Infrastructure Victoria - Towards 2050: Gas infrastructure in a zero emissions economy

August 2021

To Infrastructure Victoria,

RE: Towards 2050: Gas infrastructure in a zero emissions economy

Beyond Zero Emissions is an independent, solutions-focused think tank. We conduct and publish research on zero-emissions solutions that unlock economic potential for industries, regions and communities.

We have a strong track record undertaking world leading research which demonstrates practical, ambitious pathways to achieve rapid decarbonisation using existing technology.

Research we have undertaken relevant to the Gas Substitution Roadmap includes:

- **The Million Jobs Plan** (2020) which showed how to create 940k jobs through retrofitting existing buildings
- **Electrifying Industry Plan** (2018) which demonstrated how manufacturers can replace fossil fuels with renewable electricity and eliminate 8% of Australian emissions.
- **The Energy Freedom Home** (2015) which guides home owners on how to improve their home and eliminate gas and electricity bills.

In this submission we have strongly recommend a *Go Hard, Go Households* approach that will deliver high impact, unlock economic benefits and is technological deployable today to rapidly electrify every home in Victoria using existing proven and readily available products. The pathway would enable Victoria to slash gas usage by 40% in five years and is implementable immediately.

The submission has also focused on developing a roadmap to electrify industry. Industry can already electrify a significant amount of low heat uses but requires careful forward planning for Renewable Energy Industrial Precincts and green hydrogen development.

An ambitious yet pragmatic approach will reduce energy costs for Victorians, improve supply security and reduce price volatility for manufacturers, and reduce Victorian gas use by more than 113PJ per annum.

Our submission covers four major opportunities:

1. **Electrification:** Electrify every Victorian home in five years.

   Modern electrical appliances for cooking, heating and hot water production are superior to gas equivalents in every way. We recommend the Victorian Government undertake an ambitious program to upgrade every single residential gas appliance to a superior, safer, and more efficient electric appliance.

   There is no need for gas use in Victorian homes, let's electrify everything for good.

2. **Improving Energy Efficiency:** Insulate 1.5 million 2-star rated homes in five years.

   Victorian homes are cold, unsealed and costly to heat - but this can be easily fixed. We recommend a comfortable homes program to rapidly improve the thermal performance of Victorian homes. Comfortable homes, better health, lower bills, and lower demand for gas and electricity.

3. **Household electrification roadmap:** plan for integration of household energy infrastructure in energy transition.
   Households will increasingly own energy assets that can perform a range of energy services. Planned well, the aggregated integration of household energy assets would create major energy assets in the form of Virtual Power Plants and Virtual Transmission Lines. An all electric housing stock with integrated EV storage could boast a combined storage of 185 GWh.

4. **Electrifying Industry:** Power industries with modern, efficient electrical processes

   Industries face increasing fossil gas prices as well as increasing pressure for decarbonisation. Electrifying their gas-based processes is a win-win that can deliver increased energy efficiency, cost savings and tangible climate action. This also reduces overall gas demand, providing time for more difficult processes to adopt alternative zero-emission technologies like biomethane and hydrogen.

Beyond Zero Emissions thanks Infrastructure Victoria for the opportunity to provide this submission. This submission focuses on the opportunity to rapidly electrify every household in Victoria and future development of Renewable Energy Industrial Precincts.

We would welcome the opportunity to brief further on the opportunities and pathways to electrify industrial processes and substitution options for remaining gas requirements based on our extensive experience working with industry to establish Renewable Energy Industrial Precincts and Zero Carbon Factories.

Kind regards,

Tom Quinn

Head of Policy and Research
Beyond Zero Emissions

Recommendations

1. Go Hard, Go Households

2.1 Electrify existing homes

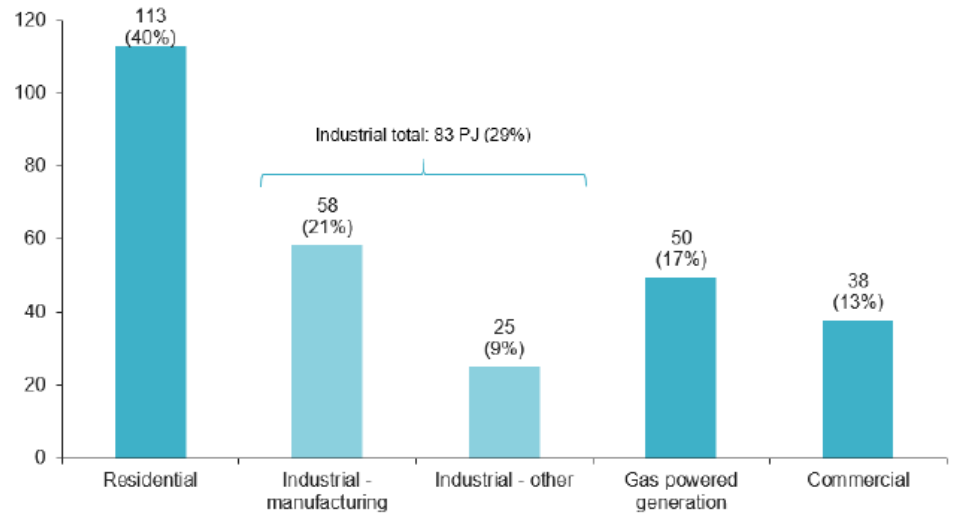
Victoria is on the cusp of a fundamental transformation in how we use energy in our homes.

A transformation that will electrify every appliance and make homes safer, save money, lower emissions, and reduce demand for finite gas supplies.

The opportunity is significant and independent research from Beyond Zero Emissions has shown how a program to electrify every home in the state could save Victorian householders in total $4.3 billion p.a., create over 3,000 jobs and put the state on track to meet Victoria's Climate Change Strategy of emissions reduction targets of 28 to 33 per cent by 2025 and 45 to 50 per cent by 2030.

More gas is burnt by Victorian households than the combined usage of every single household in the rest of Australia. Eight per cent of Australia's total gas use is combusted in Victorian homes. On top of that Victorian households as a whole are the single largest consumers of gas in the state, burning through 40 per cent of the state's gas supply every single year, Figure 1.

Figure 1. Victoria gas consumption for energy, by sector, PJ and % total (2018-19)



Numbers may not add to 100% due to rounding.
Source: Department of Industry, Science, Energy and Resources (2020a), Accenture (2021), IV analysis

All of this is avoidable. **There is no need for gas use in Victorian homes.**

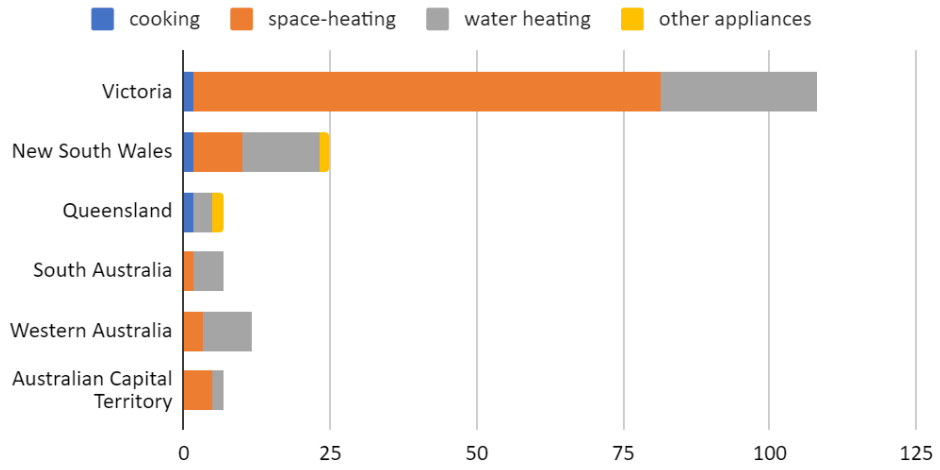
Gas has only three current uses in households: heating air, heating water, and cooking. All three of these uses can be electrified simply, easily and cost efficiently using proven and readily available technology.

