

Exploiting flexibility of base stations in local DSO markets for congestion management with shared balancing responsibility between TSO & DSO

C. Madina ⁽¹⁾, J. Jimeno ⁽¹⁾, J. Merino ⁽¹⁾, M. Pardo ⁽²⁾, M. Marroquín ⁽³⁾, E. Estrade ⁽⁴⁾

⁽¹⁾ Tecnalia, ⁽²⁾ Endesa, ⁽³⁾ Our New Energy, ⁽⁴⁾ Vodafone

Generation mix at:
21.20 of 11/05/2018

Motivation

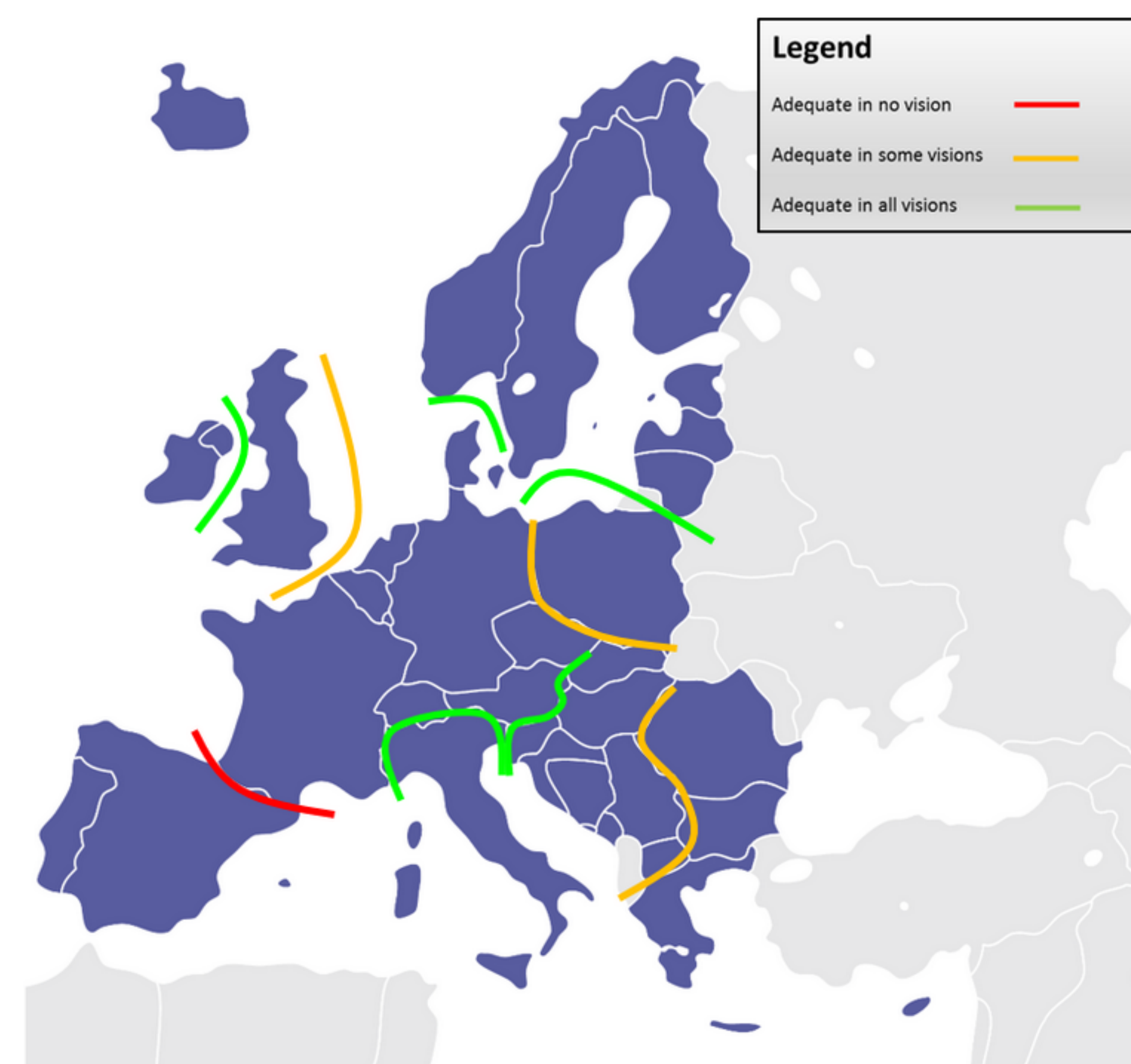
- Demonstration of the applicability of the concepts developed within the SmartNet project. In particular, of Coordination Scheme C, where the TSO transfers part of the balancing responsibility to the DSO.
- Real-life implementation in Spain, where there is a high share of intermittent renewable generation and poor interconnections.

