Chapter 1

The Ideology of Progress and the Globalization of Nuclear Power

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Introduction

As an energy source, nuclear power was not technologically feasible nor economically viable when it was embraced by the U.S. in 1946. It did not originate as an invention of enterprise, nor was there a market for its supply. In fact, the U.S. committed itself to the development of the "peaceful atom" 11 years before it would be successfully demonstrated. The national government sought to discover the advantages of the technology and to discount its costs in the *absence* of knowledge of its economic or technical practicality. When Lewis Strauss, a former chairman of the U.S. Atomic Energy Commission (AEC), announced that nuclear power would bring forward an energy supply "too cheap to meter," he signaled that, for this technology, social desirability would be decided in advance of performance, since his declaration of nuclear energy's economicalness was 17 years before the opening of the first commercial reactor (Byrne and Rich, 1986).

Despite the catastrophic accident at Chernobyl in 1986, the near meltdown at Three Mile Island in 1979, over 200 "precursors" to core meltdown accidents in the brief period of the technology's commercial use (Adato, et al, 1987), and an industrial history worldwide of massive cost overruns, nuclear power continues to be evaluated in the "future tense",[1] that is, in terms of what it will bring rather than what it has already wrought or what it requires from society to maintain operation. While enthusiasm is expressed more modestly today than in the heyday of its early promotion, support for nuclear power remains strong in several quarters despite its authoritarian politics, its failed economics and its dubious performance history. Thus, Mr. Ryo Ikegame, executive vice president of Tokyo Electric Power Company, one of the largest electric utilities in the world, recently offered this assessment of nuclear power in the only country that has suffered a nuclear attack (Taylor, July 1992: 32):

> [I]t rained after Chernobyl, and now it's cloudy — but we can see the sunny part of the sky. I'm rather optimistic about the future of nuclear power plants, because Japan has no oil, no coal, no gas — so we have to depend on nuclear, and this is good for the environment.

Nuclear development plans for Japan reflect this belief: over the next twenty years, Japan intends to add 38 more nuclear plants to its existing stock of 49 (for a total nuclear capacity of 40 GWe); 5 of these plants are already under construction and will begin operation by 1997 (*Nuclear News*, August 1992: 60-61; March, 1995: 32-33; June, 1995: 40). Japan is not alone in its commitment to nuclear power: as of December 1994, 66 nuclear plants are under construction or on order in 19 countries, the majority of which are scheduled for completion by the year 2001 (*Nuclear News*, March, 1995: 27-42).

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1 This phrase is borrowed from David Noble, 1983.

Below we examine the continuing worldwide momentum for nuclear power development. It is argued that support for nuclear power is embedded in first, the modernist ideology of progress that equates economic growth and technological power with social success; and second, the "nuclear consortium" — comprised of the state, military, science and industrial apparatuses — which must be integrated in order to develop nuclear technology (Camilleri, 1984; Byrne, Hoffman and Martinez, 1989). Together the modernist ideology of progress and the nuclear consortium are argued to constitute a political economy of "technological authoritarianism" (Byrne and Hoffman, 1988). This political economy has been institutionalized in the core industrial countries and is now being "transferred" to the periphery and semi-periphery countries of the Third World.

Nuclear Power and the Industrial Idea of Progress: The Case of the U.S.

Since industrialization, Western ideas of progress have equated social success with national wealth and scientific and technological prowess (Mumford, 1934). In this equation, energy has had a central role. Indeed, a routine assumption of industrial societies throughout the 20th century has been that higher energy consumption directly corresponds with higher orders of civilizations. As Aldous Huxley remarked, "because we use a hundred and ten times as much coal as our ancestors, we believe ourselves a hundred and ten times better intellectually, morally and spiritually" (in Basalla, 1980: 40). Basalla (1980) coined this idea of progress "the energy-civilization equation."

Not only more energy but more sophisticated technologies to produce, distribute and use energy are prized in the energy-civilization equation. In this vein, electric power plants have held special status as the highest stage of development yet achieved by Western civilization to realize the goal of cheap and abundant energy. Power plants are the ideal "abundant energy machines"

(Byrne and Rich, 1986) and in the energy-civilization hierarchy, nuclear power has been touted by many as the most advanced of our energy machines. William Laurence, an early American nuclear propagandist, captured the modernist attraction to the technology when he characterized atomic energy as a "veritable Prometheus bringing to man a new form of Olympic fire" (1940: 12-13) that would deliver "wealth and leisure and spiritual satisfaction in such abundance as to eliminate forever any reason for one nation to covet the wealth of another" (1959: 240). Weinberg echoed this sentiment when he branded nuclear power "a marvelous new kind of fire" (1972: 28) capable of providing "the solution to one of mankind's profoundest shortages" (1956: 299).

Virtually all industrial countries have actively pursued nuclear power programs in the latter half of the 20th century in the hope of securing a bountiful energy future. The U.S. has the longest running commitment to the nuclear dream and has built more domestic nuclear capacity and exported more nuclear plants than any other country in the world. Its nearly 50 years of experience with the technology, however, has hardly been problem-free. American nuclear "troubles" include a long list of accidents, unresolved waste disposal problems, the irradiation of Native American communities and lands, plant workers and neighborhoods adjacent to nuclear facilities, and never-met promises of low-cost energy supply (Carter, 1987; Byrne, Hoffman and Martinez, 1992; Gilles, this volume).

