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AN EMPIRICAL APPROACH TO OPTIMIZE NON-LINEAR PROBLEMS OF DOMESTIC ENERGY MANAGEMENT SYSTEMS

Fernando CARRERAS[1*], Harald Kirchsteiger[2]

[1, 2] *University of Applied Sciences Upper Austria, Energy Research Group ASIC, Ringstraße 43a*

* ***Corresponding author.*** *E-mail address: fernando.carreras@fh-wels.at*

Abstract – Energy management system for domestic houses comprising photovoltaic energy production and battery electrical storage combined with time-variant electricity prices use to be controlled mean numerical optimization algorithms. The modelling of the system comprises the different involved devices, energy flows and their constrains, and an objective function, which parametrizes the object of the optimization (usually the minimization of the operative costs and/or the CO^2 emissions). The solution of the optimization problem provides the optimal operation (charging/discharging) of the battery along the prediction horizon considered. Power inverter efficiencies are usually modelled by assuming that they have constant values, and hence, that charging and discharging energy-flows lie on the most probably operating region of the inverter. A more realistic modelling of the power inverter efficiencies should consider a non-linear parametrization of the efficiency curves. This consideration converts the optimization problem into a non-linear one. It this paper, we propose a method to solve non-linear optimization problems means iterations of linear optimization problems. At the first step, an optimization problem will be solved by using the values of the efficiencies of the battery inverter provided by the manufacturer for the values. The values of the solution of that problem will be the seed of an iterative process: with help of measured (dis)charging power curves and the optimized (dis)charging energy flows, new values of (dis)charging efficiencies will be determined, and a new optimization problem will be defined and solved. The process stops after a certain number of iterations, or once a convergence is achieved. The results of the experimentation show that the modified method improves the performance of the system by reducing the operative costs with respect to the original method. The results summarized in the table correspond to a whole year with a 15-minutes time resolution and a 24-hour prediction horizon. The second method has the same time-steps, and for each time step triggers an iterative process. Simulations were implemented in Matlab and run on a COREi7 processor (8th generation) platform with 16 GB RAM. A wide experimentation by selecting representative cases with shorter periods (one week) will be done. The main objective of these selected cases is to analyze the dependencies between both methods under different circumstances (seven consecutive days of the year with maximal and minimal solar radiation, seven consecutive days of the year with maximal and minimal standard deviation of the buy and sell prices).

Keywords – Distributed energy resources; energy management; linearization; micro grid; renewable energy; smart grid

Method	Costs, €	Time, s	Time per sample, s
1: constant values	275.61	1961.3	0.056
2: iterative optimization	261.67	6908.1	0.197