BRITISH AMERICAN SECURITY INFORMATION COUNCIL

Changing the Frame of the International Debate over Iran's Nuclear Programme:

Other solutions to Iran's Energy Insecurity [1]

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[1] This is a paper presented at a conference on Iran's nuclear programme in Tehran on 9th March, hosted by the Institute for Political and International Studies (IPIS), a think-tank closely associated with the Ministry for Foreign Affairs of the Islamic Republic. BASIC believes fundamentally in dialogue and the importance of exploring with others mutually-beneficial solutions to apparently intractable problems. The international dispute over Iran's nuclear programme is exactly the sort of problem that demands an understanding from all sides of the perspectives of others, an effort to speak in a 'language' that it understood, whether or not there is agreement between these perspectives; this paper and BASIC's involvement in this conference is in this spirit. This version of the paper lacks many of the footnote references that will appear in the final version.

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Summary

Iran's claim that it needs greater energy diversity is indisputable. Even with essential investment in energy infrastructure, energy efficiency measures, a tightening of the market and reductions of subsidies, Iran is in no position to continue the level of its dependency on oil and gas. But nuclear power holds big costs: it is dangerous, expensive, leaves a long legacy and undermines trust regionally. Even without weaponisation the current programme will lead to knock-on programmes in neighbouring states, and race to develop nuclear weapon capabilities.

Iran could achieve its obvious need for energy diversification through alternative means. Renewable energy technologies are rapidly developing as a realistic option, and in Iran they hold particular promise, dwarfing the potential from nuclear. Solar power in particular, both in large scale and micro projects, has virtually unlimited potential to create the energy revolution that springboards Iran into the take-off. Alongside wind, hydro, biogas and geothermal options, the energy mix could be sustainable and reliable. Investment in these options would also give Iran the chance to develop an important forward-looking high-tech industry with a large and growing export market.

The Context: Demand for Energy and the Nuclear Option

Iran's justification for the nuclear programme relies upon a belief that the country needs to diversify its energy production; currently it is heavily reliant upon oil and gas production for both its domestic energy requirements and to generate foreign currency. While there is plenty of scope to greatly improve production rates and efficiency through infrastructure improvement, this will be far from sufficient. In any case, which country has ever voluntarily limited its energy diversity on the grounds that it has enough already when alternative options exist? At a time of industrial take-off and heavy expectations for further growth, continually increasing population and global climate change, it makes even less sense than historically to rely upon one or two sources of energy to power Iran's economy.

Table 1: GDP growth in Iran (1997-2006)[2] in %

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
3.4	2.7	1.9	5.1	3.7	7.5	6.7	5.6	5.7	5.4

In 2002 more than 98% of Iran's primary energy supply and 92% of its installed electricity capacity (36 GW) were derived from oil and gas resources.[3] Government subsidies mean that prices paid for energy in the Iranian domestic market are around 20% of the price paid in the Persian Gulf generally, opening up possibilities of arbitrage and corruption, and encouraging profligate use.

[2] Source: IMF World Economic Outlook, Sept 2005, Table 6, p.214

[3] See Islamic Republic of Iran, http://wwwpub.iaea.org/MTCD/publications/PDF/cnpp2003/CNPP_Webpage/PDF/2002/Documents/Documents/Islamic%20Republic%20of%20Iran%202002.pdf

The government is projecting a consumption of 70 GW of electricity by 2021, 10% of which it plans to produce with nuclear power in at least seven reactors.[4] The cost and the role of economies of scale in such an Iranian nuclear programme is not clear, but must be considerable. The nuclear programme, still to involve a workable power reactor has probably cost between $10 bn and $20 bn investment to date.

