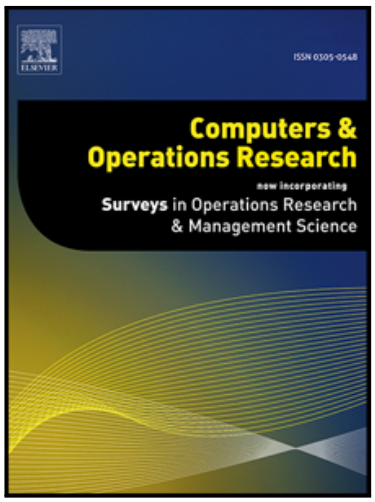

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Genetic algorithms to optimize the operating costs of electricity and heating networks in buildings considering distributed energy generation and storage

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Abstract.- This paper deals with the optimization of the operating costs of electricity and heating networks in buildings with distributed energy generation and electric storage via batteries and thermal storage for heating. The problem considers distributed energy sources such as electric grid, renewable sources (including thermal, photovoltaic and wind power), boilers, Cooling, Heating and Power (CHP) systems, as well as storage systems as electric batteries and thermal storage. Both electric and heating networks are coupled by the consideration of the CHP that joins both networks, increasing the complexity of the optimization problem and emerging as a critical network element. The objective is to obtain the optimal configuration of energy supply from the energy sources or from the energy storage systems to fulfil the electric and heating demands each 15 minutes' period, which minimizes the operating costs. The proposed mathematical model was firstly solved using Gurobi optimization commercial software that provided a very confident benchmark for the problem. Gurobi provided the optimum in most of the cases within the 15 minutes slot, but for specific instances the optimum could not be obtained in such slot. We implemented two genetic algorithm approaches differencing the crossover genetic operator: a basis genetic algorithm (BGA) and a segmented genetic algorithm (SGA). Both genetic algorithm implementations provided appropriate results within the time slot when compared to the benchmark. However, SGA provided better solutions than BGA considering both time convergence and quality of solutions appearing as an appropriate approach for solving real life cases. The system was successfully implemented at the premises of the School of Engineering of the University of Seville.

Keywords: Optimization; CHP; cogeneration system; genetic algorithms; energy distributed generation; electric storage

1.- Introduction

Energy production, storing and distribution has arisen as big challenge in the incoming future. The deployment of smart networks capable of identifying the most effective way to produce or generate energy together with the possibilities of storing energy to be used in the most appropriate period are turning into a key element both at the scale of cities and buildings. Indeed, the efficient planning of such different energy sources to give answer to the energy demand in buildings appears as a significant aspect of its economic performance as the European Commission states at [1]. In fact, the International Energy Agency describes energy efficiency as the "first fuel" [2], appearing also as a relevant ethical issue to protect the