



## Spanish Pilot – Pilot C

### Flexibility from Radio Base Stations

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# Introduction

- The new functionalities of the DSO

From a “fit and forget” approach to the active distribution system management approach



## DER integration

Advanced control and monitoring system interacting with distributed generation

## Increased interaction between DSOs and TSOs

Evolution of the current procedures for the procurement of ancillary services from DER



## DER forecast

To reduce the uncertainty of energy injection and improvement of scheduling through accurate prediction of DER production and loads



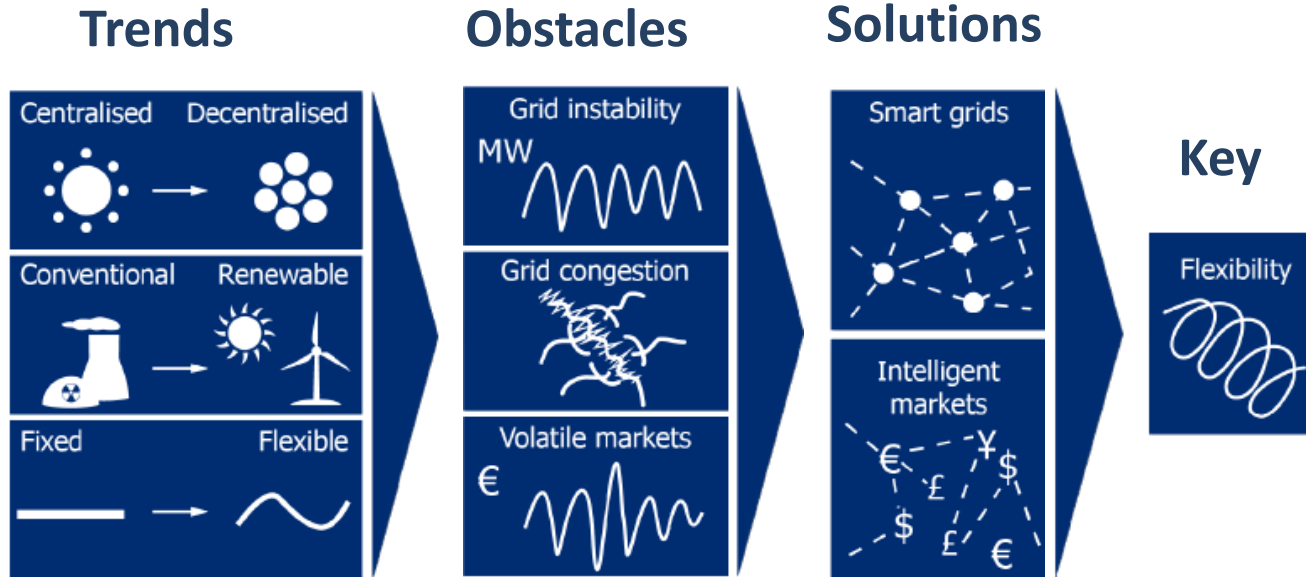
## Storage

Use of storage systems in the distribution network to support network operation purposes



