The India Nuclear Deal: Implications for Global Climate Change

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Introduction

The debate over the India nuclear deal has been too one-dimensional. Nearly all commentary has focused on whether this proposal would undermine efforts to contain the proliferation of nuclear weapons. Dissent along these lines has been based on a series of largely overblown claims. And the singular focus on proliferation has allowed the debate to lose sight of other ways that this deal is in the interests of the United States and India alike.

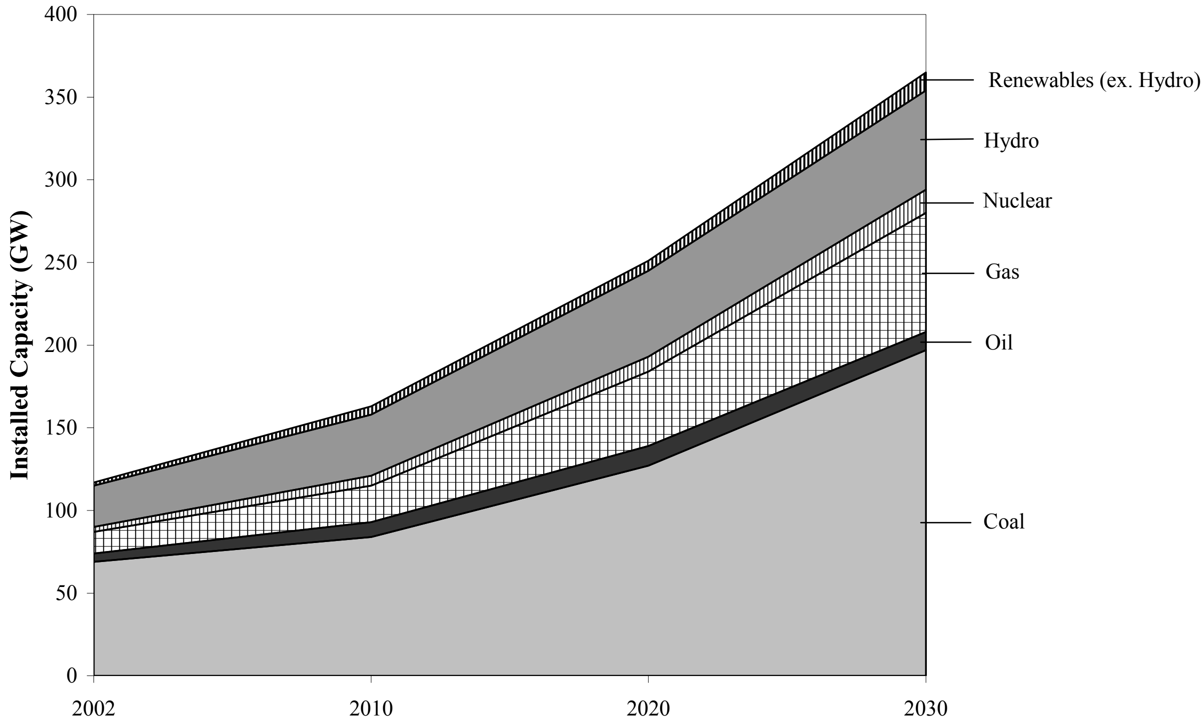
Chief among those other reasons is environmental. The fuller use of commercial nuclear power, if done to exacting standards of safety and protection against proliferation, can play an important role as part of a larger strategy to slow the growth in emissions of the gases that cause global warming. That's because nuclear power emits essentially no carbon dioxide (CO_2), the most prevalent of these so-called "greenhouse gases." While this benefit is hardly the chief reason for initiating this deal, with time it will become one of the main benefits from the arrangement. The nuclear deal probably will lead India to emit substantially less CO_2 than it would if the country were not able to build such a large commercial nuclear fleet. The annual reductions by the year 2020 alone will be on the scale of all of the European Union's efforts to meet its Kyoto Protocol commitments. In addition, if this arrangement is successful it will offer a model framework for a more effective way to engage developing countries in the global effort to manage the problem of climate change. No arrangement to manage climate change can be adequately successful without these countries' participation; to date the existing schemes for encouraging these countries to make an effort have failed; a better approach is urgently needed.

