Load Scheduling for Smart Energy Mangement in Buildings with Renewable Power Generation

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***Abstract* - Energy management systems for buildings should consider improving energy efficiency, reducing energy costs and using renewable energy technologies to address local energy costs in building structures with hybrid power generation with mixed generation reserves Renewable together with Grid Interface. The proposed system is intended to be operated in user selection table modes, such as isolated Micro Grid with multiple Renewable Generations that is not connected to the network, or a Grid Attached Grid Generation system without mains supply or a system of Full-utility grid interface that allows bi-directional power transfer to and from the grid. Also, the proposed work facilitates the prioritization of the load based on the management of the overload. Load scheduling based on maximum demand for peak load management. A number of strategies are also used to control low priority conditions and medium priority loads through multipoint time programming.**

Keywords: Building Energy Management, Demand Management, Energy Cost, Optimization, Distributed Generation, Construction Integration to the Network.

I.INTRODUCTION

The power grid is a system with some or all of the following four capacities, power generation, transmission, distribution and control. The integration of advanced information and communication technologies (ICT) increases the efficiency of the traditional network, making it capable of making fast and accurate decisions. The integration of ICT in the traditional network results in greater automation, reliable supply of electrical services, safe operation of electrical appliances and, therefore, a greater level of consumer comfort. The advent of the intelligent network has argued the proposal of several emerging technologies in the last decade of many researchers around the world. Intelligent metering technology advanced metering infrastructure (AMI), two-way communication, home automation and residential area networks (HANs) are technologies run by several researchers. The traditional power grid has been serving humanity for the past 100 years. The world population and the level of dependence of human energy on the phenomena of electricity are increasing continuously and exponentially. As there has not been much change in the traditional network to cope with growing demand, the end result is that the traditional network has worn away and the idea of the smart grid has evolved. Distributed applications for the smart grid can be found in the consumption, distribution, transmission and generation of electrical energy. The intelligent grid improves the efficiency of the use of electricity. If the devices are equipped with sensors, AMI can be used to predict the load of a specific area. The efficient consumption of electricity benefits us socially and economically. The use of HEM systems in a residential area reduces energy bills for consumers and maximum demand. With normal demand for peak hours, utilities are able to provide electrical power from the base plants and hence the contribution of greenhouse gases (GHG) is less for environmental pollution. A power quality monitoring strategy has been enabled through the use of sensor networks in the intelligent network (transmission and distribution application). The ZigBee protocol has been used to monitor and control energy for efficient consumption and distribution (application of consumption and distribution). The option of distributed power generation is always present in the smart grid technology, where you can generate electricity at home (photovoltaic, wind), use energy locally and sell spare energy to the company. The load demand curve in the traditional grid, where flat-rate tariffs are active, shows that load demand is comparatively high during peak periods compared to times with less activity. Therefore, electricity companies are not able to provide such a high energy of their base plants and have to compulsively activate their high efficiency plants (power plants) for which the costs of power generation and GHG emissions are very high compared to Base Plants. The originally inelastic load demand curve needs to be altered to reduce the maximum load demand, energy cost and GHG emission.

A. Hierarchical Control Strategy

In general, control systems for the energy and energy management of a micro grid can be organized in a three-level hierarchical structure, based on the time scales of control responses. Primary controls include local controls for frequency and voltage settings that can respond at millisecond time scales; Secondary controls are steady state set points provided to the primary controls at periodicities

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

from a few seconds to a few minutes, usually by a centrally executed algorithm; and the tertiary controls refer to energy scheduling decisions over longer planning time horizons. Depending on the capability of the micro-grid system, network configuration and generation technology, several challenges can be encountered in the application of hierarchical controls to micro grids, especially with the design of primary controls. For example, in micro grids where DG resources are separated by a resistive network, primary tilt controls for frequency and voltage adjustments are very difficult to implement due to the coupling between active power and reactive power. High-bandwidth site-to-site communication may be required to coordinate primary controls to allow energy exchange between DG resources.

