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Cooperating on Nuclear Power

Regional Management of Energy Initiatives

FEBRUARY 28, 2018 — SELIM CAN SAZAK

As the world grows thirstier for energy by the day, and climate change adds urgency to the need to find new sources of kilowatts while cutting carbon emissions, many countries have stepped up their efforts to reduce their dependence on fossil fuels and diversify their energy mix. In the West, the move toward a postcarbon economy is largely associated with alternative energy sources like solar and wind.[1] Nuclear energy has fallen out of favor, synonymous with catastrophe (Chernobyl) and intractable cleanups (Fukushima).[2]

Despite all of the anxiety around nuclear power, however, many parts of the developing world, and not a small number of energy scientists, continue to look to nuclear plants as viable and powerful ways to produce zero-carbon-emission energy.[3] And perhaps nowhere has its popularity as a clean energy option endured and grown as in the Middle East.[4] Fission power uniquely responds to the region's growing and interconnected challenges surrounding water, energy, and food—challenges that climate change and rapid urbanization are compounding. For the Gulf's petro-monarchies, as well as for high-population countries like Egypt, this expanding nexus of problems is especially worrisome, since their political stability partly depends on a vast and costly system of price subsidies that is increasingly unsustainable in the face of growing demand and declining hydrocarbon revenues.[5] Energy-importing market economies like Turkey[6] and Jordan[7] are also in search of greater energy independence and new sources of economic growth. It makes for a delicate balance, with energy production at the fulcrum. Nuclear power—clean and putatively cheap in the long run—provides an alluring solution.

Yet even as the appeal of nuclear energy to the Middle East is clear, its potential spread also causes anxiety around the world and tensions between neighbors.[8] This is not to say that the rising nuclear ambitions in the Middle East are a charade for more sinister intentions. Empirical evidence does not support the argument that countries pursue civilian nuclear power to augment nuclear weapons programs, at least from the beginning.[9] Civilian nuclear power, however, inevitably contributes to a state's capacity to build nuclear weapons—its "nuclear latency."[10] The line between civilian and military nuclear programs is extraordinarily thin: It is relatively easy for a country with an advanced civil nuclear program to move from developing power stations to nuclear weapons. With some planning, discretion, and luck, a country can easily use the fuel and byproducts of light-water nuclear power reactors—enriched uranium and plutonium —to produce nuclear bombs. Indeed, since Britain developed its atomic bomb in 1952, all nuclear aspirants have hidden their military programs behind the mask of peaceful nuclear power, to one extent or another.[11] This gives rise to a potential security dilemma: a state cannot risk not reacting to the possible increase in an adversary's nuclear capabilities, but in reacting to it the state produces circumstances that lead to a nuclear race spiraling out of control.[12] Furthermore, poorly regulated technology could fall into the hands of terrorists[13] or black market traders.[14] In the region's perennially turbulent political environment, it is impossible to ponder the spread of nuclear energy and the growth of nuclear latency without also raising fears about nuclear weapon proliferation and rising insecurity.

Even aside from the security concerns, the Middle East's nuclear journey is destined to be a bumpy one. Building a nuclear power plant is neither cheap nor easy. Even in countries that have a long history of nuclear energy development and strong institutional, regulatory, managerial, and educational systems, nuclear power projects rarely go as planned. Cost overruns are common, as are delays and cancellations. Middle Eastern countries' social, economic, and political fragility makes nuclear energy progress in the region all the more doubtful. Moreover, the Middle East's race for nuclear power also serves as a theater for the geopolitical competition between China, Russia, and the United States, which will certainly complicate nuclear ambitions.[15]

One pathway may enable the Middle East to more effectively deal with these pressing challenges, allowing interested countries to enjoy the promises of nuclear energy while ensuring security and safety and avoiding political impasse. That pathway is regional cooperation. Indeed, the spread of nuclear energy in the Middle East, while fraught, would essentially be salutary for the region's economies, environment, and security—if the development of the sector is pursued in the right way, with concerted efforts toward mutual aims and collaboration.

Proposing cooperation in a region where many neighbors can barely coordinate basic diplomacy—when they are not actually sworn enemies—may seem quixotic. But in fact, because of the nature of the risks, challenges, and opportunities associated with nuclear power, cooperation in the development of the sector is uniquely possible and can even have positive repercussions in other vital sectors. This report argues that effective cooperation on nuclear energy in the Middle East will need to tackle multiple angles at once, some of them more indirect or less official. Formal agreements have a role, but piecemeal and highly targeted forms of collaboration will also be important, as will be the creation of both a culture of collective knowledge advancement and a community of regional experts without strong national or political affiliations. By integrating nuclear energy cooperation with other efforts, Middle Eastern countries can also help to solve other problems.

The report provides an overview of nuclear energy development in the Middle East, and then describes the various incentives driving nuclear ambitions in the region. It then identifies and discusses four specific opportunities for cooperation—foreign agricultural investment, educational mobility, scientific research cooperation, and multilateral resource management—and how they could be implemented. In conclusion, it summarizes these findings and their implications for regional and international security.

Order from Ashes

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Why Is the Middle East Going Nuclear?

As noted, nuclear energy remains popular in emerging economies even though it has fallen somewhat out of favor in more developed countries. As of September 2017, fifty-six reactors were under construction in fifteen countries.[16] China, the world's fourth-largest nuclear energy producer, accounts for more than one-third of this growth, with twenty reactors under construction. Other fast-growing Asian economies like India, Pakistan, South Korea, and Taiwan also have reactors under construction.

