Poster E-10

The Death and Possible Revival of Nuclear Power In The USA

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Basic Facts About Nuclear Power

★Nuclear fuel is cheaper than natural gas or coal for generating electricity.

★In the USA 20% of our electricity is from nuclear. In France it is 80%.

★The potential supply of nuclear fuel is unlimited for practical purposes.

★Nuclear power does not generate carbon dioxide or smokestack pollution. If the world's electricity all came from nuclear, carbon dioxide levels in the atmosphere would nearly stop rising, because half of all CO2 emissions are absorbed by the oceans and plants.

★Far more deaths are associated with conventional power than nuclear power.

★Disposal of nuclear waste is a solvable problem if hysterics would get out of the way. Future reactors could "burn" high level nuclear waste, extracting useful energy and greatly reducing the amount of high level waste.

★The nuclear power industry in the United States was destroyed by fear mongering by environmental activists. The industry has moved to other countries such as France.

★Research into nuclear power receives trivial support in the USA.[1] On the other hand billions are thrown down the renewable power rathole. Solar power, wind power, plug in hybrid cars, and corn ethanol are all exorbitantly expensive, impractical and heavily subsidized by the federal government.

★The research and commercial development opportunities in nuclear power are wide open. Many improvements in cost, safety and practicality are theoretically possible, but development is hindered by lack of government support and hysterical attacks by environmentalists.

★Nuclear bomb proliferation is a political and military problem. Nuclear power reactors can be used to generate plutonium that can be used to make bombs, but such an project requires a large engineering and science organization. Bombs can also be made, probably more easily, by uranium enrichment that does not involve reactors. Killing or starving nuclear power will not solve or significantly help nuclear proliferation.

★The danger from low level radiation has been systematically exaggerated. The danger of "dirty" bombs made from nuclear waste is exaggerated because such waste is difficult to handle due to radioactivity and thermal heat. Absent irrational fears, dirty bombs are mainly a danger to their makers. The dirty bomb is mainly a psychological weapon.

A campaign based on spreading fear of nuclear energy and constant courtroom challenges raised barriers to building new nuclear generating plants.

Between 1967 and 1971 the cost of building a nuclear plant in constant dollars tripled. Key scare tactics were associating nuclear energy with nuclear bombs and associating radioactivity with cancer .

... our society persists in stumbling about on the dark side of exponential energy demand, trifling with atomic poisoning and gambling with the future of 1,333 generations of our descendants, not to mention all of life itself.

Sierra Club Bulletin April 1975 p 5

A more realistic approach to a sustainable-energy society is to gradually decentralize the energy supply system by utilizing small-scale solar, wind and bioconversion technologies.

Sierra Club Bulletin May 1977 p. 11

Nuclear energy is not the bargain it was once thought to be. Real (uninflated) construction costs for nuclear power stations have quintupled in the past 8 years.

Sierra Club Bulletin May 1976 p. 44

By the year 2000, such renewable energy sources could provide forty percent of the global energy budget...Coal combustion necessarily produces carbon dioxide ... raises the earth's temperature ... if nuclear advocates were forced to find a safe way to dispose of long-lived radioactive wastes ... solar equipment would be more economically competitive.

Sierra Club Bulletin Summer 1977 p. 13 (Denis Hayes)

