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OPTIMAL SCHEDULING OF RESIDENTIAL APPLIANCES CONSIDERING DISTRIBUTED GENERATORS

Arvinder Singh, Er Gurpreet Kaur
M.Tech Student, Guru Kashi University, Talwandi Sabo
Assistant Professor, Guru Kashi University, Talwandi Sabo
deepmonga@gmail.com
ergurpreet88@gmail.com

Abstract- As the transition of traditional grid to smart grid, the major change includes demand-side management. Traditionally, the grid was a one-way road due to its vertically operating structure. But the concept of a smart grid introduces the participation of consumers through demand-side management. Now the grid operators, utilities, and other stakeholders can manipulate the demanded load by consumers. The desired output load profile can be obtained by the grid operators, which could increase their profit. They can create a win-win situation with consumers as following instructions could make customers also the stakeholders. If the consumer agrees to load scheduling, it can reduce the electricity billing. In this thesis, an example of a consumer is taken and an objective task has been developed to minimize the day operating cost using particle swarm optimization. The optimization is done considering solar and wind generation at the consumer's premises. The reduction in a day billing has been achieved of about 3 percent per day.

Keywords:Demand Side Management Demand reaction Load Scheduling Load Profile Before

INTRODUCTION

Modern power distribution systems are facing problems like high power losses, poor power quality, peak power demand, and high carbon emissions. Demand Side Management refers to initiatives and technologies that stir up consumers to improve their energy uses and change the load design.

Demand reaction is described as the reduction in purchasers' electricity intake in line with changing electricity expenses or via the encouraging factors supplied by the electrical distribution groups. One stir-up aspect may be to pay consumers to use much less electricity or allow it to be set in the surcharge for excessive load, even a mixture of each may be counseled. In different words, call for response changes

according to the behavior of load consumption.

Generally, the goal of demand response is to lessen the power consumption in peak call for. Peak demands depend upon two situations:

(i) High Power prices and

(ii) Lowdemand response trustworthiness for reasons such as overload in distribution transformers, faults in generation units, and bad weather conditions.

DSM are broadly classified into Energy efficiency and demand response. Energy efficiency and smart use of energy like employing LED bulb instead of the incandescent light bulb. Demand response (DR) is a scheme used by electric utilities to reduce or change energy consumption during peak hours of the day.

Distribution generation is a small electrical power system independent of a traditional utility grid which is located on the user side to meet end-user demand When the peak demand occurs, generation should be increased to meet this increasing demand. But it has limitations due to limited generation capacity and fixed installed power system infrastructure.

In a smart grid, demand reaction stores the obtained energy of renewable resources to cowl up for the uncertainty in these aid generations. To this cease, operators can reduce energy intake rather than receive power from the grid through renewable generation modification.

As a result, the demand response program will offer greater options to eliminate unbalanced power. Consumers do not have any incentive to reduce consumption at peak demand due to the fact that the electricity costs are the same throughout the day.

However, the consumers could have the motivation to reduce energy intake at the peak load or shift them to other hours by applying the changeable electricity price for every hour. Energy consumption then reduces the peak load of the system and transfer the consumption to off-peak load hours.

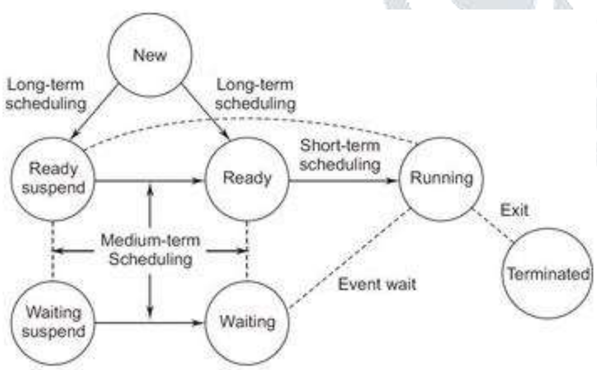


Fig 1. Different Types of Load Scheduling

II.PROBEM DEFINING

Demand response helps shift consumer energy patterns. Modern power distribution systems are facing problems like high power losses, poor power quality, peak power demand, limited power transfer capability of line, and high carbon emission. Like high power losses, poor power quality peaks power demand and high carbons emission. Demand Side Management refers to initiatives and technology that encourage consumers to optimize their energy uses and shift the energy consumption pattern. Demand-side management refers to initiatives and technologies that encourage consumers to optimize their energy uses and shift the load pattern. Demand reaction is defined as a reduction in purchasers electricity consumption in line with converting energy charges or using the encouraging element supplied by electrical distributions agency. The primary encouraging aspect will be to pay purchasers to apply less energy all through peak hours. In another way, demand response changes with the behaviors of load consumption patterns.

