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# **Nuclear Energy of Turkey in the context of the Russian experience.**

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## **Abstract**

Nuclear energy has become one of the widely discussed topics in Turkey due to the controversial points of view. Turkey is new to nuclear power; the construction of the first nuclear reactor started in April of 2018. Production of electricity in Turkey is highly dependent on imported energy sources. Continuously increasing energy prices and foreign energy supply reduce national energy security and undermine the sustainable economic growth of the country, whose exports heavily depend on foreign energy sources. Therefore; one of the solutions to decrease dependence on foreign energy sources for such an industrial country, as Turkey, is to produce nuclear energy. Opinions of specialists and the population are divided in controversial groups, where advantages and disadvantages of nuclear power oppose each other. This chapter analyses the usage of nuclear power in the world and reasons for countries, which have reduced or vice versa increased the implementation of nuclear energy. The Russian company conducts the construction of the first nuclear plant in Turkey, therefore history and experience of Russia in nuclear energy are analysed in this chapter. The discussion on benefits and weaknesses of Russian experiences and how they can be applied to new a Turkish nuclear industry conclude the chapter.

## Introduction

On 12 May 2010, the Turkish and Russian Governments signed an agreement to construct Turkey's first nuclear power plant in Akkuyu, Turkey. On May 2013, the Turkish and Japan Governments signed the agreement for the second nuclear plant construction in Sinop, Turkey. The construction of the first nuclear power plant started in April 2018. It is planned that the first production of electricity from the nuclear power will start by 2023 (MENR). Turkey expands the variety of energy sources with nuclear power to decrease dependency on imported energy and to have access to cheaper domestic energy sources. The interest in the world to nuclear power plants accelerated in the 1970s after the oil crisis with soaring oil prices. Nuclear energy as an alternative to renewable and non-renewable energy sources has its advantages as well as disadvantages.

One of the reasons why nations expand their available energy resources with nuclear energy is that it is relatively cheaper compared to other sources and its price is not affected by the world production tendencies as natural gas or oil. The main fuel source of nuclear energy is uranium, which is not concentrated in one particularly country, but can be found in different nations. Production of nuclear energy does not depend on environmental conditions like renewable energy and the production can be continuous, while the generation of energy requires relatively less fuel. One of the important advantages is that nuclear energy plants emit relatively low amount of carbon dioxide and therefore the level of contribution to global warming is very low. Despite of its numerous benefits, nuclear energy production has some very important disadvantages. One of the important concerns of all nations is nuclear waste, which is highly radioactive and has to be cautiously kept in order to reduce the risk of spreading radiation. Modern technologies allow implementing safety systems, which reduce risk of radiation; however, there are still risks of accidents and as history has shown not always can these

accidents be predicted as it was the case in Japan, Fukushima Daiichi, where a tsunami followed by a significant earthquake caused a nuclear accident involving three reactors on 11 March 2011.

World production of electricity from nuclear power continuously increased until 2010 reaching 2757 TWh with a slight decline in the consecutive 2 years as a result of the accident in Japan, declining until 2479 TWh in 2013. However, in 2014 total world production started to increase again. Looking at the electricity production from nuclear power as a share of total energy, the declining tendency was observed in the world since 1996, when this share composed 17.59% with a continuous decline to 10.05% in 2016 (WDI). The reason is in the growth of energy sources alternatives and not in the total decline of nuclear power usage. In 2016 about 450 nuclear power reactors were utilized for electricity generation in the world consisting about 11% of the world generated electricity. At the same time, about 60 reactors are under construction while about 160 reactors are under planning (WNA).

The general tendency in the world towards necessity for decreasing carbon dioxide emissions requires an increase in more environmental friendly resources and a decrease of the use of polluting fuels like coal. Nuclear power is one of the environmentally friendly energy sources in terms of carbon dioxide emissions. The world energy organisations predict that such requirements will lead to a double increase of nuclear energy for electricity generation to 5345 TWh by the year 2040 (WEO, 2017), and to 10,000 TWh by 2050 (WNA). Despite of essential advantages of nuclear energy, risks related with its waste and possible accidents outweigh and lead countries towards less risky alternatives. Thus, a lot of countries, mostly European, are phasing-out nuclear power, shutting down existing plants. As for today, there is only Italy who has completely shut down all its nuclear reactors and continues the generation of electricity with alternative energy resources. Particularly after the accident in Japan, in 2011, many countries took a decision to phase out nuclear energy.

