A Powerful Cleaner Queensland:
Unlocking Bill Savings through Renewable Energy

www.powertogether.org.au

Summary

Queensland can use our sun and wind to bring down electricity prices and keep them stable. Building additional renewable energy and storage at the large scale and household level could reduce Queensland's wholesale power price in **2025 by 25%**.

This would save every household around **$200/year;** a total saving of **$1.3bn/year** for electricity bill payers in Queensland.

Queenslanders have been hit with spiralling electricity prices in recent years. Our coal fired power stations have become increasingly unreliable, with frequent and long term break downs, at the same time as gas and coal prices have skyrocketed due to international tensions such as the Russian war in Ukraine. In 2022-2023, the average wholesale price of electricity was $145/MWh, slightly lower than the previous year, but more than double the average price between 2018 and 2021.

This is being passed through to bill payers. The second consecutive increase to the Default Market Offer hit bills on 1 July 2023.

The average household in South East Queensland may now be paying up to $515/year more than they were two years ago.

Controlling these rising costs of energy was a focus of the Federal Budget, with $1.3 billion pledged to household energy relief. The Queensland Budget, delivered on 13 June announced complementary state support to bring relief of $550/year to low income or otherwise vulnerable households. This is hugely important for households already struggling to make ends meet.

The Queensland Budget also committed a record $19bn funding to large-scale renewable energy. Deploying this funding to build renewable energy is vital as, with no end in sight to the war in Ukraine, and Queensland coal fired power stations still plagued by problems, electricity prices will remain high.

Queenslanders need a long term solution to rising energy prices beyond annual rebates.

This research shows that building large and small scale renewable energy and storage, to take advantage of Queensland's wind and solar, would bring down wholesale power prices.

This report quantifies the impact of building more renewable energy at a household and large scale, in line with the asks of the Power Together alliance.

This alliance was launched in May 2023 by Queensland Conservation Council, Solar Citizens, Queensland Community Alliance, Queensland Council of Social Services and other faith and community groups to advocate for real action on power prices and energy equity.

If our campaign's asks were achieved, Queensland's wholesale power costs would be reduced by $1.3 bn in 2025, around a 25% reduction on wholesale prices expected under business as usual.

Renewable energy at a household level can save that household enormously, up to $3000/year when combined with energy efficiency measures.

Building this large and small scale renewable infrastructure will need significant capital investment. We estimate that the renewable energy and storage infrastructure would require around $5.5bn investment, which could be paid back in less than five years of Queenslanders' bill savings.

The Queensland Government has made a good start with the draft Energy (Renewable Transformation and Jobs) Bill released last week, and the funding announced in the Budget.

Delivering these projects also needs strong leadership and regulation from the Government. There needs to be robust community engagement, strict environmental controls and good regional planning for large-scale renewables. There also needs to be effective education and support for households to roll out energy solutions to all households.

Power Together calls for

2,000 MW of additional large-scale renewable energy

500 MW of additional storage

10,000 rooftop solar systems installed on rental houses

10,000 social housing tenants brought into Virtual Power Plants of rooftop solar and batteries

in Queensland by 2025

This report demonstrates the immense opportunity to reduce power prices through large and small-scale renewable energy.

We need the Government to commit to the Power Together asks, and accelerate the build of renewable energy we need for the transition in a sustainable and equitable way.

Scenarios

The Base Case

Queensland has a number of large-scale wind projects under or close to construction. By 2025, this will be an additional 1.85 GW of renewable energy, primarily in the Darling Downs, as shown in Table 1.

Table 1: Assumed renewable energy build to 2025 base case

Region	Wind	Solar
Fitzroy	Clarke Creek (450 MW)	
Western Downs	Dulacca (180 MW) Wambo (250 MW)	Kingaroy (40MW)
Southern Downs	MacIntyre (926) Karara (100 MW)	

On top of recently commissioned solar projects at Wandoan and Western Downs, solar farm capacity is at 3.84 GW.

