

**NATIONAL  
ENERGY  
EMISSIONS  
AUDIT**

National Energy Emissions Audit  
*Electricity Update*

**July 2018**

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

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## Introduction

Welcome to the July 2018 issue of the *NEEA Electricity Update*, with data updated to the end of June 2018. *Electricity Update* is the companion publication to the quarterly *National Energy Emissions Audit Report*, the next issue which will be in September 2018. The *Electricity Update* presents data on electricity demand, electricity supply, and electricity generation emissions in the National Electricity Market (NEM).

Each issue of *Electricity Update* contains a more detailed discussion of one or two particular issues relating to the electricity system. In this issue we report results from an analysis of emission reductions likely to be achieved in the NEM with policies and programs already in place nationally (the Large Renewable Energy Target) and in several states. We compare these reductions with the emissions reduction target proposed for the National Electricity Guarantee (NEG). The conclusion is that the NEG will make no contribution to reducing emissions because the target will be met or exceeded by existing policies and programs.

## Key points

- + ***A continuing fall in emissions from generation in the NEM is being driven by steadily increasing supply of electricity from new wind and grid scale solar generators***

The closure of Hazelwood power station in 2017 is no longer contributing to lower emissions in the NEM. Emissions continue to fall due to rapidly growing renewable generation displacing supply from black coal, brown coal and gas generators.

- + ***There has been a small increase in annual electricity consumption over the past few months in both the NEM and in WA***

The increase has occurred in every state except South Australia, where consumption of grid electricity has been constant over the past few months. However, when electricity supplied by rooftop solar installations is included, total electricity consumption is seen to be gradually increasing in all states.

- + ***In the year to June both non-hydro and total renewable generation in the NEM reached new record levels, in terms of both absolute quantities and shares of grid generation***

In the year to June 2018, i.e. financial year 2017-18, total renewable generation supplied 15.7% of NEM generation, and variable renewable generators supplied 7.6%; both figures are records. When supply from rooftop solar is added to both numerator and denominator of the equation, the renewable share of supply for the year increases to 18.8%. The ratio for Victoria alone is at least 18.3%, showing that the state is well on the way to its interim target of 25% renewable generation by 2020.

- + ***New modelling shows that the emissions reduction mechanism proposed for the NEG will make little or no contribution to reducing emissions in the NEM***

Wind and solar generators now under construction or committed to being built will reduce NEM emissions to within 5 Mt CO<sub>2</sub>-e of the 129 Mt CO<sub>2</sub>-e target by 2020-21. This leaves emissions reduction of less than 4% to be achieved by 2030.

- + ***In the absence of stronger emission reduction targets, the currently booming wind and solar generator construction industry is at risk of completely collapsing after 2021***

When all current projects are commissioned, further construction of just two medium size wind farms in each of the following ten years would ensure that the NEG emissions target is reached by 2030. The total new capacity required will be only about two thirds of the capacity expected to be commissioned in 2018-19 alone.

# GENERATION, DEMAND AND EMISSIONS TRENDS

## Demand for electricity

Changes in annual net demand for electricity supplied through the NEM in each state, up to the end of June, are shown in absolute and relative terms in, respectively, Figures 1 and 2. It appears that over the past year demand has grown somewhat in Victoria and Tasmania, but is unchanged or slowly declining in the other four states, and in the NEM as a whole. However, Figure 3 tells a somewhat different story, by graphing changes in total consumption of electricity, calculated by adding electricity supplied through the NEM grid to electricity generated by rooftop solar installations, including both electricity exported into the local distribution network and electricity consumed on the premises “behind the meter”. It can be seen that, with this inclusion, total electrical energy used by consumers in all the NEM states and in Western Australia is gradually increasing, rather than remaining constant. For the year to June 2018, i.e. financial year 2017-18 as a whole, the consumption increase compared with 2016-17 was 0.3% for grid supplied electricity, but 1.1% when rooftop solar supplied electricity is included.

