Submission on Victoria's Gas Substitution Roadmap

By: Lighter Footprints

Lighter Footprints is a community-based group that aims to influence Australian local, state and national decision makers to take the action necessary to halt global warming as a matter of urgency. For over a decade, we have educated, advocated and brought people together in Boroondara and surrounding suburbs to inform the community and promote a clean energy future. We have over 2,500 people on our mailing list.

Lighter Footprints welcomes the opportunity to respond to Victoria's Gas Substitution Roadmap Consultation Paper.

Our submission is structured as follows:

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EXECUTIVE SUMMARY

Lighter Footprints firmly believe that Victoria needs to stop burning all fossil fuels as soon as possible. Whilst natural gas was previously a low cost, lower-than-coal-pollution solution to cooking, water and space heating, we now have alternatives that are economically viable, healthier, and low emissions.

We thoroughly agree with the **IEA Special report on net zero emissions by 2050 (NZE2050)** and are aligned with their succinct and tangible timetable outlining key milestones in the pathway to net zero. We strongly advocate for DELWP, Infrastructure Victoria and other Victorian Government departments to adopt the IEA pathway and timeline (see figure 1 below) and leverage this report as a strong guide to policy decisions.

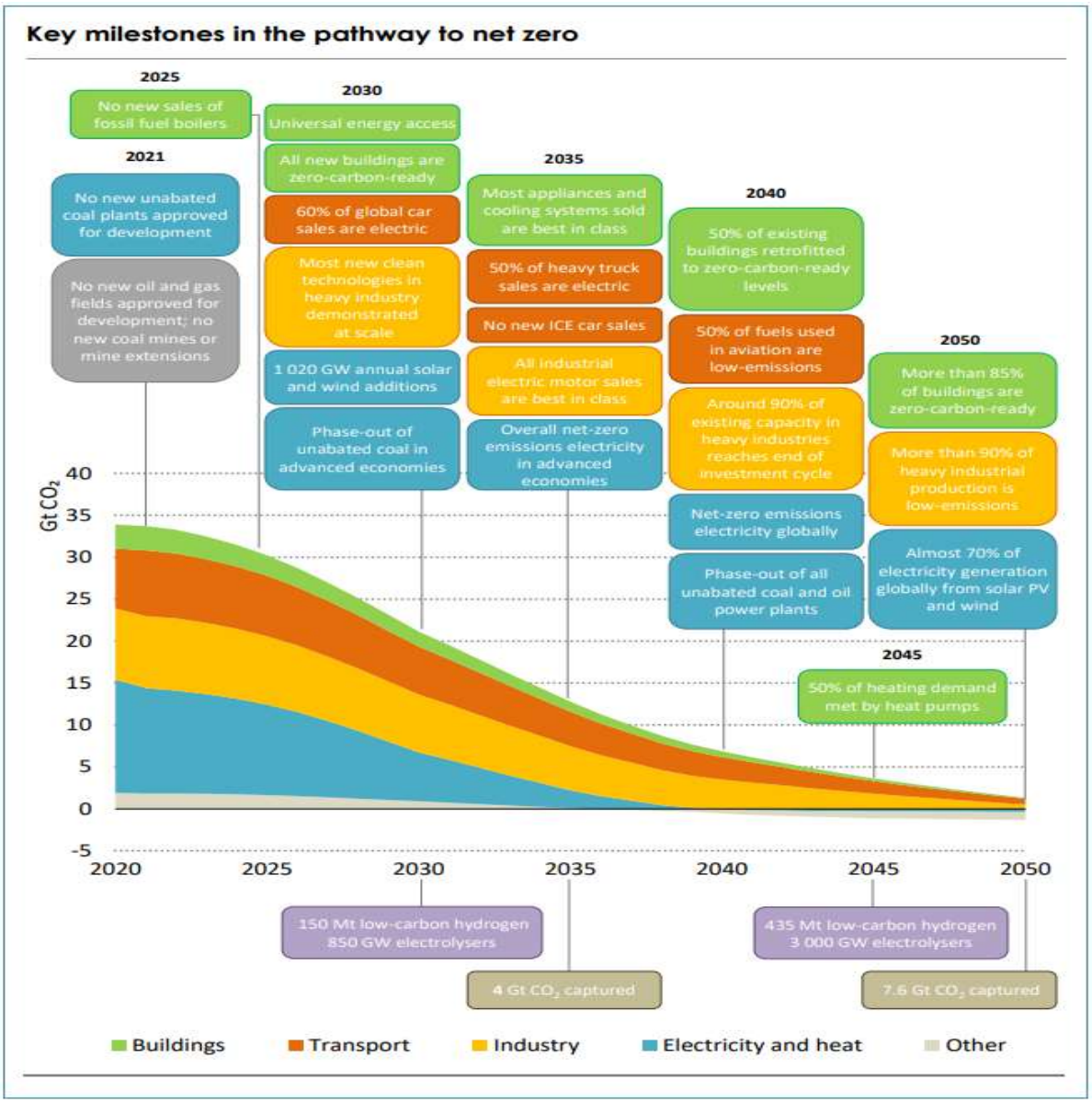


Figure 1 International Energy Agency (IEA) - Key milestones in the pathway to net zero by 2050

We support the creation of a roadmap for gas substitution. We believe that this must be a "no regrets" roadmap. By "no regrets" we mean that emerging technologies should not be included as roadmap solutions until proven (from technology, social and economic perspective). Our objective of "stopping burning natural gas" is too important to be based, even partially, on emerging technology.

The following solutions should not form part of a "no regrets" Roadmap:

- Hydrogen in the current gas network (endgame of 100% hydrogen cannot be achieved because of inadequate pipe network capacity for hydrogen's energy density and leakage risks from inappropriate pipe materials for hydrogen)
- Hydrogen in a new network (this material/volume solution is technically unproven but more importantly appears uneconomic)
- CCS (the technology is unproven, and the solution appears uneconomic).

We recommend the roadmap be reviewed on a regular basis (every 5 years for example) with consideration being given to incorporating new proven technologies only if they represent better solutions.

It is our belief that the Initial Gas Substitution roadmap should focus on the following:

- Improving energy efficiency through energy efficient initiatives, incentives and education
    - The cheapest and cleanest energy is energy you don't use
- Electrifying households and businesses whenever and wherever possible
    - Electrification is a "no regrets" solution with all relevant technology proven and the Victorian Government having a commitment to a green low-emissions grid
    - Achieving this will require consistent messaging, consumer incentives and education

- The changes required by the roadmap should be accessible by all households and businesses and action should be taken to see that no section of the community is adversely impacted by these changes. The following will require special attention:
    - Vulnerable people
    - Renters
    - Rural customers
    - Gas network owners (significant investment to be written down and they need to be compensated in an equitable way

Submission

Lighter Footprints position on gas

Lighter Footprint's fundamental principles on energy and the environment are:

- Combusting natural gas (although lower CO2 emissions than combusting coal, wood or oil products), is incompatible with the International Energy Agency Special Report, 'Net Zero Emissions 2050' (NZE2050) so we must set a trajectory to eliminate the burning of natural gas.
- We must move quickly to meet interim emissions targets.
- Emerging technologies should not be included as roadmap solutions until proven (from technology, social and economic perspective)
    - We believe that this must be a "no regrets" roadmap. Our objective of "stopping burning natural gas" is too important to be based, even partially, on emerging technology and the risk that roadmap goals are not met.
    - This does not mean that we should not apply resources /funding /focus to these new technological possibilities as the situation requires all solutions. But it must be proportional to risk and reward and recognise that these alternative solutions may not have a significant role in our future energy solution.
- Transitioning from natural gas to other fuels is a necessary part of the transition.
- The solutions must be equitable.

Material research from infrastructure Victoria

We have reviewed Infrastructure Victoria's "Towards 2050: Gas Infrastructure in a Zero Emissions Economy. Interim report[1]" with interest and believe that it requires careful consideration. The report considers 4 scenarios for analysis:

- A: full electrification, no natural gas (by 2050), no CCS
- B: partial electrification, limited natural gas use (in 2050), limited CCS
- C: green and blue hydrogen with carbon offsets, electrification, no natural gas (by 2050), no CCS
- D: large-scale brown hydrogen, large-scale CCS, no natural gas (by 2050)

Option C is an interesting scenario as it appears to be the least cost option while reaching net zero by 2040, ten years ahead of options A and B. However, it involves building a new hydrogen distribution system and cannot be considered as no-regrets at this stage, that is technologies are unproven and the assumptions about the costs of these technologies cannot be factual or verifiable. We support an outcome somewhere between scenarios A and B at this stage as they have the least risk, including more reliable cost assumptions for established technologies.

