Coal fired power - twin elephants in the room

William Grace
Urban Design Research Centre
University of Western Australia

Ever since the unfortunate South Australia wind energy induced blackout (i.e. wind energy blew over heavily engineered steel transmission towers) there has been an intensified debate about the future of renewable energy. The Prime Minister's recent Press Club call for new coal fired power stations has further stoked this fire. Although the absurdity of his argument, both in respect of energy economics and climate policy has been identified by many expert commentators, a couple of points remain to be made.

Coal fired power, as the PM has identified, is associated with baseload power generation, i.e. stations operate on an (almost) continuous basis to meet the minimum level of demand required throughout the day. Conventional coal generators cannot be easily scaled up or down – they have long start up times. That is why so-called peaking plants are gas combustion turbines that can react quickly to changes in network load and be switched on and off. In the Western Australian South West Interconnected System (SWIS), coal provides about 50% of the output and is the cheapest to operate per MWh (without any carbon price). This is why the PM says we need low cost coal.

What is missing in this view of the world is the rapidly growing impact of household and business solar on the network. As far as the network is concerned, this generation is manifested as reduced demand during the daylight hours, with the effect peaking in the middle of the day. Here is a graph of the approximate network load on a typical March day on the SWIS compared to overall demand.

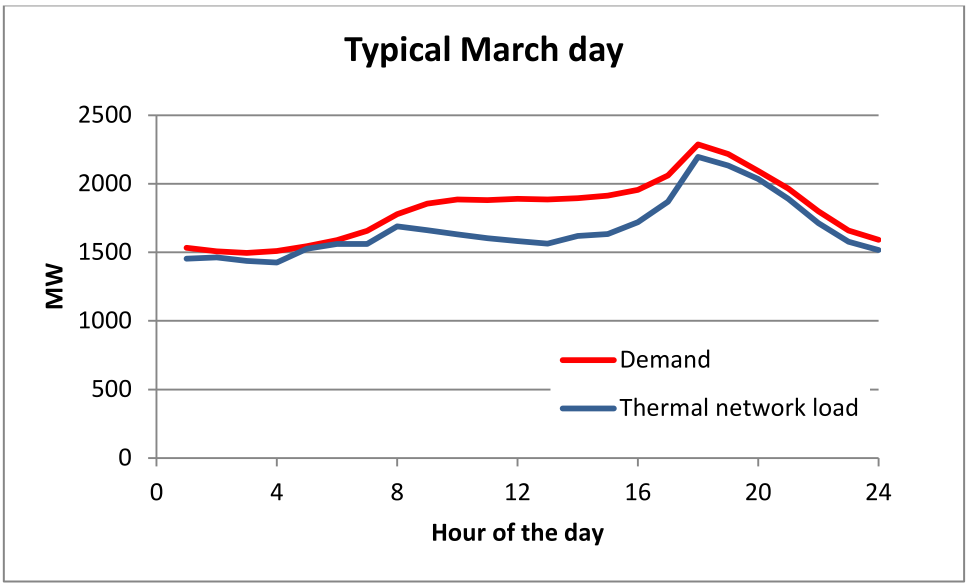
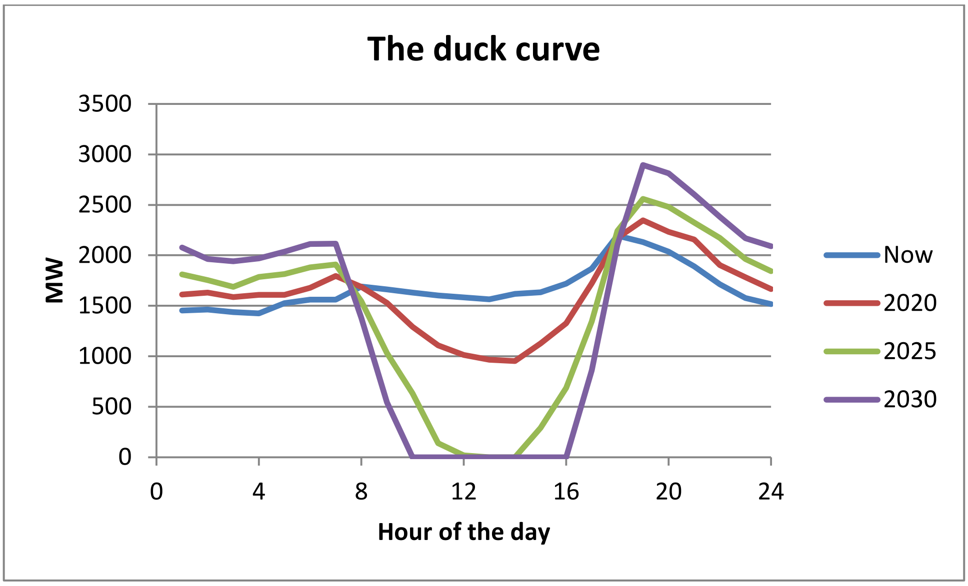


