Iran and multinational enrichment in the Middle East

Ali Ahmad and Ryan Snyder

ABSTRACT
As implementation of the 2015 Iran nuclear deal begins, five other states in the Middle East are moving forward with civilian nuclear power programs. While most of these programs involve contracts with foreign vendors to provide reactors and the low-enriched uranium to fuel them, some states may want to follow Iran’s example and develop their own uranium enrichment programs, giving them a potential nuclear weapons capability. The authors assess the uranium enrichment capacity needed to fuel planned nuclear programs in the Middle East and support the idea of using the next decade to convert Iran’s Natanz national enrichment plant to a multinational one – in partnership with one or more of the international parties to the Iran nuclear deal and some of Iran’s neighbors. Such an arrangement could help maintain the transparency of Iran’s program after restrictions on it expire, thereby easing tensions between Iran and other regional powers. This confidence-building measure could create a political context within which other Middle Eastern states forgo acquiring their own national enrichment programs and begin a worldwide movement away from such programs in favor of more proliferation-resistant multinational arrangements.

KEYWORDS
Iran; joint comprehensive plan of action; Middle East; nuclear power; nuclear weapons; proliferation; spent fuel; uranium enrichment

The July 2015 Iran nuclear agreement established constraints on Iran’s program for at least 10 years in return for lifting international economic sanctions (Joint Comprehensive Plan of Action 2015). Meanwhile, other countries in the Middle East are advancing their own civilian nuclear power programs, which are projected to include the construction of new reactors over the next decade. While most of these programs are expected to include contracts to import reactors and reactor fuel, with the take-back of spent fuel, there is concern that some states may decide to acquire their own uranium enrichment capability. The acquisition of such technology may raise fears that these states are seeking an option of building nuclear weapons, making the region’s security concerns vastly more challenging to manage.

States in the Middle East could decide to acquire an enrichment capability for many reasons, but concerns about the long-term risks from Iran’s program a factor in such a decision. The former intelligence chief for Saudi Arabia, Prince Turki bin Faisal, recently stated, “Whatever the Iranians have, we will have, too” (Sanger 2015). What Iran has by way of enrichment capability is, however, a moving target. The Joint Comprehensive Plan of Action limits Iran’s installed enrichment capacity for 10 years, with the installation of more advanced centrifuges permitted after this period. Restrictions on the size and enrichment level of Iran’s uranium stockpile expire after 15 years. By then, Iran intends to have an enrichment capacity at least sufficient to fuel its Bushehr-1 nuclear power reactor.

As recently proposed by our Princeton colleagues Alexander Glaser, Zia Mian, and Frank von Hippel, one approach to addressing this concern would be to use the next 10 years to convert Iran’s national enrichment plant to a multinational one, with some of Iran’s neighbors and one or more members of the P5 + 1 included as partners (Glaser, Mian, and von Hippel, 2015).¹ (P5 + 1 refers to the UN Security Council’s five permanent members – China, France, Russia, the United Kingdom, and the United States – plus Germany, which together negotiated the recent agreement with Iran.) This could begin a movement toward phasing out or merging national enrichment programs worldwide – a step toward applying equally to all states the rules about control of the fuel cycle.

A multinational arrangement could be designed to add long-term institutionalized transparency to Iran’s enrichment program above and beyond that offered by International Atomic Energy Agency safeguards. It could give more clarity should Iran ever attempt to “breakout” and produce weapons-grade uranium within its enrichment facility. The added transparency also could complicate efforts to establish a parallel, clandestine facility, addressing perhaps the most important concern related to Iran’s program. More
broadly, this arrangement could ease the current political tensions between Middle Eastern powers. It should be viewed a confidence-building step in enhancing the region’s security, as weak states and overlapping revolutions are causing existing security structures to collapse.

**The future of nuclear power in the Middle East**

There are currently six states in the Middle East (Egypt, Iran, Jordan, Saudi Arabia, Turkey, and the United Arab Emirates) with planned nuclear power programs. Iran and the UAE have the most advanced programs, with Iran having the only operating reactor in the region (Bushehr-1), and the UAE constructing four. Turkey also has advanced plans, having already signed project contracts with Rosatom – Russia’s national nuclear corporation – to build four reactors at the Akkuyu site on the south coast of Turkey (Turkish Atomic Energy Authority 2014).

Six Gulf states (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) decided in 2006 to develop a joint nuclear program, but Bahrain, Kuwait, Oman, and Qatar have since walked away from this project in the wake of the accident at Japan’s Fukushima nuclear plant (Kholopkov 2012). Jordan and Saudi Arabia have committed plans and are currently developing the legal and regulatory framework, as well as acquiring the required infrastructure and human resource capacity. More recently, in November Egypt and Russia signed an agreement to construct a reactor at Dabaa in northern Egypt (Alsharif et al. 2015).

