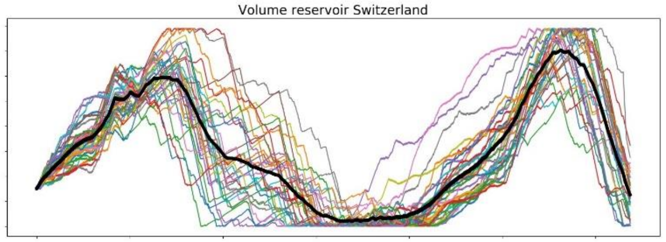




Italy

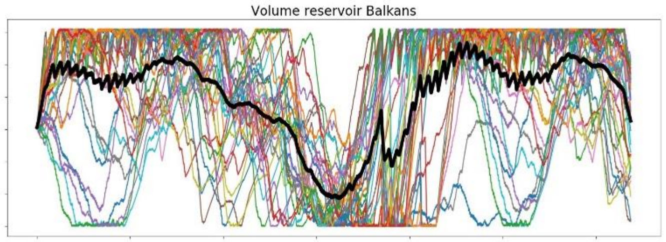
Iberia

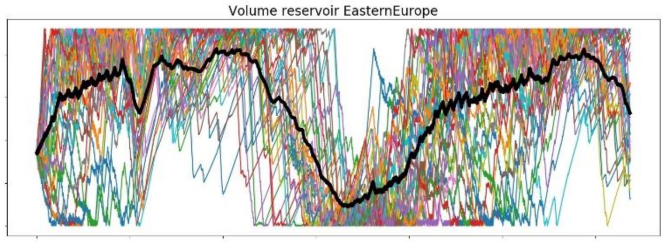




Switzerland

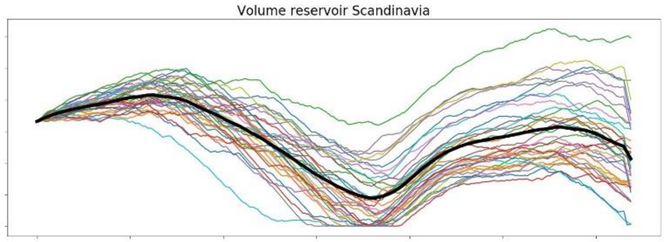
Balkans

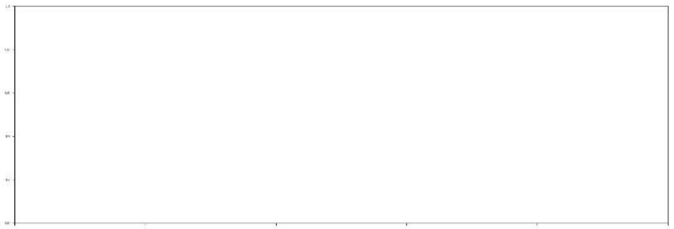




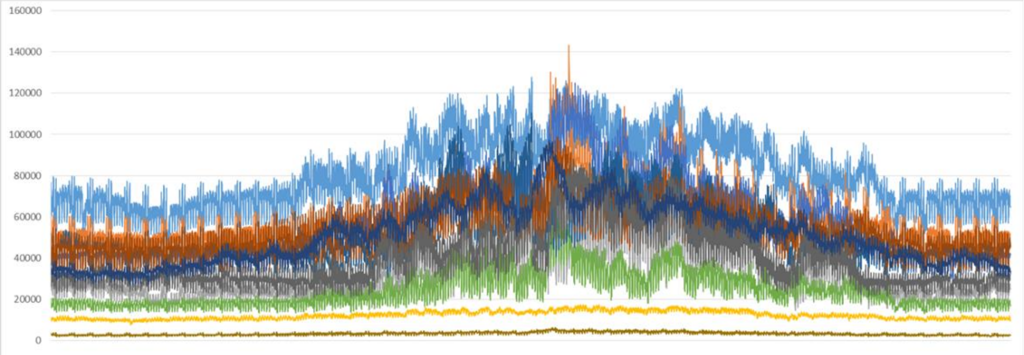
Eastern Europe

Scandinavia

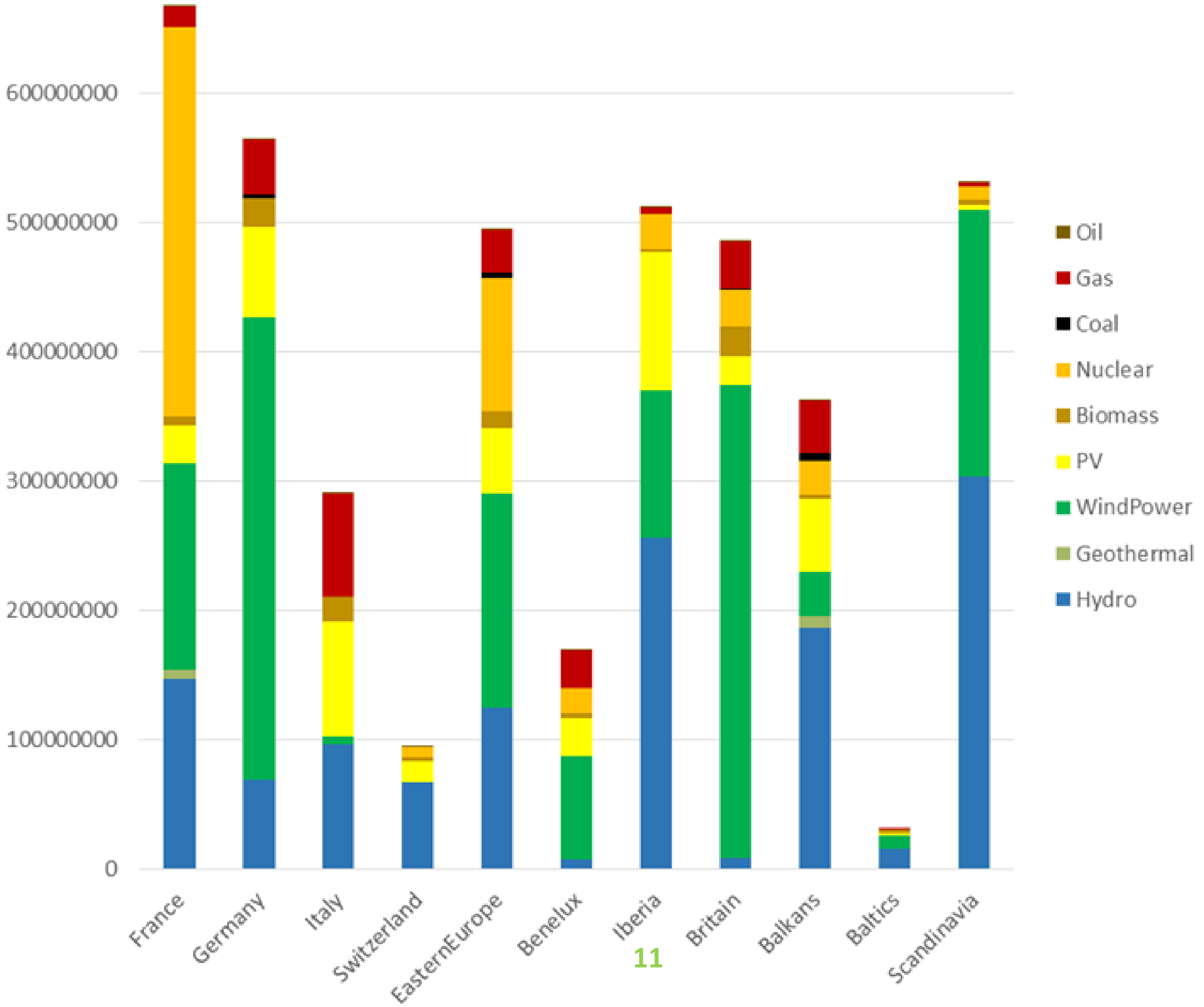




Electricity generation (1 scenario)

