EFFICIENT SCHEDULING FOR PEAK LOAD OPTIMIZATION IN SMART GRID

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ABSTRACT :- In this research paper in order to schedule the load of three different areas by proposing coordinated load scheduling and using Particle Swarm optimization (PSO) algorithm to minimize the peak load consumption. The system under analysis consists of three different areas ,out of which one area is considered as critical load area and the other two are considered as non critical load areas .The critical load area needs a continuous supply and thus the supply of other two load areas is adjusted and shifted according to the grid requirements with the main aim to reduce the peak load demand. The study even aims to reduce the time required for the system, under analysis to respond in very short time interval , and after this time interval, area 2&3 will shut down automatically using three phase breaker in the design. The results obtained are very encouraging in terms of reducing peak load consumption and overall efficiency of the system. Simulation analysis verified by MATLAB 2013 a SIMULINK software.

Keywords: Load Scheduling, Load data of three different areas, PSO algorithm, Peak load.. Matlab 2013 a.

1. INTRODUCTION

Electrical power frameworks over the globe are experiencing changes attributable to the difficulties they face in issues of generation, dependability and proficiency. Quick crumbling of regular power assets makes pressing call for supplanting with option inexhaustible sources. Existing force grids with vertically incorporated structure will not bolster this on a business premise. Aside from hydro and maybe wind control, non-ordinary vitality assets are not accessible in bounty henceforth making them unfit for large scale manufacturing. Also, the exceedingly dispersed nature of their accessibility and absence of dependability unquestionably take out the likelihood of a brought together creation however with decentralization of the current system and alongside the presentation of disseminated generation positively tosses light to a possible arrangement. Various power organizes over the world have effectively taken activities toward this path. Little scale generations inside the buyer premises, mechanical or residential, are accepting consolation from utility grid even as monetary motivating forces. Once introduced, appropriated generators have demonstrated gainful to both the providers and buyers alongside the reinforcing of grid unwavering quality. With the point of upgrading the productivity of such a decentralized system, ordinary power frameworks have been encountering change from unified supply side administration to decentralized free market activity side administration. Along these lines, load the executives under the new working condition turns out to be more troublesome than that under the ordinary condition. At present, the electrical vitality utilization isn't proficient in many structures for the most part as a result of buyers' numbness.

A. Demand Side Management

The need to control the demand in order to shape the load profile was first realized in1970s [1]. Now it has evolved to the concept of Demand Side Management (DSM) and is characterized by utility operations and incentives for the consumers in order to bring power usage at desired level at all times. Major objectives of DSM include: peak clipping, valley filling, peak shifting and deploying new efficient uses [2]. DSM can help the consumers to lower their payments and utility to minimize the need of peaking plants. Obviously, the utility desires the shape of the load curve to be balanced with a reduced Peak to Average Ratio (PAR) for all the hours while consumers want reliable energy supplies at minimum cost. In literature, Load Management (LM), Demand Response (DR) and DSM are found as overlapping concepts and are used interchangeably.

There are three noteworthy sorts of DSM programs: load shedding, dynamic estimating based plans and motivating force based plans. Burden shedding, otherwise called intentional power outage or feeder pivot, is the way toward detaching the heap at feeder level so as to lessen the over burden condition on matrix. Estimating based projects incorporate Continuous Valuing (RTP), Time of Utilization (ToU) evaluating[5-6], Basic Pinnacle Evaluating (CPP) and so forth., while motivating force based projects incorporate Direct Burden Control (DLC), reduce capable administrations, request offering and so forth. DLC acts just when the pinnacle request crosses as far as possible though the dynamic valuing is a progressing marvel. Since it is hard to react the dynamic valuing plans physically, the clients need Home Vitality The executives Frameworks (Trims) so as to naturally react the value varieties through planning of their machines for ideal expense. As opposed to previously mentioned ordinary power framework, present day dynamic EMS comprises of the four noteworthy parts: shrewd end-use-gadgets, smart disseminated vitality assets, current structure control frameworks and combination of the propelled correspondence foundation for bi-directional progression of information and power among clients and utility.

