



Smart TSO-DSO interaction schemes, market architectures and ICT
Solutions for the integration of ancillary services from demand side
management and distributed generation

SmartNet Final Workshop, Arona | 16.05.2019

Pilot C

Endesa - Vodafone – ONE – Tecnalia – IREC



This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 691405





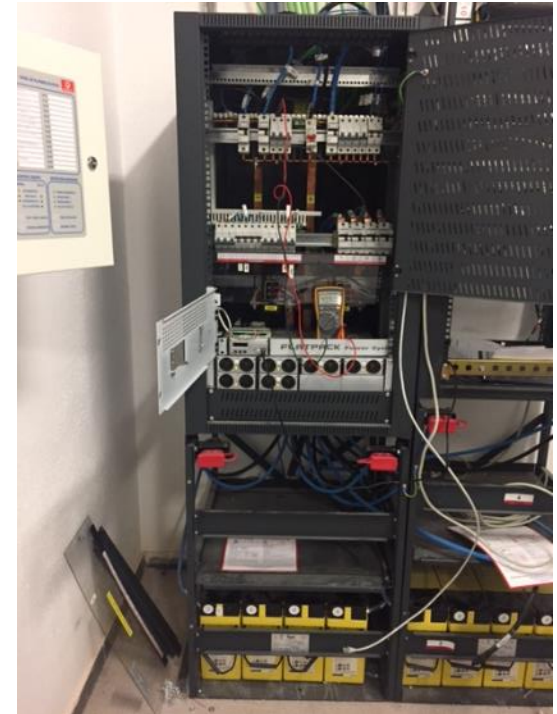
Vodafone Base Stations

