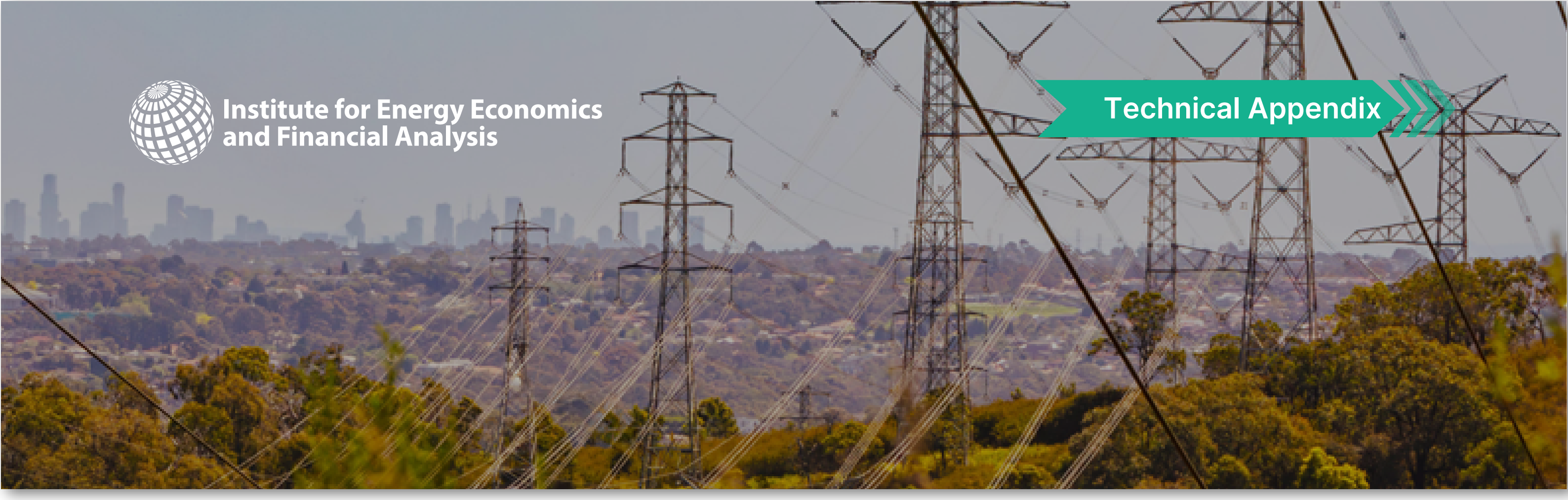

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Technical appendix: Modelling the impact of electrification regulations in Victoria

This technical appendix accompanies the IEEFA briefing note: **Electrification regulations in Victoria would lower energy bills and reduce gas supply gaps**

It details the approach and key assumptions for three broad modelling approaches used in the analysis:

1. Modelling of energy bill savings and costs
2. Modelling of statewide impacts on residential gas demand
3. Modelling of aggregated energy bill savings and costs

Modelling energy bill savings and costs of electrification

IEEFA has used a custom household energy use model to analyse the following:

- Expected energy bill savings and upfront costs of electrification for a typical household under three Regulatory Impact Statement (RIS) options, and;
- Expected incremental energy bill savings and upfront costs incurred for the electrification of individual household appliances.

Outline of modelling approach

The household energy use model accepts a series of typical hourly household load profiles across several categories:

- Thermal loads (heating and cooling)
- Hot water loads
- Cooking loads
- Other loads

The model then analyses the hourly electricity and/or gas required to meet these loads under a baseline and comparison case, given a set of assumptions for the appliance configuration used, NatHERS star rating of the house, and typical household size.

Rooftop solar can be added to either the baseline or comparison case at any specified capacity.

The model then calculates the energy costs faced by the household, based on a selected gas and electricity tariff. If a time-of-use tariff is selected, the time of energy consumption is taken into account. Solar self-consumption, exports and feed-in tariff income are accounted for if rooftop solar is enabled.