Figure 1

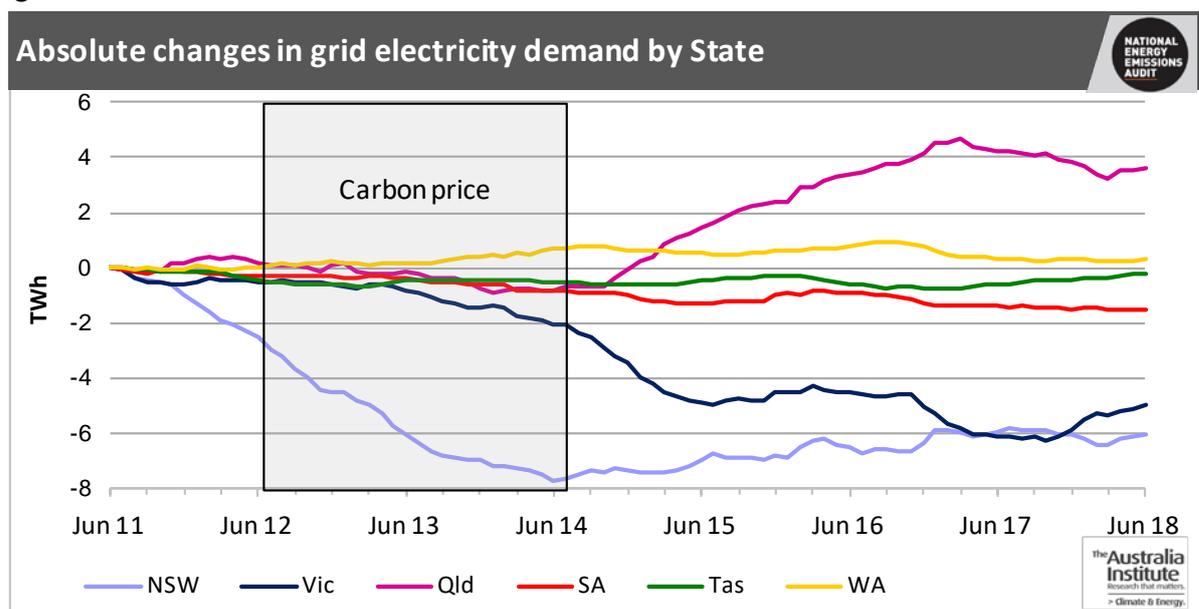


Figure 2

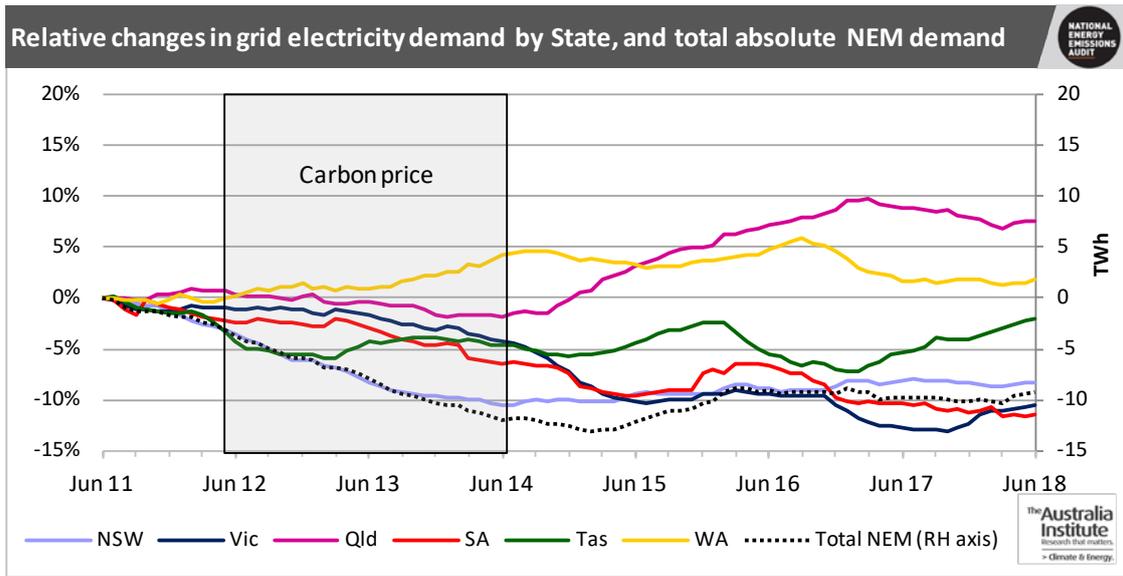
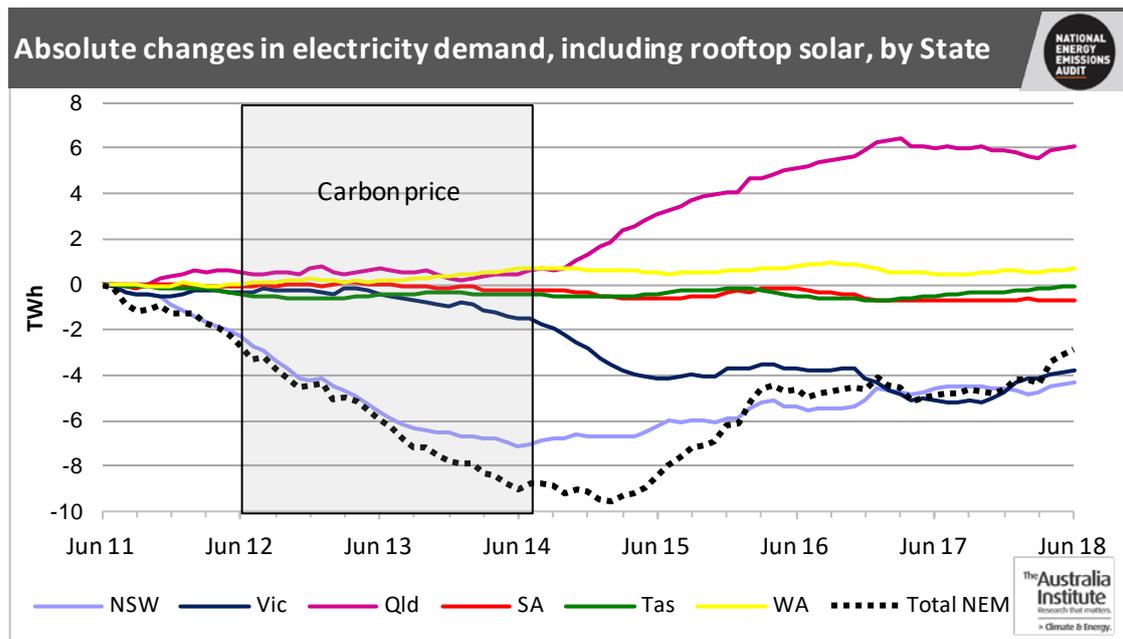


