

A REVIEW PAPER ON ENERGY MANAGEMENT THROUGH SMART GRIDS

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The several existing generating stations, systems involved in transmission and also, distribution systems are not able to be in pace with the ongoing rise in the demand of consumers because of the expeditious development in economy. The rise in demand has led to the establishment of several new power generation units having huge capacity features has an adverse and severe effect on the environment. Thus, the need of proper management for longer use and reliability is an imperative. By introducing smart grids, crisis like supply, usage, distribution, storage and utilization of energy can be solved. Efficiency and reliability of the power systems will also be increased.

The smart grids facilitate the bi-directional communication between supplier and consumer that enable and integrate the various actions of users. The smart grid helps to control, gather information and communicates in order to save energy. The smart energy management has the ability to store and process the consumption of power data of various equipments in a smart way.

Keywords- Energy- management, smart grid.

INTRODUCTION:

A supervisory control unit for the proper optimization of power resources is needed in the world of renewable energy is required. The smart grids are way far important for reliability and sustainability of the power systems. The control units generate the set point for all the sources and storages so that power dispatch can be economically optimized and it fulfills the load demands. In smart energy management technique, generators supply certain loads in such a manner that is efficient and economic. The optimization of power dispatch and the energy availability are defined by the usage of high-speed online algorithms in the forecast of power demand and the power generation during the planning in the smart grids. In an EMS i.e. energy management system, the operators use advanced computer aided devices in order to control the system, monitoring via smart hold and the optimization of performance module is also done by it automatically without any manual requirement. The smart technology being used by the utility operators is SCADA/EMS or EMS/SCADA in the smart grids. The energy consumption is optimized smartly in smart grids and it makes the system reliable by solving the issues of disturbances. The long transmission network has been in use with the ongoing technological development and the emissions of carbon dioxide are also under control in smart energy management. Thus, as a whole smart energy management via smart grid is an important aspect of modernization for sustainable activities related to development and has an technological importance also.

ENERGY SAVING:

For the process of energy saving in the system, energy management is a well known technique by which monitoring, controlling, analyzing and conservation of energy can be done. The list of methods which are involved in the energy saving process:

1. By metering the consumption of energy and then, collecting the data from it.
2. By finding the ways in which the energy can be saved for longer use and then, estimating the amount of energy which can be saved for better use.
3. By taking various actions which can tackle the opportunities of saving energy.
4. Certain meters are kept in performance in order to check the measures which are implemented in saving energy.
5. The term energy management has been referred to specific aspects of energy saving measures which are taken for better use of energy and equipments but this definition limits its behavioral aspect. However, the usage of cheap equipments should also be considered in the saving of energy in the power systems.

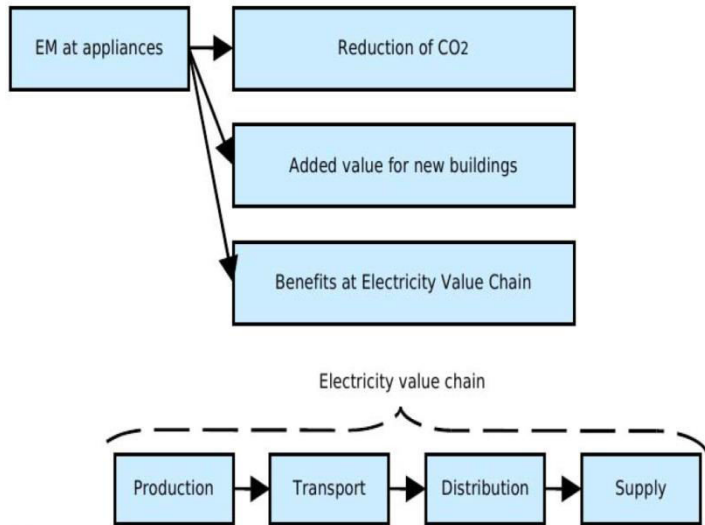
ANALYSIS OF ENERGY MANAGEMENT:

The increasing demand of the energy and its usage leads to the emission of carbon dioxide into the surroundings which leaves a long lasting impact on the environment and hence, becomes the reason of global warming. Therefore, energy efficiency is the vital concern for sustainability and reliability of development. Because of the emergence of the new technologies, smart services are provided to the consumers and hence, they are investing more capital in the production sectors. It becomes an important issue to solve the energy demand by implementing new techniques and strategies which will work in accordance with the efficient energy consumption and thus, energy can be managed efficiently.

The energy management analysis has various goals which are described as:

1. To understand the energy management's benefits from environment through the usage of connected house-hold appliances, thus analysis should take stand by energy consumption in view.
2. To quantify the reduction in CO₂ emission enabled by a better consumption and load management.
3. To do a cost analysis in house energy management.

