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Detecting the rate of growing electrical energy loads using SCADA

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Abstract

In this research, models of electrical loads were developed after transferring the data of the substations by using the SCADA system and calculating the electrical loads accurately for a period of 24 months taking into consideration the high and low weather temperatures in Babil Governorate in 2016 and 2020 and indicating the amount of growing loads Electricians and finding ways to handle control or reduce the value of this growth, especially since the poor consumption of electric energy causes great financial losses in light of the economic crisis that rocked the world countries.

Keywords: SCADA, Transmissions, distributions, communications, substation, RTU
2020 MSC: 91B74

1 Introduction

The process of calculating and predicting the growth of electrical loads is very important. There are complex relationships between high and low weather temperatures and real electrical load values [20]. Traditional methods based on calculating electrical loads at specific times of the day are not sufficient to know the true growth of loads. One of the important features of the SCADA system is that it gives the operator an accurate view of the values of electrical energy loads every second, so the SCADA system is one of the powerful means in explaining the process of growing electrical loads [33].

The growing size of wind turbines, as well as the trend toward building them offshore, has increased the need for better maintenance procedures to save operational costs [1]. Prescriptive analytics need extensive information on turbine status. The utilization of data from the turbines supervisory controlling and data acquisitions (SCADA) systems was tempting since the great price of specialized situation monitoring system depending mostly on vibration requirements [32]. This analysis focuses on techniques that have previously shown their capacity to identify anomalies in data from actual turbines once utilizing SCADA data for fault diagnosis and situation monitoring (CM). Expert systems, alarm evaluation and damage modeling, normal behavior modeling, clustering, and trending have been some of the approaches. Using SCADA data for enhanced turbine CM is explored, as well as the potential for future study.

Wind turbines have high operating and maintenance expenses, which reduces their total cost efficiency [3, 8, 12, 30]. Unplanned maintenance caused by unexpected breakdowns is one of the greatest contributors of maintenance charges. By identifying breakdowns before they reached a catastrophic state and minimizing wasteful planned maintenance,

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monitoring system of wind turbine condition utilizing automatic fault detecting algorithms may enhance turbine dependability and minimize maintenance charges [2, 4, 6, 17, 29]. A situation monitoring system depending on SCADA (Supervisory Controlling and Data Acquisitions Systems) data leverages data already gathered at the turbine wind controller [13]. It is indeed a cost-effective method of monitoring wind turbines to detect faults and performance concerns early. We explain our investigation of current wind turbine SCADA data so as to build problem detection and diagnostic algorithms for wind turbines in this study [6]. We researched categorization strategies utilizing clustering algorithms and principle components analysis for collecting fault signs and employed a variety of metrics to construct anomaly detection programs. A collection of original data, involving rotation speed and generated power, have been used to identify anomalous signatures caused by a claimed gearbox breakdown.

The introduction and evolution of the smarts grids concept for operating electrical power and microgrids has opened up a slew of possibilities for increasing efficiency and whole performance. An intriguing scheme for remote controlling and monitoring of sources of renewable energy (RES) is a supervisory controlling and data acquisitions (SCADA) scheme [26]. SCADA systems have been extensively employed in a variety of industrial applications and have aided in the improvement of scheme efficiency. However, in the attempt to security, safety, and assure dependability for power production, transmission, and distribution, SCADA schemes still confront significant obstacles. Integration of SCADA schemes to allow remote controlling of electrical microgrids and grids, monitor and controlling electrical network equipment as a way of achieving reliability and targeted efficiency for the whole utility is one of the concerns in building the capabilities of the smarts grids. Given these schemes' potential to manage the flow of energy across the network, more planning is necessary to guarantee that all conceivable safeguards against compromise are included. This article examines the existing scheme architecture as well as some of the security mechanisms in place. More crucially, it explores how to make the various needed standards easier to apply. Because of the RES's unpredictability, it's become critical to continually monitor their statuses so as to calculate the quantity of energy produced at any given moment, which will aid in power consumption planning and energy conservation once power production sources are insufficient. Nevertheless, stationing workers to continually monitor the condition of the sources will be virtually difficult, necessitating the use of a monitoring and controlling scheme. The using of SCADA schemes in power schemes, particularly the RES, is discussed in this article. It shows the key components of SCADA schemes, such as the software and hardware of the master stations. Outstation hardware would be shown, including data collecting devices including remote terminal and programmable logical controller. These devices work in conjunction with the smart appliances, data condensers, and other communications schemes found in substations. The basics and prospective software as a service of SCADA scheme reveal the smart grid's possible and encourage more people to participate in the change process. SCADA schemes deployed on fuel cells (FCs), solar photovoltaic (PV) array, and wind turbines capture a great quantity of data, which may be highly useful. SCADA schemes could optimize and enhance PV generation, as well as increase the performance of wind farms while they are in operation. This article examines the automation of renewable energy sources including fossil-fueled power plants, wind farms, and solar PV plants.