More than 400 units just in
Barcelona

Contracted Power of each
one from
5kw to 15kw

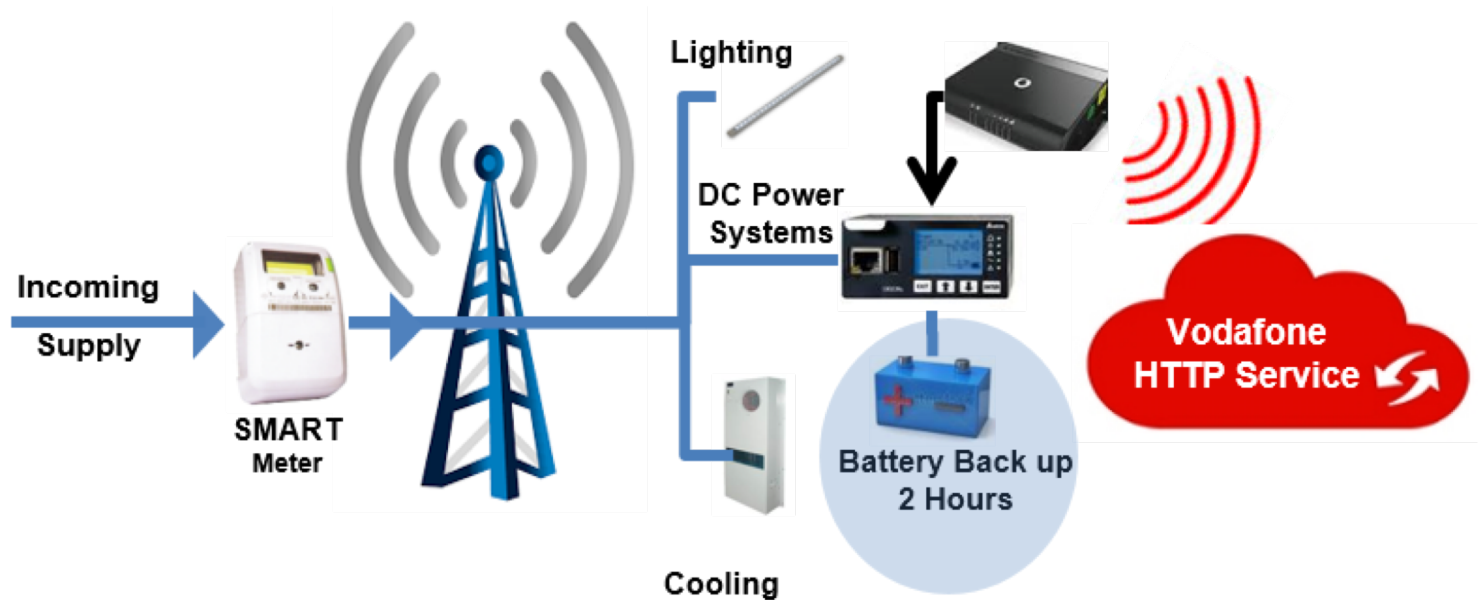
Flexibility by Storage Capacity

- Back Up Batteries - Base Station of Vodafone



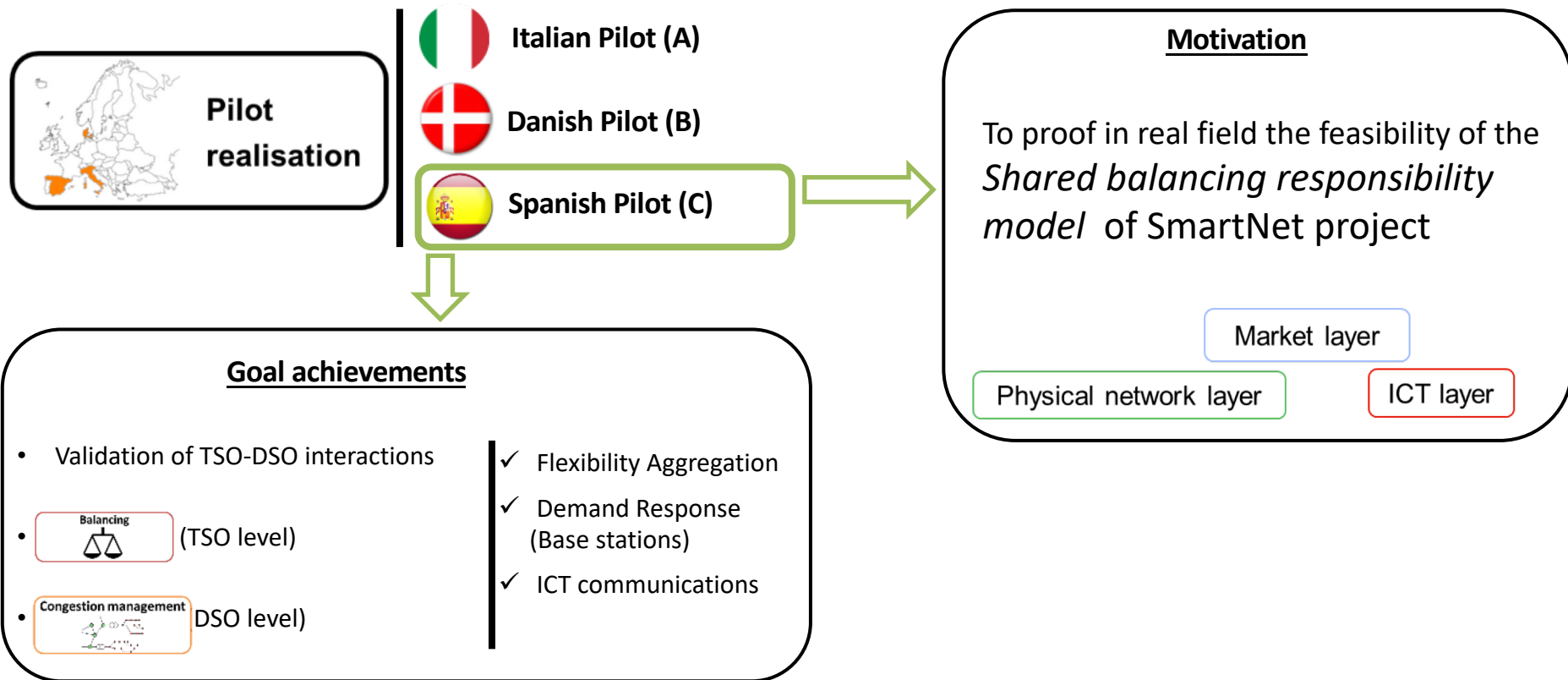
Spanish pilot

DER Owner side. Demand Response Technology over VF Base Stations



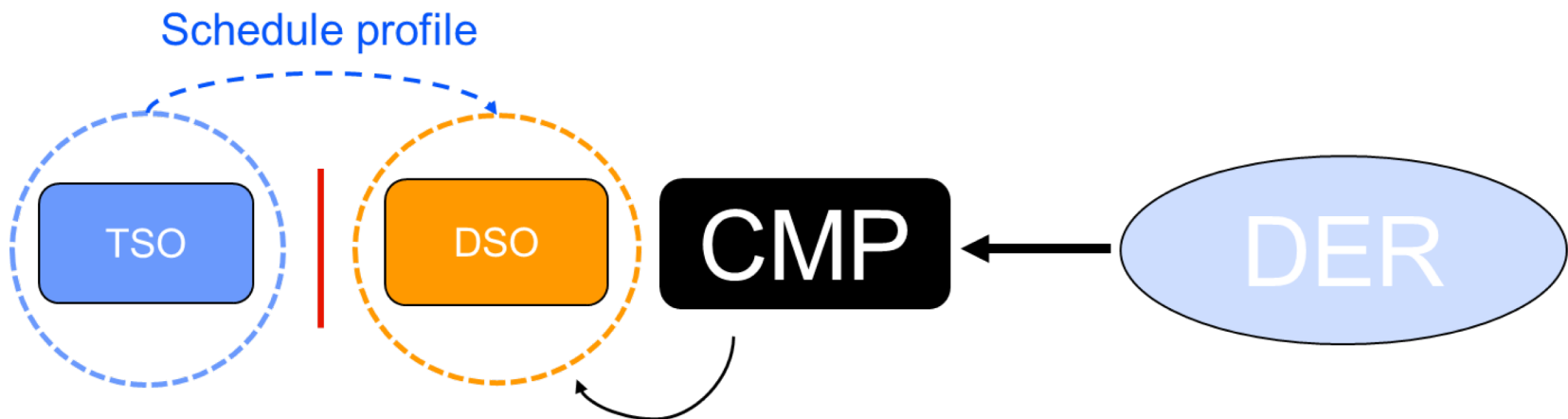
Pilot flexible aggregation capacity:
around 100 kW

