

Energy Management Based On Demand Response in Smart Grid

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ABSTRACT: Now a days, energy saving is one of the most important issue for development of smart grid. The utility companies have higher electric tariff during peak periods, so smart grid emphasizes off-peak energy consumption. The Home Energy Management system shall play a very important role in realizing residential demand response in smart grid environment. Therefore, the Residential smart grid with Demand Response (DR) is proposed, in which different resources are used and corresponding priority is adjusted based on need of load as well as the capacity of resource. The PIC Microcontroller is used, which makes a decision to switch between the resources based on capability of resource and residential load. The proposed system is also responsible for reduced electrical consumption and minimum electricity cost. A prototype is implemented and tested to prove the concept.

KEYWORDS: Demand Response, Smart Grid, Renewable Energy.

I. INTRODUCTION

Smart grid is an electrical grid that uses information and communication technology to gather data and act on information about the behaviour of suppliers and consumers in an automated fashion. Hence smart grid is a generic label for the application of computer, intelligence and networking abilities to the existing dumb electricity distribution systems.

Microcontroller based grid designed to choose the mode of resource according the demand of the particular residential network and the capacity of the resource. According to the requirement of energy, the capacity of the battery which is charged by Photovoltaic module is checked for its sufficiency to full fill the needs, if it is sufficient then the residential load is connected to the battery, if it is insufficient then the residential load is connected to electricity board connection. The switching of the resource is carried out by relay. Efficiency of photovoltaic module is maintained by boost converter. The modulated pulse width for boost coveter is provided by microcontroller.

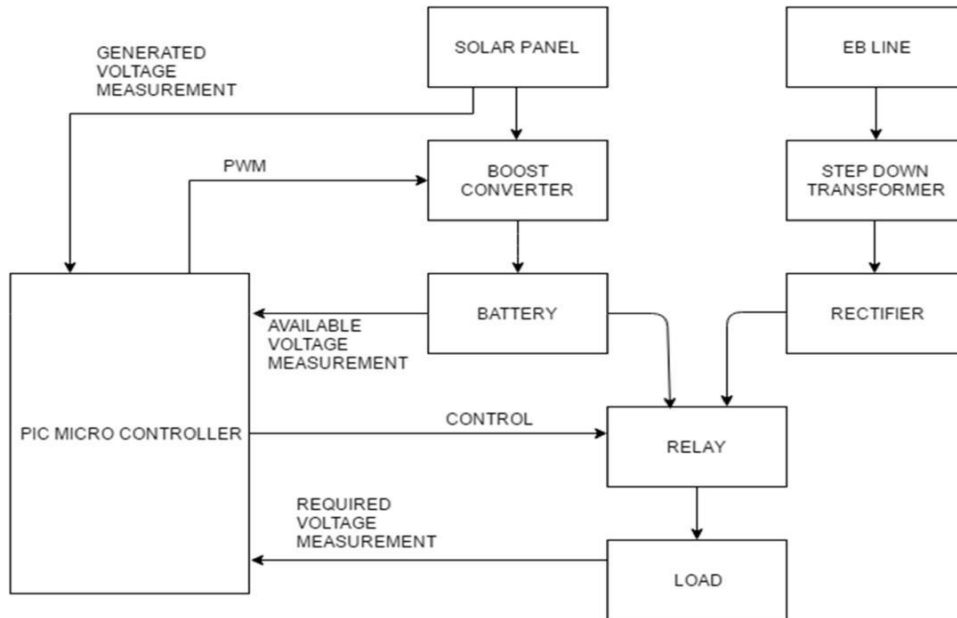


figure 1.1 Block Diagram

II. RELATED WORK

I) ELECTRIFICATION, as made possible by the electric power grid, has been selected as the most significant engineering achievement of the 20th Century by the US National Academy of Engineering. However, not until recently has the imperative of revitalizing US electric infrastructures been realized and a lot of efforts are being put into the grid modernization, which transforms the century-old power grid to the “smart grid.” This transformation has been motivated by the following notable drivers: 1) The physical infrastructure of the electric grid is aging and overburdened. The electricity demand continues to rise while the investments in the power transmission and distribution infrastructure have been dwindling. 2) Concerns over global climate change (e.g., global warming) and carbon emissions have forced us to aim at more aggressive goals of deep integration of large amounts of renewable generation, especially wind and solar, to meet our electric energy needs. As stated in, the smart grid would be the enabler for meeting environmental targets, accommodating a greater emphasis on demand response (DR), and supporting widespread plug-in hybrid electric vehicles (PHEVs) as well as distributed generation and storage capabilities. To realize such vision for the smart grid, we have to seek helps from advanced communication, information, and control technologies in conjunction with advances in renewable energy generation, energy storage, materials, sensors, and power-electronics.

