# SMART GRID-ENERGY POLICY, TECHNOLOGY & STANDARDS

Lipi K. Chhaya
Nirma University

## ABSTRACT

A 'Grid' is a network that carry electricity from the power plants to the consumers. The grid includes wires, substations, transformers, switches etc. The grid is made 'smart' as it can monitor and control the distribution system. Smart Grid is an automated and broadly distributed energy delivery network. It is characterized by bidirectional flow of electricity and information. It is a close loop system for monitoring and response. It is deployed from the point of generation to the point of consumption. Smart Grid network integrate elctrical distribution system with information and communication network. Integration of renewable energy sources can lead to better energy management.There are many definitions of smart grid technology based on functional, technological and benefitial viewpoints. A common element in all the definitions is the application of digital signal processing and ICT to the electrical power grid.The aim is to acheive bidirectional data flow and central information management system for the smart grid. Enormous capabilities result from the highly integrated use of digital technology with electrical power grids.Integration of the new grid information flows into utility processes and systems is one of the major issues in the design of smart grids. Smart meters are the key contributors in the development of smart grid technology. Broadband over power line technology is an another application of smart grid technology. Smart grid technology ensures reliable, improved and advanced energy distribution system with enormous features. Use of renewable energy resourses will lead to reduced carbon footprint and emissions. IEEE has developed over 100 standards for different smart grid applications. Government of India has formed a smart grid energy policy in order to achieve reliability and interoperability. The smart grid policy in India is being developed by collaborative grouping of state and central government. An important decision regarding Smart grid energy policy was taken in 2008 with the implementation of Re-Structured Accelerated Power Development and Reforms Program (R-APDRP). This programme may take 3 to 5 years for establishment. This paper focuses on indian national energy policy , issues and standards for smart grid technology.

Key words- Smart Grid, Renewable energy resources, Smart meters, AMI.

## I. INTRODUCTION

An electric 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. It provides efficiency, reliability and safety. It controls intelligent applications at customer premises to save energy, reduce cost and increase reliability, efficiency and tranperancy [1]. 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 [2].

## II. OPTIMIZATION OF SMART GRID INFRASTRUCTURE

**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 |

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 green energy solutions. Most of the current transmission systems are considered as "dumb" and "passive" as they are not capable of intelligent operations [3,4].

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 green energy demand for the sustainable future [5]. Therefore the implementation of smart grid technology is an inevitable requirement to reduce emissions of green 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.

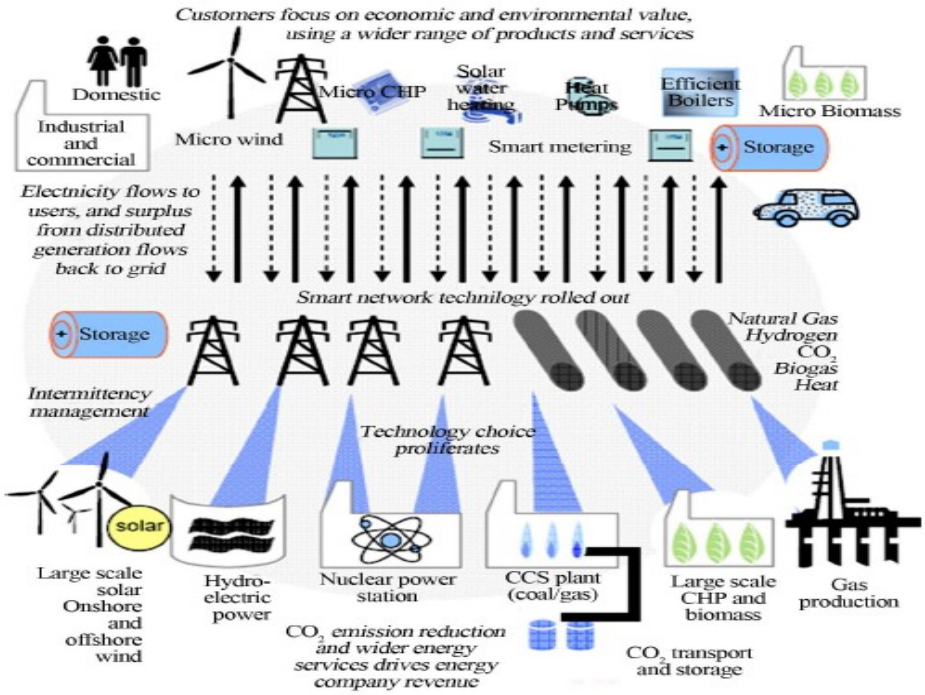


Fig. 1. The smart grid evolution—a proposed model by national grid, USA [6].