# Introduction

The key role of the DSO









## Vodafone Base Stations

More than 400 units just in  
Barcelona

Contracted Power of each  
one from  
5kw to 15kw

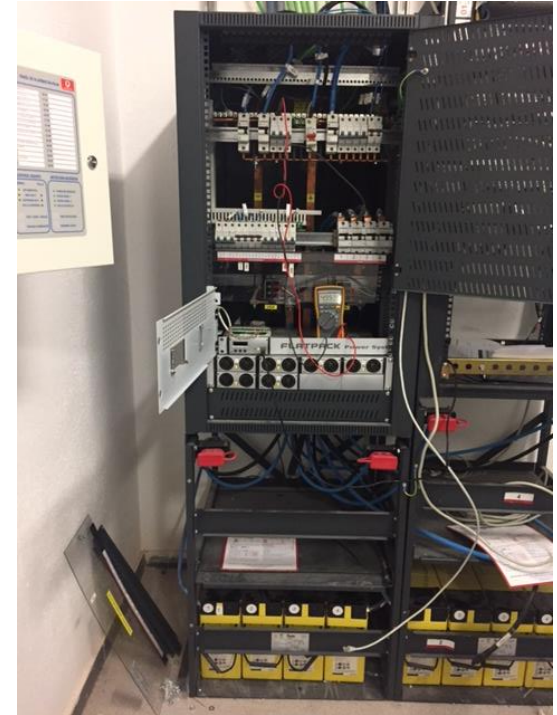


# Vodafone Base Stations



# Flexibility by Storage Capacity

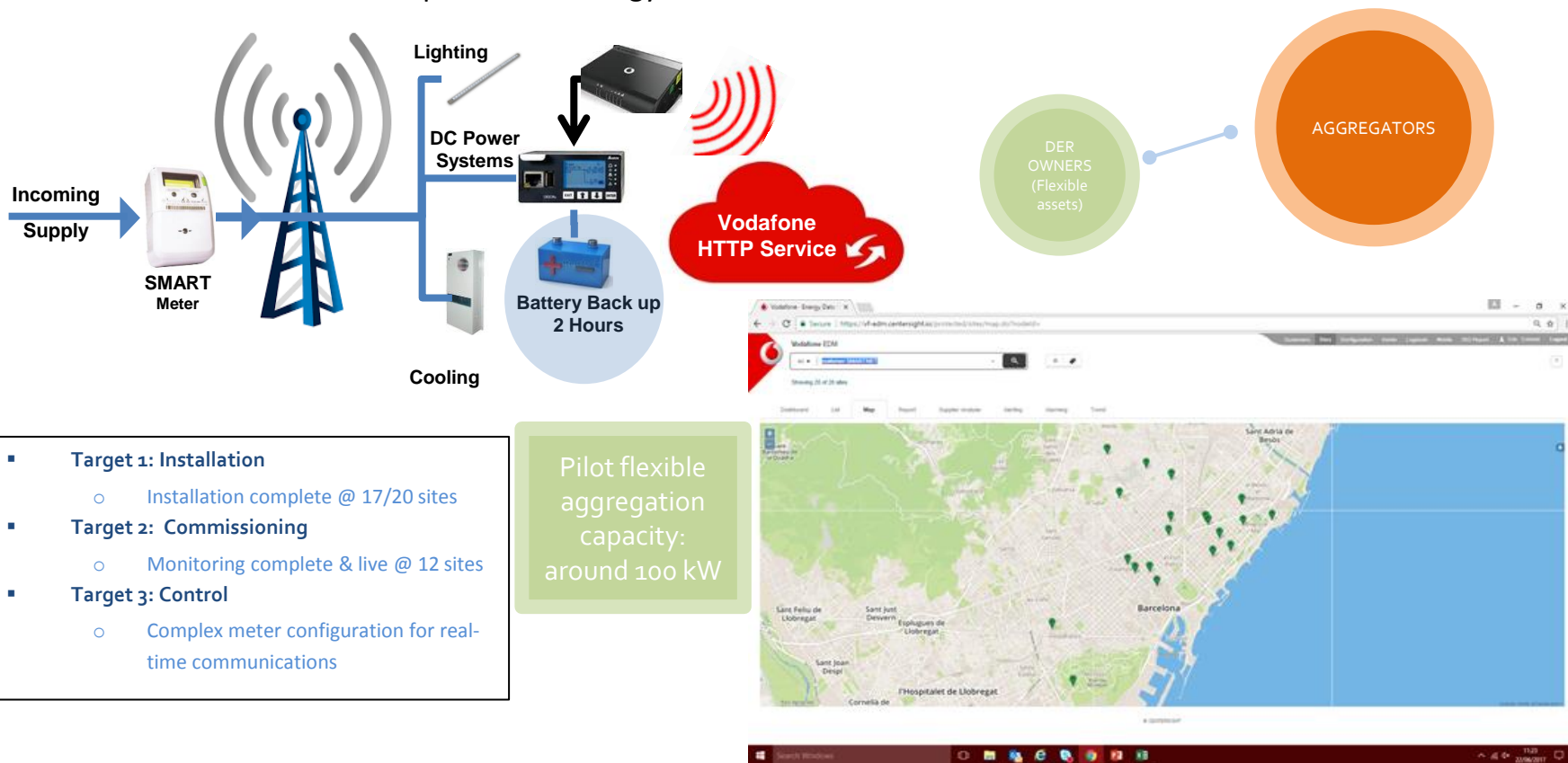
- Back Up Batteries - Base Station of Vodafone



