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A Survey on Existing Energy Management Schemes and a Theoretical Approach on Smart Energy Management

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***Abstract*: -- As energy scarcity is the major issue, energy management is the solution. In this modern society consumer needs power round-the-clock to fulfil that introduction of renewables along with grid power was the solution. Utilization of renewables are to be well established to make it more efficient and smarter. Overview of different methods of energy management schemes is briefed here. A theoretical approach for the betterment of the utilization of renewables along with grid power is the main objective of the paper. This approach will make the system self-reliant and self-learning. This will reduce the human work.**

***Index Terms:*In-house energy management scheme (IHEMS), Differential pricing, Distributed generation (DG), Home energy management system (HEMS), IOT (Internet of things).**

I. INTRODUCTION

Energy scarcity is the major issue in almost all the energy consumption sectors right from fuel to electric power. As it's difficult or virtually impossible right now to fulfil the current energy demand. So an alternate solution when we cannot generate required power would be to, utilize the available power in a smarter way which is known as energy management. The idea of energy management has its application right from an individual house to the Grid itself. This paper covers most of the existing management schemes available for wide range of sectors to utilize energy in an efficient way. It is known fact that load curve is not smooth it has peak periods during which generation has to be boosted up to meet the demand. Peak clipping, peak shifting, valley filling and peak reduction are a few of the techniques for effective load management. EMS will help in smoothened operation of equipment in generation and transmission sector by reducing the peak loads on the central grid. The initial idea of energy management was to have different tariff rates at different time periods of the day. This will help in encouraging the consumers to utilize power in other than peak hours. This method is known as dynamic pricing [4]. The best method to achieve effective load management under the present scenario of market progress is to use renewable sources at consumer end i.e. distributed generation by which we can have peak reduction on grid to smoothen the operation of grid. This is needed as the consumers need electricity round the clock, because the modern life runs smoothly with electric gadgets only. Introduction of renewable sources in generation side reduces carbon footprint. EMS benefits consumer with round-the-clock power utilization along with tariff reduction. EMS brings advantage to both generation sector and the consumer community. Today such a beneficial EMS requires new strategies for management and operation of electric grid to maintain its quality and reliability. The most commonly used renewable energy is photovoltaic system on rooftops. It can be in an individual home or a commercial building or an apartment. They are different to each other based on the way of utilization of power. Installation of solar panel on a single residential building is well established, but still there can be improvisations made to make this work more efficiently. Utilization of distributed generation (DG) in residential buildings have to be improved a lot for its efficacy.

This paper focuses on following sections.

II. OVERVIEW OF OTHER METHODS FOR ENERGY MANAGEMENT.

When dynamic pricing [4] was initially introduced it was based on the time period of the day. We have a traditional method to balance the peak and off-peak loads by utilizing the power at off peak period, which is decided by grid, one of the example is to supply three phase power for irrigation to rural areas during night and having single phase supplied during the entire day. If we consider social life there are few loads which cannot be turned off during peak periods, example base loads. This created a ciaos in society. So an idea of differentiating loads came to picture. Loads were differentiated as primary load, modular and deferrable load [4]. Differential pricing was implemented is china from year 2004-2009. This reduced the use of electricity roughly around 100 TWh, with this the emission of carbon dioxide was also reduced in large amounts roughly around 82 million tons [5].

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III. OVERVIEW OF EXISTING SOLUTION FOR ENERGY MANAGEMENT IN RESIDENTIAL SECTOR

Energy management can be done effectively on demand side by educating consumer about energy scarcity and enlightening them with new technologies for effective energy utilization. EMS at the residential sector i.e. Home EMS (HEMS) [1] broadcasts the idea of why small scale consumers should abstain from exploitation of grid power. An effective scheme proposed under HEMS [1] encourages the use of renewable energy in individuals instead of relying mostly on grid at all point of time. This modification will smoothen the burden on the generation process.

