Automatic Electrical Energy Tariff Management, Billing System, Theft Monitoring and Alarm System using PLC and SCADA (ATMOB's)

Sowrabha L, Varun Kumar M S, Akhila Amruth R
Department of Electrical and Electronics Engineering
Sri Krishna Institute of Technology
Bangalore, India

Raghavendra K
Department of Electrical and Electronics Engineering
Sri Krishna Institute of Technology
Bangalore, India

Abstract **: Energy shortage is the main problem faced by present day in the society. A suitable solution to control the energy crisis is by managing the usage of electricity. Load shedding, power cut etc. helps to rearrange the available power but they can't be used to prevent the unwanted usage of energy, peak time load control etc. Also there is a is need to monitor the power consumption of an overall area to select the areas to suitably control the energy usage and also theft detection. One of the easiest solutions for this is by using 'PROGRAMMABLE LOGIC CONTROL' and 'SCADA'.by using PLC & SCADA correcting errors, flexibility can be achieved at low cost. Thus by using PLC & SCADA we can monitor and control the usage of devices by providing a control at consumer end. In this project we are trying to control, monitor (metering & theft detection), messaging through PLC & SCADA to monitor the consumer end from the centralized control room. Thus flexible load control & monitoring can be achieved.**

Keywords**: PLC and SCADA, Energy management, automatic metering, theft detection.**

I. INTRODUCTION

This project is mainly implemented for the purpose of getting a fully ***ATMoB's.*** The aim of this project is to control, measure and monitor the electricity consumed by consumers in a particular area and transmitting the measured reading between the consumer and utility. It also helps in reducing the malpractices and damages of the meter. Using this system the Electricity Board can access all data regarding the consumed power at each home. The system can monitor the power usage and can warn the users when the power usage is getting increased which may affect the peak hour tariff. It also possesses the capability to automatically turn off the low priority devices when the load limit exceeds threshold level during the peak hour, & also the concept of PLC & SCADA is used for the transfer of data between consumer and utility. The main advantage of this method is it is very fast, flexible and economical.

A. PLC

Programmable logic controller (PLC) works by looking at its field inputs and depending on their state, and the user entered program, terns ON/OFF field output. PLC programming is written in high level language which is easier for understanding. This system perform many functions providing a variety of analog and digital input **Error! Bookmark not defined.**), or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

PLC s have been gaining popularity on the factory floor and will probably remain predominant for some time to come. Most of this is because of the advantages they offer.

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.
- Trouble shooting aids make programming easier and reduced downtime.
- Reliable components make these likely to operate for years before failure.

II. HARDWAREOPERTION

The hardware components of a PLC system are CPU, Memory, Input/Output, Power supply unit, and programming device.The fig shown in 4.1.1 is a diagram of the system overview of PLC.

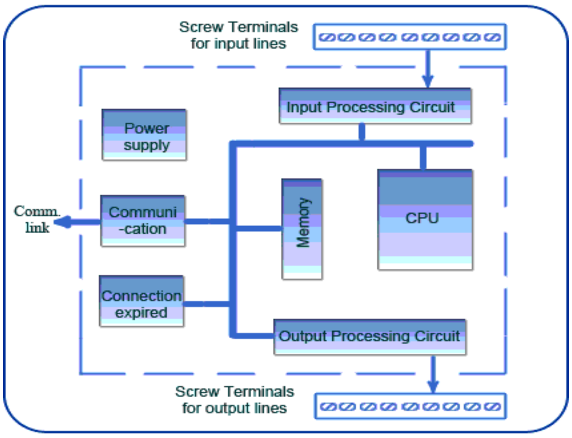


Fig4.1.1:Hardware components of PLC system

- **CPU** – Keeps checking the PLC controller to avoid errors. They perform functions including logic operations, arithmetic operations, computer interface and many more.

- **Memory** – Fixed data is used by the CPU. System (ROM) stores the data permanently for the operating system. RAM stores the information of the status of input and output devices, and the values of timers, counters and other internal device.
- **I/O section** – Input keeps a track on field devices which includes sensors, switches.
- **O/P Section -** Output has a control over the other devices which includes motors, pumps, lights and solenoids. The I/O ports are based on Reduced Instruction Set Computer (RISC).
- **Power supply** – Certain PLCs have an isolated power supply. But, most of the PLCs work at 220VAC or 24VDC.
- **Programming device** – This device is used to feed the program into the memory of the processor. The program is first fed to the programming device and later it is transmitted to the PLC's memory.