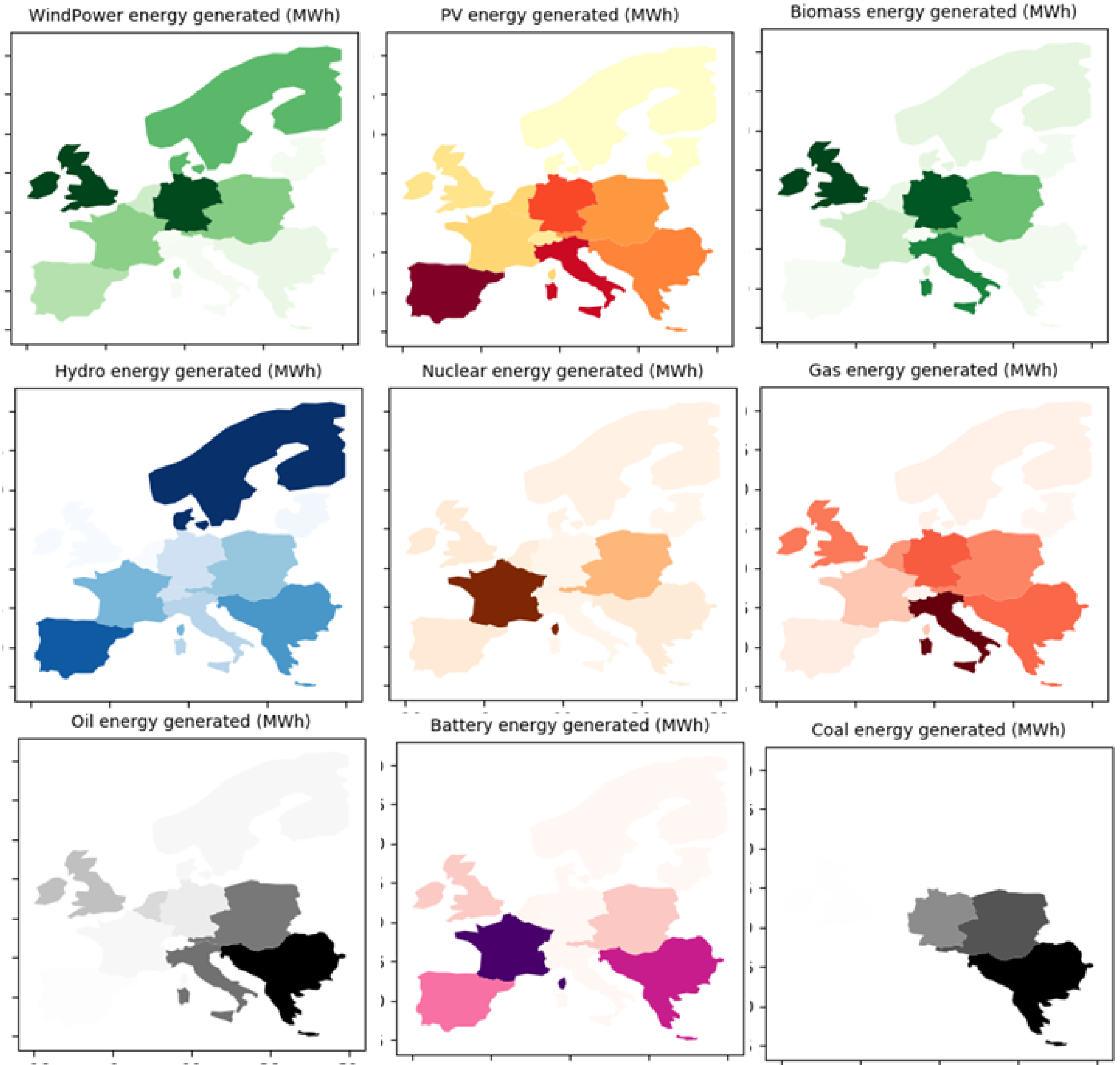


Hourly Electricity demand over 1 year (1 scenario)
rom Jul 1 to June 30

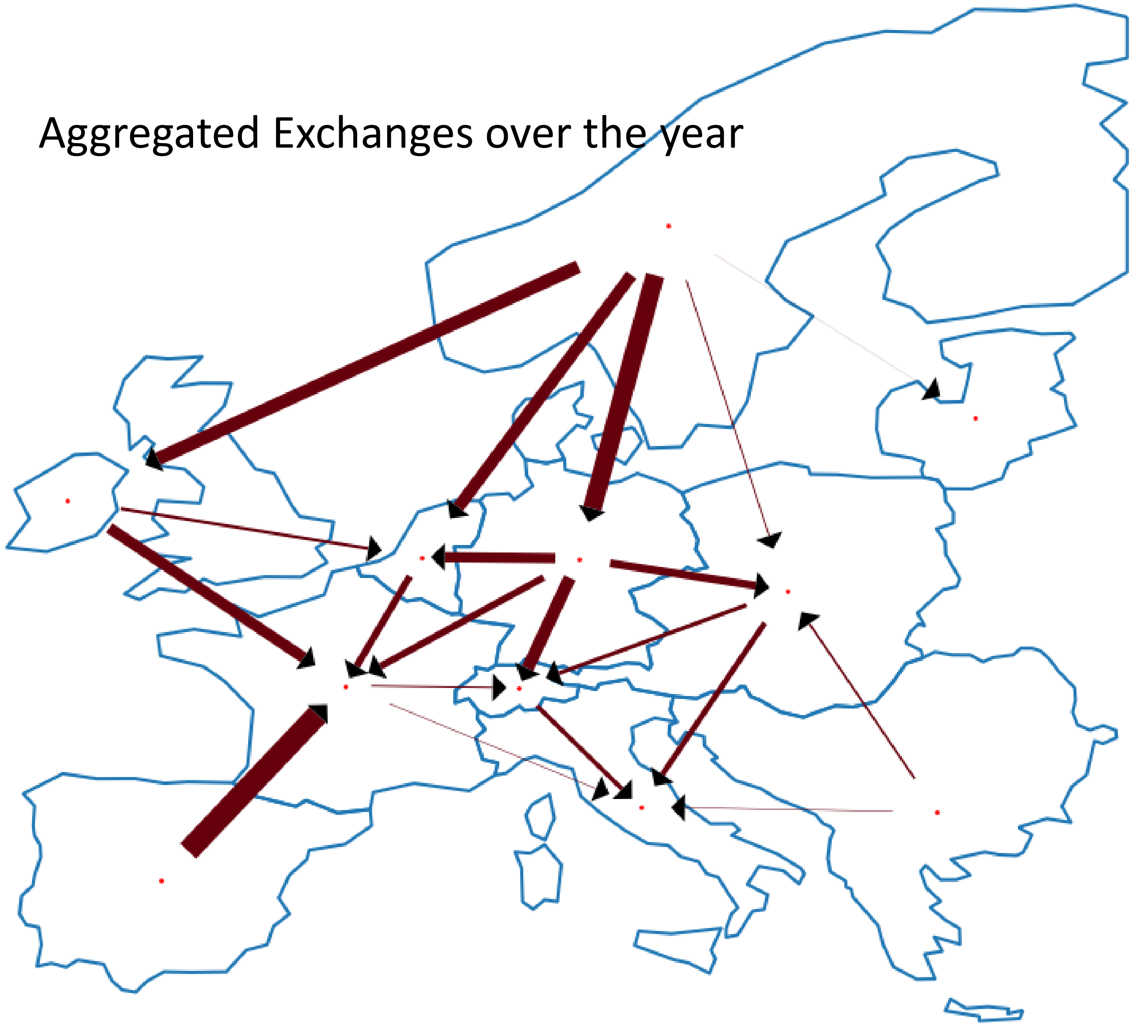


Electricity Generation and interconnections
(1 scenario)

