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NATIONAL ENERGY EMISSIONS AUDIT

National Energy Emissions Audit - Electricity Update

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Providing a comprehensive, up-to-date indication of key electricity trends in Australia

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Introduction

Welcome to the first issue of the *NEEA Electricity Update*, the companion publication to the *National Energy Emissions Audit Report*. From now on the *Electricity Update* will be published monthly and will present data on electricity demand, electricity supply, and electricity generation emissions in the National Electricity Market (NEM) up to the end of the immediately preceding month. It will include similar data on demand in the South West Interconnected System (SWIS), in WA. At present it will not be providing the corresponding supply and emissions data for the SWIS; we are hoping to upgrade our data system to provide this information in the not too distant future.

Each issue of *Electricity Update* will also contain a more detailed discussion of one or two particular topics relating to the electricity system which have assumed particular importance in the period prior to publication. For this inaugural publication the topic is, of course, the Report of the Finkel Review.

All data are reported as annual moving averages. This approach removes the impact of seasonal changes on the reported data. Annualised data reported in both the *NEEA Report* and the *NEEA Electricity Update* will show a month on month increase if the most recent monthly quantity is greater than the quantity in the corresponding month one year previously. Most data are presented in the form of time series graphs, starting in June 2011, i.e. with the year ending June 2011. Some graphs start in June 2008. These starting dates have been chosen to highlight important trends, while enhancing presentational clarity.

Demand

Figure 1 shows the relative changes, since the year ending June 2011, in total annual demand for electricity in each of the five regions of the NEM, and also in the SWIS. It also shows the absolute change in total demand in the NEM as a whole. The absolute contributions of each state to total demand are shown in Figure 2, which highlights the importance of the closure of two older aluminium smelters in NSW, in 2012, and in Victoria, in 2014. Other, hard to identify factors have also contributed to the general fall in demand for the entire period since 2011 in NSW, Victoria and SA. Demand in Tasmania has been rather up and down, and was affected by supply rationing applied during the first part of 2016, following the BassLink cable failure in December 2015.

Figure 1

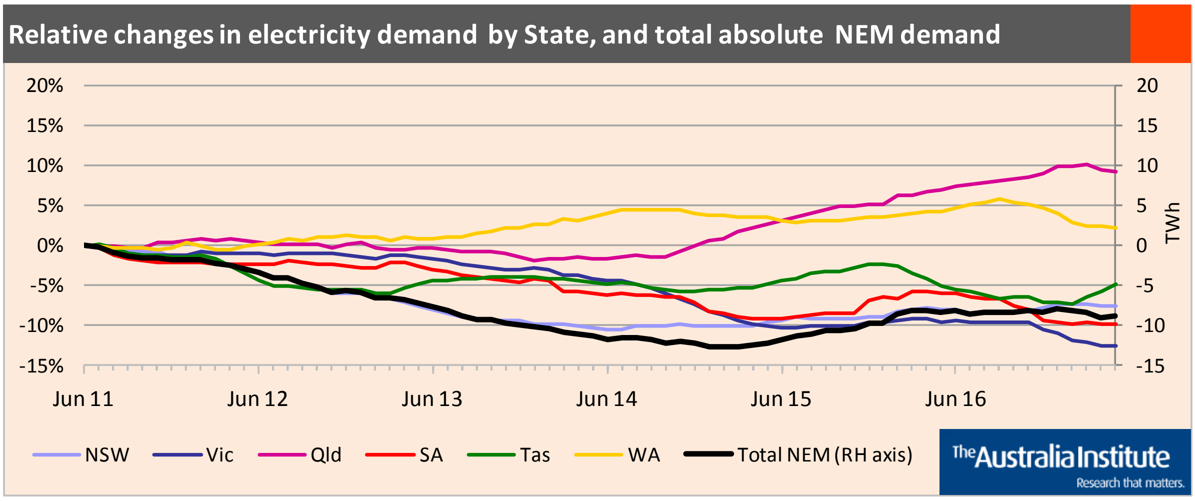
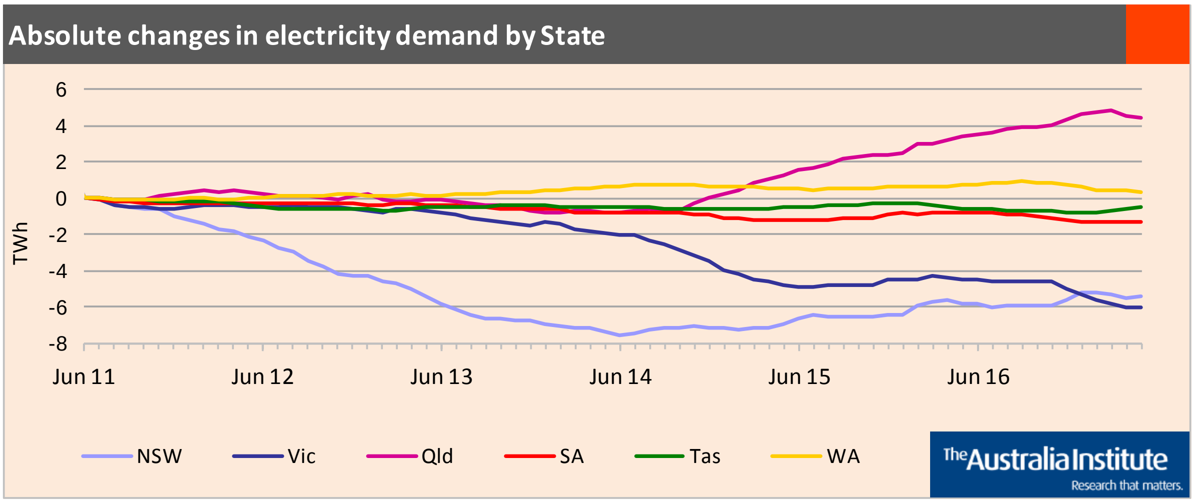


