

## TSO-DSO coordination and market architectures for an integrated ancillary services acquisition: the view of the SmartNet project

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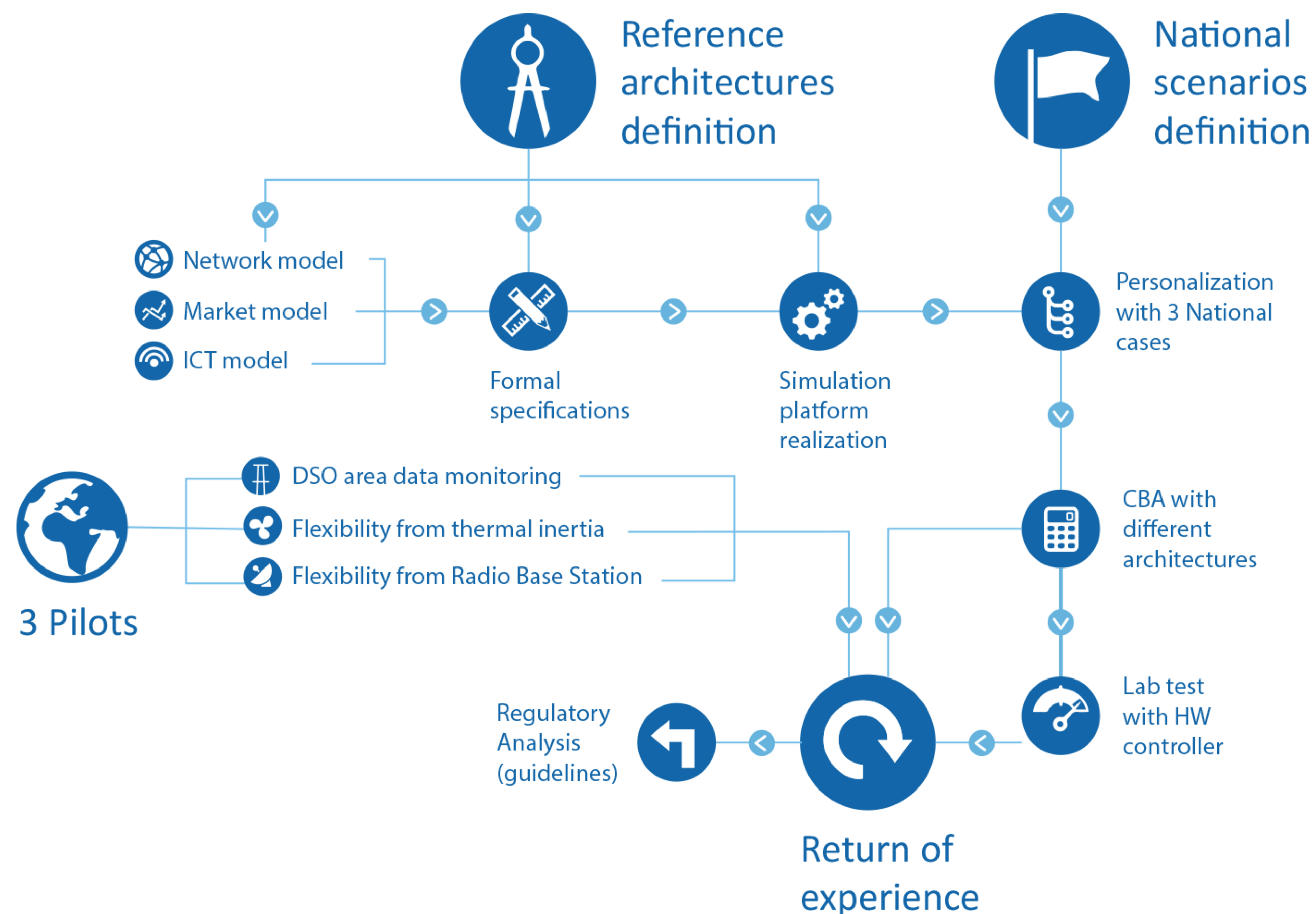
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### The project aims at identifying

