Market Studies: Regional Focus

Fabrizio Vedovelli
Market Study coordinator
Continental Central South

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Reliable Sustainable Connected

Contents

1. *Process*
2. Perimeter of the study and main hypothesis
3. Model
4. Project assessment
5. General results

Process
Storyline

Scenario building & PEMMDB

- process lead by WG SA&MM
- four Visions provided (2 bottom-up, 2 top-down)
- already discussed in pubblic consultation

Regional Framework

Fine Tuning of the Model

- possibility to improve the model including Regional specificity
- possibility to modify the perimeter of the study

Preliminary Market Study

- main purposes
  - to provide the snapshots for the NS
  - to check concistecy between MS and main scenario hyp.

Network Study

- to verify the transmission capacity among Market areas

Project Assessment by Market Study

- TOOT approach
- to provide Market indicators (Gen.cost saving,CO2 emission, Dumped energy, …..)

Process

Main difference between PEMS and RGMS

Pan European Market Study

- ✓ Main goals:
  - ✓ To check the consistency of data provided by TSOs
  - ✓ To build top-down scenarios
  - ✓ To define the exchanges among countries (for RGMS)
- ✓ Model:
  - ✓ All ENTSO-E perimeter
  - ✓ Based only on PEMMDB
- ✓ Tools & resource:
  - ✓ Using existing TSO tools (provided on voluntary base)
  - ✓ Market study experts (provided on voluntary bases) for the expert team
- ✓ Coordination
  - ✓ By WG SAMM

Regional Group Market Study

- ✓ Main goals:
  - ✓ To provide input for Network Study
  - ✓ To provide project assessment
- ✓ Model:
  - ✓ Possibility to restrict the perimeter
  - ✓ Border flows from PE MS
  - ✓ Based on regional database
- ✓ Tools & resource:
  - ✓ Using existing TSO tools(provided on voluntary base)
  - ✓ Existing market Regional model groups
- ✓ Coordination:
  - ✓ Directly by RG

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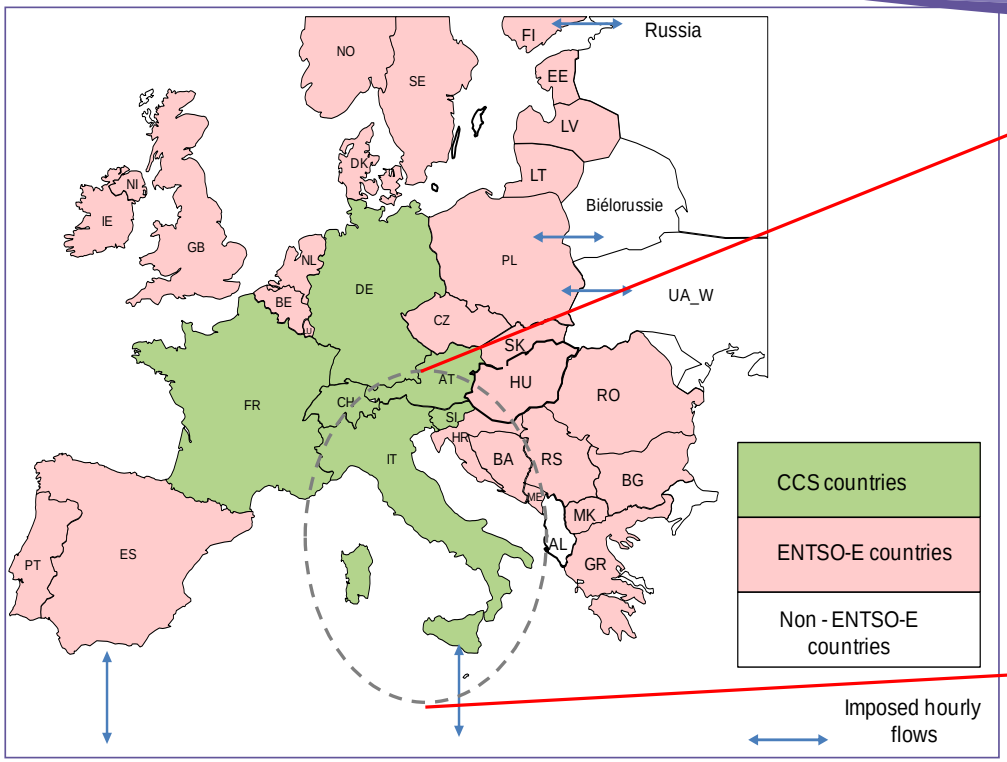
Perimeter of the study and main hypothesis

Perimeter of the study



- ✓ The whole ENTSO-E perimeter has been considered
- ✓ Italy modelled by six areas
- ✓ NoN ENTSO-E countries modelled by imposed hourly power flows

Perimeter of the study and main hypothesis

Main general hypothesis

Market Model

- ✓ Deterministic approach used
- ✓ Perfect Market Model considered (no competitors strategy modelled)

