



SmartNet

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

COEIC - Barcelona | 28.11.2018

Pilot C Miguel Pardo – Endesa Distribución



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research and innovation programme under grant agreement No 691405







Vodafone
Base Stations

More than 400 units
just in
Barcelona

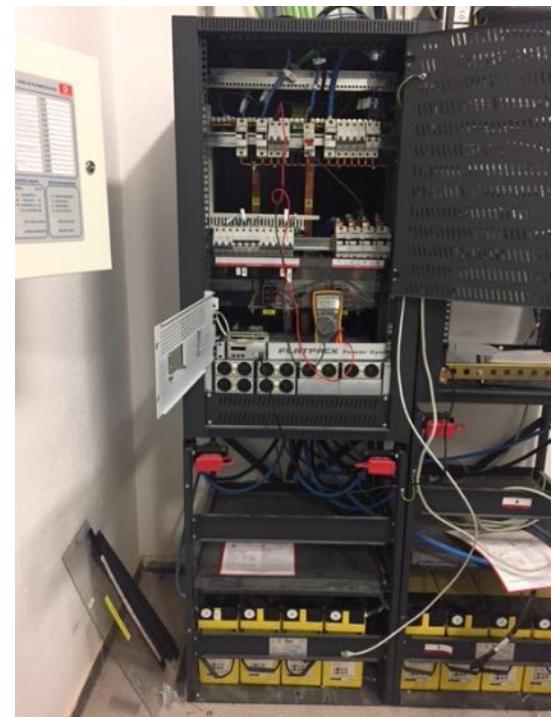
Contracted Power of
each one from
5kw to 15kw