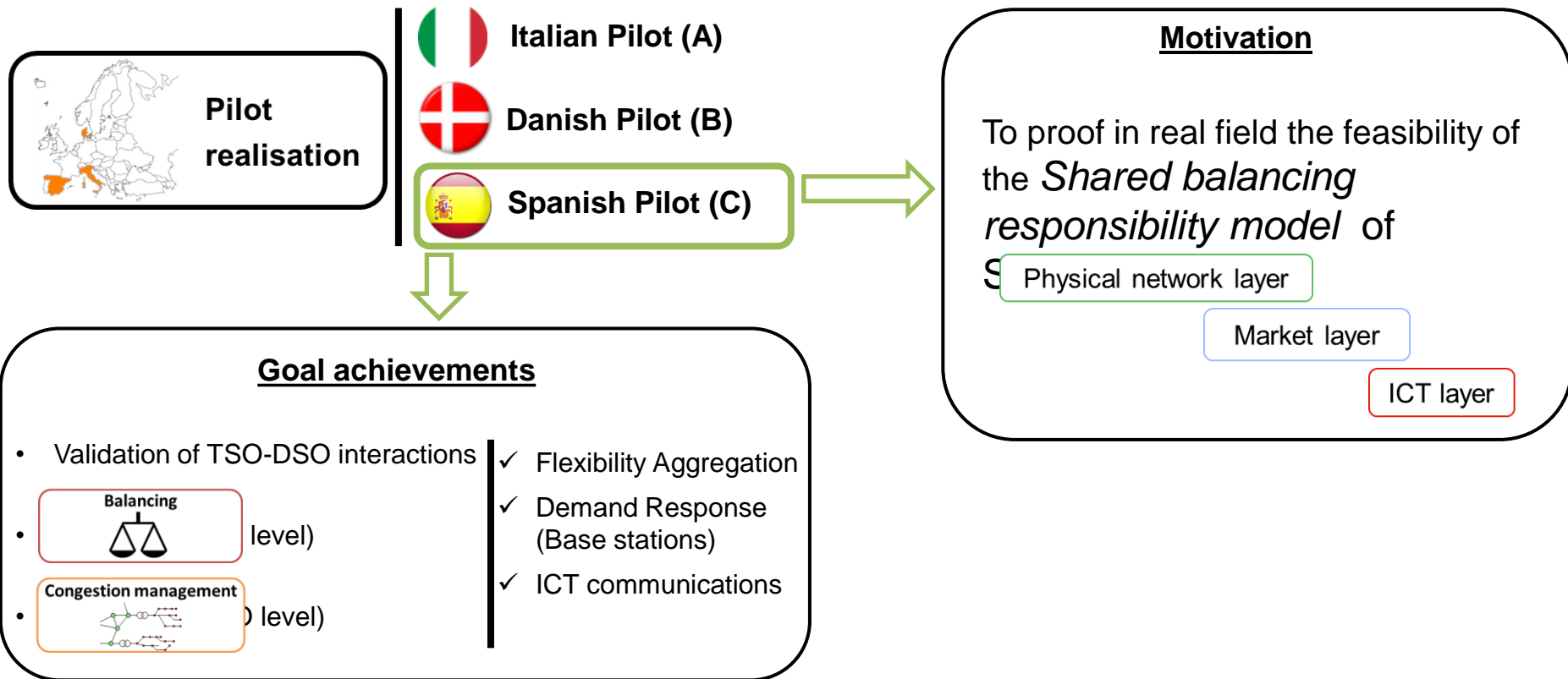


# Spanish pilot

DER Owner side. Demand Response Technology over VF Base Stations

