Efficient electrification for Australia's 2035 target – Policy brief

Executive summary

- This brief summarises analysis of modelling conducted by Climateworks Centre[1]. The scenario from which this analysis is derived is consistent with Australia decarbonising at least-cost and in line with the Paris Agreement temperature goals.
- Electrification and energy efficiency can contribute around 20% of the emissions reduction required to meet an ambitious 2035 target of 75% below 2005 levels.
- From 2026-2035 electrification and efficiency represent the largest abatement opportunity on the demand side, with average annual abatement of 33 $MtCO_2$-e (electrification) and 11 $MtCO_2$-e (efficiency). This compares to 3 $MtCO_2$-e per year for other fuel switching (e.g. hydrogen).
- Energy efficiency can offset increased demand from electrification of the stationary energy sector by up to 46 TWh (26% of the increase in electricity demand from electrification)
- Energy efficiency, electrification and the switch to renewables modelled in a high ambition scenario, could collectively double Australia's average annual energy intensity improvement rate between 2025 and 2030, aligning with Australia's COP28 pledge to double the rate of energy efficiency improvement by 2030.
- The analysis shows that meeting net zero emissions requires Australia's energy mix shifting from around 24% electricity today to 50% by 2035 and 61% by 2050. The Australian Government could support this shift by setting clear targets for electrification.
- The resources sector offers the largest abatement opportunity with annual average emissions reductions of 21 $MtCO_2$-e between 2026 and 2050.
- The built environment offers the second largest abatement opportunity, with annual average emissions reduction of around 20 $MtCO_2$-e between 2026 and 2050.
- Electrification of households could deliver the largest emissions reductions within the built environment, with 89% of total gas savings in the built environment coming from homes, primarily in Victoria.

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[1] Climateworks Centre, 2024, Climateworks Centre decarbonisation scenarios 2023: Paris Agreement Alignment for Australia, https://www.climateworkscentre.org/wp-content/uploads/2023/11/Climateworks-Centre-decarbonisation-scenarios-2023-April-2024.pdf

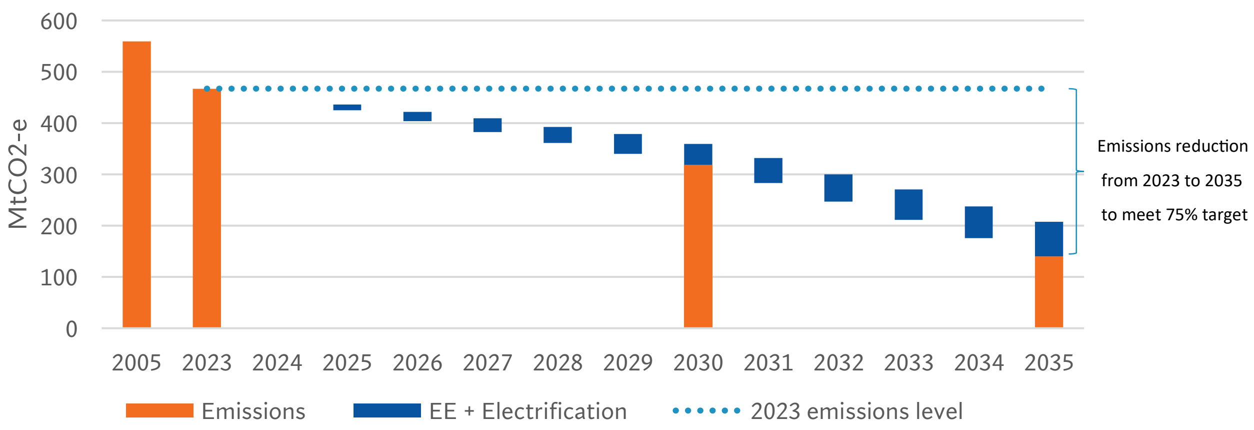
- Deployment of key technologies like heat pump hot water systems in homes needs to be about twice as fast to achieve the emissions reductions in this analysis.

Economy-wide (Energy)

Efficient electrification is a critical part of meeting an ambitious 2035 target

The Federal Government has committed to an emissions reduction target of 43% below 2005 levels by 2030, and net zero emissions by 2050.[2] The Climate Change Authority consulted on a 2035 emissions reduction target range of 65%-75% below 2005 levels[3], with the Government planning to confirm targets imminently. Figure 1 shows the contribution energy efficiency and electrification in stationary energy use can play in helping to meet ambitious emissions reduction targets. Energy efficiency and electrification could contribute around 20% of the emissions reductions required to meet a target of 75% below 2005 levels by 2035.[4]

Figure 1 - Emissions abatement from efficiency and electrification relative to national emissions reduction targets.



Note: Emissions in 2030 are the Australian Government's target of 43% below 2005 levels and emissions in 2035 are 75% below 2005 levels, the upper level of the range consulted on by the CCA.

Between 2026–2035 electrification and efficiency represent the largest abatement opportunity on the demand side, with average annual abatement of 33 $MtCO_2$-e (electrification) and 11 $MtCO_2$-e (efficiency). This compares to 3 $MtCO_2$-e per year for other fuel switching (e.g. from fossil fuels to

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[2] Parliament of Australia, 2022, [Australia legislates emissions reduction targets]

