

Nuclear Power

Both Sides

AFTER THE ACCIDENT AT THREE MILE ISLAND IN 1979, THE UNITED STATES WROTE off the expansion of civilian nuclear power as a dead issue. Now, with oil prices and anxiety about global warming on the rise, this energy source is getting a long second look. Here, advocates on each side of this complex issue make the case for and against nuclear power. The authors continue the debate with rejoinders at the *WQ* website, www.wilsonquarterly.com.

Nuclear Power Is the Future

BY MAX SCHULZ

IN THE EARLY MORNING HOURS OF MARCH 28, 1979, a pump that provided cooling water to Unit No. 2 at the Three Mile Island Nuclear Generating Station suddenly broke down. The 880-megawatt reactor, located on an island in the Susquehanna River 10 miles from the Pennsylvania capital of Harrisburg, was operating at close to full capacity.

When the cooling pump failed, the turbine and the reactor automatically shut off, as they had been programmed to do. But an entire nuclear power plant doesn't halt operations as easily as one flips a switch. The other parts of the plant that are going full-bore have to ramp down, too, in a carefully managed process. The safe shutdown of a nuclear plant relies partly on automation—an elaborate, sophisticated series of computers, pumps, valves, and mechanical checks and balances—and partly on human oversight.

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As the turbine and reactor at Unit No. 2 turned off, the pressure in the nuclear portion of the plant began to build excessively. In such situations, a valve should pop open, releasing coolant and thereby relieving the pressure. In this case, the valve did. But it failed to close when the pressure decreased. It was stuck.

Worse, according to the federal government's subsequent investigation, "signals available to the operator failed to show that the valve was still open." As a result, "cooling water poured out of the stuck-open valve." As coolant continued to escape, unbeknownst to the engineers in the control room, the reactor began to overheat. It was melting down, and, terrifyingly, Three Mile Island's overseers didn't know it.

After that accident 27 years ago, a consensus quickly emerged that nuclear energy was too inherently dangerous for the United States to pursue a future powered by splitting the atom. More than 60 nuclear reactor units at various stages in the permitting and construction pipeline were

canceled in the aftermath of Three Mile Island. So complete was this rout that not a single new nuclear power plant has been ordered since. The disaster at Chernobyl in the Soviet Union seven years later seemed merely to confirm that nuclear power was dead.

The obituaries written for U.S. nuclear power in the wake of Three Mile Island were, however, premature. True, the industry suffered greatly, but it did not die entirely. In fact, under the radar, nuclear energy production has actually *expanded*. In 2005, the 103 U.S. commercial nuclear reactors operating in 31 states generated 782 billion kilowatt-hours (kWh), three times more power than in 1979.

Not every nuclear plant in the pipeline was cancelled after Three Mile Island. In fact, there are 50 percent more commercial nuclear reactors in operation today. More important, massive gains in operating efficiency have helped boost nuclear plants' output. At the time of the accident, nuclear facilities ran at about 60 percent of their capacity; they were offline for several months a year for refueling and maintenance. Today this work is done in weeks, not months, and plants can run at nearly 90 percent of capacity. From 1990 to 2002, these gains helped add the equivalent of 26 new, standard-sized 1,000-megawatt nuclear power plants to the U.S. power supply system.

While the United States has been suffering its crisis of confidence about nuclear energy, much of the rest of world has shrugged off such anxieties. Today, more than 300 nuclear reactors produce electricity in nearly 30 other countries. The vast majority have come online since Three Mile Island. More than 130 new plants are under construction worldwide.

Now, the United States seems poised to catch up. Today, we routinely hear about a "renaissance" or "revival" of nuclear energy. The recognition that nuclear power is vital to global energy security in the 21st century has been growing for some time. Public opinion on the relative dangers and benefits of atomic energy is shifting, particularly in the United States. Opinion polls routinely show that a majority of Americans support nuclear energy. That support translated into favorable provisions in the Energy Policy Act of 2005, which specialists claim will facilitate the construction of new nuclear plants in the United States. Within the next 10 years, we are told, we should see the first new nuclear power plant in decades get licensed and built.

But such a renaissance is not a sure thing. Legitimate questions remain about safety, about the licensing process for new reactors, and, most important, about how to handle and where to store spent nuclear fuel. Failure to answer these questions adequately could imperil the nuclear revival so many have proclaimed is nigh.

The beauty of nuclear fission is its ability to derive so much from so little. The energy density of nuclear fuel far exceeds that of any other energy source. As my Manhattan Institute colleague Peter Huber has noted, "A bundle of enriched-uranium fuel rods that could fit into a two-bedroom apartment in Hell's Kitchen would power [New York City] for a year: furnaces, espresso machines, subways, streetlights, stock tickers, Times Square, everything—even our cars and taxis, if we could conveniently plug them into the grid."

