India’s Energy Security

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Executive summary

The story of India’s search for energy security may be summarized as: a late start, lots of catching up to do. India’s planners have realized that rapid economic growth, which has begun to be taken for granted by the public, depends on the availability of energy. Coupled with the single-minded and successful efforts of the other big emerging nation, China, in locking up energy supplies, the realization dawned that India needed to redouble its own efforts. The result has been a number of efforts to tie up supplier relationships around the globe in a variety of areas: oil, natural gas, nuclear, and also hydro-electric power from neighbors. Unfortunately, these efforts have not been as successful as China’s efforts.

In the medium term, it still appears as though India is going to be dependent on external sources of supply of hydrocarbons for its energy needs.

There is perhaps a lack of strategic intent. There is no clearly-articulated idea that energy is something that Indian fully intends to capture, whatever the cost. Therefore, India’s energy security does not look very assured, and the Chinese are considerably more successful in their quest for energy. If there are no major oil and gas finds in Indian territorial waters, India may be forced down a perilous path that includes a massive increase in the use of coal – with the attendant environmental issues – as well as increasing dependence on nuclear power. On the other hand, if there are some technological breakthroughs in alternative energy, India may be rescued from its predicament.

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1 This paper is included in the proceedings of the conference at Osmania University, Hyderabad, India in March 2009 on the topic “India and Russia: Problems in ensuring Energy Security”. The author is also an adjunct faculty at IIM Ahmedabad and IIM Kozhikode. He is a graduate of IIT Madras and the Stanford Business School, and his professional experience includes Bell Laboratories, Sun Microsystems and Siemens. He was a Fellow of the Salzburg Global Seminar on the Global Energy Fulcrum.
Global energy usage

The global picture in terms of energy use is decidedly mixed. On the one hand, it does not appear likely that the world will run out of oil (and oil-like substances, including shale, tar sands, liquefied natural gas, liquefied coal, etc.) in the immediate future. It also appears that according to fundamental laws of physics, there is plenty of energy available in the current known reserves of various sources of energy.

According to CSTEP⁹, quoting research from Harvard University, the theoretical sources of energy appear to be practically inexhaustible. Compare this to the actual current world energy use of only 15 Terawatt-years per year. The trick, of course, is in converting this potential into actual available energy.

Table 1: Potential Sources of Energy

<table>
<thead>
<tr>
<th>POTENTIAL SOURCE OF ENERGY</th>
<th>TERAWATT-YEAR ENERGY CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Gas (Conventional)</td>
<td>1,000</td>
</tr>
<tr>
<td>Oil and Gas (Unconventional)</td>
<td>2,000</td>
</tr>
<tr>
<td>Coal</td>
<td>5,000</td>
</tr>
<tr>
<td>Uranium (Conventional reactors)</td>
<td>2,000</td>
</tr>
<tr>
<td>Uranium (Breeder reactors)</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Solar (per year)</td>
<td>30,000</td>
</tr>
</tbody>
</table>

The other side of the picture is the increasing concern about environmental effects, such as global warming. It is probably not appropriate to continue with business as usual — the burning of increasing amounts of fossil fuels — because of predictions that the average temperature may rise as much as 6°Celsius by the year 2100. This would spell disaster especially because of huge disruptions in weather patterns, not to mention a rise in the sea level by several meters, which would render many of the world’s coastlines uninhabitable.

As a result of conservation, greater fuel efficiency, and so forth, it is possible that energy demand growth will decline. Nevertheless, it is still likely that conventional energy sources will continue to predominate and that more benign renewable will not be a major factor even in twenty years’ time. There are a number of scenarios based on various assumptions, but the following is the “reference case” used by the OPEC, which his similar to those used by IEA, etc. (from OPEC, World Oil Outlook 2008³⁹)

The IEA, in its World Energy Outlook 2008 sees “more of the same: a vision of a laisser-faire fossil-energy future.” It too considers a Reference Scenario — business as usual — which suggests that world energy
usage will grow from 11,730 Mtoe\(^2\) equivalent to 17,010 Mtoe in 2030, an increase of 45%. This will require massive investments in energy infrastructure – equivalent to $26 trillion in 2007-2030.

![World Supply of Primary Energy](image)

**Figure 1: World Supply of Primary Energy in the reference case. Source: OPEC, “World Oil Outlook 2008”**

The general forecasts from various experts suggest that demand for energy, especially in developing countries in Asia, is also going up substantially. The following data is from the Asian Development Bank, quoting the IEA\(^iv\). As they industrialize and urbanize, increasingly prosperous Asians are going to act more like rich-country consumers, that is to say far more profligate in their use of energy. The forecast suggests that both per capita energy consumption and aggregate energy consumption in developing Asia will increase rapidly.

