Global Advanced Research Journal of Engineering, Technology and Innovation (ISSN: 2315-5124) Vol. 3(7) pp. 149-153, September, 2014
Available online http://garj.org/garjeti/index.htm

Review

Evaluation of Smart Grids and Turkey

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Accepted 25 September 2014

In the global electricity sector, as the renewable energy sources such as wind and solar are included in the traditional grid system, it is expected to grow, to expand and to diversify. Therefore, the diversity of energy sources will lead to the problem of integration. The exposure to a more limitation for the reliability of power systems and increased security risks in the developed and developing countries increases the dependence on fossil fuels and raises energy costs. Smart Grids (SG) have become the most important mainstay to solve the problems. In this study, the effects of SG development in environmental, economical and energy sectors are discussed. The main obstacles encountered in the transition to SG practices in our country are also highlighted and suggestions to solve these problems are offered. A possible frame for the architecture, design and features of SG is specified taking into account the practical limitations.

Keywords: smart grids, power grids, smart meters, distribution grids.

INTRODUCTION

Economic, social and environmental sustainability represents the most important variables in the energy scenario of the 21th century (Amin SM and Wollenberg, 2005), (Rustemli and Dinçer, 2011), (Garrity, (2008). The greenhouse gas released into the environment is increasing every day because of the energy reliability, increasing energy demand and rising customer expectations (Garrity, (2008), (Sood et al., 2009), (Cirit, 2011). Because of increasing cost and maintenance expenses of generation, transmission and distribution grid of the old traditional grid that has completed its life should be accelerated by restructuring in order to reduce the amount of greenhouse gas emission. Because, the first steps of transition to SG have been taken with the new generation options such as the computer already included locally in the system, communication technologies, modular automation systems and so on (Sood et al., 2009). Smart Grid (SG) technologies have been extremely important in the world to solve the energy crisis. The faults that occur in the system increase the uncertainty. Recently, because of geographical conditions and random system links, many major power plants are established in rural, mountainous and remote areas. In addition, the power system is heading towards instability because of the fact that the industry organizations which demand load increase get involved in the system (Higgins, 2008), (Grid 2030, 2003). In order to avoid the instability, it is important to make power transmission urgently to the existing power systems. SG is a rational option in order to overcome such problems in the 21th century. Because, the future of the technology used for energy generation today is subject to the availability of low-cost fuel (Ipakchi and Albuyeh, 2009), (Turhan and ve ark, 2010), (Turhan and ve ark, 2010), (McGranaghan et al., 2008). There is a lack of organization for the implementation of SG in developing counties. As in other developing countries, SG is newly discovered in our country, too (Vivek, 2008). The

companies, especially from private sector, that have global experience in SG technology contribute to the market of our country for the execution of SG services. Today, thanks to SG, energy saving, emission reduction, green energy application, sustainable development, customer satisfaction, safe and reliable intelligent power systems have become the focus of interest. Still, there is a need for SG in order to facilitate the integration of various sources such as this type of renewable resources, demand response, electricity storage and electric vehicles.

Concept And Effects Of Smart Grid

In modern power systems, power grid consists of various networks and multiple power generation companies with many operators. While SG power system is used with network optimization at various levels such as control, monitoring, analyzing, communication and coordination for the national electricity distribution systems, it, at the same time, may reduce energy consumption. SG is a system that meets the requirements of the 21th century and that includes all the production and storage options. SG provides the efficiency with all network users, particularly renewable energy sources and no or low carbon emissions (McDaniel and McLaughlin, 2009), (Roncero, 2008), (Ateş and ve ark, 2011). SG provides consistent, flexible and highly reliable answers to the demands of digital age that increases the security of supply (Ipakchi and Albuyeh, 2009), (McGranaghan et al., 2008). This provides new products, services and markets to occur in order to optimize the asset utilization and management efficiency. In this way, power distribution integration and high level benefit are provided (EPRI Intelligrid, http://intelligrid.epri.com [Ziyaret Tarihi: 1 Ocak 2013). SG provides electric vehicles, real business values, end to end power distribution control and a more secure infrastructure (http://www.eia.doe.gov/cneaf/electricity [Ziy.T.: 21 Ocak 2013), (http://www.naspi.org [ZiyaretTarihi: 29 Ocak 2013). Nowadays, energy saving and emission reduction, green energy, sustainable development, security, reduction of loss, optimal use of assets constitute reasons of why SG is mostly preferred. There is a need integrate between power, knowledge and workflow in order to achieve different, flexible, clean, safe and economic SG application (Vivek, 2008), (Raghuraman and Sajal Ghosh, 2003). Defining characteristics of SG are summarized in Table 1.

