

ISSUE BRIEF

Turkey's Nuclear Program

Challenges and Opportunities

DECEMBER 2016 AARON STEIN

Turkey has a plan to increase the production of nuclear energy, in part to decrease its heavy reliance on fossil fuels. In the past decade, domestic demand for electricity has almost doubled, increasing to 207 terawatt hours (TWh) in 2015.¹ The Turkish government has outlined an ambitious energy policy, including the reduction of greenhouse gasses, the promotion of indigenous resources like coal and renewables, and the procurement of three nuclear power plants. Turkey currently relies on natural gas to produce 37.8 percent of total electricity production, followed by coal (28.4 percent), hydroelectric (25.8 percent), and other renewable sources (7.9 percent).²

Ankara is seeking to increase the share of nuclear energy, as part of a broader strategy to diversify Turkish energy sources and, to that end, has reached tentative agreement with Russia and a Japanese-French consortium to build two nuclear power plants near Mersin on Turkey's Mediterranean coast and in the Sinop District on the Black Sea coast. Turkish authorities are working to rewrite the country's current nuclear legislation and regulations, in order to strengthen the state's capacity to oversee and safely manage the generation of nuclear power. The fate of Turkey's nuclear projects, however, is dependent on vendor financing, related to adoption of a "Build, Operate, Own" (BOO) model, in addition to political arrangements with the Russian Federation. Turkey's current energy minister, Berat Albayrak, who is the former chief executive officer of Calik Holding and President Recep Tayyip Erdogan's son-in-law, has prioritized the development of nuclear energy. Albayrak has taken advantage of a recent improvement in Turkish-Russian relations, following months of tensions after the Turkish Air Force downed a Russian bomber that violated Turkish airspace on November 24, 2015.

The Atlantic Council's **Rafik Hariri Center for the Middle East** studies political and economic dynamics in the Middle East and recommends US, European, and regional policies to encourage effective governance, political legitimacy, and stability.

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- 1 "Energy Policy of IEA Countries: Turkey," International Energy Agency, 2016, 9, <http://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountries-Turkey.pdf>.
- 2 Turkey's Energy Profile and Strategy, Turkey, Republic of Turkey, Ministry of Foreign Affairs, last accessed December 9, 2016, <http://www.mfa.gov.tr/turkeys-energy-strategy.en.mfa>.

The Russian Federation imposed financial sanctions and froze work on site preparation for a nuclear power plant in Turkey in December 2015, and reportedly explored terminating the contract all together.³ The Turkish government also explored other options, but the heavy financial penalties Rosatom would have incurred prevented the outright cancellation of the contract.⁴ The Turkish government apologized for the incident in June 2016 and shortly after, a broad rapprochement developed between the two regional powers.⁵ The return to cordial ties has resulted in the resumption of work at Akkuyu.⁶ In parallel, however, Turkey's domestic situation has deteriorated following a failed coup on July 15, 2016. The government withstood the putsch attempt, but the domestic uncertainty prompted the ratings agency Moody's to downgrade Turkey's credit rating to levels below investment grade.⁷ S&P had already listed Turkey as sub-Investment Grade, but then lowered Turkey's rating further, leaving only Fitch that lists Turkey as investment worthy. The combination of the downgrades and the large-scale purge of the Turkish bureaucracy raises questions about the viability of the Sinop project, particularly given the rising costs associated with the project following the depreciation of the Turkish lira and increased borrowing costs for investment in Turkey.⁸

The Turkish government remains committed to the development of nuclear power. President Erdogan retains considerable control over the direction of Turkish policy and his son-in-law, Albayrak, controls the energy portfolio and has become a more prominent fixture in Turkish politics. The external political environment is also more favorable to cooperation with Russia. The United States

has a longer-term interest in ensuring that the development of nuclear energy goes smoothly. The BOO model is under consideration in numerous other countries in the Middle East and Asia. If one or both of the projects is successfully implemented, Turkey will be the first in the world to rely on a foreign vendor to own and operate a nuclear power plant in its country. Thus, the lessons learned through these projects could be replicated in other countries, increasing their potential significance. This issue brief explains the current status of nuclear power projects in Turkey, the BOO financing model, the regulator concerns associated with this model, the current regulatory environment in Turkey, and the longer-term plans for developing a nuclear energy industry and for the storage of spent fuel.