Electrifying each of these processes with superior electrical appliances will save households more than $1000 per year, remove harmful pollution inside the home, and slash Victoria's gas usage.

The most efficient way to decrease energy demand is to electrify the residential building stock through two technologies; heat pumps and induction cooktops. Heat pumps can be used for both space heating and hot water.

The solution to Victoria's household gas problem is simple - **electrify everything.** Victoria's residential sector holds both state and national significance in the way of gas consumption. 12% of national domestic gas consumption is in the residential sector and 8% is for Victoria alone which accounts for almost 2/3rds of Australia's residential gas demand, figure 2[1] (Wood & Dundas 2020).

Figure 2. Estimated residential gas end use 2020



The vast majority of gas use in Victorian homes is for space heating (74% - 80PJ) followed by water heating (25% 27PJ) and cooking (1% - 2 PJ)[2].

2.1.1 Electrifying space heating

Electrifying space heating is the lowest hanging fruit and should be prioritised.

More than 80 per cent of Victorian households already have a reverse cycle air-conditioner installed - but the majority are used solely for summer cooling rather than winter heating. A behaviour change campaign focussed on getting Victorians to turn on the aircon and turn off the gas would be a highly effective intervention to rapidly reduce gas use for space heating intervention at zero cost to households.

The benefits would be immediate and lower gas demand with no installation lag times.

[1] Wood, T & Dundas, G. 2020. *Flame Out: the future of natural gas.* Grattan Institute.

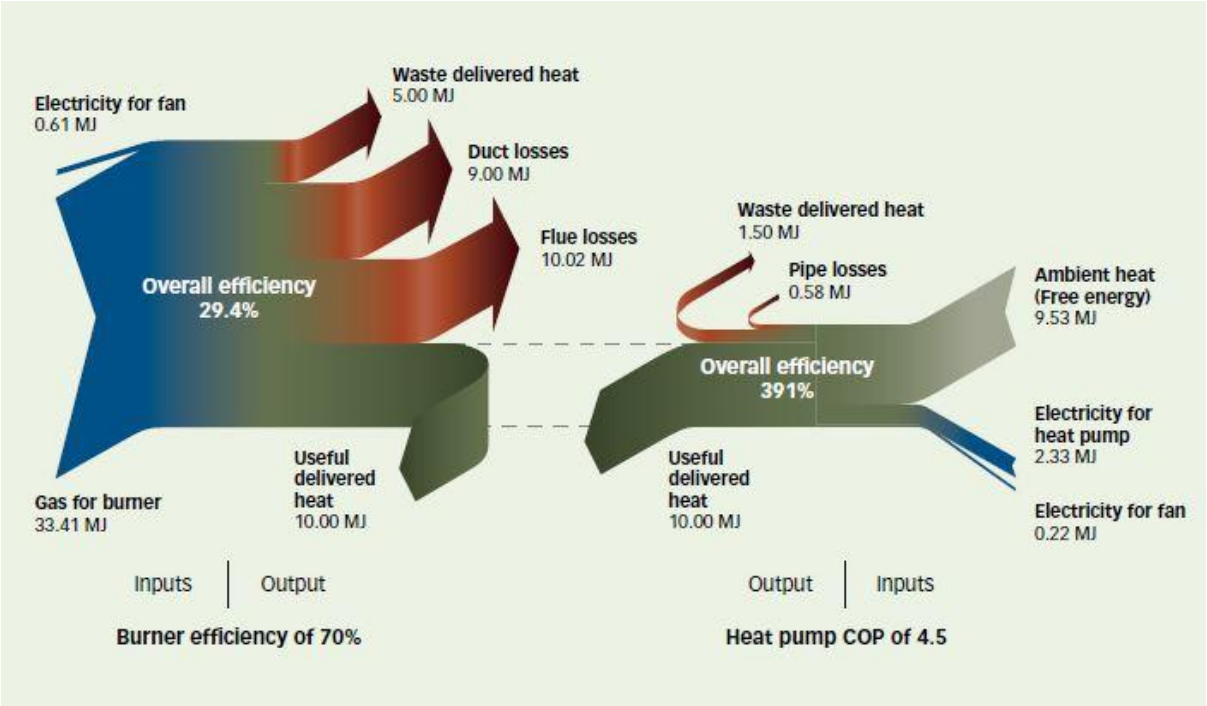
[2] Wood, T & Dundas, G. 2020. *Flame Out: the future of natural gas.* Grattan Institute.

The energy efficiency benefits of this approach are also significant. Heat pumps are up to 13 times more efficient at warming a home than gas heaters as the following example demonstrates.

Example 1 - Providing 10 MJ of useful heat into a home using a ducted gas heating system requires 33.41 MJ of gas to be burnt[3]. More than two thirds of the original energy is lost as waste heat and leakage before useful heat energy is delivered into the home.

Example 2 - In contrast, a heat pump can deliver 10 MJ of useful heat into a home using only 2.55 MJ of electricity. This is because a heat pump uses the electricity it draws to 'harvest' heat from the outside air and sends it inside as useful heat as demonstrated in Figure 3.

Figure 3. Ducted gas space heating (left) compared to split-system reverse cycle air-conditioning (right)[4].



Using reverse cycle air conditioners is a smarter, more efficient and more affordable way to heat Victorian homes.

Electrifying space heating in Victorian homes will reduce gas demand by 80PJ equivalent to the total amount of gas used in Victoria's entire industry and manufacturing sector.

2.1.2 Electrifying water heating

Heat pumps are a much more efficient way to heat water too compared to gas fired water heating systems. Electrifying Victoria's hot water heating systems will reduce gas demand