2. LITERATURE SURVEY

Suyang Zhou, Zhi Wu, Jianing Li, et al. (2014) investigated a real–time energy control approach for a home energy management system, including the electric water heater, air conditioner, clothes dryer, electric vehicle, photovoltaic cell, critical loads, and battery system in their article. A demand response mechanism is proposed to enable households to participate in demand response services. A fuzzy logic controller was utilized to determine battery charging/discharging power. They proposed rules to ensure benefits from operating the battery under the real–time electricity price. They concluded in their work that by shifting the load towards off– peak periods or low priced time slots, new peak load might appear.**Qinran Hu et al (2013)** has hardware propose of Smart Home Energy Management System (SHEMS) with the application of announcement, sense technology and mechanism learning algorithm. SHEMS is planned with sensors to identify human behaviour and after that a mechanism learning algorithm is applied to intelligently help customers decrease overall compensation on power with no or with small consumer participation. The proposed plan, customers can realize a RTP-responsive manage plan over residential loads counting EWHs, HVAC units, EVs, dishwashers, washing machines, and dryers. This paper also includes difficult and imitation consequences which show the power of the hardware coordination of the SHEMS model. If this propose can be extensively used in the potential, the manager- user arrangement will provide good potentials for electrical energy aggregators. **Zhuang Zhao, Won Cheol Lee, Yoan Shin, et al. (2013)** combined RTP with the inclining block rate (IBR) model. By adopting the combined pricing model, they claimed that proposed power scheduling method would effectively reduce both the electricity cost and PAR, thereby, strengthening the stability of the entire electricity system.**Christopher Bennett, Rodney Stewart and Junwei Lu (2013)** described the method of a prototype forecast component of the energy resource management control algorithm for STATCOMs with battery energy storage. It is desired to be computationally efficient and of minimal complexity due to the required purposes of forecasting each load in an LV network. During validation of the model, discrepancies between the forecasted and observed electricity demand profiles were observed in their work.**David Chinarro et al (2013)** Smart grids are a rising leaning that set up intelligence in the control grid to optimize reserve usage. This proposed system present a multi-agent arrangement representation for essential power plants, a latest power plant thought in which production no longer occur in big installation but is the consequence of the assistance of lesser and additional bright fundamentals. The ANN can nearby several diverse architectures, and is usually configured to study from knowledge when confront with a bottom reality recognized a priori. To facilitate be why this MAS design has to be enrich with require forecasting algorithm base on artificial neural networks to has been validate productively through actual data. Accessible forecast algorithms include be utilize to make easy prediction on a large aggregate range (nations, regions, etc.), excluding the one of propose forecasts demand at a lesser micro grid level that improved hysterics the VPP range. **Kenji Iba, Ryuichi Yokoyama and Kaoru Koyanagi (2012)** described that constructing small power sources and consumed renewable energy from solar and wind sources would affect the power grid through fluctuation of power output and the deterioration of power quality. Therefore, a new social infrastructure to supply electric power would be required. Introduced and cluster–oriented expandable networks are discussed focusing on the resiliency of the grid against natural disaster. **Jinghuan Ma et.al**,the research paper titled “Residential Load Scheduling in Smart Grid:A Cost efficiency Perspective”describes residential load scheduling based on cost to improve the electricity consumption.Load scheduling algothrim and real time pricing mechanism is used.

3. METHODOLOGY

A. Existing Work

There have been a number of techniques suggested in the recent past to minimize peak load consumption such as conservation and energy efficiency programs, fuel substitution programs, dynamic pricing programs, and load scheduling programs [3]. Scheduling deferrable appliances to minimize peak load consumption has been studied in the past and is proved to be NP-hard [7-10]. A number of papers in the literature have solved this problem of scheduling for peak minimization as two-dimensional strip packing (2SP) problem where the appliances can be considered as jobs, with their execution time as widths and power consumption as heights. The time horizon corresponds to the total width of the strip. In strip packing, jobs of rectangular shapes are required to be placed in a strip of specific width, such that the height of the resulting packing is minimum. Several heuristic algorithms have been proposed in the past to address the problem.

Although existing literature suggested strip packing based modeling for the problem of peak minimization and provided results based on the existing strip packing solutions, the two problems are different in the fact that, blocks in strip packing are rigid and does not allow overlapping, while in peak power scheduling the items' power consumptions are simply added. Moreover, level based strip packing solutions require placing of items on the base of the strips only. The majority of the existing literature on strip packing based peak load minimization solutions have not incorporated these differences, and therefore the direct implementation of the existing strip packing solutions for power scheduling is questionable.

B. Proposed Work

Load Scheduling has become increasingly important over previous years as the demand for electricity is increasing day by day and the sources are limited, also the cost of generating sources has increased. The main aim of my research is to schedule the load of three different areas by proposing coordinated load scheduling and using Particle Swarm optimization (PSO) algorithm to minimize the peak load consumption. The system under analysis consists of three different areas ,out of which one area is considered as critical load area and the other two are considered as non critical load areas .The critical load area needs a continuous supply and thus the supply of other two load areas is adjusted and shifted according to the grid requirements with the main aim to reduce the peak load demand. The study even aims to reduce the time required for the system, under analysis to respond in very short time interval , and after this time interval, area 2&3 will shut down automatically using three phase breaker in the design. The results obtained are very encouraging in terms of reducing peak load consumption and overall efficiency of the system. Simulation analysis verified by MATLAB 2013 a SIMULINK software.

