© 2012 World Future Society • 7910 Woodmont Avenue, Suite 450, Bethesda, MD 20814, U.S.A. • www.wfs.org • All rights reserved.

Nuclear Power's Unsettled Future

A year after the Fukushima Daiichi disaster in Japan, prospects for the nuclear power industry worldwide are far from certain. An energy policy scholar assesses the key economic, environmental, political, and psychological hinges on which nuclear power's future now swings.

By Ozzie Zehner

On March 16, 1979, Hollywood released a run-of-the-mill film that might have been rather unremarkable had the fictional plot not played out in real life while the movie was still in theaters. *The China Syndrome,* starring Jane Fonda, Jack Lemmon, and Michael Douglas, features a reporter who witnesses a nuclear power plant incident that power company executives subsequently attempt to cover up. Many days pass before the full extent of the meltdown surfaces. Just 12 days after *The China Syndrome* premiered, operators at the Unit 2 nuclear reactor at Three Mile Island, outside Harrisburg, Pennsylvania, received abnormally high temperature readings from the containment building's sensors.

They ignored them.

Many hours passed before the operators realized that the facility they were standing in had entered into partial core meltdown. Power company executives attempted to trivialize the incident and many days passed before the full extent of the meltdown surfaced.

The China Syndrome went viral. When star Michael Douglas appeared on NBC's *The Tonight Show,* host Johnny Carson quipped, "Boy, you sure have one hell of a publicity agent!" The staged nuclear leak filmed in the back lots of Hollywood and the real nuclear leak on Three Mile Island became conjoined, feeding into one another, each event becoming more vividly salient in the eyes of the public than if they had occurred independently. The intense media and political fallout from the leak at Three Mile Island, perhaps more than the leak itself, marked the abrupt end of the short history of nuclear power development in the United States.

Nuclear industry officials regularly accuse their critics of unfairly brandishing the showmanship of disaster as if it were characteristic of the entire industry while downplaying the solid safety record of most nuclear facilities. Indeed, meltdowns like the ones at Three Mile Island, Chernobyl, and Fukushima don't occur as frequently as oil spills. But then, the risks that people associate with nuclear leaks are inordinately more frightening. As with oil spills, industry officials frame meltdowns as accidents, almost without exception. Alternatively, we could choose to frame nuclear power activities as highly unstable undertakings that are bound to expel radioactive secretions into the surrounding communities and landscapes over time.

For some concerned citizens, nuclear power is an opportunity for low-carbon and independent energy generation, while for others it's a guarantee of nuclear proliferation and fallout risks. Greens in Germany, for instance, rail against nuclear power. Meanwhile, environmentalists in Britain frequently support it. In Japan, nuclear energy risks remained conceptually separated from the fallout horrors of World War II until the March 2011 meltdowns at Fukushima folded those perceptions together into the nation's history.

The fallout at Fukushima contaminated a large swath of Japan. However, the fallout incurred by the nuclear industry itself was not limited to the island nation. The Fukushima meltdowns prompted nuclear cancellations across the globe.

To capably assess possible nuclear futures following this moment of crisis, we must first interrogate nuclear power's past. The successes and failures of modern nuclear power facilities have not hinged on the kind of technical limitations that surround alternative energy technologies such as solar, wind, and biofuels. Nor have they been beleaguered by the threat of eventual resource scarcity associated with oil, gas, and coal. (There's plenty of uranium fuel on our planet, both in the ground and in ubiquitous seawater.) Rather, the coming generations of nuclear power will pivot on something equally foreboding: those same rusty hinges upon which the nuclear establishment has swung for decades.

Hinge 1: An Enduring Dilemma

Travel 200 miles off the northeast coast of Norway into the Arctic Ocean toward the shores of Novaya Zemlya Island and you'll see seals, walrus, and aquatic birds, as well as numerous species of fish, such as herring, cod, and pollack, much as you'd expect. But some of them will be swimming around something less anticipated—a curious fabricated object rising above the dark sea floor like an ancient monument, identifiable only by the number, "421." Inside the corroded steel carapace lies a nuclear reactor. Why, we might wonder, has someone installed a nuclear reactor under the sea so far from civilization?