Figure 3

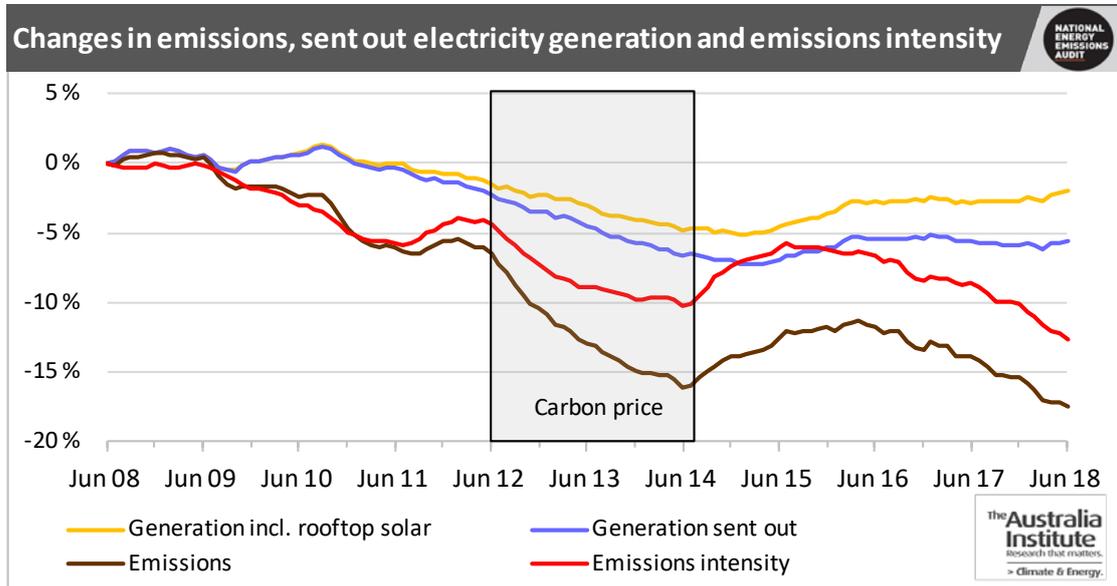


## Generation and emissions

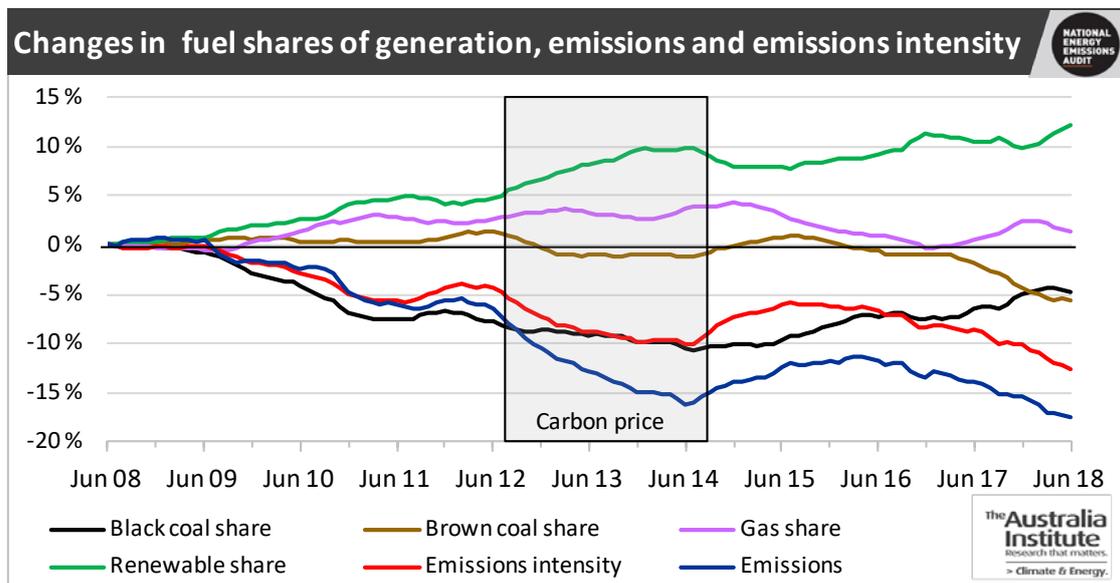
Over the past fifteen months, *NEEA Electricity Update* has been charting the steady decline in annual greenhouse gas emissions from NEM generation as a result of the closure of Hazelwood power station at the end of March 2017. There was some expectation that this decline might cease, following the anniversary of the closure, as the share of electricity supplied by coal generators steadied at a new, lower level. However, data for the three months to June 2018, shown in Figures 4 and 5, indicate that emissions are continuing to decrease. What is happening, as shown in more detail in Figure 6, is that strong growth in renewable generation

is causing the shares of all fossil fuel generation, including black coal, brown coal and gas, to continue falling, with a consequent continuing fall in emissions.

