EDAM Discussion Paper Series 2014/4

Turkey's Nuclear Power Plans and Nuclear Fuel Cycle Options

Çiğdem Bilezikçi Pekar

Research Assistant – Çanakkale Onsekiz Mart University

May 2014

Centre for Economics and Foreign Policy Studies
Discussion Paper Series

Introduction[1]

Turkey first began to explore nuclear energy in the mid-1950s and made firm plans to construct a small heavy water reactor in 1967.[2] Recently, Turkey concluded two intergovernmental agreements (IGA) with a Russian and Japanese-French consortium for the construction of nuclear power plants (NPP) in Akkuyu /Mersin and Sinop. While the host country agreement is concluded for the former NPP, the latter is still awaiting for ratification.

Much of the focus about nuclear energy in Turkey has focused on the amount of electricity it will produce and the NPP's future role in Turkey's nuclear energy mix. However management of nuclear waste deserves much more attention due to the lack of a permanent solution for the back end of the fuel cycle. According to the 3130 page Akkuyu NPP Environmental Impact Assessment (EIA) report, spent fuel storage is an important step in the nuclear fuel cycle that will constitute a vital challenge for the Akkuyu NPP operators.[3] However, neither the Turkish government, nor the Akkuyu project company has clearly articulated a plan for the back-end of the fuel cycle.

This paper assesses the fuel cycle options for Akkuyu and Sinop NPPs and the long-term options for spent fuel produced at Akkuyu and Sinop.

Nuclear Fuel Cycle and Management of Spent Nuclear Fuel

The International Atomic Energy Agency defines "spent fuel" as nuclear fuel that has been irradiated in and permanently removed from a reactor core.[4] Management of spent nuclear

[1] I would like to thank Nicolas Delerue from France Pugwash, Alexei Arbatov from the Russian Academy of Sciences, İlhan Or from Boğaziçi University, Andrey Zolotkov from Bellona Murmansk, Hajime Matsukubo from Citizens' Nuclear Information Center for their kind contribution. I would also like to thank Aaron Stein from EDAM for his valuable comments and edits on the earlier versions of the paper.

[2] For history of Mustafa Kibaroğlu, "Turkey's Quest for Peaceful Nuclear Power," *Nonproliferation Review*, Spring-Summer 1997, Cilt. 4, No. 3, Center for Nonproliferation Studies, Monterey Institute of International Studies, Monterey, California, s. 33-44

[3] 4.800 MWe Kurulu Gücünde Olan Akkuyu Nükleer Güç Santralı Projesi (Nükleer Güç Santralı, Radyoaktif Atık Depolama Tesisi, Rıhtım, Deniz Dolgu Alanı Ve Yaşam Merkezi) ÇED Raporu, http://www.csb.gov.tr/db/ced/editordosya/Akkuyu_NGS_CED_Raporu.pdf, Section V.2.1-2.5, p. 118

[4] International Atomic Energy Agency, The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, reproduced in document INFCIRC/546 by the IAEA, Status report, Art.2

fuel (SNF), remains a difficult problem for the global nuclear industry. Following electricity production, highly radioactive SNF is either reprocessed or stored. There are two major options for the management of spent fuel; a) closed cycle: decomposition and recycling of uranium and plutonium in the spent fuel and storage of the remaining waste, b) Open Cycle: direct storage of spent fuel.

In both cases once the highly radioactive spent nuclear fuel is removed from the reactor and placed in a spent fuel pond. Moreover, while interim storage is temporary (and is cheaper than reprocessing or direct disposal), permanent solutions are more expensive than temporary ones.[5]

Turkey-Russia Agreement on Nuclear Cooperation and Nuclear Fuel Cycle

Russia's state-owned nuclear company Rosatom has been offering to build and operate nuclear power stations abroad, as part of a larger package known as "Build, Own, Operate" (BOO).[6] Under the BOO model, Rosatom not only builds the nuclear plant, but also owns it and runs it for some sixty years. Rosatom will also deliver the nuclear fuel for the plant.[7]

On 12 May 2010, Ankara and Moscow signed the "Agreement between the Government of the Russian Federation and the Government of the Republic of Turkey on cooperation in relation to the construction and operation of a nuclear power plant at the Akkuyu site in the Republic of Turkey." The Turkish Parliament ratified the agreement in July 2010 and it was published in the Official Gazette on 6 October 2010.[8] According to the agreement, the

[5] Bunn, Matthew, Steve Fetter, John Holdren, and Bob van der Zwaan. "The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel". December 2003, http://belfercenter.ksg.harvard.edu/files/spentfuel.pdf

[6] http://uk.reuters.com/article/2013/05/13/uk-rosatom-nuclear-russia-idUKBRE94C09G20130513 , accessed on 4 March 2014; As Jong Kyun Park, the director of the IAEA division of nuclear power and team leader of the Integrated Nuclear Infrastructure Review (INIR) mission stated. "it is the first time in history of nuclear power that this approach has been used and it is very interesting because it solves two of the biggest challenges that newcomers face: financing and experienced operators," http://www.nucnet.org/all-the-news/2013/11/18/turkey-has-made-important-progress-in-nuclear-power-programme-says-iaea.

According to the World Nuclear Association (WNA), in addition to Turkey those countries include Vietnam, China, India, Bangladesh, Belarus, Ukraine and Bulgaria. Russia has already built nuclear plants in China, India, Iran and Ukraine.

[7] Ibid

[8] Official Gazette of the Republic of Turkey, 6 October 2010, http://www.resmigazete.gov.tr/eskiler/2010/10/20101006-6-1.pdf , accessed on 10 February 2014

Russian consortium will construct four 1200 MWe VVER reactors at the Akkuyu site. On 21 July 2010, the Grand National Assembly of Turkey ratified the Intergovernmental Agreement (IGA) and on 24 November, the Council of Russian Federation ratified it. And, on 13 December 2010, the "Akkuyu Nuclear Power Plant Electricity Generation Joint-Stock Company" was established.

The project company has submitted two Environmental Impact Assessments (EIA) to the Ministry of Environment and Urban Planning, but both were rejected.[9] Due to the revision and resubmission process of the environmental report, the project is likely to be delayed.[10] According to Rauf Kasumov, the deputy general manager of Akkuyu NGS stated that they are expecting a positive decision on the resubmitted EIA in the first half of the 2014. He added that January 2016 is the expected time for construction to begin.[11]

How much spent fuel will the Akkuyu NPP produce?

