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BUILDING ENERGY MANAGEMENT SYSTEM USING ISO 50001 STANDARD

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ABSTRACT

Neither energy can be created nor can be destroyed, so the main purpose of Building Energy Management Systems Software is to control the energy devices to make effective utilization of energy. All efforts are being put reduce energy consumption and decrease the carbon footprint. There are many alternative renewable energy sources to harvest naturally but currently these devices are costly for daily use. The ISO 50001 Standard has been proposed in 2001 for efficient use of energy in all commercial buildings which consume more energy. Our paper explains about implementation of ISO 50001 standard at software level and successfully reduce the carbon footprint. The paper includes compared results of non ISO and ISO 50001 Standard.

KEYWORDS: Energy, Consumption, ISO 50001, RTU, BEMS, standard, Building, Management.

INTRODUCTION

Energy is everything and it manifests in varieties of ways and forms like air, water, electromagnetic waves, plasma, gravity and so upon. When we had studied in schools that energy can't be controlled and they were right. Even though if we can't control energy in large scale but still we direct energy in smaller levels like in electronic circuits. When digital revolution happened in computer chips in 1971 people started to believe that we can't control energy but we can redirect and use it efficiently. This led to the creation of superfast computers and high speed computations. Now we have such a technology we can send digital data at very high speed like using Optical Fiber technology. When humans gradually started to understand how energy works at smaller levels like in atoms led to the miniaturization of electronic circuit components and helped to create smart phones. Now smart phones are everywhere and also computers at every office. After arrival of computers from research to business the office infrastructure has changed drastically. When computation load increases on computers they tend to become heated up and finally burn of electronic circuits. To avoid this problem the offices sorted out to use of A/Cs and apart from A/Cs a building needs many other equipment like dust filters and air cleaners and suitable labs set up with A/Cs for testing of products. These all above components consume a lot of energy and many times energy will be wasted for computers and A/Cs running in idle. When infrastructure grew more rapidly it eventually led to a lot of energy waste and lack of billing of energy consumed by any organization. To avoid difficulty of energy management in buildings a software solution can be given for many organizations.

This Building Energy Management Systems is a software that has been developed mainly to gathers information from small electronic components like energy meters which give the readings of voltage (V), current (I) and many other factors. This software applies some data filters to the data and finally put everything back into a database and it will be referred for further data visualization. This includes individual meters reading, inference system for generating the alarms, report generation for audition and complex data visualization algorithms.

This paper is organized as follows. Section II outlines the design and architecture of Building Energy Management System (BEMS). The energy efficiency factors are discussed in section III and implementation of overall system is in section IV. Finally, the results and conclusions are mentioned in section V and section VI respectively.

DESIGN AND ARCHITECTURE OF BEMS

The design and architecture of BEMS consist of mainly three parts,

- RTU
- Modbus TCP/IP
- BEMS Software

RTU [4] Remote Terminal Unit is an A/C or any other device which is embedded with a controller that is used to collect the data from A/Cs and other devices. These are connected to Modbus device via RS-232 [4] or RS-485 [4] serial communicators. These devices job is to gather the information, construct packets or frames and send them to a Modbus. The RTU [4] unit is mentioned in below figure.

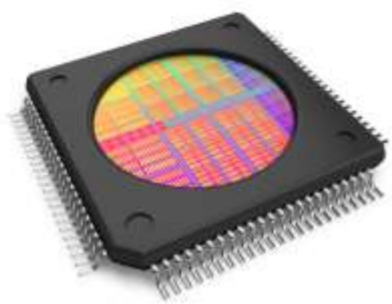

Fig.1. Embedded Microprocessor or Controller

This above controller senses the environmental data from greater device and if necessary it converts analogue to digital data and sends to master system. This RTU is many times called a Slave system which will polled to send the required response based on master commands. This uses RS-485 serial communicator to send the data to the Modbus RTU which collects all the data and sends back to master station.

Modbus RTU is another small embedded processors which supports Ethernet module or TCP/ IP module for communicating with a stationed computer. This device uses RJ-45 male cable to connect to the device and RS-485 to connect to the RTU [4]. This supports the TCP/IP module, so computer which supports Ethernet communication can connect to these devices and collect the information. The figure of Modbus RTU is shown below

Fig.2. Modbus RTU with RS-485 and RS-232 and RJ-45 Female

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Modbus TCP/IP is an industrial Ethernet protocol that is used mainly for interconnecting with end computer system for data visualization. The Modbus TCP/IP [5] acts as slave for computer and master for RTUs. Which always polls the respective the meters and sends data back to the computer.