Electrical Power Research Insti- tute's (EPRI's) Intelligrid has undertaken an initiative to develop the technological foundation for a smart po- wer grid that links electricity systems with communication and computer networking technology to achieve tremendous gains in reliability , efficiency and customer services [7]. Figure 2 illustartes the model proposed by Intelligrid.

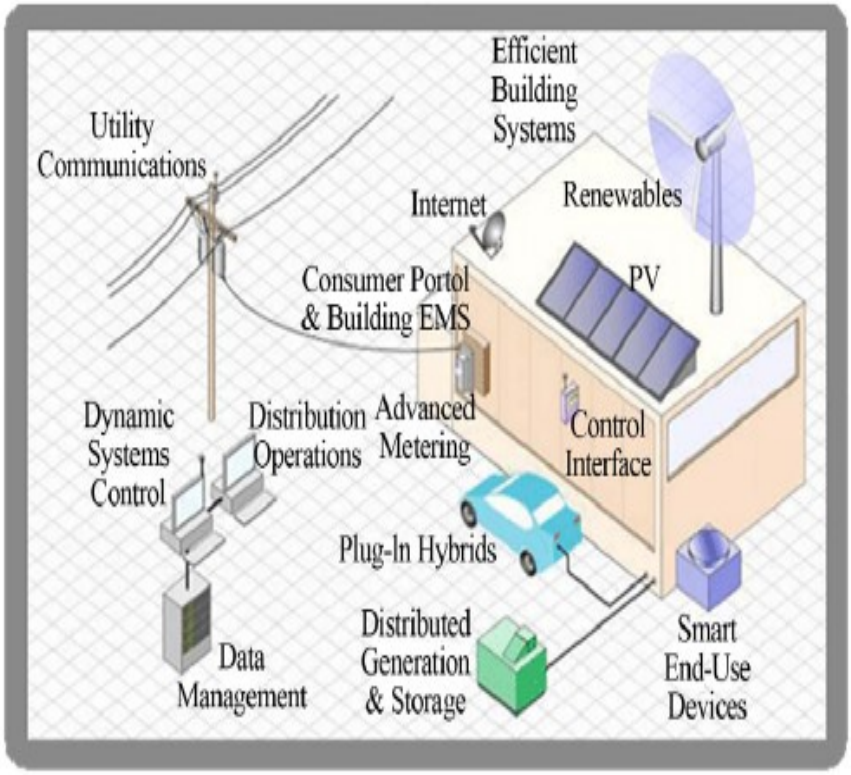


Fig. 2. The smart grid evolution—A typical scenario of EPRI's intelligrid model [7].

The smart grid can be implemented by integrating following features.

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

## III. ADVANCED METERING INFRASTRUCTURE

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 [8].

