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THE ELLIOTT SCHOOL
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THE INSTITUTE FOR MIDDLE EAST STUDIES

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**U.S.-IRAN ENERGY DIPLOMACY: AN ANALYSIS OF THE POTENTIAL FOR
RENEWABLE ENERGY PARTNERSHIPS TO SERVE AS A VEHICLE FOR
DÉTENTE WITH IRAN**

THOMAS BUONOMO

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Executive Summary

The Joint Comprehensive Plan of Action (JCPOA) parameters concluded between Iran and the P5+1 on 2 April 2015, if consummated in a final nuclear agreement, would buy 10-15 years of time for the international community and the U.S. in particular to work toward détente and devise a more sustainable solution to the security dilemma created by Iran's nuclear program, after which its safeguards would begin to be eased (or the agreement was extended). Much could change over this time, including reductions in the cost of renewable energy and improvements in thermal and electric storage that would place renewables on par with nuclear energy and incentivize their market growth over nuclear in Iran (and throughout the broader MENA region).

Given that a better nuclear deal is probably not possible and that attempting to exert additional leverage through sanctions and military threats would probably result in the collapse of the negotiations and the international sanctions regime itself, U.S. policymakers should pursue the consummation of a final nuclear deal by the end of June 2015 and use the time it would buy to pursue détente. Partnership between the U.S. and Iran on renewable energy research and development as well investment in the expansion of a domestic Iranian renewable energy industry could serve as a vehicle toward this objective.

Although policymakers should remain clear-eyed about the possible dual purpose of Iran's nuclear program and the regional conflicts that will continue to complicate efforts toward détente for the foreseeable future, they should not assume that Iran's

revolutionary ideology dictates implacable hostility toward the U.S. or even Israel or that Iran's nuclear program is not guided by a cost-benefit analysis—it is, albeit one influenced more by pride, politics, and its own threat perceptions than by economics.

The relative weight of these variables is not necessarily constant, however, and by taking steps to reduce Iran's threat perceptions and affirm its dignity the U.S. may open up opportunities to influence Iran's political economy in favor of renewables. Indeed, if conventional wisdom in Washington had prevailed, diplomacy with Iran would never have achieved what it has up to this point and the U.S. and Iran would likely be on the path to war.

Iran will likely still have a nuclear program in 10 or 15 years assuming events continue along their current trajectory but it need not expand to a scale that would effectively preclude early warning of a weapons breakout effort. There is also in principle no reason why the anticipated terms of the final nuclear agreement could not be renegotiated and extended in 10 years but the chances of this occurring would be much higher if the relationship between the U.S. and Iran had substantially improved.

Accordingly, this paper reviews:

- specific actions the U.S. could take to promote renewable energy market growth in Iran;
- the benefits and shortcomings of the JCPOA parameters and the ostensible and alleged motives driving Iran's nuclear program;

- energy industry and governmental agency analysis of the comparative economics of renewable versus nuclear power;
- Iran’s renewable energy potential, policy incentives and obstacles to market growth; lessons learned from renewable energy deployment to date; and
- the most difficult foreign policy disputes beyond the nuclear issue that will have to be resolved in order to achieve détente with Iran.

Specific Support the U.S. Could Provide to the Development of Iran’s Renewable Energy Markets and Industries

Although Iran has a nascent renewable energy industry, it is not nearly as developed and has not been given the same high-level political prioritization as Iran’s nuclear program. This is partly because renewable energy technologies have not matured as quickly as nuclear energy technologies as well as because Iranian senior officials have built up Iran’s nuclear program as a symbol of Iran’s independence—arguably due more to U.S. opposition to it than to its actual economic or security value. Therefore policy initiatives that counter the narrative of an implacably hostile U.S. government bent on hindering Iran’s technological progress could influence the psychology of Iranian officials in such a way that they become less fixated on defining the value of Iran’s nuclear program in terms of defiance and become more focused on assessing its economic cost-benefit analysis in comparison with other energy technologies.

U.S. policymakers would be wise to support not only the development of renewable energy markets in Iran but also domestic industries there that would have a financial

stake in competing for market share with Iran’s nuclear industry. Efforts by foreign powers to impose foreign-owned technology, projects, and industries on Iran are likely to face suspicion if not outright hostility. U.S. policymakers should therefore focus on promoting R&D partnerships and technology-sharing initiatives, joint ventures in which Iranian partners hold equal or controlling stakes, and industries developed and owned largely by Iranians themselves. Genuine partnership demonstrates respect. U.S. support for this would require crafting policies that establish and maintain the primacy of this objective over promoting the growth of U.S. businesses and industries, although benefits to American businesses would perhaps be a natural outcome to some extent.

U.S. government entities are in fact already involved in promoting renewable energy market growth in various countries not including Iran at present. The Overseas Private Investment Corporation (OPIC), the U.S. government’s development finance institution, “mobilizes private capital to help solve critical development challenges and in doing so, advances U.S. foreign policy and national security objectives.... OPIC achieves its mission by providing investors with financing, guarantees, political risk insurance, and support for private equity investment funds.” Moreover, “...OPIC operates on a self-sustaining basis at no net cost to American taxpayers.”¹

In 2009 OPIC provided Indian company Azure Power with a \$6.2 million loan to build a 2 megawatt (MW) solar power facility in the state of Punjab, India—the largest at that time. It was completed in 10 months and provides sufficient power for 20,000 people in 4,000 rural homes distributed among 32 villages. In 2010 OPIC provided an additional \$26.8 million loan to Azure Power to construct a 10MW solar facility in the state of

¹ “[Who We Are](#).” OPIC. Last accessed 19 April 2015.

Gujarat, India. OPIC notes, “By supporting Azure Power’s early expansion and helping it demonstrate the success of its business model, OPIC also helped Azure Power attract other investors supporting the clean technology sector in India.”²

In 2014 OPIC approved a “loan facility of up to \$20 million to U.S. citizen Inderpreet Wadhwa, California-based venture capital firm Helion Venture Partners, and Azure Power for a 19MW portfolio of rooftop solar generation systems...providing environmentally benign energy to a projected 100,000 customers.” Azure Sunlight (subsidiary of Azure Power) is designated as the “turnkey construction contractor as well as operations and maintenance provider.” OPIC notes in its public information summary of the contract, “Solar power in India has already surpassed diesel-based power in terms of economic viability and is now rapidly moving towards grid parity. The market potential for grid connected photovoltaic rooftop solar is estimate to be a minimum of 20 [gigawatts] (GW) for the next 10 years.”³

On 30 September 2014 OPIC also committed to provide solar company SunEdison with up to \$25 million (out of a total project cost estimate of \$63.2 million) for a 50MW solar PV project in the Ma’an Development Zone, Ma’an, Jordan.⁴

Also in 2014, OPIC approved a \$250 million loan for a \$1.1 billion concentrating solar solar (CSP) plant with a net capacity of 110MW in the Negev Desert in Israel. OPIC’s project summary states, “Negev Energy-Ashalim Thermo-Solar Ltd. (‘Negev Energy’), a

² [“OPIC in Action: Azure Power: OPIC loans fund India’s first large-scale solar power plants.”](#) 2011. Last accessed 19 April 2015.

³ [“OPIC in Action: All Project Descriptions.”](#) Last accessed 19 April 2015.

⁴ Ibid.

limited liability company incorporated under the laws of Israel, has entered into a Build-Operate-Transfer (‘BOT’) Concession with the State of Israel for a 25-year operation period, and a 25-year power purchase agreement (‘PPA’) with the Israel Electric Corporation (IEC’), the state-owned electricity utility. IEC will purchase 100% of the electricity generated by the new power plant under PPA, which is guaranteed by the government of Israel (‘GOI’).” The U.S. sponsor is Abengoa Solar LLC and the foreign sponsor is Shikun & Binui Renewable Energy Ltd.⁵

The U.S.-Africa Clean Energy Finance Initiative (ACEF), developed by OPIC, the U.S. State Department, the U.S. Trade and Development Agency (USTDA), and the U.S. Agency for International Development (USAID), is a four-year program intended to catalyze private sector investment in countries throughout Africa, including Algeria, Morocco, and Tunisia, by “providing support for early stage project development costs.” These include

- “engineering costs, associated with project design, technology assessment, and overall feasibility studies
- “legal costs for preparation of documentation related to permitting, PPAs, EPCs, O&M, and financing agreements
- “consulting costs for the preparation of environmental and social impact studies
- “third-party costs associated with physical and technical analysis of renewable resources”

⁵ Ibid.

Under ACEF, OPIC provides “fixed rate, long-term financing through direct loans or loan guarantees up to \$250 million with tenors [i.e. loan terms] extending up to 20 years.” It also provides “coverage for protection against investment risks in emerging markets up to \$250 million, including governmental interference (e.g. expropriation, changes in law, and breach of contract by a government off-taker), political violence, and currency inconvertibility. Specifically for Renewable Energy projects, OPIC has expanded its expropriation coverage to protect investors against unforeseen changes in regulations that could result in reduction in feed-in tariffs during the life of the project.” Lastly, OPIC “provides support for the creation of privately-owned and managed investment funds, including renewable energy and renewable resources investment funds.”⁶

The U.S. Department of Energy, perhaps under the auspices of the National Renewable Energy Laboratory, could also provide technical support to maximize the efficiency of solar project deployments, along the lines of what German aerospace research center DLR (under the Institut für Solarforschung) is doing elsewhere in the MENA region with its enerMENA Meteo-Network: a network of meteorological stations intended to supply data, particularly Direct Normal Irradiance, necessary to optimize CSP technology. “In the first phase of the project, eight high-precision meteorological stations are being installed in five MENA partner countries [Algeria, Egypt, Jordan, Morocco, and Tunisia] to set up a base for the enerMENA Meteo-Network. The obtained meteorological data...is available for all parties working on CSP related R&D activities in the region. It

⁶ ACEF Factsheet: “U.S. Africa Clean Energy Finance Initiative (ACEF): Catalyzing private sector investment in African clean energy solutions.” Downloadable via webpage “[How OPIC supports renewable resources in the developing world](#).” Last accessed 19 April 2015.

can be used also for the preparation of feasibility studies, project performance calculations, support for project financing and solar power plant operation monitoring.”⁷

To provide a clearer sense of current solar power project capacities and costs, a partial dataset of select operational and under-construction CSP projects can be found in figure 1.

Figure 1: Select CSP Project Data (operational unless otherwise noted)

Country	Project	Irradiance (kWh/m ² /day)	Power Capacity (Net) (MW)	Storage Capacity (hours)	PPA (US\$/kWh (nominal))	PPA Period (years)	Cost (billion US\$) (nominal)
Algeria	ISCC Hassi R'mei		20	0		25	0.340
India	Dhursar		125	0	0.19	25	0.336
India	Diwakar*		100	4	0.17		
India	Godawari		50	0	0.20	25	
India	Gujarat Solar One*		25	9			
India	KVK Energy *		100	4			
India	Megha Solar Plant		50	0	0.18	25	0.136
Morocco	Noor I*	7.22	143	3	0.16	25	1.13
Spain	Andasol-1	5.85	50	7.5	0.29	25	
Spain	Andasol-3	6.02	50	7.5			0.340
UAE	Shams 1	5.29	100	0		25	0.600
U.S.	Solana Generating Station		250	6		30	2
U.S.	Genesis		250	0		25	
U.S.	Ivanpah	7.44	377	0		25	2.2
U.S.	Mohave		250	0		25	1.6
U.S.	Crescent Dunes*	7.36	110	10	0.135	25	

* Under construction

Source: NREL⁸

⁷ “[enerMENA Meteo-Network](#).” DLR Institut für Solarforschung. Last accessed 20 April 2015.

⁸ “[Concentrating Solar Power Projects](#).” NREL. Last accessed 18 April 2015.

Best-Case Scenario of an Iran Nuclear Agreement

Having highlighted how the U.S. is currently supporting renewable energy market development in various parts of the world, it is important to discuss in further detail why such an initiative is important to U.S.-Iran relations and the stability of the Middle East.

Prior to the framework nuclear agreement Iran and the P5+1 concluded on 2 April 2015, the Atomic Energy Organization of Iran declared that its long-term goal was to produce 20,000 megawatts (MW) of electricity from nuclear power plants and the Iranian parliament passed legislation requiring the Atomic Energy Organization of Iran (AEOI) to meet this target by 2025.⁹ Although this is an overly ambitious target even without the constraint of international sanctions, it is in any case equal to 20 nuclear power plants with the capacity of Iran's Bushehr reactor, which has an electricity production capacity of 1,000MW.

