Design of an Efficient Power Control System for Computer Laboratory

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Abstract:

Many attempts has been carried out to save energy in the form of energy saving devices or designing a system which helps to reduce the power consumption using the existing device. In this paper the role of modern power electronics system and microcontroller has been used to save consumption of energy in University of Engineering and Technology Peshawar Abbottabad Campus. The proposed system will provide reliable cooling and lighting system for the satisfaction of users. In this paper intelligent energy saving system and the decision making algorithm are discussed. As per algorithm the system will first check any occupant in the library. If so then the system will check the intensity of light and temperature and make decisions accordingly.

Keywords: **Intelligent energy saving system (IESS), Power Electronics, Proposed System**

1. INTRODUCTION

The economic growth of a community is highly reliant on energy. Production & supply of products and energy intake has powerful impact on the surroundings at local and international level. It demands an excellent stability between the use of energy for the development of social welfare and the maintenance of atmosphere, as excessive use may lead to adverse an ecological impacts. So controlling and management of energy is essential, since the conventional source will absolutely be tired within a few decades. It's an effort to handle the use of electricity energy through the development of innovative system with a perspective to decrease the intake of energy and consequently to decrease the bill of electricity. At the same time the saving of conventional fuel will lead to expansion of use of energy for longer period and hence the efficiency of power. The paper [1] home automation along with security is done. Voice activated automation [2] is not suitable for university's computer laboratory because for automation it is required to store the voice command of each student. The paper [3] deals with power saving system for class rooms using microcontroller. The paper [4] show the energy saving of public building and specially air conditioning system. The paper [5] show the design of energy efficient lighting for building. The paper [6] explain smart metering for energy audit. This paper offers with the power management review, suggestions of power effective equipment available in market and design of a system based on Modern power electronics and pic-microcontroller to decrease the energy consumption.

In this paper first survey of different places are taken explained in section 2.Proposed methodology is presented in section 3. Section 4 contains hardware used in this system. Section 5 explains the system operating functions in details. Section 6 and 7 contains the results and conclusions.

2. SURVEY

Different aspects of electricity generation, Utilization and conservation have been studied. Analytical and field review has been completed to know about power utilization status in academic institutes.

2.1. Analytical Survey

The Universities and Colleges of America and Canada spend an average of $1.10 per square foot (ft2) on electricity [3]. According to the Survey any college or university class room building, lighting symbolizes 31 % and space heating records for 28 % of total power use, making those systems the best target for energy savings [7].In Asian countries like Pakistan, India, and Srilanka instead of space warming, space cooling is needed through ceiling fans, air cooler or air conditioners. Mostly ceiling fan is used for space cooling. In order to collect statistical data we consider the consumption of energy of different devices and their power ratings. PEPCO (Pakistan Electric Power Company) [8] has provided the approximated statics of power consumption by different appliances depending on their usage for different hours in terms of unit consumed in the course of one month as shown in Tab I.

Table I: Estimated Units Consumed in One Month.

Type of Appliance	Watts	Average usage in Hrs per day						
		1	**2**	**4**	**6**	**8**	**10**	**12**
Tube light (Ordinary Choke)	40	2	3	6	09	10	16	19
GLS Bulb	100	3	6	12	18	24	30	36
Ceiling Fan	70	2	5	9	14	16	23	27
Pedestal Fan	100	3	6	12	18	24	30	36
Computer	300	9	18	36	54	72	90	108
Monitor	70	2	4	8	13	17	21	25

2.2. Actual Field Survey

Random survey is done in two computer labs of two engineering institutes, first in University of science and Technology Peshawar Abbottabad Campus & second in Comsats institute of information and technology Abbottabad Campus. Survey carried out in different time slots of working hours as mentioned below.

- Practical hours
- Tea breaks
- Lunch breaks

2.3. Survey Observation

Survey show the following observation

1. Computer labs fully occupied and all appliance turned ON
2. Computer Labs not fully occupied and all appliance turned ON
3. Computer Labs fully un-occupied and all appliance turned ON

Observation 1 shows the occupancy of student in Practical hours and found no problem. Observation 2 shows the occupancy in Tea Break, observation 3 shows the status of appliances when no one is present in computer lab. Hence Observations 2 and 3 are of great interest which shows that there exist tremendous opportunity to save the energy in the Computer Labs by using the appliances as per the authentic requirement for the students and turning then Off when not required.