Vodafone Base Stations



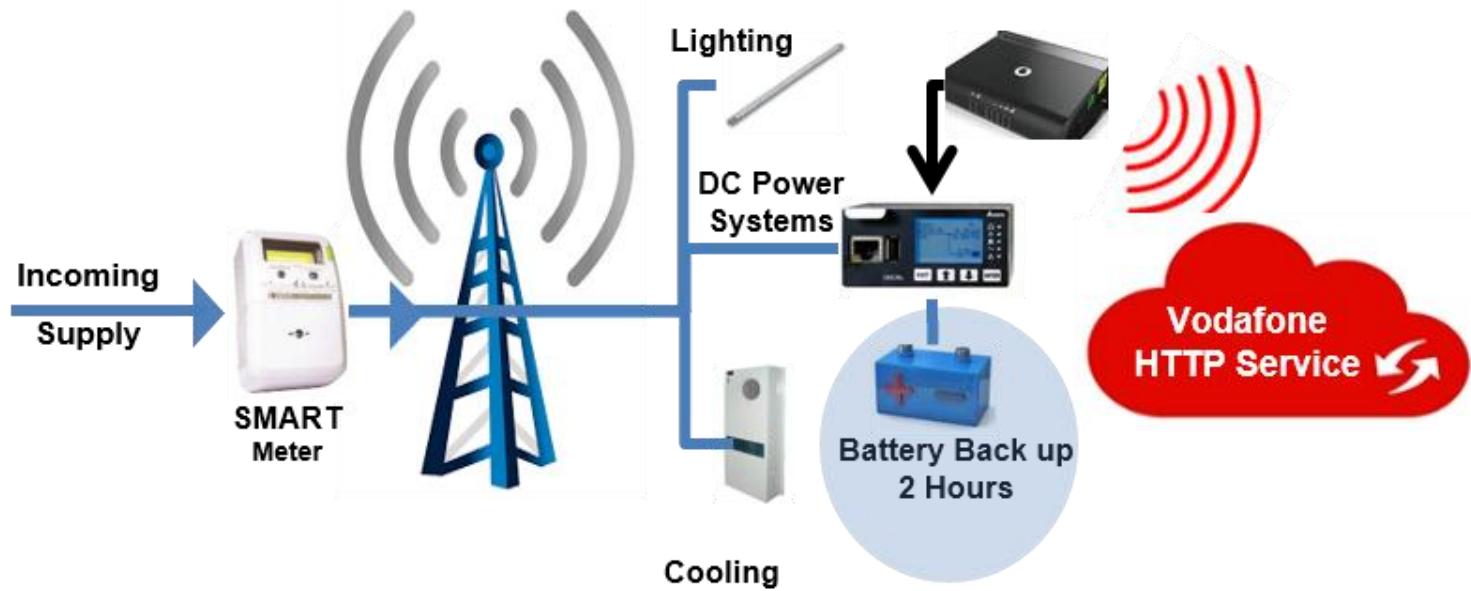
Flexibility by Storage Capacity

- Back Up Batteries - Base Station of Vodafone



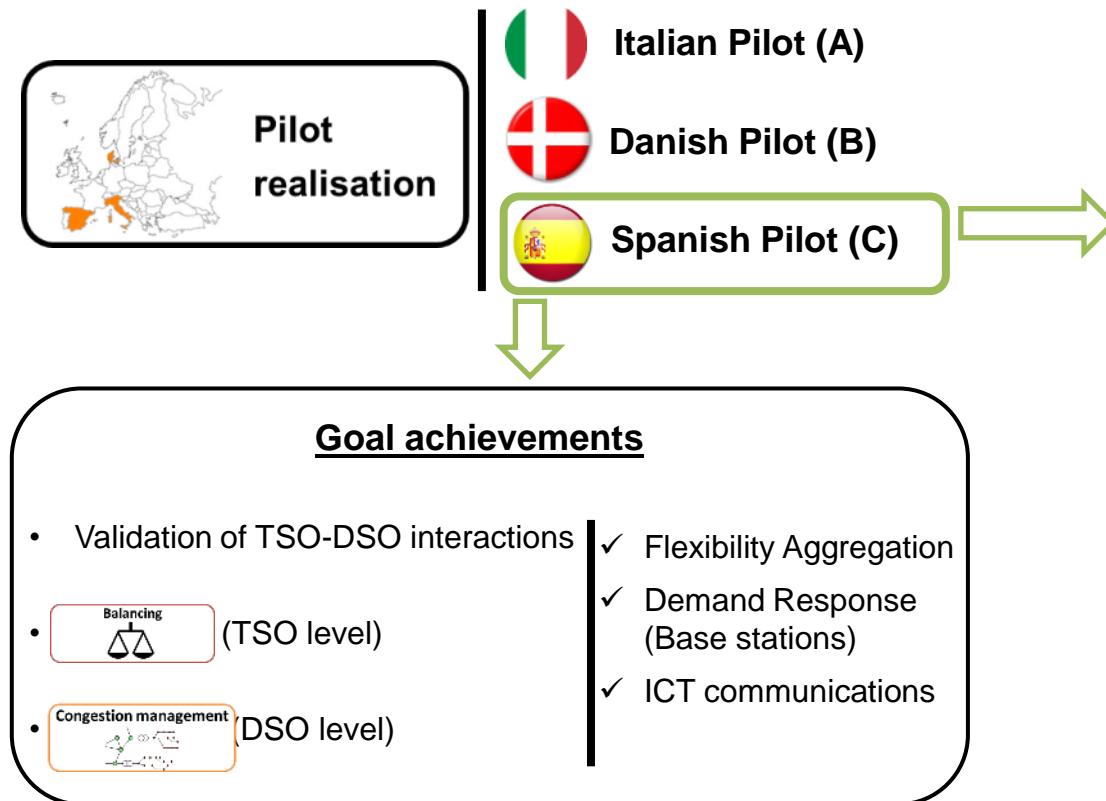
Spanish pilot

DER Owner side. Demand Response Technology over VF Base Stations



Pilot flexible aggregation capacity:
around 100 kW

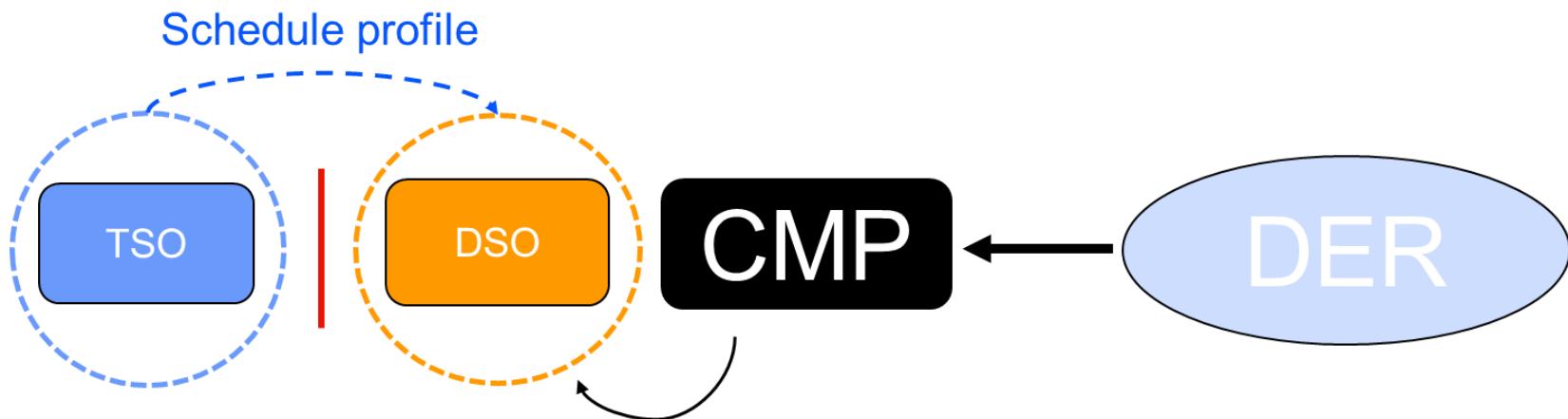
Spanish pilot



- ✓ Flexibility Aggregation
- ✓ Demand Response (Base stations)
- ✓ ICT communications

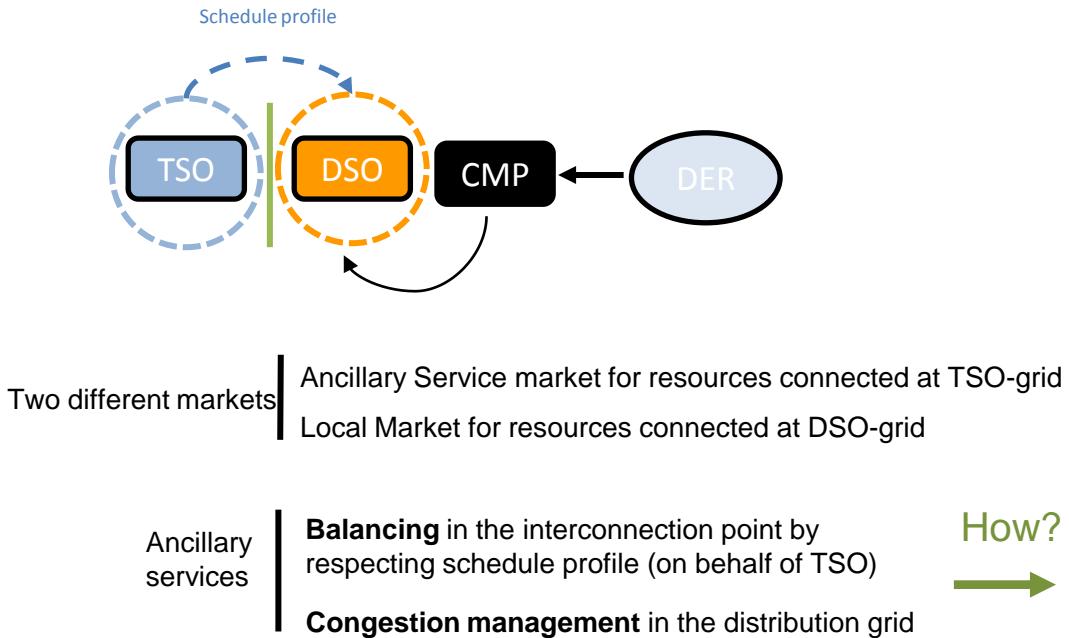
Coordination scheme

Shared balancing responsibility model



Coordination scheme

Shared balancing responsibility model



TSO	Transmission system operator
DSO	Distribution system operator
CMP	Commercial market parties
DER	Distributed energy resources
	Local market operator
	AS market operator
	Schedule profile
	Balancing responsibility transfer

