

## IN THE LIGHT OF GLOBAL DEVELOPMENTS, TURKEY'S ELECTRICITY MARKET, ROLE AND CAPACITY OF ELECTRICITY GENERATION COMPANIES

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**Abstract-** Energy demand and consumption of natural sources in the world are rapidly increasing in parallel to the population growth, industrialization and urbanization as a result of the globalization. In the light of global developments, Turkish government target is to provide timely, sufficient, reliable, competitively priced and environmentally friendly energy for the consumers, supporting the economical growth and social enhancement advances. In this study, energy policies of Turkey and the role, mission, investment, maintenance management and energy market activities of Electricity Generation Company (EGC/EUAS) is going to be evaluated with the help of data obtained from annual activity report of company.

**Keywords:** Electricity Market, Electricity Generation, Electricity, EGC, Installed Capacity.

### I. INTRODUCTION

With rapid integration process in the world economies, Turkey aims at completing its infrastructure, realizing the targets of development, increasing public welfare and turning industry sector into competitive levels with international fields. Energy is the boosting factor for economic and social developments and one of the most fundamental requirements. Energy is both consumed directly and used for input for the services and material in the other sectors. Therefore, energy is crucial sector for the industry and the economy in a country.

The main input of the industry the electricity has been preserving its importance not only for industrialization but also for being the main indicator of development level. Electricity like the other natural resources is the common wealth of the community. Every single person of the community has the right to get access to these resources. The entity known as Electricity Generation Company (EGC) that was established as the Turkish Electricity Authority (Turkiye Elektrik Kurumu, TEK) in 1970 has been born out of restructuring process in 2001. EGC with its 13.000 workforce and 5.6 billion TL paid capital provides almost 50% of the electricity generated

in Turkey [1]. Turkey' installed capacity and the share of producers shown in Figure 1 [2].

Under the free and fair competition rules of the liberalized market, the sector must continue to be the low-cost, high quality and reliable supplier despite the growing globalization of the energy markets. Electricity Market Law No. 4628 enacted on February 20, 2002 has caused fundamental changes in the mechanisms of electricity generation, transmission and distribution. These changes have saddled the all sector with the new duty and responsibilities unforeseen up to now [2, 3, 4].

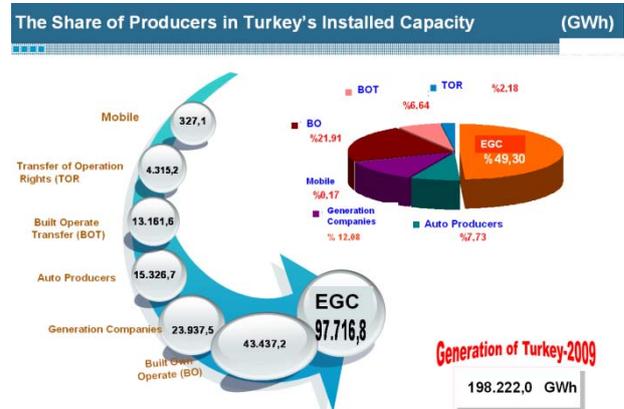


Figure 1. Turkey's installed capacity and the share of producers

One of responsibilities is to implement the duty of electricity generation together with the state, private and other market participants. This duty has primarily been carried out by operating, the hydro and thermal power plants under the state ownership. The operation of thermal and hydraulic power plants entails to develop a well organized spare parts and logistical management approach. In order to operate the hydro and thermal power plants efficiently and cost-effectively owned by EGC. They make sure the implementation of a thorough maintenance and repair activity. These maintenance expenses have been financed overwhelmingly by their resources if necessary the resources provided by international institutions.

The Electricity Market Law gives the sector, entity new powers to build and lease new power plants not only on the basis of the long-term energy need the country but also on the basis of the investments of the private sector. By taking advantage of the opportunities presented by this law, EGC must evaluate the investment options and puts into practice the most suitable ones [5, 7].

