Added value of storage in distribution systems

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About STORY

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General project information

• 18 institutions from 8 countries
• Coordinator: VTT
• Technical coordinator: Th!nk E
• Horizon 2020 (LCE-08-2014)
• Start: May 1st, 2015 (Duration: 66 months)
• Budget: 15.8 million Euro
Project partners
Objectives

Show the added value of storage in the distribution grid

• To demonstrate and evaluate innovative approaches for energy storage systems
• To find solutions, which are affordable, secure and ensure an increased percentage of self-supply of electricity
• To accelerate innovation and business models for deployment of storage at local level.
Project demonstrations

1. Demonstration in residential building (Oud-Heverlee, Belgium)

- Technologies (new or existing)
  - PV, PV-Thermal, vacuum collectors
  - Natural gas, oil, heat pumps
  - 2 electric vehicles
  - Load shifting

- Storage type (new)
  - Batteries
  - Small and large scale thermal water storage (low and high temperature)
  - Fuel cells
  - ICT at building level (interoperability)

Site contains 7 new and old buildings at the end of the electricity line
Project demonstrations

1. Demonstration in residential building (Oud-Heverlee, Belgium)

- Building 1
  - $U < 0.1 \text{ W/m}^2\text{K}$
  - LED
  - Smart 2-zone ventilation: continuous measuring of $\text{CO}_2$, $T$ and humidity
  - Smart household appliances
  - KNX home control
  - BTES + heat pump
  - Electric vehicle
  - PV-Thermal and vacuum collectors
  - Hot water tanks / cooling basins
  - 2 batteries
Project demonstrations

2. Demonstrating the roll out of a neighbourhood (Oud-Heverlee, Belgium)

- Buildings from demo 1 are connected, combined with another 7 buildings -> microgrid
- ICT will integrate operation of thermal storages, heat pumps, fuel cell, PV and batteries and optimize it at the neighborhood scale
- Neighborhood battery

Additional 7 buildings compose last part of the line with its specific challenges
3. Demonstration of storage in factory (Navarra, Spain)

- **Existing situation**
  - Facility produces professional fridge rooms and requires high power peak values (280 kW)
  - Installed 113 kWp PV does not deliver expected cost savings

- **Objectives and technologies**
  - 50 kW, 200 kWh Li-Ion battery will be added to improve the business case
  - Reduction of peak power
  - Demand side management

Site is located in an industrial zone in Navarra.
Project demonstrations

4. Demonstration of storage in residential district (Lecale, Northern Ireland)

- **Existing situation**
  - 250 kW of PV installed
  - 2 x 2,5 MW onshore wind turbines
  - 500 kW anaerobic digestion unit
  - 1.2 MW tidal energy test

- **Objectives and technologies**
  - Extension with a large scale, medium voltage 250 kW and 2 MWh Compressed Air Energy Storage (CAES)
  - To increase security of supply

Site is under development to become a complete self-sufficient, greener, cheaper energy grid for the 300 residential buildings
Project demonstrations

5. Flexibility and robustness of large scale storage unit (Germany/Slovenia)

- Objectives and technologies
  - Flexible design of medium voltage battery: 800 kW, 660 kWh
- Location: Suha, Slovenia
  - 210 kW of PV already installed
  - Low Voltage (LV) network supplied by 400 kVA transformer
- Objectives
  - Demonstration of flexibility and robustness of the battery

A village, where the battery will be installed at the Low Voltage (LV) substation
6. Roll out of private multi-energy grid in industrial area (Olen, Belgium)

Site is located around a large joinery, which has a large amount of wood waste

- **Existing situation**
  - Old wood-fired boiler

- **Objectives and technologies**
  - New highly-efficient wood-fired boiler
  - Organic Rankine Cycle (ORC)
  - Large scale thermal energy storage (low and high temperature)
  - Multi-temperature district heating
  - To increase efficiency of ORC
  - To reduce power peaks
  - To increase self-sufficiency
Project demonstrations

6. Roll out of private multi-energy grid in industrial area (Olen, Belgium)
Project demonstrations

http://horizon2020-story.eu/
Description of technology: energy content of water tanks
Energy content of water storage tanks

Why needed?

- A lot of water storage tanks are equipped with only one temperature sensor
  - Electric hot water heaters
  - Tanks for solar collectors
  - Etc.
- Advantage:
  - Only one temperature sensor is needed
  - Works well for the application
    - Start full loading of the electric hot water heater if temperature is below certain value
    - Stop loading via solar collector if temperature is above certain level
- Disadvantage
  - No detailed information about the energy content of the tank, only information at one certain point
  - Difficult to be used for smart control
Energy content of water storage tanks

Why needed?

• Some applications use a lot of sensors
  – Large-scale water storage tanks for CHP in greenhouses
  – Etc.

• Advantage:
  – Multiple sensors give detailed overview of the temperature of each of the layers in the tank
  – Could be used for smart control

• Disadvantage
  – Higher investment cost for monitoring equipment
  – Higher cost for maintenance (multiple sensors)
Energy content of water storage tanks

VITO solution

• Combination of a limited number of sensors and a model of the tank
Energy content of water storage tanks

VITO solution - procedure

- Starting with detailed testing of the storage tank
- Including flow meters and temperature sensors

![Diagram showing the process of testing and monitoring water storage tanks with flow meters and temperature sensors.](Diagram)
Energy content of water storage tanks

VITO solution - procedure

- Reducing number of sensors (no flow meters, only temperature sensors)
- Optimal location of sensor
Energy content of water storage tanks

VITO solution

- Cloud application (API – Application Programming Interface)
Energy content of water storage tanks

VITO solution

- Tested solution (Story-demonstration project in Oud-Heverlee)
Energy content of water storage tanks

VITO solution

- Used in our VITO-Building Energy Management System
Energy content of water storage tanks

VITO solution

- Implemented in our STORM district heating network controller
Energy content of water storage tanks

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THANK YOU!