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Computerized (Digital) Energy Monitoring System

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ABSTRACT:

This paper demonstrates the design and implementation of a PLC based digital energy monitoring system. Firstly, all Energy meters are connected though the switch to take into the same ethernet network. The entire system is also studied and simulated in terms of utility side supply, load, PLC digitization and Software communication. A virtual data sharing technic is also studied for the proposed system using state flow logic. A prototype system is verified real-time with its test and verification phase results. In this work, remote monitoring of electricity has been made easier for the utility. Demand side management is also presented as customers can instantly get their electricity consumptions when requested. Further, an effective consumption monitoring system has been embedded along with a backup database source. Results obtained from the experiments prove that with this emerging technology it is possible to move towards smart energy consumption monitoring in easiest way.

GENERAL BACKGROUND:

Nowadays, **manufacturing industrial services** need are highly competitive. Energy is one of the key factors in reducing operating costs. Energy conservation is also one of the supports of sustainability and sustainable energy development.

Digital Energy Management concentrates on planning and implementation of energy related objectives such as cost savings, resource preservation, carbon footprint reduction.

The initial design stage of an energy management system is vital to maximize energy savings without compromising on function or comfort.

Currently, demand of customization is increased, the energy industry is experiencing **a vital change** due to the demand from various types of industries. **Decentralization and digitization** entail new processes, new business models and not least new IT solutions, which can be combined with current IT settings.

Power is distributed across the plant in multiple section which is managed by utility department of that plant and face many challenges into their day to day activity which can be reduced by achieving below objectives.

OBJECTIVE:

1. Real time monitoring of energy consumption
2. Eliminate manual error in data capturing
3. Longer retention of energy consumption data

4. Actionable insights by analyzing energy data

5. Electrical equipment optimization

6. Electrical network improvement

7. Optimization of energy consumption: Ideal vs Actual

8. Data: the technological advancements in the data sources and flows. The impact of the new data on existing applications and integration of the new data sources.

9. Information: extraction of information from new data, required visualization strategies, and effective utilization approaches.

10. Knowledge: new tools for data analytics used for conversion of information to knowledge

11. Communication Architecture: the communication architectures to cater the new data flows and control applications.

12. Decision making: New applications supporting decision making for new business scenarios.

SCHEME:

1. Draw a single line diagram of electrical distribution network to understand energy consumption measurement points.

2. Install digital energy meters with Modbus TCP/IP compatible at all measuring points.

3. Connect all energy meters with centralized monitoring system though hub.

4. Develop an application to retrieve data from all energy meters.

5. Develop a dashboard or graphical representation of energy meters for real time monitoring and actionable insights.

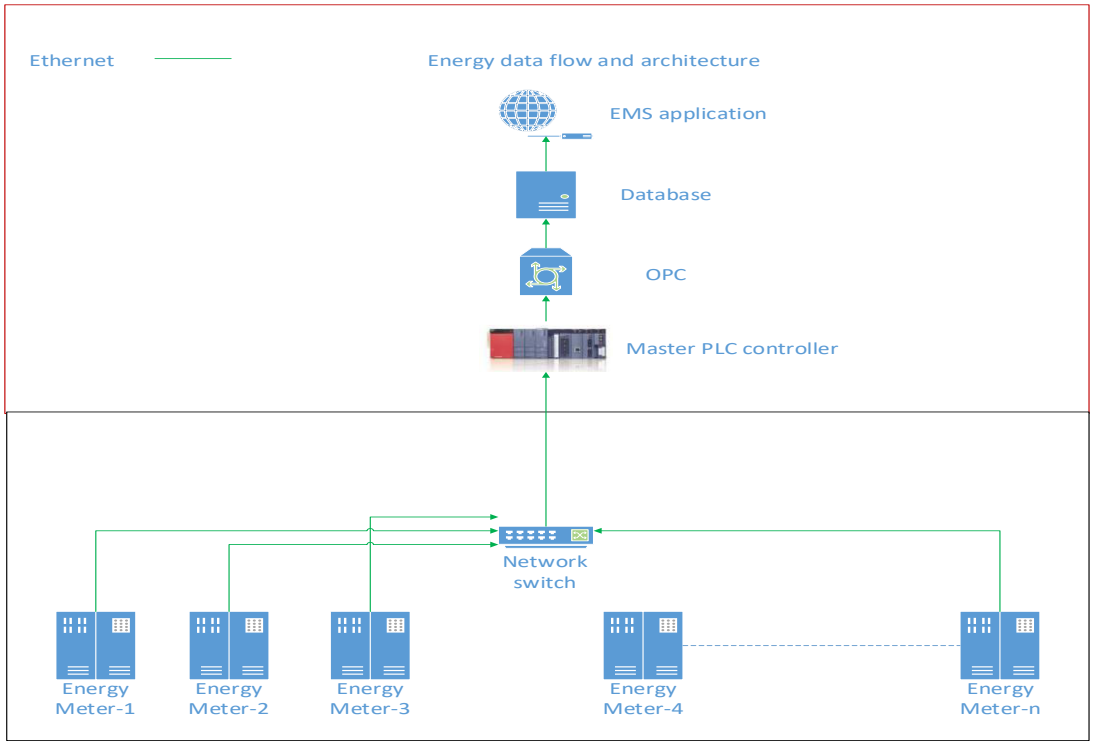

Fig: 1.3.1 Energy consumption dataflow architecture

LITERATURE SURVEY

Introduction:

An energy meter is a device that is able to measure electric energy at any instant of time. The data on energy consumption is very important for the study about energy demand especially on domestic loads. But the meters in paste were very expensive because of the expensive hardware such as CTs & PTs installed in it. It therefore, was the need of the day to design such a meter that could efficiently measure the electrical energy consumed by home appliances such as electric irons electric kettle, motors, television, lighting loads etc, and thus the Digital Energy meter was developed. Some of the main features of this meter is that its robust, user friendly and informative enough for the purpose of simple data collection.

In this research project I have designed & interfaced the hardware with the PLC. In this hardware design, the energy consumed is determined in a digital form. The main role of the PLC is to execute the output signal on the soft code specially written to calculate energy cost. The total energy consumption done by the appliances and its cost charged is displayed in the software.

For a customer to pay the electricity bill, he/she should install an energy meter that measures the amount of electrical energy consumed by the customer. This meter needs to be calibrated and sealed so that the client cannot mess with its hardware. The meter has to be read instantly and then the data collected will be processed.

This system uses PLC as a central part to provide the features like real time monitoring of the unit's measurement, and display the units consumed in software. So that at the end of month one can have the information about the units consumed with proper date and time of units consumed.

The scope of this work includes using, assembly to program PLC, build hardware for the system, and interface the hardware to PLC and different electronics components like Energy meter, OPC server etc.

Literature review:

1. Devadhanishini et al., [2] "Smart Power Monitoring Using IoT" that energy Consumption is the very important and challenging issue. Automatic Electrical Energy meter is used in large electric energy distribution system. The integration of the Arduino WIFI and SMS provides the system as Smart Power Monitoring system. Smart energy meter provides data for optimization and lessthe power consumption. This system also includes a motion sensor such that if there is no human in house or house it will automatically turn off the power supply.
2. Mohammed Hosseiu et al., [3] presented a paper titled "Design and implementation of smart meter using IoT" describing the growth of IoT and digital technology. The future energy grid needs to be implemented in a distributed topology that can dynamically absorb different energy sources. IoT can be utilized for various applications of the smart grid consisting power consumption, smart meter, electric power demand side management and various area of energy production. In this paper, the Smart Energy Metering is explained as the main purpose of Smart Energy Metering is necessary for collecting information on energy consumption of household appliances and monitor the environmental parameters and provide the required services to home users.
3. Himanshu K Patel et al., [4] demonstrated "Arduino based smart energy meter" that removes human intervention in meter readings and bill generation thereby reducing the error that usually causes in India. The system consists the provision of sending an SMS to user for update on energy consumption along with final bill generation along with the freedom of reload via SMS. The disconnection of power supply on demand or due to pending dues was implemented using a relay. The system employs GSM for bidirectional communication.
4. Bibek Kanti Barman, et al., [5] proposed "smart meter using IoT" on efficient energy utilization plays a very vital role for the development of smart grid in power system. Hence proper monitoring and controlling of power consumption is a main priority of the smart grid. The energy meter has many problems associated to it and one of the key problems is there is no full duplex communication to solve this problem, a smart energy meter is proposed based on Internet of Things. The smart energy meter controls and calculate the consumption of energy using ESP 8266 12E, a Wi-Fi module and send it to the cloud from where the consumer or customer can observe the reading. Therefore, energy examine has been by the consumer becomes much easier and

controllable. This system also helps in detecting energy loss. Thus, this smart meter helps in home automation using IoT.

