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Control Methodology for Peak Demand through Multi-Source Environment at Demand Side

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Abstract: *In India, the quality of the grid supply in some places is characterized by large voltage and frequency fluctuations, scheduled and unscheduled power cuts and load peak restrictions. Load shedding in many cities in India due to power shortage for which there is no immediate remedy in the near future since the gap between the power demand and supply is increasing every year. Cogeneration is another alternative to meet the peak load demand. This paper gives the information of effective usage of solar power during peak demand. Peak demand management system will automate the building's usage of electricity during peak periods, resulting in significant reduction load requirement from grid. The system requires both the grid and demand-side entities with infrastructure to support the exchange of signals. The grid entity puts in place infrastructure capable of communicating demand response signals to their customer's automation equipment and the customer installs equipment capable of receiving these signals. Furthermore the signals are typically relayed to existing facility control systems where demand response strategies have been pre-programmed to execute the appropriate load control.*
Keywords: *Load Shedding, Peak Demand, GSM, Captive Power, Demand-Side Management*

I. INTRODUCTION

The electricity sector in India had an installed capacity of 211.766 GW as of January 2013, and it is the world's fifth largest country. Captive power plants generate an additional 31.5 GW. Non Renewable Power Plants constitute 88.55% of the installed capacity and 11.45% of Renewable Capacity. Over one third of India's rural population lacked electricity, as did 6% of the urban population. Of those who did have access to electricity in India, the supply was intermittent and unreliable.

A well-known characteristic of the current electricity market is the low elasticity of its short run prices. This is mainly due to the fact that end consumers hardly react against peaks of demand, in spite of the fact that their consumption habits are largely causing imbalance. Most electricity markets do not consider consumers as active elements capable of adopting optimized strategies and decisions but simply as loads to be continuously supplied. Electricity peak demand occurs on hot summer days and cold winter nights when high energy appliances such as air conditioners and heaters are cranked up and added to our usual energy needs. On these occasions, when demand exceeds supply, Energy distributors are forced to 'shed loads' or sometimes turning off power to entire suburbs. Currently, in order to avoid peak events, energy distributors build excess capacity for reserve to meet the infrequent demand. With peak demand in India growing at 7% per year, continuing to build new infrastructure to meet our needs means spending billions developing new power stations, multiplying our greenhouse gas emissions, facing continuous energy price hikes (i.e., [1]).

With the Power Ministry set to introduce increased tariff on power usage during peak hours, it makes more sense to use proposed system to power domestic loads through solar power (i.e., [2], [3]). When the predefined states acquired, the system automatically control the various sources available to meet the load during peak usage hours thus reducing power bills by a considerable amount.

II. PROPOSED SYSTEM

The proposed system uses solar power and battery source as an alternate power sources to meet the demand during peak hours. The system as shown in Figure 1 is controlled by a processor to operate the various power sources as per predefined conditions. The information on peak demand hours will be predicted by Load Study Center using various load forecasting algorithms (i.e., [4]).and will send the data to the controller at customer node via GSM Modem. The data is processed by the controller on hourly basis and will take controlling action on specific relays. The details of each module are explained in the following sub-sections.

2.1 SOLAR POWER SYSTEM

Grid-connected residential PV systems use modules with rated power output ranging from 100-300 watts. Rated power is the maximum power the panel can produce with 1,000 watts of sunlight per square meter at a module temperature of 25^{o}C. Inverters take care of four basic tasks of power conditioning such as Converting the DC power coming from the PV modules or battery bank to AC power, ensuring that the frequency of the AC cycles is 50 cycles per second , reducing voltage fluctuations , ensuring that the shape of the AC wave is appropriate for the application, i.e. a pure sine wave for grid-connected systems (i.e., [5]).

