NUCLEAR INFORMATION AND RESOURCE SERVICE

6930 Carroll Avenue, Suite 340, Takoma Park, MD 20912
301-270-NIRS (301-270-6477); Fax: 301-270-4291
nirsnet@nirs.org; www.nirs.org

Briefing Paper

NUCLEAR ENERGY IS DIRTY ENERGY (and does not fit into a "clean energy standard")

The nuclear power industry has spent more than $650 million on lobbying, campaign contributions and advertising over the past 10 years in its persistent effort to achieve a nuclear "renaissance."[1]

One of the industry's primary goals has been to convince Congressmembers and the media that nuclear power is somehow "clean" energy, because nuclear reactors emit little carbon dioxide into the atmosphere. But this disregards the alphabet soup of other cancer-causing pollutants spewed into our air and water by nuclear facilities. Unfortunately, lobbying campaigns backed by so much money often attain some success.

Thus, there are increasing calls from nuclear industry backers, inside and outside of government, to establish a new "Clean Energy Standard" to promote nuclear power (and for some proponents, coal and natural gas as well) to the detriment of genuinely clean and affordable technologies like wind, solar, geothermal, energy efficiency and others.[2]

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Proposals to include nuclear power as part of a Clean Energy Standard suffer from three fundamental misconceptions: 1) that carbon dioxide is the only pollutant that matters when defining "clean energy;" 2) that because radiation is invisible and odorless, it is not a toxic pollutant; 3) that nuclear power is carbon-free. None of these is true.

Only one of the many technologies that can produce electricity is capable of a catastrophic accident that can kill tens or even hundreds of thousands of people, presents a security threat of unprecedented proportions because of this vulnerability, and creates a lethal byproduct that will be toxic for hundreds of thousands of years: nuclear power. To call nuclear power "clean" is

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[1] Investigative Reporting Workshop, January 2010. http://investigativereportingworkshop.org/investigations/nuclear-energy-lobbying-push/story/nuclear-energy-working-hard-win-support/

[2] For example, see "Creating a Clean Energy Standard," Third Way, January 2011, http://www.thirdway.org/publications/361

an affront to science, to common sense, and to the English language itself.

Carbon Dioxide is not the only pollutant on the planet

Carbon dioxide is definitely a pollutant and is a leading cause of global climate change. There is no question—except among a few climate deniers who prefer, like the ostrich, to hide their heads in the sand and shun reality—that we must drastically cut our carbon releases to the environment.

But that is not the same as saying—as does a "Clean Energy Standard" based entirely on carbon releases—that carbon dioxide is the only pollutant that matters to the health and safety of our people and planet.

By basing a "Clean Energy Standard" on a simplistic carbon formula, its backers simply ignore the past fifty years of accumulated knowledge of the effects of other long-lasting and toxic pollutants on the public.

Nuclear power facilities release a variety of cancer-causing radionuclides, including Tritium, Strontium-90, Cesium-137, Plutonium-239 and dozens more. Nuclear reactors also release other toxins into our air and water. While nuclear power qualifies, barely, as a "low-carbon" technology (although it is not carbon-free, see below), the presence and release to the environment of these other pollutants, not to mention the radioactive waste every nuclear facility generates, clearly disqualifies nuclear power as being in any sense "clean."

Many "Clean Energy Standard" backers also would include "clean" coal in such a standard, ignoring the fact that burning coal (even if its carbon could be captured, which is by no means clear) also releases mercury into the environment, creates toxic coal ash, and increasingly entails mountain top removal mining that devastates large portions of our beautiful nation.

To call nuclear power "clean" is an affront to science, to common sense, and to the English language itself.

Policymakers and others who support a "Clean Energy Standard" that includes nuclear power or coal are either insincere or misinformed. Given the amount of money the nuclear industry has spent to promote its polluting agenda, it appears that too many are insincere. It is our hope that it is not too late for those who have been misinformed to recognize the reality and act to prevent establishment of such a standard that includes nuclear power or coal.

Radiation is a toxic, persistent, and long-lasting pollutant

Nuclear radiation seems "clean" only because you cannot see, feel, touch or smell it. But that doesn't mean it isn't released by nuclear reactors and other facilities. It is. It doesn't take an accident: nuclear reactors emit radiation into our air and water as part of their routine, daily operations. And that it cannot easily be detected or avoided makes radiation even more dangerous.