3. PROPOSED METHODOLOGY

A creative approach is proposed to save the power consumption of electrical appliances generally used in the computer laboratory like fan, bulb and computer. For this the design of power management system (PMS) is required. PMS is intended to control one computer, light and fan for one student. This PMS is working on two observations.

1. Chair is free
2. Chair is not free.

4. SYSTEM HARDWARE

Proposed system is developed by integrating a module of Light sensor, Temperature sensor, Power Relays, Power electronics components and Pressure switch. The interfacing of the all the modules with PIC Microcontroller are shown in Fig 1.

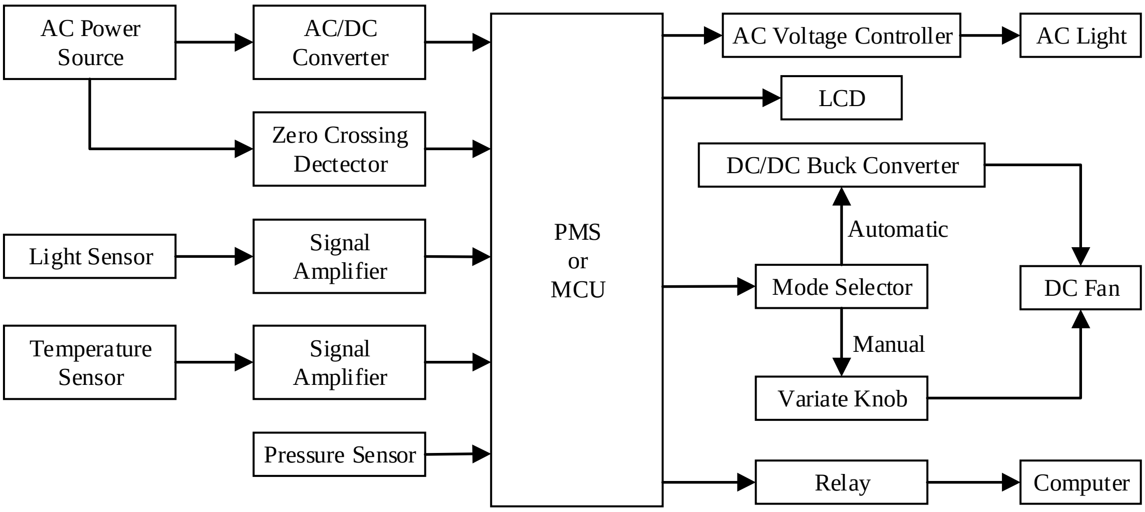


Fig 1: Block Diagram of Proposed System

5. SYSTEM OPERATING FUNCTIONS

The block diagram of proposed system was shown in Figure. 1 and its parameters were described as follow:

5.1. Lighting Management

Here in this venture, LDR will sense the light illumination in Laboratory. When the illumination in the Laboratory is more, the level of resistance of LDR will reduce and the voltage fall across the LDR is less, which is later on fed to the ADC (Analog to Digital Converter) pin of the micro-controller. Dimmers are devices used to vary the brightness of a light. By reducing or increasing the RMS voltage, it is probable to vary the brightness of the light using firing the TRIAC. Although variable-voltage devices are used for various purposes, the term dimmer is generally retained for those envisioned to control lighting. Here a single phase controlled inverter is used. Its Block outline is demonstrated in Fig 2.

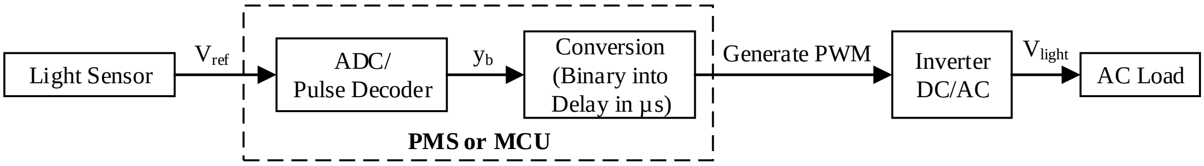


Fig 2: Block Diagram of Lighting System

5.2. Fan Control Management

The Fan control system has two operating modes Automatic and Manual. The utilization of LM 35 sensor is extremely successful and inconvenience. It's a non-contact advanced sort temperature transducer well-suited for measuring room temperature. In automatic mode LM35 is used to detect very small variations in temperature. It specifically changes over the room temperature to yield the voltage froth. The maximum voltage that a LM35 sensor gives 1.5V but ADC pin of microcontroller will require maximum of 5V, so therefore an operational amplifier is placed with a certain gain to amplify the input to the required level, which is later on given to the ADC pin of microcontroller. After that the DC to DC Buck converter is used to regulate fan speed accordingly to PWM signal provided by MCU. Similarly in manual mode the user will rotate the knob and adjust the speed of fan manually according to its mood. Its Block outline is demonstrated in Fig 3.

