

Requirements for a gas-free commercial centre

ACT Government
Suburban Land Agency

Final Report

V1.0

30 July 2021



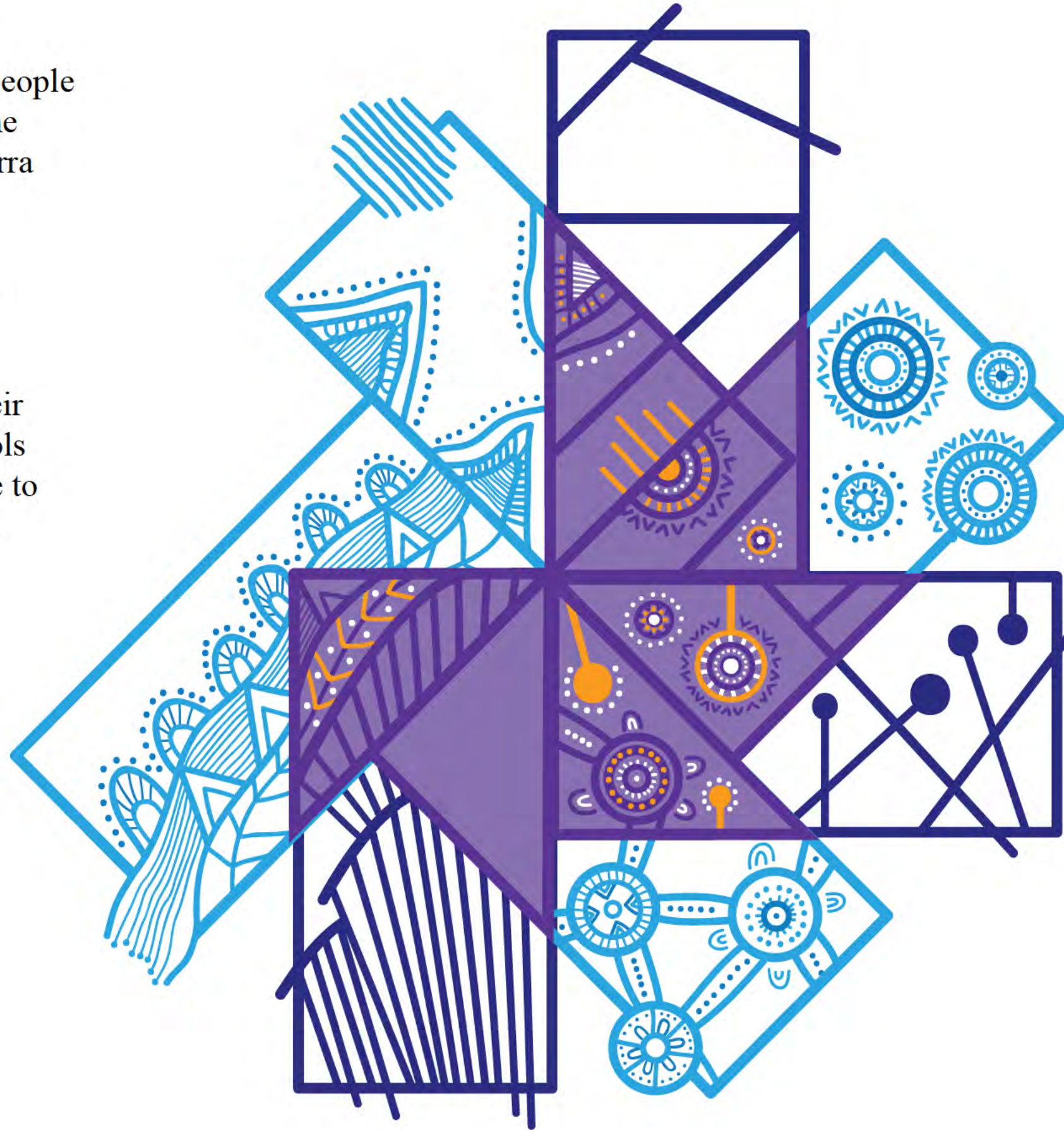
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		Name	[Redacted]		

The Arup team would like to acknowledge the Ngunnawal people as the Traditional Owners of the land on which the Arup Canberra office is located.

We pay respect to Elders past, present and emerging.

We recognise and celebrate their cultures, traditions and protocols and the contribution they make to the life of our city and beyond.



Executive Summary - Overview

The ACT Government is establishing a pilot mixed-use precinct in the Molonglo Valley that will provide a variety of commercial, residential, retail and community facilities. In line with the recent Parliamentary and Governing Agreement, the precinct will not be connected to the natural gas network. This presents both perceived and actual barriers and opportunities for a variety of stakeholders.

Purpose of this Report

This Report explores and documents the perceived barriers and opportunities for the Molonglo Commercial Centre. It:

- Documents findings from stakeholder consultation and a literature review in the context of the Molonglo Commercial Centre.
- Provides a relative comparison of technological and non-technological solutions, based on assumptions specific to the Centre context and at a high level, given the very early stages of planning for the development.

The cost information and commentary provided are for the purposes of planning direction and to inform conversations with stakeholders, and are not to be used for actual cost estimation.

Our Approach

The development of this Report has involved the consolidation and analysis of stakeholder insights, external research and internal technical knowledge. This process has involved:

- **Stakeholder interviews** to identify perceived barriers, opportunities and other perspectives
- **Literature review** to inform the technology assessment and fill gaps in understanding
- **Case study development** to identify lessons to apply to the Centre
- **Barrier analysis** to identify and map the actual and perceived barriers of being without a gas network
- **Building technology assessment** to outline the benefits and implications of different technology options
- **Precinct scenario development** to identify possible directions for the precinct's energy strategy
- **Program and policy solution identification** to outline where additional incentives or other initiatives may assist precinct stakeholders

In this report, Arup has worked to:

Identify actual and perceived barriers

Identify solutions and opportunities at a building technology scale and precinct scale, and in program and policy

From this work, Arup has recommended steps for the Suburban Land Agency to:

Further explore opportunities with targeted research, modelling and planning

Consult and support stakeholders

This Report is for internal ACT Government use only.

Executive Summary - Context

Local and Global Context

The ACT exceeded its goal to reduce greenhouse gas emissions by 40% from 1990 levels in 2020 and is on track to meet the ultimate goal of net zero emissions by 2045. The decarbonisation of the electricity grid has been key to meeting this 2020 target and, moving forward, the ACT plans to maintain and leverage this 100% renewable grid to reduce transport emissions and phase out fossil-fuel gas use¹.

With such a clear direction on the decarbonisation of the electricity network and transport, the focus shifts to the gas network which is a growing emission source for the ACT by share. The Molonglo Commercial Centre provides a significant opportunity for the ACT to design and deliver a modern, carbon responsible centre that effectively meets the needs of current generations while protecting future generations. The Centre is well timed to be a pilot development, as supported by the following targets and initiatives and committed to in the recent Parliamentary and Governing Agreement²:

- **Global** – United National Sustainable Development Goals with targets for 2030, Paris Agreement with international Climate Change Commitments.
- **Territory** – 2045 zero emissions target, the wellbeing framework, climate change strategy.
- **Local** – Parliamentary and Governing Agreement 2020, planning studies.

Suburban Land Agency Ambitions

Through its functions, the Suburban Land Agency (SLA) seeks to encourage and promote inclusive communities, through the delivery of people-focussed neighbourhoods and suburban development that supports:

- affordable living
- a safe and healthy population
- social inclusion
- housing choice
- environmental sustainability

This is underpinned by the SLA's Sustainability Strategy, which covers categories across social and environmental sustainability. The report draws on these elements and the above objectives, for example by mapping precinct scenarios against these.

Gas Industry Direction

- Gas has an **uncertain national and international outlook**

The International Energy Agency highlights the uncertain future of gas and proposes bans on new fossil fuel boilers by 2025. The Energy Council of Australia highlights that price and sustainability are key factors determining future gas use.

- **Buildings** are being **pushed to transition** to gas-free

The new Green Star Buildings v1 tool requires 6-star buildings to be fossil fuel free. Other ratings need to meet this requirement in the future depending on their registration date. The Living Building Challenge has similar requirements and the Australian Building Code's Board has developed a 2028 net zero trajectory for buildings which is currently only compatible with all-electric buildings.

- In the ACT, gas is mostly used for **space and water heating**

Natural gas is responsible for approximately 20% of the ACT's emissions inventory. 2020 projections using 2015 data demonstrate the split as 77% space heating, 21% water heating and 2% cooking⁸. 13% of the ACT's gas use is for commercial / industrial uses, with most of this being used by the ACT Government and the ANU⁵⁷.

- **Decarbonisation** of the gas network is receiving **growing attention**

Energy Networks Australia's *Gas Vision 2050* outlines a plan for decarbonising the gas network using biogas and hydrogen, with the next 5 years focused on demonstration and a targeted decarbonised network in 20-40 years⁷.

Executive Summary - Context

Energy Prices

- **Electricity prices** are anticipated to be **steady**

The Australian Energy Market Operator (AEMO) expects prices to hover around the current mark. Renewable projects and adoption are expected to develop in the coming years, reducing prices, however the retiring of aging generation fleet will increase costs, returning the price to near 2017 levels¹⁰. The ACT's feed-in tariff scheme partially protects consumers from generation price changes however Evoenergy can pass on distribution costs.

- **Gas prices** are uncertain but expected to **rise**

The AEMO also reviewed the gas prices in Australia and forecast the gas price to rise in the order of 35% within 10 years on the east coast¹⁰. Gas is exposed to future carbon / price exposure in the transition to low carbon futures. Anticipated trends are largely influenced by:

- Continued influence of overseas markets
- Limited policy intervention anticipated
- Significant rises in recent years

While gas prices in the ACT are set to reduce by 1% in 2021/22, these are expected to rise over the following four years¹².

Carbon Pricing

- Carbon pricing enables the **actual social cost of carbon to be accounted for**

There is growing support for pricing carbon and taking shadow prices into business decision making in Australia, including amongst business groups such as the Business Council of Australia^{14,15}. Australia had a price on carbon through the 'carbon pricing mechanism' under the *Clean Energy Act 2011*, however regardless of whether Australia introduces one, global activity in this space represents a possible risk. The European Union is considering a carbon border tax, which would place a tariff on imports from nations without prices on carbon, providing further incentive for a local price¹⁶.

- **The ACT is considering the social cost of carbon**

The ACT's Climate Change Strategy (2019-25) identified actions to include the social cost of carbon and climate change adaptation are considered in all ACT Government policies, budget decisions capital works projects and procurements. It also committed to investing \$20 per tonne of emissions from Government operations into measures to meet the Zero Emissions Government target from 2020-21.

The ACT is engaging a consultant to recommend an appropriate social cost, with preliminary results to be introduced this financial year.

- **A future price on carbon should be considered when comparing renewable and fossil-fuel energy**

The cost varies between models. Social costs of carbon range from US\$109 per tonne of carbon dioxide to US\$220 per tonne in 2050¹⁷.

The ACT's social cost of carbon, which is initially \$20 per tonne, applies to Government operations. The ACT does not have the ability to introduce a carbon tax and the financial costs of fossil fuel gas are at high risk of increasing.

Molonglo Commercial Centre

The Molonglo Commercial Centre will provide important services to the Molonglo Valley, including supermarkets, retail, office space, schools and varied residential offerings.

As a greenfield "gas-free" precinct, there will be no connection to the gas distribution network. Some transitional arrangements may be available (e.g. gas cylinders on site), and this would not preclude arrangements such as hydrogen fuel for transport being driven in the precinct in the future.

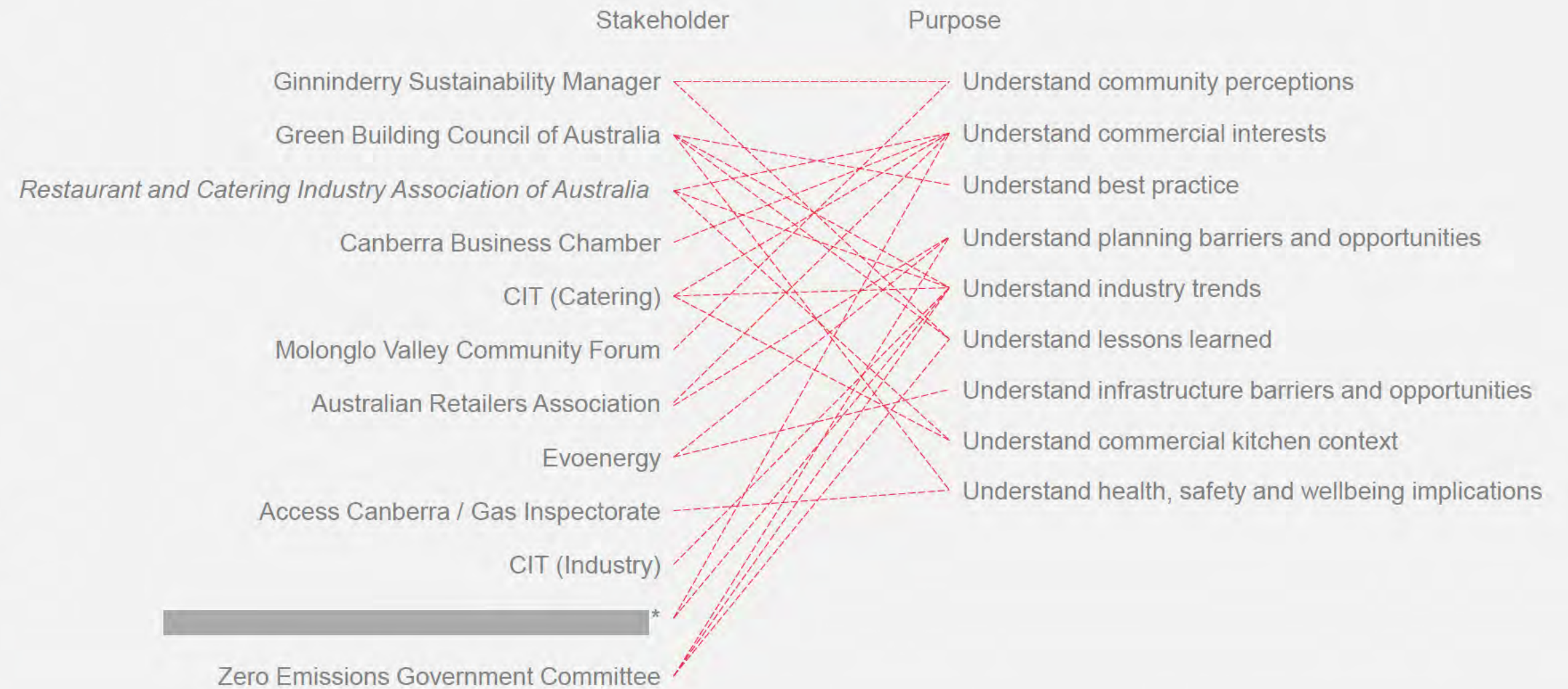
This project will assist to establish what best practice gas-free development looks like in the ACT context and will aim to address perceived and actual barriers to gas-free developments.

Executive Summary – Stakeholder consultation and barrier analysis

Stakeholders were selected to provide the project with a wide variety of perspectives. The Restaurant and Catering Industry Association of Australia was approached but a meeting was not secured. It is recommended the SLA engage with the industry association going forward as their input is expected to be valuable.

Arup also conducted research and case study assessments to further understand the barriers and opportunities of gas-free development. Key outcomes include:

- Residents and their **dwelling**s are not anticipated to be a major challenge.
- The **top concerns** of businesses are **cost and business continuity**. The challenge of cost is made more difficult due to the 'split incentive' problem, whereby landlords are not incentivised to install efficient equipment.
- Some developers will find the development attractive, however more **local developers** may require more information and support.
- It is anticipated that **some restaurants** will have a **strong preference** to have gas cylinders on site.



[Redacted] was interviewed as an industry representative due to his broad experience and involvement with the Property Council of Australia. [Redacted]. Importantly, his views do not represent those of the entire industry and it is recommended the SLA conduct additional stakeholder engagement with bodies such as the Property Council of Australia to obtain a more representative understanding of industry views.

Executive Summary – Building technology solutions

For each networked gas use in the assessed building technologies, alternative technologies have been identified and assessed. Key observations are summarised below:

- **Capital cost uplift varies, as does operational cost benefits.** They are context dependent, however, reverse cycle systems tend to provide significant cost benefits in operation which may offset increased capital expenditure.
- **Behaviour change is minimal,** other than for cooking which requires specific cookware and limits cooking practices.
- Indoor **air quality consistently increases** with the switch to electric.
- Refrigerants used in electric technologies can introduce environmental and fire risks, so **class A refrigerants should be selected.**
- High temperature specialist equipment is **challenging to replace** with electric technologies.
- Technologies are **impacted by the environment they operate in.** For example, the cool Canberra climate reduces the efficiency of air source heat pumps and building air tightness alters the effectiveness of various space heating technologies.

Building typologies	Characteristics	Gas uses
Residential (class 1)	Typical usage patterns of residents with higher usage in the morning and evenings. Class 1 – typically a single lease, no common property.	<ul style="list-style-type: none"> • Cooking • Space heating • Domestic hot water • Swimming pools
Residential (class 2)	Typical usage patterns of residents with higher usage in the morning and evenings. Class 2 – typically units with common property.	<ul style="list-style-type: none"> • Cooking • Space heating • Domestic hot water • Pool heating
Education	Some peaks in demand during events and due to scheduled nature of school day. All future ACT schools to be all-electric.	<ul style="list-style-type: none"> • Space heating • Domestic hot water • Bunsen burners
Supermarket	Large commercial retail space with requirements for backup generation.	<ul style="list-style-type: none"> • Space heating • Domestic hot water
Retail (restaurant)	Highly focused on cooking requirements and preferences.	<ul style="list-style-type: none"> • Commercial cooking • Space heating • Domestic hot water
Health	Depending on the facility, can be similar to an office space with larger health facilities requiring steam generation.	<ul style="list-style-type: none"> • Space heating • Domestic hot water • Specialist high temperature uses including laundry, high temperature treatments / pathology and steam generation for sterilisers

Executive Summary – Precinct scenarios

Four **precinct scale scenarios** outline the possible directions for the precinct. The scenarios consider what possible arrangements or requirements might **influence the energy infrastructure** required, where we might be able to **reduce or delay network upgrades required by Evoenergy** or collaborate for mutual benefit, and, how we might be able to **reduce the peak energy demand** for the precinct. These scenarios are an opportunity for thought, and are not based on engineering design or modelling work. Each scenario has been assessed in terms of how it **impacts users of the spaces, owners, developers and Evoenergy**, in addition to how the scenario **supports SLA objectives**.

