ENDGAME ECONOMICS

MODELLING ELECTRICITY BILL IMPACT OF TRANSMISSION PROJECT DELAYS

A Report for NEXA Advisory

7 June 2022

Disclaimer

This work has been prepared to assist NEXA Advisory understand the potential consumer bill impacts due to delays in new transmission projects and the resulting disorderly transition. Endgame Economics has exercised all reasonable care in the preparation of the scenarios and analysis but notes actual conditions could vary from these scenarios. The modelling relies on data sourced from publicly available information, primarily from AEMO's draft 2022 ISP. Endgame Economics disclaims any and all liability for use of this data and for the analysis other than for its intended purpose by NEXA Advisory or any use by a third party.

About Endgame Economics

Endgame Economics is a firm focused on providing mathematical modelling, market intelligence, market design and economics advice in the energy sector. Our team is comprised of four directors with a combined 50 years' experience in the fields of economics, mathematical optimization, and energy modelling. Our firm brings together a unique combination of expertise in data analytics, strategy consulting, and deep domain knowledge in the energy and utilities industry. We have successfully delivered projects with a large variety of clients including governments, regulators, investors and commercial clients.

We have extensive experience undertaking large-scale modelling in the energy sector and have provided quantitative market and policy design advice on major projects including the following:

- Regulatory modelling and advice such as the review of Reliability Standard and Settings for the Reliability Panel and determining Customer Export Curtailment Value for the Australian Energy Regulator (AER)
- Modelling to analyse new market design such as potential new markets for operating reserves and other essential services for the Energy Security Board
- Advising market bodies and government departments on generation and transmission infrastructure planning to develop Renewable Energy Zones (REZ)
- Providing modelling advice to government departments and market participants such as developing their internal modelling and quantitative capabilities
- Providing market intelligence and commercial advice to market participants on the operation of various assets in the energy market

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1. Introduction

Endgame Economics ('Endgame') have been engaged by Nexa Advisory to provide evidence-based insights on the potential increase in consumers' electricity bills with delays incurred to planned transmission network upgrades and augmentations.

We have conducted this analysis through modelling a base scenario with no delay to planned transmission and four sensitivities with delays to AEMO's 2022 Integrated System Plan (ISP) actionable and future transmission network augmentations from the optimal development path (ODP), described further in Section 2.

The National Electricity Market (NEM) is currently undergoing unprecedented transformation as traditional thermal generators retire and are replaced by decentralised forms of electricity, including Variable Renewable Energy (VRE) and Distributed Energy Resources (DER). This presents a challenge to the transmission network that was originally designed for the centralised transportation of fuel-based forms of electricity through large-scale transmission lines.

Typically, VRE generators are located in remote areas with weaker connection to the grid. As the generation mix evolves and decentralises, transmission network upgrades are required to effectively transport energy to load centres. Transmission network upgrades and augmentations alleviate network congestion and subsequent curtailment and enable regions to capture the benefits of decentralised electricity. This enables utilisation of cheaper forms of energy and displacement of more expensive and emissions intensive fossil-fuel generators.

VRE rely on solar irradiance and wind availability and have geographic resource variability across the NEM. Stronger transmission allows electricity to be transported more readily to other parts of the grid, capitalising on the diversity of their resources and reducing the requirement for large utility scale generation and storage investment.

1.1. Structure of this document

The remainder of this document comprises the following 3 sections:

- **Section 2** provides a description of the modelling methodology that we have adopted.
- **Section 3** sets out our analysis and observations about the wholesale market impact due to transmission delay.
- **Section 4** presents our findings regarding the impact of transmission delay on consumer bills.

2. Description of the modelling methodology

This section sets out a description of the modelling methodology that we have applied for the purposes of this project.

