SmartNet Final Workshop, Arona | 16.05.2019

Pilot C

Endesa - Vodafone – ONE – Tecnalia – IREC

This project has received funding from the European Union’s Horizon 2020 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
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

Motivation

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

Goal achievements

- Validation of TSO-DSO interactions
  - Balancing (TSO level)
  - Congestion management (DSO level)

- Flexibility Aggregation
- Demand Response (Base stations)
- ICT communications
Coordination scheme

Shared balancing responsibility model

Schedule profile

TSO  DSO  CMP  DER
Coordination scheme

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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<th>Role</th>
<th>Responsibilities</th>
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| 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 |
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 to solve congestion issues from the d-grid**
  - Facilitates flexibility to solve congestion issues from the DSO

- **Comercial market participants send their bids and Baselines to the LMO**
  - Performs market clearing
  - Facilitates flexibility for balancing at the TSO-DSO interconnection
  - Acquires information from participants and broadcasts market results

- **DSO transfers their needs for balancing**
  - Balancing at TSO-DSO level

- **Aggregators**
  - **DER OWNERS (Flexible assets)**
Pilot C: Overview
Pilot C: Balancing & Congestion Management

Diagram showing the integration of DSO, LMO, and a database (DB) along with BCM and endesa components.
Pilot C: Balancing & Congestion Management

- Tele-management
- RTUs
- Scheduled profile (day ahead)
- Manager
- Optimization
- CMP
- BCM
- DB
- ENDESA DISTRIBUCIÓN

Information Process

Active CMP:
ONE last bids: 2018-03-21T15:30:00Z
VCMPO1 last bids: 2018-03-21T15:10:00Z

Next calculations at: 2018-03-21T15:14:00Z
Next market at: 2018-03-21T15:15:00Z
Pilot C: BCM - Optimization

**BCM**

**Manager**

**Optimization**

5'

**DB**

mongoDB

Bonmin

Julia computing

**Bonmin**

**SmartNet**

**MC** = Market Clearing Time

**dmc** = 5 min

Messages

Connections to DB

Start Optimization

Load the network status

Evaluate consumption with Sch.Prof. (TSO-DSO)

Optimal Power Flow + Market Clearing

Send dispatch orders

End

Network(t-dmc..t)

Sch.Prof.(MC)

Sch.Prof.(MC–dmc)

Bids(t)

Baseline(t)

marketresults(t)

marketresults(t)
Pilot C: BCM - Opt. – OPF + MarketClearing

\[
\min \sum_{g \in G} \sum_{k \in K_g} \lambda_{g_k}^+ P_{g_k}^+ + \sum_{k \in K_{G_0}} \lambda_{0_k}^- P_{0_k}^- + \sum_{(i,j) \in \mathcal{L}} C_{ij}
\]

\text{st.}

- Power Flow technical constraints
- Balancing constraints
- Congestion constraints
- Market Clearing constraints
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
Market price

- Time plot of the clearing price per market session at each TSO-DSO interconnection point (cent/kWh)
  - 1 plot per each TSO-DSO interconnection point in Pilot C
  - Adjustable time filter (window)
CMPs (aggregated load)

- Time plot of aggregated load of customers’ portfolio of each CMP
  - Baseline (grey)
  - Dispatched power, i.e. (baseline + dispatched flexibility) (light blue)
  - Delivered (measured) power (dark blue)
DER Conclusions
Potential & Benefits of flexibility

• **0 Service impact** during live test. We proved the mobile communication network is not at risk.

• We could drive HW and SW Technology vendors for **performance efficiency** to support site remote management.

• We are able to **prepare future mass market DSR deployment** program set up – do’s and don’t ( site built, access management, etc…).

• We can integrate DSR in BTS **new power design** with 5G introduction.

• We could verify fit for purpose of **IoT Technologies** to get live DSR program with aggregators and DSO’s.

• Installed power capacity in EU could represent **+250 MW** of dispatchable load.

• Regulation towards **fairly DER compensation** is necessary.
DSO Conclusions.
Potential & Benefits of flexibility

From the DSO perspective:

• Innovative ways of integrating **new battery systems** into the power grid.
• DSOs are active **neutral market facilitator** for DER and prosumers.
• **Avoiding possible reinforcements** of the grid. Network upgrades only when needed.
• **Helping Balancing Services** (BRP)
• Envisioning **different coordination's schemes** with different results on the CBA.
• Pushing **new technologies** for the grid **digitalization**.
• Regulation towards **local markets**.
Thank You

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