NUCLEAR POWER IN TURKEY: PROS AND CONS

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Abstract

Turkey, with an increasing demand and consumption for electricity, is in need of finding a sustainable source for electricity production. The country has a huge current account deficit most of which results from its energy imports. Plans for nuclear power construction are a key aspect of the country's aim for sustainable economic growth. In Turkey building up a nuclear power plant has always been a hot topic for discussion at least for 40 years. Most people in the country are against having a nuclear power plant because of its risks. As a country which had closely witnessed and experienced the consequences of Chernobyl nuclear disaster in 1986, it seems really difficult to convince people completely on the benefits of having a nuclear plant within the borders. On the other hand, while public discussion continues, Turkish government unfortunately, until the year 2013 had never achieved to finalize nuclear power plant projects due to economic reasons. In this paper we will examine the pros and cons of having nuclear power plants in Turkey mostly in terms of economic aspects considering economic and social costs as well as economic gains. In addition we will look at Turkey's nuclear energy policies. We will also mention about environmental effects debates of the nuclear power plant in the country.

Key Words: Turkey, Nuclear Energy, Cost, Challenges, Benefits

Nuclear Power in Turkey: Pros and Cons

Nuclear power has always been some part of Turkey's future plans so far in the history. Current government also has been using future nuclear power projects as a strong card for the elections as well.

Nuclear energy in Turkey has been presented by the government as cheap, sustainable, and environmentally friendly and is seen by many as a powerful way to diversify the country's energy portfolio while at the same time reducing energy dependence. The Energy Ministry emphasizes nuclear power's relatively low cost and high sustainability as the main reasons for pursuing the project. Former energy Minister Hilmi Guler stressed that nuclear technology would be beneficial to development, would provide a threshold for attaining high-tech products, and would contribute to Turkey's prestige. (Udum, 2010)

For a variety of reasons, including public opposition, high capital cost and financing difficulties, and insufficient governance and management capacity on the part of the state agencies, Turkey has not been able to build its first nuclear plant yet. At the same time, Turkey is closer to its first nuclear facility that the country has been pursuing since the 1970s. The official goal is 5% nuclear by 2020. Given that renewables are still costlier than conventional technologies and intermittent, and have low capacity factors, nuclear offers another option for Turkey to diversify its energy portfolio with an emissions-free technology. Perhaps, the biggest concern is the lack of an independent nuclear regulator and a ''safety culture'' in state institutions that is commensurate with the risks inherent in nuclear operations. A five-page nuclear law is not sufficient to instill confidence that Turkey is institutionally ready to build and operate a nuclear facility, and manage radioactive waste properly. (Atiyas et al., 2012)

Yet, nuclear energy remains expensive with costs increasing more than any other technology in the last decade. Most importantly, as reminded by the Fukushima Daiichi accident, nuclear power plants can be dangerous if they are not managed well and regulated properly beginning with the site selection process and following through with safety inspections during construction and operation.(Atiyas et al., 2012)

Proponents of nuclear power have made several arguments to support their cause. They argue that nuclear energy would not only fulfill Turkey's future energy demands and prevent a shortage, but would also facilitate rapid development in other sectors. As Turkey's dependence on natural gas increased, nuclear energy proponents drew attention to the increasing demand for electricity and the growing dependence that kept energy costs high, turned the trade balance to Turkey's disadvantage, and constrained its diplomatic negotiating power. They also argue that because Ankara has ratified the Kyoto Protocol, fossil fuels are not a good option for Turkey to address its energy needs, and that renewable resources are insufficient to make up the gap. In addition, proponents regard a nuclear energy program as a matter of prestige. Overall, they argue that nuclear energy will have beneficial economic, political, and security aspects, as well as be conducive to environmental protection and development goals. (Udum,
2010)

Opponents in Turkey, on the other hand, perceive nuclear power as dangerous and disadvantageous. They argue that nuclear energy is costly and that nuclear energy plants threaten human life and the environment because of the risk of radioactivity related accidents, the unresolved waste disposal issue, and the threat of proliferation. More importantly, they do not believe that Turkey is facing a dire future energy shortage, and maintain that the contribution of nuclear power could well be substituted for by a combination of local and renewable resources and energy efficiency measures such as upgrading existing infrastructure. Opponents also question the rationale of the decision to pursue nuclear energy, arguing that political concerns and bureaucratic interests might be at play instead of technical assessments of supply and demand. The opposition includes civil society organizations with an emphasis on the environment. In Table 1 you can see the details of nuclear energy debate in Turkey.

