

Turkish Power System: From Conventional Past to Smart Future

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Abstract-- Smart grids are becoming an important issue in the future power system network configurations. Main goal of smart grid is to intelligently integrate the behavior and actions of all users connected to it. There are many researches dealing with the implementation of a self-healed, reliable, sustainable, economic, safe and highly efficient power system network. Many new challenges try to solve the problems that face to transform the conventional grid into a smart grid because of renewable energy integration, communication errors and smart meter disturbance.

One of the basic priorities of Turkish Power System is the supply security. Therefore, competitive deregulated market has been restructuring to improve supply security. The generation and distribution parts of Turkish Power System have already been partly privatized. At this initial phase of future smart grid, Distributed generations are being extended as well as installation of remote control and monitoring facilities. In addition, regulatory issues regarding the smart grid are being organized. This paper is focused on the evolution of conventional Turkish Electric Power System, as to constitute a smart grid.

Keywords: Smart Grid, Turkish Power System, Power System Management

I. INTRODUCTION

Energy is a strategic parameter, which demonstrates the development of a country. Electrical energy management plays an important role with increasing energy usage. Therefore, smart grids are becoming an important issue in the future power system network configurations. In today's world, electric power networks have grown and developed, hence generation, transmission and distribution is not possible to separately manage anymore. Main goal of smart grid is to intelligently integrate the behavior and actions of all users from generators to customers connected to it. In general, smart grid is an evolved power system which has communication systems, advanced metering, measurement infrastructure, and complete decision support.

The attractiveness of the smart grid is that generation, transmission and distribution networks become more efficient, flexible, and reliable, more renewable and variable energy sources integrate into the grid and consumers get greater information and the capability to control their electricity consumption and costs [1].

In order to efficiently deliver sustainable, economic and secure electricity supplies, smart grid becomes a need for power networks of every country. The authority of many

power grids stated their action plan for smart grid evolution. Many applications are reported in literature. The United States electric power research institute proposed "Smart Grid 2030 Plan" of United States which is analyzed electricity industry status and smart grid vision, monitored and controlled all grids, and located advanced metering and measurement equipments. In 2004, the European Commission submitted the action plan for smart grid proposed by "Smart grid project report" According to this report; the European power grid will become more flexible, easy-access, reliable and economical until 2020. Historical development of smart grid evolution in Southern California Edison is proposed in [2].

Smart grid works give a chance to upgrade and develop the whole power grid, including electric power generating, transmission, distribution and supplying. In China, UHV AC and DC power grid is upgraded and expanded through smart grid plan [3]-[5]. One of the most widely information about the development of smart grid is proposed by the Alberta Utilities Commission. In "Alberta Smart Grid Inquiry", the deployment of smart grid applications and technologies are gradually described and the information necessary to make informed policy decisions is provided to the government.

Smart grid is a common aim of the power networks. However, every country or organization has different circumstances, so implementation of smart grid differs from every country. In Turkey, any strategy about smart grid is not determined yet. The works to constitute a deregulated environment has been gone on nowadays in Turkey. The generation and distribution parts of Turkish Power System have been partly privatized. In order to pass into a smart grid, many steps have to been performed. This paper is focused on the determination of the needs of Turkish Power System, as to constitute a smart grid.

II. CONCEPTION OF SMART GRID

Smart grid is a new type power grid describes the integration of hardware, software, monitoring and control technologies, and modern communication networks. It is the evolution of power networks. In today's world, electric power networks have been so much loaded that such a case has never been observed before, and there are many actors from generators to customers. Furthermore, renewable energy sources must be easily integrated the power system. Under these circumstances, management of transmission congestion is a crucial task for successful

operation of power systems. Main objective of smart grid is to constitute a more efficient, secure, reliable, flexible, green, and economic power system [1], [4], [5].

Smart grid is not created all at once. It will evolve over many years from the existing infrastructure through the development and integration of intelligent systems. There are two main infrastructures which are electrical infrastructure and intelligent infrastructure. Generation, transmission and distribution parts of power system are upgraded and developed, at the same time, smart metering equipments are widely deployed all parts.

