# Report of the Technical Advisory Group on Nuclear Energy in the Middle East


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Since 2006, almost all of the states in the Middle East have declared their intentions to pursue nuclear energy programs. Iran is the first to operate a nuclear power reactor: the reactor in Bushehr is expected to go on-line in early 2011.[1] Within six or seven months of beginning operations, it could reach a peak electricity production capacity of 1,000 megawatts (MW).[2] In addition, Iran has announced plans to build an additional four reactors, with a 20-megawatt research/medical reactor estimated to take about five years to build.[3] More troubling, Iran is developing a complete fuel cycle to support its reactors, including uranium enrichment facilities, which also could be used to produce the highly enriched uranium (HEU) required for nuclear weapons. The enrichment facility at Natanz includes operational cascades that are producing both reactor-grade fuel and uranium enriched to the 20 percent level, the level needed for an existing research/medical reactor in Tehran. Beginning with uranium that has already been enriched to the 20 percent level greatly foreshortens the time necessary to produce the highly enriched uranium (90+ percent) required for weapons.[4] Iran also has a second, previously secret, enrichment facility near Qom, which has not yet been equipped with centrifuges, and has announced

1 "Start-up of Iran's Bushehr Nulcear Plant Delayed," BBC News, September 30, 2010, http://www.bbc.co.uk/news/world-middle-east-11445126.

2 The Bushehr facility was started in 1974 under the Shah, who had an extensive nuclear program under consideration. Indeed, at that time, the Shah had unveiled plans to purchase several nuclear reactors from Germany, France, and the United States to generate electricity. With Washington's blessing, the Shah's government awarded a contract to a subsidiary of the German company Siemens to construct two 1,200 MW reactors at Bushehr. The United States was encouraging the Shah to expand Iran's non-oil energy base, given projections at that time for Iran's mushrooming electricity demand. The first generation of Iran's nuclear engineers was trained at the Massachusetts Institute of Technology. In recognition of Iran's energy needs, the final draft of the US-Iran Nuclear Energy Agreement was signed in July 1978. The agreement stipulated, among other things, American export of nuclear technology and material and help in searching for uranium deposits. At the time, the shah's goal was to build 20 nuclear power stations over a ten-year period to produce a total of 30,000 MW of atomic energy to ensure that it would be able to meet domestic energy demand and still maintain oil export levels. With the fall of the Shah in 1979 and the onset of the Islamic Revolution, one of Ayatollah Khomeini's first acts was to scrap the entirety of the shah's grandiose modernization program – including the nuclear project. See: Mohammad Sahimi, "Iran's Nuclear Program. Part I: Its History," *Payvand* (October 2, 2003) http://www.payvand.com/news/03/oct/1015.html

3 "Iran to Build 'Powerful' New Nuclear Research Reactor," *Gulfnews.com* (June 16, 2010) http://gulfnews.com/news/region/iran/iran-to-build-powerful-new-nuclear-research-reactor-1.641983?localLinksEnabled=false&utm_source=Feeds&utm_medium=RSS&utm_term=News_RSS_feed&utm_content=1.641983&utm_campaign=Iran_to_build_'powerful'_new_nuclear_research_reactor.

4 Jon Leyne, "Iran Reveals 'Faster' Uranium Centrifuges," *BBC News* (April 9, 2010) http://news.bbc.co.uk/2/hi/8611864.stm.

plans to construct an additional 10 facilities, although that announcement was almost certainly made for political purposes.[5]

Besides Iran, there are a number of countries in the Middle East pursuing nuclear energy capabilities.[6] The United Arab Emirates (UAE) is in the forefront, having already let a contract with a consortium led by South Korean companies to construct four nuclear power reactors. The UAE has agreed with the US, however, that it will acquire uranium fuel services from abroad and not develop its own enrichment or reprocessing capabilities.[7] Jordan has discovered potentially large uranium deposits and has signed nuclear cooperation agreements with nine countries, including Canada, France, Japan, and Russia. Negotiations are currently underway with companies to construct Jordan's first nuclear power reactor, planned for completion by 2019. Jordan is resisting American entreaties to similarly forego enrichment, viewing it as a potentially important source of revenue.[8]

Among other countries that have some basic nuclear know-how—labs, and research reactors, and the potential to develop their civilian nuclear capabilities over a longer period of time—are Algeria, Egypt, Kuwait, Saudi Arabia, and Turkey. Each of these countries has announced plans to do so at various times, but they have made less tangible progress than the UAE or Jordan.[9]

Turkey operates two small research reactors and one fuel pilot plant. In May 2010, Turkey and Russia inked a $20 billion deal to build Turkey's first nuclear power plant, a 4000 MW nuclear power plant at Akkuyu in the southern province of Mersin. This move followed an earlier court decision that invalidated the sole bid for the project from Russian firm Atomstroyexport and its Turkish partner Park Group, which had been deemed insufficiently transparent by some.[10] Turkey is also currently in final negotiations, reportedly with South Korean firm Korea Electric Power Corporation (KEPCO), for it to lead a consortium to build a nuclear power facility in northern Turkey.[11]

Egypt currently has two research reactors, two fuel fabrication units, one hydrometallurgy unit (reprocessing), and one molybdenum production unit. Although Egypt announced in

5 "Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran," Report by the Director General, IAEA (September 6, 2010) http://www.iaea.org/Publications/Documents/Board/2010/gov2010-46.pdf.