Countries of the Middle East, too, are in the race to join the nuclear club. The Middle East's nuclear aspirants can be grouped into two categories. One is the Gulf Cooperation Council (GCC) countries striving to decrease their dependence on oil and gas revenues.[17] The second group includes import-dependent countries such as Turkey[18] and Jordan[19] aspiring for energy independence. The GCC is facing the fourfold challenges of declining hydrocarbon revenues, high energy consumption per capita, chronic water scarcity, and rising demand for both water and energy.[20] With oil selling for less than fifty dollars per barrel at times during the last two years, the commodity has been trading at historic lows, sometimes barely half the price needed for these countries to break even.[21] Most GCC countries depend heavily on oil and gas revenues: in Saudi Arabia and the United Arab Emirates, for example, these revenues account for about 50 percent of gross domestic product (GDP).[22] These revenues are also crucial to the fragile political bargain these countries have with their citizens: generous subsidies, no taxation, and no representation. Saudi Arabia, where more than 80 percent of the public budget comes from oil and gas revenues, has free education and healthcare, guaranteed public employment, and no income taxes.[23] It spends around $61 billion on oil and gas subsidies, with an additional $10 billion for electricity and water.[24] If current low prices persist, however, the status quo will certainly be difficult to sustain.[25] Meanwhile, this vast and costly system of subsidies also has created unsustainably high rates of consumption: five of the GCC's six members are among the fifteen countries with the highest energy consumption per capita.[26]

The same holds true of water. The GCC countries sit in an arid region with few aquifers, no permanent rivers or lakes, and erratic rainfall. Ninety-five percent of Saudi Arabia's territory, for example, is covered by desert.[27] Yet, over the past decade, water demand in the GCC has increased by 140 percent.[28] To address this demand, GCC countries must rely on desalination for their freshwater supply.[29] Saudi Arabia and the Emirates are the world's two largest producers of desalinated water: at 1.3 and 1.12 billion cubic meters respectively, the two countries account for more than one-third of

the global outputs, and the GCC makes for about 60 percent.[30] Desalination, however, is an energy-intensive process: it uses about fifteen thousand kilowatt-hours of power for every million gallons of fresh water produced.[31] As the world's largest petroleum producers, GCC countries can currently afford the energy outlay. Saudi Arabia, for example, already burns approximately 250 million tons of crude oil equivalent every year, with a significant portion of that output powering desalination plants.[32] Yet oil extraction is in turn a water-intensive process—76 percent of the region's freshwater consumption is already attributed to oil extraction.[33] And nuclear energy requires large supplies of water to

A FIGHTER FROM A LOCAL TRIBE KEEPS WATCH FROM HIS ROOFTOP OUTPOST UNDER SKIES FILLED WITH SMOKE FROM BURNING OIL WELLS SET ON FIRE BY FLEEING ISIS MEMBERS ON NOVEMBER 10, 2016 IN AL QAYYARAH, IRAQ.

cool reactors. No matter how it happens, fresh water acquisition is an energy-intensive process in the Middle East, and energy production also requires a great deal of water. GCC countries are caught in a spiral: for water, they need energy and for energy, they need more water.[34] It is estimated that the region's total water consumption will reach thirty-four billion cubic meters by 2050: a shortage of about twenty-six billion cubic meters—or worse, depending on the adverse effects of climate change.[35]

Tied into the Middle East's water woes is the persistent and growing issue of food security.[36] Close to 60 percent of food consumed in the Gulf countries is imported from outside the region, making the Middle East not only the largest importer of food in the world but also the largest importer of cereals.[37] As Thanassis Cambanis observes, controlling the supply of food is also crucial for regime survival: "Rulers obsessed with security have created a twisted web of importers and bakeries whose aim is not to feed the population efficiently or nutritiously but simply to maintain the regime and stave off that much-feared revolution of the hungry. . . . In many Middle Eastern countries, the level of control was more basic: Without the government, citizens would starve."[38]

Indeed, food insecurity contributed to the Arab uprisings of 2011, since rising food prices were a trigger to the unrest —"not enough to trigger regime change" by themselves, but "a necessary part of this particular mix" of factors that caused upheaval.[39] Troy Sternberg proposed a direct causal link between a once-in-a-century winter drought in China and uprisings in the Arab world: "Of the world's major wheat-importing companies per capita, the top nine importers are all in the Middle East," wrote Sternberg. "Seven had political protests resulting in civilian deaths in 2011."[40] Food was an issue at the front and center of many protests. In Tunisia, protesters brandished baguettes;[41] in Egypt, a popular chant was *a'ish, hurriyya, 'adala igtima'iyya*—bread, freedom, and social justice.[42]

Here too, in the realm of food politics, nuclear energy holds promise. If droughts worsen or oil profits steeply fall, regimes may no longer be able to simply buy their way out of food deficits. Nuclear-powered desalination plants offer an enticing escape hatch: they would support agricultural production while taking some of the load off of oil and gas as the all-around work horses of economic growth and political stability.[43]

Countries in the Middle East are pursuing nuclear energy for other reasons as well. Not all face this particular mix of challenges related to food, water, and subsidies. Turkey, for example, has abundant water resources. For Jordan and Turkey, nuclear energy offers a path to energy independence and economic growth. Jordan imports more than 95 percent of its energy needs, at a cost of about one-fifth of its GDP.[44] Turkey imports 75 percent of its net energy use: in 2017, it is expected to spend close to $40 billion on energy imports.[45] Both countries are also investing heavily in renewable energies, but nuclear energy is a popular option because of its high output.

TABLE 1

Operating and Under-Construction Reactors by Country		
Country	**Reactors Operable**	**Reactors Under Construction**
Argentina	3	1
Belarus	0	2
Brazil	2	1
China	37	20
Finland	4	1
France	58	1
India	22	6
Japan	42	2
South Korea	24	3
Pakistan	5	2
Russia	35	7
Slovakia	4	2
Taiwan	6	2
United Arab Emirates	0	4
United States	99	2
Source: “World Nuclear Power Reactors and Uranium Requirements,” World Nuclear Association.		

Middle Eastern countries are pursuing nuclear energy for myriad reasons. They are all compelling reasons, with no other obvious solutions besides nuclear power. The quest for nuclear energy is destined to remain a strong one in the region for the foreseeable future.

Nuclear Power Developments in the Middle East

The Emirates almost certainly will be the Middle East's first nuclear newcomer. The first of the four 1,400-megawatt APR-1400 pressurized water reactors that South Korea's KEPCO is building at the country's Barakah site, three hundred kilometers (185 miles) west of Abu Dhabi, at a total cost of $20 billion, is almost complete.[46] When its Barakah site is fully operational, about a quarter of the Emirates' energy production will be nuclear.

Others are keen to follow suit. In the Middle East and North Africa (MENA) region, fifteen other countries are considering nuclear energy programs: Algeria, Egypt, Iran, Israel, Jordan, Kuwait, Libya, Morocco, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, and Yemen.[47] In many of these countries, such considerations have not advanced beyond policy statements and feasibility studies. Only six have material proposals or actual plans for building reactors.

