DER Projection Results

April 2020

Enlightening environmental markets

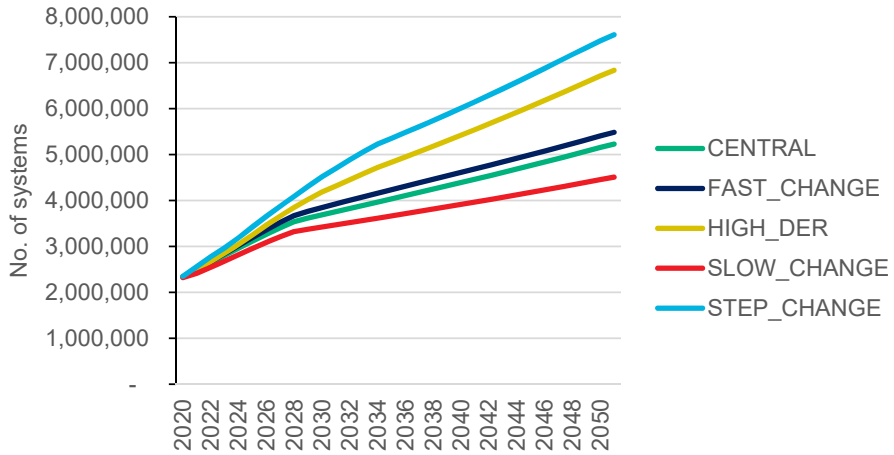
Green Energy Markets

Nation-wide cumulative results - Solar

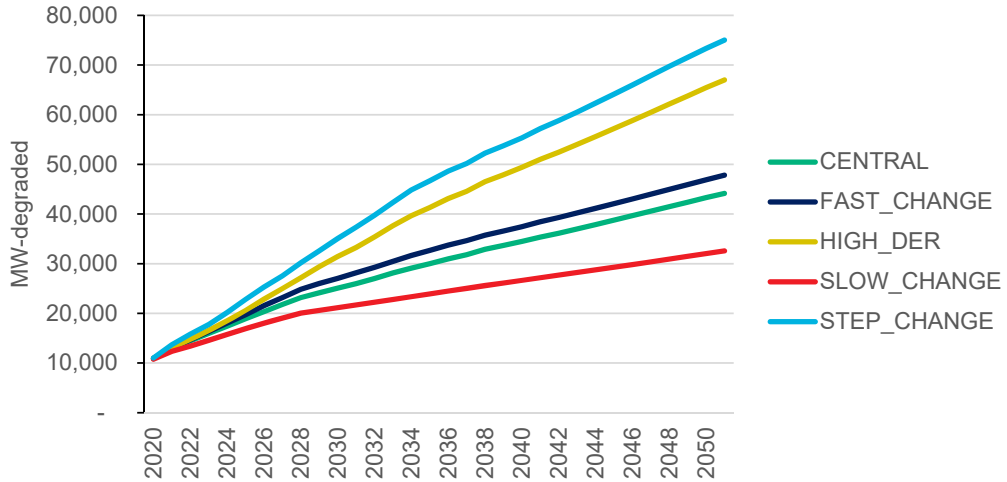
Final Results – April 2020

- On a cumulative basis the national number of solar systems under Central grows from the current level of close to 2.4m to reach over 5m by 2051. The high point under Step Change is 7.6m and low under Slow Change is 4.5m.
- The megawatts of degraded capacity expands from just under 13GW to reach 44GW by 2051 under Central. It peaks at 75GW under Step Change and is down to 33GW in Slow Change.

Cumulative number of behind the meter solar installations by scenario



Cumulative degraded megawatts of sub-30MW solar by scenario

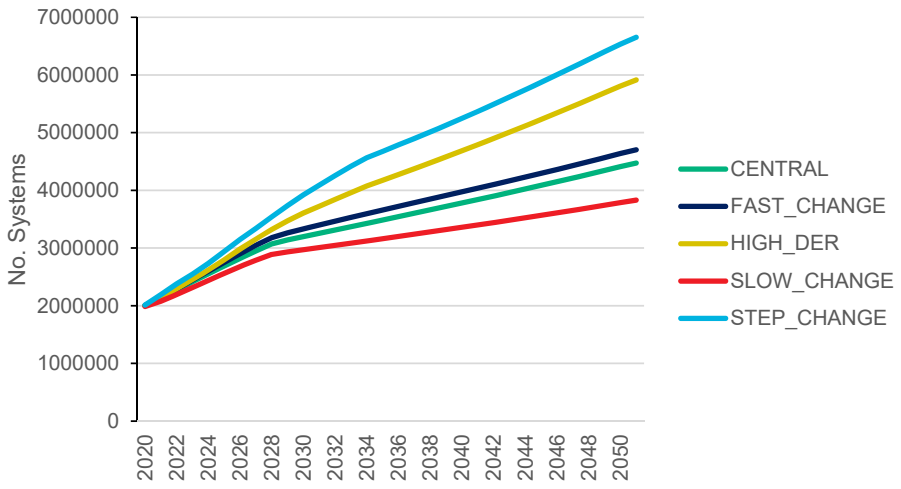


NEM cumulative results - Solar

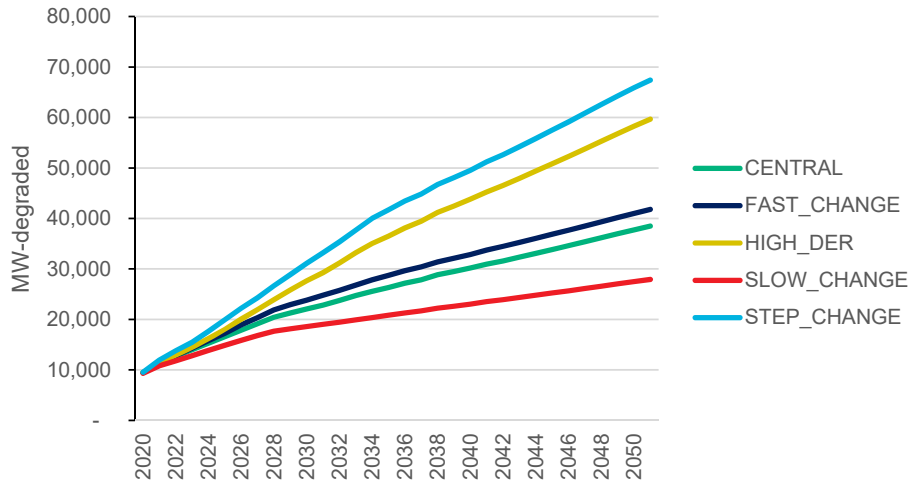
Final Results – April 2020

- For the NEM the cumulative number of solar systems under Central grows from the current level of close to 2m to just under 4.5m by 2051. The high point under Step Change is 6.7m and low under Slow Change is 3.8m.
- The megawatts of degraded capacity in the NEM expands from just under 11GW to reach 38.5GW by 2051 under Central. It peaks at 67.4GW under Step Change and is down to 27.9GW in Slow Change.

NEM cumulative number of behind the meter solar installations by scenario



NEM cumulative degraded megawatts of sub-30MW solar by scenario

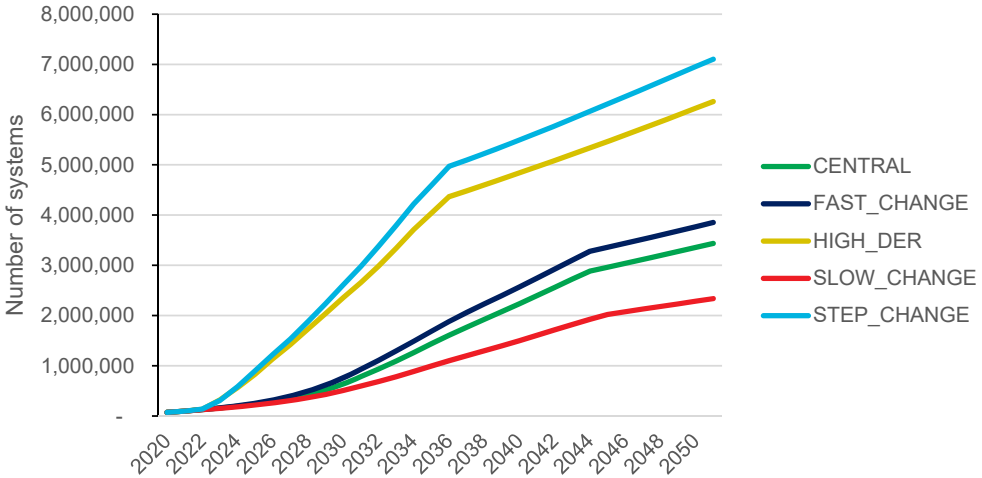


Nation-wide cumulative results - Batteries

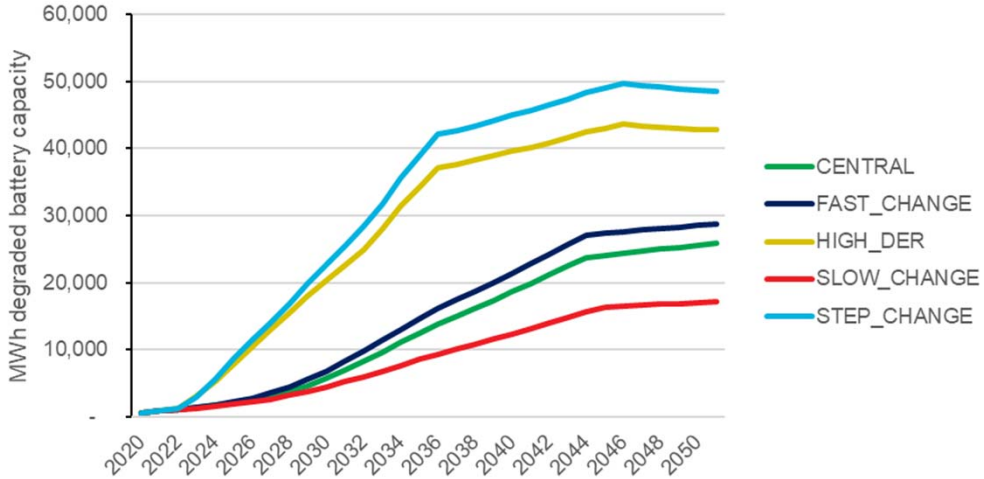
Final Results – April 2020

- On a cumulative basis the number of battery systems under Central grows from the current level of close to 74,000 to reach slightly over 3.4m by 2051. The high point under Step Change is 7.1m and low point under Slow Change is 2.3m.
- The megawatts of degraded battery capacity expands from 668MWh to reach almost 26,000MWh by 2051 under Central. It peaks at 48,500MWh under Step Change and is down to 17,228MWh in Slow Change.