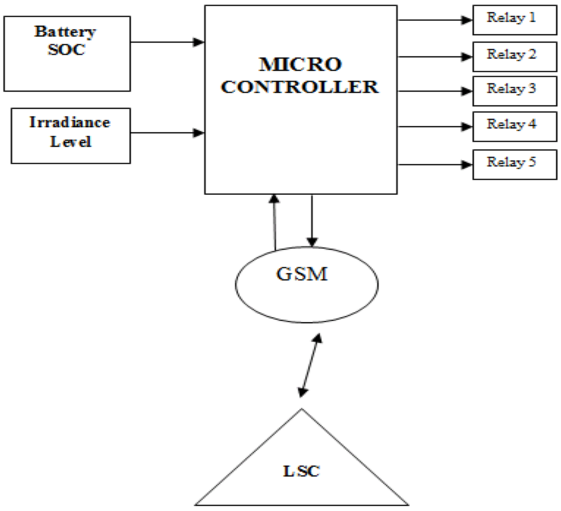

Fig. 1 Block Diagram of Proposed System

2.2 GSM MODULE

A "GSM (Global System for Mobile Communications): based Control System" implements the emerging applications of the GSM technology. The main concept of this paper is receiving the sent SMS from LSC (Load Study Center) and processing it further as required to perform Peak Demand Management operation. Whenever the LSC sends the message to GSM module, it will transfer the data to the Microcontroller through serial communication and then the controller will check for the data of the message. If the data is correct, controller acknowledges the LSC or else it requests the LSC to resend the data. The data sent is a twenty four bit data representing the daily load curve and defining the peak demand in Twenty Four Hour pattern (i.e., [6], [7]). The principle in which the project is based is fairly simple. First, the sent SMS is stored and polled from the receiver mobile station and then the required control signal is generated and sent to the intermediate hardware that we have designed according to the command received in from of the sent message.

III. DESIGN

The design is followed by the control logic which was shown through flowchart in Figure 3. The control of power from various source depends on the day and night mode. The control logic executes the action on five relays to supply power to the Load. The peak demand will be pre-calculated through various algorithms through the daily load profiles as shown in Figure 4. The load was categorized based on the starting current and the block diagram as shown in Figure 2 will give clear idea on classification and will explain the control logic of relays peak and non-peak hours based on the mode in which system operating (i.e., [8], [9]). Generally, the load like refrigerator, Air conditioner, water heaters come under category-2 loads. General lighting and fans comes under category-1.

