



Union of Concerned Scientists  
Citizens and Scientists for Environmental Solutions

# position paper

## Nuclear Power and Global Warming

**G**lobal warming poses a profound threat to humanity and the natural world, and is one of the most serious challenges humankind has ever faced. We are obligated by our fundamental responsibility to future generations and our shared role as stewards of this planet to confront climate change in an effective and timely manner.

### THE SCOPE OF THE PROBLEM

The atmospheric concentration of carbon dioxide (the heat-trapping gas primarily responsible for global warming) has reached levels the planet has not experienced for hundreds of thousands of years, and the global mean temperature has risen steadily for over a century as a result. The U.S. National Academy of Sciences, the Intergovernmental Panel on Climate Change, and scientific academies of 10 leading nations have all stated that human activity, especially the burning of fossil fuels, is a major driver of this warming trend. The window for holding global warming emissions to reasonably safe levels is closing quickly. Recent studies have concluded that avoiding dangerous climate change will require the United States and other industrialized countries to reduce their global warming emissions to approximately 20 percent of current levels by mid-century.

### WHAT CAN BE DONE

A profound transformation of the ways in which we generate and consume energy must begin now. The

urgency of this situation demands that we be willing to consider all possible options for coping with climate change, but in examining each option we must take into account its impact on public health, safety, and security, the time required for large-scale deployment, and its costs.

While there are currently some global warming emissions associated with the nuclear fuel cycle and plant construction, when nuclear plants operate they do not produce carbon dioxide. This fact is used to support proposals for a large-scale expansion of nuclear power both in the United States and around the world. The Union of Concerned Scientists (UCS) has monitored the use of nuclear power in this country for over three decades, and has been deeply engaged in the related issues of nuclear weapons and proliferation. UCS recognizes the need for a fresh examination of all possible options for coping with climate change, but it must be borne in mind that a large-scale expansion of nuclear power in the United States or worldwide under existing conditions would be accompanied by an increased risk of catastrophic events—a risk not associated with any of the non-nuclear means for reducing global warming.

These catastrophic events include a massive release of radiation due to a power plant meltdown or terrorist attack, or the death of tens of thousands due to the detonation of a nuclear weapon made with materials obtained from a civilian—most likely non-U.S.—nuclear power system. Expansion of

nuclear power would also produce large amounts of radioactive waste that would pose a serious hazard as long as there remain no facilities for safe long-term disposal.

In this context, the Union of Concerned Scientists contends that:

1. Prudence dictates that we develop as many options to reduce global warming emissions as possible, and begin by deploying those that achieve the largest reductions most quickly and with the lowest costs and risk. Nuclear power today does not meet these criteria.
2. Nuclear power is not the silver bullet for “solving” the global warming problem. Many other technologies will be needed to address global warming even if a major expansion of nuclear power were to occur.
3. A major expansion of nuclear power in the United States is not feasible in the near term. Even under an ambitious deployment scenario, new plants could not make a substantial contribution to reducing U.S. global warming emissions for at least two decades.
4. Until long-standing problems regarding the security of nuclear plants—from accidents and acts of terrorism—are fixed, the potential of nuclear power to play a significant role in addressing global warming will be held hostage to the industry’s worst performers.
5. An expansion of nuclear power under effective regulations and an appropriate level of oversight should be considered as a longer-term option if other climate-neutral means for producing electricity prove inadequate. Nuclear energy research and development (R&D) should therefore continue, with a focus on enhancing safety, security, and waste disposal.

#### **PROBLEMS WITH U.S. NUCLEAR POWER TODAY**

Nuclear power currently provides eight percent of the nation’s total energy supply, and is now used only to generate electricity. To address global

warming we have to address all sources of emissions including transportation.

Since its birth, the nuclear power industry has benefited from major government subsidies. Nevertheless, no new nuclear plants have been ordered since 1978, primarily because the industry has been unable to attract investors after cost overruns and large financial losses.

The Nuclear Regulatory Commission (NRC) has not properly enforced safety regulations at existing plants; such negligence nearly led in 2002 to a catastrophic accident at the Davis-Besse plant in Ohio. Furthermore, NRC security requirements still assume that terrorists targeting a nuclear facility will not use aircraft, will not attack with more than a handful of individuals, and will not use widely available weapons such as rocket-propelled grenades.

The disposal of spent nuclear fuel also remains an unresolved issue. Spent fuel rods can, however, be stored safely in aboveground steel cylinders (“dry casks”) for at least 50 years. Permanent storage should be in deep underground “geological” sites, but the Yucca Mountain geological facility in Nevada may never be licensed.

