TURKEY'S NUCLEAR ISSUE - THE PAST AND FUTURE DYNAMICS

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ABSTRACT

This article analyzes Turkey's whole nuclear issues in conjunction with nuclear history, nuclear future plans, possible risks, scenarios, and suggestions as nuclear energy is a subject, which is of strategic and comprehensive character. Turkey has had plans to build a nuclear power plant since the 1970s. A nuclear power has been a strategic aim for Turkey since then. All these years, restraints, economic deficiencies, diplomatic troubles, and technological deficiencies have delayed Turkey's nuclear targets and plans. Within the last decade, economic growth and stable development signified a new turn in terms of nuclear energy. The article aims to examine the utility of nuclear energy in Turkey and to present whether or not nuclear energy might offer an important solution for Turkey's energy future.

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TURKEY'S ENERGY RESOURCES AND ELECTRICITY GENERATION - GENERAL OUTLOOK

Turkey's energy consumption and exports are rapidly increasing and this increase in demand on energy makes all the issues strategical in terms of energy politics. The development of economy and finances places energy as a premium in political spheres. Various factors affect both the demand and supply side of the global energy sector, where Turkey is one of the main actors on the consumer side. Consequently, economical developments in Turkey are expected to continue in the upcoming years and Turkey's energy needs as well. In order to understand Turkey's energy future, the current state of energy resources and electricity generation should be overlooked and analyzed thoroughly so that substantive analyses, suggestions, and conclusions can be realized.

Lignite, pit coal, asphaltite, oil shale, crude oil, natural gas, Uranium and Thorium are all present as fossil resources whereas hydraulic energy, geothermal energy, solar and wind power, and biomass energy all represent potential renewable energy resources. Natural gas and lignite have a high rate in distribution of installed capacity of fossil fuel plants by resources as it can be seen from Figure 1. Imported coal, fuel oil, and pit coal exist subsequently. When the energy source potential of Turkey is examined, it can be seen that lignite has highest potential with 12.5 gigaton and pit coal follows it with 1.34 gigaton. Renewable energy potential takes its place as having a high rate in pie chart following these two fossil fuels. Wind power is gradually expanding in capacity, mainly in the Aegean and Marmara regions. Turkey has reached to 6.6 GW of installed capacity as of July 2016. Turkish government has a target to increase wind capacity tenfold by 2020. If the target reached, anticipated futurity energy leader becomes the wind power.

Renewable energy sources have a high share of energy supply in Turkey and especially hydroelectric power accounts for about 35% (as of July 2016) of the electricity demand. The percentage of solar energy power capacity is also continuously rising in that pie chart. Turkey is located at a sufficient zone that makes it a sun-soaked country. The total yearly insulation period is approximately 2,460 hours per year and 7.2 hours per day. These qualities functionalize Turkey to be a great solar power. High solar energy poten-

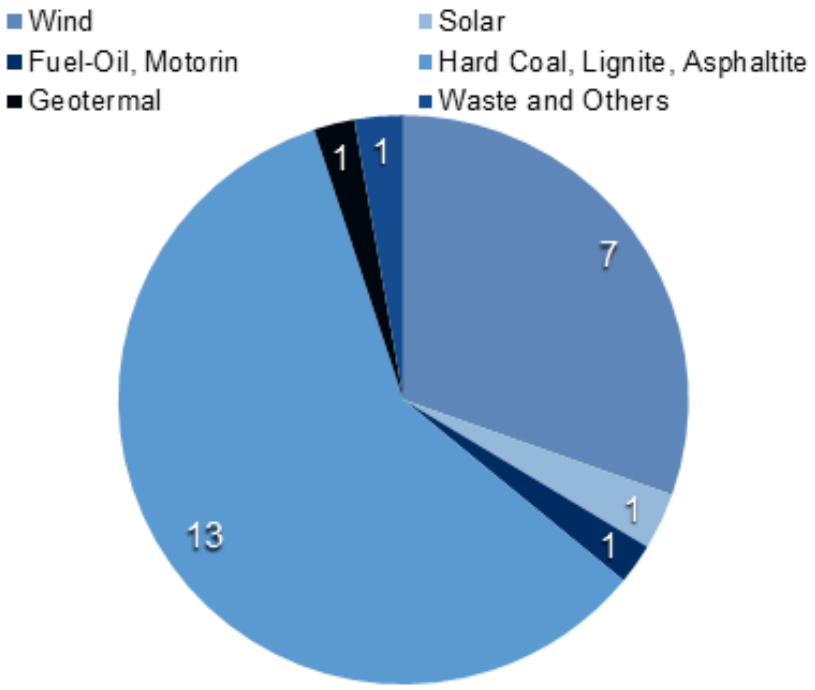

Figure 1: Installed capacity percentages for electricity generation by sources in Turkey as of July 2016. (Source: TEIAS).

