eLUX UniBS

Energy Laboratory as University eXpo

Mission and Vision

eLUX operates in the framework of low carbon economy and devotes its research activities to manage energy system and to develop facilities for energy management system, use of renewable energies, innovative technologies, and energy efficiency.

eLUX is a place where **companies**, **researchers** and **students** can share their specific skills and it can provide tailored services to all users.

eLUX is a lab working in the following areas:

- **Smart Grid and Smart Living**
- **Energy Efficiency and Renewable Resources**
- **Energy Economics**
- **Data management and privacy**
- **Building O&M management**

Multidisciplinary activities

A multidisciplinary research team

- Different expertise:
  - Electrical and Electronic Engineering
  - Information Engineering
  - Mechanical (Energy) Engineering
  - Energy economics
  - Data Protection and Privacy
  - Architectonics and Civil Engineering

- Some Numbers:
  - 2 Full professors
  - 4 Associate professors
  - 2 Researchers
  - 2 Post-doc

A lab opens to students

- Students are actively involved in the lab at different levels:
  - Lectures, classes projects, thesis, ..

- The students have access to the facilities of the lab during their activities
  - PV plants, storage system, grid emulator, ...

- Students currently working in the lab:
  - Bachelor Thesis: 4
  - Master Thesis: 2
  - Research Grants: 4
  - Ph.D. Student: 1

- No Erasmus students are currently involved, but they are welcome!
  - Our lab is young and it needs to grow!

On-going research projects

Smart Campus as Urban Open Labs

- Smart campus project, focusing on the energy management

Brescia Smart Living

- Smart cities and communities research project, focusing on the integration of systems for asset management

SAndroidE

- Integration of sensors in Android framework for IoT

Virtual-e Gateway

- Research project about Cognitive Building and integration of IoT sensors with machine learning for energy efficiency