Cumulative number of behind-the-meter battery installations by scenario



Cumulative battery megawatt-hours by scenario

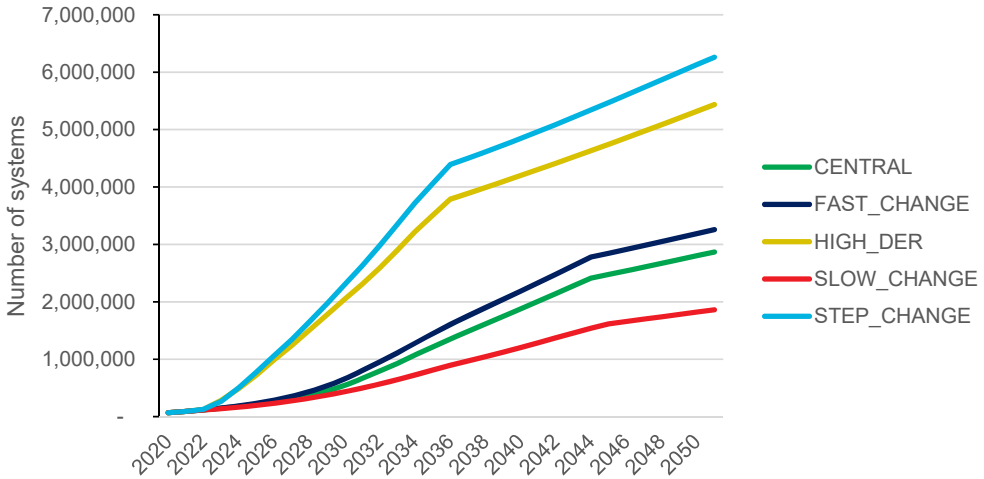


NEM cumulative results - Batteries

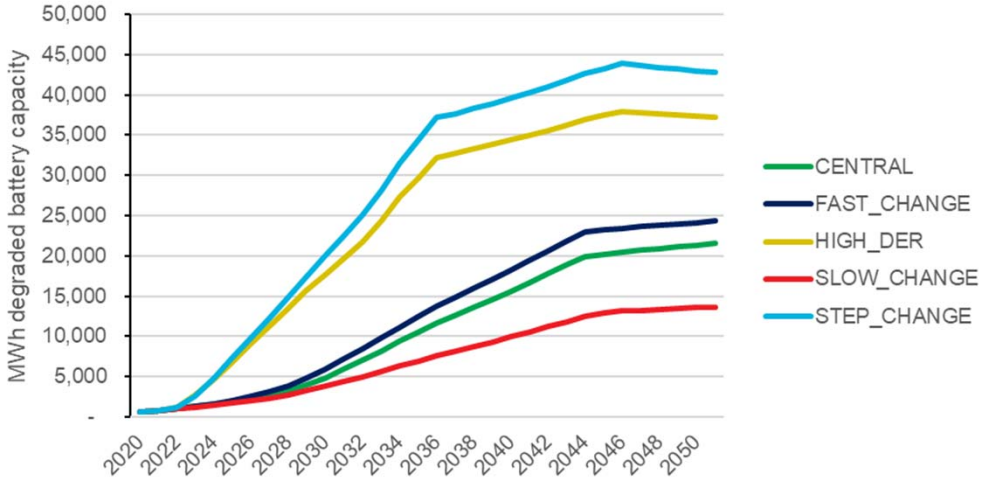
Final Results – April 2020

- For the NEM the cumulative number of battery systems under Central grows from the current level of close to 69,500 to reach slightly over 2.9m by 2051. The high point under Step Change is 6.3m and low point under Slow Change is 1.9m.
- The NEM megawatts of degraded battery capacity expands from 627MWh to reach almost 21,600MWh by 2051 under Central. It peaks at 42,800MWh under Step Change and is down to 13,700MWh in Slow Change.

NEM cumulative number of behind-the-meter battery installations by scenario



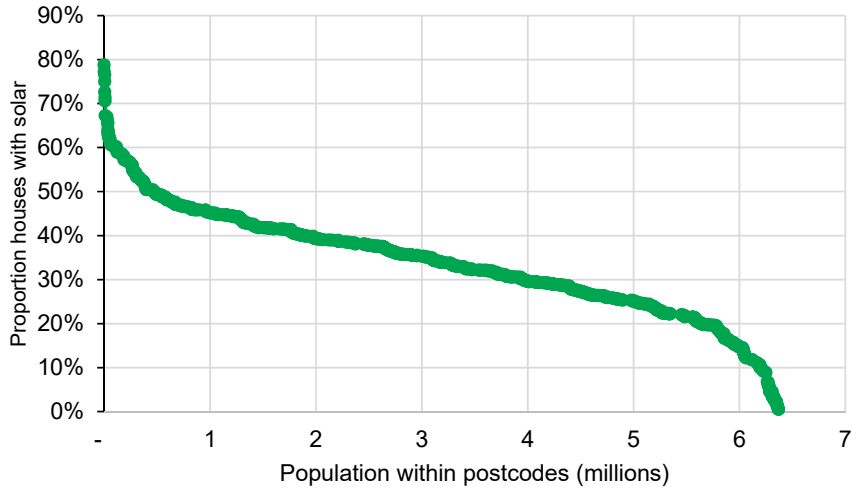
NEM Cumulative battery megawatt-hours by scenario



Context for overall results

- Some points of comparison/context for the number of solar systems (5m under central and up to 7.6m under Step Change):
  - The total number of residential electricity connections is expected to grow to just under 15m by 2050. Central equates to around 35% of all connections and Step Change is slightly more than 50%.
  - The 2016 census recorded 8.3m detached and semi-detached dwellings in Australia, which represented 85% of total dwellings.
  - Meanwhile Australia's population is expected to grow by about 13.8m people that will require around 5.3m new dwellings. If 60% of the new dwellings were detached or semi-detached this results in about 11.5m detached and semi-detached dwellings by the end of projection. Central equates to 45% of detached and semi-detached dwellings and Step Change equates to 66%.
  - Postcodes representing around 1m people within QLD and SA have already reached or exceeded 45% penetration of total dwellings suggesting such penetration is achievable, but 66% remains rare.

SA & QLD postcodes' solar penetration relative to population



Context for overall results

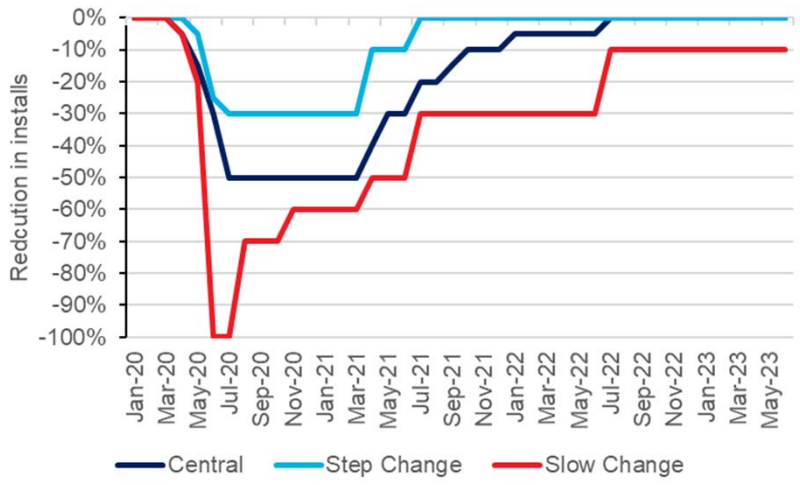
- Some points of comparison/context for the megawatts of solar (44GW under central and up to 75GW under Step Change):
  - While this amount of capacity is very large relative to maximum demand levels, let alone minimum demand levels, the average capacity factor of the aggregate installed base of solar around the middle of the day is about 55% of total installed capacity. So the effective capacity likely to be generating power is closer to between 24GW to 41GW in the middle of the day.
  - Our projections indicate that under Central just about every new solar system installed will be coupled with a battery from around 2030 onwards. For Step Change this occurs from around 2023 onwards.
  - The total battery capacity expected to be in place under central is 26GWh-degraded and under Step change it is close to 49GWh. This provides a significant buffer to absorb generation from the solar capacity.
  - In addition it is worth noting that the capacity we have projected is on a DC panel basis – not the AC inverter capacity. Already the standard residential solar system is around 6.6kW of panel capacity to a maximum inverter grid export capacity of 5kW. Over time our projection is the DC rated capacity per system will grow. There is already a growing segment of systems being installed that are 10kW of DC panel capacity with 5kW export-limiting inverters. In addition we expect that as the market becomes more saturated and modules drop in price, less optimal roofspace (poorer orientation and greater shading) will be utilised. This means that the actual output we see exported to the grid from a given amount of DC panel capacity will decline over time.