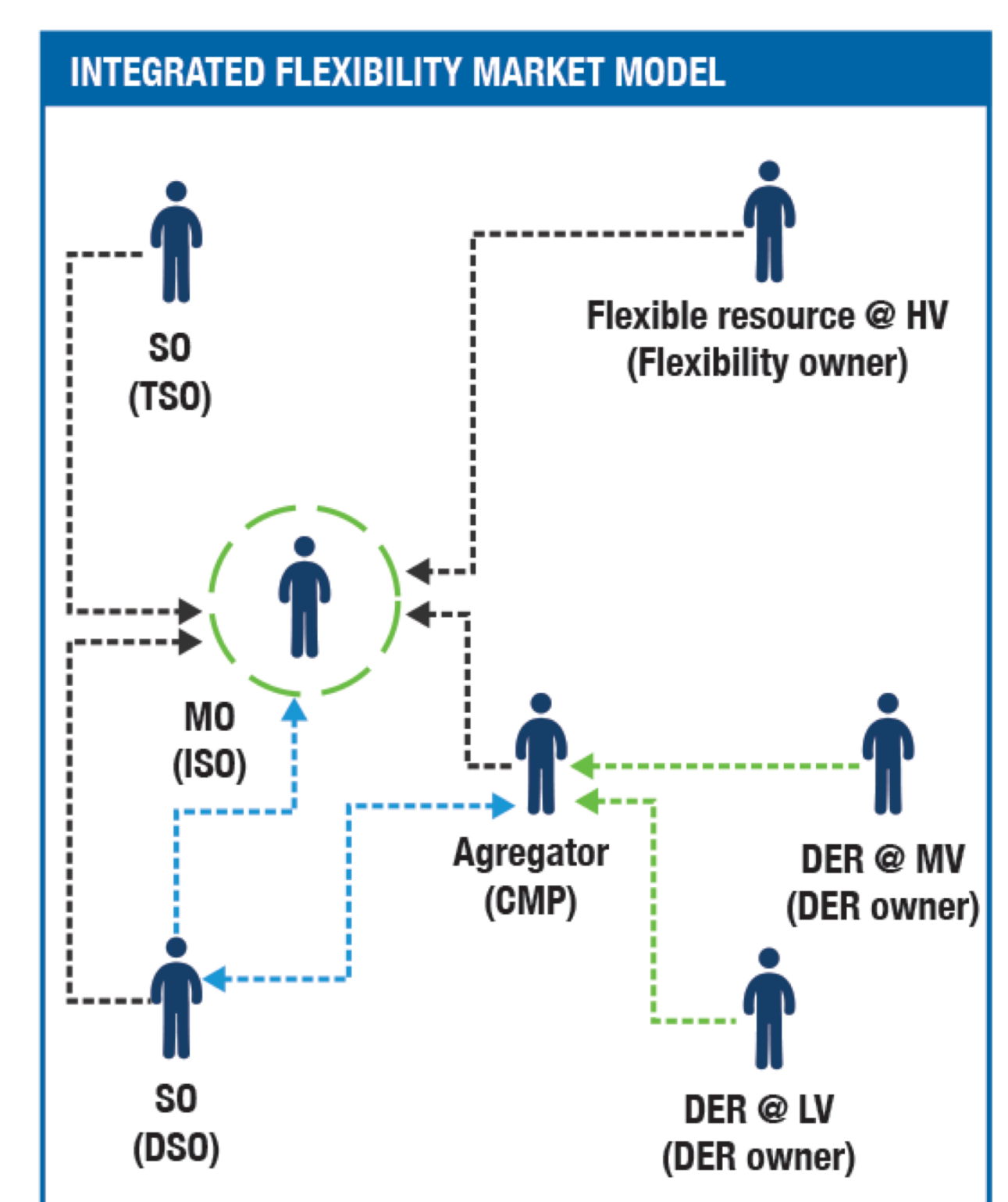
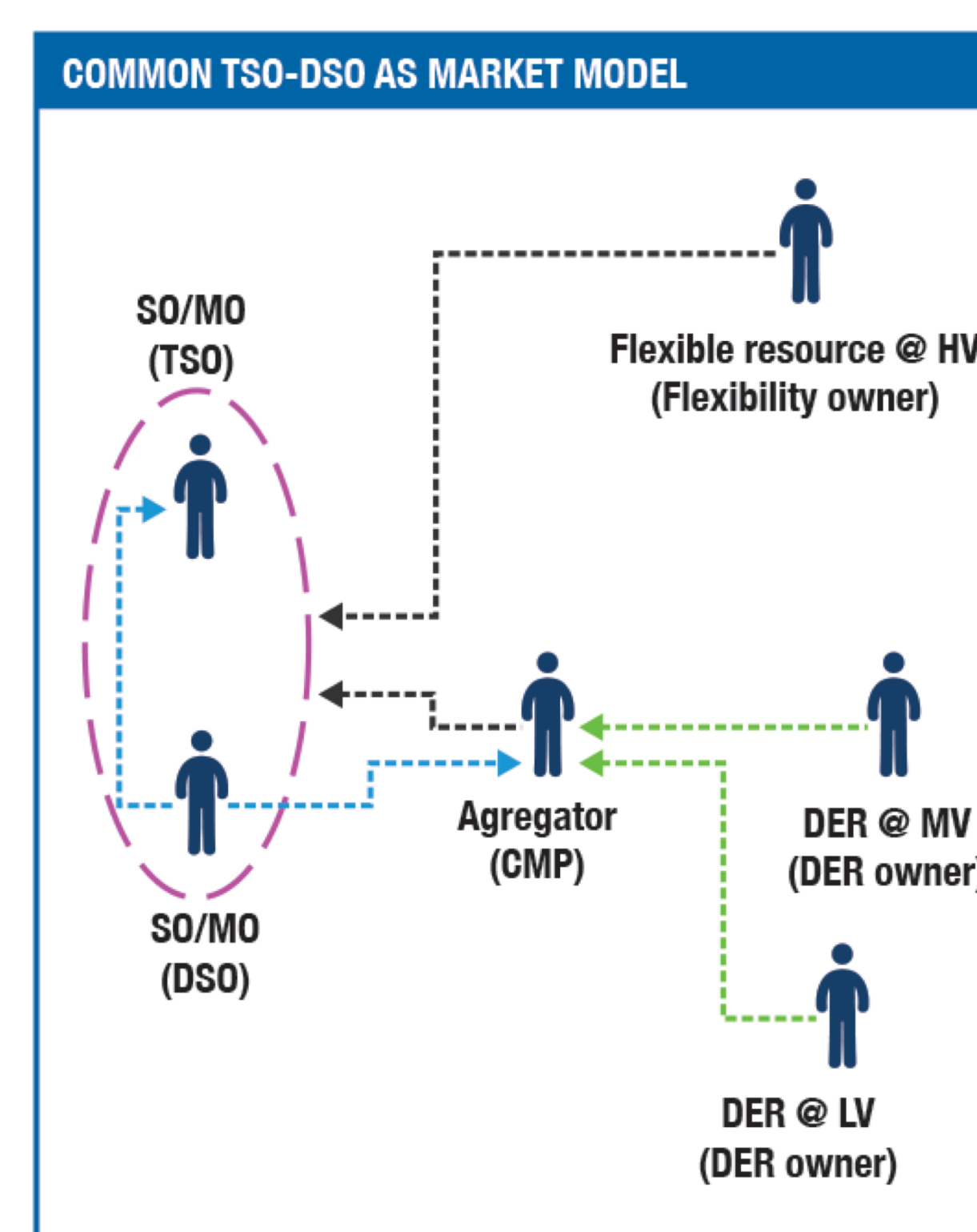
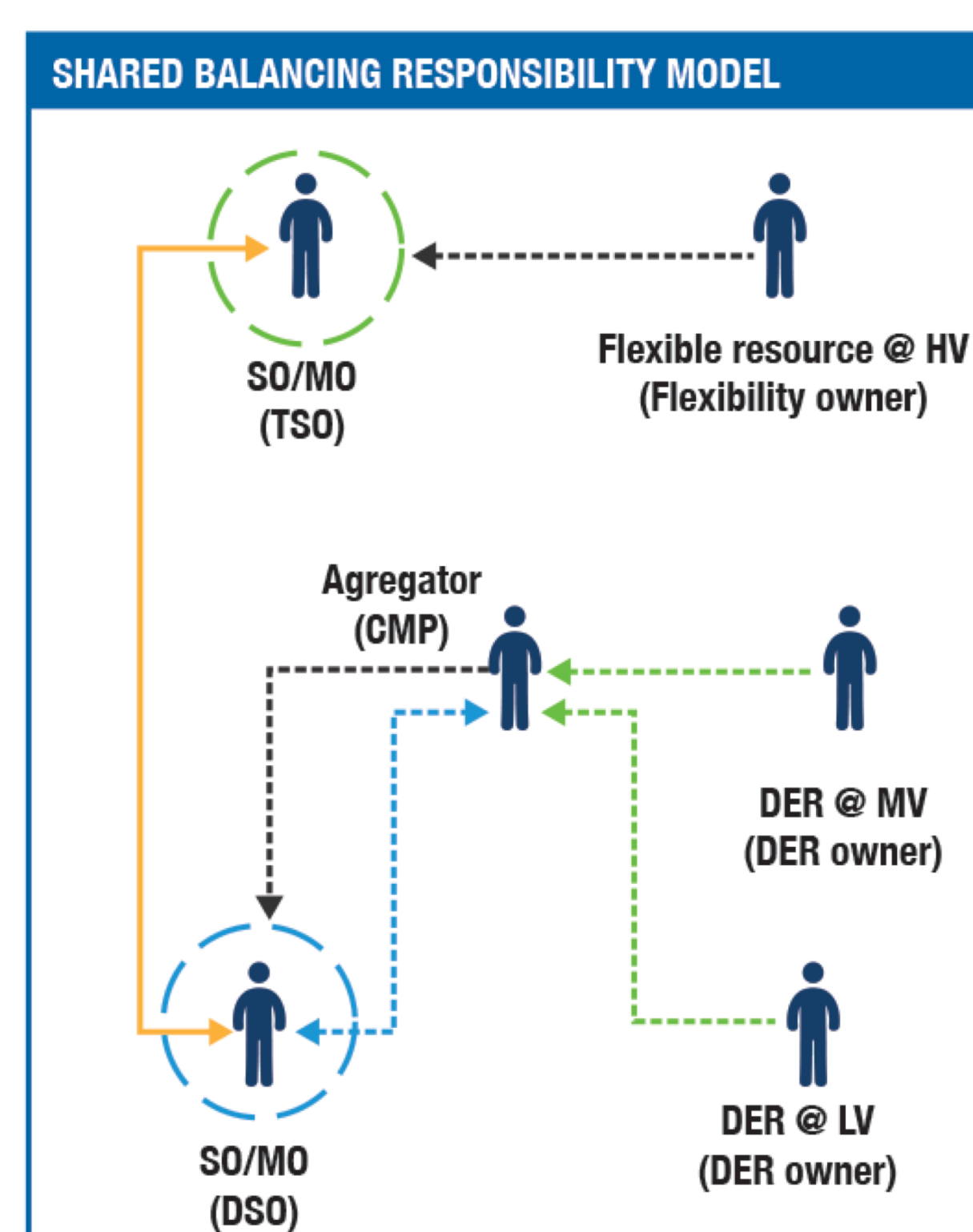
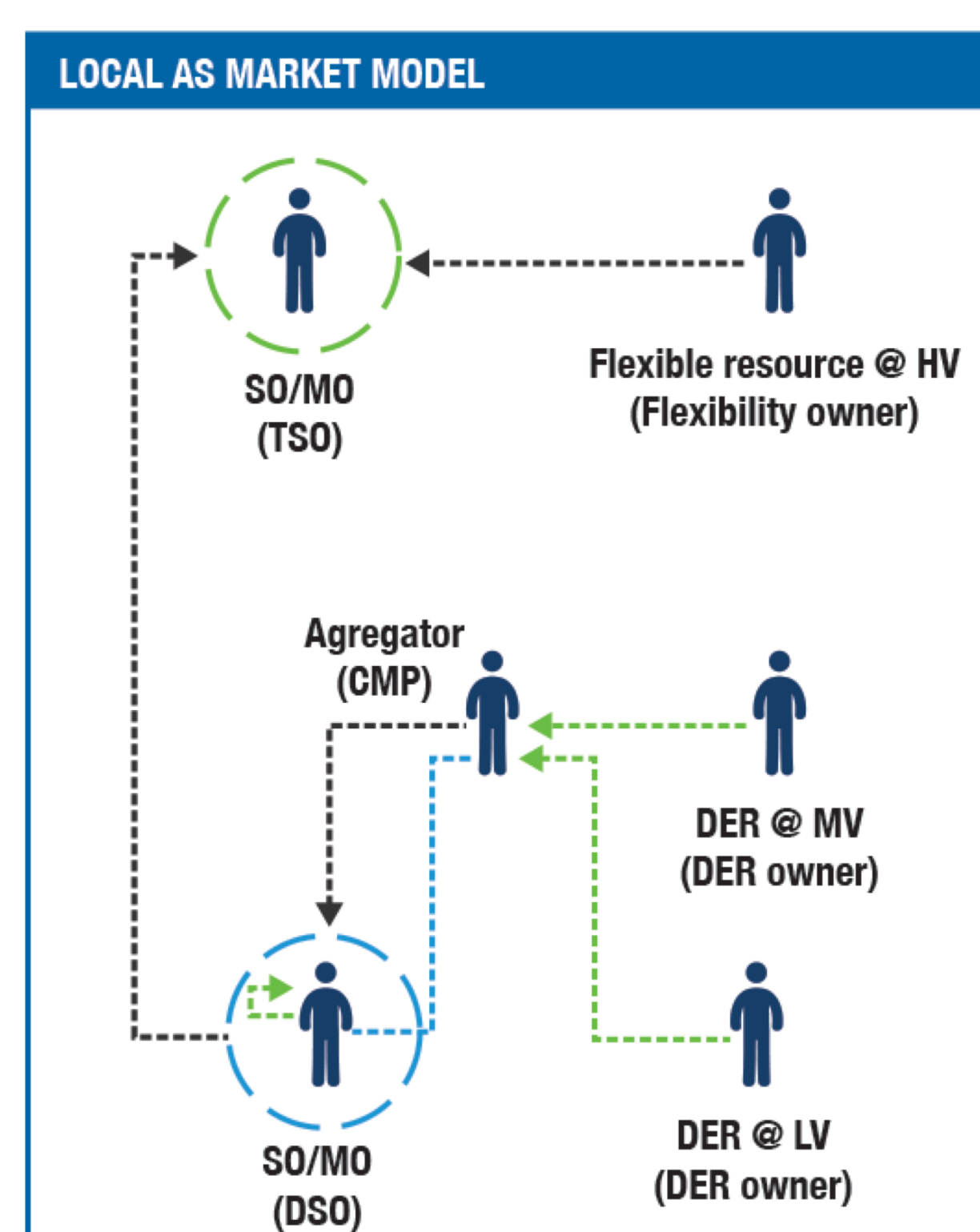