**II. THE ROLE AND MISSION OF EGC**

EGC carries on its services and operations generally mentioned below [3]:

- Generation of electricity at generation facilities under the framework of the Electricity Market Law numbered 4628 and the corresponding regulations, contracting electrical energy sales and/or sub services.
- To take over the due facilities, to operate the generation facilities of which have not taken over by the private sector, via by itself and/or Subsidiaries, or to take out of the system when necessary.
- To establish, lease, operate new generation facilities that envisaged by the Ministry, to hold the property of the facilities and enterprises and the additional investments of them, of whose transfer of operating rights to the corporate bodies have been or to be completed, to accomplish the transfer of the facilities or shares in accordance with the relevant legislation.
- In accordance with the relevant legislation about nuclear energy generation facility establishment, to accomplish the relevant procedures of acquiring placement, construction, operation and alike licenses and permissions from the relevant authorities.
- To procure all kinds of studies, projects, constructions and facilities needed for electricity generation and to take all kinds of measures for concordance of these with the domestic environmental legislation. And make them taken by the related companies or organizations accordingly, leaving their legal and financial responsibilities as is.
- To procure all kinds of goods and services for the maintenance, repair, rehabilitation, operation and development of the generation facilities domestically and/or via import.
- To procure research, development and training studies on the system, machinery and equipment necessary for the installation and operation of the electricity generation facilities, and to manufacture or make them manufactured when needed, considering the domestic availability.
- Related to its targets and activity issues, utilizing its own capabilities, to hire out tools and machinery or to lease from third parties with charge to trade services and goods under the framework of the related legislation without interfering its core activities, to trade all kinds of by-products during or after the electricity generation processes and when it is needed.
- To operate the mines to be used for electricity generation at the existing and/or future thermal power plants and other resources or to make them generated via service procurement.

- To install, to make it installed, to operate or to make the mining facilities to be operated via service procurement.
- To lease mining areas to the third parties for electricity generation.

**III. PRIMARY RESOURCES FOR ELECTRICITY GENERATION OF TURKEY**

Coal and hydraulic resources as being the basic resources; oil, natural gas and geothermal resources are main primary energy resources of Turkey in electricity generation [3, 6, 7]. Hydraulic potential, constituting another basic primary energy source of the country, has been estimated about 130 billion kWh for a year with normal hydrological conditions. As this hydraulic potential has been concentrated in mainly 11 basins, Firat and Dicle basin that make up 45% of the total potential is the biggest basin of country. Electricity generation of Turkey and EGC are given versus years in Figure 2.

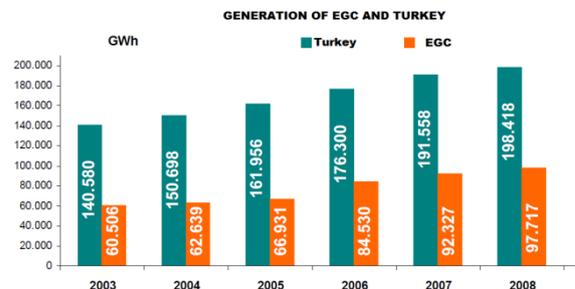


Figure 2. Electricity generation of Turkey and EGC

**IV. INSTALLED CAPACITY OF EGC**

As of 2009, the total installed capacity of EGC was 24.199 MW. Of this capacity, 12.525 MW is thermal and 11.675 MW is hydro. 48.22% of this capacity is hydraulic, 16.88% is natural gas, 32.09% is hard coal and lignite and 2.82% is liquid fuels. As shown in Figure 3, EGC installed capacity accounts for 57.34% of Turkey's installed capacity [8, 9].

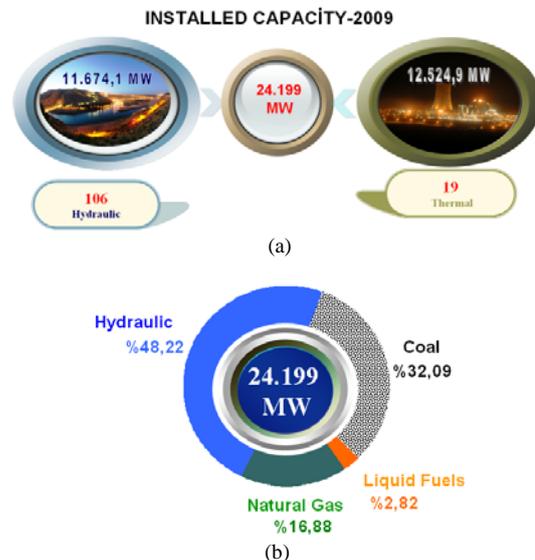


Figure 3. (a) Installed capacity, (b) Distribution of sources for installed capacity

In order to ensure the timely and uninterrupted meeting of electricity demand with the view to keep the highest level of the generation, efficiency, reliability and availability of thermal power plants; general maintenance works have been realized as per the annual programmes and also at some modifications were carried out for solving the problems due to aging, erosion and wear [8].

