Impacts of Forced Electrification on the Victorian Energy System, Costs and Emissions

L.E.K. analytical report

18 February 2025

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Background: Energy Networks Australia has engaged L.E.K. to analyse the impact of the policy instruments that are the subject of the Victorian Government's Building Electrification RIS

- The Victorian Government released its Gas Substitution Roadmap in July 2022, with a further Update released in December 2023. The Roadmap proposes a pathway and set of policy instruments to phase out gas use in residential and commercial buildings, and to support industrial users to electrify or transition to renewable gas fuel sources

- A Building Electrification Regulatory Impact Statement (RIS) was released in December 2024. This RIS covers several policy levers to electrify Victorian gas customers, including:
  - Electrifying all new residential buildings
  - Electrifying "most" commercial buildings where appropriate electric appliance options are readily available
  - Requiring the replacement of gas appliances at the end-of-life with electric for residential buildings (with gas cooktop appliances exempt, as articulated by the Victorian Government as its preferred option)
  - Requiring the replacement of gas appliances at the end-of-life with electric for "relevant commercial buildings"

- L.E.K. has been engaged on behalf of Energy Networks Australia to assess the impact of the RIS on Victorian customers. L.E.K. has partnered with Endgame Analytics to prepare a 'whole of energy system' analysis of the impacts of the RIS – considering the wholesale electricity and gas market impacts, the network costs, customer costs of electrification and the notional reductions/increases in emissions. L.E.K.'s work adopted a similar approach and assumptions to the recent *The Time is Now* report produced for Energy Networks Australia (see next page for more detail). This has been used to assess the impact of the RIS at both a system wide level, and at an individual customer level.

Context: *The Time is Now* report outlined benefits for consumers of making better use of distribution networks outside of peaks. By contrast, forced electrification will add pressure during peaks

- The ENA and L.E.K.'s 2024 report *'The Time is Now: Getting Smarter with the Grid'* emphasises that policy levers that maximise the utilisation of the existing electricity distribution grid are a more effective and economical strategy for advancing Australia's energy transition than the immediate replacement of gas appliances with electric ones

- Key insights from *The Time is Now* include:
  - Accelerated Renewable Integration: By empowering electricity distribution networks to play a more dynamic role, Australia can expedite its progress toward achieving 82% renewable energy by 2030. This approach involves integrating additional rooftop solar capacity, front-of-meter generation, and distribution-connected battery storage, as well as supporting the adoption of electric vehicles.
  - Cost Savings: Increasing the utilisation of today's electricity distribution grid can deliver sizeable financial benefits. The report estimates that such improvements could save consumers roughly $160 annually and reduce overall system costs by $7 billion in 2030 alone.

- These outcomes are due to better utilisation of existing infrastructure and spare capacity in electricity distribution networks to support more generation and to enable electrification of transport in the short term. This delivers benefits to consumers immediately, allowing the energy transition to move forward while larger grid transformations, the construction of new generation capacity, and the retirement of coal generation all take place over the coming decade.

- By contrast, the changes that are proposed under the Building Electrification RIS are imposed on the Victorian electricity grid and the wider NEM before these larger grid transformations and capacity investments have been made. This places additional pressure on the grid during peak periods (unlike the changes in *The Time is Now*, that are designed to increase grid utilisation outside the peaks).

- This report describes the expected impacts of the forced electrification of buildings under the RIS on Victorian energy costs and emissions.

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Key findings: the Victorian Government's proposal will cost consumers $22bn additional over the next 20 years

- We have conducted a 'whole of energy system' modelling exercise that compares the implementation of Victorian Government's Building Electrification Regulatory Impact Statement (a '**Forced Electrification**' scenario) against the likely alternative outcomes (a '**Progressive Electrification**' scenario where customers electrify appliances progressively when it makes good financial sense to do so).
- We found that pursuing the policies set out in the Forced Electrification scenario will:
  - **Increase overall energy system costs** (electricity, gas and customer costs) for Victoria by $22bn over 20 years
  - **Increase wholesale electricity costs**, which will impact not only the portion of new load that is switched from gas to electricity, but also all electricity users across Victoria
  - **Require a material amount of new natural gas** peaking generation to be built and used, both in Victoria and elsewhere in the NEM, to meet the additional electricity demand. This will result in 0.5 tonnes of additional emissions to generate the electricity required, with a system cost of $1,222 per tonne, for every 1.0 tonnes of gas consumption emissions saved from FY25-45
  - Significantly **increase the risk of breaching the secure electricity system operating conditions** with there being c.10+ more hours on average of electricity prices exceeding $500/MWh each year under the Forced Electrification scenario (reflecting more time for the system under considerable strain)
- Victorian electricity supply in the late 2020s and early 2030s will already be constrained as the connection of renewable energy zones will still be ongoing. Our modelling applies a set of realistic constraints to the rate of build of new generation capacity, reflecting the most likely outcome for actual electricity supply in Victoria during the proposed period of forced electrification for the Building Electrification RIS. The effects of forcing customers to switch to electric appliances will exacerbate the period of constrained supply, and place additional cost of living pressure on Victorian energy consumers.
- The increased cost of electricity alone is more than the savings from reduced gas consumption. Including the additional capital expenses from replacing gas assets under Forced Electrification increases these overall costs further.
- The net emissions impact per year under the Building Electrification Regulatory Impact Statement are expected to be between an 0.1% increase to a 2.2% reduction to Victoria's current total annual emissions (at an average cost to consumers of $1,222 per tonne of abatement, as noted above).

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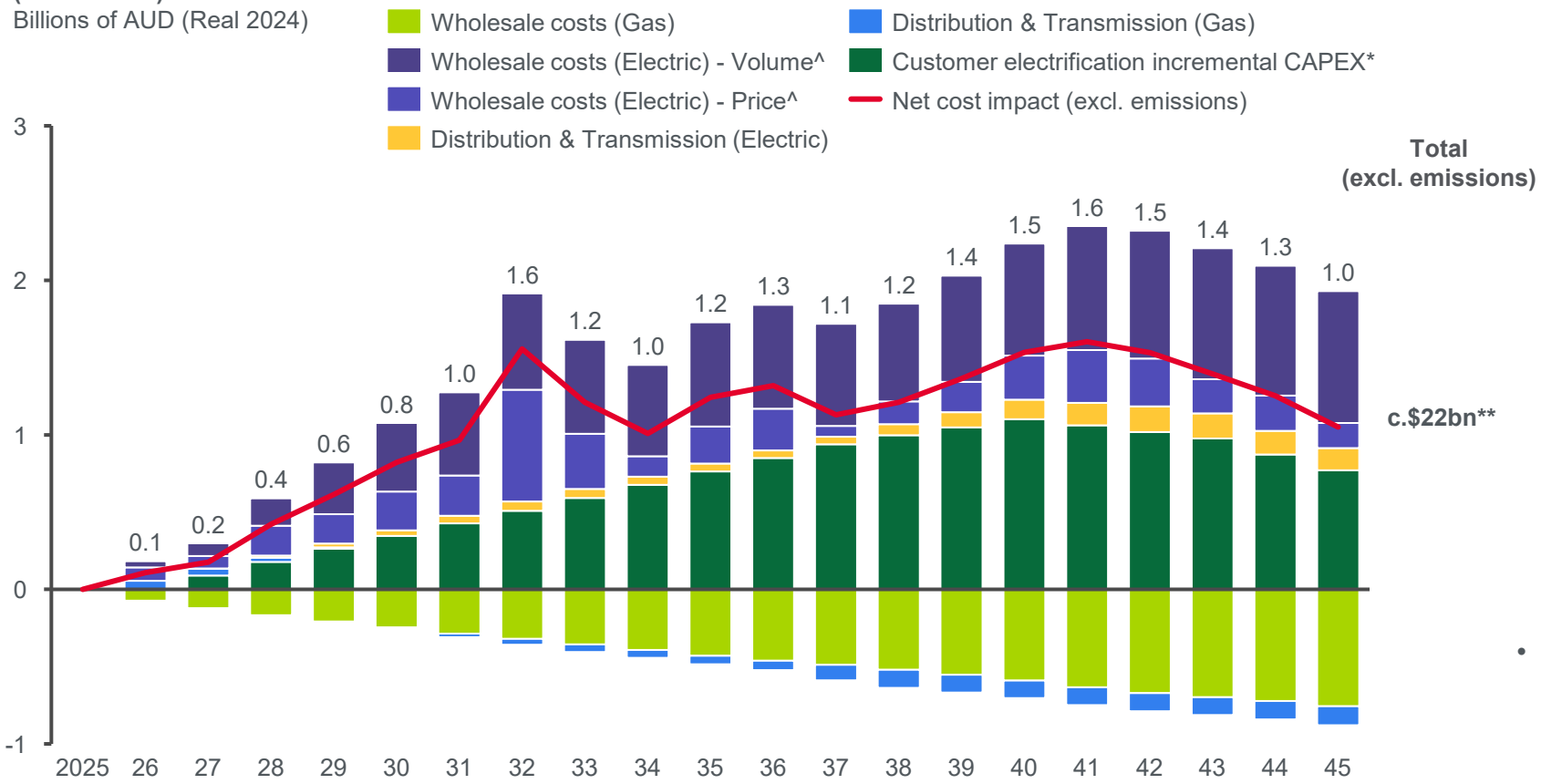
Under the forced electrification scenario the increase in wholesale electricity prices will be higher than the cost savings a consumer receives by not spending on gas (by c.$22bn from FY25-45F)

System cost impacts from Victoria's Building Electrification RIS – Delta between scenarios, by cost category (FY2025-45F)

Billions of AUD (Real 2024)



- The Forced Electrification scenario results in uneconomic outcomes for customers as wholesale electricity prices are higher than the cost saving a consumer receives by not spending on gas
  - Wholesale electricity prices are c.$5 / MWh higher on average under the forced electrification scenario, with a wider gap observed in the early 2030s when electricity supply is most constrained
  - This means that even without the incremental cost to purchase efficient electric appliances, it is more expensive for customers as the complete shift to electricity will increase wholesale electricity costs and outweigh the total cost savings from reduced gas consumption
- The cumulative cost to consumers of the Forced Electrification scenario is $22bn over 20 years and results in emissions impacts of a 0.1% increase to 2.2% decrease (see next page)

