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Promoting use of Solar energy using Smart Meter

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***Abstract*—Energy has become a detrimental factor for survival and progress of anthropology. For the past decade, we have become totally dependent on unlimited and continuous supply of electrical energy. However, the generation of such huge amount of electrical energy is done from nonrenewable sources of energy like coal, oil gas etc. This way of producing electricity involves heavy consumption of non-conventional sources of energy and has given rise to the ominous problem of global warming. Thus, energy conservation has become an important concern all over the world. Switching to the use of renewable sources like solar, wind and hydro energy has become a recent trend. This is the reason why our project, aims to maximise the use of solar energy by analyzing the present system such that it can be beneficial for the economy of our country. The analysing process is done using the smart meter, which captures the readings on an hourly basis.**

Keywords—Smart Meter, big data, ICT

I. INTRODUCTION

The Smart meter is the basic building block of our project. The key functionality of the smart meter is the capture and transfer of data relating to the consumption and events like meter status and power quality. Such capability has also resulted in the generation of large amounts of data and complexity which has resulted in a big data challenge. To make use of such large amounts of data, this big data needs to be analyzed. This process helps in predicting future consumption trends and detecting thefts. Along with this analysis, the customer is given a choice to switch over from nonrenewable to solar, a renewable source by assessing solar irradiance in his area.

Over the last few years, the functionality of smart meters has evolved with the new technology and user requirements. Initially these meters were called Automated Meter reading(AMR) which used one way communication. Then, Advanced Metering Infrastructure(AMI) was introduced which is an upgrade to the existing AMR which enables time based rates and dashboard type user interface for real time usage monitoring [1]. Based on the smart metering process, we identify the key factors which influence metering intelligence. This evolution acted as a foundation for smart metering using big data and analytics.

II. LITERATURE SURVEY REVIEW

The power system is at it's nascent stage. Looking at the current scenario, it is the need of the hour to implement smart-grid which can interact with the organization and the customer i.e to make the system customer oriented. There is a need for different services by differentiating user service model for electricity usage. This model would be based on analysis of a smart metering data trace where they observed that there exists various usage patterns among the customers.So analysis can be done by clustering and by building load profiles [1].It also focuses on classification and regression methods like K-means used to classify the customer on their consumption pattern [3].

A. Existing Systems and their drawbacks

The present system fails to detect electricity thefts.The detection of change in customer behavior is not easy since most customer behaviors are quite irregular and accompanied with a number of random variations.The change in behavior of customer pattern can be due to heating solution change, changed habitation or other equipments. This behaviour change detection can be used in improving load modeling accuracy by considering the recent consumption information after the change that has occurred and can also help to detect energy theft.

The present system also lacks the communication between the grid and the customer. So during power failure, the customer is unaware of the events happening at the grid.

B. New Proposed System

In the proposed system we try to overcome lack of communication by introducing two way communication between customer and the power unit or grid using ICT technology. Increasing the use of solar energy would also help to reduce pollution to some extent, compared to the pollution caused by generating electricity by fossil fuel .

Large quantity of information about how customers use their energy is available through the uptake of smart meters.We can further use this information for prediction and giving suggestions to the customer on how to use energy efficiently. Clustering is a very common method for better understanding of the different residential energy behaviors that exists and has many applications.[4] This could provide us with a number of opportunities for grid to be managed and plan it's demand and supply. Apart from this, it includes the

identification of suitable customer for demand response and the improvement of energy profile model.

Parameters	Present system	New Proposed system
Communication between the customer and the grid	Lack of communication.	2-way communication is established using ICT technology.
Risk analysis and assessment	No.	Cost benefit analysis(CBA) is done for the same.
Energy theft detection	Has not been implemented.	Outlier analysis helps us to achieve that.

Table. 1. Present system v/s New Proposed System

III. Requirements For The Proposed System

A. *Functional Requirements*

1) Consumption pattern at consumer level.
2) Power generation pattern at grid level.
3) Use of any alternative non renewable source of energy.
4) Detection of energy theft.
5) Helps consumers save money by using less energy at peak times.
6) Keeping customers better informed about the status of power grid.
7) Comparing and correcting metering service provider performance.