Adjustment for COVID downturn

Final Results – April 2020

- Forecasts were adjusted in the short-term to take into account likely reductions in solar installs as a result of the economic downturn caused by measures to control spread of COVID-19
- A survey of installers over early April in conjunction with PV Magazine was undertaken which suggested most of those had experienced a significant downturn in customer enquiries. The approximate decline was very approximately 25% to 50% but some had experienced a complete evaporation of enquiries. In addition input specific input was sought from online solar sales lead generators and a top 5 solar retailer. They had seen a similar downturn in enquiries of 25% to 50% over March to early April.
- However, the impact in the next month or two will be blunted by the fact a significant proportion of retailer/installer had built up a backlog of installs out to 6 weeks, with a few having backlogs as large as 3 months.
- That chart below details downward adjustments we have made in installations relative to initial forecasts.

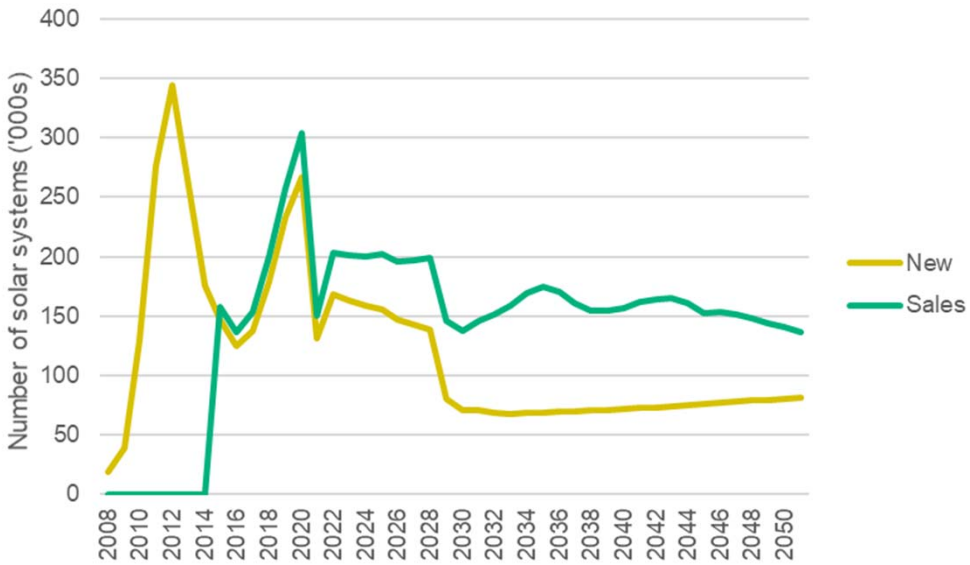
Downward adjustments to system installs relative to initial forecasts due to COVID-19



What is driving solar uptake

- While on a cumulative basis installed capacity rises to high levels, this is actually built on an expectation that the solar market will contract substantially from historical highs in terms of annual sales for the Central scenario as well as Fast Change and Slow Change.
- The number of solar systems sold in 2021 drops precipitously, halving relative to 2020 numbers, which is mainly a result of the COVID-19 economic downturn, but also a general deterioration in underlying economic attractiveness.
- In 2022 sales recover somewhat but remain significantly below 2019 and 2020 levels. Sales across 2022 to 2028 are about 28% to 30% lower than 2019 to 2020 numbers and a third lower than the first market sales peak which occurred from 2011 to 2013.

Number of total solar system sales versus new increments (not replacements) Central Scenario - National



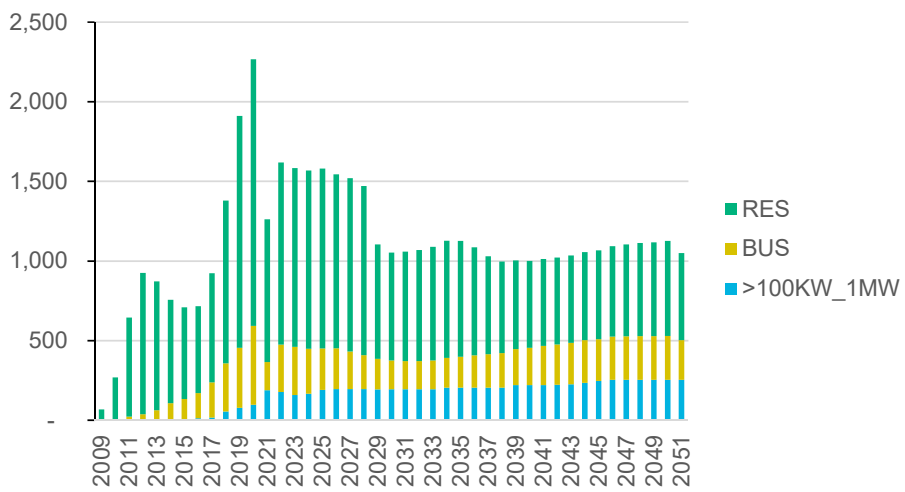
- Once the Victorian Government Rebate ceases in 2029 we expect another large drop in sales to levels around half those experienced in the last two years.
- They then are expected to oscillate between around 150,000 and 175,000 to the mid-2040's after which saturation effects lead to small sales declines.
- It is important to recognise 2 factors which help provide an underlying base level for solar sales:
  - Replacement of old systems.
  - Construction of new dwellings which tend to be high adopters of solar systems.

What is driving solar uptake

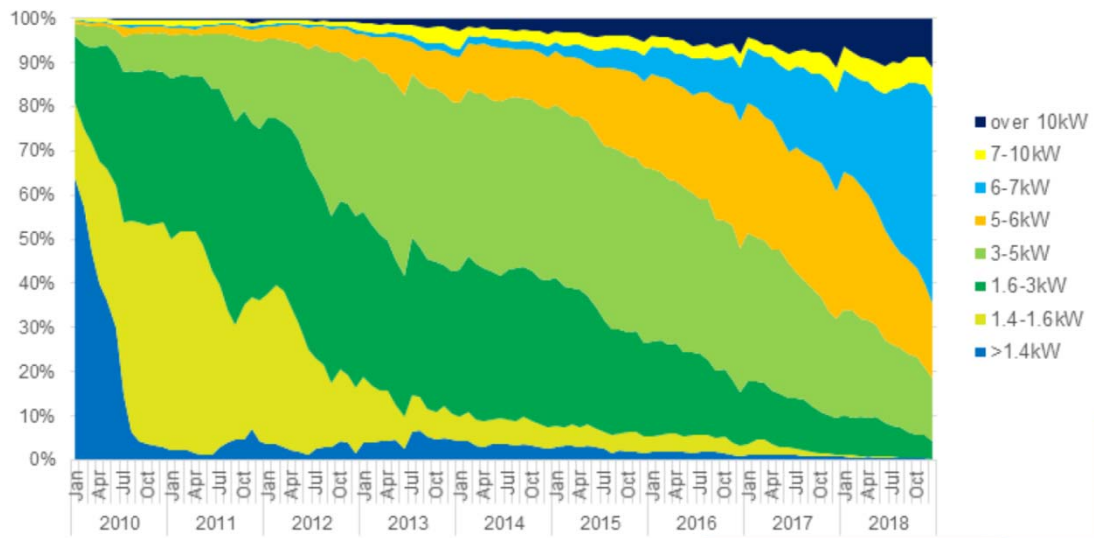
Final Results – April 2020

- In terms of megawatts of capacity it follows a similar pattern to that of system numbers.
- However, an important factor that boosts capacity installs over the next decade is the replacement of the large number of residential systems installed over 2011 to 2013 which are much smaller that what is typically installed currently. These are likely to be upsized from around 2kW to closer to 6.6kW. This means that capacity additions manage to hold-up in spite of a large drop in system numbers.
- In addition the steady growth in business and large commercial (>100kW) systems from 2030 helps to keep capacity installs above 1,000MW per annum in spite of system sales that are not far off lows in the market in 2015.