tial and land availability give an opportunity for solar energy to be the most important clean energy resource for Turkey as it has a puissant demand in energy. The country also develops its hydropower potential, which is actually the only renewable source that is capable of providing huge amounts of renewable power. Hydropower holds an important advantage on lower operational costs, rather than its opponent thermal sources. It is perfectly superior to the rest of the sources in terms of fuel cost, which is zero in hydro plants. But, despite this advantage, and low construction and labor costs, investments in and operations of hydro plants in Turkey are lower compared to developed countries. Geothermal energy is set to grow rapidly against hydropower. Turkey is one of the hottest markets for geothermal plants with its theoretical geothermal potential of 31,500 MWt according to Turkey's Mineral Research and Exploration Agency (MTA). With this high resource potential, Turkey ranks 7th in the world and 1st in Europe.[1] Turkey has a potential for 1.000-2.000 MW but only 160 MW are currently installed and the government plans to have 600 MW more installed by the end of 2023.[2]

If all energy resources and the markets are considered, it can be seen that nonrenewable resource reserves are utilized more comparing to the renewable energy sources. Natural gas has especially been the most used energy resource in the electricity market in Turkey. Statistics show that its demand is expected to increase by 2.9% annually until 2020.[3] In spite of this rising demand, Turkey has a limited natural gas production capacity. Natural gas production is operated in accordance with the Petroleum Law. Pursuant to the statics of EMRA, the highest market share in natural gas production belongs to Turkish Petroleum Corporation (TPAO).[4] Moreover, Turkey sustains average of 98% of its natural gas consumption from the imports. It can, thus, be said that Turkey is dependent too much on foreign natural gas. However, thanks to its geostrategic location, Turkey provides opportunities for investments in pipeline projects such as TANAP. The similar circumstances are true for the oil resources and markets as well. Turkey has a limited oil production capacity because of geographical

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factors that are extremely affected by active fault systems. This situation makes the country poor of oil supplies and, for this reason, all market activities such as refining, storage, distribution, and transmission depend on imports (more than 90% of total liquid fuels being imported). Despite its terrestrial lack of fossil fuel reserves, Turkey is well placed to serve as a hub for oil and natural gas supply headed to Europe and other Atlantic markets from Russia, the Caspian region and the Middle East.[5] The country is located in between energy consumers and producers. Turkey's oil pipelines extend beyond 3,400 km and are part of an international and domestic web. Turkey's oil pipelines are of the utmost significance for Azerbaijan and Iraq since Baku-Tbilisi-Ceyhan (BTC) and Kirkuk-Ceyhan are their main export outlets.[6] The BTC, thus, allows Azerbaijan to become less dependent on Russia and Iran for its exports. Turkey's geographical advantages might construct the regional energy web in and around the country.

ANALYSIS OF THE ENERGY PROBLEM IN TURKEY

"Despite the limited production from fossil fuel resources, Turkey's demand is rapidly rising, causing increase in oil and gas imports. The solution lies in the diversification of energy sources."

Energy is an essential component of all economic activity and the provision of all services. Hence, preserving energy is one of the most vital actions for governments and energy security and thus it is linked with all political activity. If we examine Turkey's actions to provide energy security for present and future, the major problems appear as to be fossil fuels as the country has limited reserves whereas infinite reserves are highly concentrated in certain regions in the World. Middle Eastern countries and the Russian Federation possess almost 70% of the world's oil and gas reserves.[7] Thus, each parameter of the energy security can be accepted as having a direct connection with geographical distribution of energy resources and reserves.