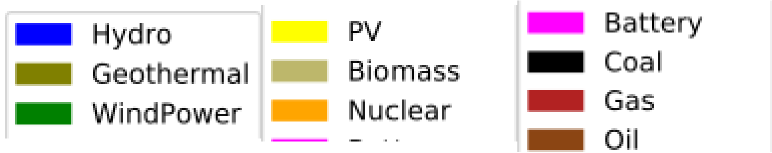
Contribution of technologies

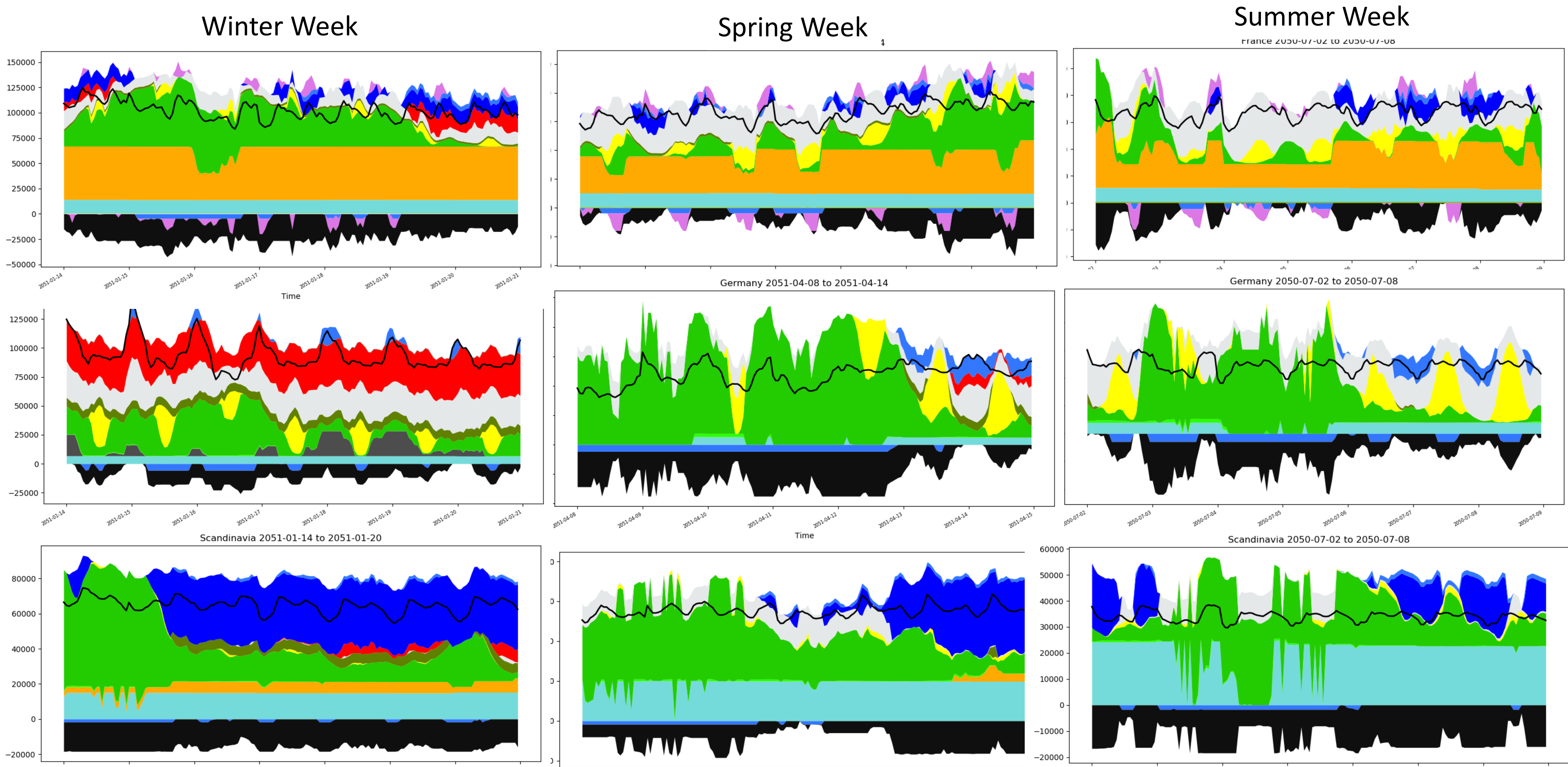


Aggregated Exchanges over the year



Hourly Profiles for specific weeks

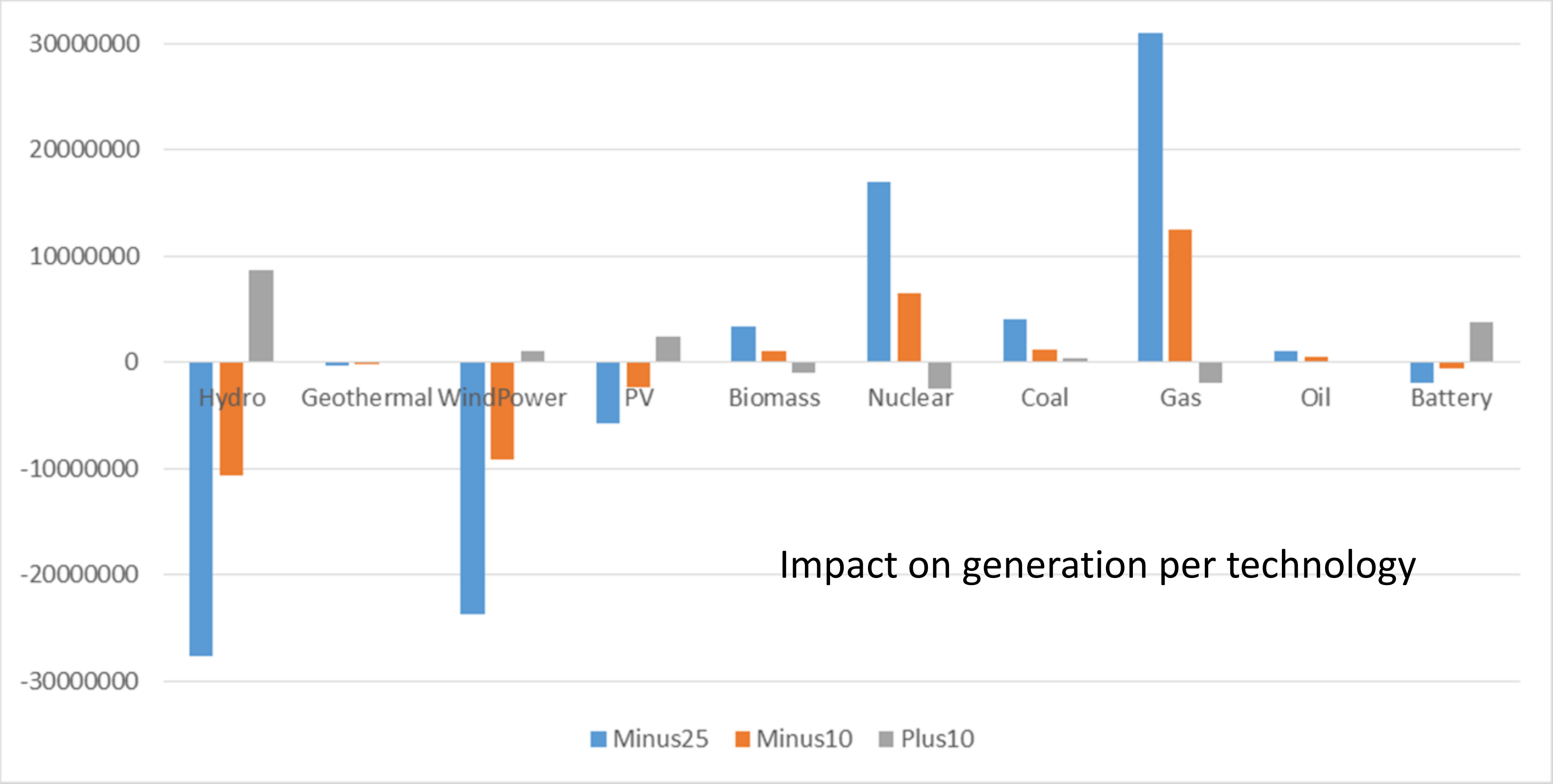




Value of Flexibilities

Interconnections