Even if it were cost effective, the proposed expansion of a nuclear power infrastructure is probably not the best option for Iran. Nuclear power is associated with a number of risks:

- *Proliferation.* There is no clear way of separating the technology needed for nuclear power from that used to manufacture the fissile material for nuclear weapons. IAEA inspections provide a confidence level of detection, but as long as there is a lack of trust, there can be no absolute confidence.
- *Pollution*. Despite decades of research and development, there have been no permanent sites for the disposal of high-level radioactive waste anywhere in the world. Governments and companies involved in nuclear power production have stored up liabilities of hundreds of billions of dollars, as a result of outstanding waste disposal. This issue alone drastically affects the economics of nuclear power as well as the impact on future generations.
- *Terrorism*. Nuclear power plants and other facilities represent significant terrorist targets that could present devastating impacts with the potential to equal or even exceed the meltdown of Chernobyl in 1986. The possibilities of theft of either enriched uranium or reprocessed plutonium by factions within the state, opposition groups or terrorists make the existence of such fissile material dangerous to the Iranian state and to the wider international community, demanding significant security measures.
- *Accidents*. The safety of nuclear power plants has improved, but there remains the danger of accidental release of nuclear material, as well as the gradual release of radioactivity into the environment with consequent health effects.

Nuclear energy is also capital intensive; it requires huge up-front investments, and many years of research and development. It also creates undetermined levels of future liabilities in the disposal of waste and decommissioning.

Iran currently has a clear stated objective of developing a full indigenous nuclear fuel cycle and constructing a number of nuclear reactors in order to achieve a near independent nuclear power programme. Its uranium reserves are only sufficient to power the planned seven reactors for 12 years. Presumably an indigenous supply would be intended to enable the country to weather interruptions to supply for political purposes.

Renewable Alternatives

Nuclear is the technology of the 20th century, born out of a nuclear arms race; in an era of climate change and nuclear proliferation, solar is the technology of the 21st century. Last year Germany installed new solar cell systems with an electrical capacity

[4]Muhammed Sahimi, Forced to Fuel, Iran's nuclear Program, at http://hir.harvard.edu/articles/1294/.

equivalent to that of a nuclear reactor, and Japan now has a similar annual manufacturing capacity. Next year one single Japanese solar cell factory will come online that will double this capacity. [5]

Iran's legitimate justification for seeking a nuclear power capability applies equally to renewable energies. Efficient and reliable renewable energy sources would diversify and ensure supply without using up valuable oil and gas reserves. Such sources of energy have a strong potential to tackle the increasingly damaging environmental impacts arising from the use of fossil fuels in cities, as well as their contribution to climate change.[6] Renewable energy also has a rich potential for dispersed job creation in many parts of Iran, in the construction, erection and repair of large scale and micro-generation plant. Given the growing global concerns over energy insecurity and climate change, technologies associated with renewables have a strong export potential.

Iran's varied geography is well suited to a diverse and extensive use of renewable energy sources: hydro and geothermal in the northern and western areas, wind in the eastern and southern plains, and solar energy in the central and southern areas. Until now this potential has remained limited to a modest increase in the exploitation of hydroelectricity; otherwise there are no plans for a significant investment in renewable energy at present.[7] The lack of interest in renewables can be put down to the cheap price of fossil fuels, kept low by subsidies and the historically abundant supply of fossil fuel resources. It is also down to the Iranian government's attraction to nuclear power.

Hydro

In Iran's modest renewable energy story to date, hydroelectricity is the notable exception. Iran is clearly investing significant resources in its development. The country has an estimated potential for hydroelectric power generation of between 23 and 42GW.[8] In 2003 Iran generated 11,098GWh of hydro electricity.[9] By 2007 the seven hydroelectric power plants being constructed should be generating over 8GW of electricity – more power than all Iran's other power generation projects currently being developed combined. With further expansion planned, the government hopes to be generating 14GW by hydroelectric power by 2021 (representing 20% of Iran's projected electrical capacity).