In terms of addressing SLA objectives and with respect to the reference scenario (1) the **'BAU' electric scenario** (2) shows least improvement and the **'interconnected' electric scenario** (4) shows the most improvement.

1

Reference scenario

- Gas and electricity distribution networks in precinct and buildings.
- Meter reading and maintenance costs and liabilities for both networks.
- Some solar PV, demand management and batteries to match individual building needs.

2

'BAU' electric

- Scenario 1, except electricity distribution network only.
- Potentially higher capacity substation/s required to meet seasonal / peak demand profiles.

3

'Stretch' electric

- Scenario 2, with the introduction of a **simple energy framework for peak reduction** enabling widespread solar PV, battery and demand management uptake.
- The framework may include rules requirements and features that reduce barriers to the uptake of distributed energy resources, the reduction in overall grid energy consumption, the reduction in peak energy demand, introduction of demand management and the inclusion of energy efficiency requirements for buildings beyond BAU.

4

'Interconnected' electric

- Scenario 3, with the introduction of a **comprehensive energy framework for sharing energy and resources** enabling maximum adoption of solar PV to export from low density to higher density areas and more optimised use of distributed energy resources.
- The framework may promote interconnectivity such as energy sharing and centralised plant, and should enable the best utilisation of current and future technologies. Various operational structures are possible, depending on the ownership structure, demand profiles and infrastructure requirements, for example.

Executive Summary – Program and policy solutions

Education and engagement

- The transition in cooking technologies is expected to be more effective if a learning/communicating /testing space is provided for households and commercial kitchens to negotiate existing values whilst opening up possibilities for changing cooking practices⁴⁰. This approach was used in Ginninderry and could be supported by CIT's new Woden campus.
- Ginninderry research with ARENA have shown workshops to be a highly effective way to demonstrate the benefits of electric technologies.
- Early and regular consultation with businesses is key, particularly small businesses. Key information includes lifetime costs, design guidelines, maintenance requirements, examples of prior use and fire, health and environmental risks of refrigerants.
- Messaging should go beyond 'green' and consider the various incentives for each stakeholder. For example, 'modern, child-safe, zero-carbon ready cooktops'.
- There is opportunity for industry education similar to the Spark program at Ginninderry which enables sustainable development whilst providing training and education opportunities to disadvantaged Canberrans.

Controls and incentives

- Requirements could be placed on solar PV, batteries and demand management technologies to limit the peak energy demand in the area.
- Gas cylinders could be restricted on commercial sites, or only considered on a case-by-case basis. The SLA will need to consider if it would like to use the precinct as a trial for 100% electric, or whether some exceptions can be made.
- Restrictions to refrigerants (Class A only) are recommended to be implemented.
- Building design guidelines can reduce the peak winter demand. These include passive design and the consideration of building thermal efficiencies and water efficiencies (see page 87-88).
- Incentives such as the Home Energy Rebate Program, an extended Energy Efficiency Improvement Scheme and Ginninderry incentives have been shown to be effective.

Energy modelling and planning

- Precinct energy modelling is an opportunity to de-risk the investment for developers. It could enable cost estimation, attract larger interstate developers with net-zero commitments and inform smaller, local developers.

- Early engagement between developers and Evoenergy may also de-risk investment.
- There are opportunities for a 'working party' involving key stakeholders to be formed, enabling planning activities to focus on stakeholder concerns.
- Planning should consider reducing lifecycle costs, and this process should inform the selection of precinct 'scenario' is appropriate and what governance arrangements are best implemented to support an affordable development.

Shared business models

- Business models that align more closely with the circular economy framework may provide triple bottom line benefits in the Centre.
- The Centre could facilitate leasing arrangements for roof space of for solar PV.
- Community-owned renewable energy could support the Centre's energy ambitions.

Energy efficiency and thermal networks

- A thermal network could be considered, however energy efficiency would likely be a higher priority.
- Space, acoustics and safety should be considered alongside efficiency.

Executive Summary – Recommended steps

Based on the identified barriers, solutions, and opportunities for the Molonglo Commercial Centre, it is recommended that the SLA explores these opportunities, and consults and supports stakeholders moving forward for the precinct.

Further explore opportunities with targeted research, modelling and planning

- The SLA will need to consider if it would like to use the precinct as a trial for 100% electric [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
- Once the precinct uses and target outcomes are more developed, **energy modelling and planning** can inform what technologies, governance models and controls are most appropriate.
- Developing **design principles** will support the achievement of good outcomes from the all-electric technologies. These would guide the design and construction process covering requirements for energy systems, energy efficiency and other design principles

Consult and support stakeholders

- Consultation will need to be **an ongoing task**, including through:
 - Discussions with potential tenants and business owners explaining design requirements, once identified, and then through support during construction and operations.
 - [REDACTED]
 - Awareness activities with possible restaurants including workshops and/or trials on commercial induction cooktops.
 - Learning from pilots underway, including Ginninderry with Evoenergy, [REDACTED]
[REDACTED]
 - Engagement with the community, who do not want the energy strategy to compromise other good outcomes for the precinct.

Overview

Molonglo Commercial Centre

The ACT Government is establishing a pilot mixed-use precinct in the Molonglo Valley that will provide a variety of commercial, residential, retail and community facilities. In line with the recent Parliamentary and Governing Agreement (see right) the precinct will not be connected to the natural gas network. This presents both perceived and actual barriers and opportunities for a variety of stakeholders.

Purpose of this Report

The purpose of this Report is to explore and document the perceived barriers and opportunities for the Molonglo Commercial Centre. This Report:

- Documents findings from stakeholder consultation and a literature review in the context of the Molonglo Commercial Centre
- Provides a relative comparison of technological and non-technological solutions, based on assumptions specific to the Centre context and at a high level, given the very early stages of planning for the development

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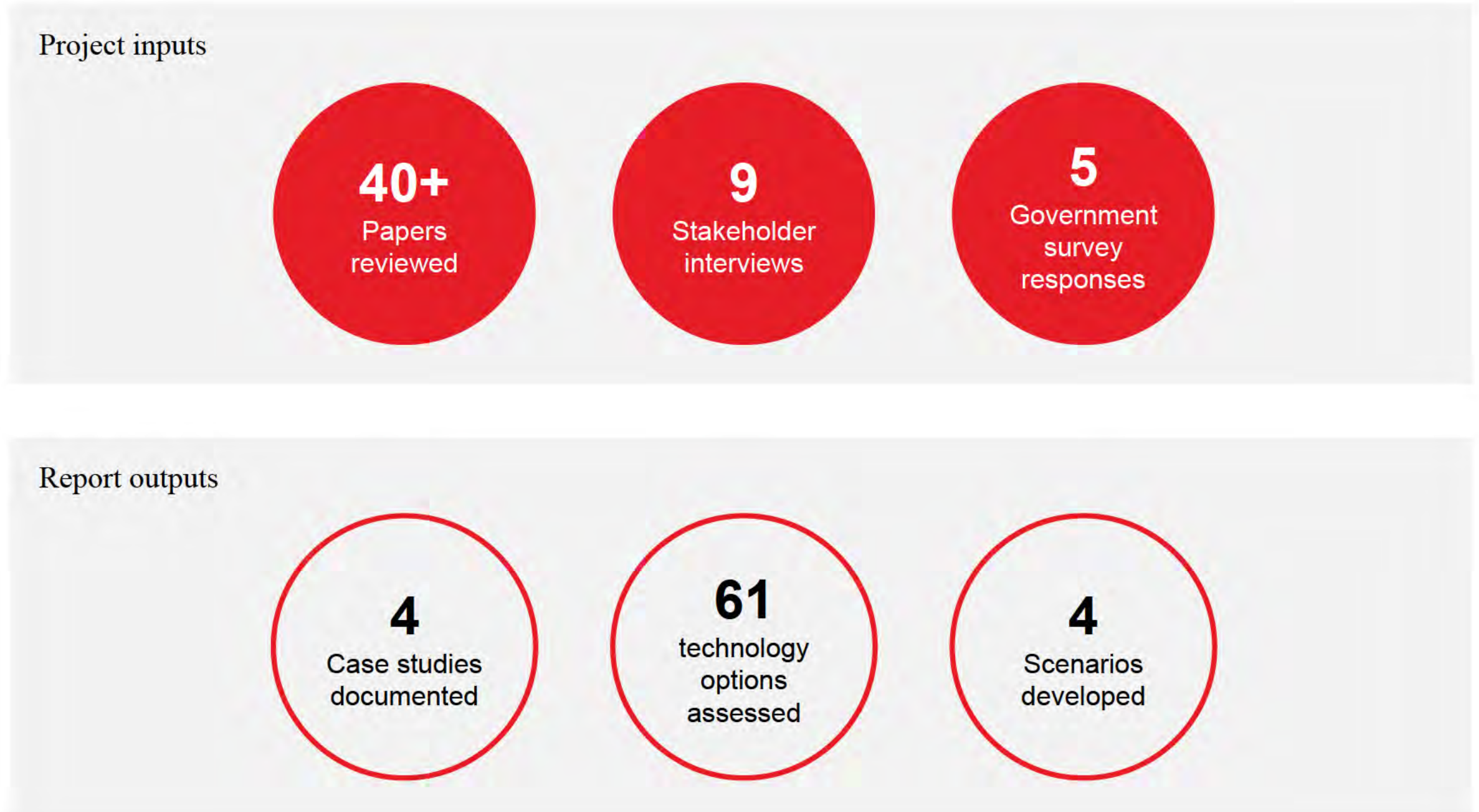
“Develop the Molonglo Commercial Centre as an all-electric commercial centre (no new connections to gas mains network, but allow transition gas arrangements such as tanks), in partnership with expert stakeholders, and use lessons from this project to assist the phase out of fossil-fuel gas in the ACT, and demonstrate national best practice.”

**- Parliamentary and Governing Agreement,
10th Legislative Assembly for the ACT, 2020**

Approach

The development of this Report has involved the consolidation and analysis of stakeholder insights, external research and internal technical knowledge. This process has involved:

- **Stakeholder interviews** to identify perceived barriers, opportunities and other perspectives
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Glossary

Key terms and acronyms utilised include:

Carbon - is a colloquial term used by industry to refer to carbon dioxide emissions and greenhouse gas emissions more broadly

'Gas-free' - in the context of this Report means no gas provided via a distribution network and some possible allowance for gas cylinders as part of transitional arrangements.

Net zero - refers to a building, company or other operation that is removing and producing equal amounts of greenhouse gas emissions. The boundaries and specific definitions used can vary

- **ACT** - Australian Capital Territory
- **AEMO** - Australian Energy Market Operator
- **AIRAH** - Australian Institute of Refrigeration Air conditioning and Heating
- **ANU** - Australian National University
- **ARENA** - Australian Renewable Energy Agency
- **BAU** - Business as usual
- **BREEAM** - Building Research Establishment Environmental Assessment Method
- **CIT** - Canberra Institute of Technology
- **CO** - Carbon monoxide
- **CO₂** - Carbon dioxide
- **CO₂eq** - Measure to compare various greenhouse gases on global-warming potential (GWP) equivalent to CO₂
- **COAG** - Council of Australian Governments
- **CoP** - Coefficient of performance
- **DHW** - District hot water
- **EEIS** - Energy Efficiency Improvement Scheme
- **EPSDD** - Environment, Planning and Sustainable Development Directorate
- **EUI** - Energy use intensity
- **EV** - Electric vehicle
- **F+B** - Food and beverage
- **GBCA** - Green Building Council of Australia
- **GWP** - Global warming potential
- **HES** - Home energy system
- **HVAC** - Heating ventilation and cooling
- **IEA** - International Energy Agency
- **LPG** - Liquefied petroleum gas
- **MWh** - Mega Watt hour
- **NO₂** - Nitrogen dioxide
- **NSW** - New South Wales
- **PV** - Photovoltaics
- **RCAC** - Reverse cycle air conditioning
- **SLA** - Suburban Land Agency
- **UK** - United Kingdom
- **VOCs** - Volatile organic compounds

Report sections

Click the sections below to navigate to each section of the Report.

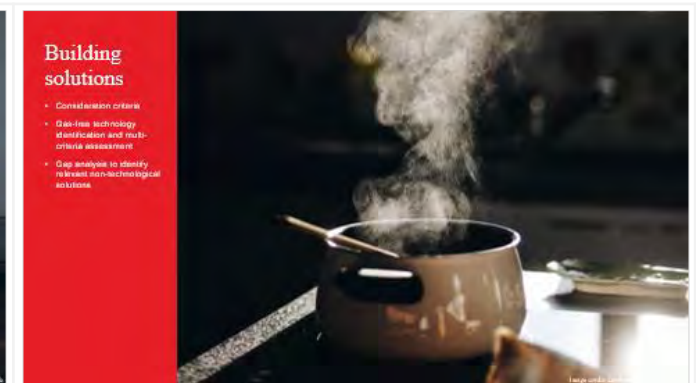
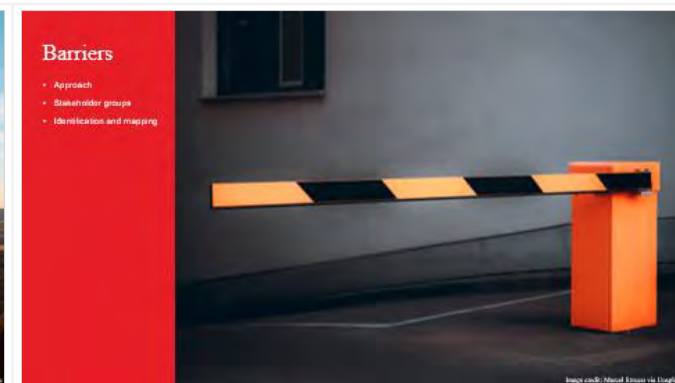
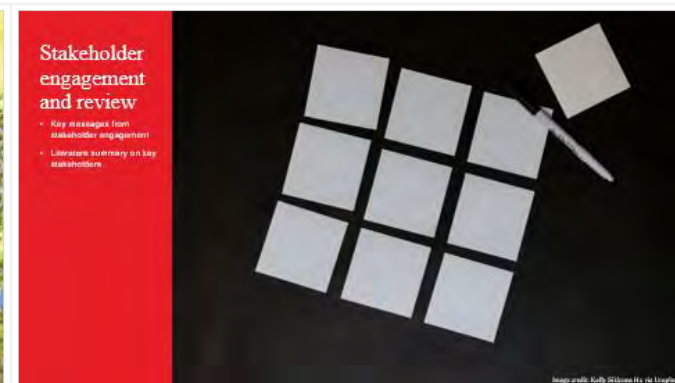
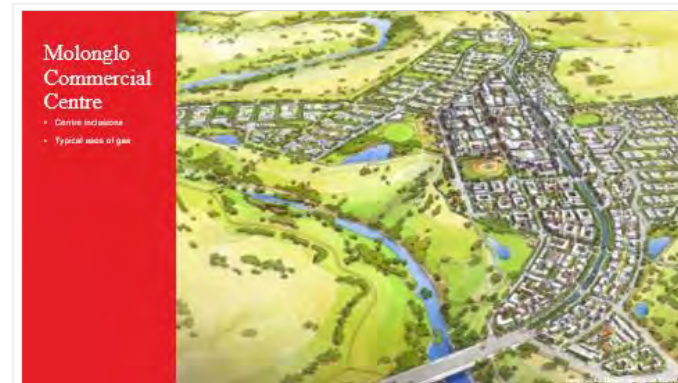
Introduction to the Centre

Literature review and stakeholder engagement

Case studies

Barriers

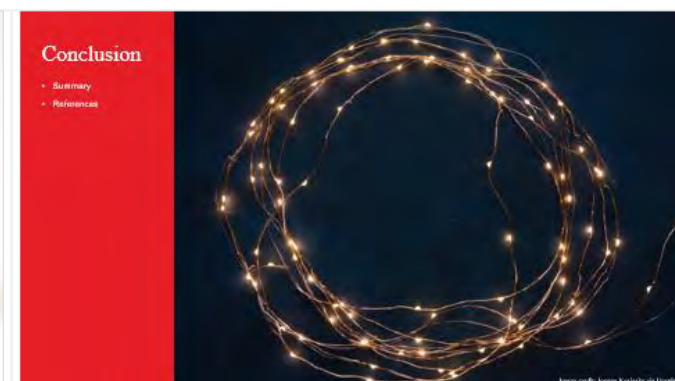
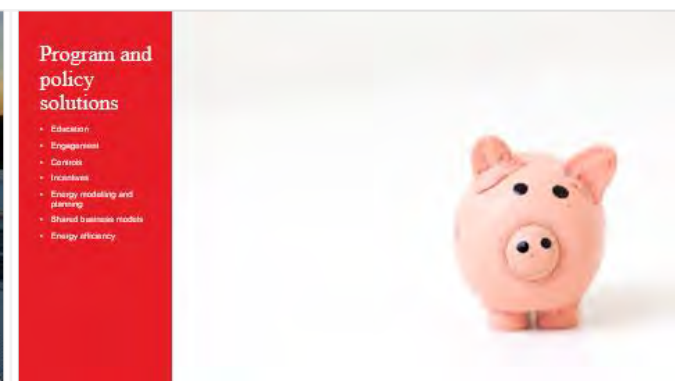
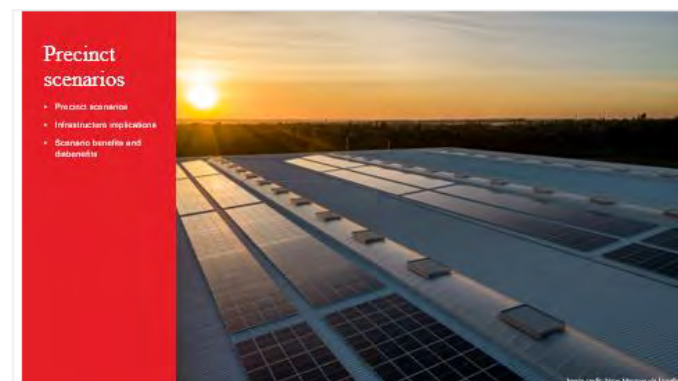
Building solutions



Precinct solutions

Program and policy solutions

Conclusion



Strategic and industry context

- Local and global context
- Suburban Land Agency ambitions
- Gas and electricity industry trends



Local and global context

The ACT exceeded its goal to reduce greenhouse gas emissions by 40% from 1990 levels in 2020 and is on track to meet the ultimate goal of net zero emissions by 2045. The decarbonisation of the electricity grid has been key to meeting this 2020 target and, moving forward, the ACT plans to maintain and leverage this 100% renewable grid to reduce transport emissions and phase out fossil-fuel gas use¹.