Turkey's energy security challenges can be classified into two main categories. (1) The above-mentioned energy supply problem represents the first category here. Turkey's main energy suppliers are Russia, Iran, Azerbaijan, Algeria, Nigeria, Qatar, Saudi Arabia and Iraq with Russia and Iran being the biggest suppliers. Turkey's energy security axis is, therefore, highly dependent on Russia and Iran. The reliability of these suppliers is a subject of argument in terms of energy diplomacy. Probable and mature disagreements with these suppliers put energy security at risk. The formula to keep energy under control is to highly diversify the suppliers. Turkey is trying to find new suppliers to diversify its gas and oil supplies and signing long-term contacts with many countries like Nigeria, Egypt, Azerbaijan, and Turkmenistan.[8] These pursuits represent attempts to decrease dependency on the main suppliers and can be seen as the first step to achieving energy security.

The limited production from domestic sources have resulted in a high dependency on energy imports. Hence, (2) another important challenge for the country is high dependency on imported fossil fuels. While the first problem was about the reliability of suppliers, the second focuses on energy supply varieties. Turkey's domestic oil and gas production is insufficient to meet the country's energy need. Despite the limited production, the country's demand is rapidly rising, causing increase in oil and gas imports. The solution lies in the diversification of energy sources. The rate of imported fossil fuels must be decreased by adding more sources to the energy supply equation. In this sense, it can be said that creating an energy source mix is vital to solve the problem because dependency on a single resource harbors both economic and political risks. At this point, Turkey should evaluate its renewable energy alternatives such as wind, solar, geothermal, and hydro and independent energy types like nuclear. Without this type of energy formula, Turkey will be under risk of energy supply distribution and be volatile to energy prices.

Other challenges in terms of energy for Turkey are energy saving and resources planning. Energy saving is completely involved with energy efficiency and storage capacity.

It is generally understood as less consuming, though actually evaluating energy wastes and preventing energy loss.[9] According to statistical analyses, Turkey can save up to 25% of its energy consumption[10] and this ratio can thus bring a remarkable acquisition for Turkey's economy. On top of that, the amount of loss and illegal electricity usage is higher than 20% and the average annual damage from these represents a big deficiency for the economy. Moreover, the economic measures suggest that storage is a big problem. Energy storage provides short-term security against unexpected disruptions, accidents, sabotages, and technical failures. For such reasons, Turkey generated its first underground storage facility in Silivri. Despite its functionality, capacity of the facility is not enough to meet the demand against mentioned risks. Accordingly, Turkey should enhance its storage capacity.

Finally, possible and more valuable energy resources should be discussed for Turkey's energy future. There are too many prominent energy types for the solution like biofuels, GTL (Gas to Liquids), CTL (Coal to Liquids), Hydrogen, fuel cells, and nuclear energy. All these types offer advantages for Turkey. Non-conventional energy types are mostly dependent on technical developments and economic structure comparing to those of conventional energy resources. With all these keys mentioned above, it can be understood that nuclear energy is one of the most common solutions for countries that aim to succeed energy security. Turkey has many reasons to go nuclear. It is an undeniable fact that nuclear power is the main source of energy in some of the major developing countries in the world.[11] In this regard, France will make of a good example thereby, generating %75 of its electricity from nuclear energy. France now claims a substantial level of energy independence and almost the lowest cost electricity in Europe.[12] Nuclear technology can have an important role to enable an increase in the share of renewable energy sources as well as fossil fuels to meet a more sustainable energy mix demand.[13]

Nuclear energy has the lowest impact on the environment. A little amount of Uranium, a raw material of nuclear energy, produces a great amount of clean energy and a smaller use of fossil fuels means lowering greenhouse gas emissions (like carbon dioxide and methane) that are largely responsible for the greenhouse effect. The most promotive future for nuclear energy is actually reliability. Traditional sources of energy like solar and wind require sun or wind to produce energy. They need fertile dates. However, nuclear energy doesn't require a special time. Nuclear energy can be produced continuously from the plants even in case of rough weather conditions and the production can be provided 7/24. Aside from these main advantages, nuclear energy presents other benefits such as powerful and efficient output, cheap electricity, low fuel cost, economic advantages in setting up nuclear power plants, and easy transportation. Optimal and minimal utilization of energy resources in generation is preferred condition for any nation. The economic advantages in favor of the countries prompt to choose rational variants. From that point of view, Turkey will be able to significantly reduce energy bills due to the high rates of production. As economic advantage, the raw materials import for nonrenewable energy will be decreased accordingly. The amount of energy production depending on a variety of raw materials addresses that raw material of nuclear power generates more electricity than any other raw materials. TAEK provides figures on electricity generation by types of raw materials as follows: 1000 gram coal produces 3 kWh electricity, 1000 gram oil produces 4 kWh electricity, 1000 gram Uranium produces 50,000 kWh electricity. The figures prove that nuclear materials are a highly efficient source to produce energy at a very little cost. These figures are given on Figure 2.

