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NATIONAL ENERGY EMISSIONS AUDIT

National Energy Emissions Audit
Electricity Update

September 2018

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

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Key points

+ ***Wholesale prices appear to have peaked in most states as a surge of new renewables come on-line***

Average wholesale prices appear to have peaked in all NEM states, and the strong growth in new renewable generation should put continuing downward pressure on prices.

+ ***The next two years will see continuing rapid growth in both wind and solar equal to more than double the current output from Liddell power station***

If the capacity of new wind and solar generation as reported by the Energy Security Board operates at the same average capacity factors as current wind and solar generators, the total increase in annual electricity generated between the start of this year and the end of 2020 will be equal to about 10% of all NEM generation over the past year. This is equal to more than the current total annual output from Eraring, the largest power station in Australia, and more than double the current output from Liddell.

+ ***Increased LNG exports are the main driver of increased national emissions***

While electricity emissions have fallen, emissions in nearly every other sector have increased, resulting in an increase in national emissions. Factors include the continued increase in diesel use in transport, increases in agriculture, and there has been a small but unusual increase in waste emissions, despite waste projects receiving one third of credits under the Emissions Reduction Fund.

However the major factor has been increased LNG exports. LNG is a highly emissions intensive industry through increased fugitive emissions and gas combustion during processing, as well as increased electricity demand. The protracted delays in commissioning carbon capture and storage at the Gorgon LNG Project in WA have contributed millions of tonnes of emissions, making up a substantial part of the national emissions increase. These trends highlight the need both for greater emissions reductions in electricity, and policy to address emissions in other sectors.

+ ***Annual total demand and total emissions in the NEM were almost unchanged during September; demand was also unchanged in Western Australia***

With no significant change in total demand, annual supply for coal and wind generation was also virtually unchanged. However, hydro generation increased slightly while gas generation decreased slightly. Rooftop solar generation continued to increase in annual terms, reflecting the continuing high levels of new system installations. This means that, although demand for grid supplied electricity is not increasing, total electricity consumption across all consumers, including rooftop solar consumed behind the meter, is gradually increasing, though at a slower rate than population.

Introduction

Welcome to the October 2018 issue of the *NEEA Electricity Update*, with data updated to the end of September 2018. The *Electricity Update* presents data on electricity demand, electricity supply, and electricity generation emissions in the National Electricity Market (NEM), plus electricity demand in the South West Interconnected System (SWIS). From time to time it will also include information and commentary on other fossil fuel related emissions, including emissions from consumption of petroleum products and natural gas. This will replace the quarterly *National Energy Emissions Audit Report*, which will no longer be published on a regular quarterly basis. This change will facilitate the reporting of important new data about Australia's energy combustion emissions, as and when such data become available.

In this issue we look two recent government publications. The most recent *Quarterly Update of the National Greenhouse Gas Inventory* was released late on Friday 28 September, a day which was a public holiday in Victoria, and preceded a long weekend in most other states. A day or two earlier, the government released the 2016-17 issue of *Australian Energy Statistics*. This is the most authoritative reference source of comprehensive data on Australian energy extraction, transformation and use, and the key input for the calculation of Australia's energy combustion emissions for the National Greenhouse Gas Inventory. It is usually published in July, one year after the end of the financial year to which the data relate. On this occasion it had been ready and waiting Ministerial approval for release for well over two months.

