

Examination and Comparison of Nuclear Energy with other Available Energy Sources for Electricity Production in Turkey

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Abstract: This paper presents the nuclear options for Turkey's energy future while comparing the other available energy sources. Firstly, importance of sustainable energy sources and policies are discussed. Should existing energy policies which formed mostly by importing energy (natural gas) from the neighbors' countries continue or should find different alternatives such as local energy sources (wind and solar energy) and nuclear energy be evaluated. Then, the potential of the local renewable sources convenient for Turkey, such as wind and solar are investigated and compare with the nuclear energy. The advantages and disadvantages of nuclear energy usage, as well as the place of nuclear energy in electricity production in the world are scrutinized. It is clear that the usefulness of nuclear energy and nuclear power plants depend heavily upon the progress in technical developments. Improving technology on operation systems and waste problems of them brings more secure and more environment friendly power plants. Finally, our current energy consumption and energy need in short and medium term (+50) conducted for the evaluation of nuclear power plants are discussed.

Keywords: Nuclear energy, wind energy, solar energy, Turkey.

I. INTRODUCTION

In 1942, Fermi and his team came together at the University of Chicago to establish the first reactor of the World Chicago-1. In the following years, the Russian Government's studies on nuclear energy concluded with the first operation of a small nuclear power plant (NPP) in Obninsk in 1954 (nuclear.org, W.L. Cisler, 1956). The first commercial NPP was Dresden-1, which began servicing in April 1960 in the USA, after the first reactor time; the nuclear power projects have been extensively increased and developed all over the World. In the period of 1960-70, on average every two months, and in the period of 1970-80, every three weeks, an NPP began to be deployed (reactor data 2016 neinuclearnotes 2017). Today, NPP around the World have a power rate of 372,686 MW. There are 449 nuclear reactors for electricity generation and 60 new nuclear plants are under construction in 15 countries (S. David Freeman, 2017, Serteller 2016). Turkey has followed these projects theoretically during these years, except for two small reactors for academic studies. However, for the last two years, the projects for building nuclear power plants have accelerated due to the increasing demand for electrical energy and defecating and external dependency. Nowadays, in Turkey, the design and planning phase has begun to turn into the construction phase (Energy and Natural Resources Ministry, 2016; N.F. Serteller, 2006).

Energy is central to all human activities and it is needed to accomplish the most basic task. It has also been established that there is a link between access to energy and development, the more energy consumed creates the greater economic activities in area (F.M. Dahunsi, 2013). Increasing in the energy consumption brings technological developments and progress of the human rate. It is this reason that energy has been called "the lifeblood of a nation". Thus, the high standard of living enjoyed by the developed nations is the result of the consumption of abundant and cheap energy. Until now, mostly the World's energy has been dominated by the burning of hydrocarbons in the form of coal, oil and natural gas. Although the global warming about the greenhouse gases have been articulated for more than two decades there has been no discernable impact on fossils fuel consumption. Clearly, the concerns have not been translated into action. As it is same in Turkey where it is energy production is highly dependent on imported natural gas (Figure 1, source: EPDK report 2016-2017) and imported fossil and produced fossil energy (EPDK report 2016-2017; TEIAS 2015-2019). The fear of using fossil energies raising the level of greenhouse gases, especially CO₂ which induce irreversible climate change has stimulated the search for alternative energy sources, such as renewables and nuclear energy. As a result of rapid consumption and burning of fossil fuels, the environmental disasters directed humankind towards new energy sources. This energy sources mainly predicted to be nuclear and the renewable energy sources. Renewable energy sources such as solar, wind, biomass, geothermal, and natural

