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The Nuclear Power Generation Programme of Turkey

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THE NUCLEAR POWER GENERATION PROGRAMME OF TURKEY

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1. Introduction

Nuclear power has become a significant feature of the global energy scene during the past half century. Today, fast-growing electricity demand in some regions, coupled with goals to improve energy security and lessen emissions of greenhouse gases and other air pollutants, suggest that nuclear power could have a highly important role to play in future power generation. Yet some governments and their citizens have rejected the use of nuclear power; and even where this is not the case, there is often uncertainty about the pace and scale in which new reactors will be built and how long the existing ones will continue to operate.

Nuclear power faces big challenges with respect to the economics and financing of new builds. With high upfront investment costs and long construction periods, especially in competitive markets where utilities face significant market and regulatory risk, the licensing and construction of new nuclear power plants is a difficult proposition. Nuclear power also faces intense public scrutiny over a wide range of issues that could undermine prospects if they are not adequately addressed. Safety is the dominant concern – in operating plants, managing radioactive waste. The scale of these issues is such that, ultimately, only governments can determine the future of nuclear power. Individual countries, taking into account their own situation and priorities, assess the costs involved and the anticipated benefits and intervene with appropriate policy action. Policies may be more or less stringent: they may set an explicit course either to support nuclear power or to phase it out, or they may affect nuclear power more generally by determining the structure of electricity markets.

Today in SE Europe a small number of countries including Bulgaria, Romania and Slovenia/Croatia have developed effectively nuclear power generation with substantial benefits to their economies and increased energy security as part of their diverse energy mix. Turkey is the newcomer in SE Europe's nuclear sector and indeed a new player in the global scene, having planned, and already executing, a very ambitious nuclear power programme.

The purpose of this Briefing Note is to present in some length Turkey's current nuclear power generation programme and also discuss its role in satisfying the country's electricity demand.

2. Global and Regional Developments

More than four years after the Fukushima nuclear disaster of 11 March 2011, its conceptual impact on the global nuclear industry is still visible. Global electricity generation from nuclear plants dropped by a historic 7 % in 2012, in addition to a record drop of 4 % in 2011. As of May 2014, 30 countries worldwide were operating 435 nuclear plants for electricity generation and 72 new nuclear plants were under construction in 15 countries. Nuclear power plants provided 12.3 % of the world's total electricity generation in 2012. In total, 13 countries relied on nuclear energy to supply at least one-quarter of their total electricity.

The electricity produced by nuclear power plants in Europe decreased by 0.6 % between 2012 and 2013. The largest share of electricity produced by nuclear energy in the 14 EU Member States to produce electricity can be found in France (73.6 %), followed by Slovakia (54.7 %), Belgium (52.1 %), Hungary (51.5 %), Sweden (42.6 %) and Czech Republic (35.9 %). Germany that has decided to close down its nuclear power plants during the next decade

Table 1. Key nuclear power statistics by region, end-2013

	Operational reactors	Installed capacity (GW)	Electricity generation (TWh)*	Share of electricity generation*	Under construction (GW)**
OECD	324	315	1 961	18%	20
United States	100	105	822	19%	6.2
France	58	66	424	74%	1.7
Japan***	48	44	9	1%	2.8
Korea	23	22	139	26%	6.6
Canada	19	14	103	16%	0
Germany	9	13	97	15%	0
United Kingdom	16	11	71	20%	0
Other	51	41	297	11%	2.7
Non-OECD	110	78	517	4%	56
Russia	33	25	171	16%	9.1
China	20	17	117	2%	32
Ukraine	15	14	83	44%	2.0
India	21	5.8	32	3%	4.3
Other	21	16	113	2%	9.5
World	434	392	2 478	11%	76

* Electricity generation data are the latest available estimates for 2013. ** Differences in the definition of the start of construction may lead to discrepancies between the figures here and those in other sources. The *World Energy Outlook* uses the IAEA definition, which specifies the start of construction as the date of the first major placing of concrete, usually for the base mat of the reactor building. *** While Japan's nuclear reactors are operable, they have largely been idled since the accident at Fukushima Daiichi in March 2011. Notes: GW = gigawatts; TWh = terawatt-hours.

Sources: IAEA Power Reactor Information System (PRIS); IEA databases.

has a share of 15.4 %.

The 434 operating reactors are 17 less in number than that in 2002, while, the total installed capacity at the peak level in 2010 was 375 GWe before declining to the current level. Annual nuclear electricity generation capacity has reached a maximum in 2006 at 2,660 TWh, and then dropped to 2,346 TWh in 2012 (down 7 percent compared to 2011, down 12 percent from 2006). About three-quarters of this decline is due to the situation in Japan, but 16 other countries, including the top five nuclear generators, have decreased their nuclear generation too.

The nuclear share in the world's power generation declined steadily from a historic peak of 17 percent in 1993 to about 10 percent in 2012. Nuclear power's share of global commercial primary energy generation plunged to 4.5 percent, a level last seen in 1984. Only one country, the Czech Republic, reached its record nuclear contribution to the electricity mix in 2012.

In 2013, the world's 392 GW of installed nuclear capacity contributed 11% of the global electricity generation. This share has declined gradually since 1996, when it reached almost 18%, as the rate of new nuclear additions (and output growth) was outpaced by the expansion of other technologies.

After hydropower, nuclear is the second-largest source of low-carbon electricity generation worldwide and the largest in OECD countries. Globally, its output is estimated to be nearly four-times greater than that of wind power and 18 times that of solar photovoltaics (PV) (though these ratios are declining rapidly, due to the fast growth of renewables). Some 80% of operational capacity is in OECD countries; however, it is non-OECD countries that are presently driving new construction. Of the 76 GW of nuclear capacity being built by the end of 2013, three-quarters was in non-OECD countries (and 40% in China). This reflects the need to add large increments of baseload capacity to meet fast-growing electricity demand, and to diversify the power mix, while emitting less air pollutants. The average age of nuclear capacity worldwide is 27 years, while expected technical lifetimes for reactors are 30-60 years, depending on the reactor type and location. More than three-quarters of the fleet in OECD countries is over 25 years old, posing big questions in the medium term about the schedule for retirements and how such a large tranche of capacity might be replaced. By contrast, around half of the capacity in non-OECD countries (excluding Russia) is less than 15 years old.

However, fifteen countries worldwide are currently building nuclear power plants, one more than a year ago as the United Arab Emirates (UAE) started construction in Barrakah. The UAE is the first new country in 27 years to have started building a commercial nuclear power plant. The other one is Turkey.

As of May 2014, 72 reactors were under construction (13 more than in July 2012) with a total capacity of 76 GW. The average construction time of the plants under construction, as of the end of 2013, is 8 years.

3. The Energy System of Turkey

Dependency on energy imports

Turkey's importance for the European energy markets is growing fast, both as a regional energy transit hub and as a growing consumer. Turkey's energy demand has increased by 6.0-6.5 % on the average over the past few years and is likely to continue to grow in the future by at least 4.5-5.0 % . Over the past eight years, Turkey has exhibited some of the fastest growth in energy demand of the countries belonging to the Organization for Economic Cooperation and Development (OECD), although the last three years Turkey's economy hasn’t avoided the prolonged stagnation that has also characterized many of the European countries for the past few years.

The country's energy consumption per capita is still relatively low, although it is increasing at a fast pace. According to the International Energy Agency (IEA), energy consumption will continue to grow at an annual growth rate of around 4.5% from 2015 to 2030, approximately doubling over the next decade. The IEA expects electricity demand growth to increase at an even faster pace.

Meeting this level of growth will require significant investment in the energy sector, all of which will come from the private sector. Although Turkey is planning large investments in natural gas and electricity infrastructure, the government seeks to reduce the country's dependence on imported natural gas by diversifying its energy mix, introducing alternative energy sources such as the nuclear energy. Today, Turkey imports much of its energy, including nearly all of its oil and gas, and in 2013 this amounted to more than $60 billion.

The government thus outlined principles to improve energy efficiency and energy security with high priorities.