Iran's Supreme Leader, Ayatollah Ali Khamenei, declared during a 7 July 2014 speech that Iran would need a uranium enrichment capacity of 190,000 separative work units (SWU) according to the country's nuclear energy officials, caveating, "It is possible that we will not need this number of SWUs this year and in two, five years from now, but this is the definite need of the country."¹⁰ The head of the AEOI, Ali Akbar Salehi, clarified that Iran would need a uranium enrichment capacity of 190,000 SWU after 2021, when

⁹ The Embassy of the Islamic Republic of Iran in Oslo. "[Basic Facts About Iran's Peaceful Nuclear Activities](#)." Last accessed 5 April 2015.

Atomic Energy Organization of Iran. "[A Brief Introduction to the Atomic Energy Organization of Iran](#)." Last accessed 5 April 2015.

¹⁰ "[Supreme Leader's Speech in Meeting with Government Officials](#)." Center for Preserving and Publishing the Works of Grand Ayatollah Sayyid Ali Khamenei, 7 July 2014.

its nuclear fuel contract with Russia for Iran's Bushehr reactor is set to expire. This capacity would also be sufficient to fuel Iran's Arak reactor and Tehran Research Reactor, according to Salehi.¹¹

Even without a significant stockpile of low- or medium-enriched uranium, this would certainly provide Iran with an imminent nuclear weapons breakout capability of perhaps a few weeks or even days at most. One can base this rough estimate on the official U.S. calculation of a breakout time of 2-3 months before Iran began implementing the Joint Plan of Action (predecessor to the JCPOA parameters) in February 2014, when it had roughly 10,000 IR-1 centrifuges in operation and another 10,000 installed.¹²

Although the 2 April 2015 JCPOA has delayed if not nullified Iran's ostensible nuclear power production capacity targets, the international community may find itself facing the same or a more imminent security dilemma after the expiration of a JCPOA (assuming it is concluded around the end of June and the U.S. Congress or Iran's Supreme Leader does not abrogate it).

The framework JCPOA, as published on the U.S. State Department's website on 2 April 2015, commits Iran to limit its enrichment capacity to 5,060 IR-1 centrifuges (with a capacity of <2 SWU per centrifuge, according to Salehi) for 10 years. It also commits Iran to limit its level of uranium enrichment to 3.67% for "at least 15 years", as well as its stockpile of this low-enriched uranium (LEU) for 15 years. It would not be permitted to

¹¹ "[Salehi: Iran's 3 Proposals on Fordo Trust Building, Flexibility.](#)" IRNA, 9 July 2014.

¹² Patricia Zengerle. "[Kerry Says Iran Nuclear 'Breakout' Window Now Seen as Two Months.](#)" Reuters, April 8, 2014.

build additional uranium enrichment facilities for 15 years and would be held to a breakout timeline—defined as “the time that it would take for Iran to acquire enough fissile material for one weapon”—of “at least one year, for a duration of at least ten years”. Enrichment activity would be limited to Iran’s Natanz facility. Use of advanced centrifuges would be prohibited for “at least ten years”, although Iran would be permitted to conduct R&D on advanced centrifuges “according to [an unspecified] schedule and parameters which have been agreed to be the P5+1.”¹³

Although the JCPOA parameters commit Iran to adhere to the Additional Protocol of the IAEA permanently, it does not require an exhaustive review of the former to comprehend that the final JCPOA would delay and temporarily alleviate but not solve the security dilemma presented by Iran’s nuclear program. To be sure, much could change in the span of 10 or 15 years. Iran’s 75 year-old and reportedly ailing Supreme Leader could be succeeded by a more pragmatic, less paranoid and ideologically strident leader, which could facilitate more moderate Iranian foreign policies and improved diplomatic relations. A successful conclusion of the JCPOA negotiations could itself have positive effects on Khamenei’s perceptions of the U.S., leading to some measure of detente over the course of a decade and perhaps a conditional non-aggression pact with Israel that might in turn empower Israeli moderates and generate momentum toward a two-state solution that would obviate the justification for Iran’s hostility. Moreover, there is in principle no reason why the JCPOA or elements of it could not be extended, although it is perhaps

¹³ U.S. Department of State, Office of the Spokesperson. “[Parameters for a Joint Comprehensive Plan of Action Regarding the Islamic Republic of Iran’s Nuclear Program](#).” 2 April 2015. Last accessed 4 April 2015.

impossible to assess whether Iranian officials' expectations, now raised by the agreement, would preclude this.

Consummation of the JCPOA may be just as likely to trigger a nuclear arms race in the region, however, leading to a more precarious situation at the expiration of the agreement if regional dynamics did not cause the agreement to collapse before its expiration. U.S. Senator Lindsey Graham stated unequivocally at a Council on Foreign Relations event on 23 March 2015, "All of the Arab regimes have told me to my face that if the Iranians get a nuclear capability, they'll match it."¹⁴ Rumors abound of Saudi Arabia negotiating or having negotiated an agreement with Pakistan to acquire nuclear weapons directly from them as a hedge against Iran's nuclear capability. In 2011, Saudi Arabia announced plans to construct 16 nuclear power reactors over a period of 20 years after the monarchy declared, "The development of atomic energy is essential to meet the kingdom's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources."¹⁵

In summary, although the JCPOA would buy the international community time to come up with a more tenable long-term solution to the Iranian nuclear dilemma, it does not itself actually solve the problem unless one assumes that it would be indefinitely extended. What are the options moving forward then, assuming a successful conclusion to the P5+1 negotiations with Iran by the beginning of July?

¹⁴ "[Lindsey Graham on Iran's Nuclear Program](#)." Council on Foreign Relations, 23 March 2015.

¹⁵ Olli Heinonen and Simon Henderson, "[Nuclear Kingdom: Saudi Arabia's Atomic Ambitions](#)." The Washington Institute for Near East Policy, 27 March 2014.

123 Agreement

One is a “123 Agreement” with Iran. Senator Graham noted in a speech before the Council on Foreign Relations on 23 March 2015 that the U.S. has signed such agreements with 27 countries including Egypt, Turkey and UAE that enable them to acquire access to U.S. nuclear technology, technical support, and reactor fuel as well as retain the right to their own nuclear reactors in exchange for a commitment not to establish a domestic enrichment capability.¹⁶ Graham declared, “I have zero problem with the Iranians having a peaceful nuclear capability.”¹⁷

This suggests that on the U.S. side at least, a 123 Agreement with Iran would be a politically viable alternative to the JCPOA. This scenario would seem to be precluded by Iran’s stated determination to eventually establish a much more expansive domestic uranium enrichment program, however, as well as the expectations established by the JCPOA parameters, which would probably be exceptionally difficult for the U.S. to convince Iran to reconsider after having committed to them on 2 April 2015. Getting Iran to yes on such a concession would probably at the very least require the international community to pay for enrichment costs for Iran’s future nuclear energy production and compensate it for billions of dollars in past expenditures on its domestic enrichment program in exchange for dismantling it. Given Khamenei’s emphasis on minimizing reliance on foreign powers, deep distrust of the U.S., and U.S. substantiation of his

¹⁶ “[123 Agreements for Peaceful Cooperation](#).” National Nuclear Security Administration. Last accessed 5 April 2015.

For a summary of the provisions of 123 Agreements, refer to Paul K. Kerr and Mary Beth D. Nikitin, “Nuclear Cooperation with Other Countries: A Primer.” Congressional Research Service, November 4, 2014.

¹⁷ “[Lindsey Graham on Iran’s Nuclear Program](#).” Council on Foreign Relations, 23 March 2015.

distrust by obstructing Iran's pursuit of nuclear reactor technology and fuel on the international market (among other issues), in all likelihood this would be a non-starter.

Ambassador Seyed Hossein Mousavian, quoting Shahir Shahidsaless, writes, "Iran's nuclear program has become an important symbol of national pride. 'The Iranian leadership has constantly linked Iran's nuclear program to the nation's pride and dignity (*ezzat-e melli*). To surrender to pressures and suspend that program is tantamount to betrayal and abandoning the nation's dignity. In such cases, the Iranian leadership will lose its authority and stature among grassroots supporters and rank-and-file conservatives. Simply put, the *nezam* (Iran's political system) cannot afford the costs of such a decision.' The Iranian leadership also believes that to retreat under coercion would simply encourage further pressure from America, resulting at best in the Iranian system losing its independence, at worst in its downfall."¹⁸

Diako Hosseini, analyst with the Institute for Political and International Studies of Iran's Ministry of Foreign Affairs, sees continuity between Iran's nuclear motives and policies under the Shah and the Islamic Republic, describing Iran's nuclear program partly as an element of a hedge strategy. He writes that the Shah "was trying to [demonstrate] his competence...and was terrified by his shaky legitimacy and he thought maybe some saber-rattling [would] help him to fix it. In the foreign policy [arena], [the nuclear program] sent a clear message to potential and actual enemies: Iran could not accept [being] left behind technologically and if [necessary], could transform [its] peaceful

¹⁸ Seyed Hossein Mousavian. *Iran and the United States: An Insider's View on the Failed Past and the Road to Peace*. Bloomsbury, 2014. Pages 276-277.

nuclear program to [a military program]. The Islamic Republic is [continuing this policy]. We know that Iran is located in the most dangerous region of the world and surrounded by a few nuclear powers. According to IAEA's reports there is no specific evidence that Iran has been diverting from peaceful use but I believe this temptation would be there in the coming decades [even if a nuclear agreement is concluded], unless the U.S. and Iran [engage] in deep strategic negotiations. I believe reaching a nuclear agreement will pave the way toward this.”

He continues, “You should know that for years Iranians have engaged in very serious debates on the economic justification of nuclear energy. I think it is irrelevant to the current crisis around the nuclear program because according to the [prevailing Iranian view], the progress, enormous costs and structural development of the nuclear establishment are irreversible. Most Iranians think that political negotiations between Iran and the P5+1 are correlated with Iran's national honor and its final results will determine Iran's standing in the world. In other words, [this is a matter of] self-esteem. This doesn't mean that Iran's political positions in negotiations are inflexible or the final deal is unattainable. Any proposal to Iran should [be in accord with] Iran's legitimate and basic rights according to the NPT, international justice and maintain Iran's national prestige.”¹⁹

Nasser Hadian, Professor of Political Science at Tehran University, stated in an interview with me, “There is a security [dimension to the program] because we feel that it has made us an international player. Why is the West interested in us? Because of the capability

¹⁹ Email correspondence with author, 16 January 2015.

we have developed. And we think it is our right. And if we are going to limit the exercise of our rights we want something in return for it. We have invested so much in it and [if we turn back now] everyone would question the legitimacy of the government. [It would raise the question], what did we suffer so much for? But for sure, a good economic offer would be extremely important for the limitation of the nuclear program, qualitatively and quantitatively, for adopting a much more intrusive inspection regime, and for accepting a longer-term limitation on the program.”

“What would a good economic offer look like?” I asked him. “Investment in oil and gas infrastructure,” he replied. “This is extremely important. Simply lifting sanctions would enable this.”²⁰

“Would you say renewables are a priority in Iran?” I responded. “The vice president in charge of the environment [Masoumeh Ebtekar] is very pro-renewable energy but [it is not a high-level priority].”²¹ Whether this is because renewables are still considered nascent technologies, because they do not have an established lobby of the nuclear program’s stature, or because the nuclear program is a cover for a weapons program is unclear. This is worth exploring however.

Perhaps a more viable alternative to a 123 Agreement would be to attempt to shift Iran away from the nuclear track over the duration of the JCPOA so that by the time it expired or was renegotiated, Iran’s ostensible economic and alleged security motives for an

²⁰ Audio-recorded interview with writer, 19 January 2015. 9:35-11:45

²¹ Audio-recorded interview with writer, 19 January 2015. 14:25-16:10.

expansive nuclear program would be minimized and its economic incentives for renewable energy would be maximized. It would almost certainly still have a domestic uranium enrichment program at the end of the JCPOA's expiration but that program might be much smaller and manageable in terms of monitoring and verification if Iran could satisfy much of its domestic energy demand with renewable energy.

