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Elements of an Alternative to Nuclear Power as a Response to the Energy-Environment Crisis in India

Development as Freedom and a Sustainable Energy Utility

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Even as the conventional energy system is fundamentally challenged by the "energy-environment crisis," its adherents have presented the prospect of "abundant" and purportedly "green" nuclear power as part of a strategy to address the crisis. Surveying the development of nuclear power in India, this article finds that it is predisposed to centralization and secrecy, that nuclear power as energy policy is based on a presumption that overabundance is imperative for viable forms of social and economic development; its institutionalization has tended to reduce deliberations on energy policy and human well-being to narrowly technocratic terms. Given these proclivities, nuclear power, as evaluated in this article, is considered unlikely to facilitate a viable response to the energy-environment crisis. Alternatives are thus surveyed here to include the sustainable energy utility and the capability approach as well as synergies between them, to challenge the offer of nuclear power as a response to the energy-environment crisis.

Keywords: *India; energy policy; nuclear power; sustainable energy utility; environment; development; capability approach*

The present organization of society has delivered stupendous economic expansion during the past 60 years. It has also, however, bequeathed an unprecedented ecological crisis while failing to resolve the challenge of deep-seated inequality in wealth, well-being, and political power (see, for example, Global Environment Outlook [GEO], 2007; Intergovernmental Panel on Climate Change [IPCC], 2007; McNeill, 2000; Millennium Eco System Assessment [MEA], 2005).[1] Indeed, in many ways, the ecological crisis has even created and accentuated new manifestations of inequality (see, for example, Byrne et al., 2002; Duraiappah, 2004).

India, a country that is home to over 17% of the world's 6.6 billion people, is in the midst of these trends. And in response to the challenges posed by these conditions, India is exploring various policy options to guide economic development and energy policy. Broadly, the preferred policy direction, as lauded by India's decision makers, proposes to alleviate these inequalities by dramatically expanding the generation and supply of energy to fuel a concomitant expansion of the economy (Planning Commission, 2006, 2008). And taking cognizance of ecological concerns, this policy direction seeks to alleviate challenges such as the growing concentration of CO_2 in the atmosphere, by selecting a menu of energy policies to facilitate the utilization of purportedly *greener* technologies and enhanced system efficiencies.

In this vein, efforts to revive the generation of purportedly green and abundant nuclear power enjoy tremendous support in India, as such proposals do in many countries of the world (e.g., Whitford, 2007). However, as experience and scholarly opinion suggest, broadly, a political economy of abundance and purported greenness appears unlikely to resolve the challenges of inequality and the ecological crisis (Byrne & Rich, 1986; Haberl, Krausman, & Gingrich, 2006; Sachs, 1999).

This article is an effort to help open up new possibilities for economic development and energy policy choices, beyond those offered by the conventional discourse. To do so, the article merges an alternative conception of economic development as offered by the capability approach (Alkire, 2002; Sen, 1999), with a recent innovation in the architecture of energy policy known as the sustainable energy utility (SEU; SEU, 2007). The article explores these innovations, as well as possible synergies between them, in support of a more viable nature—society relationship. But first it proceeds through

an overview of the now dominant economic development and energy policy approach and a discussion of the political economy of nuclear energy in India.

Overview of Economic Development and Energy Policy in India

The first decade of the 21st century is witness to the phenomenal economic and cultural transformations in the so-called third world, home to a majority of humanity. India, as one of the most populace members of this group, is materializing a dramatic economic transformation by integrating into the conventional development model.

At the time of its independence, achieved in 1947, India, outside of its urban and incipient industrial centers, relied on traditional biomass-based energy as the mainstay for life and livelihoods. The total installed electricity generation capacity in the country was 1,360 MW (a large coal-fired thermal power plant today is rated at about 1,000 MW) and per capita electricity consumption was about 18 kWh per year (Smith, 1993).

In the ensuing six decades, installed electricity generation capacity (not including captive generation estimated to be approximately 30,000 MW) has grown by approximately a hundred fold, to 132,000 MW (Central Electricity Authority [CEA], 2007). This equates to per capita electricity consumption of more than 500 kWh. Notwithstanding this growth, these quantities of electricity consumption are modest. Indeed, per capita primary energy consumption in 2003 for India at 439 kilograms of oil equivalent (kgoe) was modest in comparison to other less industrialized countries such as China and Brazil, which utilized some 1,200 kgoe per capita. And it was substantially lower when compared to industrialized societies such as Japan and Germany, which weighed in at more than 4,000 kgoe per capita, and the United States which came in at 7,835 kgoe per person (Planning Commission, 2006, 2008).

