Nuclear Renaissance in the Age of Global Warming

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Nuclear energy in full bloom?

With oil prices and global temperatures rising, the nuclear option has once again entered discussions about the future of the world's energy supply. Piggybacking on the growing awareness of global climate change, the nuclear industry in the United States, Russia, and elsewhere has launched a new public relations campaign, marketing its services in the interest of clean, environmentally sound energy. In contrast to similar proposals from the 1950s, technical feasibility and economic profitability seem to be taken for granted, whereas concerns about safety and nonproliferation have gained significance. The nuclear industry today promotes new, "inherently safe," and proliferation-resistant reactor designs, improved methods of personnel training, and cost-effective standardization, along with strict licensing procedures under independent regulatory agencies. Thus, in addition to legal provisions, the industry advocates a series of "technical fixes" to prevent nuclear proliferation. The unresolved problems of radioactive waste and lingering public opposition to nuclear power are either left out of the picture, or countered with unswerving technological optimism.

This article looks at differences and similarities between current and past proposals for developing a civilian nuclear industry. It provides some historical background - particularly on the Soviet experience, which the author has explored in some depth elsewhere. Although recent proposals continue to advocate the normalization of nuclear energy on the basis of its further commercialization, a reflection on past successes and/or failures is largely missing from current discussions. A cautious reading of recent enthusiastic endorsements of nuclear energy would be well-advised.

International nuclear policy development in a nutshell

In 1953, President Eisenhower's famous "Atoms for Peace" speech at the United Nations initiated the international diffusion of nuclear energy technologies (transcripts of the speech are readily available online, e.g. at www.eisenhower.archives.gov/atoms.htm). In fact, in 1954 the United States amended the McMahon Act of 1946 to make comprehensive technology transfer to and cooperation with non-nuclear nations legally possible.

The main concern in the 1950s and 1960s, for both the United States and the Soviet Union, was to extend their political influence by providing "friendly" countries with know-how and technologies to launch their own civilian nuclear industries. Although specialists worried about the spread of potentially dual-use technologies, these concerns were largely dismissed in the interest of winning yet another Cold War race: that of nuclear energy markets. As Leonard Weiss pointed out in his article on the Atoms for Peace program in the Bulletin of the Atomic Scientists in 2003, Eisenhower's original plan proposed the creation of a uranium bank that would help to monitor the amount of fissile material distributed under peaceful nuclear programs.

Current U.S. proposals involve the creation of another uranium bank, this time from dismantled nuclear warheads. The recent proposals are made in the context of the so-called Global Nuclear Energy Partnership (GNEP), an initiative that involves a new generation of nuclear power reactors that are supposedly safer and proliferation-resistant, revised spent fuel management, strict control over fuel supply and reprocessing, and improved international nuclear safeguards [on GNEP read Harold Bengelsdorf's commentary, "Proposals to Strengthen the Nuclear Nonproliferation Regime " in this issue of *bridges*].

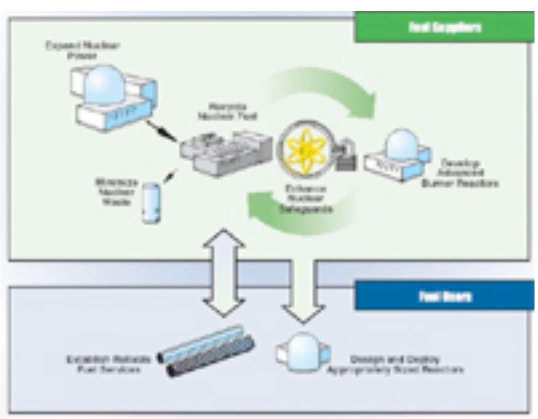
The 2006 Global Nuclear Energy Partnership (GNEP) initiative

GNEP's proliferation resistance is to be achieved in two ways: first, through modified reactor design, and secondly, by strictly limiting the diffusion of enrichment and reprocessing technologies. In other words, the reactor design itself would prevent the operating country (the "fuel user," in GNEP terminology) from extracting weapons-grade material, even in the eventuality that international safeguards would fail to monitor a particular facility.