With such a clear direction on the decarbonisation of the electricity network and transport, the focus shifts to the gas network which is a growing emission source for the ACT by share. The Molonglo Commercial Centre provides a significant opportunity for the ACT to design and deliver a modern, carbon responsible centre that effectively meets the needs of current generations while protecting future generations.

The Centre is well timed to be a pilot development, as committed to in the recent Parliamentary and Governing Agreement².

Global



- United Nations Sustainable Development Goals with targets for 2030
- Paris Agreement with international Climate Change Commitments

Territory



- 2045 zero emissions target
- Wellbeing framework
- Climate change strategy

Local



- Parliamentary and Governing Agreement 2020 (directive for gas-free)
- Planning studies

Suburban Land Agency ambitions

The Suburban Land Agency (SLA) delivers the ACT Government’s suburban land development program, which includes the release of the land for the Molonglo Commercial Centre.

Through its functions, the SLA seeks to encourage and promote inclusive communities, through the delivery of people-focussed neighbourhoods and suburban development that supports:

- affordable living
- a safe and healthy population
- social inclusion
- housing choice
- environmental sustainability

This is underpinned by the SLA’s Sustainability Strategy, which covers categories across social and environmental sustainability, as shown on the right. The report draws on these elements and the above objectives, for example by mapping precinct scenarios against these.

Environmental sustainability:

- Conserving and enhancing biodiversity
- Reducing emissions from waste and reusing materials
- Reducing water use and improving water quality
- Reducing energy use and encouraging renewable energy
- Improving transport outcomes
- Adapting to a changing climate

Social sustainability:

- Creating people-focussed neighbourhoods and communities
- Supporting affordable living
- Encouraging safe and healthy people
- Promoting social inclusion
- Providing housing choice



Gas industry direction

Gas has an uncertain national and international outlook

- The International Energy Agency's (IEA) recent World Energy Outlook highlights the uncertain future of gas⁴.
- The IEA recent *Net Zero by 2050* roadmap proposes bans on new fossil fuel boilers globally by 2025⁷.
- The Energy Council of Australia has highlighted that gas's role will depend on how competitive it can be on price and sustainability¹.
- Domestic consumption in Australia is reducing due to increase in electric heating and hot water, related to the uptake of solar photovoltaics (PV) and energy efficiency measures³.
- Environmental and cost based targets are reducing gas consumption. Victorian state schools are removing gas connections and replacing Bunsen burners with electric hot plates, for example⁶⁵.

For now, no gas in Green Star 6-star buildings

- Under the 2019 version of Green Star Design and As-built v1.3, more points are likely achieved if gas based systems are used. This is a result of a method that only considers grid emissions.
- In the 2020 issue of Green Star Buildings v1, a 6-star rating will only be awarded to buildings that eliminate the use of fossil fuels. Specifically, a building must be fully electric and powered completely by renewable sources to achieve the 6-star certification in future.
- For the Living Building Challenge, which represents global best practice, ultimately gas is not allowed except for commercial catering on a case by case basis – for example, a flame grilled wok.
- The Australian Building Code's Board has developed a 2028 net zero trajectory for buildings which, unless rollout of green gas was accelerated, would only be compatible with all-electric buildings⁵⁹.

In the ACT, gas is mostly used for space and water heating

- In the ACT, natural gas is responsible for approximately 20% of our emissions inventory⁵.
- The ACT is turning to all-electric greenfield and infill developments.
- The majority of gas in households is used for space and water heating, with a small amount used for cooking. 2020 projections using 2015 data demonstrate the split as:
 - 77% space heating
 - 21% water heating
 - 2% cooking⁸
- 13% of the ACT's gas use is for commercial / industrial uses, with most of this being used by the ACT Government and the ANU⁵⁷.
- Other uses can include:
 - Bunsen burners or sterilising equipment in education or health settings
 - Pool heating
 - Heavy industry, particularly for heat-based processes, which is limited in Canberra

- There are businesses and tradespersons in Canberra with vested interests in gas. Provision of misinformation by tradespeople has been observed by the ACT Government⁹.

Decarbonisation of the gas network is receiving growing attention

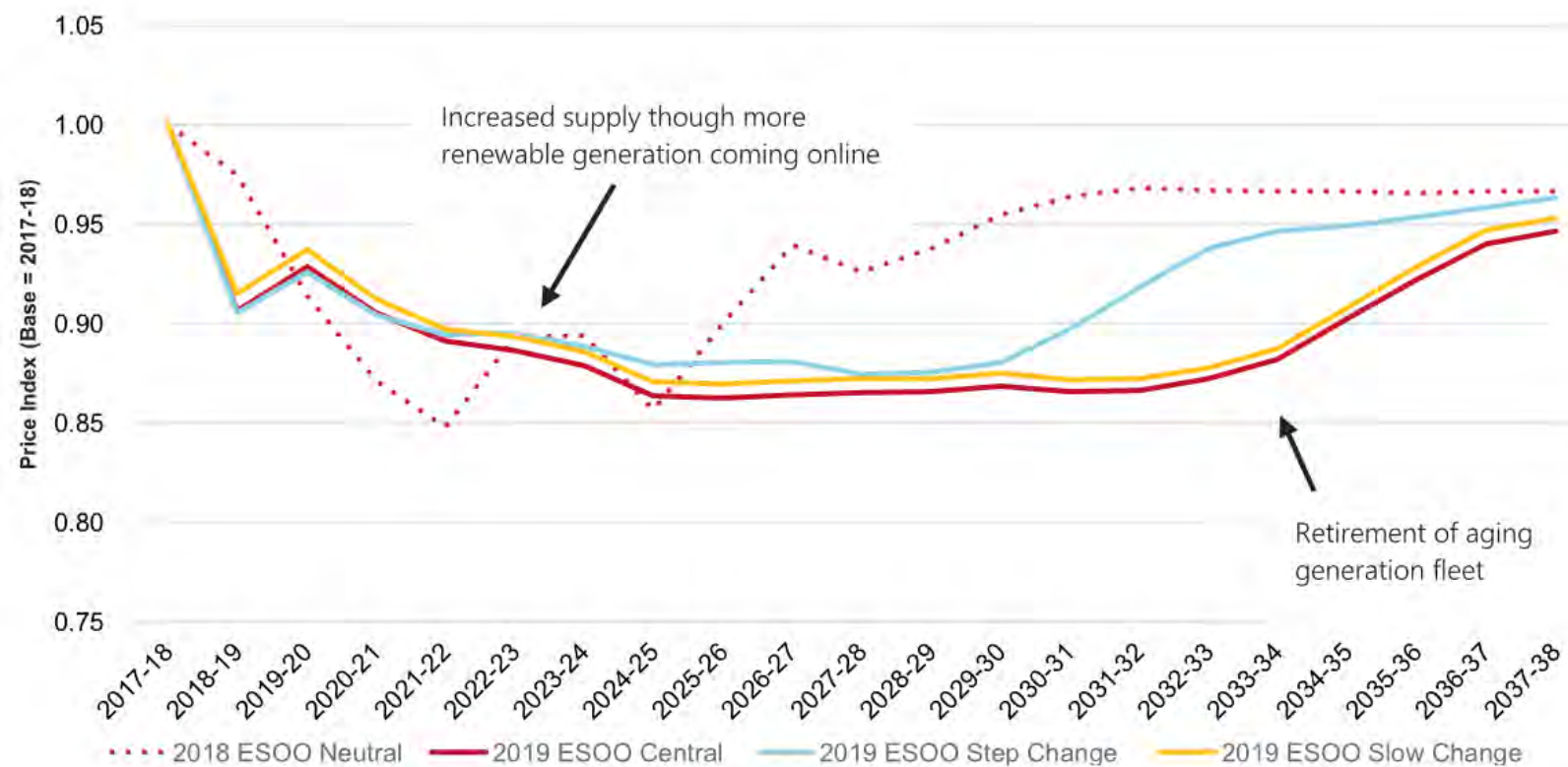
- Energy Networks Australia's *Gas Vision 2050* outlines a plan for decarbonising the gas network using biogas and hydrogen, with the next 5 years focused on demonstration and a targeted decarbonised network in 20-40 years⁷.
- There is consideration of the potential impacts of this for the Molonglo Commercial Centre on page 79 of this Report.

Energy prices

Electricity prices are anticipated to be steady

- The Australian Energy Market Operator (AEMO) forecast the supply and cost of electricity on the basis of market drivers and insights including changing demand, climate variations, policy, costs and industry trends.
- Prices are expected to hover around the current mark as renewable projects and adoption develop in the coming years.

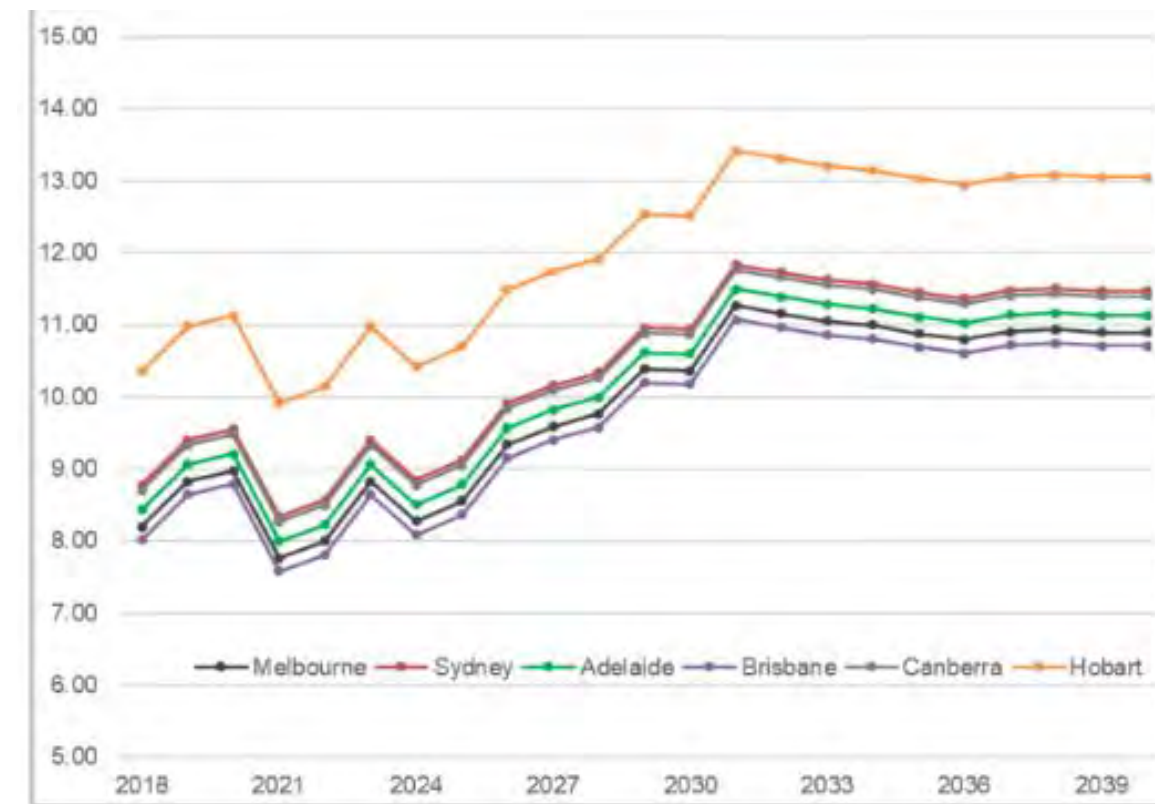
- Retirement of aging generation fleet will lead to increased costs in the near future, returning the price to near 2017 levels.
- In the ACT, consumers are somewhat protected from generation price changes due to the feed-in tariff scheme, however distribution costs are still passed on via Evoenergy.
- Despite prices falling 2.6% in the 20/21 financial year, from 1 July 2021 electricity prices will increase by up to 11.95% for small business and residential customers in the ACT¹¹.



Gas prices are uncertain but anticipated to rise

- The AEMO also reviewed the gas prices in Australia and forecast the gas price with consideration of the supply and demand of natural gas in each state.
- Gas price are anticipated to further rise in the order of 35% within 10 years for the east coast.
- Compared to the roughly stable electricity prices shown previously, gas will become increasingly expensive.

- Gas is exposed to future carbon regulation / price exposure in the transition to low carbon futures.
- Anticipated trends are largely influenced by:
 - Continued influence from overseas markets.
 - Limited policy intervention anticipated.
 - Significant rises in recent years.
- While gas prices in the ACT are set to reduce by 1% in 2021/22, these are expected to rise over the following four years¹².



Wholesale gas price forecasts (\$/GJ) for East coast

Carbon pricing

Carbon pricing enables the actual social cost of carbon to be accounted for

- There is growing support for pricing carbon and taking shadow prices into business decision making in Australia, including amongst business groups such as the Business Council of Australia^{14,15}.

- Australia had a price on carbon through the ‘carbon pricing mechanism’ under the *Clean Energy Act 2011*.
- Whether Australia introduces one or not, global activity in this space represents a possible risk. The European Union is considering a carbon border tax, which would place a tariff on imports from nations without prices on carbon, providing further incentive for a local price¹⁶.

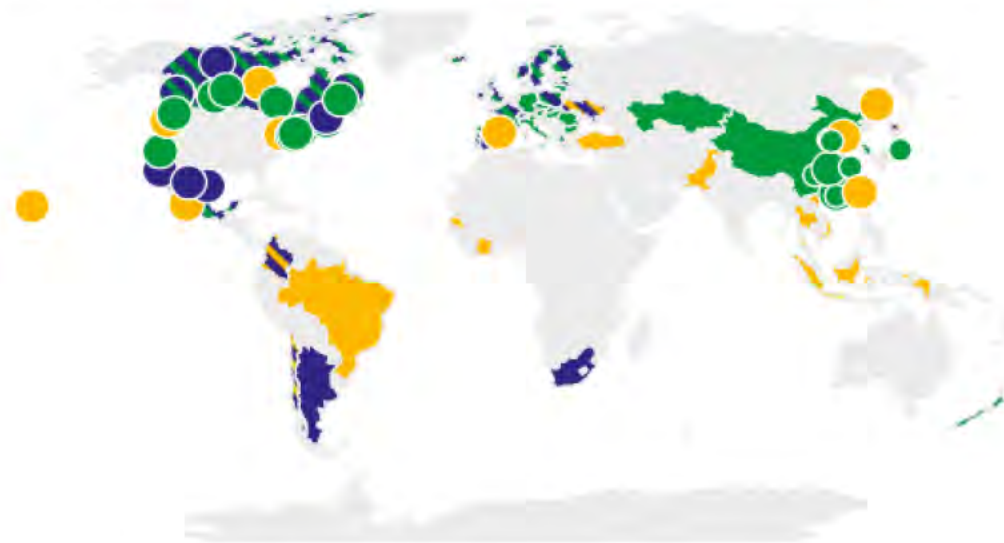
The ACT is considering a social cost of carbon

- The ACT’s Climate Change Strategy (2019-25) identified actions to:
 - “Ensure the social cost of carbon and climate change adaptation outcomes are considered in all ACT Government policies, budget decisions, capital works projects and procurements.”
 - “Invest an interim price of \$20 per tonne of emissions from government operations into measures to meet the Zero Emissions Government target from 2020–21, and arrange for an independent body to develop a social cost of carbon for application from 2025.”
- The ACT is currently engaging a consultant to recommend an appropriate social cost, with an interim cost to be introduced this financial year.

A future price on carbon should be considered when comparing renewable and fossil-fuel energy

- Estimates for the appropriate price vary. Models that estimate the social cost of carbon can be as high as US\$109 per tonne of carbon dioxide, increasing over time to as high as US\$220 per tonne by 2050¹⁷.
- The ACT Government’s interim, internal social cost of carbon is understood to initially be \$20.
- While this social cost on carbon would apply to government operations and the ACT does not have the ability to introduce a carbon tax, given the likelihood of a national or global price, the financial costs of fossil fuel gas are at high risk of increasing.

Summary map of regional, national and subnational carbon pricing initiatives



- ETS implemented or scheduled for implementation
- Carbon tax implemented or scheduled for implementation
- ETS or carbon tax under consideration
- ETS and carbon tax implemented or scheduled
- ETS implemented or scheduled, ETS or carbon tax under consid...
- Carbon tax implemented or scheduled, ETS under consideration

Molonglo Commercial Centre

- Centre inclusions
- Typical uses of gas



The Centre

The Molonglo Commercial Centre will provide important services to the Molonglo Valley

This will likely include one or more supermarkets, retail businesses, office space, one or more schools and a variety of residential lots.

“Gas-free” means no gas distribution network

For the Centre, “gas-free” means without a connection to the gas distribution network. Some transitional arrangements will be able to be put in place (e.g. gas cylinders on site), and this would not preclude arrangements such as hydrogen fuel for transport being driven in to the precinct in the future.

Given it will be the first mixed use/commercial centre or precinct without a connection to the gas distribution network in the ACT, it will assist in establishing what best practice looks like in the ACT context and will aim to address perceived and actual barriers to gas-free developments.

As a greenfield site, there is no gas infrastructure that would be stranded by the gas-free approach and no need to retrofit existing buildings with electric appliances or plant.

This study will enable effective communication to the SLA team, potential tenants and developers, and the local and wider community on the benefits and practicalities of a networked gas-free community.

Typical uses of gas

This study looks at six different typical building typologies for the precinct in order to identify the common uses of gas from the network, summarised on the right.

Gas uses were identified based on typical inclusions on other projects, survey results from ACT Government Directorates and Agencies and stakeholder engagement activities.

