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Deterministic and Stochastic Modeling of a Micro-Grid Management for Optimal Power Self-Consumption

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Abstract : Mafate is a natural circus in the north-western part of Reunion Island, without an electrical grid and road network. A micro-grid concept is being experimented in this area, composed of a photovoltaic production combined with electrochemical batteries, in order to meet the local population for self-consumption of electricity demands. This work develops a discrete model as well as a stochastic model in order to reach an optimal equilibrium between production and consumptions for a cluster of houses. The management of the energy power leads to a large linearized programming system, where the time interval of interest is 24 hours The experimental data are solar production, storage energy, and the parameters of the different electrical devices and batteries. The unknown variables to evaluate are the consumptions of the various electrical services, the energy drawn from and stored in the batteries, and the inhabitants' planning wishes. The objective is to fit the solar production to the electrical consumption of the inhabitants, with an optimal use of the energies in the batteries by satisfying as widely as possible the users' planning requirements. In the discrete model, the different parameters and solutions of the linear programming system are deterministic scalars. Whereas in the stochastic approach, the data parameters and the linear programming solutions become random variables, then the distributions of which could be imposed or established by estimation from samples of real observations or from samples of optimal discrete equilibrium solutions.

Keywords : photovoltaic production, power consumption, battery storage resources, random variables, stochastic modeling, estimations of probability distributions, mixed integer linear programming, smart micro-grid, self-consumption of electricity.
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