System Model

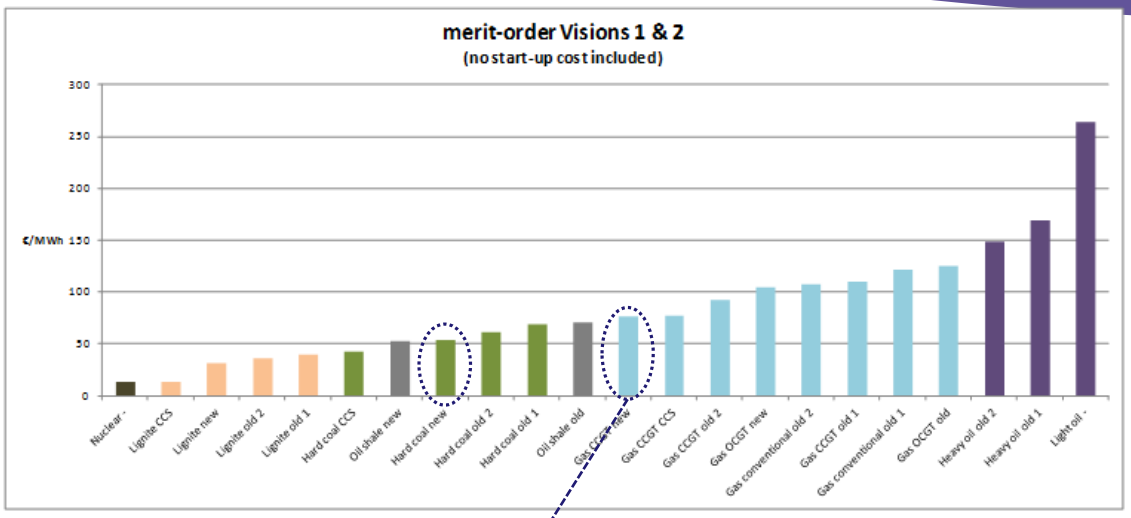
- ✓ System reserve constraints not modelled
- ✓ Grid impedance constraints not modelled
- ✓ Maintenance profile optimized

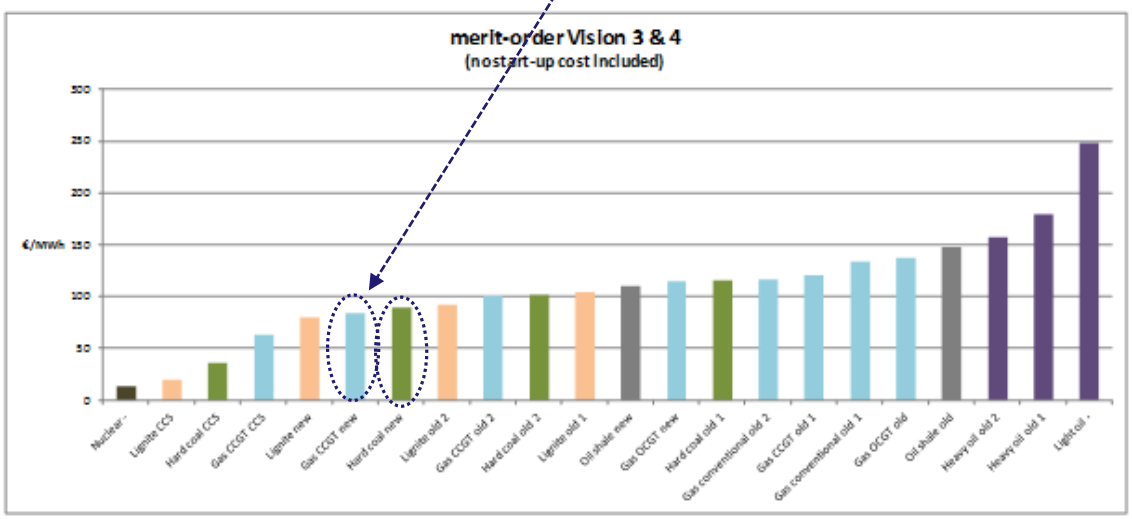
Solar and Wind Model

- ✓ Wind and Solar generation profile provided on the base of Pan European Climate Database

Perimeter of the study and main hypothesis

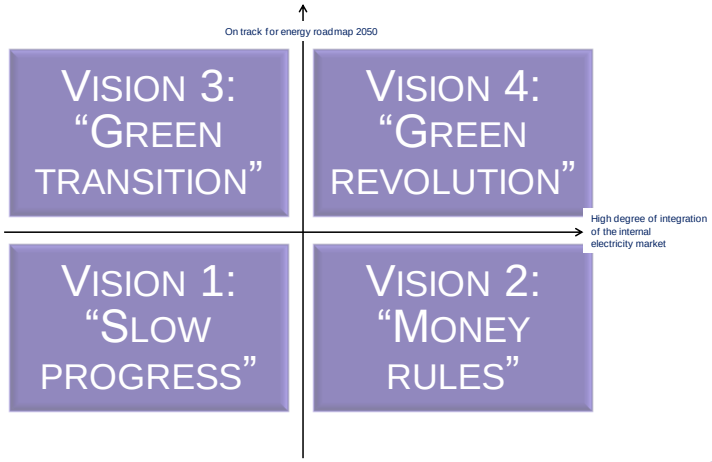
Generation Merit order





Variable Generation cost

- *Fuel cost*
- *CO2 cost*
- *Efficiency rate*
- *O&M costs*



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Model
Input and output

Inputs

- Multiple scenarios with hypotheses regarding
  - *Demand profile*
  - *Generator characteristics*
  - *Other generation profile*
  - *Wind and Solar Profiles*
  - *Transfer Capacities*
  - *Exchanges to Rest of World profile*
  - *Fuel and CO_2 prices*