5. Garrab et al., [6] proposed AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication" on the raising demand of energy. Smart meters are one of the proposed solutions for the Smart Grid. In this article, an AMR solution which gives detailed end-to-end application. It is based on an energy meter with low-power microcontrollerMSP430FE423A and the Power Line Communication standards. The microcontroller includes an energy metering module ESP430CEl.

6. Landi et al., [7] presented "ARM-based Energy management system using smart meter and Web server about a low-cost real-time ARM-based energy management system. An integrated Web Server helps to collect the statistics of energy consumptions, power quality and is to interface devices for load displacement. The device is used to access the information. In this way it is possible to manage the power consumption of the power system leading to a consumption of power.

7. Koay et al., [8] explained "Design and implementation of Bluetooth energy meter" described around the year 2004, digital meter has started to replace the electromechanical meters in Singapore. A wireless digital power meter would offer greater convenience to the meter reading task. Bluetooth technology is a possible wireless solution to this issue. The power reader can collect the power consumption reading from the energy meter wirelessly based on Bluetooth. Two methods that can retrieve the meter reading with little human intervention, are added and implemented in the targeted applications, they are Automatic meter reading. Some commercial applications are applied for the Bluetooth-enabled energy meter.

MODELLING AND IMPLEMNTATION:

3.1 Physical Modelling, Software & Hardware Implementation Process:

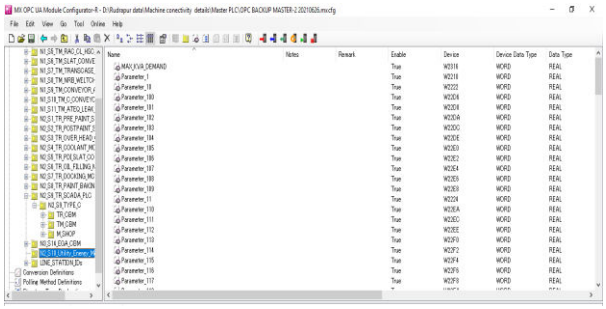

Fig: 3.2.1 OPC server Tag mapping for data acquisition Fig: 3.2.2 Digital energy meter (source: google)

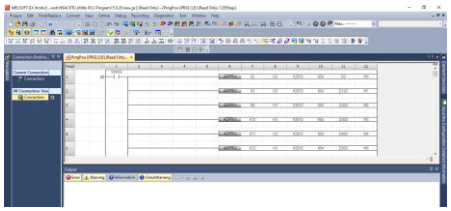

Fig: 3.2.3 PLC program to integrate energy meters

Architecture:

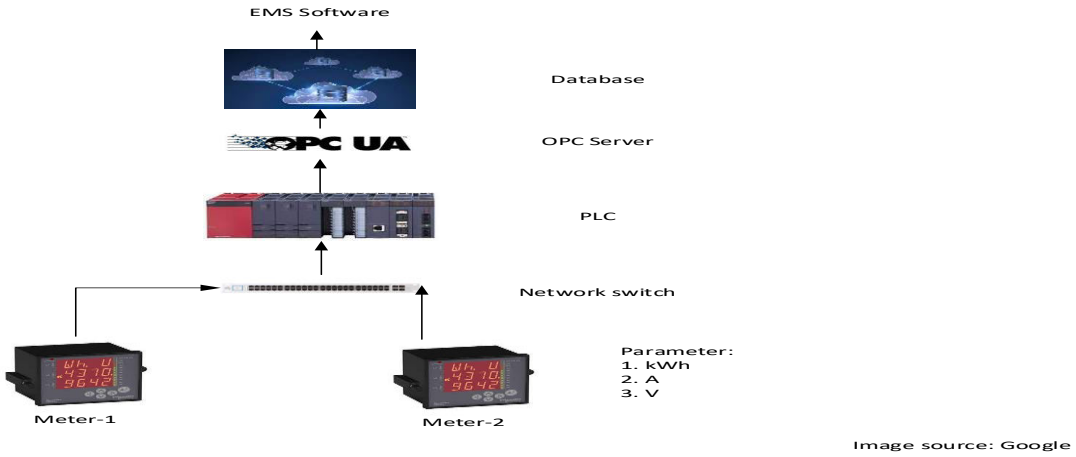

Fig: 3.2.4 Energy meter data flow Architecture

3.3 SOFTWARE:

Application is developed with HTML and JavaScript for real time energy consumption data monitoring and access details history. It will be received data at the interval of 1 hour and plot graph as visualization for user. Data will be updated after every 1 hour to avoid overloading on website.