This is, however, not a new approach; consider how carefully the Soviets chose the sites for their graphite-water reactors (the RBMK, infamous since the Chernobyl disaster in 1986) only within the territory of the Soviet Union, while exporting pressurized light water reactors to Central and Eastern European countries (a similar idea of "black-boxing" proliferation-relevant know-how also guides the Russian proposal of floating nuclear power plants). In addition, the entire front end and back end of the nuclear fuel cycle would be monopolized in the hands of the countries that already possess these technologies, which is bound to raise concerns about a reliable fuel supply on the part of countries interested in operating nuclear power stations.

Closing the Nuclear Fuel Cycle?

For the first time since the 1980s, the United States is considering a closed fuel cycle, an idea that had been dismissed previously as not economical. Another part of the recent GNEP proposal is "advanced burner" reactors, a proposal the United States had also considered problematic in terms of proliferation and too expensive, and therefore not competitive, in the past. But fast reactors are capable of destroying elements that could potentially be diverted to nuclear weapons production. The Soviets, by contrast, had supported not only the closed fuel cycle, but also the idea of fast reactors as early as the 1950s and 1960s.



Fuel cycle © GNEP / DOE
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Soviet nuclear specialists had advocated the idea of a closed fuel cycle from the outset, although available records indicate that spent fuel reprocessing capabilities remained mostly limited to their production reactors (i.e., reactors designed exclusively to generate weapons-grade plutonium). There is little evidence that the plutonium produced as a by-product of normal reactor operation in RBMKs (the Chernobyl- type reactors still running at sites near St. Petersburg, Kursk, and Smolensk, as well as in Lithuania) was actually used for military applications. Western sources have sometimes portrayed the RBMK design as a plutonium factory, but although the design was derived from military production reactors, it had been significantly modified and optimized to produce electricity before its introduction as a power reactor in the early 1970s. In fact, the economical improvements in the design (in combination with other factors, such as a different organizational culture in the civilian power industry) might actually have contributed to a less stable operating system in the RBMKs, compared with military and dual-use reactors of related design.

It was at the third Geneva Conference on Peaceful Applications of Atomic Energy in 1964, that the Soviets announced that their civilian nuclear program would ultimately involve the creation of a fleet of breeder reactors in an effort to reach independence from limited uranium supplies and in the interest of overall energy autonomy. Their standpoint was shared by Great Britain, France, Germany, and others, while the United States and Canada remained skeptical.

In contrast to thermal reactors, which rely on a moderator to slow down neutrons, these fast reactors operate without a moderator and achieve nuclear fission by relying on "fast" neutrons. Back in the 1950s, they were named "breeder reactors" because they can be adjusted to "breed" plutonium, the most sought-after radioactive isotope in the Cold War nuclear arms race. The Institute of Physics and Power Engineering (FEI) at Obninsk started developing their first fast reactor in the late 1950s and launched the first industrial scale breeder reactor (BN-350) at Shevchenko (today Aktau, Kazakhstan) in 1973. The Soviet breeder program, however, never progressed past the stage of prototypes. After the start-up of a powerful breeder reactor at the Beloiarsk nuclear power plant in 1980 (BN-600), the program was cut back, mostly for economic reasons but also because the country's leading reactor design institutes supported other types of nuclear reactors.

One person's "breeder" is another person's "burner"

In the past, both the United States and the Soviet Union were accumulating plutonium for nuclear weapons, and fast reactors were designed to do just that. Now the situation has changed, and the question has become: "Where should all the plutonium go?"

Fast reactors can be adjusted quite flexibly in a way that allows plutonium to burn up. In the context of the new U.S. nuclear strategy, the fast neutron reactor seems likely to stage a comeback - in combination with current light water reactors, "advanced fast reactors " are envisioned as crucial parts of a future "advanced nuclear fuel cycle." In addition, they are promoted as economical and safe, two characteristics never conceded to the Soviet breeder program. Instead, the halting development of the Soviet breeder program has often been interpreted as the result of high costs and a bad accident record. Several other countries, Sweden and Germany in particular, had advanced a breeder program but eventually abandoned it for safety and economic reasons. France had a substantial program that is being shut down, and Japan's breeder program had safety problems that temporarily halted its operation.

