Panel Discussion
Data sharing, access and storage

Filipe Guerra | SENSIBLE | Utility week – Vienna – 06/11/2018

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Overview and highlights

Scope

- **Demonstration of energy storage and management** in buildings, communities and distribution grids in **real operation scenarios**

Objectives

- **Demonstrate applications of distributed energy storage** and energy management aiming to **increase RES penetration**.
- **Find technical, legal and regulatory barriers** blocking storage applications
- **Develop business cases** able to support the large scale deployment of distributed small scale storage

Demonstrators

- **Évora:** Distribution networks management and new energy services
- **Nottingham:** Communities/ESCO energy management
- **Nuremberg:** Buildings energy management

Budget and timeline

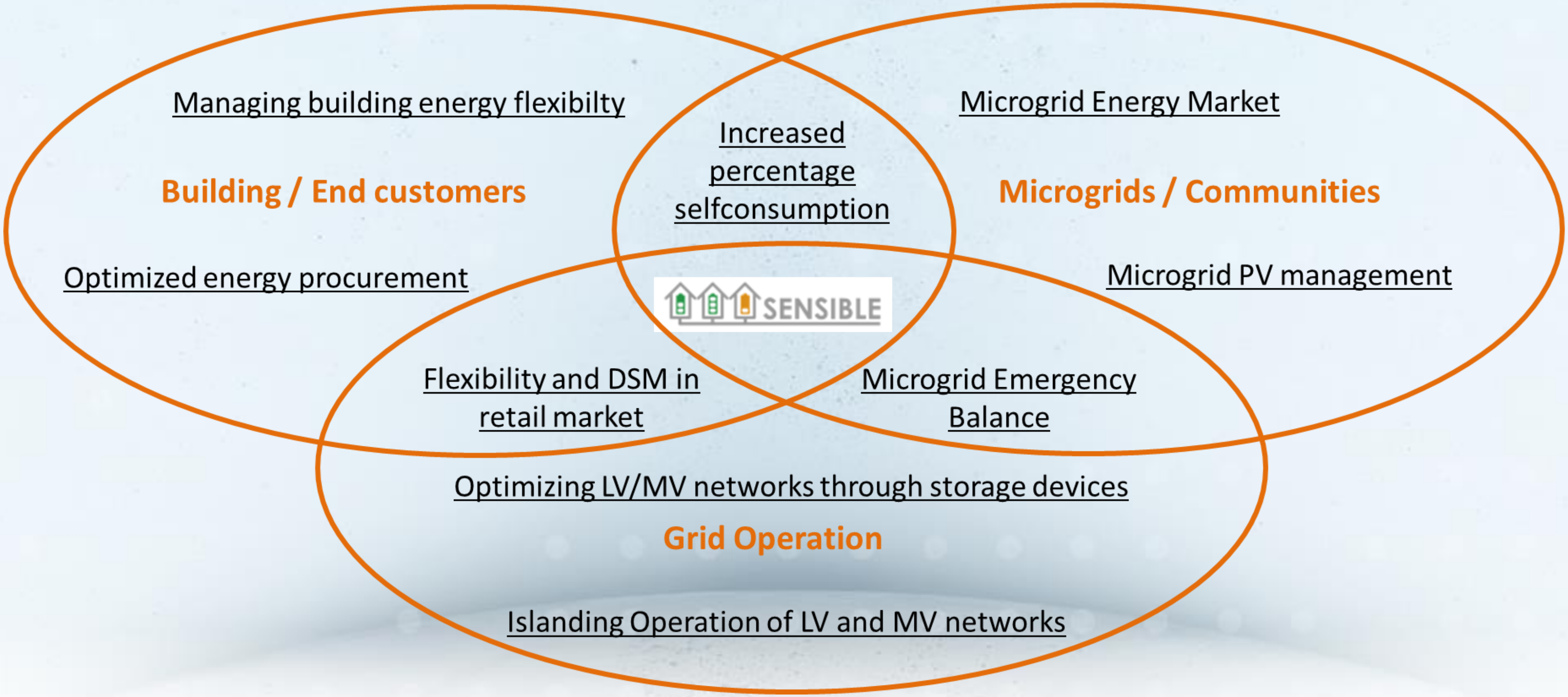
- 15,6 M€
- January 2015 - December 2018

Partners

- Siemens AG
- ARMINES
- EDP Labelec
- Empower
- GPTech
- INDRA
- K&S
- INESC TEC
- Mozes
- Univ. of Nuremberg
- Univ. of Nottinhgam
- Univ. of Seville
- Siemens S.A.