It should be emphasized, however, that economics is not the primary variable influencing Iranians' cost-benefit analysis of their nuclear program. Technological prestige, pride, and sheer determination and resolve, hardened by decades of international obstruction, should not be underestimated; nor should Iran's threat perceptions or hegemonic ambitions be discounted simply because Iran has demonstrated a willingness to take a pragmatic and patient approach toward its nuclear expansion. The U.S. and Iran will have to address their broader foreign policy disputes in order to avoid ending back where they started or in an even more tense security posture at the expiration of the JCPOA (if the plan is successfully concluded). Although these foreign policy disputes and recommendations on how to solve them are largely outside the scope of this paper, they are outlined briefly at the end of it to emphasize that energy economics could be an important facet of a strategy for pursuing detente with Iran but would not be sufficient on its own.

Energy diplomacy could nevertheless build diplomatic goodwill in a substantive way that would help Iran to meet its ostensible economic and energy security goals and dispel the

views of senior Iranian officials that the U.S. is trying to hinder Iran's technological potential, economic growth, and independence.

What are the realistic alternatives to nuclear energy however? The most current forecasts vary on when various renewable energy sources will reach cost parity with nuclear energy but some of the more sanguine assert that they already have in some geographic locations, albeit not with the same reliability as nuclear power given the intermittency of sources such as wind and solar. (This could change in the near future depending on prioritization of policies and regulations structured to incentivize long-term, large-scale investments as well as on-the-horizon battery storage technologies.) Before delving further into the subject of renewables, however, it is worth examining the arguments for and against Iran's nuclear program in more detail.

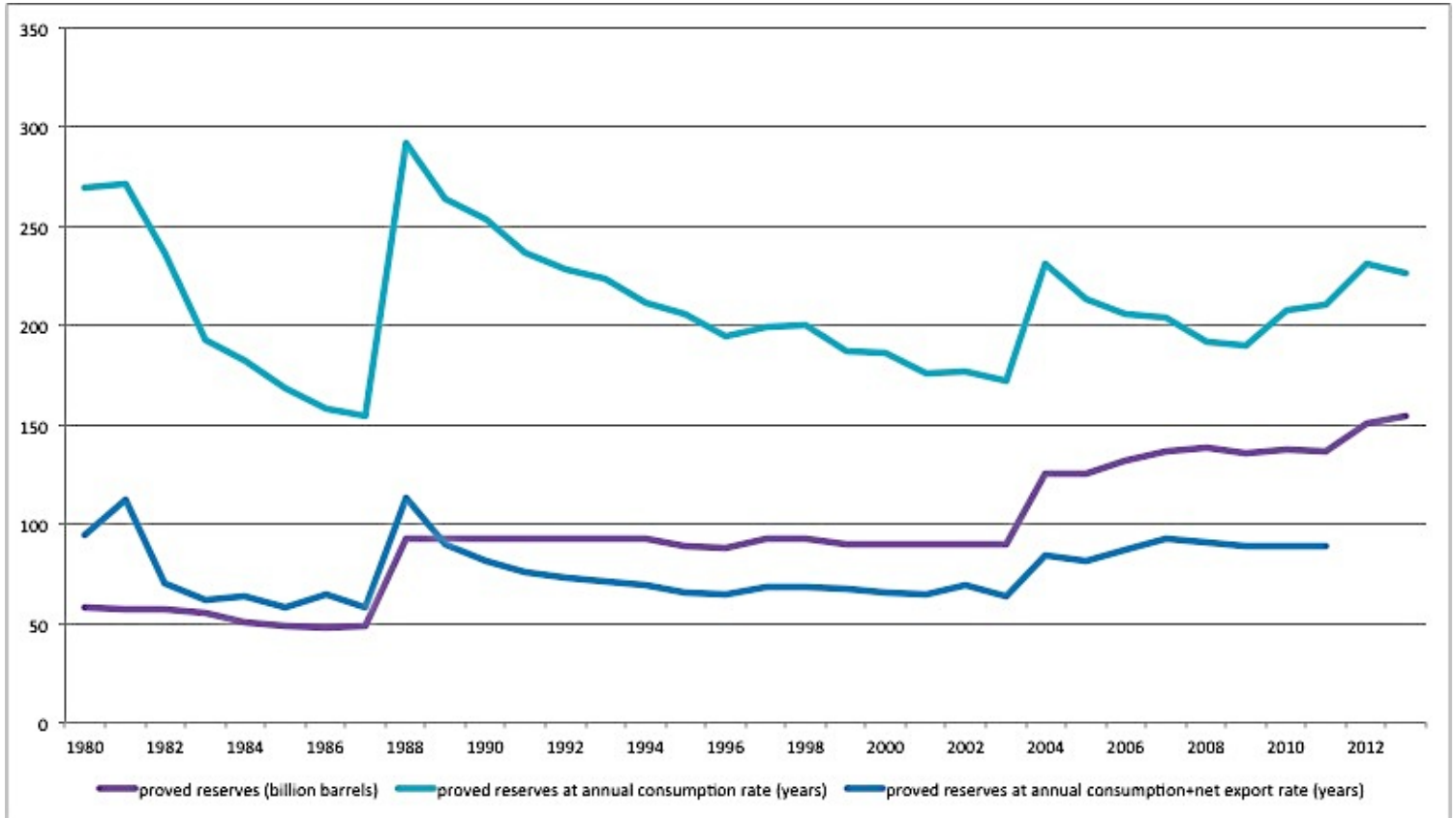
Arguments For and Against a Domestic Nuclear Enrichment Capability

Iranian officials have made three arguments in support of their pursuit of nuclear technology:

- it would enable them to diversify their energy portfolio and thereby reduce their domestic consumption of oil and gas products that could otherwise be exported for profit or used to produce higher value petrochemical products (Iran has also imported hundreds of millions of tons of coal for decades) (see figures 2-4 below);
- it is needed to produce medical isotopes to treat cancer patients;

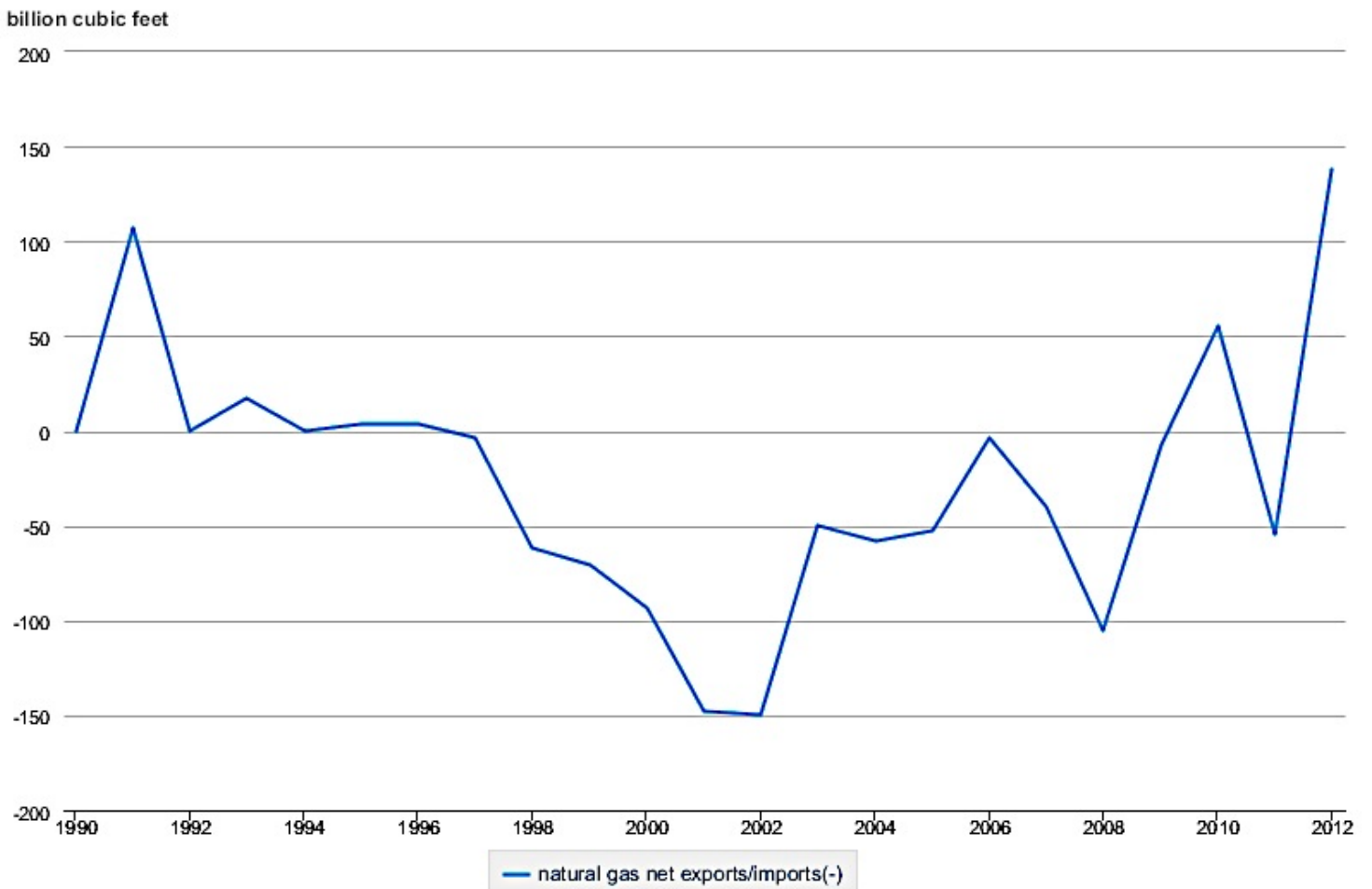
- it would enhance Iran’s national self-image and international prestige as its citizens demonstrate their scientific and technological abilities to the world.

Figure 2: Iran Proved Crude Oil Reserves
(in terms of billions of barrels and estimated years left at annual domestic consumption and net export rates)



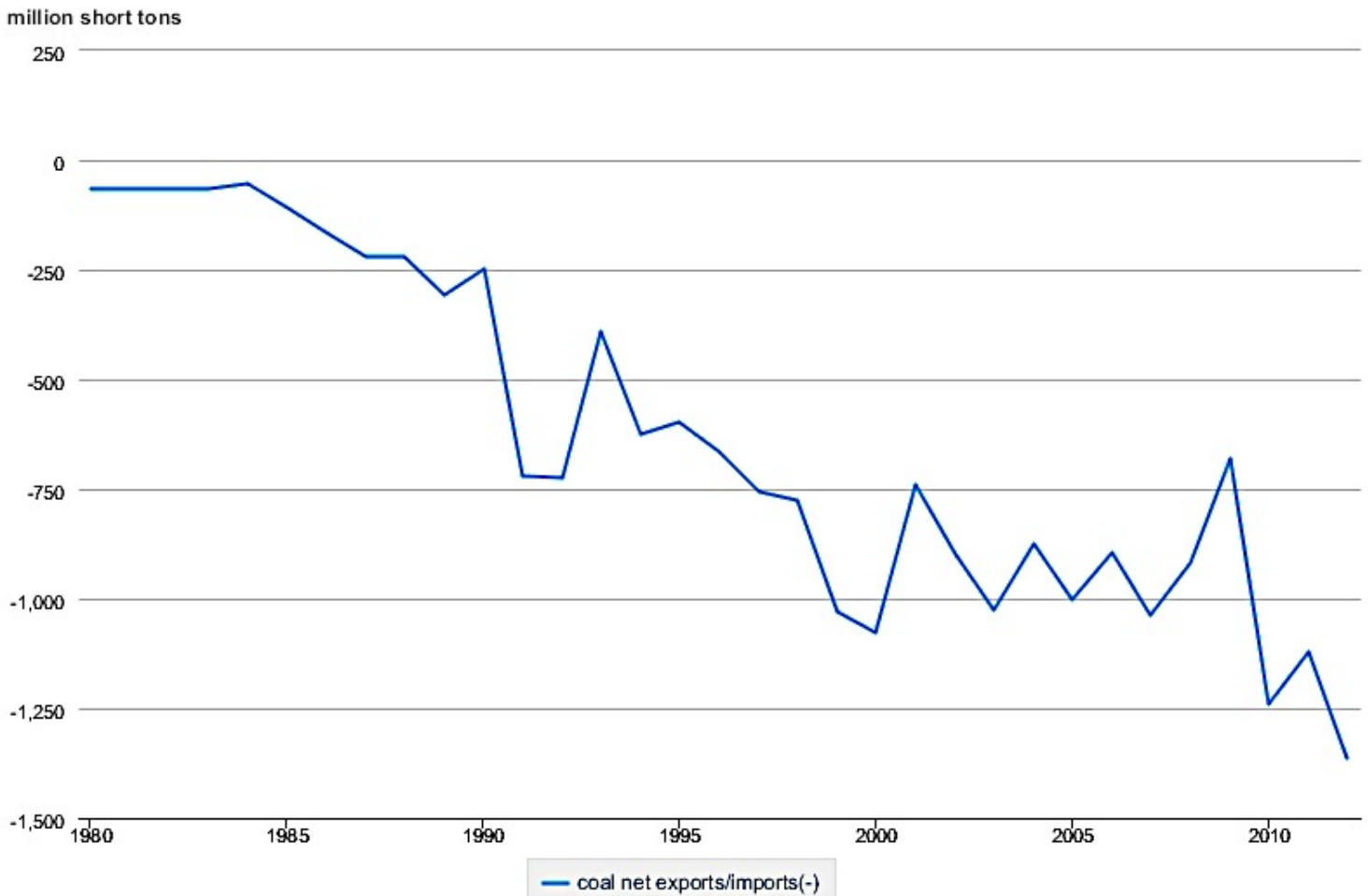
Source: analyst calculations based on U.S. EIA data