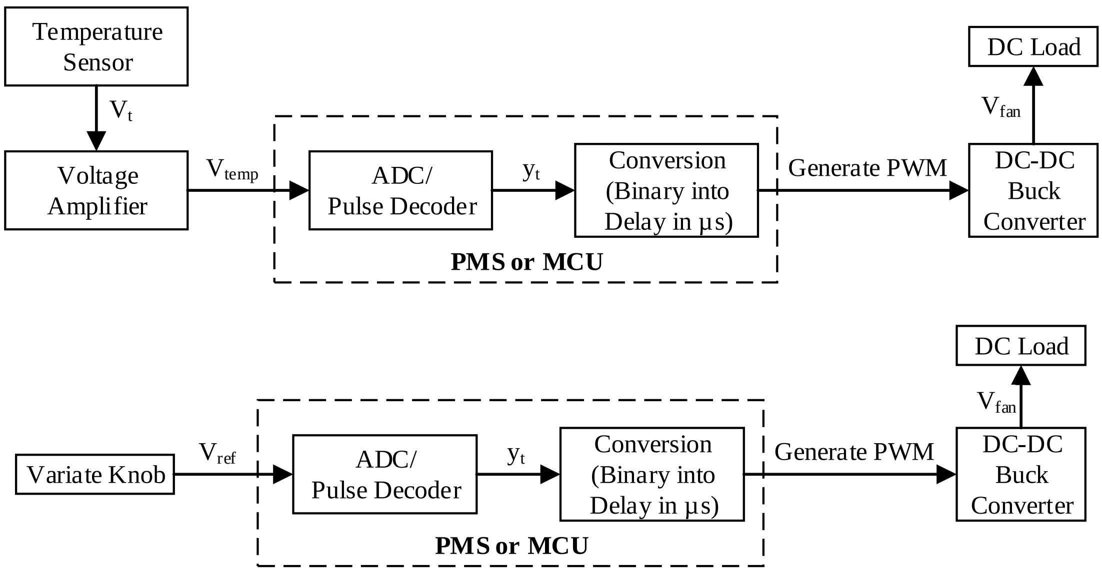


Fig 3: Block Diagram of Fan Control System (a) Automatic (b) Manual

5.3. Computer Control System

The Computer power is controlled by relay. At the point when a chair is free, the microcontroller will begin a timer and count for 300 sec (5 minutes) which will additionally displayed on LCD. In the event that no other student identification is happened on chair, the microcontroller will send an indicator signal to relay and power to computer will be cut off. Meanwhile any other student sit on the seat, the microcontroller will reset the counter and work in its typical mode and LCD will show that seat is not free. The block diagram is shown in Fig 4.

5.4. Detection of student system

Fenix remote weight switch is utilized to sense vicinity of student on seat. Fenix remote weight switch holds four sensors which are spot at better place inside seat structure. At the point when a student sits on seat, microcontroller will on the frameworks if any of the sensors has sent the actuation indicator.