Example of cost escalation

Millstone 1 Nuclear Power Plant
660 megawatts Cost $101 million 1966

Shoreham Nuclear Power Plant
820 megawatts cost $6 billion 1973

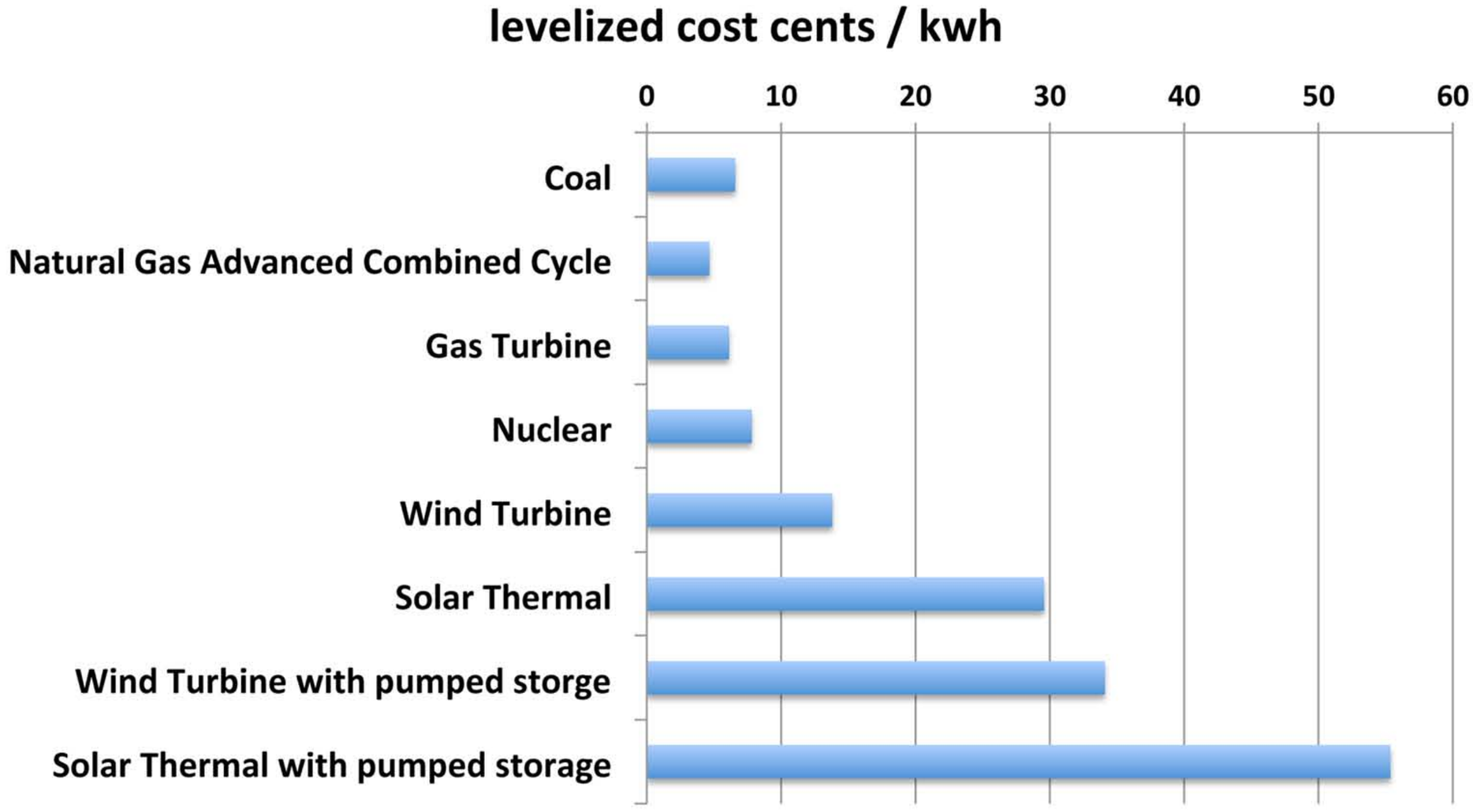
Millstone 1, near New London, CT was constructed in 5 years and operated from 1970 to 1998. Two other reactors, units 2 and 3 are still operating on the site.

The Shoreham plant on Long Island, NY was under construction for 11 years. In June, 1979 thousands of protestors gathered at the plant and 500 were arrested. The plant was finally scrapped In 1989 and never generated electricity.

Anti-nuclear agitation

Even though nuclear is an obvious solution to avoiding CO2 emissions, the clean development mechanism of the Kyoto accords prohibits credit for avoiding emissions by using nuclear power. This provision was inserted at the urging of the environmental lobby.

Green energy baloney
Cost of wind and solar many times greater than nuclear



Based on numbers from: **Updated Capital Cost Estimates for Electricity Generation Plants**, November 2010, U. S. Energy Information Administration, Office of Energy Analysis. Plant life 40 years, interest rate 6%, fuel cost coal 2.5 cents/ kwh, natural gas 3 cents/kwh, nuclear 0.7 cents/kwh. Pumped storage$ 5500/ kw and transmission lines for solar and wind $1000/kw. Utilization: 20% wind and solar, 80% Coal, 80% natural gas advanced, 60% gas turbine, 85% nuclear. Operation and maintenance per referenced document. Solar PV is similar to thermal.

Graph from American Thinker, April 8, 2013. Wind Power Fiasco: Call Your Congressman by Norman Rogers
http://www.americanthinker.com/2012/11/wind_power_fiasco_call_your_congressman.html

Nuclear Accidents

Since the widespread deployment of nuclear power began in the 1960's there have been a number of accidents.