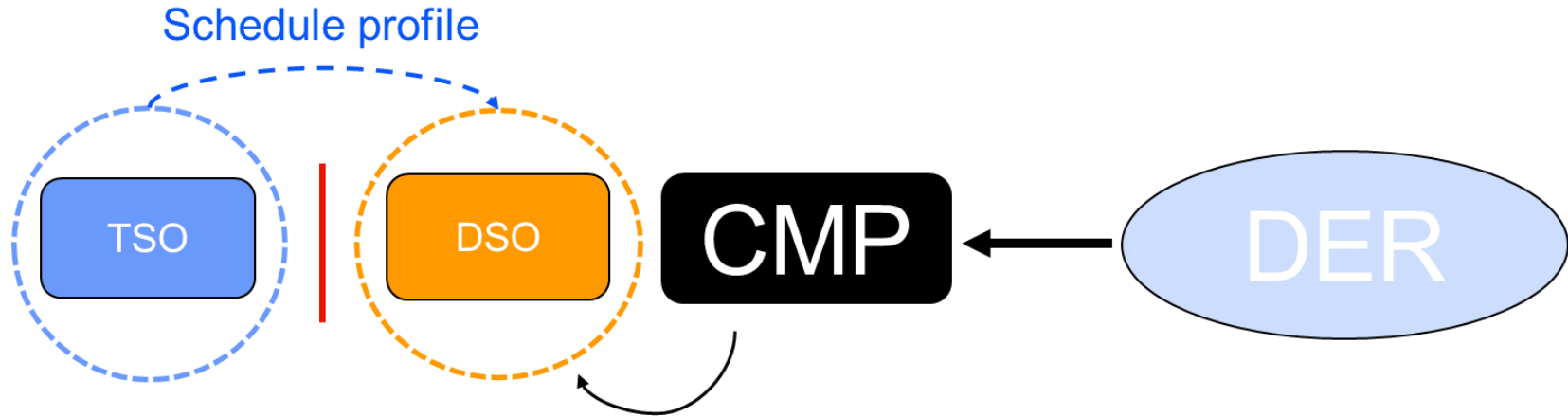


# Spanish pilot



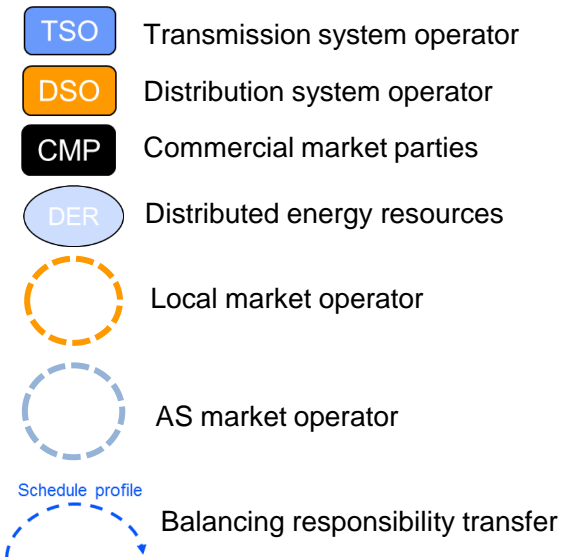
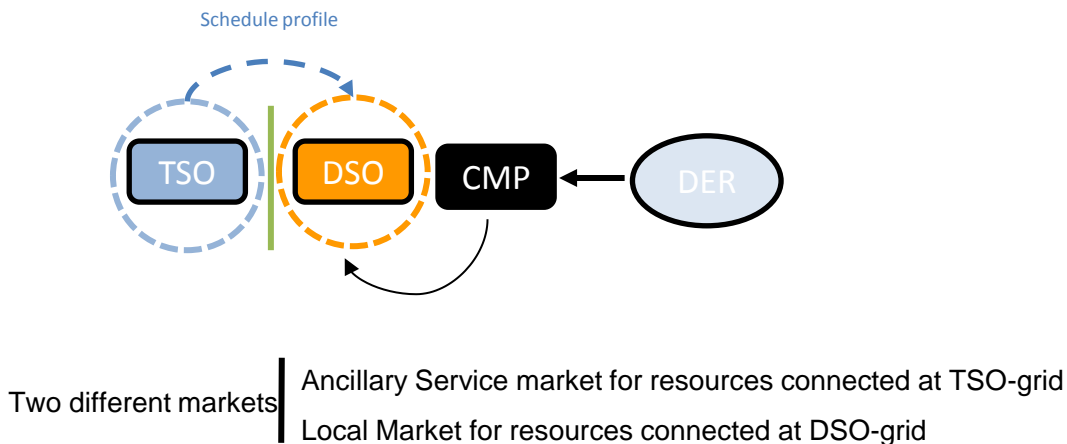
## Coordination scheme

