

ANNUAL REPORT

MIDDLE EAST NUCLEAR ENERGY MONITOR 2019

*A Decade Later:
South Korea's Nuclear Energy Exports
to the Middle East*









June Park, Pamela Rizkallah and Ali Ahmad

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EXECUTIVE SUMMARY

The nuclear power program of The United Arab Emirates (UAE) is South Korea's first sale of its nuclear technology and services abroad and its only one since the deal was signed by the two countries in 2009. The Barakah project, named after the site where it is located, has often been described as a role model for nuclear newcomers. However, as with most nuclear projects, it has been hampered with delays, with the latest expected operation date set in 2020, an almost three-year delay following the initially planned operation date. Even though there is not much official information detailing the reasons behind these delays, except for ensuring the plant's operational readiness, speculations about other underlying reasons abound. Challenges related to the relationship between Abu Dhabi and its South Korean partners, unsatisfactory human resources development, and cracks in the reactors' containment building have been reported. The project's delays translate into economic and reputational consequences that affect the UAE, South Korea and the nuclear industry at large.

From the Republic of Korea (ROK)'s perspective, the delays in the UAE nuclear project exhibited the delivery constraints of ROK's nuclear exports. As the anticipated date of Saudi Arabia's first bid to build a nuclear power plant draws near, South Korea is facing challenges domestically and abroad, with a domestic energy policy on nuclear phase-out that is at odds with continued nuclear power technology sales overseas. The global nuclear power export market is fierce, with strong competition from China and Russia. Building on its experience in working in the UAE, South Korea will likely continue to be in the run for future nuclear power sales in the region, but will face challenges in terms of the business model and strategies. The likelihood of South Korea cooperating with the US for Saudi Arabia's nuclear market is a key scenario that deserves attention, but the current dynamics of US domestic politics also present uncertainties.

INTRODUCTION

In December 2009, Abu Dhabi, the capital of The United Arab Emirates (UAE), awarded its nuclear power development project to a South Korean consortium, amid competition from other technology suppliers such as Areva and General Electric. The consortium, headed by Korea Electric Power Corporation (KEPCO), led the construction of four 1,400-megawatt reactor units at the Barakah site. Since its inception, the Emirati nuclear program has been advocated as a “significant contribution to [the country’s] economy and future energy security” and an “environmentally promising and commercially competitive” option compared to other energy alternatives (such as diesel, crude oil, or coal).¹

South Korea’s sale of four APR-1400 reactors to the UAE is the only sale that South Korea has achieved abroad thus far. However, following its Barakah deal, South Korea became involved with Saudi Arabia to assist the kingdom develop a nuclear power program. Like the UAE, Saudi Arabia is seeking to transform its fossil fuel-oriented energy mix by including nuclear energy and renewables to cover projected increase in electricity demand.²

South Korea’s involvement with the nuclear power market is a topic worthy of review and assessment in light of (1) the delays in the delivery of the Barakah project, which has been hailed as a model for the nuclear newcomers; (2) the mismatch in the ROK’s domestic and export policies towards nuclear energy; (3) and the deepening tension in the Gulf where critical energy infrastructure has been targeted or considered as potential targets.

In this 2019 Middle East Nuclear Monitor, we closely examine South Korea’s involvement in the region’s nuclear market. Following introduction, the second section — The View from the UAE — looks at the progress of the Emirati nuclear program and discuss the reasons that led to it being three years behind schedule and the potential impact of the project delays. In the next section — The View from South Korea — we provide an overview of the domestic dynamics that govern the South Korean nuclear industry and how it might affect its pursuit of export markets. The last section — South

Korea as a Nuclear Technology Supplier in the Middle East — reports the advantages and challenges faced by the South Korean nuclear industry in the Middle East market with focus on the prospects of South Korea’s nuclear industry in Saudi Arabia’s nuclear plans.

THE VIEW FROM THE UAE

The UAE nuclear power program has often been described by the nuclear industry and nuclear power’s promoting agencies as an exemplary model for nuclear newcomer countries and “strategic to the future of global nuclear energy plans”.³ Additionally, the UAE signed the “123 agreement”, which pertains to Section 123 of the US Atomic Energy Act, whereby the UAE abandoned nuclear enrichment and fuel reprocessing, hence the “gold-standard” label awarded to the UAE’s nuclear program. By ensuring that the UAE abandoned uranium enrichment and reprocessing and abided by international protocols and standards⁴, the UAE nuclear program has been showcased as a counter-example to the Iranian nuclear program, thereby pinpointing the various “problematic” elements in the Iranian program that directly oppose the US’s demands in its 123 agreements.

As with most nuclear power projects around the world, the UAE Barakah project has been hampered with delays; the operation date of the first unit has been pushed back from 2017 to early 2020.^{5,6} Although the occurrence of delays in nuclear power projects is not uncommon, the reasons behind their occurrence varies by project. For instance, the Vogtle Nuclear Plant expansion in Georgia, US has been faced

3 Al Kaabi, H. (September 26, 2018). *Viewpoint: UAE’s Programme Strategic to Future of Global Nuclear Energy*. Retrieved from World Nuclear News: <http://world-nuclear-news.org/Articles/Viewpoint-UAE-s-programme-strategic-to-future-of-g>

4 World Nuclear Association. (April 2019). *Nuclear Power in the United Arab Emirates*. Retrieved from World Nuclear Association: <http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/united-arab-emirates.aspx>

5 Nuclear Engineering International. (May 7, 2017). *Operation of UAE Nuclear Plant Postponed by a Year*. Retrieved from Nuclear Engineering International: <https://www.neimagazine.com/news/newsoperation-of-uae-nuclear-plant-postponed-by-a-year-5808327>

6 Reuters. (May 26, 2018). *UAE’s First Nuclear Reactor Start-Up Delayed - Operator*. Retrieved from Reuters: <https://uk.reuters.com/article/emirates-nuclearpower-plant/uaes-first-nuclear-reactor-start-up-delayed-operator-idUKL5N1SX0EU?rpc=401&>

1 United Arab Emirates. (2008). *Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy*. Retrieved from Embassy of the United Arab Emirates – Washington, D.C.: https://www.uae-embassy.org/sites/default/files/UAE_Policy_Peaceful_Nuclear_Energy_English.pdf

2 Korea Atomic Energy Research Institute, ‘사우디 원자력 정책 및 국제협력 현황,’ *Nuclear Policy Brief Report, Issue 6, 2018*. <https://kaeri.re.kr/eng/fileDownload?titleId=5920&fileId=1&fileDownType=C¶mMenuId=MENU00928>

with several delays and cost overruns attributed to some capacity to regulation-mandated design changes.^{7,8} As of 2019, the operation of the two additional reactors has been delayed for five years, with the latest planned operation date being 2021 and 2022 for the two reactors respectively. France's Flamanville nuclear project also faced delays and cost overruns; however, the delays and increased costs were due to faulty welding in the plant.⁹

delayed due to “safety concerns” in the plant.^{12,13}

As depicted in Figure 1, the construction of unit 1 of the Barakah nuclear power plant (NPP) began in July 2012 and had been initially expected to go into operation in 2017. However, the operation date was pushed back to 2018 because additional operator training and regulatory approvals were needed.¹⁴ In fact, The Emirates Nuclear Energy Corporation (ENEC) stated

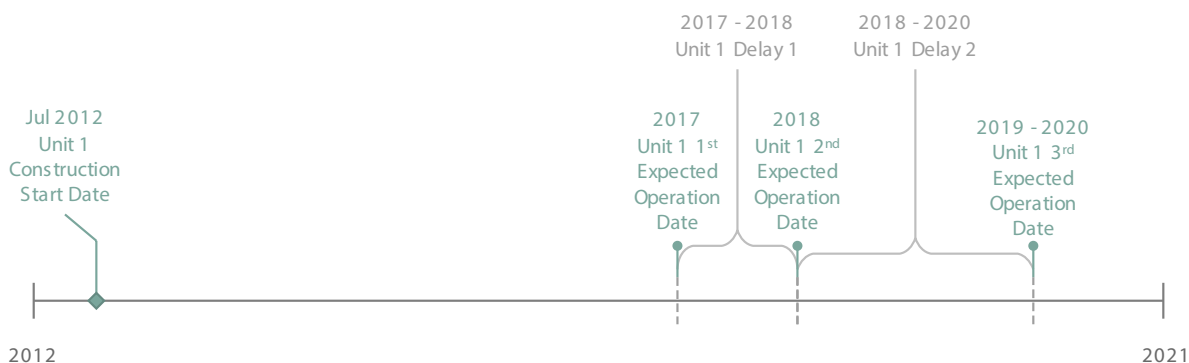


Figure 1 – Project delays of the UAE’s nuclear power plant (Unit 1)

Similarly, Finland’s Olkiluoto nuclear reactor is, as of 2019, around ten years behind schedule, and the latest delays were a result of additional commissioning tests and “changes to automated systems”.^{10,11} Moreover, China’s AP-1000 nuclear reactor “was originally expected to make its debut in 2014” but has been

that the first delay was “to ensure sufficient time for international assessments and adherence to nuclear industry safety standards and as a reinforcement of operational proficiency for plant personnel”.¹⁵ The operation of the first unit was then further delayed till early 2020, based on the same justification for the

7 Adams, R. (November 12, 2014). *Root Cause of Vogtle and VC Summer Delays*. Retrieved from ANS Nuclear Cafe: <http://ansnuclearcafe.org/2014/11/12/root-cause-of-vogtle-and-vc-summer-delays/#sthash.Pwh8dFze.J6MjzV18.dpbs>

8 Kempner, M. (2019, July 30). *Georgia Regulators Raise Fresh Concerns about Nuclear Project’s Timing*. Retrieved from The Atlanta Journal-Constitution: <https://www.ajc.com/news/local/georgia-regulators-raise-fresh-concerns-about-nuclear-project-timing/P8WKuQKIkbnRx904xtgZK/>

