Op-ed

Energy for the Foreseeable Future

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Many people believe that wind and solar energy are essential for replacing nonrenewable fossil fuels. They also believe that wind and solar are unique in providing energy that's carbon-free and inexhaustible. A closer look shows that such beliefs are based on illusions and wishful thinking.

About half of the carbon dioxide (CO_2) put into the atmosphere by humans is from the production of electricity by burning fossil fuels. Electricity from nuclear fission produces essentially no CO_2 and has none of the disadvantages of solar/wind (described below). Opposition to nuclear power is based on irrational fears and misleading cost comparisons.

Although it appears at first glance that solar, wind, and nuclear sources of energy do not emit CO_2, this is not quite true. All require equipment manufacture that involves CO_2 emission; a rough measure is given by comparing the relative costs of construction as well as operation and maintenance (O&M). But caution must be exercised here: a nuclear plant has a much longer life (60 years and more). Because of limited experience there is inadequate information about corresponding lifetimes and O&M costs for solar/wind.

A major problem for solar/wind is intermittency, which is partially overcome by providing "stand-by" power—mostly from fossil fuels. Nuclear also has special problems (e.g., the care and disposal of spent fuel) that raise the cost and make comparisons rather difficult and also somewhat arbitrary, especially since the "externalities" associated with fossil fuels (e.g., coal plant waste disposal and health costs associated with coal) are rarely counted.

There is general agreement that both solar and wind energy are truly inexhaustible and satisfy the principle of sustainability. However, both are very dilute sources of energy and require large land areas, favorable locations, and the transmission of electric power. In contrast, nuclear power plants have a comparatively tiny footprint and can be sited wherever cooling water is nearby.

Moreover, nuclear energy is also, for all practical purposes, inexhaustible. Uranium is not in short supply, as many assume; this is true only for high-grade ores, the only ones worth mining at current market prices.

About 0.7 percent of natural uranium is in the form of the fissionable U-235 isotope; the remainder is inert U-238. For use in power reactors the uranium fuel must be enriched in U-235 to at least the 2 percent level (for weapons, the required level is 80 percent or more).

Currently, low enriched uranium is cheap enough to justify "once-through" use in light water power reactors; fuel rods are replaced after a fraction of the energy contained in them is "burnt up." Fissionable plutonium (Pu) is created during burnup (from the U-238 in the fuel rods) and contributes to the generation of electric power. The spent fuel contains U-238, radioactive fission products with lifetimes measured only in centuries, and small amounts of long-lived radioactive Pu isotopes and other heavy elements. As every nuclear engineer knows, this spent fuel is itself an important potential resource. Most of it can be transformed into valuable reactor fuel for fast-neutron reactors, enlarging the useful uranium resource by a factor of about 100. If used in the "breeder" mode, such reactors can make uranium resources truly inexhaustible.

Nuclear fusion, the energy source that powers the Sun, has been the "holy grail" of plasma physicists, who after decades of research have not yet been successful in building a stable fusion reactor (the hydrogen bomb is an example of unstable fusion). In a hybrid fusion-fission design, fusion could be a source of neutrons for creating fissionable material for reactor fuel.

So why is this country not moving full speed ahead with all forms of nuclear to make it the primary source of energy for generating heat and electricity? Are precious time and dollars being wasted on marginal improvements to solar photovoltaic and wind technology?

What seems to be holding back the adoption of nuclear energy is public concern about cost, safety, proliferation, and disposal of spent fuel. We briefly address these concerns.

Cost: Growing scarcity of coal and a trend toward factory-assembled modular nuclear reactors reduce existing cost differentials—and may even reverse them.

Safety: There have never been lives lost in commercial nuclear accidents. Proper design is further improving safety by reducing the number of valves and pipes and relying on gravity in inherently safe designs.

Nuclear proliferation: Much has changed in recent decades. There is no longer a nuclear duopoly. If North Korea and Iran can build weapons—and delivery systems—it may be time to rethink the international nonproliferation regime.

Disposal of spent reactor fuel: There are no real technical problems. The containment time for a waste repository is reduced to less than 500 years by using reactor designs that burn up much of what is currently called "waste." Reprocessing works, but has been discouraged because of historic concerns about proliferation based on plutonium. US reprocessing of spent fuel would make nuclear truly sustainable and eliminate the long-term waste problem, without contributing to proliferation.