III. FUNCTIONALITY

The functionality of the PLC has evolved over the years to include sequential relay control, motion control, process control, distributed control systems, and networking. The data handling, storage, processing power, and communication capabilities of some modern PLCs are approximately equivalent to desktop computers. PLC-like programming combined with remote I/O hardware, allow a general-purpose desktop computer to overlap some PLCs in certain applications. Desktop computer controllers have not been generally accepted in heavy industry because the desktop computers run on less stable operating systems than do PLCs, and because the desktop computer hardware is typically not designed to the same levels of tolerance to temperature, humidity, vibration, and longevity as the processors used in PLCs. Operating systems such as Windows do not lend themselves to deterministic logic execution, with the result that the controller may not always respond to changes of input status with the consistency in timing expected from PLCs. Desktop logic applications find use in less critical situations, such as laboratory automation and use in small facilities where the application is less demanding and critical, because they are generally much less expensive than PLCs

IV. PLC FEATURE

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold), and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems. Some use machine vision. On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders, magnetic relays, solenoids, or analog outputs. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC.

B.SCADA

Supervisory control and data acquisition (SCADA) works like a supervisor who supervises the entire plant area, also control the process as well as it converts the data segments for storing process value.

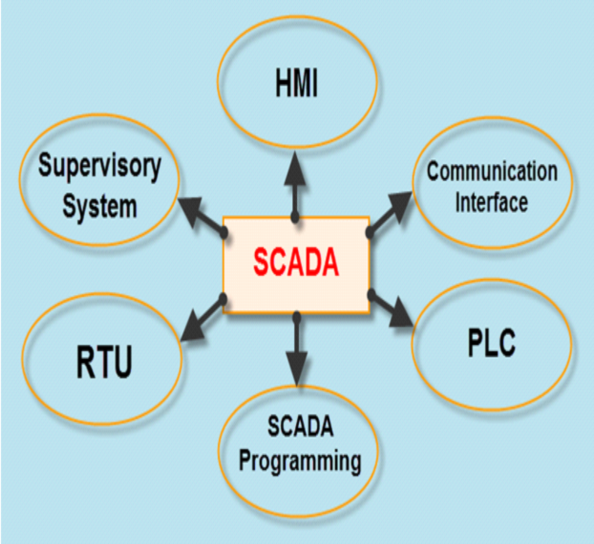
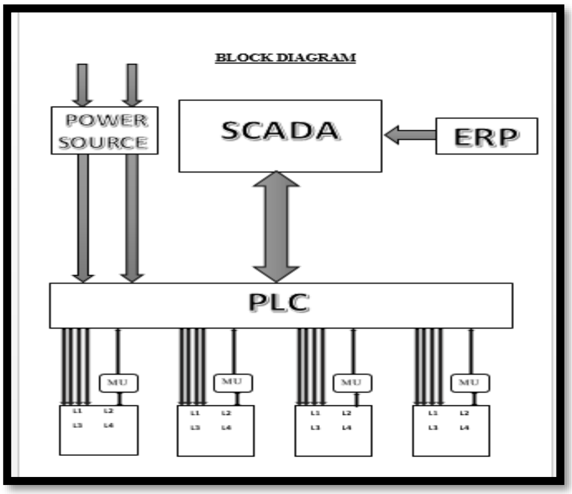


Fig 3.4.1:Components of SCADA system

The main function of the SCADA system is the collection of data and supervisory level. SCADA is a software designed to view an industrial process or real time environment in a much elaborated and simple way. So the end user can easily use it with graphical user interface. So SCADA can be classified as monitoring software. SCADA as mostly used in industrial process where a vast area of process is going on and sometimes even in small applications. It can communicate to any of the protocol. It runs on PC and conservation of data is possible. SCADA system is a branch of instrumentation engineering, which consists of input output signal hardware, controller and human machine interface (HMI), networks data bases, communications and software. It usually refers to centralized system which monitors and controls the entire process.