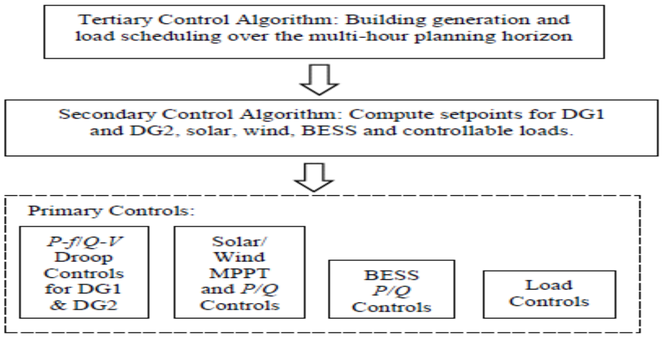

Figure 1 : Hierarchical Controls of the Building Micro grids.

In addition, in the micro-grid where the dominant generation resources are inverter-based, there are significant complications in the filtering of harmonic contents to obtain valid control signals. These micro grid control challenges can be successfully addressed for a micro-grid building, as DG resources are very close to each other, with fossil fuel-based generation groups, mainly to meet capacity requirements. As a

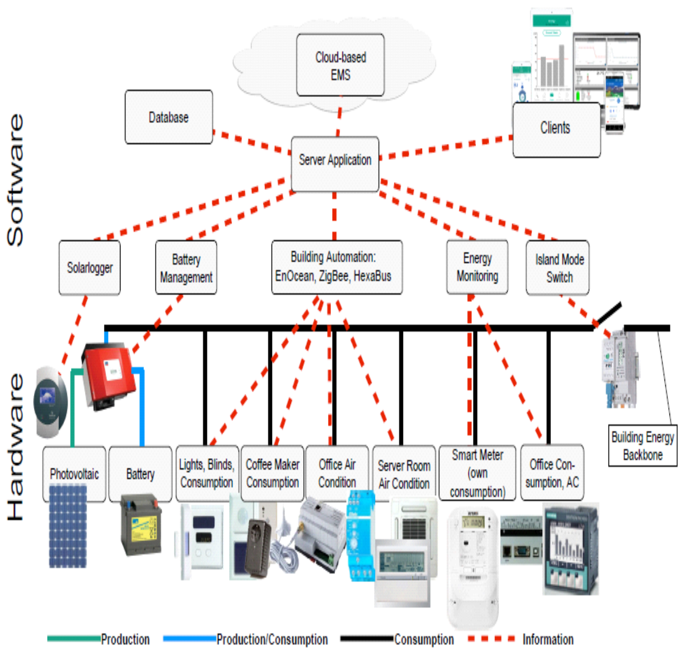

Figure 2 : Overview of the Smart Energy Living Lab.

result, conventional slope control methods, such as active power-frequency (P-f) and reactive power-voltage (Q-V) can be successfully applied to DG fossil fuels for voltage and frequency regulation. However, one of the most outstanding challenges with controls in the Micro Grid building is associated with power quality management. For the Smart Energy Living Lab, a flexible, scalable and lightweight architecture is used in a layered and component approach to ensure scalability, flexibility and scalability. Figure 2 provides an overview of the system. From the bottom, several sensors and actuators are connected to the server application, or middleware, respectively. The sensor and the active layer the software components of the server application's system layer allow user management, their functions, associations with rooms and personal profiles, and modeling of intelligent building environments in terms of allocating peripherals to rooms and Buildings respectively. This layer includes a central register to allow the integration of sensors and additional actuators in plug and play.

II. PROPOSED WORK

GUIDE, the MATLAB graphical user interface development environment, provides a set of tools for creating graphical user interfaces (GUIs). These tools simplify the process of laying out and programming GUIs. Using the GUIDE Layout Editor, you can populate a GUI by clicking and dragging GUI components such as axes, panels, buttons, text fields, sliders, and so on into the layout area. We can also create menus and context menus for the GUI. From the Layout Editor, you can size the GUI, modify component look and feel, align components, set tab order, view a hierarchical list of the component objects, and set GUI options.