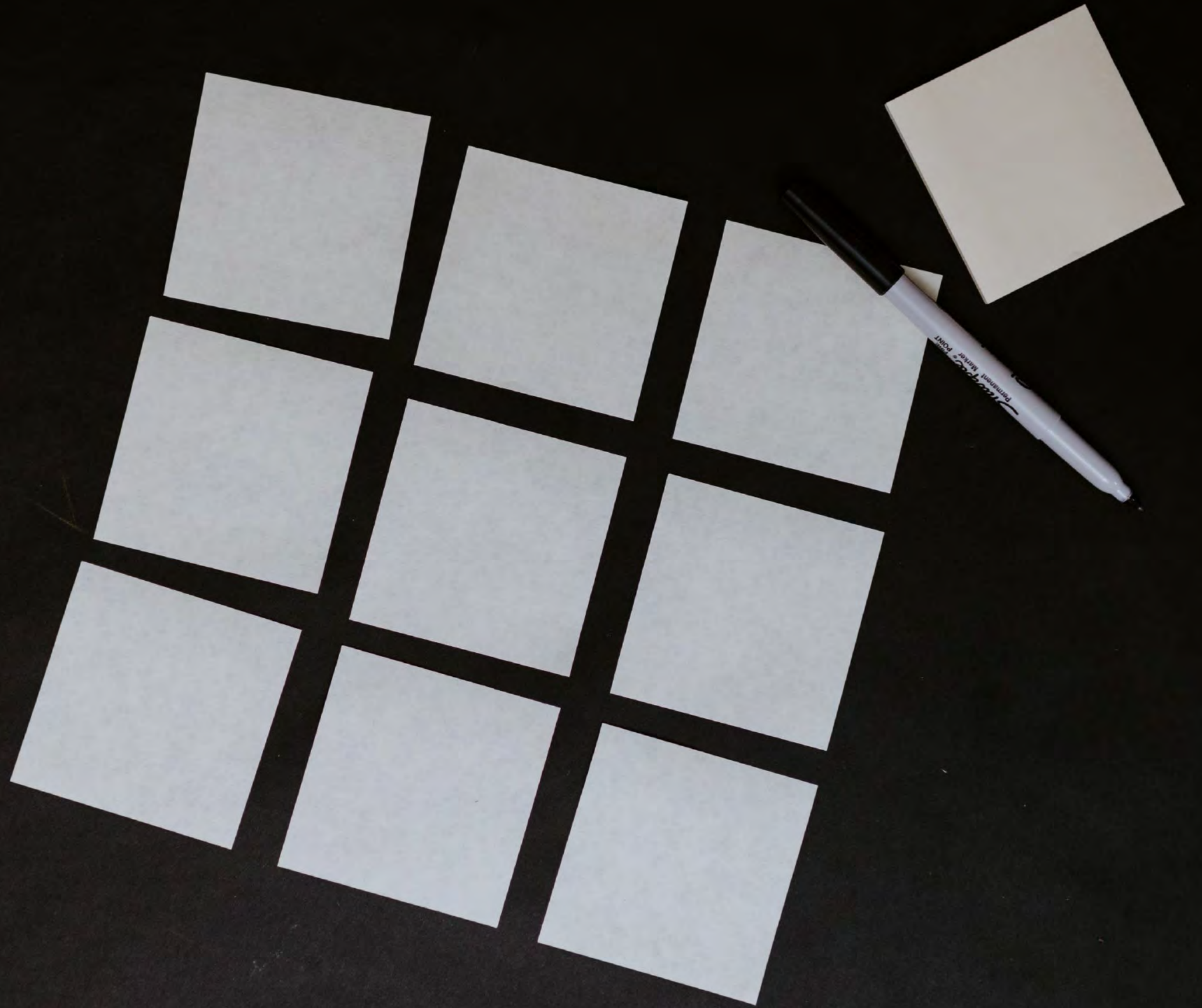
Additional typologies

While this list does not cover all different building typologies, it provides breadth that enables insights to be drawn from these – for example, office spaces could refer to health facilities to understand likely space heating comparisons. Similarly, cooking in schools can draw lessons from the retail and residential typologies.

Building typologies	Characteristics	Gas uses
Residential (class 1)	Typical usage patterns of residents with higher usage in the morning and evenings. Class 1 – typically a single lease, no common property.	<ul style="list-style-type: none"> • Cooking • Space heating • Domestic hot water • Swimming pools
Residential (class 2)	Typical usage patterns of residents with higher usage in the morning and evenings. Class 2 – typically units with common property.	<ul style="list-style-type: none"> • Cooking • Space heating • Domestic hot water • Pool heating
Education	Some peaks in demand during events and due to scheduled nature of school day. All future ACT schools to be all-electric.	<ul style="list-style-type: none"> • Space heating • Domestic hot water • Bunsen burners
Supermarket	Large commercial retail space with requirements for backup generation.	<ul style="list-style-type: none"> • Space heating • Domestic hot water
Retail (restaurant)	Highly focused on cooking requirements and preferences.	<ul style="list-style-type: none"> • Commercial cooking • Space heating • Domestic hot water
Health	Depending on the facility, can be similar to an office space with larger health facilities requiring steam generation.	<ul style="list-style-type: none"> • Space heating • Domestic hot water • Specialist high temperature uses including laundry, high temperature treatments / pathology and steam generation for sterilisers

Stakeholder engagement and review

- Key messages from stakeholder engagement
- Literature summary on key stakeholders



Stakeholder approach

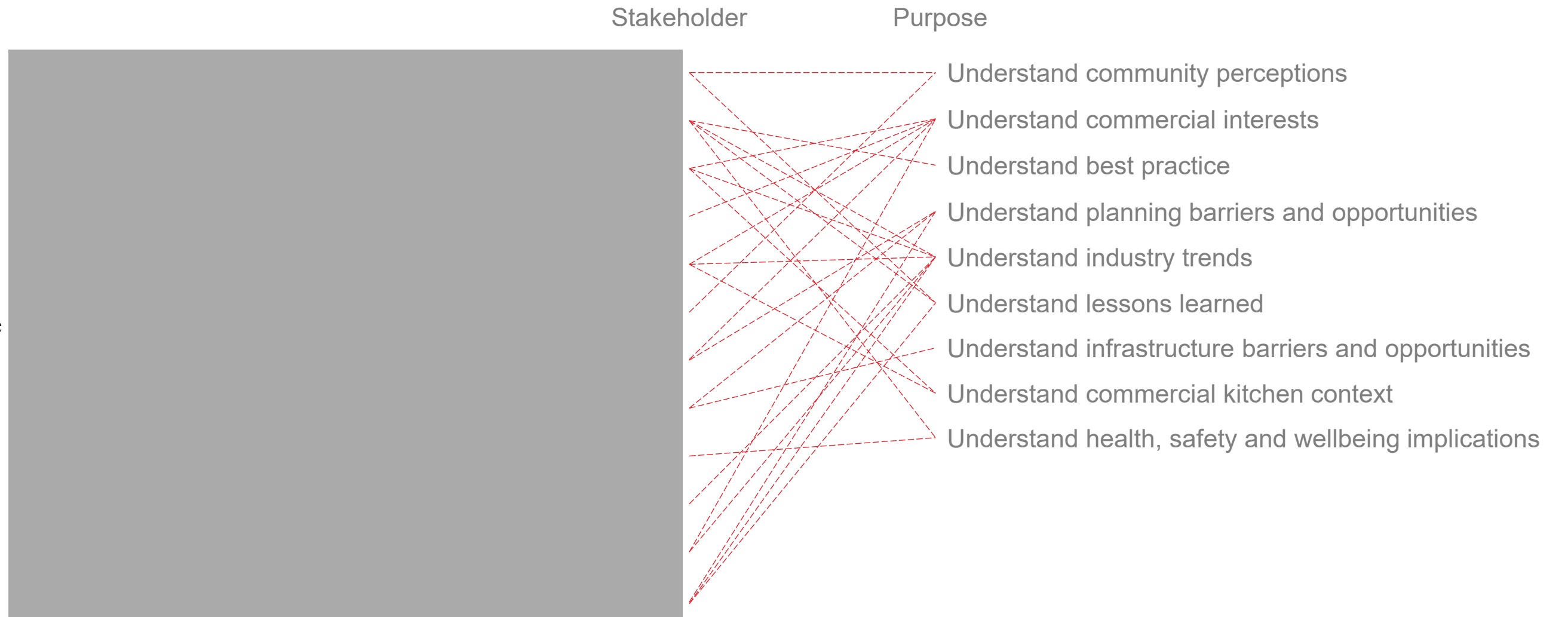
Stakeholders were selected to provide the project with a wide variety of perspectives. The purpose of each stakeholder engagement is summarised in the diagram on the right.

The Restaurant and Catering Industry Association of Australia were approached for interview, however, an interview was not secured. Research and feedback from other interviewed stakeholders highlighted the unique requirements of the field and the importance of stakeholder consultation. It is recommended that the SLA consult groups in this field to inform the development of the Molonglo Commercial Centre.

Excluded stakeholders

At this stage the following stakeholders were considered but excluded:

- Developers and real-estate/leasing agents (to keep project details confidential)
- Tenants (given the early project stage)



Engagement key points

Stakeholder	Key points
[Redacted content]	

Engagement key points

Stakeholder	Key points
[Redacted content]	

Engagement key points

Stakeholder	Key points
[Redacted content]	

Engagement key points

Stakeholder	Key points
[Redacted content]	

Developers and investors

Top tier developers are committing to net zero and all-electric

- Across Australia, ‘top tier’ developers are announcing net zero targets (see below) and are more likely to see gas-free precincts as an opportunity.
- For example, Mirvac has a goal to be net positive carbon by 2030, and this means developing all-electric buildings that run on 100 per cent renewable energy.

Local developers have not yet made similar commitments

- Geocon, Molonglo and Bloc do not have publicly available commitments/ targets.
- Doma Group also does not have a public commitment, though they have delivered 480 Northbourne as a zero-emissions (in operations) building.
- Riverview Group also does not have a public commitment, though they have delivered Ginninderry and sustainability is referenced in their mission and vision.

Investors are increasingly making decarbonised investments

- Industry funds such as Cbus Super, HESTA and First State Super have all announced decarbonisation strategies and investment in more sustainable assets¹⁸.
- Impact Investment Group is an example of an emerging investment group that invests in industry-leading green buildings¹⁹.

The approach to developers will depend on what kind of developer the ACT Government would like to attract

- For developers with strong sustainability commitments, it is likely the Centre will be perceived as an opportunity. Given these developers are largely operating outside of the ACT, this presents an opportunity to attract these kinds of developers to further expand into the Canberra market if desired – ideally setting up local operations where they do not already exist.

- For developers without strong sustainability commitments, work is required to pitch this as an opportunity and not a cost, though this does present an opportunity for a local developer to gain experience in all-electric developments, which will be essential in the future market.
- In both cases, actions that could assist include:
 - Developing economic models to estimate costs and benefits.
 - Reducing risk by working with Evoenergy early, before developers are involved and supporting the developer to work with EvoEnergy in tandem.
- The GBCA note that infrastructure impacts are not as great as perceived by developers, given over-sizing of infrastructure that occurs²⁰.



Retailers

Overall, retailers are increasingly supporting sustainability

- The Australian Retailers Association is developing a sustainability strategy, which is likely to be modelled on the British Retail Consortium's net zero by 2040 plan which is supported by major retailers including Aldi, KFC, Ikea, WHSmith, The Body Shop and more. This plan states stores and warehouses are to be net zero electricity by 2030²¹.
- Larger retailers are more likely to have long-term strategies, while smaller retailers are focused on short-term actions and keeping their operating costs low²².
- In public statements, retailers often focus on renewable *electricity* targets so it can be unclear if they are reducing gas use as part of this.

Supermarkets are generally supportive of all-electric

- There is an interest from major players in all-electric developments, with no pushback observed from supermarkets²².
- Coles has the ambition to be the most sustainable supermarket in Australia and a target to be powered by renewable electricity by 2025 and eventually net zero²³. They are achieving this through power purchase agreements and solar on supermarkets over the coming 5 years.
- Woolworths has a similar target to be powered by 100% green energy by 2025²⁴ and eventually net positive.
- Aldi is already using 100% renewable electricity through on-site solar, power purchase agreements and purchase of renewable energy certificates²⁵.
- Supabarn has no public commitments on their website.

- SPAR's environmental initiatives do not include a renewable energy target²⁶.
- IGA supports its independent grocers to implement sustainability initiatives though there are no specific targets or mandated actions²⁷.

Other large retailers are also increasingly supportive of all-electric but cost is a consideration

- Bunnings has committed to 100% renewable electricity by 2025 and net zero (scope 1 and 2) emissions by 2030. Bunnings-owned rooftop PV supplies 30% of its needs²⁸.
- Large bakeries can be high gas users⁵⁷, however electric ovens are also used. Bakers Delight has been working on their own highly efficient electric ovens⁵⁸.
- Some with specialist steam needs may be faced with high electricity costs to transition, and this will likely not be appealing.

- For example, a commercial laundry chose not to locate in [Burwood Brickworks](#) due to the gas-free requirement.

The split-incentive problem is a challenge for tenants

- Where landlords are responsible for failed equipment replacement and are not paying utility bills, they wish to install cheap like-for-like and are not interested in more expensive systems delivering cheaper hot water.

Gas in Canberra kitchens

Food and beverage retailers are a challenge, with no definitive recommendations and targets

- The Australian Restaurant and Catering Association does not have a public sustainability strategy or report.
- The USA’s National Restaurant Association’s completed a *State of Restaurant Sustainability 2018* report which does discuss energy, however it does not discuss the issue of gas vs induction cooktops and focuses on energy efficiency instead²⁹.
- Globally, McDonald’s has made a commitment to reduce greenhouse gas emissions by 2030 (from 2015) by 36%, though has no specific renewable energy targets or initiatives³⁰.

- KFC does not have specific targets but is looking at sustainability certifications for stores³¹.

Individual restaurants have mixed views

- There has been a mixed response from the restaurant and catering industry regarding the transition to gas-free cooktops³².
- A summary of discussion points in the public domain is provided below – note that some of these points conflict, for example people believe both gas and induction cooktops provide more control.

Cooktop	Identified pros	Identified cons
Gas	Responsive heat, even heat distribution, required for some cooking methods, can use any pot or pan	Not energy efficient, releases traces of pollutants, safety issues, creates uncomfortable/hot cooking environment
Electric ceramic	Easy to clean, can use any pot or pan	Not considered an option for industrial / professional kitchens due to time requirements to adjust temperature
Induction	Energy efficient, faster to cook, easy to clean, advanced control over speed and temperature, diverse design features (including wok)	Expensive to install, require specific pots and pans, not suitable for older or other buildings unable to meet high load requirements, not appropriate for people with pacemakers

- Restaurant owners like to have the ability to choose. Particular styles of restaurant may choose not to be involved in a gas-free precinct.
 - While electric woks are available, there are mixed preferences for these.
 - Ginninderry have encountered one food type – an Indian bread called Chapati – that cannot be cooked without gas.

The local catering education sector is preparing for a partial transition

- For commercial hospitality the transition has been underway for many years.
- [Redacted]
- [Redacted]
- [Redacted]
- CIT highlighted that the rate of technology change is quite high and so this assumption may change in the coming 5 years.

Households without gas cooking are becoming more normal for the ACT

- Households tend to be less concerned about gas for cooking than commercial kitchens and this is becoming business-as-usual for new suburbs in Canberra.
- In Ginninderry about five (of 800) residents in the first suburb have put gas bottles in for cooking (see Ginninderry case study for more).