Spanish pilot



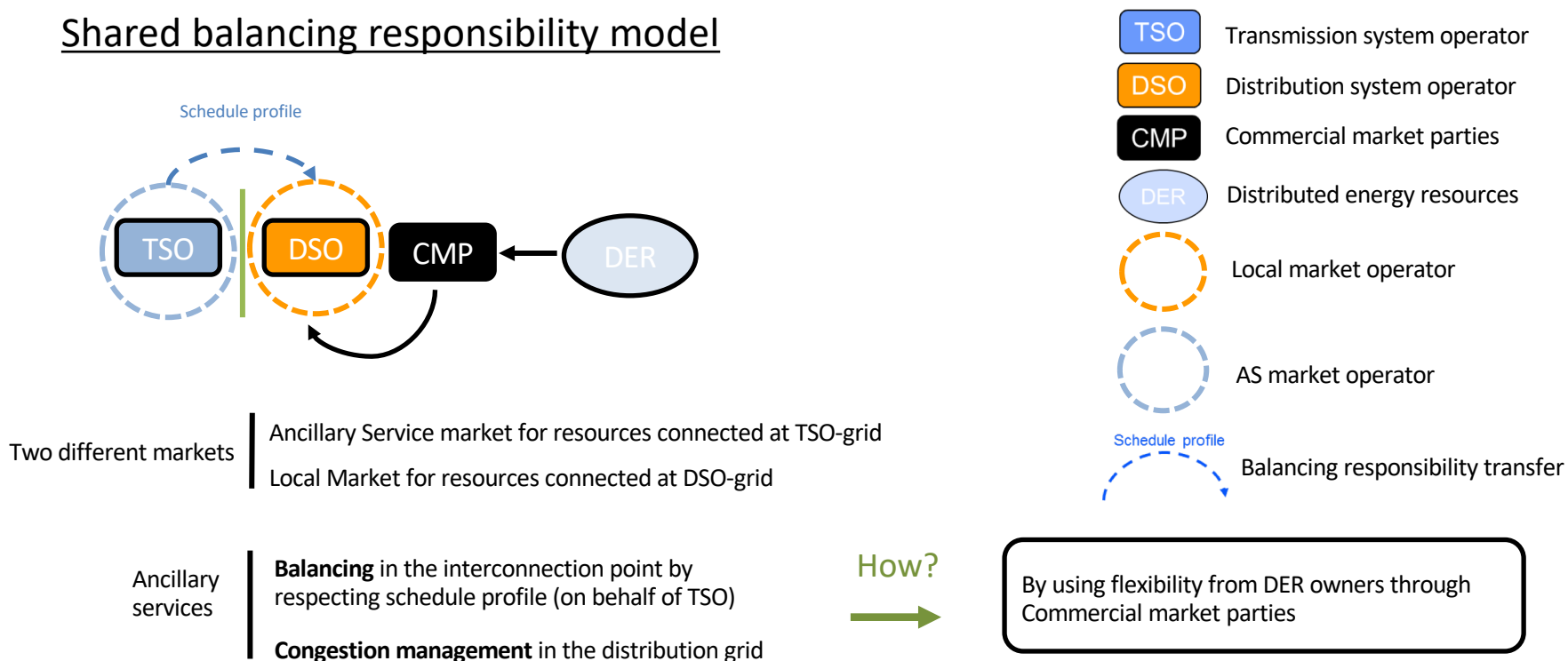
Coordination scheme

Shared balancing responsibility model







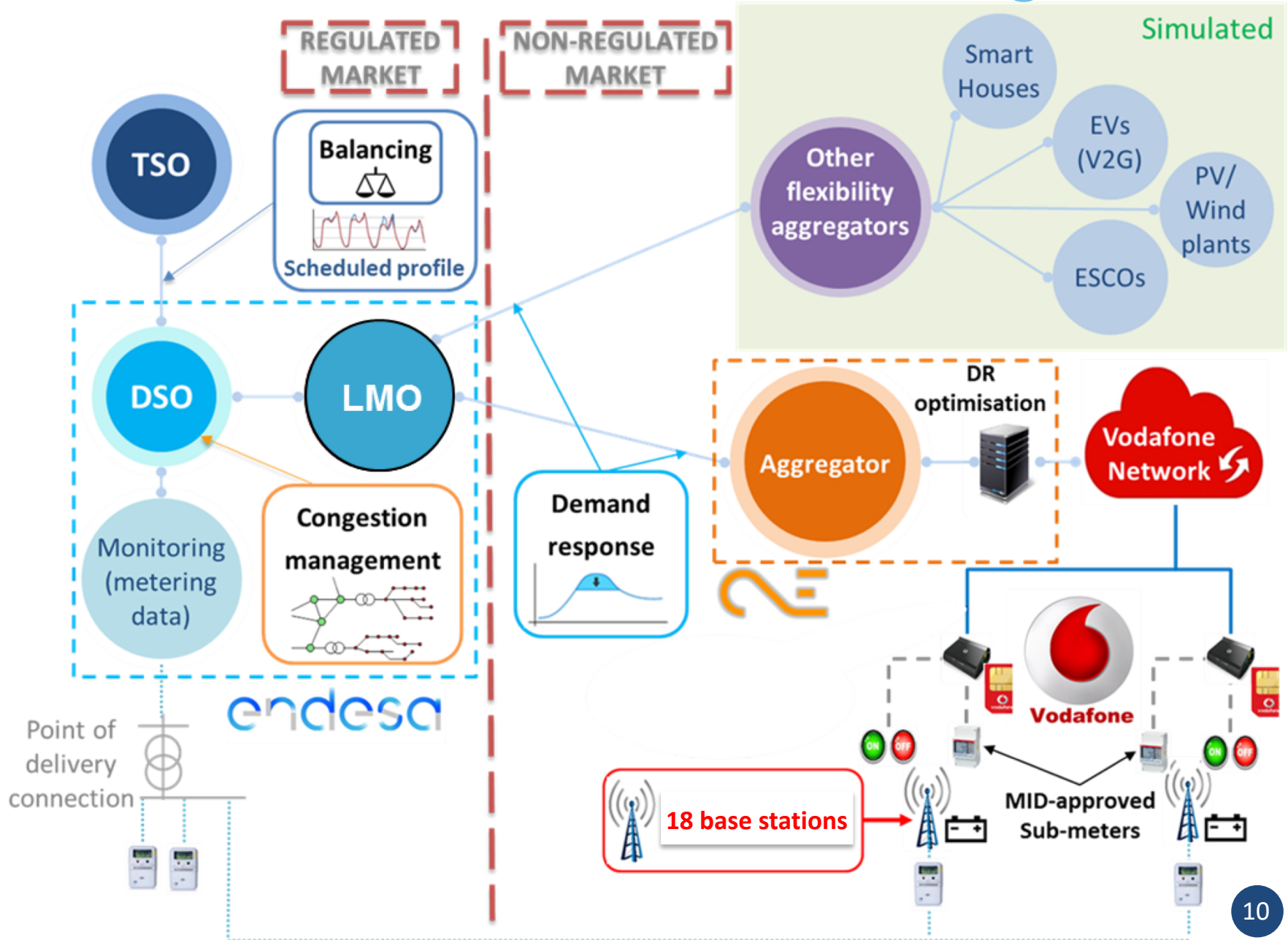
Coordination scheme

Shared balancing responsibility model



Roles in the project

	Transmission System Operator	Balancing at interconnection level Developing the TSO-DSO interaction
	Distribution System Operator	By doing congestion management services for itself at local network
	Commercial Market Party	Virtual nodes emulating other CMP's (Smarthouses, PV's, BSs)
	Market operator	Local market operation
	Commercial Market Party	Managing the portfolio of Vodafone radio base stations
	DER owner	Owner of the base stations (flexible resource) Provider of connectivity services to CMP's
	Consultant	DR providers