Turkey: Nuclear Background

Turkey was the first country to sign an Atoms for Peace Agreement, the US policy that promoted the development of civil nuclear energy globally at the start of the atomic energy era, in June 1955. The Turkish government subsequently pursued nuclear energy-related projects in the 1960s and 1970s, but failed to make much progress, owing to internal political instability and a lack of financial resources. Following the 1980 military coup, Prime Minister Turgut Ozal, a former International Monetary Fund employee and a proponent of Turkey's transition to export-oriented market capitalism, once again prioritized the development of nuclear energy and developed a variation of its current financing model, BOO, in 1984.⁹ This financing model requires that the nuclear vendor provides financing for the construction of the reactor and operates it for the life of the power plant, in return for a Turkish state-owned electricity utility guaranteeing a purchase price for an agreed amount of electricity produced at the plant. The Turkish government has consistently refused to give the vendor a guarantee from the Turkish treasury, a prerequisite for most nuclear firms to secure the required funding from third parties and to finalize the construction agreement.¹⁰

3 Orhan Coskun, "Russia Halts Turkey Nuclear Work, Ankara Looks Elsewhere," Reuters, December 9, 2015, <http://www.reuters.com/article/mideast-crisis-turkey-russia-nuclear-idUSL8N13Y31G20151209>.

4 Ibid.

5 Andrew Roth and Erin Cunningham, "Turkish President Apologizes for Downing of Russian Warplane last year," *Washington Post*, June 27, 2016, https://www.washingtonpost.com/world/turkey-apologizes-for-shooting-down-russian-warplane-last-year/2016/06/27/d969e0ea-3c6d-11e6-9e16-4cf01a41decb_story.html.

6 The Turkish Atomic Energy Agency continued to work during this period, reviewing with the assistance of the Czech Republic's technical support organization, UJV Rez, the review of documents for the construction license. See: Phil Chaffee, "Newbuild: Moscow Eyes Turkish Partners for Akkuyu," *Nuclear Intelligence Weekly*, April 29, 2016.

7 "Turkey Junked by Moody's," *Financial Times*, September 23, 2016, <https://www.ft.com/content/98a1944b-fed2-384a-8c50-e4c7c55a555e>.

8 Phil Chaffee, "Nuclear Projects Uncertain after Failed Turkish Coup," *Nuclear Intelligence Weekly*, July 22, 2016.

9 Ann Taboroff, "The Turkish Electrical Authority Has Raised the Financing Requirement," *Nucleonics Week*, vol. 25, no. 18, May 3, 1984.

10 Ann Taboroff and Ann MacLachlan, "AECL Ready to Consider Turkish Government's Terms for Akkuyu Project," *Nucleonics Week*, vol. 25, no. 47, November 22, 1984; Ann Taboroff, "AECL Given Edge as Akkuyu Deadline Passes without Decision," *Nucleonics Week*, vol. 25, no. 50, December 13, 1984; Ray Silver, "Akkuyu Financing Guarantees Being Sought from Three Nations," *Nucleonics Week*, vol. 26, no. 24, June 13, 1985; "Turkey's Nuclear Plant Delayed," *Modern Power System*, May 31, 2000; "UAE Eyes Turkish Nuke Tender," *Hurriyet Daily News*, October 12, 2012, <http://www.hurriyetdailynews.com/uae-eyes-turkish-nuke-%20>



Sinop, Turkey, the location of where one of two Turkish nuclear power plants is planned to be built.
Photo credit: Bjørn Christian Tørrissen/Wikimedia.