Roles in the project

 endesa

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



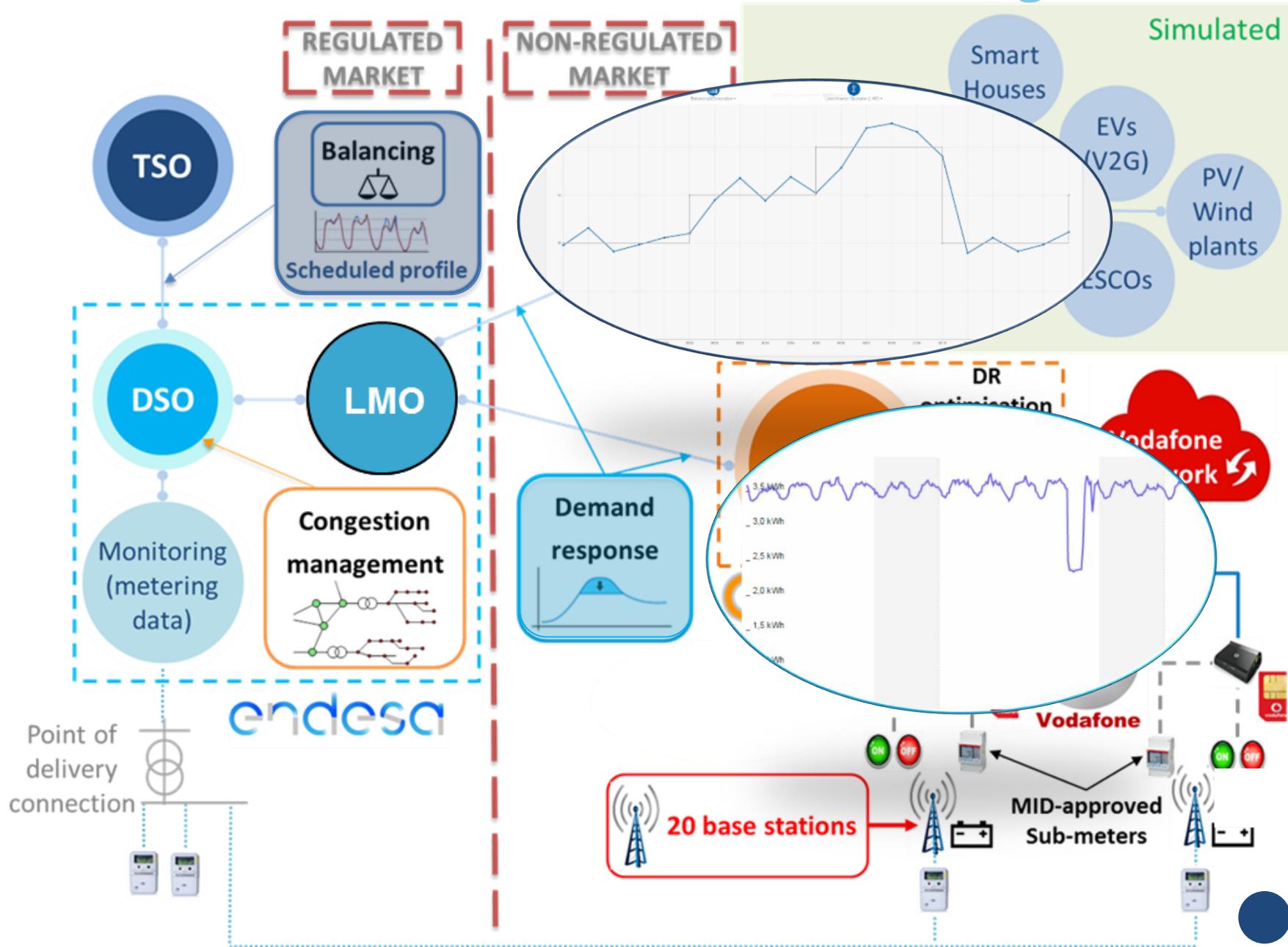
DER owner

Owner of the base stations (flexible resource)
Provider of connectivity services to CMP's
DR providers

 tecnalia Inspiring Business

Consultant





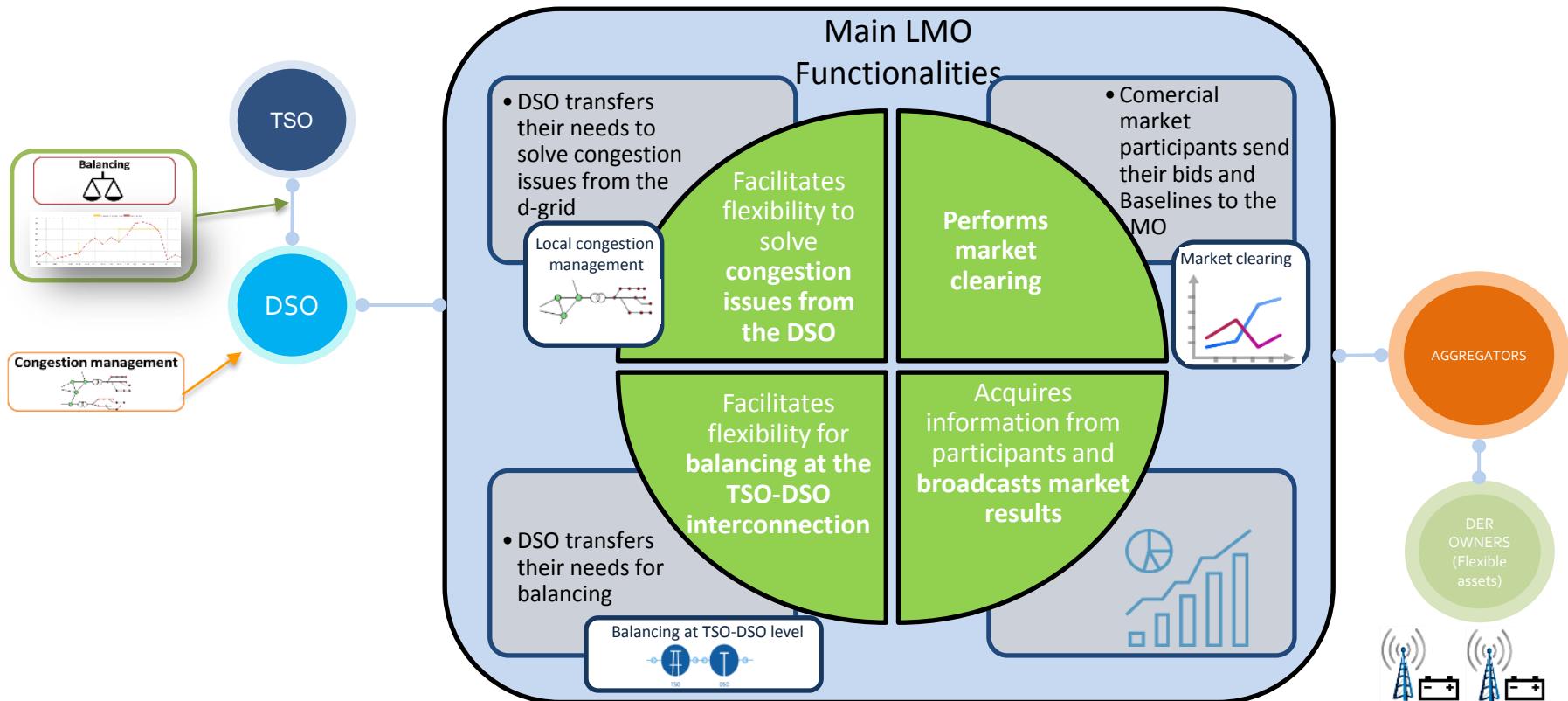
Pilot C: Local Market Operator

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).