Table 1
Nuclear energy debate in Turkey

Supporters	**Dissenters**
Nuclear energy is necessary for Turkey: it will meet future demands, decrease energy dependency, and contribute to development.[b]	Projections of a future energy shortage scenario are exaggerated. Nuclear energy is disadvantageous; the costs exceed benefits.[c]
Nuclear energy is urgent because its absence is a threat; without it Turkey will have darkness and dependency.[d]	Nuclear energy is a threat because of radiation accidents that could have lethal impacts on humans, tourism, the environment, agriculture. Chernobyl is proof; the waste issue is also unresolved.[e]
Nuclear power compares favorably to fossil fuels and renewables.[f]	Other alternatives exist: renewables (solar, wind, hydro, biomass, thermal), the efficient use of energy.[g]
Nuclear energy will augment Turkey's power in national security, economic, environmental, and developmental aspects, and it will increase its status and prestige.[h]	Decision makers are irrational and immoral: nuclear power plants are dangerous, costly, and threatening; the developed world is giving up on nuclear, but Turkey is pursuing it.[i]
Opposition is irrational, misinformed, or collaborating with foreign powers to keep Turkey non-nuclear and weak.[j]	The government is irrational and immoral: it is influenced by the nuclear lobby and pursues bureaucratic interests at the expense of its citizens.[k]
Turkey's security is at risk: Iran's nuclear program is worrisome. The United States and the EU are not reliable. Nuclear technology will create infrastructure for a proliferation option—not a bad thing.[l]	Nuclear power plants are gateways to proliferation, which is a serious threat.[m]

Source: Udum, 2010

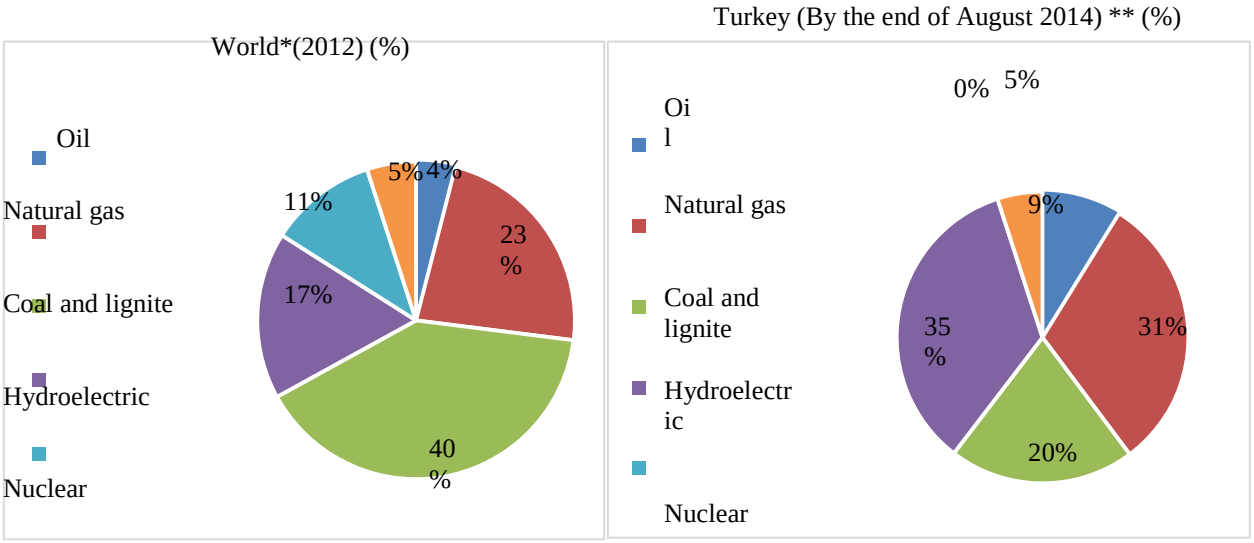
In some countries in Europe, such as Switzerland and Germany, the governments announce publicly that they are not going to build up new Nuclear Power Plants when their currently working plants complete their operation. On the other hand some other European countries such as Sweden and France seem quite committed to continue their nuclear power programs. When we look at Asia, fast growing countries like South Korea and China are still trying to construct new Nuclear Plants in addition to their existing plants.