Solar

The potential for solar electricity generation in Iran is virtually limitless. Iran is just outside the tropic of Capricorn and much of the country experiences high levels of solar radiation, a daily average of between 5.0 and 5.4 kW h/m^2 in the south of the country

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[5] Figures supplied by Professor Keith Barnham of Imperial College, London

[6] See Ardehali M. M., Rural Energy Development in Iran: Non-renewable and Renewable Resources, in Renewable Energy, 31 (2006) 655-662

[7] See Islamic Republic of Iran at http://www-pub.iaea.org/MTCD/publications/PDF/cnpp2003/CNPP_Webpage/PDF/2002/Documents/Documents/Islamic%20Republic%20of%20Iran%202002.pdf

[8] IEA Energy Statistics 2003

[9] http://www.payvand.com/news/04/dec/1056.html

(in comparison London receives a daily dose of around 1.0 kW h/m^2). This gives an energy generating capacity of approximately 0.5kW /m^2 of solar panelling, or 500MW /km^2. The deserts of Iran occupy a quarter of the total land area; if only one per cent of the desert area was covered by solar PV collectors, the energy obtained would be five times more than the current annual electricity consumption in Iran.[10]

Particularly suitable areas for solar thermal power plants have been selected for future construction at Esfahan, Fars, Kerman and Yazd. The first Iranian Solar Thermal Power Plant is due to be constructed at Yazd.[11] With enough investment and a serious commitment, the potential is vast.

Solar thermal systems on the roofs of buildings have many merits, not least that more primitive designs can be installed with cheap and freely available plumbing components with limited expertise, and provide significant return in energy savings. A study of the economic feasibility for domestic solar water heating systems around Iran was published in 2000,[12] but the technology remains surprisingly underutilised. The total cost of installing a full domestic solar central heating and hot water system in Iran is estimated at 80m Rials (roughly $9,000).[13] If all the public buildings in Iran were fitted with solar panels, the cost could be as little as 45,000 Rials/m^2.[14]

Wind

Wind energy for electricity generation and water pumps holds a great deal of promise in the east of Iran. The wind potential has been studied in 45 experimental sites. It was estimated that there was a realistic prospective capacity of 6,500 MW. The currently installed capacity is only 11 MW, compared to Egypt's 69 MW and Morocco's 54MW.[15]

Biogas

Each year Iranian society produces 15m tonnes of municipal waste and 4.6bn m^3 of urban and industrial sewage (with a collection and burial cost of $225m). Biogas technology presents an important energy potential.[16] Indeed, the use of biogas in Iran has steadily grown over the last 30 years but its potential remains largely unexploited.

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[10] Tavanir Organization, *Detail Statistics of Iran Power Industry*, Teheran, Iran: Statistics Department; 2002

[11] See http://www.ystpp.com/profile.htm

[12] Keyanpour-Rad M., Haghgou H. R., Bahar F., Afshari E., *Feasibility study of the application of solar heating systems in Iran*, Renewable Energy, Elsevier Science Ltd, Vol. 20, 2000, 333-345.

[13] The system includes heat collectors, exchangers, pumps, storage tank, installation, and radiators.

[14] These costs refer to 1999. The technology has developed, and the costs may well now be lower. Keyanpour-Rad et al, *Idem.*

[15] Sahin Ahmet Duran, Progress and Recent Trends in Wind Energy, in Progress in Energy and Combustion Science; Vol. 30, Issue 5, 2004, pp. 501-543

[16] See Kia A. S., Taleghani G., Nazari A., *Biogas Incentives in Iran* , Center for Renewable Energy Research and Application , Atomic Energy Organization of Iran, *RIO 3 - World Climate & Energy Event, 1-5 December 2003, Rio de Janeiro, Brazil,* http://www.rio3.com/proceedings/RIO3_301_A_S_Kia.pdf.

Biogas is a by-product of the domestic waste stream, and does not require complex high-technology for its extraction.