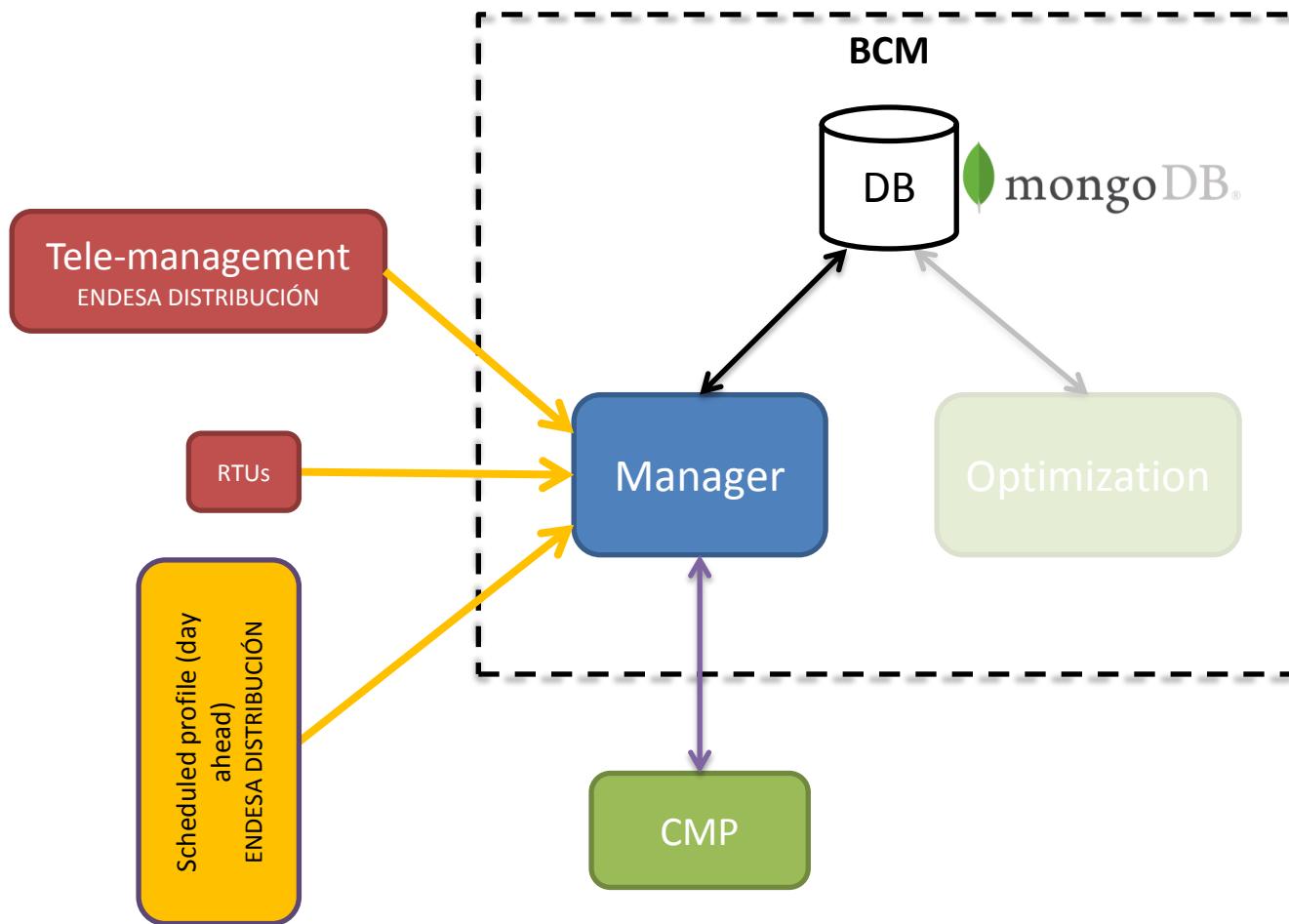
The OPF solves in the same optimization model both technical and market-related aspects of the balancing and congestion management services.