Smart Grıd Studies In The World

Many countries in the world have started the initiatives within the scope of SG studies. In this context, between the years 2000-2005, 2.7 million meters were replaced with smart meters that can be read remotely in Italy with the Teledestore Project. In 2009, 200.000 smart meters, smart thermostats and sensors were placed on the grid in Texas and smart grid has reached approximately 1.000.000 consumers. Hydro One which is the company of public electricity of Canada served 1.3 million consumers by the end of 2010 with the Hydro One remote reading project. In Sacremento, US, 600.000 smart meters were installed both residential and commercial consumers in June 2009. The EU has formed The European Union Smart Grid Technology Platform in 2006. This platform has identified the vision for the grid structure of Europe in the future and the strategy needed to achieve this vision. Smart grid investments made on the basis of countries in the world by the year 2013 are shown in Figure 1.

The reason of why the investments of countries such as France and England are low is because of the fact that energy infrastructures of these countries are much more improved.

"European Technology Platform (ETP) Smart Grids" report which states haw to establish the smart grid that brings Europe's solar energy from South, wave energy from West and wind energy from North is available. Germany has planned to be 12.5% in 2010 and 30% in 2020 with the project "DENA-I and II". The main goal is to use renewable energy to a certain extent instead of the power plants which complete their life. Malta can also been called as the land of smart grid. Because it raised awareness of its society for energy consumption, placed 250.000 meters in the grid and rewarded those customers who consumed less energy. Amsterdam, Netherlands, aims to decrease the cost of energy and greenhouse gas emission using renewable energy resources at a rate of 20% until 2020. According to Indian Ministry of Energy, the country that has the largest transmission and distribution loses (26%, 62% in some regions) in the world is India. When the illegal usage of energy is included, these loses are reported to be 50%. India started SG studies in 2008. Still, new productions and new routes are being formed very quickly in China, in Asia. Therefore, it is one of the countries which need a grid mostly that is smart and available for development. Smart grid studies in China were launched after the MIT (Massachusetts Institute of Technology) forum in 2007. In Russia, Ericson Company, the major manufacturer of telecommunication tools in Sweden, founded the science research center that would work for the solution of problems concerning the development of smart electricity grids in "Skolkovo" invasion city of Russia. Again, as a part of the South Korean government's target of reduction of carbon emission, $ 1.8 billion was envisaged for smart grid investments between the years 2012-2017 (EPRI Intelligrid, http://intelligrid.epri.com [Ziyaret Tarihi: 1 Ocak 2013), (http://www.eia.doe.gov/cneaf/electricity [Ziy.T.: 21 Ocak 2013), (http://www.naspi.org [ZiyaretTarihi: 29 Ocak 2013).

