2010

Nuclear energy: a panacea for climate change?

Adam Robert Lucas
University of Wollongong, alucas@uow.edu.au

Publication Details

Lucas, A. Robert. (2010). Nuclear energy: a panacea for climate change?. Australian Options, Spring (62), 11-15.

Nuclear Energy: A Panacea for Climate Change?

by **Dr Adam Lucas**
Science & Technology Studies Program, University of Wollongong

Calls for a public debate about nuclear energy as part of the solution to global warming have been gaining regular coverage in the international media for the last several years. A number of politicians, business leaders and scientists tell us that the world is experiencing a 'nuclear renaissance' which none of us can afford to ignore.

Proponents of nuclear argue that the grounds for scepticism about nuclear energy are no longer valid, and that technological improvements in recent years make it a viable and even a desirable option for new electricity generating capacity.

So what is the status of nuclear energy in the world at the moment? And do the arguments of its proponents stand up to scrutiny?

Nuclear energy is currently responsible for generating around 14% of the world's electricity.[1] And although nuclear contributes anything from 2 to 6% of the world's total energy needs, it has been steadily losing out to renewables over the last decade or so, which now contribute between 7 and 20% of total global energy.[2]

Just under 70% of the world's nuclear energy comes from five countries: the US, France, Japan, Russia and Germany. Almost half of the world's nuclear energy is generated by just two countries: the US and France.[3]

In December 2009, there were 436 nuclear power plants operating around the world in 31 different countries:[4] eight less than in 2002. And the world's reactor fleet is getting old: more than 3/4 of these plants have been operating for more than 20 years, and 1/4 of them for more than 30.

Because the operating life of a nuclear power plant is at best 40 years, three-quarters of all the plants running now will need to be replaced by 2030 just to maintain their current generating capacity. That means 300 new plants within 20 years. And although there is talk of extending reactor lifetimes to 60 years, there are a host of technical problems that would have to be overcome to make that a reality.[5]

But the fact is that nowhere near that number of reactors are actually being built, and it's very unlikely that they ever will be.

In December 2009, there were only 56 nuclear power plants being built around the world, and one quarter of them have been under construction for more than 20 years. Forty of these plants are in China, Russia, India and South Korea, and none of those countries are transparent about construction costs or schedules.[6]

In the US, the American Nuclear Energy Institute has plans to expand the capacity of existing power plants by 10,000 MW, and to build 50,000 MW of new generating capacity by 2020: that means 40 to 50 new reactors across the US. But the industry also admits it would have to construct 35 new plants by 2030, just to maintain nuclear's current share of around 20% of total US electricity production.[7]

As of March 2010, there were 18 applications for new nuclear power plants in the US, eight less than a year ago.[8] In February, President Obama announced US$8.3 billion in federal funds to underwrite the cost of building two new 1,100 MW reactors in Georgia, out of a total projected cost of around $14 billion.[9]

But regulatory issues, community opposition and a lack of private sector financing, mean that it's not at all clear that any of these plants will actually be built.[10]

It's therefore not only unlikely that the industry's plans of expanded nuclear capacity in the US will be realized, it's not likely to even maintain its current share of total generating capacity over the next two decades.