Additional incremental megawatts of behind the meter solar per year Central Scenario - national



Number of systems installed by capacity band from 2010 to 2018

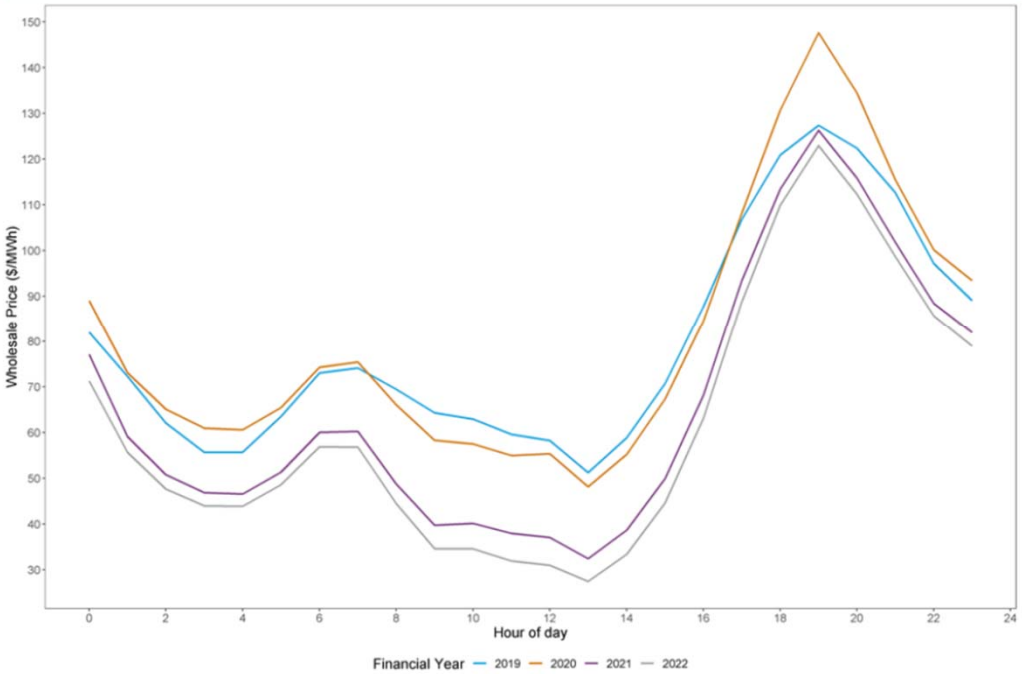


What is driving solar uptake – residential revenue

Final Results – April 2020

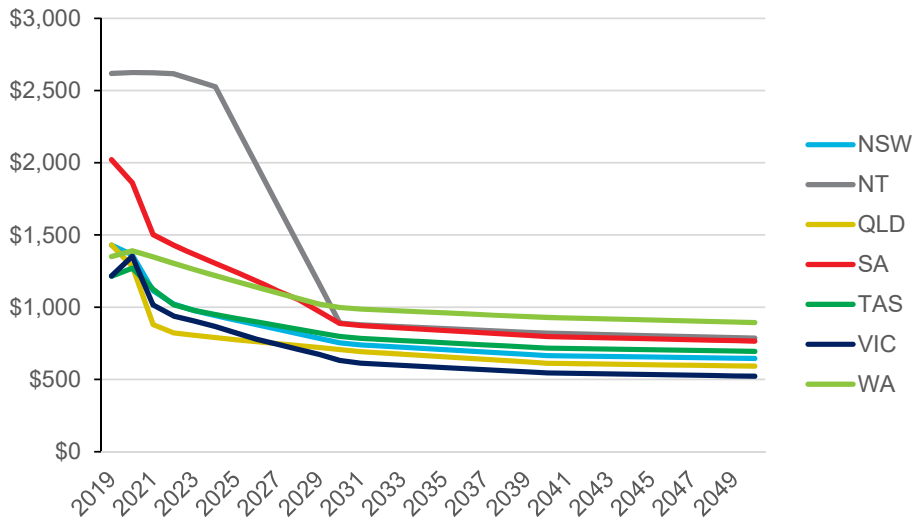
- The hollowing out of daytime power prices (based on AEMC analysis) drives significant fall in revenue per system.
- In addition an expected move towards recovery of network costs via “cost reflective” pricing also erodes revenue provided by solar without a battery.

Figure 2.3: Average wholesale electricity prices by hour of day in QLD



Source: AEMC analysis

Annual revenue per residential system - Central

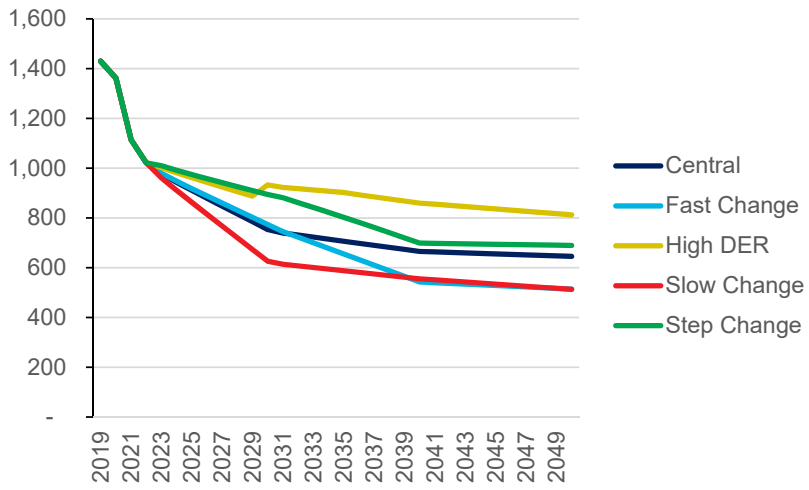


What is driving solar uptake – residential revenue

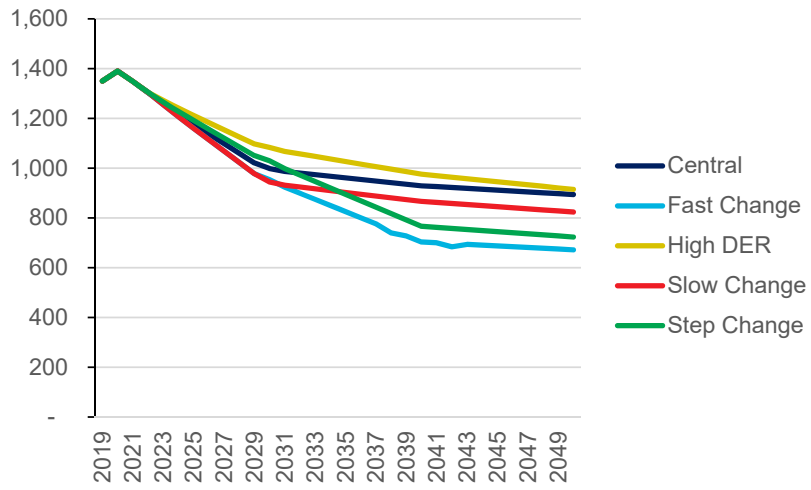
Final Results – April 2020

- Falling revenue for solar systems over time is shared across all the scenarios, irrespective of the state.
- High DER delivers the highest revenue because it is assumed that a great proportion of network charges are recovered from variable kWh charges while the slow change scenario places a greater proportion of network costs out of per kWh charges.

NSW annual revenue per residential system



WA annual revenue per residential system

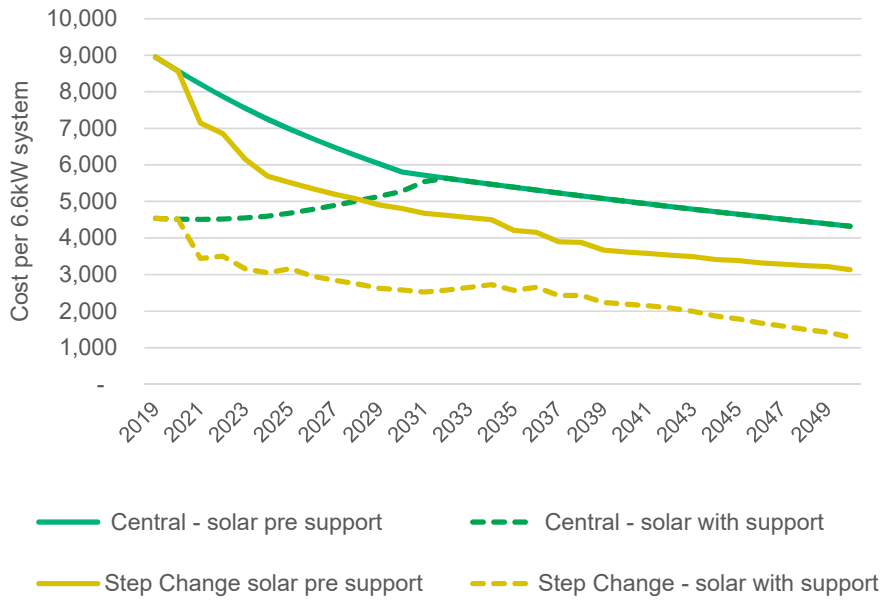


What is driving solar uptake – residential costs

Final Results – April 2020

- Residential system numbers under Central fall because cost reductions are expected to slow and will fall behind reductions in the value of the STC rebate as deeming steps down in annual increments to 2030, meanwhile revenue is also falling.
- Revenue is also falling in the Step Change Scenario and also High DER but not quite as much, but more importantly the underlying cost of solar systems are assumed to fall far faster in short term plus it is assumed they will benefit from new policy support that fills a large portion of the lost support from STCs.

