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Importance for Smart Grid in The ICT Perspective

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***Abstract-* A smart grid is a modernized electrical grid that uses analog or digital information and communications technology to gather and act on information - such as information about the behaviours of suppliers and consumers - in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. [2] Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.**

Keywords: -* smart, *grid , efficiency, Electronic, power, such

I. INTRODUCTION

Information and communication system is the fundamental of achieving intelligent management and control in the grid. It builds up two-way information channel between grid and consumer to achieve interaction, such as demand response, real-time price, and home energy management. The automation level of grid is improved by implementing ICT for auto-collecting and analyzing grid information.

By establishing unified and open communication infrastructure and standard system, the 'plug and play' environment could be formed to facilitate the networked communication between elements in grid and the interoperability between sensors, intelligent electronic devices and application systems. Therefore, the robustness and ability of self-healing of grid are strengthened.

Smart Grid is a power system in which the power generation, delivery and consuming are information-driven. ICT plays the core role of information collection, transfer, processing and management in Smart Grid. By means of ICT, two-way communication channel between energy relevant elements and corresponding operation units can be interconnected in Smart Grid. Therefore, it is able to reach every energy relevant element to implement information collection, such as generation capability, consumer demand, each part of power delivery, for sensing comprehensive grid situation. In this case, the reliable, safe and efficient match between power supply and demand can be achieved by intelligent information processing, decision and control implement.

II. Key areas for standardization

As shown in Figure 4, key areas for Smart Grid standards include:

- Technologies for automated energy management and decentralized power generation in customer premises, including home, building, and factories;
- Intelligent grid management at the power transport and distribution level;
- Smart meters and AMI;
- Information and communication infrastructure to provide energy intelligence, control and security;
- Applications and services for the coordination the energy system on the business level;
- Security control and management with the different level of requirements for Smart Grid.

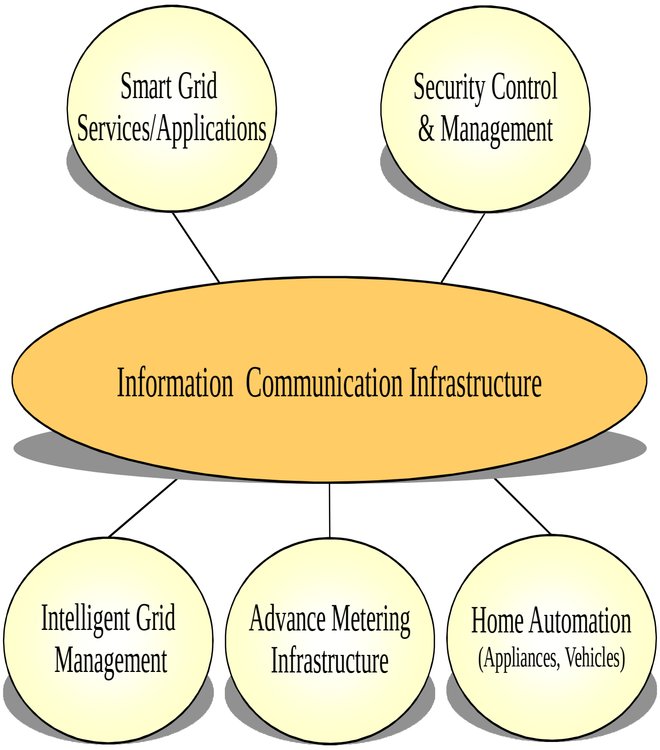

Figure 1. Key areas for standardization in the ICT perspective

III. Key applications and platform in Smart Grid

In this section, we present the key applications in Smart Grid and the platform to support those applications from ICT perspective. As shown in Figure 2, we list the reprehensive applications.