[3] Climate Change Authority, 2024, [Targets, Pathways and Progress] p. 6

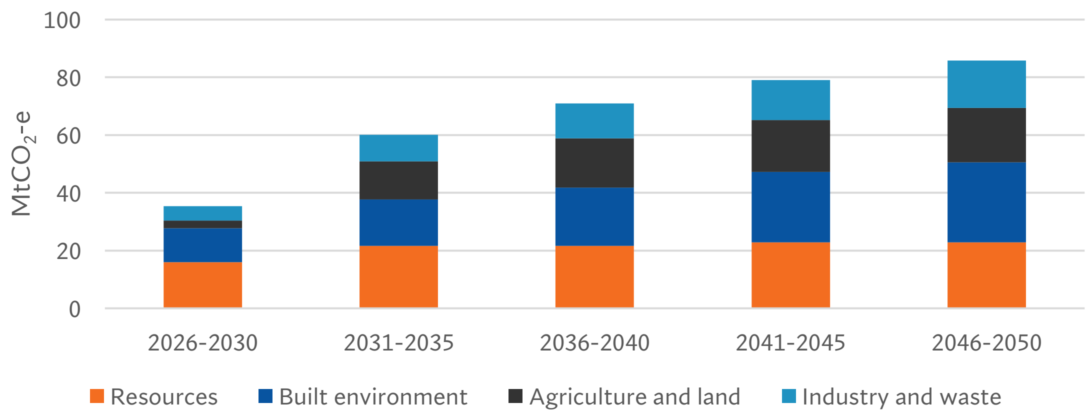
[4] Calculation based on the emissions reduction 'gap' between 'current emissions' (using data from 2023, the latest available inventory data) and emissions level required in 2035 to meet a target of 75% below 2005 levels.

biofuels or hydrogen). Opportunities to switch fossil fuel use to alternative fuels other than electricity increase after 2035, when these technologies mature.

This suggests that while Government investments in alternative fuels like green hydrogen are important and should continue, equivalent efforts should be invested in deploying efficient electric technologies at scale now, in time to meet an ambitious 2035 target.

There are opportunities for efficiency and electrification across the economy

Figure 2 – Average annual emissions reductions from energy efficiency and electrification by sector



There are opportunities to reduce emissions using energy efficiency and electrification from stationary energy use across the whole economy, with the largest in the resources and built environment sectors, where mature technologies already exist to efficiently electrify. On average, the resources and built environment sectors could reduce emissions by 21 and 20 $MtCO_2$-e per year respectively between 2026 and 2050 under a 1.5℃ aligned scenario (Figure 2).

In aggregate, efficiency and electrification opportunities across the economy (excluding transport) have the potential to save over 30 $MtCO_2$-e per year to 2030, with the abatement benefits almost doubling to 60 $MtCO_2$-e per year from 2031-35, as the higher penetration of renewables reduces emissions from electricity use.

Taking up 'shovel-ready' opportunities in the built environment and resources sector is critical to allow time for technologies in harder-to-abate sectors to mature. Even in sectors where mature technologies exist, acting now is critical to unlocking abatement in future years, due to the time needed to deploy retrofits at scale.

Efficiently electrifying supports the transition to a renewables-dominated electricity grid

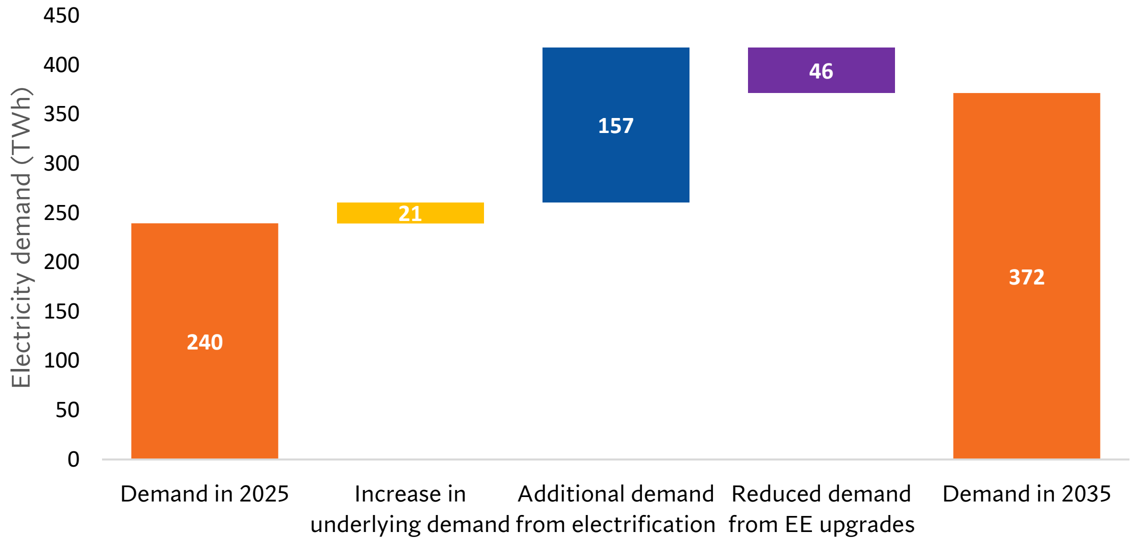
Efficiency and energy flexibility can help ensure that electrification supports the transition from fossil fuels to firmed renewables.

Leveraging energy flexibility to align demand with periods of high availability of renewable electricity – such as during the middle of the day – maximises the utilisation of zero carbon energy.

Equally, efficiency measures – such as improving the thermal performance of homes – has a critical role to play in lowering peak demand between 6 and 9PM.

Thus partnering electrification with energy efficiency and flexible demand supports the electricity market operator to maintain grid stability, and lower energy costs for all consumers.

