

SITE INSTRUMENTAL DE RECHERCHE PAR TÉLÉDÉTECTION ATMOSPHÉRIQUE

# **NRLAB: Laboratory scale nano-grid powered by**

## renewable sources of energy with battery storage

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## **INTRODUCTION - OBJECTIVES**

In the future decentralized, decarbonized and digitalised energy world, the importance and the usage of nano-grids are going to increase exponentially.

Renewable sources of energy, together with battery storage solutions, will make the nano-grids available at a large scale. In order to have accurate results at a laboratory-scale, data acquisition process from the grid's elements has to be precise and robust.

The objective of this work is to implement a new measurement collection process to the 12V DC nano-grid, part of the NRLAB (Nano-grid) Research Laboratory). The actual system of data acquisition, compound of an Arduino Mega + Raspberry Pi has limitations in terms of accuracy. The new DAQ system offers also the posibility of PWM control of the power source, which is a future objective of the NRLAB.

## **NRLAB SETUP DESCRIPTION**

The 12V DC nano-grid is an off-grid system with 3 main types of elements:

- **Generation**:
  - Photo-voltaic panels: 1 panels of 240W
  - Laboratory programmable power source  $\rightarrow$  960 W
- **Storage:** 
  - Lead acid battery: 1 battery of 26 Ah
- **Consumption** consumption profile is generated by the energy demand of one of the buildings from the • École polytechnique's campus, at 1% scale
  - DC Electronic load  $\rightarrow$  300 W



### **RESULTS – DISCUSSION**

2 systems of automatic data saving:

Arduino Mega + Raspberry-Pi



The new measurement system is compound of:

- **Campbell Scientific CR1000X Data Logger**
- **Voltage and current sensors**
- LoggerNet software





Analysis of the measurement process for the 'total power of the system': the sum of the powers of every element – load, Pb battery, power source, PV panel





Standard deviation of the 1 minute step change resolution		
	Arduino Mega + Raspberry Pi	CR1000X
Total power of the system [W]	1,44 [W]	1,19 [W]

#### **Campbell Scientific Data Logger (CR1000X)**



Validation of the measurements from the 2 systems:

- Similar behaviour and values consistency of the power profile of every element
- In order to asses the stability of the measurements, standard deviation of 1 minute step change was chosen. In this way, the fluctuating behaviour (day and night consumption profile) is going to have less impact in the evaluation of the measurement process. All the power metrics assessed, except the power of the Pb battery, show a better standard deviation from CR1000X in comparison with the old measurement system.
- Changing to Campbell Scientific Data Logger is definitely a step foward into this project because in order to have an efficient energy management system, a high quality data collection process has to be in place.

#### **Energy balance of the 12V DC off-grid system during the analyzed period**

Load : -45697 Wh Potential PV : 69554 Wh Battery Pb: -1891 Wh Source : 10881 Wh

73% of the energy consumption was feed by the solar panel, while only 27% was feed by the power source, which plays the role of the national grid. Given the PV potential available, which is 146% of the total energy demand, with a higher capacity battery, our system could have easily satisfied its own demand and also act as an energy supplier for other systems.

LOAD.

#### **Future perspectives**

The NRLAB system is going to be upgraded:

- Transformation to 24V DC
- Integration of the wind turbine as an active element, adding another PV panel and changing the DC Load and the power source
- Implementation of an Energy Management System

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