The concept of demand response covers a wide range and is helpful for consumers as well as the electricity market. The modern power system has vertical utility integration in which power flow from source to load. So, the tariff rate of electricity is relatively high. Demand response is used for flattening the load profile, in this consumers agree for shifting their load from peak to off-peak period. For this activity, consumers get benefits by providing perks, incentives, etc. There are various methods for implementing demand response programs, two main classifications are incentive-based demand response and price base demand response. In price-based programs, dynamic pricing is provided to the consumer. This pricing scheme is provided in advance such that the pricing for consuming the energy during the peak hours will be high and during the hours of low power consumption the rates of energy consumption will be low. Such a type of demand response program will motivate the consumer to change the pattern of consumption such that the electric bill consumption will be as low as possible.

In incentive-based programs the one in which the incentives are provided for the curtailment or load shifting. In most of these programs, an agreement is been signed with the customers who are willing to participate in demand response programs, but if they do not act according to the agreement, there are various penalties. The penetration of distributed energy resources, like distributed generation, battery storage, and electric vehicles, considerably affects the operations of distribution grids. Ensuring reliable electricity supply in this perspective is a costly effort given the requirement for backup flexible electric power generation joined with limited electricity transmission capacity. Regulatory authorities are increasingly allowing for demand flexibility, also known as demand response (DR), for improving system coordination.

III.Objectives

Therefore, based on the above discussion the objectives of this theses are:

1.To study and analyze the applications of optimal scheduling of the appliances for the disentailed sector

2.To study and analyze different types of techniques for optimal scheduling

3.To study and analyze different factors that affect optimal scheduling.

4.To develop an optimal scheduling technique to assist customers in decision-making.

IV Research Methodology

To obtain an optimal operation program, an objective function is required which would recognize the operation strategy of the micro grid. The function aims to maximize the profit (revenue minus the cost) that is eventuating to all the provisions of operation. This function is used to increase the micro grid profit, determine the load supplying, the participation rate of generators, storage, and energy exchange. Despite the nature of renewable units, in the on/off mode all the generated energy would be injected into the micro grid bus.

The overall structure of this objective function is s follows:

$$F = maximize \sum_{1}^{24} [revenue(t) - cost(t)] \quad (1)$$

In this equation, the range of *t* changes is considered 1–24, which indicates the period is 24 h a day.

The objective function is divided into two parts: earning and cost. The micro grid earning and costs are listed within the following: -

1.Electrical Energy to the Local Electrical Companies

2.Selling Electrical Energy to Normal Loads

3.Selling Electrical Energy to Washing Household Appliances

4.Selling Electrical Energy to Light Loads

According to the above costs and earnings, the goal of the objective function in the modeling of this paper is considered.

$$OF = \sum_{1}^{24} \{[P_{grid}(t).\rho_{grid}(t) + P_{load}(t).\rho_{load}(t)] - [C_{pv}(t) + C_{w}(t) + C_{bat}(t)]\} \quad (2)$$

Where,

P_{grid}(t)=energy exchange between the micro grid and the main grid.

ρ_{load}(t)=price of sold electrical energy to load.

C_{pv}(t)= price of solar unit generation cost.

$C_{w}(t)$=wind unit generation cost.

C_{bat}(t)=charge and discharge energy cost.

The optimization is done considering the following constraints:

P_{load}^{max} (t) <P_{grid}^{max}(t) Here,

P_{load}^{max} (t)= Maximum energy exchanged between grid and load.