Specific objectives

The specific objectives of SENSIBLE were divided in three vectors…



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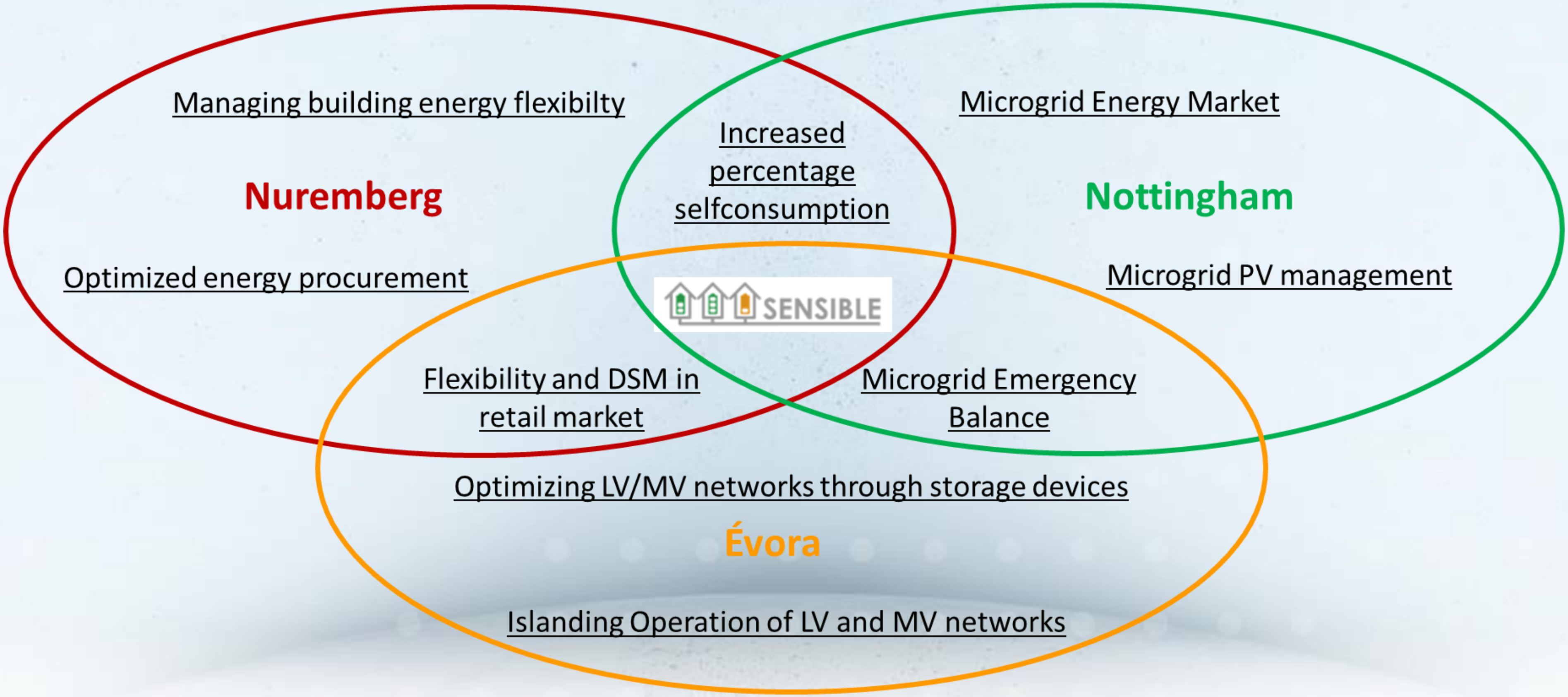
Specific objectives

…where each demonstrator is particularly focused on!



