Spanish Pilot – Pilot C
Flexibility from Radio Base Stations

Miguel Pardo (Endesa)
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**

#### Target 1: Installation
- Installation complete @ 17/20 sites

#### Target 2: Commissioning
- Monitoring complete & live @ 12 sites

#### Target 3: Control
- Complex meter configuration for real-time communications

**Pilot flexible aggregation capacity: around 100 kW**
Motivation

To proof in real field the feasibility of the *Shared balancing responsibility model* of SmartNet project.

Goal achievements

- Validation of TSO-DSO interactions
  - (TSO level)
  - (DSO level)
- Flexibility Aggregation
- Demand Response (Base stations)
- ICT communications

Spanish pilot

Italian Pilot (A)

Danish Pilot (B)

Spanish Pilot (C)
Coordination scheme

Shared balancing responsibility model

Schedule profile

TSO  DSO  CMP

DER
Shared balancing responsibility model

Two different markets
- Ancillary Service market for resources connected at TSO-grid
- Local Market for resources connected at DSO-grid

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

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

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

  - Congestion management at DSO level
  - Frequency regulation respecting the exchange program at TSO-DSO interconnection
  - Demand response aggregation by using storage flexibility (BS’s)

  - Balancing
  - Scheduled profile

  - Monitoring (metering data)
  - Congestion management
  - Demand response

  - TSO
  - DSO
  - LMO

  - Aggregator
  - Other flexibility aggregators
  - Smart Houses
  - EVs (V2G)
  - PV/Wind plants
  - ESCOs

  - 20 base stations
  - MID-approved Sub-meters

  - Vodafone Network
  - Endesa
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

Main LMO Functionalities

- **Facilitates flexibility to solve congestion issues from the DSO**
- **Facilitates flexibility for balancing at the TSO-DSO interconnection**
- **Performs market clearing**
- **Acquires information from participants and broadcasts market results**

**DSO**
- Transfers their needs to solve congestion issues from the d-grid
- Transfers the TSO needs for balancing

**TSO**
- Commercial market participants send their bids and Baselines to the LMO

**Local congestion management**

**Congestion management**

**Balancing at TSO-DSO level**

**Balancing**

**AGGREGATORS**

**DER OWNERS** (Flexible assets)
Software Flexible Tool for the DSO

Balancing & Congestion Management  Interconnection 01

State: Running

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

Balancing

- Scheduled profile DSO-TSO
- Measured data

Graph showing balancing and congestion management data over time.
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:
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- Progress so far
  - Functional specification
    - Definition of roles
    - Definition of architecture
    - Definition of Vodafone’s constraints
    - Definition of services to be tested
    - Definition of Endesa’s constraints
  - 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
      - January 2018 to November 2018
  - Site selection & installation
    - Identification of primary substations
    - List of base stations
    - HW installation plan
    - HW installation. DR kits
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- Following 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.

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

January 2018 to November 2018

Reporting of the Pilot

Regulatory framework analysis and Propose policy recommendations
Thank You

Miguel Pardo

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