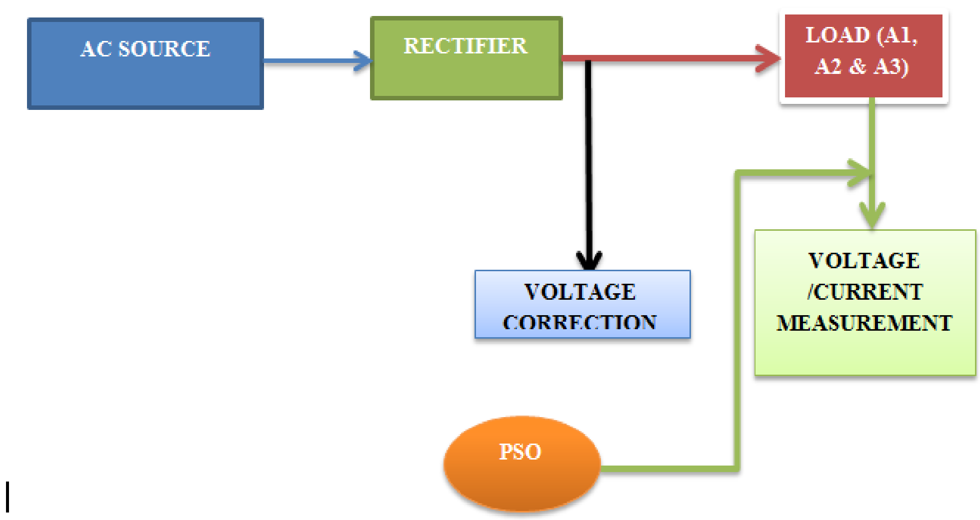


Figure 1 Block Diagram of Proposed work

C. Data Sheet

Load value = 1.85 Kw

Load current of Grid = 8 Amps

Table 1 Data sheet values

S.NO	PARAMETERS	RESIDENTIAL LOADS (A1,A2 & A3)		
		A1	A2	A3
1	**LOAD (Kw)**	**0.65**	**0.6**	**0.6**
2	**LOAD CURRENT (Amps)**	**2.8**	**2.6**	**2.6**

D. Pso algorithm

PSO is a computational methodology in which each particle is a solution belonging to a population called swarm. All particles in the swarm move in the search space and each particle finds a position according to its own experience and neighboring particles. The steps involved in PSO algorithm are:

- Starts with initial parameters like size of swarm, total number of iterations etc.
- Particles are initialized randomly for their positions and velocities. The position and velocity of *ith* particle in D dimensional space are represented by

$$Xi = [Xi1, Xi2, ---------------------XiD] \quad (1)$$
$$Vi = [Vi1, Vi2, --------------------ViD] \quad (2)$$

- Fitness of objective function is evaluated. The objective function can be presented as:

$$Fi = F(Xi1, Xi2, ---------------------XiD) \quad (3)$$

- Two best positions, known as global best position and personal best position, are obtained.

The personal best position is the best position obtained by a particle itself up to current iteration and is designated by *pid*. At first iteration, *pid* for each particle is same as *Xi*, whereas for subsequent iterations, *pid* of a particle is obtained by comparing its fitness value at current position *Xi* with that of *pid*. If fitness value is better than that of *pid* then set this value as *pid*; whereas *pid* remains unchanged otherwise. The global best position is the best position amongst *pid* and is designated by *pgbest* .

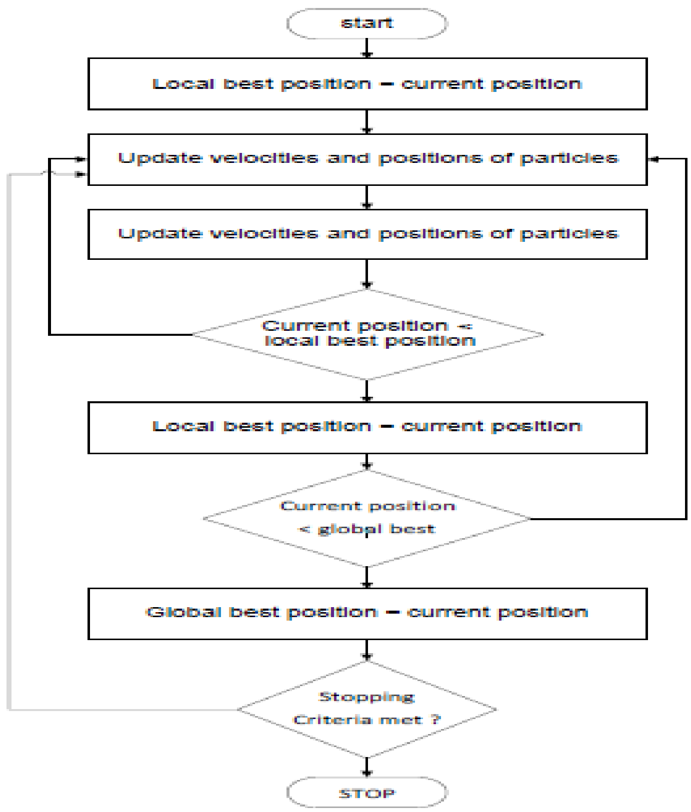
- Fitness of each particle is evaluated and global best and personal positions are obtained 8.