6 At present, Israel is believed to be the only state in the Middle East that has the technical capabilities, infrastructure, human resources and organizations to produce nuclear weapons.

7 "UAE Leads Gulf Nuclear Power Plans," *Strategic* Survey (International Institute for Strategic Studies, Volume 16, February 2010) http://www.iiss.org/publications/strategic-comments/past-issues/volume-16-2010/february/uae-leads-gulf-nuclear-power-plans/.

8 Nayla Razzouk, "Jordan, Japan to Sign Nuclear Cooperation Agreement This Week," *Bloomberg* (September 6, 2010) http://www.businessweek.com/news/2010-09-06/jordan-japan-to-sign-nuclear-cooperation-agreement-this-week.html.

9 Dr. Mohamed Abdel Salam, "Arabs, Iran and Nuclear Weapons: Balancing the Equation," *Arab Insight* (Fall 2008) http://www.arabinsight.org/pdf/Arabinsight27.pdf.

10 "Turkey Wants Nuclear Project Forms Set Up This Month," *Reuters Africa* (September 21, 2010) http://af.reuters.com/article/energyOilNews/idAFLDE68K1H920100921?pageNumber=1&virtualBrandChannel=0.

11 Shinhye Kang, "KEPCO, Turkey Are in Final Stages of Talks on Construction of Nuclear Plant," *Bloomberg* (October 7, 2010) http://www.bloomberg.com/news/2010-10-07/kepco-turkey-are-in-final-stage-of-talks-on-construction-of-nuclear-plant.html.

2007 that it planned to build several nuclear power stations and has invested in consultancy services and studies, it has yet to raise the capital necessary to build its first reactor.[12]

In 2008, Saudi Arabia signed a Memorandum of Understanding with the United States on the development of civilian nuclear power generation. In April 2010, King Abdullah announced that he would establish the King Abdullah City for Nuclear and Renewable Energy in Riyadh, and a handful of top-level officials have been appointed to head the organization. Meanwhile, in May 2010, Saudi Arabia and Japan entered into an agreement to cooperate on atomic energy and water, and, the following month, the Kingdom hired the Finish engineering firm Poyry to conduct an analysis of the economic feasibility of each phase of the nuclear energy generation process.[13]

Kuwait is conducting a feasibility study on nuclear energy but is not actively engaged in any nuclear activities at present.[14]

Syria has been silent about its nuclear plans, but is believed to have constructed a secret reactor capable of plutonium production with North Korean assistance at al-Kibar; the building was destroyed by an Israeli air strike on September 6, 2007.[15]

All of these countries state that they need nuclear energy because of current and worsening electricity shortages. Many of the countries pursuing nuclear power have experienced brown-outs and shortages in recent years, including Iran. Some countries, notably Saudi Arabia and Kuwait, are burning crude oil for electricity, cutting into their high-earning petroleum exports and creating pollution problems. Given the high rate of population growth in the region and its prospective economic growth, regional electricity shortages are expected to worsen in the coming decade unless new policies are adopted. This has put governments under pressure and created internal constituencies for nuclear programs.[16]

However, looking even 30 years into the future, nuclear power is neither the most cost-effective nor environmentally-friendly solution for these Middle Eastern nations' electricity shortages. The cost of developing nuclear power per kilowatt hour is among the most expensive options available to countries in the Middle East. These governments' mismanagement of their oil and gas industries and electricity sectors; their continuing subsidies of fuel and electricity costs, leading to excessive demand; the inability of neighboring states to cooperate due to regional tensions and geo-political competitions;

12 Mohamed M. Megahed, "Challenges And Opportunities For Human Resources Development In Egypt, Paper Presented at the International Conference on Human Resources Development for Introducing and Expanding Nuclear Power Program," (Abu Dhabi, March 14-18, 2010) http://www.iaea.org/inisnkm/nkm/pages/2010/UAE%20Conference-interactivePresentations/Session%202/IAP07%20Megahed.pdf

13 Mark Hibbs, "Saudi Arabia's Nuclear Ambitions," (Carnegie Endowment for International Peace, July 20, 2010) http://carnegieendowment.org/npp/publications/index.cfm?fa=view&id=41243.

14 Tsuyoshi Inajima and Yuji Okada, "Kuwait Plans to Build Four Nuclear Reactors as It Seeks Alternative to Oil," *Bloomberg* (Sep 9, 2010) http://www.bloomberg.com/news/2010-09-10/kuwait-joins-gulf-push-for-nuclear-power-with-plans-to-build-four-reactors.html.

15 Daveed Gartenstein-Ross and Joshua D. Goodman, "The Attack on Syria's al-Kibar Nuclear Facility,". *inFocus Quarterly*, Volume III: Number 1 (Spring 2009)
http://www.jewishpolicycenter.org/826/the-attack-on-syrias-al-kibar-nuclear-facility.

16 Tom Arnold, "Dark Days Ahead?" *Arabian Business* (August 17, 2008)
http://www.arabianbusiness.com/dark-days-ahead--45065.html.

and poor long-term investment decisions have blocked cheaper and simpler solutions to diversify and stabilize the supply of electricity. In addition to improving the efficiency with which electricity is produced through structural economic and industrial reforms and actions to reduce demand, the development of regional grids for the distribution of electricity and natural gas would constitute more cost-effective and safer options for expanding electrification in the region. In addition, some countries, like Iran, have ample geo-thermal resources that could be developed. Other resources that need to be explored further in many countries are solar and wind power, as well as oil shale in the case of Jordan.

