Intelligent Power Management System

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Publication Date: 2025/03/28

Abstract: The paper deals with an Intelligent Power Manage- ment System, a System that works by SCADA model supported by AI subsystems. The system will automate the operation of the power system.

Keywords: *PMS(Power Management System), AI, ANN, ML, Rational.*

How to Cite: Manu C Madhu; Jean Jacob; Shiva Krishna M M; Krishna Ramesh (2025). Intelligent Power Management System. *International Journal of Innovative Science and Research Technology*, 10(3), 1372-1377. https://doi.org/10.38124/ijisrt/25mar1046

I. INTRODUCTION

Power Management System or PMS is a newer scaled-up version of Power Automation System designed to automate the Power Generation and supply of Energy throughout the Network of grids. The system collects data from users through specialized smart meters which can push data to server though API interface and this data is used to control and manage the grid. The system works similar to SCADA but when SCADA is scaled up there will be no insight for the operators on how to control the system as the past data is not available. The present data will only be available after a delay in time in the future. Considering the fact that the new system is designed to incorporate AI subsystems which train this available data of generators and users from the past and predict the current statistics which will help in the effective management of grids. An AI based real-time system can be implemented in PMS to handle real-time situations and avoid mishaps. The main objective is to provide quality power supply along with driving down the cost of energy production by choosing generator with higher rank and heuristics.

II. POWER MANAGEMENT SYSTEM

The PMS is an intelligent system incorporated with mul- tiple AI as sub-modules to map the working of the existing manually operated power grids. Considering existing power grids which are operated by mostly unskilled labor force, the main issue lies within the outcomes like unexpected power outages, excess power generation and incurred losses, increased downtime, increased maintenance costs. The final result of all this combined is higher power production costs. As technology grows, their is higher demand for power as power demand increases the technology for power production is also being improved, but the cost for production and supply stays same or increased, this occurs as a result of the poor management strategies used by the authorities.

The newer technologies should kick into the management phase of the Power Grids. The PMS is an integral solution to the higher-level management of the power grids and the grid network. The idea of Incorporating highly complex algorithms such as Random Forest Tree and Isolation forest is to classify the generators and users and assign them rankings to choose the generator with the highest utility and also identify the abnormalities in the user and inform the authorities. By this process, we can minimize waste and produce electricity with fewer CO_2 emissions.

III. ARCHITECTURE

➢ *The main Architecture of the System Consists of the the Server*

- Power Generation management
- Usage Data Collection and Server Management
- Power Load Management
- User & Device Management Subsystems
- Assistive ML Modules