Modelling

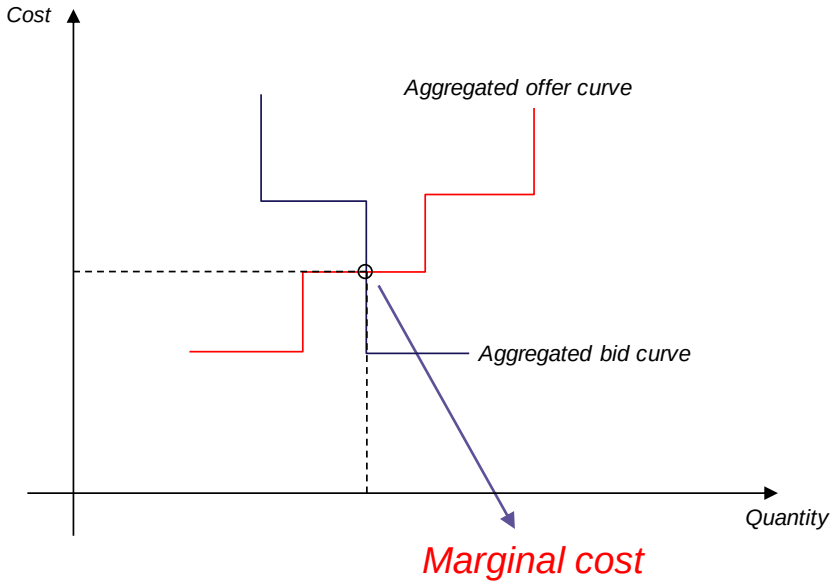
- Chronological Unit Commitment Economic Dispatch model
- Hourly model
- Each bidding area is a single market node
- Minimise the system cost (fuel bill/operating costs) subject to constraints such as must-run, generator capabilities.

Outputs

- Country Balances
- Market Node Marginal costs
- Hourly generation pattern for each generator
- System/Fuel cost
- Fuel consumption by fuel type
- CO_2 emissions

Model

Market Model Algorithm …. in brief



- ✓ Offers/Bids are accepted under the economic merit order criterion and taking into account transmission capacity limits on the Italian grid
- ✓ The cost is determined, for each hour, by the intersection of the demand and supply curves and is differentiated from zone to zone

It is necessary to check that the planned dispatching program respects adequacy and security constraints.