We also recommend that the significant issues surrounding building a new hydrogen distribution network, transitioning all gas appliances to hydrogen and the ongoing cost of energy from such a system should be further researched and trialled before option C can be considered a "no-regrets" option

We especially agree with Infrastructure Victoria's view (page 5):

> *Under all scenarios that we considered,* ***the opportunity to repurpose existing natural gas infrastructure over the long term (beyond 2040) is limited****.* (our emphasis)

[1] https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/4916/2622/6516/Gas_Infrastructure_Advice_-_Interim_Report_FINAL_4.PDF

The future of low or net zero emissions gases, such as hydrogen produced with renewable electricity and seawater (known as green hydrogen), and decarbonisation pathways such as CCS remains uncertain. Victoria could support further research and development in these technologies until their economic and environmental viability at scale is known, with the aim of keeping Victoria's options open rather than locking in a single approach which may not turn out to be the best course of action.

Transitioning to alternative fuel sources

If we are to eliminate emissions from the burning of natural gas, Lighter Footprints contends that we must transition to alternative fuel sources. We believe that the following fuel sources should form part of the mix:

- **Electricity**
  - Although electricity in Victoria is currently highly dependent on coal, the transition of the grid to high (>90%) renewable penetration is technically and economically feasible and well underway. We note that by 2025 the Victorian Energy Upgrades (VEU) program has electricity emissions at 0.393 CO2e/MWh over the forward 10-year average.
  - Within the investment timeframe of gas transition, it therefore can be assumed that electricity will be low emissions. High heat pump COP (co-efficient of performance) translates to effective emissions of less than one quarter of 0.393 = 0.1 CO2e/MWh for 2025 10 years forward estimates. Even traditional gas industry players recognise the efficiency gains of modern heat pumps[2].
- **Hydrogen**
  - Fundamentally hydrogen has a lower energy density by volume than any alternative. Hydrogen can be produced using existing and emerging technologies, but the current cost of production makes it less economic than other low carbon alternatives for many uses. The cost and inefficiency of bulk storage of hydrogen also limits some use cases. However, the cost of renewable (Green) hydrogen is widely forecast to fall to AUD2 per Kg by 2030 at which time it may become economic in some specific applications. Green hydrogen will initially be most valuable in replacing the brown/grey hydrogen supply chain and this will consume the majority of green hydrogen production to 2040. This will be important, for example, in retaining aluminium smelting onshore by companies with renewable electricity powered smelters in other countries.
  - Renewable hydrogen may also have a further significant role to play if further analysis shows that transitioning to a hydrogen network is feasible and sensible.
- **Biogas**
  - Biogas can have uses for industrial heat or local co-generation.
  - There are insufficient volumes for biogas to play a major role in the distribution network and hence residential market.
  - A key emerging sector for biogas is cogeneration (heat and electricity) in agriculture using agricultural byproducts.

Possibly solutions that are currently not yet sufficiently proven (technically, environmentally, economically)

These solutions may have a role to play if they are proven. However, we have excluded them from our "no-regrets" transition recommendations.

[2] https://discover.agl.com.au/your-home/heat-pumps-why-are-they-more-efficient/

- **Blending hydrogen (green or other) with natural gas distribution networks**
  - This does not provide a proven roadmap to the long-term objective of zero carbon emissions
  - Currently not proven it can ever make economic sense (trials are taking place)
  - Does not significantly reduce the CO2 emissions as hydrogen carries less energy than natural gas by volume so that the proportion of hydrogen required to significantly displace gas cannot be carried by the existing network.
  - This simply prolongs reliance on combusting gas
  - Requires further investment in gas distribution networks (stranded asset investment that will never be equitably recovered)
  - Logistically challenging
  - Electrification of residential space and water heating is more timely, economic and greener than adding green hydrogen to the gas distribution network[3].

- **High levels of green hydrogen in distribution networks**
  - Assuming alignment with IEA NZE-2050 pathway of no combustion of fossil fuels, the objective would need to be for residential gas distribution to transition to 100% hydrogen or small levels of biomethane blended into predominantly hydrogen.
  - This will require a new pipe network with the materials and volumes to handle hydrogen.
  - We believe that transitioning the current gas network to deliver green hydrogen is **not** a viable alternative. We support the finding in the draft Infrastructure Victoria report Infrastructure Victoria's "Towards 2050: Gas Infrastructure in a Zero Emissions Economy. Interim report[4] on page 5 which states: "Under all scenarios that we considered, *the opportunity to repurpose existing natural gas infrastructure over the long term (beyond 2040) is limited."* (our emphasis)
  - Building a new hydrogen distribution network may be an option. Such an exercise would be a significant body of work and should only be considered after further analysis and trials. If such an option is proven to be viable it may be possible to incorporate this option into the Roadmap at a later date.

- **Other hydrogen (Brown, Blue or grey)**
  - We believe that investment in brown hydrogen (from fossil fuels) and grey hydrogen (fossil fuels with carbon capture storage) is a retro-grade step. Brown hydrogen is emissions intensive defeating the goal of reducing emissions by 2050. Grey hydrogen is economically more expensive to build and operate than green hydrogen. Price Waterhouse (PwC) forecast[5] that green hydrogen will be cheaper than both brown and grey hydrogen by 2030 and, given the headwinds of some explicit or implicit 'carbon price' and the ability to manufacture green hydrogen close to the end user industry without the need for gas network costs, institutional investors will cease financing brown and grey hydrogen capex projects 3 to 5 years before 2030.
  - We note that KPMG have modelled carbon capture storage (CCS) costs as +50% additional capex for grey hydrogen versus brown hydrogen and opex costs are 15 to 20% higher for grey hydrogen versus brown hydrogen.

[3] https://www.rechargenews.com/energy-transition/using-clean-hydrogen-for-domestic-heating-and-transport-is-nonsensical-says-enel-ceo/2-1-1039690
[4] https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/4916/2622/6516/Gas_Infrastructure_Advice_-_Interim_Report_FINAL_4.PDF
[5] the-dawn-of-green-hydrogen.pdf (pwc.com)

- **CCS retrofit for electricity generation**
  - Carbon capture and storage has not been a successful technology over many decades and the current operational Gorgon example cannot meet its contracted targets. It is not feasible (especially for Australia's aging coal fleet) and should not be a priority for funding/effort in Victoria because there are multiple better solutions for us.
- **CCS for industry**
  - CCS for industries with less clear decarbonisation pathways (eg cement production) should be researched and piloted.
- **Concentrated solar thermal** has potential to provide some capability in firmed renewable electricity (and co-generation of heat is required) and deserves R&D/pilot funding but should not be relied on at this time to be a major player in the AU electricity market. But it should not yet be excluded.

The following three unproven solutions could have a role to play if trials (which do not necessarily need to be Australian) prove successful and the solutions can be proved to be technically feasible, environmentally friendly and economically viable:

- Green hydrogen in a new network
- CCS for Cement and other industrial uses and
- Concentrated solar thermal.

Transitioning building emissions

The IEA Special report on NZE2050[6] has a strong focus on buildings emissions (ref Figure 2) which proposes banning fossil fuel furnaces/boilers by 2025 and the replacement of a majority of non-electric appliances with all-electric by 2035. The good news is that the majority of domestic, commercial and industrial gas combustion uses have viable and mostly more economic electric alternatives.

Household energy efficiency

Lighter Footprints believes that energy efficiency should be used to drive a reduction in household emissions.

Lighter Footprints takes a hierarchical priority approach to household energy efficiency with priority on using less energy, then paying less for energy etc as per Figure 2. The lower layers generally provide a significantly better return on investment/effort and are fundamental to achieving fair ROI on upper layers. Government should consider a similar approach in efforts and expenditure, especially subsidies and considerations of inequities.