Israel, the only nuclear-weapon state in the Middle East, has considered building nuclear power plants in the northern Negev Desert (Erlanger 2010). The discovery of natural gas then made the need less urgent, and the Fukushima accident prompted a reconsideration of the project. Israeli Prime Minister Benjamin Netanyahu stated in a March 2011 interview, “I don’t think we’re going to pursue civil nuclear energy in the coming years” (Rinat and Ravid 2011).

The official rationales for nuclear power in the Middle East include meeting the rising demand for electricity and desalinated water due to economic and population growth, addressing energy security concerns by reducing reliance on imports or diversifying sources of dependence, and the opportunity costs of using oil and gas to generate electricity instead of for export (Kamrava 2012). Nuclear power has also been advocated as a means to stimulate economic growth and build a highly skilled workforce (Jordan Atomic Energy Commission 2011).

Nuclear power makes little economic sense in the Middle East, however, if solar energy costs continue to decline (Ahmad 2015; Ahmad and Ramana 2014). The role of nuclear power in resolving energy security concerns is also questionable, given the likely creation of new technological and human resource dependencies. As for the diversification of energy sources, one major challenge is that both nuclear power and renewable energy projects are capital-intensive. This limits the possibility for countries in the region to invest in both energy options. Resource-rich countries such as Iran, Saudi Arabia, and the UAE, however, may find it easier to diversify their energy sources given their large sovereign funds, but even these have limits, with the International Monetary Fund warning in 2015 that Saudi Arabia is running an unsustainable fiscal deficit because of low oil prices (Feteha 2015).

**Nuclear fuel cycle needs and proliferation concerns**

As nuclear power expands, so too will the flow of enriched uranium and plutonium. More centrifuges will be needed to enrich uranium to 3–5 percent to fuel new reactors, but these machines could also be connected in cascades to produce weapons material enriched to 90 percent or more. The reactor-grade plutonium present in spent fuel is also weapons material if separated by reprocessing (Mark, von Hippel, and Lyman, 2009).

The need for enrichment or reprocessing in the production of weapons material was identified in the 1946 Acheson-Lilienthal report, which proposed placing these activities under international control (US State Department 1946). The concern was that if these activities remained under the control of states, competition between them in the nuclear realm would eventually make technical monitoring unworkable.

The risk that a national civilian nuclear fuel cycle program would be redirected to nuclear weapons production because of national security concerns, or result in the transfer of fuel cycle technology or knowledge to other states, depends on many factors. These include the scale of the operation, how activities are controlled and monitored, economic and political incentives, and most importantly, whether a state’s leaders decide acquiring nuclear weapons is in their interest. The impossibility of decoupling these factors means that the problem of ensuring the peaceful use of nuclear technology is not merely of a technical or military nature, but also is fundamentally political at both the domestic and international levels. In the Middle East, these issues of technology acquisition, security politics, and proliferation have been interlinked at least since
the 1950s when Israel set out to acquire its nuclear weapons.

A summary of the currently projected nuclear power capacity and uranium enrichment needs of the planned national nuclear power programs in the Middle East is presented in Table 1. The low estimates assume that not all planned projects will be completed. For example, the low estimates for Egypt, Jordan, and Saudi Arabia are zero because there are no signed construction agreements, despite these countries’ plans to build at least one plant. The high estimates assume that all current plans will be realized. The annual enrichment needs required by each state, and for the region as a whole, can be calculated using the capacity projections (in megawatts of electric power) for each country.

Even under the conservative low estimate, the region would require about 230 metric tons of low-enriched uranium (LEU) annually, and thus 1.2 million separative work units (SWU) per year. (An SWU is a measure of enrichment capacity.) This would increase to 4.4 million SWUs in the high estimate case (see Table 1). Much of this enrichment capacity is projected to be required by 2025, the date most restrictions on Iran’s program expire. The options for meeting these enrichment needs are enriched uranium fuel imports to meet national needs, domestic uranium enrichment plants with their attendant proliferation risks, or a multinational enrichment facility, or some combination of these.

The SWU capacity shown in Table 1 could be met by fuel contracts offered by nuclear suppliers. Gaining fuel supply contracts is a source of profit for reactor vendors, with the exact details of fuel supply contracts varying by vendor and parent-country. For example, Russia – through its national nuclear corporation Rosatom – is currently the fuel supplier of Iran’s power and research reactors, and will continue supplying fuel until Iran is able to enrich and manufacture its own, as allowed under the nuclear deal.