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

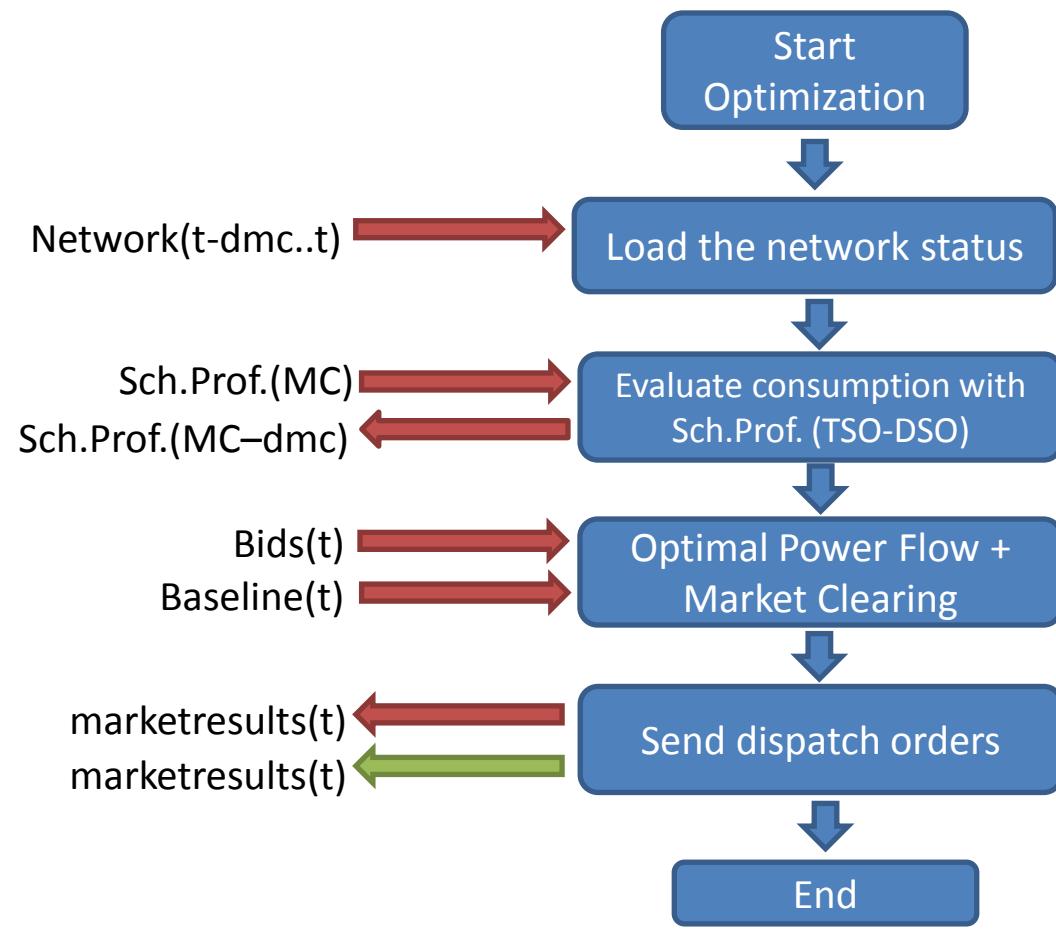
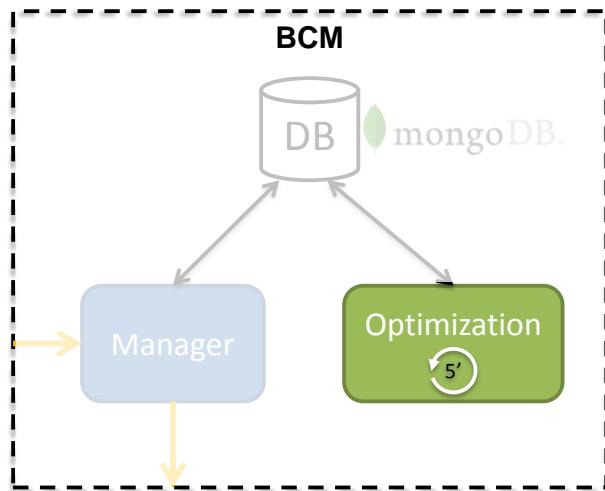