Figure 3: Iran Natural Gas Net Exports/Imports (-) (billion cubic feet)



Source: U.S. EIA

Figure 4: Iran Coal Net Exports/Imports (-) (million short tons)



Source: U.S. EIA

Skeptics including perhaps most prominently Karim Sadjadpour and Ali Vaez have expressed doubt that Iran would endure more than a decade of increasing international isolation and sanctions for a civilian nuclear power program and correctly note that if Iran wanted to acquire low-enriched uranium for nuclear power reactors it could do so on the international market for a much lower price than what it would cost to produce it domestically, where its uranium reserves are also highly limited.²²

²² Karim Sadjadpour and Ali Vaez. *Iran's Nuclear Odyssey: Costs and Risks*. Carnegie Endowment for International Peace and Federation of American Scientists, April 2, 2013.

Ambassador Seyed Hossein Mousavian dismissed these points, stating, “The economic considerations are secondary.... From the beginning Iranian officials have considered that it may not be economical to have a domestic enrichment capability—that’s why they sought for 15 years to import fuel. When the world led by the U.S. didn’t cooperate, they had no other option. Iran has the Tehran Research Reactor [used to produce medical isotopes], a million cancer patients, and the Bushehr [nuclear power plant], and it has to provide the fuel for them.”²³

Likewise, Nasser Hadian stated, “I don’t want to say economics doesn’t play any role but for sure it doesn’t play a primary role. Thus only economic reasoning and incentives are not going to convince Iranians to limit the [nuclear] program. There is a developmental and scientific part to it as well.”²⁴

It is clear from these statements that however economically rational Sadjadpour and Vaez’s study may be, it divorces economics from politics, the latter of which seems to be more important in the view of Iranian government officials. These officials appear to have calculated—correctly, it seems—that if they demonstrated their resolve to acquire a nuclear capability, the international community would eventually acquiesce to it and allow them to purchase uranium ore at a lower cost on the international market and enrich it themselves. A domestic enrichment program could also allow Iran to import cheaper uranium ore, enrich it, and export it to other states without domestic enrichment capabilities for use in their own nuclear reactors.

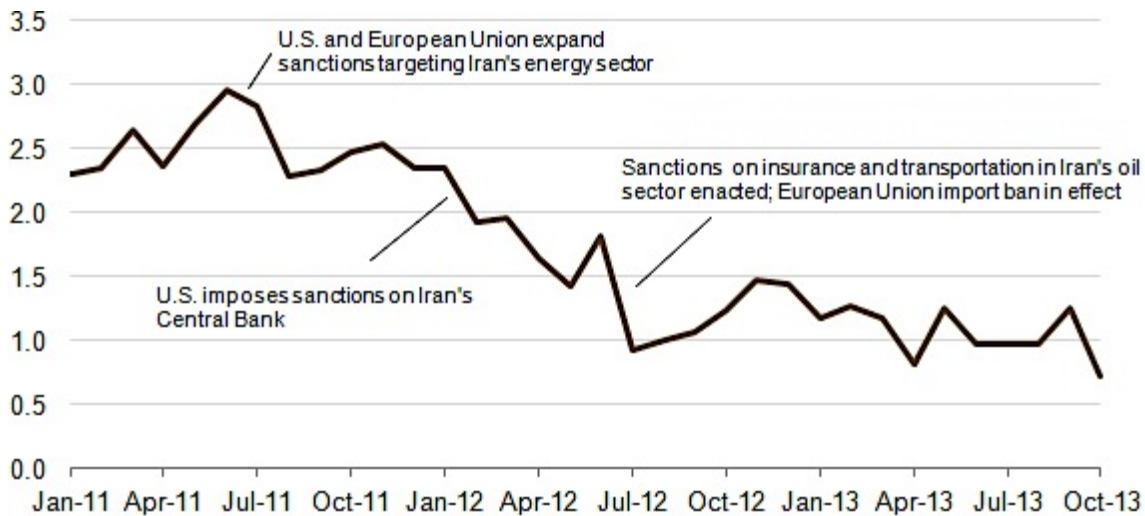
Uranium 2014: Resources, Production and Demand: A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency

²³ Email correspondence, 29 January 2015.

²⁴ Audio-recorded interview with writer, 19 January 2015, 6:30-7:10.

Sadjadpour and Vaez’s study also does not account for the fact that until 2011-2013, sanctions were a hindrance to Iran’s economic growth but did not do serious damage to its economy, much less threaten the stability of the regime, as shown in Figure 5 below.

Figure 5: Iran Crude Oil Exports (million barrels per day)



Source: U.S. EIA

It was also not until 2013 that the stars aligned between the Rouhani and Obama administrations and the two convinced each other of their sincerity in wanting to explore the possibility of coming to a compromise.

CIA Director John Brennan’s conclusions partly corroborate these points. He attributed the most constricting sanctions imposed in the Obama administration’s second term, as well as President Rouhani’s pragmatism and warnings to the Supreme Leader of the damage they were causing to Iran’s economy, as the main reasons why Iran moderated its position in the nuclear negotiations.²⁵

²⁵ David Sanger. “C.I.A. Director Says Iran’s Economic Peril Helped Drive Nuclear Deal.” The New York Times, April 8, 2015.

The Bush administration's diplomatic approach to Iran, in contrast, was a non-starter—particularly after it rejected the Iranian government's overtures, reportedly made with the tacit approval of the Supreme Leader.²⁶ Iran would not be threatened into ceding recognition of its rights under the Nuclear Non-Proliferation Treaty. Certainly it was not the first time in history that Iranian leaders' national pride trumped their fear of the potential consequences of defying one of the most powerful countries in the world.²⁷ The fact that they were willing to do so in the case of Iran's nuclear program may therefore be more indicative of the value they give to the principle of independence (and perhaps their underestimation of the economic consequences) than a nuclear weapons motive, although this remains to be seen considering their continuing obstruction of the IAEA's access to their Parchin military base.

Sadjadpour and Vaez also argue that Iran flares much of its natural gas and wastes more of it on costly subsidies. If Iranian officials were serious about improving the country's energy and economic security, these analysts argue, they would correct the perverse incentives that result in the squandering of its resources.

Although Iran has taken significant steps in this direction, it is politically challenging to remove subsidies generally, including in the U.S.²⁸ David Ramin Jalilvand writes that due to structural flaws within Iran's government, "It can be argued that there is an institutional bias in favour of (possibly short-term) factional interests at the expense of rational policies on the basis of a long-term national interest."

²⁶ Trita Parsi. *A Single Roll of the Dice: Obama's Diplomacy with Iran*. Yale University Press, 2013.

²⁷ Kenneth Pollack. *The Persian Puzzle: The Conflict Between Iran and America*. Random House, 2005.

²⁸ See, for example, David Kocieniewski, "[As Oil Industry Fights a Tax, It Reaps Subsidies](#)." The New York Times, July 3, 2010.

He continues, “Based on the revolution’s theme of social justice and in an attempt to promote economic diversification and industrialization, the Islamic Republic initiated the redistribution of incomes from oil revenues. Natural gas—besides food, fuel, and electricity, was provided for the Iranian people at highly subsidized prices for the past several decades. With \$80.8 billion or 22.6% of the GDP, in 2010 Iran’s subsidies were both in absolute and relative terms the largest throughout the Middle East and North Africa. ...They hampered the performance of the Iranian economy, for example by discouraging private investment in the energy sector as prices were below production costs. Equally, investments in energy efficient technologies were retarded. In the gas sector, low prices contributed to lack of incentives to recover around 37 bcm/y, which were flared, vented, or lost otherwise in 2011, representing almost 16% of the country’s gross production.” (The U.S.’s loss was 7%.)²⁹

Jalilvand notes that Iran has taken steps to address this problem however. He writes, “Several administrations realized the economic damage caused by subsidies but only in December 2010 were substantial price increases introduced. ...When the Ahmadinejad administration introduced a first round of—rather modest—price increases in 2007, riots sparked across the country. But besides public unrest, it was also feared a subsidy cut might trigger inflation, hurt the Tehran Stock Exchange, and bankrupt private as well as energy-intensive state enterprises. Nevertheless, the Ahmadinejad government announced in December 2010 that it would phase out all subsidies. Iran is the first and so

²⁹ David Ramin Jalilvand. “Iran’s Gas Exports: Can Past Failure Become Future Success?” The Oxford Institute for Energy Studies, June 2013. Pages 14-15.

far only country in the Middle East and North Africa to embark on a reform programme of this magnitude.”³⁰

Jalilvand caveats, “Iran’s total consumption continued to increase throughout 2011 and the first months of 2012, albeit at a slower rate. In previous years, consumption was growing by more than 5%/year whereas in 2011 the increase was 2.7%. The effect of the subsidy reform on this deceleration of growth, however, should not be overestimated. To some extent natural gas consumption fell in response to higher prices but another impact appears to come from the slowdown of economic development. The average real GDP growth in the period from 2000 to 2010 was 4.6% but only 2% in 2011 and -0.8% in 2012.”³¹

The economic effects of international sanctions appear to have had the unintended consequence of helping to spur reform. On 25 April 2014, President Rouhani reduced fuel subsidies after receiving approval from the parliament, resulting in a 75% increase in subsidized fuel from \$0.16 to \$0.28 per litre, saving the federal budget \$16 billion. Unsubsidized fuel prices were increased by 42% and heating fuels were increased by 25% in 2013.³²

Returning to renewable energy, not until this decade has it begun to become cost competitive with alternatives including nuclear. The Islamic Republic restarted Iran’s nuclear program in the 1980s, when renewables were nowhere near as competitive as they are today, and the nuclear program now has decades of bureaucratic and political

³⁰ Ibid, page 15.

³¹ Ibid, page 16.

³² Daniel Fineren. “[Iran parliament backs Rouhani plan for subsidy cuts.](#)” Reuters, 6 February 2014. “[Iranians brace for price hikes as government rolls back on subsidies.](#)” The Guardian, 28 April 2014.

inertia behind it, not the least of which includes the determination to demonstrate to the P5+1 that Iran will not be cowed into submission.

The structural and psychological dynamics driving Iran's nuclear program need not lead to an imminent nuclear weapons breakout capability however. Iran could retain the right to a domestic uranium enrichment capability for research and reactor fuel production and nuclear reactors for electricity generation while shifting its domestic electricity generation portfolio primarily to renewable energy if the economic incentives (or market conditions alone) rationalized such a decision. It would thereby achieve its ostensible goal of achieving recognition of its right to enrich under the NPT while forgoing the right of unlimited expansion of its nuclear program. In fact it has already committed to do so, albeit for a limited duration, under the JCPOA parameters.

In any case, the U.S. could potentially pursue détente with Iran in part by offering it technological, financial, and economic incentives to meet its ostensible economic and energy security goals via renewable energy, which some studies indicate have reached cost parity with nuclear energy or could in the near future. Certainly it is within the realm of possibility that this will occur over the 10- to 15-year duration of the JCPOA, particularly as energy storage technologies improve.³³

³³ On energy storage, see, for example, Mark Chediak, "Musk Battery Works Fill Utilities with Fear and Promise." Bloomberg, 5 December 2015.