Model
Dispatchable generation

Dispatchable Generation

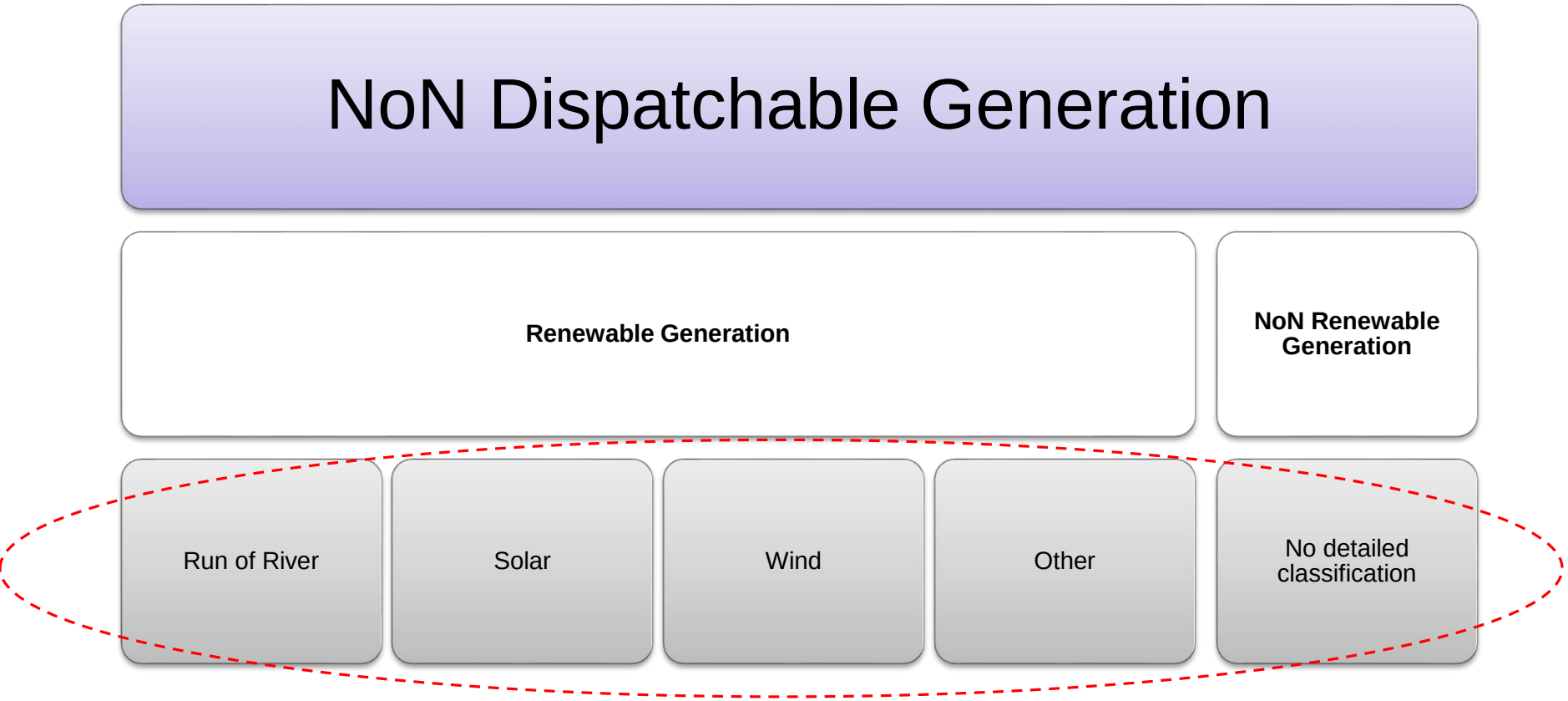
Thermal generation

- Capacity
- Flexibility & Must run constraints
- Efficiency rate
- Fuel
- CO2 emission
- Outage rate
- ……

Hydro Generation (storage)

- Pumping and turbining capacity
- Starting reservoir level
- Reservoir (annual/weekly/daily)
- Inflow
- ….

Model
Dispatchable generation



Each of these category is modelled by:

- ✓ *installed capacity*
- ✓ *hourly generation profile*

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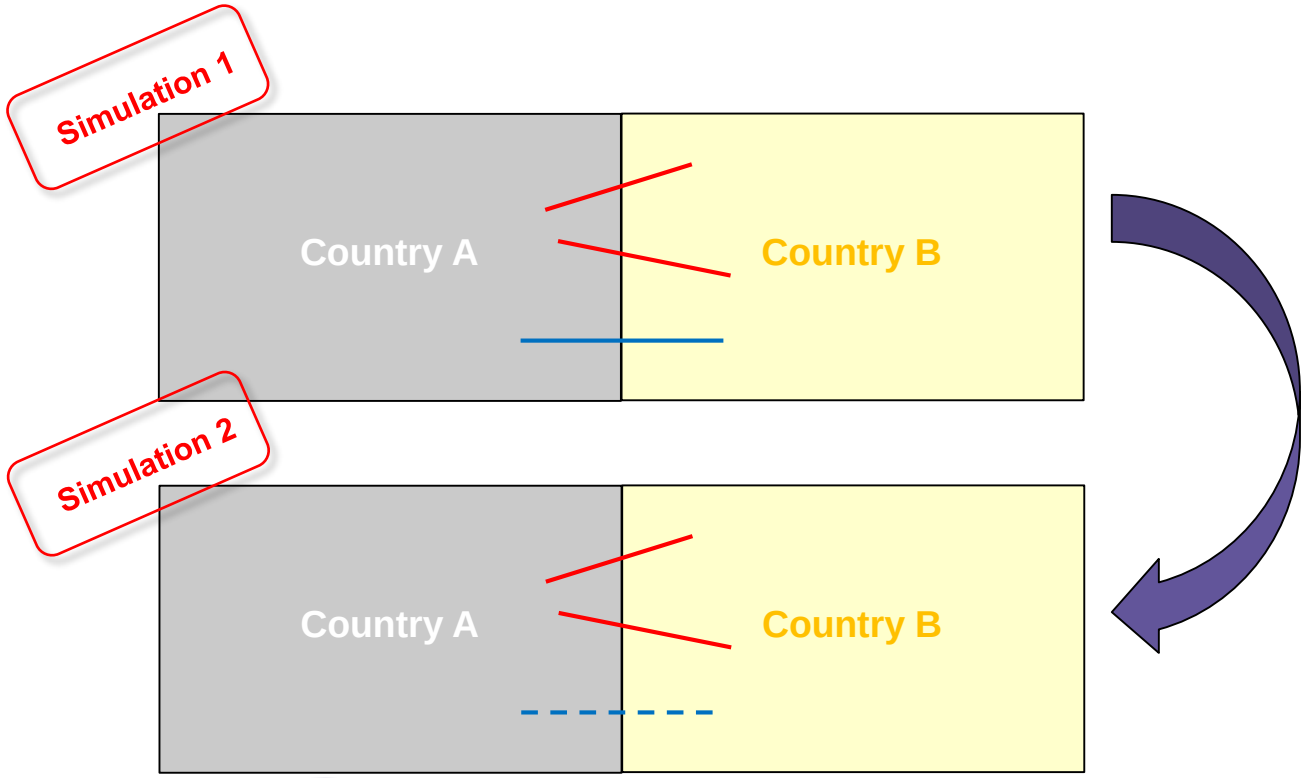
Project assessment
TooT approach

TooT *= Take out one at Time*

✓ Comparing the results between the two simulations is possible to evaluate the effect of the project under consideration



- ✓ Generation costs saving
- ✓ CO2 emission variation
- ✓ Dumped energy variation
- ✓ Security of supply