Uranium, Thorium and specifically their certain isotopes are called radioactive raw materials that are used as resources in nuclear plants. Uranium is considered as the main raw material of nuclear fuel and today, it is commonly consumed as fuel in nuclear power plants. To use Uranium in electricity

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"The cost of solar power is now cheaper by 80%, and wind power by 30%. IEA estimates that 60% of energy investments globally in the next 25 years will be on renewable energy sources."

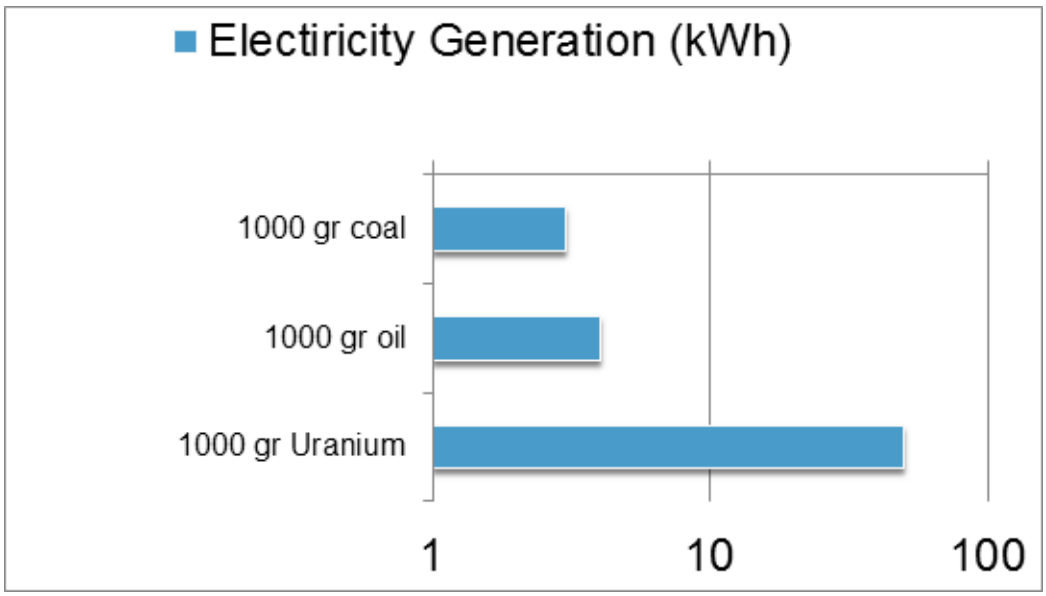

Figure 2: Comparison on electricity generation by types of raw materials. (Source TAEK).

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generation, U235 isotope, which has ability of divisibility (fissile material) of Uranium, must be occurred with enrichment process. If Thorium is not a fissile material, it cannot be just used alone. It requires a neutron and a fissile material like U233 isotope to be able to use as nuclear fuel. According to General Directorate of Mineral Research and Exploration's (MTA) technological and scientific works and findings since 1958, there is quite important radioactive raw material reserves in Anatolia. See Figure 3 for reverse distribution of nuclear materials. Turkey's Uranium reserves has 0.07% rate that equals to 9,129 tons. The Thorium potential of the country is 0.21% that totals to 380,000 tons.[14] Most of the radioactive raw material reserves are situated in the western parts of Turkey. The largest known Uranium bed is located in Koprubasi area, Manisa. Thorium bed lays in Beylikahir, near Eskisehir-Sivrihisar region.