BEMS software is a computer large computer program that uses the TCP/IP socket modules to connect to the Modbus RTU [4] and collects the information at Round Robin fashion. It polls every individual meter at given intervals and parses the responses that have come from Modbus RTU. These collected raw data will be filters and visualized later. The overall functioning of BEMS system is depicted below

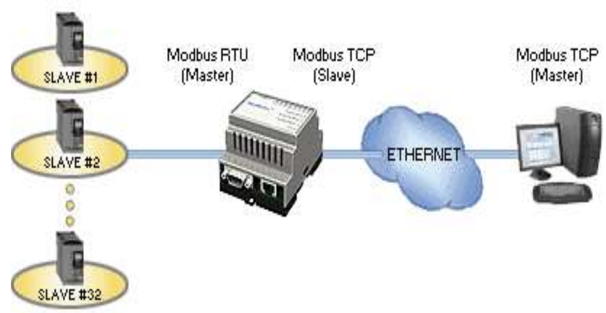

Fig.3. Overall BEMS system architecture

ENERGY EFFICIENCY FACTORS

There are many energy efficiency factors that are to be considered for maintaining building but among them following are more important and basic metrics for computation and visualization.

- Area and size of the Building
- Frequency of Audit
- Real time data monitoring
- Reorganizing electric equipment for efficiency
- Studying the environmental interferences
- Real time data visualization

1) **AREA AND SIZE OF BUILDING:** It is always matters a lot in energy consumption because if area of building increases than the numbers of energy consuming devices increase. This leads to use of different topological connections to interconnect the energy meters and increases the burden of frames forwarding to master station. Therefore the entire building area has to be divided and based on its geography the well suited topology has to be chosen for interconnection of energy Modbus RTUs. This reduces the energy loop holes formed because of using same topology for different geographical regions. The area is measured in m2.

A = Area of a Building (M),

The individual buildings are taken as {B, C, D, E, and F},

C=Consumption of energy per unit area that is Energy/1m2.

Total area A = (B+C+D+E+F)

Probability of maximum energy required for B (PBE) = B/ (B+C+D+E+F)*C.

2) **FREQUENCY OF AUDIT:** It is very important for keeping an eye on performances of each and individual devices. The audit should be conducted frequently to know what is happening in system and it also enables

one to reinforce the certain conditions to reduce the unnecessary energy consumption. The ISO 50001 recommends to do frequent audit to readjust certain energy factors to slow down the carbon footprint.

3) **REAL TIME DATA MONITORING:** It is another original aspect of energy monitoring system. The data which is being read from a RTU should be very reliable data and it should be on time to carry out certain necessary commands or logic. If data is not real time, then it will become highly impossible to dispatch the necessary events to RTU devices. The delay in action can be tolerated but for critical events it would be disastrous.

4) **REORGANIZING ELECTRIC EQUIPMENT FOR EFFICIENCY:** It is very important because if infrastructure does not support the flexibility for reorganizing the electric equipment, then it would be very difficult to relocate some devices to another place. This relocation should not cost the organization instead the set up should be very flexible, so that if necessary everything can be rearranged.

5) **STUDYING THE ENVIRONMENTAL INTERFERENCES:** It is very sensitive part of topology set up. The different geography of a building will have different humidity, temperature and the type of device which is set up in that environment. Suppose if a heater is set up in 6 degree Celsius then it will consume a lot of electricity to heat the water and even if an A/C is set up in many window room, then it runs in futile because of leakage.

6) **REAL TIME DATA VISUALIZATION:** It is another factor it mainly depends on how fast a data can be visualized and how recent that data should be? If data is not very recent, then it will create a lot of problems in taking actions on failures of any greater device. The very recent data always will be helpful to make proper decisions and predictions of future events.

IMPLEMENTATION

ISO 50001[3] is a standard model of design and planning for reducing carbon footprint which has been proposed in 2001. This system includes mainly following parts for implementation of any energy management system.

- Energy Policy
- Energy Planning
- Checking
- Management Review
- Continual improvement

1) **ENERGY POLICY:** A policy is a statement that has been set as goal for efficient use of energy. An industry sets many policies for its gradual curbing of energy cost and of its resources. For example a company sets its energy policies as follows,
   - Energy usage awareness must be brought to notice to all working staffs
   - Energy consumption should be reduced 30% by next year of end
   - A standard should be used for planning and designing of energy management system
   - Audit should be conducted very frequency for performance and costing

2) **ENERGY PLANNING:** This planning phase includes design and planning of entire Building Energy Management System. All case scenarios will be considered before designing any design and minimizing faults and errors in initial stages of development.

3) **CHECKING OR AUDIT:** This is mainly for auditing the entire power usage of the building. This audit planning also includes the frequency of number of auditions required to manage the energy systems efficiently.

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4) **MANAGEMENT REVIEW:** This includes the procedural ways of representing data to management. There is an implementation of authorization system for authenticity of viewer and a separate console is provided for administrational actions.

5) **CONTINUAL IMPROVEMENT:** This includes the continual development of BEMS software and fixing of loopholes and hardware defects. The Management Review plays very important role in continual improvement because of all energy information representation and policies are changed and improved by energy management body any organization.