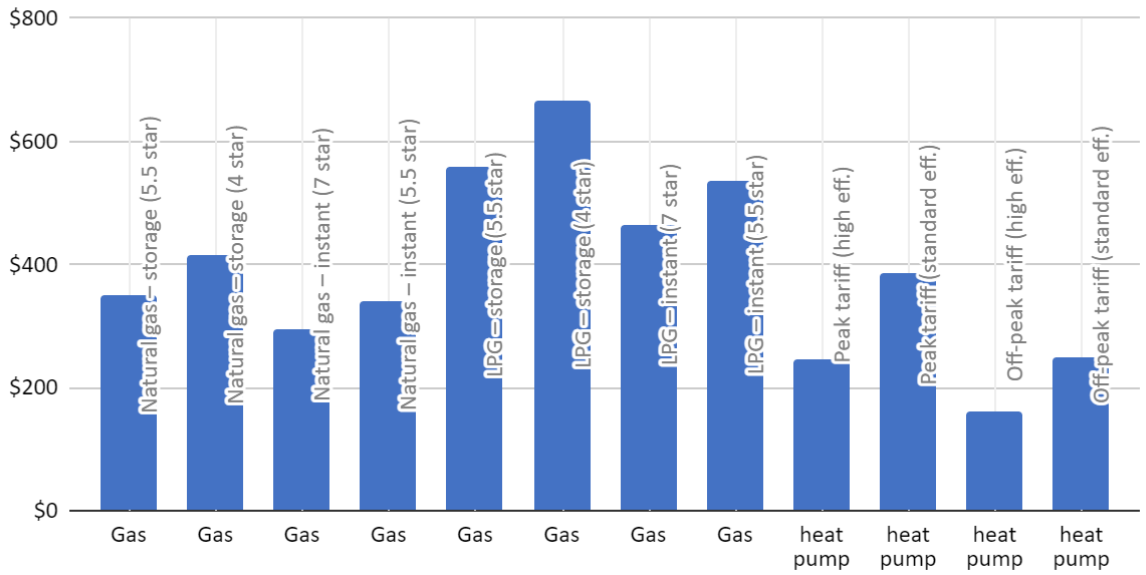
[3] Beyond Zero Emissions. 2013. *Energy Freedom Homes.*

[4] Ibid

by 27 PJ, reduce household bills, and if designed appropriately will help the electricity grid accommodate higher levels of solar generation.

Research by Sustainability Victoria (Figure 4.) has demonstrated that heat pumps are the most economical way to heat water. As gas prices rise and electricity prices fall this situation will continue to widen - and hurt the hip pocket of households stuck on gas hot water systems.

Figure 4. Water heating running costs annual comparison gas vs heat pump for 3 person household[5]



2.1.3 Electrifying cooking

The use of gas for cooking in Victorian households is the smallest portion of residential gas use - consuming 2 PJ per annum. The health impacts of this use are arguably the highest as burning gas inside our homes releases harmful pollutants. Research by the Climate Council has estimated that up to 12% of the burden of childhood asthma in Australia is due to cooking with gas inside the home - comparable to the risk children living with household cigarette smoke[6].

Induction cooktops are also twice as efficient as gas burners - meaning less waste heat and lower bills. A program to replace unsafe cooking appliances with modern, safe, and efficient appliances will reduce the health impact to Victorian householders, save money and reduce gas demand.

[5] Sustainability Victoria. 2021. *Choose the right hot water system for your home.*

[6] Climate Council. 2012. *Kicking the gas habit: how gas is harming our health*.

2.2 Scale of opportunities

a. Electrifying Victorian homes is simple from a technological perspective. Mature, proven and superior technology existing to replace all current gas use in the residential sector.

b. At least 80% of homes already have reverse cycle air conditioning. A behaviour change campaign to get people to turn on the air conditioning and turn off the gas for heating will yield immediate results.

c. Almost 400,000 households already have solar hot water systems and heat pumps installed for hot water[7]. The technology and supply chains are mature and are positioned for mass deployment.

d. Induction cooktops are twice as efficient as gas burners and more households are considering the switch.

Figure 5. Victorian Household Gas Use Breakdown across ownership types[8] [9]

Victoria	Owner-occupied	Rental	Social housing
%	63	33	4
No. Hot water	940884	489852	53664
No. gas space heating	914960	476355	52185
No. gas cooking	1180669	614691	67340

The scale of the opportunity is significant. There are roughly 1.55 million homes in Victoria with gas space and water heating. A program to electrify space heating and hot water at a rate of 400,000 homes per year can achieve almost full electrification in 5 years. This would slash gas demand by 107 PJ in five years.

i. At least 1 million hot water heat pumps will need to be installed in owner-occupied homes; 500,000 in rentals; 55,000 in social housing

ii. At least 1.2 million induction cooktops can be installed in owner-occupied homes, 600,000 in rentals, 70,000 in social housing

iii. At least 1 million owner-occupied homes will need to start using or replace existing gas systems with reverse cycle air conditioning as will 500,000 rentals and 50,000 social housing.

[7] Clean Energy Regulator. 2021. *Postcode data for small-scale installations. Accessed 18/07/21*

[8] Australian Bureau of Statistics. 2020. *ABS Dataset: Residential Dwellings: Values, Mean Price and Number by State and Territories.*

[9] Clean Energy Regulator. 2021. *Postcode data for small-scale installations. Accessed 18/07/21*

e. A no regrets opportunity already exists. More than 80% of Victorian homes already have air conditioners installed and the majority are reverse cycle air conditioners. Switching to reverse cycle air conditioning for heating can immediately reduce gas demand and save households hundreds of dollars.

f. A behaviour change campaign to get Victorian's with split systems to use them in the winter to heat their homes would be highly effective. There would be zero capital cost for households and would significantly reduce gas demand for space heating.

g. BZE strongly recommends that a three year behaviour change campaign be launched during the winter months to encourage households to "turn on the aircon, and turn off the gas". A budget of $20m would enable this campaign to be highly effective at cutting gas demand from the 80% of homes with aircon and require no capital outlay by householders. This is a highly efficient mechanism to immediately reduce gas use in Victoria and free up reserves for manufacturing and industry.

h. A second easy win is to implement a targeted program to upgrade the 350,000 homes with non-ducted gas heaters and replace them with reverse cycle air conditioners. This could be deployed through the $335 Home Heating and Cooling Upgrades Program initiated by the government in 2021.

i. The electrification of hot water heating can play a significant role in balancing supply and demand in the electricity network. Demand-side response strategies such as load shifting and aggregated management offers opportunities for heat pumps to provide a range of benefits including soaking up excess renewable energy generation during the day. This is already being trialled through ARENA funding in South Australia to explore the role of hot water heat pumps aggregated as a virtual power plant across 2400 households[10].

2.3 Key technical, regulatory and economic barriers

a. An all-electric housing stock will shift peak electricity demand to the winter months[11].

b. Upfront costs for gas fixed appliances are often incentivised by government schemes such as VEU which make these appliances cheaper than alternatives like heat pumps.

c. Separate rebates for space heating and hot water reduces speed of uptake.

d. Gas hot water rebates undercut electrification and incentivises locking in gas.

e. Variability in gas disconnection fees are uncompetitive, unnecessary and disincentives all-electric homes.

[10] ARENA. 2021. *Storing excess solar from the grid using hot water systems.*

[11] Wood, T & Dundas, G. 2020. *Flame Out: the future of natural gas.* Grattan Institute.

2.4 Roles to be played by government, industry and accounting for consumers

a. Cease all subsidies and support programs for gas appliances to prevent locking in gas fixed appliances in households for decades.

b. Recalibrate the Victorian Energy Upgrade scheme to intentionally increase the uptake of heat pumps and induction cooktops.

c. Run a multi year behaviour change campaign to encourage residents to “Switch on the aircon, and switch off the gas” in winter.

d. Utilise existing entities, such as Solar Victoria, to deliver rebates on to low income households for the replacement of gas appliances with heat pumps and induction.

e. Increase minimum product performance standards (MEPS) for fixed appliances

f. State government should work more closely with industry to decrease costs of electric based fixed appliances as well as making it easier to switch to all-electric homes

g. Develop heat pump bundles for both hot water and space heating to accelerate uptake and decrease costs

h. Set an ambitious target to electrify every Victorian home by 2026 and support local industry to scale up to meet the demand.