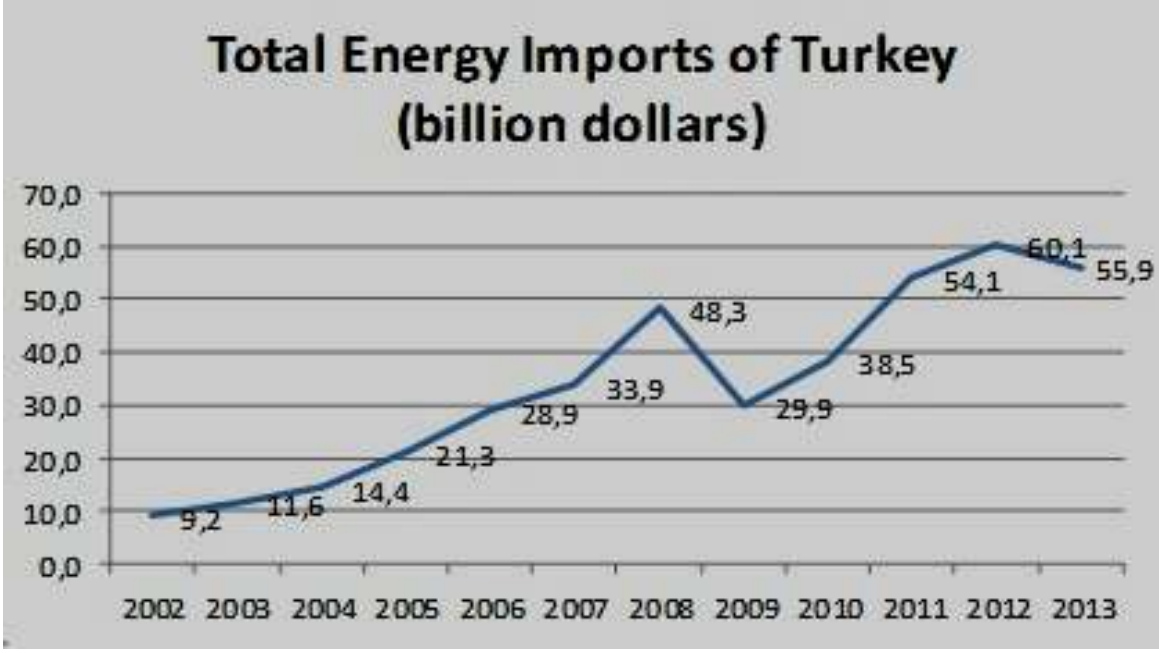


Fig. 1. Total Energy Imports of Turkey

In addition to being a major market for energy supplies, Turkey's role as an energy transit hub is becoming increasingly important with the development of TANAP-TAP gas pipeline projects. Turkey's role is key in the transiting of oil and natural gas supplies movement from Russia, the Caspian region, and the Middle East to Europe. The country has been a major transit route for seaborne-traded oil and is lately becoming more important for pipeline-traded oil and natural gas. Growing volumes of Russian and Caspian oil are being sent by tanker via the Turkish Straits to Western markets, while a terminal on Turkey's Mediterranean coast at Ceyhan serves as an outlet for oil exports from Azerbaijan and lately from northern Iraq while natural gas from Azerbaijan is exported to Turkey via the South Caucasus pipeline. Furthermore a new gas pipeline project, the TANAP-TAP with 30 bcm annual capacity is under construction. It should also be noted that Turkey receives gas from Iran via the Tabriz – Erzurum pipeline. Already Turkey is exporting limited gas quantities, originating in Azerbaijan, to Greece, an EU member.

Table 2. Turkey's Dependence on Oil and Gas Imports (2014, 2023)

2014	
Total Electricity Generation in 2014 (billion Kwh)	256,66
Electricity Generated by Gas Fired Power Plants in 2014 (Billion kWh)	120,47
Percentage of the Electricity Generated by Gas Fired Power Plants in 2014 (%)	46,94
Mevcut Tuketim (bcm)	48,50
Gas Tariff (Gazprom) in 2014 (USD/1000 m3)	375,00
Payment Made for Total Gas Consumption in 2014 (Billion USD)	18,19
Gas Consumed for Electricity Generation in 2014 (bcm)	21,51
Gas Consumed by Consumers other than Electricity Generation in 2014 (bcm)	26,99
2023	
Additional Gas to be Consumed by Power Plants Licensed by EMRA Up to Now (bcm)	19,50
Gas Consumption other than for Electricity in 2023 (bcm)	24,46
Increase in Gas Consumption until 2023 (bcm)	43,96
Total Extra Gas Consumption in 2023 (bcm)	92,46
Payment to be Made Total Gas Consumption in 2023 (Billion USD)	34,67
Payment Made to Oil in 2014 (Billion USD)	36,81
Payment to be Made Total Gas and Oil Consumption in 2023 (Billion USD)	71,47

Source: Prof. Dr. Osman Sevaioglou, "*The Nuclear Option for SE Europe",* IENE Conference, *Bucharest, May 6, 2015*

Power generation and electricity imports

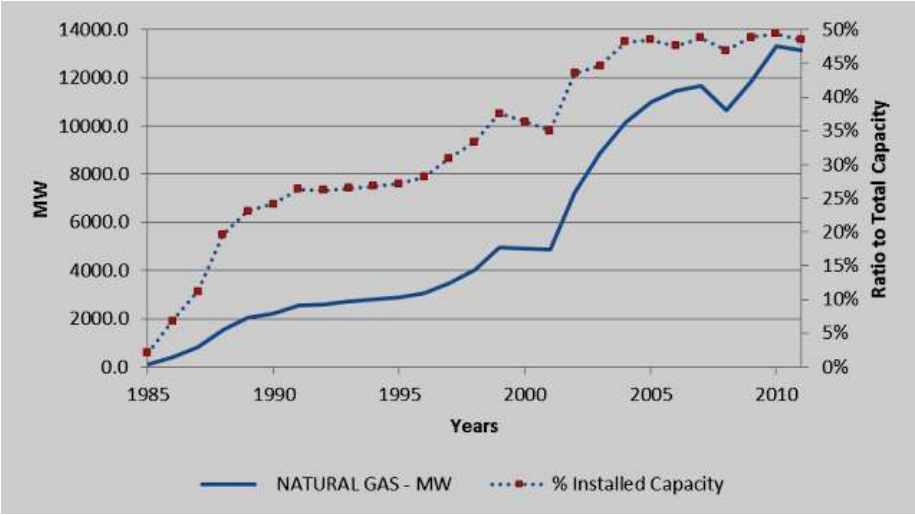
In 2014, Turkey's total electricity installed capacity stood at 56.1 GW. Turkey's electricity demand grew by more than 90% from 2001 to 2012, with much of the growth occurring between 2002 and 2008. Although demand has dropped in 2009 compared with the previous year, because of the economic slowdown, in 2010 consumption rebounded by about 10% compared with the previous year.

In 2014 Turkey's electricity generation was 254 billion kWh. Of this, 111 TWh (44%) came from gas (two thirds of this from Russia, most of the rest from Iran), 72 TWh (28%) from coal, and 61 TWh (24%) from hydro. Net import was 3 TWh. Demand growth stood at about 8% pa, and in the first half of 2013 consumption was 119.3 billion kWh. Per capita consumption has risen to 3400 kWh/yr in 2014. Demand in 2023 is expected to be 450 billion kWh, implying new investment by then of $100 billion. Peak demand reached 40 GWe in the first half of 2013.

Fossil fuel and hydroelectricity generation accounts for nearly all of Turkey's electricity although in recent years the shift of electricity generation toward RES is notable. Fossil fuel

sources account for the largest share of electricity generation, with natural gas as the most important source with 48 % of the total generation. Natural gas is mainly used for power generation and domestic heating and cooking, although a significant amount of natural gas also goes to the industrial sector. Consumption growth is expected to remain strong as rising electricity consumption and new power plants continue to spur demand.

Fig. 2 Natural Gas Based Power Generation (Installed Capacity – MW)

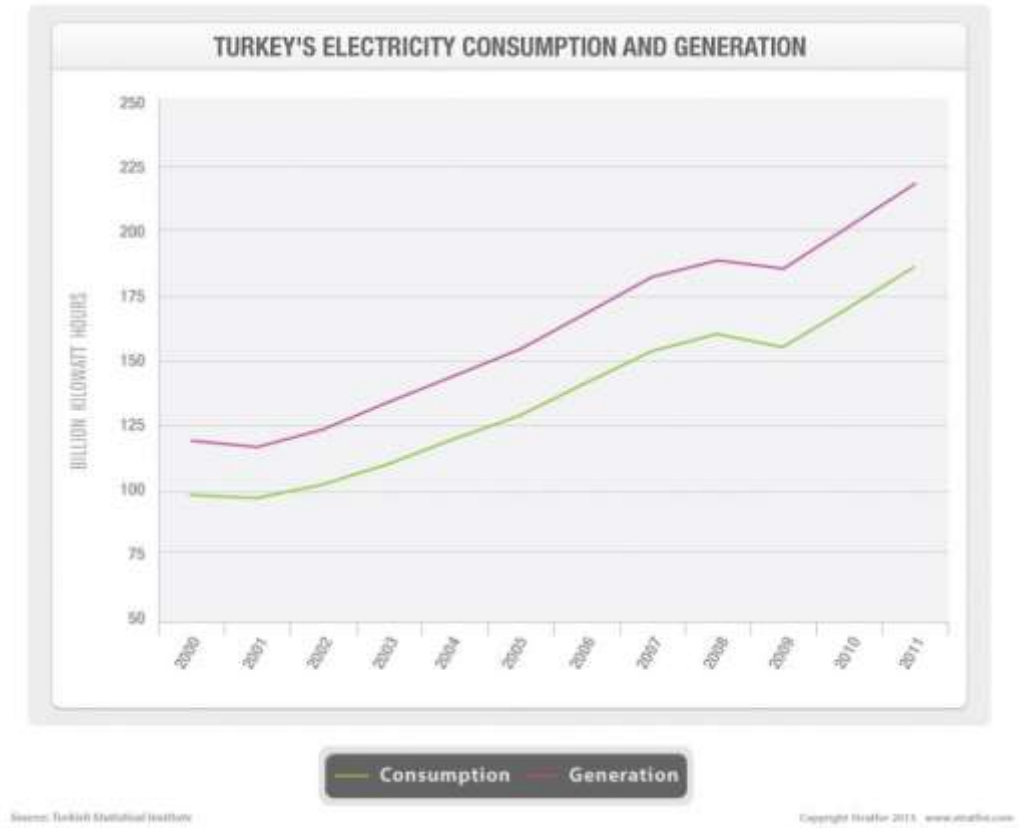


About 50% of electricity generation is generated by power plants that use natural gas.

Coal-fired power plants are also important to Turkey's electricity generation mix. The country imported 23% of its total coal supply in 2012. Volumes of imported coal may rise in the future as coal's importance for power generation increases, while the price of coal remains low. However, after a decade in which rapidly rising power demand was met from new gas-fired power stations based on imported gas, in mid-2012 the Turkish government signaled its intention to drive a switch back to domestic coal. As a result government incentives for new gas-fired power stations have disappeared and instead shifted in encouraging new coal-fired power stations. In mid-2012 the Minister of Energy, Taner Yildiz, stated that the country's coal resource was enough to support 17,000 megawatts of coal-fired power stations, equivalent to approximately one-third of the country's current installed capacity. To encourage the switch from gas to coal, Yildiz flagged that the government intends to call tenders for 5,000 to 6,000 MW of new plants in 2014 with up to 18,000 MW by 2023. The government is simultaneously pursuing a rapid programme of privatising the generation sector and encouraging private investment in the previously undeveloped coalfields. It is important to note that in its Medium Term Coal Report 2012, the International Energy Agency (IEA) stated that it expected only 0.4% growth per year in coal

demand between 2012 and 2017 with "the bulk of this growth in coal demand coming from Turkey".

