PV-wind-powered nanogrid set-up for research and training

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INTRODUCTION

Nanogrids are raising more and more interest in the scenario of the ongoing energy transition, several believe that the deployment of small, smart and fully controllable energy systems is the first step to achieve a smarter electrical system on the large scale.

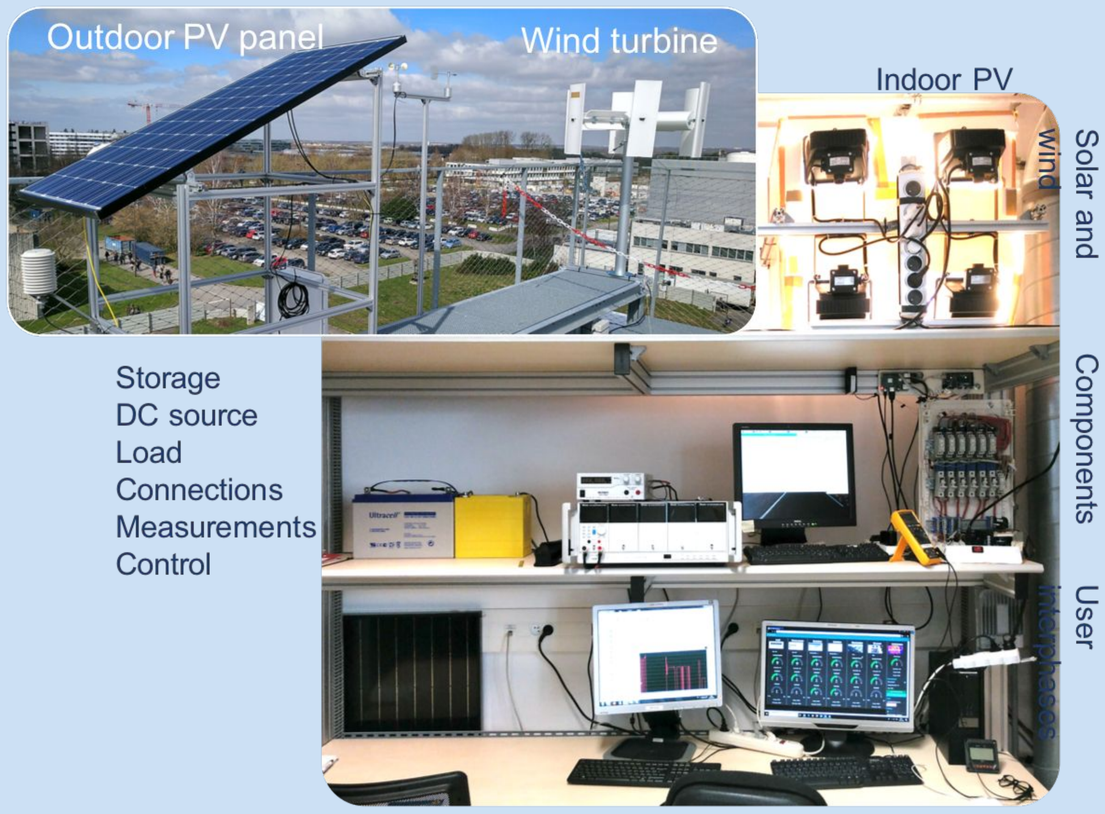
The implementation of several renewable sources (PV and wind) at the same time and the coexistence of two different storage systems (lead-acid and lithium ion batteries) in the same system could result in operation control difficulties and management issues.

The aim of the project is to develop a DC nanogrid for research and teaching purposes. The system can be useful to study the energetic and electrical behavior in operation and understand how the system should be managed in order to achieve the optimal result.

SETUP DESCRIPTION – METHODOLOGY

The Nanogrid is a 12V DC off-grid system.
It has three main category of elements:

- Generation: elements that feed energy in the system
  - Vertical axis wind turbine (500 W)
  - Two photovoltaic panel (inside 50 W, outside 230W)
  - Laboratory electric power supplier (900 W)
- Storage: elements that are able to store energy
  - Lead-acid battery (100 Ah)
  - Lithium ion battery (40 Ah)
- Consumer: element that withdraw energy from the system
  - DC electronic load (300 W)



Ancillary elements:

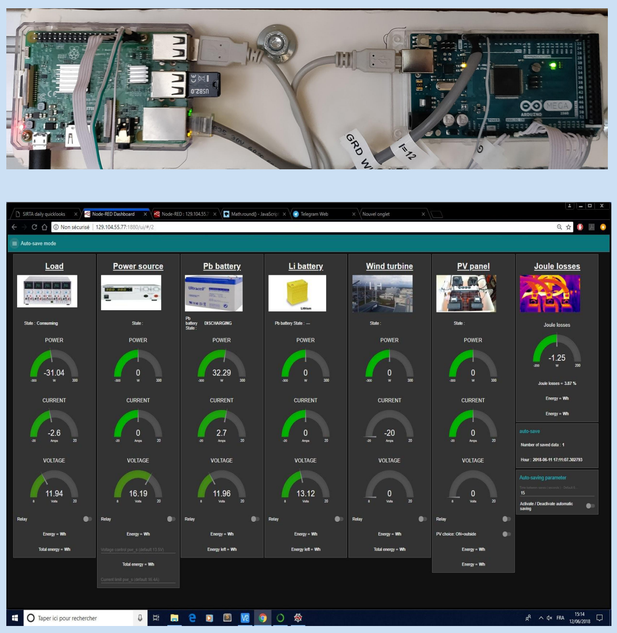
- Current and voltage sensors
- Relay
- Alimentator