Compounding matters is the fact that no new nuclear plants could be completed before 2014 according to government estimates, and plants with genuinely advanced designs no earlier than 2025.

#### **APPROPRIATE STRATEGIES FOR COMBATING GLOBAL WARMING**

A truly effective and timely response to the risk posed by global warming would take the form of a comprehensive national policy covering the entire spectrum of technologies and practices that could reduce global warming emissions. The following strategies would set the nation on a cost-effective and prudent path toward that end:

- The government should adopt policies that maximize energy efficiency and conservation, increase the use of renewable energy resourc-

es, and eliminate barriers to existing technologies that can reduce global warming emissions without the risks associated with nuclear power. Such policies provide the best prospect for the large near-term reductions in global warming emissions that are needed to stabilize the global average temperature at a reasonably safe level.

- The government should create conditions under which energy prices would reflect the full cost of global warming emissions, by setting emission targets and establishing a mandatory revenue-neutral carbon tax or cap-and-trade system. A constraint on carbon will make nuclear power more competitive with fossil fuels; how well it would then compete with other technologies that do not generate global warming emissions remains to be seen. Of course, nuclear power's safety, security, nuclear terrorism, and waste problems would still need to be addressed for it to be an acceptable option for reducing global warming emissions.
- Nuclear power should not receive the disproportionate direct and indirect subsidies currently provided by the Bush administration and Congress. Start-up subsidies, licensing shortcuts, and liability limits made available through the Price-Anderson Act (which shift financial risk from investors to taxpayers and customers) should not be provided for new nuclear plants.
- Government and industry should recognize that an expansion of nuclear power is contingent on public confidence, and taking shortcuts in either safety or security measures increases the chance of catastrophic events. A serious accident or successful terrorist attack would hobble expansion, as did the accidents at Three Mile Island and Chernobyl, or might even result in the closure of many existing plants.
- Because Yucca Mountain may not be licensed, preliminary assessment of other geological sites should begin. The federal government should take possession of spent fuel (at least at decommissioned reactor sites) and upgrade

security of on-site storage. Centralized dry-cask storage should be investigated.

- The government's current investment in energy R&D is less than half its 1979 level, and is minuscule compared with its investment in defense and homeland security R&D. The nation's energy R&D effort should be raised to a level commensurate with the threat to national security posed by global warming.

### **CHANGES NEEDED IN U.S. NUCLEAR POWER**

Whether or not there is a major expansion of nuclear power in the United States, the following measures are long overdue, and should be considered prerequisites to any expansion:

- Thorough reform of the NRC; for example, public access to NRC proceedings should be restored to the level that prevailed when nuclear plants were last being licensed.
- Realistic definition of the terrorist threat facing nuclear power plants, and rigorous testing of their readiness for an attack.
- Unambiguous definition of the government's and plant owners' responsibilities for defense against terrorism and sabotage.

Congress should exercise close oversight of the NRC and of the practices employed by the government and industry to protect nuclear plants against terrorism.

### **WEAPONS IMPLICATIONS OF EXPANDED NUCLEAR POWER**

A major global expansion of nuclear power would require the United States to adopt domestic and foreign policies that deal effectively with the potential threats to national and global security that would result. Under the existing non-proliferation regime, such an expansion would be irresponsible because it would entail a corresponding growth in facilities for producing nuclear fuels—facilities that can readily produce the materials needed to build nuclear weapons.

The government should, therefore, commit itself to reinforcing the non-proliferation regime so that it can provide reliable control over nuclear fuels.

A nuclear fuel of paramount concern is plutonium, which can serve as a highly effective material for nuclear weapons. For that reason, U.S. policy has long barred the extraction (“reprocessing”) of plutonium from spent power reactor fuel. The Bush administration broke with this policy by proposing the Global Nuclear Energy Partnership (GNEP), which includes reprocessing as its central component.

Contrary to the administration’s claims, GNEP shows no prospect of creating a proliferation-resistant nuclear fuel cycle or of solving the waste disposal problem. The technologies required for turning this vision into reality do not exist, while the proposed waste disposal scheme is considerably more costly and substantially less proliferation-resistant than the current practice of direct disposal of spent fuel. Furthermore, the administration’s high-profile advocacy of reprocessing as an integral part of GNEP is encouraging other nations to engage in dangerous plutonium fuel operations.

Congress should therefore restore the U.S. commitment to direct disposal of spent reactor fuel and bar reprocessing. Any congressional commitment to GNEP should await a favorable outcome of a thorough and independent assessment of the program’s prospects for success and its implications for national security.