TABLE 2

Planned and Proposed Reactors in the Middle East

Country	Reactors Operable	Reactors Planned	Reactors Proposed
Egypt	0	2	2
Iran	1	4	7
Israel	0	0	1
Jordan	0	2	0
Saudi Arabia	0	0	16
Turkey	0	4	8

Source: "Emerging Nuclear Energy Countries," World Nuclear Association.

Among these countries, Turkey's nuclear energy program is arguably the most advanced. Turkey's quest for peaceful nuclear power, which dates back to the 1970s,[48] bore fruit only recently. In 2010, Turkey signed a $20 billion build-own-operate contract with Atomstroyexport, the export arm of Russia's government-controlled nuclear technology entity Rosatom, for four 1,200-megawatt VVER-1200 pressurized water reactors at its Akkuyu site on the Mediterranean coast.[49] Despite various setbacks, including strained relations with Russia over the war in Syria, Turkey is expecting to break ground on the Akkuyu plant in early 2018.[50] Along with Akkuyu, Turkey plans to develop nuclear power at two other sites: Sinop on the Black Sea coast, and Igneada, on the border with Bulgaria.[51] However, both these projects are running behind schedule and even face uncertainty about their ultimate viability, not least because of Turkey's ongoing economic and political instability.

Jordan also has nuclear ambitions, and has declared its intention to get 30 percent of its electricity from nuclear sources and to become a net electricity exporter by 2030.[52] The desert nation's water needs also factor into its energy plans: the country has a "water deficit" of about six hundred million cubic meters per year and plans to offset this deficit with an ambitious desalination program.[53] Jordan's nuclear program started in 2007 with the formation of the Jordan Atomic Energy Commission (JAEC). By 2011, Jordan declared that three vendors, from Canada, France, and Russia were shortlisted for its nuclear program.[54] The country eventually inked a deal with Russia's Atomstroyexport in 2013 for two VVER-1000 reactors that will be operated in a joint venture with the JAEC.[55] The reactors are scheduled to enter service in 2025.

Although the Emirates, Jordan, and Turkey have been making slow but steady progress, they could soon be overtaken by Saudi Arabia. Riyadh aspires to enter sixteen nuclear reactors (at a cost of more than $80 billion) into service by 2040, adding seventeen gigawatts of nuclear capacity.[56] Saudi Arabia is already in talks with two Japanese-American consortiums for Generation III+ reactors.[57] France's Areva-EDF has also partnered with a Saudi company to undertake a feasibility study for its Evolutionary Power Reactor model.[58] Riyadh is also working on building smaller units: Saudi Arabia has already signed a $2 billion deal with South Korea's Korea Atomic Energy Research Institute (KAERI) for the construction of two 330-megawatt nuclear reactors and a ninety-megawatt reactor-integrated desalination plant.[59] There are also ongoing efforts with Argentina's Invap to build a small modular reactor,[60] and with China's CNEC for the construction of a reactor.[61] These projects will help build indigenous expertise and pave the way for more complex, large-scale projects.

Egypt, Iran, and Israel are also likely candidates for future nuclear development. In 2016, Egypt finally entered an agreement with Russia to construct four 1,200-megawatt reactors at the El Dabaa site, financed by a thirty-five-year, $25 billion loan.[62] The plant is expected to be fully operational by 2025. Iran's ambitions for its nuclear energy program have also found new momentum. Iran already operates a Russian-made one-thousand-megawatt reactor at Bushehr, which it

is hoping to expand.[63] Tehran also has plans for small reactor projects like the three-hundred-megawatt reactor at Darkhovin[64] and two Chinese-made one-hundred-megawatt reactors at Makran.[65] Despite the opacity surrounding Israel's nuclear programs (both civilian and military), it is also well-known that Israel is undertaking a feasibility study for a plant at its Shivta site in the Negev desert.[66]

(L TO R) SOUTH KOREAN PRESIDENT LEE MYUNG-BAK, RUSSIAN PRESIDENT DMITRY MEDVEDEV, JORDAN'S KING ABDULLAH II AND AZERBAIJANI PRESIDENT ILHAM ALIYEV ATTEND THE 2012 SEOUL NUCLEAR SECURITY SUMMIT AT COEX ON MARCH 27, 2012 IN SEOUL, SOUTH KOREA.WORLD LEADERS GATHER IN SEOUL TO DISCUSS PREVENTING POSSIBLE NUCLEAR TERRORISM AND THE RECURRENCE OF NUCLEAR POWER PLANT MELTDOWNS, AS WELL AS HOW TO MINIMIZE NUCLEAR MATERIAL ACROSS THE WORLD. SOURCE: YONHAP NEWS VIA GETTY IMAGES.

Challenges to Nuclear Energy Development

Not all of the Middle East's nuclear aspirants are likely to reach the finish line. Jessica Jewell of the Central European University suggests that only the Emirates and Saudi Arabia are moderately likely to succeed in building nuclear energy programs.[67] Turkey and Egypt, Jewell writes, face heavy challenges with regard to political instability, budget constraints, and government effectiveness, while Jordan, Bahrain, Qatar, and Yemen have insurmountable barriers to nuclear power development, such as small economies and weak governments. These problems are particularly worrisome since an unready government is liable to abandon half-completed nuclear programs, increasing the risk that fissile material may fall into the wrong hands and nuclear expertise may become available to the highest bidder.[68] Stanford University's Lauren Sukin, too, argues that "the Middle East's desire for nuclear power does not translate into speedy development . . . as it will have to overcome international opposition in addition to confounding domestic factors like low levels of expertise and unsteady government commitment, structural issues such as lack of suitable sites and the need for grid improvements, and industry-wide patterns of cost overruns, construction delays, and corruption."[69]

One major hurdle facing nuclear programs is cost. Although exact construction figures for nuclear power plants are often commercially sensitive and hard to obtain, the cost for constructing a Generation III reactor between 1,400 and 1,800 megawatts in Organisation for Economic Co-operation and Development countries is estimated to be in the region of $5–$6 billion.[70] On average, however, the ultimate cost per kilowatt-hour for nuclear power generation has consistently proven to be nearly three times greater than preconstruction estimates.[71] Even in countries with long-established nuclear energy programs, such as the United States, average construction costs for a plant are typically double the initial estimates.[72] Additionally, some Middle Eastern countries with nuclear ambitions, such as Turkey and Saudi Arabia, have opted for untested designs, which almost certainly will drive up costs and delay construction.

