It's Time for Next-Generation U.S. Nuclear Plants

by Marsha Freeman

While dozens of nations start building their first nuclear power plants, a parallel effort is under way to deploy more advanced, next-generation nuclear technology to supplement, and then replace, today's light-water fission reactors. The United States is decades behind in this effort, upon which future economic survival depends. Although there is an acknowledged lack of skilled manpower and industrial infrastructure, the greatest obstacle to moving forward has been the lack of political will.

Next-generation nuclear reactors include an array of technologies. The most immediately necessary is a family of high-temperature reactors (see p. 55). Through the production of outlet temperatures up to three times that of today's power plants, high-quality heat can be applied to create desperately needed freshwater, through desalination, and to produce synthetic fuels, like hydrogen.

Efforts in Russia, China, India, Japan, and South Africa to carry out research, build prototypes, and deploy fourth-generation nuclear technologies, are under way. In the United States, although there are small-scale concept development and design activities, there is no plan to *build* anything for more than a decade. How could there be? Adjusted for inflation, the budget for nuclear energy R&D today is *11 percent* what it was in 1980.

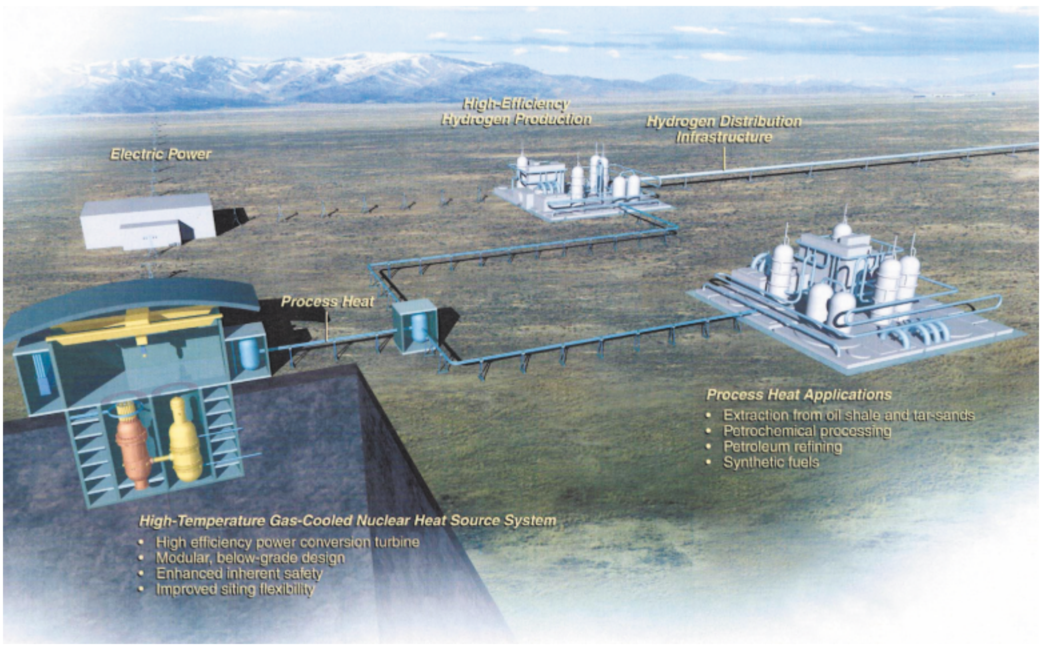
Congress has recently taken a small step to reorient the Bush Administration's nuclear R&D program, which is geared not toward economic development, but toward "nonproliferation," in order to get the next-generation reactor program moving. We need a crash effort, with the massive infusion of resources, which characterized President Eisenhower's Atoms for Peace program.

A Budget-Driven 'Strategy'

In 2002, the Department of Energy started a new program to design and demonstrate a Next-Generation (also referred to as a fourth-generation) Nuclear Plant project. In 2004, the Department approved the development of a full-scale nuclear plant that would be combined with a facility for producing hydrogen. The very-high-temperature reactor was chosen as the power source, to operate at about 950°C, or 1,742°F, nearly three times that of today's commercial nuclear power plants. Recognizing that it was years behind other nations in nuclear R&D, a Generation IV International Forum was initiated by the United States, to "cooperate" with other nations already engaged in advanced nuclear R&D.

But from the beginning, the program had no sense of urgency, too little funding, and a schedule that was determined not by the pace of technical progress, but mainly by the budget-driven strategy of spending smaller amounts of money, over a longer period of time.

