Modelling household energy consumption bill

Prepared for MBIE

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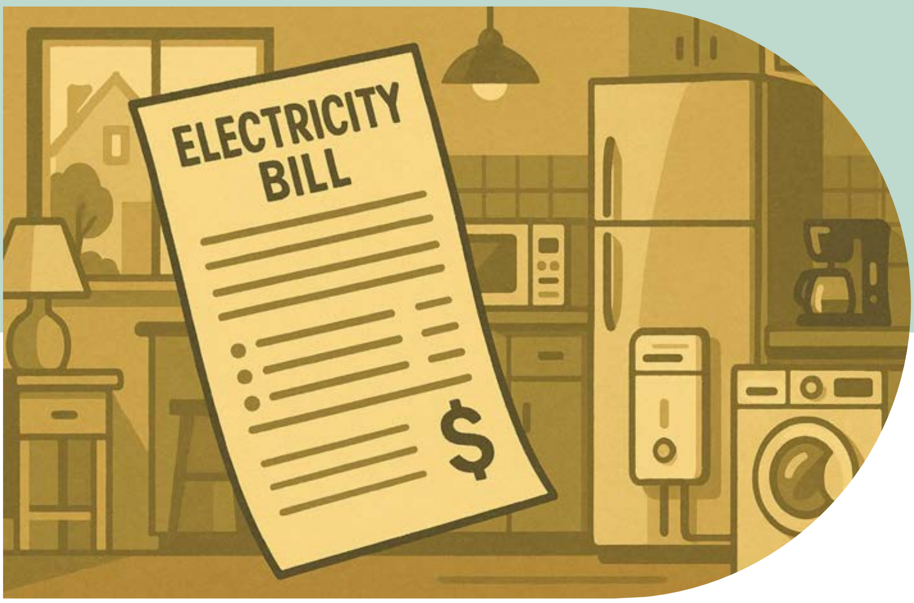

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Glossary

Abbreviation	Stands for
ADMD	After diversity maximum demand
Baseline	Late Electrification/Late Solar + BESS – LE/LS
BD	Business Day
BESS	Battery Energy Storage Systems
EDBs	Electricity Distribution Businesses
EECA	Energy Efficiency and Conservation Authority
EV	Electric vehicle
HWC	Hot water cylinder
ICE	Internal combustible engine vehicles
ICP	Installation connection point
LE	Late electrification
LRMC	Long-run marginal cost
LS	Late solar
LV	Low voltage
MBIE	Ministry of Business, Innovation and Employment
NBD	Non-Business Day
PV	Photovoltaic
TOU	Time-of-use

Executive summary

Purpose and scope

The Ministry of Business, Innovation and Employment (MBIE) commissioned this report to provide a clear, accessible summary of recent modelling work that explores how different levels of rooftop solar and battery uptake affect household energy costs in New Zealand. The analysis integrates outputs from models developed under contracts with MBIE and Energy Efficiency and Conservation Authority, and draws on analysis undertaken by the authors, Jacobs, and ANSA. Jacobs and ANSA provided us data from reports they did for MBIE.[1][2] This report is intended for non-technical audiences, including policymakers and stakeholders, and covers a wide range of household configurations and energy scenarios.

Modelling approach

This modelling covers 60 distinct household profiles, reflecting variations in:

- patterns of appliance use (e.g. lighting, heating, water-heating, etc.)
- rooftop solar installation with and without Battery Energy Storage Systems (BESS)
- electric vehicle (EV) adoption and charging management
- use of gas versus fully electric appliances.

The assessment integrates three main modules:

1. **Energy Price Module**: incorporates wholesale price scenarios from Jacobs (modelled for MBIE as part of this programme of work) and models retail price structures, including flat rates and time-of-use (TOU) pricing. The module is designed to be able to configure for a variety of TOU structures, including up to 144-part pricing. The output is up to 25 years of forecast retail electricity prices.
2. **Transmission and Distribution Price Module**: uses average costs for transmission and distribution, based on Commerce Commission disclosures and Transpower's revenue model, and the ANSA scenarios (modelled for MBIE as part of this programme of work) for the low voltage (LV) network. The model applies capital expenditure forecasts and regulatory asset base values to estimate annual costs for typical households.[3] Avoidable costs over time (from

[1] (Non-Utility Solar-BESS Uptake Market Impact Study - MBIE RT Solar Study, 2025)
[2] (Low Voltage Distribution Network Investment Requirements from Electrification, 2025)
[3] While the model developed assesses after diversity demand profiles, it does so for one household type at a time, e.g. a household with electric heating, cooking, water heating, no-one home during the day, no EVs. The average household for each scenario would vary on the relative numbers of each household type for each scenario, e.g. less households with EVs vs more households with EVs. Therefore, there isn't an average household to use as a benchmark across scenarios, and we instead use typical household types to show comparisons.

controlling peak demand) are pro-rated based on the ANSA LV savings. The output is up to 30 years of forecast retail lines prices.

3. **Load Module**: builds the profiles for various household types based on configurable profiles at the appliance level (including solar, BESS, and EVs). The household types are also configurable based on mixing different combinations of appliances. The output is 25 years of load profiles by household type.

Summary scratchpad: the final model will also have a summary module but this isn't yet available so the results for this report were collated in a bespoke 'scratchpad'. This bespoke model reconciles the other modules outputs into a time series of costs for each household and then summarises these by year.

The modules are each built in an Excel workbook as the final model is intended to be readily accessible to government departments and selected industry groups.

Coordination with other modelling work

This report's modelling is coordinated with Jacobs, ANSA, Sapere and Rewiring Aotearoa's work, though each was conducted independently. Jacobs' outputs provide wholesale electricity forecasts, which are averaged against retail price structures. ANSA's work focuses on total costs and cost savings in LV networks for scenarios involving early/late EV and solar uptake, with particular attention to demand response and coincident peak demand reductions. Meanwhile, Rewiring Aotearoa provided the growth rates and costs for solar and batteries. This report tries to provide consistency in assumptions and scenario linkages, though some differences in approach and scope remain. We caveat though, that the balance of distribution and all transmission cost savings are estimates based on the ANSA analysis. The analysis would benefit from further distribution and transmission modelling.

Key findings

Managing peak demand

This modelling demonstrates that it is plausible to hold average peak demand per residential installation connection point (ICP) to zero growth, even as the number of ICPs increases. Which means that some existing ICPs would need to reduce peak demand to cater for ICP growth, e.g. conversion from resistive heating to heat pumps can plausibly reduce after diversity maximum demand (ADMD) by about 1kW per household given strong enough incentives.

Electrification (switching from gas to electric appliances and vehicles) increases peak demand, but demand management and energy efficiency measures can potentially fully offset this growth.

Role of EVs

EVs represent a relatively new, highly manageable load that can significantly affect peak demand.

Unmanaged EV charging or price incentives that cause many vehicles to charge at the same time (due to static price structures) can create new, higher peaks ("herding" effect).

Managed overnight charging, incentivised by TOU pricing or smart chargers, can flatten demand profiles and reduce peak impacts, though achieving this requires carefully designed pricing. The ideal pricing structure, which is probably different between energy and lines as energy prices reflect the variable cost of energy supply in real-time while network charges are principally driven by peak capacity, would allow households to invest and operate their manageable load (BESS, EV charging, and demand management) so that an optimal balance is found by some limited increase in peak demand (with some limited network investment) to allow some demand to respond to wholesale electricity costs.

Solar and Battery Energy Storage Systems

Adding solar alone can create issues with export peaks, especially for households with low daytime load. The addition of BESS significantly reduces both import and export peaks, helping to manage network capacity and flatten demand profiles. Larger BESS installations further enhance peak management and overall system efficiency. However, it is difficult to design price structures that provide strong incentives for BESS.

Household cost savings

Household energy costs are affected by both total supply costs (wholesale, transmission, distribution) and the allocation of these costs through retail price structures.

Pricing structures that reward households for reducing supply and network costs (e.g. through demand shifting or investment in solar/BESS) are efficient, providing they are revenue adequate and without cross-subsidy.

To model potential cost increases from different levels of electrification and uptake of solar with or without BESS, we start with using baseline scenarios of late electrification and solar uptake. This results in moderate long-term costs, providing stakeholders with sufficient time to plan for infrastructure upgrades and policy development. However, the key driver on the baseline, electrification, is also the one which is driven most by external factors. The rate of take up of electrical appliances from other fuels, especially EVs, will be affected to some extent by policy but mainly through the price of the appliances relative to alternatives, availability of other fuels, availability of finance, and the price of electricity.

If electrification were to increase rapidly and early, then there is a risk of significant[4] expenditure in infrastructure, unless there are incentives to manage demand and invest in solar + BESS. Solar + BESS becomes cheaper than grid supply under all scenarios for all households analysed at least by the 2040s. Under early electrification, and particularly for households that have higher peak energy

[4] Table 1 shows the average difference in the total costs for different scenarios. For early electrification, coupled with late solar + BESS, the total cost can reach up to $4,800 for households with electric appliances, who are at home all day with two EVs, on average.

contributions, solar + BESS can be competitive to grid supply today (although this does depend on the pricing structure).

There is a balancing act. To avoid costs before they are incurred, solar + BESS would need to be incentivised earlier than the network costs. Early investment would also substantially lower wholesale energy costs under the scenarios analysed. However, if electrification were to occur later than expected then early solar + BESS would be expensive,[5] especially for households that aren't electrified or are small users.

Under most scenarios solar only was cheaper than solar + BESS but caution needs to be taken here. The scenarios developed by Jacob's and ANSA were built on solar + BESS. It is not surprising that, in an electric power system that has significant storage capability, solar only would look attractive. However, this would not be the case if the power system didn't have the BESS capacity.

Table 1 summarises the case for adding a 5kW solar + 9kWh BESS over a no solar case for each scenario. These scenarios combine three dimensions: pricing structures, technology adoption pathways, and household energy profiles. Pricing structures range from simple static TOU tariffs to complex models incorporating energy, capacity, and network peak charges. Adoption scenarios vary from late electrification and solar uptake to accelerated solar deployment with early electrification and battery storage. Household profiles reflect increasing demand intensity, from fully electric homes to those with one or two EVs and high all-day loads. The values in Table 1 show the total average cost of different combination of scenarios. For example, if you use static TOU price structure, assuming late electrification and late solar + BESS uptake, households with no one home during the day, with electric appliance and no EV, would expect to pay $1,916.18 for their annual total energy cost. The 'change' columns show the total cost increase if positive or decrease if negative between 'no solar' or baseline scenario with 'solar + BESS' scenario. The 'electric' household will incur, on average, $145.28 more in their total energy cost every year.[6] In 2050, our model calculates $255.84 annual saving for the same household.

With the static TOU network pricing, the profile of the solar + BESS system is the only driver of cost differences. The capacity + peak price structure pushes network cost increases onto parties that cause the greatest need for capacity increases. This causes rate shock for the high consumption households, but the transition needn't be as stark as used in this analysis. The cost savings are relatively modest[7] for solar + BESS over no solar for the high consumptions households compared to the initial rate lift, but these households could install much larger solar + BESS installations and increase the savings.[8]

[5] Our model estimated a little under $3,000 of average total cost for households with electric appliances at home all day and own two EVs.
[6] We model total cost up to 2050. Please see the tables in the annex to match the numbers in the Table 1 above.
[7] Refer to the last four columns in Table 1. Red indicates savings in the annual total energy cost.
[8] We have not modelled variations in solar PV or battery storage system sizes; therefore, the following statements are intended to illustrate potential implications rather than provide precise quantitative outcomes.

The herded[9] electrification scenario shows what could happen with careless incentives and no other demand management approaches. With significant peak demand growth, every household's costs increase dramatically[10] through much higher network costs.

Table 1: Summary of change in cost ($) for solar + BESS over no solar, with average no solar cost ($)

Modelled price structure	Scenario	Household type	Average cost (no solar)	2026 change	2038 change	2050 change	Average change
Static TOU	Late Electrification/ Late Solar + Bess	Electric	1,916.18	498.84	203.57	-255.84	145.28
		All day	2,248.35	498.84	203.57	-255.84	145.28
		Electric + 1EV	2,309.35	498.84	203.57	-255.84	145.28
		All day + 2EV	2,938.14	498.84	203.57	-255.84	145.28
TOU energy/capacity + peak for network	Early Electrification/ Late Solar + Bess	Electric	2,153.37	450.09	-114.63	-552.88	-92.92
		All day	2,904.29	109.00	-481.26	-930.07	-441.29
		Electric + 1EV	2,871.09	345.59	-206.20	-653.37	-180.91
		All day + 2EV	4,817.45	28.68	-503.48	-952.25	-469.51
	Late Electrification/ Early Solar + BESS	Electric	1,866.01	447.41	157.94	-163.77	186.30
		All day	2,550.94	106.43	-137.94	-498.71	-124.56
		Electric + 1EV	2,297.62	343.01	68.80	-253.42	94.27
		All day + 2EV	4,058.85	26.10	-177.64	-530.71	-169.82
	Early Electrification/ Early Solar + BESS	Electric	1,922.22	447.41	118.95	-204.49	156.74
		All day	2,629.89	106.43	-210.07	-523.74	-163.97
		Electric + 1EV	2,366.62	343.01	24.88	-273.01	69.54
		All day + 2EV	4,229.40	26.10	-245.11	-550.50	-203.73
	Early Electrification/ Accelerated Solar + BESS	Electric	1,716.52	387.65	605.27	-307.19	360.76
		All day	2,355.86	46.67	278.93	-620.99	43.17
		Electric + 1EV	2,086.33	283.25	513.84	-372.26	275.94
		All day + 2EV	3,814.80	-33.66	245.34	-647.00	4.69
Static TOU		Electric	4,607.63	498.39	-197.90	-643.68	-158.20

[9] Herded electrification refers to a scenario where the adoption of electric technologies (like solar + BESS) happens in a coordinated or clustered way as opposed to organically.
[10] Refer to 'herded electrification' tables in the Appendix A for the model results.

Modelled price structure	Scenario	Household type	Average cost (no solar)	2026 change	2038 change	2050 change	Average change
	Herded Electrification/ Late Solar + BESS	All day	4,993.77	498.39	-197.90	-643.68	-158.20
		Electric + 1EV	5,020.06	498.39	-197.90	-643.68	-158.20
		All day + 2EV	5,736.14	498.39	-197.90	-643.68	-158.20

Electric = electric appliances, no one home during day, no EV, All day = electric appliances, someone home during day, no EV.

Retail pricing structures

Flat Rate Pricing: customers pay a fixed rate per unit of electricity (usually per kWh), regardless of the time of day or how much electricity they use. Provides limited incentives for demand shifting or investment in BESS. Solar-only households benefit most (with symmetric buyback rates), but this structure is inconsistent with efficient network management and future energy scenarios.

Time-of-Use Pricing: customers are charged different rates for electricity usage depending on the time of day, day of week (weekdays or weekend) and sometimes the season. Incentivises demand shifting and solar/BESS adoption, but the strongest incentive remains reducing overall consumption as avoiding a cost is still preferable to a cheaper cost. Static TOU pricing can create new peaks if not carefully managed, especially with EV charging.

Dynamic/Peak Pricing: signals the need for new network investment and encourages efficient demand management. Solar or solar + BESS profiles remain cheaper as they can genuinely avoid costs in the wholesale electricity market, but this needs to be balanced with not creating more expensive network upgrades. A dynamic pricing approach (such as dynamic TOU prices or an inherently dynamic pricing approach – such as peak pricing for lines prices) can theoretically achieve an optimal equilibrium between energy and network costs. However, there is a complex balancing act.

1. Background and purpose

The Ministry of Business, Innovation and Employment commissioned this report to provide a clear, accessible summary of modelling work that explores **how different levels of solar and battery uptake affect household energy costs**. This report is intended for non-technical audiences, including policymakers and stakeholders.

This modelling covers a range of household configurations, including:

- with and without rooftop solar
- with and without household batteries
- with and without EVs
- using gas appliances vs fully electric appliances.

In total there are 60 profiles that we model.[11]

[11] Our profiles do not specify the number of people at home. Instead, our model allows unlimited bottom-up configuration to specify the load consumed by households.

2. Approach to assessment

2.1 Coordinating with other work

The work done by ANSA, Jacobs and us (Sapere) has been done separately, but with the same intent and guidance on how each piece of work relates to the others. Nevertheless, there is no 'in built' coordinating network. Our understanding is that Jacobs and ANSA's work has been coordinated in the way the briefs were set and the work done. This was also done with our work, but we have also had discussions with Jacobs and ANSA to understand how best to link together.

One thing to note is that our work is looking at the average ICP level, while both Jacobs' and ANSA's work is looking at total demand (or demand and supply). Total demand over time is a function of both the ADMD per ICP but also the growth in ICPs. This means that it can show, for example in ANSA's zero peak growth scenarios, that ADMD can offset the growth in numbers of ICPs. We don't try to reconcile this exactly but simply demonstrate whether this is plausible.

2.1.1 Coordinating with Jacobs work

In some ways, it is easier to coordinate with Jacobs work as the Jacobs output is literally a wholesale electricity forecast, which we average up against different retail price structures to give equivalent retail prices. However, we also need to ensure that our demand response scenarios or, more particularly, our solar and solar + BESS profiles are consistent with Jacobs work.

This is not something we can do easily as ours is a static model (profiles are assumed they do not dynamically react to price). We must make assumptions that are consistent with Jacobs' work. We cannot make reasonable assumptions about coordinating with the supply side. Generally, supply side costs in the wholesale electricity market are positively correlated with level of demand over time. Intermittent renewable generation weakens this correlation, but we make no explicit assumptions for this. Our general assumption is that flatter residential load profiles reduce wholesale market volatility and reduce supply side costs and prices. Significant integration of residential solar + BESS would result in flatter residential loads.

This doesn't work that well with large amounts of solar only, as there is limited ability to cater for solar profiles without BESS. It is the use of solar + BESS that is most instructive.

2.1.2 Coordinating with ANSA's work

We have the opposite challenges with the ANSA work. For ANSA, all we have is the total costs for each counterfactual scenario and the total cost savings for the variations of early/late EVs and early/late solar. We must convert these total costs into retail prices with incentives for demand response that is consistent with the scenario.

What the profiles themselves need to achieve is explicit in the ANSA work. ANSA's work used fixed coincident peak demand increases of 0kW, 1kW, and 2kW on average per ICP. Therefore, our profiles for the ANSA scenarios need to be consistent with achieving coincident peak demand by 0kW, 1kW and 2kW per ICP on average. However, with growth in the number of ICPs and electrification, then to hold growth at 0kW or to limit growth requires reduction in household after ADMD. Different households have different abilities to reduce demand peaks. For example, a household that uses fossil fuels for heating, water heating, cooking and transport will have less ability to reduce peak demand than a fully electric household without people home during the day.

It should also be recognised that reductions of even 1kW are challenging. Significant numbers of residences collectively have an ADMD of around 3kW, so a reduction of 1kW is significant.

As shown in the ANSA numerical results to accompany LV study, it has several scenarios around level of demand growth, late or early electrification, late or early solar + BESS. As our work is looking at individual household types, the linkage to the ANSA work is directly through the relative costs of each scenario and how different pricing approaches affect different households. The early vs late scenarios are about the proportion of households that procure EVs and/or solar + BESS. Our work is less about how those numbers of households evolve over time but the profile of individual household types.

2.1.3 Note on EV assumptions

EVs are tricky to make consistent with assumptions because they do not have an established counterfactual with natural diversity and their actual demand also depends on predictions of human behaviour. Of course, all demand is a function of human behaviour but with other demand types we have precedent.

To the extent we have precedent for EVs, we already know that they are controllable loads that respond to retail prices, they mostly use low power charging (10A), and few are plugged in every day. Whether these patterns of behaviour continue in the future is a matter of conjecture.

Strangely this makes a baseline more difficult to determine than a forecast profile. You can show that EV demand can be readily shifted, with coordination, to nighttime consumption with relatively flat after-diversity demand. You can also show that current behaviour, where a large proportion of EVs are responding to static EV tariffs, would lead to far higher peaks through herding than would have occurred with natural diversity.

We can assume that, as EVs become more prevalent, owners may become less price sensitive, especially without a strong incentive, and a more natural diversity will become more normal. However, this counterfactual will be no less of an uncertain forecast than the scenarios where EV demand is managed.

3. Modelling approach

3.1 Energy module

The energy module produces the energy component of the customer's bill, given the chosen inputs. It takes in the wholesale prices from three different scenarios ran by Jacobs. These scenarios represent different wholesale prices that resulted from different uptake of solar + BESS.

For wholesale prices, we were provided three scenarios:

1. **Base** is the counterfactual scenario that has approximately 3.5 GW of non-utility solar installed by 2055.
2. **Rewiring Aotearoa case one (RA1)** as base case but using Rewiring Aotearoa's assumptions of non-utility solar + BESS, reaching about 28 GW by 2040.
3. **Rewiring Aotearoa case two (RA2)** is an adjusted Rewiring Aotearoa case that reaches a similar level of non-utility solar but not until 2055 and at a slower rate that is indexed to demand growth.

Using the wholesale prices, the energy module calculates the retail tariff at an hourly interval categorised by:

1. year range chosen by user
2. month: January – December
3. type of day: Business Day (BD) or Non-Business Day (NBD).

The Jacobs wholesale price output is on an hourly basis – we convert this to a half-hourly time-series by assuming the same hourly wholesale price for each of the corresponding half hour.

The module allows the following input parameters (with choices) to be configured to generate the required retail price time series.

Table 2: Chosen parameters in the energy module

Parameters	Choices	Purpose
Retail contract and price schedules	• Flat • TOU Peak • TOU Super-peak	The different retail pricing structures available to households can significantly affect the electricity bill as different incentives exist.
Retail component of tariff	• % TOU • Fixed charge	This is added to wholesale energy prices to determine total retail tariff. The component can be calculated either as % wholesale energy tariff, or as a fixed charge in the start year that escalates at an assumed inflation rate.
Future scenarios	• Base • RA1 • RA2	Different scenario reflects future states with varying uptake of non-utility solar + BESS.
Region	• North Island • South Island • NZ Average	The regions are highly aggregated with each island modelled separately. The NZ average use outputs from both islands.

Using the combination of the chosen parameters, the module will calculate daily charge aggregated to monthly charge for the chosen region, future state and the selected retail structure. Note that the values given in the table below for retail structures are themselves configurable.

Table 3: The configurable retail contract and price schedules in the energy module

Energy module parameters		**Value**	**Explanation**
Retail contract type	Price schedule		
Flat	Flat	• Whole-day and whole-night	This contract type always uses the same charge.
TOU peak	Peak	• 07:00 AM – 09:00 PM	User choosing TOU Peak contract will apply more expensive pricing at the specified peak hours and flat rate at other times.
	Flat	• 12:00 AM – 06:00 AM • 10:00 PM – 12:00 AM	
TOU super-peak	Peak	• 07:00 AM – 09:00 AM (morning peak) • 07:00 PM – 09:00 PM (evening peak)	User choosing TOU super-peak contract will have two blocks of peak periods, morning and evening while applying flat rate at other times.
	Flat	• 00:00 AM – 06:00 AM • 10:10 AM – 06:00 PM • 10:00 PM – 12:00 AM	

3.2 Load module

The load module is comprised of the modelled household profiles of interest. The profiles are permutations of combinations across:

1. energy source for cooking (electric or fossil fuel)
2. vehicle type (EV or internal combustible engine vehicles (ICE))
3. heating type (heat pump, resistive or fossil fuel)
4. solar adoption (none, solar or solar + BESS)
5. usage pattern (people at home all day, people at work).

The table below shows the first ten household profiles where there is no solar photovoltaic (PV) and batteries installed. Among the variations modelled are the type of cooktop, vehicles used for daily commute or transport, water and space heating. Household types are also defined by the time of usage of appliances. Each appliance, for example cooking appliance, heater, EV, etc., is given a usage duty of power consumption and duration, and then a normal distribution for when the appliance usage starts, e.g. people come home at different times and start cooking. This distribution of when people start using their appliances is what creates diversity.

Table 4: Permutations of the first ten household profiles without solar PV and batteries.

Household	Method of cooking	Water heating	Transport	Space heating	Solar	Battery
Full electric (2EVs)	Electric cooktop	HWC	2EV	Resistive heater	No solar PV	No batteries
Full electric 1EV	Electric cooktop	HWC	1EV	Resistive heater	No solar PV	No batteries
Full electric + ICEs	Electric cooktop	HWC	ICE	Resistive heater	No solar PV	No batteries
Electric + gas cooking	Fossil fuel	HWC	ICE	Resistive heater	No solar PV	No batteries
Fossil + electric heat	Fossil fuel	Fossil fuel	1EV	Resistive heater	No solar PV	No batteries
Fossil + 1EV	Fossil fuel	Fossil fuel	1EV	Fossil fuel	No solar PV	No batteries
Full fossil	Fossil fuel	Fossil fuel	ICE	Fossil fuel	No solar PV	No batteries
Full electric (heat pumps)	Electric cooktop	HWC	2EV	Heat pump	No solar PV	No batteries
Full electric 1EV (heat pumps)	Electric cooktop	HWC	1EV	Heat pump	No solar PV	No batteries
Full electric + ICEs (heat pumps)	Electric cooktop	HWC	ICE	Heat pump	No solar PV	No batteries

To complement the table above, the permutations include the usage pattern of people being at work during the day or at home all day and those who have solar and/or batteries. For example, our 'all-day' profiles that represent people staying at home most times will have higher load than people who commute to work. These combinations create 60 different household profiles that we model, for example some households are electric-dominant, mixed or choose to use mostly fossil fuel.[12]

The output of this module is the load simulation for all different household types modelled. To illustrate, Figure 1 and Figure 2 below shows the selected profiles of household with and without heat pumps. With heat pumps, the load curve is more balanced, featuring moderate peaks in the early morning (around 06:00–08:00) and evening (17:00–21:00), with full electric households reaching about 1.1 kWh at peak times. In contrast, the scenario without heat pumps exhibits sharper peaks, particularly in the evening, where full electric demand rises to approximately 1.3–1.4 kWh. Both profiles show a midday dip to around 0.3–0.4 kWh, but the absence of heat pumps results in greater variability and higher peak loads, driven mainly by EV charging. Overall, heat pumps help smooth demand and reduce peak intensity compared to households without them.

[12] For the full list of the household profiles modelled, please ask authors.

Figure 1: Variation of winter load profiles (with heat pumps) of different number of EVs

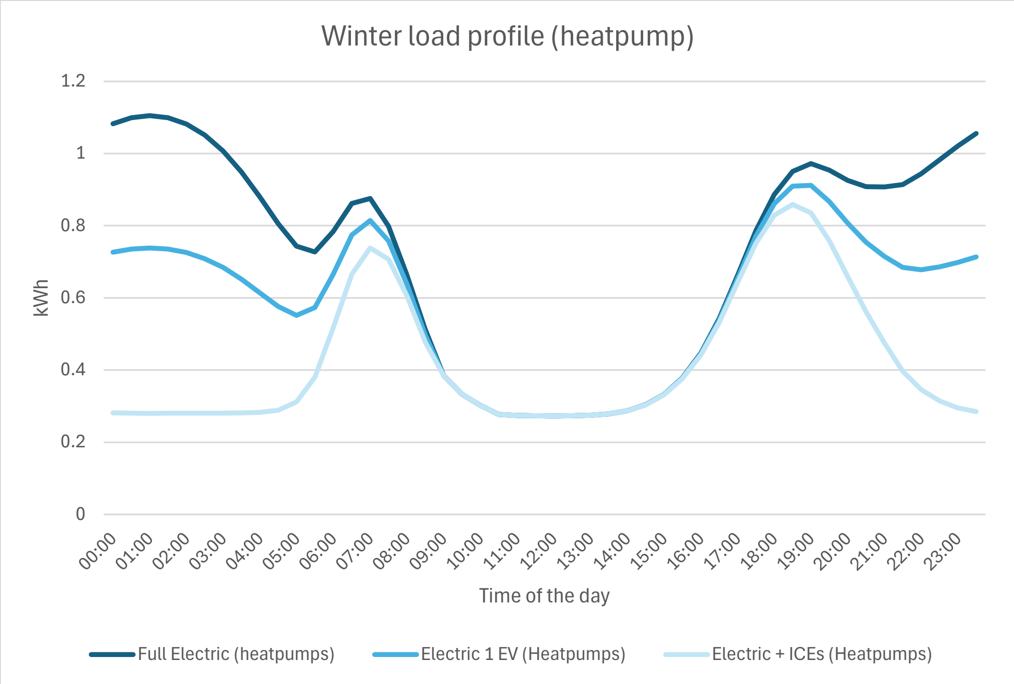
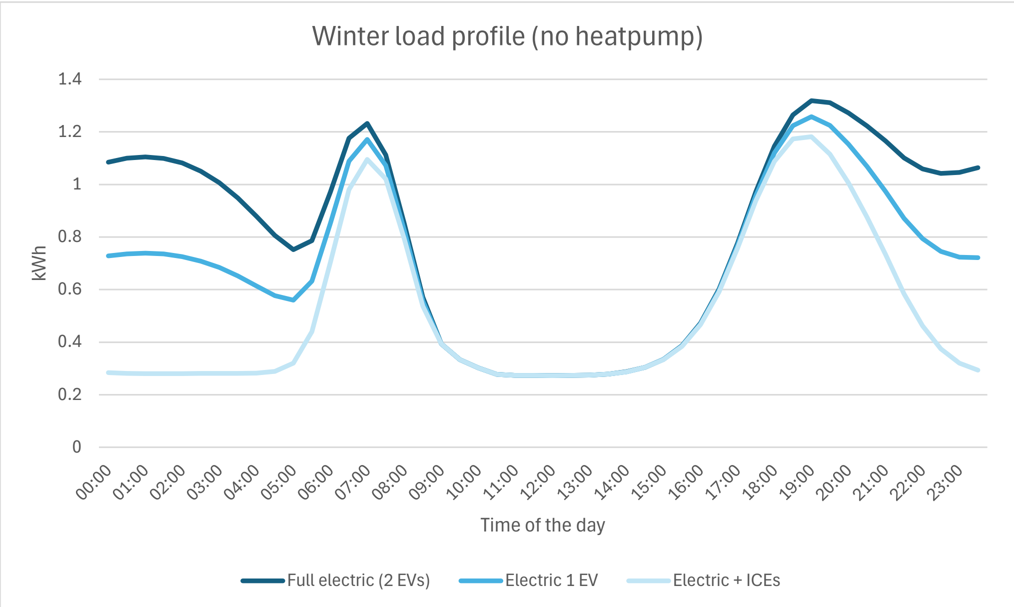


Figure 2: Variation of winter load profiles (without heat pumps) of different number of EVs



Further, the load module explores the household profiles with solar and batteries. The two summer load profiles below, Figure 3 and Figure 4, highlight the impact of BESS compared to solar-only systems. When BESS is included, the load curve remains relatively stable throughout the day, with small dips around sunrise and sunset as the battery charges and discharges, and midday loads hover near zero due to effective solar and storage integration. In contrast, the solar-only scenario shows extreme variability, with deep negative troughs around midday (up to -1.5 kWh) caused by excess solar generation that cannot be stored, and sharp evening peaks as demand rises after sunset. Overall, BESS significantly reduces fluctuations and prevents large negative loads, creating a smoother and more balanced demand profile compared to solar-only setups.