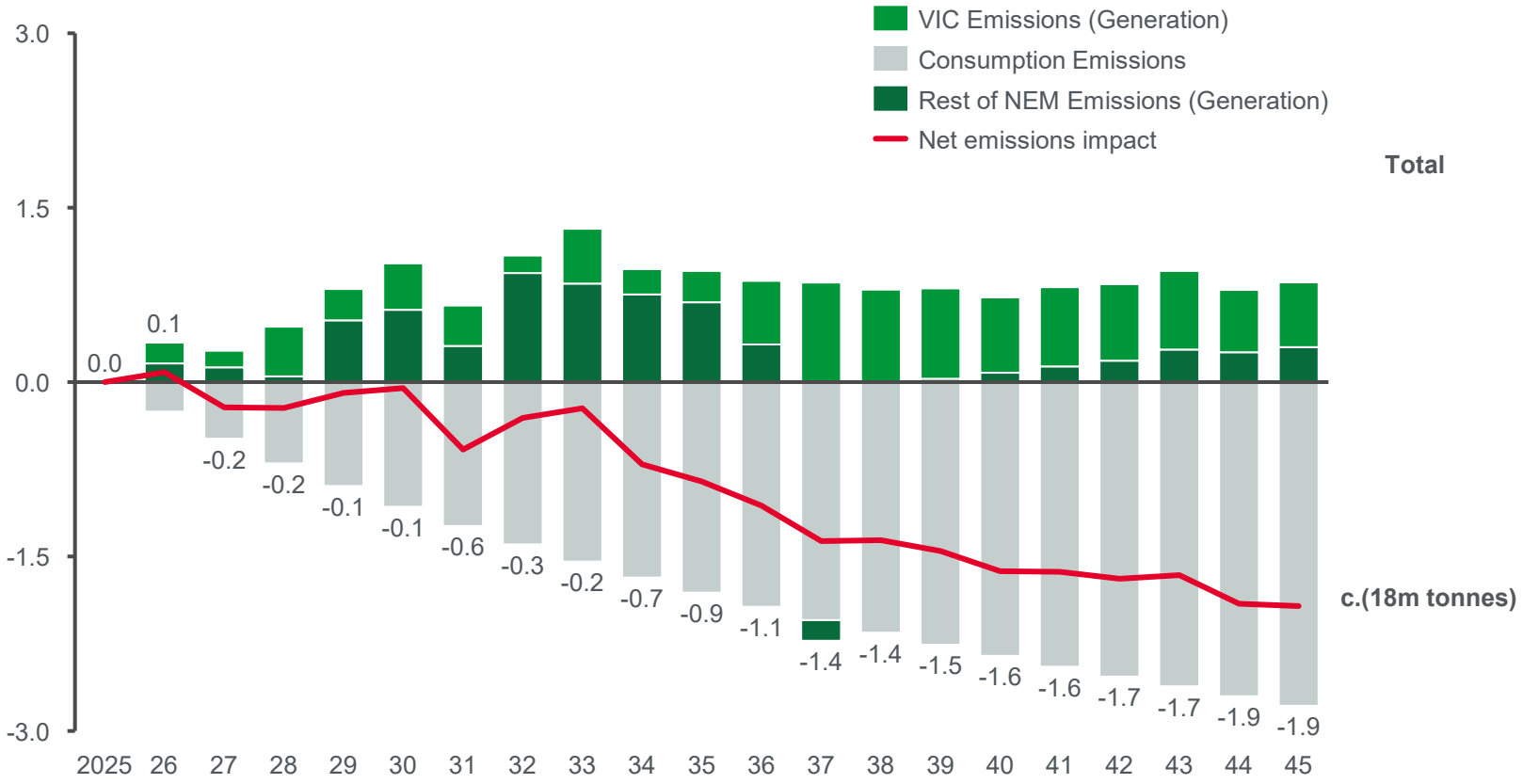
Notes: * Customer electrification capex represents the incremental cost of electrifying (ie. the cost difference where an electric appliance is more expensive than a gas alternative)
** Total is cash costs only, and excludes the implied value of emissions saved which are valued at c.$5 billion over the 20 years based on the AER's value of emissions reduction
^ Volume includes the incremental wholesale costs from additional electricity consumed as a result of higher electrification;
^ Price includes the impact of higher electricity costs under the Forced Electrification scenario on all electricity being consumed in Victoria

Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

Forced electrification results in very low net emissions savings prior to 2034, as there will be increased emissions from electricity generation

Emissions impact from Victoria's Building Electrification RIS – Delta between scenarios, by emissions category (FY2025-45F)

Millions of tonnes



- Analysis demonstrates there will be greater coal and gas peaker generation to meet the increased electricity demand under the Forced Electrification scenario in the period up to 2034
- As a result, emissions savings from reduced natural gas consumption are largely offset by increased emissions from greater coal and gas peaker generation to support the grid over the first 10 years
- The Forced Electrification does not begin to produce material net emissions savings until 2031, at which time those savings represent <1% of Victoria's 2022 emissions
- Cumulative savings of 18 million tonnes are achieved at a cumulative consumer cost of $22 billion. This equates to an $1,222 per tonne of CO2e saved, much higher than alternative abatement options*.

Note: * Prior L.E.K. reports have calculated that Australian heavy industry (eg. cement production, steel production, aluminium smelting) can be decarbonised at abatement costs of $240-$710 per tonne CO2e

Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; ENA Time is Now; L.E.K. research and analysis

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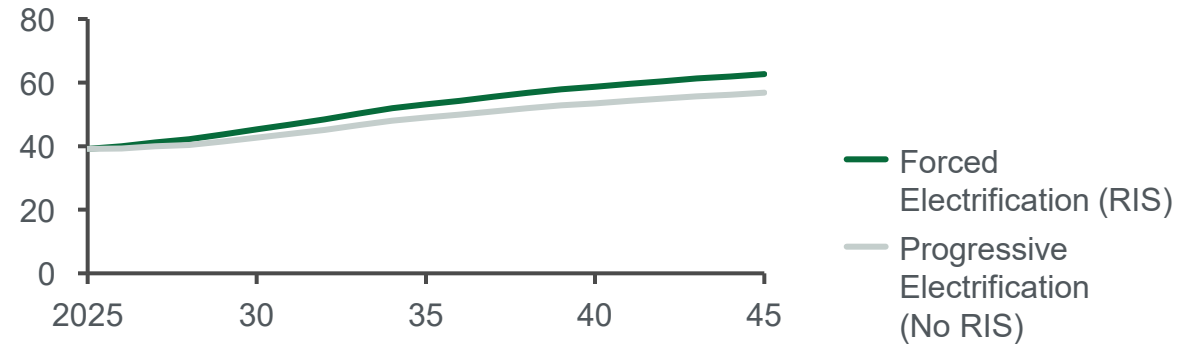
Our modelling has isolated the impact of Forced Electrification by comparing the energy system cost impact to Victorian customers across two scenarios

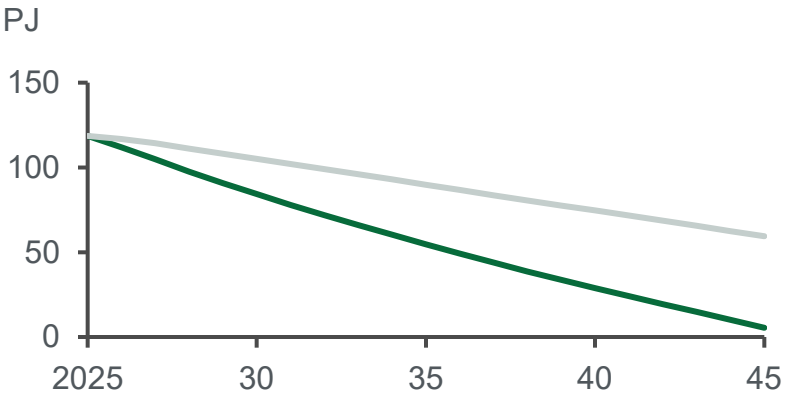
Modelling approach

- We have modelled two scenarios for the Victorian energy system:
  - A '**Forced Electrification (Building Electrification RIS)'** scenario in which existing Victorian households and addressable commercial businesses progressively electrify their premises over a 20-year period (2025-2045) in line with the policy instruments being proposed. Under this scenario all new households are electric only, and all gas appliances that can be feasibly electrified at their end-of-life are replaced with electric appliances, and gas is disconnected once a premises no longer has any gas appliances. Electrification of gas cooktops is exempt from the RIS, so the modelling assumes gas cooktops electrify at a rate consistent with historical consumer preferences
  - A **'Progressive Electrification (No Building Electrification RIS)'** scenario, in which existing households and commercial businesses progressively electrify when it makes good financial sense to do so, at rates consistent with existing policy and historical consumer preferences, and net gas disconnections maintain their historical rate. This scenario includes all existing policy measures that were introduced prior to the current Building Electrification RIS, but excludes any measures that have been discussed but not introduced
- Our modelling tests the impacts of these assumptions on all aspects of the Victorian energy system including the impacts on electricity supply/demand and wholesale prices, gas supply and availability, and total costs to consumers (including the incremental cost of new appliance investments)

Victoria residential / commercial electricity demand, by scenario (FY2025-45)



Victoria residential / commercial gas demand, by scenario (FY2025-45)



Note: By 2030 Victorian residential/ commercial gas demand reduces by 35PJ under the Forced Electrification scenario and 14PJ under Progressive Electrification.

Source: L.E.K. modelling; AEMO GSOO 2024

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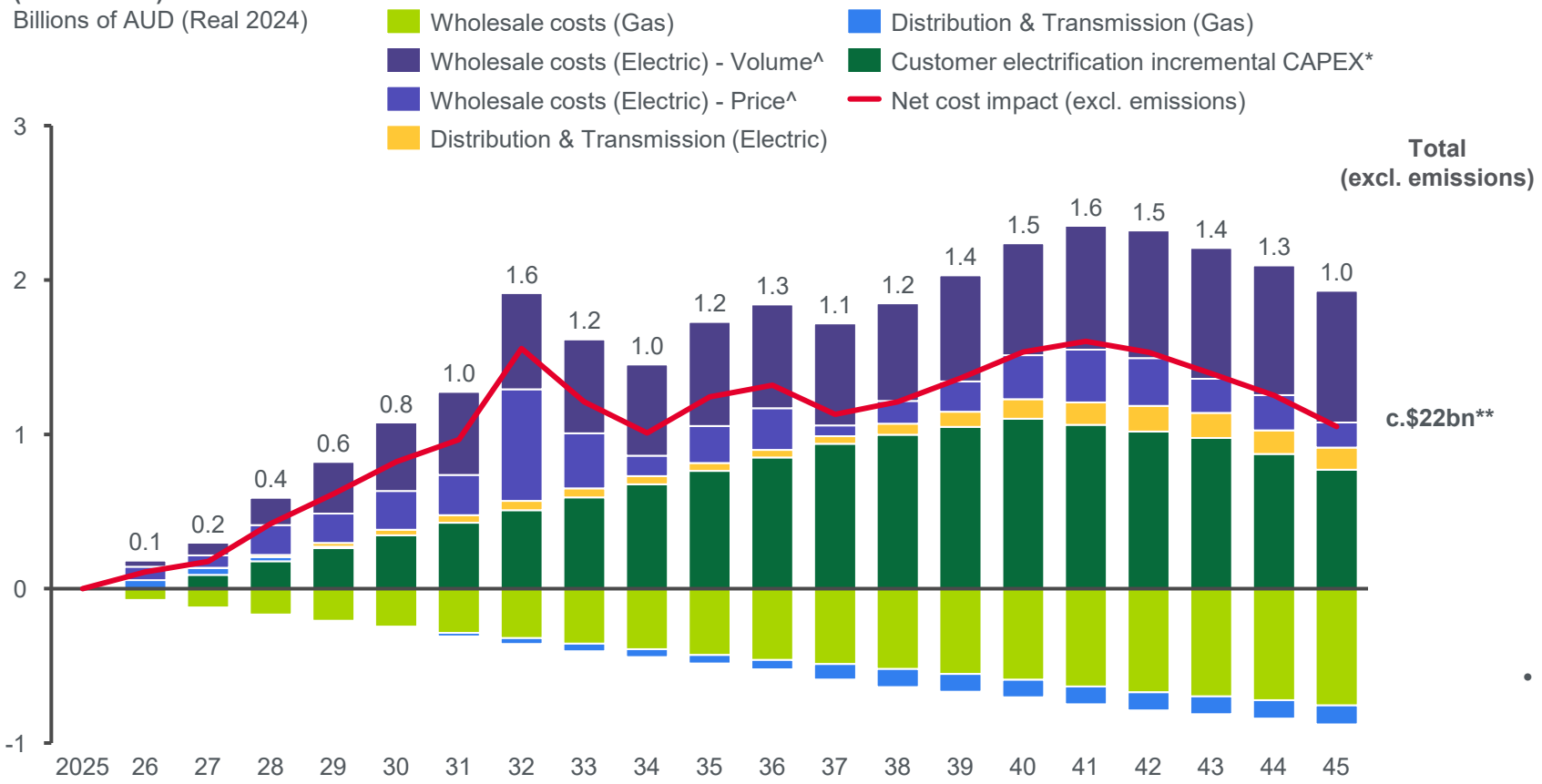
Analysis shows that pursuing the Building Electrification RIS will increase energy system costs for all Victorian customers by c.$22bn from FY25-45F