The GUI interfaces of MATLAB GUI (also referred to as user interfaces or graphical user interfaces) allow you to control software applications on a one-time basis, eliminating the need to learn a language or write commands to run the application. MATLAB applications are autonomous MATLAB programs with front-end GUI that automate a task or a calculation. The GUI typically contains controls such as menus, toolbars, buttons, and cursors. Many MATLAB products, such as the Curve Adjustment Toolkit, the Signal Processing Toolkit, and the Control System Toolbox, include applications with custom user interfaces. We can also create your own custom applications, including their corresponding user interface, that others can use.

Project guide screen shot for our thesis is shown in figure3. It consists of three major blocks which are :(1) Solar Array (2)Load Control Block (3)Appliance Load Matrix.

A. SOLAR ARRAY

In this block, we can consider any kind of renewable energy source. In this model, we use solar array each having capacity of 1000 W. It consists of three solar array each having adjustable slider to up or down the value of solar generation. We can control renewable energy using slider.

B. LOAD CONTROL BLOCK

This block is used for metering, for controlling power flow, switching and also provides option for peak demand hour setting. It can be divided into three panels:

a. PEAK DEMAND HOUR SETTING PANEL

In this panel, we can run the system by provide time setting

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

which will follow the strategies provide by us and give results according to our program. We can also control peak demand by time setting in this panel.

b. METERING PANEL

In this panel, various real time load readings as well as system parameters are display according to any changes in load or system parameters. In this panel, we can see outputs and status for total renewable energy generation, grid feeder limit, total power limit, load status, system configuration (i.e. hybrid mode or grid tie mode), power flow etc. All real-time readings are displayed in this panel.

c. GRID AND FEEDER ON/OFF PANEL

In this panel, we have switching option to connect or disconnect the supply available from grid. We have option to use energy either from renewable or from grid or from both renewable as well as grid. We can easily switch the grid according to our requirement. We have also option to feed extra renewable power feed to grid when our power demand is less. We can switch the grid feed according to own premises.

III.RESULT ANALYSIS AND DISCUSSION OF LOAD SCHEDULING

In this case, we assume different conditions to describe the system which is given in table 1. In this we take load premises from user and our system evaluate the load demand according to system status and provides us priority based load scheduling. If load demand doesn't meet than in this case tier-3 i.e. Low priority load will OFF first, then tier-2 load i.e. Medium priority load will OFF and tier -1 i.e. High priority load will run if it not exceeds the total power limit. If its value also exceeds the power limit i.e. Either a renewable power limit or sum of renewable as well as grid power, then high priority load will be also OFF. At different time no. of conditions are assumed in table and what is consumer premises and how much load system provide according to our load scheduling strategies stated in following table with diagrams and appropriate time v/s load graph shown in figure 4 and 5..

A.LOAD SCHEDULING DURING PEAK DEMAND HOUR-1

In this case of load scheduling peak demand hour-1 considered in this we set time duration according to our requirement. In this time region, low priority load i.e. tier-3 load will permanently OFF. If consumers turn ON any load this will

automatically cutoff by system itself. Only medium priority and high priority load can be ON. If load exceeds in both priority, then first medium priority will OFF if further load more rises then permissible limit then high priority load will also OFF. Various type of applicable loads and its case study is shown in table 2 and its diagram and graph is shown in figure.