Fig. 3 Turkey's Electricity Consumption and Generation



As far as renewable energy is concerned, having more than doubled over the last 10 years the country's total installed RES energy capacity by the end of 2014 amounted to 3883 MW in addition to the 605 MW in construction. According to industry estimates Turkey is expected to reach 10.000 MW of RES capacity by 2020. In addition to this, 3.000 MW of solar power capacity is set to reach by the end of 2020. According to Turkey's Energy Market Regulatory Authority (EMRA), fuelled by a burgeoning appetite for solar and government support for locally produced equipment manufacturing. Wind power, however, is set to lead the way, accounting for almost half of the country's renewable power generation by 2023. Geothermal energy will play a small part too, increasing to 600 MW within a decade. Having a substantial potential for geothermal energy, Turkey ranks seventh in the world and first in Europe in terms of power generation from geothermal energy resources.

Aiding a small part of this growth in renewable energy generation is the European Bank for Reconstruction and Development (EBRD), which has put together a financial loan package totalling $700 million for one of the most significant banks in Turkey, Turkiye Is Bankasi. This loan will be used by the bank to fund mid-sized renewable energy projects in the country,

helping Turkey reach its sustainability goals for 2023. Turkey also aims at further increasing its use of hydro, wind and solar energy resources with the main target to produce 30% of its electricity need from the renewable by 2023.

Market operation

In 2001, the government enacted the Electricity Market Law in order to set up a comprehensive electricity reform programme. Under the law, the state-owned Turkish Electricity Generation and Transmission Corporation (TEAS) was unbundled and split into separate generation, transmission, distribution, and trade companies, with a goal of eventual privatization of these trade companies. Turkey has since taken steps to create competitive wholesale trading and retail sales markets and plans to open up the market for all customers by 2015. In addition, retail tariffs were modified to reflect the cost of generation, transmission, and distribution by removing the subsidies.

The 2001 law also created the Energy Markets Regulatory Authority (EMRA) as the regulator of the electricity market. It is tasked with issuing licenses for all market activities related to the electricity market, determining and approving regulated tariffs, and setting the eligibility limit for market opening. In addition, it is involved in drafting legislation affecting electricity markets, resolving disputes, and applying penalties. In March 2013, the Turkish Government passed a new Electricity Market Law, establishing an independent regulatory and auditing mechanism for the electricity market.

The largest generation company is the state-owned Electricity Generation Company (EUAS), which controls about half of all generation capacity in Turkey in 2013. The remainder of generation comes from independent power producers, generation companies acting in the competitive market and the firms with special state concessions on the basis of build/operate and build/operate/transfer status. The Turkish Electricity Transmission Company (TEIAS) is the publicly owned enterprise that owns and operates the transmission system and is legally unbundled.

With the recent market liberalization drive the competitive characteristics of the Turkish electricity energy sector improved significantly, while the level of competition has substantially increased with more and more players entering the market every year. The new regulations regarding the market structure and trading, the decrease of public share due to privatizations in electricity distribution and generation, and fierce competition due to

increased investments increased the need for market players to develop new competencies and restructure themselves.

Turkey has as a top priority and target the synchronous connection with the ENTSO-E network, which is important in terms of the country's relations with the Balkans and South-East Europe. Substantial improvements in the quality of the system's frequency have been achieved to enable this synchronous connection, thus the expectation for the establishment of such connection in the near future has significantly increased.

When Turkey and the ENTSO-E member countries are compared with respect to the anticipated demand growth rates in 2010-2020, it is clear that Turkey has a relatively much higher growth potential. Especially, when neighbouring countries which are also expected to have high growth rates are considered, it could be seen that Turkey might not only meet its own demand but also could exploit the opportunity to make a major contribution to cross-border electricity trading in the coming years. Moreover, countries with aggressive targets regarding clean energy in their current agenda would provide trading opportunities for electricity generated from renewable resources and even more from nuclear energy in the future.

Electricity Prices

The increase of electricity imports is partly explained as a result of the sharp increase in energy prices in the Turkish market. In 2014, Turkey's electricity imports have mainly risen due to the decrease in the expected rains in winter and spring, resulting in a reduction in the generation of the hydropower plants, and failure to meet their goal of providing a quarter of Turkey's electricity demand. As many energy experts note, if electricity generation in Turkey is not supported with some robust alternative sources such as coal or nuclear energy, these types of problems will become inevitable and electricity prices will continue to rise even further in the years to come.

In general, household consumers in 2013 paid on average 35,7 Kurus (0,357 Turkish Liras) per kWh electricity with all the supplements included, while the industrial consumers paid on average 24.1 (0,241 Turkish Liras) per kWh electricity as it is shown in the table below.

Table 3.

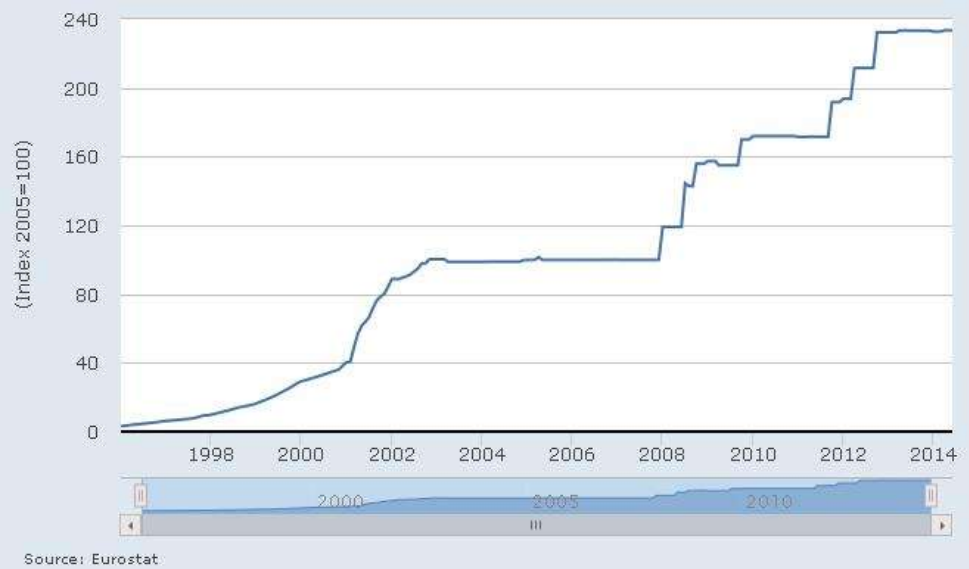
Average Electricity Unit Prices[4], I. Period: January-June, 2013

(Kurus/kWh)

	2012		2013
	I. Period	II. Period	I. Period
Household	30,9	33,9	35,7
Industry	20,7	22,8	24,1

(4) Average electricity unit price is the average price paid by households and industrial consumers for 1 kWh electricity including all taxes within the respective six-month period of the year.

Fig. 4 Electricity Prices in Turkey



Electricity Demand Forecasts

Demand for electricity is basically affected by economic growth, population increase and urbanization as well as energy efficiency applications and factors related to climate change. Although, Turkish electricity demand forecast should be based on the cumulative demand forecast of each regional distribution company by virtue of the Electricity Market Grid Regulation and Regulation Concerning Electricity Demand Forecast, currently it is still calculated by Ministry of Energy and Natural Resources by using MAED (Model for Analysis of Energy Demand) with data obtained from the distribution companies. According to the latest "Turkish Electrical Energy 10-Year Generation Capacity Projection (2009 -2018) Report" published by TEIAS, total electricity demand is expected to reach 336 TWh with 6.3% compound annual growth rate (CAGR) in base scenario in 2018 and 357 TWh with 7% CAGR in high scenario.

In 2012 and 2013, the electricity demand somehow dropped due to a deterioration of the economic climate. However, with the decreasing impact of economic recession in Turkey, electricity demand is expected to rebound over the next 2-3 years which increases the likelihood of supply and security issues emerging once again in the medium term.

While GDP was 2,100 USD/capita and the electricity consumption per capita was 750 kWh/capita in 1980s, both were doubled in 1990s and GDP reached 6,350 USD/capita on average and electricity consumption per capita levelled at 3400 kWh/capita in 2013. After the economic crisis of 2008, whose effects gradually diminished, the economic growth returned to normal patterns. Due to accelerated economic growth and increase in population and urbanization, the expectations for consumption per capita and GDP which show an upward trend indicate that there is a huge potential for electricity demand growth. In other words, it could be predicted that electricity demand will continue to increase exponentially in medium to long term with electricity consumption per capita also increasing in parallel to GDP.

4. Turkey’s Nuclear Power Programme

Background

Turkey’s interest in establishing nuclear power generation was expressed as early as 1970. Today, plans for developing nuclear power are a key aspect of the country's aim for economic growth. The government has been advocating construction of nuclear power plants in an effort to diversify Turkey's electricity supply portfolio and reduce its vulnerable reliance on Russian and Iranian gas for electricity.

The main objective of Turkey’s Nuclear Power Generation Programme is to establish a 15.000 MW power generation capacity at Akkuyu, Sinop and Kırklareli at a base load level with relatively low variable costs. The expected generation capacity will roughly be 112 billion kWh, i.e. 44 % of the existing generation capacity in 2014.

