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

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

  **Increased interaction between DSOs and TSOs**
  Evolution of the current procedures for the procurement of ancillary services from DER

  **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
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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
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Motivation

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

Goal achievements

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

Balancing (level)

Congestion management (level)

Italian Pilot (A)

Danish Pilot (B)

Spanish Pilot (C)
Shared balancing responsibility model

Coordination scheme

TSO | DSO | CMP | DER
Coordination scheme

Shared balancing responsibility model

<table>
<thead>
<tr>
<th>Two different markets</th>
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<tbody>
<tr>
<td>Ancillary Service market for resources connected at TSO-grid</td>
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<tr>
<td>Local Market for resources connected at DSO-grid</td>
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</table>

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

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

- **DSO** transfers their needs for balancing.
- **DSO** transfers their needs to solve congestion issues from the d-grid.
- **Comercial market participants** send their bids and Baselines to the LMO.
- **DSO** transfers their needs to solve congestion issues from the d-grid (Facilitates flexibility to solve congestion issues from the DSO).
- **DSO** transfers their needs for balancing at the TSO-DSO interconnection (Facilitates flexibility for balancing at the TSO-DSO interconnection).
- Acquires information from participants and broadcasts market results (Performs market clearing).
- Acquires information from participants and broadcasts market results (Acquires information from participants and broadcasts market results).

TSO

DSO

AGGREGATORS

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

Balancing & Congestion Management

Interconnection 01

Sate: Running stop

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

Balancing

Scheduled profile DSO-TSO  Measured data
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 Vodafone-ONE communications
- 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

Site selection & installation
- Identification of primary substations
- List of base stations
- HW installation. DR kits
- HW installation plan

Experimentation in field during 1 year
November 2017 to November 2018
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- Following steps

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

Reporting of the Pilot

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
Thank You

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