This is the core of the SCADA system, gathering data on the process and sending control commands to the field connected devices. It refers to the computer and software responsible for communicating with the field connection controllers, which are RTUs and PLCs, and includes the HMI software running on operator workstations. In smaller SCADA systems, the supervisory computer may be composed of a single PC, in which case the HMI is a part of this computer. In larger SCADA systems, the master station may include several HMIs hosted on client computers, multiple servers for data acquisition, distributed software applications, and disaster recovery sites. To increase the integrity of the system the multiple servers will often be configured in a dual-redundant or hot-standby formation providing continuous control and monitoring in the event of a server malfunction or breakdown.

V. BLOCK DIAGRAM



The above block diagram depict the architecture integrating power distribution unit, communication platform, data acquisition units and software platform to compute acquired data to produce desired actuation signals. Actuation signals are like, producing theft alarm, producing tariff management log and setting priorities on consumables.

Power input to the system is AC power (230V 50Hz), stepped down and DC converted using SMPS (Switched Mode Power Supply). DC power is distributed across PLCs and MUs as shown in above block diagram.

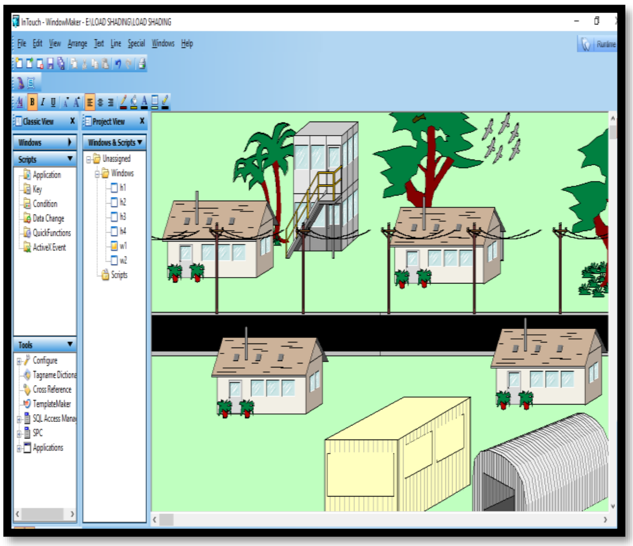
The data input to the system is from electrical Loads, household devices like incandescent bulbs, TV, Cooler etc, (L1, L2, L3 and L4 as mentioned in block diagram. The amount of power consumed per House is read from measuring unit, thereby calculating total amount of power consumed by particular house.

The PLC – Programmable Logic Controller, is programmed to take its input from Measuring Units (MU) and process them to compare with ideal power consumed by particular house to perform energy monitoring. PLC even compares measured power with the ideal power of a house to determine extra power being consumed to detect power theft. PLCs are programmed to prioritise the type of electrical household loads to manage consumed power per house.

Energy monitoring and Management is done and logged in the software called SCADA. Communication between PLC and system having SCADA is done by using Open Platform Communication (OPC). As the PLC and SCADA are two different products from two different manufacturers not having common communication platform in between, it is required to have open platform to exchange data between them. The open platform communication, PLCs, SMPS and SCADA are discussed in detail in further sections

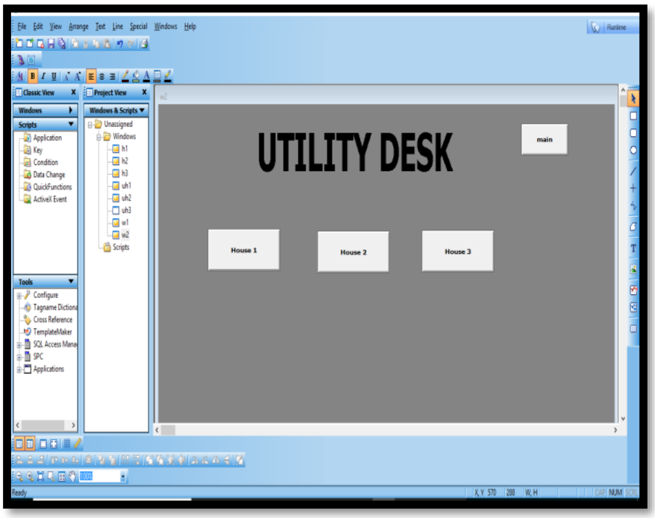
VI. SIMULATION

STEP 1:Double click and open the Wonder ware intouch software .