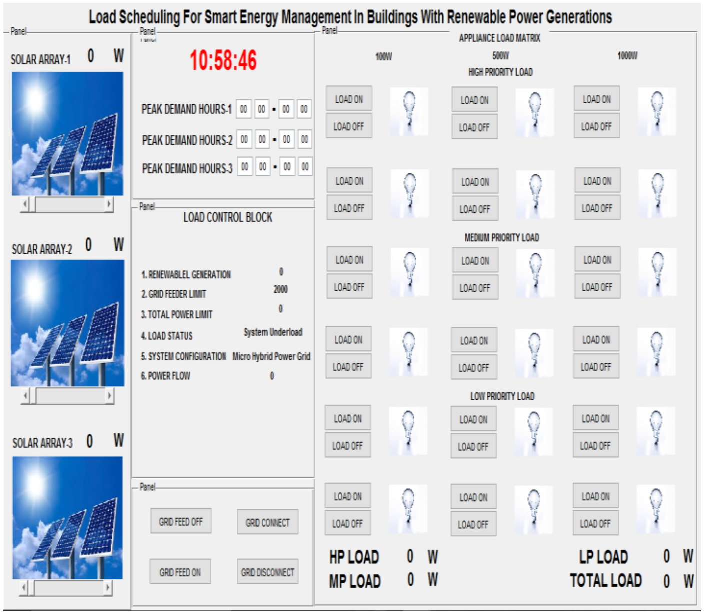

Figure.3:Project Guide SnapShot.

S. No.	Time	Grid Conn-ect	Grid Feed	SA1 W	SA2 W	SA3 W	Total Renewable Gen.(W)	Grid feeder limit	Total power flow	Load Provide By User(W)			Total Load By User(W)	Load Provide By System			Total Load (w)	Load status	Power flow	System Configuration
										LP	MP	HP		LP	MP	HP				
1	10:58:46	OFF	OFF	0	0	0	0	2000	0	0	0	0	0	0	0	0	0	UL	0	MICRO HYBRID POWER GRID
2	10:56:13	OFF	OFF	1000	1000	1000	3000	2000	3000	1600	1000	500	3100	0	1000	500	1500	AL	0	
3	11:02:32	OFF	OFF	1000	1000	1000	3000	2000	3000	1000	1000	1000	3000	1000	1000	1000	3000	OL	0	
4	11:10:55	ON	ON	1000	1000	1000	3000	2000	5000	0	0	0	0	0	0	0	0	UL	-3000	GRID TIE MODE
5	11:12:25	ON	ON	1000	1000	1000	3000	2000	5000	1000	600	1000	2600	1000	600	1000	2600	AL	-400	
6	11:17:26	ON	ON	1000	1000	1000	3000	2000	5000	2000	1600	1000	4600	2000	1600	1000	4600	OL	1600	
7	11:20:12	ON	ON	1000	1000	1000	3000	2000	5000	2000	1600	1500	5100	0	1600	1500	3100	AL	100	
8	11:22:29	ON	OFF	1000	1000	1000	3000	2000	5000	0	0	0	0	0	0	0	0	UL	0	MICRO HYBRID POWER GRID
9	11:24:14	ON	OFF	1000	1000	1000	3000	2000	5000	1000	1500	2000	4500	1000	1500	2000	4500	AL	1500	
10	1127:36	ON	OFF	1000	1000	1000	3000	2000	5000	200	2100	2500	4800	200	2100	2500	4800	OL	1800	
11	11:29:28	ON	OFF	1000	1000	1000	3000	2000	5000	700	2100	2500	5300	0	2100	2500	4600	OL	1600	
12	11:31:25	OFF	ON	1000	1000	1000	3000	2000	3000	0	0	0	0	0	0	0	0	UL	0	
13	11:33:23	OFF	ON	1000	1000	1000	3000	2000	3000	500	500	1500	2500	500	500	1500	2500	AL	0	

Table.1:Priority Based Load Scheduling Chart .

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 03, March-2017

S. No.	Time	Grid Connect	Grid Feed	SA1 W	SA2 W	SA3 W	Total Renewable Gen.(W)	Grid feeder limit	Total power flow	Load Provide By User(W)			Total Load By User(W)	Load Provide By System			Total Load (w)	Load status	Power flow	System Configuration
										LP	MP	HP		LP	MP	HP				
1	15:06:46	OFF	OFF	1000	1000	1000	3000	2000	3000	500	2200	700	3400	0	2200	700	2900	OL	0	MICROHYBRID
2	15:07:34	OFF	OFF	1000	1000	1000	3000	2000	3000	100	2200	1000	3300	0	0	1000	1000	AL	0	MICROHYBRID
3	15:12:40	ON	ON	1000	1000	1000	3000	2000	5000	100	1500	500	3000	0	1500	500	2000	AL	-1000	GRID TIE MODE
4	15:14:13	OFF	ON	1000	1000	1000	3000	2000	3000	0	1000	2100	3100	0	0	2100	2100	AL	0	GRID TIE MODE
5	15:16:12	ON	OFF	1000	1000	1000	3000	2000	5000	0	3100	2000	5100	0	0	2000	2000	AL	0	MICRO HYBRID

Table2:Peak Demand Based Load Scheduling Chart.