Approach

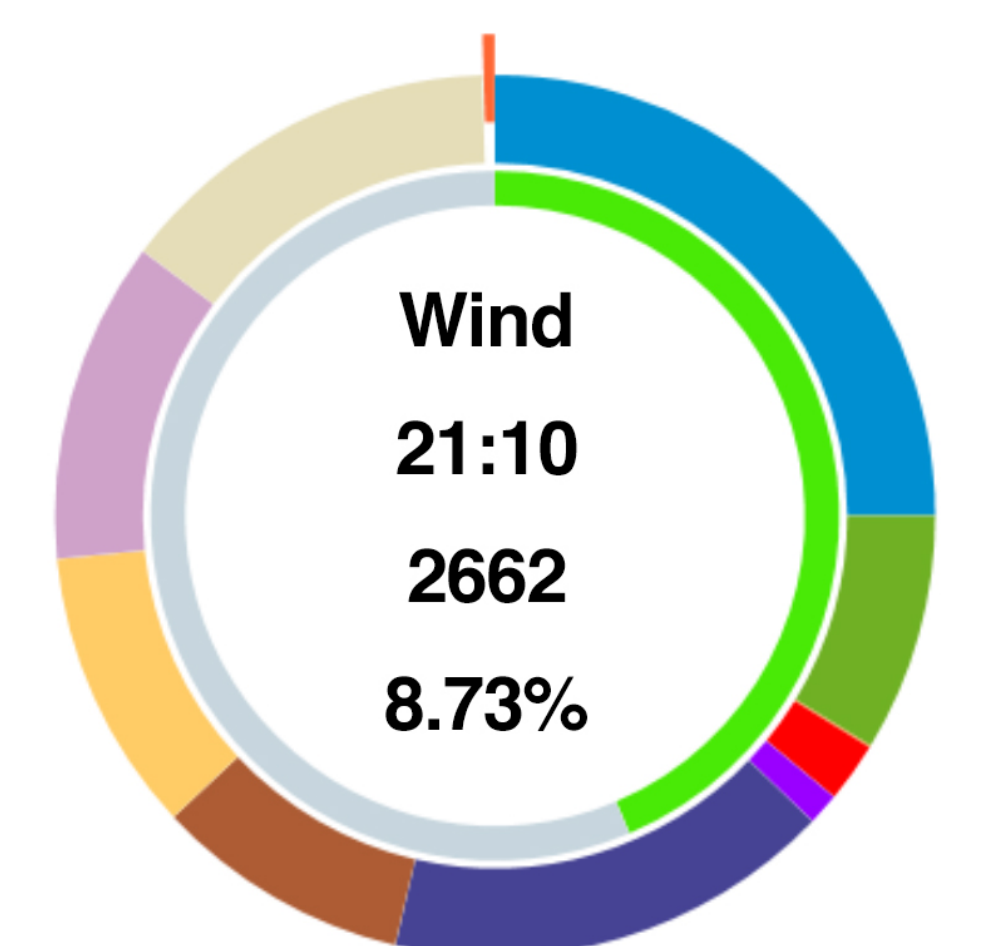
- Exploitation of the flexibility from radio base stations to solve local congestion problems in the distribution network.
- Base stations are equipped with back-up batteries to ensure to continuity of communication service in the (rare) event of a black out.
- Base stations can be disconnected from the grid on purpose to provide demand response when required by the DSO.
- 20 base stations involved, more than 50 kW of flexibility.
- Six primary substations in the city of Barcelona.
- DSO creates local flexibility market to avoid congestions in the grid and to keep a scheduled exchange program in the TSO-DSO interconnection.

Objects of investigation

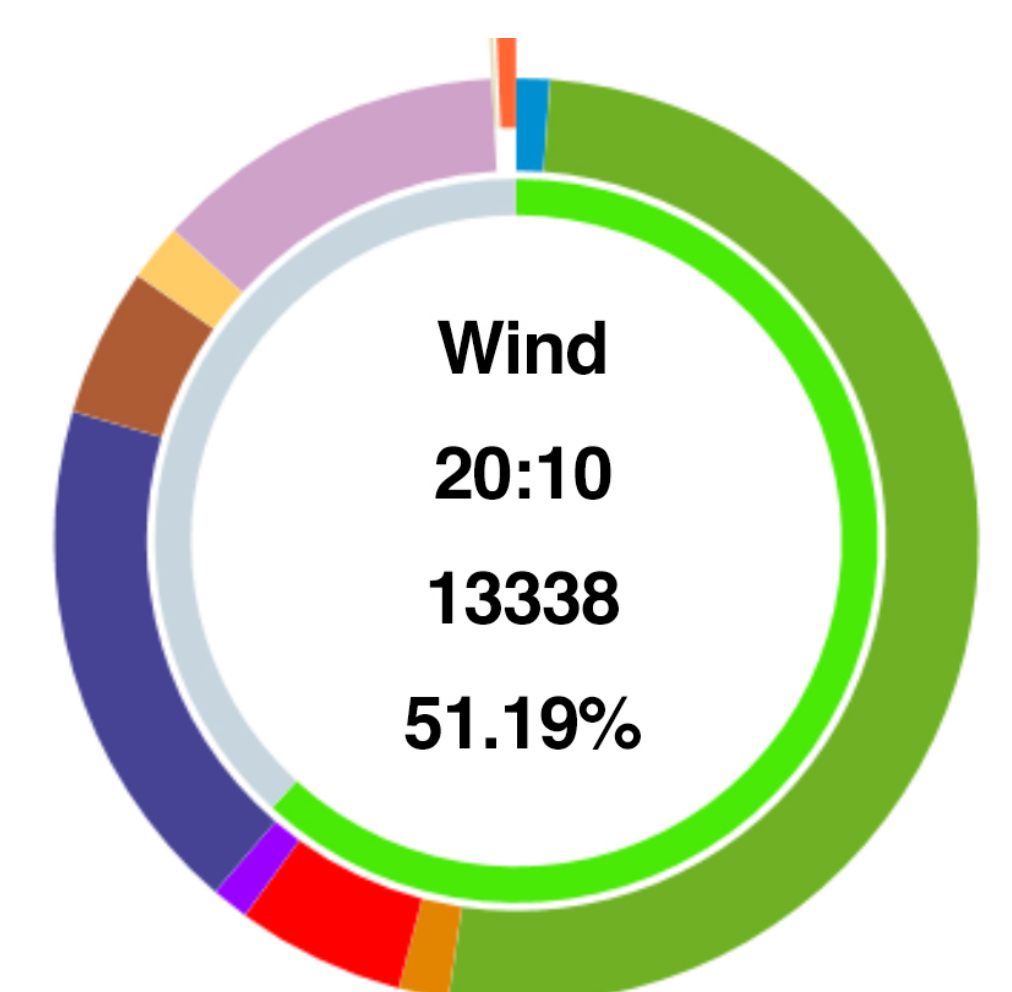
- Potential of batteries to maintain the communication service when the base station is disconnected from the grid: interruption time, frequency and battery degradation.
- DSO monitoring requirements to confirm the provision of the service and for billing purposes.
- DSO methods to identify constraints in the network.
- Communication requirements between the base stations, the aggregator and the DSO.
- Optimisation techniques by the aggregator to maximise the benefits from available flexibility.