System wide impact

System cost impacts from Victoria's Building Electrification RIS – Delta between scenarios, by cost category (FY2025-45F)

Billions of AUD (Real 2024)



- The **Building Electrification RIS** (Forced Electrification) results in uneconomic outcomes for customers as wholesale electricity prices are higher than the cost saving a consumer receives by not spending on gas
  - Wholesale electricity prices are c.$5 / MWh higher on average under the forced electrification scenario, with a wider gap observed in the early 2030s when electricity supply is most constrained
  - This means that even without the incremental cost to purchase efficient electric appliances, it is more expensive for customers as the complete shift to electricity will increase wholesale electricity costs and outweigh the total cost savings from reduced gas consumption
- The cumulative additional cost to consumers of the Forced Electrification scenario is $22bn over 20 years and results in emissions impacts of a 0.1% increase to 2.2% decrease

Notes: * Customer electrification capex represents the incremental cost of electrifying (ie. the cost difference where an electric appliance is more expensive than a gas alternative)
** Total is cash costs only, and excludes the implied value of emissions saved which are valued at c.$5 billion over the 20 years based on the AER's value of emissions reduction
^ Volume includes the incremental wholesale costs from additional electricity consumed as a result of higher electrification;
^ Price includes the impact of higher electricity costs under the Forced Electrification scenario on all electricity being consumed in Victoria

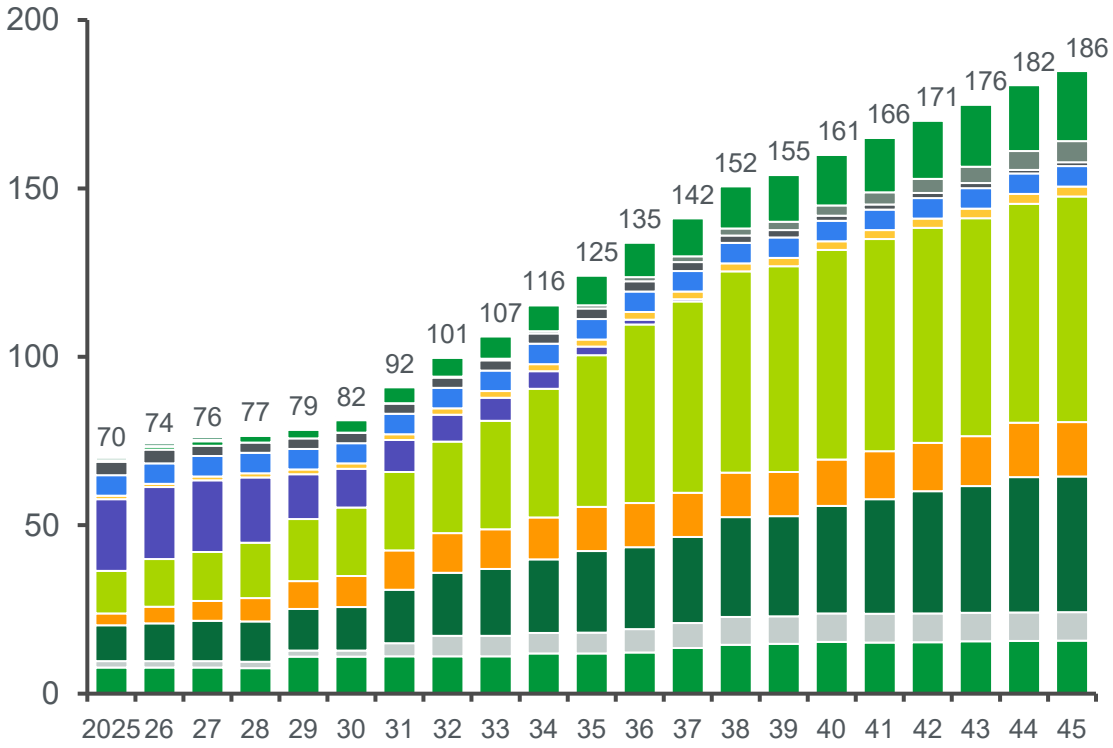
Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

Up to 4.1GW of additional generation capacity is needed to meet the higher electricity demand under Forced Electrification, with 27% of additional demand met by additional gas peaker output (1 of 2)

System wide impact

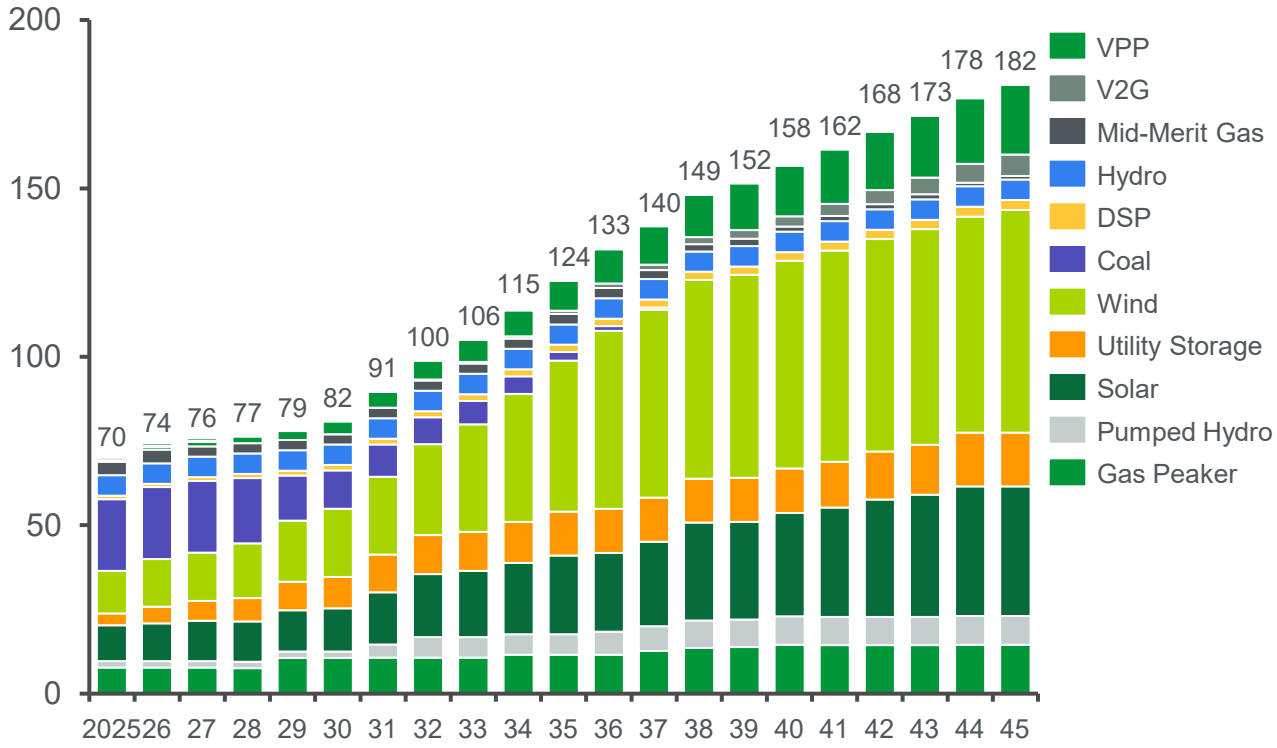
Forced Electrification: NEM-wide installed capacity* (FY2025-45)

GW



Progressive Electrification : NEM-wide installed capacity* (FY2025-45)

GW



Note: * Large scale generation only, chart excludes rooftop solar capacity additions
Source: Endgame Analytics modelling; L.E.K. analysis

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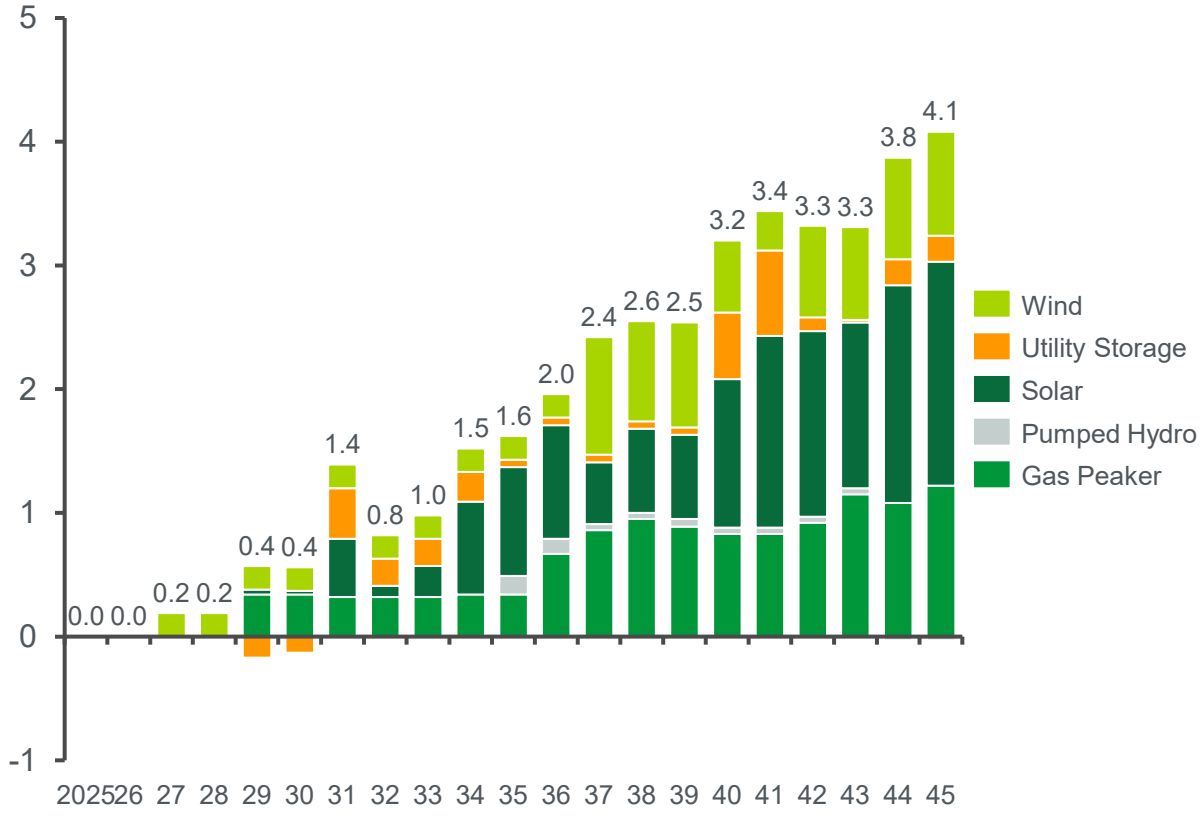
Up to 4.1GW of additional generation capacity is needed to meet the higher electricity demand under Forced Electrification, with 27% of additional demand met by additional gas peaker output (2 of 2)