The United States has not pursued the diplomacy necessary to persuade these nations to explore these safer and more cost-effective power generation options as part of its strategy to incentivize Iran (and others) to curtail their nuclear aspirations. In particular, the United States has not attempted to promote a regional natural gas grid that could provide the needed fuel to enhance electricity supplies throughout the Middle East more safely and more efficiently. This stands in contrast to US diplomacy in other regions, such as Latin America's southern cone, where the World Bank and the US pro-actively promoted the creation of a natural gas pipeline network. Southeast Asia is also successfully pursuing a regional natural gas grid to ease electricity shortages, so there are precedents for cooperative regional solutions to electricity shortages.

Instead, the US government has responded to the proliferation of planned nuclear programs across the region by supporting American companies in competition with such other technical suppliers as South Korea, Japan, Canada, France, and Russia for commercial contracts to supply the equipment for nuclear programs, and by seeking to elicit pledges to forego nationally-controlled enrichment facilities. The United States has not focused adequately on the diplomacy of additional terms these competing suppliers could be placing on their proposals to minimize proliferation and has failed to show sufficient leadership in attempting to limit contracting terms in ways that would make the conversion of civilian facilities into weapon programs more difficult.[17]

## Does Iran "need" nuclear energy?[18]

Iran is the largest generator of electricity in the Middle East at roughly 40,000 MW, but its electricity output is inadequate to meet its growing consumer demand. Roughly 25 percent of Iran's power output comes from aging plants suffering from maintenance problems; some plants are operating at only 10 percent of nameplate capacity. The World Bank has also named Iran the number one country wasting electricity in the Middle East and North Africa.[19]

During much of the last decade, Iranian energy demand rose at more than five percent annually. In addition, the country's electricity demand often grew faster than its GDP.

17 The one exception is the US attempt to persuade nations to forego acquiring enrichment capabilities; successful in the case of the UAE, so far unsuccessful in other countries.

18 The material for this section comes from a longer paper, which contains more detailed analysis demonstrating that nuclear power is a more expensive capital project than development of natural gas or geothermal energy for the Iranian electricity sector. The working paper, "Iran, Energy and Geopolitics," is available on line at http://bakerinstitute.org/publications/IEEJIran.pdf.

19 Ali Kheradpir, "Blackouts Threaten Iran," *Institute for Way and Peace Reporting*, IRN Issue 32, April 16, 2010, http://www.iwpr.net/ru/node/35548.

According to the International Energy Agency's *2005 World Outlook*, Iranian electricity demand was projected to grow at 3.2 percent annually to 2030, increasing from 153 terrawatt hours (TWH) to 359 TWH in 2030, and requiring $92 billion in new investment.[20]

There is no question that Iran has been suffering from debilitating energy shortages over the last decade or so. Various regions in Iran have experienced brown-outs and repeated power outages. In the summer of 2008, for example, the Iranian government had to ration electricity in major cities throughout the country, with the leadership blaming a drought for diminishing output from the country's hydroelectric plants. Ironically, despite its difficulties in meeting domestic electricity demand, Iran exports power to several neighboring states, including Armenia, Azerbaijan, Iraq, Pakistan, and Turkey.

The major problem in Iran's electricity sector is that the government—under pressure to satisfy consumer demands so as to avoid popular unrest—has continued a costly and inefficient policy of heavily subsidizing the purchase of electricity and fuels by its rapidly growing population. Iran's large energy subsidies, which represent more than 10 percent of Iran's GDP, have actually stimulated even greater demand for electricity growth. Reductions in energy subsidies, while the most effective means to solve Iran's electricity problems, would make the ruling government even more unpopular and risk extending popular unrest from the urban middle classes to working class and poor Iranians, something the ruling elite fears.[21] For this reason, among others, Iran's rulers advocate developing other sources of energy and, in particular, nuclear energy as a means of curtailing the electricity problem.

Construction of the two nuclear power plants in Iran planned for the near-term could free up 200 million metric cubic feet per day (mmcf/d) of natural gas that could be used for other purposes or exported to reap higher revenues. However, this improvement is only a drop in the bucket when compared to the real problems of the Iranian energy sector and would serve more as a band-aid than a salve. Regardless of the ultimate construction cost of the two proposed nuclear power plants, the electricity created by them will only represent **6 percent** of current total Iranian electricity generation.

By contrast, from a rational economist's perspective, phasing out natural gas subsidies would be a more sensible policy approach to Iran's electricity shortages than building nuclear capacity. By ending natural gas subsidies and pricing fuel for power generation at appropriate levels, the Iranian government would be able to properly weigh the opportunity cost for the full range of uses of all its natural gas production, and not just the very small volume that might be freed up by the construction of the two nuclear power facilities.

20 Daniel Brumberg, Jareer Elass, Amy Myers Jaffe and Kenneth B. Medlock III, "Iran, Energy and Geopolitics," *Working Paper Series: The Global Energy Market: Comprehensive Strategies to Meet Geopolitical and Financial Risks, Energy Forum* (James A Baker III Institute for Public Policy, Rice University, May 2008) http://www.rice.edu/nationalmedia/multimedia/iran.pdf.

