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The Astounding High Cost of 'Free' Energy

by Laurence Hecht

The author is editor-in-chief of 21st Century Science & Technology.

Jan. 31—Every time someone mentions wind or solar power as the answer to our energy needs, the image that should form in your mind is that of 1 billion or more dying and starving children. If you do not yet understand why this is the case, you are forgiven. By the end of this piece you shall have been given the essential concepts and facts both to understand this ugly truth, and to act to prevent it.

Begin with this: To maintain a global population in a condition resembling a modern 21st-Century standard of living will require an installed electrical generating capacity of at least 3 to 5 kilowatts per capita. Today, only the United States, Japan, and a few countries of western Europe even approximate this level of generating capacity. Let us understand the meaning of this more clearly, before moving on to the crucial question of how we shall generate this power the world so desperately needs.

Kilowatts are a measure of electrical *power,* the amount of work that can be done per unit of time. One of the first means of measuring power was to compare it to that of a working horse. The standard horsepower is equivalent to about 750 watts of electricity. That means that it takes 750 watts of electricity, driving a motor or other device, to do the same work as a standard working horse. Thus, 1 kilowatt (1,000 watts) of electricity, is equivalent to the work of about 1.33 muscular horses of the working type. The horse cannot work all day, however, but perhaps for only one third of it, after subtracting the time for meals and rest. Thus, 1 kilowatt of electrical generating capacity, available all day and night, could do the work of 3 times 1.33 horses, which equals 4 horses.

Here in the United States, we have about 3 kilowatts of electrical generating capacity available per capita—much less than we need to be a truly productive economy, but still, something that most of the world comes nowhere near. Thus, we could say that every person in the United States, on average, has the work of 12 horses available to him every hour of the day and night, in the form of electricity.[1] Without electricity, the work of those silent horses must be done by men and women, laboring to turn pumps, to carry water on their heads, to spend a whole day scrubbing clothes, and another heating irons on a fire to press them, while

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[1] A useful pedagogical device that used to be found more often at science museums and other public displays was the bicycle-driven generator. By mounting on the bicycle, the student could discover just how much work, in the form of pedaling, was required to keep a single 100-watt light bulb glowing, thus getting a sensuous appreciation for the labor-saving efficiency of modern electrical power generation.

Gustave Doré illustration of Don Quixote, 1863

Don Quixote knew what to do with windmills.

such simple requirements as water and sewage treatment, refrigeration, and even the light bulb, go wanting. Such and worse remains the condition of a majority of the world's population—some 1.7 billion people who are entirely without electricity, and several billion more for whom the supply is intermittent and deficient.

China, for example, which produces a great part of the manufactured products consumed in the U.S.A., had only 0.3 kilowatts of generating capacity available per capita in 2005, which increased by 2008 to an estimated 0.5 kilowatts. Well over half of this electricity goes to power Chinese industry, the product of which is primarily exported. Thus, the amount available per person for use in China is less than 0.25 kilowatts, about one-third of a horsepower. Taken over the full 24 hours, we can say that the average person in China has available to him the work of 1 horse, compared to the 12 horses available in the United States. The source of most U.S. manufactured products is the low-wage labor of millions of Chinese, many of them from families with no access to even the electric light.

In India, Egypt, most of the rest of Africa, and large parts of South America, it is far worse. In Mexico, another major source of U.S. manufactured goods, the electricity available per capita is about the same as China. Such an injustice cannot continue for long. How then will we remedy it?

No one can seriously propose that the world energy shortage can be solved with windmills and solar panels. The proponents of these systems have never addressed the world need, except to propose such patronizing and pathetic schemes as solar-powered refrigerators for African villages, which only work, if at all, when the Sun is shining. But even the proposals to use solar and windmills in the developed countries are a chimera. They have never proven economically or technologically feasible, despite the enormous public expense in tax credits and subsidies which they have drawn upon.

To bring the present world population of 6.7 billion people up to a level of just 1.5 kilowatts of electrical generating capacity per capita will require that we build 6,000 gigawatts[2] (6 million megawatts) of generating capacity. The only feasible way to accomplish this is to embark now on a crash program to build nuclear power plants, making use of our limited existing capabilities

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[2] 1 gigawatt = 1 thousand megawatts = 1 million kilowatts

and gearing up for a serial production capability for the new breed of fourth-generation, high-temperature helium-cooled reactors, among other models.

Could solar or wind power possibly address the world electricity deficit? The largest existing solar power plant, the solar concentrator known as Nevada Solar One, produces less than 15 megawatts of power, averaged over the course of the day.[3] The largest solar plant using photovoltaic panels is in Jumilla in southeastern Spain. It is rated at 23 megawatts maximum capacity. Divide this by four, and you have the actual average output of less than 6 megawatts! A single large nuclear power plant can produce 1,000 megawatts (1 gigawatt) or more of electrical power. It can do this all day every day, not just when the Sun shines, and on a land surface area hundreds of times smaller than the equivalent solar plants or wind farms.

PRNewsFoto/Acciona

Acciona's Nevada Solar One concentrating solar power plant, the world's largest, produces less than 15 megawatts of power, averaged over the course of a day.

What Is Energy Density?

But wind and solar power are "free" people say: The energy is there, a bounty of nature, we just have to use it. Yet once one analyzes such an argument, one sees that it is meaningless sophistry, even on the face of it. Coal, oil, and uranium are "free" in the same sense. A certain amount of work has to be done to mine them and bring them to the place where they will be consumed, but work also has to be done to utilize wind and solar, a very great deal of work compared to the benefit received.

Instead of such loose use of language, let us examine the two most important concepts in evaluating a power source, *energy density* and *energy flux density.* By the *energy density* of a fuel or power source, we mean the amount of useful work that can be derived

Kilowatts of Electricity Available Per Capita in Selected Nations (2005)

	Developing Sector					Advanced Sector			
	Argentina	China	Egypt	India	Mexico	France	Germany	Japan	U.S.A.
Electrical Generating Capacity in Gigawatts (10^9 Watts)	28.2	442.9	19.3	137.4	51.1	112.7	120.4	249.9	956.7
Population (Millions)	39.2	1,306	77.6	1,094	106.2	62.9	82.4	127.5	295.6
Kilowatts Available Per Capita	0.7	0.3	0.2	0.1	0.5	1.8	1.5	2.0	3.2

Sources: U.S. Energy Information Administration, U.S. Census Bureau (International Data Base).

