NUCLEAR POWER AND THE EARTH

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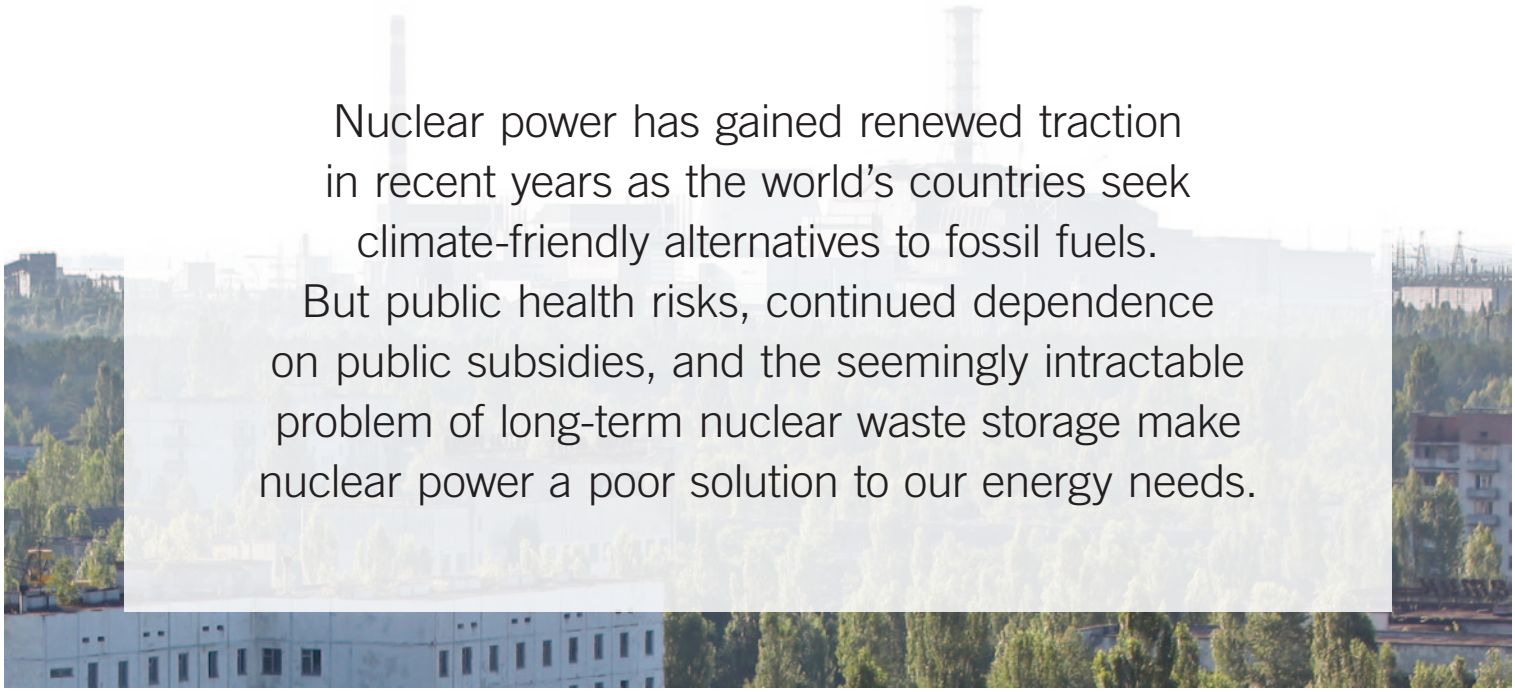
Photo: Doug Tompkins. *The Chernobyl nuclear power station looms over the mouldering remains of the former town of Pripyat, Ukraine.*



Nuclear power has gained renewed traction in recent years as the world's countries seek climate-friendly alternatives to fossil fuels. But public health risks, continued dependence on public subsidies, and the seemingly intractable problem of long-term nuclear waste storage make nuclear power a poor solution to our energy needs.

Nuclear technology is leaving a visible legacy on and within the Earth that could last longer than the human species itself. Giant craters mar the surface of countries that have tested nuclear weapons underground. Leaking high-level nuclear waste tanks at Hanford, Washington, have created a vast basin of radioactive groundwater, some of which has already reached the Columbia River.