**Figure 4**



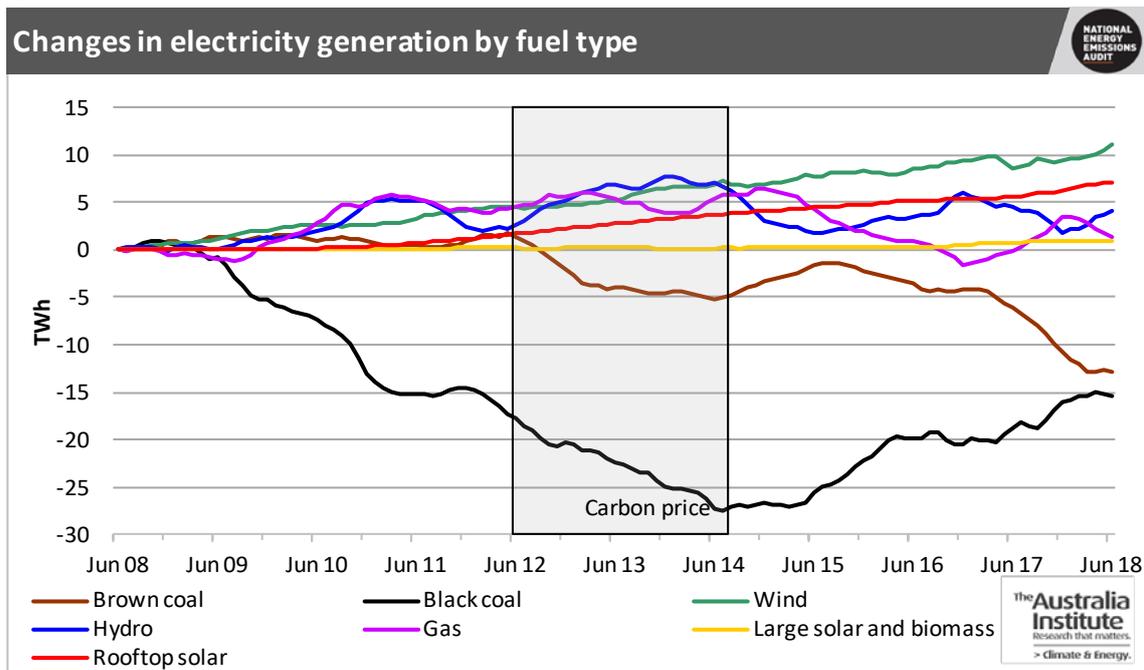
**Figure 5**



When Hazelwood closed it was both the oldest and the most emissions intensive power station remaining in the NEM. It was also, in terms of generating capacity, the largest single power station closure in the history of the Australian electricity supply system, and the closure occurred with less than five months advance notice. Despite these challenges, there have been no significant supply disruptions, though there have been some challenges to system operation caused by sudden failures of coal fired generation units. Moreover, the average level of spot wholesale prices in all five NEM regions over the past six months has been generally lower than during the corresponding period last year. Wholesale prices are certainly

higher than they were prior to the Hazelwood closure. However, as a report just released by the Grattan Institute points out, when not affected by market gaming, as they often are, particularly during summer, current prices are about equal to the long run marginal cost of new generation capacity.<sup>1</sup> This is precisely the outcome to be expected in a functional market, when excess supply capacity is removed, represented in this case by the closure of Hazelwood power station.

**Figure 6**



To summarise, the closure of Hazelwood power station has led to a decisive and apparently continuing fall in emissions, accompanied by an increase in wholesale prices from short term to long term marginal cost level, with negligible impact on the reliable supply of electricity to consumers. At another time and place, such a transition could and should be seen as a tribute to sound policy and skilful implementation by the system operator, but Australia in July 2018 is not such a time and place.

## New renewable generation

The last (April/May 2018) issue of *NEEA Electricity Update* included a table listing all the grid scale wind and solar generators which started supplying the NEM during the period from January to May 2018. Total capacity of the listed wind and solar farms, when completed, will be 530 MW wind and 500 MW grid solar. Since that issue was published two more have been added: Salt Creek wind farm in Victoria, 54 MW, and Sun Metals solar farm in Queensland, 124

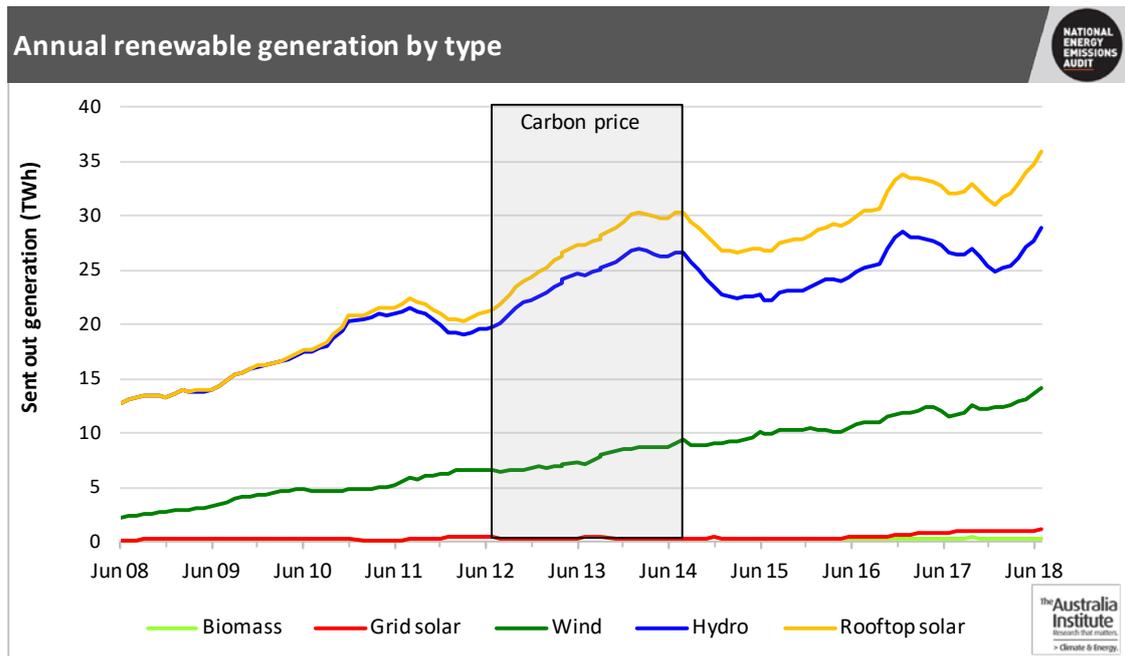
<sup>1</sup> Wood et al (2018) *Mostly working: Australia's wholesale electricity market*, <https://grattan.edu.au/wp-content/uploads/2018/06/905-Mostly-working.pdf>

MW, bringing total new capacity in 2018 to date to 584 MW wind and 624 MW solar. More is expected to be commissioned by the end of 2018.

This surge in new capacity is the direct consequence of the renewable industry’s “escape” from two years of turmoil created in 2013 by the incoming Abbott government, with the passage, in June 2015, of legislation confirming a new and reduced 2020 renewable electricity generation target. The flow of new investment, released by the removal of most of the uncertainty which had crippled the industry, is now coming on line. It is this new renewable generation capacity which has driven the continuing fall in NEM emissions since the anniversary of the Hazelwood closure.

Figure 7 shows that, in the year to June 2018, grid scale renewable generation (hydro, wind, large solar and sugar mill biomass) in the NEM reached a new record level of 28.9 TWh, equal to 15.7% of NEM generation. The share of hydro was 8.0%, well below the record level of 9.0% set in the year to December 2016, but the combined 7.6% share of wind and solar generation was a record, as was the total generation of 14.2 TWh. The stream of new wind and solar projects has seen generation reach record levels, in terms of both total annual quantity and shares of grid generation, in each successive month for the past six months, a pattern which seems likely to continue for months into the future.