First stage of smart grid evolution is passing from centralized power grid to decentralized power grid. In order to do so, competitive market structure must be established and managed to adapt all types of generation. The basic features of the competitive market are fair, efficient, open to all market participants, and easily exchanging electricity. In order to provide reliable, flexible and economical electricity for customers, decisions to build generation plants are shifted from regulatory authorities to investors. At this point, the integration of renewable resources plays a critical role for competitive market structure. The deployment of intelligent remote control, monitoring, and smart metering equipments facilitates the integration of renewable generation.

Intermediate stage of smart grid evolution is to determine a roadmap of management distributed generations (DG) and renewable energy sources (RES) especially wind energy. Due to technical and natural reasons, DG and RES is not permanent and stable sources. Therefore, the specific operation problems can be faced when DG and RES access to power network [05658506]. Penetration of DG and RES is increasing day by day. This penetration brings the improvement of operation, control and protection strategies of the system. Smart distribution technologies provide a switchable network. These automation systems allow improving the system reliability and quality, and reducing the network problems because of DG and RES.

Final stage of smart grid evolution is full active power management. A distribution network management regime using real-time communication and remote control to meet the majority of the network services requirement. The transmission and distribution networks are both active, with harmonized and real-time interacting control functions and efficient power flow. In order to provide these targets, advanced smart metering equipments are the most important enabler devices.

III. BRIEF HISTORY OF TURKISH POWER SYSTEM

Turkish Electricity Authority (TEK) was founded in 1970, aiming at the rendering of generation, transmission, distribution and trade of electricity services. The works to constitute a deregulated environment have begun with privatization of TEK in 1990s. Then, "Program for Economic Stability and Fighting Against Inflation" was implemented by the Government in 2001. The aims of

this program were restructuring of the power sector, transition into a free electricity market ensuring free competition, setting up of separate companies for generation, transmission, and distribution of electricity, and privatization of the all public entities other than that of transmission.

Energy Market Regulatory Authority was established as enforcement institution of this program. The works to constitute a deregulated environment has been gone on nowadays in Turkey. The generation and distribution parts of Turkish Power System have been partly privatized. A big part of generation units is managed by regulatory authority. A little part of generation is distributed generation and wind energy generation.

Generation units are mainly located in the east of Turkey, on the other hand, load concentrated areas are located in west of Turkey. Nowadays, Turkish electricity transmission system is composed of 380 kV EHV transmission lines, 154 kV HV transmission lines, 220 kV interconnection lines connecting Turkish system to Georgia, to Armenia, to Bulgaria and to Greece, 66 kV HV sub-transmission lines, 380/154 kV autotransformers, 380 kV/MV and 154 kV/MV step down substations, and serial and shunt capacitors. Turkish generation and transmission system is managed via 9 regional dispatching centers and coordinated by the National Dispatching Center [6].

Power system operation is controlled by SCADA2 and Energy Management System EMS3 software. SCADA system includes 380 kV lines and power plants greater than 50 MW. System operator can manage every kind of system studies necessary for more quality, daily operating programs and system frequency control. Installed capacity is given in Table I.

IV. MILESTONES OF TURKISH SMART ELECTRIC POWER GRID

Power grid in Turkey is the first stage of smart grid evolution. In order to pass into a smart grid, many steps have to been performed. The basic priority of Turkish Power System is supply security. The works of structuring competitive deregulated market is going on to ensure supply security.

In Turkey, the major solution to the dependency on foreign energy resources is domestic production, technological development, and operation of renewable energy sources. First milestone of Turkish smart grid is the extension of distributed and renewable energy generation. By Turkish Government, the share of renewable resources in electricity generation is grown at least 30% by 2023 [7]. The improvement of transmission and distribution networks is crucial for smart grid evolution. Deployment of monitoring and remote control equipments is necessary to assess supply security. Some connections will rely on bilateral contracts with distributed generators for ancillary services. In [7], all consumers except residential becoming eligible consumers by the end of 2011, and all consumers

becoming eligible consumers by the end of 2015 is targeted.

Second milestone of Turkish smart grid is the management of penetration of DG and RES. In Turkey, wind energy is an orientation point of the energy investments. Integration of wind needs additional management strategies for power systems. To reduce wind power output swings, wind farm diversification can be used. Wind farm diversification is to distribute the wind turbines across the land. Wind power generation will be smoother and more predictable by diversifying wind farms. Wind turbines are located western side of Turkey and dominant wind regime is from northern west to southern east. Due to geographical situation of Turkey, wind farm diversification is not possible. These circumstances cause the reliability and supply security

problems. In order to alleviate these problems, smart metering equipments, switchable network and storage facilities seem to be remarkable alternatives.