Nuclear technology is also creating very real problems for us right now. The 2011 Fukushima disaster reminded the world that every nuclear power plant is a potential public health catastrophe, while the spread of civilian nuclear power heightens the risk of nuclear weapons proliferation. Meanwhile, the U.S. nuclear power industry is still very much dependent on public subsidies, despite more than sixty years of strong government support.

Nevertheless, nuclear power remains a major part of our energy mix, and in recent years it has gained new traction as countries seek climate-friendly alternatives to fossil fuels. This renewed push is not because we are close to solving the problems of nuclear power, but rather because of a deep—and ultimately misguided—faith in the engineers, scientists, and leaders we trust to guarantee the safety of nuclear power plants.

ATOMS FOR WAR AND PEACE

To fully understand the impact of nuclear technology, we must first clear our heads of the fundamental deceit of the nuclear age: namely, that there exists such a thing as "Atoms for Peace." This little phrase, launched by President Eisenhower in a famous speech to the United Nations on December 8, 1953, created a powerful belief that the world's governments were capable of cleanly separating—politically, psychologically, and technologically—the evils of "atoms for war" from the benefits of "atoms for peace."

Unfortunately for humanity, the atoms of uranium and plutonium do not know the difference between war and peace. Nuclear technology is indivisible: Whether you're building bombs to turn cities into wastelands or boiling water to make electricity, the underlying physics and the raw materials are the same. The processes used to slightly "enrich" naturally occurring uranium for reactor fuel can also be used to produce highly enriched uranium for weapons.

When Eisenhower spoke to the U.N., he spoke to people for whom the first images of nuclear technology were the searing photographs of Hiroshima and Nagasaki, blasted landscapes where nothing was left standing except the skeletons of a few steel structures. (Later came the images of whole islands obliterated by testing in the Pacific, and mushroom clouds, heaving and boiling, carrying

radioactive fallout into the stratosphere to be distributed by the winds across the entire planet). Eisenhower began his speech by reviewing the "dark chamber of horrors" of the arms race but soon turned to his vision of a world in which nuclear technology would be put to use for peaceful purposes instead:

> *The United States knows that if the fearful trend of atomic military build-up can be reversed, this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind. The United States knows that peaceful power from atomic energy is no dream of the future. The capability, already proved, is here today.*

Nuclear power plants were supposed to produce electricity "too cheap to meter." They were presented as the apotheosis of twentieth-century technology, alongside equally shiny images from the space program: lots of highly polished gleaming metal, fantastically elaborate control rooms, and workers dressed in surgically white uniforms. In outdoor shots, the plants appeared to be antiseptically clean, with bucolic backgrounds of meadows, green trees, and blue sky flecked with clouds. There was nary a hint of the ferociously dangerous radioactive process going on inside these reactors. The contrast between such images and those from Hiroshima and Nagasaki could not have been greater.

SAFETY AND HEALTH

Given nuclear power's arrival as a child of the nuclear weapons program, it was only natural that the public was concerned about how dangerous these plants were. In 1957, scientists at the Brookhaven National Laboratory issued a report that predicted that an accident at a small nuclear plant could cause 3,400 deaths, 43,000 injuries, and $7 billion in property damages. When an update of this report suggested that an accident might affect an area "equal to that of the state of Pennsylvania," the Atomic Energy Commission suppressed it.

Nuclear proponents have always insisted that reactors are "safe." They avoid even using the word "accident." For example, officials referred to the core meltdown at the Three Mile Island nuclear power plant in 1979 as an "event," an "incident," an "abnormal evolution," or a "normal aberration."

But as we learned after Three Mile Island, the fundamental cause of nuclear accidents is not a technical problem, but a mental one. A presidential commission found that witnesses repeatedly referred to the need to change the "mindset." It concluded that, over the years, "the belief that nuclear power plants are sufficiently safe grew into a conviction. One must recognize this to understand why many key steps that could have prevented the accident at Three Mile Island were not taken."

CHERNOBYL

At the Chernobyl nuclear power plant in Ukraine, Soviet nuclear engineers were so convinced that their design was safe that they did not build a containment building around the reactor to prevent radioactive materials from rapidly escaping into the environment if there were an accident.

