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Solution for Sustainable Clean Energy: Smart Grid

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ABSTRACT: In recent years, electricity consumption will comprise an increasing share of global energy demand. During the next two decadesincreasing prices of fossil fuels and concerns about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of alternative energy resources. In particular, the Fukushima Daiichi accident was a turning point in the call for alternative energy sources. Renewable energy is now considered a more desirable source of fuel than nuclear power due to the absence of risk and disasters. Considering that major component of greenhouse gases is carbon dioxide, there is a global concern about reducing carbon emissions. In this regard, different policies could be applied to reducing carbon emissions, such as enhancing renewable energy deployment and encouraging technological innovations. Two main solutions may be implemented to reduce CO_2 emissions and overcome the problem of climate change: replacing fossil fuels with renewable energy sources as much as possible and enhancing energy efficiency. In this paper, we discuss alternative technologies for enhancing renewable energy deployment and energy use efficiency.

KEYWORDS : Energy resources, renewable energy, Smart Grid , Transmission Losses, Fault Isolation, Smart meters.

I. INTRODUCTION

Over the years there is a substantial growth in the society. The demand of energy is expected to triple by the year 2050. Distribution of power including renewable and sustainable sources of energy is expected to double every three years. Electricity generation accounts for approximately half of the carbon emissions in India. In recent decades, many industries have grown or perished from the advances made in information and communication technology. However, electric utility systems are still largely operated today in much the same way they were in the early 20th century. Central generating stations produce electric power that is transmitted via high-voltage transmission lines to local community substations.

With smart grids, there is scope for CO_2 reductions due to improved energy efficiency, new mechanisms such as demand response management and the integration of more renewables into the grid. The impact depends on deployment and penetration of the smart grid technology in the mass market

The term "Smart Grid" refers to the computerization of the traditional distribution grid. In the recent times, power, communications and information technology need to be transmitted in a cost effective manner. All these increasing demands of the society can be satisfied by the Smart Grid technology.

The electricity grid in Singapore is currently amongst the most reliable and robust in the world with intelligent systems already installed in the generation and transmission network. The grid performance of Singapore's electricity network far exceeds that of other cities and countries. Network losses are reported to be only around 3%.

This grid in Singapore is already smart, but the grid still employs conventional grid technologies. This distribution network can be upgraded to meet the certain requirements like continued growth in demand, improvement in the security of supply and enhancements in the delivery of electricity through better communications with households and businesses.

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II. SMART GRID TECHNOLOGY

Smart grid serves as one of the most suitable alternatives to the conventional sources of energy. It is basically a grid which applies digital processing and communications to the power grid making the energy flow more efficient, reliable and flexible in nature. In a commoner's language smart grid is basically computerization of the conventional grid that is already prevalent from a long time only the technological aspects are improved to enhance the efficiency and make it more cost effective. The functioning of the smart grid can be easily compared to computers. The way computers have input and output devices similarly a smart grid can sense the usage of energy in a more effaceable way.

