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ROLE OF PARTICLE SWARM OPTIMIZATION FOR OPTIMAL GRID OPERATIONS

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ABSTRACT

A Particle Swarm Optimization (PSO) based methodology is proposed and applied to the schedule of several energy resources, including demand response, distributed generation, and the energy that can be bought to a set of suppliers, minimizing the operation costs from the network. The PSO method has been successfully implemented to solve Demand side response. The application of PSO algorithm to DSM has proven to be better than normal strategies and has the ability to find the better quality solution and has better convergence characteristics, computational efficiency, and robustness.

KEYWORDS: *Renewable Energy Sources; Smart Grid, Economic Load Dispatch ; Demand Response*

I. INTRODUCTION

The smart grid (SG) is conceived as an electric grid able to deliver electricity in a controlled, smart way from points of generation to consumers that are considered as an integral part of the SG since they can modify their purchasing patterns and behavior according to the received information, incentives and disincentives. As confirmed by some recent research, most of the advantages of SG are, in fact, due to its capability of improving reliability performance and customers' responsiveness and encouraging greater efficiency decisions by the customers and the utility provider. Accordingly, demand side management (DSM), including everything that is done on the demand side, represents an integral part of SG. The complete integration of DSM requires communication systems and sensors, automated metering, intelligent devices and specialized processors. Smart metering and advanced information and communication technologies (ICT) solutions for energy management in buildings appear, in fact, as a tangible opportunity to achieve energy savings, exploit renewable energy resources (RES) and favor customers' participation in the energy market.

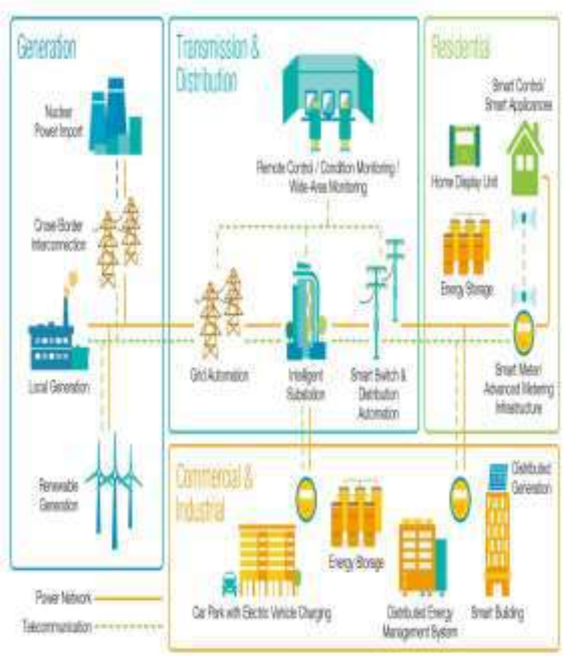

Fig 1 DSM Renewable Sources

New ICT infrastructures, supporting a more efficient network operation and allowing the communication of frequent price updates, offer new challenges for DSM. They allow a much more dynamic, reactive pricing mechanism required to take into account real-time availability of fluctuating RES and to follow the evolution of the balance between supply and demand in real time. DSM commonly refers to programs implemented by utility companies to manage the energy consumption at the customer side of the meter. Both utilities and customers can benefit of DSM programs that can help electricity power markets operate in a more efficient way, thereby reducing peak demand and spot price volatility.

The organization of present paper is as follow. Section II presents the literature survey which highlights the facts of various researchers. Section III describes the methodology used for proposed work as in this paper optimization is used. Result analysis is presented in section IV following the concluding remarks in section V.

II. LITERATURE REVIEW

This section will provide the brief description and highlights the contribution, remarks and factors of the work done by the researchers. Many attempts have been made in the past to heavy industry & home automation.

Aghaei, Jamshid, et al. (2013) [7] obtain the mentioned aims, MGs (microgrids) act as key solutions. The proposed model implements a simple MIP (mixed-integer programming) that can be easily integrated in the MGCC (MG central controller). The effectiveness of the proposed methodology has been investigated on a typical 24-bus MG.

