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New Nukes

The Bush administration's plan to use fuel reprocessing as the spark to revive nuclear power will not succeed. Only centralized interim waste storage can make a difference in the near term.

For the first time in decades, nuclear power is back on this country's list of possible energy sources. New nuclear power plants are on the drawing board. Public opinion is shifting in favor of nuclear energy. Even some veteran antinuclear campaigners have begun talking up its environmental benefits. The Bush administration has been actively promoting the nuclear industry. But its latest policy initiative threatens to set back the nuclear revival.

Several trends have helped refocus national attention on the role of nuclear power in meeting the nation's energy needs: intensifying concerns over global climate change, increasing natural gas prices, serious instabilities in the oil- and gas-rich regions of the world, and vigorous growth in domestic electricity demand. But despite generous new subsidies for nuclear construction, prospective investors in the new projects remain wary of the financial risks.

A nagging problem is the continuing uncertainty at the "back end" of the nuclear fuel cycle. Nuclear power generates electricity, but it also generates radioactive waste. This waste will remain hazardous for thousands of years. How can it be disposed of safely, with minimal risk to the lives and health of citizens today and in the future?

A public opinion survey, carried out as part of a recent Massachusetts Institute of Technology study on the future of nuclear power, revealed that nearly two out of three respondents believe that nuclear waste cannot be stored safely. That contrasts sharply with the broad consensus in the scientific and engineering community that disposing of high-level radioactive waste in mined geologic repositories can effectively isolate the waste from the biosphere for as long as it poses significant risks.

But the federal government's decades-long track record on nuclear waste—not least its failure to meet contractual obligations to remove spent fuel from existing utility nuclear plant sites—does not inspire confidence. The drive to build a high-level waste repository at Yucca Mountain in Nevada has dominated federal fuel cycle policy for nearly two decades, to the exclusion of all other disposal options. Yet the much-delayed project still faces many obstacles.

The government remains strongly committed to the Yucca Mountain project. Growing doubts about current policy, however, suggest that a major rethink may be needed. Work at Yucca Mountain should continue. But if the project fails, an alternative will be required. And even if it eventually goes forward, it may not suffice if there is a major new commitment to nuclear power in the United States.

Is it possible to imagine a different policy, one that would

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engender confidence that nuclear waste will be disposed of safely and cost-effectively?

Requirements for a back-end policy go beyond successful waste disposal, important as that is. An effective policy must also contribute to the goals of controlling the proliferation of nuclear weapons; fighting terrorism; and minimizing health, safety, and environmental risks during the lengthy interval between the generation of waste and its final isolation; all this while keeping nuclear power economically competitive with other ways of making electricity. Moreover, the policy must be "scalable"; that is, it must be capable of accommodating significant expansion in the number of nuclear power plants.

In this year's State of the Union address, President Bush announced a new nuclear power initiative, the Global Nuclear Energy Partnership (GNEP). If adopted, GNEP would constitute the biggest shift in U.S. nuclear fuel cycle policy in decades. According to the president, GNEP is intended to help nuclear power expand safely and economically both at home and in other nations, including developing nations, while minimizing the risk of nuclear weapons proliferation. The centerpiece of GNEP is a scheme to accelerate the introduction of new technologies for reprocessing and recycling spent nuclear power reactor fuel. The Bush administration claims that this scheme could eliminate the need for repositories other than Yucca Mountain, cut the duration of the waste disposal problem from hundreds of thousands of years to something much shorter, and use almost all the energy in uranium fuel. This is an appealing vision, but the reality is that GNEP is unlikely to achieve these goals and will also make nuclear power less competitive economically. The good news is that there is an alternative pathway that can lead to success.

The reprocessing solution

The president's GNEP proposal also has several other elements. One is a plan to create an international consortium of leading nuclear nations that would guarantee fuel supplies and spent-fuel management services to nations that agree not to develop their own enrichment and reprocessing plants. In the GNEP vision, the new reprocessing and recycling technologies would be deployed only in the United States and other advanced nuclear nations. The United States abandoned reprocessing in the 1970s out of fear that it would increase the risk of nuclear weapons proliferation. Although some countries followed the same path, others, including France, the United Kingdom, and Japan, proceeded with reprocessing.