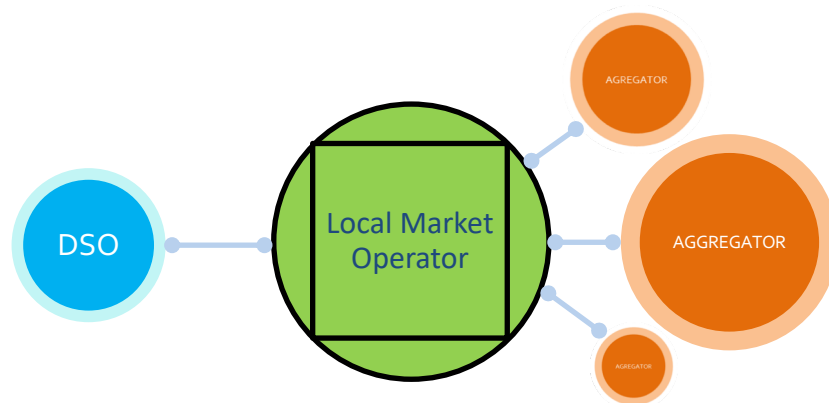


Pilot C: Local Market Operator

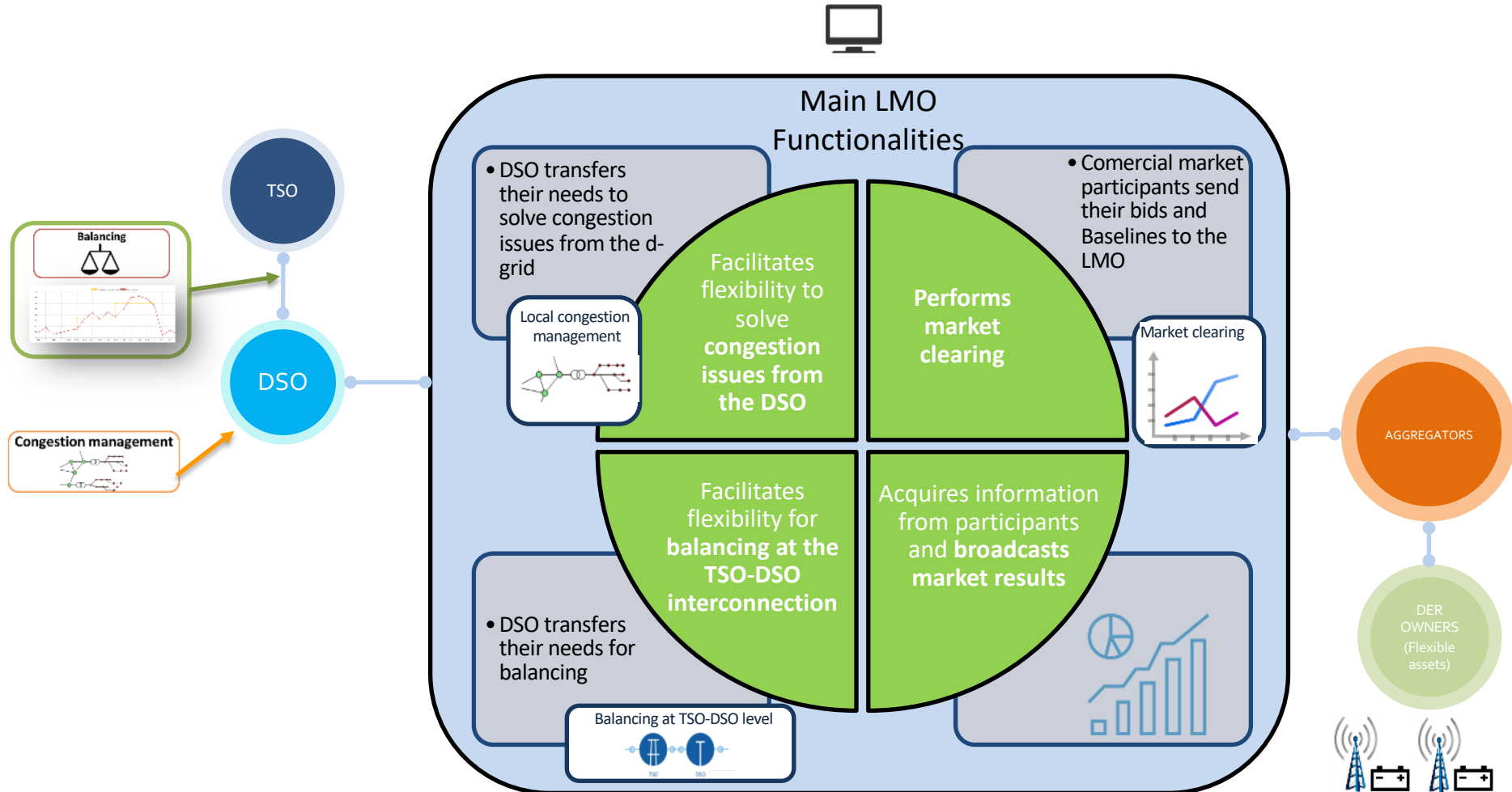
Endesa Distribución will play the **market operator** role at the local (distribution) level by means of the **market clearing algorithm**, which at the end is an OPF (Optimal Power Flow).

The OPF solves in the same optimization model both technical and market-related aspects of the balancing and congestion management services.

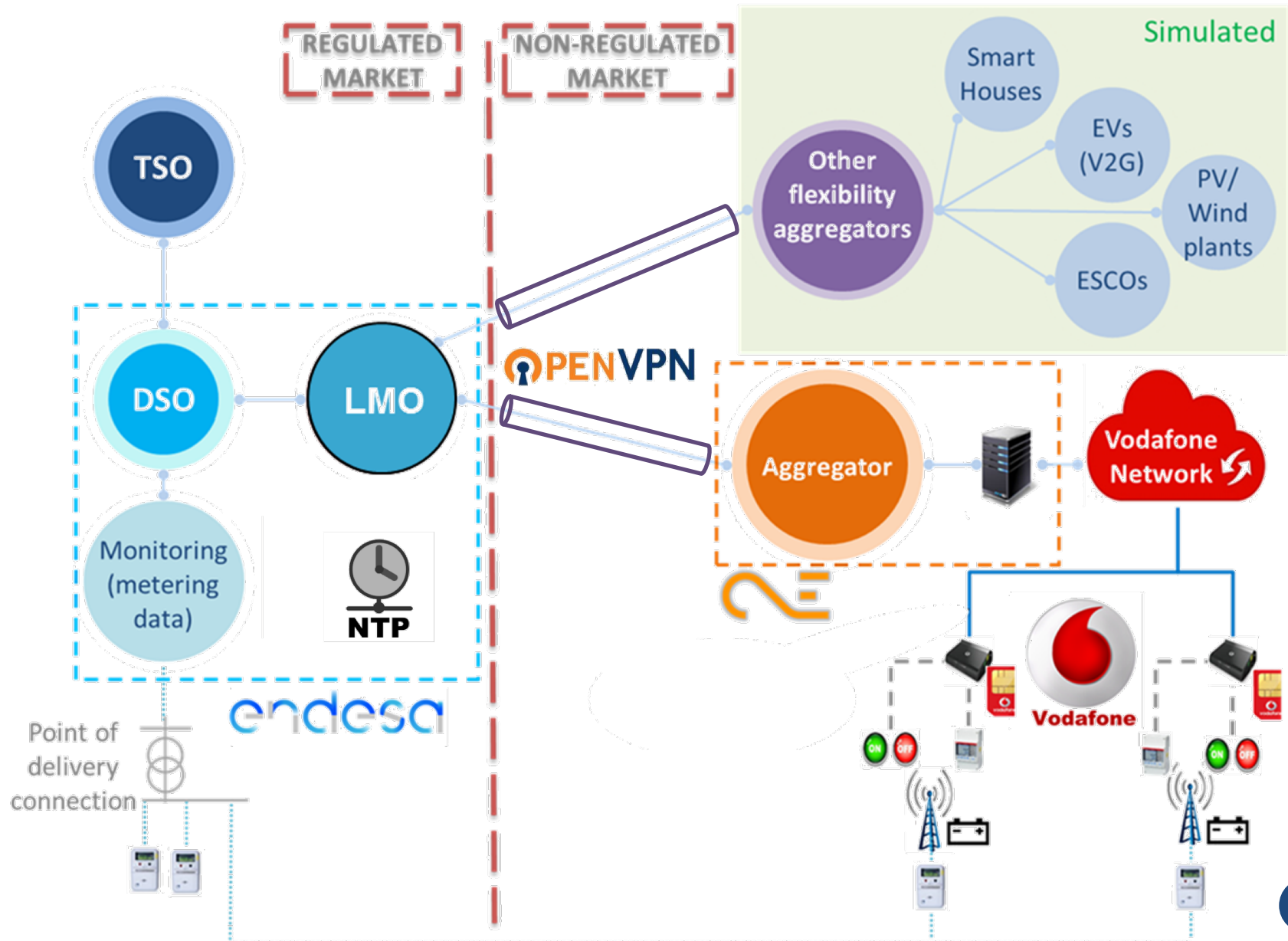
In other words, **technical constraints and bid prices are combined in the same optimisation problem**, which provides an optimal economical outcome.