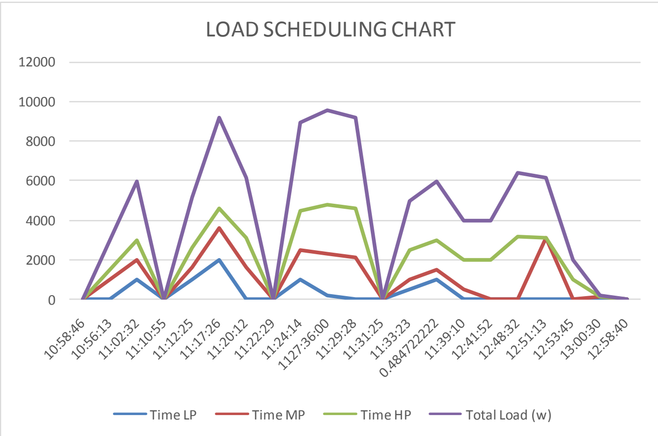

Figure.4:Priority Based Load Scheduling Graph

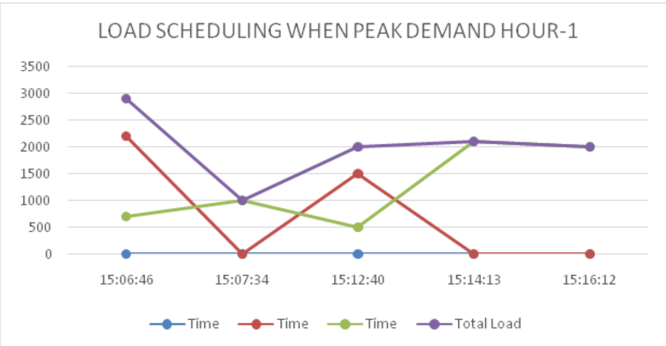

Figure5.:Peak Demand Hour Based Load Scheduling Chart.

IV. CONCLUSION

- The above work investigates the application of computerized control & automation technology in efficient energy management system.
- The above work provides various control strategies to use renewable energy more and more that considers the use of energy efficiency, reduction in energy costs and the use of renewable energy technologies to handle the load.
- The proposed algorithm used Information Technology in conjunction with open server standards to emphasize renewable energy usage, & Peak Time overload management strategies.
- We got load scheduling basis on time as well as multilevel priority towards overload management.
- We can also observe and examine different situations regarding varying loads and easily justify them.
- The above work supports the worldwide aim of reduction of carbon emission that supports a cleaner environment & stronger economy and strengthens economy by providing a stable & diverse energy generation, especially for wind & solar, & smart grid concepts are critical technologies needed to addresses global warming related issues.

V.FUTURE SCOPE

The above work opens a pioneering field in the energy management of buildings through the efficient use of renewable energies and energy companies. Here are some important aspects that can be improved in the future:

- Integration of wireless monitoring and data recording techniques with the existing set up to learn the specific needs of users and energy demand.
- Use of artificial intelligence algorithm to automatically schedule non-continuous loads & manage their operation permanent automatically to share energy during peak load hours.
- Use of Smart metering along with automation technologies to segregate energy consumption in various lively expenses such as refrigeration, Heating, Air Condition, Washing, Water pumping etc.
- Involvement of fuel cell technology to store unused renewable energy, before feeding to grid, to create a Peak Demand Hours Usage energy store, so that utility grid is not overloaded during peak consumption.

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