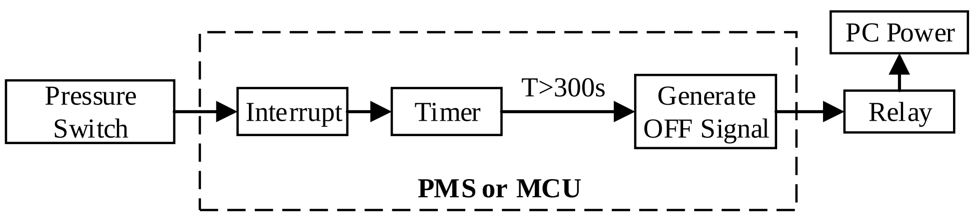


Fig 4: Block Diagram of Computer Control System

5.5. Power Management System

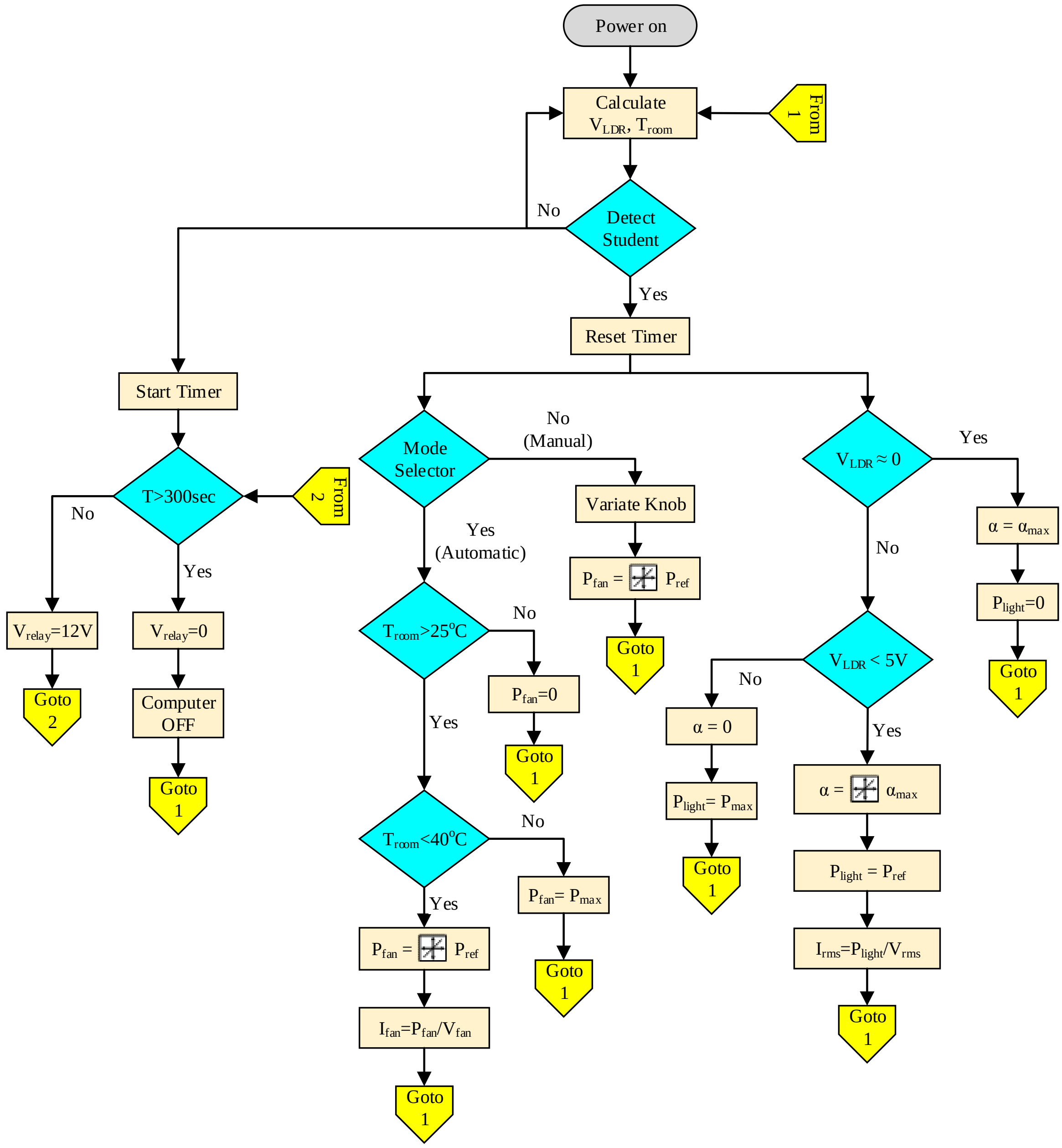
The complete flows chart his shown in Fig 5. Initially the system will sense the voltage reading of LDR and temperature sensor. According to the proposed system, timer will be ON for 5mint (300sec) to check any student on the chair, if the condition is true (student is present on chair) it will keep ON the computer, otherwise OFF. Similarly a chair is occupied by a student, it will check reading of the LDR, if it is nearly equal to zero then it means that there will be sufficient brightness in the lab and no need to ON the light so it will send no power to light by firing inverter at maximum angle. If the LDR reading is 5V means there is no light in the lab, it will send the maximum power to the light so that it will glow with maximum brightness. If the reading is between the 0 & 5, it will send power to AC load according to define slew rate which is directly related with firing angle and LDR reading. The relationship between firing angle and LDR voltage is given by (1)