The Comparative Economics of Renewable vs. Nuclear Power

Bloomberg New Energy Finance (BNEF), one of the leading consulting companies analyzing and forecasting trends in energy markets, assessed in the central scenario of its H1 2015 Global Levelized Cost of Electricity (LCOE) Outlook that geothermal is significantly less costly and solar photovoltaic (PV), onshore wind, and even solar thermal technologies are potentially cost competitive on a dollar per megawatt-hour basis (\$/MWh) with nuclear power in Europe depending on a number of variables including perhaps most importantly, in the case of Iran, the cost of finance.³⁴

BNEF cautions in its report, “A key driver of the LCOEs for all renewable energy technologies is the cost of finance, and specifically the cost of debt finance. The cost of availability of debt is a function of project risk and market conditions. The technology-independent portion of debt costs is the level of the underlying interest rate from which debt costs are calculated. The specific market in which a project is being financed can also have an effect on debt spreads through lenders’ perception of market-specific sovereign, policy, regulatory or economic conditions. The higher the perceived risk, the higher the cost of debt.”³⁵

³⁴ “H1 2015 Global LCOE Outlook: Solar continues its cost decline.” Bloomberg New Energy Finance, 13 March 2015, pages 3-4.

How BNEF specifically calculates LCOE is proprietary but it is a commonly used framework for comparing costs between different sources of electricity production. According to IEA, “The LCOE represents the present value of the total cost (overnight capital cost, fuel cost, fixed and variable operation and maintenance costs, and financing costs) of building and operating a generating plant over an assumed financial life and duty cycle, converted to equal annual payments, given an assumed utilization, and expressed in terms of real money to remove inflation.”

Technology Roadmap: Solar Thermal Electricity. IEA, 2014. Page 17.

³⁵ Ibid, page 3.

Technology advancements and market maturation have reduced solar PV LCOE from ~\$300/MWh in the second half of 2009 to less than half that in the first half of 2015.³⁶ The latter figure falls below \$80/MWh in BNEF's more optimistic scenario. It should be emphasized that the central scenario of BNEF's report bases cost analyses on a global average that is by definition weighted toward countries with high levels of solar deployment such as Germany, whose southernmost major city, Munich, sits at 48.13 degrees north latitude. Tehran, in contrast, situated in the northern part of Iran, sits at 35.7 degrees north latitude and therefore Iran can be expected to have a higher average irradiance value annually (although irradiance within a country varies significantly based on terrain, altitude, weather and atmospheric conditions, etc.). BNEF's LCOE calculation depends on variables including 'capacity factor', which will generally be maximized at lower latitudes not necessarily well-represented in the study.³⁷ BNEF's report therefore likely does not offer an adequate appreciation of the LCOE of solar energy based on higher capacity factor values in Iran.

In its January 2015 report, Fraunhofer ISE cites an average irradiance value of 2.89kWh/m² per day for Germany, one of the largest solar energy markets in the world due to the priority Germans have placed on addressing energy and economic security, the environment, and climate change (see figure 6 below).³⁸ The most economical areas for solar in Iran, comprising thousands of square kilometers in the south central part of the

³⁶ Ibid, page 9.

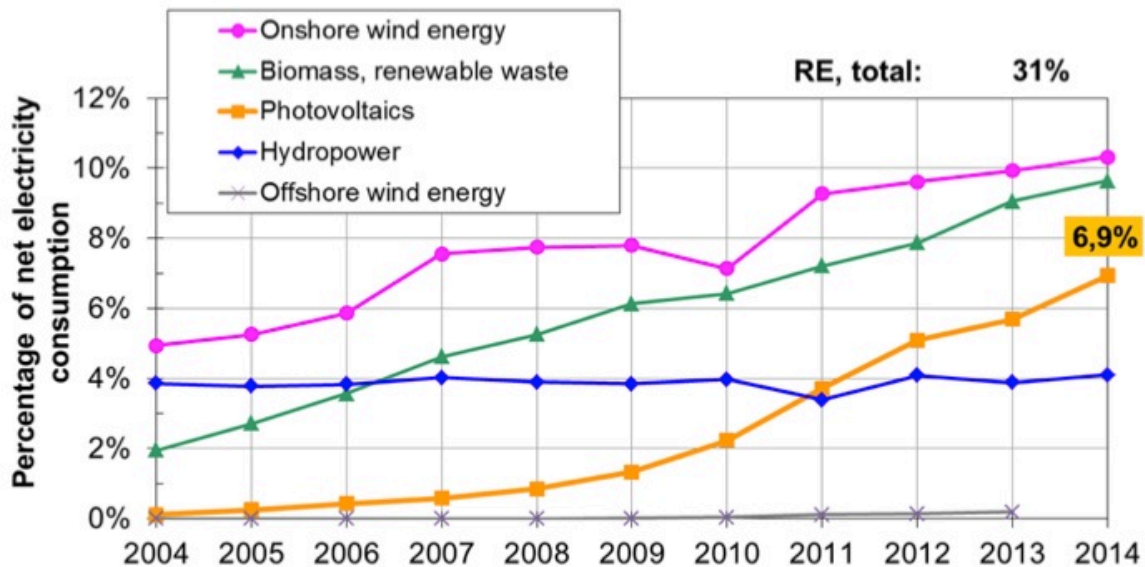
³⁷ The U.S. Department of Energy defines 'capacity factor' as "the ratio of the average load on (or power output of) an electricity generating unit or system to the capacity rating of the unit or system over a specified period of time."

Tracking enables a solar panel array to optimize its power output by automatically changing its angle based on the angle of the sun on the horizon. The upfront cost of construction is more expensive than solar PV without tracking but this cost can be recovered more quickly over time based on increased power output enabled by the tracking capability.

³⁸ *Recent Facts about Photovoltaics in Germany*. Fraunhofer ISE, 7 January 2015. Page 32.

country (see figure 13 below), have average irradiance values ranging from 4.5-5.2kWh/m² per day. Breyer and Schmid estimate a maximum irradiance value for Iran of 6.18kWh/m² per day.³⁹

Figure 6: Renewable Energy Share of Net Electricity Consumption in Germany



Source: Fraunhofer ISE, January 2015

In its February 2015 report, Fraunhofer ISE notes that “cost of capital...can be as important as the level of irradiation [for LCOE of PV systems].”⁴⁰ It provides solar PV LCOE estimates for various countries including Morocco, which benefits from a similar annual irradiance value as Iran and therefore offers a good comparison between the two countries. It specifically analyzes the weighted average cost of capital (WACC) as a variable influencing LCOE and concludes that for Morocco in 2015, a WACC value of 10% would yield an LCOE of 6.5-9 EUR₂₀₁₄ct/kWh, i.e. US\$83-\$115/MWh (see figures

³⁹ Ch. Breyer & Jurgen Schmid. *Population Density and Area Weighted Solar Irradiation: Global Overview on Solar Resource Conditions for Fixed Tilted, 1-Axis, and 2-Axes PV Systems*. September 2010.

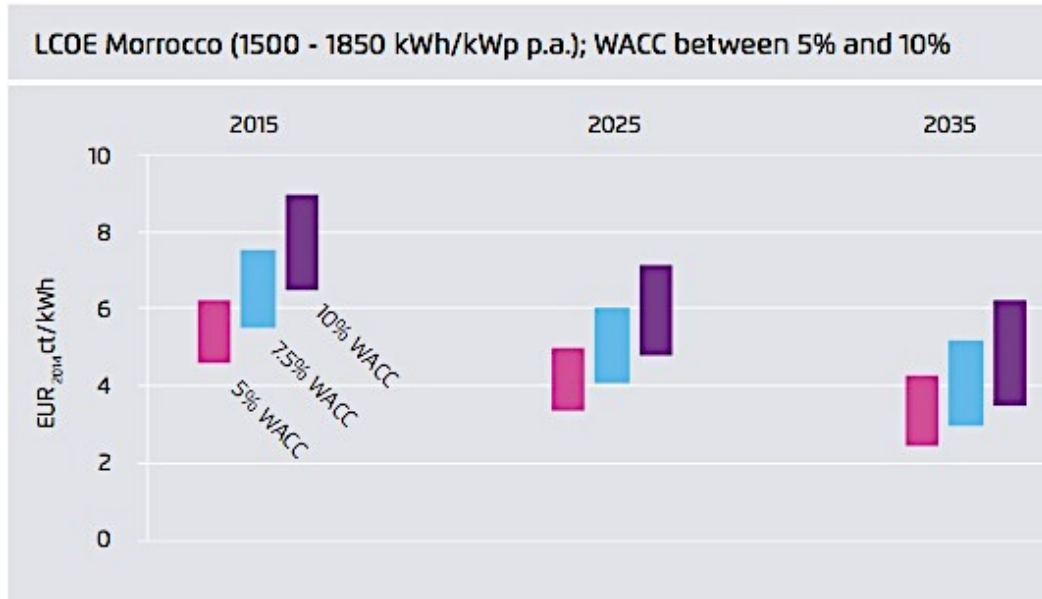
⁴⁰ *Current and Future Cost of Photovoltaics: Long-term Scenarios for Market Development, System Prices and LCOE of Utility-Scale PV Systems*. Fraunhofer ISE, 24 February 2015. Page 55.

7 and 8 below).⁴¹ Even the high-end figure is below the estimated LCOE of nuclear (\$130/MWh) for Europe and the Middle East in BNEF's 1H 2015 central case. The median is potentially competitive even with natural gas.

It follows that lower capital costs, which could be reduced through various policy and regulatory mechanisms including political risk insurance, feed-in tariffs (i.e. calibrated subsidies), power-purchasing agreements, etc. could substantially lower the LCOE of solar or other sources of renewable electricity to make them competitive with nuclear. Iran has already implemented some of these measures, as discussed below.

⁴¹ Ibid, pages 62, 65.
“[Yearly Average Currency Exchange Rates.](#)” IRS.

Figure 7: Range of Levelized Costs of Electricity Derived from Solar PV in Morocco, based on Variable Capital Costs



Source: Fraunhofer ISE, February 2015

Figure 8: Range of Levelized Costs of Electricity Derived from Solar PV in Southern Germany and Southern Spain, based on Variable Capital Costs



Source: Fraunhofer ISE, February 2015

The LCOE assessment of wind energy in BNEF’s report is also based on a global average that BNEF notes is raised by construction costs and lower capacity factors in some regions. Nevertheless, the global average in BNEF’s central case has decreased from <\$100/MWh in the second half of 2009 to \$85/MWh in the first half of 2015.⁴²

Likewise, geothermal energy ranges from <\$100/MWh to \$65/MWh, depending on the sophistication of the technology used, in the central case of BNEF’s report.⁴³

El-Katiri notes, “An Environmental Investigation Agency projection for US average levelized costs for advanced nuclear power plants entering service in 2017 suggests a price range of between [US\$107 and \$118 MWh].⁴⁴

Figure 9: Regional Variation in LCOE for New Generation Resources in the U.S. (Utility Scale), 2019 (2012 \$/MWh)

Plant Type ¹	Minimum	Average	Maximum
Dispatchable			
Advanced Nuclear	92.6	96.1	102.0
Non-dispatchable			
Solar PV ²	101.4	130.0	200.9
Solar Thermal	176.8	243.1	388.0

¹ U.S. EIA cautions, “Since load must be balanced on a continuous basis, units whose output can be varied to follow demand (dispatchable technologies) generally [add] more value to a system than less flexible units (non-dispatchable technologies), or those whose operation is tied to the availability of an intermittent resource.”⁴⁵

² Costs are expressed in terms of net AC power available to the grid for the installed capacity.

Source: U.S. EIA, April 2014

⁴² Ibid BNEF, pages 11-12.

⁴³ Ibid BNEF, page 13.