## **CONCLUSION**

How we address global warming will be the lasting legacy of this generation. The enormity of the challenge demands that no option for reducing global

warming emissions be left permanently off the table. However, the most sensible strategy is to first deploy those options that achieve the largest reductions most quickly and with the lowest costs and risk. As this paper has demonstrated, nuclear power today does not meet these criteria.

A major expansion of nuclear power in the United States is not feasible in the near term. Even under an ambitious deployment scenario, new plants could not make a substantial contribution to reducing U.S. global warming emissions for at least two decades.

Long-standing problems regarding the security of nuclear plants must be adequately addressed. A single major accident or successful act of terrorism would likely stop any industry expansion, and could even lead to a contraction that would undermine efforts to address global warming.

The administration’s Global Nuclear Energy Partnership (GNEP), which includes extraction of plutonium from spent reactor fuel (“reprocessing”) as its central component, shows no prospect of creating a proliferation-resistant nuclear fuel cycle and is encouraging other nations to engage in dangerous plutonium fuel operations. Congress should therefore restore the long-standing U.S. policy barring reprocessing.

An expansion of U.S. nuclear power—under effective regulations and an appropriate level of oversight—should be considered as a longer-term option if other climate-neutral means for producing electricity prove inadequate. Nuclear energy R&D should therefore continue, with a focus on enhancing safety, security, and waste disposal.

## Appendix: SUPPORTING MATERIAL

### ENERGY USE AND ELECTRICITY IN THE UNITED STATES

The extent to which nuclear power could be a climate solution in the United States is related to how energy is now produced and consumed here. Today, 86 percent of the energy we consume is generated from fossil fuels (and is therefore accompanied by global warming emissions). Nuclear power supplied eight percent of the total energy consumed by the United States in 2005 and slightly over 20 percent of the electricity consumed.

The figures below show that the required reductions in global warming emissions will only be possible if our energy production infrastructure and modes of energy consumption undergo a profound transformation. In other words, the majority of the now-dominant technologies for producing and distributing energy must either be modified or replaced, or shrunk to a much smaller share of the market. Alternatives to fossil fuels will not, however, grow to the levels required for a successful response to global warming until energy prices and policies reflect the true cost of climate change.

### U.S. NUCLEAR POWER TODAY AND TOMORROW

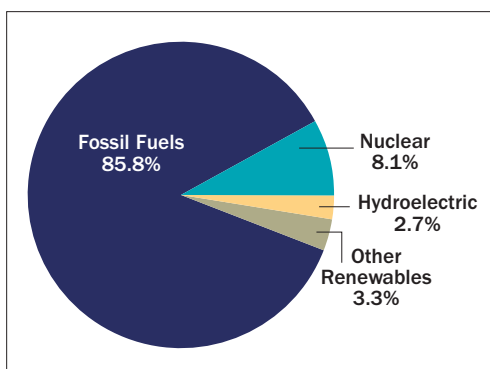
As of now, 103 nuclear power plants are operating in the United States, supplying 21 percent of our electricity. For fuel, they use “low-enriched” uranium,

four to five percent of which is the fissionable isotope U-235 (compared with less than one percent in uranium ore). The spent fuel, which is lethally radioactive, is stored on-site pending decisions by the federal government.

By the government’s own estimates, the first new nuclear plant in the United States could not be completed before 2014, and the first of the advanced designs (“Generation IV”) no earlier than 2025. As a result, nuclear power could not make a substantial contribution to emission reductions in the United States for at least two decades—even under an ambitious deployment scenario.

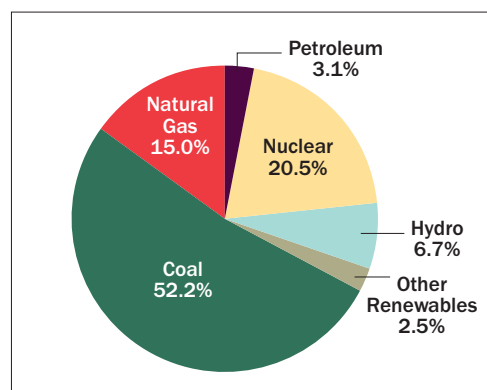
Nuclear power historically has received large government subsidies. Nevertheless, construction cost overruns incurred in building the last generation of nuclear power plants exceeded \$150 billion in 2005 dollars (excluding expensive changes required after the Three Mile Island accident). These cost overruns led to nuclear plants being uneconomic compared with other electricity generation choices. As a result, no nuclear plants have been ordered since 1978, and none of those ordered after 1974 were completed. Large financial losses from both completed reactors and reactors abandoned during construction were incurred by utility customers, investors, and taxpayers.