As regards growth in gross domestic product (GDP), available estimates suggest a stark contrast between pre- and post-independence India. Estimates of annual national income growth between 1900-1901 and 1946-1947 vary between 0.8% and 1.0%, while per capita income varies between 0.04% and 0.2%. Since independence, between 1950-1951 and 2003-2004, India has recorded significant increments on this score with total GDP and GDP per capita growing at 4.2% and 2.1%, respectively (Nayyar, 2006).

Over this period, indicators of well-being such as infant mortality rate (IMR), life expectancy at birth, and literacy rates in the population also have revealed significant improvements. The IMR improved from 146 to 66 (the world average is about 54, with Singapore at 3 as the lowest) per 1,000 births. Life expectancy at birth increased from 32 years to 65 years. Moreover, the literacy rate grew from 18% to 65% of the population (Nayyar, 2006).

However, at present there is growing consensus that the post-liberalization years in India, commencing in 1991, are witnessing a slowing down in progress on social indicators even as dramatic increments in economic output occur. While the specifics of measuring poverty and deprivation for this period remain a bit muddled (see discussion by Dreze & Sen, 2002), these authors reveal that improvements in many critical social indicators had slowed down during the 1990s. This has led to a conclusion among some that economic growth has not been adequately transformed into conditions of wider well-being for many people in India (e.g., Dreze & Sen, 2002; Nayyar, 2006).

It appears that a roughly similar phenomenon also had been manifested in the past, in the first two decades after independence. At that time, however, the failure was in transforming overall respectable economic growth into an alleviation of income poverty. For example, the percentage of the population living below the poverty line grew from 45% in 1951-1952 to a peak of over 56% in the mid-1960s.

The persistence of deep-seated inequality in wealth has been acknowledged by the Government of India, with the result that its latest Five Year Plan (the 11th Plan, covering the period 2007-2012) endorses the theme of growth with equity—"inclusive growth" (Planning Commission, 2008). Toward this end, the Report of the Expert Committee on Integrated Energy Policy (Planning Commission, 2006), commissioned by the Planning Commission of the Government of India, commences with the condition that "India needs to sustain an 8% to 10% economic growth rate over the next 25 years, if it is to eradicate poverty and meet its human development goals" (Planning Commission, 2006 p. xiii).

Within this overarching constraint of required economic growth rates, the planning commission uses assumptions and data that project installed electricity generation capacity in 2031 to be in the range of 778 to 960 GW, with corresponding per capita electricity consumption in the range of about 2,500 to 3,000 kWh per year (Planning Commission, 2006). In terms of primary energy supply scenarios

and fuel mix, the document also presents a set of 11 scenarios with the caveat that "they are designed to map out extreme points of feasible options and none of them should be looked upon as a preferred scenario" (Planning Commission, 2006, p. 40). In terms of total primary energy requirement by 2031, these scenarios range from over 1,500 to about 1,900 million tons of oil equivalent (Mtoe), approximating 1,250 kgoe per capita, for realizing an 8% economic growth rate in the intervening years.

The role of fossil fuels within the projected fuel mix for energy supply in 2031 is dominant in all the scenarios, ranging from a low of more than 70% to a high of more than 85% of primary energy. Nuclear source is projected to supply 4% to 6% (or 76-98 Mtoe) energy and renewable energy is expected to increase from 0.1% to more than 5.5% (or 2-87 Mtoe). And finally, noncommercial energy remains unchanged and continues to account for about 10% to 12% of total energy in all the scenarios (Planning Commission, 2006). While the projected contribution of nuclear power in 2031 appears modest, this energy source has been actively pursued in India as part of a long-term strategy purportedly for economic development, energy security and, more recently, as a response to climate change. This situation is discussed in greater detail below.

The Political Economy of Nuclear Power in India

In 1948, Jawaharlal Nehru, India's first and longest-serving prime minister, addressed the Constituent Assembly of India during the course of a legislative debate on whether to institute nuclear power. Often called the architect of modern India, Nehru stated, "The point I should like the House to consider is this, that if we are to remain abreast in the world as a nation which keeps ahead of things, we must develop this atomic energy" (cited in Perkovich, 1999, p. 20).

Contained within Nehru's view is an important peg that has bolstered and sustained the enthusiasm to institutionalize and exploit nuclear energy in India. As suggested by Adas (1989) in the eloquently titled book, *Machines as the Measure of Men,* the history of Western dominance—and the reaction to it in many postcolonial societies such as India—has been molded by the attitude that science and technology[1] are the preeminent currencies of modernity, well-being, civilization, prestige, and power in geopolitics. That the spectacularly forceful pursuit of nuclear energy in India embodies this theme is borne out by documentary narratives of the history of nuclear power in the country (see, for example, Abraham, 1998; Perkovich, 1999; Pathak, 1980; Sharma, 1983, 1986).