Geothermal

Iran has substantial geothermal potential.[17] It has been estimated that Meshikin-shahr, Sabalan, Damavand and Azarbaijan could produce 7.5GW of electric power.[18] Geothermal exploration was started in Iran by Ente Nazional per l'Energia Elettrica of Italy (ENEL) and the Ministry of Energy 30 years ago in 1975. After the establishment of the Electric Power Research Center (EPRC) and the Renewable Energy Organization of Iran (SUNA) 1990, a new round of exploration activities began. In 1995, SUNA started to explore other sites for geothermal potential.[19]

Wave and Tidal

There is also some potential for ocean wave and tidal energy in the Persian Gulf. It remains untapped and unstudied.

Conclusion

Issues of energy security and sustainability are global challenges, though the dynamics may be different in Iran than in developed countries. Industrial development and economic growth, a primary policy objective of every government, mean dramatic increases in the consumption of energy in countries that have not completed their economic takeoff. It is a primary responsibility of governments to ensure that energy supply is adequate to the demand.

The projected level of energy consumption in Iran demands a substantial rethink of energy policy. Iran's fuel subsidies need to be reduced to encourage a more efficient use of energy and the development of energy conservation measures and more efficient means of production. As it is, President Ahmadinejad's electoral boost rested on his call for social justice and more equitable economic opportunities, and is likely to imply even heavier government subsides to energy consumption. The current regime's programme has also discouraged foreign investment in energy infrastructure, and is likely to harm the prospects for the broader economy. The current state of energy infrastructure also causes waste and inefficiencies.

With sufficient political backing and investment renewable energies present an enormous opportunity for Iran.

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[17] M.M. Ardehali, *Rural Energy Development in Iran: Non-renewable and Renewable Resources*. In Renewable Energy, 31 (2006) 655-662

[18] Rostamihozori N., *Development of energy and emission control in Iran*, http://www.ubka.uni-karlsruhe.de/vvv/2002/wiwi/2/2.pdf. At Sabalan, with 1450 km2 of effective area and temperature range of 140-260 C, the estimated geothermal energy available is 48 GJ capable of supporting a generation facility with a capacity of 4,000 MW. At Damavand, Khoy are identified as high potential sources with approximately 5,40 and 23 GJ of geothermal energy, respectively.

[19] Manuchehr Fotouhi and Y. Noorollahi, Updated Geothermal Activities in Iran, at http://iga.igg.cnr.it/pdf/WGC/2000/R0178.PDF

Table 2: Nuclear and Renewables Compared (GW of Electricity Generation)

	CURRENT	PROJECTED CURRENT PLANS (2020)	POTENTIAL IF HEAVY INVESTED (2020)
NUCLEAR	0	7	7
SOLAR	0	0	0.5/km^2
WIND	0	0	6.5
HYDRO	3	14	43
GEOTHERMAL	0	0	7.5

Renewable energies have been slower to catch on than might have been expected because of fuel subsidies, the easy availability up to now of fossil fuels and a lack of political interest. But while Iran is rich in fossil fuel reserves, it also has a significant potential in solar, wind and hydropower sources. There has recently been a general spark of interest in alternative energy – as an energy source and as an answer to the environmental impact of fossil fuels. Hydropower, already well developed in Iran, is further promoted in its Five-Year Economic Development Plan.

Micro-renewables could play an important role in generating energy at the point of consumption, given the poor state of the country's energy infrastructure and dispersed rural population. Iran has vast rural areas with small towns of one thousand or less in population, which cannot realistically be served by the electricity grid. Renewable energy technology does not require the enormous, lumpy capital investments demanded of, say, an oil refinery or a nuclear power station. It also offers the possibility of supporting healthy local economies, with local job creation both in installation and repair. The abundance of clean renewable energy sources offers a unique opportunity for win-win partnerships with countries leading the global development of renewable energy technology.

Renewable energy has the potential not only to defuse the current 'nuclear' crisis, but also to offer an important sustainable self-sufficiency for Iranian electricity generation.