**Figure 7**



Output from rooftop solar installations has also been growing steadily for many years now, a trend clearly seen in Figure 7. Consequently, total renewable supply, including rooftop solar, is also growing rapidly as a share of total generation inclusive of rooftop solar. This can be seen in Figure 8. In the year to June 2018, small scale solar supplied 7.1 TWh and the share of all renewables in total supply reached 18.8%. This ratio is important because it is the metric used

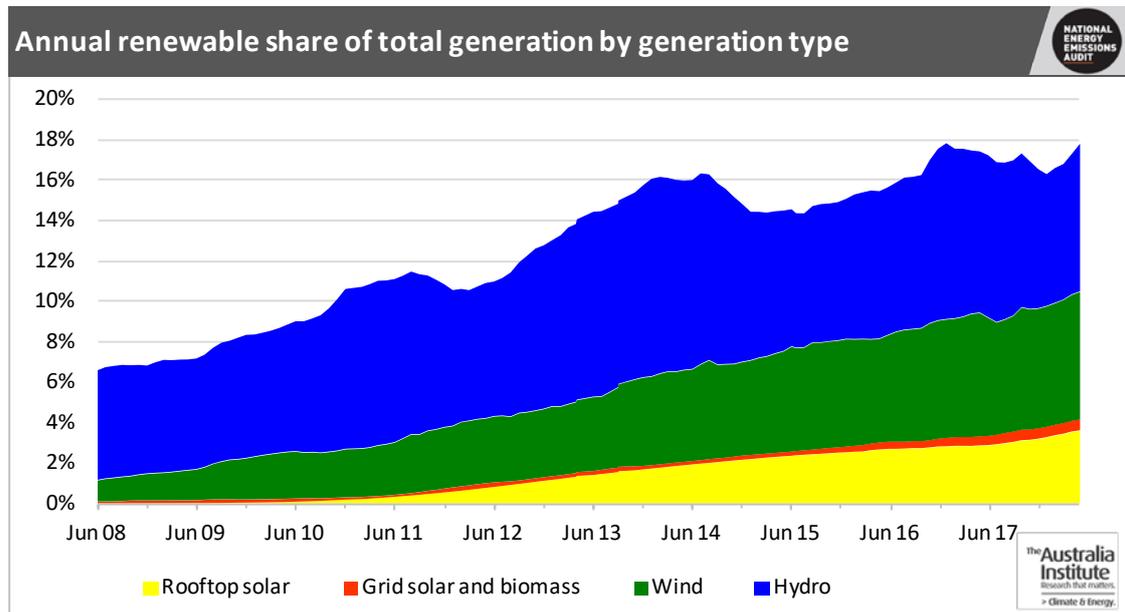
by the ACT, Victoria and Queensland governments to define their legislated or proposed renewable energy targets.

The A.C.T. has a legislated target of 100% renewable supply by 2020. As at June 2017 its share was just under 30%, but with a number of large wind generation contracts starting over the past year, its share by the end of June 2018 is likely to be considerably higher.

Victoria has legislated targets of 25% by 2020 and 40% by 2025. As at June 2018, its annual figure has been calculated to be 18.3% in the NEEA model, but the true figure will probably be slightly higher because of the contribution of small renewable generators, such as landfill gas, for which data for 2018 are not readily available. The current Victorian renewable share represents an increase of seven percentage points (from 11.3%) since June 2014. With the number of new wind and solar projects coming on line in Victoria, the 2020 target should be readily achievable.

The current Queensland government has committed itself to a plan to reach 50% total renewable electricity by 2030, but the target is as yet not legislated. The renewable share of electricity supply in the year to June 2018 was 6.5% but, as with Victoria, this share should increase rapidly because of the large number of new renewable generation projects currently being built.

**Figure 8**



The remainder of this issue of NEEA Electricity Update presents the results of an analysis of likely trends in electricity generation emissions in the NEM under various combinations of existing policies, and compares the outcomes with the emissions reduction target announced for the National Energy Guarantee (NEG).

# PROJECTIONS OF FUTURE ELECTRICITY GENERATION EMISSIONS IN THE NEM

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The model used to produce the graphs and other information presented each month in NEEA Electricity Update has been used as the basis from which to project likely future NEM emissions with different mixes of generation types in future years, out to 2030. The results have been set against the announced emissions target for the NEM of 129.0 Mt CO<sub>2</sub>-e, which is 26% below the 175 Mt level of NEM emissions in 2005.<sup>2</sup>

The NEEA includes details for every power station in the NEM, including emissions per unit of electricity sent out (sent out emissions intensity). These values for each power station are the same as the values which AEMO uses to calculate its Carbon Dioxide Emissions Intensity Index (CDEII). The logic of the modelling of future generation was to define mixes of generation types which would supply each year the quantity of electrical energy needed to match annual consumption levels in each state as projected in AEMO's 2017 *National Electricity Forecasting Report (NEFR)*. The 2018 *NEFR* is expected to be published in the near future, but it seems likely that there will be little change in projected consumption figures. The modelling also incorporated the estimates for future rooftop solar output contained in the 2017 *NEFR*.

Three policy/program scenarios were modelled:

- Large Renewable Energy Target (LRET) only completed,
- LRET plus Victorian Renewable Energy Target (VRET), and
- LRET plus VRET plus Queensland Renewable Energy Target (QRET).

The starting point for all three scenarios was the list of under construction and firmly committed new renewable generation projects published in May this year by the Clean Energy Regulator (CER).<sup>3</sup> The modelling confirmed that this capacity would be more than sufficient to meet the full LRET target for the NEM, i.e. the definite projects will take the total annual supply of electricity from qualifying renewable generators to a higher level than would be required by the LRET. Finally, the modelling included AGL's announced plan to close Liddell power station at the end of 2022 and replace it with a mix of renewable generation, gas generation, and energy storage.