It can be said that the problem of overloading electric load represents non-linear maps that give different patterns consistent with different weather temperatures. Also, the same weather conditions give different load levels depending on whether it is business day, weekend or holiday. The current study describes a technique for detecting the rate of growing electrical loads using the SCADA scheme [5].

2 SCADA System

Supervisory Controlling And Data Acquisitions (SCADA) system was considered considered as an approach for monitoring and controlling the productive and transformational electric power stations, as it transmits the data of the substations to the system core from a number of remote terminals or programmed logic controllers [21, 19, 28, 36]. The system collects the information that has been transferred and processed. Therefore, the SCADA system provides access to information that helps electric power companies to make decisions to improve the electric power system, see Figure 1.

Without SCADA software, gathering enough data to make consistently well-informed judgments will be exceedingly difficult, once not impossible. For instance, once electrical energy loads are collected for a specific geographical area and continuously followed up, appropriate plans can be devised to accommodate the rate of growing electric loads in the future or for the next several years [9, 7, 35].

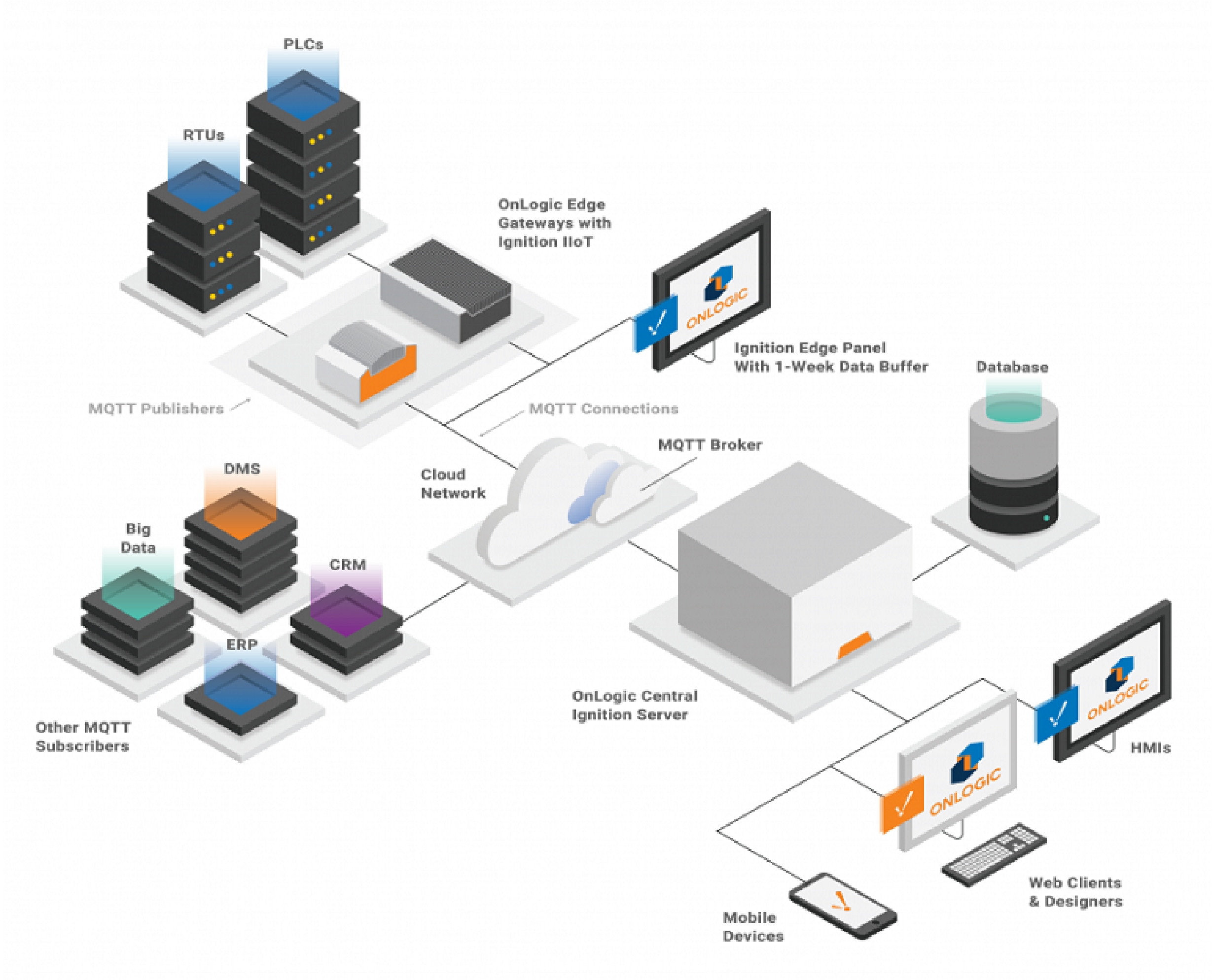

Figure 1: SCADA structure system and operation.

3 Electric power loads

Electric power loads are classified as residential, commercial, agricultural, and industrial. Commercial and residential loads are largely made up of household appliances, fireplaces, and lighting. These loads usually consume very little interactive energy. Industrial loads are complex loads that constitute induction motors and are the highest percentage of industrial loads. As for agricultural loads, they usually belong to water pumps that work to irrigate agricultural lands [11, 23, 27, 34].