The research activities of eLUX

Smart Campus

Living-Lab

Cognitive Building

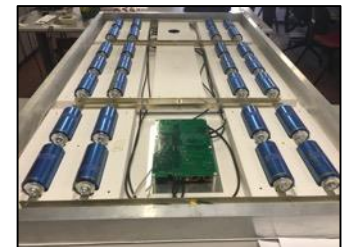
Smart Electric Vehicle

Distributed Sensing

Solar Test Facility

Solar Modeling

Smart-PV Module

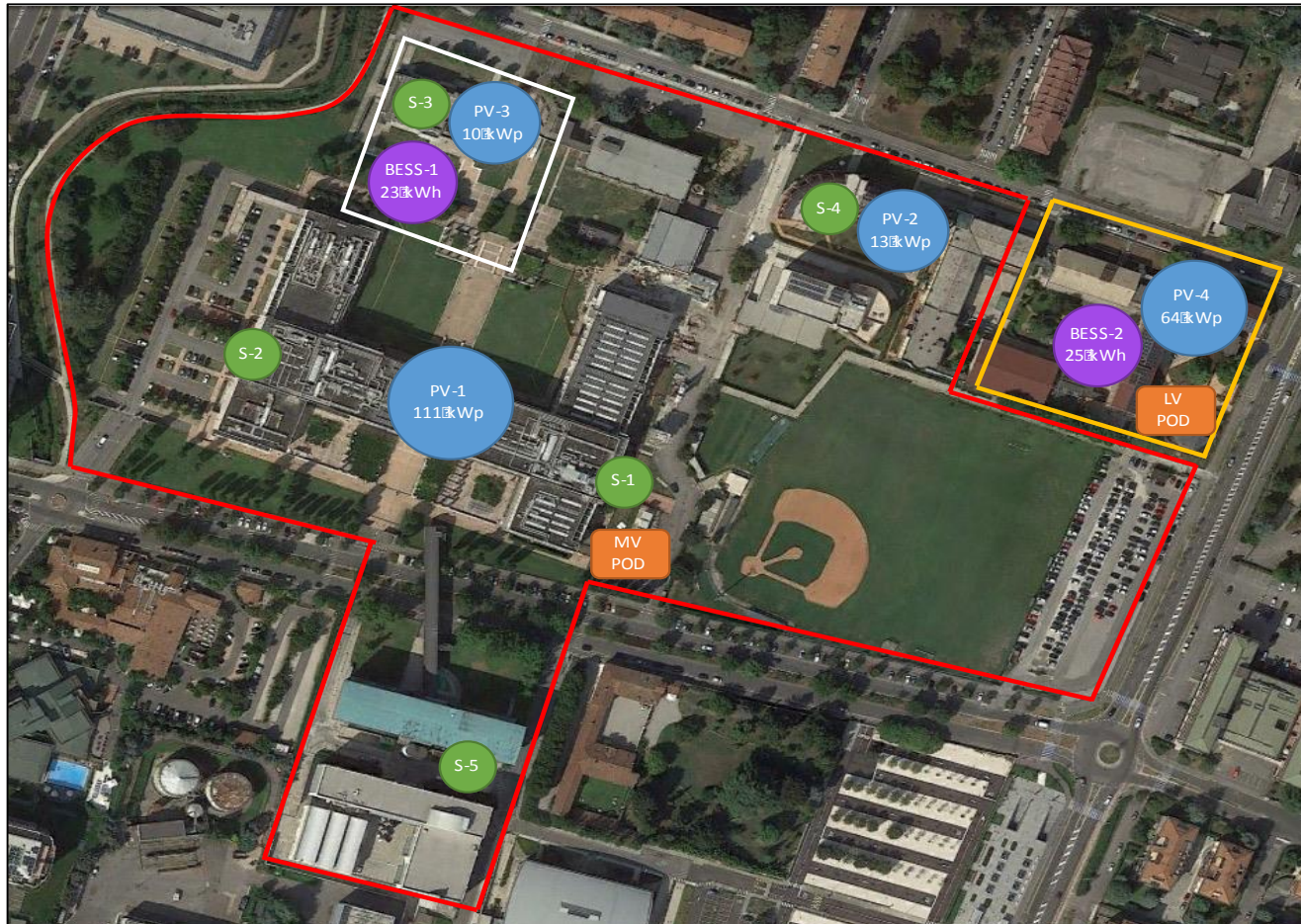Energy Storage

Smart Controllers

Smart-Grids

Virtual Lab

The area of the campus

Smart Campus: eLUX

- **Communication system** for the monitoring, the management and the automation of the grid of the campus;

- Sensors for the evaluation of **power consumption and quality of the electricity** in the grid of the Campus;

- Monitoring and control of **e-vehicles recharging**;

- **Monitoring and control** of **photovoltaic plants** and **electric storages** installed in the Campus;

- **Energy Management System** for the optimization of energy flows (loads and generators) and application of **demand/response** with Distribution System Operator (DSO);

- Communication system and **remote control operated by DSO** of generators and storage systems for testing **grid services.**

Living-Lab & Cognitive Building

- Analysis and application of innovative technologies for the **management and energy optimization of a building of the Campus** by means of the prediction and the scheduling of the thermal and electrical plants;

- Installation of **advanced sensors** and **wireless sensors networks** for **indoor environmental monitoring** (user presence, quality of the air, illumination);

- Development of **Smartphone apps for the interaction among users and the building**, to optimize the behavior of the plants;

- Testing new technologies for **Building Information Modeling** and **IoT system**

Smart Electric Vehicle

- **Recharging station (44 kW)** with 2 recharging points and **Wi-Fi connection**;

- **Electric-Vehicle (Renault Zoe):** 22 kWh Li-Ion battery, 220 km range, maximum recharging power 44 kW;

- **Monitoring and control** system of the **charging station** considering the production and the overall power consumption in the Campus;

- **Control algorithms of the recharging power**;

- **Real-Time Measurement** of the performance of the electrical vehicle and of the **charging efficiency**;

- Design of **app for smartphone** for the interaction among the users and the charging station.

