Nuclear Energy Summary

The large-scale use of nuclear energy for the generation of electricity has a history dating back to the 1950s. A major energy source in most of the World's developed countries, nuclear energy provides 20% of the electricity in Massachusetts, 30% in New England, and a world high of 80% in France. There are currently 436 nuclear power plants worldwide and 104 in the United States. However, the original optimism about nuclear energy has been seriously eroded by a small number of very serious accidents at nuclear facilities and, as a result, the future of this energy source is at a major crossroad. There is strong and vocal support both for and against a nuclear future.

Arguments in Favor of Nuclear Energy

Small Fuel Requirement: Pound for pound, nuclear fuel provides 3-5 million times more energy than fossil fuels, and has waste products that are similarly less massive. A single load of fuel in a nuclear generating plant lasts for 1-2 years between re-fueling cycles.

Clean Operation: There are no greenhouse gases and in routine operation there are no emissions of any kind other than the heat that must be removed from all electric generating plants.

Inexpensive Operation: Although nuclear plants are more expensive to build, the fuel and operation costs are, except for natural gas, among the lowest. The current low price of natural gas is unlikely to remain.

Arguably Safe: A number of analyses have estimated the cost in human life due to all causes attributable to the generation of electricity. These analyses show that under routine operation the death rate per unit of energy is much less for nuclear than for any of the fossil fuels. On the other hand it is too early to estimate the death rate from the accident at Fukushima.

Arguments against Nuclear Energy

Radioactive Waste Products: The "spent fuel" that is removed from a nuclear reactor contains both unburned fuel and radioactive waste products. These radioactive products are highly toxic and must be kept isolated from the environment for many centuries. At the start of the nuclear era, the U.S. government took on the responsibility to find solutions to the reprocessing and/or storage problem, but has failed to do so. As a result, the entirety of spent fuel at all nuclear generating plants is stored in cooling pools located at the sites, still waiting for a permanent solution.

Serious Accidents: The otherwise excellent safety record of nuclear generation of electricity has been sullied by 3 very serious accidents worldwide: Three Mile Island in 1979, Chernobyl in 1986, and Fukushima in 2011. TMI suffered a partial core meltdown; but, except for a minor radiation release, the accident was contained within the plant and there was negligible environmental or health impact. Chernobyl was much more serious. The reactor was a flawed design used almost nowhere outside the USSR; during a risky procedure it caught fire and its core contents were spread over a wide area surrounding the plant, resulting in the immediate loss of several workers, the permanent quarantine of a large land area, and radiation exposure to a substantial population. The reactors at Fukushima suffered the double whammy of a magnitude-7 earthquake and an enormous tsunami. The combination cut off or disabled the availability of any electrical energy source to operate the emergency cooling of the reactor cores at 4 of the 6 plants at the site. The ensuing developments once again resulted in explosions and releases of radioactivity into the environment. The long-term damage to the environment is yet to be

evaluated, but is undoubtedly serious. The seriousness of potential accidents at nuclear power plants may well be their Achilles' heel.

Is there a Nuclear Future?

The Current World Status: A number of countries, notably Belgium, Germany, Switzerland and Italy, have declared their intent to shutdown or phase out all of their current nuclear fleet of reactors. Japan has not decided. On the other hand, a large number of countries that currently have no nuclear reactors have reaffirmed their intention to build them and there are 63 reactors under construction worldwide.

The Current U.S. Status: The U.S. fleet of reactors is aging and most are approaching the 40-year limit of their operating licenses. Many of them (71 out of 104) have been granted 20-year extensions, including Vermont Yankee. The Nuclear Regulatory Commission recently granted Georgia Power Company construction permits for two new 1,100 Megawatt reactors to be built at the Vogtl, Georgia site, and other utilities have proposed a total of 26 new nuclear power plants elsewhere. The new Georgia reactors incorporate gravity-fed passive cooling systems that can provide automatic core cooling without pumps for at least 72 hours following a reactor shutdown, even in the absence of onsite or offsite sources of electricity. This emergency system would operate without operator intervention, but would require some source of electricity after 3 days. Hence there is still the need for onsite emergency backup generators that are protected from flooding.

The Future of U.S. Nuclear Energy: There are proposals for radical new nuclear reactor designs that have passive cooling systems designed to prevent core meltdown accidents as well as designs that use alternative nuclear fuels that are both safer and more abundant. Unfortunately these designs would require a lengthy process of approval, construction, and proof of operation and safety before being approved. Nevertheless there are companies actively pursuing these designs. A solution is badly needed for the problem of reprocessing and long-term storage of the residual products in the spent fuel that is currently stored at the nation's nuclear plants. A Presidential Blue Ribbon Panel, charged with exploring this question, has proposed that new federal commission be formed and charged with the sole task of seeking and proposing a long-term solution to this problem.

Conclusion

The long-term future of nuclear energy is uncertain. If it could overcome the safety issues and the long-term waste storage problem, it could be an abundant, economical and non-polluting base-load source of electricity to complement the non-constant sources of wind and solar. The question is whether it can survive public opposition long enough for solutions to the technological challenges to emerge.