2.5 Interdependencies and trade-offs with other scenarios

a. Compliments energy efficiency pathway.

b. Technologically simple which creates a longer runway for gas substitution technological development in other sectors.

c. Rooftop solar benefits maximised by self consumption with electrified housing.

d. Minimises infrastructure spending by reducing peak demand.

2.6 Benefits and risks

The Benefits

a. Electrifying Victoria’s residential building stock will reduce gas demand by 113 PJ or 40% of Victoria’s gas consumption.

b. Electrified homes are both healthier to live in and cheaper to run.

c. Electrification of homes has the potential to create upwards of 3000 jobs in installing hot water heat pumps and RCAC[12].

[12] Beyond Zero Emissions. 2020. *The Million Jobs Plan*.

d. Electrification of residential housing - while a significant task due to the number of homes - is relatively simple from a technological point of view. Mature and cost effective technology exists to electrify space heating and water heating.

e. A program to rapidly electrify Victoria's homes will create an incentive to scale up local manufacturing capabilities to meet the forecast demand. Industry policy design should be considered to ensure the local manufacturing opportunity is realised.

f. Victorian households with solar will benefit most from self-consumption over lower feed-in tariffs.

g. Electrified homes in combination with demand side response strategies such as load shifting and virtual power plants can help 'soak up' high rates of renewable energy generation in the middle of the day and better match demand to supply.

h. Electricity prices will continue to fall as renewable penetration increases in the NEM, in contrast gas prices are volatile and will cause further bill shock to consumers.

i. Electric appliances are safer, smarter and more efficient than gas appliances.

The Risks

a. Full electrification of Victoria's housing stock will increase electricity demand during the winter which if not managed may increase winter prices.

b. Careful policy design is required to ensure that low income households and renters are not left behind and burdened with old, expensive and polluting gas appliances

c. As electrification increases, cost burden may increase for households still connected to gas and risks disproportionately disadvantage lower socio-economic households.

d. Current policy settings 'lock in' continued gas installations and usage, including high disconnection fees, these will act as a drag on electrification without rectification.

e. A failure to electrify homes as rapidly as possible will continue to expose Victorian householders to negative health effects in their homes.

f. Opening new gas fields is a risk to our natural environment and without a rapid reduction in gas use will reduce quality of life for this and future generations.

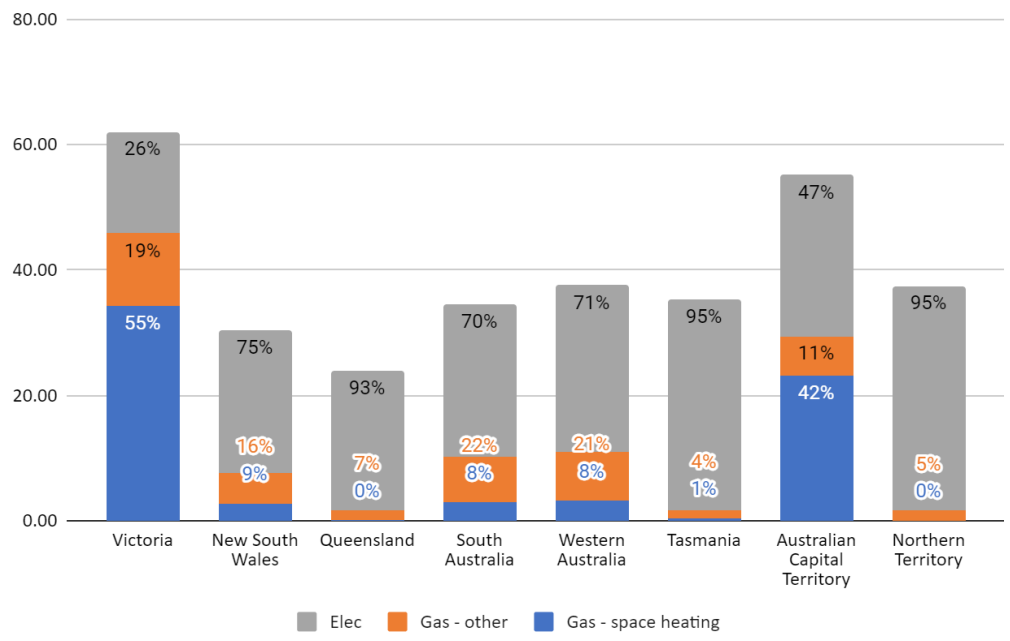
2.2 Thermally efficient existing homes

Improved energy efficiency for Victorian households is a no regrets policy approach that delivers benefits to all users at minimal cost and risk. The combination of a large quantity of houses with low thermal performance, the high usage of gas for heating in Victorian homes, and the high total usage of gas in heating residential buildings, makes this a priority policy focus.

The average Victorian home is rated at less than 2 stars for thermal performance using the Nationwide House Energy Rating Scorecard (NatHERS)[13] [14]. The majority of Victorian homes were built pre-2005 before mandatory energy standards. The low thermal performance of the average building stock contrasts sharply with the average rating of 6.1 stars for new build homes.

While this is consistent with homes across Australia, due to the colder climate and high penetration of gas burning appliances, Victorian homes are the most energy intensive in the country, figure 6.

Figure 6. Estimated Australian household energy use by fuel and end use, gigajoules per household[15] [16]



Improving the thermal performance of homes is a major opportunity to reduce energy demand in homes. Victorian gas use for heating is more significant than any other state at around 80 PJ per annum or 28% of Victoria's total gas use. Lifting every home in the state by just 1 star would reduce heating demand by ~30% and save 22 PJ of gas demand[17].

The potential is enormous, improving homes from 2 stars to 6 stars in line with new build standards has been shown to reduce space heating by 70%[18].

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[13] Shiel, J. J. (2017). *Low-carbon and affordable retrofits of Australian housing for climate change and scarce resource scenarios.* The University of Newcastle

[14] ASBEC et al. 2020. *Joint Proposal for Economic Stimulus Healthy & affordable homes: national low-income energy productivity program*.

[15] Energy Consult. 2015. Residential Energy Baseline Study: Australia.
https://www.energyrating.gov.au/document/report-residential-baseline-study-australia-2000-2030

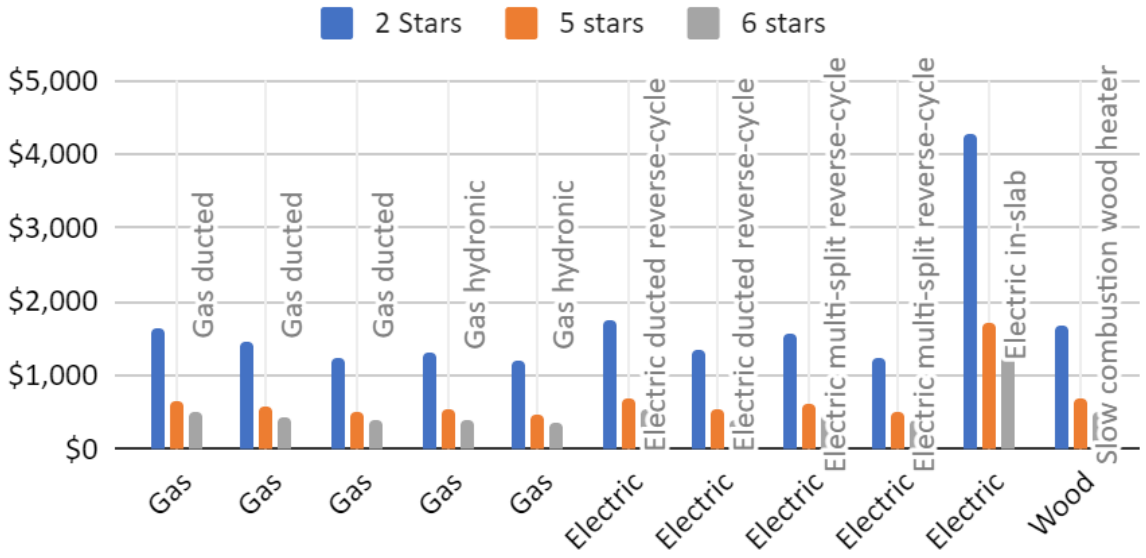
[16] Wood, T & Dundas, G. 2020. *Flame Out: the future of natural gas.* Grattan Institute.