Figure 2



In Queensland, demand increased steadily throughout 2015 and 2016, largely driven by the installation of electric motor drives for compressors, pumps and other equipment in the coal seam gasfields. The data suggest that production of coal seam gas, mostly for conversion to LNG, has added about 5 TWh of annual electricity consumption in the NEM, equivalent to about 2.7% of total NEM demand at the end of 2014. Note that this figure does not include electricity used in the conversion of gas to LNG, all of which the three LNG plants generate themselves on-site, using some of the gas supplied to the plants.

In the WA SWIS, demand increased steadily up to September 2014, i.e. just after the carbon price was removed. It then fell slightly over the next few months before resuming gradual growth until September 2016. Since then SWIS demand has fallen steadily. While at one level this is not unexpected, given the fall in economic activity in WA over the past couple of years, it can also be seen as suggesting WA has, as it were, joined the rest of Australia, and, indeed, most other OECD countries, in moving to a regime of zero electricity demand growth.

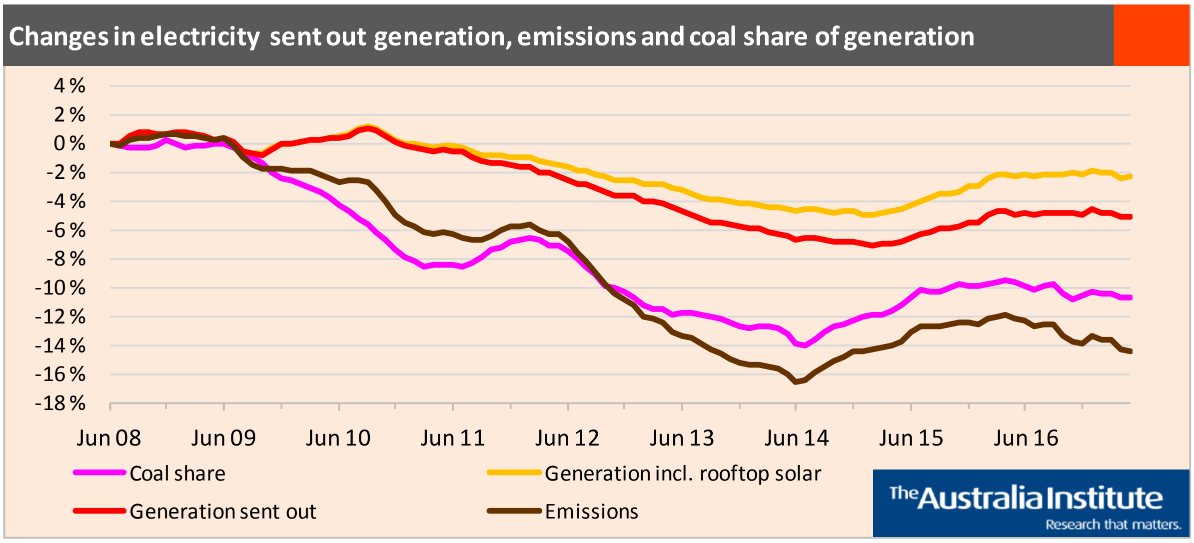
Generation and emissions

Figure 3 shows changes in total NEM generation, which is equal, of course, to NEM demand as shown in Figure 1. Figure 1 also shows the additional generation supplied by rooftop solar PV installed by both residential and commercial electricity consumers. To correctly interpret these graphs, it is important to understand how the terms generation and demand are defined for the purposes of NEM operation.

Demand, as defined for the purpose of system operation, includes all the electricity required to be supplied through the grid level dispatch process, operated by AEMO. This includes all the electricity delivered through the transmission grid to distribution network businesses, for subsequent delivery to consumers. It also includes energy losses in the transmission system and auxiliary loads, which are the quantities of electricity consumed by the power stations themselves, mostly in electric motors which power such equipment as pumps, fans, compressors and fuel conveyors. Auxiliary loads are very large: in 2011 they amounted to 6.3% of total electricity generated and currently about 5.6%. Most of this load is at coal fired power stations, where it can be as high as 10% of electricity generated at an old brown coal power station and 7% at a black coal fired power station. Auxiliary loads are much lower at gas fired power stations, and close to zero at hydro, wind and solar power stations. Demand, as shown in Figures 1 and 2, and generation, as shown in Figure 3, have both been adjusted by subtracting estimates of auxiliary loads. Thus demand, as shown, is equal to electricity supplied to distribution networks (and a handful of very large users that are connected directly to the transmission grid) plus transmission losses.