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General Results

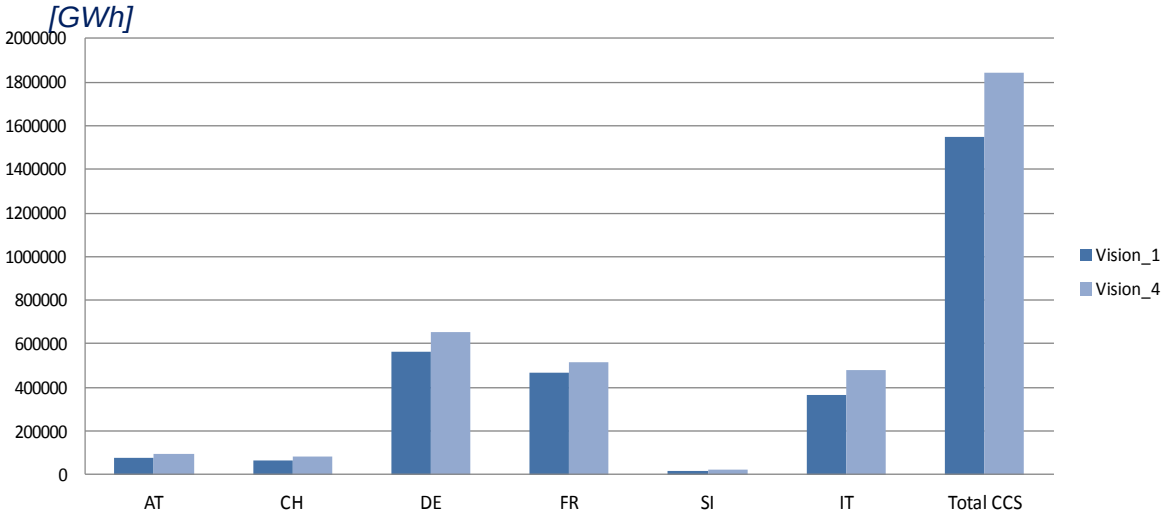
Comparison Vision4 – Vision 1: Load

Variation of Load

- *ENTSO-E perimeter: +680 TWh*
- *CCS perimeter: +294 TWh*

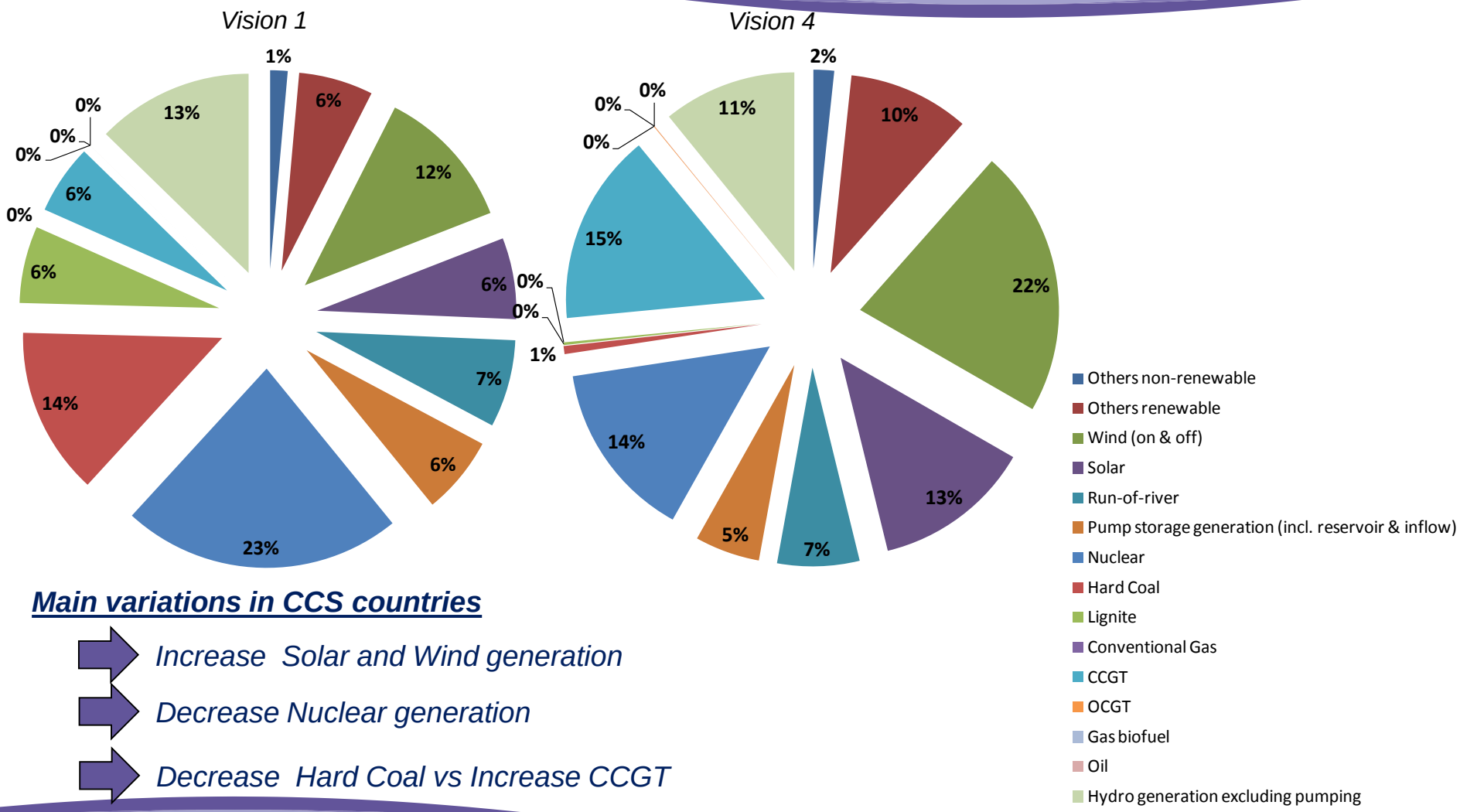
Main parameters

- *Demand respons*
- *Electric vehicles*
- *Heat pumps*



General Results

Comparison Vision4 – Vision 1: Generation mix



Main variations in CCS countries

