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Energy Efficient Building using PLC and SCADA

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***Abstract*- This paper concentrates on the energy efficient side of the implementation of energy saving measures in the Satguru Partap Apollo Hospital. This paper consists of audit of a hospital in which various electrical and thermal utilities are considered such as lightning, air conditioning system etc. audit was conducted and various measurements and calculation was done the basis of the data collected and performance assessment was done of the equipments installed in the hospital. In this paper main concern is on the HVAC system. All the pumps are driven by the Variable Frequency Drives thereby saving around 20% of energy. In case we use VFDs to control the speed of AHU (Air Handling Units) and use PID with them, there will be more saving of around 20% and we gets a saving of around Rs 193332.6.**

Keywords – Energy Saving, AHU, VFD, SCADA, PLC, PID, Energy Efficient

I. INTRODUCTION

Energy is a vital input for social and economic development of any nation. According to International Energy Agency (IEA) data, final energy consumption of the building sector in the world has risen to 2,974 millions of tons of oil equivalent in 2007. The building sector represents around 34% of the final energy consumption and hence is the first consumer sector. According to the reference scenario of IEA, the building sector will remain the first consumer in 2030 with consumption share of 32%. Its energy demand will grow with an average of around 1.2% per year against 1.4% for the whole final energy consumption. Heating Ventilation and Air Conditioning systems (HVAC) which plays an important role in the occupant comfort are among the largest of consumers in the commercial buildings. HVAC accounts for around 40% of electrical energy usage.

i) PLC and SCADA

A. Defining PLC

PLC (Programmable Logic Controller) has been widely accepted in various process industries which is a solid state device designed to perform logic functions. PLC has several known features including, flexibility, reliability, low power consumption and ease of expandability. The software abstraction level changes mere requirement in extending and optimizing the control process rather than internal rewiring. Higher productivity, superior quality of end product, efficient usage of raw materials and energy, improved safety in working condition, reduced space, energy saving, easy trouble shooting, greater life and reliability are some of the advantages of the PLC.

B. SCADA

SCADA stands for Supervisory Control and Data Acquisition. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunication, water and waste control, energy, oil and gas refining and transportation. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units (RTUs) and/or Programmable Logic Controllers (PLCs), and the central host and the operator terminals. A SCADA system gathers information, transfers the information back to a central site, then alerts the home station that a leak has occurred carrying out necessary analysis and control.

II. COMPONENTS OF HVAC SYSTEM

HVAC system consists of many components that help in the proper working of the system in the buildings. The main components are:

- Primary pumps: They give user the ability to operate any chiller with any primary chilled water pump. These pulls down the used water which is then inlet to the chiller. The air is circulated and water is sent up.
- Secondary pumps: The primary goal of the secondary pump system is to deliver flow to cooling loads by maintaining a differential set point at one or more locations in the distribution system.
- Chiller: Chiller is a refrigeration device designed to produce chilled water for space cooling purpose. The chilled water is then circulated to one or more cooling coils located in air handling units, fan coils or induction units.
- Air Handling Unit (AHU): An air handling unit (AHU), is a device used to regulate and circulate air as a part of a heating, ventilating, and air conditioning (HVAC) system.
- Cooling Towers: A cooling tower is a heat rejection device, installed outside the building envelop through which condenser water is circulated as the heat energy absorbed by the chiller needs to be rejected out of the system and into the atmosphere.

III. EXISTING SYSTEM

The secondary pumps consist of motors which are controlled by the drives of equal horsepower as that of the pump's motor. These pumps will lift the cold water up and is responsible for cool air. The primary pumps, pulls down

the used water and is an inlet to the chiller. Between chiller and the primary pumps there exists a temperature sensor called RTD (Resistance Temperature Detector). Let us suppose the inlet water temperature is 45 degree Celsius and at the outlet we want it to be 30 degree Celsius. 1 input of PID is to RTD and 1 is to the drive. Drive will start running fast to reach the temperature of 30 degree Celsius. As the temperature starts coming down from 45 degree Celsius the drive will slow down its speed. The chilled water then be lifted up to the cooling towers and from there will start circulating to all the 8 floors of the hospital with the help of AHUs. PLC is used to design the program for the hospital. SCADA helps in monitoring and controlling. All the AHUs are on/off through SCADA system from a control room. PLC program is connected to SCADA through tags defined in the PLC software.

IV. PROPOSED SYSTEM

The AHUs are working with the help of DOL starters. Starters will make the AHUs move in a constant speed. Hence to save the energy we should use VFDs to control the motors working. 10% reduction of speed gives 20% energy saving. Using LEDs in place of CFLs will help save more energy.

V. CALCULATIONS

- Existing system

Let an AHU is running with a motor of 5 HP, consuming 3750 Watts and current of 7.5 Amperes. This AHU runs for 9 hours a day, so the KWh consumption will be 33.75KWh and it will add Rs. 236 (Rs. 7per hour) to the electricity bill.

Lightning in the hospital is accomplished by CFLs.

- Proposed system

If for the same ratings of AHU's motor, we use VFD and PID there will be consumption of 6 Amperes of current and 2.9 KW. KWh consumption will be 26.1KWh and it will decrease the amount of bill to be Rs.182.7.

In lightning for saving energy we replace the CFLs by LEDs. As 8-12 Watts of CFL will produce an output light of 450 Lumens and for same output a LED of 4-5 Watts is sufficient.

- Investment

VFD for 5 HP motor will cost up to Rs.17210 and PID will be of Rs.2500.

Cost of LED is more than CFL but it will last for a longer period.

VI. RESULT

Energy conservation is necessary because ever increasing demand need for electrical power can only be met by conserving the electrical power. Demand for the electrical energy is projected to be double by 2030. So, measures are to taken to reduce the overuse and wastage of electrical energy.

- Using VFD and PID in the working of AHU will save the electrical energy up to 20%.
- Using LEDs in place of CFLs, there will be additional saving of 55-60%.

If all the motors of AHU are to be operated by the VFDs and PIDs there will be a saving of Rs. 19332.6 each month based on the energy cost of Rs. 7 per KWh with the total cost in HVAC system. The HVAC proposed system will pay for itself in less than 2.5 years. Savings in using LEDs in place of CFLs will be around Rs. 122400.

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