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Potential and Use of Renewable Energy Resources in Turkey

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Abstract – This study compares the state of renewable energy sources in our country in comparison with the world in general while also examining their usage areas. Renewable energy sources with a potential for generating energy in our country are solar energy, hydraulic systems, geothermal energy, biomass energy and wind energy. Especially wind and solar energy potentials have received significant attention. The installed power based on renewable energy in Turkey and the electrical energy generated have been examined comparatively. Information was provided about the general potential of the installed WEP in Turkey, the cost effectiveness of energy generation, development of energy generation technology in addition to the necessity of clean environment and clean energy. Turkey has a rich potential with regard to renewable energy sources. The problems with regard to energy deficit in our country will be minimized when the renewable energy sources that have received significant attention in recent years are used actively. Thus, the energy problem in our country will have been partially solved while also decreasing foreign-source dependency in the field of energy.

Keywords -
Renewable Energy, Renewable Sources, Wind Power, Solar Power, Statistics

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1. Introduction

Energy problem that has been ongoing since the 1970's continues to increase in recent years as a result of the increasing industrialization activities and industrialization due to technological advancements. At first, there was a shift towards conventional energy sources to meet the increasing energy demand all over the world. However, the studies carried out have put forth the necessity of making use of renewable energy sources due to the limited life of conventional energy sources as well as the disproportionate increase in the processed fuel oil or gas prices. This has been supported by the fact that the costs for establishing renewable energy source plants are now comparable with those of conventional sources, that the efficiency of the batteries has been increased as a result of innovations in solar cells used in photovoltaic batteries, developments in materials science and the ability to meet energy demand in a functional manner by converting wind energy into electricity. Energy obtained from exhaustible energy sources result in air pollution, water pollution, noise and electromagnetic pollution. The increase of such problems has increased the importance of renewable energy sources resulting in more support to projects developed for these purposes. Even though the use of conventional sources has not been abandoned completely, it has been estimated according to acquired data that 10-15% of the total electrical energy generated will be supplied by renewable energy sources within the next 15 years. More efficient systems are being developed using renewable energy sources of sun, wind, hydraulic, hydrogen, biomass as well as hybrid systems which combine these renewable sources. The shift towards renewable energy sources will provide a more optimum environment with regard to clean environment and clean energy. When similar applications in the world are examined, it can be observed that many countries such as USA, China, Germany and Holland make use of wind and solar energy sources. Renewable energy generation in these countries made up 0.1% of the total energy production in the world. Whereas the contribution of Turkey to this total energy generation is close to zero.

2. Use of Renewable Energy in Turkey

Solar energy is used for home-office heating, meeting water demand, thermal systems and solar cells. In addition, it is also used in calculators, street lamps, traffic signalization applications and for meeting the electricity demand of communication facilities at locations that are far away from the mains [1].

The main usage area of wind energy is electricity generation and the charging of batteries and storage using the generated electricity. Wind energy proceeds from the different heating of land surfaces by solar radiation and thus solar energy is the main source of wind energy. When the distribution in our country of the power plants that generate electricity from wind energy is examined, it is observed that they are mostly scattered around the Aegean, Mediterranean and Marmara Regions. This is due to the fact that the current energy potential is higher in these regions. Establishing facilities close to the energy sources prevents problems that might occur in the transmission of energy to areas that require it as well as to power plants that are far away from the region thereby decreasing energy losses. Wind energy stations are mostly located in the coastal area of the Aegean Region with the remainder in İstanbul, Hatay and Osmaniye. Economic wind potential is around 48 GW corresponding to about around 120 million kWh [2].

However, studies indicate that only 3,1 GW portion of this potential can be used until 2020. A total of 112,5 billion kWh electrical energy generation would have been generated if it was possible to use the remaining wind energy potential effectively in Turkey. Table 1 and Table 2 shows the wind potential installed power and total installed power graphs for Turkey ranging between the years of 2000-2016.