\(^2\) Million tons of oil equivalent
India's per capita energy consumption is among the lowest even among developing nations. However, the projected increases in the sales of cars and other energy-intensive appliances will cause India's per capita energy usage to increase and become comparable to richer nations. The following data is from the ADB, quoting the IEA:

![Per Capita Energy Consumption (MTOE, 2005)](image)

**Figure 3: Per capita consumption, selected countries. Source: ADB**
World situation: oil prices to go back up to $80-100 shortly

The volatility of oil prices in 2008 surprised everybody. After hitting an all-time high around $150, oil prices have plunged, reaching lows in the $30s. This has been the result of recession-induced reduction in demand, including the cooling of the previously red-hot Chinese economy. The implications of oil in the $30 range are many – including the possibility that people, seduced by low prices, will now go back to their profligate use of energy, and that the lessons of this Second Oil Shock are not going to be internalized. Furthermore, it is quite clear that the producing countries have great incentives to ensure a much higher “normal” or “base” price, because the windfall transfer of trillions of dollars to them through high prices is something they have gotten used to, and it is hard for them to forgo it. Reports suggest that the breakeven prices required by certain major oil exporters in OPEC are as follows, according to the Wall Street Journal Asia:

<table>
<thead>
<tr>
<th>Country</th>
<th>Breakeven Price $/Barrel of Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iran</td>
<td>100</td>
</tr>
<tr>
<td>Bahrain</td>
<td>90</td>
</tr>
<tr>
<td>Kuwait</td>
<td>80</td>
</tr>
<tr>
<td>Oman</td>
<td>70</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>60</td>
</tr>
<tr>
<td>Qatar</td>
<td>50</td>
</tr>
<tr>
<td>UAE</td>
<td>40</td>
</tr>
</tbody>
</table>

Figure 4: Breakeven price of oil for selected producer nations. Source: Wall Street Journal Asia

While the actual cost at the wellhead of oil may be much lower (there are reports that it only costs Saudi Arabia $1-$2/barrel to dig the stuff out of the ground), the budgetary price that OPEC countries live by is much higher, and they will not be able to sustain their spending below a certain minimum price. Thus production quotas will be observed by OPEC until the desired pricing level is reached.

Observers in the know suggest that the “natural” price of oil is around $85-$100 in 2009 dollars, and that prices will reach this equilibrium level in the near future. The extreme volatility in prices, according to them, is acting as an inhibitor to investment in OPEC countries, and therefore most likely will lead to supply reductions in the long-run, as existing oil wells get exhausted.

But it is argued that the era of peak-oil has not arrived, contrary to Cassandra-like predictions (“Hubbard’s Peak”). OPEC dismisses these concerns by saying “Resources are plentiful”. Oil company officials suggest that new oil supplies will continue to come online. Therefore, they do not see a fundamental constraint to oil availability from the supply side, although actual future capacity to deliver
petroleum may be affected in future by failure to make investments today. The world is not running short of oil or gas just yet, they say reassuringly, although there have been many warnings about the coming oil bust. The argument is that there is still a significant amount of recoverable oil, including extra-heavy oil, oil sands and oil shales, although the cost of recovery – and thus the cost of products derived from them – may be high. However, the IEA does agree that field-by-field declines in oil production are accelerating and that barriers to upstream investment could constrain global supply. This is one of the arguments made about the ultimately harmful effects of oil prices being “too low”.

Apparently, major projects are being cancelled or put on hold.

The projections by the IEA, OPEC and others are remarkably consistent: their reference cases are similar, as in Figure 1. They expect that despite large increases in energy consumption going forward, the share of both oil and natural gas will remain more or less stable. However, they project, gloomily, that the share of coal will shoot up. This is taken as an inevitable phenomenon, given that several major users of energy, including the US, China, and India, all have very large coal deposits which are obviously under their own control.

Given the compulsions of energy security, it is likely that many nations with large coal deposits will attempt to exploit them, despite concerns about global warming. In fact China has already embarked on a program of building a large number of coal-fired electricity plants, which is almost certainly contributing to acid rain and the so-called Asian Brown Cloud that hovers over the continent.

That brings up the question of exactly what energy security consists of. A good working definition is that a nation should have guaranteed supplies of energy sufficient for its needs. This is a familiar dilemma in corporate strategy: nobody wants to be a consumer of something that is controlled by somebody else. The more a nation has invested in energy mechanisms where it is at the mercy of third parties, the more likely it is to find itself held hostage by them.