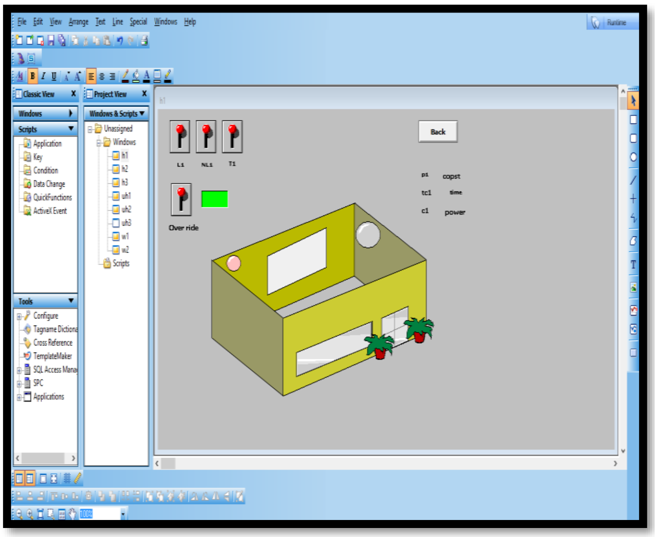
STEP 2: File=>open window=>Select the required window

Here the w1 shows the 4 houses as per the block diagram, when we click on the houses or on the utility desk (as labelled) the respective window will popup.



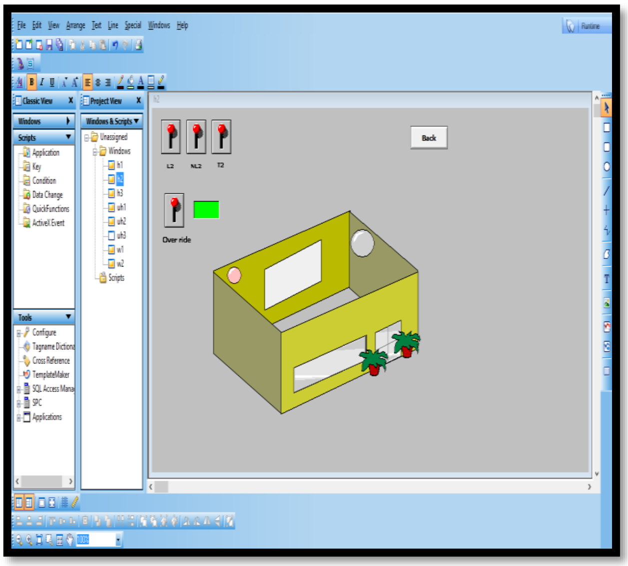
STEP3: Click on the window w2

The window w2 shows the utility end from where the energy consumed is monitored and also theft is detected. IN the software there are three blocks namely house 1,house2 and house 3 ,the respective house's window pops up when we click the respective block,and the main block is used to return to w1.



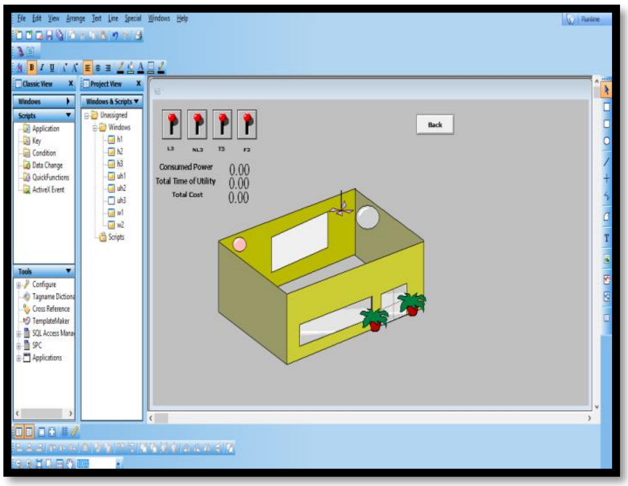
STEP4: Click on the window h1

The h1 shows the house 1 and the loads are night lamp, lamp and TV and the 3 switches are there respectively. There is one override switch which is used by the consumer when he wants to use the load which is turned off due to excess usage. The green block is the indicator in case of excess power consumption.