The absence of a Turkish treasury surely had, since the early 1980s, prevented Turkey from reaching agreement with an outside vendor. In 2008, Turkey passed an updated vendor financing law, designed to entice foreign vendors to finalize a reactor deal. The law empowered a state-owned electricity utility, TETAS, to negotiate directly with the vendor for a bilateral energy sales arrangement. This process, while not tantamount to granting a direct treasury guarantee, sought to assuage potential vendors that a state-owned utility would purchase electricity for a fixed rate and for an agreed amount of time. This arrangement, however, still failed to attract much interest from Western, Japanese, or South Korean nuclear vendors.¹¹ The one exception,

Russia's Rosatom, submitted a bid that included an offer of 21.16 US cents per kilowatt-hour for electricity produced. Turkey rejected Rosatom's demand, but rather than relaunch an open tender process where multiple nuclear vendors could submit bids, Turkey began a bilateral negotiation with the Russian government.¹² The two sides reached agreement in 2010, stipulating the construction of four VVER-1200 reactors at a site in the Akkuyu bay, near the city of Mersin.¹³ Rosatom lowered its price to 12.35 US cents, a 58 percent price decrease in the guaranteed cost of electricity from the initial offer.

Turkey Nuclear Race," *Financial Times*, April 8, 2012, <http://www.ft.com/cms/s/0/8e2c86ae-8147-11e1-8aae-00144feab49a.html>.

tender.aspx?pageID=238&nid=32240.

11 Unlike their Western/Asian counterparts, China's state-owned nuclear firm, China General Nuclear Power Corporation, accepted every Turkish demand indicating that they were prepared to follow the Russian Akkuyu financing model. However, Beijing was unable to export its latest reactor designs because they were still being produced under license from Areva and Westinghouse. See: Leslie Hook and Daniel Dombey, "China Edges Ahead in

12 In late January 2010, the former minister of energy and natural resources, Taner Yildiz, chose to forego another tender process, after receiving only one bid from Rosatom. This decision prompted direct bilateral negotiations, dependent on Russia lowering the cost of electricity purchased from the plant. See: David O'Byrne, "Turkey Plans its First Nuclear Plant under Partnership with Russia," *Platts Global Power Report*, January 28, 2010.

13 Turkey and Rosatom may eventually decide to build the VVER-TOI, a nuclear power plant designed after the Fukushima disaster in Japan.

Three years later, in 2013, the Turkish government signed a similar agreement with the Japanese-French consortium of Mitsubishi Heavy Industries (MHI), Itochu, and Areva for the construction of an Atmea-1 reactor in Sinop. Mitsubishi refused to finalize the deal, however, until it could find a third party to operate the reactor, in this case, the jointly designed Atmea-1. After reaching agreement with Areva, the MHI-led consortium then quickly finalized an arrangement with the Turkish government. Ankara also changed its own approach to reactor financing and allowed EUAS, a state-owned utility company, to purchase an ownership stake in the project company. This arrangement differs considerably from the Rosatom financing model, wherein no Turkish company has an ownership stake.

Both reactor designs are “evolutionary,” which means that they have never been built before, but are based on older and proven technologies. The VVER-1200, for example, is based on the VVER-1000, a reactor design in operation throughout Russia, Eastern Europe, and Asia. The Atmea-1 is based on an older, pressurized water reactor design. The Turkish government, in its initial tender request, asked for proven reactor designs approved for licensing in either the United States or the European Union (EU). The VVER design is still being reviewed in the EU,¹⁴ but it was designed with EU utility requirements in mind.¹⁵ The French nuclear regulator, *autorite de surete nucleaire* (ASN), approved the Ameqis general design in 2012.¹⁶

Turkey: The Regulatory Environment

If the Akkuyu or Sinop reactor deals are finalized and construction finished, Turkey will be the first country in the world to have used the BOO model for reactor financing and construction. The BOO model poses a number of regulatory challenges and presents an inherent conflict of interest between the vendor and the host country. This conflict of interest stems from the financing arrangement, in which the vendor is expected to raise capital for a \$20 billion investment and not recoup on its investment for at least fifteen to twenty

years. This requirement ties up the vendor's budget for foreign and domestic projects for years, which can make the cost of doing business with Turkey prohibitive.