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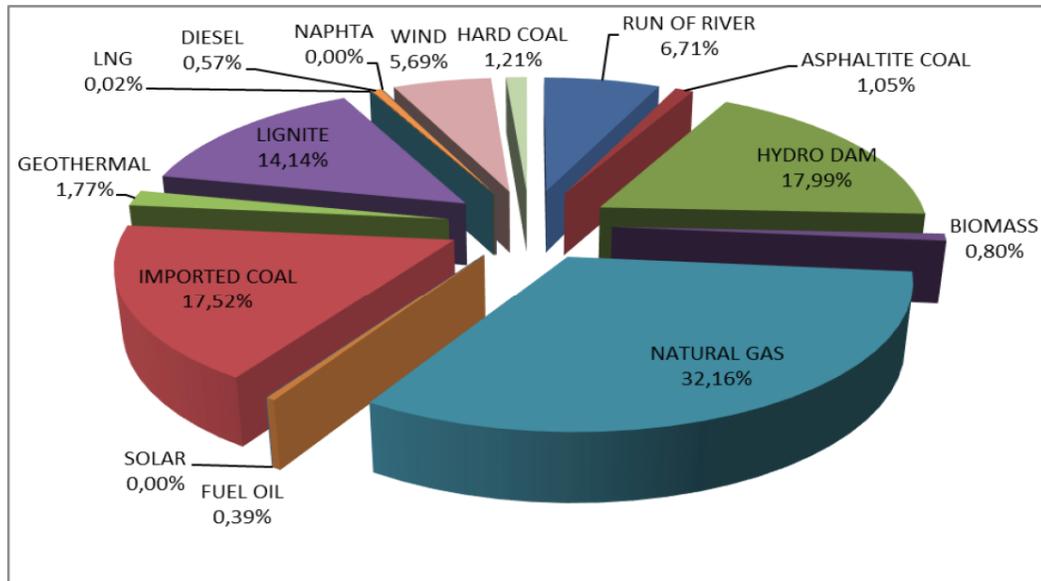


Figure 1: Present energy supplement by plant type in Turkey.

gas have been gaining wide popularity because of their clean, safe, and environmentally friendly energy production. In this paper, two (solar and wind) are discussed because besides their advantages as renewable energy, there is a proportion in Turkey. However, in recent years, Turkey has brought the NPP to its agenda (TEIAS 2015-2019; EPDK, 2016). There are several reasons to discuss NPP; firstly, the large rise in energy demand, secondly, nuclear technology is being placed at a more and more secure level, thirdly, rapidly improving nuclear waste technology and finally, it is environmentally friendly (at continuous operation). In Turkey, the improving energy efficiency and energy security and environmentally friendly energy production should be high priorities. In this way, NPPs for energy production, excluding any accident or leak condition, look suitable for electric power system service. The following sections discuss solar, wind, and the nuclear energy briefly.

II. ENERGY SCENARIO IN TURKEY

In all areas of modern life in which we witness large developments, the need for energy is increasing at a very fast rate because of the rapid population growth and technological development. Energy consumption has become one of the parameters to determine the economic growth and development levels of countries in the international arena. Achieving sustainable development is possible by keeping the balance between economic, environmental and social dimensions (HT Nguyen 2015; L. Ozturk, 2010; neinuclearnotes 2017). It is vital to implement

appropriate energy policies, and to provide the security of energy supplies for sustainable development. The security of energy supplies can be provided by getting energy from continuous, safe, cheap, clean and diverse sources, and by using it in productive ways (Dahunsi, 2013). Moreover, because of insufficient energy policies, Turkey, which is not some country rich in fissile materials - except for lignite - which are mainly used in the generation of clean energy, has become a country that is heavily dependent on imported energy sources. Besides, the large rates of illegal and inefficient use of energy sources, means that Turkey has been lagging behind about turning towards renewable energy sources and nuclear option.

Energy demand of human progressing causes some economic and environmental problems. It is desirable that energy should be continuous, reliable, provided at a minimum cost and plentiful enough to meet the demand for increased energy. These criteria should be taken into consideration when exploring or requesting energy resources (L. Ozturk 2010; Dahunsi, 2013) When these criteria are taken into account, two important sources of energy together with nuclear energy, and renewable ones, so that they are clean and environmentally friendly (steady state operation) are being discussed for Turkey. Wind and solar energy are of great importance because they are both renewable, i.e. not harmful to living things, and can last more than other energy types and in some ways are economical. However, they have some disadvantages, which will discuss in further sections as wind, solar, and nuclear energy.