STEP5: Click on the window h2

The h2 shows the house2 and the loads are night lamp, lamp and TV and the 3 switches are there respectively. There is one override switch which is used by the consumer when he wants to use the load which is turned off due to excess usage. . The green block is the indicator in case of excess power consumption.



STEP6: Click on the window h3

The h3 shows the house3 and the loads are night lamp, lamp, fan and TV and the 4 switches are there respectively. This house3 is considered as the theft according to our project if there is any load consumed by the house3 then an alarm will pop up on the utility side. . The green block is the indicator in case of excess power consumption.

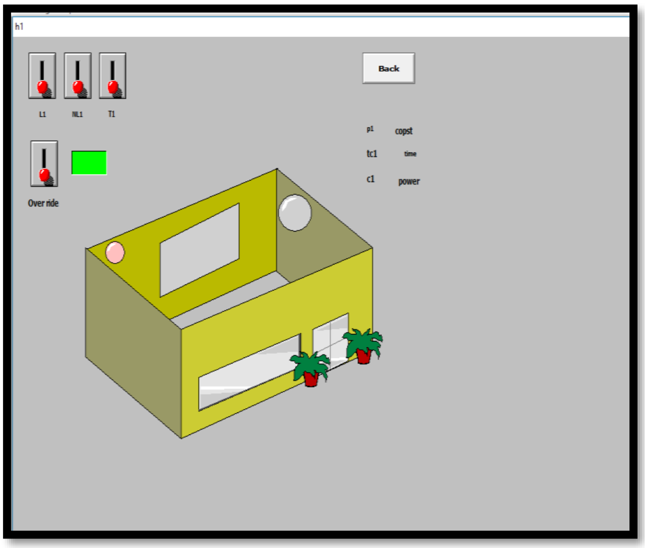


Fig1

STEP7: Click on runtime.

In the fig1 we can see that all switches are in the off position and the loads are turned off. And the indicator is green in colour.

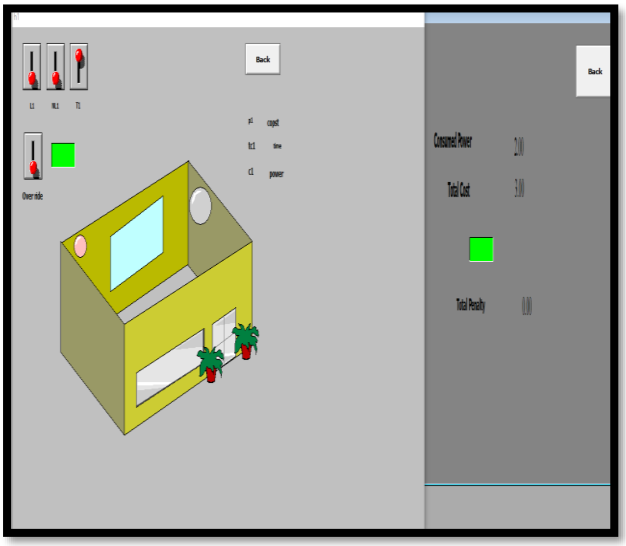


Fig2

The Fig2 shows the power consumption on the utility side when one load is turned on. Here T1 is switched on and TV is on.And on the utility side the penalty is 0.

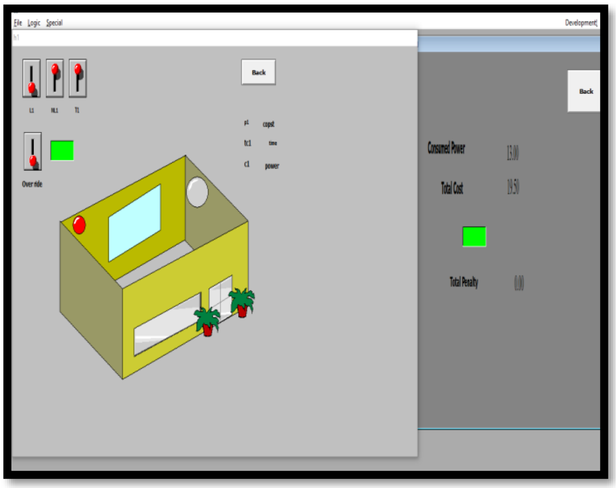


Fig3

The Fig3 shows the power consumption on the utility side when two loads are turned on. Here T1 and NL1 are switched on so TV and night lamp is turned on. And on the utility side the penalty is nill.