9 Felix, B., & De Clercq, G. (June 20, 2019). *UPDATE 2-EDF’s Flamanville nuclear plant faces new delay over faulty welding*. Retrieved from Reuters: <https://www.reuters.com/article/edf-flamanville/update-2-edfs-flamanville-nuclear-plant-faces-new-delay-over-faulty-welding-idUSL8N23R0V8>

10 Kauranen, A., & Karagiannopoulos, L. (April 10, 2019). *UPDATE 2-Fresh setback for Finland’s delayed Olkiluoto 3 reactor*. Retrieved from Reuters: <https://www.reuters.com/article/finland-nuclear/update-2-fresh-setback-for-finlands-delayed-olkiluoto-3-reactor-idUSL8N21S3EX>

11 World Nuclear News. (November 29, 2018). *New delay in start-up of Finnish EPR*. Retrieved from World Nuclear News: <https://www.world-nuclear-news.org/Articles/New-delay-in-start-up-of-Finnish-EPR>

12 Stanway, D. (February 12, 2018). *China nuclear reactor delayed again on ‘safety concerns’*. Retrieved from Reuters: <https://www.reuters.com/article/us-china-nuclear/china-nuclear-reactor-delayed-again-on-safety-concerns-china-daily-idUSKBN1FX02P>

13 South China Morning Post. (n.d.). *China nuclear plant delay raises safety concern*. Retrieved from South China Morning Post: <https://www.scmp.com/business/china-business/article/1325973/china-nuclear-plant-delay-raises-safety-concern>

14 Nuclear Engineering International. (May 7, 2017). *Operation of UAE Nuclear Plant Postponed by a Year*. Retrieved from Nuclear Engineering International: <https://www.neimagazine.com/news/newsoperation-of-uae-nuclear-plant-postponed-by-a-year-5808327>

15 Yurman, D. (April 27, 2019). *Delays in Startup of 1st UAE Nuclear Reactor Linked to Problems with South Korean Firms Building all Four Units*. Retrieved from Energy Central: <https://www.energycentral.com/c/ec/delays-startup-1st-uae-nuclear-reactor-linked-problems-south-korean-firms>

first delay.¹⁶ Nawah, the joint venture operator formed by ENEC and KEPCO, stated that the one-year delay “reflects the time required for the plant’s nuclear operators to complete operational readiness activities and to obtain necessary regulatory approvals, all of which are designed to ensure safe, sustainable nuclear operations after start-up”.¹⁷ The remaining units are expected to go online and operate consecutively after the first unit, with an interval of approximately one year between each operation date. Therefore, delays in the first unit’s operation consequently cause delays in the operations of the remaining three units.

The official statements issued by ENEC and the other involved entities explained that the operation of the first unit was delayed because the plant’s operators had been undergoing further training and Nawah is yet to receive its operating license from the Federal Authority for Nuclear Regulation (FANR).^{18,19} As of early July 2019, Nawah’s first batch of plant operators were certified by FANR. The operators had “completed a three-year training programme developed by ENEC and Nawah”.²⁰ Given that the plant’s operators are now qualified and

certified, the remaining source of delay, per ENEC, is the absence of an operating license. However, there are numerous speculations around other underlying reasons behind the delays in operation, which are summarized in Table 1 below. The potential underlying reasons for the delays are divided between specific factors (i.e., pertaining to the UAE itself) and general factors.

Human Resources: The Barakah plant is the UAE’s first nuclear endeavor, and as such, the UAE’s first time implementing a nuclear program, in addition to building and operating a nuclear reactor. Therefore, the operational delays can be attributed to some degree to the UAE’s lack of prior nuclear experience. Even though the UAE is working on developing a domestic nuclear workforce and industry by offering nuclear engineering degrees and various scholarships to develop a workforce with the needed skills and knowledge²¹, the UAE still largely relies on expatriates. In fact, the ENEC 2017 Sustainability Report indicates that 447 foreign employees were hired by ENEC, Nawah, and Barakah One Company, while only 231 Emiratis were

SPECIFIC FACTORS	GENERAL FACTORS
UAE’s need to develop an appropriate human resources experience and capabilities in building and operating nuclear reactors from scratch	Inherently complex nature of nuclear energy projects
Precautionary measures taken by UAE in response to ROK’s corruption and quality assurance scandal in the nuclear industry	Delays in the operation of ROK’s nuclear reactors, which the UAE nuclear reactors are based on
Cracks in the containment building of units 2 and 3	

Table 1: Factors contributing to the delay of the UAE’s nuclear power program

16 Reuters. (May 26, 2018). UAE’s First Nuclear Reactor Start-Up Delayed - Operator. Retrieved from Reuters: <https://uk.reuters.com/article/emirates-nuclearpower-plant/uaes-first-nuclear-reactor-start-up-delayed-operator-idUKL5N1SX0EU?rpc=401&>

17 Gulf News. (May 26, 2018). Barakah to Begin Operations by 2019 End or Early 2020. Retrieved from Gulf News: <https://gulfnews.com/uae/government/barakah-to-begin-operations-by-2019-end-or-early-2020-1.2227327>

18 Nuclear Engineering International. (May 7, 2017). Operation of UAE Nuclear Plant Postponed by a Year. Retrieved from Nuclear Engineering International: <https://www.neimagazine.com/news/newsoperation-of-uae-nuclear-plant-postponed-by-a-year-5808327>

19 Reuters. (May 26, 2018). UAE’s First Nuclear Reactor Start-Up Delayed - Operator. Retrieved from Reuters: <https://uk.reuters.com/article/emirates-nuclearpower-plant/uaes-first-nuclear-reactor-start-up-delayed-operator-idUKL5N1SX0EU?rpc=401&>

20 World Nuclear News. (July 8, 2019). First Barakah Operators Receive Regulatory Certification. Retrieved from World Nuclear News: <http://world-nuclear-news.org/Articles/First-Barakah-operators-receive-regulatory-certifi>

hired by those same companies.²² This demonstrates a considerable dependency on a foreign workforce. Additionally, due to the presence of a large expatriate workforce, challenges such as language barriers and cultural clashes are bound to affect the work process, especially considering the cultures’ contrasting styles of communication, leadership, and decision-making.²³

21 ENEC. (2018). Developing the Next Generation of Nuclear Experts. Retrieved from ENEC: <https://www.enec.gov.ae/careers-and-scholarships/scholarships/>

22 ENEC. (2017). Sustainability Report 2017. Retrieved from ENEC: <https://www.enec.gov.ae/doc/sustainability-report-2017-english-5b30815c13e2a.pdf>

23 Expert interviews, 2019.

Precautionary Measures: There are speculations that the delays are a strategy employed by the UAE as a precautionary measure in response to the corruption and quality assurance scandal in the South Korean nuclear industry.²⁴ The scandal involved the use of counterfeit parts, along with their forged safety documents, in the construction of South Korean nuclear plants. The counterfeit parts were also said to have been used in the construction of the UAE nuclear plant, which “is still creating a problem to this day” and has caused the Emiratis to lose “complete faith in the Korean supply chain”, according to Neilson-Sewell, a Canadian advisor to Barakah.²⁵ Given that South Korea is the main technology partner responsible for the operation and maintenance of the Barakah plant, the UAE could be attempting to adopt a more cautious stance with South Korea, therefore delaying the start-up of the first unit.

Cracks in Containment Buildings: In late 2018, ENEC “publicly acknowledged [the presence of] concrete cracking in the containment buildings” of units 2 and 3 of the Barakah plant.²⁶ Although ENEC claims that repairing the cracks will not impact “the broader schedule for completing and commissioning Barakah’s South Korean-supplied APR-1400s”, the exact impact of those cracks is still unknown.²⁷ Therefore, one cannot yet conclusively identify whether the cracks contributed to the operational delays in some capacity.

Nuclear Projects’ Complex Nature: Nuclear projects, worldwide, have a history of cost and time overruns.²⁸ Coupled with the fact that nuclear energy projects are highly technical and require a very specific set of expertise and skills, it comes as no surprise that these projects are inherently complex, and factors such as the project’s scale and scope, the “regulatory and utility requirements”, and “political pressures” only add to a project’s complexity.²⁹ Therefore, issues and delays are likely to arise in the process of developing

and completing such a project, especially for a country like the UAE that is a nuclear newcomer.

Delays in South Korean Nuclear Reactors: The scandal in South Korea concerning the use of counterfeit parts in Korean reactors caused delays in the start-up of the Shin Kori-3 plant since “out-of-standard cables” were installed and therefore had to be replaced. Given that the UAE nuclear reactors’ design are based on the South Korean Shin Kori-3 plant, in addition to the fact that Emirati operators were supposed to gain training experience at Shin Kori-3, there have been claims that the delays in Shin Kori-3 translated into delays in Barakah as well.^{30,31,32} The internal dynamics within the ROK with regard to nuclear power exports is discussed in detail below, but the current administration’s lack of trust in nuclear energy domestically raises concerns among countries working with or looking to work with the Korean nuclear industry. As phrased by Matthew Blumberg, an analyst at Hayberry Global Fund, “potential customers would be asking themselves why they should use South Korean (nuclear) technology, when the technology is being phased out in South Korea itself”.³³

Examining the Delays of the Barakah Project from South Korea’s Perspective

The delay of three years in the completion of South Korean reactors can be attributed to the factors mentioned above. However, some of these factors were either initiated in or highly impacted by South Korea’s nuclear industry. Of particular interest is the whistleblower report of forged warranties and the use of faulty control cables in the construction process.³⁴ When it was reported that poor quality parts included in Shin

24 Ibid.

25 Kim, M. S. (April 22, 2019). *How Greed and Corruption Blew Up South Korea’s Nuclear Industry*. Retrieved from MIT Technology Review: <https://www.technologyreview.com/s/613325/how-greed-and-corruption-blew-up-south-koreas-nuclear-industry/>

26 Cooke, S., & Klaus, O. (December 7, 2018). *Newbuild: Has Barakah Lost Its Magic?* Retrieved from Energy Intelligence: http://www.energyintel.com/pages/eig_article.aspx?docid=1018264