In April 1986, the Chernobyl plant experienced a sudden power output surge during a systems test. This was followed by a series of explosions and a fire that sent a plume of highly radioactive smoke into the atmosphere, affecting parts of Europe and the western Soviet Union. The first victims at Chernobyl were the workers and emergency response crews, who absorbed huge doses of radiation; two died within hours, 28 died within three months.

In a clear example of how the nuclear mindset affects our ability to assess the dangers of nuclear power, Soviet authorities had failed to surround the Chernobyl plant with enough sensors to assess radioactive emissions from an accident. So the estimates of how much radiation was released vary widely, resulting in equally wide estimates of the number of accident-related deaths.

In 2005, a joint study by the World Health Organization, the United Nations Development Programme, and the International Atomic Energy Agency settled on an estimate of 4,000 total deaths from radiation exposure.

In 2006, Greenpeace released a study with a radically higher estimate of 200,000 additional deaths, including more than 93,000 fatal cancers.

FUKUSHIMA

Despite all the official exhortations, even serious accidents like Three Mile Island and Chernobyl have not been sufficient to change the nuclear mindset, as we have learned from the post-mortems on the latest nuclear disaster at Fukushima on March 11, 2011. TEPCO, the large Japanese utility that owned the six reactors at the ocean-front site, had not learned the very simple lesson from Chernobyl about the need for more sensors to provide post-accident data. Once again, there are huge uncertainties about the amounts of radiation released from the crippled reactors and the spent fuel pools.

The Japanese government and TEPCO initially downplayed the threat, following the pattern of officials at Three Mile Island and Chernobyl. In June, 2011, the government released an estimate of the total amount of biologically dangerous cesium-137 (15,000 terabecquerels) released. But in October, an international team released a new estimate *more than double* the June estimate (35,800 terabecquerels). Some of the data for the October study came, ironically, from the International Monitoring System, a global network of sensors that was put into place to monitor nuclear weapons tests under the Comprehensive Nuclear Test Ban Treaty (which the United States has never ratified).

The October study also cast serious doubt on the government claim that the fire in the spent fuel pool of Reactor 4 did not release significant amounts of radiation. The authors concluded that this spent fuel pool was responsible for the release of large amounts of cesium-137. The level of cesium-137 dropped dramatically once TEPCO flooded the pool with water more than a week after the start of the accident, a step that probably would have greatly reduced the release if the utility had acted earlier.

MISSING PICTURES

Nuclear power plants are the most visible manifestation of nuclear technology. But the plants themselves sit in the middle of a cycle, the beginnings and endings of which are far less well known. On the front end of this cycle, for both nuclear weapons and nuclear plants, are operating mines and thousands of abandoned mines. The public rarely sees images from this part of the process, where millions of tons of radioactive mill tailings accumulate in piles and ponds. These tailings contain 85 percent of the radioactivity of the original ore, and they remain dangerous for thousands of years.

The history of the management of mill tailings is a dismal story. In the rush to mine uranium during the huge buildup of nuclear weapons in the early decades of the Cold War, mining companies simply left the tailings in piles on land, or in poorly constructed ponds. When the demand for uranium slowed in the 1970s, many companies abandoned their mines and mills. The federal government was late to respond. It was not until 1978 that Congress made the Department of Energy responsible for dealing with tailings at 24 milling sites in ten states, as well as at 5,200 other related properties. These included more than 500 abandoned mines on Navajo land, where more than 4 million tons of uranium ore had been mined.

Nor does the public see much of the back end of the production cycle: the highly radioactive spent fuel rods from nuclear power plants, and the high-level liquid wastes from producing plutonium for nuclear weapons. In one sense, the back end of the cycle does not even exist in the United States for the waste from nuclear power plants, since there is no permanent waste storage site—more than fifty years after the first commercial nuclear plant went into operation.

And then there are the nuclear power plants themselves. The intense radioactivity generated during normal operations turns the plant into a behemoth of nuclear waste. In an age of shrinking budgets, there will be great pressure to mothball these reactors and leave them sitting on the landscape for a century or two while the radioactivity inside slowly dies away.