“This arrangement risks “regulatory capture,” wherein the regulated entity manipulates lawmakers and regulators to put private interests ahead of those of the general public.”

The vendor, therefore, has an incentive to finish the project on time in order to avoid cost overruns. This incentive structure could lead the vendor to cut corners or encourage building project managers to overlook small problems during the construction process. This places an increased burden on Turkey's nuclear regulator and requires clear legislation to ensure that the Turkish agency in charge of overseeing nuclear energy is independent. The Turkish nuclear agency has never overseen a project of this size and, per the stipulations in the intragovernmental agreement with Russia, is working with Rosatom to assist with the drafting of Turkey's updated regulatory framework.

This arrangement risks “regulatory capture,” wherein the regulated entity manipulates lawmakers and regulators to put private interests ahead of those of the general public. This problem is not limited to Turkey or the BOO model, but was one of the “lessons learned” following the Fukushima partial melt down in Japan—one of world's largest operators of nuclear power reactors. According to the United States' National Academy of Sciences report on the Fukushima accident, Japan's nuclear regulator was captured by the nuclear industry and turned into a caretaker, rather than an entity with real enforcement powers to ensure proper standards.¹⁷

14 “Advanced Nuclear Power Reactors,” World Nuclear Association, September 2016 (Updated), <http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/advanced-nuclear-power-reactors.aspx>.

15 “Status Report 108 - VVER-1200 (V-491) (VVER-1200 (V-491)),” International Atomic Energy Agency, August 1, 2011, [https://www.iaea.org/NuclearPower/Downloadable/aris/2013/36.VVER-1200\(V-491\).pdf](https://www.iaea.org/NuclearPower/Downloadable/aris/2013/36.VVER-1200(V-491).pdf).

16 “Advanced Nuclear Power Reactors,” World Nuclear Association, September 2016.

17 The National Academy of Sciences, “Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of US Nuclear Plants,” Chapter 7 summary, Committee on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, Nuclear and Radiation Studies Board, Division on Earth and Life Studies; National Research Council, *Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants* (Washington, DC: National Academies Press, 2014), <http://www.ncbi.nlm.nih.gov/books/NBK253947/>.

The Turkish government is in the process of rewriting its nuclear regulatory standards and would be wise to incorporate these lessons learned, to guard against Rosatom or other nuclear interests interfering with oversight legislation, in order to use the Turkish arrangement as a marketing vehicle for other countries currently negotiating a similar financing arrangement.

Turkey is a signatory to the Convention on Nuclear Safety (CNS), which aims to legally commit participating states to upholding a common set of nuclear safety and regulatory principles. At the time of writing, the Turkish government has not passed a single, comprehensive nuclear regulatory act similar to the US Atomic Energy Act. Instead, the Turkish government has two different pieces of legislation: governing construction and operation of nuclear power plants (Law: 5710) and the nuclear regulatory agency, TAEK (Law: 2960).¹⁸ A decree issued in 2012 elevates International Atomic Energy Agency (IAEA) regulations in cases where Turkish legislation is vague or does not address a specific regulatory issue. In the event that IAEA regulations are similarly vague, the vendor is expected to appropriate domestic or third country nuclear laws and regulations.¹⁹

These measures are intended to serve as a stop-gap, until an updated—and comprehensive—nuclear energy and radiation law is passed in parliament. At the time of writing, the Turkish government has not yet passed legislation to this effect, despite reportedly having circulated a draft copy of updated legislation in 2013. The two different nuclear projects are at different stages. Rosatom is still waiting for TAEK to finalize the construction license, and officials now hope to pour first concrete in 2018, according to *Nuclear Intelligence Weekly*. The Sinop project is at a more preliminary stage of development, with talks continuing about the formation of the project company and ongoing seismic studies to finalize the feasibility study.

