The Big Aussie Battery Can Be Homemade

White Paper

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MARCHMENT HILL CONSULTING

Commissioned by

DC Power Co

About Marchment Hill Consulting

Marchment Hill Consulting is a management consulting firm determined to make a difference by serving the needs of the energy industry. Operating across the value chain, they are experts in the evolution of business models, markets and technologies in response to the transition to a low carbon future.

About DC Power Co

DC Power Co aims to unlock the collective power of Australian households, starting with the 2 million homes with solar panels. They support their customers to move to renewables in the home and lower their bills with a suite of personalised energy services. Their mission is to put households in control to create a more reliable, renewable energy supply for the nation.

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1. Foreword

In the last decade, over 2 million regular Australians began the march towards renewables by getting solar panels on their roofs[1]. I believe they'll be the ones leading the charge once again with battery storage, as we're faced with a dysfunctional energy industry that is one of the world's most expensive and polluting[2].

With the uptake of rooftop solar continuing to climb and more action being taken by the States and Territories to combat climate change, the majority of Australia's energy mix is projected to come from renewables by about 2030[3]. The Australian Energy Market Operator (AEMO) has also projected that 15GW of storage will be required by 2040[4], that's equivalent to around 3 million home batteries.

This is an unprecedented shift in an industry that has operated with only incremental change for the last 100 years. Without significant Federal Government leadership, this transformation will be severely compromised and households will pay the cost of ill-suited network infrastructure.

Of particular concern is the lack of attention that is being paid to the willingness of Australian households to invest directly in this transformation. There is no doubt that solar homes are on the frontline - by 2040 they could potentially supply over a quarter of our nation's energy needs and over half of our energy storage needs.

This leadership is not complicated. If the Federal Government provided a 50% subsidy for battery storage for 400,000 homes and mandated that those batteries be virtual power plant-enabled, it could achieve the same storage capacity as its proposed Snowy 2.0 project, but in half the time.

At the heart of any great revolution are people. One in five households have already chosen a future powered by renewables in their home, so we are well on our way to making an impact. But sometimes people need a little nudge.

I have learned this first hand with my experience leading the record-breaking The Great British Light Switch campaign, which got 4.5 million energy efficient light globes into UK homes in just one Saturday morning. We saved almost 390,000 tonnes of carbon emissions and slashed almost £1.1 million off electricity bills.

DC Power Co, who commissioned this paper, and other like-minded companies stand beside each of these solar homes leading the charge. We believe they are a critical and overlooked part of our future energy mix. It's time for all of us to act, and for Government to lead and support. And with the right leadership, the future of energy in Australia can be a Sunny one.

Nic Frances Gilley MBE

Co-founder and CEO

DC Power Co

2. Harnessing the power of the Home Renewables Revolution

2.1. The Home Renewables Revolution has begun

Australia is in the midst of a Home Renewables Revolution. Over 2 million households have invested in rooftop solar systems[5], that's one in every five households, and Australia is ranked #1 in the world based on installations per capita[6].

These systems have the combined generation capacity of over 9GW[7], which is more than three times the size of Australia's largest coal-fired power station[8].

The uptake of rooftop solar started with the Howard Government's Photovoltaic Rebate Program in 2007 and has been driven over the years by further supporting policies, rising electricity prices, the declining cost of solar systems, and the need to act on climate change.

This trend is not about to change. These drivers persist and installations have seen a steady increase over recent years and are now approaching 25,000 per month[9]. Forecasts[10] predict that by 2030, the uptake of rooftop solar will have doubled to 4 million homes.