Several types of upfront costs can be specified for both the baseline and comparison case. This includes purchase and installation cost of appliances, purchase and installation cost of rooftop solar, upfront charges to abolish the gas connection, incidental costs such as switchboard upgrades, and gas appliance removal costs.

The modelling in this analysis assumes that upfront purchase and installation costs would apply for both the baseline and comparison appliance configuration. In other words, it shows the cost difference between the two potential appliance configurations if replaced at end of life.

The model compares results both with and without the impact of rebates under the Victorian Energy Upgrades (VEU) scheme and Small-scale Renewable Energy Scheme (SRES). The impacts of these rebates are used for discussion purposes only and are not counted in the core results of the analysis, recognising that these schemes operate as cross-subsidies that are paid for by energy consumers.

Key model outputs include energy bill savings, upfront costs and payback periods, and final time-of-use energy consumption profiles.

Energy consumption profiles for this analysis are based on a typical household in Melbourne. This is likely to be a conservative approach, when considering that cooler regions of Victoria are likely to have higher household gas consumption in winter, and would therefore experience larger energy bill savings from electrification.

Key modelling assumptions

Key modelling assumptions for the household energy model are summarised below:

Table 1: Key modelling assumptions used in the household energy model

Assumption	Source	
Baseline time-of-use profiles	**Thermal loads:** • Mohseni et al. 2023, Residential load profiles for Heyfield, Victoria. (Calibrated to NatHERS annual load profiles) **Hot water loads:** • Uncontrolled: Mohseni et al. 2023, Residential load profiles for Heyfield, Victoria. • Midday-optimised: Analysis of load profile data provided by Solar Analytics	**Cooking, lighting and other loads:** • EnergyConsult (2021), Residential Baseline Study for Australia and New Zealand for 2000 to 2040 – Power demand by time of use data.
Appliance efficiencies / coefficients of performance (CoP)	**Heating:** • Gas ducted heating: 72% (based on a furnace efficiency of 90% with 20% ducting losses) • Gas room heating: 95% (EnergyRating; assumed maximum furnace efficiency of a new 5-star heater) • Reverse-cycle air-conditioner (RCAC): 3.95 CoP (Average of minimum required heating seasonal performance factors for units < 4kW and 4-7kW under the VEU scheme) **Cooling:** • RCAC: 3.17 (based on the average difference in measured heating versus cooling CoP of RCACs in the GEMS database) • Older-style refrigerative air-conditioner: 2.38 (assumed 25% lower efficiency than a modern unit)	**Hot water:** • Gas instant hot water: 86% (Renew) • Gas storage hot water: 70% (Renew) • Heat pump hot water: 3.5 CoP (Reduced for conservatism; average CoP across available models was previously found to be 4.17) **Cooking:** • Gas cooktop: 40% (Renew) • Electric induction cooktop: 80% (Renew)
Thermal load limits by NatHERS star rating	**Total annual load limits:** • Drawn from current NatHERS Star bands	**Estimates of heating versus cooling loads:** • Tony Isaacs Consulting Pty Ltd
Constraint factor	75% (Climateworks Centre) This is the proportion of the total thermal load that is actually assumed to be met, after accounting for occupancy and non-conditioned floor areas.	
Typical energy consumption by household size	Frontier Economics, Simple electricity and gas benchmarks (Used to make adjustments for energy consumption of different household sizes)	
Average household size in Victoria	2.5 people (ABS, 2021 Census Data)	
Typical rooftop solar output profiles	Australian Energy Market Operator (AEMO; extracted from NEMWEB)	
Electricity and gas tariffs	Collected from Victorian energy retailers in January 2025. For each gas and electricity distribution region in Victoria: • The recommended energy plan was taken from each of the three major retailers (AGL, Origin and EnergyAustralia), which collectively hold about 50% of market share. • The three lowest-cost plans were taken from the EnergyMadeEasy website, reflecting a likely approach other Victorians would take to select an alternative retailer. Where available, both flat-rate and time-of-use electricity tariff options were recorded. Each model scenario involved calculating the energy bill savings under every valid combination of electricity network, electricity tariff, gas network and gas tariff out of the available dataset (124 combinations in total). All costs and savings used in the report reflect the average value from these model runs.	