The twin efforts at Sinop and Akkuyu are moving in parallel to the ongoing debates about Turkish nuclear legislation, leaving TAEK as the current regulator in charge of overseeing both projects. The 1982 decree empowers TAEK to oversee and inspect—and, perhaps, rescind licenses for—nuclear facilities at all stages of the project, from the decision to issue the site, through

construction, to operating licenses.²⁰ This current arrangement, however, does not guarantee regulatory independence. TAEK remains too closely tied to the office of the Turkish prime minister for funding and grants the prime minister too much power over the appointment of the regulator's president.

TAEK is funded with money allocated to the total budget of the prime minister's office, an arrangement at odds with typical government-led mechanisms to ensure independence, as would be the case with a dedicated, designated tax revenue. The prime minister, along with the Ministry of Energy and Natural Resources (MENR) appoint TAEK's president, albeit without special protections to ensure his/her removal from duty. This arrangement could allow for the prime minister to use the threat of termination to place political pressure on the regulator to hasten construction, or ensure that non-technical/regulatory related issues are taken into account during various stages of the regulatory and approval process.

The updated draft legislation reportedly takes steps to rectify these shortfalls. An unpublished draft, leaked online in March 2013, suggests that the Turkish parliament is considering the elimination of TAEK all together in favor of a dedicated nuclear regulatory agency. The financing structure remains unclear, but the updated legislation would include employment protections for the new regulator's board and president, effectively making it independent from the prime minister.²¹ It is also unclear how this legislation could be affected if the Justice and Development Party (AKP) succeeds in its planned referendum for a change to the Turkish constitution and installs a centralized presidential system, instead of the current parliamentary model.

Project Financing: Questions about Viability

The Turkish government hopes to have at least one reactor online by 2023, the one-hundred-year anniversary of the founding of the Turkish Republic. The two nuclear reactor deals differ in structure. Rosatom is shouldering 100 percent of the financing burden and has agreed to recoup its expenses through the guaranteed sale of electricity for up to fifteen years. After this period expires, Rosatom will continue to own and operate the plant, but will be expected to pay a percentage of its

18 Izak Atiyas, "A Review of Turkey's Nuclear Policies and Practices," Centre for Economics and Foreign Policy Studies, August 12, 2015, <http://www.edam.org.tr/en/File?id=3174>.

19 Ibid.

20 Ibid.

21 Ibid.

earnings back to the Turkish government until the reactor is decommissioned.²² The reactor is financed through a project company, Akkuyu JCS, which ultimately relies heavily on Russian state subsidies to remain financially viable. The project company, in turn, has the option to sell a 49 percent stake of the company to an outside vendor, if it can find a third party vendor.²³

“The rapid drawdown of capital in the Reserve Fund could force Rosatom to request loans from commercial banks, or pursue alternative means of financing, the former of which could derail the project.”

Akkuyu JCS has approached different vendors, beginning with EDF, a French government-backed energy company, but has not yet found a partner willing to take on the financial risk. Up until 2015, Rosatom relied heavily on subsidies from the Russian national budget for reactor builds abroad. In Finland, where Rosatom is constructing a similar VVER-1200, the Russian government approved a \$2.3 billion loan for construction from its Reserve Fund in 2015.²⁴ Rosatom first requested this funding in 2013, according to the Bellona Foundation, when global energy prices were higher and the Russian economy was in better shape.

22 Russia has agreed to establish a local special purpose vehicle (SPV) to finance and manage the construction and operation while TETAS agreed to purchase 70 percent of the electricity from the first two units for a guaranteed price of 12.35 US cents per-kWh. TETAS also agreed to purchase 30 percent of the electricity from the third and fourth unit.