The big reprocessing plants at La Hague in France, Sellafield in the United Kingdom, and Rokkasho-Mura in Japan employ the plutonium uranium extraction (PUREX) process to extract most plutonium and uranium from spent fuel. Some recovered plutonium has been fabricated into mixed-oxide (MOX) fuel and recycled to commercial light-water reactors in Europe and Japan, but an estimated 100 tons of separated plutonium remains in storage (most of it at Sellafield and La Hague.) The waste stream from PUREX reprocessing contains most of the radioactive fission products in the spent fuel, along with small quantities of unextracted uranium and plutonium. The waste also contains radioactive isotopes of the transuranic elements neptunium, americium, and curium. These materials, formed during irradiation of fuel in the reactors, are collectively known as the minor actinides, to distinguish them from the larger quantities of uranium and plutonium also present in the fuel. The highly radioactive liquid waste is encapsulated in glass "logs," which are destined eventually for high-level waste repositories. The French, British, and Japanese have been moving even more slowly than the Americans to dispose of the waste, and none has yet formally designated a repository site.

The Bush administration's new reprocessing proposal is more ambitious than current practice. Most important, it seeks to extract and recycle all actinides in spent fuel: all uranium and plutonium, and all minor actinides. These materials account for much of the risk posed by the waste after the first several hundred years, by which time most of the fission product inventory will have decayed to harmless levels. Removing all actinides, major and minor, would facilitate waste disposal. In the GNEP scheme, the transuranic actinides would then be destroyed by recycling them to power reactors, where they would be fissioned and thus converted to shorter-lived products. Complete destruction of actinides is not feasible in conventional light-water power reactors, so specialized fast-neutron burner reactors (possibly a great many of them) must be built for this purpose. According to one estimate, it would take one 300-megawatt (MW) burner reactor to mop up the actinides discharged by three or four 1,000-MW light-water reactors. If so, the United States would need 25 to 30 of these reactors just to deal with the actinides from existing U.S. reactors. And since not even advanced burner reactors are capable of destroying all actinides in a single pass, spent burner reactor fuel would have to be reprocessed and recycled several times before the actinides could be reduced significantly.

The list of development needs for the GNEP plan is long. It includes a modification to the PUREX reprocessing process known as UREX+. PUREX currently separates plutonium in pure form. In the UREX+ modification, plutonium extracted from light-water reactor fuel would never be fully separated from its more radioactive actinide cousins. The idea is to preserve a barrier of radiation that would complicate unauthorized attempts to recover weapons-usable material. GNEP will also require the development of advanced burner reactor systems, new fuels and actinide targets for those reactors, fabrication methods for such materials, and new reprocessing technologies for reactor fuels.

This is a formidably expensive and long-term development program, and the administration has proposed to carry it out in cooperation with other advanced nuclear states. The GNEP initiative has been welcomed overseas, with the French, among others, declaring their satisfaction at having the United States finally back in the reprocessing fold. But neither the organizational nor the financial details of GNEP are yet clear. It remains to be seen how much of the development costs would actually be borne by others.

Why it won't work

Even if the government can find the funds, GNEP is unlikely to succeed in meeting its goals. First, it will have little or no impact on the group of "first mover" nuclear power plants now in the planning stage. The full actinide recycle scheme envisaged by GNEP could not be deployed for decades—too far into the future to mitigate the uncertainty over spent fuel confronting prospective investors during the next few years, when decisions on whether to proceed with these projects will be made.

Would GNEP affect prospects for the Yucca Mountain project? Once again, the answer is probably not. Predicting the containment performance of the repository over hundreds of thousands of years, as the regulations require, will be enormously challenging. So, in principle, eliminating long-lived actinide isotopes from the waste could lighten the regulatory burden substantially. But much work remains to figure out whether developments envisaged by GNEP are feasible, work that will take far more time than the estimated 10 years it will take to license Yucca Mountain. During the licensing period, the possibility of achieving major reductions in the actinide inventory will remain just that, a possibility.

Even if these timing problems could be overcome, a significant technical problem would remain. The most optimistic advocates of actinide extraction and transmutation suggest that it will cut the time required for waste disposal to only a few hundred years. But no extraction scheme is perfect. Small quantities of long-lived actinides will inevitably find their way into the waste. Moreover, significant quantities of actinides are present in waste that has already been generated, much of it from defense programs, which is also scheduled for disposal at Yucca Mountain.