21 Legislation to reduce subsidies was introduced in Iran's parliament (Majlis) in March 2009 and approved by the Guardian Council in March 2010. The reductions were scheduled to be implemented at the end of September, but have been delayed.

If electricity price subsidies were removed, Iran would experience sharply slower growth in electricity demand.[22] The amount of electricity saved by eliminating the price subsidies for domestic consumption would more than offset the planned immediate additions in nuclear capacity (1360 MW). In fact, given accepted estimates for elasticity and reasonable growth, a doubling of price would save more than 13,800 MW by 2030 (assuming these are base-load power plants operating at 85 percent capacity utilization), which represents the equivalent of the electricity provided by almost fourteen 1,000 MW nuclear power plants. Moreover, lower electricity demand, if stimulated by a reduction in price subsidies, would result in considerable capital savings, and those funds could be used for other endeavors that could provide significant benefits to the Iranian people. In short, price reform would be a far more effective means of overcoming the projected energy shortage, and Iran's leaders must therefore have other reasons for pursuing the nuclear option so assiduously.

Iran's electricity problem is compounded by its inefficient development, extraction, and distribution of natural gas. Iran ranks second globally in both proven natural gas reserves and undiscovered potential natural gas resources, but only ranks 25$^{th}$ among world natural gas exporters. Around 62 percent of Iranian natural gas reserves are located in fields not associated with oil production, and have not yet been developed. Geologically, there is an abundance of natural gas in Iran that could be used to meet domestic electricity generation needs.

In practice, natural gas flaring represents as much as **14 percent** of Iran's total natural gas usage. Flaring results in about 23 billion cubic meters a year (bcm/yr) or 1.8 billion cubic feet a day (bcf/d) of gas being wasted that could otherwise be marketed, again more than double the amount of equivalent fuel being provided by planned nuclear power stations. If natural gas supplies currently being flared could instead be marketed domestically and used for power generation, it could fuel more than eight times the amount of power generation expected to be provided by the two proposed nuclear power stations. In terms of providing natural gas for export, the 2 bcm/yr expected to be freed up by nuclear power is an order of magnitude lower than the 23 bcm/yr currently being flared, some of which might be exported if the sector was simply better managed.

The unavailability of Iranian natural gas for greater electricity generation, therefore, mainly reflects poor management. As Iran was developing its natural gas sector over the past few decades, the government encouraged domestic natural gas consumption. The opportunity cost of this was relatively low as the international market for natural gas was relatively immature. The domestic emphasis for gas use was aimed at reducing gas flaring at oil fields, as well as making more oil available for export by encouraging the substitution of natural gas for oil by various end-users and through using natural gas in enhanced oil recovery efforts. The policy has been successful, as the annual growth of gas consumption has been

22 For example, using a long-run price elasticity of demand for electricity of -0.4, a doubling of price, which would likely still not entirely remove the price subsidy, would result in a reduction of 40 percent in the annual growth rate of electricity demand, thus reducing growth to about two percent per year. (Note that if one accounts for any slowdown in economic growth as a result of the lifting of price subsidies, the savings is even larger.) Mark Glenn Lijesen ("The Real-Time Price Elasticity of Electricity," *Energy Economics* (29, no. 2, 2007): 249:58) reports a range of studies in which the price elasticity of electricity has been estimated for different regions of the world. Al Faris ("The Demand For Electricity in the GCC Countries," Energy Policy 30 (2002): 117-24.) reports price elasticities for a handful of Middle East countries, exclusive of Iran. The elasticities reported by Faris fall in the middle of the range reported by Lijesen.

as high as 17 percent in recent years, thanks in large part to the low prices. In fact, Iran has significantly expanded its gas network, making gas available to consumers in all economic sectors, even to households in small communities in remote locations. [23]

These artificially low prices have contributed to Iranian natural gas demand rapidly outstripping available domestic supply, creating avoidable shortages that are again being used to justify the need for nuclear power. Low natural gas prices create a self-fulfilling, self-perpetuating supply crisis by making expanding infrastructure and developing fields for domestic use an unattractive proposition for both foreign and private Iranian investors, meaning, yet again, that the government must underwrite the expense. This has proven to be an unsustainable path, resulting in burgeoning government debt, rapidly growing energy demands, and an inability for Iran's government to keep domestic supply in line with rising demand.

Regardless of the demand outlook, the sheer size of Iran's natural gas resource base means that it could become a significant natural gas exporter in coming years, if it can make the massive investments needed to develop its resources. Thus, the outlook for domestic supply development is also important in determining the need for alternative energy sources in Iran. In fact, given the size of the Iranian resource base, if investment in domestic supplies were to be made at an efficient pace, it is doubtful that demand (under most reasonable growth rates) would outpace supply. An easing of domestic price subsidies could all but guarantee a more positive outcome. The only questions are whether Iran's leaders can acquire the financial and technical resources needed to exploit undeveloped natural gas resources, as well as the political will to phase out subsidies.

In short, Iran's pursuit of nuclear power is not justified by rational economic factors. Indeed, because it has led to tightening international sanctions which have reduced foreign investment and resulted in other adverse economic effects, the pursuit of nuclear power is worsening Iran's electricity and natural gas problems. If Iranian leaders persist in defying demands that they limit their nuclear industry in ways that would alleviate concerns that they are, in fact, seeking to develop a nuclear weapons capability, then they clearly are pursuing nuclear power for reasons of national prestige, domestic and international politics, and national security.

