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PLC Based Home Energy Management System

Pooja Patil¹, Pragati Deshamukh², Sumedha Thorat³, Pallavi Kadam⁴

B.E, Dept. of Electrical Engineering, JSPM'S Wagholi, Pune, India^{1,2,3}

Asst. Professor, Dept. of Electrical Engineering, JSPM'S Wagholi, Pune, India⁴

ABSTRACT: The Ever increasing demand for electricity has been an impediment for smooth running of power system operation. Generally, most of the outages in transmission line occur at critical peak hours which lead to limit the supply. The limited power is sanctioned for the distribution network of a particular area. However, domestic power consumption may exceed the sanctioned limit and the overloading and outages of the lines may occur. Hence, it becomes necessary to have domestic power consumption below the limit. Home energy management system (HEMS) is used as a tool for activating residential or end user demand response. A HEM is connected to multiple devices in residential premises from smart meters to the household appliances. It monitors and manages the operation of the household appliances, hence can perform demand response such as load shifting and shedding in reply of the utility sanctioned power-limit.

KEYWORDS: About PLC, Home Energy Management, Relay

I. INTRODUCTION

Electric Energy Utilities are under pressure from annual increases in customer demand. In the past, utilities used system expansion to meet this rise in demand. Economic restrictions now prevent utilities from expanding existing transmission and distribution systems while a growing concern in greenhouse gas (GHG) emissions has prevented the expansion of fossil fuel generation facilities. With the elimination of past solutions a new philosophy must be adopted. Smart Grid Technology, communications infrastructure, and clean energy technologies will be required to meet the increasing in consumer demand.

1.1 INTRODUCTION TO HOME ENERGY MANAGEMENT SYSTEM

An **HEMS** is designed to optimize consumer costs by managing consumer demand, communicating with the utility to determine the market price of energy, and calculating the use of local generation to off-set remote generation costs. This behavior allows the utility to help direct consumers into "smarter" choices for the grid. This is done by "rewarding" responsible decisions with lower price per kWh and "punishing" poor decisions with higher price per kWh. It gives the utility the ability to proactively account for system conditions (planned outages, load shifting, etc). The utility's ability to shape the demand profile will result in efficient use of the power grid. This effectively increases the utility's generation and transmission capacity to meet the rising consumer demand while avoiding system expansion and GHG emissions. The HEMS is installed in a home and works by modeling the consumer demand for that home. A fixed load is used to represent appliances that must operate at a certain time of day and cannot be interrupted. Thermal loads and loads that have a definite start and stop time (but are not critical to the consumer) are considered flexible. A thermal load will respond to changes in the ambient air temperature and adjust a heating or cooling according to a consumer's comfort level. Loads with a definite start and stop time are usually bigger appliances, like a clothes-washing machine. After the HEMS model the consumer demand, it will begin to optimize costs. Through proprietary algorithms (and after receiving energy cost information from the utility) the HEMS will be able to schedule flexible loads to periods of lower energy costs. [1]

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HEMS can be used to provide voltage stability reduce generation or consumer costs. More importantly, consumers will be driven to reduce their power bill, forcing them to adopt HEMS technology.

II. PROPOSED WORK AND SYSTEM

PLC based home energy management system as per Indian scenario; we are using 5 different loads having different power rating and their different use and priorities. For example Light, Air conditioner, Refrigerator, Washing Machine, and Electric Heater.