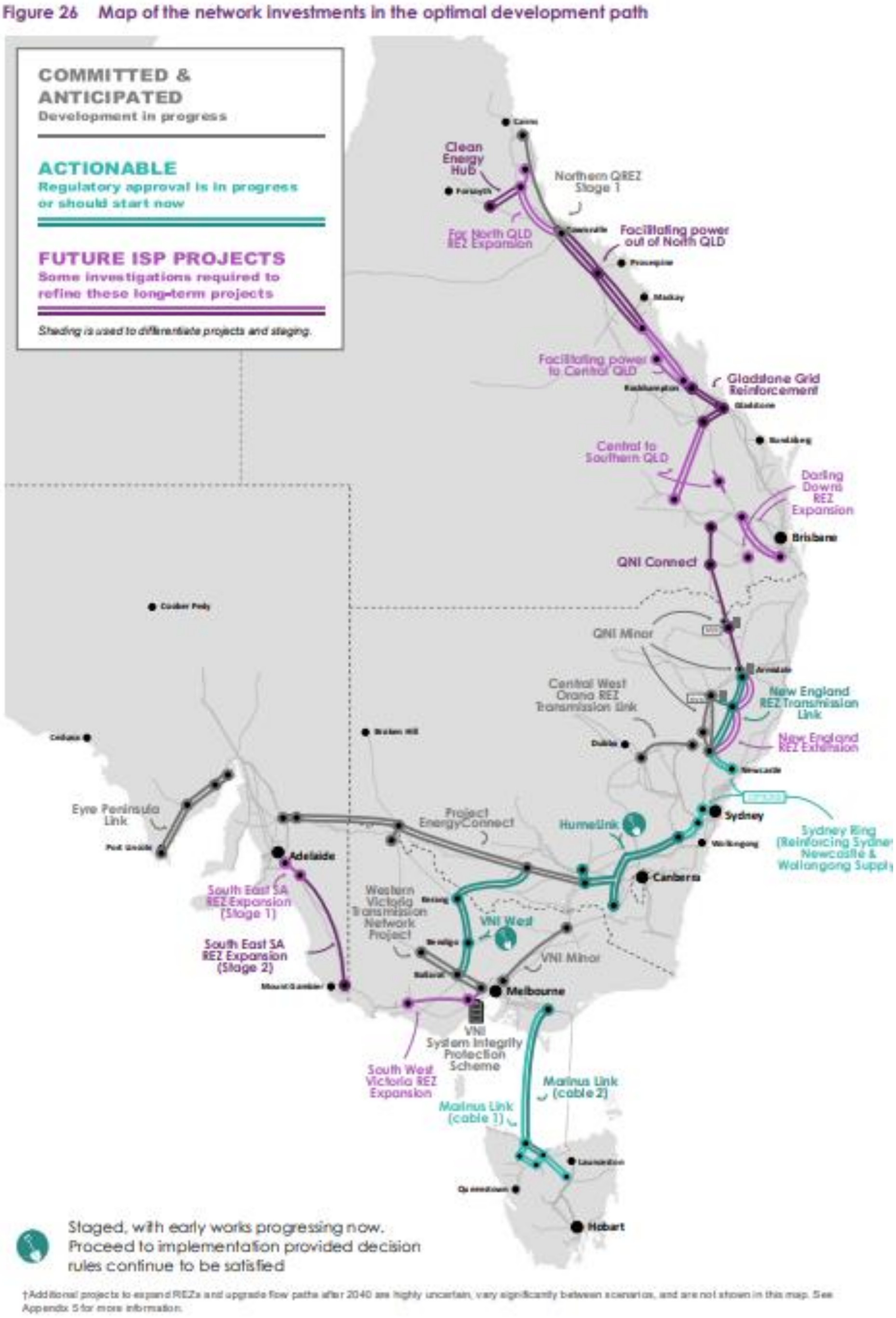
2.1. Overview of the modelling process

The modelling for was undertaken over the horizon of FY 2026-2040 with input assumptions based on AEMO's 2022 Draft ISP Step Change scenario, which reflects the scenario considered to be the most likely to eventuate by industry stakeholders.