According to the Turkish Atomic Energy Authority (TAEK), the annual amount of the spent fuel that will be produced by the NPP will be identified during the design of the plant.[12] According to the EIA report, the plant will have 42 fuel assemblies that will be changed annually. Thus, the annual amount of spent fuel produced by the four reactors will be around 89,712 kg.[13] And, throughout its 60-year service period NPP will produce 5,382 tons of spent fuel.

According to Nicolas Delerue, "the typical burn up of this kind of reactor is 60-70MWd/kg. So if in a day the reactor produces 60MW (thermal) then it has produced 1kg of waste. For a VVER 1200 it is about 3200MW thermal for 1200MW electrical. So in average in a day the reactor will produce 3200/60=53kg of waste. This is only the fuel waste. There is secondary

[9] Akkuyu EIA report turned down by Environment Ministry, http://www.todayszaman.com/news-322112-akkuyu-eia-report-turned-down-by-environment-ministry.html , accessed on 15 February 2014

[10] Turkey's first nuclear plant facing further delays – sources, http://uk.reuters.com/article/2014/02/07/uk-turkey-nuclear-delay-idUKBREA160P220140207 , accessed on 15 February 2014

[11] Akkuyu'dan Türk şirketlere 7.8 milyar dolar gelecek, 25.02.2014, http://www.dunya.com/akkuyudan-turk-sirketlere-7-8-milyar-dolar-gelecek-220161h.htm , accessed on 01 March 2014

[12] E mail correspondance with Turkish Atomic Energy Authority, 16.12.2013

[13] http://www.csb.gov.tr/db/ced/editordosya/Akkuyu_NGS_CED_Raporu.pdf, Section V.2.1-2.5, p. 124, accessed on 01 March 2014

waste due to the materials that are activated by radioactivity, but those need only to be dealt with at the end of the lifecycle of the reactor (during decommissioning)."[14]

Nuclear fuel cycle issue in the agreement

According to art. 12.1 of the IGA "nuclear fuel shall be sourced from suppliers on the basis of long-term agreements entered into between the Project Company and the suppliers."[15] Rosatom incorporates the Russian Fuel Company "TVEL" which is the only supplier of the enriched fuel for this type of reactors.[16] TVEL is the exclusive supplier of nuclear fuel to all Russian NPPs. The project company will sign a fuel supply contract with TVEL for fuel supply. Yet, according to the Turkish government, "in practice it is foreseen to supply nuclear fuel from Russia, however there is no legal obligation for it."[17] And, more broadly, Turkey is working to keep its enrichment options open. As part of Turkey's original tender, Ankara had expressed an interest in developing a thorium fuel cycle.[18]

According to Mark Hibbs, "Turkey's interest in thorium-based nuclear fuel [was] apparently driven primarily by the country's natural resource agencies, especially its Mineral Research and Exploration Institute, or MTA, and not by its nuclear research bureaucracy."

In September 2008, Turkey expressed an interest serving as a regional fuel fabrication center for Middle Eastern and central European states. Turkey, therefore, asked that the vendors propose a plan for domestic fuel production. However, because Ankara had not yet selected a vendor, the nature of the fuel cycle remained ambiguous. Ankara did, however, rule out

[14] E mail correspondance with Nicolas Delerue. Mr Delerue states that regarding the calculation, there might be some small changes depending on local conditions.

[15] Official Gazette of the Republic of Turkey, http://www.resmigazete.gov.tr/eskiler/2010/10/20101006-6-1.pdf , accessed on 10 February 2014

[16] Russian State Atomic Energy Corporation (ROSATOM)
http://www.rosatom.ru/en/about/activities/power_complex/fuel_fabrication/

TVEL Fuel company is the fuel division of Rosatom State Corporation. The fuel manufactured at TVEL's plants is supplied to 76 nuclear power reactors in 14 countries. TVEL is an exclusive supplier of fresh nuclear fuel to Bulgarian, Hungarian, Ukrainian and Slovakian NPPs.

[17] Ministry of Energy and Natural Resources (MENR), Department of Nuclear Energy Projects Implementation, FAQ (6) http://www.nukleer.gov.tr/index.php/sorular , accessed on 12 March 2014

[18] Mark Hibbs, "Turkey will press for fuel technology transfer," *Platts Nucleonics Week,* 11 February 2008.

enrichment, saying that it was only interested in fuel fabrication. According to Mark Hibbs, TAEK's criteria "[suggested] that Turkey aimed to manufacture power reactor fuel using UO2 feedstock, not UF6."[19] Thus, while TVEL is likely to provide Turkey with fuel for Akkuyu, the MENR noted in an answer to a question submitted in parliament that the Russian reactor deal paves the way for domestic fuel production in Turkey.[20] However, Ankara has taken no definitive steps to develop fuel cycle technologies and is far more likely to rely on fuel guarantees for the foreseeable future.

According to art. 12.2:

> subject to separate agreement that may be agreed by the Parties, spent nuclear fuel of Russian origin may be reprocessed in the Russian Federation." Russia, therefore, is only interested in reprocessing Russian origin spent fuel, and has no plans to reprocess spent fuel from other potential suppliers. In the last paragraph of the same article it says "the project company is responsible for decommissioning and the nuclear waste management of the power station." (art.12.4.) And for this aim the company will contribute with US$ 0.15 cents/kWh to two separate funds established for financing each of these activities. (art.10.9)

Yet, more broadly, the spent nuclear fuel issue is not detailed in the IGA. Thus, in order to answer, "will SNF be sent back to Russia" and "what will happen to the reprocessed spent fuel," one should look at Russia's SNF import policy.

Russian policy on importing spent nuclear fuel

Article 50 of the Russian Environmental Protection Law prohibited the "import for storing or burying of radioactive waste and materials from abroad."[21] Although Russian law allowed the import of such materials for reprocessing, Government Decree No. 773 of 29 July 1995 set

[19] Hibbs, "Turkey will press for fuel technology transfer," 11 February 2008.

