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# Burning Bright: Nuclear Energy's Future

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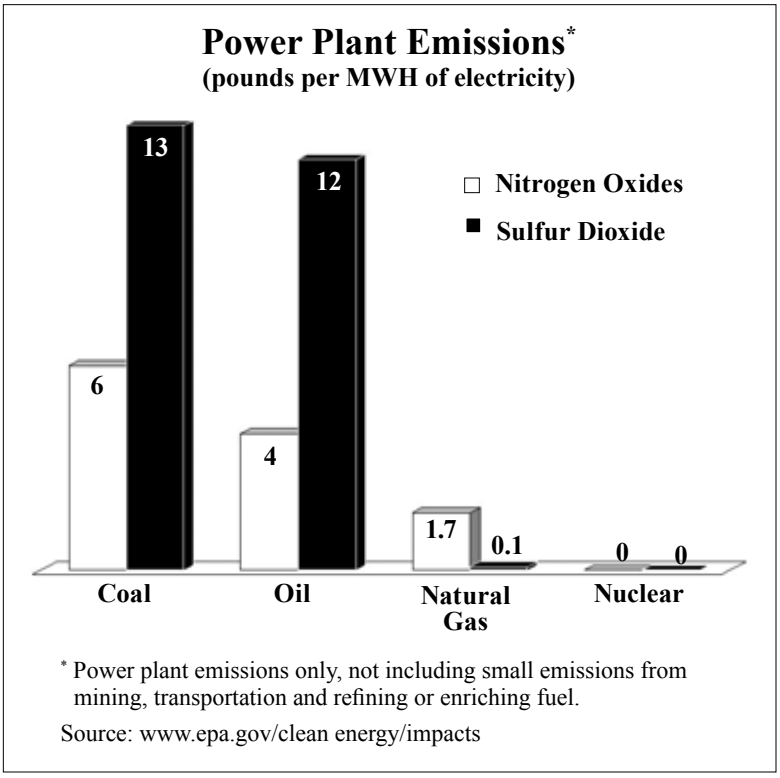
U.S. demand for electricity will increase 50 percent by 2025, according to forecasts in the Energy Information Administration's (EIA) "Annual Energy Outlook 2004." At least 350,000 megawatts of new generating capacity — hundreds of new power plants — will be needed before then.

While the 1979 accident at Pennsylvania's Three Mile Island nuclear power plant abruptly halted the construction of new reactors in the United States, nuclear power has not been dormant. Indeed, 103 operating nuclear reactors generate approximately 20 percent of the nation's electricity. Given forecasted energy demand, positive changes in the nuclear power industry, ever-fluctuating fossil fuel prices and environmental concerns, nuclear energy likely will grow as a percentage of the nation's energy mix.




**Market Conditions and Technological Improvements.** In 1980 the average nuclear plant operated at 58.5 percent of its rated capacity. Today's nuclear plants average more than 90 percent of capacity. Indeed, the increased electricity produced by existing nuclear plants since 1990 could power 26 cities the size of Boston or Seattle.

Due to consolidation within the nuclear power industry, streamlined federal relicensing procedures and improved operating efficiency, operating costs have fallen from 3.31 cents per kilowatt-hour in 1988 to 1.7 cents, which is slightly lower than coal and much lower than the 3 to 5 cents per Kwh cost for natural gas-fired plants. Only hydroelectric plants have lower operating costs.

Of course, operating costs are only one part of any energy facility's cost structure. Historically, various factors made nuclear plants among the most expensive generators to build. While constructing reactors isn't cheap, it is the redundant safety mechanisms and massive containment facility that have made nuclear plants, and thus the energy they supplied, so expensive. Furthermore, constantly changing safety requirements made it impossible to standardize reactor designs, meaning each nuclear plant was unique.

Fortunately, new technologies and improved knowledge about risk factors have made it possible to produce much safer light-water nuclear plants with fewer, standardized parts. Construction costs have fallen from the range of $2 to $6 billion to an estimated $1.4 to $1.8 billion. While still more expensive to build than most other types of electric power generating facilities, low fuel costs make nuclear power one of the cheapest electricity sources.