Faria, Pedro, et al. (2013) [8] price-based demand response is applied to electric power systems. Demand elasticity and consumer response enables load reduction. The methodology is implemented in the DemSi demand response simulator. Competitive electricity markets have arisen as a result of power sector restructuration and power system deregulation.

Gkatzikis, Lazaros, et al. (2013) [9] design of efficient Demand Response (DR) mechanisms for the residential sector entails significant challenges, due to the large number of home users and the negligible impact of each of them on the market. Using realistic demand traces, they quantify the arising DR benefits. Interestingly, users that are extremely willing to modify their consumption pattern do not derive maximum benefit.

Joo, Jhi-Young, et al. (2013) [10] concerns mathematical conditions under which a system-level optimization of supply and demand scheduling can be implemented as a distributed optimization in which users and suppliers, as well as the load serving entities, are decision makers with well-defined sub-objectives. We propose a novel set of methods for coordinating supply and demand over different time horizons, namely day-ahead scheduling and real-time adjustment. We illustrate the ideas by simulating simple examples with different conditions and objectives of each entity in the system.

Kennel, Fabian, et al. (2013) [11] presents an energy management system for smart grids with electric vehicles based on hierarchical model predictive control (HiMPC). Throughout the paper, the energy management system is evaluated for the smart grid of an intermediate city.

Marzband, Mousa, et al. (2014) [12] In this paper, both performance optimization and scheduling of the distributed generation (DG) are relevant implementing an energy management system (EMS) within Microgrid (MG). The proposed method is validated experimentally. Obtained results show the improved performance of the proposed algorithm in the isolated MG, in comparison with conventional EMS.

Ali, Mubbashir, et al. (2014) [13] optimized the Demand Response (DR) control of partial storage electric space heating using a Linear Programming (LP) approach. The objective is to combine the DR control of direct electric space heating and partial thermal storage in order to minimize the total energy cost of customers without sacrificing user comfort. The optimal DR control model can easily be integrated at the household level for better utilization of distributed energy resources under the Smart Grid scenario.

Siano, Pierluigi et al. (2014) [14] In this paper a survey of DR potentials and benefits in smart grids is presented. Innovative enabling technologies and systems, such as smart meters, energy controllers, communication systems, decisive to facilitate the coordination of efficiency and DR in a smart grid, are described and discussed with reference to real industrial case studies and research projects.

Barbato, Antimo, et al. (2014) [15] In this paper, the residential sector is currently one of the major contributors to the global energy balance. DSM for individual users *versus* DSM for cooperative consumers, deterministic DSM *versus* stochastic DSM and day-ahead DSM *versus* real-time DSM. Based on this classification, they provide a big picture of the key features of different approaches and techniques and discuss future research directions.

De Craemer, et al. (2014) [16] In this paper addresses the challenges of integrating existing PHEV charging algorithms, which optimize PHEV charging per market timeslot (e.g., 15 minutes), into an environment with realistic communication conditions. A case study of 1000 PHEVs shows that it is possible to achieve results on par with the timeslot based algorithm but with significantly reduced communication with the PHEVs.

Akhavan-Rezai, et al. (2015) [17] In this paper, PEV coordination introduces a significant challenge in demand response programs (DR). This approach includes a real-time interaction between the aggregator and the PEV owner, where the aggregator suggests different offers and, accordingly, the owner responds based on his/her preference.

This section has provided the brief review of the work done in past. It also highlighted the factors, contribution and remarks on the achievement.

III. FRAME WORK FOR IMPLEMENTATION

The main focus of this research is to implement a smart connected grid for increasing the penetration of renewable energy resources. Power dispatch strategies of active generators are the key to achieve this task. The DR may be formulated as a nonlinear constrained problem. Both convex and non-convex DR problems have been modeled in this paper. The convex DR problem assumes quadratic cost function along with system power demand and operational limit constraints. The practical non-convex DR (NCELD) problem, in addition, considers generator nonlinearities such as valve point loading effects, prohibited operating zones, ramp rate limits, and multi-fuel options.