27 Ibid.

28 Schneider, M., & Froggatt, A. (September 2018). *The World Nuclear Industry Status Report 2018*. Retrieved from World Nuclear Industry Status Report: <https://www.worldnuclearreport.org/IMG/pdf/20180902wnisr2018-lr.pdf>

29 World Nuclear Association. (April, 2018). *Lesson-Learning in Nuclear Construction Projects*. Retrieved from World Nuclear Association: <http://www.world-nuclear.org/getattachment/e9c28f2a-a335-48a8-aa4f-525471a6795a/REPORT-Lesson-learning-in-Nuclear-Construction.pdf.aspx>

30 Yurman, D. (April 27, 2019). *Delays in Startup of 1st UAE Nuclear Reactor Linked to Problems with South Korean Firms Building all Four Units*. Retrieved from Energy Central: <https://www.energycentral.com/c/ec/delays-startup-1st-uae-nuclear-reactor-linked-problems-south-korean-firms>

31 Adams, R. (May 4, 2017). *Delayed Start Up At Shin Kori Unit 3 In South Korea Delays Barakah Unit 1 Start Up In UAE*. Retrieved from Forbes: <https://www.forbes.com/sites/rodadams/2017/05/04/delayed-start-up-at-shin-kori-unit-3-in-south-korea-delays-barakah-unit-1-start-up-in-uae/#25832f757d6a>

32 Yeon, C. (July 23, 2015). *UAE Media Outlet Says Shin-Kori Reactors Hinder UAE’s Nuclear Energy Programme*. Retrieved from Korea IT Times: <http://www.koreaitimes.com/news/articleView.html?idxno=52068>

33 Song, J. (October 1, 2018). *South Korea’s Political Winds Blow Ill for Nuclear Energy Industry*. Retrieved from Financial Times: <https://www.ft.com/content/6dee6f5c-bb00-11e8-94b2-17176fbf93f5>

34 Kim, M. S. (April 22, 2019). *How Greed and Corruption Blew Up South Korea’s Nuclear Industry*. Retrieved from MIT Technology Review: <https://www.technologyreview.com/s/613325/how-greed-and-corruption-blew-up-south-koreas-nuclear-industry/>

Kori 1, Shin Kori 2, Shinwolsung 1 and Shinwolsung 2 may have also been used in Shin Kori 3 and Shin Kori 4, speculations that they may have been used in the Barakah NPPs arose, causing an uproar by the UAE authorities. Korea Hydro & Nuclear Power (KHNP) then conducted thorough tests on Shin Kori 1 and Shin Kori 2, and replaced the entirety of control cables with new cables of about 674 km in total length imported from RSCC of the US over the span of three months in 2014.³⁵ These incidents also led to the delay in training programs for the 1,800 Emiratis that were scheduled at the Shin Kori 3 and 4 sites. Following this incident, the Nuclear Safety and Security Commission (NSSC) – which has been under the South Korean Prime Minister’s Office (not the Presidency)³⁶ since March 2013 – began to operate a nuclear energy ombudsman system from June 2013, whereby it would conduct investigations on corruption, bribery, unlawful practices and quality control related cases in the South Korean nuclear industry.^{37, 38}

The series of incidents that have occurred from 2013 onwards regarding quality control and potential impact on the Barakah NPP project have caused a rift in bilateral relations and revealed trust issues at a deeper level, and as a consequence has created a negative image of South Korea’s NPP export projects.³⁹

Impacts of Delays

The delays in the start-up of Barakah’s first unit – and consequently, the remaining units – have caused various economic effects. Because nuclear energy projects are capital-intensive, “the economics of nuclear energy may be compromised severely by schedule delays”.⁴⁰ Past literature suggests that “accumulated experience

with nuclear reactor technology does not necessarily translate into a learning curve”, implying that “accumulated experience is likely to result in a capital cost escalation”.⁴¹ Long lead-times, which represent the time needed for licensing procedures and financial planning, can also significantly increase the costs of nuclear power projects.⁴² Additionally, innovation and the “increasing complexity and uncertainty of nuclear projects”, especially considering the newer generation reactors, are other drivers of increased construction costs and lengthy lead times.^{43,44,45} As such, one of the delays’ impacts can be the significant increase in the project’s overall cost. Equally, the resulting lack of revenue generation has a corresponding negative economic impact including indirectly through the extended interest payments, given that the project is financed by various national and international financial institutions. Given that the UAE’s pursuit of nuclear energy was motivated by the economic advantages of nuclear energy over other energy forms⁴⁶, the construction cost overruns could result in “the possible loss of economic justification for the project”.⁴⁷

35 ‘신고리원전 3호기 케이블 교체 완료,’ *Power Generation Industry News*, November 5, 2014. <http://www.pgnkorea.com/news/articleView.html?idxno=3181>

36 This means that the presidential power over nuclear matters has decreased. Such a distinction has to do with the separation of powers – the South Korean presidency is the executive branch, and the prime minister is the legislative branch.

37 ‘원자력안전위원회 ‘원자력안전 읊부즈만’ 운영,’ *JoongAng Ilbo*, June 4, 2013. <https://news.joins.com/article/11708427>

38 Nuclear Safety Ombudsman System, Nuclear Safety and Security Commission. http://www.nssc.go.kr/nssc/participation/sinmungo_main.jsp

39 Authors interviews with the energy industry personnel in the Middle East.

40 World Nuclear Association. (April, 2018). *Lesson-Learning in Nuclear Construction Projects*. Retrieved from World Nuclear Association: <http://www.world-nuclear.org/getattachment/e9c28f2a-a335-48a8-aa4f-525471a6795a/REPORT-Lesson-learning-in-Nuclear-Construction.pdf.aspx>

41 Pereira, J. P., Ferreira, P., Cunha, J., Szklo, A., Schaeffer, R., & Araujo, M. (September 2018). *Better late than never, but never late is better: Risk assessment of nuclear power construction projects*. *Energy Policy*, 120, 158-166. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0301421518303446>

42 Barkatullah, N., & Ahmad, A. (2017). *Current status and emerging trends in financing nuclear power projects*. *Energy Strategy Reviews*. Retrieved from https://www.aub.edu.lb/ifi/Documents/programs/energy_policy_and_security/articles/20171003_current_status_financing_nuclear_power_ali_ahmad.pdf

43 Grubel, A. (September 2010). *The costs of the French nuclear scale-up: A case of negative learning by doing*. *Energy Policy*, 38(9), 5174-5188. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0301421510003526>

44 Berthélemy, M., & Escobar Rangel, L. (July 2015). *Nuclear reactors’ construction costs: The role of lead-time, standardization and technological progress*. *Energy Policy*, 82, 118-130. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0301421515001214>

45 Pereira, J. P., Ferreira, P., Cunha, J., Szklo, A., Schaeffer, R., & Araujo, M. (September 2018). *Better late than never, but never late is better: Risk assessment of nuclear power construction projects*. *Energy Policy*, 120, 158-166. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0301421518303446>

46 United Arab Emirates. (2008). *Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy*. Retrieved from Embassy of the United Arab Emirates – Washington, D.C.: https://www.uae-embassy.org/sites/default/files/UAE_Policy_Peaceful_Nuclear_Energy_English.pdf

47 Pereira, J. P., Ferreira, P., Cunha, J., Szklo, A., Schaeffer, R., & Araujo, M. (September 2018). *Better late than never, but never late is better: Risk assessment of nuclear power construction projects*. *Energy Policy*, 120, 158-166. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0301421518303446>

From the South Korean perspective, the developer, KEPCO, is also affected economically because the delays can – in some capacity – reflect poorly on the South Korean nuclear industry. Scholars note that, “the overseas capacity of Korea’s nuclear industry will undoubtedly be judged based on its performance in the UAE”, especially since the Barakah project the South Korean’s “first project outside of South Korea”.⁴⁸ A hurdle like the above mentioned delays can be one among several other factors standing in the way of the South Koreans in securing future nuclear energy projects abroad and profiting off of them financially. In addition, assuming that the delays were mainly caused by the Koreans, the UAE could demand additional fees as a form of compensation.⁴⁹

On the reputational side, the delays could indicate both the Emiratis’ and the South Koreans’ diligence in ensuring that the operators are sufficiently trained and that the plants meet the highest international safety standards. This shows both countries’ commitment in going through the appropriate means and channels and their unwillingness to expedite the project by cutting corners or compromising the overall safety and quality of the Barakah plant.

On the opposite side, the delays could depict the Emiratis’ and the South Koreans’ inability to anticipate challenges and respond to them accordingly, therefore requiring additional time than what was originally planned to complete the project and begin plant operations. This could be especially harmful to South Korea’s reputation in exporting its technology. Additionally, since the Barakah plant is the UAE’s first venture into the domain of nuclear energy, the country’s nuclear industry is entirely dependent on the successful completion and operation of the Barakah plant. Given that some other UAE mega-projects like the Masdar City project have also been delayed and downscaled⁵⁰, the additional delay of the Barakah project could have an amplified negative impact on the UAE’s reputation in the successful and timely completion of mega-projects.

48 Kane, C., & Pomper, M. A. (2013). *Reactor Race: South Korea’s Nuclear Export Successes and Challenges*. Retrieved from Korea Economic Institute of America: http://www.keia.org/sites/default/files/publications/south_koreas_nuclear_export_successes_and_challenges.pdf

49 Choi, H. (October 17, 2018). *KEPCO Undergoes Repairs for Cracks in Nuclear Reactor Containment Buildings in UAE*. Retrieved from Hankyoreh: http://english.hani.co.kr/arti/english_edition/e_business/866228.html

50 *ME Construction News*. (October 11, 2010). *Masdar City Delayed and Downscaled*. Retrieved from *ME Construction News*: <http://meconstructionnews.com/272/masdar-city-delayed-and-downscaled>

From the perspective of the global nuclear industry, the occurrence of the operational delays and the way in which the Barakah project progresses do not solely impact the UAE and South Korea. Rather, they also affect the wider nuclear industry, especially given that the UAE “is the first country to start the construction of its first nuclear power plant in 27 years”.⁵¹ Nuclear power projects around the world have been plagued with increasing costs and continuous delays, with “at least 33 of the 50 units under construction” several years behind schedule.⁵² The reputation of the nuclear industry and nuclear power projects is further harmed by the delays and various challenges in the Barakah project. As such, it may become harder to justify future nuclear power projects since they are prone to cost overruns and years of delays⁵³, which renders the rationale behind nuclear projects null. The delays at Barakah also demonstrate the overall unreliable nature of nuclear power projects, especially in light of renewable energy alternatives.