In other cases, such as Jordan and Turkey, Russia is likely to demand lifetime fuel supply contracts. Another case is the UAE, which has decided to award fuel contracts to three different nuclear fuel suppliers (Urenco, headquarters in Stoge Poges, UK; Areva, Courbevoie, Paris, France; and Teax, Moscow, Russia) to achieve “long-term security of supply, high quality fuel and favorable pricing and commercial terms,” according to Emirates Nuclear Energy Corporation CEO Mohamed Al Hammadi (ENEC 2012).

Table 1 displays the contracted or expected fuel suppliers for the region’s programs. All contracts will likely have the vendor supplying fuel and taking it back for waste storage. In fact, Russia offers a “take-back” option for spent fuel in its business model; this option is currently in place for Iran’s Bushehr-1 reactor and is part of the agreement with Jordan (Rosatom 2015). The question of whether fuel from the Akkuyu site will remain in Turkey has not been settled (World Nuclear Association 2015).

Multinational enrichment

A Middle Eastern multinational enrichment facility based in Iran needs to address several concerns. First, control of the facility must be structured so that other states in the region have their doubts about the peaceful nature of Iran’s program sufficiently addressed. An additional, but related, concern is the assurance of a secure supply of fuel to regional customers. Meeting these objectives could dissuade states from beginning their own programs by raising the risks of economic and political isolation. Proliferation-sensitive knowledge and technology also need to be adequately controlled and monitored, to reduce the risk of transfers to potential proliferators. Lastly, in addition to satisfying the concerns of P5 + 1 members about Iran’s program upon expiration of the Joint Comprehensive Plan of Action restrictions, a structure is needed that earns the support of planned fuel suppliers to the region’s programs (see Table 1).

A precedent exists for multinational enrichment: Urenco, a company established in the 1970s, combined the national enrichment programs of the Netherlands, Germany, and the United Kingdom. The arrangement

<table>
<thead>
<tr>
<th>State</th>
<th>Initiation date</th>
<th>Current capacity (mwe)</th>
<th>Projected capacity (MWe)</th>
<th>Million SWU/year (LOW-HIGH)</th>
<th>Fuel supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>1960s</td>
<td>0</td>
<td>0 – 4,800 (2030)</td>
<td>0 – 0.5</td>
<td>Likely Russia</td>
</tr>
<tr>
<td>Jordan</td>
<td>2006</td>
<td>0</td>
<td>0 – 2,000 (2026)</td>
<td>0 – 0.2</td>
<td>Russia</td>
</tr>
<tr>
<td>Iran</td>
<td>1974</td>
<td>1,000</td>
<td>2,000 – 5,000 (2030)</td>
<td>0.2 – 0.3</td>
<td>Russia</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>2006</td>
<td>0</td>
<td>0 – 17,000 (2040)</td>
<td>0 – 1.8</td>
<td>Unknown</td>
</tr>
<tr>
<td>Turkey</td>
<td>1970</td>
<td>0</td>
<td>3,350 – 9,400 (2030)</td>
<td>0.4 – 1.0</td>
<td>Russia</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>2006</td>
<td>0</td>
<td>5,600 – 5,600 (2040)</td>
<td>0.6 – 0.6</td>
<td>South Korea</td>
</tr>
<tr>
<td>Total</td>
<td>1,000</td>
<td></td>
<td>41,800 (2040)</td>
<td>1.2 – 4.4</td>
<td>-</td>
</tr>
</tbody>
</table>

The following assumptions were used to calculate the numbers in Table 1: 22.12 metric tons of low-enriched uranium (LEU) per megawatt of electric power (MWe). Burn-up equals 45,000 megawatt-days per metric ton of heavy metal. Capacity factor equals 90 percent. Thermal efficiency equals 33 percent. Product assay equals 3.5 percent. Feed assay equals 0.71 percent. Tails assay equals 0.25 percent. The initiation dates displayed indicate the start of nuclear power plant construction, rather than the beginning of nuclear activities.
set up a multinational company with three enrichment plants (one in each country) that are jointly managed. Since each stakeholder already had centrifuge technology, the arrangement did not create significant new proliferation risks. Nonetheless, the treaty that established this collaboration provided rules for workers and the monitoring of proliferation-sensitive activities and information (Treaty of Almelo 1970). One goal of this multinational project was to prevent Germany from using its uranium enrichment capability to develop a nuclear weapons option.

One step in limiting the long-term risk from Iran’s program could involve multinationalizing the Natanz facility. An invitation by Iran for all states to profit from and manage the project would be an important confidence-building step in establishing its peaceful intentions. The P5 + 1 and regional states could, for instance, purchase shares of the Natanz plant at the commercial market cost per unit of enrichment capacity, with Iran subsidizing the program until it became economically competitive. The P5 + 1 would not need to supply technology, but could be given full access without raising proliferation risks, as all six states have centrifuge expertise. Regardless of whether the facility ever became profitable, however, the transparency granted should be enough of an incentive that states would pay for access.