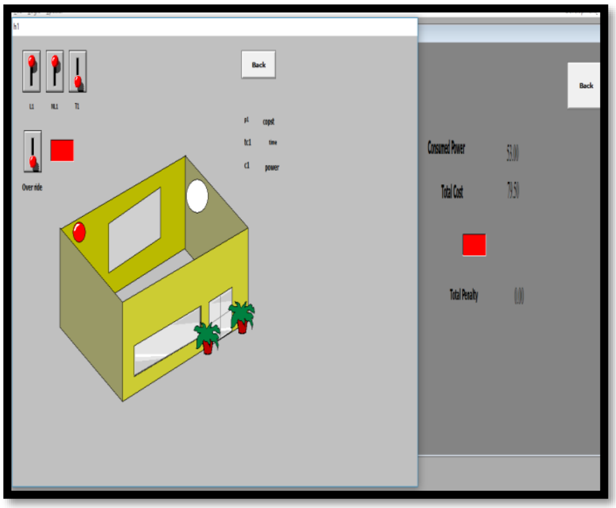


Fig4

The Fig4 shows the indicator glowing in red both in consumer as well as utility side, because the power consumption is exceeding the limit and hence the least priority load ie, TV is turned of automatically ,but if the consumer wants to turn on the TV ,he can on the override switch and the TV is turned on but the next least priority load ie night lamp gets turned off as shown in Fig5

But if the consumer still wants to use all the loads he is permitted to do so as per his requirement but the penalty will be leaved as shown in Fig6.And once the override switch is turned on the indicator stops glowing.

ISSN: 2278-0181

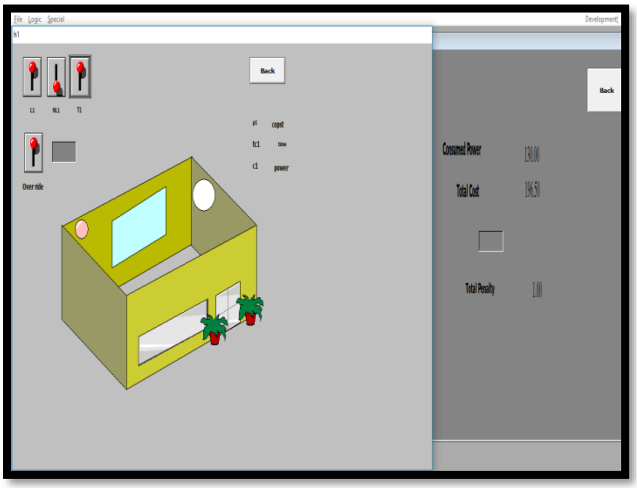


Fig5

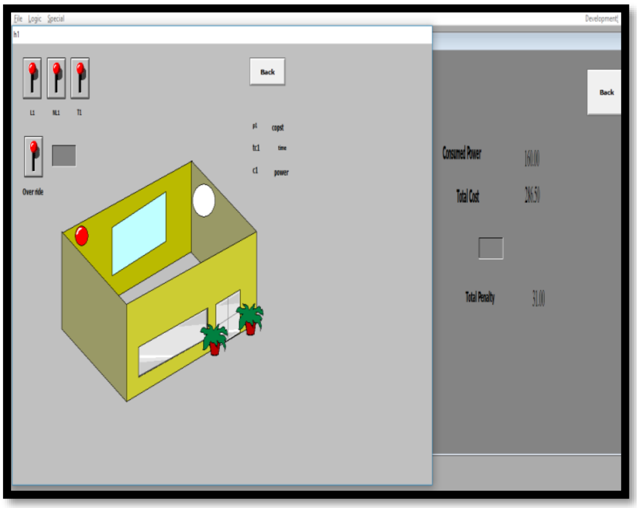
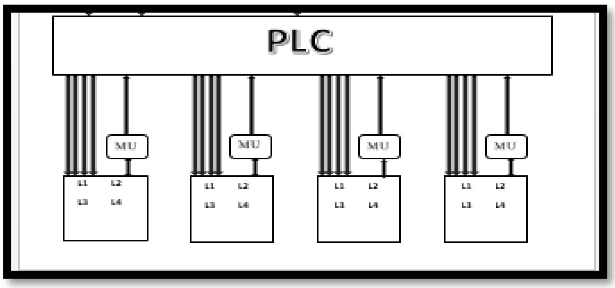