Perhaps the most telling evidence of nuclear's appeal to U.S. science and business elites is the enduring commitment to build and operate a nuclear complex in the country's Pacific Northwest. The history of the Washington Public Power Supply System illustrates the staying power of the nuclear idea of progress in the face of overwhelming evidence of failure. During the mid-1950s, the Pacific Northwest was presented with a "future-tense" crisis: the possibility of restrictions on the economic growth of the region conditioned by a lack of energy resources. Home to some of the world's largest hydroelectric dams operated by an integrated system of region-wide management, the area nonetheless enthusiastically embraced nuclear power as the proposed solution to this dubious dilemma. The region's nuclear dream was articulated in the so-called Hydro-Thermal Power Plan (HTPP) adopted in 1968 by a consortium of 108 investor-owned and public utilities located in six states in the Pacific Northwest. The HTPP proposed to add 41,400 megawatts of hydro- and thermal power — including 20 new nuclear power plants. It was a spectacular vision of energy abundance justified in appropriately fervid terms: "Increased use of electricity has contributed importantly to the emancipation of peoples from poverty and drudgery and to expansion in human capacity to live the good life . . . [T]o expand these benefits to a larger segment of our society will require more electricity" (quoted in Olson, 1982: 19).

A few years later the technology's advocates were forced to temper their dreams but by the early 1970s the Washington Public Power Supply System (WPPSS) nonetheless found itself trying to manage the simultaneous construction of five nuclear plants. As so often has been the case with nuclear projects, things did not proceed according to plan, even though premier engineering and financial companies managed WPPSS. For the project, Bechtel and the "Big Four" reactor vendors — General Electric, Westinghouse, Babock and Wilcox and Combustion Engineering — were responsible for the design and construction of the five plants, while Merrill Lynch, Paine Webber, Solomon Brothers and Blythe Eastman Dillon managed the financial transactions (Byrne and Hoffman, 1992). Despite this impressive gathering of engineering and financial acumen, on January 22, 1982, construction was terminated on two of the five plants and by 1983, two other plants had been mothballed. Only one plant, with a rated capacity of 1,154 MWe was ever completed. All told, the System defaulted on municipal bonds representing $6.7 billion in principal and some $23.8 billion in interest. This represents, by the far, the largest default in the history of the American municipal bond market. The System collected over 30 years of construction delays while completing only one plant capable of delivering continuous electric power to the region. According to estimates made in the late 1980s, the WPPSS plants have been largely responsible for the region's 700 percent increase in wholesale power rates and 250 percent increase in household electric rates (Comptroller General, 1984: 7; Northwest Power Planning Council, 1988: 2).

Despite this record, the region's energy planners persisted in their favorable treatment of nuclear power. The 1986 Northwest Conservation and Electric Power Plan, for instance, argued that WPPSS Nuclear Plants 1 and 3 could still be completed, providing the region with some $630 million worth of net benefits; these presumed social benefits, were, of course, contingent upon the commitment of a $2.8 billion investment to complete the plants. Only very recently have these same planners accepted the fact that nuclear power will not constitute a major source of new energy for the region. Thus, on May 13, 1994, the System's managers voted to terminate WNP-1 and 3 effective January 13, 1995. Yet, even at this stage in a long history of failure, some in the System are trying to salvage the technology. In a proposal that underscores the arbitrariness of the distinction between military and civilian uses of the atom, the WPPSS Board of Directors are hoping that the plants will find useful lives as reactors used to burn excess weapons-grade plutonium (*Nuclear News,* June, 1994:20):

> WPPSS has proposed a plan in which WNP-1 and the operating WNP-2, both at Hanford, Washington, would be converted to a mixed-oxide fuel of uranium and plutonium in order to dispose of the weapons-grade plutonium as well as to generate power.

Unfortunately, the *actual* history of the U.S. Nuclear Project, including the WPPSS fiasco, seems to have had little effect on government, military, scientific and corporate support for the technology. Indeed, support for nuclear power seems virtually immune to the negatives of its own history. For example, after the oil crises of the 1970s, nuclear power was frequently cited by its advocates as the path to energy independence while preserving American ideals of abundance. Thus, Harold Agnew, former director of the Los Alamos National Laboratory, declared ten years of escalating fossil fuel prices proved that "nuclear is the only nonfossil fuel energy source that will be available to us in sufficient amounts to supply our current civilization and to fuel progress for the foreseeable future" (1983: 1). The U.S. Department of Energy (DOE) kept faith with the nuclear ideal, even after the Three Mile Island accident in 1978, protecting nuclear R&D throughout the 1980s while cutting conservation and renewable energy funding drastically. In fact, a new program for nuclear energy was initiated with an investment of over $160 million to search for "inherently safe" reactor designs. Westinghouse and General Electric added $70 million of their own money to keep the dream alive (Greenwald, 1991: 61). To date, the American government-corporate partnership has spun off 12 new reactor types for commercialization (*Nuclear News*, September 1992).

Environmental concerns of the 1980s and early 1990s have also been cited to garner support for the U.S. Nuclear Project. Alvin Weinberg has emphasized the nonpolluting nature of nuclear power in his call for a "second nuclear era" (1985). More recently, the National Academy of Sciences released a study supporting rapid deployment of a new generation of "inherently safe" plants to combat the "greenhouse" effect (*Time* Magazine, April 29, 1991: 54). The depiction of nuclear power as "environmentally friendly" is truly remarkable, given the fact that the technology produces some of the most toxic, long-lived and life-threatening wastes known to humankind.

Passage of the 1992 Energy Policy Act (EPACT) rewarded America's nuclear faithful for their persistence. The bill included: $100 million of new funding "for inherently safe" reactor designs;

limits on utility payments for nuclear plant decommissioning with cost recovery from ratepayers; and delegated authority to set high-level waste disposal standards to the National Academy Science in lieu of public participation in standard-setting proceedings. Most important, the Act established a nuclear plant siting system with only one evidentiary hearing prior to the start of construction and it authorized, in principle, advance certification of plant design by the Nuclear Regulatory Commission (see Greenberg, this volume). One industry publication characterized the passage of EPACT as a watershed event in the resuscitation of a moribund industry (*Nuclear News*, November 1992: 34):

> In a single stroke, the [American] nuclear community has now been given virtually everything it has said it needed from the federal government to make nuclear power an attractive, economic choice.