## **V. WIND ENERGY SITUATION IN TURKEY**

Turkey is located in the northern hemisphere between the 36° and 42° northern parallels and the 26° and 45° eastern meridians. Turkey borders the Black Sea, the Mediterranean, the Aegean and the Marmara Sea and has a total coastline of 8333 km. Turkey lacks large natural gas, coal and oil reserves: over 75% of energy demand is imported and indigenous sources only meet 40% of Turkey's electricity production [9]. The average annual increase in the rate of electricity production was approximately 8.7% for 1970-2008. Therefore, meeting the rapid increase in electrical energy demand and finding solutions for energy security problems are the main dilemma in Turkey. To overcome this problem, it is crucial to increase the rate of indigenous and renewable sources in electrical energy production.

Among the renewable energy sources, wind energy has considerable economic potential, but its utilisation rate is very low. Wijk and Coelingh reported that Turkey's technical and economical wind energy potentials were 83,000 MW and 10,000 MW, respectively [10]. In 2002, a Turkey Wind Map was prepared from Turkish State Meteorological Service data. The results of the wind map showed that the economic potential was 10,000 MW and the technical potential was 88,000 MW. Further research to determine the technical wind potential of Turkey was carried out in 2006 by the General Directorate of Electrical Power Resources and Development Administration. The Wind Energy Potential Atlas (REPA) was prepared by numerical weather prediction methodology at 200 × 200 m resolution for different heights [11]. Wind energy potential at 50 m above ground level in land regions was calculated as 131,756 MW, which is equivalent to a wind power density greater than 300 W/m<sup>2</sup> [11].

Wind power may have a meaningful contribution to Turkish electricity generation as in some European countries. Turkey has 28 operating wind power plants with 727.45 MW installed capacity [12]. At the end of 2005, the cumulative installed wind power capacity was 20.1 MW; wind power then experienced dramatic growth and now represents more than 1% of the total installed power capacity.

The mean capacity factor of installed power plants in Turkey ranged from 30% to 45% between 1998 and 2008. The mean capacity factor of wind license applications was 41.9%. However, the mean realised capacity factor for European countries was below 21% between 2003 and 2007. In other words, Turkey has unutilised considerable wind energy potential. The findings of this study indicate that the capacities in the investigated locations were between 19.7% and 56.8%,

and the production cost of electrical energy varied between 1.73 and 4.99 \$cent/kW h for two different wind shears. According to the Turkish law on energy efficiency, 5-5.5 Euro cent/kW h is paid for renewable electrical energy. These results indicate that it is possible to generate cost effective wind electricity in these locations.

## **VI. CURRENT SITUATION OF RENEWABLE ENERGY IN TURKEY**

Renewable energy creates multiple public benefits such as environmental improvement, increased fuel diversity, reduction of energy price volatility effects on the economy, national economic security and increase in economic productivity and GDP through more efficient production processes. With a world excessively dependent on decaying fossil fuel resources and with a new appreciation of the damage caused by greenhouse gases (GHG), it is becoming more and more evident that renewable energy resources must be utilized to create a sustainable future. Renewable energies can be broken down into those where the sun is the source of the energy (Solar Energy) and those where it is from another source (Non-Solar Energies).

Solar energies include biomass, biofuel, solar power, hydro energy and wind energy. Renewable Non-Solar energies include tidal energy and geothermal energy. There is virtually all kind of energy sources available in Turkey. However, these sources except for lignite and hydraulic energy are not enough to meet the energy requirement of the country; hence, more than half amount of this requirement is met by imported energy. This low share of renewables in global energy production could be explained by analyzing the barriers that renewable energy face today. However, it is expected that a significant global increase in the use of renewable energies will occur in the future. This increase can be understood by analyzing the main driving forces pushing renewable energy development [13].

## **V. EVALUATION OF CURRENT SITUATION AND DISCUSSIONS**

Based on the European Union norms in particular, Turkey tends to take part in the direction of competitive and operative market structure in energy sector, so as to ensure its integration with global economy and economic development. The importance is paid to the issue of building a truly competitive electricity market based on the prices reflecting the real costs of generation. In this respect, "Pricing Mechanism with the Cost Base to be applied by the State Economic Enterprises of Energy Sector" came into force on 01.07.2008.

After the enactment of the renewable law, the window of opportunity for generating electricity from the renewable sources by means of private sector has emerged. As a guide for the investors to make electricity generation by using wind and solar energy, the studies for the preparation of "Potential Wind Energy Map" and "Potential Solar Energy Map" have been completed.