The following large scale batteries are also assumed to have been built. These are not assigned a region:

- Kidston Pumped Hydro (250 MWh/ 2000 MWh)
- Greenbank Battery (200 MW/ 400 MWh)
- Chinchilla Battery (100 MW/ 200 MWh)
- Tarong Battery(150 MW/300 MWh)
- Swanbank Battery (150 MW/300 MWh)
- Western Downs battery (200 MW / 400 MWh)
- Bouldercombe (50 MW / 100 MWh)
- Stanwell Battery (150 MW/300 MWh)

Power Together Scenario

The following additions would be made if the Government implemented the asks of the Power Together coalition:

- An additional 2,000 MW of renewable energy
- An additional 500 MW of battery storage
- 10,000 rental homes with solar
- 10,000 social houses in a Virtual Power Plant (VPP)

This doesn't include unquantified asks of low interest loans for electrification and energy efficiency and minimum energy efficiency standards of rental homes which would further bring down demand and reduce prices.

Table 2 shows the projects assumed to be accelerated, to build an additional ~1,200 MW of wind and ~800 MW of solar by 2025.

Table 2: Assumed renewable energy build to 2025 base case

Region	Wind	Solar
Fitzroy	Lotus Creek (340 MW)	
Banana	Banana Range (230MW) Specimen Hill (330MW)	Aldoga (440MW) Rodds Bay (300MW)
Western Downs	Tarong West (500MW)	Aramara (100MW)

Total renewable energy build and distribution for the base and Power Together scenarios are shown in Figure 1.

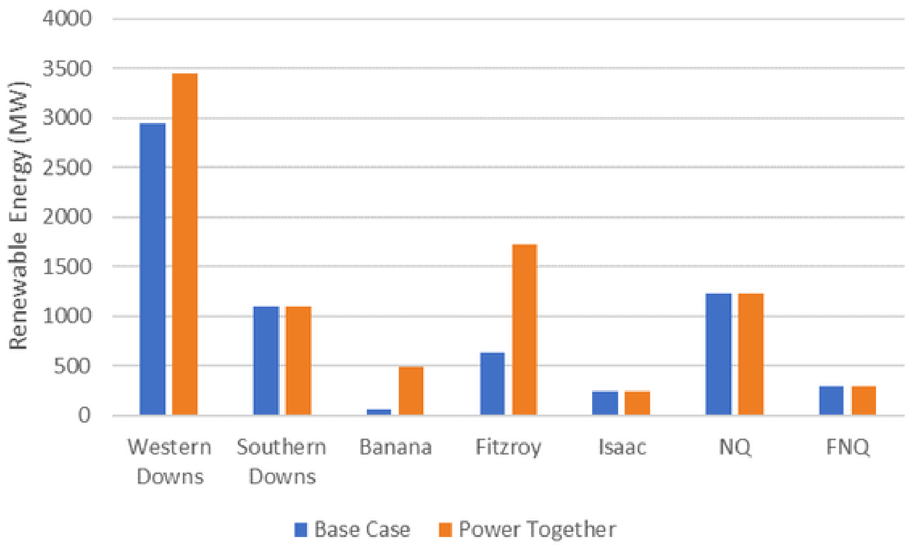


Figure 1: Renewable Energy Build in Base Case and Power Together Scenarios

The solar for rentals programme is assumed to be additional to growth in rooftop PV assumed in the Step Change scenario, as are the 10,000 social homes in the VPP. By 2025, without additional incentive, it is not likely that a significant number of private rental or social housing tenants would have been able to access solar and batteries.

Case Study: Mathieu

Mathieu, a 37-year-old full time PhD student studying environmental toxicology is describing how rising energy costs are impacting him and other housemates as renters in their shared home. As a student on a living stipend that is under minimum wage, Mathieu and his housemates are increasingly aware of the rising energy prices further limiting their finances. Additionally, he highlighted how renewables like rooftop solar can help mitigate the increasing climate change impacts Queenslanders are experiencing.

Investing in solar panels could provide Mathieu and his housemates with an affordable and sustainable energy source, lowering their dependence on conventional energy grids and mitigating the impact of rising energy prices.

Solar energy systems generate electricity from sunlight, eliminating the need for expensive fossil fuels and reducing the overall energy consumption of the household.

This transition to renewables would alleviate any unnecessary financial strain on Mathieu and his housemates, enabling them to allocate more resources to enhance quality of life, and their education and research endeavours.

However, being a renter and financially constrained student means Mathieu has a reduced ability to invest and adopt rooftop solar.

“I would love to have solar here for sure. However, because I don't own the house, I can’t really make that call and even if I had the choice, I can't afford to invest in something that would not be paid back within the time I’m renting. Personally, it would bring the cost down. It's an extremely affordable energy source. And, solar energy is energy that we can have straight from the sun that won't impact our future."