Figure 3: Variation of summer load profiles (with Solar + BESS) of different number of EVs

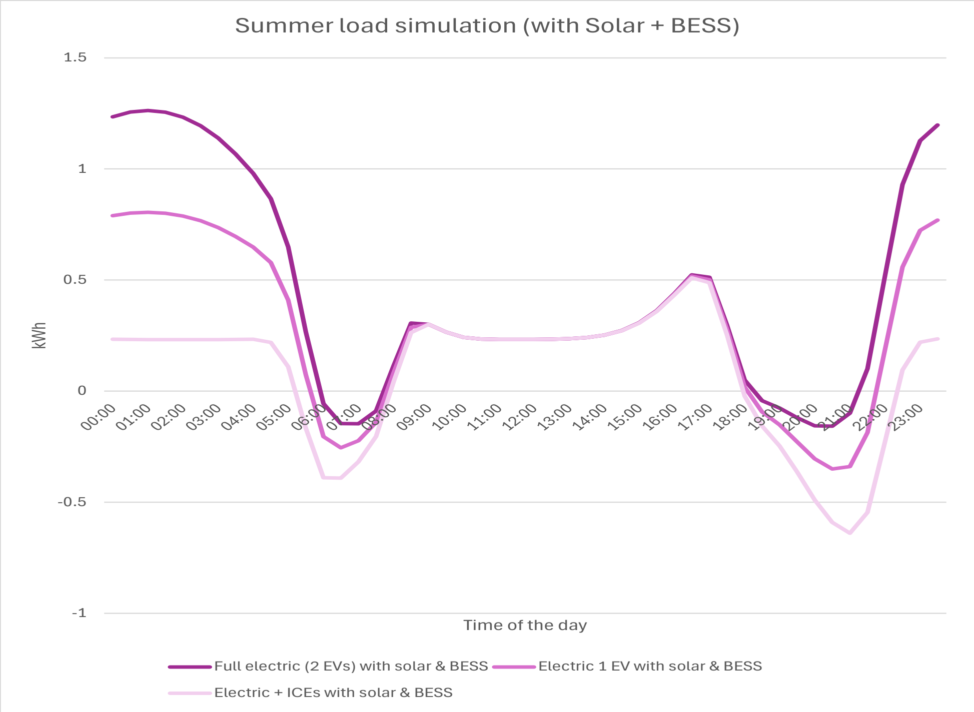
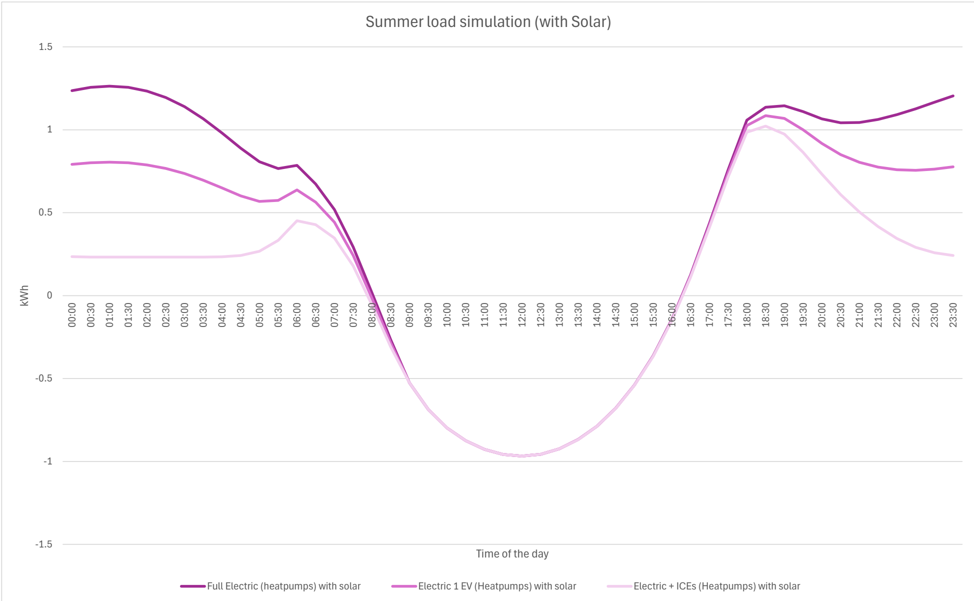


Figure 4: Variation of summer load profiles (with Solar) of different number of EVs



3.3 Transmission and distribution module

We understand that the costs of transmission and distribution are regulated by the Commerce Commission which cover maintenance, replacements and renewal of assets, as well as the business-as-usual activities of the power line industries. We recognise there are regional differences, however for simplicity, our model takes the average cost and applies it to a typical household.[13]

In modelling the transmission and distribution cost, our cost and pricing parameters revolve around the capital expenditure of the power lines companies. It is assumed that the LV capital expenditure forecasts, and transmission Regulatory Asset Base values are the most determining factors in the costs to customers. We primarily use publicly available information from Commerce Commission’s information disclosure for Electricity Distribution Businesses (EDB) and Transpower’s revenue model to represent the annual cost for these companies.[14]

The model uses the average consumption from the chosen profile to determine the peak loads for every year the user specifies. Also, these peak demands are calculated after-diversity is considered.

To complete modelling of cost and pricing, we use other key parameters summarised in the table below.

Table 5: Default inputs into the transmission and distribution module

Transmission and distribution parameter	Value	Unit	Purpose
Fixed cost	20%	%	Portion of total cost allocated as fixed daily charges
Starting cost ($2026)	$552.23	$million	Base year cost for transmission and distribution
Growth rate	1.5%	%	Annual increase in total system cost
Daily fixed charge	11.4	c/day	Daily charge applied to all households
Capacity recovery	$187.2	$	Cost recovered based on household capacity usage
Peak recovery	$20.8	$	Cost recovered based on peak demand periods
Peak charge (excess)	236.1	c/kWh	Charge for consumption above capacity during peak
Location exposure to peak	1%	%	Adjustment based on geographic peak load exposure
Typical household consumption	7,200	kWh	Used to calculate the pricing profiles in the module (average household consumption.)

To consider the different retail pricing structures that households sign up to, such as flat rates or TOU pricing with peak, off-peak, or super off-peak periods, it's important to consider how these choices affect electricity use and costs. TOU pricing has become more popular recently, especially with the rise

[13] Our typical household here is those that follow the key inputs in Table 5. For example, those that consume on average 7,200 kWh of electricity annually.
[14] We modelled multiple scenarios relating to the levels of electrification that impacts the capital costs faced. These scenarios are explored further in the scenarios section.

of EVs and BESS. These technologies allow households to shift their electricity use to cheaper times of the day, like charging EVs overnight during super off-peak hours.

We adopted a staged approach to modelling retail pricing structures. First, is to determine how electricity demand is distributed across months[15] then how electricity prices vary by time of day and pricing structure.[16] Lower weighting is applied during the weekend to reflect lower pricing due to lower demand. Technically, the model allows an infinite number of configurations as the user can choose continuously variable ratios or proportions of each pricing structure.

Further, we noted that reserve or security margin decisions affect electricity costs. These margins mean having extra power available just in case demand spikes or something goes wrong. Keeping this backup power ready costs money, like building and maintaining power plants that might not run all the time. These costs are built into the price of electricity and are paid by customers through their power bills. Even though you might not see a separate charge for it, it's included in what you pay to make sure the lights stay on when demand is high or there's an emergency. The model incorporates this mechanism by adjusting the peak demand and is essential in normalising the capacity/ peak pricing. Increasing the security margin also pushes more cost on to peak charges. If the security margin is calibrated to cost increases, this has the effect of making those that contribute most to peaks taking a greater share of the increased costs.

[15] This helps simulate the seasonal variations in electricity use and peaks, especially for winter peaks.
[16] We model weekdays and weekends separately.

4. Key scenarios compared

The scenarios modelled are derived from ANSA's electrification capex scenarios for transmission and distribution costs while our wholesale price impacts are outputted by Jacobs.

The transmission and distribution model incorporates the variation of capex scenarios provided by ANSA LV electrification study. It consists of 12 scenarios comprising of 0–2 kW growth in peak demand and different level of electrification including solar and batteries.

They show a critical dynamic in the energy transition. On one side the electrification refers to replacing fossil-fuel-based systems (for example gas heating, petrol cars) with electric alternatives such as EVs, heat pumps and induction cooktops. In effect, this will increase the electricity demand significantly while reducing carbon emissions and improving energy efficiency at the same time. On the other hand, the solar and battery adoption involves installing solar panels and home/ grid-scale batteries to generate and store renewable electricity. As a result, it delays the need for an expensive upgrade of distribution and transmission infrastructure as it buffers the increase in peak demand. Ideally, both processes should progress in tandem, enabling a synergistic relationship where clean energy generation meets growing electric demand efficiently and reliably.

Table below shows ANSA's capex scenarios (12) that we model in our transmission and distribution module.

Table 6: List of capex scenarios adopted in our model

Peak demand growth (kW)	Electrification (including EV)	Solar and battery
0	Late electrification	Late solar and battery
		Early solar and battery
	Early electrification	Late solar and battery
		Early solar and battery
1	Late electrification	Late solar and battery
		Early solar and battery
	Early electrification	Late solar and battery
		Early solar and battery
2	Late electrification	Late solar and battery
		Early solar and battery
	Early electrification	Late solar and battery
		Early solar and battery

Generally early electrification pushes up both energy and network costs as electrification increases demand and peak capacity.[17] Generally, early solar + BESS reduces energy and network costs as they reduce wholesale demand and network peak capacity, although costs are also incurred for the installation of solar + BESS.

[17] Even if peak capacity doesn't increase, changes in when peaks occur can still require the network to move more electricity.

5. Findings

The following findings look at whether peak demand can be held to the ANSA scenarios, the relative costs for certain households for different pricing approaches and how costs per household change on average and how it shows incentives can fall when avoiding peak demand growth through demand shifting or solar + BESS.

The implications of this can then be derived, e.g. pricing approaches with little incentive to invest in demand shifting or solar + BESS cannot be expected to meet the lowest peak demand growth scenarios.

5.1 Managing peak demand

We start by considering whether, with increasing growth in ICPs, on average peak demand per ICP can be held to zero growth. We think, if there are sufficient net incentives (benefits less costs) to encourage heat pumps then, yes, this is plausible.

Figure 5: Electric houses (no EVs) - resistive heating vs heat pump - winter weekday

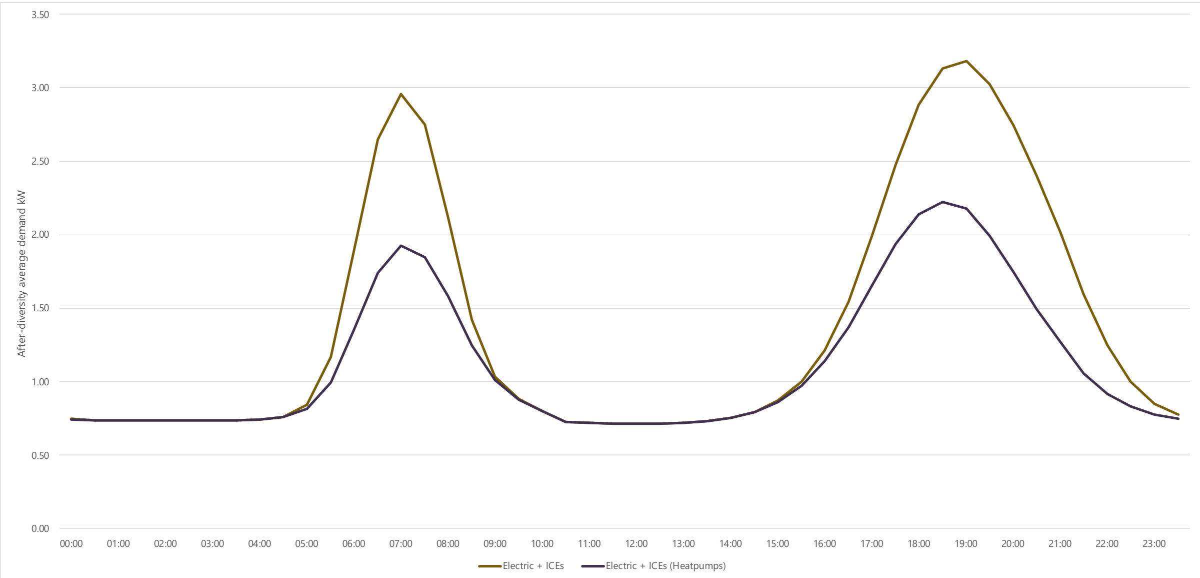


Figure 5 shows our simulated winter weekday profiles for reasonably typical households with electric appliances including heating. If we assume the same TOU patterns between the households, with one using resistive heating and one using heat pumps, then there is almost 1kW of reduced ADMD by using the heat pump. If roughly twice as many existing households convert to heat pumps from resistive heating as new residences connect (assuming the new residences also use heat pumps and/or are other high efficiency household like apartments), then peak demand growth would average zero.

For this, we have assumed heat pumps have an average Coefficient of Performance of four. We have also assumed that they will be reverse cycle heat pumps (also air conditioners) which, therefore, will increase the summer peak demand. This summer peak demand is still less than winter. We think this shouldn’t matter to EDBs, whose capacity is mostly limited by voltage drop, but could be a concern for any power lines with thermal limits subject to summer ratings. Transpower would probably be the most concerned about increased summer peaks.

It is also feasible that peak demand could increase on average, not only due to ICP growth but also electrification. Some of this peak growth will come from conversions, gas to electricity in the home.

Figure 6: Uplift in growth from converting from gas to electric - winter weekday

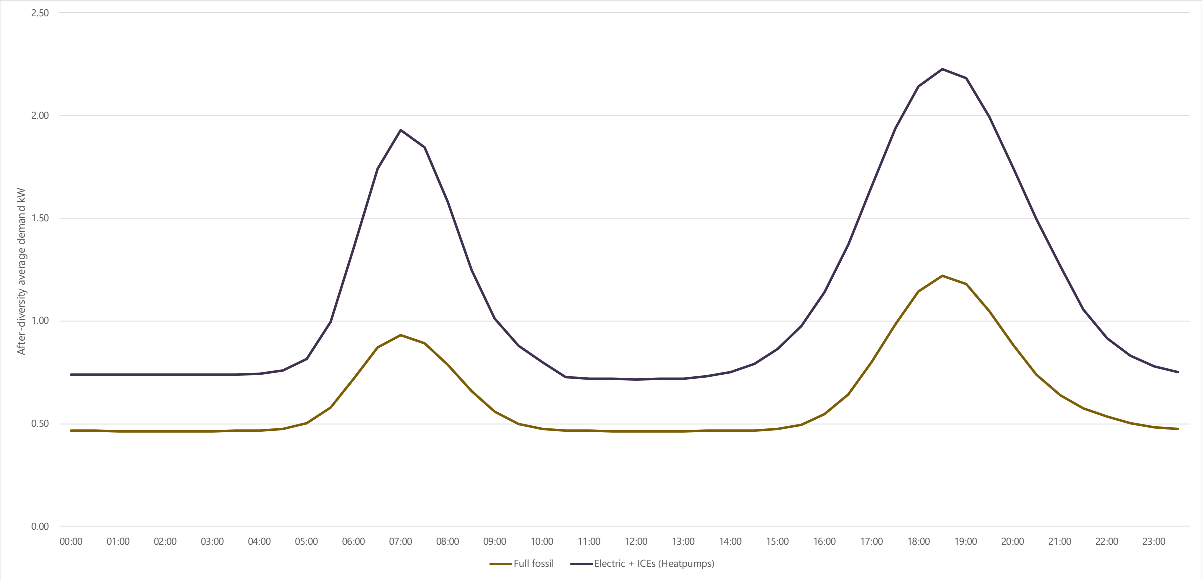


Figure 6 shows our simulated profiles for a household with gas cooking, water heating, and heating compared to one that is all electric. The after-diversity winter peak lifts by slightly over 1kW.

However, EVs are the new load that could affect peak demand the most.

Figure 7: Typical electric household with and without peak EV charging

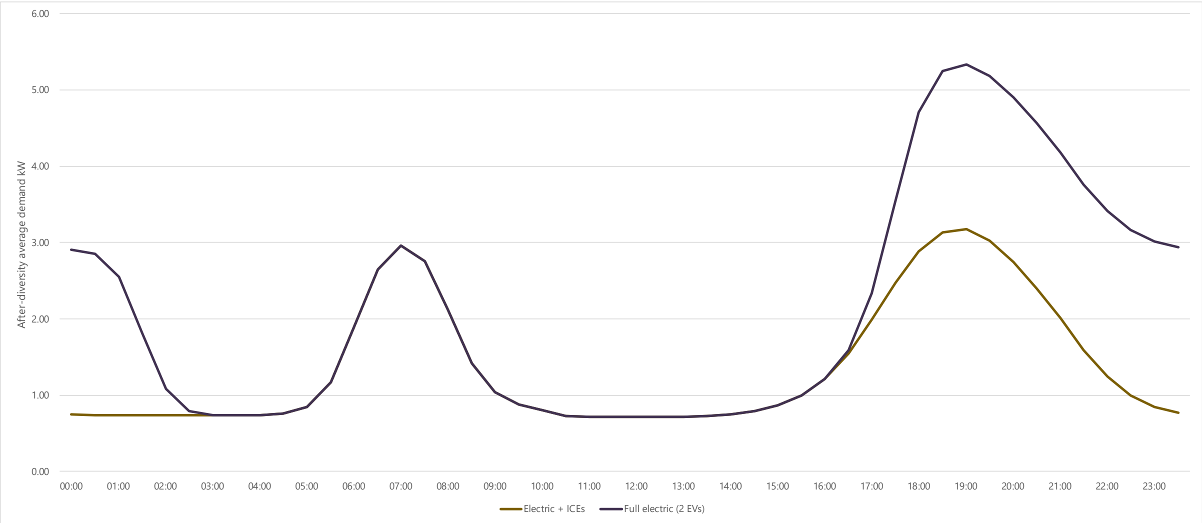
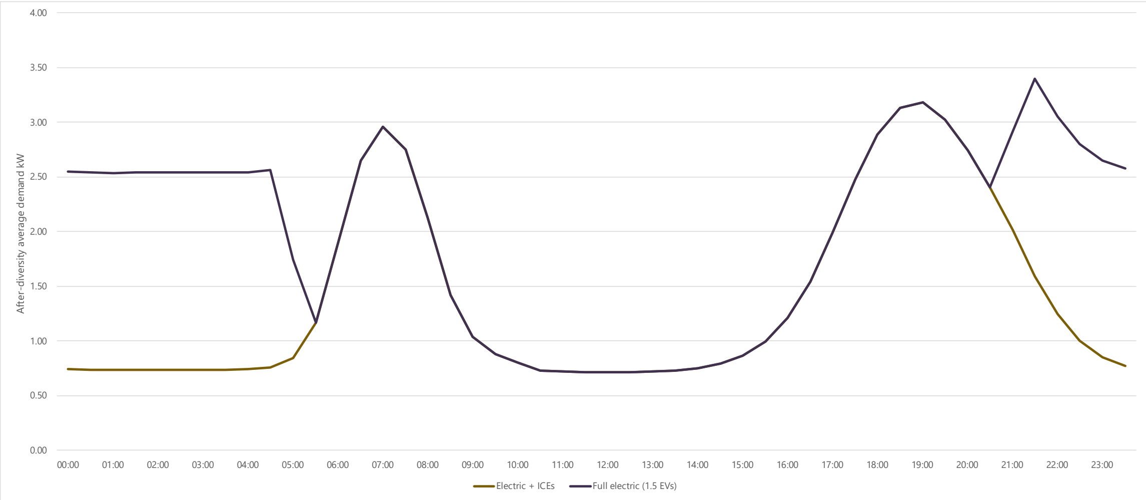


Figure 7 shows that even with 10A chargers, a two-car household plugging in one car most days after work lifts the ADMD by 2kW. However, many households will have only one vehicle, and many two-car households will have someone home during the day (diversifying charging times) so EVs[18] should remain price sensitive loads. Due to the potential impact on the electricity market and line capacity TOU, pricing structures are likely to be offered to EVs. Therefore, the Figure 7 case may not be a widespread profile.

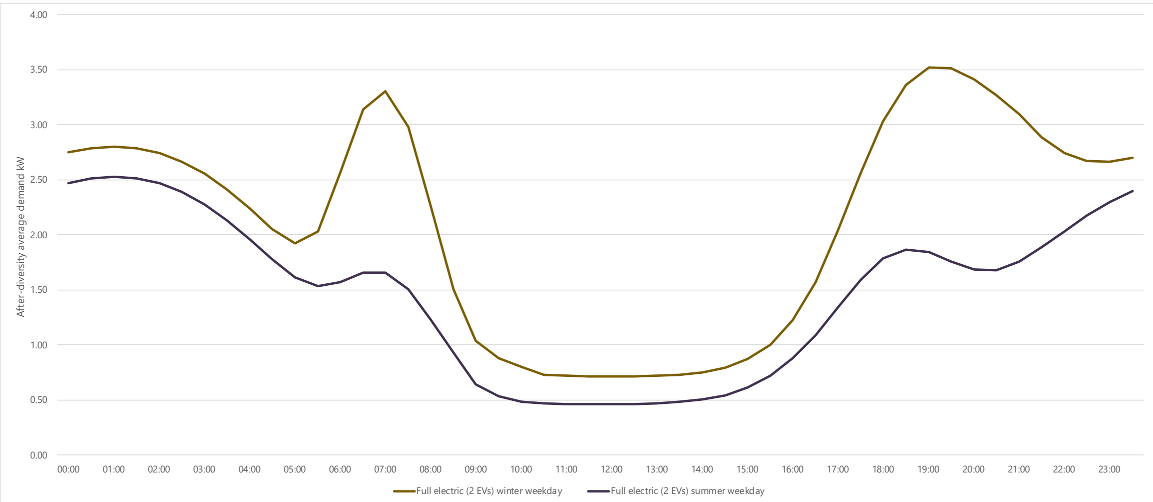
Figure 8: Electric house with and without an average 1.5 EVs



Clumsy pricing structures can worsen diversity. Figure 8 is an extreme example of such a pricing structure with unintended consequences, to make the point of how many typical households respond to a static EV tariff that starts at 9pm. In this example, even though the household demand is dropping quickly, a new higher peak is created at 9pm. This is called herding and is a risk when static pricing has a negative impact on natural diversity. As well as creating a new, higher peak herding can create large load shifts that would increase wholesale electricity market volatility.

As discussed above, EVs are generally a price sensitive demand.

Figure 9: Typical electric house with two EVs - summer vs winter



[18] EVs with storage and programmable.

Figure 9 shows that EV demand when incentivised to charge overnight can flatten peak demand rather than add to it. This regime still allows EVs to be fully charged for average travel distances by the morning. Smoothening this demand can be achieved through smart chargers, but it can also be achieved through pricing. Each household can get a static time to charge with a reduced price and, if the retailers normally distribute those start times, then a relatively smooth, flatter demand profile is achieved.

Figure 9 shows that applying that same pricing regime in summer creates a new demand peak overnight. However, this peak is still lower than the winter peak, occurs during cooler nighttime temperatures, and is negatively correlated with daytime commercial activity.

5.1.1 Adding solar + BESS

It is widely known that just adding solar and not BESS to residential profiles can create issues.

Figure 10: Solar only - home during the day vs low mid-day load

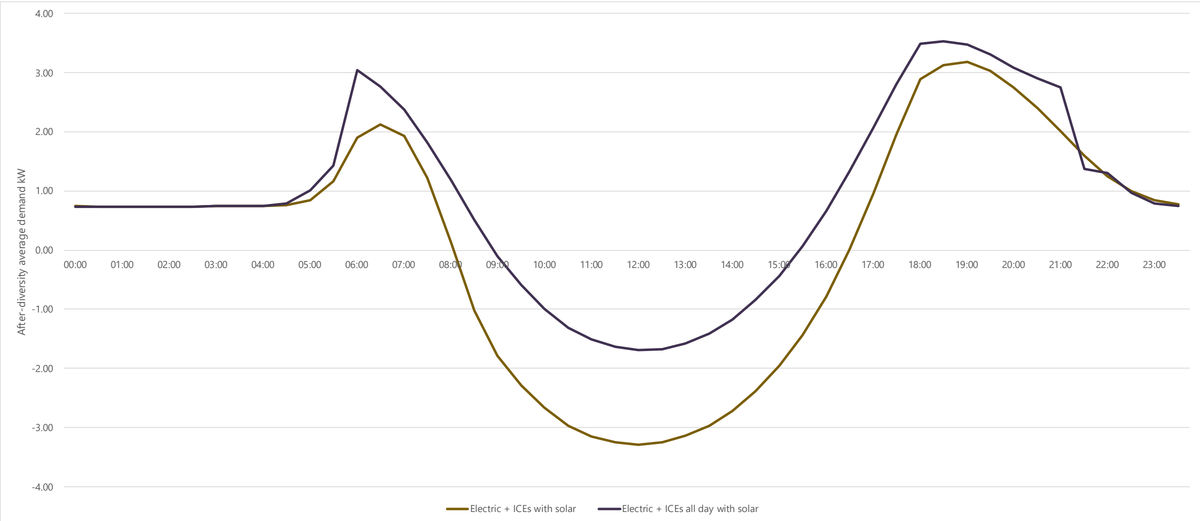


Figure 10 shows two household types with ADMD solar output of 4kW. The household with someone home during the day still has net export during the day. However, the household type with low load during the day has an after-diversity export peak as high as the import peak.

Adding a BESS can make a significant difference to the peak capacity. Even though roundtrip losses reduce the effective solar generation by 10-15 per cent.

Figure 11: Electric households - solar vs solar + BESS

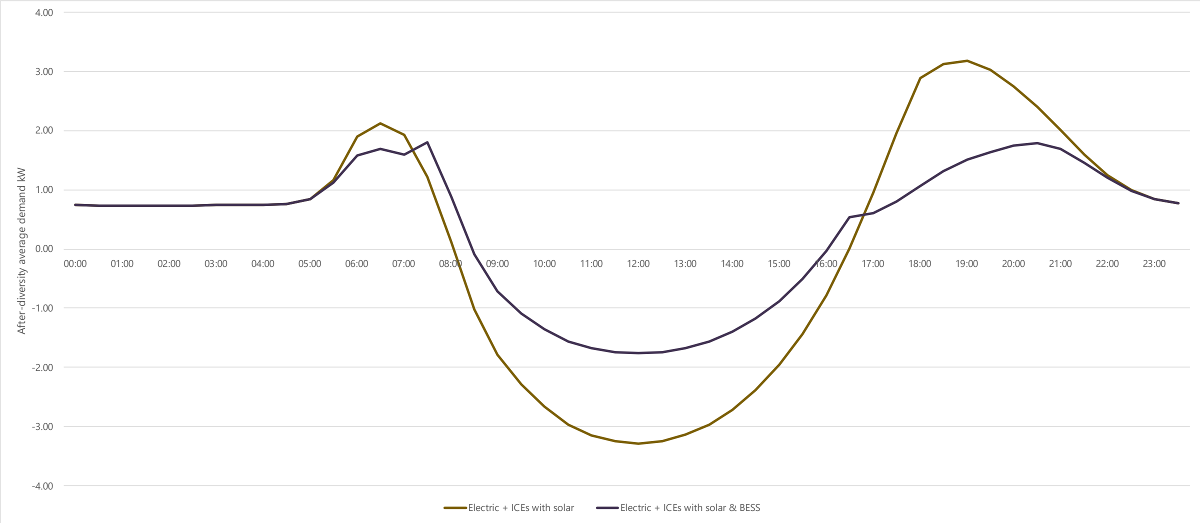


Figure 11 adds a 2kW/9kWh BESS to one of the households while both have solar with ADMD export of 4kW. Note that while it is a 9kWh BESS it turns over around 18kWh (approximately 10kWh while charging and 8kWh discharging). Using the BESS for a short duration in the morning peak but mainly for the evening peak while charging during the day, reduces both ADMD and the export peak by about 1.4kW.

