The STORY project: The added value storage can bring to flexible and secure energy networks

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07.11.2017

About STORY

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 646426

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: 60 months)
- Budget: 15,8 million Euro

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Project partners – 18 from 8 countries

STORY

VIESSMANN climate of innovation
UC Leuven Limburg MOVING MINDS
CENER ADItech
elektro gorenjska
Basen
VTT
vito
prospex institute
VLERICK BUSINESS SCHOOL
JOANNEUM RESEARCH
University of Ljubljana Faculty of electrical engineering
Th!nk E
exkal
Reneens
B9 ENERGY STORAGE
EnerSys
actility
LOPTAFILM

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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.

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Methodology

- Project demonstrations
  - Technology Readiness Level (TRL) 5 to 7
  - Interoperability
  - ICT
- Validate large scale models
- Understand impact (economic, environmental)
  - At demonstration level (measurements and simulations)
  - At level of grid (through simulations)
- Create framework for viable business cases

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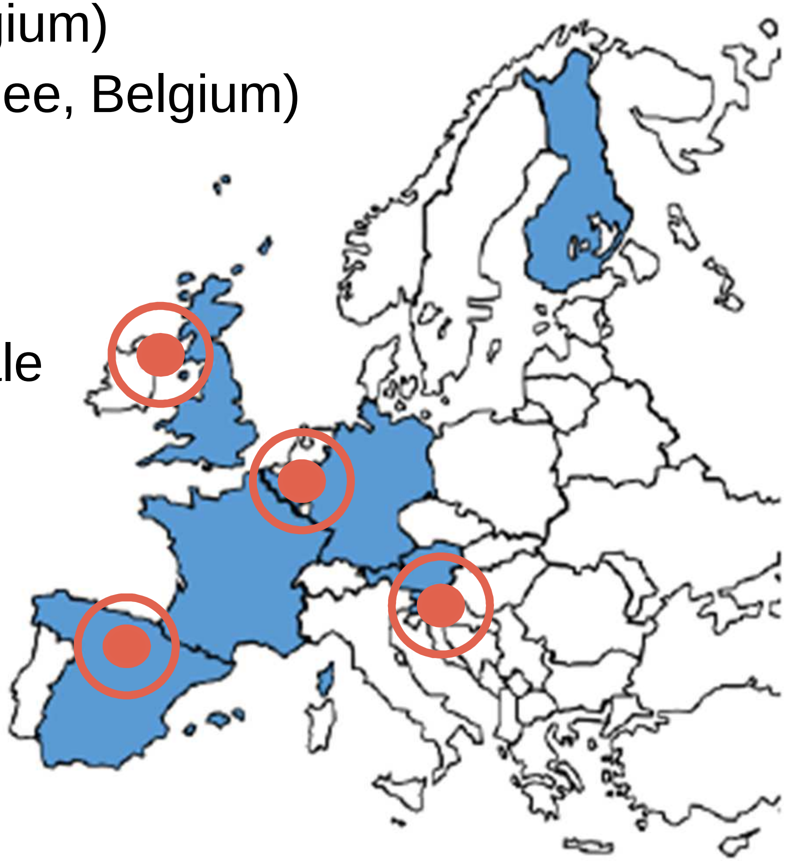
Project demonstrations

Overview

1. Residential building (Oud-Heverlee, Belgium)
2. Roll out of a neighbourhood (Oud-Heverlee, Belgium)
3. Storage in factory (Navarra, Spain)
4. Storage in residential district (Lecale, Northern Ireland)
5. Flexibility and robustness of medium scale storage unit in:
    1. Industrial area (Hagen, Germany and Kranj, Slovenia)
    2. Residential area (Suha, Slovenia)
6. Roll out of private multi-energy grid in industrial area (Olen, Belgium)



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Project demonstrations

The demonstration cases of STORY

		BE: Residential buildings	BE: Neighborhood multi-energy grid	ES: Storage in a factory	UK: Storage in a residental district	SI + DE: Large scale storage unit	BE: Private multi-energy grid
Type of storage	Thermal storage	■	■			■	■
	Battery	■	■	■	■	■	■
	Compressed air storage				■		
Technology	Combined heat and power					■	■
	Vacuum solar collectors	■	■				
	Heat pump	■	■				
	PV	■	■	■	■	■	■
	Wind power				■		
	Tidar power				■		
	Biogas				■		
	Fuel cell	■	■		■		
User sector	Residential	■	■		■	■	
	Industrial			■		■	■
Demo aims	Peak shifting and shaving	■		■			
	Load and generation control	■	■	■	■	■	■
	Grid support					■	
	Scheduling of flexbility	■	■			■	

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Project demonstrations

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

Site contains 5 new and old buildings at the end of the electricity line

- 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)

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Project demonstrations

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

Additional 7 buildings compose last part of the line with its specific challenges

- 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
- A hardware solution for black-outs will be implemented using the actual grid configuration

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Project demonstrations

3. Demonstration of storage in factory (Navarra, Spain)

Site is located in an industrial zone in Navarra.

- 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

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Project demonstrations

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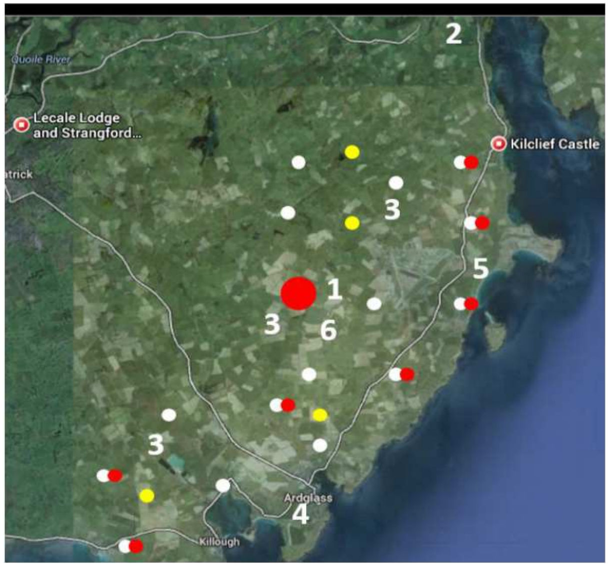
4. Demonstration of storage in residential district (Lecale, Northern Ireland)