Building a reactor is only part of the challenge; maintaining and operating it is another. Many of the region's nuclear aspirants also lack prior nuclear energy experience, the needed system infrastructure, or sufficient human capital. In most countries, for example, electricity grids are not suited for nuclear power, meaning that they would have to be significantly revamped to improve their capacity and stability.[73] Building these capacities is also a costly endeavor. With oil prices at an all-time low, even countries that can afford to absorb these high costs, like the Emirates and Saudi Arabia, are unlikely to tolerate them.

In this regard, another particularly tough hurdle for nuclear energy aspirants is developing a capable workforce. Plant operators, regulators, and government personnel all require expertise, which in turn requires an adequate academic base and devoted funds. This is a time-consuming process: it requires ten to fifteen years for nuclear operators to function at their full capacity, and most of the region's nuclear aspirants are starting with very limited capacity.[74] Traditionally, the Middle East—particularly the Gulf—has turned to expatriates for its human capital. In Saudi Arabia, for example, one-third of the population, two-thirds of all workers, and nine-tenths of private sector employees are foreign-born.[75] Such a solution is not possible in the nuclear industry: the International Atomic Energy Agency (IAEA) states that "the responsibility for safety [of a nuclear power plant] cannot be delegated to another country or organization" and holds states primarily responsible for creating "independent regulatory regimes, policies on nuclear waste management and decommissioning, and involvement with international nonproliferation measures."[76] By and large, the region's education sector lacks the infrastructure to tackle these challenges.

Siting is another factor that complicates nuclear power projects in many countries. Turkey's Akkuyu, for example, is located near a popular resort town and has drawn intense opposition from residents worried the project could hurt local tourism.[77] Overall, the Turkish population remains strongly opposed to nuclear power development.[78] For Saudi Arabia, the issue is water scarcity. The country's Gulf coastline is seismically active and poses security risks should tensions with Iran escalate.[79] Siting the plant inland, however, requires the construction of water pipelines, another expense. Jordan,

too, faces similar difficulties. Its prospective nuclear reactor location, Qasr Amra, is a UNESCO World Heritage site and home to the powerful Beni Sakher tribe, which opposes the project.[80] On top of this, the nearest water source is seventy kilometers (forty-five miles) away.

Even if all these problems are solved, there is also the variable of international political dynamics. This factor is particularly salient for countries that have entered deals with Russia. Russia's economy is hurting from international sanctions and low oil prices. Its operators have a terrible record of corruption and malfeasance, the likes of which is estimated to have "been responsible for up to 40 percent of nuclear power plant costs" in Russian-led projects.[81] In addition, Russia's nuclear industry is overstretched. Unable to produce more than one reactor per year, the Russians have nevertheless committed to nineteen reactors in fourteen nations, meaning that some projects will inevitably be delayed or terminated.[82] Even if Moscow stays committed to its nuclear projects, those Middle Eastern countries working with it are in for a rough ride. Rosatom had originally stated that its new-generation reactors would take roughly four years to build; so far, trials alone have taken seven years and counting.[83] Delays translate to further cost overruns: although Rosatom puts the list price of its reactors at $5 billion each, ultimately they are expected to cost closer to $8 billion.[84]

Russia and China's foray into the Middle East's nuclear business is also adding to the worries about nuclear proliferation. Unlike the United States, these countries do not have a legal regime that ties civilian nuclear cooperation with a forswearing of enrichment and reprocessing activities. Under Section 123 of the U.S. Atomic Energy Act of 1954, all American nuclear cooperation with other countries requires a closely monitored peaceful nuclear cooperation agreement —commonly referred to as a "123 agreement."[85] Even then, most countries receiving higher levels of peaceful nuclear assistance are more likely to pursue and acquire the bomb, as seen in U.S. civilian nuclear assistance to Iran; Soviet aid to Libya; French, Italian, and Brazilian nuclear exports to Iraq; and U.S. nuclear cooperation with India.[86] It is also true, however, that American leadership in peaceful nuclear cooperation and its place in the broader context of the United States' nonproliferation policy has had a critical role in limiting the spread of nuclear weapons. There is empirical evidence that nations dependent on the United States for economic and military support have been significantly less likely to pursue nuclear weapons after the development of credible sanctions policies in the late 1970s (namely, the Nuclear Non-Proliferation Act of 1978).[87]

When the United States was at the helm of the spread of civilian nuclear technology, 123 agreements were the cornerstone of the global nonproliferation regime. Washington currently has such agreements in place with twenty-two individual countries—including two of the Middle East's nuclear aspirants, the Emirates and Turkey—as well as the twenty-seven members of the European Atomic Agency (Euratom).[88] Jordan and Saudi Arabia are also in negotiations for 123 agreements. And because American companies are deeply linked to supply chains, intellectual property, and partnerships with other countries' nuclear firms, such as those in Japan and South Korea, 123 agreements have a

significant impact even in countries where Americans are not leading reactor construction. In contrast, neither Russia nor China has a comparable legal regime to ensure that their civilian nuclear technology is not diverted to noncivilian uses. Those countries' nuclear developers can operate without 123 agreements in place, and it is doubtful whether the nature of a client's nuclear ambitions are of great concern to Moscow and Beijing. The upshot is that, despite the United States' development of a fairly robust nonproliferation legal framework, the international community is likely to continue to treat the acquisition of any new nuclear capabilities in the Middle East with anxiety, if not outright opposition.

Opportunities for Cooperation

In the face of such pressing challenges, it is obvious that few if any of the region's nuclear aspirants can afford to purse nuclear energy without regional and global cooperation. In this regard, some scholars have offered the European experience of confidence-building and political integration through resource cooperation as a model for regional stability in the Middle East.[89] The European template has also been a major influence behind the proposals for multilateralizing the nuclear fuel cycle in the Middle East.[90]

In 1952, the European Coal and Steel Community (ECSC) brought coal and steel, two dual-use industries essential for any conventional war effort, into a common market. Five years later, the 1957 Euratom treaty applied the same model to the nuclear industry. The treaty did not prohibit its member states from pursuing nuclear military activities, but it did bring every aspect of the nuclear field under the supervision of a supranational commission.