As can be seen in Figure 9, reducing the peaks with shifting EV demand to the night reduces the peaks at peak times and instead occur at night. This would still be useful in the shorter term as this evening peak would still be offset by other demand profiles, including non-residential. However, the evening peak might become a problem if EV numbers get large. To manage this, we need a different BESS profile.

Figure 12: Full electric with two EVs - winter vs summer

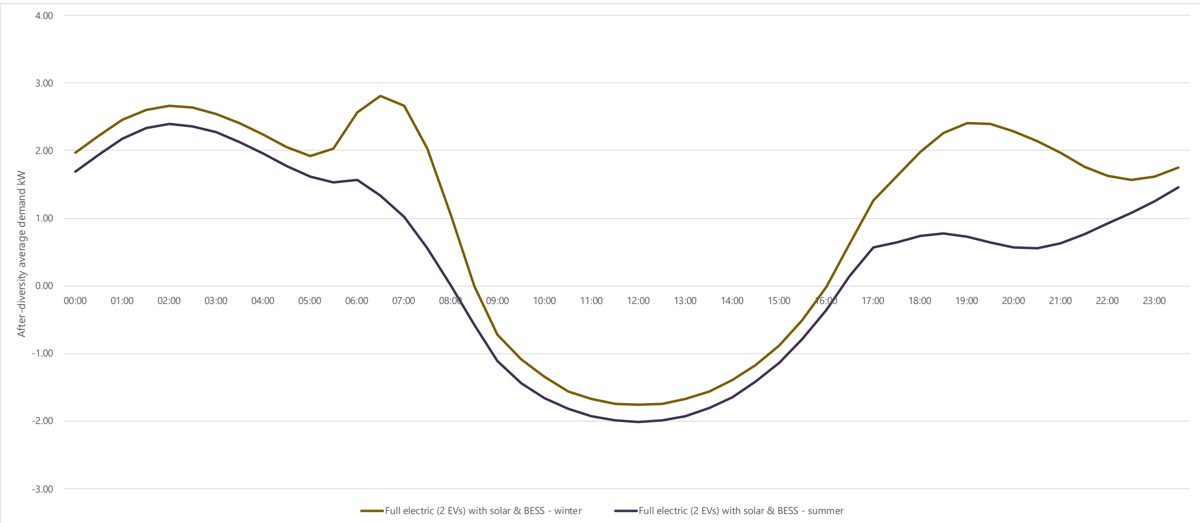


Figure 12 shows that only discharging the BESS at 1.1kW for a longer time has a lower impact on the evening peak but flattens the whole profile. The summer profile could be better optimised, but the load module has a simplified seasonal adjustment. The after-diversity solar export is still held below the import peak. A larger BESS would flatten the profile further.

5.1.2 Demand management observations

The demand profile exploration above shows that the ANSA scenarios can be met practically. Under scenarios of high electrification (gas to electric and EVs) it is possible that demand peaks could grow by 1-2kW. However, it is also possible to manage demand to zero peak demand growth even with growth in the number of ICPs and early electrification. However, this requires a continual increase in energy efficiency (in our case a shift from resistive heating to heat pumps was necessary).

The use of solar only is problematic due to solar exports being strongly positively correlated to other solar sites but generally negatively correlated to residential demand. However, solar + BESS can reduce electricity consumption and manage peak demand even without efficiency benefits and early electrification.

5.2 Household cost savings

Two factors affect the cost that each household will face. The total cost incurred for wholesale supply, transmission, and distribution, and the way price structures allocate costs to end consumers. The economic ideal is for those that help to reduce supply costs to benefit sufficiently from doing so to invest in any equipment needed to do this, while total costs also reduce for everybody. What we will show is how different price structures can reward those that respond to prices and how much they can benefit from this. For the selected scenarios, costs are shown with and without the costs for the solar and/or BESS installations. Obviously, this assessment is dependent on the scenarios provided by Jacobs and ANSA.

Jacob's work identifies the effect on energy prices from reducing supply costs through elevated residential rooftop solar production. ANSA's work identifies reductions in LV network costs using various combinations of load control, solar, and solar + BESS to reduce network peaks. As such, each study identifies avoidable costs. Dynamic efficiency would be maximised if the cost of the equipment needed to avoid these costs are lower than the avoided cost. While each investor would seek to benefit by a greater amount than they spend on their investments. Therefore, pricing structures that don't reward those that can genuinely avoid energy supply and network costs up to the avoided cost would likely be inefficient.

In Figure 13 we show the magnitude of potential savings from the Jacobs and ANSA analyses.

Figure 13: Costs for a typical household for selected scenarios

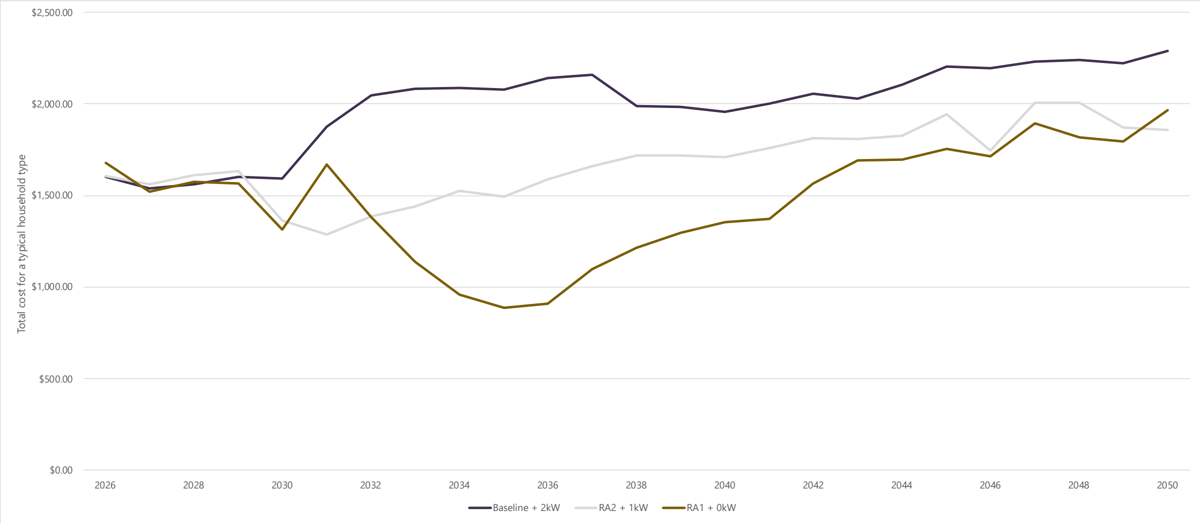


Figure 13 is selected to demonstrate a range of cost outcomes for a typical current household type (electric house with ICE vehicles, no-one home during the day and no solar). It demonstrates a reasonable range of cost outcomes from a simple price structure.

The baseline + 2kW scenario represents the cost of slow take up of solar + BESS but the early adoption of electrification, especially EVs. In this scenario EV demand is not dynamically managed, leading to a significant increase in peak capacity requirements. The wholesale energy price forecasts are reasonably flat, but network costs rise early and significantly.

The RA2 + 1kW scenario has steady growth in solar + BESS over the forecast period and EV demand is managed so that it doesn't significantly impact peak capacity. Demand growth comes from ICP growth and the electrification of households (removing gas appliances). Network costs grow steadily over the period but there is a significant reduction in wholesale electricity prices.

The RA1 + 0kW scenario is the scenario with Rewiring Aotearoa's accelerated solar + BESS and the use of the early BESS development is used to manage peak capacity down for most households, which offsets natural growth in peak demand. Wholesale electricity prices drop dramatically early in the forecast period. Network costs still increase steadily but at a slow rate. This could be because, while the peaks are held down, the LV networks need to move a lot of power around from when solar is peaking to when the BESS discharges and EVs charge. If this case, then this effect may occur mostly at the LV level and may not affect transmission or sub-transmission as much. As we have pro-rated non-LV costs per the LV forecasts from ANSA then the network costs could be overstated.[19]

The costs in Figure 13 don't include fixed costs (retail operations, risk margins, metering, or solar + BESS financing costs). These are added in the more detailed analysis below.

[19] The kick up in household costs in the RA2 scenario in 2031 is driven by an increase in volatility. Prices in 2031 are generally lower but peak prices increase lifting the average price in 2031. This volatility then falls away in subsequent years. This kick up also occurs as network prices are rising.

It should be noted that there are higher cost outcomes in the ANSA analysis. However, our interpretation of ANSA's results is that the worst outcomes occur due to early electrification (predominantly EVs with little early solar and little management of EV peaks). While highlighting the cost of this scenario is useful, to keep focus on the importance of managing EV demand, we think this is an unlikely factual. Nevertheless, we should note the worst ANSA outcome, with 2kW of household peak growth through unmanaged electrification demand and unmatched by solar & BESS, would lift costs for the household in Figure 5 to around $4,000 per year just for lines charges.

It is worth noting a significant difference between the Jacob's cost savings and the ANSA cost savings. ANSA's baseline is a current level of network capacity. The analysis doesn't seek to reduce current costs but avoid extra costs. The lower Jacob's costs are a function of not only avoiding energy supply costs but also reducing those supply costs. The Jacob's cost savings are also accrued differently. ANSA's costs are annual cost numbers, as are the underlying transmission and distribution costs, which then have to be allocated to a more granular level of prices according to the price structure chosen. Whereas the Jacob's cost savings come through as lower wholesale electricity prices, in an hourly time series, which are then averaged according to the price structure chosen as the basis for the retail pricing.

There are some potential inconsistencies in the way we combine Jacob's and ANSA's scenarios, which aren't directly comparable, but we try to keep the matching of the scenarios relevant to each issue we investigate. We also note that Jacob's price forecast, even for the early years, are significantly lower than current wholesale electricity prices.

Next, we look at direct cost comparisons for the addition of solar and solar + BESS on a selection of household types for a selection of scenarios. To give a reasonable selection of household types we have selected four. The first is an all-electric household with no-one home during the day that retains ICE vehicles. While there are many households that don't use electricity for all appliances, or users that use far more than average consumption, they tend to have the same basic profile. Therefore, there isn't too much error in scaling such households for their annual consumption.

For the same reason we use an all-electric house with someone home during the day as the second household type. Again, this profile is typical of consumers with relatively standard activity and can be scaled for smaller and larger users.

The third household type adds one EV to the no-one home during the day household and the fourth household type adds two EVs to the someone home during the day household.

Six scenarios are modelled. Four are variations of a middle forecast for the future. The first scenario has rooftop solar + BESS and EV take up progress steadily over the next 25 years and is called the Late Electrification/Late Solar + BESS scenario and is also used as the baseline scenario. The second scenario considers solar + BESS uptake occurring faster – Late electrification/Early solar + BESS. The third scenario accelerates EVs – Early electrification/Late solar + BESS, and the fourth accelerates both – Early electrification/Early solar + BESS.

Two further scenarios are analysed. One looks at the effects of a policy of accelerating solar + BESS even faster than the scenarios above. The second looks at the effects of 'herding' EVs, where pricing approaches inadvertently encourage EVs to create a new peak later, e.g. if the majority of EVs all get a cheaper price at 9pm.

Each household type is assessed for the baseline cost.[20] Its cost under the scenario without solar, and its cost with solar only, and with solar + BESS. The costs include fixed costs, including for the solar options the cost of funding the solar installations. The retail bill only portion for solar options (without financing) are also shown. The costs for solar + BESS were provided by Rewiring Aotearoa and are the same costs used in the Jacob's forecasts.

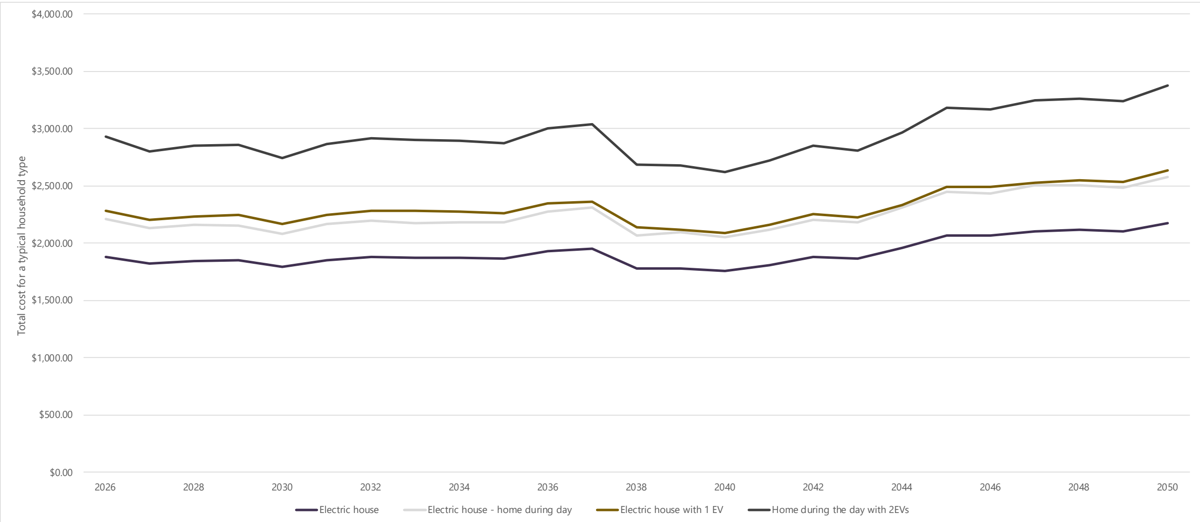
We haven't sought to optimise the solar + BESS across household types and have kept the solar configurations constant for comparison. We use a 5kW solar installation and 2kW/9kWh BESS. 5kW is chosen because that size is easily incorporated into every household. The 9kWh BESS is chosen as it best moves the solar output across peaks reducing equivalently the solar peak injection and peak consumption. It should be noted that households with someone home during the day, and particularly with an EV at home during the day, could incorporate much larger systems and could save more than indicated in the following analysis.

The costs for EVs are higher as households with EVs add electricity consumption to the equivalent household without EVs. The scope of this exercise is to show the electricity supply costs, but it should be noted that households with EVs would see a reduction in their total energy costs (i.e. including petrol and/or diesel costs).

5.2.1 Baseline (Late Electrification/Late Solar + BESS – LE/LS)

For the LE/LS scenario we use the Jacob's baseline and the appropriate ANSA table for LE/LS and 1kW growth in typical household demand. We start by showing the cost comparisons for the four household types in this scenario using simple TOU price structures like those currently in use.

Figure 14: Baseline comparison of household types

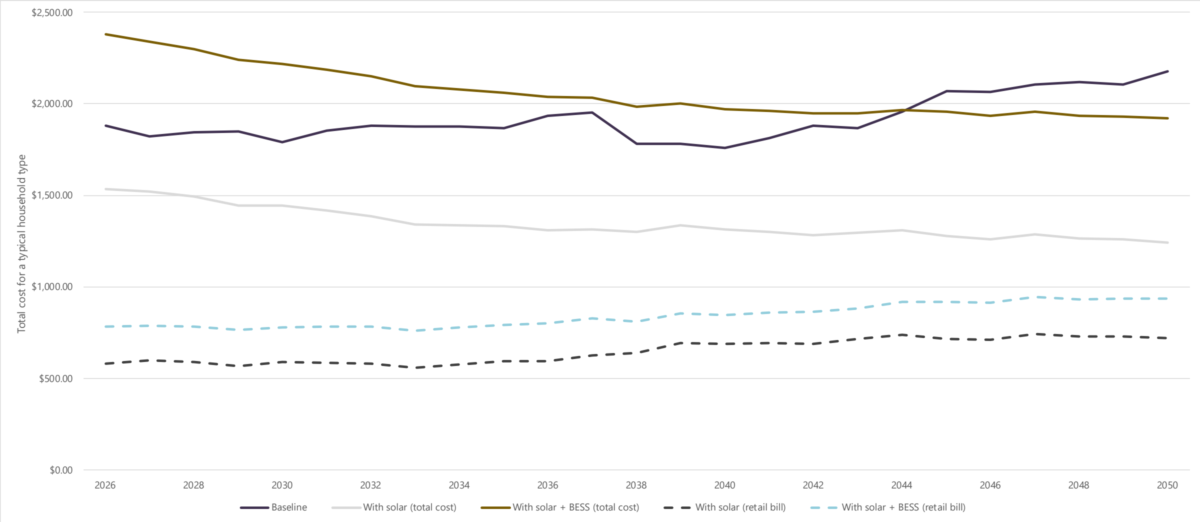


[20] The Baseline scenario used is the Jacob's baseline with LE/LS and 1kW growth. It is not always directly comparable to the scenario being evaluated but gives context for the costs in that scenario.

Figure 14 shows that while profile is causing small differences in the cost, the key driver on real cost (before inflation) is the annual volume of consumption. In real terms costs stay relatively flat elevating a little around 2040 as electrification starts to lift peak capacity.

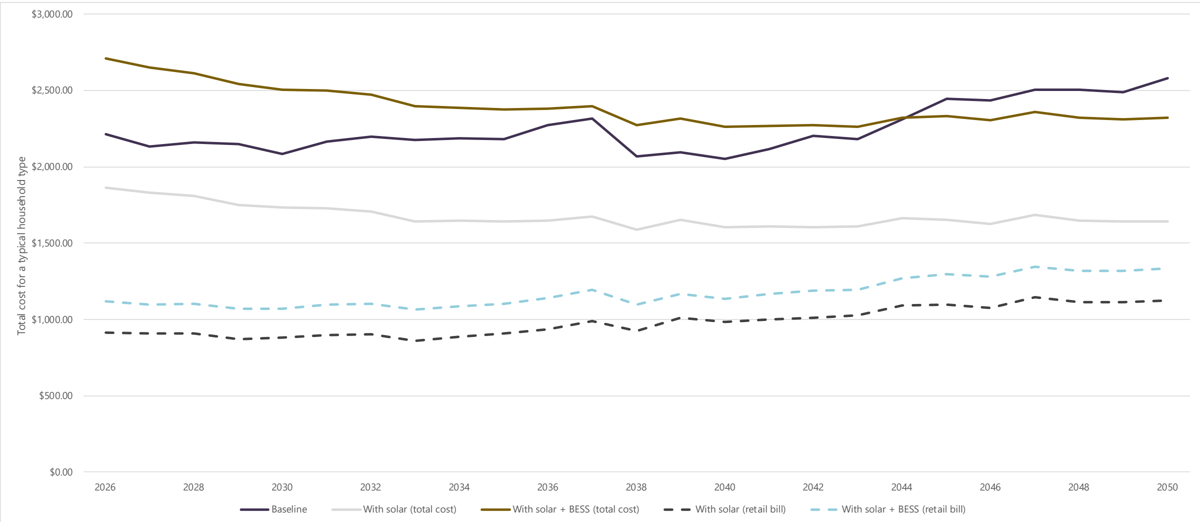
The impact of adding solar and solar + BESS is shown below.

Figure 15: Baseline - effect of solar + BESS on all-electric house



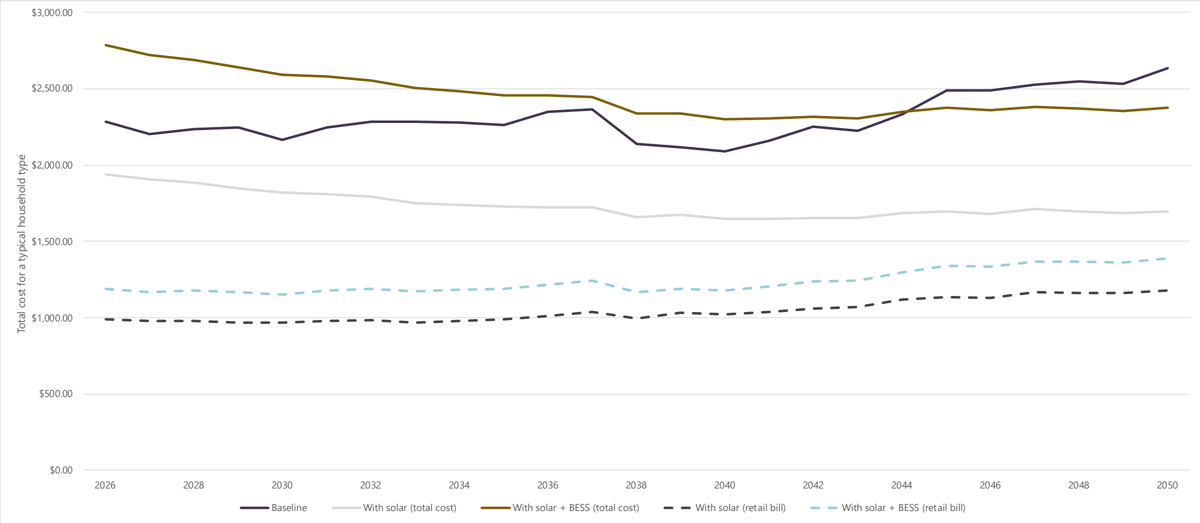
Data available in Table 7 on page 44.

Figure 16: Baseline - effect of solar + BESS on all day electric house



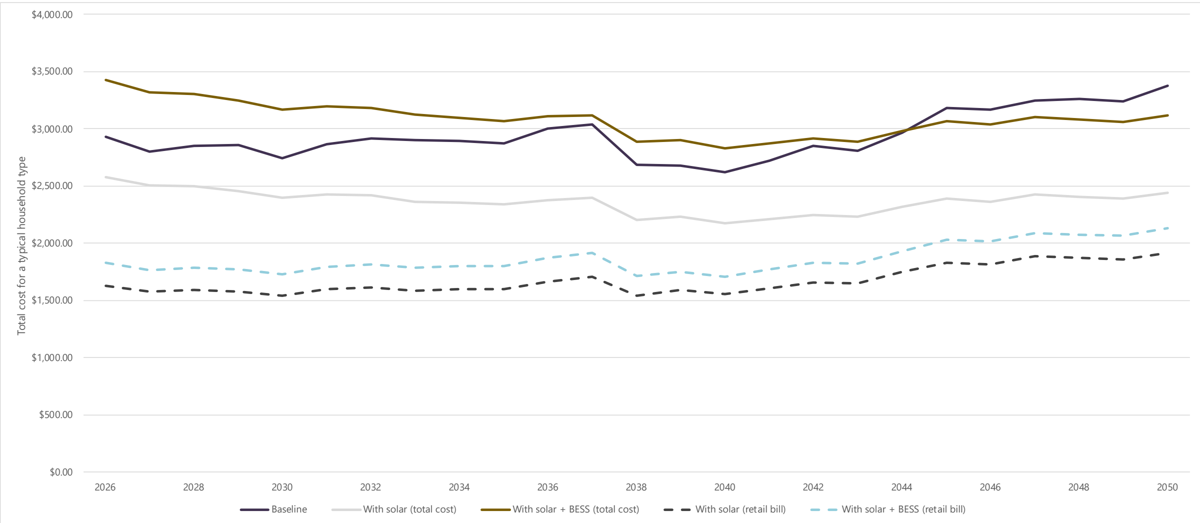
Data available in Table 8 on page 45.

Figure 17: Baseline - effect of solar + BESS on electric house with one EV



Data available in Table 9 on page 46.

Figure 18: Baseline - effect of solar + BESS on all day electric house with two EVs



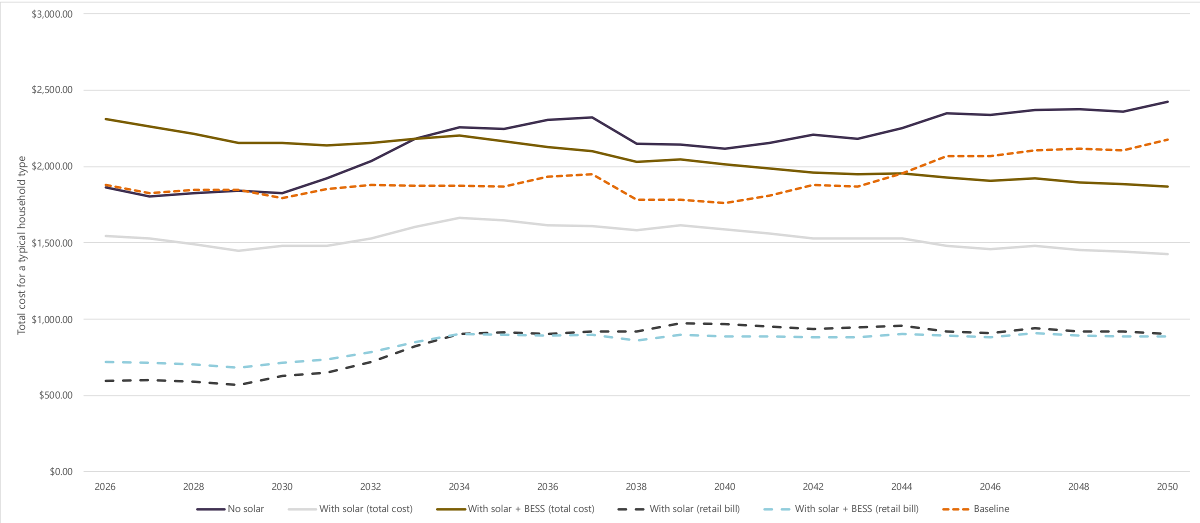
Data available in Table 10 on page 47.

This pricing approach, with relatively weak peak signals, the key driver on cost is annual consumption. This also leads the household types to be affected by the solar options in the same way. From the start of the forecast period, solar only reduces cost even with the cost of finance. The retail bill is higher for solar + BESS than solar only as there is little benefit from the BESS and some of the solar output is lost as roundtrip losses to and from the BESS. With the extra capital cost of the BESS, solar + BESS is more expensive at the start of the period and gets cheaper than supply costs by 2044 when network costs start to rise. However, in this case the solar + BESS would be cheaper before this. We are trying to determine the average cost for a household type in any year which include households that have bought solar + BESS earlier and households that bought in recent years. The marginal cost of a BESS drops substantially over the forecast period, but we have averaged the costs on the basis that there is linear take up on solar or solar + BESS over time. This is a simple assumption used for comparison over all scenarios. However, in the case where the substantial benefits occur later, households wouldn't buy BESS early and the average cost of solar + BESS would be a lower than we show.

5.2.2 Early Electrification/Late Solar + BESS (EE/LS)

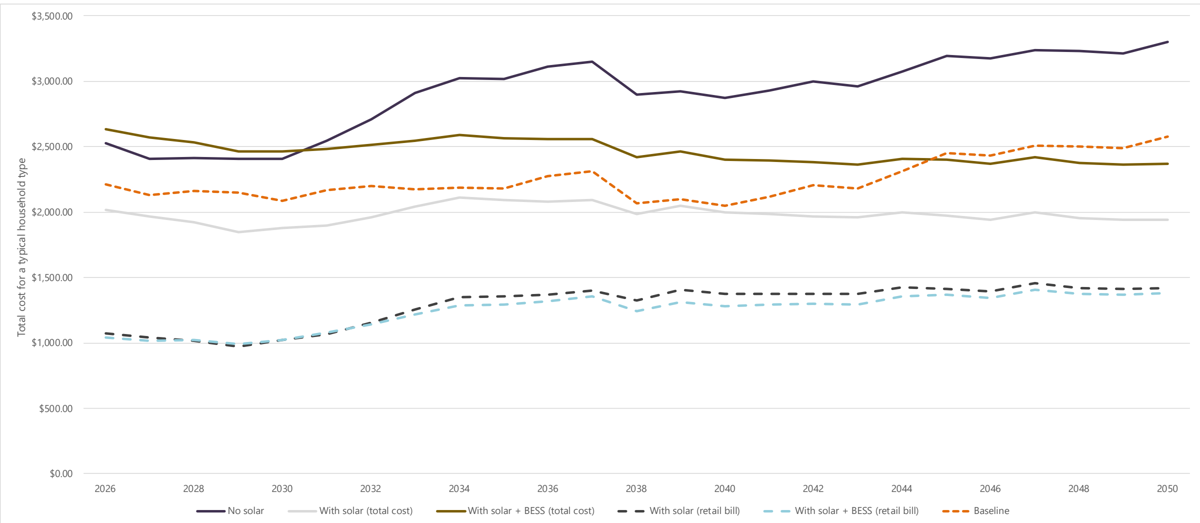
For the EE/LS scenario we use Jacobs baseline scenario and ANSA 1kW EE/LS scenario. For this scenario rather than use a static TOU for network prices we use a peak pricing approach with the growth in peak component tied to the rate of capital expenditure under the ANSA scenario. This tries to estimate a pricing regime where the marginal cost of new investment is priced in a peaking signal, and existing costs are recovered on a flat capacity basis. Energy prices are still recovered under a TOU structure which are reflective of the underlying wholesale forecast.