Figure 3 - Changes in electricity demand from 2025 to 2035

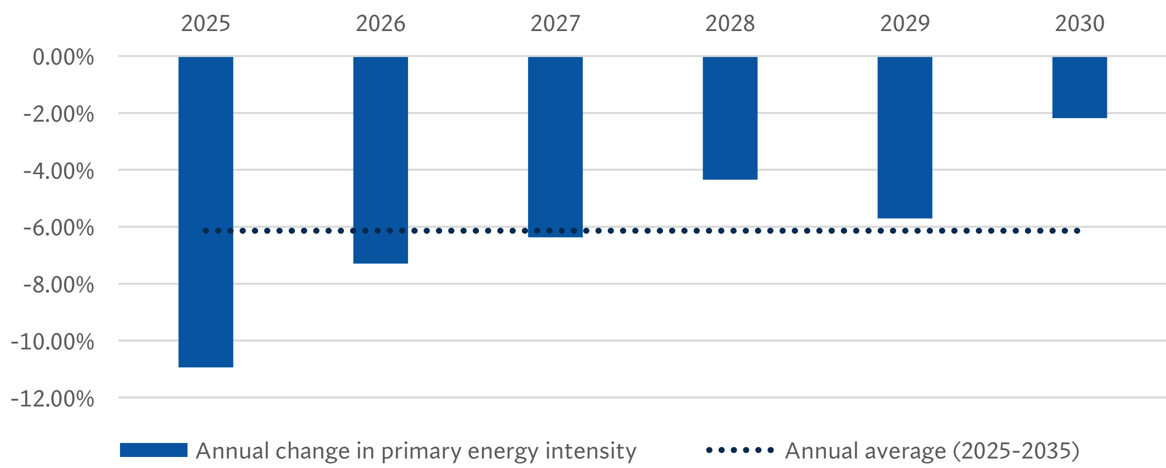


Note: Underlying demand includes a growth in demand from electric vehicle uptake. Additional demand from electrification refers to the electrification of stationary (non-transport) energy use.

This analysis – which does not include the impact of flexible demand – shows that taking up the electrification opportunities (excluding transport use) across the economy adds 157 TWh to demand by 2035. However, this is offset by 46 TWh of demand reductions from energy efficiency, meaning a net increase of only 111 TWh of extra electricity demand beyond that expected due to underlying growth (Figure 3).

Ambitious action would see Australia play its part in meeting global energy efficiency targets

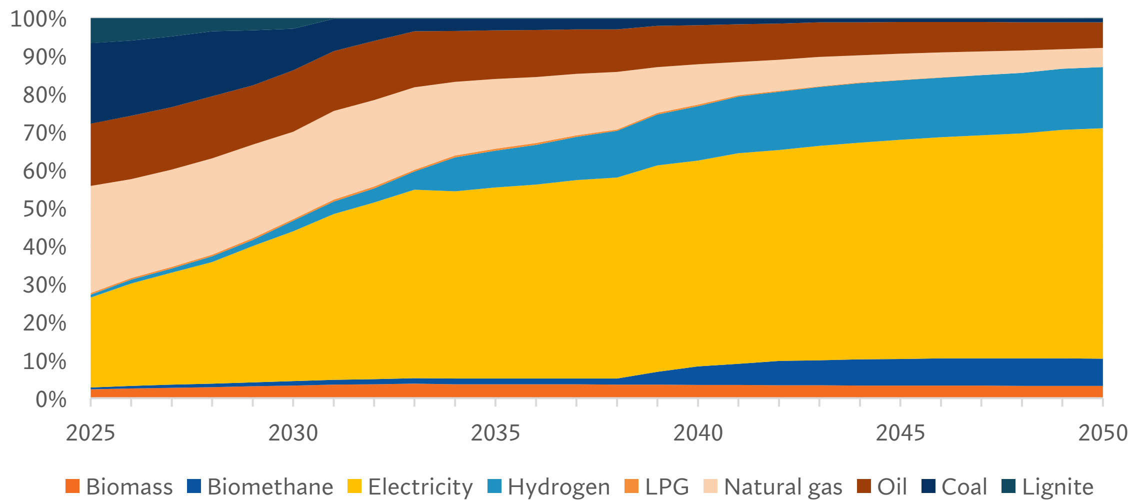
Figure 4 - National annual change in primary energy intensity under a high ambition scenario



At COP28 in 2023, Australia pledged to support global efforts to double the rate of energy intensity improvement by 2030.[5] The average annual rate of change in energy intensity over the last 5 years is approximately 3%. [6] This analysis suggests that the energy efficiency, electrification and switch to renewable electricity generation modelled in a high ambition scenario, could collectively double Australia's average annual energy intensity improvement rate to 6% between 2025 and 2030 (Figure 4), aligning with the global target to double the rate of energy efficiency improvement by 2030.

Electricity will dominate energy demand in a net zero world

Figure 5 - Australia's stationary energy fuel mix between 2025 and 2050



This analysis shows that meeting an ambitious emissions reduction target at least-cost results in a fundamental shift in Australia's fuel mix, with electricity becoming the dominant energy carrier. In the analysis, electricity's share of total energy demand grows from around a quarter today, to over 60% by 2050 (Figure 5). In residential buildings, the change is even more stark, with electricity reaching nearly 100% of demand by 2045.

While maintaining 'consumer choice' between fossil gas and electricity is a priority for some governments, this analysis demonstrates that in a net zero future, the clear choice for most energy end uses will be electricity.