The Ministry of Energy and Natural Resources (ETKB) projects 2020 electricity generation as possibly 499 TWh in a high scenario of 8% growth, or 406 TWh with a low one with 6.1% growth. Plans envisage 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 (i.e. in Afsin Ebistan) at less than 5 MJ/kg.

Various nuclear power projects have been proposed over the years: In 1970 a feasibility study was made for a 300 MWe plant, in 1973 the electricity authority decided to build a 80 MWe demonstration plant, but did not go ahead and then in 1976 the Akkuyu site on the Eastern Mediterranean coast near the port of Mersin was licensed for a nuclear plant. In 1980 an attempt to build several plants failed due to lack of government financial guarantees.

In 1993 a nuclear plant was included in the country's investment programme following a request for preliminary proposals in 1992. But revised tender specifications were not released until December 1996. Bids for a 2000 MWe plant at Akkuyu were received from Westinghouse + Mitsubishi, AECL and Framatome + Siemens. Following the final bid deadline in October 1997, the government postponed its decision no less than eight times between June 1998 and April 2000, when plans were eventually abandoned due to economic circumstances.

Table 4. Basic Characteristics of Turkey's Current Nuclear Power Plant Programme

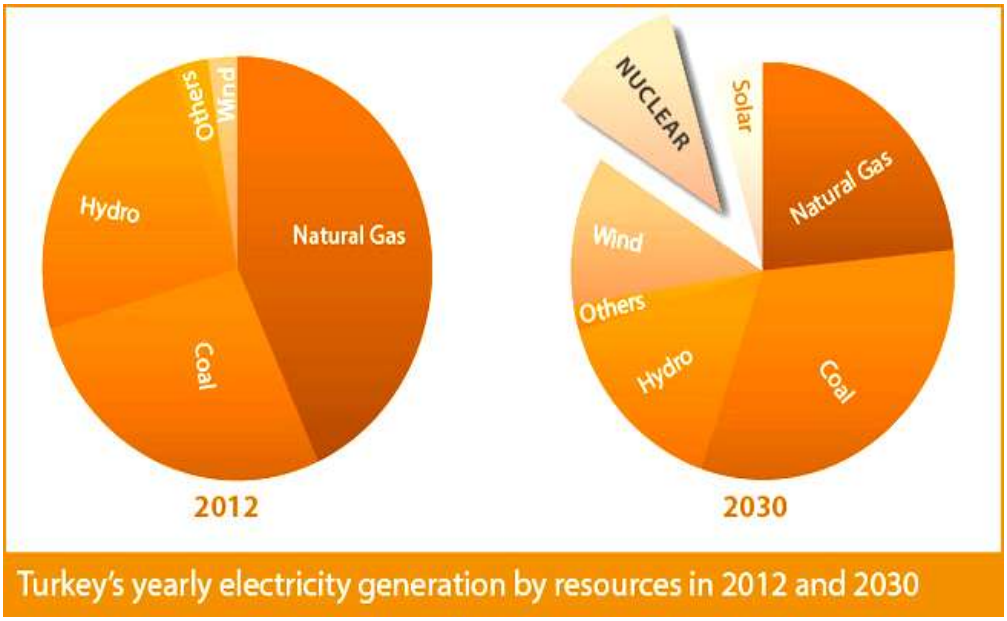
Details	Akkuyu NPP	Sinop NPP
Location	Akkuyu-Mersin	Sinop or another location
Land ownership	Nonremunerative allocation	Nonremunerative allocation
Reactor	VVER 1200 (AES 2006 Design)	ATMEA-1
Installed capacity	4 x 1,200 MWe (4,800 MWe)	4 x 1,120 Mwe ▪ 4,480 MWe
Project duration	Until the decommissioning process of NPP	Until the decommissioning process of NPP
Commissioning (Planned)	Unit-1: 2020 Unit-2: 2021 Unit-3: 2022 Unit-4: 2023	Unit-1: 2023 Unit-2: 2024 Unit-3: 2027 Unit-4: 2028
Company and shareholders	Main Contractor JSC "Atomstroyexport" (ASE)	Mitsubishi, ITOCHU and EÜAŞ. EÜAŞ will hold the 30% - 49% of the equity during the period of Power Purchase Agreement (PPA)
Financing	Project finance for 70% and eqity for 30%. Equity will be 100% funded by Russia.	Project finance for 70% and eqity for 30%. Turkey will fund equity based on the EÜAŞ shares in the project company.
Feed-in tariffs	The average sales price to be equal to USD cents 12.35/kWh for the half of electricity generated during the first 15 years. The price cap is set at USD cents 15.33/kWh.	The average sales price to be equal to USD cents 10.8 (10.83) /kWh for the first 20 years. Tarrifs will be finalized after the feasibility.
Feed-in tariff period (Year)	15 year	20 year
Fuel price	Included in the tariff	Excluded in the tariff
Waste management tariff (USD cents/kWh)	0,15	0,15
Decommissioning fund tariff (USD cents/kWh)	0,15	0,15
Post PPA period after feed-in tariff	Electricity will be free-traded in the market. 20% of the net profit to be transferred to Turkish party by the Project Company.	Electricity will be free-traded in the market.
Radioactive wastes	Project company will pay the necessary funds for the waste management.	Project company will pay the necessary funds for the waste management.

Nuclear energy as a key component of Turkey's energy strategy

In August 2006 the government announced its intention to have three nuclear power plants built totalling 4500 MWe to be put in operation by 2012-15. Discussions had been under way with the Atomic Energy of Canada Ltd regarding two 750 MWe CANDU units as an initial investment. These and the PWR type were apparently preferred at the time. The first units of some 5000 MWe total were to be built at Akkuyu, since the site was already licensed, but licensing was also proceeding for the Sinop location.

In November 2007, a new law concerning the Construction and Operation of Nuclear Power Plants and Electricity Sales was passed by the Parliament and approved by the President. The bill provided for the Turkish Atomic Energy Authority (TAEK) to set the criteria for building and operating the plants. The Turkish Electricity Trade & Contract Corporation (TETAS) would then buy all the electricity to be generated with respect to 15-year contracts. The bill also provided for public institutions to build the plants if other offers are not satisfactory. It also addressed waste management and decommissioning, providing for a National Radioactive Waste Account (URAH) and a Decommissioning Account (ICH) which generators would pay into progressively at USD 0.15 c/kWh. The OECD Paris and Brussels Conventions on third party accident liability would apply.

Fig.5 Turkey's Electricity Generation by Sources, 2012 and 2023



Immediately subsequent to this law, "Criteria for Investors who will Construct and Operate Nuclear Power Plants", and regulations were published with IAEA safety standards being applied. Then, in May 2008 a civil nuclear cooperation agreement with the USA entered into force, and in June 2010 a nuclear cooperation agreement with South Korea was signed, and in April 2012 two similar agreements with China were signed.

In November 2013, the IAEA conducted an Integrated Nuclear Infrastructure Review (INIR) in Turkey to assess the country's progress in preparing for the new nuclear power programme. It reported positively but recommended completing first a national policy on nuclear energy, strengthening the regulatory body, and developing a national plan for human resource development.

Table 5. Planned Nuclear Reactors in Turkey

Type		MWe	Start of construction	Start of operation
Akkuyu 1	VVER-1200	1200	January 2016	2022
Akkuyu 2	VVER-1200	1200	2017	2022
Akkuyu 3	VVER-1200	1200	2018	2023
Akkuyu 4	VVER-1200	1200	2019	2024
Sinop 1	Atmea1	1150	2017	2025
Sinop 2	Atmea1	1150	N/A	2026
Sinop 3	Atmea1	1150	N/A	N/A
Sinop 4	Atmea1	1150	N/A	N/A

In addition to these, the government has announced its intention for three further nuclear power plants each with four reactors, all to be operational by 2030.

Financing

In contrast to some new nuclear states -- like the United Arab Emirates -- Turkey until recently refused to cover any reactor-building costs with treasury guarantees, under which the government commits to making up the difference if revenue falls short. Instead, it insisted that the foreign company bidding on a tender commits to financing all the costs of construction. This model was designed to avoid incurring any public debt.

Beginning in 1984, Ankara had asked that the foreign bidder pay for the cost of construction and recoup expenses from guaranteed electricity sales fixed at artificially low rates for 15

years. After recouping expenses, the foreign firm was then expected to transfer the reactor to a Turkish firm, in exchange for a percentage of future profits. While some foreign suppliers initially agreed to this arrangement, Ankara's insistence on 100 percent foreign financing prevented the conclusion of any deal.

In the mid-1990s, Ankara replaced its build-operate-transfer financing scheme -- which hadn't led to any significant investments in the electricity sector -- with a new arrangement dubbed build-operate-own (BOO). The BOO model still demands that the foreign bidder finance the cost of construction and recoup costs from guaranteed electricity sales, but Turkey abandoned its demand for transfering the reactor to a Turkish firm. Ankara still does not provide treasury guarantees, though, and so continued to struggle to find nuclear suppliers among major Western and Asian companies.

Eventually, Turkey attracted interest from Russia, and in May 2010 and concluded a $20 billion BOO arrangement with a consortium led by Rosatom, the state-owned nuclear company. Rosatom agreed to go ahead with construction without receiving any financial guarantees from Ankara. Ankara avoided granting Russia a second deal when it issued its latest nuclear tender. However, it was difficult for Turkey to entice the most reliable nuclear suppliers without altering its financing demands. Faced with a choice between revising its policy and partnering with an unproven supplier like China for older reactor designs, Turkey's leadership opted for the former path.