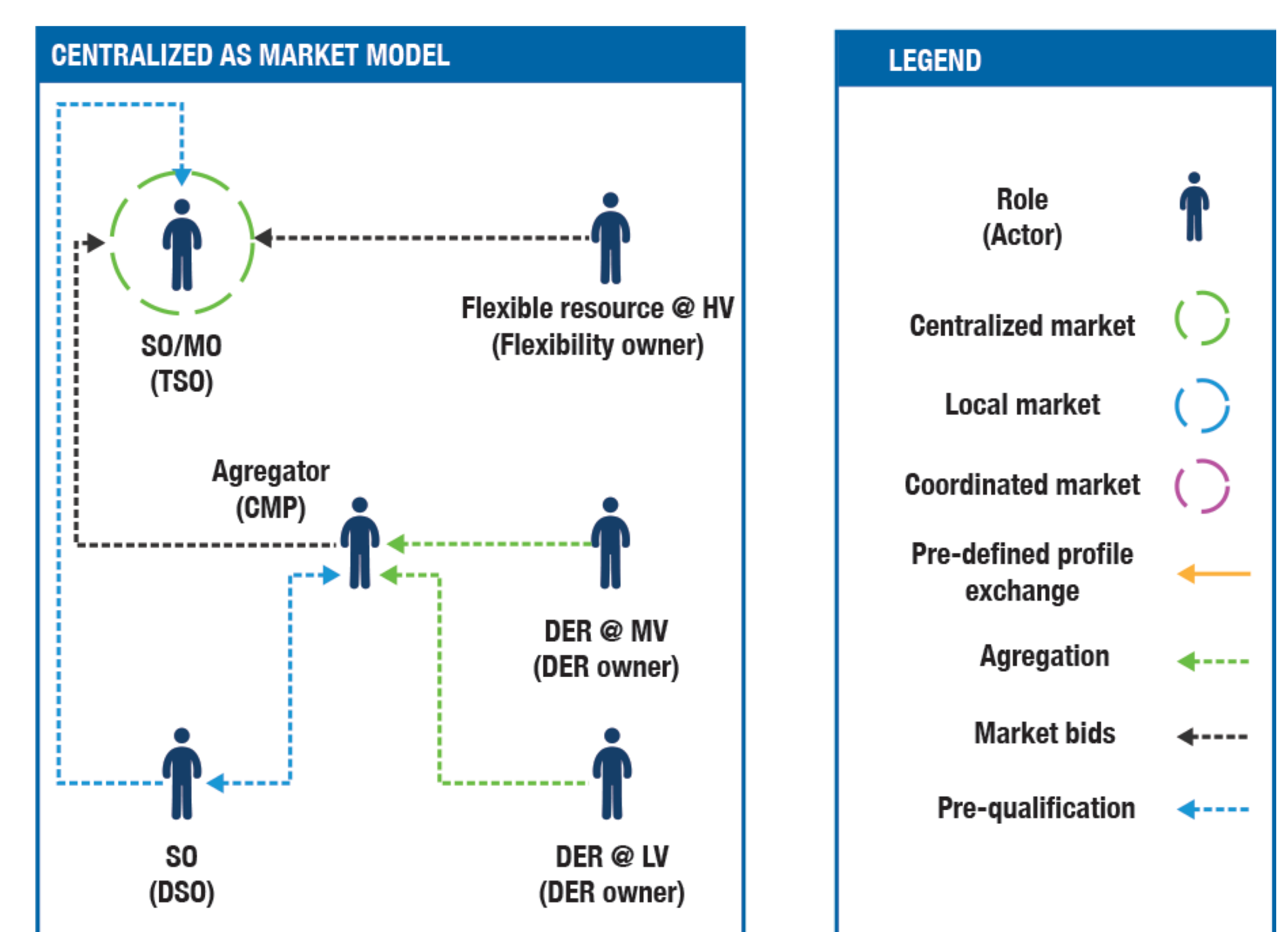
- Which **ancillary services** could efficiently be provided from distribution to the whole system.
- Which **optimized modalities** could be adopted for managing the network at the TSO-DSO interface and what **monitoring and control signals** could be exchanged.
- What information are relevant to be exchanged and how ICT could **favor the process**.
- The **regulatory implications** on the European system.



