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Genetic algorithm for optimal management of electrical demand side

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Abstract: This paper presents a study about centralized management of domestic electrical demand side. The purpose of the work is to show all steps behind optimal management of a domestic user. First it is investigated which domestic devices can be managed. The choice falls on interruptible devices in order to reduce of discomfort given to inhabitants of dwellings. Then total load of interruptible devices is subtracted to total demand. A genetic algorithm is used to find how interruptible devices are re-inserted in order to flattened load profile. Consequences of optimization is that peak load of optimized demand side is lower than original one and several economical advantages are achieved. Results obtained are shown.

Keywords: Demand side management, Genetic Algorithms, Energy management system

I INTRODUCTION

The last few years have been marked by an unexpected and substantial increase in demand for electricity.
Underlying this increase should be considered, in the first analysis, now documented change in weather conditions, with winters increasingly rigid and hotter and hotter summers.
In winter seasons there are many factors that contribute to this increase: weather conditions, such as intense cold, critical rainfall and strong wind, use of artificial lightening since the first afternoon due to short light period of the day, and the holiday season, with the increase of demand that has always been associated with this period.
In the summer season, however, the torrid heat days led to a sharp increase in the use of air conditioners, not only as centralized facilities for offices, hospitals or hotels, as well as facilities for self homes and shops, as evidenced by increasing of found sales for these devices.
Another very important factor that should be considered to explain the increase in demand found, is the amazing technological progress of the last 50 years, which has enabled a marked improvement in quality of life. Man has always placed much attention to their welfare, which today is largely guaranteed by its devices such as microwave ovens, personal computers, washing machines, dishwashers, DVD player and so on, responsible, however, a net increase of consumption of electricity. In addiction it should be taken into account the fact that a lot of these devices are just set to standby mode, with consequent consumption of useless vampire power.

II PROBLEM DEFINITION

To afford increasing of peak of power demand it would be sensible making a study about management of electrical demand side, as presented in [1,2], but in domestic field. First of all the definition of which domestic electrical appliances can be controlled by a centralized manager without causing too much inconvenience to inhabitants must be done. Surely equipment that can not be controlled are those for the treatment of foods (oven, microwave, electric plate), for the home and personal cleaning (vacuum cleaner, iron, hair dryer) and for entertainment (television, video recorder, personal computer). The lighting could be automated too, but with predominant purpose of avoiding wastage due to the absence of people. Same reasonings can be made with refrigerator-freezer which could be managed so as to temporarily suspend operations, provided that its temperature does not exceed a ceiling harmful to the conservation of food. These two options will not be considered, but the equipment that will be checked in order to try to flatten the diagram are total load the dishwasher and washing machine, representing programmable loads. In the context of control, and then, their operation does not depend on the will of people, but by program optimization.
The general idea is to start by a load profile of several households, subtract this diagram the washing machines and dishwashers consumption under not controlled condition, that is freely used by people throughout the day and then re-insert it with optimal distribution such a way to generate a load profile where, instant per instant, power demand is as closer as possible to mean power request of studied time period. To achieve this goal it is used a genetic algorithm [3], where solutions are feasible load profiles and fitness function overlaps with objective function :

$$f_{obj} = \sqrt{\sum_{i=1}^{NI} \left[p(i) - p_{med} \right]^2} \qquad (1)$$

where:

NI is number of time intervals in which problem is studied
p(i) is power demand in i*th* time interval
p_{med} is the medium of power request

In Figure 1 it is shown a free electrical demand (red) compared with optimized load profile (blue). In Figure 2 it is shown evolution of best fitness and mean fitness of population of genetic algorithm versus generation of research.

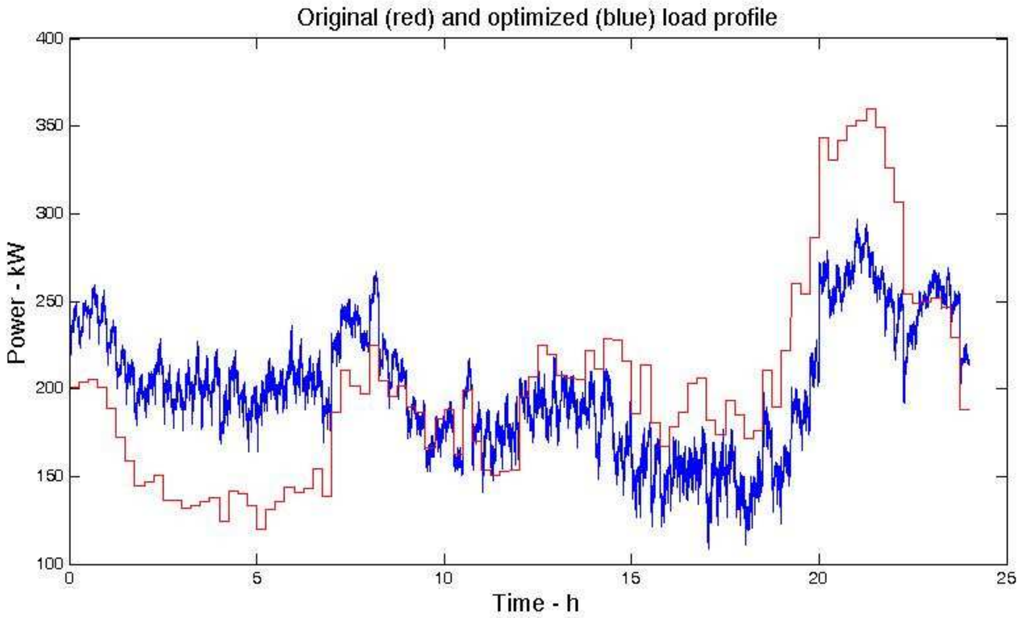

Figure 1 - Optimal (blue) and not optimal (red) management of demand side

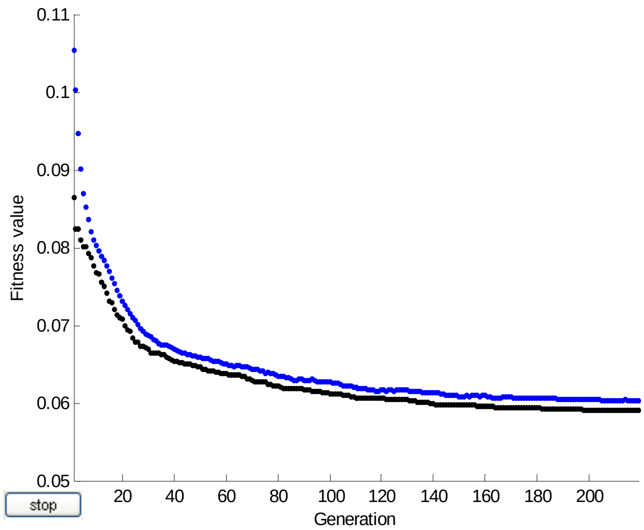

Figure 2 - Evolution of fitness function with respect to generation of research

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