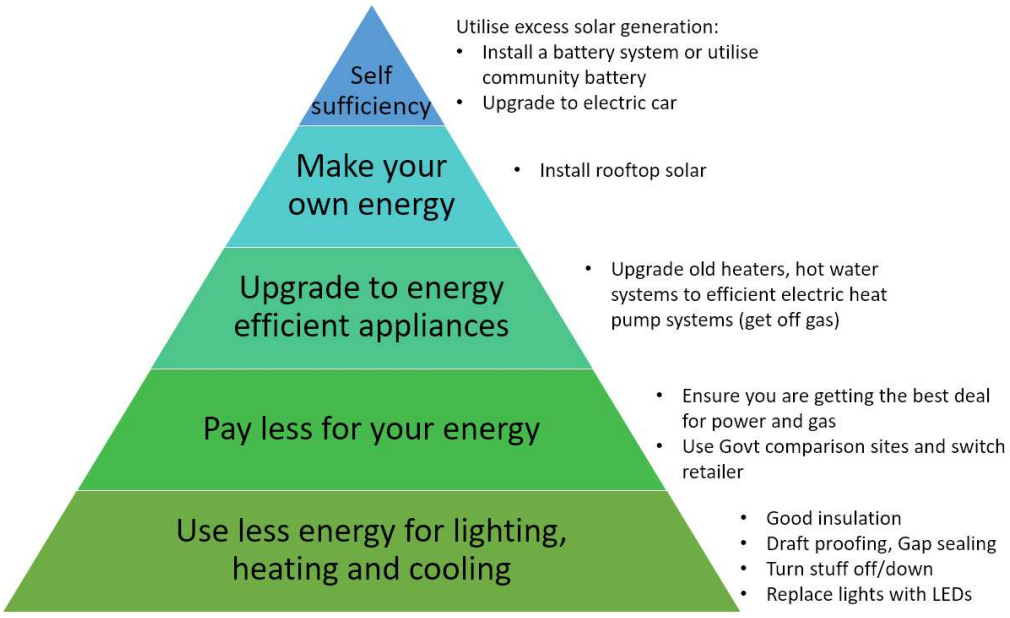


Figure 2 A "Maslow" hierarchy of energy efficient homes

[6] https://iea.blob.core.windows.net/assets/20959e2e-7ab8-4f2a-b1c6-4e63387f03a1/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

Electrification of business and commercial buildings

- Similar process as per residential, for space and water heating (low temperature applications)
- Similar trade education/incentives
- Business case may be more attractive than residential (tax effective, higher utilisation, electric heat can be more targeted than gas, opportunity to leverage NEM market prices, Time of Use (ToU) electricity tariffs etc vs rising gas prices)
- Incentivise development of commercial appliances (eg electric cooking appliances, especially pizza ovens)

Reducing gas combustion in industry

- We have limited expertise in industrial applications but recognise that the majority of low-mid temp industrial heating can be effectively and efficiently electrified (often more efficient and controllable than gas). We acknowledge and refer to significant efforts by Beyond Zero Emissions[7] and the Grattan Institute[8].

Non-combustion use of gas in industry

- We have limited expertise in this area but supports the transition from methane to green hydrogen and green ammonia for industrial feedstock.

Gas in electricity generation (GPG)

- Gas can play an important role for firming and system strength through the transition of the grid, as coal exits.
- However, battery, inverter and synchronous condenser technologies are rapidly displacing gas technologically and economically for such system services such as the shorter, shallower firming (4 hours and overnight) plus reduction in inertia, as thermal generators exit. Hydropower also addresses some of the deep storage/firming requirements but lacks sufficient capacity in the near term. Whereas gas-powered generation (GPG) has played an important role in intermediate and regular peaking services, it will be called into play less and less as renewables and associated storage (especially 2-4 hour batteries) increase. Though the amount of gas consumed for GPG will reduce, it's importance will increase, as will the cost of GPG electricity (higher gas prices and significantly lower capacity factors) but it will play a critical role for the next 25 years as the grid evolves to 100% renewables.
- We refer to Grattan Institutes work on moving to a net zero electricity grid which reinforces a critical but diminishing role of gas in firming a high renewables grid as we rapidly exit coal.[9]
- We note that GPG manufacturers[10] are certifying new turbines and retrofits for increasing levels of hydrogen so transition of existing GPG to hydrogen to support zero-emissions firming deep storage is feasible once hydrogen production and storage (high volumes, low pressure) becomes economically viable.

[7] https://bze.org.au/research_release/repowering-collie/ https://bze.org.au/research_release/rethinking-cement/ and https://bze.org.au/repowering-australian-manufacturing/
[8] https://grattan.edu.au/report/start-with-steel/
[9] https://grattan.edu.au/report/go-for-net-zero/
[10] https://www.powermag.com/siemens-roadmap-to-100-hydrogen-gas-turbines/

Equity issues

There are substantial energy efficiency equity issues that must be addressed:

- Renters who suffer from properties with inefficient or no insulation and inefficient appliances that landlords have little incentive to upgrade or replace
- The vulnerable who cannot afford to upgrade to efficient appliances
- As households electrify and disconnect from the gas network, the depreciation and operating costs of network assets are spread across fewer users, increasing their costs. If the vulnerable are left behind in the transition they will bear the burden of those increased costs.

Responses to Key questions

Victorian Energy Upgrades

How can we ensure that the costs of transition to lower emissions energy sources are borne equitably?	There are two main transition cost areas: 1. the cost of maintaining legacy network and equipment with decreasing usage/demand and 2. the cost of new equipment/appliances. Like rooftop solar, LED lighting and home batteries, new energy efficient electric technologies such as heat pump hot water and space heating will need to be subsidised initially to promote rapid early adoption and drive economies of scale. It is important that additional subsidies are put in place for those who may find transitioning difficult (low-income earners, retirees, people renting and in those in public housing) in addition to providing assistance to the vulnerable the Government should take measures to encourage landlord investment. Initially, legacy gas network charges (largely regulated monopoly gas distribution networks) must be 'held steady for low-income users' with increases limited to CPI, so that the fewer and fewer remaining low-income users do not have to pay disproportionately to cover the total costs. Late in the transition, it may be necessary for the Government to change regulations and provide some support for write-offs to regulated distribution businesses.
How can we help low-income and vulnerable households manage any upfront costs in changing energy sources?	• We can help low-income and vulnerable households manage the upfront costs in changing energy sources by providing interest free loans repayable out of efficiency savings. • Appliance upgrade is often beyond the fmeans of people renting and in the hands of their landlords, so incentivising or mandating landlords to invest in energy efficiency is critical.
What are the barriers for households in improving the efficiency of their use of gas for heating, cooking and hot water and/or switching to solar/pump hot water in existing homes?	Key barriers are: • Public ignorance of issues, options, determining who can be trusted for advice. This is exacerbated when needing to make a decision about an old appliance – A tradesperson called for repair of an old/inefficient gas appliance is likely to suggest replacement with a new gas appliance rather than the extra effort of explaining and installing a new efficient electric heat pump alternative. In a household without hot water or heating due to failure, an expedient solution often wins over a considered better solution. • Misleading advertising by groups with vested interests (eg gas industry, Australian Gas Networks claiming gas is cleaner and greener than alternatives) • Lead-times and resistance to change of current trades – most plumbers simply opt to replace like-for-like when HWS, heating furnace fails (easier, faster, cheaper). This is the 'missed opportunity', which will not then be available again at that same household for another 10 to 20 years when the appliance is next due for replacement. This is especially obvious when old appliances fail and rapid replacement is essential for continuity of hot water and warm homes. • Upfront costs (heat pump and induction appliances are often more expensive and more complex/expensive to install, though cheaper to run) and many consumers don't prioritise the impact of lower lifecycle costs.

	• Tenants are poorly placed to progress changes in the properties they are renting. While the impact of poor efficiency is felt by tenants the landlord is required to fund efficiency improvements with only indirect return for that investment. Mechanisms to reward landlord investments are required (perhaps coupled with enforced regulation compliance as additional incentive). • Property owners may lack confidence in dealing with tradespeople. • Property owners may not realise that a single contractor will supply equipment and co-ordinate electrical and plumbing work ○ Hot water storage sizing needs to be sufficiently large so as to mean that water heating mainly occurs just once/day i.e. in solar peaks. Need some industry standards in quotation – i.e. how many in household? or how many bedrooms? This dictates size of buffer tank and should be a requirement in quoting. • There may be insufficient Trades trained on new technology and simplifying for consumers. The technology must be made as simple as possible so consumers can achieve full benefits (eg setting timers to utilise lowest tariffs and achieve best efficiency)
What are the opportunities for the Victorian Energy Upgrades program to incentivise efficient gas use, thermal upgrades of buildings (e.g. insulation) and electrification?	A priority system (ie a Maslow-style hierarchy of energy efficiency – refer Figure 2 above) should be adopted incorporating: 1. Education (households, landlords, trades and peak bodies) 2. Energy efficiency of existing home (insulation, draft-proofing, optimised retailer/tariffs) 3. Where possible, installing rooftop solar 4. Switching from existing gas appliances to electric. The Victorian Energy Upgrades program should concentrate on electrification where feasible. However, for businesses where electrification is not a solution at this stage, the program should focus on energy efficiency and pathways to emerging solutions such as solutions that are hydrogen compatible.
What issues and elements do you see as most important to improve the energy and emissions performance of new homes?	1. Cease the mandate of gas connection to new estates, new builds, and cease gas connection to new housing estates. ACT has already mandated this[11]. 2. Extend building energy efficiency rating beyond just design to certify that the actual build and ongoing operation meets the designed efficiency rating. 3. Incentivise architects, designers, volume builders to include efficient, electric appliances. 4. Incentivise new builds to include both rooftop solar and fully electric heating and cooking. (Recognising the co-benefits of rooftop solar PV and heat pump hot water for the grid as well as cost for households). 5. There is an information gap and there needs to be a focus on education (how, where, why energy costs can be reduced), energy efficiency (insulation, draft prevention etc), optimising retail energy bills (encourage move to most economic retailer/tariffs) and then upgrades of appliances. This communication and education needs to span the end users, landlords and the building industry.