Figure 19: Early electrification - effect of solar + BESS on all-electric house



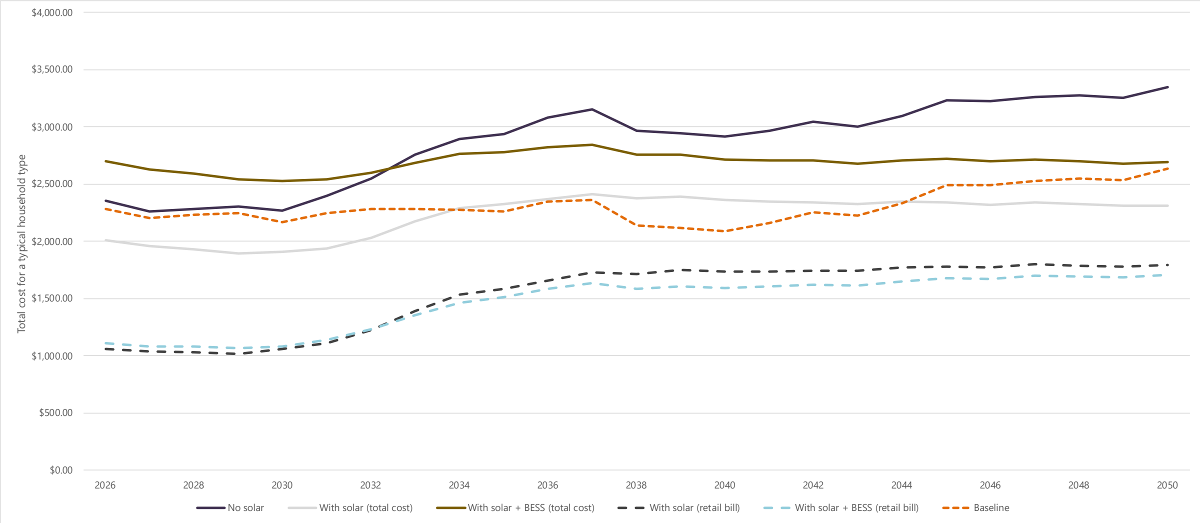
Data available Table 11 on page 48.

Figure 20: Early electrification - effect of solar + BESS on all day electric house



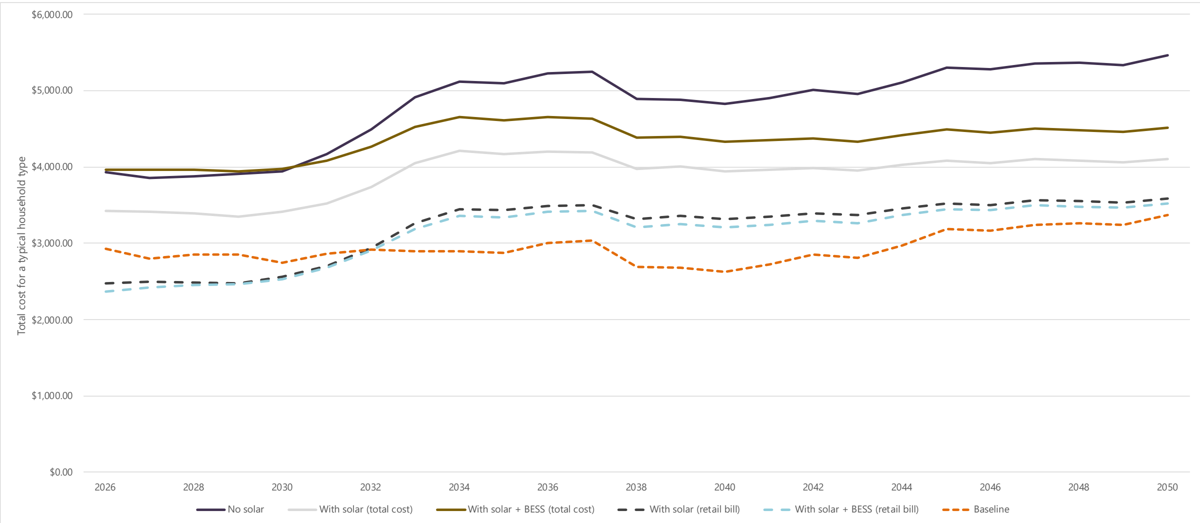
Data available in Table 12 on page 49.

Figure 21: Early electrification - effect of solar + BESS on electric house with one EV



Data available in Table 13 on page 50.

Figure 22: Early electrification - effect of solar + BESS on all day electric house with two EVs



Data available in Table 14 on page 51.

The peak pricing is designed around revenue adequacy for the electric house with no EVs, which has slightly more than average residential consumption. The other scenarios have greater consumption, and more importantly here, more consumption over a base level of capacity. Smaller users would generally have lower bills, but it does depend on the profile of use.

In both cases the houses with no-one home during the day (with one EV) solar + BESS is more expensive than not having solar but become cheaper around 2032. The savings are relatively small around 2032 but grow to around $500 per year by 2050. While the change in household costs is significant for the high usage someone home during the day households, this makes solar + BESS competitive immediately. From around 2032 these households are about $500 per household better off, and this rises to closer to $1,000 per household by 2050.

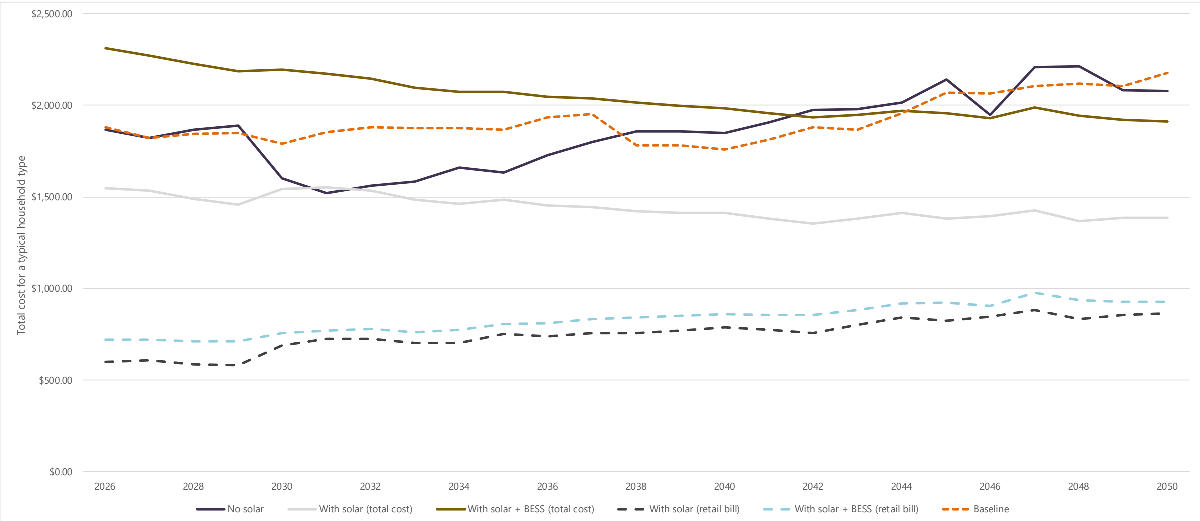
Under all scenarios[21] solar only is the cheapest option. This is because the profile rewards are relatively low in the Jacob's energy price forecast, and the network pricing is the only driver on BESS incentives. However, it should be noted that solar only would not be able to completely contribute to avoiding the network spend. The scenarios have reduced cost because they already have significant solar + BESS. In the case where solar + BESS have been extensively deployed, and there is plenty of storage capacity, then solar only would be cheaper. In practice, the market would be searching for an equilibrium where solar + BESS is cheaper due to price volatility and peak costs and where there are adequate BESS capacity and the relativity between solar only and with BESS would equalise.

This scenario shows a potential tragedy that could happen. In this scenario the network spend occurs anyway even though solutions that could substitute for the network spend are available early. This can easily occur when network pricing is lagging (prices lift only after costs are incurred). This means by the time that it is clearly cheaper to invest in solar + BESS the network costs are incurred anyway. Therefore, the late investment in solar + BESS will just create spare capacity. In practice, if the solar + BESS investment occurred early then this would avoid much of the later network costs. Under the early electrification scenario around half the cost is already incurred by 2032.

5.2.3 Late Electrification/Early Solar + BESS (LE/ES)

This scenario uses Jacob's RA2 scenario and ANSA's 0kW LE/ES scenario. The early use of solar + BESS could keep peak demand growth in check over the period.

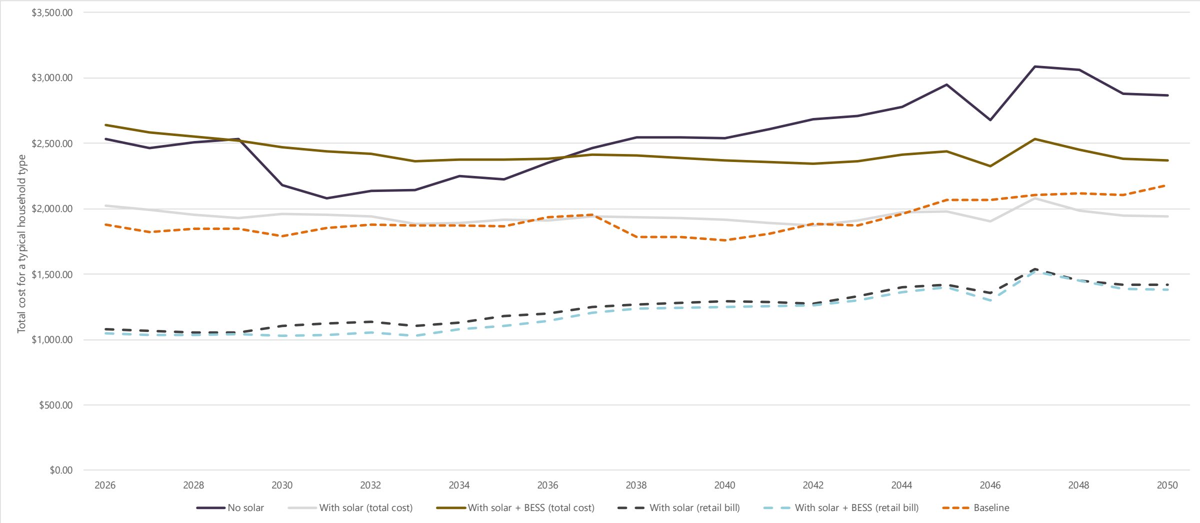
Figure 23 : Early solar + BESS - effect of solar + BESS on all-electric house



Data available in Table 15 on page 52.

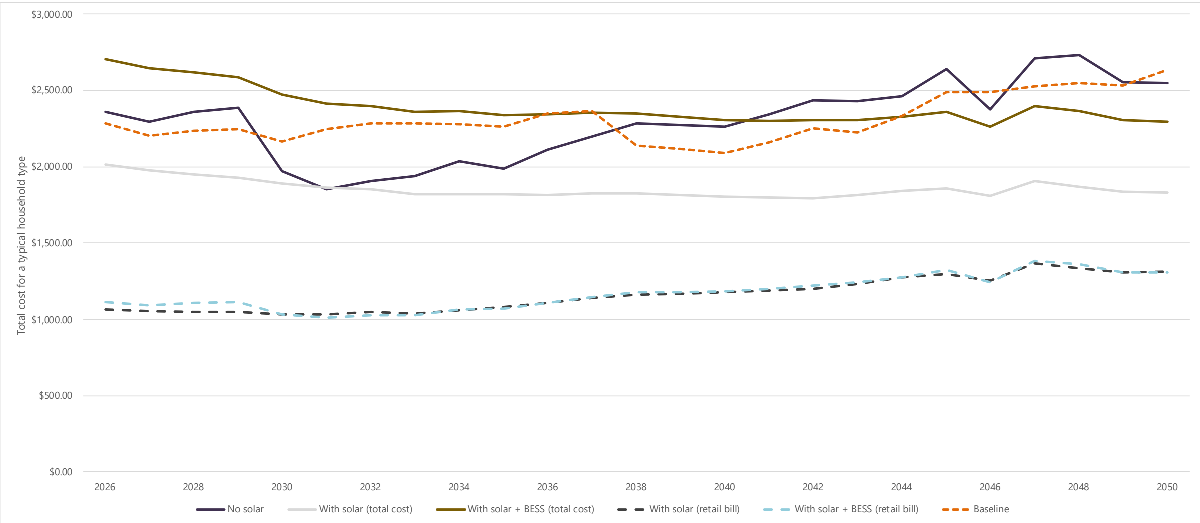
[21] These scenarios are the combinations of the scenarios displayed in Table 1. Please refer to tables in Appendix A for more detailed results.

Figure 24: Early solar + BESS - effect of solar + BESS on all day electric house



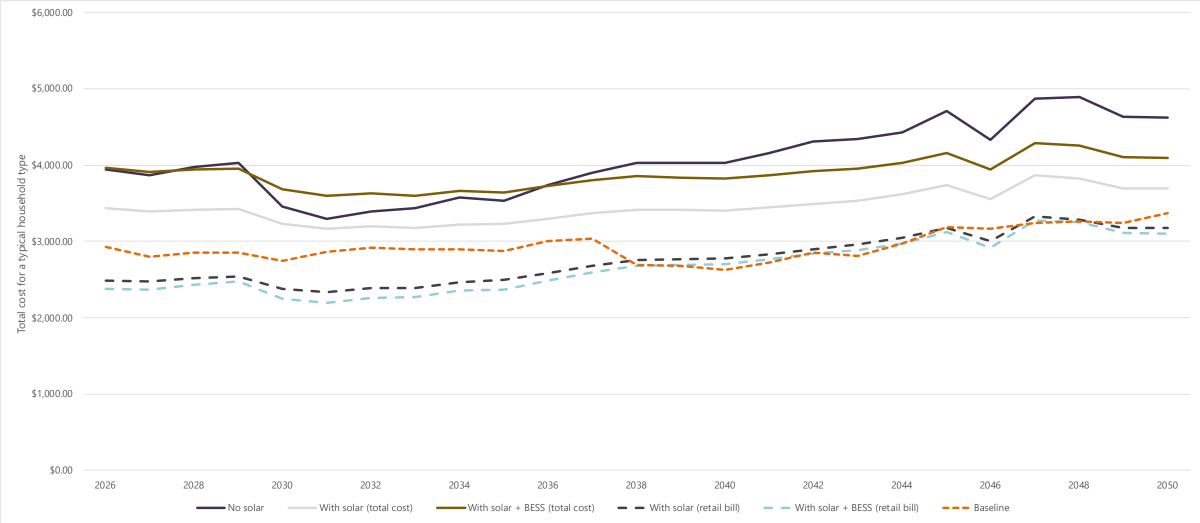
Data available in Table 16 on page 53.

Figure 25: Early solar + BESS - effect of solar + BESS on electric house with one EV



Data available in Table 17 on page 54.

Figure 26: Early solar + BESS - effect of solar + BESS on all day electric house with two EVs



Data available in Table 18 on page 55.

In both households where no-one is home during the day costs are cheaper in the short run (but not the long run) with no solar than the baseline. While the higher demand households (someone home during the day) are both higher due to the emphasis on peak pricing. Prices could possibly be adjusted so that everyone is better off than the baseline in the short term with no solar but, of course, there needs to be high take up of solar for this scenario.

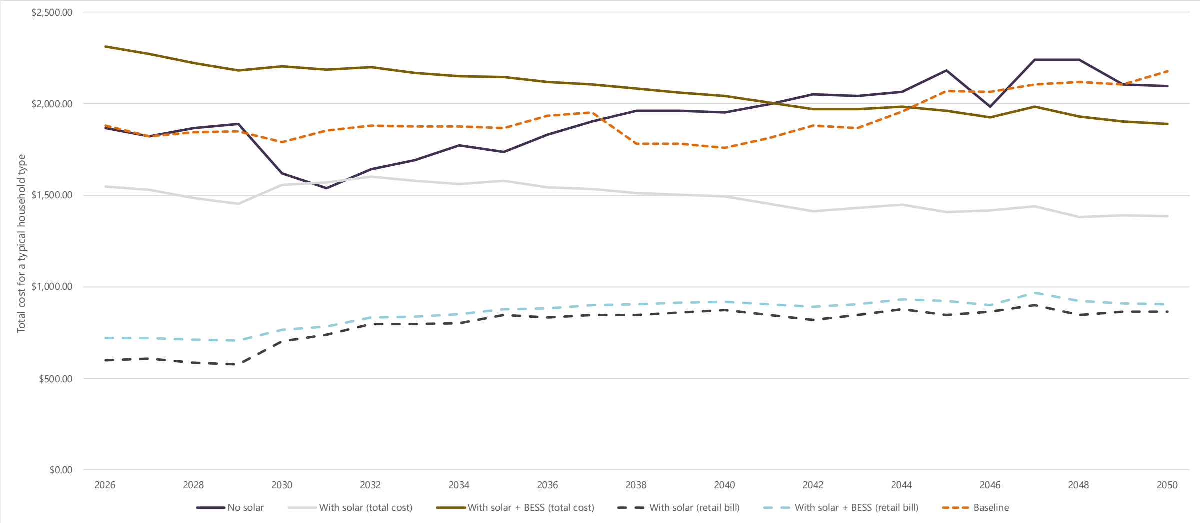
Every household has lower costs with solar than without under this scenario, but the costs savings are relatively low in the shorter term for higher consumption households (down to $100p.a.). However, all cost savings are at least $500p.a. by 2050. It should be noted that the size of the solar installation is holding the higher consumption households back and they could save more with more solar. Care needs to be taken with the solar only findings, though. The Jacob's forecasts were based on significant solar + BESS which seems to have flattened prices significantly. Replacing solar + BESS with solar only would likely result in substantially more price volatility and give a different result to the above. It should be noted that solar only would not be able to completely contribute to avoiding network costs.

Initially the cost of solar + BESS is competitive against the cost of no solar for all but the lowest consumption household. Then the competitiveness of solar + BESS falls away for all but the highest consumption household (with two EVs) when wholesale energy prices drop in response to the solar uptake. By 2050, all households are better off with solar + BESS by $200-$500p.a. Although there would need to be significant take up of solar + BESS early to achieve this scenario.

5.2.4 Early Electrification/Early Solar + BESS (EE/ES)

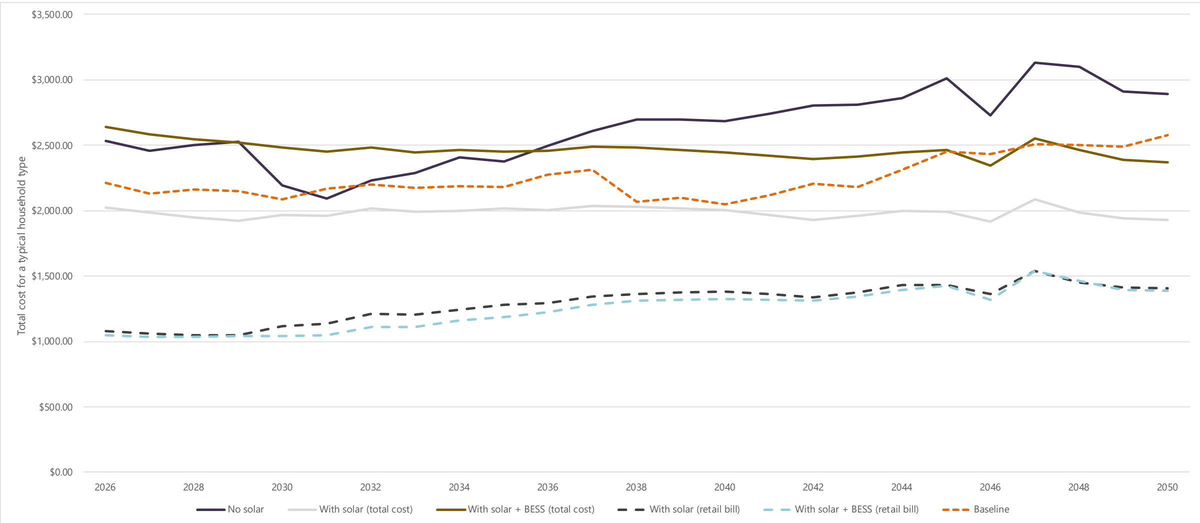
This is the case where both electrification and solar + BESS are developed early. This case uses Jacob's RA2 and an ANSA 1kW EE/ES scenario. Peak demand grows because, although demand is moved, a flattening of the peak doesn't reduce the peak demand for existing households (on average) while new households are built leading to natural peak growth.

Figure 27: Early electrification, solar + BESS - effect of solar + BESS on all-electric house



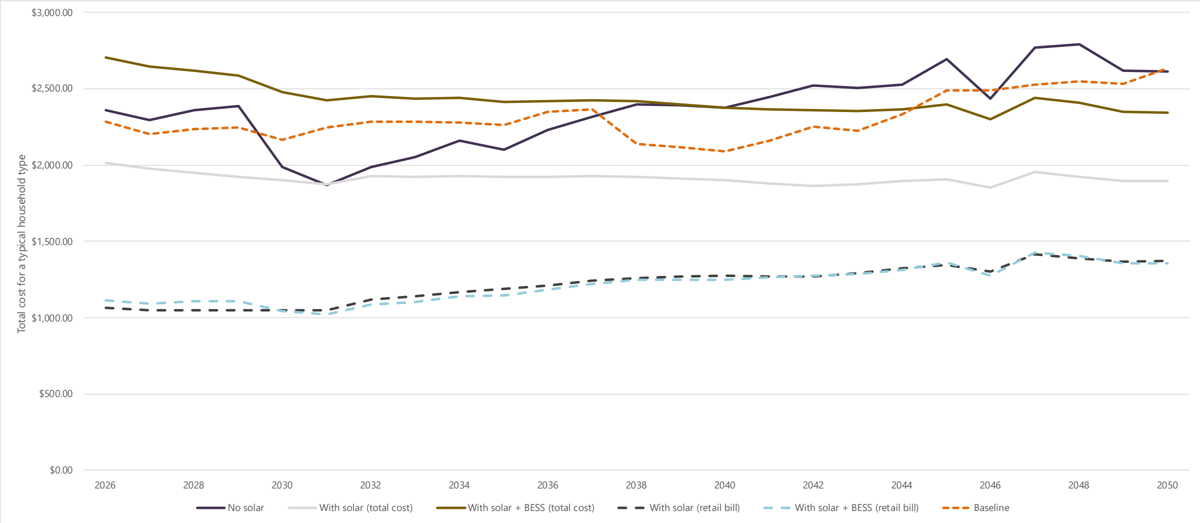
Data available in Table 19 on page 56.

Figure 28: Early electrification, solar + BESS - effect of solar + BESS on all day electric house



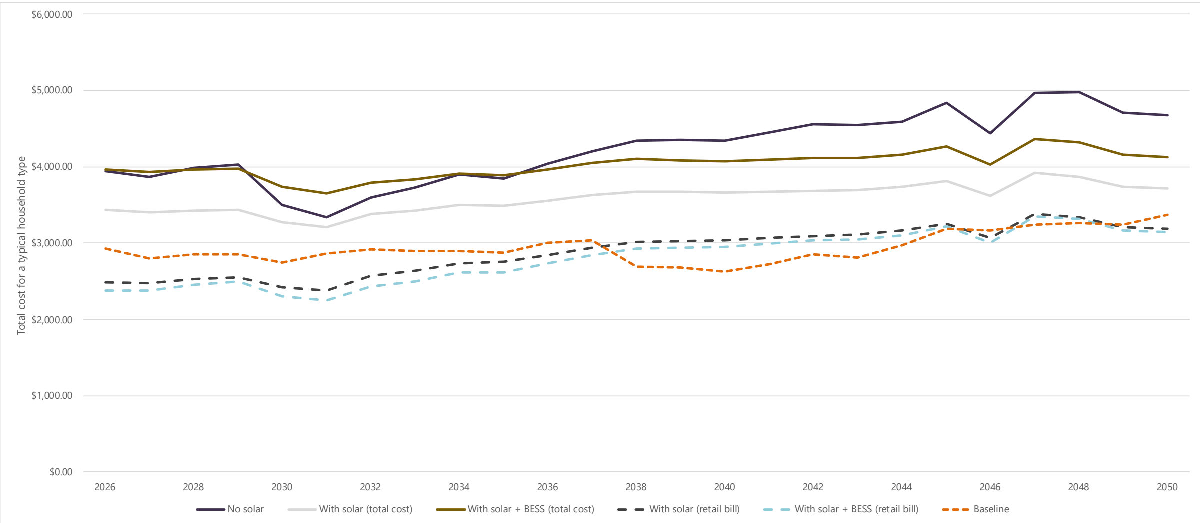
Data available in Table 20 on page 57.

Figure 29: Early electrification, solar + BESS - effect of solar + BESS on electric house with one EV



Data available in Table 21 on page 58.

Figure 30: Early electrification, solar + BESS - effect of solar + BESS on all day electric house with two EVs



Data available in Table 22 on page 59.

Similar results occur in this scenario. The focus on peak prices lifts costs for the households with someone home during the day. This makes solar + BESS competitive for these households early. Solar + BESS is close to competitive for the no one home during the day with one EV household but the competitiveness drops away as the wholesale market prices drop before rising again. Solar + BESS is competitive for every household by 2042, and all households are better off by $250-$500p.a. by 2050. For the higher consumption households, the savings become significant by 2038. Although, the benefits for these households would be higher, and occur earlier, with larger solar + BESS installations.

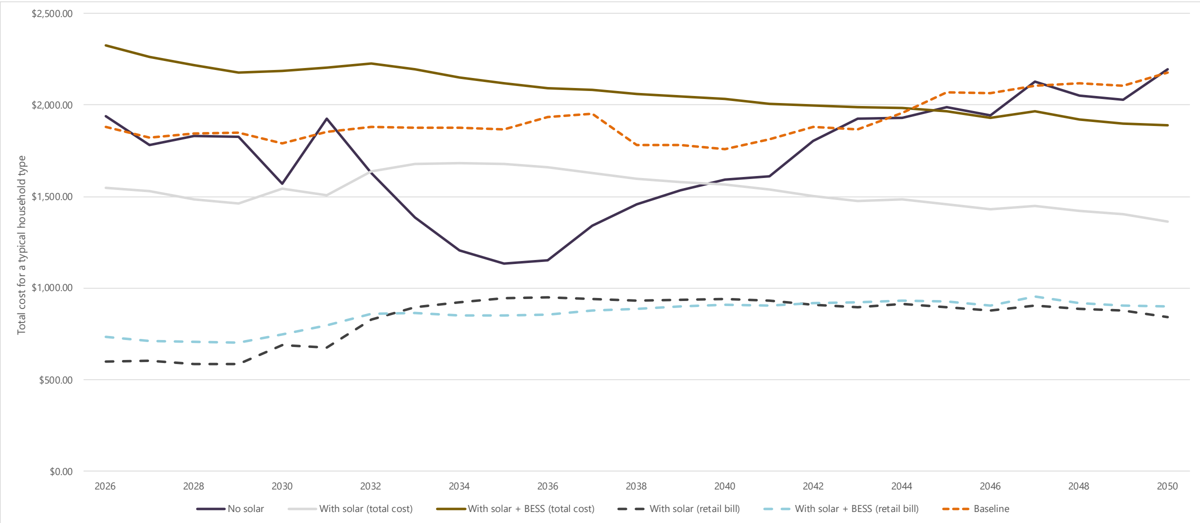
The network cost increases under this scenario are delayed by four years compared to the Early Electrification/Late Solar + BESS (EE/LS) scenario. For the someone home during the day household with two EVs costs are $750p.a. cheaper than under the EE/LS scenario by 2034. The savings are still $400p.a. by 2050.

In all scenarios solar only still seems cheaper but the same caveat remains. Both the wholesale energy and network cost outcomes are dependent on significant solar + BESS take up.

5.2.5 Early Electrification/Accelerated Solar + BESS

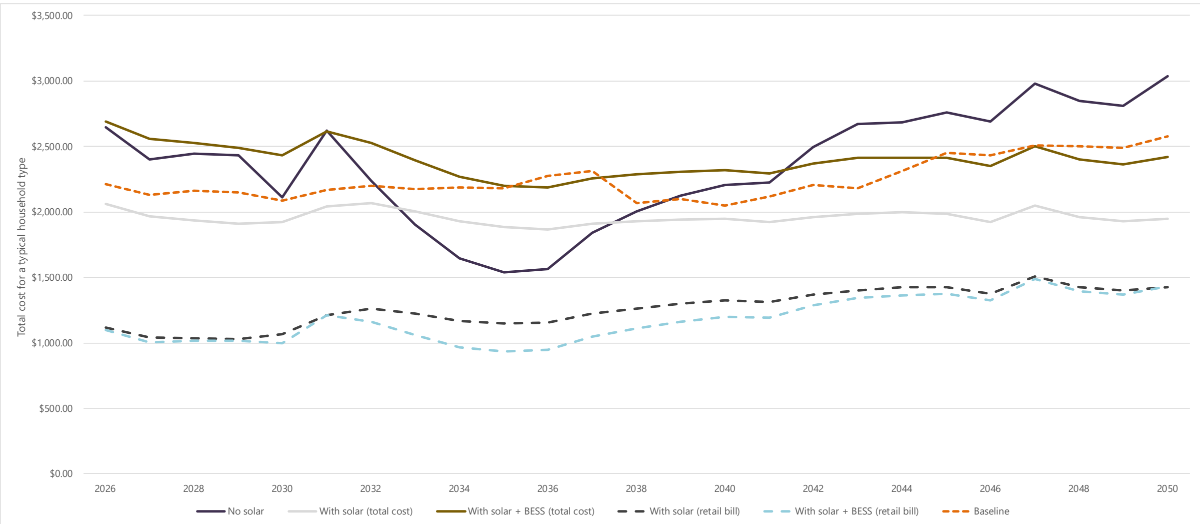
This scenario looks at the benefits of a more accelerated take up of solar + BESS than the early solar + BESS scenarios above. This uses Jacob's RA1 wholesale price forecast. It is paired with an ANSA EE/ES scenario but this time it is assumed that the early deployment of solar + BESS can hold peak demand growth to 0kW.