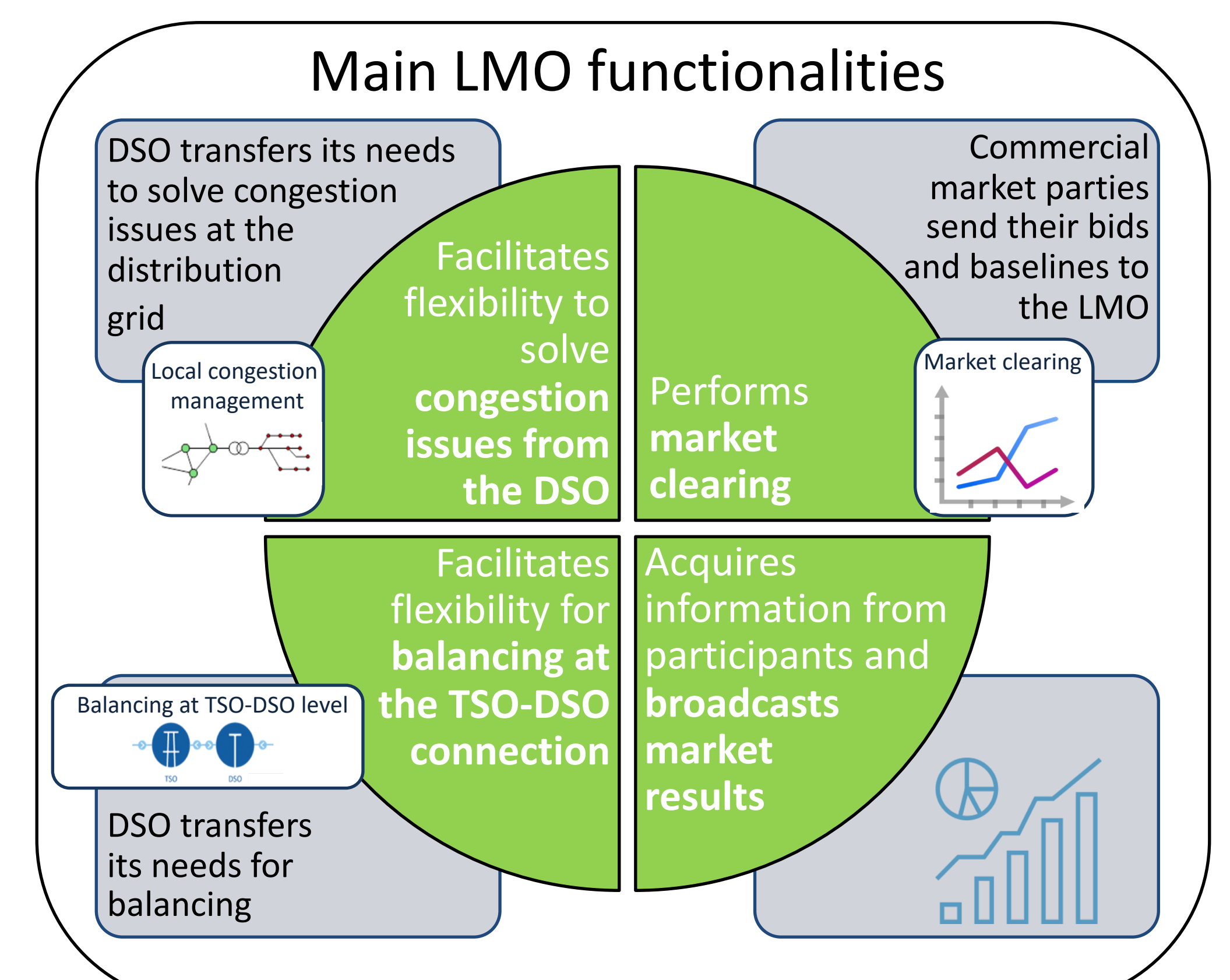
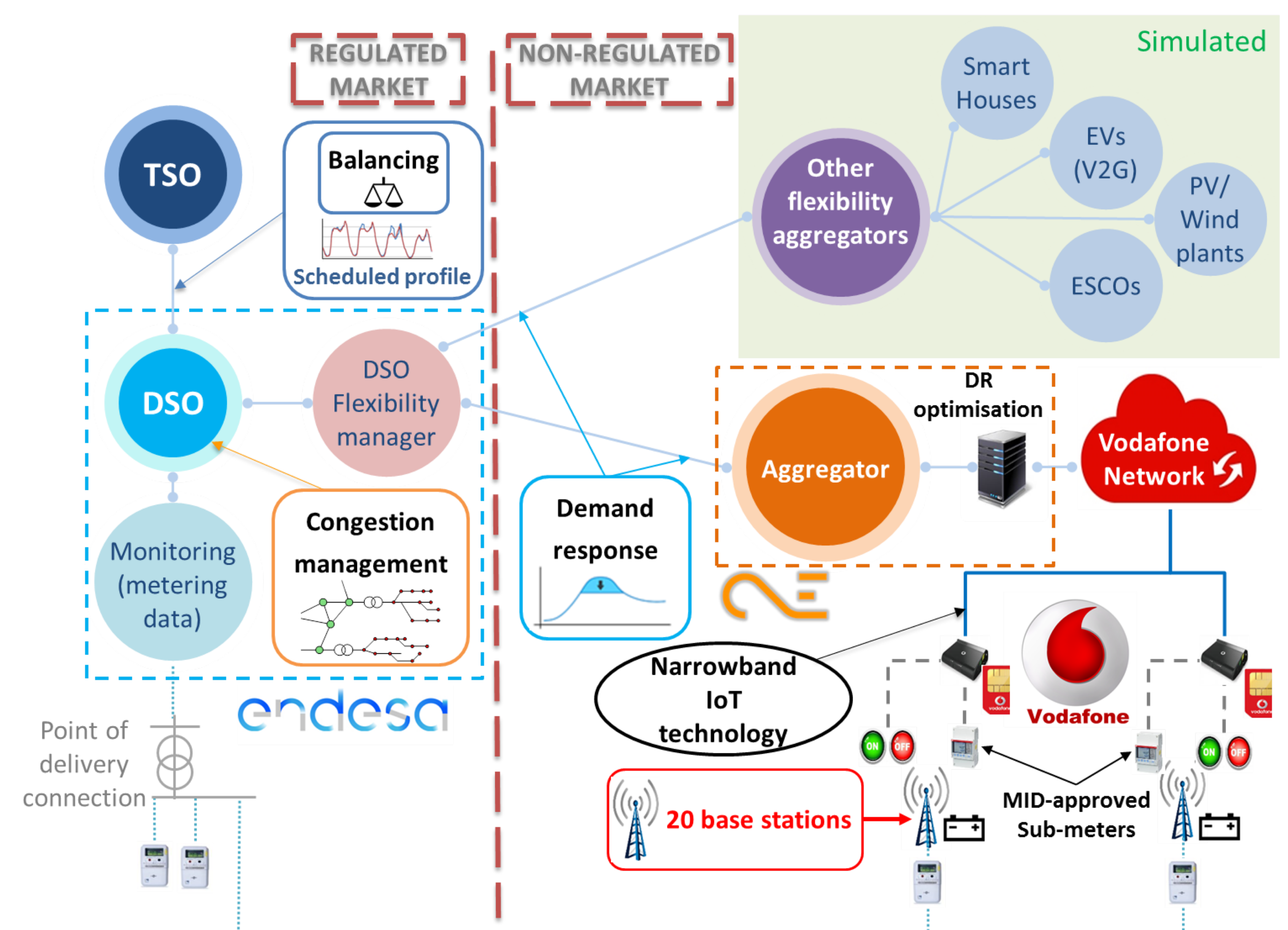
2030 Transmission adequacy (TYNDP'16)
<http://tyndp.entsoe.eu/exec-report/>