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar1046

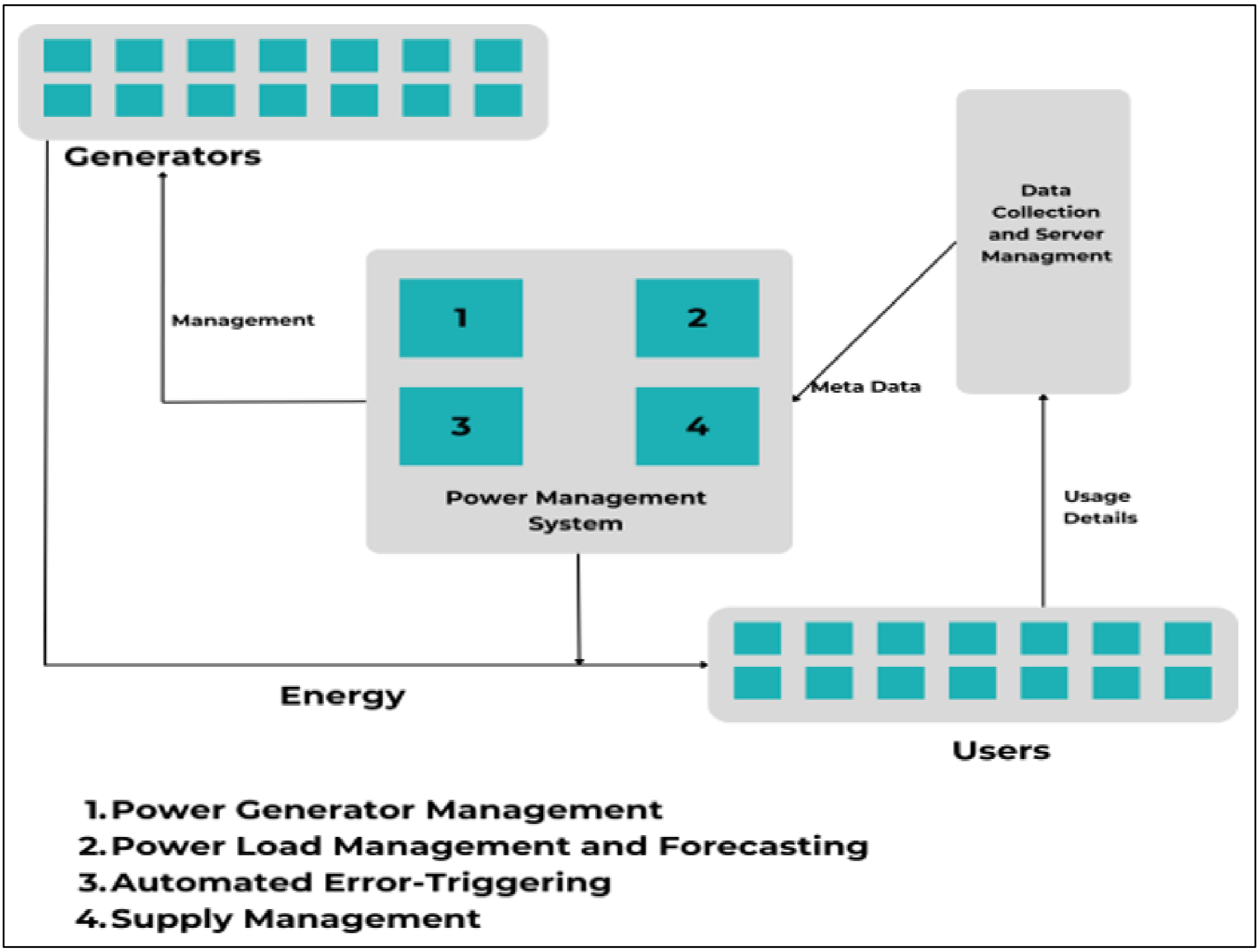

Fig 1 Power Management System Architecture

➢ *Power Generation Management*

Power Generators are the source from which power is generated and this power is transmitted through the power infrastructure to reach the end users. The generators need constant management and control. The idea of this module is to develop a ML System that can automate the power generation management. The older idea under SCADA was to use real-time available user data to manage the power grids, but when scaled up to a larger system this implementation fails as the real-time data is available with higher latency and a separate system needs to be used to collect and analyze the data to get high speed results. The data analytics is harder and the collection requires a separate network so as to maintain reliability. These framework and infrastructure would cost higher and is not easily implementable.

An ML assisted module is used to rank the generators in real-time, the rank obtained, is based on multiple parameters such as temperature, time, season, wind , previous usage etc.., this is used to manage the power systems. There are two possible options to use the system one is to automate and control the generator automatically and the other is to use them to assist the existing control mechanisms so that it is easier to implement above the existing infrastructure. The ML is rational and can provide better output. The ML is equipped with Artificial Neural Networks that can intelligently analyze the predefined data and rank the generators.

The generator management is assisted in the PMS with the help of Power Prediction Modules. Dynamic user data cannot be solely used for generator management. The data needs high amount of processing. Since its time-consuming this cannot be used in real-time systems such as Power Management Systems. The PMS has inbuilt modules that train on the existing user data to predict the future power demands. The predicted power usage is used to increase the power production of the generators. This will be assisting the future power demands and will be helping create an Ideal System where demand and supply of power is always the same.

