Energy Management System Using Supervisory Control and Data Acquisition (SCADA) & Human Machine Interface (HMI)

B.Sc. ELECTRICAL ENGINEERING

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A thesis submitted in partial fulfillment of the requirements for the
Degree of BS in Electrical Engineering System

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DECLARATION

This thesis is a presentation of my original research work. Wherever contributions of others are involved, every efforts are made to indicated this clearly, along due to references to the literature review, and the acknowledgment of collaboration research work and discussions. I also declared that this work is the result of my own investigations, except where identified by references, and free from plagiarism of the work of others.

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The undersign hereby certify that they have read and recommend the thesis entitled **"Energy Management System using Supervisory Control and Data Acquisition (SCADA) & Human Machine Interface (HMI)"** by Sabtain Hussain and Muhammad Tanzeel for the degree of Bachelor of Science in Electrical Engineering System.

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Thank you to all those who have supported me throughout this journey.

Thank you,

Sabtain Hussain

Muhammad Tanzeel

DEDICATION

We would like to dedicate this thesis to my beloved family, teachers and friends.

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DL	Data Logging
EE	Energy Efficiency
EA	Energy Analyzer
EMS	Energy Management System
EBP	Easy Builder Pro
HMI	Human Machine Interface
OPC	Open Platform Communication
RG	Report Generation
SCADA	Supervisory Control and Data Acquisition
VSD	Variable Speed Drive

ABSTRACT

The power consumption data is very important for the implementation of energy-saving strategies and the installation of an energy monitoring data logging and automatic report generation system can help in planning for the energy-saving strategies need a record of consumption data in the form of reports, which is, consists of daily and monthly load curves. The selection of energy-saving strategies depends on energy-saving management, monitoring, and data logging systems that can help to improve power consumption quality in the industrial sectors of the developed country. Therefore, this studies, which is going to introduces the sector of developing an energy management monitoring and data logging system using a real-time data-taking system and use from the Superior University, Pakistan. The energy consumption data, which also includes the data on power like current, voltage, frequency, kw/h, and power factor will be collected the real-time data-taking with the help to the energy analyzer where transmit to the customized a Supervisory Control and Data Acquisition (SCADA) based software's for the monitoring, real-time data logging and reporting. Therefore, the purposed system for this study is to impact of the energy management system on the improvement of the energy management system based on results and proposed energy-saving strategies for a University. The energy management system on the improvement of energy saving consumption data results. The proposed system that can be help to achieved the improvement of power saving.

CHAPTER 1

INTRODUCTION

This chapter presents the background of the Energy Management System Using Supervisory Control and Data Acquisition & Human Machine Interface (HMI) based in the terms of electrical technology. Therefore, we discussing the objective of our thesis, main contribution, structure, and the environment used for this working.

The system, which is going to introduce, is a status monitoring system for labs. This system monitors the detected parameters. Along with a monitoring system, it generates daily reports of labs. It is HMI and SCADA based. There are seven parameters, which can affect labs. For monitoring the real-time lab data HMI communicates with collected data to show it on the HMI display. Supervisory Control and Data Acquisition (SCADA) on Excel is also part of this system. It is an industrial software, used for monitoring any system. It has email alerts on both hardware and software. In this customized SCADA, users can design daily reports of any lab automatically and analyze the lab's daily data through designed energy analyzers. It has a real-time dashboard where users can visualize real-time data of labs. The parameters which are under consideration are current, voltage, frequency, power factor, and kw/h input and output it checks every time, and in case of any abnormality, it sent an alert email to any concerned person.

1.1 Background

This study for globally demanded energy is increase gradually according to continuously economically grooming and burned fuel [1]. The consumers in the developed countries face many difficult circumstances according to the grooming power value and transferred distance because they are have to facing high power amounts and energy wattage in areas. The passive investment of the under-structure data are require to increase the all power wattage of generation power electricity that can be taken almost few year to develop the power resources in the developed countries of Pakistan [2]. This study are show that the power wattage losses and un-efficient uses of an energy management system are developed power shortages of many areas [3]. Therefore, develop country that have been already working on this chapter, so power consumed in developed countries still very needs to the educated about the active measuring users requirement to improving power efficiencies by reduced power crises losses. Therefore, according to the US Information of energy the industrial sectors consume 34% of the world's transferred power efficiency of the industrial facility are very importance of all each sector [4]. Therefore, industrial sectors of the Pakistan consumers 30% of maximum production and power is the biggest power consumer in the industry areas in Pakistan [5]. The industrial sectors in all country partially effected to the many power growing difficult circumstances occurs in the industry sector all departments. The energy management monitoring and data logging systems that can be help for reduced the power losses in the industry sector in Pakistan, which is going to easily can improve the geo-economic and environmental stability. The energy management monitoring and data logging and reporting of load on the consumers inside becomes more convenient due to the involvement of the latest Ethernet switching and data transmitted technologies in energy sectors in Pakistan [6]. Most important the things of internet data base system energy management monitoring and data logging

device that can be monitor automatically by hand, and they are transferred to where reporting region with the help of the Ethernet gateway switching. Therefore, advance energy meter that are good for the residence system, because a complete the energy management monitoring data logging system that can be fully must important requirement for the sector of industry and consumers to details of power consumed data-se in customized servers [7]. The purposed this study which is going to introduce that the design system of structure, and hardware of implementation an energy management systems in a well-known University in the Pakistan. This energy management system that are consist of a software and hardware network of connect the customized power monitor data logging software's to the real time energy consumed power quality of the datasets to the one by one labs of the University. This data an customized that the parts to the design systems where the comparison of Ethernet switching to an data communicate waiting make sure an real time energy management monitor, data logging in the customized servers. This systems is to elaborate the equipped data with the advance and latest features such as energy management monitoring data logging and reporting of energy automatically generating the reporting of faculty inside the all labs to trying transfer daily, monthly reports to each lab with help of Ethernet switching via email, Therefore, the advanced and faster technology that are used in our design system including, but system were not be limited to customized a Supervisory Control and Data Acquisition (SCADA) customized servers with database management as per the requirements of consumers [8].

1.1.1 SCADA System Application:

In this study, the system, which is going to introduce the Supervisory Control and Data Acquisition (SCADA) system, is widely used in industry sectors for energy management monitoring data logging, and reporting systems. Also, that can able to design many latest features of energy management monitoring data logging and reporting applications such as many kinds of customized a Supervisory Control and Data Acquisition (SCADA) based systems on the an energy management monitoring data logging and reporting for each lab [9]. The author of [10] shows the installation for monitoring data logging, and reporting of this system is Supervisory Control, and Data Acquisition (SCADA) and Human Machine Interface (HMI) base energy management monitoring data logging and report purposes [10]. Customized the Supervisory Control and Data Acquisition (SCADA) based system that can be also use for energy management monitoring and data logging and reporting purpose [11]. The author of [12] of this study is going to introduce a customized a Supervisory Control and Data Acquisition (SCADA) based systems software's to energy management real-time monitor data logging and reporting systems with centralized datasets. They were few huge communicates with the help of the Open Platform Communication (OPC) servers [12]. This system is reviewed for many years for continuous energy management monitoring data logging and reporting system that can along help of the Supervisory Control and Data Acquisition (SCADA) based systems. The study is an accurate example of energy management system monitoring and data logging and reporting for the power process. The author brief that the users were able to save the power monthly implementation of power-saving strategies with the help of the energy management systems [13]. Previously these studies view that all customized a Supervisory Control and Data Acquisition (SCADA) based system on energy management real-time monitor data logging and reporting systems design according to the specification to the consumers. The designed system is more efficient, reliable, advance features and cost-effective.

1.1.2 Energy Monitoring System:

The design system of this system which is going to design the an energy management monitoring system and data logging system use to the implementation of the power consumed policy for the labs at our University. The study of an energy management system that are consist of a huge amount of software connect to the customized SCADA system for monitoring data logging and reporting software's for monitor power consumption and energy qualities datasets of each these labs. The data synchronization is also the part of the systems design a mixture of gateway Ethernet switching is minimum the data synchronization and to make sure the real time power monitor and data logging system with the customized server. This system had to demonstrate that equipment system is the very latest and advanced feature such as energy monitor and data logging and reporting of load consumption data for each lab inside the department, and the region where the system is installed. Therefore, in adding to the daily and months wise report of each lab through the SCADA operator and user via email. Also, define the daily energy consumption data of each lab Therefore, the previous study shows that every energy management system is used to design the system according to the requirement of the consumers. The purpose of this study was to discuss a further detailed introduction of the install systems. Also, method that are used for power saving, and results of all these method. The majority of the industry consumer in developed country did not pick up the latest and most advanced features of technology to improving energy efficiencies that those technology are used very much reliable, and cost-effective because of they do not have general expensive budget benefits for the country. The design system for energy monitoring data logging and reporting is an expensive, cost-effective, reliable, innovative, and real-time monitoring data logging and reporting system. The purpose system has a smooth representation of automation energy management monitoring data logging and reporting access to the system for the automatic data logging and reporting system. The Supervisory Control and Data Acquisition (SCADA) system is very widely used for the latest, advanced, and fast mechanism for monitoring data logging and reporting systems [14].

- ☐ The very important and mainly purposes is designed the reliable, innovative, efficient and real-time energy monitoring data logging and reporting system for the process industry and secondly our University labs. The purposed system has a reliable digital presentation of an energy management monitoring data logging and reporting via email to the SCADA software operator of the system. Therefore, it can easily access to the user and easily reporting and indication detection.

- ☐ The important secondly purpose is to found an improved energy monitoring systems through the flexibilities to the future term for hardware to the an energy management monitoring data logging energy consumption system. An energy management system for monitoring data logging and report generation is fulfil in deduction of the energy losses in developed country for improve the power efficiencies to the labs and any faculty of industry. Therefore, this system can promote developed countries to manage energy.

- ☐ Customized a Supervisory Control and Data Acquisition (SCADA) based system also help for ability to monitor, and report communication with the purposed system, and the power supply and SCADA monitoring person can monitor the energy flow in side of labs along the approval from the users. The latest and advanced application that are can be help for load supplied

authorities limited to power off non-critical power in choose any industry and labs with the permission of consumers.

1.1.3 System hardware:

In this study, the energy management system using customized a Supervisory Control and Data Acquisition (SCADA) and Human Machine Interface (HMI) is a hardware and software system of energy management monitoring data logging and reporting systems designed and install successfully implement in labs in our University. The hardware system, which is going to introduce, is a very flexible and efficient platform of hardware. The hardware system enabled the real-time monitoring of data logging and reporting through energy analyzers. Hardware used in this system for energy management monitoring data logging and reporting for this system used equipment is an energy analyzer, current transformer (CT), Ethernet cable, power supply, DP panel box, an Human-Machine Interface (HMI), Customized a Supervisory Control and Data Acquisition (SCADA) based systems communication servers. The energy analyzers is a very powerful main device and part of our designed systems. This energy analyzer enabled the detail of lab parameters like power factor, kw/h, voltages, currents, and frequency to monitor the system. In addition, every measuring of the data is through to energy analyzers, which transmit the HMI via Ethernet switching and update continuously at a time in digit displaying. The energy analyzer is used to measuring the power datasets flow-voltages and medium-voltages stages along the help of the current transformer (CT).

An HMI is a device, which use in every industry. Users can switch any hardware from its screen. It can communicate with PLCs, s of any brand. It communicates with sensors to extract data and display this data on the screen to view the real-time status of any hardware device. There are many brands available in the market. Every HMI has its own software and communication protocols. The HMI used in this project is Weintek. It is used in most industries in Pakistan. The software for this HMI is easy builder pro, which is easy to use, and the user can design an HMI screen according to the system. Data logging is the main part of this system. At the main tab, there is a menu bar existing. This manual data logging option work for data logging. When the user clicks on data logging the system give two option to the user to open or create data logged report. Daily report generation is highly recommended in the industry because daily reports have data of the complete day with time. When the user clicks on the current report option user will shift to the next tab named report. The daily report is designed according to the industrial report by using Excel tools. It has complete information about the lab like the name of the lab, the date that update automatically, start and end time of the report. The report analysis is in the form of graphs. During the report, generation graphs update automatically. This report automatically saves every day at pre define time. Moreover, this tab has four buttons for starting data logging, ending data logging, and saving PDFs at any time. In case of any abnormality in parameters, the cell without range value will change color to red automatically [15].