The modelling adopted the capacity outlook from the 2022 Draft ISP Step Change scenario for the new generation and storage entrants and baseload retirement forecast. All committed projects included are based on AEMO's NEM Generation Information published in February 2022.

The modelling involved a base case scenario which adopts the 2022 Draft ISP ODP for transmission development, as shown in Figure 1. An additional four sensitivities were carried out which involve a delay to the actionable and future flow-path expansion by 1, 2, 3, and 4 years respectively.

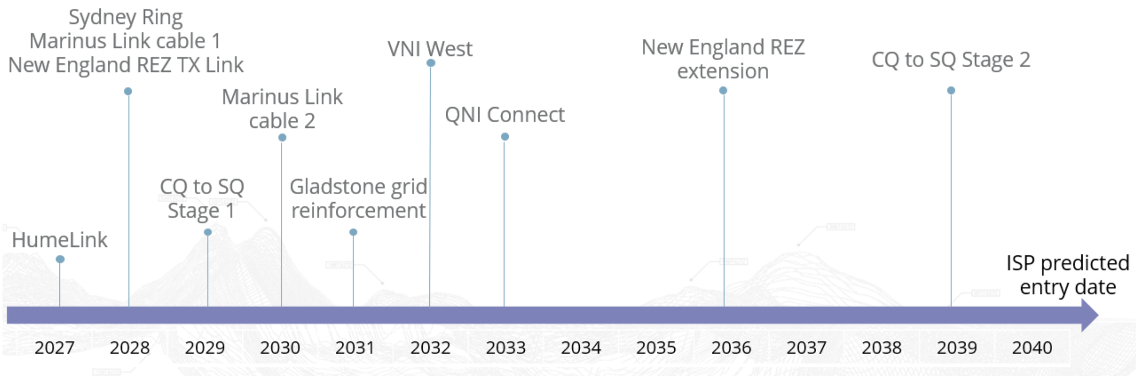
Figure 1 – Draft 2022 ISP optimal development path



Source: AEMO draft 2022 ISP

The timeline of predicted commissioning date for actionable and future ISP projects are shown in Figure 2. These are the projects and dates used in the base case modelling which have been adjusted for the sensitivities which incur delay to transmission development.

Figure 2 – Optimal Development Path Timeline



2.2. The scope of our assessment

Our modelling results is not an endorsement of the draft ISP optimal development path or any transmission project. Regardless of the transmission expansion plan, the system will need GWs of new VRE and storage plants to achieve net-zero before 2050. Having a coordinated transmission plan and being able to commit such plan in the long-term will give investors the necessary certainty to plan their generation investment accordingly. To demonstrate the benefit of having such certainty, we modelled a world where transmission delays are “unexpected”, and the generation sector is unable to respond in time. Our analysis can be seen as showing the benefit of preventing a “disorderly” transition by comparing the cost of delivering transmission projects on time versus wholesale price impact resulting from unexpected transmission delays.

2.3. Our modelled prices vs observed recent wholesale price volatility

Since early 2022 the wholesale electricity prices in the NEM have been at historically high levels. For example, the average NSW pool prices between 1st and 26th of May was at approximately $310/MWh. While such sustained high wholesale pool prices are unprecedented in the NEM, they are primarily driven by high fuel (coal and gas) costs on the international market. Such high prices are unlikely to persist in the long-term, and we expect the NEM wholesale prices to return to their normal levels as the international fuel prices eventually fall. Given our modelling period is between FY2026-2040, we have used the long-term fuel price forecast from the ISP Step Change Scenario, and our forecast pool prices are more consistent with the long-term levels under normal market conditions. However, if we instead used the current high fuel prices throughout our modelling period (which we consider to be unlikely), the cost of transmission delay would be even higher than our modelled results.