Under the LRET only scenario, the renewable share increases to a higher level than required by the LRET, for the reason explained above. It is assumed that thereafter, i.e. following completion of all the projects in the CER list, no new renewable generation is built, other than that foreshadowed by AGL as part of the replacement for Liddell. One other closure of an old

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<sup>2</sup> Note there are different estimates of 2005 emissions from different models. NEEA's estimate is 175.7, while earlier work by Frontier Economics is based on 174.3.

<sup>3</sup> <http://www.cleanenergyregulator.gov.au/RET/About-the-Renewable-Energy-Target/Large-scale-Renewable-Energy-Target-market-data/large-scale-renewable-energy-target-supply-data>  
Accessed 29/6/2018

coal fired power stations occurs in Queensland, because a large proportion of the new generation capacity listed by the CER is located in Queensland, meaning that less fossil fuel generation will be needed in the state.

Under the LRET plus VRET scenario, there is no additional renewable generation except in Victoria. Victoria is also the other state with the largest share of new renewable generation capacity listed by the CER. This means that the state will easily exceed its 2020 target, but will require between 1,000 and 1,500 MW of additional wind and/or solar capacity to meet the 2025 target. Note that this is less than the new capacity which will be commissioned in the state over the next three years. The increasing supply of energy from new renewable generators is projected to result in Yallourn power station closing by the mid 2020s.

With QRET as well as LRET and VRET, much more new renewable generation capacity is required than under either of the two other scenarios. Queensland currently sources only about 6.5% of its electricity from renewable sources, most of it coming for rooftop solar. Consequently, despite the large volume of wind and solar projects being commissioned over the next few years, the renewable share in 2020 will be still be below the current share in Victoria, not to mention South Australia and Tasmania. Consequently, a continuing program of new renewable generation construction, at or slightly below the level expected over the next three years, will be required throughout the 2020s in order to meet the 2030 target. The large increase in renewable generation will mean that a second old coal fired power station will close during the later 2020s.

Figure 9 shows the results of the emission modelling for each of the three scenarios. It also shows the NEG emissions target for 2030 of 129.0 Mt CO<sub>2</sub>-e, as defined in the original NEG modelling, published in November 2017 (red horizontal line).