Some countries seemed to be discouraged by nuclear accidents and they paused their nuclear operations for a while however they start rebuilding nuclear power plants again.

Turkish economy has an annual growth rate of 7-8% on the average in the long term. Therefore it has a rising demand for electricity. Turkey has been a dependent country for energy. It imports almost all of its gas and oil. In 2013, Turkey had a current account deficit of 64.9 Billion dollar. Turkey had total energy imports of 55.9 billion dollar which accounts for 22.2% of all country's imports. (Central Bank of Turkey, 2013). Therefore, either with starting up with nuclear power projects or finding new alternatives, the country should find ways to reduce energy import bills and its energy import dependent situation.

Figure 1

Breakdown of electricity generation by resources in the world and in Turkey



**The Shift Project Data Portal from http://www.tsp-data-portal.org/Breakdown-of-Electricity-Generation-by-Energy-Source#tspQvChart*
*** http://www.teias.gov.tr/YukTevziRaporlari.aspx*

When we examine Figure 1, we obviously see that oil and natural gas the resource of almost 40% of Turkey's electricity production. This situation causes a continuous and unreducible current account deficit in Turkey's balance sheet as the country imports almost all of its gas and oil. In search for a solution to this problem, politicians in Turkey are really keen supporter of constructing a nuclear power plant in Turkey. In general, in the country having a nuclear power is associated with being a powerful country, so most people except for environmentalists are for the construction of the plant.

The biggest argument of people who are against building a nuclear power plant in the country is that they claim that all European countries are closing down existing plants due to its dangers. When we analyze Table 2 we can see that the highest number of nuclear power plants under construction are in eastern countries such as China, Russia and India. On the other hand we can see from the table that the highest number of nuclear power plants under operation are in western countries such as USA, France, UK and Germany.

Table 2
Number of NPP for first 18 biggest countries in the World

Countries	Net Energy Import (%)	NPP in Electricity generation	Number of NPP in operation	Number of NPP under
USA	22	19%	104	3
China	11	2%	16	28
Japan	86	18%	50	2
Germany	64	18%	9	-
France	53	78%	58	1
Brazil	15	3%	2	1
UK	37	16%	16	-
Italy	81	10%*	-	-
Russia	-72	18%	33	11
India	32	4%	20	7
Canada	-40	15%	20	-
Spain	75	20%	8	-
Australia	-135***	0%	1**	-
Mexico	-13	4%	2	-
S.Korea	86	35%	23	4
Indonesia	-88.78	0%	-	-
Netherlands	32	4%	1	-
Turkey	72%	0%	-	-
S.Arabia	-116	-	-	1

Notes: Italy has had four operating nuclear power reactors but shut the last two down following the Chernobyl accident. Some 10% of its electricity is now from nuclear power – all imported. The government intended to have 25% of electricity supplied by nuclear power by 2030, but this prospect was rejected at a referendum in June 2011. (World Nuclear Association, 2013. Retrieved from http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Italy/)*
***For research purposes only.*
**** World Bank, 2013 (Retrieved from http://data.worldbank.org/indicator/EG.IMP.CONS.ZS)*
****Minus values mean those countries are energy exporters.*

The first commercial nuclear power stations in the world started operation in the 1950s. There are over 430 commercial nuclear power reactors operable in 31 countries, with over 370,000 MWe of total capacity. About 70 more reactors are under construction. They provide over 11% of the world's electricity as continuous, reliable base- load power, without carbon dioxide emissions. 56 countries operate a total of about 240 research reactors and a further 180 nuclear reactors power some 150 ships and submarines. Nuclear technology uses the energy released by splitting the atoms of certain elements. It was first developed in the 1940s, and during the Second World War research initially focused on producing bombs by splitting the atoms of particular isotopes of either uranium or plutonium. (World Nuclear Association, 2014)