[11] https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/rattenbury/2020/now-were-cooking-with-electricity!-gas-no-longer-a-requirement-in-canberra-suburbs

Outcomes framework and multi-criteria assessment

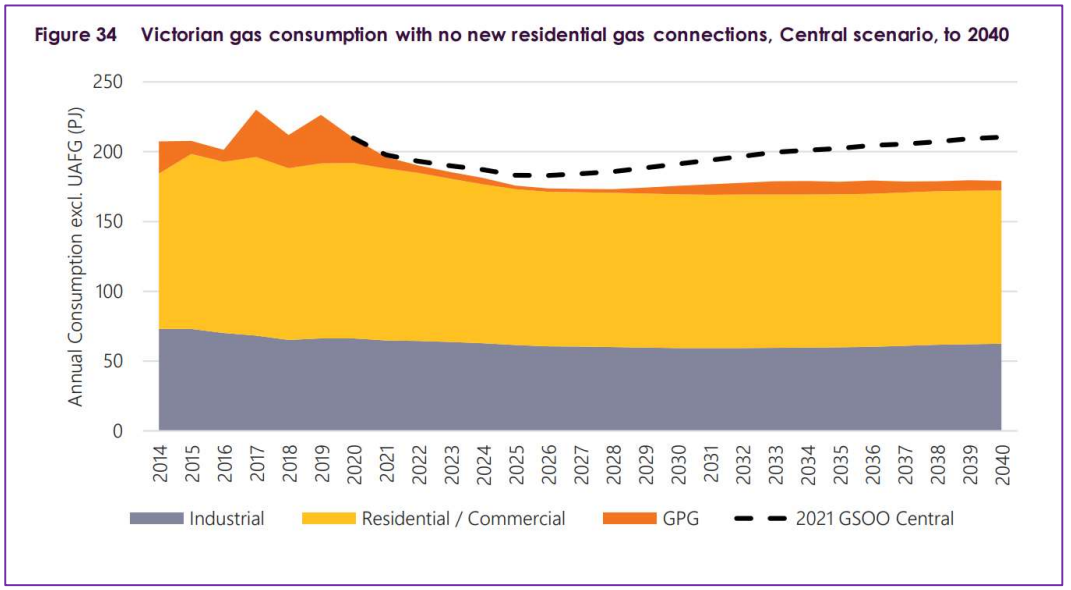
Do the range of outcomes measures identified above adequately cover key considerations for assessing the costs and benefits of options and strategies to decarbonise the use of gas in Victoria?	We consider that the outcome measures are sensible.
What would be appropriate metrics through which to measure these outcomes?	Emissions reduction: • Annual number (or number of gas disconnections) and total of homes transitioned to electricity (public and private) • Annual number and total of new all-electric homes (private and public) • Number of residential customers remaining on the gas network • Decrease in residential gas consumption • Estimate of emissions reduction from transition Energy security and reliability • AEMO reports on Victorian gas • Regulator reports on reliability Affordability and equity • Gas distribution and retail prices compared to 2021 benchmark • Conversion rates by sector (owner occupiers, renters, public housing) Safety • Existing safety reporting for gas distribution • Safety reporting on conversion Market viability • Distribution business revenue compared to allowed revenue (regulatory) Social licence • Consumer surveys Social impacts • Consumer survey • Fall in numb er of asthma and health issues associated with combusted gas inside the home (e.g. cooking, older gas heaters) Economic impacts • direct and indirect jobs associated with renewable energy and energy efficiency initiatives

Responses to key questions per pathway

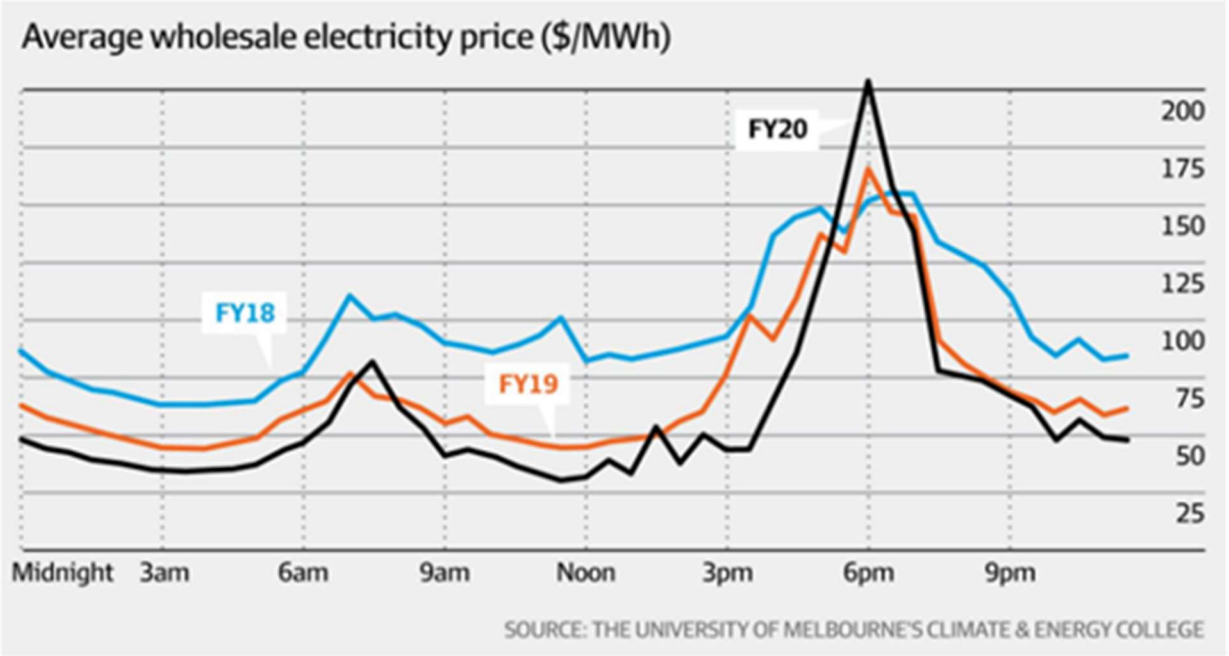
Pathway 1. Improving Energy Efficiency (Housing energy efficiency upgrades, appliance upgrades)	
Our View: Our view is that improving *energy efficiency* is a high priority pathway. We believe that energy efficiency initiatives should cover business as well as households.	
What are the key benefits, risks, and potential impacts on various end-users, on energy affordability, safety, security, reliability and equity?	The benefits from improving energy efficiency are reduced energy bills, a reduction in demand (reducing gas demand or reducing electricity demand reducing pressure on the grid). The key risk is that a major transition could place pressure on generation and on the grid. However, the pipeline of new renewable project is very strong and AEMO is already planning to have Australia's grids able to handle periods of 100% renewables by 2025. It seems clear that we can manage a fast take up of energy efficiency through electrification. There are no affordability, safety or security issues. There are potential equity issues for those who cannot afford to take action and for those renting.
What are the scale of opportunities and potential to accelerate uptake?	The scale of the opportunity is large with much of the housing stock having poor insulation. Australian building standards fall well behind Europe in terms of energy efficiency. In addition, many appliances are not efficient.
What are the key technical, regulatory and economic barriers?	There are no technical barriers. However, there are practical issues associated with replacing gas HW with electric HW as it requires the rapid co-ordination of both gas and electrical trades in an 'emergency purchase'. . Only 10-15% of new hot water services (HWS) are 'considered purchases' by owners. A massive 55-65% are 'emergency purchases' after breakdown (E3 Hot Water Systems Roadmap 2018[12]). Innovative models should be considered to neutralise this disincentive. Perhaps a 'pool of electricians' could be contracted at a set rate for 'emergency hot water replacement' (managed centrally by small team funded by VECCS) . In an 'emergency replacement' a Plumbing Contractor would get an incentive or payment each time they co-ordinate electricians for the electric wiring for a new electric heat pump HW. (Plumbers still do actual HW unit removal and new HW unit placement, water dis-connect/connect and gas disconnect) Builders of new houses install the remaining 25-30% of new HWS. They are driven by capital cost, without regard for the running cost to be borne by the household. The owner of an investment property will have similar priorities. Innovative models should be considered to neutralise this 'upfront cost' disincentive.