A typical nuclear reactor contains a myriad of different types of radionuclides, amounting to some 16 Billion curies of radiation (by comparison, a typical large medical center may hold a total of two curies of radiation and a household smoke detector contains a miniscule fraction of one curie—and even that must be shielded to prevent human exposure).

Since the dawn of the Atomic Age in the 1940s, the U.S. National Academy of Sciences has done periodic reviews of the dangers of radiation to determine acceptable exposure levels for nuclear workers and the general public. Over the years, estimated risks from radiation exposure increased. In their most recent report, released in 2005, the Academy determined that there is no safe level of radiation exposure—every exposure to radiation increases the risk of cancer, birth defects, and

other disease.[3] While it is impossible to avoid exposure to natural radiation from the sun and earth, it is essential that society not allow unnecessary additional exposures. In practical terms, this means curtailing the use of nuclear power as quickly as feasible—not encouraging new reactor construction.

Tritium releases from nuclear reactors

The federal Nuclear Regulatory Commission has acknowledged that, in recent years, there have been releases of radioactive tritium from existing nuclear reactors, exceeding safe drinking water standards, at 37 sites, or more than half of the nation's nuclear sites.[4] The NRC argues that no actual drinking water supplies have been affected; that since the tritium has been released into groundwater, the problem is not so severe. That is small comfort to the millions of Americans who live near these sites.

Radioactive tritium levels above 1,000,000 picocuries/liter were measured at nine sites covering 18 reactors.

Normal background levels for radioactive tritium in drinking water are 3 to 24 picocuries per liter. By contrast, the Environmental Protection Agency's "allowable" standard (note that "allowable" does not necessarily equal "safe") for radioactive tritium in drinking water is 20,000 picocuries per liter of water. According to the NRC, since January 2009, that level has been met or exceeded by releases into groundwater (not necessarily drinking water) at 37 reactor sites (out of 65). Radiation levels have ranged from 20,000 picocuries/liter to an astonishing 15,000,000 picocuries/liter (at New Jersey's Salem reactor complex). Radioactive tritium levels above 1,000,000 picocuries/liter were measured at nine nuclear sites covering 18 reactors.[5]

Like all radionuclides, radioactive tritium causes cancer. With a half-life of more than 12 years, the tritium released by these reactors over the past two years will remain hazardous in the environment—and likely be added to by new tritium releases—for the next century (hazardous life of a radionuclide is generally considered to be ten to twenty half-lives).

Nuclear Accidents and Security

Nuclear power holds the potential for a catastrophic accident that is unique among all energy sources—even failure of the largest dam would be unlikely to cause the same level of permanent destruction of a nuclear reactor meltdown. Fortunately, major reactor accidents are few and far between, with the most recent being the explosion at Ukraine's Chernobyl reactor in 1986. Unfortunately, more nuclear accidents cannot be ruled out.

The Chernobyl accident has caused anywhere from 4,000 to 900,000 deaths, depending on which estimates one finds most compelling.[6] By any assessment, it was the most devastating industrial accident in history. Economically, the accident has caused damages in excess of $300 Billion—in a region where average wages are a

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[3] The National Academies of Science Biological Effects of Ionizing Radiation-VII, "Health Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII," http://search.nap.edu/nap-cgi/de.cgi?term=BEIR+VII+Phase+II

[4] "*Leaks and Spills of Tritium at U.S. Commercial Nuclear Power Plants*," U.S. Nuclear Regulatory Commission, Rev 6, September 14, 2010. http://www.nrc.gov/reactors/operating/ops-experience/tritium/sites-grndwtr-contam.html

[5] Ibid.

[6] The United Nations' World Health Organization continues to cling to estimates on the low end, about 4,000 fatal cancers caused by Chernobyl. Other studies have calculated much higher fatalities. For example the TORCH study of 2006 estimates 30,000-60,000 deaths (http://www.nirs.org/c20/torch.pdf) and was largely responsible for WHO updating its previous estimate of several dozen deaths. A Greenpeace study in 2006 conducted largely by scientists from the former Soviet Union estimated 90,000-200,000 deaths (http://www.nirs.org/c20/chernobylhealthreportgp.pdf). More recently, the New York Academy of Sciences published a study by three Russian/Belorussian scientists, including Russia's former Environment Minister, that estimates as many as 1,000,000 deaths from Chernobyl ("Chernobyl: Consequences of the Catastrophe for People and the Environment"). http://www.nyas.org/publications/annals/Detail.aspx?cid=f3f3bd16-51ba-4d7b-a086-753f44b3bfc1

fraction of those in the U.S.--and made significant sections of Ukraine and Belarus uninhabitable while perhaps permanently ending agricultural in the most highly contaminated zones.