Figure 31: Early electrification, accelerated solar + BESS - effect of solar + BESS on all-electric house



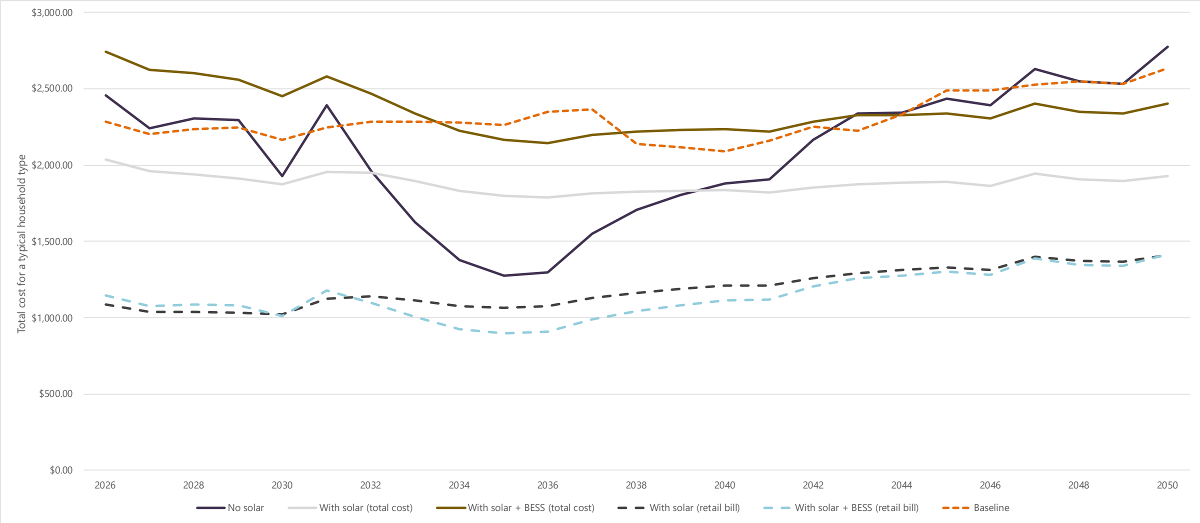
Data available in Table 23 on page 60.

Figure 32: Early electrification, accelerated solar + BESS - effect of solar + BESS on all day electric house



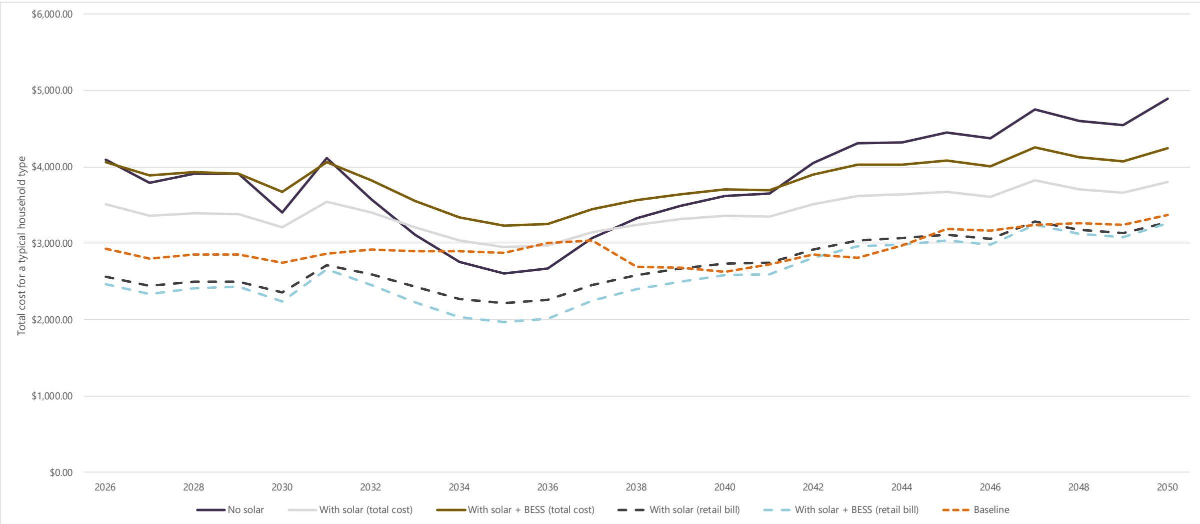
Data available in Table 24 on page 61.

Figure 33: Early electrification, accelerated solar + BESS - effect of solar + BESS on electric house with one EV



Data available in Table 25 on 62.

Figure 34: Early electrification, accelerated solar + BESS - effect of solar + BESS on all day electric house with two EVs



Data available in Table 26 on page 63.

As with previous scenarios the peaking price structure for network costs makes solar + BESS competitive for the high consumption households. However, solar + BESS is cheaper than wholesale market and network for every household analysed by 2041/2042. Costs grow steadily after a dip in wholesale electricity prices driven by the accelerated solar roll out.

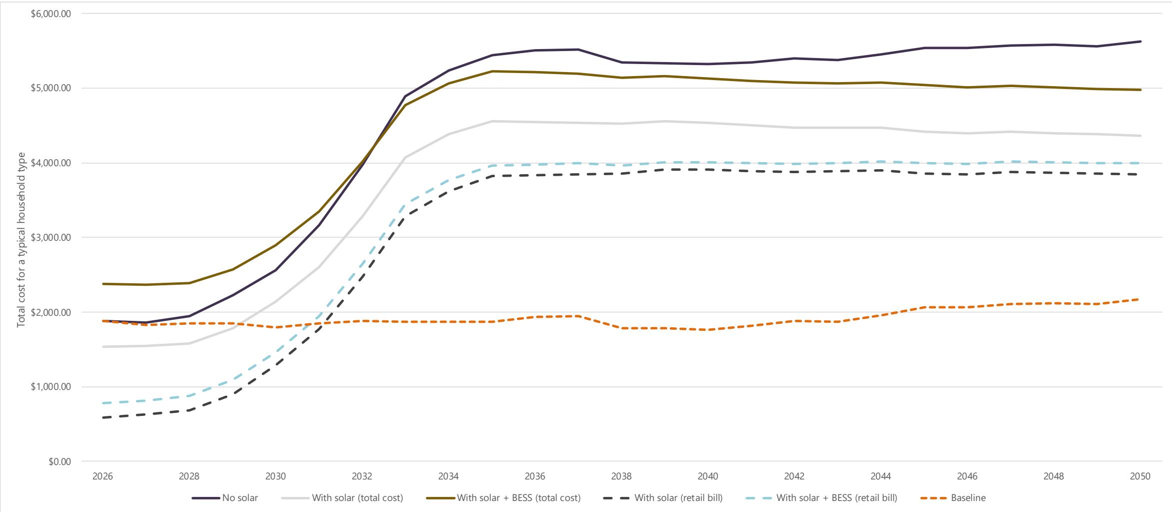
Wholesale electricity prices drop so low in the period before 2040 (where the installation of solar + BESS is concentrated) that the cost of wholesale electricity and network supply falls below not only solar + BESS but also solar only. It should be noted that this isn't uncommon in electricity markets. The investment in a large generating facility can push prices down just after commissioning with revenue adequacy for the project relying on long run prices.

This scenario has significantly lower retail bills for solar + BESS installations (worth about $200p.a.) over the 2030s. As energy costs are low reducing the network bill matters more over this period. However, once the annualised costs of the solar + BESS installation are added, solar only still looks cheaper. Once again it should be noted that caution is required in the solar only costs because, in the scenarios modelled, prices have been flattened and network costs avoided by the large number of BESS installations. A solar only scenario would have more volatile (possibly higher) energy costs and higher network costs.

5.2.6 Herded Electrification/Late Solar + BESS

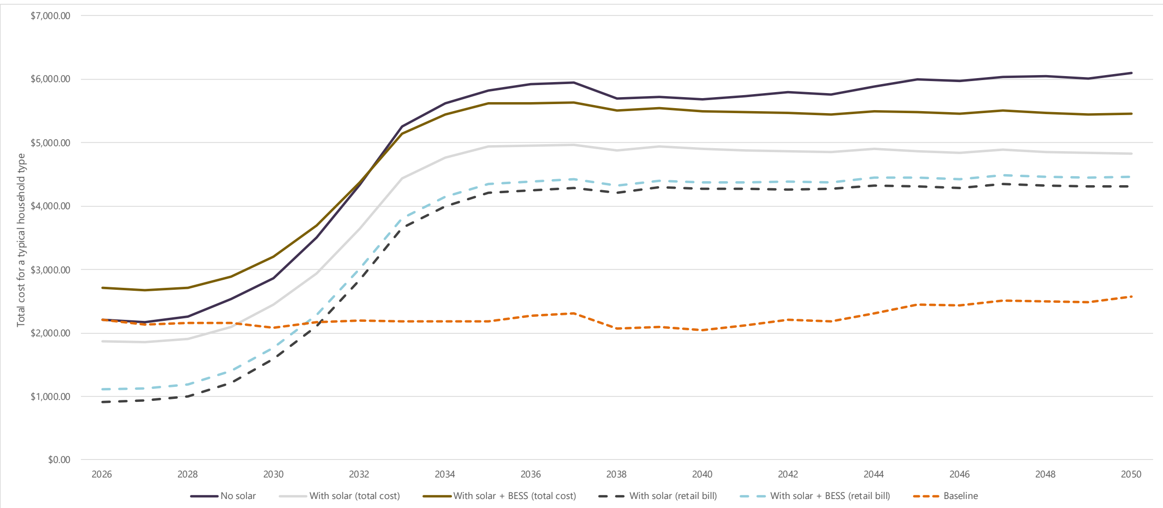
This scenario highlights the potential danger of early electrification with either ineffective demand management or pricing structures that inadvertently 'herd' EV demand into a later but higher peak demand. It combines Jacob's baseline scenario (late solar) with ANSA's 2kW EE/LS scenario. For this scenario a static price structure for network pricing is used.

Figure 35: Herded electrification, late solar + BESS - effect of solar + BESS on all-electric house



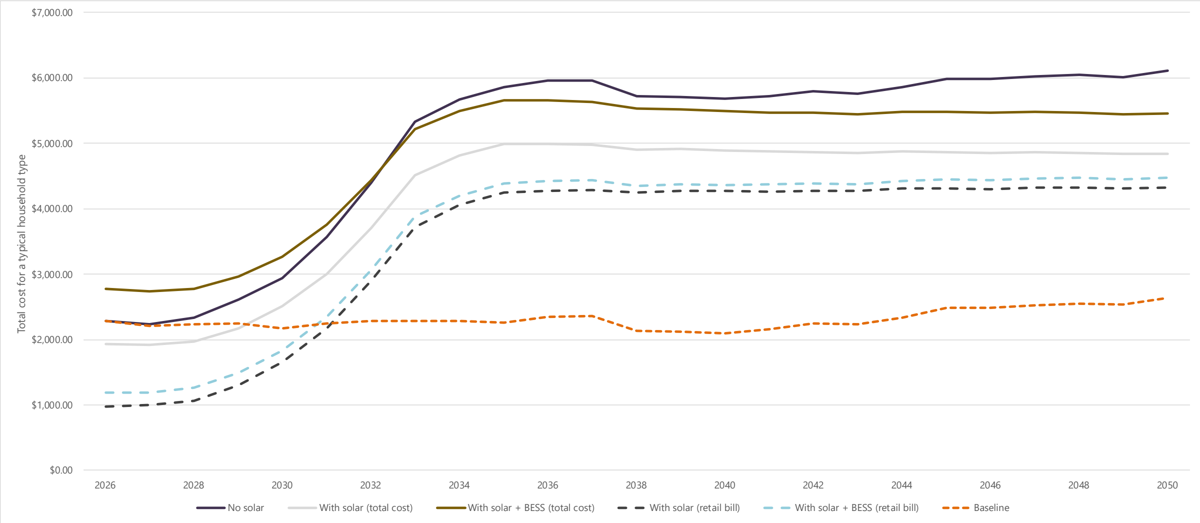
Data available in Table 27 on page 64.

Figure 36: Herded electrification, late solar + BESS - effect of solar + BESS on all day electric house



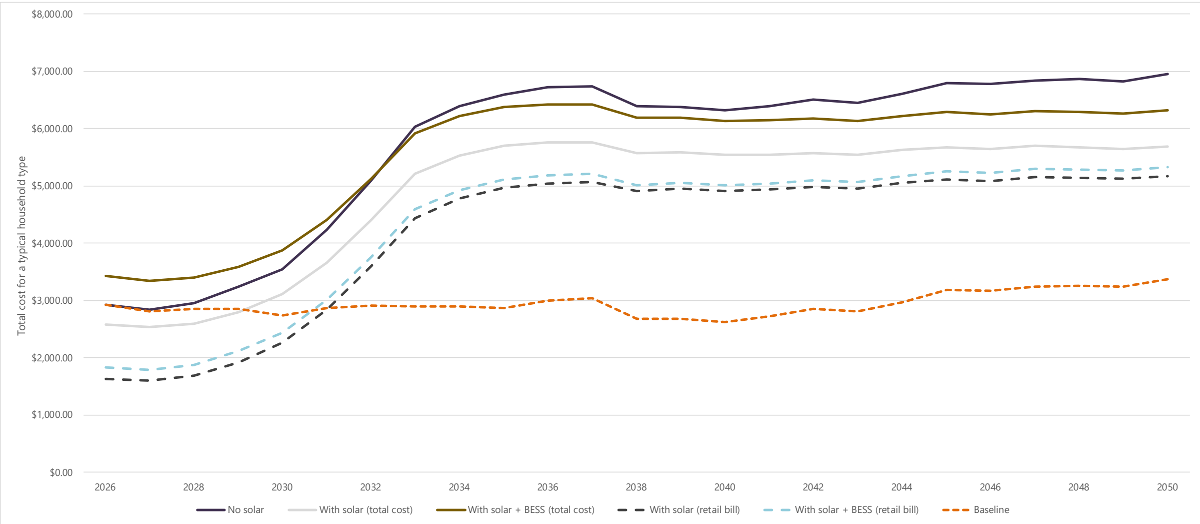
Data available in Table 28 on page 65.

Figure 37: Early electrification, accelerated solar + BESS - effect of solar + BESS on electric house with one EV



Data available in Table 29 on page 66.

Figure 38: Early electrification, accelerated solar + BESS - effect of solar + BESS on all day electric house with two EVs



Data available in Table 30 on page 67.

This scenario highlights the cost[22] of getting it wrong. If early electrification occurred with little confidence in the ability to manage peak demand (especially EVs) or in the contribution of other demand management technology (such as BESS) then network spend could become significant. This should be unlikely as the industry is aware of the problems but there is yet to be consensus on how this would be managed. Among other potential options the pricing of retail energy and network costs is critical to creating the incentives to avoid this outcome.

[22] Refer to tables in Appendix A for herded electrification scenario. The total costs of about $5,000 in 2033 for most households and earlier for those with two EVs, reaching even higher total costs.

The tragedy discussed earlier is evident again here. Under the static pricing approach none of the households have an early incentive to invest in solar + BESS, and the static pricing approach can also cause the herding of EV charging. Yet, under this scenario, for every household, solar + BESS is cheaper than network supply by 2032. However, by 2032 the costs have already been incurred and the solar + BESS option, or even the solar only option, are only adding some value at the margin of this scenario. If the solar + BESS had been deployed earlier (with EV charging coordinated to avoid herding) then these costs would be avoided.

While the extremity of this scenario should be avoided there is still a risk that, in the absence of certainty about approaches to EV charging and the role of solar + BESS, some unnecessary cost could be incurred.

5.2.7 Household costs summary

The following conclusions are based on the scenarios from Jacobs and ANSA. The ANSA analysis only looked at the LV distribution network and the costs for the rest of distribution and transmission are estimates. The analysis would benefit from analysing transmission and the balance of distribution costs consistent with the Jacobs and ANSA analysis.

We used a baseline of late electrification/late solar, which showed moderate costs[23] over the long run and plenty of time to prepare. However, the key driver on the baseline, electrification, is also the one which is driven most by external factors. The rate of take up of electrical appliances from other fuels, especially EVs, will be affected to some extent by policy but mainly through the price of the appliances relative to alternatives, availability of other fuels, availability of finance, and the price of electricity.

If electrification were to increase rapidly and early, then there is a risk of significant transmission and distribution expenditure unless there are incentives to manage demand and invest in solar + BESS. Solar + BESS becomes cheaper than grid supply under all scenarios for all households analysed at least by the 2040s. Under early electrification, and particularly for households that have higher peak energy contributions, then solar + BESS can be competitive to grid supply today (although this does depend on the pricing structure).

There is a balancing act. To avoid costs before they are incurred solar + BESS would need to be incentivised earlier than the network costs, in particular. Early investment would also substantially lower wholesale energy costs under the scenarios analysed. However, if electrification were to occur later than expected then early solar + BESS would be expensive, especially for households that aren't electrified or are small users.

Under most scenarios solar only was cheaper than solar + BESS but caution needs to be taken here. The scenarios developed by Jacob's and ANSA were built on solar + BESS. It is not surprising that, in an electric power system that has significant storage capability, solar only would look attractive. However, this would not be the case if the power system didn't have the BESS capacity.

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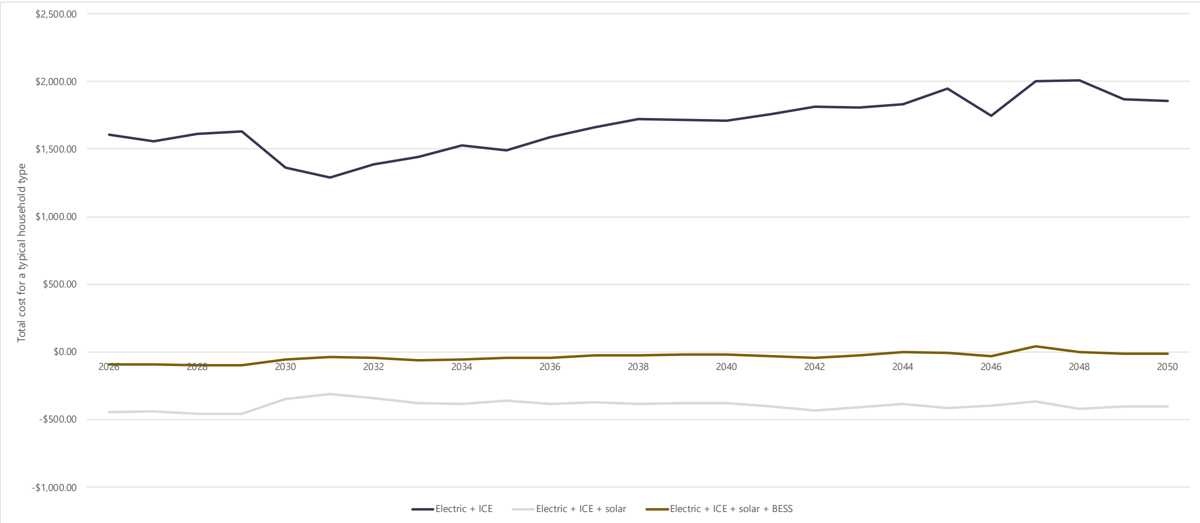
[23] Refer to Table 1.

5.3 Pricing and incentives

Simple price structures

For Figure 39 we use the middle scenario from Figure 13 (RA2 + 1kW ADMD growth) to show the effect of a flat price structure on the incentives for adding solar or solar + BESS to the typical household type.

Figure 39: Typical household type response to solar on flat price



NB. The solar buyback rate is the same as the retail sales price.

As expected, the change in costs is purely a function of the net purchases of electricity (or in this case net sales). In this case the strongest incentive is for solar only due to the roundtrip efficiency losses associated with a BESS. A solar + BESS configuration is less efficient than solar only. However, as shown in Figure 11, both the peak export and peak import are significantly higher than if using the BESS. Notably, neither solar profile is making a significant contribution to network costs even though they both import and export from, at least, the LV network.

We should note this scenario is illustrative only and we do not consider it plausible. The Jacob price forecasts are generally quite flat, which implies to us that Jacob's are assuming demand shifting and some contribution from BESS. As a flat price structure doesn't incentivise demand shifting or BESS then this price structure is inconsistent with both ANSA's and Jacob's scenarios.

Figure 39 highlights that there needs to be a significant benefit from controlling demand to offset the efficiency losses of a BESS.

We will also look at the incentives around the load shifting of EVs. However, as the volume of consumption is the same regardless of when an EV is charged, then a flat price structure will give the same result no matter what the profile is.

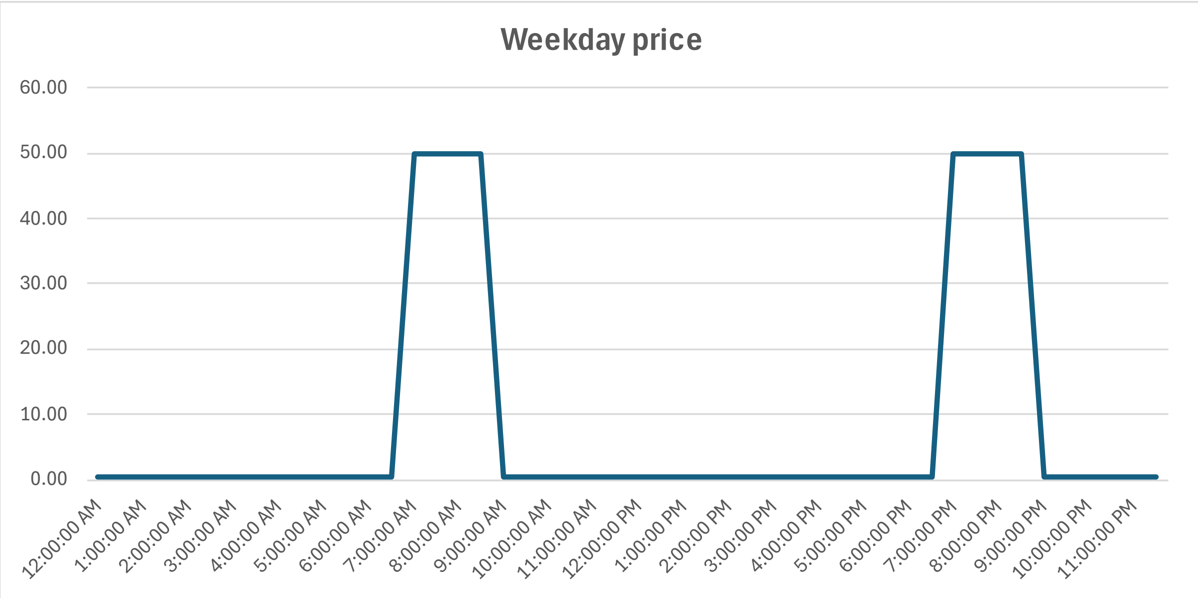
Time-Of-Use price structures

TOU price structures have long been used for large commercial and industrial customers to try to recover the average cost of electricity supply while signalling marginal cost over time. With smart metering TOU price structures are being increasingly used for residential retail pricing.

We now look at the potential for a TOU price structure to incentivise the solar + BESS option, which is the one that limits the network peak and, of these three options, would assist in avoiding the network costs. To investigate this, we use what is sometimes known as a 'superpeak' price structure. This averages energy prices to aggregate peak costs within a narrow band at morning and evening peaks and uses a lines price structure that weights cost recovery to peak periods.

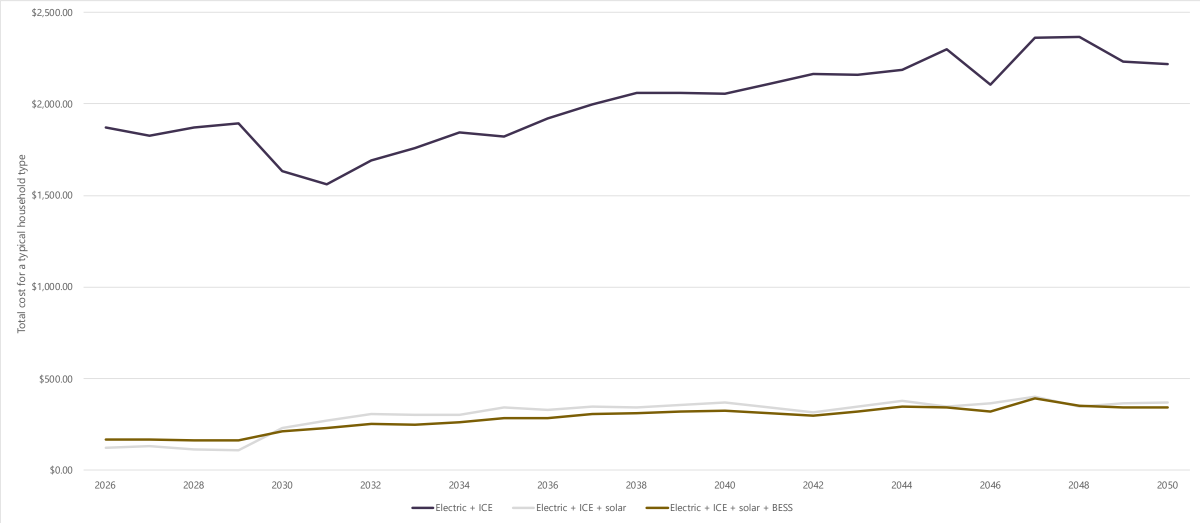
As retail energy prices are based on wholesale price forecasts, once you have chosen the price structure there is no ability to weight peak periods further without distorting the signals expected from the energy market. Therefore, the key discretion in setting the super-peak price is the weighting of the lines charge recovery. To demonstrate the limit on the economic incentive for investing solar + BESS we use the extreme weighting for lines charges shown in Figure 40.

Figure 40: Super-peak price structure for lines charges to incentivise solar + BESS



Using unadjusted super-peak energy prices and the lines prices from Figure 40 gives the cost result in Figure 41.

Figure 41: Typical household response to solar from TOU tariff



The TOU charge was targeted to try to keep the average annual cost of the typical household without solar or BESS roughly equivalent to the baseline outcome from Figure 13, but with the total cost benefits accruing from some increased solar and limited peak demand growth (RA2 & 1kW). The reason to try to eliminate the cost savings from the household without solar is to maximise the savings available to those that invest in solar with BESS, which is the only profile that reduces peak demand.

As a TOU charge is still fundamentally a volumetric charge then the level of total consumption is still the main driver of costs savings, especially from energy prices which are very flat anyway. The TOU tariff now means that both solar profiles are contributing to lines costs (they are still receiving payments from energy pricing) and has levelised the total cost between solar only and solar + BESS.

However, even with a cost reflective, super-peak, energy price structure and extreme lines charge super-peak weighting the strongest incentive is to reduce consumption rather than reduce peak demand. There is no extra incentive to add the BESS as well.

Two issues are raised from this result – network revenue adequacy and equilibrium. The solar profiles are saving households about five times more in total charges than is actually being saved in energy and network costs. Therefore, with significant uptake of solar the amount of money recovered by networks would become inadequate to fund their existing assets. Using this price structure would then require lines charges to be generally higher lifting costs for the household with no solar. At this point the pricing would constitute a cross-subsidy because the solar providers can't be made better off without making non-solar worse off, and the solar savings are higher than the actual costs avoided.[24]

The solar only profile is the least consistent with the Jacob's and ANSA's scenarios but is as cheap as the solar + BESS profile. Ignoring the revenue adequacy and cross-subsidy issue above, this outcome

[24] Significant solar uptake under the current price structure could undermine network revenue recovery, forcing higher charges on non-solar households and creating a cross-subsidy. In other words, solar customers save far more than the costs they avoid, so maintaining equilibrium would require raising prices for others, making the pricing model unsustainable and inequitable.

isn't necessarily inconsistent. When energy prices are more shaped there would be stronger incentives to invest in solar + BESS. As prices flattened the incentives change and, at times, might favour solar only. However, too much solar only would start to create price separation again lifting the incentives for including BESS. An equilibrium leading to flatter prices and an optimal balance between solar installs is theoretically possible. However, achieving dynamic equilibrium with static price structures is unlikely and, in any event, the incentives to install solar are too strong under this TOU structure.

To look at the incentives on EV charging from this same TOU structure we look at three EV profiles based on an electric household with two EVs. For this comparison we look at the EV load profiles for 'natural' diversity (Figure 8), one with herding (Figure 7), and one with managed overnight EV charging (Figure 9).

Figure 42: Electric household type with two EVs response to TOU tariff

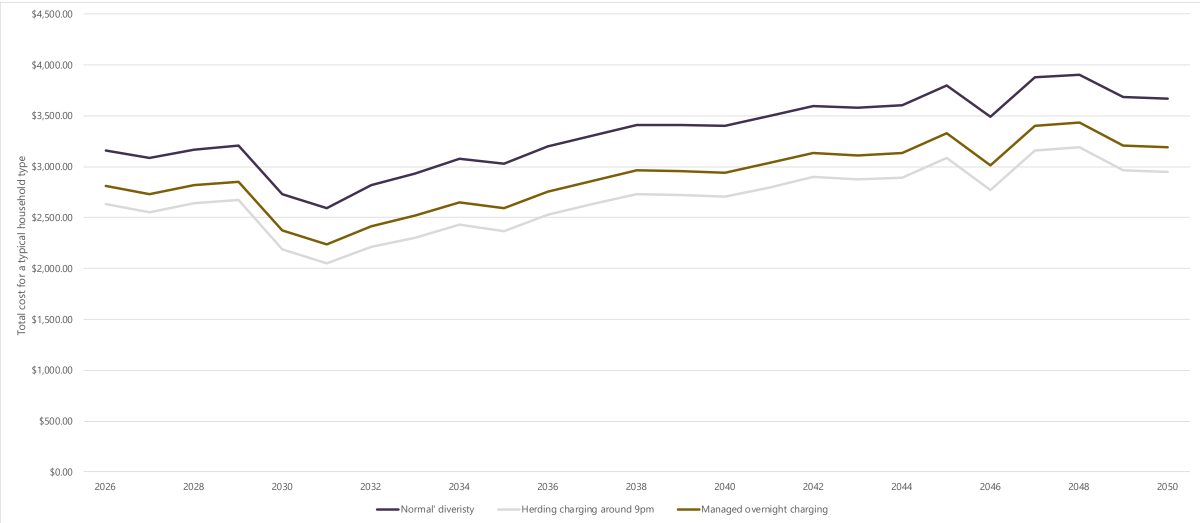


Figure 42 shows that, being a volumetric charge, consumption is still a strong driver of total cost. Therefore, the pattern of annual prices tends to follow wholesale market prices, with cost-reflective retail pricing. However, TOU does significantly affect the relative cost between the profiles. The most expensive profile is the 'natural' diversity, where EVs are plugged in after work (for this household type). This profile also has the highest peak demand growth (2kW). The cheapest profile is the herding profile, however, this profile also increases peak demand (by 0.5kW post-diversity) albeit now a later peak at 9pm.[25] The only profile that doesn't increase peak demand and is consistent with managing peak demand to the cheapest ANSA outcomes, is the managed overnight charging profile but this profile is $220 more expensive per year on average than the herding profile.