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

- 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

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Project demonstrations

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

First site is the Enersys factory, where the battery will be placed near the gas engine CHP unit

- Objectives and technologies
  - Flexible design of medium voltage battery: 800 kW, 660 kWh
  - This battery will be tested at 3 different locations
- First location: Hagen, Germany
  - Gas engine cogeneration (CHP) already installed
  - Test flexibility storage unit for peak shaving potential and support for optimization of CHP operation

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Project demonstrations

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

Second site is a village, where the battery will be installed at the Low Voltage (LV) substation

- Second 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
- Demonstration starts in 2017

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Project demonstrations

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

Third site is the headquarters of distribution grid operator Elektro Gorensjka, near the Suha residential substation

- Third location: Kranj, Slovenia
  - 2 x 630 kVA transformer station
  - 35 kW PV
  - 27 kW CHP unit
  - 80 kW diesel generator
  - Cold storage (ice bank)
- Objectives
  - Integrated management of these devices with electric storage unit
  - High degree of self-sufficiency
  - Peak demand & voltage control

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Project demonstrations

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

Site is located around a large wood product factory, 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

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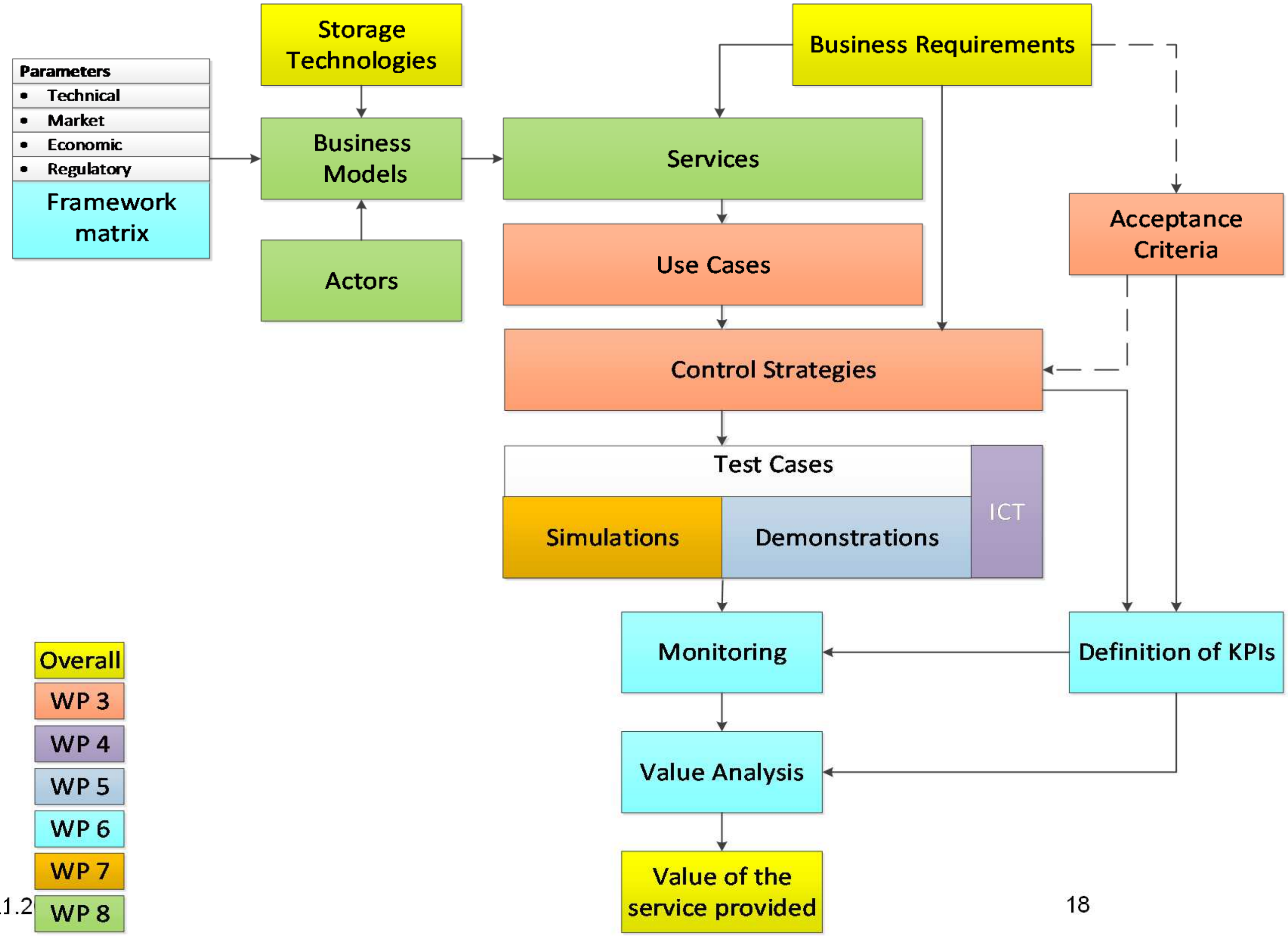
Added Value analysis framework



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Result highlights from two first years

- Three demos in full action (WP5)
- Control strategies (WP3)
- Control algorithms (WP3)
- Three-level ICT architecture (WP4)
- Communication gateways (WP4)
- Interoperability guidelines (WP3 & 4)
- Common and demo specific KPIs and monitoring methodology (WP6)
- Added Value analysis framework (WP6 & 7)

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Result highlights from two first years