RESULTS AND DISCUSSION

Energy consumption monitoring dashboard and insights

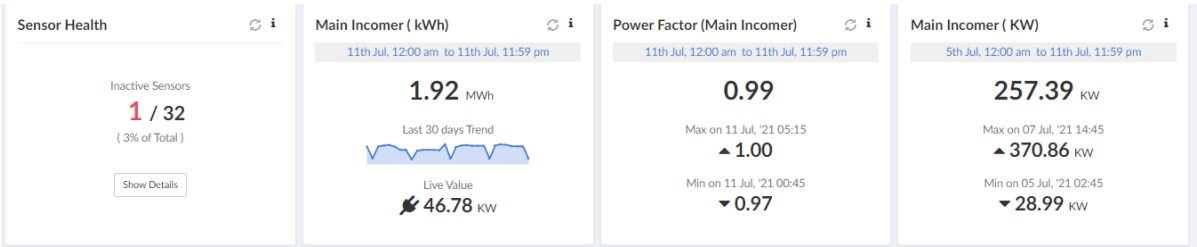

Fig. 4.1.1 Energy consumption real time monitoring

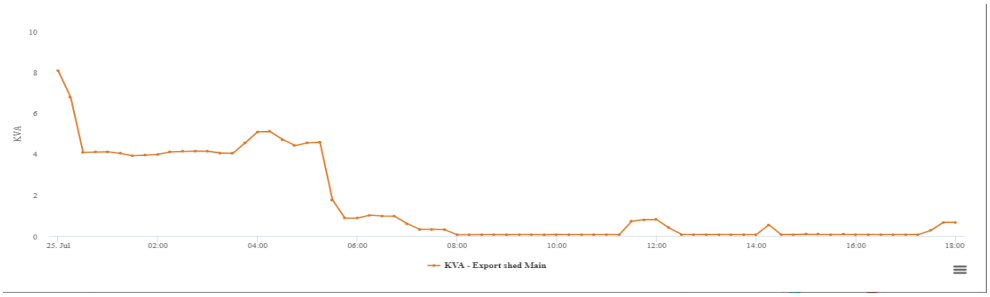

Fig. 4.1.2 kVA historical data analysis

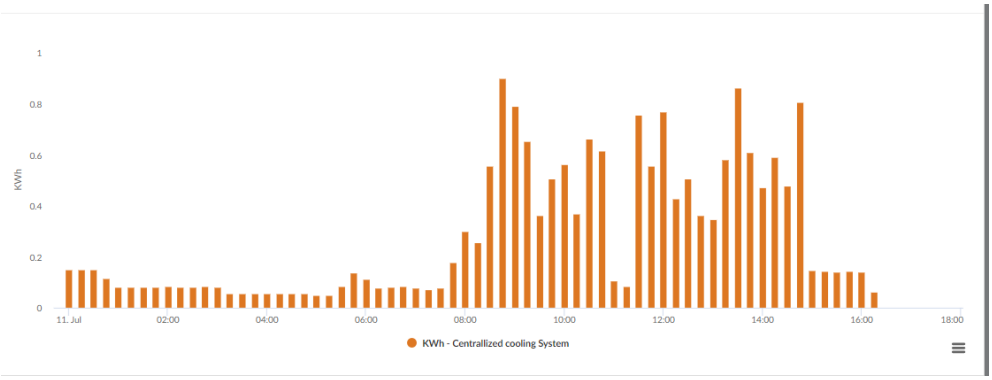

Fig. 4.1.4 Energy consumption monitoring of subunit

FUTURE SCOPE:

IoT based data analytics can be prepared for prediction of energy consumption.

IoT based system can be taken over a convention method of energy monitoring system. Energy will be smart enough to send data autonomously to the database over internet.

Following are the future scope in order to save electric power and to detect theft: -

1. There can be a system where Automatic Switching of electric equipment's by the use of IoT is applied.
2. To make a system where user can receive alerts, if one crosses threshold of electricity usage.
3. User can monitor energy consumption on fingertips.
4. Application of IoT based theft detection buzzer with Energy Meter.

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