- *Increase Solar and Wind generation*
- *Decrease Nuclear generation*
- *Decrease Hard Coal vs Increase CCGT*

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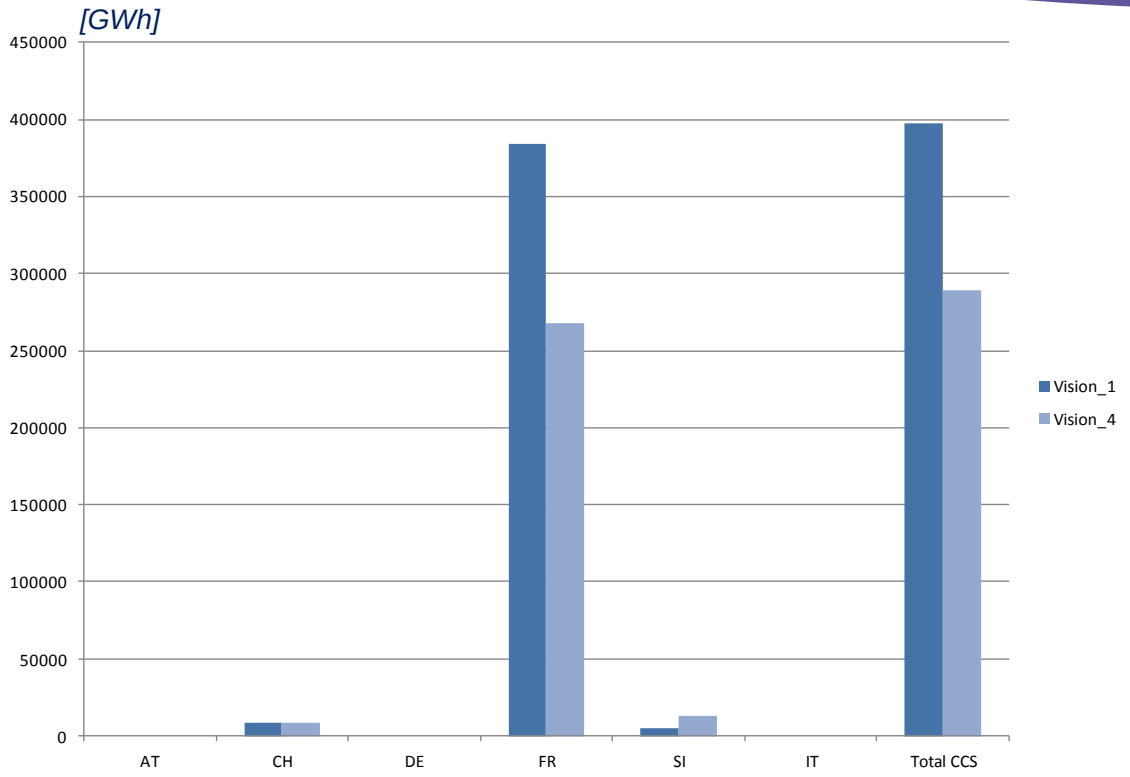
General Results

Comparison Vision4 – Vision 1: Nuclear generation



Main decrease

- ✓ *France*
- ✓ *Spain*
- ✓ *Slovakia*

Main increase

- ✓ *Bulgaria*
- ✓ *Czech Republic*
- ✓ *Finland*
- ✓ *Great Britain*
- ✓ *Hungary*
- ✓ *Poland*
- ✓ *Slovenia*