- Main grid challenges to be addressed by storage solutions (WP3)
- Large scale scenarios (WP7)
- Large scale network models (WP7)
- Large scale network modelling approach (WP7)
- Business model archetypes (WP8)
- Understanding of practical barriers for implementation (WP5)

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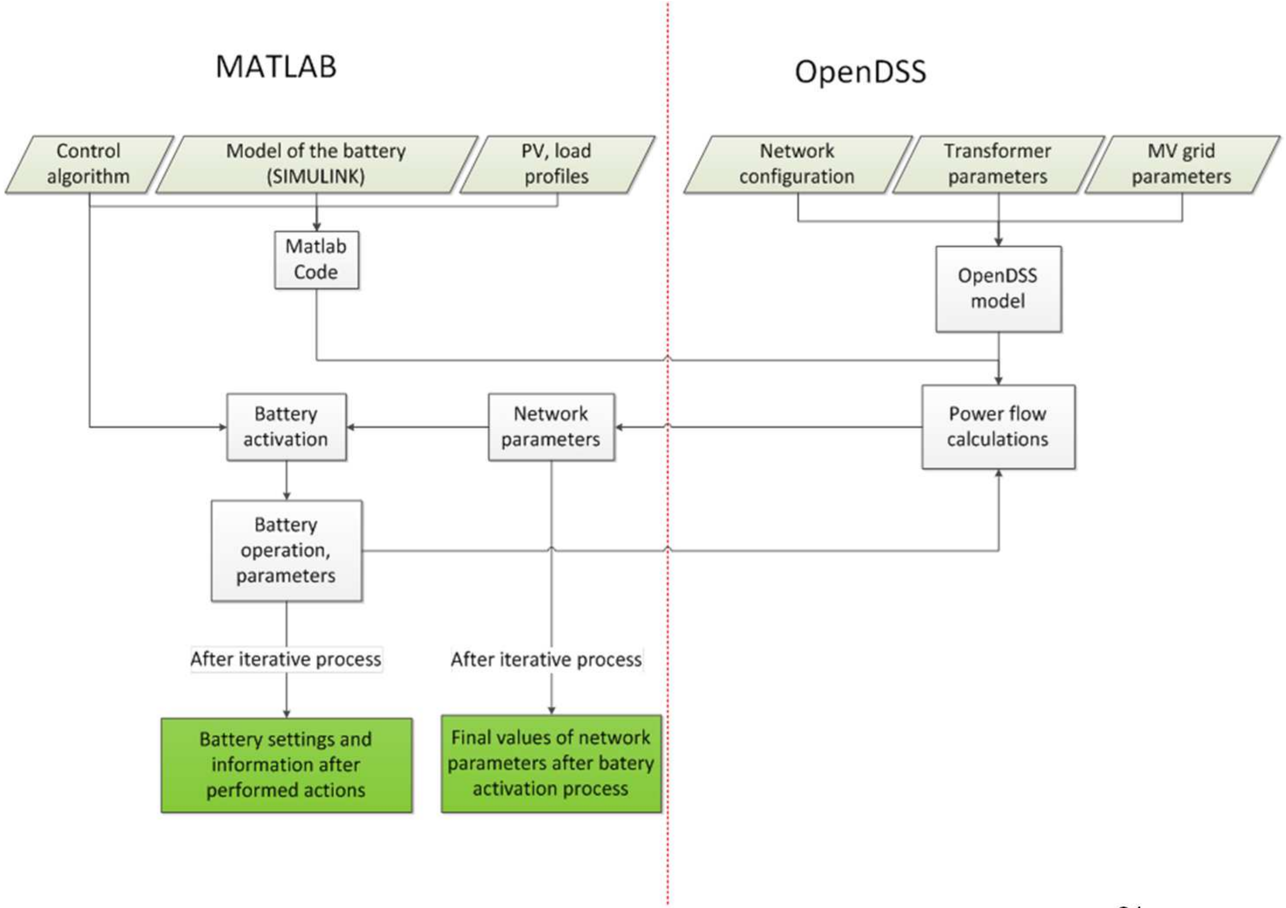
Large scale network modelling approach