ORIGINS OF TURKEY'S NUCLEAR HISTORY

The world has stepped into nuclear age on December 20th, 1942 by realizing self-feeding chain reactions.[15] This age was going to

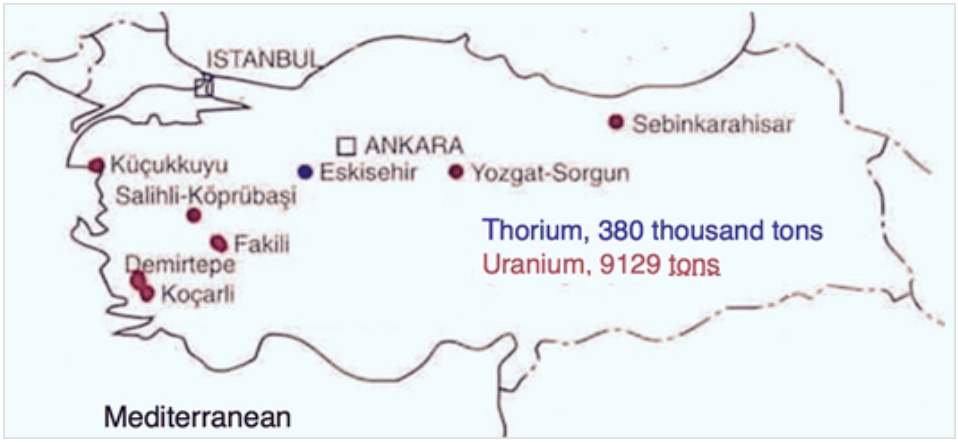

Figure 3: Turkey's Radioactive Raw Materials Map. (Source: TAEK).

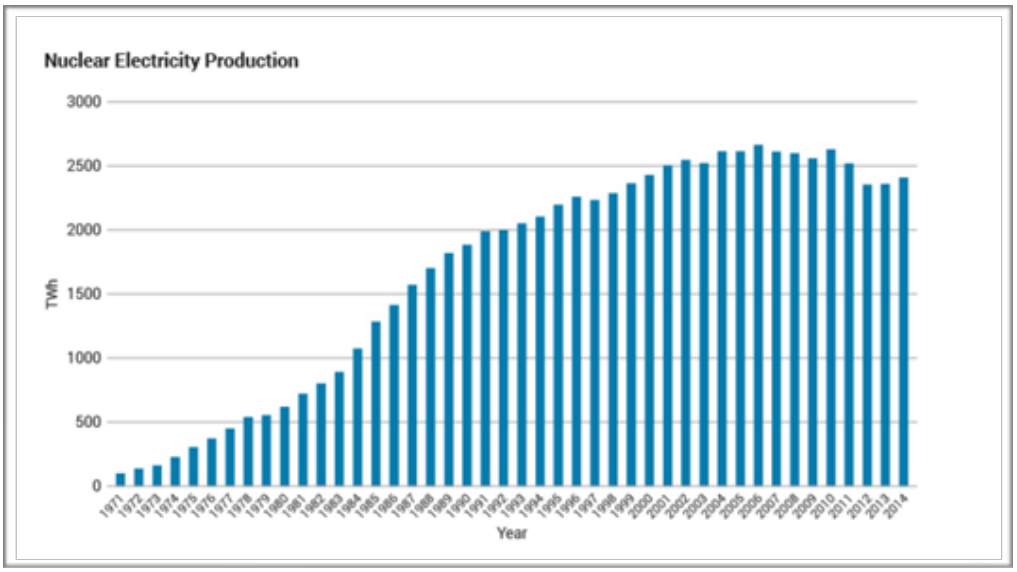

Figure 4: Nuclear electricity production in the World. (Source: World Nuclear Association).

bring too many alterations to Earth and this nuclear movement has affected a lot of countries. The movement changed the meaning of power and security, so that obtaining power meant obtaining nuclear for some countries and security meant national responsibilities and international obligations. If we want to look at nuclear history and the changes it has brought, we must also look at where we stand now. Today, the world meets 11% of its energy needs from nuclear energy and this number is 21% for OECD countries.[16] A graphic chart showing the world's nuclear electricity production throughout years is given in Figure 4.

