

PROJECT ON MANAGING THE ATOM

Iran and a New International Framework for Nuclear Energy

John Carlson



HARVARD Kennedy School

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Cover photo: An Iranian flag flutters in front of the International Atomic Energy Agency (IAEA) headquarters in Vienna, Austria, January 15, 2016. (Reuters)

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1. Introduction

As early as the end of the Second World War it was recognized that nuclear fuel cycle technologies developed for military purposes—specifically, uranium enrichment and reprocessing—had major potential for peaceful applications but remained inherently dual-purpose, and if not controlled appropriately, could be diverted to military use. The very first issue considered by the newly founded United Nations was “the problems raised by the discovery of atomic energy.”¹ Unfortunately, given all that has followed, ideas advanced then for international control of the fuel cycle did not gain the support needed to be taken further.

Today the principal international framework for ensuring peaceful uses of the nuclear fuel cycle comprises the 1970 Nuclear Non-Proliferation Treaty (NPT) and International Atomic Energy Agency (IAEA) safeguards, which apply primarily to non-nuclear-weapon states (NNWS) to verify that their nuclear programs are used only for peaceful purposes. Some of the provisions of the Joint Comprehensive Plan of Action (JCPOA) concluded with Iran in July 2015, and the need to address the dangers posed by Iran’s program once key restraints of the JCPOA expire, create both an opportunity and a need to strengthen the international framework for control of sensitive nuclear fuel cycle technology.

The usual interpretation of the NPT is that NNWS can develop any nuclear technology provided they do so under IAEA safeguards. But the NPT does not actually say this. Article IV says the NPT does not affect “the inalienable right of all the Parties . . . to develop research, production and use of *nuclear energy* (emphasis added) for peaceful purposes,” in conformity with other key provisions of the treaty. This is not an explicit right to develop a particular technology regardless of the impact on the NPT’s objectives.

¹ UN General Assembly Resolution 1, A/RES/1(I), January 24, 1946, <https://documents-dds-ny.un.org/doc/RESOLUTION/GEN/NR0/032/52/img/NR003252.pdf?OpenElement> (accessed October 17, 2016).

Unfortunately the NPT is vague about the extent to which a party can pursue a particular technology, provided this is for peaceful purposes under IAEA safeguards. As Iran and others in the non-aligned group of states are quick to remind, NPT signatories agree to the “fullest possible exchange of equipment, materials and scientific and technological information.”² Today it is clear that the NPT did not anticipate the problem of the spread of proliferation-sensitive nuclear technologies, and does not adequately address this problem. Hence the effort now to develop multilateral approaches, ensuring sensitive stages of the fuel cycle are not left exclusively in national hands.

It is against this background that President Obama, in his 2009 Prague speech, referred *inter alia* to the need for a “new framework for civil nuclear energy cooperation, including an international fuel bank.” Unfortunately, he has not elaborated on what this new international framework might be.³

In recent years, several proposals from various quarters have aimed at reducing incentives for the spread of enrichment and reprocessing to further states.⁴ Most have attempted to provide states with added assurance that the supply of fuel for nuclear reactors will not be interrupted or withheld for political reasons.

The Nuclear Suppliers Group (NSG) Guidelines specify that:

If enrichment or reprocessing facilities, equipment, or technology are to be transferred, suppliers should encourage recipients to accept, as an alternative to national plants, supplier involvement

2 Treaty on the Non-Proliferation of Nuclear Weapons, March 5, 1970, Article IV, para. 2, <http://www.state.gov/documents/organization/141503.pdf> (accessed October 17, 2016). The article specifies such exchanges are to be for peaceful uses: the key issue here is whether it is possible to ensure that proliferation-sensitive technologies will remain in exclusively peaceful use into the future.

3 See John Carlson, “The Prague Agenda and Nuclear Energy” (presentation given at the Australian Embassy as part of the Australian Ambassador’s 2012 Speaker Series, Washington DC, November 13, 2012), <http://belfercenter.ksg.harvard.edu/files/uploads/NewFrameworkWashington.pdf> (accessed October 17, 2016).