Figure 1 Current SWIS demand and load

The difference between the two graphs is the 360 MW of private solar and the small amount of wind energy (170 MW) on the SWIS. The private solar has the dual effect of reducing demand whenever generating, and exporting excess energy to the grid. It can be seen that this is already having a significant impact on the generation of coal and gas fired power.

But as we know, the growth of private solar has been spectacular and this will continue irrespective of any debate about coal fired generation on the receiving network. My modelling identifies what the graph above will look like in coming years due to this increase in private solar, driven (mainly) by reducing unit costs of solar PV, but exacerbated by increasing electricity tariffs.



Source: author's modelling

Figure 2 Future SWIS load

This is the so-called 'duck curve', a term that was coined by the California Independent System Operator (CAISO) 2013 in their analysis of the impact of solar on network generation, that produced a similar graph[1]. That analysis identified the risk of 'overgeneration', i.e. ' …when more electricity is supplied than is needed to satisfy real-time electricity requirements.' Overgeneration is a major issue for systems like the SWIS and the NEM that are reliant on coal and gas baseload generation because they can't be easily scaled up or down. By around 2020 there will be so much private solar connected to the SWIS that the system operator will need to protect the (mainly) coal baseload power stations by curtailing other generation sources, namely wind and solar. This would lead to the ridiculous situation where we pay $80-100 per MWh to operate high emission generators rather than zero marginal cost emission-free renewable generation. The situation outlined above is ameliorated to some extent by private battery storage, but this will be insufficient over the noted timescale to change the overall picture.

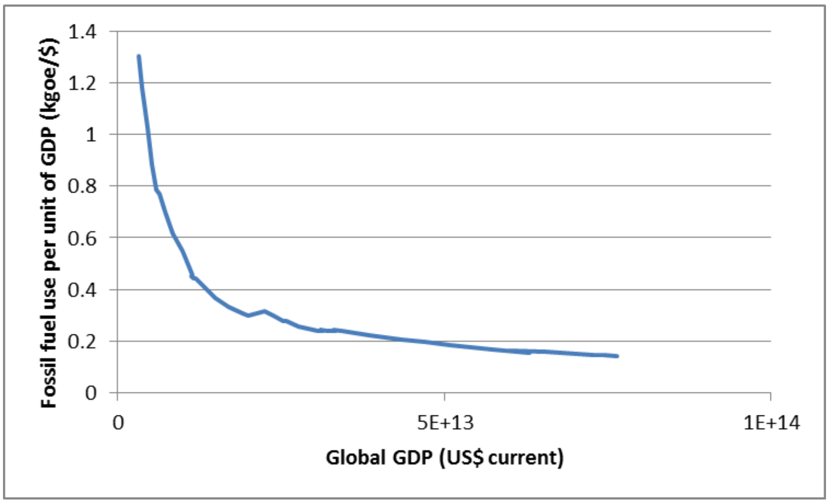
So while the government claims that baseload coal is needed for 'decades to come', it will in fact be very problematical to retain legacy generation within ten years, a fact grasped by Californians but apparently not by Australian politicians. Power station investments are made over 30-50 year periods, so this further highlights the failure of the pro-coal lobby to grasp the fact that the renewable energy revolution means the existing market model is outdated and must change.

[1] It has recently been reported that the "duck has landed" in California.