Generation is similarly defined to include only electricity supplied by large generators connected to the transmission grid. It does not include electricity generated by rooftop PV installed by electricity consumers, irrespective of whether that electricity is used on-site ("behind the meter") by the consumer, or exported into the local distribution network. From the perspective of the supply system as a whole, the effect of this generation, usually termed either "embedded" or "distributed" generation, is to reduce the demand for grid supplied electricity below the level it would reach without such distributed generation. That effect can be clearly seen in Figure 3; the gap between the red line – electricity sent out to the grid from large grid connected power stations – and the yellow line – that electricity plus estimated electricity generated by distributed solar systems – is the electricity supplied by those systems, which is currently about 5.5 TWh p.a., equivalent to nearly 3% of the combined total.

Figure 3



It should not be forgotten that there are other sources of distributed generation as well as rooftop solar, all supplying electricity directly into local distribution networks. These other sources include landfill gas and other types of biomass derived fuels, which in total supplied about 1.7 TWh in the NEM states in 2017, as well as smaller hydro generators, generators burning waste coal mine methane, and natural gas fuelled cogeneration. There are no reliable data on total output from these generators, but that is not a great problem in thinking about the future of electricity supply because supply from these sources is unlikely to change greatly in future years. Hence, depending on which way they are conceptualised, these generation sources will have little impact on changes in either the electricity supply mix or demand for grid supplied electricity.

In quantitative terms it makes little difference whether distributed generation is seen as additional electricity supply or reduced electricity demand. However, the distinction is important when considering policy options for the future. The primary decision to invest in rooftop solar is made by electricity consumers. Government can provide financial support, as it currently does through the Small Renewable Energy Scheme, but investment decisions will not be driven by large scale policy settings, such as the recommendation of the Finkel Review Report, except indirectly, through the effect of the chosen settings on retail electricity prices. It will be interesting to see whether the large retail prices increases, coming in July in NSW, Queensland and SA, will accelerate uptake of rooftop PV.