### Five TSO-DSO coordination schemes

SmartNet compares costs and benefits of five TSO-DSO coordination schemes at 2030 scenarios for Italy, Denmark and Spain

- Centralized ancillary services market model
- Local ancillary services market model
- Shared balancing responsibility model
- Common TSO-DSO ancillary services market model
- Integrated flexibility market model





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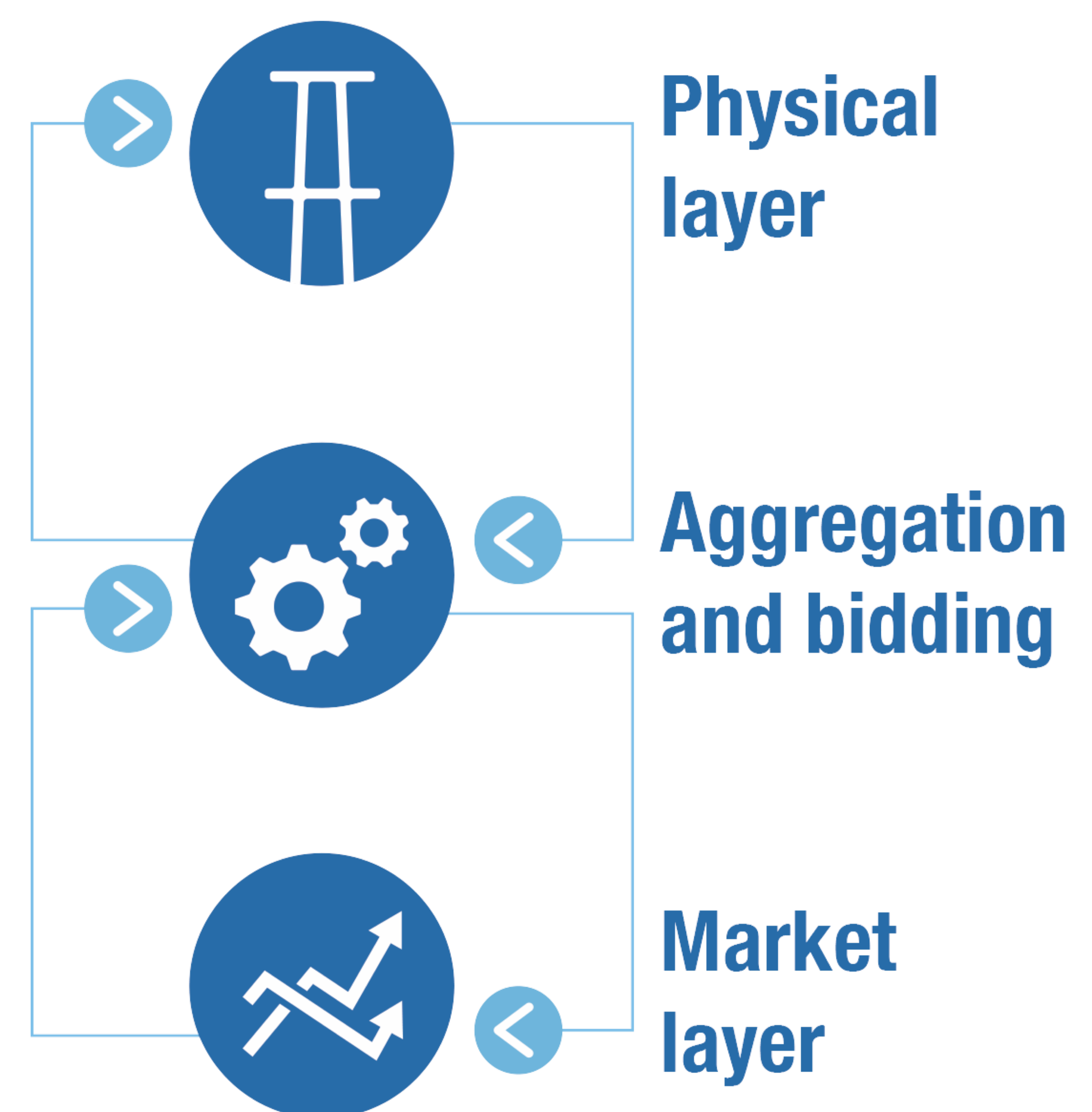
### Simulation Platform

The **physical layer** simulates Transmission and Distribution network together with devices physics. It includes models aimed at representing low-level network operations, such as voltage regulation, reactive power compensation, automatic frequency regulation services.

The **bidding layer** aggregates by means of optimization routines the flexibility of various resources (electrical storage, electric vehicles, distributed and conventional generation, demand response) into balancing market bids and translates market clearing results into activations.