20.10 of 12/05/2018



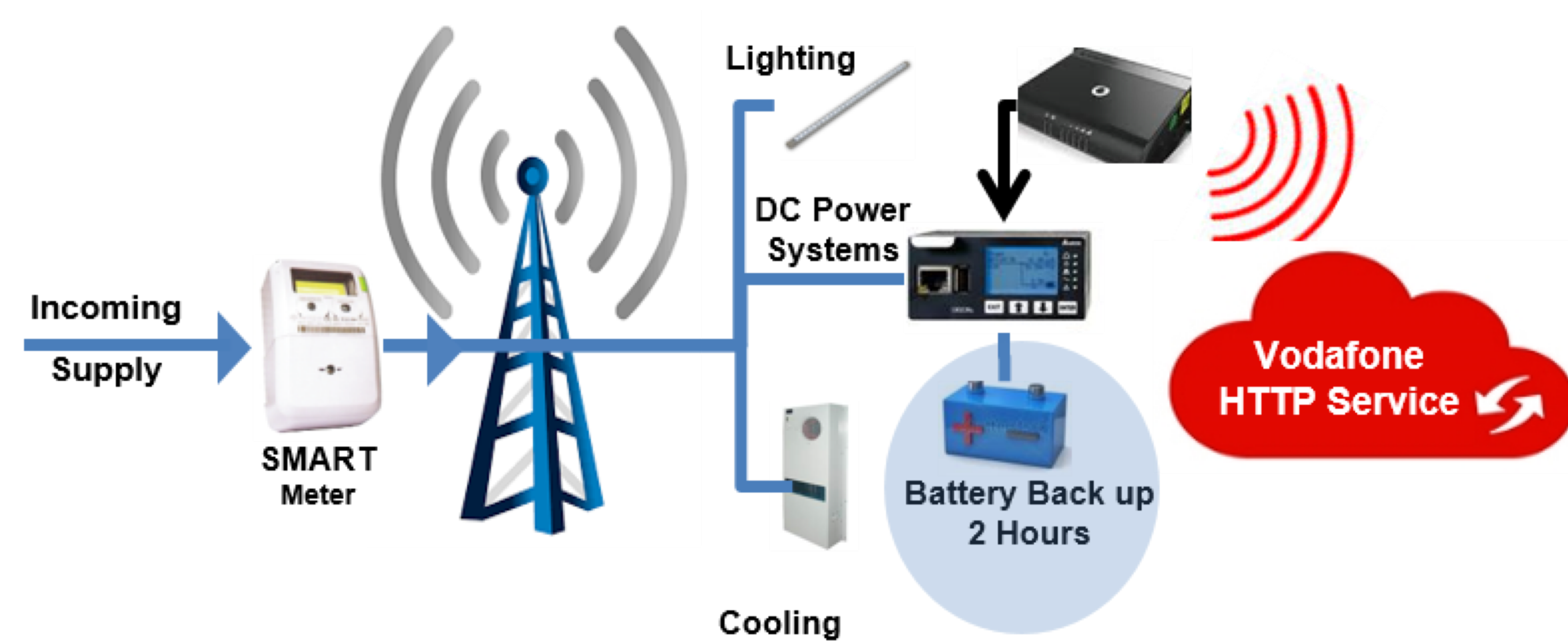
REE, Electricity demand tracking in real time
<https://demanda.ree.es/visioma/peninsula/demanda/total/2015-11-21>