That was enough to bring the Japanese to the table with a $22 billion deal. Under the agreement, Japan's Mitsubishi and Itochu, together with France's GDF Suez, will build and operate four Atmea1 1100-megawatt pressurized water reactors at Sinop. This time, Ankara agreed to back the project with a substantial minority stake. The initial terms of the agreement call for EUAS, Turkey's state-owned electricity utility, to take a 49 percent stake, although Turkey has expressed interest in selling up to half of that in a public offering. In return, Japan and Turkey agreed to sell the power produced in the reactors for $11.80 Cent/KWh to the state-owned Turkish Electricity Trading and Contracting Company (TETAS) -- a price even lower than the Russian plant at Akkuyu will charge.

The Uranium and fuel cycle

Turkey has modest uranium resources, including 7400 tU listed in the 2007 Red Book which are amenable to mining by in situ leaching. The Temrezli deposit in the central Anatolian

Region 220 km east of Ankara was discovered by the Department of Energy, Institute of Mining and Exploration (MTA) in the early 1980s. MTA continued to explore the region for the next 10 years. The towns of Yozgat and Sorgun are nearby. Australian-based Anatolia Energy Ltd* has a 100% interest in 18 exploration licences which include the Temrezli Project. Project activities are undertaken by A Dur Madencilik Ltd. (Adur), a wholly-owned subsidiary.

A preliminary economic assessment of the Temrezli ISL uranium project was published in June 2013, based on NI 43-101 figures. It found that costs would compare favourably with other (US) ISL projects at envisaged production of 3500 tU over ten years, up to 385 tU/yr. Known and inferred resources at Temrezli are 4200 tU and 2500 tU, at 0.12%U and 0.077%U respectively. Cash production costs are estimated at $22.30/lb U3O8 (excluding tax and royalty). The Ministry of Energy & Natural Resources has awarded a Production Licence for the project, and a pre-feasibility study is now being carried out. A decision to proceed with mining is then possible, with a prospective start date in 2016.

Anatolia Energy also has a significant tenement holding in the Sefaatli (35 km away from Yozgat) and West Sorgun areas. The Rosatom agreement for Akkuyu also provides for setting up a fuel production plant in Turkey. Anatolia Energy expects to start full-scale development at Temrezli by the end of 2015 after a pre-feasibility study (PFS) revealed better-than-expected economics for the high-grade uranium project in eastern Turkey. The independent PFS study was carried out by Tetra Tech and confirmed the proposed in situ leach (ISL) project to be technically low risk as well as highly profitable. Based on the development of the deposit's measured and indicated resources, which total 11.3 million pounds U3O8 (4347 tU), plus the development of some 80% of Temrezli's 2 million pounds U3O8 (769 tU) of inferred resources, the PFS foresees a total output of 9.9 million pounds U3O8 (3808 tU) over a mine life of 12 years, at a cash operating cost of $16.89 per pound U3O8. The initial capital cost for developing the site would be $41 million, with project payback within the first 11 months of operation. According to Australian Anatolia, the figures will position it as one of the world's lowest cost uranium producers.

The company plans to construct a central processing plant at Temrezli, with an annual capacity of 1.2 million pounds U3O8 (462 tU). The plant could also process uranium-loaded resin from future satellite operations such as the nearby Sefaatli project, where Anatolia is about to start the second phase of a drilling programme which should lead to initial resource

estimates. The project will benefit from existing local infrastructure including roads and power lines. Anatolia describes the estimated $7.3 million cost of life-of-mine infrastructure as small relative to other ISL uranium projects. The company hopes to further reduce up-front costs by using Turkish plant suppliers where possible. Anatolia CEO Paul Cronin noted that the test work completed during the PFS study phase had seen many upgrades to the project since a preliminary economic assessment was completed in 2014, leading to better financial returns than previously anticipated. With an operation licence already in hand, Anatolia now needs to complete an environmental and social impact assessment (ESIA) before applying for an operation permit. The ESIA is already in preparation, with the first stage expected to be submitted for approval by the end of February 2015. Subject to finance, Anatolia expects that full-scale development will begin within 2015 and says it plans to begin some pre-development activities immediately.

Institutional and regulatory aspects

Turkey does not yet have an integrated policy with regard to nuclear energy. First of all, the political authority has not yet presented a study comprising a critical analysis on whether the country needs a nuclear power plants and discussing the benefits and costs of nuclear energy compared to its alternatives. In preparing such a study the views of the public should also be received. After this stage, there is a need for a policy document indicating how the nuclear policy will be developed, how the relevant legal and regulatory infrastructure is to be formed, how the safety culture will be created and what type of steps are to be taken in topics such as spent fuel and decommissioning.

Fig. 6 Turkey's Seismic Hazard

An effective regulatory framework and sound, independent regulatory oversight are prerequisites for safe operation of a nuclear power plant fleet and critical to establishing and maintaining public confidence in nuclear energy. This was highlighted by official investigations into the Fukushima Daiichi accident in 2011, which concluded that the accident could and should have been foreseen and prevented, and stressed the need to improve the competence and independence of the regulatory body. The message is clear to all countries that have or are planning to introduce a nuclear power programme. For countries planning to introduce nuclear power, it is vital to recognise that operating nuclear plants requires sophisticated technical, scientific, industrial, institutional, and legal capacities. Robust and independent oversight regimes are similarly necessary for nuclear waste storage and disposal.

By its very nature, nuclear power has implications beyond national boundaries and, in any case, many of the challenges posed by nuclear power can be daunting for an individual nation. Challenges facing all countries with nuclear programmes can and should be addressed collectively. Institutions have been established to facilitate such co-operation, for example on best practice in regulation, safe operation and managing nuclear waste, bringing together industry, regulators, national and international bodies. Organisations such as the International Atomic Energy Agency, the OECD Nuclear Energy Agency (NEA) and the World Association of Nuclear Operators provide fora for promoting high standards and engaging in joint technology development. These institutions are of particular value to countries with small or new nuclear programmes to enable them to draw upon the broader experience of more established nuclear enterprises. Co-operation should also extend to research and development aimed at advances in safety and cost reduction (IEA, 2015). The safety and security requirements for the technical facilities required and the long timelines before research investment yield returns are strong reasons for international collaborative actions.

Furthermore, decisions concerning nuclear power need to be taken with the informed consent of the public. Public engagement needs to occur both at the national level during the process of broad policy formation or its revision, and at the local level concerning specific projects. It should include all relevant stakeholders – industry, policy-makers, regulators, civil society and the potential host communities. The commitment to public engagement does not stop after the initial planning decision: it must extend all the way through to decommissioning and waste management. The public must have the opportunity to comment on both plans and operations and needs to be assured that its concerns have

been heard and taken into account. Definition of the precise mechanism to achieve this varies with local circumstances, as is the precise extent of the public role in final decision-making. Governments are ultimately accountable to the public for the effectiveness of these procedures and, accordingly, for their establishment and successful operation. It should be noted that Finland and Sweden have succeeded in gaining public approval for sites suitable for long-term waste disposal facilities on the basis of best practices in this respect.

5. Current Nuclear Projects

5.1 The Akkuyu Project

TETAS called for tenders in March 2008, inviting bids for the first nuclear power plant at Akkuyu, near the port of Mersin in the Mediterranean. TAEK issued specifications, allowing for PWR, BWR or PHWR types of at least 600 MWe and with 40-year service life. Design certification in country of origin was acceptable, allowing TAEK to concentrate on site-specific aspects of the 4800 MWe project. In the event, only one bid was received from 14 interested parties, this being from Atomstroyexport in conjunction with Inter RAO (both from Russia) and Park Teknik (Turkey), for an AES-2006 power plant with four 1200 MWe reactors. After some deliberation, TAEK found that it met the technical criteria. (It was later reported that TAEK required foreign vendors to take back used fuel, and none except ASE were prepared to do so.)

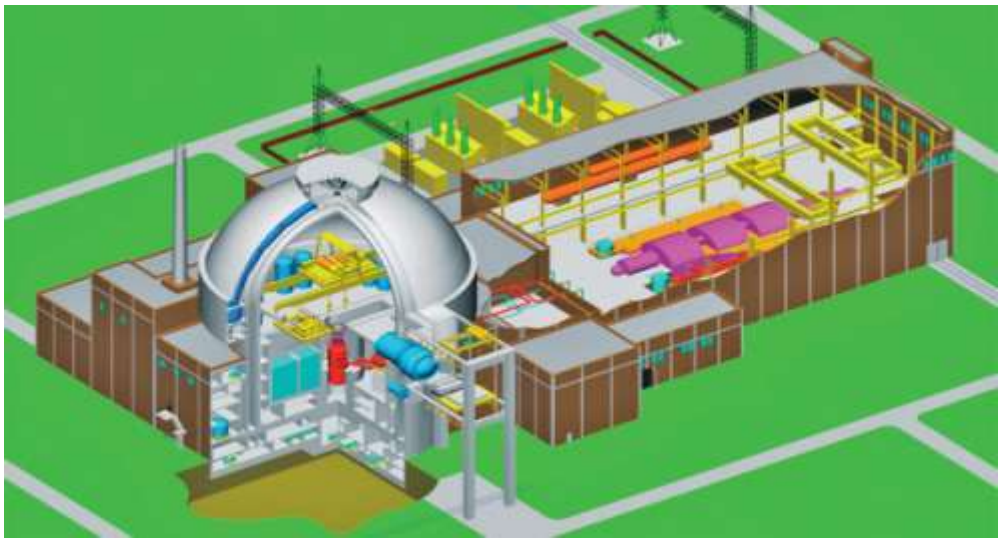
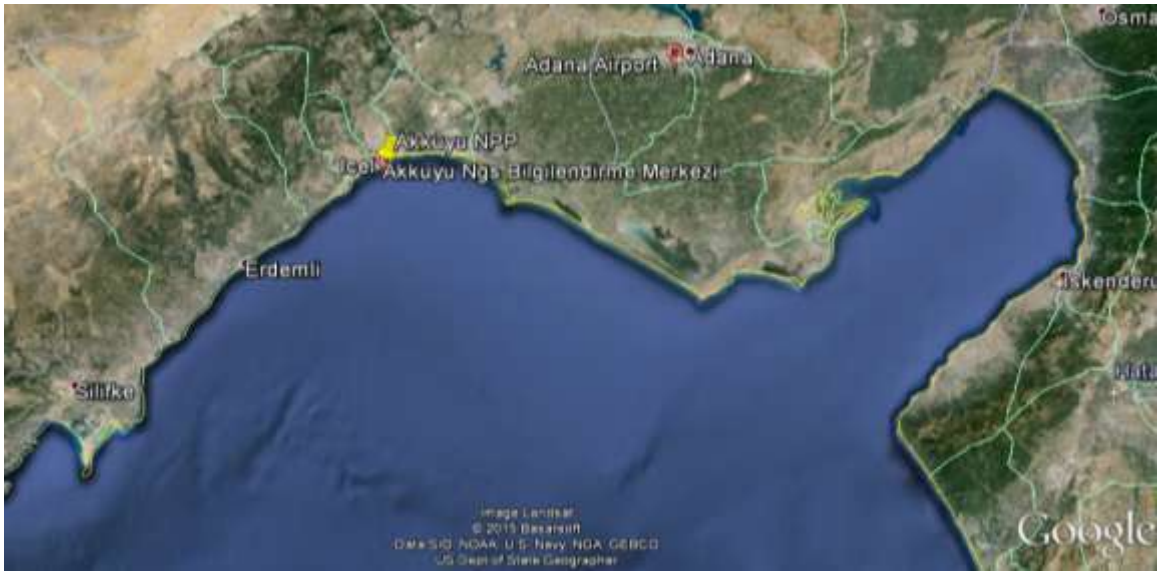