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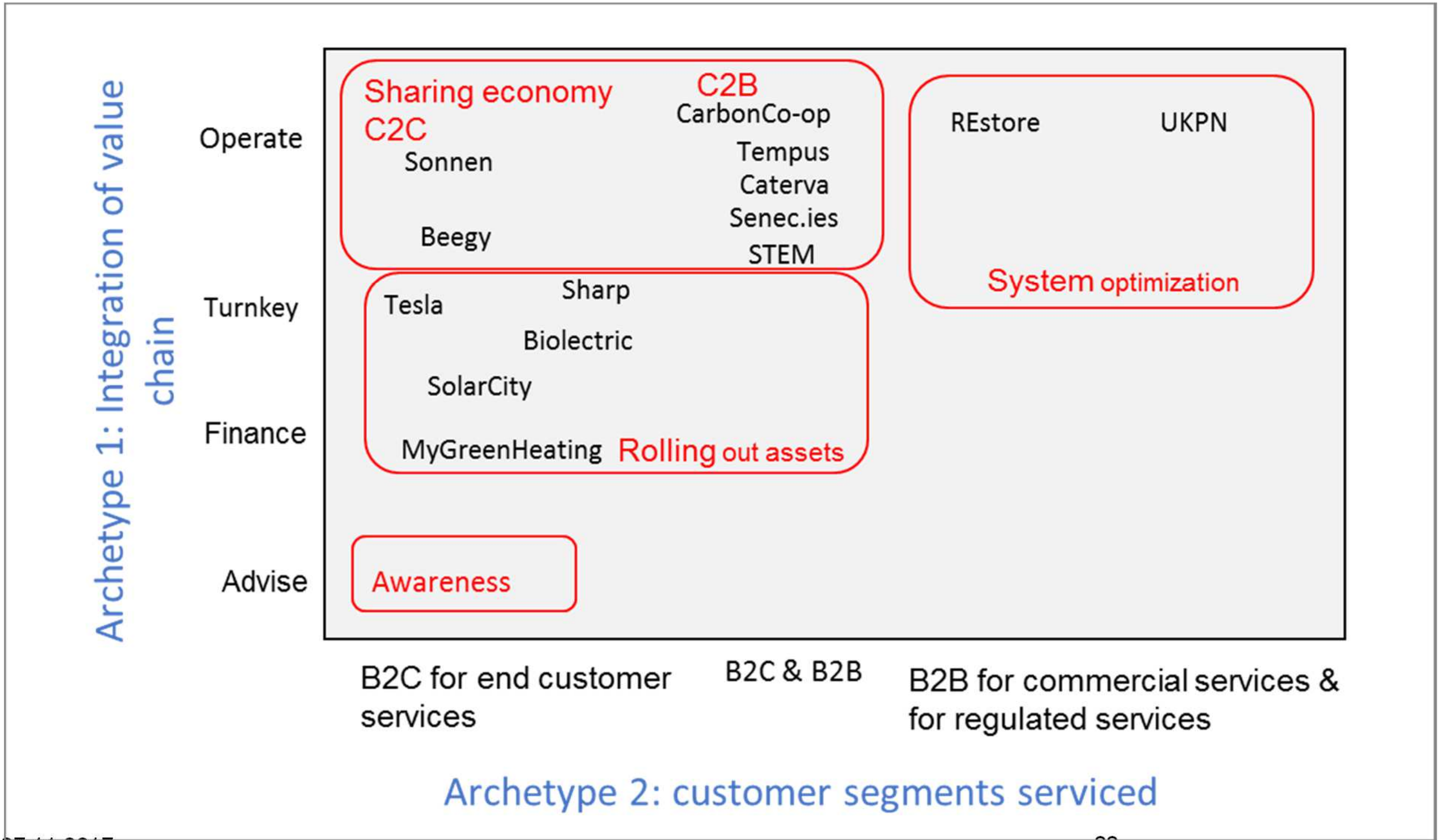
Mapping business model archetypes



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Demonstration of storage in factory (Spain)

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Located in Marcilla, Navarra (Spain)

Company **EXKAL S.A**, with technical advice from **GREEN RENOVABLES, S.A**

Manufacturer of refrigerated cabinets

Current situation

- Peak demand: 200-250 kW
- Demand charge: 260-270 kW
- PV system: 113 kWp

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Demonstration of storage in factory (Spain)

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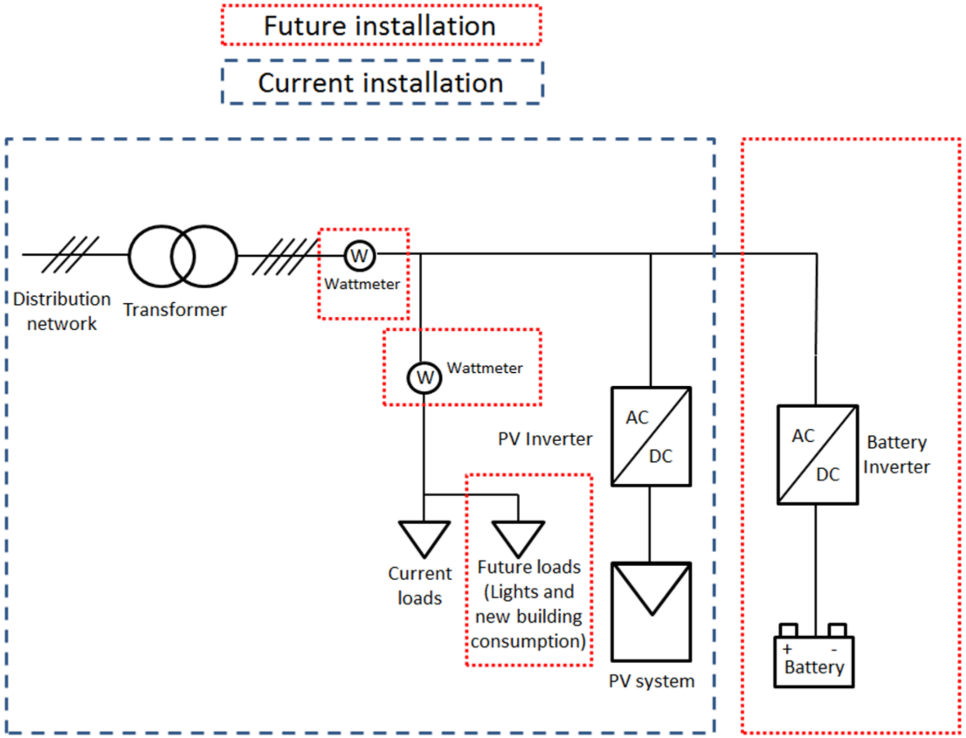
Proposed solution: microgrid



- **TARGET:** reduction of demand charge (peak shaving)
- **SOLUTION:** integration of energy storage system and efficient management
- **TECHNOLOGY:** Li-ion battery 50 kW/200 kWh (60 kVA with overload capacity)

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Demonstration of storage in factory (Spain)

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Demonstration of storage in factory (Spain)

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Energy management strategies

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Basic energy management strategy

The original target application was focused on a **peak shaving** approach according to a pre-calculated threshold to reduce the demand charge

Now, the consumption of the factory has decreased due to a restructuring

Hence, the threshold has been moved down and the strategy is also focused on reducing the energy charge