If the seeds sown with the ECSC and Euratom bloomed into the European Union, one might think that a similar approach could lead to similar results in the Middle East. But in many ways, the European experience was unique: from a history conspicuously free of the injuries of colonialism to robust democratic institutions to higher standards of living, postwar Europe had many attributes that the contemporary Middle East does not. The Euratom treaty persuaded Western European nations to place their nuclear development under the supranational authority of the Euratom Commission because these countries hoped to benefit from joint ventures with France and the United States, which became possible after the signing of the 1958 United States–Euratom bilateral treaty.[91] And as mentioned earlier, U.S. nonproliferation policy has tied civilian nuclear cooperation to the forswearing of enrichment and reprocessing activities. In contrast, the Middle East's nuclear aspirants have a lesser incentive for nuclear cooperation, as their principal suppliers (Russia and China) have not established a similar link between civilian nuclear assistance and nuclear nonproliferation. Moreover, the current political circumstances in the Middle East are unlike postwar Europe: wracked by war and sectarian divisions, and lacking robust democratic and economic institutions.

Nonetheless, it is possible to identify avenues for cooperation—focusing on political engagement and technical partnerships—that would help address the region's growing challenges at the water, energy, and food nexus while mitigating the risks of nuclear proliferation and insecurity. The countries of the region have at least four possible opportunities for cooperation: foreign agricultural investment, educational mobility, scientific research cooperation, and multilateral resource management schemes.

Foreign Agricultural Investment

Food security is a regional problem, but one that can offer the opportunity for regional cooperation, with indirect links to nuclear energy development. Agriculture is a primary factor driving up water demand, as well as adding to concerns about regime survival in Middle Eastern capitals. Since many countries are citing nuclear-powered desalination as a reason for seeking nuclear energy, cooperation toward food security would decrease, if not eliminate, the pressing concern from soaring water demand and weaken the argument for nuclear power development.

One possible mode of cooperation would be to establish a regional food bank: in cases of food crises, this food bank could provide emergency relief to the affected countries and stabilize food supply. Such a mechanism can be housed under the Arab League's Khartoum-based Arab Organization for Agricultural Development, or the Islamic Development Bank, which operates under the auspices of the Organization of Islamic Cooperation. Another example would be to work toward harmonizing foreign agricultural investments. In recent years, many countries in the region have embraced a strategy of buying foreign farmlands to secure food and water supplies. In Africa, for example, one-third of all large-scale land acquisitions were by Middle Eastern countries.[92] So far the Emirates, Qatar, and Saudi Arabia have been the most active investors, with varying degrees of activity from Turkey, Egypt, Jordan, Israel, and other GCC countries (Kuwait, Bahrain, and Oman). Although the scope and nature of these investments vary greatly, from rice farms in the Philippines to ranches in Argentina to wheat fields in Ukraine to shrimp producers in Mauritania, two patterns are apparent. First, investments are mostly directed to Muslim-majority countries, from Senegal and Mali in West Africa, to Sudan and Somalia in East Africa, to Malaysia and Indonesia in Southeast Asia. Second, the level of investment increases by geographical proximity: Saudi Arabia's investments, for example, are concentrated in East African countries like Sudan and Ethiopia, which lie across the Red Sea, while the Emirates has shown a preference for Pakistan, which sits on the Gulf of Oman. Since most stakeholders in Middle Eastern foreign agricultural investment are members of the Arab League and/or the Organization of Islamic Cooperation, these organizations can collaborate with international financial institutions like the IMF and the World Bank and deploy their own development programs, like the Islamic Development Bank, to incentivize cooperation in such efforts. Cooperation would take the form of measures such as investment guarantees, political risk insurance, project finance, and public-private partnerships.

Educational Mobility

Human resource development is another crucial challenge facing nuclear aspirants. Each country has different economic and political conditions, levels of educational quality, and prior experience with civil nuclear power. Those looking to develop indigenous capacity in nuclear energy have to establish and staff universities, colleges, and other training facilities at great administrative and financial expense.

Some, like the Emirates and Saudi Arabia, have the financial resources to establish a wide array of institutions and programs in a very short time, and to attract a large cadre of senior expatriate experts. Still, they lack a robust educational infrastructure. For example, only 32 percent of male Emirati public school students finish sixth grade on time. For females, graduation rates are even lower.[93] Among those who stay in school, actual academic ability often falls short of the minimum requirements necessary to succeed in technical disciplines like nuclear engineering. When one of the Emirates' leading universities raised its admissions standards on par with other international institutions, for example, the result was a sharp downturn in the number of those eligible to enroll.[94] Smaller countries like Bahrain, Kuwait, Oman, and Qatar have problems of size and scale. Jordan faces funding difficulties that affect all aspects of the civil nuclear program, including human resource development. A Jordanian nuclear professional can make up to ten times more money in the Emirates or Saudi Arabia, leaving the country facing the prospect of losing its indigenous talent to deep-pocketed neighbors.[95]

Turkey and Egypt are arguably the only countries with a somewhat developed human resource infrastructure, but they too face capacity shortages. However, even if they do not currently have nuclear power, they do have certain advantages that other countries in the region lack: existing robust legal and regulatory frameworks, legacy institutions that have been in operation for a long time, an adequate number of university graduates in the relevant fields, research reactors, substantial international cooperation, and an existing base of professional scientists.[96]

The relative strengths and weaknesses of different regional countries' human resource portfolios, and the fact that none of them are capable of creating an adequate human capital base for nuclear energy on their own, underline the value of cooperation in education. Each country can benefit from another's strength and at the same time lend its own strengths to regional partners. One model for achieving this goal would be joint training activities and regional mobility schemes for students and researchers, similar to the EU's Erasmus and Comenius programs. Currently, there is little prospect for such mechanisms materializing in the near term, and such cooperation cannot reasonably bear the entire responsibility of training a civil nuclear workforce. At the very least, however, there is merit and even urgency to further exploring the

viability of such programs. After all, the mismanagement of nuclear issues has international consequences that do not observe political borders. This type of human capital capacity-building is advantageous for all countries in the region, regardless of political rivalries.