Table 1. Features of smart grid

Network Transformation	Authorized Consumer	Clean Energy Supply
Guidance to crews should be provided when there is a power cut by detecting it immediately	By analyzing customer consumption, special energy products and services should be got according to the needs	The usage of renewable energy production such as wind, solar, geothermal
The prolonging of assets life should be provided by placing the hardware which detects aging in the system.	Making accurate and timely billing to the customers	Less dependence on air pollutant resources such as coal, nuclear, oil and gas
Power cuts should be prevented by detecting the failures originating from hardware	Energy conservation should be ensured by providing necessary tools for consumers to manage energy use proactively	The balance of cost-power should be considered while managing the targets of greenhouse gas emission
The peak load should be decreased ensuring non-essential machinery or equipment to be closed communicating with consumers	Consumers should be helped while switching to the "smart home" that automatically turns on/of the devices in the home in order to reduce energy costs	Power should be claimed at a time when demand for power is low

Table 2. Comparison of existing grid with smart grid

Traditional Network	Smart Grid
Electromechanical devices	Digital devices
Very limited or one-way communication	Two-way (mutual) communication
Limited, non-transparent operation	Watching in monitors and Point Operation
Limited control over the flow of power	Widespread Control System, Transformer, Distribution and Feeder Operation
Reliability concerns-manual maintenance	Automatic self-improvement
Individual work	Enterprise Information Integration
Carbon-based production	Green energy that complies with the carbon limits
Personal initiative (urgent decisions on the phone)	Intelligent Decision Support Systems
Limited price information, static tariff	Full Price Info, Dynamic Tariff, Demand Response
Selecting a few customer	The choice of many customer

Smart Grıd Power Scenarıos In Turkey

The development of energy sector should be accelerated in order to meet the growth expectations in Turkey. In addition to rich coal resources, our country has a high potential in terms of renewable energy such as solar, wind, hydroelectric, geothermal and bioenergetics. The energy necessary to ensure future economic growth in the world depends on the existence of energy obtained from environment friendly sources (Ministry of Non-conventional Energy Sources, http://mnes.nic.in), (Kumar, 2010). The electricity of our country is in the last among the developing countries in the world rankings. Thermal and hydroelectric potentials are still available in may regions of our country. Studies about wind and solar power plants continue rapidly. "Network Connection Criteria of Power Plants Based on Wind Power" published in the Annex-18 of grid regulations is available as the regulation about the integration of renewable energy sources in our country to our energy system (Elektrik Piyasası Şebeke Yönetmeliği “Ek-18). In addition to the fact that every country has its own studies and reports about renewable energy integration towards solar energy, that Turkey takes place in the Germany-based project, known as DESERTEC, which emerged with the slogan "The energy consumed by human beings in 1 year can be produced by deserts in 6 hours" can be considered within the scope of these studies (Red Paper “An overview of the Desertec Concept”, Desertec Foundation, Berlin), (Çetinkaya, 2009).

A great wind potential is available in the west of Turkey and it is used. However, because research on solar and especially wind potential in the east of our country hasn't been done, such renewable energy resources are not benefited except for a few individual attempts. The most rational way of establishing a better system and infrastructure in the energy sector in our country is the transition into SG. In our country, the main reasons of