The other striking feature of Figure 3 is the close relationship it shows between the coal share in total NEM generation and the emissions intensity of that generation. Emissions intensity, combined with total electricity supplied, determines the total quantity of emissions for electricity generation. The contribution of each factor is shown in Figure 4, in stacked format, and in Figure 5, with each factor shown separately. It can be reasonably said that, while lower demand has been an important contributor to reducing Australia's electricity generation emissions since 2008, the lower average emissions intensity of total generation has been more important. The urgent need to reduce coal generation, if we are to reduce Australia's greenhouse gas emissions, is obvious.

Figure 4

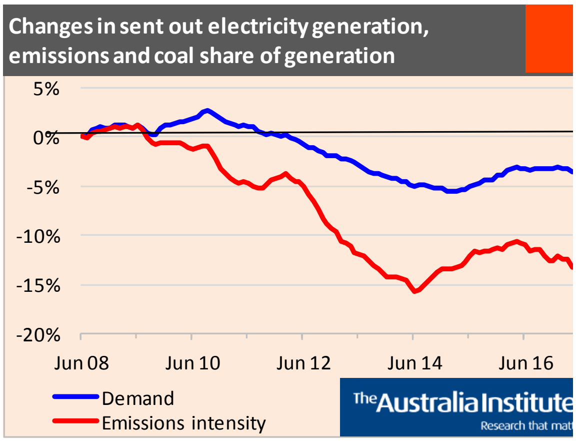


Figure 5

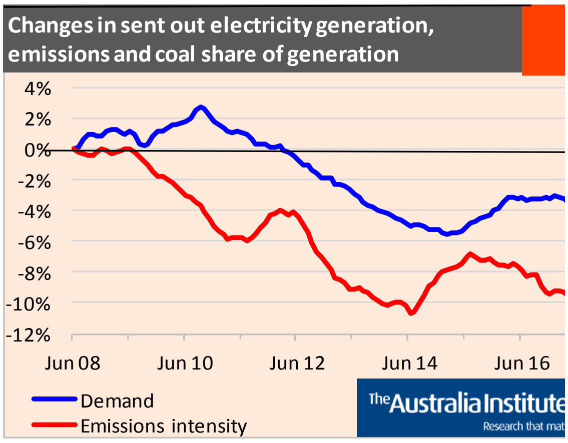


Figure 6

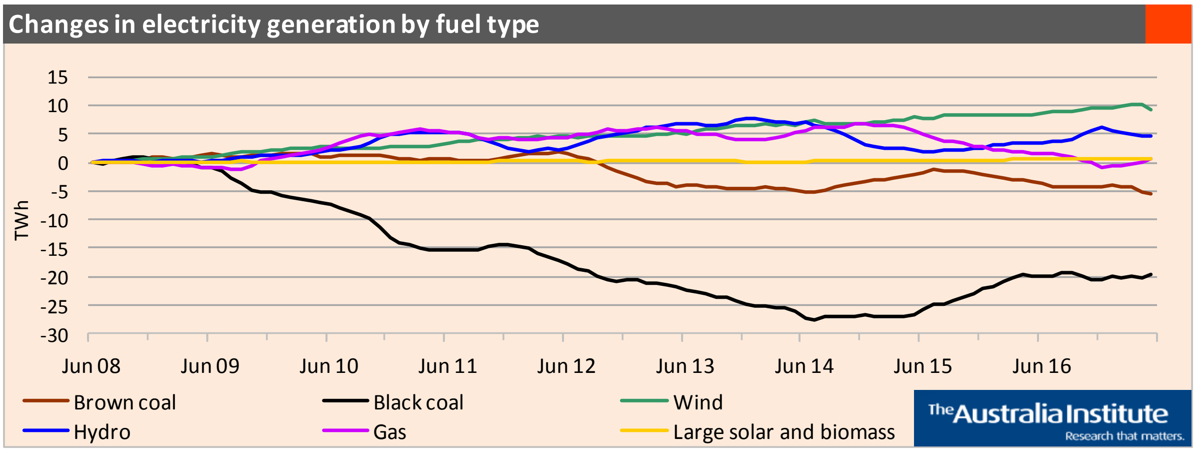


Figure 6 shows the changes in the NEM generation mix since 2008. Significantly reduced black coal generation follows the closure of a series of ageing power stations, including Munmorah (2011), Swanbank B, Collinsville, and Playford (all 2012), Wallerawang and Redbank (2014) and Northern (2016), plus reduced output, meaning lower capacity factors, from most of the five remaining NSW black coal power stations. The closure of two small brown coal generators, Morwell/Energy Brix (2014) and Anglesea (2015), has been followed by the closure of the much larger Hazelwood at the end of March this year; the impact of the Hazelwood closure is just starting to show up in the annualised data graphed in Figure 6.