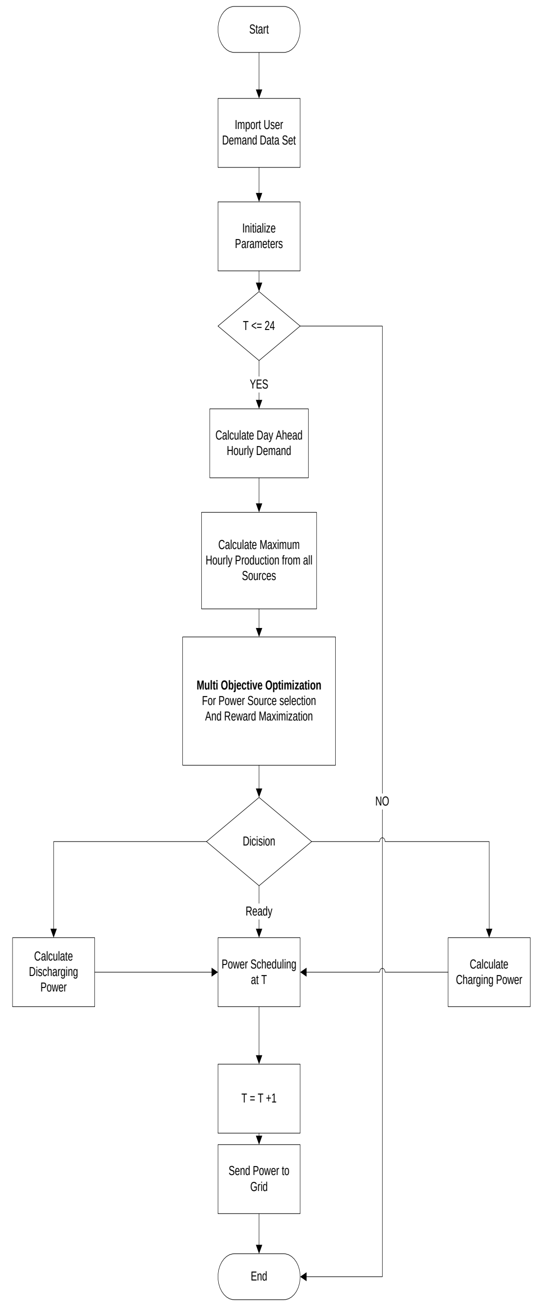

Fig 2. Proposed Workflow of Hour Ahead DSM aggregator policy based on multi-objective optimization

The objective function of DR problem may be written as

$$Ft = \min(\sum_{i=1}^{m} Fi(Pi) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5.1)$$

$$= \mathrm{m} \sum_{i=1}^{m} ai + biPi + ciP_i^2 \ \ldots\ldots\ldots\ldots\ldots\ldots(5.2)$$

where Fi(Pi) is the ith generator's cost function, and is usually expressed as a quadratic polynomial; at, b,. and c, are the cost coefficients of the ith generator; m is the number of committed generators to the power system; Pi is the power output of the ith generator.

IV. RESULT ANALYSIS

MATLAB platform has been used to evaluate the results. Some assumptions are made to simulate the results as discussed The different parameters used in proposed work are given in table 1. The performance parameters are analyzed using MATLAB 2016a.

