# Nuclear Energy: A Vital Component of Our Energy Future

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Nuclear power is proven to be safe, and it is our best shot at increasing energy production while reducing $CO_2$ emissions levels.

Serious and far-reaching questions are being asked regarding our industrial and societal future and how we will power it. Whether one believes the theories or not, the potential for climate change is causing the world to reconsider the way it does business with respect to energy. History shows that *every* choice carries opportunity *and* risk and there are *no* silver bullets. This is no less true for our energy challenges.

In 2007, the U.S. consumed $10^{13}$ kWh of electrical energy and emitted 6 billion m.t. of carbon dioxide. Furthermore, assuming no increase in efficiency or decrease in demand, electricity usage is expected to increase by 26% by the year 2030.

Notwithstanding the controversy surrounding potential climate change and its effects, any carbon emissions associated with energy production are likely to become expensive as a result of cap-and-trade legislation or the imposition of carbon taxes. Consequently, the U.S. will need competitive, reliable, "carbon-free" energy-generation technologies to play an increasing role. This will require a combination of energy efficiency, increased renewable generation, and expanded nuclear power to meet projected demand and, at the same time, achieve $CO_2$ emissions reduction goals. Nuclear energy, as the source of 70% of the carbon-free electricity generation in the U.S. today, must play a significant role in reshaping the country's energy mix while maintaining quality of life.

## The cost of energy

The U.S. Dept. of Energy's (DOE) Energy Information Administration, in its *Annual Energy Outlook,* has projected the cost of new electricity generation resources in 2016 (Figure 1, p. 30). Nuclear power is currently the lowest-cost option for new, low-carbon electricity-generation resources. Note the increasing cost-competitiveness of nuclear power with coal and natural gas when carbon-capture systems (CCS) are implemented. Remember that there are no new sources of hydroelectricity on the horizon, and that some are advocating the decommissioning of existing plants in the Pacific Northwest to help replenish salmon populations. In addition, the ability of biomass and geothermal sources to provide baseload electricity generation is fairly limited.

The possible introduction of mandatory charges for carbon emissions will increase the cost-competitiveness of nuclear power. A recently updated study conducted by the Massachusetts Institute of Technology on the economics of nuclear power found that a cost as low as \$5–15/ton $CO_2$ was enough to create favorable economics for nuclear plants. To put this in perspective, Rep. John B. Larson (D-CT) introduced a bill in Congress in 2007 that would impose a \$15/ton $CO_2$ tax in the first year, increasing by \$10/ton every year for the next five years.

Nuclear power could stabilize the cost of electricity by reducing U.S. dependence on natural gas, which is subject to price volatility. Although nuclear power requires a larger initial investment, its long-term fuel costs are much lower and more predictable than those of other generating technologies.

## Nuclear waste

The waste from nuclear plant operations has always evoked considerable debate. In the U.S., there are currently about 70,000 m.t. of used nuclear fuel (enough to cover a football field 15 ft deep) safely stored at power plant sites awaiting final disposal.

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# Nuclear Renaissance: A Flawed Proposition

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Nuclear power has never been safe and it never will be. Efficiency gains and investment in renewable sources of energy will be sufficient to power the planet without resorting to nuclear reactors.

The seriousness of the world's energy and climate problems demands equally serious solutions. Advocates have done an amazing job of painting nuclear power as a carbon-free source of electricity that can provide energy securely and cheaply around the world. When the full nuclear fuel cycle is considered, along with a broader range of costs and benefits, a different picture emerges.

Far from being climate-neutral or cheap — and when nuclear reactors are considered along with uranium mines and mills, enrichment facilities, spent-fuel repositories, and decommissioning sites — nuclear power proves to be one of the costliest sources of energy, all while emitting prodigious amounts of greenhouse gases (GHGs). New nuclear power plants are capital-intensive, environmentally destructive, potentially unsafe, dependent on uranium as a fuel source, and wasteful. Satisfying growing energy demand through nuclear power is an unnecessarily risky investment.