THE VIEW FROM SOUTH KOREA

The Barakah NPP project has been ongoing under three South Korean presidencies of Lee Myung-bak (conservative), Park Geun-hye (conservative), and Moon Jae-in (progressive). The three presidents have demonstrated different approaches to energy issues, and partnering institutions of the Barakah NPP project have had to adjust to and reflect any changes in the policy direction.

Moon’s relatively short election campaign in early 2017 appealed to South Korean voters with a nuclear phase-out policy in a short-term period, but criticisms on a complete phase-out scenario arose in a petition by

51 Quevenco, R., Starz, A., & Dyck, E. (September 5, 2012). *UAE First “Newcomer” In 27 Years To Start Nuclear Power Plant Construction*. Retrieved from IAEA: <https://www.iaea.org/newscenter/news/uae-first-newcomer-27-years-start-nuclear-power-plant-construction>

52 Schneider, M., & Froggatt, A. (September 2018). *The World Nuclear Industry Status Report 2018*. Retrieved from *World Nuclear Industry Status Report*: <https://www.worldnuclearreport.org/IMG/pdf/20180902wnisr2018-lr.pdf>

53 *Ibid.*

the public, compelling Moon to construct a citizen jury panel, a group of 471 ordinary South Korean citizens that would be serving as jury to different interest groups and expert presentations. The key question was on building and completing NPPs, and 59 percent of the jury asked for resumption of NPP projects while around 40 percent voted for cancellation of NPP projects. At the time, the panel voiced support for reducing nuclear energy dependence, and thus, as a result of the panel, the Moon Jae-in government decided that South Korea would complete the halted NPP projects of Shin Kori 5 and Shin Kori 6 (APR-1400) by 2021 and 2022, respectively. The old NPP Kori Unit 1 would be decommissioned, and further plans for NPPs would be cancelled.⁵⁴

South Korea's Nuclear Energy Market

Nuclear power has been an essential part of South Korea's economic drive and industrialization process in the postwar decades. Despite the ongoing nuclear phase-out policy since May 2017 by the incumbent Moon Jae-in administration, nuclear power still accounts for about 18 percent of South Korea's electricity production⁵⁵, albeit a steep decline compared to previous decades when nuclear power accounted for a third of South Korea's electricity generation. Moon's nuclear phase-out policy derives from the potential dangers of a disastrous scenario akin to the Fukushima incident in 2011, and has led to the closure of aged NPPs in addition to others planned in the coming years. Over time, under Moon's presidency, the policy has come under scrutiny by the South Korean nuclear energy community and in some part by the public.⁵⁶ The complications regarding Moon's nuclear phase-out policy have been accentuated by domestic politics, where the conservative party, which produced two previous presidents, Lee Myung-bak and Park Geun-hye, are at odds with the incumbent progressive party under Moon Jae-in. In recent decades, the fallacies of South Korea's political system embodying a single five-year presidency have contributed to certain inconsistencies in energy policy agenda setting.

54 'South Korea to complete Shin-Kori 5&6,' *Nuclear Engineering International*, October 25, 2017. <https://www.neimagazine.com/news/newssouth-korea-to-complete-shin-kori-5-6-5956391>

55 *Electricity Statistics Report*, Korea Electric Power Corporation, p.14. August 2019. http://home.kepco.co.kr/kepco/KO/ntcob/list.do?boardCd=BRD_000097&menuCd=FN05030101

56 *Fitch Solutions – Utilities & Power: 'South Korea Nuclear Phase-Out Policy To Face Headwinds,'* July 30, 2019. <https://www.fitchsolutions.com/corporates/utilities-power/south-korea-nuclear-phase-out-policy-face-headwinds-30-07-2019>

Currently, South Korea operates 24 NPPs of different capacities. Proponents of nuclear energy within the country argue that a transition to a low-carbon energy structure is required for the country and are calling for retaining South Korea's technological edge and economic advantages. South Korea's Ministry of Trade, Industry, and Energy (MOTIE) looks favorably upon new additional NPP sales in different parts of the world, including Middle Eastern countries such as Saudi Arabia and Egypt, Eastern Europe (Romania, Bulgaria, the Czech Republic), and the UK.⁵⁷ At the same time, South Korea also looks to formulating plans for NPP decommissioning projects abroad, beginning with 11 South Korean NPPs that will cease to operate by 2030, creating a domestic market worth 22.5 trillion KRW (roughly \$18.9 billion USD, 2019). South Korea is joining a number of countries that were first to deploy NPPs – the US, the UK, Germany, France, and Japan – in the global NPP decommissioning market, which is expected to grow at a rapid pace from the 2020s onwards, and expand up to \$250 billion USD in the next 50 years.⁵⁸

Mismatch of Domestic and Foreign Policy on Nuclear Energy

South Korea under the Moon administration has raised eyebrows by discouraging the use of NPPs internally, but delving into and proceeding with promoting NPP sales abroad. The mismatch of domestic and foreign policy on NPPs is generating conflicting views on South Korea's intent regarding nuclear energy use. The double-sided policy is a critical factor impacting South Korea's NPP sales activities and related business activities abroad, as the nuclear phase-out agenda clearly has an impact on the future nuclear energy workforce that is reared by South Korea.

To secure higher chances of NPP sales abroad, KEPCO and KHNP submitted the application for the certification of the APR-1400 standard plant to the US Nuclear Regulatory Commission (NRC) on December 23, 2014. After years of revision processes and publication of the direct final rule in the Federal Register for public

57 *World Nuclear Power Market Insight (Biweekly)*, January 11, 2019, Korea Energy Economics Institute. <http://www.keei.re.kr/keei/download/nprd/WNPMI190111.pdf>

58 김남일, '에너지기술 수출산업화 전략연구 – 원자력산업의 중동·북아프리카 지역 선점 전략 연구,' *기본연구보고서 12-29*, 2012. Korea Energy Economics Institute. <http://www.ndsl.kr/ndsl/commons/util/ndslOriginalView.do?dbt=TRKO&cn=TRKO201400003347&rn=&url=&pageCode=PG18>

commenting⁵⁹, the APR-1400 was granted certification in June 2019.⁶⁰ The certification was the first obtained by a non-US entity, and would facilitate the export process of South Korean APR-1400s to the US accompanied by a safety test on construction sites based on its specifics. The certification is valid for 15 years and can be extended up to a maximum of 15 years. Prior to obtaining the NRC certification, KHNP also gained approval on the modification of the APR-1400 nuclear reactor design from the European Utility Requirements (EUR) for exports to Europe in November 2017.⁶¹

However, criticism remains from within on the mismatch of domestic policy on nuclear energy use (nuclear phase-out) and foreign economic policy encouraging NPP exports overseas. As of 2017, the domestic workforce on nuclear energy was estimated to be around 37,200 persons, of which 12,400 persons (33.3%) were engaged in nuclear energy-oriented electricity generation industries, 21,700 persons (58.2%) in nuclear power provision industries and 3,200 persons (8.5%) in research and development at

public institutions.⁶² In 2017, South Korea produced a total of 620 college graduates with a degree relevant to nuclear energy (nuclear energy systems, nuclear engineering, nuclear fusion engineering, mechanic engineering, etc.).⁶³ However, under Moon’s nuclear phase-out policy, complaints are on the rise on the impact of the policy on future workforce maintenance of the South Korean nuclear industry. It is reported that students that sense rocky future career paths after graduation are falling out of relevant majors and transferring to different disciplines, while graduates are facing difficulty finding jobs in the nuclear energy industry, amid the absence of institutional pressures to keep these jobs (personal interviews with college students and Korean students studying nuclear engineering abroad).⁶⁴

Recent South Korean Efforts for Strategic Planning of Nuclear Technology Exports

As the race in the bidding process for Saudi Arabian NPPs started, there was a call for a concerted effort among nuclear industries, government ministries, and South Korea’s main actors KHNP and KEPCO to come together

CATEGORY	ENTITIES
Nuclear energy or engineering public corporations and its subsidiaries	KHNP, KEPCO KEPCO KPS (Korea Plant Service & Engineering) KEPCO E&C (Engineering & Construction) KEPCO NF (Nuclear Fuel)
Private corporations	Doosan Heavy Industries, Soosan ENS, Samshin Valves, Energy Station (ES) Dasan, Hana Engineering, Unison E-Tech
Export financing corporations	Korea Trade Insurance Corporation (K-Sure), Export-Import Bank of Korea
Private corporations in nuclear exports	Korea Nuclear Association for International Cooperation (KNA), Korea Atomic Industrial Forum, Inc. (KAIF)

Table 2: ROK Consortium on Nuclear Export Strategy, launched September 19, 2019

59 Federal Register: The Daily Journal of the U.S. Government, *Advanced Power Reactor 1400 (APR-1400) Design Certification: A Proposed Rule by the Nuclear Regulatory Commission*, May 22, 2019.