Economic Growth, Electric Power and the Options for Supply

Evaluating the environmental benefits of this deal requires, first, understanding the basic factors that affect investment in the Indian electric power market. From the 1970s through much of the 1990s India's economy was famous for its low rate of growth; with low growth came low demand for electricity. A series of economic reforms, initially introduced in the wake of a financial crisis in 1991 but strengthened over the many years since, has changed that situation dramatically. India's economy enjoyed an average annual growth rate of around 7% from 1994-2004. Most analysts expect growth to be sustained at 8% over the next few years if not longer. India's population is young; and an important fraction is well-educated and increasingly engaged with the world economy. To be sure, the Indian economy has many deep flaws. India has made no progress in solving the development problem in the rural areas where most Indians live, and India's democracy is notorious for its political gridlock. All that said, there is palpable evidence that India's economic reforms have finally taken hold.

Higher growth has led directly to higher demand for electricity. While the exact future needs for power remain uncertain, there is considerable evidence that electric demand will grow at roughly the same rate as the economy. Some factors will tend to dampen the growth in demand for power. For example, economic growth is expected to cause a shift in the Indian economy away from energy-intensive manufacturing and also engender investments that make the economy more efficient in its use of energy. But other factors will cause demand for electricity to accelerate. Among them is an improvement in power quality that is likely to accompany the extensive efforts to reform India's electric power system that have been under way for 15 years. While reformers have found it difficult to make progress, these reforms are beginning to take effect in some parts of the country. Those effects are evident not only in the improved performance of some of the country's power utilities, but also in the rising role for privately owned (and generally more reliable) power plants. In industry, for example, reliable power is essential; many companies are taking matters into their own hands and building their own plants. And where electricity is more reliable, Indians will consume more of it.

There are many projections for total demand for electricity. In Figure 1, I show the International Energy Agency's projections, which envision a doubling of power demand from the present to 2020. Barring an economic catastrophe, I would be surprised if demand for electric power were dramatically lower than these projections. And it is possible that demand could be higher if India discovered, as China has in recent years, that demand for electricity rises even faster than economic output. For now, let's use these projections to illustrate the stakes.



Source: IEA, World Energy Outlook 2004.

Figure 1: India's Installed Capacity (2002 – 2030)

At present, the total size of India's electric power system is 124 GW. Of that, coal comprises 55%, hydroelectric 26%, natural gas 10%, renewables 5%, and nuclear makes up only 3% of total installed capacity. Looking to the future, India has five main options for providing the bulk of its electric needs:

Hydroelectric. Official Indian plans call for much greater use of hydro, but in practice, India has found this option increasingly difficult to deploy due to local opposition to dams. This pattern is evident in all large democracies and there is no evidence that it will become significantly easier to site domestic hydro facilities in the future. While there are possibilities of hydro imports from Bhutan and Nepal, such international projects are invariably fraught with political uncertainty. Overall, hydro will probably play a declining role in the future Indian system; projections that claim otherwise are probably wishful thinking and unlikely to be realized.

Renewables. India makes extensive use of biomass digesters in rural areas and wind and solar energy in a few states. Given India's aggressive and expanding renewable energy program, particularly in wind power, the projection shown in Figure 1 (about 6 GW of installed renewable electricity generation capacity by 2020) is certainly too low. However, even assuming India were to continue its aggressive push on renewable energy, renewables are not likely to represent more than 10% of installed capacity by 2020. More importantly, renewable power generators, notably wind turbines, are intermittent. They are available less frequently than conventional power plants, contributing to the unlikelihood that renewables will supply more than 5% of India's total electricity by 2020 even given optimistic assumptions.