[12] E3 Hot Water Systems Roadmap - 12 November 2018.pdf (energyrating.gov.au)

	The regulatory barriers consist of a lack of regulations in certain areas. We would like to see: • Appliances to be required to show kWh per annum for electric, or GJ for gas, applied to Government default offer tariffs to highlight more clearly the advantage of heat pump COP, for small, medium and large households This would allow consumers to understand the longer-term ramifications of buying the "cheaper" but inefficient products • Minimum energy efficiency standards should be mandated for rental properties. Economic barriers are as follows: • The solutions require an upfront payment with benefits accruing over time. Many people find this makes commitment difficult • Vulnerable people may not be able to afford the up-front payments • Landlords may see investments in property efficiency improvements as producing no returns.
What are the roles to be played by government, industry and how will consumers preferences be accounted for in the transition?	The government should establish the framework, update regulations as required, amend the grants and subsidies to drive the required outcomes and promote the program. Industry already has the capability to deliver the required solutions. Consumers will have a choice of provider and a choice of appliances.
What are the likely timings of technical maturity and economic viability?	There are already mature solutions in the market that provide economically viable solutions. Naturally, some of these solutions will improve over time.
What are the best ways to maintain social acceptability and consumer confidence?	The solutions are socially acceptable. Consumer confidence could be improved by providing better information on the benefits of insulation and by requiring better explanations of the benefits of newer improved appliances.
What are the inter-dependencies and trade-offs with other pathways (are pathways complementary or alternatives)?	There is a clear complimentary inter-dependency with the electrification pathway. For example, roof-top solar PV and heat pump HW that can be programmed to run during the middle of the day. The efficiencies of electric appliances should take advantage of these inter-dependencies.
What are the key uncertainties and potential for unintended consequences?	We are not aware of any unintended consequences with what we propose

Pathway 2. Electrification	
Our View: Electrification of many activities will be more efficient and will result in lower emissions. As the electricity grid moves to higher renewables penetration, electric appliances get increasingly de-carbonised as a result. As more roof-top solar pv gets installed, further de-carbonisation results.	
What are the key benefits, risks, and potential impacts on various end-users, on energy affordability, safety, security, reliability and equity?	Benefits include reduced energy costs, health benefits and reduced emissions. Risks include overload of electricity network (will be managed by AEMO[13] and network service providers) Energy affordability should be improved, health risks (e.g. gas cooking) are removed, security should remain high. Equity issues will arise due to up-front costs or tenancy arrangements if not addressed by Government Grattan Institute[14] agree that a new all-electric house is generally cheaper to live in than a dual-fuel house (Page 46)
What are the scale of opportunities and potential to accelerate uptake?	The opportunities are significant. 1. Vehicle owners will transition to EVs if barriers (cost and charging) are removed 2. If new homes are all electric this will have a significant impact on gas demand – see chart below:  *Figure 3 AEMO GSOO (P63, Mar 2021) Victorian gas consumption*

[13] 100pc renewables 'is where we're heading': AEMO boss (afr.com)
[14] https://grattan.edu.au/wp-content/uploads/2020/11/Flame-out-Grattan-report.pdf

	3. Electrification of social housing is largely in the control of Government 4. Electrification of government buildings is largely in the control of Government 5. Other electrification can be accelerated with appropriate promotion and incentives.
What are the key technical, regulatory and economic barriers?	The up-front costs of appliances and installation is a barrier to the electrification of homes. Similarly, this can be a barrier to the electrification of space and water heating in commercial and industrial buildings. There are some technical barriers to the electrification of combustion and some non-combustion industrial uses. Limited availability and uptake of TOU tariffs reduce consumer incentive to move energy consumption to times of strong supply (now daytime vs traditional overnight off-peak). Encouraging the move of TOU off-peak tariffs to daytime (solar soaker) and consequent higher consumer adoption of TOU tariffs will play an important role in grid and consumer support of higher household electrification. 9am-3pm off-peak aligns with the evolving wholesale market price troughs, lower than historical overnight lows.  *Figure 4 Melbourne Energy Institute trend analysis of average NEM spot prices*

What are the roles to be played by government, industry and how will consumers preferences be accounted for in the transition?	Strong messages need to be sent to business and the community that ''*electricity is cheaper and more efficient in the majority of cases*''. ''*Combustion of gas must end as soon as possible''*. These messages, together with appropriate incentives must drive business investment in electrification as replacement for gas combustion, Innovative models should be considered to neutralise this disincentive. In particular the Government should provide assistance to plumbing contractors called out to replace gas HW to ensure that they can offer electric HW in an 'emergency purchase'. Government must support these messages with: • Incentives / subsidies to electrify efficiently (revised VEU incentives) • The cessation of VEU subsidies for conversion of electric to gas appliances • Continue incentives for roof-top solar PV • Consumer education to provide business with an understanding of the issues and certainty of investment • Assistance with trade and workforce transition • Assistance to local manufacturers of gas appliances to produce all electric appliances. • Assistance to Plumbing contractors replacing gas HW with electric HW in an 'emergency purchase'
What are the likely timings of technical maturity and economic viability?	• There are significant electrification opportunities that are economically viable. • With Government commitment to the electrification program further solutions will be developed and become economic.

What are the best ways to maintain social acceptability and consumer confidence?	• Establish an electrification program that ensures that participants benefit (should be possible with opportunities currently being NPV positive}
	• Encourage high-profile consumers to transition.
	  ○ Ensure selection of consumers are in the group that will benefit based on honest assessment
	  ○ Ensure that the transition process is smooth
	  ○ Publicise the success stories.
	Use community groups and the Community Power Hubs to deliver the messages.

What are the inter-dependencies and trade-offs with other pathways (are pathways complementary or alternatives)?	This pathway is complementary with the energy efficiency pathway.
What are the key uncertainties and potential for unintended consequences?	Switching away from gas represents a change of behaviours. It is uncertain that consumers will change.

Pathway 3. Substituting natural gas with hydrogen

Our View: It is our view that hydrogen will not be used to displace natural gas in the existing gas distribution network. Building a new hydrogen gas distribution should not be categorised as "no regrets" until it is fully analysed and tested.

Lighter Footprints believes that Victoria should focus on green hydrogen production for the higher use cases only (A,B,C) in Figure 5 below.

- Bloomberg New Energy Finance (BNEF[15] – ref Figure 5 below) suggests that industry feedstock will be the priority use of green hydrogen (denoted A: replacement non-combustion uses of methane) followed by combustion uses where there are currently few viable alternatives to combusting fossil fuels (denoted B: aviation, shipping, steel, deep storage for electricity firming). Industry will arrive at the optimum pathway – be it hydrogen or ammonia, or gas with CCS, in areas denoted D,E in due course.
- Progressing down the chart moves into uses where (typically) electrification provides increasingly technically and economically viable alternatives to gas combustion. (Denoted F,G)