There has been, to be sure, some retreat from the nuclear alternative by the Clinton administration since the passage of the 1992 Act. Nonetheless, the 1995 fiscal year budget calls for over $1 billion of direct and indirect support for the development and maintenance of the U.S. Nuclear Project. This includes some $209 million for civilian reactor development, an additional $122 million for other power technologies, and over $500 million for the Civilian Radioactive Waste Management program, a 40 percent increase over the previous year's appropriations. Despite such handsome subsidies, nuclear supporters find the Clinton Administration's commitment to the technology to be too small (*Nuclear News*, March, 1994: 25).

Enthusiasm for the technology, and belief in its promise, remains high within the ranks of the faithful. For instance, J. Bennett Johnston, senior U.S. Senator from Louisiana, and a long-time and enthusiastic supporter of the technology, continues to actively promote its role in the U.S. energy mix. In a recent interview, Johnston argued that nuclear waste, for the most part, is not "a daunting scientific or engineering problem. [I]t is instead a political problem and to some extent an emotional problem" (*Nuclear News,* November 1993: 47). A number of proposals to prop up the technology continue to circulate through the American political system . These include: a proposal to spend several billion dollars for the International Thermonuclear Experimental Reactor; the implementation of a "one-step" licensing process to keep local or state agencies from obstructing site characterizations at proposed waste sites; and the use of off-budget accounts for federal expenditures associated with DOE's obligations to accept responsibility for high-level nuclear waste generated by civilian reactors (*Nuclear News,* November, 1993: 46-49.)

Federal regulation, as it has done since the beginning of the Nuclear Age, also continues to do its part to keep the technology alive. Thus, in what is only the latest in a long series of accommodating initiatives, the Nuclear Regulatory Commission (NRC) is studying ways to alleviate what the industry sees as an unnecessarily burdensome process required for relicensing. Undaunted by persistent incidences of cracked reactor cores, leaking piping systems requiring early replacement, and numerous other failures, the NRC is preparing to make relicensing a less demanding process (*Nuclear News,* September, 1994: 24-25). At the present time, the rules governing the process, found in 10 CFR 54, require that (*Nuclear News,* September, 1993: 21):

> [A]n applicant for renewal of a power reactor for 10 to 20 years beyond the license's 40-year term must compile the plant's current licensing basis and show how the plant's key systems, structures and components would perform at the 40-year mark and beyond.

The Commission indicated sympathy for the industry's "plight" and has announced its intent to clear away burdens imposed by regulations that are perceived, by the industry, as "uncertain, unstable, or not clearly defined" (*Nuclear News*, September, 1993: 21).

Nuclear Power and the Industrial Order

While an initiator of the nuclear ideal, the U.S. has been joined by most of its industrial allies in the promotion of the technology. France and Japan are among nuclear's most fervent advocates. As well, the former Soviet Union, despite major political differences with the U.S. and other industrialized countries, actively pursued its own Nuclear Project and became a key user and salesman of the technology. With the conclusion of the Cold War, Russia remains a staunch supporter of the nuclear ideal.

The French Experience

By comparison with the U.S., France has encountered fewer obstacles in its pursuit of the nuclear ideal of progress. Nuclear power now accounts for over 70 percent of national electricity production, highest in the world (*Nuclear News*, May, 1992: 53). The country is a leader in nuclear sophistication with its program to commercialize the largest (1,455 MWe) reactor in history (*Nuclear News*, November 1992: 90) and its vitrification technology, designed to secure and store high-level radioactive waste, is regarded as among the most advanced in the world. Perhaps more than any other industrial country, France appreciates the institutional and political requirements for successful growth of nuclear power supply. Indeed, French advocates have even developed an aesthetic vision of nuclear technology as art to bolster support for the technology. Leclerq captures this unusual idea of nuclear power in his comparison of the nuclear cooling tower to some of the grandest architectural monuments of Western culture, including the Arc de Triumph and the Eiffel Tower (1986: 182):

> The age in which we live has, for the public, been marked by the nuclear engineer and the gigantic edifices he has erected. For builders and visitors alike, nuclear power plants will be considered the cathedrals of the twentieth century. Their syncretism mingles the conscious and the unconscious, religious fulfillment and industrial achievement, the limitations of uses of materials and boundless artistic inspiration, utopia come true and the continued search for harmony.

For the modernist, France represents the closest Western society has come to realizing the nuclear dream (Rippon, 1992: 86):

> The great promise of what might be achieved by the peaceful use of nuclear reactors has largely been realized in France. An advanced industrial country with scarcely any indigenous energy resources, France is today endowed with an abundant and reliable source of clean energy. The French nuclear industry has had its share of problems and no doubt will continue to do so, but with its construction program of the '70s and '80s, it has demonstrated that nuclear power reactors can be built in less than six years, can be commissioned at a rate as high as one unit every two months, and can be operated economically, even in a load-following mode. The French have shown that if there is political will, nuclear energy can make a very large contribution to solving global problems of atmospheric pollution.

As in the case of the United States, French experience with failure has done little to dampen its enthusiasm; indeed, it has often been the case for the French nuclear industry that failure is simply reinterpreted as another sign of success. Thus, a four-year delay in the opening of the 1470-MWe Chooz B1 reactor (originally scheduled for start-up in 1990 and now due to begin operation in 1996), has "not been a total setback for Electricité de France". Rather, the delay is seen positively because it "brought the addition of this large block of new capacity more in line with the load growth of the EdF system," and allowed the plant to be built using more advanced fabricating and operating technologies (*Nuclear News,* July, 1994: 42). Another indicator of the industry's ability to abide failure, was the August 4, 1994 restart of the Super-Phénix fast-breeder reactor. Considered to be a key component of a fully functioning nuclear fuel cycle, the reactor has been plagued by breakdowns, disappearing fuel, and other assorted problems. So serious have these problems been that the reactor has operated only 174 days in eight years (Rothstein, 1994). Nonetheless, a two-year relicensing procedure for the Super-Phénix was completed at the beginning of July, 1994 and the French government has announced that it intends to consider a plan to turn the plant into a plutonium burner rather than a breeder (*Nuclear News,* September, 1994: 90; Rothstein, 1994).