Appliance purchase costs	**Heating and cooling:** • Gas ducted heater: $3,372 • Gas room heater: $1,214 • 3-4kW RCAC: $1,086 • 7-8kW RCAC: $1,828 All appliance purchase costs based on values used in previous IEEFA modelling, adjusted for inflation.	**Hot water:** • Gas instant hot water system: $1,440 • Gas storage hot water system: $1,776 • Heat pump hot water system: $2,659 **Cooking:** • Gas cooktop: $489 • Induction cooktop: $607
Appliance installation costs	**Heating and cooling:** • Gas ducted heater: $3,041(GHD) • Gas room heater: $379 (The Good Guys) • RCAC: $1,478 (The Good Guys plus added provision for a new circuit)	**Hot water:** • Gas instant hot water: $975 (Sydney Plumbing & Hot Water) • Gas storage hot water: $575 (Sydney Plumbing & Hot Water) • Heat pump hot water: $1,400 (Top end of range from Solar Choice, assuming a new circuit is required) **Cooking:** • Gas cooktop: $269 (The Good Guys) • Induction cooktop: $903 (The Good Guys plus added provision for a new circuit)
Additional appliance costs	Complex RCAC installation: • Add $841 (based on maximum end of range from Complete Electrical Service) Complex induction cooktop installation: • Add $500 (representing the costs to modify a stone benchtop – from The Stone Guy)	
Gas connection abolishment fee	$226 (inflated cost based on Australian Energy Regulator decision in 2023)	
Switchboard upgrade cost	$1,200 (Based on recent quotes obtained for a full switchboard replacement in Melbourne; applied in some "complex" cases)	
Available VEU rebates	Rebated costs are discussed for comparison purposes only and are excluded from the main results. Estimated Victoria Energy Efficiency Certificates (VEECs) based on the VEU registry calculator, for all relevant activities. The VEEC price as at March 2025 ($110/certificate) is discounted by 25% to $82.50, recognising that this price could change in future, and may not be passed on in full from appliance installers. The maximum VEU rebates have been capped at the level of estimated rebates featured in communications on the VEU website: • Space heating: $2,520/upgrade • Hot water: $520/upgrade • Cooking: $140/upgrade The VEU program is undergoing review, and the nature of these incentives may change in future.	
Available SRES rebates	Rebated costs are discussed for comparison purposes only, and are excluded from the main results. Estimated hot water system rebates based on the Clean Energy Regulator's STC calculator, with an installation date of 2026.	

Typical household configurations

Three example cases were referred to in the briefing note, to illustrate the likely impacts of Options 1, 3 and 2 & 4 on a typical household. The scenario settings for these cases are detailed in Table 2.

The design of these cases was informed by the following:

New homes in Victoria are required to be constructed to a 7-star NatHERS rating.

The average existing home in Victoria is likely to be equivalent to a 2-star NatHERS rating.

Gas ducted heating is the most common form of gas heating in Victoria according to the Residential Baseline Study.

Gas instant hot water is the most common form of gas hot water in Victoria according to the Residential Baseline Study.

Table 2: Configuration of baseline and comparison households used in model case studies

Scenario	Baseline configuration	
RIS Option 1 (Comparing a dual-fuel vs all-electric new home)	• Average household size • 7 NatHERS stars • Gas ducted heating • Single RCAC for cooling • Gas instant hot water • Gas cooktop	• Average household size • 7 NatHERS stars • Three RCACs for heating and cooling • Heat pump hot water • Induction cooktop
RIS Option 3 (Comparing a dual-fuel existing home versus one with electrified heating and hot water)	• Average household size • 2 NatHERS stars • Gas ducted heating • Older-style single refrigerative air-conditioner for cooling • Gas instant hot water • Gas cooktop	• Average household size • 2 NatHERS stars • Three RCACs for heating and cooling • Heat pump hot water • Gas cooktop
RIS Options 2 & 4 (Comparing a dual-fuel vs all-electric existing home)	• Average household size • 2 NatHERS stars • Gas ducted heating • Older-style single refrigerative air-conditioner for cooling • Gas instant hot water • Gas cooktop	• Average household size • 2 NatHERS stars • Three RCACs for heating and cooling • Heat pump hot water • Induction cooktop • Gas connection abolished