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[5] European Commission, 2023, *Global renewables and energy efficiency pledge*

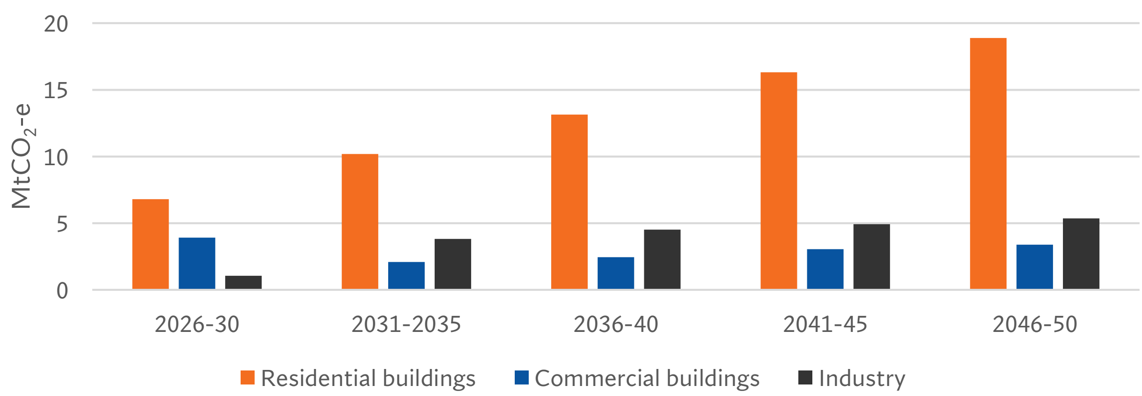
[6] DCCEEW, 2024, *Australian energy intensity and energy productivity*

Built Environment

The built environment presents the second largest opportunity for emissions reductions from efficiency and electrification. In this analysis, average annual emissions reductions between 2026 and 2030 are 11.75MtCO_2-e and reach 27.6 MtCO_2-e per year on average between 2046 and 2050 (Figure 5).

Residential buildings offer the largest opportunity for abatement in the built environment

Figure 6 - Average annual emissions reductions from energy efficiency and electrification in the built environment by subsector

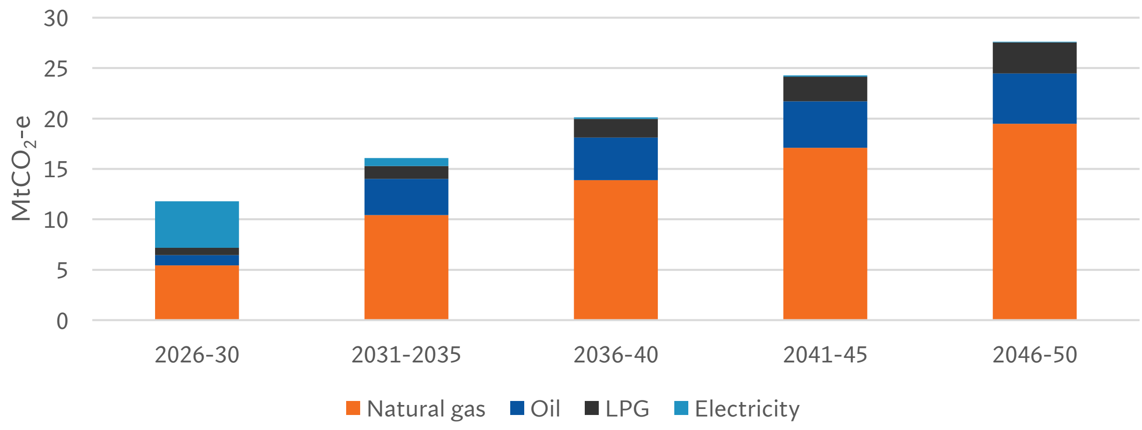


Within the built environment, residential buildings present the largest abatement opportunity, with average yearly savings of 6.5 MtCO_2-e between 2025-2035 and increasing further out to 2050 (Figure 6). To realise these savings, policy settings need to be conducive to improving appliance energy efficiency and undertaking minimal thermal upgrades (e.g. level specified in the first national energy efficiency code adopted in 2003[7]) and electrification of Australian homes.

[7] Australian Buildings Code Board 2003, *Building Code of Australia 1996 – Amendment 13*. Available here: https://ncc.abcb.gov.au/editions-national-construction-code

Clear federal policy on gas substitution will yield large emissions reductions in the built environment

Figure 7 -Average annual emissions reductions in the built environment from energy efficiency and electrification by fuel



In the short term, energy efficiency improvements are critical to deliver emissions abatement across a range of fuels, including electricity, which is yet to fully decarbonise. However, throughout the project period, the largest emissions reductions from energy efficiency and electrification come from reducing natural gas use (Figure 7). Reducing gas use has the potential to abate over 10 $MtCO_2$-e on average per year in 2031–35, which doubles to nearly 20 $MtCO_2$-e in the years 2046–50. 89% of total gas savings in the built environment comes from residential electrification, coupled with minimal building thermal upgrades, primarily in Victoria.

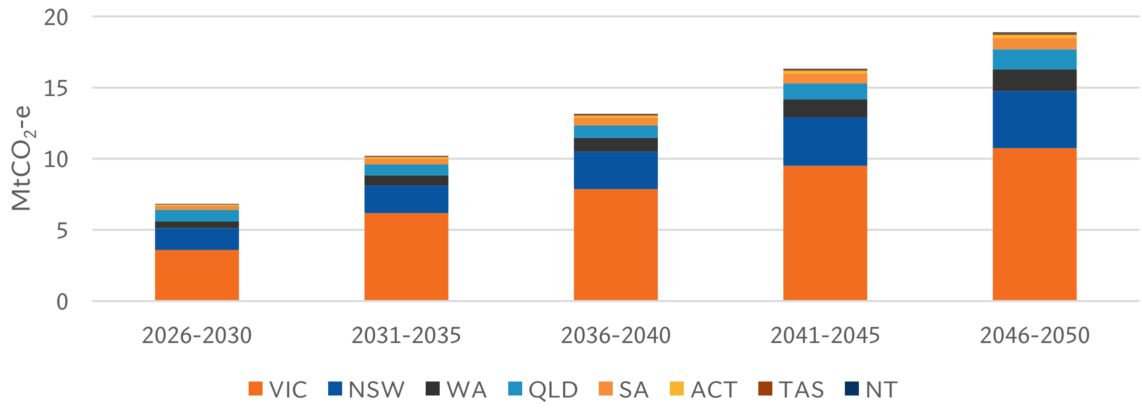
However, while the built environment has the technologies to electrify now, other barriers exist, necessitating a role for government. A clear strategy for efficiently electrifying the built environment, coupled with tangible policies, is therefore central to unlocking the abatement opportunities highlighted in this analysis.