Few critical voices have been heard to challenge the French Nuclear Project. But recent reports suggest that such criticism is, in fact, in order. Mary Byrd Davis, for instance, has documented the extent to which carelessness and mismanagement of waste was a common feature of the French civilian power program (1994). The system is also being scrutinized for its financial practices. According to Rothstein, "the French civilian power industry owes bondholders billions of francs and is increasingly regarded as unreliable" (1994: 8). Nuclear development has also left other parts of the French energy system dangerously exposed. According to one study, "so much money was spent on nuclear power that France neglected to clean up its coal plants. [The result is that] its sulfur dioxide emissions are twice as high per kilowatt-hour as neighboring Germany, which installed scrubbers" (Rothstein, 1994: 9).

Japan and the Plutonium Economy

Japan's embrace of the nuclear ideal may prove to be the most technologically far-reaching. Japan operates the third largest nuclear power system in the world and has already surpassed the U.S. in the percent of national electricity production from nuclear power (24 percent vs 22 percent). In 1993 alone, the country saw the start-up of four reactors with a total generating capacity of 3,799 MWe, increasing Japan's nuclear capacity by 12%. Moreover, Japan has adopted an aggressive construction program to double its nuclear capacity by 2010 (*Nuclear News*, May 1992: 53).

Japan's lack of indigenous energy resources is generally used as the basis upon which to justify its pursuit of a nuclear economy, an argument most recently reprised by the Japanese Atomic Energy Commission in their basic policy statement, the *Long-Term Program for Research, Development and Utilization of Nuclear Energy* (the "Long-Term Plan"). In the country's Long-Term Plan, nuclear energy is portrayed as satisfying two overriding social goals: assurance of a stable supply of energy and the improvement of social welfare (Oyama, 1995: 38). Akira Oyama, vice chairman of the Commission, argues that nuclear energy can be "considered a quasi-domestic energy source produced by technology, making it possible for Japan to overcome its vulnerability in the energy supply system" (1995: 38).

While Japan's aggressive stance toward nuclear expansion is itself noteworthy, it is the nation's commitment to plutonium-fueled fast breeder reactors that sets it apart from all other nations; indeed, plutonium-based technology is considered so hazardous that virtually every other nation (except France) has discarded it as too risky. As Berkhout et al have pointed out (1990: 526):

> The ambition in Japan . . . has been to make the plutonium-fueled fast-breeder reactor [FBR] the

> eventual mainstay of the electricity supply system. Japan's uranium and fossil fuel requirements could thereby be greatly reduced, bringing freedom from foreign influence over electricity supplies.

National commitment to this technology has recently been affirmed in the Long-Term Plan. The Plan argues that uranium, like other resources, is limited and continued use may cause severe pressures in supply and demand by the mid-20th century. According to Oyama (1995: 39):

> It is important, therefore, that [Japan] prepare for future energy security by steadily continuing R&D efforts towards practical nuclear fuel recycling . . . For [plutonium] fast breeder reactors to be commercialized by the year 2030, it is necessary to pursue R&D towards establishing nuclear fuel recycling technology systems of FBRs.

Japan's Long-Term Plan calls for the continued operation of the Monju and Joyo experimental fast breeder reactors, the development of a prototype Advanced Thermal Reactor, the construction of the engineering-scale Recycling Equipment Test Facility (begun in January 1995), and the full commercialization of fast breeder reactors by the early part of the 21st century (*Nuclear News,* July, 1994: 48-49 and June, 1995: 40).

Enthusiasm for the technology is strong in both the public and private sectors. The political leadership has been (and is) willing to risk international criticism by shipping plutonium from France on a seven-week voyage to its Tokai reprocessing plant. And Satuski Edi, Director General of the Science and Technology Agency and head of the Japanese Atomic Energy Commission, has urged the government to augment its reprocessing capacity (*Nuclear News,* December, 1993: 76). Edi was joined in his assessment by the heads of Japan's 10 leading power companies, who put their names to a series of full-page advertisements in British newspapers, which proclaimed, "We don't just support plutonium recycling. We need it." As a demonstration of their commitment, these Japanese business and political leaders pleaded with the British government to give the go-ahead to the Thermal Oxide Reprocessing Plant (THORP) at Sellafield as soon as possible so that Japan could contract for its use (*Nuclear News,* December, 1993: 76).

Notwithstanding such support, early indications are that Japan's ambitious plans might well be endangered by the operating problems that have beset plutonium-breeder reactors. In December 1995, it was reported that the $5.9 billion Monju reactor was shut down after two to three tons of radioactive liquid sodium leaked and began to burn. The plant was reported running at 40 percent capacity when the sodium leaked from a secondary cooling system. The accident was characterized by the government's Nuclear Safety Commission as very serious (*New York Times*, December 17, 1995: A4).

Russia, the Commonwealth of Independent States, and Eastern Europe

Nuclear enthusiasm long ago transcended what, at least at one time, was thought to be the most fundamental ideological division among industrial societies, namely, the contest between capitalism and socialism. The former Soviet Union and its East European allies were among the most bullish nuclear promoters over the technology's 50-year history, operating within their national borders 46 plants representing 10 percent of total world capacity. After the breakup of the Union, Russia still maintains the world's fifth largest nuclear electrical power system, with 25 plants and a rated capacity of 19,800 MWe (*Nuclear News*, March, 1995: 27-42).

Even the worst plant accident in human experience at Chernobyl No. 4 failed to deter Soviet development efforts. A few months after the 1986 Chernobyl explosion, then General Secretary Mikhail Gorbachev assured the world that socialist enthusiasm would not diminish: "The future of the world economy can hardly be imagined without the development of nuclear power . . . [H]umankind derives considerable benefit from atoms for peace" (Vital Speeches of the Day, 1986: 516). Five years later, Soviet Minister for Atomic Energy Vitaly Konovalov announced that the country was committed to expanding its Nuclear Project with 7 GWe of new nuclear capacity to be brought on line by 1995 and an additional 12.6 GWe planned for start-up by the year 2000. In response to a question about the effects of the Chernobyl accident on Soviet thinking, he observed (*Nuclear News*, July 1991: 89):

> [I]n many regions of the country recently there has been a trend, especially among decision-makers and legislators, toward understanding how necessary atomic energy is.