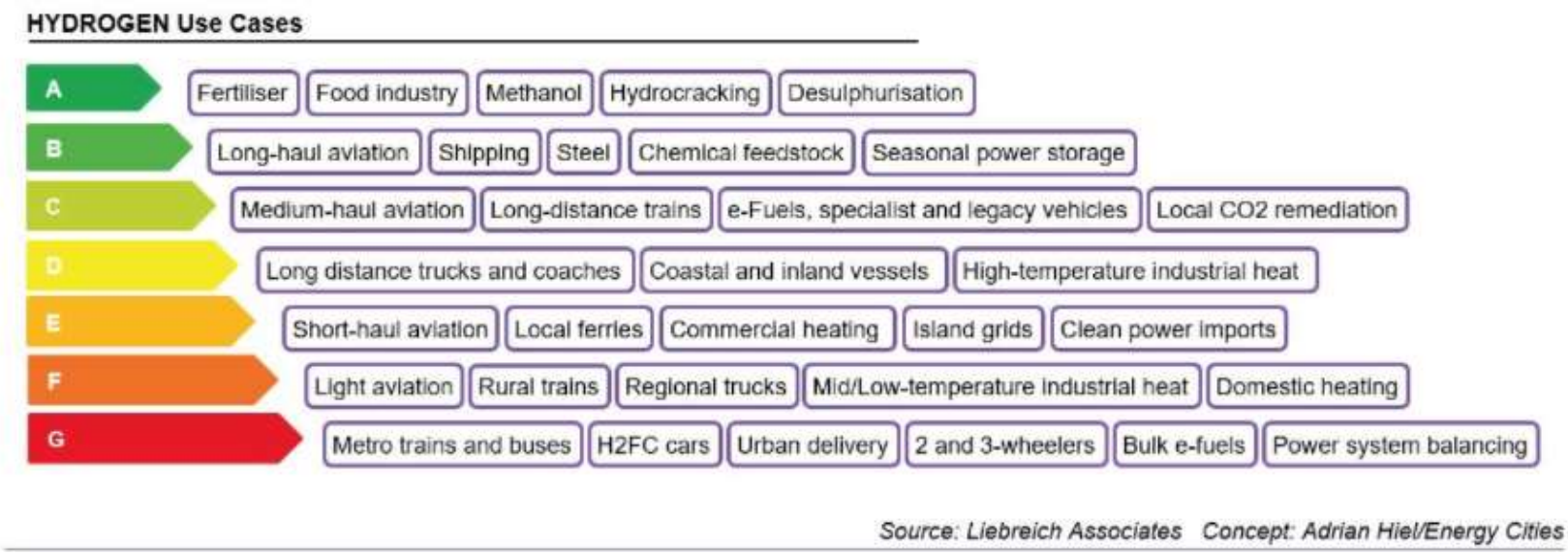


Figure 5 Bloomberg NEF (M Liebreich) hydrogen demand priority (merit order by demand sector)

[15] https://about.bnef.com/blog/liebreich-separating-hype-from-hydrogen-part-two-the-demand-side/

What are the key benefits, risks, and potential impacts on various end-users, on energy affordability, safety, security, reliability and equity?	Industry will decide where and when to use green hydrogen. The decisions will be made based on the cost of hydrogen and safety issues. If it is decided at some later date to build a hydrogen distribution network end-users will need to understand all of these matters. The analysis required to deliver a business case for a new network should address all of these matters.
What are the scale of opportunities and potential to accelerate uptake?	• There are significant opportunities for green hydrogen to replace brown and grey hydrogen when the costs of green hydrogen fall sufficiently. Victoria can accelerate uptake by funding innovation and benefiting from technological developments as outlined in the Victorian Hydrogen Development Program[16]. • It is not possible to address the opportunities associated with a new hydrogen distribution network in advance of further analysis and a business case.
What are the key technical, regulatory and economic barriers?	• The key barries is an economic barrier although recent forecasts predict that green hydrogen will be cheaper than blue or brown hydrogen by 2030. • There may be technical, regulatory and economic barriers to the use of hydrogen in the home distributed by a new hydrogen distribution network.
What are the roles to be played by government, industry and how will consumers preferences be accounted for in the transition?	• Refer point on accelerating uptake above. Victoria can accelerate uptake by funding innovation and benefiting from technological developments as outlined in the Victorian Hydrogen Development Program. • For a hydrogen distribution network these matters should be considered as part of the evaluation process.
What are the likely timings of technical maturity and economic viability?	• Current estimates are that green hydrogen will reach economic viability by 2030. • For a hydrogen distribution network these matters should be considered as part of the evaluation process.
What are the best ways to maintain social acceptability and consumer confidence?	• Green hydrogen will be used by business and there should be limited or no issues regarding social acceptability. • For a hydrogen distribution network these matters should be considered as part of the evaluation process.
What are the inter-dependencies and trade-offs with other pathways (are pathways complementary or alternatives)?	• Green hydrogen is complementary.
What are the key uncertainties and potential for unintended consequences?	• Uncertainties regarding the timing of economic viability and the penetration of green hydrogen. Neither of these should produce unintended consequences. • Significant uncertainties surrounding the concept of a new hydrogen distribution network.

[16] https://www.energy.vic.gov.au/__data/assets/pdf_file/0021/513345/Victorian-Renewable-Hydrogen-Industry-Development-Plan.pdf

Pathway 4. Substituting natural gas with biogas	
Our View: Biogas can have uses for industrial heat or local co-generation, especially in the rural sector and regions. The Victorian government has a policy to limit the total capacity of energy from waste projects to 1 million tons per annum until 2040 which is equivalent to 10 PJ p.a. This is not sufficient to replace natural gas in the distribution network. We do not support using farmland to produce material for biogas generation (As per Northern American ethanol production driving government subsidised preference for using prime farmland for ethanol corn production, subsidising biomethane production to ramp up volumes required to replace natural gas may have un-intended impacts on food production and social license of biomethane).	
What are the key benefits, risks, and potential impacts on various end-users, on energy affordability, safety, security, reliability and equity?	• While Biogas produces emissions, these emissions are considered lower than the avoided fugitive emissions from the source fuel. • Biogas will only find a market where it is cost competitive. Safety and security issues are known.
What are the scale of opportunities and potential to accelerate uptake?	• We do not see an opportunity to scale up biomethane to replace natural gas in the distribution network • Small, modular biogas digesters that can be deployed close to the source of industry waste/by-product would be optimally deployed for local generation/co-generation. Probably limited to waste water precincts and some regional precincts where remoteness makes biogas economic and reduces fugitive methane emissions from waste organic material.
What are the key technical, regulatory and economic barriers?	• No comment. This is not our area of expertise.
What are the roles to be played by government, industry and how will consumers preferences be accounted for in the transition?	• If biomethane is blended into the gas distribution network it would be transparent to consumers. • Government and industry should work together on individual generation projects.
What are the likely timings of technical maturity and economic viability?	• No comment. This is not our area of expertise.
What are the best ways to maintain social acceptability and consumer confidence?	We have no specific comment as the Biogas production and emissions are not material to the Gas Roadmap.
What are the inter-dependencies and trade-offs with other pathways (are pathways complementary or alternatives)?	We have no specific comment as the Biogas production and emissions are not material to the Gas Roadmap.

What are the key uncertainties and potential for unintended consequences?	• There is potential for unintended consequences if Government subsidies lead to farmland being used to grow material for biogas generation

Pathway 5. Emerging technologies (CCS, CST, geothermal)	
Our View: CST and geothermal cannot currently reach a price point that makes sense. CST trials with storage (eg RyaGen/AGL/ARENA) will provide data on economics but all indications are that PV and battery learning curves and economies of global scale will keep them significantly ahead of bespoke CST systems. CCS has limited applications and cannot be economically retro-fitted. Should not pursue in Roadmap until trials prove successful. CCS also has a risky development pathway in the 10-15 year time-frame. The Gorgon WA CCS project is a relatively straight-forward CCS project, and that has been plagued by technical problems[17]. Chevron has now conceded failure with its CCS project and is seeking a revised deal with WA regulators[18]	
What are the key benefits, risks, and potential impacts on various end-users, on energy affordability, safety, security, reliability and equity?	• At this point it is unclear that CST and geothermal technologies will reach a price-point where they can make a significant contribution to meeting our energy needs. However, if the technologies do attain affordability, they can play a role in our energy solution. • CCS will have a role going forward in cases where other emissions reduction solutions are not available. CCS will not be used in conjunction with coal powered generation or the creation of hydrogen as these solutions will be more expensive that renewable solutions. • These technologies will, at best, be support technologies and are unlikely to play a major role in safety of reliability. There are no apparent equity issues.
What are the scale of opportunities and potential to accelerate uptake?	• We cannot answer at this time, but no attempt should be made to accelerate a technology before it is proven.
What are the key technical, regulatory and economic barriers?	• All of these technologies have technical and economic barriers. Unless trials prove that these solutions can be deployed efficiently, they will play no role in our energy markets.
What are the roles to be played by government, industry and how will consumers preferences be accounted for in the transition?	• Governments are currently funding trials into these technologies. The role of Governments should continue to be restricted to funding trials until these trials prove these technologies to be viable. • These technologies will not impact customers directly.

[17] WA's Gorgon project fails to deliver on pollution deal, adding millions of tonnes of carbon a year (smh.com.au)
[18] https://reneweconomy.com.au/chevron-concedes-ccs-failures-at-gorgon-seeks-deal-with-wa-regulators/

What are the likely timings of technical maturity and economic viability?	• Timing and economics are uncertain. Government should wait until trials prove these technologies to be viable
What are the best ways to maintain social acceptability and consumer confidence?	
What are the inter-dependencies and trade-offs with other pathways (are pathways complementary or alternatives)?	No identified inter-dependencies
What are the key uncertainties and potential for unintended consequences?	• Uncertainties regarding technical maturity and economic viability. • If we adopt these technologies without appropriate trials and testing, we may fail to meet our targets and end up with stranded assets.

