Smart Energy Monitoring and Its Future Prospects

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Abstract

In this paper, Smart Real-Time Energy Monitoring System (EMS) has been built, incorporated and designed using concepts of IoT, which is a modern framework for controlling, observing, and dealing with the electrical burden frameworks. Today, this has become a need for present day mechanical activities. Not just that, Smart Energy Monitoring frameworks likewise give a way to check if every one of the heaps and meters are working as indicated by the normal usefulness and help in clearing a path for the smooth and blunder free working of the whole burden framework.

To satisfy all the above models just as for making a whole structure that can yield every one of the normal outcomes, a UI has been made, joined with application improvement utilizing front-end and back-end alongside a functioning site so that constant checking should be possible to obtain every one of the normal logical instruments to screen the meters and loads at the back-end.

Keywords

API, IoT, Database, XAMPP, MySQL, Frontend, Backend, Python, Real – Time Monitoring system

1.INTRODUCTION

The entire project is based on a very clear approach. It is based on the principle that irrespective of the date and time of the day, real time monitoring shouldn't stop and keep on getting refreshed as and when the data at the backend is refreshed. Also, the approach adopted for the entire process is based on communication between the frontend and the backend which has been set up with the intervention of APIs. Following this approach, APIs play an extremely crucial role in this project in a way that not only do they help in mapping the user command to the required pathway at the backend, but they also process the data through the intermediate channel connecting the two soft wares. Android Studio and Boot-Strap have been used in this project for the establishment of the app and website interface such that everything can be appropriately queried and translated towards the backend. For real time trend analysis, graphs that can display the trends of the average values of the number of values depending upon the user's choice have been used.

2.TECHNICAL SPECIFICATION

In this project, fetching of the desired results and the establishment of a connection between the software and the electrical domain has been established through the use of APIs. Following is the workflow of how the whole connection has been established:

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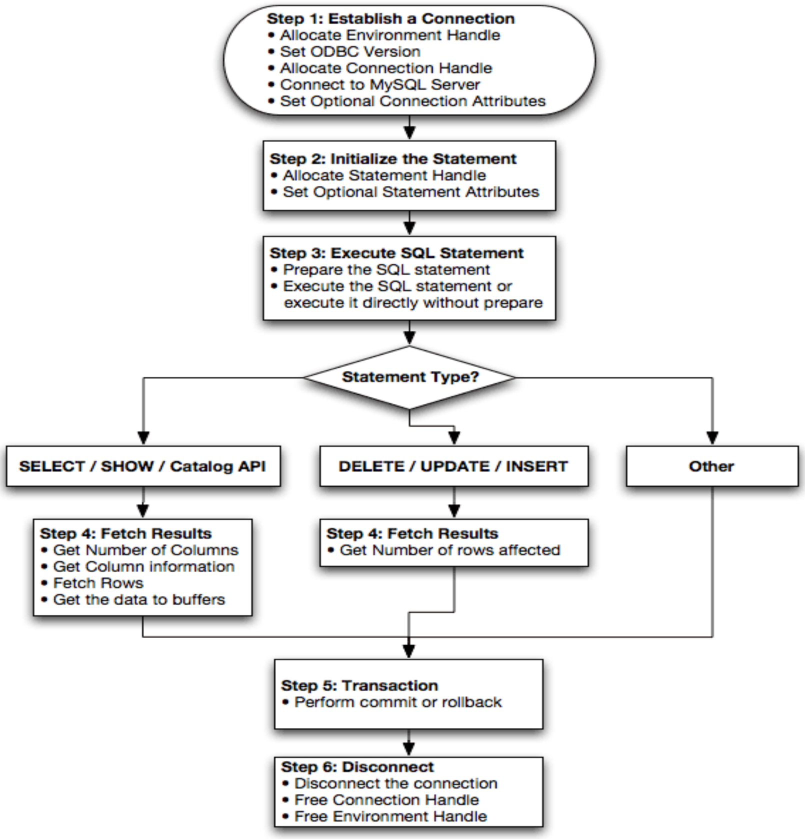


Figure 1: Depiction of the workflow of the communication channel

Once the communication channel has been set up using the APIs, the above tables lend their data according to the demand of the user that comes through the frontend and paased onto the backend after which this data, after getting processed by the rsepective method to which the function call has been mapped, gets transferred onto the frontenf for display [1]. In this way, the entire system helps in real time monitoring of the entire electrical system.