Pound for pound, coal stores twice as much energy as wood. Oil packs the same amount of energy that coal does into half the weight and space. But a gram of uranium 235 contains as much energy as four tons of coal. This is why splitting the atom was key to inventing the new type of bomb that could win World War II. And it is why President Dwight D. Eisenhower, an early proponent of commercial nuclear power, could argue that atomic energy might transform medicine, agriculture, and, in particular, electricity generation. It succeeded on all counts.

At times, enthusiasm for nuclear power's potential bordered on the hyperbolic. In 1954, the chairman of the Atomic Energy Commission famously predicted in a speech to science writers, "Our children will enjoy in their homes electrical energy too cheap to meter." Though to this day there remains speculation about whether he was referring to nuclear fission or perhaps to something farther off in the future, such as fusion power, the "too-cheap-to-meter" promise has been attached to commercial nuclear power generation ever since. It is cited frequently by antinuclear activists as evidence that the technology's proponents have their heads in the clouds.

Just as there is no such thing as a free lunch, there is no such thing as "too cheap to meter"—though in some respects nuclear energy isn't all that far off the mark. The generation of electricity from nuclear power entails significant costs. By and large, however, these are capital investments having to do with construction and trans-

mission. Because a plant requires so little uranium to generate so much power, once a nuclear plant is built—and the expected life span of a conventional reactor is 40 to 60 years, perhaps longer—the price of fuel is close to irrelevant in figuring the cost of electricity. The nuclear industry boasts of providing some of the cheapest electricity on the grid, at an average production cost (after a plant is built) of less than 1.8 cents per kWh. These costs are close to 40 percent lower than they were just two decades ago.

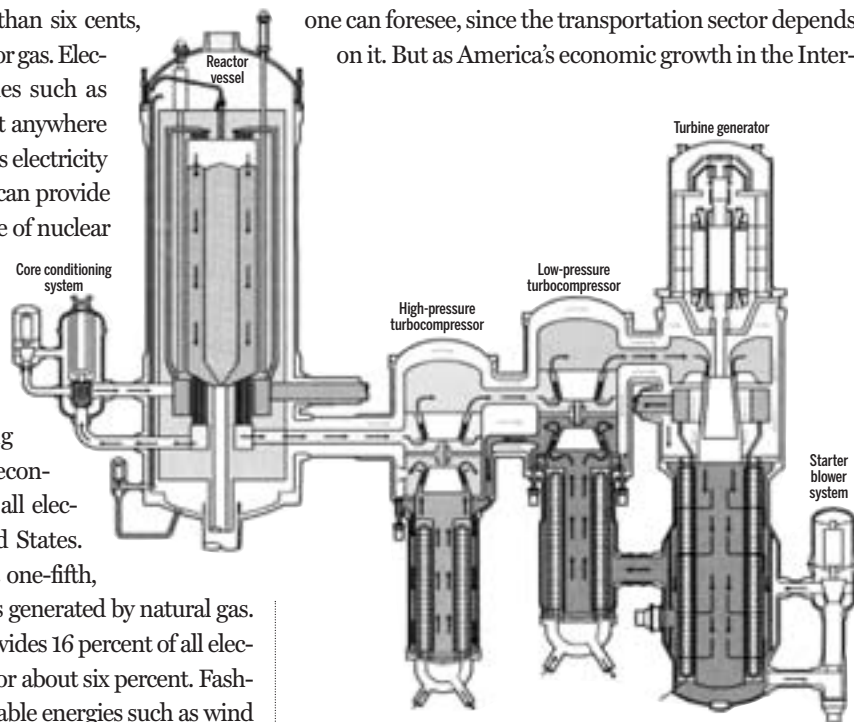
On its merely pecuniary merits, then, nuclear power looks pretty good compared to the alternatives. Electricity generated from natural gas can cost anywhere from three cents per kWh to more than six cents, depending on the market price for gas. Electricity from renewable energies such as wind, solar, or biomass can cost anywhere from two to six times as much as electricity from nuclear power. Only coal can provide electricity at prices to rival those of nuclear energy, but coal has evident environmental drawbacks tied to pollution and climate change.

Given the economics, it is little wonder that nuclear power has gained a strong foothold in America's energy economy. Coal accounts for half of all electricity generated in the United States. Nuclear power's share is about one-fifth, roughly as much electricity as is generated by natural gas. (Worldwide, nuclear power provides 16 percent of all electricity.) Hydropower accounts for about six percent. Fashionable but uneconomic renewable energies such as wind and solar power generate less than half of one percent of America's electricity.