To support Mathieu and others facing similar challenges, it is crucial to prioritise the adoption of renewable energy on both individual and societal levels.

Policymakers, energy providers, and communities must facilitate the installation of solar panels and promote the use of renewable energy sources. This could be rolled out to low-income households and renter households to simultaneously reduce cost of living pressures and emissions.

Methodology

This modelling created a generation profile and price outcome for each half hour of 2025. This is primarily based on the Australian Energy Market Operator's Inputs, Assumptions and Scenarios for the Integrated System Plan.

Inputs

Demand

The half hourly Operational Sent Out (OPSO) demand is used from the 2022 AEMO Integrated System Plan's Step Change scenario for 2025. Operational demand is met by scheduled generators, so it already accounts for rooftop solar.

The Probability of Exceedance 10 (POE10) forecast is used. This means that there is a 10% chance that the maximum demand in this forecast will be exceeded. It is likely that the maximum demand would actually be less than forecast.

Large-scale Renewable Energy

AEMO generate half hourly profiles for renewable energy, called traces. A representative trace picked for each region as shown in Table 3. Traces are generated using a historical year as a reference point, the reference year 2011 was used for all renewables.

Rooftop PV

A rooftop PV forecast is also created for AEMO's Step Change scenario (Probability of Exceedance 10). The 2025 forecast is used.

Cogeneration

Yarwun cogeneration plant is assumed to have a constant operation to supply the refinery at 130 MW.

Demand excluding renewable energy and cogen

For every half hour, the renewable energy offered by large-scale wind, solar and run of river hydro, as well as Yarwun's demand, is subtracted from the operational demand. This gives the remaining demand that must be met by fossil fuels and storage.

For the run of river hydro plants, Kareeya and Barron Gorge, their output in 2022 was assumed to be representative of all future years.

Table 3: Renewable Energy Traces used for each Region

Region	Wind Trace	Solar Trace
FNQ	Mt Emerald Wind Farm	n/a
NQ	Kennedy Wind Farm	Ross River
Fitzroy	Fitzroy Wind Low	Fitzroy SAT
Isaac	Isaac Wind Low	Isaac SAT
Banana	Banana Wind Low	Childers
Western Downs	Coopers Gap wind farm	Darling Downs Solar Farm
Southern Downs	Darling Downs Wind Low	Warwick

Coal

Queensland's coal fired power stations are assumed to be all running again by 2025, including Callide C. If Queensland's roughly 8 GW of coal was fully dispatched it could cover projected demand 98.4% of the time in 2025.

However, Queensland's coal fired power stations are rarely dispatched at maximum capacity for a range of operational and economic reasons. In 2021-22, Queensland coal could have covered demand in 97.6% of the half hour periods in the year.

However, Queensland coal actually generated at an average of 66% capacity. This is due to breakdowns, particularly the persistent outage at Callide C4, as well as a number of shorter outages.

Economic reasons are also a large part of operational patterns. Gladstone, as Queensland's most expensive coal fired power station, operated at an average of just under 40% of capacity, while MIllmerran, the cheapest stations, operated at nearly 90% average capacity.

The biggest constraint on coal fired power stations is the minimum load. They can only operate stably down to a certain percentage of rated capacity, usually around 40 - 50%. Below this, there is not enough momentum to keep the generator operating. The minimum load is given for each unit by AEMO's Inputs Assumptions and Scenarios workbook.

Not all units of coal generators are kept online at all times. Gladstone, for example, had on average only 4 of its 6 units online at any one time in 2022.

By 2025, the minimum load for a power station is the minimum load of half of a station's units. The exception is Gladstone, where minimum load is assumed at 2 of the 6 units.