A recent example has been the Russian use of its natural gas monopoly to hold the European Union to ransom. Russia’s energy giant Gazprom supplies 25% of all of the EU’s gas, which is used for heating purposes. Given the large investment in gas-related infrastructure (“co-specialized assets”) already made by the consuming countries, they would face tremendous switching costs if they were to try to use a different supplier, or to move to an alternative source of energy. Taking advantage of this, Gazprom, in January 2009, suddenly cut off supplies to EU, ostensibly over an argument over pricing and transit fees with Ukraine, through which the pipelines run. Regardless of the merits of the Russian vs. the Ukrainian positions, there was a crisis in the EU and other parts of Europe as citizens shivered during a cold winter, and authorities scrambled to try and find alternatives. This is the essence of energy non-security, where the actions of another country can have catastrophic effects on the citizens, or the economy, of the country under consideration.
The most familiar instance of energy insecurity was the “oil shock” of the 1970s, and perhaps the more recent commodity price shock of 2008. Many countries put in place efforts to reduce their dependence on OPEC oil as result of the huge expenses they incurred as a result of the sharp rise in oil prices in 1973. In particular, some Scandinavian countries have been successful in increasing their national energy security by utilizing other forms of energy. India, however, has not learned any lessons from this. It is true that India’s consumption of oil in the 1970s was relatively low, because of the low level of economic activity thanks to socialist policies. However, in the recent past, especially after liberalization and the strong growth in GDP, the nation has become dangerously dependent on imported oil. This is a matter of deep insecurity.

The persistent current account deficit that India runs can mostly be attributed to its large purchases of hydrocarbons, since the country is critically short of these. IEA estimates suggest that India currently imports almost 80% of its oil, and that by 2030 India will be importing more than 90% of its oil.

**Moving forward, with or without hydrocarbons**

China is the second biggest and India the sixth biggest consumer of energy in the world. China’s oil imports grew by 33% in 2005, and India’s by 11%. India was the world’s fifth largest consumer of energy in 2006. India is already importing two-thirds of its oil and this may continue to rise to 90% of its oil needs and 40% of its gas needs by 2030. Furthermore, China has proven oil reserves of 18 billion barrels while India has only 5.5 billion barrels, in its Bombay High, Cambay, Upper Assam, Krishna-Godavari and Kaveri basins. China also has known reserves of 53 trillion cubic feet (tcf) of natural gas, while India’s is roughly 30 tcf, although discoveries in the Bay of Bengal may increase this total. Thus China is relatively better off, even though its appetite is more ravenous.

“Oil is the world’s vital source of energy and will remain so for many years to come, even under the most optimistic of assumptions about the pace of development and deployment of alternative technologies.” This is the view of the authoritative World Energy Outlook 2008, produced by the OECD and the International Energy Agency in November last year. Correspondingly, they see the energy mix for developing Asia as being relatively unchanged going from 2005 to 2030, with the major change being that coal more or less grabs market share from biomass.

The effective substitution of renewable biomass by coal in India is probably bad news on two fronts – one in the global warming and CO₂ arena, and two in the issue of energy self-sufficiency. This is likely to affect India particularly hard, as a large fraction of the energy being consumed by its households – especially the rural and lower-income households – is based on renewable and locally produced biomass and waste.

This is similar to the changes that have been observed already in the relatively prosperous state of Kerala. A generation ago, most households used wood-burning stoves where waste biomass from the ubiquitous coconut tree, for instance leaves, husks, inflorescences, and shells accounted for much of the firewood used for cooking. However, the arrival of bottled cooking gas has spelt the end of the wood-burning stoves, and has left the state vulnerable to price fluctuations in the global market for natural gas. In addition, the biomass from the trees has now become a waste product which needs disposal.
There are two ways India can deal with this apparently inevitable move towards more and more reliance on hydrocarbons. The first is to redouble efforts to ensure that both Indian and offshore sources of fossil fuels are available on long-term contracts. The second would be to pursue alternatives, especially those that do not involve dependence on suppliers. In other words, use locally-available fuel, which inevitably suggests solar, wind and bio-fuels, and to coal.

There are problems with both approaches. The first approach carries with it the risk that offshore and remote supplies are not particularly secure unless India has the military might to ensure that its investments are protected. For instance, various suppliers have asked for price re-negotiations when market prices went up, thus negating the very idea of long-term contracts. Iran is an example, with its insistence that India now pay higher prices for the large amount of gas, which, under a much-praised deal, India had signed with them. In extreme cases, it is also possible that countries may nationalize any investments made by India in their countries.

The problem with the second approach is that alternative energy sources are not quite ready for prime time. Both wind and solar, despite the tremendous advantage that they are locally available, have problems with storage and transmission. Wind energy needs to be transmitted long distances from the hilly, windy locations where there is enough of a steady wind, all the way to the cities where there is demand. Besides, since wind does not blow steadily, it is necessary to capture the electricity captured when it is blowing, store it, and then use it when it is needed.