Loads change throughout the day, depending on the amount of energy spent by consumers on demand. The sum of the requests submitted by different groups of users is called the daily load curve. The maximum demand within 24 hours is called the peaking load, for example. the largest magnitude of the load. The proportion of the mean loading over a period to the higher load that occurs during this period is called the load parameter. The load parameter can be provided for one day, one month, or one year. The annual loading parameter is amongst the useful parameter to know the percentage of growing electrical energy loads compared to previous years [14, 15, 22, 25, 31, 37].

$$DailyL.F. = \frac{MeanLoad}{PeakingLoad} \tag{3.1}$$

Multiplying the numerator and denominator of (1) by a period of one day,

$$DailyL.F. = \frac{MeanLoad \times 24}{PeakingLoad \times 24} = \frac{Energyconsumedduringoneday}{PeakingLoadoneday} \tag{3.2}$$

$$AnnualLoadFactor = \frac{TotalAnnualEnergy}{PeakingLoad \times 8760hr} \tag{3.3}$$

On the whole, there is a difference in peaking load between multiple loading classes that helps improve the overall system load parameter. Growing electrical loads at all levels is an important function of operating and creating real power system planning [10].

4 Segment Load Shapes

Loads were determined according to consumption patterns at the level of the customer category during the 12-month peaking period, the sub-stations were chosen from the Babylon network sites, which are dominated by the load from one of the residential, commercial, industrial or agricultural parts. Loads were determined according to consumption patterns at the level of the customer category during the 12-month peaking period, the sub-stations were chosen from the Babil network sites, which are dominated by the load from one of the residential, commercial, industrial or agricultural parts. As it was observed in Figure 2, the high and low agricultural loads are related to the seasonal planting seasons that start by the spring season in March. Industrial loads Figure 3, whose Hittite loads increase in the summer months of July and August [19].

Figure 2: Agricultural loads.

Residential loads Figure 4 may rise in June and the reason may be related to the preparation Most consumers of the school exams, as this time is the end of the school year, which makes most families a few out of homes, unlike commercial loads, Figure 5, as it has risen in September mostly due to increased shopping in September with the start of the new school year [18].