The roadmap for a $2.4 billion demonstration program has construction on the very-high-temperature reactor scheduled to begin in 2016, and the plant to be operational by 2021. The Department of



Idaho National Laboratory

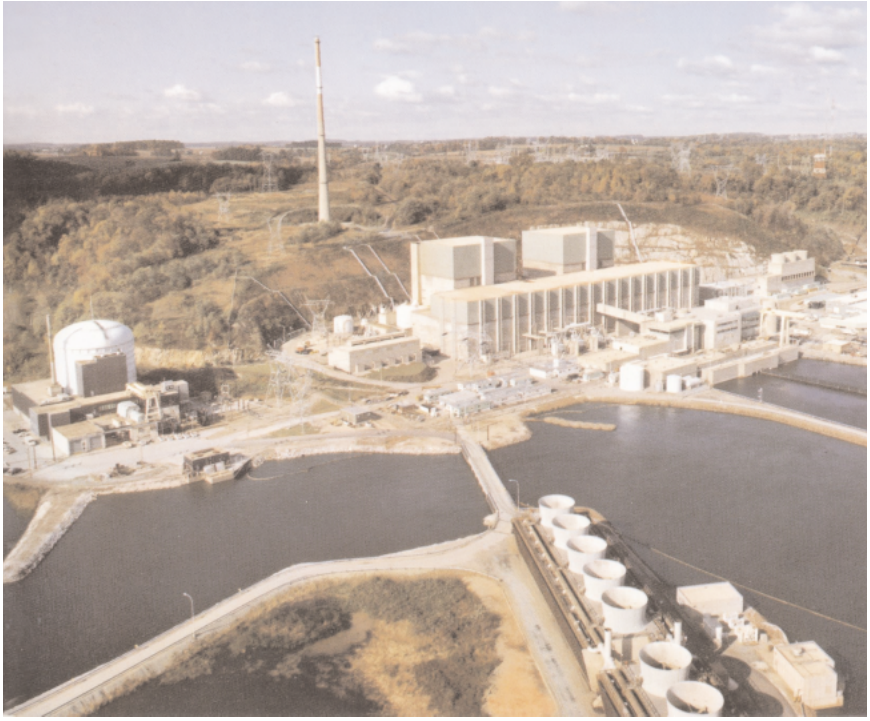
The Idaho National Laboratory's conception of the Next Generation Nuclear Plant, which would be used to produce electricity and high-quality heat for the production of synthetic fuels, like hydrogen, and for process heat applications in industry. This artist's drawing is similar to the Nuplex concept, nuclear centered agro-industrial complexes, designed by Oak Ridge National Laboratory in the 1960s.

Energy proposes commercial introduction by 2030! Even were this a revolutionary new technology, never before engineered, this schedule would be a bit conservative.

But consider the following: The United States operated two higher-temperature gas-cooled reactors in the past—the Peach Bottom Unit One reactor (1969-1974), and the Fort St. Vrain reactor (1979-1989); Japan and China have operated small high-temperature gas-cooled reactors, demonstrating the feasibility of the concept; and South Africa is building a fuel fabrication facility and completing the R&D to begin mass producing small, modular, high-temperature gas-cooled reactors, using the pebble bed design, in the next decade.

To make matters worse, in February 2006, President Bush announced his Global Nuclear Energy Partnership (GNEP). This program is a *25-year* effort to engage other nuclear-energy nations to develop "proliferation-proof" nuclear designs. The purpose is to limit access by the new nuclear energy nations to the full nuclear fuel cycle, including uranium enrichment to produce fuel, and reprocessing of spent fuel. When GNEP became the Administration's focus, the Next-Generation Nuclear Reactor became a lower priority.

Concerned that this next-generation nuclear program was floundering, Rep. Darrell Issa (D-Calif.), chairman of the Subcommittee on Energy and Resources of the Government Reform Committee, asked the General Accountability Office (GAO) to examine the progress of the program.



Peach Bottom Unit 1 (far left), in York County, Pennsylvania, was a 40-megawatt experimental high-temperature, helium-cooled reactor that gave the United States experience with this type of reactor, during its 1967-1974 operation.

Moving Forward, Faster

In its September 2006 report, "Status of DOE's Effort to Develop the Next Generation Nuclear Plant," the GAO reviewed the progress made, and the recommendations by two independent advisory groups. A group of experts gathered by Idaho National Laboratory, where the next-generation reactor will be built, and the DOE's Nuclear Energy Research Advisory Committee (NERAC), both recommended that the DOE accelerate its schedule for completing the plant. As the GAO notes, what good will an "even more advanced" reactor be in 2030, when other countries already have high-temperature systems for sale?

The Idaho group suggested that three years could be trimmed off the schedule, by scaling back some of the technology advances planned for the project, and taking a more incremental approach. The reactor could be designed to incorporate more advanced fuels and materials as they are developed, rather than waiting for the "best" to be ready before building anything.

NERAC pointed out that accelerating the schedule will make the project more "attractive to industry," which is supposed to pay a share of its development. In testimony before the Senate Committee on Energy and Natural Resources on June 12, 2006, NERAC member Dr. Douglas Chapin stated that a "completion date of 2021 greatly decreases the chances of substantial industry and international contributions." NERAC recommended that a reactor facility "that can be built soon, to gain experience, and then upgraded as the technology advances," would be preferable. It could be a "technology demonstrator," and a smaller machine.

