Case Study - Industrial IoT for Smart Electrical Energy Management by MPS Digital

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Overview

This case study is about electrical energy management in an industrial environment. The industry has multiple critical operations and many of these are being performed by electrical equipment consuming a major share of electrical energy. The critical operations are shredding, washing, heating, extrusion, water treatment processes, filtering, pumping and solar energy generation etc.

Goals

1. To make a more accurate estimate of gross electrical energy consumption everyday on a continuous basis so as to be able to forecast the electricity requirement for next day enabling them to bid for the optimum prices from DISCOM and procure the electrical energy at optimum pricing by accurate estimates.

2. To monitor the consumption of different critical units on a day-to-day basis and get a report of the same automatically.

3. To compare the energy consumption between the similar equipment installed in multiple similar lines of production in order to assess the relative efficiency of the equipment.

4. The breakup of electrical energy consumption continuously for each 15 min. timeframe for the entire day to analyze the pattern of electrical consumption for blocks of hours for bidding purposes.

5. It was also required that the daily report of these parameters be mailed to concerned staff automatically and also the monthly register be maintained for the same.

6. To be also to visualize the electrical parameters from any location and optionally to get the alarm in case of major deviations.

7. To retain the above reports and visualizations for the long term - perhaps yearly basis for any investigation in future.

It was with these requirements and goals the solution was to be built. After studying their unit processes, the layout and locations of critical sections, the kind of equipment and energy sensing needs, we had developed the automated solution.

Prior to the automated system, they had installed energy meters and had manual data collection that would be done multiple times a day and then computed. The process was completely manual and therefore was prone to negligence, errors and resulted in inaccurate and delayed results.

The Implementation Plan - OT Grouping and Topology

As a plan of industrial IoT solution for Smart electrical Energy Management, a total of 70 odd nodes were identified which were critical to the industrial process and these nodes/machines would consume a significant part of the electrical energy. These were grouped into five sections as per topology and/or function of the group. Measurement of parameters of all nodes of each group was implemented in one data loop which was connected to a converter or aggregator resulting in five/six segments, each segment having its own converter. All the converters cum aggregators were linked to a common digital network. Each aggregator would read the sensor and convert the measurement into digital form and communicate on a common network along with individual ids of the sensors/meters. From here onwards the servers and software would take over.

The Edge Server

An edge server was set up and installed on the common network and was configured to collect the measurements from all the nodes of all the loops via respective aggregators. This data was filtered for dropping out the spurious or invalid values. Edge server was also programmed to smoothen the measurements by continuously averaging samples of small time frames (approx. 3 minutes) to eliminate the effect of transient spikes in measurements and to give a realistic value. Edge server was optimized for speed and latency. This is usually used for real time processing and not for large data stores so as to be more responsive. For long term data storage, data analysis for anomalies and reports, it was to be continuously synchronized with the repository of the cloud servers, relieving edge servers dedicated to data collection and filtering before onward processing. Another important function of the edge server device was to be able to cache data for up to a week in case of intermittent loss of connectivity and to be able to sync with the cloud upon resumption without losing the measurement values.

The Cloud Server

Cloud server was used for multiple purposes. (1) To enable larger data repositories enabling data retention for up to months and years and still be fast for retrieval upon request, (2) to enable heavy data computation and analysis fast, (3) to enable access from anywhere (4) to

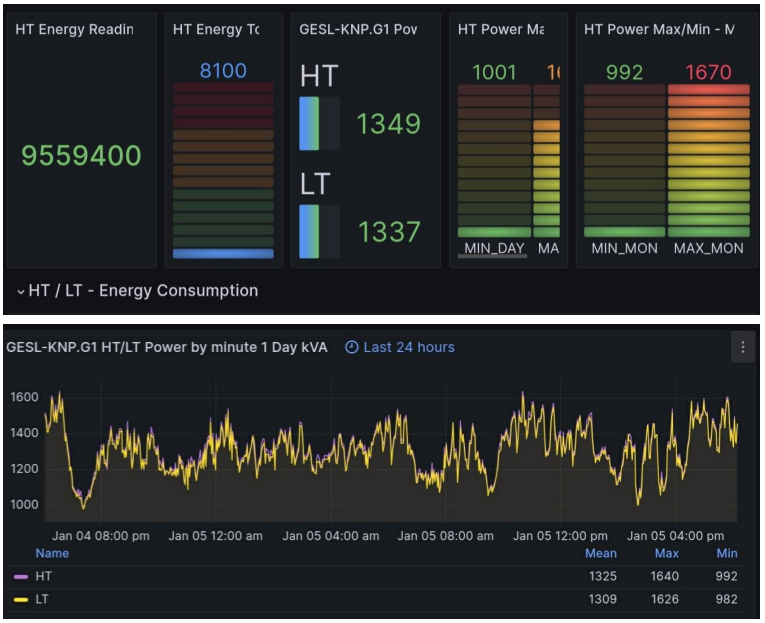
provide automated email and alert capability (4) to enable generate complex reports and (5) provide easy to comprehend, appealing visualization and dashboards..