Cost of residential solar system pre and after government support
Central compared to Step Change

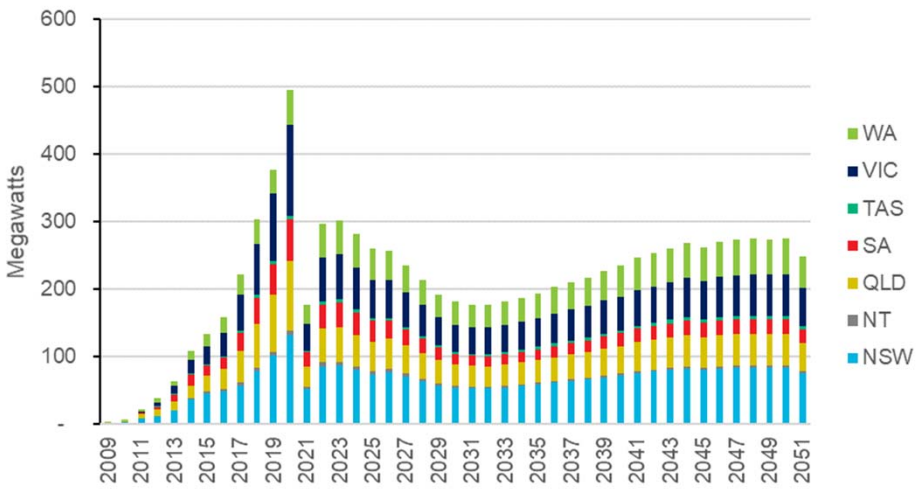


What is driving solar uptake - Small commercial

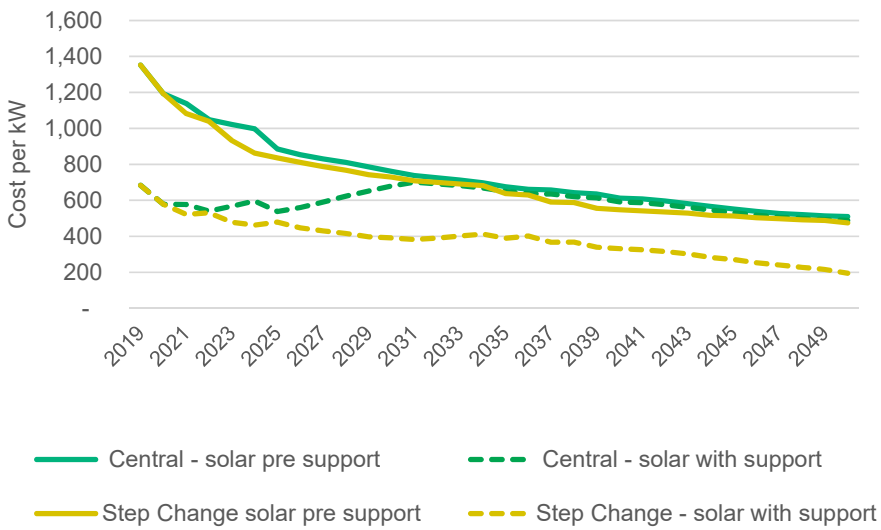
Final Results – April 2020

- Small commercial (sub-100kW) solar systems also suffer a decline in installations over the next decade as a result of falling daytime wholesale prices and decline in STC rebate.
- However these larger systems have greater capacity to benefit from ongoing labour installation cost declines through improving module conversion efficiency (less panels need to be installed for the same amount of kilowatt capacity). In addition the commercial market is less saturated than residential. This leads to a recovery in installations over the 2030's.
- The main driver of lower system costs and higher uptake under Step Change over Central is a higher level of government support for abatement activities

Megawatts of small commercial solar installations per year by state - Central



Cost for commercial solar systems per kW – Central vs Step Change

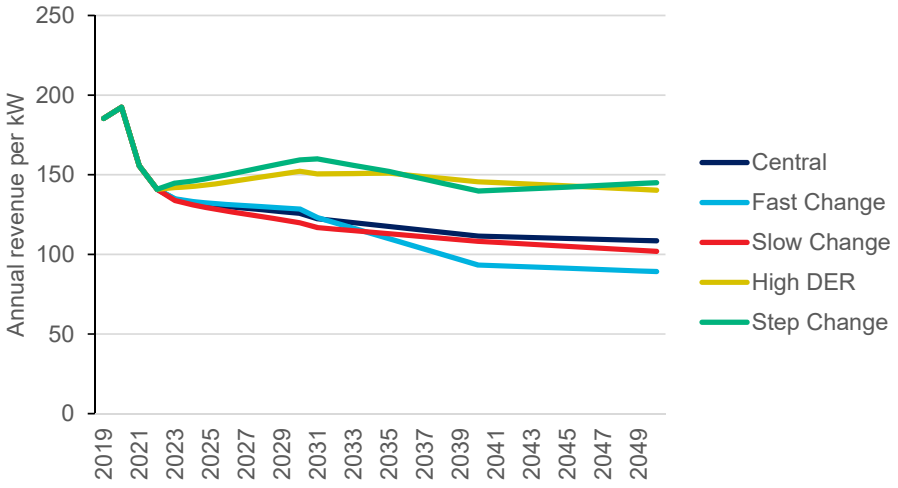


What is driving solar uptake - Large commercial

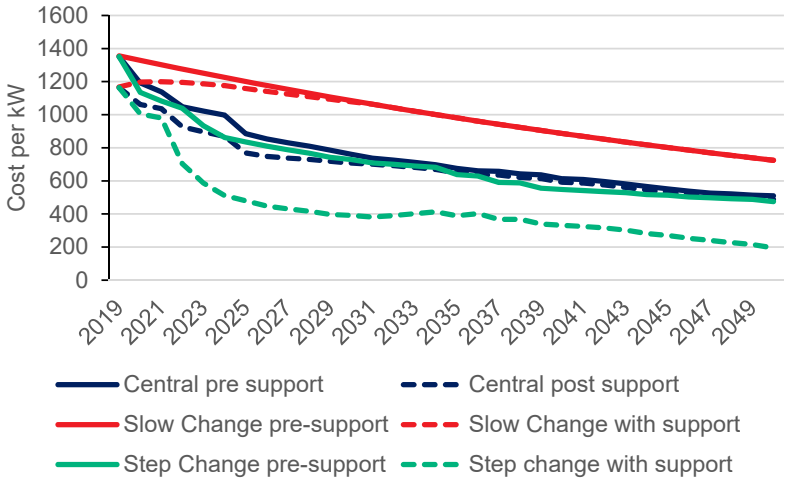
Final Results – April 2020

- The higher growth of large commercial solar (>100kW) under Step Change and High DER is partly due to higher revenue but mainly due to higher levels of government support for abatement which the model takes into account through a reduction in capital cost rather than revenue.
- Revenue for large commercial solar systems is equally effected by hollowing out of daytime wholesale energy prices. But because large commercial are already on network demand tariffs, their overall revenues are more stable than residential or small commercial.

Annual revenue per kW for 100kW+ systems



Cost of solar before and after government support by scenario



What is driving battery uptake

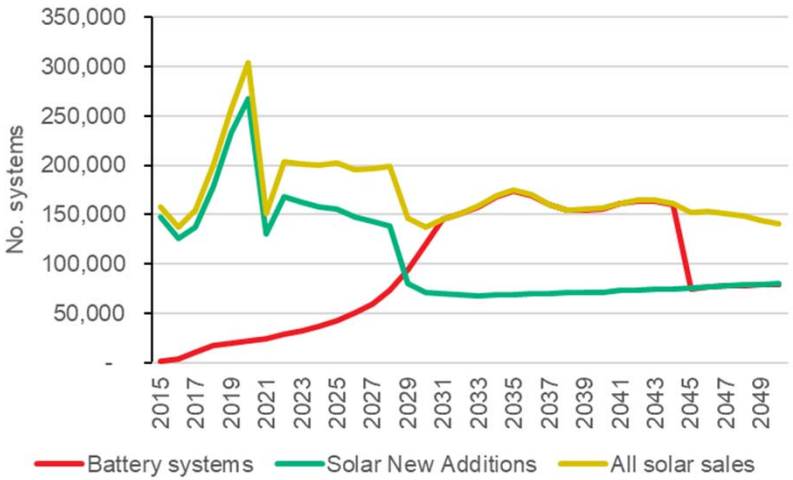
- Due to little sales history for home battery energy systems, we have tied battery uptake to levels of solar uptake. As solar + battery payback gets closer to solar only payback an increasing proportion of solar systems include a battery – with total uptake being a function of historical adoption of solar relative to different levels of payback.
- However, there is also an early-adopter market for batteries that appears likely to grow as battery costs decline. This is the case even if the paybacks are long and substantially greater than paybacks available from a solar-only system. This early-adopter market is estimated separately for an interim period up until battery+solar paybacks reach levels approaching that of solar only. Estimates are based on past growth rates and changes in paybacks over time by state.

What is driving battery uptake

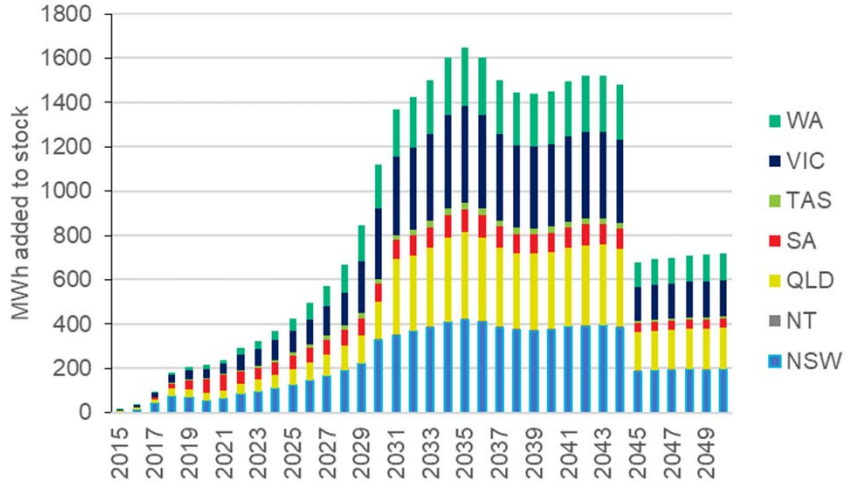
Final Results – April 2020

- Battery uptake is expected to remain low under the Central scenario until the back end of the 2020's when it rises rapidly and almost all solar system sales are expected to incorporate a battery system. However by 2045 batteries have penetrated much of the existing stock of solar systems and further growth is linked to incremental new additions of solar systems to the stock beyond replacement systems.