Nuclear generation

- *ENTSO-E area: -50 TWh*
- *CCS area: -110 TWh*

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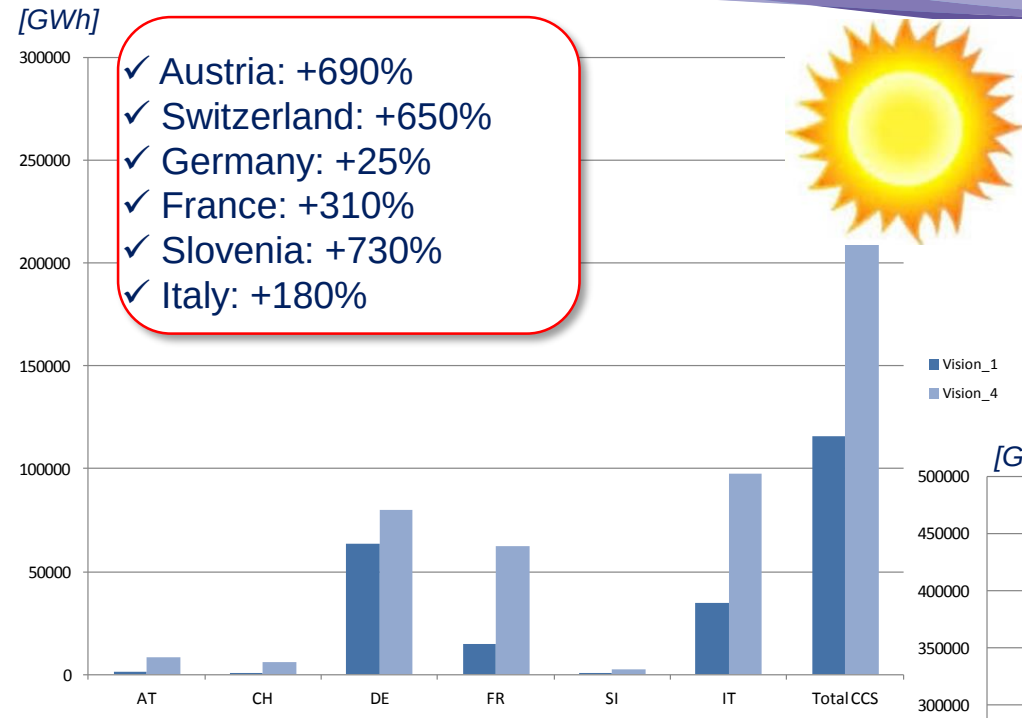
General Results

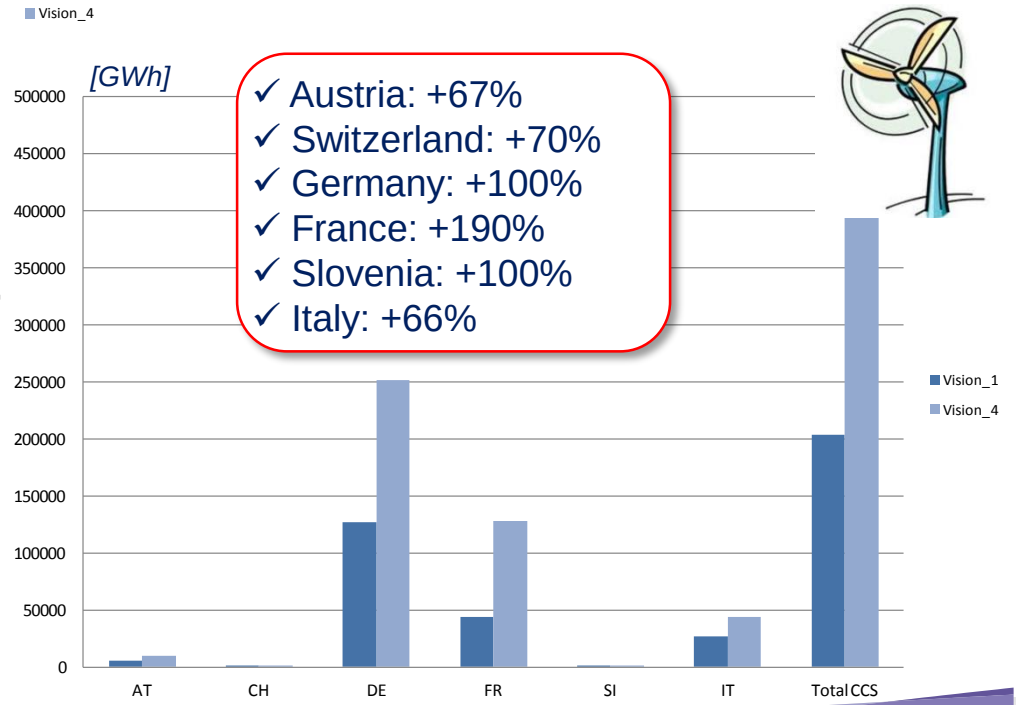
Comparison Vision4 – Vision 1: Solar and Wind



- ✓ Austria: +690%
- ✓ Switzerland: +650%
- ✓ Germany: +25%
- ✓ France: +310%
- ✓ Slovenia: +730%
- ✓ Italy: +180%

Solar

- *ENTSO-E area: +290 TWh*
- *CCS area: +140 TWh*



- ✓ Austria: +67%
- ✓ Switzerland: +70%
- ✓ Germany: +100%
- ✓ France: +190%
- ✓ Slovenia: +100%
- ✓ Italy: +66%