Nuclear power could become an even lower-cost source of electricity if emerging reactor technologies prove to be commercially feasible. For instance, both South Africa and China are building the world's first commercial demonstration pebble-bed reactors (PBRs). PBRs differ radically from light-water reactors. They use helium instead of water to cool the nuclear fuel, increasing electric generating efficiency and safety. In addition, rather than using uranium fuel rods, the PBRs use thousands of billiard-ball-sized pebbles each containing 10,000 or so tiny fuel microspheres coated with tough silicon carbide in a hardened graphite ball. The containment facilities typical in other reactors are unnecessary because even in the worst possible scenario for reactor coolant loss, a meltdown is impossible. The cost of energy produced

from these reactors is expected to be less than the cost of natural gas, which has been the fuel of choice in recent years in the United States. And, PBRs should be able to extract several times more energy from a ton of fuel — which means more efficient fuel use and less space required to store spent fuel.

But other concerns, such as energy security and environmental impact, also make nuclear plants a critical component of a diverse electric power system.

**Nuclear Power's Role in Energy Security.** America has become increasingly reliant on imported supplies of oil and natural gas, two of the three fossil fuels used to generate electricity. World oil and natural gas prices fluctuate rapidly and significantly, and these fuel supplies too often depend upon regimes with interests hostile to the United States. Accessible uranium reserves, however, can provide an estimated 300-year fuel supply for all the world's existing reactors.

One kilogram of natural uranium contains as much energy as 38.5 tons of coal, but conventional reactors only utilize approximately 3 percent of that energy. Thus, if the United States joined France and Japan in recycling used fuel, existing and future spent fuel rods would provide an almost unlimited supply of nuclear fuel. Another supply of nuclear fuel is also available, after reprocessing, in the more than 15,000 plutonium pits removed from dismantled U.S. nuclear weapons.

**Environmental Benefits of Nuclear Power.** Compared to other significant sources of electricity, nuclear power has many environmental benefits. For instance, numerous studies indicate that various air pollutants contribute to thousands of premature deaths and illnesses annually. Much of this pollution comes from fossil-fuel power plants. By comparison, nuclear plants produce virtually no air pollution. [See the figure.]

Nuclear energy's clean air benefits have spurred China to take the global lead in building new nuclear energy capacity. China has determined that, in the interest of human health, it cannot afford to tap its vast reserves of coal for all of its growing energy needs. Accordingly, it plans to add approximately 32,000 megawatts of nuclear power capacity, meaning about two new 1,000 MW nuclear power plants per year for the next 16 years.

In addition, for those concerned about $CO_2$ emissions contributing to global warming, nuclear power is a $CO_2$-free energy option. By comparison, average $CO_2$ emissions per MWh of energy produced are 2,249 pounds for coal fired power plants, 1,672 pounds for oil fired power plants, and 1,135 pounds for gas fired power plants. This is why a number of prominent environmentalists have recently argued for increasing the role of nuclear power in the world's energy mix, including Greenpeace founder Patrick Moore and Dr. James Lovelock.

Another environmental drawback of some fossil fuel power plants is solid waste. While natural gas-burning plants do not produce significant volumes of solid waste, coal-fired and oil-burning plants do. Coal-fired power plants produce more than 20 million tons of waste ash annually. Though some recycling is possible, these residues require disposal, generally burial, in a manner that limits migration into the general environment.

By comparison, nuclear power plants produce a miniscule volume of spent fuel. Indeed, after more than 30 years of operation, nuclear plants have only produced 50,000 tons of spent fuel, all of which has been safely stored. To put this in perspective, if all spent fuel was collected in one location, it would cover a football field to a depth of six feet.

Most of this spent fuel could be recycled, as it is overseas. In 1979, however, the Carter administration banned commercial recycling due to security concerns over the plutonium produced as a byproduct. Barring a decision to recycle it, all 50,000 tons of spent fuel will be safely stored in the government's Yucca Mountain waste repository, when it becomes operational. The cost of the Yucca Mountain facility has already been paid via a disposal tax levied on the nuclear power industry.

**Conclusion.** There is a growing, worldwide demand for electricity — to maintain current living standards in developed countries and to raise those in the world's developing nations, where populations are rising precipitously. In addition, people have expressed growing concerns about air quality. These factors make building new nuclear power plants essential to meet our growing energy requirements while addressing environmental concerns.

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