**Figure 9: Grid generation and projected NEM emissions under three scenarios**

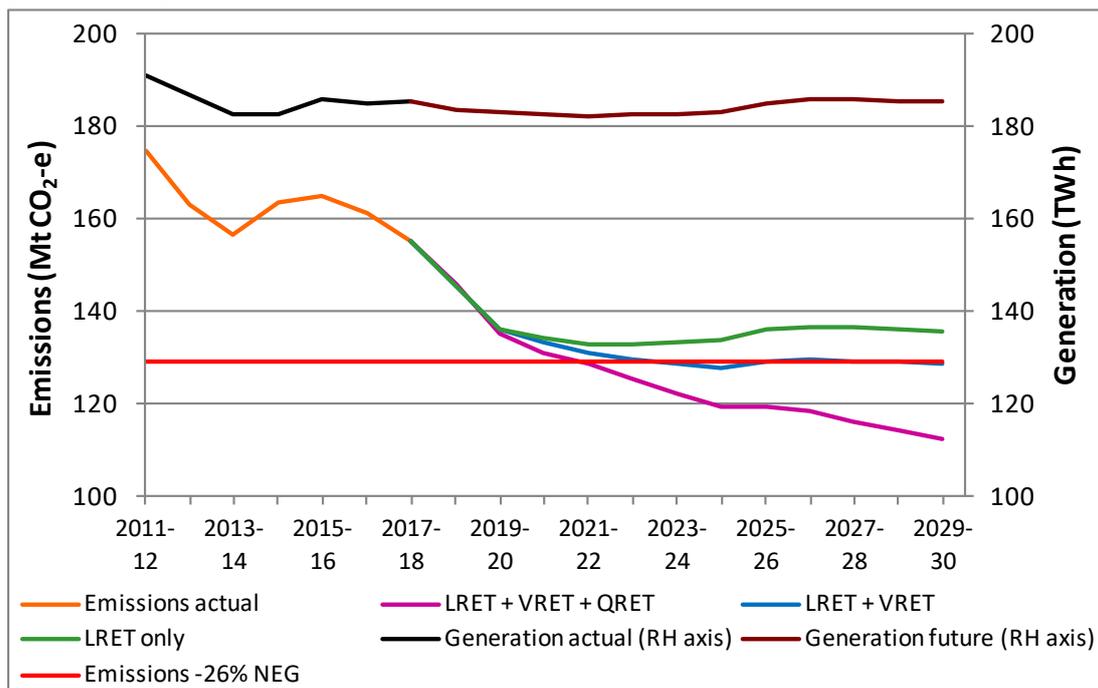


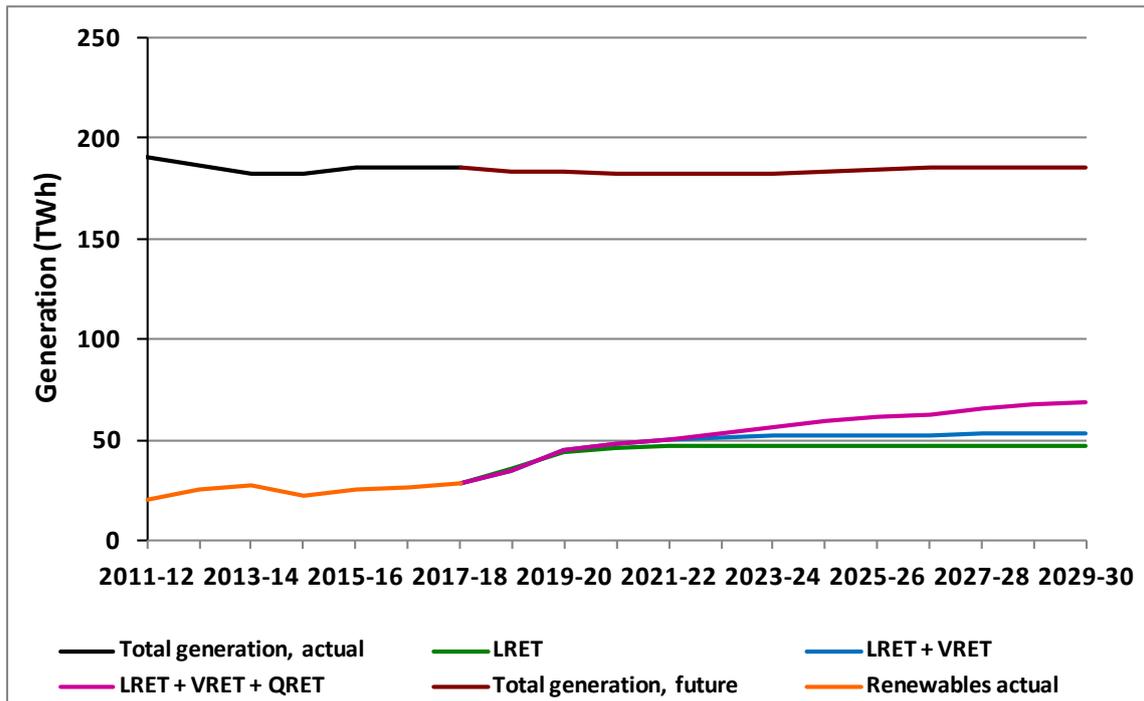
Figure 9 shows that, under the LRET only scenario (green line), emissions fall to 136 Mt CO<sub>2</sub>-e in 2019-20, 4.0% above the NEG target. Emissions reach a minimum of 133 Mt CO<sub>2</sub>-e in 2021-22. To reach the 129 Mt CO<sub>2</sub>-e target by 2029-30 would therefore require NEM emissions to fall by a further 0.5 Mt CO<sub>2</sub>-e per year for eight years. This could be easily achieved. Assuming no increase in electricity consumption beyond that estimated by AEMO, it would only require about 200 MW of new wind farm capacity or 300 MW of new solar capacity each year built in New South Wales or Queensland. In these states, the new capacity would displace black coal generation. Still less capacity would be required if built in Victoria, where the new renewable generation would displace mainly higher emission brown coal generation.

In addition, as can be seen in Figure 9, AEMO expects annual consumption, and therefore generation, to increase by about 3 TWh between 2025 and 2027 (brown line). Under the LRET only scenario, with strictly no new renewable generation after current projects are completed, we have assumed, implausibly, that this additional demand will be supplied from ageing existing coal fired generators, rather than from new wind and solar. Using new wind and solar instead would require only about 1,000 MW, i.e. not much more than half the new capacity commissioned during the past twelve months.

Under the LRET plus VRET scenario, emissions fall below 129 Mt CO<sub>2</sub>-e by 2023-24 and remain almost exactly on the target 129 Mt CO<sub>2</sub>-e for the rest of the decade (blue line). Under the LRET plus VRET plus QRET scenario, emissions fall in line with the LRET plus VRET scenario until 2021 (pink line). Thereafter, emissions continue to fall steadily, to well below the NEG target level. When the QRET target is reached in 2030, emissions are about 18 Mt CO<sub>2</sub>-e below the target, equivalent to a reduction of almost 36% on the 2005 NEM emissions level.

This should not be thought of as a particularly challenging task, so far as generation construction is concerned. As Figure 10 shows, there will be a surge in renewable generation growth between now and 2020, based entirely on projects either already being built or financed and ready to be built. Subsequent growth in renewable generation needed to meet the QRET target is not much faster than has been experienced over the past few years, blighted as they have been by the policy turmoil between 2013 and 2015.

Figure 10: Total grid generation & projected grid renewable generation under 3 scenarios



The generation levels shown in Figure 10 translate to the shares renewable generation in the whole NEM grid, under the three scenarios, shown in Figure 11. In the VRET only scenario, the renewable share of generation reaches 27% in 2030, but the variable renewable share, i.e. renewable exclusive of hydro, is only 19%. Corresponding figures for the VRET plus QRET scenario are 37% for all renewable and 29% for variable renewables.