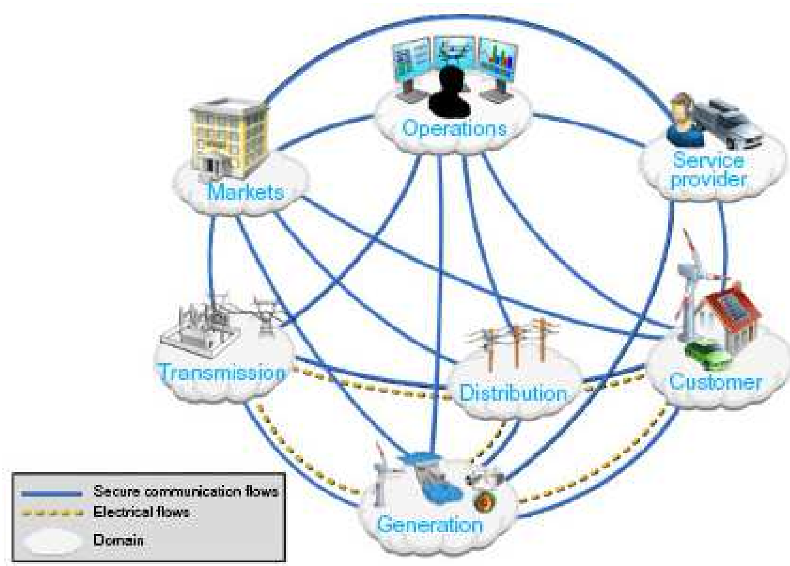

Fig 1: Conceptual model of Smart Grid

Figure 1 shows the vast areas where smart grid could evolutionize various sectors. Sensors in various locations on the grid collect information on grid operating conditions and transmit that information to utility computers. These computers can automatically make changes to grid equipment settings without human intervention, continuously and/or instantaneously if needed. In many cases these changes can proactively address issues before they create problems for customers. Information can also be stored for future use, analysis, and decision making by people, whereas in traditional grids to obtain data from a distribution grid is quite a clumsy and time-consuming task. There are mainly two key components of smart grid which can be implemented more or less independently or better if implemented together. The components are as follows-

Smart Meters

Smart Meters are digital electric meters that take the place of traditional mechanical meters. Traditional mechanical meters use magnets to measure the electric current flowing through the wires leading into a customer's home; Whereas smart meters also stores information and receives and responds to commands and status inquiries from the utility. Smart Meters are much more accurate than mechanical meters, can detect tampering, and can alert the utility when they lose power.

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Distribution Automation

Distribution Automation involves the section of the Smart Grid between the Smart Meter and the local community substation. Although some parts of many utilities' traditional grids have been automated to a limited degree for some time, Distribution Automation is a much more intensive and focused effort to computerize and/or automate grid operations. Distribution Automation capabilities are largely imperceptible by customers, but research indicates their aggregated benefits are potentially significant.

The main essence of this grid is that the energy is not only sent into our homes or workstations but extra energy can also be given back to the grid so that it can be circulated and used much more efficiently. Another point which makes the use of smart grid even more fascinating is that it is much more user friendly because of the technology present which makes it simpler and organized in nature.

III. ECONOMICALANDTECHNICAL ASPECTS

One concern is the cost of telecommunications to fully support smart grids may be prohibitive. A less expensive communication mechanism is proposed, using a form of "dynamic demand management" where devices shave peaks by shifting their loads in reaction to grid frequency. Grid frequency could be used to communicate load information without the need of an additional telecommunication network, but it would not support economic bargaining or quantification of contributions.

Direct and indirect benefits

Direct benefits are those that could affect customers' bills, whereas the indirect benefit calculations represent our attempt to translate reliability and environmental performance improvements from Smart Grid capabilities into economic terms.

Challenges to Implement Smart Grid

Switching to smart grid from conventional grid is not an easy task. Though energy consumption growth is high, generation is failing to meet demand rate. A global statistics on energy consumption is given below:

Challenges required to meet the implementation of smart grid can be divided into two different types; security challenges and integration challenges:-

Security Challenges:-

- Network security of distributed systems across meters, substations and in-home devices including authentication, detection, and monitoring.
- Identity & access management for managing customer information.
- Messaging and application security communications including data, network communications, and transactions.
- Security policy management and implementing web services security standards.

Integration Challenges:-

- Web service enablement of legacy apps.
- Format bridging, transformation and routing.
- Handling wide variety of non-XML data formats.
- Interfacing with partners and customers.

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Costs by Smart Grid Component

The average Smart Grid cost per customer, based on budget information from U.S. utilities' applications for the U.S. Department of Energy's Smart Grid Investment Grant (SGIG) program funds, is presented in Table by component.

. *Table1: Average cost per customer by Smart Grid component*

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Smart Grid Component	Sample Size	Average Cost per Customer
Smart Meter	24 projects	$291.54
Distribution Automation	12 projects	$63.64

IV. APPLICATIONANDEXPECTEDIMPACT

The culmination of attention by utilities, regulators, and society for smart grid systems to address operational and electrical efficiencies, improving system reliability, and reducing ecological
Impacts, has resulted in a significant number of discussions around the requirements and capabilities of a smart grid.