These two modules make sure that the power produced is greener as possible as well as the power is not wasted. These all are implemented as the sub-modules of the Main Power Management System Architecture.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar1046

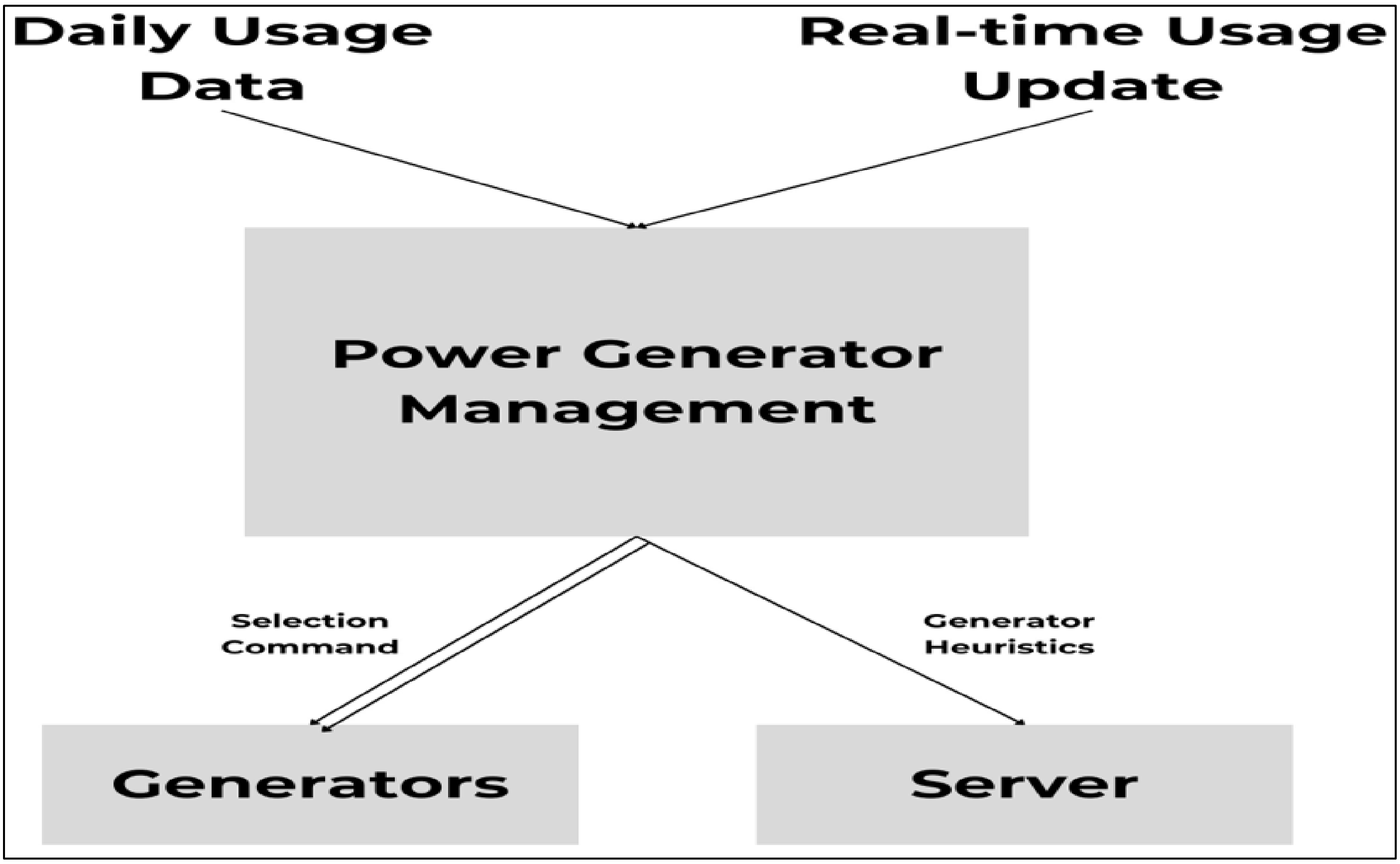

Fig 2 Power Generation Management Sub-Module

➢ *Usage Data Collection and Server Management*

The usage data collection is done through multiple methods on the existing power systems. The PMS is developed with an inbuilt API access for the end-point edge devices to ping into the server. These devices can send or receive data through the API through https requests which can be implemented over the existing Internet Architecture rather than opting for a separate system. The server is maintained by Django framework which can handle basic requests from all devices and work safely under the load.