System wide impact

NEM-wide installed capacity delta (Forced vs Progressive Electrification) (FY2025-45)

GW



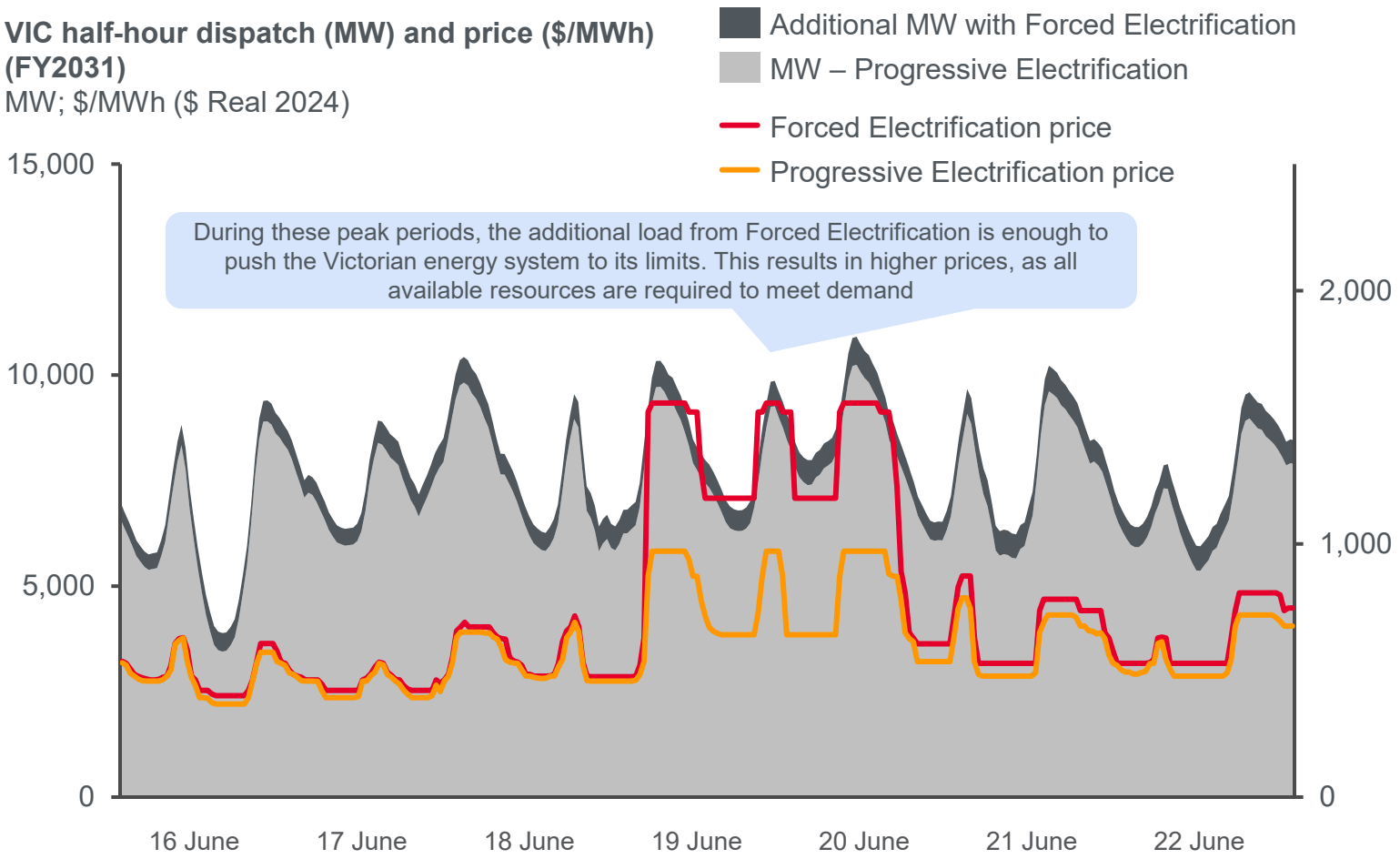
- The National Electricity Market (NEM) will require additional electricity supply to meet the additional demand resulting from RIS policies, with an additional 1.4GW of installed capacity required in 2031 vs no RIS, and an additional 4.1GW by 2045
- The shape of the daily and seasonal consumption curves for gas heating means that much of the increased electricity consumption from electrifying gas occurs in mornings / evenings and during winter, when the ability for renewables or shallow energy storage to supply the required electricity is lowest
- As a result, the market requires additional gas peaker capacity to meet this demand, even though it is not the most cost-effective option at other times
  - During the first 10 years of the RIS (2025-2034) electricity supply in Victoria is most constrained. New transmission projects have not yet been completed, which limits the rate at which new renewable generation can be added
  - During this period c.27% of the additional electricity demand that arises from the RIS must be met with gas peaker generation, which results in both higher electricity prices for Victorian consumers, and higher emissions from electricity generation than would otherwise have occurred

Source: Endgame Analytics modelling; L.E.K. analysis

Particularly in winter months, the electricity system is at risk of breaching system security operating conditions, relying heavily on generation with higher cost

System wide impact

VIC half-hour dispatch (MW) and price ($/MWh) (FY2031)
MW; $/MWh ($ Real 2024)



- Peak seasonal electrification demand in winter coincides with times when Victoria's wind and solar resources are at their lowest
- During these periods the electricity system is heavily reliant on firm generation assets such as coal, gas generation and various forms of energy storage. These resources (typically bidding in at higher costs when the system is constrained) magnify the impact on wholesale prices, as generation with higher costs are dispatched
- This chart shows a modelled 1-week period in June 2031, with several days of low wind output (June 19-20). During this period the Victorian electricity system relies heavily on coal, gas generation, battery storage, hydro, and imports from other states
  - Under the Forced Electrification (RIS) scenario demand is higher, resulting in prices (shown as the red line) of $1000-1500 per MWh for several days, compared to $500-1000 per MWh under the Progressive Electrification (No-RIS) scenario

Source: Endgame Analytics modelling; L.E.K. analysis

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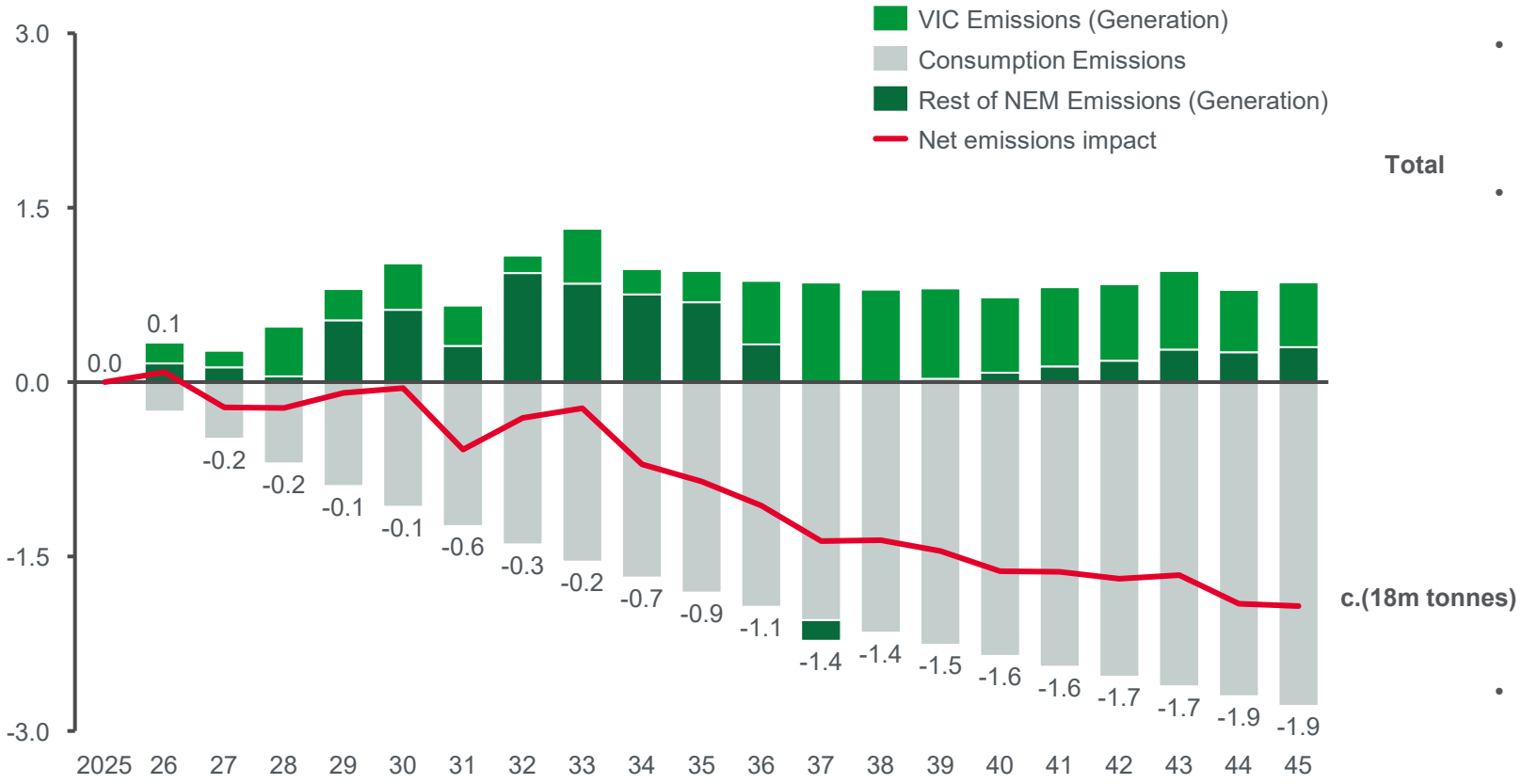
The Victorian Government's Building Electrification RIS produces very low net emissions savings prior to 2034, as the increased emissions from electricity generation that is needed offset any savings

System wide impact

Emissions impact from Victoria's Building Electrification RIS – Delta between scenarios, by emissions category (FY2025-45F)

Millions of tonnes



- There will be greater coal and gas peaker generation to meet the increased electricity demand under the **Building Electrification RIS** in the period up to 2034
- As a result, emissions savings from reduced gas consumption are largely offset by increased emissions from greater coal and gas peaker generation to support the grid over the first 10 years
- Forced Electrification does not begin to produce material net emissions savings until 2031, at which time those savings represent <1% of Victoria's 2022 emissions
  - This saving is relatively small compared to the c.200m+ tonnes of petrol emissions forecast over that period
  - Cumulative savings of 18 million tonnes are achieved at a cumulative consumer cost of $22 billion. This equates to an implied cost of abatement of $1,222 per tonne of CO2e saved, much higher than alternative abatement options*. If customer electrification capex costs were half what we have modelled the implied abatement cost would be $838 per tonne, still higher than most alternatives
- The net annual carbon emission impact from the RIS (an 0.1 million tonne increase of CO_2e in 2026, shifting to a 1.9 Mt decrease in CO_2e by 2045) ranges from an increase of +0.1% to a decrease of 2.2% of Victoria's 2022 total state carbon emissions of 84.7 Mt CO_2e