While nuclear manufacturers and operating utilities take great pains to prevent nuclear accidents, all major accidents so far share one attribute: at their root is some form of component failure compounded by human error. And human error is the one thing that is impossible to design around. It is simply folly to believe that because there have been no major new nuclear accidents in the 25 years since Chernobyl, there will never be another. The odds, in fact, are precisely opposite—the longer reactors operate and the more reactors there are, the more likely another catastrophic accident will occur.

Moreover, nuclear reactors pose a massive security threat compared to other energy sources. No terrorist or enemy state would attack a windmill or solar facility, why bother? There is no possibility of mass destruction or even a widespread power outage. But a successful attack on a nuclear power reactor could cause both mass destruction and lead to widespread and prolonged power outages, crippling our nation's ability to function.

Nuclear power is not carbon-free

A common fallacy advanced by those who would declare nuclear power a "clean" energy source is that the technology is "carbon-free."[7] It is not.

Nuclear reactors themselves are low carbon-emitters—they do release small amounts of radioactive carbon. But they are carbon-intensive to build, since they require enormous amounts of concrete, steel and carbon-based fuels for transport of materials, workers, etc. And the nuclear fuel chain necessary to support reactor operations, which consists of uranium mining, milling, processing, enrichment and fuel fabrication, then shipment of fuel to reactors, then reactor operation and finally millennia of radioactive waste storage, results in fairly substantial and unavoidable carbon emissions.

Nuclear power is responsible for about six times the carbon emissions of wind power, and 2-3 times the carbon emissions of various types of solar power technologies.

More than 100 studies have been done about nuclear power's carbon footprint, and many have come to contradictory conclusions. A major study that sought to make sense of all the other studies was conducted in 2008 by Virginia Tech and University of Singapore professor Benjamin Sovacool.[8] His conclusion is that nuclear power is responsible for about six times the carbon emissions of wind power, and 2-3 times the carbon emissions of various types of solar power technologies. At such a disparity in carbon emissions, nuclear should not qualify as a "clean energy" technology even based only on carbon releases, much less other pollutants.

The nuclear fuel chain is necessary for nuclear reactors, and polluting

Nuclear reactors cannot, of course, operate without uranium fuel. In that respect, nuclear power is much more like fossil fuels, which are extracted from the earth, than like renewable power, which produces energy from natural and omnipresent phenomena like wind and the sun.

Mining uranium, processing it, milling it, enriching it and producing uranium fuel pellets from gaseous enriched uranium is both carbon-intensive and dirty business at every step of the way. Perhaps the dirtiest part of this lengthy process is the mining, which, like coal mining, leaves massive quantities of "tailings" that are often left either as mountainous piles, or as slag in "empoundments" that pose substantial threats to

[7] For example, see Creating a Clean Energy Standard, Third Way, page 6 "Nuclear energy is entirely carbon-free…." Page 6, January 2011

[8] "Valuing the greenhouse gas emissions from nuclear power: A critical survey," Benjamin Sovacool, University of Singapore and Virginia Tech University, Energy Policy 36, June 2008. http://www.nirs.org/climate/background/sovacool_nuclear_ghg.pdf

miners, local communities, and to the larger environment.

Because of the widespread contamination and health effects caused by uranium mining on its land in the Southwest, for example, the Navajo Nation has banned any more uranium mining. But 500 to 1300 abandoned uranium mines from the Cold War era remain on its land awaiting cleanup. At one mine abandoned years ago near Cameron, Arizona, for example, the EPA found in November 2010 that radiation levels were higher than its equipment could measure.[9]

Clean-up estimates for the hundreds of abandoned mines run into the many hundreds of millions of dollars.

Enriching uranium 235 from the mined and milled uranium is enormously energy intensive and creates long lasting, deadly solid, liquid and gaseous wastes. Similarly, at the end of the fuel chain, after nuclear reactors split atoms, making them millions of times more radioactive, radioactive waste is generated for which there is no known permanent isolation from the environment.

Efforts are underway to release some "low-level" radioactive waste—radioactive metal, concrete, soil, wood, chemical, plastic and other nuclear waste into the everyday commercial recycling supply and consumer goods.

Most uranium used nowadays by U.S. reactors is—like oil—imported. While renewable energy sources are secure as long as the sun shines and the wind blows, nuclear power, like other technologies requiring extraction of fuel, remains an insecure means of power production, dependent on the whims of other nations.