4 For an overview of the various proposals for international fuel cycle management see Anthony Andrews, Mark Holt, and Mary Beth Nikitin, “Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power” (Washington, D.C.: Congressional Research Service, October 19, 2012, pp. 17-37), <https://www.fas.org/sgp/crs/nuke/RL34234.pdf> (accessed October 17, 2016). See also John Carlson, “Multinational Approaches to the Nuclear Fuel Cycle,” in *Handbook of Nuclear Proliferation and Policy*, ed. J. Pilat and N. Busch. (New York, NY: Routledge, 2015), pp. 403-15.

and/or other appropriate multinational participation in resulting facilities. Suppliers should also promote international (including IAEA) activities concerned with multinational regional fuel cycle centers.⁵

There are also the efforts of the International Framework for Nuclear Energy Cooperation (IFNEC—formerly the Global Nuclear Energy Partnership or GNEP) to develop proposals for comprehensive (cradle-to-grave) fuel supply arrangements, such as fuel leasing. In addition, there are fuel supply assurances provided by the United States and also proposed by the United Kingdom and others, fuel banks established by Russia and the IAEA, and Russia's international enrichment center at Angarsk, in which it has invited other states to purchase shares. But there is no comprehensive effort to draw these various developments and ideas together, and in particular there is no effort to gain support for a new international framework—this is seen to be too difficult politically.

Largely as the result of an effective Iranian campaign, developing countries are especially sensitive to what they see as any attacks on Article IV rights. States that are unlikely to develop enrichment themselves have been vociferous about Iran's right to do so.

There is no doubt that the proliferation challenge presented by Iran's nuclear program was part of the context for President Obama's proposal for a new international framework. The conclusion of the JCPOA is a remarkable achievement. The JCPOA sets out comprehensive confidence-building steps for the Iranian nuclear program, but the underlying issue remains: Can confidence-building measures provide sufficient assurance if Iran proceeds with a massive expansion of its enrichment program when the applicable JCPOA limits are lifted in 15 years' time?

The Iranian situation highlights the urgency of developing international consensus on the control of proliferation-sensitive parts of the fuel cycle, addressing the Iranian case and also avoiding similar cases in the future.

5 IAEA, "Nuclear Suppliers Group Guidelines," INFCIRC/254/Rev.12/Part 1, para. 6(e), November 2013, <https://www.iaea.org/sites/default/files/publications/documents/infcircs/1978/infcirc254r12p1.pdf> (accessed October 17, 2016).

2. Ongoing Iranian issues

The JCPOA is frequently described as being transactional not transformative. The truth of this statement will not be known for several years. If in the course of faithful implementation no transformation occurs in Iran's fuel cycle plans, in its relations with its neighbors, or in the world's (and particularly the P5+1's) perceptions of Iran's nuclear intentions, then a crisis is almost certain to re-emerge in 10–15 years, if not sooner. The JCPOA defuses the immediate crisis, and provides a vital breathing space. It is absolutely essential for all parties to use this opportunity productively to find a lasting solution. The most important steps Iran and other governments can take during this period may well be those aimed at easing political tension in the Middle East, with no direct connection to Iran's nuclear conduct and capabilities.

If Iran abides by the letter and spirit of the JCPOA for its duration but continues to fuel conflicts in Yemen, Syria, and elsewhere in the Middle East, no combination of nuclear restraints and verification will suffice to reassure Iran's neighbors that an Iranian “breakout” will be a remote risk once the JCPOA's limits expire. If, by contrast, Iran improves its relations with its neighbors and the United States, the concern with Iran's nuclear program will be less salient, especially if the program is integrated in a web of cooperative arrangements of the type described below.

But the challenges of confidence-building in the nuclear domain alone are immense. The Atomic Energy Organization of Iran has said that after the limits of the JCPOA expire, it plans to expand enrichment capability to one million separative work units, or SWU, a metric of enrichment effort—200 times the capacity allowed under the JCPOA.⁶ One million SWU would be sufficient to meet the fuel needs for around six to eight power reactors. As Iran has foreshadowed an eventual nuclear power program of double this size, from a purely technical perspective this enrichment capacity seems reasonable. But it would have major impact in terms of breakout potential.

⁶ Statement by Behrouz Kamalvandi, *Fars News*, July 29, 2015, <http://english.farsnews.com/newstext.aspx?nn=13940507001415> (accessed October 17, 2016).

With an enrichment plant of this scale, the time needed to produce sufficient highly enriched uranium (HEU) for one warhead would be reduced from the 12-month period under the JCPOA to a matter of days. IAEA safeguards might detect an attempted breakout very quickly, but it is unlikely external intervention could be fast enough to be effective. Once HEU, or low enriched uranium hexafluoride intended as feedstock for high enrichment, is removed to unknown locations for further processing and weaponization, the problem will be a lack of specific targets for preemptive action.