Homes

Homes offer the biggest opportunity for abatement, led by Victoria.

Within the residential sector, homes in Victoria and New South Wales offer the largest opportunity for abatement, due to the high population in these states. More than half of the abatement opportunities are in Victorian households where gas use for water heating, space heating and cooking is more significant than other states, due to its cooler climate and historical policy settings encouraging the use of Victorian gas reserves (Figure 8). This highlights the importance of the Victorian Government's Gas Substitution Roadmap for achieving emissions reductions from gas combustion and the need for clear Commonwealth policy settings that support this push.

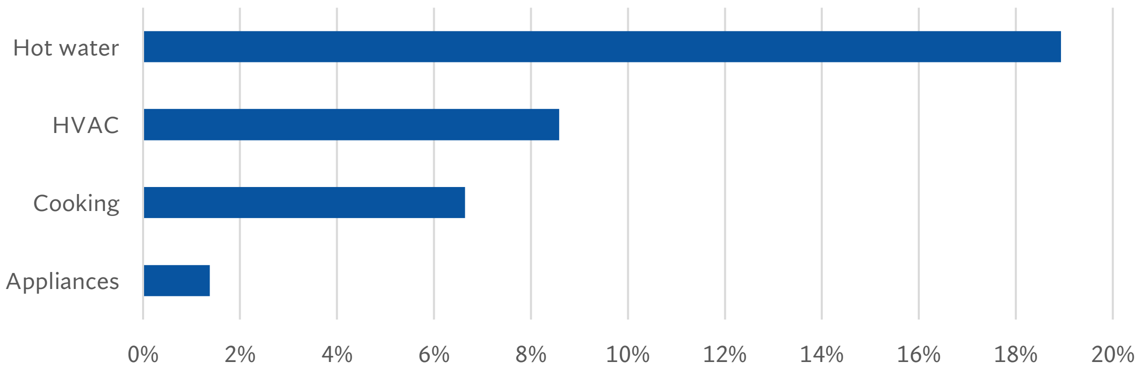
Figure 8 - Average annual residential buildings abatement from efficient electrification by state



Deployment of key electric technologies needs to accelerate

In the analysis, around 19% of existing homes electrify their gas hot water systems to achieve the projected emissions reductions (Figure 9).

Figure 9 - Share of existing residential dwellings' end uses to be upgraded to achieve projected emissions reductions by 2035 (electrification only).



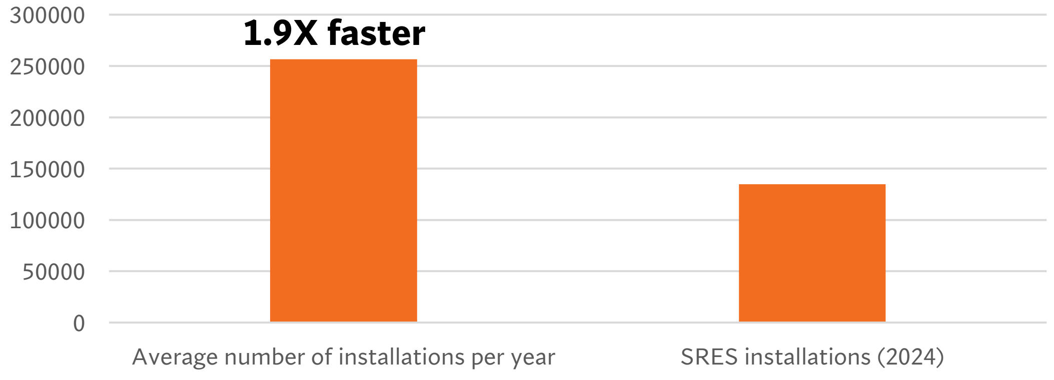
Note: Certain dwellings will undergo multiple treatments with different technologies, therefore these percentages cannot be added.

Upgrades are more concentrated In Victoria, where around 80% of Victorian homes are currently connected to gas.[8] The analysis implies that just less than half of Victoria's estimated 2 million households with a gas connection electrify their hot water systems by 2035.

While this level of upgrades is achievable, realising them requires accelerating the adoption of efficient electric technologies for major end-uses. As an indication of the scale of change needed, this analysis suggests the annual residential heat pump installations between 2025 and 2035 must be nearly double the current number of installs per year occurring through the Small-Scale Renewable Energy Scheme (SRES) (Figure 10).

[8] SEC Victoria, 2025, *Households*.

Figure 10 - Household heat pump hot water system deployment rates, modelled potential and current rates under SRES