Distributed Sensing
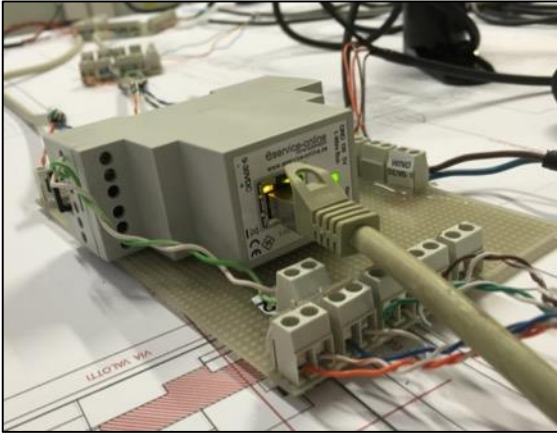
Deployment of a **distributed sensors network** into the buildings for the monitoring of the following parameters:

- Parameters related to the **operation of the plants** (photovoltaic plants, electric storage plants, thermal and electric plants);

- **Weather parameters**: Solar Irradiance, wind speed and direction, temperature, relative humidity, UV index, atmospheric pressure and rainfall;

- **Quality of the air in the building**: temperature, relative humidity, CO_2, volatile organic compounds;

- Measurement of **power quality and energy consumption** (active and reactive power, total harmonic distortions, etc ..) in different section of the grid of the Campus.

Solar Test Facility & Modeling

Deployment of a **testing facility in operating conditions** for the characterization of photovoltaic and thermal modules:

- Measurement of **global solar irradiance** (horizontal and on the plane of the modules), direct and diffuse, **wind** speed and direction, **environment and modules temperature**;

- Measurement of **electrical** (MPP voltage and current) **and thermo-dynamical parameters** (temperature, fluid flow rate and pressure);

- Analysis and validation of **predictive models** of photovoltaic and thermal plants (partial shadings, mismatching, hot-spots, …);

- Analysis of advanced strategies for **management and optimization of solar plants** (thermal, photovoltaic and hybrid thermal-photovoltaic).

Smart-PV Module
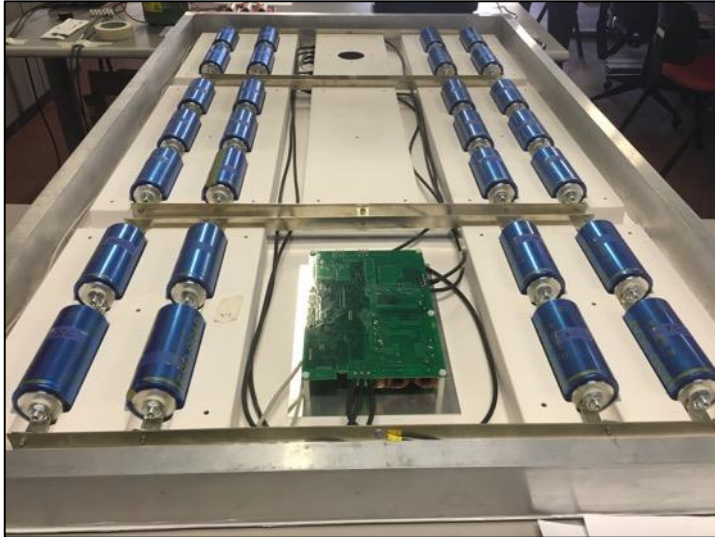
Prototype of Smart-PV Module

Details of power and data section

Design, realization and testing under operating conditions of an **electrical storage system integrated into photovoltaic modules** for Smart Grid applications:

Features:

- **Super-Caps storage** modules applicable to standard photovoltaic modules;
- Electronic control board for the **integrated management of photovoltaic and storage sections**;
- On-board measurement and **communication system** based on **Modbus RTU**.

Target and applications:

- **Management** of photovoltaic and storage power under the control of **inverter**;
- **Damping of daily power fluctuations** due to photovoltaic source.