Figure1.shows the energy management analysis,



ENERGY MANAGEMENT THROUGH SMART GRIDS:

The energy management system ensures that there must be the effective energy efficiency in the system and this means that the use of energy should be wise. But, this condition is difficult to achieve as there are various consumers that use energy and it becomes a necessity to improve this circumstance. With proper control and monitoring the consumption of energy, an effective management for the flow of energy is established. Multiple production centers, several consumers and devices interact there in the smart grids and thus, the system operates and functions properly. In smart grids, the sources of energy are optimized and stability of the system is achieved.

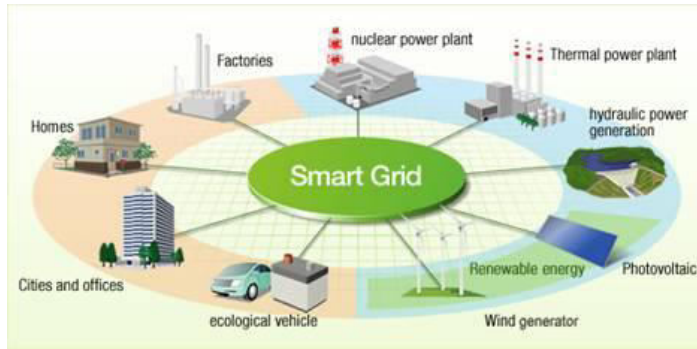


Fig2 Smart Grid

Methods used can be stated below:

1. By the use of smart meters
2. By the use of smart substations
3. By smart distribution
4. By using high-speed communication network

SMART METERS:

The smart meters used in the smart grids are capable to realize the real-time voltage measurements and also about the communication which is in between controllers of the network and consumers. The measurement, observation, analysis and report of actual network status can be done by using the metering technologies in smart grids. The voltage issues like over and under voltage in the network when occurs, various signals are given to the devices which are placed in the system in order to compensate this issue i.e. On Load Tap Changing device is kept to resolve this problem. As a result of this, a coordinated voltage control measure is performed with ease and flexibility which gives power of high quality to users. The power sensors which are used in smart grids are considerably of greater number than used in the power grids. The real smartness of the smart grids comes from the high speed data sensing technology via wireless network system of communication. This feature of smart grids makes them really smart and efficient. Also, real-time control voltage information can be provided to power suppliers and consumers end. However, the information related to voltage can all be gathered and given to the master control in short duration and usage of Automatic Voltage Control Technique with wireless data communication for coordinating the OLTC has been considered as a new approach for better voltage control systems.

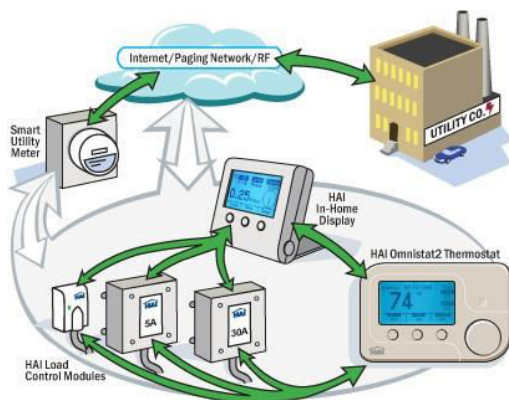


Fig 3 Smart Meters

SMART SUBSTATIONS

The sub branches of substations are almost present in every zone or region at a certain distance from the main station. Several factors like security related to the transformers, performance and status of power and also about circuit breakers are controlled by them and also, they monitor the performance factor of power in the system. The routes of power supply can be split up by substations and voltage transformation is also done at multiple stations by them. Heavy equipments like transformers, relays, circuit breakers, capacitor banks and switches are required in the substations and quite large number of workers and distributed generators are there in the system. The generation of energy is done by distributed generators and heavy power equipments and devices from renewable sources.