Scientific Research Cooperation

Similar to education cooperation, the formation of regional networks of bureaucrats, scientists, and researchers would also give a disproportionate boost to research and development in the region. Although an Arab Atomic Energy Agency has existed since 1989, operating under the auspices of the League of Arab States, it has been mostly inactive. In recent years, however, regional scientific cooperation has gained momentum.

One promising example of science diplomacy is the Amman-based Synchotron-light for Experimental Science and Application in the Middle East (SESAME).[97] Modeled after Europe's Conseil Européen pour la Recherche Nucléaire (CERN), SESAME brought together an impressive array: its membership includes Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority, and Turkey. Forging such cooperation was not easy. The idea of a Middle Eastern synchotron—a particle accelerator that acts as a powerful microscope—had been in discussion for more than two decades, but the region's political sensitivities, along with the financial, operational, and technical challenges involved, had led to endless delays. Strikingly, SESAME's current membership includes countries that have no diplomatic relations with each other: Iran and Israel, and Turkey and Cyprus. This is not without its problems, but SESAME nevertheless stands as living proof that cooperation on certain matters of shared interest is possible even between bitter rivals. Iran has other problems, too: it is under financial sanctions, which has prevented Tehran from paying its contribution to SESAME on more than one occasion. But there are solutions to such issues. In 2012, after Iran, Israel, Jordan, and Turkey each agreed to contribute $5 million, provided that all the others did too, the European Union and UNESCO also agreed to provide financial support and CERN agreed to provide technical assistance, including manufacturing the high-tech magnets that guide SESAME's beams. SESAME is, at best, a modest success: there are more than sixty synchotrons around the world, and such research activity is not at the cutting edge of modern science. But SESAME is the Middle East's first, and the fact that it bore the fruit of regional cooperation is extremely valuable.

The region has had other successes in science diplomacy. The Middle East Desalination Research Center (MEDRC) in Oman, a product of the multilateral track of the Middle East peace process, offers a blueprint on how scientific cooperation can serve as a confidence-building measure in contentious issues. Other such examples include the InterAcademy Partnership, a global network of national science academies that includes Egypt, Jordan, Morocco, and

Sudan; the Eastern Mediterranean Public Health Network, which conducts trainings for public health workers in seven Arab countries; and the Israeli-Palestinian Science Organization, which fosters research and education cooperation between Israeli and Palestinian scientists.[98]

The region's political sensitivities are such that bringing one country in pushes another out. In a telling example, the GCC shunned SESAME because of Israel and Iran's participation. Had the GCC countries also participated, SESAME's financial problems would have been much less acute. Moreover, with the ongoing diplomatic crisis with Qatar, the chances for any sort of GCC-wide cooperation have dwindled. Although SESAME indeed managed to bring Iran and Israel together with each other and with other countries in the region, it is unlikely that its success can be replicated in the near future. The two countries best suited for taking the lead on scientific cooperation are Egypt and Turkey, but they too are at each other's throats because their leaders, Recep Tayyip Erdogan and Abdel Fattah el-Sisi, are personally hostile to each other.

WORKERS OF THE KOREA HYDRO AND NUCLEAR POWER CO. PARTICIPATE IN ANTI-CYBER ATTACK EXERCISE AT THE STATE-RUN WOLSONG NUCLEAR POWER PLANT ON DECEMBER 22, 2014 IN GYEONGJU, SOUTH KOREA. SOURCE: KOREA HYDRO AND NUCLEAR POWER CO. VIA GETTY IMAGES.

Currently, Jordan is singularly the leader of science diplomacy in the region. Along with SESAME, Amman spearheaded the establishment of the Middle East Scientific Institute for Security (MESIS), an institution dedicated to building regional capacity against chemical, biological, radiological, and nuclear (CBRN) risks. MESIS also serves as the Middle East Regional Secretariat of the European Union's "Centres of Excellence" initiative on CBRN issues, the first to become operational worldwide. It leads the effort for the creation of an Arab Network of Nuclear Regulators, a professional community of nuclear specialists. The Royal Scientific Society of Jordan, in collaboration with the United Nations Economic and Social Commission for Western Asia and the U.S.-based nonprofit CRDF Global, has organized a series of

high-level events on scientific cooperation, including the 2014 Regional Forum on Science & Technology Diplomacy and the 2015 Arab Leadership Dialogue on Science Advice to Governments. Jordanian royals like Prince Hassan bin Talal and Princess Basma bint Talal have emerged as vocal champions for such efforts.

Yet a crucial question remains: how much can Jordan do by itself? Scientific cooperation requires the political and material commitment of other regional countries. Even though such commitment remains unlikely in the region's current political circumstances, an incremental approach is the best bet to bridge this gap. The experience of SESAME also shows that there is room for cooperation and a role for the international community to play; international assistance, after all, was crucial to SESAME's continued operation. Such international involvement can play a similarly important role in catalyzing the formation of professional networks—also known as epistemic communities—that would not only create opportunities for policy coordination but also provide a medium for learning and acculturation among their members. There already exists a substantial literature on the role that such networks played in matters like nuclear arms control and environmental politics.[99]

The EU Non-Proliferation Consortium[100] could offer a blueprint for how such a network could be structured. Established and funded by the European Council, the consortium is a network of independent nonproliferation think tanks that encourages political and security-related dialogue and the long-term discussion of measures to combat the proliferation of weapons of mass destruction. It is managed jointly by four think tanks: Fondation pour le Recherche Strategique in Paris, the Peace Research Institute in Frankfurt, the International Institute for Strategic Studies in London, and the Stockholm International Peace Research Institute. The consortium also works in close coordination with the office of the High Representative of the European Union for Foreign Affairs and Security Policy.

In the Middle East, it will be particularly important to develop these efforts with an eye on the next generation. In 2010, the Middlebury Institute's James Martin Center for Nonproliferation Studies took a crucial first step in this direction with the establishment of the Middle East Next Generation of Arms Control Specialists Network (MENACS). Bringing together young experts from more than seven countries in the region, MENACS has emerged as an important vehicle to help develop and promote region-based approaches to arms control and nuclear proliferation through capacity-building, regional dialogue, and knowledge dissemination.

