

Cover Story nuclear energy

Power Play

by Srikanth Srinivas & Uttara Choudhary in New York



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NUCLEAR REVIVAL: Cirus, India's second nuclear reactor (above) was set up in 1960 in Trombay; and now the 1-2-3 deal has given a fillip to India's civilian nuclear ambitions

FOR most people, the nuclear energy issue is much like the story of the six blind men and the elephant: different pieces, but no coherent overall picture. For some, it's like the sides of the pachyderm in John Godfrey Saxe's poem: a wall. For others, it's like the trunk, snake-like and hard to get a handle on. For yet others, it's like the elephant's tail, a rope that we are binding ourselves with.

Nuclear energy is politically sensitive and divisive, and many people believe that the US-India deal compromises our sovereignty and makes us a vassal of the US. Neither do

we want foreigners dictating our national security. Then there are health, safety and environmental concerns, which are well-documented and widely known.

But nuclear energy is important to sustain our growth momentum as well. The recent oil price hikes and the near-crisis that high energy prices caused in several countries have reopened the nuclear debate. Climate change concerns have also forced policy makers and politicians globally to reconsider the option of nuclear energy. Simply put, we may be on the cusp of a nuclear renaissance.

And for the first time in decades, the creation of a civilian nuclear energy industry in India has

Winning the vote was just the beginning. Creating a nuclear energy industry will need far more

become a real possibility once the US-India 1-2-3 Agreement is signed. It's an idea that excites global companies that design, construct and manage nuclear energy plants and complexes: GE, Areva and Westinghouse Electric, in addition to Mitsubishi Heavy Industries and Toshiba of Japan.

For three years now, executives from the US nuclear power industry have been coming to New Delhi, meeting with Indian government officials, and lobbying the US Congress for the passage of the deal. Ron Somers, president of the US-India Business Council in Washington, says US industry would be "front and centre" in advocating the deal when it comes up for ratification before the US Congress.

"We are encouraged by recent statements made by Senate Foreign Relations Committee Chairman, Senator Joe Biden, who says he will find time to press for ratification of the 1-2-3 Agreement so long as India is able to complete its steps," says Somers. Also standing on the sidelines — at least for the present — are a host of Indian companies such as Reliance Power, Tata Power and Larsen & Toubro, who want a piece of the action.

The Nuclear Renaissance

India is likely to spend more than \$100 billion expanding its national power capacity over the



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next 20 years and US firms are expecting the nuclear deal to pave the way for big contracts. This message is unlikely to be lost on the US Congress. At an estimated \$2.5 billion per 1,000 MW of electricity — the capacity that most new plants will provide — the nearly 30 new reactors India will commission over the next four decades could be windfall business for US companies such as GE Energy, Thorium Power and Westinghouse Electric.

With 17 plants in operation, India already has a flourishing and largely indigenous nuclear power programme. But at present, nuclear energy provides only about 2.5 per cent of India's electricity; the goal is for nuclear power to supply 25 per cent of electricity by 2050.

The target since 2004 has been to provide 20,000 MW of nuclear power by 2020; in 2007 Prime Minister Manmohan Singh said this target was "modest" and capable of being "doubled with the opening up of international cooperation". However, it is evident that on the basis of only indigenous fuel supply, the 20,000 MW target is not attainable, or at least not sustainable without uranium imports.

The Department of Atomic Energy (DAE) says that the large energy gap projected for 2050 — an estimated 40,000 MW of capacity that has to be added — can be bridged if 40 one-GW (gigawatt, or 1,000 MW) pressured water reactors (PWRs) plus uranium to fuel them are imported during 2012-20.

Because India is not a signatory to the Nuclear Non-Proliferation Treaty (NPT), due to its

EXECUTIVE SUMMARY

- A successful nuclear deal will open the door for possible transfers of technology that could benefit Indian companies as well
- Specific deals between foreign companies and India will take at least two years after the NSG approves the 1-2-3 Agreement to become a reality

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weapons programme, it is largely excluded from access to nuclear plants or materials, which has hampered development of a civilian nuclear energy industry. That is what the US-India nuclear agreement is intended to address: assured fuel supplies for its operating plants and access to new technologies.

The Thorium Advantage

India also needs advanced US technology to best use thorium, a silvery metal that has been considered an alternative nuclear fuel to scarce and expensive uranium. Due to years of nuclear isolation and lack of domestic uranium, Indian scientists have worked hard at tapping the country's abundant thorium reserves.

"The thorium available in India allows it to pursue a nuclear power programme without much reliance on outside sources of fuel material," points out Seth Grae, president and CEO of Thorium Power, a firm specialising in developing and testing proliferation-proof nuclear fuel based on thorium. "Some countries have a lot of uranium; others import all of the fuel material. India has the ability to use its own thorium. I think that is very important."

It's true that so far, India's nuclear power programme has gotten along largely without fuel or technological assistance from other countries. But until the mid-1990s, Indian-made power reactors had some of the world's lowest capacity factors, reflecting the technical difficulties of the country's isolation.

