Outdated Thinking Is Holding Us Back

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The question I'm most often asked about nuclear energy is how we plan to deal with the wastes. The answer I give is this: The spent fuel from nuclear reactors may just be the best managed waste in the world. Unlike other energy technologies that can dump some of their wastes on the ground or in the air, nuclear plants manage every bit of theirs, and include an explicit charge for its safe, long-termdisposal in their power prices.

The volume of high-level nuclear waste is not all that large: The total generated byAmerica's 103 nuclear plants during their lifetimes could be stacked less than 15 feet high in a space the size of a football field. Equivalent coal plants, by comparison, produce thousands of times more waste volume (albeit nuclear wastes are very hazardous and far more concentrated).

Commercial high-level nuclear wastes are currently safely stored in spent-fuel pools and dry-storage casks at the plants where they were generated. The long-term U.S. government plan is to find and license a national underground repository. The Department of Energy has spent nearly $6 billion to research and test a deep geological site in the remote desert at Yucca Mountain, Nev. The nuclear industry has alreadycontributed $16 billion intothe nuclear waste fund that will pay for developing and operating the repository.

The United States may be able to learn something, however, from France, Britain and Japan, where nuclear energy is a major component of electricity generation. These countries have the technology and political will to recycle spent fuel rather than throwing it away after a single use. This strategy extracts more energy from the fuel, while at the same time reducing the volume and radioactive lifetime of the wastes that have to be stored in the repository.

Recycling, or reprocessing, essentially involves dissolving spent nuclear fuel and separating out the uranium, plutonium and certain other materials for re-use in the reactor. The remaining fission product wastes -- which remain radioactive fordecades or at worst centuries, as opposed to thousands of years for uranium and plutonium -- are then dissolved in melted glass for disposal and long-term storage in stainless steel canisters.

In the late 1970s, the United States instituted a policy prohibiting the recycling of commercial nuclear fuel. President Jimmy Carter signed theoriginal directive in response to concerns that recycling was not economical and fears of the possible proliferation of nuclear materials and technology for non-peaceful purposes. That policy deserves to be revisited in light of today's technical and political realities.

Three issues should be considered in choosing the "best" nuclear fuel cycle for the United States in the 21st century.

¥ Economics: How does the cost of recycling spent nuclear fuel compare with the cost of ausing it only once before disposal? That is hard to know, in part because it is impossible tocalculate the ultimate cost of a geologic repository that might have to last thousands of years, and in part because we have little experience in commercial reprocessing. In the United States, the comparison is further distorted by the presence of large amounts of government-subsidized high-enriched uranium from former Soviet weapons programs, and because the U.S. policy places zero economic value on recycled plutonium.

The French experience with reprocessing, though, may offer some answers. According to the French data, considering all factors from mining to disposal, the cost of recycling spent fuel is roughly the same as for using it once and then storing it permanently. So the economic tradeoff is approximately equal.

But reprocessing has a potential bonus: There is up to 100 times more energy potential in nuclear fuel than is extracted in one cycle. Multiple recycling in future advanced reactors could thus offer significant advantages in sustaining low-cost nuclear fuel supplies for manygenerations -- particularly if the use of nuclear power expands substantially.

¥ Environmental impact: Is it better to directly dispose of all our spent nuclear fuel in a geological repository that has to be designed and managed to provide barriers to the release of hazardous materials for thousands of years, or to reprocess it, recycling the plutonium and other fuel materials in the reactor and only disposing of the shorter-lived fission products? Certainly recycling can simplify waste disposal -- relatively speaking, it's a cinch to designstorage that can last for a few hundred years. In the recycle scenario, there would be far less plutonium and other long-lived materials to store in the repository.

Multiple recycling, to extract the largest amount of energy from the fuel and minimize the net waste volume, would require development and deployment of a new class of fast burner reactors. This development work was also stopped in the United States in the late 1970s with the cancellation of the Clinch River Breeder Reactor project. Reactor and fuel cycle research and development needs to be reinstated to form a solid technical basis for future policy decisions.

¥ Social responsibility: An often-raised concern about reprocessing is that the separated plutonium could be vulnerable to theft or diversion for nuclear weapons. It is worthwhile to note that no nuclear materials have ever been proliferated from commercial spent fuel, both because of the substantial cost and technical difficulty and because of strict oversight by the International Atomic Energy Agency.

New technology may eliminate the proliferation concern entirely. An electrometallurgical process developed by Argonne National Laboratory separates uranium, plutonium and other fuel materials from the fission product wastes, but not from each other. Therefore, no weapons-grade material emerges from the process.

Nuclear power, in one or more advanced states, holds great promise for the generation of abundant, clean and affordable electricity for the United States and the world. If spent fuel recycling can be made economical in the United States, and if advanced technology can respond effectively to the proliferation concern, then America may have an attractive new option for dealing with the growing need for clean energy, while at the same time improving the social acceptability and cost of our waste disposal strategy.

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