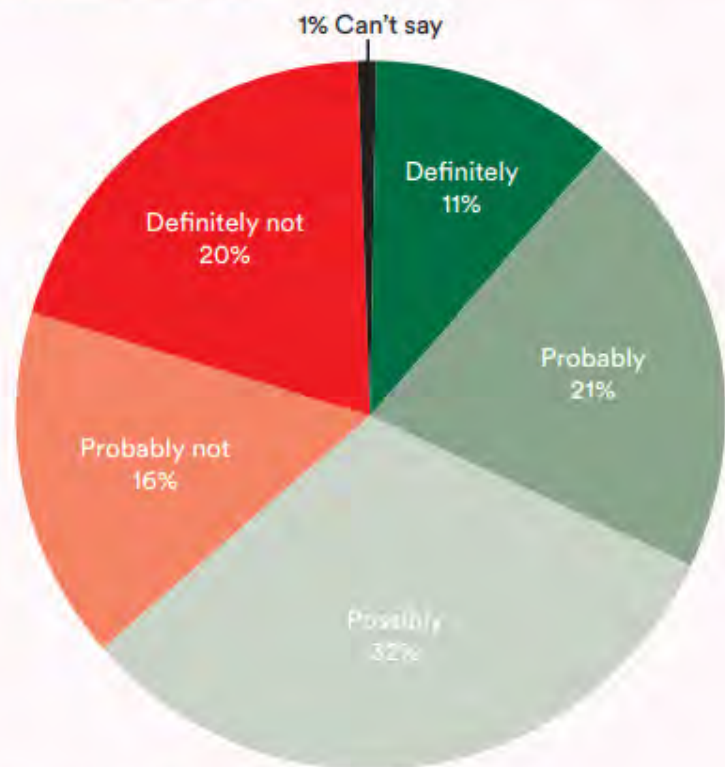
Canberra residents and gas

Most Canberrans have an appetite for no-gas suburbs

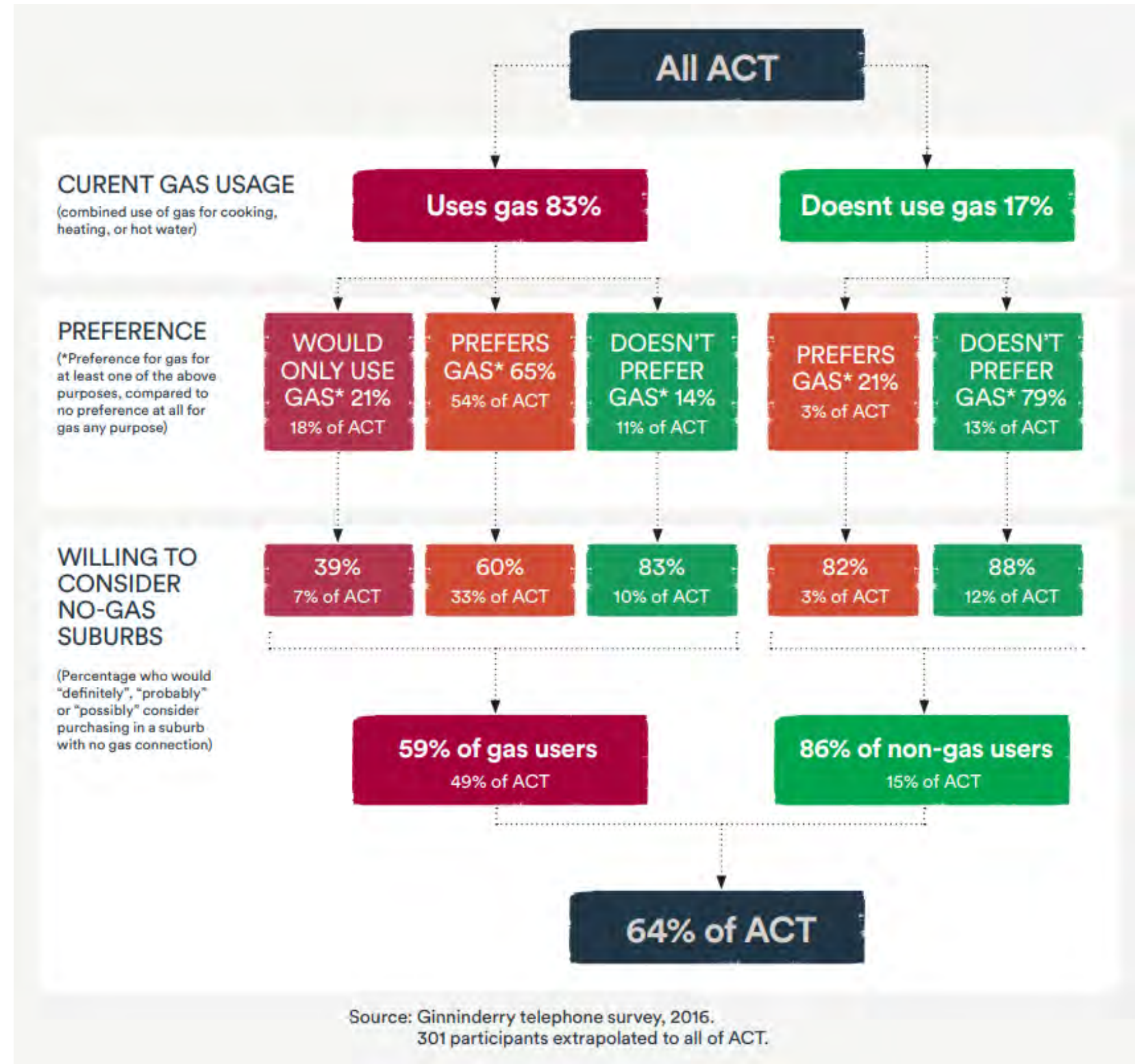
- Previous surveys from Ginninderry in Canberra indicated that about two-thirds of Canberrans would be willing to consider no-gas suburbs.

- Whether a person currently used gas was a strong indicator for their preference, with 86% of non-gas users willing to consider no-gas suburbs compared to 59% of gas users³³.

Would you consider buying a house in a suburb you like that only had electricity connections, but not gas?



Source: Ginninderry telephone survey, 2016. 301 participants



Sustainable technology adoption

Decision making is driven by many factors, particularly cost

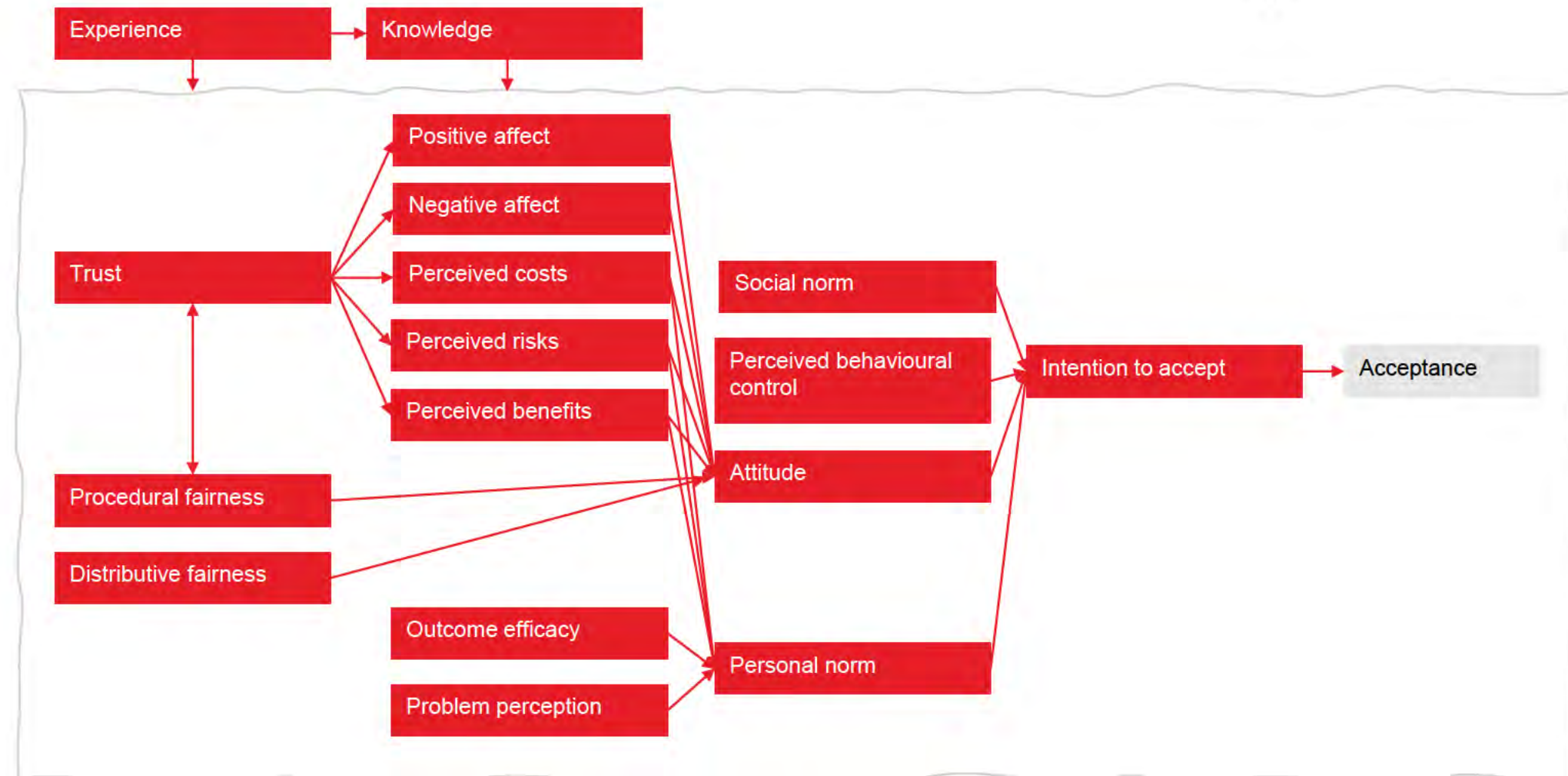
- When considering electricity supply, households are mostly driven by cost factors such as cost of bills, upfront costs and payback periods, as well as reliability³⁴.
- A perceived lack of credible information is an important barrier for homeowners to adopt sustainable measures³⁴.
- People perceive things as less valuable or significant if further away in time or space, even with long-term benefits – e.g. cost benefits of spending more on non-gas appliances³⁶.

- More broadly for sustainability issues, there are also several socio-cultural and psychological barriers to climate action that can limit decision making³⁷. These barriers exist despite 4 in 5 Australians agreeing that climate change is occurring³⁸.

Frameworks for sustainable technology adoption can help identify the different types of barriers to acceptance

- The below framework highlights the factors that lead to acceptance of sustainable technology options, from experience and knowledge, through to social norms and personal norms.

- This framework excludes individual traits and situational factors, though socio-demographic characteristics can have an influence on this process.
- The framework highlights the significant number of factors that inform decision making, and has informed barrier identification for this study.



Schematic representation of a technology acceptance framework, focused on citizen acceptance³⁵

Socio-demographic characteristics

Socio-demographic characteristics influence sustainable technology decision making

- When considering investments in renewable energy technology like solar PV, most households would be interested in purchasing the solar upfront. However, households earning under \$60,000 p.a. preferred leasing and agreements with energy service providers³⁹.
- Older Australians might feel less certain whether their investment will pay off during their remaining time living in their homes and therefore may be less willing to invest⁴⁰.
- There is a direct positive association between natural gas-free policy support and social trust, education level and being female, while this support is negatively associated with homeownership. This study concluded that support for a high ambition level and steering role by the municipality in the heat transition is favoured among individuals with increased age, education level and financial capability.
- The same study also indicated that residents who are young, live in urban areas and have a low income and education level can take on less responsibility in the heat transition due to a lower financial and collaborative ability⁴¹.
- Perspectives can vary based on home ownership status. Homeowners are willing to pay more for the convenience and safety of induction cooktop³⁴ while renters are more likely to be concerned whether the decrease in energy use would cover the higher rent⁴⁰.

Residents select appliances in the ACT based on a number of factors

- An ACT Government-funded study identified the factors that influence how households choose appliances for space heating, water heating and cooking. These included:
 - Number of people in household
 - Dwelling characteristics (size, age, control over appliance choice)
 - Upfront costs
 - Appliance use (e.g. whether they share the house, whether they work from home).
- Ability to generate on-site solar energy.
- Household preferences for a particular fuel for an activity, particular appliance features, particular appliance brands⁴².

Case studies

- Ginninderry, ACT
- Barangaroo, NSW
- 480 NBA, ACT
- Ebury, UK



Ginninderry

The Ginninderry development has demonstrated that all-electric at the residential scale is feasible and desirable in the ACT.

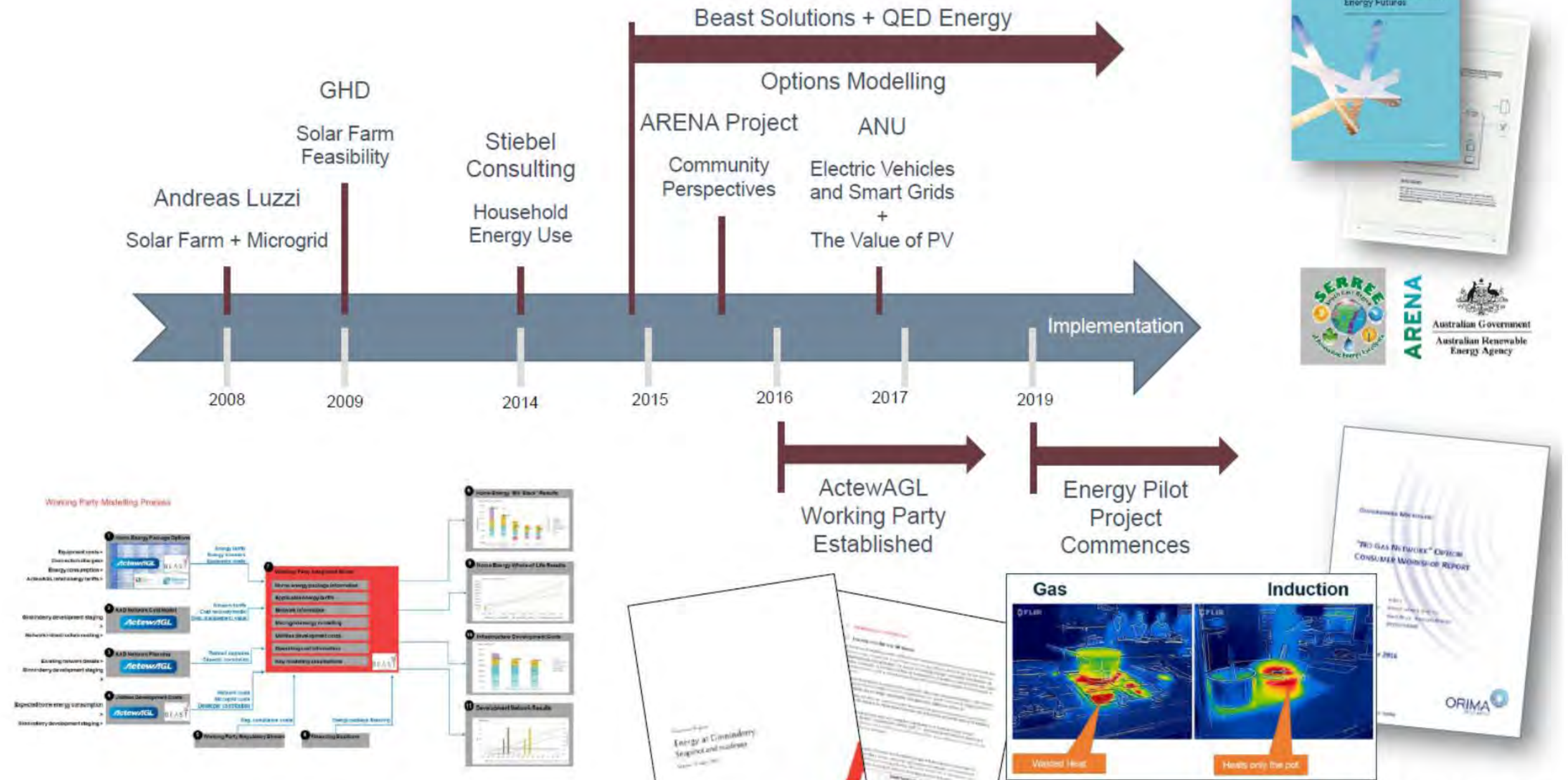
The education, incentive and control mechanisms put in place have been enablers during implementation.

Location	<ul style="list-style-type: none"> • ACT (eventually NSW as well)
Governance	<ul style="list-style-type: none"> • Joint venture between ACT Government and Riverview Developments
Scale	<ul style="list-style-type: none"> • Planned: 11,5000 dwellings over 30-40 years • Completed: 800 dwellings
Uses	<ul style="list-style-type: none"> • Four suburbs, four schools, market centre (major + minor supermarket, shops, community facilities, businesses) – approximately the size of Manuka and likely to be all-electric • Recreation, sports and community facilities • Traditional blocks, townhouses, terraces and apartments (300-400 dwelling sites per year) • 596 hectares of conservation corridor
Energy Features and Systems	<ul style="list-style-type: none"> • Virtual power plants, microgrids and other community-scale innovations • Home energy system (HES) – all-electric, solar PV, demand management system, energy efficient appliances and future-proofed for batteries and EV charging <ul style="list-style-type: none"> • Heat pump hot water, reverse cycle air conditioner, induction cooktop • All-electric suburbs • Public electric vehicle charging • Future possible hydrogen refuelling station • Café uses induction cooktop, despite this not being mandatory
Non-technological interventions	<ul style="list-style-type: none"> • Education – cooking demonstration videos, live demonstration equipment, information packs online • Incentives – front yard landscaping package (\$5,000) tied to HES • Controls – bond tied to HES

Ginninderry's energy features

Implementation has been informed by several studies

- Ginninderry has completed multiple models and feasibility studies at both the precinct and household scale over many years.
- There has been Australian Renewable Energy Agency (ARENA)-funded research into community perspectives that is able to inform other developments too.
- A working party with ActewAGL was established to develop collaborative approach and identify opportunities for shared benefit. For example, creation of an 'energy pilot' for both Ginninderry and Evoenergy to validate past modelling and better understand the implications of all-electric. Note, the results of this are not yet available.
- Ginninderry has worked with both consultants and the ANU to complete studies and design opportunities for learning.

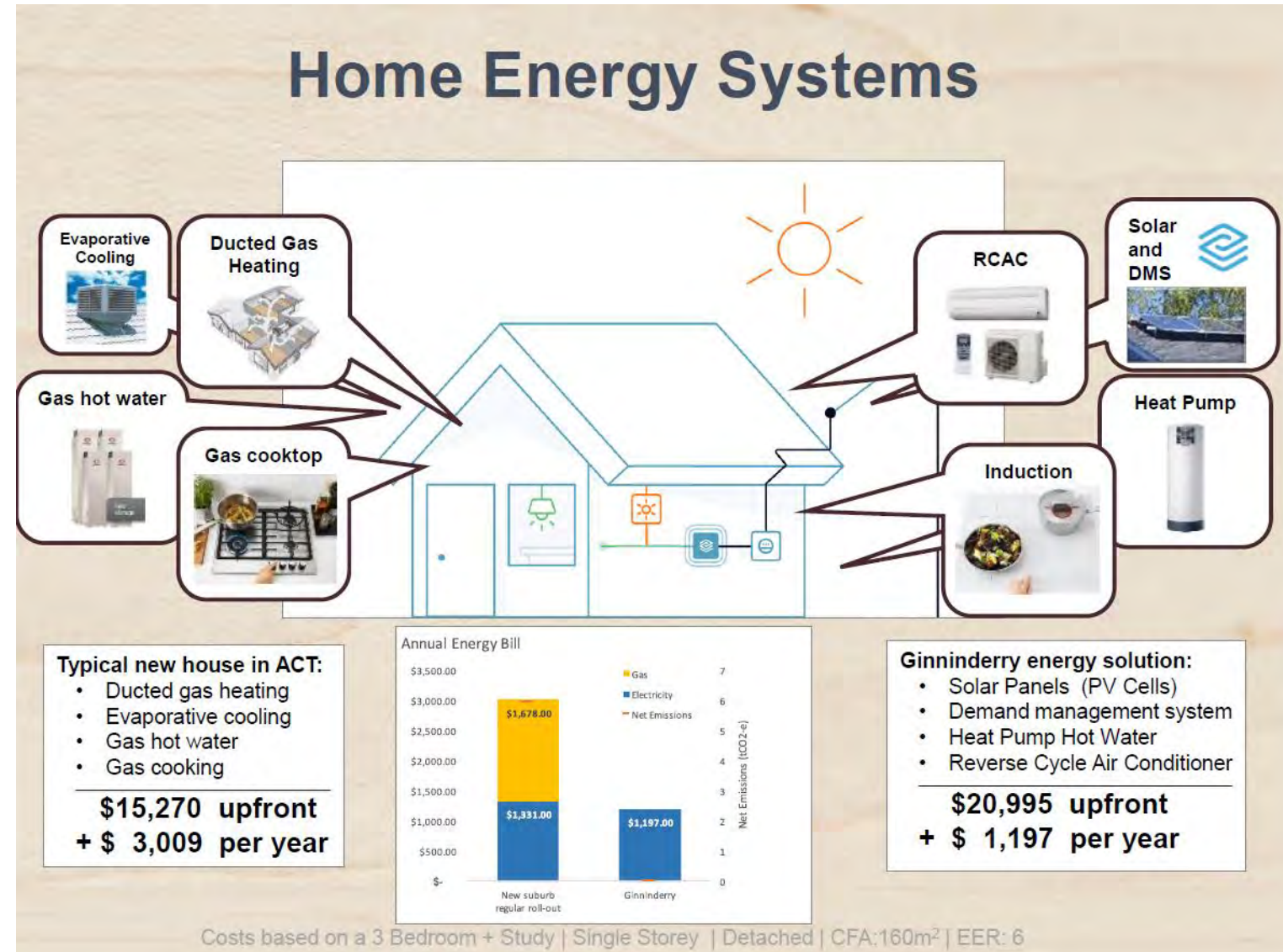


43 Ginninderry: All things electric presentation

Ginninderry's energy features

Ginninderry introduced a comprehensive Home Energy System

- Features of the HES include: Extensive solar generation, demand management by Reposit, Evergen and Solahart, electric vehicle charging, electric bike sharing, in-home centralised battery storage⁴³.
- Ginninderry completed a study comparing the costs of a typical three-bedroom house and a house under their HES, shown on right. While upfront costs increased by approximately \$5000, this was returned in savings within three years.