II) Demand-side management (DSM) has emerged as an important smart grid feature that allows utility companies to maintain desirable grid loads. However, the success of DSM is contingent on active customer participation. Indeed, most existing DSM studies are based on game-theoretic models that assume customers will act rationally and will voluntarily participate in DSM. In contrast, in this paper, the impact of customers’ subjective behaviour on each other’s DSM decisions is explicitly accounted for. In particular, a noncooperative game is formulated between grid customers in which each customer can decide on whether to participate in DSM or not. In this game, customers seek to minimize a cost function that reflects their total payment for electricity. Unlike classical game-theoretic DSM studies, which assume that customers are rational in their decision-making, a novel approach is proposed based on the framework of prospect theory (PT) to explicitly incorporate the impact of customer behavior on DSM decisions. To solve the proposed game under both conventional game theory and PT, a new algorithm based on fictitious play is proposed using which the game will reach an mixed Nash equilibrium. Simulation results

are provided to assess the impact of customer behaviour on DSM. In particular, the overall participation level and grid load can depend significantly on the rationality level of the players and their risk aversion tendencies.

III) An HEM system plays a fundamental role in implementing the automated DR within a house, as most residential customers do not have time, nor practical enough to perform DR manually. A DR event is defined as a period during which the customer demand needs to be curtailed to improve a system stress condition. Customers who participate in a DR program can be informed of a DR event by an external signal from a utility via their smart meters. Different loads are used in this project and the corresponding priority is adjusted based on the priority of the loads and user preferences. As mentioned in Fig.1, a distribution board and meter can be used to provide an interface between utility and home owner in a real life environment. HEM receives external signal, which includes demand reduction request and duration, for implementing this concept the algorithm is designed to guarantee the total power consumption below the specified demand limit level during the specified duration. The proposed HEM algorithm allows the home owner to operate their appliances when needed as long as the total household consumption remains below the specified limit during a DR event. In earlier, the system proposed would make use of GSM module, hand based gesture which took into limited working of project. Hence in proposed system, the GUI view will be used to monitor and control appliances status and power consumption.

IV) Intermittent renewable energy resources such as, wind and photovoltaic (PV) plays a considerable role in today's power generation. In order to compensate this highly variable generation demand response is employed as a part of demand side management instead of costlier generation side spinning reserves. This capability can be achieved through responsive electric devices such as electric water heaters. Simulation model of the DR loads (heater) is mainly focused in a building considering the indoor and outdoor conditions. This paper presents a new approach for modeling flexible loads and aims to create further knowledge on the potentials of residential demand response concepts. The simulations are performed in MATLAB software.

V) In deregulated market environment, congestion management plays an important role in power system operation. An approach of applying Demand Response (DR) programs has been used for transmission line congestion management in a deregulated power system. In this paper DR is modelled considering Time of Use (TOU), Critical Peak Pricing (CPP) using MATPOWER software. The paper evaluates DR effects on the generating companies, consumers, merchandising surplus, power system security and operating cost in addition to the congestion management. The proposed models are implemented on IEEE-14 bus system.

VI) This paper presents of a hybrid solar-wind energy system which uses a DC-DC converters for conversion purpose for both solar and wind. In solar, the technique called MPPT is implemented by using an algorithm called P&O. In wind, PMSG is used as generator which eliminates the need of gear box to WECS, thereby reducing the cost of the overall system. The output can be extracted from both solar as well as from wind too. The DC-DC converter used here is of CUK & SEPIC which can act as Charge controllers, Maximum power point trackers, also used to reduce harmonic contents in the system by acting as a filtering circuit. This system can be used to run DC loads.