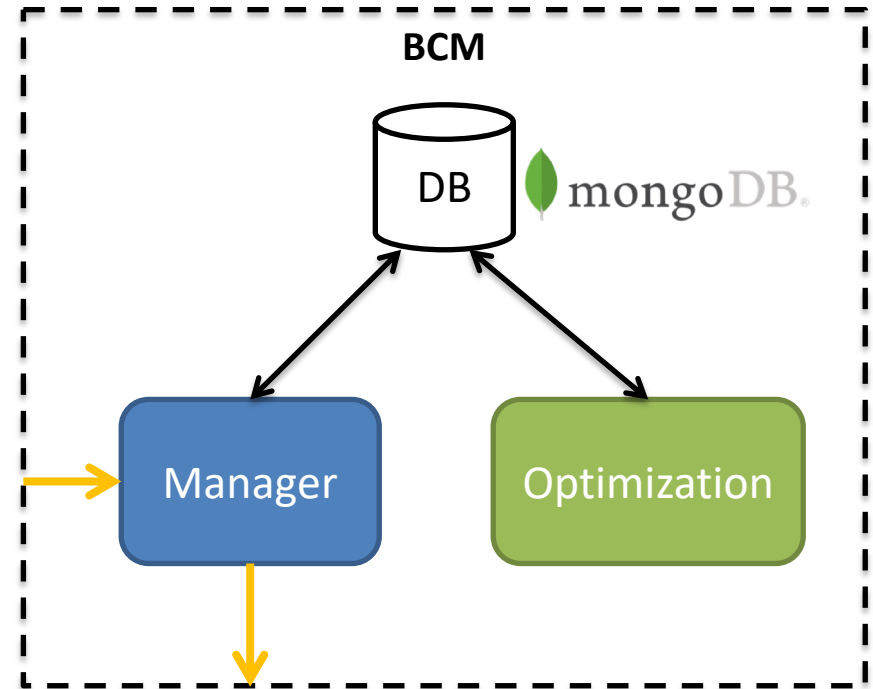
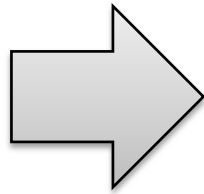
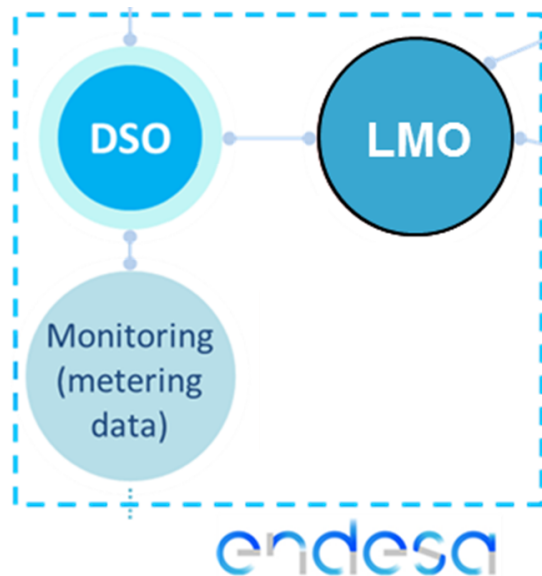
Local Market Operator



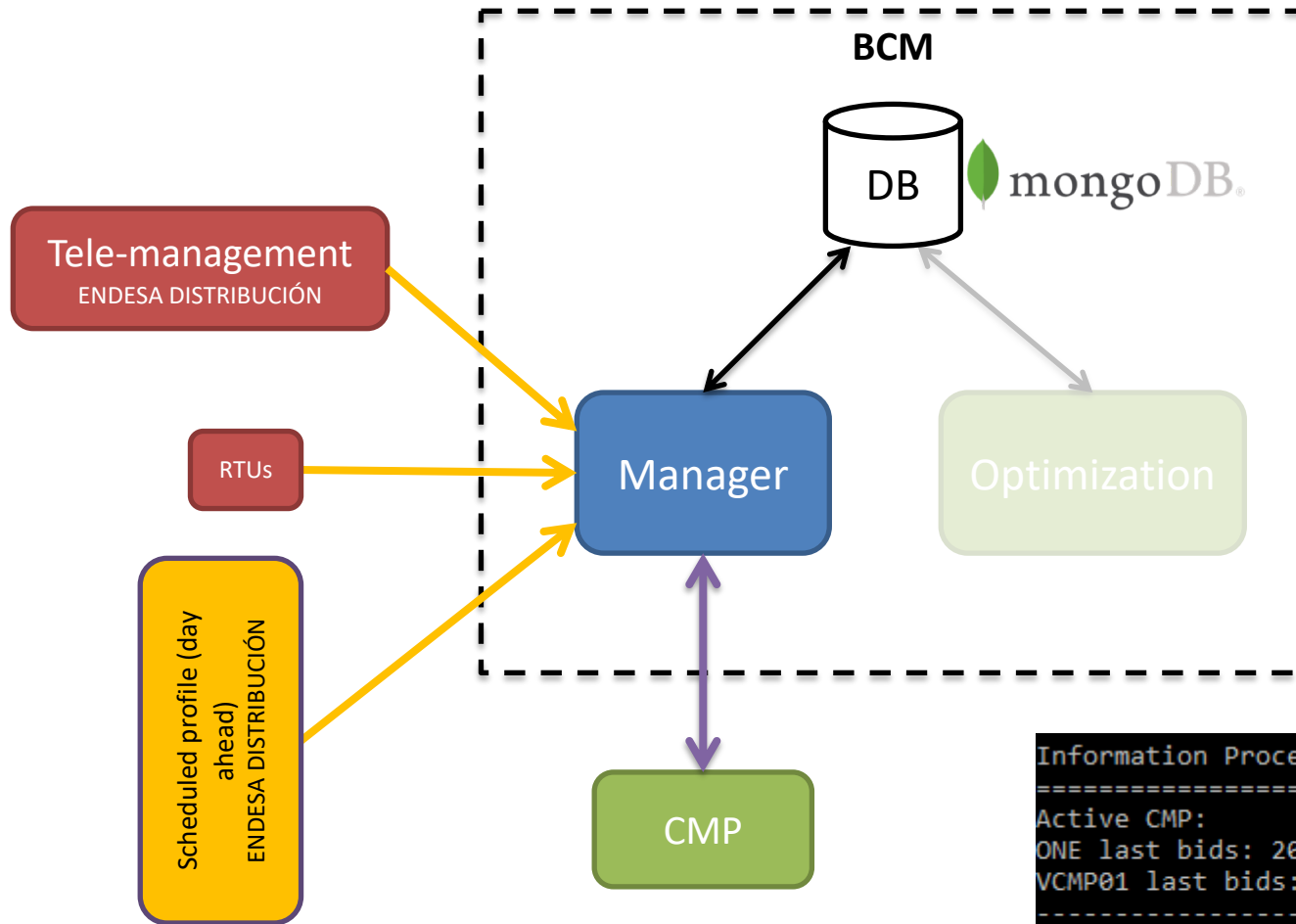
Pilot C: Overview



Pilot C: Balancing & Congestion Management



Pilot C: Balancing & Congestion Management



Information Process

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Active CMP:

ONE last bids: 2018-03-21T15:30:00Z

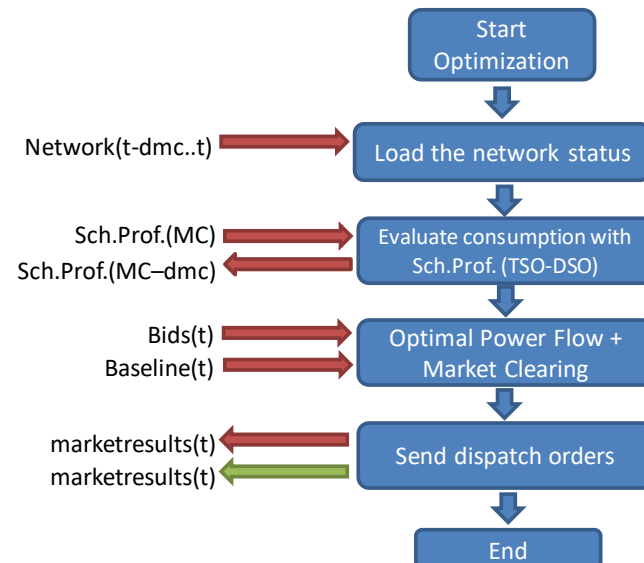
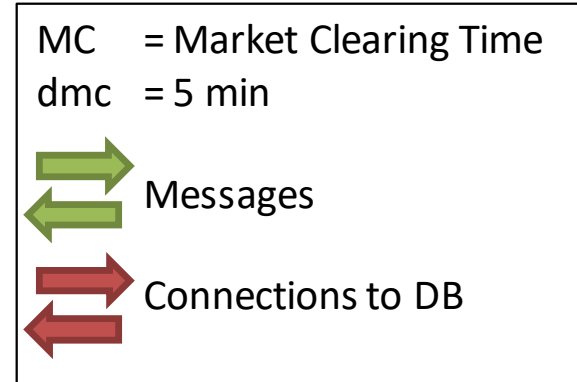
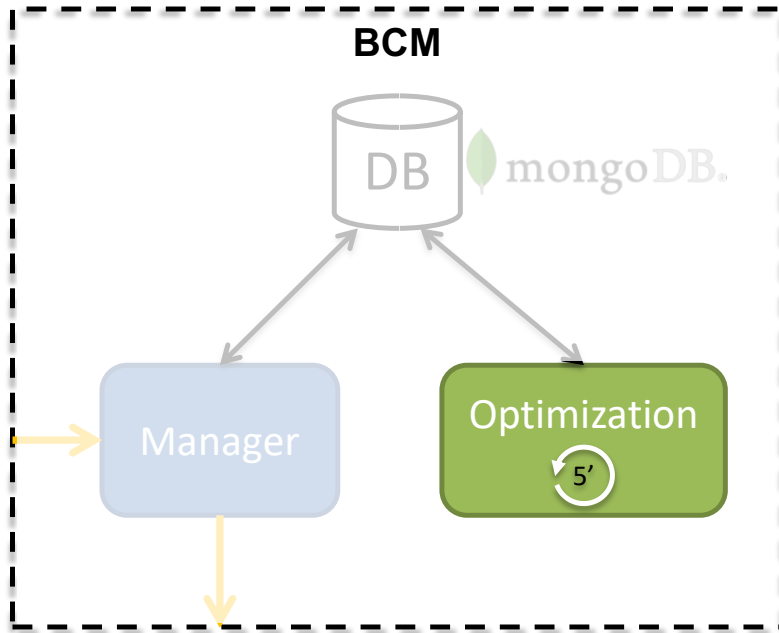
VCMP01 last bids: 2018-03-21T15:10:00Z

Next calculations at: 2018-03-21T15:14:00Z

Next market at: 2018-03-21T15:15:00Z

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Pilot C: BCM - Optimization



Pilot C: BCM - Opt. – OPF + MarketClearing

$$\min \sum_{g \in G} \sum_{k \in K_g} lb_{gk}^+ P_{gk}^+ + \sum_{k \in K_{G_0}} lb_{0k}^- P_{0k}^- + \sum_{(i,j) \in \mathcal{L}} C_{ij}$$

s.t.