Ginninderry experiences challenges with the distribution network that are not anticipated to occur again

- Evoenergy installed gas mains which remain unused, however this is due to a regulatory issue which has now been addressed.
- Typically connection agreements in the ACT are \$2,000 for households. Originally Evoenergy proposed \$9,000 based on the non-standard design solution (largely driven by solar PV uptake and need for tap changing sub-station). Once Ginninderry agreed to complete a pilot with Evoenergy to test modelling and data management, this figure was reduced to \$4,000⁴⁴.

Ginninderry lessons

Several benefits of the energy approach have been identified by Ginninderry, including:

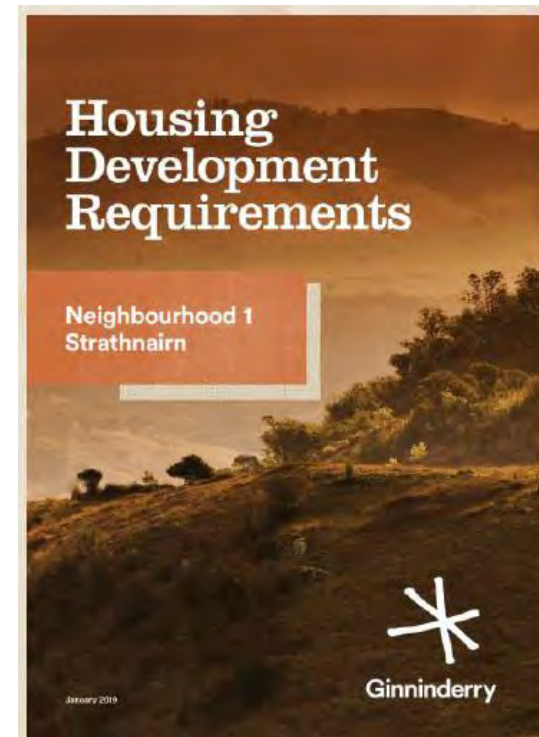
- Reduction in ongoing energy costs for residents, reduce greenhouse gas emissions, reduce peak electricity demand on grid⁴³.
- Three-year break even.
- (As it's a greenfield development) all-electric limits need for new gas infrastructure.
- Aligns with perception that mains gas 'no longer a cheap, clean, green alternative'.
- Takes advantage of the 100% renewable grid.
- Good capacity and skill availability in Canberra for installations⁴⁴.

Non-technological interventions were required to support the transition

- Ginninderry introduced 'sustainable living requirements' – see below right. A compliance bond was taken to encourage home energy system requirements to be met, then returned once performance verified. All houses are compliant, though only half have claimed back the bond to date.
- The compliance bond could then be used for a front yard landscaping package.
- A residential battery subsidy trial has been launched (\$3,000 for 65 batteries) – and a community scale battery trial is coming.
- Education has been key for Ginninderry. Cooking demonstrations were successful.
- The only food unable to be cooked without gas is thought to be chapati⁴⁴.

“Education is key”

- The development has partnered with Mr Wai, a Chinese chef who has observed the shift to induction cooktops in commercial kitchens in China. Benefits sited include better comfort (reduced heat in a hot kitchen), consistent heat and speed.



Sustainable living requirements

- PV (solar) panels
- Inverters
- Demand management systems
- Hot water systems
- Energy efficient heating and cooling
- Water efficient fixtures
- Rain water tanks
- Dog & cat containment

Residents had an overall positive experience

- For residents, there has been an overall positive experience with all-electric approach.
- The only bad experience with electric cooktops has been when a ceramic electric cooktop was installed rather than an induction cooktop.
- About five (of 800) residents have put gas bottles for cooking, which is still cheaper than using gas mains⁴⁴.

2: Barangaroo South Retail, Sydney

Barangaroo is a nominated C40 Cities Climate Positive project, delivering industry leading initiatives across carbon, water and waste.

To deliver this, the project required a novel approach to governance and engagement with the retail sector.

Relevance

- Provides lessons in engaging and incentivising retailers and tenants, including smaller businesses.
- Leverages the scale of a precinct development in providing shared resources and infrastructure.
- Demonstrates opportunities through joint venture delivery between government and private industry and developers.



© Barangaroo Delivery Authority, Courtesy of Lend Lease

Barangaroo

Early consultation, upskilling and ongoing support through an 'eco-concierge' were important for supporting tenants to implement the sustainability requirements in the Barangaroo South development.

Smaller retailers in particular found the process and decision making onerous, and experienced increased upfront costs associated with applied building margins and administrative process to meet these requirements being new to the industry.

Whilst for some retailers, the sustainability requirements conflicted with practices central to their core identity and business (choice of equipment), many of the retailers welcomed the innovation in sustainability and the benefits of attaining operational energy cost savings and Green Star certification as an outcome of being in the precinct.

Location	<ul style="list-style-type: none"> • Sydney, Australia
Governance	<ul style="list-style-type: none"> • Overseen by Infrastructure NSW (Barangaroo Delivery Authority) • Barangaroo is one of only 19 projects around the world participating in the C40 Cities Climate Positive Development Program • Development agreements ensure the entire precinct remains in public ownership, with the buildings and infrastructure on 99-year leaseholds.
Scale	<ul style="list-style-type: none"> • Over 80 retailers in Barangaroo South • 22 Ha site (6 Ha Barangaroo South)
Uses	<ul style="list-style-type: none"> • Commercial office • Retail and entertainment, including restaurants and food-court kiosks • Residential • Variety of open public spaces and a cultural centre 'Cutaway' at Barangaroo Reserve
Energy Features and Systems	<ul style="list-style-type: none"> • On-site solar PV • District Cooling Plant • Contributions by tenants to off-site renewable energy and carbon offsets
Non-technological interventions	<ul style="list-style-type: none"> • 'Eco-concierge' for education and upskilling tenants • Baseline carbon – BAU against optimised version to set retailer specific carbon target • Carbon targets linked with cost / rent if they are not met during operation (offset) • Briefing shop fitters regarding sustainability commitments • Sustainability 'defects' inspection to certify equipment installed • Measuring /validating outputs when operational • Green Star Interiors (Volume Certification) for retail • Green Star and other sustainability rating tools across the wider development

Barangaroo energy features

Barangaroo has several precinct-level energy and water initiatives

- Barangaroo claims to be Australia's first large-scale carbon neutral precinct.
- It includes centralised infrastructure such as Sydney Harbour water cooling, embedded electricity networks, recycled water treatment plants and on-site renewable energy generation (6,000m² of solar panels)⁴⁵.
- The district cooling plant uses Sydney Harbour water for heat rejection.
- An 'eco-concierge' was introduced to support tenants understand and implement their sustainability obligations (see next page).

The precinct has comprehensive Governance arrangements

- Through development agreements, the precinct is and will remain in public ownership, with the buildings and infrastructure on 99-year leases.
- Sustainability requirements are cascaded down from the NSW Government to sub-tenants through an 'Estate Levy' in every lease and other governance arrangements. These are passed on from the NSW Government through to development partners, building owners, tenants and sub-tenants.
- All buildings at Barangaroo contribute to carbon neutrality through annual greenhouse gas reporting by LendLease and financial contribution towards off-site renewable energy and carbon offsets. Each building has contracted annual targets for operational greenhouse gas emissions.
- International Towers Sydney, the three commercial towers at Barangaroo, have achieved 6-star Design and As-Built ratings from Green Star. The project has also achieved 6-star Green Star Communities rating.

The energy strategy was supported by several other sustainability goals

- Reducing construction waste going into landfill by 97%, by sorting and separating waste and recycling or reusing
- Planting 100% native plants in Barangaroo Reserve
- Using recycled water for flushing toilets through to irrigation and fire sprinklers
- Encouraging retailers and suppliers to avoid packaging, reduce waste and offer healthy food choices from locally and sustainably produced food.
- Stringent retail requirements for compostable packaging.
- Providing and promoting access to and facilities for walking, cycling and passive and active recreation through design for active living and healthy lifestyles.

Barangaroo lessons

Consultation was critical

- Equipment is very specific to retailers especially for cafes and restaurants. The team found their ability to influence and change types of equipment to be challenging as there is a clear link between preference of equipment and their core business output. Consultation is key to understand this elasticity to influence.
- Consultation needs to happen at the start with development team so that sustainability targets and obligations associated with the precinct are clearly communicated to prospective tenants and business owners. On this project, this was with the retail leasing team during the preliminary discussions with tenants so they understand their obligations. It cannot happen later.

Upskilling and guidance was required for tenants

- Upskilling and awareness building was key for design and for operation. There was ‘eco concierge’ who drove this. They were engaged during the construction phase, and continue into operation of the precinct working with the retail and commercial tenants on their obligations.
- A ‘sustainable retail design guideline’ was developed and was foundational to make clear all obligations, targets, and dos/don’ts for the retailers. This was provided to both the tenant as well as to their shopfitters and design team so that design decisions could be made early.

Sustainability certification created additional work

- Volume Certification (Green Star Interiors) became onerous on retailers and the team needed to evolve the tool to be responsive to retail projects. Documentation and process needed to be streamlined as the cost and time associated with this become challenging and disincentivised Green Star for retailers on comparable precincts at the time.
- If Green Star is pursued, managing the expectations of retailers on ratings is important – it is great for marketing however there are trade-offs.

A cost burden was observed

- Higher construction costs were experienced by tenants due to a cost mark-up applied by shopfitters to meet sustainability requirements. It was unfamiliar territory to many which increased costs (due to perceived risk), and there was an increase in associated paperwork needed which created additional cost.
- Smaller retailers and family run businesses are at risk of feeling overwhelmed. Consultation both during design and operation, as early as possible, was key to address this.
- Lendlease held a bond for tenants that was not released until they were satisfied with the delivery of sustainability obligations. This was often a point of contention between tenants and Lend Lease.
- The lease agreements also had a % of earnings 'give back' included in the rent. This is not uncommon in these developments where this % in addition to base rent is for the perceived benefit of footfall from being located within an attractive development.

3: 480 NBA, Canberra

480 Northbourne Avenue is the ACT's first 'zero emissions' office building.

Relevance

- ACT location provides Territory-specific context
- Insights into Canberra-appropriate technologies
- One of the limited completed all-electric office developments in Australia



480 NBA

This development was the first all-electric office building in the ACT.

It has demonstrated that all-electric, while more expensive to construct, is more affordable over the whole of life of a building due to reduced operational costs.

This work highlighted the technical challenges of the Canberra climate which can limit the performance of air source heat pumps.

Location	<ul style="list-style-type: none"> • Canberra
Governance	<ul style="list-style-type: none"> • Developed by Doma Group, managed by Colliers, engineered by Rudds, built by Bloc
Scale	<ul style="list-style-type: none"> • 13,200 sqm
Uses	<ul style="list-style-type: none"> • Office • Café
Energy Features and Systems	<ul style="list-style-type: none"> • All-electric heating, cooling and ventilation • Both water-cooled and air-cooled heat pump chillers (providing both chilled water hot water) • Optimised chiller arrangements to handle variability in Canberra climate • Radiant slab heating at ground level • Solar PV on the rooftop • 5 star NABERS Energy rating and 5 star Design and As built Greenstar
Non-technological interventions	<ul style="list-style-type: none"> • Guarantees lease by the ACT Government as anchor tenant for 20 years

480 NBA energy features and lessons

The building utilises air source heat pumps and induction cooktops

- For space heating, air source heat pumps were selected for their energy efficiency and ability to utilise solar PV on the roof.
- The café utilises an induction cooktop, which was paid for by the operator as part of the fit-out.
- This building has achieved its milestones of achieving 5 star NABERS (Design) and Greenstar accreditation.

Responses to the all-electric approach varied with initial resistance and now awards

- There was initially some resistance from the building owner and builder as this is a relatively new approach to office accommodation in south eastern Australia and the first in Canberra.

- The building's all electric HVAC system has been shortlisted for the Property Council of Australia national award for innovation.

Lifecycle costs for all-electric are lower

- Design costs are the typically the same irrespective of whether a gas solution is adopted or an all-electric solution is adopted.
- Construction costs with the all-electric solution are higher than a gas solution which is mainly driven by the price of the space heating plant and additional electric infrastructure.
- However, in terms of life cycle costs, the all-electric solution works out to be cheaper over the life of the plant when you factor in maintenance and operating costs.
- This is due to the higher efficiency of space heating and hot water plant.
- The use of solar PV on the roof also supported this reduction in lifecycle costs.

The Canberra climate does impact the performance of air source heat pumps

- The cold climate in Canberra was the biggest barrier for the 480 NBA team.
- Air source heat pumps de-rate in heating capacity and drop off in efficiency during cold ambient conditions (typically below 4°C). As such this needed to be taken into consideration when selecting the size of the heat pump plant and size of the coils in the air handling units.
- The 480 NBA heating coils were sized to handle 50°C supply water temperature, as this is what the equipment can deliver at -5°C ambient temperature. Heat pumps are typically sized to -2.5°C ambient temperature in Canberra, and the selection of equipment operable at -5°C ambient temperature provides system resilience. The final heating coil selections have approximately 15-20% additional capacity in relation to design figures, and the heat pump capacity increased by approximately 25%.
- The heat pumps will periodically operate in defrost mode. This involves operation in reverse cycle, with only one refrigeration circuit able to operate in defrost mode at any time. Defrost mode avoids the coils freezing, and was important to factor in when determining the plant configuration to avoid a drop off in heating in the building.
- To cater for defrost mode requirements, the chiller size increased, adding approximately 1m to the heat pump length for each heat pump. Note that this metric is dependent on equipment selection and is indicative only.

4: Ebury Bridge Estate, London

Ebury Bridge Estate is a sustainable housing development located in London. The development consists of 781 new homes which will be powered by all-electric systems in typical operation. Homes are designed to be affordable, with a portion allocated to social housing. The development includes community spaces including cafés, retail space, a community hall and a fitness centre.

Relevance

- Demonstrates that all electric solutions are achievable in a climate cooler than the ACT and at a multi-building scale
- Provides lessons in cost sensitive all electric solutions



Ebury Bridge Estate

This project is currently in development and involves the demolition of the existing Ebury Bridge Estate.

The design so far highlights that sustainable, gas-free development can result in affordable dwellings. The design achieves this via operationally efficient systems, passive design and good envelope performance.

The London climate is cooler than the Canberra climate, demonstrating that technical challenges associated with cold temperatures can be overcome and all electric design is achievable in cool climates.

Location	<ul style="list-style-type: none"> Westminster, London, UK
Governance	<ul style="list-style-type: none"> Developed by Westminster City Council
Scale	<ul style="list-style-type: none"> Planned: 781 dwellings across 9 blocks ~18,500 sqm site area
Uses	<ul style="list-style-type: none"> Residential dwellings, with approximately 50% of dwellings for social and intermediate rent Local facilities for the community such as a community garden, local cafés, community hall, local shops, nursery and fitness centre Five large public outdoor spaces
Energy Features and Systems	<ul style="list-style-type: none"> Ground source heat pumps The development is largely car free, however, electric vehicle (EV) charging is to be provided for 50% of car spaces (37 spaces) with infrastructure allowing for a further 37 to also be provided for. Load management will be installed. On-site solar PV Two centralised energy centres serve the 9 blocks. Each centre generates low temperature hot water for heating and chilled water for cooling using the following technologies: <ul style="list-style-type: none"> Open loop ground source heat pump Air source and water source heat pumps Gas fired boilers for resilience only. They will not run during normal operation and dwellings and tenancies do not have access to a gas supply.
Non-technological interventions	<ul style="list-style-type: none"> Extensive and ongoing community consultation with existing and future residents Various community commitments, including commitments to affordability, social value and economy.

Ebury Bridge Estate energy features

Passive design principles support operational energy efficiency

- Carbon has been reduced by 90%. The building massing and building envelope have been designed to reduce heating and cooling loads, passively improving energy efficiency of the development.
- Mechanical ventilation has been installed with heat recovery to improve efficiency, allowing waste heat from cooling to be used to heat domestic hot water. The air conditioning systems are controlled in each apartment via heating interface units.
- Ground source heat pumps have been proposed as a potential solution to reduce operational emissions.

Sustainability and energy efficiency are at the core of the development

- The development is a low car scheme, where 50% of car parks are dedicated to electric vehicle charging and 2,000 cycle spots have been provided for residents.
- Solar PV is proposed to further reduce emissions.
- Smart meters are recommended to allow visualisation of the precinct energy performance.

The buildings use centralised energy centres to improve operational efficiency

- The development features two centralised energy centres. The centralised approach provides the following benefits:
 - A reduction in total plant space required.
 - A single energy centre centralises the plant and thus simplifies the maintenance requirements.
 - Refrigerant based equipment is centralised, rather than spread between buildings or even individual homes, so that there are fewer possible sources of leaks, and fewer requirements for leak detection and management.
 - Benefits from larger diversities in loads, made possible by the larger distribution.
 - A reduction in the quantity of resilient plant required, by providing resilience to the centralised systems.

