The World Needs Nuclear Energy Now!

by Marsha Freeman

It's possible today to forgo nuclear energy—but only if you are willing to have an average lifespan of under 30 years.

Contrary to what you may have heard or read, the world does not need nuclear power because we are running out of oil, because natural gas is too expensive, or because burning coal is leading to "global warming." Although none of these axioms is even true, in fact, the world needs nuclear power because it is a superior form of energy, required for a variety of applications that enable the world's population to live longer and better. These include the efficient production of electricity, advances in medicine, improvements in agriculture and the preservation of food, the creation of fresh water and new materials, and propulsion systems to explore the Solar System and beyond.

While oil, coal, and natural gas create heat by being burned, nuclear fission produces heat through atomic reactions, and more versatile than the heat produced, is the radiation. Harnessing nuclear energy was a quantum leap from the age of fire into the Atomic Age.

Here is a brief review of some of the nuclear benefits.

Feeding the World

From the beginning of President Eisenhower's 1950s Atoms for Peace program, using nuclear radiation to help increase the world's food supply was a major goal. In fact, it's essential to stop today's widespread hunger.

Although world food production still falls drastically short of the needs of the world's population, a large percentage of the food that is grown (in some places more than 50%) rots or becomes insect-infested before it can reach the table. Even in the United States, food that is infected with bacteria, parasites, and insects, kills more than 9,000 people each year through food poisoning, and sickens 30 million more. But these numbers pale by comparison with the hundreds of millions so afflicted in developing nations, where food processing and refrigeration are often nonexistent.

The gamma rays emitted by radioactive cobalt-60 at very low levels can kill the vermin and bacteria in food, as can beams of electrons and X-rays, without altering its taste or nutritional quality. Ionizing radiation at higher levels virtually sterilizes the food. Food irradiation is used in more than 40 nations around the world, including China, France, Germany, Israel, Japan, and South Africa. But the need is for industrial-scale mass-production facilities to process agricultural products, especially for the Third World.

Irradiated food, which since the 1960s has been provided for astronauts, as well as those with debilitated immune system cabilities, such as cancer patients, allows for the long-term, safe storage of food without refrigeration. World food consumption could double if we were to use irradiation to preserve what is already produced.

Radiation has also been used to develop new strains of plants, by altering particular characteristics. Disease-resistant and drought-resistant plants, best adapted to different environmental conditions, have greatly increased agricultural productivity.

The use of radioisotopes as tracers to monitor a plant's uptake of nutrients and of water, allows for the more precise application of fertilizers and irrigation, as agriculture becomes more scientifically vectored, and less limited to educated guesswork.

Saving Lives

In the United States, one in three patients in hospitals is diagnosed or treated using nuclear medicine, with 38,000 medical procedures using isotopes per day. Worldwide, more than 70 million procedures are performed using the radiation from nuclear isotopes per year. Radioactive isotopes of an element are created when extra neutrons are absorbed by the common, non-radioactive isotope during the fission process. Man-made radioactive isotopes of ordinary elements, or radioisotopes, can be efficiently created in nuclear power plants, or in the nuclear spent fuel, or "waste," and can be tailored to specific medical requirements.

The uptake of iodine by the thyroid, for example, means that a radioactive isotope of iodine can be used as a tracer, to study the health of a patient's thyroid gland. Similarly, radioactive phosporous can be used to diagnose the presence of cancerous tumors in bones, while potassium is preferentially concentrated in muscles.

Once a malignant tumor is located, a more intense dose of focussed radiation can be applied to destroy the diseased tissue specifically. In some forms of cancer, radiation therapy has replaced surgery, particularly where the tumor is embedded deep within healthy tissue.

More than 70 nations are members of the World Federation of Nuclear Medicine and Biology, and the International Atomic Energy Agency leads efforts for the application of nuclear medicine in the early detection of cancer, which kills more people in the developing world than HIV and malaria combined.

In research applications, more than 70% of new pharmaceutical drugs in the United States use radioactive tags to test their effectiveness.

Doubling Energy Efficiency

Energy flux density, measured by the amount of energy created per unit area of production, defines the efficiency of the source of fuel. One pound of fissile uranium-235 creates as much energy as burning 1,300 tons of coal.