SCADA is an industrial software or system which is used in all industries and is mostly used in the manufacturing automation current, voltage, peak power consumption, kw/h, active power, and, reactive power. It supervises and controls industrial processes both locally and remotely. It acquires data and records it. It also informed users by creating reports and alarms. Customized SCADA designed in Excel. This system is completely designed like software. It includes data logging, report generation real-time analysis, reporting dashboard, and alarm logging features. It is totally automated

software and easy to use for users It has access to open any software related to automation like the TIA portal, Kepware OPC expert and etc. It is designed in Excel according to industrial requirements.

1.1.4 Energy Management System:

This study is going to introduce an energy management system, monitoring, data logging, and report generation using SCADA-HMI consisting of a master terminal database monitoring report generation processing in the record.

In the case of Pakistan, there are industrial sector rapidly affected due to the real-time server energy crises that occur. In this chapter, the energy management system monitoring and data logging, report generation customized SCADA-HMI users can design automatic reporting of any power system and energy analyzing the daily data through the analyzer. It has a dashboard where users can visualize real-time energy management systems. The designed hardware system working on the block diagram is shown in Figure 1.

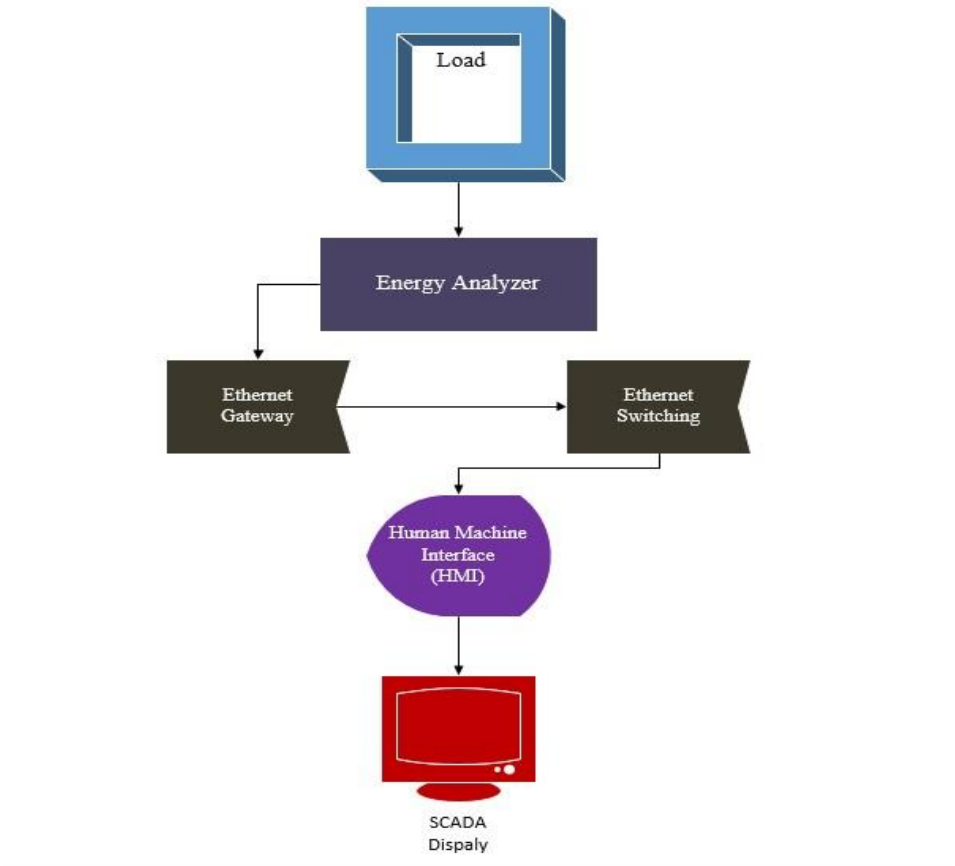


Figure 1: Block Diagram of Energy Management System

1.1.5 Energy-Saving Strategies:

The industrial sectors in Pakistan that are used many energy saving techniques any other end-use sectors and present users, therefore, this industry sectors that are consumed the 30% of the world's total generate power. The an power consumption in the industrial sectors by a various community of the industry including manufacture, agriculture, mining, and building material construction, for a huge rate of activities, such as preprocessing and assembling, spaces conditioning, and lightning. This paper presents a comprehensive literature review of industrial sectors power saving techniques by an energy management system, advance technologies, and policies.

1.1.6 Energy-Saving Through Variable Speed Drive (VSD):

Energy saving strategy used in industry through to the variable speed drive for (VSD) improvement of energy saving technique. When using the variable speed drive (VSD) then the result of total output per annual energy saving in industry boilers (MWh) energy can save a maximum of 10 to 70% speed reduction.

1.1.7 Evaporation Cooled Air Conditioning System:

The air conditioning system is based on compressor vaporization and cooling consumption the amount of electricity. The working of the air cooling conditioning system along the air-cooling condensers the challenges problems. The air evaporation cooling system increases the energy capacity and demand then the result of the compressor running out fewer results in an energy-saving air-cooled system.

1.1.8 Energy Saving Management Techniques:

- ☐ Utilization the energy saving mostly improves efficiency through lamps.
- ☐ Maximum the usage of light in a day.
- ☐ Light controlling the energy management using the ceiling and walls.
- ☐ Energy saving strategy-involving staff planning.

1.1.8 Lamps and Luminaires:

The energy management system uses lamps and luminaires to reduce the consumption of efficient and effective lightning that could require lightning parameters.

1.1.9 Control Strategy:

The energy management system is using specific plans for what to do when your process shows the presence of special causes. The plans out of control situations possible to check the causes and results of all control chars in the use of control strategies.

1.1.10 Daylight Using:

The daylight systems is comprised not just of daylight such as windows. The daylight responsive lighting control system. When there is lighting provided from daylight alone, this system has the capability to reduce the electric lightning power.

1.2 Objectives:

This thesis has the following objectives:

- ☐ To study an Energy Management System (EMS) on SCADA-HMI.
- ☐ To analyze national and international collaboration of industrial automation systems.
- ☐ To Purpose the energy saving strategy in output given by an energy management systems.
- ☐ To identify an continuously maintain the database of the power consumption data.
- ☐ To study automatic report generation.
- ☐ To study the monitoring and Data logging.

In order to meet the objective of this study we use SCADA-HMI. This Thesis presents two types of analysis. First, we conduct industrial automation system analysis to explore the trends and features of the supervisory control and data acquisition and identify top research of industrial standard areas as well as to explore the structure of the energy management system monitoring, data logging, and automatic reporting. Secondly, we also try to understand the patterns and trends of National collaboration of the industrial automation system by exploring co-authorship networks.

1.3 Main Contributions:

We analyze the industrial automation products and national and international collaborations of the SCADA-HMI because we do not find any comprehensive study being conducted to measure the energy management system using the SCADA-HMI automation system. Secondly, we introduce a new measure to calculate the monitoring, data logging, and automatic report generation system using an automation system like SCADA-HMI. This measure can be used to measuring the voltages, currents, frequency, power factor, and kw/h to the inside our lab parameters were we have for real-time implementation and installation.

1.4 Structure of the Dissertation:

In Chapter 2, related works of industrial automation systems like SCADA- HMI to investigate research trends discussed. Chapter 3 described the methodology of designed project. Therefore, in chapter 4 represents the system design and development. Also in chapter 5 represents the about business description and model discussion. Therefore, in chapter 6 represents the results and discussion. Lastly, in chapter 7 represent the conclusion and future work also provides few latest suggestions of the future research.

1.5 Used Environment:

The used environment many tool where use for the data pre-processed and such as visual.

1.5.1 Easy Builder Pro (Version 6.8):

Easy builder pro provides sufficient high-quality graphics libraries. This software is used for the simulation of the system for creating the project with functional objects.

1.5.2 Microsoft Excel 2016:

The Microsoft Excel 2016 provides a fastest category of formulation to calculate the different pictures related to the data sets. In addition, used and simple for write formulas to the calculation of few important datasets relates the required data. Also used for the data logging in Excel sheets for storing real-time data in the software of the project.

1.6 Conclusion:

In this chapter, SCADA and HMI related discussed. All study has cases discussed in detail about SCADA system application, energy monitoring system, energy management system, energy saving strategies, energy saving techniques, which software we use in this project, and the main contribution of the SCADA and HMI automation system and structure of the dissertation. Also described our project objectives.

CHAPTER 2

LITERATURE REVIEW

The explanation regarding the Supervisory Control and Data Acquisition (SCADA) Human Machine Interface (HMI) system.

2.1 Developed Smart SCADA System:

The developed customized a Supervisory Control and Data Acquisition (SCADA) based system to the monitoring data logging and estimate the focusing of popular most air pollution environments gases, in rural areas. There systems measures those systems of air pollution from different example of measuring platform and from a large number of measuring points. This system predict the pollution in the air from this one predicted peoples are they wanted to avoid sites areas along potentially hazards focusing [16].

2.1.1 SCADA System Application Platform:

The developed an automatically station of controlling for the intelligent buildings using customized a Supervisory Control and Data Acquisition (SCADA) based systems that can integrated different example of information for different inside parameters, like controlling of ventilation, heat controlling, control of illumination, etc. Therefore, coming from the several advanced technologies presented in the modern buildings areas. Therefore, the SCADA systems that can be as an applications developed tools that creates portfolio customized supervisory and monitoring features. Therefore, further more choose the abilities of customized Supervisory Control and Data Acquisition (SCADA) to Ethernet switching along holding equipment's in the site, through the implementation network [17].

2.1.2 SCADA-MATLAB Platform:

The built customized a Supervisory Control and Data Acquisition (SCADA-MATLAB) station that connection the partially customized a Supervisory Control and Data Acquisition (SCADA) based systems in the MATLAB software for handle difficult engineering algorithms. Their results explained the innovative, cost effective and reliable for the customized Supervisory Control and Data Acquisition (SCADA-MATLAB) stations for real-time usually conditions, including digital gates manufacturing and ultra-level of the designed algorithm take-off conditions [18].

2.1.3 Designed SCADA System:

Designed a customized a Supervisory Control and Data Acquisition (SCADA) based system for process and search that the SCADA system is too much longer, faster and latest than the conventional Distributed Control System (DCS). They are also mention the customized a Supervisory Control and Data Acquisition (SCADA) based software's could be recorded and stored a various amount of data. Therefore, they search SCADA display are longer and faster efficient than DCS systems display that can be monitoring the system from each and other region [19].

2.1.4 Analyzed SCADA Data:

They analyzed customized an Supervisory Control and Data Acquisition (SCADA) data for accessing the importance of real-time monitoring data logging and reporting for how to work turbines align in the patterns of the directions way along SCADA data, they show that non-vertical alignments of the direction of turbines with respect to the regions and efficiently performance derivation occurring along the most precious configurations [20].

2.1.5 Internet-Based SCADA System:

The employed Internet-based customized a Supervisory Control and Data Acquisition (SCADA) based systems for the real-time monitor, and reporting, power supply inside each parameters voltage, frequency, power factor, current, and kw/h conditions. Therefore, they are reporting that the implementation of internet-based customized Supervisory Control and Data Acquisition (SCADA) based system that can be saving for energy costs by optimizing maintenance schedules and reducing the risk of losses to the energy transferred.

2.1.6 SCADA Solutions:

According to the solutions of customized Supervisory Control and Data Acquisition (SCADA) based system that can provide a base for the huge amount of power monitoring of each industrial sector installations such as line pap sector, production sector, valve installation sector, also other automatically control sectors. The report are optimizing and functioning of the filtration systems, safety and encourages growth demand in the equipment's efficiency power usage data, and op data of the drink able water because of the implementation of the SCADA systems [21].

2.1.7 SCADA Control via PLC:

Presented the uses of customized Supervisory Control and Data Acquisition (SCADA) based system controller via programmable logic controller system for a fluid-levels controller monitoring system along fuzzy controllers. They are assembling a liquid levels monitoring, controlling sets, and programmable logic controller together [22].

They are also found that will be because of the above systems, faults detected could be identified at early soon levels, which will let the operators makes more informative decisions for maintenance of the system [23].