The **market layer** carries out system balancing and congestion management while including voltage constraints. Some innovative features consist of:

- Management and scheduling of flexibility with time-dependent behavior/constraints
- Optimization routines capable of including distribution networks constraints
- Arbitrage opportunities between different markets (day-ahead, intra-day, ancillary services)



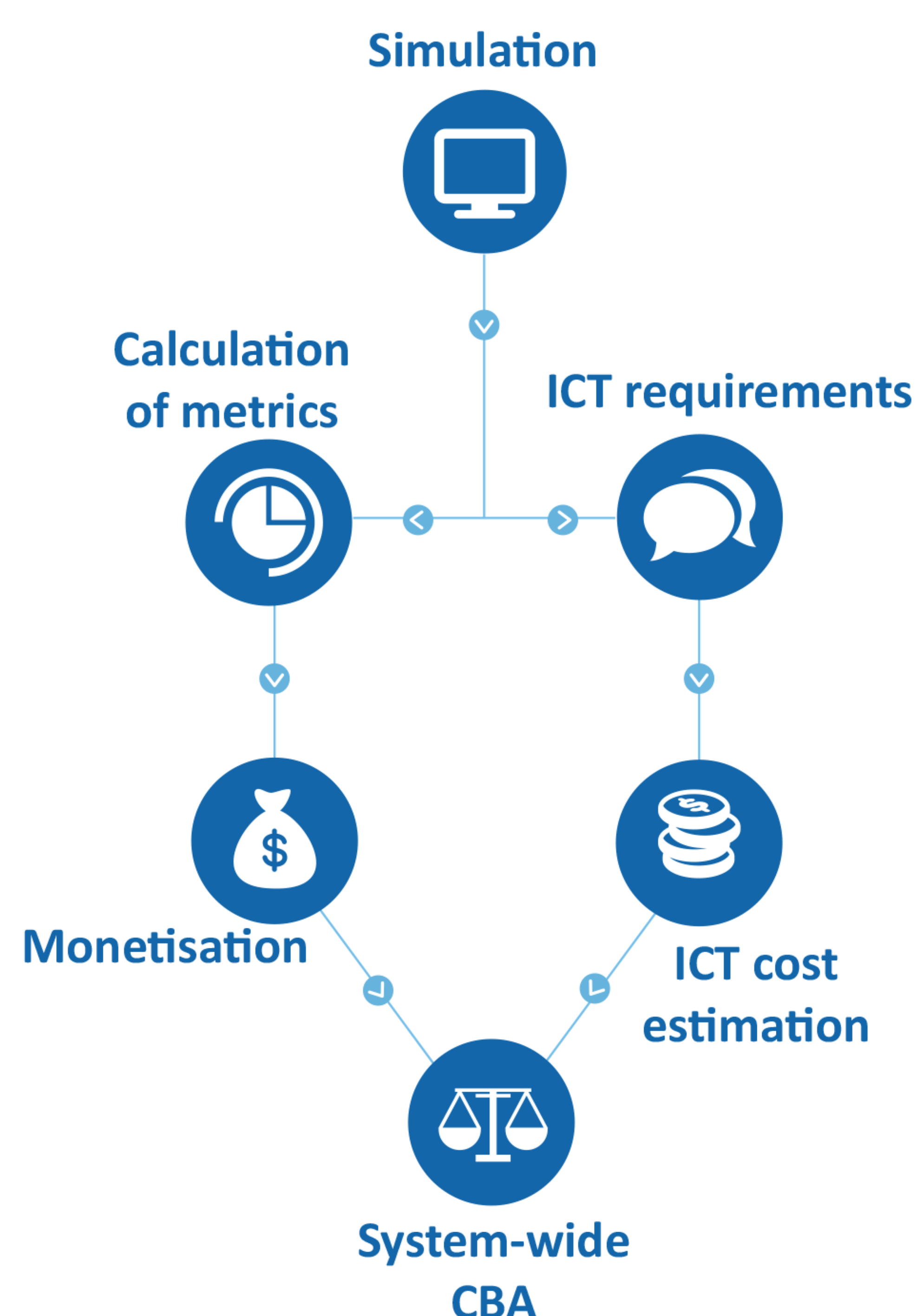
### Cost Benefit Analysis

The **Cost Benefit Analysis** compares the five coordination schemes over the three national scenarios on the basis of cost indicators (metrics):

- Costs for the activation of **mFRR/RR services**
- Costs for the activation of **aFRR services**
- **ICT costs**

Additional non-monetized items

- Adoption of unwanted measures to solve unexpected network congestions
- CO<sub>2</sub> emission savings