Similarly, solar energy, although it has the potential to transform India’s energy picture utterly – with 300 days of sunshine, India is very rich in sunshine – has a few problems. One is that the efficiency of photo-voltaic solar panels is low, perhaps 15%, and they are expensive, being produced using a semiconductor-like process. The good news is that there are newer technologies such as thin films, which are far cheaper to make, but which, unfortunately, are even lower in efficiency. In addition, battery technology and capacitive storage are in their infancy. A couple of technological breakthroughs, coupled with economies of scale, are required to make solar photo-voltaic truly viable.

The other type of solar energy, thermal solar, involves the heating up of a fluid by using an array of mirrors that track the sun and focus it on a container which holds the fluid and it requires a lot of land to install the mirrors, and also a good deal of capital expenditure. This also means that waste land, for instance deserts or semi-arid areas need to be identified. These are usually far from the cities, once again making transmission a problem as with wind.

Although there have been a number of experiments with bio-fuels, such as the jatropha plant that grows well on surplus or marginal land, it is not entirely clear that it is cost-effective. There have been instances where non-edible vegetable oils (such as jatropha) have been combined with diesel to run railroad locomotives. However, there are concerns that:

a) crops cultivated for bio-fuels may displace food crops (as has been the case in the US when corn was diverted to make ethanol, driving up the price of corn as well as other food crops which were competing for the same acreage, and led to steep prices increases for end consumers such as peasants in Mexico)
b) more rainforests may be destroyed (as has been the case in Malaysia where palm-oil cultivation has led to clearing endangered tropical forests), and

c) the economics of land-use for bio-fuels may be unacceptable.

A study by CSTEP suggests that the production of bio-fuels leads to unacceptably low output of energy from the same acreage, as compared to, say solar, although the latter is much more expensive.

![Gross Energy Output from 1 Hectare of Land](image)

Figure 5: The amount of energy (and the cost of it) that can be generated per unit of land. Source: CSTEP

There are similar problems with nuclear energy and hydro-electric power.

**Sources and uses of India’s energy**

Where do India’s energy supplies come from? And how is it used up? The following charts are based on a study by CSTEP and the Lawrence Livermore Laboratories which analyzed in detail the flow of energy commodities from both internal and imported sources. The study also considered how much of the energy is converted to electricity, and how much is used for transportation, and by which sector. The flow-charts that summarize this data are fascinating. The following is an overview of this data, and is out of a total of 5,421 billion kWh consumed:
Table 2: The sources of India's energy, in billion kWh. Source: CSTEP and Lawrence Livermore Laboratories

<table>
<thead>
<tr>
<th>Source</th>
<th>Total</th>
<th>Imported</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum</td>
<td>1645</td>
<td>1243</td>
<td>402</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>324</td>
<td>Data Not Available</td>
<td>Data Not Available</td>
</tr>
<tr>
<td>Coal</td>
<td>1852</td>
<td>1646</td>
<td>206</td>
</tr>
<tr>
<td>Biomass</td>
<td>1682</td>
<td>0</td>
<td>1682</td>
</tr>
<tr>
<td>Nuclear</td>
<td>58</td>
<td>Data Not Available</td>
<td>Data Not Available</td>
</tr>
<tr>
<td>Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wind</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Hydro</td>
<td>85</td>
<td>0</td>
<td>85</td>
</tr>
</tbody>
</table>

Note that biomass includes firewood, dung, and other forms of energy used for residential purposes. Traditionally, this is a huge source of energy for residential uses, and the data suggests that it still constitutes the majority of residential energy used especially for cooking. However, urban households are moving to more modern forms of energy.

Where does this energy go? The study provides details on the end use of the energy.

Table 3: Uses of India's energy, in billion kWh. Source: CSTEP and Lawrence Livermore Laboratories

<table>
<thead>
<tr>
<th>Uses</th>
<th>Useful Energy</th>
<th>Lost Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railways</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Heavy Vehicles</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Light Vehicles</td>
<td>338</td>
<td></td>
</tr>
<tr>
<td>Industrial</td>
<td>1548</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>1511</td>
<td></td>
</tr>
<tr>
<td>Agricultural</td>
<td>301</td>
<td></td>
</tr>
</tbody>
</table>
A remarkable fact from the above table is that 50% more energy is simply ‘lost’ than what ends up as ‘useful’ energy. Let us note that this is not even ‘stolen’ electricity, and it does not include the energy wasted due to, say, traffic congestion or poorly designed buildings. So the overall amount of leakage and wastage is very high. These leakages lead to the conclusion that one of the best mechanisms for India to improve its energy security would be to energy conservation.

