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Intelligence Management of Electrical Systems in Industries

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Abstract

The purpose of this paper is to provide an overview of intelligent management of electrical systems in industries using the commonly used SCADA system. The paper is divided into four parts: Introduction, background, literature review, and conclusion. The introduction details because industries are opting for smart electric grid (energy management systems) systems in their intelligence management of electric power. Background of the topic highlights how industry has played a major role in influencing the development of Energy Management Systems (EMS). The literature review is divided into three parts. The first section discusses the components of a typical EMS system which include the measurement communication and analysis subsystems. The second part is an analysis of the SCADA system, including its feature such as sensors, conversion units, and communication networks. The last part is a discussion of how SCADA can be used to control and monitor electrical grids in plants (either through substation control or feeder control). The conclusion is a general summary of the entire paper.

Keywords: Intelligent management; Electrical systems; SCADA system; Smart electric grid; Energy management system; Substation control; Feeder control

Introduction

The global population is becoming increasingly environmentally conscious as a result of growing concern about climate change and the depletion of fossil fuel reserves. Numerous nations have committed to reducing their Carbon Dioxide (CO_2) emissions by increasing their use of energy efficiency and renewable power. Cost cutting is a priority for many facets of society, from businesses and governments to households looking to lower their monthly power bills [1]. There must be a shift in how we manage our energy supplies in light of these facts. To this end, the Smart Electric Grids (SEG) idea promotes the use of cutting edge communication and control technologies and techniques to enhance the dependability, efficiency, and security of the energy grid, among other benefits. An EMS is known as an energy management system is a system that uses many technologies to automatically keep tabs on, secure, and fine tune the performance of every component inside a larger network. This paper discusses the components of primary energy management systems and provides a detailed analysis of the SCADA system which is extensively used in as an industrial intelligent electrical system [2].

Background

Industry is the result of recent developments in information and communications technology principles integrated in industries. The key to this new industrial revolution is equipping companies with the intelligence to quickly detect and repair inefficiencies in the manufacturing process. SEGs have the potential to play a pivotal role in Industry by enhancing the adaptability of power systems and other production resources. Economic, socio productive and environmental gains are anticipated from the introduction of SEGs by various energy system players [3].

The expenses of maintenance and operation, measurements, technical and nontechnical losses, and the cost of energy may all be reduced, while expenditures in expanding generation capacity can be put off. Additionally, it aims to lessen the expense associated with fixing power outages, both permanent and temporary. All of this has the potential to lessen the amount of carbon dioxide released during the production and manufacturing process in industries [4].

Literature Review

Components of an energy management system

Measurement subsystem: Measurement, displaying, logging, updating, and obtaining data as needed are all handled by this subsystem. Acquiring data from remote energy meters and showing it in a variety of user defined views such as gauge view, meter view, and trends view are examples of these tasks [5]. The energy data is logged in the database at a logging rate chosen by the user, so it may be analyzed at a later time. Depending on the setup, the logging interval might range from tens of seconds to a few minutes.

Communication subsystem: This component facilitates data transfer between energy meters installed in the field and the control room's Graphical User Interface (GUI) equipped workstations. This component is also responsible for the remote configuration and firmware updates of energy meters. Each energy meter requires a unique identifier, communication parameters, and data types integer, float, and long to be specified.

Analysis subsystem: In order to improve energy consumption, it is necessary to get data about energy usage that has been saved in a database and present that data in a clear and concise manner. This module allows users to generate and evaluate reports and views of energy use at the hourly, daily, weekly, monthly, and annual levels [6].

Supervisory Control and Data Acquisition (SCADA) intelligent system

The Supervisory Control and Data Acquisition (SCADA) system is the commonly used intelligent system in industries for managing large scale data acquisition, monitoring, and control systems. For the most part, SCADA systems are put into place in industries like power generation, oil and gas processing, water and waste management, and telecommunications in order to monitor and control the functioning of equipment and plants [7]. Measurements are taken at the plant's field

or process level using a network of remote terminal units, and the collected data is then uploaded to the SCADA central host computer so that more thorough process or manufacturing data may be made available remotely (reddy 837). Data received from the main plant's terminal units is analyzed and displayed on multiple screens in the systems which allow the operators to make comprehensive decisions about what actions to take.