HIDDEN SUBSIDIES

Comparing the cost of nuclear-generated electricity with that of electricity from other sources is difficult because of the large number of assumptions about what costs to include and what costs to exclude. Prices for coal, for example, usually do not include any costs associated with global warming or increased lung disease, while prices for nuclear power usually do not include costs associated with long-term waste disposal.

Nevertheless, even in a direct comparison considering only construction, operations, and fuel, nuclear power does not fare well. Recent studies from the Massachusetts Institute of Technology and the National Bureau of Economic Research have estimated the cost of electricity from nuclear power to be 30–50 percent higher than from coal or natural gas, largely due to the higher costs for plant construction and the higher risk of default.[1] Hidden government subsidies can introduce large distortions in cost estimates—and the nuclear industry has benefited enormously from dozens of direct and indirect subsidies. In 2010, the Union of Concerned Scientists released the most rigorous study to date of government subsidies to the nuclear industry. After adding up subsidies from 1960 to 2008, author Doug Koplow reached a stunning conclusion. These subsidies were:

> *… more valuable than the power produced by nuclear plants over that period. Without these subsidies, the industry would have faced a very different market reality—one in which many reactors would never have been built, and utilities that did build reactors would have been forced to charge consumers even higher rates.*[2]

Indeed, the subsidies were so high, Koplow concluded, that "buying power on the open market and giving it away for free would have been less costly than subsidizing the construction and operation of nuclear power plants. Subsidies to new reactors are on a similar path."

THE TEN-MILLENNIUM DANGER

Ensuring the safe day-to-day operation of nuclear plants has proved to be extraordinarily difficult. And the damage from the spent fuel pool at Fukushima's Reactor 4 highlights an even more difficult problem: how to dispose of the highly radioactive wastes from nuclear plants for periods of time far in excess of the ten thousand years of recorded human history.

Nuclear proponents in the United States have recited the same mantra for decades when asked about disposing of nuclear waste: It should go into an underground repository. However, this seemingly sensible declaration is not based on scientific studies showing that identifying and building such a repository is possible. Geologists looking for a permanent underground repository site have repeatedly learned that the Earth's geology is much more complex than anyone imagined. And the political struggles over site selection have become metaphorically radioactive.

The most recent effort to build a high-level waste repository has been at Yucca Mountain in Nevada. The selection of this site and its subsequent history has been a highly politicized process from the very beginning. Nevada's politicians, led by Democratic Senator Harry Reid, have waged a bitter fight to prevent Yucca Mountain from ever opening. In 2009, President Barack Obama officially abandoned Yucca Mountain, announcing the start of yet another process to find another site. Meanwhile the ever-growing accumulation of spent fuel rods stored on-site at nuclear plants increases the dangers of Fukushima-like accidents, or the intentional release of highly radioactive materials from terrorist attacks on the poorly protected spent-fuel storage areas.

IS NUCLEAR POWER WORTH THE CANDLE?

The lure of putting nuclear energy to work is mythological in its intensity. As the Department of Energy puts it:

> *One ton of natural uranium can produce more than 40 million kilowatt-hours of electricity. This is equivalent to burning 16,000 tons of coal or 80,000 barrels of oil.*

Nor is it surprising that, once scientists and engineers had seen the results of unleashing the power of the atom on Hiroshima and Nagasaki, they felt an overwhelming desire to find ways to turn this destructive force to peaceful ends.

At a philosophical level, the problem we face in trying to build "safe" nuclear plants requires us to confront one of humanity's oldest and most well-documented weaknesses: hubris. After several hundred years of ever-more-powerful scientific and technological triumphs, today's leaders find it hard to consider, much less admit, that some tasks may be so difficult that the risks of attempting them are greater than the reaped rewards.

ENDNOTES

1 Lucas W. Davis, "Prospects for Nuclear Power," National Bureau of Economic Research NBER Working Paper No. 17674 (December 2011), http://www.nber.org/papers/w17674.

2 Doug Koplow, *Nuclear Power: Still Not Viable without Subsidies* (Cambridge, MA: Union of Concerned Scientists, February 2011), http://www.ucsusa.org/assets/documents/nuclear_power/nuclear_subsidies_report.pdf.