NUCLEAR WASTE

Nuclear Waste: Knowledge Waste?

A stalled nuclear waste program, and possible increase in wastes, beg for social science input into acceptable solutions.

Eugene A. Rosa,[1,2]* Seth P. Tuler,[3] Baruch Fischhoff,[4] Thomas Webler,[3] Sharon M. Friedman,[5] Richard E. Sclove,[6] Kristin Shrader-Frechette,[7] Mary R. English,[8] Roger E. Kasperson,[9] Robert L. Goble,[9] Thomas M. Leschine,[10] William Freudenburg,[11] Caron Chess,[12] Charles Perrow,[13] Kai Erikson,[13] James F. Short[1]

Nuclear power is re-emerging as a major part of the energy portfolios of a wide variety of nations. With over 50 reactors being built around the world today and over 100 more planned to come online in the next decade, many observers are proclaiming a "nuclear renaissance" (*1*). The success of a nuclear revival is dependent upon addressing a well-known set of challenges, for example, plant safety (even in the light of improved reactor designs), costs and liabilities, terrorism at plants and in transport, weapons proliferation, and the successful siting of the plants themselves (*2*, *3*).

Particularly challenging is the disposal of high-level nuclear wastes (HLW). More than a quarter-million tons of commercial HLW is in need of disposal worldwide (*1*). Wastes accumulate at all stages of the fuel and weapons development cycle: mining, enrichment, fabrication, and reactor operation. The most dangerous of these wastes accumulate at the "back end" of the fuel cycle, particularly in the form of spent fuel, which, despite reprocessing technologies, may remain highly radioactive for a million years (*4*). Although disposal of HLW remains one of the most challenging scientific and social problems facing all nuclear nations, recent events in the United States, home of 60,000 tons of HLW, make this a particularly important time to highlight often-overlooked social science expertise needed to develop strategies for publicly acceptable solutions to the problem.

More Waste for a Stalled Waste Program

There is disagreement about short-term and mid-term approaches for disposing of HLW, which include hardened on-site or regional storage, but the global scientific and policy consensus for long-term disposal is through deep geological sequestration (*5*). In the United States, where a successful waste-disposal program has eluded 10 presidential administrations, the 1982 Nuclear Waste Policy Act, amended by Congress in 1987, designated a single deep geologic repository at Yucca Mountain, Nevada. Authorized to store 77,000 metric tons of spent fuel, this site was projected to begin accepting wastes by 31 January 1998. However, surprises arising from technical analyses of the site, such as the discovery that water flows more rapidly at the site than expected (*6*), increasing the chances of human exposure (*7*), led to this deadline being missed. Strong, persistent opposition among Nevada residents and others also contributed to delays, with the site not yet having accepted any waste (*8*, *9*). The Obama Administration withdrew funding for Yucca Mountain in its 2010 budget and directed the Department of Energy (DOE), the federal agency responsible for building a repository, to withdraw its licensing application to the Nuclear Regulatory Commission (NRC). These actions are currently the subject of multiple lawsuits and NRC review (*10*). If successfully upheld, they will effectively stop the Yucca Mountain project, despite its being the only congressionally authorized site for a repository.

The problem could worsen. The nuclear industry has taken advantage of a new one-step licensing process for commercial nuclear plants, submitting 22 applications to the NRC for 33 new reactors (*1*, *11*). Each new reactor could generate about 25 metric tons of HLW per year (*1*). President Obama confirmed the Administration's nuclear commitment by pledging $8.3 billion in federal loan guarantees for two new nuclear plants in Georgia (*12*) and by seeking to increase the total amount to $54.5 billion by next year (*13*).

Facing a stalled national waste program on one hand, and a possible increase in the volume of wastes on the other, the president directed the secretary of energy to appoint a Blue Ribbon Commission on America's Nuclear Future, which "should include recognized representatives and experts from a range of disciplines and with a wide range of perspectives" (*14*). The 15-member commission formed in January 2010 is charged with conducting "a comprehensive review of policies for managing the back end of the nuclear fuel cycle," including civilian and defense used nuclear fuel and nuclear waste (*14*). The White House further recognized that "Such a solution must be based upon sound science and capable of securing broad support, including support from those who live in areas that might be affected by the solution" (*15*).

Physical Constraints, Social Acceptability

Unfortunately, the scientists and officials seeking to craft an acceptable waste-management strategy are starting from the weak position created by the legacy of past actions. For example, the mishandling of wastes from military weapons facilities (*16*, *17*) generated considerable controversy and loss of social trust and confidence in the integrity of the siting and facility development program. Trust is a key factor in risk perceptions (*9*, *18*). The DOE is especially mistrusted (*19*) and has been unable to address this mistrust (*20*).