[17] Department of Industry, Science, Energy and Resources. N.D. *NatHERS Star Band Criteria.*

[18] Ibid.

Improving energy efficiency, especially thermal performance, can play a key role in reducing total heating energy demand, for both gas and electricity, in the residential sector. This would reduce household costs, improve home comfort and ensure gas is available for higher value activities in the manufacturing sector.

Figure 7. Comparative heating costs by NatHERS rating for large home (220m2) in Melbourne[19]



Improving the energy efficiency of residential buildings can be achieved using existing technologies and generates significant benefits for households and the economy.

Lifting the thermal performance of Victorian homes will also improve health outcomes. A 2015 Lancet study found 6.5% of deaths in Australia are attributed to cold weather compared to 0.5% for hot weather[20]. Victoria is likely to be overrepresented in these statistics due to a colder climate comparative to other regions of Australia.

There is no technological barrier to improving the quality of Victorian homes and reducing total gas demand.

Insulation, draught sealing, improved glazing, curtains and blinds are all mature, effective and affordable technologies that can play a major role in improving comfort and reducing gas demand in Victorian households.

2.2 Scale of opportunities

a. Introduce minimum thermal standards for Victorian rental properties. Adopting the insulation standards as specified in the NZ Healthy Homes Standards into the Residential Tenancies Act would improve thermal performance, improve health, lower bills and reduce energy usage for tenants in rental properties.

[19] Sustainability Victoria. 2021. *Choose the right heating system for your home.*

[20] Barnett, A. 2015. Cold weather is a bigger killer than extreme heat – here's why. https://theconversation.com/cold-weather-is-a-bigger-killer-than-extreme-heat-heres-why-42252

b. Create thermal upgrade packages under the Victorian Energy Upgrades program

i. Targeting the quantity of low quality thermally performing homes in Victoria is a major opportunity to simultaneously address health risks, energy poverty and reduce energy demand for both electricity and gas.

ii. The greatest opportunity lies in lowest quality homes which includes more than 80,000 social housing dwellings; ~1,600,000 homes rated 2 stars or less built prior to bulk insulation standards. This figure includes ~650,000 rental properties with the remaining divided as 750,000 with a mortgage; 700,000 owned outright[21].

iii. A new approach to deliver thermal efficiency upgrades involving more than one product is needed to accelerate uptake. For example, to include draught sealing, plus insulation, plus secondary glazing.

c. Potential to accelerate uptake is high because of mature technologies and requires low skilled labour.

i. The technology to accelerate uptake exists and programs to address low income groups and public housing can help catalyse early mass uptake of products and reduce costs through economies of scale.

The Home Insulation Program showed that insulation installations can be rapidly scaled. Important lessons from the Royal Commission into the *Home Insulation Program* can be adopted to avoid the well publicised failures of the program which was otherwise very successful in terms of speed and scale. Insulation rates rose from 70,000 p.a. to 180,000 per month[22]. In the first 12 months of the *Home Insulation Program*, 2.2 million homes received insulation[23]. At a rate of about 25,000 per month.

Victoria could insulate the approximately 1.5 million homes built prior to new build standards for bulk insulation in five years. This would initially target the more than 80,000 social housing dwellings and the approximately 1,100,000 experiencing housing stress[24].

d. Initiatives that could accelerate uptake include:

i. Establish minimum insulation standards for rental properties using the NZ Healthy Homes legislation as a model.

ii. Update VEU to delivery thermal efficiency “bundles” to include more than one product

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[21] Australian Bureau of Statistics. 2019. Housing Occupancy and Costs. https://www.abs.gov.au/statistics/people/housing/housing-occupancy-and-costs/latest-release

[22] Parker, A. 2014. *Lessons to be learnt from the pink batts disaster.* ABC News.

[23] Austin, A. 2013. *We really must talk about the pink batts.* Independent Australia.

[24] Raynor, K. 2017. *Housing affordability in Victoria.* Parliament of Victoria.

iii. Marketing campaign i) to incentivise demand ii) incentive action through behaviour change campaigns and smart technology. A specific campaign could be targeted at gas users to save money and lower energy demand by reducing set point temperatures. Every 1 degree drop in set point temperature equals 10% in energy savings[25].

iv. Mandatory disclosure on thermal performance at point of sale

v. Engage a heat mapping firm, like MyHeat, to conduct thermal imaging of individual homes and LGAs to map and visualise heat loss. Making heat loss visible overcomes the information gap on thermal performance and can successfully incentivise households to invest in building fabric upgrades.

2.3 Key technical, regulatory and economic barriers

a. No technical barriers exist.

b. Consumer trust - perceived compliance and quality of installers and products.

c. No mandatory disclosure at point of sale or lease.

d. Barriers shift depending on ownership structure.

Owner occupiers

a. Knowledge of range of benefits namely health and monetary savings.

b. Range of incentives including subsidies and bulk purchase programs.

c. Trust that installers and products will deliver to an acceptable standard.

Renters

d. Split incentives: if landlord invests, renters receive cheaper energy bills, if renters invest, return on investment greater than duration of lease.

e. No available green loans that suit rental/landlord arrangements.

Public housing

f. Dependent on government policies for minimum standards.

Green loan access

g. Access to green loans limited to owner-occupiers.

h. Green loans favour owners without mortgages and those with less debt.

[25] Sustainability Victoria. 2021. *Choose the right heating system for your home.*

i. Significant gaps and limited data relating to household energy and thermal performance.

2.4 Roles to be played by government, industry and accounting for consumers

a. Programs and initiatives to coordinate the market and deliver greater efficiencies in order to meet greater speed and scale.

b. Government can play a role to work with industry to better coordinate the range of actors including the range of installers and suppliers.

c. Government to set targets and prioritise vulnerable housing groups in transition.

d. Government to establish mandatory energy disclosures at point of sale/lease as legislated in ACT.

e. Government to introduce minimum thermal standards in Residential Tenancies Act.