The process is repeated till convergence criterion is met. The pseudo code based on above mentioned procedure for this algorithm is described here:

```
Start < PSO Algorithm >
Initialize parameters;
Initialize each particle Xi;
Initialize velocities Vi;
Initialize best position Pid; (for each particle to current position)
Pgbest ←minXiF(Xi);
While (iteration ≤ iterationmax)
For each particle Xi;
For (d = 1 to D)
Initialize random w in the interval (0, 1);
Accommodate velocity and position of a particle in d;
Vid ←w∗ (vid +c1) ∗ rand1 ∗ (Pid −xid)+c2 ∗ rand2 ∗ (Pgbest1dxid);
Velocity limit [vmin, vmax];
Update position;
xid ←xid +vid;
Particle, position limit [Xmin,Xmax];
End
Update best position Pi;
if ( f (Xi) ≤ f (Pi)) then
Pi ←Xi;
End
Update global position Pgbest ;
If ( f (Pi) ≤ f (Pgbest )) then
End
End
End
End
Pgbest ←Pi
End
```

The above mentioned procedure is summarized in flow chart shown in Fig. 5.1. PSO has wide range of applications. It has been utilized for speech reorganization in training Hidden Markov Models [46]. PSO has been used to find the optimal subset of image and audio features, for speaker identification based on face and voice reorganization in [47] and [48], respectively. In [49], PSO algorithm has been employed for many image applications such as extracting useful objects from image, image segmentation etc. PSO has also been successfully used in wireless networks for detecting the optimal path that an attacker may use [50]. Furthermore, in the field of power engineering, PSO has wide variety of applications such as to solve load balancing, Economic Dispatch (ED), peak load management etc. [42,48]. In power systems, ED is one of optimization problems which has been solved frequently with PSO for different situations. ED is the process of calculating the optimal output of all generating units, in order to meet the load demand at lowest cost, based on generation and transmission constraints. Its objective is to minimize the generation cost. Considering the non-linearity of ED problems, PSO algorithm provides the robust solution [49]. In [180], the ED problem with Demand Participation (DP) representation is presented and solved by PSO. Equality constraints create the major problem in PSO algorithm and are often handled by penalty function along with an enforcement mechanism. In [50], the dynamic economic load dispatch problem is used to minimize the total operating cost by finding the optimal set of generators; PSO algorithm is used to find the optimal schedule of generating units that can fulfil the load demand at minimum cost while satisfying the constraints such as transmission losses, effect of valve point and limits of ramp rate. The test system of five generators has been considered as an example. The main objective of this problem is to find minimum cost to operate the generating units while satisfying the load demand. For this purpose, the user load demand is properly shared in all generating units.

E. Flow chart of PSO



4. RESULT AND DISCUSSION

Ist: To Schedule the Load of three different areas by using PSO algorithm

In this we are taking load current of 8 Amps as Grid current with the help of PSO we are dividing load into three areas as A1, A2 and A3. Where A1 iss the emergency load example hospital. During the overload and peak demand are 2 and 3 will be disconnected at a particular time