Natural gas. Until recently, most analyses of the Indian power sector envisioned that gas would play a much larger role in the future. Gas is attractive because it is the cleanest of the fossil fuels and because the capital cost of gas plants is much lower than for all the other main rivals such as nuclear, coal, and hydro. Thus, gas plants have been especially attractive to private investors who are wary of sinking large amounts of capital into projects where regulatory rules are in flux. Indeed, nearly all foreign-owned private power plants in India are fired with gas. (In other developing countries, most privately-owned power plants are gas fired). However, the price of gas has risen sharply in the last four years. For two decades gas prices were regulated at approximately $3/mmbtu and supplies were controlled by the state transmission and marketing monopoly. Over the last decade a private gas market has emerged, with prices much higher than those in the historic government-managed market. India has built three terminals to import LNG as a supplement to its own domestic gas supplies, and has plans to build several others. The workings of that gas market are the best indicator of the real price of gas in India. The most recent large transaction, in which India purchased a spot cargo of LNG from Algeria's Sonatrach, put delivered prices at above $10/mmbtu. Our group at Stanford is heavily involved in analyzing this gas market, and we expect delivered gas prices will remain high—perhaps not as high as $10, but probably in the range of $7-$8/mmbtu.[1]

Nuclear. Until now, nuclear power has been controlled by the central government, mainly for non-energy purposes (namely weapons), and has not been exposed to commercial accountability. In addition, India's domestic uranium reserves are quite meager – the Atomic Energy Commission estimates that domestic resources could support only 10 GW of installed nuclear capacity.[2] Thus, not surprisingly, nuclear energy has played only a small role in the power sector. Whether and how that could change is at stake in this deal.

The India nuclear deal would provide for "full" civil nuclear cooperation between the U.S. and India. By enabling India to import modern nuclear energy technology, as well as uranium, a properly regulated deal would in effect alleviate the historical restrictions placed on civilian Indian nuclear power.

Coal. In the past and in the foreseeable future coal is expected to provide most of India's electricity. In fact, coal has not met its full market potential in the last decade because coal supplies are unreliable (partly because the railroad network is badly in need of investment) and of notoriously low quality. Both those impediments to coal sector growth are being alleviated. India has begun to encourage private investment into coal mines and pithead power plants that will send the coal "by wire" to the national electric grid rather than via railcars. In addition, the country has adopted favorable rules to encourage investment in the inter-state power grid, enabling the grid to move much larger quantities of electricity.[3] At the same time, changes in import tariffs are making it easier to import high quality coal from other countries; those imports, in turn, are inducing India's domestic coal industry to perform better. These reforms are set to have a huge impact on growth in coal-fired capacity. India is soliciting bids for five new 4 GW coal-fired power projects (known as the "ultra mega power projects") – two of which will produce electricity at coal pitheads in the interior of the country and three coastal plants that will import foreign coal supplies.

In this context, the question for the India's energy future centers on the rivals to coal. Where alternative fuels can be successful, the share left to coal will decline. All the rivals have problems. For hydro and renewables those problems are severe, and the United States, in any case, has no ability to influence them. For gas the severity of the problems created by high gas prices are not yet known. On the one hand, high prices have discouraged (but not stopped) investment in plants that use gas. Indeed, some investors who would have built gas-fired power plants are now looking closely at coal. On the other hand, barely a month passes without the announcement of new gas discoveries in India (in particular the large resources discovered off the country's east cost). These new gas supplies may eventually help to lower the price of gas, which in turn will allow for a much larger gas-fired generation capacity.

For nuclear, the future is really wide open. So long as India's nuclear industry remains isolated, it is hard to see that India will build more than the occasional reactor as the cost basis for nuclear equipment will be too high and fuel needed for such reactors will not be available. Some critics have claimed that allowing exports of fuel for use in Indian commercial reactors will free up domestic fuel supplies for use in the nuclear weapons program. The more likely outcome is that India simply will not expand its commercial reactor fleet so that the military program can obtain the fuel it needs.