Therefore, they are have a few challenges that needed to conquer in the analysis of the real-time data collection by SCADA software. Also one of them is SCADA can different from the other is SCADA data sets changing in the operational condition. Therefore, according to them pre-processing the raw data collect that can equally contributes to the success of the machine algorithm itself. Collins explained the energy management system for industry features [24].

2.1.8 Described The Change of SCADA Analysis Various Sources:

Described the changeable necessities due to privatization and deregulations that have created the need for analyzing information from various sources. These needs require new high-performance solutions represented by the latest data warehouse of SCADA and EMS systems along with its characteristics

and structure outlined in the paper. Utilities have started to take benefit of this new technique and many other plans to pursue. As the industry gains experience from this new tool, the latest applications will develop on the SCADA & EMS system [25].

2.1.9 Elaborated SCADA Systems:

Elaborated that Supervision Control and Data Acquisition (SCADA) system is a communication and control system utilized to monitor, do the operation, and maintenance of energy infrastructure grids. As a compared file, highlight all of the contents and import your prepared text file. You are now ready to style your paper with traditional applications; a SCADA system has a crucial deadline for critical tasks. SCADA systems have special time constraints for the real-time database. In this paper, the key principle of real-time database has been introduce. The most important aspect of the SCADA systems that can be successful implementation in each variety of applications, which is includes the Industrial application features, energy features, power features, defense features and space features, etc. [26].

2.1.10 Datasets for SCADA Networks in Cybersecurity:

Present the labeled data sets for customized a Supervisory control and Data Acquisition (SCADA) based networks for use in security network advanced research. Therefore, the data sets are includes in packet captured from each maliciously and non-maliciously data sets for networking. However, their data are generate for uses a simulation environment, that which is not a better representative for a real-time implementation of plants [27].

2.1.11 Intelligent Technique in SCADA Platform:

The SCADA platform has provide the pre-review to the station for intelligent manufactured technique in the standard of the Industry 4.2. Therefore, the exclusive growing of the most sensors datasets in the customized a Supervision Control and Data Acquisition (SCADA) based systems throughout the IIoT technique station has been results in the increasing uses of the real-time online monitor data mining and analytically in the industrial process, improved the importance of the machine learning techniques [28]. In addition, the author survey of various artificial intelligence (AI) techniques to the fault detection analysis of the rotatory machine mechanism. The datasets derived approaches has based on emergency alerts, management events, and exposer datasets diagnosis that proposed [29].

2.1.12 Failure Detection in SCADA:

The failures detection system design and real-time installation of customized a Supervisory Control and Data Acquisition (SCADA) based systems for the improvement of the uses to industry machines have been increase with in previous few years, along an evolution forwards and novels objective, such as kind of industry standard, complexed datasets diagnoses, and robots detection failures techniques [30].

2.1.13 Internet of Things (IoT) and SCADA System:

The industrial Internet of Things and its domain, the big huge amount of data and cloud computing, bring great promotion in developing the industrial sector's latest and brand new features of customized a Supervisory control and Data Acquisition (SCADA) based systems in the industry standard

4.2.Therefore, in the attractive datasets changed firstly by customized a Supervisory control and Data Acquisition (SCADA) based systems also Internet of Things (IoT) demanded in the more effective, reliable and efficient to the industry sectors. Therefore, the communication provide stations purposed for the linkage the customized a Supervisory Control and Data Acquisition (SCADA) based systems are provide datasets for Cloudy weather's information. Therefore, the design system are two parts of knowledge that can should analyzed real-time installation and open platform stations communicate infrastructure. They are also allowed previously without any cost that designed systems for adopt to the various industry requirements features [31].

2.1.14 Open Platform Communication (OPC):

An Open Platform Communications (OPC) is a communication standard for the full privacy and efficient transferred to the datasets in the industrial automation system. It allows the flow of information among devices from different manufacturers. The OPC standard defines the interface between clients and servers, including real-time data, monitoring alarms and events, and accessing historical data. The purpose of this standard is to abstract PLC-specific protocols into a standardized interface allowing an Human-Machine Interface (HMI), customized a Supervisory Control and Data Acquisition (SCADA) based systems to exchange the generic Open Platform Communications (OPC) read and write requests into the device-specific requested and vice-versa. Therefore, along the introduced of services oral sketch in the manufactured systems, new create challenges in authentication and data modeling rises. Therefore, other many various-layer adopted accomplishment to the original design specified objective of deliverable functional equivalence, station independencies, and privacy [32].

2.1.15 Interactive Work for Software:

The SCADA software security in a real-time software system needs that include many advanced applications has been too able the fulfill requirement of designed system such many optimizing to manufactured processes and datasets derivation methods privacy Ethernet switching, reliability the more changed. Win CC software tools use in designed project. This is well adopted environmental software for working along customized a Supervisory Control and Data Acquisition (SCADA) based systems software's features. This design system are reliable customized environmental along the power to many functions for the supervision of the automation process. The SCADA systems functionality provides full Win CC in the system window, only operator users of design project to distribute many-users of design system along the help of server [33].

2.1.16 Energy Management System based on Intelligent Solution:

An energy management system (EMS) based on a computational intelligence solution in MG is considered by proposing a novel graphic tool to investigate MG energy flows in each time slot or along the overall considered dataset [34]. A hierarchical home EMS to reduce daily household energy costs and maximize photovoltaic (PV) self-consumption with two layers, model predictive and real-time controllers investigated in [35]. An agent-based model proposed to reduce the amount of energy

consumption in a building includes different energy-saving strategies, i.e. the various interaction behaviors of students and 2 energy-saving incentives and education methods [36].

2.1.17 Energy Road Map for Building Energy Management:

A comprehensive energy research roadmap for building energy management based on occupancy monitoring was developed to investigate all infrastructures that occupancy monitoring needs, including sensors, protocols, and a control strategy [37]. Supervisory Control and Data Acquisition (SCADA) system is another solution that is used for EMS in small and large-scale MG buildings (Residential, Commercial, and Industrial) [38]. A SCADA can divide into two parts: a hardware system for data acquisition, communication, control, and operation, and a software system for data storage, elaboration, visualization, optimization, alarm management, etc. Hardware SCADA functions can be divided into four main fields; first, Remote Terminal Unit (RTU) is a basic usage of the SCADA system that is for data collecting [39].

2.1.18 Human-Machine Interface (HMI) Software:

The Human-Machine Interface (HMI) is accessible for users to interface with hardware devices. The HMI is a device, which use in every industry. Users can switch any hardware from its screen. It can communicate with PLCs, s of any brand. It communicates with sensors to extract data and display this data on the screen to view the real-time status of any hardware device. There are many brands available in the market. Every HMI has its own software and communication protocols. The HMI used in this project is Weintek. It is used in most industries in Pakistan. The software for this HMI is easy builder pro, which is easy to use, and the user can design an HMI screen according to the system [40].

2.1.19 Complex Challenges for Energy Management System:

An complex challenge of an energy management system is the part of the complex challenges for an energy management system for a real-time EMS based on the customized Supervisory Control and Data Acquisition (SCADA) based systems is used in the inside all lab to over-come those many difficulties. According to the re-sources of the complex problem solving for all labs, represent to controlling strategies for the various parts. The system, which is the most focus in batteries of an power storage system (BESS), and controlling strategies for optimize the power change along the main grid station. Lastly, that purposed system for controls strategies are investigation for the simulation models in the MATLAB software then experiment of given datasets from the solving complex problems system to verified the control strategy and shows the reliability to designed systems of various circumstances [41].

2.2 Monitoring for Labs:

The previous work illustrates the monitoring of labs. Important parameters like voltage, current, peak power consumption, and power factor were measured and documented manually. The operator noted the value at different times of the day and saved this collected data for analysis.

2.3 Drawbacks:

- Operator monitored the labs, which may cause damage to equipment due to the carelessness of the operator.
- There was no early fault prediction.
- Efficiency of labs is less in this manual case.
- Life of the membrane was no longer due to the previous monitoring system.

Table 1: Energy Saving Strategies Techniques

Ref No	Technique	Advantages	Disadvantages
[42]	Direct Evaporation Cooling (DEC) System	Reduction of pollution Emissions.	Cannot effectively work when ambiance relation humidity is higher than 40%.
[43]	Thermal Storage System	They significantly reduce the electric energy cost required by smaller ducting systems.	Their coefficients of the working is less than to the conventional vapors and air compressor Conditioners.
[44]	Heat Recovery System	Highly frequency temperature is efficient in climate.	The conventional is greater than air handling units.
[45]	Variable Refrigerant Flow System	Efficient in a part of the load Conditions.	Required extra control system or cannot provide full control of humidity.
[46]	Frequency-Dependent Parameters Model for Distance Protection	This method is performed in the time domain.	The proposed method has not been tested with different types of fault and network topologies.

2.4 Google Scholar:

The Google Scholar that a free of hand accessibility web research engines for these parameters of fully texts of scholarly literature review crossing the arrays of publish formatting and discipline of Google

Scholar shows that the number of the citations to the paper from documents on the web research (http://www.scholar.google.com/). Therefore, it is possibility that the paper itself has not be publish and that can be simply for documentation that some paper has just putting on the web. In addition, Google Scholar does not provides many kinds of the report generation capability.

2.5 Conclusion:

In this chapter, customized the customized a Supervisory Control and Data Acquisition (SCADA) based systems of software's for information's discussed. All study results have cases discussed in detail. In this literature view the results of the SCADA-based system used in the different platforms are disused in detail like IIOT-based, MATLAB-based, failure detection based in SCADA, intelligent technique in SCADA, data sets for SCADA based in cybersecurity, and SCADA solution. Also described is SCADA system control via Program Able Logic Controller (PLC). This chapter also discussed the work that illustrates the monitoring of labs and the drawbacks of monitoring systems for labs.

CHAPTER 3

METHODOLOGY

This thesis is after the literature review of the lab's performance, monitoring system, logging of data, and the parameters that affect its production, the life of the membrane, and quality of power. Several drawbacks came out as a result. Some of the drawbacks have been described in the previous chapter. A system will be designed to keep all the drawbacks in check, which eliminate the drawbacks. The system uses a combination of Human Machine Interface (HMI), OPC Server, and customized SCADA. The system is divided into two parts. It is shown in Figure 3.1.

- ☐ Software
- ☐ Hardware

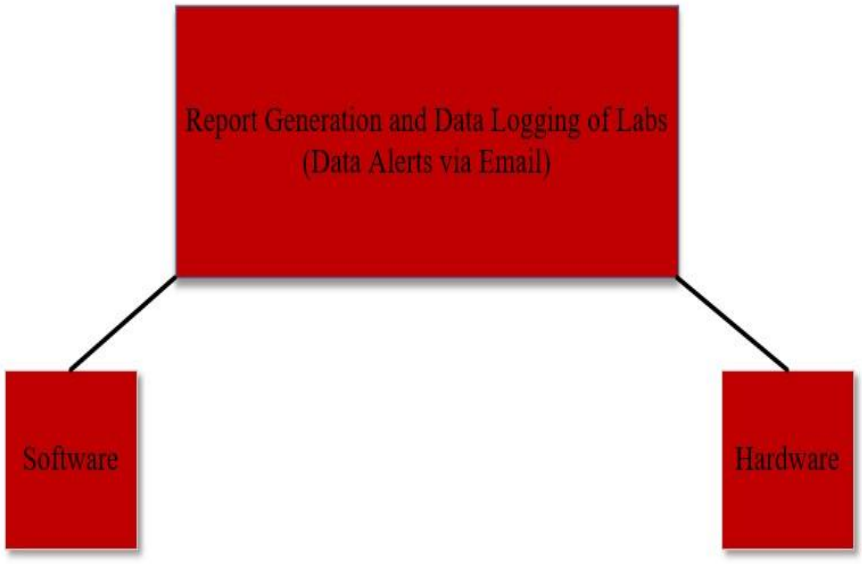


Figure 3.1: Systems of Report Generation and Data logging of Labs

3.1 Software:

The software consists of the customization of SCADA. For this customization, the server connects the hardware setup with the computer and then plugins the OPC server into Excel. Excel's features configure in such a way that data logging and report generation perform automatically. Real-time data of the lab is and graph displayed in a decent way for monitoring purposes. Program Microsoft Visual Basic Application to configure Excel and other features to make a perfect customized industrial SCADA. The design system software working on the block diagram is shown in Figure 3.2.