Even if future coal fired power stations could be scaled up and down to meet variable demand, their costs would be higher than the levellised cost of energy (LCOE) figures currently thrown around to support coal. The LCOE calculations have capacity factors built into them (i.e. how many hours of the year the plant produces energy). If the historical 80-90% capacity factor for coal drops to 60% the LCOE increases to over $100 per MWh, making it completely uncompetitive against the future costs of wind and solar which will be well below that figure. For this reason alone, new coal generation will not happen in Australia, irrespective of the apparent commitment of the government to push it.

But there is a second elephant in the room, and that of course, is that fossil fuels will run out even if we don't abandon their use for climate reasons. They would eventually become scarce and then exhausted. When will this happen? The sums can be done by anyone with a reasonable handle on excel spreadsheets.

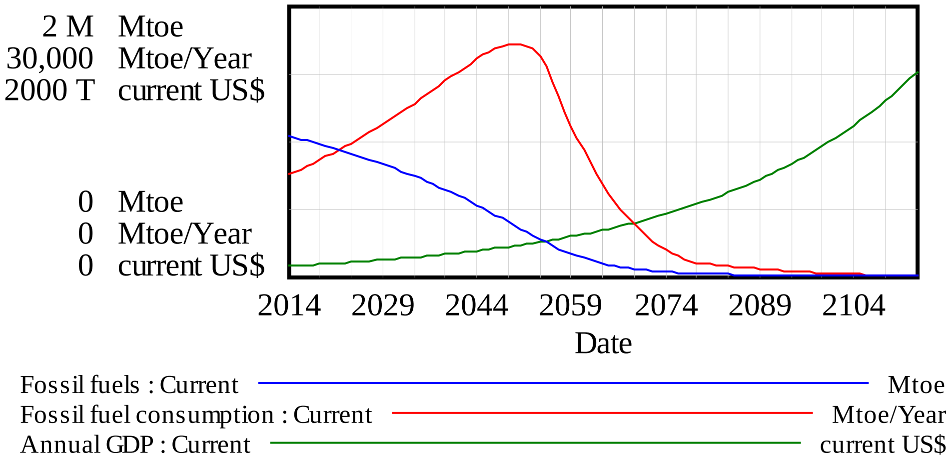
The 2015 BP Statistical Review of World Energy identifies global stocks of oil, gas and coal at the end of 2014 as a little over 1 trillion tonnes of oil equivalent. If it is optimistically assumed that these resources are interchangeable; and the levels of fossil fuel intensity (i.e. amount of fossil fuels consumed per unit of global GDP) continue to decline in line with historical trends (Figure 3); the annual consumption (a rate) and remaining resources (a stock) can be determined for various assumptions about global GDP growth into the future.



Source: Data from database: World Development Indicators

Figure 3 Fossil fuel intensity

If global growth is set at a constant 3% per annum, the result is that fossil fuel consumption will peak by mid-century (after which costs can be expected to increase dramatically) and stocks will be virtually exhausted by the end of the century. You can see this simple model in action here.



Source: author's modelling

Figure 4 Fossil fuel depletion

It could be reasonably argued that an increase in GDP by a factor of 20 over this timeframe is unrealistic, and / or that more resources will be found. However shifting these assumptions doesn't change the picture much. If global growth is half of that assumed above, the consumption peak occurs in 2065 rather than 2055. If GDP growth is 1.5% and stocks are 50% greater than assumed above, the peak occurs in 2070. Whichever way you look at it, we have less than 50 years to wean ourselves off fossil fuels. We design major infrastructure like power networks for a lot longer than 50 years. So even if you don't believe in climate change you should still see the need to transition to renewable energy now.

Of course we can't wait at all, because acting on climate change is urgent now for reasons much bigger than the cost of our power network. The scenario above would see emissions from fossil fuels increasing in proportion to consumption, that is rising from the present 10 Gt/year to 26 Gt/year when we need them to be near to zero by then if we are to keep atmospheric CO2 concentrations to a level consistent with the global target of 2 degrees C.

Our energy future is clear to those who can see beyond the coal mine: a completely revamped system powered largely by onsite private solar generation and battery storage, complemented by a smaller network consisting of large scale wind, solar and wave technology (all of which exist now), with pumped hydro and other energy storage systems to balance the residual load with generation. Our only challenge is to map a least-cost transition to this future, a task that sadly seems to be beyond our current political establishment.