Hardware elements:

- Arduino Mega: data gathering
- RaspberryPi: data manipulation (softwares: Python and Node-Red)

Functionalities:

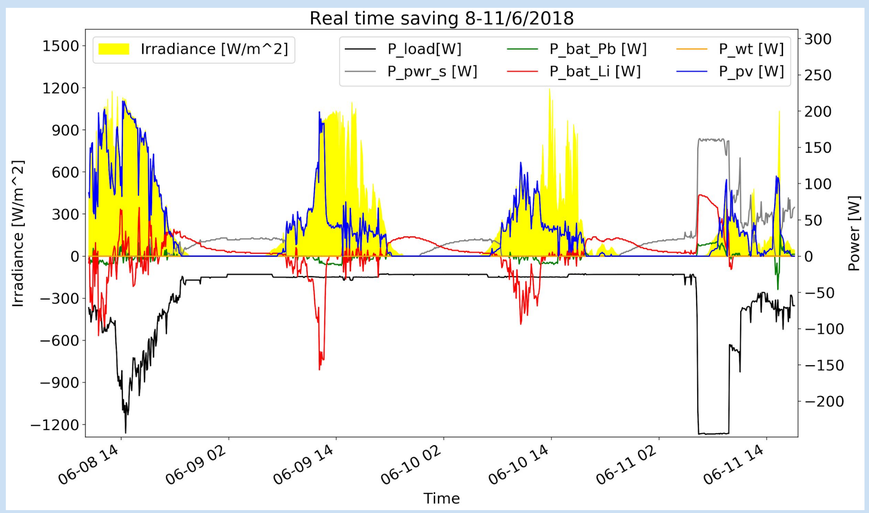
- Live measurement web page interface
- Automatic real time data saving
- Accelerated grid test



RESULT – DISCUSSION – CONCLUSION

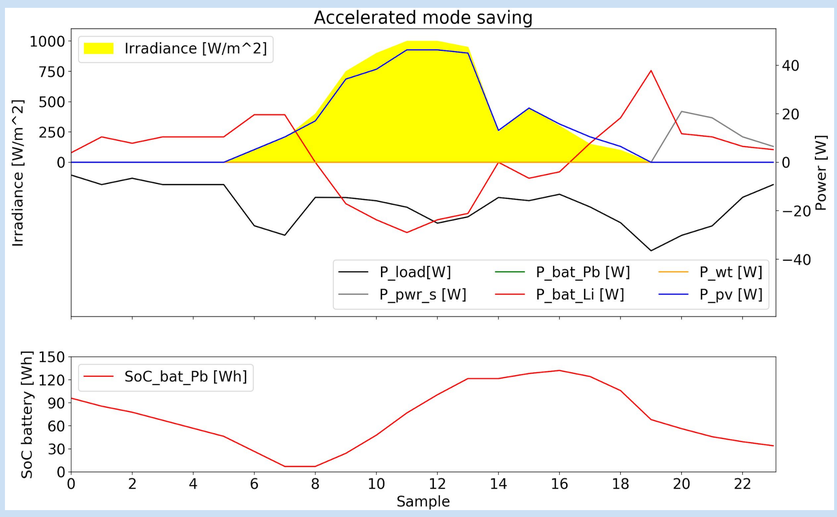
Automatic real time data saving:

- Saving of all the components electrical behaviour with 15 second time-step (graph resolution 5 min).
- Validation of the measurement elements: power consistency and similar behaviour of the PV power and the irradiance.
- Detection of the not used PV production.



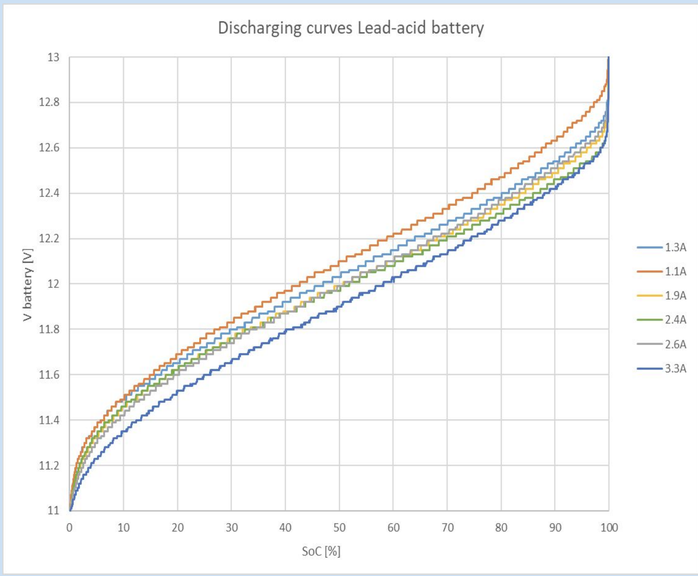
Accelerated grid test:

- Ability to perform an accelerated simulation providing load and irradiance profile, in this case the PV panel is illuminated by a set of halogen lamps.
- Evaluation of the State of Charge (SoC) of the used battery during the analyzed period.
- Possibility to test EMS algorithms.



Lead-acid battery State of Charge (SoC) detection method:

Development of a SoC model for the calculation of the state of the batteries utilizing measured battery discharging curves for different values of discharging current



REMERCIEMENTS

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