Fig. 7 The layout of the WWER-1200 pressurized water reactor. Four similar units are planned to be built at Akkuyu

Following advice from TETAS, a final government decision was expected by April 2009, but in fact only a series of statements resulted, regarding the cost of power over the first 15 years which was considered to be too high. Then in August 2009 two agreements between TAEK and Rosatom were signed. One was a nuclear cooperation agreement, the other was a standard one for the early notification in case of a nuclear accident and the exchange of information on nuclear facilities. These progressed the possibility of a Russian nuclear project at Akkuyu, probably with 25% government equity to dampen the likely electricity price rise. The first reactor was expected to come on line in 2016, and others in 2017, 2018 and 2019. However, following a ruling by the country's top legal body, TETAS cancelled the Atomstroyexport proposal and said that a new tender would be launched soon. Following this setback the parties proceeded with a direct high-level agreement instead.

Fig. 8 Location of the Akkuyu NPP



In May 2010 Russian and Turkish heads of state signed an intergovernmental agreement for Rosatom to build, own and operate (BOO) the Akkuyu nuclear power plant of four 1200 MWe AES-2006 units as a US$ 20 billion project. This will be its first foreign plant on a BOO basis. Rosatom, through Atomstroyexport, will finance the project and start off with 100% equity in the Turkish Akkuyu project company (APC) set up to build, own, operate and decommission the plant. The project company became Akkuyu NPP JSC (Akkuyu Nukleer Santral/ NGS Elektrik Uretim AS) in 2011. Longer-term, Rosatom entities intend to retain at least 51% of the company. The Turkish firm Park Teknik and state generation company Elektrik Uretim AS (EUAS) are expected to take up significant shares. In May 2013 Rosatom

invited EdF to become an equity partner in the project. Meanwhile, EUAS transferred the site to the project company.

Table 6. Investment Profile of Akkuyu NPP Project

Monthly Return Payment (Million USD)	238,04
Commercial Capacity Factor (Percentage of Purchasing)	70%
Annual Generation Capacity (Billion kWh)	29,45
Annual Duration of Operation (Hours)	6.135
Annual Generation sold to TETAS (Billion kWh)	29,45
Monthly Generation Sold to TETAS (Billion kWh)	2,45
Capacity Cost (Cent/kWh)	9,699
Fuel Cost (Cent/KWh) (UO2 – Uranium Fuel, 140 USD/Lb)	0,760
For National Radioactive Waste Disposal Foundation (Cent/kWh)	0,150
For Plant Decommissioning Foundation (Cent/kWh)	0,150
Operation and Maintenance Expenditures (Cent/kWh)	1,280
Cost of Wholesale Electricity (Cent/kWh)	12,039
Rated Power/Unit (MW)	1.200
No of Units	4
Rated Power of the Project (MW)	4.800
Overnight Cost/kW (USD/kW)	3.340
Total Overnight Cost (Million USD)	16.032
Interest Rate (Libor + Spread) (%)	5,50
Total Interest During the 7 Year Construction Period (Million USD)	4.209
Total Financial Cost of the Investment (Million USD)	20.241
Return Period (Years)	9
No. of Return Payments/Year	12

Source: Prof. Osman Sevaioglou, *The Nuclear Option for SE Europe, Bucharest, May 6, 2015*

In July 2010 the Turkish parliament ratified the May agreement for the 4800 MWe plant at Akkuyu, and in November the Russian parliament also ratified it. The project company was registered in December 2011, and by mid 2012 the equity position was as follows: Rosenergoatom concern 92.85%, InterRAO UES 3.47%, Atomstroyexport 3.47%, and 0.1% each for Atomenergoremont and Atomtekhenergo. Late in 2012 JSC Akkuyu NPP quoted the cost as $18.7 billion, and in December Russia's President announced that Russia would fully finance the project to the tune of $20 billion. Turkey's prime minister later said that the equity capital of the JSC Akkuyu NPP would be increased to $2.4 billion, and the overall investment in the project would reach $22 billion. In October 2013 It was further agreed that Rusatom Overseas was to be made responsible for the main Russian involvement in the project, as majority owner and manager, apparently taking over Rosenergoatom and Atomstroyexport equity. InterRAO UES reduced its holding to 0.8% in April 2014. A 49% non-Russian strategic investor was being sought, and early in 2014 this was still on offer. It was

further agreed that Rusatom would supply the fuel. In February 2015 Russia's Inter RAO said it would not participate in an authorized capital share issue of JSC Akkuyu Nuclear and would decrease its shares in the company from 1.15% to 0.5%. The equity position then was: Rusatom Overseas (64.96%), Rosenergoatom (30.66%), AtomStroyExport (3.17%), Atomenergoremont (0.03%) and Atomtechenergo (0.03%).

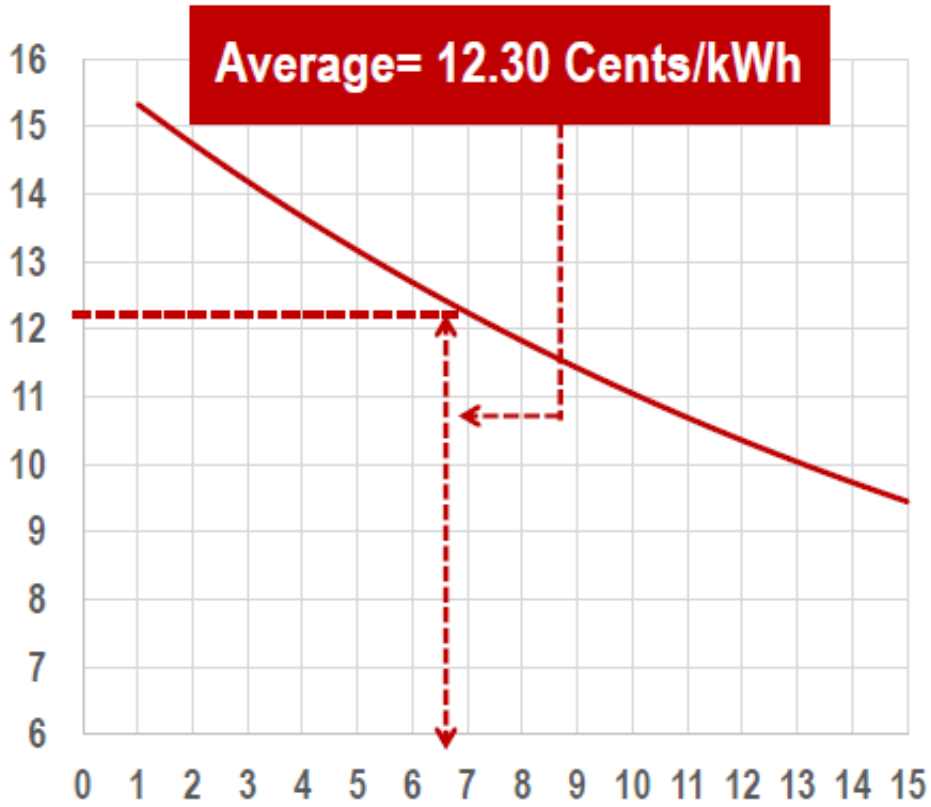
Table 7. Anticipated Installed Capacity and Power Generation of Akkuyu NPP

Rated Power (MW)	1.200
No. of Units	4
Total Rated Power (MW)	4.800
Annual Duration (Hours)	8.765
Technical Capacity Factor (%)	85,00
Annual Generation (Billion kWh)	35,76
Annual Demand of (billion kWh) (2014)	255,00
Percentage of AKKUYU in the Annual Demand of Turkey (%)	14,02

Source: Prof. Osman Sevaioglou, *The Nuclear Option for SE Europe, Bucharest, May 6, 2015*

It was agreed that 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. The proportion will be 70% of the output of the first two units and 30% of that from units 3 & 4 over 15 years from commercial operation of each. The remaining power will be sold by the project company on the market. After 15 years, when the plant is expected to be paid off, the project company will pay 20% of the profits to the Turkish state. Commercial status of the company will be reduced to "Generation Company acting in the Competition-Based Market". The Company will then be allowed to participate in trading activity in the wholesale market with respect to the competition-based market prices for the remaining 25 years, following the 15 years of agreement period.