Number of battery systems added per year relative to solar system sales and additions (Central - National)



Megawatt-hours of battery additions per year by state (Central)

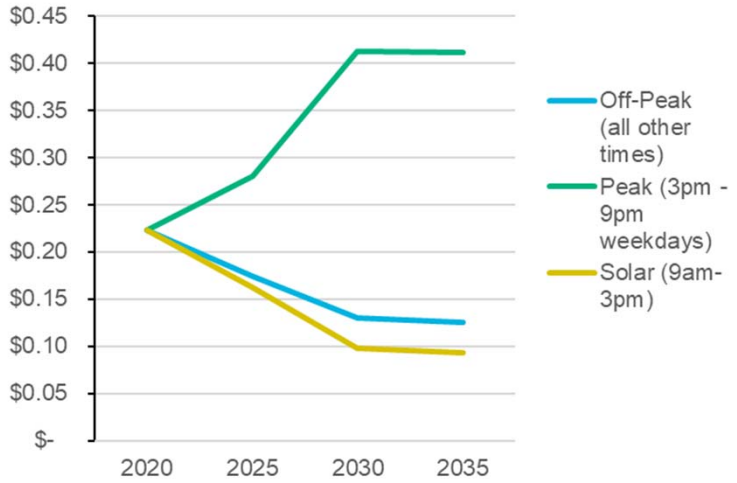


What is driving battery uptake

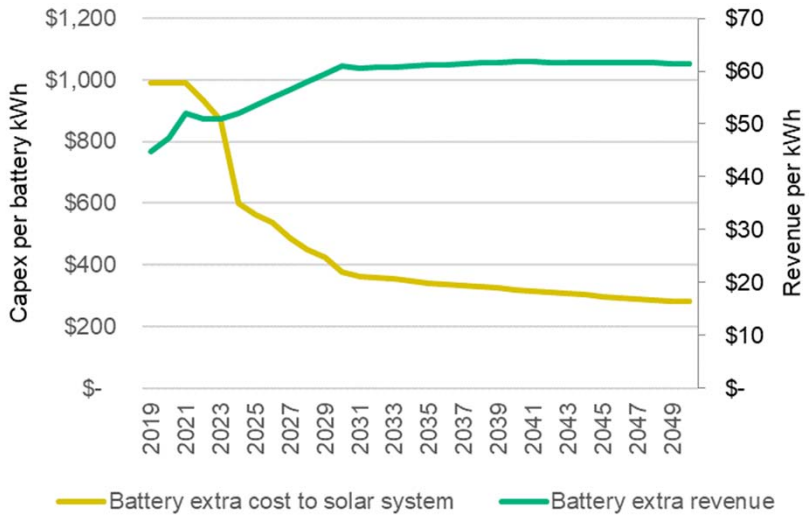
Final Results – April 2020

- Battery economics are expected to improve in terms of:
  - **Revenue** from a battery is enhanced by an increasing discrepancy in both network and wholesale prices between the solar generating daytime period and the afternoon-evening peak.
  - However the greatest improvement comes in reduced **costs,** which are anticipated to fall substantially between now and 2029.

Assumed changes in NSW residential power price by time period (Central)



Fully installed cost per battery kWh versus annual extra revenue on top of solar system (Central)

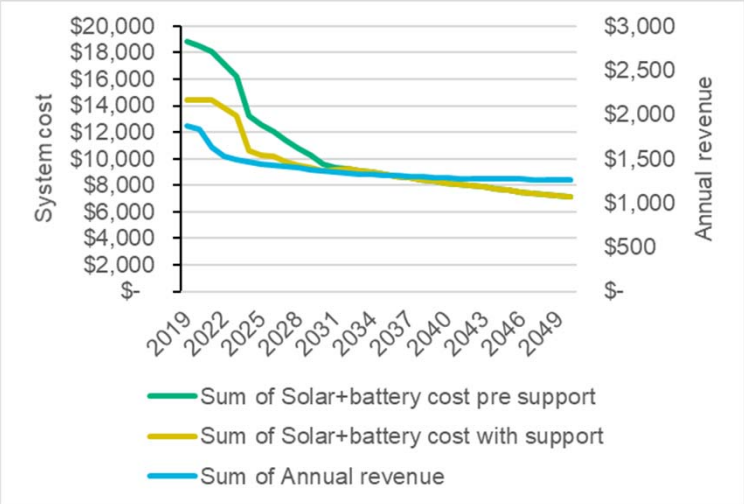


What is driving uptake – reasons for variance across scenarios

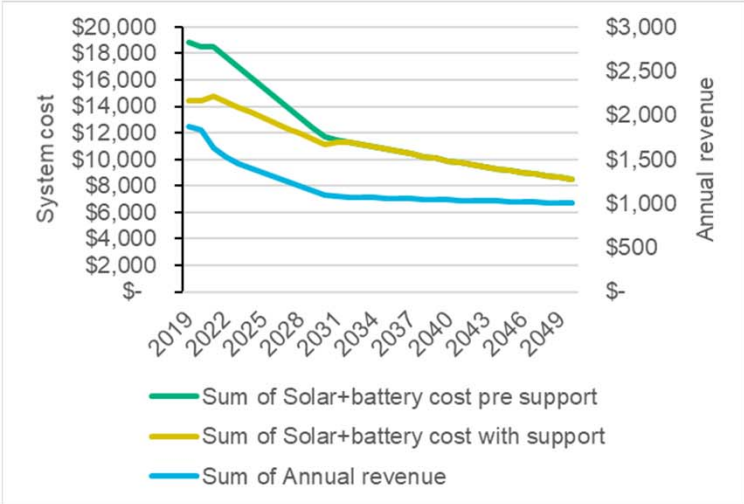
Final Results – April 2020

- Most of the difference across the scenarios can be explained by differences in capital cost assumptions and levels of government support/subsidies, with revenue playing a secondary role

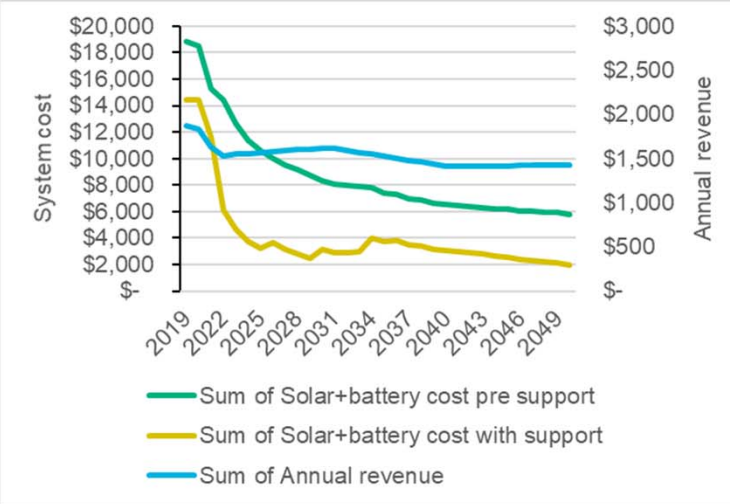
Central
Solar + Battery cost versus revenue (Residential)



Slow Change
Solar + Battery cost versus revenue (Residential)



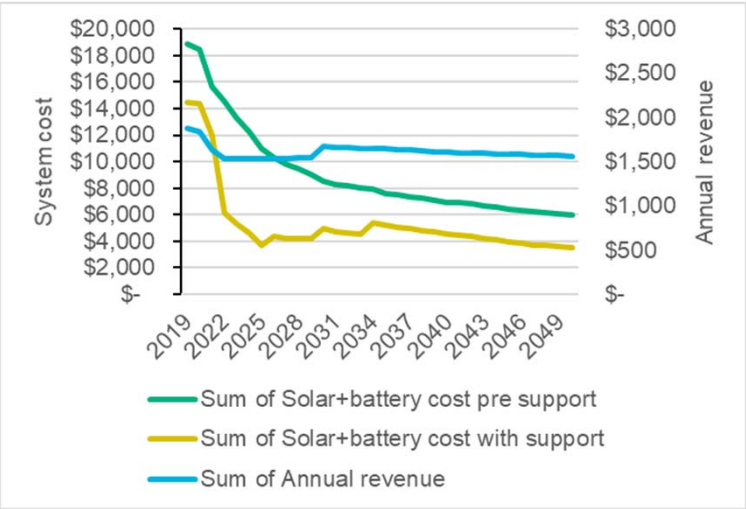
Step Change
Solar + Battery cost versus revenue (Residential)