3. Wholesale market impact due to transmission delay

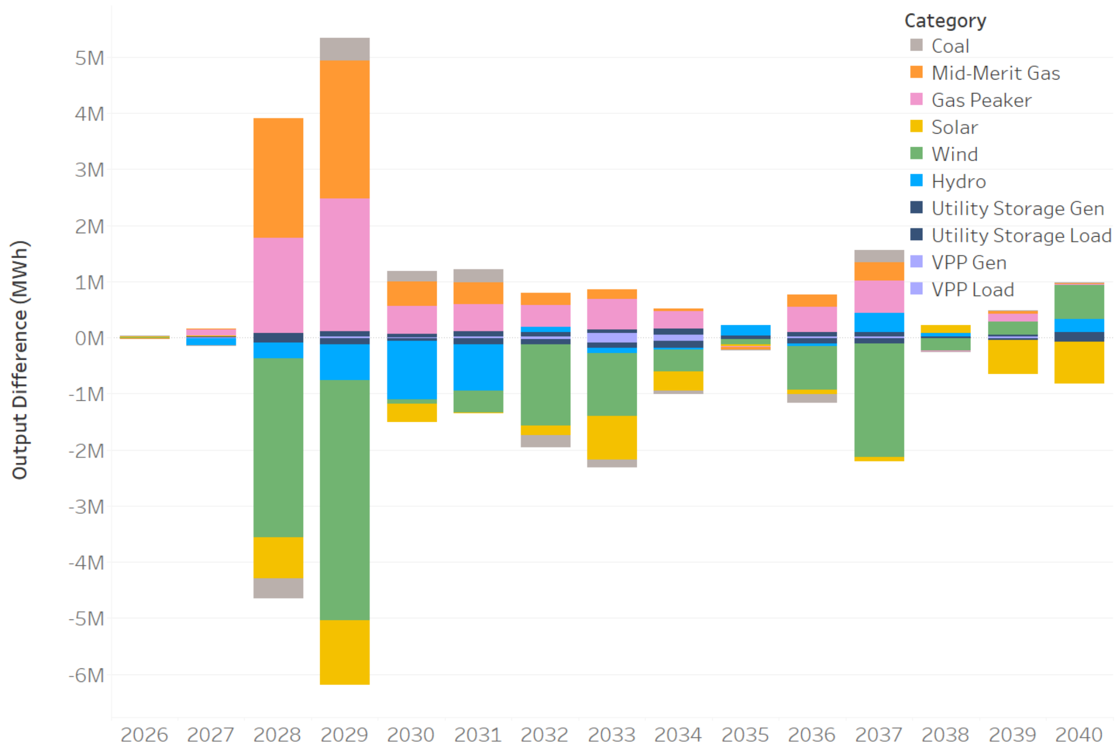
This section provides our modelled findings, describing the impact on the wholesale market due to delays to planned transmission upgrades and augmentations.

3.1. Impact on generation mix

In general, the modelling outcomes indicate that stronger interconnection leads to greater access to lower-cost generation, with renewable generators experiencing greater utilisation overall.

Figure 3 compares the base case and the two-year delay in transmission augmentation and highlights the difference between NEM-wide generation mix. A positive bar means the more generation by that technology due to transmission delay, and a negative bar mean less generation due to delay. When transmission is delayed, more expensive gas generation is dispatched to meet demand. This shows that timely transmission upgrades render it more feasible for demand to be more regularly be served by low-cost generation from more remote locations of the network. Unlike coal and gas-fired power plants, VRE is not exposed to the volatile nature of fuel prices. Transmission upgrades allow the NEM to unlock the benefits of low-cost energy, through a reduction in reliance on traditional thermal generators and an increase in the utilisation of VRE.