## Natural gas resources for electricity generation in the region

The Middle East region's natural gas reserves are quite substantial at 2,658 trillion cubic feet (tcf), or about one-third of world proven natural gas reserves. Several countries in the region are exporters of natural gas, including Qatar, UAE, Egypt, Oman, and Algeria. In addition to Iran, several other countries pursuing nuclear power facilities as a strategy to cope with growing electricity shortages have sizable untapped natural gas resources, most notably Saudi Arabia and the UAE.

The US Geological Survey (USGS) indicates a median assessment of 530 tcf of undiscovered non-associated gas resources in Saudi Arabia, plus an additional 110 tcf of associated gas. In addition, the USGS has a median assessment of 40 billion barrels of Natural Gas Liquids (NGLs). While a large majority of the assessed gas resource is in non-associated fields,

23 Dr. Manouchehr Takin, *Iran's Energy Crisis* (Centre for Global Energy Studies, May 2007), page 50.

approximately 60 percent of Saudi Arabia's proven natural gas reserves consist of associated gas. The Ghawar field alone accounts for one-third of the country's proven natural gas reserves. The majority of Saudi Arabia's non-associated gas reserves are located in the deep Khuff reservoir. Natural gas also is located in the country's extreme northwest, at Midyan, near the Jordanian border, and in the Empty Quarter. The Rub Al-Khali province, in southern Saudi Arabia, is believed to contain natural gas resources of over 300 tcf.

When he was Crown Prince, King Abdullah of Saudi Arabia initiated a major initiative for natural gas development and related businesses in 1998. The Strategic Gas Initiative was focused on attracting foreign investment to more fully explore and harness the country's vast natural gas resources. However, internal opposition and drawn out negotiations stifled the initially ambitious plans to increase the Kingdom's production of natural gas. In the end, the Initiative wound up with only a handful of smaller projects, led mainly by Russian, Chinese, and European firms, and not the largest US oil companies, which had originally negotiated for participation in major billion dollar projects in highly prospective areas. The tracts eventually offered for investment in Saudi Arabia were generally non-prospective and so far the Initiative has made little progress. [24]

Opposition to broad natural gas development in the Kingdom comes from those who believe that the Kingdom's revenues are better spent in other areas, including oil field development. Since the rate of return on investment was so much higher for oil projects than for natural gas projects because natural gas has a low domestic price in Saudi Arabia and abroad compared to oil, industry leaders have argued that Saudi Aramco, Saudi Arabia's state-owned national oil company, should not use its own capital to develop more natural gas.

Domestic natural gas prices for local industry are also set at levels well below international prices for oil and natural gas, leaving Saudi Aramco with little commercial incentive to exploit natural gas reserves for domestic consumption. In addition, the Saudi oil industry is similarly opposed to allowing foreign investors to enter the Kingdom, leaving Saudi gas industry development stymied despite a relatively large resource endowment. Proposals to develop the Western Midyan gas field and export natural gas to Jordan and around the Middle East Levant as part of a peace agreement has never gotten off the ground.

The United Arab Emirates also has substantial natural gas resources whose development has been thwarted by low domestic natural gas prices. The UAE has the sixth largest proven natural gas reserves globally at 214.4 tcf, or four percent of the world's total. Burgeoning UAE domestic demand from industrial projects, power generation and desalination plants, and for use in enhanced oil recovery (EOR) projects have resulted in periodic natural gas shortages in Abu Dhabi and Dubai. The UAE became a net natural gas importer in 2007, as consumption has grown much faster than production. In 2008, the UAE produced 1.77 tcf and consumed 2.1 tcf of dry gas. Electric power production represents almost 60 percent of the federation's total gas consumption. Nearly 92 percent of the UAE's gas reserves are located in Abu Dhabi, with the giant Khuff reservoir beneath the oil fields of Umm Shaif and Abu Al-Bukhoosh ranking among the largest single gas reservoirs in the world.

24 State monopoly Saudi Aramco, bolstered by royal support, slowed the process of negotiating investment contracts for the Initiative and the program became difficult to implement at both the political and operational level. Saudi Aramco was keen to defend its special status and bargained hard with the frustrated Western oil companies.

Despite looming domestic shortages, the UAE remains a liquefied natural gas (LNG) exporter from Das Island. The three-train facility processes associated gas from the Um Shaif, Lower Zakum, and Bunduq oil fields, with a capacity of eight million tons per year. ADNOC subsidiary Abu Dhabi Gas Liquefaction Co. (ADGAS) is studying long-term options for the plant, including whether to upgrade the capacities of Trains 1 and 2—each of which currently has a two million ton capacity—or build a fourth train. The existing third train has a four million ton capacity. The company wants to have the extra capacity in place by 2019. Around 85 percent of the LNG produced at Das Island is contracted to Japan's Tokyo Electric Power Company.

The highly competitive landscape for export markets, the high expense of exploiting Abu Dhabi's technically complex, high cost "sour" natural gas, and highly subsidized domestic pricing for natural gas and electricity has made it difficult for Abu Dhabi to attract sufficient foreign investment to increase its domestic natural gas supply. ConocoPhillips recently cancelled plans to develop the Shah gas field project, which would have included exploitation of sour natural gas and condensate reservoirs within the Shah gas field, which is situated southwest of the city of Abu Dhabi. The project was estimated to cost as much as $10 billion (including export facilities) and would have required constructing one of the largest sulfur removal plants in the world, thereby thwarting the commercial viability of the deal.