Pilot C: BCM - Manager



Pilot C: BCM - Optimization



MC = Market Clearing Time

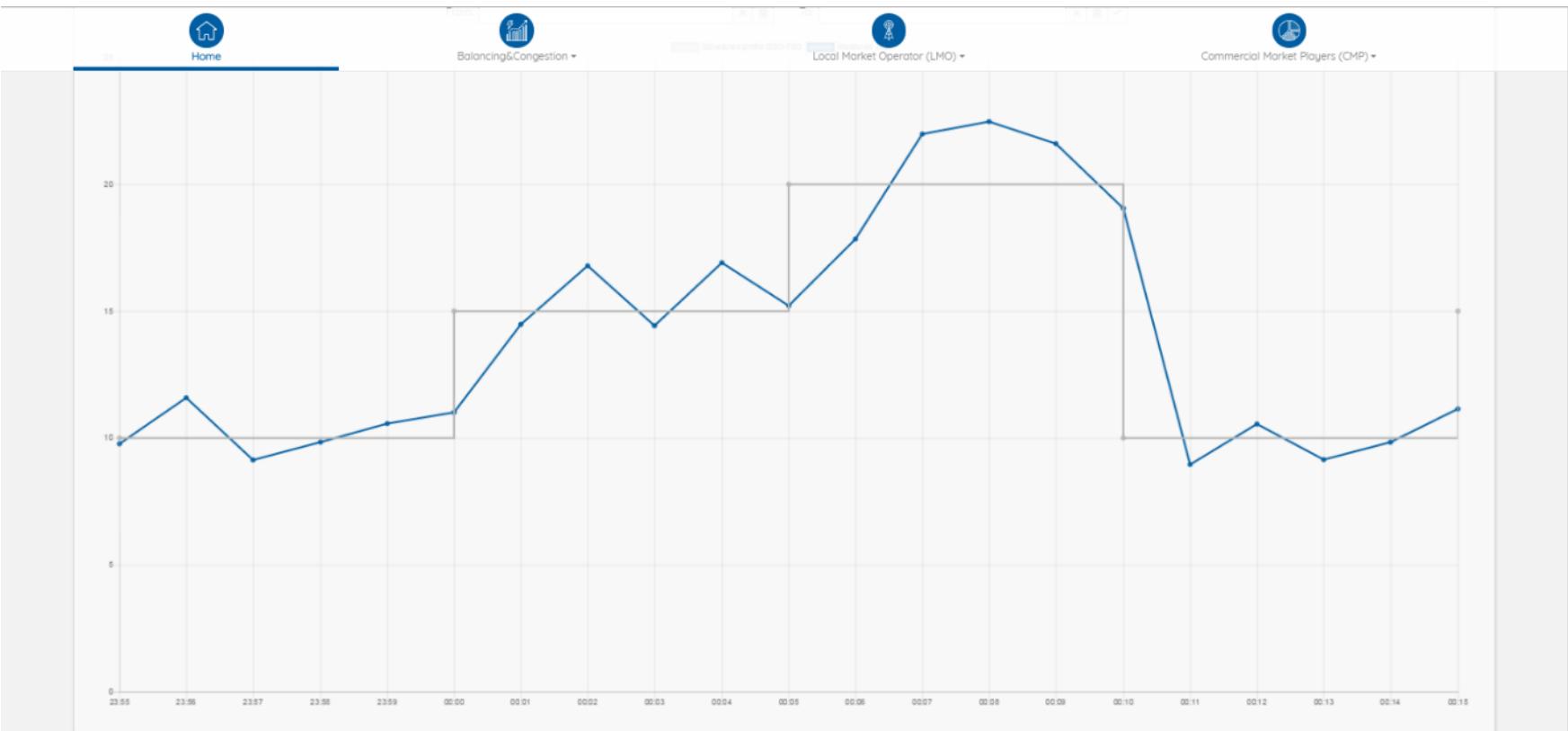
dmc = 5 min

 Messages

 Connections to DB

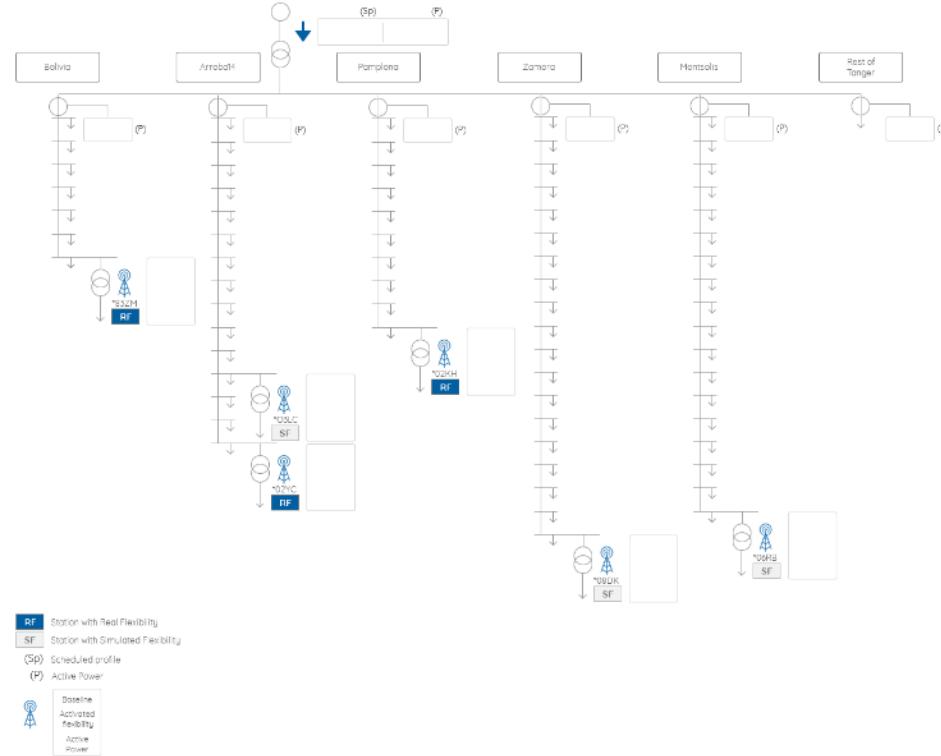
Balancing

- 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



CMP bids

- Table of submitted flexibility bids per CMP per market session and node at each TSO-DSO interconnection point
 - Curtailable/non-curtailable bid blocks
 - Real/virtual CMP

CMP bids

CMP	Market time	Curtailable	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