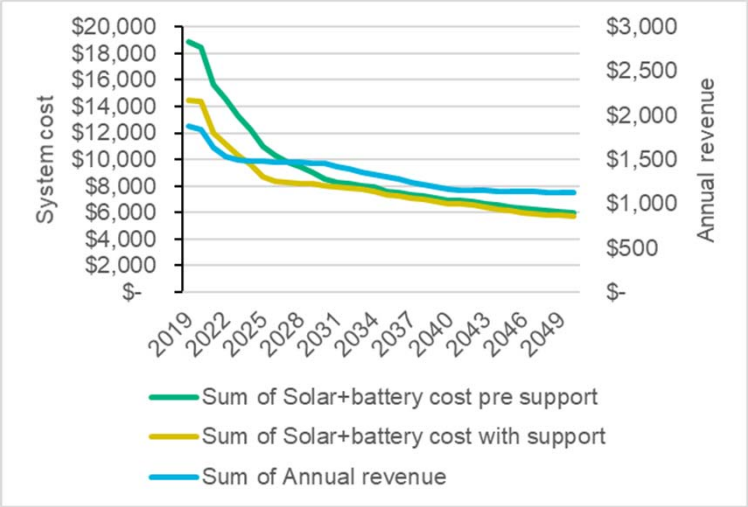
What is driving uptake – reasons for variance across scenarios

- Most of the difference across the scenarios can be explained by differences in capital cost assumptions and levels of government support/subsidies, with revenue playing a secondary role

High DER
Solar + Battery cost versus revenue (Residential)



Fast Change
Solar + Battery cost versus revenue (Residential)

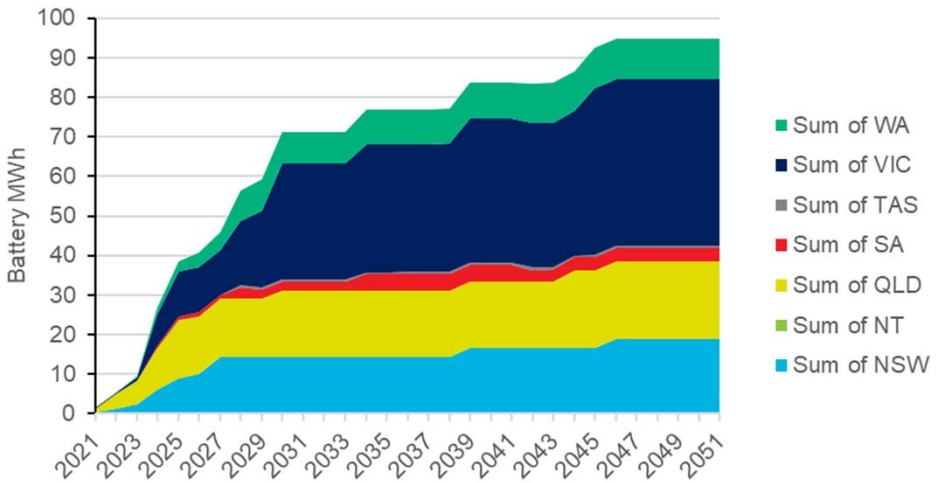


What is driving battery uptake – Large commercial

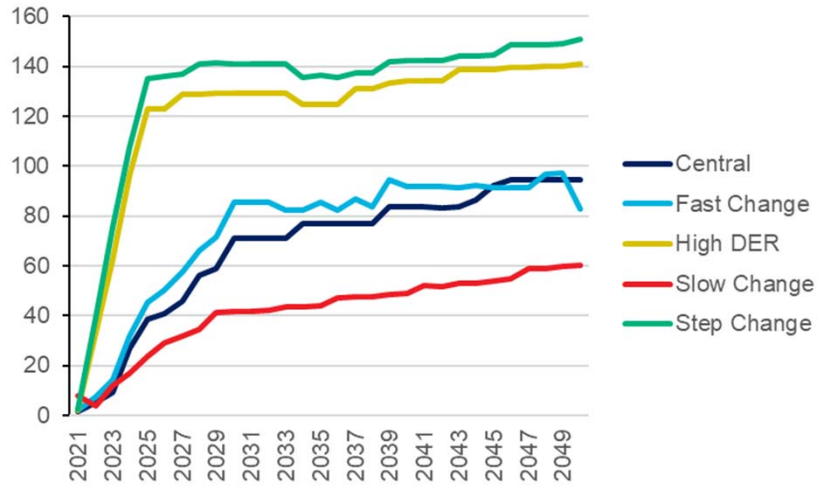
Final Results – April 2020

- Battery uptake in the large commercial market follows a more rapid growth path than residential.
- This is because large commercial consumers' network costs are largely embodied within demand charges, batteries provide significant value in firming-up the potential for solar to deliver reductions in network demand charges while also allowing arbitrage between a low wholesale price solar period and high afternoon-evening peak.
- The assumption in our modelling based on feedback from solar businesses, is that the battery system enables the demand reduction benefit from the solar system as well as that from the battery to be priced-in to the business case.
- Differences in uptake across the scenarios are largely down to different capital cost assumptions and levels of government support.

Megawatt-hours of battery systems installed per year by state Central



Megawatt-hours of battery systems installed per year by scenario

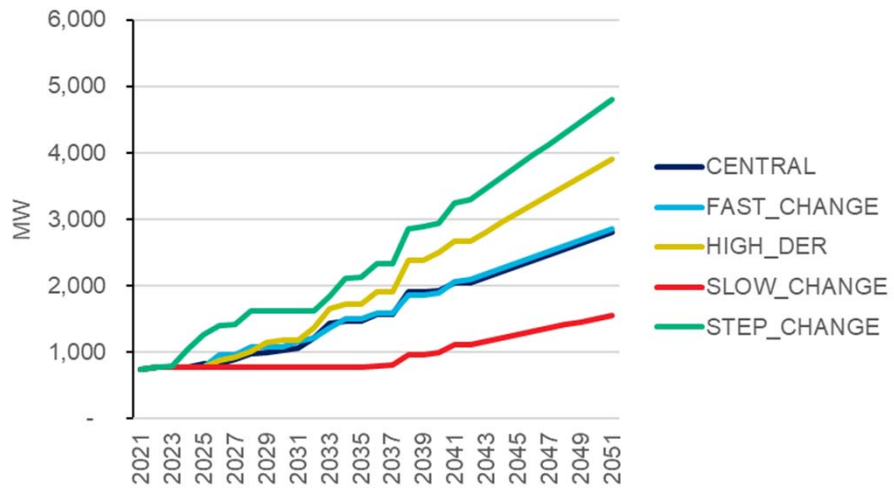


Megawatt-plus Solar in the NEM

Final Results – April 2020

- For the purposes of modelling systems greater than 1MW in size are assumed to be in front of the meter installations which only capture the wholesale pool price.
- Given these installations face very similar cost and revenue drivers as scheduled solar farms we assume that they would follow similar installation levels and timing as scheduled solar in the NEM.

NEM Cumulative megawatts of 1MW+ solar systems by scenario



- Consequently after 2021-22 the projection installs above 1MW solar when the draft ISP also envisages large scheduled solar capacity to be installed. This is because presumably if the market conditions are conducive to building large solar farm capacity then these will also be favourable conditions for smaller, non-scheduled in-front-of-the meter systems.
- Under Central, Fast Change and Slow Change the amount of 1MW+ capacity installed is 6% of the scheduled solar installed in each year as estimated in the draft ISP.
- For High DER and Step Change it is 10% of the scheduled solar installed in each year as estimated in the draft ISP.

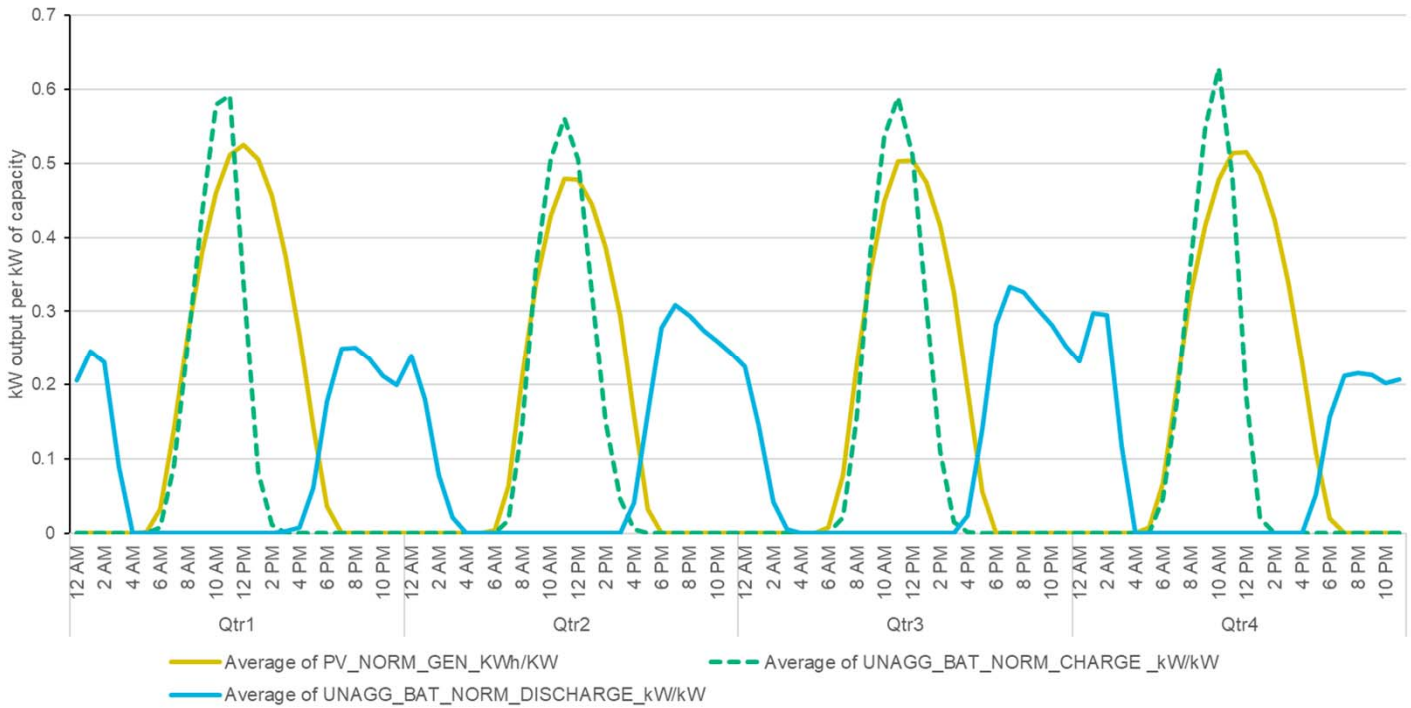
Questions?

