ACCELERATING THE TRANSITION TO NUCLEAR ENERGY SYSTEMS IN TURKEY

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Abstract

Turkey is the country which imports electricity. Advanced and almost all of the countries that have achieved sustainable development have made investment nuclear power plants about 40 years ago and these countries provide at least 20% to 70% of its energy needs from nuclear energy. Policy makers of Turkey have various goals to achieve through electricity generation in nuclear power plants (NPP). In this way, they are targeting to to decrease the current deficit caused by such dependence. This paper analyzes Turkey's past and present stuations, motivation, capacity and strategies to determine the factors which influence spread of nuclear power and accelerating the transition to nuclear energy.

Key Words: Nuclear power, Nuclear energy, Energy security, Turkey.

Türkiye de Nükleer Enerji Sistemlerine Geçişin Hızlandırılması

Özet

Türkiye elektriği ithal eden bir ülke konumundadır. Sürdürülebilir kalkınmayı başarmış ülkelerin birçoğu ve gelişmiş ülkelerin hepsi nükleer güç santrallerine yaklaşık 40 yıl öncesinden yatırım yapmışlar ve en azından kendi enerji ihtiyaçlarının %20 ile %70 ini nükleer enerjiden sağlamaktadırlar. Türkiye de politikacıların koyduğu, nükleer güç santrallerinden elektrik üretimi yoluyla ulaşılacak hedefler vardır. Enerjiye olan bağımlılık nedeniyle oluşan cari açığında azaltılması bu hedeflerden birisidir. Bu makalede, nükleer enerjinin yaygınlaşması ve nükleer enerjiye geçişi hızlandırmayı etkileyen faktörleri belirlemek amacıyla Türkiye'nin geçmiş ve mevcut durumları, motivasyon, kapasite ve stratejileri analiz edilmektedir.

Anahtar Kelimeler: Nükleer güç, Nükleer enerji, Enerji güvenliği, Türkiye

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INTRODUCTION

The development of renewable energy sources for the dissemination throughout the world, as well as for investments in projects on a global scale, nuclear energy is gaining momentum. As of January 2016, 441 nuclear power plants are in operation in 31 countries, 67 units in 16 countries and is also a nuclear power plant is under construction. Electricity generation from nuclear energy is estimated to rise from 3.908 TWh (2010) to 2.756 TWh in 2035. However, it is estimated that too; the share of nuclear energy in total energy production 12.9 percent falls to 9.7 percent. Preparations are underway for the establishment of a nuclear power plant in the world [1].

Turkey is one of many countries trying to become less dependent on imported fuels. Currently, 74 percent of the country's capacity comes from petroleum and natural gas, with about 90 percent of that imported, mostly from Russia and Iran, according to the Daily Energy Report blog. Given Turkey's limited natural resources, nuclear could be a strong, viable option in its energy security quest [2].

Ideal to build Turkey a nuclear power plant for half a century have begun to take place on 12 May 2010 with the signing of the agreement on the establishment and operation of a nuclear power plant in Akkuyu between government of T. C. and the Russian Federation [2- 4].

The commissioning of two nuclear power plants until 2023, and 3 is planned to start the construction of the nuclear power plant to meet the rapidly growing demand for electricity and to reduce the risks associated with the import dependency in Turkey [4, 5].

In this study analysis of Turkey's nuclear transition is made. So for this nuclear power transition process examined and has carried out an analysis of past and present in Turkey. As a result, there is a strongly need nuclear power plant in Turkey. This elimination of the need to reduce dependence on energy and economic efficiency and technological developments in the field will be a huge contribution.

THEORETICAL FRAMEWORK

As a result of fragmentation of atomic nuclei, a large energy is becoming clearer. This energy is called "nuclear power" obtained by fission and fusion reactions. Nuclear reactors are systems that

convert nuclear energy into electrical energy. Basically, the result of released fission nuclear power, thermal energy within the nuclear fuel and other materials, this thermal energy is converted into kinetic energy and then into electric energy in the generator system [5, 6].

A nuclear reactor with 1,000 MW produces fuel used about 27 tons (7 m^3). For the continuity of electricity generation, nuclear power plants are safer than thermal and hydraulic power plants. Nuclear power plants are an option should be preferred in terms of environmental impact. Operating nuclear reactors under normal operating conditions, maximum radioactivity can give out is limited to 0.1-1% of the natural radiation level, in practice this situation is even below these limits [6, 7].

