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# Smart Grid on Issues and Challenges

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***Abstract*:-Smart grids ensure the energy conservation and cost effective energy management that encourage the clean energy environment. . The transformation of power grid involves implementation of contemporary measuring equipment's and communication technologies for effective energy data transfer and management. The smart grids do have their benefits but they also come with bottlenecks pertaining to the areas of SM (Smart Meters), information and communication technology (ICT) and in unification of RES (Renewable Energy Source). This paper provides a survey of challenges related to these bottlenecks. It also throws light on the advancement in communication technology which is helpful to induce reliability and efficacy in the smart grids (SG). A complete overview of the same including its limitations in the current scenario is also provided. The survey on the advanced communication technologies, security on the utility and consumers smart grid devices, turns the smart grid as the better solution for the future energy demand.***

***Key Words: Smart meter, renewable energy sources, information and communication technology (ICT), Smart grids (SG), Advanced Metering Infrastructure (AMI), Demand management.***

## I. INTRODUCTION

The introduction of smart methods helps in transferring data from the customary grid to the advanced SG consistently and efficiently. The SG technology benefits both the utilities and a consumer by the connection of smart equipment's that helps in electrical data transfer with the suitable data exchange network. SG is resourceful grid, combining ICT to the present-day electrical network. Electricity providers and end users exchange live data regarding the usage of energy in both directions and is a high tech electrical network to enhance energy efficacy. The application of energy supervision and controlling techniques reduces the peak demand and satisfies the consumer needs. SG gained its importance because of consistent power that is supplied with the highlighted features of real time pricing for demand side management [1].

Global environment climate challenges due to the coal and nuclear power hazards motivated the world to turn their view to the renewable energy integration into the existing grid. Increased use of fossil fuel and nuclear energy has a direct impact on the global climatic changes. This has prompted the nations to alter to RES. Though the smart grids have benefits such as bidirectional communication, computing technologies, amplified the results to meet the demands, still there are barriers in communication technologies, RES storage devices and in the unification of replenishing energy reserves.

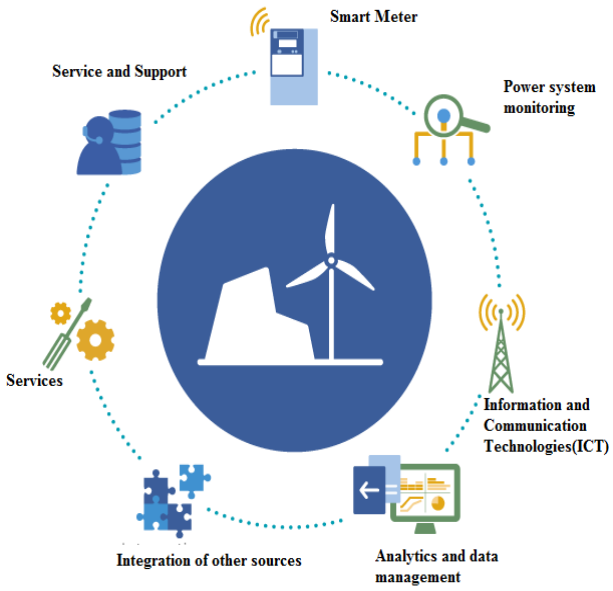


**Fig 1: Smart grid components**

Smart grid involves the components such as SM, communication systems, sensors and devices that facilitate the measurement of electricity consumption and accumulates the data as shown in Fig 1. The data is analysed using the software tools which is communicated with the communication technologies between the utility and the consumers. The existing communication technologies are ZigBee, WLAN, cellular communication, WiMAX, Power Line Communication (PLC) benefits the enhanced smart grid operation and synchronization with the other equipment's connected with it [2].The smart grid gaining its importance because of efficient control over the energy consumption and real time operation commands for the control with the advanced communication technologies. The techniques and equipment used for cyber protection must be cost effective and should not interrupt the other smart grid components [2].

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Since the smart grids are interconnected with the renewable sources for demand management affected with the cyber-attacks due to the improper control over the voltage.