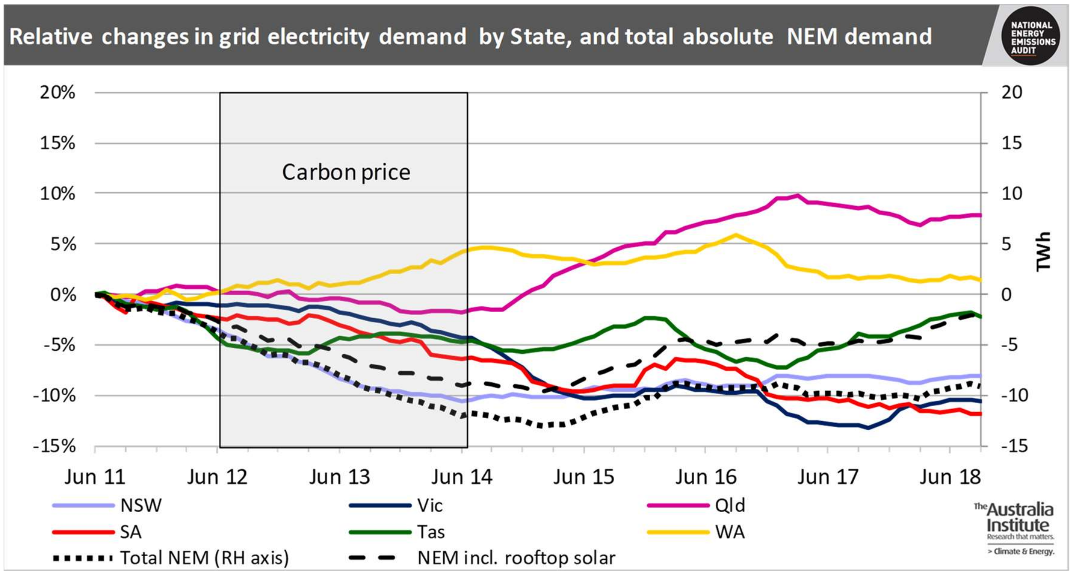
We look in detail at the *Quarterly Update* report, commenting on each of the sectors which have contributed to the increase in Australia's greenhouse gas emissions recorded in the report. We use the data in *Australian Energy Statistics* to inform the commentary, particularly relating to the increase in emissions arising from growth in diesel fuel consumption and from increased production of LNG.

GENERATION, DEMAND AND EMISSIONS TRENDS

Demand for electricity

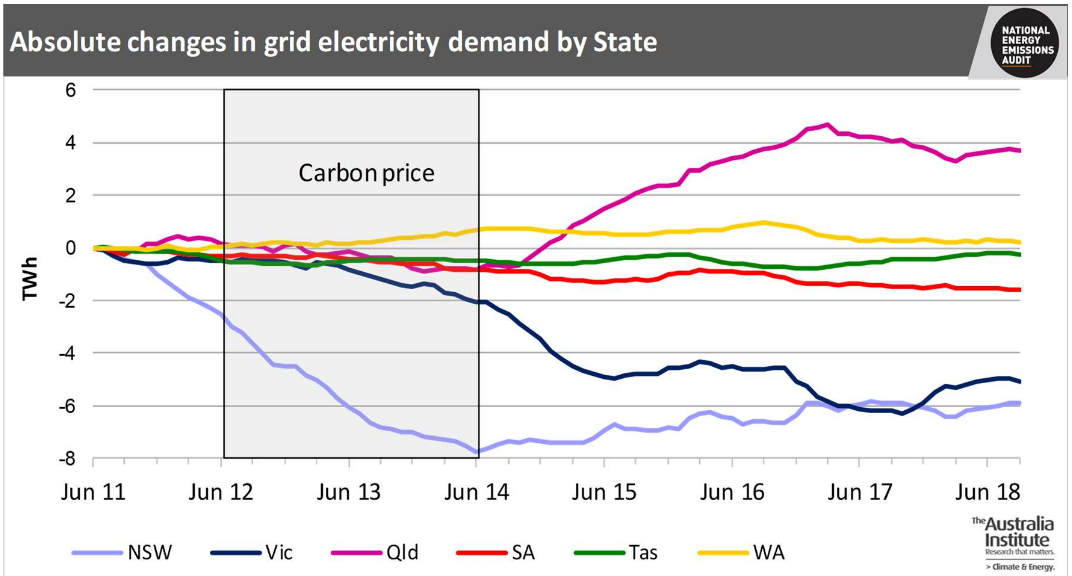
There was almost no change in annual net demand for electricity supplied through the NEM up to the end of September 2018. This is shown in Figure 1, together with relative changes in demand in each state.