3. DESIGN APPROACH AND DETAILS

The entire design approach is based on the principle of collaborating the electrical domain with the software domain so that both can work synchronously and complement each other's respective functionality. Following is a schematic briefing of the design approach:

- Firstly, the database is set up according to the desired needs on a given server, which in this case is the XAMPP server. This is done using the XAMPP control panel and PHP Local Admin.
- Secondly, the connection of the server is established with the Python code designed at the backend using appropriate libraries provided by Python editors.
  Units Utilized/day = Number of Units at present – Number of units at starting of the day
  The APIs are designed to set up a communication channel between the server and the code at the frontend and the backend [2,3].
- Once the backend is appropriately set up, the frontend of both, app and website using Boot-Strap and Visual Studio is designed and interactively set up with all error codes embedded.
- Lastly, the frontend and the backend are combined with each other using appropriate embodiment of code structures into proper URL set up.

Following are the Python libraries that have been extensively deployed for the development of the API set up, connection with XAMPP server and development of backend [4,5,6].

- **Flask** - Flask is a web framework which means that flask provides with tools, libraries as well as technologies that allow to build a web application.

- **PyMySQL** – It helps in connecting to MySQL. The exact way to get an instance of this class is to call **connect()** method.
- **JSON** - JavaScript Object Notation (JSON) is a conceptualized format usually used to transfer data as text that can be sent across a network.
- **Jsonify** - Jsonify is a function in Flask's flask library. Json module establishes Jsonify to serialize data and wrap it in a Response object with the application or json mime-type.

- **Datetime** - Datetime module comes built along with Python, so that there is no need to install it externally.

4. DEMONSTRATION

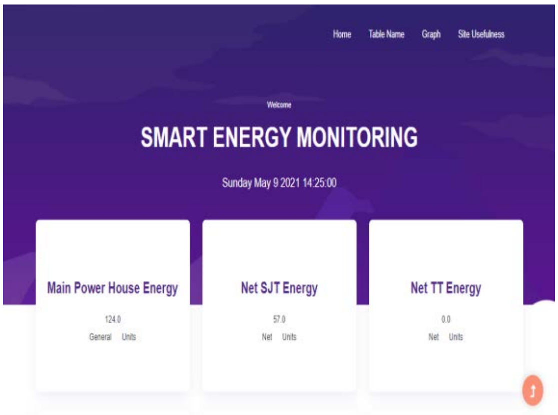


Figure 2: Homepage of the Website symbolic of the NET Energy calculated for separate buildings

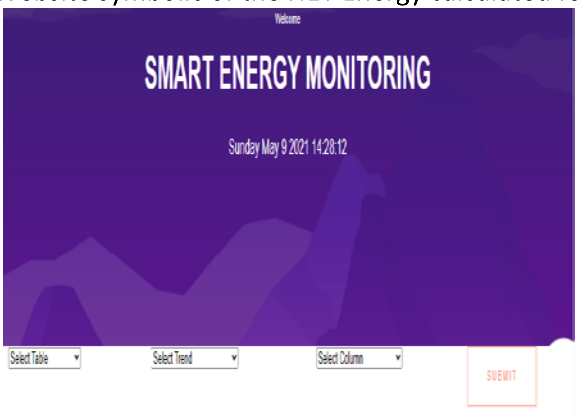


Figure 3: Webpage denoting the parameters to be selected for plotting graphs

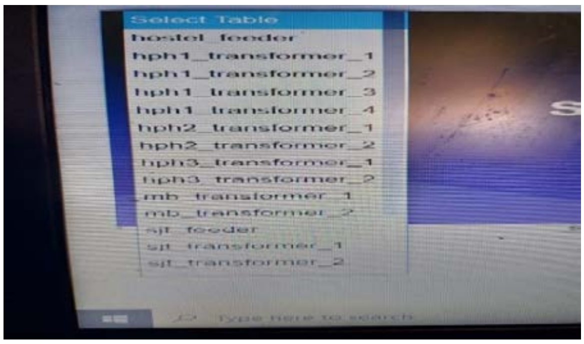


Figure 4: Drop-down menu displaying the transformer or feeder whose graph is to be plotted