[20] MENR's reply to a parliamentary written question on 28 February 2014 (no:7-32589)

http://www.tbmm.gov.tr/develop/owa/yazili_sozlu_soru_sd.onerge_bilgileri?kanunlar_sira_no=141526

[21] Russian Federation Law No. 2060-1, On Environmental Protection, 19 December 1991.

http://faolex.fao.org/cgi-bin/faolex.exe?database=faolex&search_type=query&table=result&query=LEX-FAOC043278&format_name=@ERALL&lang=eng , accessed on 10 March 2014.

detailed guidance for spent fuel transfer and obligated Minatom (the forerunner to Rosatom) to send back the radioactive waste resulting from the reprocessing of SNF to its country of origin within thirty days.[22] Russian Federation Federal Law On The Use Of Atomic Energy, which was adopted by the State Duma on 20 October 1995, states that "The importing of spent nuclear fuel from foreign countries into the territory of the Russian Federation for processing is conducted in accordance with the legislation of the Russian Federation and the international agreements of the Russian Federation."[23] Yet according to the International Panel on Fissile Materials (IPFM), foreign interest in reprocessing turned out to be much lower than expected. Russia's insistence on returning the waste from reprocessing to owners of the reprocessed spent fuel was the most likely reason for the lack of foreign interest in Russia's reprocessing services.[24]

On 10 July 2001, President Putin signed a package of laws that would allow the import of irradiated spent fuel into Russia for *technical storage, reprocessing and/or even disposing in Russia.* [25] In 2002, following the 2001 law package, the Duma passed a new Federal Law On Protection Of The Environment. The amendments introduced in 2001 allowed for the bringing into Russia of spent fuel for "temporary technological storage and/or reprocessing." The second change allowed the government to decide whether or not to return reprocessing waste to fuel owners.[26] While the federal law still prohibits the import of radioactive waste for

[22] The only exception was the fulfillment of contracts that predated the environmental protection law for the repatriation of SNF from nuclear power plants (NPPs) that the Soviet Union helped construct. These countries are such as Ukraine, the Czech Republic, Slovakia, Finland, Bulgaria, Armenia, and Kazakhstan. Most of these contracts expired in the mid-1990s.

[23] Government of Russian Federation, Order No. 773, 29 July 1995, article 64.

[24] International Panel on Fissile Materials (IPFM) Global Fissile Material Report 2007, p.75, http://fissilematerials.org/library/gfmr07.pdf , accessed on 10 February 2014.

[25] Federal Law, "On amending Article 50 of the Federal Law of RSFSR 'On protection of the environment'," 10 July 2001 No 93-FZ. For more information see;

Bunn, Matthew. "Russian Import of Foreign Spent Fuel: Status and Policy Implications." 15-19 July 2001, http://belfercenter.hks.harvard.edu/publication/2304/russian_import_of_foreign_spent_fuel.html

Harold Feiveson, Zia Mian, M.V. Ramana and Frank von Hippel (eds), Managing Spent Fuel from Nuclear Power Reactors Experience and Lessons from Around the World, Report of the International Panel on Fissile Material, https://www.princeton.edu/sgs/publications/ipfm/Managing-Spent-Fuel-Sept-2011.pdf

[26] Federal Law "On Protection Of The Environment," 10 January 2002, No. 7-FZ, Article 48.4 quoted in International Panel on Fissile Materials (IPFM) Global Fissile Material Report 2007, p.76, www.ipfmlibrary.org/gfmr07.pdf

permanent disposal, spent fuel and the waste generated during reprocessing are explicitly exempted by this provision.[27] The approval procedure established by the federal law requires an international treaty to provide a legal foundation for a contract governing practical aspects of spent fuel storage or reprocessing in Russia and a thorough environmental impact assessment of all aspects of the transfer.

Following the changes to the law, Russia approved new Guidelines on the Transfer Of Irradiated Fuel Assemblies Of Nuclear Reactors in 2003. According to the guidelines there is a distinction between Russian-origin fuel and foreign-origin fuel. As a rule, the radioactive waste produced by reprocessing of the former can be left in Russia, while the waste from foreign fuel should be returned to the fuel owner. [28] Furthermore, if fuel is imported for eventual reprocessing, an international treaty is required to establish the legal basis for a subsequent contract. [29]The Federal Environmental, Industrial and Nuclear Supervision Service was responsible for the "timely return of spent fuel assemblies of nuclear reactors and relevant reprocessing products to the supplier country, with which the Russian Federation has an international agreement on importing to the Russian Federation spent fuel assemblies of nuclear reactors for the purpose of temporary technological storage and reprocessing with the condition of sending back the reprocessing products" [30]

In spite of the aforementioned legislation and regulations, Rosatom has not signed any contracts with new customers to import spent nuclear fuel. Furthermore, there was significant public pressure from critics highlighting environmental and proliferation risks in allowing Russia to permanently store spent fuel. Thus as a result of financial disappointment and strong public pressure, Rosatom chief Sergei Kiriyenko announced in July 2006 that "Russia has not imported foreign spent fuel, is not importing [spent fuel], and will not import it in the

[27] Ibid., Article 51.

[28] "On transfer of irradiated fuel assemblies of nuclear reactors into Russian Federation," Government of Russian Federation, Order No. 418, 11 July 2003, Article 10(v) and Article 11, quoted in Harold Feiveson, Zia Mian, M.V. Ramana and Frank von Hippel (eds), Managing Spent Fuel from Nuclear Power Reactors Experience and Lessons from Around the World, Report of the International Panel on Fissile Material, September 2011,p.76 https://www.princeton.edu/sgs/publications/ipfm/Managing-Spent-Fuel-Sept-2011.pdf

[29] Ibid

[30] Russian Federation Government Ordinance No. 401 of 30 July 2004, http://en.gosnadzor.ru/activity/polojenie_o_slujbe_NEW%20eng.doc , accessed on 10 February 2014

future."[31] At the same time, however, he did say that Rosatom is taking back some of the Russian-origin spent fuel and will continue this practice. [32] He also stated "If the fuel is of Russian origin, we are ready to propose leasing solutions over the entire lifespan of the nuclear plant. We would take the spent nuclear fuel for treatment."[33]

Most recently, after long consideration and several amendments, Russia's Duma adopted a new Federal Law on Radioactive Waste Management that establishes a legal framework for radioactive waste management on 29 June 2011.[34] According to Article 1, the scope of the present Federal Law is intended to regulate activities relating to the management of radioactive waste. On the other hand, its provisions do not apply to activities relating to the management of spent nuclear fuel.

Article 10 (2) of the Federal Law prohibits "importing and exporting radioactive waste into and out of the Russian Federation for purposes of storage, reprocessing and disposal, with the exception of those cases for which provision is made in article 31 of the present Federal Law."[35] According to article 31 of the Federal Law on special conditions for the import and export of radioactive waste, "i) importing radioactive wastes into the Russian Federation for

[31] Global Fissile Material Report 2007, International Panel on Fissile Materials, October 2007, www.ipfmlibrary.org/gfmr07.pdf , p. 99.