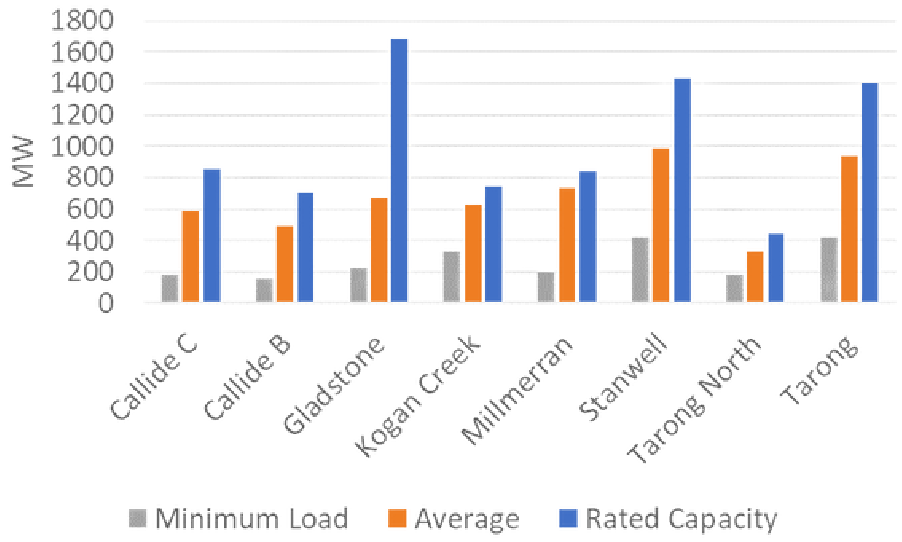
If the remaining demand is less than minimum load of Queensland's coal, the generators are constrained to minimum load, and price is set to -$100/MWh. This assumes that some renewable energy is spilled, that is, the generators don't produce as much as they could.

In reality, coal generators often bid down to the market price floor, of -$1000/MWh to ensure they remain dispatched at minimum load.

This is not assumed to be continued as renewable energy continues and the instances of lower than minimum load demand become more common. It is assumed that coal fired generators would change their bidding behaviour to limit costs.

The assumed minimum load, average availability in 2021-22 and maximum capacity are shown in Figure 2.

Figure 2: Minimum, average and maximum capacity of Queensland's coal fired power stations



The operation of Queensland's coal fired power stations varies throughout the day, as well as over the year. In general, more expensive stations are more susceptible to demand, and therefore price, changes throughout the day.

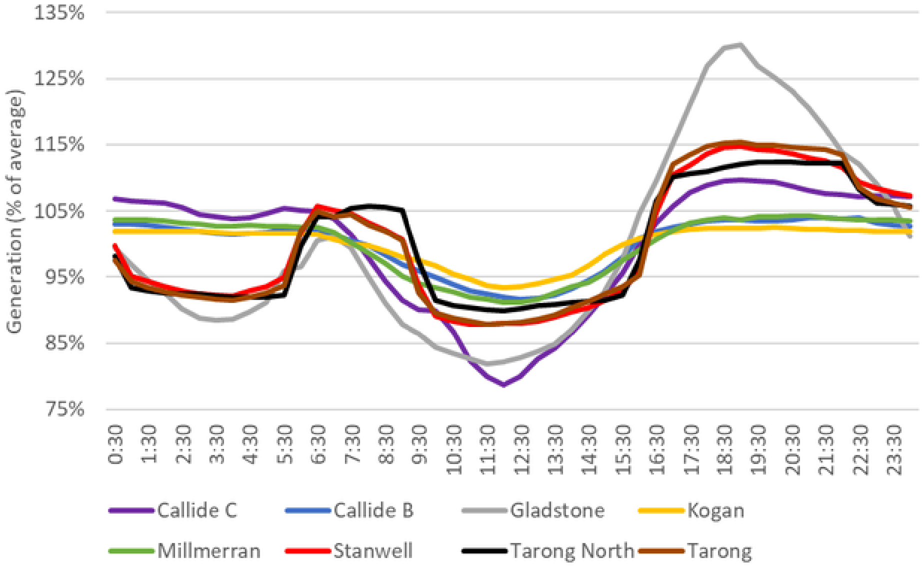
Figure 3 shows the average generation at each half hour of the day in 2021-22. Gladstone had the peakiest operation, while Millmerran largely operated consistently throughout the day, reflecting their positions as most expensive and cheapest coal in Queensland.

The Stanwell owned coal fired power stations, Stanwell, Tarong North and Tarong, operated in general with a noticeable pattern of higher generation for the morning (6 - 10am) and evening (5 - 10pm), and lulls overnight (midnight - 6am) and during the day. This likely reflects their contracted position.

CS Energy's Kogan Creek and Callide B stations also operated in a similar manner with some dip in the middle of the day. Kogan Creek is another comparatively cheap plant to run, while Callide B may be making up for lost generation at Callide C4, which was out for all of this period.