Less than a year after independence, the Government of India enacted the Atomic Energy Act in 1948, which authorized the creation of the Atomic Energy Commission (AEC). At its inception and during the early decades of the AEC's operation, the institutionalization of nuclear energy in India appears to have been under the personal control of two individuals, that is, Prime Minister Nehru and the first chairman of India's AEC, Dr. Homi J. Bhabha. Reflecting this arrangement, Sharma (1983, p. 18) refers to this phase (1948-1966) of nuclear development in India as the "personalized policy of Bhabha and Nehru".

As India's nuclear program expanded, attracting a larger set of key scientists and engineers, the Atomic Energy Act of 1948 was revised in 1962 to further centralize executive power and secrecy. The government steamrolled the revised act through parliament, with the normal parliamentary protocol for such matters effectively sidestepped even as a total of 4 hours were allocated for an unscheduled debate on the revised legislation's provisions (Abraham, 1998).

The act had the impact of placing everything related to atomic energy within the purview of the central government. The act also dismissed petitions for consultation with Indian states in regards to the mining of raw materials or any other matter. The legislation further vested unprecedented executive and financial powers in the chairman of the AEC along with far-reaching discretionary powers to declare any information pertaining to nuclear energy as restricted. During the debate leading up to the revised act's passage, one member of parliament complained that the range of new powers being vested with the AEC "could only be based on the laws of 'Fascist Germany'" (Abraham, 1998, p. 117; Sharma, 1983).

While today the full intent of India's nuclear program is explicit, the early decades were marked by official dismissal, initially, and later, favorable ambiguity regarding the use of this technology to make weapons. However, what remained preeminent throughout this period was nuclear energy's purported indispensability, as espoused by its supporters, for fuelling economic development. This position was consistent with the original views of Bhabha and Nehru on the ideal relationship between economic development and energy policy.

The understanding of economic development internalized by both Nehru and Bhabha accords it the

status of an independent variable, exogenous to the context of society and ecology and characterized inherently by the need to realize overabundance. Prime minister Nehru set the stage in this regard by noting that "the application of nuclear energy to peaceful and constructive purposes has opened limitless possibilities for human development, prosperity and *overabundance*" (as quoted by Perkovich, 1999, p. 15; italics added).

And Bhabha, for his part, reasoned that all countries of the world would eventually come to consume energy at the same rate as the United States, which according to Bhabha accounted for 37% of total world energy consumption in 1950. He endorsed this state of affairs by noting that the "standard of living in industrially advanced countries is rising, and, we hope, will continue to rise." Turning to the rest of the world, he offered that "for the full industrialization of the underdeveloped countries, *for the continuation of our civilization* and its further development, atomic energy is not merely an aid; *it is an absolute necessity*" (Bhabha, 1955, p. 126; italics added).

The contemporary discussion on the role of nuclear power in India has retained this enthusiasm even though nuclear power generation has not reflected a commensurate level of achievement. This is despite the steadfast political and financial support for the Department of Atomic Energy (DAE) provided by the Government of India. For instance, in the late 1950s DAE was the recipient of nearly a quarter of the country's budget for science and technology, and in 2005-2006, the DAE's budget was $1.2 billion. In comparison, the Ministry of New and Renewable Energy (MNRE) received $87 million. Notwithstanding this highly preferential treatment, India's nuclear establishment has failed to meet its own goals. For instance, against a projected capacity of more than 43 GW by the year 2000, the DAE has so far managed around 4 GW (Ramana, 2007). Nevertheless, enthusiasm continues unabated and optimistic projections suggest that 63 GW of nuclear energy capacity will be installed by 2030, climbing to more than 275 GW by 2050, if the required uranium can be imported (Planning Commission, 2006).

While India has limited uranium resources, the country retains about a quarter of the world's thorium reserves, a heavy metal that can be transmuted into the radioactive isotope uranium-233. This endowment is the basis for India's three-stage nuclear program, originally articulated by Bhabha in 1954 during India's First Atomic Energy Conference. The first stage of nuclear development, which accounts for all the reactors in the country today, has been fueled by uranium with a projected capacity of supporting about 10 GW of installed capacity. The second stage, which is just commencing, relies on fast breeder reactors (FBRs) fuelled by plutonium, extracted by reprocessing the spent fuel in the first stage, and uranium and thorium to produce more plutonium and uranium-233. It is estimated that the FBR technology at maturity will have the potential to support 500 GW of installed capacity in India. The third stage is based on thorium. As alluded to above, the transmutation of thorium into its radioactive isotope (U-233) is to be accomplished by exposing thorium to neutrons when placed inside the second-stage breeder reactors. The energy potential of this technology is recorded by the IEP as very large, even in relation to the 500 GW projected for second-stage FBR technology (Planning Commission, 2006). The overabundance of this technocratic vision for economic development, where the production of more and more energy is realized, is striking.