[32] Pavel Podvig, "Rosatom confirms it will not bring foreign-origin spent fuel to Russia", April 20, 2011. http://www.fissilematerials.org/blog/2011/04/rosatom_confirms_it_will_.html , accessed on 10 February 2014

[33] Russia Proposes Nuclear Fuel Leasing, http://www.nuclearpowerdaily.com/reports/Russia_proposes_nuclear_fuel_leasing_999.html

It is known for Bushehr reactor in Iran that Russian-Iran contract involves Russian fuel leasing and Iran is required to send the used fuel back to Russia. In February 2005, the two countries concluded an agreement to supply fuel for the reactor for a period of 10 years. This kind of precaution was taken because of proliferation concerns. At the moment no repatriation has taken place but the Bushehr nuclear power plant is switched off for its first fuel change operations after successfully operating for 7,000 hours., Bushehr Nuclear Power Plant Off For Fuel Change Operation, http://www.irna.ir/en/News/2637711/Economic/Bushehr_nuclear_power_plant_off_for_fuel_change_operation , accessed on 4 March 2014.

[34] For full text of Federal Law on Radioactive Waste Management in English, 29 June 2011, see; http://connection.ebscohost.com/c/articles/74205041/federal-law-management-radioactive-wastes-amendments-certain-legislative-acts-russian-federation

For Russian, see; http://www.rg.ru/2011/07/15/othodi-dok.html

[35] Ibid, p. 188

the purposes of storage, reprocessing or disposal is prohibited except as otherwise provided for within this article."[36]

Moreover, the "radioactive waste produced in the course of reprocessing depleted nuclear fuel[37] that was imported into the Russian Federation may be exported if provisions to that effect exist in an international agreement to which the Russian Federation is a party." No funds shall be transferred into the special reserve fund for the disposal of radioactive waste produced in the course of reprocessing such depleted nuclear fuel.

And, according to the third paragraph iii) where a sealed radioactive source[38] was imported into the Russian Federation, it is permitted to return the disused source to the supplier's country. The procedure for returning disused (spent) sealed radioactive sources[39] to the supplier's country shall be established by Russian Federation Government. Thus, it is clear that current Russian legislation prohibits the import of radioactive waste for the purposes of storage, reprocessing or disposal, unless the two sides conclude an inter-governmental agreement that allows for the transfer.

Russia does not currently have a facility for reprocessing VVER 1200 type spent fuel. Following storage in the cooling ponds adjacent to the reactor sites, the spent fuel is shipped to the centralized wet storage facility at the MCC in Zheleznogorsk, Siberia near Krasnoyarsk, where a reprocessing facility is being constructed.[40] Yet, as of now, the Bellona Foundation notes that, "Russia has nowhere to store radioactive waste and spent nuclear fuel besides at

[36] Ibid, p.198

[37] Spent / used nuclear fuel

[38] A sealed radioactive source (SRS) is defined as "radioactive material that is either permanently sealed in a capsule or closely bonded and in a solid form", usually has high concentration of radioactive material in a small volume. IAEA Net Enabled Waste Management Database glossary, http://newmdb.iaea.org/help.aspx?HTopicId=23&GLetter=S , accessed on 5 March 2014.

[39] Disused sources are defined as sources that are no longer used and there is no intention of using them again in the practices they were authorized for. If lost or not properly controlled, disused sealed sources can be a threat to human health and the environment. http://www.iaea.org/OurWork/ST/NE/NEFW/Technical_Areas/WTS/sealedsources-sealedsources.html

[40] Anatoli Diakov, "Status and Prospects for Russia's Fuel Cycle", *Journal: Science & Global Security*, Volume 21, Issue 3, September 2013, p.176, http://www.tandfonline.com/doi/pdf/10.1080/08929882.2013.837333

temporary on-site facilities at the nuclear power plants, research facilities, medical facilities using radiological equipment, and other nuclear installations that have produced it."[41]

According to Alexander Nikitin, chairman of the St. Petersburg based ERC Bellona, "Rosatom's eagerness to repatriate the fuel that it sells abroad to plants built by the state company's international arm, Atomstroiexport, is a major selling point to international customers of Russian nuclear power plants."[42] Turkey was no exception.

Will SNF go back to Russia?

In the Turkish case, the additional agreement on spent nuclear fuel referred to in the IGA has not been concluded. As Kasumov stated the agreement should be signed before the operating period of the Akkuyu NPP is expired.[43] Thus, the answer to this question will depend on the additional agreement.

In the July 2013 EIA report (which was subsequently rejected), the parties envisioned that the spent fuel would be stored at the onsite fuel pond for about 10 years.[44] Thus, it is likely that spent fuel will be temporarily placed in a Spent Nuclear Fuel Storage (SNFS) facility before being transported to Russia for reprocessing and then placed in a final disposal facility. Dry storage facility will have the capacity to store the spent nuclear fuel produced by four reactors for a time period of four years.[45] According to TAEK's specifications, the SNFS facility will be placed in a 2.651m^2 space built on the northeast part of reactor building in a restricted access area.[46] For low and intermediate level of radioactive waste, the processing and storage

[41] Charles Digges, "Russia's Nuclear Corporation Embarks On Permanently Storing Radioactive Waste – But Final Solutions Still Distant", 18 November 2013, http://bellona.org/news/nuclear-issues/radioactive-waste-and-spent-nuclear-fuel/2013-11-russias-nuclear-corporation-embarks-permanently-storing-radioactive-waste-final-solutions-still-distant , accessed on 12 March 2014

[42] Charles Digges, "Russia advances some $14 Bln for Hungarian nuclear reactor build-out in dicey environmental bet", 15January 2014, http://bellona.org/news/nuclear-issues/2014-01-russia-advances-14-bln-hungarian-nuclear-reactor-build-dicey-environmental-bet , accessed on 12 March 2014

[43] "Nükleer Santrale Bir Adım Daha Yaklaşırken", Akkuyu NGS AŞ.

http://www.akkunpp.com/nukleer-santrale-bir-adim-daha-yaklasirken

[44] http://www.csb.gov.tr/db/ced/editordosya/Akkuyu_NGS_CED_Raporu.pdf , Section V.2.1-2.5, p. 108

[45] Ibid. Section XI, p.16, also see Section V.2.1-2.5, p. 109

[46] Ibid, Section II, p.10, see also Section II, p.8

facility will cover an area of 3.726 m^2. While the storage facility is planned to allow five-year storage capacity for low and intermediate level solid radioactive waste, it is 50 years for highly activated waste are during the operation of NPP.[47]