$$\propto = 36\, V_{LDR} \qquad (1)$$

Similarly aside with light control system upon the detection of student fan control system is also running with it. Fan control system will check the operating mode weather it is automatic or manual. Upon manual mode it will send power to fan with the define slew rate which is related with knob voltage reading. Maximum set temperature (Tmax) is the maximum temperature above which fan will run with full speed similarly minimum set temperature (Tmin) is the temperature below which the fan will stop. These set points are set with potentiometer (knob) manually. Default values of Tmax and Tmin are 25ºC and 40ºC. The relationship of room temperature (Troom) and duty cycle (TD) in percent is given by (2)

$$T_D = \frac{T_{room} - T_{min}}{T_{max} - T_{min}} \times 100\% \qquad (2)$$

In automatic control mode the proposed system first sense the room temperature, and ON and OFF the fan according to room temperature .if room temperature is above maximum set temperature it will ON the fan at full speed otherwise stop for minimum set temperature. Also If the room temperature is in between set points the DC-DC converter will fired at appropriate duty cycle.



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g 5: Flow Chart of Power Management System

6. RESULTS

The observation of power consumption (practically) is calculated using wattmeter connected to library's electricity input power (Water and Power Development Authority (WAPDA)) while theoretically it is calculated with the references power given in Tab I. Similarly the power consumption of a single cabin (Intelligent Energy Saving System (IESS)) is also calculated (Practically and theoretically). The power usage per hour (i.e.Wh) is shown in Tab II.

Tab II: Power Usage (Wh)

Day/ Time	Monday		Tuesday		Wednesday		Thursday		Friday	
	WAPDA	IESS	WAPDA	IESS	WAPDA	IESS	WAPDA	IESS	WAPDA	IESS
8-9 AM	560	4	560	4	560	4	560	4	560	4
9-10 AM	1210	280	560	4	1050	490	950	420	560	4
10-11AM	810	210	1310	490	1350	980	850	630	850	350
11-12PM	1210	700	1210	630	1150	700	1150	350	960	560
12-1 PM	1110	630	1110	630	750	280	950	420	560	4
1-2 PM	555	175	900	735	375	70	475	175	0	0
2-3 PM	810	210	810	350	850	210	650	4	650	140
3-4 PM	710	140	520	140	650	4	650	4	650	70

The standby usage of electricity is 4Wh for this energy system because it needs some power to remain active to detect the student. Weekly power usage calculated on per day basis is shown in Tab III.

Tab III: Power Usage Per Day

Day/Time	WAPDA (Wh)	IESS (Wh)
Monday	6975	2349
Tuesday	6980	2983
Wednesday	6735	2738
Thursday	6235	2007
Friday	4790	1132
Total	**31715Wh 31.7 KWh**	**11209Wh 11.2 KWh**

6.1. Results using MATLAB

As the observations are taken manually, so it is better to compare these results graphically by using MATLAB. Based on daily readings a weekly histogram is shown in Fig 6. To elaborate the difference, same histogram is presented in line graph in Fig 7. In Fig 6 or 7, The WAPDA system uses more energy on Monday then that of other days. This is because here in Pakistan Monday is the first working day after weekend. Similarly on Friday the energy used for both the system is less due to prayer break during working hours. For getting more precise results, the readings are taken throughout month and the comparison line graph between WAPDA system and IESS system is shown in Fig 8. In this Fig the x-axis show the dates on which readings are taken. Weekend holydays are excluded from it.

After one month analysis it is concluded that this energy saving system saves energy upto 64%. It can be calculated using (3)

$$Saved\ Energy = \frac{P_{WAPDA} - P_{IESS}}{P_{WAPDA}} \times 100\% \quad (3)$$

This analysis is done on the basis of 25 cabins and using both practically and theoretically taken reading it is also concluded that this system will use 70Wh per cabin. It depends upon the requirement of any institute. If this system will installed in homes and offices, it will work very efficiently and saves maximum energy.