Figure 1



Total NEM demand at the grid level has now recorded no sustained or significant change for two and a half years. The relatively modest increase in total electricity consumption has, in net terms, been supplied by the growth in rooftop solar PV generation. Figure 2 shows the same data for individual states, but in absolute rather than relative terms. While total NEM demand has hardly changed, there have been more significant changes, including both increases and decreases, in individual states.

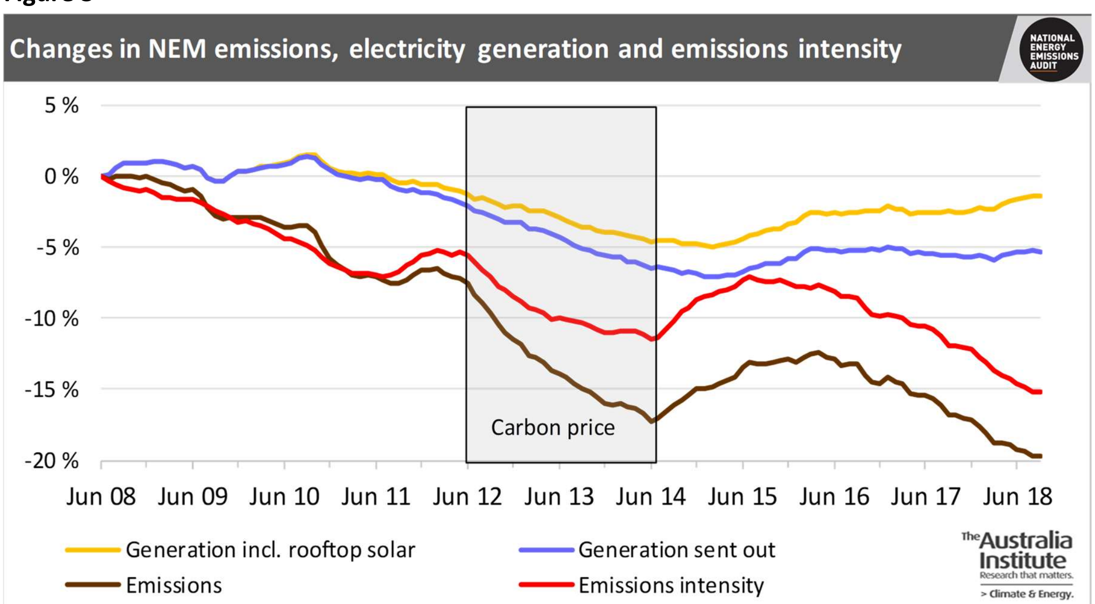
Figure 2



Generation and emissions

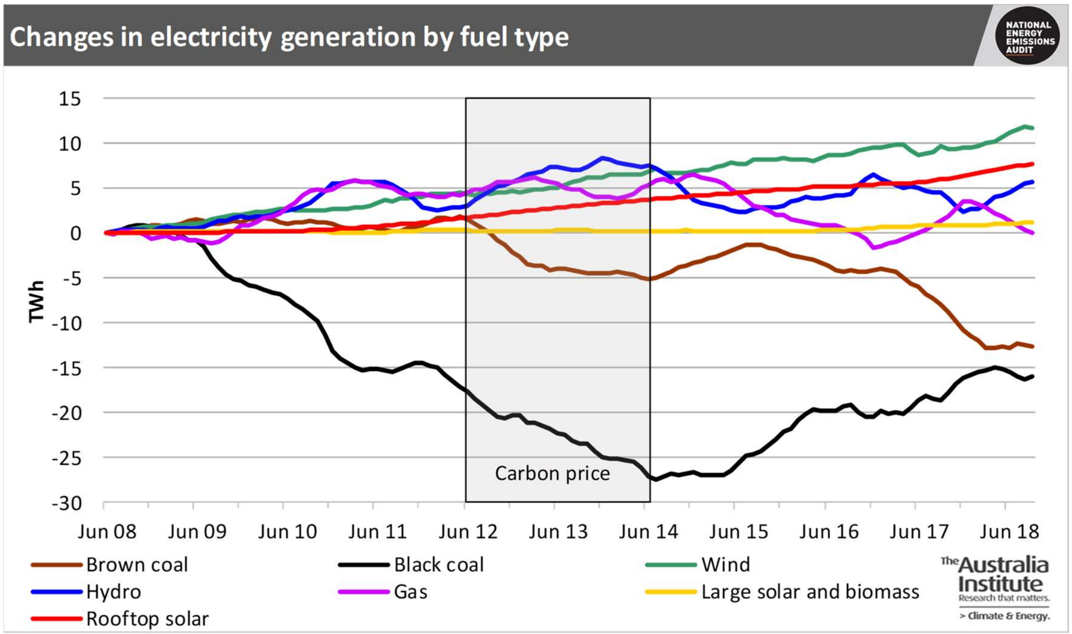
Figure 3 shows that total grid generation was almost unchanged in September, while emissions, and the emissions intensity of generation sent out, both continued to decrease, though only by a small amount.