Modelling statewide impacts on gas demand

Outline of modelling approach

To model the impact of the proposed RIS options on residential gas demand in Victoria, IEEFA adapted gas appliance stock modelling that was previously used in our report Managing the transition to all-electric homes. This modelling is described in detail in the technical appendices to that report.

For this analysis, the following changes were made to the model:

- The modelling start year was updated to 2026 (with one sensitivity conducted for Option 3 with a start year of 2027).
- Under Option 1, electrification of gas appliances in existing dwellings was disabled.
- Under Option 1, we assumed that 20% of new homes would already be all-electric by default based on statistics from the Gas Substitution Roadmap.
- Under Option 3, electrification of gas cooktops in existing dwellings was disabled.
- A percentage of the appliance stock was excluded from the modelling to represent possible exemptions from the regulations.
- Several minor categories of gas appliances were ignored for simplicity, including gas-boosted solar hot water systems and gas ovens.

Assumed exemptions

The exemptions in Table 3 were applied to the modelling, which reduced the number of gas appliances electrified.

These exemptions should not be interpreted as recommendations, and they do not represent IEEFA's view of the likely scale of exemptions that would be required under the regulations.

Rather, they have been deliberately cast broad for the purpose of introducing conservatism to the analysis, ensuring that model outcomes reflect a reasonable minimum estimate of the reduction in gas demand under each RIS option.

In order to maximise the benefits of the proposed regulations, the Victorian government should constrain exemptions to be as narrow as practical. Casting exemptions that are too broad may leave a larger number of households at risk of high-cost lock-in, and may degrade the impact the regulations would have on mitigating gas supply gaps.

Table 3: Electrification exemptions included in the model

Exemption	Explanation	Impact in model
Inner-city terrace houses	Although many of these dwellings can be, and are, electrified, they face a higher likelihood of encountering: • Supply upgrade challenges; • Restrictions due to heritage overlays; • Space constraints, or; • Retrofit challenges when working with older construction methods. We have assumed that: • 75% of semi-detached dwellings in the LGAs of Melbourne, Yarra and Port Phillip are exempt. • 50% of semi-detached dwellings in the LGAs of Stonnington, Merri-bek, Moonee Valley, Maribyrnong and Hobsons Bay are exempt. Dwelling numbers are taken from ABS 2021 Census data accessed via TableBuilder.	Exclude **19%** of existing semi-detached dwellings in Victoria from any electrification measures.
Apartment buildings with bulk gas hot water systems	The Victorian government has proposed to exempt existing apartment buildings with bulk gas hot water systems from electrification. These systems are common in newer buildings, although data is scarce on the exact proportion.	Exclude **25%** of existing apartments from hot water electrification.
Apartments and townhouses with insufficient space for a heat pump hot water system	The Victorian government has proposed to exempt existing dwellings from electrification of hot water if there is inadequate space for a heat pump hot water system. We have assumed this could significantly affect apartments and, to a lesser extent, townhouses.	Exclude a **further 75%** of remaining existing apartments from hot water electrification. Exclude a **further 25%** of existing semi-detached dwellings from hot water electrification.
Apartments and townhouses with insufficient space for RCACs	The Victorian government has proposed to exempt existing dwellings from electrification of hot water if there is inadequate space for RCACs. We assume this is less challenging than hot water electrification, as there is greater potential to place outdoor split system units on balconies, or mounted against exterior walls, which could be common property.	Exclude **50%** of existing apartments from heating electrification. Exclude a **further 25%** of existing semi-detached dwellings from heating electrification.