It wasn't built there. It was dumped there—along with at least 15 other unwanted nuclear cores previously involved in reactor calamities.

These cores lie off the coasts of Norway, Russia, China, and Japan, as reported by the Russian government in 1993. Many of the reactors still contain their fuel rods. Resurfacing them and processing them in a more accepted manner would be risky and expensive. But even disposing of the world's existing nuclear reactors that haven't been tossed in the ocean won't be a straightforward proposition. The largest problem is, of course, what to do with the radioactive waste.

The U.S. Department of Energy started to construct a repository in Yucca Mountain, Nevada, to store the nation's spent reactor fuel. It was to accept spent fuel starting in 1998, but management problems, funding issues, and fierce resistance by the state of Nevada pushed the expected completion date back to 2020. President Obama called off the construction indefinitely, slashing funding in 2009 and finally withdrawing all support in 2011. If completed, the Yucca Mountain crypt will cost about $100 billion, according to the U.S. Department of Energy. Even then, it's designed to house just 63,000 tons of spent fuel. More than that is already scattered around the country today, reports Frank von Hippel in a study for the U.S. Army's Strategic Studies Institute.

In the meantime, utility companies have been storing waste in open fields surrounding their plants. A large nuclear power reactor typically discharges 20 to 30 tons of 12- to 15-foot-long spent fuel rods every year, totaling about 2,150 tons for the entire U.S. commercial nuclear industry annually. Taxpayers will end up paying billions to temporarily store this waste, according to the Congressional Research Service,

Decommissioning: Before its 2007 demolition, the Chapelcross nuclear plant in Scotland produced weapons-grade plutonium as well as electrical power.

PHOTOGRAPHS COURTESY OF LYNNE KIRTON, GEOGRAPH.ORG.UK which brings us to the next hinge of nuclear power's future.

Hinge 2: Costly Secrets

Every single nuclear plant in the United States was built with taxpayer help. It costs hundreds of millions of dollars to carefully assemble a nuclear power plant. And it costs hundreds of millions to carefully disassemble one, as well.

In addition to direct expenditures, the nuclear industry incurs substantial capital write-offs through bankruptcies and stranded costs. This leaves the burden of their debt on others—a hidden and formidable set of often overlooked expenses. To make matters worse, economies of scale don't seem to apply to the nuclear industry. Just the opposite, in fact. Historically, as the United States added more nuclear energy capacity to its arsenal, the incremental costs of further expanding capacity didn't go down, as might be expected, but rather went up, reports energy policy scholar Gregory F. Nemet.

If the costs to taxpayers are so high and the risks are so extreme, why do nations continue to subsidize the nuclear industry? It's partly because so many of the subsidies are hidden. Subsidy watchdog Doug Koplow (founder of Earth Track) points out, "Although the industry frequently points to its low operating costs as evidence of its market competitiveness, this economic structure is an artifact of large subsidies to capital, historical write-offs of capital, and ongoing subsidies to operating costs."

The nuclear industry often loops taxpayers or local residents into accepting a variety of the financial obligations and risks arising from the planning, construction, and decommissioning of nuclear facilities, such as:

- Accepting the risk of debt default.
- Paying for cost overruns due to regulatory requirements or construction delays.
- Dropping the requirement of insurance for potential damage to surrounding neighborhoods.
- Taking on the burden of managing and storing high-level radioactive waste.

Since these handouts are less tangible and comprehensible to the public than cash payments, the nuclear industry and its investors have found it relatively easy to establish and renew them.

These costs may be worth it, some say, since nuclear power generation produces less carbon dioxide than fossil-fuel alternatives. It therefore promises to mitigate the potentially far greater risks of catastrophic climate change. For solar, wind, and biofuel power generation, the projected costs to mitigate a ton of CO_2 are very high. Does nuclear fare any better?

Not really.