While the economics of exploiting natural gas for domestic use may not pass investment hurdles under current investment and domestic pricing regimes, it is unclear whether under different internal pricing circumstances, exploitation of the UAE's large natural gas resource base might make more sense than development of costly nuclear facilities. South Korea announced in October 2010 that it intends to lend $10 billion to the UAE to help finance the construction of the UAE's first nuclear plants. Given the scale of the required investment, even after accounting for the cost of desulphurization of domestic sour gas production and building relatively low cost combined cycle generation, it is questionable if the cost of building nuclear plants for power generation is indeed the lower cost option.

The Gulf region began first steps for a pipeline that could carry natural gas around the region in the 2000s, but the project failed to gain full regional backing. Talks have also begun to link electricity grids, but complex bilateral pricing negotiations, difficulty attaining international financing, and territorial and geo-political disputes have blocked any hopes of the kind of comprehensive regional natural gas trade that could make the push to nuclear power unnecessary.

The Dolphin Pipeline, which began shipping natural gas from Qatar to the UAE in late 2007, is the first major cross-border natural gas pipeline among Gulf countries. However, it has been plagued by the same financial and geo-political issues that block natural gas development generally in the region.

Dolphin Energy, which is controlled by the Abu Dhabi government's investment conglomerate, Mubadala Development, and also includes partners Occidental and Total, is currently supplying about 2 bcf/d of Qatari gas from the giant North Field via an 364-km undersea pipeline from Ras Laffan, on the upper tip of the Qatar Peninsula, to Taweelah, on the coast of Abu Dhabi, for sales within the federation and Oman. From Taweelah, a 152-mile pipeline will run to the Qidfa Water and Electricity Station in Fujairah. Construction

of this line is scheduled to be completed by the third quarter of 2010. Dolphin Energy has been seeking to increase gas volumes as the main pipeline has a 3.2 bcf/d capacity. Qatar was able to supply Dolphin with extra volumes in late 2009 as the gas glut in the United States freed up supplies that would otherwise be shipped as LNG.

Kuwait is currently an importer of liquefied natural gas but could someday be part of a larger Middle East gas pipeline network. Its largest natural gas field, the Dorra field, borders Saudi Arabia and Iran. Border delineation problems have prevented Kuwait from developing these resources. While parliamentary opposition remains fierce, a five-year deal was signed between Royal Dutch Shell and Kuwait Oil Company (KOC) in February 2010 to develop deep gas reserves in six northern fields. The Shell gas project targets 1 bcf/d of output from the Raudhatain, Sabriya, Bahra, Umm Niqa, Northwest Raudhatain, and Dhabi fields, or approximately seven times their current output.

Kuwait was unable to join the Dolphin gas pipeline project when Saudi Arabia refused to approve a section of the pipeline (which also could have been connected to Bahrain) that would have had to pass through Saudi territorial waters. Instead of waiting for geopolitical solutions for a regional gas grid, Kuwait opted to develop LNG receiving capability and is currently buying LNG from the spot market. Dubai is considering a similar strategy. The shift to either LNG or nuclear energy comes in the aftermath of failed pipeline talks that were thwarted by geopolitical tensions and pricing disputes.

Typically, the Gulf countries have tried to get regional natural gas suppliers to offer pipeline gas at prices discounted from international levels to bridge the gap to low domestic natural gas and electricity prices. Lack of pricing benchmarks for Gulf pipeline sales have made international financing of pipeline projects more difficult than even more expensive LNG projects, since LNG is a more transparent, globally traded commodity. Natural gas sales through the Dolphin pipeline are sold to the UAE, for example, at $1.35 million btu, while international LNG prices have ranged from $4 mmbtu to $12 mmbtu in recent years. Kuwait, Bahrain, and the UAE have each held natural gas pipeline supply talks with Iran over the years, but these were complicated by the geopolitical problems created by each country's territorial disputes with Iran, Iran's nuclear aspirations, and Iran's support of international terrorism and subversion.

Despite lack of progress on natural gas grids, the six members of the Gulf Cooperation Council have agreed to develop a regional power grid that member states can tap to try to avoid power blackouts. The interconnection project is estimated to cost $14 billion. Under the grid agreement, countries would have the right to an established number of hours of emergency power annually, which if not paid back by a certain time would subject member states to fines. Phase one of the grid project was completed in July 2009 when Bahrain, Saudi Arabia, Kuwait, and Qatar were connected to form the North Grid. Phase two involves the integration of networks within the UAE and Oman to form the South Grid, followed by phase three, which will tie the South Grid to the countries in the North Grid. The UAE is scheduled to connect to the GCC grid by early 2011, with Oman following after. The ownership of the GCC power grid is divided according to the expected portion of grid use, with Saudi Arabia taking a 31.6 percent interest, Kuwait 26.7 percent, the UAE 15.4 percent, Qatar 11.7 percent, Bahrain 9 percent and Oman 5.6 percent.

To achieve similar success with development of regional natural gas resources would take active diplomacy to settle existing border disputes and complex commercial negotiations about pricing and financing schemes. However, such a grid could potentially alleviate the need for costly investments in nuclear energy and the strategic and proliferation risks associated with them. A broader grid, one that could be expanded to include supplies from Iraq and Iran, could be part of a more comprehensive regional peace initiative, were diplomatic progress to become realistically achievable on the Iranian nuclear issue and other outstanding regional problems.