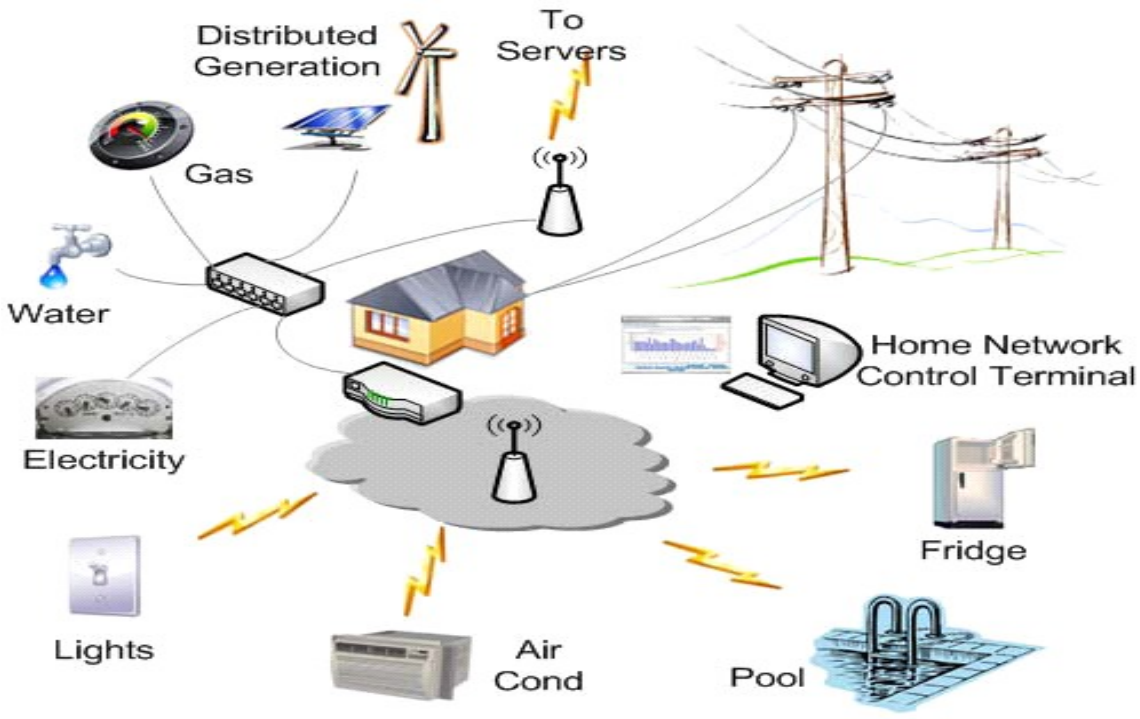


Fig. 3. The smart grid evolution—A typical AMI model [8].

## IV. POLICY

The smart grid policy in India is being developed by collaborative grouping of state and central government. An important decision regarding Smart grid energy policy was taken in 2008 with the implementation of Re-Structured Accelerated Power Development and Reforms Program (R-APDRP). India has planned 15 year plan from 2012 to 2027 for the implementation of smart grid. USA has also declared the mission Grid 2030 and developed the policies for the same.Europe and Australia are also working on this front. Govt. of India (MoP) is the Patron, and retains Chairmanship of ISGF. It isRegistered as a Society under the Indian Societies Act as a not-for profit Organization. ISGF will seek the best practices in the world and help develop a roadmap for development of Smart Grid solutions for Indian needs and conditions. Funding of ISGF will be from membership fees. Different members categories are Associate, Academia, founding, limited etc.

## V. STANDARDS

TABLE II
OVERVIEW OF SMART GRID STANDARDS

| Type/Name of Standards | Details | Application |
|---|---|---|
| **IEC 61970 and IEC 61969** | Providing Common Information Model (CIM): IEC 61970 works in the transmission domain and IEC 61969 works in the distribution domain | Energy management systems |
| **IEC61850** | Flexible, future proofing, open standard, communication between devices in transmission, distribution and substation automation systems | Substation Automation |
| **IEC 60870-6 /TASE.2** | Data exchange between utility control centers, utilities, power pools, regional control centers | Inter-control center communications |
| **IEC 62351 Parts 1-8** | Defining cyber security for the communication protocols | Information Security Systems |
| **IEEE P2030** | A Guide for smart grid inter-operability of energy technology and IT operation with the electric power system (EPS) | Customer-side applications |
| **IEEE P1901** | High speed power line communications | In-home multimedia, utility and smart grid applications |
| **ITU-T G.9955 and G.9956** | ITU-T G.9955 and G.9956 contain the physical layer specification and the data link layer specification | Distribution Automation, AMI |
| **OpenADR** | Dynamic pricing, Demand Response | Price Responsive and Load Control |
| **BACnet** | Scalable system communications at customer side | Building automation |
| **HomePlug** | Powerline technology to connect the smart appliances to HAN | HAN |
| **HomePlug Green PHY** | Specification developed as a low power, cost-optimized power line networking specification standard for smart grid applications | HAN |
| **U-SNAP** | Providing many communication protocols to connect HAN devices to smart meters | HAN |
| **ISA100.11a** | Open standard for wireless systems | Industrial Automation |
| **SAE J2293** | Standard for the electrical energy transfer from electric utility to EVs | Electric Vehicle Supply Equipment |
| **ANSI C12.22** | Data network communications are supported and C12.19 tables are transported | AMI |
| **ANSI C12.18** | Data structures transportation via the infrared optical port han | AMI |
| **ANSI C12.19** | Flexible metering model for common data structures and industry "vocabulary" for meter data communications | AMI |
| **Z-Wave** | Alternative solution to ZigBee that handles the interference with 802.11/b/g | HAN |
| **M-Bus** | European standard and providing the requirements for remotely reading all kinds of utility meters | AMI |
| **PRIME** | Open, global standard for multi-vendor interoperability | AMI |
| **G3-PLC** | Providing interoperability, cyber security, and robustness | AMI |
| **SAE J2836** | Supporting use cases for plug-in electric vehicles communication | Electric Vehicle |
| **SAE J2847** | Supports communication messages between PEVs and grid components | Electric Vehicle |

## VI. 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 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 Green Smart grid technology to make it more efficient and eco friendly.

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