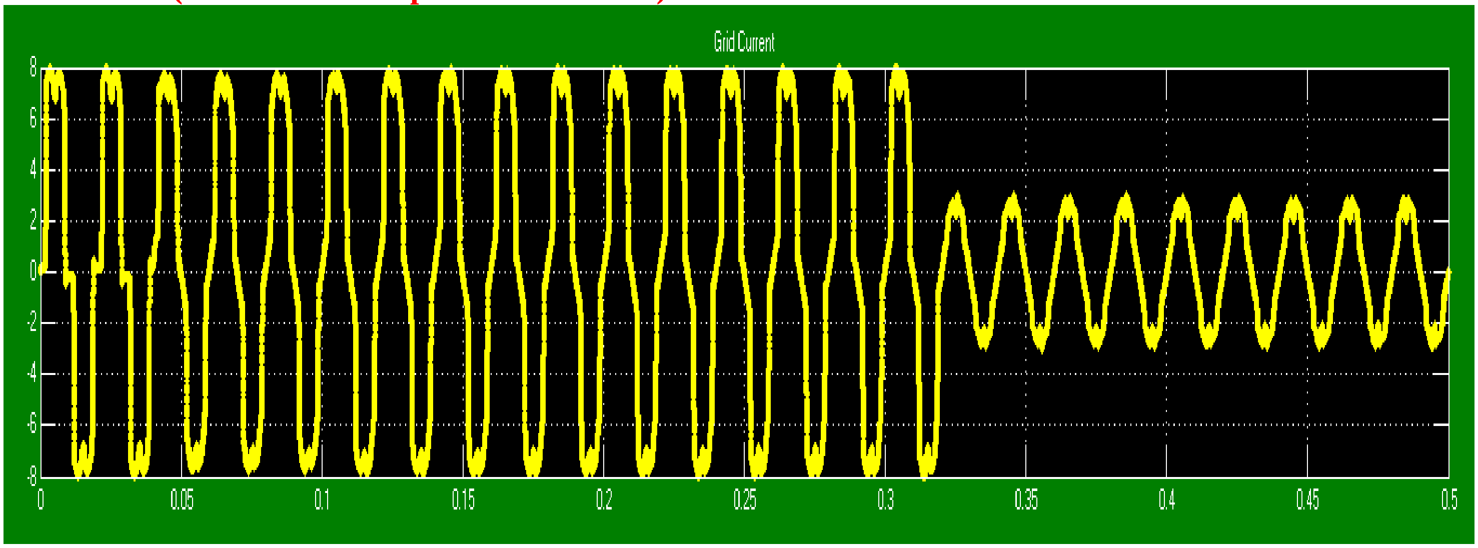


Figure 2 Grid Load Current vs Time

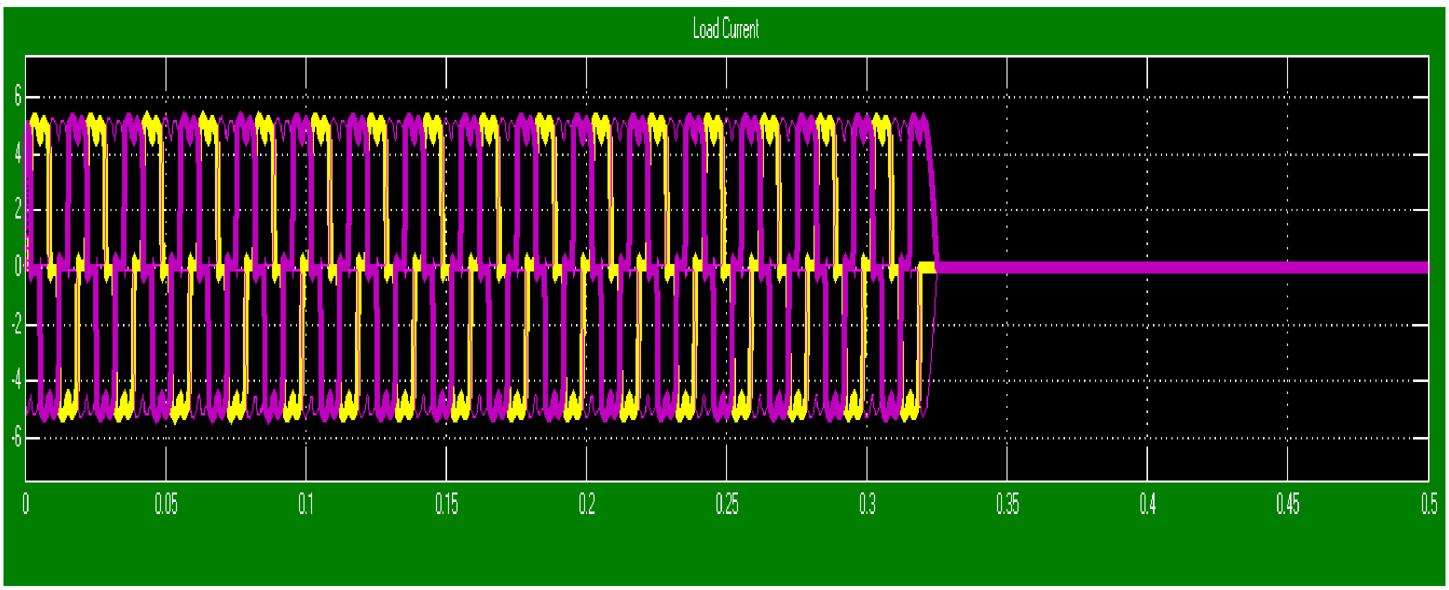


Figure 3 Load Current of Area 2&3 vs Time

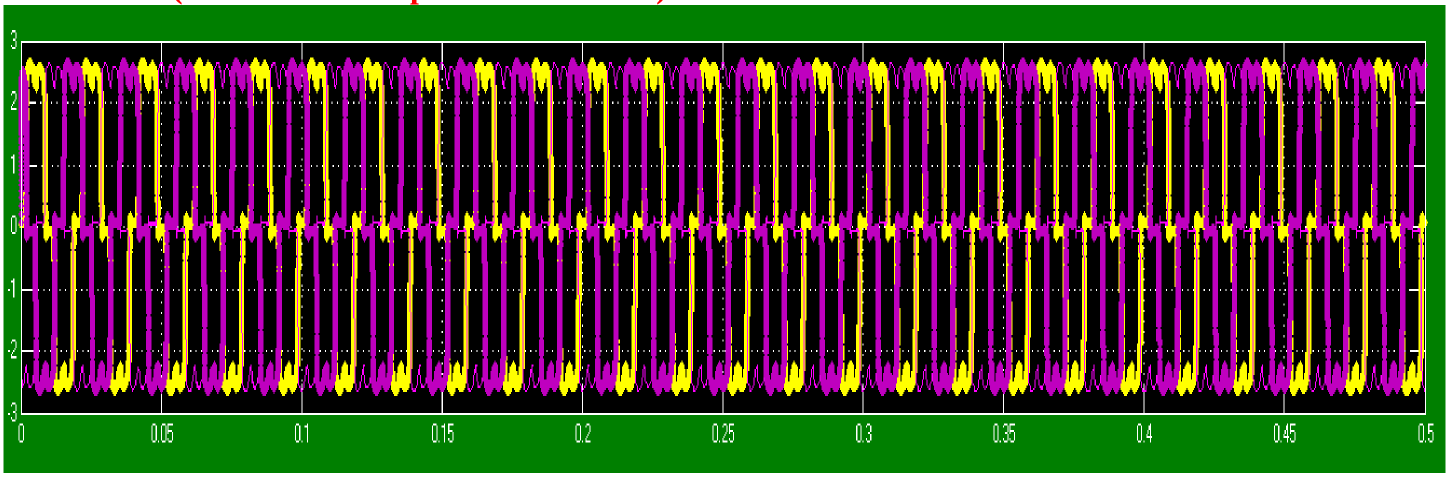


Figure 4 Load current of Area 1 vs Time (Emergency Load)

Second: To maintain Constant voltage using DC capacitor

There are many losses on the transmission line due to sag and swell so in order to maintain proper load voltage is kept constant with the help of Dc capacitor that is connected with the voltage correction in series as shown in simulation diagram