In the US, between 1990 and 2007, productivity gains enabled improvements in the performance of civilian nuclear facilities by an amount equivalent to 27 new 1,000-MW power plants. Based on that success, the Nuclear Regulatory Commission has, since 2000, authorised 67 power up-rates — increases in power capacity and output — that will yield a



cumulative capacity increase of almost 2,965 MW, equivalent to about three new 1,000-MW plants. For India, access to those technological advances would improve efficiency dramatically.

Global reserves of thorium — India, Australia, Norway and the US possess the largest reserves — could meet the world's energy needs for centuries. Now, consider what it means for India to be able to do business with the cliquish club of nuclear technology suppliers.

"There is a strong interest in potentially working together once the 1-2-3 Agreement for civil nuclear co-operation is completed, which looks like it will be in the relatively near term," says Grae.

The Economics Of Nuclear Power

Despite the advantages that the nuclear deal can bring, opponents to it point out that the economics of nuclear power make it very expensive; additionally, they say (see 'N-Energy Is Not Clean' on page 44) the adverse environmental fallout is considerable, from mining, extraction and processing, to storage and disposal of nuclear waste.

The four factors that we have to take into con-

sideration in assessing the economics of nuclear power are construction, financing, operating and waste management costs. According to the World Nuclear Association — an association of companies that trade in nuclear energy-related materials — construction costs per kilowatt hour have fallen considerably due to standardised design, shorter construction times and more efficient generating technologies.

Financing costs for new nuclear plants, a critical component of nuclear economics, are expected to fall as new approaches are developed and tested, says the WNA. Operating costs of nuclear power plants have fallen steadily over the past 20 years as capacity factors have increased, squeezing far more output from the same generating capacity. Waste management costs, which are included in the operational costs of nuclear plants, represent a tiny fraction of the lifetime costs of a reactor's operation.

Energy analysts use the levelised cost of electricity (LCOE) — the price that covers both the operating costs and the annualised capital costs — as a benchmark for economic viability. Several studies have been conducted in the past five years — including by the University of Chicago,

the International Energy Agency (IEA) and Organisation for Economic Cooperation and Development (OECD), the Massachusetts Institute of Technology and the Royal Academy of Engineering — on the costs of setting up new nuclear energy facilities.

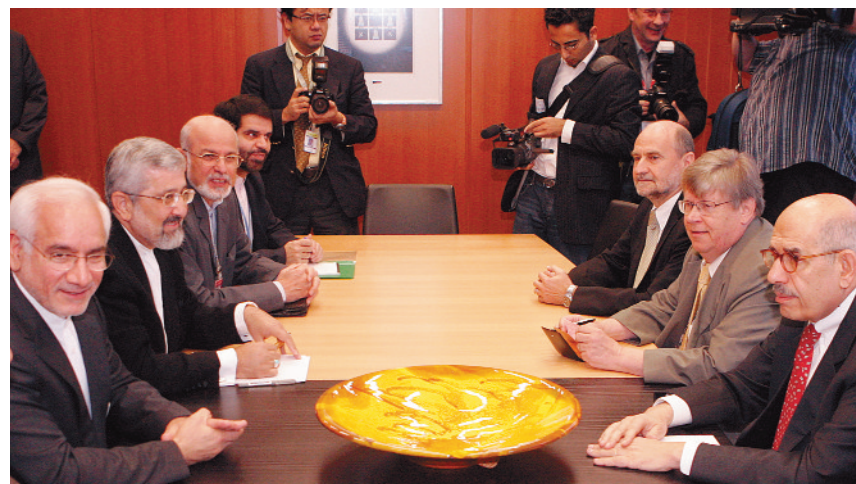
The balance between capital costs and fuel costs depends upon the generating technology. For combined cycle gas turbine (CCGT, that uses naphtha), the capital costs account for about 20 per cent of the investment. For a new nuclear plant, that number (including accrued interest) is nearly 60 per cent. With CCGT plants, fuel costs are almost 75 per cent of the LCOE, but nuclear fuel account for just about 25 per cent. Recent events — the volatility in fossil fuel prices that some analysts believe will continue for some years to come — underscore the viability of nuclear energy as an alternative.

The Long And Winding Road

But the road to achieving energy security for India is a difficult one (see timeline below). In between, there are several uncertainties. "The US-India deal goes against the grain for those members — including New Zealand and the Netherlands — for whom non-proliferation is

UNDER SCRUTINY: The Tarapur Atomic Power Station, Maharashtra (left) and the Dukovany Nuclear Power Station in the Czech Republic; the growth in global energy demand has re-ignited the nuclear debate

STEP BY STEP: The IAEA will meet on 1 August to assess India safeguards agreement