Like all affected countries, Turkey also wanted to come in contact with the nuclear age. Along with the constantly changing parameters, the country has been generating strategic plans to possess nuclear energy since the feasibility studies conducted in the 1970s. After the denomination of nuclear plans, Turkey decided to build its first nuclear reactor with a 80 MW capacity in 1973. The intended address was the city of Mersin, licensed for NPP (Nuclear Power Plant) in 1976. However, that plan failed because of lack of financial guarantees by the Turkish government. Turkey's nuclear history shows us that there were several attempts to build power plants like the Mersin NPP. All these plans were delayed not any less than eightfold between June 1998 and April 2000.[17] The abandonments of these plans were about economic conditions and unsteady politic circumstances. In 2006, the government announced that it had planned to have three nuclear power plants built. Sinop and Akkuyu in Mersin were chosen cities to host the nuclear power plants (See Figure 5). Turkey has thus concluded two of the three planned regions. Drafts passed the parliament in 2007 and subsequently, a civil nuclear cooperation agreement was signed with the USA in 2008. In the same year, TETAS (Turkey Electricity Trading and Contracting Co.) called for offers and TAEK (Turkish Atomic Energy Authority) issued specifications for the first NPP in Akkuyu. Only one bid was received from 14 interested parties and TAEK and ROSATOM (Russian Nuclear Energy Corporation) signed the agreement for the Aes-2006 NPP. In the following years, the other nuclear cooperation agreement was signed with South Korea in June 2010 and then two such agreements with China in April 2012. In May 2010, Russian and Turkish head of states signed a 20 billion USD intergovernmental agreement to build the Akkuyu NPP. The decision was for Rosatom to finance the project. Following all the agreements and intergovernmental contracts being signed, start

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Figure 5: Nuclear power plants planned to be built in Turkey. (Source: Google).

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of the Akkuyu's construction is expected at the end of 2016, Sinop in 2017, and the last determined region for the third NPP is decided to be in Igneada, Kıklareli in 2019.

From Turkey's historical data, it is understood that the country's motivation for nuclear power is triggered by the energy dependency mentioned in the 4th section and the changing dynamics of the world. Turkey's rapidly growing energy demand requires an immediate solution and Turkish policymakers are determined that solution can be nuclear energy. The nuclear security issue is considered by the Turkish government along with nuclear supply advantages that the country has. Ankara is one of the parties that signed the Treaty on the Non-Proliferation of Nuclear Weapons, the Comprehensive Test Ban Treaty, the Wassanaar Arrangement, the Missile Technology Control Regime, the Zangger Committee, the Nuclear Suppliers Group, and the Treaty banning nuclear tests in the Atmosphere and so on.[18] This active diplomatic support for international nonproliferation accounts Turkey as a reliable country for the uses of nuclear power. Turkey's peaceful stance and aim clear doubts about any struggles caused by possible uses of nuclear power in military activities as noted by the nuclear authority.

OVERVIEW OF NUCLEAR POWER POLICY IN TURKEY

Turkish energy policy can be summarized in six main topics that shapes the three objectives of the Ministry of Energy and Natural Resources (MENA).

1. Minimize the dependency on the supply of energy sources from foreign countries.
2. Diversify of energy sources and routes.
3. Increase the rate of domestic and renewable energy sources.
4. Generation, transmission, and consumption of energy efficiency.
5. Increase state's and private industry's capabilities under a liberalized energy markets framework.
6. Activate policies that enforce measures to provide Turkey's energy demand in a safe manner.

The main aim of these strategies is meant to ensure the supply security, competitiveness, and sustainability. Under these circumstances, it's very easy and strategic to reach nuclear energy as a reliable solution. The essential

disputes in Turkey's nuclear energy is completely about nuclear risks.

The nuclear industry is surrounded by a variety of risks related to safety, operation, finance, and strategy. All the risks that might threaten Turkey's nuclear program can be classified in five categories:

1. Political.
2. Regulatory.
3. Commercial and financial.
4. Safety.
5. Public risks.

The most significant of these risks is certainly the political one, since the loose international diplomacy can be altered at the least expected moment. For instance, the conflict between Turkey and Russia following the airspace incident changed the Akkuyu NPP's fate and we cannot talk about absolute progress for the future.

Another significant risk is regulatory, since national safety requirements, site permit requirements, reactor licensing requirements, safety requirements, discharge authorizations, hate management, storage transport, and disposal requirements all need to be clearly specified as part of the regulatory framework.[19] In that sense, the most substantive fact is prudential, well-though regulatory works. Commercial and financial risks depend on the company that runs the project. If an example needs to be mentioned, we can look at Akkuyu's financier, Rosatom. The company's commitment and financial risks, thus, indirectly represents Russia's commitment and risks. This is why financial risks are involved with diplomatic risks. Safety risk is concerned with engineering process. The most dangerous disadvantage of nuclear energy is without a doubt the radioactivity issue. After the 1986 Chernobyl and 2011 Fukushima incidents, the nuclear reactor technology was immediately controlled. Some countries changed their minds about nuclear, while some proceeded with their plans by making improvements. As for Turkey, the country has not changed its nuclear agenda.