Existing gas mains have been retained for resilience and back-up purposes

- Although no gas is provided to retail or residential tenants, the existing gas mains will serve base building boilers which are provided for resilience only. These boilers will not run in typical daily operation.

Ebury Bridge Estate lessons

Community consultation and commitment is a core part of the development process

- The development is committed to supporting the community by engaging them throughout the development process, with a number of public community commitments. This process ensures that community needs are central to the design, and affordability, amongst other factors, are prioritised. It also holds the design team accountable.
- The project is designed to achieve a Building Research Establishment Environmental Assessment Method (BREEAM) Communities rating which requires projects to consider the ongoing economic impact of the development. Commitment to such ratings can ensure that the cost to tenants post practical completion is considered.

Affordable gas-free development is achievable

- Heating bills are expected to be approximately 25% of those of the existing development. This is achieved via the consideration of how building massing impacts heat and cooling loads of the buildings, in addition to careful façade design. The façade design balances thermal requirements via high performance glazing and appropriate window to wall ratios with daylighting and acoustic requirements. Designing passively is key to achieving affordable design outcomes.
- The proposed smart metering system allows tracking of energy consumption and serves to educate residents to alter their behaviour.
- By centralising services, the maintenance fee can be shared amongst residents and retail tenants, reducing ongoing cost burden.
- Ongoing, scheduled maintenance ensures that the systems maintain functionality over time.

Barriers

- Approach
- Stakeholder groups
- Identification and mapping



Barriers to gas-free

Barriers to the implementation of network gas-free alternatives have been identified for the Centre, covering both actual and perceived barriers.

It is important to note that different barriers may exist for different developments – for example, the barriers around retrofitting existing buildings or sites with gas appliances or technologies do not apply to the Centre.

Barriers have been mapped against stakeholders and energy uses on the following pages.

Observations are summarised on the right.

The social barriers outnumber the technical and financial

- There are a significant number of socio-cultural and behavioural barriers that have been identified.
- These tend to be common across stakeholders and technologies, though most were noted for cooking.
- People make decisions based on what they know and are familiar with.

The financial barriers are driven largely by upfront costs

- All-electric equipment often has greater capital costs associated with it.
- While solar PV and battery investments can improve the financial case for all-electric, these too require early investment which are not always feasible for all.
- This challenge is exacerbated by the 'split incentive problem' whereby landlords are not incentivised to select equipment that reduces ongoing costs and emissions.

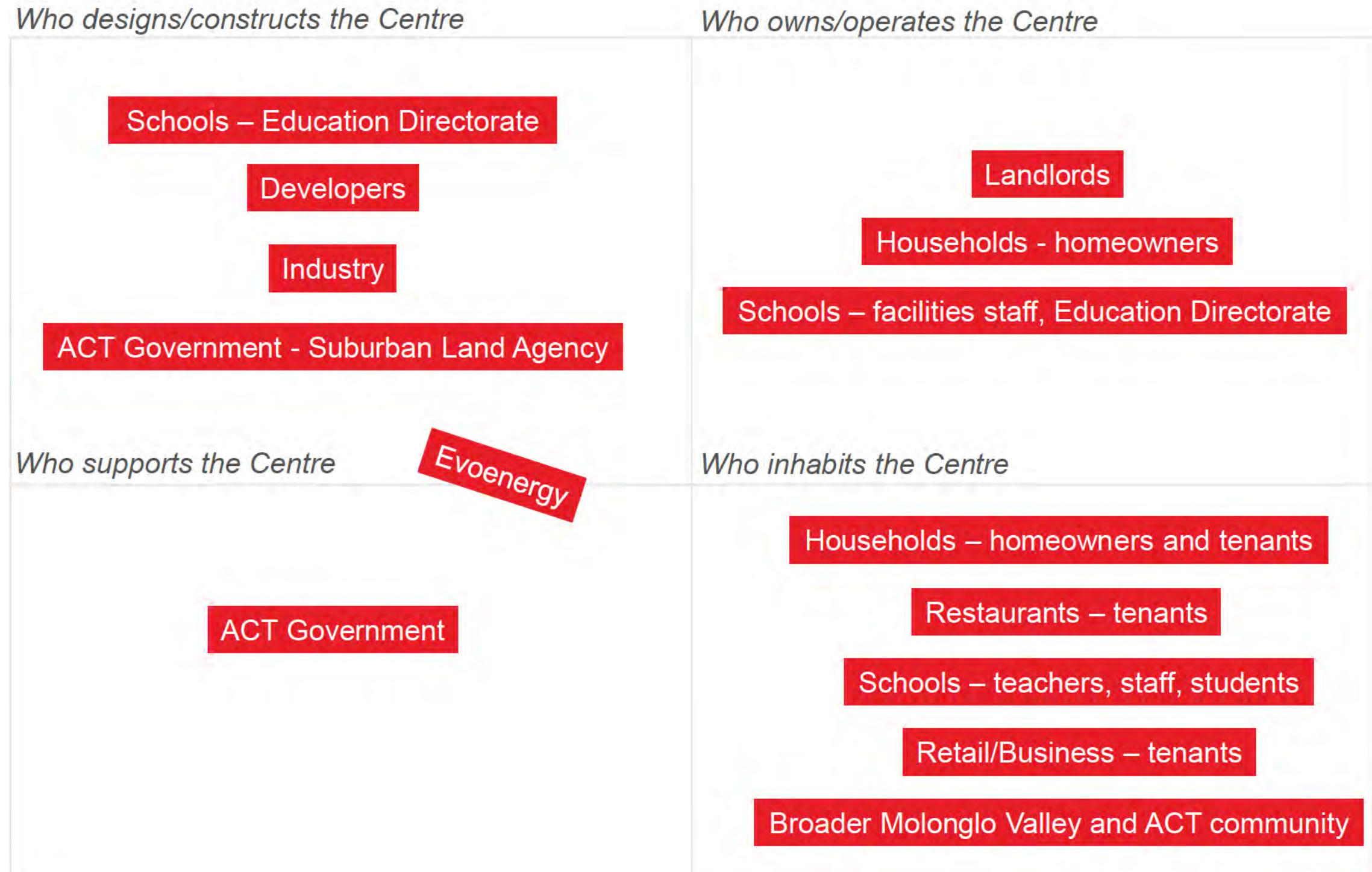
For technical barriers, stakeholders focused more on energy reliability and peak load changes rather than individual appliances

- Reliability and resilience of supply was a concern, especially for businesses who need to maintain business continuity.
- The increases in peak load with all tenants using only electricity and no gas network will impact the timing of sub-station upgrades and the costs of electricity within the precinct.
- For air source heat pumps, the low temperatures in Canberra do limit performance.

Stakeholders considered

The stakeholder groups considered for the barriers are shown on the right.

Some stakeholders fall into multiple groups (for example schools will both use and operate the space) and some stakeholders may fulfill multiple roles (for example, a developer may construct the space then go on to be a landlord as well).



Barriers

Grouping	Barrier	Perceived by									Relating to				
		Households	Restaurants	Schools	Retail / Business	Government	Evoenergy	Developers (during construction)	Landlords	Industry (HVAC, construction)	Cooking	Hot water	Space heating	Other gas use	Energy generation, transmission, storage
Financial	Ability of renters / low income households or small businesses to invest upfront	(Renters / low income)			(Small)										
	Uncertainty over realisation of return on investment due to age or agreed tenancy period	(Elderly)													
	Short-term increases in electricity prices (12% this financial year) – note these are likely not to continue rising relative to gas														
	Perceived risk working with Evo and uncertainty over charges that will be applied														
	The 'split incentive' problem – landlords motivated by capex not opex savings														
	Electric induction cooking appliances currently have higher upfront and ongoing costs														
Technical	Cool Canberra temperatures limiting air source heat pump performance														
	Evoenergy's connection agreements with the AER are 5-year terms, which limits their short-term flexibility														

Barriers

		Perceived by									Relating to				
Grouping	Barrier	Households	Restaurants	Schools	Retail / Business	Government	Evoenergy	Developers (during construction)	Landlords	Industry (HVAC, construction)	Cooking	Hot water	Space heating	Other gas use	Energy generation, transmission, storage
Technical cont.	Increase in peak load, especially winter														
	Perceived reduction in reliability of energy supply														
Socio-cultural and behavioural	Preference for gas cooktops (by some)														
	Desire to have ability/freedom to choose cooktop type														
	Close relationship between cooktop equipment preference and core business output														
	Personal norms - lack of personal experience with all-electric buildings and technologies														
	Social norms – majority of experience is not with all-electric buildings and technologies														
	Lack of credible information available / on hand														

Barriers

Grouping	Barrier	Perceived by									Relating to				
		Households	Restaurants	Schools	Retail / Business	Government	Evoenergy	Developers (during construction)	Landlords	Industry (HVAC, construction)	Cooking	Hot water	Space heating	Other gas use	Energy generation, transmission, storage
Socio-cultural and behavioural cont.	Lack of knowledge on all-electric technologies														
	Uncertainty around future of green gas in the ACT grid and therefore uncertainty around appropriate degree of 'gas-free'														
	Broader socio-cultural and psychological barriers to action on climate change and sustainability														
	Perception that all-electric is not a cost effective approach or an attractive opportunity									(Some)					

Building solutions

- Consideration criteria
- Gas-free technology identification and multi-criteria assessment
- Gap analysis to identify relevant non-technological solutions



Technology assessment

For each networked gas use, alternative technologies have been identified and assessed.

This assessment is attached as Appendix 1.

Given that the precinct is in the early stages of planning and that many parameters go into the sizing and selection of technology systems, the assessment of technologies provides a relative comparison only.

The results have also been used to estimate the increase in peak electrical demand in the Centre.

Snapshot of the technology assessment (Appendix 1)

Building Type	Gas Application	Alternative Technology	Alternative technology system efficiency	Relative Cost				Regime		Risk Categories, Wellbeing and Safety										Equipment		Other	
				CapEx Difference (\$/m ²)	OpEx Difference (\$/m ² yr)	OpEx [X] (\$/m ² yr)	OpEx [Y] (\$/m ² yr)	Spatial requirements	Other	Acoustic implications	Visual amenity	Maintenance	Reliability/longevity	Indoor air quality	Fire	Other	Operational maintenance cost (\$/m ² yr)	Operational maintenance cost (\$/m ² yr)	Operational maintenance cost (\$/m ² yr)	Challenges	Risks		
Residential Class 1	Space heating	Reverse cycle	3.00	0.00	0%	-6.40	-63%	Similar to BAU	None	Single ductless central air conditioning systems are typically less expensive than traditional ducted systems.	Indoor air quality: Indoor air quality is improved as there is no ductwork to collect and distribute dust and allergens.	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.	
	Space heating	Reverse cycle + air to air heat recovery	2.50	6.50	25%	-7.02	-68%	Similar to BAU	None	Single ductless central air conditioning systems are typically less expensive than traditional ducted systems.	Indoor air quality: Indoor air quality is improved as there is no ductwork to collect and distribute dust and allergens.	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.	
	Space heating	Electric panel heater	1.00	-3.50	-13%	1.14	11%	Similar to BAU	None	Personal preference: None	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.		
	Space Heating	Electric hot water boiler	0.85	5.50	21%	3.16	31%	Similar to BAU	None	Personal preference: None	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.		
	DHW	Air source heat pump	2.50	7.00	37%	0.40	50%	None	None	Hot pumps should be located in a well-ventilated area with high air circulation for optimal operation.	Personal preference: None	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.	
	DHW	Electric instant	0.90	-2.00	-15%	1.53	45%	None	None	Electric instant water heaters are typically less expensive than traditional tank water heaters.	Personal preference: None	Visual amenity: None	Maintenance: None	Reliability/longevity: High	Indoor air quality: None	Fire: None	Other: None	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Operational maintenance cost (\$/m ² yr): 15	Challenges: None	Risks: The efficiency of the building is not affected.	

This assessment is based on several key assumptions

This assessment assumes that each building operates independently, rather than via shared or district services.

It is also independent of factors such as building massing and envelope performance, which impact heating demand and the performance of some systems.

Assumptions have also been made regarding the size of the various building typologies. For example, buildings ranging from townhouses to mid-rise apartment complexes have been considered under the residential category.

A summary of assumptions is provided on page 64-65.

For the purposes of this assessment, the following definitions have been used:

Building Typology

Residential, education, supermarket, retail (restaurant), health.

Gas Application

Business as usual gas uses.

Alternative Technology

A technology not reliant on the gas network that provides equivalent outcomes to BAU gas technologies.

These definitions inform the multicriteria assessment.

Assessment criteria

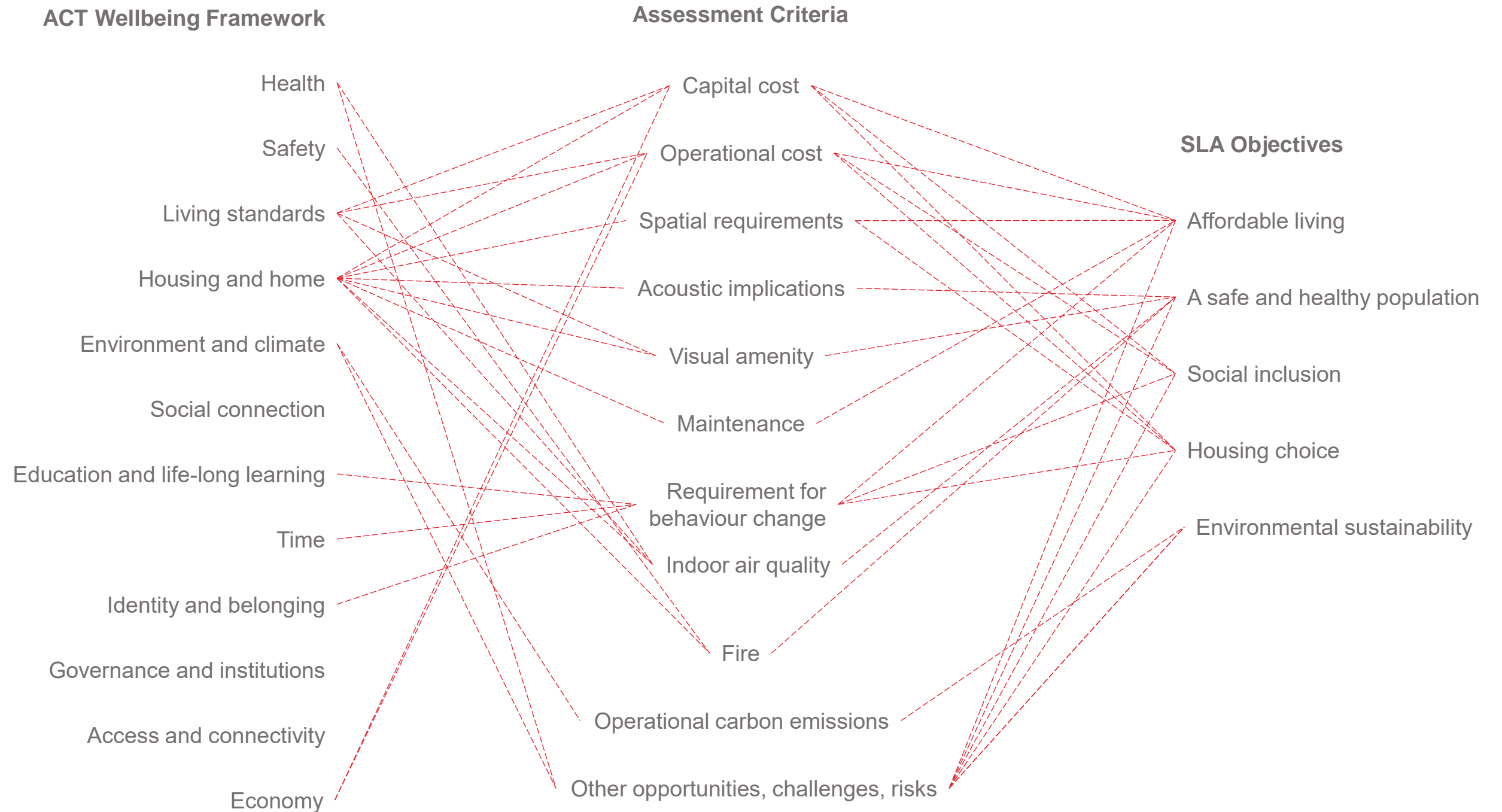
Each alternative technology has been assessed against the criteria to the right, which were developed in consideration of SLA objectives and the ACT Wellbeing Framework.

They have been mapped back to these objectives as part of the assessment.

A description of the criteria is provided on page 63.



ACT Wellbeing Framework



Assessment criteria

The assessment criteria are defined as follows:

System Efficiency

A measure of energy consumption. This varies between technologies. For example, induction cooktops transfer approximately 90% of the plate energy directly to the pan, whereas a larger proportion of heat from gas cooktop flames is transferred to the surrounding air.

Cost – Capital

The upfront cost of the technology, including purchase and installation. Gas and electricity connection fees have been excluded from this technology assessment.

Cost – Operational

The ongoing cost of the technology, including energy consumption and maintenance costs. Arup have assumed:

Electricity cost = \$0.20 /kWh

Gas cost = \$0.04 / MJ

Design – Spatial considerations

The spatial impacts of the technology, for example plant space and associated services e.g. ductwork.

User Experience, Wellbeing & Safety – Acoustic

Impacts on acoustic comfort. For example, fan noise.

User Experience, Wellbeing & Safety – Visual

Impacts on visual amenity, such as extensive plant space.

User Experience, Wellbeing & Safety – Maintenance

Predicted ongoing maintenance requirements.

User Experience, Wellbeing & Safety – Behavioural change

Actual, not perceived, behaviour change required by end users.

User Experience, Wellbeing & Safety – Indoor Air Quality

Impacts on airborne particulates.

User Experience, Wellbeing & Safety – Fire

Impacts on fire safety or requirements.

Environment - Operational carbon emissions saved (kgCO₂eq/yr)

Estimated carbon emissions during standard operation. Due to the decarbonisation of the ACT electricity grid, the emissions saved are based on the emissions of the gas technologies.

Environment – Other Operational Considerations

Additional environmental considerations during operation, such as the impact of refrigerant use.

Other – Opportunities, challenges and risks

Summary of other opportunities, challenges and risks. These are sourced from stakeholder consultations, research and Arup project experience.

