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As a contribution to the ongoing debates regarding US energy policy, PIRINC is enclosing two articles supporting a greater role for nuclear power. The first, "A Second Look at Nuclear Power" is by Paul Lorenzini, a retired PacifiCorp executive and former general manager of contract operations the Department of Energy's nuclear defense facilities in Hanford, Washington.. The second, "An Introductory Survey of Economics and Nuclear Energy is by Ferdinand E. Banks, Uppsala University, Sweden.[1]

PIRINC has long expressed the view that there is no single realistic policy option that can solve US energy problems. Since these problems were a decade or more in the making, they will take some time to correct. A broad mix of policies is required, including emphasis on research, incentives for renewables and clean coal, conservation, and access to domestic supplies. For too long policy makers have focused on only half the equation and have simply taken for granted that supply would be there at reasonable prices. This has been true for natural gas as well as crude oil supply and infrastructure for power generation. In addition, while coal has been the stepchild of U.S. energy policy, nuclear has been the orphan.

Nuclear energy has minimal bearing on oil concerns that are so much in the public eye. Oil is only a marginal fuel source for electricity production, accounting for less than 3% of total US electricity generation so a higher or lower level of nuclear power would have little impact on US demand for oil and oil import requirements. However, greater availability of nuclear power would impact demand for the two other fossil fuels, coal and natural gas. Currently, nuclear power accounts for about 20% of US power generation, coal nearly half, and natural gas about 16%. Power generation from gas, the cleanest of the fossil fuels, has been rising rapidly, up about 75% over the past 10 years, spurred by pollution concerns and the development of high efficiency gas combined cycle technology. But gas prices have risen sharply in recent years as production growth at home, and in our most important source of imports, Canada, has slowed and siting difficulties hold back the growth of

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LNG terminals to receive increased supplies from alternative sources. Even coal, our most abundant fossil fuel resource has run into supply problems, especially for the cleanest, high-heat value coal.

PIRINC is not suggesting that the problems associated with nuclear power have been resolved or can be ignored. However, nuclear energy can make an important contribution to energy diversity and to the global environment. Growing concerns about global warming tend to highlight the advantage nuclear power has versus fossil fuel generation in terms of greenhouse gas emissions. While renewable energy is viewed by many as the environmentally preferred alternative, its role in power generation remains very modest. Currently, electricity from renewable sources (including municipal waste) other than conventional hydropower amounts only to about 1.5% of total power generation. In effect, it is the more sobering prospects for the alternatives that suggest nuclear should reenter the energy policy debate.

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PAUL LORENZINI

A Second Look at Nuclear Power

By overlooking nuclear power in the quest for clean energy, we are condemning ourselves to a future of increased fossil fuel use.

For more than three decades, energy policies in the United States and much of the Western world have been held in the ideological grip of a flawed concept: the notion that we can achieve sustainable energy by relying solely on conservation and renewable resources, such as wind, the sun, the tides, and organic materials like wood and crop waste. Born in the wake of the 1973 oil embargo and arising out of renewed commitments to environmental quality, this idea has an almost religious appeal. An unintended result is that the world has become ever more reliant on fossil fuels and therefore less able to respond to global warming.

Although the vision of a renewable energy future has obvious appeal, it simply hasn't worked. Yes, energy efficiency has improved. We can now produce incremental gains in gross national product with much less energy than in the past, and electricity growth rates have been cut by more than two-thirds. But renewable energy sources have not come close to displacing fossil fuels as our primary source of energy. The failure is significant, eroding a fundamental premise on which modem energy planning is based. The long-term goal has been consistent: a supply adequate to meet global human needs while moving away from fossil fuels, ensuring environmental sustain ability (especially reducing greenhouse gas emissions), and achieving energy security. Instead, we are moving unwittingly toward a fossil fuel future, exactly what we've been trying to avoid.

Renewable energy has been sold on the premise that it has significant energy potential that could be tapped inexpensively. Yet after 30 years of effort, even with significant social, political, and financial incentives, the energy contribution from renewable sources has not budged. In 2002, renewable sources supplied about 6 percent of U.S. total energy consumption, unchanged from the 6 percent they provided in 1970. And the bulk of that 6 percent is supplied by sources that are far from new: hydropower and wood waste.

