Addendum – A short review of the first phase of the Consumer Energy Bills modelling and potential future developments – May 2026

Introduction

This addendum has been jointly prepared by MBIE and by Rewiring Aotearoa as a comment on the Sapere Energy Consumption Bill Report. Sapere was commissioned by MBIE to develop a flexible model that could examine the effect of rooftop solar on consumer bills. To test the model a report was produced using outputs and assumptions that derived from two earlier exercises modelling the wholesale market and network costs respectively.

When the report exercise was completed we identified that limitations in the output of the wholesale market meant that care is needed in interpreting the report's numeric results. This is because the wholesale market model did not fully capture the potential volatility possible in daily prices which means that in some circumstances the value of solar and batteries to consumers has been underestimated. In addition to this limitation there were other issues with the assumptions and modelling that need further development, therefore the report does not fully reflect the real world effects of solar and batteries on consumer bills. However, even with such limitations, MBIE considers the report provides a useful indication of the potential ways rooftop solar and batteries could affect costs. MBIE's key takeout from this work is that a smart electricity system will be critical as rooftop solar and battery uptake continues.

The addendum discusses these issues and identifies learnings that will be useful to inform future work in this area.

Background

The (Sapere) Energy Consumption Bill Report (the Report) was the final component in a three stage research project:

- The first phase of this study examined the effects of large scale household solar and battery deployment on the electricity wholesale market. This work was undertaken by Jacobs.
- The second phase undertook a detailed examination of low voltage network costs as a result of large scale household solar and battery deployment. This work was carried out by ANSA.
- The third phase was the development of a model that could examine the effect on consumer energy consumption bills from different tariff structures, network and wholesale costs. This model was developed by Sapere.

The Report's model

The purpose of this third phase of the work was to develop a model for future research. In testing this model, we used inputs and assumptions from the earlier two research phases (wholesale and network). Once the consumer model was completed a decision was made by MBIE to commission an additional report on the effect on consumer energy bills.

The report uses the inputs and assumptions of the first two phases. The first phase wholesale electricity market modelling was not originally designed to provide robust input for a consumer model. For example, the forecast wholesale price produced by Jacobs using SDDP is an hourly series with less within day variation than can be found in actual historical prices. This lack of variation flows through into the consumer model by reducing the arbitrage value of batteries in shifting load between time periods. Consequently the results discussed in the consumer report are not necessarily reflective of the current electricity market and as a result may underestimate how consumers would benefit from their consumer energy resources.

Nevertheless, noting this shortcoming, this work provides a significant first step to shift how we model our energy system to take account of the role of energy resources like solar panels batteries and smart devices in homes and businesses. This technology can play an increasing role in our energy system and developing the right tools to understand these impacts is important but is a large and iterative undertaking.

The rest of this document outlines the review of modelling undertaken for the consumer energy bills report, and highlights where further work is needed to better reflect the value of solar and batteries to consumers. The consumer energy bills model is highly configurable and flexible by design meaning improvements from a second phase of development can be easily incorporated.

Below we share our initial review of the modelling and highlight next steps to improve the accuracy of results.

Review of the first phase of consumer energy bills modelling

Missing direct benefits of solar and batteries in results

Table 1 in the Sapere report indicates that a household with all electric appliances and petrol cars with demand of approximately 6850 kWh per year would pay an additional $387.65 to $498.84 per year to have solar and batteries including the repayment costs for solar and batteries. This modelled result is not fully consistent with the current savings households are experiencing when investing in solar and battery systems. The consumer bills model had not been tested when these results were calculated. To understand why these results occurred we tested the model by back cast using historic 2025 wholesale electricity prices and reconciled to average 2025 retail prices.

Table 1 shows the results of this back cast analysis and indicates that a household with electric appliances (but no electric vehicles) would in 2025 save money from having either solar or solar with batteries. The savings for a typical household with electric appliances

would be higher than those below because these figures do not include automated load shifting to maximise use of solar generation and they underestimate the value for a household from battery use. The saving from solar are based on 39% own use of solar generation.

	2025 reconcilliation	2026 reported results
Savings from solar	-$1,021.67	not reported
Savings from solar & BESS	-$163.17	$498

Table 2 shows the breakdown of a back cast energy bill for a household with all electric appliances that matches the historic average cost per kWh for a household in 2025.