Shortly after Minister Konovalov's statement, the Soviet Union devolved into 15 separate nations. However, the dissolution of the USSR has done nothing to alter commitment to the nuclear ideal. Ending the moratorium against new plant construction imposed after the 1986 Chernobyl accident, the Russian government has recently approved a vigorous program of nuclear power plant construction (see Marples, this volume). The first step towards the realization of this new nuclear capacity was taken with the opening of the Balakovo-4 plant in 1993 (*Nuclear News,* March 1995: 34).

Many of the former republics, as well as satellite countries of the Warsaw Pact, have also maintained the nuclear faith. As in the case of the United States, France, and Japan, these countries' commitments to nuclear power are founded upon promises of economic growth and technological power. The argument seems to be working: the Ukraine announced at the end of 1993 that it will open three new reactors, Zaporozhye-6, Rovno-4, and South Ukraine-4. And while the Ukrainian government has indicated a willingness to shut down the Chernobyl complex, its leaders have also cited a lack of both money for the shutdown and replacement energy as reasons why they must keep the plant running into the foreseeable future (*Nuclear News,* November, 1994: 41).

The same arguments are being repeated throughout Eastern Europe (Hinrichsen, 1993: 37):

> [F]or the troubled nations of the region, the need for electricity is taking precedence over public demands that unsafe plants be closed down permanently. Lithuania's Ignalia plant, though condemned by Western experts, is likely to remain on stream because it produces about 60 percent of the country's electricity. Similarly, Sosnovyi Bor generates 60 percent of the electricity for St. Petersburg; Kozludoy produces 40 percent of Bulgaria's electricity; [and] Paks 40 percent of Hungary's.

The appeal persists despite the well-known economic and technological problems being experienced in the region. Romania, for instance, is readying for start-up of its first ever nuclear plant, the 700 MWe CANDU reactor at Cernavoda. Romania is also considering follow-through on a second unit at Cernavoda, which is currently 32% complete, if it can arrange funding through international partners (*Nuclear News,* October, 1994: 17).

Explaining Nuclear Faith

Why have so many countries, many of them characterized by historically divergent social and economic systems, been so willing to ignore the many failures, risks, and profound dangers associated with the Nuclear Project? In our view, nuclear power represents a logical step in the progression and development of technological society (Ellul, 1964; Mumford, 1934). The Nuclear Project embodies all of the essential elements of the industrial dream — material abundance, technological acumen and independence from the constraints of nature. It also epitomizes the modernist values of scientific rigor, precision and complexity. Indeed, for its supporters, the choice of nuclear power signals the embrace of the modern way of life under the guidance and protection of technological culture. All that stands in the way is pre-technological culture with its "backward" thinking (Lilienthal, 1949: 147-148):

> Atomic energy is a force as fundamental to life as the force of the sun, the force of gravity, the forces of magnetism . . . Within the atomic nucleus are those deep forces, so terribly destructive if used for warfare, so beneficent if used to search out the cause and cure of disease, so almost magical in their ability to pierce the veil of life's secrets . . . For the citizens of the world's leading democracy to be in the dark as to the nature of the fundamental structure and forces of the atom — and of the great good as well as evil this knowledge can bring — would be for them to live in a world in which they are, in elementary knowledge, quite blind and unseeing. It would be almost as if they did not know that fire is hot, that water is wet; as if they did not know there are seasons and gravity and magnetism and electricity.

The attainment of advanced status hinges, in this view, on a future-tense understanding of progress in which enhanced scale, quality and sophistication of technological infrastructure are always valued for their promise of success and present-tense actualities of failure are swept aside. Any other basis of social evaluation is to be judged anti-progressive from this perspective. Langdon Winner has depicted the technological positivism of modernity in this way (1977: 102):

> Certain technical means stand at the very basis of human survival. Failure to provide for them is to invite discomfort, suffering, or even death . . . Any attempt to deny this . . . can only be an expression of malice, stupidity or madness.

The attraction of the industrial world to nuclear power manifests precisely this ideology.

Ideological Transfer: Nuclear Power in the Third World

> And then there's the question of development: If you have no power, there is no development (M. A. Khan, past chairman of the Pakistan Atomic Energy Commission, quoted in Taylor, 1990: 39).

The transfer of nuclear ideology to the Third World is now underway: over half (23 of 45) of all firm orders for new nuclear plants scheduled for commercial start-up in the 1990s are from developing countries; the remaining 21 plants currently in some phase of construction are located in Russia or the CIS countries (*Nuclear News*, March, 1995: 27-42). The rationale for nuclear power in the Third World, as with the "advanced" tier, has had little to do with the present-tense conditions and needs of societies.

The elite of the Third World have been courted for over three decades to provide leadership in diffusing nuclear technology and values throughout the region. This elite has been educated in the ideology by the International Atomic Energy Agency (IAEA) and other multilateral organizations and has, in turn, supplied them with some of their recent leaders. A prime example, in this regard, is Munir Ahmad Khan, who served as chairman of Pakistan's

Atomic Energy Commission and then took over the reins of the IAEA. He is one of the world's strongest advocates of this highly expensive, esoteric technology. He makes the case for nuclear power in the Third World on familiar grounds. First, Khan defines the issue in terms that echo the long-held Western belief in increased energy supply as a prerequisite for the advance of civilizations (see Basalla, 1980). Khan argues that (1992: 76):

> The developing countries desperately need electric power to speed up their industrialization and improve their economic lot, to overcome poverty and forestall the social and political upheavals that have rocked Eastern Europe.

The issue can be framed in precise terms:

> [Developing] countries constitute about 67 percent of the world population, but consume only 17 percent of world energy. The average annual per capita electricity consumption stands at 0.7 megawatt-hours in the developing countries, versus 6.5 MWH in industrialized countries. In addition to having low electricity consumption, these countries are also deficient in conventional energy resources. Excluding the few oil-rich countries, the per-capita energy reserves in the developing countries amount to less than 45 tons of oil equivalent, compared to 366 tons in the industrialized countries.