## Crippling costs

Although historic costs of producing nuclear energy are relatively low — due in large part to generous subsidies and almost five decades of commercial operating experience — the expense of building new nuclear plants is immense. The nuclear industry reports construction costs of about $2,000 per installed kilowatt. However, independent assessments suggest about $5,500–8,100/kW. This translates into a whopping $6–9 billion price tag for each 1,100-MW plant.

Unlike other energy sources, nuclear capacity costs are rising. The Keystone Centre, an independent think-tank, estimated in 2007 that operating costs for these plants would be 30¢/kWh for the first 13 years, then 18¢/kWh after the plants have been paid off. This makes nuclear more expensive than natural gas, coal, wind, biomass, geothermal, landfill gas capture, and new hydroelectric power plants.

These figures exclude decommissioning, unexpected delays, cost overruns, insurance, interest on loans, early retirements, and building transmission and distribution networks. The average construction time for all 376 nuclear power plants built from 1976 to 2007 was more than 7 yr, and some have loomed on for more than 20 yr. In that 20-yr timeframe, five gas-fired combined-cycle plants or 18 wind farms of comparable size could have been completed.

Because of this long timeframe, nuclear plants are exceptionally prone to cost overruns. The independent Congressional Budget Office in the U.S. has estimated that actual construction costs for American reactors are *twice* as much as expected and that the risk of default on loan guarantees exceeds 50%.

## Waste disposal

The proverbial elephant in the room when it comes to the challenges facing nuclear energy is waste — a problem for which no one has yet worked out a satisfactory solution. The world's nuclear fleet creates about 10,000 m.t./yr of high-level spent nuclear fuel. Most of this is stored onsite, and 85% is *not* reprocessed.

The experience in the U.S. is telling. The revocation of the license application for Yucca Mountain earlier this year leaves the future of 60,000 m.t. of nuclear waste undecided.

Already, almost 30 years have passed since the Nuclear Waste Policy Act of 1982 committed the federal government to construct an underground nuclear waste repository. So far, some $13 billion has been spent on Yucca Mountain; as the recently appointed Blue Ribbon Commission on America's

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By law, the U.S. government should be taking title to this fuel and disposing of it at the Yucca Mountain geologic repository, a remote desert location in Nevada. However, in 2009, the Obama administration announced plans to terminate the Yucca Mountain program and empanel a blue-ribbon commission of experts to study alternatives. This occurred despite the Yucca Mountain repository having been scientifically demonstrated sufficient to protect public health and safety for thousands of years. Yucca Mountain's cancellation reflects political challenges from the state of Nevada and has no technical basis.

Notwithstanding the fact that permanent disposal of used nuclear fuel in geologic repositories is safe, a more-appropriate question is whether this is the only, or, if a significant expansion of nuclear were to occur, the best, option for dealing with used nuclear fuel. The used fuel still has tremendous energy value. In addition, the opponents of nuclear power argue that the world's supplies of uranium are limited. Thus, it makes sense to recycle that spent fuel and recover its energy.

But another question remains: Would a Yucca Mountain-scale repository be large enough if the U.S. maintains or increases the present level of nuclear generation? Yucca Mountain's technical capacity is about 140,000 m.t. of spent nuclear fuel, or about double the quantity currently in temporary storage. If nuclear power remains at or exceeds its 20% share of electricity generation, at least two repositories will be needed some time this century. Finding a second geologic repository would undoubtedly prove difficult given the political controversy surrounding Yucca Mountain.