Power Flow technical constraints

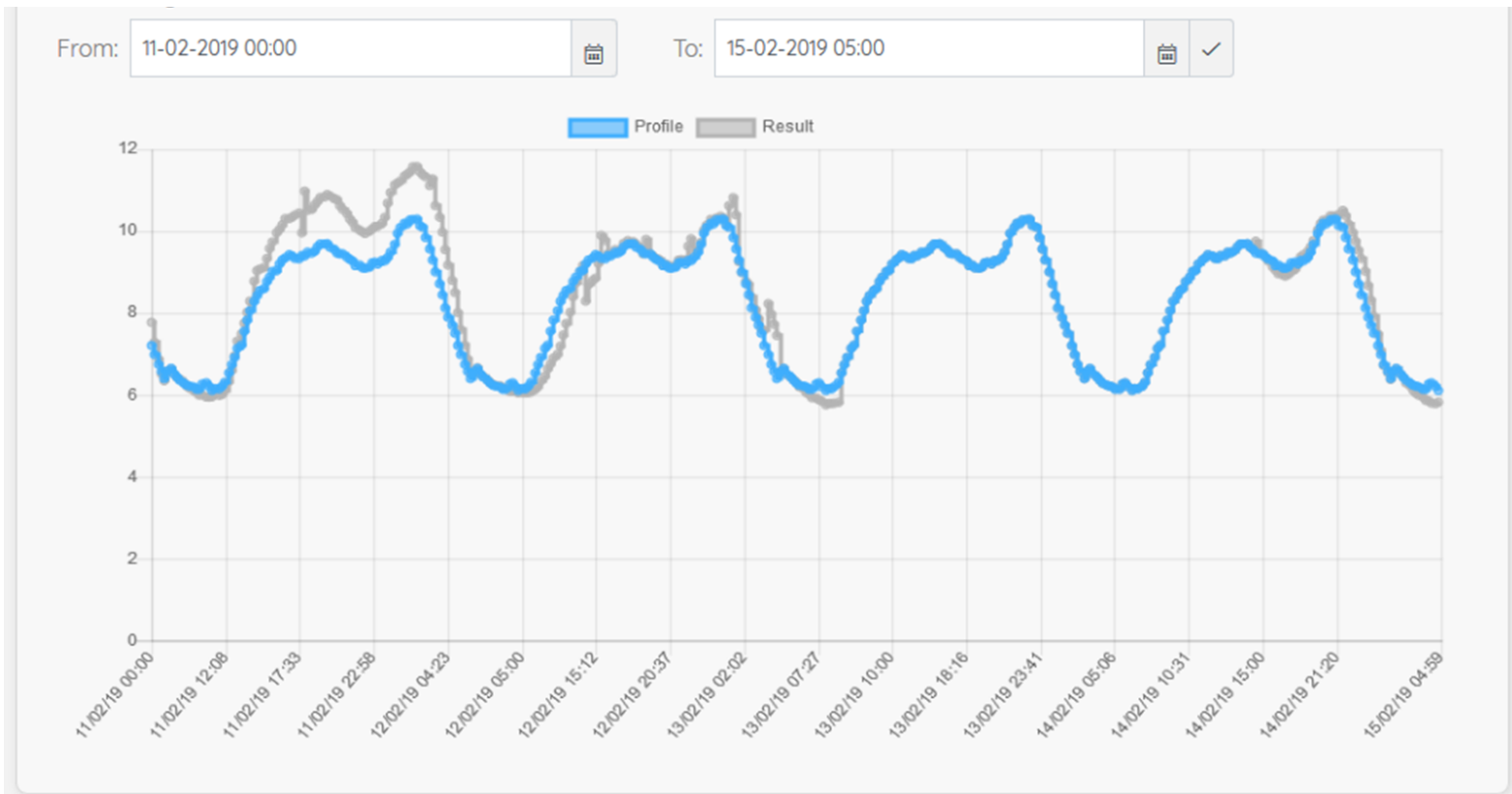
Balancing constraints

Congestion constraints

Market Clearing constraints

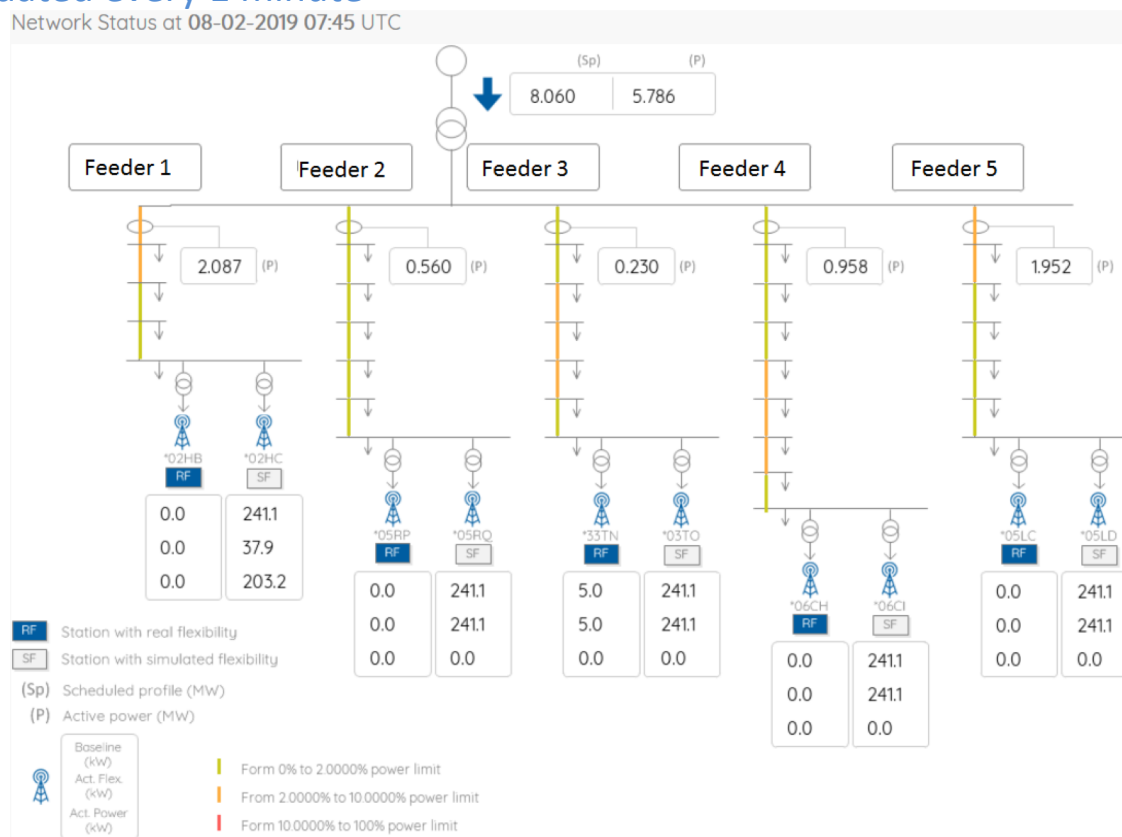
Balancing

- Time plot of active power exchanged at TSO-DSO interconnection points
 - Scheduled profile (MW)
 - Actual active power measured data (MW)
 - 1 plot per each TSO-DSO interconnection point in Pilot C
 - Adjustable time filter (window)