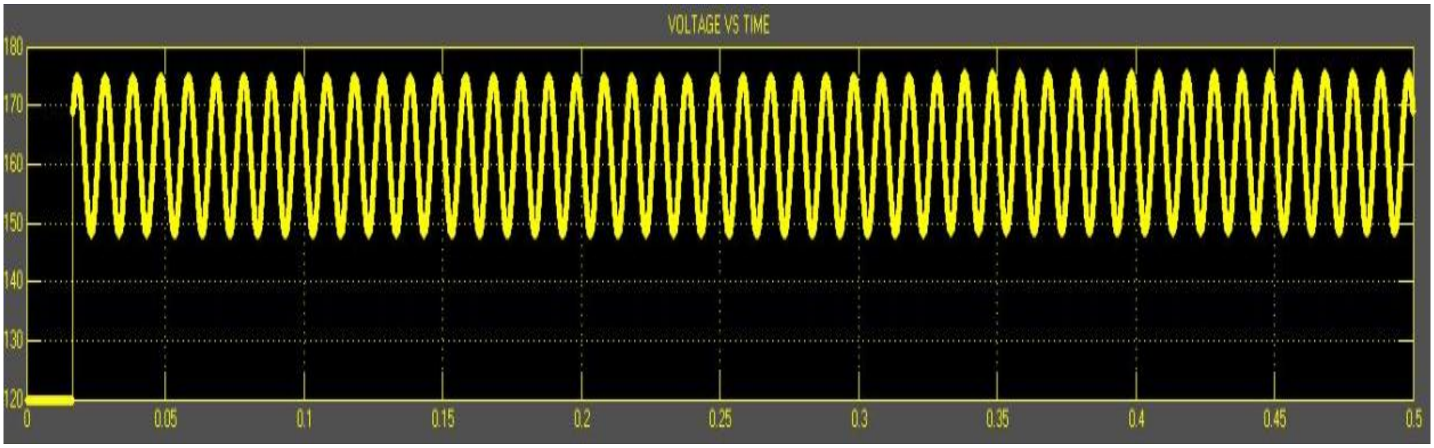


Figure 6 Voltage vs Time

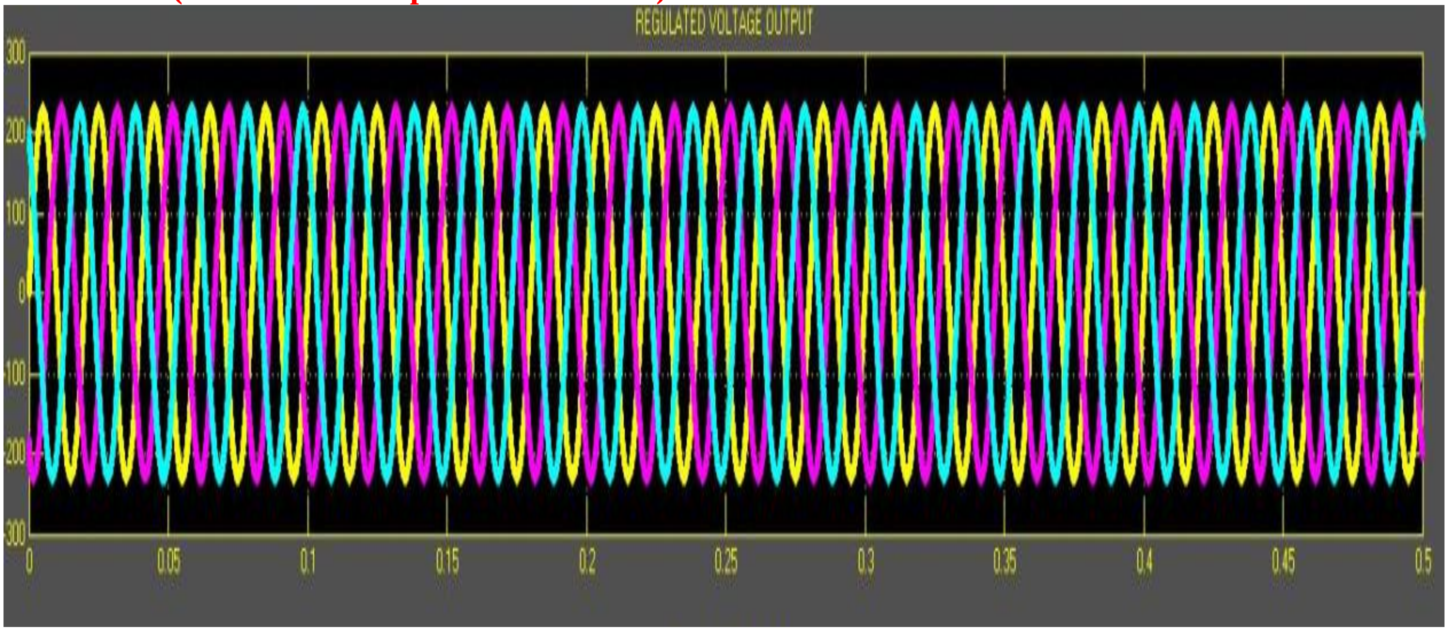


Figure 5 Rated Output voltage vs Time

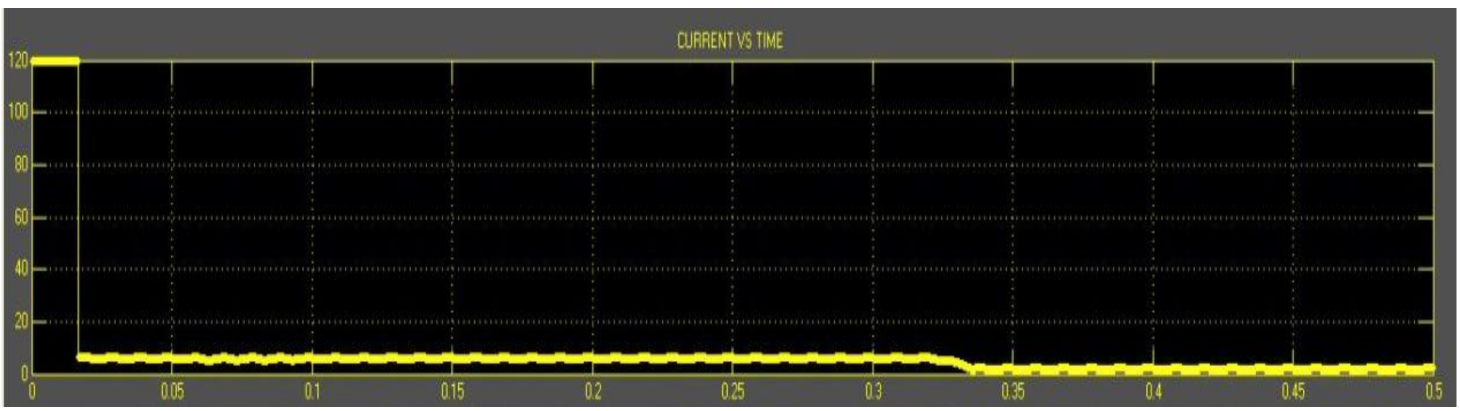


Figure 7 Current vs Time

Third: To reduce the time response during overload and power demand.
This is the time during the peak load or over-demand of load occurs. During the peak hours A1 and A2 will shut down at time interval of 0.32 and only A1 will run as A1 is emergency load as shown in figures