On the cloud based server the visualizations were developed which were accessible from anywhere on a mobile as well as on desktop devices. Alerts were programmed as per user defined limits to trigger and send notice / email to the concerned staff whenever any unusual condition was met crossing the preset limits. Reports are being generated for all the devices and groups appropriately as well as total electrical requirement for each 15 min. Time window for the entire day is being logged and reported. These are presented as daily registers renewing every month and being mailed every day. Reports for daily monitoring of individual groups and nodes are also generated automatically and mailed.

Visualization and Sample Reports

Some visualizations from the dashboard - both on mobile and desktop devices and also sample reports are shown below.

Sample Visualizations of various electrical energy metrics on Mobile



Sample Visualizations of various electrical energy metrics on Desktop

[redacted] Electrical Energy (KVAH) Consumption Chart Date: [redacted]								
M No	**Gp**	**Description**	**Read 07:00 hrs**	**Read 19:00 hrs**	**Read 07:00 hrs**	**Nett kVAh (Day)**	**Nett kVAh (Night)**	**Nett kVAh (Total)**
		GROUP-1 ([redacted] Plant, Utility)						
M1	G1	Main HT	9511100	9529000	9544600	17900.0	15600.0	**33500.0**
M2	G1	Main LT	9883337	9900987	9916344	17650.0	15357.0	**33007.0**
M2	G1	M2 KWH	0	9757710	9772868	0.0	15158.0	**15158.0**
M2	G1	M2 MDI (KVA)	0	1700.94	1700.94			**1701.0**
		M2 PF (KWH/KVAH)						**0.4592**
M2	G1	M2 Total Kwh EP(-)	0	137	137	0.0	0.0	**0.0**
		Net M2 (Total KVAH-Total Kwh EP-)						**33007.0**
M3	G1	PCC1 [redacted] Incomer Discom	5151039	5161740	5170800	10701.0	9060.0	19761.0
M4	G1	PCC1 [redacted] Incomer DG 1500KVA	242559	242559	242559	0.0	0.0	0.0
					Import Total Sl.3-4			**19761.0**
M5	G1	Out Feed to Unit 1 PCC Incomer	1444238	1446968	1449400	2730.0	2432.0	5162.0
M5	G1	M5 Total Kwh EP(-)	0	33771	33771	0.0	0.0	0.0
		Net M5 (Total KVAH-Total Kwh EP-)						**5162.0**
M6	G1	Out Feed [redacted] Ext PCC	256908	257226	257545	318.0	319.0	637.0
M7	G1	Out Feed [redacted] 1&2 MCC	470851	471270	471288	419.0	18.0	437.0
M8	G1	Out UPS1 Input	1638404	1639705	1640837	1301.0	1132.0	2433.0
M9	G1	Out UPS2 Input	215021	215550	216162	529.0	612.0	1141.0
M10	G1	Out UPS3 Input	1640554.12	1641800.25	1642874.25	1246.1	1074.0	2320.1
					Sub Import Total Sl.8-10			**5894.1**
M11	G1	Out Feed Korea Crimp MCC	0	0	0			0.0
M12	G1	Out Feed Power DB LT Room	0	0	0			0.0
					Export Total Sl. Net M5-M12 & M23			**16482.1**
		GROUP-2						
M13	G2	UPS Out Elect & Adm	24705.7	24782.5	24802.3	76.8	19.8	96.6
M14	G2	UPS Out Thermopack 40 LKC						0.0
M15	G2	UPS Out Unit1 UPS PCC	3700236	3701267.5	3702251.25	1031.5	983.8	2015.3
M16	G2	UPS Out Thermopack 40 LKC MCC (TF Pump 10HP)	171578.7	171837.5	172083.3	258.8	245.8	504.6

Sample Automated Email Report from IIoT System for Electrical Energy Management (partial)

Benefits

Adopting a modern IIoT based electrical energy management has enabled the organization to keep an eye on the electrical energy consumption as well as monitor the individual equipment for any variance as well. This is also useful for costing purposes and has also resulted in an accurate estimation of energy needs for the next day on an hourly basis, resulting in optimum prices and thus direct saving in costs.

Ready to have a live demo or discuss your needs? Please contact us today at rt@mps.in or visit https://www.mps.in for contact details.