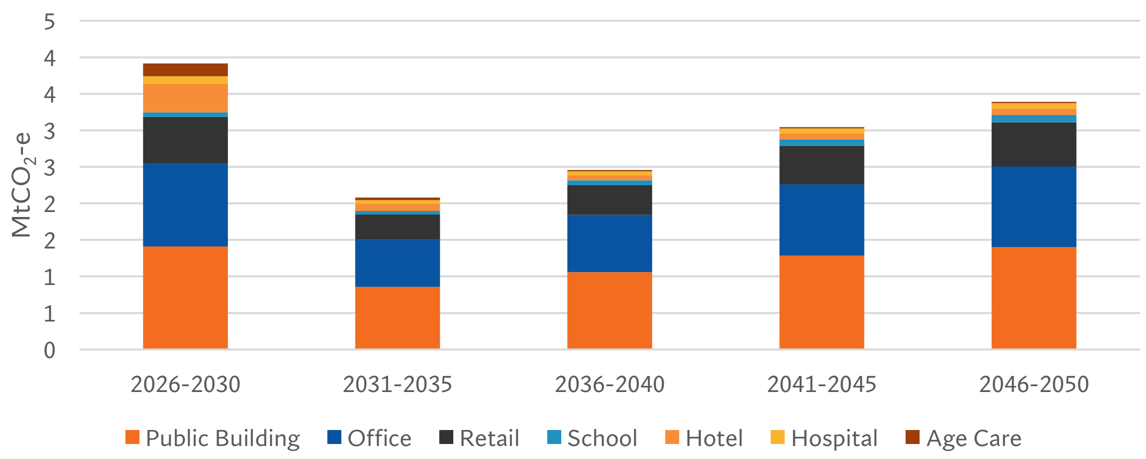
Commercial buildings

Leadership from government could have a big impact on commercial buildings

The analysis finds that energy efficiency and electrification could deliver average emissions savings of 3.0 $MtCO_2$-e per year between 2026 and 2050 (Figure 11).

In this diverse sector, the largest opportunities for emissions reduction through efficiency and electrification come from public buildings and offices, building types that represent a significant proportion of the total commercial building floor space and energy use in Australia.

Figure 11 - Average annual emissions reductions from energy efficiency and electrification in commercial buildings by building type

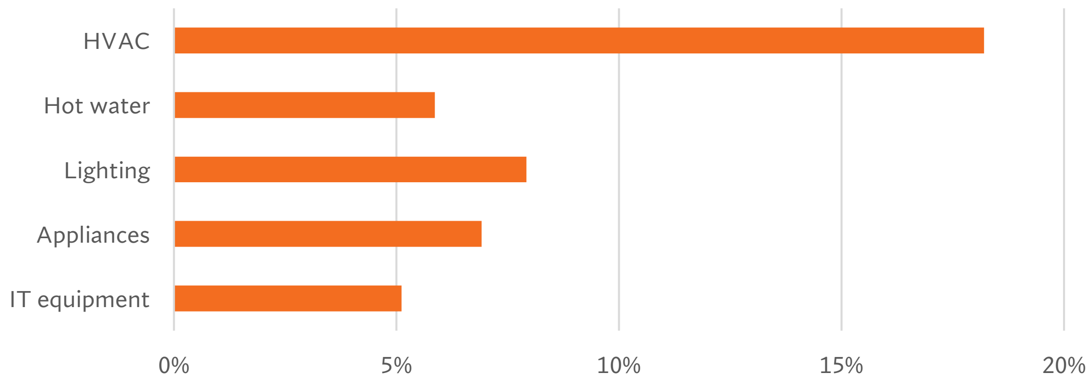


Significantly, governments own and/or lease a large share of public buildings and offices in most states and territories. As such, governments' actions to upgrade building stock they own or occupy could be pivotal to demonstrating the feasibility of commercial building upgrades, particularly in buildings that are technically difficult to upgrade or electrify.'

HVAC systems in buildings make up the largest potential energy savings in our analysis, including from more efficient equipment, thermal efficiency, and electrification of HVAC systems currently using gas. Other uses where energy savings are available include lighting, IT equipment, hot water and appliances.

Efficiency is key in commercial buildings, where electricity use is already high

Figure 12 - Share of commercial floorspace end uses to be upgraded to achieve projected emissions reductions by 2035 (energy efficiency only)



Note: Certain areas of floorspace will undergo multiple treatments with different technologies, therefore these percentages cannot be added.

Around 83% of commercial buildings energy use is electricity.[9] Consequently, some of the largest abatement opportunities stem from energy efficiency.

In this analysis, much of the abatement from commercial buildings is achieved through relatively modest efficiency upgrades. For example, in the analysis only 17% of existing commercial floorspace is upgraded with energy efficient HVAC systems and 8% is upgraded with efficient lighting by 2035 (Figure 12). These numbers indicate there is a large opportunity to increase emissions reductions in this sector beyond the levels modelled.

Construction and utilities

Between 3–5 $MtCO_2$-e per year could be saved in the construction sector from electrification, particularly after 2030, once electric technology options mature and reduce in price (Figure 13). Opportunities include electrifying construction vehicles and generators, reducing the need for diesel in these operations.

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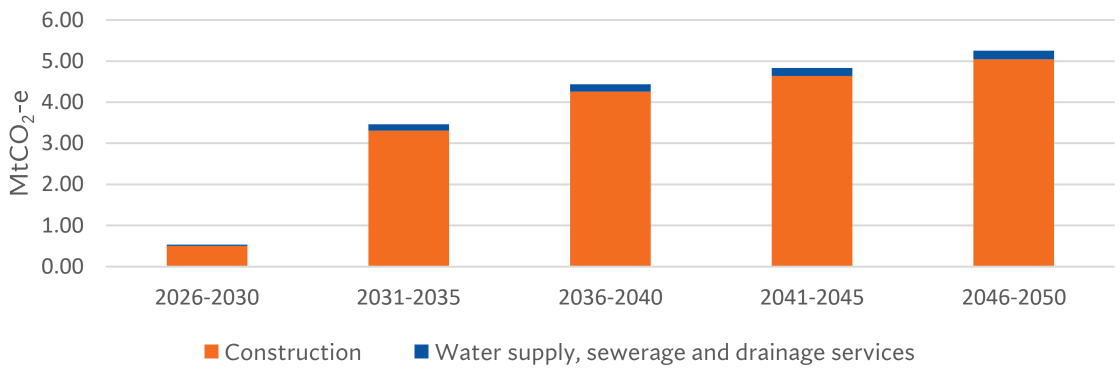
[9] DCCEEW 2024, [Commercial building baseline study – 2024 update]

