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**Bureau d'études 5 : Smart management of a micro-grid by numerical techniques**

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## 1 Introduction

The goal of this project is implementing a numerical technique for managing a micro-grid. The concept of a micro-grid is used here in the sense of “a local electrical grid with defined electrical boundaries acting as a single controllable entity” [1]. We suppose the micro-grid is connected to the national grid, so it is possible that they exchange energy, but the main goal of the project is devising strategies for minimizing their energy exchange. We consider the micro-grid has electrical energy production in the form of photovoltaics, so minimizing the energy-exchange with the national grid can be seen as a form of maximizing self-consumption (*autoconsommation*).

We suppose a micro-grid composed by around a dozen of houses (the number of houses is an adjustable parameter). The electrical energy consumption of each house can be divided in two parts:

- Fixed loads : loads for which the consumption profile can not be shifted in time as they are directly linked to the consumer demands. Examples: refrigerator (has to be on constantly), hair-dryer, air-conditioning. These loads follow the consumption profile of a typical house.
- Adjustable loads : loads whose energy profile can be shifted in time with no noticeable effect on consumer experience. The most significant example of this is an electrical water heater.

One can clearly see that the adjustable loads can be seen as a type of energy storage. Clearly, when energy is plentiful it can be stored as heat in the water. Later, when demanded the water will be available for consumption. A clear way of storing energy over time. This is the main mechanism envisioned for establishing balance between production and consumption on the micro-grid. It would also be interesting to consider the impact of adding additional storage in the form of batteries, but this will be considered a “future-target” to be pursued if time is available.

## 2 Hypothesis (summary)

- The micro-grid is connected to the national grid ;
- The objective of the numerical methods is maximizing self-consumption ;
- The micro-grid is composed by houses:
  - The consumption profile of each house has a fixed and an adjustable component ;
  - Some houses have photovoltaic production capability ;
- We will only deal with active power exchange in the grid ;
- The decision making will be centralised : and all information be available and all adjustable charges can be controlled remotely ;

### 3 Methods

In order to simulate the micro-grid, a simple power-flow model will be developed in C++ using object oriented techniques. Each proposed solution is defined by its adjustable load activation. Each solution will be tested in simulation and evaluated by its level of self-consumption. A numerical technique will be used to sort among the proposed solutions. Initially we think of using a variation of Monte-Carlo sampling or genetic optimisation, but the possibilities must be further explored.

### References

- [1] Wikipedia. *Microgrid* — *Wikipedia, The Free Encyclopedia*. <http://en.wikipedia.org/w/index.php?title=Microgrid&oldid=1213526887>. [Online; accessed 04-April-2024]. 2024.