According to the same EIA report "Today [Turkey's] nuclear fuel cycle for VVER type reactors is an open fuel cycle in which recovery of spent nuclear fuel is not considered. The advantage of open fuel cycle in comparison with closed fuel cycle is the former is short, simple and much more environmentally friendly."[48]

Moreover, Rauf Kasumov has yet to fully clarify Akkuyu's future spent fuel policy. For example, he is on the record saying, "nuclear waste could be used for many times and therefore it was valuable, and if Turkey wanted to purchase the waste, nuclear waste could stay in Turkey. I do not think that Turkey can use spent fuel under existing conditions. Thus the spent fuel probably will go to Russia."[49]

The current practice suggests that once a country buys nuclear fuel, it will stay in this country, and this country also has to ensure its safe storage.[50] In another words "used fuel becomes the responsibility of the country in which it has been used." However, in Russian BOO model nuclear fuel will be leased to the Project Company by Russian TVEL company via a fuel supply contract. The destiny of the nuclear waste following reprocessing of spent nuclear fuel will depend on the leasing country's national laws.

For the map of the reactor site, see Appendix 1

[47] Ibid, Section V.2.8-2.10, p. 33

[48] Ibid, Section V.2.1-2.5, p.101

[49] http://www.milliyet.com.tr/Ekonomi/SonDakika.aspx?aType=SonDakika&ArticleID=1472812&Date=17.07.2012&Kategori=ekonomi&b=Akkuyu%20Nukleer%20Santrali%202019da%20devrede

Also see Wikileaks document dated 08 December 2011 and released on 11 March 2013, Construction of Turkey's first nuclear power plant will start in 2013", https://wikileaks.org/gifiles/docs/57/57871_-mesa-turkey-russia-energy-turkey-to-begin-construction-of.html , accessed on 12 March 2014

[50] "Russia to buy back spent fuel from Iranian reactor", 25 April 2003. http://www.wiseinternational.org/node/2878 , accessed on 9 February 2014.

What will happen to the nuclear waste if reprocessing occurs?

Would Russia keep the nuclear waste on its soil? Or send back nuclear waste to Turkey as the origin country?

According to article 12 (2) of the intergovernmental agreement, reprocessing is "subject to a separate agreement that may be agreed to by the Parties, spent nuclear fuel of Russian origin may be reprocessed in the Russian Federation. Possible reprocessing operations would be carried out in Russian Federation. The price and other issues will be determined by the terms of this agreement. The nuclear waste management associated with the reprocessing of the spent nuclear fuel shall be subject to the terms of the agreement again."[51]

There are still many outstanding questions. What would happen if an additional agreement is not concluded between the parties? Or what would Turkey do if Russia sends back nuclear waste to Turkey after it is reprocessed in Russia? And, has Turkey included the potential costs of waste management into its nuclear power related financing models? The answer to these questions depends on Turkish nuclear legislation. According to the Turkish government, officials from the Ministry of Energy and Natural Resources (MENR) and TAEK are currently conducting a preparatory waste management study. [52]

In the context of establishing Turkish national nuclear energy legislation, a draft law on nuclear energy was prepared by the Ministry of Energy and Natural Resources and submitted to Parliament on 31 October 2006. It was enacted by the Turkish Parliament on 9 November 2007 as "Law No. 5170 Concerning the Construction and Operation of Nuclear Power Plants and the Sale of the Energy Generated from Nuclear Power Plants" (the "Nuclear Energy Law").[53] The Nuclear Law establishes the legal basis for the operation of NPPs in accordance with Turkey's general energy plans and policies. According to the law, a decommissioning fund and a national radiological waste fund shall be established and shall be utilized to meet the costs associated with the construction, licensing and operation of temporary and permanent waste storage facilities, transport and processing of wastes, research and

[51] Email correspondence with TAEA. Reply to formal request for information 16.12.2013

[52] Ibid

[53] http://www.tbmm.gov.tr/tutanaklar/KANUNLAR_KARARLAR/kanuntbmmc091/kanuntbmmc091/kanuntbmmc09105654.pdf , accessed on 12 February 2014

development studies related to the nuclear waste management, and the dismantling of the nuclear power plant.

The vendor is required to pay a certain amount to the decommissioning fund and the national radiological waste fund in an amount to be determined by TAEK. Furthermore, the Regulation on the Radioactive Waste Management was published in the Official Gazette in March 2013. Section 7 Article 52 (1) states that "Management of spent nuclear fuels and radioactive waste, which are products of activities in nuclear facilities are under the responsibility of person authorized to that facility. Bankruptcy or resignation or similar actions of the authorized person do not remove these responsibilities".[54]

Moreover, according to the same article, "spent nuclear fuel is temporarily stored in storage facilities constructed onsite before being transferred off site. Then, the authorized person may transfer spent nuclear fuel to an offsite spent fuel storage facility or to a radioactive waste facility and may also opt for reprocessing and/or disposal or sending them to another country."[55]

In the 2013 Turkish Regulation on Radioactive Waste Management, Ankara indicates "High level radioactive waste shall only be disposed of in deep disposal facilities."[56] Thus, it is clear that Turkey aims to give all the responsibility of nuclear waste management to Russia with the article 12 of the IGA. However, the agreement is ambiguous and experts disagree about storage and reprocessing of spent fuel.

According to Alexei Arbatov, a scholar at the Carnegie Moscow Center's Nonproliferation Program and a member of the Russian Academy of Sciences, Russia will return waste to Turkey after reprocessing. Arbatov maintains that Turkey has no control over fuel supply and

[54] Radyoaktif Atik Yönetimi Yönetmeliği, 9 Mart 2013, http://www.resmigazete.gov.tr/eskiler/2013/03/20130309-4.htm , accessed on 1 March 2014

[55] A Draft Nuclear Energy and Radiation Law is being prepared to enable regulation and supervision of nuclear activities by an independent regulatory body and to rearrange the responsibilities and authorities of TAEK and some other authorities. This draft law was planned to be submitted to Prime Ministry by the end of December of 2013. Moreover, the Nuclear Energy Law envisages TAEK to be replaced by another public authority to be established in the future thus "the regulation and supervision authorities of TAEK are of a temporary nature". Nuclear Energy Legislation And Projects In Turkey, Çakmak Avukatlık Bürosu, 21 July 2010

http://www.cakmak.av.tr/articles/Power/Nuclear%20Energy%20Legislation%20And%20Projects%20in%20Turkey.pdf