Assuming the most favorable scenario for nuclear power, where nuclear power generation directly offsets coal-fired base-load power, avoiding a metric ton of CO_2 costs about $120 ($80 of which is paid by taxpayers). This figure does not include the costs of spent-fuel containment and the risks of proliferation and radiation exposure, burdens that are especially difficult to quantify. This is far more expensive than boosting equipment efficiency, streamlining control system management, improving cropping techniques, and many other competing proposals to mitigate climate change. Why spend $120 on nuclear to avoid a single ton of CO_2 when we could spend the same money elsewhere to mitigate five tons, or even ten, without the risks? Nuclear energy will become a more plausible CO_2 mitigation strategy after we have exhausted these other options, but we have a long way to go before that occurs.

Hinge 3: Boom!

In 2008, the Nuclear Suppliers Group, an organization of 45 nations that patrols nuclear material trading and technology, agreed to bend its rules. The cartel allowed India access to uranium imports for the first time. When it announced the waiver, political sparring arose between those who identified the move as a step toward nuclear armament proliferation in the region and others who argued the freely flowing uranium represented a peaceful development of power, which stood to benefit millions of Indians. So who's right? Is nuclear power a way to produce electricity or a path toward building deadly weapons?

In reality, it's both.

A large part of the problem comes back to storage. How can we keep spent fuel away from those who

COURTESY OF JUSTIN STAHLMAN

In the wake of Chernobyl: Radioactive bumper cars lie silent in the abandoned city of Priypat near the Chernobyl reactor.

might craft it into dirty bombs, disperse it with conventional weapons, or otherwise compromise its stability?

Another factor arises from the main alternative to storage: recycling. Reprocessing used fuel rods is expensive and leaves behind separated plutonium. Since plutonium is ideal for making bombs, many countries, including the United States, consider reprocessing a proliferation risk. Meanwhile, the United Kingdom, France, Russia, Japan, India, Switzerland, and Belgium reform their spent rods. They have separated a combined 250 metric tons of plutonium to date, more than enough to fuel a second Cold War.

Alternatively, fast-neutron "burner" reactors can run directly on spent fuel. This presumably sidesteps the plutonium issue, though such plants may not be commercially feasible to build. And they run hot. As a result, relying on them may merely trade in proliferation risks for meltdown risks.

In short, the often-cited separation between civilian nuclear power and military nuclear weaponry is problematic for several reasons. First, countries often end up desiring a bit of both—a little civilian electricity and a little nuclear weaponry. Political desires rarely congeal into exclusively one form or the other.

Second, peacetime and wartime nuclear technologies are intermingled. The facilities, the expertise, and even the waste products can easily cross the imagined division between peacetime and wartime nuclear enterprise.

Third, nation-states are in constant flux—politically, economically, and culturally. The motivations of a country today cannot be assumed to hold in the future. Even the Department of Energy acknowledges in one report that we can't assume the United States will remain a contiguous nation-state throughout the time frame required to see nuclear waste through its decomposition.

Hinge 4: The Psychology of Fear

The Colorado River flows through one of the largest natural concentrations of radioactive surface rock on the planet, containing about a billion tons of uranium in all. The levels of radiation are 20 times the proposed limit for Yucca Mountain. Unlike the glass-encapsulated balls used to store radioactive waste, Colorado's uranium is free ranging and water soluble.

"If the Yucca Mountain facility were at full capacity and all the waste leaked out of its glass containment immediately and managed to reach groundwater, the danger would still be twenty times less than that currently posed by natural uranium leaching into the Colorado River," claims Berkeley physicist Richard Muller, author of *Physics for Presidents* (W. W. Norton, 2008).

Does this mean Coloradans are exposed to more radiation than the rest of us? Yes—along with those in Los Angeles who regularly bathe and drink water piped in from the Colorado River. Yet, the residents of Colorado and California, together with those of the nearby states—South Dakota, Utah, and New Mexico—experience the lowest cancer incidence rates anywhere in the contiguous United States, according to the National Cancer Institute. This goes to show how tricky it is to assess complex radiation risks.

According to early documentation of the 1986 Chernobyl nuclear reactor meltdown, the catastrophe exposed 30,000 people living near the reactor to about 45 rem of radiation each—about the same radiation level experienced by the survivors of the Hiroshima bomb, Muller observes. According to a statistical scale developed by the National Academy of Sciences, 45 rem should have raised cancer deaths of residents near Chernobyl from the naturally occurring average of 20% to about 21.8%—or roughly 500 excess fatalities.