Yet even despite such enthusiasm for the potential of nuclear energy to serve India's development goals, it is widely recognized that nuclear technology has failed to furnish convincing answers to a range of questions about the consequences of its propagation (see, for example, Byrne & Hoffman, 1996; Coplan, 2008; Clapp, 2005; Ramana & Reddy, 2003; Ramana & Suchitra, 2006; Sustainable Development Commission [SDC], 2006). These include its implications for national security, nuclear weapons proliferation, public health, safety, radioactive waste disposal, and the distribution of the risks involved, and also its purported ability to help mitigate climate change. While critical to assessing the real benefits and costs of reliance on this energy source, such issues are outside the main focus of the present article. Instead, we inquire more into the consequences of this technocratic notion of unbounded energy abundance (epitomized in the nuclear energy discourse) that is situated at the intersection of economic development and energy policy discussions in India today.

Byrne and Rich (1986) coined the phrase *in search of the abundant energy machine*[2] to depict the motivation of energy research and development efforts in the post–World War II United States. They offer that this search was inspired and made possible by a confluence of three factors, namely, the war effort to develop the atomic bomb, the entrenched myth that the level of civilization is proportional to the amount of energy consumed, and that the energy problem is first and

foremost a technical problem in the sense that social and political considerations are by and large extraneous.

We briefly situate these factors in the context of India's nuclear program and discuss their consequences for the discourse on economic development, energy policy, and responses to the energy-environment crisis.

It is instructive that despite the fact that India's nuclear program was not conceived with the immediate goal to devise an atomic bomb, the institutional and ideological support structure delineated above by Byrne and Rich (1986) in the context of the United States, seems to have been largely reproduced in the case of India too—as was the bomb, eventually. This is perhaps an affirmation of a tendency inherent to technique that Ellul (1964, p. 141) identified as follows:

> Indeed, independently of the objectives that man pretends to assign to any given technical means, that means always conceals in itself a finality which cannot be evaded . . . if the technique in question is not exactly adapted to a proposed human end, and if an individual pretends that he is adapting the technique to this end, it is generally quickly evident that it is the end which is being modified not the technique.

Ellul (1964, p. 142) notes, "Technique does not accept the existence of rules outside itself, or of any norm. Still less will it accept any judgment upon it. As a consequence, no matter where it penetrates, what it does is permitted, lawful, justified."

Thus, as noted in the previous section, the centralization, secrecy, and unprecedented assemblage of big science and technology under the control of the Indian AEC are reminiscent of the organization of the Manhattan Project (see Martinez & Byrne, 1996) and have been largely accepted as necessary even in a country with deep democratic tendencies (see, for example, Sen, 2005). But it appears that the Indian AEC actually went a step further than its U.S. counterparts in these respects. In the case of the United States, the making of the atom bomb brought together three of its most powerful institutions (corporations, research universities, and the military). In the case of India, the AEC essentially assembled the functions of the corporation and research university within itself. To this end, the DAE was constituted as the executive arm of the AEC, and it has spawned a vast, well-funded, tightly knit, and closely guarded network of organizations focused singularly on nuclear education, research, and fabrication. Moreover, these activities are completely isolated from any kind of interaction with broader Indian society.[3] Thus, Gopalakrishnan (2002) notes,

> The nuclear establishment in India, which handles both the civilian and military aspects of nuclear power, is a very powerful entity with direct access to the highest levels of government. Its recommendations on policy and projects are often unquestioned by decision makers, and the establishment has its own rationale of why their present policies are the right ones. (p. 391)

Second, as seen above, the opinions voiced by both Bhabha and Nehru with regard to development and progress asserted that, qualitatively, a civilization was better in proportion to the level of energy consumed by its members.[4] As a consequence, the growing use of nuclear energy was perceived as an absolute necessity to facilitate the betterment of the people of India. To this extent, the Indian atomic energy program and its understanding of its interaction with economic development mirror the views held about progress in the United States, where the pursuit of the "peaceful atom" was instituted as standard energy policy.

Finally, it appears that decision makers in India conceive of the dynamics of energy policy and economic development, and the relationship between the two, in largely technocratic terms. Thus, the Planning Commission of India decides on the appropriate level of economic growth required to remove poverty, and energy policy follows by assembling the technological infrastructure to fuel this level of growth. The present targets, according to the Planning Commission, are 8% to 10% growth in GDP over the next 25 years. Given this required level of economic activity, it is noted that the power sector has to grow by 7 to 8 fold, and much of this growth is to be realized through the rapid expansion of the existing centralized architecture of the power system (Planning Commission, 2006).