Details of India’s energy supplies: Who owns them?

Most of the oil – and the natural gas – in the world is concentrated in a few producer nations, which has implications for consuming nations. There is, as of now, no particular substitute for oil for transportation. Since almost the entire transportation industry – and that is not only people transport, but also shipping on the high seas – depends totally on petroleum derivatives and the internal combustion engine, the chances of us weaning ourselves off oil are quite small, bio-fuels notwithstanding. Renewables have an increasing role in electricity generation, but the dominance of hydrocarbons, and in particular that of coal, is not going away very soon.

If coal and renewables are set aside for a moment, India’s energy supplies are almost entirely supplied from overseas. India’s domestic exploration has produced relatively little by way of large oil and gas finds. The ones that are currently being exploited, Bombay High offshore and oil fields in Assam, are ageing. Despite hopes that large amounts of Krishna-Godavari basin gas may become available, there are no immediate prospects for India to become less dependent on imported oil and gas.

India’s energy mix in 2005, and China’s, are as follows, according to the ADB, quoting IEA, World Energy Outlook 2007. Projections are the proportion of coal will increase, based on the issue of energy security and ease of access, despite its environmental costs. As can be seen below, India does have large deposite of coal. Unfortunately, Indian coal tends to have high ash content, and therefore some thermal power plants have chosen to import coal especially from Australia.
Energy Mix in India, China (2005)

Figure 6: India’s and China’s energy mix are heavily dependent on coal. Source: ADB

Coal

Since India has large coal reserves\(^{11}\), coal is likely to become a larger part of India’s future energy mix. As of now, India is not exploiting its thermal power plant capability anywhere near as energetically as, say, China, which has embarked on a crash program to build many coal-fired electric plants.

Coal Reserves, 2007 (million tonnes)

Figure 7: Where the world’s coal reserves are. Source: BP

Coal consumption patterns in 2007, also from BP’s Statistical Review of World Energy, 2008, show the impact of China’s thermal power plant activity.
Coal consumption, 2007 (MTOE)

Figure 8: Who uses coal the most. Source: BP

Oil

India and China will be increasingly dependent on oil imports, according to the ADB, quoting IEA, World Energy Outlook 2007.

Net oil import as % of total oil demand (Forecast)

Figure 9: How India will import almost all of its oil by 2030. Source: ADB

It is important for India to ensure that it has clear access to oil, as it will be forced to import almost all of its oil by 2030, as seen in Figure 9. According to OPEC, as in Figure 10, most of the world's oil in 2030 will continue to come from OPEC, and they are also likely to increase their production of non-conventional
liquids, including NGL (natural gas liquids). Non-OPEC oil producers like Russia and the Central Asian states are not going to increase their production quite as much as OPEC will. Therefore India's ability to enter into long-term contracts with OPEC members may well be critical for India's energy security in the reference case, viz. assuming there are no market-distorting breakthroughs in renewables.

![World Oil Supply](image)

Figure 10: Where the world's oil will come from. Source: OPEC

**Natural Gas**

Just as in the case of oil, India's lack of large local deposits of natural gas is a major factor in energy insecurity. In addition, Bangladesh, which has discovered significant gas fields, refuses to sell the gas to India and even to permit a pipeline from Myanmar to India on its territory. Other deals with Iran are bogged down in controversy. However, India has built a few LNG (liquefied natural gas) terminals, and the first shipments of LNG to these ports from Qatar have started arriving. India needs to pursue both additional exploration as well as the building of more LNG ports. The following data on Natural Gas reserves and consumption is from the BP Statistical Review of World Energy, 2008.
Natural gas reserves, 2007 trillion m$^3$

Figure 11: Who owns the world's natural gas? Source: BP

Natural gas demand, 2007 (MTOE)

Figure 12: Who uses the world's natural gas? Source: BP

Nuclear

After a contentious debate, the Indo-US Nuclear agreement was signed in 2008. It is believed by many Indians that this will release India from the nuclear apartheid it has labored under ever since it exploded Pokhran I some years ago. Some strategic experts believe that India made too many concessions in the negotiations and that the overall value of nuclear fission is questionable, especially given the extraordinary amount of cleanup and waste processing that needs to be done during the decommissioning of a nuclear reactor.
The opposing camp, those who are pleased with the nuclear deal, suggest that this is a sensible solution for the short term, and one that does not involve too many greenhouse gases. Wherever the truth of the matter lies, it is clear that it will be an expensive proposition for India to increase its electricity production from nuclear fission. Indeed, even the government admits as such when it suggests that in the best case scenario, nuclear fusion is only going to account for 7% of India’s electricity needs.