When applied across the full stock of gas-connected dwellings in Victoria, these exemptions amount to 15.3% of dwellings being exempt from hot water electrification, 11.5% from heating electrification, and 3% from cooking electrification.

Aggregating costs and energy bill savings

To estimate the aggregated costs and energy bill savings of the regulatory measures for the state of Victoria, we have combined the two previous modelling approaches.

The appliance stock model provides an estimate of the number of gas appliances that would be retired and replaced with electric alternatives each year.

We have then used the household energy modelling to determine the incremental upfront costs and energy bill savings that would be experienced by a household that electrifies that appliance.

The appliance stock model also tracks the likely number of homes that would be able to fully disconnect from the gas network over time. We have assumed these households pay an upfront abolishment fee, and experience energy bill savings equivalent to the average fixed annual charge across all gas tariffs recorded in the model.

In reality, these fixed charges, and hence savings from disconnecting, would increase if the Australian Energy Regulator were to approve ongoing full cost-recovery for gas networks as households leave the network.

A discount rate of 4% was used to calculate the 10-year net present value (NPV). This aligns to the central scenario from the Victorian government's published modelling of the RIS options, which is based on state Treasury guidelines.

Differentiating household costs and savings

Different households will experience different costs and savings from electrification depending on the existing conditions of their household. It would be overly simplistic to multiply the costs and savings for a single typical household across every instance of electrification in Victoria.

Therefore, for each appliance that is electrified over time, we have considered a weighted average of the costs and savings that would be experienced by various cohorts of households. We have split these cohorts based on factors considered to be material to the economics of household electrification, described in Table 4.

Table 4: Cohorts of households assumed to face differing costs/savings from electrification

Cohort	Explanation	Impact in analysis
Households with existing rooftop solar panels	These households will likely experience higher benefits from electrification, as some of the electrified load will be met via solar self-consumption. This is nearly always more economical than exporting excess solar.	20% of new homes in Victoria will choose to install solar panels with an average system size of 9kW.[1] 15% of existing gas-connected homes in Victoria already have solar panels, with an average system size of 5kW.[2]
Households with an existing RCAC for cooling	These households will likely experience lower upfront costs when electrifying, as they are able to use their existing RCAC to take up some of the electrified heating load.	42% of existing homes in Victoria with gas ducted heating have an RCAC for cooling. This assumption is ignored for homes replacing a non-ducted gas heater.

1 30% of new homes in Australia install solar panels. We have adjusted down to 20% to reflect potentially lower rates in Victoria. The average installed size of a new solar system in June 2024 was 9kW.
2 About 30% of existing Victorian homes have solar panels. We have halved this to 15% to account for a likely bias where many solar homes may already be electrified. We have assumed a conservative 5kW value for average solar capacity on existing homes, as the average capacity per installation has grown over time.

Households that shift their hot water loads to midday	It is generally advantageous to optimise electric hot water systems (including heat pumps) to use energy in the middle of the day when solar is abundant, while avoiding consumption during peak periods. Basic timer controls are standard in many heat pump models, and are already a requirement for appliances installed under the Solar Victoria program, meaning many new systems are likely to operate in the middle of the day.	50% of new heat pump hot water system installations are set to mostly operate in the middle of the day.
Households that face more complex appliance installations	Some electric appliance installations may be more complex and expensive than typical examples. For example: • Where the RCAC outdoor unit cannot be located close to the indoor unit; • Where modifications are needed to a stone benchtop to accommodate an induction cooktop, or; • Where a household's switchboard is not compliant with modern safety standards, and must be upgraded.	19% of households will face "complex" installation costs. This is a proxy based on the estimated number of dwellings that would require a switchboard upgrade in order to be electrified (Deloitte). This may be an overestimation, given we have assumed an exemption for most inner-city terrace houses.

Tables 5 to 8 show the final breakdown of weightings used in the analysis, for each type of gas appliance that could be electrified.