Table 1: Installed power of wind potential in Turkey [3]

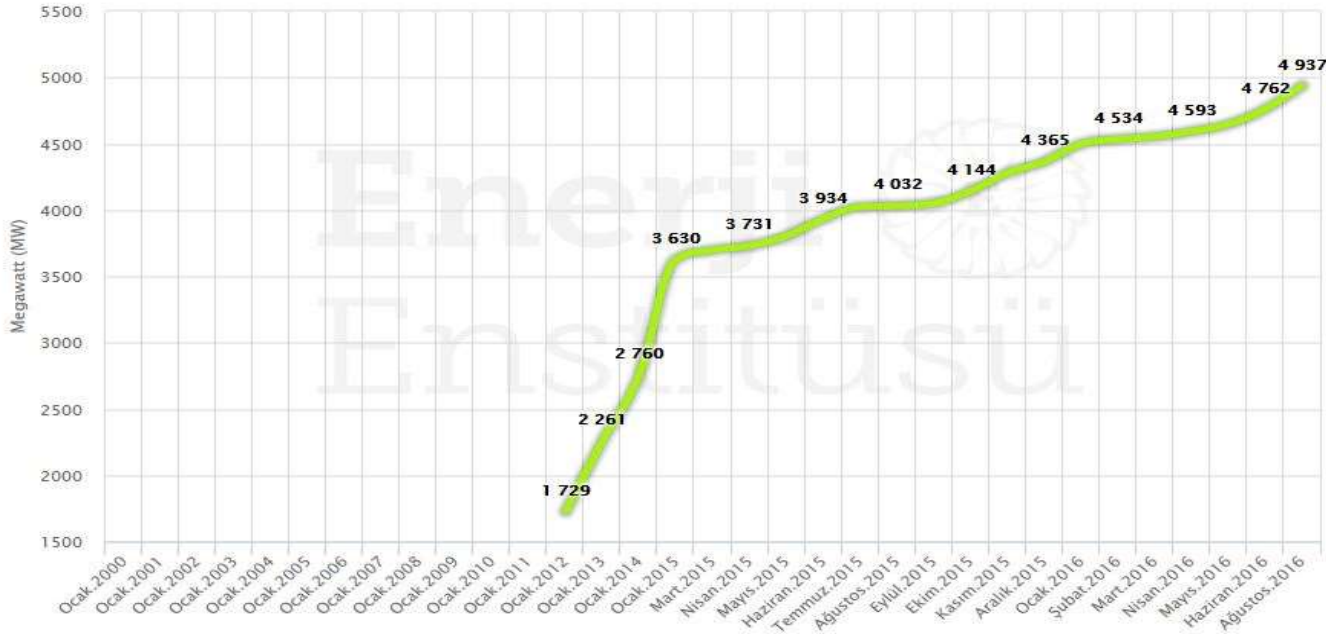


Table 2: Total installed power graphs for Turkey [4]

Existing wind potential has started to be used since 2012 and an increase has been observed in the installed power amount for generating electricity from wind energy. The electricity generation of wind energy stations that can be monitored in Turkey has been parallel with the estimations that have been made. The share of the contribution of

electricity generated from wind energy in the installed power has increased with the increase of licensed installed power plants. However, this is not the case for unlicensed production. In this case, the increase in production (small production values) and the number of power plants does not provide a significant increase in the total amount of renewable energy generated. The numerical data related with the use of renewable energy in Turkey have been given in Table 3.

Table 3: Use of renewable energy in Turkey [5]