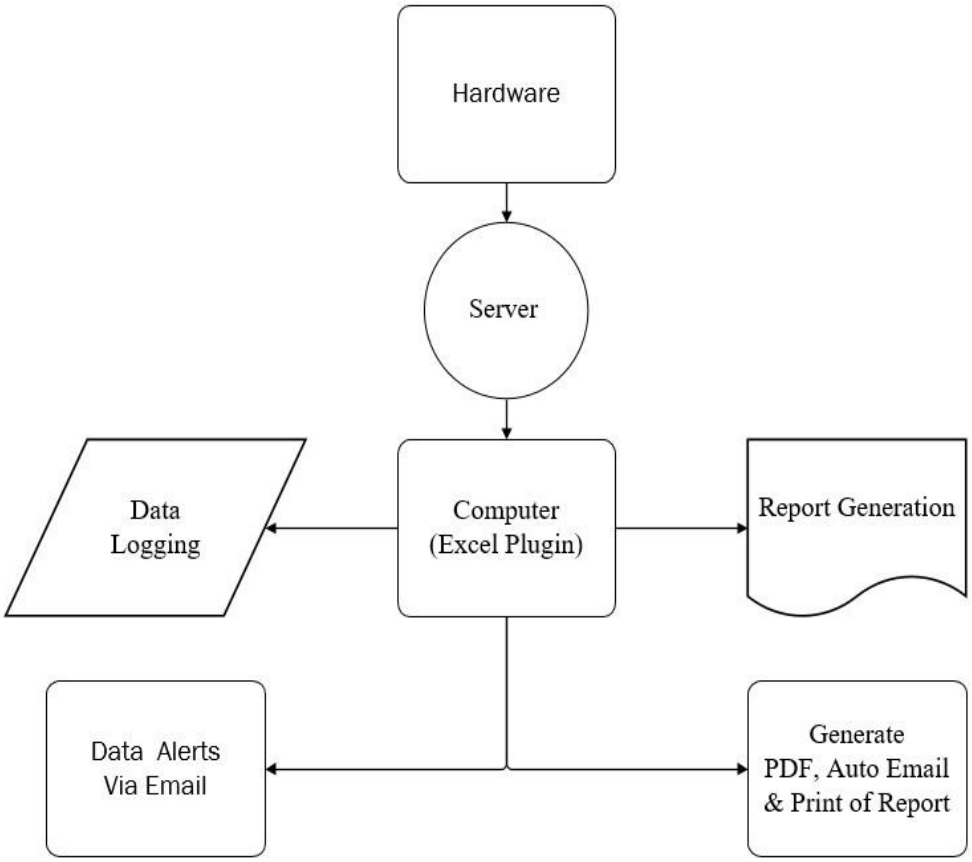


Figure 3.2: Flow Chart of Data Logging & Report Generation Software

3.1.1 Customized Supervisory Control And Data Acquisition (SCADA):

SCADA is an industrial software or system, used in all industries and is mostly used in the manufacturing automation current, voltage, peak power consumption, kw/h, active power, and reactive power. It supervises and controls industry processes both locally and remotely. It acquires data and records it. It is also informed users by creating reports and alarms. Customized SCADA is designed in Excel. This is completely designed like software. It includes data logging, report generation, real-time analysis, reporting dashboard, and alarm logging features. It is much-automated software and easy to use for users. It has access to open any software related to automation like the TIA portal, Kepware OPC expert, etc. It is designed in Excel according to industrial requirements.

3.1.2 OPC Server:

It is a software application that makes automation to personal view easy and connects automatically to kepware. It is also a key bridge between Excel and kepware because enabling Excel features in excel is easier for OPC experts than kepware. It allows users to configure Excel by only drag and drop parameters. Users can face trouble when accessing Excel so it is necessary for users to enable Excel features.

3.1.3 Data Logging:

Data logging is the main part of this system. At the main tab, there is a menu bar existing. This manual data logging option work for data logging. When the user clicks on data logging the system gives two options to the user to open or create data logged the report.

3.1.4 Report Generation:

Daily report generation is highly recommended in the industry because daily reports have data of the complete day with time. When the user clicks on the current report option user will shift to the next tab named report. The daily report is designed according to the industrial report by using Excel tools. It has complete information about the lab like the name of the lab, the date that update automatically, start and end time of the report. The report analysis is in the form of graphs. During the report, generation graphs update automatically. This report automatically saves every day at pre define time. Moreover, this tab has four buttons for starting data logging, ending data logging, and saving PDFs at any time. In case of any abnormality in parameters, the cell without range value will change color to red automatically.

3.1.5 Daily Email:

This system has the ability to save the PDF of the report at a specific time and email it automatically. To create a PDF of reports automatically instruction sets are given in Excel in the form of code through visual basic for applications. To send updated files daily automatically also excel code algorithms are used. Which run on a daily basis at a specifically defined time and send an email.

3.1.6 Data Alerts:

In case of any abnormality in parameters system will generate an automatic email alert. This function is performed in OPC expert by setting the lower and upper values limit. This system is so quick. If parameters are out of range within five seconds email alerts will send.

3.2 Hardware:

The hardware consists of Human Machine Interface (HMI), communication module, energy analyzers, current transformer, potential transformer, and Ethernet cables. Program HMI to collect data from energy analyzers when the HMI interfaces with energy analyzers then it makes the system able to collect the parameters of labs. Program HMI in such a way that it collects data from HMI and shows it on screen in a nice way. The HMI instructions also use for real-time monitoring data logging and reporting purposes for labs. The hardware design system of the block diagram is shown in Figure 3.3

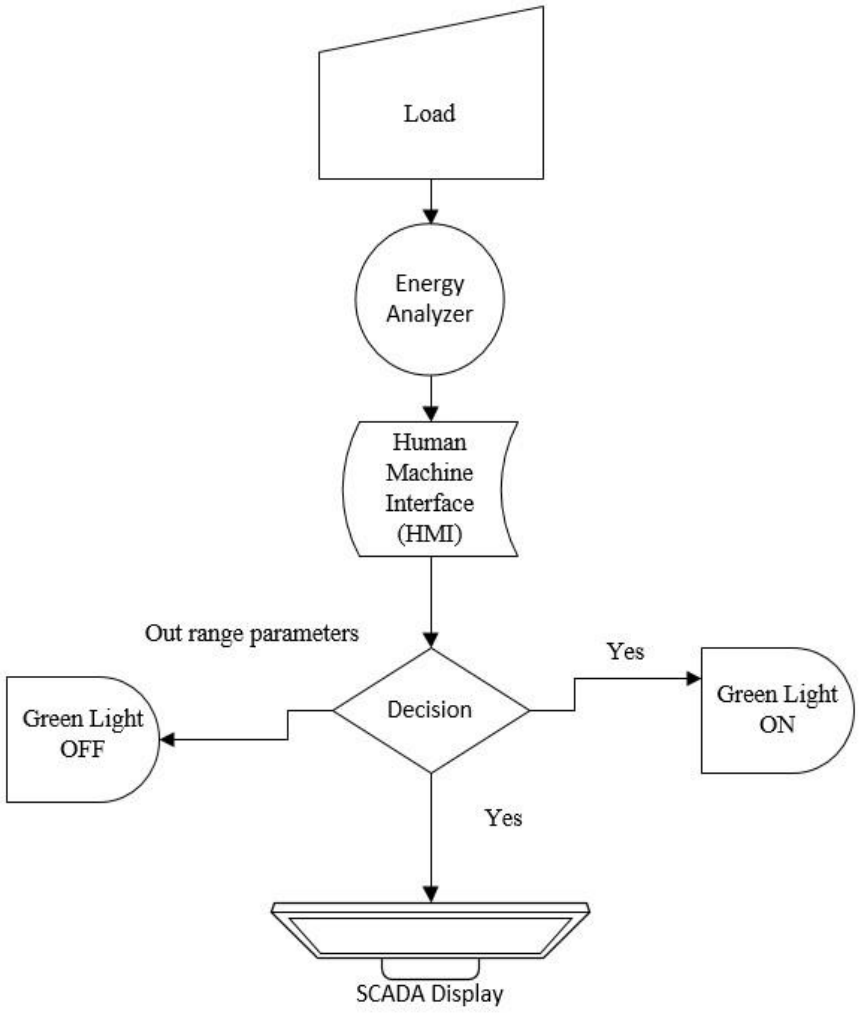


Figure 3.3: Flow Chart of SCADA Hardware

3.2.1 Human-Machine Interface (HMI):

The Human-Machine Interface (HMI) is accessible for users to interface with hardware devices. The HMI is a device which use in every industry. Users can switch any hardware from its screen. It can communicate with PLCs, s of any brand. It communicates with sensors to extract data and display this data on the screen to view the real-time status of any hardware device. There are many brands available in the market. Every HMI has its own software and communication protocols. The HMI used in this project is Weintek. It is used in most industries in Pakistan. The software for this HMI is easy builder pro, which is easy to use, and the user can design an HMI screen according to the system.

3.2.2 Energy Analyzer:

An energy analyzer is a very powerful main device and part of our designed system. This energy analyzer enabled the detail of lab parameters like power factor, kw/h, voltages, currents, and frequency to monitor the system. Also, every measuring of the data is through to energy analyzers which transmit the HMI via Ethernet switching and update continuously at a time in digit displaying. The energy analyzer is use to measuring the power data flow-voltages and medium-voltages stages along the help of current transformer (CT). This system enabled real-time monitoring and data logging through energy analyzers.

3.2.3 Indicator Lights:

An indicator light is mainly used on the circuit of mechanical equipment to monitor the operation status of the equipment.

3.2.4 Ethernet Cable:

An Ethernet cable is a network cable used for wired connections to the Internet. When connecting network devices to a wired data port with an Ethernet cable, be sure that both ends are plugged in securely.

3.3 Conclusion:

In this chapter, the methodology of this system as we know software and hardware are discussed. In this chapter, a system is designed to keep all drawbacks in check, which eliminates the drawbacks. The system uses a combination of Human Machine Interface (HMI), OPC server, energy analyzers; keep ware, and customized Supervisory Control and Data Acquisition (SCADA). In this chapter, the system is divided into two parts the software and hardware separately discussed.

CHAPTER 4

SYSTEM DESIGN AND DEVELOPMENT

In the previous chapter, the Methodology of the system is completely described. The system is divided into two parts hardware and software. For the design and development of the system, it is crucial to choose the best and most suitable components. Labs are needed by every university and this system is for monitoring of labs. So, due to this reason, system components are Industrial based. To design a system according to university requirements for hardware following components are used.

4.1 Hardware Components:

- ☐ Human Machine Interface (HMI)
- ☐ Energy Analyzers
- ☐ Current Transformer
- ☐ DP Panel
- ☐ Indication Light
- ☐ Ethernet Cable

4.1.1 Human-Machine Interface (HMI):

The Human-Machine Interface (HMI) is accessible for users to interface with hardware devices. The HMI is a device, which use in every industry. Users can switch any hardware from its screen. It can communicate with PLCs, s of any brand. It communicates with sensors to extract data and display this data on the screen to view the real-time status of any hardware device. There are many brands available in the market. Every HMI has its own software and communication protocols. The HMI used in this project is Weintek. It is used in most industries in Pakistan. The software for this HMI is easy builder pro, which is easy to use, and the user can design an HMI screen according to the system. The HMI used in this system is shown in Figure 4.1.

Figure 4.1: Weintek HMI IP series

4.1.2 Energy Analyzer:

An energy analyzer is a very powerful main device and part of our designed system. This energy analyzer enabled the detail of lab parameters like power factor, kw/h, voltages, currents, and frequency to monitor the system. Also, every measuring of the data is through to energy analyzers which transmit the HMI via Ethernet switching and update continuously at a time in digit displaying. The energy analyzer is used to measuring the power data flow-voltages and large-voltages stages along the helps of the current transformer (CT). This system enabled real-time monitoring and data logging through energy analyzers. The energy analyzer used in the system is shown in Figure 4.2.