The largest increase in lower emission generation has been wind generation, driven of course by the Large Renewable Energy Target (LRET) legislation. Hydro generation has also increased and is now at roughly its long term average level, having been much below in 2008, because of drought. Between 2008 and 2015, gas generation more than doubled, driven by the former ALP Queensland government policy for a mandatory share of gas generation in the state's electricity supply. Since 2015, however, the dramatic increase in wholesale gas prices has seen the share of gas generation fall right back to its 2008 level.

How might generation shares and emissions intensity change over the years to come? Clean Energy Regulator data show that In calendar year 2016 approximately 18.5 TWh was generated across Australia under the LRET. This means that an additional 14.5 TWh of annual generation will be needed over the next four years if the 33 TWh target is to be met. On the basis of trends to date, about 90% of this total, i.e. about 13 TWh, is likely to be generated in the NEM states. Since there is little scope for further generation from landfill gas and the other distributed generation technologies mentioned above, most of the additional generation will come from new wind and grid-scale solar generators. 13 TWh is more than sufficient to meet the shortfall, in purely energy terms, from the closure of Hazelwood, which over recent years supplied about 10 TWh each year.

Last February the Clean Energy Council published a list of new large scale wind and solar projects which, at that time, were either already under construction or had financial commitment in place to start construction during 2017. We have estimated that these projects would be able to supply at least 4.5 TWh annually, meaning that new projects able to supply a further 8.5 TWh may be expected to come forward. A further 1.9 TWh will come from wind farms directly contracted by the ACT government, outside the LRET framework. With no growth in demand, as forecast by AEMO, these changes imply an increase in the renewable share of NEM generation from around 15% in 2016 to over 23% in 2020, accompanied by a fall in emissions of about 18 Mt CO_2-e p.a., a reduction of about 12%.

2020 is when growth in the LRET ends, meaning that it will not drive any further decarbonisation of NEM generation. For the next steps we must look to the Report of the Finkel Review.

The Report of the Finkel Review

The Review recommends the establishment of what it calls a Clean Energy Target (CET) mechanism to continue to decarbonise the electricity supply mix in the NEM, by providing a clear signal for would-be investments in electricity generation. This would be achieved by imposing an obligation on electricity retailers to source a specified volume of the electricity they supply to consumers from qualifying clean generators, with the obligation being defined in terms of certificates.

However, instead of a simple relationship of 1 certificate per MWh, as applies under the LRET, certificate numbers earned by generators would be “in proportion to how far their emissions intensity is below the threshold” (p. 89). Hence if, as recommended by the Review, the threshold for generator eligibility is an emissions intensity is 0.7 t CO_2-e/MWh sent out, 1 MWh from a wind generator would earn 1 certificate, whereas 1 MWh from a generator with an emissions intensity of 0.6 t CO_2-e /MWh would earn 1 – 0.6/0.7 = 0.143 certificate. It is clear that this weighting will greatly reduce the incentive for a retailer to meet its obligations by buying certificates from the high emission generator, compared with a renewable generator. To put the relationship the other way round, the high emission generator would receive only one seventh as much subsidy per MWh sent out from electricity consumers as a renewable generator. Weighting by emissions intensity in this way would seem to place a significant obstacle to investment in a generation technology such as coal with carbon capture and storage, even assuming, most improbably, that it could be made both cost competitive with renewable generation and able to meet a threshold emissions intensity of 0.7 t CO_2-e /MWh.

