Assessing the role of storage in EU27 using the JRC-EU-TIMES model

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Overview

• Context
  • Methods
  • Results
  • Conclusions
Context

1. Increased share of variable RES may require the deployment of energy storage solutions, which could store power generated in times of discrepancy between supply & demand and shift the stored energy to periods of high demand and/or to ease bottlenecks on grids.

2. What could be the role of energy storage from an energy system perspective?

3. What factors affect the deployment of energy storage across EU?

4. To what extent can a large energy system model with limited time resolution provide useful insights to model energy storage?

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Methods

**Electricity Storage**
- CAES, pumped hydro, large batteries
- H2 (seasonal), small batteries

**Thermal Storage**
- Large water tanks, underground storage

JRC Technology Map
ETSAP technology datasheet

**JRC-EU-TIMES model**
2005-2050 | 12 time-slices

Assess factors affecting deployment of storage:
- CO2 cap
- Costs
- RES electricity deployment
- Electricity versus heat storage?
- Impact on power mix?

Bulk ELC storage in JRC-EU-TIMES
RSD, COM, TRA ELC storage

Thermal storage (heat and cooling)
Overview

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New storage only from 2020

- Maximum deployment of storage due to CO2 cap (in 2050 85% less from 1990 levels; 20% less in 2020)
- Electricity stored represents 1-8% of total generated electricity
- Heat stored only up to 7-11% of generated heat
Stored energy in EU in 2050
(% energy delivered per technology group)

- interplay between heat and electricity storage
- role of existing pumped hydro highly dependent on costs of other storage technologies, especially large batteries and heat storage
- CO2 cap drives electrification of buildings (67% of FEC and 37-46% in other scenarios) which have higher variation across time-slices than other end-use sectors
- higher variable RES electricity shares does not lead to higher storage but affects storage portfolio

Power mix in EU in 2050
(% electricity delivered per technology group)

- as expected it is the limited energy storage does not affect the power mix
- improve modeling of variable electricity commodity to see if a large system model with limited time resolution can capture this
Factors affecting storage in EU in 2050

<table>
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<tr>
<th></th>
<th>Ref</th>
<th>STG</th>
<th>CO2</th>
<th>-30%</th>
<th>-50%</th>
<th>REScost</th>
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<tbody>
<tr>
<td>% RES electricity</td>
<td>37%</td>
<td>36%</td>
<td>47%</td>
<td>36%</td>
<td>36%</td>
<td>58%</td>
<td>70%</td>
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<tr>
<td>% RES heat</td>
<td>20%</td>
<td>19%</td>
<td>48%</td>
<td>18%</td>
<td>18%</td>
<td>16%</td>
<td>19%</td>
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<tr>
<td>% electricity wind+PV</td>
<td>16%</td>
<td>16%</td>
<td>30%</td>
<td>16%</td>
<td>16%</td>
<td>39%</td>
<td>51%</td>
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Stored energy (PJ)

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<tr>
<th></th>
<th>Heat</th>
<th>Electricity</th>
<th>Total</th>
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<tbody>
<tr>
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<td>127</td>
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<tr>
<td>Electricity</td>
<td>156</td>
<td>416</td>
<td>572</td>
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<tr>
<td>Total</td>
<td>129</td>
<td>283</td>
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</table>

Energy storage where in 2050?

- Where higher differences in ELC and HEAT prices across time slices:
  - ELC price difference 2.5 higher
  - Heat price difference 1.5 higher

- Thermal storage
- CAES
- Large batteries
- Small batteries
- Pumped hydro
Overview

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- Methods
- Results

Conclusions

1. Not only storage technology costs or RES deployment determine the deployment; electrification in end-use sectors seems to be relevant;
2. There is an interesting competition between electricity and thermal storage;
3. A model as JRC-EU-TIMES seems to be able to provide interesting first insights on the role of energy storage technologies;
4. It is necessary to further assess technical possibilities and limitations for bulk storage deployment, especially CAES.
Next steps (on-going work)

1. Fully assess the contribution of storage technologies in the peaking equation as sometimes the storage capacity is directly used;
2. Introduce a maximum potential for CAES deployment;
3. Further analyse the storing of cooling, not competitive at this moment;
4. Include in the model heat storage associated to solar thermal heat, also available for industry;
5. Further assess the effect in deployment of variations in efficiency of storage technologies as well as for the other techno-economic parameters already tested;
6. Improved modelling on variable electricity via ELCINT commodity and taking into account the load curves of PV and wind;
7. Soft-link with detailed (dispatching) storage models with high time resolution to assess energy system effects.

Thank You!

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Demand projections (GEM-E3) and use energy services & materials

Primary energy supply: Refinery, imports and renewable energy

Electricity generation

Transport: road passengers & freight, rail, aviation

Industry: Iron & Steel; Non-Fe metals; Cl & NH4+; Cu; Al; Other

Residential: Rural, Urban, Apartment

Commercial: Large and Small

Agriculture

Policy constraints: feed-in, green-cert, subsidies

EU primary energy potential

Base year & New energy technologies capacity, availability, efficiency, life, costs, emission factors

Minimise total system costs

ETRI + Nuclear individual plants from IAEA (PRIS), WNA

Final energy prices

Materials and Energy flows

Emissions

Costs

Installed capacity

JRC-EU-TIMES model inputs

GEM-E3 (IPTS): Growth scenarios for EU; evolution of macro-economic & demographic parameters

POLES (IPTS): Primary energy import prices into EU

Macro-economic scenarios

POLES (IPTS): Primary energy

ETRI (IET): Energy technologies techno-economic data & AF (IET-Ispra)

Modelling Scenarios

Demand Scenarios

- REF
- Base

Analysis Scenarios

- BAU
- GHG caps
- Specific variants (e.g. technology cost reductions, low biomass, late CCS)

Policy assumptions

Per EU27 country + CH, IS, NO:
- Energy consumption per sector/process
- Technology mix
- GHG emissions
- Cross border and endogenous EU Trade

Per year (each year has 12 time slices)

JRC EU TIMES (energy system)

2005

2050/2075

20