Fig. 9 Wholesale Electricity Rates for the Akkuyu Plant



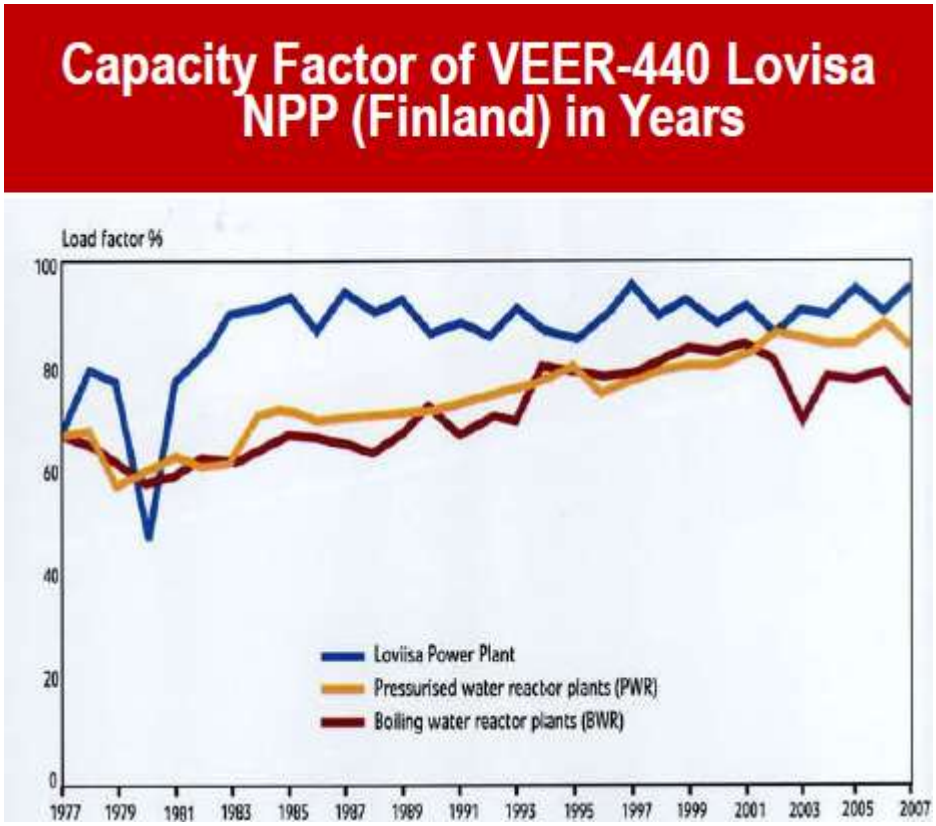
Source: Prof. Osman Sevaioglou, "*The Nuclear Option for SE Europe", IENE Conference, Bucharest, May 6, 2015*

Retail and wholesale companies will be obligated to trade the electricity produced by the Akkuyu NPP with respect to the formula shown below:

$$\text{Share of Retail and Wholesale Company} = \frac{\text{Consumption of the Company}}{\text{Consumption of Turkey}} \times \text{Nuclear Electricity}$$

Further details on the purchasing obligations to be imposed on the retail and trading companies will be developed and outlined in a regulation to be issued by the Ministry of Energy and Natural resources (MENR).

Fig. 10 The Capacity factor of Akkuyu NPP is estimated at 85% which is almost the same with the capacity factor of Lovisa in Finland as showed below.



Source: Prof. Osman Sevaioglou, "*The Nuclear Option for SE Europe", IENE Conference, Bucharest, May 6, 2015*

At the end of 2011 if was agreed that the project company was to apply for all licences, and the first reactor will come on line within seven years of receiving these, with the others to follow at one-year intervals. In December 2011 the project company had filed applications for construction permits and a power generation license, as well as an environmental impact assessment by the deadline, with a view to Atomstroyexport as general contractor starting construction in 2013. In mid 2012 the company had received the site licence, and in February 2013 it let the first major contract for site works. Another site licence was received in January 2014. A revised environmental impact assessment (EIS) was re-submitted in July 2014 – the fourth time, and approved at the end of November. The Minister of Energy announced in October 2014 that once a construction licence was issued site construction could start in April 2015. Atomstroyexport is the general contractor for all construction work. The company expected to commission the first unit in 2021, though in March 2014 the Minister of Energy said he expected it to operate in 2019. Then in March 2015 he suggested 2022 as the earliest possible date due to anticipated delays.

Environmental Impact Assessment

Largely because of nuclear's high 'hidden' costs and waste disposal problems, environmental groups tend to oppose all nuclear projects. Turkey is not immune to environmental protests made by groups with strong relations to those in Europa. With Turkey being an active earthquake zone country the area is prone to seismic activities, with a 6.2 Richter-scale earthquake having hit Adana, 180 km from the plant site, only recently.

JSC Akkuyu NPP submitted an environmental impact assessment report (EIA) for the project in July 2013, but had to resubmit a revised version - with an additional 2000 pages - in April this year. The revision was in response to feedback from a special commission set up to review the EIA report. That commission had a meeting on October 2014 and received comments and recommendations from numerous organizations and institutions involved. The document has now been found "to be consistent with the special format of the Turkish EIA legislation and has been agreed upon", Akkuyu NPP said on December 1st, 2014.

The 5500-page report studies the potential impact of the planned nuclear power plant on the environment and specific areas of activity, including agriculture, tourism, infrastructure, localization of production, fishing and much more. Independent consultants and other experts in ecology and in the design, licensing and construction of nuclear power plants in Europe and Asia contributed to the report. The Akkuyu nuclear power plant in the Mersin Province will be the first nuclear power plant in Turkey and represents the beginning of a nuclear electricity generation industry for the country. As a result, government agencies, non-governmental organizations, political parties and Turkish citizens have been paying close attention to this highly sensitive construction project.

Table 8. Interest Rates for Akkuyu NNP Loan

Years	Percentage of Loan (%)	Loan (Million USD)	Interest (Million USD)
1	10	1.603	728,94
2	15	2.405	911,04
3	15	2.405	738,18
4	15	2.405	574,33
5	15	2.405	419,02
6	15	2.405	419,02
7	15	2.405	419,02
Total	100	16.032	4.209,53

Source: Prof. Osman Sevaioglou, "The Nuclear Option for SE Europe", IENE Conference Bucharest, May 6, 2015

After receiving approval by the EIA as part of the licensing process, Akkuyu Nuclear will now focus in obtaining all the necessary licences, permits and agreements in accordance with Turkey's legislative and regulatory requirements in order for the construction of the plant to start. Site permitting is expected, following changes to Turkish laws governing coastal areas and the rowing of olives. After that, a provisional licence for electricity generation, the signing of a construction licence and obtaining a building permit will follow. A building permit for maritime and coastal areas and then for the plant will follow.

Construction work is currently expected to begin on the first of Akkuyu's four 1200 MWe Gidropress-designed AES-2006 VVER pressurized water reactors in late 2015 or 2016. The plant is being financed by Russia under a build-own-operate (BOO) model, under an intergovernmental agreement signed by Turkey and Russia in 2010. The company is expected to commission the first unit in 2021.

Table 9. Decommissioning costs of Akkuyu NPP

Ratio of Decommissioning Cost to Overnight Cost (%)	**15**
Total Decommissioning Cost During the Commercial Life (Million USD)	**2.404,80**
Commercial Life (Years)	**40,00**
Decommissioning Cost/Year (Million USD)	**60,12**
Total Generation During the Commercial Life (Billion kWh)	**1.178,02**
Decommissioning Costs/kWh (Cent/kWh)	**0,20**
Annual Decommissioning Cost with 0,15 Cent/kWh (Million USD)	**44,18**
Total Decommissioning Cost within the Commercial Life with 0,15 Cent/kWH (Million USD)	**1.767,02**

Source: Prof. Osman Sevaioglou, "*The Nuclear Option for SE Europe", IENE Conference, Bucharest, May 6, 2015*

5. 2 The Sinop Project

Since February 2008 preparatory work has been under way in Sinop on the Black Sea to build a second nuclear plant there, along with a EUR 1.7 billion nuclear technology centre. A 5000-5600 MWe nuclear plant there is planned and is expected to cost about $22-25 billion.

In March 2010 an agreement was signed between the Korea Electric Power Corporation (KEPCO) and EUAS for KEPCO to prepare a bid to build the plant in Sinop, with four APR-1400 reactors starting operation from 2019. The bid, in conjunction with local construction group Enka Insaat ve Sanayi, was submitted in August 2010. KEPCO was to take 40% equity in the plant, and would help with financing. However, this proposal foundered due to the KEPCO's

insistence in receiving an electricity sales guarantees from the government, rather than from TETAS, as done at Akkuyu. In November 2011 the Prime Minister of Turkey requested the South Korean President to renew the KEPCO bid. In April 2013 the Minister of Energy said that KEPCO was no longer in contention, and one report said it pulled out because of lack of treasury guarantees.