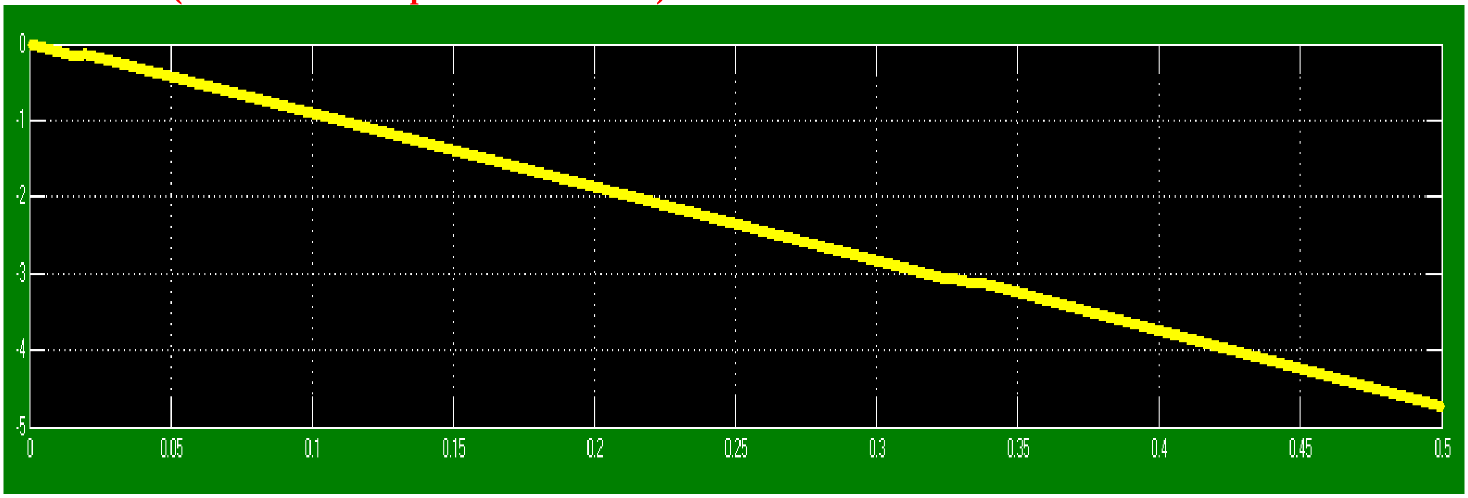


Figure 8Time Response of A1, A2 and A3

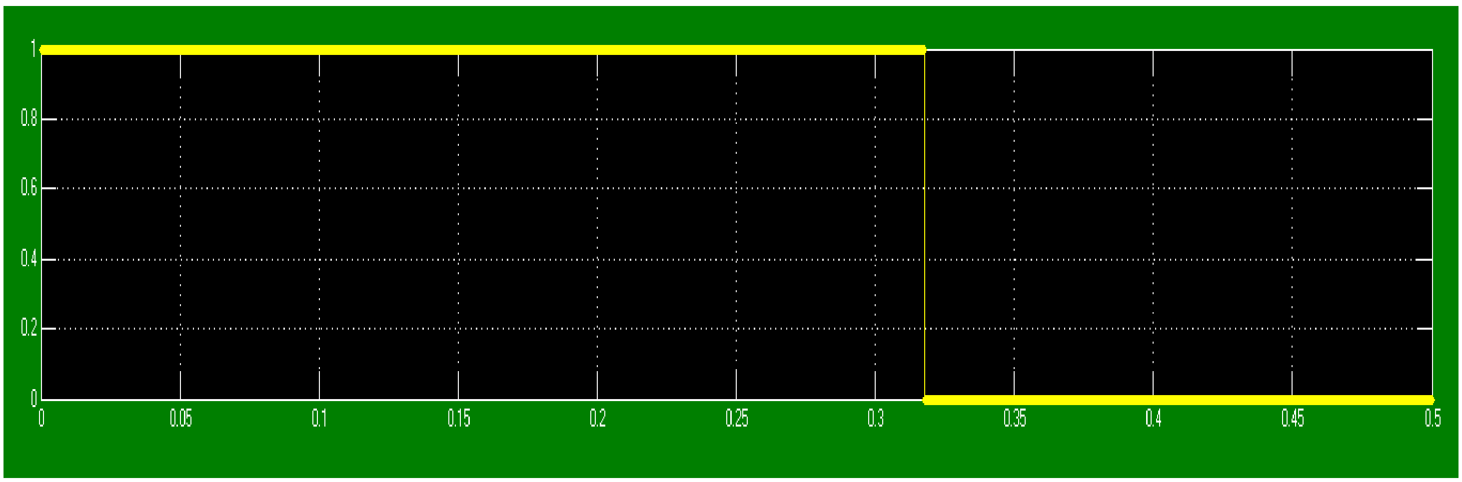


Figure 9 Peak Hour Time Response

5. CONCLUSION

Based on the above results we had found out the objectives as peak load optimization, to maintain constant voltage and reduction in time response. Demand Response is an efficient tool in bringing about energy conservation, reduction in wastage of energy and proficient utilization of the utility grid without stressing the existing transmission and distribution network. It is beneficial to both utility and consumer. An attempt to implement DR through scheduling loads at the consumer end has been made in this work. This was achieved by designing and developing a PSO algorithm applicable for residential loads commitment in a building that is facilitated with renewable power generators as well as utility grid connection. Due to overload and peak demand the Areas A2 and A3 will be disconnected at 0.32 sec and only A1 (emergency load) will run

In future by the use of hybrid algorithm for better output. Short term load forecasting based appliance scheduling. Development of co-operative DSM schemes and design of implementation strategy is also one of the future plans.

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