Experts and officials have discussed numerous ideas for how the Iranian program could be normalized. One question concerns metrics for normalization: what are convincing indicators for an exclusively peaceful program? Criteria in this regard might include:

- No enrichment above 5 percent U-235.
- No stockpiling enriched uranium hexafluoride (UF₆).
- No reprocessing.
- No stockpiling spent fuel, particularly low burnup fuel containing plutonium of a composition most attractive for weapons.
- No weaponization activities.
- No nuclear-capable missiles or other delivery systems.

Apart from the last point on delivery systems, Iran has agreed to all of these measures in the JCPOA, though their value is diminished because most are limited to specific durations. But it is important to acknowledge that Iran has given some significant commitments and assurances on an ongoing basis, not limited to the JCPOA durations. These include no weaponization activities, no intention to reprocess, and no retention of spent fuel from the Arak reactor (and Iran has agreed to the modification of this reactor to reduce its plutonium production potential).

Additional ideas that could make meaningful transformation more likely might include:

- *Normalization of ownership and control.* Iran's enrichment program could be operated by a commercial entity on a commercial basis, like other uranium enrichment organizations in Europe, Japan, Russia, and China, that are expected to turn a profit.
- *Multinationalization of Iran's enrichment program.* Iran could invite other parties to invest in and cooperatively manage the operation of enrichment in Iran.⁷ Countries investing (for non-proliferation rather than commercial reasons) might get seats on a governing board, and perhaps the right to have staff working at the facility—creating both higher political barriers to seizing the facility and turning it to military purposes, and greater transparency. It would be important to ensure that there was no leakage of know-how to parties who were not technology holders, and it must be acknowledged that any enrichment program, even in multinational form, could still provide technology and experienced staff for undeclared activities.
- *Embracing international governance rules, norms, and treaties.* Currently Iran remains outside the treaties that constitute the international framework for safe, responsible and accountable conduct of nuclear energy programs.⁸ Without further delay, Iran should join the Convention on Nuclear Safety, the amended Convention on the Physical Protection of Nuclear Materials, and other key treaties on radiation safety, nuclear liability, and so on. Iran should also establish an independent nuclear regulator, in accordance with these treaties.
- *Enmeshing Iran's nuclear establishment in international cooperative arrangements.* Iranian nuclear scientists, engineers, and policy experts could engage far more extensively in cooperative multilateral initiatives such as IFNEC, the Nuclear Security Implementation

7 Multinationalization was proposed to the author, then an Australian government official, in talks in Tehran in 2004. In 2005 newly elected President Ahmadinejad proposed multinational participation in his UNGA address of September 17, see President Mahmoud Ahmadinejad, "Address before the Sixtieth Session of the United Nations General Assembly" (New York, NY, September 17, 2005), <http://www.un.org/webcast/ga/60/statements/iran050917eng.pdf> (accessed October 17, 2016).

8 See Ariel Levite, "The Iran Deal's Future Remains Uncertain," *The National Interest*, June 21, 2016, <http://nationalinterest.org/feature/the-iran-deals-future-remains-uncertain-16671> (accessed October 17, 2016).

Initiative (INFCIRC/869), regional emergency response initiatives, and in the activities of the World Institute for Nuclear Security (WINS), the World Association of Nuclear Operators (WANO), and others.

- *Negotiation of long-term fuel leasing arrangements.* Iran could replicate the fuel supply and take-back arrangements it currently enjoys with Russia in all future reactor construction and operation agreements (regardless of which supplier is involved), and continue to rely on such arrangements throughout the lifetime of these facilities.

None of these measures is by itself a panacea, and even if Tehran adopted all of them, there would still be major concerns about the pursuit of large-scale enrichment by Iran.

An important principle to establish, not only for Iran but as a general norm, is that a state's enrichment program should be limited to the scale needed to meet its demonstrated fuel needs on an economic basis.