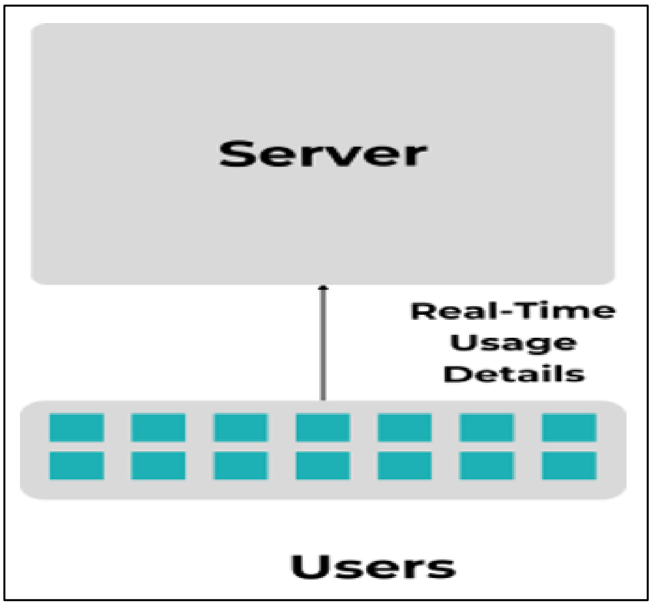

Fig 3 Data to Server Uni-Channel Communication

The system will be having a server that is used to process the incoming usage data from the users. It is a uni-channel communication and the data is saved on to the database by the module. Separate module is responsible for communicating with the users so that the whole process is similar to transactions.

➢ *Power Load Management and Forecasting*

Power Load Management is the essential task to maintain the equilibrium between user demand and supply the equilib- rium needs to be maintained so as to make the grid effective. The main disadvantage in all the existing system is the latency associated with the power usage data collection, this affects the management is a negative way as sudden spikes in usage disturbs the equilibrium and often incur in losses or power outage. This has been one of the major concern from the I-o-T integration as it was costly yet still ineffective. The main idea is to incorporate an ML that can predict the accurate power usage that can calculate the spikes and manage the demand in a better possible way so that it can result in reliable power supply.

The database holds the value of the usage data when there is a spike (positive or negative), the load management system checks for the load and calculates the exact values passes it on to the server and modules so that they can access it and along with this it broadcasts the message across the power-grid so that the smart devices can take the appropriate actions. This is important as real-time mapping of input to output can be only done with the help of Load Management.The system is essential as it can

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25mar1046

also easily figure out overload, take the necessary actions and inform the authorities regarding. The action part is specified by the Supply Management module.

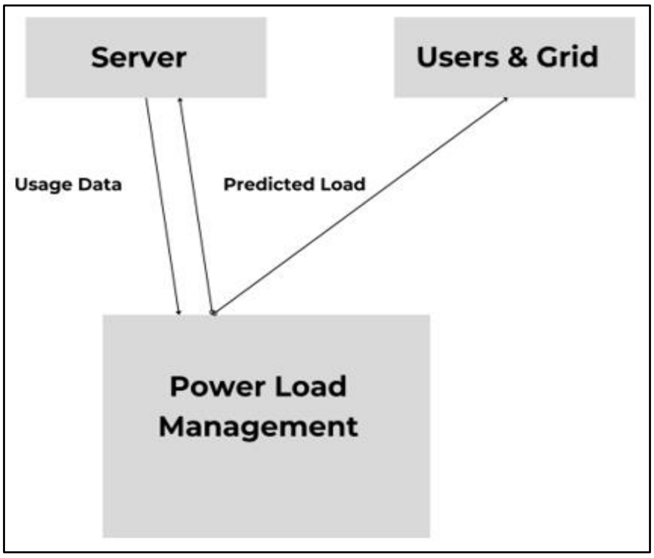

Fig 4 Load Forecasting

➢ *Automated Error Triggering*

The Errors are usual in the Power grid and this is not easily detectable at the management side, but since data collection is implemented the usual change is predictable, But when there is unusual changes the ML can recognize it this can be used to trigger automated error checking mechanism that can run itself to find the point of issue and inform the authorities to correct it. This process only takes few minutes and is accurate that it can also inform the end users about the same also it can anticipate the errors in case of Climate. The higher wind, thunders all of the natural things can be predicted these all affect the power consumption directly but the linear connection cant be mapped easily but ML can help with the same by mapping the data and producing the anticipates error triggers so that the users as well as the authorities stay alert so that errors can be tolerated easily and in an effective manner rather than going for outages