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[1] Jackson, Mike (2006). "India: challenges to growth," in *Fundamentals of the World Gas Industry, 2006*. Petroleum Economist.

[2] Presentation by Kakodkar, Anil: Chairman, Atomic Energy Commission (2005). "Energy in India for the Coming Decades."

[3] In fact, India's power regulations indirectly encourage projects that transmit power long distances across state lines because such inter-state investments are governed by federal regulators and can be managed more reliably than projects that are exposed to the whims of state regulators.

It is hard to predict with certainty how the costs of the different options will unfold. In Table 1, I focus on the main contenders: nuclear, coal, and natural gas. I show estimates for nuclear power drawn from a study by a group at MIT evaluating nuclear power in developed countries ("high" and "medium cost" estimates) and also from a study that focuses on nuclear power options in the Indian context ("low cost") but used a notably low capital cost estimate. The coal numbers provide an approximation for costs of a new pulverized coal plant—technology widely available in India—for a plant that meets U.S. environmental standards, as well as a conventional plant in India. The estimates for gas are based on the Indian experience and levelized costs are shown at different prices—from the low price for public gas (which is essentially unavailable for new power plants) to various feasible private gas prices.

Generation Options	US cents/kWh
Nuclear - Light Water Reactor	
High Cost[1]	6.7
Medium Cost[1]	4.2
Low Cost[2]	3.8
Pulverized Coal	
U.S. Context[1*]	4.2
Indian Context[3*]	3.9
Natural Gas	
Public Supplier ($2.86/mmbtu)[3]	4.6
Private Supplier ($5/mmbtu)[3]	6.9
Private Supplier ($8/mmbtu)[3]	10.1

[1] Massachusetts Institute of Technology (2003). *The Future of Nuclear Power: An Interdisciplinary MIT Study.*
[2] Bharadwaj, Anshu, Rahul Tongia, and V.S. Arunachalam (2006). "Whither Nuclear Power?" *Economic and Political Weekly* 41(12): 1203-1212.
[3] Adapted from Shukla, P.R., et al. (2004). *Electricity Reforms in India: Firm Choices and Emerging Generation Markets.*
* Both coal calculations based on assumed delivered cost of US$1.20/mmbtu.

Table 1: Carbon Implications of India Nuclear Deal

Three things are clear from Table 1. First, at the high gas prices typical of today's market, gas-fired electricity is extremely expensive. Second, while there are many uncertainties—especially for nuclear power—the cost of coal and nuclear are comparable. Third, the costs noted in Table 1 may exaggerate the cost advantage of coal because coal-fired electricity has larger environmental consequences. (The "U.S. Context" number is for a plant capable of meeting current U.S. environmental standards; the "Indian Context" number includes some particulate control but only monitoring of other pollutants). If these are taken into account, nuclear power would be even more competitive with coal.

CO_2 and Global Climate Change

While there remains some divergence in opinion in the United States about the causes of global changes in climate and the severity of the global climate problem, the risk of unacceptable changes in climate will undoubtedly rise with increasing atmospheric concentrations of CO_2 and other greenhouse gases. It is impossible to predict the outcomes from climate change with complete certainty. (Indeed, the most worrisome possible changes are the least certain, such as possible catastrophic rise in sea level, a change in ocean currents, or the destruction of vast ecosystems like the Amazonian rainforest). Looking at the totality of the evidence, however, it is hard to escape the conclusion that a prudent and risk-averse policy strategy toward the threat of global climate change must include a substantial effort to control emissions. And because those emissions emanate globally, such a strategy must be pursued globally.