- Interco Capacities reduced by 10 & 25% or increased by 10%



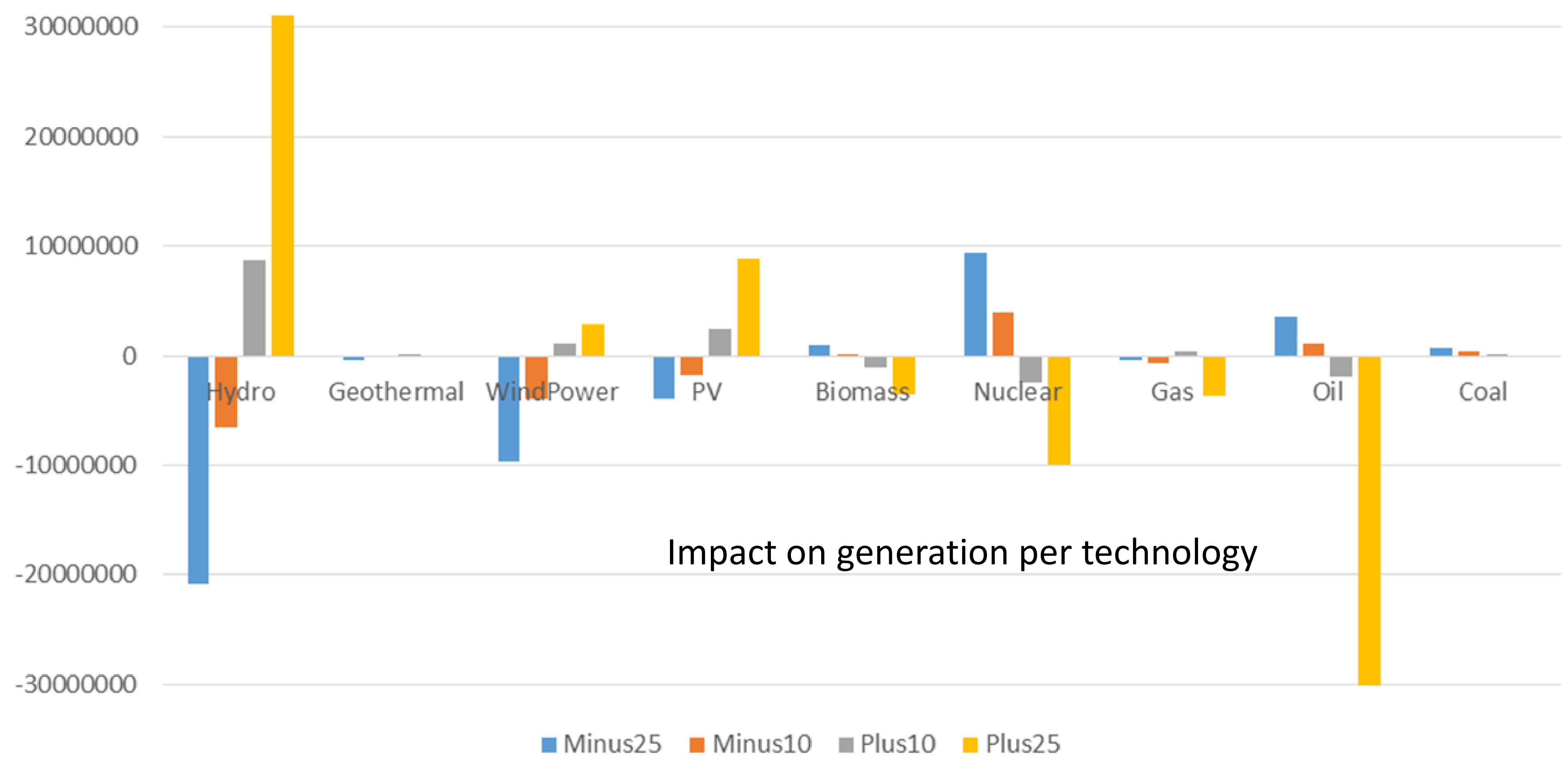
Impact on generation per technology

Scenario	Cost deviation (%)
Minus25	17.21
Minus10	5.21
Plus10	-0.52

Impact on operation cost

Battery Storage

- Battery Capacities reduced by 10 & 25% or increased by 10% or 25%



