Nuclear is the least-cost, low-carbon, baseload power source

Tags: baseload power Carbon and De-carbonization Electricity Energy Nuclear Power

0 November 27, 2010 by Barry Brook

This is a press release to accompany a new peer-reviewed paper by Martin Nicholson, Tom Biegler and me (Barry Brook), published online this week in the journal *Energy*. In subsequents BNC post, I will look at how the media has reacted so far to the story (the good, the bad and the ugly), and also explore the paper's findings in more depth. For now, here's the overview. If you want a PDF copy of the paper, email me.

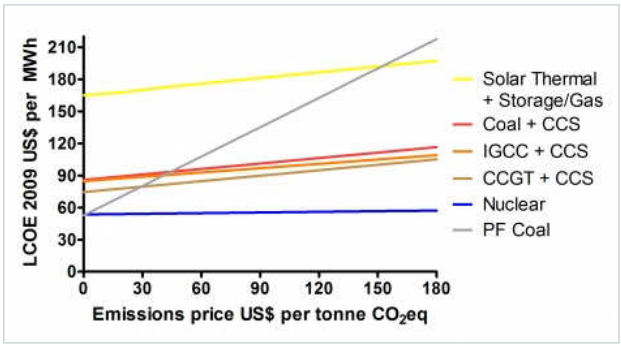
Nuclear is the least-cost, low-carbon, baseload power source

Climate change professor supports nuclear in newly published analysis

When a carbon price that is high enough to drive a technology switch eventually kicks in, only nuclear power will keep the lights on, keep electricity costs down, and meet long-term emission reduction targets, say three Australian authors in a paper published this week in international peer-reviewed journal *Energy**.

Introducing a carbon price changes relative technology power costs because rates of carbon emissions differ between technologies.

"In order to understand where our future electricity will come from" says lead author Martin Nicholson, "we need the best possible insights into generating technologies, their costs and their carbon emissions".



After analysing a wealth of peer-reviewed studies on market needs, technology performance, life-cycle emissions and electricity costs, the researchers conclude that only five technologies currently qualify for low-emission baseload generation. Of these, nuclear power is the standout solution. Nuclear is the cheapest option at all carbon prices and the only one able to meet the stringent greenhouse gas emission targets envisaged for 2050.

Only one of these five qualifiers comes from the renewable energy category – solar thermal in combination with heat storage and gas backup. However, on a cost basis, it is uncompetitive, as are the carbon capture and storage technologies.

Professor Barry Brook, director of climate science at the University of Adelaide's *Environment Institute* says: "I am committed to the environment, personally and professionally. The evidence is compelling that nuclear energy must play a central role in future electricity generation. No other technology can meet our demand for power while reducing carbon emissions to meet global targets".

Martin Nicholson says: "Researching for my book *Energy in a Changing Climate* made me appreciate the central issues in producing low-emission electrical energy. This new paper supports my view that Australia must prepare immediately for a future where most of its electricity will eventually come from nuclear energy".

The researchers also note that, given the importance of reducing electricity generator emissions, the need to keep electricity costs down, and the expansion of nuclear power globally, it seems essential that the Australian government rethink its nuclear energy policy.

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*Nicholson M, Biegler T & Brook BW. (2010) How carbon pricing changes the relative competitiveness of low-carbon baseload generating technologies. *Energy*, doi:10.1016/j.energy.2010.10.039

BACKGROUND INFORMATION

A new paper by three Australian researchers, published in the international peer-reviewed journal *Energy*, looks at 16 electricity generating technologies as candidates for meeting future greenhouse emission reduction targets.

The technologies are assessed in terms of their potential to produce reliable, continuous, baseload power. The assessment covers performance, cost and carbon emissions.

Cost, and the impact of carbon pricing on that cost, is analysed on the basis of 15 comprehensive cost studies published over the past decade. Similarly the carbon intensity estimates are based on 14 published studies of life cycle greenhouse emissions from electricity generation. The comprehensive range of authoritative studies analysed (including research from the International Energy Agency, Energy Information Administration, Massachusetts Institute of Technology and the Intergovernmental Panel on Climate Change) means that the results that emerge are reliable, comparable and representative.

For a technology to be considered fit-for-service as a baseload generator it needs to be scalable, have a reliable fuel supply, a low or moderate emissions intensity, and high availability without the need for a large external energy storage facility.

It turns out that technology options for replacing fossil fuels, based on established performance and objective cost projections, are much more limited than is popularly perceived. The review identifies only five proven low-emission technologies that could meet this set of fit-for-service criteria for the supply of baseload power. The technologies are: pulverised fuel coal combustion (PF coal) coupled with carbon capture and storage (CCS); integrated gasification combined cycle coal (IGCC) with CCS; combined cycle gas turbine (CCGT) with CCS; nuclear; and solar thermal with heat storage and gas turbines.

Of these five, the only renewable technology is solar thermal with heat storage and gas backup. However, this is the most expensive of the technologies examined and replacing coal with solar thermal power would require a carbon price of over $150 per tonne of emissions.

The paper summarises the joint cost and emissions results in the diagram below. This shows how the assessed cost per megawatt-hour of electricity varies with the technology used and the price set for carbon dioxide emissions. These prices, known as levelised costs of electricity, are the accepted way of expressing the average cost of generating electrical energy over the lifetime of a plant. They are regarded as a good indicator of the average wholesale price the power station owner would need to break even, in financial terms, and can be standardised across different technologies (and so are comparable).

In the diagram, the five fit-for-service technologies are compared with costs for conventional coal-fired generators using pulverised fuel (PF). The point where each line hits the vertical axis on the left is the cost when there is no carbon price, as happens now. It shows that a modern coal power station produces the cheapest power.

As the emission price (e.g., carbon tax) rises, so does the electricity cost. Coal-based power rises fastest because it has the greatest emissions. The points where the line for PF coal crosses the other lines represent the carbon prices where each technology becomes more economic than traditional coal-fired power.

Nuclear stands out as the cheapest solution to provide low-emission baseload electricity over almost the whole carbon price range shown. The next cheapest is CCGT (natural gas) with CCS, which needs a carbon price of just over $30. To justify building either of the two coal technologies (PF or IGCC) with CCS requires a carbon price over $40.

According to international experience, if nuclear energy were adopted in Australia its initial cost (termed 'first-of-a-kind') would be about $30 per MWh higher than in the diagram, but would come down to that level as more plants were built.

Filed under: Emissions reduction, Hot news in climate science, Nuclear Energy, Renewable planet

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