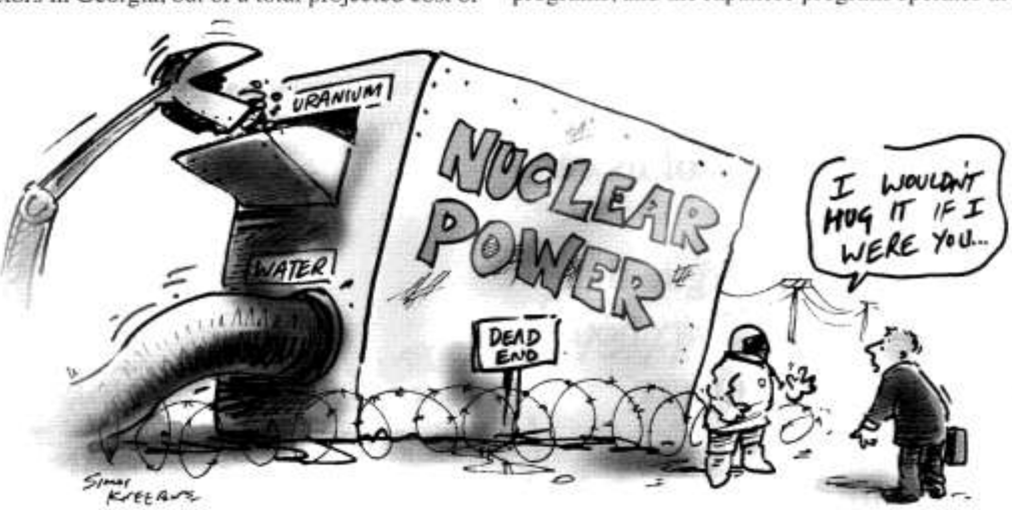
But let's assume for a moment that the industry's optimistic forecasts are achievable. How much of a reduction in carbon emissions would result, and how would it impact on the world's high-grade uranium reserves?

Doubling the current nuclear capacity across the world by 2035 would mean building more than 600 new plants, but would only result in a 6.5% reduction in CO2 emissions on 1990 rates by that date.[11] Tripling the current worldwide capacity by 2050 means building more than a thousand new plants, and would only reduce atmospheric CO2 loads by 12 to 20% on 1990 levels.

Current estimates are that there is only 40 to 70 years of high-grade uranium left to be mined at current consumption rates.[12] If consumption was tripled, the high-grade uranium would run out within 13 to 23 years. If all of the world's electricity demand were converted to nuclear, almost 3,000 new plants would have to be built worldwide by 2030, just to maintain today's electricity generating capacity. That means the high-grade uranium would run out in anything from three to twelve years.

Some argue that because there's been much less world-wide exploration for uranium than for fossil fuels, it may be that there are larger reserves still to be discovered.[13]

But even so, once the high-grade uranium starts to run out, existing plants will have to start using lower grade ores, or thorium (which is a new and unproven technology), or switch to fast breeder reactors with plutonium reprocessing to fuel them. That is highly polluting and dangerous. The US, Germany and France have abandoned their fast breeder programs, and the Japanese program operates at a fraction of the capacity that was promised by its supporters.



The three main arguments that proponents of nuclear energy have been using in recent years to promote its future expansion are that nuclear is reliable and relatively cheap compared to most renewable energy, and that it's safe and produces far fewer GHG emissions than fossil fuel-based energy. So let's examine each of these claims in turn.

France is often held up as a model for nuclear energy development, as almost 80% of its electricity is generated from 59 nuclear power plants.[14] But the reliability of its large scale nuclear programme has come under pressure from climate change. In the summer of 2003, French nuclear plants were unable to operate at design capacity due to a lack of cooling water, which contributed to major blackouts in continental Europe.[15]

To provide some idea of the water requirements of a nuclear reactor, the US Department of Energy recently published estimates of between 780 and 1,340 gigalitres of water per annum for a 1,000 MW plant.[16] To put that in some perspective, the Greater Sydney region uses about 650 gigalitres of water per annum.[17]

Furthermore, siting nuclear plants near water sources makes them vulnerable to flooding and storm surges due to climate change, as well as water scarcity due to drought. When the world's water resources are under threat from population growth and climate change, the wisdom of retaining any energy source that relies heavily on water for production has got to be seriously questioned.

Let's now examine the claim that nuclear energy is relatively cheap. Despite having benefited from hundreds of billions of dollars in investment and R&D over the last 50 years, nuclear energy has never lived up to the optimistic forecasts of profitability touted by the industry, and almost invariably experiences construction over-runs and cost blow-outs for both construction and operation.

Doubling the current nuclear capacity across the world by 2035 would mean building more than 600 new plants, but would only result in a 6.5% reduction in CO2 emissions on 1990 rates by that date.