Battery charge and discharge profiles - Residential

Final Results – April 2020

- Formula seeks to get battery to always charge to full capacity in advance of peak period, preferencing solar generation that would otherwise be exported. If exports inadequate to charge to full capacity then extra charge from grid is employed during solar tariff period.
- Discharge seeks to cover households' residual consumption left over after solar during peak period (3pm-9pm) first and will then continue discharging until 2AM if it still has charge.

Quarterly averaged charge-discharge profile example – NSW

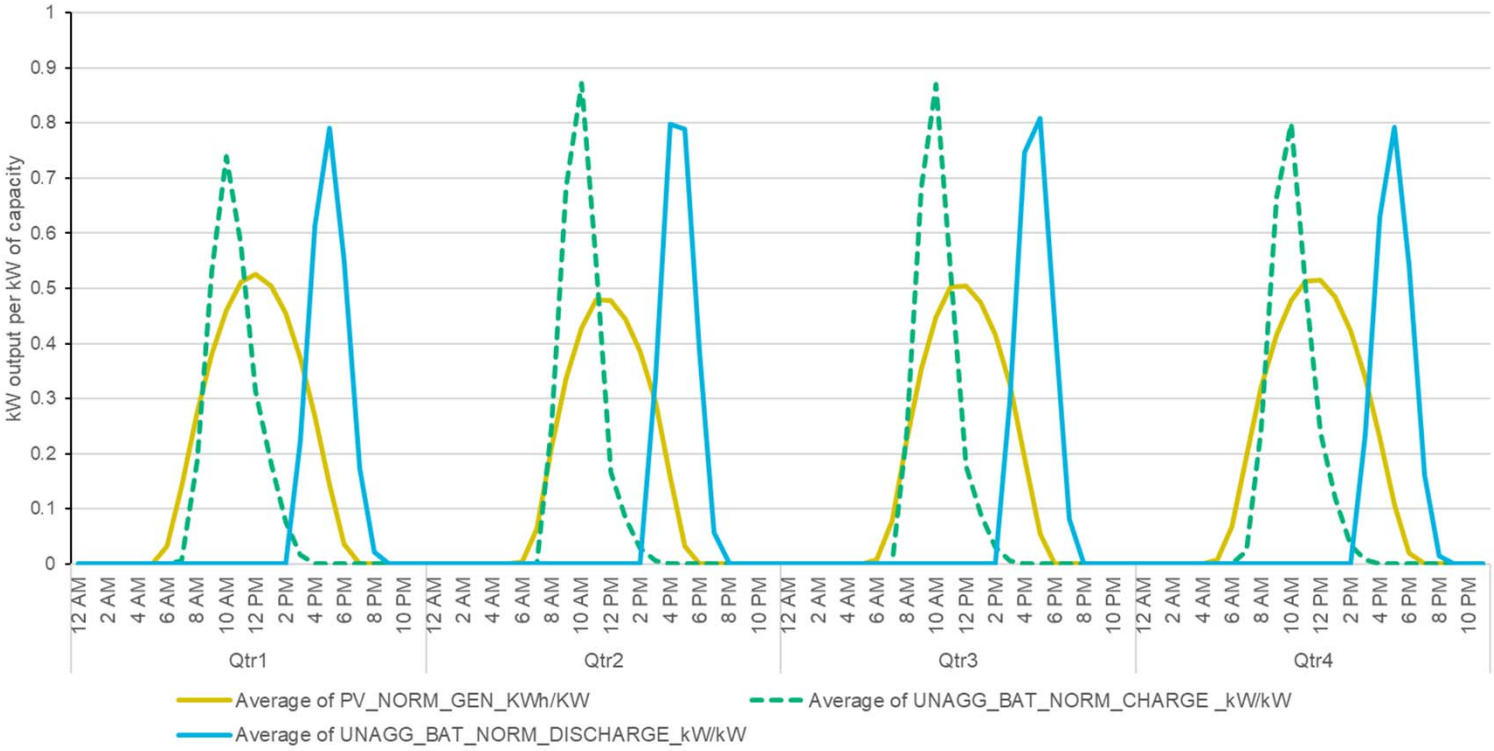


Battery charge and discharge profiles – Small commercial

Final Results – April 2020

- Small commercial employs the same charging and discharging formula as residential.
- However because solar system sized to minimise exports and excess load to solar occurs earlier in day, battery discharges earlier and is fully discharged sooner than for residential.

Quarterly averaged charge-discharge profile example – NSW

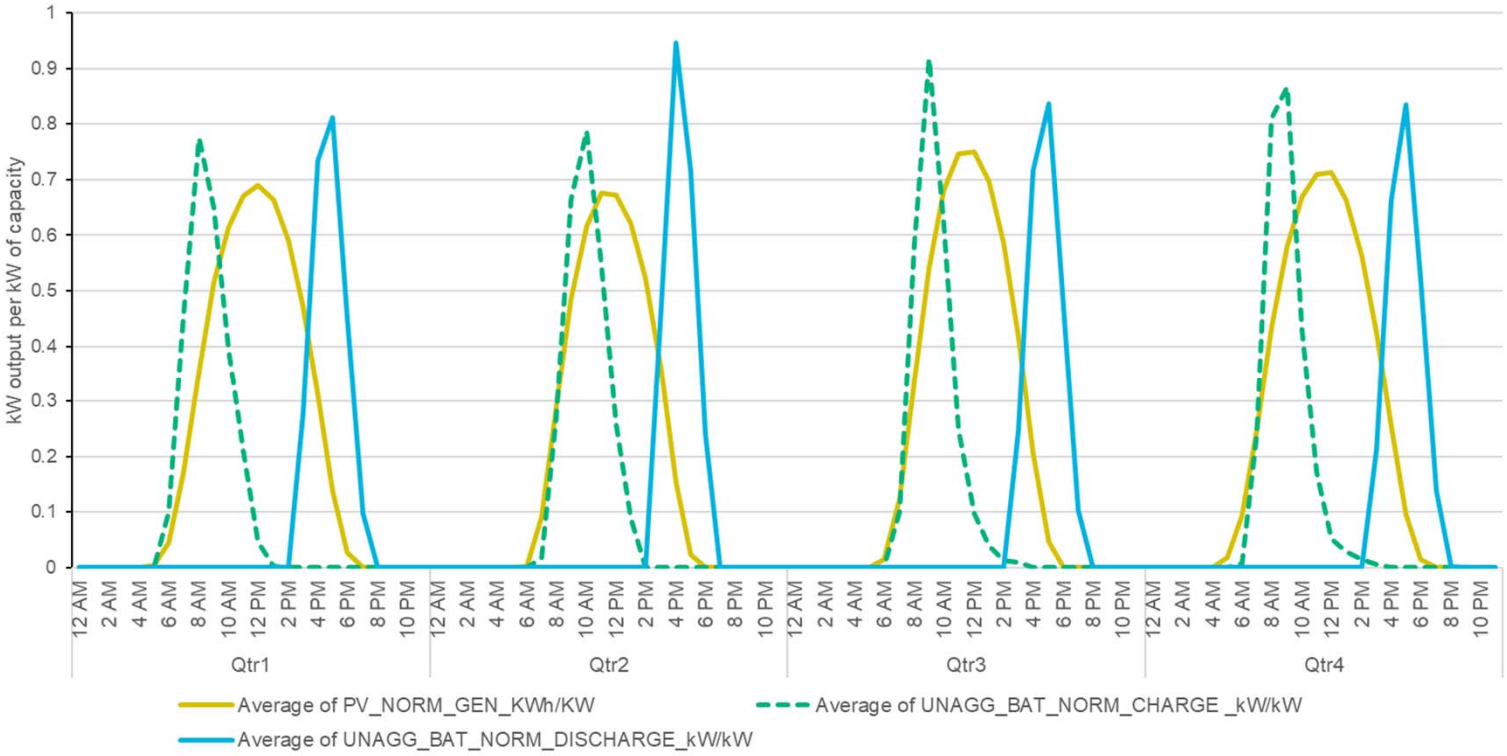


Battery charge and discharge profiles – Large Commercial

Final Results – April 2020

- Large commercial employs the same charging and discharging formula as residential.
- However because solar system sized to minimise exports and excess load to solar occurs earlier in day, battery discharges earlier and is fully discharged sooner than for residential.

Quarterly averaged charge-discharge profile example – NSW



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