In the 1950s attention turned to the peaceful purposes of nuclear fission, notably for power generation. Today, the world produces as much electricity from nuclear energy as it did from all sources combined in 1960. Civil nuclear power can now boast over 15,500 reactor years of experience and supplies almost 11.5% of global electricity needs, from reactors in 31 countries. In fact, through regional grids, many more than those countries use nuclear-generated power. (World Nuclear Association, 2014)

Now 31 countries host over 430 commercial nuclear power reactors with a total installed capacity of over 370,000 MWe. This is more than three times the total generating capacity of France or Germany from all sources. About 70 further nuclear power reactors are under construction, equivalent to 20% of existing capacity, while over 160 are firmly planned, and equivalent to half of present capacity. (World Nuclear Association, 2014)

Sixteen countries depend on nuclear power for at least a quarter of their electricity. France gets around three quarters of its power from nuclear energy, while Belgium, Czech Republic, Hungary, Slovakia, Sweden, Switzerland, Slovenia and Ukraine get one third or more. South Korea, Bulgaria and Finland normally get more than 30% of their power from nuclear energy, while in the USA, UK, Spain and Russia almost one fifth is from nuclear. Japan is used to relying on nuclear power for more than one quarter of its electricity and is expected to return to that level. Among countries which do not host nuclear power plants, Italy and Denmark get almost 10% of their power from nuclear. (WNA, 2014)

Nuclear power plants also need significantly less fuel than those generating power through the use of fossil fuels. One ton of uranium can produce more than 40 million kilowatt-hours of electricity, which is equivalent to burning 16,000 tons of coal or 80,000 barrels of oil. (Davis, 2011)

There is also this matter of the 'fading away' of the global nuclear sector, that is so heartily desired by various people and parties. At the present time, there are roughly 433 reactors in operation, while, at the beginning of 1999, another 36 were under construction, mostly in Asia. If the present estimates of world population growth are even approximately correct, unless per capita energy requirements sink drastically, or some developments in the near- miracle class take place with unconventional energy resources, then a more systematic wave of reactor construction is unavoidable. In addition, something that many observers refuse to understand is the macroeconomic implications of choosing high-cost, as compared with low-cost, energy: countries that have the opportunity to utilize safe, economical nuclear power, but refuse to do so, will find their international competitiveness decreasing relative to those with another point of view.(Banks, 2000)

Turkey has had plans for establishing nuclear power generation since 1970. Today, plans for nuclear power are a key aspect of the country's aim for economic growth. Application has been made for construction and operating licenses for the first plant, at Akkuyu in early 2014. A renowned Czech research and development and engineering company focused on nuclear technologies has been invited to sign a contract in mid-august 2014. In 2012 Turkey’s electricity production was 240 billion kWh gross from 53 GWe of plant. Of this, 105 TWh (44%) came from gas (two thirds of this from Russia, most of the rest from Iran), 68 TWh (28%) from coal, and 58 TWh (24%) from hydro. Net import was 3 TWh. Demand growth is about 8% pa, and in the first half of 2012 consumption was 119.3 billion kWh. Per capita consumption has risen from 800 kWh/yr in 1990 to about 2500 kWh/yr. Demand in 2023 is expected to be 450 billion kWh, implying new investment by then of $100 billion. Peak demand was 40 GWe in first half of 2013.

Plans for nuclear power are a key aspect of the country's aim for economic growth, and it aims to cut back its vulnerable reliance on Russian and Iranian gas for electricity. The Ministry of Energy and Natural Resources (ETKB) projects 2020 electricity production as possibly 499 TWh in a high scenario of 8% growth, or 406 TWh with a low one with 6.1% growth.