60 Rulemaking Issue (Affirmation), *United States Nuclear Regulatory Commission, 'DIRECT FINAL RULE: ADVANCED POWER REACTOR 1400 DESIGN CERTIFICATION (RIN 3150-AJ67; NRC-2015-0224),'* February 19, 2019. <https://www.nrc.gov/docs/ML1830/ML18302A069.pdf>

61 'Korea Hydro & Nuclear Power gains reactor design approval in Europe,' *Pulse by Maeil Business News Korea*, October 10, 2017. <https://pulsenews.co.kr/view.php?year=2017&no=667736>

for strategy and information sharing to maximize the probabilities of being selected. On September 19, 2019, South Korea’s MOTIE organized the launch of the Consortium on Nuclear Export Strategy, comprising five organizations: public NPP corporations KHNP and KEPCO, Korea Trade Insurance Corporation (KTIC), the

62 Ministry of Science and ICT (MSIT), *Survey on the Status of Nuclear Industries in 2017*, April 2019. http://www.kaif.or.kr/upload/KAIF_EBook_2019/23th.compressed.pdf

63 MSIT, *ibid.*

64 *Personal interviews with college students and Korean students studying nuclear engineering abroad* '원자력전공 30%만 취업...유학후 귀국 포기, 석박사 전공 바뀌,' *MK News*, June 23, 2019. <https://www.mk.co.kr/news/economy/view/2019/06/447817/>

Export-Import Bank of Korea, and the Korea Nuclear Association for International Cooperation (KNA) signed an MOU on the facilitation of support for financing nuclear export industries.⁶⁵

The five organizations would be working closely with one another to share information and strategies on large-scale NPP export projects, work on policy coordination, enhance the export capabilities of South Korean small and medium-sized enterprises to enable their independent contracting abroad⁶⁶, and develop specific programs to operate working groups on NPP export financing. The complete list of 16 entities in the Consortium in four different categories are as follows:

Public Perception of Nuclear Technology Exports

While there is a significant level of rigor and interest by large and small private entities involved, there is a lack of public interest in the government's endeavors on NPP sales to the Middle East. Public concerns remain fixated on domestic nuclear facilities and the trends of energy mix and cost affordability, and such trends are exacerbated by the government's downplay of NPPs in the energy policy discourse. The public also focuses on the impact of radiation from Japan post-Fukushima, the danger of radiated food consumption from Japan⁶⁷, and radiated water releases into the ocean by Japan in the midst of typhoon Hagibis as of late.⁶⁸ In the ongoing trade spat with Japan, heavy media coverage, geographical proximity and historical animosity vis-à-vis Japan compel Japan's post-Fukushima nuclear energy issues and policy moves to gain much traction in South Korea. The issue looms large over the average South Korean's thinking on the nuclear energy policy discourse.

This leaves very little room for public policy discourse on safety issues with regard to NPP exports and operations abroad, when in fact it should have been the paramount point of discussion from the very onset

65 Press Release: '원전 전(全)주기 분야 수출활성화로 우리 원전산업 글로벌화 박차,' MOTIE, September 19, 2019. http://www.motie.go.kr/motie/ne/presse/press2/bbs/bbsView.do?bbs_seq_n=162085&bbs_cd_n=81¤tPage=171&search_key_n=title_v&cate_n=&dept_v=&search_val_v=

66 List of SMEs in the South Korean nuclear industry, ATOMXPORT 2.0. <http://www.atomxport.com/atomxport-sub0505>

67 'South Korea WTO appeal succeeds in Japanese Fukushima food dispute,' Reuters, April 12, 2019. <https://www.reuters.com/article/us-japan-southkorea-wto/south-korea-wto-appeal-succeeds-in-japanese-fukushima-food-dispute-idUSKCN1RN24X>

68 'Fukushima, Beaten Down by Nuclear Disaster, Takes Big Typhoon Hit,' The New York Times, October 15, 2019. <https://www.nytimes.com/2019/10/15/world/asia/typhoon-hagibis-fukushima-japan.html>

of NPP exports to the Middle East. Previous nuclear disasters in human history have had issues regarding post-crisis management, albeit with differences in their core causes. As seen in Fukushima, in an NPP disaster, the public would likely be kept in the dark regarding the actual facts and figures, although they impact the public's livelihood. The ramifications of an NPP disaster falls onto neighboring states, decimating diplomatic relations. Ensuring a government's ability to guarantee safety maintenance toward natural or manmade NPP disasters is very difficult, and potential risk assessment is all the more crucial, especially in the turbulent region of the Middle East.⁶⁹ Such concerns are not limited to South Korea's NPP sales activities overseas, but would apply to activities by China and Russia. The consequences of such deficiencies in policy discourse may, in turn once again, lead to the lack of transparency in decision-making processes, as there had been in the Barakah nuclear plant deal.^{70, 71, 72}

Issues Regarding Services Contracts

In 2016, KHNP and ENEC signed the Operating Support Services Agreement (OSSA) for the Barakah NPP.⁷³ Up until 2015, the negotiations for a private long-term maintenance agreement (LTMA, a mega project worth \$1.79 billion to \$2.69 billion USD) for the Barakah NPP were bilaterally convened between the ROK and the UAE, and in 2016 it was assumed by South Korean authorities that it would become the main provider of the services. However, the negotiations fell through

69 J. Portugal-Pereira, P. Ferreira, J. Cunha, A. Szklo, R. Schaeffer, and M. Araújo, 'Better late than never, but never late is better: Risk assessment of nuclear power construction projects,' *Energy Policy*, September 2018. One of the key components in the argument by the authors is calling for the development of more transparent processes to guarantee the safe and reliable operation of nuclear reactors.

70 'Nuclear expert raises concerns about Chinese role in UK's new nuclear plants,' *The Guardian*, October 17, 2013. <https://www.theguardian.com/environment/2013/oct/17/nuclear-expert-warning-chinese-role-uk-plants>

71 'China Has Big Plans for Its Nuclear Energy Industry. But Will They Pan Out,' *World Politics Review*, April 29, 2019. <https://www.worldpoliticsreview.com/insights/27799/china-has-big-plans-for-its-nuclear-energy-industry-but-will-they-pan-out>

72 'China's gambling on a nuclear future, but is it destined to lose?' *CNN Edition*, September 14, 2019. <https://edition.cnn.com/2019/09/13/business/china-nuclear-climate-intl-hnk/index.html>

73 Press Release: Emirates Nuclear Energy Corporation, 'ENEC and KHNP Sign Operating Support Services Agreement for the Barakah Nuclear Power Plant,' July 24, 2016. <https://www.enec.gov.ae/news/latest-news/enec-and-khnp-sign-operating-support-services-agreement-for-the-barakah-nuc/>

when KEPCO KPS, which would be the contractor for the LTMA, failed to accept a new condition attached by Nawah just before reaching the deal in February 2017, that a full refund of the contract amount would be guaranteed by KEPCO KPS in the case of any accidents.⁷⁴ Without KEPCO KPS accepting the full responsibility clause, senior officials in the UAE government would not sign the deal. Consequently, the UAE transitioned the process to an international bidding process, whereby Doosan Babcock Ltd. of the UK (Doosan Babcock, part of Doosan Power Systems, subsidiary of Doosan Heavy Industries & Construction) and Allied Power of the US were also included as potential service providers. The LTMA originally intended for a contract for 10-15 years would be divided into short-term contracts of 3-5 years. In June 2019, a short-term contract of 5 years of an LTMA was awarded to the consortium of KHNP and KEPCO KPS, and a management services agreement (MSA) to Doosan Heavy Industries & Construction (DHIC) as a result of the international bidding process.⁷⁵

The evaluation on the bid is that ‘Team Korea’ managed to maintain the first mover advantage as the designer of APR-1400, but it may be the case that exclusive contracts are no longer the baseline scenario for the UAE. Several factors may be taken into consideration for this move. First and foremost, the UAE has been growing very weary of being cornered in a situation where Team Korea – South Korean state-owned companies and private companies involved in the nuclear project in the UAE – would have full control of the Barakah NPP and its management by an exclusive contract.⁷⁶ Having KHNP as the signatory to the OSSA, nuclear fuel insertion done by KEPCO NF, NPP design done by KEPCO E&C, machinery of reactors and steam generators by Doosan Heavy Industries, and construction by Hyundai E&C and Samsung C&T Corporation, the NPP project in the UAE was basically dominated by South Korean state-owned companies and chaebols – large family-owned conglomerates – under exclusive contracts. The UAE appears to have sought divergence from Team Korea’s control over the project. In December 2018, the UAE

awarded Électricité de France (EDF), the state-owned electricity company of France, a small-scale consulting contract on protection and radiation safety, which is a long-term services agreement (LTSA, worth \$10 million USD over 5 years) without informing the South Korean counterparts.⁷⁷ When South Korea’s MOTIE and heads of Team Korea held a meeting with ENEC and Nawah a month afterwards, the UAE explained that the contract awarded to France was too small of a size in total amount and not directly related to the operation of the Barakah NPP, and thus it did not seek to inform Team Korea. In the South Korean media, MOTIE emphasized that such moves by the UAE were not related to the Moon administration’s nuclear phase-out policy, but it nevertheless raised eyebrows.⁷⁸

Second, the Barakah NPP Unit 1 operation timeline allows for the UAE to make a prudent decision by taking the time to do so. Management services can be divided into two kinds – check-up maintenance that are convened on a regular basis, and planned preventive maintenance, which requires the shutdown of all NPP operations for a period of time for a full-scale check-up. For the Barakah NPP Unit 1, it is estimated that fuel insertion and connection to the grid will occur in early 2020 for a year of pilot operation, then the unit would be going online for commercial purposes if there are no issues found in the first year of operation. Since a regular check-up maintenance would occur only 18 months following that schedule, and since based on the refueling cycle, a full-fledged check-up would not be required until then, the UAE is taking the time to choose its service provider very carefully for full-scale maintenance.