From 1988 to 1998, U.S. wind, solar, geothermal, and hydropower grew at 27 percent per year, and the contribution to U.S. energy supply from nonhydro, nonbiomass renewable sources grew nearly 100fold from 1980 to 1995. Even so, wind, solar, and geothermal energy accounted for only about 0.5 percent of the energy consumed in 2002. The contribution from fossil fuels did drop from 93 percent in 1970 to 85 percent in 2002, but it did so only because nuclear power made a substantial new contribution, supplying 8 percent of the 2002 energy consumption. Globally, the situation is similar. In 2000, nearly 90 percent of global energy came from fossil fuels.

Current forecasts project little improvement. In its *Annual Energy Outlook 2004*, the U.S. Department of Energy (DOE) expects coal, oil, and natural gas to provide 89 percent of all new U.S. energy through the year 2025. In fact, fossil fuels are expected to increase, from 85 percent in 2002 to 87 percent in

2025. The International Energy Agency's (IEA's) *World Energy Outlook for 2002* paints a similar picture: Coal, oil, and natural gas are expected to provide more than 90 percent of all new energy from 2000 through 2030.

This failure to perform cannot be blamed on inadequate support. Since 1978, DOE has invested more than $10 billion in renewable technologies, supplemented with generous tax incentives and state subsidies. Added support has come from the private sector. Oil behemoths such as Exxon, Shell, Mobil, ARCO, and Amoco, as well as non-oil energy companies such as General Electric, General Motors, Owens-Illinois, Texas Instruments, and Grumman, have all tried to enter the renewable energy market.

But renewable energy production has been constrained by physical limitations that have resulted in consistently high costs, because the energy that renewable energy technologies collect is both diffuse and intermittent. New York City, for example, uses 10 times more energy than its land area collects in sunshine. Resources such as sunlight and wind require large elaborate systems of collection, conversion, transport, and distribution to make them available as electricity. Substituting wind power for the Indian Point nuclear complex that now serves New York City would require somewhere between 125 and 385 square miles of wind farms, depending on the quality of the wind site and under the dubious assumption that a suitable site is available in the region. Even that huge field would not be sufficient, because wind turbines operate only when the wind blows, making backup supplies from other sources necessary. In California, for example, 73 percent of wind output is generated during six months of the year. Overall, California wind fields produce only about 23 percent of their energy capacity, because they are idle so much of the time.

Because the market has failed, efforts are now being made to force a shift to renewable energy through legislated mandates coupled with direct subsidies. The European Union has set an aggressive target of 22 percent of electricity from renewable sources by 2020. Many countries, including Denmark and the United Kingdom, have enacted targets into law. A dozen U.S. states have followed suit, legislating goals for renewable supplies, with penalties if they are not achieved.

It is doubtful that these mandates will be fully successful. Unless the penalties are very high, it is often cheaper to pay the penalty than the high price of renewable energy. But even if they succeed, the energy future would not change dramatically. The IEA forecasts that, even with such mandates, more than 60 percent of all new energy will still come from fossil fuels during the 30-year forecast period, and such fuels will still supply roughly 80 percent of all energy in the final year. And this projection applies only to the developed countries, where renewable energy mandates have been popularized. Globally, 87 percent of incremental new energy will still come from fossil fuels during the period, and coal consumption is expected to increase by 42 percent.

The grim conclusion is unavoidable. Both in the United States and around the globe, our hope that renewable energy will displace fossil fuels has left us with a de facto fossil fuel energy policy.

A fossil fuel future

There are many reasons to be concerned about continuing dependence on fossil fuels, but the most pressing one is global warming. If there is urgency at all in addressing global warming, energy policies must shift to non-carbon emitting resources more quickly. The environmentally favored energy source today is natural gas, because it is less polluting than coal and releases about half the carbon dioxide per unit of energy. However, when the total atmospheric carbon load continues to increase every year, it is little comfort to know that new energy contributes only half as much as previous sources. Moreover, in the rush to embrace natural gas, we have largely ignored environmental issues associated with exploration, drilling, recovery, and transportation.