The Need for New Directions

As noted above, the average per capita energy consumption in India is modest in comparison to the global average and is substantially lower than that in OECD (Organization for Economic Cooperation and Development) countries. To the extent this situation is reflected in unmet energy services in India, there is a strong ethical and practical case to be made for the availability of more energy supply in the country. But this argument should not be used as a blind endorsement for urgently privileging the existing architecture of the energy system, its technologies, and the conception of economic development inherent in them. There are a number reasons that suggest that less industrialized

countries need to chart a new course, even as industrialized countries grapple with the enormous ecological debt of their historical and extant model of economic organization.

The present dominant energy system is characterized by deep-seated inequality in terms of the consumption of energy resources and distribution of its negative impacts. If we look to CO_2 emissions as a prominent manifestation of the energy-environment crisis, this global inequality has been recognized for a long time (see, for example, Agarwal & Narain, 1991, Kahrl & Roland-Holst, 2007). However, an acknowledgment is also emerging as regards such inequalities within national boundaries. A recent study documented the stark stratification of CO_2 emissions in India, as differentiated along household income. While the overall per capita emission in India is about 1.7 tonnes of CO_2, the corresponding value for the richest 1% of the population (about 10 million people) is already 5 tonnes of CO_2 per capita. Yet both the global and national elite are likely to be better buffered from the immediate consequences of climate change (Ananthapadmanabhan et al., 2007).

It is in this context that the conventional energy discourse offers nuclear power as a response to climate change. However, as Byrne et al. (2007, p. 4557) argue there is no empirical evidence to suggest that the greater use of nuclear power "effectively reduces national CO_2 emissions." They offer that this trend is driven by two factors. First, apart from electricity generation, a significant source of CO_2 emissions is the transportation sector, where the role of electricity is limited. Second, they offer that the economic viability of nuclear power depends on a sustained increase in electricity consumption over the 30- to 50-year life of the plant. As such, the political economy of societies with such energy systems is likely to privilege energy-intensive modes of development and a supply-oriented approach to energy policy. Indeed, based on data for Japan, Takagi (1997, cited in Byrne et al., 2007) found that the increase in nuclear power capacity had actually gone hand in hand with growth in CO_2 emissions.

Overall, the existing energy system is characterized by an inability to resolve its ecological impacts. Indeed, in the context of the OECD countries, Wilhite and Norgard (2004) offered that these industrialized countries cannot meet the challenge by merely pursuing technical options such as efficiency in place of realizing significant curbs on their energy use, a novel challenge for the architecture of the existing energy system and, more broadly, the conventional discourse on economic development and energy policy. Thus, even as India seeks to meet the demand for unmet energy services, its choices should avoid the possibility of lock-in through the use of technologies that tend to predispose social arrangements toward high-energy and material throughput.

Hawley (1978) offered that "tools and organization are two sides of the same coin. Technology is nothing more or less than the instrumental aspect of culture." As such, the question needs to be asked, how capable is nuclear energy of responding to the needs of the vast majority of Indians? Will a further prioritization of the privileged technocratic possibility of overabundance in the discourse on economic development and energy policy meet the imperatives of alleviating India's deep social and economic inequality? Can it improve the well-being of India's people while addressing the energy-environment crisis? Or, does this approach merely envision the transformation of India into another mass consumption society, similar to those that have ushered in the present energy-environment crisis, and thereby continuing the inequality now deepened by the degradation of ecologies?

The extreme secrecy and absence of the scope for public engagement with India's nuclear energy establishment does not bode well for a socially and ecologically sound response to these questions. Gopalakrishnan (2002) noted that the DAE fears "an open debate of the economics and safety of nuclear power in India at this stage might stunt the DAE's ambitious plans for growth." However, if technology may be considered an instrumental aspect of culture, as Hawley (1978) offered, any possibility of culture informing the choice of technique has been obviated by the extreme secrecy surrounding nuclear power in India's energy policy. For instance, if India's population is considered, the only segment that appears to have influenced the current course for pursuing nuclear power seems to be the small upper-income brackets of Indian society, who in turn have seemingly internalized the culture of energy overabundance.

As such it seems that the Indian government is likely to allow openness on the issues of nuclear energy, when Indian culture fully comes to realize its embrace of overabundance. But this might be too late, for, as noted above, even nuclear power's purported green abundance appears incapable of resolving the challenge posed by climate change to the world's mass consumption societies.