Note: * Prior L.E.K. reports have calculated that Australian heavy industry (eg. cement production, steel production, aluminium smelting) can be decarbonised at abatement costs of $240-$710 per tonne CO2e

Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; ENA Time is Now; L.E.K. research and analysis

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We have assessed the impact of Forced Electrification at an individual customer level based on 5 customer archetypes, which collectively cover c.85% of Victorian households today

Customer level impact

Customer type A

Ducted gas heating, gas cooktop and gas hot water

- Customer type A represents a customer that has not yet electrified their household gas assets under all scenarios – this means that they have gas heating, gas cooktop and gas hot water
- This is reflective of the majority of residential customers today
- Over time, this type of customer becomes less common as they electrify all assets except for the gas cooktop

Customer type B

Full disconnection from gas. Electrical appliances high efficiency

- Customer type B has fully disconnected from the gas network
- This customer has the financial means to replace its gas assets with high efficiency electrical appliances (efficiency of 350% - space conditioning, 300% - water heating, 84% - cooking) and so by 2030 this customer has fully electrified and disconnected from the gas network

Customer type C

Full disconnection from gas. Electrical appliances high efficiency Requires additional capex (e.g., power system upgrade)

- Customer type C is similar to Customer type B; this customer is fully disconnected from the gas network
- However, this customer has faced additional costs associated with switching their gas appliances out for electric, and disconnecting from the gas network
- For example, this customer might require a power system upgrade in their home

Customer type D

Full disconnection from gas. Electrical appliances low-efficiency

- Customer type D is similar to customer type B, but lacks the financial means to invest in high-efficiency electrical appliances
- As a result, this customer has replaced their appliances at end of life with below average efficiency (appliance efficiency reduction of c.38% compared to the high efficiency appliances in customer type B)

Customer type E

Remains connected but with reduced usage. Gas cooktop, electric hot water, and electrical heating

Invests in solar

- Customer type E is reflective of a customer that has electrified most of their appliances with exception of their gas cooktop, and are able to self-generate electricity with solar
- This has been modelled to understand whether the economics are better for a customer that has made the investment into solar and therefore reduces their exposure to wholesale electricity costs

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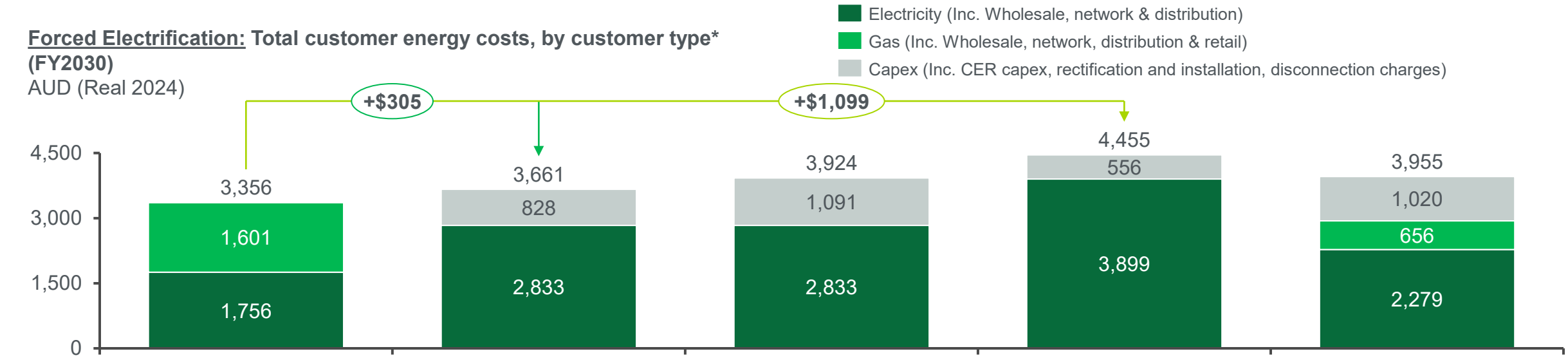
In FY30, customers that have electrified due to the Building Electrification RIS are worse off

Customer level impact

Forced Electrification: Total customer energy costs, by customer type* (FY2030)
AUD (Real 2024)



VIC house-holds****	*c.980k*	*c.800k*	*Subset of customer type 2*	*c.410k*	*c.60k*
	Customer type A ***Ducted gas heating, gas cooktop and gas hot water***	***Customer type B*** ***Full disconnection from gas. Electrical appliances high-efficiency***	***Customer type C*** ***Full disconnection from gas. Electrical appliances high-efficiency*** *Requires additional capex*	***Customer type D*** ***Full disconnection from gas. Electrical appliances low-efficiency***	***Customer type E*** ***Remains connected but with reduced usage. Gas cooktop, electric hot water, and electrical heating*** *Invests in solar*
	Gas network connected	***Disconnected***	***Disconnected***	***Disconnected***	***Gas network connected***

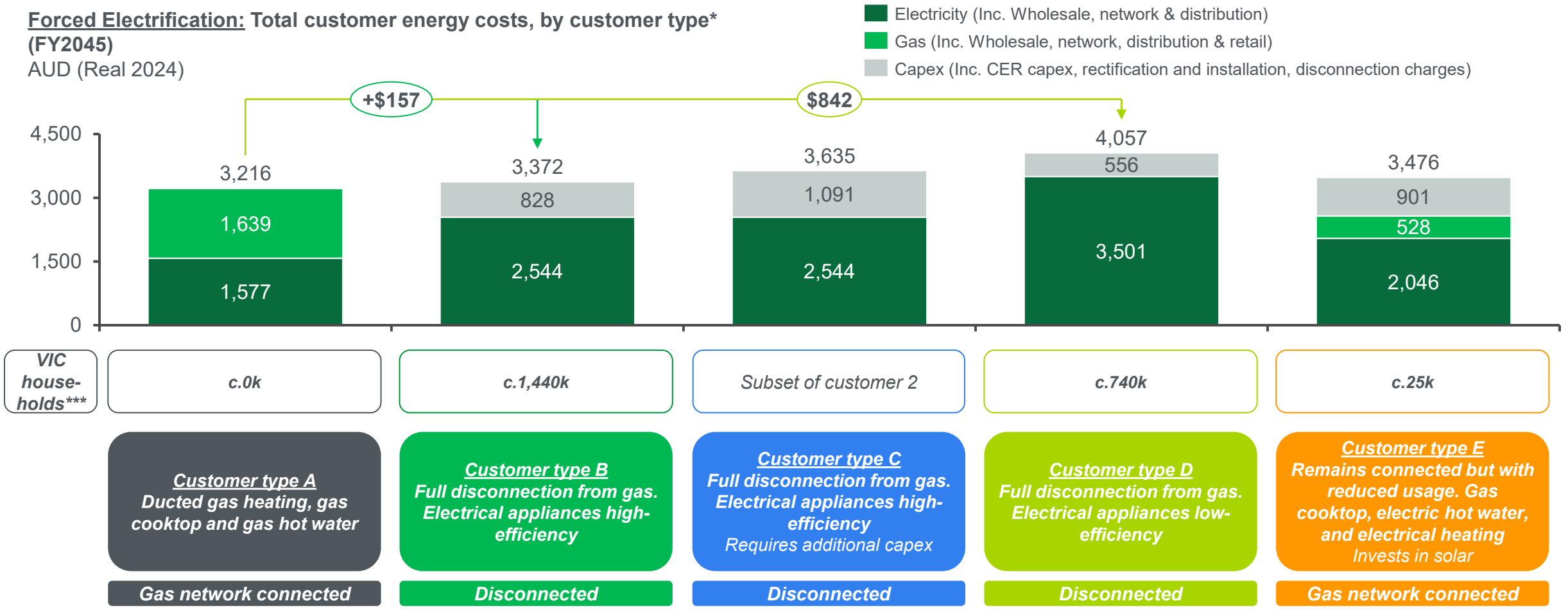
Note: * Energy includes the cost of gas, electricity and amortised electrification costs (excludes ICE fuel costs)
Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

The average Victorian house is assumed to have three bedrooms, single storey & free standing. Gas space heating in two rooms

By 2045, electrified customers are still worse off compared to customer archetype A, with total costs 5% greater for high efficiency electrification and 26% greater for low efficiency electrification

Customer level impact

Forced Electrification: Total customer energy costs, by customer type* (FY2045)
AUD (Real 2024)



VIC household***	c.0k	c.1,440k	Subset of customer 2	c.740k	c.25k
	Customer type A Ducted gas heating, gas cooktop and gas hot water	**Customer type B** Full disconnection from gas. Electrical appliances high-efficiency	**Customer type C** Full disconnection from gas. Electrical appliances high-efficiency. Requires additional capex	**Customer type D** Full disconnection from gas. Electrical appliances low-efficiency	**Customer type E** Remains connected but with reduced usage. Gas cooktop, electric hot water, and electrical heating. Invests in solar
	Gas network connected	Disconnected	Disconnected	Disconnected	Gas network connected

Note: * Energy includes the cost of gas, electricity and amortised electrification costs (excludes ICE fuel costs);
Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

The average Victorian house is assumed to have three bedrooms, single storey & free standing. Gas space heating in two rooms

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We have examined the effect of Forced Electrification on the major customer cost components derived from three models – including the impact on energy bill components, customer capex and emissions

	Wholesale modelling	Network modelling	Customer cost modelling
System wide / customer costs	• **Wholesale costs (gas):** Total wholesale cost derived from total gas consumption in VIC (incl. residential, commercial, industrial and GPG) and $/GJ • **Wholesale costs (electricity):** Total wholesale cost based on VIC electricity demand and wholesale electricity price ($/MWh) **Note:** This analysis uses a combination of economic assumptions and practical historical build rates to determine the entry rate for new electricity generation capacity. This differs from the assumptions in AEMO's ISP, which assumes state and federal targets for generation entry are met without consideration of economic criteria or historical build rates. See page 26 for details.	• **Distribution and transmission (gas):** Distribution and transmission costs across VIC based on estimated network capex and opex. Opex includes the cost associated with safe disconnection • **Distribution and transmission (electricity):** Distribution and transmission costs across VIC, including the costs of any additional investments needed to meet new peak demand under the RIS **Note:** This analysis assumes the major infrastructure projects specified in AEMO's ISP are all delivered, but we apply delays of 1-2 years vs. AEMO's assumptions to align to current expected project timelines. See page 26	• **Customer electrification capex:** Total incremental cost associated with electrifying gas assets. Cost includes the incremental appliance capex, as well as the installation and rectification and disconnection charge borne by consumers. These costs have been amortised over the life of the asset **Note:** This analysis uses a higher capex cost for electrification than assumptions adopted by DEECA. Our analysis is based on data gathered by ACIL Allen and Frontier Economics directly from gas and electric appliance installers in Victoria in 2022. • **Customer CER Capex:** Capex associated with solar PV, BTM storage, and incremental EVs • Excludes ICE vehicle petrol costs
Emissions	• **Generation emissions:** Emissions (and shadow emission costs) associated with coal, gas peaker and mid-merit gas technology		• **Gas consumption emissions:** Emissions (and shadow emissions costs) associated with gas appliance consumption

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A number of inputs and assumptions are used to drive the analysis