The issue is caused due to the cyber-attackers that can reduce the performance with control on information exchanged and by delayed time [3]. Smart grid future enhancement is influenced by the accessibility of consistent measured data used for monitoring and controlling the grids. The controlling of the grid depends on the fast communication technologies that transfer the data efficiently and securely. In additional emergency response the smart grids also provide protection which is unavailable in the convention power grid operations [1] [4]. SM serves a pivotal role in the SG to accumulate the energy utilization data that perform the operations with the control commands provided by the control stations using the measured electrical parameters and communication networks available [1].

The secure, energy effectual and economic power supply to the consumers and proper control over the RES by the utility are linked with the SG. The proper utilization of the communication technologies and analysing the challenges and solutions are surveyed in this work.

The paper involves the following sections as

1. Issues and challenges related to the smart metering
2. Issues and challenges with the integration of RES in smart grid
3. Advancement in Communication technologies that upgrade the security of smart grid.
4. Conclusion

## II. ISSUES AND CHALLENGES RELATED TO THE SMART METERING

The conventional energy meter that is used in existing centralized grid communicates the consumer in a one way. The information about the energy consumption is delivered to the customer periodically. The demerits of the conventional energy meter or updates on the energy consumption cannot be known. If any issues with the equipment are used by the consumers it may cause power factor issues that may lead to penalty and it is uneconomical since regular updates are not available. Similarly the utility grid also cannot get information from the consumers due to lack of facility in implementing sensors, computing and communication to monitor the data. To overcome the demerits of the conventional energy meter the SM are introduced. The SM is advanced meter that provide the information to the consumer about their consumption of energy with other additional information based on their utility value [1].

The SM plays both the role of monitoring and control. SM collects the amount of energy utilized from all consumption areas on continuous updating to utility that helps to forecast the load demand [4]. SM also includes other functionalities such as consumers can have a better visibility in their power usage, energy savings possibility with some online application provided to the consumers for tracking the instant energy consumption. Accurate information is provided as per the standards and greener energy inspiration is offered by the SM since it investigates the demand and supply concerns through communication networks. It also provides option for the effective initiation of replenish able energy sources and energy storage devices. On variation with the peak demand energy consumption tariff is set by the companies, power quality and power conditioning is offered by the SM [1].

Though the usage of smart metre is gaining its importance because of its features of real time control and monitoring over the smart grid architecture, it has a major risk on power theft. It is uneconomical to the consumers and utilities due to the financial losses. But SM became mandatory part of the smart grid nowadays because of its accurate information and secure data transfer to the Advanced Metering Infrastructure (AMI) [1] [5].SM are vulnerable to security risks. The data transferred may be easily hacked because the mobile communication networks are used for the transfer of energy consumption data. In AMI along the with the smart meter addition devices can be added to make the system suitable for upgrading and monitoring but due to the lack of infrastructure to coincide with the existing technologies also intervenes in implementation of the SM [6].

With the exception to the utility and consumers there is chance of transferred data exposure data exposed to the illegal consumers to identify the population of the particular locality. SM along with the communication technologies have an option of communicating with other SM. This cause issue when consumers are not interested in authentication of their energy information by neighbourhood. Smart grid are connected with the different operating conditions and protocols through the internet make the smart grid system exposure to the cyber-attacks that cause the serious issues like damage and failure of the smart grid subsystem [7].

SM are deficient with the basic operating security functions which lead to the decrease in efficiency of the system and quality of the software used for monitoring the SM is vulnerable to security risks[1][7]. Cyber-attacks are classified into different classes as availability, integrity, confidentiality and Authenticity. Among this classification of attacks Dos and ARP are the two basic security attacks made on the SM. The SM should have basic packet filtering capacity and high speed network to avoid the DoS attack [7].

## III. ISSUES AND CHALLENGES WITH THE INTEGRATION OF RES IN SMART GRID

RES connected with the SG has beneficiaries such as peak demand management that improves the consistency and efficacy of the SG. The system becomes efficient and reliable when there is decrease in the quality of power and voltage regulation issues. But in SG applications it faces challenges in the security, safety and reliability. The issues can be solved with the quality subsystem and communication technologies [1].

Its functional consistency combined with the renewable energy requires accurate energy management and control. The estimating and monitoring the data concerning the energy consumption, demand and fault in the grid system enable the utility to evaluate and react to the situations. To be cost effective to the consumers and to improve the reliability, a digital technology can provide flexibility that integrates variable power generation.