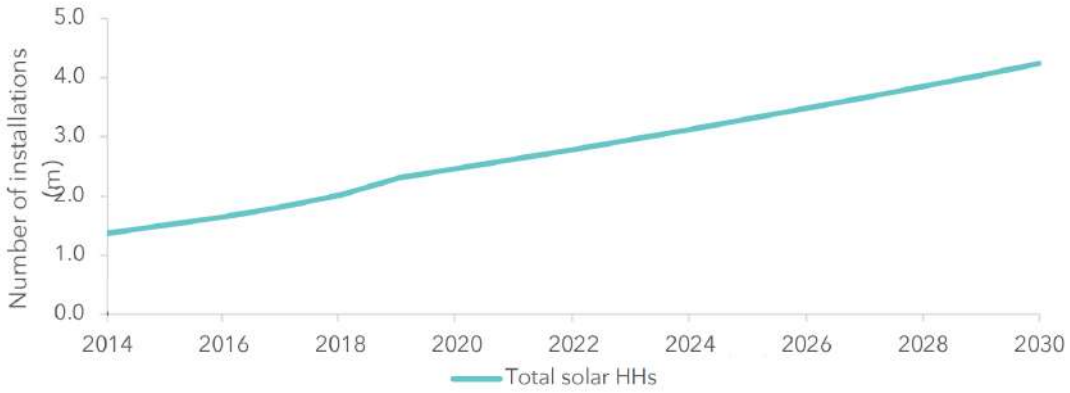

FIGURE 1: INSTALLATIONS FOR HOUSEHOLD (HH) ROOFTOP SOLAR SYSTEMS FORECAST TO 2030 (SOURCE: VENTURE INSIGHTS)

2.2. Households are willing to act

Whatever their reasons, Australian households have acted. They have, and continue to, express their willingness to participate directly in transitioning their energy supply, and consequently the energy system as a whole, to renewables.

This is an immensely powerful statement and a huge opportunity for the country. Particularly as it seeks to meet its obligations as part of global efforts to reduce carbon emissions and combat climate change.

In their recent Integrated System Plan, AEMO forecast that under a scenario where there are high levels of home energy devices like solar and batteries, significant downward pressure will be placed on the total costs of supply. This equates to market benefits of $4 billion, compared to a neutral case[11].