Valley period: **charge battery = PV generation**

Peak period: **constant battery discharge**

Battery charging from the grid is forbidden

Delivering PV generation to the grid is forbidden

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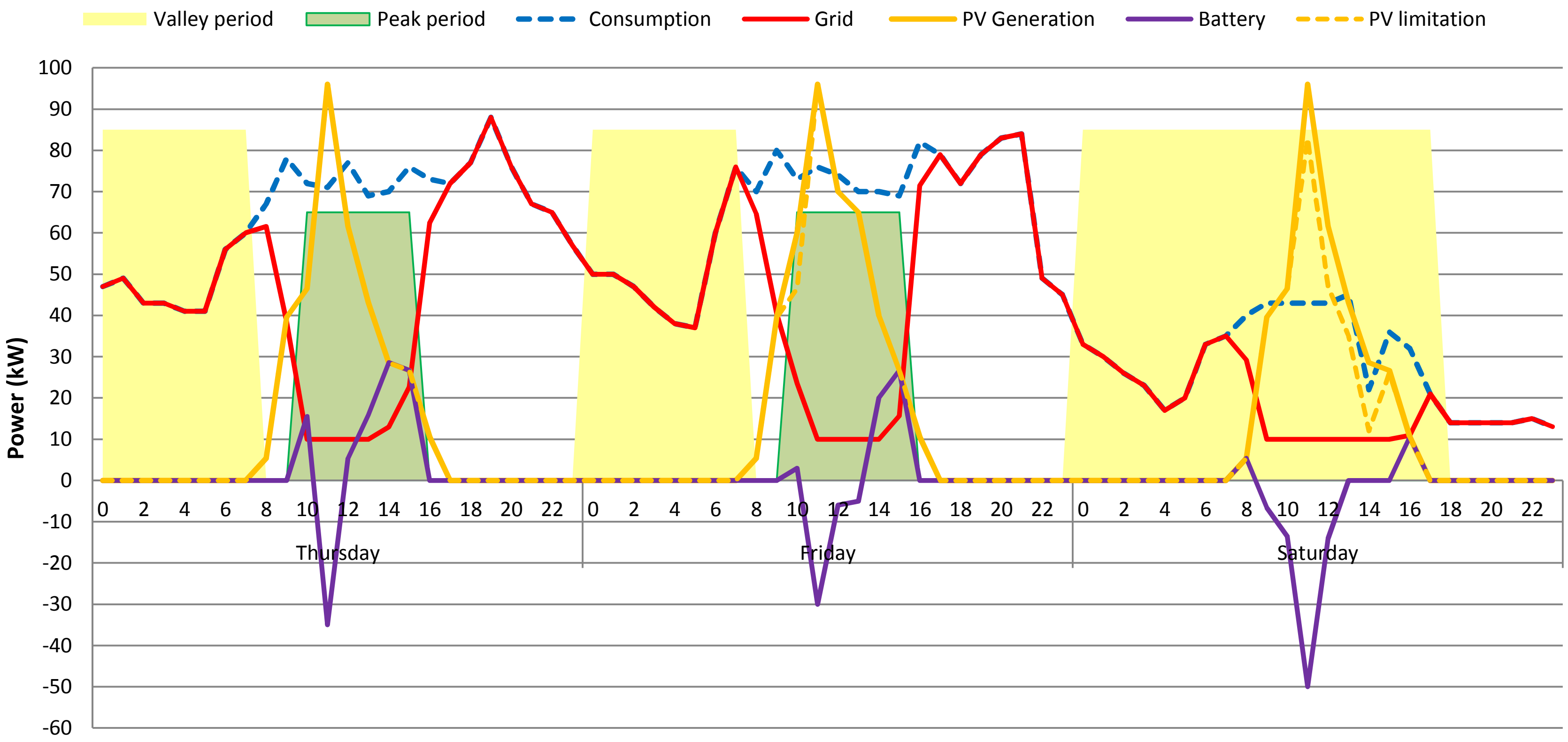
Energy management strategies

Basic energy management strategy



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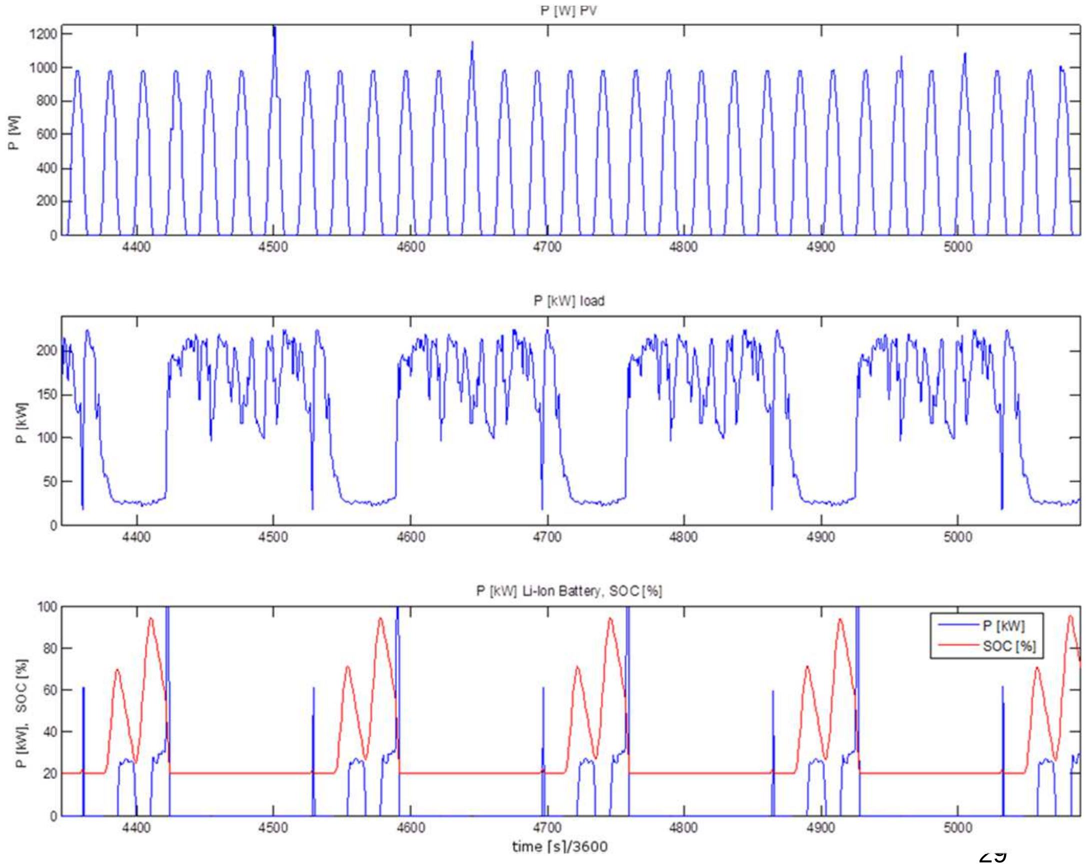
Case studies results