Nevertheless, deaths are only one of many measures we might choose to evaluate harm, and even then, what counts as a radiation fatality in the first place is not so clear and has changed over time.

In 2005, the United Nations put the Chernobyl death toll at 4,000. And in 2010, newly released documents indicated that millions more were affected by the fallout and cleanup than originally thought, which in turn led to tens of thousands of deaths as well as hundreds of thousands of sick children born long after the initial meltdown.

To make matters more complex, the concrete sarcophagus entombing the reactor is now beginning to crack—a reminder that it is far too early to complete a history of Chernobyl and its aftermath. We will have to wait equally long to assess the fallout at Fukushima Daiichi, which is now, long after the tsunami, still posing new challenges to our conceptions of acceptable radioactive risk.

Humans won't be able to calculate nuclear risks as long as humans have nukes. Perhaps it is this very uncertainty that evokes particularly salient forms of nuclear unease. The emotive impulse that wells up in response to free radiation is a more visceral phenomenon than one bound to the shackles of calculation. Fossil-fuel executives should consider themselves lucky that the arguably more dangerous fallout from fossil-fuel use, which kills tens of thousands of people year after year, has not elicited a corresponding fear in the minds of the citizenry.

As a society, we begrudgingly tolerate the fossil fuel–related risks of poisoning, explosions, asthma, habitat destruction, and spills, which regularly spawn tangible harms. Yet, when it comes to nuclear power, we slide our heads back on our necks and purse our lips with added skepticism. Whether the degree of our collective skepticism toward nuclear power is appropriate, or even justified, doesn't really seem to matter. The public doesn't need experts to tell them when to be terrified.

As simple as fear, and as complex as fear, public angst will remain a nagging bête noire of the nuclear industry. Is it possible that taxpayers and investors could spend billions of dollars constructing a new generation of nuclear reactors just to have a hysterical public again shut the whole operation down following the next (inevitable) mishap? Absolutely. As taxpayers subsidizing the nuclear industry, we must worry not only about the risk of a hypothetical nuclear event with tangible consequences but also about an event with imagined consequences, especially if it should strike during a slow news week.

The Path Forward

Should concerned citizens make it their job to push for nuclear power? Proponents argue that nuclear yields less CO_2 than coal or natural gas. But this might not matter in the contemporary American context. There is little precedent to assume that nuclear power will necessarily displace appreciable numbers of coal plants. In fact, historically, just the opposite has occurred. As subsidized nuclear power increased, electricity supply correspondingly increased, retail prices eased, and greater numbers of energy customers demanded more cheap energy—a demand that Americans ultimately met by building additional coal-fired power plants, not fewer.

Without first addressing the underlying social, economic, and political nature of our energy consumption, can we assume that nuclear power, or any alternative production mechanism for that matter, will automatically displace fossil-fuel use? Should we address these underlying conditions before cheering on nuclear energy schemes? Will the risks of nuclear energy forever outweigh the benefits? Or will the scarcity of traditional fossil fuels eventually leave us with no other option?

Whether governments, taxpayers, politicians, and investors are willing to increasingly place nuclear wagers will, more than technical feasibility, become the central nuclear question over coming decades. Then again, someday we may find that our choices on the matter have dwindled. The more nuclear plants we establish today, the less choice we'll have about lugging around their protracted risks tomorrow.

Ultimately, those in favor of nuclear power should not underestimate its inescapable hazards. Those against nuclear power should not underestimate its inevitable allure. These four hinges of nuclear power's future may not tell us which way nuclear will swing. But they do clarify its range of motion. ❑

About the Author
Ozzie Zehner is the author of the forthcoming *Green Illusions: The Dirty Secrets of Clean Energy and the Future of Environmentalism* (University of Nebraska Press, June 1, 2012; www.GreenIllusions.org). He is a visiting scholar at the University of California, Berkeley, and serves as the editor of *Critical Environmentalism.* E-mail OzzieZehner@berkeley.edu; Web site http://berkeley.academia.edu/OzzieZehner or http://OzzieZehner.com.