The Herbert Scoville Jr. Peace Fellowship could offer another model to advance the work of networks like MENACS. The fellowship is a highly competitive program for emerging experts in nuclear arms control, and helps to recruit and train the next generation of policy and advocacy leaders on international peace and security issues by providing recent college graduates with funding to spend six to nine months in Washington, D.C. Fellows work at a partner organization, like the Carnegie Endowment for International Peace, the Center for Strategic and International Studies, the Nuclear Threat

Initiative, or the Stimson Center. The United States could replicate this model with its allies in the Middle East to offer their emerging experts a similar opportunity. The EU Consortium, too, could set up a similar mechanism to host emerging experts at one of the seventy-two organizations in its network as a first step toward expanding its outreach to the region and catalyzing the formation of an epistemic community of nuclear arms control specialists in the Middle East.

Multilateral Resource Management Schemes

With water and energy growing ever scarcer, the development of multilateral resource management schemes is also emerging as a viable forum for cooperation. Connecting the three regional electricity grids that are already in place would allow for the development of a common energy market. Multinational cooperation on large-scale construction projects like nuclear and hydroelectric power plants would increase their chances of success by pooling the region's financial resources and technical know-how. The proliferation of desalination technologies is a particularly promising avenue for multilateral cooperation.[101] Similarly, multinational governance regimes over transboundary waters would build confidence and enable cooperation among states.[102] Such cooperative schemes would be a positive first step toward reducing the incidence of conflict by building confidence and increasing economic interdependence among their stakeholders.

In the case of energy, the economic benefits of interconnection are tested and proven. The pooling of resources optimizes the use of available resources, reduces operation costs, and increases generation capacity margins while also reducing the need for investment in peak capacity. Lower costs reduce and stabilize consumer energy prices. Improved reliability adds to the quality of service by reducing the frequency of power interruptions, which has an overall positive economic effect by minimizing productivity losses in the commercial and industrial sectors. Interconnection would also make it easier for countries to attract investments to develop their untapped energy potential as their production is now available in a larger market. Indeed, a vision discussed for Europe's energy future is the Desertec/Medgrid programs under which Europe will step up renewable energy investments in areas with optimal resources like North Africa, which will then be exported to European energy markets.[103]

North America and Europe have integrated energy grids, and others are following suit. One of the landmark projects of the Asian Development Bank (ADB), for example, is the establishment of an energy common market in the Mekong Delta. The ADB estimates that the economic and environmental benefit of such integration would amount to about 19 percent of total energy costs, or about $200 billion.[104]

Recognizing the benefits of energy interconnectivity, the Middle East has also put in place several multilateral initiatives toward this objective. These efforts, however, developed haphazardly. Currently, the Middle East has three different grid networks.[105] The Maghreb interconnection, which includes Algeria, Morocco, and Tunisia, now features multiple high-voltage transmission interconnections between the three countries and is synchronized with the pan-European high-voltage transmission network. The regional interconnection between Egypt, Iraq, Jordan, Syria, and Turkey started as part of an effort to upgrade those five countries' electricity systems to a regional standard; eventually expanded to eight countries with the inclusion of Lebanon, Libya, and the Palestinian Authority; and has been connected to the European network since Turkey joined the European grid ENTSO-E in 2015. Finally, the GCC has a regional power interconnection that allows electricity exchange among its six member states—Bahrain, the Emirates, Kuwait, Oman, Qatar, and Saudi Arabia.

In an ideal world, respective national comparative advantages could be exploited in a regional cooperation, combining Gulf capital with Turkish, Egyptian, and perhaps Israeli technical know-how. Regionwide integration would allow smaller states to tap into nuclear generation, possibly encourage certain countries to abandon their nuclear ambitions, and serve as a regional confidence-building measure. Once again, what is lacking is not the opportunity or the resources but rather the political will. Israel is entirely excluded from the Middle East's integrated grids. In the current landscape, it is not viable to connect the three grids to a regionwide network: Libya, which would serve as the gateway between the Maghreb grid and the eight-country grid, is in a civil war. With the worsening security situation in Iraq, which could have been a node to connect the eight-country grid to the GCC grid, the only remaining alternative is a connection from Saudi Arabia to Egypt through the Sinai, which is in no better shape. Moreover, even aside from the possibility of a regionwide network, the existing grids are not fully functional: the civil wars in Iraq and Syria are blocking the southern countries' access to the European markets, while the diplomatic crisis with Qatar has left the GCC facing problems bigger than its energy-grid interconnection. Indeed, a poorly planned energy integration scheme can even contribute to conflict, with countries threatening to cut supplies to their adversaries and the strong pushing the weak around. Therefore, such schemes have to be developed with an eye toward ensuring that increased interdependence does not turn into a vehicle of hegemonic power.

It also must be pointed out that even when the political conditions were more favorable, electricity trade among countries of the Maghreb and eight-country grids has remained at modest levels. Although structural barriers like limited generation reserve margins and limited power interconnection capacities have played a role in this low level of trade, the most important factor has been the absence of a harmonized regulatory framework and poor national and regional institutional capacity. Without some form of multilateral power regulatory authority, similar to Europe's Agency for the Cooperation of Energy Regulators, it would be impossible to take steps toward regional energy integration in the near term. Regional integration would, however, be a win-win for everyone—it would help to solve the GCC's energy

problems, make a windfall for Turkish and Egyptian engineers, provide increased supply for European markets, spur foreign energy investments, and build confidence by mitigating the risks of nuclear proliferation.

The business community is a critical partner in bringing about such cooperative schemes. From grid upgrades to power generation facilities to regional energy exchanges, the private sector has an important role to play and many benefits to reap. Many of the region's major construction conglomerates are owned by either the state or well-connected business interests, meaning that their advocacy for such projects would have the ear of their countries' leaders. Foreign companies already have a foothold in the region's large-scale public works projects and they, too, would make a windfall from the ramping up of such investments. Moreover, the Nuclear Non-Proliferation Act of 1978 provides that the United States will cooperate with other nations to help them meet their energy needs through nonnuclear technologies.[106] Traditionally, the academic communities working on the water-energy-food nexus and hard-security issues like nuclear arms control have been siloed into their own professional space. It is similarly rare for business and academia to come together to explore solutions and engage in coordinated action. Breaking this tradition, however, could open the door for greater and meaningful cooperation in the region.