For example Germany is in the world's top 10 of nuclear power producers and after 2011 Germany shut down 8 out of its 17 nuclear reactors with the plan to phase out the rest by 2022. Belgium's government has planned to phase out 7 of its active nuclear reactors by 2025. Currently, the existing nuclear energy is used for the generation of half of the country's electricity; therefore, the Belgian government plans to attract investments into renewable energy and gas in order to compensate the nuclear energy for half of the country's electricity generation. Spain considers to phase out its 7 nuclear reactors, which produce a fifth of the country's electricity by 2030. Switzerland does not have certain dates for the closure of their 5 nuclear plants, which generate more than a third of domestic electricity; however, the referendum in 2017 revealed the decision of population towards gradual phase out of nuclear energy and its replacement with renewable energy. In 2018, there were two countries in the world, Italy and Lithuania, which completely closed all their formerly active nuclear reactors (WNA).

Despite the European move to clean energy, there is an opposite move in the mainly Asian part of the world towards construction of new nuclear power plants. Even though the number of nuclear reactors that are planned to be phased out exceeds the number of new planned reactors, the total world nuclear capacity is increasing. About 50 reactors are under construction and more than 300 are proposed. China is one of the fastest countries in terms of increase in nuclear energy. In addition to its existing 45 reactors, 15 are under construction and more are under proposal. Most of electric energy in China is generated from coal, which is the cause of high air pollution. With the fast growing population and industrial production energy demand accelerates and leads the government of China to implement new energy policies to replace non environment friendly energy resources and to facilitate increasing demand. It is suggested that by 2030 China may lead the world in nuclear power (Hibbs, 2018). India similar to China more than 70% of its electricity from coal and aims to become a world leader in nuclear energy

development. In line with nuclear policies in China and India, Russia, Korea, United Arab Emirates, Belarus, Slovakia and more other countries contribute to the increase in the world nuclear power by constructing new facilities (WEA).

### **The Russian Experience**

Russia's first nuclear plant was built in 1954 and it was the first nuclear plant in the world to generate electricity and by the middle of the 1980s, Russia had about 25 operational reactors (WEA). However, the accident at the Chernobyl nuclear power plant in 1986 significantly slowed down the construction of new plants. At the same time, the collapse of the Soviet Union in 1991 reduced available funds for the development of most industries including nuclear and only after 2000 the nuclear industry started to revive. Currently, Russia has 35 operational reactors and is planning to increase their number to 59, while about 20% of global nuclear energy belongs to the Russian market (Rosatom). Production of electricity in Russia mainly depends on natural gas, which generates 50% of electricity, while about 19% of electricity is produced from nuclear energy. The share of electricity produced from coal and from hydroelectric sources is very similar, about 15% each, while electricity from renewable sources is not popular in Russia and composes less than 1%. Production of electricity from oil resources decreased from 11% in 1991 to less than 1% in 2017 (WDI). Export of oil and natural gas is strategically important for the Russian economy; therefore, nuclear energy is one of the important sources preferred for electricity production. Rosatom, the State Nuclear Energy Corporation, plans to increase the share of electricity using nuclear power to 45-50% by 2050 and to 70-80% by the end of the century.

Russia is a leader in the world for advanced nuclear technologies. Russia commenced the Proryv (Breakthrough) project for development of new generation nuclear energy technologies.

The project is focused on invention of a technology for a closed cycle of nuclear fuel using fast reactors. The aim of this project is to create a new generation of nuclear technology that will allow to efficiently use uranium in the process of electricity production and to solve the nuclear waste problem, which is one of disadvantages of present and older generation nuclear power reactors.

Another leadership of Russia in the nuclear industry is the world's first floating nuclear power plant on the ship named Akademik Lomonosov. The construction of the floating nuclear power plant started in 2009 and is designed to serve production of electricity to problematic cold areas such as the Northern sea territories. The official launch of the first reactor took place in November 2018. The second world's floating nuclear power plant is under construction in China.

Being a leader in the advanced nuclear technology, Russia is the principal country in international trade of nuclear technology. At the moment, Rosatom has signed agreements for the construction of 36 nuclear power reactors abroad, where 25 of them are currently under construction, which consists of 67% of the world's nuclear export market. Russia plans to expand its exports with more than 30 foreign nuclear power plants in proposal. In April of 2018, Russia started the construction of the first nuclear reactor in Turkey, where the construction of 3 more reactors will follow shortly.