Figure 13 - Average annual emissions reductions from energy efficiency and electrification in construction and utilities buildings

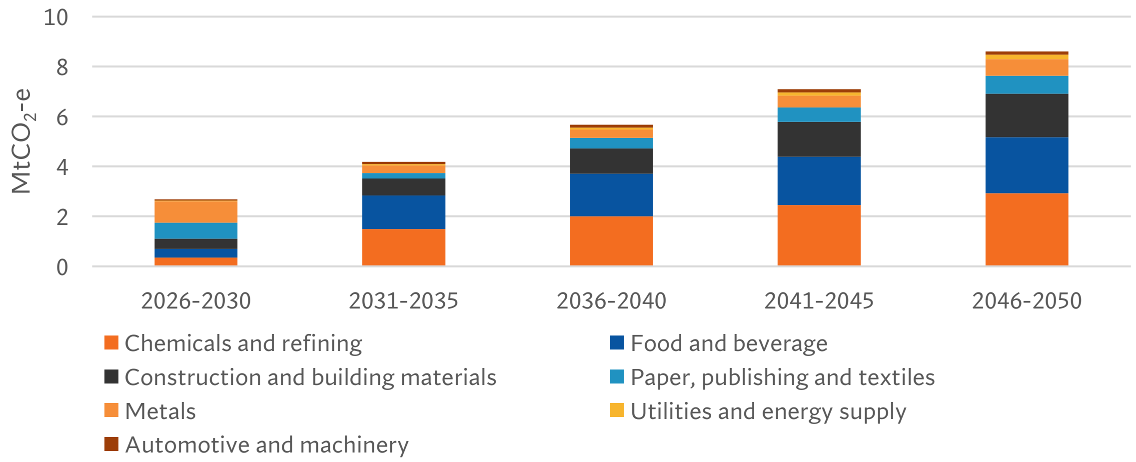


While smaller in scale, there are also opportunities for emissions reductions in water supply, sewerage and drainage services. Energy efficiency options include upgraded pumps and motors used throughout water supply and treatment facilities.

Industry and Waste

Efficiency and electrification in the industry and waste sector offers total emissions savings of 2.8 $MtCO_2$-e per year on average between 2026 and 2030 reaching 8.6 $MtCO_2$-e per year on average between 2046 and 2050 (Figure 14).

Figure 14 - Average annual emissions reductions from energy efficiency and electrification in industry by subsector

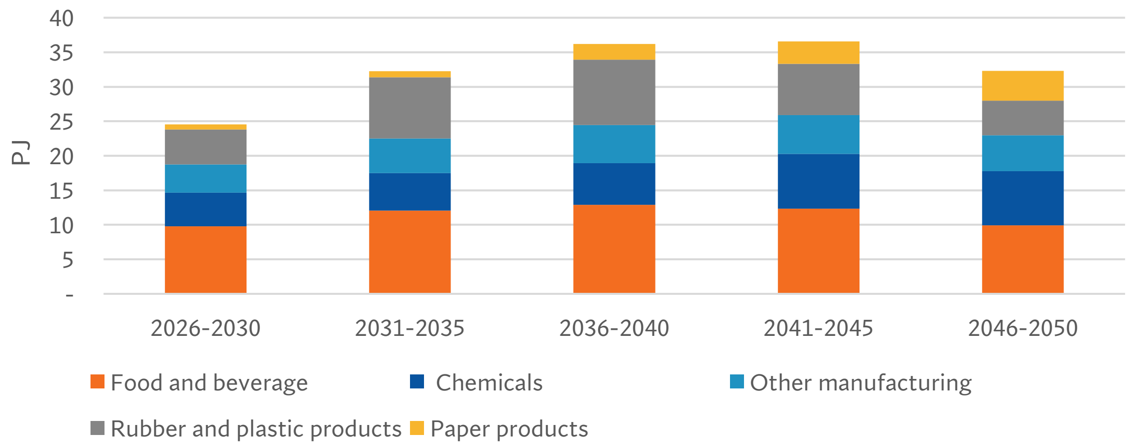


Chemicals and refining could contribute an average of 1.8 $MtCO_2$-e of emissions reduction between 2026 and 2050 and food and beverage manufacturing, including meat processing, an average of 1.5 $MtCO_2$-e (Figure 14). This can be achieved through electrification of boilers and furnaces, technologies to generate steam, variable speed drives and heat exchangers, as well as energy efficiency upgrades including process optimisation.

In industry, efficiency is critical to reducing emissions associated with electricity use before the decarbonisation of the electricity sector is complete, particularly before 2030. After 2030, the analysis shows electrification of industrial end uses could cut gas use by an average of 66 PJ per year between 2031 and 2050 with corresponding average annual emissions reductions of 3.4 $MtCO_2$-e. These impacts can be achieved through electrification of gas process heat, including replacing blast furnaces with electric furnaces or using heat pumps for low temperature process heat and efficient electric motors replacing gas or steam turbines for pumps and compressors.