## How is Iran's nuclear strategy affecting the region?

Given the high cost of nuclear power investments, the shortage of knowledge, infrastructure, and construction capacity in most Middle Eastern countries, and the ample reserves of regional natural gas, the push to nuclear power across the region seems to have broader motivations than anticipated electricity shortages.

One plausible explanation for the pursuit of nuclear power by certain countries in the Middle East could be that those nations are interested in a hedging strategy against the development of nuclear weapons by Iran. Attaining nuclear weapons and the stature believed to go with it would strengthen Iran's claim to be the regional leader, and perhaps encourage Iran to act more aggressively in pursuit of its geo-political aims and territorial claims. Many other nations in the Middle East, such as Egypt, Saudi Arabia, and Turkey, consider themselves to have a natural role as a regional leader and thus are unwilling to cede that role to Iran. Still others are concerned that they may need nuclear weapons to deter Iranian aggression or nuclear blackmail. It is also possible that nuclear capability is now seen in the region as a minimum standard to maintain regional leadership status, thus possibly escalating the risks of a proliferation of secret weapons programs in the region.

Although always couched in terms of meeting future energy needs and/or preserving oil and gas to earn export revenues, as we have noted, most Middle Eastern nations are at least talking about pursuing nuclear development programs and a few are making tangible progress toward that end. They cite the need to preserve oil and gas and to produce more electricity for these plans and activities, but their motivations also include the aforementioned competition for regional leadership, to gain economic/technical prestige on the world stage, and to prepare to defend themselves, if necessary, against a nuclear-armed Iran.

It is unclear at this point how hard it would be to divert the countries of the Middle East from the nuclear pathway or, if that is not possible, to shape their nuclear power programs in ways that do not pose significant risks of weapons proliferation. Much depends, of course, on whether or not the US and its allies are successful in containing the Iranian program well short of a weapons' capacity. It also depends on the evolution of the financial situations in individual countries, as well as their internal politics. The UAE is certainly the

farthest along toward the construction of nuclear power reactors, and will have both the resources and political support to complete at least two of the four reactors that have been announced, but these reactors and their fuel will be safeguarded by the IAEA and the UAE has agreed not to build uranium enrichment facilities, and thus does not pose a weapons proliferation risk.

Saudi Arabia no doubt has the resources to build nuclear power plants, but it is starting from such a rudimentary nuclear infrastructure compared to Iran that it will take it many years to be able to emulate the status of the Iranian program, and may take its cue from the evolution of that program.[25] Jordan seems more resistant to foregoing enrichment, but both its internal politics and finances are on shaky grounds and negotiations with the US are continuing. In the end, given its dependence on the US for security guarantees, it may not be willing to defy the US on the enrichment issue, assuming guarantees of assured uranium services are also proffered. Turkey has announced ambitious nuclear plans repeatedly over the past 10 years, but has made only limited progress and there is considerable internal debate over the right course. Turkey also has competing needs for resources. Egypt aspires to a leadership role in the Middle East, but has difficult resource limitations and has not advanced very far toward building a nuclear infrastructure or technology base.

Thus, although the course of proliferation in the Middle East will have much to do with the United States' success or failure with respect to Iran's nuclear program, it is also important for the United States to broaden its proliferation diplomacy beyond Iran and to address larger regional issues and alternative regional energy solutions.

What is, and what should, the United States be doing about the prospective proliferation of nuclear technology in the Middle East?

The United States' efforts to negotiate non-proliferation and other safeguards/ commitments with key Middle East pre-nuclear states have been mixed. On the bright side, all those states are signatories to the Non-proliferation Treaty and full scope safeguards agreements with the IAEA. In addition, 10 of the 18 non-nuclear Middle East and North African states have signed the Additional Protocol (AP) to their Safeguards Agreement with the IAEA, permitting the IAEA to inspect undeclared facilities to determine if there are any nuclear activities at those sites.[26] As noted, the US was successful in persuading the UAE to forego uranium enrichment.

On the other hand, six states in the Middle East—Iraq, Iran, Libya, Egypt and Syria—were, or are still, involved in undeclared nuclear activities, some with a full fledge plans to develop nuclear weapons program. The US experience with Jordan, a key US partner in the region, has been rather different than with the UAE. As noted, so far Jordan has rebuffed

25 Saudi Arabia also has a long and close relationship with Pakistan, which is currently a nuclear power. Pakistan's continuing expansion of its fissile material production capacity has led to speculation that it would assist Saudi Arabia but an official Saudi website has published articles by third parties implying it would reject this option for geopolitical reasons.
See http://www.saudi-us-relations.org/articles/2008/ioi/080209-lippman-nuclear.html

26 Bahrain, Iran, Iraq, Jordan, Kuwait, Libya, Morocco, Tunisia, Turkey, and the UAE have signed the Additional Protocol. Of those states, however, only Jordan, Kuwait, Libya, and Turkey have so far taken the additional steps necessary to put it into effect.

US objections to its current plans to exploit its own uranium deposits to make nuclear fuel. Rather than allow Jordan to become a regional center for uranium enrichment or a nuclear fuel bank, as Jordan aspires to for economic reasons, the United States has been pressing Jordan to sign guarantees that would oblige it to buy reactor fuel from the international market as a further safeguard against diversion of fissile materials for military purposes. Another reason for the US pressing Jordan on this issue is that Jordanian enrichment would provide Iran with another justification for its own enrichment program, just as it uses Israeli nuclear capabilities to justify its allegedly peaceful nuclear program. The jury is still out on these negotiations.

