Congressional Research Service

Memorandum March 22, 2006

TO: House International Relations Committee
Attention: Jamie McCormick

FROM: Mark Holt and Larry Parker
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Resources, Science, and Industry Division

SUBJECT: Energy Implications of Proposed U.S.-India Nuclear Cooperation Agreement

As you requested March 16, this memo provides a brief overview of the major energy security and environmental implications of the proposed U.S.-India nuclear cooperation agreement. As we agreed, a more detailed memo will be provided later. Please feel free to contact us about this issue at x7-1704 (Holt) or x7-7238 (Parker).

President Bush announced plans for U.S. nuclear cooperation with India on July 18, 2005, as one part of a new global partnership with India, which is intended to improve overall U.S.-India relations. The President said he would "work to achieve full civil nuclear energy cooperation with India" and would "also seek agreement from Congress to adjust U.S. laws and policies." The nuclear cooperation agreement cannot be implemented without congressional action.

Because India is not a signatory to the Nuclear Nonproliferation Treaty and has used its nuclear power program to develop nuclear weapons, the United States and other nuclear supplier nations have restricted India's access to foreign nuclear technology and materials since the early 1970s. As a result, India's nuclear power program has relied on indigenous heavy water reactor designs based on small imported reactors that were supplied before the international cutoff. India had set a goal of 10,000 megawatts of nuclear generating capacity by 2000,[1] but by 2005 only 2,550 megawatts of nuclear capacity was on line.[2]

Proponents of the U.S.-India nuclear cooperation proposal argue that allowing India to import U.S. reactors would allow India's nuclear generating capacity to expand much more rapidly. "The agreement also is good for the American economy because it will help meet India's surging energy needs — and that will lessen India's growing demand for other energy

[1] "Datafile: India." *Nuclear Engineering International*. February 1995. p. 17.

[2] "World List of Nuclear Power Plants." *Nuclear News*. March 2005.

supplies and help restrain energy prices for American consumers," according to a White House statement.[3]

The extent to which the U.S.-India nuclear agreement would help restrain U.S. energy prices, as cited by the White House, would depend primarily on the amount of new Indian nuclear generating capacity resulting from the agreement and the amount of Indian fossil fuel consumption displaced by any such nuclear capacity. The White House has not yet provided a detailed analysis to support its contentions about the potential energy and environmental benefits of the proposed nuclear agreement. As indicated by the following discussion, the energy benefits to U.S. consumers are likely to be negligible for at least the next 20 years, although longer-term benefits could be significant under some imaginable scenarios.

A recently released draft of India's first Integrated Energy Policy calls for India to order 6,000 megawatts of foreign-supplied nuclear generating capacity (six or seven large commercial reactors) during the next 10 years, in addition to a two-reactor Russian nuclear power plant already under construction. The draft plan calls for Indian nuclear capacity to reach 9,000-11,000 megawatts in 2010, 21,000-29,000 megawatts in 2020, and double each decade thereafter through 2050. The upper range of the projections assumes imports of technology and nuclear fuel.[4]

Far more modest nuclear growth is predicted by the International Energy Agency (IEA), which estimates that India's nuclear generating capacity will reach 6,000 megawatts in 2010, 9,000 megawatts in 2020, and 14,000 megawatts in 2030.[5] Given India's past shortfalls in meeting its nuclear power targets, the IEA projections may be more realistic than those in the Indian energy plan. However, because the IEA estimates were issued in 2004, they do not consider any potential boost from reactor imports.

Even if legal barriers to nuclear sales to India were lifted, the potential difficulty in financing such sales would pose a significant obstacle to Indian nuclear power expansion. Nuclear power plants are far more capital-intensive than competing technologies; the higher construction costs are supposed to be recouped by lower fuel and other operating costs. However, the overall economic viability of nuclear power has been inconsistent throughout the world, and worldwide nuclear growth has been slow since the 1980s. The relatively few nuclear power plants that have been completed in recent years have experienced such a wide variety of construction circumstances and are of so many designs and sizes that no clear track record on capital costs has been demonstrated. Costs reported in the news media for reactors completed since 2000 range from less than $1,000 per kilowatt of capacity for Russia's Rostov 1[6] to about $4,400 per kilowatt for Brazil's Angra 2.[7] Costs toward the lower end of that range will probably be necessary for a worldwide resurgence in nuclear power plant construction.

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[3] The White House. Office of the Press Secretary. "India Civil Nuclear Cooperation: Responding to Critics." March 8, 2006.

[4] Saraf, Sunil. "Indian Energy Policy Stresses Indigenous Nuclear Development." *Nucleonics Week*. January 26, 2006. p. 8.

[5] International Energy Agency. *World Energy Outlook 2004*. p. 500.

[6] Weekly Business Report, March 13, 2001; Interfax, July 1, 1999 (from Nuclear Threat Initiative web site, www.nti.org).

[7] Dow Jones, July 14, 2000.