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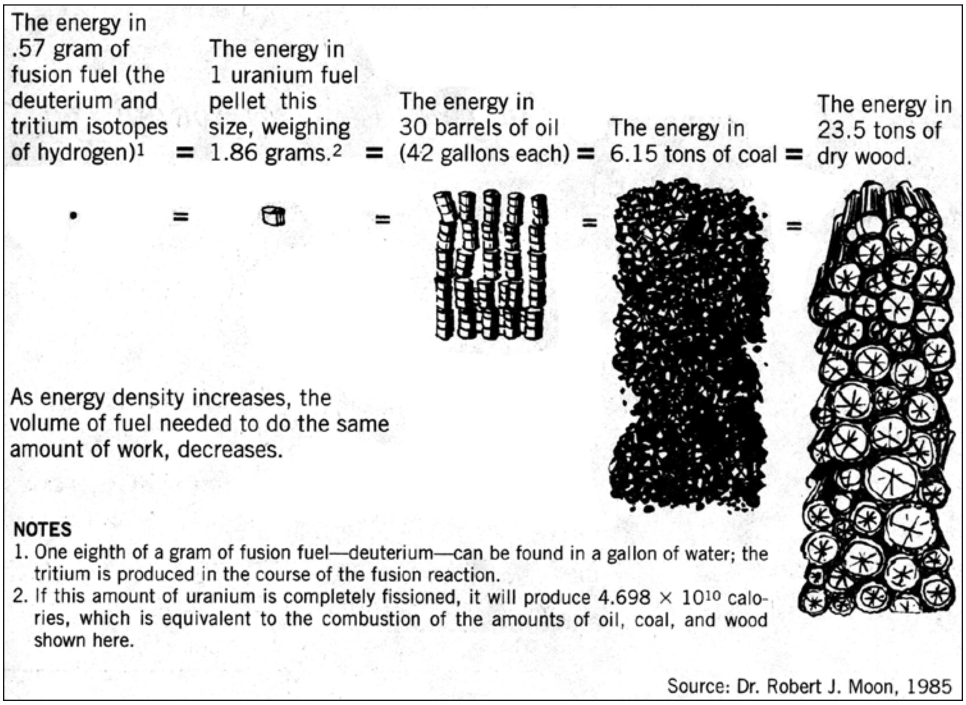
[3] Beware of labelling. The plant has a peak power output of 64 megawatts. But, like all solar plants, that is the amount it can produce at high noon. As the Sun falls in the sky, the output of the solar plant falls with it, until, for half the day, the solar plant produces no power at all.

When shopping for a solar power plant, divide the manufacturer's claimed output by four to five, and you will have a clearer idea of the con-job you are about to buy into. Also remember, that for most of the day, solar concentrator plants require back-up power from natural gas-powered heaters to keep the working fluids flowing. And don't forget that the Sun doesn't shine every day. In order to integrate such an erratic power source into the grid, requires sophisticated planning, electronic circuitry, and maintenance work, the cost of which is rarely considered.

from a given mass of the substance. By *energy flux density,* we mean the transformative power which can be obtained from that fuel source. Let us examine the first term first, and see what we can learn from it.

FIGURE 1

Fuel and Energy Comparisons



As energy density increases, the volume of fuel needed to do the same amount of work, decreases.

NOTES

1. One eighth of a gram of fusion fuel—deuterium—can be found in a gallon of water; the tritium is produced in the course of the fusion reaction.
2. If this amount of uranium is completely fissioned, it will produce 4.698×10^{10} calories, which is equivalent to the combustion of the amounts of oil, coal, and wood shown here.

Source: Dr. Robert J. Moon, 1985

Over the course of human history, there have been several progressive increases in the *energy density* of the fuels employed. The transition from wood burning to coal (which is almost four times more energy-dense than wood), took place in Europe in the 18th Century. The higher temperatures and regulation that could be achieved with coal fires permitted the introduction of new technologies related to smelting of ores, steelmaking, and other techniques. Until the 1950s, coal was the primary energy source for industry and transportation, and it remains the principal fuel used for electricity generation in the U.S.A.

Oil is about 50% more energy-dense than coal. The advantage of oil over coal as a fuel for powering steam ships became a factor in geopolitics at the close of the 19th Century, with the conversion of the British Royal Navy from coal- to oil-fired steam boilers. The weight advantage of oil, and its ease of handling (not requiring manual stokers to feed the fire), increased the range and efficiency of warships. The lighter derivatives of petroleum, such as gasoline, benzene, and kerosene, are among the most energy-dense liquids, which made them desirable as a transportation fuel—as long as they last.

But each of these improvements in the energy density of fuels was dwarfed by the discovery of atomic energy. As illustrated in the accompanying figure, a barely visible speck of uranium fuel, when fully fissioned, is equivalent to 1,260 gallons of fuel oil (weighing 4.5 tons), 6.15 tons of coal, or 23.5 tons of dry wood. When compared by weight, the advantage of uranium fuel over the older types is as follows:

Advantage per unit weight of Uranium . . .[4]

. . . over Wood:	**11.5 million** times
. . . over Coal:	**3.0 million** times[5]
. . . over Petroleum:	**2.2 million** times

We shall be modest and note that these figures are derived by assuming that all of the fissionable uranium in the fuel pellet is burned up (fully fissioned). The fuel burn-up rate in many presently operating reactors, may be only about 4%, although it is higher in advanced re-

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[4] Derivation of figures in this table:

Weight of oil equivalent (at sp. gr. = 0.9):

30 bbls × 42 gals/bbl × 7.2 lbs/gal × 453.6 grms/lb. = *4.12 ×* 10^6 *grams*

Weight of coal equivalent:

6.15 tons × 2,000 lbs/ton × 453.6 grms/lb = *5.58 ×* 10^6 *grams*

Weight of wood equivalent:

23.5 tons × 2,000 lbs/ton × 453.6 grms/lb = *2.13 ×* 10^7 *grams*

Dividing these weights by 1.86 grams of uranium, which when fully fissioned is equivalent to the energy content of the above weights of oil, coal, and wood, gives the results shown in the table. (Derived from graphic by Dr. Robert J. Moon, 1985.)