Integration of various types of ES causes congestion in the network lack of dispatch stability. Therefore it leads to the failure of the system since it is unable to cater to the demands in perspective of load. The penetration of the system level must be predicted to avoid the voltage stability issues. The communication technologies and control systems are insufficient to find the location of the source of the RES and their penetration level. Hence intelligent data analysing technics facilitates the suitable location of the renewable sources [4].

The smart grid involves the different sizes of RES from the different types of consumers. The utilization of the energy from the different consumers is priced with the different price that follows the standards and regulation of the utility. The pricing of the end user power depends on their type of power generation and energy price tariff can be estimated by the utility in association with the analysing the values of lost load [1].The drilling aspect of this renewable energy leads the power system stability issues. The control devices used in grid system for rectifying the stability issues requires the storage devices for employing the stability. In SG, the storage systems are gaining its importance to maintain the power quality and continue power supply at emergency conditions. The consistency of the power system is improved by regulation of grid frequency and controlling the renewable energy penetration level at the utility [9].

Home area network (HAN) in the SG integrate the RES and home appliances through the SM. NAN communicates and gathers information from the HANs .The NAN collected data are transmitted to the Substations and Utility data centres with the Wide area network (WAN) that serves as a communication network. The renewable energy generations into the smart grid include the large number of SM and sensors along with the communication technologies for bidirectional communication form the AMI [2]. With the renewable energy generating consumers at home can be communicated with the utility with the information of demand side management, load scheduling, real time price evaluating and advanced software up gradation with the AMI. This information transfer regarding the energy consumed and real time pricing is communicated between the utility and the consumers in periodic or bulk. The risk occurs in the secure data transfer. So the algorithms and protocols development should be satisfy the consumer privacy [1].

The efficient smart grid integrated renewable energy needs an advanced level of information, communication, automation and participation. The benefits of the smart grid system are in addition to the electrical network data it includes the climatological and environmental information that improve the customer service and economic benefit .Smart grid technologies incorporates the measurement data and communication information from the generation, transmission and distribution sections which is unpredictable [1][10].

Due to complexity in power grids and the need of instant power balance leads to incorporation of the analysed data into the power grid as essential. On integrating the challenges such as complexity in data security and computation becomes threatening [1] [4]. When large information is handled it leads to loss of information and the optimal performance is affected. Hence, it provides the path to design suitable protocols for the smart grid wireless communication. The optimization WiMAX module becomes essential for WiMAX communication because the severe packet loss in information occurs due to the of radio controller interface. Zigbee network technologies are used in the HANs but have effect with the Wifi which are used in the residential areas since they both work on the ISM band [2]. The advancement in communication technologies are need for the SG integrated renewable sources.

Due to the global warming exhausting of fossil fuel the transportation turned their full view towards the electric vehicles. The regenerative braking used in the traction application can inject the saved energy when braking applied in to the power grid or energy storage devices that can be utilized for energising the railway equipment's. In the SG, energy storage combination with the RES will offer the welfare of grid frequency regulation, reliability and power quality improvement [11].

## IV. ADVANCEMENT IN COMMUNICATION TECHNOLOGIES THAT UPGRADE THE SECURITY OF SMART GRID & RESULTS

IoT in the smart grid find its applications in both the utility and consumer side .This overcome the gap to provide services that will support the growth of intellectual solution for public. In the utility side IoT is used in power plant monitoring, Transmission line monitoring and renewable energy monitoring [12].

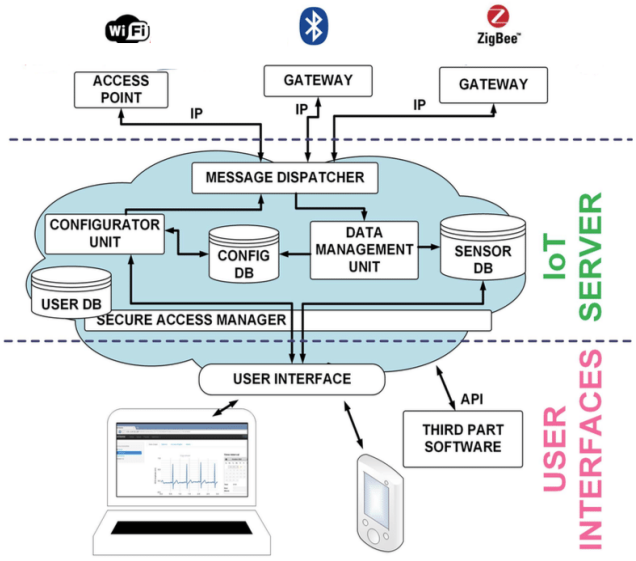


**Fig 2: IoT in smart grid**

From the consumer side it is used in predicting the renewable energy requirements and energy management. Smart grids are becoming more elegant to cyber attackers because the screening and scrutinizing in IoT is carried out with the public network connection as shown in Fig 2. As the demand increases more number of energy resources, SM and communicating devices are connected into the IoT network.