### Shared balancing responsibility model



# Coordination scheme

## Shared balancing responsibility model



Ancillary services





**Balancing** in the interconnection point by respecting schedule profile (on behalf of TSO)

**Congestion management** in the distribution grid

How?  
→

By using flexibility from DER owners through Commercial market parties

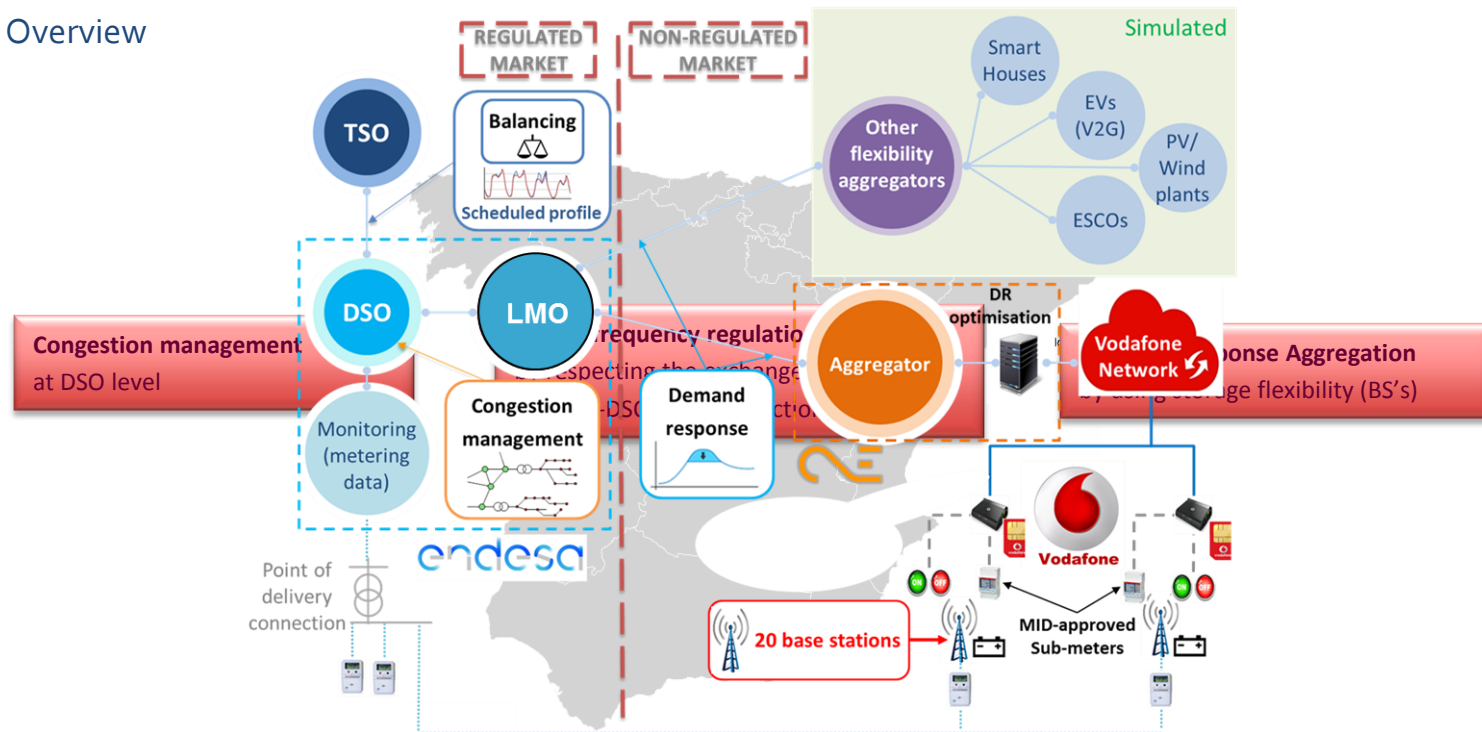
## Roles in the project

	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



# Spanish pilot

- Overview



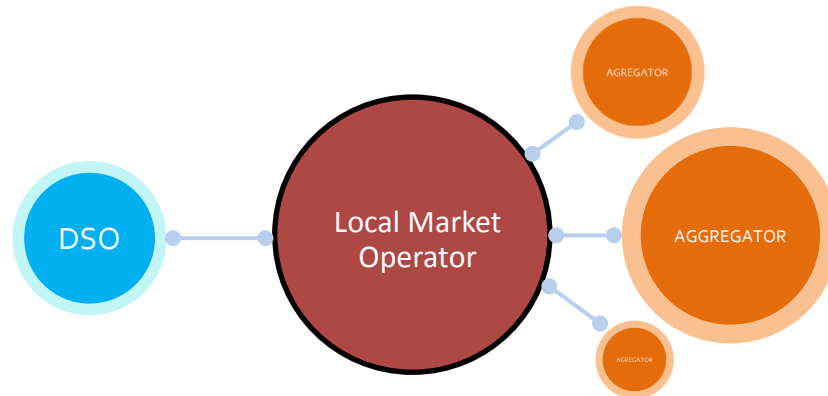