[5] The weight comparison to coal is not academic, as coal accounts for nearly half the tonnage carried on U.S. railroads. Gradually replacing coal-fired plants with nuclear power will be an important step in creating a viable rail freight transportation system.

Marie and Pierre Curie's separation of the first gram of radioactive radium introduced a new physical principle, making a revolution in physical chemistry.

Lawrence Berkeley National Laboratory

A PET (positron emission tomography) scanner used with radioisotopes in medical imaging. The use of radioisotopes in medicine, with scanners and in targetted therapies, is just at the beginning of its potential to save lives and lengthen lifespans.

actor designs. Thus, the figures above need to be divided by 25, giving nuclear power, in the worst-case scenario, an energy density advantage over wood, coal, and petroleum of *only* 88,000 to 460,000. However, with fuel reprocessing, a form of recycling, the burn-up rate is nearly total. Because of the production of extra neutrons in the fission reaction, new fuel can be created by nuclear transmutation as the old fuel burns up. The full nuclear fuel cycle, employing reprocessing and fuel breeding, is a virtually limitless cycle. Nuclear is the only fuel that replaces itself as it burns.

Energy Flux Density

To progress from the concept of *energy density* to *energy flux density,* it is necessary to have a deeper conception of the notion of *work.* In physics-textbook terms, *energy* is the same as *work.* It was one of the great achievements of 19th-Century physics, to demonstrate the equivalence of heat, electricity, and mechanical motion, resolving all these forms of energy (work), and others, to a common measure. Thus, the technical definition of *energy flux density* would simply be the amount of energy passing across a given surface area in a unit of time. An example of a higher energy flux density could be had by comparing the capability of a sharp knife to a dull one. Holding the sharper knife, the same work exerted by the hand is concentrated over a smaller surface area. The energy flux density is greater and the sharp knife is able to cut where the dull one cannot.

By that method of accounting, the energy flux density produced by the fission of a single uranium atom can be shown to be from about 20 million to 20 quadrillion times greater than that gained by burning a molecule of an energy-dense fuel, such as natural gas.[6] However, even this astounding numerical advantage does not yet comprehend the essential difference. To understand energy flux density in the context of physical economy, a higher conception of *work* is required. It is not sufficient to regard *work,* as we do in physics, merely as the expenditure of energy measured in calories, joules, kilowatt-hours, or electron volts.

Rather, when considering a physical economy, we must look at the transformative power of the work. Something akin to the skilled worker's maxim "don't work hard, work smart," is appropriate as a first approximation of the concept. Implied in the saying is the idea, that by application of the human mind, the same expenditure of effort can be made more efficient, perhaps by

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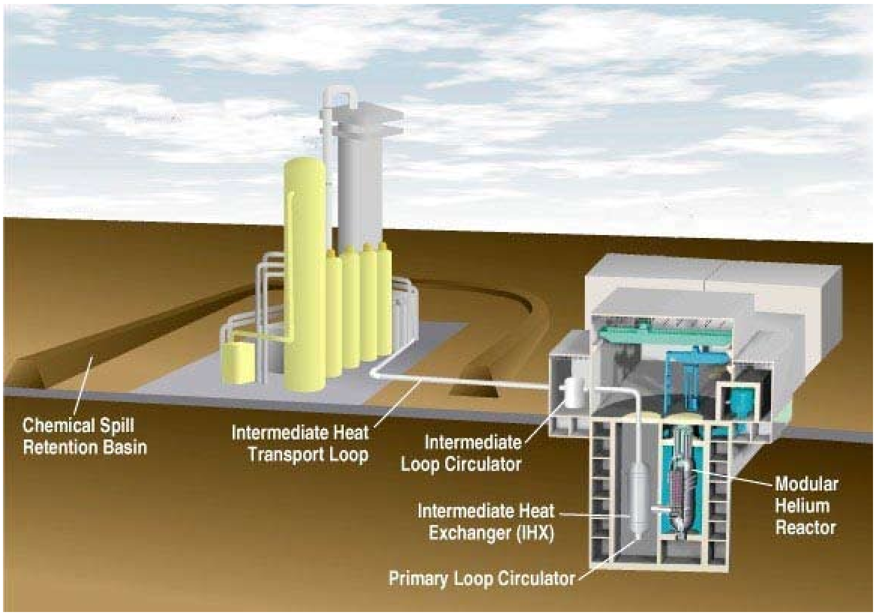
[6] See Appendix for calculation.

FIGURE 2

High-Temperature Reactor Coupled with Hydrogen Production Plant



General Atomics

This General Atomics design for a high-temperature gas-cooled reactor couples its GT-MHR to a sulfur-iodine cycle hydrogen production plant. The sulfur-iodine cycle, which uses coupled chemical reactions and the heat from the high-temperature reactor, is the most promising thermochemical method for hydrogen production. Nuclear-produced hydrogen or hydrogen-based fuels in the future will provide the transportation fuels for the nation, replacing oil imports.

use of a different tool, or by the improvisation of a new one, or by organizing the process in a different way. In the case of nuclear, as opposed to chemical or mechanical processes, a higher order sort of innovation is at work. Here, we are dealing with the introduction of a new discovery of *universal physical principle,* the revolution in physical chemistry which began with the Curies' separation of the first gram of radium, and proceeded through the identification of the radioactive decay process, nuclear transmutation, the energy-mass relation, the nucleus, the isotope, the neutron, the accelerator, the discovery of fission, the chain reaction, and so forth.

Apart from the questions of cost and efficiency, the fallacy of saying that wind and solar can be made to generate electricity, just as nuclear power can, is that it leaves out the transformative power which the application of this new universal physical principle permits. Nuclear energy works smarter, vastly smarter, than wind, solar, or fossil fuels ever can. The reason is not merely its superior *energy flux density,* measured in caloric terms, but the transformation in the physical economic process as a whole which it can accomplish.

