Hypothesis & Design of Energy Efficient 'Green' Intelligent Grid Technology

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***Abstract*: A 'Grid' is a networks that carry electricity from power plants to consumers. The grid is made 'smart' or 'intelligent' as it can monitor and control the distribution system. Intelligent Grid is an automated and broadly distributed energy delivery network. It is characterized by bidirectional flow of electricity and information. Intelligent Grid network integrate elctrical distribution system with information and communication network. Enormous capabilities result from the highly integrated use of digital technology with electrical power grids. Intelligent grid technology ensures reliable, improved and advanced energy distribution system with enormous features. Integration of renewable energy sources can lead to better energy management. This paper focuses on optimization of Energy-efficient Intelligent Grid technology by integrating renewable energy resources.**

Keywords- Energy-efficient Intelligent Grid, Renewable energy resources, Smart meters, AMI, Solar energy, Wind energy

I. INTRODUCTION

An electric power grid is a network that deliver electricity from power plant to customer premises.It is a network of transmission lines, substations and transformers. It allowes one way communication between power plant and customer premises. A grid is made smart by incorporating advanced two way communication, automation, control and pervasive computing capabilities. Enormous capabilities result from the highly integrated use of digital technology with electrical power grids.

It provides efficiency, reliability and safety. It controls intelligent applications at customer premises to save energy, reduce cost and increase reliability, efficiency and tranperancy. Integration of the new grid information flows into utility processes and systems is one of the major issues in the design of smart grids.

Existing power systems acan be considered as one of the major reason for global warming that cause adverse environmental impacts due to fossil fuels. The comparisions between existing grid and smart grid is shown in table-1.

Table 1. Comparison between existing grid and smart grid.

Existing grid	Smart grid
Mostly electromechanical	Digital in nature
One-way communication	Two-way communication
Mostly centralized generation	Distributed generation
Sensors are not widely used	Sensors are widely used
Lack of monitoring; only manual	Digital self-monitoring
Failures and blackouts	Adaptive and intelligent
Lack of control	Robust control technology
Less energy-efficient	Energy-efficient
Usually not possible to integrate RE	Possible to integrate large-scale RE
Customers have less scope to modify uses	Customers can check uses and modify

II. OPTIMIZATION OF GREEN INTELLIGENT GRID INFRASTRUCTURE

Optimization is the process of designing the system in such a way that it can operate as efficiently as possible. Existing power grid demands enormous amount of fossil fuels and contribute significantly in global warming. In contrast to fossil fuels, renewable energy resources like wind and solar offers environment friendly solutions to mitigate the adverse effects of global warming. Renewable energy resources are eco friendly, technologically efficient and pollution free. There is unprecedented attention to renewable energy which provides clean and Energy- efficient Intelligent energy solutions. Most of the current transmission systems are considered as "dumb" and "passive" as they are not capable of intelligent operations.

The existing power power grid network has no potential to offer adequate services with security, reliability, safety, energy efficiency and the integration of renewable energy resources at the scale needed to meet the clean and Energy- efficient Intelligent energy demand for the sustainable future. Therefore the implementation of smart grid technology is an inevitable requirement to reduce emissions of Energy- efficient Intelligent house gases. Use of application based resources can provide energy-efficient solutions. Small wind turbines or photo

voltaic arrays can be used at customer premises. High capacity solar and wind turbines can be installed in the electric grid system at the generation side to reduce the carbon emissions. The impact of integration of renewable energy resources with smart grid technology was investigated by national grid, USA. Figure 1 shows the proposed model by national grid, USA.

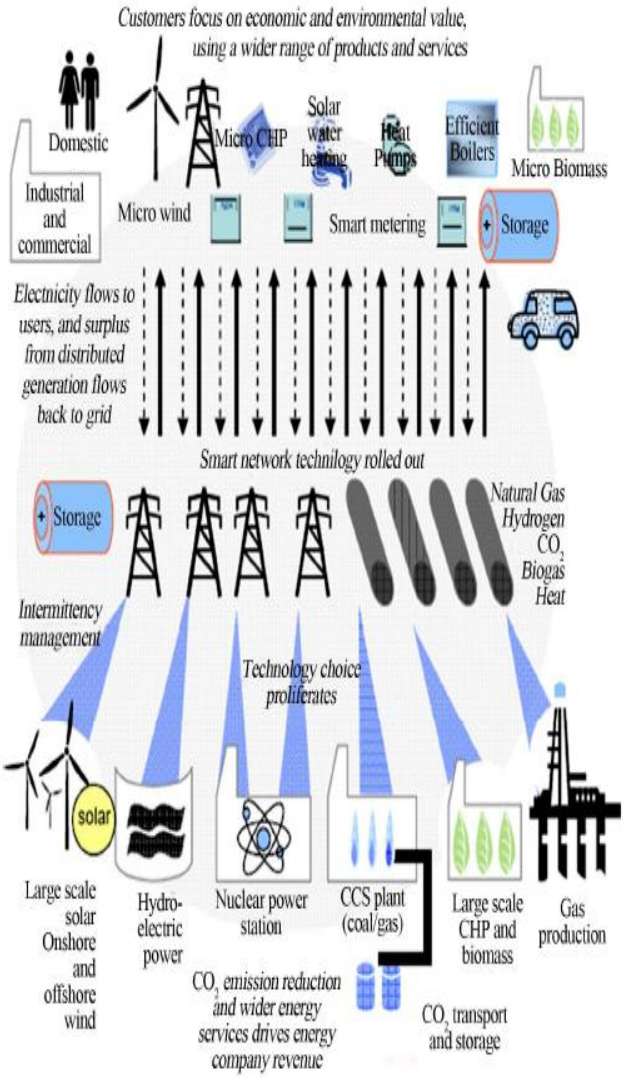

Figure 1. The Smart grid evolution—a proposed model by national grid, USA.