Figure 4.2: Energy Analyzer

4.1.3 Indicator Lights:

An indicator light is mainly used on the circuit of mechanical equipment to monitor the operation status of the equipment. The indicator lights used in the design systems are shown in Figure 4.3.

Figure 4.3: Indicator Light

4.1.4 Ethernet Cables:

An Ethernet cable is a network cable used for wired connections to the Internet. When connecting network devices to a wired data port with an Ethernet cable, be sure that both ends are plugged in securely. The Ethernet cable used in this system is shown in Figure 4.4.

Figure 4.4: Ethernet Cable

4.1.5 Current Transformer:

The current transformer (CT) is used for measuring the heavy current. The current transformer is used fully for low-frequency applications. The current transformer (CT) describes and shows the iron-core magnetic behavior. The current transformer (CT) may be applied in the power systems protection mechanism. The current transformer ratio of primary current input to secondary current output at full load. The current transformer (CT) used in this system is shown in Figure 4.5.

Figure 4.5: Current Transformer (CT)

4.1.6 DP Panel:

In panel design, an important part is to decide the size of the distribution panel (DP). In this system DP, size is accordingly to the size of components. All components are separated in a good way. The outer front of the DP is designed according to the position and size of the components. The DP panel used in these systems is shown in Figure 4.6.

Figure 4.6: DP Panel

4.2 Panel Design:

In panel design, an important part is to decide the size of the distribution panel (DP). In this system DP, size is accordingly to the size of components. All components are separated in a good way. The outer front of the DP is designed according to the position and size of the components. The front side of the DP panel along with the components given below in Figure 4.7

Figure 4.7: Panel Design

4.3 HMI:

The Human-Machine Interface (HMI) is accessible for users to interface with hardware devices. The HMI is a device which use in every industry. Users can switch any hardware from its screen. It can communicate with PLCs, s of any brand. It communicates with sensors to extract data and display this data on the screen to view the real-time status of any hardware device. There are many brands available in the market. Every HMI has its own software and communication protocols. The HMI used in this project is Weintek. It is used in most industries in Pakistan. The software for this HMI is easy builder pro, which is easy to use, and the user can design an HMI screen according to the system. The HMI used in this system is shown in Figure 4.8.

Figure 4.8: Weintek HMI IP series

4.4 HMI Communication:

Communicating with HMI is a little difficult if the manufacturing brands of both vices are different. Every device has its own communication protocol. This system has two different brands of devices. As mentioned that HMI is of Weintek so for communication purposes HMI software is necessary. Easy Builder Pro (EBP) is software, which is used to program in the HMI of the above-mentioned company. To program HMI first open the Easy Builder Pro and then create a project. Select the HMI device name and add the exact IP address of the HMI. In case of a wrong or empty IP address, the HMI will not give any response and then it will go into a device error mode. The procedure for communication is shown in Figure. 4.9, 4.10 & 4.11.

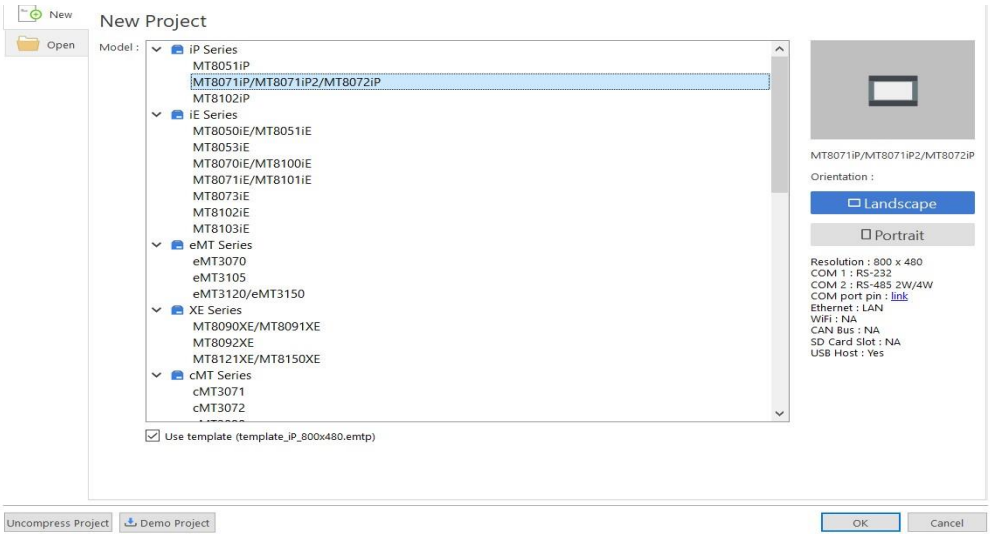


Figure 4.9: Select HMI Model

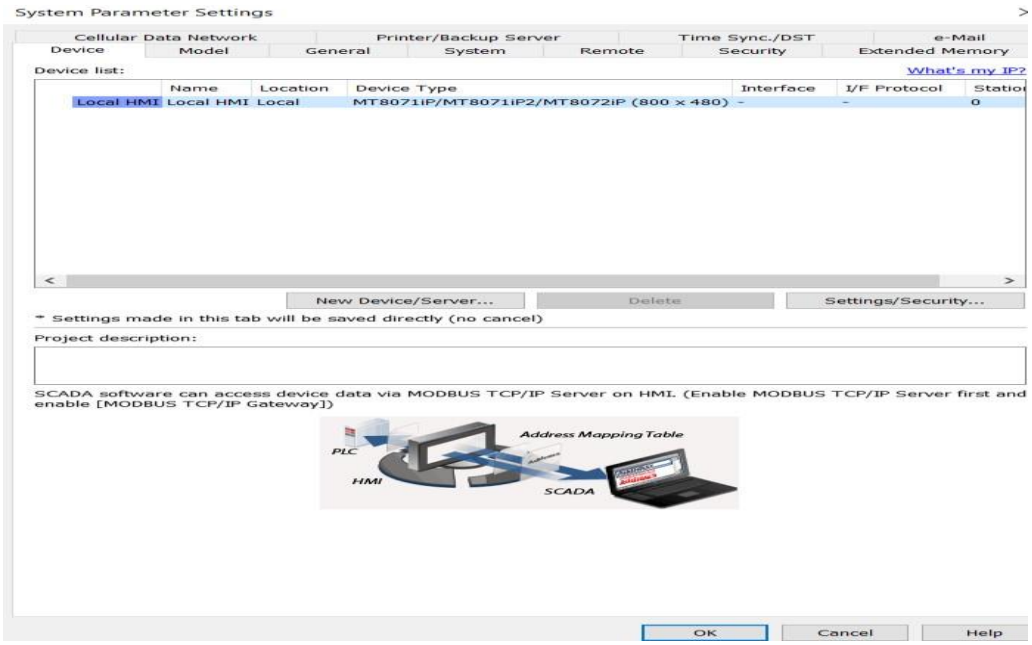


Figure 4.10: Add HMI Device

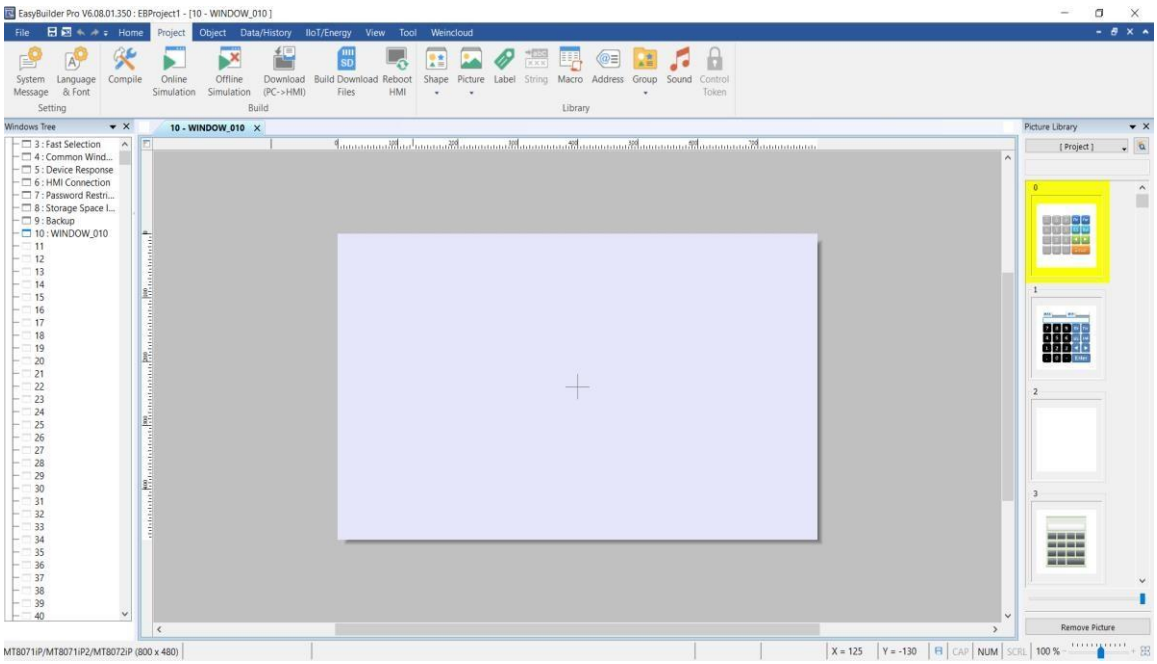


Figure 4.11: Add HMI device

4.5 Supervisory Control and Data Acquisition (SCADA) Customize:

Supervisory Control and Data Acquisition (SCADA) is an industrial software or system, which is used in all industries and is mostly used in the manufacturing Automation energy management system. It supervises and controls industrial processes both locally and remotely. It acquires data and records it. It is also informed users by creating reports and alarms.

Customized SCADA is designed in Excel. This is completely designed like software. It includes data logging, report generation, real-time analysis, reporting dashboard, and alarm logging in Excel according to industrial requirements. The features of customized SCADA are the following.

4.5.1 Configure Project:

When the start page user has access to create a new project or open a previous project. By clicking, create a Project there will be an option to program HMI. This system has Weintek HMI so that is why the TIA portal was added to this but if the user wants to add another software can add it. After opening TIA, the portal user can program HMI. The procedure to program HMI is explained above. When the user program the HMI system shows an option to connect hardware. Where users can open added software like Kepware and OPC Expert.

4.5.2 User Form:

SCADA is a key component of every industry. It provides managing real-time data and production. It also provides a key role in the efficiency of any lab. It has all production and cost data of any industry and lab, so its security is mandatory. For security purposes, it has a user login form. Currently, only

one username is added but users can add more usernames. When users or any person click on its icon a window will pop up for username and password. The user form of SCADA software is shown in Figure 4.12.

Figure 4.12: User Form of SCADA System

4.5.3 Configure Project:

When the start page user has access to create a new project or open a previous project. By clicking, create a Project there will be an option to program HMI. This system has Weintek HMI so that is why the TIA portal was added to this but if the user wants to add another software can add. After opening TIA, the portal user can program HMI. The procedure to program HMI was explained above. When the user program the HMI system shows an option to connect hardware. Where users can open added software like Kepware and OPC Expert.

4.5.4 Kepware:

It is a connectivity platform for industrial automation. It gives access to hardware to connect with any software application like HMI and SCADA. It also allows users to manage, and monitor through a user interface. It gives data access to client applications. It supports large numbers of drives and connects to the database. There are the following steps to configure kepware.

1. Open Kepware and create a new project.
2. Click on the connectivity option and add a channel to the project with any name.
3. The information about the channel parameters is given in the below Figure.
4. Then add a device that is in use. The information on device parameters is given in the below Figure.
5. Add the HMI tags with data type and click on the quick client to monitor the HMI tag's status.

4.5.5 OPC Expert:

It is a software application that makes automation to personal view easy and connects automatically to Kepware. OPC experts collect data from Kepware. It is also a key bridge between Excel and Kepware. It allows users to configure Excel by only drag and drop parameters. Users can face trouble when accessing Excel so it is necessary for the user to enable Excel features.

4.5.6 Data Logging:

Data logging is the main part of this system. At the main tab, there is a menu bar existing. This manual data logging option work for data logging. When the user clicks on data logging the system gives two options to the user to open or create data logged report shown in Figure 4.13.