With the fission of each uranium nucleus, several tiny entities, part particle and part wave, are released at velocities approaching that of the speed of light. These particle/waves, which we call neutrons, have the ability to penetrate the nucleus of another nearby atom, and to transform it into a new element, a process known as transmutation. But this is only the beginning, for that new element may, in turn, spontaneously transmute into another, and another, producing a family of by-products (isotopes) which finally settle into a stable form. By mastering the chemistry of these transformations, we have the ability to make new materials, some known and some yet to be discovered, which will be of benefit to future human life. We have also the benefit of the rays these isotopes give off, at least three different types, and each one at a different strength. Their uses in diagnosis and treatment of an array of dangerous diseases are proven, and every day brings new possibilities.[7]

Nuclear for Fuel and Water

In many parts of the world, including some of extremely high population density, such as the east coast of India, the supply of clean water is running out. Ground wells are becoming contaminated as the fossil water supply within the ground becomes exhausted. Substantial regions of the United States, including Southern California and the American Southwest, are also reaching critical water supply limits. Producing drinking water by desalination of seawater is a proven process. Currently, 40 million cubic meters of water a day are produced by desalination, mostly in the Middle

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7. Alas, the United States is falling far behind in the use of medical isotopes, because we have nearly shut down our capability to produce all but the commonest of them, and now must import more than 90% of what we use. The chances for survival of certain types of cancers are far greater in a hospital in Europe than here, because U.S. doctors do not make use of the relevant targetted radioisotope therapies.

East and North Africa. The leading methods are reverse osmosis, using electric-powered pumps to force salt or brackish water through a specially designed membrane, and flash distillation. However, desalination is an energy-intensive process.

The feasibility of using nuclear power for large-scale desalination was first demonstrated nearly 40 years ago in Soviet Kazakstan. For 27 years, the Aktau fast reactor produced 80,000 cubic meters per day of freshwater, and up to 135 megawatts of electric power at the same time. Japan has operated ten demonstration desalination facilities linked to nuclear reactors, and India in 2002 set up a demonstration desalination plant at the Madras Atomic Power Station in the southeast, with a 6,300 cubic meter per day output. Windmills and solar panels will not supply the large amounts of electric power required to produce freshwater in dry areas of the world, but nuclear plants can do it.

Nuclear power also offers the solution to the dependency on imported oil. The key is the two atoms of hydrogen contained in every molecule of water. Hydrogen is a fuel, which can be utilized on its own, or combined with carbon sources to produce liquid fuels quite similar to those we now use. Hydrogen can be obtained from water either by electrolysis or by thermo-chemical splitting. At the higher temperatures available from the new generation of modular helium-cooled reactors, the efficiency of both these processes is greatly increased. Nuclear-produced hydrogen or hydrogen-based fuels, combined with ample electricity for battery vehicles, will provide a stable local supply of the transportation fuel the nation needs. Instead of enriching the Anglo-Saudi oil cartel by shipping petroleum across thousands of miles of ocean, we can produce our own, cleaner fuel at domestic nuclear power plants, while also providing our electricity and other needs.

These are the things that we as a nation need. They are also the things the world needs. They are but some of the immediately knowable practical advantages of the use of this new physical principle, which has defined the 20th-Century revolution in science. Much more lies ahead, waiting to be discovered. Some breakthroughs, such as the practicable development of thermonuclear fusion energy, are almost now within our grasp. Others are yet to come. To deny its application to our economy, and to return to 18th Century and earlier modes of power generation, is to stop human progress.

APPENDIX

Calculation of Energy in Electron Volts From Burning a Fossil Fuel[1]

(Example is methane, the principal component of natural gas)

Heat of combustion of methane (CH_4) = 891 kilojoules/mole . . .

$$(8.91 \times 10^{2}\ \text{kJ/mole}) / (6.02 \times 10^{23}\ \text{molecules/mole})$$
$$= 1.48 \times 10^{-21}\ \text{kilojoules/molecule of methane}$$

1 kilojoule = $6.24150974 \times 10^{21}$ electron volts . . .

$$(1.48 \text{ x } 10^{-21}\ \text{kJ/molecule}) \times (6.24 \times 10^{21}\ \text{eV/kJ})$$
$$= 9.24\ \text{electron volts per molecule of methane}^{2}$$

The energy released in the fission of a single uranium atom is 200 million electron volts, making the simple advantage of uranium fission over combustion of natural gas about 20 million to 1. However, the figure does not include the surface area over which the work occurs. In comparing nuclear to chemical reactions, we must consider the ratio of the surface area of the nucleus (about 10^{-24} cm^2) to that of a molecule (about 10^{-15} cm^2 for methane). Thus an additional factor of 10^9 (1 billion) must be factored in, bringing the potential *energy flux density* advantage of nuclear fission over fossil fuel burning to approximately 20 quadrillion to 1. This advantage is not yet realized in the present design of nuclear reactors, but demonstrates the potential still contained within this new regime of energy production.

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[1] An electron volt is the work required to move an electron through a potential difference of 1 volt.

[2] Calculated per atom, the advantage for uranium increases somewhat more. This may be seen by dividing the result for methane by 5 (the number of atoms contained in the molecule), resulting in 1.85 electron volts per atom. For ethane, the figure would be 2.02 eV/atom and so forth, the figure increasing with the molecular weight of the hydrocarbon in question.

Why Windmills Can’t Fly : The Non-Science of Wind Energy

by Gregory Murphy

Sandia National Laboratory

An offshore wind farm in Denmark, the country that has the most wind turbines per capita. But Denmark has never been able to shut down one of its coal-fired plants.