Applying this principle, it is clear that currently Iran has no demonstrated need for domestic enrichment, because it has only one power reactor (Bushehr) and Russia has contracted to supply the fuel for this reactor. For future reactors, if supplier states guarantee to supply fuel to Iran at a lower cost than domestic production, there would continue to be no legitimate case for domestic enrichment. There are practical issues trying to apply this principle, however. First, Iran, having sought vigorously in the JCPOA negotiations to preserve the option of expanding its enrichment program in the future, is unlikely to agree explicitly to a principle that would rule out a substantial enrichment program in Iran. Second, Iran's enrichment costs are secret, so it cannot be readily demonstrated that external supply is cheaper (although given the enormous financial and political investment Iran has made in its enrichment program, it is inconceivable that external supply would have been more costly). Two aspects of normalization, therefore, should be transparency about costs, and an ongoing discussion and exploration of incentives targeted on convincing Iran that it has no near-term or medium-term need to implement the option of building large-scale enrichment facilities.

Given the history of conflict over its nuclear aspirations, it is unlikely Iran would agree to limit its future enrichment program without strong incentives to do so, including additional fuel assurances and broader political arrangements. It may be easier to convince Iran to choose for itself to postpone large-scale enrichment than to get Iran to agree to binding commitments on this score. It bears noting, however, that in earlier rounds of negotiation, Iran expressed a willingness to sign on to precisely such a needs-based principle.⁹ The JCPOA, though, contains no such principle. It establishes “mutually determined parameters, consistent with practical needs, with agreed limits on the scope of Iran’s nuclear programme, including enrichment activities and R&D.” There are no limits on enrichment after 15 years. This should be addressed during the life of the JCPOA—sooner rather than later—and it is in Iran’s interest to do so.

Iran will argue that self-sufficiency is a strategic necessity, that it cannot afford to be at the mercy of external suppliers—and it presents its version of the Eurodif saga in support of this argument.¹⁰ It is understandable for Iran to have concerns about energy security: it does not wish to be vulnerable to a politically motivated cut in its fuel supply from Russia, or any other supplier. But commercial-scale enrichment in Iran would almost inevitably provoke regional and international anxiety about the possibility of rapid breakout, resulting in a return to threats and counter threats.

Self-sufficiency is not only costly and politically provocative, it is also an impractical goal. Iran claims to have found “unexpectedly high” uranium reserves, but its known reserves (4,000 tonnes) are equivalent to only about 20 reactor reloads in total, which certainly does not provide self-sufficiency even for a very small power program. Further, to be self-sufficient

9 In March 2005, as part of its negotiations with the EU/E3 (the UK, France, and Germany) Iran offered a “limitation of the extent of the enrichment program to solely meet the contingency fuel requirements of Iran’s power reactors.” See IAEA, “Communication dated 1 August 2005 received from the Permanent Mission of the Islamic Republic of Iran to the Agency,” INFCIRC/648, August 1, 2005, p. 3, <https://www.iaea.org/sites/default/files/publications/documents/infcircs/2005/infcirc648.pdf> (accessed October 17, 2016).

10 Under the Shah, Iran had joined the French-led Eurodif enrichment consortium. In 1979, following the revolution, Iran cancelled its agreement with Eurodif and refused to take its share of enriched uranium. Iran then took legal action to recover funds invested in Eurodif. In 1991, Iran changed its position and demanded delivery of enriched uranium based on the former contract. France refused—not only had the contract been terminated, but Iran was by then subject to Western sanctions. Iran claims the French refusal demonstrates that external fuel supply cannot be relied upon. For more on the Eurodif dispute, see Oliver Meier, “Iran and Foreign Enrichment: A Troubled Model,” *Arms Control Today*, January-February 2006, www.armscontrol.org/act/2006_01-02/JAN-FEB-IranEnrich (accessed October 17, 2016).

Iran would also have to fabricate all its fuel, an ambitious and expensive undertaking.

This means the only solution that can provide strong international confidence is one where Iran uses an external fuel supply rather than insisting on self-sufficiency. The question is, therefore, how to establish fuel assurances that are sufficiently credible to demonstrate there is no genuine need for self-sufficiency, and that have sufficient advantages to be accepted as a preferable alternative to a national enrichment program. This is not just an issue with respect to Iran, but is a generic issue, relevant for any state seeking to establish domestic enrichment capabilities.

3. Nuclear hedging—the elephant in the room

While this discussion so far has focused on fuel cycle self-sufficiency, there can be little doubt that Iran's enrichment program was developed for strategic purposes. If nothing more, Iran's breakout capability will be seen by some Iranians as a form of strategic deterrent.¹¹ Within Iranian policy-making circles, it can be assumed some have reasoned that as long as Iran's adversaries possess nuclear weapons, or could pursue these, Iran should have the know-how and infrastructure to generate a strategic deterrent if or when one is needed.