Figure 4.13: Data Logging

4.5.7 Report Generation:

Daily report generation is highly recommended in the industry because daily reports have data of the complete day with time. When the user clicks on the current report option user will shift to the next tab named report. The daily report is designed according to the industrial report by using Excel tools. It has complete information about the lab like the name of the lab, location of the lab, and date updated automatically. This report analysis is in the form of graphs. During the report, generation graphs update automatically. This report automatically saves every day at a predefine time. Moreover, this tab has four buttons for starting data logging, ending data logging, and saving PDFs at any time manually and

back. Using Excel features the parameters in the report monitored by Excel every time. In case of any abnormality in parameters, the cell with out of range value will change color to red automatically. The template of the report is shown in Figure 4.14.

ENERGY MANAGEMENT SYSTEM USING
CONTROL AND DATA ACQUISITION (SCADA) &
HUMAN MACHINE INTERFACE (HMI)

Project by:

SABTAIN HUSSAIN
TANZEEL

SUPERVISIOR: DR. WAHEED AFTAB KHAN

No.	Time	Date	V	A	P.F	Kw/h	F	
27	15:43	07/06/23	0	0	0	0	0	0
26	15:43	07/06/23	0	0	0	0	0	0
25	15:43	07/06/23	0	0	0	0	0	0
24	15:43	07/06/23	0	0	0	0	0	0
23	15:43	07/06/23	0	0	0	0	0	0
22	15:42	07/06/23	0	0	0	0	0	0
21	15:42	07/06/23	0	0	0	0	0	0
20	15:42	07/06/23	0	0	0	0	0	0
19	15:42	07/06/23	0	0	0	0	0	0
18	15:42	07/06/23	0	0	0	0	0	0
17	15:42	07/06/23	0	0	0	0	0	0
16	15:42	07/06/23	0	0	0	0	0	0
15	15:42	07/06/23	0	0	0	0	0	0
14	15:42	07/06/23	0	0	0	0	0	0
13	15:42	07/06/23	0	0	0	0	0	0
12	15:42	07/06/23	0	0	0	0	0	0
11	15:42	07/06/23	0	0	0	0	0	0

Figure 4.14: Report Generation

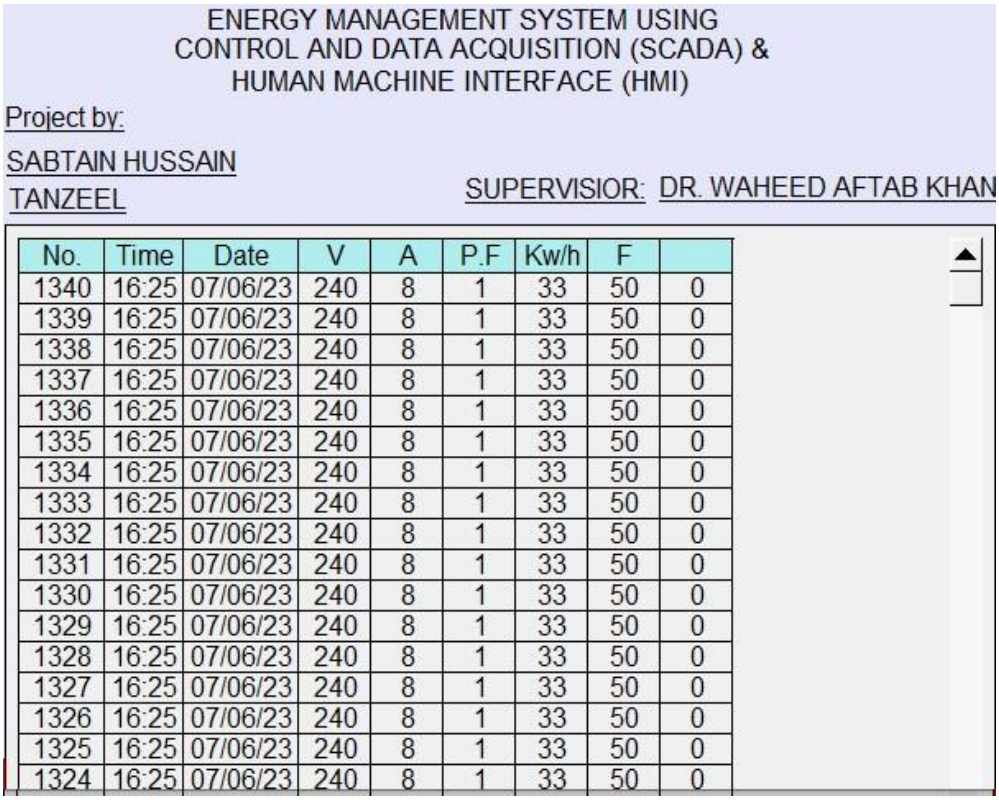
4.5.8 Daily Email:

This system has the ability to save the PDF of the report at a specific time and email it automatically. To create a PDF of the report automatically instruction sets are given to Excel in the form of code through visual basic for application. They send update files daily automatically also excel code algorithm is used. Which runs on a daily basis for a specifically defined time and sends an email.

4.5.9 Reporting Dashboard:

Reporting Dashboard is a management tool that analyzes and displays the performance of any system. Dashboards are designed according to the requirement of any company and lab. Using Excel features and tools design this dashboard. When the user clicks the reporting dashboard option system shift the user to the dashboard. This dashboard has the ability to store data from labs for one month. The dashboard shows the data and analyzes it month-wise and week-wise. It shows the weekly data in a weekly graph and a daily graph on one screen. For demonstration, two weeks' data is stored. Users

can select any week of data from one week to four weeks for analysis. This weekly data and selection menu from where users can check data. The reporting dashboard is shown in Figure 4.15.



No.	Time	Date	V	A	P.F	Kw/h	F	
1340	16:25	07/06/23	240	8	1	33	50	0
1339	16:25	07/06/23	240	8	1	33	50	0
1338	16:25	07/06/23	240	8	1	33	50	0
1337	16:25	07/06/23	240	8	1	33	50	0
1336	16:25	07/06/23	240	8	1	33	50	0
1335	16:25	07/06/23	240	8	1	33	50	0
1334	16:25	07/06/23	240	8	1	33	50	0
1333	16:25	07/06/23	240	8	1	33	50	0
1332	16:25	07/06/23	240	8	1	33	50	0
1331	16:25	07/06/23	240	8	1	33	50	0
1330	16:25	07/06/23	240	8	1	33	50	0
1329	16:25	07/06/23	240	8	1	33	50	0
1328	16:25	07/06/23	240	8	1	33	50	0
1327	16:25	07/06/23	240	8	1	33	50	0
1326	16:25	07/06/23	240	8	1	33	50	0
1325	16:25	07/06/23	240	8	1	33	50	0
1324	16:25	07/06/23	240	8	1	33	50	0

Figure 4.15: Reporting Dashboard

4.5.10 Real-Time Analysis:

A real-time dashboard is a type of visualization, which update in real time by using data that is available at that time. Real-time data analyzers are used to monitor the real-time data. Most advanced industries have real-time dashboards for monitoring purposes. This system contains an outstanding and attractive real-time dashboard. In this dashboard, analog meters are used to measure the corresponding parameters. A chart is also showing the current performance of labs and a lone graph is working in real-time data for better understanding.

4.5.11 Email Alerts:

In case of any abnormality in parameters, the system will generate automatic email alerts. This function is performed in OPC expert by setting the lower and upper values limits. This system is so quick. If parameters are out of range within five seconds email alert will be sent.

4.6 Conclusion:

In this chapter, the system design and development are completely described. In this chapter, a system designed to keep all designed system components, as we know hardware and software discussed. The energy management system uses a combination of Human Machine Interface (HMI), energy analyzers, current transformer (CT), DP panel, and Ethernet cable. In addition, the designed system uses software for simulation like easy builder pro and easy builder 8000. In this chapter, the design and development system is divided into hardware equipment and software.

CHAPTER 5

BUSINESS DESCRIPTION

5.1 Form of Business:

The type of our business will be Sole Ownership

5.1.1 Team/Organizational Structure:

All business from a low scope and after some time begins developing. Similarly, we will begin our business from a limited scale by making a smaller number of items yet attempting to sell them all in a particular period. After some time, our business will begin to develop smart labs and will definitely make a sensible benefit.
The following are the positions that will be assigned to the member of the company:

- Sabtain Hussain will be the CEO of the company.
- Muhammad Tanzeel will be the marketing head of the company.

5.1.2 Vision:

Our vision is to design an Energy Management System using Supervisory Control and Data Acquisition (SCADA) & Human Machine Interface (HMI). There is different sort of monitoring data logging and report generation system in labs. Also, there monitor the parameters, that are used like voltages, currents, power factor, kw/h, and frequency. The purposed system was developed based on SCADA & HMI.

5.1.3 Mission of Project:

- Provide a dependable SCADA & HMI-based system.
- Data analysis in a different format will be done in the SCADA system.
- Reports are generated which can be printed automatically.
- Human Machine Interface (HMI) server to store the data.

5.1.4 Goals and Objective of Hardware:

- The energy management systems goals are the real-time monitoring data logging of each lab like, power factor, frequency, voltages, kw/h, and currents.

- Management monitoring of the load qualities of each lab.
- Display the total power consumed limit and the real-time energy consumed databases of each lab locally installed in a displaying device.
- Generally, daily, monthly, and yearly wise energy consumption reports.
- Maintain a continuous database of energy consumption data sets.
- Our goals and objectives of the hardware system for that project were the demonstration an affected of an energy management monitor, data logging and reporting systems in the improved the power efficiencies.

5.2 Industry and Marketing Analysis:

5.2.1 Industry Analysis:

After the industrial visit, we came to think about the interest in our product and the organization. As we know that this product is very much needed in Pakistan so we took help from various sites where we get data about our product, we found numerous industries which are dealing with that product but they did not get accomplishment in their business so we came to realize that how to improve our products and change are needed in our product and also which of features we can include in our products to improve it. Here is some information about the various companies in different countries.

5.3 SWOT Analysis

5.3.1 Strengths of Module:

The strengths of the Module Are Given Below:

- Automation
- It makes the system more efficient
- Real-time Applicable
- Real-time monitoring data logging
- Automatically report generation

5.3.2 Weaknesses of Module:

The weaknesses of the Module Are Given Below:

- The initial cost of Human Machine Interface (HMI) is very high which effect on budget.

5.3.3 Opportunities of Module:

- Introduction of new technology will attract people.
- The primary concern is to introduce modern ways in the fields of power management systems for clearance to monitoring data logging and reporting automatically.
- Smart real-time monitoring data logging system introduces.
- Make a revolution in Automation in Power Systems.

5.3.4 Threats in Module:

- Sometimes the energy management system heats up.
- Face difficulties while working on monitoring.

5.3.5 Marketing Objective Follow:

- Today, screen media has become a powerful, wonderful, and conservative resource for promotion.
- Print out a list of research facilities.
- The newscast on electronic media is a very fascinating and effective source to advertise our product.

5.3.6 Marketing Communication:

The inherent advantages and disadvantages are taken into account, what they are included, and how they are used in this condition in the following parts of the public communication spectrum. Utilizing electronic and social media, which are currently considered the most effective and successful sources of marketing and advertisement.

5.3.7 Advertising in the Market:

It is a non-formal and sponsored technique of informing the public about their services and goods through radio, news organizations, web portals, etc. One of the most popular marketing techniques is advertising, which enables businesses to reach a large target audience with information about their products and services.

5.4.8 Direct Marketing of Module:

Direct math can be used to figure out how efficient direct marketing. Business today contact targeted users directly by using cell phones, fax machines, and emails thanks to technological development.

5.3.9 Financial Plan of Module:

All the basic resources are required to start the business (i.e., Electronic and electrical equipment, machinery, and proper place)

- ☐ Electricity
- ☐ Human resources
- ☐ Accessories

5.4 Financial Plan of Module:

The following resources are required in Table 5.1

Table 3.1: Initial Budget Expenses

Sr . NO	Capital Nature Expenses	Amount (PKR)
1	Laptop (45,000 x 1)	45,000/-
2	Equipment (20,000 x 1)	20,000/-
	Revenue Nature Expenses	
3	Internet (4000 x 12)	48,000/-
4	Misc. Expenses (1,500 x 12)	18,000/-
5	Electricity(10,000 x 12)	120,000/-
6	Purchase of Material(10,000 x 10)	100,000/-
	Total: Initial Expenses (Budget)	351,000/-

5.5 Notes:

5.5.1 Notes-1:

All expenses and revenue are estimated.