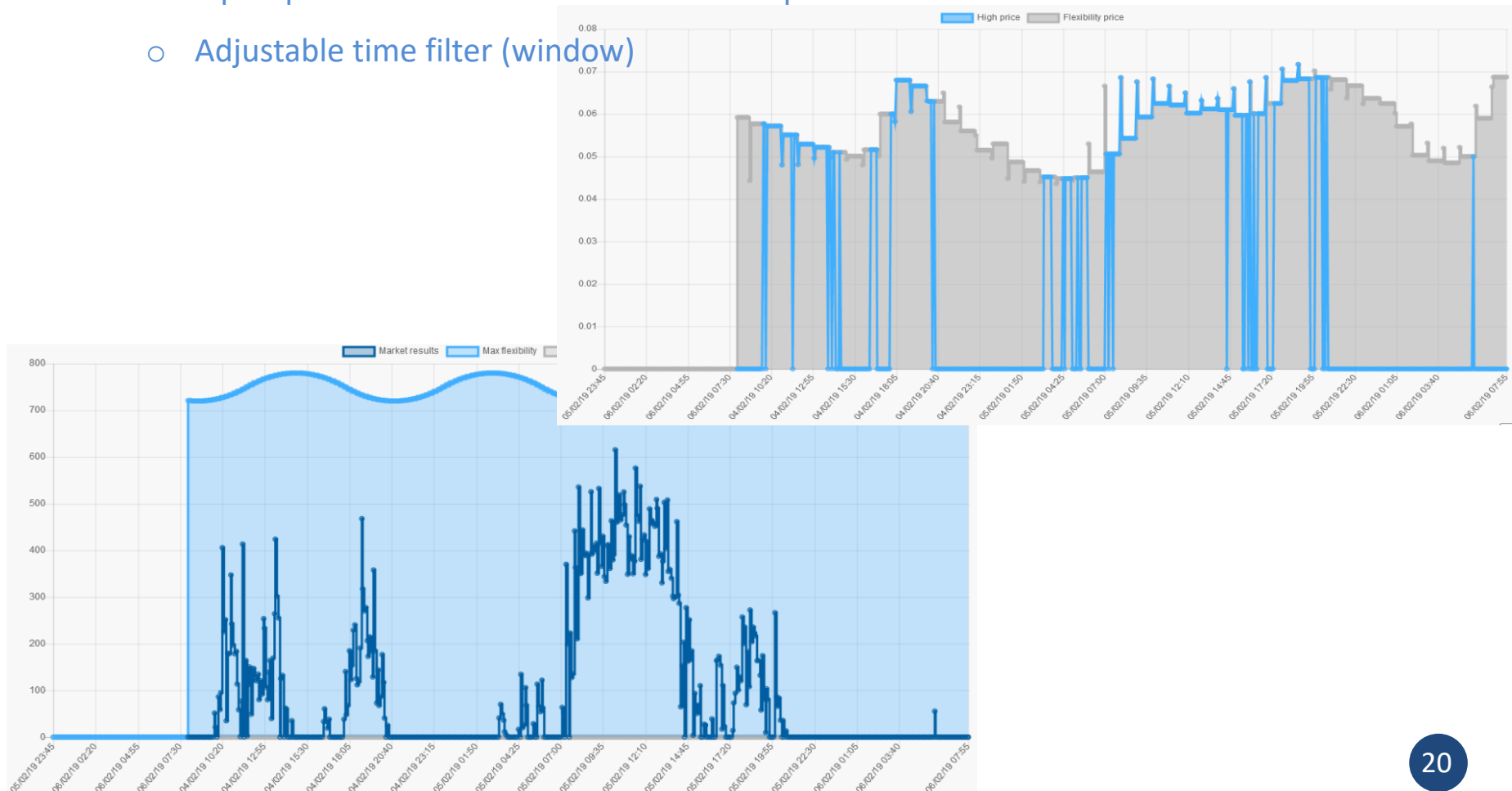
Network status

- Diagram of the distribution network downstream each TSO-DSO interconnection point
 - Voltage levels per node
 - Branch loadings (lines/cables, transformers)
 - Actual delivery of flexibility resources of the Pilot C (VODAFONE and virtual)
 - Updated every 1 minute



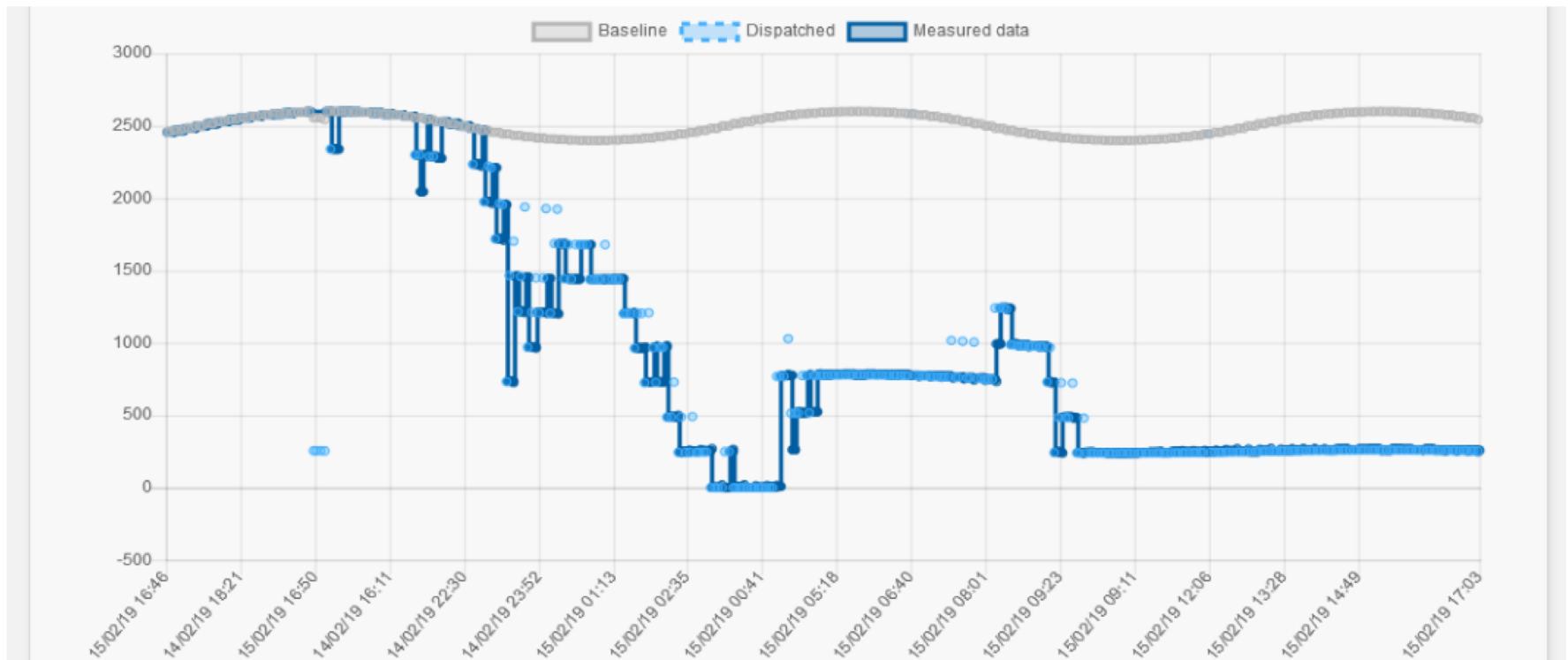
Market price

- Time plot of the clearing price per market session at each TSO-DSO interconnection point (cent/kWh)
 - 1 plot per each TSO-DSO interconnection point in Pilot C
 - Adjustable time filter (window)



CMPs (aggregated load)

- Time plot of aggregated load of customers' portfolio of each CMP
 - Baseline (grey)
 - Dispatched power, i.e. (baseline + dispatched flexibility) (light blue)
 - Delivered (measured) power (dark blue)



Potential & Benefits of flexibility

- **0 Service impact** during live test. We proved the mobile communication network is not at risk.
- We could drive HW and SW Technology vendors for **performance efficiency** to support site remote management.
- We are able **to prepare future mass market DSR deployment** program set up – do's and don't (site built, access management, etc...).
- We can integrate DSR in BTS **new power design** with 5G introduction.
- We could verify fit for purpose of **IoT Technologies** to get live DSR program with aggregators and DSO's.
- Installed power capacity in EU could represent **+250 MW** of dispatchable load.
- Regulation towards **fairly DER compensation** is necessary.

Potential & Benefits of flexibility

From the DSO perspective:

- Innovative ways of integrating **new battery systems** into the power grid.
- DSOs are active **neutral market facilitator** for DER and prosumers.
- **Avoiding possible reinforcements** of the grid. Network upgrades only when needed.
- **Helping Balancing Services (BRP)**
- Envisioning **different coordination's schemes** with different results on the CBA.
- Pushing **new technologies** for the grid **digitalization**.
- Regulation towards **local markets**.

Thank You

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Global Infrastructure & Networks

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