Total world energy demand is expected to double by 2050. Over the next two decades, global appetites for electricity are expected to increase 75 percent over current levels. Electricity demand is predicted to skyrocket in the United States as well, continuing a recent trend that has gone largely unnoticed by many pundits and energy industry observers. Though the news media constantly broadcast our angst about reliance on petroleum, particularly oil from the Middle East, the most significant energy development in recent times has been the increasing electrification of America's amazing economic engine. More than 85 percent

of the growth in U.S. energy demand in the last quarter-century has been met not by oil but by electricity, most notably in the information technology and telecommunications industries. Today, nearly three of every five dollars of U.S. gross domestic product come from industries and services that run on electricity. In 1950, just one in five dollars of GDP was dependent on electrical power.

This shift from oil to electricity points to the gradual fulfillment of President George W. Bush's goal, expressed in the 2006 State of the Union address, that our nation "move beyond a petroleum-based economy." Oil will remain critical to the energy economy for as long as anyone can foresee, since the transportation sector depends on it. But as America's economic growth in the Inter-



Pebble-bed reactors, still under development, are fueled by graphite-encased uranium pebbles (in the reactor vessel at left) rather than rods, reducing waste products as well as the risks of meltdown and proliferation.

net age continues, sparked by electrons dancing along wires and fiber-optic cables, it will require ever more massive amounts of electricity. Nuclear power seems a promising solution to this need.

The questions about nuclear power, however, are not merely economic. If they were, there would be little controversy about whether to split atoms. Since Hiroshima and Nagasaki, during the Cold War, and particularly in the wake of Three Mile Island and Cher-

nobyl, legitimate inquiries into the safety, security, and environmental effects of nuclear energy have dominated the debate.

With regard to the incidents at Three Mile Island and Chernobyl, these objections don't quite seem fair. Opponents of nuclear energy seized on these episodes to argue that nuclear power is inherently unsafe, and they found a receptive audience in the United States and Europe. But a closer examination of the two events tells a different story.

God willing, Three Mile Island will be remembered as the worst nuclear accident in American history. But nobody

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died. Nobody was even injured. Despite the scary-sounding partial core meltdown that occurred, the nearby community was never really endangered. The massive concrete containment structures that are standard on almost all nuclear reactors did their job and ensured that no radiation leaked.

Chernobyl was different. The 1986 accident spiraled out of control partly because of human error by the Soviet-trained engineers, but more because of the nuclear plant's tragically flawed design. Many reactors built in the Soviet era, as Chernobyl was, did not feature the containment buildings found at virtually every other facility around the world. A toxic plume of radioactive fallout drifted across the Soviet Union, the rest of Europe and Asia, and even as far as North America. Hundreds of thousands of people in Ukraine and Belarus were forced to relocate permanently. Several dozen people perished in the first few months after the accident. A recent United Nations report suggested that as many as 4,000 people will die from radiation-induced cancers tied to the disaster. Had Chernobyl been built with the containment structures standard in nuclear reactors the world over, that tragedy could have been avoided.

Still, the critics of nuclear power are right: Nuclear power *is* dangerous. Dealing with radioactive materials entails very real peril. Concerns about the proliferation of materials, technology, and nuclear know-how are by no means

unfounded. And for all of the nuclear industry's protestations about its safety record amassed almost 3,000 years of collective reactor operating experience, that record will mean nothing if even one catastrophe occurs. As one industry trade group executive recently acknowledged, "With nuclear energy, an accident anywhere is an accident everywhere."

In truth, every energy source has drawbacks, many related to safety. A large pile of coal, left alone, eventually will smolder and combust. Petroleum is highly flammable. Windmills kill birds and, arguably, disrupt the Navy's sonar. Hydroelectric dams kill fish, divert rivers, and threaten ecosystems with soil erosion. The question isn't whether the dangers associated with nuclear energy outweigh those from coal or petroleum or the Grand Coulee Dam. Of course they do. The question is whether the enormous benefits derived from nuclear power—which

pound for pound outweigh those of any other fuel or energy technology—are worth accepting its risks.

Critics also cite concerns about the spread of dangerous nuclear waste that can be used to manufacture nuclear weapons. But the latest technology research is geared toward developing systems that resist proliferation. China and Russia are expected to join the United States, France, Canada, Japan, Britain, and other nations later this year in the Generation IV effort, an international consortium explicitly devoted to fostering technologies that limit proliferation risks.