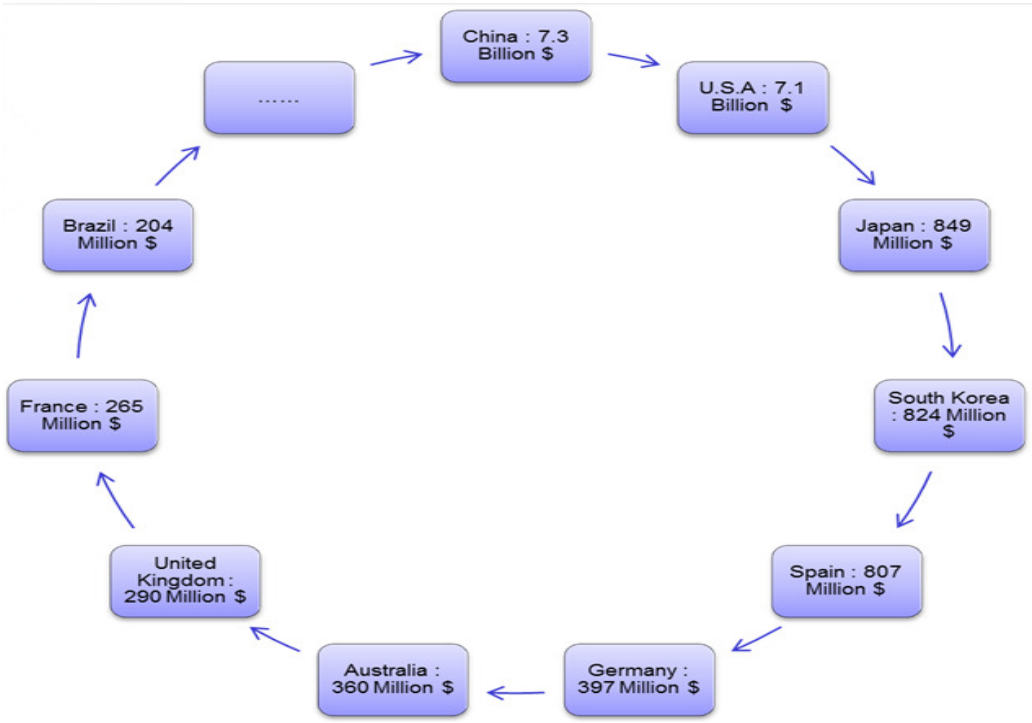

Figure 1. Investments made for smart grid in the world by 2013.

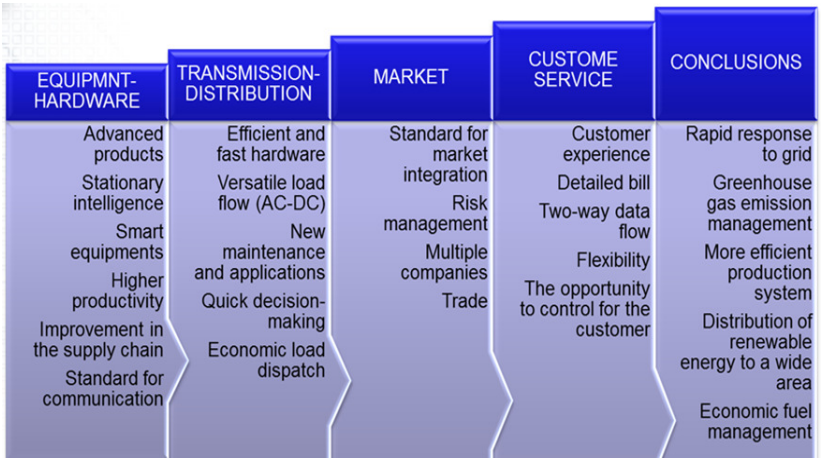

Figure 2. Inputs and outputs of smart grid.

why the traditional network infrastructure is insufficient are shown in Figure 2.

CONCLUSIONS

- As the technological development or capacity increase is performed with SG in energy sector in the developing countries like Turkey, system stability and contribution to reliability are expected.
- In the transition for SG, Turkey has a great advantage in terms labor force with cheap and efficient human resources.
- It is expected to make savings by using advanced AC Transmission-Distribution System devices, communication and information technologies, fine-tuning and smart meters and by determining transmission-distribution losses and illegal consumptions.
- The instability and reliability problem of Turkey power system can be overcome with keeping communication

and coordination at a high level and developing analysis.

• It is known that it will be easier to reach the target of increasing the reliability of energy sector, the quality of supply and energy efficiency with Smart Grid technology, in addition to the fact that it is consumer-friendly and reduces line losses.

• Because every country has different network structure, detailed system analysis should be made in the integration of SG and renewable energy resources. Because, as the network structure of the United States, China or any developed country will not resemble the network structure of our country, system integration will not be provided with the logic of plug and play. For this reason, it is necessary to design the detailed system analysis specific for each micro grid system that make up SG regionally and then nationally.

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