In spite of all the potential risks, Turkey has rich Uranium and Thorium reserves as mentioned above. This big and vital advantage, along with other above-mentioned energy problems all are dragging Turkey to this compulsive nuclear power. However, nuclear is also related to authorities and other countries, as well as Turkey's domestic decisions. In that sense, conjunctures should be looked at to ensure the process. Iran was a key actor for countries newly stepping into nuclear. The nuclear deal between Iran and the West generated a new circle, thus the mainstream suspicions on Turkey was mostly eliminated. Therefore, the proliferation domino theory was under control. If we look at the IAEA (International Atomic Energy Agency)'s conclusion about Turkey, additional protocols can be seen. Turkey's nuclear activities have been subject to a comprehensive IAEA safeguards agreement since 1982. That long process is shaped by two causes.

- First, the bilateral nuclear cooperation between Turkey and Pakistan in the 1980s.[20] According to the USA, these were corrupt trade relationships between the two countries. The investigations went on until Turkey finally took measures for a crackdown.
- Second, the IAEA's drilling into front-end materials processing and experimenting. Despite all the suspicions and investigations, the IAEA found no evidence of any undeclared or clandestine nuclear activity.[21] The IAEA asked questions about centrifuges to Turkish scientists and still did not find any nuclear latency.

The conclusion then ended with; "... no indications have been found by the IAEA that, in its judgement, would constitute a safeguard concern."

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After all the historical arguments in Turkey, nuclear policies must include reliability and technical steps should take the safety of the world, thus, not be allowed the energy attitude that creates insecurity in the region. Possible scenarios and constructive critics on security issues as like "Long term reliability of the factors that kept Turkey from acquiring nuclear weapons" should be considered for stable and reliable energy policy.

POLICY SUGGESTIONS AND CONCLUSIONS

Turkey as a middle power in Eurasia has some aspiring purposes for the future. The Turkish government aims to become a regional power in the Middle East. That essential aim concerns the energy sector and policy. The objective of becoming a regional power then turns into becoming a transit country for energy policy issues. That strategic future goal requires some professional decision making to be achieved and nuclear power is, thus, a very important step towards the realization of the Turkish objective.

Suggestions can be gathered under the management process. Nuclear energy requires robust management and control systems. These are not completely about policy, thus the technical containment needs engineering suggestions. In that sense, the suggestions for nuclear power are mostly related to perception management. Adverse opinions must arise to clearly increase awareness about breaking the taboos on nuclear. Energy authors and the Ministry should labor on nuclear as a future energy source for Turkey. Arguments against nuclear power mostly include unsafety. This thesis must be changed into a perception of safe nuclear energy. This argument can be supported with the latest generation of nuclear reactor designs that are getting safer every day. Another argument against nuclear is about supporting renewable energy. Though renewable energy is indeed environmentalist, renewable energy supplies aren't able to take over nuclear power, yet. The country thus needs to use all energy sources. The hazardous energy sources are fossil fuels like coal and oil and the environmentalist argument must actually oppose fossil fuels since these are more polluting and damaging than nuclear energy. Thirdly, it is important to prove the good intention behind the use of nuclear. It must be asserted that nuclear would supply all energy needs and all investments are for technology to generate electricity. These arguments for and against nuclear power should be considered by the authorities because this perception management can bring the end of public risks. Nuclear fuel and waste management hold an important place in suggestions. Turkey has improved nuclear cooperation relations in terms of policy. Safety and security should also be processed in a synchronized way in order to ensure reliable nuclear energy areas.

As a result, Turkey's energy demand is rapidly rising and the energy security problem is surviving with all remarkable effects. Thus, solutions should be immediately rearranged for a reinforced energy future. Turkey lacks domestic energy reserves and this fact causes a dependency on energy imports, accompanied by supply security risks. The national and local formula seems more likely to be nuclear power. In that sense, nuclear energy offers a powerful solution and has many benefits for Turkey.

In this aspect, nuclear energy appears to be one of the most efficient and effective solutions. Turkey has rich Thorium reserves and this fortune must not be omitted as mentioned above.

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