23 The Turkish press has reported that a tripartite group of major Turkish businesses, Cengiz-Kolin-Kalyon Group (CKK), could purchase the stake in the project company. *Daily Sabah* with *Andolu Agency*, “Rosatom holds talks with Turkish CKK Group for Akkuyu partnership,” November 14, 2016, <http://www.dailysabah.com/money/2016/11/15/rosatom-holds-talks-with-turkish-ckk-group-for-akkuyu-partnership>.

24 Vladimir Sliviyak, “Survival of the fittest? World’s Major Nuclear Builders are in for a Long Stretch in the Red,” The Bellona Foundation, May 18, 2015, <http://bellona.org/news/nuclear-issues/2015-05-survival-fittest-worlds-major-nuclear-builders-long-stretch-red>.

The collapse of global energy prices and Western sanctions following the invasion of Ukraine has prompted budget cuts in Russia. To offset a decrease in domestic spending, the Kremlin is now using funds from sovereign wealth funds to offset spending shortfalls. At the rate of current spending, Russia will deplete its \$38 billion Reserve Fund in 2017, according to Bloomberg News.²⁵

The rapid drawdown of capital in the Reserve Fund could force Rosatom to request loans from commercial banks, or pursue alternative means of financing, the former of which could derail the project.²⁶ For the Akkuyu plant, Russia and Turkey appear to have opted for the latter, agreeing in August 2016 that Akkuyu would receive “strategic investment status.” This allows for Akkuyu JCS to reclaim value-added-tax expenditures on construction services the project company pays to Turkish companies for infrastructure development at the nuclear site. According to Russia’s energy minister, Alexander Novak, this arrangement “significantly [improves] the plant’s break-even point and economics.”²⁷

The MHI-Itochu-Areva arrangement for the Sinop plant is structured differently. Turkey’s state-owned electrical utility, EUAS, has agreed to take a 49 percent stake in the project company. The consortium, however, remains divided over the percentage each will take in the project company.²⁸ The nuclear firm Engie (previously known as GDF Suez, a large energy company partially under the control of the French government) is currently conducting seismic studies of the proposed site, which has led to concerns that the area is too seismically active for the proposed reactor. Areva has proposed placing the reactor on specially designed pads, but cannot move forward until the site studies are completed.²⁹ The proposed Turkish ownership stake is also being debated. According to Turkey’s former energy minister, Taner Yildiz, EUAS may have plans to sell up to 50 percent of the shares of its stake in the project company.³⁰

25 Olga Tanas, “Russia Blows Through Wealth Funds as Plans Said to Focus on Debt,” *Bloomberg*, July 5, 2016, <http://www.bloomberg.com/news/articles/2016-07-05/russia-blows-through-wealth-funds-as-plans-said-to-focus-on-debt>.

26 Ibid.

27 Ibid.

28 Phil Chaffee, “Newbuild: Akkuyu Pulls Ahead of Sinop,” *Nuclear Intelligence Weekly*, July 22, 2016.

29 Ibid.

30 “Nuclear Plants to Help Turkey Save \$7.2 bn. in Gas Imports,” *Anadolu Agency*, May 6, 2013, <http://www.aa.com.tr/en/headline/173346--y>.



Construction of a VVER-1000 model reactor, a similar model to that planned for the Akkuyu nuclear power plant, in Koodankulam, India. *Photo credit:* International Atomic Energy Agency/Wikimedia.

Turkey remains interested in the Atmea-1, in part because the reactor does not have a closed supply chain. This means that Turkish industry could provide reactor components, something it cannot do for the VVER-1200. In previous nuclear negotiations, the Turkish government had sought to guarantee some local production, including assistance with the development of a fuel fabrication facility to manufacture fuel rods for the reactor.³¹ This demand could complicate Turkey's ongoing