Figure 3 – Impact on generation mix

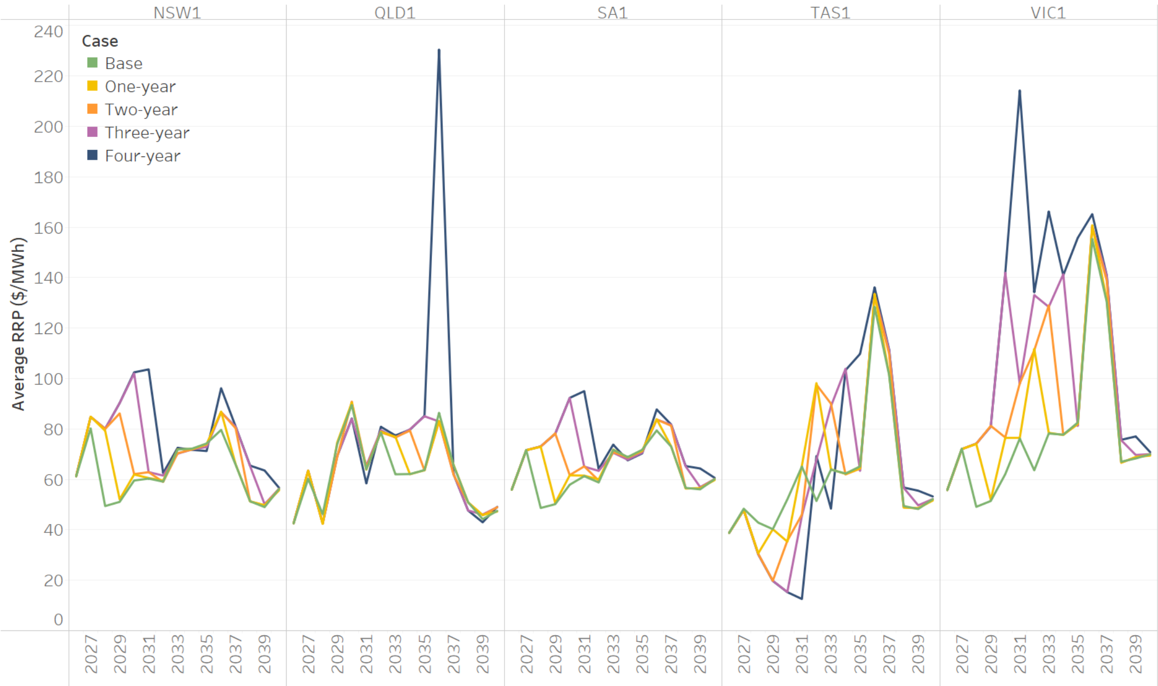


3.2. Impact on wholesale energy market prices

The time-weighted average pool prices for each region are shown in Figure 4. In general, prompt investment in transmission upgrades bring down the average wholesale price of electricity. The figure exhibits significantly lower prices in the base case than any other scenario and prices become higher and more volatile with extended delays to transmission upgrades. As renewable penetration increases, the market is more susceptible to renewable resource droughts. Interconnection is essential for enabling transfer of dispatchable energy inter and intra-regionally. Coincidingly, thermal baseload generators are forecast exit the market due to end of technical life and commercial reasons. Without sufficient transmission, the NEM relies on more expensive gas generators to meet demand requirements, which increases the overall average prices.

This is with exception of Tasmania, where the modelling shows that strong interconnection results in an increase in its average wholesale prices. The Tasmanian Renewable Energy Target (TRET) is forecast to increase Tasmanian renewable generation to approximately 150 percent of its demand by 2030 and 200 percent by 2040. As renewable generation ramps up in Tasmania, it is reliant on the new Marinus Link interconnector to export the excess energy to the mainland. The delay of Marinus Link will depress Tasmanian pool prices due to its inability to fully export the additional low cost energy.

Figure 4 – Time Weighted Average RRP ($/MWh, real 2022 AUD) by sensitivity



The increase in Queensland prices is substantial in FY2036 with a four-year delay to transmission. QNI Connect is anticipated for FY2033 and serves to approximately double the transfer capacity between NSW and QLD. By FY2036, Queensland serves a large proportion of demand with wind generation, however in times of low wind availability coupled with limited access to NSW supply, more expensive local gas-fired generation would be required to meet Queensland demand. Queensland is particularly vulnerable to evening peak periods due to the large volumes of solar generation during daylight hours which reduces the requirement for coal and increases the ramp requirement in the evening when solar irradiance disappears coinciding with high demand.

