# China and India Must Lead the Way For Nuclear Power

by Ramtanu Maitra

The world's two most populous nations, China and India, representing more than 2.2 billion people, are now seemingly committed to an economic development program which would strengthen both nations and pull the entire population out of miserable poverty. The most immediate requirement for both these nations is to ensure a long-term supply of energy in its most efficient form—electricity. In addition, of course, both nations have to make sure that energy in the form of oil and gas also remains in abundant supply in the years to come.

The approach taken by China and India suggests that they have lumped together all kinds of energy requirements in one basket, without making a clear distinction among the various forms of energy required for efficiently running high-tech manufacturing, basic industries, transportation, agriculture, and commercial and domestic sectors. It is perhaps because of this inadequacy in the planning process, that although they have adequate nuclear know-how, both nations have kept nuclear power generation on the back-burner.

## Hunt for Oil and Gas

Most recently, China, in particular, but India as well, has been scouring the world to secure a long-term supply of oil and gas. India has invested more than $3 billion in global exploration ventures, and has said it will continue to spend $1 billion a year on more acquisitions. China, which has already invested about $15 billion in foreign oil fields, is expected to spend 10 times more over the next decade. Their hunt for a secure supply of oil and gas has taken them to Africa, South America, and Central Asia, in addition to getting engaged more vigorously in exploring their own on-shore and off-shore fields, and those in the Middle East.

China's hunger for coal to fuel the furnaces to generate electricity has led the country to step up imports, transforming the once dirt-cheap commodity into the next "black gold," as international prices went up 50% last year. Analysts said that China's combined imports of thermal and coking coal were heading for 18 million tons in 2004, up 64% from 11 million in 2003. The cost of importation is already being felt, and it is likely that China will cut back exports of coal next year to meet rising domestic demand, while it cracks down on unsafe mines after a series of fatal disasters.

*The first of India's pressurized heavy water reactors, a 540-MW unit, located at Tarapur. A second unit will be commissioned there this year.*

## Coal . . . and More Coal

Coal has remained the dominant fuel in India's energy mix as well, and if New Delhi's linear projection remains in force in the coming years, coal would dominate the thinking of Indian planners through 2030. Demand is projected to grow from 391 million tons in 2002, to 758 million tons in 2030, at an average rate of growth of 2.4% per year. Unfortunately, the power sector is the chief driver of Indian demand. Currently, 71% of India's electricity is generated from coal.

India's coal needs are largely met domestically. Production totalled 364 million tons 2002, and is projected to increase to 705 million tons in 2030. India has 92.4 billion tons of proven coal reserves, 10% of the world total.

In addition to the obvious logistical nightmare entailed by the handling of bulk quantities of oil, gas, and coal, moving the raw materials also puts extreme strain on less-than-adequate transportation infrastructure, as well as on ports, and on the land space needed for handling these bulk quantities near congested residential and commercial areas. Both China and India are religiously developing these space-consuming handling stations, and are shoring up their weak infrastructure, paying a high premium.

## U.S. Uneasiness

What these two most populous countries will also have to worry about in the near future is: How to ensure national security while depending on the importation of such vital commodities by sea. The most obvious brick wall that both these countries may run into is an aggressive American geostrategic policy. The present Bush Administration, with its deep interest in ensuring strong physical control over oil and gas fields around the world (and developing a military-technology capability which can physically hurt any nation), has already shown uneasiness about China and India's aggressive investment in foreign oil and gas fields.

News reports indicate a distinct U.S. nervousness over China's intentions in South America. Some observers point out that the Chinese interests in South American oil triggered the U.S. action to impede China's access to the Panama Canal, which connects the Pacific and Atlantic Oceans. In December 2004, Beijing signed a landmark deal with Venezuela and its neighbor Colombia, under whose terms a pipeline would be constructed linking Venezuelan oil fields to ports along Colombia's Pacific coastline. This will allow Venezuelan oil to bypass the Panama Canal, creating a new, direct route to China.