Plans are to have 30 GWe of coal-fired capacity by 2023. However, much of the country's coal resources are lignite with low calorific value – less than 12.5 MJ/kg, and a substantial amount (Afsin Ebistan) at less than 5 MJ/kg. (WNA, 2014)

Today, Turkey has plans to build up 2 nuclear power plants. One is on the north coast of Turkey near a city named Sinop. The other one is planned to be located in the south coast of Turkey near a southern city of Akkuyu.

Akkuyu nuclear project has an estimated investment cost about US$ 20 Billion. Akkuyu plant will have four 1200 MWe AES-2006 units. The plant is estimated to be paid off in 15 years. The first plant is planned to be operational in 2018 and the other plants will be active in 2019-2021.

Sinop nuclear project will be accompanied with EUR 1.7 billion nuclear technology center. It will have a capacity of 5600 MWe and is expected to have an overall cost about $20 billion.

Turkey imports much of its energy, including nearly all of its oil and gas, and in 2012 this amounted to more than $60 billion. Improving energy efficiency and energy security are high priorities.

Considering Turkey's yearly energy bill that is about $60 billion, the cost of constructing two new nuclear plants is not too high for the country.

In May 2010, Turkey appeared to be taking additional steps toward developing nuclear energy. During a visit to Istanbul, Russian President Dmitry Medvedev singed a series of agreements with his Turkish counter- part, Abdullah Gul and met with Prime Minister Erdogan. At the top of the bilateral agenda were agreements furthering plans for an oil pipeline from the Black Sea to the Mediterranean. In addition, a deal was signed for Russian assistance in developing a nuclear power plant near Mersin on the Mediterranean.[23] Reactions to the nuclear agreement were not universally favorable. Necdet Pamir, a Turkish energy expert, was quoted as saying that, "if we add dependency on nuclear energy on top of the current energy trading from Russia, it's inevitable that we get concerned. Those concerns may explain Turkey's subsequent decision to hold talks with a South Korean consortium for other future nuclear power plant development. (Caravelli, 2011)

Advantages of Nuclear Power for Turkey

First of all, by building up two new nuclear power plants Turkey will be able to reduce its energy bills considerably. Since it imports most of its oil and gas, nuclear plant project will help to assure the security of electricity supply. Most important environmental positive effect is reduced greenhouse gas emissions.

Since nuclear power plant uses uranium reserves, they have high level of potential reserves which will be adequate for all nuclear power plants for at least 150 years more. Nuclear power plants supply very high level of energy compared to the volume of its raw material. For example, whereas 1000 gram coal produces 3 KWh electricity, 1000 gram oil produces 4 KWh energy; 1000 gram uranium produces 50,000 KWh electricity. (TAEK, 2010)

Nuclear power plants have a little cost of raw material since a very small volume of raw material is used for electricity generation. This makes nuclear energy a very advantageous source compared to fossil fuel utilizing electricity generation. (Temurcin and Agaoglu, 2003)

Compared to other electricity generation plants using other sources, nuclear power plants use a small portion of land. In addition, it is possible to recycle nuclear waste. By the help of high technology re-processing nuclear waste of uranium or plutonium etc. makes it possible to use them to produce fossil fuels. Also in nuclear power plants, fuel can be stored for 10 years which helps to have a sustainable source and therefor reduces external dependency. (TAEK, 2010)

Due to the safety measurements taken in nuclear power plants risk of accidents is very low. People have a hard time estimating some kinds of risks. For example, they fret about the safety of fly-ing but show little concern for driving, despite statistics showing that cars kill vastly more people than planes do.

Similarly, incidents like Chernobyl, Three Mile Island, and Fukushima capture our attention but mislead us as to the risks. Statistics from the World Health Organization and other sources suggest that coal kills about 4,000 times as many people per unit of energy produced as nuclear power does. That counts only here-and-now effects such as air pollution and ignores long-term damage due to climate change.