The Shoreham nuclear power plant in the US is emblematic of the kinds of problems that can occur. The plant was estimated in 1966 to cost US$65-75 million,[18] but ended up costing US$5.8 billion by 1987, more than an 8,000% cost blow-out. It was closed by protests in 1989 without generating any commercial electricity.[19]

Even with improved technology and economies of scale with multiple plants being constructed in the one country, a new 1,000 MW nuclear plant can cost anything from US$6 to $10 billion, and has a six to twelve year lead time before it can start producing power.[20] Current low estimates of the kilowatt hour costs of nuclear currently circulating in the US and UK are based on the heroic assumption that the costs of construction and of uranium ore will remain stable over the six to twelve years it takes to build them, as well as the 30 to 40 year operating life of the plant. And as I've already noted, limited supplies of uranium and construction over-runs almost guarantee much higher costs than the industry is prepared to admit. A massive new reactor currently under construction in Finland is now almost 60% over budget and three years behind schedule for completion after only three and a half years of construction. The same new reactor design currently under construction in France is also behind schedule and over budget.[21]

Reprocessing of spent nuclear fuel was also supposed to be a big money earner for the industry, but the collapse of demand for plutonium in nuclear weapons and the failure of fast-breeder reactor technology have all but sunk the market for reprocessing.

The THORP reprocessing plant in the UK went into operation in August 1997, and was touted to make profits for British Nuclear Fuels Limited of £500 million. But a huge leak from the plant of 22 tons of uranium and 200 kg of plutonium forced its closure in 2005, leading to company losses of £1 billion. A recent leak detected in May 2009 may lead to permanent closure of the plant.[22]

Decommissioning nuclear power plants and remediating the sites on which they're located has also proven to be extremely expensive. In the UK, decommissioning of the Sellafield power plant is expected to cost the UK taxpayer £1.5 billion per annum for at least another ten years. The UK Government has committed £73 billion to cleaning up its nuclear legacy, a figure which has risen steadily in recent years.[23]

In the summer of 2003, French nuclear plants were unable to operate at design capacity due to a lack of cooling water, which contributed to major blackouts in continental Europe.

The much touted Yucca Mountain facility in the US has been effectively cancelled after serious questions were raised about the site's long-term geological stability and huge cost overruns. Although the Obama Administration has ruled that the site can no longer serve as a nuclear waste repository and substantially cut its funding, lawyers for the US Department of Energy are still attempting to win a license application to continue construction.[24]

While industry proponents continue to attempt to persuade the public that a "nuclear renaissance" is underway, the fact remains that it's taxpayers who provide the capital for any cost overruns, accidents or problems, rather than the companies building and operating nuclear power plants and other nuclear facilities. It continues to require billions of dollars in government subsidies and unlimited levels of indemnity to attract private sector investment. By any rational assessment, nuclear is a poor investment. And even nuclear power plant constructors like Sandia in the US are putting their own money into concentrated solar thermal with salt storage: baseload renewable energy, not into nuclear.

Contrary to what the proponents of nuclear energy keep telling us, nuclear power isn't clean. It isn't cheap. It isn't secure and there's still no safe way to deal with nuclear waste.

A relatively new argument that's being used to promote nuclear energy is that it can help reduce CO2 emissions.

The most recent comprehensive study of CO2 emissions from nuclear power plants using high-grade uranium found that various reactor types generate only one-sixth of the CO2 produced by a gas-fired power plant when a total lifecycle analysis is undertaken.[25] However, it takes 7-10 years of operation before they achieve net CO2 reductions, compared to 2-3 years for wind power, and around the same for concentrated solar thermal power using parabolic troughs. More importantly, once the far more common low-grade uranium ores start being used as fuel, the CO2 generated by mining, milling, enrichment and power plant construction adds up to more than that of an equivalent gas-fired power station.[26]

Let's now look at the argument that nuclear energy is very safe. While it's true that the safety record of the nuclear industry has improved in recent years, and that new reactor designs are far safer than the old ones, a single major accident can have catastrophic consequences, as was the case with the Chernobyl nuclear disaster in 1986: an accident which the industry continues to attempt to minimize. Epidemiological studies by the International Physicians for the Prevention of Nuclear War found 10,000 deaths to date, and estimates another 50,000 deaths in the future.[27]
The safety of nuclear energy should also be considered with respect to the prospects of nuclear terrorism, and the use of uranium and plutonium in nuclear weapons, artillery shells and 'dirty bombs'.