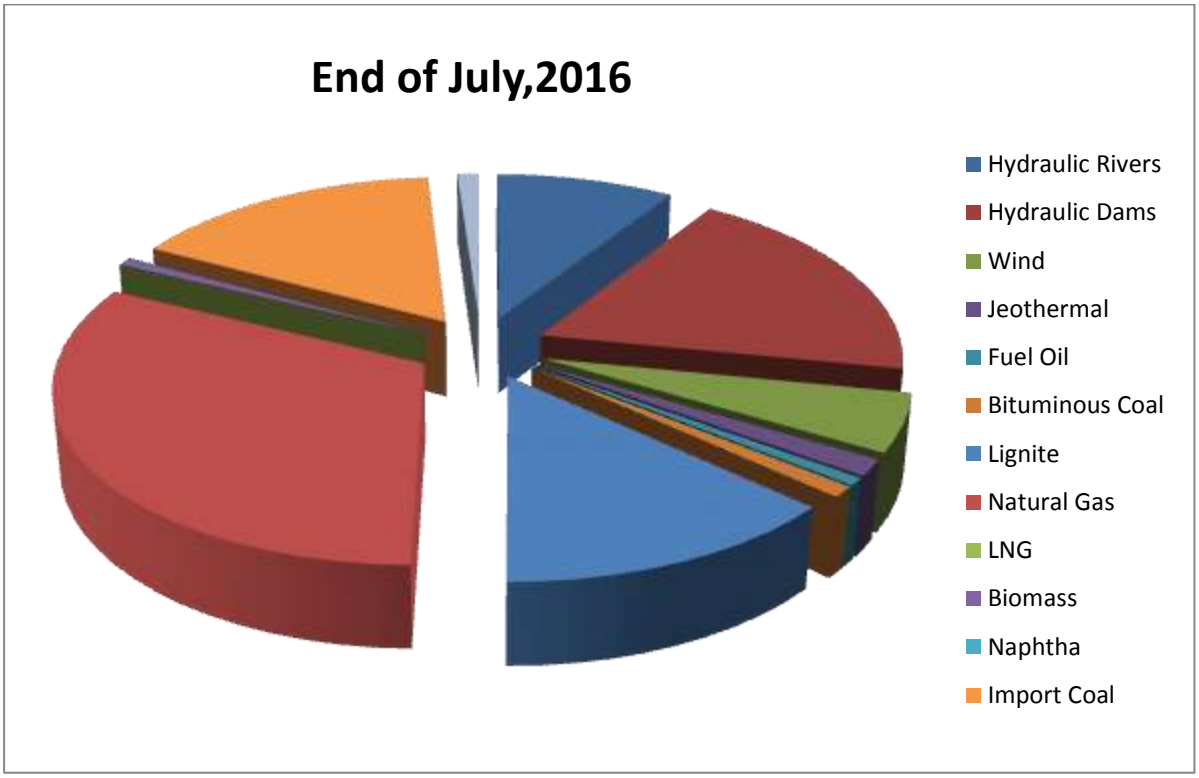
Renewable energy resource	Total brut potential (GWh/year)	Technical potential (GWh/year)	Economic potential (GWh/year)	Potential in use (GWh/year)	Utilization (%)
Hydraulic	430-450	215	100-130	35330	30
Solar	365	182	91**	4.07	4.5
Biogas	1.58	0.79*	0.4**	0.067	16.8
Wind	400	124	98	61	62
Jeothermal	16	8*	4**	0.89	22.5
* : brut potential for %50					
**: technical potential for %50					

Accordingly, even though it seems that wind energy is used the most when compared with the current potential and use, highest efficiency is gained from hydraulic energy generation systems. The flow rate of water is indirectly or directly transformed into electrical energy in hydraulic energy generation. Whereas annually about 35.330 GWh energy is generated according to current potential, 61 GWh energy is generated by wind energy power plants. This is followed by solar energy based systems with 4,07 GWh. Geothermal energy is another form of renewable energy. This energy that stems from the heat of the earth is used in heating systems, health sector as well as fields such as agriculture and greenhouse cultivation. Even though there is a significant potential in our country with regard to renewable energy sources and even though this potential can meet a high portion of the energy demand of our country, these sources are either not used at all or are used at a level that is below their potential.

3. Conclusions

The existence and variety of energy sources are very important for meeting the energy demand required for the development of a county. Turkey has a rich potential with regard to renewable sources to be used for clean energy. Even though the energy generated from renewable energy sources in Turkey cannot yet provide a significant contribution to the total amount of energy generated in the world, high efficiency can be obtained from applications where it is used directly. Technologies have been developed for transforming renewable energy into electrical energy. In this regard, hydraulic sources, wind energy, geothermal sources and solar collectors (solar-photovoltaic cells) are systems which are best suited for transformation into electrical energy. It is not appropriate to call systems with no sustainability as reliable sources. Wind and solar energy based systems contribute to the energy deficit in the mains despite their unpredictable nature. Such hybrid systems are used for meeting the electrical energy demand in establishments for which it is problematic to transmit energy from the mains. Surplus electrical energy is transmitted to

the national mains via required system tools and sold to TEİAŞ. Hence, the installation expenses can be amortized. Even the most problem free source damages the environment during installation. However, wind and solar energy from among renewable energy sources cause less damage during installation in comparison with other sources (hydraulic systems). R&D activities on WEP have increased in recent years along with completed projects in this field. However, local capital flows outside since local resources cannot be used completely for systems that generate electricity from wind energy. The established power plants will contribute more to the country economy and technological development if the studies carried out focus more on manufacturing energy system components in our country as well. Figure 1 indicates local energy generation according to data from Turkish Energy Statistics.