Third, the UAE has been dissatisfied with KHNP services thus far, and the UAE may be expressing its intent to alter the original partnership in future steps by diversifying its nuclear partners. The UAE has expressed continuously its dissatisfaction with the quality in English language proficiency by the South Korean personnel deployed on the Barakah site. On this point, the UAE has continuously requested KHNP and KEPCO KPS to dispatch staff equipped with verbal English proficiency. Miscommunication and disharmony between the ENEC and the KHNP has also been

74 ‘KEPCO, KHNP Forgo Private Maintenance Contract for UAE Power Plant for Fear of Taking Responsibility,’ *BusinessKorea*, January 14, 2019. <http://www.businesskorea.co.kr/news/articleView.html?idxno=28234>

75 Press Release: Nawah Energy Company, ‘Nawah Energy Company signs Long-term Maintenance Service Agreement with KHNP & KPS,’ June 24, 2019. <https://www.nawah.ae/media/press-news/2019/06/24/nawah-energy-company-signs-long-term-maintenance-service-agreement-with-khnp-kps>

76 ‘3조 규모 UAE 원전정비 한국 단독수주 무산위기,’ *MK News*, May 26, 2019. <https://www.mk.co.kr/news/economy/view/2019/05/351474/>

77 ‘UAE “EDF계약은 원전운영과 무관한 소규모 기술 컨설팅,’” *Energy & Environment News*, December 6, 2018. <http://www.e2news.com/news/articleView.html?idxno=205227>

78 MOTIE, *correction of media report*: ‘(해명자료) 에너지전환 이후에도 정부는 원전수출을 적극 추진중이고 일부성과도 나타나고 있으며, 영국 무어사이드 사업의 우선협상대상자 지위 소멸 등은 에너지전환 정책과는 무관함(조선일보, 5.29일자 보도에 대한 해명),’ *ROK Policy Briefing*. May 29, 2019. http://www.korea.kr/news/pressReleaseView.do?newsId=156333895&call_from=rsslk

spotted prior to the LTMA finalization in 2019.⁷⁹ Other issues regarding the lack of international experience, organizational management, and passion of the South Korean counterparts in the Barakah NPP project itself also led to some evaluations that KHNP is not very savvy or thorough in its legal matters and contracting, while they are very well-compensated by the South Korean authorities. To make matters worse, several disappointing incidents by deployed staff of KHNP that were inconsiderate of the UAE's religious customs and rules also came under scrutiny – drunk driving, carrying alcohol into the country, sexual harassment, and verbal abuse. Such staff were placed under disciplinary measures and were sent back to South Korea.⁸⁰

From the perspective of a contract awarding entity, it would be hard to rule out the possibility that the UAE's overall frustration is coming from the constant changes in the South Korean political leadership and as well as policy takes on nuclear energy, which has brought complications and uncertainties to the future of the Barakah NPP project. Nonetheless, the South Korean government rejects this claim.⁸¹ Nawah, the joint venture between ENEC and KEPCO, has noted that South Korea's nuclear phase-out policy is irrelevant to the awarding of management contracts.⁸²

Allegations of Technology Leaks and Criminal Investigations

In tandem with the media coverage on the LTMA bidding process and results for the Barakah NPP, reports emerged in June 2019 on alleged core nuclear energy tech leaks by KHNP to Nawah. It was reported by several South Korean news media outlets that a case of tech leaks at the Barakah NPP were reported to the nuclear energy ombudsman of the NSSC, whereby the NSSC has requested assistance by the National Intelligence Service (NIS) of South Korea to gather detailed information for a thorough investigation. News media outlets reported that the software Nuclear Application Programs of APR-

1400 (NAPS) was among the items leaked to Nawah.⁸³ The news gained considerable momentum in South Korean media, stirring controversies in the context of Moon's nuclear phase-out policy. KHNP denied all allegations by stating that KEPCO E&C, a subsidiary of KEPCO, transferred NAPS to Western Service Corporation (WSC), a US simulator upgrading contractor, under a full-fledged software license agreement from October 2018 to April 2020.⁸⁵ The procedure of the license agreement underwent the South Korean export control review procedures and the NAPS software program was identified as a 'non-strategic' item on June 22, 2018, and therefore was a legitimate export. KEPCO E&C further elaborated on the defense by explaining: a) that NAPS is a non-safety related software program, and is mainly designed for purposes of monitoring NPP capacities; b) that KEPCO E&C, under its contract with ENEC, provided NAPS under full authorization by the Korea Institute of Nuclear Nonproliferation and Control (KINAC); c) that Nawah, as operator of the Barakah NPP, proceeded with assigning WSC as the main services provider for the Barakah NPP upgrades involving design alterations and personnel training; and that d) therefore, KEPCO E&C provided WSC with the NAPS software and related documents in November 2018. It further elaborated on the conditions of the contract with WSC that the software under any circumstances could not be used for purposes other than upgrading the Barakah NPP simulator, and would not be altered, revised, translated, or merged with other software, nor re-contracted, rented, or transferred to other entities other than Nawah for the Barakah simulators.⁸⁶

Regarding allegations that individual A, a retiree of KHNP, handed over the APR-1400 design and related South Korean light water reactor technology to the US and the UAE, KHNP expressed its limitations in information gathering on the case, but emphasized that the former KHNP personnel moved to Nawah in 2015, which was two years prior to the Moon administration's nuclear phase-out policy. MOTIE and KHNP denied any connection of the allegation to the current direction of nuclear energy policy.⁸⁷

79 'UAE protests withdrawal of KHNP experts from Barakah plant,' *Yonhap News Agency*, April 3, 2019. <https://en.yna.co.kr/view/AEN20190403001000320>

80 *Exclusive Report*: '한수원 영어 부족·일탈 물의...수십조 계약 탈락설 무성,' *ShinDonga Exclusive*, December 18, 2018. <http://www.donga.com/news/article/all/20181218/93349677/1>

81 *MOTIE, correction of media report*: 'UAE 원전 정비계약 협상중...에너지전환 정책 무관,' *ROK Policy Briefing*, May 27, 2019. http://www.korea.kr/news/actuallyView.do?newsId=148861146&call_from=naver_news

82 'Korean consortium wins UAE nuclear reactor maintenance bid,' *The Korea Herald – The Investor*, June 24, 2019. <http://www.theinvestor.co.kr/view.php?ud=20190624000652>

83 'Korea's nuclear reactor technologies allegedly leaked to UAE, US,' *The Korea Herald*, June 18, 2019. <http://www.koreaherald.com/view.php?ud=20190618000628>

84 '한수원 "원전 핵심기술 유출 아니다...정상절차 따라 제공",' *Yonhap News Agency*, June 18, 2019. <https://www.yna.co.kr/view/AKR20190618075300003>

85 *KEPCO E&C: List of Overseas Projects - Major Projects(Nuclear)*. <https://www.kepco-enc.com/eng/contents.do?key=1567>

86 <https://www.kepco-enc.com/portal/selectBbsNttView.do?bbsNo=251&key=1457&nttNo=32511>

87 *MOTIE: Correction of media report*: '(해명자료)최근 원전인력들의 퇴직, 이직, 채용 등 변화가 에너지전환정책 때문이라고 단정하는 것은 적절치 않습니다.' *ROK Policy Briefing*, May 29, 2019. http://www.korea.kr/news/pressReleaseView.do?newsId=156333904&call_from=rsslink

Regarding allegations of the illegitimate transfer of confidential KHNP documents by company D to US company W (presumably Westinghouse), via individual B, a retiree of KHNP who moved to company D after working on the Shin Kori 5 and Shin Kori 6 simulator designs while at KHNP, KHNP rebutted that it maintains an institutional system whereby transfer contracts embody prohibition of third-party access to KHNP's design-related documents, and that it would cooperate with the NIS investigation procedures if required. The NIS launched investigations on June 19, 2019, but because the NIS lacks the legal authority to issue a search warrant, it stated it would work with the Supreme Prosecutors' Office of the Republic of Korea (equivalent to the Federal Bureau of Investigation of the United States), via the NSCC's charges pressed on individual A and company D, under the South Korean law on prevention and protection of industrial technology. Two initial rounds of investigations were conducted by the Prosecutors' Office in June and July 2019.⁸⁸ In August 2019, MOTIE requested an investigation by the Prosecutors' Office on the five individuals who are KHNP retirees, including individual B. Individual A, currently in the UAE, has yet to be subpoenaed by the Prosecutors' Office, even during a visit to South Korea in recent months due to the current political climate in South Korea discussed on page 11. As of December 2019, further information on the ongoing investigation have yet to be released. Meanwhile, regardless of the series of incidents involving the Barakah NPP project, KEPCO and Barakah One Company (BOC)⁸⁹ – a subsidiary of ENEC and KEPCO established in 2016 – signed an MOU at the 24th World Energy Congress (WEC) in Abu Dhabi in September 2019 for joint nuclear exports abroad by South Korea and the UAE.^{90, 91}

88 [단독] '한국형 경수로' 기술 유출 의혹에도... 해당업체 최근까지 입찰; *Segye Ilbo*, September 29, 2019. <http://www.segye.com/newsView/20190929508049>

89 'Enec and Kepco create commercial subsidiary Barakah One,' *World Nuclear News*, October 20, 2016. <http://www.world-nuclear-news.org/Articles/Enec-and-Kepco-create-commercial-subsiary-Baraka>

90 Press Release: Emirates Nuclear Energy Corporation, 'Barakah One Company and Korea Electric Power Corporation sign MoU,' September 10, 2019. <https://www.enec.gov.ae/news/latest-news/barakah-one-company-and-korea-electric-power-corporation-sign-mou/>

91 'Korea and UAE sign nuclear know-how export deal,' *Global Construction Review*, September 12, 2019. <http://www.globalconstructionreview.com/news/korea-and-uae-sign-nuclear-know-how-export-deal/>

SOUTH KOREA AS A NUCLEAR TECHNOLOGY SUPPLIER IN THE MIDDLE EAST

The nuclear deal between the UAE and South Korea was done during the term of President Lee Myung-bak, who had held former engagements in the Middle East while working in South Korea's private sector as CEO of Hyundai Engineering and Construction, and had targeted energy sales to the region to fortify his political agenda of expanding markets abroad under the slogan, 'resources diplomacy'. Lee's sealing of the Barakah NPP deal seemed to involve a secret military pact between the UAE and South Korea, as well as a significant price markdown by South Korea.⁹²

In 2015, ENEC had reached an agreement with Russia's Tenex of Rosatom for the delivery of half of the UAE's required uranium from 2020 to 2035,⁹³ among other leading international nuclear fuel suppliers such as the US, Canada, France and the UK that were awarded nuclear fuel supply contracts in 2012.⁹⁴

For the maintenance of the Barakah NPP, it was originally expected that South Korean operators from KHNP would service the Barakah NPP by 2030 with a long-term maintenance agreement (LTMA) for 10-15 years. These expectations were withdrawn when in June 2019, Nawah Energy Company proceeded with dividing the long-term contract into 3-5 year short-term contracts, each with a mix of different maintenance service providers including KHNP, instead of having KHNP as the exclusive maintenance service provider.⁹⁵ South Korea's MOTIE had originally anticipated a long-term contract totaling 3 trillion KRW (roughly \$253 million USD).