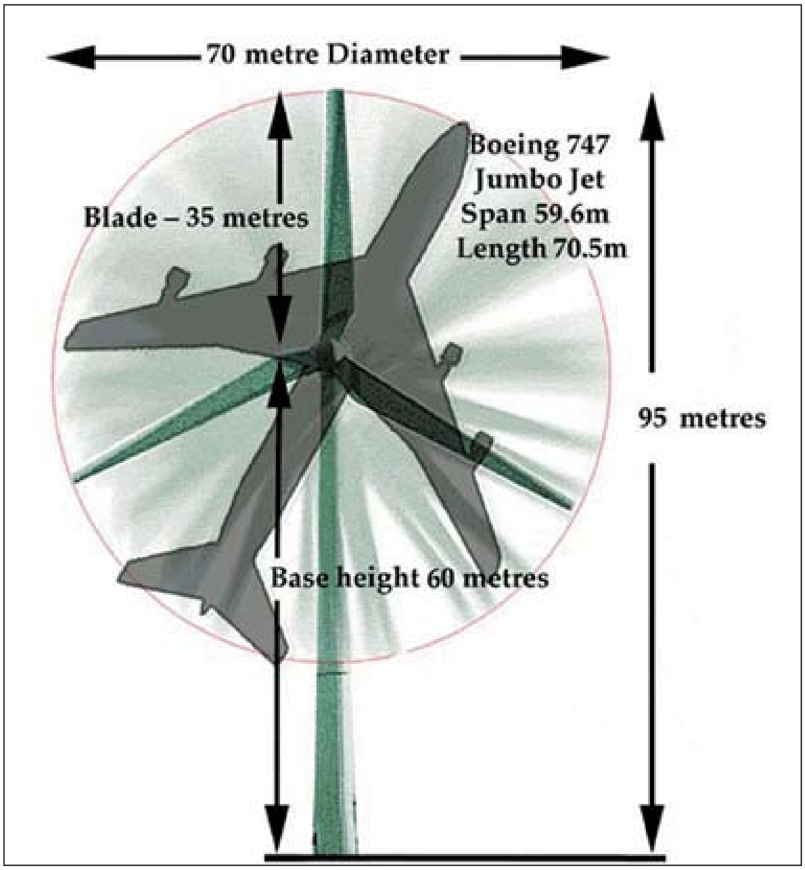
Unless you want to kill people by energy starvation, wind is useless for an industrial society. It is intermittent, unreliable, high cost, and low energy density. Although its proponents call wind energy a renewable source, even that is not true: You cannot produce even one wind turbine from the electricity produced by a wind farm of 100 wind turbines.

Let’s look at the basics: Like most renewables, wind needs lots of land area. For comparison, let’s take a typical nuclear power plant in Texas. I have chosen the Comanche Peak Nuclear Power Plant, south of Dallas, which has two units with a combined capacity of 2,500 megawatts (MW). Comanche Peak is sitting on 4,000 acres, which includes a man-made cooling lake that also serves as a recreation area.

How many 1.5-MW General Electric wind turbines (the kind chosen by T. Boone Pickens for his much-hyped plan to replace baseload electric sources with wind turbines) would it take to produce the same amount of energy that the Comanche Peak reactors produce? To find out, we first divide the amount of energy that the reactors produce (2,500 megawatts) by the nameplate rating of the wind turbine, which is 1.5 megawatts. That would seem to give us the number of turbines that would be needed to produce that same amount of energy as the nuclear reactor: 1,667 wind turbines.

But not so fast. It turns out that the nameplate rating is not what the wind turbine actually puts out. The average wind turbine has a capacity factor of only 25%. This means that only 25% of the rated capacity is actually produced, on average, by the wind turbine, and thus it will take four turbines to equal the nameplate rating of one turbine. Given that fact, we must now multiply our 1,667 wind turbines by 4, which gives us 6,668 wind turbines to equal the output of the two nuclear reactors at Comanche Peak.

Now let us look at the amount of land area that would be needed for these 6,668 wind turbines. General Electric, the producer of the 1.5-MW wind turbines used in this example, recommends spacing the turbines at three times the diameter of the turbine’s rotor, so that the wind trailing off the rotor does not affect neighboring turbines. GE also recommends that the spacing between rows of turbines be five times the diameter of the rotor, so that the next row of turbines can make use of the available wind.



Naturstrom-Euphorie

This gives an idea of the immensity of a 1.5-megawatt wind turbine, the model that T. Boone Pickens has ordered from General Electric for his now-on-hold project to build the world's largest wind farm, in the Texas panhandle. The area that the rotor sweeps out is large enough to fit a 747 jumbo jet.

The GE 1.5-MW wind turbine has a rotor diameter of 77 meters (262.6 feet). To get an idea of the size, the area that the rotor sweeps out is big enough to place a 747 jumbo jet inside.

To figure the spacing between the turbines, multiply the rotor diameter of 77 meters by 3, which gives us 231 meters. Now, to figure the spacing between rows of wind turbines we multiply the rotor diameter of 77 meters by 5, which gives us 385 meters between rows. If we multiply the 231 meters by 385 meters, it will give us the total area required to site one of our 1.5-MW wind turbines. This comes out to 88,935 square meters, or 22 acres of land.

If we multiply the 22 acres by our 6,668 wind turbines, we get 146,696 acres, which is 229.21 square miles (about three times the size of the metropolitan Washington, D.C. area).

Compare that to the 4,000 acres required for the nuclear plants. And then consider, that the Comanche site can support two more units (the license is currently under review by the Nuclear Regulatory Commission). That would double the power output achieved on the same 4,000 acres, and bring the ratio of land use efficiency of nuclear power, compared to windmills, to 73 to 1.

Statistical Fakery

Promoters of wind energy use every conceivable numerical trick to hype the great benefits of wind energy. The biggest fraud comes in the comparisons of levelized cost. Levelized cost is figured by taking the nameplate-rating capacity and multiplying it by, say, 30 years, and then subtracting the cost of maintenance. In the case of wind, however, there is major element of fraud: It is assumed that the wind is going to blow 25-27 miles per hour, every hour of the day, for 30 years! In truth, there is no place on the planet where the wind blows at those speeds every day for 30 years.