There are growing concerns as well about supply vulnerability if we become more dependent on a single fuel source. Currently, the United States imports about 20 percent of its natural gas, mostly from Canada, and so far this amount seems manageable. As reserves in North America begin to dwindle, however, the United States will need to draw more heavily on distant sources. Russia, a problematic partner, has large reserves of natural gas (transportable as liquefied natural gas) and is one likely source. Dependence on natural gas also makes the United States more vulnerable to price spikes. Indeed, economic warning signs are already going up. As Alan Greenspan pointed out to Congress in 2004, the contract price for gas went from $2.55 per million Btu in July 2000 to $6.31 in July 2003, and there has been little relief since.

We didn't plan it this way. Thirty years ago, no one intended that fossil fuels should dominate the energy supply as the new century advanced. Indeed, a major goal of energy policy planning was to avoid just such an outcome. This predicament was the unintended consequence of failing to see that conservation and renewable energy alone would not be enough.

Rethinking nuclear power

The one resource that might have made a difference is nuclear power. Despite the controversy it provokes, U.S. nuclear power quietly increased its contribution during the 1980s and 1990s, as plants ordered in the early 1970s were added to the grid. Twenty countries now depend on nuclear energy for more than 20 percent of their electricity, and nine countries count on it for more than 40 percent. Nuclear power remains the only mature and readily expandable source of energy that emits no carbon (or any other pollutant associated with fossil fuels). But because we cling to the belief that renewable sources will be sufficient, nuclear power's contribution is predicted to remain static in the decades ahead. Should we not rethink the role that nuclear power might play?

The problems of nuclear power are well known. Many Americans remain concerned about questions of safety and the disposal of nuclear waste, as well as nuclear proliferation and economic viability. Given the urgency of finding alternatives to fossil fuel, however, it is worth reconsidering what nuclear power can actually offer. We need to be more candid as well about the extent to which ideological considerations have influenced our perception of nuclear power's problems.

The real advantage of nuclear energy is its potency. One pound of uranium contains the energy equivalent of roughly one million pounds of coal. Such potency means that nuclear power's energy potential is vast, clearly sustainable as a long-term resource. It also means that nuclear's environmental impact is inherently low. With so much energy coming from such a small volume of material, producing nuclear fuel requires much less exploration, mining, transportation, and collection, with all their attendant environmental problems, than do fossil fuels. For example, a 1,000-megawatt nuclear plant requires one refueling per year, whereas a similarly sized coal plant requires 80 rail cars of coal per day. And because the process of releasing nuclear energy occurs entirely inside the small fuel pellets that make up a reactor core, airborne releases from nuclear power plants are insignificant. This difference gives uranium a significant advantage over fuels, especially coal, that burn and emit airborne effluents. From 1973 through 1996, nuclear power displaced enough coal to reduce sulfur dioxide emissions by 5.3 million tons, nitrogen oxide emissions by 2.5 million tons, and CO2 emissions by 147 million tons.

The environmental and human health advantages of nuclear power over coal-even including accidents and nuclear waste-are actually well known. In his 1990 analysis *The Nuclear Energy Option*, University of Pittsburgh physics professor Bernard Cohen lists no fewer than 23 studies comparing coal with nuclear power. These include studies by the American Medical Association, the U.S. Environmental Protection Agency (EPA), the Stanford Research Institute, the Norwegian Ministry of Oil and Energy, and the National Academy of Sciences. All of these studies came to the same conclusion: that coal was far more hazardous, both to the environment and to human health, than nuclear power. According to a 2004 report for the EPA's Clean Air Task Force, as many as 26,000 U.S. deaths a year can be attributed to the ambient particulate emissions in the atmosphere from coal-burning power plants. In terms of health effects, that's roughly equivalent to one Chernobyl accident every two or three years. The report, which was intended to assess the relative effectiveness of policy approaches to reducing the harmful effects of coal combustion, estimated that even after federal action, coal-related deaths in 2010 would still range from 7,800 to 17,000, depending on the policy alternative adopted.