What this political economy effectively bolsters is an energy, development, and environmental policy

discourse within India that excludes the insights and agency of a vast majority of Indians on these issues. It is based on the assumption that overabundance of energy is imperative to facilitate well-being and the continuation of civilization. As such the only possibilities for economic development and energy policy visible to India's policy makers appears to be those pursued historically by the world's industrialized countries.[5]

Scarcely any attention is paid to the lessons offered by Indians whose lifestyles and livelihoods do not require energy and material overabundance. Assuming a Rostowian linearity to social change, the benefits of such social arrangements are completely discounted. Instead, the problems facing them not only remain unaddressed, but also are readily seen as grounds to discard them completely in favor of pursuing the ideal of a highly mass consumption–oriented society. This sizable population of Indians is presumed to not have a contribution in shaping the objectives of economic development and energy policy in India. It is assumed that their well-being and attendant energy services can only be enabled by a nuclear-powered state seeking to recreate the ecologically catastrophic model of economic development realized in the industrialized societies.

In Search of New Directions

Outside this dominant political economy, alternative formulations of the technology-environment-development dynamic have been put forward for some time. Perhaps it is Gandhi who realized the critical need for a choice of technique in the context of culture and who asserted that the installed technique should first redress inequality, not further it (Ghatak, 1988). His insights about development, with deep consequences for energy policy, have been categorized by Ghatak (1988) as follows: (a) the whole village development experiment, (b) a basic-needs approach to development, (c) growth with redistribution, and (d) choice of appropriate technique.

Building on these themes, a notable illustration of an alternative approach in the field of energy, environment, and development comes from the work of Dr. Amulya Reddy. As part of the now much-acclaimed DEFENDUS (development focused, end-use oriented, service-directed) approach, Reddy et al. (1995a, 1995b) build on the premise that energy planning first and foremost has to be informed by a context-based normative discussion of the desired ends (translated into energy services) to be achieved. Once this level of introspection has been accomplished, demand scenarios are then created. These scenarios entail attention to the energy resources (including savings from efficiency and conservation) available to the entity being planned for namely, the village, town, province, or nation. And finally, a comparative cost assessment of energy from these various sources must be undertaken, taking special care to compare comparable costs.[6]

A comparison of the energy plans for the state of Karnataka, with one of these devised using the DEFENDUS approach, is illustrative. The DEFENDUS plan realizes certain ends identified as development priorities for the state, such as electrifying all homes, energizing all agricultural irrigation pumps, and supplying electricity to low-tension loads in small-scale industries.[7] Further, the DEFENDUS plan achieves these goals using only 38% of the electricity projected to be needed under the government's official generation scenario, which does not even seek to realize the development goals noted above (Reddy, 1990). It turns out that 59% of the savings realized by DEFENDUS can be attributed to defining the development focus in concrete terms (instead of extrapolating from previous trends, without a basis in goals), while 41% can be attributed to efficiency improvements.

Even while the DEFENDUS approach is striking in its elegance and for its insight into energy planning, it appears that at least two additional strategies can be utilized to extend its innovative impact. First, as discussed above, energy planning commences with a normative exercise inquiring into the appropriate ends for the entity being planned for. In this regard, an outline is presented here of the capability approach to human development, which is intended to serve as an appropriate framework to guide and perhaps improve the normative process of discerning desired ends being sought through economic development.

Second, the least-cost–planning approach used by DEFENDUS can be enhanced to more systematically realize a fundamental transformation in the organization of the energy infrastructure, and thereby economic development, from one that is currently top down and centralized to one that is potentially more democratic.

Development as Freedom

A distinctive feature of the capability approach to human development is that it regards economic development as the expansion of valuable human

freedoms or capabilities, rather than simple expansion of per capita income, commodity ownership, or resource use as offered from a utilitarian perspective (Alkire, 2002; Sen, 1999). In this regard, the capability approach provides a framework that redefines economic development so as to extract it from association with overabundance or maintaining our civilization, in ways otherwise offered in India and the world over to justify the recent history of centralized and profligate energy policy. This insight also is offered here in support of this article's efforts to utilize the capability approach as a contribution to the DEFENDUS approach.