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Demonstrators' infrastructures built for the different specific objectives

Évora

Grid infrastructure

- 2 Sec. Subst (250 kVA)
o 1 Advanced LVSG
- 4 LV ESS: 50 /2x30 /10 kW
o Total of 160 kWh
- 246 Smart Meters (GPRS)

- 1 MV Client (870 kVA)
- 1 MV ESS 480 kW
o 360 kWh
- 1 MV Circuit Breaker

Residential infrastructure

- 25 Clients from which:
o 25 with PV
o 10 with Water Heaters(WH)
o 10 with Batteries
o 6 with Battery and WH
o 25 with HEMS

Nottingham

Domestic installations – 27 houses:

- 11 x SMA SB Storage 2.5 + Tesla Powerwall 1
- 4 x SMA Sunny Island (3.0/6.0) + LG Chem Resu 6.5
- 6 x ImmerSuns (Water Heaters Power Control)
- 6 x Monitoring only

Community installations – 3 sites:

- School / Library: Tesla Powerwall 2 with 5kW inverter
- Creative Energy Homes: 30kVA 4-wire inverter with 34 kWh battery

Nuremberg

Generator-Systems Lab in Nuremberg

- Geothermal heat pump (10.5kW)
- Combined heat and power unit
- Thermal storage devices (with resistive heaters)
- Building Thermal Load Emulation System (40kW)

BEMS Lab in Erlangen

- Base load Emulator (80kW)
- PV Emulator (40kW)
- Li-Ion Battery (31kWh)
- Building Energy Management System

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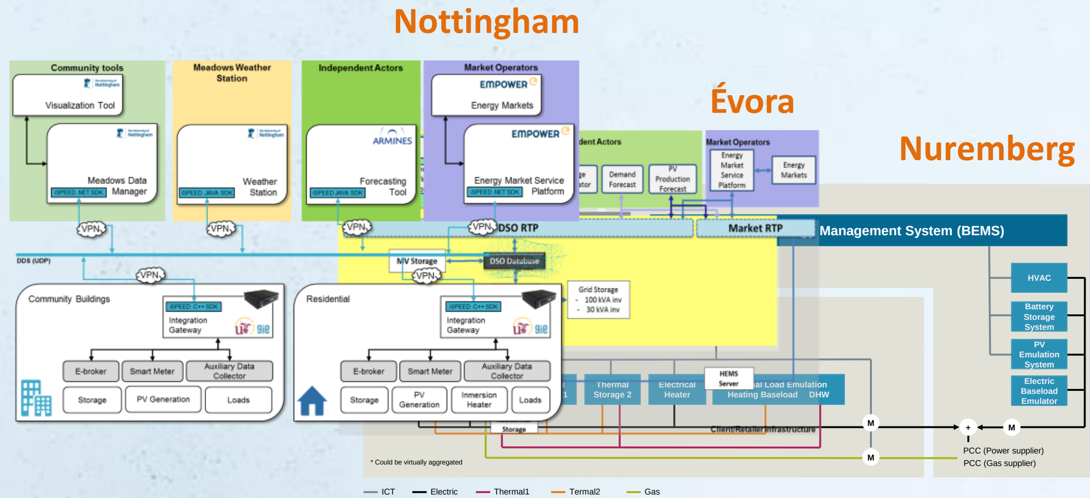
ICT architectures