And actinides are not the only long-lived constituents of nuclear waste. A small number of fission products also have very long half-lives, notably technetium-99 (212,000 years) and iodine-129 (16 million years.) Some repository risk studies suggest that these isotopes would contribute more than most actinides to the radiation dose that could be received by the repository's neighbors in the far future. Why go to the trouble of removing actinides from the waste if these fission product isotopes are still there? No credible scheme for separating and transmuting them has yet been proposed.

Thus, although GNEP promises significant reductions in long-lived isotopes in the repository, some will remain. The biggest regulatory challenge at Yucca Mountain—demonstrating compliance with radiation protection standards for up to a million years—will not be much different with or without GNEP.

Still, there is a second benefit of removing actinides from spent fuel. After about 70 years, many fission products will have decayed away. From then on, it is the actinides (specifically, isotopes of plutonium, americium, and curium) that will contribute most to radioactive decay heat. The amounts of heat are relatively small. After 100 years, a typical pressurized water reactor fuel assembly weighing about half a ton will generate only about 200 watts of heat, and after 1,000 years, about 50 watts. Nevertheless, in a repository containing, say, a hundred thousand such fuel assemblies, the total amount of heat is significant. Making sure that it dissipates without causing overheating of the waste canisters or surrounding rock is an important design consideration.

Removing actinides means that waste canisters in the repository could be packed closer together without violating thermal limits. This would increase storage capacity, which in turn could reduce the number of repositories. Energy Secretary Sam Bodman recently suggested that GNEP has the potential to postpone a second U.S. waste repository indefinitely, even if nuclear power growth does resume. This appeals to politicians, who are almost desperately eager to avoid another politically painful repository-siting process. But offsetting this promise is the requirement, also implicit in GNEP, to find sites for new reprocessing plants, fuel and target fabrication facilities, and fast-spectrum burner reactors. Each of these may be easier to site than a second waste repository, though perhaps only marginally so. But GNEP is likely to increase the quantity of required nuclear sites, possibly by a large number.

Moreover, as far as prospects for the Yucca Mountain repository itself are concerned, the space-conserving attributes of GNEP are not obviously positive. If there are any people left in Nevada still favorably disposed to the project, the idea of a blank check enabling the nuclear power industry to dispose of all future waste at Yucca Mountain may be enough to tip them over the edge.

In sum, the GNEP initiative is at best a policy for the long term. It will have little bearing on the near-term outlook for nuclear power. It will not help the nuclear plants currently at the planning stage to move ahead. It will have little or no beneficial effect on the Yucca Mountain repository's application for a license. And it is not a substitute for the Yucca Mountain project. This is not an indictment of GNEP, but it is important to be clear about what problems GNEP will not solve as well as those that it might.

A near-term option

Is there a back-end policy that would have a near-term impact? One possibility would be for the federal government to establish a centralized storage system for spent fuel. In such a system, the fuel, after cooling for several years in water-filled pools adjacent to the reactors, would not be reprocessed but would simply be shipped offsite and stored for several decades either at a few regional facilities or at a single national facility. The fuel would be contained in dry casks: sealed metal cylinders enclosed within thick concrete outer shells. Passive air cooling of the surfaces of these concrete casks is sufficient to remove the spent-fuel decay heat. The thick concrete shells provide protection against floods, tornados, and projectiles, as well as shielding against the radiation emitted by the fuel. Offsite storage in concrete casks would also present fewer risks of terrorist attack than leaving the fuel where it is, in reactor storage pools.

If the federal government were to launch a new centralized spent fuel interim-storage initiative during the next year or two, it could then credibly guarantee to take ownership of the spent fuel discharged by the currently planned new power plants and move it offsite within, say, 10 years of discharge. Such a guarantee, which would be consistent with existing federal obligations under the Nuclear Waste Policy Act, would be the single most effective action the government could take to reduce waste management uncertainties confronting investors and would surely help these projects move forward. In this it is superior to GNEP.

In the past, some in industry and government have opposed a federal spent fuel interim storage facility because they feared it might deflect attention from developing a final repository. Such fears now seem beside the point. The Yucca Mountain project is now sufficiently far advanced that whether it eventually succeeds or fails will hinge on other issues. As a matter of fact, storing the spent fuel offsite for an extended period could even improve Yucca Mountain's prospects. It might lessen the pressure to freeze the repository design, allowing more time for the emergence of other technical approaches that would enhance the project. But these are speculations. The prudent assumption is that there would be no positive impact. In this, however, interim storage would be no different from GNEP.