The key issue here is not only to get the science right but also to get the "right" science (*21*). Getting the right science means answering the right questions. Given the history of nuclear waste management, in the United States and elsewhere, those questions must focus on the conditions for social and political acceptability, within the constraints identified by physical science and engineering. Some communities will be asked to host the processing, storage, and disposal of used nuclear fuel and HLW. Others will be asked to allow the transport of these materials. All Americans will pay for the infrastructure. Although scientific and technical analyses are essential, they will not, and arguably should not, carry the day unless they address, both substantively and procedurally, the issues that concern the public.

Fortunately, there is a sizable social science literature that has systematically investigated the questions of public acceptability, making basic tenets of public concerns quite clear (*8*, *22*). People do not like projects that pose highly uncertain risks, unless they see great compensating benefits and have deep trust in the institutions managing them (*8*, *9*). Many studies have shown that these condi-

[1]Washington State University, Pullman, WA 99164, USA. [2]Woods Institute for the Environment, Stanford University, Stanford, CA 94305, USA. [3]Social and Environmental Research Institute, Greenfield, MA 01301, USA. [4]Carnegie Mellon University, Pittsburgh, PA 15213, USA. [5]Lehigh University, Bethlehem, PA 18015, USA. [6]The Loka Institute, Amherst, MA 01002, USA. [7]University of Notre Dame, Notre Dame, IN 46556, USA. [8]University of Tennessee, Knoxville, TN 37996, USA. [9]Clark University, Worcester, MA 01610, USA. [10]University of Washington, Seattle, WA 98105, USA. [11]University of California, Santa Barbara, CA 93106, USA. [12]Rutgers University, New Brunswick, NJ 08901, USA. [13]Yale University, New Haven, CT 06520, USA.

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tions for public acceptance are lacking with HLW (*8*, *9*, *18*, *23*). Citizens have expressed great concern about siting a repository in their vicinity, even while supporting nuclear power in the abstract (*8*, *18*).

Many studies have demonstrated the importance of engaging impacted publics at the beginning of policy planning and projects, to get the right questions to frame analyses, ensure that expectations for inclusive and fair processes are met, and ensure legitimacy of decisions (*24*–*26*). A variety of frameworks, such as the staged approach (*27*), have been developed for "analytic-deliberative" (*21*) processes to ensure a technically competent and publicly engaged solution. These frameworks emphasize "continuous, adaptive learning in both technical and societal areas," continuous public engagement, and transparent use of public inputs (*27*). Case studies show the benefits of public involvement, for example, the cleanup of an Ohio nuclear weapons facility (*28*) and the siting of a facility in New Mexico for storage of defense-generated transuranic wastes (*23*).

Moreover, public engagement and transparent deliberations are "communication acts" that build social trust and legitimacy, whatever their content. The social science needed to create such communications is well understood (*21*, *27*, *29*, *30*) and essential for strategies that rest on the principal of voluntary consent and the public's right to know (*31*, *32*).

However, despite decades of social science, guidance to promote adaptive learning, social trust, and legitimacy has not been followed in addressing waste and other challenges to nuclear power (*26*). For example, how state structures of democracy, and the role of technical elites in policy formation and implementation, may influence whether and how scientific evidence is used. Institutional cultures typically frame challenges as technical problems rather than societal challenges. To the extent that the social side is recognized, it has often been viewed as an obstacle to overcome, not an element of the democratic process; planners and officials can be fearful that public involvement may shift an unengaged or uninformed public toward more controversy or opposition, thus reducing their control. Those institutions may not trust the public to make the "right" decisions. Agency guidance is often very general, leaving planners vulnerable to missteps when dealing with contingencies of specific situations and averse to trying new approaches.

Rebuilding Trust

The Blue Ribbon Commission, the DOE, and other responsible agencies should make the rebuilding of social trust and credibility central to their operations and their proposed strategies for waste management, then draw on the social sciences needed to fulfill these commitments. This means making the public and the social sciences serving the public a driving priority (*33*). The science that can inform an adaptive learning process that involves the public in a way that improves decisions and enhances trust and credibility is remarkably inexpensive, compared with the stakes riding on their efforts.

The commission is particularly well positioned to begin the process of overcoming the problematic legacy that it inherited. It has taken steps toward transparency by fulfilling the requirements of the Federal Advisory Committee Act. However, there is little scientific reason to expect such a pro forma approach—where the emphasis is on meeting formal requirements, not the needs of the public—to succeed where its predecessors have failed. Rather, it runs the risk of exacerbating indifference, mistrust, and resistance (*24*). The alternative is to treat the public in a respectful, evidence-based way throughout the deliberations. Social science can provide effective guidance in the selection of representative publics, in the development of effective deliberation techniques, and in the integration of technical and lay knowledge. The commission, consistent with its charge and charter, should include expertise on its subcommittees to inform recommendations addressing social trust and credibility, perhaps even creating a subcommittee devoted specifically to procedural issues of a proposed waste-management strategy. The strategy adopted by the commission will affect not only how its recommendations are judged but also how the public should be involved in subsequent policy and siting decisions. Addressing relevant social issues does not guarantee success, but ignoring them increases the chances of repeating past failures.

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