Nuclear isn't necessary

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The notion that we need nuclear power to address climate change does not reflect the realities of the marketplace or rapid new developments in energy technology.

SUNPOWER CORPORATION

A 750-kilowatt solar-photovoltaic installation at a US Navy base in San Diego.

It is now generally understood that carbon dioxide emissions from fossil fuel burning are at the centre of the climate crisis. In the electricity sector, that primarily means the burning of coal. China and the United States are the leading users, and Russia, Germany and India also use coal as a mainstay of power generation. Long-term assured carbon sequestration is not yet a proven technology, and it is unclear when it might become available on the required scale. In environmental terms, the world cannot afford new coal-fired power plants; indeed, even existing coal-fired power plants may have to be phased out before 2050. The nuclear-power industry, proclaiming a 'nuclear renaissance', has suggested itself as a saviour with a simple formula: if you don't like coal, build nuclear plants.

Politically, support for new investment in nuclear power is gaining traction. In the US, Republican presidential candidate John McCain has pledged to build 45 plants in 20 years if elected, while Democratic Candidate Barack Obama admits that nuclear power is probably necessary to meet climate goals, conditioning his support on a prior resolution of concerns about terrorism, proliferation and waste. Across the Atlantic, the UK government has stated its intention of including nuclear power in electricity plans, motivated mainly by climate concerns. Asia, home to almost all of the 35 new power plants under construction globally in 2007, also clearly supports the expansion of nuclear energy[1].

Considerable backing for nuclear power has also emerged in some unusual quarters. Perhaps the best-known scientist advocate is James Lovelock, who conceived the Gaia hypothesis, in which he proposed that the biological and physical components of the Earth form a complex, interacting system. According to Lovelock, renewable energy sources can contribute only a "small" amount to the world's future energy mix, and there is "no chance" that they will supply enough energy to replace conventional sources on the timescales needed to stem climate change[2]. Hence, the world should "emulate the French", who get almost 80 per cent of their electricity from nuclear reactors, because it is "the only effective medicine we have now"[3].

RELIABLE RENEWABLES

The common perception is that renewables can provide only a small portion of the energy supply — unlike nuclear plants, which can supply baseload power, churning out electricity day in, day out for extended periods. Actually, though, renewable energy resources are plentiful, but not fully exploited. For instance, the wind-energy potential of the United States is about three times greater than its current total electricity generation[4,5]. And the potential for solar energy is even greater. Land area in the US southwest equivalent to one-eighth the area of the state of Nevada could supply all present-day US electricity generation[6]. About three per cent of the area of Saudi Arabia could supply the present South Asian population with solar electricity at the European average consumption level of about 6,000 kilowatt-hours per year. Less than one per cent of the area of the Sahara could do the same for Europe and Africa. In many places, solar scarcely needs new land area, because photovoltaics can be built in modules on commercial rooftops, parking lots (see photo) and other available urban surfaces[7], right where most of the electricity is needed.

Though intermittency of supply has often been cited as an important disadvantage of wind and solar power, it can be overcome by coordinating these energy sources in a distributed smart grid that tailors the shape of demand closer to the availability of supply. For instance, a new device, now commercially available, integrates an ice-making function into air-conditioners. Ice is made at times when electricity supply is plentiful; air conditioning is

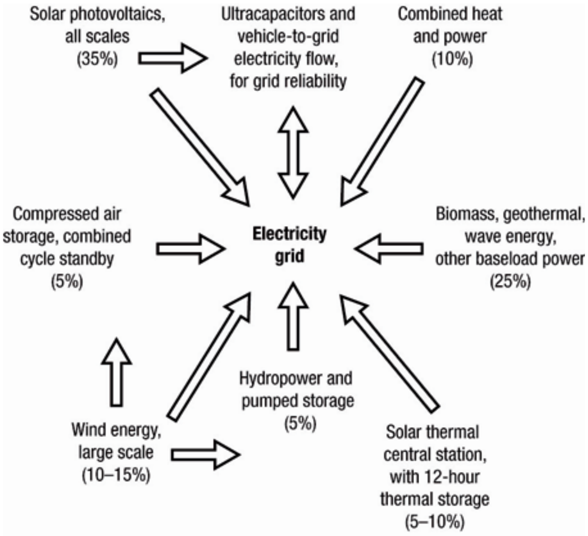

Figure 1 One possible US electricity grid configuration in 2050 without fossil fuels or nuclear power.

accomplished when the weather is hot, mainly using the cold stored in the ice. In a smart grid configuration, such devices would mainly be remotely controlled by the grid operator, allowing demand for air-conditioning electricity to be tailored to its availability. Furthermore, reserve capacity from natural gas could be added as the share of renewables on the grid reached relatively high levels. Specifically, in the United States, natural-gas-fired power plants, built on the incorrect assumption of perennially cheap fuel, are now idle more than 80 per cent of the time[8]. In 2006 the US natural-gas-fired capacity was about 340,000 megawatts excluding cogeneration plants, enough to supply about half of its peak demand. This capacity could be put to excellent use to back up renewables and would be sufficient to support a well-coordinated wind and solar system providing up to 40 to 50 per cent of total US generation. And unlike nuclear power plants, wind energy and solar photovoltaics do not require cooling water, which could be a crucial consideration for a reliable power supply in the future.