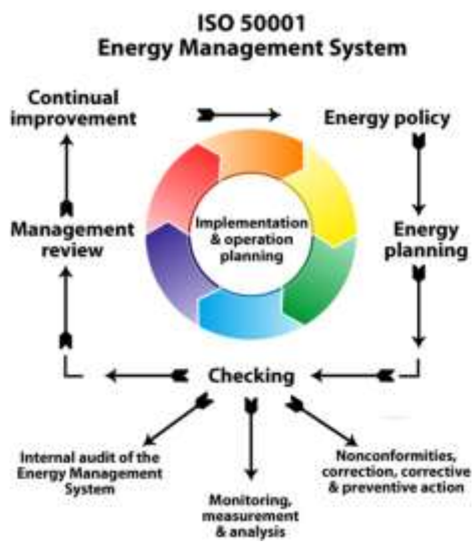

Fig.4. ISO 50001 energy standard

RESULTS

The following results are obtained from actual implementation of ISO 50001[1]. The below graph shows that meter reading of every device. This is plotted using two parameters Timestamps vs KWHR (Kilo Watt Hour).

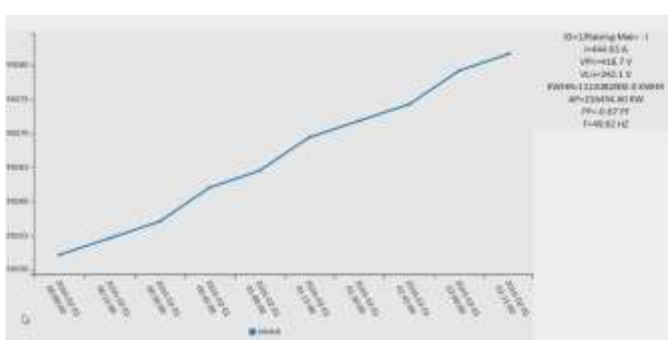

Fig.5. Individual energy meter plotting

The below is the pie chart that shows the energy consumption of each and every meter of particular set of devices like A/C, Lighting Panel, UPS and Raw Powers.

- A/C-25%
- Lighting Panel-6.2%
- UPS-44.9%
- Raw Powers-23.9%

The above all are calculated by following method,

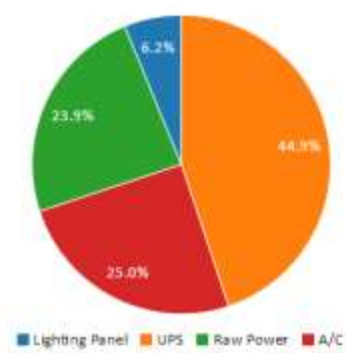

Fig.6. Pie chart for different divisional areas of building

This above figure shows the individual meters of Light Panel. The 34, 38, 50, 67, 81, 108 are metes. The chart visualizes KWHR vs each meter.

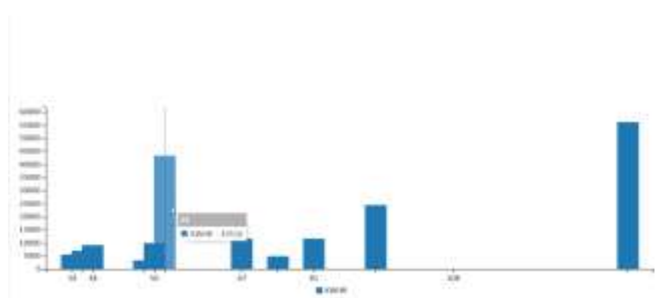

Fig.7. Bar chart for individual meters in entire division

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CONCLUSION

The energy consumption is increasing every day and it is leading to extra burn of fossil fuels. The reduction in carbon footprint can be done by following the standard set up by ISO 50001. This software covers the inferences and alarms to predict and to take actions on certain conditions respectively but it still requires manual intervention for taking actions. The future work to be done in this part should be to do automation of dispatching of events whenever certain events happened at any place. This automation adds value to overall software and to hardware.

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REFERENCES

1. Paul G. Ranky, “Sustainable Energy Management and Quality Process Models Based on ISO50001: 2011 The International Energy Management Standard”, 16-18 May 2012, IEEE
2. Ranky, P G. (2012), “An Introduction and overview of ISO 50001, the International Energy Management Standard”… A DVD video quarto (4) set, by www.cimwareukandusa.com, 2012 [2] Ranky, P.G. (2006-2010) Visual Factory, IEEE
3. Thorsten Fiedler, Paul-Mihai Mircea, “Energy Management Systems according to the ISO 50001 standard — challenges and benefits”, 25-27 Oct. 2012, IEEE
4. W. N. S. E. Wan Jusoh, M. A. Mat Hanafiah, M. R. Ab. Ghani , S. H. Raman, “Remote terminal unit (RTU) hardware design and implementation efficient in different application”, 3-4 June 2013, IEEE
5. Qing Liu, Yingmei Li, “Modbus/TCP based Network Control System for WaterProcess in the Firepower Plant”, IEEE