Meanwhile, South Africa and China are pioneering the development of smaller, "pebble-bed" reactors that operate differently from reactors typically found in the United States. Pebble-bed reactors use uranium-specked graphite balls, rather than rods, for fuel. Conventional fuel rod assemblies must be removed before they are completely used up, but pebble-bed fuel balls burn until they are depleted, lessening the chance for trafficking in dangerous nuclear waste.

In addition, the Bush administration has proposed a new method for reprocessing spent nuclear fuel. Reprocessing traditionally has entailed recycling the remaining uranium from spent fuel rods after removal from a reactor and using it as additional fuel. But the procedure used to separate the uranium for reuse also produces small amounts of

weapons-grade plutonium. For that reason, President Jimmy Carter banned the reuse of spent fuel in the United States as a proliferation risk. Today, spent nuclear fuel is stored on-site at nuclear plants, awaiting final disposal upon the completion of the Yucca Mountain nuclear waste repository in the Nevada desert.

The Bush proposal, however, seeks to develop a promising new technology for recycling spent fuel in a manner that renders the material suitable for use as nuclear fuel but not for use in nuclear weapons, thereby eliminating the risk. If successful, this technology could not only help make nuclear energy safer, but could also extend its benefits to the far reaches of the globe.

The equation skews more decidedly in favor of nuclear power with the introduction of the environment as a factor. Electricity generated by nuclear power plants gives off no emissions: no sulfur, no mercury, and, most important, none of the greenhouse gases, such as carbon dioxide (CO₂), thought to contribute to climate change.

Roughly 700 million metric tons of CO₂ emissions are avoided each year in the United States by generating electricity from nuclear power rather than some other source. According to the U.S. Department of Energy, that is nearly equivalent to the CO₂ released from all U.S. passenger cars.

The argument that nuclear power should be a critical component in a strategy to deal with concerns about climate change is quite new. Certainly, it was not anything that occurred to Eisenhower when he crafted his *Atoms for Peace* message for a postwar era. Nor was it much on the radar screen in the 1970s when concerns about global cooling were in vogue. And even those who have raised the specter of global warming most alarmingly by and large haven't embraced the potential of nuclear energy. Former vice president Al Gore, who has stated that global warming ultimately is a greater threat than terrorism, pointedly refuses to endorse expanded use of nuclear power.

Yet some longtime opponents are overcoming their fear of atomic energy. Patrick Moore, one of the founders of Greenpeace, recently declared his support for nuclear energy as "the only large-scale, cost-effective energy source that can reduce [greenhouse-gas] emissions while continuing to satisfy a growing demand for power." British prime minister Tony Blair, an enduring critic of nuclear power, this

spring signaled his government's support for expanding nuclear energy production.

Today, it is the global climate change argument that clinches the case in favor of nuclear power. If, as Gore asserts, combating climate change is our highest priority, and if the future of civilization itself is at stake, then nuclear power must play a significant and expanded role not just in America's energy mix but in the world's.

For all of nuclear energy's apparent advantages (even when weighed against its risks), its renaissance faces several challenges. The chief question is what to do with the waste. Political squabbling has pushed back the opening of Yucca Mountain, the disposal facility the Department of Energy began contemplating in 1978, to 2017 at the earliest, and even that date is in doubt. The country's reactors have accumulated 55,000 metric tons of nuclear waste in temporary storage, and many are running out of space. Failure to open Yucca Mountain or otherwise solve the waste question could force some reactors to shut down and discourage investors from supporting new nuclear plants.

Meanwhile, the nuclear licensing process must be improved. Last year's energy bill streamlined procedures somewhat, but the Nuclear Regulatory Commission must get serious about processing license applications in a timely manner. Delays caused by red tape and bureaucratic foot-dragging could send private investment elsewhere.

The 21st century will be marked by a near-insatiable thirst for energy around the world, particularly in the large and growing economies of the United States, China, and India, and among the large-scale consumers of industrial Europe. At the same time, the developing world will greatly benefit if granted access to cheap, reliable sources of energy. According to the United Nations, 2.4 billion people lack access to modern energy service for cooking and heating. Roughly 1.6 billion—about a quarter of the world's population, including most of sub-Saharan Africa—have no access to electricity at all.

Nuclear power alone is positioned to help meet the world's burgeoning energy demand and supply electricity to the power-starved areas of the world in a manner that safeguards the environment. It alone can raise standards of living on every continent while emitting no pollutants or greenhouse gases. It is the best candidate among many to help raise more than a billion people out of darkness and grinding poverty, and to do so in a way that does no harm, but only good. ■