Pathway 6. Fugitive Emissions	
Our View: It is not clear that fugitive emissions in gas development and production can be easily managed and regulated. We should follow IEA recommendations.	
What are the opportunities and barriers to further reductions in fugitive emissions?	• Set fugitive emissions price for gas industry ($/MtCO2e) aligned with EU carbon price. • Set stringent standards for gas supply chain (exploration, production, processing, transportation, distribution) • Mandate strict industry self-monitoring, compliance and reporting across the supply chain • Introduce independent monitoring (eg satellite or drones) and open-web 'live-streaming' and reporting. Mandatory funding by Gas-field Operators. • Introduce meaningful, proportionate penalties for non-compliance NOTE: 25% of GHG (greenhouse gas) effect globally is due to methane. IEEFA (Inst for Energy Economics and Financial Analysis). Note that the implications of fugitive hydrogen emissions across the supply chain is a topic for further research. Although it appears far less potent than methane, it must still be minimised and measured.

Responses to further questions

1. Maintaining electricity reliability with new sources of demand

1.1. What policies are needed to ensure that the electricity network can reliably serve new sources of demand from hydrogen production, electric vehicles and electrification of gas demand?	It is AEMO's role to publish forward looking 'Statement of Opportunities' annually for industry to respond to changes to electricity and gas supply and demand. The Victorian Government should announce their program and brief AEMO about the targeted impacts on the Victorian gas and electricity industries. This will allow the market operators (e.g AEMO) to report accordingly in the annual "Statement of Opportunities". Industry and Trades can then plan accordingly with a level of confidence.
	• The Victorian Government should produce (or ask AEMO to provide) a forecast of electricity demand assuming fast and central transition scenarios. The transition timetable should assume:
	  ○ An electrification transition timeline assuming:
	  ▪ An accelerated transition for exiting gas in households
	  ▪ Mass electrification of households, commercial buildings and industry (aka sector coupling) and
	  ▪ Building regulation changes encouraging electrification and switch from gas
	  ○ A timetable for the electrification of the Government vehicle fleet (direct and indirect)
	  ○ A timetable for increased EV penetration based on an incentive regime
	  ○ The implications of energy efficiency initiatives.
	  ○ The implications of hydrogen generation
	  ○ The NEM technical, economic and regulatory structure can then plan to handle the forecast changes in demand (preferably with minimal state and federal Government intervention).
	• Secondly the Government should consider the plan to manage the increase in demand and should remove obstacles that may stop AEMO and the electricity industry from meeting the forecast demand. Policy changes that support the flattening of the load curve may be required including:
	  ○ Encouraging tariff changes that reward use during 9am to 3pm 'solar peak'. i.e. move energy use from night-time to daytime (solar sponge activities).
	  ○ Ensuring that electric water heating operates during the solar peak in a managed way to mitigate electricity network upgrades.
	  ○ Promoting the use of smart EV chargers that can also support battery to grid. This will allow EV owners to take advantage of substantial electric vehicle charging during daylight hours (and in future high peak grid price arbitrage via V2G).

	○ Ensuring that regulation surrounding neighbourhood batteries are simplified so that these batteries can also be part of the solution. (Refer AEMC[19] plans to help batteries play a more critical role in our low-carbon future) ○ Continuing to promote roof-top Solar PV
1.2. What is the role for gas-fired power generation and hydrogen in maintaining electricity reliability?	• GPG will play an important role in firming a high renewables penetration grid in the short-medium term as coal exits. Although critical, GPG will only be used when emerging peaking solutions such as batteries (lithium and redox flow) and pumped hydro are unable to meet the demand. That is, GPG will be used less and less but will stay play an important role. Grattan Institute[20] outline occasional but high probability requirement for long duration deep storage in 90+% renewable grids – GPG can fill this requirement in the medium term. • The use of hydrogen in GPG (increasing amounts blended with natural gas) is technically proven, with many newer GPG turbines already certified for various levels of hydrogen[21]. It is possible but unproven that pure green hydrogen GPG could be used for peaking and deep storage requirements in a 100% renewables grid. Economics would suggest nearby massive uncompressed storage of green hydrogen would be required (compression and liquification of hydrogen is likely excessively energy intensive to be viable for GPG).

2. Transitioning to more sustainable gaseous fuels with minimal disruption to end-users

2.1. What are the key technical challenges in converting existing gas networks to accommodate more sustainable gaseous fuels?	We do not recommend transitioning to more sustainable gaseous fuels in the current gas network for the following reasons: • We understand that the current natural gas network cannot be converted to accommodate high levels of hydrogen. • We are unaware of more sustainable gaseous fuels that could sensibly use the existing gas network. • Blending small amounts of hydrogen into the network will not lead to the desired outcome. ○
2.2. What are the potential costs and opportunities in switching to more sustainable gaseous fuels for consumers?	We do not see any zero-emission gas fuels that could practically use the existing gas network.

[19] https://www.aemc.gov.au/news-centre/media-releases/new-plans-batteries-cut-red-tape-and-boost-revenue-options
[20] https://grattan.edu.au/report/go-for-net-zero/
[21] https://www.powermag.com/siemens-roadmap-to-100-hydrogen-gas-turbines/

3. Maintaining the reliability, affordability and safety of gas supply

3.1. What are the affordability, reliability and safety considerations related to gas supply and gas infrastructure, both in the short term and during a long-term transition to a decarbonised gas sector?	• Once the decision is made that natural gas combustion for space and water heating is not consistent with net zero emissions, then investment in the natural gas infrastructure must be reconsidered:
	  ○ Expansion of gas distribution networks must be capped (no new estates, minimal new connections, only maintenance and safety regulated investment)
	  ○ Asset economic life must be addressed and accelerated depreciation and write-downs agreed without burdening remaining users to pay more than their fair share of depreciation. This may require the Victorian Government to intervene making up the shortfall.
	  ○ Investment for anything but maintenance and safety must be capped
	  ○ The gas industry will still have responsibility for the safe and efficient operations of the networks and should examine and resolve any safety and reliability issues that may arise with the operation of a low volume network.

3.2. What policies are needed to ensure that the gas system continues to operate reliably and safely and remain affordable for end-users during this transition?	• Supply and distribution KPIs must be maintained to support remaining users • National Gas Objective (NGO) should be revised to address emissions (combustion and fugitive) and accelerated write asset down • Our main concern is that as the majority of consumers transition from gas to decarbonised alternatives, the remaining users will pay increasing connection and usage fees as the network fixed costs (asset depreciation and return on assets) are recovered from fewer and fewer users. Action should be taken to ensure the vulnerable are not unfairly impacted. • The gas distribution businesses should remain responsible for safety and reliability. No policy change is required in this area.

4. Supporting Victoria's workforce, industry and the institutions that support them

4.1. What workforce skills and industry capabilities are required to transition to new and emerging energy sources?	• Many industries will need to convert from combustion based industrial heat to electrified equivalents. This will require some transition of gas fitters to installation of heat pump HW and Reverse cycle air-con installs. • Some industries without directly viable electric alternatives to gas industrial heating will need to convert to hydrogen combustion alternatives – this skill transition should be relatively straight forward. New standards for working with hydrogen must be introduced but should be variants of global standards. • For those specific industries where CCS for methane combustion is this most viable alternative (eg cement production), the skill set transition is to be determined but is expected to remain within the same trade pool (ie gas fitters) • For green hydrogen production, similar skill sets to the LNG industry are envisaged.

4.2. How can government, industry and unions best work together, including through the Victorian TAFE and Training system, to help to build these skills and capabilities, and support existing workers through the transition?	• We do not have expertise in this area, but we recommend that you investigate and cooperate with the UK equivalent boiler electrification program[22]
4.3. How do we maximise local job opportunities, including for industry training centres such as that operated by the Plumbing Industry Climate Action Centre, to prepare workers for the future?	• The electrification of residential premises and industry will create jobs across Victoria. • This will necessitate the establishment or upgrade of industry training centres to ensure that we have the resources to train the workers. TAFE should play a major role in retraining and developing the workforce (alongside energy efficiency assessors, advisors, certifiers). This must be seen as a value add rather than a burden • We should support training enabling trades to re-deploy to manufacture and installation of: 1. heat-pump technology (eg EarthworkerEnergy in LaTrobe Valley[23]) 2. green hydrogen construction and operation. 3. Electric trucks and buses (e.g. similar to SEA-Electric) 4. Green hydrogen and construction • We would propose ongoing discussions and development of renewable jobs plans with for example PICAC and BZE (Beyond Zero Emissions – see The Million Jobs Plan and plans for Gladstone and the Hunter Valley[24]), and The Grattan Institute [25].