Table 5: Proportions of gas ducted heating cases

Existing solar panels?	Existing AC for cooling?	Simple or complex install	% of total appliance upgrades
No	Yes	Simple	28.9%
No	Yes	Complex	6.8%
No	No	Simple	39.9%
No	No	Complex	9.4%
Yes	Yes	Simple	5.1%
Yes	Yes	Complex	1.2%
Yes	No	Simple	7.0%
Yes	No	Complex	1.7%

Table 6: Proportions of gas room heating cases

Existing solar panels?	Simple or complex install	% of total appliance upgrades
No	Simple	68.9%
No	Complex	16.2%
Yes	Simple	12.2%
Yes	Complex	2.9%

Table 7: Proportions of gas hot water cases (applies to both instant and storage)

Existing solar panels?	Configuration of new heat pump	
No	Uncontrolled	21.3%
No	Optimised	63.8%
Yes	Uncontrolled	3.8%
Yes	Optimised	11.3%

Note: Optimised refers to a heat pump that consumes the majority of its energy around midday.

Table 8: Proportions of gas cooktop cases

Existing solar panels?	Simple or complex install	% of total appliance upgrades
No	Simple	68.9%
No	Complex	16.2%
Yes	Simple	12.2%
Yes	Complex	2.9%

Electricity price sensitivities

One of the biggest challenges with analysing long-term energy bill impacts is considering long-term changes in energy prices, which can be difficult to forecast even over the short term.

The core analysis in this briefing note assumes electricity and gas prices remain flat, at current levels.

For gas prices, we consider this to be a conservative view, as there are a number of pressures that could lead to long-term increases in retail gas prices, including:

Ongoing exposure to global LNG markets, including any future price volatility;

Additional infrastructure costs that would be incurred if greater volumes of gas were imported into Victoria via pipeline;

Additional costs that would be incurred if volumes of gas were imported into Victoria as LNG, and;

Additional costs that would be incurred if new production sources in Victoria were accessed, which are likely to be higher cost than Bass Strait sources.

For electricity prices, several analyses offer conflicting views of potential future price trends.

The Australian Energy Market Commission's (AEMC) Residential Electricity Price Trends 2024 report forecast that residential electricity prices in the National Energy Market (NEM) could decline by 13% between 2025 and 2034 under AEMO's Step Change scenario. This was driven by a combination of increasing renewable energy generation, and larger levels of household energy consumption (including from electrification) leading to lower unit network costs.

By contrast, Simshauser and Gilmore (2024) suggest that wholesale prices in Victoria could rise by as much as 75% by 2035, if renewable deployment is not co-ordinated with electrification. Recent analysis by Jacobs for the Clean Energy Council also found that retail electricity prices could be as much as 48% higher than the AEMC's forecast in 2030, under a scenario with slower renewables build and catastrophic coal plant failure.

IEEFA has not analysed these reports detail to provide a view on whether any of these scenarios are more or less likely than others. However, our research has identified a number of ways that policy action could drive lower electricity prices.

For example, there is a strong correlation between renewable generation and lower wholesale electricity prices – suggesting that the continued integration of renewable generation can drive down electricity prices.

We have also identified that regulated electricity networks in Australia made over $15 billion in supernormal profits between 2014 and 2023, which could be reduced through more effective regulation, leading to much lower network prices for consumers.

To manage the uncertainty in future electricity prices, we have modelled two additional sensitivities in addition to the "flat price" comparison:

A "low electricity price" sensitivity, where real retail electricity prices fall by 13% from 2025-2034 in line with AEMC forecasts, and continue this trend.

A "high electricity price" sensitivity, where real retail electricity prices rise at a rate consistent with the Jacobs "Reduced renewables build and catastrophic coal plant failure" scenario.

These sensitivities are applied as a simple scaling factor to the electricity bill impacts from the household energy model, as a time series to 2050.

The results of these sensitivities are shown in the statewide costs and savings graphs (Figures 1-3) in the briefing note. The "high electricity price" sensitivity resulted in lower energy bill savings in the long term, in the order of billions. However, even under this relatively extreme scenario, the savings of electrification far outweighed the costs, and the key recommendations of the report remain unchanged.