Energy-dense nuclear power increases efficiency and reduces transportation requirements, compared to coal.

But the heat produced by nuclear fission can provide even more efficient ways of making electricity. Today, electricity is produced either by burning fossil fuels, or in nuclear power plants using heat to turn water into steam. Steam turbines transform the heat into rotational energy, which then moves the coils of a generator through a magnetic field to induce an electrical current. Up to two-thirds of the energy in the fossil or nuclear fuel is generally lost using this method, during the conversion from fuel to electric power.

It has been recognized for more than 150 years that if an electrically conducting, or ionized material, is moved directly through a magnetic field, electrical currents will be created, without the intermediate, and inefficient use of turbines. Magnetohydrodynamics (MHD) is the process of moving an electrically conducting fluid through a channel surrounded by magnets, to directly generate electricity, using no moving mechanical parts.

Although it is possible to use the stream of hot coal gas as the working fluid in an MHD converter, the impurities from the coal create corrosion problems, as do the deposited materials on the electrodes inside the MHD channel. A more efficient application of direct conversion is with high-temperature nuclear reactors.

For nuclear fission reactors, the heat would be used to ionize a liquid metal conducting fluid, which would then be accelerated through the MHD channel to produce power directly. Since the fluid would still be hot as it exits the channel, a steam turbine "bottoming cycle" could be included. This two-phase design could bring electricity conversion to up to at least 70%.

This would mean that each new nuclear plant that is built could produce *twice* as much electricity. So using an MHD system, the energy from the 30 or so nuclear power plants now under construction worldwide, would be the equivalent of 60 plants.

Road to the Stars

Manned exploration of the Solar System is impractical without the use of nuclear power. Although it takes only two days to reach the Moon using today's chemical propulsion systems, a round-trip to Mars involves a life-threatening multi-year excursion, exposing the crew to potentially deadly cosmic radiation, and the disabling physiological effects of microgravity.

The capability of a rocket propulsion system is measured in seconds, and is called specific impulse. It is determined by the speed at which a propellant is expelled from the rocket, and the weight of that propellant to create thrust. The limits on the temperature of chemical combusion limit the speed of the expelled propellant, allowing a maximum specific impulse of about 450 seconds. Higher-temperature nuclear-powered propulsion can double the specific impulse of the system, increasing the rate of acceleration of the spacecraft.

This allows a nuclear-powered rocket to carry twice the tonnage of cargo, or to cut the travel time to the destination in half. For trips to Mars, the shorter trip time is critical for manned missions. And increased cargo capacity would reduce the number of unmanned trips necessary to land the tons of infrastructure cargo needed to support manned exploration.

The United States carried out a nuclear propulsion research and development program between 1955 and 1972, when the manned Mars program was cancelled. Solid-core nuclear reactors and rocket engines were built and tested successfully throughout the 1960s, while parallel research was also under way in the Soviet Union. Now that the manned Mars mission is again under discussion, there are efforts in both countries to recover three lost decades, and resurrect nuclear propulsion technology development programs.

On to Thermonuclear Fusion

Beyond the use of nuclear fission, will come fusion—the fusing together of light elements that creates the nuclear energy in the Sun. In fact, it was astronomers who first observed that chemical and fission sources were inadequate to account for the energy of the stars. The fusion process depends upon fuel that is ionized, or electrically charged, described as a plasma. The nuclear reactions produce an array of charged particles, not just neutrons as in fission reactors, that can be used directly as a working fluid in an MHD electric conversion system.

The thousands-degrees fusion plasma can be applied directly to the thermal cracking of water for desalination, and the separation and concentration of minerals, creating a new base of resources.

The fusion process also generates an array of electromagnetic radiation which can be fine-tuned for specific applications in industry, medicine, raw materials processing, and space propulsion. Fusion energy will enable trips to Mars measured in weeks, rather than months. The continuous acceleration possible with such high-powered systems creates an artifical gravity that will provide protection for the crew.

Fusion power will be needed to process the tons of materials on the Moon, Mars, asteroids, and other heavenly bodies, which are the potential future sources of raw materials needed on the Earth.

Although the nuclear age opened more than a half-century ago, the potential applications of nuclear power are yet to be fully realized. The health, welfare, and future of the world's population depends upon the quickly accelerating deployment of nuclear power.