Spreading the "Peaceful Atom"

In addition to getting their own domestic nuclear energy programs off the ground, the United States and the Soviet Union have also engaged in active nuclear proselytizing. The initial research reactors provided under the Atoms for Peace program ran on highly enriched uranium and were often operated in environments protected casually (if at all). In recent years, Russia and the United States have been replacing the initial fuel loads with fuel of much lower enrichment.

Locked Atom. © GNEP / DOE

The Atoms for Peace initiative not only provided "friendly nations" with research reactors, but also covered the transfer of nuclear power plants and their respective infrastructure to interested countries. This much more extensive nuclear technology transfer has followed a quite distinct path in Central and Eastern Europe. The Soviet Union set up a sophisticated system of cooperation with its Warsaw Pact allies under the Council of Mutual Economic Assistance (CMEA). From the outset, this cooperation involved shared manufacturing of nuclear reactor parts, training and exchange of technical experts and, most importantly, a system of nuclear fuel supply and take-back. Central and Eastern European countries in the early 1960s were eager to acquire cutting-edge nuclear technologies to relieve their dependence on fossil fuel imports.

And the Soviet Union was not only willing to share its expertise with these countries (the reactors in Eastern Germany, e.g., were assembled more or less simultaneously with the construction of the first industrial-scale pressurized water reactor near Voronezh), it also worked out a fuel regime that effectively relieved the customers from dealing with "the plutonium problem," that is, the need to handle and store permanently spent fuel containing highly toxic radioactive isotopes.

Political considerations notwithstanding, the advantages of this kind of arrangement are likely to have played a major role in Finland's decision to adopt a Soviet, rather than a Western, design for their first nuclear power plant at Loviisa. The idea that this system prevented nuclear proliferation has informed Soviet cooperation with a number of other countries, and is reflected in current proposals for establishing credible international fuel supply regimes (see the March 2006 issue of the Nonproliferation Review for a pertinent article by Chaim Braun and Michael May).

Past imperfect - present "tense" - future perfect?
In contrast to the 1950s, nuclear energy today is portrayed as "climate friendly," as opposed to just progressive and excitingly new. But the plans for storing radioactive waste remain unspecified in the GNEP proposal, and the reference to Yucca Mountain vague at best. Even a concerted effort at recycling nuclear fuel, thus reducing the volume of radioactive waste, will not answer the question of how and where this waste will ultimately be kept for the next centuries, and who (individuals as well as institutions) will guard and monitor it.

Nuclear energy proponents in the United States and elsewhere have been announcing new, improved, and "inherently safe" designs that are going to be standardized. But whether a design is considered safe depends not only on its technical features, but also on how it is situated economically, socially, and politically. What is considered safe today might not be considered safe after the next nuclear accident, the next terrorist attack, or the next major shift in international political alliances. The idea of standardization poses problems of its own: When is it reasonable to standardize, rather than continue to improve a design? Who decides when standardization is appropriate as opposed to premature?

With regard to the everyday operation of nuclear power reactors, a new "safety culture" is sometimes invoked. To contain the risk emanating from the "human factor," a dramatic increase in automated processes and more and better simulator training has been suggested. Especially in the United States, such proposals are often modeled on the nuclear Navy: The U.S. Navy , under its legendary Admiral Hyman Rickover, is regularly invoked as an exemplary organization capable of guaranteeing nuclear safety and operating discipline. However, the idea of using the nuclear Navy as a model for all nuclear facilities, including power plants, neglects the not insignificant problem of transferring routines and norms of behavior from military to civilian organizations - a problem the Soviets encountered when a civilian ministry was put in charge of operating their nuclear power plants in 1966.

In addition to new reactor designs and advanced training methods, proposals for making nuclear energy proliferation-resistant also include the promotion of new legal, organizational, and economic arrangements. For example, independent regulatory agencies are promoted, ignoring the specifics of organizational histories and experiences in different cultural contexts. It is worth remembering that a fundamental distinction within the U.S. context, between public and private sectors, was completely absent from the Soviet scene. In the latter, responsibilities for managing the country's nuclear energy program were divided up against a complicated and constantly changing backdrop of state ministries, state agencies, and other state organizations.

Conclusion
The questions the nuclear power industry faces today differ from those facing nuclear energy specialists 50 years ago. And yet, the rhetoric of the recent GNEP initiative is disconcertingly similar to that of the 1953 "Atoms for Peace" proposal.

