Nuclear Power One of Several Green Weapons Against Global Warming

The MIT study of the future of nuclear power, as summarized by Jim Dawson, (PHYSICS TODAY, December 2003, page 34) states that "the management and disposal of high-level radioactive spent fuel from the nuclear fuel cycle is one of the most intractable problems facing the nuclear power industry throughout the world." In reality, it is a problem that exists only in people's minds.

For the first 20 years or so of operation, a power plant stores spent fuel underwater in a small pool. When the pool becomes full, the older fuel—for which much of the radioactivity has decayed away—is removed from the water and stored in dry casks on site. An area the size of a football field is adequate for storing the spent fuel from hundreds of years of a power plant's operation. Considering the huge number of kilowatt hours that are produced, the problem should be regarded as insignificant, rather than "intractable."

The spent fuel is valuable and should be kept in a manner that allows easy retrieval. It still holds about 97% of the original potential energy but may be even more valuable for the fission products it contains. To give one example, rhodium, a platinum metal, makes up about 2% of the fission products, and the price of rhodium fluctuates between the price of gold and 10 times that.

Rhodium has many uses and would replace platinum in many applications if the price could be reduced to a more reasonable value. Fresh fission-product rhodium contains traces of isotopes with half-lives of 2.9 and 3.3 years. It is just a matter of time until these radioactivities decay to negligible levels. The material in US spent fuel is worth billions of dollars and gets more valuable every day as the shorter-lived activities decay away.

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A recent story in PHYSICS TODAY summarized the case for nuclear power as a strategy for combating carbon emissions and global warming. Although the MIT study[1] on which the story was based was careful to point out that nuclear power is

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one of several such strategies (including energy efficiency, carbon sequestration, and renewable energy resources), all of which deserve increased governmental support, this point was lost in the magazine's review, which appeared to present an either–or choice of fossil fuels or nuclear power.

The MIT study itself consciously sidesteps the most important question: Which strategies deserve the most governmental support based on their promise to minimize the total societal costs of energy? To answer that question, we urgently need more *comparative* studies of all greenhouse-gas reduction strategies that consider both the raw cost of power generation and so-called external costs (emissions, nuclear waste disposal, proliferation risks, and so forth). External costs are notoriously difficult to quantify, but comparative studies do exist.[2] The MIT study considers the effect of a "carbon tax" to quantify the external costs of CO_2 emissions from fossil fuels and proposes a fee for nuclear waste disposal. But it does not attempt to quantify the full external costs of these strategies or compare such costs with those of other strategies.

The raw generation cost of leading renewable sources such as wind and solar energy dropped 80% from 1980 to 2002 and will continue to fall as economies of scale and new technologies take hold.[3] The cost of wind power at the most favorable sites ($0.05 per kilowatt hour) already makes it nearly competitive with fossil fuel sources on a raw-cost basis. Given that the external costs of wind power are probably much lower than those of fossil fuels and nuclear power, wind power should be getting much more support than it currently receives. Denmark generates 15% of its electricity from wind, compared with 0.3% for the US. What are we waiting for?

References

1. Massachusetts Institute of Technology, *The Future of Nuclear Power*, available at http://www.mit.edu/afs/athena/org/n/nuclearpower.
2. US Congress, Office of Technology Assessment, *Studies of the Environmental Costs of Electricity*, available at http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/ns20/alpha_f.html.
3. US National Renewable Energy Laboratory, *Renewable Energy Cost Trends*, available at http://www.nrel.gov/analysis/docs/cost_curves_2002.ppt.

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Dawson replies: PHYSICS TODAY contacted Ernest Moniz, cochair of the MIT study, for a response.

Moniz comments: Both the Norbeck and Clark-Phelps letters contain some valid observations, but they fail to note additional key considerations.

Edwin Norbeck's assertion that the nuclear waste management problem "should be regarded as insignificant" underestimates both the technical and political challenges if considerable growth in nuclear deployment is to be realized. The MIT report states that "geological disposal is technically feasible but execution is yet to be demonstrated or certain." The issue of execution should not be minimized. Second, he emphasizes the economic value of actinides and fission products in the spent fuel but does not acknowledge either economic or proliferation concerns. Several countries today separate plutonium and uranium from irradiated fuel for recycling. However, this is not economically competitive, and an accumulation today of about 200 tonnes of separated plutonium is a clear proliferation risk (the International Atomic Energy Agency defines "significant quantity" as 8 kg). Further partitioning of commercial-reactor spent fuel to extract specific fission products is not currently performed, has been explored for some elements, and faces major economic hurdles.

Robert Clark-Phelps correctly asserts the importance of comparative studies of alternative greenhouse-gas reduction strategies. However, all carbon-free technology pathways are likely to be needed in a robust response to the daunting greenhouse-gas challenge, and comparative studies should be grounded in objective, in-depth multidisciplinary analyses of each pathway. Nuclear power, the starting point for the MIT group, is in many ways the most contentious, but all others face significant challenges at the terawatt scale. Wind, for example, has a substantial tax credit, and its deployment should continue to show strong growth, but many issues, such as intermittency, long-distance transmission, energy storage, and public ac-