By far the worst accident was the destruction of the Chernobyl[2] reactor in the former Soviet Union in 1986. This accident was caused by reckless carelessness on the part of the reactor operators and made worse because of the design of the reactor. Unlike almost all nuclear power reactors, the Chernobyl reactor did not have a containment vessel to prevent the escape of radioactivity. In addition the reactor used flammable graphite as a moderator in the core. The graphite caught fire when the reactor overheated, spreading radioactive material far and wide. Thirty people died from acute radiation poisoning at the accident site. Concerning radiation caused cancer this is what a United Nations report written 20 years later said:

"Among the residents of Belarus, the Russian Federation and Ukraine, there had been up to the year 2005 more than 6,000 cases of thyroid cancer reported in children and adolescents who were exposed at the time of the accident, and more cases can be expected during the next decades. Notwithstanding the influence of enhanced screening regimes, many of those cancers were most likely caused by radiation exposures shortly after the accident. Apart from this increase, there is no evidence of a major public health impact attributable to radiation exposure two decades after the accident. There is no scientific evidence of increases in overall cancer incidence or mortality rates or in rates of non-malignant disorders that could be related to radiation exposure. The incidence of leukaemia in the general population, one of the main concerns owing to the shorter time expected between exposure and its occurrence compared with solid cancers, does not appear to be elevated. Although those most highly exposed individuals are at an increased risk of radiation-associated effects, the great majority of the population is not likely to experience serious health consequences as a result of radiation from the Chernobyl accident. Many other health problems have been noted in the populations that are not related to radiation exposure."

Thyroid cancer can result from consuming food contaminated with iodine 131, a radioactive isotope that is chemically the same as the non radioactive iodine 130. iodine is a necessary human nutrient that is selectively taken up by the thyroid gland. Irradiation of the thyroid gland can be largely prevented by consumption of sufficient amounts of non radioactive iodine to displace the radioactive iodine. For this reason iodine pills are distributed in case of radioactive contamination. Iodine 131 has a half life of 8 days, so it is rapidly removed from the environment. The areas around Chernobyl are iodine deficient and the population suffered considerable iodine deficiency diseases. That probably aggravated the tendency of thyroid to absorb radioactive iodine. Although iodine pills were distributed and taken by many people in

the affected zone, the prophylactic effect was reduced by delays and insufficient dosing. It is thought that the children received iodine 131 from milk produced by cows that grazed in contaminated pastures. Thyroid cancer is almost always curable by surgery or ironically by treatment with radioactive iodine. Cured patients must take thyroid hormone for life since their thyroid gland has been removed or destroyed by radiation treatments.

Claims by anti-nuclear organization of genetic defects, birth defects and other types of diseases[3] from the Chernobyl accident have not been supported by credible scientific evidence.

The 6,000 cases of curable thyroid cancer and the deaths of less than 100 emergency workers in 20 years subsequent to the Chernobyl accident, can be compared to about 5,000[4] deaths every year, world wide, from coal mining, an alternative to nuclear for the production of electricity, or the approximately 1,000,000[5] deaths, every year, world wide, from traffic accidents.

The Nuclear Power Safety Bottom Line

Nuclear power does not emit CO2 and thus one would expect that the promoters of global warming hysteria would embrace nuclear power. Although a few individuals in the global warming movement have embraced nuclear power, the major, big budget, organizations remain opposed to nuclear power. The Sierra Club is actually opposed to every method of generating electricity other than wind power and solar power. The persistent opposition to nuclear power shows a serious inconsistency in the positions of the environmental groups, probably rooted in the fact that for many years these organizations lived off major anti-nuke campaigns filled with misinformation and scare stories. To backtrack now would show that they were wrong previously.

Nuclear power is not without risk, but neither are airplanes, automobiles, chemical plants or pipelines, to name a few elements of industrial civilization where we accept and manage risk. Chernobyl was an extreme, worst case accident. Yet, the consequences were manageable. With good design of the equipment, good training of the operators, and planning for emergency, such a bad accident in the future is not likely.

The Fukushima nuclear accident in Japan, in March, 2011, caused by an earthquake and tsunami is still being studied, but it appears that there were no serious exposures to radiation[6] among the workers or the general population.

Innovation in Nuclear Power

There are many concepts and designs under consideration[7] for improvements in nuclear power. The new concepts can result in improved safety and cost. Smaller reactors that can be assembled in a factory and transported to the site obviously have potential to dramatically reduce cost. Small reactors[8] that can be buried and that do not require refueling for decades potentially can reduce cost, and improve safety. A major problem is the residual heat, from radioactive decay, that continues for days or weeks after shutdown. It is this residual heat production that can cause a meltdown of the core if the system for removing the residual heat fails. Many proposed designs incorporate passive cooling systems that do not depend on having electrical power to driven the residual heat removal system.

