Nuclear Power as an Energy Source

IN HIS PRESIDENTIAL ADDRESS "SCIENCE, sustainability, and the human prospect" (Association Affairs, 9 Aug., p. 954), Peter H. Raven writes, "Lester Brown cogently points out…that a combination of wind turbines, solar cells, hydrogen generators, and fuel cell engines offers both energy independence and an alternative to fossil fuels…Worldwide and over the past decade, the use of wind power grew by 25% a year…" (p. 956).

This deserves a closer look. The July-August issue of *Renewable Energy World* lists current worldwide wind generation capacity at 24,900 MW. Although current wind turbine units have capacities of over 1 MW, I suspect that the average unit is closer to 500 kW; hence, one can assume that about 50,000 grid-connected wind machines are in place. The same spreadsheet that lists the capacity at 24,900 MW shows an annual energy output of 54.5 billion kW hours. If we take 8760 hours per year and assume that the units operate 25% of the time, then a capacity of 24,900 MW will produce 54.5 billion kW hours per year. No one knows the actual grid contribution of 50,000 wind machines, so the total capacity quoted is a guess and the energy is derived assuming a 25% capacity factor.

In spite of the ambiguity in both capacity and energy, one fact stands out: Modern wind turbines in good locations can produce about 800 kW hours of electric energy per year for each square meter of wind disc.

Now let's look at the 25% growth in wind-generated electricity. Current wind-generation technology includes wind-disc diameters of 100 m. In round numbers, this is 8000 m^2 of wind disc per unit and 6 million kW hours per year per unit. A 25% growth in wind energy would require about a 13 billion kW hours increase in wind energy in the first year. Someone must find a home for 2000 wind machines—each one 100 m in diameter.

But this is only the beginning. The availability of wind energy does not coincide in time or location with the need for electricity. Brown proposes using the wind energy to generate hydrogen and then recovering the electric energy through fuel cells (*1*). If one calculates the losses associated with this system, the 2000 wind machines may expand to 4000.

I must point out that the Seabrook nuclear station in Seabrook, NH, routinely delivers over 8 billion kW hours per year. At the moment, worldwide, about 433 nuclear plants are in operation, delivering 2560.9 billion kW hours per year. Even without the hydrogen interface, close to 500,000 very large wind machines would be required to replace the world's nuclear establishment.

Raven ignores the nuclear option. I don't understand that. If the atmospheric load of carbon is indeed a problem, and if an industrial society is to survive, then nuclear-generated electricity must be part of the mix.

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Reference
1. L. R. Brown, *Eco-Economy* (Norton, New York, 2001).

I HAVE LONG ADMIRED PETER RAVEN FOR his fine contributions to biological science, and I find his Presidential Address "Science, sustainability, and the human prospect" (Association Affairs, 9 Aug., p. 954) an excellent summary of the subject.

However, there is one flaw. He makes a strong case for decreasing our dependence on fossil fuels. But the only mention he makes of nuclear power is that we should have "more secure ways of dealing with nuclear materials." There is no mention of nuclear energy as a power source.

Although wind and other forms of solar energy may someday make a significant contribution to our total energy picture, it will be decades before this comes to pass. In the meantime, nuclear power has provided 20% of our electric power, which means 20% less noxious pollutants from fossil-fuel generation of electricity. In addition, nuclear fuels are found right here in the United States, with no need for reliance upon fickle Middle East sources.

Commercial nuclear power has never killed a single person outside the former Soviet Union. We have a glut of uranium, which we have not had to mine for over a decade. If we do have to mine more, that mining is only 10% as lethal to the miners as is coal mining (*1*).

One may thus make a good environmental case for increasing our use of nuclear power.

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Reference
1. J. Jagger, *The Nuclear Lion: What Every Citizen Should Know About Nuclear Power and Nuclear War* (Plenum, New York, 1991).

Response

THERE IS NO "SILVER BULLET" FOR EXPANDING carbon-free energy supply. All of the possibilities pose significant challenges. In the case of nuclear energy, a substantial expansion of today's contribution (one-fifth of the U.S. electricity supply, one-sixth of the world's) would require meeting several conditions. First, nuclear electricity generation costs from new plants (not old ones that have already been depreciated) must be competitive with alternative no-carbon or low-carbon electricity sources. Second, a very high level of safety against accident and terrorist attack must be achieved and

sustained in all nuclear-energy operations. Third, the problem of radioactive-waste management must be addressed in a way that is both technically adequate and politically acceptable. Fourth, tight barriers must be in place against leakage of nuclear-explosive materials from nuclear-energy systems into the hands of terrorists or proliferant nations. It is possible that these formidable conditions can be met. We ought to be trying. But they are not met as of today. Until they are, the role that nuclear energy will be able to play in reducing carbon emissions from the energy sector will remain uncertain.