31 In September 2008, Ankara expressed an interest in serving as a regional fuel fabrication center for Middle Eastern and central European states, asking that vendors propose a plan for domestic fuel production. However, because it had not yet selected a vendor, the nature of the fuel cycle remained ambiguous. Ankara did, however, rule out enrichment saying that it was only interested in fuel fabrication, thus suggesting that it "aimed to manufacture power reactor fuel using UO₂ feedstock, not UF₆." Turkey has also expressed some interest in a thorium fuel cycle around the same time and, during the 1980s, engaged Canada's AECL about the building of a fuel fabrication facility. See: Mark Hibbs, "Turkey will Press for Fuel Technology Transfer," *Platts Nuclear Week*, February 11, 2008; Ann Taboroff, "Atomic Energy of Canada Ltd. (AECL) Has Reached an Agreement with Turkey," *Nuclear Week*, July 11, 1985.

efforts to reach agreement with Westinghouse and China's State Nuclear Power Technology Corporation for the construction of a four-unit plant, reportedly at a site near the border with Bulgaria.

The negotiations for this third plant began in December 2014. According to *Nuclear Intelligence Weekly*, "these talks were troubled from the get-go: Pittsburgh-based Westinghouse wanted to lead the discussions, but couldn't offer an intergovernmental agreement (something Washington doesn't do for specific nuclear projects) or serious equity financing."³² Turkey has since sought to engage directly with Beijing, a process that culminated in the signing of a memorandum of understanding (MOU) in June 2016.³³ China had previously offered to finance reactor construction, a key Turkish demand. China's State Nuclear Power Technology Company (SNPTC), however, is unwilling to export

32 Chaffee, "Newbuild: Akkuyu Pulls Ahead of Sinop."

33 Turkey and China signed a formal nuclear cooperation agreement in 2012.

design information to customers. In response, Turkey has reportedly approached South Korea's KEPCO, which engaged in discussions for the Sinop site. These previous negotiations failed over financing concerns, a disagreement about the cost per kilowatt-hour, and the Turkish government's stake in the project company.³⁴

Decommissioning Costs: Long-Term Storage

Areva and Rosatom are currently facing financial pressure associated with the decommissioning of legacy reactors, a cost that is often overlooked in calculating reactor operation costs. The Turkish government has reached a fuel supply arrangement and "take back" provision with Rosatom. This means that Russia's fuel company, TVEL, will provide the fuel rods for the VVER-1200 reactor and take back the waste generated from the plant's operation. Areva is expected to supply the fuel for Sinop, but neither France nor Japan take back spent fuel.

Rosatom's take-back provision has yet to be finalized, but it appears likely that "burned" fuel rods³⁵ will be stored on-site at Akkuyu for up to ten years in a spent fuel pond. The Akkuyu site will also have room for the dry storage of nuclear waste for up to four years, before possible transport to Russia for reprocessing or long-term storage. After reprocessing, Russia could choose to return vitrified waste to Turkey for long-term storage. The Turkish government has yet to finalize plans for this possibility, reportedly because it is contingent on the still un-passed updated nuclear legislation. To finance this, Turkish law requires that the vendor contribute a percentage of profits from electricity sales to a decommissioning fund and the eventual construction of a deeply buried, long-term storage facility.³⁶ If the

cost of fuel storage exceeds that in the fund, however, current Turkish law requires the treasury to "to contribute up to 25 percent of the amount accumulated in the fund," according to Izak Atiyas.³⁷

The Japanese government has made clear that Turkey is responsible for waste management. France has not completely ruled out reprocessing spent fuel, but even if it did so, it would return the vitrified waste to Turkey for long-term storage. It is unclear if Turkey has factored the cost of long-term storage into its pricing models for the development of nuclear energy, or if TAEK has the expertise to design and build a long-term storage facility, and how these price models may be impacted by the current lira depreciation, slower economic growth, decreased electricity consumption, and Turkey's currently poor credit ratings.

As Turkey moves forward with its nuclear energy plan, the issue of long-term storage will have to be addressed. In the short term, the policy is to store fuel rods on-site in a spent fuel pond, and then transfer the waste to dry storage. The spent fuel from Akkuyu, in turn, will be returned to Russia for reprocessing, and then returned to Turkey. The long-term storage for Sinop is far less clear, with precedent suggesting that France will not take back spent fuel, leaving Turkey with a need to build a long-term facility.