Another piece of fakery relates to the availability factor, that is, the percentage of time that the wind turbine or any other power source is available. Wind energy advocates purposely confuse the availability factor with the capacity factor, in order to show how many wind turbines could produce the same energy as a nuclear power plant. The fraud is that although the availability factor of a wind turbine is 100%—because it is available to produce power at any time—wind turbines actually produce their full-rated power less than 25% of the time.

Compare this to the nuclear power plant, in which the availability factor and the capacity factor are the same—around 95%. The only time the nuclear reactor is not producing power is during maintenance periods. But wind turbines also have maintenance downtime, and a lot more of it.

Then there is the subsidy issue. Renewables like wind and solar are highly dependent on government subsidies. The Production Tax Credit (PTC), recently

NRC

The Comanche Peak nuclear plant site in Texas, has two reactors totalling 2,500 megawatts, sited on 4,000 acres that include a cooling pond and recreation area. The nominally equivalent output in wind turbines would occupy 229 square miles, about three times the size of the metropolitan Washington, D.C. area.

extended for another year, is a 1.8-cent tax credit per kilowatt hour for the first ten years of the wind turbine's life. Average electricity rates fall between 7 and 11 cents per kilowatt hour, so the credit amounts to a subsidy of 16 to 25%.

This is not the only subsidy that wind energy industry gets. Several states offer tax breaks on operating revenue, and allow write-offs for capital investment. State laws that require a certain percentage of electricity to be produced by renewables guarantee that there will be a market, no matter what the cost.

Myth of Green Job Creation

In December 2008, radical Malthusian Lester Brown of the Earth Policy Institute held a teleconference where he said that millions of "green collar" jobs could be created with the transition to a green energy economy. This author challenged that claim, and asked in an e-mail, what the real effect of the green-collar jobs would be, and if these were permanent jobs or only temporary jobs. Jonathan Dorn, the lead researcher responsible for compiling the data for the reports issued by the Earth Policy Institute, gave a telling answer.

After reiterating the statistical mumbo jumbo of his job creation model, Dorn admitted that "the majority of the jobs are temporary construction and manufacturing jobs. Once construction of the power facility or the retrofitting of a building is completed, the construction workers will be laid off."

To review the case against wind energy ever becoming a mainstay power source:

- Great tracts of land are needed to produce the same amount of energy as a nuclear or conventional power plant.
- Wind patterns can be erratic. Even if the wind blows fairly regularly in an area, physical design requirements limit the speeds at which the turbines work. This means that you cannot make the most use of the available energy contained in the wind.
- Because of the irregularity of wind, there always has to be a back-up power source available.
- Wind requires a high level of government subsidy to operate.

The case of Denmark shows that it is a pipe-dream to suppose wind will ever replace mainstream power. Denmark has more wind turbines per capita than any country in the world, and still, it has not been able to turn off a single coal-fired plant.

The Myth of Nuclear ‘Waste’

by Marjorie Mazel Hecht

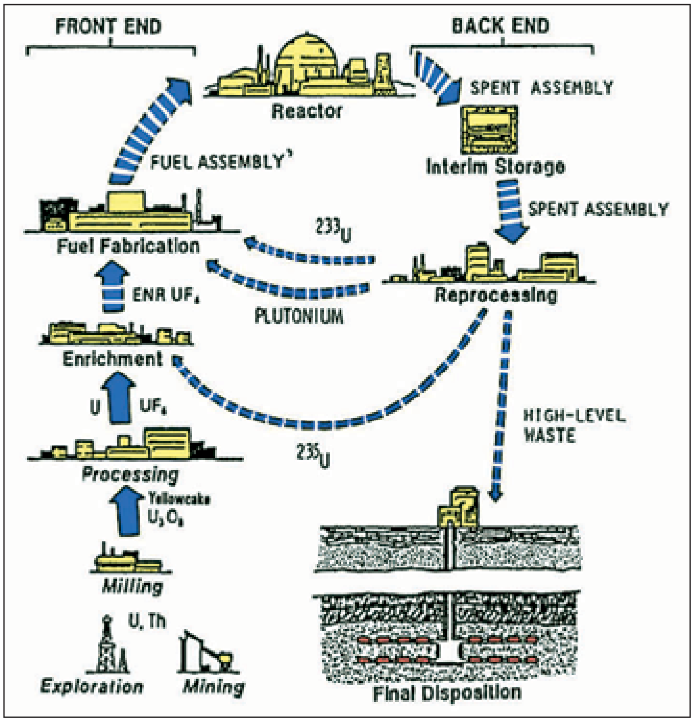
There’s no such thing as *nuclear waste*! This nasty term was invented just to stop the development of civilian nuclear power.

The spent fuel from nuclear power plants is actually a precious resource: About 96% of it can be recycled into new nuclear fuel. No other fuel source can make this claim—wood, coal, oil, or gas. Once these fuels are burned, all that’s left is some ash or airborne pollutant by-products, which nuclear energy does not produce.

Thus, nuclear is a truly *renewable* resource. Furthermore, unlike wind, solar, and other so-called alternative energy sources, a nuclear fission reactor (the fast reactor or breeder reactor) can actually *create more fuel* than it uses up.

In the Atoms for Peace days of the 1950s and 1960s, it was assumed that spent reactor fuel would be reprocessed into new reactor fuel. The initial plan was for the United States and other nuclear nations to have closed nuclear fuel cycles, not “once-through” cycles. In the closed fuel cycle, uranium is mined, enriched, and processed into fuel rods; then it is burned as fuel and reprocessed, to start the cycle again.[1]

“Burying” spent fuel (as planned for Yucca Mountain) was not in the Atoms for Peace picture. Why bury a fuel source that could provide thousands of metric tons of uranium-238, fissile uranium-235, and plutonium-239 that could be used to make new reactor fuel?



NRC

The closed nuclear fuel cycle, shown here, reprocesses spent nuclear fuel to create new reactor fuel. Uranium is mined, milled, converted into uranium hexafluoride, and then enriched. Because most uranium (99.276%) is U-238, the uranium fuel must go through a process of enrichment, to increase the ratio of fissionable U-235 to the nonfissionable U-238 from about 0.7% to 3 to 4%. The enriched uranium is then fabricated into fuel rods for use in light water reactors.