[56] Radyoaktif Atik Yönetimi Yönetmeliği, 9 Mart 2013, http://www.resmigazete.gov.tr/eskiler/2013/03/20130309-4.htm

is obligated to lease the fuel from Russia, send back the spent fuel to Russia, and then take back the highly-radioactive fission product waste after reprocessing.[57] İlhan Or, a professor at Boğaziçi University, indicates that the project company is responsible for the spent fuel. Turkey does not have authority over it. He also says that Turkey cannot make any choice between sending back spent fuel or not.[58]

Andrey Zolotkov, the Chairman of Bellona Murmansk, states that Russia will take spent nuclear fuel for reprocessing. But he doubts Russia will send the waste back to Turkey. He says, "it never happened before that Russia sent back the waste. Maybe someday in the future with new technologies Russia will send it back like in the case of France."[59]

According to World Nuclear website Russia's policy for building nuclear power plants in non-nuclear weapons states is to deliver on a turnkey basis including supply of all fuel and repatriation of used fuel for the life of the plant. The fuel is to be reprocessed in Russia and the separated wastes returned to the client country eventually.[60] However, it is also argued that Russia's default position in supplying reactors to non nuclear weapons states is to take back Russian-origin fuel without requiring the return of the waste, as is the case with the Bushehr reactor in Iran." [61]

The main reason for the uncertainty on spent fuel issue is because the Akkuyu project is the world's first BOO project. In any case, Turkey is unlikely to have any control or choice over Russian decision-making vis-à-vis spent fuel storage.

[57] Personal interview with Alexei Arbatov, 11.01.2014. Mr. Arbatov states that the views expressed in the interview are his own not the Russian Academy of Sciences or Russian Government.

[58] Email correspondance with Professor İlhan Or. Professor Or states that these are his own views in the framework of Russia-Turkey Nuclear Cooperation Agreement.

[59] Email correspondance with Andrey Zolotkov, 4 March 2014

[60] http://www.world-nuclear.org/info/Country-Profiles/Countries-O-S/Russia--Nuclear-Power/ , accessed on 14 February 2014.

[61] http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/International-Nuclear-Waste-Disposal-Concepts/

Turkey-Japan Agreement on Nuclear Cooperation and Nuclear Fuel Cycle

Turkey has contracted with an international consortium consisting of Mitsubishi Heavy Industries and Itochu Corporation from Japan and France's company GDF Suez to build and operate a second nuclear power plant at the Sinop site.

Japan and Turkey signed a nuclear cooperation agreement in 2013 and recently concluded a second agreement regarding cooperation on nuclear power plant construction. The "Agreement between the Government of Japan and the Government of the Republic of Turkey on Co-operation for Development of Nuclear Power Plants and the Nuclear Power Industry in the Republic of Turkey" facilitates the construction and operation of an NPP comprising of 4 ATMEA-1 reactors to produce 4,400 MWe of electricity. On 27 January 2014 French GDF SUEZ signed Memorandum of Understanding (MOU) with Turkish Government relating to cooperation on future energy initiatives in Turkey.[62] It is estimated that the project will cost $22 billion and that the plant's first unit will be in operation in 2023, coinciding with Turkey celebrating its centennial anniversary as a republic.[63]

The Turkish Parliament ratified the nuclear cooperation with Japan on 9 January 2014 and it was published in the Official Gazette on 18 January 2014.[64] The Japanese Diet, however, has yet to ratify the agreement.[65] The ratification of the agreement is not expected to be controversial and it should pass easily. The details of the project will be determined by Host Government Agreement (HGA), which will be signed between the international consortium and the Turkish Government at a later stage.

The Preamble of the Law on the Approval of the Ratification of the Japan-Turkey Cooperation Agreement notes that it will form the basis for future nuclear cooperation

[62] http://www.gdfsuez.com/wp-content/uploads/2014/01/pr-gdf-suez-mou-turkey.pdf , accessed on 1 March 2014.

[63] http://analysis.nuclearenergyinsider.com/new-build/role-nuclear-energy-and-turkey%E2%80%99s-economic-growth-projectory#sthash.sqAInd74.dpuf , accessed on 1 March 2014.

[64] The Official Gazette No. 28886 dated 18 January 2014, http://www.resmigazete.gov.tr/eskiler/2014/01/20140118-2.htm accessed on 1 March 2014.

[65] Reiji Yoshida, "Economy to be Abe's Diet focus, at least at first", 23 January 2014, http://www.japantimes.co.jp/news/2014/01/23/national/economy-to-be-abes-diet-focus-at-least-at-first/#.UyX4Jc57TNo

activities with Japan regarding peaceful use of nuclear energy and also includes the legal basis supply chain of the Akkuyu nuclear power plant. [66]

Fuel Cycle Options for the Sinop NPP

Who will supply the enriched fuel for the reactors?

A high officer from Japan Atomic Energy Commission says that he does not know who will supply enriched uranium for the Sinop NPP. However he states, "typically, the recipient utility (buyer) will decide. French supplier (AREVA) has its own enrichment capability, so it is possible that the French/Japanese consortium is interested in selling enriched uranium with the reactors."[67] According to Hajime Matsukubo, "MHI has its own fuel maker Mitsubishi Nuclear Fuel. But based on my understanding, it has no or a few export experience. And ATMEA-1 is basically Areva's design. We do not know the contract details. But I expect Areva will supply fuel to Sinop NPP."[68] In any case, as of now, the fuel supply issue remains unresolved.

Will there be a take back provision for the spent fuel?

Although Japan has a full fuel cycle set-up, including enrichment and reprocessing of used fuel, most reprocessing of Japanese fuel is done in the UK and France under contract with Japanese utilities. Japan has a small reprocessing plant already in operation at Tokai, and a much larger reprocessing plant has been built at Rokkasho.[69] At the end of 2012 Japan had a

[66] TBMM Yasama Dönemi: 24 Yasama Yili: 4 Sira Sayisi: 520

Türkiye Cumhuriyeti Hükümeti ile Japonya Hükümeti Arasında Nükleer Enerjinin Barışçıl Amaçlarla Kullanımına Dair İşbirliği Anlaşmasının Onaylanmasının Uygun Bulunduğuna Dair Kanun Tasarısı ile Sanayi, Ticaret, Enerji, Tabii Kaynaklar, Bilgi ve Teknoloji Komisyonu ile Dışişleri Komisyonu Raporları (1/850)

http://www.tbmm.gov.tr/sirasayi/donem24/yil01/ss520.pdf
http://www.tbmm.gov.tr/develop/owa/kanunlar_sd.durumu?kanun_no=6515

[67] Officer states that the views expressed in the correspondance are his own not the Japan government.