2.5 Interdependencies and trade-offs with other scenarios

a. Complementary with all pathways and no regrets

b. Thermally efficient houses substantially reduce energy demand in all pathways. Thermally efficient homes are one of the most effective demand side responses due to the passive nature of these products and benefits to energy efficiency regardless of fixed appliances efficiency and fuel source

c. Highly compatible with electrification scenarios from a health standpoint as gas risks are removed in electrified housing

2.6 Benefits and Risks

The Benefits:

a. Improving thermal performance is a no regrets option - irrespective of heating source. Improving thermal performance does not increase energy demand for either gas or electricity.

b. Building fabric upgrades are long lasting, do not add maintenance costs and deliver benefits regardless of a household's energy behaviours[26]

c. Improving thermal efficiency delivers significant health outcomes

d. Mature and mass produced technology available for rapid deployment.

[26] Daly, D., Tartarini, F., Waitt, G., Tibbs, M., Cooper, P., & Harada, T. 2021. *'Die of cold or die of stress?': Social housing is frequently colder than global health guidelines.* The Conversation.

e. Research by Beyond Zero Emissions has shown that 11,500 jobs can be created across the state in insulating and weatherproofing homes in Victoria to a higher NatHERS rating[27].

The Risks:

a. Public perception of *Home Insulation Program*. This can be mitigated adopting the recommendations in the *Ensuring quality control and safety in insulation installation* report by ASBEC & EEC 2021 relating to existing buildings[28]:

i. Develop state guidelines and documents for insulation retrofits.

ii. Industry to maintain a list of products that have been verified to meet the current version of *AS/NZS 4859.1 Materials for the thermal insulation of buildings.*

iii. Public programs to require the use of quality installers, processes and products.

iv. Public programs to require the use of companies that are pre-approved to install insulation.

v. Commission independent audits of insulation installations completed under government programs.

vi. Develop a competency-based 'Insulation Professional' certification.

vii. Review and refine entry-level training and accreditation for installers.

b. Not addressing residential thermal efficiency is the larger risk - in particular it perpetuates negative health outcomes. Poor building envelopes increase the risk of weather related health outcomes from both hot and cold weather. In a New Zealand study, occupants of insulated homes are about half as likely to report respiratory symptoms compared to uninsulated homes[29]. The same study found hospitalisations were significantly less in insulated homes compared to uninsulated homes.

2.3 Homes as energy infrastructure

Electrifying Victorian homes will reap benefits for households and radically change how we view homes in the energy transition. It's now time to think of homes as major part of our energy infrastructure and energy assets - rather than just end users.

Victoria's energy sector is in a rapid transition as renewables and supporting technologies increasingly replace fossil fuel based energy. The speed and complexity of the transition is

[27] Beyond Zero Emissions. 2020. *The Million Jobs Plan*.

[28] ASBEC & Energy Efficiency Council. 2021. *Ensuring quality control and safety in insulation installation.*

[29] Fyfe, C., Telfar, L., Howden-Chapman, P., & Douwes, J. (2020). *Association between home insulation and hospital admission rates: retrospective cohort study using linked data from a national intervention programme.* doi: https://doi.org/10.1136/bmj.m4571.

significant as the energy sector shifts from traditionally centralised infrastructure to a distributed and decentralised network. Electrifying homes will be key in this transition and Australia's modernised energy system. The emergence of distributed energy resources (DERs) and behind the meter technologies are shifting households from consumers to prosumers of energy. Rooftop solar, home batteries, smart appliances, and electric vehicles are rapidly evolving how homes in the future will participate in the energy sector. Planned well, households are set to become major beneficiaries as their homes become energy assets.

The scale of change is significant as will the role of behind the meter assets. Modelling by CSIRO and Energy Network Australia in the *Electricity Network Transformation Roadmap* forecasts behind the meter electricity generation in Australia to grow from 3% up to 45% by 2050[30]. This will likely happen before 2040 as the deployment of rooftop PV outpaces forecasts to date. All electric homes will become essential to managing a range of energy challenges such as variable solar generation through storage and demand response capabilities. By integrating these capabilities, all electric homes in Victoria could become a major energy asset to the energy system as a whole by functioning as an array of Virtual Power Plants (VPPs).

Household electrification is a *no-poles-no-wires* solution to energy infrastructure. All electric homes limit the need for further gas infrastructure spending and would be better invested in supporting homes to function as electricity infrastructure. As already outlined, all electric homes would cut Victoria's gas demand by 40% and free up supply elsewhere while other sectors electrify.

This can be achieved quickly. Investing in all electric homes can help manage a range of electricity system issues such as variable rooftop solar loads, peak demand, transmission congestion, firming capacity and limits the need to upgrade infrastructure such as substations and transformers.

Achieving the desired outcomes of an energy transition will require ambitious forward planning. Victoria can prepare for this transition by developing an *Electrification Roadmap for Households*. The roadmap would integrate electrification and energy efficiency agendas outlined in this submission to transform homes into energy infrastructure whilst being more comfortable and cheaper to live in for households. The Victorian Government will need to work with industry and private sector to design and implement the roadmap, beginning with a range of pilot programs before large scale implementation.

3.2 Scale of opportunities

a) The potential for dispatchable energy storage through household batteries and electric vehicles is enormous. If every private vehicle became an EV, assuming a 40kWh capacity battery, the combined storage capacity of EV's in Victoria would be

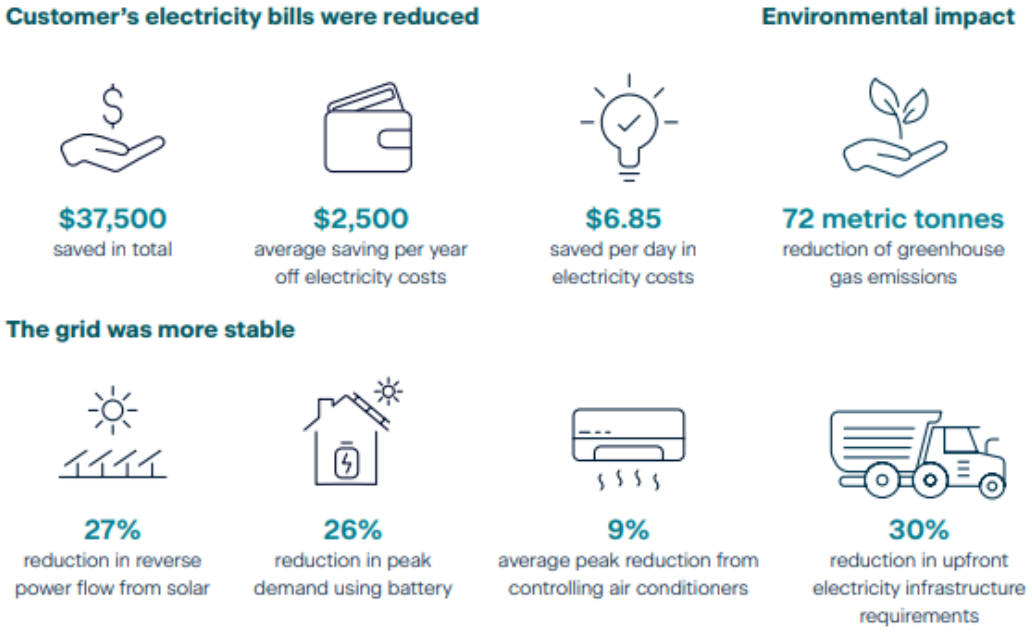
[30] CSIRO and Energy Network Australia. 2017. Electricity Network Transformation Roadmap.