The impact of transmission delay in Victoria is particularly pronounced in the three-year and four-year delay sensitivities. The delays to Marinus Link Stage 2 and VNI West, which are planned for FY2030 and 2032 respectively, result in a combined reduction in transfer capacity to Victoria of approximately 2550 MW during the years incurring delay. Victoria experiences high average wholesale prices which result from reduced access to supply from NSW and Tasmania during evening peak periods. Following retirement of their baseload coal-fleet, Victoria relies heavily on wind, gas-fired generation and hydro to meet the demand. During periods of low wind availability, prices rise significantly as local gas-fired generators are required meet demand.

For the purposes of this Project, the renewable energy-build out follows the 2022 Draft ISP Step Change outcomes and remains unchanged throughout the scenarios despite the delay in transmission upgrades. In practice, delays, or uncertainties in the timing of transmission augmentation could lead to delays in new generation capacity due to less utilisation and less overall profitability without existence of strong interconnection. Thus, with a reduction in new entrant capacity, the price increases caused by the delay in transmission would only be exacerbated by reduced availability of cheaper energy and a heavier reliance on more expensive thermal generation.

4. Impact on consumer bills

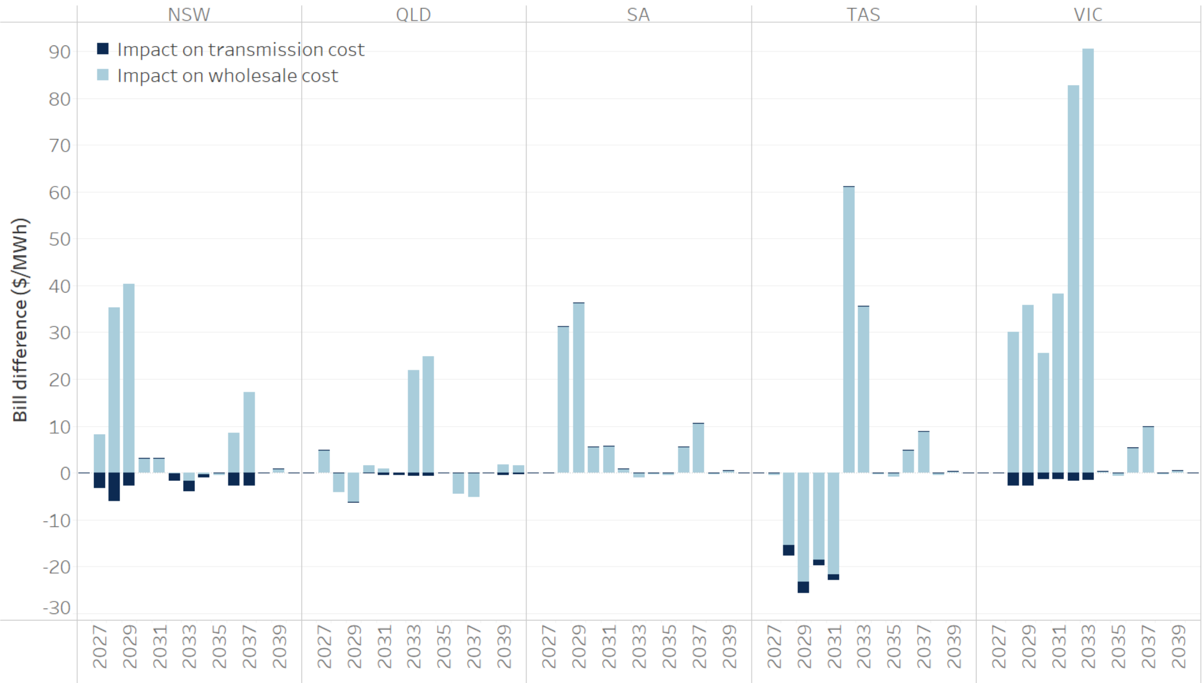
This section sets out an assessment of the impact of transmission delays on the consumer bill for both residential and industrial consumers in each region.