Needless to say, Washington does not like any of it. Writing in the *New York Times* on March 2, Juan Ferero reported, "Latin America is becoming a rich destination for China in its global quest for energy, with the Chinese quickly signing accords with Venezuela, investing in largely untapped markets like Peru, and exploring possibilities in Bolivia and Colombia." The tone of the article leaves no doubt that Beijing should recognize that the project could become highly vulnerable at any time.

India, which had been less aggressive than China in its oil and gas deals around the world, has also worked out an oil deal with Venezuela, and is also suspect in the eyes of the Bush Administration. In addition to Russia, Latin America, and the Middle East, Indian oil companies are looking to Chad, Niger, Ghana, and Congo in Africa, in particular, for oil and gas fields. Already sixth in global petroleum demand, India meets 70% of its needs through crude oil imports. By 2010, India is expected to emerge as the world's fourth-largest energy consumer, after the United States, China, and Japan.

Some observers in Washington are dismayed that India, by extending military and political support to Iran, Vietnam, and Myanmar, in exchange for energy supplies, is really working against the U.S. interest. But Indian authorities have indicated that they are not hesitant in seeking deals with states at odds with Washington. In Sudan, India has invested $750 million for the 25% stake in the Greater Nile Oil Project previously held by Talisman Energy of Canada.

Washington has, in fact, already expressed its displeasure at New Delhi's ongoing friendship with the regime in Tehran. In January, the state-run Indian Oil Corp. reached an agreement with the Iranian firm Petropars, to develop a gas block in the gigantic South Pars gas field, home to the world's largest reserves. India is cooperating with Iran to secure Gulf sea lanes and helping Iran to develop its Chahbahar port, as well as several other infrastructure projects.

Washington has strained relations with many of India's new-found oil and gas clients. This became a talking point when U.S. Secretary of State Condoleezza Rice, on her one-day visit to India on the Ides of March, reportedly urged India to give up the long-awaited $4.5 billion Iran-Pakistan-India gas pipeline. Because it is so wholly unethical to deprive India, an energy-short nation, of meeting its energy requirement, Rice has reportedly signalled to New Delhi that Washington would permit India to purchase nuclear reactors from the United States, if New Delhi so chooses.

In addition to the energy deal suggested by Secretary Rice, aggressive political maneuvering exercised by the Bush Administration worldwide should be an eye-opener for both New Delhi and Beijing. The sea lanes remain vulnerable. There is no question that the United States is a massive sea power, and possesses the ability to choke off the supply line, particularly for a short period of time, if it so chooses. Building up naval power to match that of the United States is hardly a viable alternative, nor does it solve the real problem.

## Go Nuclear

It is important to note that both China and India have developed complete nuclear fuel cycles. Both have a respectable manufacturing sector, and both are friendly to another major nuclear power—Russia. Under these circumstances, the logical solution to the long-term electricity requirements of both China and India is to generate nuclear power in bulk quantities. It is also important that these two countries exchange scientific expertise and technology to speed up the process. Both nations possess a large and competent manpower base, and if they determine to go the nuclear route, it could be achieved at a much faster clip.

At the same time, it is evident that an all-out commitment to utilize nuclear power for long-term security is still not on the horizon. According to people involved in China's nuclear program, the current plans call for new reactors to be commissioned at a rate of nearly two a year between now and 2020. Although size of the plants has not been clearly defined, even this rate of growth of nuclear power would hardly make a dent in the country's power demand.

China's eight nuclear reactors now in operation supply less than 2% of current demand. By 2020, assuming that the national plan is fulfilled, nuclear energy would still constitute less than 4% of demand. Although China had been working on various aspects of neutron physics and nuclear technology for almost 30 years, the program has not developed a definite Chinese reactor line. China now plans to import a significant number of pressurized light water reactors, while developing its own commercial-size High Temperature Reactors (HTRs), including the pebble bed HTR.