## Spanish pilot

- Local Market Operator

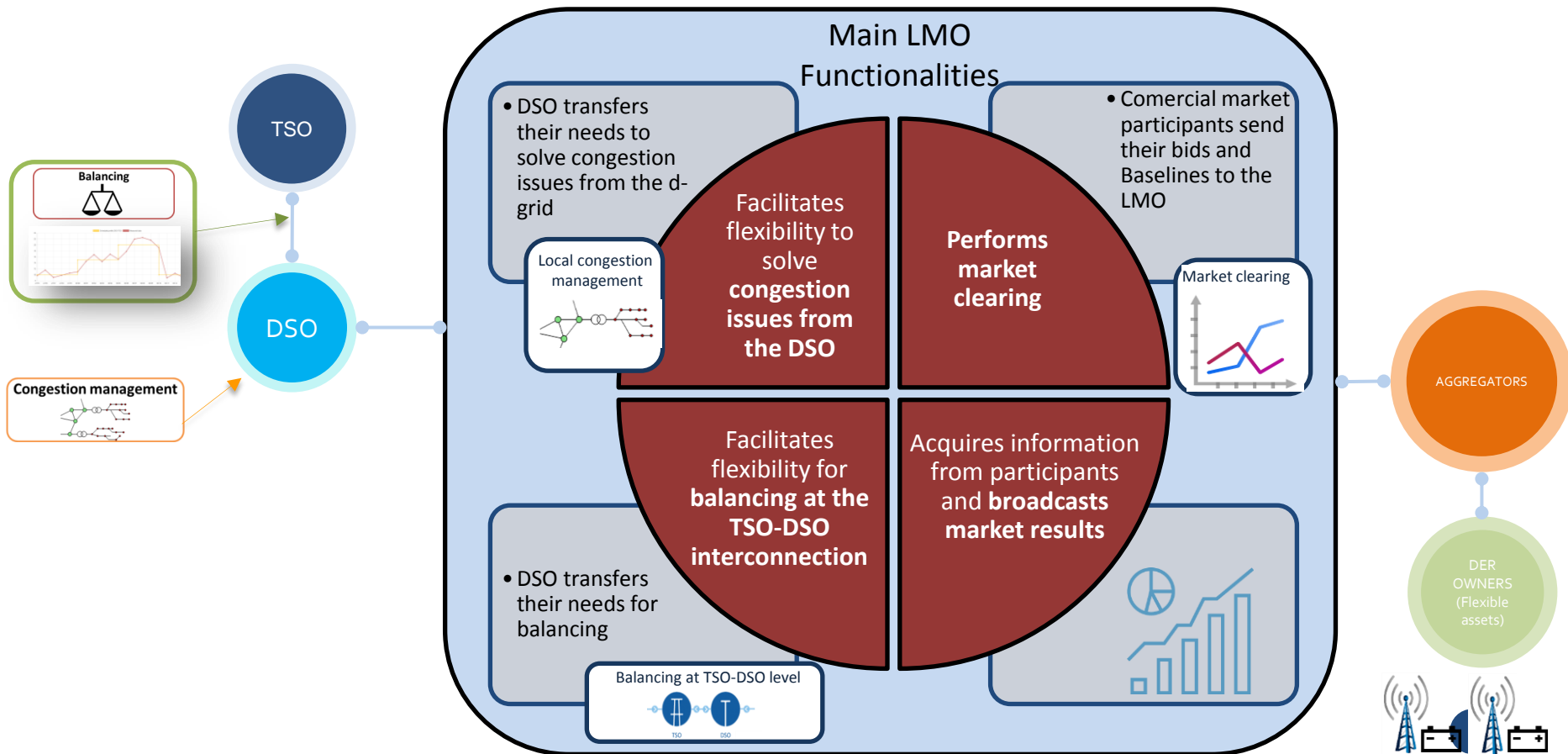
Endesa Distribución will play the **market operator** role at the local (distribution) level by means of the **market clearing algorithm**, which at the end is an OPF (Optimal Power Flow).

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



# Software Flexible Tool for the DSO

Balancing & Congestion ▾

Market ▾

CMP ▾

User guide

## Balancing & Congestion Management Interconnection 01

State: Running Stop

03/05/2017 - 10:32:16 UTC

Time Filter ▾