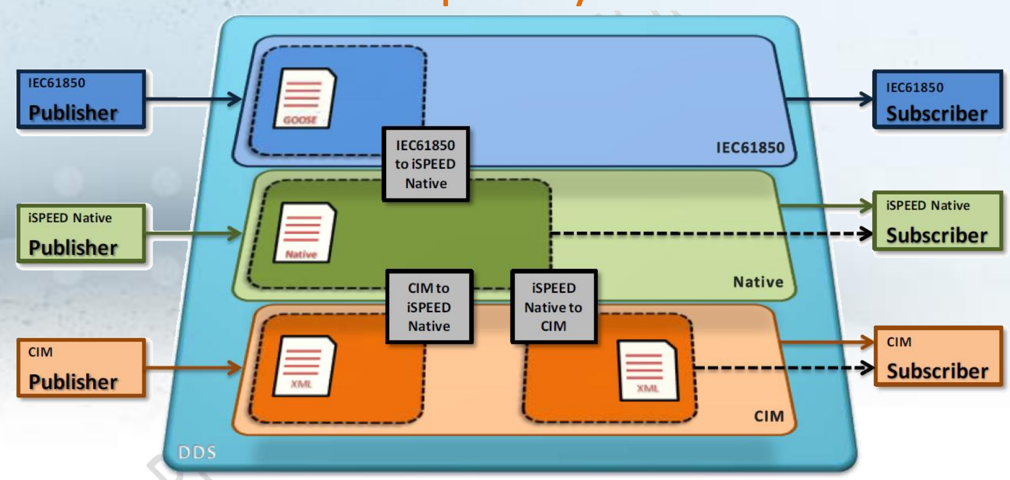
Digitalization as key role to enable the provision of energy services

RTP (iSPEED from INDRA)

- High performance distributed platform for **real-time data exchange**
- Implements the **Data Distribution Service** (DDS) **standard** from the **OMG (Object Management Group)** that aims to enable scalable, high-performance and interoperable data exchanges using a **publish–subscribe** pattern.
- Oriented to the **distribution of logic between nodes** located at different network levels
- Flexibility is achieved by implementing the interoperability among different data models, protocols, and standards through the use of **international standards** as **CIM** and **IEC 61850**.
- **Routing service** enhancing network interoperability in broad and WAN.



Interoperability



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Data flow

The three demonstrators followed a similar approach focusing their own objectives

Forecast

PV
MV and LV
- Day ahead gen.
- Intraday gen

Electric Load
MV and LV
- Day ahead gen.
- Intraday gen

Heat Load
- Day ahead
- Intraday

DSO

Flexibility
DSO flexibility request
(to optimize grid operation)
- Day ahead
- Intraday

Optimization
Grid (MV and LV)
- ESS P/Q setpoints

Retailer

Flexibility
Retailer flexibility request
(to optimize market results)
- Day ahead
- Intraday

Market

Market
Prices forecast
- Day ahead
- Intraday

Flexibility
Auction between
DSO and Retailer

Aggregattor

Flexibility Aggregation
Clients Flexibility
aggregation
(Equip. status ->
Flexibility forecast)

Flexibility Dispatch
Clients flexibility
Dispatch
(Flex. Request -> equip.
setpoints)

RTP

Clients

Metering
- Consumption/Injection

PV
- Energy Production

Battery
- Consumption/injection
- SoC

Water Heaters
- Consumption
- Temperature

Grid

Metering
- Voltage, Consumption/Injection
    - 246 clients

Protection equipment
- Status (Open/Close)
- Alarms and Trips

Grid Storage (5 ESS)
- Consumption/injection
- SoC
- Voltage

Buildings

Metering
- Consumption/Injection at PCC

Generation devices
- Generation status electrical & thermal (CHP/PV/HP)

Management
- Forecasts (load/weather)
- Market and tariff info
- Flexibilty requests