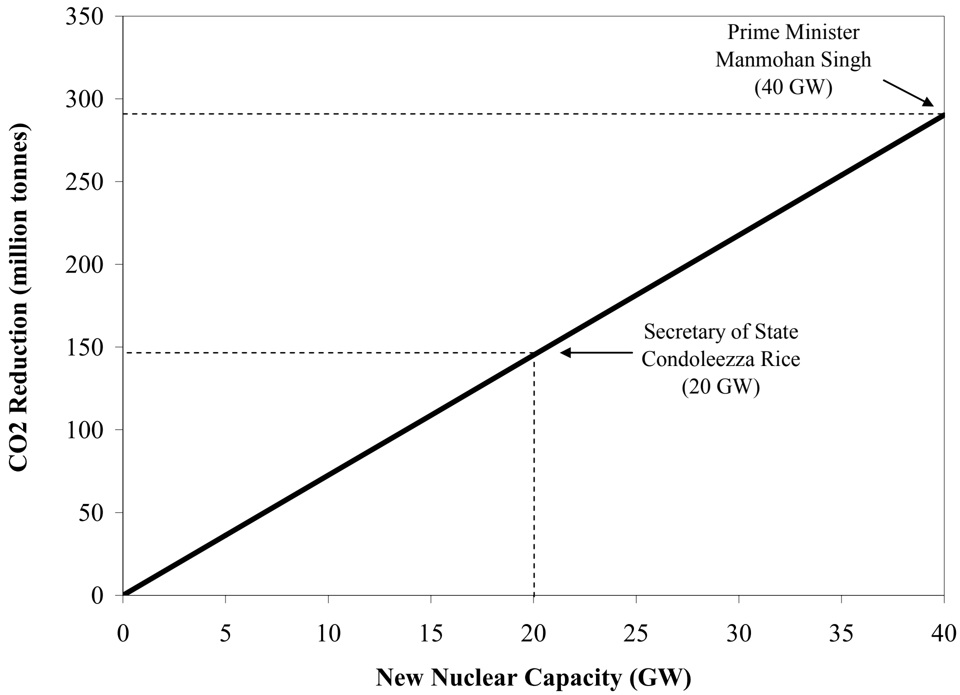

Figure 2: Carbon Implications of India Nuclear Deal

The CO_2 savings implications of replacing coal with a range of installed nuclear capacities are provided in Figure 2 above. Because there is considerable uncertainty as to the exact amount of new nuclear capacity likely to arise from the deal, Figure 2 shows a line rather than any particular point. India's track record of installing power plants, combined with the difficulties that are likely to arise in a shift to a truly commercial nuclear power program, suggest to me that new nuclear capacity could be in the range of 10-20GW by 2020. The State Department has proposed that 20GW of new nuclear capacity could be built by 2020— this represents a middle-of-the-road estimate provided by Secretary of State Condoleezza Rice in her April 5th remarks to the Senate Foreign Relations Committee. Under this scenario, by displacing 20GW of capacity that would otherwise be coal-fired, the new nuclear capacity would save 145 million tonnes of CO_2 per year.[4] Indian Prime Minister Manmohan Singh has recently suggested that the India nuclear deal could have even larger implications, arguing that it might lead India to install up to 40GW of new nuclear capacity by 2015.

In Figure 3, I put the CO_2 savings from a 20 GW buildout of nuclear power into perspective by comparing it with other relevant emission estimates. The annual savings from the Indian deal could be nearly as large as the entire commitment of the 25 EU nations to reducing emissions under the Kyoto Protocol. This single arrangement in India would exceed the total carbon savings from the 100 largest developing country projects under the Kyoto Protocol's Clean Development Mechanism (CDM). At present, the CDM is the only mechanism for engaging developing countries in the effort to control greenhouse gas emissions.

[4] Jackson, Mike, et al. (2006). "Greenhouse Gas Implications in Large Infrastructure Investments in Developing Countries: Examples from China and India" (working paper, Program on Energy and Sustainable Development, Stanford University).