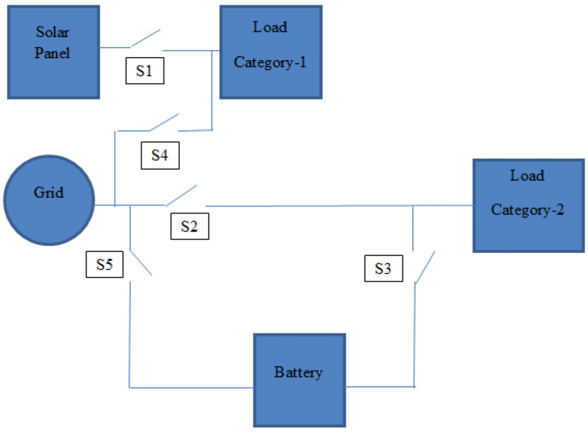

Fig.2 Block Diagram of PDM

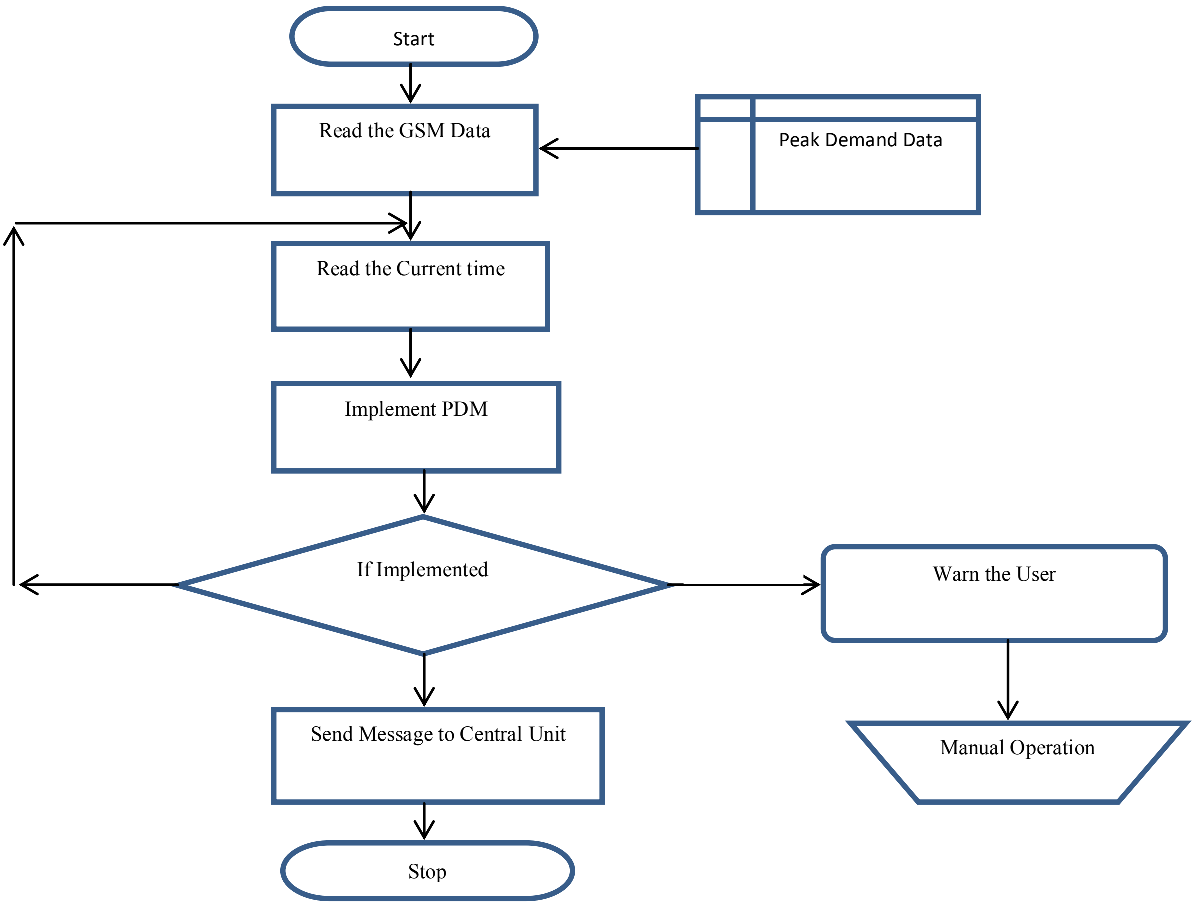

Fig. 3 Flowchart of the Peak Management System

IV. RESULTS

We evaluated LSC data in simulation and taken residential load as test-bed to explore its performance in realistic settings. Our simulator, Matlab R2007a uses input traces of load demand events to simulate background Multi-Source scheduling. The data the LSC was shown in Figure 4 and control logic was excuted according to the Table 1.

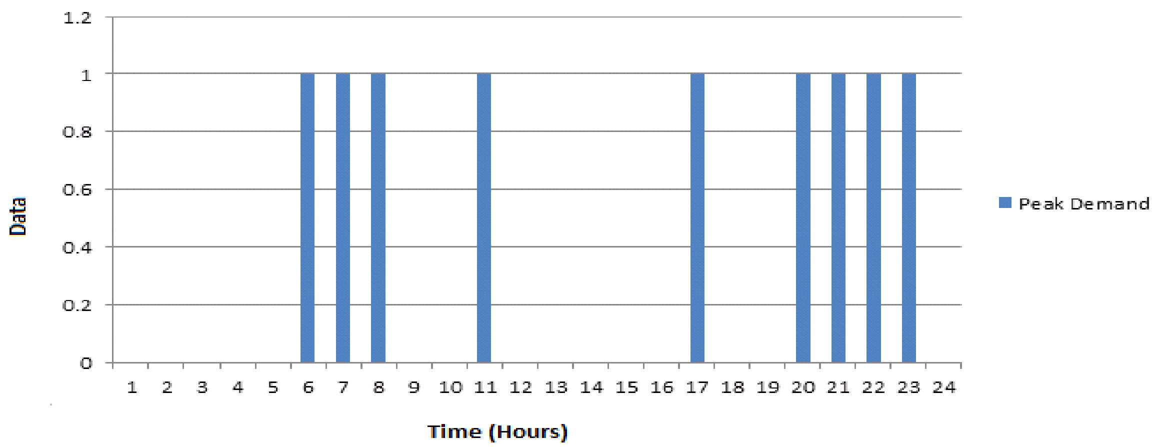

Fig. 4 Peak Load Information

The logic to control the five relays was displayed in the Table 1 and Figure 5 shows the Matlab model of the overall system. Resultant output volatgecan be verfied through Figure 6

Table 1 Control Logic for Switching Relays

Mode	**Peak Hours (1)**					**Non-Peak hours (0)**				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Day	ON	OFF	ON	OFF	OFF	ON	ON	OFF	OFF	ON
Night	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	ON	ON