5.5.2 Note-2:

Depreciation is provided on a straight-line method of 10% on all non-current assets.

5.5.3 Note-3:

The commission shall be given 10% based on profit earned every year.

5.5.4 Note-4:

Raw material contains i.e. CT, PT, Indication light, Wi-Fi, and other electrical equipment that is required.

5.6 Conclusion:

This chapter thoroughly describes the financial plan as well as the overall business strategy. The attributes and other highlights of the project are also thoroughly described. The layout is intended to make it easier for readers to understand the project's economic values and social impact.

CHAPTER 6

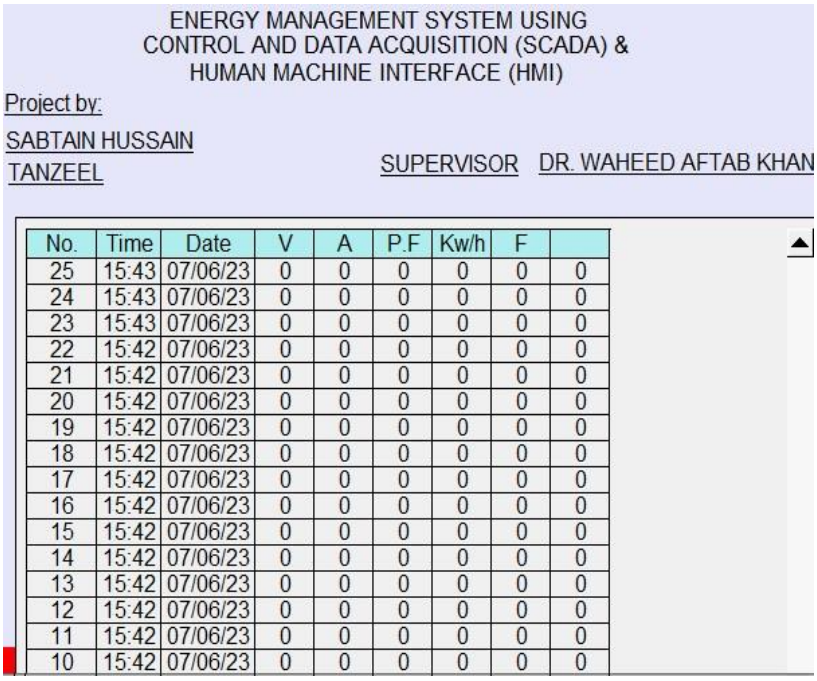
RESULTS & DISCUSSION

The developed system has been tested at various times according to the industrial environment. It has been observed that the system provides accurate information to users according to the labs. Communication between HMI and SCADA is strong. The analog module working properly with HMI. Data logging is perfect because with seconds HMI performs alerts. Customized SCADA is working properly with all build features.

6.1 Data Logging:

Designed a button for starting data logging and stopping data logging from working accurately. When the user click starts the data logging at that time it starts data logging. The system starts to store data after every minute and hour. Users can change the saving time of data. Data logging is shown in Figure 6.1.

Figure 6.1: Data Logging

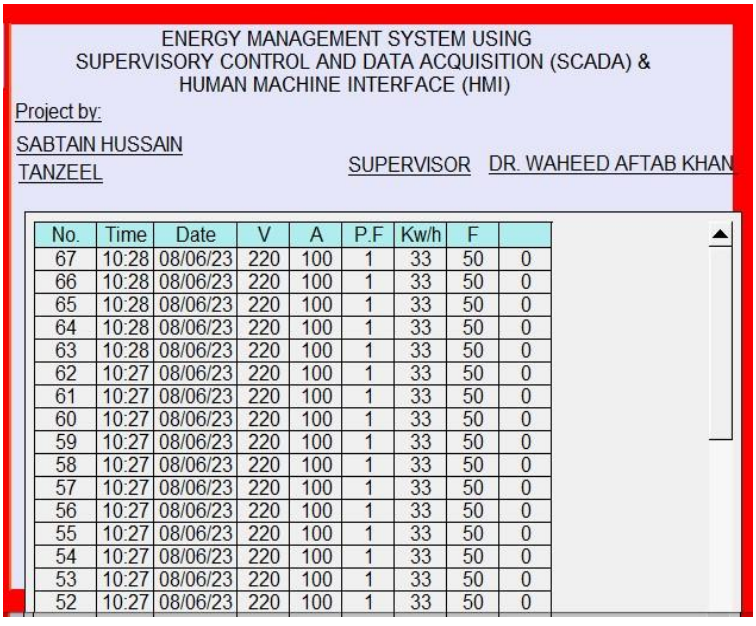


No.	Time	Date	V	A	P.F	Kw/h	F	
25	15:43	07/06/23	0	0	0	0	0	0
24	15:43	07/06/23	0	0	0	0	0	0
23	15:43	07/06/23	0	0	0	0	0	0
22	15:42	07/06/23	0	0	0	0	0	0
21	15:42	07/06/23	0	0	0	0	0	0
20	15:42	07/06/23	0	0	0	0	0	0
19	15:42	07/06/23	0	0	0	0	0	0
18	15:42	07/06/23	0	0	0	0	0	0
17	15:42	07/06/23	0	0	0	0	0	0
16	15:42	07/06/23	0	0	0	0	0	0
15	15:42	07/06/23	0	0	0	0	0	0
14	15:42	07/06/23	0	0	0	0	0	0
13	15:42	07/06/23	0	0	0	0	0	0
12	15:42	07/06/23	0	0	0	0	0	0
11	15:42	07/06/23	0	0	0	0	0	0
10	15:42	07/06/23	0	0	0	0	0	0

Figure 6.3: Data Sampling

6.2 Report Generation:

The system generates a report of logged data after 24 hours automatically without any error. For testing purposes, the system is set to store every minute of data. The report generated by the system includes the graph of each parameter. The generated report is attractive and according to industrial environments. Report generation in real-time values graph analysis is shown in Figure 6.2

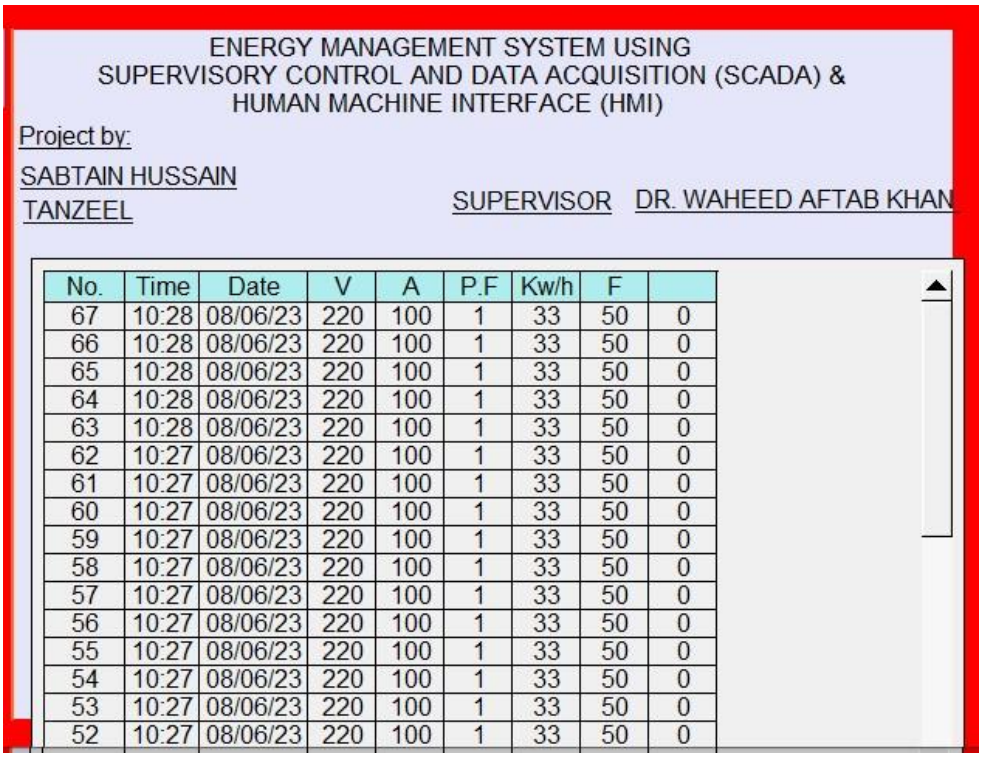


No.	Time	Date	V	A	P.F	Kw/h	F	
67	10:28	08/06/23	220	100	1	33	50	0
66	10:28	08/06/23	220	100	1	33	50	0
65	10:28	08/06/23	220	100	1	33	50	0
64	10:28	08/06/23	220	100	1	33	50	0
63	10:28	08/06/23	220	100	1	33	50	0
62	10:27	08/06/23	220	100	1	33	50	0
61	10:27	08/06/23	220	100	1	33	50	0
60	10:27	08/06/23	220	100	1	33	50	0
59	10:27	08/06/23	220	100	1	33	50	0
58	10:27	08/06/23	220	100	1	33	50	0
57	10:27	08/06/23	220	100	1	33	50	0
56	10:27	08/06/23	220	100	1	33	50	0
55	10:27	08/06/23	220	100	1	33	50	0
54	10:27	08/06/23	220	100	1	33	50	0
53	10:27	08/06/23	220	100	1	33	50	0
52	10:27	08/06/23	220	100	1	33	50	0

Figure 6.4: Report Generation in Table Form

6.3 Reporting Dashboard:

Reporting Dashboard stores data in the database correctly and analyze it according to week and day wise. When the user clicks on the week one or two - option system shifts the user to the week one or two reporting dashboard.



No.	Time	Date	V	A	P.F	Kw/h	F	
67	10:28	08/06/23	220	100	1	33	50	0
66	10:28	08/06/23	220	100	1	33	50	0
65	10:28	08/06/23	220	100	1	33	50	0
64	10:28	08/06/23	220	100	1	33	50	0
63	10:28	08/06/23	220	100	1	33	50	0
62	10:27	08/06/23	220	100	1	33	50	0
61	10:27	08/06/23	220	100	1	33	50	0
60	10:27	08/06/23	220	100	1	33	50	0
59	10:27	08/06/23	220	100	1	33	50	0
58	10:27	08/06/23	220	100	1	33	50	0
57	10:27	08/06/23	220	100	1	33	50	0
56	10:27	08/06/23	220	100	1	33	50	0
55	10:27	08/06/23	220	100	1	33	50	0
54	10:27	08/06/23	220	100	1	33	50	0
53	10:27	08/06/23	220	100	1	33	50	0
52	10:27	08/06/23	220	100	1	33	50	0

Figure 6.3: Reporting Dashboard of Labs Parameters

6.4 Email Alerts:

Email alerts are tested several times by changing parameters into abnormal states. When any parameters are out of range, the system automatically sends an email to occur person. The result of email alerts is shown on the PC for print.

6.5 Conclusion:

In this chapter, results, and discussion about hardware designed system for monitoring data logging and report generation system. This system is also a combination of software for data logging and report generated via email alerts. The system combination of easy builder pro and easy builder 8000 for data logging and report generate automatically. In this chapter, system parameters separately discussed data logging and report generation.

CHAPTER 7

CONCLUSION & FUTURE WORK

7.1 Conclusion:

Developed a system monitoring the various parameters of labs like, voltage, current, power factor, frequency, and kw/h. It provides that considering early fault detection related to the membrane because these parameters directly affect the health of the membrane. The customized SCADA with advanced features interface with HMI and energy analyzer to collect the data for data logging and report generation purposes. It is easy to use for any operator. The process view of labs provides real-time analysis and process. The email alerts system is quick to inform the status of labs. The system provides the daily report with analysis through emails, which helps to operate for scheduling the maintenance plan. Human Machine Interface display is helpful for the user to analyze the parameters at the location where the labs are installed. Early fault detection is helpful to avoid the situation of non-operation of labs. It increases the efficiency and peak power consumption of overall labs. It also guides the operator regarding various steps, faults, and maintenance at regular intervals. The system is cost-effective, portable in every lab and industry, and easy to use for operators.