4.1. Impact on residential consumers

To provide an assessment on the benefit of timely transmission upgrades for consumers, we have calculated the average consumer bill impact by region for each sensitivity using the modelled outcomes and average residential electricity consumption benchmark data as reported by AER in December 2020.[1] This includes the change in the wholesale electricity cost component (generally higher due to higher pool prices) and the change in the transmission cost component (lower due to deferred capital expenditure) due to the delay.

A comparison of the base case to the delayed cases highlights the difference in total consumer bill across the horizon of the study as a direct consequence of transmission delays. A breakdown of both components, the wholesale energy cost and the transmission cost, is shown in Figure 5 For a delay of two years with comparison to the base case.

Figure 5 – Change in wholesale and transmission cost ($/MWh, real 2022 AUD) caused by a two-year delay in transmission



The increase in average wholesale cost added to consumer bills with a delay greatly outweighs the small reduction in transmission cost due to deferred transmission capital expenditure. This

[1] https://www.aer.gov.au/retail-markets/guidelines-reviews/electricity-and-gas-consumption-benchmarks-for-residential-customers-2020

emphasises the cost-benefit experienced by consumers across all regions with timely transmission upgrades which allow access to lower-cost energy.

To demonstrate the overall impact of delayed transmission on average residential consumer bill across the horizon of the study from FY2026-2040, a comparison for each region between the base case and each sensitivity is shown in Figure 6 with the data provided in

Table 1. **To be clear, all figures and numbers (in real 2022 dollars) shown are consumer bill impact solely due to transmission delay and are in addition to other future drivers (which were held constant in base and all sensitivities).** It shows that the longer the transmission is delayed, the worse the consequences for consumers and their electricity bills.

Figure 6 - Total impact on residential consumer bill due to transmission delay (real 2022 AUD, incl GST)