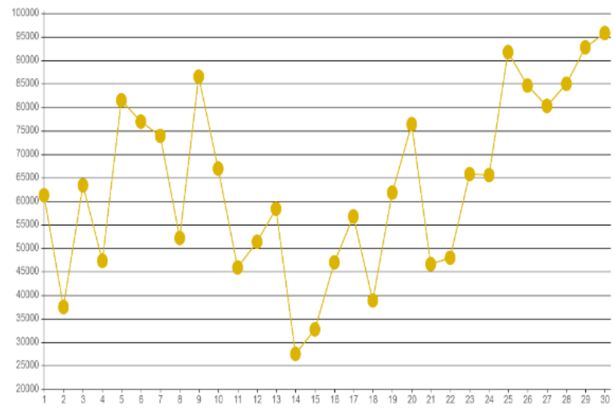


Figure 5: Graph plotted for SJT Transformer – 1 for 30 value sets {monthly} – Graph denoting utility curve

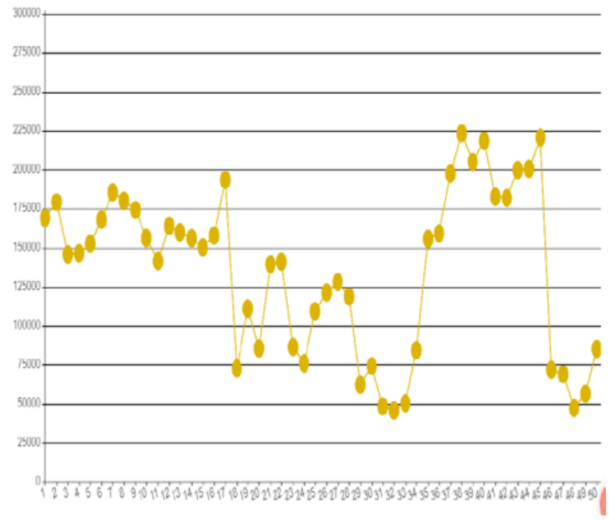


Figure 6: Graph plotted for SJT Transformer – 1 for 365 value sets {yearly} – Graph denoting utility curve

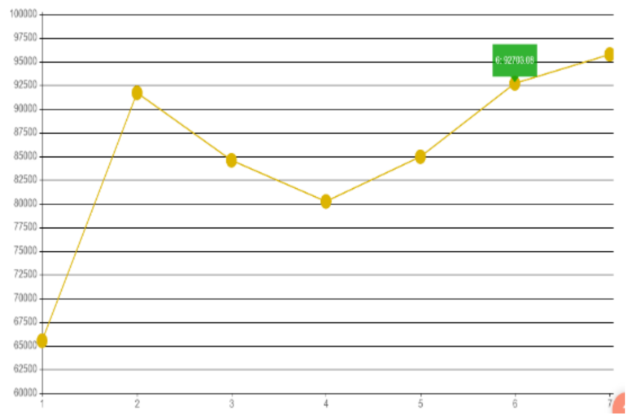
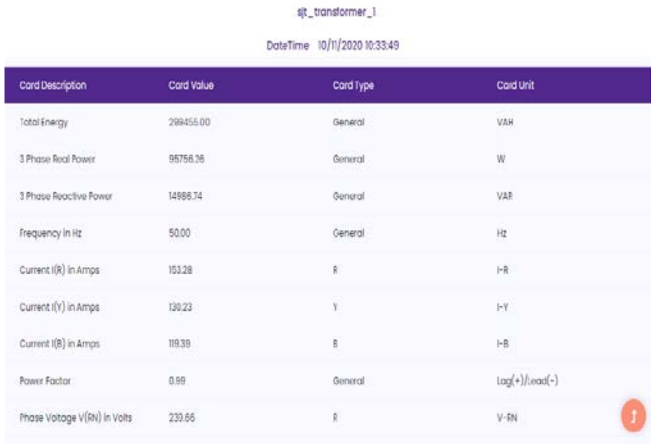