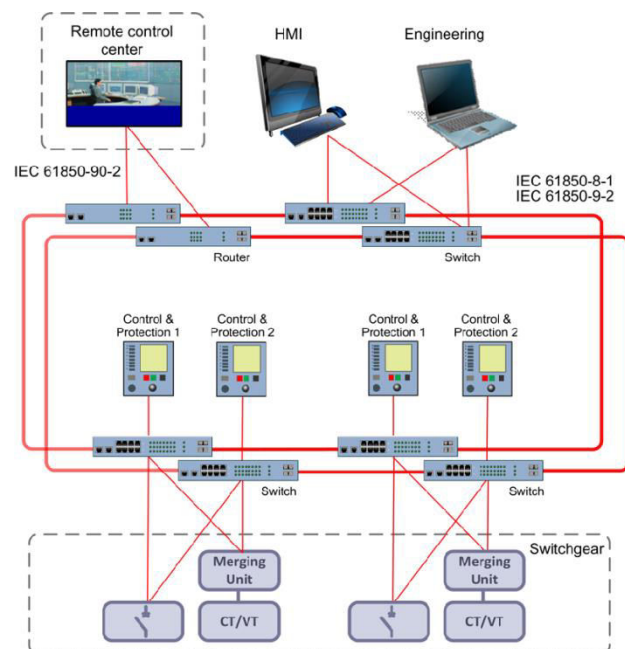


Fig 4 Smart Substation

SMART STATIONS

The design of the smart stations is in such a way that it covers a large area of the smart city under its influence. The systematic and quick approach of the smart stations towards various conflicting issues makes it more attractive in an anticipated way. The traditional-transport hub lags behind by this new ongoing demand for smart stations and they also tend to fulfill and satisfy their users with power quality demands. The agenda of long-distance transport with this innovated idea which is greatly suited to the local specificities adds a bonus value in the smart cities. With the promotion of smart stations, a city can be able to draw various benefits with peak rise from its position. A sense of well being with the immediate surroundings can be achieved by adopting the new ideas and customers can be also to harness maximum power with less interruptions.

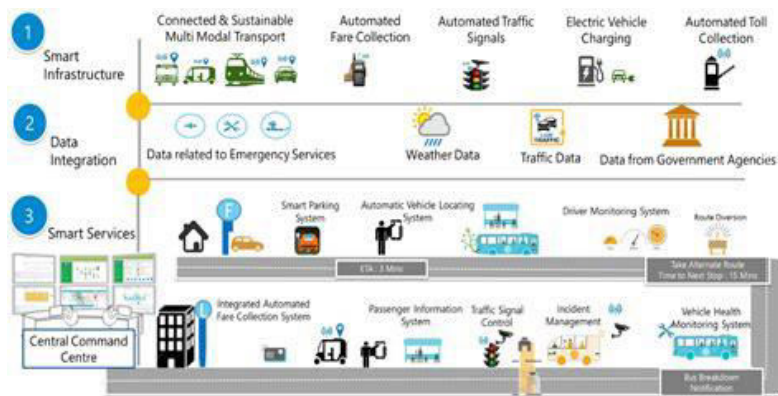


Fig 5 Smart Station

SMART DISTRIBUTION SYSTEM

In order to deliver power from the power stations and grids to the consumer ends, the formation of distributive systems becomes an important factor. Therefore, distributive systems are designed. The smart distribution systems can be considered as those which are able to distribute power by smart methods. Storms, hurricanes and several weather events participate in the interrupting distribution of supply which in turn disturbs the reliable operation of distribution as efficiency and reliability are the basic measures of distribution systems. In order to prevent these situations, smart distribution systems have been established which solve the problems of reliability up to a certain extent. The new technology is involved in the introduction of smart distribution systems which follows the merging of devices in an intelligent format which controls and monitors the system. Device like remote control switches have been deployed because of the emergence of smart grids and its management. The transformation to smart grids has been accelerated by the feature like bidirectional communication taking place in the system. The systems are monitored to operate properly through the gathered information via intelligent devices used in the smart grids. The various applications of smart grids including the location of fault and outage management in an advanced way, isolation and service restoration are developed and integrated into systems which are smart distribution systems.

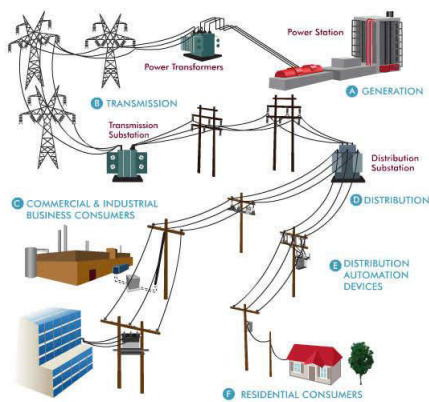


Fig 6 Smart Distribution System

HIGH SPEED COMMUNICATION NETWORK

The high communication of the networks comprised of network premises which are discussed below:

Premises Network:

These networks help in gathering information from various appliances which are used by customers and helps in using the power in a more smart ways. The following ways are given below:

1. Home-Area Network (HAN):

The home area network is deployed where individuals are living. The use of HANs in a system is very essential as it can perform functions which can help them saving more power for further use. The heater cycling, turning off of an air conditioner and also, control of charging or discharging can be done by employing HAN. The use of HAN also gives an additional benefit of HEMS which is a home energy management system and it enables the users to check their usage of power and the amount of power left with them at any instant.