Figure 3



The cause for the month of September, as Figure 4 shows, was increased hydro generation (in Tasmania), which displaced some gas generation. The growth in hydro generation in Tasmania was mainly attributable to abundant rain.

Figure 4



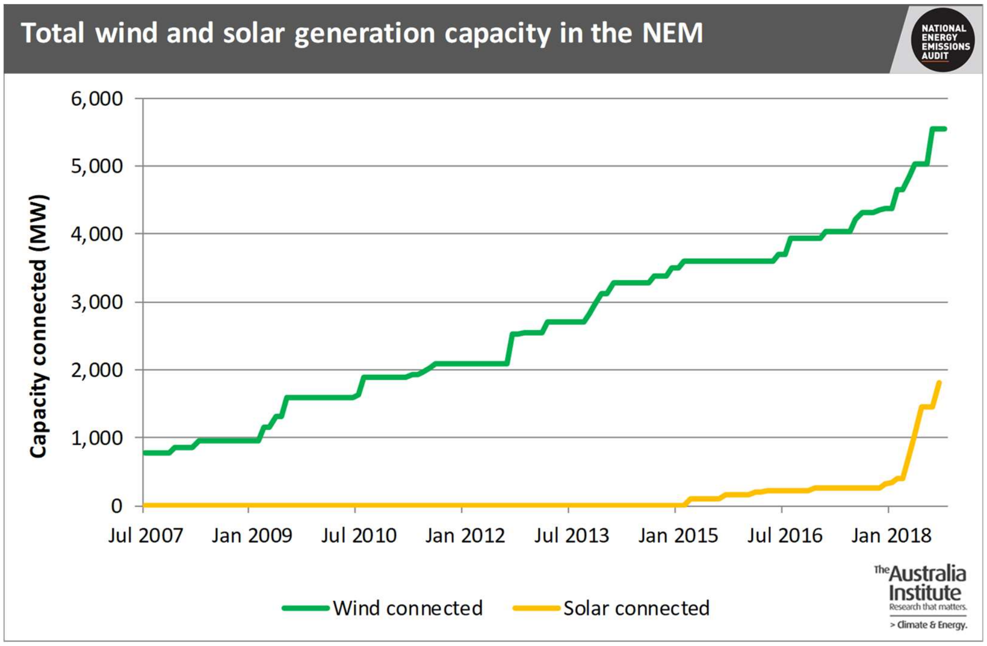
In August, Tasmania recorded its highest monthly total hydro generation since joining the NEM in 2005. The Tasmanian hydro generation system consists of a large number of separate power stations, many of them quite small, and many separate water storages, many of which are also quite small. Most of the power stations have been generating in very high levels. The weighted average capacity factor for the whole month of August was 99% of nameplate capacity, for all except for two large power stations, and two small stations closed for extended maintenance.