Nuclear Power and Water Pollution

Nuclear power's pollution of our nation is not limited to releases of radioactive materials.

Nuclear reactors are also responsible for significant damage to marine environments and diversion of increasingly scarce water supplies.

Nuclear reactors require vast amounts of water for cooling their red-hot nuclear cores as well as simply to produce electricity. Those with cooling towers take in some 20,000 gallons per minute of water from rivers, lakes, or oceans. Reactors without cooling towers, which use "once-through" cooling systems, take up to 500,000 gallons per minute of water before spewing it back out again. When the water comes out and is discharged back to its source, it is five to ten degrees warmer than it was when it went in.[10]

This causes havoc among marine environments. The huge amount of water taken in, and the rate at which its taken, also results in massive fish kills at reactors that use once-through cooling systems—often numbering in the billions of fish and fish eggs per year at a single reactor.[11]

Further, because the water discharged is so much hotter than the water taken in, it can cause problems downstream for other industrial uses, and even drinking water uses.

No assessment has yet been conducted as to the effects on water supplies, especially drinking water supplies, of a major new nuclear reactor construction program.

Finally, when evaporated in cooling towers, or made unusable through heating, water use by reactors can use up a significant amount of

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[9] *Abandoned Uranium Mines: An Overwhelming Problem in the Navajo Nation*, Scientific American, December 30, 2010. http://www.scientificamerican.com/article.cfm?id=abandoned-uranium-mines-a&print=true

[10] A more complete discussion of water use by nuclear reactors is found in "*Got Water*," a December 2007 issue brief from Union of Concerned Scientists. http://www.nirs.org/reactorwatch/water/20071204ucsbriefgotwater.pdf

[11] See, for example, "*Licensed to Kill*," published in 2001 by NIRS, SECC and the Humane Society of the United States, which documents the environmental devastation caused by once-through cooling systems. http://www.nirs.org/reactorwatch/licensedtokill/licensed2kill.htm

municipal and regional water supplies. This will become increasingly important in coming years, as the Department of Energy already has predicted droughts in about 2/3 of the United States over the next decade.[12] Electricity generation and agriculture are the two predominant consumers of water in the U.S., and nuclear power is by far the largest consumer among electricity producers.[13]

No assessment has yet been conducted as to the effects on water supplies, especially drinking water supplies, of the kind of major reactor construction endeavor including nuclear power in a "clean energy standard" would seek to encourage.

In France, which obtains nearly 80% of its electricity from nuclear power, summer heat waves in recent years—which increased river water temperatures to the point reactors could not legally use the water for cooling—forced reactors to close at the exact time electricity was most needed for residential cooling. But France had no back-up supplies of electricity to provide that cooling. In the summer of 2003, thousands of people died because of the heat and related blackouts.

But it's not just a French problem: in recent years in the U.S., reactors, such as those at the Browns Ferry complex in Alabama, have been forced to close or reduce power because of rising river temperatures.

In an era of global warming, it is folly to encourage new reactor construction without a thorough, scientific assessment of water availability for reactor operation, taking into account drinking water needs.

Conclusion

No source of electricity generation is absolutely "clean." Every source requires use of resources, some of which are toxic. Every source of electricity results in some level of carbon emissions. The only "clean" electricity is the electricity that is not used. Ensuring the use of energy as efficiently as possible should be the number one goal of any "clean energy standard."

Nuclear power, compared to the viable renewable alternatives like wind, solar, geothermal, etc, coupled with smart grids, distributed generation and other 21st century energy technologies, does not even come close to "clean."

Nuclear power releases toxic radiation on a routine basis; it is not carbon-free—its carbon footprint is substantially higher than its competitors; it uses far more water in an era of water scarcity; it requires a vast and polluting nuclear fuel chain simply to function.

Inclusion of nuclear power in a Clean Energy Standard would make a mockery of the concept. Moreover, although beyond the scope of this paper, nuclear power's enormous costs and typical reactor size would discourage use of genuinely clean, safe and affordable renewable technologies were nuclear chosen as a means of meeting a "clean energy standard."

The United States wants, needs and deserves clean energy. Nuclear power does not fit the bill.

--Michael Mariotte, Nuclear Information and Resource Service, January 2011

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[12] "*Water Dependency of Energy Production and Power Generation Systems*," Virginia Water Resources Research Center, Virginia Tech University, July 2009. http://www.nirs.org/reactorwatch/water/sr46waterdependency.pdf

[13] Ibid.