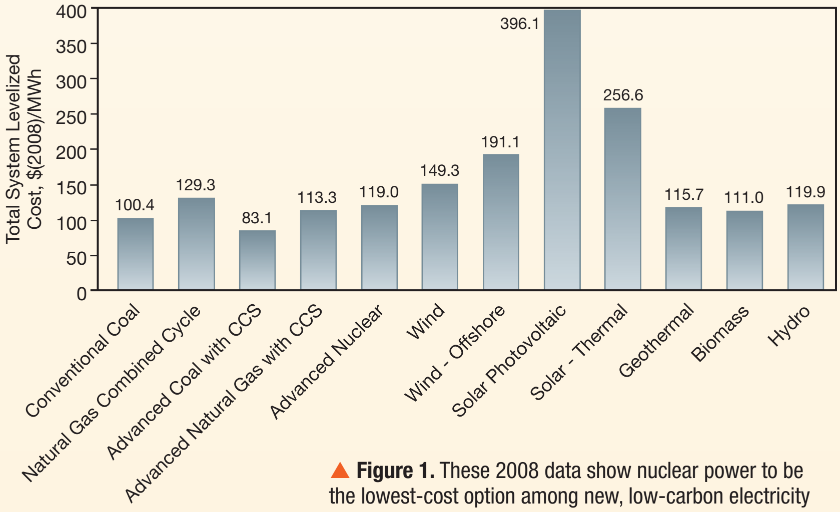
One way to substantially reduce the volume of waste requiring expensive geologic disposal is to process the used nuclear fuel and recover the unused uranium and other fissile material to make new fuel for additional power generation. Additionally, 99% of the radioactivity is concentrated in a volume less than 10% of the original volume of spent nuclear fuel that would require disposal in a geologic repository. The remaining radioactive material can be disposed of according to current practice. Recycling used nuclear fuel therefore optimizes waste disposal, improves nuclear power's economic viability, and improves nuclear power's sustainability by reducing reliance on geologic repositories.

## Reducing the environmental impact of energy production

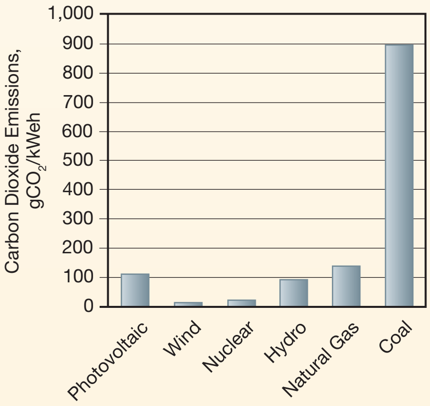
Electrical energy generation in 2008 produced about 2,400 million m.t. of $CO_2$, more than any other sector of the U.S. economy. The Intergovernmental Panel on Climate Change's (IPCC) consensus on the global warming impact of $CO_2$ has led to concern about finding ways to limit greenhouse gas (GHG) emissions and mitigate the effects of a changing climate. To achieve the targets for reduction now being considered by Congress, the U.S. will need carbon-free energy-generation technologies that are available on a realistic timescale.

Nuclear power is currently the source of 70% of the nation's carbon-free electricity production. Maintaining nuclear power's 20% contribution to meeting the total electrical energy demand will require an additional 27 GW of nuclear generating capacity to be put into service. This will displace the 100–400 million m.t. of $CO_2$ emissions that otherwise would be produced if that electricity had instead come from new natural gas or coal-fired plants. In turn, this represents about 10–40% of President Obama's mid-term (2020) carbon reduction goal of 1 Gt.

Nuclear power has the potential to reduce emissions relative to other carbon-free sources on a lifecycle basis. A recent German study (Figure 2) concluded that the environmental impact of nuclear power, including mining,




▲ **Figure 1.** These 2008 data show nuclear power to be the lowest-cost option among new, low-carbon electricity generation options.




▲ **Figure 2.** Including mining, transportation, enrichment, and use, nuclear power has the second-lowest carbon footprint among these electricity-generation resources.

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Nuclear Future works to identify an alternative site, the total expenditures will continue to grow. Concomitantly, nuclear plant operators and utility companies have successfully filed suit against the U.S. Dept. of Energy (DOE), recovering more than $7 billion thus far in damages caused by DOE's inaction.

Other countries continue to experience the effects of historical waste mismanagement. Tajikistan's Leninabad region is one such area, suffering from high radiation levels caused by Soviet-era uranium ore mining. Even though mining was halted in 1991, improper disposal of tailings and barely covered storage sites have resulted in radiation levels several times higher than internationally accepted standards. Uzbekistan and Kyrgyzstan are similarly threatened, because their trans-boundary waters have been tainted by the chemicals in Tajikistan.

Furthermore, these countries are home to some of the 23 waste dumps scattered across Central Asia's Ferghana Valley. With low public awareness about radiation and the harmful effects of these sites, villagers have unknowingly allowed livestock to freely graze and children to play in potentially hazardous areas.