This leads Khan to the nuclear solution:

> This is why the energy-starved developing countries look to nuclear power as a potential source of meeting their future electricity needs at a reasonable cost and reducing the increasing burden on their debt-ridden and fragile economies. If the

> nuclear power alternative is not available to [developing countries] for technical, financial, or political reasons, they will inevitably turn toward using oil or even poor-quality coal, which will greatly increase carbon dioxide emissions to the atmosphere.

Seen in these terms, nuclear power is "a practical choice which is economic, less polluting, more reliable, and affords . . . diversification" (Khan quoted in Taylor, 1990: 38).

Khan's assessment contains many of the future-tense arguments made in the U.S. and elsewhere to promote the development of nuclear technology. But the appropriateness of these arguments for the Third World are doubtful. Developing countries typically lack the necessary investment capital, research and technical infrastructure, and fully articulated electric grids to "plug in" a nuclear plant. Moreover, access to energy services is often more important in defining social need than the amount of available supply. And surely, developing countries should not assume the burden of reducing greenhouse gas emissions at this time. Quite the reverse, it is the low-carbon development pattern of the Third World that has, so far, offset the overuse of the atmosphere by industrial countries for storing CO_2 (see Byrne et al, 1994).

To date, present tense objections to nuclear power have been no more successful in the Third World than in the industrial tier. Developing countries with nuclear power aspirations routinely justify their interest on the basis of future economic and technological benefits. Actual social problems and costs are made abstract while unrealized possibilities are treated as though they were concrete. This logic has found favor throughout Latin America, Asia and the Indian subcontinent. The cases of Mexico, Argentina, Brazil, South Korea, Taiwan, India, Pakistan and China are instructive for the revealing glimpse they provide into Third

World elite thinking on the relations between energy, technology and development.

Latin America

Mexico's experience is illustrative of Latin countries that have sought national progress and energy independence through atomic development. As a leader in the movement to control global proliferation of nuclear weaponry, Mexico initially showed little interest in the peaceful use of the atom. By the mid-1960s, however, the country was in the process of institutionalizing the capacity to build and operate indigenously fabricated nuclear power plants, based upon a long term goal of "infus[ing] knowledge and skills that could then be applied to future development" (Stevis and Mumme, 1991: 60). Mexico pursued this policy despite the fact that it has an abundance of conventional fossil fuels, including proven and potential oil reserves currently estimated at about two trillion barrels (Miramontes, 1989: 36). Key government officials and scientists from the National Council for Science and Technology, the Physics Institute of the National University, and the Institute for Nuclear Research persuaded the government that nuclear power was essential for Mexico "because it signals an era of progress and modernity" (Miramontes, 1989: 38). These beliefs have not been shaken by the experience of steep present-tense costs at the country's experience 654 MWe Laguna Verde nuclear reactor. As Miramontes points out (1989: 38):

> Nearly all of the nuclear technology has been imported. In turn, Mexico gets hard currency from oil exports. This means that Mexico must sell hydrocarbons to pay for the nuclear power plant. It has been estimated that Mexico will have to export about 345 million barrels of oil to pay for the [Laguna Verde] plant, but the plant will save only about 240 million barrels. In an effort to save

> hydrocarbons, Mexico will lose 105 million barrels of oil and gain hundreds of tons of radioactive wastes.

Like Mexico, Argentina and Brazil pursued nuclear power for future-tense reasons. A healthy dose of military aspirations also attracted the two countries to nuclear energy. According to Adler, both countries' nuclear ventures can best be understood by taking into account the ideology of autonomous development and industrial development (1988). The quest for "nuclear autonomy", according to Adler, is part of a larger quest to achieve international parity (1987:18):

> [P]rogress is viewed . . . not only as modernization and economic and technological development but as a matter of autonomy and equality as well. This is why [each country's] nationalist ideology is so strongly linked to development and equality. Liberation, cultural self-affirmation, development, science and technology: these are the core dimensions of the idea of progress in the Third World.

Brazil recently announced its intent to continue its program, and specifically to complete the Angra-2 plant. Despite having spent some $4.6 billion on Angra-2 and 3, the plant (which was originally begun in 1976) it is still only 69% complete. The President is recommending that an additional $1.4 billion be spent in order to bring the plant into operation (*Nuclear News,* October, 1994: 59).

Asia's Developing Countries

The Korean Peninsula. Asian developing countries have demonstrated a keen interest in nuclear power not only in their development plans, but in a willingness to, in the vernacular, "pour the concrete." Two of the "Asian Tigers" — South Korea and Taiwan — have already installed 7.2 GWe and 4.9 GWe of nuclear capacity, respectively, ranking them 9th and 12th in the world. Moreover, the two countries have adopted the world's most ambitious nuclear expansion plans for the 1990s; Korea alone accounts for over 10 percent of all new orders placed to date for start-up in this decade (*Nuclear News*, March, 1995: 27-42).

Perhaps the most impressive of any nation's commitment to a nuclear future is South Korea's. The country currently has nine plants in operation and plans to add nine more by the year 2001, as well as an additional nine plants by 2006. It is currently the most nuclear-intensive country in the developing world (Taylor, November, 1992: 41). South Korea's nuclear capacity places it ahead of Spain, Belgium, Bulgaria, Hungary and Finland and, in percent of electricity generation supplied by nuclear power, it outpaces Germany and Japan, as well (*Nuclear News*, May 1992: 53 and August, 1992: 55-72). When the 18 new plants come on line by 2006, nuclear power will be supplying well over half of the nation's total electricity needs.