Electrical Power Research Institute's (EPRI's) Intelligrid has undertaken an initiative to develop the technological foundation for a smart power grid that links electricity systems with communication and computer networking technology to achieve tremendous gains in reliability , efficiency and customer services. Figure 2 illustartes the model proposed by Intelligrid.

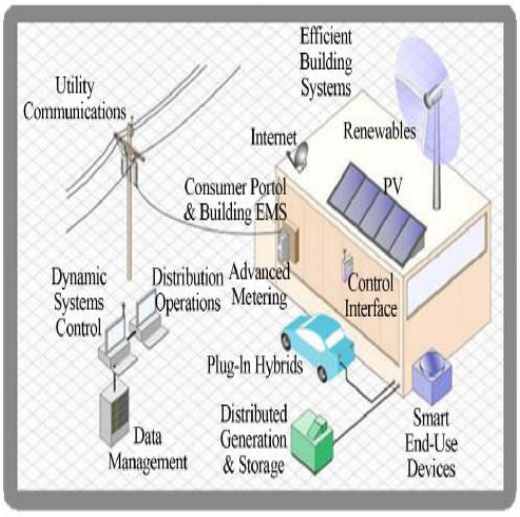

Figure 2. The smart grid evolution—A typical scenario of EPRI's intelligrid model

III. ADVANCED METERING INFRASTRUCTURE

Smart meters are the key contributors in the development of smart grid technology. A smart meter is an electrical meter that records the consumption of electricity in specific timing intervals and communicates that information back to the utility system for monitoring and billing purposes. Smart meters enable bidirectional communication between the meter and the central system.

A smart meter is an advanced meter which identifies power consumption and communicates the collected data to electricity company as well as customers for utility and billing purpose. It requires two way communication system. Advanced metering system requires an efficient ICT infrastructure. Figure-3 shows the AMI system. It will monitor various application like electricity, Consumer equipments and data usage. IEEE has developed more than 100 standards for various applications.

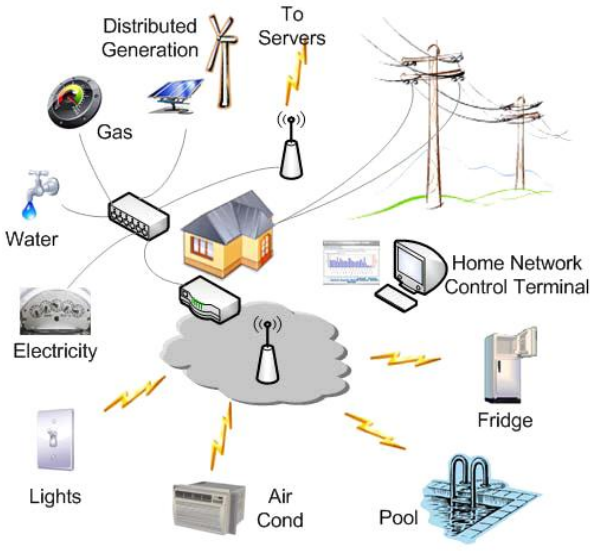

Figure 3. The smart grid evolution—A typical AMI model

IV. PROPOSED MODEL OF ENERGY EFFICIENT GREEN INTELLIGENT GRID SYSTEM

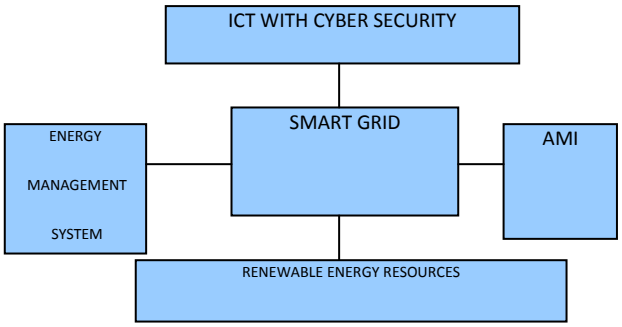

Figure 4. Proposed model of an Energy efficient 'Green' Intelligent grid

The Energy- efficient Intelligent grid can be implemented by integrating following features. It requires the integration of different standards as well as technologies.

- Smart meters
- Dynamic Pricing
- Automated control of appliances
- Real time feedback system
- Scheduling and control of loads
- Interoperability between standards
- Cyber-security

CONCLUSION

Smart grid is a self regulated, automated, energy efficient and intelligent power distribution system. The use of technology must be harmonised with nature. So, Advancement in technology must mitigate the adverse effects of existing technologies in terms of pollutions and energy efficiency. Integration of renewable energy resources with smart grid technology offers a promising features to reduce GHG emissions. Optimization of Energy- efficient Intelligent Smart grid technology is a journey towards nature friendly technology-development. It also demands interoperability between standards. We should focus on challenges in design and implementation of Energy- efficient Intelligent Smart grid technology to make it more efficient and eco friendly.

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