Also worth considering is that the technology has now been commercialized for storing heat in molten salts at concentrating solar-thermal power plants. Plants with sufficient storage to generate electricity for 6 to 16 hours after sundown are on the drawing board. Widespread deployment of this technology would reduce the need for natural-gas standby support for solar and wind energy. After about 15 or 20 years, even the use of natural gas for electricity generation can gradually be phased out (Fig. 1).

CONSIDER THE COSTS

Another of the supposed benefits of nuclear energy is its reputed low cost, but this is true only of existing depreciated plants, for which fuel and operating costs are the main cost elements. For new plants, capital costs dominate, and for those in the planning stage today, nuclear-industry and Wall Street capital cost estimates are in the range of US$5,000 to US$8,000 per kilowatt. This implies total electricity costs of 10 to 17 cents per kilowatt-hour, assuming a privately owned power plant with no subsidies other than insurance. A case in point is the reactor being built in Finland by the French company AREVA, the first such plant to be built in Europe in 15 years. Its cost has risen from €3 billion to €4.5 billion — or about US$4,200 per kilowatt — plus substantial penalties for delays. It has run two years over schedule and is now due to come online in 2011.

In comparison, wind energy, at 8 to 12 cents per kilowatt-hour, is already more economical. And though solar-photovoltaic electricity is more expensive than nuclear today, on average, the energy industry is still in the early stages of a shake-out between the various technologies. For instance, new large-scale solar-photovoltaic plants ordered by the California utility Pacific Gas and Electric are expected to yield electricity costs that are about the same as wind-generated electricity or concentrating solar power plants[9]. Unlike that of nuclear power plants, the cost of solar-thermal power is actually declining and is expected to fall below 10 cents per kilowatt-hour within the next decade[10]. Moreover, concentrating solar-thermal power plants currently can compete with nuclear on cost. For instance, Arizona Public Service has signed a contract with a Spanish company, Abengoa Solar, for a 280-megawatt plant at about 14 cents per kilowatt-hour. The plant will have six hours of heat storage and will be available to supply electricity about 90 per cent of the time on hot summer days and evenings — the time of peak demand[5].

But the economic costs of expanding nuclear energy pale in comparison to the potential environmental costs. Even those who support a new generation of nuclear power plants are uncertain how to deal with the waste that the industry has created in the past. France, which supposedly 'recycles' its nuclear waste, actually uses only one per cent of it as fuel, the plutonium part, separated in a reprocessing plant at La Hague on the Normandy peninsula. Of the 95 per cent that is contaminated uranium, it has sent some to Russia. Most of the rest is piling up in France and may have to be declared as waste in the absence of even more costly breeder reactors and reprocessing plants to convert the uranium-238 to plutonium. Even if we ignore the perils of nuclear proliferation, global efforts to commercialize the plutonium economy have failed after more than half a century and US$100 billion in expenditures[11]. A deep geologic repository will now be needed for the high-level reprocessing waste that is piling up at La Hague in the form of radioactive glass logs.

Roughly 400 million litres of low-level liquid radioactive waste pour into the English Channel each year from the La Hague reprocessing plant, and similar discharges from any newly built facilities would be a concern. Expansion of nuclear energy would doubtless leave large areas of land covered with uranium-mill tailings threatening future water supplies with contamination by radium-226 and thorium-230, which have half-lives of 1,600 years and 75,000 years, respectively. Even a program designed to maintain the 16-per-cent share of global electricity that nuclear has at present would need an estimated one thousand reactors and create considerable risks[12]. Multiplying the reactors and spent-fuel storage facilities could also raise the number of targets for terrorist attacks, creating security risks.

Then there are the proliferation problems of plutonium. More than 80 tonnes of surplus separated commercial plutonium — about 10,000 bombs' worth — is stored at La Hague, second only to the British stock of over 100 tonnes at Sellafield. To emulate France and get three-fourths of global electricity from nuclear power, the world would have to build more than two reactors of one gigawatt each per week over the next 42 years.

Supplying them with fuel would require about four new uranium-enrichment plants to be built somewhere in the world each year. Today, just one such plant — being built in Iran, where the government claims it is for peaceful purposes — is at the centre of a major global diplomatic crisis.

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The notion that nuclear power is necessary to address climate change does not reflect a close examination of the realities of the marketplace or rapid new developments in solar energy, wind energy and energy storage technologies. Indeed, current cost trends indicate that new nuclear power plants are likely to be economically obsolete even before the first new ones come online in the United States. Relying mainly on large power plants in a centralized grid today is the electrical equivalent of depending on punch cards and mainframe computers — clunky, costly, risky, inefficient and unnecessary. The age of laptops and the Internet offers the opportunity of solving the climate crisis by moving to a world of smart, secure, distributed, efficient and fully renewable grids. For the sake of environmental health, global security and the economy, we should seize the moment and get it done.

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