## Environmental impacts

The nuclear fuel cycle involves some of the most hazardous elements known to humankind — including more than 100 dangerous radionuclides and carcinogens, strontium-90, iodine-131, and cesium-137, which are the same toxins found in the fallout from nuclear weapons. Two environmental issues in particular are important but seldom discussed: water and climate change.

Like all thermoelectric plants, nuclear reactors draw vast quantities of water for both cooling cycles and dissipating waste steam. According to a study conducted by the Electric Power Research Institute, nuclear plants demand 25–50% more water per unit of electricity generated than a fossil-fueled plant with an equivalent cooling system.

Droughts and extended periods of high temperatures can subsequently cripple nuclear power generation. It is often during these times that electricity demand is highest because of air conditioning and refrigeration loads and diminished hydroelectric capacity. This mismatch was clearly demonstrated in Europe after a series of heat waves in 2003 forced France to cut back 6 GW of capacity. Several German reactors were also forced to operate at partial capacity. Similar experiences were faced in continental Europe again in the summer of 2006. A more recent episode occurred in August 2007 at the Browns Ferry plant in Alabama, where one unit was shut down and two more were cut back because of high water temperatures in the Tennessee River.

As for climate change, nuclear energy is nowhere near climate-neutral. Yes, its lifecycle carbon footprint is considerably better than equivalently sized coal, natural gas, and oil-fired facilities. But this point obscures two very disturbing facts.

First, the nuclear lifecycle consists of many activities that emit substantial amounts of GHGs into the atmosphere, such as uranium mining and milling and spent-fuel conditioning. When these are added to the emissions associated with plant construction, operation, and decommissioning, the typical reactor emits about 66 g of $CO_2$ equivalent ($CO_2e$) for every kWh of electricity it produces. That may not sound like much, but it demonstrates that nuclear energy is worse from a climate perspective than every single source of renewable electricity, as well as small-scale distributed generators that rely on fossil fuels.

Second, the carbon footprint of nuclear power is expected to increase significantly as high-quality uranium ores are

▶ An open-pit uranium mine in Gas Hills, WY, is evidence of the environmental impact of the nuclear fuel cycle.

▼ Consolidated Edison's Indian Point nuclear power station is located on the Hudson River about 24 miles north of New York City. The station became operable in August 1962. (Photo circa 1963.)

Photos courtesy of the U.S. Dept. of Energy.

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transportation, enrichment, and use, had one of the lowest carbon footprints of all electricity generation resources, second only to that of wind turbines. It is worth pointing out that, until recently, Germany was phasing out its nuclear power reactors.

Other renewable technologies, such as wind and solar, are very land-use intensive. For example, generating 20% of the U.S.'s electricity with wind would require a land area the size of West Virginia. Another important distinction is the type of power produced from these different sources of renewable energy. Solar and wind provide distributed generation sources that, currently, are intermittent and unreliable. Nuclear, on the other hand, provides a scalable, baseload power source.

## Plant safety

The International Atomic Energy Agency (IAEA) was set up by the United Nations in 1957. One of its functions is to act as an auditor of world nuclear safety. It prescribes safety procedures and the reporting of even minor incidents. Every country that operates nuclear power plants has a nuclear safety inspectorate and all work in conjunction with the IAEA.

The International Nuclear Event Scale (INES) was developed by the IAEA and the Organization for Economic Cooperation and Development in 1990 to communicate and standardize the reporting of nuclear incidents or accidents to the public. The scale runs from 0 for an event with no safety significance to 7 for a major accident on the scale of Chernobyl.

The two significant accidents in the 50-yr history of civil nuclear power generation are:

• Three Mile Island (1979), where the TMI-2 reactor was severely damaged, but radiation was contained and there were no adverse health or environmental consequences. This was rated a Level 5 accident.

• Chernobyl (1986), where the destruction of the reactor by steam explosion and fire killed 31 people and had significant health and environmental consequences. The death toll has since risen to about 56. This Level 7 accident was ascribed to serious design flaws in the reactor.

▲ The white dome of British Energy's Sizewell B nuclear power station in Suffolk, U.K., houses a pressurized water reactor.