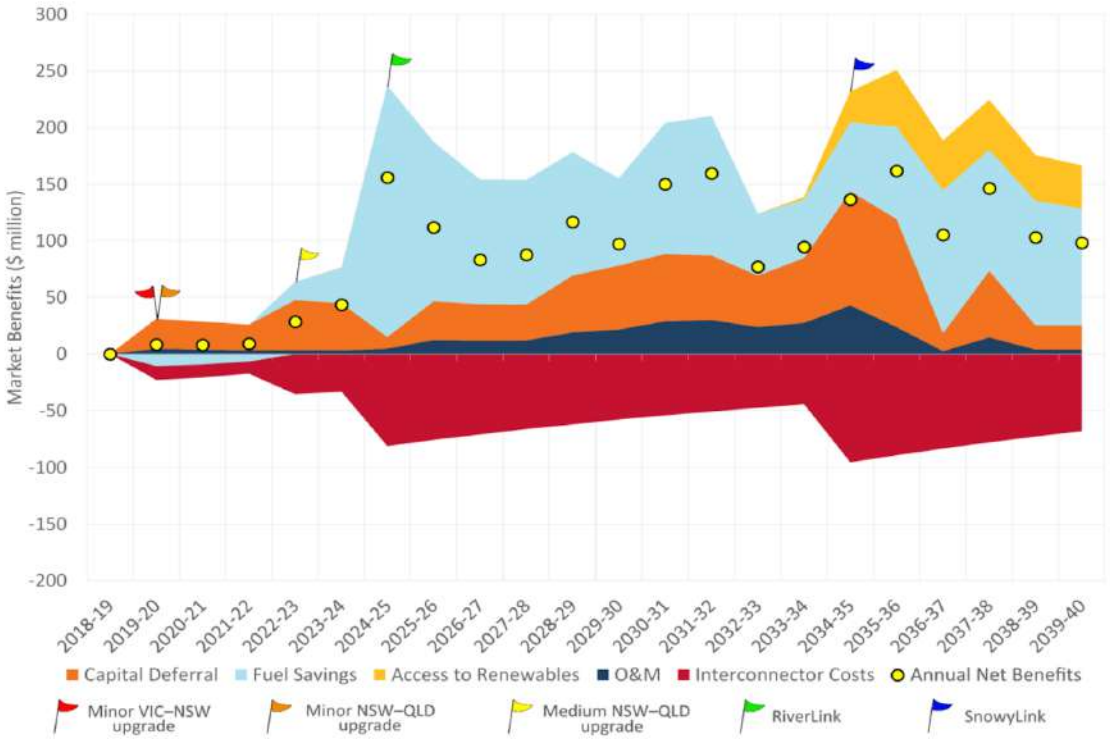

FIGURE 1: MARKET BENEFITS FOR AEMO'S BASE DEVELOPMENT PLAN (HIGH DER SCENARIO) (SOURCE: AEMO, INTEGRATED SYSTEM PLAN, 2018)

High levels of rooftop solar and batteries creates $4B in market benefits.

2.3 Transitioning the networks

This opportunity does not come without risk. The network of poles, wires and substations built to deliver energy from remote power stations to households was designed for one-way electricity flows. However, typically more than half of the energy generated by rooftop solar systems is exported as household energy use is often low during the periods of peak midday sunshine.

There is now so much solar power being exported in some areas of the network that the peak energy flow is in the reverse direction, back up the grid. As a result, there is a transition underway to adapt this infrastructure and the ways in which we operate the system to accommodate customer preferences.

There is so much solar power exported in areas of the network that the peak energy flow has been reversed.

If this transition is not well managed, increased rooftop solar uptake will have major impacts on the power system and households.

Firstly, rooftop solar exports cause the voltage in the local network to rise. High network voltage levels can cause solar systems to automatically turn off (a safety feature) or ramp down, reducing the revenues solar customers receive from their feed-in tariffs, or in the worst case temporarily eliminating any customer revenue from the solar system.

In addition, localised high voltage often requires intervention from the network owners to fix. This adds cost to the system, which can impact all consumers.

In response, network owners are starting to impose restrictions on the size of solar systems that can be connected, and the level of exports allowed. In some instances, zero export limitations have been put in place.

These types of restrictions could reduce the bill savings for a typical solar customer in NSW by as much as $500 per year[12].

Secondly, the potential for significant fluctuations in the combined regional rooftop solar generation within relatively short time periods can also lead to a range of technical issues for the network.

Difficulty in predicting this behaviour, which can be a function of weather patterns, system settings and other network shocks, presents a new challenge for network owners and AEMO[13].

Finally, the simple forces of supply and demand mean that if there is growing excess rooftop solar outputs during the middle of the day, without a similar increase in demand, prices will fall.

South Australia, a state with one of the highest penetrations of rooftop solar, has recently experienced several instances of negative wholesale energy prices during the middle of the day due to excess renewable energy supply[14].

Restrictions put in place by networks could negatively impact solar households by as much as $500 per year.

This trend, within the current market structure, will ultimately result in decreased value for solar feed-in-tariffs, which will further reduce solar customers' returns on their investments.

Ultimately, the difference in total system costs in a well managed future where Australia achieves net zero emissions by 2050 (including a third of electricity demand from rooftop solar) compared to one where this transition is not well managed, could be up to $100 billion[15].

2.4. The Federal policy debate has ignored this revolution

Despite the massive interest by Australian households in rooftop solar and the significant opportunities and risks this presents for our energy transition, the majority of the big policy debate in Australia around energy has focussed on large-scale energy assets.

Debate has raged about incentives and policy certainty for large-scale wind and solar farms and policy support for large-scale pumped hydro energy storage via the "nation building" Snowy Hydro 2.0 and Tasmania's Battery of the Nation. But the Federal Government has been silent on the Home Renewables Revolution currently underway.

While policy positions on large scale renewables and storage are important, they are not enough.

Policies supporting large scale assets can create impact over the long term, but Australians want action now, while many of the problems associated with our energy system's transition are coming to the fore.

These large-scale assets do not address the highly location specific network issues and opportunities related to the increase in rooftop solar and the forecast uptake of additional distributed energy resources such as electric vehicles.

