

Energy in a Changing Climate

Emission reductions are not blowin' in the wind

IF the government puts a price on carbon, as it seems committed to do, the electricity industry will be one of the first to feel its effect.

Two important questions are yet to be answered, however. What is the carbon price that will encourage a widespread shift to technologies which will actually reduce emissions? And what will those technologies be?

To find answers, we conducted a meta-review of 25 authoritative peer-reviewed studies of electricity generating technologies, which was published in the international peer-reviewed scientific journal *Energy*. We looked at cost and life-cycle emission studies to arrive at the most likely costs and emissions of these technologies. We focused on baseload generators which account for more than 75 per cent of the electricity generated in Australia.

We concluded that technology options for replacing fossil fuels, based on proven performance and reliable cost projections, are much more limited than is popularly thought. We identified only five proven low-emission technologies that met a set of objective fit-for-service criteria to supply baseload power. They were: pulverised fuel (PF) with carbon capture and storage (CCS); integrated (coal) gasification combined cycle (IGCC) with CCS; combined cycle gas turbine (CCGT) with CCS; nuclear; and solar thermal with heat storage and gas turbines. IGCC is relatively new technology not yet in operation in Australia. CCS is still only in pilot stage anywhere in the world.

It might come as a surprise to some that wind, solar photovoltaic and engineered geothermal systems (EGS), also known as hot rocks, did not qualify to be fit-for-service for baseload. Wind and solar PV need either extensive gas backup or large-scale energy storage for baseload operation. The associated extra costs will depend on plant location and are difficult to assess accurately.

One technical study we covered assessed wind with storage against IGCC with CCS. The wind/storage solution could only compete at a carbon price above \$350 a tonne of carbon dioxide, well above anything being contemplated. EGS is a possible future baseload technology, but it is still too early to estimate performance and costs with the degree of reliability we required.

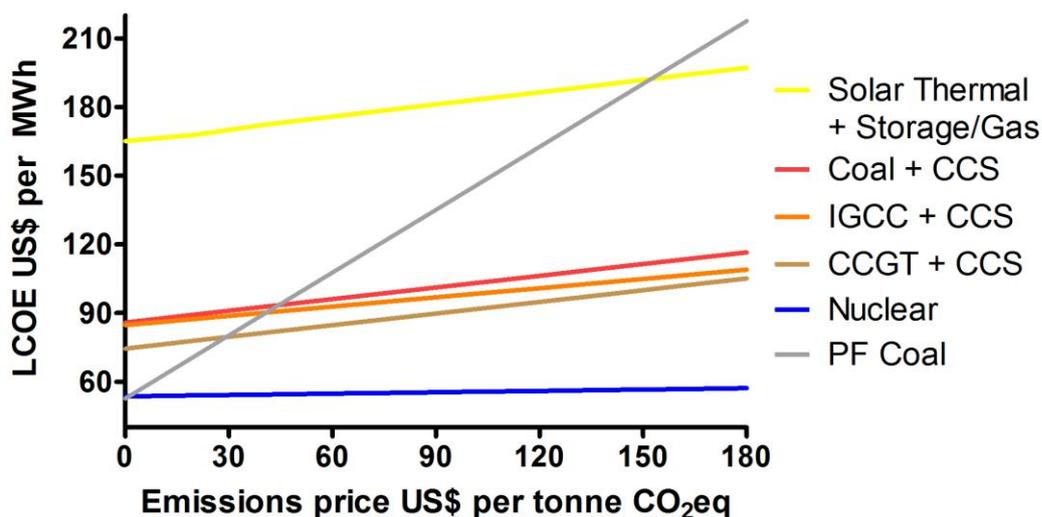
Most of Australia's electricity comes from PF coal and this will be the primary target for emissions reduction. The illustration shows how the median costs per megawatt-hour of electricity vary with the emissions (carbon) price.

The technologies included are the five fit-for-service replacement technologies plus, for comparison, new PF coal plants without CCS. With no carbon price (as now), new pulverised fuel coal is the cheapest technology, but as the carbon price increases so does the cost of electricity from such plants.

The levelised cost of electricity, shown in the illustration, is a good indicator of the average wholesale price the power station owner would need to break even.

The points where the cost line for pulverised fuel coal crosses the others represents the minimum carbon price needed to make the technology switch worthwhile. Leaving aside nuclear for the moment (as it is presently banned in Australia), the cheapest solution is combined cycle gas turbine (natural gas) with carbon capture and storage, which needs a carbon price of just over \$30. To justify building either of the coal technologies (PF or IGCC) with carbon capture and storage for new plants would require a carbon price over \$40. Retrofitting existing coal plants with carbon capture and storage might have different costs.

The problem is, carbon capture and storage may only make sense if you take a short-term view of emission reductions. While it can deliver the probable reduction targets until 2030, the current technology will not deliver the tougher emission targets recommended for 2050. Coal plants often have a 40-year life, so new coal plants with CCS built over the next few decades may still be operating by 2050, holding us back from meeting those targets, unless they can be modified later.



Written by Martin Nicholson and first published in The Australian 29 November 2010