VII) In this article we describe our efforts of extending demand-side control concepts to the application in portable electronic devices, such as laptop computers, mobile phones and tablet computers. As these devices feature built-in energy storage (in the form of batteries) and the ability to run complex control routines, they are well-suited for the implementation of smart charging concepts. We developed simple hardware and software based prototypes of smart charging controllers for a laptop computer that steer the charging process depending on the frequency of the electricity grid and in case of the software implementation also based on the battery charge status. If similar techniques are incorporated into millions of devices in UK households, this can contribute significantly to the stability of the electricity grid, help to mitigate the short-term power production fluctuations from renewable energy sources and avoid the high cost of building and maintaining conventional power plants as standby reserve.

III. WORKING

The output of the solar panel is connected to the boost converter, if the energy from the solar panel is not equal to the maximum efficiency, PIC microcontroller provides the modulated pulse width signal to the boost converter to obtain the maximum efficiency according to solar panel's output. Battery gets charged by constant DC voltage provided by boost converter. Line from the battery is connected to the NC (Normally closed) part of the relay. AC voltage from electricity board line is stepped down with the help of step down transformer and then converted into DC voltage with the help of bridge rectifier. The output from the rectifier is connected to the NO (Normally Opened) part of relay. Load (residential electrical appliances) is connected to the com of the relay. The required energy to full fill the load, energy available in the battery and the solar panels output voltage is measured using voltage divider circuit and given as analog input to PIC microcontroller. Comparison of energy required by the load and energy available in the battery is made by PIC micro controller and the result signal is given to the relay driving circuit. According to the signal from the PIC microcontroller, driver circuit provides the necessary voltage to magnetize the relay. Relay works according to the strength of magnetization. That is, com of the relay will stick or change to the Normally Closed or Normally Open part of relay according to magnetization strength. The digital display of measured values and source chosen is displayed in

LCD. In electronics, a voltage divider (also known as a potential divider) is a simple linear circuit that produces an output voltage (V_{out}) that is a fraction of its input voltage (V_{in}). Voltage division refers to the partitioning of a voltage among the components of the divider. In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or other component, such as a high-power transistor.

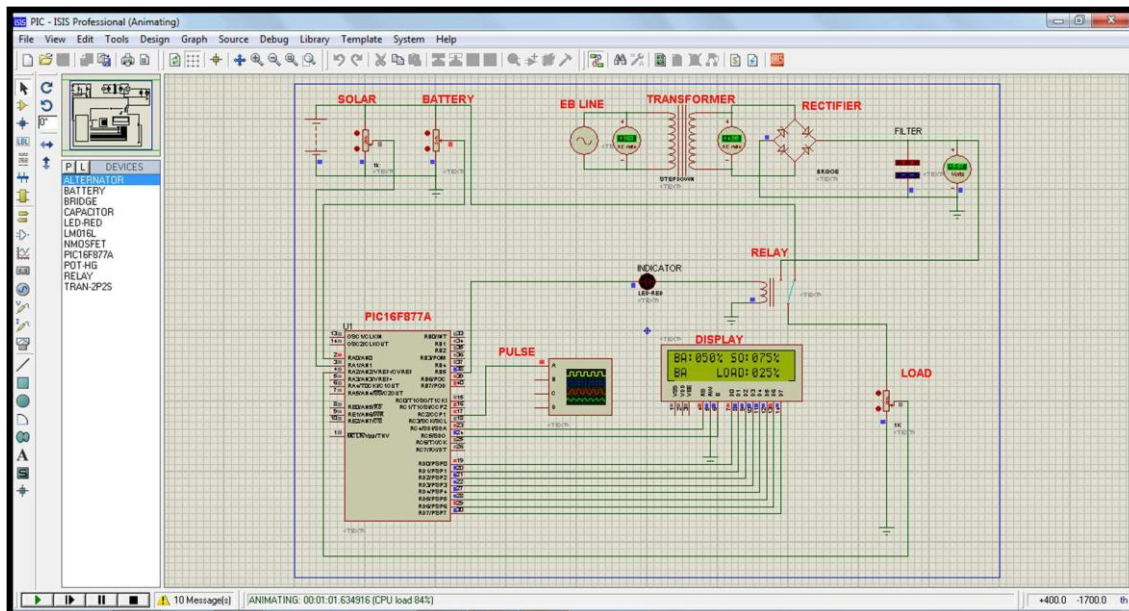


Figure 1.2

In this simulation capacity of the battery is greater than the load, so that the energy source chosen by the PIC microcontroller is Battery. Hence the relay sticks to it and serves the load with batteries energy.