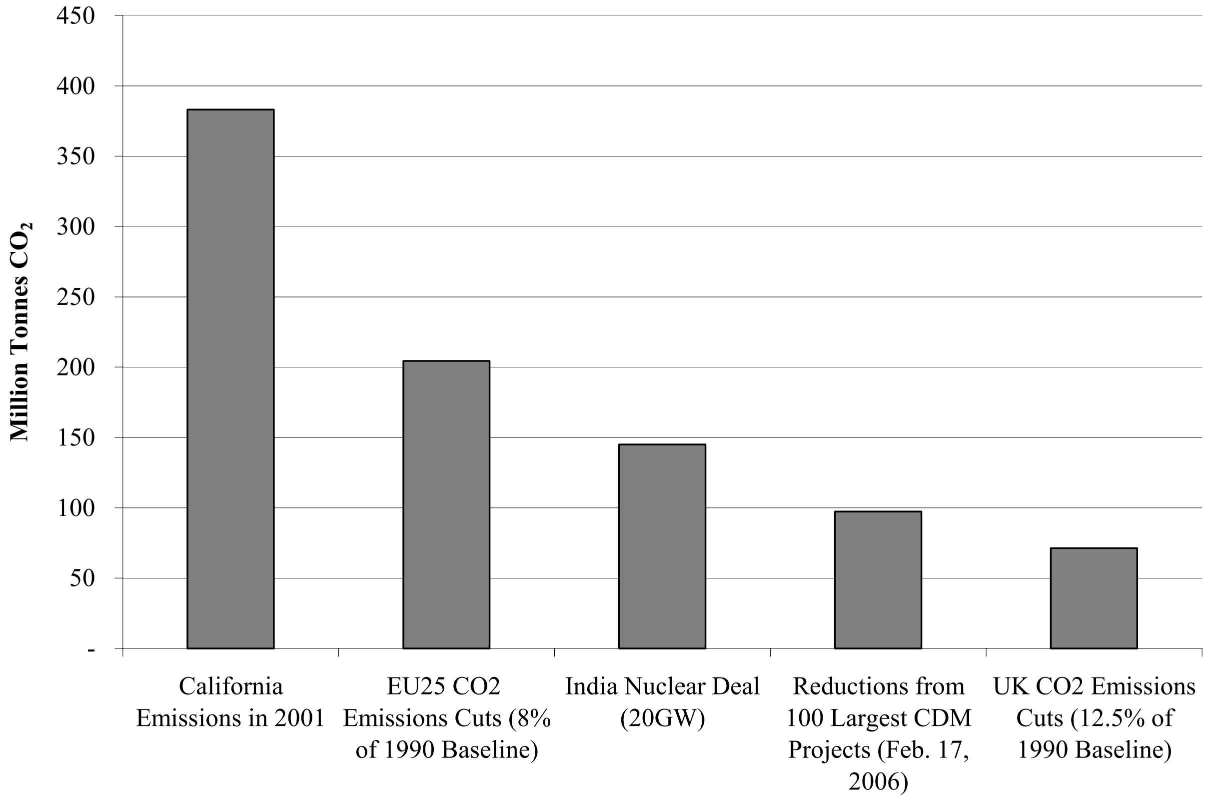

Figure 3: India Nuclear Deal Carbon Savings in Perspective

Beyond India: Engaging Developing Countries

Until now, developing countries have adamantly refused to limit their emissions of greenhouse gases. These countries are wary that the possible high costs of climate change mitigation will jeopardize their development goals. The result of that opposition is the CDM—a system that compensates developing countries for the full extra cost of any policies to control emissions. The CDM was a good idea in principle, but in practice it is not working well. The scheme has become mired in red tape as countries and investors try to establish their baseline levels of emissions and the reduction in emissions from each project. (The difference between the baseline and the reduced level is the key to the CDM concept—that difference becomes a credit that can be used to offset emission obligations elsewhere in the world, such as in Europe's emission trading system). The problems have encouraged gaming and they have caused CDM investors to focus on activities that are easy to quantify and which are marginal in nature. Indeed, energy projects account for just 17% of the CDM pipeline. Almost none of the energy projects are of the type that will lead to fundamental changes in countries' energy systems.[5]