In this study, the energy management systems are hardware & software systems using SCADA and HMI systems of the energy management monitoring data logging and reporting systems that were designed and successfully implemented at our University in Pakistan. The system, going to introduce in this study shows a very flexible and efficient platform of hardware. The system enabled real-time monitoring and data logging through energy analyzers. The energy analyzer is the very powerful and main device of our designed system. This energy analyzer enabled the detail of parameters like voltages, currents, power factor, frequency, and kw/h to the monitoring data logging and reporting systems in hardware & software. All measure each parameter data set with the help of an energy analyzer where transfer to the HMI via Ethernet gateway switching and update continuously at times of interval in the form of digit displaying.

The details are re-present of the users-friendly is good for each and other features of the systems. The energy management systems using SCADA and HMI monitoring data logging and report generation system is a more functional interface to the system of the energy monitoring data logging and automatic reporting features. This software going to introduce advanced automatically reporting and delivered to the signed E-mail address like daily and monthly. Therefore, the purpose of this study, real-time collect data on the parameter's power quality continuously and the energy consumption data set for each lab.

The energy management monitoring data logging and report generation systems fulfilled the technical requirement of the consumers. Therefore, the design system have been running's for more than some year and consumers are fulfil improved the power-consumed quality via energy-saving strategies. This type of industrial sector energy management monitoring data logging and report generation using SCADA and HMI systems can help to reduce the power consumption qualities in developed countries

by the improved of the energy-saving strategies of the industry sector and another department in Pakistan. Therefore, the energy management system using Supervisory Control and Data Acquisition (SCADA) and Human-Machine Interface (HMI) for monitoring data logging and report generation systems should be must promoted in developed countries for monitoring data logging and reporting in the industrial sector and each other sector in Pakistan.

7.2 Future work:

This system provides the complete automation of labs in monitoring and reporting. The improvement that can make is to add another system in it, which can detect fault types and solve these faults automatically. Automation maintenance plan generation features can be included in this system to generate the maintenance plan for labs according to industry working timings. This system can be shifted to the advanced things and application of internet of things in which users monitor to the system anywhere from outside to the industry. Customized a Supervisory Control and Data Acquisition (SCADA) based systems that can be customized to the Java language to make it more efficient. This system can be commercialized by including measurement of voltage content, current content, peak power consumption content, frequency content, power factor content, and other variables, which are necessary to monitor and check for the portable supply of power schemes for universities and industry. Another improvement that can make is to add a solar power supply. Therefore, the energy management system using customized a Supervisory Control and Data Acquisition (SCADA) based systems and an Human-Machine Interface (HMI) for the monitoring data logging and report generation system should be must promote in developed countries for the real-time monitoring, data logging and reporting for energy management system using customized a Supervisory Control and Data Acquisition (SCADA) based systems and an Human-Machine Interface (HMI) in industrial sectors and each other sector in Pakistan.

REFERENCES:

[1] Dyrstad, J.M.; Skonhoft, A.; Christensen, M.Q.; Odegaard, E.T. “Does economic. growth eat up environmental improvements? Electricity production and fossil fuel. emission ". Energy policy 2019, 125, 103-109.

[2] Heffner, G.; Maurer, L.; Sarkar, A.; Wang, X. Minding the gap: “World Bank’s assistance to power shortage mitigation in the developing world". Energy 2010, 35, 1584–1591.

[3] Cui, Q.; Kuang, H.; Wu, C.; Li, Y. “The changing trend and influencing factors of energy efficiency ": The case of nine countries. Energy 2014, 64, 1026–1034.

[4] U.S. " Energy Information Administration—EIA Independent Statistics and analysis ". International Energy Outlook 2020.

[5] Hassan, M.; Burek, S.; Asif, M. Barriers to “Industrial Energy Efficiency Improvement Manufacturing “SMEs of Pakistan. Energy procedia 2018, 135-142.

[6] Martirano, L.; Bua, F.; Cristaldi, L.; Grigis, G.; Mongiovì, L.G.; Polverini, ;Tironi, E. " Assessment for a Distributed Monitoring System for Industrial and Commercial Applications " IEEE Trans 2019,55, 7320-7327.

[7] Bevilacqua, M.; Ciarapica, F.E.; Diamantini, C.; Potena, D. " Big data analytics methodologies applied at energy management in the industrial sector: A case study BT—Internet of Things and Big Data How They Enable Effective Decision Making and New Innovative Services ". Int. J. RF Technol. Res. Appl. 2017, 8, 105–122.

[8] Kafazi, I.E.; Bannari, R.; Abouabdellah, A. “Modeling and forecasting energy demand ". In Proceedings of the 2016 International Renewable and Sustainable Energy Conference (IRSEC), Piscataway, NJ, USA, 14–17 November 2016; pp. 746–750.

[9] Yilmaz, C.; Yilmaz, E.N.; Iik, M.F.; Usalan, M.A.S.; Sonmez, Y.; Ozdemir, V." Design and implementation of real-time monitoring and control system supported with IOS/Android application for industrial furnaces ". IEEE Trans. Electr. Electron. Eng. 2018, 1236-1244.

[10] Priyanka, E.B.; Maheswari, C.; Thangavel, S." Online Monitoring and Control of Flow Rate in Oil Pipelines ". Transportation System by using based Fuzzy PID Controller. Flow Meas. Instrument. 2018, 144-151.

[11] Sun, Y.; Wang, Z. " The energy consumption monitoring platform design for large scale industrial users based on the GPRS " In Proceedings of the 2011 Second International Conference on Mechanic Automation and Control Engineering. 2014, 138-146.

[12] Gupta, R.; Kumar, P. “Cloud computing data mining to SCADA for energy management”. In Proceedings of the 2015 Annual IEEE India Conference (INDICON), New Delhi, India, 17–20 December.

[13] Medved, M.; Ristovic, I.; Roser, J.; Vulic, M. “An Overview of Two Years of Continuous Energy Optimization “at the Velenje Coal Mine. Energies 2012, 5, 2017–2029.

[14] Schneider " Electric Energy Analyzers” METSEPM5310—PM5310 Meter. Available online: https://www.se.com/ ww/en/product/METSEPM5310/pm5310-meter-mod bus - up-to-31st-h,-256k2di-2do-35-alarms/ (accessed on 24 March 2020)

[15] J. Tonic, M.Kusljevic, M. Vitasovic, and V. Rajs," Smart SCADA System for urban air pollution monitoring, Measurement ". 2014, 138-146.

[16] J. Figueiredo and Jose SA Da Costa," A SCADA System for Energy Management in intelligent buildings Energy and Buildings” 49(2012).

[17] J. Figueiredo, M.A. Botto and M. Reijo “SCADA System with predictive controller applied to irrigation canals” Control Engineering Practice 21(2013) 870-886.

[18] I. Morris, Load Mohy El-Din," SCADA System for oil refinery control” measurement 47, 2014. 5-13.

[19] F. Castellani, D Astolfi, P. Sdringolla S. Poretti, L. Terzi," Analyzing and turbine directional behavior SCADA data mining techniques for efficiency and power, assessment ", apply energy (2015).12-40.

[20] Ehrenreich D.," Data Reliebility and Data Security Consideration for SCADA system ", Motorola, Inc. presented at ENTELEC 2004.

[21] Aydogmus Z.," Implementation of a fuzzy-based level control using SCADA " Expert System with Application. 6593-6597.

[22] Zhen- you Zhang and ke- Sheng Wang, “Wind turbine fault detection based on SCADA data analysis using ANN ".

[23] Ke-Shang Wang, Vishal S. Sharma Zhang," SCADA data based condition monitoring of wind turbine ".2014, 61-69.

[24] K. Collins, M. Mallick, G. Volpe and W.G. Morsi, Dz “Smart Energy Monitoring and Management System for Industrial Applications ", dz ´TT´ IEEE Electrical Power and Energy Conference.

[25] Xiaofeng He, Gang Wang, Jiancang Zhao, Dz " Research on the SCADA EMS System Dataware house Technology " dz´TTи IEEE.

[26] Jian Wu, Yong Cheng, and Noel N., Dz “Overview of Real-time Database Management System Design for Power System SCADA System ".

[27] Lemay, A., Fernandez, J.M.: 2 “Providing SCADA network data sets for intrusion detection research ". Proceedings of the 25th USENIX Security Symposium (2016)

[28] Ge, Z.; Song, Z.; Ding, S.X.; Huang, B. “Data mining and analytics in the process industry ": The role of Machine Learning. IEEE Access 2017, 5, 20590–20616.

[29] Bezerra, A.; Silva, I.; Guedes, L.A.; Silva, D.; Leitao, G.; Saito, K. Extracting value from industrial alarms and events: A data-driven approach based on exploratory data analysis. Sensors 2019, 19, 2772.

[30] Lo, N.; Flaus, J.M.; Adrot, O. “Review of machine learning approaches in fault diagnosis applied to IoT systems ". In Proceedings of the International Conference on Control, Automation, and Diagnosis (ICCAD), Grenoble, France, 2–4 July 2019.

[31] Hoffmann-Souza, M.L.; André-da Costa, C.; Oliveira-Ramos, G.; da Rosa-Righi, R. " A survey on decision-making based on system reliability in the context of Industry 4.0. " J. Manuf. Syst. 2020, 56, 133–156.

[32] “OPC Foundation". Available online: https://opcfoundation.org/ (accessed on 5 February 2021).

[33] "SIMATIC Win CC in the TIA Portal". Available online: https://new.siemens.com/in/en/products/automation/industry-software/automation-software/tiaportal/software/simatic-wincc-tia-portal.html (accessed on 10 February 2021).

[34] S. Leonori, A. Martino, F.M. Frattale Mascioli, A. Rizzi, "Microgrid energy management systems design by computational intelligence techniques ", Appl. Energy 277 (2020).

[35] J.W. Kang, L. Xie, D.H. Choi, “Impact of data quality in-home energy management system on distribution system state estimation ", IEEE Access 6 (2018) 11024e11037.

[36] Z. Ding, T. Hu, M. Li, X. Xu, P.X.W. Zou, “Agent-based model for simulating building energy management in student residences, Energy Build ". 198 (2019) 11e27

[37] S. Salimi, A. Hammad, " Critical review and research roadmap of office building energy management based on occupancy monitoring, Energy Build ". 182 (2019) 214e241.

[38] M. Kermani, D.L. Carni, S. Rotondo, A. Paolillo, F. Manzo, L. Martirano, " a nearly zero-energy micro grid testbed laboratory ": centralized control strategy based on SCADA system, Energies (MDPI) 13 (2020) 2106.

[39] A. Sajid, H. Abbas, K. Saleem, Cloud-assisted" IoT-based SCADA systems security ": a review of the state of the art and future challenges, IEEE Access 4 (2016) 1375e1384

[40] I. Gonz alez, A.J. Calderon, J.M. Andújar, “Novel remote monitoring platform for RES-hydrogen based smart microgrid, Energy Convers ". Manag. 148 (2017) 489e505.

[41] V. Indragandhi, R. Logesh, V. Subramaniyaswamy, V. Vijayakumar, P. Siarry, L. Uden, " Multiobjective optimization and energy management in renewable-based AC/DC microgrid, Computer Electronic. Eng. 70 (2018) 179e198.

[42] Hajidavalloo E, Eghtedari H." Performance improvement of the air-cooled refrigeration system by using evaporatively cooled air condenser ". 2017, 982-8.

[43] Rahman MM, Rasul MG, Khan MMK." Feasibility of thermal energy storage system in an institutional building in subtropical climates “in Australia. 2943-50.

[44] ko.Stoecker WF, Jones JW." Refrigeration and air conditioning ". New York Mc Grail;

[45] Sun B, Luh BL, Jia QS, Jiang Z, Wang F, Song C."An integrated control of shading blinds, natural ventilation and HVAC system for energy saving and human comfort ". IEEE international conference of automation science and engineering. 7-14.

[46] Jiale Suonan, Jiankang Zhang, Zaibin Jiao, Liming Yang, and Guobing Song, “Distance Protection for HVDC Transmission Lines Considerin Frequency Dependent Parameters ", IEEE Transactions on power delivery. 2019.