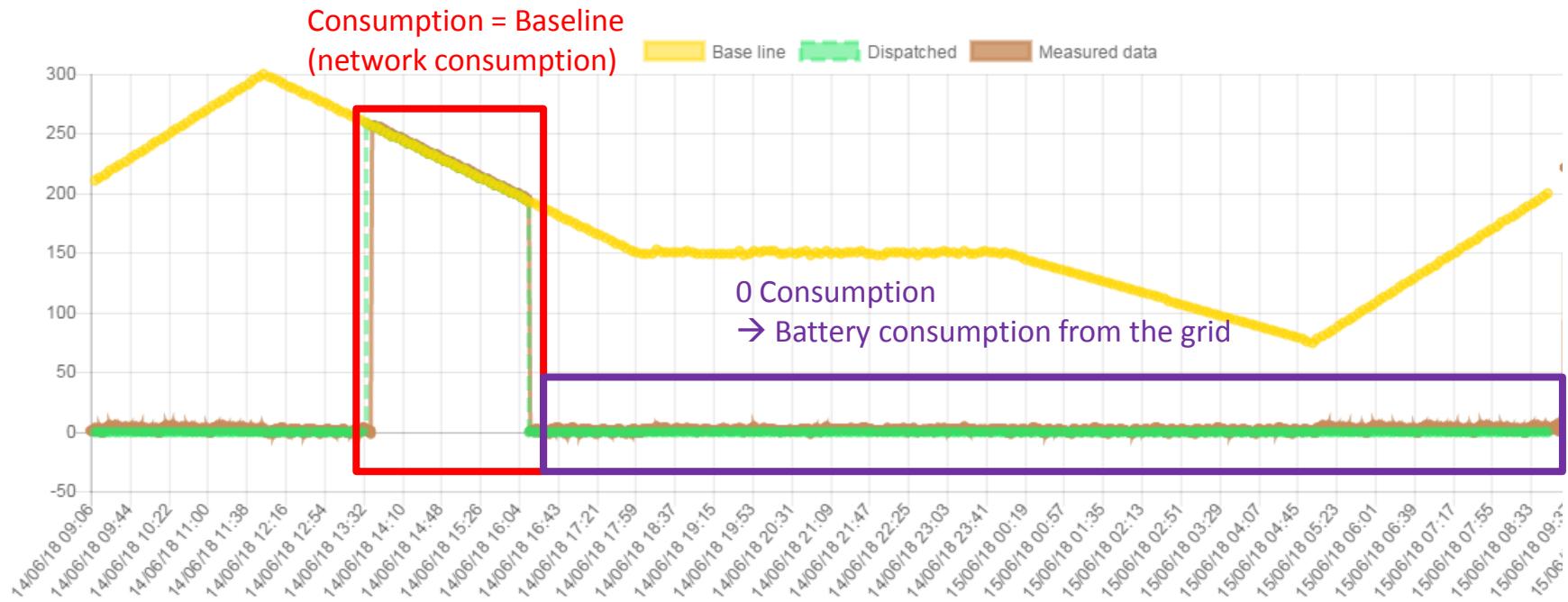
VCMP01

State: Running

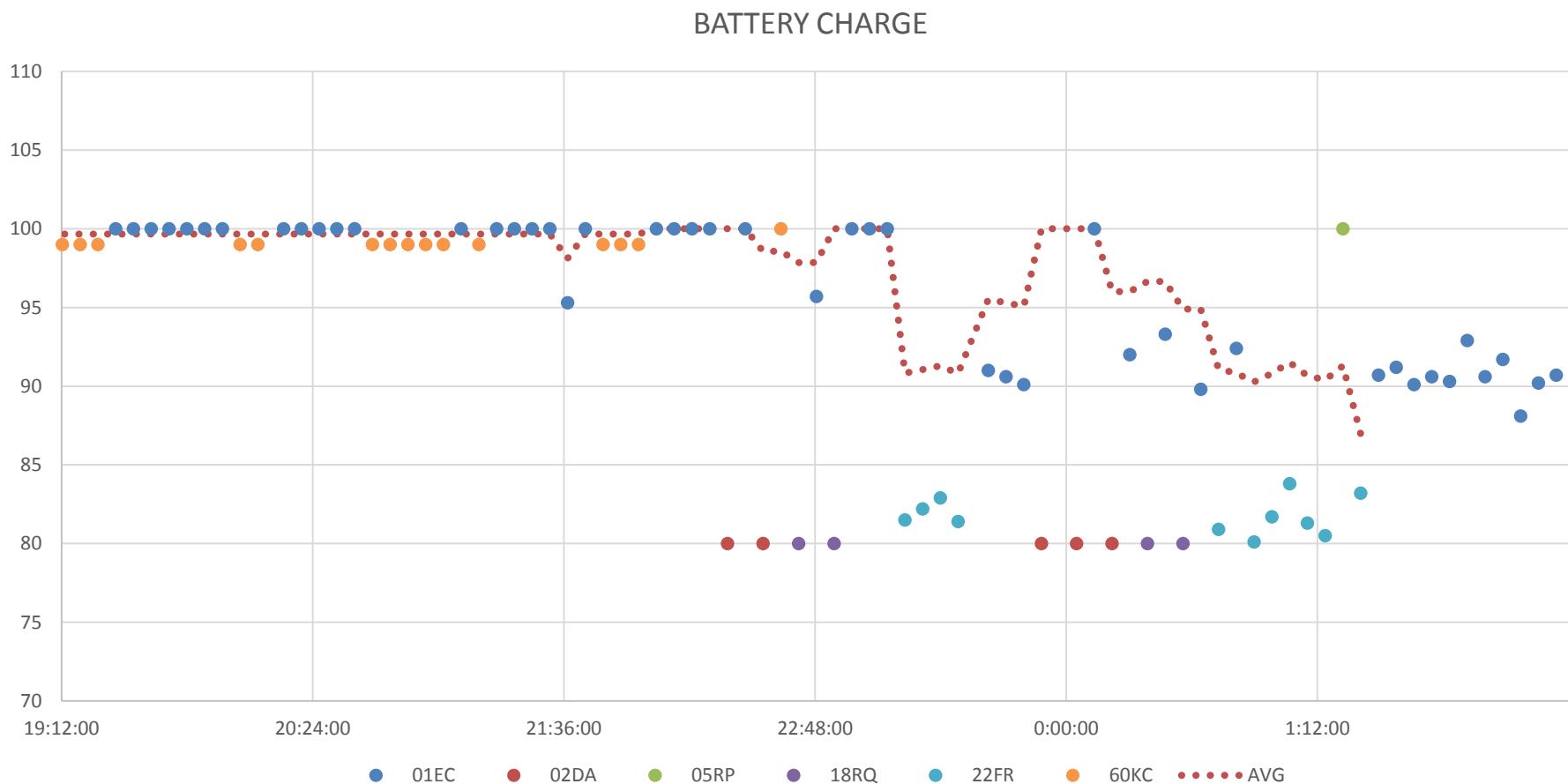
18/06/2018 06:52:21 UTC

Time Filter ▾

Aggregated Load



Status – Real Time



Field test: 90% operational

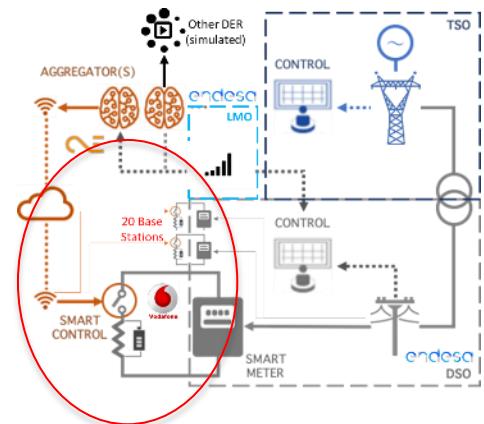
Feb 2018

Jun 2018: 90 to 100 Kw curtailable

Substation	Vf Site	Vodafone Name	PSU Type	Battery Status	Monitoring	Batt Test	Comment/Actions
MONTFRANC	618	B_SANTS	Huawei	TBC	TBC	Good	Remote meter connectivity in test
TANGER	620	B_MALLORCA	Eltek	Good	Good	Working	ok
MARAGALL	801	B_ERCILLA46	Eltek	Good	Good	Working	ok
VILANOVA	3208	B_PAULCLARIS	Eltek	Good	TBC	TBC	Site Visit Required to Enable Remote Connects
VILANOVA	5297	B_CARTAGENA	Eltek	TBC	TBC	TBC	Site Controller upgrade 2nd Feb
MARAGALL	7769	B_ARAGAN72	Eltek	Good	TBC	TBC	Site Visit Required to Enable Remote Connects
MARAGALL	11847	B_MONTSERRAT20	Eltek	Good	TBC	TBC	Site Visit Required to Enable Remote Connects
VILANOVA	26435	B_GRANVIA63	Huawei	Good	Good	Working	Smart Meter Polarity issue
VILANOVA	26354	B_TRAFALGAR21	Huawei	Good	Good	Working	ok
BESOS	52652	B_MALLORCA272	Huawei	Good	Good	TBC	Site Visit Required to Enable Remote Connects
VILANOVA	52653	B_DIAGNOMAR_U	Huawei	Good	Good	Working	ok
BESOS	62036	B_SANTO_SYNTHELABO_AVENTIS_VP	Huawei	TBC	TBC	TBC	Site Visit Required to Enable Remote Connects
MONTFRANC	7769	B_ARAGAN72	Eltek	Good	TBC	TBC	Site Visit Required to Enable Remote Connects
VILANOVA	70903	B_BAC_DE_RODA_LLULL	Eltek	TBC	Good	TBC	Site Visit Required to Enable Remote Connects
TANGER	76469	B_BCNACTIVA	Eltek	TBC	Good	TBC	Site Visit Required to Enable Remote Connects
MARAGALL	77879	B_ARAGAN72	Huawei	Good	Good	ok	ok
MARAGALL	80263	B_PS_MARAGALL74	Huawei	Good	Good	ok	ok
TANGER	85405	B_LLACUNA_10	Eltek	TBC	TBC	TBC	Site Visit Required to Enable Remote Connects
VILANOVA	85407	B_PALLARS_193	Eltek	TBC	Good	TBC	Site Visit Required to Enable Remote Connects