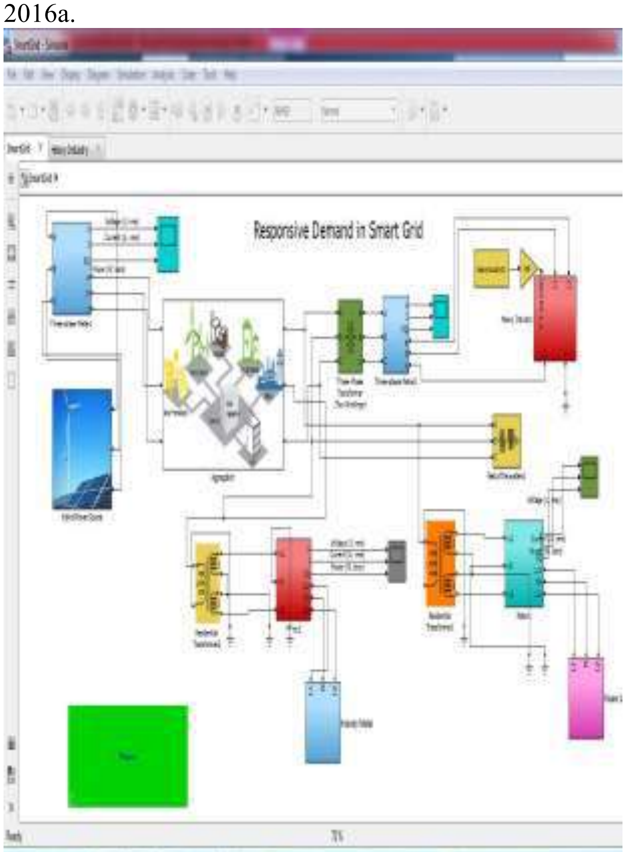

Fig 3 Simulink model for Demand Response Management

Fig 3 gives the Simulink model for demand response Management Simulink model. In this complete model is design to give the demand response. This system is used to design the different power supply, different controller.

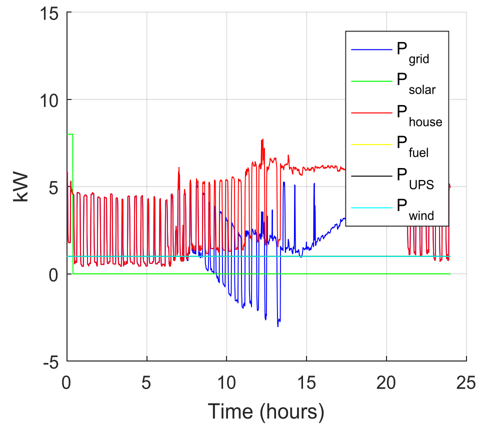

Fig 4 Demand (KW) P_{house} from houses and Grid Response for various sources Solar, House, fuel and Wind sources.

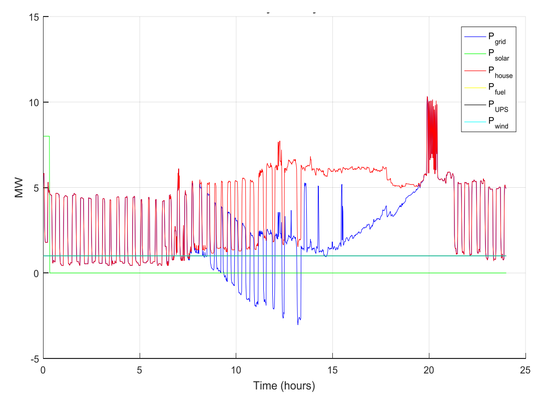

Fig 5 Visualization of Heavy industry Demand Response

Fig 4 & 5 shows the visualization of heavy industry demand response. The demand response is given by different industry. The local society .personal office & home demand response is given in the Simulink design.

V. CONCLUSION

This Work presents a Particle Swarm optimization (PSO) algorithm to solve both convex and non-convex economic load dispatch (ELD) problems of thermal plants. The proposed methodology can take care of economic dispatch problems involving constraints such as transmission losses, ramp rate limits, valve point loading, multi-fuel options and prohibited operating zones. Biogeography deals with the geographical distribution of biological species. Mathematical models of biogeography describe how a species arises, migrates from one habitat to another and gets wiped out. PSO has some features that are in common with other biology-based optimization methods, like genetic algorithms (Gas).

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