Densys Summer School

Application Session : Operational planning of microgrids

01/06/2021

LIÈGE université
Sciences Appliquées

Selmane Dakir | s.dakir@uliege.be

Description

- Design, simulate and compare the operation of a microgrid with the use of three controllers:
    - A idle controller
    - A rule-based controller
    - An optimization-based controller
- The microgrid is operated in grid-tied mode. It can purchase / sale energy from / to the grid.
- It consists of the following components:
    - A PV system
    - A Load
    - A lithium-ion battery

LIÈGE université
Sciences Appliquées

Microgrid bench

- Simulate an operation planning policy on real data
- New datasets can be easily integrated (timeseries.csv)
- Microgrid topology can be easily changed (data/data.json)
- Results are stored in the results folder (e.g. case1_out.json)
- Plots are automatically generated and can be regenerated from the results.

Device models

- Load: non_felxible_load + dishwasher + washing_dryer (timeseries)
- Non-steerable generation: pv_production (timeseries)
- Simple battery model: Limited capacity, max [dis]charge rates, [dis]charge efficiencies (.json file)
- Inputs:
  - “examples/data/application_data.json”
  - “examples/data/application_timeseries.csv”

Main requirements

- A Python 3.6 distribution
- Main libraries:
  - Numpy
  - Pandas: time-series management
  - Pyomo: mathematical programming
  - Matplotlib
- Install missing packages with « conda » or « pip» if needed.

1) Idle controller (Idle)

- The battery is not in use.
- The photovoltaic energy is consumed directly and the surplus is injected into the grid.
- Energy is imported from the grid when necessary.
- Used as a baseline for comparison with other controllers.

2) Rule-based controller (RBC)

- It stores in the battery as much as possible when the consumption exceeds generation, and discharges it as much as possible otherwise.
- It has no information on the future state of the microgrid. It only imposes actions for the current time-step.
- The goal is the maximization of self-consumption.
- You are asked to provide:
    - The logic used for the implementation of the controller (e.g. by using a process chart).
    - The implementation of the controller in the micro-grid benchmark tool.

3) Optimization-based controller (OPC)

- Using a mathematical programming formulation (Linear Programming), compute decisions with a rolling look-ahead horizon of 24 hours making a perfect information assumption.

- The goal is the minimization of the operational cost over the rolling horizon of 24 hours. You are asked to provide:

  - The optimization function and the constraints used.

  - The implementation of the problem in the microgrid benchmark using pyomo.

  - Comparison of the above operation policies (idle, rule-based, optimization-based) on the case provided, on period from 2018-01-01 to 2018-12-31

Application

- Complete the files:
  - microgrid/control/rule_based_controller.py
  - microgrid/control/optimization_based_controller.py
- Compare the above operation policies (idle, rule-based, optimization-based) on the case provided
- Period from 2018-01-01 to 2018-12-31
- Use a time step of 1 hour
- Total cost : Idle >> RBC > OPC