Case Study I

- The battery is fully charged during weekend and mostly discharged on Monday



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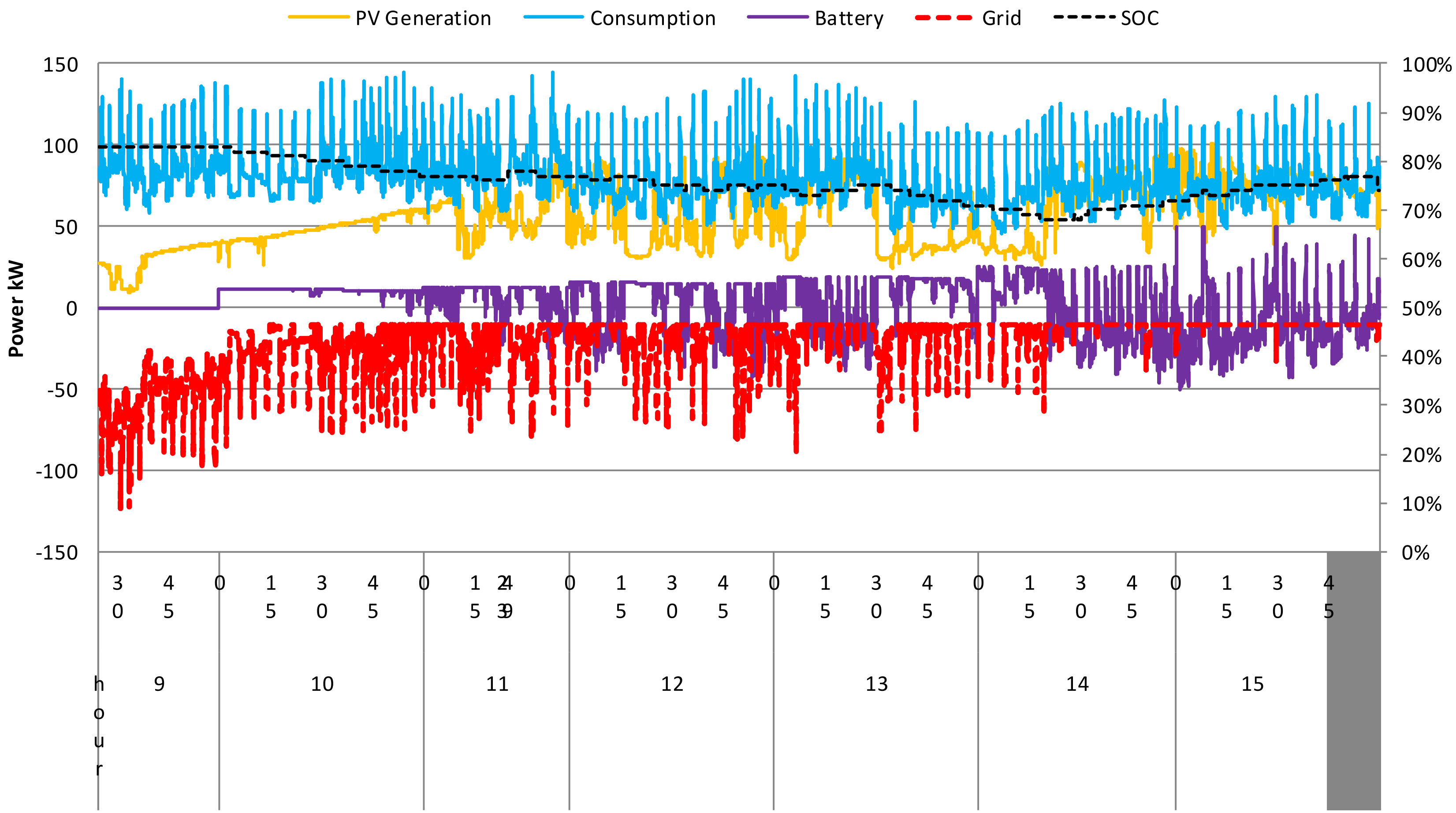
Case study in Spain



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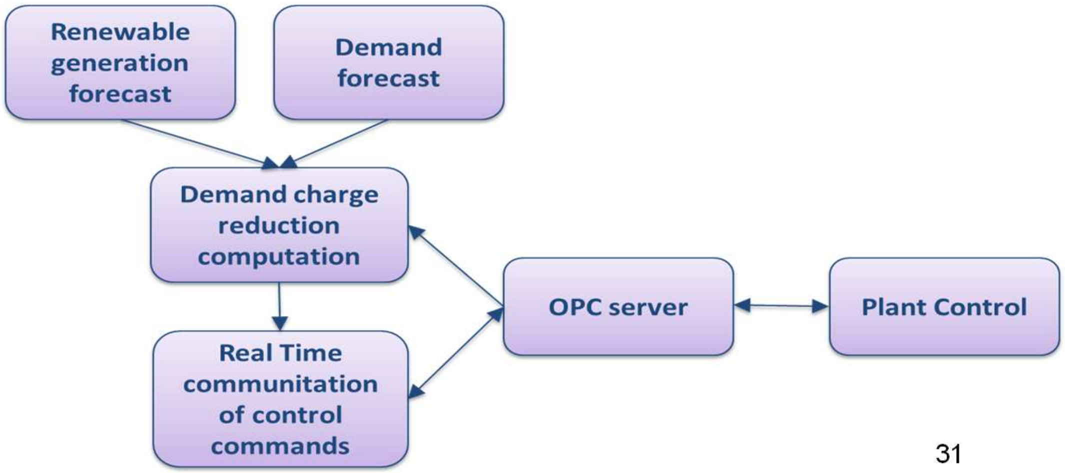
Energy management strategies

