SIRFN Capability Summary
MINES ParisTech, Centre for Energy and Processes

Introduction

The Center of Energy & Processes develops R&D on **renewable energies (RES) and DER integration** into power systems and on smartgrids. The activities in this area cover three axes :

- Short-term forecasting of RES generation (wind, photovoltaic)
- Hybrid systems: dimensioning, design, and optimal operation.
- Smartgrids: modelling/simulation, management and planning.

These research activities are supported by a laboratory facility, the **CEP-microgrid**, which is located at MINES ParisTech at Sophia Antipolis campus. It is a Low Voltage AC microgrid (230 Volts) that can operate in both isolated and grid-connected mode. This laboratory facility is an AC coupled hybrid system, where all sources, storage units and loads are connected in parallel to the microgrid.

The main objective of the facility is to permit experimentation and study of Renewable Energy and Distributed Sources integration aspects at a microgrid scale.

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SIRFN Subtask 2.1

Renewable Energy and DER Integration

Desired Level of SIRFN Participation: 3

Description of Activities

The CEP has participated in numerous RD&D projects in the last 20 years on RES and DER integration including More-Care, Dispower, Anemos.plus, SafeWind and other projects. The experimental microgrid supports research activities in CEP that relate to RES and DER integration in isolated or connected networks. The focus is on aspects like:

- Evaluation of the various components performance and reliability with focus on PV panels.
- Monitoring and study of the behavior of a multi-energy system at different time scales (transients up to days ahead).
- Evaluation of different strategies for the management and operation of storage devices taking into account uncertainties in the renewable units output and load flexibilities.
- Dimensioning of storage device capacity to achieve a specific level of controllability of the coupled RES/storage output.
- Evaluation of different operation strategies for hybrid systems feeding isolated loads.

The network is fully configurable to simulate a comprehensive range of real-world situations and a different mix of renewable resources , storage, microsources and loads.

The test bench is also used for training purposes

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SIRFN Subtask 2.4

Microgrids

Desired Level of SIRFN Participation: 3

- 1 = Low 2 = Med 3 = High

Description of Activities

The CEP participated in the last 10 years in some of the main EU projects in the field of microgrids like the Microgrids (FP5) and the More-Microgrids (FP6) projects. Today it participates in the GRID4EU (FP7) demonstration project and the linked NICE GRID national project, that test microgrid concepts at large scale. The CEP-microgrid test bench aims at supporting R&D activities such as:

•Testing of centralized (and decentralized as a perspective) controls of DER in grid-tied or autonomous mode.

•Evaluation of the performance of different forecasting agents for RES generation and demand ranging from simple plug&play to more advanced ones.

•Detailed monitoring and performance evaluation of the microgrids operation under high RES penetration conditions.

•Pre-deployment testing of software prototypes before application to real world environment in the frame of demonstration project.

•Training (Masters, PhDs etc).

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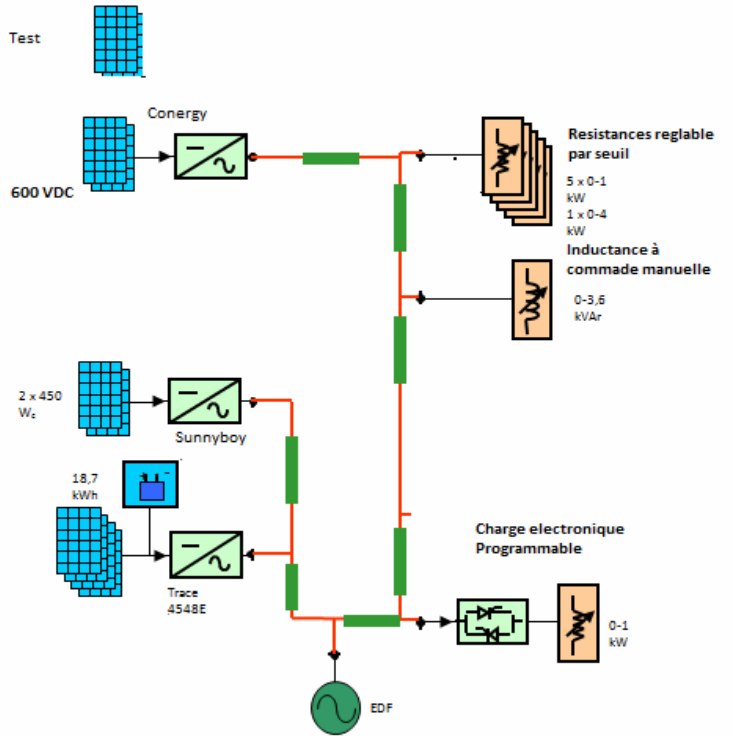

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Summary of Capabilities for Simulation and Testing

AC and DC sources:

- A Diesel Generator GENELEC: single phase, 3000 rpm, 4.5 KVA
- PV systems: 1) 3.4 KWp of multi-crystalline modules (Photowatt PW1000) connected with two PV inverters of 1.7 KVA each (projected renewal of panels in 2013)
- A 4.5 kVA programmable source CHROMA. This device can be configured to simulate different types of Distributed Energy Resources (DER)

Loads:

- A programmable load CHROMA: electronic load for the simulation of AC loads (resistive, inductive and capacitive) up to 4.5 KVA.
- A resistive load of 3.8 kW based on a set of light bulbs in parallel.

Storage:

- A storage system composed of 24 lead acid batteries of 400 Ah nominal capacity each. Those are connected in series (48 Volts DC) to provide a total capacity of 19.2 kWh. Those are connected to the microgrid through a bi-directional battery inverter of 4.5 KVA.

Other equipment:

- A meteorological station DAVIS to measure solar radiation (global horizontal), wind speed and direction, temperature, atmospheric pressure and others.
- Two pyranometers to measure solar global radiation in a 45° plane, which is the plane of the Photowatt PV system, in order to study the performance of that system.

Test Configurations:

- The sources and the loads can be activated independently without grid constraints
- Each unit can be controlled though fixed schedules or with purpose built control algorithm
- The state of each system connected and its output are monitored and logged

Summary of Capabilities for Data Acquisition and Analysis

Data Acquisition:

- A data acquisition unit (Agilent) taking measurements with a 1 Hz frequency in order to make possible supervisory control and energy management.
- An oscilloscope to measure dynamic variables in AC and to perform power quality evaluations.
- A software (HP VEE) for real time monitoring, live command and the execution of predefined command lists or decisions coming from the energy management system (implemented in Matlab). HP VEE also manages the storage of data.
- Human Machine Interfaces (HMIs): A touch screen is available for live command of the microgrid and a PC terminal is available for automatic command and monitoring.
- A remote control and monitoring system: MINES ParisTech communication network (LAN) makes it possible to monitor and control the microgrid as well as the meteorological data from any authorized PC in the campus.

Test Configurations:

- The sources and the loads can be activated independently without grid constraints
- Each unit can be controlled though fixed schedules or with purpose built control algorithm
- The state of each system connected and its output are monitored and logged