150 GWh. If every home installed a 13KWh battery in Victoria, a further combined capacity of 36 GWh could be added to Victoria. Through Virtual Power Plants, the demand side benefits and services of integrating storage technologies would become major energy assets.

b) Virtual Power Plants will grow in prominence in Australia's energy system. Homes across Australia are already participating in trials and there is an estimated combined 5-10MW of VPP capacity installed and a further 700MW planned for 2022[31]

c) Case Study: Sun Pilot Broome.
A VPP trial was established across 15 households retrofitted with hot water heat pumps, battery storage, rooftop PV and energy management systems. Findings captured in figure 8.

Figure 8: Findings from Horizon Power's Smart Sun Virtual Power Plant pilot, Broome[32].



3.3 Key technical, regulatory and economic barriers

a) Home battery storage is a proven technology with over 6,000 homes in Victoria and over 34,000 across Australia having already installed a home battery system[33].

b) Both electric vehicles and home batteries are not yet economically viable for most, however, like rooftop solar, prices are expected to fall quickly as uptake accelerates and economies of scale decreases wholesale prices.

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[31] Renew Economy. 2019. AEMO to trial using virtual power plants for frequency control. https://reneweconomy.com.au/aemo-to-trial-using-virtual-power-plants-for-frequency-control-92695/

[32] Horizon Power. 2017. *Smart Sun: Summary Pilot Report Findings*. https://docs.google.com/document/d/1npqJQCdTiDauYHf7q5l4GapkeBaJbMTEvsgBg0nKS04/edit#

[33] Clean Energy Regulator. 2021. *Postcode data for small-scale installations.*

2.5 Interdependencies and trade-offs with other scenarios

a) All electric homes coupled with thermal efficiency and behind the meter technologies are highly complementary. Homes that demand less energy require smallery battery sizes, flatten energy peaks and provide other grid and energy services.
b) All electric homes and electric vehicles are mutually beneficial. Households will gain from both fuel savings and storage capabilities.

3.4 Roles to be played by government, industry and accounting for consumers

a) Government to establish major funding to subsidise household batteries in line with solar subsidies at the minimum.
b) Government to establish funding to subsidise EV charging infrastructure for households to incentivise future EV owners.
c) Government to work with the energy industry on how best to plan and prepare for a transformed energy sector with a greater role to be played by households with energy assets.

3.6 Benefits and Risks

The Benefits:

a) A plan to electrify housing can best position Victoria to capture the benefits of all electric housing and household energy infrastructure.
b) Go hard, go early, go households to avoid new gas developments and deliver greatest benefits to households and the economy.
c) Behind the meter generation, storage and management at scale minimises broader energy infrastructure spending.
d) Aggregating all electric homes at scale creates major energy assets through Virtual Power Plants and Virtual Transmission Lines.
e) Investing in homes as energy infrastructure is cost effective delivering cheaper energy to households, reduces network costs and builds resilience into Australia's rapidly changing energy sector.
f) Well designed and operated housing energy infrastructure will place downward pressure on both domestic gas and electricity prices.

The Risks:

a) Not planning for household electrification risks overspending on gas infrastructure and locking in higher gas prices and tariffs for households who remain on gas.
b) Unplanned, household electrification can further exacerbate network challenges and create new challenges such as overnight demand for electric vehicle charging.

2. Electrify Industry

Projections from AEMO indicate that gas prices will continue to increase, reaching over $10/GJ in 2030 for Melbourne Industrial users under the Central Scenario.[34] These prices are vastly higher than historic prices and what are unrealistic calls from some in industry for a $4/GJ plan.[35]

Put simply, cheap, abundant fossil gas no longer exists.

The choice for Victorian gas users is to either adapt to a high gas price reality or reduce exposure to volatile prices through new technologies.

BZE recommends a comprehensive program to electrify and substitute gas in manufacturing and industrial sectors. Significant industry support will be required to achieve this transition if Victoria is to maintain a deep and diverse manufacturing and industry base.

The good news is the fact that the dominant role of gas in Victorian industry is not a reflection of the best-in-class technology. In fact, gas based heating systems are inefficient and costly when compared to more modern electric-based technologies such as heat pumps, infrared ovens and electric furnaces. These have been adopted around the world as ways to improve efficiency, throughput, cost and safety.[36] Importantly, they help industries fuel shift away from ever more expensive fossil gas and tap into the electricity market with benefits from decreasing prices[37] as well as decarbonisation through the use of renewables.

Several studies have been published on this topic

- Strategy. Policy. Research., *Electrification Opportunities in Victoria's Industrial Sector*, October 2019[38]
- ARENA, *Renewable Energy Options for Industrial Process Heat*, November 2019[39]
- Australian Alliance for Energy Productivity, *Renewable Energy for Process Heat Opportunity Study*, May 2020[40]

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[34] "2021 GSOO Gas Price Forecasts - AEMO." https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/gsoo/2021/2021-gas-statement-of-opportunities-report-figures-and-data.xlsx?la=en.
[35] "Industry needs a $4 gas plan now - AFR." 10 Jun. 2020, https://www.afr.com/companies/energy/industry-needs-a-4-gas-plan-now-20200610-p551a4.
[36] "Electrifying Industry - Beyond Zero Emissions." https://bze.org.au/research_release/electrifying-industry/.
[37] "REVIEW - Australian Energy Market Commission." 21 Dec. 2020, https://www.aemc.gov.au/sites/default/files/2020-12/2020%20Residential%20Electricity%20Price%20Trends%20report%20-%2015122020.pdf.
[38] "Electrification Opportunities in Victoria's Industrial Sector" https://www.vic.gov.au/sites/default/files/2020-02/Appendix_6_Electrification_Industrial.pdf.
[39] "Renewable energy options for industrial process heat." https://arena.gov.au/assets/2019/11/renewable-energy-options-for-industrial-process-heat.pdf.
[40] "Renewable Energy for Process Heat Opportunity Study - Australian ...." https://arena.gov.au/assets/2020/06/renewable-energy-for-process-heat-opportunity-study.pdf.

Industrial heat pumps in particular represent a major opportunity for businesses, achieving efficiencies of 300-700% (as compared to the 50-85% efficiency for gas). These have been widely adopted in places like Japan, EU, Korea and UK, reducing cost and emissions at the same time with estimations from the International Energy Agency reporting a typical payback period of 2-7 years. Some great examples of industrial systems in Japan have been collated by the IEA Heat Pump Programme in Annex 48, some of which are highlighted in Table 1.

Table 1: Industrial heat pump use examples in Japan[41]

Company	Sector	Description	Benefits
Kosmos Food Co., Ltd.	Food	Simultaneous hot water and cold water supply for food processing, sterilization and washing. Water-to-water heat pumps (80 kWh/unit, 3 units)	• 87% CO_2 reduction • 80% cost reduction • 5 year payback period
Aishin A W Co., Ltd.	Machinery/ electronics	Cooling water for cutting process and hot water for washing process. Fourteen 22 kW cooling/heating units and eight 44 kW heating units	• 79% running cost reduction • 3.5 year payback period
Suda Industry Co., Ltd.	Chemicals	Hot air for drying process in laminating film. Water-to-air heat pumps (108 kWh)	• 72% CO_2 reduction • 75% energy cost reduction
Oji Tokushushi c.Ltd.	Paper products	Steamless heating in broke pulper process. Air-source hot water supply heat pump, 320 kW	• 50% CO_2 reduction • 42% energy savings
Hokkaido Bioethanol co.Ltd.	Chemicals	Steam heat pump in distillation process of bioethanol. Steam generation heat pump using exhaust water from cooling tower (1,481 kW)	• 43% CO2 reduction • 40% energy savings • 54% energy cost reduction

Some high potential applications of industrial heat pumps include:[42]

- Hot air generation and preheating for drying processes (ie: wood, paper, bricks, starch)
- Process steam generation for sterilisation of food (ie: milk)
- Hot water generation for washing and cleaning (ie: food, meat, product washing)
- Heat recovery in biomass incinerators
- Production of injection moulded components

[41] "Japan-2019-4 - Industrial Heat Pumps – IEA HPT TCP ANNEX 48." https://waermepumpe-izw.de/wp-content/uploads/2020/12/Japan-2019-4.pdf.
[42] "Final Report Annex 48: Industrial Heat Pumps, Second Phase - HPT ...." 4 Feb. 2021, https://heatpumpingtechnologies.org/publications/final-report-annex-48-industrial-heat-pumps-second-phase/.