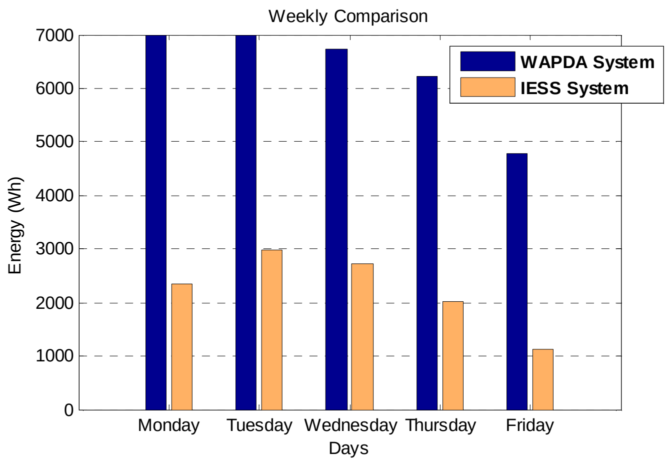


Fig 6: Week Comparison Histogram

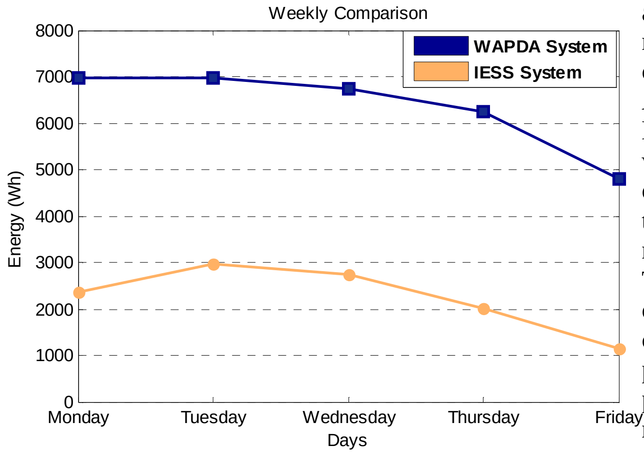


Fig 7: Week Comparison Line Graph

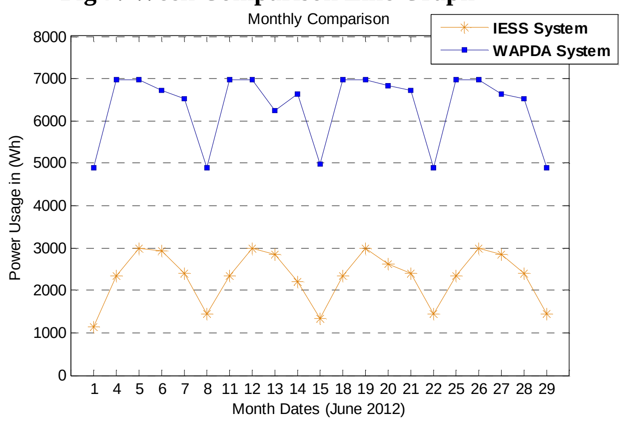
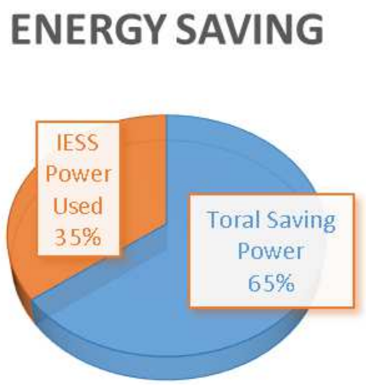


Fig 8: Entire Month Analysis



7. CONCLUSION

The paper addresses the energy saving strategy using modern power electronics based on microcontroller for ac appliances are discussed. Based on the analysis of principle of energy saving control methods and power management system, the power consumption reduces to the maximum limit. Automated Power Saving System for computer laboratory focuses on ways to cut down power wastage. Energy saved through this system not only reduces the financial burden but also reduces the pressure of generating power, which in turn reduces the exhaust of pollutants in the environment. The results verify the feasibility and effectiveness of the developed energy saving system and control strategy. Moreover, the efficiency and thus power factor are enhanced greatly. Due to use of power electronics conditional unit both active and reactive power saving rate are controlled, which offering great economic and social benefits. The proposed control strategy is developed for computer laboratory only and also extended to more number of consumer electronic and home appliances.

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BIOGRAPHIES

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