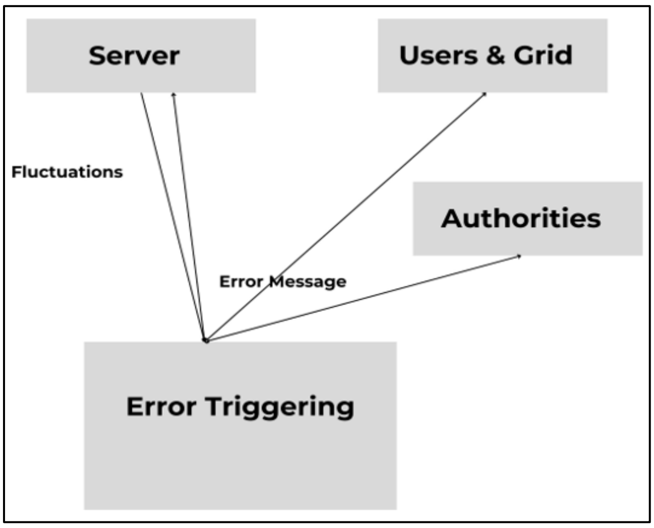

Fig 5 Error-Triggering

IV. COMPARISON WITH EXISTING SYSTEM

There are existing power grid management systems across the world but in most of the cases such as in rural areas the grid is mostly operated manually this is not efficient and causes accidents as well as power outages. This is the main area of scope where the system can be implemented. The older systems are manual time consuming as well ass inefficient. Most of the people are yet not familiar with electricity. In developing nations itself there are places where power is only available for just one day per week for which farmers have to wait to complete the process of agriculture. The better power grid may not show its effect directly in the light in a short period but it will reduce the cost of operation across multiple sectors providing better quality products at a lower rate and a better lifestyle to majority of the people. Consider the example of agriculture, if power is available continuously the crop will be better as there is proper irrigation, pest control etc.. The farmers wont have to wait for long hours the cost of production will also decrease as power will be rather available at a lower cost this will increase the profit at the root level.

The profit is available to all markets and this also helps people to rely more on grids and thus indirectly reduce the power usage from Non-renewable energy thus reducing the carbon emissions. In case of Industries when there is shortage of power they rely on fossil fuel powered generators thus operation can produce more pollutants, If there is reliable power from Renewable sources they can use it and run on a lower operation cost.

The system can be coupled and scaled across nation to develop a united power grid so that the intra-territorial power exchanges can be easily monitored and the usage of Non- renewable energy can be reduced.