	Wholesale modelling	Network modelling	Customer cost and emissions modelling

Key inputs	• Electricity demand assumptions
	• Electricity supply-side assumptions:
	  – Costs of investment and operation of different generation types
	  – Committed investment plans for generation and transmission (incl. state govt targets)
	  – Coal retirement plans
	• Gas demand assumptions
	• Gas supply assumptions
		• Existing electricity and gas network investment plans
		• Current price determinations
		• Future regulatory determination assumptions
		• Future network throughput and peak demand
			• Customer investment plans, timing and costs:
			  – Capex for electrification asset types and associated costs; timing of electrification investments
			  – Capex for other CER investments
			• Current and forecast fuel consumption
			• Forecast fuel costs

Key outputs	• New generation capacity investments and retirements
	• Wholesale electricity price and energy cost
	  – NEM electricity supply/demand balance by dispatch period (30 mins), for each period 2025-2050
	• Gas supply/demand balance and cost
	• Future network throughput and peak demand
		• Electricity network capex and opex
		• Electricity network revenue and costs / tariffs
		  – Average price (c/kWh)
		• Gas network costs
			• Total costs related to energy consumed in residential / commercial premises
			• Emissions from electricity and gas generation across the NEM
			• Emissions from gas consumed in Victoria
			• Cost impact for different customer archetypes

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Modelling sources and assumptions – 'whole of energy system' (1 of 2)

Demand assumptions (FY25-45)	Source / Notes	Values	
Wholesale costs (electricity)	Endgame Analytics modelling based on changes to electricity consumption	Average load weighted wholesale price (RIS): FY30: 172 ($/MWh) FY45: 146 ($/MWh)	Average load weighted wholesale price (No RIS): FY30: 166 ($/MWh) FY45: 143 ($/MWh)
Wholesale costs (gas)	AEMO ISP GPG fuel prices - *Step Change scenario*	Average across Victorian GPG units: FY25 - $17.35 ($/GJ) FY45 - $14.01 ($/GJ)	
Generation emissions	**Emissions factor**: National Greenhouse and Energy Reporting (NGER)	Generation type: Coal - 1.3 (t/MWh) Gas Peaker - 0.54 (t/MWh) Mid-Merit Gas - 0.56 (t/MWh)	
	Emissions price: AER's Value of Emissions Reduction (VER)	FY25 - 75.55 ($/t) FY45 - 307.91 ($/t)	
Distribution and transmission (electricity)	Consistent with the approach in *The Time Is Now*, distribution costs reflect approved and forecast network capital and operating expenditures without increased electrification, with additional peak load for electrification used as a driver for additional distribution network investment	Total network MAR (RIS): FY25 - $3,233m FY30 - $3,553m FY45 - $4,661m	Total network MAR (No RIS): FY25 - $3,233m FY30 - $3,518m FY45 - $4,518m
Distribution and transmission (gas)	*AGIG & AusNet Network Modelling* – Includes opex associated with disconnections**	Total network MAR (RIS): FY25 - $700m FY30 - $738m FY45 - $385m	Total network MAR (No RIS): FY25 - $700m FY30 - $745m FY45 - $509m
Customer electrification capex	*ACIL Allen - Renewable Gas Target 2024* - Incremental capex costs from gas to electric asset including appliance cost, installation and rectification	Residential: Cooktops - $823 Water heating - $2,661 Space conditioning - $9,199	Commercial*: Cooktops - $823 Water heating - $8,117 Space conditioning - $36,595
Gas consumption emissions	**Gas consumption**: L.E.K. modelling	Residential / Commercial consumption (RIS): FY25:119 PJ FY45: 5 PJ	Residential / Commercial consumption (No RIS): FY25: 119 PJ FY45: 59 PJ
	Emissions factor: National Greenhouse and Energy Reporting (NGER)	Emissions factor - 51.53 (Tonnes of CO_2/GJ)	

Note: * Commercial electrification CAPEX has been scaled up / down depending on the building size and primary use case; ** The Gas Substitution Roadmap has capped customer disconnection fees for customers at $220 (excl. GST), consequently, the $220 charge has been allocated to the customer archetypes and the remaining c.$730 has been allocated to network Opex costs

All prices are in real FY24 dollars

Modelling sources and assumptions – 'whole of energy system' (2 of 2)

Supply assumptions (FY25-45)	Assumptions	Rationale
Federal renewable energy targets (RET)	• Excluded & subject to economic entry	• Assumes investors in new generation capacity require an economic return in order to invest • Storage targets are assumed to be met as storage has favourable economics during periods of wholesale price volatility and system constraints
State RET pre-FY2030	• Excluded & subject to economic entry; some policies might not be met – VIC storage target met – 2.6GW	
State RET post-FY2030	• Excluded & subject to economic entry; some policies might not be met – VIC storage target met – 6.3GW	
Infrastructure timing	• Committed projects: – Snowy 2.0 – Dec 2031 – VNI West – Dec 2032 – Marinus Link Stage 1 – Dec 2033 • Delayed Loy Yang A retirement: – 2 units retire in FY35 – 2 units retire in FY36	• Assumes major infrastructure projects are delivered as per AEMO's ISP optimal development pathway, but with 1-2 year timing delays consistent with delays to other large energy infrastructure projects in the NEM • Assumes Loy Yang A retirement is slightly delayed to meet expected generation shortfalls in the Victorian region
Build limit	• 4GW/year new VRE across the NEM (onshore wind + solar) before 2030 • Constrained onshore wind build: – 1.5GW/year (FY27-28) – 2GW/year (FY29-30) – Constraint increases by 1GW/year from FY30-45 • No constraints to offshore wind build, but subject to economic entry • Allow PHES build from FY35 • VIC gas peakers: – Allow new entrants (FY34) – 3GW total gas capacity – ISP	• Assumes the build rate for new onshore wind generation capacity in the NEM is constrained at levels consistent with the highest historical build rates due to ongoing limitations from supply chains, planning approvals, and social licence. These constraints are assumed to relax over time

Modelling limitations: the modelling assumptions include a number of limitations that collectively may understate the increased system cost impacts of the Building Electrification RIS

Modelling limitations	Limitation	Potential impact
Electrification Load Curves	• Modelling applies the AEMO load curves for the electrification load profile that results from conversion of gas appliances to electricity on a time of day basis. Some analysis suggests that these curves may under-estimate the 'peakiness' of demand from gas networks and as a consequence may underestimate the additional peakiness from electrification	• A more peaky electrification load would result in more system constraints and higher prices during peak periods
Impacts of other new electricity loads	• Our modelling uses AEMO's load forecasts for Victoria from the 2024 Integrated System Plan. These forecasts may underestimate the impact of new large loads (e.g. data centres) that have been announced in the past 18 months	• If larger data centre loads eventuate these may place further pressure on electricity demand in Victoria, leading to higher prices
Impacts of renewable gas	• Our analysis does not include a future role for renewable gas, which could reduce emissions from continued use of gas appliances	• If a role emerges for renewable gas the emissions profile of customer archetypes that continue to use gas appliances will fall, further reducing the emissions benefit of Forced Electrification
Practical limitations on electrification	• Our modelling assumes that electrification under the Forced Electrification scenario is possible at the rates and timelines proposed under the Building Electrification RIS. Practical constraints that may impact the implementation (e.g. supply chain constraints, availability of electricians) have not been applied.	• The presence of practical constraints may slow the pace of electrification, changing the profile and realisation of benefits vs. our modelling

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Modelling sources and assumptions – Customer archetypes (1 of 2)

Customer bill assumptions (FY2030)	Source	Customer A *All gas*	Customer B *All high efficiency electric*	Customer C *All high efficiency electric w/ additional capex*	Customer D *All low efficiency electric*	Customer E *Gas cooktop & water, high efficiency electric conditioning + Solar*
Total electricity demand (kWh)	*ACCC's 2023 Inquiry into the NEM report*	5,232	8,443	8,443	11,619	8,258
Wholesale electricity costs ($/kWh)	*Endgame Analytics Modelling*	No RIS – $0.166, RIS – $0.172				
Network electricity costs ($/kWh) (transmission and distribution)	*Consistent with the approach in The Time Is Now*	No RIS – $0.067, RIS – $0.070				
Retail electricity costs and margin (% of total bill cost)	*Essential Services Commission of Victoria 2024 VDO review*	25%				
Total electricity costs ($AUD)		**1,756**	**2,833**	**2,833**	**3,899**	**2,279***
Total gas demand (MJ)	*ENA - 2022/23 Gas Network Benchmarking Report*	46,600	-	-	-	1.398
Wholesale gas costs ($/MJ)	*AEMO ISP GPG fuel prices - Step Change scenario*	c.$0.012				
Network gas costs ($AUD per connection)	*AGIG & AusNet Network Modelling*	No RIS – $340, RIS - $376				
Retail gas costs and margin (% of total bill cost)	*ACCC Gas Inquiry Report*	40%				
Total gas costs ($AUD)		**1,601**	-	-	-	**656**

Note: * Includes reduction from PV self consumption

All prices are in real FY24 dollars

Modelling sources and assumptions – Customer archetypes (2 of 2)

Customer bill assumptions (FY2030)	Source	Customer A *All gas*	Customer B *All high efficiency electric*	Customer C *All high efficiency electric w/ additional capex*	Customer D *All low efficiency electric*	Customer E *Gas cooktop & water, high efficiency electric conditioning + Solar*
Incremental capex - $AUD *(Amortised over average asset life - c.14 years)*	*ACIL Allen - Renewable Gas Target 2024* *Frontier Economics - Cost of switching from gas to electric appliances* *ATO*	-	12,683 *(816)*	12,683 *(816)*	8,497 *(544)*	11,680 (747)
Disconnection fee - $AUD *(Amortised over forecast period - 20 years)*	*Gas Substitution Roadmap*	-	242 *(12)*	242 *(12)*	242 *(12)*	-
Additional capex* - $AUD *(Amortised over forecast period - 20 years)*	*Frontier Economics - Cost of switching from gas to electric appliances in the home*	-	-	5,250 *(263)*	-	-
Solar system size - kW	*Energy Council Solar Report Q3 2023*	-	-	-	-	6.7
Avg. yearly generation - kWh	*Australian Renewable Energy Agency*	-	-	-	-	9,782
PV self-generated consumption - %	*Australian Renewable Energy Agency*	-	-	-	-	15
Solar system capex - $AUD *(Amortised over average asset life - c.25 years)*	*CSIRO GenCost for rooftop PV*	-	-	-	-	8,790 *(273)*