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Experimental setup

- Real distribution grid of Barcelona.
- TSO-DSO exchange profile based on historical information.
- Simulated increase of demand and DER to create congestions & simulated forecasting errors for balancing.
- Local market based on OPF to calculate DSO needs.
- Real aggregator (ONE) competes versus simulated CMPs.
- ONE activates real DER following market results.

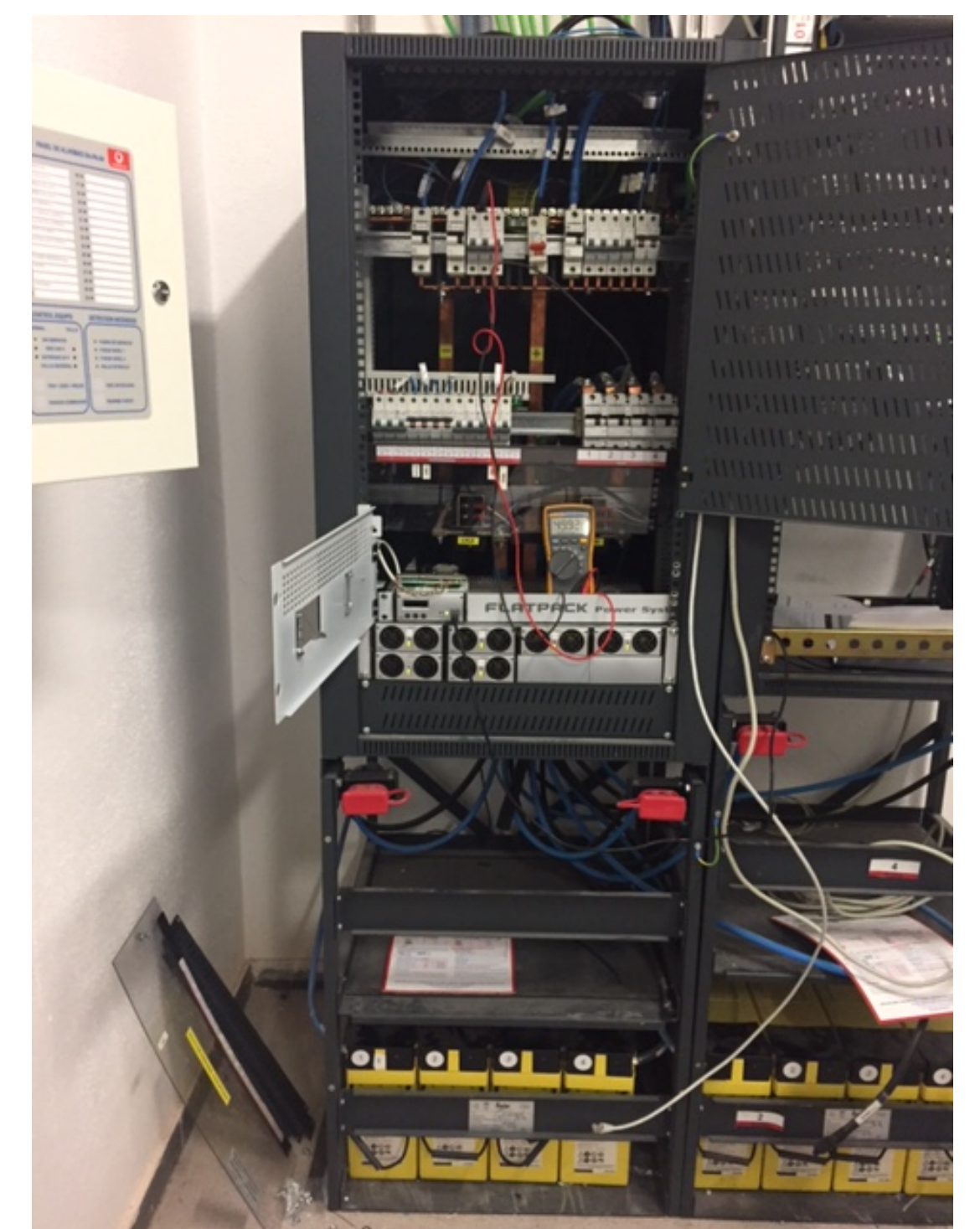


More than 400 base stations just in **Barcelona**

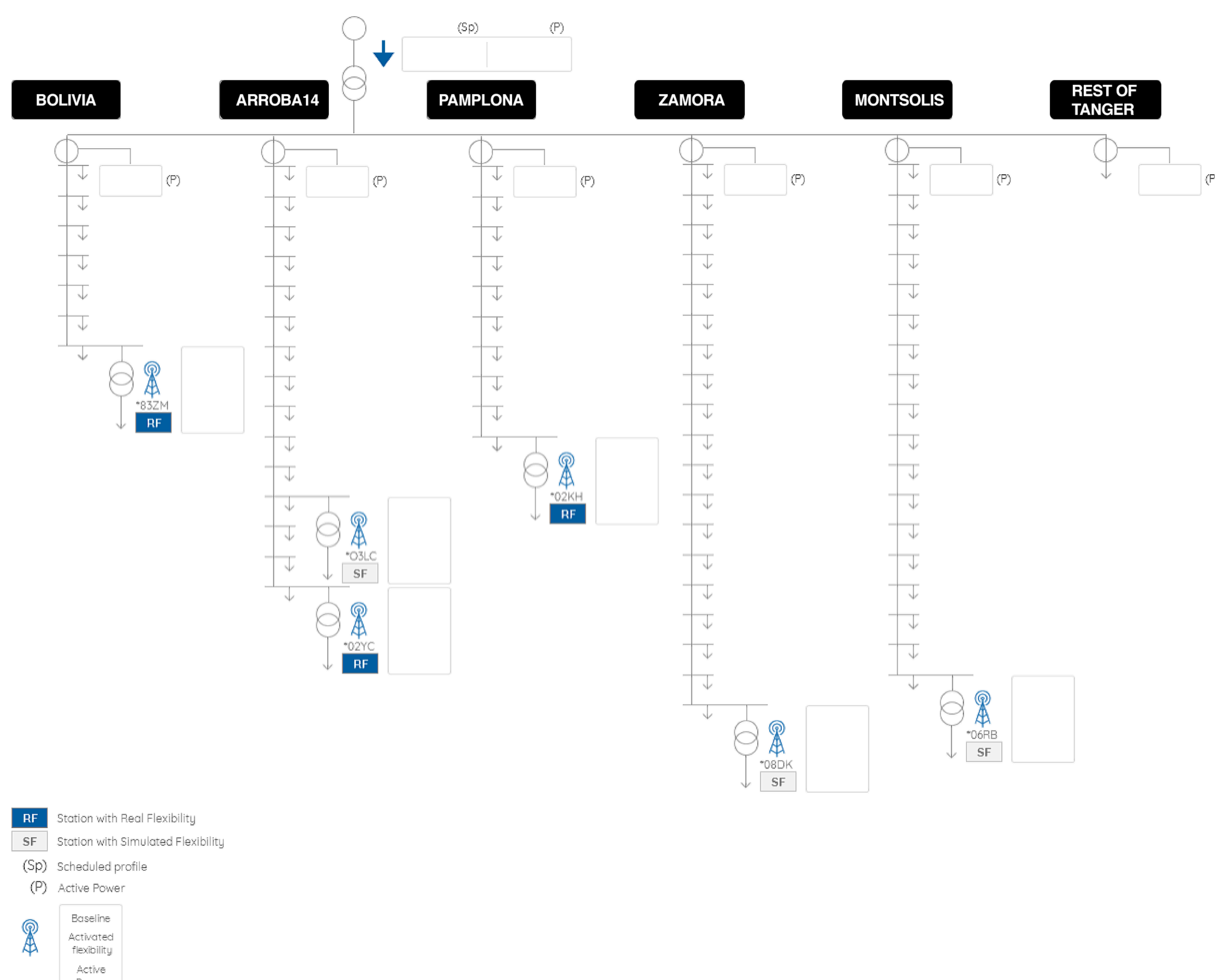
Contracted Power of each one from **5 kW to 15 kW**



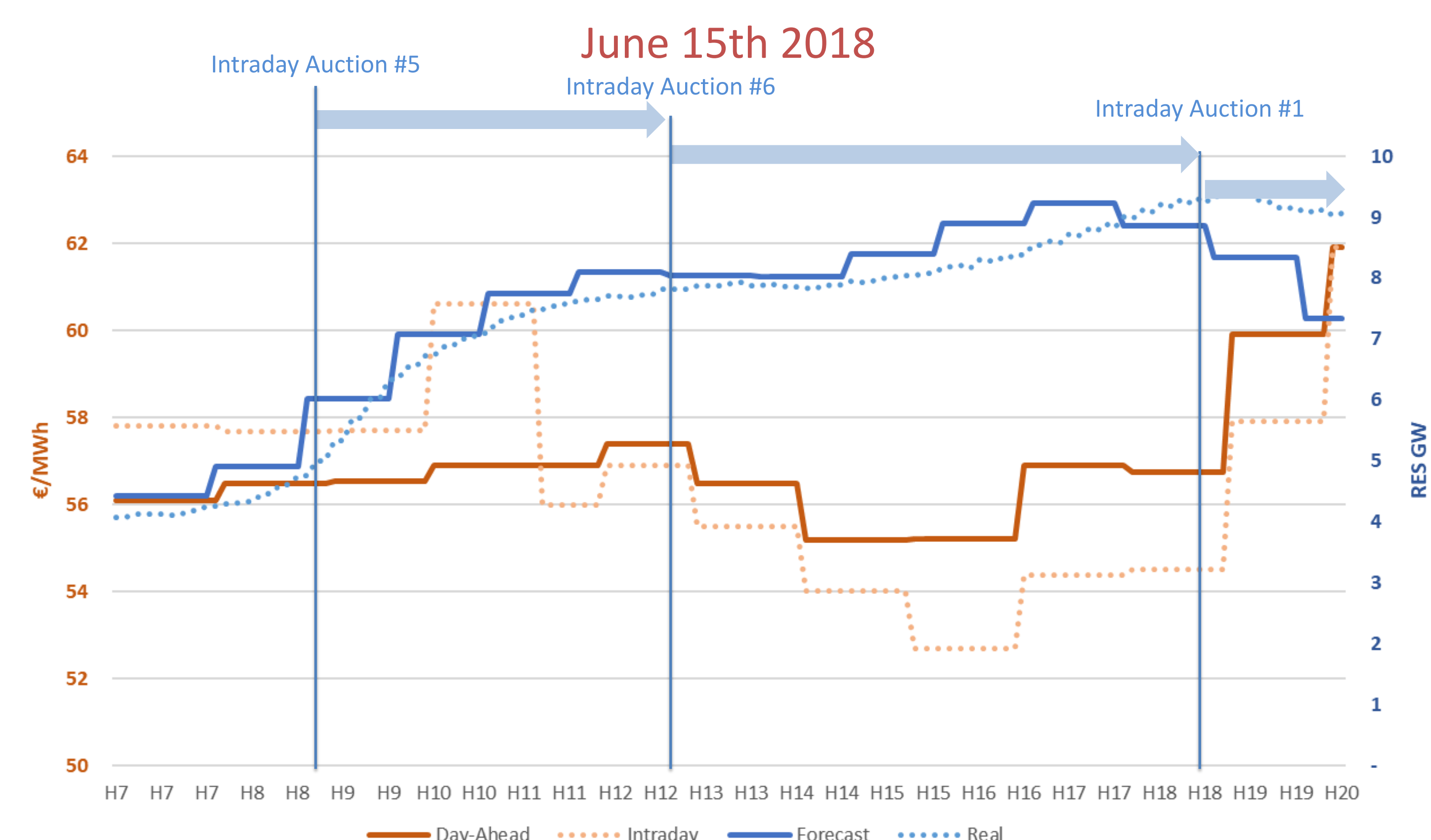
Pilot flexible aggregation capacity: around 100 kW