Many of these processes are well represented in Victorian industries particularly where temperature requirements are lower (< 200°C). This includes those relating to food and beverage, pulp, paper and printing as well as textiles and clothing. Combined, these industry sectors use close to 24 PJ of gas, or 29% of total industrial gas use[43] with many more potential applications in other industrial sectors. These low temperature processes are all prime candidates for electrification through heat pumps, reducing gas use while taking advantage of the associated cost, efficiency and emission benefits.

Currently, a key hesitancy of electrification is due to lack of experience and relevant working examples.[44] However this will rapidly change as industries and their supporting service sectors prioritise energy efficiency; both in response to increasing energy prices as well as pressure from customers to reduce emissions. Pressure for decarbonisation is only increasing and industries are beginning to adapt to the increasing expectations for sustainability and climate action.[45] Gas fired heating for industries will simply become uncompetitive both financially and from a social licence point of view.

Pioneering industries in Victoria have already begun to take steps to electrify. These include large multinationals as well as smaller industry players keen to tap into the growing market demand (Table 2).

Table 2: Australian businesses switching to electrification

Company	Sector	Description
McCain[46]	Food	Committing to being powered by 100% renewables by 2030 including building Australia's largest behind the meter solar farm. Planning a $1.5 million project to incorporate heat pump[47]
Carlton & United Breweries[48]	Beverage	Offsetting 100% of their electricity use with Kardoc Solar Farm
Hardwick Meatworks[49]	Food	Plans to replace gas system with heat pump linked to their refrigeration, all powered by a solar farm to add value and drive costs down

[43] "Gas infrastructure international comparisons - Infrastructure Victoria." https://www.infrastructurevictoria.com.au/wp-content/uploads/2021/07/Accenture-Gas-Infrastructure-Advice-International-Comparisons.pdf.
[44] "Renewable energy options for industrial process heat." https://arena.gov.au/assets/2019/11/renewable-energy-options-for-industrial-process-heat.pdf.
[45] "Net Zero Asset Managers Initiative - Home." https://www.netzeroassetmanagers.org/.
[46] "McCain Foods pledges to be powered by 100 per cent renewable ...." 13 Jul. 2021, https://www.abc.net.au/news/rural/2021-07-14/mccain-foods-report-commits-to-100-per-cent-renewal-energy-/100207726.
[47] "Renewable Energy for Process Heat Opportunity Study - Australian ...." https://arena.gov.au/assets/2020/06/renewable-energy-for-process-heat-opportunity-study.pdf.
[48] "Victoria Bitter puts the Australian sun to work as it goes solar in 2020." 13 Sep. 2019, https://cub.com.au/victoria-bitter-puts-the-australian-sun-to-work-as-it-goes-solar-in-2020/.
[49] "Fired Up - Four Corners - ABC." 12 Apr. 2021, https://www.abc.net.au/4corners/fired-up/13299104.

Mars Australia[50]	Food	PPA with Kiamal Solar Farm
Lion	Beverage	Investigating $3.4 million heat pump project[51]
ANCA[52]	Machining	PPA with Flow Power, “potentially saving thousands of dollars in energy costs”
SCS Plastics[53]	Plastics	300 kW solar system

Electrification of these lower temperature industry processes also means that there will be more gas reserved for industries that require longer transition periods, for example Qenos. This freed up gas supply can help buy more time for these more difficult to transition industries until their decarbonisation technologies are more mature. Potential future pathways include the use of sustainable biomethane as a substitute for fossil gas feedstock, hydrogen and/or concentrated solar for high temperature heating and more advanced electrification technologies like electromagnetic or electric arc heating.

The future of industrial heating is via electricity and Infrastructure Victoria should plan accordingly by investing in grid reinforcement and electricity firming for industrial applications. This includes planning for how Renewable Energy Zones and associated transmission can deliver energy to nearby industrial hubs (ie: Geelong, Latrobe, Ballarat, Portland) as well as key industry locations in Melbourne (ie: Dandenong, Altona). Strong synergies can be found by pairing industry electrification demand with new renewable generation and firming capabilities, ensuring a balanced grid along with tools such as PPAs to build investor and industry confidence. This is a core part of our Renewable Energy Industrial Precincts strategy, enabling manufacturers and their industrial ecosystems to decarbonise efficiently while building skills in key sustainable technologies and attracting new markets overseas.[54]

Recommendations:

1. Infrastructure roadmap that plans for the electrification of industries in the coming decades. It should factor the increased electricity demand from electrified industries and pair them to REZs and the required transmission upgrades. Early focus will be on industries with low temperature processes (ie: food and beverage) with a longer term strategy to transition the more difficult processes with new technologies as they mature.
2. Identify existing industrial hubs that may benefit from continued fossil gas infrastructure for the short to medium term. These are likely to have high

[50] "Mars Australia begins offsetting 100 per cent of its power ... - ABC." 2 Mar. 2021, https://www.abc.net.au/news/2021-03-03/chocolate-company-mars-emissions-reduction-power-deal/13211162.
[51] "Renewable Energy for Process Heat Opportunity Study - Australian ...." https://arena.gov.au/assets/2020/06/renewable-energy-for-process-heat-opportunity-study.pdf.
[52] "ANCA invests in renewable energy to power its headquarters with ...." https://machines.anca.com/E-Sharp-News/March-2018/ANCA-invests-in-renewable-energy-to-power-its-head.
[53] "Sustainability - Tom Peters - SCS Packaging." https://scspackaging.com.au/sustainability/.
[54] "Renewable Energy Industrial Precincts - Beyond Zero Emissions." https://bze.org.au/research_release/renewable-energy-industrial-precincts/.

concentrations of processes that are currently difficult to electrify (ie: Altona). Areas outside of these hubs should consider decommissioning their gas infrastructure as electrification reaches critical mass.

3. Utilise the Breakthrough Victoria Fund to cofund electrification of major critical industries in manufacturing centres.
4. For areas that will require biomethane and/or hydrogen as part of their industrial process (most likely related to those identified in Recommendation 2), ensure the existing or planned gas infrastructure is compatible with 100% hydrogen or has good connection to potential biomethane resources.
5. Roll out of an industry engagement initiative that explains the benefits of industry electrification, drawing on the experiences from local and international businesses. This can be done in partnership with industry groups, unions and regulators to accelerate the uptake of more modern, electrified processes.