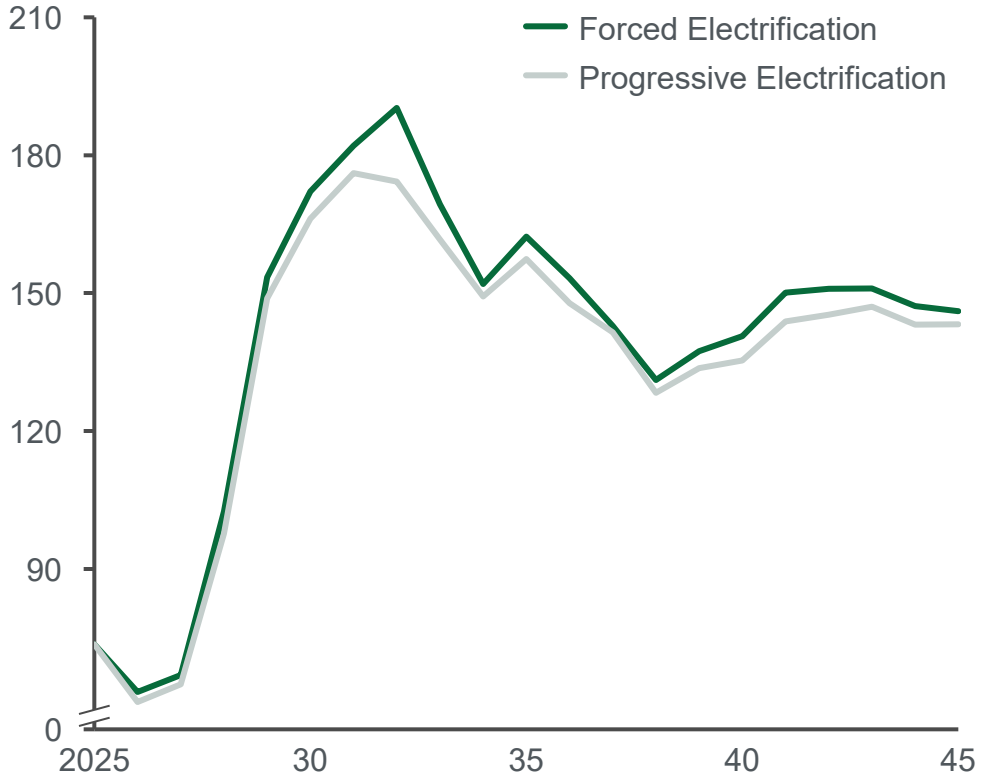
Note: * Additional capex = Cost of a power supply upgrade for a typical Victorian house

All prices are in real FY24 dollars

Contents

Electricity prices are the primary driver causing a delta between RIS and no RIS scenarios. The RIS adds an additional $5-15/MWh, increasing electricity prices to c.$190/MWh by FY2032

VIC: Load weighted average Regional Reference Price (RRP) (FY2025-45)
$/MWh (Real 2024)

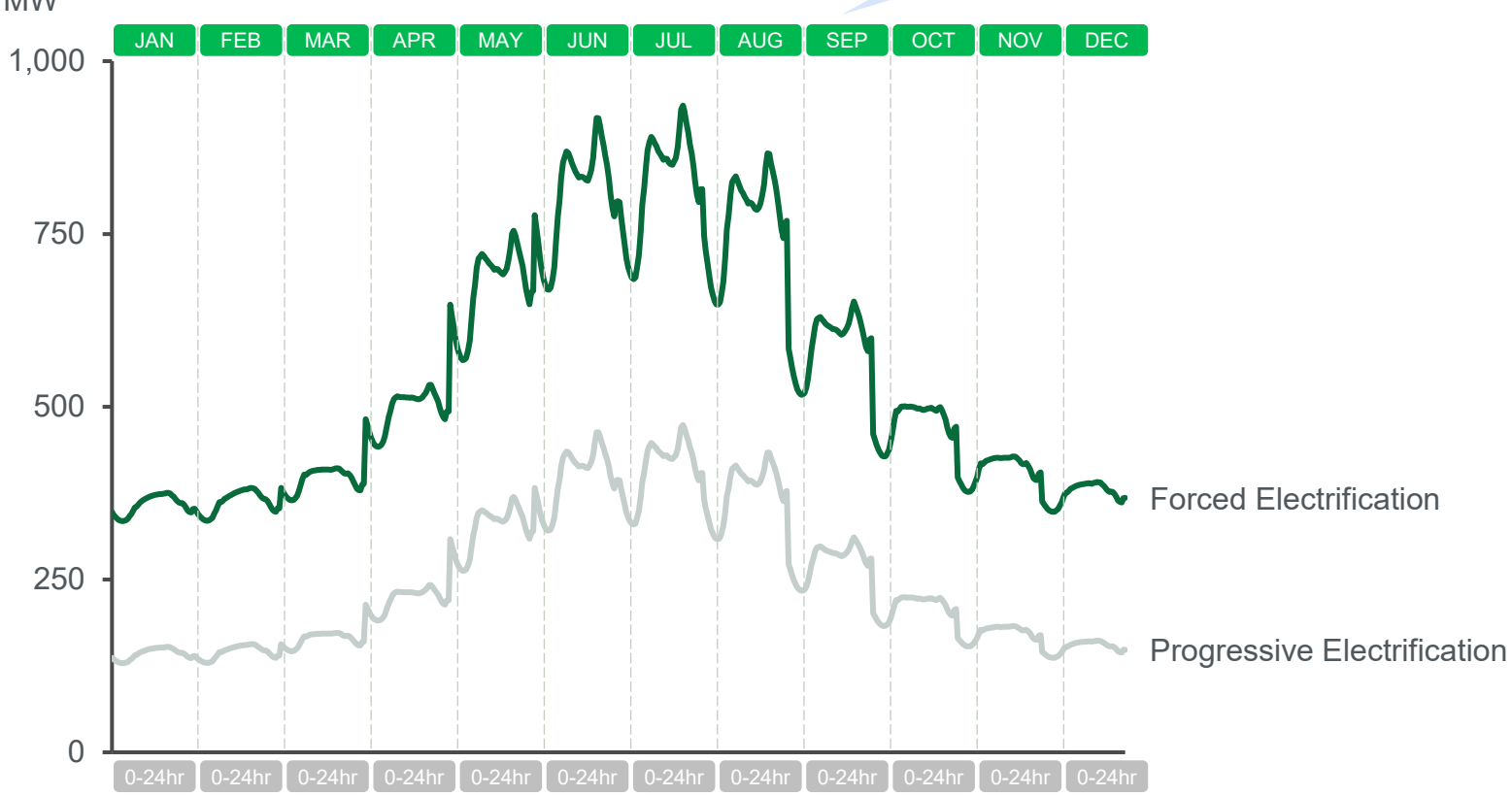


- Our modelling assumes coal plant retirements occur in line with AEMO's ISP and currently announced retirement plans. We assume addition of new renewable generation capacity and supporting transmission in line with the ISP optimal development pathway, but with practical constraints applied to the pace at which new generation is built and new transmission completed (see page 26 for full detail)
- The net result of brown coal retirement, and the expected pace of wind and solar capacity additions, means that wholesale electricity prices in Victoria are expected to increase significantly relative to today (this is consistent with modelling under the ISP, and L.E.K./ENA's *The Time is Now* report)
- As transmission interconnectors are completed and additional wind and solar enters the system from the early 2030s downward pressure is placed on prices, stabilising at levels c.2x current prices
- Wholesale prices are c.$5 / MWh higher on average under the Forced Electrification (RIS) scenario (compared to under the Progressive Electrification scenario), with a wider gap observed in the early 2030s when electricity supply is most constrained
- Under Forced Electrification, the system faces additional pressure to reliably supply electricity – with there being c.10 more hours on average per year of electricity prices exceeding $500/MWh each year under the RIS scenario
- There are several factors of uncertainty which could further exacerbate the impact of the RIS:
  - These prices are based off AEMO's half-hourly demand forecasts for electrification demand. Some analysis suggests that electrification demand could be peakier than AEMO forecasts (ie. more concentrated in periods of high demand), which would place further upwards pressure on wholesale prices and electricity network costs, especially during critical peak periods during winter when renewable electricity supply is also low (see page 15)
  - Additional demand from data centres has not been incorporated, which could drive further increases in wholesale prices

Source: Endgame Analytics modelling; L.E.K. analysis

The Forced Electrification scenario exacerbates the existing electricity load in the winter months and the demand peaks in the morning and evening

VIC: Average load demand, by 30min time intervals and month (FY2030)

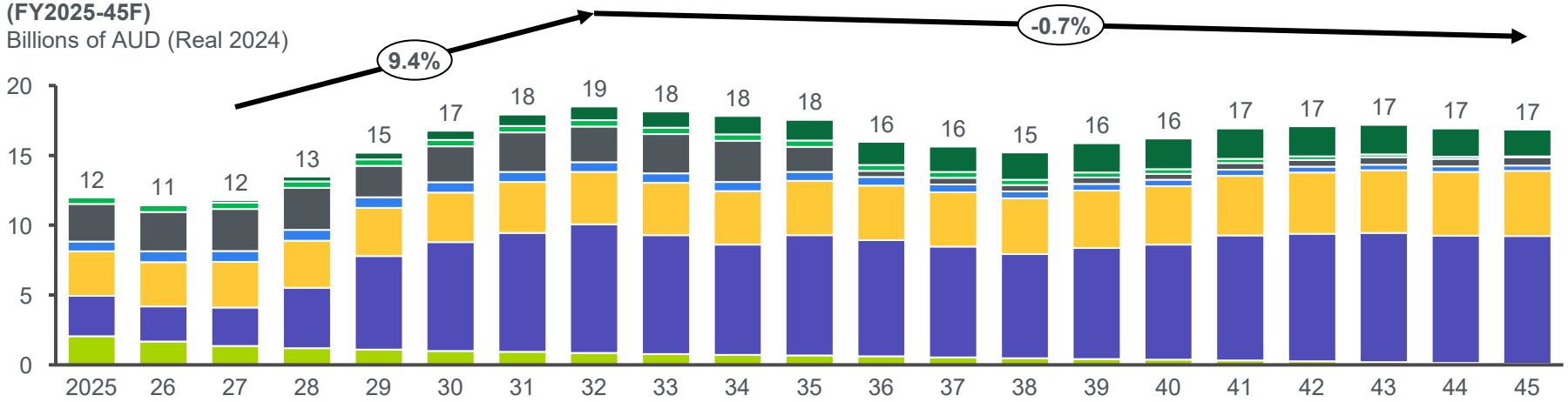


- Since most residential gas is used for space heating in VIC, the additional electrification load is primarily seen in the winter months
- The winter profile is peakier than the summer profile due to residential space heating use
- Over summer the profile is flatter as the business electrification load makes up a larger proportion of the profile

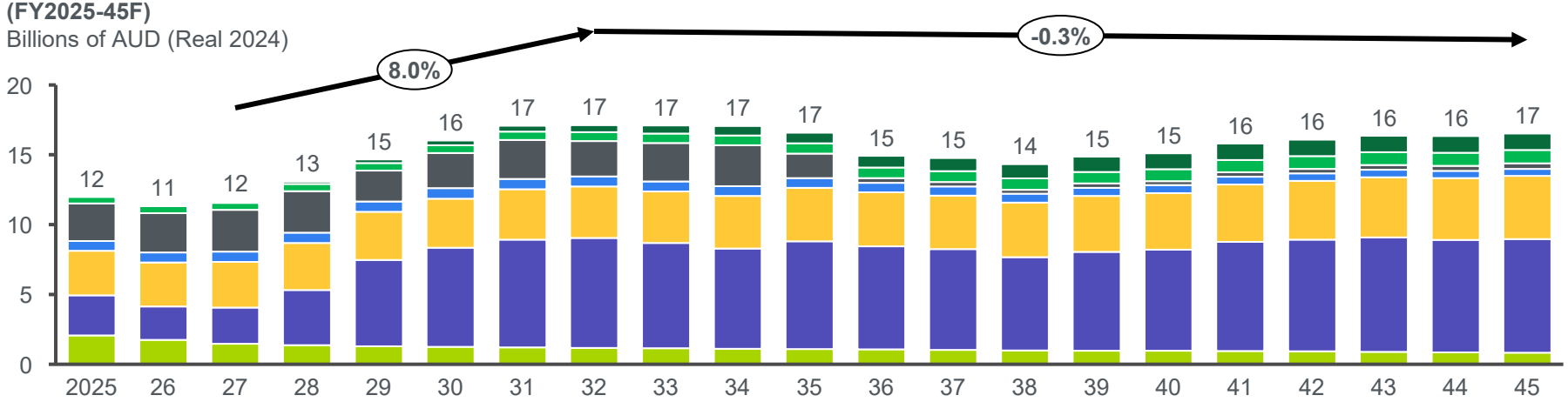
Source: Endgame Analytics modelling

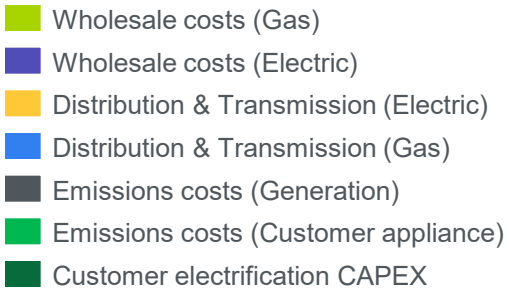
Forced Electrification causes total energy system costs in Victoria to grow by c.9% from FY27-32, compared to 8% under Progressive Electrification, primarily driven by wholesale electricity costs