It has been discussed that to find the most appropriate nuclear power plant location alternative for Turkey with using different methods [7]. When considering the Akkuyu Nuclear Power Plants and will be built in Sinop, it is expected to be produced annually about 80 billion kWh of electricity in Turkey. To obtain this amount of electricity from natural gas power plant about 16 billion cubic meters of gas imported annually versus 7.2 billion US dollars (about 13 billion) are to be paid for Turkey. Thus, only 4 units in 3 years in Mersin-Akkuyu nuclear power plant can be set up with the money to be paid to import natural gas.

Turkey - Russia agreement mentioned within the scope of the realization of the project company, it was founded with the name of Akkuyu Nuclear Inc. on December 13, 2010 in Ankara in Turkey. Under this project, for the purpose of nuclear training, 600 Turkish students have been sent to Russia. Concerned Turkish students, after a close study of approximately 6.5 years that including internships at plants in Russia, will be employed in different fields from engineering to management levels in Akkuyu Nuclear Power Plant Project [8].

Turkey also signed a nuclear cooperation agreement with Japan in May, 2013 for exclusive negotiating rights for the Sinop plant. Under the agreement, Japan will build a nuclear power plant with an installed capacity of about 4.5 GWe. The project is estimated to take 10 years and cost 22 billion dollars. The agreement also lays the groundwork for nuclear cooperation on everything from training and capacity development to spent fuel and radioactive waste management. Unlike the Russian deal, according to the information from the government, the share of Turkish Electric-ity Generation Company (EUAS) in the investment could reach up to 49% with the other 51% owned by the Japanese-led consortium. Political statements indicate that

this consortium will include Japan's Mitsubishi and Itochu, France's GDF Suez and Areva, and EUAS from Turkey. Similar to the Russian agreement, the Japanese-led consortium is guaranteed an electricity rate of 11.80¢/kWh [8].

THE HISTORY OF NUCLEAR POWER IN TURKEY

First phase: Initial interest and plans (1953-1971)

- Turkish Atomic Energy Commission established (1957)
- First research reactor commissioned (1961)
- Plan to start nuclear electricity generation by 1977

Outcome: Discontinued following military coup (1971) and accompanying political and economic instability.

Second phase: First site selection and license issued (1972-1980)

- Feasibility studies and site selection at Akkuyu and near Sinop
- License issued negotiations for financing and construction with vendors (1976)

Outcome: Discontinued following military coup (1980) and accompanying political and economic instability

Third phase: Negotiations under proliferation concerns (1982–1988)

- Bids invited from seven major suppliers
- Letters of intent issued to three firms

Outcome: Vendor negotiation failure exacerbated by proliferation concerns and doubts about the appropriateness of the Sinop site

Fourth phase: Another failed negotiation (1993–2000)

- International tender issued for a turnkey project
- Bids received but tender eventually cancelled

Outcome: Vendor negotiation failure combined with proliferation concerns

Fifth phase: Return of nuclear power amidst growing dependence on Russian gas (2002–2009)

- Plan to connect the first nuclear power plant by 2015
- Sinop chosen as the initial site for a nuclear power plant

Outcome: International tender only resulted in one bid (from Rosatom) which was deemed to be too expensive

Sixth Phase: Era of intergovernmental agreements (2010–present)

- Intergovernmental agreements (IGA) signed with Russian Federation for the construction of a Build-Own-Operate nuclear power plant in Akkuyu (2010)
- IGA signed with Japan on the construction of a NPP at Sinop (2013)

Outcome: In progress [9-11].

CURRENT STATUS, PLANS AND FUTURE PROSPECTS

Motivation

Nuclear power in Turkey is framed as central to energy security and as the only "national energy" and necessary to meet growing demand. The ruling party's economic plans frame nuclear power as central to the Turkey's economic goals. Several commentators have also hailed it for increasing Turkey's prestige. Currently, there is controversy as to the proliferation risk in Turkey; historically, proliferation concerns caused several western vendors to abandon negotiations.

Capacity

Turkey's economy and electricity grid are both large enough to absorb a nuclear power plant though there are concerns about the capacity of the grid operator to regulate frequencies from the NPPs. In spite of the long-standing interest, Ankara has been unable to attract investment over the last five decades partly due to proliferation concerns and political instability. Turkey also has limited human resources capacity with one main research reactor. Furthermore, the program was abandoned following military coups.

Strategy

In Turkey the same organization (TAEK) has been both the promoter and regulator of nuclear energy and reports directly to the prime minister. Ankara has signed intergovernmental agreements with both Russia and Japan. In Turkey, the secrecy surrounding the program in the 1980s and 90s was cited as one of the reasons for Western opposition. Today Ankara's nuclear energy program is still subject to public opposition, which it has cast as "uncivil" [9, 10].