Now, the United States has a “once through” fuel cycle, so that spent fuel is stored in cooling pools at the reactor site, and after it cools, it is stored in dry casks, awaiting “burial.” What a waste!

But, as explained below, the U.S. stopped its reprocessing program in the 1970s and instead now stores spent nuclear fuel, waiting for a long-term burial site. Despite the scary headlines, the total amount of spent fuel in storage in the United States is small. The U.S. Department of Energy stated in 2007: “If we were to take all the spent fuel produced to date in the United States and stack it side-by-side, end-to-end, the fuel assemblies would cover an area about the size of a football field to a depth of about five yards.”

The amount of usable fuel in that hypothetical football field, however, is vast. Burying 70,000 metric tons of spent nuclear fuel would waste 66,000 metric tons of uranium-238, which could be used to make new fuel, and an additional 1,200 metric tons of fissile uranium-235 and plutonium-239, the energetic part of the fuel mixture. Looking at it another way, the spent fuel produced by a single 1,000-megawatt nuclear plant over its

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[1] See “The Beauty of the Nuclear Fuel Cycle,” *21st Century Science & Technology,* Winter 2005-2006, www.21stcenturysciencetech.com/2006_articles/NuclearFuel.W05.pdf

NRC

Dry casks of spent reactor fuel, stored on a concrete pad at a nuclear power plant. Why not reprocess it and burn it up?

40-year lifetime is equal to the energy in 5 billion gallons of oil, or 37 million tons of coal. Would you throw that away?

In addition to the multi-trillion-dollar amount of new reactor fuel that could be recycled from 96% of the spent nuclear fuel now in storage, the remaining 4% of so-called high-level waste—about 2,500 metric tons—is also usable. Dr. Michael Fox, a physical chemist and nuclear engineer, has estimated that there are about 80 tons each of cesium-137 and strontium-90 that could be separated out for use in medical applications, such as targetted radioisotope therapies, or sterilization of equipment.

Using isotope separation techniques, and fast-neutron bombardment for transmutation (technologies that the United States has refused to develop), we could separate out other valuable radioisotopes, like americium, which is widely used in smoke detectors, or plutonium-238, which is used to power heart pacemakers, as well as small reactors in space. Krypton-85, tritium, and promethium-147 are used in self-powered lights in remote applications; strontium-90 is used to provide electric power for remote weather stations, and in remote surveillance stations, navigational aids, and defense communications systems.

Progress vs. Malthus

To explain how a valuable resource became "waste," it's necessary to look back at the world situation as Atoms for Peace was taking off, and man was headed for the Moon. Scientific optimism and progress were all around. Most people assumed that the next generation would have increasing prosperity.

But after the death of Franklin Roosevelt and the resurgence of the British imperial design, Malthus reared his ugly head. As the first director of UNESCO (the United Nations Educational, Scientific, and Cultural Organization) in 1945, Sir Julian Huxley euphemized Nazi eugenics into "conservation" and "environmentalism."[2] Britain's Prince Philip and the Netherlands' Prince Bernhard (a former Nazi) organized a royal green movement to preserve raw materials and wildlife for their own pleasure and to remove what they considered to be an excess number of ordinary human beings.

Prince Bernhard established the "1001 Club" in 1971, an exclusive grouping with a $10,000 initiation fee used to bankroll the International Union for the Conservation of Nature and the World Wildlife Fund, which Philip had founded in 1961 (along with Huxley). Prince Philip himself led the World Wildlife Foundation until 1996.

Behind the IUCN and the WWF, and their public relations appeal for cute fuzzies and other critters, is the hatred of proliferating human beings, especially those of color. If you think this is far-fetched, read some of Prince Philip's own statements. He told *People* magazine in 1981: "Human population growth is probably the single most serious long-term threat to survival. We're in for a major disaster if it isn't curbed—not just for the natural world, but for the human world. The more people there are, the more resources they'll consume, the more pollution they'll create, the more fighting they will do. We have no option. If it isn't controlled voluntarily, it will be controlled involuntarily by an increase in disease, starvation, and war."[3]

The Malthusians' Club of Rome, founded in 1968, campaigned for population control to preserve Earth's limited resources, eliminating any mention of the fact that advanced technologies could create new resources.

In the United States, this anti-people view gained prominence with Paul Ehrlich's 1968 book *The Population Bomb,* launching his message on American campuses: People are raping the Earth and the world popu-

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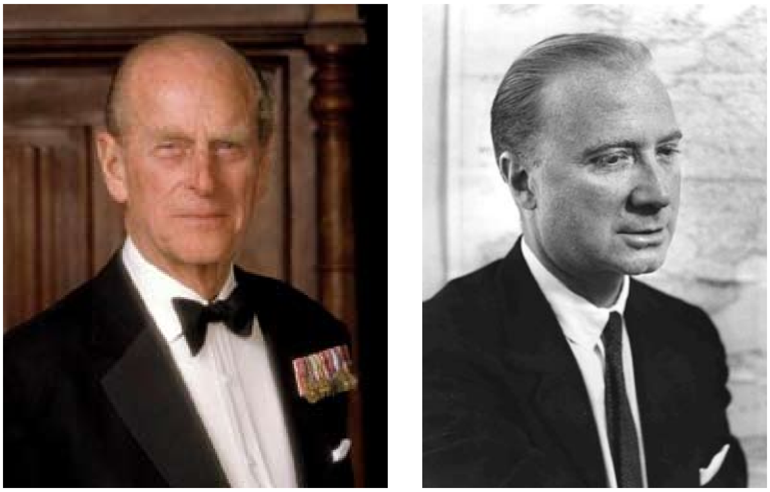
[2] For details on Huxley, Prince Philip, and Prince Bernhard, see *EIR*'s Special Report, "The True Story Behind the Fall of the House of Windsor," September 1997.

[3] *People* magazine, Dec. 21, 1981.