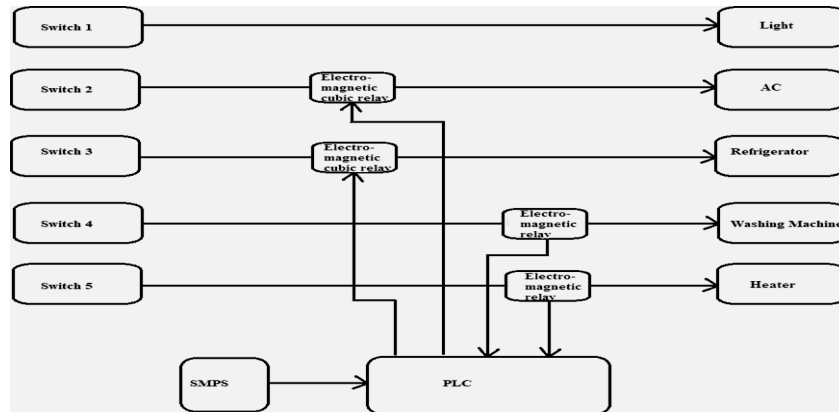


FIG. 1: Block diagram of PLC based home energy management system

- Circuit Diagram**

Below circuit diagram shows connection between power circuit and control circuit. Total loads are control by switches, and relays are operated by PLC in which electromagnetic relay senses which load is in ON or OFF state. And electromagnetic cube relay is used as a circuit breaker

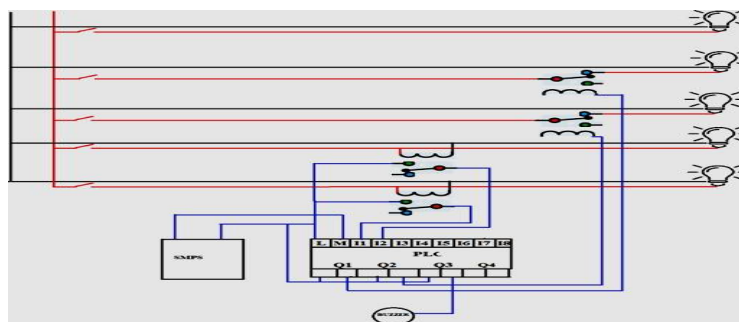


Fig. 2: Circuit Diagram of System

- Ladder programming**

HEM system runs on following ladder program. Zeliosoft 2 software used for ladder programming. Three logics are used in it, these are NO, NC, and coil.

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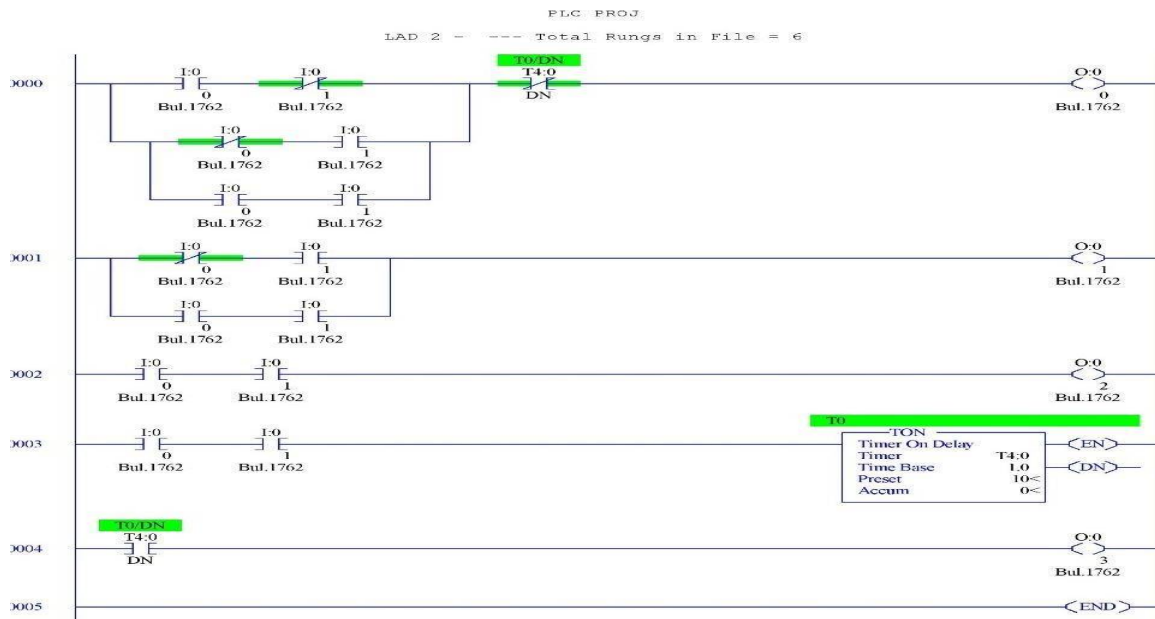