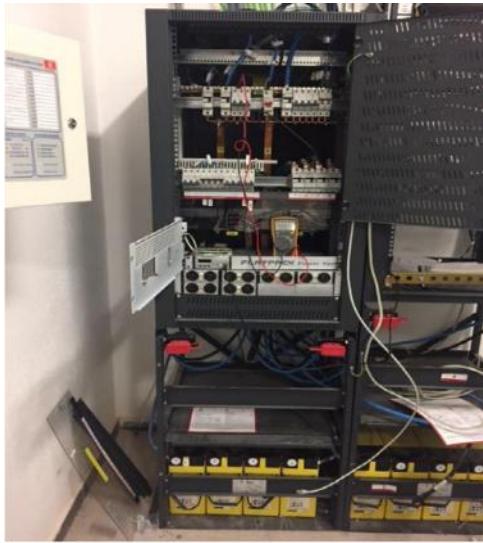


ID	Vodafone Name	PSU Type	Battery Status	Monitoring	Batt Test	Comment/Actions
618	B_SANTS	Huawei	Good	TBC	Good	Remote meter connectivity in test
621	B_PERU	Huawei	Good	TBC	Good	Remote meter connectivity in test
801	B_ERCILLA46	Eltek	Good	Good	Working	ok
3208	B_PAULCLARIS	Eltek	Good	Good	Working	ok
5297	B_CARTAGENA	Eltek	Good	Good	Working	ok
1004	B_TOLRAS1	Huawei	TBC	TBC	TBC	Coms issue on controller
11847	B_MONTSERRAT20	Eltek	Good	Good	Working	ok
26435	B_GRANVIA63	Huawei	Good	Good	Working	ok
28354	B_TRAFALGAR21	Huawei	Good	Good	Working	ok
29424	B_LLLU111	Eltek	Good	Good	Working	ok
52652	B_MALLORCA272	Huawei	Good	Good	Working	ok
52653	B_DIAGNOMAR_U	Huawei	Good	Good	Working	ok
62800	B_SANOFI_SYNTHELABO_AVENTIS_VP	Eltek	TBC	Good	TBC	SNMP issue
64936	B_CN_MONTJUICH	Eltek	TBC	LAG to repla	TBC	Replace ML4G
70903	B_BAC_DE_RODA_LLULL	Eltek	Good	Good	Working	ok
75469	B_BCNACTIVA	Eltek	Good	Good	Working	ok
77879	B_ARAGA72	Huawei	Good	Good	ok	ok
80263	B_PS_MARAGALL74	Huawei	Good	Good	ok	ok
85407	B_LLACUNA_10	Eltek	Good	Good	Good	ok
85407	B_PALLARS_193	Eltek	Good	Good	Good	ok

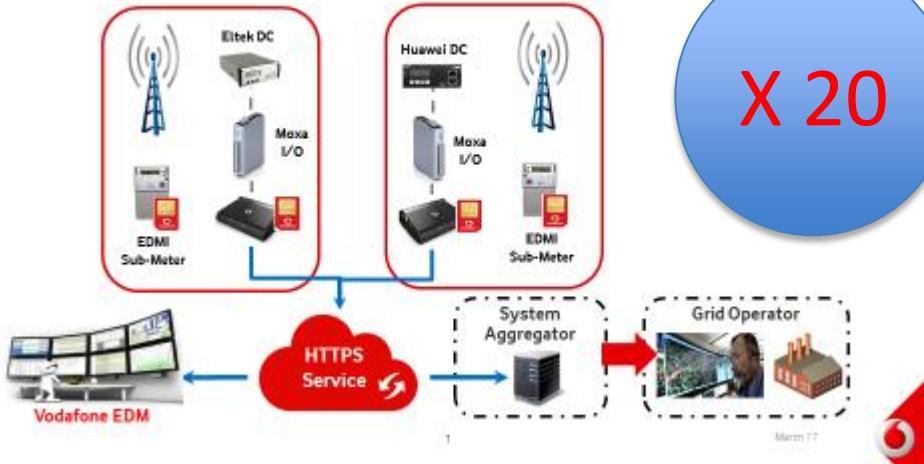


Pilot C - Physical Layer

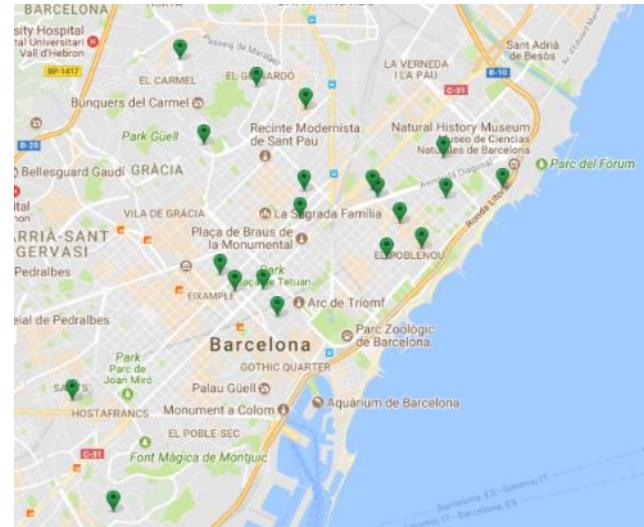
Vodafone BTS transformation into plants.



Network Schematic



- **Curtailment principle :** integrate the remote battery test functionality to pilot the radio equipment switch to back up batteries on demand
- **Scenario:** 20 Radio Base stations equipped with
 - 48V controller SW: 2 brands – Eltek and Huawei
 - SNMP connection
 - Mobile Link 4G modem+ Moxa gateway
 - 4x12 V 100amph VRLA Batteries
 - 1 smart meter with 1mn slot readings



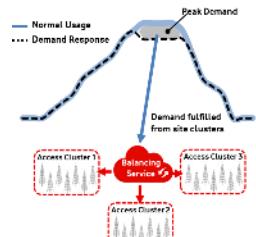
Conclusiones

La capacidad ociosa de las estaciones base, si se agrega correctamente, es muy útil para resolver restricciones técnicas en la red de distribución e, incluso, evitar el arranque de unidades térmicas poco eficientes. Alto potencial de replicabilidad: Vodafone tiene 250MW flexibles en toda Europa.



Beneficios:

- Probar formas innovadoras de integrar los sistemas de almacenamiento en la red de distribución.
- Compensar adecuadamente a los recursos distribuidos (incluidos los prosumidores).
- Evitar algunos refuerzos de red. Sólo se refuerza cuando es absolutamente necesario.
- Obtener servicios de ajuste más eficientes, lo que reduce el coste de la tarifa eléctrica.
- Vislumbrar esquemas de coordinación diferentes, con distinto resultado en términos económicos.
- Impulsar nuevas tecnologías y la digitalización de la red.
- Contribuir al bienestar social de los ciudadanos europeos y activar la economía circular.



Thank You

Miguel Pardo

New Technologies & Innovation
Network Technology Iberia
Global Infrastructure & Networks



Contact Information

Affiliation: Endesa Distribución Eléctrica
Email: miguel.pardo@enel.com





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