B. *Non Functional Requirements*

1) Efficiency: The reports and graphs obtained as the output must be accurate.
2) Quality Control: Validating the platform independent format before inserting it into the centralized repository.
3) Recovery: In case of failure, the system should recover in few hours.
4) Security: The details of the users should be kept secured.

C. *Constraints*

1) Complete data set is not available.
2) Not taking weather changes into consideration.

D. *Hardware/Software Requirements*

1) Hardware

- Quad core CPUs or greater that have Hyper-Threading enabled.
- Use High Availability and dual power supplies for the host machine.
- 4-8 GBs of memory per processor core, with 6% overhead for virtualization.
- 2 Gigabit Ethernet interface to provide adequate network bandwidth.

2) Software

- SQL Server 2014
- R programming language
- Microsoft Excel 2016

IV. Proposed Block Diagram and Modular Diagram

The block diagram provides us with the information of the inputs, the outputs, the database in which the values are going to be stored and the different modules which are present in the system. The inputs which will be provided are the customer's id, name, area and region at which the smart meter is installed, it's reading and the time at which the reading is taken.

The database stores values such as monthly consumption of the customer, the predicted value, the savings which can be incurred, monthly consumption and rate of investment for the customer.

The different modules present in our system are

- Customer Profile
- Analysis
- Prediction
- Graphs

The outputs which are going to be produced will be the predicted output which will result in the form of clustered data and consumption forecasting. Data can then be visualized with the help of graphs for various factors such as monthly consumption, savings and the error percentage per month.

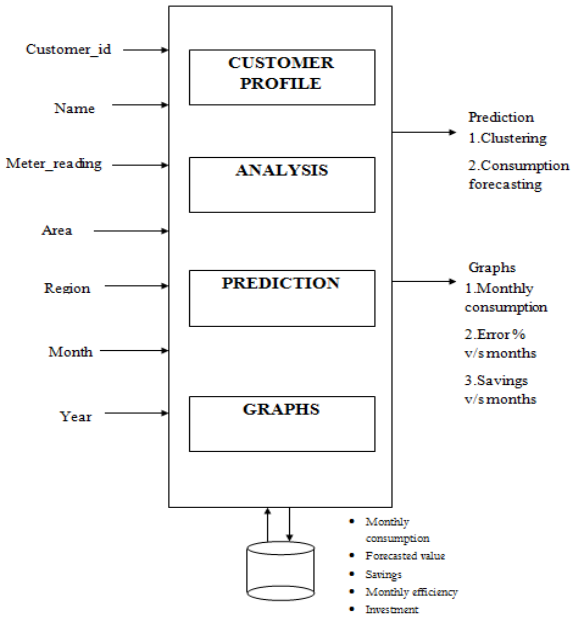

Fig. 1. Block Diagram

The modular diagram gives in-depth information about the flow of our system. The first module is Customer Profile which provides us with the information of customer. We have customer details, wherein the data is collected. Then classification is done based on area, consumption and price. By having time and customer details as input, we can analyse the pattern of consumption and the output will be feeded to the graphs module. We will find the peak consumption i.e time at which consumption was higher than the average value and graphs will be produced for the same. With the investment, comes risk. Risk analysis will be done which will help in the assessment of risk and if it occurs, will be known to the customer through ICT.

The second module is Analysis. It includes Energy Management which can provide us with the monthly efficiency. There is Demand Supply Management which takes the monthly demand of a particular area and the current supply and provides us with the graph for it. Forecasting analysis is done by studying the pattern analysis and peak consumption, and accordingly we can forecast the consumption. Similarly, we can analyse the finance required as well. As the units of electricity increase, so does the cost for it. In Outlier Analysis, the meter is analysed for some unusual behaviour. There can be various scenarios for it such as:

1. If the customer is getting very high or very low reading, then there maybe a fault in the meter.
2. If the customer is getting very high reading than expected, then there might be some theft which had been occurred. To issue this problem, the User Monitoring module has been used through which the customer can complain about it through the use of ICT.

