Analyzing cross-border balancing capacity coordination in a high-RES power system

Using the open-source energy system model generator SpineOpt

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**Case study on Cross-Border Integration**

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<th>Ongoing</th>
<th>Planning</th>
<th>Not planned</th>
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<tr>
<td>Activation</td>
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<tr>
<td>Procurement*</td>
<td>Unoordinated</td>
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<td>Sizing*</td>
<td>Unoordinated</td>
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- **Day-ahead** market with joint energy & balancing capacity market clearing
- **Scope:** **2030** scenario for **CWE** with 5 countries (BE, DE, FR, LU, NL)

*Need to allocate cross-control area interconnection capacity!

- IGCC
- MARI
- TERRE
- PICASSO
- EBGL 2017
- All TSO’ proposal 2019
- Exception:
  - Nordics
  - Some bilateral reserve sharing (e.g., BE-FR)
Realization in SpineOpt.jl

SpineOpt is a generic open-source energy system model generator

- High level of technical detail required
  - Clustered unit commitment formulation
  - Ramping and reserve constraints
- 1-year optimization (MILP)
  - Rolling horizon optimization
- Different market scenarios for coordination
  - Realized through SpineOpt’s generic constraints
  - Database-driven differentiation between market designs

Balancing Capacity Exchange

- Exchange impacts “must-run” constraints
  - Spinning reserves imported (aFRR!)  
  - Relaxation of “must-run” requirements
- Allows more efficient DA scheduling
  - Low-flexibility, low-OPEX units operate closer to maximum output  
  - Avoiding start-ups of high-flexibility, high-OPEX units
- Results in moderate cost savings
  - Order of magnitude ~25 M€/year

Spinning reserves in France

Energy production in France
Balancing Capacity **Sharing**

- Sharing reduces balancing capacity need
  - Benefits of joint sizing exercise
  - Further relaxation of technical constraints
- Allows even more efficient DA scheduling
  - Schedule even closer to cost-optimal DA electricity schedule
- Results in moderate cost savings
  - Order of magnitude \(~155\) M€/year
  - Biggest benefits not yet captured?
    - *Results suggest that the total amount of high-flex capacity could be reduced*