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Defining Scientific Misconduct

IN HIS EDITORIAL "NEXT STEPS IN THE SCHÖN affair" (18 Oct., p. 495), Donald Kennedy appropriately discusses the need for further actions, by many parties, to try to prevent future instances of misconduct like the one described in our report (*1*) on the Schön affair. In his conception of the issues, Kennedy sees scientific misconduct and professional responsibility (the coauthor responsibility issue discussed in our report) as closely linked—"a distinction without a difference."

The issue is not so simple. As used in our report, the term "scientific misconduct" carries a precise definition, contained in the U.S. Federal Policy on Research Misconduct (*2*). Although "misconduct" may sound mild, it entails the most egregious offenses that can be committed in scientific research: fabrication, falsification, or plagiarism that is intentional or reckless. However, as is no doubt clear to all readers of our report, the committee strongly believes that even when coauthors are not guilty of scientific misconduct, they have a broader responsibility, and we welcome the ongoing discussion of this issue. We only wish to point out that there are important distinctions to be made between scientific misconduct and our broader responsibilities as scientists.

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References
1. See www.lucent.com/news_events/researchreview.html.
2. See www.ostp.gov/html/001207_3.html.

Should Coauthors Share Liability?

ACCORDING TO DONALD KENNEDY'S Editorial "Next steps in the Schön affair" (18 Oct., p. 495), "The hard question is this: If the benefits of authorship are enjoyed jointly and severally by all the authors, shouldn't the liability be shared in the same way?"

Actually, this is not a hard question at all; the answer is "no."

First, if the coauthors signed their names to a fraudulent paper in the sincere belief that it reported honest data, then they were the victims of a fraud, not its perpetrators. Second, the coauthors were not the only ones who sought to enjoy benefits from these fraudulent publications. Among others, editors who publish "high-impact" papers in their journals also get a share of the glory and advancement in their careers.

However, none of these beneficiaries acted unethically; they all believed the data to be honest, and they were all victims of a squalid deception. For this reason, none of them deserves to be stoned by the scientific community. Enough handwringing—resist the temptation to blame the victim.

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A Proposal for Transparency

THERE IS AN EASY, CHEAP, AND RESPONSIBLE way to link credit for published papers with responsibility for their contents, and I am surprised that it was not mentioned in Donald Kennedy's otherwise excellent editorial on the Schön affair ("Next steps in the Schön affair," 18 Oct., p. 495). This is for journals to publish for the reader a brief list of what the authors agreed had been their contributions—what part of the work reported each author actually did (*1*). My colleagues and I proposed this and devised a successful system that has since become common practice among the big medical journals, which were long ago forced to deal with irresponsible authorship and the phenomenon of multiple fabricated studies and coauthors disappearing whenever problems were raised (*2*). This system was devised to link credit to responsibility, transparency being a goal of science. The Beasley committee, in investigating Schön, would have had a far easier time, and been more convincing in their assessment, had they been able to see in print what Schön and his colleagues had asserted they had actually contributed to the work at the times when their joint papers were submitted. Then the committee, like the readers, would have plainly seen that the coauthors did nothing. *Nature* agreed to adopt this rule, but to make it voluntary. Because we all like credit without accountability, needless to say, almost no authors took up *Nature*'s offer. I now hope that both *Science* and *Nature* will change to this system, if only to remind authors that a scientific publication is, in Joshua Lederberg's words "an inscription under oath, a testimony" (*3*).

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References
1. D. Rennie, L. Emanuel, V. Yank, *JAMA* **278**, 579 (1997).
2. V. Yank, D. Rennie, *Ann. Intern. Med.* **130**, 661 (1999).
3. J. Lederberg, *Scientist*, 8 February 1993, p. 10.

Response

WHAT MY EDITORIAL ACTUALLY SAID WAS, "That sounds like a distinction without a difference." What I had in mind was that to most people, under most circumstances, scientific misconduct and professional responsibility really are linked. For example, most institutional rules hold failures of professional responsibility by scientists to be sanctionable. Under such rules, research misconduct would surely lead to sanctions, and has. I would agree with Beasley and his colleagues that although all research misconduct entails failure of professional responsibility, not all failures of professional responsibility constitute research misconduct.

It is easy to agree with Phillips that victims shouldn't be blamed. I find it harder to accept a world in which coauthors enjoy benefits but never have to accept risks. Rennie offers an ingenious way to finesse that problem, but it would make for complex (and costly) presentation in the journals.

DONALD KENNEDY

Nature Versus Nurture Redux

IN PATRICK BATESON'S REVIEW OF *THE Blank Slate* ("The corpse of a wearisome debate," Books *et al.*, 27 Sept., p. 2212), he attacks the book's author, Steven Pinker, on three levels. First, Bateson argues that Pinker has set up a caricature of