These two significant accidents occurred during more than 12,700 reactor-years of civil operation. Apart from Chernobyl, no nuclear workers or members of the public have ever died as a result of exposure to radiation due to a commercial nuclear reactor incident.

Nevertheless, disciplines in training, operations and event reporting that grew from the lessons of the TMI-2 accident have made the nuclear power industry demonstrably safer and more reliable. A key indicator of this is the number of significant plant events, which, according to data compiled by the U.S. Nuclear Regulatory Commission (NRC), decreased from 2.38 per reactor unit in 1985 to 0.10 at the end of 1997. Meanwhile, the median capacity factor for nuclear plants (*i.e.,* the percentage of maximum energy that a plant is capable of generating) increased from 62.7% in 1980 to almost 90% in 2000 (the goal for the year 2000 was 87%).

Nuclear power's safety is ensured by the ability of the industry to learn and apply its lessons, and demonstrated in its record of continuous improvement.

## Public health

Epidemiological data were used by the International Commission on Radiological Protection and others to estimate the fatal cancer risk as 5% per sievert (Sv) exposure for a population of all ages. In other words, one person in 20 exposed to 1,000 mSv (400 times higher than the annual average exposure of U.S. nuclear industry workers) could be expected to later develop a fatal cancer. In Western countries, about a quarter of all deaths are due to cancer, with smoking, dietary factors, genetic factors and strong sunlight among the main causes. Radiation is a weak carcinogen.

In 1990, the U.S. National Cancer Institute (NCI) found no evidence of any increase in cancer mortality among people living near 62 major nuclear facilities. The NCI study was the broadest of its kind ever conducted and supported similar studies conducted elsewhere.

A study by the Radiation and Public Health Project has claimed that levels of strontium-90 in baby teeth are higher in areas near nuclear power plants. The claims have been refuted or questioned by the National Institutes of Health, the NCI, the NRC, the American Cancer Society, and government health officials.

In itself, nuclear power presents no health risk to the public or the industry's workers.

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exhausted and uranium enrichment becomes more energy-intensive. According to the Oxford Research Group, by 2050, the total lifecycle carbon footprint for 1 kWh of nuclear electricity will be the *same* as that for 1 kWh from natural gas.

## Safety

Although the accidents at Three Mile Island and Chernobyl are widely known, no less than 76 nuclear accidents totaling $19.1 billion in damages have occurred worldwide from 1947 to 2008. These figures correspond to at least one incident and $332 million in damages every year for the past three decades. Nuclear reactors that "operate perfectly" are still correlated with higher risks of cancer and unexplained deaths. Contaminants such as strontium-90 have been found in the teeth of babies living near nuclear facilities.

New evidence from the U.S., home to 104 operating nuclear reactors at 65 sites, documents elevated rates of leukemia and brain cancers at nuclear power plants. Joseph Mangano from the Radiation and Public Health Project and his colleagues estimated that roughly 18,000 fewer infant deaths and 6,000 fewer childhood cancer cases would occur over a period of 20 yr if all reactors in the U.S. were closed. In other words, each nuclear plant was associated with 175 deaths and 58 cancer cases. Of course, these numbers pale in comparison to the health consequences of fossil fuels, but they are still much worse than renewable energy facilities that involve little to no cancer risk.

## Fuel availability

Commercially available nuclear power technologies are dependent on natural sources of uranium, an exhaustible resource prone to uncertainty surrounding reserves and significant price volatility. Last year, the world's 370 GW of nuclear capacity needed about 65,000 tons of natural uranium to operate. Although historical reserves of uranium have been plentiful, the security of future supplies is uncertain. The International Atomic Energy Agency's *Red Book* has noted for each of the past five years that the primary supply of uranium will cover only 4–6% of the industry's fuel requirements for 2025. It has cautioned that low-cost ores are being rapidly depleted, forcing countries into more-expensive exploration projects.

One study from the Institute of Particle Physics of ETH Zurich and the European Organization for Nuclear Research (CERN) cautions that extraction from known mines and secondary resources during the coming 5–10 yr appears to be much more critical than generally believed, and almost no country that uses nuclear energy is self-sufficient in fuel production. Such pessimism was confirmed recently by another independent study on available uranium resources at 93 deposits and fields located in Argentina, Australia, Brazil, Canada, Central African Republic, France, Kazakhstan, Malawi, Mongolia, Namibia, Niger, Russia, South Africa, the U.S. and Zambia.