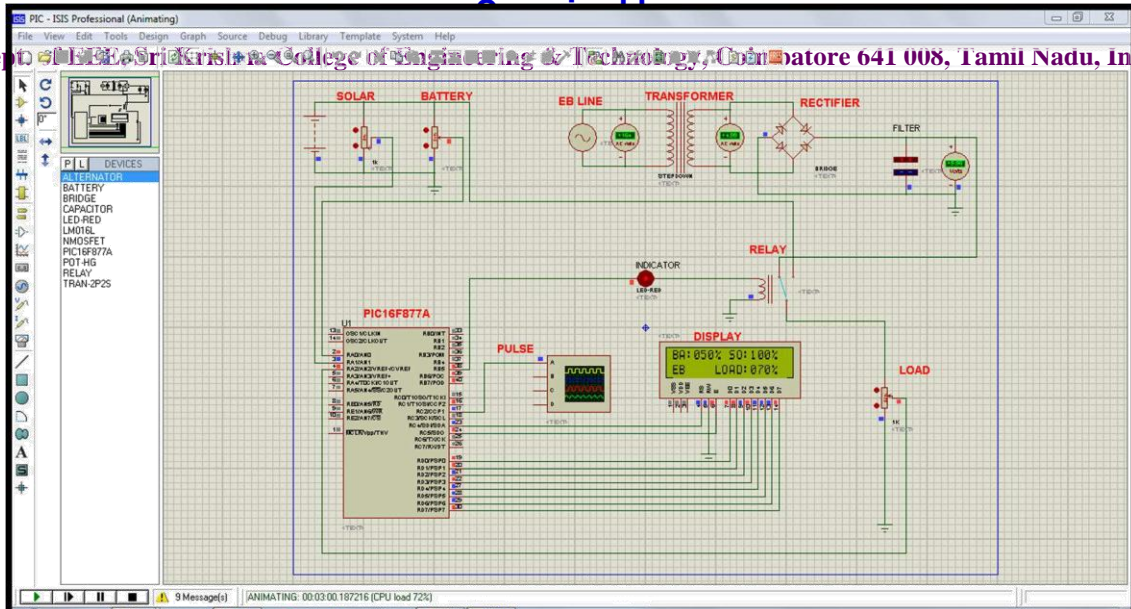


Figure 1.3

In this figure the alternative working is shown, the capacity of the battery is less than the loads requirement, so the PIC microcontroller choses the Electricity Board (EB) to serve the Load

IV. EXPERIMENTAL RESULTS

The output, choosing the energy source based on the capability of the resources and the required load is simulated successfully.

CASE	LOAD (%)	BATTERY (%)	ENERGY SOURCE
1	25	50	Battery
2	70	50	Electricity Board

If the output of the solar panel is less than its maximum efficiency, PIC gives the pulse input to boost converter to obtain maximum efficiency.

VII. CASE 2:

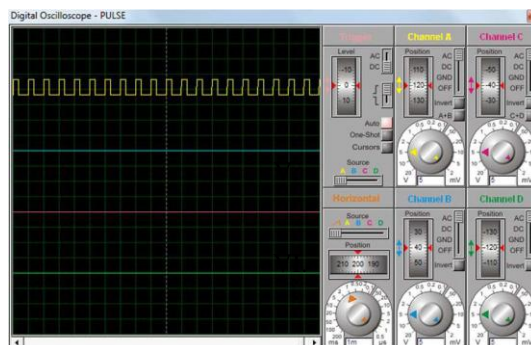


Figure 1.3

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization

Volume 6, Special Issue 14, August 2017

Two Days National Conference on Modernization in Engineering Science (NCMES 2K17)

23rd-24th March 2017

Organized by

Dept. of EEE, Sri Krishna College of Engineering & Technology, Coimbatore 641 008, Tamil Nadu, India

V.CONCLUSION

We have proposed an approach to addressing the optimal management of real-time pricing, inelastic and elastic energy demands, renewable energy generation, and energy storage to reduce the electricity cost for a residential customer in the smart grid. The intuition behind our approach is to use energy storage to harvest excessive renewable generation for later use and to charge the battery when the electricity price is low while discharging it when the electricity price is high. By using our proposed techniques, we can achieve close to optimal cost with increased battery capacity. Moreover, we have also investigated the case for elastic energy demand and use the technique of virtual queue to guarantee the finite worst case delay for any buffered energy demand. Finally, we use practical data sets to evaluate the effectiveness of our method.

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