Iran maintains its enrichment program is permitted under the NPT, and is no different from what, for example, Japan and Brazil have done. This overlooks Iran's past violations of its safeguards agreement and numerous Security Council resolutions. It is essential to develop an international understanding—not just with respect to Iran but generally—that “nuclear hedging”—pursuing a breakout capability in the guise of a civilian program—is not consistent with the NPT, and jeopardizes the NPT's objectives of providing confidence in the peaceful intent of nuclear programs.¹²

Of course Iran does not officially admit to hedging as a motivation and has pledged never to acquire nuclear weapons. Nonetheless, realistically the effort to persuade Iran to discontinue its enrichment program must take into account Iran's strategic motivations.

The principal strategic argument against nuclear hedging is that it is counterproductive. If Iran proposes a major expansion of its enrichment program after the JCPOA limits expire, this could motivate others in the

11 For more on the possible deterrent effects of latent nuclear capability, see Gene Gerzhoy, Rupal N. Mehta, and Rachel Whitlark, “The Causes and Consequences of Nuclear Latency,” (paper presented at Project on Managing the Atom Seminar Series, Cambridge, Massachusetts, May 11, 2016) <http://belfercenter.ksg.harvard.edu/events/7071> (accessed October 17, 2016).

12 For a general discussion on peaceful uses, nuclear latency and hedging, see John Carlson, “‘Peaceful’ Nuclear Programs and the Problem of Nuclear Latency” (Washington, D.C.: Nuclear Threat Initiative, November 2015), http://www.nti.org/media/pdfs/Peaceful_Nuclear_Programs_and_the_Problem_of_Nuclear_Latency.pdf (accessed October 17, 2016).

region to pursue similar capabilities—an outcome that is hardly in Iran’s interest. Saudi Arabia and Turkey have each expressed interest in national enrichment programs, in Saudi Arabia’s case clearly linking this idea to developments in Iran.¹³ Even the United Arab Emirates, which represents the “gold standard” for non-proliferation commitments in nuclear cooperation, have made hints about enrichment.¹⁴ Iran’s strategic advantage is only temporary—if others initiate nuclear programs to close the gap, this “advantage” will have worked against Iran. If Iran does not change direction, it risks being in a much worse security environment two or three decades from now.

A far better course for Iran is to support the establishment of an effective zone free of weapons of mass destruction (WMD) in the Middle East, indeed to take a leadership role on this issue. Achieving such a zone is a major political challenge, but obviously preferable to a nuclearized Middle East.¹⁵ Iranian cooperation on incremental steps toward the establishment of such a zone could have powerful confidence- and security-building effects in the Middle East and beyond. For example, Iranian ratification of the Comprehensive Test Ban Treaty (CTBT),¹⁶ and its constructive participation in regional security discussions alongside other states of the region including Israel, could have a major effect on Gulf Arab and Israeli perceptions of Iran’s regional political intentions. At the same time, it must be recognized that addressing Iran’s security concerns will be a necessary element of achieving a wider relaxation of tensions.¹⁷

13 Turkey has left open the possibility of pursuing enrichment and reprocessing plans. See comments of President Erdogan cited in Sinan Ulgen, *Turkey and the Bomb*, The Carnegie Papers (Carnegie Europe Center, February 2012), http://carnegieendowment.org/files/turkey_bomb.pdf (accessed October 17, 2016). In the case of Saudi Arabia, see e.g. Prince Turki al-Faisal, quoted in “Saudi prince says Gulf states must balance threat from Iran,” *Reuters*, April 23, 2014, <http://www.reuters.com/article/2014/04/23/us-saudi-security-idUSBREA3M1BJ20140423>; also “View from the inside: Prince Turki al-Faisal on Saudi Arabia, nuclear energy and weapons, and Middle East politics,” *Bulletin of the Atomic Scientists*, January 7, 2016, <http://dx.doi.org/10.1080/00963402.2016.1124655>. (accessed October 17, 2016).

14 See “Report: UAE might seek right to enrich uranium,” *Al Jazeera*, October 16, 2015, <http://www.aljazeera.com/news/2015/10/report-uae-seek-enrich-uranium-151016052723467.html> (accessed October 17, 2016). In subsequent discussions, however, UAE officials have made clear that they have no intention of pursuing enrichment in the near term. See Robert Einhorn and Richard Nephew, *The Iran Nuclear Deal: Prelude to Proliferation in the Middle East?* (Washington, D.C.: Brookings Institution, May 2016), <https://www.brookings.edu/research/the-iran-nuclear-deal-prelude-to-proliferation-in-the-middle-east/> (accessed October 17, 2016).

