Multi-Objective Optimization applied to MicroGrid

Motivation & Objectives
The MicroGrid technology is part of the "smartgrid" technological concept. While it aims at improving the efficiency of energy production, the smartgrid technology is expected to achieve a fast deployment in the forthcoming years. In this study, a MicroGrid management problem is formulated, from the modeling of the system, to the definition of the objectives to optimize.

The aim of the project is to evaluate the opportunities offered by Genetic algorithm for solving multi-objective problem in the case of MicroGrid system operation. The Genetic Algorithm gives the ability to the solutions to avoid getting stuck on local optima and to escape from local optima. Therefore, it is adapted to the multi-objective problem. The Genetic Algorithm can be used in the multi-objective problem by using a Pareto approach which allows obtaining weights inherent to the distribution of the solutions. This method has been used to identify the solutions available before taking decision. A GUI has been used to identify the solutions of the Pareto set.

Formulation of the multi-objective optimization problem
The Genetic Algorithm gives the possibility to find optimum for objectives expressed in different units. The economic/environmental dispatch problem is implemented and a third objective, improving the operation of the utility with respect to the effects caused by load transient, is added.

Minimize $E_{\text{opex}} + E_{\text{capex}} + E_{\text{fuel}} + E_{\text{emissions}}$ (S/kWh)

Minimize $\sum_{i=1}^{n} (W_{\text{avg}} - W_{i})^2$ (kWh)

Minimize $\sum_{i=1}^{n} (W_{\text{avg}} - W_{i})^2$ (kWh)

if $(\text{T} - T_{\text{ref}}) > 0$ then $W_{\text{avg}}(\text{day}) = \frac{1}{n} \sum_{i=1}^{n} W_{i}$
else $W_{\text{avg}}(\text{day}) = 0$.

Decision making method
A preferred solution is selected using a Multi-Attribute Decision-Making method that allows obtaining weights inherent to the distribution of the solutions. This method has the advantage to be valid even if the objectives are expressed in different units.

Conclusion & future work
This study contributes in the development of MG by providing further information to the decision maker on the quality of its operation strategy. The results have shown that buying the electricity at the market price was enabling better benefits and higher stability, because of the lower price. However, it involves higher imports, and therefore higher emissions. The formulation of the objective for the operation stability brings an important feature to the optimization. Indeed the production profiles obtained can become more stable, and it creates a new strategy for the use of storage devices.

Acknowledgements
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