The overwhelming conclusion is that nuclear power is better than coal for both the environment and human health. That conclusion not only runs counter to the consistently shrill rhetoric from antinuclear activists, it says something far more telling: With their blind opposition to nuclear power and advocacy of policies that permit coal consumption to increase while nuclear power remains dormant, environmental groups have worked against their own stated objectives. No new nuclear plants are being built in the United States, but 94 new coal plants are in the planning stages. The story is the same across the globe. The *Wall Street Journal* recently reported a surge in coal consumption, particularly in China and India, as these developing giants feel the strains of rising oil demand. Using coal is the path of least resistance, given the current political resistance to nuclear power from the environmental community.

One astounding example of this is recent German energy policy. More than 50 percent of German electricity derives from coal burning; 12 nuclear power plants produce another 30 percent. Because its Green Party has become politically powerful, Germany has turned to the aggressive pursuit of wind and other renewable sources-not to reduce coal burning and coal pollution, but to shut down German nuclear power. Replacing 30 percent of German energy supply with renewable energy is improbable in itself; but why target nuclear power when coal burning is by far the largest source of environmental contamination from electricity production?

Ideological blinders

Many analysts have attempted to explain the visceral hostility toward nuclear power, and the most common explanation is that people link nuclear power with nuclear weapons. Others say it is simply irrational fear.

Although fear of unfamiliar technology is understandable, it hardly explains the organized opposition from those who are well educated and technologically literate and who have given the movement its legitimacy. There is, however, a different question one might ask: To what extent have such fears been exploited and encouraged by nuclear opponents for reasons that are more ideological than scientific? Two surveys taken in the early 1980s speak volumes on this question.

In 1982, a random survey of scientists listed in *American Men and Women of Science* sought to describe with some objectivity the attitudes of scientists toward nuclear power. The survey was conducted roughly a year and a half after the accident at Three Mile Island, a time when virtually every environmental organization, claiming to act on the best science, had lined up in opposition. At the time the survey was taken, a poll had reported that almost one in four Americans believed that a majority of scientists who are energy experts opposed further development of nuclear energy. For years the media had hammered home the message that there were deep divisions within the scientific community about nuclear power, a message that reinforced the legitimacy of the antinuclear movement. But the results of the scientist survey showed overwhelming support for nuclear power. Nearly 90 percent of the scientists surveyed believed nuclear power should proceed, with 53 per cent saying it should proceed rapidly. So why would nearly the entire environmental community be on one side of the nuclear question while, overwhelmingly, scientists were on the other?

Six months later, another survey of attitudes toward nuclear power development focused on "opinion leaders." Seven different groups were surveyed, each of which was assumed to playa key role in shaping opinions on nuclear power. Those surveys included directors of major national organizations such as the Natural Resources Defense Council, Friends of the Earth, the Sierra Club, and Critical Mass, as well as important regional anti nuclear groups.

Those surveyed were asked to rate the relative importance of 13 different areas of concern about nuclear power, including plant safety, risks to workers, high-level and low-level waste disposal, transportation, decommissioning, and proliferation. Every group except the nuclear opponents reported distinctions among the concerns, rating some quite important and others of little import. Opponents of nuclear power, on the other hand, considered virtually every item to be of critical importance. "Clearly the anti's make few distinctions in their assessments of nuclear power's dangers," the researchers noted, "which raises the possibility that their views on these problems may be less the cause of their opposition to the development of nuclear energy than its consequence." In other words, although the debate over nuclear power had been waged primarily on a technical front with arguments focused exclusively on technical issues, it seems likely that for many antinuclear activists their ideological position came first and the technical arguments were adopted to fit it.

These surveys have not been updated, so it is possible that attitudes may have shifted somewhat over the years. Even so, the rather remarkable alignment at the height of the controversy - virtually the entire environmental lobby on one side while virtually the entire group of scientists was on the other strongly points to an ideological polarization that existed at the time and likely continues today. The link here is to a line of thought going clear back to Rousseau, with its evolutions through 19th-century romantics, 20th-century existentialists, and other individual thinkers, most prominently Nietzsche: The consistent theme has been hostility toward the "mechanical and soulless" world of science and the technologies that flow from it. During the 1960s, it resonated with writers such as Jacques Ellul and Herbert Marcuse, who saw our technological society as dehumanizing. Others such as Paul Ehrlich and Barry Commoner equated technological growth with a pending environmental crisis. Environmentalism itself changed, from a pre-1960s preservationist posture to a post1960s attack on Enlightenment visions of progress, identified especially with technology.