While the managed overnight charging profile is $430 cheaper per year on average from the natural diversity profile, it cannot occur naturally. To achieve the post-diversity managed overnight charging profile would require individualised, statistically distributed, TOU prices or be actively managed.

We note that, in trying to create the incentive to manage peak demand, the price before 9pm is 100 times higher than the price after 9pm. This means that, without changing the energy price, the 9pm

[25] This is the peak result from this version of the load profile model, which has a 30-minute granularity. Our 5-minute model shows an even higher herding peak.

peak could be significantly higher without making the herding profile more expensive, although in practice energy prices would be affected. The cheapest outcome from TOU pricing could result from the profile where prices are herded into a new peak demonstrates the problem with trying to manage highly manageable loads (like EVs) or load adjusters (such as BESS) using static TOU prices. The result of load shifting in response to static TOU prices will not necessarily be a net better result.

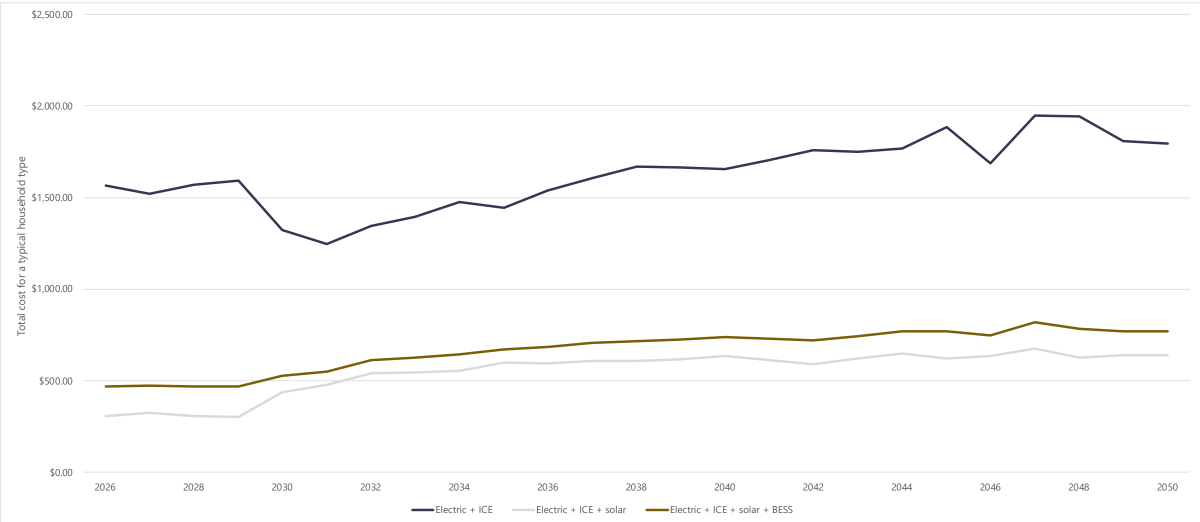
Nevertheless, the slight herding example in this case is not necessarily sub-optimal. This is easier to show in the discussion below.

Dynamic pricing or peak pricing for lines charges

It is difficult to apply a dynamic pricing outcome to a static model. Nevertheless, the result can be simulated by having a price regime that is not connected to static TOU but a cost-reflective attribute of demand. For this we use a pricing structure that is substantially fixed for the recovery of sunk costs (over the short term, i.e. a 30-minute trading period) and a peak charge for exceeding a secure capacity level, which would then start to signal the need for new lines investment. This is a theoretically ideal line charging structure as it is substantially unavoidable for sunk capacity and prices exceeding this capacity can be set to be generally at the long-run marginal cost (LRMC) of new capacity. This is approximated in the model by setting a level of post-diversity capacity allocated for residential consumers and charging an LRMC approximation for exceeding the peak.

The same pricing structure could be applied to energy prices, but energy resources are workably variabilised in the wholesale electricity market, i.e. marginal prices from the wholesale electricity market, on which retail prices are based, are deemed to be genuinely avoidable over a trading period.

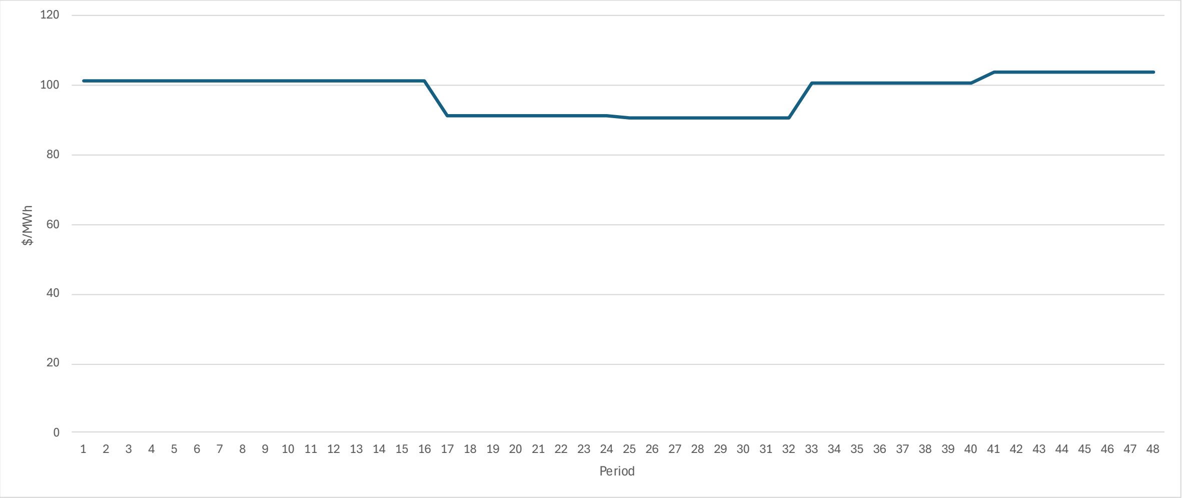
Figure 43: Typical household response to solar from peak/dynamic pricing



The energy prices applied in Figure 43 are a 144 part price structure (six x 4-hour pricing periods per BD and per NBD day per each month), which is the most cost reflective price structure typically applied to retail customers (although more usually applied to commercial/industrial). This is still a volumetric price structure and so the solar profiles still save significantly on energy costs (and receive payments to the extent they are net exporters). However, the solar profiles are paying their contribution to existing network costs, and the solar only profile is paying an extra contribution equivalent to the non-solar profile as they use the same peak capacity.[26]

However, the solar only profile is still cheaper than the solar + BESS profile. This occurs because the solar only profile hasn't increased peak capacity and pays only a moderate peak charge, while the energy prices based on Jacob's forecasts incentivise a different profile, as shown in Figure 44.

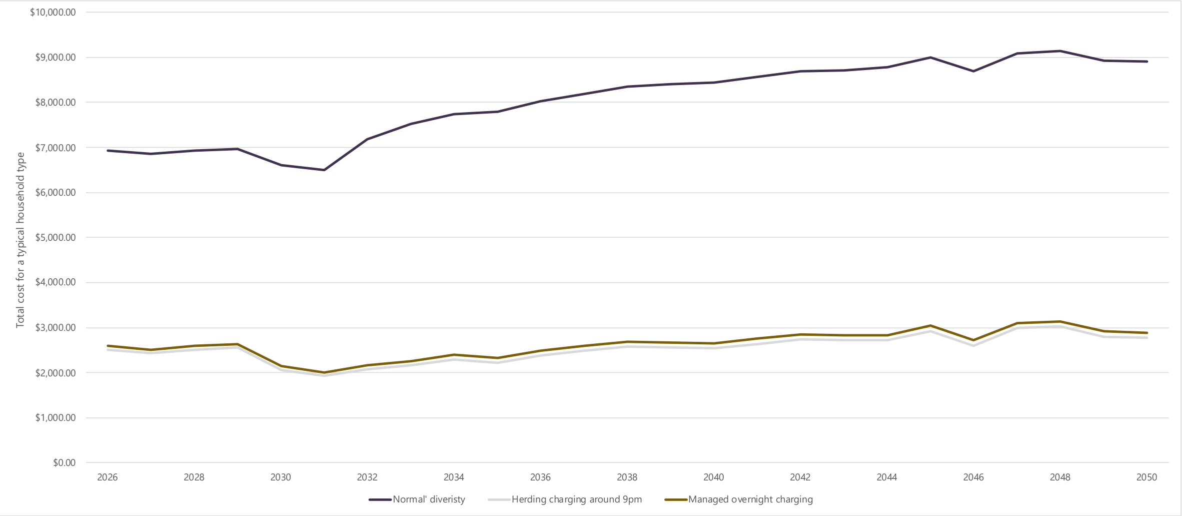
Figure 44: Six-part BD retail price based on Jacob's RA1 forecast - March 2040



While the prices in Figure 44 are very flat, the highest prices of the day occur at 9pm and overnight on this occasion. Noting that there is no typical price structure in the future forecasts. In general, however, the RA1 price series tends to encourage demand away from night and towards daytime.

Providing that the retail energy prices are suitably dynamic then this should lead to efficient outcomes. This is better illustrated in Figure 45.

Figure 45: Electric household type with two EVs response to peak/dynamic pricing



[26] In this version of the transmission and distribution pricing module the peak charge is approximated based on existing costs and does not align with the ANSA scenarios. We may be able to improve this in the final version.

Figure 45 uses the same electric house with two EVs profiles as Figure 42. In this case the household profile using only natural diversity, with the 2kW increase in peak capacity, faces a huge increase in cost as it pays a significant share of the costs required for investing in network capacity. The herding profile also pays a significant peak penalty as it increases peak demand by 0.5kW. However, the benefits to the herding profile from the energy price profile still makes it cheaper than the managed overnight demand. Given these inputs this outcome is theoretically efficient.

It can be seen how an equilibrium is theoretically achievable. While the energy price profile might encourage a peakier profile the peak charges increase exponentially as peak demand lifts.[27] If both pricing approaches are suitably dynamic then and household should be able to find the profile where the marginal change in energy costs equals the marginal change in network costs – the theoretically optimal point. However, optimality (and equilibrium) is much harder to achieve in practice.

Note on dynamic pricing

We think this modelling shows the need for dynamic, and carefully structured, pricing to incentivise efficient levels of solar, BESS, electrification, and demand shifting. It might be tempting to think that just passing through spot prices is a way of making retail pricing suitably dynamic but there are two problems with this.

First, smoothing retail prices, and preventing shocks from short-term wholesale market volatility, is a reasonable expectation of retail customers.

Second, while spot prices would likely incentivise efficient management of BESS and demand shifting it is equally important to have the right incentives for investment in solar, BESS, and demand shifting technology. Wholesale market participants are expected to make their own forecasts of wholesale prices and invest based on their own expectations of forward price. This is an unreasonable expectation of retail customers. Therefore, a retail pricing system needs to balance being suitably dynamic with providing reliable forward price signals.

The peak pricing method is an elegant way of encouraging dynamic with a static price signal. However, we had the luxury, having derived after-diversity household profiles, to apply an ADMD cap. To apply to individual households this would have to be converted to a suitable before-diversity peak cap that gives the correct after-diversity incentives.

Dynamic network response could also be achieved by using dynamic TOU prices but the same issues as with energy would then apply.

Any retail pricing approach needs to balance workable complexity with workable effectiveness. And any significant change in price structures creates the potential for 'winners and losers' and rate shock.

[27] Due to the shape of demand peaks the volume exceeding a peak threshold increases exponentially as peak demand lifts.

References

Low voltage distribution network investment requirements from electrification. (2025). ANSA.

Non-utility Solar-BESS Uptake Market Impact Study—MBIE RT Solar Study. (2025). Jacobs.

Appendix A Tables of household costs

Table 7: Late electrification solar + BESS - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,880.42	$1,532.35	$2,379.26	$583.92	$786.15	-$348.06	$498.84
2027	$1,822.61	$1,522.70	$2,338.62	$597.92	$787.10	-$299.91	$516.02
2028	$1,844.15	$1,492.12	$2,297.29	$591.01	$785.87	-$352.03	$453.14
2029	$1,849.33	$1,445.47	$2,242.10	$568.02	$767.71	-$403.87	$392.76
2030	$1,792.13	$1,445.26	$2,215.84	$591.57	$777.37	-$346.87	$423.71
2031	$1,853.42	$1,415.68	$2,186.04	$585.80	$782.91	-$437.75	$332.62
2032	$1,879.42	$1,387.19	$2,151.04	$581.08	$782.86	-$492.22	$271.62
2033	$1,874.54	$1,339.64	$2,096.03	$557.26	$762.67	-$534.91	$221.48
2034	$1,874.04	$1,335.16	$2,077.73	$576.56	$777.77	-$538.89	$203.68
2035	$1,868.17	$1,330.98	$2,059.49	$596.14	$791.87	-$537.20	$191.32
2036	$1,932.71	$1,307.90	$2,038.93	$596.84	$802.86	-$624.81	$106.22
2037	$1,951.47	$1,313.78	$2,034.83	$626.53	$829.78	-$637.68	$83.37
2038	$1,781.36	$1,302.07	$1,984.93	$638.60	$810.45	-$479.29	$203.57
2039	$1,781.79	$1,337.53	$2,002.67	$694.84	$855.43	-$444.25	$220.88
2040	$1,758.74	$1,315.08	$1,969.75	$690.76	$847.08	-$443.66	$211.01
2041	$1,811.59	$1,301.16	$1,959.67	$692.91	$858.50	-$510.44	$148.08
2042	$1,880.99	$1,283.54	$1,948.61	$689.48	$866.41	-$597.45	$67.62
2043	$1,869.05	$1,296.38	$1,948.74	$714.92	$883.41	-$572.67	$79.70
2044	$1,956.77	$1,309.09	$1,967.96	$738.92	$917.71	-$647.68	$11.19
2045	$2,069.44	$1,276.75	$1,954.82	$716.73	$918.15	-$792.68	-$114.62
2046	$2,066.58	$1,260.99	$1,936.69	$710.16	$912.31	-$805.59	-$129.89
2047	$2,104.06	$1,286.55	$1,958.51	$744.07	$945.29	-$817.50	-$145.55
2048	$2,117.55	$1,263.37	$1,936.25	$728.51	$933.23	-$854.18	-$181.30
2049	$2,106.22	$1,259.50	$1,928.59	$731.63	$934.92	-$846.72	-$177.63
2050	$2,178.00	$1,243.20	$1,922.16	$721.76	$937.09	-$934.80	-$255.84
Average	**$1,916.18**	**$1,344.14**	**$2,061.46**	**$650.64**	**$842.20**	**-$572.04**	**$145.28**

Table 8: Late electrification solar + BESS - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,212.21	$1,864.15	$2,711.06	$915.71	$1,117.95	-$348.06	$498.84
2027	$2,131.67	$1,831.76	$2,647.68	$906.99	$1,096.16	-$299.91	$516.02
2028	$2,159.11	$1,807.08	$2,612.25	$905.97	$1,100.83	-$352.03	$453.14
2029	$2,151.38	$1,747.51	$2,544.14	$870.06	$1,069.76	-$403.87	$392.76
2030	$2,082.41	$1,735.54	$2,506.11	$881.84	$1,067.64	-$346.87	$423.71
2031	$2,167.59	$1,729.84	$2,500.21	$899.96	$1,097.08	-$437.75	$332.62
2032	$2,199.25	$1,707.03	$2,470.87	$900.91	$1,102.70	-$492.22	$271.62
2033	$2,176.55	$1,641.64	$2,398.03	$859.27	$1,064.68	-$534.91	$221.48
2034	$2,184.14	$1,645.25	$2,387.82	$886.66	$1,087.86	-$538.89	$203.68
2035	$2,181.32	$1,644.13	$2,372.64	$909.29	$1,105.02	-$537.20	$191.32
2036	$2,272.02	$1,647.21	$2,378.24	$936.15	$1,142.17	-$624.81	$106.22
2037	$2,314.00	$1,676.32	$2,397.37	$989.06	$1,192.31	-$637.68	$83.37
2038	$2,066.58	$1,587.29	$2,270.16	$923.83	$1,095.68	-$479.29	$203.57
2039	$2,095.32	$1,651.07	$2,316.20	$1,008.38	$1,168.96	-$444.25	$220.88
2040	$2,049.20	$1,605.54	$2,260.21	$981.22	$1,137.55	-$443.66	$211.01
2041	$2,118.93	$1,608.49	$2,267.01	$1,000.25	$1,165.84	-$510.44	$148.08
2042	$2,202.72	$1,605.27	$2,270.33	$1,011.21	$1,188.14	-$597.45	$67.62
2043	$2,182.07	$1,609.40	$2,261.77	$1,027.95	$1,196.43	-$572.67	$79.70
2044	$2,309.81	$1,662.13	$2,321.00	$1,091.95	$1,270.75	-$647.68	$11.19
2045	$2,447.74	$1,655.06	$2,333.13	$1,095.04	$1,296.46	-$792.68	-$114.62
2046	$2,432.63	$1,627.04	$2,302.74	$1,076.21	$1,278.36	-$805.59	-$129.89
2047	$2,504.34	$1,686.84	$2,358.80	$1,144.36	$1,345.58	-$817.50	-$145.55
2048	$2,502.80	$1,648.62	$2,321.51	$1,113.76	$1,318.49	-$854.18	-$181.30
2049	$2,487.03	$1,640.31	$2,309.40	$1,112.44	$1,315.73	-$846.72	-$177.63
2050	$2,577.91	$1,643.11	$2,322.07	$1,121.67	$1,337.00	-$934.80	-$255.84
Average	**$2,248.35**	**$1,676.31**	**$2,393.63**	**$982.81**	**$1,174.36**	**-$572.04**	**$145.28**

Table 9: Late electrification solar + BESS - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,284.80	$1,936.73	$2,783.64	$988.30	$1,190.53	-$348.06	$498.84
2027	$2,203.82	$1,903.91	$2,719.83	$979.14	$1,168.32	-$299.91	$516.02
2028	$2,234.24	$1,882.22	$2,687.39	$981.10	$1,175.97	-$352.03	$453.14
2029	$2,248.32	$1,844.46	$2,641.09	$967.01	$1,166.70	-$403.87	$392.76
2030	$2,165.73	$1,818.86	$2,589.44	$965.17	$1,150.96	-$346.87	$423.71
2031	$2,247.98	$1,810.23	$2,580.60	$980.35	$1,177.47	-$437.75	$332.62
2032	$2,283.47	$1,791.25	$2,555.09	$985.13	$1,186.92	-$492.22	$271.62
2033	$2,284.18	$1,749.27	$2,505.66	$966.90	$1,172.31	-$534.91	$221.48
2034	$2,277.04	$1,738.15	$2,480.72	$979.56	$1,180.76	-$538.89	$203.68
2035	$2,262.88	$1,725.69	$2,454.20	$990.85	$1,186.58	-$537.20	$191.32
2036	$2,347.79	$1,722.98	$2,454.01	$1,011.92	$1,217.94	-$624.81	$106.22
2037	$2,362.45	$1,724.77	$2,445.82	$1,037.52	$1,240.76	-$637.68	$83.37
2038	$2,135.52	$1,656.23	$2,339.10	$992.77	$1,164.62	-$479.29	$203.57
2039	$2,117.79	$1,673.54	$2,338.67	$1,030.84	$1,191.43	-$444.25	$220.88
2040	$2,088.41	$1,644.74	$2,299.41	$1,020.42	$1,176.75	-$443.66	$211.01
2041	$2,157.75	$1,647.31	$2,305.83	$1,039.07	$1,204.66	-$510.44	$148.08
2042	$2,250.30	$1,652.85	$2,317.91	$1,058.79	$1,235.72	-$597.45	$67.62
2043	$2,226.74	$1,654.07	$2,306.44	$1,072.62	$1,241.10	-$572.67	$79.70
2044	$2,334.67	$1,686.98	$2,345.85	$1,116.81	$1,295.60	-$647.68	$11.19
2045	$2,489.88	$1,697.19	$2,375.26	$1,137.17	$1,338.59	-$792.68	-$114.62
2046	$2,487.89	$1,682.30	$2,358.00	$1,131.47	$1,333.62	-$805.59	-$129.89
2047	$2,526.99	$1,709.48	$2,381.44	$1,167.00	$1,368.23	-$817.50	-$145.55
2048	$2,549.63	$1,695.45	$2,368.33	$1,160.59	$1,365.31	-$854.18	-$181.30
2049	$2,533.94	$1,687.22	$2,356.31	$1,159.35	$1,362.64	-$846.72	-$177.63
2050	$2,631.63	$1,696.82	$2,375.78	$1,175.38	$1,390.71	-$934.80	-$255.84
Average	**$2,309.35**	**$1,737.31**	**$2,454.63**	**$1,043.81**	**$1,235.37**	**-$572.04**	**$145.28**

Table 10: Late electrification solar + BESS - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,927.34	$2,579.28	$3,426.19	$1,630.84	$1,833.07	-$348.06	$498.84
2027	$2,803.68	$2,503.77	$3,319.69	$1,579.00	$1,768.17	-$299.91	$516.02
2028	$2,847.52	$2,495.49	$3,300.66	$1,594.38	$1,789.25	-$352.03	$453.14
2029	$2,855.90	$2,452.04	$3,248.67	$1,574.58	$1,774.28	-$403.87	$392.76
2030	$2,741.00	$2,394.13	$3,164.71	$1,540.44	$1,726.24	-$346.87	$423.71
2031	$2,863.79	$2,426.05	$3,196.41	$1,596.17	$1,793.29	-$437.75	$332.62
2032	$2,912.06	$2,419.84	$3,183.68	$1,613.72	$1,815.51	-$492.22	$271.62
2033	$2,899.11	$2,364.20	$3,120.59	$1,581.83	$1,787.24	-$534.91	$221.48
2034	$2,893.66	$2,354.77	$3,097.34	$1,596.18	$1,797.38	-$538.89	$203.68
2035	$2,874.83	$2,337.64	$3,066.15	$1,602.80	$1,798.53	-$537.20	$191.32
2036	$3,002.43	$2,377.62	$3,108.65	$1,666.56	$1,872.58	-$624.81	$106.22
2037	$3,035.56	$2,397.87	$3,118.92	$1,710.62	$1,913.87	-$637.68	$83.37
2038	$2,686.03	$2,206.74	$2,889.60	$1,543.27	$1,715.12	-$479.29	$203.57
2039	$2,680.13	$2,235.88	$2,901.01	$1,593.18	$1,753.77	-$444.25	$220.88
2040	$2,621.46	$2,177.80	$2,832.47	$1,553.48	$1,709.80	-$443.66	$211.01
2041	$2,722.11	$2,211.67	$2,870.18	$1,603.43	$1,769.02	-$510.44	$148.08
2042	$2,847.47	$2,250.02	$2,915.08	$1,655.96	$1,832.89	-$597.45	$67.62
2043	$2,804.94	$2,232.27	$2,884.64	$1,650.82	$1,819.30	-$572.67	$79.70
2044	$2,969.06	$2,321.38	$2,980.25	$1,751.20	$1,930.00	-$647.68	$11.19
2045	$3,183.83	$2,391.14	$3,069.21	$1,831.12	$2,032.54	-$792.68	-$114.62
2046	$3,169.92	$2,364.33	$3,040.03	$1,813.49	$2,015.64	-$805.59	-$129.89
2047	$3,244.44	$2,426.94	$3,098.90	$1,884.45	$2,085.68	-$817.50	-$145.55
2048	$3,258.64	$2,404.46	$3,077.34	$1,869.60	$2,074.32	-$854.18	-$181.30
2049	$3,235.83	$2,389.11	$3,058.20	$1,861.24	$2,064.53	-$846.72	-$177.63
2050	$3,372.78	$2,437.98	$3,116.94	$1,916.54	$2,131.87	-$934.80	-$255.84
Average	**$2,938.14**	**$2,366.10**	**$3,083.42**	**$1,672.60**	**$1,864.16**	**-$572.04**	**$145.28**

Table 11: Early electrification - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,860.90	$1,545.23	$2,310.99	$596.80	$717.88	-$315.66	$450.09
2027	$1,803.98	$1,527.24	$2,264.29	$602.47	$712.77	-$276.74	$460.31
2028	$1,827.65	$1,492.18	$2,216.06	$591.07	$704.64	-$335.47	$388.42
2029	$1,838.91	$1,447.08	$2,156.31	$569.63	$681.93	-$391.82	$317.41
2030	$1,825.91	$1,481.97	$2,153.28	$628.27	$714.80	-$343.94	$327.37
2031	$1,924.75	$1,480.98	$2,138.76	$651.10	$735.63	-$443.77	$214.01
2032	$2,036.92	$1,526.24	$2,152.29	$720.13	$784.11	-$510.67	$115.37
2033	$2,179.36	$1,606.55	$2,183.55	$824.18	$850.20	-$572.81	$4.19
2034	$2,254.78	$1,663.62	$2,201.17	$905.03	$901.21	-$591.16	-$53.61
2035	$2,243.93	$1,649.46	$2,165.03	$914.62	$897.42	-$594.47	-$78.90
2036	$2,304.85	$1,616.15	$2,125.85	$905.09	$889.78	-$688.71	-$179.00
2037	$2,321.16	$1,607.79	$2,100.95	$920.53	$895.90	-$713.38	-$220.21
2038	$2,147.37	$1,583.44	$2,032.74	$919.97	$858.26	-$563.93	-$114.63
2039	$2,144.15	$1,615.94	$2,047.16	$973.25	$899.92	-$528.21	-$96.99
2040	$2,118.45	$1,590.51	$2,011.44	$966.19	$888.77	-$527.95	-$107.01
2041	$2,154.93	$1,562.20	$1,987.20	$953.95	$886.03	-$592.73	-$167.74
2042	$2,207.66	$1,530.44	$1,962.26	$936.38	$880.06	-$677.22	-$245.40
2043	$2,178.85	$1,529.34	$1,948.87	$947.89	$883.54	-$649.51	-$229.98
2044	$2,249.99	$1,528.00	$1,953.75	$957.83	$903.50	-$721.99	-$296.24
2045	$2,346.35	$1,481.41	$1,926.83	$921.39	$890.16	-$864.94	-$419.52
2046	$2,337.55	$1,460.80	$1,904.26	$909.97	$879.88	-$876.75	-$433.29
2047	$2,368.23	$1,481.46	$1,921.14	$938.98	$907.93	-$886.77	-$447.09
2048	$2,375.72	$1,453.73	$1,894.37	$918.87	$891.35	-$921.99	-$481.35
2049	$2,358.39	$1,444.97	$1,882.09	$917.10	$888.42	-$913.42	-$476.30
2050	$2,423.59	$1,423.95	$1,870.71	$902.51	$885.64	-$999.64	-$552.88
Average	**$2,153.37**	**$1,533.23**	**$2,060.45**	**$839.73**	**$841.19**	**-$620.15**	**-$92.92**