Long-term solutions are also inherently risky in an environment where technology innovation and uptake can have significant impacts on the problems these solutions are trying to solve.

AEMO's recent analysis revealed the need for 15GW of storage to be in place by 2040[16]. The current Snowy Hydro and Battery of the Nation plans would expand our pumped hydro storage capacity to about 7GW[17] so there is still a considerable need for more storage.

Large scale renewables are important, but they are not enough.

AEMO's analysis not only highlighted the importance of storage, but the "critical role" of distributed storage (batteries) with shorter discharge times that can provide value through capacity firming to support the grid at peak times[18].

Critically, these policy debates completely ignore everyday Australians, their clear desire to be part of the energy transition and their willingness to invest in supporting solutions. They focus on the big energy companies and developers who have a vested interest in large-scale generation and grid-based consumption.

So, how do we harness the momentum of the Home Renewables Revolution in Australia to support the transition of the energy system? And how do we ensure risks are managed so Australians have improved access to affordable, reliable and clean energy?

We need to acknowledge that solar households are a critical part of the renewable energy future and their adoption of new energy technologies is fundamental to an efficient transition.

But rooftop solar alone is not the answer. For optimal support of the transition of the energy system this source of variable renewable energy needs to be harnessed and stored – and for this we need home battery storage.

3. The case for home battery storage

In their simplest use, home batteries enable households to store excess solar power they would otherwise have exported during the day so that they can use this energy in the peak evening period.

As the cost of grid imports in the peak period is typically much higher than the feed in tariff for solar exports during the day, customers enjoy increased bill savings by installing a battery alongside their solar system.

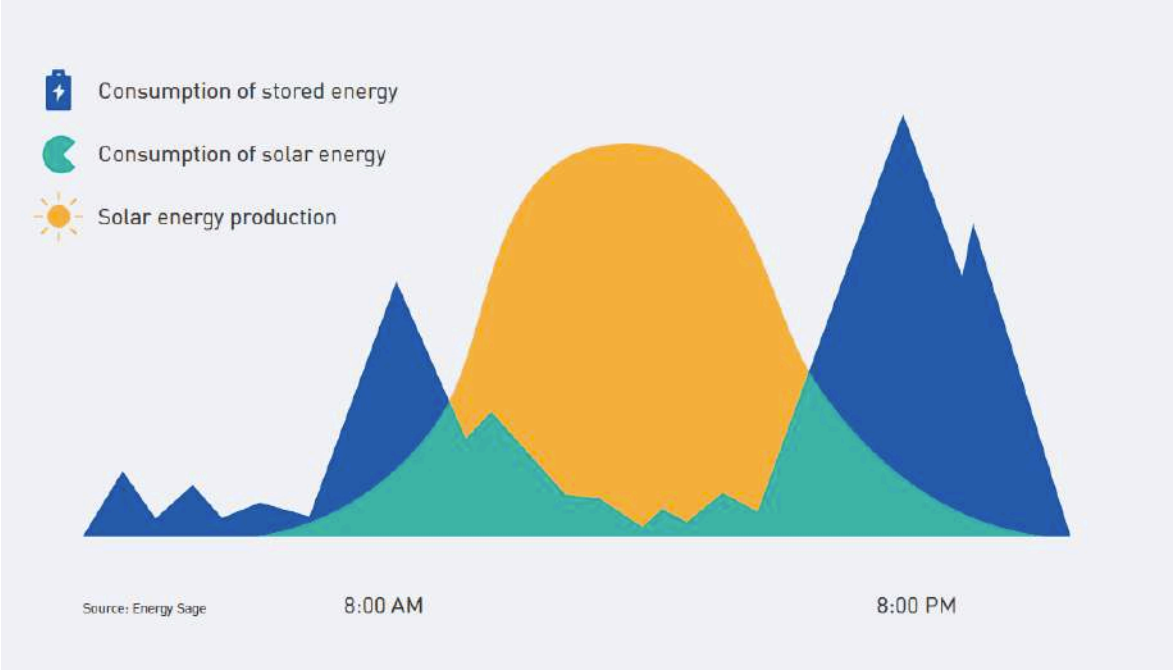

FIGURE 2: HOW BATTERY STORAGE UTILISES ENERGY WITHIN THE HOME.