The two larger power stations not running at capacity were Gordon and Poatina, supplied by Lake Gordon and Great Lake respectively. Over the past four years these storages were run down to low levels, as excessive generation in the carbon price period was followed by drought and then by six months of being cut off from Victorian generation because of the Bass Strait cable break. Hydro Tasmania is now allowing these two storages to replenish, so Gordon and Poatina are generating at half or less of their nameplate capacity.

New renewable generation connections

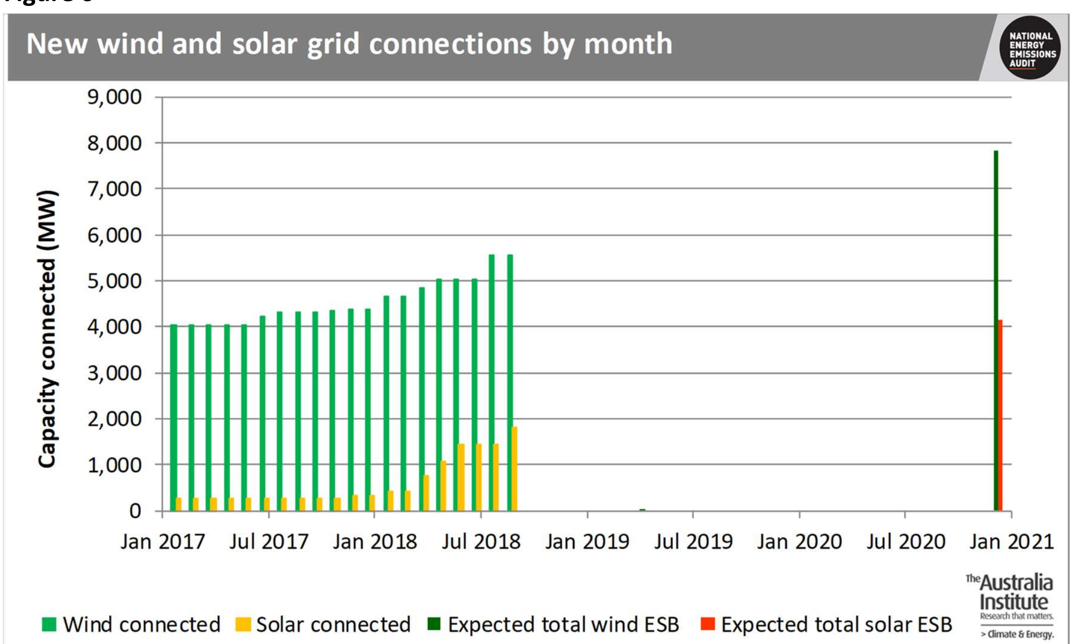
Figures 5 shows grid connected capacity of wind and solar generation at the end of each month.

Figure 5



During September, four new solar farms started supplying the grid: Coleambally in New South Wales, which at 150 MW is the largest solar farm to date in Australia, Emerald and Ross River in Queensland, with a combined capacity of 216 MW, and Bannerton in Victoria, with a capacity of 110 MW.

Figure 6



Many of the projects newly connected to the grid are not yet operating at full capacity, so the rapid growth shown in both Figures will continue for some time. Moreover, with a continuing steady flow of announcements about new projects and power purchase agreements, the end of 2020 end point or target shown in Figure 6 is the capacity of wind and solar generation capacity which the Energy Security Board expected, in a publication released in late July, to be connected by the start of 2021, is already out of date. At the beginning of October the Clean Energy Regulator, the Commonwealth agency responsible for administering the Renewable Energy Target scheme, released its latest *Update on new large-scale renewable energy projects*. This reported on capacity which would be added between the beginning of 2016 and the end of 2020. When added to the capacity already connected in 2016, the new figures represent an increase of about a quarter on the capacity shown for 2020 in Figure 6: from about 12 GW wind and solar combined to over 15 GW. Unfortunately, the Update does not provide separate figures for wind and grid scale solar projects, so it not possible to update Figure 6.