Figure 7: Graph plotted for SJT Transformer -1 for 7 value sets {weekly} – Graph denoting utility curve



sjt_transformer_1

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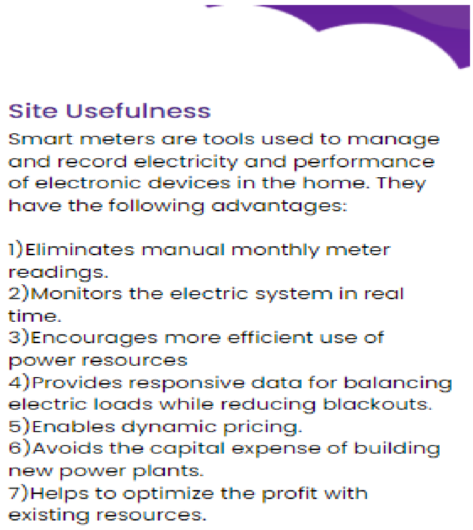
Card Description	Card Value	Card Type	Card Unit
Total Energy	299455.00	General	VAH
3 Phase Real Power	95756.26	General	W
3 Phase Reactive Power	14986.74	General	VAR
Frequency in Hz	50.00	General	Hz
Current I(R) in Amps	153.28	R	I-R
Current I(Y) in Amps	130.23	Y	I-Y
Current I(B) in Amps	119.39	B	I-B
Power Factor	0.99	General	Lag(+)/Lead(-)
Phase Voltage V(RN) in Volts	239.66	R	V-RN

Figure 8: Portrayal of parameters & corresponding values, types and units for SJT Transformer-1



Site Usefulness

Smart meters are tools used to manage and record electricity and performance of electronic devices in the home. They have the following advantages:

1)Eliminates manual monthly meter readings.
2)Monitors the electric system in real time.
3)Encourages more efficient use of power resources
4)Provides responsive data for balancing electric loads while reducing blackouts.
5)Enables dynamic pricing.
6)Avoids the capital expense of building new power plants.
7)Helps to optimize the profit with existing resources.

Figure 9: Depiction of System Usefulness and Advantages

5. FUTURE PROSPECTS

This project is extremely oriented towards establishing a channel that paves a way for soothing the analytical measurement and study of electrical systems using software mechanisms and tools [7,8]. Following are the key futuristic aspects of this project:

1) Automatic fetching of the data at backend without any manual intervention and thus reducing the scope of error unlike the present state whereby manual input of data at some sites is necessary.
2) Being able to develop a mechanism to automatically fetch and analyze power usage trends results in a set-up whereby one can develop realistic targets in order to meet and fulfil future energy management and thus work towards managing the energy such that it is not wasted and fruitfully used unlike the manual reading and analysis making which attracts scope of error.
3) Not only this, but it can also help in decreasing the downtime involved in the maintenance of the electrical systems unlike present-day scenarios. This would not only ensure consistency for long durations of time but would also help in comforting the lives of individuals.
4) Also, this project can save loads of money and enhance cost effectiveness of energy and software systems as regular monitoring can help in catching faults at early stages, thereby decreasing costs to rectify those faults and enable a much more efficient mechanism for dealing with systems at backend.
5) And most importantly, real time monitoring helps in thinking of new strategies and plans that can yield more amount of fruitful benefits from the system at backend as far as energy efficiency

enhancement and energy conservation issues are concerned, thus leading to enhancing energy conservation and maintenance [9].

6. RESULTS AND CONCLUSION

Today, smart energy monitoring system has become a necessity for modern industrial operations. Not only that, Smart Energy Monitoring systems also provide a means to check if all the loads and meters are working according to the expected functionality and help in paving a way for the smooth and error-free functioning of the entire load system.

Through Flask, APIs have been developed which extract the required data from the backend and pass it on to the frontend which has been developed using Boot-Strap. Based on the user requirement, the data can either be fetched from the backend side where the data is retrieved into the database using the provided server, through the application or the website and app, both of whose functionality ultimately leads to real-time monitoring and analyses.

Thus, the entire set-up not only aids in monitoring and analyses but also helps in drawing manipulative conclusions so as to maintain the harmonious and synchronous functionality of the system at the back-end, viz., the loads and the meters. All-in-all, through this endeavor, a pathway for energy conservation and maintenance gets a pathway that can be tiptoed upon and achieve milestones thereafter.

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