The reduction in exports decreases the grid impacts of rooftop solar systems. In addition, the reduced grid consumption during the evening peak periods, cuts down the need for bigger distribution networks and more generation assets (which are designed to cater to these peak periods only). This helps reduce electricity costs for all consumers.

Reducing exports lowers the impact of rooftop solar on the grid and cuts down the need for bigger networks and more generation assets.

In a recent speech at Australian Energy Week 2019, AEMO's CEO Audrey Zibelman spoke of the break-neck speed at which consumers, through their uptake of new energy technologies, were changing the energy markets of Australia.

She also spoke of the importance of the "four Ds" that will shape the future of Australia's electricity market: decarbonisation, digitalisation, decentralisation and democratisation. Home batteries support all of these pillars.

3.1 Decarbonisation

The ability for customers to store their excess solar power at times when the grid is "full" means that the risks from high network voltage and other technical impacts are reduced.

This means less of the renewable energy is wasted by solar systems switching off or ramping down and networks are less inclined to place restrictions on rooftop solar connections or system sizes.

Because of this more, and bigger, solar systems can be connected to the grid – increasing the ultimate use and uptake of renewable energy.

3.2 Digitalisation

Using the latest communication and control technologies home batteries can be grouped together and remotely orchestrated as "virtual power plants" (VPPs). They can provide benefits to the grid and all its users, as well as creating more bill savings for battery owners.

These savings will increase over time as the system evolves and new markets for grid services open up to fully utilise the batteries' potential.

3.3 Decentralisation

The dispersed nature of home batteries throughout the grid means that they can provide location specific services. This geographical dispersion, as well as their number, creates a more resilient system – providing grid support at critical times in critical locations, improving grid reliability and security.

Their proximity to end users also means that batteries support a system with less energy losses as power doesn't need to travel across great distances to reach its destination.

It is also important to acknowledge that smaller, distributed storage solutions would not require as substantial investment in the large-scale transmission infrastructure[20].

3.4 Democratisation

Importantly, home batteries empower the consumer to play their part in the energy system of the future. They can invest their own capital for their own reasons and take back control of their energy costs and their emissions.

This technology also provides a gateway to additional advanced technologies that can further enhance a consumer's participation in, and benefits from, the energy system of the future – such as electric vehicles and controllable household devices.

3.5 State support for home battery storage

Home batteries are already becoming more economic for some solar customers with paybacks of less than 10 years in some states[21]. However, these systems are still out of reach for the vast majority of customers.

While there are a number of state-based home battery storage programs currently available or planned, not all States offer support for home batteries and many of those that do are either highly limited in relation to the number of systems they support or the level of subsidy they provide.

State programs supporting battery storage are limited and do not do enough.

For example, Victoria's Solar Homes program is subsidising only 1,000 home batteries per year while NSW's Empowering Homes program is only offering no interest loans for home battery systems.

These programs are unlikely to be a sufficient incentive to significantly impact uptake, at least in the short term.

In addition, market analysis has found that although there are a number of home battery-based VPP trials across Australia, less than 5% of existing home batteries are participating in a VPP to provide additional benefits for the household and the system[22].

These VPP trials are also uncovering challenges associated with customer willingness to share the advanced functionality of home batteries to support the local power system.

Nevertheless, these existing programs do provide some level of support for approximately 400,000 home battery storage systems over the next 10 years[23].

But if the uptake of these 400,000 batteries could be accelerated and we could ensure they were VPP ready, we could easily build a Big Aussie Battery at the scale of Snowy 2.0[24].

This Big Aussie Battery would be dispersed throughout Australia and built within half the time of its large scale hydro counterpart. It could be coined, “Sunny 1.0”.

Ultimately, to achieve AEMO’s forecast 15GW of storage requirements by 2040, we would require four Sunny 1.0s in addition to Snowy Hydro 2.0 and Tasmania's Battery of the Nation[25].