### Balancing



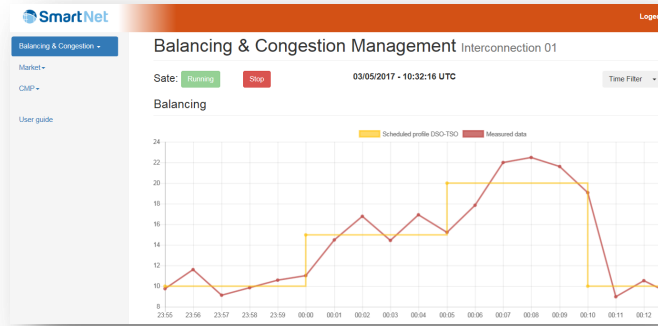
# SW Flexible Tool



LMO  
DSO  
Virtual CMP



## Control of the pilot



**Balancing.** Time plot of active power exchanged at TSO-DSO interconnection points

**Flexibility.** Time plot of total flexibility volumes per market session at each TSO-DSO interconnection point (kW)

**CMPs.** Time plot of aggregated load of customers' portfolio of each CMP.

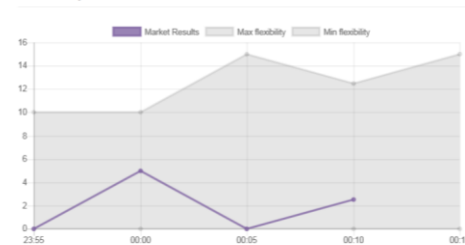
**Market prices.** Time plot of the clearing price per market session at each TSO-DSO interconnection point