5 Annual electrical load model

The growth of the electrical energy loads is evaluated and the records are evaluated for the years 2016-2020, as the findings have been demonstrated in Table 1. Where the table shows the highest electrical load required to be consumed with the highest temperatures and humidity levels during the months of the year. The highest electrical load was recorded in August 2016, where the temperature was up to 45.5 degrees Celsius, while the highest load

Figure 3: Industrial loads.

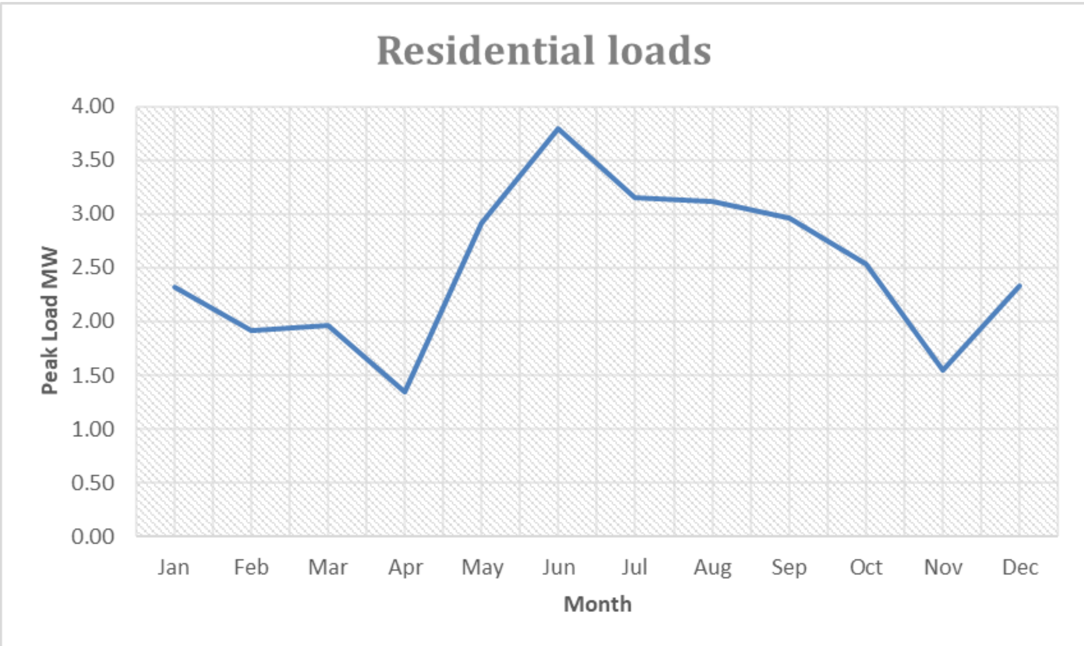

Figure 4: Residential loads.

recorded in July 2020 was at a temperature of 45.8. This shows that there is a direct correlation between the electrical load increase and the temperature increase [16, 24].

6 Conclusions

The means of detecting the growth of loads were developed by recording accurate data using the SCADA system, and it was found that the rate of load growth in Babil Governorate during 4 years increased by an approximate rate of 42%, or at a rate of 10.25% annually, and this requires a relative increase in production of approximately 20% at the least annually to cover the growth The outcome every year and in anticipation of any increase resulting from the

Figure 5: Commercial loads.

Table 1: Sample temperature and humidity data at peaking loads for the Babil Province during 2016-2020.

Month	2016			2020		
	Peaking Load (MW)	Max Temp. (°C)	Humidity %	Peaking Load (MW)	Max Temp. (°C)	Humidity %
Jan	982	17.3	66	1856	18.7	68
Feb	895	22.1	64	1777	20.4	59
Mar	698	25.9	53	1390	25.7	57
Apr	990	32.5	45	1430	31.5	43
May	1225	37.2	36	1755	38	34
Jun	1252	41.9	29	1913	42.1	32
Jul	1217	44.7	30	2212	45.8	32
Aug	1284	45.5	33	2134	43.1	38
Sep	1273	39.7	35	2078	42.7	43
Oct	582	35.4	41	1483	35.9	42
Nov	811	24.7	46	1516	25.9	44
Dec	972	16.6	65	1999	19.8	62
Mean	1015	32	45	1795	32	46

growth of the population or economy or increases in energy consumption may be caused by an unexpected rise in temperatures.

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