In the United States, no commercial reactors have been ordered since 1978 (and all orders since 1973 have been cancelled). About a dozen nuclear power plants are currently under consideration in the United States, but the Energy Information Administration calculates that new reactors would not be financially feasible without tax credits provided by the Energy Policy Act of 2005 (P.L. 109-58).[8]

Nuclear power's relatively high up-front costs, in addition to hindering nuclear energy expansion throughout the world, pose particular problems for India. IEA estimates that India will need to invest $665 billion in its electricity sector over the next 30 years and concludes, "Given the extremely poor financial situation of the Indian power sector, the availability of the necessary finance remains very uncertain." Most Indian power plants are government-owned, with about two-thirds owned by State Electricity Boards (SEBs). Revenues to the SEBs cover only about 70% of their costs, and about 40% of their revenues come from subsidies. Power theft, non-billing, and non-payments are widespread.[9]

Private-sector financing in India remains problematic as well. India opened the electricity sector to independent power producers (IPPs) in 1991, but 10 years later only 10,000 megawatts of such capacity had been constructed. According to IEA, "The time and effort required to develop new IPP projects in India proved too great for some foreign investors, and many reduced their Indian exposure. Among recurring difficulties are the lack of prior clearance of the projects by the authorities, problems in securing fuel supply agreements and the bankruptcy of the SEBs."[10] The relatively high up-front risk of nuclear generation would appear to make private-sector financing especially difficult for Indian nuclear projects, although some interest has recently been expressed by Indian firms.[11]

Nuclear power in India is currently owned and operated by the central government through the Nuclear Power Corporation of India Ltd. (NPCIL). Because of the financing obstacles facing the SEBs and private sector, it appears likely that nuclear power expansion in the foreseeable future would have to continue to be undertaken by the central government. However, industry observers have questioned whether NPCIL has the resources to expand India's nuclear capacity at the rate envisioned by India's draft energy plan without private-sector assistance.[12]

If a U.S.-India nuclear cooperation agreement is implemented and adequate financing for new nuclear power plants can be arranged, any resulting energy and environmental benefits would not be realized immediately. Reactor projects currently under consideration in the United States are expected to require at least 10 years of design, licensing, and

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[8] Energy Information Administration, *Analysis of Five Selected Tax Provisions of the Conference Energy Bill of 2003*, February 2004.

[9] International Energy Agency. *World Energy Investment Outlook 2003*. p. 388.

[10] International Energy Agency. *Electricity in India: Providing Power for the Millions*. 2002. p. 25.

[11] AsiaPulse. "India's Tata Group Expresses Interest in Nuclear Power." March 6, 2006.

[12] Hindu Business Line. "India Nuclear Power Generation Sector." March 3, 2006.

construction before operation can begin.[13] For Indian reactors, additional time would probably be needed to negotiate a deal, including price, financing, and local content and technology transfer requirements. After China began serious negotiations in 1984 for its first foreign reactors, from France, the first two units began operating in 1994, and four additional foreign-supplied reactors have been completed since.[14] (Two Russian-supplied reactors are currently under construction, and China is expected to soon award foreign contracts for four more nuclear units.) A case could be made that India's nuclear program might follow a similar pace.

If India began operating six new commercial reactors by 2025 resulting from the U.S.-India nuclear cooperation agreement, the additional nuclear generating capacity would total about 7,200 megawatts (about 1,200 megawatts each). Any additional Indian nuclear power capacity would be expected to displace some of the growth that would otherwise have taken place in electricity generation fueled by coal, natural gas, and oil. IEA projects that by 2025, coal-fired generating capacity will grow by 94,000 megawatts, natural gas-fired capacity will grow by 45,000 megawatts, and oil-fired capacity will grow by 7,000 megawatts.[15]

If U.S.-supplied reactors displaced those three fuels in proportion to their expected growth, then the displacement would be 4,636 megawatts of coal-fired capacity, 2,219 megawatts of natural gas-fired generation, and 345 megawatts of oil-fired generation. The 7,200 megawatts of displaced fossil-fuel generating capacity would have produced about 37 million metric tons of carbon dioxide per year. India's projected natural gas consumption in 2025 would be reduced by 119 billion cubic feet per year and annual oil consumption reduced by 2.9 million barrels.

With world oil consumption projected to reach 119 million barrels per day by 2025,[16] the reduction in India's oil consumption calculated above would have little or no impact on world oil markets. The calculated natural gas reduction would also be a small proportion of the projected world annual total consumption of 156 trillion cubic feet by 2025. Natural gas prices are currently set primarily in regional markets, but it is possible that by 2025 a world market could develop and that Indian imports could directly affect U.S. prices (although not the small amount of gas in the calculation above). Carbon dioxide reductions of 37 million metric tons per year would be similarly small in comparison to total worldwide carbon dioxide emissions. However, such reductions would constitute 2% of India's current annual CO2 emissions and 3.6% of India's current energy-related emissions,[17] which could help India meet future reduction goals that might be required by international agreements.

If faster nuclear growth than described above were assumed, the displacement of fossil fuels and carbon dioxide emissions would increase proportionately. Future advances in technology, such as commercially viable electric vehicles or vehicles powered by hydrogen

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[13] Weil, Jenny, and Margaret Ryan. "New Plants Entice Utilities, Investors, But Risks Loom Large." *Nucleonics Week*. February 16, 2006. p. 1.

[14] MacLachlan, Ann. "Framatome and Chinese Sign Letter of Intent for Daya Bay Units." *Nucleonics Week*. March 20, 1986. p. 1; "World List of Nuclear Power Plants." *Nuclear News*. March 2005.

[15] IEA, *World Energy Outlook 2004*. p. 500. (Average of 2020 and 2030 capacity projections.)

[16] Energy Information Administration. *International Energy Outlook 2005*. p. 93.

[17] World Resources Institute. *Climate Analysis Indicators Tool*. [cait.wri.org].

from nuclear reactors, could further increase nuclear power's potential displacement of oil consumption in the long run. However, the timing and possible commercial impact of such technologies remains highly speculative. crsphpgw