**Total U.S. Energy Consumption by Source, 2005**



Source: U.S. Energy Information Administration. 2006. *Annual Energy Review 2005*.

**U.S. Electricity Consumption by Source, 2005**



Source: U.S. Energy Information Administration. 2006. *Annual Energy Review 2005*.

Current forecasts regarding the cost of nuclear power are based on assumptions about the reliability and capital costs of new plants, many of which are still in the design phase. Knowing that past estimates of nuclear plant construction times and financing costs often proved grossly optimistic, forecasts assuming great improvements in new plant construction should be viewed with skepticism.

## **FACTORS AFFECTING EXPANSION OF U.S. NUCLEAR POWER**

**2005 Energy Policy Act.** In the 2005 Energy Policy Act, the Bush administration and Congress have already legislated subsidies for nuclear power even though this is not the public investment that would provide the most cost-effective near-term response to global warming or energy security. These subsidies include start-up support in the form of loan guarantees and production tax credits for a handful of plants, and a 20-year extension of the Price-Anderson Act, which limits plant owners' liability for accidents to an amount far below the potential costs of a serious accident.

**Liability protection.** Applying the Price-Anderson Act to new plants removes the financial incentive for plant owners to develop reactor designs that would have safety margins large enough so the owners could buy insurance and not need federal liability protection. The act also functions as an indirect subsidy that puts less risky technologies at a disadvantage.

**New designs.** While some argue that new plant designs will be much safer than current-generation reactors, these claims are difficult to evaluate because they are based largely on probabilistic safety assessments that in most cases have not been validated by actual operational experience. While certain design features would correct major safety deficiencies in current plant designs, the associated benefits could be offset by other factors such as cost-cutting actions that reduce safety margins, lack of operating experience, and the need in some cases to develop advanced

materials that will have to perform under punishing conditions.

**NRC policy and safety oversight.** New NRC policies include licensing process shortcuts that prevent meaningful public participation in proceedings related to the siting of new reactors (by taking away the intervenor's rights of discovery and cross-examination). The NRC's focus on schedules is reducing the number of NRC inspections, making it more likely that the practice of allowing reactors to start up with known but unresolved safety problems will persist.

In addition, serious safety problems continue to arise at operating plants because the NRC does not adequately enforce existing safety standards. In the last decade alone, nine reactors have been shut down for at least a year in order to rectify safety problems. An effective regulator would be neither unaware nor tolerant of safety problems so extensive that a year is needed to fix them.

Unfortunately, the NRC has tended to act more like a protector of the nuclear power industry than a guardian of the public welfare. An internal NRC survey in 2002 revealed that almost half of the agency's employees feared that their careers would suffer if they raised safety concerns. Regarding the near-accident at Ohio's Davis-Besse plant in 2002, the NRC inspector general reported:

*"The fact that [the licensee] sought and [NRC] staff allowed Davis-Besse to operate past December 31, 2001, without performing these inspections was driven in large part by a desire to lessen the financial impact [on the licensee] that would result from an early shutdown."*

Had a loss-of-coolant accident occurred at Davis-Besse, it is doubtful that an expansion of U.S. nuclear power would even be under discussion now.

**Protection against terrorism and sabotage.** Regardless of whether any new plants are built, it is essential for the government to ensure that all plants have the ability to withstand acts of

terrorism. The NRC, however, requires nuclear power plants to be protected against a “design basis threat” that remains far less severe than the actual threat demonstrated by the 9/11 attack. In addition, the responsibilities of the government and plant owners for defending against acts of terrorism and sabotage must be clearly defined—which they are not now—and a system must be in place to ensure that both the government and plant owners fulfill those responsibilities.

In short, Congress should recognize that thorough reform of the NRC is long overdue whether or not new plants are built, and that such reform is a prerequisite to any expansion of U.S. nuclear power.

**Waste disposal.** With increased nuclear power comes increased nuclear waste. While the problem of waste disposal can (from a technical and safety standpoint) be postponed for decades by storing waste in aboveground “dry casks,” the political challenge of expanding our nuclear capacity without a long-term disposal plan is another matter.

The best available means of dealing with radioactive waste is to place it underground in a permanent geologic repository, where it will remain isolated from the environment anywhere from tens of thousands of years to a million years or more. The location of such a repository must be chosen based on a high degree of scientific and technical consensus; no such consensus currently exists on the proposed Yucca Mountain facility in Nevada.