Table 1 below shows where NEM wind and solar capacity is installed across states as at the end of September. South Australia still has the largest share of total NEM wind generation capacity, but Victoria and, to a lesser extent New South Wales, are catching up. New South Wales was the first state with grid connected solar farms, but Queensland has already overtaken it.

Table 1: Share of NEM wind and solar capacity by state – September 2018

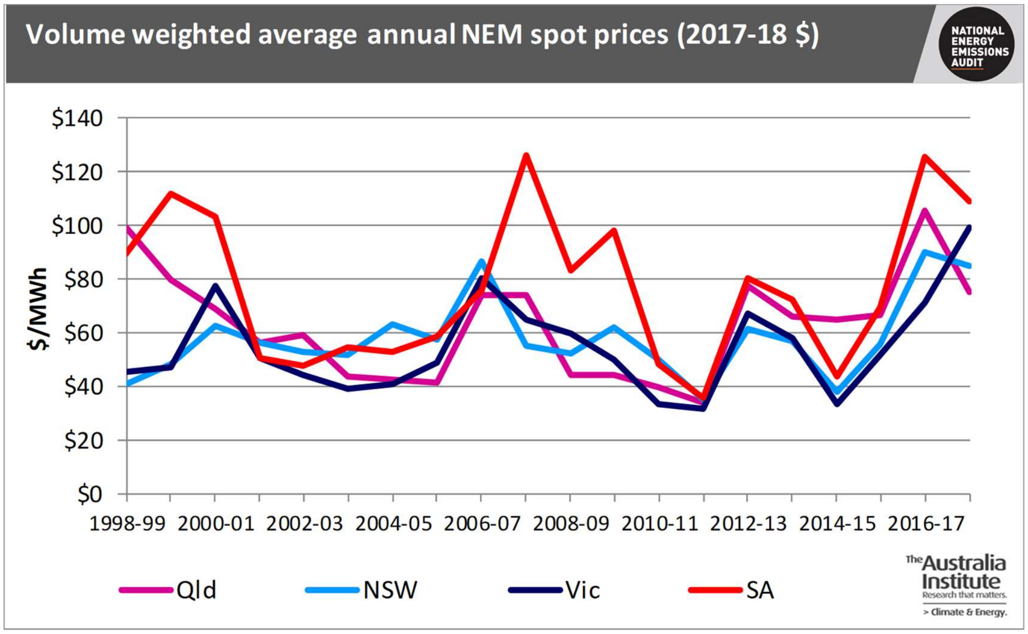
	Share of NEM wind capacity	Share of NEM solar capacity
New South Wales (incl. ACT)	27%	30%
Queensland	3%	54%
Victoria	30%	9%
South Australia	34%	7%
Tasmania	6%	0%

If the capacity of new wind and solar generation represented by the Energy Security Board figures operates at the same average capacity factors as current wind and solar generators, the total increase in annual electricity generated between the start of this year and the end of 2020 will be equal to about 10% of all NEM generation over the past year. This is equal to more than the current total annual output from Eraring, the largest power station in Australia, and more than double the current output from Liddell.

Wholesale price trends

Figure 7 shows the average volume weighted wholesale prices by year for each NEM state. The underlying data are compiled, in nominal dollars, by the Australian Energy Regulator.

Figure 6



Wholesale prices have declined modestly in most states, consistent with the widely held view that wholesale prices in the NEM have peaked, and are now expected to gradually decrease. Quarterly volume weighted average spot prices, as calculated by the Australian Energy Regulator, have been lower in each of the five NEM regions (states) in both the June and September quarters this year than in the corresponding quarters in 2017, indicating that the market is now recovering from the shock induced by the sudden closure of Hazelwood power station. The strong growth of new renewable generation should continue to put downward pressure on prices.

NATIONAL EMISSION TRENDS

Overview

As has been quite widely reported in news media, the most recent, much delayed *Quarterly Update of Australia's National Greenhouse Gas Inventory* was publicly released two months late on Friday 28 September. Consistent with what NEEA has been reporting for some time, the government's Inventory Update shows electricity generation emissions decreased over the year from March 2017 to March 2018. However emissions from nearly all other sectors increased. The one exception was Land Use, Land Use Change and Forestry (LULUCF). These changes are summarised in Table 2 below.