The more uranium that's mined and processed, and the more plutonium that's produced as waste from nuclear power plants, the more of a security risk is posed by that material. The Australian Government can't guarantee that Australian uranium won't find its way into nuclear weaponry somewhere, at some stage, although it assures us that it can. And even if that guarantee was rock solid, supplying Australian uranium to nuclear weapons states frees up uranium from other countries to be used for weaponry.[28] And that includes depleted uranium weapons used in Iraq and Afghanistan, which we know are already causing major public health problems due to the radioactive dust that's been dispersed by the weapons after use.
Contrary to what the proponents of nuclear energy keep telling us, nuclear power isn't clean. It isn't cheap. It isn't secure and there's still no safe way to deal with nuclear waste.
By continuing to promote the fiction that massive nuclear power production is a viable alternative to the use of fossil fuels and competitive with renewable energy, governments and industries around the world are wasting precious time that can and should be used to build and promote economically and ecologically sustainable energy solutions.

[1] http://www.iaea.org/NewsCenter/News/2008/np2008.html; Renewable Energy Policy Network for the 21st Century, Renewables 2007: Global Status Report, p. 9.
[2] The International Energy Agency puts the global energy contribution of nuclear at 6% (see IEA, Key World Energy Statistics 2007, pp. 6, 17), whereas the Renewable Energy Policy Network for the 21st Century puts the figure for nuclear at 3% and18% for renewables as a share of global final energy consumption in 2006. See REPN21C, Renewables 2007: Global Status Report, p. 9.
[3] Ibid, p. 17; also http://www.iaea.org/NewsCenter/News/2008/np2008.html
[4] http://www.iaea.org/cgi-bin/db.page.pl/pris.oprconst.htm
[5] Schneider, op.cit., pp. 16-17.
[6] http://www.iaea.org/programmes/a2/; Schneider, op.cit., p. 14; http://www.iaea.org/programmes/a2/ China (19), Russia (9), India (6) and South Korea (6).
[7] Nuclear Energy Institute, Powering the Future With Environmentally Sound Nuclear Energy, NEI, 2003, p. 3. Nuclear Energy Institute, "The Nuclear Energy Industry's Priorities for 110th Congress", January 2007, p. 1.
[8] http://www.nrc.gov/reactors/new-reactors/col.html
[9] http://online.wsj.com/article/SB10001424052748704804