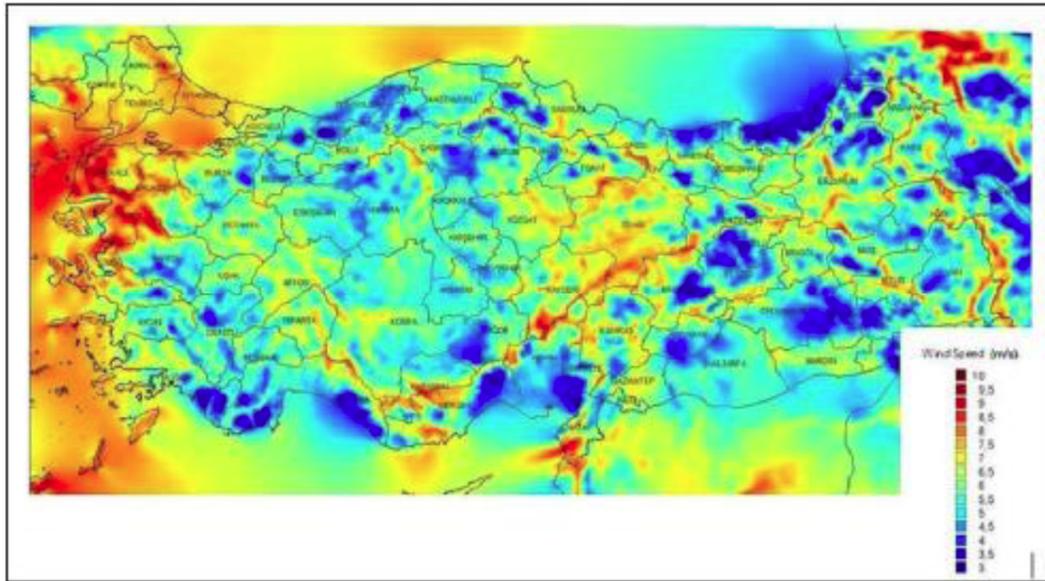


Figure 2: Map of Turkey's Wind Energy Potential, the Distribution of Average Wind Speed in 80 m. of Elevation above Ground.

A. Wind Energy in Turkey

Electric Production from wind energy was initiated in 1998 in Turkey. However, in recent years, with the progressing of suitable laws and reinforcement of renewable energy sources by the government, establishment of wind energy power plants has been increased stably. Turkey's wind energy is in the range of "good-extraordinary" wind potential, and it is estimated that windy areas can support a potential wind power of about 48,000 MW as seen in Figure 2, source: EPDK, Wind Energy Potential of Turkey, EIE, Ankara 2016, shows the total wind energy potential of Turkey.

Although wind's potential of Turkey looks suitable and sustainable in medium and long term, the first problem, the wind energy power stations established in coasts with intense tourism activity, this may lead to problems between energy production and tourism activities in terms of the land use.

Table 1: Wind Energy Potential Data Per Year

Turkey's Annual Energy Need	250.000 MW
Turkey's Total Wind Potential	48.000 MW
Cost of a wind power plant	\$1 million
Energy produced by a wind power plant	5.000 KW

Table 1 gives the total energy potential of Turkey in numbers. As we have observed clearly from Table 1; second problem on wind energy is the big amount of

difference between Turkey's total wind energy potential with total energy need for Turkey per year and unfortunately, it is constantly increasing. With intense and fast technological development, wind energy is unable to reduce its costs and is becoming increasingly more competitive with conventional based generating technologies (C. Iikilic, 2012; J. Serrano, 2016). However, in Turkey even if we assume that a wind power plant will generate the energy of 5,000 KW, it is clear that wind energy alone will not be sufficient for electricity generation, so the demands of the energy gap cannot be filled with wind energy and there must therefore be an alternative.

B. Solar Energy Potential in Turkey

Due its geographical location, our country is more fortunate than many other countries in terms of potential solar energy (Figure 3). The solar collector area in our country is approximately 12 million m² and its annual production volume is 750 thousand m². The annual production of heat energy generated from solar energy is around 420 thousand TEP (Ton Energy Petrol) (EPDK, 2016). Turkey's average annual sunshine duration is 2640 hours, which equals a total of 7.2 hours per day. Although Turkey does not have a large source of solar energy to provide electricity, it has big potential compared to other possible renewable sources (A.E. Ozdemir, *et al.* 2017). In this context, public and private companies in our country should be encouraged to take advantage of alternative energy sources; especially solar energy. These systems are used especially in remote and small areas where there

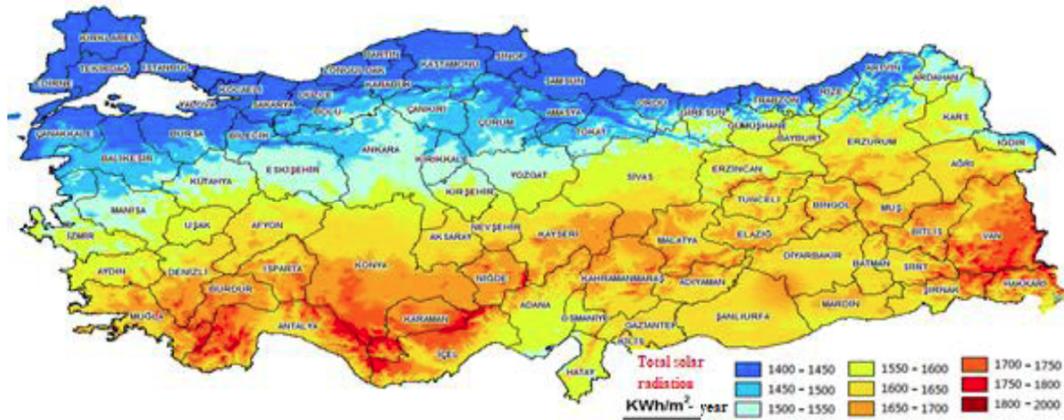


Figure 3: Solar Map of Turkey.