The following figures use data from the US Government, Energy Information Administration\textsuperscript{iii}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure13.png}
\caption{Expected nuclear capacity in gigawatts. Source: EIA, US Govt.}
\end{figure}

France’s Areva has just signed an agreement to supply two nuclear reactors for an approximate outlay of $10 billion. A number of India’s civilian reactors (thus marked under the agreement) are currently working at very low capacity because of the lack of enriched uranium fuel, which has been refused to India by the small group of nuclear suppliers, who have their own OPEC-equivalent cartel, the NSG (Nuclear Suppliers’ Group). The NSG was set up expressly to punish India after the Pokhran II tests in 1998.

At least one prominent member of the NSG, Australia, has flat-out refused to sell India uranium unless India signs the Nuclear Non-Proliferation Treaty as a non-nuclear-weapons state, which would automatically put all of India’s nuclear capability under the control of the IAEA. In effect, India will lose its nuclear weapons capability, and will have signed up to, in perpetuity, be a nuclear have-not. There is some concern that the NSG members will pressure India to sign a blatantly unfair treaty and create long-term problems just to get around the short-term problem of not enough fuel for reactors.
Figure 15, with data taken from the Wikipedia, shows how uranium mining is concentrated in the hands of a small number of countries, who effectively have veto power over the running of a power plant. India knows this because it has faced this problem from the supplier cartel before.

![India's Nuclear Energy Consumption, billion kWh](image)

Figure 14: India's production of nuclear energy. Source: EIA, US Govt.

The supplier issue makes nuclear energy possibly a generator of energy security because India's uranium stocks are very limited. On the other hand, India has 31% of the world's reserves of thorium, so that a possible thorium-based fast-breeder technology could change this drastically. Unfortunately, the technology is not ready for large-scale or commercial use, and it has to be surmised that Indian nuclear scientists do not see it becoming viable in the immediate future.

Thus nuclear power presents a complex scenario: there is relatively little energy security today, but in the long run it could lead to self-sufficiency assuming certain technological breakthroughs.
Renewables: solar, wind and hydro

India has established itself as a power in wind energy, and has a technological leadership position therein, especially based on the strengths of companies like Suzlon. India is one of the top wind energy generating countries in the world along with Germany, the US, China, Denmark and Spain.

If solar-electric technology were to ever become economical, India would be highly advantaged, because much of the nation is in the tropics with significant numbers of sunny days. But at current cost, solar energy is not cost-competitive. There are also experiments with bio-fuels, for example bio-diesel which mixes non-edible vegetable oils with diesel, but these are not yet commercially viable.

Hydroelectric power is something India has been striving to develop, although the long-term effects of large dam projects have not necessarily been positive in many cases. The series of dams being built on the Narmada River in India has been plagued by environmental concerns. The proposed Baglihar dam in the Punjab is the subject of acrimony between India and Pakistan. There is however, an opportunity for India to gain access to Nepalese and Bhutanese hydro-electricity, as the Himalayan kingdoms have high potential and limited demand.
Energy Diplomacy

The search for energy and military power go hand in hand. America’s interest in Afghanistan may well be partly predicated on the Turkmenistan-Afghanistan-Pakistan-India (TAPI) natural gas pipeline (long sought by Unocal) to bring Central Asian gas via Afghanistan to Karachi, Pakistan. Iraq’s and Iran’s large reserves may be the principal reasons for American interest.

On a smaller scale, China has embarked on a similar tack, with its ‘string of pearls’ approach: a series of naval facilities in friendly ports all around India, in the Indian Ocean and the Bay of Bengal. The newest is the Chinese-financed port of Gwadar in Baluchistan which sits close to the Straits of Hormuz, through which 40% of the world’s oil passes. Gwadar has multiple advantages for China, including potential veto power over the flow of West Asian oil through Hormuz.

The recent instances of Somali piracy – including the hijacking of a Very Large Crude Carrier carrying $100 million worth of Saudi oil – off the Horn of Africa points out the risks run in shipping oil across the open ocean. The two main choke-points are Hormuz and Malacca, and virtually all large trading nations are now forced to keep some sort of naval force in place off the Gulf of Aden and in the Arabian Sea.

China has observed with unease the growing co-operation between the US and Indian navies in the southern Indian Ocean and the Straits of Malacca, which is a virtual choke-point, as 80% of China’s oil imports flow through these straits; an embargo would bring the Chinese and Japanese economies to their knees. As a result of all this, China has embarked on an accelerated program to build up a blue-water navy, capable of projecting Chinese power far and wide.