The surprising operation is Callide C3, which had a marked reduction in daytime demand, potentially because it is younger than Callide B, so more flexible and CS Energy have therefore chosen it as the plant to be flexible to accommodate more renewable energy.

Figure 3: Average Operation of Queensland's coal fired power station by time of day, 2021-22



Within this general time of day pattern, coal fired power stations will ramp up or down to meet overall demand. In the model, the average 2021-22 availability by time of day is scaled by the deviation of demand from average for that time of day. This preserves the historical operating pattern of coal fired generators and ensures that more capacity is offered at times of higher demand. This capacity is dispatched at Short Run Marginal Cost (SRMC), as given by AEMO.

In reality, coal is not dispatched neatly by cost, not least because of minimum demand constraints. If the remaining demand is greater than minimum load, but less than the sum of average coal dispatch, it is distributed evenly between the coal fired power stations. This avoids unrealistic options where, for example, Gladstone is frequently turned on and off.

Above the average dispatch, the remaining coal capacity is split into two tranches:

- at $300/MWh, all coal generators, except Gladstone, are assumed to offer 80% of available capacity. This represents the cap price, assuming that a lot of coal generators have sold cap contracts
- at $1000/MWh, remaining coal capacity is dispatched

<u>Combined Cycle Gas Turbines</u>
Queensland has three combined cycle gas turbines: Darling Downs, Condamine and Swanbank E. No minimum load is applied to these but they are assumed to offer their minimum stable load at SRMC, as given by AEMO. Additional capacity is offered at $800/MWh.

<u>Open Cycle Gas Turbines</u>
Queensland's open cycle gas turbines are assumed to offer 80% of their available capacity at SRMC and the remainder at $1200/MWh.

Pumped hydro

Wivenhoe pumped hydro generation in 2022 was analysed to provide a typical operating pattern across the day. This was scaled by demand as for the coal fired power stations to reflect higher operation at times of higher demand.

The same pattern was assumed for Kidston when it comes online in 2025. The operation is shown in Figure 4.

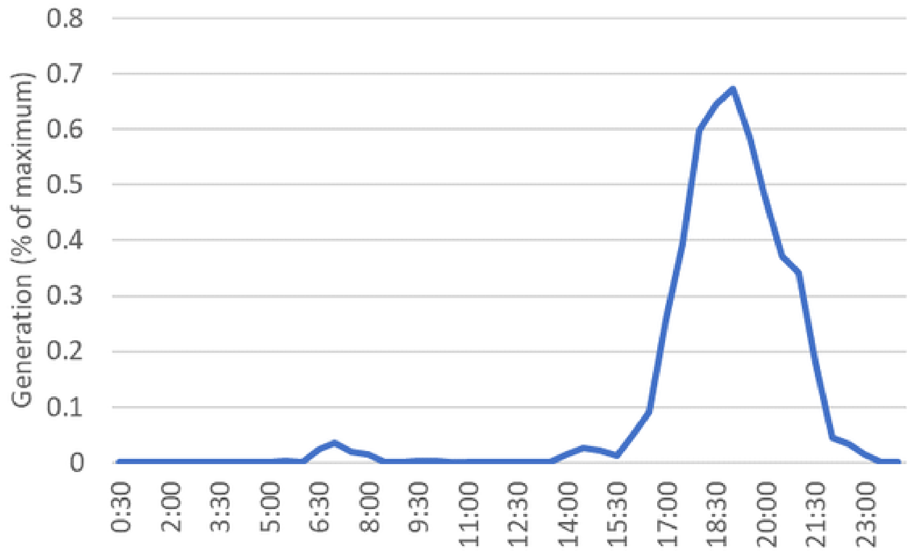


Figure 4: Average Operation of Pumped Hydro by time of day

Large-scale batteries

Large-scale batteries were assumed to charge at all times when coal generators were constrained to minimum load. They discharge starting at the maximum possible price differential for the next 12 hour window.

This is not assumed to add costs at times of minimum demand, as it is still assumed that coal generators are paying to stay online.

Batteries are assumed to displace gas. For a 12 hour period, batteries are discharged to displace the most expensive generator. This assumes that batteries are being operated to minimise system price, rather than maximise profit.

In the period where the maximum price differential can be achieved, the batteries can be discharged up to their rated capacity.