Table 2: Emissions by industry (Mt CO_2-e) to *Quarterly Update* to March 2018

Sector	Year to March 2017	Year to March 2018	Change
Electricity generation	189.6	181.5	-8.1
Stationary combustion	93.9	98.3	4.4
Transport	98.5	100.5	2.0
Fugitive energy	50.4	57.3	6.9
Industrial processes	35.0	36.1	1.1
Agriculture	72.2	73.7	1.5
Waste	12.5	12.6	0.1
LULUCF	-22.2	-23.3	-1.1
	529.9	536.7	6.8 = 1.3%

NEEA reports have been pointing out for some time that while the reductions in electricity sector emissions are noteworthy, they will not be sufficient to offset increases in the other energy related sectors. The actual results shown here, however, are even worse than we feared. The main causes of the increase in energy related emissions are discussed below. First however we address emissions in the non-energy sectors.

Non-energy related emissions

Industrial processes

Emissions from the various chemical and primary metal manufacturing processes, which account for much of this sector, have been steady or slowly decreasing for several years. However, emissions from HFCs and other synthetic gases (formally termed Products Substituted for Ozone Depleting Substances) continue to increase. A year ago, the

Environment Minister Josh Frydenberg proudly announced that Australia was one of the first ten countries to ratify the Kigali Amendment to the Montreal Protocol, and stated that imports of HFCs would start to reduce in 2018. It remains to be seen whether, and if so when, and such reduction in imports will start to show up in the emissions inventory.

Agriculture

Nearly three quarters of emission from the agriculture sector arise from enteric fermentation, i.e. methane belched by cattle and sheep. Destocking because of the current severe drought is almost certain to see this source of emissions fall somewhat next year. In the longer term, however, emissions can be expected to increase again. This is a particularly intractable source of emissions, emphasising how important it will be to achieve deep cuts in electricity sector emissions, as well as continuing to fund research on reducing emissions from agriculture.

Waste

Waste is a small source of emissions, around 2% of the national total, and has been gradually decreasing for many years. It is therefore surprising that emissions have apparently increased marginally during the year to March 2018. This is particularly surprising, given that a number of supposed waste sector emission reduction projects were funded through the government's Emissions Reduction Fund, and the credits issued against these projects account for over one third of the total emission reductions claimed for the Fund. While recognising that these emission reductions, if they are real, will be spread out over many years into the future, this new data would tend to support the finding of critics who have been saying for some time that many of the funded projects are non-additional, i.e. the funding supports activities which were already occurring or were going to occur without taxpayer subsidy.

LULUCF

This sector has received the greatest share of support from the Emission Reduction Fund. Credits issued account for well over half the emissions reductions purchased to date. Some of these projects are undoubtedly very successful and have contributed to the decline in LULUCF emissions though others have been criticised as non-additional. It is most important to note that, although the government consistently quotes very big numbers of total abatement from these projects, most projects have very long lifetimes. This is entirely unsurprising, given that they are dependent on the growth of trees, many of them in relatively low rainfall areas where growth is slow. But it means that the contribution to annual emission reduction will be small for some years to come, and, in most cases, is unlikely to reach a maximum until after 2030

Energy related emissions

Electricity generation

The Environment Department estimates an 8.1 Mt CO_2-e reduction in electricity emissions over the year to March 2018. This is in line with NEEA estimates of 7.8 Mt CO_2-e – especially noting that NEEA data do not include Western Australia.

Transport

As shown in earlier NEEA publications, and its predecessor, there has been a seemingly inexorable rise in diesel consumption in Australia. However, since the source data reports only total diesel sales, it has been difficult to determine which activities and sectors are responsible for the large diesel consumption increase. *Australian Energy Statistics* - released a couple of days before the *Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2018* - shows that, over the three year period from 2013-14 to 2016-17, road transport accounted for almost two thirds of the total increase in diesel consumption. There was also a large increase in relative terms (though considerably smaller in absolute terms) in diesel used for rail transport. It is important to note that much of Australia's rail transport activity is devoted to transporting huge volumes of coal and iron ore from mine to port.