Many powers have also established strategic footholds in Central Asia. This region has large reserves of oil and gas, so the interest is not coincidental. In fact, after the Russian differences of opinion with the Ukraine, and its invasion of Georgia more recently, Europeans are beginning to get alarmed. One of the reasons for Russian muscle-flexing may well have been the proposed pipelines shipping Central Asian and Caspian Basin oil and gas to Western Europe bypassing Russia. Russia is loath to let its stranglehold over Western Europe’s energy be diluted.

India has a military facility in Tajikistan; the US has a military presence in Afghanistan, Tajikistan, Kyrgyzstan and Uzbekistan. China has created the Shanghai grouping to gain support for its products, policies and ideas in the region. Russia has a military presence in Tajikistan and in Kyrgyzstan.

India faces larger challenges; on the one hand it is being systematically encircled and contained by China; on the other, it faces hostile neighbors in Pakistan and Bangladesh. For instance, Bangladesh has proven resources of 38 tcf of natural gas, but is loath to sell it to India.

Some Indian analysts have a pipe-dream of building natural gas pipelines from Myanmar via Bangladesh, and from Turkmenistan or Iran via Pakistan (the Iran-Pakistan-India and Turkmenistan-Afghanistan-Pakistan-India or TAPI and IPI pipelines). But the proposed gas pipeline from Myanmar’s Shwe offshore field to Kolkata was bogged down in disagreements with Bangladesh, and finally it was lost because the Myanmarese announced they would sell the gas to China. The proposed gas pipeline from the South Pars field in Iran to India is under a cloud because 700 kilometers of that traverses restive Baluchistan,
and because of general distrust of Pakistani intent and the risk of terrorist sabotage. Iran is also seeking a renegotiation of the price.

Deep-sea pipelines bypassing Pakistan and Bangladesh, while more expensive in the short run, may be required as insurance against disruption. A better choice may be liquefied natural gas (LNG) imported by ship: this has become a viable alternative. With rapid reductions in liquefaction and transportation costs, the economics of LNG now compares favorably with the cost of piped gas, not to mention the advantage of LNG terminals being able to deal with gas shipped from anywhere in the world.

Table 4: Indian overseas investments in oil and gas. Source: Woodrow Wilson Center Asia Program

<table>
<thead>
<tr>
<th>Country</th>
<th>Blocks where invested</th>
<th>Comments (Investment by)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia/East Timor</td>
<td>103</td>
<td>BPCL</td>
</tr>
<tr>
<td>Brazil</td>
<td>BC-10, ESM 470, SM 1413</td>
<td>OVL</td>
</tr>
<tr>
<td>Colombia</td>
<td>Omimex de Colombia</td>
<td>Manasarovar Energy Limited, a joint venture of ONGC with Sinopec</td>
</tr>
<tr>
<td>Colombia</td>
<td>RC 8, RC 9, RC 10</td>
<td>OVL</td>
</tr>
<tr>
<td>Cuba</td>
<td>25, 26, 27, 28, 29, 34, 35, 35A, 36</td>
<td>OVL</td>
</tr>
<tr>
<td>Egypt</td>
<td>North Ramadan 6</td>
<td>OVL</td>
</tr>
<tr>
<td>Gabon</td>
<td>Shakthi</td>
<td>OIL, IOCL</td>
</tr>
<tr>
<td>Iran</td>
<td>Farsi Offshore</td>
<td>OVL, IOCL, OIL</td>
</tr>
<tr>
<td>Libya</td>
<td>NC 188, NC 189, 81-1, Contract Area 43, 86, 102 (4)</td>
<td>OVL, IOCL, OIL</td>
</tr>
<tr>
<td>Myanmar</td>
<td>A1, A3, AD-2, AD-3, AD-9</td>
<td>OVL, GAIL. Even though India was the early investor, the gas contract was won by China</td>
</tr>
<tr>
<td>Nigeria</td>
<td>OPL 279, OPL 285, OPL 205</td>
<td>OMEL</td>
</tr>
<tr>
<td>Nigeria/Sao Tome &amp; Principe</td>
<td>2</td>
<td>ONGC, Narmada</td>
</tr>
<tr>
<td>Oman</td>
<td>56</td>
<td>GAIL, BPCL, HPCL</td>
</tr>
<tr>
<td>Qatar</td>
<td>Najwat Najem</td>
<td>OVL (100% ownership)</td>
</tr>
<tr>
<td>Russia</td>
<td>Sakhalin-1</td>
<td>OVL. This is a very major oilfield</td>
</tr>
<tr>
<td>Country</td>
<td>Project/Block</td>
<td>Companies</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Syria</td>
<td>XXIV, Al Furat Project</td>
<td>ONGC, OMEL + China National Petroleum Corp.</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>Block 11-12</td>
<td>OMEL</td>
</tr>
<tr>
<td>Vietnam</td>
<td>6, 1, 127, 128</td>
<td>OVL</td>
</tr>
<tr>
<td>Yemen</td>
<td>82, 83</td>
<td>OIL, IOCL</td>
</tr>
</tbody>
</table>