Water is another potential avenue for cooperation—and for conflict.[107] Unlike energy, water grids are already integrated, at least in one sense of the word: many of the region's main rivers cross borders, including the Tigris, the Euphrates, the Nile, and the Jordan. And unlike energy, water flows its own course, and cannot be diverted at will—a fact that pits upstream and downstream users against one another.

Multilateral cooperation in water management has enjoyed some successes over the years. Just one example is Syria and Jordan's 1987 agreement on the utilization of the Yarmouk River, which led to the construction of the jointly financed al-Wahdah (Unity) Dam.[108] On the whole, however, water management collaboration has advanced haltingly, or even faltered. In 2008, as part of the Turkish-mediated peace talks between Syria and Israel,[109] the three countries had a series of negotiations exploring the feasibility of a shared water grid that eventually would expand to include countries like Egypt and Jordan. Today, however, not only are those talks entirely shelved, but the three countries that participated in them are no longer on speaking terms. Meanwhile, continuing unrest in Iraq and Syria and the ongoing diplomatic crisis within the GCC have all but scuttled the once-promising idea of extending a grid to bring Euphrates water to other Gulf countries.

Interestingly, cooperation on nuclear energy development might present opportunities for easing tensions over water in the region, albeit indirectly. In recent years, the IAEA has expanded its footprint into water resource management issues, since water availability is crucial for nuclear power development and some of the peaceful uses of nuclear energy include applications like insect pest control,[110] food irradiation,[111] mutation breeding of high-yield crop varieties,[112] and isotopic

marking techniques for the discovery of groundwater resources.[113] All nuclear aspirants must engage the IAEA in some fashion. The organization is granted inspection authority under the 1968 Nuclear Non-Proliferation Treaty to ensure that civilian nuclear technology is not diverted for weapons purposes, and it is also a major source of technical assistance for countries seeking to develop nuclear power for peaceful uses. None of the region's currently planned nuclear power plants would rely on transboundary waters for cooling purposes, so it would not be possible for the IAEA to tie the operation of these plants to increased multilateral engagement. The IAEA could, however, encourage nuclear aspirants to establish multilateral management schemes like the regional water cooperation authorities discussed above as part of the comprehensive watershed management and environmental protection planning that is part of any nuclear project.

Conclusion

In the face of ever-growing challenges at the energy, food, and water nexus, the Middle East's nuclear aspirants are unlikely to walk away from their ambitions unless forced to do so by circumstances. Some countries inevitably will see their plans falling by the wayside, but those with the political will and financial means can succeed in becoming nuclear energy producers. The potential spread of nuclear technology in the Middle East, however, gives rise to a well-founded fear of nuclear proliferation and a security dilemma, since distrust and suspicion are so widespread in the region.

In such an atmosphere, cooperation is at a premium. Even though the prospects seem bleak, a measured, pragmatic, and incremental approach to cooperation over nuclear energy could be tied into and even enhance expanding cooperation in areas like foreign agricultural investment, educational mobility, scientific research cooperation, and multilateral resource management. In that sense, nuclear energy development in the region holds as much potential for increased security as it does for increased risk.

An approach to cooperation that integrates nuclear energy issues with these other areas has important implications for international policy in the Middle East. First, Western powers that have strong, established regulatory frameworks for nuclear energy need to offer more types of assistance in the sector to stave off competition from Moscow and Beijing. Russia's and China's commitments to nonproliferation as a precondition of civilian nuclear assistance are much less stringent than those of the United States and its allies. And though the nuclear industry is declining in the United States and Europe—making those places somewhat unlikely sources of technical assistance—allied countries like Canada, Japan, and South Korea are still active players in the market. A comprehensive strategy that pools the West's political, economic, and technological resources would be a first step toward preventing Chinese and Russian dominance of

emerging nuclear markets in the Middle East and elsewhere. Indeed, for these very reasons, not only the West but also the entire international community have a key interest in the Middle East's nuclear sector developing according to established norms, not haphazardly and unsafely.

Second, it is crucial to build and empower epistemic communities that can help increase engagement and cooperation. Barring dramatic changes in the security environment, formal cooperation between Middle Eastern states over nuclear energy at the political level remains unlikely. Existing regional structures like the League of Arab States and the Organization of Islamic Cooperation are not exactly paragons of successful cooperation. Even organizations like the GCC, where such cooperative steps would have been considered possible in another time, are currently in crisis. In such an atmosphere, technical cooperation in areas like science and education, which can be relatively isolated from politics, could achieve material success, as was the case with SESAME. Such a course can also open the door to increased political engagement: the success of Cold War–era nonproliferation groups like the International Physicians for the Prevention of Nuclear War[114] and the Pugwash Conferences for Science and World Affairs,[115] which have won Nobel Peace Prizes for their work, laid the foundation for the nonproliferation commitments that the West enjoys today. Such collaboration is a testament to how empowered epistemic communities can positively influence policy outcomes.

Third, business must be a key partner in cooperation over nuclear energy. Increased cooperation is a boon for the private sector both inside and outside the region. Academic dialogue and Track Two diplomacy can only go so far.[116] To bring politicians around to see the wisdom of cooperation, they must understand that cooperation has material, economic incentives. The sector's readiness for growth in the region, and the numerous add-on benefits that cooperation over nuclear energy would bring to other sectors, mean that there is plenty of money to be made from cooperation. Businesses will grow, and with them the GDPs of Middle Eastern countries.

The prospect of nuclear energy in an embattled region should not simply be feared and dismissed. The technology has no inherent moral quality; managed correctly, it could do a great deal of good for the economies and societies of the Middle East. The countries of the region have the world's mistakes to learn from as they consider how to forge a nuclear future. All the same, it is impossible to deny that the stakes are especially high for proper nuclear energy management, and the consequences of mismanagement especially dire in a part of the world troubled by weak states and numerous violent nonstate actors. The world and regional leaders must confront the challenge of nuclear cooperation head on, and with an eye toward building trust. In doing so, they may find that they have unlocked keys to progress on several dogged Middle Eastern problems.

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