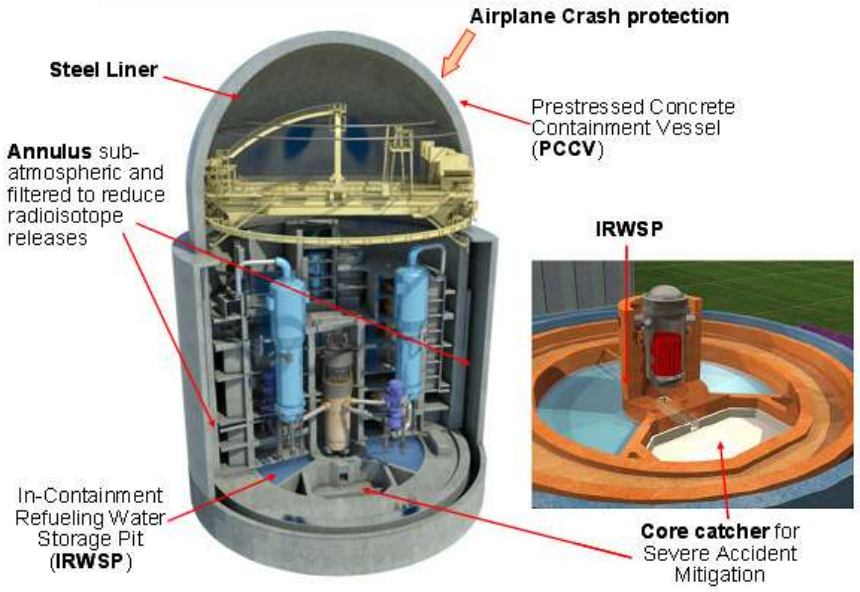


Fig. 11 The ATMEA type nuclear reactor will be used in the Sinop plant

Following this negative development two Japanese firms expressed their interest in negotiating to build the 5600 MWe plant, and in December 2010 an agreement was signed to prepare a bid. Toshiba and Tepco were involved with the proposal, using four 1350 MWe ABWR units. However talks were suspended at Japan's request following the Fukushima accident, and Tepco has since opted out. In March 2012 Japan's Ministry of Foreign Affairs announced that progress continued towards a nuclear cooperation agreement with Japan.

Fig. 12 The Sinop Project Site

Indeed, in May 2013 the government accepted the proposal from a consortium led by Mitsubishi Heavy Industries (MHI) and Areva, with Itochu, which proposed four Atmea1 reactors with total capacity of about 4480 MWe (1120 x 4) at a cost of some $22 billion. An intergovernmental agreement was then signed with the Japan Side for "exclusive negotiating rights to build a nuclear power plant", and in October an official agreement at prime ministerial level was signed for the project. EUAS declared to take a 35% stake in the project company, with the balance shared among Mitsubishi, Itochu, Areva and GdF Suez. GdF Suez, which operates seven nuclear reactors in Belgium, is to be the operator. Government sources have described it as a build-operate-transfer (BOT) arrangement. Within this framework the duration of the agreement is 20 years and the average price of electricity will be 10.38 Cents/kwh.

In October 2013 an official agreement at prime ministerial level was signed for the project. EUAS declared to take a 25% stake in the project company. Subject to a GdF Suez decision to proceed in 2016, construction is planned to start in 2017 and operation from 2023. The project is likely to be the first Atmea1 power plant built. The ünits are designed for load-following and use the same steam generators as Areva's large EPR (but 3 instead of 4). However, the same sovereign guarantees as applied at Akkuyu regarding power offtake are not included in the Sinop project.

The Third Site

Plans are again being discussed to build one more nuclear power plant in a completely new site, as part of 100 GWe required by 2030. TAEK has identified "Igneada" on the Black Sea, 12 km from the Turkish-Bulgarian border, and Akcakoca between it and Sinop as possible third nuclear power plant sites. Ankara – with low seismic risk – and Tekirdag on the northwest coast of the Sea of Marmara have also been mentioned as possible sites. When the agreement for the development of the Sinop plant was to have been finalised, the energy ministry planned to announce the site for the third plant with an invitation for expressions of interest to be issued by the end of 2013. This didn't happen and in October 2014 the prime minister said that the project would be substantially indigenous, with construction stated to start in 2019.

In November 2014 EUAS signed an agreement with the State Nuclear Power Technology Corporation (SNPTC) of China and Westinghouse to begin exclusive negotiations to develop and construct a new four-unit nuclear power plant in Turkey, i.e. the third nuclear power

plant in Turkey. No site was declared at the time. As well as Westinghouse-based passive reactor technology, either AP1000 or CAP1400, the agreement also covers all lifecycle activities including operations, nuclear fuel, maintenance, engineering, plant services and decommissioning. SNPTC was the agent introducing Westinghouse technology into China, and has developed it further. Eight AP1000 units are under construction in China and USA.

Safety and Risk Considerations

Neither the Japanese-French nor the Russian reactors pose a significant proliferation risk. For one thing, Ankara has agreed to abide by the tough inspections called for under the International Atomic Energy Agency's (IAEA) Additional Protocol. It has also concluded a fuel guarantee and take-back arrangement with Rosatom, under which the company takes back spent fuel, a fissile material that could theoretically be diverted for non-peaceful uses. Turkey will likely negotiate a similar arrangement with a member of the Japanese-French consortium. Moreover, the fact that both plants will be foreign-owned and foreign-operated decreases the likelihood that any Turkish official will seek to divert material or technology for a weapons programme.

However, Turkey’s rush to develop nuclear power as quickly and financially competitive as possible could pose a number of safety and security risks. The BOO model adopted has never been used before for nuclear power generation. With the plants being operated by foreign companies, Turkish officials will have to find a way to ensure that suppliers do not cut corners to keep costs low.

The Turkish government is eager to have at least one reactor each from the Japanese-French and Russian projects come online before the 2023 Turkish centennial. The IAEA, however, recommends that new nuclear states take 10 to 15 years to bring their first reactor online. Government’s 10-year vision may be regarded to be unrealistic in that respect.

With both projects likely to suffer delays, it is important that politics do not trump safety, but there's a serious risk that they could. Ever since the disaster in 2011 at the Fukushima Daiichi Nuclear Power Station, the IAEA has recommended that a country's regulatory authority be separate from the body that promotes nuclear energy, in order to prevent a conflict of interest between commercial and safety considerations. But the Turkish Atomic Energy Authority is tasked with promoting nuclear energy along with inspecting nuclear facilities and issuing site licenses. Moreover, the prime minister's office has substantial sway

over the authority's decision-making, selecting its leadership and allocating funds. This raises uncomfortable questions about political interference in the project, for example by pushing for speed over safety.

While the planned reactors do not pose a significant proliferation risk, the combination of weak export controls and an increased presence of nuclear materials and related technologies could lead to uncontrolled circumstances. According to recent indictments in Turkey, Europe, and the United States, nuclear materials have been transhipped via Turkey to Iran with Iranian nationals having established front companies in Turkey to trans-ship technologies critical to Iranian nuclear and ballistic missile programmes. Ankara realizes its vulnerabilities, but has yet to pass the appropriate legislation that would close loopholes and harmonize Turkey's export control laws with those in the European Union.

Turkey has pledged to work closely with the IAEA to ensure safe construction and strict quality controls. In spite of its decades-old quest for nuclear power, it has so far failed to develop the necessary laws and regulatory framework with the same eagerness. Such a framework through is essential for safety and security. Latest statements by Turkish Government officials suggest that Turkey will soon enact the necessary legislation.

6. Benefits expected from Nuclear Power Generation

Nuclear energy would not only fulfill Turkey’s future energy demands and prevent electricity shortages, 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. On the other hand, while Ankara has ratified the Kyoto Protocol, fossil fuels are not the optimal option for Turkey to address its energy needs, while renewable energy resources are insufficient to fill the gap.

According to latest reports Turkey’s economy is set to grow at an annual rate of 3,5% on average in medium term. Therefore, there is going to be a rising demand for electricity. Turkey has been is a heavily dependent on energy imports as it imports almost all of its gas and oil. In 2013, Turkey had a current account deficit of 64.9 billion dollars with total energy imports of 55.9 billions dollars which accounted for 22.2% of the country’s imports. (Central Bank of Turkey, 2013). Therefore, either through nuclear power generation or by means of

other alternatives, the country should find ways to reduce its energy import bills and its overall energy dependence.

As already mentioned in 2012 Turkey's electricity generation was 240 billion kWh gross with 53 GWe istalled capacity. Of this, 105 TWh (44%) come from gas 98% of which is imported, 68 TWh (28%) from coal, and 58 TWh (24%) from hydro while, net imports were 3 TWh. It is therefore apparent that Turkey's electricity system is highly dependent on imports which make the country vulnerable on both energy security and financial grounds.

In view of the above, plans for the introduction of nuclear power generation are a key aspect of the country's aim to cut back its high reliance on Russian and Iranian gas for electricity generation and push for further economic growth. According to the government following the building of at least one nuclear plant, Turkey will be able to save some 1,5 billion dollars every year from energy imports. By building the nuclear power plants in Akkuyu and Sinop, Turkey will not only satisfy fully its domestic electricity consumption but it will become a net electricity exporter to neighbouring countries such as Greece, Bulgaria, Iran, Iraq and Georgia. To achieve the above objective, Turkey should develop its electricity interconnections with the neighbouring countries in Europe and strengthen its national grid. It should also be noted that Turkey sees nuclear energy as complementary to its goal of becoming a natural energy bridge between East and West (Central Asia – Europe), North and South (There have been discussions of joining the electrical grids around the Black Sea between Turkey and Russia).

In short, by building two new nuclear power plants Turkey will be able to reduce substantially its dependence on oil and gas imports for power generation energy. Since it imports most of its oil and gas, the impact of nuclear power generation will help substantially in improving the security of electricity supply. In addition greenhouse gas emissions will significantly be reduced. Since nuclear power plants use uranium reserves, there is a high level of potential reserves which will be adequate for all nuclear power plants operating worldwide for at least 150 years more. Nuclear power plants face a relatively low cost for the supply of fuel, since a very small volume of material is used for electricity generation. This makes nuclear energy a very advantageous source compared to fossil fuel used for electricity generation.

In addition, Turkey regards the nuclear energy programme as a matter of prestige in the region. Overall, it is argued that nuclear energy in Turkey will bring substantial economic, political, and security benefits as well as contributing positively to environmental protection.

8. References

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