> The carbon footprint of nuclear power is expected to increase significantly as high-quality uranium ores are exhausted and uranium enrichment becomes more energy-intensive.

Uranium availability is not the only concern — so is price. Lack of knowledge about known reserves of uranium fuel, as well as long supply chains and almost complete dependence on importers, have contributed to large price spikes on the global market. The cost of uranium for reactors in the U.S., for example, jumped from $10/lb in 1994 to $60/lb in 2008. Although still less than oil and natural gas price volatility, uranium price volatility is a disadvantage not shared by renewable fuels such as wind, geothermal steam, water, sunlight, and biomass.

A final fuel-related dilemma relates to the energy payback period of the nuclear fuel cycle, or how much energy is obtained from a nuclear power plant after deducting the energy needed to build it. Helen Caldicott, founder of Physicians for Social Responsibility and a former instructor at the Harvard Medical School, has calculated that a nuclear power plant must operate at full load for 10–18 yr before it has paid off its construction debts. Analysts at the Oxford Research Group suggest that declining ore grades will eventually lead to a net energy loss for nuclear power plants before the end of this century.

## A better path

Don't despair and put the article down, vowing to never again read *CEP*. There is hope. There is one resource that is widely abundant around the world, in every country, and that, according to some studies, offers more potential than any other known source of energy. Unlike the next generation of nuclear reactors, it is already commercially available and ready to be utilized without the need for subsidies or further research. It is not capital-intensive, does not consume water, emits very low amounts of GHG, does not melt down, and does not rely on a depletable fuel.

What is this wondrous resource? Energy efficiency and demand-side management, which the nonpartisan International Energy Agency has noted saves electricity at a cost of about 2–3¢/kWh. Energy efficiency does not necessarily mean doing *without* power, but instead getting more for your money out of energy equipment. It involves light bulbs that need less energy, weather stripping around doors and windows, more-efficient industrial motors and pumps, better heating, ventilation and air conditioning (HVAC) systems, and improved vehicle mileage.

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"To create more of these clean energy jobs, we need more production, more efficiency, more incentives. And that means building a new generation of safe, clean nuclear power plants in this country."
*— President Obama, 2010 State of the Union Address*

## Sustainability

Excluding the uranium in sea water, total uranium reserves are sufficient for more than 600 yr at the current consumption level using today's reactors, and at a cost less than $80–130/kg. As nuclear power increases its share of electricity production, recycling the used nuclear fuel to recover the unused uranium and other fissile elements (as practiced today in Europe) becomes more economically attractive. In addition, advanced reactors currently existing as prototypes are more efficient at extracting the available energy from the fuel.

Together, these advances make nuclear power sustainable for several thousand years.

## The path ahead

Nuclear power is becoming increasingly accepted as an environmentally responsible and economic energy source. This increasing acceptance is exemplified by the views of Dr. Patrick Moore, a founder and former leader of Greenpeace, who writes in the *Washington Post:*

*"Nuclear energy is the only large-scale, cost-effective energy source that can reduce these* [carbon] *emissions while continuing to satisfy a growing demand for power. And these days it can do so safely."*

To dispel any arguments that he is a traitor to his former cause, he writes:

*"And I am not alone among seasoned environmental activists in changing my mind on this subject. British atmospheric scientist James Lovelock, father of the Gaia theory, believes that nuclear energy is the only way to avoid catastrophic climate change. Stewart Brand, founder of the 'Whole Earth Catalog,' says the environmental movement must embrace nuclear energy to wean ourselves from fossil fuels … The late British Bishop Hugh Montefiore, founder and director of Friends of the Earth, was forced to resign from the group's board after he wrote a pro-nuclear article in a church newsletter."*

Moore also writes:

*"Wind and solar power have their place, but because they are intermittent and unpredictable they simply can't replace big baseload plants such as coal, nuclear and hydroelectric … Given that hydroelectric resources are built pretty much to capacity, nuclear is, by elimination, the only viable substitute for coal. It's that simple."*

Following nuclear power's increasing acceptance, more than 50 new nuclear plants are being constructed throughout the world and the lives of existing plants are being extended.