The Indian establishment has been attempting for about a decade to get a foothold in the markets for oil and gas. Indians have been considerably less successful than the Chinese in getting guaranteed long-term supply contracts, for a variety of reasons. One is the head start (and the clear strategic intent) that the Chinese have had. Another is their willingness to pay premium prices. In head-to-head competition, the Chinese willingness to utilize their $2 trillion trove of reserves sometimes bests Indian negotiators. In a number of cases, the Chinese have outbid the Indian NOGCs (national oil and gas companies).

In addition, China has the advantage of being willing to deal with and even sponsor dubious regimes. An example is China’s long-standing support of Sudan, despite serious concerns about its war crimes in the Darfur region. China has also prevented this issue from being taken up in the UN Security Council (as it has indicated it would veto any censure of Sudan). Besides, China has been willing to give out goodies – weapons, for instance – to dictators in some of these nations. In the process, China has also become a major donor of development aid, although, predictably, most of that goes hand-in-hand with the objectives of energy extraction.

There is good reason for China’s obsession with Africa. West Africa is a major source of new energy, and by 2010 will account for 33% of all new oil pumped worldwide. China is active there, and is wooing other producers such as Angola, Sudan and the Congo. In particular, Angola has become a focus for Chinese interest, and it has replaced Saudi Arabia as the largest supplier to the Chinese. In turn, China has announced over $5 billion in development aid and investment in Angola.

India is beginning to promote its own energy diplomacy, although this is still confined to foreign policy and not military policy. For instance, despite American apprehensions, India is pursuing ties with Iran, with which it has traditionally had good relations. In early 2005, India completed a $40 billion, 25-year deal on LNG from Pars, the largest gas field in the world, although Iran is now asking to renegotiate the deal. India also has stakes in Iran’s Yahavaran and Jufeir oilfields. India is also developing the Iranian port of Chabahar as well as the highway from there to Afghanistan and Central Asia, also strategically as a way of getting to Central Asia bypassing Pakistan.

India and China are co-operating and competing in Iran: the Yahavaran oilfield is a joint Indo-Iranian-Chinese effort. In the event of an American attack on Iran, Chinese analysts worry that there will be a major disruption in their supplies.
China has the advantage over India in terms of geography, as it has access to Central Asia and to energy-rich Russian Siberia. China is building pipelines from Central Asia via restive Xinjiang, and has a major charm offensive aimed at the ex-Soviet Central Asian states. The Chinese are in the process of building a very expensive gas pipeline from Lunnan in Xinjiang to Shanghai, and there is talk of another to bring Kazakh oil to Dushanzi in Xinjiang.

Lingering tensions between China and Vietnam have affected exploration in the Gulf of Tonkin, but a thaw between the traditional rivals may result in additional assets being developed there.

Given the large amounts of energy available in Russia, both China and India are pursuing alliances there. Given traditionally warm strategic relations between India and Russia, even though they are not neighbors, there have been a number of Indian investments in Russian assets. India’s ONGC holds stakes in Sakhalin, for instance.

The recession has not stopped the diplomacy and high finance in the energy sector. China is opening its wallet in a big way. In just one week in February, China has announced a number of major investments:

- an investment of $10 billion in Brazil’s Petrobras in exchange for a long-term commitment to provide oil to China 160,000 barrels a day at market prices
- an investment in the Russian oil pipeline through Siberia ($25 billion in loans to Rosneft and the pipeline company Transneft in return for 15 million tons of crude oil a year for 20 years)
- a $6 billion investment in Venezuela (which brings the loan total to $12 billion)

India is unable to match these big-ticket items, which makes it fall further behind China in the energy race.

**Conclusions**

There are a few concerns about India’s energy future. One is that India is likely to continue to be dependent on external suppliers, whether in oil, gas, or nuclear power. Unless new technologies are proven to be commercially viable in the near future, India looks to have relatively little energy security. It is vulnerable to pricing shocks as well as to supply shocks. India’s attempts to gain guaranteed supply lines have not succeeded as well as those of the Chinese. The chances that energy will become a bottleneck for industrial growth are fairly high. The only alternative is coal, but the widespread use of that will attract much criticism from around the globe, and will create pollution and global warming. Therefore, it is not realistic to depend on coal alone. Until renewables come along in a big way, India will simply be energy-insecure.

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“India’s energy security”, Tata Energy Research Institute, New Delhi, 2000