Courtesy of the University of Chicago

Prince Philip *Albert Wohlstetter*

What do His Royal Highness and the now-deceased "Dr. Strangelove" have in common? They both want to reduce the human population and stop civilian nuclear power.

lation should be cut by two-thirds. Biologist Ehrlich, whose predictions of disaster have all bombed over the past 40 years, mentored many of the scientists prominent in environmental causes, including the nation's new science advisor Dr. John Holdren, who co-authored one of Ehrlich's books.

Another influential anti-population book was the 1972 *Limits to Growth,* written by a group of MIT Malthusians, who made dire pronouncements about the future, unless population were cut back. Never mentioned was the idea that advanced technologies could solve these problems and shatter any limits.

To these Malthusians, the development of civilian nuclear power was the enemy, not because it was costly or unsafe, but because they knew it would successfully free human society from poverty, disease, and Dark Age conditions. From the top down, the anti-nuclear leaders today know that this is true. Fear-mongering about the dangers of waste, radiation, and high costs are just cover stories for the well-meaning credulous. The real issue is population control.

Dr. Strangelove Invents Nuclear Waste

Behind the scenes working to destroy civilian nuclear power was "Dr. Strangelove," the man behind the maniacal figure in the famous film of that name: Albert Wohlstetter. Wohlstetter, a Chicago University mathematician/logician and RAND consultant, became the nation's top nuclear strategist and advisor to five Presidents. He specialized in ghoulish scenarios of nuclear war, measured in death counts. He also mentored many of today's leading neocons, including Richard Perle, Paul Wolfowitz, and Zalmay Khalilzad.[4]

Wohlstetter played a key role in killing civilian nuclear power and manipulating antinuclear policies. He deliberately equated civilian nuclear reactors with "bombs," redefined spent nuclear fuel as "waste," and campaigned to stop reprocessing, because it would only lead to more nuclear plants. He argued not only that developing countries shouldn't have them, but that the United States should not continue to go nuclear, because of another nasty term that he promoted: "proliferation." Although Wohlstetter admitted that nuclear would produce power cheaply, he insisted that cheap energy was not key for growth of an economy!

In California, Wohlstetter was instrumental in getting a law passed that prohibited any new nuclear plant being built until there was a national burial site to bury what he defined as high-level "waste." Then, Wohlstetter's environmentalist friends campaigned against having nuclear "waste" stored or buried anywhere—a fight that is still with us today.

At the same time, Wohlstetter et al. moved to stop reprocessing. It was not President Carter who took this step, as is commonly thought, but Wohlstetter and the neocons, including Dick Cheney. As chief of staff for President Ford, Cheney presided over a Presidential advisory committee that advised an end to the U.S. reprocessing program for the reasons that Wohlstetter had articulated. Ford came out with his anti-reprocessing policy in 1976, during the election campaign. Jimmy Carter, who had an identical policy on reprocessing, won that election. Wohlstetter, then a consultant to the Department of Defense, wrote one of the key reports supporting Carter's ban on reprocessing.[5]

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[4] "Albert Wohlstetter's Legacy: The Neo-cons, Not Carter, Killed Nuclear Energy," *21st Century Science & Technology,* Spring-Summer 2006, www.21stcenturysciencetech.com/2006_articles/ spring%202006/Special_Report.pdf

[5] For the inside story on reprocessing, see Clinton Bastin, "We Need to Reprocess Nuclear Fuel and Can Do It Safely, at Reasonable Cost," *21st Century Science & Technology,* Summer 2008, www.21stcenturysciencetech.com/Articles%202008/Summer_2008/Reprocessing.pdf.

Which End Is Up?

Nobody likes "waste," and so the Wohlstetter strategy, which labeled nuclear fuel as "waste," easily became a pillar of the environmentalist movement. Environmentalists today have a fixation on "waste," because to them it represents "evil" industrialized civilization. Human beings are measured in terms of how much solid waste they produce each year. In the United States, the "Environmental Almanac" solemnly warns, each American creates three-quarters of a ton of solid waste yearly! The obvious solution is to stop looking at the wrong end of the human being. Instead, focus on the head, and how the human mind can invent new solutions to problems!

Here are some of the solutions:

We know how to reprocess used nuclear fuel, and can do it safely, as this country did for years. We also know that there are new technologies to be developed that can eliminate the long-lived radioisotopes in the 4% of used nuclear fuel that cannot be recycled. New technologies could retrieve many of these isotopes for use in medicine and industry.

We can develop fusion power, with high enough temperatures (millions of degrees) to reduce nuclear spent fuel and other matter—including garbage or rock—down to its constituent elements. The fusion torch was an idea patented in the 1960s, but its development was stopped by the same anti-nuclear forces noted above. Plasma torches, with lower than fusion temperatures, are used today in industry in several applications—steelmaking, for example.

The idea here, absent from the green mentality, is that advanced technologies should be used to eliminate pollution. For every problem there is a solution.

The anti-nukes know that reprocessing is possible. Their next argument is "safety." They assume that human beings are not capable of using advanced technologies safely. Of course, all of life is risky, and it is through human beings' creative ability that we design ways to protect ourselves from danger. Again, the anti-nukes' argument looks at the wrong end of the human being.

But then comes the argument: "What about terrorism? What if bad people get hold of nuclear materials?" The United States successfully reprocessed spent nuclear fuel in the past, in a secure fashion. We can do it again.

"Ah, but it costs too much," the learned anti-nukes of the Union of Concerned Scientists, among others, then say. They produce an accountant's balance sheet of costs and benefits to show that it's cheaper *not* to reprocess. Left out of this accountant's argument, however, is reality. We are not going to get out of civilization's most catastrophic financial collapse unless we massively invest now in the infrastructure projects, including nuclear power plants, that will guarantee adequate power for future generations. Not doing that will kill people. The cost/benefit accountant's mentality is a death trap.

The leading anti-nukes like that death trap, because they want to eliminate 4 billion people or more. The question is, how many of the unsuspecting environmentalists who have fallen for the nuclear "waste" argument will wake up, and use their heads?

NRC

Assemblying fuel rods for a light water reactor. The enriched uranium fuel is converted into uranium dioxide and fabricated into uniform pellets. The pellets are loaded into long tubes made out of a zirconium alloy, and the rods are loaded into the core of a nuclear reactor.