This deeply felt philosophical position could help explain the harsh rhetoric. It is "modem technology with its ruthlessness toward nature," as University of California, Los Angeles, historian Lynn White characterized it in a 1967 essay. The prominent psychologist Abraham Maslow attacked science as a "dead end" that had become a "threat and a danger to mankind." E. F. Schumacher complained in his influential 1973 critique of modern society, *Small is Beautiful*, that humans are "dominated by technology," and called technology a "force that is out of control. . . [It] tends to develop its own laws and principles, and these are very different from human nature." The troubling consequence of these declarations has been a tendency to trivialize the enormous benefits in public health, material prosperity, and lengthened lifespan that science and technology have made possible. As a result, these ideologies have too often become barriers to developing and using the technologies humans really need.

A particularly revealing aspect of this has been the singular intensity with which environmentalists have opposed nuclear power, knowing full well it would mean a wider use of coal with its known environmental and human health disadvantages. Why would nuclear power receive such intense scrutiny since coal too supports industrial growth? A partial explanation for the difference in treatment is that coal combustion is a comfortingly familiar technology, whereas nuclear power symbolizes as nothing else the new world of technological advancement.

But nuclear power touches an even deeper ideological chord: mistrust of modern institutions. Nuclear power depends on functioning public institutions to ensure plant safety and to protect the public from radiation hazards. The political left, where environmental lobbies are most comfortable, doesn't trust these institutions. More basically, they mistrust the values of modern Western society that these institutions embody, particularly their capitalist economics and their reliance on science and technology.

This philosophical predisposition against technology explains, at least to some extent, why virtually the entire environmental lobby would have opposed nuclear power when the overwhelming proportion of scientists was on the other side of the issue. Many people today remain skeptical about nuclear power, even though recent polls show that as many as 73 percent of college graduates favor nuclear power, as do 65 percent of the general population. Much of the skepticism about nuclear power has been influenced by a relatively small activist environmental lobby that is motivated as much by ideology as by concerns with the technology itself. These ideological differences make it difficult, if not impossible, to find a common ground and work collaboratively to use technologies such as nuclear power to their full advantage. Rather than seeing nuclear power as a beneficial technology with problems we could solve together, they view it as anathema and oppose it without regard to its benefits. As one example, the legal system of reviews intended to protect the public became for them a vehicle for blocking nuclear power. As a result, by the 1980s the process had become so cumbersome that it took more than 15 years for most nuclear projects to be completed. That economic burden was too much to handle, so no new U.S. nuclear plants have been ordered since the 1970s.

Making regulation work

Reforms currently being enacted in the United States could make the regulatory system more effective. They include consolidation of required hearings, preapproval and "banking" of project sites, and preapproval and certification of standardized designs. Some advanced designs have now been certified and are expected to reduce construction costs significantly and to make plants safer to operate. A consortium of manufacturers and potential owners has been formed' to test the workability of this revised regulatory process.

International evidence suggests that these changes will help. New plants continue to be built in countries such as South Korea, Finland, India, Brazil, China, and Russia, where nuclear power has not been stifled by overregulation. In 1996, Japan completed a plant that took only four and a half years to build and came in under budget. Some newer designs have been targeted for completion in three years.

Nevertheless, the politicization of nuclear power continues to compromise efforts to solve the biggest issue of nagging public concern: the disposal of nuclear wastes. The sustainability of nuclear power depends on an adequate approach to nuclear waste, one that serves the public purpose and is workable. The difficulty in the current approach is demonstrated by the fact that efforts to locate a suitable U.S. waste repository have been underway since the aborted attempt in Lyons, Kansas, in the early 1970s. After more than $9 billion in expenditures, there is still uncertainty that the current site at Yucca Mountain, Nevada, will ever be approved. Unless there is a recalibration of both the nature of the risk and the appropriate regulatory response, disposing of nuclear waste will remain a political quagmire.