Forced Electrification cumulative system cost - by cost category (FY2025-45F)
Billions of AUD (Real 2024)



Progressive Electrification cumulative system cost - by cost category (FY2025-45F)
Billions of AUD (Real 2024)



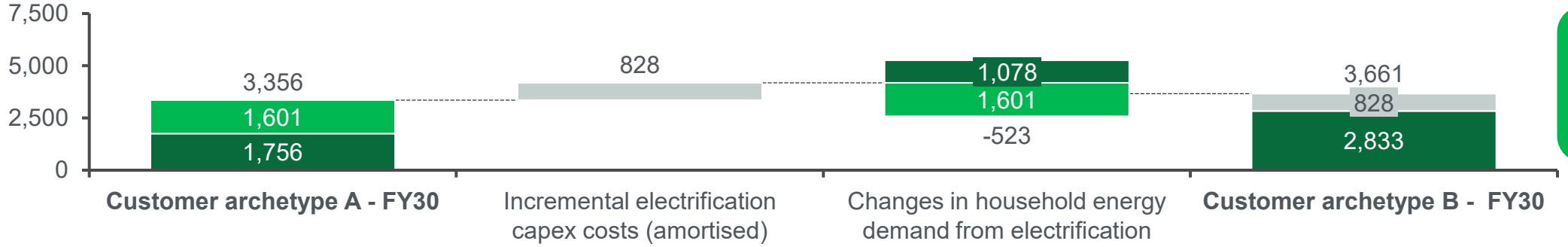


Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

Customers that electrify their gas appliances face higher costs due to the additional investment in appliances, and the projected rise in electricity prices

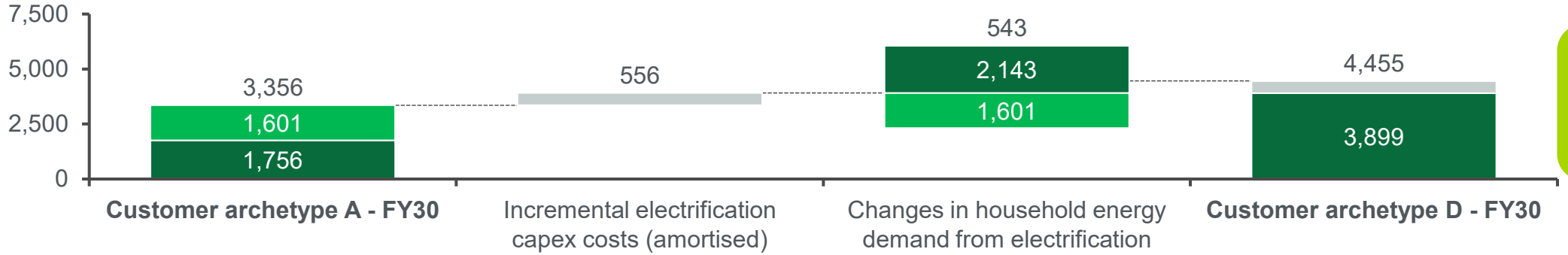
Forced Electrification: Customer archetype A conversion to archetype B, by incremental costs (FY2030)
AUD

Average wholesale costs
Electricity (Inc. Wholesale, network & distribution) 172 ($/MWh)
Gas (Inc. Wholesale, network, distribution & retail) 12 ($/GJ)
Capex (Inc. CER capex, rectification and installation, disconnection charges)



Customer type B
Full disconnection from gas. Electrical appliances high-efficiency

Forced Electrification: Customer archetype A conversion to archetype D, by incremental costs (FY2030)
AUD



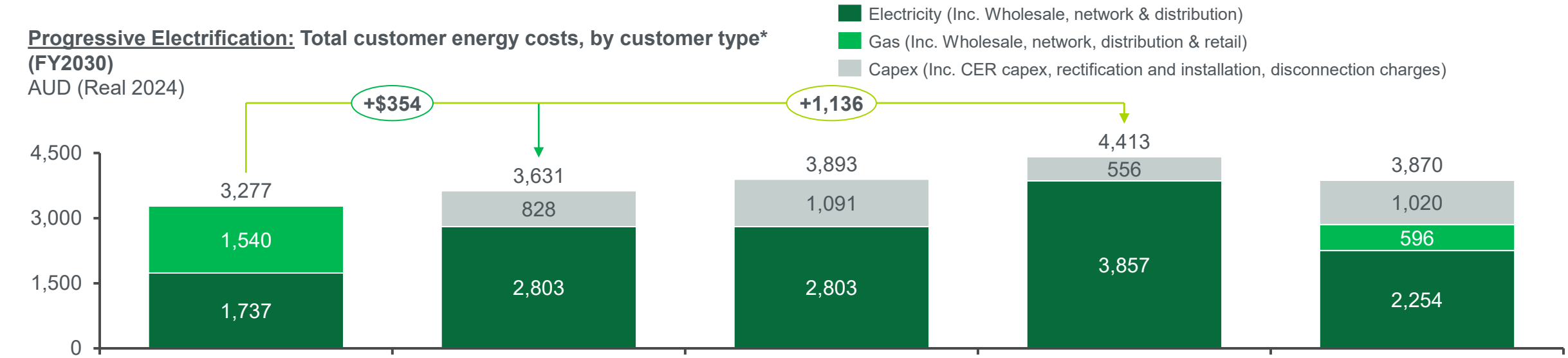
Customer type D
Full disconnection from gas. Electrical appliances low-efficiency

Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

In FY30, customers that have electrified due to Progressive Electrification are worse off

Customer level impact

Progressive Electrification: Total customer energy costs, by customer type* (FY2030)
AUD (Real 2024)



VIC house-holds**	c.1,260k	c.610k	Subset of customer type 2	c.320k	c.60k
	Customer type A Ducted gas heating, gas cooktop and gas hot water	**Customer type B** Full disconnection from gas. Electrical appliances high-efficiency	**Customer type C** Full disconnection from gas. Electrical appliances high-efficiency. Requires additional capex	**Customer type D** Full disconnection from gas. Electrical appliances low-efficiency	**Customer type E** Remains connected but with reduced usage. Gas cooktop, electric hot water, and electrical heating. Invests in solar
	Gas network connected	Disconnected	Disconnected	Disconnected	Gas network connected

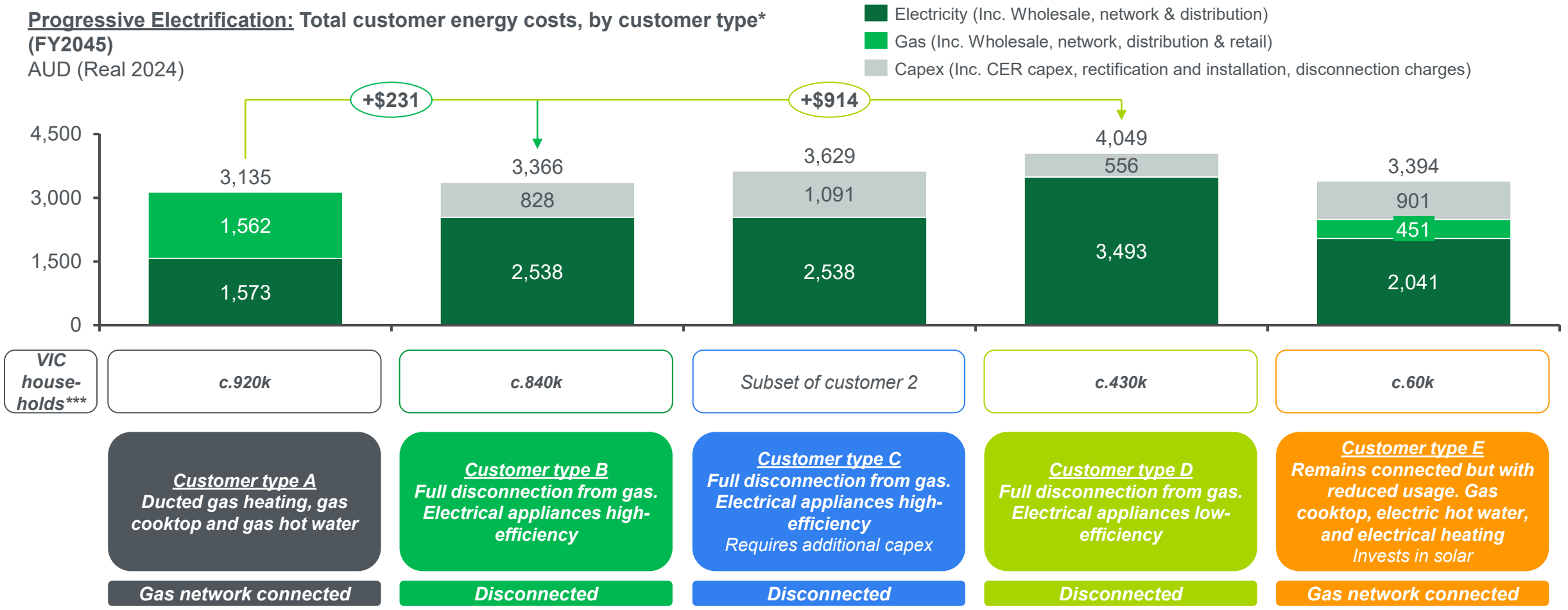
Note: * Energy includes the cost of gas, electricity and amortised electrification costs (excludes ICE fuel costs);
Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

The average Victorian house is assumed to have three bedrooms, single storey & free standing. Gas space heating in two rooms

By 2045, electrified customers are still worse off compared to customer archetype A, with total costs 7% greater for high efficiency electrification and 29% for low efficiency electrification

Customer level impact

Progressive Electrification: Total customer energy costs, by customer type* (FY2045)
AUD (Real 2024)



Note: * Energy includes the cost of gas, electricity and amortised electrification costs (excludes ICE fuel costs);
Source: AEMO Draft 2024 ISP; AEMO GSOO 2024; ABS; ACIL Allen; AER; AEMC; Australian National Greenhouse Accounts Factors; Climate Council; Endgame Analytics; L.E.K. Modelling

The average Victorian house is assumed to have three bedrooms, single storey & free standing. Gas space heating in two rooms