2045750693019267990046.html#printMode
http://newsblaze.com/story/20100216082102000002.pnw/topstory.html
[10] "NRG Energy Files License Application For Two New Reactors at Texas Plant", Nuclear Energy Insight, October 2007, available for download at: www.nei.org/filefolder/insight_200710_2.pdf; Mycle Schneider, et al., The World Nuclear Industry Status Report 2009: With Particular Emphasis on Economic Issues, German Federal Ministry of Environment, Nature Conservation and Reactor Safety, Paris, 2009, p. 16
[11] This CO2 reduction figure is based on an analysis of the UK's nuclear industry and emissions profile. See Sustainable Development Commission, "The role of nuclear power in a low carbon economy - Paper 2: Reducing CO2 emissions - nuclear and the alternatives", Scottish Parliament, March 2006, p. 30.
[12] See, for example: Angela Jameson, "Uranium shortage poses threat", The Times, 15 August 2005 for the EU's 2001 estimate of 42 years of supply at current consumption rates. The Australian Uranium Association predicted 70 years of supply at current consumption rates in 2007, but the publication making that prediction has been removed from its website. A joint report authored by the OECD and IAEA has offered a more sanguine assessment of future reserves, suggesting 85 years of supply using known reserves: OECD NEA/IAEA, Uranium 2003: Resources, Production and Demand, AEN/NEA, 2004. See also: James Hopf, "World Uranium Reserves", American Energy Independence, May 2004, available for download at: http://www.americanenergyindependence.com/uranium.aspx;
[13] Sussex Energy Group, "Response to Government's 'The Future of Nuclear Power' Consultations", SPRU, University of Sussex, 10 October 2007, p. 17; See J.W.S. Van Leeuwen & Philip Smith, Nuclear Power: the Energy Balance, "Ch. 2: From ore to electricity – energy production and uranium resources", 6th rvn, August 2005, pp. 19-23, for a more sceptical position.
[14] International Energy Agency, Key World Energy Statistics 2007, p. 17; also http://www.iaea.org/cgi-bin/db.page.pl/pris.oprconst.htm
[15] Julio Godoy, "Heat Wave Shows Limits of Nuclear Energy", IPS News, 27 July 2003, available for download at: http://ipsnews.net/news.asp?idnews=34121; UNEP, "Impacts of Summer 2003 Heat Wave in Europe", Environment Alert Bulletin 2, UNEP/GRID Europe, March 2004, available for download at: http://www.grid.unep.ch/product/publication/download/ew_heat_wave.en.pdf
[16] Dominion Energy Inc., "Study of potential sites for the deployment of new nuclear power plants in the United States", US Dept. of Energy, September 2002, pp. 7–8, http://www.ne.doe.gov/np2010/espStudy/espStudyDominion.pdf
[17] Grace Mitchell, et al., "The Reuse Potential of Urban Stormwater and Wastewater", Report 99/14, Cooperative Research Centre for Catchment Hydrology, December 1999, p. 3.
[18] Kenneth F. McCallion, Shoreham and the Rise and Fall of the Nuclear Power Industry, Praeger, 1995, p. 4.
[19] Ibid., p. 19.
[20] Mycle Schneider, et al., The World Nuclear Industry Status Report 2009: With Particular Emphasis on Economic Issues, German Federal Ministry of Environment, Nature Conservation and Reactor Safety, Paris, 2009, pp. 45-67.
[21] Ibid., p. 65; James Kanter, "In Finland, Nuclear Renaissance Runs Into Trouble", The New York Times, 28 May 2009:
http://www.nytimes.com/2009/05/29/business/energy-environment/29nuke.html
[22] Geoffrey Lean, 'Shambolic' Sellafield in crisis again after damning safety report", The Independent, 3 February 2008, available for download at: http://www.independent.co.uk/environment/green-living/shambolic-sellafield-in-crisis-again-after-damning-safety-report-777551.html; CORE, "THORP – Living on a knife-edge. Future hopes evaporating fast", 18 May 2009.
[23] Robin McKie, "Sellafield: the most hazardous place in Europe", The Guardian, 19 April 2009, available for download at: http://www.guardian.co.uk/environment/2009/apr/19/sellafield-nuclear-plant-cumbria-hazards; George Coupe, "Getting to the Core Issue", The Engineer, 14 May 2004, available for download at: http://www.theengineer.co.uk/in-depth/getting-to-the-core-issue/267995.article; Mycle Schneider, et al., The World Nuclear Industry Status Report 2009: With Particular Emphasis on Economic Issues, German Federal Ministry of Environment, Nature Conservation and Reactor Safety, Paris, 2009, p. 106.
[24] Mycle Schneider, et al., The World Nuclear Industry Status Report 2009: With Particular Emphasis on Economic Issues, German Federal Ministry of Environment, Nature Conservation and Reactor Safety, Paris, 2009, p. 63; Keith Rogers, "YUCCA MOUNTAIN: Licensing efforts continue - Energy Department keeping nuclear repository options open", Las Vegas Review-Journal, 14 December 2009, available for download at: http://www.lvrj.com/news/licensing-efforts-continue-79202892.html
[25] Benjamin K. Sovacool, "Valuing the greenhouse gas emissions from nuclear power", Energy Policy 36 (2008), p. 2950. See also M. Lenzen, "Life cycle energy and greenhouse gas emissions of nuclear energy: A review", Energy Conversion and Management 49 (2008), pp. 2178-99, which made very similar findings.
[26] J.W.S. Van Leeuwen & Philip Smith, Nuclear Power: the Energy Balance, "Ch. 2: From ore to electricity – energy production and uranium resources", 6th rvn, August 2005, p.
[27] http://www.ippnw-students.org/chernobyl/research.html
[28] Eve Vincent (ed.), Yellowcake Country? Australia's uranium industry, BNI, 2006, pp. 6-7.