The capability approach conceptualizes development as the expansion of freedoms that people enjoy *to do* and *to be* what they value. In this way, the capability approach contributes greatly to situating the discourse on economic development in a process of exploring and deliberating upon values and valuable ends, instead of the top-down conventional emphasis on surrogates of well-being. This possibility is well suited to the normative assessment of ends already contained within DEFENDUS. Thus, while per capita income or economic growth or resource use, the conventional measures of the economic system and human well-being, remain relevant, they are important only insofar as they are means toward valuable ends. This clarification helps temper the importance of surrogate measures of well-being and makes available critical opportunities to address the energy-environment crisis. For instance, considering the case of nuclear power, a reliance on insights from the capability approach can allow energy policy to be extricated from the constraints embedded in the presumed nonnegotiability of economic development's parity with notions such as overabundance. Sachs (1999) aptly articulated this Gordian knot as follows:

> The rambling development creed impedes any serious public debate on the moderation of growth. Under its shadow, any society that decides, at least in some areas, not to go beyond certain levels of commodity-intensity, technical performance or speed appears to be backward. (p. 42)

As the capability approach offers, the ends being sought by individuals are not necessarily a particular level of commodity-intensity or technical performance; these are only means. Instead, the ends being sought are valued *doings* and *beings*. Furthermore, the relationship between commodities (means) and capabilities (ends) is mediated in a variety of ways that broadly reflect the diversity of human conditions (Sen, 1987). As such the presumed imperative for a particular rate of economic growth, energy use, or technology dissemination, to realize a desired outcome, is not something set in stone.

This opening-up of the meaning and process of economic development, enabled by the idea of "Development as Freedom," creates a space in which to foster public debate on the goals and implementation of economic development, energy policy, and the relationship between the two. No longer is the goal of energy policy or economic development merely the maximization of economic growth at all costs. The conception of well-being as the expansion of valuable freedoms for being and doing is quite possibly the widest casting of the idea. This makes it adaptable to the diversity of contexts that characterize human beings and their communities, to include India but also nations and regions throughout the globe.

Conclusion: The SEU as a Conceptual Synthesis and Practical Alternative

As discussed above, nuclear power is faced with many shortcomings that carry important consequences, if one is concerned with the achievement of socially just and ecologically viable energy and development policies. To recap, these shortcomings include the following:

1. The nuclear energy establishment is characterized by extreme levels of centralization, secrecy, and isolation from society at large.
2. The entrenchment of nuclear power as energy policy was in large measure affected by the presumption that overabundance is essential for progress and the continuation of civilization, as well as humbler pursuits such as viable economic arrangements.
3. The institutionalization of nuclear power as energy policy helps reduce the deliberations on energy policy and human well-being to narrowly technocratic terms.

Devising a response to the energy-environment crisis requires in some measure a cultural context that is conducive to this outcome (Byrne & Toly, 2006). Using the illustration of climate change, we have discussed above that a cultural milieu of mass consumption, even if it is one powered by green nuclear power, appears incapable of realizing ecological viability. As such, a key learning from our discussions, using the observation by Hawley (1978) that "technology is

nothing more or less than the instrumental aspect of culture," is that the choice of technique as made by a society must reflect desired cultural milieus.

A cultural milieu capable of responding to the energy-environment crisis, it appears, has to be one that is not predisposed to overabundance as a central organizational goal. As such, it must also be a milieu that is capable of deliberating upon its economic development goals. As seen above, the DEFENDUS approach to energy planning and insights from the capability approach for economic development emerge as mutually reinforcing alternatives to business-as-usual energy planning. The DEFENDUS approach is premised on situating the process of energy planning within a normative process of ascertaining ends, while the capability approach offers a more formal and "philosophically more rigorous way" of informing deliberations and selection of ends (Alkire, 2002, p. 167).

Even so, the question of how to install an energy infrastructure reflective of these attributes is yet to be answered. While DEFENDUS and the capability approaches make beneficial contributions by favorably shaping alternatives to energy planning and the discourse on economic development, the ultimate realization of a transition in energy infrastructure still requires action for practical change.

In this vein, Byrne and Rich (1983, pp. 146-148) noted, "An energy transition hinges upon whether our energy choices include alternatives to conventional sources as systematic options," and cautioned,

> The next energy transition will fail to materialize without *changes in political economy* [italics added] comparable to those which accompanied each of the previous transitions. Without such changes some new options may be exploited, but the principal opportunities offered by a new energy future will be foregone. For the most part, options would be limited to those which can be easily absorbed within a primary system of centralized energy production and distribution.

The SEU, recently legislated into law in the United States in the state of Delaware and in Washington D.C., presents a meaningful alternative to the status quo that can help realize a new energy transition by privileging energy efficiency and customer-sited renewables. It is noted in SEU (2007):

> The most important feature of the SEU is that energy users can build a relationship with a single organization whose direct interest is to help residents and businesses *use less energy* and *generate their own energy cleanly.* Directly put, the SEU becomes the point-of-contact for efficiency and self-generation in the same way that conventional utilities are the point of contact for energy supply. (p. 2, italics in original)

As such the SEU offers a systematic approach to incentivize energy efficiency as well as customer-sited renewable technologies. Integrated with the energy market, the SEU works to shift the political economy of energy in favor of reducing conventional energy use and boosting self-harvesting of renewable energy.