A long-term comparison

Storing spent fuel in dry casks is feasible for several decades and perhaps for much longer. But it is not a permanent solution. At some point, the fuel must either be disposed of once and for all (or, alternatively, reprocessed and the resulting waste disposed of). Will the country be better off with an interim strategy of centralized cask storage followed by direct disposal or with a GNEP strategy based on reprocessing? The comparison must address each of the issues relevant to a back-end policy: waste disposal, nuclear proliferation, safety, and economic competitiveness. It must also consider financial and political feasibility.

Waste disposal. The opportunity to delay or even eliminate the need for a second or subsequent repositories is a major motivation for GNEP. Removing heat-emitting actinides and increasing the canister packing density would mean that more waste could be stored at Yucca Mountain. To exploit this advantage, Yucca Mountain's statutory capacity limit of 70,000 metric tons (MT) equivalent of spent fuel would have to be lifted. Congress is likely to take this step, given its strong desire to avoid another repository-siting imbroglio. But relaxing the limit would allow substantially more waste to be stored at Yucca Mountain even without extracting the actinides. The 70,000 MT limit was imposed originally for political rather than technical reasons. The actual physical capacity of Yucca Mountain is believed to be considerably greater; according to one recent estimate, from four to nine times greater. Moreover, the approach of simply delaying disposal by allowing the spent fuel to cool in concrete casks for several decades would also increase the effective storage capacity of the repository. In the end, the GNEP strategy might enable more waste to be squeezed into the Yucca Mountain facility. But whether this would translate into a practical advantage over interim storage is not clear, since in neither case would it be necessary to open a second repository for at least several decades.

Nuclear proliferation. Nuclear power creates potential security risks. Unless the risk of misusing the commercial nuclear fuel cycle to gain access to technology or materials as a precursor to acquiring nuclear weapons is kept low, nuclear power will not fulfill its potential as a global energy source. According to the Bush administration, a key goal of GNEP is to field fuel cycle technologies that are not only less waste-intensive but also more proliferation-resistant. In fact, the most important element of the GNEP initiative from a nonproliferation perspective is not the advanced reprocessing and recycling scheme, but rather the proposal to establish an international consortium of advanced nuclear nations to guarantee fuel cycle services to other countries, especially in the developing world. If implemented effectively, this proposal could indeed reduce incentives for such countries to build enrichment or reprocessing facilities of their own. It deserves strong support.

The GNEP proposal to introduce full actinide recycling is also advertised as contributing to nonproliferation. But whether its impact is positive or negative depends on what it is being compared to. If the countries that now do conventional PUREX reprocessing—principally France, the United Kingdom, Russia, and Japan—were to adopt the UREX+ process, and as a result stopped accumulating separated plutonium, the outcome might be positive. But in practice, the proposed UREX+ strategy of keeping the plutonium mixed with other, more radioactive transuranic isotopes might not create much of a radiation barrier to potential proliferators. Recent calculations suggest that the radiation level would not be particularly high—perhaps as much as several orders of magnitude lower than the intense radiation fields associated with spent fuel. So adoption of UREX+ reprocessing of light-water reactor fuel combined with reprocessing of advanced burner reactor fuel would introduce sizeable new flows and stocks of contaminated plutonium that might be only marginally better protected from would-be proliferators than pure plutonium, and much less protected than if the plutonium simply remained in the spent fuel. For countries that are not now reprocessing, including the United States, this would not be a positive development. Additional protection could be obtained using a variant of the UREX+ process that mixed certain radioactive fission products in with the plutonium and the minor actinides. But these fission products would have to be separated from plutonium before fuel fabrication and then recycled back to the waste stream, adding further, costly steps to the GNEP fuel cycle.

Another argument for GNEP, and for reprocessing more generally, is that it will eliminate the risk that the plutonium could eventually be recovered from a repository containing unreprocessed spent fuel and then used for weapons. (The French have recently cited this "plutonium mine" scenario as one of their primary motivations for continuing to reprocess.) The technical feasibility of plutonium recovery will indeed increase with time as the fission product radiation barrier decays away. On the other hand, the deeper and more remote the repository, the less plausible such a scenario. In any case, it is difficult to assess the significance of avoiding this risk. The value of eliminating one particular technical means for malevolent behavior that might or might not occur centuries or millennia from now is a question perhaps better addressed by philosophers than by engineers or economists.