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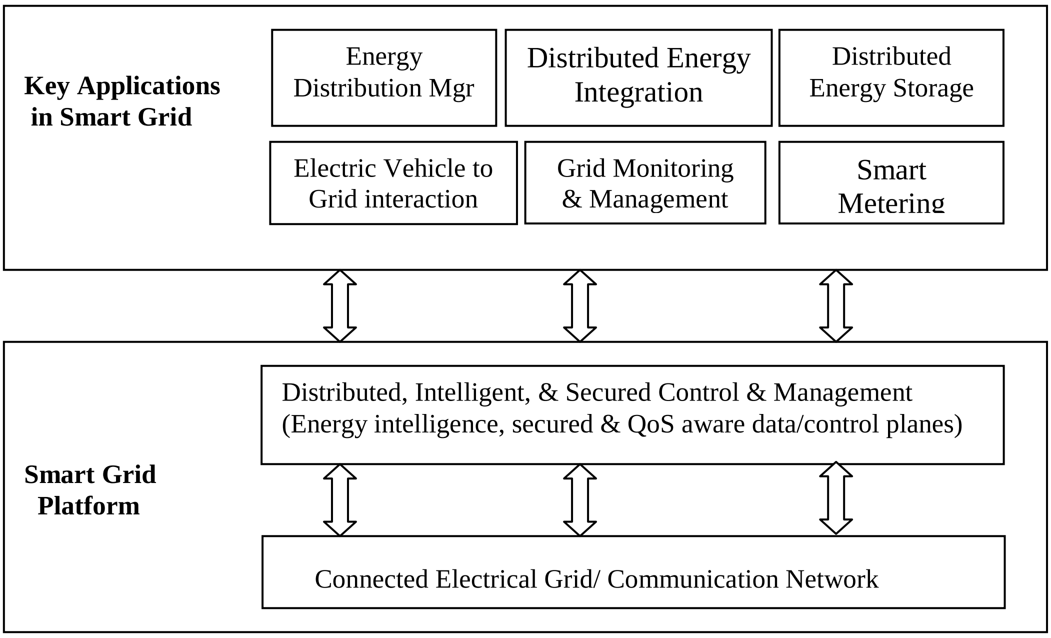

Figure 2. Key Applications and Platform in Smart Grid

- **Energy distribution management**: The goal of this application is to make the energy distribution system more intelligent, reliable, and self-repairing, self-optimizing. This application enables the monitoring and display of grid system components and performance across interconnections and over large geographic areas in near real-time. It includes the deployment of ubiquitous networked sensors, the software system to understand and ultimately optimize the management of grid-network components, behaviour, and performance, as well as to anticipate, prevent, or respond to the problems before disruptions can arise.
- **Distributed renewable energy integration**: The goal of this application is to integrate distributed renewable-energy generation facilities, including the use of renewable resources (i.e., wind, solar, thermal power, and others, as part of total energy sources. This application includes the projection of expected demand, the prediction of alternative generation capacities, and the integration of distributed generation into the distribution grid. Energy generation in a customer and micro-grid environment will require the bidirectional metering, and bidirectional energy distribution networks, which will be supported by Smart Grid.
- **Distributed energy storage**: In order to evenly distribute the demand and consequently lowering the need for peak generation facilities, this application enables new storage capabilities of energy in a distributed fashion, and mechanisms for feeding energy back into the energy distribution system.
- **Electric vehicles to grid interaction**: This application refers, primarily, to enabling large-scale integration of plug-in electric vehicles (PEVs) into the transportation system. The major challenge is the supports of PEV charging and the establishment of charging infrastructure, including the power distribution capacity to prevent overloading of circuits and the charging facility, as well as the information system to manage the energy distribution, and customer interface such as accounting and billing need to be in place.
- **Grid monitoring and management**: This application aims to enable the demand response and consumer energy efficiency. With demand-response, the balance of power supply and demand can be largely balanced. To this end, utilities, business, industrial, and residential customers have the feasibility to cut energy usage during the time of peak demand or when the power reliability is at risk. This application requires the dynamic pricing from the energy markets, the smart meters and real time usage data, the smart appliances, the home area networks and the networks for metering infrastructure, which will be illustrated next.
- **Smart metering infrastructure**: This application enables the AMI and provides customers real-time (or near real-time) pricing of electricity and can help utilities achieve necessary load reductions. It demands the communications hardware and software and associated system and data management software that creates a two-way network between advanced meters and utility business systems to enable the collection and the distribution of information to customers and other parties, such as the competitive retail supplier or the utility itself. Utilities also rely on AMI to implement residential demand response and to serve as the main mechanism for implementing dynamic pricing.