Évora demonstrator

Focused on LV/MV networks and end-customer storage applications

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Nottingham demonstrator

Focused on communities' energy storage applications

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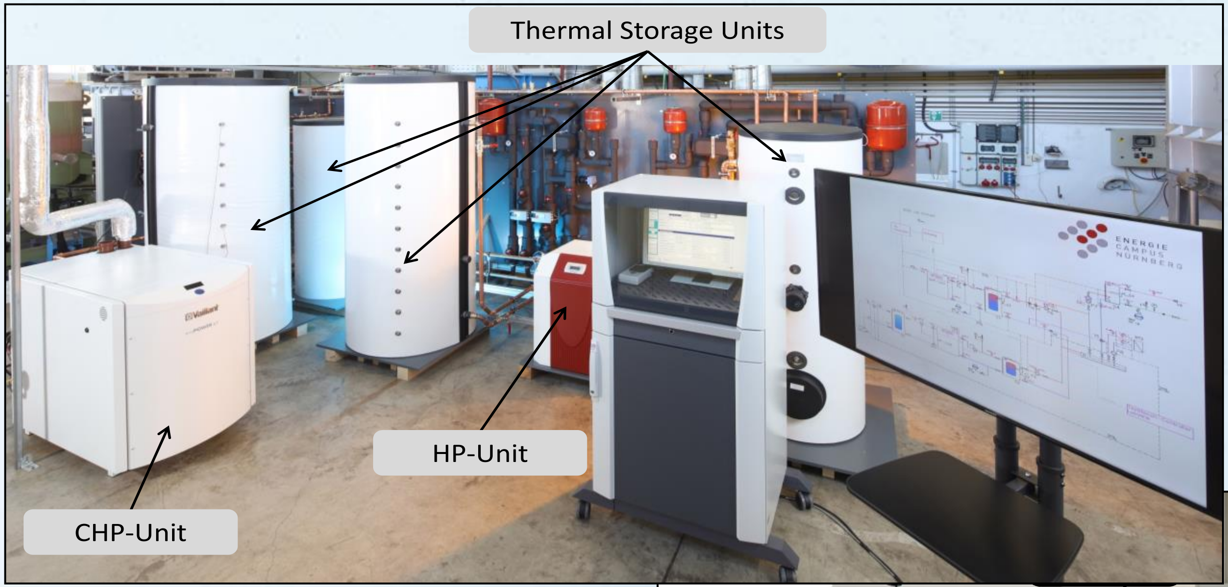
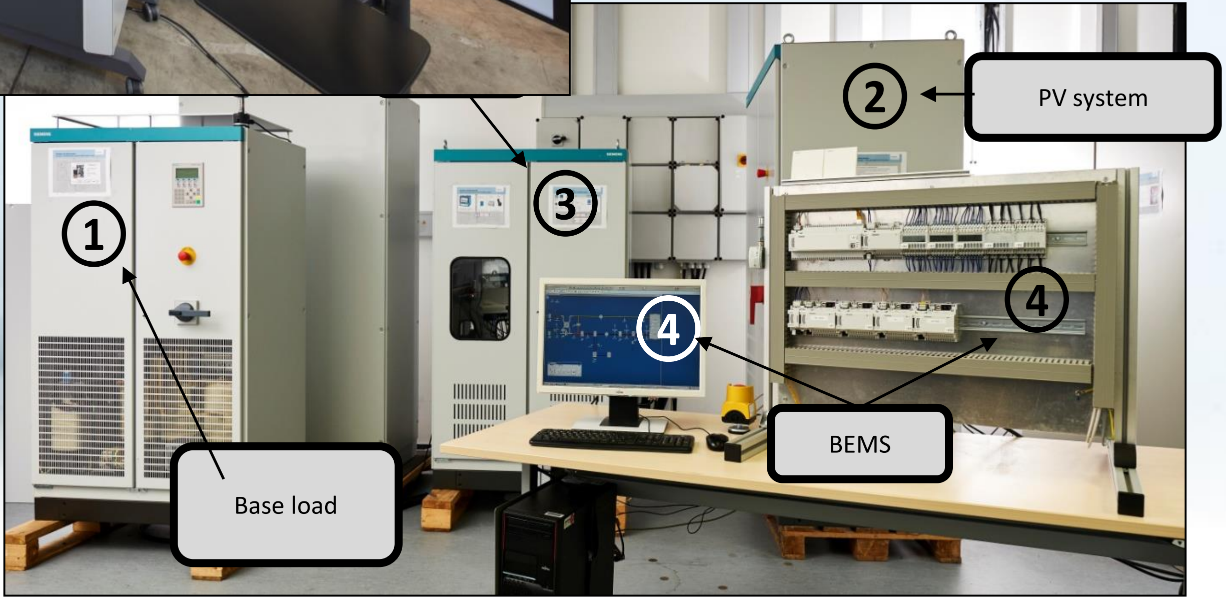
Nuremberg demonstrator