Table 2 - Average cost per kWh including fixed costs from the model - back cast to reflect

	Average price (total)	Wholesale electricity cost	Network costs	Retail margin	Risk premium	GST
2025 reconcilliation	$0.37	$0.11	$0.08	$0.01	$0.12	$0.05
Proportion of bill	100.00%	28.95%	22.17%	2.76%	33.08%	13.04%

Rewiring has identified that the following factors likely contributed to underestimates of the direct benefits from solar and batteries in the results from the *Modelling household energy consumption bill* report.

1. ***The value of generation from rooftop solar panels was only included for half of solar panel technical lifetime.*** The model assumed a 15-year payback period for solar loans. Consequently, the model did not fully capture the value of the last 10-15 years of solar panel lifetime where there would be no solar finance repayments and solar generation would continue. Changes to the model will address this shortcoming.

2. ***Arbitrage value for batteries not captured in wholesale market prices modelled.*** The modelled forecast hourly wholesale prices that were used in the evaluation of the household energy consumption model were derived from a stochastic model (SDDP) of wholesale market operation and investment. Intraday wholesale electricity price spread is a function of offers made into the market. In addition the high level of grid connected BESS modelled likely has resulted in flat prices during some periods.

   Consequently, the resulting forecasts do not fully represent real world bidding strategies and wholesale prices produced were as a result flatter over the day. This meant there was very little arbitrage value for batteries in the modelled wholesale electricity prices. It is expected that within-day price volatility would increase over time creating more arbitrage value for batteries. This was not seen in any of the wholesale price scenarios including where battery uptake was low, meaning the result is not simply due to greater use of batteries to arbitrage away intra-day price volatility, but is an artifact of inputs to the modelling undertaken.

This is a limitation only with the results of this initial report. The consumer model is able to be used with different wholesale price series that more accurately model intraday variance.

3. ***Hot water load shifting into the solar window was not assumed for households with solar or solar and BESS***. Hot water is about 30 per cent of household energy use. Households can maximise value from solar through using as much of their own solar generation as possible. Automated load shifting of hot water into the solar window could potentially create significant customer savings from solar, but this was not assumed in the model which used a more conservative view of hot water load shifting based on previous research findings.

4. ***High electrification scenarios not provided for wholesale market price inputs***. The report provides results on a combination of early and late electrification and early and late solar and battery uptake. System cost inputs were modelled for all combinations for low voltage distribution networks and aligned assumptions were used for remaining network costs. However high and low electrification rates were not modelled for wholesale electricity prices. The same moderate electrification (demand) assumption was used to model wholesale electricity prices under baseline, early and late solar uptake assumptions. Results from these three scenarios were provided for use in the household bill modelling

5. ***There was a very large risk premia in the current contracts market in 2025.*** The consumer bills model assumes that future prices would be more dynamic and cost reflective and risk premia would reflect a good standard of security of supply.

6. ***Baseline network costs appear to be underestimated in the model***. In the 2025 backcast the baseline network cost is 0.8c/kWh. This is lower than the 11c/kWh to 12.5c/kWh reported 2025 costs for transmission and distribution for the big generator retailers[1]. Lines costs for residential customers are likely to be higher than the average for all customers, with MBIES QRSS sales base electricity price data suggesting 2025 residential network costs were 14.92c/kWh[2].

7. ***Currently the retail cost for a household with solar and BESS is higher than a household with just solar in some of the modelled results.*** This means the model assumes the battery operates in a way that adds costs to the customers electricity bill. This does not fully reflect the benefits customers can gain simply from utilising batteries to maximise use of own solar generation, reducing electricity purchased from their retailer. The model used a single profile for BESS use across all households. Calibration of the model and battery operation is needed to better reflect households with EVs and higher specification water heating for example.

The seven issues above, identified through the model testing process mean that some of the results as they relate to the value of solar and batteries are incorrect or underestimates.

[1] https://www.ea.govt.nz/data-and-insights/charts-and-dashboards/retail-gross-margin/
[2] https://www.mbie.govt.nz/assets/Data-Files/Energy/nz-energy-quarterly-and-energy-in-nz/qrss-december-2025-q4.xlsx

However the trends in cost changes may provide some useful insights. This fault does not reduce the value of the model, however it highlights that further work is needed to better calibrate the modelling following this review process, as it was designed to utilise multiple inputs. Care is needed in interpreting individual values presented in the report, however overall trends and some conclusions arising from them are still robust.

Future model and input assumptions developments

The following developments were all outside the initial scope given to consultants that undertook this project. They are aspects or issues that may be considered for future work.