As it now stands, the very-high-temperature reactor needed to meet the Department of Energy's design criteria would require a pressure vessel (which houses the nuclear reactor core) that is more than twice the size of that of a conventional nuclear power plant. There is only one company, Japan Steel, that could even scale up production to manufacture such a vessel, the GAO notes.

In Senate testimony on June 12, 2006, Dr. Regis Matzie, senior vice president of Westinghouse, stressed that the U.S. program could also be accelerated by leveraging the large-scale testing facilities developed in South Africa, enabling the program here to be "demonstrated within a 10-year period."

The GAO states that in addition to the efforts in China, South Africa, and Japan, the General Atomics company in the United States, and the French nuclear giant Areva, are advancing their own designs. General Atomics has started activities with the Nuclear Regulatory Commission, that could lead to an application for design certification, and has a research reactor design that could lead to a commercial prototype.

South Africa's Eskom, in partnership with Westinghouse, has also started pre-design-certification activities with the Nuclear Regulatory Commission. If the U.S. program stays on its current track, one or both of these fourth-generation nuclear reactors could be on sale to U.S. utilities, years before the U.S. demonstration reactor is up and running.

The Idaho National Lab group estimated that completing the plant three years earlier would reduce the total cost, but would require more funding in the near term. In FY2007, the Lab states, funding for design work would need to be increased from $23 million, the Administration request submitted to Congress, to $100 million. The Department of Energy's response was that although the current design work could support doubling the department's FY07 request of $23 million ... DOE has limited funding for nuclear energy R&D and has given other projects ... priority over the Next Generation Nuclear Plant."

Congress was not satisfied with this response.

In a June 11, 2007 report on the FY2008 Department of Energy budget, the House Committee on Appropriations states that its bill includes an increase to $70 million for the Next-Generation program. The money for the increase was taken from the ill-conceived GNEP program. The Committee directed the Department of Energy to make the Next-Generation program a higher priority than GNEP.

Highest priority and sufficient resources would put the next-generation nuclear reactor on the right pathway.

INTERVIEW: PHIL HILDEBRANDT

INL Plans to Put Next-Generation Nuclear Plant Online by 2018

Phil Hildebrandt is the project director for Idaho National Laboratory's Next-Generation Nuclear Plant, and is Special Assistant to the Laboratory Director for Prototype Reactors and Major Projects. He has more than 39 years of experience in the nuclear and power industries, including in the Naval Nuclear Propulsion Program.

Hildebrandt was interviewed by Marsha Freeman on Aug. 2, 2007.

Question: In June, the House Appropriations Committee increased the budget for the Next-Generation Nuclear Plant to $70 million, and urged that it become a priority for the Department of Energy.... How far does the $70 million the Appropriations Committee voted on go toward reducing the schedule?

I think it's a very important starting point. The amount of money in the budget that you'd like to have in FY|08, to keep on the schedule that we'd like to stay on, would be considerably more than that—a factor of three to four more than the $70 million. However, the $70 million makes a very important first step in putting the Next-Generation Nuclear Plant, and the demonstration plant for high temperature reactor gas technology, on the road. Let me give you the context for that.

The Next-Generation Nuclear Plant and the commercialization of the gas reactor is, in practical fact, going to be driven by private industry, not by government. We are putting together a commercial alliance. It will have members including end-users and vendors, and will be a partnership with government to help share costs.

That commercial alliance is pressing very heavily toward completing, and making operational, the Next-Generation Nuclear Plant as a demonstration plant, by 2018. That is the press of the private sector. That is a different schedule than what comes out of the Energy Policy Act [passed by Congress in 2005].

Question: Is the drive to get industry involved due to the fact that you don't see the government putting the level of funding into it that it requires?

That's correct. The government would start it off the ground, but as it's practically starting to occur, the private sector will be the driving force behind this.

Question: What industries do you see participating in the commercial alliance?

The private sector membership for the commercial alliance has end users that are considerably different than the traditional nuclear industry. In this case, they are the broader energy industry—the petroleum industry, the petrochemical industry. This involves the use of process heat; process heat, and hydrogen being one of the energy carriers from that process heat, is the primary focus here. Industry wants the capability to exist as soon as possible, but no more than a decade out.

With what has been provided by the Congress, we still could achieve a 2018 start-up, with the House Appropriations Committee budget mark. It just means we're pushing a bow wave of funding ahead of us.

Question: What level of contribution will be required from the private sector?

I would expect that by the end of the project, the government and industry would share it about equally. There would be 20/80 split early on, when we're in the developmental aspects of the program, and it flips around the other way as you get into construction of the demonstration unit.

Question: What kind of interest have you had from industry?

The broader end-users in the petroleum and petrochemical industry are beginning to be interested, based on the prices of premium fuel, like natural gas and oil. In the petroleum industry, they use a large amount of hydrogen, and depending upon which company it is, they use a tremendous amount of natural gas. Natural gas is used as a source to