Advanced energy management strategy

- Operational data to perform the computations:
  - Generation forecast: global irradiance and ambient temperature extracted from CENER meteorological services (SKIRON)
  - Demand forecast: an Artificial Neuronal Network (ANN) is trained with the daily temperature in the location and the hourly load demand data of the factory to predict the hourly load profile of the plant. Demand Profile Prediction Module (DPPM)
  - Demand charge reduction: iterative calculation to determine the power threshold over which the batteries should work. Demand Charge Reduction Computation Module (DCRCM)
  - Control data delivery in real time: active power and SOC of the subsystems of the plant



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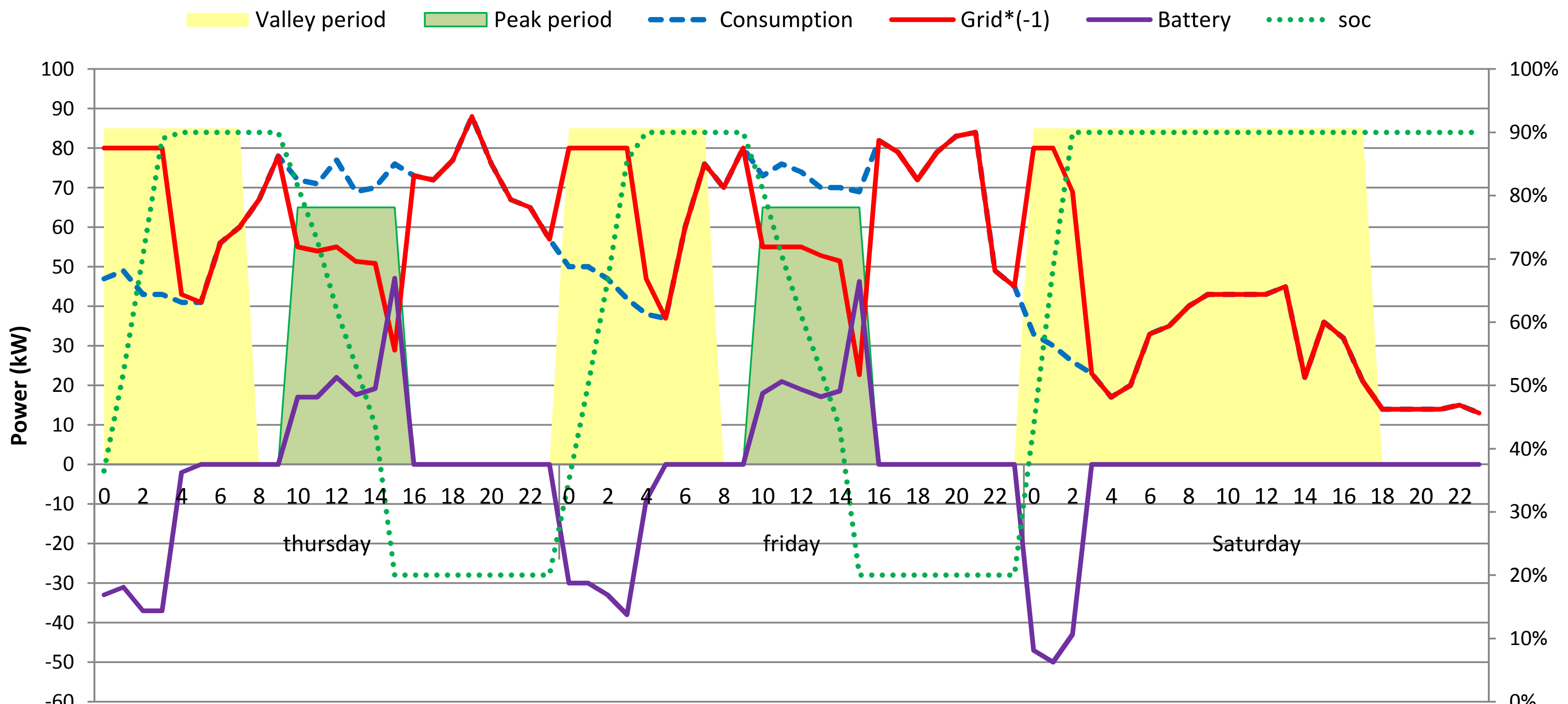
Energy management strategies

Advanced energy management strategy

- The battery can charge energy from the grid depending on the tariffs
- Delivery of energy excess to the grid is not allowed