Example Innovative Reactor: HTR-PM (Tsinghua University, China)

This reactor uses fuel pebbles and is cooled with helium gas. The reactor has inherent safety features described as follows:

-Loss of off-site power without any countermeasures;
-Main helium blower shutdown without any countermeasures;
-Loss of main heat sink without any countermeasures;
-Withdrawal of all rods without any countermeasures;
-Helium blower trip without closing outlet cut-off valve.

A prototype small reactor has been built and operated. A full scale implementation would generate 200 megawatts of electricity and reactors could be ganged together to create larger power complexes.

There are dozens of innovative advances in reactor technology under way, almost all in foreign countries.

The Traveling Wave Reactor

This is a theoretical concept that has been studied since the 1950's. The reactor is a breeder reactor that can be fueled with depleted uranium U238. A nuclear reaction is started by a small amount of a nuclear fuel such as uranium U235. The burn then progresses through the U238 converting the U238 to plutonium as it progresses and burning the plutonium to continue the traveling wave. The potential advantages are very long refueling intervals and the utilization of cheap and plentiful fuel that exists in vast quantities as leftovers from nuclear enrichment programs. A U.S. company TerraPower[9] is supported by Bill Gates to pursue this concept.

Thorium Fueled Reactors

Thorium is a naturally occurring radioactive element that is considerably more plentiful than uranium. Thorium cannot be used to construct bombs but in principal it can be used to fuel reactors. A helper source of neutrons is necessary to get the reaction started. That can be uranium, plutonium or an accelerator that generates neutrons. Once the reaction starts is it self-sustaining as the thorium is converted to uranium 233 that sustains the reaction and is burned. An additional problem is that as part of the reaction the isotope protactinium 233 is produced. This isotope decays into burnable U233 but the half life is 27 days so considerable amounts can accumulate in the reactor core. Protactinium 233 is detrimental to the reaction because it strongly absorbs neutrons, thus it must be continuously removed from the reactor core. Various schemes for doing this exist. Usually the Thorium in the core is presumed to be in the form of a molten salt and the protactinium is removed by chemical means from the circulating molten salt. There is great interest in Thorium reactors in India. India has large reserves of Thorium.[10]

[1] According to the U.S. Congressional Budget Office, the U.S. Energy Department's investment in research and development in 2012 was $3.4 billion, down from $10 billion (in 2011 dollars) in 1980. (Reporting by Erwin Seba; Editing by Ron Popeski) (Reuters: Gates favors nuclear power to help limit climate change) [Note: The wind power production tax credit costs the government $12 billon per year and is only one of many subsidies for the renewable energy industry.]

[2] The United Nations reports (United Nations Scientific Committee on the Effects of Atomic Radiation) on Chernobyl provides most of the information in this section: http://www.unscear.org/unscear/en/chernobyl.html

[3] In general the dangers of low level nuclear radiation of been exaggerated. Anti nuke elements have created a climate where the quasi official bodies designated to make statements concerning the dangers are unwilling to face the scientific evidence that low level nuclear radiation is not dangerous. See this article: American Thinker, July 6, 2012 -Forbidden Science: Low Level Radiation and Cancer by Norman Rogers. http://www.americanthinker.com/2012/07/forbidden_science_low_level_radiation_and_cancer.html

[4] Wikipedia article “Coal Mining”

[5] “List of countries by traffic-related death rate” Wikipedia

[6] Report of the United Nations Scientific Committee on the Effects of Atomic Radiation Fifty-ninth session (21-25 May 2012). http://daccess-dds-ny.un.org/doc/UNDOC/GEN/V12/553/85/PDF/V1255385.pdf?OpenElement

[7] STATUS OF SMALL AND MEDIUM SIZED REACTOR DESIGNS A Supplement to the IAEA Advanced Reactors Information System (ARIS) http://aris.iaea.org

[8] Gizmag Feb. 16, 2012: Small modular nuclear reactors - the future of energy? This is a good survey of potential small nuclear reactors. http://www.gizmag.com/small-modular-nuclear-reactors/20860/

[9] TerraPower website: http://www.terrapower.com - see also the Wikipedia article on the Traveling Wave Reactor: http://en.wikipedia.org/wiki/Traveling_wave_reactor

[10] See the Wikipedia article Thorium fuel cycle: http://en.wikipedia.org/wiki/Thorium_reactor