Harvesting solar energy and synchronizing with grid power could be done in two different methods

i. Photovoltaic system installed on rooftop along with batteries to store. These will not have any interaction with grid. And could be independently switched with grid supply based on load and demand.

ii. Photovoltaic system installed on rooftop with or without batteries and having provision of supplying surplus energy back to the grid after its required consumption.

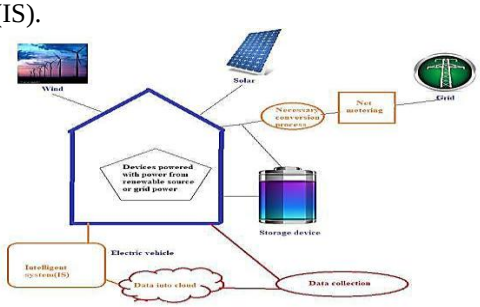
In case (i) the consumer can use the renewable source or the power from grid as per his convenience. While in case (ii) net metering comes into picture whenever consumer is having shortage of power from either battery or panel he can take power from grid or else he can also give power to other consumers via grid when excess power is available. Either of these methodologies can be easily implemented on any single residential home. In urban areas like Bengaluru, most of the areas are filled with apartments. It will be a challenging task to install DG for all needful units. So improvisations and algorithms for effective distribution of power is needed. In a single residential building to maintain round-the-clock power there need to have interaction between renewable energy stored battery (if available) and the grid via controller. One of these is explained in [1]. In this the load is divided into controllable, semi controllable and uncontrollable devices based on user convenience. This paper concentrates on the smooth operation of grid. Even after distributed generation is implemented as consumer is connected to grid based on variable weather condition or user comforts according to different time periods may have to take power in variable amounts. This will again give an unplanned load burden on to the grid. To avoid this there are proposals for adding big data into EMS example integration of IOT into DG [2]. So if we have IOT integrated to DG we can have the data collected at the grid control centre and control generation accordingly. The disadvantage in this method is that the data is collected on real time basis. So unpredicted load is known at the point of requirement. So it's necessary to know the requirement early. This could be achieved by analysing historical consumption data. Right now it's the task of operator to see the earlier data and carry out the required modifications accordingly. As the world is getting automated we are going to propose a method for automation of DG in this paper.

IV. OVERVIEW OF EXISTING SOLUTION FOR COMMERCIAL BUILDINGS

Urban areas are filled with apartments so if we are planning for DG it's quite easy to generate power but it will be difficult to use it efficiently. The utilization of power over large volume of residential apartment needs a detailed analysis. There can be house with single person to house with multiple people so we need to develop an algorithm to distribute power to house. Equal distribution of power would not help in this case. An algorithm is needed to efficiently distribute the data and to rate the tariff. Method of resource allocation and pricing. Here loads were divided and tariff was planned [3]. To make the allocation more efficient and smoother IOT was introduced into loop [2].

V. THEORETICAL SOLUTION

Using IOT we are collecting data and uploading the same for the reference of the operator at grid. As every sector of the world is into automation, machine learning etc. it's time to implement the same in power sector. The data collected will not only be stored in cloud and utilized by the operator to modify the grid operation, it would be far better if we can have the grid learn from pervious data and keep the grid ready for any contingency situation that might arise. So as shown in the model we have a commercial building or residential building which is operated with systematic sharing of renewable power and grid power. It is been continuously monitored and data is been collected, this data is fed into memory of intelligent system (IS).



Schematic of in-house EM

When there is contingency situation the necessary action to be taken also is fed into IS. So in future if there is any situation arising the system will react accordingly and take the necessary action. This will reduce the human work. Human will be tired of performing repeated job, while machine will not be. If there is a situation which the IS cannot understand or solve it, it should be programmed to alarm, so that the operator can take the necessary actions. We are still working on the actual implementation of the scenario, once that is done real time implementation and their results will be published.

VI. CONCLUSION AND FUTURE SCOPE

The utilization of mentioned methodology will improve the efficiency of power utilization and makes the grid smarter. As renewables are utilized this will also reduce the emissions and keeps environment clean and green. This method will benefit both the consumer and the generation sector. This was a theoretical approach, a proper implementation has to be done to see its actual benefits to the society.

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