Wind

- *ENTSO-E area: +530 TWh*
- *CCS area: +230 TWh*

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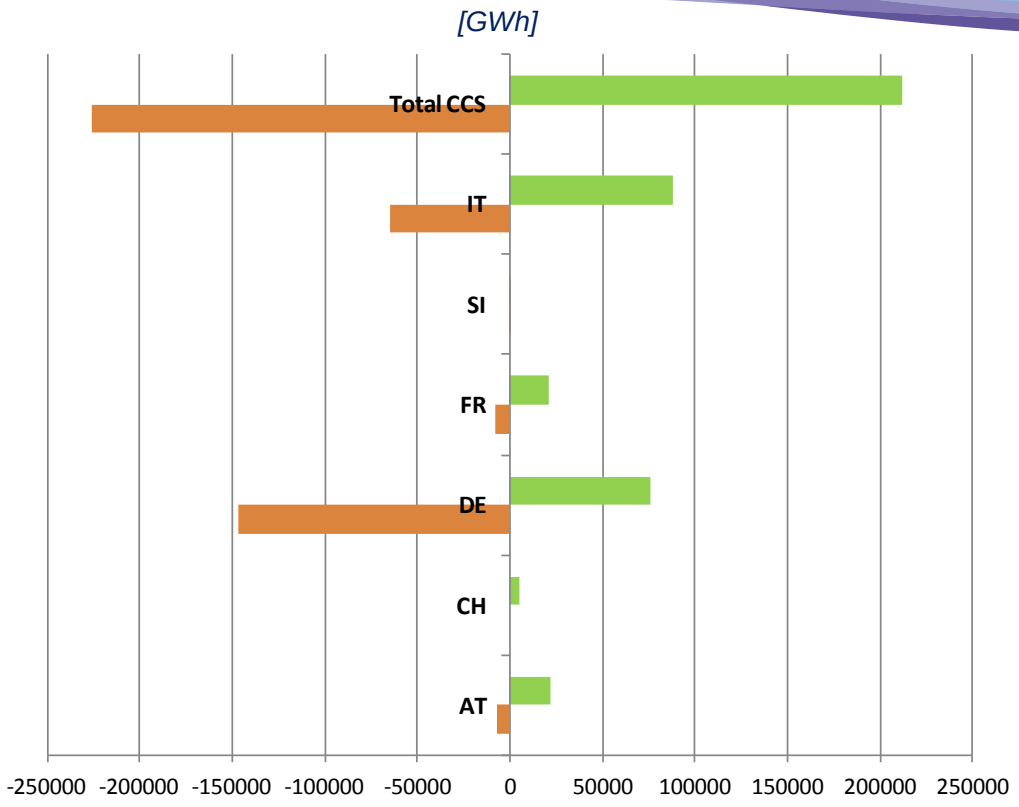
General Results

Comparison Vision4 – Vision 1: CCGT vs Coal



Hard Coal

- *ENTSO-E area: -300 TWh*
- *CCS area: - 230 TWh*

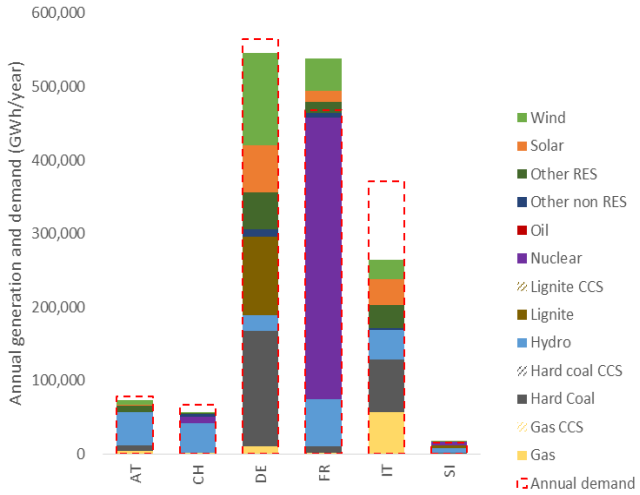
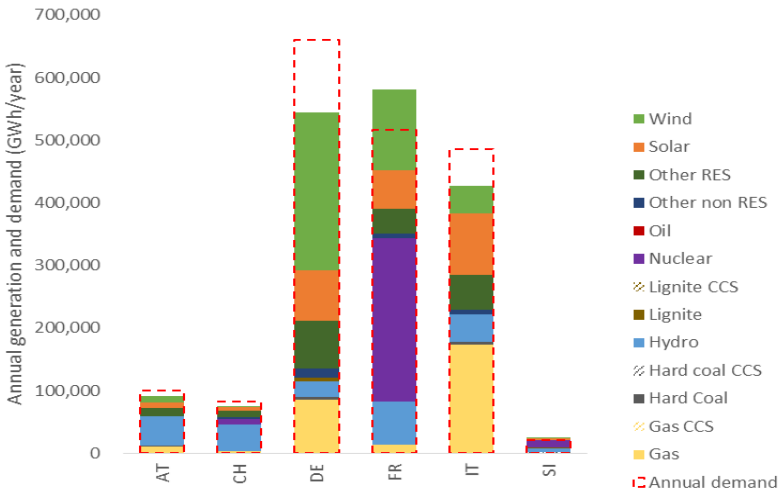
CCGT

- *ENTSO-E area: +260 TWh*
- *CCS area: 210 TWh*

Variation consistent with the scenarios

General Results *Vision4 – Vision 1:* Balance

Vision 1



Vision 4