Table 12: Early electrification - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,860.90	$1,545.23	$2,310.99	$596.80	$717.88	-$507.76	$109.00
2027	$1,803.98	$1,527.24	$2,264.29	$602.47	$712.77	-$438.11	$164.69
2028	$1,827.65	$1,492.18	$2,216.06	$591.07	$704.64	-$490.23	$121.70
2029	$1,838.91	$1,447.08	$2,156.31	$569.63	$681.93	-$555.06	$60.79
2030	$1,825.91	$1,481.97	$2,153.28	$628.27	$714.80	-$529.94	$55.35
2031	$1,924.75	$1,480.98	$2,138.76	$651.10	$735.63	-$646.04	-$63.86
2032	$2,036.92	$1,526.24	$2,152.29	$720.13	$784.11	-$749.19	-$194.32
2033	$2,179.36	$1,606.55	$2,183.55	$824.18	$850.20	-$867.84	-$358.97
2034	$2,254.78	$1,663.62	$2,201.17	$905.03	$901.21	-$915.62	-$437.40
2035	$2,243.93	$1,649.46	$2,165.03	$914.62	$897.42	-$925.36	-$455.09
2036	$2,304.85	$1,616.15	$2,125.85	$905.09	$889.78	-$1,030.14	-$554.41
2037	$2,321.16	$1,607.79	$2,100.95	$920.53	$895.90	-$1,058.88	-$589.53
2038	$2,147.37	$1,583.44	$2,032.74	$919.97	$858.26	-$913.18	-$481.26
2039	$2,144.15	$1,615.94	$2,047.16	$973.25	$899.92	-$878.92	-$465.10
2040	$2,118.45	$1,590.51	$2,011.44	$966.19	$888.77	-$877.25	-$473.72
2041	$2,154.93	$1,562.20	$1,987.20	$953.95	$886.03	-$942.32	-$534.83
2042	$2,207.66	$1,530.44	$1,962.26	$936.38	$880.06	-$1,027.85	-$613.54
2043	$2,178.85	$1,529.34	$1,948.87	$947.89	$883.54	-$1,001.95	-$599.79
2044	$2,249.99	$1,528.00	$1,953.75	$957.83	$903.50	-$1,076.22	-$667.87
2045	$2,346.35	$1,481.41	$1,926.83	$921.39	$890.16	-$1,219.81	-$791.79
2046	$2,337.55	$1,460.80	$1,904.26	$909.97	$879.88	-$1,231.29	-$805.23
2047	$2,368.23	$1,481.46	$1,921.14	$938.98	$907.93	-$1,242.44	-$820.27
2048	$2,375.72	$1,453.73	$1,894.37	$918.87	$891.35	-$1,278.91	-$855.63
2049	$2,358.39	$1,444.97	$1,882.09	$917.10	$888.42	-$1,270.91	-$851.19
2050	$2,423.59	$1,423.95	$1,870.71	$902.51	$885.64	-$1,359.42	-$930.07
Average	**$2,904.29**	**$1,982.90**	**$2,462.99**	**$1,289.40**	**$1,243.73**	**-$921.38**	**-$441.29**

Table 13: Early electrification - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,354.79	$2,008.58	$2,700.38	$1,060.15	$1,107.26	-$346.21	$345.59
2027	$2,261.00	$1,961.90	$2,630.51	$1,037.12	$1,078.99	-$299.10	$369.51
2028	$2,284.38	$1,931.58	$2,592.23	$1,030.47	$1,080.81	-$352.79	$307.85
2029	$2,301.57	$1,894.33	$2,544.56	$1,016.87	$1,070.17	-$407.25	$242.98
2030	$2,269.89	$1,910.91	$2,523.72	$1,057.21	$1,085.25	-$358.99	$253.83
2031	$2,396.56	$1,940.37	$2,544.81	$1,110.49	$1,141.68	-$456.19	$148.25
2032	$2,550.93	$2,028.71	$2,598.31	$1,222.60	$1,230.13	-$522.21	$47.38
2033	$2,760.30	$2,174.81	$2,688.54	$1,392.44	$1,355.19	-$585.49	-$71.76
2034	$2,896.16	$2,291.76	$2,765.73	$1,533.17	$1,465.77	-$604.40	-$130.43
2035	$2,935.51	$2,322.93	$2,780.29	$1,588.09	$1,512.67	-$612.59	-$155.23
2036	$3,083.88	$2,370.49	$2,819.53	$1,659.43	$1,583.46	-$713.39	-$264.35
2037	$3,152.85	$2,415.64	$2,843.59	$1,728.39	$1,638.54	-$737.21	-$309.26
2038	$2,965.88	$2,376.93	$2,759.67	$1,713.46	$1,585.20	-$588.95	-$206.20
2039	$2,944.39	$2,390.76	$2,755.87	$1,748.07	$1,608.63	-$553.63	-$188.52
2040	$2,912.70	$2,359.96	$2,714.20	$1,735.63	$1,591.53	-$552.75	-$198.50
2041	$2,965.46	$2,347.50	$2,705.84	$1,739.26	$1,604.68	-$617.96	-$259.62
2042	$3,041.97	$2,338.48	$2,703.65	$1,744.42	$1,621.45	-$703.49	-$338.33
2043	$3,002.69	$2,325.39	$2,678.26	$1,743.93	$1,612.93	-$677.31	-$324.43
2044	$3,095.11	$2,344.21	$2,703.55	$1,774.04	$1,653.30	-$750.90	-$391.55
2045	$3,233.11	$2,338.74	$2,718.02	$1,778.72	$1,681.35	-$894.37	-$515.09
2046	$3,226.25	$2,319.49	$2,696.33	$1,768.65	$1,671.95	-$906.76	-$529.92
2047	$3,259.71	$2,341.63	$2,714.66	$1,799.15	$1,701.44	-$918.08	-$545.06
2048	$3,278.32	$2,323.94	$2,697.66	$1,789.08	$1,694.65	-$954.38	-$580.66
2049	$3,256.03	$2,309.65	$2,680.15	$1,781.78	$1,686.48	-$946.38	-$575.88
2050	$3,347.76	$2,313.78	$2,694.39	$1,792.34	$1,709.32	-$1,033.98	-$653.37
Average	**$2,871.09**	**$2,227.30**	**$2,690.18**	**$1,533.80**	**$1,470.91**	**-$643.79**	**-$180.91**

Table 14: Early electrification - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$3,931.46	$3,423.57	$3,960.13	$2,475.13	$2,367.02	-$507.89	$28.68
2027	$3,854.25	$3,416.10	$3,967.60	$2,491.32	$2,416.08	-$438.15	$113.36
2028	$3,879.65	$3,389.35	$3,963.57	$2,488.24	$2,452.15	-$490.31	$83.92
2029	$3,906.68	$3,351.58	$3,937.54	$2,474.13	$2,463.16	-$555.10	$30.86
2030	$3,942.72	$3,412.75	$3,970.95	$2,559.06	$2,532.48	-$529.97	$28.23
2031	$4,172.24	$3,526.16	$4,083.77	$2,696.28	$2,680.64	-$646.07	-$88.46
2032	$4,489.86	$3,740.67	$4,269.85	$2,934.55	$2,901.68	-$749.20	-$220.01
2033	$4,913.29	$4,045.44	$4,523.79	$3,263.07	$3,190.44	-$867.85	-$389.50
2034	$5,122.60	$4,206.97	$4,653.83	$3,448.38	$3,353.87	-$915.63	-$468.77
2035	$5,092.32	$4,166.95	$4,608.70	$3,432.11	$3,341.09	-$925.37	-$483.62
2036	$5,228.86	$4,198.71	$4,648.61	$3,487.66	$3,412.54	-$1,030.14	-$580.25
2037	$5,243.62	$4,184.73	$4,630.84	$3,497.48	$3,425.79	-$1,058.89	-$612.78
2038	$4,889.84	$3,976.59	$4,386.36	$3,313.12	$3,211.88	-$913.25	-$503.48
2039	$4,881.05	$4,002.06	$4,393.78	$3,359.37	$3,246.54	-$878.99	-$487.27
2040	$4,822.50	$3,945.17	$4,326.47	$3,320.85	$3,203.80	-$877.33	-$496.03
2041	$4,903.90	$3,961.50	$4,346.80	$3,353.26	$3,245.64	-$942.39	-$557.09
2042	$5,012.95	$3,985.03	$4,377.14	$3,390.96	$3,294.95	-$1,027.92	-$635.80
2043	$4,954.82	$3,952.80	$4,332.79	$3,371.34	$3,267.46	-$1,002.02	-$622.03
2044	$5,105.96	$4,029.66	$4,415.81	$3,459.49	$3,365.57	-$1,076.29	-$690.14
2045	$5,300.58	$4,080.70	$4,486.61	$3,520.68	$3,449.94	-$1,219.88	-$813.97
2046	$5,281.41	$4,050.05	$4,453.94	$3,499.21	$3,429.56	-$1,231.36	-$827.47
2047	$5,349.97	$4,107.46	$4,507.44	$3,564.97	$3,494.23	-$1,242.52	-$842.53
2048	$5,363.10	$4,084.12	$4,485.14	$3,549.26	$3,482.12	-$1,278.98	-$877.96
2049	$5,330.78	$4,059.80	$4,457.35	$3,531.93	$3,463.68	-$1,270.98	-$873.43
2050	$5,461.97	$4,102.47	$4,509.72	$3,581.03	$3,524.65	-$1,359.50	-$952.25
Average	**$4,817.45**	**$3,896.02**	**$4,347.94**	**$3,202.52**	**$3,128.68**	**-$921.44**	**-$469.51**

Table 15: Early solar + BESS - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,866.18	$1,547.30	$2,313.59	$598.86	$720.48	-$318.88	$447.41
2027	$1,820.77	$1,532.82	$2,272.75	$608.05	$721.23	-$287.95	$451.97
2028	$1,867.95	$1,488.09	$2,224.95	$586.97	$713.53	-$379.86	$357.00
2029	$1,889.50	$1,457.05	$2,185.47	$579.60	$711.09	-$432.45	$295.97
2030	$1,602.74	$1,544.78	$2,194.83	$691.09	$756.35	-$57.95	$592.09
2031	$1,521.68	$1,554.60	$2,174.47	$724.72	$771.34	$32.92	$652.79
2032	$1,562.73	$1,533.75	$2,146.58	$727.64	$778.41	-$28.97	$583.86
2033	$1,585.44	$1,485.31	$2,095.84	$702.94	$762.48	-$100.12	$510.40
2034	$1,661.02	$1,461.80	$2,074.72	$703.21	$774.77	-$199.22	$413.71
2035	$1,632.13	$1,486.10	$2,071.90	$751.26	$804.28	-$146.03	$439.77
2036	$1,726.60	$1,451.94	$2,047.54	$740.89	$811.47	-$274.65	$320.95
2037	$1,797.51	$1,445.25	$2,039.82	$757.99	$834.77	-$352.26	$242.31
2038	$1,859.43	$1,422.02	$2,017.37	$758.55	$842.89	-$437.41	$157.94
2039	$1,858.05	$1,414.80	$1,998.71	$772.11	$851.47	-$443.24	$140.66
2040	$1,850.41	$1,413.14	$1,983.75	$788.82	$861.09	-$437.27	$133.34
2041	$1,909.36	$1,382.95	$1,958.54	$774.71	$857.37	-$526.41	$49.18
2042	$1,974.00	$1,353.31	$1,936.70	$759.25	$854.50	-$620.69	-$37.30
2043	$1,979.75	$1,382.31	$1,948.15	$800.86	$882.82	-$597.44	-$31.59
2044	$2,013.30	$1,413.87	$1,968.45	$843.70	$918.20	-$599.43	-$44.86
2045	$2,139.79	$1,383.05	$1,957.84	$823.03	$921.17	-$756.74	-$181.95
2046	$1,947.23	$1,397.25	$1,927.89	$846.42	$903.50	-$549.98	-$19.35
2047	$2,209.10	$1,426.60	$1,990.01	$884.12	$976.80	-$782.50	-$219.09
2048	$2,213.13	$1,370.13	$1,941.28	$835.27	$938.26	-$843.00	-$271.85
2049	$2,084.51	$1,384.60	$1,922.44	$856.73	$928.77	-$699.91	-$162.08
2050	$2,077.83	$1,384.26	$1,914.06	$862.82	$928.99	-$693.57	-$163.77
Average	**$1,866.01**	**$1,444.68**	**$2,052.31**	**$751.18**	**$833.04**	**-$421.32**	**$186.30**

Table 16: Early solar + BESS - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,534.97	$2,024.10	$2,641.39	$1,075.66	$1,048.28	-$510.87	$106.43
2027	$2,462.88	$1,990.88	$2,584.94	$1,066.10	$1,033.42	-$472.00	$122.06
2028	$2,509.89	$1,953.20	$2,548.67	$1,052.08	$1,037.25	-$556.69	$38.78
2029	$2,533.81	$1,929.82	$2,518.04	$1,052.37	$1,043.66	-$603.99	-$15.77
2030	$2,179.05	$1,956.53	$2,468.93	$1,102.84	$1,030.45	-$222.52	$289.88
2031	$2,080.85	$1,952.37	$2,436.80	$1,122.49	$1,033.67	-$128.48	$355.95
2032	$2,133.04	$1,941.97	$2,420.71	$1,135.85	$1,052.54	-$191.07	$287.67
2033	$2,144.98	$1,884.73	$2,364.32	$1,102.36	$1,030.97	-$260.25	$219.34
2034	$2,248.16	$1,890.23	$2,376.17	$1,131.63	$1,076.21	-$357.94	$128.01
2035	$2,222.28	$1,912.44	$2,371.69	$1,177.60	$1,104.08	-$309.84	$149.41
2036	$2,348.62	$1,907.43	$2,379.11	$1,196.38	$1,143.04	-$441.19	$30.49
2037	$2,461.72	$1,938.20	$2,410.10	$1,250.94	$1,205.04	-$523.52	-$51.62
2038	$2,545.69	$1,933.66	$2,407.75	$1,270.20	$1,233.27	-$612.02	-$137.94
2039	$2,545.97	$1,925.05	$2,389.15	$1,282.36	$1,241.91	-$620.92	-$156.82
2040	$2,536.62	$1,917.30	$2,370.68	$1,292.98	$1,248.01	-$619.32	-$165.94
2041	$2,607.08	$1,893.10	$2,353.82	$1,284.86	$1,252.66	-$713.97	-$253.25
2042	$2,684.93	$1,870.76	$2,341.10	$1,276.70	$1,258.91	-$814.17	-$343.82
2043	$2,710.12	$1,911.71	$2,365.13	$1,330.25	$1,299.80	-$798.41	-$344.99
2044	$2,775.91	$1,969.68	$2,411.29	$1,399.50	$1,361.04	-$806.24	-$364.62
2045	$2,948.09	$1,976.12	$2,438.16	$1,416.10	$1,401.49	-$971.97	-$509.93
2046	$2,674.40	$1,904.24	$2,324.97	$1,353.40	$1,300.59	-$770.16	-$349.43
2047	$3,084.01	$2,078.52	$2,534.95	$1,536.04	$1,521.74	-$1,005.49	-$549.06
2048	$3,057.72	$1,987.78	$2,453.37	$1,452.92	$1,450.35	-$1,069.94	-$604.35
2049	$2,876.48	$1,946.80	$2,380.84	$1,418.93	$1,387.17	-$929.68	-$495.65
2050	$2,866.16	$1,939.52	$2,367.45	$1,418.08	$1,382.38	-$926.65	-$498.71
Average	**$2,550.94**	**$1,941.44**	**$2,426.38**	**$1,247.94**	**$1,207.12**	**-$609.49**	**-$124.56**

Table 17: Early solar + BESS - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,360.95	$2,011.63	$2,703.96	$1,063.19	$1,110.84	-$349.32	$343.01
2027	$2,293.89	$1,976.94	$2,645.08	$1,052.17	$1,093.56	-$316.95	$351.19
2028	$2,359.67	$1,951.70	$2,618.40	$1,050.59	$1,106.98	-$407.97	$258.73
2029	$2,387.12	$1,927.64	$2,587.41	$1,050.19	$1,113.02	-$459.48	$200.29
2030	$1,970.84	$1,888.20	$2,470.82	$1,034.51	$1,032.35	-$82.65	$499.98
2031	$1,852.12	$1,862.04	$2,413.97	$1,032.16	$1,010.85	$9.92	$561.86
2032	$1,904.77	$1,853.32	$2,397.28	$1,047.21	$1,029.11	-$51.45	$492.51
2033	$1,940.33	$1,818.91	$2,360.91	$1,036.54	$1,027.56	-$121.42	$420.58
2034	$2,037.40	$1,817.68	$2,362.82	$1,059.09	$1,062.86	-$219.71	$325.43
2035	$1,984.83	$1,818.42	$2,335.42	$1,083.58	$1,067.80	-$166.41	$350.59
2036	$2,111.36	$1,816.93	$2,343.99	$1,105.88	$1,107.91	-$294.43	$232.62
2037	$2,199.59	$1,827.57	$2,353.09	$1,140.32	$1,148.04	-$372.02	$153.50
2038	$2,281.10	$1,823.99	$2,349.90	$1,160.52	$1,175.43	-$457.12	$68.80
2039	$2,275.36	$1,812.54	$2,326.62	$1,169.85	$1,179.38	-$462.82	$51.26
2040	$2,259.57	$1,802.95	$2,303.97	$1,178.63	$1,181.30	-$456.62	$44.40
2041	$2,342.46	$1,796.45	$2,302.05	$1,188.20	$1,200.88	-$546.01	-$40.41
2042	$2,432.84	$1,792.45	$2,305.54	$1,198.38	$1,223.34	-$640.39	-$127.30
2043	$2,429.22	$1,812.03	$2,306.37	$1,230.58	$1,241.04	-$617.19	-$122.85
2044	$2,462.58	$1,842.63	$2,324.36	$1,272.45	$1,274.12	-$619.96	-$138.22
2045	$2,637.40	$1,859.38	$2,360.82	$1,299.36	$1,324.15	-$778.02	-$276.58
2046	$2,377.58	$1,806.41	$2,264.72	$1,255.57	$1,240.33	-$571.17	-$112.86
2047	$2,709.86	$1,906.82	$2,398.51	$1,364.33	$1,385.29	-$803.04	-$311.35
2048	$2,729.70	$1,867.14	$2,366.96	$1,332.28	$1,363.94	-$862.56	-$362.74
2049	$2,554.77	$1,835.63	$2,302.55	$1,307.76	$1,308.88	-$719.14	-$252.23
2050	$2,545.29	$1,832.31	$2,291.87	$1,310.87	$1,306.80	-$712.98	-$253.42
Average	**$2,297.62**	**$1,854.47**	**$2,391.90**	**$1,160.97**	**$1,172.63**	**-$443.16**	**$94.27**

Table 18: Early solar + BESS - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$3,942.24	$3,431.24	$3,968.34	$2,482.80	$2,375.23	-$511.00	$26.10
2027	$3,866.43	$3,394.31	$3,914.56	$2,469.54	$2,363.04	-$472.12	$48.12
2028	$3,971.81	$3,415.00	$3,941.90	$2,513.89	$2,430.48	-$556.81	-$29.91
2029	$4,025.86	$3,421.85	$3,949.04	$2,544.40	$2,474.66	-$604.01	-$76.82
2030	$3,451.69	$3,229.16	$3,686.91	$2,375.47	$2,248.43	-$222.53	$235.22
2031	$3,297.38	$3,168.86	$3,601.46	$2,338.98	$2,198.34	-$128.52	$304.09
2032	$3,387.97	$3,196.86	$3,624.52	$2,390.74	$2,256.35	-$191.11	$236.55
2033	$3,430.98	$3,170.69	$3,600.52	$2,388.32	$2,267.17	-$260.28	$169.54
2034	$3,579.44	$3,221.47	$3,659.86	$2,462.88	$2,359.91	-$357.97	$80.42
2035	$3,535.91	$3,226.04	$3,638.84	$2,491.20	$2,371.23	-$309.87	$102.93
2036	$3,738.45	$3,297.23	$3,725.10	$2,586.17	$2,489.03	-$441.22	-$13.34
2037	$3,894.69	$3,371.09	$3,801.70	$2,683.84	$2,596.65	-$523.60	-$92.99
2038	$4,029.15	$3,417.06	$3,851.51	$2,753.59	$2,677.03	-$612.09	-$177.64
2039	$4,033.16	$3,412.17	$3,838.17	$2,769.48	$2,690.93	-$620.99	-$194.99
2040	$4,023.63	$3,404.25	$3,820.77	$2,779.93	$2,698.10	-$619.38	-$202.86
2041	$4,156.44	$3,442.40	$3,866.48	$2,834.15	$2,765.31	-$714.04	-$289.96
2042	$4,303.44	$3,489.21	$3,922.98	$2,895.15	$2,840.78	-$814.23	-$380.46
2043	$4,335.41	$3,536.94	$3,954.30	$2,955.48	$2,888.96	-$798.47	-$381.11
2044	$4,425.23	$3,618.94	$4,025.04	$3,048.77	$2,974.80	-$806.29	-$400.19
2045	$4,707.52	$3,735.50	$4,162.53	$3,175.48	$3,125.86	-$972.02	-$544.99
2046	$4,326.22	$3,556.00	$3,942.21	$3,005.17	$2,917.83	-$770.22	-$384.01
2047	$4,871.98	$3,866.44	$4,288.71	$3,323.96	$3,275.50	-$1,005.53	-$583.26
2048	$4,888.19	$3,818.21	$4,250.83	$3,283.35	$3,247.81	-$1,069.98	-$637.35
2049	$4,628.64	$3,698.92	$4,100.69	$3,171.05	$3,107.02	-$929.72	-$527.94
2050	$4,619.34	$3,692.66	$4,088.63	$3,171.22	$3,103.56	-$926.68	-$530.71
Average	**$4,058.85**	**$3,449.30**	**$3,889.02**	**$2,755.80**	**$2,669.76**	**-$609.55**	**-$169.82**

Table 19: Early electrification, solar + BESS - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,866.18	$1,547.30	$2,313.59	$598.86	$720.48	-$318.88	$447.41
2027	$1,820.69	$1,531.90	$2,271.92	$607.12	$720.40	-$288.80	$451.22
2028	$1,868.08	$1,486.36	$2,223.36	$585.25	$711.94	-$381.71	$355.28
2029	$1,889.46	$1,453.72	$2,183.01	$576.27	$708.62	-$435.74	$293.55
2030	$1,618.07	$1,555.93	$2,203.71	$702.24	$765.24	-$62.14	$585.64
2031	$1,541.11	$1,569.23	$2,185.52	$739.35	$782.39	$28.12	$644.41
2032	$1,640.16	$1,601.99	$2,201.34	$795.88	$833.17	-$38.17	$561.18
2033	$1,689.92	$1,578.47	$2,169.77	$796.09	$836.42	-$111.45	$479.86
2034	$1,771.44	$1,560.26	$2,151.60	$801.67	$851.64	-$211.17	$380.16
2035	$1,738.83	$1,580.86	$2,144.32	$846.03	$876.71	-$157.97	$405.49
2036	$1,832.05	$1,545.20	$2,117.33	$834.15	$881.25	-$286.85	$285.28
2037	$1,901.34	$1,536.16	$2,106.52	$848.91	$901.46	-$365.18	$205.18
2038	$1,962.14	$1,510.86	$2,081.09	$847.39	$906.61	-$451.28	$118.95
2039	$1,959.90	$1,501.12	$2,059.37	$858.43	$912.13	-$458.78	$99.48
2040	$1,950.67	$1,496.15	$2,041.44	$871.83	$918.77	-$454.53	$90.77
2041	$1,997.99	$1,454.08	$2,005.00	$845.83	$903.83	-$543.92	$7.01
2042	$2,050.93	$1,412.31	$1,972.09	$818.25	$889.89	-$638.63	-$78.84
2043	$2,044.48	$1,429.06	$1,972.47	$847.61	$907.13	-$615.41	-$72.01
2044	$2,066.75	$1,449.19	$1,981.79	$879.02	$931.54	-$617.56	-$84.96
2045	$2,181.41	$1,406.98	$1,960.40	$846.96	$923.73	-$774.42	-$221.01
2046	$1,983.49	$1,416.40	$1,925.02	$865.56	$900.63	-$567.09	-$58.47
2047	$2,240.79	$1,441.83	$1,981.84	$899.34	$968.62	-$798.96	-$258.95
2048	$2,239.29	$1,381.11	$1,927.82	$846.25	$924.80	-$858.18	-$311.47
2049	$2,105.82	$1,391.54	$1,903.65	$863.67	$909.98	-$714.28	-$202.17
2050	$2,094.40	$1,386.88	$1,889.92	$865.43	$904.85	-$707.53	-$204.49
Average	**$1,922.22**	**$1,489.00**	**$2,078.96**	**$795.50**	**$859.69**	**-$433.22**	**$156.74**

Table 20: Early electrification, solar + BESS - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,534.97	$2,024.10	$2,641.39	$1,075.66	$1,048.28	-$510.87	$106.43
2027	$2,455.89	$1,987.34	$2,584.21	$1,062.57	$1,032.70	-$468.54	$128.32
2028	$2,501.59	$1,949.90	$2,547.23	$1,048.78	$1,035.81	-$551.69	$45.64
2029	$2,523.37	$1,924.27	$2,517.15	$1,046.82	$1,042.76	-$599.10	-$6.22
2030	$2,191.43	$1,967.17	$2,480.89	$1,113.48	$1,042.41	-$224.26	$289.45
2031	$2,092.47	$1,962.08	$2,451.62	$1,132.20	$1,048.49	-$130.39	$359.15
2032	$2,231.74	$2,015.93	$2,480.90	$1,209.81	$1,112.73	-$215.82	$249.16
2033	$2,286.96	$1,988.16	$2,444.89	$1,205.78	$1,111.54	-$298.81	$157.93
2034	$2,403.72	$1,999.83	$2,460.26	$1,241.24	$1,160.30	-$403.89	$56.54
2035	$2,372.19	$2,014.99	$2,452.25	$1,280.15	$1,184.64	-$357.19	$80.07
2036	$2,495.34	$2,004.89	$2,458.04	$1,293.83	$1,221.96	-$490.45	-$37.30
2037	$2,607.65	$2,032.05	$2,487.42	$1,344.80	$1,282.37	-$575.59	-$120.23
2038	$2,694.15	$2,025.82	$2,484.08	$1,362.35	$1,309.60	-$668.33	-$210.07
2039	$2,695.34	$2,014.82	$2,464.58	$1,372.13	$1,317.34	-$680.51	-$230.76
2040	$2,685.45	$2,004.50	$2,445.10	$1,380.18	$1,322.44	-$680.94	-$240.34
2041	$2,741.18	$1,967.07	$2,418.59	$1,358.83	$1,317.43	-$774.10	-$322.58
2042	$2,801.46	$1,930.55	$2,395.92	$1,336.49	$1,313.72	-$870.91	-$405.54
2043	$2,808.06	$1,956.66	$2,409.97	$1,375.21	$1,344.64	-$851.40	-$398.09
2044	$2,856.38	$2,000.29	$2,446.14	$1,430.12	$1,395.89	-$856.09	-$410.24
2045	$3,008.86	$1,992.07	$2,462.71	$1,432.05	$1,426.04	-$1,016.79	-$546.15
2046	$2,726.40	$1,913.80	$2,344.58	$1,362.96	$1,320.20	-$812.61	-$381.82
2047	$3,130.24	$2,083.32	$2,549.64	$1,540.83	$1,536.42	-$1,046.92	-$580.60
2048	$3,098.40	$1,986.97	$2,463.85	$1,452.11	$1,460.84	-$1,111.42	-$634.54
2049	$2,910.83	$1,940.74	$2,387.21	$1,412.87	$1,393.54	-$970.09	-$523.62
2050	$2,893.19	$1,927.85	$2,369.45	$1,406.41	$1,384.38	-$965.34	-$523.74
Average	**$2,629.89**	**$1,984.61**	**$2,465.92**	**$1,291.11**	**$1,246.66**	**-$645.28**	**-$163.97**

Table 21: Early electrification, solar + BESS - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,360.95	$2,011.63	$2,703.96	$1,063.19	$1,110.84	-$349.32	$343.01
2027	$2,292.17	$1,974.92	$2,644.25	$1,050.15	$1,092.73	-$317.25	$352.08
2028	$2,356.71	$1,948.33	$2,616.81	$1,047.22	$1,105.39	-$408.38	$260.11
2029	$2,383.43	$1,923.97	$2,584.94	$1,046.51	$1,110.56	-$459.47	$201.51
2030	$1,985.11	$1,901.13	$2,479.71	$1,047.43	$1,041.24	-$83.99	$494.60
2031	$1,868.15	$1,876.23	$2,425.03	$1,046.35	$1,021.90	$8.08	$556.88
2032	$1,986.76	$1,926.90	$2,452.49	$1,120.79	$1,084.32	-$59.85	$465.74
2033	$2,054.35	$1,920.83	$2,436.10	$1,138.46	$1,102.75	-$133.51	$381.76
2034	$2,158.87	$1,926.37	$2,441.69	$1,167.77	$1,141.73	-$232.51	$282.82
2035	$2,101.88	$1,922.78	$2,410.71	$1,187.94	$1,143.10	-$179.10	$308.83
2036	$2,227.29	$1,919.71	$2,417.85	$1,208.66	$1,181.78	-$307.58	$190.56
2037	$2,314.43	$1,928.71	$2,425.14	$1,241.46	$1,220.08	-$385.73	$110.70
2038	$2,396.25	$1,923.83	$2,421.13	$1,260.37	$1,246.65	-$472.41	$24.88
2039	$2,390.38	$1,910.77	$2,396.70	$1,268.08	$1,249.46	-$479.61	$6.32
2040	$2,372.85	$1,899.05	$2,373.36	$1,274.73	$1,250.69	-$473.80	$0.51
2041	$2,443.64	$1,880.68	$2,362.96	$1,272.43	$1,261.79	-$562.97	-$80.68
2042	$2,520.49	$1,864.32	$2,358.15	$1,270.25	$1,275.95	-$656.17	-$162.34
2043	$2,504.20	$1,872.87	$2,352.80	$1,291.42	$1,287.46	-$631.32	-$151.40
2044	$2,527.17	$1,894.52	$2,365.47	$1,324.35	$1,315.22	-$632.65	-$161.70
2045	$2,692.19	$1,903.55	$2,396.95	$1,343.53	$1,360.28	-$788.64	-$295.24
2046	$2,432.31	$1,851.83	$2,302.07	$1,301.00	$1,277.69	-$580.48	-$130.23
2047	$2,768.19	$1,956.10	$2,437.52	$1,413.61	$1,424.31	-$812.10	-$330.67
2048	$2,793.22	$1,921.96	$2,409.70	$1,387.11	$1,406.68	-$871.26	-$383.52
2049	$2,620.69	$1,893.47	$2,347.65	$1,365.60	$1,353.98	-$727.23	-$273.05
2050	$2,613.71	$1,893.66	$2,340.71	$1,372.22	$1,355.64	-$720.05	-$273.01
Average	**$2,366.62**	**$1,913.92**	**$2,436.15**	**$1,220.42**	**$1,216.89**	**-$452.69**	**$69.54**