Monitoring of DSO network status



Arbitrage opportunities with other markets



Exploiting flexibility of base stations in local DSO markets for congestion management with shared balancing responsibility between TSO & DSO continued

Discussion (results)

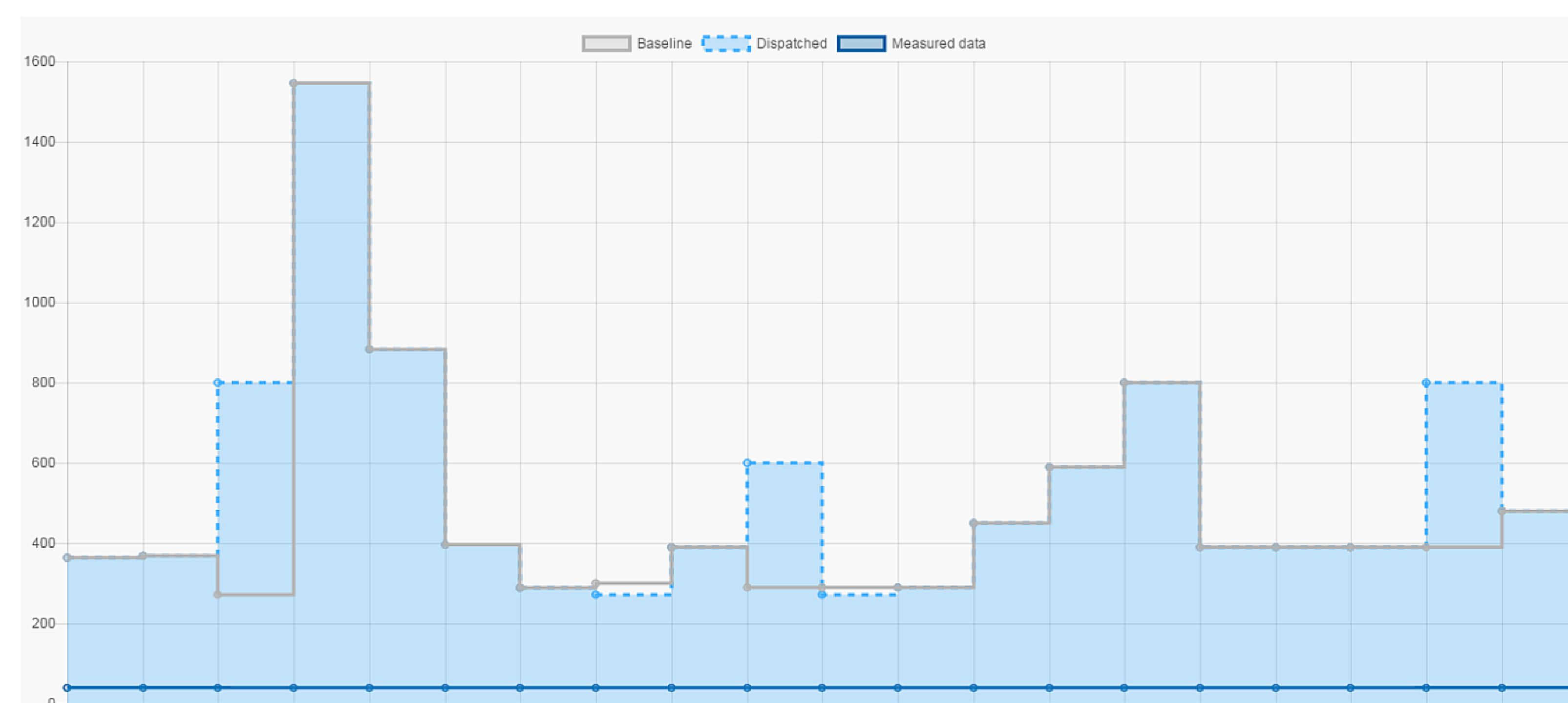
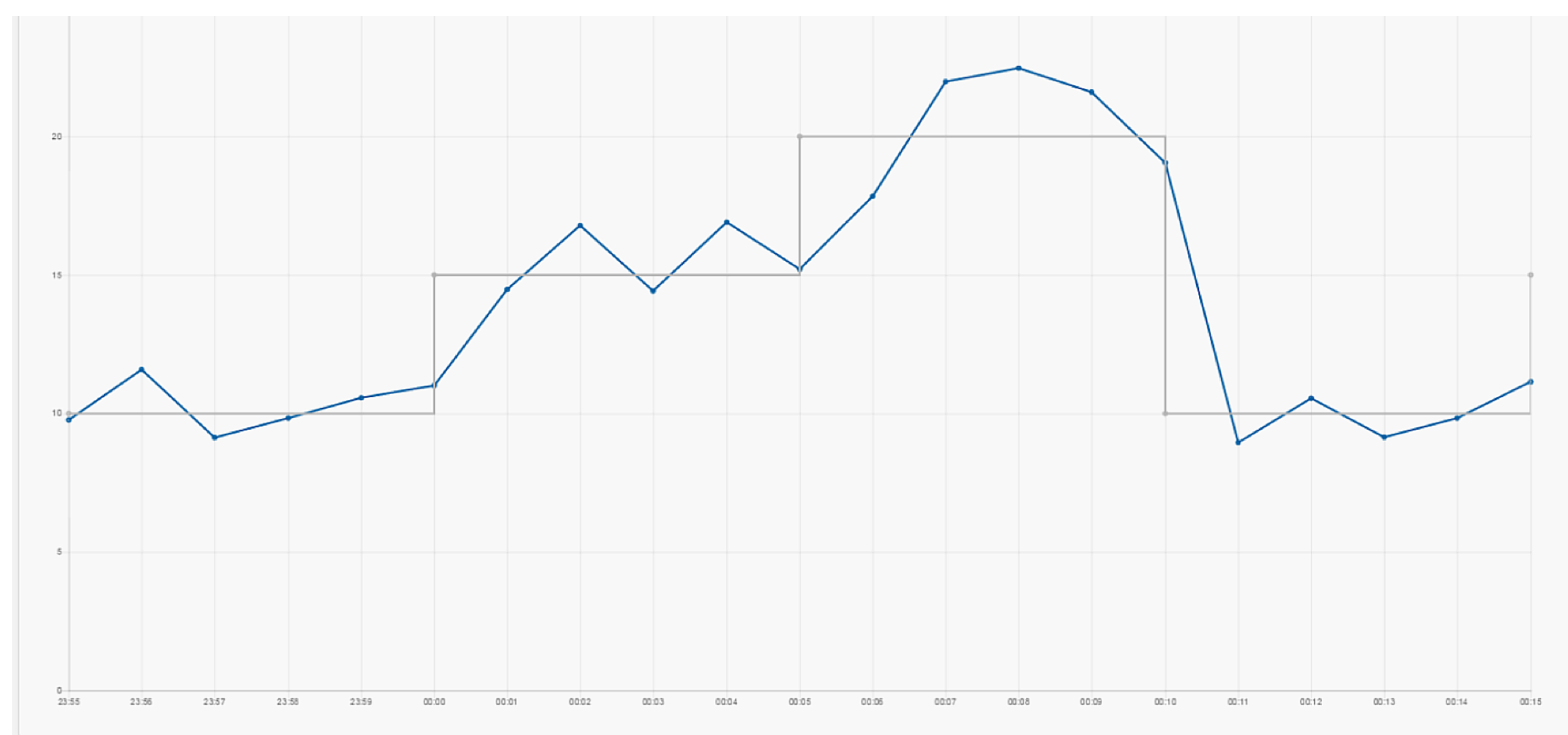
- The whole communication chain is working: DER-Aggregator-DSO
- Aggregators send their bids to the local market
- Local markets select the appropriate bids to solve DSO needs
- Base stations are disconnected from the grid when required by the DSO (through the aggregator).
- No significant issues found so far.

CMP bids

CMP	Market time	Curtable	Node	Price (€/kWh)	P (kW)	Virtual
ONE	2017-02-13T23:55:00Z	no	6	0.32	2.5	No
TWO	2017-02-13T23:55:00Z	no	10	0.26	7.5	Yes
V2G	2017-02-13T23:55:00Z	yes	7	0.28	50	Yes
ONE	2017-02-14T00:00:00Z	no	6	0.32	2.5	No
TWO	2017-02-14T00:00:00Z	no	10	0.26	7.5	Yes
V2G	2017-02-14T00:00:00Z	yes	7	0.28	57	Yes
V2G	2017-02-14T00:00:00Z	yes	7	0.28	-10	Yes

Monitoring and validation of DER activation

Balancing at TSO-DSO interconnection



Lessons learnt from the live experiment

- **Live business.** Base stations are delivering service to the public → 0 impact rule.
- **Private location.** Base stations are located on commercial or private premises → logistic required for non-permanent access authorization (e.g. 6 months to get access for cabin swap).
- **DER internal Quality of Service.** Vodafone Network is submitted to freezing period for quality management: regulator audits, Christmas period, etc.
- **SW stability.** 48V controller software releases and unequal performances requiring unexpected manufacturers deep dive and solving patches delivery.
- **DER resource reliability.** Batteries back up requirement to be adjusted with pilot rules (95%) and obsolescence → physical change requests and potentially technology evolution from VRLA to Lithium batteries.

Conclusion

- Massive penetration of DER will increase the flexibility requirements from grid operators.
- Radio base stations can be a very interesting source of flexibility for DSOs and TSOs.
- Aggregators will have additional arbitrage opportunities by participating in balancing markets.
- Live experiments result in unexpected practical and regulatory barriers to be overcome.