ICT takes the primary parameters such as the customer id and meter reading through the use of SMS or Mail. With the help of this technology, the meter reading can be easily sent.

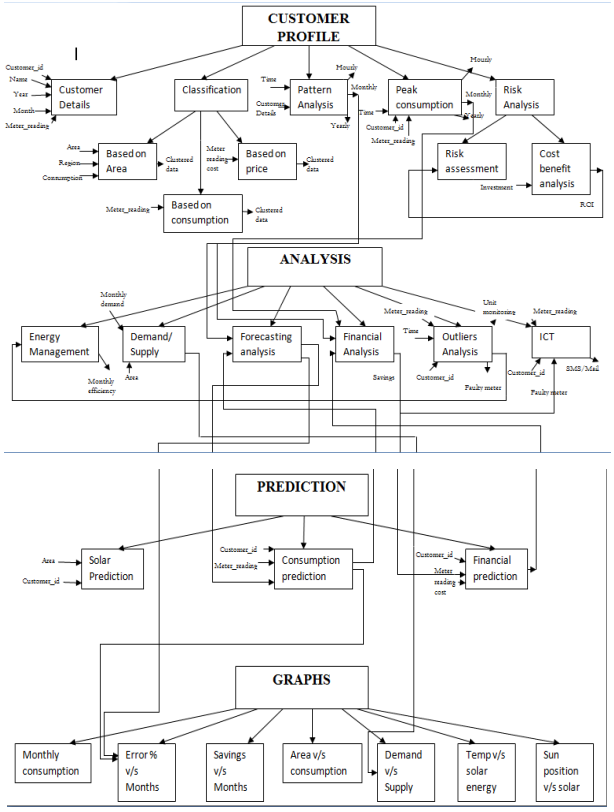

Fig. 2. Modular Diagram

The third module is Prediction. Based on the customer id and a particular area, we can predict the solar consumption. Other two predictions are Consumption and Financial Prediction. This two sub-modules are dependent on the Forecasting and Financial analysis for it's input. The output of the former are then fed into this analysis sub-module. It acts as a bi-directional linkage between the analysis and prediction sub-modules.

The fourth module is Graphs which helps us in achieving Data Visualization. Through these graphs, we are able to visualize how consumption of energy is different for different months, the savings incurred, how different areas has different consumption patterns, the temperature of the sun and how it affects the solar energy as well as the Demand Supply management.

V. Result and Evaluation

Following is the scenario from the predicted values, wherein the inputs are taken from the customer database and uses the correlation formula. The unit readings of the particular customer are forecasted for every month.

2011		2011(actua	2012(Actual)
CHAN	WENDY		
1	January	860	651
2	February	600	632
3	March	100	424
4	April	787	702
5	May	902	1000
6	June	813	586
7	July	775	662
8	August	623	697
9	September	567	632
10	October	429	423
11	November	1056	582
12	December	278	350

Fig .3 Customer Reading

The actual unit readings of two successive years for a particular user are given as shown above.Using the values from year 2011, the values for year 2013 are predicted and are shown below.

January	604
February	598
March	591
April	584
May	577
June	570
July	563
August	556
September	549
October	542
November	536
December	529

Fig 4. Predicted Value.

The forecasted and the actual unit readings are plotted on a graph and the linear regression can be found out. The graph is plotted taking the number of months on the y-scale and the unit readings for each month on the x-scale.

Fig 5. Customer Reading and Analysis.

VI. CONCLUSION

As we have seen, the current system does not provide us with an interactive frontend. The smart meter will help to monitor the behaviour of the user consumption Thus, the user will be more aware and better informed about his usage . It will also provide a medium through which the user can contribute in the fight against energy crisis, by encouraging him to use an alternative source of energy i.e solar energy at individual level.

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