Turkey's Nuclear Future: Options for the Future

Turkey's nuclear energy plans are linked to plant vendors' ability to raise capital to finance the cost of construction, a reality driven by the BOO model. This model, in turn, is impacted by external developments, like Turkey's credit downgrade, the value of the lira/ruble, and the health of Turkish political institutions. BOO also has some inherent conflicts of interest that any updates to Turkish legislation should seek to address. Further still, the Turkish policy for storage of nuclear waste, along with the mechanisms to construct and account for the costs of building a long-term storage facility, have not been clearly articulated. The Turkish government has sought to address these issues, but the passage of updated nuclear legislation has been delayed.

34 "South Korea's Reactor Deal with Turkey 'Hits Snag' over Power Price," *BBC Monitoring Service, Asia Pacific - Political*, November 15, 2010; "Seoul Pulls Plug on Turkish Nuclear Plant," *European Daily Electricity Markets*, November 17, 2010; "Agreement with Korea on Nuclear Plant may be Signed in November," *Intellinews - Turkey Sectors and Companies Today*, September 23, 2010; "UAE Eyes Turkish Nuke Tender," *Hurriyet Daily News*, October 12 2012, <http://www.hurriyetdailynews.com/uae-eyes-turkish-nuke-%20tender.aspx?pageID=238&nid=32240>.

35 This refers to fuel elements that were in the core of the reactor and then removed and replaced for storage and disposal.

36 According to the Intergovernmental Agreement with Russia, 0.15 US cents per kilowatt-hour will be deposited into a fund for waste management during the price purchasing arrangement period. See: Turkey: Country Nuclear Profiles, International Atomic Energy Agency, 2014 (Updated), <https://cnpp.iaea.org/countryprofiles/Turkey/Turkey.htm>; See also: Cigdem Bilezikci Pekar, "Turkey's Nuclear Power Plans and Nuclear Fuel Cycle Options," Centre for Economics and Foreign Policy Studies, May 2014, <http://www.edam.org.tr/en/File?id=1157>.

37 Izak Atiyas, "Risks, Incentives and Financing Models of Nuclear Power Plants: International Experience and the Akkuyu Model," Centre for Economics and Foreign Policy Studies, December 2011, http://edam.org.tr/document/EDAMNukleer/NuclearReport2011_EN/section4.pdf.

Turkey may also face difficulties developing a singular and focused nuclear energy industry, largely because financing concerns have prompted the government to make disparate decisions about reactors. The VVER-1200 and the Atmea-1, for example, operate on similar principles, but the supply chain and operation of each plant differ considerably. Thus, Turkish technicians trained as part of the program to operate Akkuyu will not have transferable skills for the Sinop plant and vice versa. This issue could be further compounded with the selection of a different vendor and reactor design for the third proposed power plant, although there are certain to be more similarities between a Westinghouse model and the Atmea-1 than with any comparable Russian plant.

The Akkuyu and Sinop plants still face financing risks, with the latter now threatened by Russia's economic deterioration and by previous disagreements over ownership stakes in the project company and construction cost estimates following seismic studies of the region. The negotiations for the third power plant are still limited and financing will remain a key issue moving forward for all parties involved. For the Turkish government, the

path forward is clear: Regardless of the status of the nuclear power plant projects, the country has an interest in finalizing and strengthening nuclear regulations. This process should be completed as soon as possible. The United States and the international community, represented by the International Atomic Energy Agency (IAEA), should play a constructive role in helping Turkey draft nuclear-related legislation. The IAEA is best suited to give advice for the drafting of this legislation. The agency has been involved in several aspects of the Turkish program, including assistance for the creation of institutions that can be independent in a BOO financing model since talks began with Russia. The Turkish case is unique and could be precedent-setting, therefore its handling of the inherent conflicts of interest between vendor and host country, created under the BOO model, is likely to provide the framework for other countries interested in using this model for reactor construction.

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