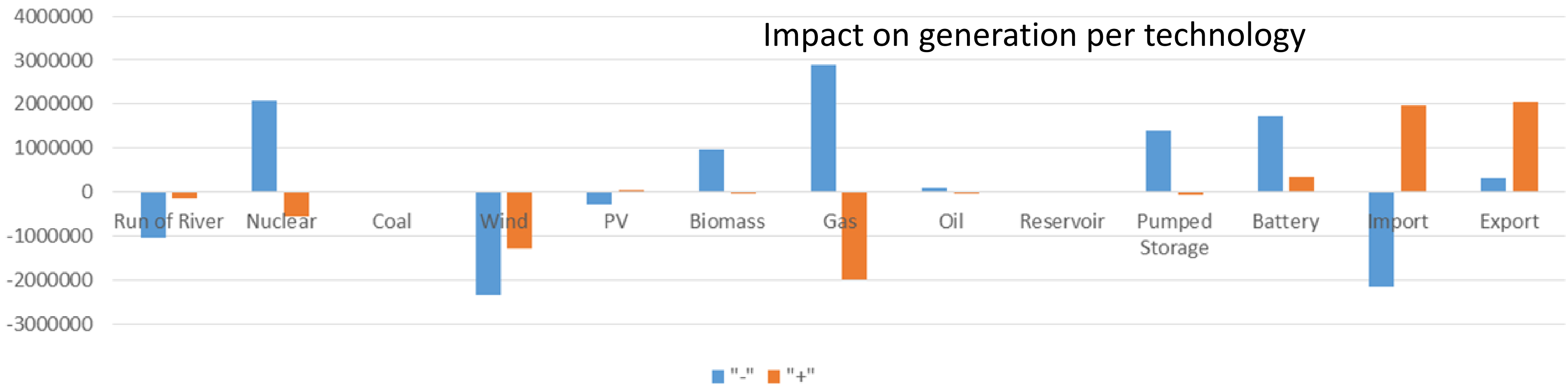
Impact on generation per technology

Scenario	Cost deviation (%)
Minus25	1.11
Minus10	0.28
Plus10	-0.52
Plus26	-11.09

Impact on operation cost

Nuclear generation

- Nuclear flexibility in 1 Country increased/decreased (MinPower, Ramping, Min Durations On/Off)