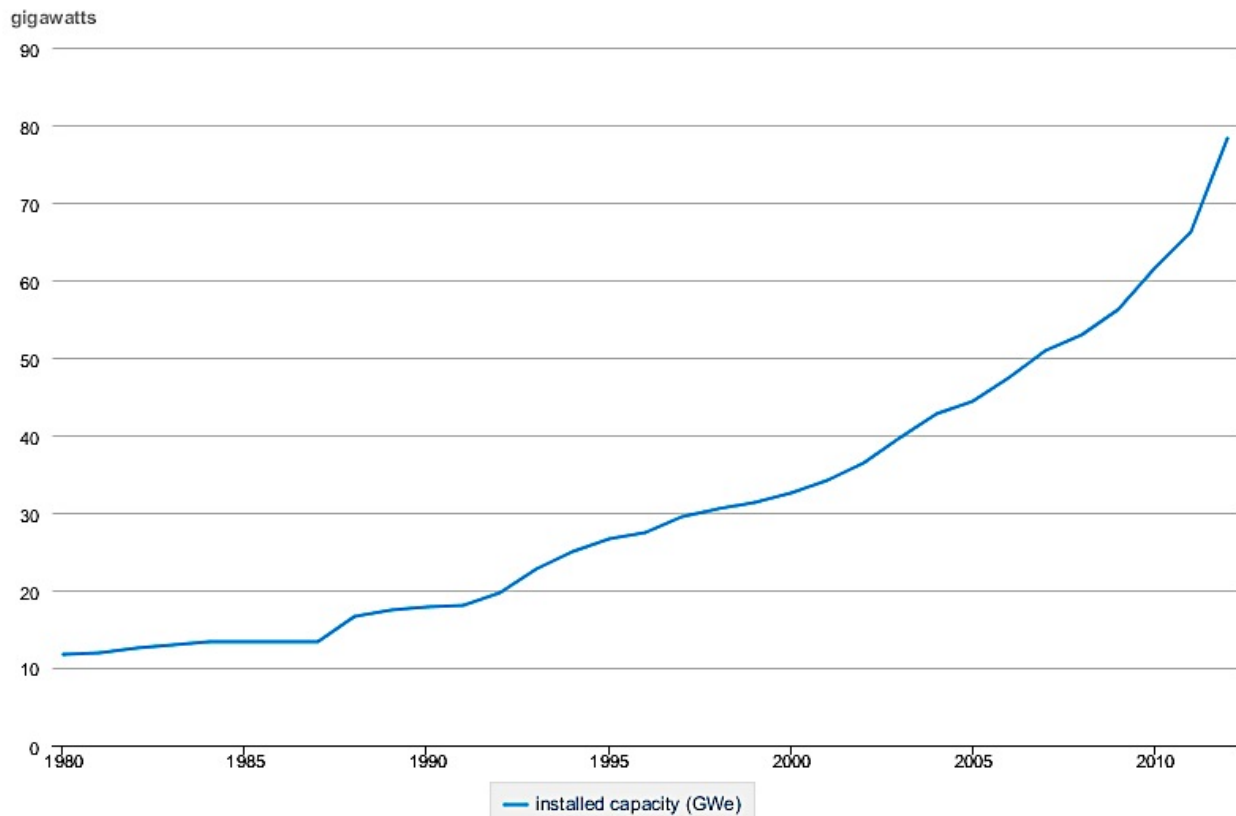
⁴⁴ Laura El-Katiri. “The GCC and the Nuclear Question.” The Oxford Institute for Energy Studies, December 2012. Page 4.

⁴⁵ “[Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014.](#)” U.S. EIA, April 17, 2014.

Current Renewable Energy Capacity and Potential in Iran, Comparable MENA Countries, and Selected EU Member States

Iran's renewable energy capacity (including hydropower) comprised approximately 10% of its total installed electricity capacity at the end of 2012. Wind, solar, and biomass comprised less than 1% of its total installed electricity capacity by that point in time (see figures 10 and 11 below).

Figure 10: Iran Installed Electricity Capacity (GWe) (1980-2012)



Source: U.S. EIA

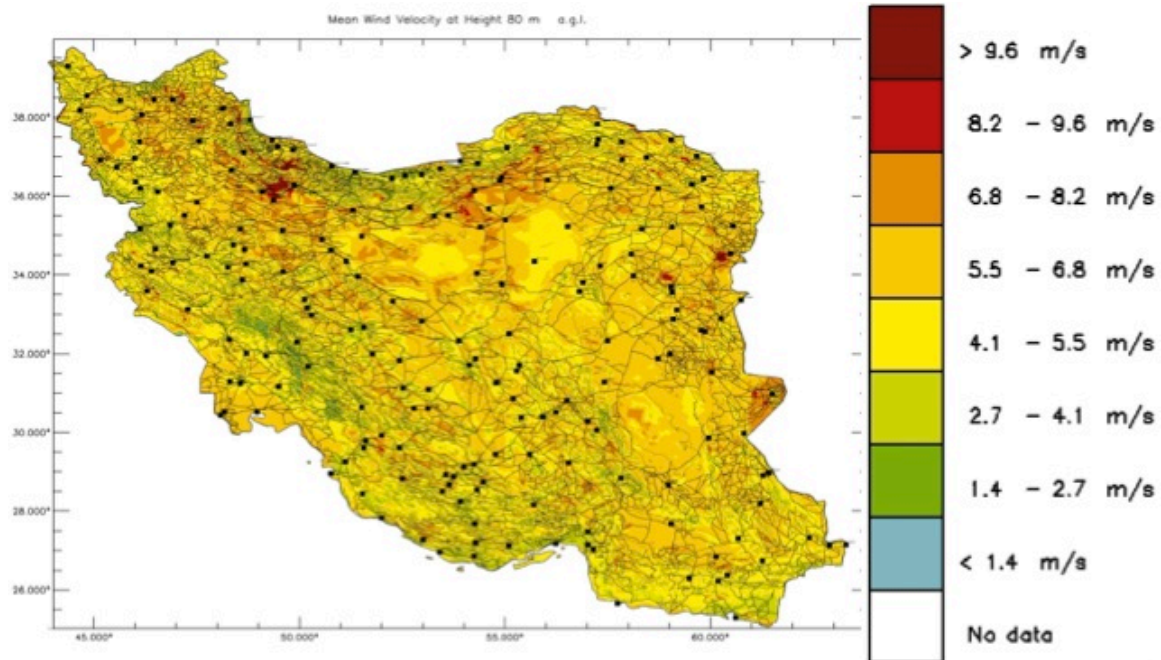
Figure 11: Installed Renewable Power Plant Capacity in Iran (as of December 2012)

Type	Installed Capacity (GW)
Wind	0.1094
Solar PV	0.0321
Biomass	0.0188
Small-Scale Hydropower	0.0590
Large-Scale Hydropower (as of December 2011)	8.7462
Total	8.9655

Source: Renewable Energy Organization of Iran (SUNA)

The Renewable Energy Organization of Iran has assessed that Iran has more than 15GW of economic potential and 40GW of technical potential in wind energy; i.e. it would be economical for it to generate the equivalent of 15 Bushehr nuclear reactors' worth of power from wind energy and it would be technically possible (although not currently economical) to generate nearly 2.67 times that amount. Its economical wind potential is therefore more than 137 times its installed wind power capacity as of the end of 2012—representing a tremendous opportunity for partnership and investment.

Figure 12: Iran's Wind Energy Potential (average wind velocity at altitude of 80m)



Source: Renewable Energy Organization of Iran

German aerospace research center DLR has assessed that Iran has a solar-thermal power potential of 60GW, equal to ~75% of Iran's installed capacity in 2012 (80GW (see figure 10 above)). Moreover, the Renewable Energy Organization of Iran states that "by allocating 100x100 square kilometers to PV power plants, we can generate electricity equal to the total produced in the country in 1389 [i.e. March 2010-March 2011]."

Figure 13: Iran's Solar Energy Potential (solar irradiation/day (kWh/m²))



Source: Renewable Energy Organization of Iran

The Renewable Energy Organization of Iran has also assessed that “there are potentially 15 zones capable of geothermal energy in Iran where the reservoir capacity is 250MW electrical and 1250MW thermal, based on feasibility and explorative studies.”

Obstacles to and Policies in Support of Renewable Energy Market Expansion in Iran

Mostafa Rabeie, Head of Promotion and International Affairs of Iran's Renewable Organization (SUNA), noted in email correspondence that Iran has “established contracts for installation of renewable power plants under power-purchasing agreements (PPAs) totaling ~5500 MW [equal to the power production capacity of 5.5 Bushehr nuclear reactors] (see figure 14 below); we have established a fund for gathering tax revenues

from fossil fuel consumption; we have supported by governmental budgets more than 1000 rural households with PV systems; we have technology for geothermal plants, parabolic trough CSP's and different types of fuel cells, but why can't we step forward faster? Two main answers: (1) a high [interest] rate in Iran (more than 25% annually) and (2) sanctions." He attributed the high interest rate to a concentration of wealth in the hands of a few and added that high inflation and the SWIFT sanctions have hindered investment.

A presentation he sent me notes nevertheless, "Based on Item B from Article 133 of the government financial regulations, the Ministry of Energy is obligated to purchase renewable electricity generated by the private sector [with a subsidy of] \$0.18[/kWh] for grid-connected systems and \$0.177[/kWh] for off-grid systems to feed extra electricity to the grid."

I asked him whether Iran's energy ministry "has conducted or commissioned any economic studies to determine whether solar or other forms of renewable electricity generation could be competitive with or cheaper than nuclear electricity generation." I also asked "what technical, financial, or other help could the international community [could] provide to help increase Iran's renewable energy technology expertise and investments (beyond lifting sanctions)?"

He replied, "We have [produced many] good studies for preparing [a] strategic road map on renewables with [the] best Iranian universities but they were just compared [with] fossil fuels; nuclear energy [has become an international issue] and we avoid political

observations.” His response corroborates the assessment that Iran’s nuclear program holds a special status that places it beyond the scrutiny of economics. Although this does not necessarily imply that elements of the Iranian government are using its nuclear energy program as a cover for nuclear weapons development, it is noteworthy nonetheless.

Certainly the removal of international sanctions would enable Iran to revitalize its finances and invest more in renewable energy. Whether or not it would prioritize this over expansion of its nuclear reactors remains an open question.

Figure 14: Renewable Power Plant Permits Issued to Private Sector in Iran

Total (MW)	Small-hydro power (MW)	Biomass (MW)	Solar (MW)	Wind (MW)	Stage of progress
30	-	1.6	-	28.4	In Operation
621.16	0.169	13.6	10	597.4	Contract Signed
6027.9	12.7	13.6	435.2	5566.4	Construction Agreement
3961.45	14.45	29.9	46.1	3871	Filing
4449.9	34.2	127.2	315	3973.5	Cancelled Permissions
9163.9	13.3	56	1420.2	76764.4	Total issued permissions

Source: Renewable Energy Organization of Iran

Figure 15: Iran Policies in Effect in Support of Renewable Energy

Policy	Year Established	Summary
Renewable Energy Development Fund (Annual Budget Law, Act 69)	2013	<p>The Ministry of Energy is required to include in electricity bills an amount of 30 Rials per kilowatt-hour as electricity duties, in addition to the price of electricity sold, and to receive such amount from clients except rural households. The amount earned must be deposited into the account of TAVANIR and expended for development and maintenance of rural electricity grids as well as for generation of renewable and clean electricity.</p>
Liquid Fuel Exchange Purchase (Annual Budget Law, Act 19)		<p>Under Article 19 of the Budget law, in order to implement efficiency improvement plans in power plants with a priority in installation of steam unit in combined cycle plants, development of renewable energy use, reduction in losses, optimization of energy consumption, saving in liquid fuel consumption and increasing the share of fuel exports, the Ministry of Energy is permitted to sign contracts up to a total value of one hundred and twenty trillion (120,000,000,000,000) Rials in buyback with investors in private and public sectors for plans of:</p> <ul style="list-style-type: none"> • Efficiency and generation improvement in governmental and private sectors' power plants • development of renewable energy plants • reduction of losses and optimization of energy consumption, in preference of using domestic equipment. <p>According to Section 3 of Article 4 of executive directive for Article 19 of Budget law of 2013, the Ministry of Energy can through TAVANIR assign contracts in buyback method with applicant investors for installation of renewable energy plants. In such contracts, the amount of fuel saved in two years of plant operation shall be estimated, and within those two years the price of electricity purchased from investors shall exclude the cost of the amount of fuel saved (that is delivered to the investors).</p>
Renewable Portfolio Standard (5 th Development Plan of the Islamic Republic of Iran, Article 139)	2012	<p>In order to establish infrastructure to manufacture solar and wind power plant equipment, deploy clean energy and increase the renewable share in the country energy mix, the government is authorized to support private and cooperative sectors by using managed funds and loan interest subsidies to pave the way for the installation of 5000 MW wind and solar energy.</p> <p>The objectives of the policy are to increase the share of renewables in the energy mix, improve energy security, reduce environmental pollution and create jobs.</p>