Saudi Arabia has called for an agreement to create a nuclear weapons free zone in the Middle East and some observers question whether the kingdom would agree to forego an enrichment capability if other states in the region, like Iran, Jordan and Israel, do not back down from an enrichment-oriented stance. It will be hard for the United States to implement a regional nuclear free agreement due to Israel's non-declaratory stance. Israel will not publicly confirm its nuclear status and has refused to join the NPT. It does not permit IAEA inspections or safeguards on its weapons stockpile or facilities at Dimona.

In any event, the United States' lack of success so far in getting close allies like Israel and Jordan to agree to forego enrichment and reprocessing activities calls into question the chances that the United States could persuade the nations of the Middle East to create a zone of free of nationally-controlled enrichment/reprocessing facilities, replacing them with either fuel services purchased from outside the region or by the development of a regional, multi-nationally controlled, enrichment solution. Both of these alternatives have been suggested as means of helping to persuade the Iranians to end their nationally controlled enrichment.

If plans for civilian nuclear power programs in the Middle East do continue to progress and eventually turn into concrete programs, it will certainly buttress Iranian intransigence on the nuclear issue. If the US fails to establish regional standards for such programs that create barriers to their transformation into military weapon programs, such as the prohibition of nationally-controlled enrichment facilities, it will further buttress the Iranian position. By the same token, as long as the US and its allies in the West fail to gain verifiable assurances from Iran that its nuclear program are strictly peaceful in purpose, it will be increasingly difficult for the United States to enforce non-proliferation standards, re-export agreements, materials safeguards, and anti-weaponization barriers with other countries—beyond those already in place—rendering the problem into a self-propelling, accelerating spiral.

We believe there are multiple risks to the wide-spread use of nuclear power in the Middle East, including expansion in the number of trained personnel in the region who could be diverted to secret weapon programs or enticed by other countries to help them develop weapons covertly. In addition, there would a risk of sudden changes in apparently benevolent proliferation policies following a regime change. Other risks include: (i) the leakage of fissile materials for illegal exports, (ii) accidents due to wars or terrorism, and (iii) other safety related issues, such as earthquakes. The spread of nuclear power programs around the region also could deepen the level of distrust among nations in the region and lead to accelerated conventional arms buildups. Finally, the more locations that store fissile

materials, the greater the risk that terrorist groups might get their hands on radioactive materials which, even if they could not fashion them into a nuclear bomb, could be used, combined with conventional explosives, to spread lethal radiation in urban centers.

US diplomacy should place a higher priority on means of avoiding these worst-case scenarios. To begin, the US government is not engaged enough in seeking to limit the competitive marketing of nuclear assistance to the Middle East but, rather, is itself helping American companies to bid effectively against companies located in Japan, South Korea, Russia, Canada, and France. More effort needs to be put into creating a coalition with the main nuclear technology supplier countries to establish guidelines for nuclear commerce with the Middle East and then to work with all parties to ensure compliance with those supplier rules and commitments. The December 2009 G-8 pledge in which the participants committed themselves not to export items for enrichment or reprocessing to newcomer countries is a good example of the type of supplier limitation that is necessary. Focus should be placed on strengthening safeguards, export controls, and requiring implementation of the Additional Protocol (AP) as a condition of supply. Implementation of the AP would be particularly helpful in preventing secret weapon programs, such as those seen in Iraq (until 1991), Libya (until 2003), Iran (ongoing), and Syria (until 2007). Wide-scale implementation of the AP, however, also will require that additional resources be made available to the IAEA; it currently lacks the manpower, equipment, and money that would be required for a major step-up in inspections.

According to sources in the Gulf, the United States has been successful in working with key member countries of the GCC—Saudi Arabia, Kuwait, and the United Arab Emirates—to increase economic pressure on Iran by making it more difficult for Iran to sell its oil in Asia. The Gulf Arab suppliers are offering special discounts to increase their own exports of oil to Asia, thereby leaving Iranian cargoes afloat on the ocean with no buyers. It is hoped among GCC members that over the longer term, increased economic problems in Iran's oil sector will help weaken the regime or at least change its nuclear course. However, GCC cooperation with the United States against Iran generally does not appear to extend to cooperation with the United States about civilian nuclear programs and the rules of the road for those programs. The United States, similarly, has not focused on resolving the problems that are blocking trade in electricity and natural gas around the region, as well as cooperative water desalination projects, that might obviate the ostensible need for civilian nuclear power. Artificial political obstacles are preventing the sensible development of regional natural gas resources as cheaper alternative to nuclear power and the United States has not focused diplomatically on helping to resolve such obstacles. Movement toward regional electrical or natural gas grids, and cooperative desalination projects, might help to persuade governments to concede that their nuclear ambitions are not really necessary to resolve their energy woes. The United States should undertake an active diplomatic initiative to see if a regional electricity and natural gas grid could be used to undermine the existing, ambitious plans for expanding nuclear capabilities. If done in combination with concerted efforts to restrict the terms under which nuclear suppliers provide assistance, personnel, and technology, a comprehensive agreement that could involve Iran seems more plausible.