Among the P5 + 1 states, Russia may be the most obvious partner in a Middle East multinational enrichment arrangement. It signed a memorandum of understanding (MoU) in 2014 that included possible cooperation with Iran in economic fuel fabrication (Kayhan International 2014), and Russia may see an advantage in setting up an enrichment plant or supplying centrifuge technology to a facility in Iran or another state in the region. By co-locating a Russian facility with Iran’s Natanz enrichment plant, and managing the two together, the enriched uranium produced at Natanz and Russia’s plant could then be combined and sold to regional customers. Alternatively, Russia could transfer advanced centrifuge technology to Iran, but this is something Iran intends to acquire anyway and so need not be of undue concern. Collaboration with Iranian scientists on centrifuge research and operation could, in fact, add some transparency about proliferation-sensitive centrifuge R&D activities.

Such a multinational enrichment facility with Middle Eastern regional partners would involve access for states without centrifuge expertise. Therefore, a structure that protects against the transfer of proliferation-sensitive knowledge and technology would be critical. Lacking full access, Middle Eastern states could find added confidence in the proper operation of the facility by, for example, forming their own regional nuclear inspectorate to complement IAEA safeguards, just as Brazil and Argentina did after abandoning their nuclear weapons programs (ABACC 1991).

Any breakout attempt by Iran using such a facility would have to involve removing IAEA inspectors, possibly regional inspectors, and perhaps workers from the P5 + 1 countries. Even though allowing the IAEA access while removing P5 + 1 states would not violate Iran’s obligations under the Nuclear Non-Proliferation Treaty, forcibly removing or denying access to workers from Russia or other P5 + 1 states would immediately raise questions about Iran’s intentions. Such an action by Iran might create the political legitimacy for a rapid international response, perhaps more so than only the removal of IAEA inspectors. These contingencies demand careful thinking about how they should be addressed.

Finally, the economic advantage to regional states of purchasing fuel from vendors or from a multinational facility could outweigh the cost of developing and operating a domestic enrichment plant. The construction and operation costs of a national facility, plus acquiring the materials and technical expertise, would only be economically attractive if a state had large commercial markets and a heavy reliance on nuclear power. At today’s current market price of $62 per SWU, a state would need to use well beyond 10 gigawatts of nuclear-generated electric power for the cost of acquiring its own enrichment plant to make economic sense (Habib et al. 2006).

By working together on multinational enrichment, Iran and the P5 + 1 could build confidence among the region’s powers that Iran’s program will remain peaceful, thereby lessening the current tensions heightened by the deteriorating security in the Middle East. Such an arrangement could begin a movement away from nationally controlled uranium enrichment facilities and toward ending the risks from the implicit nuclear weapons option such facilities provide. Success in the Middle East may be the first step in acceptance of this norm worldwide.

Notes

1. This builds on and makes more explicit the earlier suggestion by Frank N. von Hippel, Seyed Hossein Mousavian, Emad Kiyaei, Harold A. Feiveson, and Zia Mian (von Hippel et al. 2013).
2. This analysis was done before Egypt and Russia announced an agreement to construct a reactor at
Dabaa, but since the planned capacity of the reactor was not revealed, Egypt’s projected low-end enrichment needs remain zero.

3. US documents commonly refer to the Iran agreement as between Iran and the P5 + 1. However, the agreement also included the European Union, and sometimes the parties to the agreement are referred to as Iran and the E3/EU+3 to indicate Russia, China, and the United States (E3), along with the United Kingdom, France, Germany, and the EU (EU+3).

4. The security weaknesses revealed by the A. Q. Khan affair in Pakistan, and with Iraq’s clandestine program in 1990, were due to Urenco subcontractors, and later investigations suggested how these technology leakages could have been discovered earlier (Kehoe, 2002).

5. Russia has previously supplied centrifuges to the civil enrichment plants at Hanzhong and Lanzhou in China.

6. This judgment is based on an analysis by Habib et al. (2006) which projected that at the then 2006 market price of $110 per SWU, about 10 gigawatts of nuclear power would need to be generated for domestic enrichment to be economical.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Notes on contributors

Ali Ahmad is a postdoctoral researcher at Princeton University’s Program on Science and Global Security. He is also a visiting scholar at the Issam Fares Institute for Public Policy and International Affairs at the American University of Beirut. His research covers nuclear power, proliferation, energy policy, and economics in the Middle East.

Ryan Snyder is a postdoctoral research associate at Princeton University’s Program on Science and Global Security. He is working on technical and policy questions related to the proliferation risk from uranium enrichment technologies and on improving international safeguards on the nuclear fuel cycle, and the future of nuclear power.

References