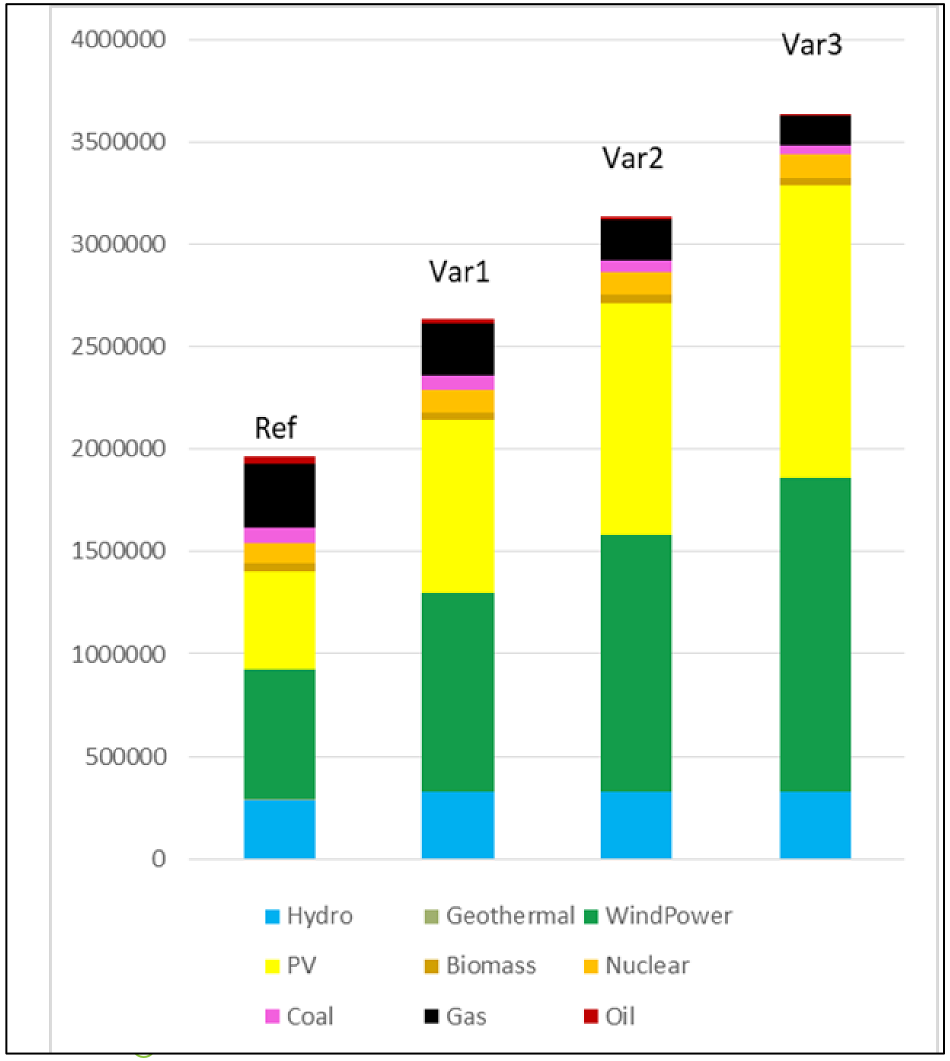


Scenario	Cost deviation in France (%)	Cost deviation in Europe (%)
-	6.90	2.58
+	-4.14	-0.18