Finally, President Obama gave an unprecedented endorsement for expanding nuclear power in his 2010 State of the Union address:

*"But to create more of these clean energy jobs, we need more production, more efficiency, more incentives. And that means building a new generation of safe, clean nuclear power plants in this country."*

## Closing thoughts

Simply put and echoing Dr. Patrick Moore, the choice is really that simple. Nuclear power has to be a significant part of our future energy mix. CEP

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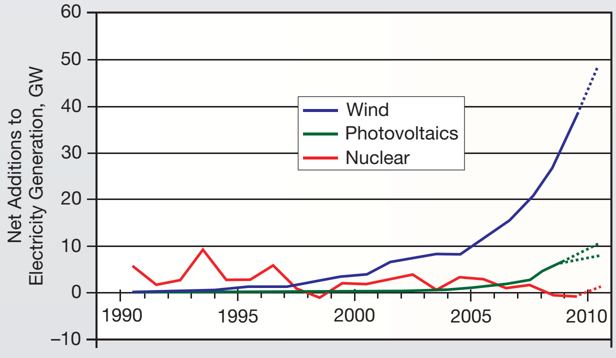
In the U.S. electricity sector, studies have shown that cost-effective energy efficiency measures could reduce national consumption by an astounding 30–75%. These measures are cheaper to implement than purchasing any form of electricity supply and, according to researchers at the American Council for an Energy-Efficient Economy, could reduce the country's power bill by as much as 75%.

Already, the cheapest renewable sources of electricity supply for markets in the U.S. and European Union are wind turbines and landfill gas capture. A global study of wind, biomass, geothermal and hydroelectric power plants conducted by the United Nations found that these facilities produce electricity for about 5–7¢/kWh when subsidies are excluded. They, like energy efficiency, do so without the need for uranium, without risking catastrophic accidents, and without producing hazardous waste. Nuclear plants, when subsidies are excluded, produce power at about 10–40¢/kWh.

It's easy to do the math, but consider also how governments and investors have been making their decisions. Renewable energy investment globally surpassed $120 billion last year — a fourfold increase from 2004. During the same period, solar energy has grown by 600% and wind energy by 250%. From 2007 to 2008, both the U.S. and E.U. added more renewable capacity than conventional coal, gas, oil and nuclear capacity. The global share of nuclear energy did not grow at all; it actually *shrank* by about 1%, and the amount invested in 2008 was one-tenth the amount invested in renewables and energy efficiency. Put another way, non-hydroelectric renewable resources as a whole grew at an annual rate of 23% in 2008, and wind energy alone added 10 GW that year, yet Figure 1 shows that nuclear energy additions have stagnated at about 2 GW/yr.

In short, investors and planners in Europe and the U.S. chose renewables over new nuclear power plants last year. The private capital market is not investing in nuclear. Without financing, the only purchases of new nuclear equipment are being made in Asia by central planners with a draw on the public purse. Amory Lovins, of the Rocky Mountain Institute, has mused that the lesson seems to be that in today's market, governments can have only about as many nuclear plants as they can force the taxpayers to purchase.




▲ **Figure 1.** Net additions to worldwide electricity generation for new renewables and nuclear power plants, 1998–2010 (in GW).

## Closing thoughts

Any one of the five challenges mentioned above — mammoth and escalating costs, intensive water use and a significant carbon footprint, a slew of accidents, declining availability of fuel and dependence on foreign suppliers, and the intractable waste problem — could by itself slow down any commitment to a global nuclear renaissance. But taken together, they imply that the risks surrounding new nuclear power plants are immense and possibly irresolvable. It makes far more sense to rapidly invest in energy efficiency, solar and wind power, and other renewables.

Sir Arthur Conan Doyle's Sherlock Holmes once said, "It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Advocates of nuclear energy must consider all the data before they make a commitment to new reactors. Ignoring serious risks relating to burgeoning operating costs, greenhouse gases, childhood cancer, insecure fuel supplies, and nuclear waste storage will not make them go away. CEP

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