If the India nuclear deal is successful, it will frame a new approach to engaging developing countries in a climate strategy. This approach would focus on finding game-changing policies that align with reluctant countries' interests.[6] Rather than involving hundreds of small and marginal projects, this style of engagement would focus on just a handful of large pivotal actions involving just a few critical countries. This concept is incidentally at the core of the Asia-Pacific Partnership on Clean Development and Climate, whose six members, including India and the

[5] Wara, Michael (Forthcoming, 2006). *Measuring the Clean Development Mechanism's Performance and Potential*.

[6] See T.C. Heller and P.R. Shukla (2003). "Development and Climate: Engaging Developing Countries" in: J.E. Aldy et al., *Beyond Kyoto: Advancing the International Effort Against Climate Change*. Pew Center on Global Climate Change.

U.S., account for half the world's greenhouse gas emissions. That Partnership has promise, but it remains young. Success with this nuclear deal could offer a credible example of practical actions that the Partnership could encourage.

Proliferation, Indian Politics and the Fuel Cycle

My brief in this testimony is to focus on the possible environmental benefits of the India nuclear deal. I close, though, with a brief word on proliferation.[7]

My sense is that the claims about proliferation risks stemming from this deal have been overblown for three reasons. One is that many observers are reluctant to treat India differently from other states that have acquired nuclear weapons. Yet that argument is not sustainable. India—in contrast with Pakistan, among others—has not been the locus for proliferation of weapons technologies to other states and possibly terrorists. Nor has India taken the kind of aggressive stance with its nuclear weapons program that has been evident in Iran or North Korea.

A second reason for these hyperbolic claims about proliferation is critics have imagined the world as they would like it—a world before India's nuclear test and when the NPT was intact and functioning—rather than the world as it really is. Both these reasons have been covered extensively and I will say no more on them.

The third reason is that critics have imagined that the U.S. somehow got hoodwinked by India—for example, the list of facilities that are exempt from external scrutiny is longer than most U.S. analysts would like. This is a valid concern, but I think it misses the point because it imagines the India nuclear deal as a construct entirely of U.S. interests when, in fact, it is the product of a nascent cooperation between two democracies that must pay attention to how the deal plays locally. It is striking how much hostility the deal has engendered in the Indian press, as Indian nationalists portray this as an erosion of India's sovereign prerogative to sustain a nuclear weapons program. In such settings I think it is imperative that we give extensive deference to those who were able to negotiate a deal that (probably) has navigated these contours of Indian domestic politics while also delivering what is most essential for the U.S. to gain from the arrangement.

The world is in the early stages of recrafting the fuel cycle. Among the proposals is the Administration's Global Nuclear Energy Partnership (GNEP). The IAEA has a proposal. A tailored proposal is emerging as the logical solution to the troubles with Iran's nuclear program—with off-site fuel production and storage. Similarly, success with the India nuclear deal can establish a practical framework for a new fuel cycle for India. Many in the anti-proliferation community have been uneasy about this shift in fuel cycles, but such a shift strikes me as inevitable. And a practical demonstration with a responsible country could go a long way to making these visions a practical reality with adequate protections against proliferation.

[7] I am mindful that many others have written much more extensively on these subjects. Notably, Levi, Michael A., and Charles D. Ferguson (2006). "U.S.-India Nuclear Cooperation: A Strategy for Moving Forward," Council on Foreign Relations, CSR No. 16. and Squassoni, Sharon (2006). "U.S. Nuclear Cooperation With India: Issues for Congress," *CRS Report for Congress*. Congressional Research Service.