Focused on storage and energy management applications for buildings





Main technical achievements

SENSIBLE was considered a H2020 Flagship project by the European Commission

Évora

- Definition of a scalable and replicable monitoring and control architecture to be used by DSO and Retailer/ESCO to manage DER (PV and different storage technologies)

- Optimization of MV/LV networks and operation in islanded mode through the coordinated use of grid ESS and customers‘ flexibility

- Implementation of an end customer flexibility agregation framework able to provide support to Retailer/ESCO to optimize results in energy markets as well as to DSO to optimize network operation

Nottingham

- Increased self-consumption of over 12.7 MWh using batteries and immersion heaters

- Reduced participants’ energy bills through self-consumption and shifting energy to lower price periods

- Improved the low-voltage network operation in the Meadows and increased PV penetration

Nuremberg

- Development of a Building Energy Management System (BEMS) that‘s able to control multi-modal energy components within the building

- Seamless integration of energy production and storage components with the ICT infrastructure including forecasting services and energy market services platform

- Demonstration of the so-called smart buildings‘ interactions with external smart grid systems like virtual power plants, DSOs and the energy markets

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Engagement strategy

A similar approach was used in Portugal and UK

Engagement strategy

A similar approach was used in Portugal and UK

Transversal

- Increased awareness for energy efficiency and decarbonization
- Capability to monitor energy consumption and change behaviour
- Fuel Independence (gas)
- Participants strengthen their social ties within the community around a shared cause
- Will to make investment with own capital for own generation and energy efficiency meausures

Évora

- 300€ of energy costs reduction on annual bill (average per client) through self-consumption maximization strategy (540€ is the national annual average electricity bill)
- ~32 tonne of CO_2 emissions avoided (From July 2017 to October 2018 considering EF of 185 gCO_2/kWh)

Nottingham

- £118 of average energy costs reduction on annual bill through self-consumption and £96 through energy shifting from high to low price periods (£619 is the national annual average electricity bill)
- 2.9 tonne of CO_2 emissions avoided (From September 2017 to October 2018 considering EF of 292 gCO_2/kWh)

Preliminary conclusions…

SENSIBLE demos are ongoing but we can take some conclusions already

Buildings/Consumers

- Energy Management System at the building level is essential while considering local energy production and storage in order to increase energy efficiency and also grid stability

- Management of customers energy consumption flexibility is difficult. Different storage technologies provide different benefits but also imply different control complexity.

- Making building devices and its operation flexible could prove to be vital for decarbonized future energy systems

Grid Operation

- Distributed LV and MV Energy Storage systems can be a powerfull asset for the DSO to optimize the network operation (in connected or islanded operation)

- Effective and efficient Smart Grid infrastructure is crucial to enable reliable monitoring of the grid and provide exploitable data to forecast and management tools.

- With increasing penetration of distributed generation and storage in distribution networks, new protection paradigms must be tested

Microgrid/Communities

- Islanding operation at LV and MV level can be achieved through independent or coordinated control of MV and LV ESS, and also with the support of DER enabled end customers.

- There is a need to work with communities to develop user acceptance of technologies (aesthetics, security, safety, understanding of system behaviour for maximum benefit)

- Potential to increase penetration of PV

Challenges…

Several challenges were faced during the four years project and are current EU concerns

Technical

- Lack of standardization for the integration, testing, installation and operation of ESS

- Integration of different software tools developed during the project – eg prediction, markets, control.

- IT architectures ensuring reliable communications and data security

- Provision and reliability of real time metering

Economical

- Cost of distributed small scale storage (when thinking on batteries) is to high and does not pay back

- Cost of managing an infrastructure for residential clients DER aggregation is to high an requires very high scale to be profitable

- Flexibility markets run again (some) Ancillary Service markets, where there are parties better prepared and inferior operation costs to respond to market and grid challenges.

Regulatory

- DNO/DSO flexibility: Approval process and battery storage classification

- Operation of Microgrids not allowed according through PT/UK regulation

- No existence of flexibility market and aggregation of clients as a service is not legal

- Storage ownership. Current guidelines state that DSO cannot own Storage equipment

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