Economies of scale present a further major impediment to the participation of new coal fired generators in the CET. Currently Australia's least emissions intensive coal fired power station is Milmerran, commissioned in 2002, which has an emissions intensity of about 0.87 t CO_2-e /MWh sent out. It consists of two 452 MW units. The newer, and slightly more emissions intensive Kogan Creek, commissioned in 2007, consists of a single 750 MW unit. Both Milmerran and Kogan Creek use super-critical technology, and both are very large, indivisible single investments. This is the scale needed to achieve maximum efficiency and minimum capital cost per MW capacity, but the need to make such large single investment is clearly a great challenge. By contrast, both wind and solar wind farms, are highly modular, and can be constructed and commissioned incrementally, so that each investment decision can be relatively small, and thus much less risky.

Seen from this perspective, arguments about the eligibility emissions intensity threshold are almost completely irrelevant to the performance of the proposed scheme, and might best be characterised a symbolic expression of cultural positioning.

By contrast, the really crucial feature of the scheme will be the emissions target it is designed to achieve, a feature almost entirely ignored by both politicians and those who comment on the activities of politicians. This target is the counterpart of the target for the LRET scheme, about which political acrimony raged for two years up to June 2015. The Report says, entirely appropriately:

> "In terms of the specific emissions reduction target that should be set for the electricity sector, the Panel acknowledges that this is a question for governments." (p. 96)

The Review commissioned modelling of the operation of the NEM with a target it defines in the following terms:

> "At a minimum, the electricity sector should have a target that reflects a direct application of the 2030 commitment of 26 to 28 per cent reduction on 2005 levels, as per the Paris Agreement." (p. 96)

This choice of a single, distinctly unambitious emissions reduction target for modelling has been widely and wrongly characterised by many from all sides of the debate as a recommendation of the Review, which it clearly is not. That said, the absence of modelling results for a more ambitious emissions reduction target means that the Report does not provide the range of information needed to conduct an informed debate on target setting.

A further problem is that the presentation of the modelling results in Figure 3.8 of the Report is misleading in that it includes an expected large increase in rooftop solar generation, even though, as explained above, this is not part of NEM generation and is not directly influenced by a Clean Energy Target or any other grid level policy instrument. Recalculating the presented results to exclude rooftop PV leads to the conclusion that the modelling yields a renewable share of grid generation in 2030 of 36%, not 42% as implied by Figure 3.8, and the coal share is 59%, not 53%.

A more serious omission is the complete absence of any mention in the Report of the renewable energy targets adopted by the state governments of both Victoria and Queensland, planning for both of which is well advanced. The report on the modelling explains that contributions from these policies were excluded because they have not yet been legislated. The main Review Report misleads by not including this explanation.

The Victorian target is for a 40% share of renewable generation by 2025 and the Queensland target is for a 50% share by 2030. On the basis of available information from both states, including the report of the Queensland Renewable Energy Expert Panel, and of AEMO's forecasts of grid electricity demand, I have calculated that the combined effect of these two programs, on top of the LRET, could increase the renewable generation share of NEM generation to about 30% in 2025 and 37% in 2030, i.e. as much or slightly more than the CET is estimated by the modelling to achieve.

Much of this new generation is likely to replace coal fired power stations which are closed because of old age. Hazelwood was just over 50 years old when it closed last March, having supplied 5% of NEM generation over the preceding year. Liddell is currently supplying about 5% and its closure in 2022, at 51 years of age, has already been announced by its owner, AGL. Between 2025 and 2030, two more power stations, Vales Point in NSW and Gladstone in Queensland, will reach 50 years; they are currently supplying a little over 7% between them. However, the modelling for the Finkel Review assumes that, after Liddell, all remaining coal fired power stations will keep operating until they are 60 years old, so that no more will close until well into the 2030s.

The state government programs have been strongly criticised by the Australian government, and many other commentators, for failing to take account of how the increased renewable generation they are promoting will affect system reliability and security. Those are the issues which the Finkel review was established to address and it has done so with a large set of recommendations. While there are potential problems with some parts of the recommendations, on the whole they set out a comprehensive program for the NEM to move from a high emission, coal-based electricity supply system to a low emission, renewable based system. Implementation of these recommendations should enable the NEM to transition towards a secure, reliable, low emission electricity system, regardless of whether growing renewable generation capacity is driven by a national Clean Energy Target or a state government program.