Due to the insecure protocols and encryption IoT devices are most exposed to the cyber-attacks. Since, IoT devices have a disadvantage with the storage space, so the reduction of handling the cryptography algorithms is minimized when it handle the more data [13]. These IoT devices depend on the batteries for operating and they don't have power connection hence there is a chance of occurring the power failure occurs. The IoT device manufactured with the large batteries is problematic and not suitable for because the life time of the batteries are less and difficult to transfer to other locations.

Evolution of smaller size of batteries with high capacity is the solution. Though the wireless communication technologies have low implementation cost and scalability, spectral inadequacy issues reducing the efficiency of the entire system .To overcome this now communication network high spectral density is preferable [13].Cloud computing involves lesser implementation cost and operating cost , quick access with the available network and device. These aspects plus its low maintenance, makes it easy for the service providers to continue their support. Cloud computing comprise the cloud storage, computing, security that succeed in fault recovery a flexibility in operation with different energy sources. In the smart grid applications cloud computing provide the high level of optimization, improves the resilience of the power system and encourages the integration of renewable energy [14] [15].

Cloud computing permits consumers for sharing the computing resources in a public or private cloud called as multi-tenancy that leads to the security issues on integration of multiple energy sources. The computing software evolved for the cloud computing in smart grid should be restricted from security risks [14]. Because of the security issue the consumers mislay their privacy and safety in public cloud. Confidentiality in data is the important issues in implementing the cloud computing for the SG. The energy consumption data and utilization of the appliance at home are the individual data that should be stored and managed. With regard to the confidentiality of the cloud, the consideration should be given to the data transfer and its consistency. The data at cloud computing kept at various locations that are maintained and controlled by that individual business society [16].

Concluding, the contribution of Cloud Computing to the IoT, and its speed are considered to be remarkable that serve the SG in terms of resource management and expediting reaction [14][16]. The effectiveness of the SM, their progressive sensors facilitate voluminous data handling from various sources at any given point of time. Despite this fact, in the absence of the information of the software database, the operation of various information employed make it complex for practical usage [1].

As a predictably, most of the data generated in the SG are highly secured and intimate only to consumers and utility and it is difficult for researchers to analyse the practical issues related to SG security [7]. To overcome all this issues the 5G technology is emerging with the high speed communication structure that can reduce the risk of the hackers. The latency issue that occurs in electric vehicle connected to smart grid are reduced and responds to the commands quickly that will avoid the time delay which avoids the risk of information packet loss and hacking activities. This improves the reliability due to the wide bandwidth and efficient date transfer rate provides the opportunity for reducing the challenging and issues occurring due to the information exchanging methodologies in the SG. It also has ability to analyse the information at faster rate and facilitates the faster demand response [10].

## V. CONCLUSION

The essential considerations for the conventional power grid to turn it into the smart grid were discussed in the work. Later the significance of the study is to overview the challenges and concerns in the smart grid technologies. Initially the issues regarding the smart metering and communication technologies that source the technical challenges related with the SM were discussed. The issues related to the SM installation that performs the demand management and challenges due to integration of RES with the SM and its data transfer issues are reviewed. Then the issues related to the RES incorporation with the SG that causes the power quality issues are discussed. Usually the wireless communication is used for transferring the data to the utility and consumer prefers the low cost cellular communication that faces serious risk with the hackers. The issues related to the information security with the communication technologies like HAN, WAN, LAN, WiMax are discussed. On literature survey proper optimization application with the efficient techniques and communication networks adoptable to various conditions leads to the secured and reliable smart grid system. The disputes in view of non-technical aspects and regulatory policies were not discussed in the in the survey. The proper planning and operation of the SG supports the nation with the economic benefits and reduced green- house effects.

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