Electrifying low temperature process heat use should be prioritised

Figure 15 – Annual average energy savings from electrifying process heat (<100°C)

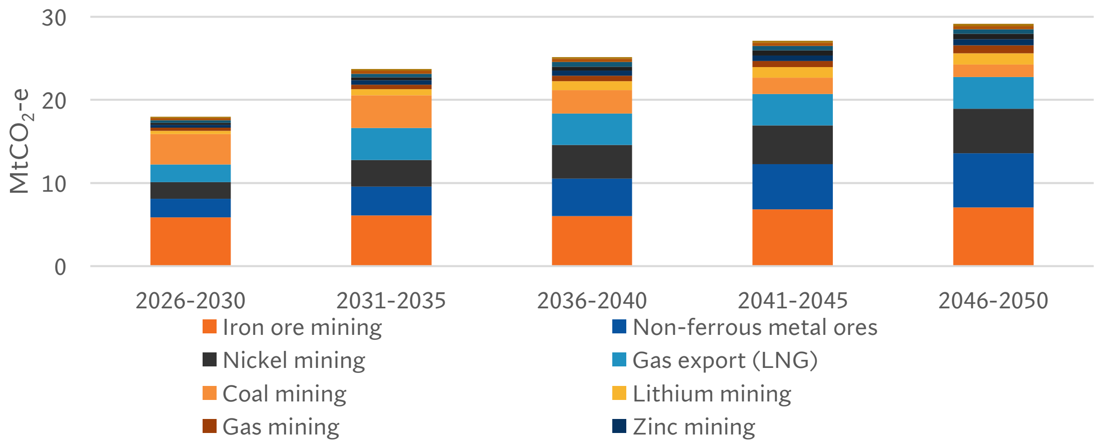


Australia's manufacturing sector uses significant levels of low temperature heat (<100°C), where heat pumps can readily substitute for gas boilers. Food and beverage product manufacturing provides the largest opportunity for reducing fossil fuel use through switching to heat pumps for low temperature process heat with, energy savings reaching up to 9.9 PJ per year by 2050 (Figure 15). Rubber and plastic manufacturing is another significant opportunity, with energy savings potential reaching 5 PJ per year by 2050.

Resources

As one of the main sources of Australia's stationary energy emissions, the resources sector presents the largest emissions reduction opportunity from energy efficiency and electrification across the economy, at 16 $MtCO_2$-e per year on average between 2026 and 2030, reaching 29.2$MtCO_2$-e between 2046 and 2050 (Figure 16).

Figure 16 - Average annual emissions reductions from energy efficiency and electrification in resources by subsector



The largest opportunities exist in iron ore and non-ferrous metal ore mining, with emissions reductions of 6.4 $MtCO_2$-e and 4.4 $MtCO_2$-e respectively on average per year between 2026 and 2050 (Figure 16). Electrification opportunities in mining include converting diesel use for transportation to battery electric trucks and trolley assist, and other fossil fuel use to electric comminution and electrified auxiliary processes. There are also opportunities to improve energy efficiency through process improvements and smaller equipment upgrades.

Similarly, Australia's LNG export industry is one of the largest consumers of gas (and sources of emissions) in Australia, with gas used to drive pumps and compressors used in transporting and liquifying gas for export. Energy efficiency and electrification in the gas export subsector could save an average of 44.7 PJ of gas per year and an average of 2.4 $MtCO_2$-e of emissions savings per year until 2050.[10]

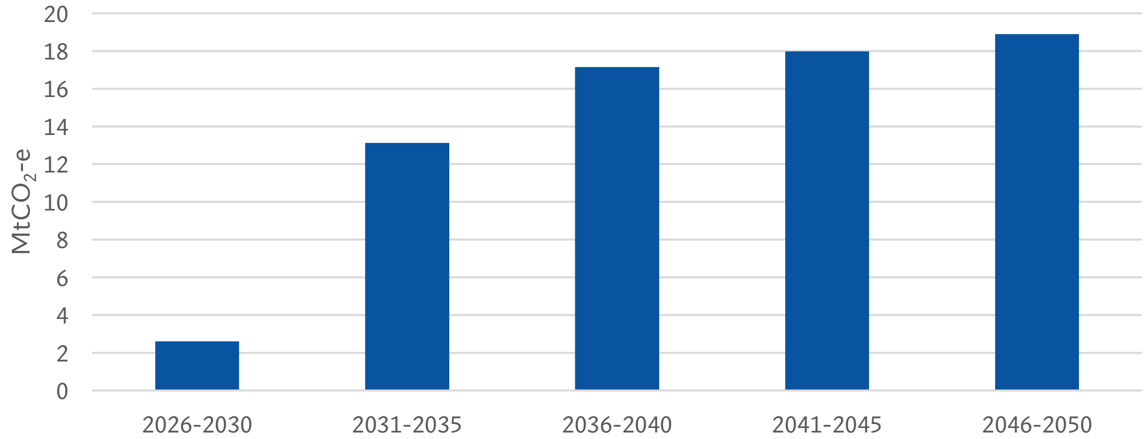
One option to help resources sector companies identify efficiency and electrification opportunities would be to lower thresholds for inclusion in the Safeguard Mechanism, as recommended by the Productivity Commission.[11] While most of the resource sector's emissions are covered by the Safeguard Mechanism, many resources companies fall below thresholds for inclusion.

[10] Although the modelled emissions reductions are technologically feasible, there are barriers associated with the electrification of the gas export industry including upfront costs and geographical constraints (e.g access to renewable energy) If these barriers can be addressed, the modelling highlights the ability of the gas export industry to reduce emissions and the impact this can have on achieving national emissions reduction targets overall.

[11] Productivity Commission 2025, *Creating a more dynamic and resilient economy*.

Agriculture and land

Figure 17 - Average annual emissions reductions from energy efficiency and electrification in agriculture and land



Emissions reductions in the agriculture and land sector are projected to increase significantly after 2030 due to availability and uptake of electrification technology. The sector can electrify various technologies including farm machinery, irrigation systems, pumping systems and crop processing systems. The sector is projected to be able to reduce emissions by up to 19 $MtCO_2$-e per year by 2050 (Figure 17).

Within the agriculture sector, agricultural services, fishing and grains offer the largest opportunity for emissions reductions from electrification and efficiency. Most of these savings come from switching from diesel to electricity. Many processes on farms could be electrified including pumps and irrigation systems, farm machinery and vehicles and livestock facilities, while battery electric generators are now available to replace diesel generators.

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