There is no immediate need to begin operating a permanent repository to store waste from existing plants. However, whether or not there is an expansion of nuclear power in this country, the United States needs to demonstrate a technically and politically viable process for identifying and licensing geologic repositories.

## **WEAPONS IMPLICATIONS OF EXPANDED NUCLEAR POWER**

The energy released by both nuclear power and nuclear weapons is ultimately due to the fission

of uranium or plutonium nuclei. Therefore, nuclear power and nuclear weapons are inextricably linked.

For uranium to be used in weapons, the ore must be modified into “highly enriched” uranium (HEU), more than 20 percent of which is the isotope U-235. While all HEU can be used to build weapons, the most suitable material contains 93 percent or more U-235 and is referred to as “weapon-grade HEU.” Plutonium does not exist in nature.

The acquisition of plutonium or HEU is the biggest obstacle to any group or nation seeking to build a nuclear weapon. While HEU may be more attractive to terrorist groups because the simplest weapon design uses HEU, a sophisticated group could also be capable of making a simple plutonium-based weapon. These materials can be the objective or the by-product of a civilian nuclear power program.

### **Uranium enrichment at civilian facilities.**

Uranium enrichment facilities have an inherent “dual-use” character because the repetitive process that yields the “low-enriched” uranium (LEU) needed for power plant fuel can simply be continued to produce HEU. Once an enrichment facility has produced LEU for reactor fuel (which is four to five percent U-235), it has already completed about two-thirds of the work required to produce weapon-grade HEU.

This is why the current Iranian enrichment effort, ostensibly for power reactors, is suspected to be the prelude to a weapon program. The Iranian crisis illustrates the limitations of the current international safeguards system in controlling proliferation threats.

**Extracting plutonium from spent fuel.** Plutonium is inevitably produced in any power plant that uses uranium as fuel. It is a component of the plant’s large and heavy spent fuel assemblies, which remain lethally radioactive for 100 years or more. Left in this state, plutonium is resistant to theft or use by a nation or terrorist group seeking nuclear weapons. It can, however, be extracted from the spent fuel using special “reprocessing” equipment and then

used to manufacture new reactor fuel. Plutonium itself is only mildly radioactive and could be handled without protection by thieves or terrorists after reprocessing.

Presidents Ford and Carter, seeking to impede the proliferation of nuclear weapons, decided to stop reprocessing in the United States and advocated this step abroad. The Reagan administration rescinded this policy, but did not succeed in restarting reprocessing in the United States because the technology was far too expensive and ample uranium supplies existed to fuel existing plants. This is still the case today.

***The proposed Global Nuclear Energy Partnership (GNEP).*** In 2006 the Bush administration announced its plan to promote the global expansion of nuclear power. To those ends, GNEP is to develop new reprocessing technologies and a new “fast burner” nuclear reactor that would consume plutonium fuel. GNEP would also create an international arrangement in which “supplier” nations (including the United States) would lease nuclear fuel to other nations; in exchange, these “recipient” nations would agree to not pursue their own nuclear fuel production facilities. Under this arrangement, the recipient nations would return their spent fuel to the supplier nations.

GNEP faces formidable problems. The “fast burner” power plants only exist as untested conceptual designs, and the net cost of nuclear power with reprocessing is projected to be considerably higher

than the continued use of uranium fuel without reprocessing. There is also no reason to expect that “states of concern” such as Iran would be willing to accept the proposed plan for controlling nuclear fuels.

Furthermore, the GNEP fuel cycle would be substantially less proliferation-resistant than the existing cycle in which plutonium remains embedded in lethally radioactive wastes. Rather than supporting nonproliferation, the Bush administration’s advocacy of GNEP is encouraging other countries to reprocess their spent fuel. The nationally owned French firm Areva, for example, recently declared its intention to develop new reprocessing plants for export to a dozen countries.

This problem is compounded by the fact that it is very difficult for reprocessing facilities that handle large amounts of nuclear waste to keep accurate track of small amounts of plutonium—amounts sufficient to build multiple nuclear bombs. Consider the amount of plutonium unaccounted for at a Japanese reprocessing facility over a five-year period: a total of 70 kilograms—enough for some 10 nuclear weapons.

Before Congress makes any further commitments to GNEP, it should conduct a thorough and independent review to evaluate the program’s compatibility with the stated goals of U.S. nuclear proliferation policy, and to assess its prospects for fostering a more economical and safer domestic nuclear power industry.