In order to support the above Smart Grid applications discussed above, it is essential to add and integrate computing and communication technologies and services with existing electricity-delivery infrastructure. To this end, the ICT platform is required to provide the bidirectional flows of energy and two-way communication and control capabilities, enabling new functionalities and applications,

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including the smart metering for homes and businesses. Generally speaking, the platform for Smart Grid consists of the following:

- **Connected electrical grid/ communication networks:** Electrical grid needs to be integrated into an advanced, digital communication network infrastructure with two-way capabilities for communicating information, controlling equipment, and distributing energy. The use of a variety of public and private communication networks (wired or wireless) shall be integrated in Smart Grid.
- **Distributed, intelligent, and secured grid control and management:** On the top of connected electrical grid and communication network, the distributed and intelligent grid control and management plays a critical role to enable all key applications discussed above. To be specific, the energy intelligence, secured and QoS aware control and data planes need to be in place to meet the reliability, security, and QoS requirements of applications in Smart Grid. Because the Smart Grid will include networks from the diverse IT, telecommunications, and energy sectors, security shall also be required to ensure that a compromise in one network does not compromise security in other interconnected systems.

IV. Conclusion

To build a future-oriented, smart, secure, efficient power system, ICT plays a critical role. The following examples further illustrate the important of ICT in Smart Grid.

***Example 1*:** To improve the grid's resistance to perturbations, natural disasters and grid flexibility, ICT should be used extensively in Smart Grid for facilities monitoring and protection. For example, the power line and environment condition (current, voltage, frequency, wind-force, etc.) shall be collected in real-time from sensor deployed on the line and around power pylon. The sensing data could be forwarded to the corresponding control unit via the various communication path (wireless: GPRS, 3G, LTE, WiMAX, etc./wired: Optical fiber, etc.).

***Example 2*:** The AMI provides a large-scale information and communication facility for energy management service. With AMI, the precise power consuming data can be collected by the EMS via a gateway (home gateway, meter, etc.) for energy consuming optimization. As such the real-time power price and consumption suggestion could be informed to customer for power consumption behavior adjustment. The unified electronic interface on home appliances and the home network are the preconditions for power relevant applications. Because smart metering involves routine collection of customer power usage data, the communication path can be provided by different information and communication networks and composed of diverse transmission technologies in the perspective of saving cost. The access to smart meter for metering data uploading could be achieved through public broadband access network/ power line communication/ wireless communication. The home appliances could use short-range wireless communication technologies (e.g., Bluetooth, ZigBee, 802.11, and others) or wired connection (power line, cable, telephone line, and others).

***Example 3*:** For the purpose of energy saving and carbon emission reduction, ICT can support low carbon systems (renewable energy generation, distributed generation, energy storage system, electric vehicle, etc.) and their interconnection with grid. ICT is in charge of realization of operation and maintenance relevance functions (consumer management, billing management, exchange of consumer demand information, power on vehicle monitoring, wind power metering, interconnection with grid control, etc.) of these low carbon systems. Using the vehicle-in-grid as an example, the vehicle is connected with grid for power transfer via bi-directional intelligent control device. The controlled-information of electric vehicle (real-time capacity, state of charging, etc.) could be forwarded to the backstage management system. The backstage management system collects and analyses the controlled-information of electric vehicles in its own area and provides them to the grid security monitoring system and SCADA system. Therefore, the backstage management system gives out charging or discharging commands to the bi-directional intelligent control devices according to the scheduling commands from grid SCADA system. The bi-directional intelligent control devices carry out the corresponding operation on electric vehicle.

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