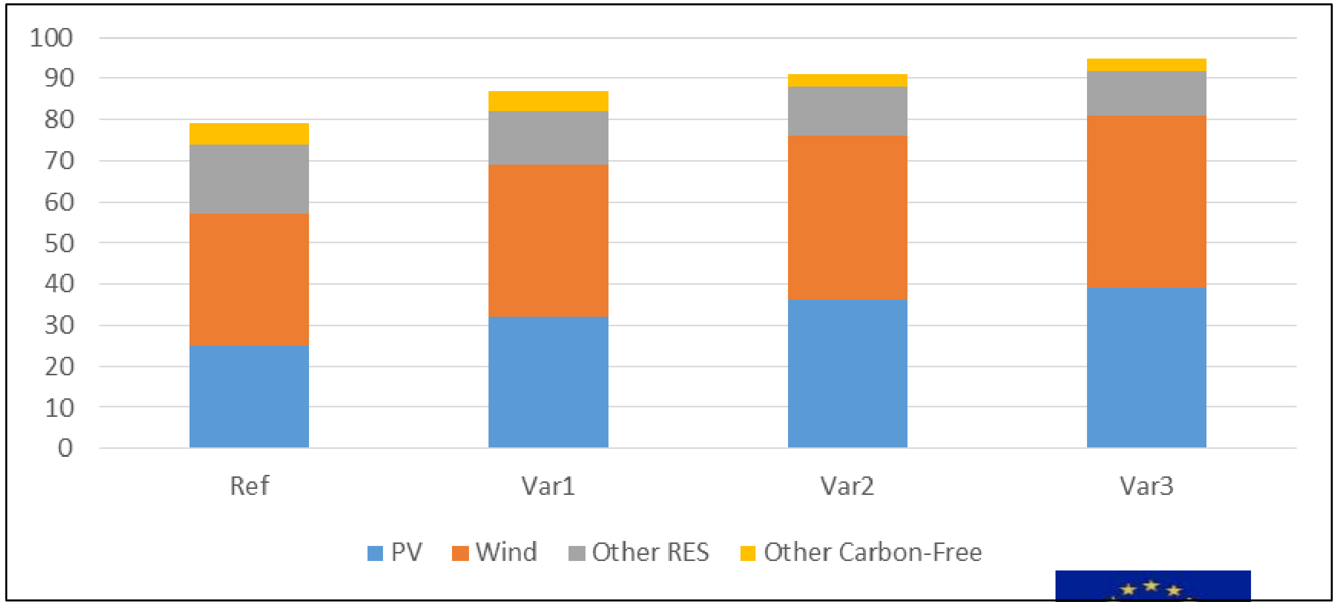
Impact on operation cost

Impact of hosting various shares of Renewable Energy

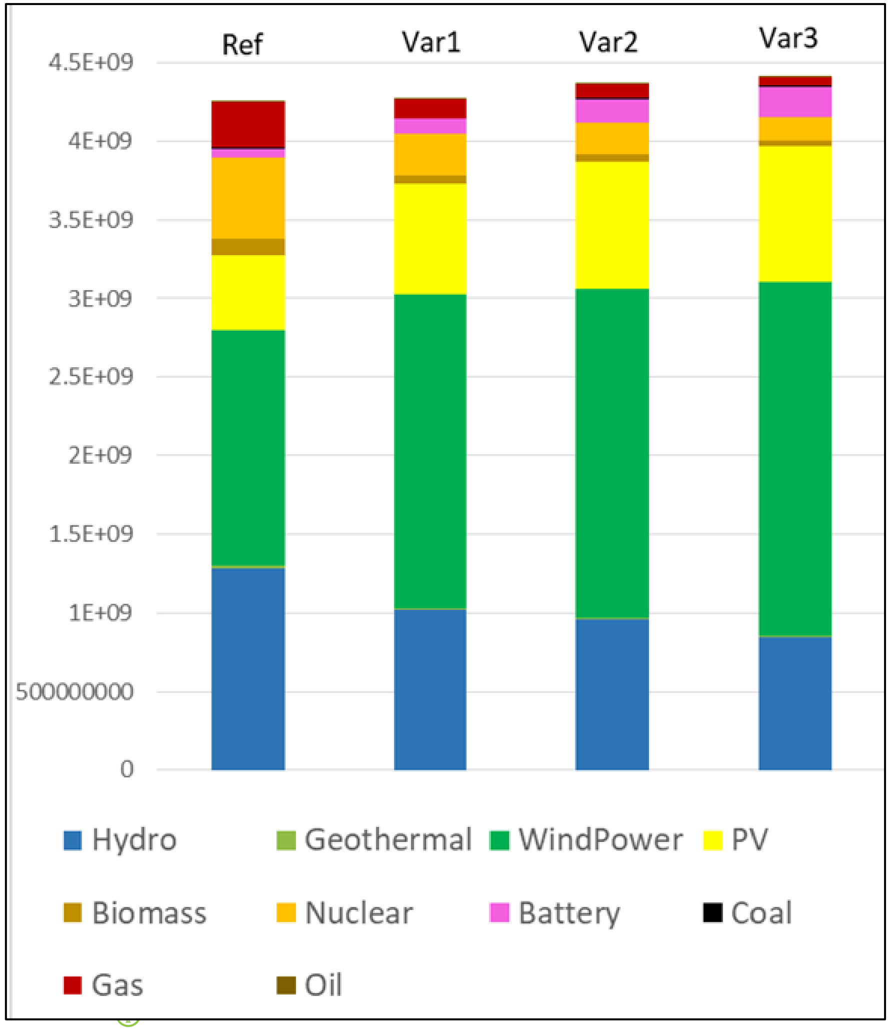
VRE Scenarios : Installed Capacity

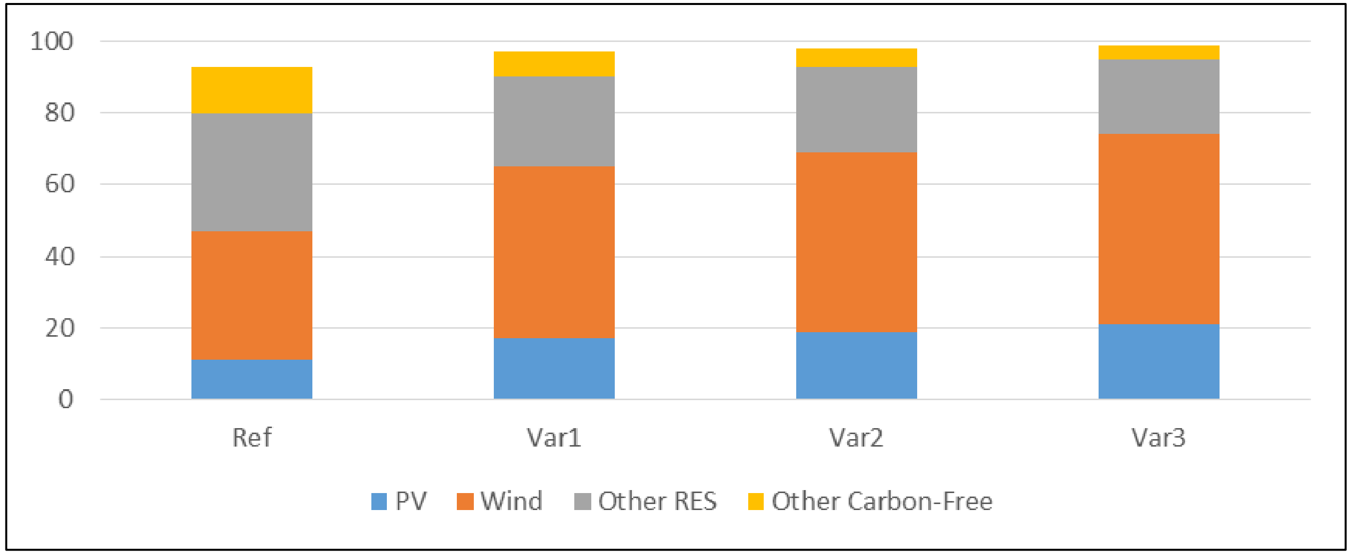


From 57 to 81% Variable Renewable Generation (Wind and PV power) in the electricity generation mix