15 A future WMD-free zone will need to extend beyond a narrowly defined Middle East to include others involved in the region, such as Turkey.

16 Iran signed the CTBT in 1996.

17 This would require, e.g., that no other enrichment program commences in the Middle East.

It is beyond the scope of this paper to discuss in detail how to advance such a zone, but the steps towards it might include a regional fissile material production treaty or understanding under which there would be no further enrichment or reprocessing in the region. Ultimately, in the context of the establishment of a Middle East WMD-free zone, it would be very much to Iran's advantage to trade its enrichment program to achieve this outcome. At the very least, after the JCPOA period, Iran should be prepared, in support of efforts to negotiate a WMD-free zone, to refrain from expanding its enrichment program beyond JCPOA levels.

The United States and the other JCPOA partners, and all other states having influence with Iran, should be doing everything they can to encourage the Iranians to think seriously about the issues discussed here.

Similar considerations apply to enrichment and reprocessing programs in other regions of tension—as shown, for example, by increasing Chinese criticism of Japan's growing plutonium stockpile. Such programs can provoke regional tensions even where the state concerned has a sound non-proliferation record. An alternative to national programs is required not only for Iran, but also for Japan, South Korea, and all others thinking of developing sensitive stages of the fuel cycle.

4. What might a new international framework look like?

The global commercial nuclear market has worked very well—no power reactor has ever had to shut down because its fuel had been denied on political grounds. Despite this fact, evidently the record is not sufficient to persuade some states against pursuing self-sufficiency. If nothing changes, an increase in the number of states with breakout potential—not only Iran—is inevitable. A new framework is needed. Industry will be essential to the successful working of any new arrangements—the new framework should be developed in partnership with industry, building on market strengths.

The key guiding principle is that programs in proliferation-sensitive areas of the fuel cycle—essentially enrichment and reprocessing—should not proceed under wholly national control. Such programs should be undertaken on a multinational basis. The exact forms of ownership and management need to be developed. Several alternatives could have the intended effects. Ownership could be bilateral (technology holder and host state), regional, or wider (though not necessarily—or even likely—an international organization).

Existing models, providing features that could be drawn on in developing the multinational approach, include:

- *Urenco*. This features an over-arching treaty with mutual oversight, separation of technology developers and operators, and equity participation by some customers.
- *International Uranium Enrichment Center, Angarsk (Siberia)*. This features equity participation by customers, control of the technology only by the host state, IAEA oversight to guarantee no cut-off of supply, and an associated fuel bank.

- *Supply of technology only under “black-box” arrangements.* This is the practice of Urenco (supply to France and the United States) and Rosatom (supply to China).¹⁸

Other key parts of the new international framework could include:

- *Strengthened international cooperation, including comprehensive partnerships of fuel suppliers and fuel customers.* These arrangements should cover all aspects of the fuel cycle, including collaboration in safety and security, and in management of spent fuel and high level radioactive waste.
- *Fuel supply assurances.* To provide guarantees against discrimination, including disruption of nuclear fuel supply, fuel supply assurances will be an essential part of the new framework. Fall back arrangements in case of supplier default (whether by intention or force majeure) will be important, together with oversight by the IAEA to ensure the assurances work effectively. The IAEA and other fuel banks will provide an additional level of assurance.
- *New models of ownership.* Customer states would be given the opportunity for equity participation in multinational facilities, including profit-sharing—addressing concerns that technology holders might exploit their position through unfair pricing.

There is no doubt that any collaborative partnership that included spent fuel take-back would be highly attractive. At present this is politically contentious in potential take-back states.¹⁹ High priority should be given to making progress in this area.

¹⁸ It is important, however, not to overstate how “black” such boxes are likely to be. In the United States and France, for example, regulators have access to substantial parts of the Urenco designs, in order to be able to ensure that appropriate safety measures are in place.

¹⁹ John Deutch, Arnold Kanter, Ernest Moniz, and Daniel Poneman, “Making the World Safe for Nuclear Energy,” *Survival*, Vol. 46, No. 4 (Winter 2004-2005), pp. 65-80, <http://large.stanford.edu/publications/coal/references/docs/2004-MakingtheWorld.pdf> (accessed October 17, 2016).