### **Prospects for Turkish Economy**

Turkey is one of the few industrial countries that does not have domestic natural resources neither nuclear energy. Therefore, the economy of Turkey is highly dependent on imported sources like natural gas. The highest share of electricity production in Turkey is coming from natural gas, about 40% in total. About 30% of electricity is produced from coal, more than half

of which is being imported, 25% of electricity is produced from hydro sources, less than 1%, like in Russia, is produced from oil and about 6% is produced from renewable sources (WDI). Turkey, unlike Russia, shows more interest to renewable resources, being one of the richest countries in terms of renewable sources; however, only recently has Turkey started to give significant importance to the share of renewables in the production of electricity. In order to decrease dependence on imported sources like coal and natural gas, and to improve the environment, the Ministry of Energy and Natural Resources of Turkey imposed a target to increase share of renewables in the production of electricity to 30% by 2023. However, renewable energy has its advantages as well as disadvantages. Renewable energy sources allow producing electricity from domestic sources with the lowest cost, though renewable sources such as wind or solar energy cannot provide continuous production due to unpredictable weather conditions. Therefore, one of the solutions to decrease dependence on imported sources for fast growing industrial country is to increase domestic energy sources by using nuclear energy.

One of important advantages of nuclear power is the lowest level of carbon dioxide emissions in electricity production compared to the usage of non-renewable sources. Nuclear power has an advantage over renewable sources as well, as it can be used 7 days per week and 24 hours per day despite of unpredictable weather conditions. As Turkey started the construction of its first nuclear power plant, advantages and disadvantages of nuclear energy have been widely discussed in Turkey. Most of the researchers agree that nuclear power plants will significantly decrease energy import dependence of Turkey and will secure sustainability of energy supplies and guarantee the security of Turkey (Erdogdu, 2007; Kurt, 2014; Akyuz, 2017). However, the main concerns are waste disposal (Sirin, 2010; Ozcan et al., 2019) and the possibility of an accident that can bring unrecoverable damage to the environment and population (Kok and Benli, 2017; Akyuz, 2015).

Benefits of nuclear energy outweigh its weaknesses for Turkey taking into account progressive experiences of leading countries in this industry, particularly of Russia. Thus, Turkey signed an agreement for the four units of nuclear power plants in Akkuyu, where the construction of the fourth unit has to be finished by 2025. Another contract with the same capacity of 4800 MWe was signed with Franco-Japanese consortium to finish the last unit by 2030 in Sinop. A construction of a third nuclear power plant for Igneada is under proposal for a possible Chinese-US cooperation (WNA). The initial goal of the National Energy and Mining policy of Turkey is to increase the share of nuclear energy in electricity generation to 10% in total (IAEA, 2018). Russia, being the first country for Turkey to cooperate in nuclear energy production, is very important in terms of its own experiences. Russia is a beneficial country for a partner for a start in such an industry as nuclear, where Russia has been passing all stages of development. Having success of being the first country in the world to produce electricity from nuclear energy in 1986 Russia experienced one of the destructive nuclear catastrophes in the world history. However, negative experience did not stop the country to continue using nuclear energy, but vice versa motivate for further researches on technology advancement. The current technology significantly differs from previous generation technologies in terms of security, while research on the next generation technologies is promised to solve or reduce the world's nuclear problem of waste disposal, for example Proryv project.

For Turkey being new in the nuclear industry means the absence of domestic human resources in this area. The construction of nuclear power plants will allow to reduce dependence on imported energy sources; therefore, it is important not to increase dependence on human resources as well. Therefore, according to the agreement between two countries, the Akkuyu nuclear power plant project provides an education for different levels of students, undergraduate, graduate or specialist training in Russia with further practical training at Russian nuclear plants.

## Conclusion

Despite of its numerous advantages, some countries reduce and even shut down production and usage of nuclear energy, while Turkey is moving in the opposite direction. The fast growing population and industrial production requires searching for new sources of energy. Turkey is an industrial country where most of its exports are from heavy industries such as machinery and steel, which are noteworthy consumers of electricity. In 2016 the share of Turkish exports composed 22% of GDP. Growing exports require more electricity, which is nowadays mostly generated from imported sources. Domestic energy source as nuclear energy will provide a guaranty of supplies and prices stability, which is essential for the sustained economic growth of an industrial country. Russian training and leading in the nuclear energy implementation will provide secure management and efficient usage of essential for Turkey nuclear energy.

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