[68] Email correspondance with Hajime Matsukubo, 17 March 2014

[69] http://world-nuclear.org/info/Nuclear-Fuel-Cycle/Transport/Japanese-Waste-and-MOX-Shipments-From-Europe/

total of 14,460 tones of used fuel in storage, mostly onsite at reactors.[70] For example, about 40% of the used fuel involved was reprocessed by Cogema/Areva (France) and the rest by British Nuclear Fuels Limited (UK).[71] Thus, it would be illogical to expect Japan to provide spent nuclear fuel take back provision for Turkey although it does not have any national law forbidding the import of spent nuclear fuel.

According to a Japan Atomic Energy Commission officer, "Japan does not have any reprocessing capacity for oversea clients at present and has no plan to do so."[72] Makio Miyagawa, Director-General, Middle Eastern and African Affairs Bureau of Ministry of Foreign Affairs of Japan indicated in response to a question posed on 22 May 2013 that it was made clear to the Turkish government during the negotiations "Japan will not undertake spent nuclear fuel from Turkey."[73] Furthermore, according to Asahi Weekly, Japanese government officials internally agreed not to discuss issues related to long-term management of radioactive waste with the Turkish government."[74] Japan has sent strong signals that the issue of waste management is up to the host country to decide.[75] Turkey has not announced any policy vis-à-vis spent fuel storage and it is unclear if the costs associated with the storage of spent fuel and the eventual construction of an underground repository were included in the Sinop price projections.

[70] http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/

[71] "Reprocessing of Japanese used fuel in France finished in 2004 and all the high-level waste from reprocessing the used fuel in France has now been shipped back to Rokkasho in Japan for long-term (30-50 year) storage prior to ultimate disposal. Waste shipments from the UK should be completed by 2016.", Ibid.

[72] Officer states that the views expressed in the correspondance are his own not the Japan government.

[73] Email correspondance with Hajime Matsukubo, 17 March 2014.
For Mr. Miyagawa's speech in the Lower House Foreign Affairs Committee see:
http://kokkai.ndl.go.jp/cgibin/KENSAKU/swk_dispdoc.cgi?SESSION=27049&SAVED_RID=1&PAGE=0&POS=0&TOTAL=0&SRV_ID=10&DOC_ID=1121&DPAGE=1&DTOTAL=1&DPOS=1&SORT_DIR=1&SORT_TYPE=0&MODE=1&DMY=27417

[74] http://www.foejapan.org/en/news/131119.html

[75] Email correspondance with Hajime Matsukubo, 17 March 2014.

http://www.shugiin.go.jp/itdb_shitsumon.nsf/html/shitsumon/b178019.htm

Would the operator take back Turkish spent fuel to France?

The GDF Suez Company has made clear that "if Sinop project goes on, like in most nuclear countries around the world, spent fuel will most probably be stored on site before underground final disposal in a place to be defined by the [host] Government." The GDF representative added that the "Possibility of reprocessing could be studied in the future."[76]

According to Nicolas Delerue "France has a big factory for Nuclear Fuel reprocessing so it is likely that the fuel will be reprocessed in France." In France general principles of radioactive waste management were initially included in the 1991 Waste Act, and were later modified by the 2006 Planning Act on Sustainable Management of Radioactive Materials and Waste. According to the updated legislation, "no radioactive waste whether originating from a foreign country or from the processing of foreign spent fuel and foreign radioactive waste shall be disposed in France".[77] Thus, even if reprocessing of Sinop SNF takes place in France, as foreign irradiated fuel it will be returned to Turkey as the owner after a storage period in compliance with the French legislation.[78]

While the government has yet to fully articulate a spent fuel policy, opposition MPs have asked about the issue in parliament. On 29 July 2013 in a written parliamentary question (no: 7/25371) an opposition MP asked "how the Sinop nuclear waste will be solved?" The Ministry of Energy and Natural Resources (MENR) answered that Turkey cooperates with the international community on nuclear waste management and takes international practices as references. Waste management will be the responsibility of the Project Company.

In another written parliamentary question directed to Ministry of Energy and Natural Resources (no:7/19343), the opposition asked about the government's long term plan to

[76] Email correspondence with GDF Suez, 6 December 2013.

[77] Radioactive Materials And Waste Planning Act, Article 8-I, 28 June 2006, p.7. Furthermore it is stated in the same act and Article L. 542-2-1 of the Environmental Code that "No spent fuel or radioactive material shall be introduced in France except for processing, research or transfer between foreign countries. Any introduction of such spent fuel or radioactive waste shall only be authorised pursuant to intergovernmental agreements and provided that no residual radioactive waste resulting from the processing of such substances shall be stored in France beyond the term prescribed by such agreements. The agreement shall include the tentative reception and processing schedules for such substances and, if need be, any prospect relating to the further use of the radioactive materials partitioned during the processing."

http://www.andra.fr/download/andra-international-en/document/editions/305cva.pdf

[78] For detailed information see OECD report on Radioactive Waste Management And Decommissioning In France, March 2013, http://www.oecd-nea.org/rwm/profiles/france_report.pdf

dispose of nuclear waste. In its reply on 6 May 2013, MENR referred to the current regulations, but did not answer the question specifically. Thus, in a follow on question, an opposition MP asked (no:7/17245) what the government plans to do with spent fuel after it is stored onsite for 10 years, and whether or not MENR has studied the issue? In its reply, MENR has indicated that studies were currently being done and that all precautions were being taking into account.

According to the Japan-Turkey nuclear cooperation agreement, "nuclear material transferred pursuant to this Agreement and nuclear material recovered or produced as a by-product may be enriched or reprocessed within the jurisdiction of the Republic of Turkey, only if the Parties agree in writing."[79] Thus, like in the case of Japan's other nuclear cooperation agreements, Turkey would first have to receive permission before reprocessing spent fuel.[80]

In any case, the vendor and Turkey could choose to reprocess the spent fuel from ATMEA 1 and use it for MOX fuel. According to IAEA "fuel management variations in ATMEA 1 can go from a full uranium core to a mix with MOX fuel up to 1/3 of the core for the standard design, and up to 100% without any major design modification."[81] However, the burning of MOX fuel would still require the building of a long-term storage facility.