92 June Park and Ali Ahmad, 'Risky Business: South Korea's Secret Military Deal With UAE,' *The Diplomat*, March 1, 2018. <https://thediplomat.com/2018/03/risky-business-south-koreas-secret-military-deal-with-uae/>

93 'Russia to supply half of UAE's required enriched uranium,' *The National*, October 14, 2015. <https://www.thenational.ae/uae/government/russia-to-supply-half-of-uae-s-required-enriched-uranium-1.71912>

94 Press Release: Emirates Nuclear Energy Corporation, 'Emirates Nuclear Energy Corporation Awards Nuclear Fuel Supply Contracts,' August 12, 2015. <https://www.enec.gov.ae/news/latest-news/emirates-nuclear-energy-corporation-awards-nuclear-fuel-supply-contracts/>

95 *World Nuclear Power Market Insight (Biweekly)*, May 31, 2019, Korea Energy Economics Institute. [http://www.keei.re.kr/web_keei/d_results.nsf/0/A0372EA9F3F5202C4925840B002F431C/\\$file/WNPMI190531.PDF](http://www.keei.re.kr/web_keei/d_results.nsf/0/A0372EA9F3F5202C4925840B002F431C/$file/WNPMI190531.PDF)

Following its NPP sale to the UAE, South Korea became involved in the Saudi Arabian NPP bidding process. Saudi Arabia is seeking to transform its preexisting oil-oriented energy mix by including nuclear energy and renewables to deliver on its projected increase in electricity demand up to 640 TWh by the year 2030.⁹⁶ In 2018, KEPCO was shortlisted among other international nuclear energy providers – the US, Russia, China and France – to compete in the bidding process for two large-scale NPPs. On small-scale NPPs, South Korea's System-Integrated Modular Advanced Reactor (SMART) and China's High Temperature Gas-cooled Reactor (HTGR) are under consideration by Saudi Arabia.

Contrary to the petrodollar era, in the current shifting global energy order, Asian economies such as China, India, South Korea and Japan are the primary consumers of Middle Eastern energy, and they have the highest demands for oil and natural gas from the region. Such demands are matched with the region's request for nuclear and renewable energy technologies from Asia, thereby creating a nexus of trans-regional energy transactions.

South Korea's Challenges in the Middle East Nuclear Energy Market

In the Middle East, in addition to the fierce competition South Korea faces with the US, Russia, China and France in the NPP market, there are other challenges that the country faces. The most critical challenge would be addressing potential political risks in the region due to geopolitical tensions, in particular owing to US and Russian geopolitical tactics and military strategies that in turn shape Middle Eastern politics. In the wake of the attacks on the Abqaiq and Khurais oil fields in eastern Saudi Arabia in September 2019, the pressures on South Korea to dispatch naval troops to the Strait of Hormuz at the request of the US are mounting. Meanwhile, Japan, also a US ally, has decided to dispatch its own Self-Defense Force (SDF) on voluntary terms, but not in the context of answering to the US request. As the US requests its allies to play a stronger role in defending their energy shipping lanes, South Korea and Japan appear to be walking on thin ice in the geopolitics of the Middle East.⁹⁷ Added to the potential ripple effect from the Saudi Arabia-Iran rivalry – with the US and Russia backing each side in the ongoing

war in Yemen – would be the nexus of North Korea and China's interests that are enmeshed within the region, especially at a time when China is penetrating deeply into the Middle East via the Belt and Road Initiative, and as North Korea fortifies its relationships with Syria and Iran. The Moon administration's adamant focus on the inter-Korean dialogue through engagements with North Korea and the shaky US-ROK alliance make South Korea's positioning in the region all the more complex.⁹⁸

The announced economic reforms in the Gulf toward energy diversification, such as UAE 2025 and Saudi Vision 2030, are taking place at a slow pace and the opaqueness of their political systems also adds to potential risks of South Korea's engagements in the region, and possibly subtle issues that may arise in business negotiations. South Korea's depth of regional understanding and the resource capacity on energy intelligence of the region also pale in comparison to the other competing states which have held extensive interactions with the Gulf economies in the past half century. South Korea would benefit from combining its geopolitical and geoeconomic analyses to establish a clear strategy vis-à-vis the Gulf, not simply in terms of exports but also in terms of weighing the pros and cons of political engagements.

There are also technical and business model-related challenges toward competition in the Middle East NPP market for South Korea. The first is that replicating the same competitive edge of the Barakah deal, which was offered to the UAE at a discount (plus a secret military pact), may not be as successful for new projects in the Middle East. Complications may arise with a potential collaborative or competitive framework with the US and with the arrangement on the 'Gold Standard' requirement for Saudi Arabia.^{99, 100} Saudi Arabia has underlined that it would not sign any deals with the US that deprives her of the possibility of enriching uranium

96 Korea Atomic Energy Research Institute, '사우디 원자력 정책 및 국제협력 현황,' *Nuclear Policy Brief Report, Issue 6*, 2018. <https://kaeri.re.kr/eng/fileDownload?titleId=5920&fileId=1&fileDownType=C¶mMenuId=MENU00928>

97 Park, June, and Emma Ashford. "Securing Energy from the Gulf amid Geopolitical Strife: Japan, South Korea and the GCC." In *The Gulf States, Asia and the Indian Ocean: Ensuring the Security of the Sea Lanes*, edited by Niblock Tim, Ahmad Talmiz, and Sun Degang, 93-114. Berlin, Germany: Gerlach Press, 2018. <http://www.jstor.org/stable/j.ctv4ncp9p.7>.

98 'Trump's push for Seoul to pay more for U.S. troops throws alliance into question and puts Tokyo on notice,' *The Japan Times*, November 3, 2019. <https://www.japantimes.co.jp/news/2019/11/03/asia-pacific/politics-diplomacy-asia-pacific/trump-south-korea-pay-troops-alliance-japan/#.Xb-yxC2B3GI>

99 'South Korea Seeks New Deals in the Global Nuclear Reactor Market,' *Energy Central*, May 12, 2019. <https://www.energycentral.com/c/ec/south-korea-seeks-new-deals-global-reactor-market>

100 'Inside the Secret Campaign to Export U.S. Nuclear Tech to Saudi Arabia,' *The Daily Beast*, July 29, 2019. <https://www.thedailybeast.com/inside-the-secret-campaign-to-export-us-nuclear-tech-to-saudi-arabia>

or reprocessing spent fuel in the future, both of which have potential implications for bomb-making efforts by Saudi Arabia to stand against Iran.¹⁰¹ Second, South Korea would also be competing with rivals with different business models. Russia can offer fully inclusive fuel cycle activities including fuel supply and spent fuel takeback, and China can offer lower construction prices.¹⁰² Third, having experienced public dissent on financing issues regarding the Barakah NPP, specifically pertaining to controversy on loan figures and possible compensation requests by the UAE on deferment of the finalization of the plant, the financing mechanisms would be crucial for South Korea.¹⁰³ Should South Korea limit itself to Middle Eastern countries that can self-finance the NPP projects, the potential is narrowed down to Saudi Arabia only.

Considering the disruptions in the geopolitical landscape in the Middle East – ranging from the massive protests over economic downturns in Iraq, the reemergence of ISIS, US troop withdrawal from northern Syria and Russian military moves to fill the void, Turkish clampdown on Kurds, to the escalation of conflict between Saudi Arabia and Iran – the volatilities in the region present great geopolitical risks. Previous alleged attempts by Houthi rebels in Yemen to target the unfinished Barakah NPP site in 2017 is a classic example of how South Korean engagements in Middle East NPP projects could backfire, as South Korea has indeed been supporting and training UAE special forces to fight in the war in Yemen.¹⁰⁴ There is an absence of shrewd strategic policy thinking by South Korea in finding the right positioning in the Middle East. As China aligns itself militarily with Russia and Iran by announcing planned naval drills in the Gulf of Oman and the Indian Ocean against US allegations that Iran was behind the drone attack on Saudi Arabian oil facilities¹⁰⁵, tensions are mounting, although China is keeping a low profile by limiting the proposed drills to anti-piracy forces so as not to be involved in the conflict

101 'Saudi plans to invite bids for nuclear power project in 2020: sources,' Reuters, April 4, 2019.

102 'Why proposals to sell nuclear reactors to Saudi Arabia raise red flags,' The Conversation, February 22, 2019. <https://theconversation.com/why-proposals-to-sell-nuclear-reactors-to-saudi-arabia-raise-red-flags-112276>

103 MOTIE: '한전 UAE 원전사업 관련 현재 지체상금 문제 없어,' ROK Policy Briefing, December 27, 2018. http://www.korea.kr/news/policyNewsView.do?newsId=148856818&call_from=rsslink

104 'Yemen's Houthi group says fires missile toward Abu Dhabi nuclear reactor,' Reuters, December 3, 2017. <https://www.reuters.com/article/us-yemen-security-emirates/yemens-houthi-group-says-fires-missile-toward-abu-dhabi-nuclear-reactor-idUSKBN1DX09E>

105 'China, Russia, Iran 'plan joint naval drill in international waters,' South China Morning Post, September 21, 2019. <https://www.scmp.com/news/china/diplomacy/article/3029819/china-russia-iran-plan-joint-naval-drill-international-waters>

between the US and Iran.¹⁰⁶ Heavily engaged in trade with China while still in a military alliance with the US, South Korea finds itself in an awkward position where it not only must secure its energy shipping lanes on its own but also must defend its economic prerogatives in the Gulf region.