Fig6

VII. HARDWAREIMPLEMENTATION



Block diagram of Hardware implementation

Fig 7 layout representation

The controlling and monitoring through SCADA system is done by interconnecting the PLC and that layout representation is as shown in the fig7.Once the program is dumped to PLC controlling can be done through SCADA.

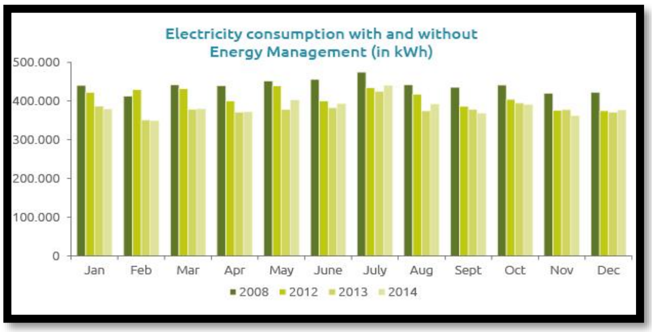


Fig8 the energy consumption with and without energy management

The Fig8 shows the energy consumption with and without energy management by implementing this model consumption of energy can be managed in a much better way.

VIII. SIMULATION RESULT

Energy consumption table for house1 without ATMOB’S

NL1	T1	L1	Units consumed	Cost	Penalty
Off	On	Off	5	7.50	0
On	On	Off	5	7.50	0
On	Off	On	5	7.50	0

(Assuming Rs.1.50/- Per unit.)

NL1	T1	L1	Units consumed	Cost	Penalty
Off	On	Off	5	7.50	0
On	On	Off	5	7.50	0
On	On	On	5	10.50	2

Energy consumption table for house1 with ATMOB'S (Assuming Rs.1.50/- Per unit and Tv as least priority)

IX. CONCLUSION

The energy efficiency improvement is a significant way to reduce the cost and to increases predictable earning, especially in times of high energy price volatility. Since the system operation mainly dependent on PLC & SCADA, it helps in monitoring the energy uses in different sections of the plant and generates the reports as per the requirement by the customer. Extension can be provided to the system as our interest and requirements. This system is time saving, consumes less power and can be also made easily available. So, that the small scale industry, large scale industry can use this system. In real time applications whenever and wherever with small investment.

X. FUTURE SCOPE

This project works on remote control based SCADA system using PLC as a controller. It can be further implemented using wireless communication or using internet and also it can be implemented on commercial fields.

REFERENCE

[1] Gilbertop.azevdo,ayruL.oliveirafilho,"Control centres with open architectures", October 2001, pp-27
[2] JimSee, WayneCarr, P.E., and Steven E. Collier, "Real Time Distribution Analysis for Electric Utilities".
[3] K. Collins, M. Mallick, G. Volpe and W.G. Morsi, "Smart Energy Monitoring and Management System for Industrial Applications," 2012 IEEE Electrical Power and Energy Conference.
[4] TheodoraC. Kouloura, Panagiotis D. Panagiotakopoulos, Anastasia S. Safigianni "A Systems Approach to Corporate Sustainability in Energy Management of Industrial Units" IEEE Systems Journal, Vol. 2, NO. 4, December 2008.
[5] J. Barreiro-Gomez, N. Quijano, Senior Member, IEEE, and C. Ocampo-Martinez, Senior Member, IEEE, "Distributed Resource Management by Using Population Dynamics: Wastewater Treatment Application", 5th IFAC Conference on Nonlinear Model Predictive Control (NMPC), 2015.