Conclusion

While there are plenty of companies eager to supply enriched uranium to nuclear reactors, there are fewer options when it comes to send spent fuel from the reactors. The government appears to have settled on a policy of addressing the spent nuclear fuel issue after the initial hurdles involved in negotiating project financing and the specifics of the power-purchasing

[79] The Official Gazette No. 28886 dated 18 January 2014, http://www.resmigazete.gov.tr/eskiler/2014/01/20140118-2.htm accessed on 1 March 2014, p.7

[80] Agreement Between the Government of the Socialist Republic of Vietnam and the Government of Japan for Cooperation in the Development and Peaceful Uses of Nuclear Energy, Art. 9,

http://9box.vn/tai-lieu/chi-tiet/thong-bao-hieu-luc-cua-hiep-dinh-ve-hop-tac-phat-trien-va-su-dung-nang-luong-hat-nhan-vi-muc-dich-68623.html , accessed on 2 March 2014

[81] Status report for Advanced Nuclear Reactor Designs, No 99 - ATMEA1, p.2,

http://www.atmea-sas.com/ATMEA/liblocal/docs/ARIS%20ATMEA1.pdf

arrangement are finalized. In Akkuyu, if the project is completed on time, Turkey would not have to make plans to store waste outside of the spent fuel pond until 2035.[82] And, it appears as if Russia will then take back the spent fuel, reprocess it, and possibly return some form of waste to Turkey. It is, however, unclear if the Turkish government, or the Akkuyu project company will then be responsible for disposing of it.

In the case of Sinop, Turkey would have to store the spent fuel in a spent fuel pond, and then build drycask storage. In turn, Ankara would then have to decide how long it will store the dry casks onsite, before moving them to a geographical repository. As of now, Turkey has not announced where it will build this facility. In general, only a few countries have built geographical repositories, and only Finland is currently constructing such a facility.[83] It is unclear if Turkey has the capability to construct such a facility, or if the costs associated with construction have been accounted for in the project's cost projections. Turkey, therefore, could opt to "kick the can down the road" and store spent fuel onsite, before making the ultimate decision about where to permanently store it.

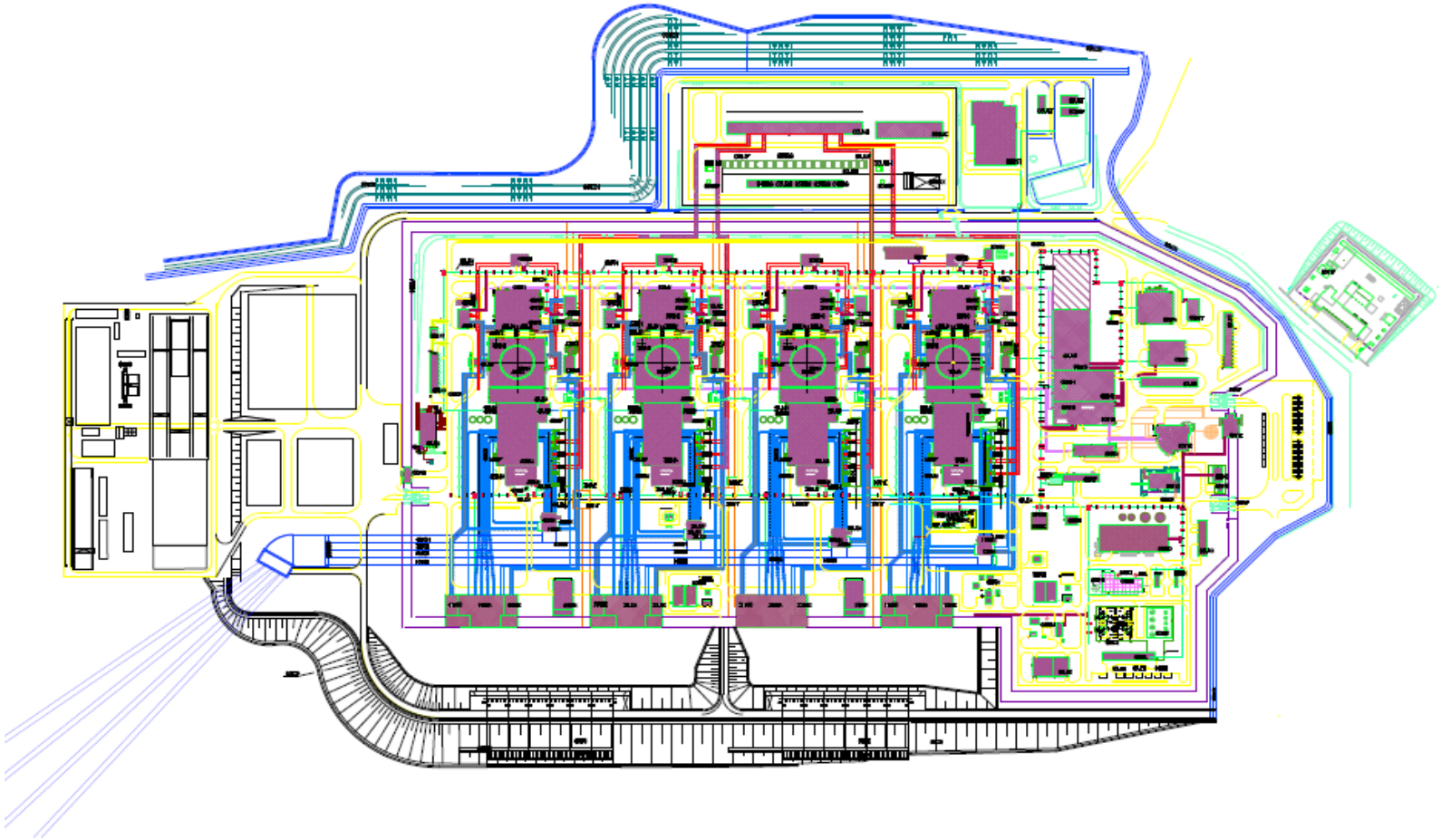
Thus, while Ankara may have some time, it is has yet to fully articulate its long term nuclear plans. It would behoove the government to be as transparent as possible, in order to avoid future misunderstandings.

[82] http://www.gazetea24.com/yerel-basin-haber/o-konuyu-22-yil-sonra-konusuruz_11144967.html

[83] Charles Digges, "Russia's nuclear corporation embarks on permanently storing radioactive waste – but final solutions still distant", November 18, 2013,

http://bellona.org/news/nuclear-issues/radioactive-waste-and-spent-nuclear-fuel/2013-11-russias-nuclear-corporation-embarks-permanently-storing-radioactive-waste-final-solutions-still-distant

Annex I – Akkuyu NPP Site Plan



Akkuyu Nuclear Power Plant Site Plan (NGS Enerji Üretim Sahası Vaziyet Planı), Section II, Appendix II-3, p.20.