PV-powered Nanogrid hardware & software development for academic experimentation

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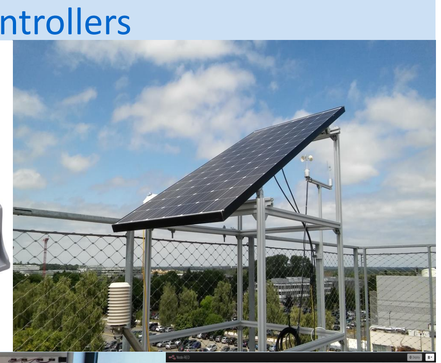
OBJECTIVES

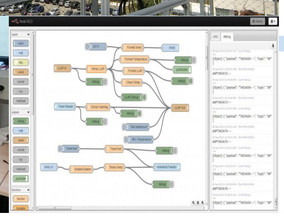
- To study small-scale low-voltage DC power systems
- Develop a hardware that allows to test basic energy management algorithms in a PV powered nanogrid
- To have a system for teaching experimentation in smart grids, small scale DC power systems and renewable energies
- To record real time data of the electrical behavior of this type of systems that can serve for further research

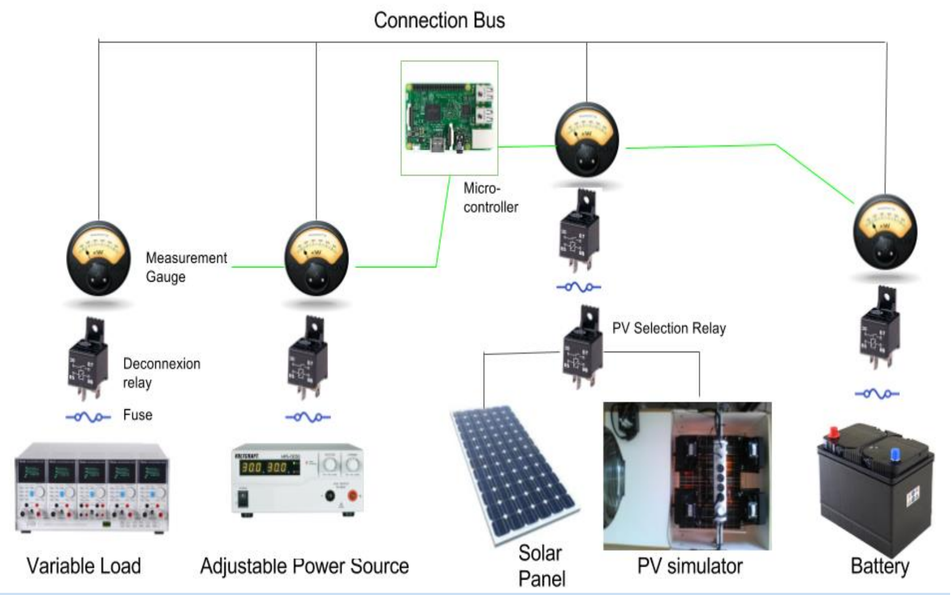
The system is intended to be a starting point for further developments of the hardware & software to include other renewable sources, alternative storage means as well as meteorological information to support the energy management of the system

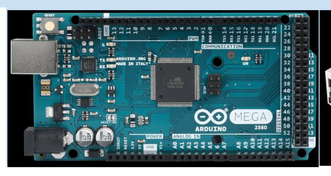
INSTRUMENTAL SETUP

- 240 W HIT Solar panel
- 50 W Solar simulator
- 2kW electronic variable load
- 100 Ah lead-acid deep-cycle Battery
- RaspberryPi + Arduino microcontrollers