Current Status and Future Prospects

The current approach to introducing nuclear power in Turkey differs from historical arrangements. In the past, Turkey issued tenders for bids from international companies, whose involve-ment was limited to the construction and time-limited operation of nuclear power plants. This time, rather then issuing open tenders, Ankara is relying on intergovernmental agreements (IGAs) which allow vendors and the government to sidestep certain competi-tion rules. Thus, Law No. 5710, which regulates nuclear energy investments paves the way for foreign companies and their respec-tive governments to take a more active role in the construction of a nuclear power plant in Turkey and enables them to actually own the plant after construction.

The new strategy also may inoculate Turkey against political opposition. While historically, parties and coalitions from different parts of the political spectrum pursued nuclear power, today two of the three main opposition parties oppose it. Under the current approach, the IGA with Russia has been ratified by the Turkish parliament and cannot be easily withdrawn in the case that the AKP loses power.

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. The state generation company is Elektrik Uretim AS (EUAS). Plans are to have 30 GWe of coal-fired capacity by 2023, along with 4.8 GWe of nuclear capacity if all goes well. 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 Elbistan) at less than 5 MJ/kg (one-quarter of typical steam coal) with high sulphur [9, 10].

Ankara has declared an ambitious goal of building eight nuclear power reactors with a total capacity 10 GW.121 The government plans to launch the first two nuclear power plants and start building a third by 2023. Preparations have already begun for the construction of the 4.8 GW Akkuyu nuclear power plant, which will consist of four reactors [10].

Turkey’s Strategic Plan for 2019 plans to increase hydroelectric capacity from 25 GWe to 32 GWe, wind capacity from 5 GWe to 10 GWe, geothermal capacity to 700 MWe, solar capacity to 3 GWe and biomass capacity to 700 MWe. Renewables will be supported by feed-in tariffs and

other mechanisms. Natural gas share of electricity generation is planned to drop from 44% to 38%, and coal to increase from 40 to 60 TWh by 2019. The country's National Renewable Energy Action Plan set out by the ETKB aims to boost the share of renewables in the energy mix to 30% by 2023, adding 61 GWe to enable secure energy supply and reduce carbon emissions. This means adding 34 GWe of hydropower, 20 GWe of wind, 5 GWe of solar, 1 GWe of geothermal and 1 GWe of biomass capacity. The plan will be assisted by the European Bank for Reconstruction and Development (EBRD). The planned and proposed nuclear reactors for Turkey are illustrated in Table I [11].

Table 1. Planned and Proposed Nuclear Power Reactors

	Type	**MWe gross**	**Start construction**	**Start operation**
Akkuyu 1	VVER-1200	1200	late 2016	2023
Akkuyu 2	VVER-1200	1200	2017	2023
Akkuyu 3	VVER-1200	1200	2018	2024
Akkuyu 4	VVER-1200	1200	2019	2025
Sinop 1	Atmea1	1150	2017	2023
Sinop 2	Atmea1	1150	2018	2024
Sinop 3	Atmea1	1150		?
Sinop 4	Atmea1	1150		?
Igneada 1-4	AP1000x2, CAP1400x2	2x1250 2x1400		

RESULTS AND SUGGESTIONS

This article examines the Turkish state's motivation, capacity and strategy for implementing nuclear power. Nuclear power has been chased in Turkey since the 1950s by actually all political regimes and parties. In spite of this inexhaustible undertaking, the program has been unable to attract sufficient investment first due to the small size of the economy and later due to political instability and proliferation concerns. By studying Turkey's five failed attempts we are able to reflect on national attributes which have been identified as "drivers" or "preconditions" of

nuclear power to determine whether these factors are sufficient for explaining nuclear energy development.

The mainstay to successfully implemented nuclear energy policy, the same as in the large hydro-electric power plant investment in a country, is that the political will to been in consensus with the community genuine about nuclear power.

In order to meet the rising global energy demand by nuclear, large scale deployment of advanced nuclear reactors is required. Advanced reactors including SMRs are safe, economically competitive with other alternatives and can play a vital role in enhancing Turkey's energy supply security.

It is expected that the Akkuyu nuclear power plant project will use the innovative build-own-operate (BOO) approach, under which Russia will supply fresh nuclear fuel and remove spent fuel back to Russia for the entire life of the nuclear power plant [10].

From an academic perspective, this paper shows that more research is needed on nuclear governance beyond the national level. The future of nuclear energy is clearly going to be shaped through bilateral relations between countries and understanding these dynamics will be key to ensuring the safe and secure development of nuclear power [11].

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