A close look at Fukushima is instructive. The tsunami killed about 16,000people; radiation from the reactor has killed none. In fact, the nuclear accident was entirely preventable. The plant has a 40-year-old design lacking modern safety features. Worse, it was designed to withstand only 5.7-meter tsunamis in a region known to endure waves of 20 meters or more. Numerous design decisions proved disastrous. (Myhrvold, 2014)

As opposed to the popular belief nuclear power plants protect the environment. A coal electricity generation plant with a capacity of 1000 MWh releases 7 million tons of CO2 gas and 140 thousand tons of gas containing acid (sulfide and nitrogen oxide) and 750 thousand tons of ash by using 3 million tons of coal. By considering these values nuclear power plants with a fifty years of history helped to use about 6000 million tons less coal during this period. Therefore, the release of more than 15 million tons of CO2 emission and 250 million tons of acidic gas and carcinogenic organic burning products have been avoided from the nature. Apergis et al (2010) suggest in their Granger causality tests that in the short-run nuclear energy consumption plays an important role in reducing $C0_2$ emissions whereas renewable energy consumption does not contribute to reductions in emissions.

Harrison and Hester reports that the attractiveness of nuclear power then, as the Intergovernmental Panel on Climate Change (IPCC) suggests, is because "the life cycle GHG emissions per kWh from nuclear power plants are two orders of magnitude lower than fossil-fuelled electricity generation and comparable to most renewables. (Harrison and Hester, 2011)

France is often held up as an example of what can be achieved in terms of emissions reductions when nuclear power forms a large part of the electricity supply, for it generates 75% of its electricity from nuclear power and emits 6.6 tons of C02 per capita, compared with 10.4 tones per capita for Germany. A recent report from the MIT on the Future of Nuclear suggests that nuclear-generating capacity he increased almost three-fold to 1000 billion Watts by
2050, thereby avoiding 1.8 billion tons of carbon emissions annually from coal plants (about 25% of the increment in carbon emissions otherwise expected in a business-as-usual scenario).

From a strict climate change perspective, nuclear power is an improvement over conventional coal-burning power plants. A nuclear power plant does not directly produce greenhouse gas emissions (unless it is running idle, being refueled or operating on backup generators) and it emits about one-tenth to one-twentieth the carbon dioxide emissions over the course of its lifecycle as compared with a comparatively sized conventional, fossil-fuelled power plant.

Still, reprocessing and enriching uranium requires a substantial amount of electricity, often generated from fossil fuel-fired power plants, and uranium milling, mining, plant construction and decommissioning all generate greenhouse gas. A recent review which assessed the most cost effective low carbon base load electricity-generating technology concluded that "nuclear energy is the cheapest option and best able to meet the IPCC timetable for GHG abatement. Whilst there would be large financial costs involved in any new nuclear program, proponents argue that all of these potential costs are insignificant compared with the risks posed by climate change. (Harrison & Hester,
2011)

According to a study conducted by Zwaan (2013) on average, GHG emissions are today around two orders of magnitude lower for nuclear energy than for conventional coal-based power production. This article also addresses the feasibility of potential deployment scenarios.

Furthermore, since nuclear power plants are designed for energy production, actually there is not risk of proliferation in these plants. Nuclear weapons needs other technology and facilities other than plants. (TAEK, 2010) Some other advantages of nuclear power in Turkey from the advocates' point of view are as follows (Ozden, 2003):

-It is a more economical since the price of energy generated from the nuclear energy power plants is much cheaper than the other conventional power plants.
-The damage to the environment is not as bad as what occurs with the fossil-based energy power plants (such as depletion of the ozone layer).
-Cutting trees from the forest for use in burning is an important side effect of the environment.
-Use of nuclear energy power plants will help protect our natural resources, such as industrial raw materials, petroleum, coal, and natural gas.
-It provides a clean energy source.
-The construction of power plants does not need too much space.
-Its construction is cheaper than the hydroelectric power plants.
-It assures a steady production of energy over the year.
-There are fewer waste products compared with other sources._
-The world has a 100 year uranium reserve.
-Fossil energy resources are declining.
-The power plants produce only water vapor.
-Nuclear energy improves nuclear medicine.
-It resolves the electrical energy problems.
-It helps improve the economy

When we talk about economic benefits of nuclear power for Turkey, we should not disregard job opportunities benefits of nuclear sector. The Nuclear Energy Institute (NEI) estimates that private investment in new nuclear power plants has created 14,000 to 15,000 clean energy jobs over the last few years in the US alone. Operation of a nuclear power plant not only generates 400 to 700 permanent jobs, but jobs that pay as much as 36 percent more than average salaries in the area they are located. On the other hand, Payne and Apergis (2009) and Apergis et al. (2010) have found out in their panel vector error correction model study that there is a bidirectional causality between nuclear energy consumption and economic growth in the short-run while unidirectional causality from nuclear energy consumption to economic growth in the long-run. Thus, the results provide support for the feedback hypothesis associated with the relationship between nuclear energy consumption and economic growth.