Today's arguments reflect a stunning lack of reflection on past mistakes or lessons learned. The public seems to be an invisible presence in the global nuclear vision, both in Russia and in the United States. It would seem obvious for decision-makers to ask whether public perceptions of nuclear power had changed in the context of global warming. Instead, politicians around the world seem to shy away from consciously engaging a public that is clearly better informed but potentially more critical than 50 years ago. One could easily get the impression that - for whatever reason - politicians prefer decisions fraught with uncertainty to be shielded from informed public discourse.

The optimistic promotion of nuclear energy also ignores the fact that the industrial base of nuclear energy is very weak: Russia has not maintained, let alone invested in, its nuclear energy program for twenty years; and the U.S. nuclear industry effectively ground to a standstill after the Three Mile Island accident in 1979. Qualified nuclear specialists are coming of age, and it is unclear how young cadres could be attracted in sufficient numbers to working in an industry that lacks an adequate infrastructure, not to mention contemporary training standards. Liability issues and their heterogeneous handling in countries with distinct economic traditions make it difficult to harmonize regulatory policies at an international level.

International nuclear safeguards will rely, yet again, on the International Atomic Energy Agency (IAEA), an organization that has been torn, since its inception in 1957, between its mandate to promote nuclear energy applications and its responsibility to monitor the peaceful use of nuclear facilities. But there is reason to doubt the IAEA's ability to manage this kind of international regulation, given past experience with the agency's lack of authority when it comes to actually enforcing its control mandate. Following the U.S.-Indian nuclear deal, compliance with the Non-Proliferation Treaty (NPT) no longer appears to be a precondition for cooperation at the level of civilian nuclear applications. It remains to be seen whether an international fuel supply regime can be accomplished solely on the basis of commercial interests.

The recent proposals could be interpreted as attempts to commercialize nuclear power and turn it into a "normal" part of the global economy. Instead of international agreements and other legal "fixes," the brunt of the task today is being shifted on to technical "fixes" where, on the one hand, reactor designs are modified, and on the other, sensitive technological processes are "black-boxed" in yet another attempt to assure nuclear nonproliferation.

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References:

Braun, Chaim, and Michael May. "An International Regime of Fresh Fuel Supply and Spent Fuel

Disposal." *Nonproliferation Review* 13, no. 1 (2006): 57-80.
Garwin, Richard L., and Georges Charpak. *Megawatts and megatons: a turning point in the nuclear age?* New York: Knopf, 2001.
Hecht, Gabrielle. *The radiance of France. Nuclear power and national identity after World War II.* Cambridge, Mass. & London, England: MIT Press, 1998.
Holloway, David. *Stalin and the bomb. The Soviet Union and atomic energy 1939-1956*. New Haven & London: Yale University Press, 1994.
Josephson, Paul R. *Red Atom. Russia's Nuclear Power Program from Stalin to Today*. New York: W. H. Freeman & Co., 1999.
Macfarlane, Allison M., and Rodney C. Ewing, eds. *Uncertainty underground: Yucca Mountain and the nation's high-level nuclear waste*. Cambridge, Mass.: MIT Press, 2006.
Mazuzan, George T., and J. Samuel Walker. *Controlling the atom: the beginnings of nuclear regulation, 1946-1962*. Berkeley: University of California Press, 1985.
Parr, Joy. "A Working Knowledge of the Insensible? Radiation Protection in Nuclear Generating Stations, 1962-1992." *Comparative Studies in Society and History* 48, no. 4 (2006): 820-851.
Schmid, Sonja D. "Envisioning a Technological State: Reactor Design Choices and Political Legitimacy in the Soviet Union and Russia." Ph.D. diss., Cornell University, 2005.
Sidorenko, Viktor A. "Nuclear power in the Soviet Union and in Russia." *Nuclear Engineering and Design* 173 (1997): 3-20.
Walker, J. Samuel. *Containing the atom: nuclear regulation in a changing environment, 1963-1971.* Berkeley: University of California Press, 1992.
Weiss, Leonard. "Atoms for Peace." *Bulletin of the Atomic Scientists* 59, no.6 (2003): 34-44.

On Russia's recent announcement to build 40 new nuclear reactors see
http://www.sptimes.ru/index.php?action_id=2&story_id=16709