Fig. 3:Ladder programming

As per the Block diagram first load is light, second load is air conditioner, third load is refrigerator, fourth load is washing machine and fifth load is electric water heater.

Here we have assumed that sanctioned load is 200W and all loads have different value like load 1 is 20W, load 2 is 100W, load 3 is 100W, load 4 is 100W and load 5 is 100W. If we are using total load below 200W that is connected load, then the power will be connected normally but if we exceed the sanctioned load limit then one of the load will turn-off automatically like first if we are using Air conditioner. and Refrigerator normally and if we suddenly started Washing machine then Air conditioner will turn off automatically and if we start Electric water heater then washing machine, Air conditioner and Refrigerator both will turn off. If we start any one of the load with water heater, load limit will be exceeded and buzzer is operated.

If we start light and total connected load is below 200 w then the load will work normally.

III. COMPONENT USED

PLC:This Zelio Logic module is a compact smart relay designed for simple control systems. In that we are using Schneider PLC SR2A101BD. The unit has 10 I/O (6x discrete inputs/4x relay outputs) and a supply voltage of 24V DC. The module also has large LCD screen that makes the system easy to use. The module is easy to install and program using either FBD or LADDER and the Zelio Soft 2 programming software is intuitive to use. Zelio Logic smart relays are operationally versatile with test, simulation and monitoring modes along with excellent supervisory functionality. Suitable for a wide range of simple control system applications carrying out tasks such as small machine control systems, decentralized control systems, lighting management, access control, control and monitoring, heating and air conditioning control, etc.To transfer program from computer to PLC, RS232 or Ethernet cable is used.

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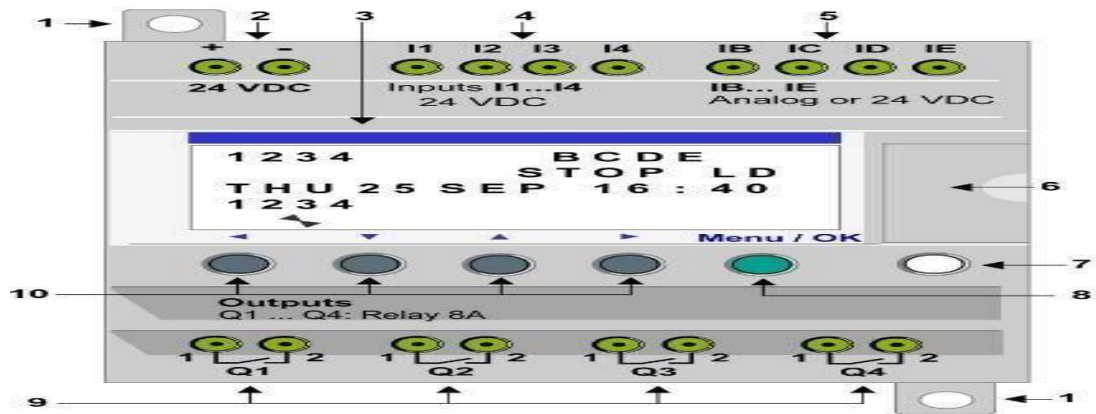


Fig. 4: Functional diagram of Schneider PLC

SMPS (Switching- Mode Power Supply): A switched-mode power supply (switching-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a AC or DC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. SMPS requires input 230V AC and it gives 24V, 2.5-3 Amp DC output. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. Ideally, a switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time. In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight. Loads:-Light, Air conditioner, Refrigerator, Washing Machine, and Electric water heater.