Rabl and Rabl (2013) reported in their study, where they compare the external costs of nuclear power and its alternatives, which wind power with the lowest external cost are still higher than nuclear power external costs due to natural gas backup for storage needs. Technical assessment studies indicate that Turkey has large wind, solar, hydro, and geothermal resources, especially relative to its energy needs but the estimates cover a wide range. Hence, a cautious approach to these resource estimates is warranted, especially given the fact that these resources have not been used much with the exception of hydro. (Atiyas et al, 2012).

According to Turkish Renewable Energy Law which is in compliance with European Law, the government needs to give price support to renewable energy generated electricity. This poses a big question for the government. Given that renewables are still costlier than conventional technologies and system operators have to deal with intermittency and low capacity factor, like any rapidly growing country without significant hydrocarbon resources.

Table 3
Renewable energy resources in Turkey

	Theoretical	Technical	Economic
Hydro	433 TWh	216 TWh	125 TWh
Wind	88 GW	83 GW	10 GW
Geothermal	4.5 GW	2 GW	22 TWh
Solar	102 TWh	102 TWh	1.5 TWh
Biomass	197 TWh		197 TWh

Source: Atiyas et al, 2012

Although renewable energy resources are technically large, only a small percentage of these resources can be expected to be brought online on a commercially viable basis.

Thorium is another important source to consider while discussing about nuclear power plants. The amount of the thorium reserves of Turkey are disputed by different sources. Some reports state that Turkey has the second order in thorium reserves in the world with 380,000 tons. However, it was also reported that Turkey is the first country having about 800,000 tons of thorium reserve with a share of 52% in the world. All technical parameters obtained from the studies on use of thorium as nuclear fuel (thorium fuel cycle) during the last 50 years indicate that in case of developing the technologies based on thorium fuel cycle systems, thorium will probably be a nuclear material much more valuable than uranium in the future. Thorium fuel cycles have been studied in the past in several countries on a smaller scale but its importance has increased in recent years as a non-proliferating fuel and also for reducing the inventory of plutonium (Pu). Thorium-232 is three times more abundant than uranium and available in India, Brazil, US, Turkey, and China. It is not a fissile material but it can produce U-233 in a reactor, which, from a neutronic standpoint, is an excellent nuclear fuel among the fuels, U-235, Pu-239 and U-233. It also produces fewer minor actinides from fission and radioactive waste, goes to higher temperatures, and allows reactors to operate in a safer mode. Thorium-based reactors as special interests in the use of thorium fuels are being investigated in Germany, US, Russia, Israel, Japan, China, and Holland. (Uslu, 2010)

Disadvantages of nuclear power for Turkey:

Although nuclear power plants have many economic and environmental benefits, we need to mention about potential risks and dangers that may constitute a disadvantage for the countries. First of all, because of radioactivity, nuclear power plants not only both before the production and during the production process but also at the end of the production pose dangers because of nuclear wastes. Nuclear wastes do not lose 99% of their poisonousness even after 600 years. (Cohen, 1983)

Despite the fact that uranium material has a very small volume, since a very wide land is processed while exploiting uranium mines, it causes enormous amounts of waste. For example in order to obtain 1 ton of uranium, 20 thousand tons of waste is released.

There is a potential danger as well posed during the transportation process of used nuclear fuel to the handling facilities and during the transportation process of high level risk waste to the burying zones. (Cohen, 1983). Furthermore, recycling spent fuel is also an expensive procedure and it runs much greater proliferation, terrorism and nuclear theft risks. (Sokolsky, 2010)

Nuclear power plants can be constructed in those areas with specific geographical features. Raw material location is not a key factor while selecting the location of the plant. The most important issue to consider here is the closeness of the plant to the cooling water and to the market. Because of this, seaside, riverside or lakeside areas are suitable places for nuclear power plants. When it comes to marketing, closeness to industrial zones is important.