The key question is what margin of safety is appropriate for nuclear waste, and the best way to answer that question is to think of nuclear waste in a broader context. In the current regulatory system, nuclear waste is treated quite differently than are nonradioactive hazardous wastes that pose similar longterm hazards. As the 1995 National Research Council report *Technical Bases for Yucca Mountain Standards* noted, "some nonradioactive substances are more persistent and can pose a greater hazard than many radionuclides." Yet 60 million of tons of nonradioactive hazardous wastes are generated annually, from chlorinated hydrocarbons such as PCBs, to petroleum products used in refining, to solvents and cleaning agents, to arsenic and beryllium, and finally to heavy metals such as lead, cadmium, mercury, and nickel. Even the most toxic of these wastes are permanently stored every year without the expense, litigation, or public concerns that have so constrained progress on nuclear waste. The public policy implications are significant. As participants in a 1998 workshop cosponsored by Johns Hopkins University and the Environmental Law Institute observed, the differences in approach between these two waste forms have left us with what amounts to "two cultures," with separate and distinct regulatory regimes that have never been harmonized. One obvious difference is that under current regulations radioactive waste storage must consider scenarios for thousands of years, whereas the typical timeframe for nonradioactive hazardous wastes is 30 to 70 years. Although the EPA imposes a 10,000-year storage requirement in the limited situation of hazardous waste disposal in injection wells, even there supporting studies and processing of the petition can typically be completed in two years, and permits are regularly granted without fanfare. As workshop participants observed, these differences not only corrupt public decision making, they "create tensions between regulators that lead to public resentment and mistrust of risk managers."

Much of this is a consequence of the public perception that radioactive wastes are more dangerous, a perception heightened by the ideological controversy over nuclear power. If one is considering the short term, this is largely correct. Especially during the first 100 years, when 90 percent of the toxicity decays away, radioactive wastes require special treatment. But after 500 or 600 years, these wastes, especially if reprocessed, pose hazards that are comparable to those of many nonradioactive hazardous wastes. Ensuring safety for 500 years is a serious challenge, but it poses very different regulatory and safety issues than does safe storage for tens of thousands of years. Providing safety for longer periods should remain a priority, but it makes little sense to impose radically different regimes for two forms of waste if the long-term health risks are substantially the same. Changing this situation will be difficult, given established public concerns and regulatory processes for nuclear waste. The National Council on Radiation Protection and Measurements has stepped in and suggested a technical approach for consistently classifying the long-term risks of chemical and nuclear wastes, but the critical stumbling block is applying such a standard and removing the inconsistency in regulatory regimes. A credible evaluation by an organization such as the National Research Council that focuses on this dichotomy and makes recommendations for harmonizing the two regulatory approaches might create conditions in which a genuine policy dialogue could begin.

Sustaining nuclear power for the long term eventually will require reprocessing to fully exploit the energy potential of uranium.

A second key is to reconsider the reprocessing of spent fuel, a process in which plutonium and uranium are chemically separated from spent fuel so that they can be reused, as is done in France. Sustaining nuclear power for the long term eventually will require reprocessing to fully exploit the energy potential of uranium. Reprocessing will make it possible to tap the energy potential of the 99 percent of uranium-238 that is virtually useless without reprocessing. Reprocessing also makes the disposal problem more manageable, because it reduces the long-term health risks and the volume of waste, while lowering the heat loading on a repository during the early years.

Reprocessing generates legitimate concerns about the proliferation of nuclear weapons. Increased inventories of separated plutonium raise the risk that it might be diverted to nuclear weapons, a concern exacerbated by recent threats of terrorism. But even here some have argued that maintaining control over and ultimately consuming these fissionable materials offer a better approach to nonproliferation than burying spent fuel, which would create what are, in effect, plutonium mines for future generations. As Michael May and Tom Isaacs argue in their recent article, "Stronger Measures Needed to Prevent Proliferation" (*Issues*, Spring 2004), "a fuel cycle that minimizes the accumulation of weapons-usable material will be increasingly viewed as necessary for security." What is needed is the opportunity to fully explore and develop proliferation-resistant fuel cycles as well as institutional controls such as international fuel leasing. Under a leasing scheme, "fuel cycle" countries that handle the entire fuel cycle would be subject to rigid international safeguards. Other "reactor" countries would be allowed to have nuclear power plants, but they would be "loaned" fuel to operate their reactors and be required to return the spent fuel to the fuel cycle countries, where it would be reprocessed. Such a scheme would greatly limit both the means and opportunities for reactor states to process and divert weapons-suitable materials.