In 2040, if 1 in 4 solar homes had a battery they could meet over half of AEMO’s forecast storage requirements.

While this may sound like a lot, based on the forecast rooftop solar uptake by that time, it would only require one in four of the households with solar systems to also have battery storage[26], that's just over 1.6 million homes.

4. Building Sunny 1.0

4.1 Federal Government support

Ensuring Australians in all States and Territories have access to home battery storage systems at a more affordable cost (with reasonable payback periods of around 5 years) would result in a significant acceleration of uptake.

A subsidy of around 50% of the cost of home battery systems could achieve this. This support could ultimately be extended to electric vehicles, provided their batteries can act in the same way as home battery storage systems (i.e. they have vehicle-to-grid charging capability).

Having an energy storage target, similar to the renewable energy target that currently drives support for solar systems through the small-scale renewable energy scheme (SRES), could be a way for these subsidies to be administered through the Clean Energy Regulator. It is also important that any subsidy scheme uses its eligibility criteria to drive high standards in technology and installations to manage risks associated with safety and performance.

4.2 Ready for the digitalised future of energy

As the scale of subsidies for rooftop solar ramps down through the SRES mechanism, it makes sense that subsidies for batteries ramp up. Ensuring that all batteries eligible for this subsidy were “VPP ready” would also help to promote the importance and benefits of sharing home batteries with the community.

This will promote competition amongst energy innovators and disruptors to incentivise consumers to participate in VPPs and reap the benefits of providing support for the grid.

VPP-ready batteries will promote competition and incentivise consumers to be part of a bigger solution.

4.3 Supporting the energy industry to transition

In addition, having a centrally managed scheme of this nature allows for recording of the number and location of household storage systems, in the same way that rooftop solar system uptake has been tracked by postcode. This provides invaluable information for the energy industry to plan and manage the system most effectively.

4.4 Supporting local job creation

Finally, Government support for emerging energy technologies creates jobs. According to the Clean Energy Council, the rooftop solar industry was directly responsible for 6,267 jobs in 2018[27] and this number can be significantly increased with the uptake of home batteries.

In addition, jobs can be created in other industries such as manufacturing and even mining, driven by eligibility requirements for the subsidy with preference given for battery systems manufactured in Australia or using raw materials mined in Australia.

For example, the South Australian battery storage program prioritised products manufactured in South Australia. This led to German energy storage company Sonnen announcing it will assemble and manufacture 50,000 energy storage systems in Adelaide over the next five years, creating around 430 new jobs[28].

Battery storage provides an opportunity for Australia to harness the power of the Home Renewables Revolution currently underway.

4.5 Providing a way for homes to lead the charge

Home battery storage systems provide an opportunity for Australia to harness the power of the Home Renewables Revolution currently underway.

Australians want to participate in the energy transition and installing a home battery with their solar system not only provides great benefits for them, but important benefits for the system – benefits that all Australians can enjoy.

But to make this happen and to accelerate home battery system uptake requires the explicit and considered support of Federal Government. As Australia’s 2 million solar homes have shown, they're ready to act. The question is, is Government ready to help?

[1] Sourced from the Australian PV Institute website on 10th July 2019: https://pv-map.apvi.org.au/analyses

[2] The University of Melbourne, 'Facts4Paris: Australia's per-capita emissions remain the highest among its key trading partners', and The Australian Financial Review, 'Australian households pay highest power prices in world', August 2017

[3] Based on plausible projections of Australia's changing generation mix to 2050 published in ENA and CSIRO's Electricity Network Transformation Roadmap, Final Report, 2017 and Reputex, 2019 as reported in the Guardian, https://www.theguardian.com/australia-news/2019/may/29/australia-to-achieve-50-renewables-by-2030-without-government-intervention-analysis-finds

[4] AEMO, Insights Paper - Increased storage and transmission to facilitate a resilient energy future. 10th July 2019

[5] Sourced from the Australian PV Institute website on 10th July 2019: https://pv-map.apvi.org.au/analyses