As NEEA has also observed, consumption of petrol is almost static, as is consumption of jet fuel by domestic aviation. Hence almost all the increase in emissions from transport is attributable to diesel consumption by road transport. The last full NEEA Report examined the relative contributions of passenger vehicles and road freight to this increase.

Stationary combustion

The Department of Energy and Environment's *Quarterly Update* nominates production of LNG as the major driver of increased stationary energy emissions. This is hardly surprising, since production of LNG is a relatively energy intensive process, which uses gas for all its direct energy requirements. The *Australian Energy Statistics* data show that, in the two years from 2014-15 to 2016-17, natural gas consumption by the oil and gas extraction and processing sector increased by 58%, and in 2016-17 it accounted for 32% of all natural gas consumption exclusive of electricity generation. Over the same two years, production of LNG more than doubled. Since LNG production is still increasing in Western Australia and the Northern Territory, it is obvious that consumption of gas for processing has also increased again during 2017-18, and accounts for the increase in stationary energy emissions up to March 2018.

The 2016-17 *Australian Energy Statistics* data show that natural gas consumption decreased over the two preceding years in all sectors of manufacturing. This result is entirely consistent with the widespread concern expressed by many sectors of manufacturing about the detrimental impact of very high gas prices on their operations. Manufacturing as a share of total gas consumption fell from 49% to 41%. Small increases in gas consumption in the residential and commercial sectors by no means offset the fall in consumption by manufacturing.

Coal consumption in stationary combustion, which is mainly concentrated in the iron and steel, non-ferrous metals and cement industries has been roughly constant.

Putting these changes together, the clear conclusion is that LNG production was the main driver of growth in stationary combustion emissions up to 2016-17, and that increase undoubtedly continued in 2017-18.

Fugitive energy emissions

The main sources of fugitive emissions are methane emissions from coal mines, methane leakage from natural gas distribution networks in urban areas, and controlled venting and leakage of carbon dioxide from gas production and processing. But the *Quarterly Update* shows that, over the past two and a half years, fugitive emissions from coal mining have trended down, while emissions for the oil and gas industry have steadily increased, and again this increase is attributed to LNG production. Coal seam gas, which is used to produce LNG at the three plants in Queensland, normally contains low concentrations of carbon dioxide when extracted. However, many of the conventional gas fields in Western Australia and the Northern Territory contain quite large concentrations of CO_2 in raw gas, almost all of which must be separated out before the gas can be liquefied. Consequently, fugitive emissions from LNG production in these regions are large and growing. The NGERS public data for 2016-17 show that Woodside Petroleum, operator of the North West Shelf and Pluto LNG projects, was the largest direct emitter of greenhouse gases (other than electricity generators) in that year. Chevron Australia, the operator of the Gorgon LNG project, also in Western Australia, was the fourth largest non-generator emitter.

Gorgon LNG Project has been lauded for its incorporation of a major CCS project. However, the sequestration part of the project is still not operational, resulting in millions of tonnes of CO_2, mixed with considerable volumes of methane, being released directly into the atmosphere during the first two years of operation. Even if Gorgon CCS succeeds, those reductions will be offset by LNG emissions from the Ichthys plant in Darwin and the Prelude plant floating in Australia's territorial waters, when they are completed.

APPENDIX: NOTES ON METHODOLOGY

Data on annual consumption of electricity, and seasonal peak demand, are for each of the six states. All other data are for the states constituting the National Electricity Market (NEM) only, i.e. they exclude Western Australia. All data are reported as annual moving averages. This approach removes the impact of seasonal changes on the reported data. Annualised data reported in *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.

Defining the particular meaning of the various terms used to describe the operation of the electricity supply system will help in understanding the data discussed.

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. Both demand and generation, as shown in the *Electricity Update* graphs, are 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 the regular total generation graph; 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.