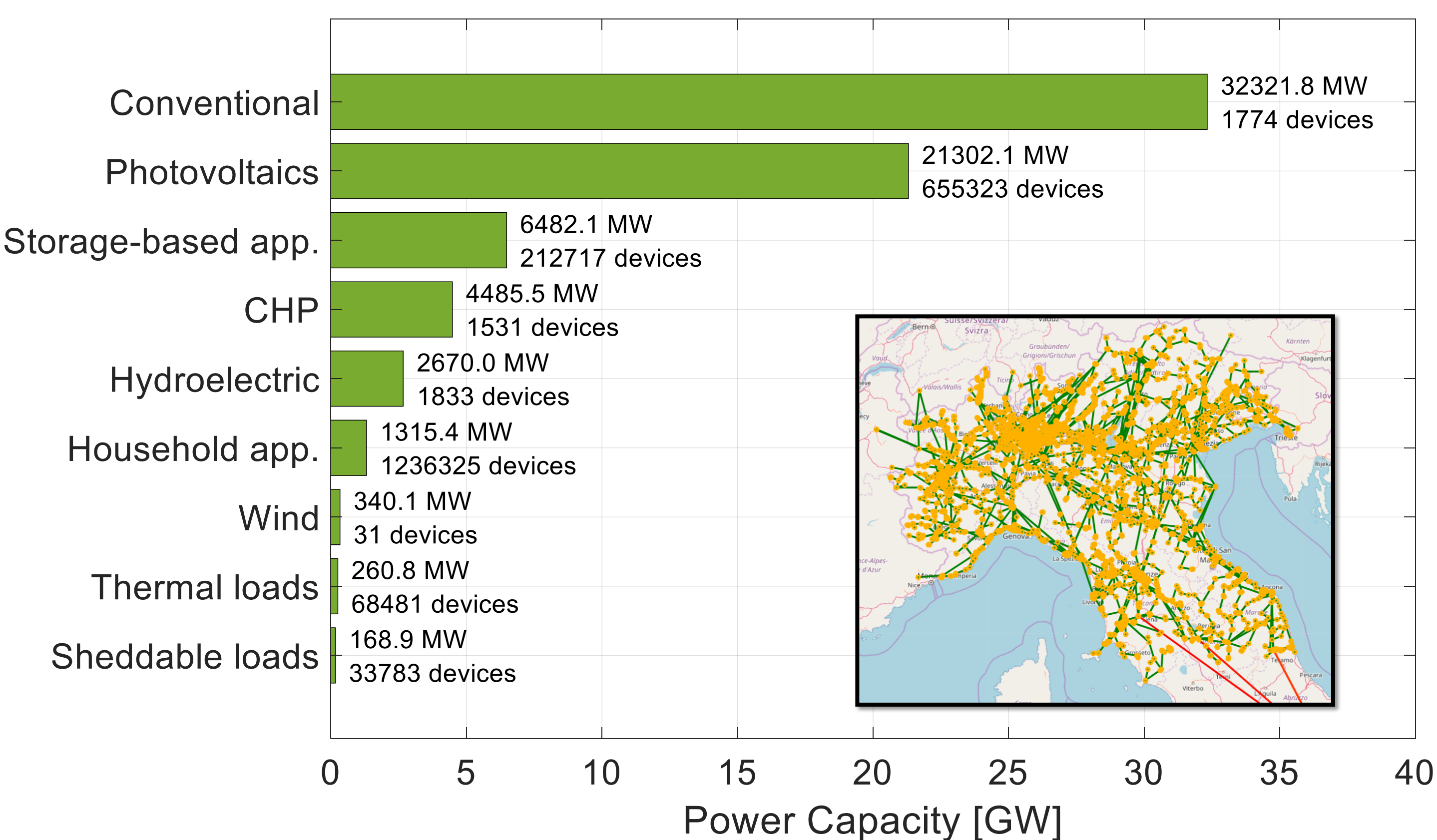


### ICT cost metrics

- **Communication Costs**  
Possibility of exploiting the existing ways to communicate (such as smart meter infrastructure) together with the impact of the communication channels reliability (single vs. aggregated units)
- **Software Costs**,  
Expenditures related to licenses of market clearing and aggregation solvers. Affected by large uncertainties related to the complexity of the system (single central market vs. multiple local markets).



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### 2030 scenario for Northern Italy

- In line with ENTSO-E Vision 3 – National Green Transition
- Demand and distribution flexibility partially bid (~50%)
- Poor cross-border capacity

### Simulation Details

- **16 hours** of an averagely sunny and windy spring day simulated
- Transmission network + 638 distribution networks simulated (15% of them with systematic congestions)

### Market and aggregation assumptions

- Market clearing frequency: **1 hour**
- Time resolution of bidding and reserve activations: **15 minutes**
- Spatial resolution:
  - **mFRR** (system balancing + congestion management): **nodal price**
  - **aFRR** (system balancing): **zonal price**
- Flexibility remuneration: **pay-as-clear** (Unwanted Measures: non monetized)

### Activated energy reserves

- All the Coordination Schemes activate similar amounts of mFRR, except for CS.C which requires additional flexibility for distribution networks balancing
- Not considering distribution grid constraints (CS.A) brings to higher levels of Unwanted Measures (load/generation manual re-dispatching)
- Unwanted Measures negatively affect balancing, resulting in larger volumes of activated aFRR (typically more expensive than mFRR)