India, in contrast, has developed a very definite plan of the contribution of various types of reactors in its nuclear power program, but the overall contribution of nuclear power to India's power grid is still as insignificant as that of China. India has developed a commercial line of 235-megawatt (MW) Pressurized Heavy Water Reactors (PHWRs), which uses natural uranium as fuel. India's first 540-MW PHWR has been commissioned in Tarapur, and another one of the same capacity is scheduled to be commissioned this year.

India has also developed prototype fast breeder reactors, as part of the second phase of its nuclear power program. Fast-breeder reactors are more important to India than to other countries because the country's uranium resources will not be able to support more than 10,000 megawatts of generating capacity. Using uranium as the starting point, augmented by the breeding potential of fast reactors with a plutonium-uranium cycle, Indian planners think that about 500,000 megawatts of electrical power can be generated.

The first 500-MW fast breeder reactor is now under construction, and is expected to be completed by 2010. In addition, India is developing the thorium-fueled Advanced Heavy Water reactor (AHWR). The third stage of India's nuclear power development plan is to utilize thorium to fuel its future nuclear power reactors. The AHWR is a 300-MW reactor moderated by heavy water at low pressure. The reactor, built on the campus of the Bhabha Atomic Research Center (BARC) at Trombay, will have a lifetime of 100 years.

## Thorium Reactors

Scientists and engineers at BARC have been working for several years on the development of the Advanced Heavy Water Reactor, and construction is under way. The AHWR will use thorium, the "fuel of the future," to generate 300 megawatts of electricity up from its original design output of 235 megawatts. The primary reason that India switched to using thorium-232 as fuel is that the country has a very large thorium supply in the form of monazite sand. But the use of thorium has other interesting aspects as well. Thorium is "fertile" rather than fissile. In this respect, it is similar to uranium-238, which makes up more than 95 percent of most nuclear fuels. A conventional reactor breeds various isotopes of plutonium from uranium-238, and some of that plutonium, in turn, undergoes fission in the reactor, adding to the power the fissile uranium-235 provides.

In the case of AHWR, thorium-232 will breed uranium-233, a fissile material, among other isotopes. The fissile uranium-233 generates the heat necessary for power generation. One reason that thorium is preferred over uranium-238 is, for instance, that thorium breeds uranium-233 more efficiently than uranium-238 breeds plutonium. This is because the thorium fuel creates fewer non-fissile isotopes. Reactor designers can take advantage of this efficiency to decrease the amount of spent fuel per unit of energy generated, which reduces the amount of waste to be disposed of.

There are other pluses as well. For example, thorium dioxide, the form of thorium used for nuclear power, is a highly stable compound—more so than the uranium dioxide typically employed in reactors today. Also, the thermal conductivity of thorium dioxide is 10 to 15% higher than that of uranium dioxide, making it easier for heat to flow out of the slender fuel rods used inside a reactor. The the melting point of thorium dioxide is about 500° C higher than that of uranium dioxide, and this difference provides an added margin of safety in the event of a temporary power surge or loss of coolant.

The hitch to using thorium as a fuel is that breeding must occur before any power can be extracted from it—and this requires neutrons. Some engineers have proposed using particle accelerators to generate the needed neutrons, but this process is costly. The only practical scheme at the moment is to combine the thorium with conventional nuclear fuels (made up of plutonium or enriched uranium, or both), the fissioning of which provides the neutrons to start things off. Previous work on thorium elsewhere in the world did not lead to its adoption, largely because its performance in light water reactors, such as in the Indian Point power plant in New York, did not live up to expectations.

In light of the potential advantages for reducing the quantity of nuclear waste and preventing the dissemination of bomb-making materials, it is not surprising that interest in thorium-based fuels has recently undergone something of a renaissance. The U.S. Department of Energy has been particularly eager to foster research activities in this area.

The main advantage of using a combination of thorium and uranium is the significant reduction in the plutonium content of the spent fuel, compared with what comes out of a conventionally fueled reactor. Just how much less plutonium is made? The answer depends on exactly how the uranium and thorium are combined. For example, uranium and thorium can be mixed homogeneously within each fuel rod. In this case, the amount of plutonium produced is roughly halved.