The last milestone of Turkish smart grid is full active power management. Real time communication and remote control are the key enablers. All market participants play an active role for power management. Real time pricing provides to reduce the bill for customers. The disadvantages of RES can be prevented with advanced storage systems. Electrical vehicles can be used for the improvement of system reliability and flexibility. Cyber security will become one of the important topics at this step [8, 9]. Time-line of the milestones of Turkish smart electric power grid is in Fig. 1.

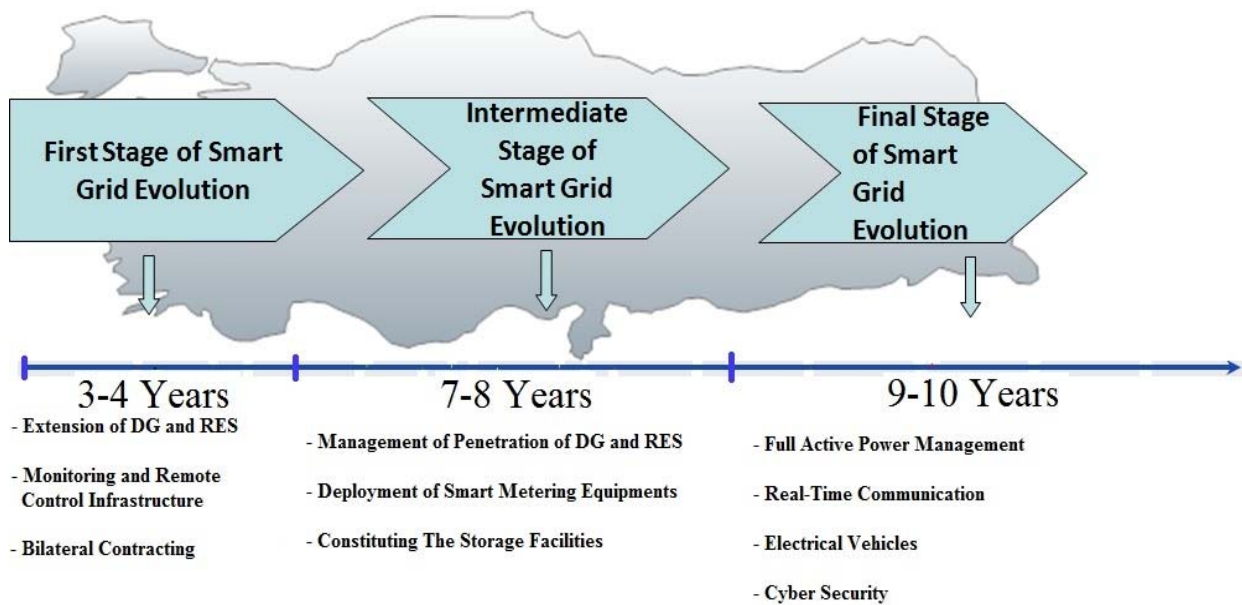


Fig. 1. Time-line of the milestones of Turkish smart electric power grid

Table I. Annual Generation and Installed Capacity-2010

GENERATING UTILITY	THERMAL	WIND	GEOTHERMAL	HYDRO	TOTAL
EÜAŞ (Public)	8,691			11,639	20,330
Affiliated Partnership Of EÜAŞ	3,870			0	3,870
Power Plants Under TOR (Transfer Of Operational Right) Contract	620			68	688
Power Plants Under BO (Built-Operate) Contract	6,102			0	6,102
Power Plants Under BOT (Built-Operate-Transfer)Contract	1,450	17		963	2,430
Private Utilities	8,960	1,492	94	3,638	14,184
Autoproducers	2,475	1		544	3,020
TOPLAM	32,167	1,511	94	16,852	50,623

V. CONCLUSIONS

Smart Grids are gradually becoming a major issue in the future power networks. In Turkey, any strategy about smart grid is not determined yet. As mentioned before, if the milestones of Turkish

smart power grid are step by step implemented, main problems of Turkish power system can be removed. At this point, Turkish Government has to take the necessary legislations and get the adequate encourage regulations for private generation and distribution level investments.

The three major stages of smarter grid evolution are estimated to take 3-4, 7-8 and 9-10 years. The overall process is estimated to take 15-20 years.

VI. REFERENCES

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