Revenue Assurance and Generation

Figure 2 helps understand the ecosystem of the smart grid. Smart meters help utilities reduce what they call "unaccounted-for losses." "Lost" Electricity is electricity generated and distributed, but not billed, to customers. With the use of smart meters, the electricity providers can compute the required consumption of electricity in the grid and can feed the grid according to it. In remote areas the smart grid system can calculate the feasibility of using various sources of electricity generation at different times of the day and supply the excessive electricity produced to nearby remote areas/facilities. Also, these individual self-sustainable energy units can cut the cost of bringing transmission lines from the cities to the remotely accessible areas.

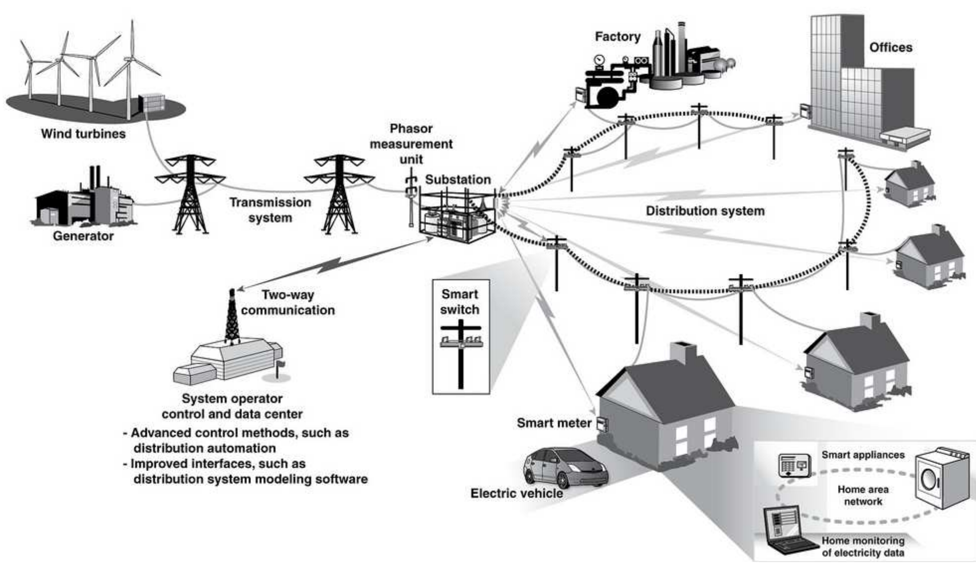

Fig 2: Smart Grid Ecosystem

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Reliability and Fault Isolation

Many utilities are turning to Smart Grid applications to provide improvements to reliability metrics. Two typical architectures are shown below. The first shows a station-based automation system with smart devices installed in the substation and in distribution circuit recloses, or switches for underground systems. Faults are detected between switches and are isolated under control of the automation system. Unfaulty sections of the feeder are restored from alternate sources depending on available sources and their capacity to carry the additional load.

Environmental Benefits & Renewable Energy Integration

The degree to which the traditional distribution grid can integrate renewable generation without harm to reliable efficiency is finite. Smart Meter and Distribution Automation capabilities can help manage the challenges faces, thereby increasing the amount of renewable generation that can be reliably and efficiently integrated. Various Renewable sources of energy like solar, thermal, hydal , and biogas which are available for limited time period only can be utilized to maximum extent and will cut down the carbon footprints of the conventional energy resources and also our dependency on them as a source of energy .

Rise of New Power Plants

With the use and implication of smart meters and Grid management tools the various renewable sources of energy will combine together to form a strong and effective unit especially in the remote areas which can help in the overall development of the area in both financial and social way

V. CONCLUSION

At present level the integration of renewable sources of energy as main source of energy to power our conventional grid is not feasible as their uptime and efficiency is not adequate to meet the current energy demands. Smart Grid offers a favorable benefit-to-cost ratio when considering both direct and indirect economic benefits. Smart Grid has proven significant reductions in environmental impact too, including both measurable and non-measurable benefits. Measured environmental impact reductions of almost 600 pounds of carbon dioxide equivalent emissions per customer per year are available in the Ideal Case from the conservation impact offered by Smart Grid. Therefore by implementing solutions such as smart grid we can cut our carbon footprints and create a smarter solution for the future world which will not only be reliable but also address the problem of powering remote areas.

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