Features of a SCADA system: A typical SCADA system used for intelligent management of electrical systems in a plant comprises of the following features.

Discussion

Sensors

Transmitters, monitors, and sensors all make up the spectrum of field instruments. Users may take readings and get information from a variety of sources thanks to the usage of sensors [8]. More sensors may be required if the system is very complicated.

Conversion units

While sensors are responsible for data collection, a means through which the data may be received and processed is also required. A conversion unit is useful in these situations. They take the analog data they receive and digitize it, sending it on to the main computer for display. Programmable Logic Controllers (PLCs) and Remote Terminal Units (RTUs) are the two primary types of conversion units utilized in a SCADA system.

Programmable logic controllers: PLCs come in handy when there is need for granular, site-specific command. PLCs are specialized industrial digital computers with flexible output configurations and many inputs (reddy 837). Due to its adaptability, cost, and configurability, PLCs are occasionally employed in place of other conversion units. To get the most out of it, though, you may require solid programming abilities.

Remote terminal units: Microprocessor controlled RTUs are electrical gadgets that may be used remotely. Their purpose is to link a sensor or other device that the RTU is attached to a SCADA system. They often use wireless transmission to send and receive data. As a result, they are recommended for events with a wide geographical scope.

Communication network

A well planned communication network system is essential to any SCADA system. In a SCADA system, the communication network is the single determinant of all other features. The major function of the SCADA system's communication network is to link the conversion units to the SCADA master station. When it comes to integrated network connectivity, most sectors rely on either wired or wireless field buses for the sake of safety.

Automation of electrical distribution system in industries

Automated equipment in modern SCADA systems eliminates the need for human work in electricity distribution systems. SCADA improves the effectiveness of a power grid by allowing operators to monitor and control vital parameters in real time, including voltage, power factor, current, and alerts. SCADA uses Intelligent Electronic Devices (IEDs) to perform automatic monitoring, protection, and control of distribution system equipment. Both the power service and the intended operational conditions are restored under fault situations. Distribution system dependability is enhanced by SCADA, which allows for more efficient and economical operations and shorter outage times. SCADA's primary functions may be broken down into the following classes: Substation control and feeder control.

Substation control: Substation automation relies on SCADA to carry out tasks like balancing bus loads, regulating bus voltage, regulating circulating current, guarding against transformer, preventing overloads, and bus faults. The SCADA system at a substation is always keeping tabs on the workings of all the different pieces of machinery within and reacting accordingly by issuing commands to the remote control devices (reddy 835). The substation control is capable of collecting previous data about an electrical system as well as generate alarms as deemed appropriate, either during failures or accidents. The information is captured by the central processing unit and then used to initiate the necessary control procedures.

Feeder control: Some of the primary functions of a feeder controller include activities such as fault identification and switching on feeds. On the other hand, the voltage regulation system handles voltage regulation and management. The SCADA design of this system continuously monitors the faults and their location using wireless fault detection devices installed at numerous feeding stations. It also makes it possible to record the current and past values of feeder parameters remotely. Devices installed underground and overhead may identify faults, both temporary and permanent, and relay that data to the control center, where it can be analyzed, and action taken to mitigate the likelihood of the fault happening again. RTUs are normally used to conduct operational duties as well as maintenance. All nodes are linked through a communication means for easy remote energy management from the control room.

Conclusion

With the increasing need to cut down on carbon dioxide released into the atmosphere due to climate change concerns, industries have resorted to using smart electric grid systems energy management system which allow them to monitor and control electricity in large scale. These systems are critical for reducing economic expenses for these industries. A commonly used EMS system in industries is SCADA. This system is used for data acquisition, control, and monitoring of electric systems, allowing a plant to take the right control actions. The feature of a SCADA system comprises of sensors, conversion units, and communication networks. Using this system, electrical management in an industry can be conducted in two ways, substation control and feeder control.

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