are no electricity networks and where it is difficult and expensive to transport fuel to generators. However, assuming our solar energy technical potential is 76 Million Tons Equivalent Petroleum (TEP), our potential for benefiting from solar energy is still very low since it is greatly influenced by the climate conditions. So, to predict the solar radiation which varies with the seasons, and atmospheric conditions is very difficult in Turkey (R.Z. Öztürel, *et al.*, 2001).

In Figure 3 source: EPDK, 2016 and TEIAS 2015-2019, in all regions in Turkey except the north of Turkey, solar energy potential seems to be positive. The Southeastern Anatolia Region (Southeastern Turkey) is Turkey's highest solar energy field. The Turkish Mediterranean Coast (South of Turkey) follows it. With these values, it is clear that they will not be able to meet the increasing energy demand in Turkey alone, and it is obvious that large solar panels are not very useful in Turkey, which is an agricultural country, for source: R.Z. Öztürel, *et al.*, 2001 and N.F. Serteller 2016. The sun seems a clean but insufficient source of energy to meet the high-energy need in Turkey.

C. Why are Nuclear Power Plant Necessary?

The fact that oil prices are rising inexplicably, and the prices of natural gas and imported coal to a certain degree, which our country is mostly dependent on for electricity, follow oil prices. Hence, all these realities have made nuclear power plants an alternative in terms of fuel diversity for our electricity needs, which increase about 8% annually (The big difference between present fossil fuels and nuclear fuel is the tremendous heat potential in relatively small amounts of nuclear fuel, which have the large advantage over nuclear energy (V. ALTIN. In a studies (M. Ozcan, 2015; M.M. arwan *et al.* 2013; Reactor data 2017), what has been shown

that accidents are unpredictable and made nuclear plants unsafe. However, with the development of technology and new generation power plants, these are now reliable sources (Reactor data 2017; <http://www.world-nuclear.org> 2016). Frightener steps of realization of reactions and stages of destruction of wastes have become safer with help of studies (neinuclearnotes 2017; M., Marwan, 2013) on the reactor theories. Security measures are extraordinary especially in the recently built nuclear power plants. Presently due to the use of pressurized water, reactor and fully automated power control make the NPP very secured and sustainable (neinuclearnotes, 2017, D.M. Digby 2014; N.F. Serteller, 2016). In addition, nuclear reaction does not produce greenhouse gases while it is normal operating. Emission of greenhouse gases increase dramatically for the last 50 years parallel to the increasing fossils fuel consumption. It is known that fossil fuel usage is one of the anthropogenic activity triggering the climate change due to the contribution to the greenhouse effect (A.E., Ozdemir, *et al.*, 2016). Thus, NPP is sustainable in nature and saves the earth from the dangerous effects of toxic greenhouse gases (CO₂).

Table 2: Energy Values of Various Fuels

1 Kg Wood	1 KWs
1 Kg of U ₂₃₅	1.300.000 kg coal
1 Kg of Coal	3 KWs
1 Kg of Oil	4 KWs
1 Kg of Uranium	50.000 KWs
1 Kg of Plutonium	6.000.000 KWs

In Table 2 shows, clearly that nuclear energy is a much cheaper energy to generate than other types of

energy sources. However, the cost of establishing the plant is high. However, once the plant has been established, energy generation becomes much cheaper and cleaner (N.F. Serteller, 2016).

III. CONCLUSION

It is well-known fact that the electrical energy is the most important factor for the human civilization. However, the production of the electrical energy is the major anthropogenic, economic and environmental problems. This paper presents a framework to meet the increasing energy demand in Turkey. The major component in the framework are the production of clean, sustainable and environmentally friendly energy such as solar and wind for a small area. However, it is mentioned again in text, the potential of these energy sources are not sufficient in Turkey. Considering Turkey's current and increasing huge and constantly increasing energy demand, environmentally friendly (steadystate condition), developed and reliable nuclear plants must also have taken into account and beyond that to be carried out solve energy problems in the short and medium term. As we seen clearly in paper, there is a need for mixing variety of energy type to meet sufficient and efficient energy production.

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