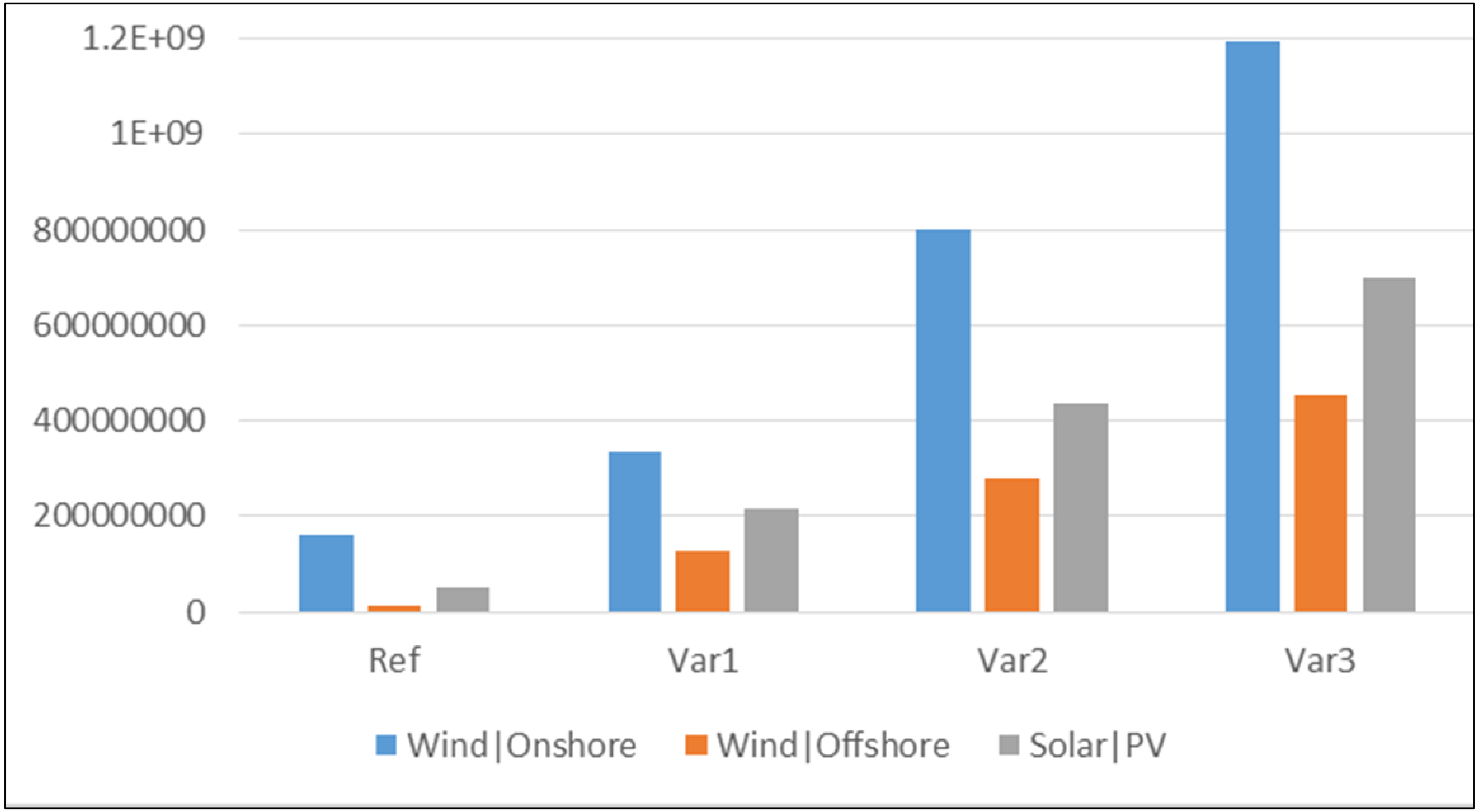


VRE Scenarios: generation

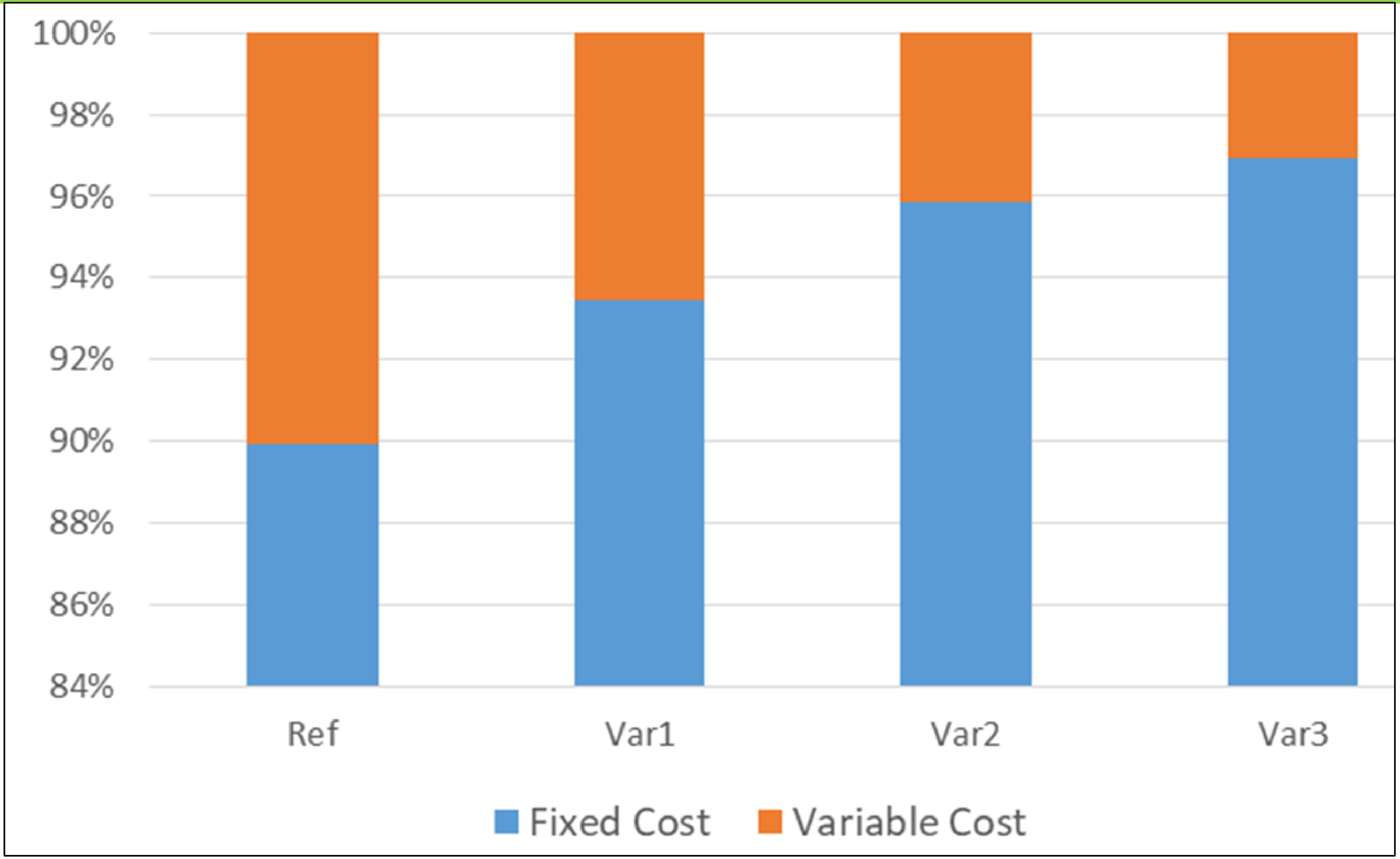




VRE Curtailement



Costs


100%
98%
96%
94%
92%
90%
88%
86%
84%
Ref
Var1
Var2
Var3
Fixed Cost
Variable Cost

Conclusion

- The models are able to evaluate the feasibility of a given long-term energy mix scenario, and to assess the costs of this scenario from the point of view of the electricity system.
- It is possible to run flexibility assessment studies, in order to evaluate the value of a given kind of flexibility.
- Finally we demonstrated that the models were able to capture the cost and value of hosting more Variable renewable Generation Systems in the electricity mix.

Thank you for attendance
Questions to Case Study 3

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