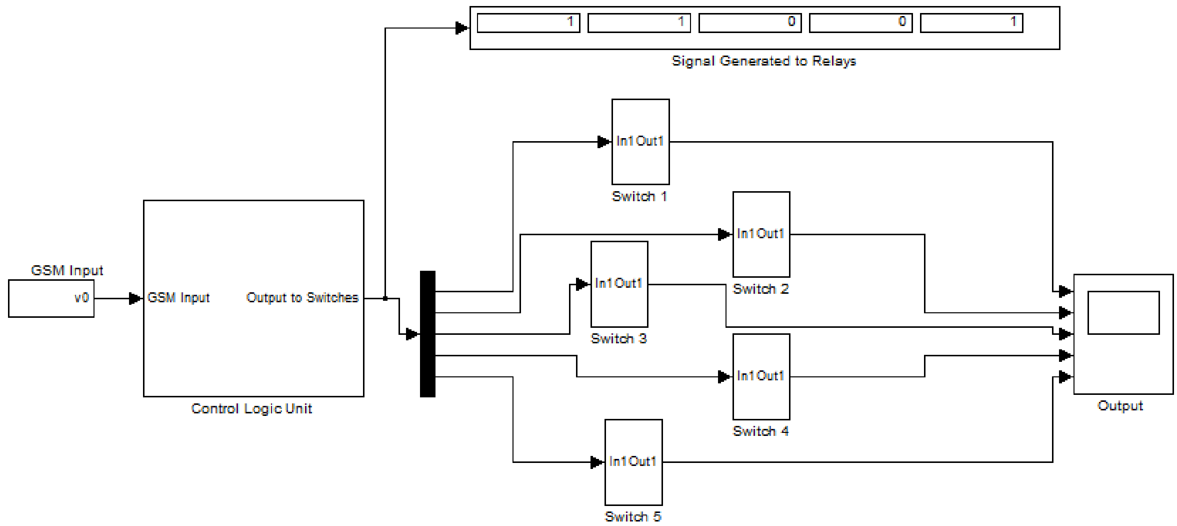

Fig. 5 Matlab Model for the Proposed System

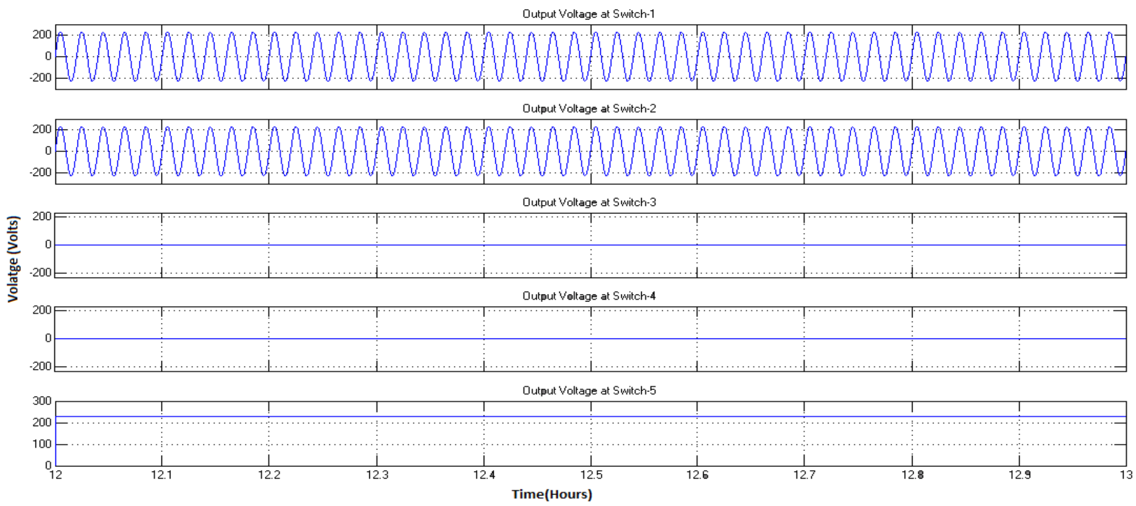

Fig.6 Resultant Output Voltage Across the Swithces

The simulated results for the instant of one hour i.e, 12:00- 13:00 hours. Through the Figure 4, the for the particular hour is “0” and considered as Non-Peak hour and the timing falls under “Day Mode”.Based on the control logic shown in Table 1, the switching logic is ON,ON,OFF,OFF,ON (1 1 0 0 1). The Display in the Matlab model gives signal generated for the particular hour. Also an inverted output has been verifed with switch-1 supplying to load category-1, Switch-2 is the direct supply for the load category-2 and Switch-5 charging the battery during Non-Peak hours.

V. Conclusion

Demand-side management is challenging, since it often requires active, and often burdensome, consumer involvement. Forcing people to think about how they use power is simply not effective in encouraging broader adoption of demand-side management. Thus, we focus on quantifying the benefits of scheduling the multi-source environment according to the peak demand requirement. The approach will flatten the house-hold demand over each day and reduces the on generating station during peak demand hours. The proposed method shows an alternate approach for load shedding. With the increase in incentives from the government for renewable based homer power automation, the solution shows great promise in current market.

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