**Market results.** Table of dispatched flexibility volumes per CMP per market session and node at each TSO-DSO interconnection point (kW)

**Network Status.** Diagram of the distribution network downstream each TSO-DSO interconnection point:



Flexibility



Market results

Market time	Node	CMP	$\Delta P$ (kW)
2017-02-14T00:10:00Z	6	ONE	2.5
2017-02-14T00:00:00Z	6	ONE	2.5
2017-02-14T00:00:00Z	10	TWO	2.5



# Spanish pilot

## Progress so far

### Functional specification

Definition of roles

Definition of architecture

Definition of Vodafone's constraints

Definition of services to be tested

Definition of DSO market

Definition of Endesa's constraints

Identification of primary substations

List of base stations

HW installation. DR kits

HW installation plan

### Technical specification

Specification of SW for simulating other aggregators

Specification of SW for simulating DSO needs

Specification of SW for simulating DSO market

Specification of ONE-Endesa communications

Specification of SW for aggregation

Specification of Vodafone-ONE communications

Specification of SW for controllers at base stations

### Software development

Development of SW for simulating other aggregators

Development of SW for simulating DSO needs

Development of SW for simulating DSO market

Development of SW for aggregation

Development of SW for controllers at base stations

### Testing

Definition of test protocol

Test of DSO market

Test of ONE-Endesa communications

Test of aggregation algorithm

Test of Vodafone-ONE communications

Test of controllers at base stations

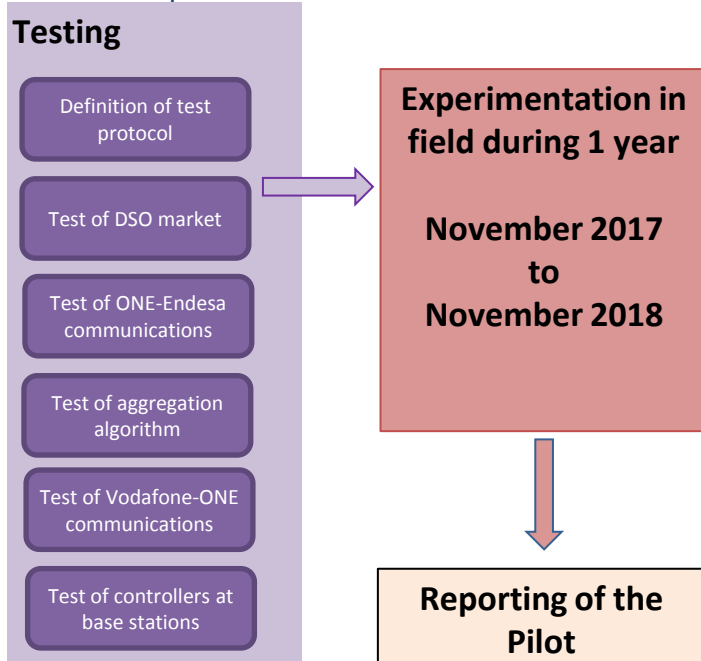
Experimentation in field during 1 year

November 2017  
to  
November 2018

Site selection & installation

## Spanish pilot

- Following



### And after Smartnet?

If the outcomes are positive, one of the following steps could be to simulate this project considering a higher number of border points (TSO/DSO), which could cover large urban areas.



**Regulatory framework analysis**  
and  
Propose **policy**  
**recommendations**

# SmartNet



[SmartNet-Project.eu](http://SmartNet-Project.eu)

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Thank You

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