Continuing the studies in order to use renewable energy resources in high level of electricity generation and also they must work on the new changes in the renewable law for the electricity generation by utilization of solar energy.

The initiatives have been accelerated to transfer the coal fields with the conditionality of erecting coal-fired power plants under jurisdiction of Electricity Generation Company and TKI to the private sector in order to make these resources economically viable. In this way, new generation and employment possibilities are going to be created in addition to the regional benefits the share of the domestic resources for energy generation is increased.

Encouraging arrangements for the efficient utilization of energy have been carried out by means of Energy Efficiency Law and the utilization exploitation of significant potential in this field has been aimed. The year 2008 was announced as "Energy Efficiency Year" by the Prime Ministry circular no. 2008/02 and numerous activities were realized so as to increase energy efficiency within the year 2008.

Electricity Generation Company responsible for the operation and generation of the state owned power plants met 57.3% of Turkey installed capacity and approximately 50% of Turkey electricity generation by the end of the year 2010, with the installed capacity of 23.977 MW. However, rehabilitation activities have been important carried out so as to increase the efficiency and generation capacity by using new technologies in thermal and hydroelectric power plants will be operated for a long time by EGC [8, 14].

In Turkey, like the other developed countries, it was decided to liberalize the sector fully through Electricity Market Law no. 4628 and in this context; the restructuring process has been started by the adoption of new legislation. With the liberalization, it is aimed to create a competitive electricity market that will enable the generation of more sufficient, reliable and good quality electricity to all consumers at low cost and environmentally-friendly manner.

## **VI. CONCLUSIONS**

Energy demand of countries takes shape depending on many socio-economic factors like their population, economic development, industrialization, urbanization and technological progress. Electricity is one of the most important inputs of socio-economic developments. Therefore providing a reliable, sufficient, good quality and environmentally responsible supply of electricity is essential. The conventional resources used for electricity generation are not inexhaustible.

The utilization of these resources will not only determine the lifestyle of next generations, but also it is unassailable that the inordinate and feckless usage of them will vitiate this future. Hence countries are obliged to constitute a policy, considering the needs of both today and future, relying on domestic resources and make their choices accordingly. The Electric Generation Company has to works under the sense of duty and endeavors to utilize the domestic resources.

The domestic share of total energy consumption is 37%, and between the years 2000 and 2010, the cost for needed energy will be approximately 55 billion US\$. The government has been planning for 81% of this amount as an investment. Considering the country's economic conditions, Turkey must come up the plan which reduces the share of fossil fuels, increases energy production (including use of more alternative energy sources), and changes the course of long-term energy plans into very effective and applicable solutions.

Turkey's abundant hydropower potential is among the highest in Europe, but only one-third of this capacity is utilized. It is obvious that, however, hydropower can meet 25-35% of Turkey's electric energy demand in 2020 and new energy plants should be made as soon as possible. The wind energy potential of Turkey, with well-defined criteria 47,849.44 MW has been identified. This scale is equivalent to 1.30% of Turkey's total land area. Turkey is one of the richest countries in terms of wind energy potential in Europe.

It is surrounded by three seas and has about 3500 km coastline, with along the Marmara and the Aegean coast, especially, wind speeds being high and regular. Investments in wind energy, starting from these regions, should be initiated quickly. Turkey should also invest in wind turbine technology, both for using its wind potential more cheaply in a long period and for supplying job opportunity to the people. Turkey will become technologically independent and could export technology.

Conclusively, the use of present wind potential is very important from both economical and environmental respects. Turkey has also considerable solar energy potential. Three fourths of the economically usable potential is considered suitable for thermal use, with the remainder for electricity generation. Currently, Turkey does not have an organized commercial and domestic photovoltaic (PV) program. On the other hand, there is a good potential for PV applications in the local market since the country is enormously suitable due to high rates of solar radiation and available land for PV applications. The priority sites for solar power plants are given in Fig. 15. Approximately 477 km<sup>2</sup> of the study area is identified as priority sites for solar power plant constructions [32].

Currently no large scale solar power plants exist in Turkey, so there is a need for new projects. Although the geothermal industry is highly developed in Turkey, excellent geothermal sources still remain undeveloped since cost for a new natural gas plant is just half of a new geothermal plant. If Turkey uses all of its geothermal potential, it will meet 14% of its total energy.

In this study, energy reserves, energy demand, energy production, energy consumption, energy policies, potential of renewable energy in electrical energy production and sustainable energy development of Turkey and recent developments are investigated and evaluated.

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