5. Building out from the JCPOA

Although the JCPOA, reportedly at Russian insistence,²⁰ expressly states that it does not establish international precedents, nonetheless it contains provisions and principles that could be important in developing the international framework for nuclear energy.²¹ Innovations contained or reflected in the JCPOA include:

- Recognition of the need for confidence-building measures with respect to sensitive nuclear technologies, especially that these should be the subject of international consultation and negotiation and should not be pursued unilaterally regardless of international concerns. Specific measures include acceptance of restraints (e.g. no reprocessing, no higher enrichment, no stockpiling of sensitive materials), capacity limits (albeit these are temporary in the JCPOA), and additional verification measures (e.g. monitoring of nuclear procurement).
- Elaboration of what is meant by weaponization activities, and a monitoring process for specified dual-use activities—though the JCPOA list is not comprehensive,²² and some of the restrictions in this area are only temporary.
- Where Security Council sanctions are involved, a snap-back mechanism modifying the ability of a permanent member to veto re-imposition of sanctions once lifted.

Notwithstanding the no-precedent disclaimer, a body of practice is evolving under the JCPOA that is likely to be influential when similar issues are being considered elsewhere.

20 Alexey Arbatov, "The JCPOA and Its Implications for Nuclear Nonproliferation," (Moscow: Carnegie Moscow Center, April 20, 2016), <http://carnegie.ru/2016/04/20/nuclear-deal-with-iran-final-step-or-new-stage/ixc4?> (accessed October 17, 2016).

21 See George Perkovich, "The Iran Deal's Building Blocks of a Better Nuclear Order," (Washington D.C.: Carnegie Center, June 9, 2016), <http://carnegieendowment.org/2016/06/09/iran-deal-s-building-blocks-of-better-nuclear-order-pub-63780> (accessed October 17, 2016).

22 For example, the JCPOA does not include major items from the NSG dual-use list such as high explosive containment vessels and high explosive materials, and it does not include development of missiles and re-entry vehicles.

Application of principles and approaches from the JCPOA need not be reactive, dealing with a problem once it has arisen, but could be promulgated as generic principles, for example by the Security Council or the IAEA.

6. Addressing the political arguments

As mentioned earlier, proposals for multinational fuel cycle approaches have been misrepresented as an attack on NPT Article IV rights to develop nuclear technology. A variant of this argument is to characterize the issue as a conflict of “haves” vs. “have-nots,” by which current technology holders are said to be seeking to maintain an oligopoly position. It is essential to move beyond such simplistic political arguments and establish a dialogue based on facts.

States seeking to establish a nuclear weapon option will oppose efforts to impose restrictions on dual-use activities. The political case needs to be argued on the basis of a rigorous analysis of the full range of interests in play.

For a start, arguments based on the need for fuel cycle self-sufficiency to guarantee energy security are unconvincing. No country has an entirely self-sufficient nuclear program; even Russia, which historically has been self-sufficient, now imports uranium. Self-sufficiency would require not only enrichment, but uranium production, conversion and fuel fabrication. Fuel fabrication is particularly demanding—safety certification for each model of fuel assembly is extremely expensive and time-consuming. Controlling costs very much depends on specialization and economies of scale—few states would have sufficient numbers of particular reactor types for it to be practicable to meet all their own fabrication needs.

Any cost-benefit analysis must include not only direct financial costs but also wider economic, political, and strategic costs.

Establishing enrichment on a commercial scale involves very substantial development costs. The current enrichment service providers had substantial government funding over an extended period. They are profitable now because they did not have to repay all historic costs. For any country thinking of starting off now, the development costs are so high that no indigenous enrichment program could realistically expect to match the

international market price for SWUs, particularly since the current significant over-capacity situation is expected to last for some time.

In the case of Iran, the costs of developing enrichment are secret, but likely to be many tens of billions of dollars—costs that can never be recovered. Iran might consider that since these costs have already been incurred, at least something can be recovered by continuing the program—but developing more advanced centrifuges will involve massive additional expenditure: financial transparency would very likely reveal that Iranian centrifuges are nowhere near competitive with the market price for SWU.