2. Building-Area Network (BAN):

The BAN can be defined as an extension of HAN where multiple HANs which are employed in a building in order to provide information regarding the utility of power. This gathered information helps and is responsible in monitoring the smart devices and also, controls them and it is basically placed at the power feeder end of building smart meter.

3. Industrial-Area Network (IAN):

The industrial area network is deployed on the floors of industries and factories. The incorporation of controlling sensors in industries and building software which is specialized for management takes place by using IAN technique. Various factors affecting the industries like economy and surrounding performances and optimization of energy are all handled and managed by this network method.

4. Neighbor-Area Network (NAN):

This type of network covers an area of square kilometers which depends on the new grid technology and communication system and protocols. This is the important component of premises network as it connects different companies and number of devices connected at consumers end and also, responsible for the transportation of huge amount of data and information

5. Field-Area Network (FAN):

This connects smart devices in the transmission and distributions power grids and various substations. Various factors like breaker controllers, voltage regulators, capacitor banks and transformers which are smart fall under this category of devices.

6. Wide-Area Network (WAN):

This network collects information from several NANs which with they are connected and gives this data to the private networks of the utility company.

Thus, above mentioned techniques sums up to the smart methods of power flow.

COMPARISON IN ENERGY MANAGEMENT THROUGH TRADITIONAL GRIDS AND SMART GRIDS AND ITS BENEFITS

Energy management through smart grid has many advantages as the losses while generation and distribution of energy get detected and compensated for the efficient output. The energy management in smart grids has many merits and the need to shift from traditional grids to smart grid management is the reliability and sustainability of energy. The reduction in losses, decentralized generation of power, using optimized power, exploring storage methods, storage of heat cool, deciding where to do load shedding and enabling time of day metering with remote monitoring has led the management onto certain level.

The generation of energy in traditional grids is with basic infrastructure i.e. a central location is set up for generating all the power. But power transmission in smart grids is from numerous power plants and various stations in order to aid in load balance, decreasing the peak time-strains, and also, power outages are limited. Thus, the monitoring of energy is done using digital technology and is beneficial in many aspects.

Table (A) showing the comparison of grids:

Traditional Grid	Smart Grid
1.One way limited communication	1.Bidirectional communication
2.One way power flow	2.Bidirectional power flow
3.No electric vehicles	3.Electric vehicles
4.Limited grid accessibility	4.Extended grid accessibility
5.Little to no consumer choice	5.Many consumer choice
6.Few sensors and analog control	6.Pervasive monitoring and digital control
7.Centralised generation	7.Loads follow generation
8.Limited usage transparency	8.Self monitoring and high visibility

The installation cost of the smart grids and its management is expensive but it is compensated by the power supply.

Energy management via Smart Grid has certain benefits-

There are numerous benefits we get from smart grids and various elements including reduce cost, enhancement in the reliability, the quality of power gets improved, very less losses and overall improved electricity supply service with low interruptions. As a whole, energy management in smart grids provide quality graded power, services related to electricity with reliability and boost the environment in to a better place to live in.

The list of benefits by using smart grids is given below:

1. Allowance is given to the consumers directly who have opted for the use of smart energy management. The direct communication with consumer makes them aware of the new ideas which are employed for electricity supply and they are provided with the choice to modify the ways by which they use power and several incentives are also provided to them.
2. Accomodation of all the generation and emporium options are provided by smart grids.

3. With the establishment of smart grids, several new products with better services and market values are being offered. This also enables its consumers to bid for the competing utilities.
4. As far modernization and digitalization are involving, smart grids provide reliable power quality services which are interruption free and have the tendency to withstand short disturbances.
5. The assets are optimized greatly in the smart energy management and operational efficiency is up to the mark.
6. Smart grids have the tendency to detect fault very quickly and their mitigate response to fault makes them more worthy of opting over traditional grids.

CONCLUSION:

The world is growing faster in terms of technology as well as population and the demand of energy is also increasing because of more consumers. Also, it is also imperative to use the resources with awareness as resources are depleting with their continuous use. By implementing the use of smart grid, many issues would get resolved as proper management will be there with less losses and in order to meet transmission requirement levels and distribution requirement levels, whole network needs to get improved. Various new technologies and optimal solutions are being employed in the power systems with on-going researches. The wastage of energy and reduction in losses can be made possible by using smart grid technology and also, it controls global warming issue up to some extent. This method is the better and developed version of traditional energy supply system which is in use from past years. Thus, this technology needs to be implemented in wider range and new ideas should be developed in order to make the best use of resources in every way possible.

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