There are also some flaws in Turkey's nuclear energy policy which may be some disadvantages for the country. Turkey does not have a comprehensive nuclear energy plan which covers globally all aspects of nuclear power. The country lacks proper legal framework as well. There are some uncertainties in the role of the government. There are also some problems regarding technology choice and there is not a satisfactory technology transfer plan. In addition, for the moment there is no precise decommissioning and waste policies for nuclear power plants. Public consultation and dispute settlement mechanisms does not exist yet. We can also mention about problems in the participation of domestic industries, problems in training of human resources and problems in project financing. (Sirin, 2010)

In the case studies, a high level of nuclear energy operating cost is taken and then the cost is gradually lowered. Optimizations are made for each level of nuclear operating costs within four different scenarios and the quantities of nuclear capacity selected by optimizations are recorded. It is determined that, nuclear energy is able to compete with other energy sources when the operating cost is less than 210$/kWhyr or 2.4cent/kWh (for Turkey). (Yildirim, Erkan, 2007)

The Turkish Electricity Trade & Contract Corporation (TETAS) would then buy all the power under 15-year contracts. TETAS will buy a fixed proportion of the power at a fixed price of US$ 12.35 cents/kWh for 15 years, or to 2030. (WNA, 2014)

Seismic risk: Turkey is a region plagued with a high degree of earthquakes. The Akkuyu site is near an active Mediterranean earthquake zone (BBC News, 2000), and there have been 6.2 Richter earthquakes hitting Adana, which is 180 km from the plant site. An earthquake would have been the most likely cause of a catastrophic nuclear accident at Akkuyu. (Akcay, 2009) There have been efforts to build a nuclear power plant since 1976 when the first license was issued for the Akkuyu site, which is now condemned by some experts as too seismically active. (Atiyas et al. 2012)

Public opposition is another disadvantage of nuclear power in Turkey. Almost 90% of Turkish people (Bolat, 2006) are against the construction of nuclear power plants in the country. This situation leaves the current government without support for nuclear investments.

Conclusion

To obtain new and more effective transformation of nuclear energy in collaboration with renewable energy, more research activities must be developed. In this context, a really technical progress in the nuclear industry is considered to be slow compared to other traditional sciences. In consequence, there is a strong need to review the educational requirements for undergraduate and postgraduate studies to provide applied engineering skills required to design, built, and operate nuclear systems and to develop new technologies that ensure energy supply in accordance with a common world standard. The first example of cooperative activities in new nuclear education like M.Sc. Level Nuclear Science and Technology education, improvement of curriculum, and infrastructures of undergraduate nuclear study programs was between Japan and Indonesia. (Orosa et al. 2011)

Hydroelectric power is reliable and cheap, but there aren't enough suitable sites to satisfy our energy demands. Wind and solar energy don't provide consistent output, and battery technology would have to improve significantly to solve that problem. Today, renewables are just an expensive supplement to an electricity system based on coal and natural gas. There is one source of carbon emission-free energy that is cheap, reliable, and proven to work on a large scale: nuclear power. It often gets a bad rap because of perceived safety problems. In reality, it has become a sort of litmus test for societal rationality. People have a hard time estimating some kinds of risks. (Myhrvold, 2014)

The renewable energy resources produce no significant waste and are generally favored by policy incentives, but some of them are plagued by high production costs and low efficiency. On the contrary, the examined nuclear technologies, despite their enhanced safety, reduced costs and minimized waste, still have to face the major issues of weapons proliferation, safety, waste handling and high costs as well as public acceptance, which have been affected by the recent Fukushima accident. (Karakosta et al. 2013)

Turkey today generates a high percentage of its electricity generation from hydro power plants which can be easily affected by dry seasons. Therefore nuclear power plants not only will be able to provide a sustainable electricity source but also will bring in new nuclear technologies for the country and will enhance the technological know-how of the country. (Aras, 2013)

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