Fig. 5: SMPS

Relay: Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. It is an electromagnetic type of relay which operates on 24V AC/DC supply. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is energized. In either case, applying electrical current to the contacts will change their state.

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Symbolic Representation OF Relay

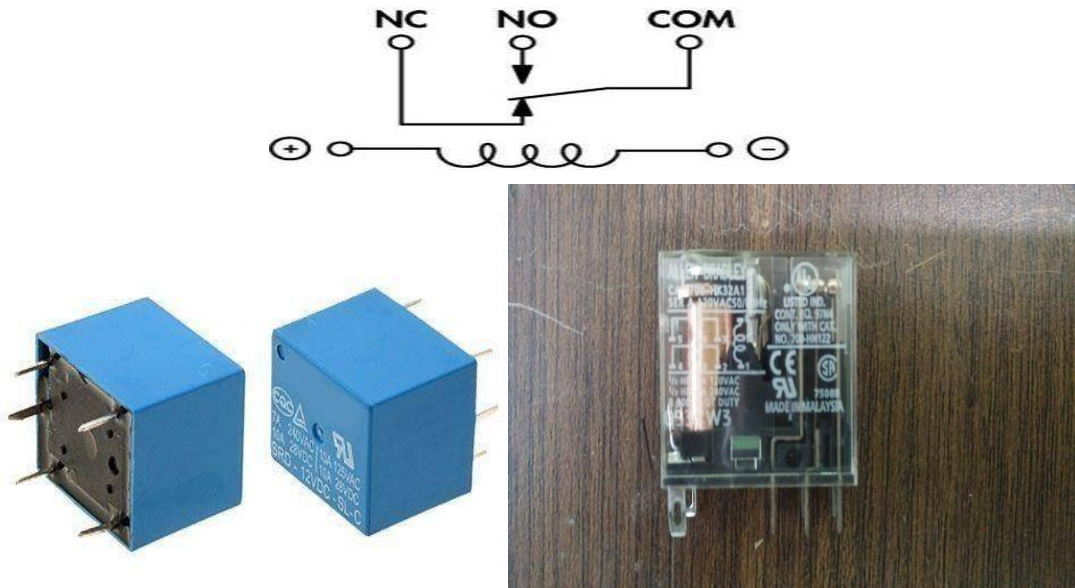


Fig. 6: Electromagnetic reyla

IV. RESULT

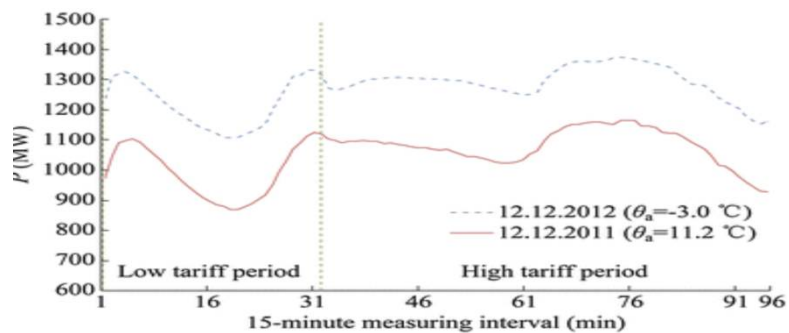


Fig. 7: Power vs. time characteristics

V. CONCLUSION

The proposed design offers the consumer with the benefits of using electric power for their most needed high priority load, even when load shedding is done. A simple low cost bidirectional PLC system has been utilized to control and monitor the load of consumers.

Instead of starting from the lowest priority load group, when it is required to do load shedding then the load group expect the highest priority group, which is currently loaded very close to the level of supply demand difference can be turned OFF first. This will reduce the time required to overcome the disturbance in the system due to overloading and also the system will remain overloaded only for a shot time interval.



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