It is also necessary to look at opportunity costs—the impact on the economy of allocating substantial funding and scarce skilled resources to enrichment rather than to more productive areas. In the case of Iran, for example, what would be the outcome if these resources were allocated to modernising the petroleum sector, to renewable energy projects, or to manufacturing and transportation?

By choosing to pursue enrichment in contravention of Security Council resolutions Iran incurred multi-billion dollar costs through the resultant sanctions. Nuclear sanctions have been lifted or suspended with the JCPOA, but meanwhile neighboring countries are increasingly nervous about the strategic implications of the Iranian program. At best this will result in heightened tensions and increased military expenditures in the region; at worst, other states will initiate sensitive nuclear programs. Either way, Iran's persistence with enrichment will incur substantial wider costs.

Rather than being a cause of regional tension—prompting others to develop matching capabilities—Iran could use its hard-won technological advantage in the region to negotiate region-wide limits on proliferation-sensitive technologies and establish itself as the regional leader in the development and utilization of nuclear energy. The JCPOA process can be central in normalising Iran's relations with the rest of the world. Non-proliferation proponents need to engage with Iran, to encourage and support Iran in using this opportunity to mutual advantage. The NPT provides the foundation for states to enjoy the benefits of peaceful uses of nuclear energy, free from the danger of nuclear threats and nuclear war.

It is misreading the NPT to emphasize national interests over and above the interest of all states in maintaining international peace and security. A multinational approach that delivers the benefits of nuclear energy in a cost-effective way, and avoids the risks, clearly fulfils the promise of the NPT.

7. Conclusions and recommendations

Iran has shown the dangers in the current nuclear order, where a state can build the option to develop a military capability in the guise of a peaceful program. For those who don't think critically about the consequences, this may seem acceptable under the NPT, but it undermines the peace and security that the non-proliferation regime is meant to provide, and ultimately works against the interests of all states, including Iran itself. It is essential to use the 15-year window provided by the JCPOA to find a different trajectory for the Iranian nuclear program, one that will sustain a peaceful outcome. At the same time an approach is needed that will avoid similar challenges arising in the future.

The United States, other JCPOA partners, and non-proliferation proponents generally should take several near-term steps in relation to Iran. These include:

- High-level engagement with Iran aimed at normalizing diplomatic relations and reducing regional tensions.
- Establishing an ongoing dialogue with Iran on strategic issues.
- Pressing and assisting Iran to join the key multilateral nuclear energy treaties referred to earlier. Iran's nuclear power program should not proceed outside these global norms and standards.
- Encouraging Iran to structure its nuclear activities on a normal corporate/commercial basis, and to establish an independent nuclear regulator.
- Encouraging Iran to ratify the CTBT.
- Encouraging Iran to participate constructively in the development of a regional WMD-free zone.
- Commencing dialogue with Iran on its post-JCPOA nuclear program.

In addition, there are generic issues that should be pursued, such as:

- Promoting greater understanding by the international community that: (i) nuclear latency presents a potential risk to NPT objectives; and (ii) nuclear hedging is a threat to international peace and security and should not be accepted.
- Promoting the norm that national enrichment programs should be limited to the scale needed to meet demonstrated fuel needs on an economic basis, having regard to available sources of supply.
- Developing a multilateral approach to the fuel cycle, including long-term fuel supply assurances and collaborative approaches to spent fuel management.
- Promoting practical steps towards a Middle East WMD-free zone, including negotiation of a fissile material production treaty and development of regional verification and monitoring arrangements.
- More generally, action by the nuclear-weapon states to de-emphasize the role of nuclear weapons and to achieve greater progress towards nuclear disarmament would have a positive effect on non-proliferation efforts.

It is time to work seriously on establishing a new international framework for nuclear energy based on multinational and collaborative approaches, not only to prevent a future Iranian nuclear crisis, but also to avoid crises in areas not yet even on the radar.

About The Project on Managing the Atom

The Project on Managing the Atom (MTA) is the Harvard Kennedy School's principal research group on nuclear policy issues. Established in 1996, the purpose of the MTA project is to provide leadership in advancing policy-relevant ideas and analysis for reducing the risks from nuclear and radiological terrorism; stopping nuclear proliferation and reducing nuclear arsenals; lowering the barriers to safe, secure, and peaceful nuclear energy use; and addressing the connections among these problems. Through its fellows program, the MTA project also helps to prepare the next generation of leaders for work on nuclear policy problems. The MTA project provides its research, analysis, and commentary to policy makers, scholars, journalists, and the public.

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