Energy Storage

- Two **installed plants**: a **Li-Ion** (LiFePO$_4$, 25.2 kWh e 13.8 kWp) and a **Molten salt** (Na-NiCl$_2$, 23 kWh e 20 kWp), **connected** in alternating current to **photovoltaic plants** in parallel to the distribution grid;

- Testing different **control logics**: in **real-time** or scheduled, depending on consumption and generation predictions (**EMS**);

- **Measurement of the performance** (charge and discharge curves), conversion efficiency analysis, technical-economics analysis and **comparison of different storage technologies**;

- Analysis of advanced strategies for the management and **optimization of charge and discharge cycles**;

- Deployment of a **remote control system** to testing **grid service for the DSO**.

Smart Controllers & Smart Grids

- Development and testing of **controller for management of power generation and controllable loads**;

- Development of devices and system for the acquisition and the **monitoring of distributed sensors** for Smart Grid and Building Automation;

- Analysis of devices and strategies for the control of **Virtual Power Plant** for Micro-Grid and Smart-Grid;

- Development and testing of devices and control architecture for the **integration of distributed energy resources in Smart-Grid** and grid service.

Virtual Lab
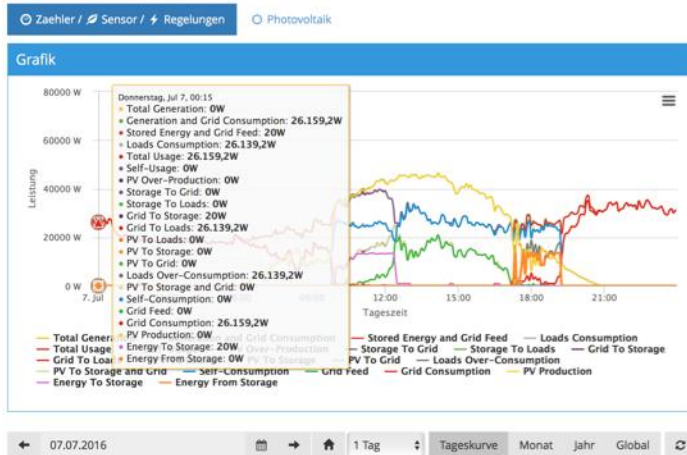
- Development and testing of a **centralized system for the monitoring and the analysis** of the performance of electric plants of the Campus (generators, storage and loads);

- Development of a **Energy Information Systems** for the collection of measurement data from the field;

- Visualization of the results of the experiment to **educate the students to a sustainable use of the buildings and of the plants** of the Campus;

- **Virtualization of the plants**, controller and sensors in simulation environment **for the development of models for Smart-Grid**;

- Testing measurement devices, controllers and algorithms in **hybrid emulation environment (OPAL-RT eMEGAsim)**.
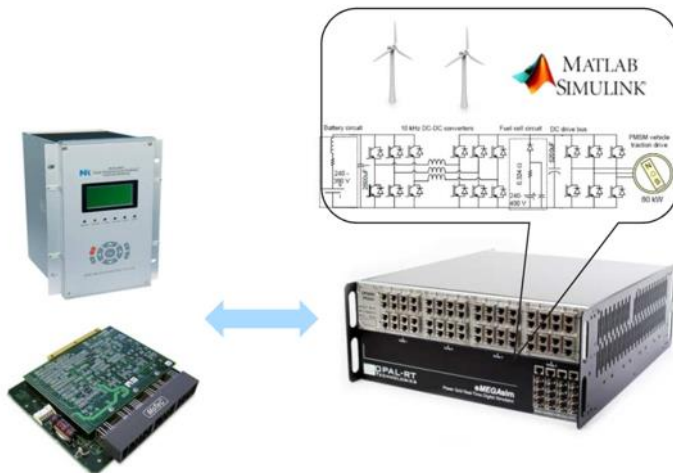
Thank you for your attention!

Any questions?

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