Timeline: The Crucial Stages of the Process

- 9 JULY:** India submitted a draft nuclear safeguards accord to the IAEA.
- 1 AUGUST:** The IAEA board could meet on the issue of rules for India.
- 2 AUGUST:** If the IAEA gives India a thumbs-up on 1 August, then the US will ask the NSG for a consultative meeting to move to the next stage.
- 11 AUGUST:** The first NSG consultative meeting at which the US will propose that the NSG give India a waiver from the NSG guideline.
- SEPTEMBER FIRST WEEK:** India may obtain a waiver for the nuclear deal from the NSG at a full plenary meeting.
- SEPTEMBER AND PERHAPS TWO WEEKS IN OCTOBER:** US Congress will be in session to consider the nuclear deal. India is yet to sign the Convention on Supplementary Compensation (CSC), an international treaty that created a fund to pay victims of nuclear disasters. If India does not sign it, American-built reactors would have to shoulder their own civil liabilities — a prohibitive cost.
- THE FINAL LAP:** After US Congressional approval, the 1-2-3 Agreement will be signed. American companies can then enter into specific deals. It could take two years from then for the first fuel supplies to arrive at our nuclear plants.

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an important issue, and they have strongly held views on it," says T.P. Sreenivasan, former Indian ambassador to the Vienna-based International Atomic Energy Agency. But perhaps not enough to test the will of the US.

What India is looking for, Sreenivasan adds, is a statement that reads something like this: "The NSG guidelines will not apply to India." But what they might get is something more qualified and that may ask for some assurances on verification of use of nuclear fuel, nuclear testing, reprocessing and similar issues.

The US Congress took 13 years to approve a 1-2-3 Agreement with China after President Ronald Reagan submitted it to the US Congress in 1985. Nobody believes that it will take that long for India. Is there time for the election-year Congress to approve the nuclear deal before President Bush leaves the White House?

The US Congress is scheduled to be out of session in September and it already has a lengthy list of bills to consider, but the administration is trying to build enough momentum for the Indian nuclear deal on Capitol Hill to get it on the agenda. "We're going to be communicat-

ing to the Hill how important this measure is for the US, and how important we believe this partnership will be for India," says State Department spokesman Gonzalo Gallegos.

"It is going to be tight, if only because we are in the second half of an election year," says Ashley J. Tellis, a senior associate at the Carnegie Endowment for International Peace, who was intimately involved in negotiating the deal as an adviser to former US Under secretary of State Nicholas Burns. But with a "bit of luck", he doesn't think it is impossible. All the players involved want to see this done quickly, he says.

"Practically speaking, it will be very difficult for the US Congress to take up the nuclear issue again before the end of the year," says Jim McDermott, a senior Democrat leader who is the co-chair of the Congressional Caucus on India and Indian Americans.

Who Wins, Who Loses, Who Gets Away?

But how important is it for the US? Any delay in the India-US deal's passage could mean US companies might not be at the front of the line for contracts for the new Indian nuclear reactors. Also, as a leading US business magazine, points out, India has yet to sign the Convention on Supplementary Compensation (CSC).

The CSC treaty is a global pool to pay victims of nuclear disasters; unless India signs it, any American-built reactors would have to shoulder their own civil liabilities.

"American companies are concerned that India has not ratified international nuclear liability agreements," says Daryl Kimball of the Arms Control Association. "They are concerned they will be liable for accidents." But companies from other countries, especially France, Russia and Japan, are not likely to be as affected.

Areva has exploratory agreements in place that almost assure it of a site in western India, and Russian companies are planning to help build a nuclear reactor in Kudankulam in Tamil Nadu once India gets a "clean and unconditional exemption" from the NSG guidelines.

But R.B. Grover, director at India's DAE and India's chief negotiator for the nuclear deal, recently suggested that there was no cause for worry. "Irrespective of any understanding or quid pro quo, the demand for electricity in India is so large, we can accommodate all countries," he told the US media.

What happens now? Read Saxe: "So the six men of Indostan, disputed loud and long,/Each in his own opinion, exceedingly stiff and strong,/Though each was partly in the right, and all were in the wrong."

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Power Reactors Under Construction

Reactor	Type	MWe Net Each	Project Control	Commercial Operation	Safeguards Status
Kaiga 4	PHWR	202	NPCIL	End of 2008	
Rawatbhata 5 & 6	PHWR	202	NPCIL	End of 2008, 3/09	By 2008 under new agreement
Kudankulam 1 & 2	PWR	950 (VVER)	NPCIL	9/2009, 12/09	Item-specific
Kalpakkam PFBR	FBR	470	Bhavini	2010	Unlikely
Total (6)		2,976 MWe			

Power Reactors Planned and Proposed

Reactor	Type	MWe net, Each	Project Control	Start Operation
Kakrapar 3 & 4	PHWR	640	NPCIL	2012
Rawatbhata 7 & 8	PHWR	640	NPCIL	2012
Kudankulam 3 & 4	PWR-VVER	1,000	NPCIL	ND
Jaitapur 1 & 2	PWR	1,000	NPCIL	ND
ND	PWR x 2	1,000	NTPC	2014
ND	PHWR x 4	640	NPCIL	ND
ND	FBR x 4	470	Bhavini	2020
ND	AHWR	300	ND	2020

ND: Not disclosed

Source: BW research