Conditioned by the need to suddenly create a free-standing electrical generation system as a result of North Korea's cutoff of its electricity in 1948, South Korea has consistently emphasized energy abundance in its development strategy (Kim and Byrne, 1991). The centrality of nuclear power, in the leadership's view, in lifting South Korea out of its impoverishment after civil war was articulated at ground breaking ceremonies for Kori-1, the country's first commercial nuclear reactor (556 MWe). The late president of South Korea, Park Chung-Hee, spelled out the Korean version of the energy-civilization equation (1971: 144):

> We are very proud of and happy that this country is constructing the most technologically-advanced [nuclear power plant] in the late 20th century. As we realize, electricity is what all countries of the world want for economic development . . . Until

> now we have not shared in enough benefits of electricity in this country . . . Awareness of this fact would let us understand how important the promotion of electricity generation is and, by constructing many nuclear power plants, how much benefit from electricity we can we receive. Furthermore, it will be possible that we can advance the larger economic development and lead the country to a higher cultural life.

Recent forecasts of electricity requirements by the Korea Electric Power Company (KEPCO) are evidence of South Korea's desire to bring the country's current average annual electricity consumption per capita of 2,500 kWh up to the 10,000 kWh consumed in the United States by early next century (Taylor, November, 1992). South Korean energy officials take special pride in the better than 10 percent average annual increases in electricity demand that have occurred over the last twenty years. While the rate of increase slowed somewhat in recent years, KEPCO officials are convinced that sizable consumption growth will continue and, for this reason, intend to stay the course of rapid expansion of the country's electrical network. In their view, nuclear power is the only viable option for an energy-poor country with high demand growth. In this vein, KEPCO continues to cite favorably a proposal by leading scientists and energy researchers of the country to construct 50 additional nuclear plants by 2031 (KEPCO, 1989). One nuclear industry commentator has summarized the country's self-rationalization of its extraordinary commitment to nuclear power (Taylor, November, 1992: 41):

> [I]n a region where underdeveloped third-world countries have economies crucially hobbled by inadequate power generation, South Korea has avoided that pitfall by staying ahead of the curve in providing adequate electricity generating capacity to fuel its astoundingly burgeoning economy.

New to the list of "nuclear hopefuls" is North Korea. While the political and social isolation of this country makes it difficult to obtain reliable information on its activities, there is a reasonable basis for believing that North Korea will soon become home to at least two 1000 MWe plants. There are a host of problems to overcome, including financing, the yet-to-be demonstrated capacity of North Korea to build, maintain and operate the plants, and South Korean willingness to supply the necessary LWR technology. Still, many commentators predict eventual construction of the plants (*Nuclear News,* November 1994: 41).

A particularly intriguing aspect of the North Korean case is that international negotiations, led by the U.S. and Japan, have advertised the installation of these plants as a step toward bringing this country into the mainstream, and at the same time, contributing to peace in the region. In the North Korean nuclear bargain, the special language, thinking, and values of the atomic age are displayed. What clearer indicator can there be of the extraordinary power of nuclear ideology than the association of peace and normalcy with the transfer of the world's most dangerous technology to what many regard as a rogue nation?

India and Pakistan. Nations of the Indian subcontinent are also firmly committed to nuclear expansion. India currently operates 9 plants with a capacity of just over 1600 MWe. The country is planning to have at least 10,000 MWe of installed nuclear capacity by the year 2000. Currently, Pakistan has only one small 125 MWe nuclear plant. But it, too, has actively sought to build a nuclear future. As with the Korean peninsula, the Indian subcontinent's pursuit of nuclear power has raised concerns about the technology's pursuit for military aims in a region plagued by armed conflict. Yet, here too nuclear power is held out by advocates as a source of hope for peace.

India's choice of nuclear power was made by its leaders in the name of sovereignty, independence and international status.

The country has remained steadfast in its commitment to indigenous nuclear technology design and construction, notwithstanding the daunting challenges of poverty facing the society.

From the outset, India conceived its national nuclear program as key to confirming the country's arrival in the modern era. The architects of the Indian Revolution accepted early on the nuclear maxim that energy abundance is the foundation of social progress. Nehru argued in 1948 that India had missed the first Industrial Revolution due to her lack of technical skill and that success in the Second Revolution hinged upon the nation's development of a nuclear energy program. Two decades later, Indira Gandhi characterized nuclear power as an essential technology necessary for rescuing developing nations "from the shackles of poverty and ignorance" (quoted in Pathak, 1980: 24-25). In a national speech, Prime Minister Gandhi presented a vision of energy-intensive development that is hardly distinguishable from the technocratic model widespread in the West (quoted in Pathak, 1980: 24-25):

> Our programme of atomic energy development for peaceful purposes is related to the real needs of our economy and would be effectively geared to this end. Atomic energy stations would play a valuable role in the future not only in areas where other sources of energy are expensive but as base-load stations working alongside large hydro-electric installations. The significance of all this to our economy which is so heavily dependent on agriculture is tremendous.

The country's energy planners continue to regard nuclear power as the "ultimate dream" (*India Today*, 1988: 87) for supplying electricity in amounts needed for India's economic development. Toward this end, India has pursued the development of all phases of the nuclear system. Work continues, for instance, on two reactors at Kaiga in Karnataka despite a 1994 construction site accident. Two more units of the 235 MWe design are under construction (Rajasthan-3 and -4) and another four units are planned (Rajasthan-5 to -8). India has also developed the technology for mixed plutonium/uranium oxide fuel fabrication, has sufficient milling facilities to meet expected requirements through the early years of the next century, and has developed facilities for the production of zirconium and the fabrication of zirconium alloy tubing, both for fuel cladding and for the calandria tubes required in PWR-type reactors. India has also operated heavy-water production plants as well as a number of small reprocessing facilities since at least the late 1960s (Rippon, 1995).