5. Managing uncertainty in the transition

5.1. What key uncertainties should the roadmap take into account, and what is the government's role in reducing these uncertainties?	• The key uncertainty is the Victorian Government's commitment to the transition. • There will be a further significant uncertainty if the Roadmap incorporates unproven solutions. We advocate strongly for committing the roadmap to only proven technical and economic solutions. The Government should set out clear transition objectives and timelines giving business and trades the confidence to invest in delivering the required solutions. The Government should also flag, and then implement: • changes to the VEU program • Legislation capping new gas connections

[22] https://www.gov.uk/government/groups/heat-in-buildings
[23] https://earthworkerenergy.coop/about-us/
[24] The Million Jobs Plan - Beyond Zero Emissions (bze.org.au)
[25] Jobs versus climate - Grattan Institute

6. Transitioning the Victorian economy efficiently and equitably

6.1. How can we ensure that the costs of transition to lower emissions energy sources are borne equitably?	During the transition consumers will be switching form gas to electricity or to low emissions gas solutions and it is possible for changes to either gas or electricity prices to change. We can ensure that this change is equitable by: • Providing financial support (grants and / or interest free loans) to help consumers afford the transition • Providing stability in energy prices: For natural gas ◦ Capping and minimising future investment in the gas network. The charges raised by the regulated monopoly network must be 'held steady for consumers with increases limited to CPI, so that the fewer and fewer remaining users do not have to pay disproportionately to cover the total costs. ◦ The Victorian Government should part-compensate the distribution businesses to compensate them if their revenue from customer charges falls below their allowed revenue. For electricity ◦ As consumers electrify, their electricity bills will increase. Inequities in the electricity industry must also be addressed. The vulnerable already pay more than their fair share of distribution, transmission, environment components of their power bill and they are typically less able to take advantage of Government incentives to reduce their bill (rooftop solar/battery subsidies, Feed-in-Tariffs, energy efficiency improvements).
6.2. How can we help low-income and vulnerable households manage any upfront costs in changing energy sources?	• The first step would be to provide renters, low-income and vulnerable households with access to free professional advice on solutions. This advice should cover up-front costs and ongoing savings. Such advice may be delivered by councils. • The Victorian government (or local councils) should then provide interest free loans to cover the up-front costs repayable out of savings or the sale of the property. The loans should cover quoted costs from reputable trades and should comply with Government guidelines (no upselling in the quote). For rooftop solar the repayment period might be quite short. • For rental properties it may be necessary to consider more innovative schemes: ◦ Dual party finance arrangements covering landlords and tenants. If linked to a loan (see above) the tenant could be responsible for the repayments out of savings for the term of the loan. ◦ "Heating as a service" with 3rd party appliance ownership (with eventual asset transfer) ◦ Mandating energy efficiency standards for rental properties. .

6.3. What are the barriers for households in improving the efficiency of their use of gas for heating, cooking and hot water and/or switching to solar/pump hot water in existing homes?	• The initial barrier is limited householder knowledge regarding the improvements of new appliances, the implications of gas combustion, green alternatives and confidence of return on investment,
	  ○ Even if the householder is convinced regarding an energy efficiency improvement solution, they may lack the ability to select the best solutions and the confidence to select a reputable supplier.
	• Other barriers are:
	  ○ Limited availability of reputable, independent, credible, knowledgeable advisors
	  ○ Limited number of skilled, experience, certified trades to advise, install, support
	  ○ Not being able to access the correct advice in an emergency (Only 10-15% of new hot water services (HWS) are 'considered purchases' by owners. A massive 55-65% are 'emergency purchases' after breakdown (E3 Hot Water Systems Roadmap 2018[26]).

6.4. What are the opportunities for the Victorian Energy Upgrades program to incentivise efficient gas use, thermal upgrades of buildings (e.g. insulation) and electrification?	The Victorian Energy Upgrades program should be reviewed with the following areas receiving particular focus: • Insulation should be a major priority for residential properties and businesses. ○ Care should be taken to ensure that the scheme is available to renters and the vulnerable. • Incentives should focus on switching to electric where electric solutions are efficient • Only where electric upgrades are not possible or are cost prohibitive should incentives be given for gas upgrades.

[26] E3 Hot Water Systems Roadmap - 12 November 2018.pdf (energyrating.gov.au)

6.5. What issues and elements do you see as most important to improve the energy and emissions performance of new homes?

We advocate taking a hierarchical priority approach to household energy efficiency with priority on using less energy, then paying less for energy etc as per Figure 6. The lower layers generally provide a significantly better return on investment/effort and are fundamental to achieving fair ROI on upper layers.

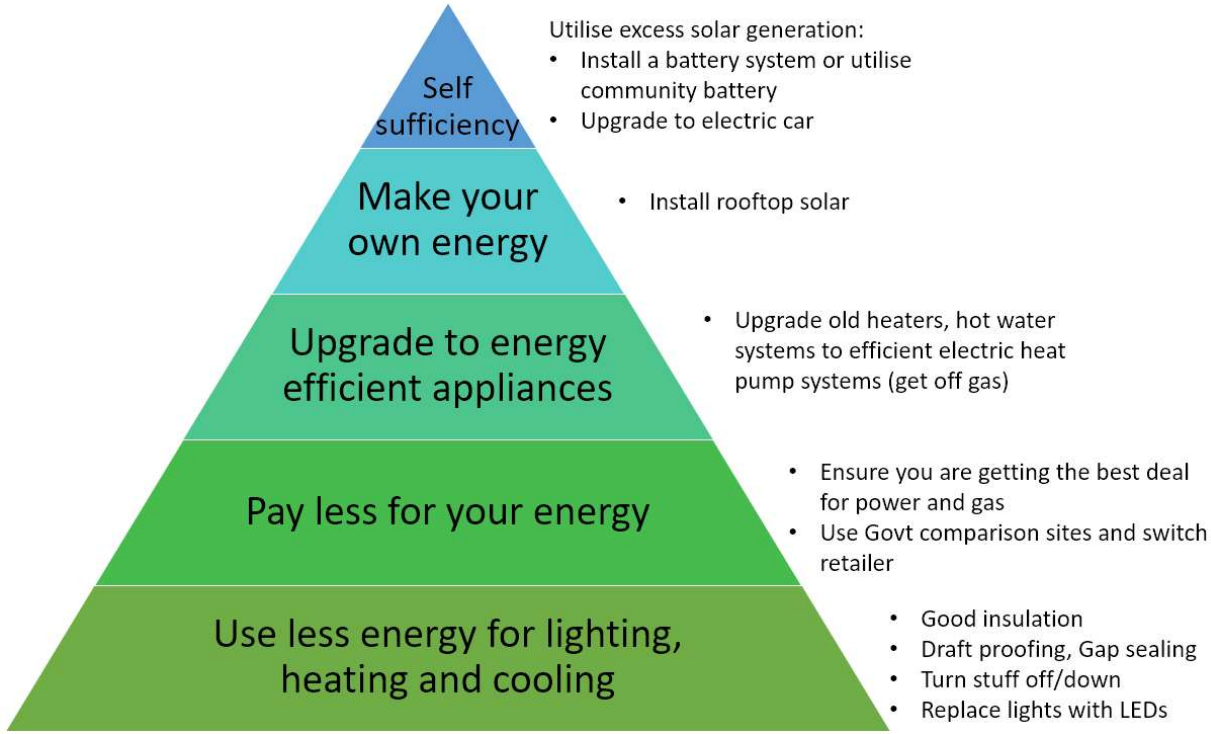


Figure 6 A "Maslow hierarchy" view on energy efficiency priorities

Figure 6 above refers to energy efficiency in the existing housing stock. However, the focus for new builds falls out of this as follows:

- Good insulation and energy efficient lighting
  - Ensure energy ratings are tracked beyond concept and design stage. Certification at completion of build as part of occupation certification. Too many new houses are designed for energy efficiency but fall well short in actual construction
  - Motivate trades and volume builders to adopt energy efficiency and all-electric concepts
- All electric new homes. This is a "no regrets" decision as studies show that this will be cheaper for the average household over a ten-year period. With the grid transitioning to high levels of renewables the emissions from an all-electric home will be very low.
- Rooftop solar. This has a short payback and could be supported by a 3-to-5-yea\\r interest free loan.
  - Policy that factors in 'co-benefits' of Heat-pump HW + roof-top solar PV is 'no regrets.
- An EV. Possibly not part of the home but it will probably be charged there at least some of the time.
- Immediate removal of mandate of gas connection for new estates and dwellings.