[6] Number of dwellings as per ABS data, 2016 census, 9.9 million: https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/036

[7] SunWiz: as reported in RenewEconomy on 8th July 2019: https://reneweconomy.com.au/australia-now-has-more-than-9gw-of-small-scale-rooftop-solar-76901/

[8] Eraring Power Station in NSW has a capacity of 2,880MW. Note: we have not considered Lay Yang A and Loy Yang B, with a combined capacity of 3,300MW, to be a single power station

[9] Sourced from the Australian PV Institute website on 10th July 2019: https://pv-map.apvi.org.au/analyses

[10] Venture Advisory, Batteries powering our residential homes, 18th June 2019. https://www.ventureinsights.com.au/product/batteries-powering-residential-homes/

[11] AEMO, Integrated System Plan, 2018

[12] Solar Indigestion, Solar Exports and Voltage Issues in the Grid, Renew, 2018. https://renew.org.au/wp-content/uploads/2018/11/Solar-indigestion-FINAL-v1.1.pdf

[13] AEMO, Electricity Forecasting Insights, June 2017

[14] As reported in RenewEconomy on 30th April 2019, https://reneweconomy.com.au/wind-solar-push-south-australia-prices-below-zero-for-almost-six-hours-39546/

[15] ENA and CSIRO, Electricity Network Transformation Roadmap, Final Report 2017

[16] AEMO, Insights Paper - Increased storage and transmission to facilitate a resilient energy future. 10th July 2019

[17] This includes existing pumped hydro capacity of 1340MW (https://arena.gov.au/blog/will-pumped-hydro-unlock-the-transition-to-renewables/) plus extra capacity from Snowy Hydro 2.0 (2000MW) and Tasmania's Battery of the Nation (up to 3500MW)

[18] AEMO, Insights Paper - Increased storage and transmission to facilitate a resilient energy future. 10th July 2019 http://energylive.aemo.com.au/News/Increased-storage-and-transmission-to-facilitate-a-resilient-energy-future

[19] As reported in RenewEconomy on 12th June 2019: https://reneweconomy.com.au/australia-has-to-look-forward-on-energy-says-zibelman-we-have-no-choice-20176/

[20] AEMO, Integrated System Plan, 2018

[21] As reported in SolarChoice in January 2018: https://www.solarchoice.net.au/blog/home-solar-battery-storage-worth-it-2018

[22] Marchment Hill Consulting, analysis of VPP trials and participation in Australia, 2019. Found that approximately 16 VPP trials has a total of 2,600 participating batteries, out of a total installed battery population of approximately 60,000 (ref: sunWiz data as at April 2019). As discussed and presented at: https://www.ventureinsights.com.au/product/do-batteries-change-everything-and-by-when/

[23] Existing home battery programs include:
South Australia: Home Battery Program subsidising 40,000 battery storage systems. South Australia VPP which aims to create batteries in 25,000 public housing households and 25,000 private properties.
- Victoria: Solar Homes Program subsiding 10,000 batteries over 10 years
- NSW: Empowering Homes Program offering zero interest loans for up to 300,000 battery and solar and battery systems over 10 years.
- Queensland: Zero interest Loans up to $6000 and grants up to $3000 for as many as 500 battery systems and loans up to $10,000 and grants up to $3000 for as many as 1000 solar+battery systems
- ACT: Next Generation Energy Storage program subsidising up to 5,000 energy storage systems.

[24] This assumes an average capacity of a household battery to be 5kW.

[25] Assumes aggregate of existing storage plus Snowy 2.0 and Battery of the Nation is 7GW and each Sunny is equivalent to 2GW (400,000 customers with 5kW battery systems)

[26] Assumes 6.5 million rooftop PV systems in 2040, based on projected installations of 52GW of rooftop solar capacity in 2040 (ENA and CSIRO's Electricity Network Transformation, Final Report 2017) and assuming an average 8kW system size.

[27] CEC, Clean Energy Australia Report 2019

[28] https://www.cleanenergycouncil.org.au/news/south-australian-battery-program-to-drive-jobs-innovation-and-quality

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