Still, the proliferation tradeoff between GNEP and the dry-cask storage and disposal strategy is conceptually clear. In the case of GNEP, the goal of ensuring that no plutonium would be available to nuclear felons centuries from now is achieved at the price of an elevated proliferation risk during the several-decade period between waste generation and disposal, as well as the additional economic costs, plus health, safety, and environmental risks, incurred during that time. In the case of dry-cask storage and disposal, the goal of minimizing proliferation risks during that interval is achieved at the price of not being able to rule out malfeasance involving plutonium hundreds of years into the future. Although this is a tradeoff on which reasonable people could disagree, the advantage clearly seems to lie with dry-cask storage and disposal.

Safety. The safety and environmental performance of dry-cask technology for spent fuel storage has been demonstrated at more than 30 U.S. nuclear power plant sites, where casks of various designs have been in use for up to 20 years. A centralized spent-fuel storage facility, although larger in scale, would be essentially identical in concept. In contrast, the complex fuel cycle envisaged by GNEP will require the development of a host of new technologies and facilities. A major engineering and regulatory effort will be needed to assess the safety and environmental performance of an integrated GNEP fuel cycle system. It is possible that safety risks from such a system could be reduced to the level of those of a dry-cask storage facility, although this seems unlikely if only because there would be so many more GNEP facilities and sites. Also, the historical safety record of reprocessing plants around the world has not been good. Once again, the advantage lies with the dry-cask storage option.

Economic competitiveness. Unfavorable economics has been one of the main barriers to new nuclear power plant investment in the United States for nearly three decades, and it remains a major concern. Keeping generating costs down will be crucial for future nuclear power plants selling their electricity into competitive wholesale power markets.

The costs of reprocessing and recycling envisaged by GNEP are uncertain, because several component technologies are still undefined. But a useful benchmark is conventional PUREX reprocessing and recycling of MOX fuel, for which cost information is available. This information makes clear that the conventional MOX fuel cycle is more costly than the alternative of not reprocessing. There is no dispute about this, although opinions differ about how large the cost penalty really is.

Much of the disagreement hinges on arguments about who should pay the penalty. The French argue that the MOX cycle cost penalty is too small to worry about. Not coincidentally, they assume that the cost will be borne by the entire fleet of power plants, not just the ones that are using MOX fuel. With that assumption, together with optimistic but not implausible assumptions about the costs of PUREX reprocessing and MOX fuel fabrication, the impact on the overall costs would indeed be fairly modest: The fleet-average fuel cycle cost would increase by about 40% and the total nuclear electricity cost would increase by about 4%. In effect, the nuclear industry would have to pay a recycle tax of about 0.25 cent per kilowatt hour, on top of the tax of 0.1 cent per kilowatt hour it currently pays to the federal government for (yet to be delivered) waste disposal services.

In France, with its single national utility, it is reasonable to assume a cross-subsidy in which all commercial nuclear power plants pay for the higher fuel cycle costs of the relatively small number that would be doing the recycling. But in the United States, unless this requirement were imposed by regulatory fiat, nuclear plant operators opting for recycling would either have to absorb the entire cost increase themselves or pass part or all of it on to their customers. That cost increase would likely be prohibitive. If we again use the conventional MOX cycle as the benchmark, it would mean a 300% increase in the nuclear fuel cycle cost, or roughly a 20% increase in the total cost of electricity. Given the choice, a private nuclear generator would not shoulder such a burden on its own; a government subsidy would be needed. The total subsidy would amount to roughly $2 billion per year for a nuclear power plant population the size of the current U.S. fleet.

Could technological advances reduce the cost of full actinide recycle below the conventional MOX cycle cost? This cannot be ruled out, but common sense suggests that it is unlikely. Full actinide recycle is inherently more demanding than the current version of the closed fuel cycle, which seeks only to recover and reuse plutonium in the spent fuel. The GNEP vision entails a complex large-scale extension of the existing nuclear power industry, with scores of burner reactors and associated reprocessing and fuel fabrication facilities and major additional stocks and flows of nuclear materials. Reducing the costs of all this should be an important R&D objective. But the only sensible assumption today is that this add-on will not be economically viable on its own, which means that it would require a much more active government role in the nuclear industry than at present. It is difficult to reconcile this vision with the goal of maximizing the economic viability of nuclear power in an increasingly competitive electric power industry. Small wonder that the nuclear industry has greeted the GNEP initiative politely, but coolly.