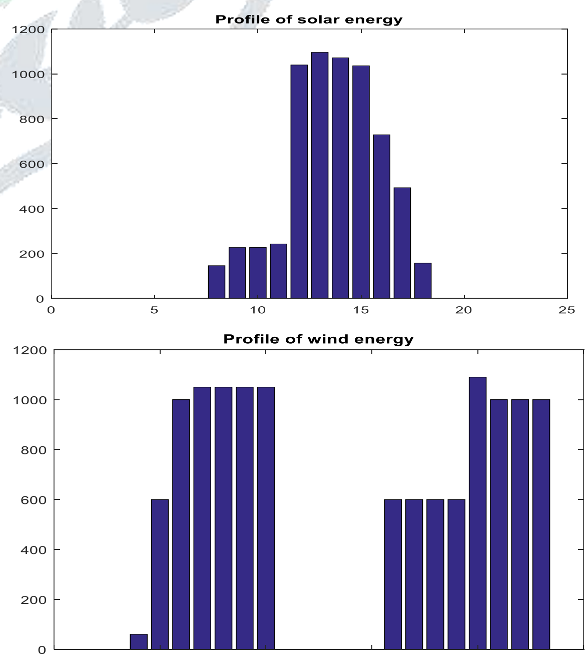
P_{grid}^{max}(t)= Maximum energy generated by grid.

It can also be observed that the profile of the grid is maximum when the demand in a particular hour is close to the power generated by micro grid.

V. Result &Discussion

The case of a household is considered in which there are uncontrollable and controllable, flexible loads. The household has solar panels and wind panels too. Fig. 2 shows the power consumption and fig.2 shows the price of the consumption respectively.

Fig.2 Real-Time Measured Power Production Profile of



Solar Power (A) And Wind (B).

Fig 3. Load Profile Before and After Demand Management

Table 1. Load Profile Before and After Demand Management

Hours	Objective	Before DM	After DM
5	644.89	824.49	816.32
10	1126.53	975.51	1126.53
15	1146.93	1032.65	1146.93
20	1138.77	355.12	616.32
23	1138.76	432.65	379.52

Case 2: Considering Demand response management

This is the special case where the objective function is formulated mathematically i.e.

$$OF = \sum_{1}^{24} \{[P_{grid}(t).\rho_{grid}(t) + P_{load}(t).\rho_{load}(t)] - [C_{pv}(t) + C_{w}(t) + C_{bat}(t)]\} \quad (14)$$

Accordingly, the objective function along with its constraints is optimized using PSO. The optimization technique is Particle Search Optimization. particle swarm optimization (PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution about a given measure of quality. It solves a problem by having a population of candidate solutions, here dubbed particles, and moving these particles around in the search space according to simple mathematical formula over the particle's position and velocity. Each particle's movement is influenced by its local best-known position, but is also guided toward the best-known positions in the search space, which are updated as better positions are found by other particles. This is expected to move the swarm toward the best solutions. PSO is a metaheuristic as it makes few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. Also, PSO does not use the gradient of the problem being optimized, which means PSO does not require that the optimization problem be differentiable as is required by classic optimization methods such as gradient descent and quasi-newton methods. However, metaheuristics such as PSO do not guarantee an optimal solution is ever found.

In this case, objective load profile is obtained, which is shown in fig.7 with a green line. If the load profile is being operated accordingly then the per-day cost would be 189.45 cents.

But the after optimizing using PSO the load profile is obtained which is shown in blue color in fig.7 but the price per day was 193.43 cents per day. Therefore, a profit of about 3.37 percent has been obtained.

VI. Conclusion & Future Scope

A household's load profile is considered, in which the load of 24 hours was given for a particular day. For this day the demand side management was implemented on this particular house. The household was having various appliances which includes shift-able and non-shift-able loads. The household was also having solar and wind generation at the facilities.

For the energy management purpose, an objection function has been formed. And the constraints were discussed. Considering the objective function and corresponding constraints, the objective function has been optimized using particle search optimization. The function is optimized to reduce the billing for the customer. It is found that the cost for the operation of the household for that particular day was 200.19 cents. But after optimization, it is found that the cost to the customer is 193.43 cents. Therefore, in total 3.37 percent can be reduced using a purposed algorithm.

In the coming future, the load of EVs is increasing exponentially. Therefore, it raises a need for demand-side management of EVs, as it will suddenly burden the grid for charging and discharging. So, future researchers have a huge scope in load scheduling considering EV.

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