Start with the customer to model load shifting, and solar exports

The existing workstream started with a predefined uptake for household solar and batteries that was then modelled into the wholesale market and distribution network. The outputs of this work was then fed into a model that considered customer energy bills, accounting for different tariff structures and customer energy use patterns.

An alternative approach would be to reverse this and start at the consumer level, i.e. modelling consumer load and solar and battery exports, followed by any distribution network constraints and finally determine the net load at each grid exit point (GXP) for use in subsequent wholesale electricity price modelling.

Additional modelled input assumptions for the *Household energy bills model* could include:

1. Modelling consumer behaviour to maximise own value and provides a residential load profile that nets off solar exports. This could include modelling of realistic (but not perfect) automated load shifting of hot water and, if relevant, EV demand and other loads that can practically move in order to maximise use of own solar generation. Achieving this would require further research as little is known at this time about the status and capability of water heating stock and the ability to interact with control systems. For households with solar and BESS, calibration and testing of battery operation is needed to capture the value households gain from using batteries to maximise own use of solar, and export to the grid when export tariffs are high.

2. Modelling practical network constraints – e.g.: solar curtailment (with dynamic operating envelopes) to avoid expensive over build of low voltage networks to export solar at summer peak. Modelled summertime solar curtailment at different solar uptake rates by distribution networks, could be subtracted from solar export assumptions

Change the approach to wholesale electricity price modelling to better capture within-day price volatility and higher electrifications scenarios

We could explore a wider range of future outcomes to draw meaningful conclusions about the impact of high solar uptake on the wholesale electricity market. As noted above wholesale electricity prices were not modelled under high electrification (demand) scenarios. Figure 1 below shows the scenario assumptions used in the first phase of wholesale electricity modelling (undertaken so far). These scenarios are shown as green dots and all

have the same moderate electrification rate with varying uptake rates for solar and batteries. Analysis of wholesale prices under further scenarios (for example in the dotted circle in Figure 1) with higher electrification uptake rates and more moderate solar and battery uptake could provide insights on the potential benefits of solar and batteries as part of a diverse mix of renewable generation.

Another alternative modelling approach could be utilised to capture bidding behaviour and therefore realistic within day volatility and a wider range of scenarios including different electrification rates could be modelled.

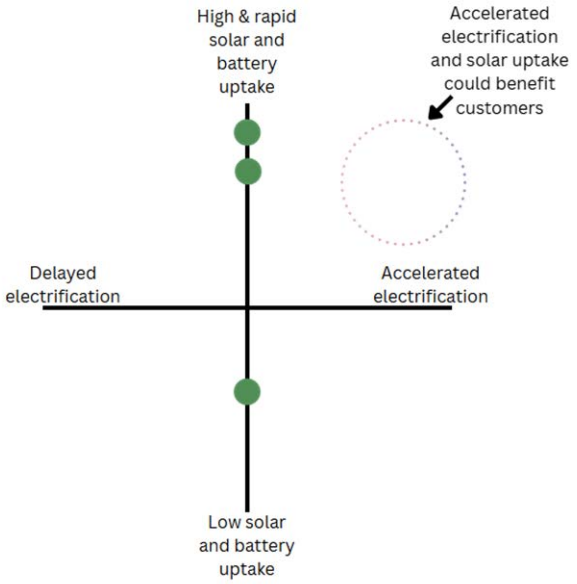

Figure 1: Wholesale electricity scenarios including solar uptake and electrification uptake and rates.

The scope for the Household energy bills model in this initial exercise was to capture the effect on electricity bills. The model could be developed to include all energy bills including transport fuels (petrol or diesel paid for at the pump) and gas bills in homes. This could provide greater insights into how much households could save as they electrify their energy use.

Currently the model includes the “costs” of people charging electric vehicles at home but does not capture the savings from the petrol and diesel they would have otherwise been buying. Given petrol and diesel use is the largest and most expensive energy bill homes have, this model currently does not show the full possible financial upside and savings from EV uptake.

In future iterations this model could be developed to include the proportion of each type of household in order to create a representative picture of how distribution and transmission costs are allocated over time under different tariff structures.

As shown above in Table 2, modelled network costs in the modelled consumer energy bills appear to be lower than they were in 2025 based on reported distribution and transmission costs. The transmission and distribution pricing part of the consumer energy bills model should be reviewed to confirm it reflects recent updates to Input methodologies and how these translate to consumer bills.