Table 22: Early electrification, solar + BESS - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$3,942.24	$3,431.24	$3,968.34	$2,482.80	$2,375.23	-$511.00	$26.10
2027	$3,871.30	$3,402.64	$3,929.34	$2,477.87	$2,377.82	-$468.66	$58.04
2028	$3,980.29	$3,428.58	$3,965.42	$2,527.46	$2,454.00	-$551.71	-$14.87
2029	$4,031.87	$3,432.73	$3,973.01	$2,555.28	$2,498.62	-$599.13	-$58.86
2030	$3,501.54	$3,277.24	$3,740.27	$2,423.55	$2,301.80	-$224.30	$238.73
2031	$3,337.41	$3,206.99	$3,649.49	$2,377.11	$2,246.36	-$130.42	$312.08
2032	$3,594.71	$3,378.86	$3,795.68	$2,572.75	$2,427.51	-$215.85	$200.97
2033	$3,721.02	$3,422.13	$3,833.57	$2,639.75	$2,500.21	-$298.90	$112.54
2034	$3,899.00	$3,495.04	$3,913.63	$2,736.45	$2,613.67	-$403.96	$14.63
2035	$3,844.69	$3,487.43	$3,885.10	$2,752.59	$2,617.48	-$357.26	$40.40
2036	$4,041.08	$3,550.56	$3,965.15	$2,839.51	$2,729.07	-$490.52	-$75.93
2037	$4,201.55	$3,625.90	$4,044.58	$2,938.65	$2,839.53	-$575.65	-$156.97
2038	$4,343.68	$3,675.29	$4,098.57	$3,011.83	$2,924.09	-$668.38	-$245.11
2039	$4,349.84	$3,669.28	$4,085.14	$3,026.59	$2,937.91	-$680.56	-$264.69
2040	$4,340.08	$3,659.10	$4,067.32	$3,034.78	$2,944.66	-$680.98	-$272.76
2041	$4,445.49	$3,671.35	$4,090.94	$3,063.11	$2,989.77	-$774.14	-$354.55
2042	$4,553.89	$3,682.95	$4,117.33	$3,088.89	$3,035.13	-$870.95	-$436.57
2043	$4,543.23	$3,691.79	$4,115.93	$3,110.33	$3,050.60	-$851.44	-$427.29
2044	$4,592.52	$3,736.40	$4,154.61	$3,166.23	$3,104.36	-$856.12	-$437.91
2045	$4,833.00	$3,816.17	$4,260.08	$3,256.15	$3,223.41	-$1,016.84	-$572.93
2046	$4,434.45	$3,621.80	$4,025.67	$3,070.97	$3,001.29	-$812.65	-$408.78
2047	$4,970.54	$3,923.60	$4,363.15	$3,381.12	$3,349.94	-$1,046.93	-$607.38
2048	$4,979.61	$3,868.17	$4,318.29	$3,333.32	$3,315.28	-$1,111.43	-$661.31
2049	$4,704.41	$3,734.31	$4,154.01	$3,206.44	$3,160.34	-$970.10	-$550.40
2050	$4,677.54	$3,712.19	$4,127.04	$3,190.75	$3,141.97	-$965.35	-$550.50
Average	**$4,229.40**	**$3,584.07**	**$4,025.67**	**$2,890.57**	**$2,806.40**	**-$645.33**	**-$203.73**

Table 23: Early electrification, accelerated solar + BESS - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,939.92	$1,549.53	$2,327.56	$601.09	$734.45	-$390.39	$387.65
2027	$1,782.94	$1,530.61	$2,264.25	$605.83	$712.73	-$252.34	$481.31
2028	$1,830.88	$1,487.27	$2,217.95	$586.16	$706.53	-$343.61	$387.07
2029	$1,825.68	$1,461.76	$2,178.82	$584.31	$704.44	-$363.92	$353.14
2030	$1,570.83	$1,542.87	$2,185.29	$689.18	$746.82	-$27.97	$614.46
2031	$1,924.79	$1,507.67	$2,201.90	$677.78	$798.78	-$417.12	$277.12
2032	$1,630.82	$1,636.74	$2,227.53	$830.62	$859.35	$5.92	$596.71
2033	$1,386.19	$1,677.64	$2,196.22	$895.27	$862.86	$291.45	$810.03
2034	$1,207.75	$1,682.29	$2,150.71	$923.70	$850.75	$474.55	$942.97
2035	$1,133.49	$1,679.03	$2,117.78	$944.19	$850.16	$545.54	$984.29
2036	$1,153.19	$1,661.53	$2,091.91	$950.47	$855.84	$508.33	$938.72
2037	$1,339.93	$1,628.27	$2,081.16	$941.02	$876.11	$288.34	$741.23
2038	$1,457.05	$1,596.37	$2,062.31	$932.90	$887.84	$139.33	$605.27
2039	$1,534.14	$1,579.12	$2,048.43	$936.42	$901.20	$44.97	$514.29
2040	$1,593.88	$1,565.68	$2,034.66	$941.36	$911.99	-$28.20	$440.78
2041	$1,611.18	$1,539.52	$2,004.67	$931.27	$903.51	-$71.66	$393.49
2042	$1,802.02	$1,503.99	$1,999.35	$909.93	$917.15	-$298.03	$197.33
2043	$1,926.43	$1,477.99	$1,989.21	$896.54	$923.88	-$448.43	$62.79
2044	$1,929.48	$1,484.90	$1,984.66	$914.73	$934.41	-$444.58	$55.18
2045	$1,988.20	$1,457.72	$1,963.98	$897.70	$927.31	-$530.48	-$24.22
2046	$1,943.28	$1,431.38	$1,929.13	$880.54	$904.75	-$511.90	-$14.15
2047	$2,125.66	$1,449.69	$1,967.62	$907.20	$954.41	-$675.97	-$158.03
2048	$2,051.30	$1,420.52	$1,921.12	$885.66	$918.10	-$630.78	-$130.18
2049	$2,028.78	$1,404.01	$1,897.86	$876.14	$904.19	-$624.77	-$130.92
2050	$2,195.19	$1,362.24	$1,888.00	$840.80	$902.93	-$832.95	-$307.19
Average	**$1,716.52**	**$1,532.73**	**$2,077.28**	**$839.23**	**$858.02**	**-$183.79**	**$360.76**

Table 24: Early electrification, accelerated solar + BESS - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,644.28	$2,061.90	$2,690.95	$1,113.47	$1,097.83	-$582.38	$46.67
2027	$2,397.78	$1,966.52	$2,557.59	$1,041.75	$1,006.07	-$431.26	$159.81
2028	$2,446.18	$1,934.14	$2,525.60	$1,033.03	$1,014.18	-$512.04	$79.42
2029	$2,433.50	$1,907.28	$2,489.01	$1,029.83	$1,014.62	-$526.22	$55.51
2030	$2,110.52	$1,922.17	$2,433.08	$1,068.48	$994.61	-$188.35	$322.56
2031	$2,617.70	$2,042.48	$2,613.10	$1,212.60	$1,209.97	-$575.22	-$4.60
2032	$2,238.80	$2,066.51	$2,526.45	$1,260.40	$1,158.28	-$172.29	$287.65
2033	$1,901.78	$2,004.39	$2,391.60	$1,222.02	$1,058.24	$102.61	$489.81
2034	$1,645.39	$1,926.04	$2,268.00	$1,167.45	$968.04	$280.66	$622.61
2035	$1,537.52	$1,882.61	$2,201.23	$1,147.77	$933.61	$345.09	$663.71
2036	$1,566.22	$1,868.10	$2,184.62	$1,157.04	$948.54	$301.88	$618.39
2037	$1,838.03	$1,911.08	$2,253.19	$1,223.83	$1,048.13	$73.05	$415.16
2038	$2,005.80	$1,925.47	$2,284.72	$1,262.00	$1,110.25	-$80.33	$278.93
2039	$2,121.11	$1,942.26	$2,307.93	$1,299.57	$1,160.69	-$178.85	$186.82
2040	$2,206.53	$1,949.12	$2,319.57	$1,324.80	$1,196.91	-$257.41	$113.04
2041	$2,223.58	$1,920.81	$2,293.44	$1,312.56	$1,192.28	-$302.77	$69.87
2042	$2,492.91	$1,960.88	$2,368.47	$1,366.82	$1,286.27	-$532.03	-$124.45
2043	$2,669.15	$1,982.27	$2,410.14	$1,400.81	$1,344.80	-$686.89	-$259.02
2044	$2,681.77	$1,994.91	$2,414.72	$1,424.73	$1,364.47	-$686.86	-$267.05
2045	$2,760.01	$1,982.71	$2,413.26	$1,422.69	$1,376.59	-$777.30	-$346.76
2046	$2,687.57	$1,924.84	$2,351.36	$1,374.00	$1,326.97	-$762.73	-$336.21
2047	$2,977.45	$2,048.19	$2,499.56	$1,505.71	$1,486.35	-$929.25	-$477.88
2048	$2,846.09	$1,958.69	$2,398.19	$1,423.83	$1,395.17	-$887.40	-$447.90
2049	$2,809.27	$1,926.50	$2,363.40	$1,398.63	$1,369.73	-$882.76	-$445.86
2050	$3,037.47	$1,944.16	$2,416.48	$1,422.72	$1,431.41	-$1,093.31	-$620.99
Average	**$2,355.86**	**$1,958.16**	**$2,399.03**	**$1,264.66**	**$1,179.76**	**-$397.69**	**$43.17**

Table 25: Early electrification, accelerated solar + BESS - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,457.09	$2,036.27	$2,740.34	$1,087.83	$1,147.23	-$420.82	$283.25
2027	$2,242.62	$1,961.94	$2,625.12	$1,037.17	$1,073.60	-$280.68	$382.50
2028	$2,306.63	$1,936.91	$2,599.34	$1,035.79	$1,087.92	-$369.73	$292.71
2029	$2,296.48	$1,909.41	$2,558.03	$1,031.96	$1,083.65	-$387.07	$261.55
2030	$1,925.32	$1,876.38	$2,450.29	$1,022.69	$1,011.82	-$48.94	$524.97
2031	$2,389.68	$1,952.95	$2,580.31	$1,123.06	$1,177.18	-$436.73	$190.63
2032	$1,962.03	$1,946.75	$2,464.74	$1,140.64	$1,096.57	-$15.28	$502.71
2033	$1,623.54	$1,893.50	$2,336.63	$1,111.13	$1,003.28	$269.97	$713.09
2034	$1,379.38	$1,832.96	$2,226.47	$1,074.37	$926.51	$453.58	$847.09
2035	$1,274.80	$1,799.60	$2,164.51	$1,064.76	$896.90	$524.80	$889.72
2036	$1,299.28	$1,787.21	$2,144.46	$1,076.16	$908.38	$487.94	$845.18
2037	$1,548.60	$1,816.12	$2,196.81	$1,128.87	$991.75	$267.53	$648.21
2038	$1,705.05	$1,824.04	$2,218.90	$1,160.58	$1,044.42	$118.99	$513.84
2039	$1,805.15	$1,830.91	$2,229.74	$1,188.22	$1,082.50	$25.76	$424.59
2040	$1,881.53	$1,834.77	$2,235.75	$1,210.45	$1,113.08	-$46.76	$354.22
2041	$1,907.02	$1,818.34	$2,218.62	$1,210.10	$1,117.46	-$88.68	$311.61
2042	$2,165.89	$1,852.22	$2,285.70	$1,258.16	$1,203.50	-$313.67	$119.81
2043	$2,337.71	$1,874.78	$2,326.81	$1,293.33	$1,261.48	-$462.93	-$10.90
2044	$2,342.12	$1,883.82	$2,324.61	$1,313.65	$1,274.36	-$458.30	-$17.51
2045	$2,433.00	$1,889.39	$2,336.95	$1,329.37	$1,300.28	-$543.61	-$96.06
2046	$2,389.47	$1,864.56	$2,303.53	$1,313.72	$1,279.15	-$524.91	-$85.93
2047	$2,630.29	$1,941.27	$2,400.83	$1,398.78	$1,387.62	-$689.03	-$229.46
2048	$2,548.42	$1,905.04	$2,349.98	$1,370.18	$1,346.96	-$643.38	-$198.45
2049	$2,532.04	$1,895.51	$2,335.36	$1,367.64	$1,341.69	-$636.53	-$196.68
2050	$2,775.11	$1,930.07	$2,402.85	$1,408.63	$1,417.78	-$845.05	-$372.26
Average	**$2,086.33**	**$1,883.79**	**$2,362.27**	**$1,190.29**	**$1,143.00**	**-$202.54**	**$275.94**

Table 26: Early electrification, accelerated solar + BESS - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$4,091.66	$3,509.16	$4,058.00	$2,560.72	$2,464.89	-$582.51	-$33.66
2027	$3,795.01	$3,363.64	$3,885.28	$2,438.87	$2,333.76	-$431.37	$90.27
2028	$3,905.62	$3,393.56	$3,926.29	$2,492.45	$2,414.87	-$512.06	$20.67
2029	$3,904.39	$3,378.14	$3,907.95	$2,500.68	$2,433.56	-$526.26	$3.55
2030	$3,399.87	$3,211.48	$3,672.99	$2,357.79	$2,234.52	-$188.39	$273.12
2031	$4,112.85	$3,537.60	$4,062.66	$2,707.72	$2,659.54	-$575.25	-$50.19
2032	$3,575.92	$3,403.61	$3,818.32	$2,597.49	$2,450.15	-$172.32	$242.40
2033	$3,110.26	$3,212.80	$3,557.26	$2,430.42	$2,223.90	$102.54	$447.00
2034	$2,751.34	$3,031.92	$3,334.25	$2,273.33	$2,034.29	$280.59	$582.91
2035	$2,608.71	$2,953.74	$3,234.23	$2,218.90	$1,966.62	$345.02	$625.52
2036	$2,668.56	$2,970.38	$3,249.88	$2,259.32	$2,013.81	$301.82	$581.32
2037	$3,068.97	$3,141.96	$3,449.28	$2,454.71	$2,244.22	$72.99	$380.31
2038	$3,323.17	$3,242.80	$3,568.51	$2,579.33	$2,394.03	-$80.37	$245.34
2039	$3,489.94	$3,311.06	$3,644.90	$2,668.36	$2,497.66	-$178.88	$154.96
2040	$3,619.51	$3,362.06	$3,701.26	$2,737.74	$2,578.60	-$257.45	$81.76
2041	$3,654.05	$3,351.24	$3,693.53	$2,743.00	$2,592.36	-$302.80	$39.48
2042	$4,047.55	$3,515.48	$3,894.54	$2,921.42	$2,812.34	-$532.06	-$153.01
2043	$4,308.77	$3,621.84	$4,022.89	$3,040.39	$2,957.56	-$686.93	-$285.88
2044	$4,321.91	$3,635.00	$4,028.08	$3,064.83	$2,977.84	-$686.91	-$293.82
2045	$4,450.85	$3,673.54	$4,077.35	$3,113.52	$3,040.68	-$777.31	-$373.50
2046	$4,371.85	$3,609.11	$4,009.14	$3,058.28	$2,984.76	-$762.74	-$362.71
2047	$4,753.89	$3,824.62	$4,249.22	$3,282.14	$3,236.01	-$929.26	-$504.66
2048	$4,595.50	$3,708.09	$4,120.79	$3,173.23	$3,117.78	-$887.41	-$474.70
2049	$4,548.00	$3,665.22	$4,075.69	$3,137.35	$3,082.02	-$882.77	-$472.31
2050	$4,891.80	$3,798.49	$4,244.80	$3,277.04	$3,259.73	-$1,093.32	-$647.00
Average	**$3,814.80**	**$3,417.06**	**$3,819.48**	**$2,723.56**	**$2,600.22**	**-$397.74**	**$4.69**

Table 27: Herded electrification, late solar + BESS - effect of solar + BESS on all-electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$1,880.96	$1,532.51	$2,379.35	$584.08	$786.24	-$348.45	$498.39
2027	$1,855.02	$1,551.68	$2,366.99	$626.90	$815.47	-$303.34	$511.97
2028	$1,946.54	$1,584.42	$2,387.80	$683.31	$876.38	-$362.11	$441.27
2029	$2,221.49	$1,781.70	$2,571.92	$904.25	$1,097.54	-$439.79	$350.43
2030	$2,560.70	$2,140.00	$2,897.40	$1,286.31	$1,458.93	-$420.70	$336.70
2031	$3,165.84	$2,602.26	$3,350.16	$1,772.37	$1,947.03	-$563.59	$184.31
2032	$3,978.81	$3,285.36	$4,013.26	$2,479.25	$2,645.08	-$693.45	$34.44
2033	$4,894.04	$4,070.78	$4,775.82	$3,288.41	$3,442.47	-$823.26	-$118.22
2034	$5,240.50	$4,380.17	$5,065.49	$3,621.57	$3,765.53	-$860.34	-$175.01
2035	$5,438.48	$4,559.56	$5,227.06	$3,824.72	$3,959.45	-$878.92	-$211.42
2036	$5,508.67	$4,541.30	$5,211.14	$3,830.25	$3,975.07	-$967.37	-$297.53
2037	$5,514.45	$4,535.75	$5,195.92	$3,848.50	$3,990.87	-$978.70	-$318.53
2038	$5,340.40	$4,520.46	$5,142.50	$3,856.99	$3,968.03	-$819.95	-$197.90
2039	$5,336.47	$4,552.80	$5,157.49	$3,910.11	$4,010.25	-$783.67	-$178.98
2040	$5,318.86	$4,534.95	$5,128.99	$3,910.63	$4,006.33	-$783.91	-$189.87
2041	$5,347.18	$4,498.28	$5,096.38	$3,890.04	$3,995.21	-$848.89	-$250.80
2042	$5,400.94	$4,466.52	$5,071.43	$3,872.46	$3,989.24	-$934.42	-$329.51
2043	$5,373.87	$4,465.71	$5,058.18	$3,884.25	$3,992.85	-$908.16	-$315.68
2044	$5,454.71	$4,472.73	$5,072.03	$3,902.56	$4,021.78	-$981.98	-$382.68
2045	$5,542.23	$4,417.89	$5,036.90	$3,857.87	$4,000.23	-$1,124.34	-$505.33
2046	$5,534.80	$4,397.18	$5,013.61	$3,846.35	$3,989.23	-$1,137.62	-$521.19
2047	$5,566.81	$4,417.77	$5,030.54	$3,875.28	$4,017.33	-$1,149.04	-$536.27
2048	$5,585.07	$4,398.68	$5,012.23	$3,863.82	$4,009.21	-$1,186.38	-$572.84
2049	$5,558.96	$4,381.69	$4,991.77	$3,853.82	$3,998.10	-$1,177.28	-$567.19
2050	$5,625.01	$4,361.00	$4,981.33	$3,839.56	$3,996.26	-$1,264.01	-$643.68
Average	**$4,607.63**	**$3,778.05**	**$4,449.43**	**$3,084.55**	**$3,230.16**	**-$829.59**	**-$158.20**

Table 28: Herded electrification, late solar + BESS - effect of solar + BESS on all day electric house

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,212.84	$1,864.39	$2,711.23	$915.95	$1,118.12	-$348.45	$498.39
2027	$2,164.80	$1,861.46	$2,676.77	$936.69	$1,125.25	-$303.34	$511.97
2028	$2,263.62	$1,901.51	$2,704.89	$1,000.40	$1,193.47	-$362.11	$441.27
2029	$2,531.05	$2,091.27	$2,881.48	$1,213.82	$1,407.10	-$439.79	$350.43
2030	$2,866.40	$2,445.70	$3,203.10	$1,592.01	$1,764.62	-$420.70	$336.70
2031	$3,506.30	$2,942.72	$3,690.62	$2,112.84	$2,287.49	-$563.59	$184.31
2032	$4,340.64	$3,647.18	$4,375.08	$2,841.07	$3,006.91	-$693.45	$34.44
2033	$5,256.78	$4,433.52	$5,138.56	$3,651.15	$3,805.21	-$823.26	-$118.22
2034	$5,618.30	$4,757.96	$5,443.29	$3,999.37	$4,143.33	-$860.34	-$175.01
2035	$5,823.19	$4,944.26	$5,611.77	$4,209.42	$4,344.15	-$878.92	-$211.42
2036	$5,919.32	$4,951.95	$5,621.79	$4,240.89	$4,385.72	-$967.37	-$297.53
2037	$5,948.47	$4,969.77	$5,629.95	$4,282.52	$4,424.89	-$978.70	-$318.53
2038	$5,696.96	$4,877.01	$5,499.06	$4,213.54	$4,324.58	-$819.95	-$197.90
2039	$5,721.50	$4,937.83	$5,542.51	$4,295.13	$4,395.28	-$783.67	-$178.98
2040	$5,680.51	$4,896.60	$5,490.64	$4,272.28	$4,367.97	-$783.91	-$189.87
2041	$5,725.24	$4,876.35	$5,474.44	$4,268.10	$4,373.27	-$848.89	-$250.80
2042	$5,793.09	$4,858.67	$5,463.58	$4,264.60	$4,381.38	-$934.42	-$329.51
2043	$5,757.22	$4,849.07	$5,441.54	$4,267.61	$4,376.21	-$908.16	-$315.68
2044	$5,877.91	$4,895.93	$5,495.23	$4,325.76	$4,444.98	-$981.98	-$382.68
2045	$5,990.39	$4,866.05	$5,485.06	$4,306.03	$4,448.39	-$1,124.34	-$505.33
2046	$5,970.38	$4,832.76	$5,449.19	$4,281.93	$4,424.81	-$1,137.62	-$521.19
2047	$6,036.38	$4,887.34	$5,500.11	$4,344.85	$4,486.89	-$1,149.04	-$536.27
2048	$6,039.72	$4,853.34	$5,466.88	$4,318.48	$4,463.86	-$1,186.38	-$572.84
2049	$6,008.99	$4,831.71	$5,441.79	$4,303.84	$4,448.12	-$1,177.28	-$567.19
2050	$6,094.25	$4,830.24	$5,450.58	$4,308.80	$4,465.51	-$1,264.01	-$643.68
Average	**$4,993.77**	**$4,164.18**	**$4,835.57**	**$3,470.68**	**$3,616.30**	**-$829.59**	**-$158.20**

Table 29: Herded electrification, late solar + BESS - effect of solar + BESS on electric house with one EV

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,277.18	$1,928.73	$2,775.56	$980.29	$1,182.45	-$348.45	$498.39
2027	$2,227.60	$1,924.26	$2,739.57	$999.49	$1,188.05	-$303.34	$511.97
2028	$2,329.05	$1,966.94	$2,770.32	$1,065.83	$1,258.90	-$362.11	$441.27
2029	$2,616.01	$2,176.23	$2,966.44	$1,298.78	$1,492.06	-$439.79	$350.43
2030	$2,934.21	$2,513.51	$3,270.90	$1,659.81	$1,832.43	-$420.70	$336.70
2031	$3,566.40	$3,002.81	$3,750.71	$2,172.93	$2,347.58	-$563.59	$184.31
2032	$4,397.50	$3,704.04	$4,431.94	$2,897.93	$3,063.77	-$693.45	$34.44
2033	$5,328.57	$4,505.31	$5,210.35	$3,722.93	$3,876.99	-$823.26	-$118.22
2034	$5,671.68	$4,811.34	$5,496.67	$4,052.75	$4,196.71	-$860.34	-$175.01
2035	$5,863.05	$4,984.12	$5,651.63	$4,249.29	$4,384.01	-$878.92	-$211.42
2036	$5,953.79	$4,986.42	$5,656.26	$4,275.37	$4,420.19	-$967.37	-$297.53
2037	$5,954.45	$4,975.75	$5,635.93	$4,288.50	$4,430.87	-$978.70	-$318.53
2038	$5,723.64	$4,903.69	$5,525.74	$4,240.22	$4,351.26	-$819.95	-$197.90
2039	$5,700.34	$4,916.67	$5,521.36	$4,273.97	$4,374.12	-$783.67	-$178.98
2040	$5,675.78	$4,891.88	$5,485.92	$4,267.56	$4,363.25	-$783.91	-$189.87
2041	$5,721.02	$4,872.13	$5,470.22	$4,263.88	$4,369.05	-$848.89	-$250.80
2042	$5,797.67	$4,863.25	$5,468.16	$4,269.19	$4,385.96	-$934.42	-$329.51
2043	$5,758.19	$4,850.03	$5,442.51	$4,268.58	$4,377.17	-$908.16	-$315.68
2044	$5,859.13	$4,877.16	$5,476.45	$4,306.98	$4,426.20	-$981.98	-$382.68
2045	$5,989.02	$4,864.69	$5,483.69	$4,304.67	$4,447.02	-$1,124.34	-$505.33
2046	$5,982.22	$4,844.60	$5,461.03	$4,293.76	$4,436.64	-$1,137.62	-$521.19
2047	$6,015.69	$4,866.65	$5,479.42	$4,324.16	$4,466.21	-$1,149.04	-$536.27
2048	$6,042.70	$4,856.31	$5,469.85	$4,321.45	$4,466.84	-$1,186.38	-$572.84
2049	$6,012.55	$4,835.27	$5,445.35	$4,307.40	$4,451.68	-$1,177.28	-$567.19
2050	$6,104.04	$4,840.03	$5,460.37	$4,318.59	$4,475.30	-$1,264.01	-$643.68
Average	**$5,020.06**	**$4,190.47**	**$4,861.85**	**$3,496.97**	**$3,642.59**	**-$829.59**	**-$158.20**

Table 30: Herded electrification, late solar + BESS - effect of solar + BESS on all day electric house with two EVs

Time	No solar	With solar (total cost)	With solar + BESS (total cost)	With solar (retail bill)	With solar + BESS (retail bill)	Difference of solar only to no solar	Difference of solar + BESS to no solar
2026	$2,926.02	$2,577.57	$3,424.41	$1,629.14	$1,831.30	-$348.45	$498.39
2027	$2,835.45	$2,532.11	$3,347.42	$1,607.34	$1,795.90	-$303.34	$511.97
2028	$2,952.15	$2,590.04	$3,393.41	$1,688.92	$1,881.99	-$362.11	$441.27
2029	$3,241.19	$2,801.41	$3,591.63	$1,923.96	$2,117.24	-$439.79	$350.43
2030	$3,538.71	$3,118.01	$3,875.41	$2,264.32	$2,436.93	-$420.70	$336.70
2031	$4,227.30	$3,663.72	$4,411.62	$2,833.84	$3,008.49	-$563.59	$184.31
2032	$5,094.27	$4,400.81	$5,128.71	$3,594.70	$3,760.54	-$693.45	$34.44
2033	$6,038.92	$5,215.66	$5,920.70	$4,433.29	$4,587.35	-$823.26	-$118.22
2034	$6,394.42	$5,534.09	$6,219.41	$4,775.49	$4,919.45	-$860.34	-$175.01
2035	$6,587.41	$5,708.48	$6,375.99	$4,973.64	$5,108.37	-$878.92	-$211.42
2036	$6,720.54	$5,753.17	$6,423.01	$5,042.11	$5,186.93	-$967.37	-$297.53
2037	$6,740.48	$5,761.78	$6,421.95	$5,074.53	$5,216.90	-$978.70	-$318.53
2038	$6,386.78	$5,566.84	$6,188.89	$4,903.37	$5,014.41	-$819.95	-$197.90
2039	$6,376.45	$5,592.78	$6,197.47	$4,950.09	$5,050.23	-$783.67	-$178.98
2040	$6,322.97	$5,539.06	$6,133.10	$4,914.74	$5,010.43	-$783.91	-$189.87
2041	$6,398.16	$5,549.27	$6,147.36	$4,941.02	$5,046.20	-$848.89	-$250.80
2042	$6,507.19	$5,572.77	$6,177.68	$4,978.71	$5,095.48	-$934.42	-$329.51
2043	$6,449.01	$5,540.85	$6,133.32	$4,959.39	$5,067.99	-$908.16	-$315.68
2044	$6,605.87	$5,623.89	$6,223.19	$5,053.72	$5,172.94	-$981.98	-$382.68
2045	$6,794.61	$5,670.28	$6,289.28	$5,110.26	$5,252.61	-$1,124.34	-$505.33
2046	$6,775.72	$5,638.11	$6,254.53	$5,087.27	$5,230.15	-$1,137.62	-$521.19
2047	$6,844.36	$5,695.32	$6,308.09	$5,152.83	$5,294.88	-$1,149.04	-$536.27
2048	$6,863.45	$5,677.07	$6,290.61	$5,142.21	$5,287.59	-$1,186.38	-$572.84
2049	$6,825.43	$5,648.16	$6,258.24	$5,120.29	$5,264.57	-$1,177.28	-$567.19
2050	$6,956.51	$5,692.51	$6,312.84	$5,171.07	$5,327.77	-$1,264.01	-$643.68
Average	**$5,736.14**	**$4,906.55**	**$5,577.93**	**$4,213.05**	**$4,358.67**	**-$829.59**	**-$158.20**

About Sapere

Sapere is one of the largest expert consulting firms in Australasia, and a leader in the provision of independent economic, forensic accounting and public policy services. We provide independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

'Sapere' comes from Latin (to be wise) and the phrase 'sapere aude' (dare to be wise). The phrase is associated with German philosopher Immanuel Kant, who promoted the use of reason as a tool of thought; an approach that underpins all Sapere's practice groups.

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