Comprehensive Scientific Plan of Iran	2011	<p>Section B of the Islamic Republic of Iran general policies on energy sector: efforts to acquire new and renewable energy technology and knowhow and build power plants in the country using sources like wind, solar, fuel cell and geothermal.</p> <p>Section 9-1 of the energy and electricity sector strategies of the Ministry of energy strategic plan 1404: concentration on realization, research and technology localization in solar and wind electricity generation activities in the country.</p> <p>Section 9-2 of the energy and electricity sector strategies of the Ministry of energy strategic plan 1404: allocate a definite and increasing percentage of research budget to localize technologies concerned with renewable energies.</p> <p>Section 9-3 of the energy and electricity sector strategies of the Ministry of energy's strategic plan 1404: define and implement new and renewable energy pilot projects.</p>
Subsidy Reform Plan (Article 8 Section B)	2011	<p>The government is required to spent 30% of net funds gained through implementation of this law on grants, loan interest subsidies or managed funds for the following purposes:</p> <ul style="list-style-type: none"> • technology structure modification of manufacturing divisions to improve energy efficiency • water • expansion of electricity from renewable resources <p>The objective of the policy is to encourage the private sector to invest in renewable energy.</p>
Feed-in Tariff (FiT) (5 th Development Plan of the Islamic Republic of Iran, Article 133, Section B)	2005	<p>TAVANIR and companies affiliated to the Ministry of Energy are permitted to sign guaranteed and long-term contracts for the purpose of purchasing electricity generated from renewable and clean energy sources, with a priority to purchase from private and co-operative sectors. The rate for purchase of power from renewable and clean energy sources in the competitive market of the national electricity grid will take into account the average annual avoided import or export value of the fossil fuel+average price of energy conversion in national electricity market+avoided cost of pollutant emission cuts approved by the Economic Council.</p> <p>According to the approved direction for this regulatory article upon act no.93/22688/20/100 of 20/07/2014 of the Economic Council, the base rate for purchase of power from plants for maximum 5 years has been defined at 4628 Rials per kilowatt-hour (cost of production and transition to 20kV station) and 4480 Rials per kilowatt-hour for plants (only electricity production).</p>

Source: IEA, IRENA⁴⁶

Lessons Learned from Other Countries in the MENA Region and Beyond

The focus of this section is primarily on STE/CSP because of its significant potential for cost reductions and medium- to long-term viability as an alternative to nuclear power (perhaps within the next 5-10 years), particularly as thermal storage technologies improve, as well as its suitability to Iran (see figures 16 and 17 below).⁴⁷ Policies and financing mechanisms can be calibrated to accelerate deployment of these technologies and reduction of their costs as they come to scale.

The International Energy Agency makes four recommendations for increasing investment in solar thermal electricity (STE) specifically that could be applied to renewables generally:

- “Implement or update incentives and support mechanisms that provide sufficient confidence to investors; create a stable, predictable financing environment to

⁴⁶ [IEA/IRENA Joint Policies and Measures Database](#). Lasted accessed 18 April 2015.

⁴⁷ According to IEA, “High DNI is found in hot and dry regions with reliably clear skies and low aerosol optical depths, which are typically in subtropical latitudes from 15 degrees to 40 degrees north or south. Closer to the equator, the atmosphere is usually too cloudy, especially during the rainy season. At higher latitudes, weather patterns also produce frequent cloudy conditions, and the sun’s rays must pass through more atmosphere mass to reach the power plant. DNI is also significantly higher at higher elevations, where absorption and scattering of sunlight due to aerosols can be much lower. Thus, the most favourable areas for CSP resource are in North Africa, southern Africa, the Middle East, north-western India, the south-western United States, northern Mexico, Peru, Chile, the western parts of China and Australia.” Ibid, pages 10-11.

IEA also points out (somewhat counter-intuitively considering that many solar thermal plants were constructed without thermal storage), “When thermal storage is used to increase the capacity factor, it can reduce [LCOE]. The extra investments needed—in a large solar field and in the storage system—are spread over more kWh, as the power block (turbine and generators), the balance of plant and the connection run for more hours.” Ibid, page 14.

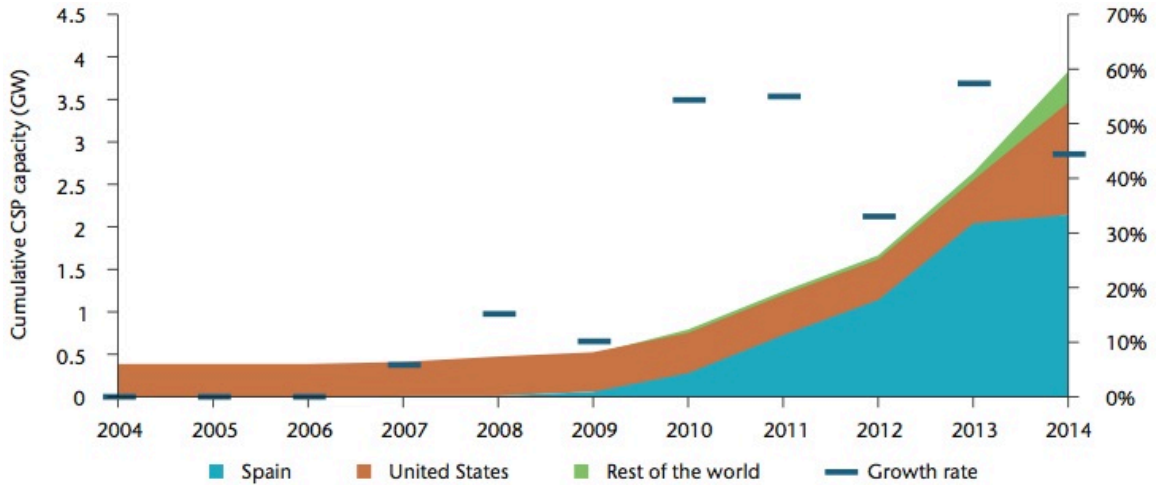
lower costs for financing. These may notably include FiTs and auctions for long-term PPAs.”

- “Avoid retroactive changes, which undermine the confidence of investors and the credibility of policies.”
- “Work with financing circles and other stakeholders to reduce financing costs for STE deployment, in particular developing large-scale refinancing of STE (and other clean energy) loans with private money and institutional investors.”
- “In countries with highly subsidized retail electricity prices, progressively reduce these subsidies while developing alternative energy sources and implementing more targeted financial support to help the poor.”⁴⁸

(Some of these could also be applied to the U.S., where tax incentives for renewables and other policy and regulatory measures frequently are of short-term duration and are extended by Congress retroactively after being allowed to lag, creating great uncertainty for investors and thereby hindering the growth of these industries.)

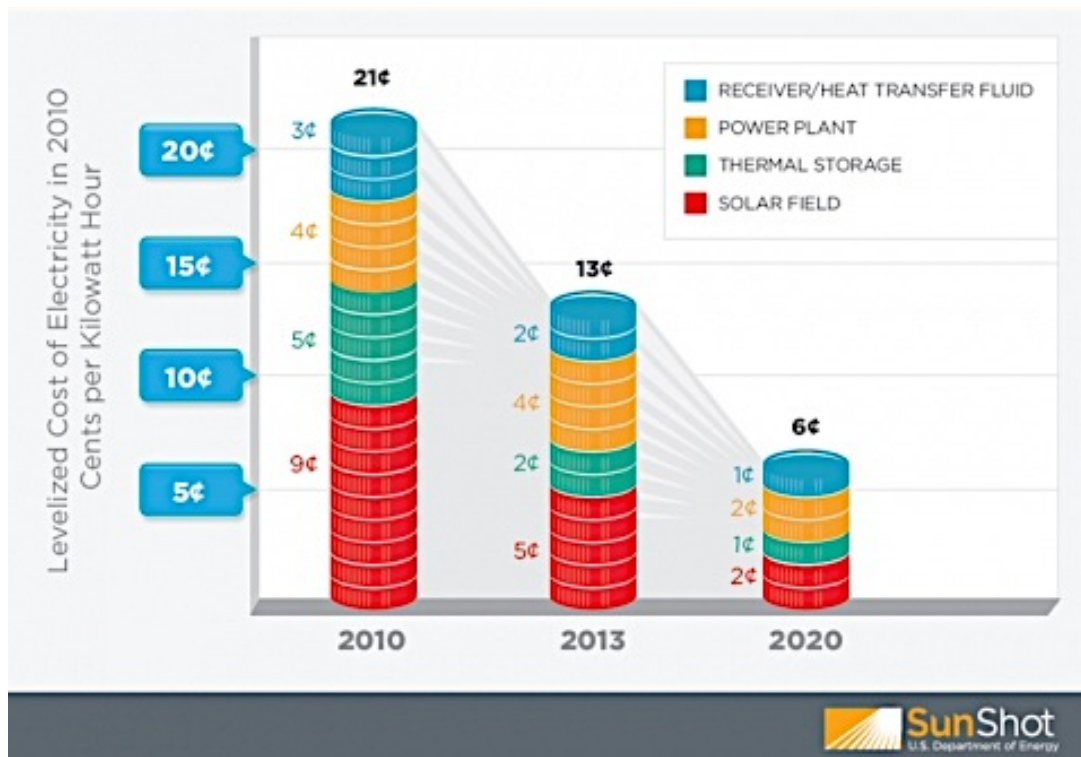
⁴⁸ “Technology Roadmap: Solar Thermal Electricity.” IEA, 2014. Page 37.

Figure 16: Global Concentrating Solar Power (CSP) Capacity Growth



Source: IEA, 2014

Figure 17: CSP LCOE Reductions and U.S. Department of Energy SunShot Initiative 2020 Objective



Source: U.S. Department of Energy⁴⁹

⁴⁹ “[Concentrating Solar Power](#).” U.S. Department of Energy. Last accessed 19 April 2015. DoE states that its “SunShot Initiative aims to reduce the total installed cost of solar energy systems to \$0.06 per kilowatt-

Relevant to Iran, IEA notes, “In Morocco...generating electricity at peak time after sunset was heavily subsidized until mid-2014.... This [distorted price signals for] the developer of CSP plants, the Moroccan Agency for Solar Energy (MASEN)....”⁵⁰

On policy options to promote renewables, IEA writes, “Feed-in tariffs (FiTs), feed-in premiums (FiPs), and auctions have prevailed for renewable energy in Europe, Australia, Canada, and Japan. In the United States, long-term power-purchase agreements (PPAs) have been signed by utilities to respond to renewable energy portfolio standards (RPSs), with or without solar carve-outs. Auctions are common in many emerging economies, from Brazil to South Africa. Up-front subsidies, directly addressing the large impediment to CSP plants’ very capital-intensive cost structure, could be very helpful, but should not offset incentives to generate electricity.”

IEA continues, “Well-managed FiTs have proven effective in stimulating deployment, while providing fair but not excessive remuneration to investors. However, they have been unevenly successful in driving cost reductions: very effective for PV in Germany, much less so for STE in Spain. FiT levels must decline over time, in a predictable manner.”

“Furthermore, FiTs do not deliver any incentive to generate electricity when and where it is most useful for the entire electric system. FiPs are being implemented or suggested as

hour (kWh) by 2020. Today, SunShot is 60% of its way toward achieving the program’s goal, only three years into the program’s ten year timeline. Since SunShot’s launch in 2011, the average price per kWh of a utility-scale photovoltaic (PV) project has dropped from about \$0.21 to \$0.11.... Solar energy could meet 14% of U.S. electricity needs by 2030 and 27% by 2050.” [“SunShot Mission.”](#) U.S. Department of Energy. Last accessed 19 April 2015.

The full SunShot Vision Study (February 2012) can be downloaded here:
<http://energy.gov/eere/sunshot/sunshot-vision-study>

⁵⁰ Ibid, page 38.

possible transition tools toward greater market exposure. Premiums are added to the market prices to remunerate renewable electricity. One should however distinguish fixed (“ex ante”) FiPs from sliding (“ex post”) FiPs. Fixed FiPs are set once for all. The total remuneration thus depends on the market prices. Sliding FiPs are set at regular intervals, typically months, to fill the gap between the average market price perceived by all generators of a given technology and a pre-determined strike price. The United Kingdom’s “contract for difference” can be considered as a sliding FiP.”