While Pakistan's nuclear involvement is currently limited to one operating plant, is also planning significant new investments in nuclear energy. Perhaps most important, the country has been "working hard to develop an indigenous capability to design and construct a series of standardized nuclear power plants" (Rippon, 1995: 42). In the meantime, according to Rippon, "efforts have been made to find international vendors to supply the nuclear plants that are clearly needed to help meet the growth in energy demand" (1995: 42). Thus, in November 1989, the country announced that it had agreed to purchase a 300 MWe pressurized water reactor based on the Chinese-designed plant in commercial service at Qinshan. The contract covered both the supply of the nuclear power plant with its fuel and the transfer of technology and other support services. Construction commenced at the Chasma site in August 1993, with a scheduled start-up date of August, 1998. The country's hydro-thermal power program calls for a total nuclear capacity of 4,625 MWe by the year 2006 (Taylor, March, 1990: 38).

China. Finally, China's bid for recognition by the community of nuclear states exemplifies the pervasiveness of the technology's ideological appeal in the Third World. While China's rulers have sought to put the country on a development road of its own definition and making and have, until recently, set restrictions on economic and technological contact with the West, its nuclear program has invited participation from American, French, British, German and Japanese corporations. Moreover, the country's strategy is modeled essentially along the same lines as ones in the industrial countries.

Qinshan-1, the country's first nuclear facility, reached criticality October, 1991 (*Nuclear News*, March, 1995: 29) while two other 900 MWe reactors at Guangdong's Daya Bay (near Hong Kong) began commercial operation in 1993 (*Nuclear News*, September, 1994: 89). According to an industry commentator, two factors are driving the Chinese nuclear program: "the need to boost its technological prowess, providing new products for Chinese exporters;" and "national prestige . . . [which is] motivating mainland China's push to become a full-fledged player in the nuclear power game" (Gallagher, 1990: 106-107). Chinese leaders have also indicated their acceptance of the cardinal principle of future-tense evaluation of nuclear industrialization. In terms reminiscent of the Soviet official response to the Chernobyl explosion, former premier Chao Tzu-yang acknowledged that the technology's history of accidents had forced greater attention to issues of safety. But, he pointed out, "that will not change our attitude toward developing the nuclear power industry" (Gallagher, 1990: 109). The reality of risk is discounted by the unrealized possibilities of nuclear-inspired development.

Many observers also believe that the recent opening of plants at Qinshan and Guangdong "has stimulated a new sense of confidence in the emerging nuclear industry, and [that] there is reason to believe that the latest predictions of an imminent take-off may soon be realized" (Rippon, June, 1995: 32). In the immediate future, plans call for the addition of two 600 MWe units at Qinshan, as well as two more 950 MWe units at Lingao, which is adjacent to Guangdong. Also, several of the more prosperous provinces along the eastern seaboard are actively planning nuclear projects, which, if they all come to fruition, will add an additional 20 GWe of nuclear capacity in the first decade of the next century. An additional 50 GWe of capacity is called for in the more ambitious plans of the central authorities (Rippon, June, 1995: 32).

As in the case of other countries in the region, China is also aggressively pursuing an indigenization policy. However, the nation's leaders are not allowing the absence of a completely developed domestic nuclear system to delay their plans. Thus, in recent years, China has signed agreements with a full set of international partners. The Russian-based St. Petersburg Atomic Energy Design Company, for example, is now working with the China National Nuclear Corporation (CNNC) to design two 1,000 MWe units at the northeastern province of Liaoning. In February of 1995, South Korea concluded a Memorandum of Understanding (MOU) for the supply of two units of its so-called Korean standardized nuclear power plant. The South Koreans are also working with CNNC on an assessment of prospective sites in Shandong and Fujian provinces. Finally, Atomic Energy of Canada Limited has also concluded an MOU designed to facilitate the sale of its CANDU reactors to China. According to one commentator, the "move exemplifies . . . the ascendency of the Asian market as power demand grows in developing Pacific Rim countries" (Rippon, June, 1995:33)

The reliance upon international vendors is likely to be only temporary since China is fairly far along in achieving its goal of indigenization. To this end, the country has invested in all stages of the nuclear fuel cycle, including the development of extraction and refining, fuel processing, and commercial fuel fabrication facilities. China also is experimenting with reprocessing activities and has initiated a pilot-scale reprocessing plant at Lanzhou. Finally, China is developing waste management programs, including low- and intermediate-level repositories, as well as deep-site geological storage capacity (Rippon, June, 1995: *Nuclear News,* November, 1994: 40 and February, 1994: 54).

The Lure of the Nuclear Dream

As in the West, the lure of nuclear power in the Third World derives from shared ideas of technological success as key to social progress. Countries with nuclear ambitions equate energy use with civilization, material abundance with national independence and technological sophistication with social progress. Military aspirations are, of course, a part of the equation, as well. But this only underscores the thinness of the distinction between civilian and military nuclear programs, a feature that advocates generally prefer not to discuss.

There is an irony in the shared aspirations of the West and the Third World toward nuclear power. Nations that are otherwise related by the contradiction of extravagant wealth amid desperate poverty have mutually embraced an ideology that presumes a general condition of harmony between them on matters of technology and development. Indeed, as Adler (1988) points out, on the question of nuclear energy, developing countries often assume that the technology is a force for parity and, therefore, *if anything* the Third World should be wary of possible industrial country efforts to prevent its full utilization. The adoption of this view assures that nuclear power is exempted from present-tense social criticism and results in the Third World being a participant in its own exploitation. In this way, ideas of technology and development that rationalize industrial hegemony — what Jacques Ellul (1964) termed the vanguard of "technical invasion" — come to inform the aspirations of the leadership of the exploited.

Conclusion

Finally, as the 20th century draws to a close, the perseverance of the Nuclear Dream warns of the era's near-complete failure to break through the facade of technological progress. It remains at least as difficult at the end of the era of the first technological century as at its beginning to recognize and value the *actual, present-tense lifeworld* ahead of the world of technique. Beyond its record of secrecy, contamination, financial boondoggle, catastrophe, and near-catastrophe, the Global Nuclear Project stands as stark testimony to the era's willingness to deny the authoritarian reality that has universally accompanied the technology's development in favor of its promise of future-tense abundance. The lifeworld risked for the ideal of More — this is perhaps the most disturbing legacy of nuclear power.

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