Where the same price differential is available over the peak demand period, the battery is assumed to be discharged at half its capacity, representing a longer impact on reducing peak demand.

The operation of the battery to displaced expensive generators is then calculated, and the final price is recalculated based on the most expensive generator required, after the batteries.

Virtual Power Plants

All new rooftop solar systems are assumed to be 6.6 kW. This is assumed for the Virtual Power Plants (VPP) as well. Although it is not essential that each participant in a VPP has solar, it makes it more profitable and therefore the Queensland Government should roll out VPPs first on houses able to host a 6.6 kW system.

It is assumed that a 13 kWh battery is added to each installation for a VPP.

It is not easy to entirely separate residential demand from other demand, particularly small business which is integrated into residential substations. The average household demand trace was estimated by comparing the load profile published by AEMO with total Queensland operational demand, to find the average time of day contribution of the distribution connected loads, approximated as the residential sector.

Residential demand makes up nearly 70% of Queensland's electricity demand. This is higher at times of peak demand, approaching 90%, as transmission connected demand is likely to ramp down to avoid high prices at these times. The weekend and weekday contribution of residential demand is shown in Figure 5.

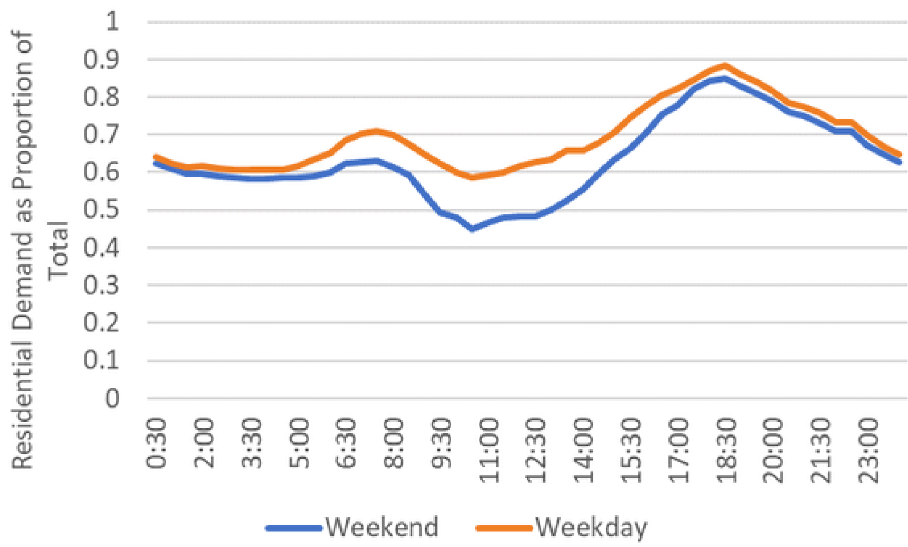


Figure 5: Average contribution of residential demand to total Queensland

The half hourly rooftop solar projection was divided by the total number of installations to give a trace per household.

The average household demand was then compared to the average rooftop solar production. Charging of batteries during the day was limited to a 3.3 kW maximum, to simulate a 4 hour charging window throughout the day.

Discharge was prioritised at the peak periods of 6pm - 7pm, by allowing maximum discharge and constraining discharge between 4pm and 10pm.

The resulting profile is shown in Figure 6.

The average household trace was then multiplied by the number of VPP and solar installations. This was added to the total demand trace for the Power Together case.