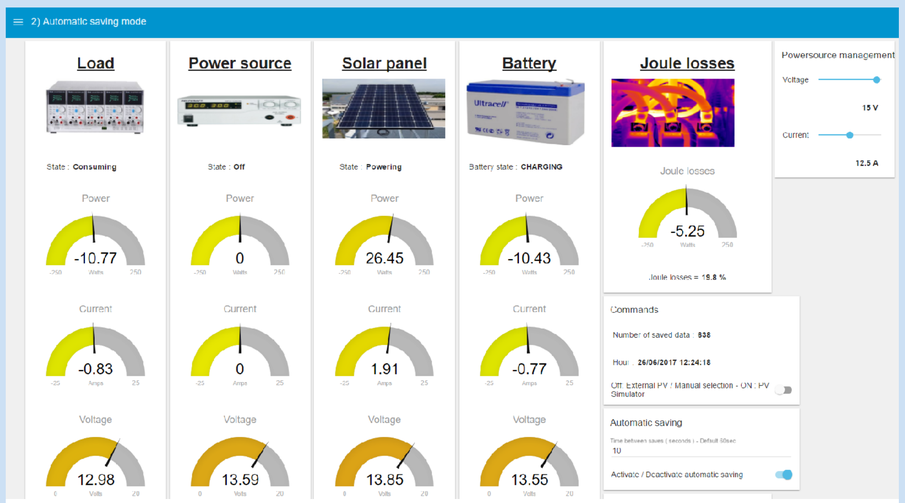
SYSTEM OUTCOMES

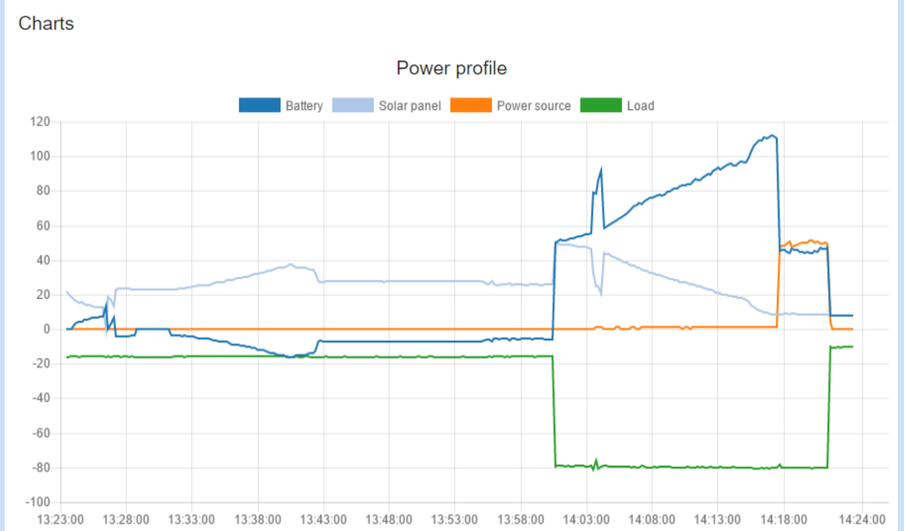
Measurements

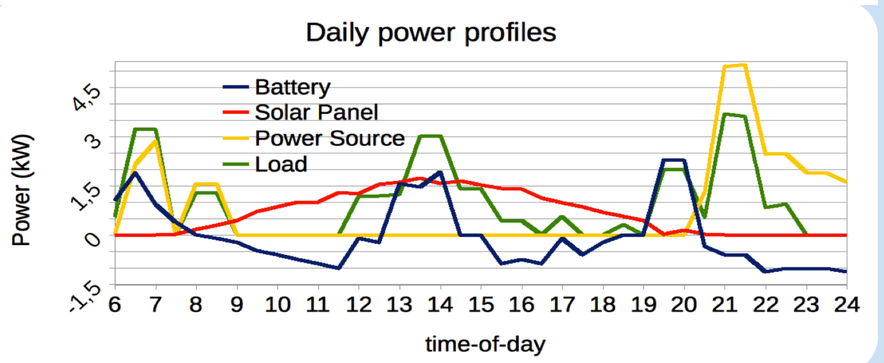
- Current, voltage, power and cumulated energy of each element
- Joule losses of the system
- Irradiance & panel temperature in PV simulator mode
- Date & time and recorded data counter

Functionalities

- Real-time power & cumulated energy graphs for all the elements
- Visual indications regarding the sense of the power flow for each element
- Remote voltage and current limit control of the power source
- Manual connection/deconection of each element of the system
- Automatic deconnection of the elements if voltage/power limits are surpassed. The system warns the user before deconnection (limit values can be user defined).
- Manual and Remote selection between external PV panel or PV simulator
- Two modes for irradiance input in simulation mode: manual and pre-loaded daily irradiance profile. Four diffferent 'type of days' can be chosen, which can be defined by the user







- Creation of excel file in simulation mode with the recorded data (V,I,P,E), power & energy graphs and performance parameters. The file is send by mail automatically to the user at the end of the simulation cycle
- User-defined simulated battery size and initial state of charge. View of the current state of charge.
- Possibility of user-defined power scale factor to simulate bigger PV arrays in simulation mode

Small scale DC power systems

- The equilibrium point between demand and consumption is always passively assured by the system as long as there is enough production to satisfy the demand
- If the system cannot supply the demand required, the voltage of the system drops until finding the balance point. If this point is not found, the system will 'collapse'
- Voltage is the agent that controls the flow of power between the elements. Voltage control of the elements is mandatory if manipulation of the flow of power in the system is required

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