“With fixed FiPs, CSP plants compete with all other generating technologies on wholesale markets. Their total remuneration is therefore more uncertain, which raises investors’ risk and ultimately increases the cost of capital and LCOE. With sliding FiPs, CSP plants compete with one another. Those performing better than average in delivering power when the electricity prices are high, get higher returns. Those performing worse than average get lower returns. The difference in returns is more modest than with ex-ante FiPs, and the increases in risk and costs of capital are less pronounced.”

“Time-of-delivery PPAs would likely be the instrument of choice for CSP projects. To preserve competition as much as possible, they could result from auctioning processes. Most emerging economies—including Brazil, India and South Africa—but also industrialized countries such as Chile, or developing countries such as Morocco, have used auction procedures to select projects and developers, with variable success.”⁵¹

⁵¹ Ibid.

On private financing, IEA writes, “In the United States...the risks may have appeared too high for large, innovative CSP projects—costing around 1 billion—to materialize, without the loan guarantee programme of the US DoE. This programme has been essential to the renaissance of CSP in the United States, allowing projects to access debt at very low cost from a US government bank and facilitating financial closure at acceptable WACC of large projects. Perhaps more important, it has allowed innovation and scaling up of innovation to take place, opening the door for significant cost reductions.... Refinancing completed projects with investors seeking long-term, secure opportunities could also help accelerate the rotation of capital for more rapid deployment.”

“In other countries, such as India, Morocco, and South Africa, public low-cost lending has been essential for jump-starting the deployment of CSP. In India and South Africa, private banks would have not provided capital for the very long maturity involved. In Morocco, the presence of a government agency as equity partner significantly reduced the perception of policy risks among other partners. In Morocco and South Africa, international finance institutions provided concessional grants that reduced the overall costs of large CSP projects. In Morocco, a syndicate of European lenders and donors (European Investment Bank, Kredit-Anstalt fur Wiederaufbau, Agence Francaise de Development) saved the developer part of the burden of addressing many different loan rates, conditions and procedures (Stadelmann et al., 2014).”⁵²

This is by no means a comprehensive review of lessons learned in renewable energy market development but it should stimulate thought on how the U.S. can support Iran’s nascent renewable energy industry. There is great diplomatic potential in such an

⁵² Ibid, page 39.

initiative; however, it is important to be clear-eyed about the complex foreign policy disputes that will have to be addressed in order to achieve détente or at least manage tensions with Iran below the threshold of military conflict.

Policy Obstacles to U.S.-Iran Détente

Israel

Starting with perhaps the most difficult and contentious issue, the U.S.'s and Iran's policy orientations toward the Israeli-Palestinian conflict will probably make it difficult if not impossible to achieve détente, due primarily to the strong American lobby in support of the Israeli settler movement as well as Iran's uncompromising support for Palestinian and Lebanese terrorist groups, namely Hamas, Islamic Jihad, and Hezbollah.

Although the U.S. rhetorically supports a two-state solution to the Israeli-Palestinian conflict, its lack of substantive action against Israeli settlement expansions in East Jerusalem and the West Bank demonstrate that it is either unwilling or unable to effectively push back against U.S. domestic pressure groups that increasingly do not even pay lip service to the two-state framework or, in the case of Christian Zionists, explicitly oppose it because it interferes with a supposed divine plan to trigger the apocalypse.⁵³

⁵³ One need only observe the lack of action by the Obama administration in response to Israeli settlement expansions during the last round of Israeli-Palestinian negotiations in spring 2014 to appreciate this. Moreover, only 79 out of 435 Members of Congress signed on to a letter to President Obama expressing concern over Israeli Prime Minister's apparent dismissal of the two-state framework during his 2015 reelection campaign. The exact language of the letter can be found here.

["J Street Welcomes Congressional Letter Reaffirming Support of Two-State Solution."](#) J Street, 31 March 2015. Last accessed 19 April 2015.

On the apocalyptic beliefs of Christian Zionists, refer to John Hagee, [Jerusalem Countdown](#). Frontline, 2007.

On the political influence of this organization, refer to Jennifer Rubin, ["Christians United for Israel hits 2 million."](#) The Washington Post, 7 January 2015.

Enabling the Israeli government to continue expanding settlements by declining to impose substantive political and economic consequences will only reinforce Iranian officials' views that the Israeli-Palestinians are a charade (not an unreasonable conclusion at this point) and that military aid to the Palestinians is the only way to correct injustices inflicted upon them.

The Supreme Leader of Iran articulated Iran's policy—often mischaracterized as genocidal or irrational—most recently and comprehensively in a tweet from his official account, dated 9 November 2014. It is worth reviewing, however disagreeable or politically unrealistic, in order to appreciate its nuances and assess the potential for influencing a moderation of his views. Khamenei emphasizes, “The elimination of Israel does not mean the massacre of the Jewish people in this region.” Rather, he proposes holding a referendum whose participants would include descendants of the pre-1948 Arab and Jewish inhabitants of the territory the modern state of Israel was established on. Under his framework, participants in the referendum would have the right to determine whether to incorporate current citizens of Israel. Khamenei believes that unless such a framework is forcibly imposed, Israel will perpetuate its occupation and territorial expansion while feigning a commitment to diplomacy. Considering his starting assumption (perhaps not unreasonable considering Israeli Prime Minister Benjamin Netanyahu's behavior over the last year), one can understand the rationale for it without having to agree.⁵⁴

⁵⁴ Mark Landler. “[Mideast Frustration, the Sequel](#).” The New York Times, April 8, 2014.

Ben Birnbaum & Amir Tibon. “[The Explosive, Inside Story of How John Kerry Built an Israel-Palestine Peace Plan—and Watched It Crumble](#).” New Republic, July 20, 2014.

Jodi Rudoren. “[Netanyahu Says No to Statehood for Palestinians](#).” The New York Times, March 16, 2015.

In response to my question, “What would it conceivably take for Iran’s Supreme Leader to moderate his position toward Israel, Ambassador Mousavian replied, “My understanding is that the only way would be for the U.S. to demonstrate a commitment to the rights of the Palestinians and to normalize U.S.-Iran relations.... Normalization of U.S.-Iran relations [could lead to moderation of] Iran’s position toward Israel, which would be like other Organization of the Islamic Conference states.”⁵⁵

It is clear that both the U.S. and Iran will have to take some steps to preclude the Israeli-Palestinian issue from drawing the two state patrons of the parties to this conflict into direct conflict with each other, which could further result in a region-wide proxy conflict that could ravage the Gulf and Levant. How could a moderation in the policies of both countries be achieved?

On the U.S. side, moderate U.S. policymakers, lobbying and advocacy organizations, and religious leaders will have to work hard to develop a powerful grassroots-based counterweight to the network of organizations and individuals who currently prevent the U.S. from taking substantive action on this issue. This will be a tough uphill battle (J Street, the most politically influential American Jewish organization genuinely advocating for a two-state solution, has yet to be recognized by the Conference of Presidents of Major American Jewish Organizations) yet there is likely no other way to achieve this goal.

⁵⁵ Email correspondence, 29 January 2015.

On the Iranian side, an official if grudging shift from a policy of implacable hostility to an offer of conditional non-aggression, contingent upon implementation of a two-state solution accepted by the Palestinians, and in line with the 2002 Arab Peace Initiative, would be massive in its implications of the potential for a positive-sum solution to be had in the Middle East (for this facet of the Rubik's cube at least). Iran would not have to cease its military aid to the Palestinians in the interim in order to implement this policy shift; it would need to channel its aid toward militant factions operating within the framework of achieving a two-state solution, however, and/or require or command the Palestinian and Lebanese organizations it is currently supporting to moderate their own policies toward Israel as a condition of further military aid from Iran. Iran should also certainly require these organizations not to deliberately target innocent civilians (i.e. those not part of the political-military chain-of-command or its enabling propaganda outlets).

While Israel has every right to expect acceptance of its basic right to exist, the notion that its policy of support for territorial expansion should have no security consequences is simply cynical. Both Iran and Israel—as well as the U.S., for that matter—are skilled at propagating one-sided narratives of national victimization that, however rooted in history, are ultimately self-defeating and will in the end result in each side becoming a victim of its own propaganda against the other.

Syria

Given that there is no stronger justification for Iranian advocates of nuclear weapons acquisition or an imminent nuclear weapons breakout capability than the U.S. military presence and posture in the region, the U.S. should be cautious about unilateral efforts at regime change in Syria. Instead it should pursue efforts at cooperation with Russia and Iran to nudge Assad out in a palace coup and to have him replaced with a Syrian leader who commands the respect of the Syrian military and political elite but who has not been implicated in major war crimes. Iran's support in transitioning Iraqi Prime Minister Nouri al-Maliki from power demonstrates that it can play a constructive role when its interests are taken into account.

Finally, the U.S. should officially acknowledge and express its apology for supporting Saddam Hussein's use (and perhaps acquisition) of chemical weapons.⁵⁶ A recent media report alleging that Reagan and Bush Sr. administration officials deliberately provided him with dual-use chemical and biological agents for use in manufacturing these weapons demands a presidential review and declassification of any documents substantiating this.⁵⁷ If recent history is any guide, partisan politics would preclude accountability but at the very least a basic acceptance of national moral responsibility should be forthcoming.

It is worth ending this assessment with an emphasis on the potential for a positive evolution in U.S.-Iran relations. As Ambassador Mousavian writes, "It is noteworthy that

⁵⁶ Shane Harris and Matthew M. Aid. "[CIA Files Prove America Helped Saddam as He Gassed Iran.](#)" Foreign Policy, 26 August 2013.

⁵⁷ Barbara Koeppel. "[U.S. Nerve Gas Hit Our Own Troops in Iraq.](#)" Newsweek, 27 March 2015.

no Iranian leader has ever permanently ruled out a relationship with the U.S. Ayatollah Khamenei stated that when the day arrives that relations with the US are beneficial, he “will be the first one to say that relations should be established.” He continues, “I am confident that the dominant viewpoint inside the *nezam*, including that of the Supreme Leader, is to end the hostilities with the US based on mutual respect, non-interference, and mutual interest,” concluding “a historical, monumental step should be taken by the two states: recognizing the other side’s grievances followed by mutual forgiveness.”⁵⁸

Conclusion

It is time for the U.S. and Iran to put the past behind and rebuild relations based on a positive sum framework. This will require bold, resolute, and poised leadership on both sides that rejects the self-righteous rhetoric of nationalists who are quick to point out the sins of the other side but are unwilling to admit to those of their own. The nationalist paradigm is a failed one that will only lead to more conflict and suffering.

Renewable energy partnerships between the U.S. and Iran could serve as a vehicle for détente and U.S. government entities are already engaged in such partnerships with other countries in the region, making it possible to leverage this institutionalized knowledge and experience immediately in pursuit of a major strategic benefit. The most forward-thinking senior Iranian and U.S. officials recognize that while the hostility between their two governments is felt on a more visceral level, they also have common enemies, the more threatening of which is not jihadi salafism but rather climate change. Instead of

⁵⁸ Seyed Hossein Mousavian & Shahir Shahidsaless. *Iran and the United States: An Insider’s View on the Failed Past and the Road to Peace*. Bloomsbury, 2014. Pages 264-265, 278, 291.

wasting potentially trillions more American taxpayer dollars on another unnecessary war, the U.S. could invest a fraction of this into helping to construct a new cooperative framework in the Middle East, accelerating the growth of renewable energy markets, maturation of these vital technologies, and promotion of energy and economic security through diversification. Helping to decouple oil export- and import-dependent economies from this commodity would also reduce instability in the region over the long term as it became more economically resilient.

To be sure, there is much bad blood and distrust between the U.S. and Iran and the two governments' divergent positions on the interlinked issues of Syria and Israel-Palestine will not be easy to bridge. The latter issue will require much difficult communications and organizing work by grassroots organizations in the U.S. in order to create the political space policymakers need to make challenging decisions and be reasonably confident that they will be reelected if they do. These issues are not insurmountable, however.

The U.S. and Iran have been in a state of hostilities for more than 35 years. Shortsighted and morally contradictory decisions made by leaders on both sides have contributed to the death and suffering of hundreds of thousands. The primal impulse to settle scores, however rationalized through the discourse of foreign policy, must be resisted. Leaders must have the courage to make peace.