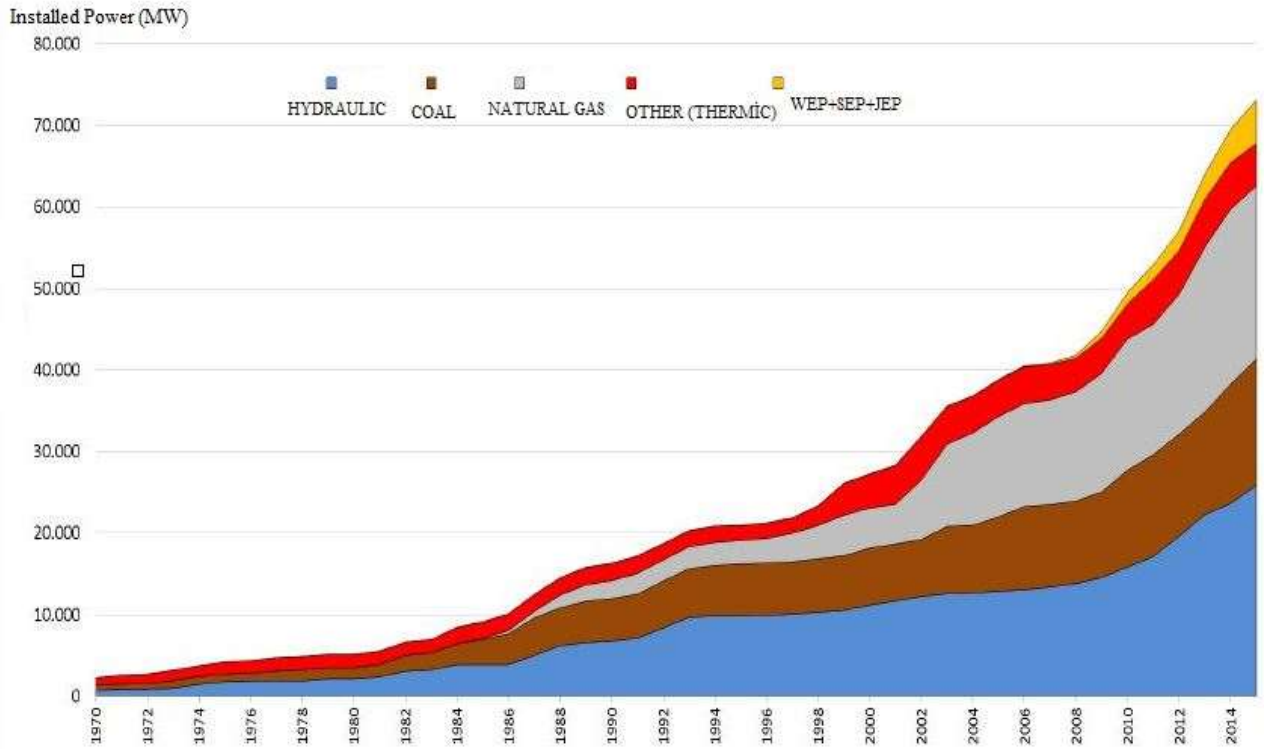
GENERATION (07/2016): **154.864.377.570 kWh**
CONSUMPTION (07/2016) : **157.662.418.980 kWh**

Figure 1: Energy generation in Turkey [6]

Even though the installed power of wind based systems is 6,6% (5,1 MW), the generated energy can be expressed as 5,4%. This corresponds to 8,3 billion kWh annually. Wind Energy power plants (WEP) that make the highest contribution to wind energy generation in Turkey are Geycek/Kırşehir WEP (150 MW), Balıkesir WEP (142,5 MW), Kangal/Sivas WEP (128 MW) , Karaburun/İzmir WEP (120 MW), Osmaniye WEP (135 MW), Soma/Manisa WEP (140,8 MW), Şamlı/ Balıkesir WEP (114 MW) [7]. Whereas the installed power of hydraulic sources makes up 125,2% of the total sources, the energy generated is about 19% of the total energy. This corresponds to 29,5 billion kWh annually. Installed energy of solar energy systems is 0,7 (562,1 MW) in comparison with the general value, however they have no contribution to the total energy generated. The installed power of solar energy systems has increased in recent years and their share in the general installed power graph has increased. This indicates that renewable energy potential in Turkey has