The centralized storage plus direct disposal alternative would also require increased government involvement, but this would be limited to one or at most a few storage facilities, and the additional cost is unlikely to exceed 1% of the total cost of nuclear electricity, or about 0.05 cents per kilowatt hour. Once again, the advantage seems clearly to lie with the centralized storage option.

The biggest objection to direct disposal of spent fuel is that closing the fuel cycle will extend fuel supplies. The once-through fuel cycle is credible in the long term only if sufficient uranium ore is available at reasonable cost to support a large-scale expansion of nuclear power. Present data suggest that the necessary uranium will be available at an affordable price for a very long time, even with such an expansion. Eventually, perhaps, the price will rise high enough to justify plutonium recovery and recycle on economic grounds. Although this does not seem likely today, the possibility exists. Thus, it is understandable that some are reluctant to "throw away" plutonium by disposing of spent fuel directly. The virtue of interim dry-cask storage is that no decision need be made, either to reprocess or permanently dispose of the fuel, for decades.

What next?

In sum, on every important count, centralized dry-cask storage will serve the Bush administration's own objectives for nuclear power as well as or better than the GNEP fuel cycle scheme for at least the next few decades. Unfortunately, the Bush administration has its priorities backward. It has put the GNEP initiative front and center but is taking no action on centralized spent fuel storage. Yet it is the latter that can help pave the way for a new round of nuclear power plant construction, and it is the latter that will more nearly achieve the goal of a safe, economically competitive, and proliferation-resistant fuel cycle for the next several decades.

Eventually the fuel-conserving and repository space–conserving attributes of the GNEP fuel cycle might deliver real value. Or they might not. At this stage, the government

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should be supporting a systematic, rigorous R&D effort, but not a major program of reactor and fuel cycle demonstration projects, and certainly not a complete reorientation of the back end of the fuel cycle. The goals articulated by President Bush in introducing the GNEP initiative deserve strong support, but the most important priorities for achieving them are:

First, focus in the near term on helping to bring the first group of new nuclear power plant projects to fruition. Significant risk-reducing measures are already in place for the first several thousand megawatts of new nuclear capacity. The administration should now concentrate on how to reduce the spent fuel risk perceived by investors in those projects. It should be mindful that an early commitment to reprocessing will not reduce those risks, and could well increase them.

Second, implement a plan to move commercial spent fuel from reactor sites to one or a few secure federal interim storage facilities as quickly as possible. Siting such facilities will be difficult, but no more so than siting new GNEP fuel cycle facilities.

Third, work with other advanced nuclear nations to provide comprehensive fuel cycle services, including spent fuel storage services, to countries that agree not to invest in their own enrichment and reprocessing plants, as called for in the GNEP initiative.

Fourth, launch a broad, balanced R&D program to prepare new fuel cycle options for deployment beyond 2050. The program should focus on both advanced once-through fuel cycles and closed-cycle options. Key elements should include:

- A uranium resource evaluation program to determine with greater confidence the global uranium resource base.
- Development of next-generation geologic disposal technologies for spent fuel and reprocessed waste, including incremental engineering and materials improvements to the mainstream mined repository approach as well as more far-reaching innovations such as deep borehole disposal. These advances could offer repository risk reduction benefits as large as those claimed for full actinide recycle.
- Development and evaluation of alternative fast burner reactors and fuels.
- Development and evaluation of advanced reprocessing technologies.

For the next 5 to 10 years, emphasis should be on fundamental research and laboratory-scale experiments. This should be supported by strong systems analysis and extensive modeling and simulation, and should explore a broad range of reactors, fuel types, and fuel cycles.

The Bush administration is pushing for early selection of particular fuel cycle technologies and early commitment to large-scale multibillion-dollar demonstration projects. But these are neither necessary nor wise at this stage, and there is a real risk that they will siphon off financial resources and public support. It would be sad—and ironic—if this pronuclear administration, presiding over the most promising environment for renewed nuclear power growth in decades, ended up undermining the prospects for a nuclear revival.

Recommended reading

Matthew Bunn, Steve Fetter, John Holdren, and Bob van der Zwaan, *The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel* (Cambridge, MA: John F. Kennedy School of Government, Harvard University, December 2003).

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