Figure 11: Grid generation & projected renewable share of NEM grid generation

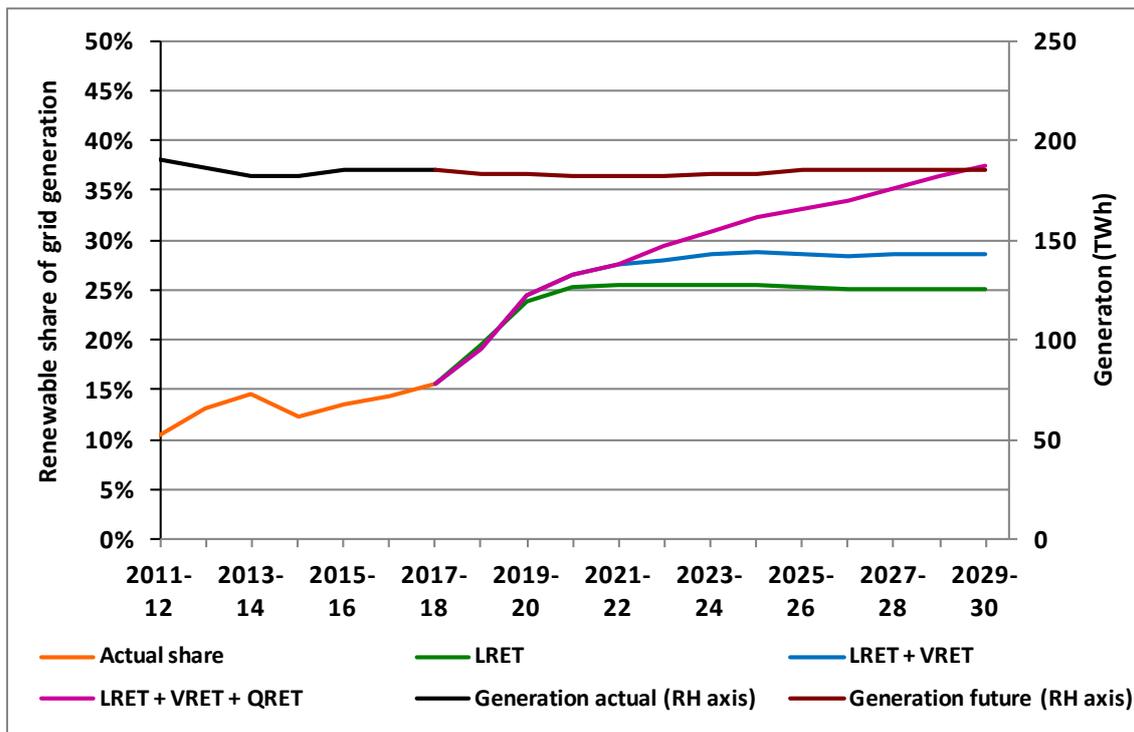
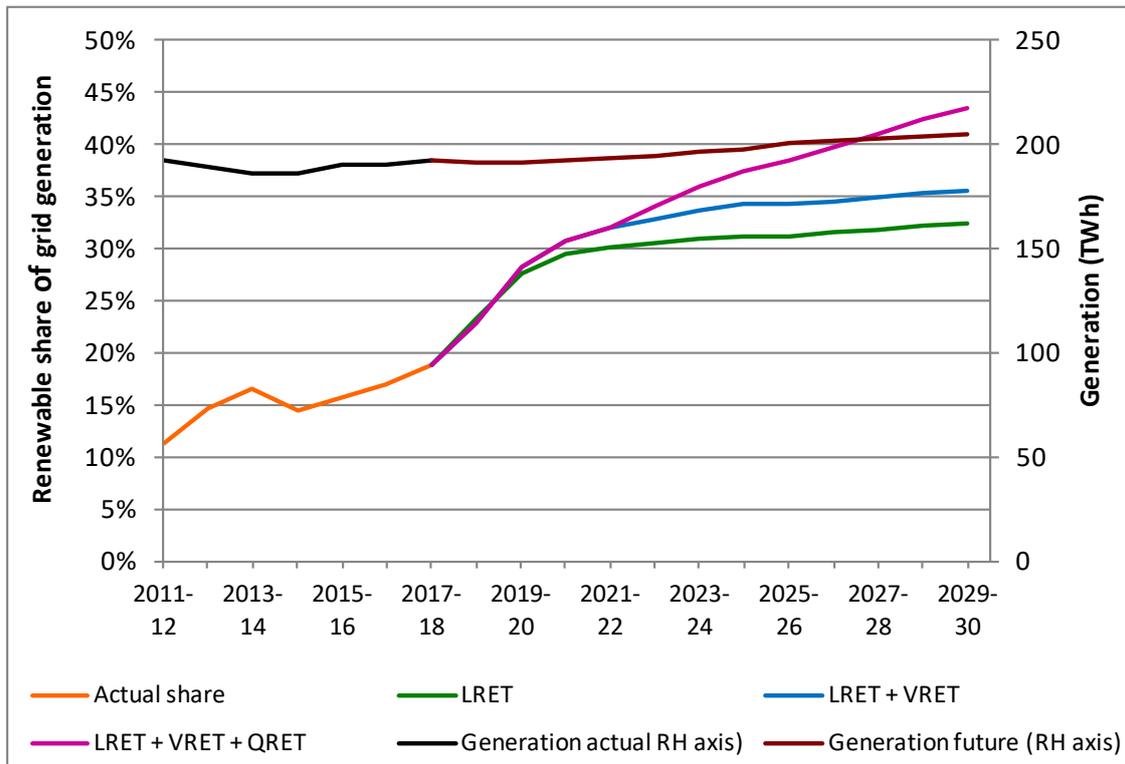


Figure 12 below shows the same set of relationships as Figure 11, but expressed in terms of total generation, including generation by rooftop solar. Both the VRET and QRET are defined in these terms, meaning, in the case of Victoria, for example, that the 40% target in 2025 requires the large renewable share of grid generation in the state to increase to less than 36%. In Queensland, the 2030 QRET target of 50% renewable is met with a renewable share of grid generation at just over 45%. It is these shares of renewable generation in the two states which, when added to renewable generation in New South Wales, South Australia and Tasmania, translate into the NEM shares of renewable generation.

**Figure 12: Grid plus small solar generation and projected renewable shares of NEM generation inclusive of small solar of total generation under three scenarios**



What are the implications of these findings for the design of the NEG? The *Draft Detailed Design Consultation Paper*, published on 15 June, contains the following words:

*Many State and Territory Governments in Australia have also established schemes to encourage renewable energy and to reduce electricity sector emissions. All State and Territory renewable energy schemes can operate with the Guarantee and contribute towards achieving the emissions reduction trajectory for the Guarantee. (p. 19)*

In other words, the state measures will not be additional to, but will substitute for, other acquisitions of renewable electricity made under the NEG. If implemented, in conjunction with the proposed -26% emissions reduction target, this design feature would mean that no mechanism other than the VRET would be needed to reach the emissions reduction target. To

use a slightly more technical expression, the emissions constraint in the NEG would not be binding.

On the other hand, should the current Victorian government be defeated at the election this year, and a new government cancel the VRET, the NEG may be called on to provide about 5 TWh of renewable electricity by 2030 to meet the target. This would require about 2,000 MW of new wind and/or solar capacity, additional to that delivered by the LRET, over the ten years between 2020 and 2030.

To put this into context, the CER's list of the wind and solar capacity which it expects to be commissioned over the next three years totals around 8,000 MW – that is, four times as much in less than one third of the time. A shift from building nearly 3,000 MW per year to building only 200 MW per year would represent a complete collapse of the currently booming renewable generation construction industry.

## 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.