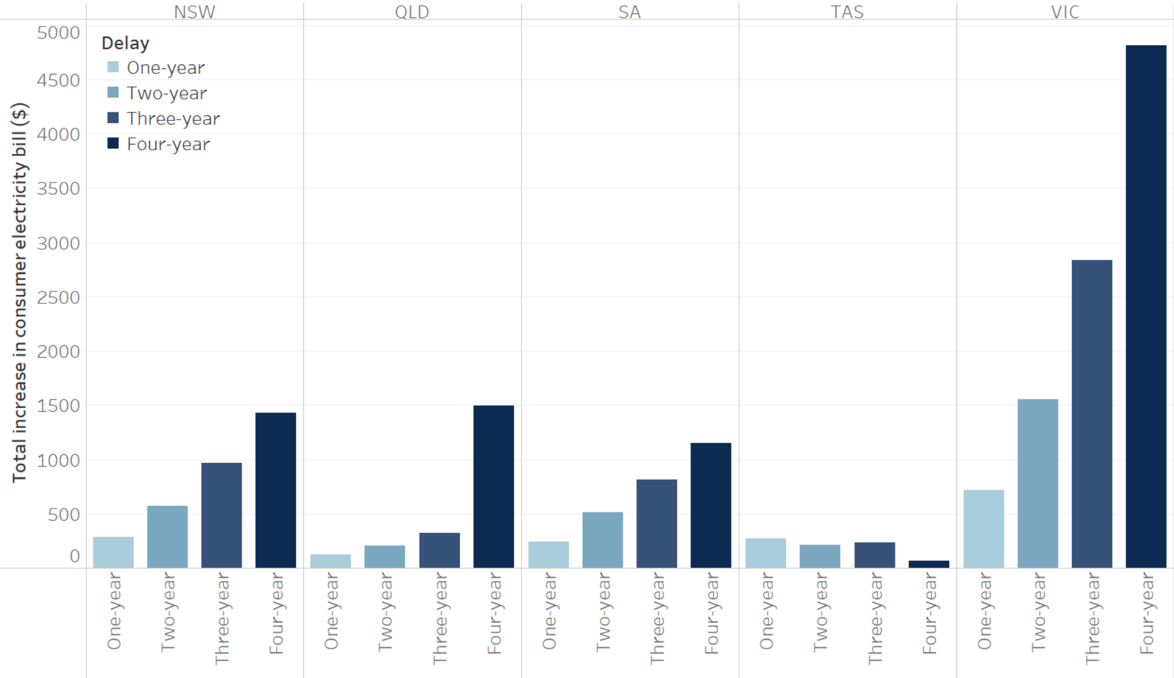


Table 1 - Total Residential consumer bill increase due to transmission delays over FY2026-2040 (real 2022 AUD, incl GST)

Region	1 Year	2 Year	3 Year	4 Year
NSW	$283	$575	$968	$1,428
QLD	$124	$208	$326	$1,497
SA	$243	$516	$814	$1,153
TAS	$271	$213	$236	$63
VIC	$717	$1,556	$2,836	$4,816
Average	$327	$614	$1,036	$1,791

The cost of transmission delay is greatest in Victoria: An average Victorian residential consumer will pay more than $1500 over the 15 years with a two-year delay to transmission. With a four-year delay, the residential consumer bill impact would be approximately $4800 over the same period.

On average NEM-wide, households would pay a total of approximately $600 more in electricity bills over the 15 years if all flow path augmentations are delayed by 2 years. This rise increases to approximately $1800 over the same period with a delay of four-years.

Table 2 shows the average annual residential consumer bill impact as a percentage of today's (May 2022) bill over 2026-2040 due to transmission delay. For example, the $1500 average increase in Victorian residential consumer bill over 2026-2040 due to a two-year transmission delay translates to approximately $100 a year, or approximately 9.6% of today's annual Victorian residential bill (based on market offers and including discounts). There is a clear trend which indicates that consumers will have larger electricity bills with greater transmission delay.

Table 2 – Annual percentage residential bill impact due to transmission delays (% of May 2022 bill)

Region	1 Year	2 Year	3 Year	4 Year
NSW	1.4%	2.8%	4.7%	6.9%
QLD	0.6%	1.0%	1.6%	7.4%
SA	1.1%	2.3%	3.6%	5.1%
TAS	0.9%	0.7%	0.8%	0.2%
VIC	4.4%	9.6%	17.4%	29.6%
Average	1.66%	3.27%	5.61%	9.84%

4.2. Impact on commercial consumers

The impact on electricity bills for different sized businesses was also assessed and the results are displayed in Table 3. The table shows the total impact on electricity bill observed for a two-year transmission delay compared to the base case for varying sized businesses over FY2026-2040.

Table 3 – Total impact on business electricity bills due to two-year transmission delay over FY2026-2040 (real 2022 AUD, incl GST)

Region	40 MWh	100 MWh	1 GWh	4 GWh
NSW	$4,062	$10,155	$101,549	$406,198
QLD	$1,505	$3,764	$37,636	$150,542
SA	$4,171	$10,428	$104,282	$417,129
TAS	$989	$2,472	$24,723	$98,891
VIC	$13,487	$33,718	$337,185	$1,348,739
Average	$4,843	$12,107	$121,075	$484,300

The percentage increase of business electricity bill for a small business with annual consumption of 40 MWh is shown in Table 4.

Table 4 - Annual percentage small business (40MWh) bill impact due to transmission delays (% of May 2022 bill)

Region	1 Year	2 Year	3 Year	4 Year
NSW	1.5%	3.0%	5.1%	7.5%
QLD	0.7%	1.2%	1.9%	8.8%
SA	1.1%	2.3%	3.7%	5.2%
TAS	0.9%	0.7%	0.8%	0.2%
VIC	4.8%	10.4%	19.0%	32.2%
Average	1.8%	3.5%	6.1%	10.8%

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