Thus, in contrast to the centralized and socially isolated infrastructure and institutionalization of nuclear power, the SEU allows for an arrangement of the energy system that is deeply intertwined with society and capable of interfacing with normative deliberations regarding desired ends. In short, it offers the possibility for a cultural milieu diametrically opposed to that required for the viability of nuclear power and, as such, offers the elements of an energy system capable of responding to the energy-environment crisis.

A fundamental challenge to the popularity of renewable energy and energy efficiency is the upfront capital investment required, even while the fuel and operational expenses are either free or negligible. In response, the SEU incorporates a mechanism to help finance the initial investments required to make the transition to either customer-sited renewables and/or energy efficiency, across all sectors of the economy and all fuels, in the jurisdictions where it has been legislated into law. Simply put, using capital from sources such as municipal bonds, the SEU can provide the initial funding for renewable energy and energy-efficiency investments. It then recoups its investment through a shared-savings mechanism, wherein the customer shares a portion of the money saved from the reduced or discontinued purchase of energy from the conventional utility (SEU, 2007).

There is much promise in the possibility of adapting the SEU model to the Indian context. At a thematic level, the SEU embodies an approach to organizing the energy infrastructure that has been informed by fundamental critiques of modernity in light of its ecological and social impacts. To wit, it represents the results of much learning about the consequences of industrialization and modernity as observed in a country, for example, the United States, grappling with the ecological and social consequences of its economic arrangement. In this respect, even as the process of industrialization gathers momentum in India, the use of an SEU-type model, one that

encapsulates learning approaches refined in already highly industrialized settings, could allow India to sidestep its deleterious consequences through a genuinely useful process of leapfrogging.

Separately, at a practical level, as demonstrated by Reddy (1990) in the case of Karnataka, the gains to be had from energy efficiency are themselves significant. Also, in terms of renewable energy endowments, specifically solar power, the Indian subcontinent offers very favorable conditions for energy harvesting (see, for example, de Vries et al., 2007). What is needed here is some way to overcome the considerable existing difficulties to the initial capital investments required to realize their benefits, an area in which an SEU approach could in turn prove quite useful.

And finally, even the largely ad hoc attempts at encouraging renewables and energy efficiency in India have yielded noteworthy results (see, for example, Usher & Touhami, 2006). A systematic institution to further these possibilities, such as that embedded in the SEU approach, with due diligence to fit the various local contexts of India, can be a promising method by which to design and deliver energy models that meet the needs of Indians safely, affordably, and equitably.

Notes

1. The impacts of the energy system fueling the process of economic development have surpassed the ecosystem's ability to neutralize their biophysical effects and maintain conditions favorable for the sustenance of a lifeworld suitable to many of the societies, cultures, and species on Earth. This persistent situation of drastically altered biophysical and geophysical trends and accompanying pervasive social injustices impelled by the process of economic development is recognized as our energy-environment crisis.

2. The reference here is to a model of European science and technology. As Dharampal (1971, quoted in Alvares, 1991, p. 46) noted, "The sciences and technologies of the non-European world had different seekings and developments to those of Europe" and did not seek to be "unnecessarily gigantic and grandiose." Referring specifically to India, Dharampal offers, "Smallness and simplicity [was] in tune with their more decentralist politics [and] . . . was in fact due to social and political maturity. . . ."

3. They explain that the abundant energy machine is a machine that "would sustain the availability of cheap energy supplies delivered by large-scale centralized institutions in a manner responsive to the demands of a high-consumption society. The prototype has been and remains nuclear power" (1986, p. 141).

4. See Ramana (2005) and Gopalakrishnan (2002) for details of the centralization and secrecy of the nuclear establishment in India.

5. See Basalla (1980) for a fuller discussion on the theme of equating energy consumption with notions of such as the quality of a civilization and progress.

6. Scarcely any attention is given to the ecological and social excesses of this economic arrangement. In this vein what is ignored, quite paradoxically by India, is the fact that this mode of economic development, based on the ideal of a "high mass-consumption society" (Rostow, 1960) was established in large measure through the colonial exploitation of societies and ecologies across the world (see, for example, Onimode, 1988).

7. For instance, if one is comparing the cost of delivered electricity, then the distinction between centralized generators (which incur substantial costs in terms of storage, transmission, and distribution) and distributed generators (which do not incur such costs) must be included to make it a fair comparison.

8. The Ministry of Micro, Small, and Medium Enterprises of the Government of India notes that such enterprises are an accepted engine of economic growth with a potential to promote equitable development. Indeed, the Ministry estimates that the labor intensity of such enterprises is 4 times higher than large enterprises, making it ideally suited for a country with abundant labor supply.

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