South Korea's Emerging Role in Saudi Arabia's Nuclear Power Bid

In 2017, Saudi Arabia sent out a request for information (RFI) to potential nuclear vendors, and invited interested parties to Riyadh for workshops convened to explain the Saudi Atomic Energy Project for building two 1.4 GW NPPs and small reactors, and to clarify the sections in the RFI.¹⁰⁷ As Saudi Arabia proclaimed its intent to diversify its energy mix to include nuclear and renewables, it announced in April 2019 the intent for a multibillion NPP tender in 2020. In July 2019, K.A.CARE shortlisted KEPCO of South Korea, ROSATOM of Russia, EDF of France, CNNC of China, and Westinghouse of the US for the NPP projects.¹⁰⁸ KEPCO held additional meetings with K.A.CARE in January 2019, and expects Saudi Arabia to select the bidder by December 2019.

But chances of South Korea's bid only came into the limelight as the Trump administration's active engagement in a civilian nuclear cooperation with Saudi Arabia backfired. Earlier in 2018, Saudi Arabia had expressed its interest to the Trump Administration to have the US as the main partner for its nuclear energy developments.¹⁰⁹ But in light of the allegations of the Saudi involvement in the death of Jamal Khashoggi and concerns over potential enrichment of uranium by the Saudis to arm itself against Iran in addition to Saudi Arabia's human rights issues, the US Senate and the House of Representatives introduced bills (S.3785

106 'China's role in joint drill with Iran and Russia limited to anti-piracy forces, analysts say,' South China Morning Post, September 23, 2019. <https://www.scmp.com/news/china/diplomacy/article/3030032/china-expected-send-anti-piracy-fleet-not-navy-joint-drill>

107 'RFI Discussion Meetings with Technology Vendors K.A.CARE & KEPCO,' K.A.Care, November 15, 2017. <https://www.kacare.gov.sa/en/mediacenter/news/Pages/مدينة-الملك-عبدالله-للطاقه-الذرية-والمتمجددة-تقيم-ورشه-عمل-مع-شركة-كبيكو-الكرية-xpsa>

108 'South Korea's KEPCO shortlisted to bid for Saudi nuclear project,' Reuters, July 1, 2018. <https://www.reuters.com/article/us-southkorea-nuclear-saudi/south-koreas-kepcO-shortlisted-to-bid-for-saudi-nuclear-project-idUSKBN1JR1GA>

109 'Saudis Want a U.S. Nuclear Deal. Can They Be Trusted Not to Build a Bomb?' The New York Times, November 22, 2018. <https://www.nytimes.com/2018/11/22/world/middleeast/saudi-arabia-nuclear.html>

and H.R.7350) in the 115th US Congress entitled, 'No Nuclear Weapons for Saudi Arabia Act of 2018' on December 19, 2018.¹¹⁰ The bill by the House of Representatives (H.R.7350) died in congress and was not enacted¹¹¹, but the issues raised in the US Congress signaled a political climate in the US that would not be favorable to a US-Saudi Arabia nuclear pact intended by the Trump administration without a 'Gold Standard' agreement. In the same line of legislation, another bill (S.612), 'Saudi Nuclear Nonproliferation Act of 2019' was introduced to the 116th Congress.¹¹² Amid mounting tensions in US domestic politics toward the 2020 re-election, US Secretary of Energy Rick Perry, who signed secret authorizations to six American companies to provide nuclear technology and technical support to Saudi Arabia, resigned due to involvement in the impeachment charges.¹¹³ While Perry would be succeeded by Deputy Secretary of Energy Dan Brouillette, who would likely carry on with the US position, US domestic political concerns present difficulties in the talks.¹¹⁴

Responding to the emerging dynamics after the US withdrew from the JCPOA, K.A.CARE expressed Saudi intent to extract uranium for a self-sufficient nuclear program (while refraining to specify whether it seeks enrichment and reprocessing uranium) in October 2017.¹¹⁵ The US Congress and Israel argue for the 'Gold Standard' by requiring a Saudi signature of the 123 agreement, but in March 2018, the Trump Administration offered that it would allow enrichment of uranium in Saudi Arabia. Such political uncertainties on the US side compel Saudi Arabia's deepening

relationships with other potential partners to explore different scenarios, as is demonstrated in Saudi Arabia's outreach to South Korea, to which KEPCO and other South Korean nuclear industries look favorably upon.

Recent Interactions Between South Korea, the US and Saudi Arabia

In June 2019, Saudi Arabian Crown Prince Mohammad Bin Salman (MBS) visited Seoul in response to President Moon Jae-in's invitation in June 2019, prior to the G20 Summit in Osaka, Japan. During his short trip, MBS welcomed South Korea's participation in the NPP bidding process and signed several MOUs pertaining to bilateral cooperation in non-nuclear energy-oriented sectors, notably on renewables, electric cars, and hydrogen energy.^{116, 117} In September 2019, an MOU was signed by the South Korean Ministry of Science, Industry and Technology (MSIT) and K.A.CARE on SMART deployment at the IAEA General Conference in Vienna, aiming to establish a joint nuclear energy research center in Saudi Arabia by end of 2019.¹¹⁸ Also in September 2019, a US delegation led by Robert McFarlane of the Washington Institute for Near East Policy (WINEP), also a former US National Security Advisor under the Reagan administration, visited Seoul, suggesting a collaboration on large-scale NPP exports to the Middle East under "The Middle East Marshall Plan".¹¹⁹ Nonetheless, South Korean media reports asserting that the US is seeking to partner with South Korea to build 40 NPPs in the Middle East¹²⁰ was immediately denied by the MOTIE, citing the maximum number of current NPP construction plans in the Middle East, which is only 25. MOTIE also underlined that there was no consortium of any sort with the US, but stated that it would be open to collaboration with the US on Middle East NPP deals, should there be mutual interests that are met.¹²¹

110 S.3785 - No Nuclear Weapons for Saudi Arabia Act of 2018, 115th Congress (2017-2018). <https://www.congress.gov/bill/115th-congress/senate-bill/3785>

111 H.R.7350 - No Nuclear Weapons for Saudi Arabia Act of 2018, 115th Congress (2017-2018). <https://www.congress.gov/bill/115th-congress/house-bill/7350/>

112 S.612 - Saudi Nuclear Nonproliferation Act of 2019, 116th Congress (2019-2020). <https://www.congress.gov/bill/116th-congress/senate-bill/612/>

113 'Decoding the US "secret authorizations" to sell nuclear technology to Saudi Arabia,' *Bulletin of the Atomic Scientists*, September 10, 2019. <https://thebulletin.org/2019/09/decoding-the-us-secret-authorizations-to-sell-nuclear-technology-to-saudi-arabia/>

114 'Trump to nominate Energy Dept. deputy Dan Brouillette to succeed Rick Perry as secretary,' *The Washington Post*, October 19, 2019. https://www.washingtonpost.com/politics/trump-to-nominate-energy-dept-deputy-dan-brouillette-to-succeed-rick-perry-as-secretary/2019/10/18/f73b7e18-f1e0-11e9-8693-f487e46784aa_story.html

115 'Saudi Arabia to extract uranium for 'self-sufficient' nuclear program,' *Reuters*, October 30, 2017. <https://www.reuters.com/article/us-saudi-nuclear/saudi-arabia-to-extract-uranium-for-self-sufficient-nuclear-program-idUSKBN1CZ10N>

116 *Press Release: The Blue House*, '사우디아라비아 왕세자 겸 부총리 등 방한 - 공식환영식,' June 26, 2019. <https://www1.president.go.kr/articles/6647>

117 '사우디 왕세자, 10조원 보따리 풀었다,' *MK News*, June 26, 2019. <https://www.mk.co.kr/news/politics/view/2019/06/459786/>

118 'Korea, Saudi Arabia to cooperate on SMART deployment,' *World Nuclear News*, September 20, 2019. <http://world-nuclear-news.org/Articles/Korea,-Saudi-Arabia-to-cooperate-on-SMART-deployme>

119 Robert McFarlane, 'The New Imperialism,' *The Washington Times*, May 23, 2019. <https://www.washingtontimes.com/news/2019/may/23/with-focus-and-good-will-the-obstacles-to-nuclear-/>

120 '[단독] 미국 "한국, 중동에 원전 40기 같이 짓자" 과격 제안,' *JoongAng Ilbo*, September 17, 2019. <https://news.joins.com/article/23578729>

121 '산업부 "美 '중동 원전 진출' 제안 없었다...권소 구성도 사실무근",' *Newsis*, September 17, 2019. http://www.newsis.com/view/?id=NISX20190917_0000771833

While specific details toward the NPP bidding process have yet to be released, there are concerns on geopolitical ramifications as a result of a potential South Korean NPP provision to Saudi Arabia, as witnessed in the UAE case. As South Korea ponders upon the US request to dispatch troops to the Strait of Hormuz to secure its own energy shipping lanes, and as South Korea continues to rely on Saudi Arabian oil (which was manifested in Moon Jae-in's phone call to console MBS and to fortify bilateral cooperation following the drone attacks on Saudi oil fields in Abqaiq and Khurais), it is likely that South Korea would be working toward winning the deal even at the cost of certain geopolitical risks, as it has done in the Barakah NPP deal with the UAE.

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The Energy Policy and Security Program is an interdisciplinary platform that seeks to examine, inform, and impact regional and global energy sectors as well as security policies within the Middle East. Moreover, it closely monitors the challenges and opportunities of the shift towards alternative energy sources. With a seed grant support from the John D. and Catherine T. MacArthur Foundation, the program investigates the prospects of nuclear power in the Middle East and its potential to promote regional cooperation to address security concerns associated with the spread of nuclear power.

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