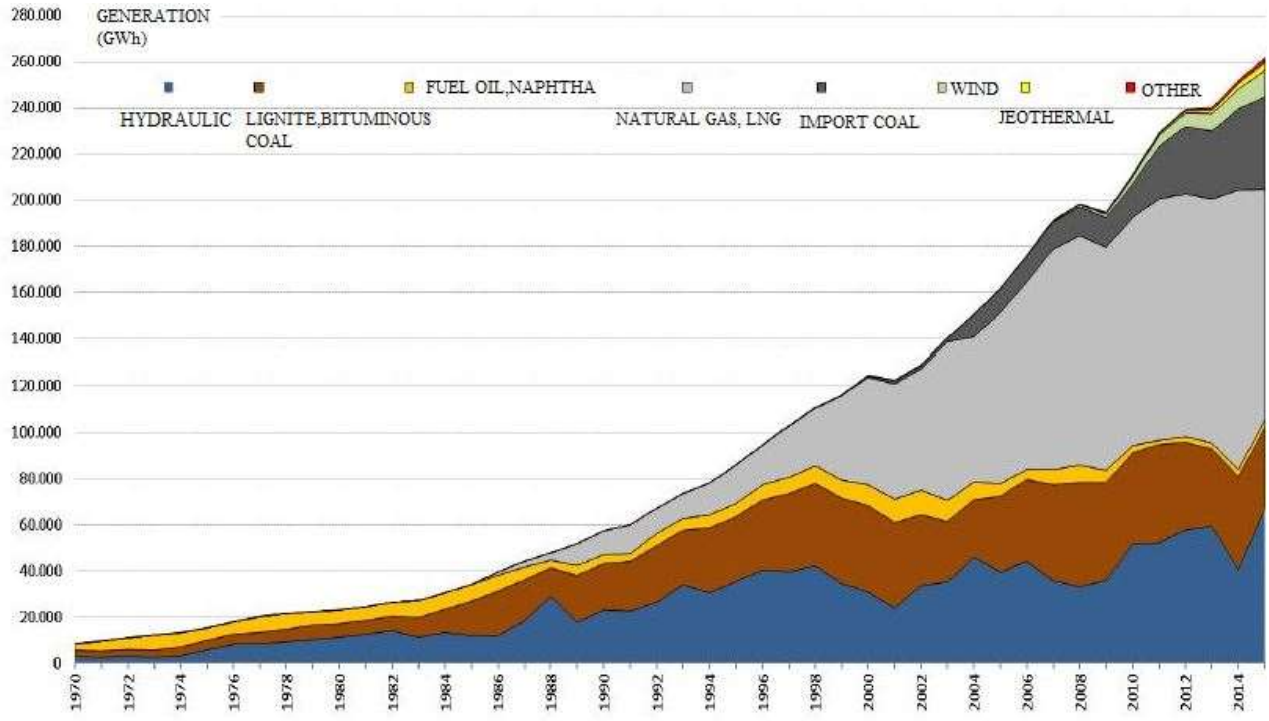
started to be used actively. Table 4 shows the change of installed power in our country from the energy crisis in 1970 up to 2015.

Table 4: Change of installed power in Turkey [8]



Accordingly, the installed power for hydraulic and renewable energy lags behind that of natural gas plants. A small change in the installed power of renewable energy sources has made significant changes in electricity generation. The energy statistics in Table 5 shows the change in the total energy generated in Turkey between 1970 and 2015.

Table 5: Change of installed power in Turkey [9]



According to Table 5, the existing wind potential in Turkey has started to be used since 2006; new plants have been established as a result of changing technology and developments in equipment. Thus, effective results have been obtained in energy generation thereby contributing to total energy generation. The share of wind energy and other renewable energy sources has increased in our country over the years and it will continue to increase with the current R&D studies carried out. Renewable source diversity and potential of Turkey will be used efficiently as a result of the required energy laws and the correct energy policies that will be applied.

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