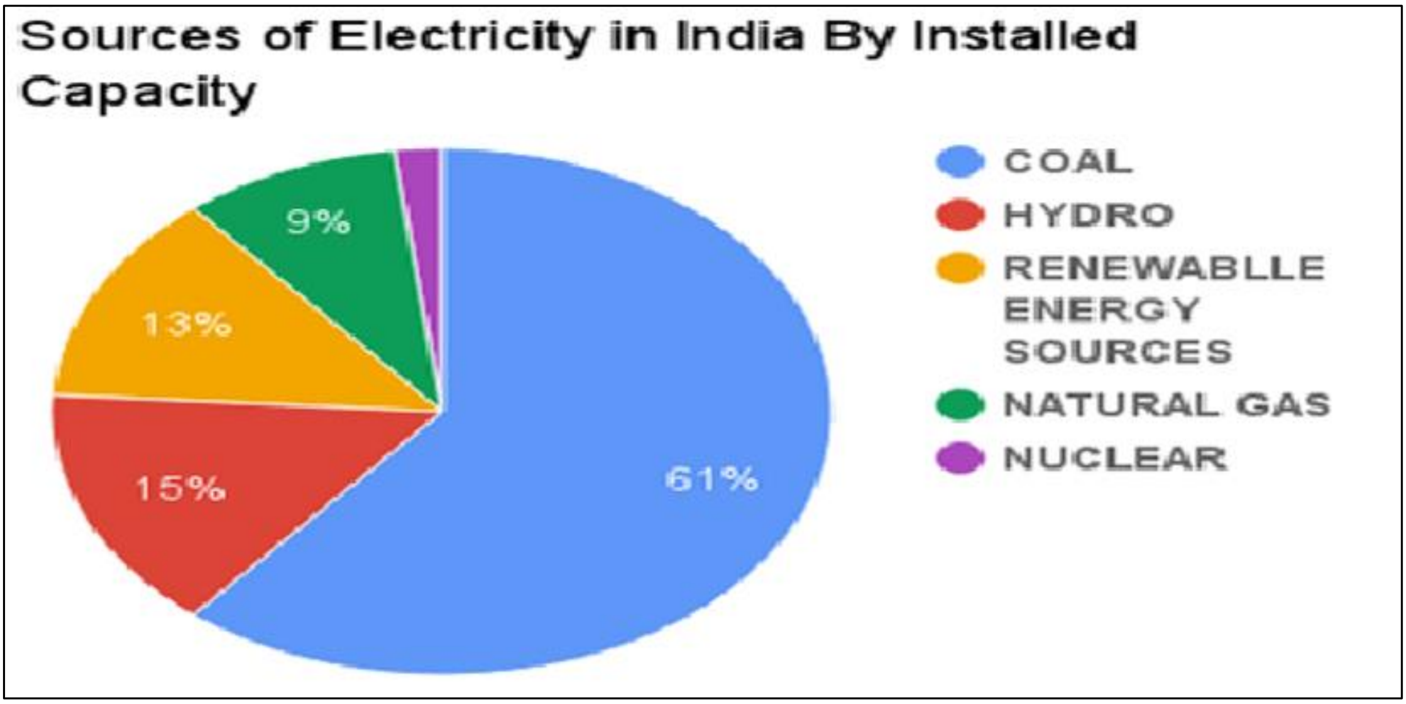

Fig 6 Pie Chart showing of Distribution of Power Sources

The above figure shows that India is primarily dependent on the non-renewable sources the primary dependency can on non-renewable sources can be brought down to renewable sources reducing the carbon emissions. The dependency is due to wastage of renewable energy and the higher cost of implementation of the power plants based on renewable energy. The older system doesn't provide the scope for further improvements and with the newer system the investments can be planned accordingly and be made efficient.

V. COMPARISON WITH SCADA

SCADA stands for Supervisory Control and Data Acqui- sition, and it's a software system that monitors and controls industrial processes in real time. SCADA systems are essential for managing and monitoring power plants, especially wind and solar power plants.

Although SCADA is useful in Power Generation Management we cannot couple it to a power grid to manage the supply. The problem is that the power supply management needs an individual high speed network to handle the large load that might occur in peak time. This might not be useful otherwise.

The Proposed model Helps to manage the grid by presump- tions and assumptions rather than real time data dependency this is a better option as real-time data availability is a large issue along with latency. Latency issues need to be solved in the grid to ensure maximum efficiency this is crucial. The ML can accurately predict the power outcomes and provide management suggestions

Although the Idea might seem similar. Both the systems differ the Predicted system can work with less computational power than SCADA.

VI. RESULTS

The Predicted Outputs from the ML subsystems were useful in early management of the Power grids. These supported the early detection of sudden spikes in the system and changing according to it. The early warning system incorporated helped in the prediction of anticipated maintenance's. These systems help in driving down the production costs and the Error detection module works tirelessly to spot any errors in the system and alerts the concerned authority. The main objective is to provide rational availability of power.

VII. CONCLUSION

In conclusion the Smart Power Grid management System equipped with multiple application specific AI and ML mod- ules can revolutionize the existing power grid by providing a better management option and also proving most rational output and from the power grid. The idea of equipping ML and AI will help in better management of the power systems. The better management results in the reduced cost of operations as well as reliable power supply. The system can ensure error and hassle free operation and can also reduce pollution. The Power grids can also focus on the power quality along with the quantity of supply. This will result in long term outcomes such as better lifestyle,less pollution, reduced cost of power, reduced price of goods and services etc...// All these will be the long term results of the system and can produce quick and anticipated actions. The manual operation needs time to adapt to a change but the automation will help in the better adaptation with the situation.

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