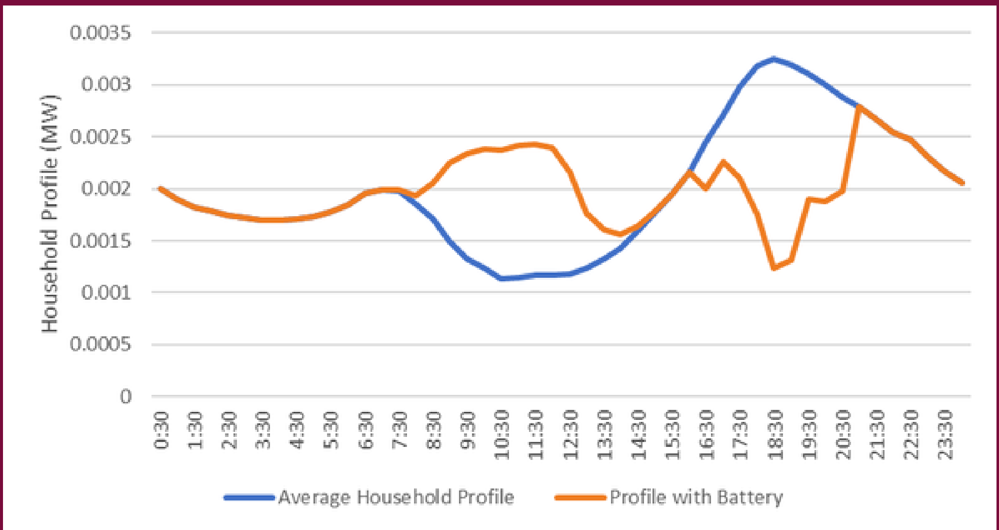


Figure 6: Average daily profile compared to profile with battery in a VPP

Backcasting

This method cannot replicate either the peaks or troughs of the actual electricity price market which varies between -$1000 and 14,1000 /MWh.

On a backcast of March 2022, it overestimates prices in the middle of the day, underestimates the scale of price spikes but overestimates the frequency of moderate price spikes, and returns a similar average price, as shown in Figure 7.

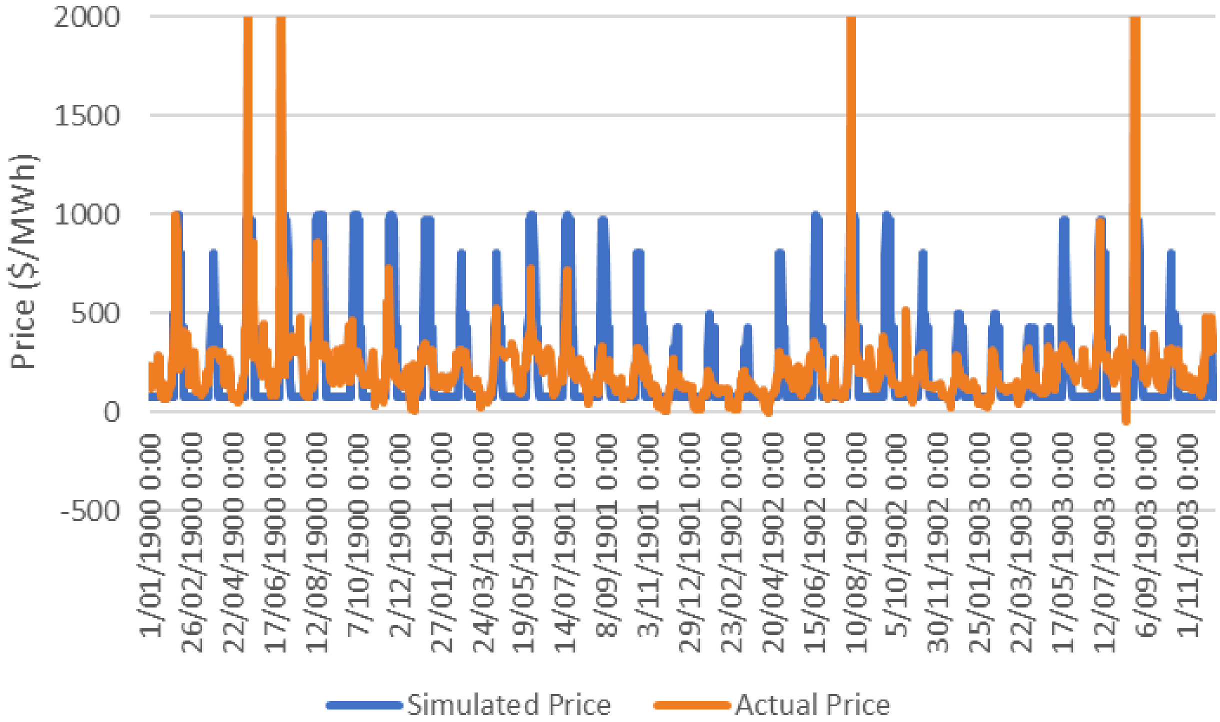


Figure 7: Simulated vs Actual Price for March 2022

This methodology also doesn't account for generator outages, transmission outages, constraints, or demand response, beyond the VPPs in the Power Together Scenario.

This is not a full price forecast, it is a quantification of the difference that renewable energy at a small and large scale can make to price trends in the Queensland electricity grid.