The preferable near-term approach to handling nuclear waste is to permit more latitude for above ground dry storage.

The preferable near-term approach is to permit more latitude for above ground dry storage. Not only would it allow time for cooling to ease the design of existing repositories, it would also permit serious reconsideration of reprocessing options. We could also evaluate more advanced technologies that involve the recovery of longer-lived materials and their destruction by irradiation in specially designed nuclear plants or accelerators, virtually eliminating the long-term risks. Here too, the greatest barrier is the entrenched ideological opposition to nuclear power. Its rhetoric has led to a false sense of urgency, which makes it politically difficult to consider policy alternatives that might delay permanent underground disposal. Until a repository is approved and operating, the waste issue will remain an impediment that nuclear opponents gladly exploit. For this reason alone, even with a move to make greater use of aboveground storage, efforts to locate and approve a suitable repository should continue simply to demonstrate its feasibility.

Reframing these important questions could be greatly assisted by the environmental community itself. A growing number of enlightened environmental leaders are beginning to appreciate the role that nuclear power might play in achieving environmental sustainability. Seeing beyond the rigid ideologies that have constrained us for decades, they could be of inestimable importance in helping to reshape the public dialogue. An example is James Lovelock, the biophysicist and public health physician who proposed in his Gaia hypothesis that Earth is a self-regulating organism. In a recent appeal to his fellow Greens, he wrote: "We cannot continue drawing energy from fossil fuels, and there is no chance that renewables, wind, tide, and water power can provide enough energy and in time." Voicing his concerns about greenhouse gases, he concluded, "we have no time to experiment with visionary energy sources: civilization is in imminent danger and has to use nuclear-the one safe, available energy source-now or suffer the pain soon to be inflicted on our outraged planet." Patrick Moore, a founder of Greenpeace, subsequently followed suit, stating that "nuclear power is the only nongreenhouse gas-emitting power source that can effectively replace fossil fuels and satisfy global demand."

Moving beyond ideology

Modern environmentalism has too often co-opted an idea that we all embrace -- environmental quality -- and used it to obscure an ideological agenda. One consequence is the way in which we define "sustainability." Everywhere that sustainability is used to guide energy planners, it is limited by definition to "renewable" resources, which are the only sources considered to be adequate to meet future needs' and to be environmentally benign. Not only has the first premise, been shown to be wrong, the second assumption is questionable as well. It is now increasingly obvious that resources should not be given an environmental pass simply because they are renewable. Large hydro, for example, has come into disfayor because dams flood large areas of land, often eliminating communities or scenic beauty, and destroy fish habitat. Similarly, geothermal sites are often located in wilderness areas that environmentalists do not want to disturb.

Even the current environmental favorite, wind, is being challenged because of bird kills, aesthetics, and land use. Last year, several prominent environmental organizations issued a joint appeal to the U.S Department of the Interior and the U.S. Fish and Wildlife Service complaining that uncontrolled wind expansion throughout the Appalachian Mountain ridges endangered hundreds of migratory bird species, running the risk that the area would "become a gigantic deathtrap for migratory songbirds and raptors."

Renewability per se should not be the issue; sufficiency for the foreseeable future with minimal environmental impact should be. Renewable sources are certainly one part of the answer, but nuclear power is another. Nuclear power is the one energy resource currently capable of displacing fossil fuels on a large scale as well as promoting other environmental goals: minimizing pressure on land use and the accompanying environmental problems of resource recovery, and avoiding atmospheric emissions that contribute to global climate change and health problems. A few key policy actions will help us move in this direction: complete licensing reforms, harmonize waste regulations with those for other similar hazards that we manage, legitimize aboveground storage as an interim solution for waste management, and focus more policy attention on reprocessing and the development of proliferation-resistant fuel cycles.

The most critical step is to build a consensus among energy planners and policymakers that "sustainability" as a policy goal should include nuclear power. Bringing nuclear power back into the mix for energy planning means shedding ideological biases. It means openness of thinking to resolve the tension between the human desire for modernization and the global need for sustainability. It means ceasing to deceive ourselves about what might be possible.