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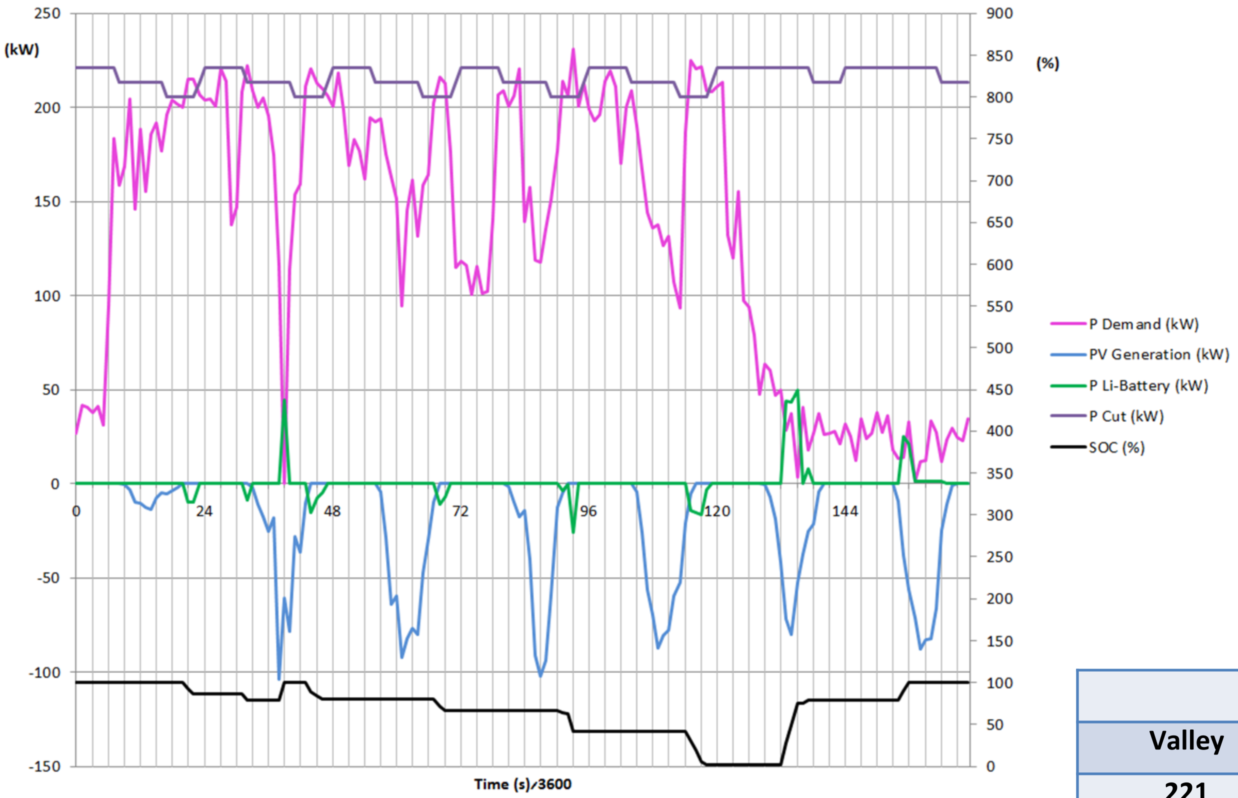
Case studies results

Case Study II.1

- Three working shifts



P Cut (kW)		
Valley	Flat	Peak
221	213	205

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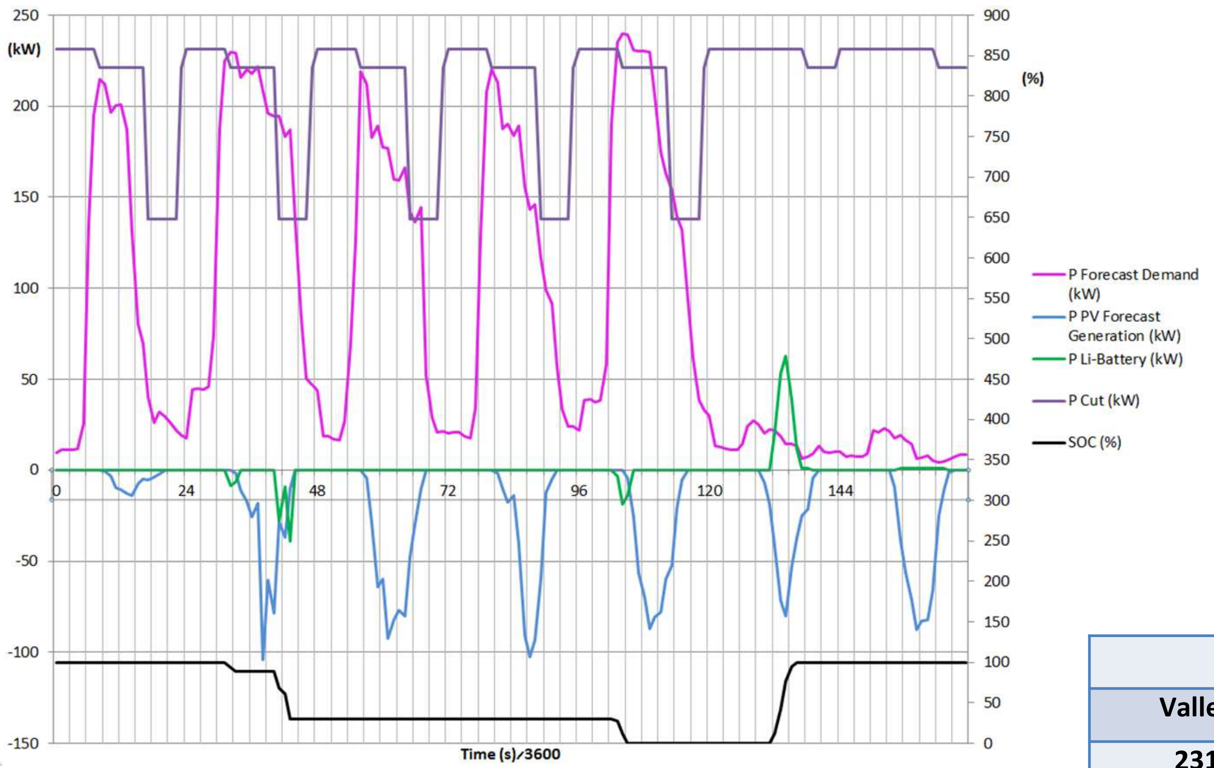
Project STORY - H2020-LCE-2014-3

Case studies results

Case Study II.2

- Two working shifts



P Cut (kW)		
Valley	Flat	Peak
231	221	138

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Impact creation

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- Proposing **policy and regulatory recommendations** that allow implementation of innovative technical solutions and business models for deployment of storage at local level
- Impact created by **involving full value chain of technology providers**: end users, investors, ICT and storage technology providers, as well as the Distribution System Operators (DSO)

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Impact creation

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Impact creation

STORY

Watch our movies:

1) What STORY is about

2) Case study Beneens

….and more to come.

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Impact creation

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