Modelling assumptions

The following assumptions have been used in the development of the energy calculations and the corresponding cost estimates. The advice provided is indicative in nature and is sensitive to changes in user behaviour, developments in technology and improvements construction standards.

Systems Efficiency Estimates

- Coefficients of Performance (CoP) have been selected based on manufacturer information at conditions similar to the expected operating conditions in Canberra and are shown in the matrix.
- Polyvalent heat pumps are assumed to be working with minimal simultaneous heating, cooling and domestic hot water provision due to building typology (medium density apartment buildings).
- Domestic hot water is assumed to be circulated at >60°C to mitigate risk of bacteria/legionella. The higher temperature gradient reduces heat pump efficiency relative to space heating.
- CoPs provided represent the technology’s average seasonal efficiencies.

Space Heating - Electric Appliance	Seasonal CoP
Electric panel heater	1.00
Electric hot water boiler	0.85
Reverse cycle/air-source heat pump	3.00
Reverse cycle + air to air heat recovery	3.50
Polyvalent heat pump	3.30

DHW - Electric Appliance	Seasonal CoP
Air source heat pump	2.50
Electric instant	0.90
Electric storage	0.85
Polyvalent heat pump	3.30

Consumption Energy Use Intensities

- Energy use intensities (EUIs) describe how much energy is being consumed per square metre per year. These figures are estimates and are not explicitly stated in the matrix in Appendix A, however they inform operational expenses and estimated kgCO₂eq/yr emissions for each technology application. For example:

$$\text{EUI} = 2\text{kWh/sqm/yr}$$

$$\text{Technology CoP} = 0.75$$

$$\text{Technology consumption} = \text{EUI} \div \text{CoP}$$

$$= 2 \text{ kWh/sqm/yr} \div 0.75$$

$$= 2.67 \text{ kWh/sqm/yr}$$
- EUIs have been determined per building typology and application. For example, the EUI for residential heating differs to supermarket heating and to retail DHW.
- They have been determined for both gas and electric applications.
- The technology consumption figure can be multiplied by the floor area and cost of electricity to calculate the operational expenses.

- It can also be multiplied by the local grid carbon factor and building area to estimate the kgCO₂eq/yr operational emissions.

Heating

- Residential heating estimated using the BASIX framework⁶¹.
- Education heating estimated using the COAG National Strategy on Energy Efficiency report. *Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia Part 1- Report November 2012*.
- Supermarket and F&B approximated using analysis from fisherman’s bend. *Fisherman’s Bend Net Zero Emissions Strategy Baseline Assessment 14 February 2018*.
- Health and consulting room data taken from AIRAH essentials. *AIRAH Technical Handbook Edition 4*.

Domestic Hot Water

- Residential calculated using BASIX data with an approximate hot water fraction of 40%.
- All other typologies calculated using Green Star estimations.

Modelling assumptions cont.

The following assumptions have been used in the development of the energy calculations and the corresponding cost estimates. The advice provided is indicative in nature and is sensitive to changes in user behaviour, developments in technology and improvements construction standards.

Consumption Energy Use Intensities cont.

Cooking

- Hours of operation calculated using the DIS residential energy baseline study.
- Gas consumption based on manufacturer information⁶².
- Commercial cooking estimate based on a bottom-up calculation with an approximate annual operation of 1500hrs.

Pool Heating

- Calculated using a bottom-up approach
- 28°C water temperature.
- Pools are assumed to be outdoor pools.
- Assumes 10% of Canberra homes have pools⁶³.

Peak demand estimates

- Based on a bottom-up approach (i.e. assumptions about technologies and buildings are used to build a precinct peak demand estimate).
- Highly sensitive to assumptions – to be replaced by a top-down methodology if/when data is available from Evoenergy.

- Uses land-use map provided by Suburban Land Agency to estimate the relative areas of each building typology. Land use ratios taken from Territory Plan NI2008-27.
- Total annual gas consumption is estimated by using by estimating total distribution of different building typologies using energy use intensities (EUIs), land use ratios, and land-use map.
- An annual hours of operation estimate is developed for each typology and gas use case (DHW, heating, pool heating, cooking). This is used to calculate an hourly “peak” for each use case by dividing annual consumption by annual hours of operation.
- Gas use peaks are summed to calculate peak demand. No diversity is applied. Appliance efficiency, which influences peak consumption, is not taken into account (i.e. residential space heating CoP of 0.8 for gas appliances and 3.0 for heat pumps).

Consideration of solar heating

- Solar heating is often used for domestic hot water systems and pool heating. Although this technology is common, it has not been considered as part of the current assessment as it acts as a supplementary technology rather than a stand alone technology.
- Since solar loads are not consistent, solar domestic hot water systems need a booster system to operate effectively. The booster system is generally one of the domestic hot water technology options included in this assessment.
- Solar pool heating is often installed in residential settings. However, without adequate solar load, it does not perform the same function as the gas heaters or electric heat pumps that have been assessed.

Technology assessment observations

Change in capital and operational cost vary depending on the scale of the development

- Capital cost uplift for electric technologies vary between technologies. Some electric options, such as electric Bunsen burners, are significantly more expensive to purchase and are more expensive to run due to the cost of electricity.
- Air source heat pumps for DHW are a consistently poor choice when considering cost only.
- Reverse cycle systems, with or without heat recovery, are more expensive to purchase but provide cost benefits during operation due to their efficiency.

Behaviour change is largely non-existent

- Behaviour change is minimal to none for most technologies.

- Cooking requires a change in cookware as well as cooking practices. This seems to be more significant in commercial kitchens where chefs are typically trained to use gas cookware. It also impacts the visual theatrics of commercial cooking, which often relies on open flame.

Indoor air quality improves with a shift to electric technologies

- Almost all technologies and applications result in improved indoor air quality. The exception is Bunsen burners using bottled LPG.

Flexibility in design is key, as user experience varies between applications and stakeholder

- Electric cooktops and electric panel heaters, for example, pose a safety risk in educational or domestic locations with small children due to the hot surfaces despite the risk associated with gas technologies' open flames being mitigated. This risk may not be considered important in domestic settings without small children.

- Flexibility in design options allows stakeholders to make decisions based on personal requirements.

Fire risk generally reduces, although refrigerants introduce additional fire considerations

- Fire risk is expected to be reduced for all technologies other than those relying on refrigerants. Low flammability and low global warming potential refrigerants should be selected to minimise risk. Robust maintenance procedures and leak detection systems will also reduce risk.

Operational carbon emissions improve, and focus should be placed on refrigerant impacts

- The decarbonisation of the ACT electricity network reduces operational carbon when there is a shift from gas BAU design.
- Refrigerants often have negative environmental impacts. The shift to electric technologies increases the use of refrigerants, and care should be taken to select Class A refrigerants where possible.

Technologies are impacted by the environment they operate in

- The cool Canberra climate is known to reduce the efficiency of air source heat pumps, which can be used for DHW and space heating. This results in a seasonal variation in efficiency and a preference to locate heat pumps in relatively warm locations.
- Air to air heat recovery systems can reduce heating requirements by reusing waste heat. However, systems rely on well sealed buildings to operate effectively. This may be a challenge for some building types.

Technology assessment observations

High temperature specialist equipment is challenging to replace with electric technologies

- Health practices such as general practices and pathology centres can have specialist equipment such as sterilisation equipment and high temperature laundry facilities. This equipment typically relies on high temperature steam generation, which is easier to generate using gas based technologies than electric technologies.
- Although electric technologies exist, their electric load is high and can dominate building loads. Buildings should be designed in consideration of this potential high load.
- If multiple pieces of high temperature, steam generating equipment is required, on-site gas storage could be considered as an exception to the gas-free suburb design.

- Precinct and building level energy modelling can help the development team understand the magnitude and significance of peak loads.

As expected, the shift to electric results in an increase in the peak electricity demand of the Centre

- [Redacted]
- Note that this is an estimate based on a number of assumptions and not based on engineering design or modelling. The calculation assumptions are summarised on page 65.
- This will likely involve a capacity increase of the high voltage (HV) authority ring mains, HV step down transformers, HV reticulation, substations, and LV reticulation.
- The actual cost of these upgrades will vary depending on the final layout of cabling, arrangement of substations, and other associated design factors.

- [Redacted]

The shift to electric impacts building connection costs

- The building connection infrastructure will be impacted by the proposed technology changes including an increase in electrical connection costs and deletion of gas connection costs.



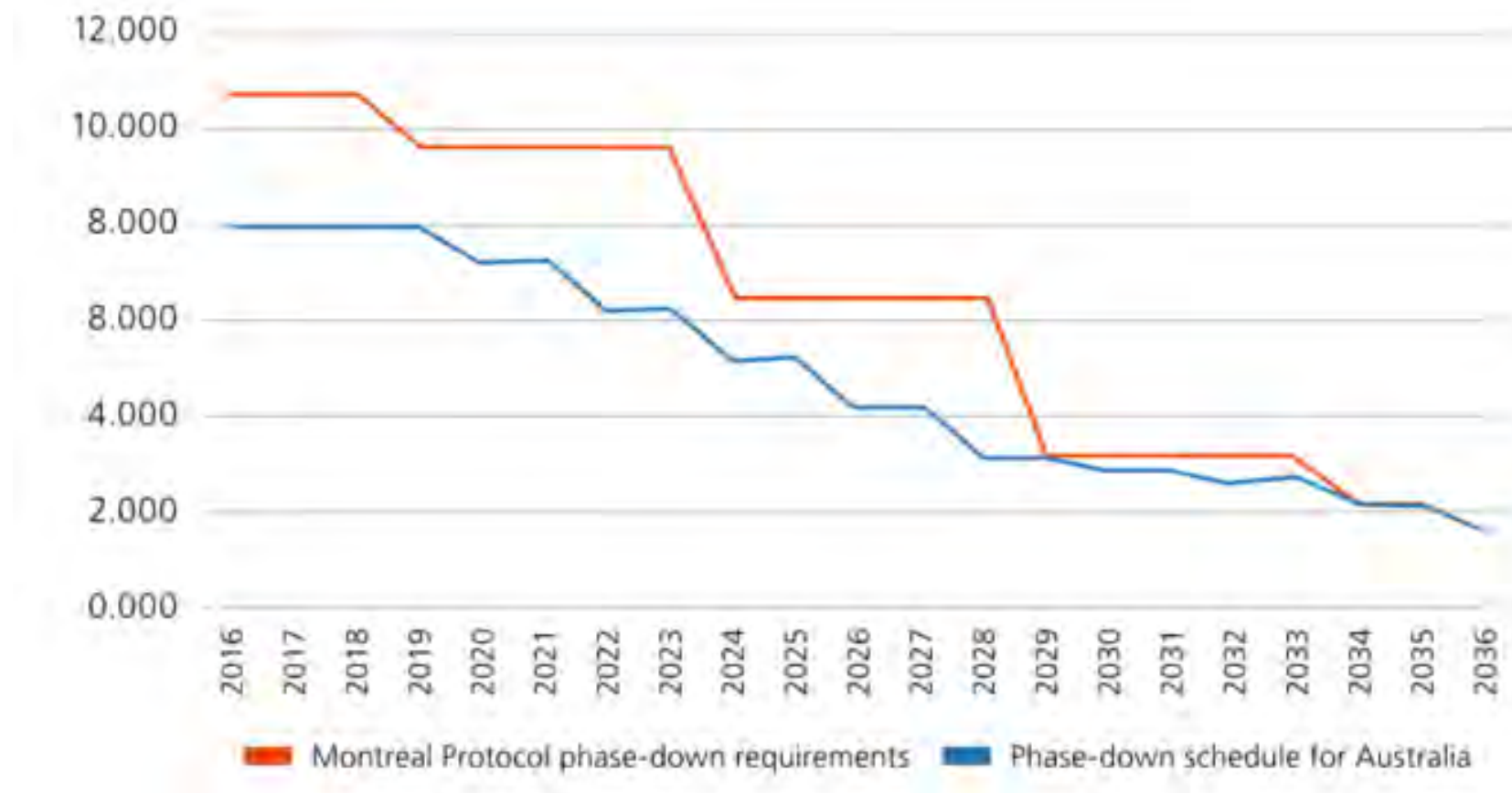
- The costs are summarised below. The values are based on numerous assumptions around load increase, mains lengths, metering arrangements, etc. All building connection costs should be calculated on a case by case basis once design details have been finalised.

Additional information: refrigerants

Emissions from refrigerants should be considered

- Electrically powered heat pumps can achieve net zero carbon through their electrical consumption. However heat pumps use refrigerants to transfer heat - gases which commonly have extremely high global warming potential (GWP).
- Therefore careful consideration of the model of heat pump should be made ensure they utilise low GWP alternatives increasingly available.
- When selecting a refrigerant, factors to consider include:
 - Global warming potential
 - Flammability
 - Toxicity

- On the issue of global warming, potential natural refrigerants such as CO2 offer safe and established technology at comparable efficiencies to systems operating on synthetic and high GWP refrigerants such as R134A.
- Class 1A refrigerants are non-flammable and non-toxic.
- Imports of HFCs over next 10 years will be scaled down significantly (see below). This will have the effect of increasing their price and ongoing operation costs of the equipment which rely on them. Coupled with a high GWP, heat pumps that utilise natural or low GWP refrigerants are highly recommended.



High GWP Refrigerant Phase Downs

Additional information: health and safety

There are health risks associated with un-flued or poorly ventilated areas

- Given Australians spend ~90% of their time indoors, which makes the protection of indoor air quality important⁴⁷.
- If gas heaters are un-flued (i.e. do not have a chimney or flue venting pollutants outside), air pollutants can be released inside, including:
 - Carbon monoxide (CO)
 - Nitrogen dioxide (NO₂)⁴⁸
 - Volatile organic compounds (VOCs)
 - Air toxics (e.g. formaldehyde)⁴⁷.
- CO and NO₂ are difficult to detect – both are invisible and tasteless, however NO₂ has a strong odour.
- Vulnerable people with respiratory and cardiovascular illness, pregnant women, children and the elderly are most at risk from adverse health effects.

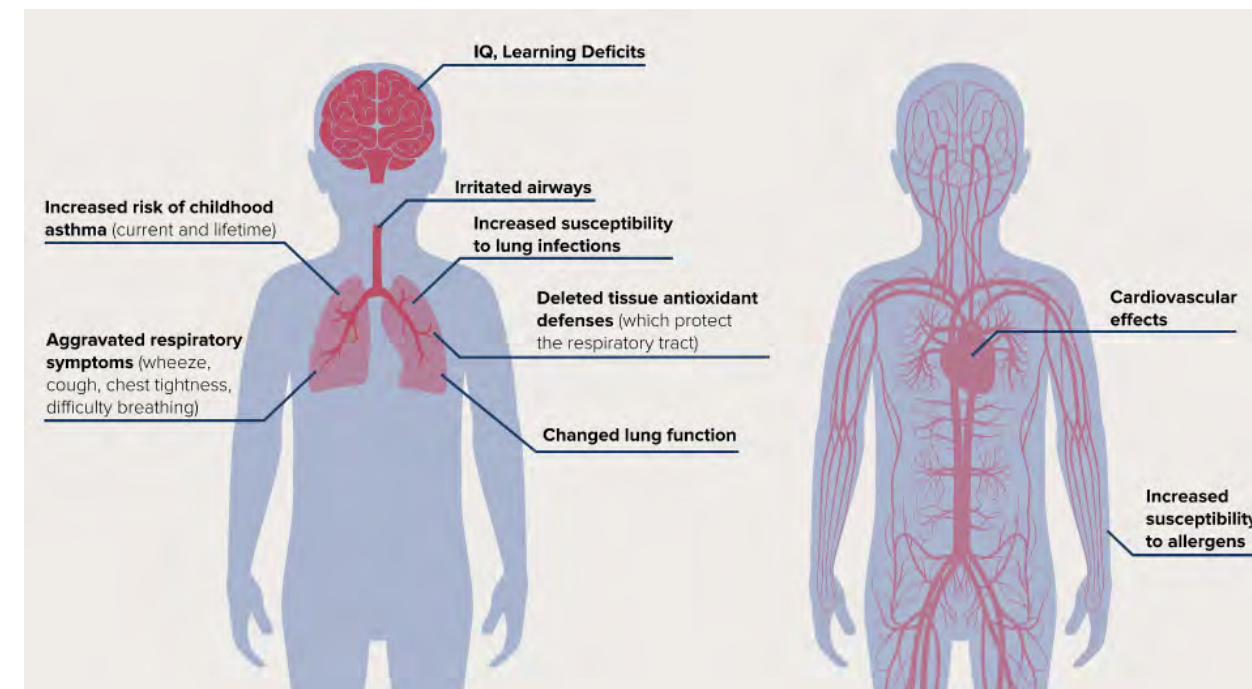
- If gas heater is poorly installed or in a room without ventilation, excessive CO levels may occur.
- There are documented health risks associated with gas cooktops in the home. A meta-analysis provided quantitative evidence that for children, gas cooking increases risk of asthma and indoor nitrogen dioxide increases the risk of current wheeze⁴⁹.
- A 2018 study by University of Queensland found that around 12 per cent of childhood asthma around the country can be contributed to gas cooking⁵⁰.
- Further impacts on children are shown in the figure below⁴⁸.
- CO is also released by gas appliances. Depending on level of exposure, health effects range from chest pain, headache and fatigue to unconsciousness and death⁴⁸.
- The ACT Government have noted recent studies about health impacts of gas in the homes, and that these are in relation to un-flued arrangements⁵¹.

- Some technologies are emerging that disable gas supply if rangehood is not on⁵¹.

LPG cylinders are likely to be used within the Centre

- The precinct may lead to increased use of LPG cylinders for BBQs or cooking. For commercial kitchens, ‘swap and go’ arrangements may require access for delivery trucks to the site.
- Access Canberra do see a high number of incidents with LPG cylinders and gas barbeques (5-6 per week). These tend to be due to residents and incorrect use.
- In-situ cylinders would need alternative arrangements with greater safety controls (under AS1596 Storage and Handling of LPG Cylinders) however, this sort of arrangement would not be aligned with the precinct’s approach to provide ‘transitional’ arrangements for gas only⁵¹.

Health impacts of NO₂ in children³



Additional information: costs and paybacks

Financial modelling demonstrates the benefits of switching to all-electric in the ACT

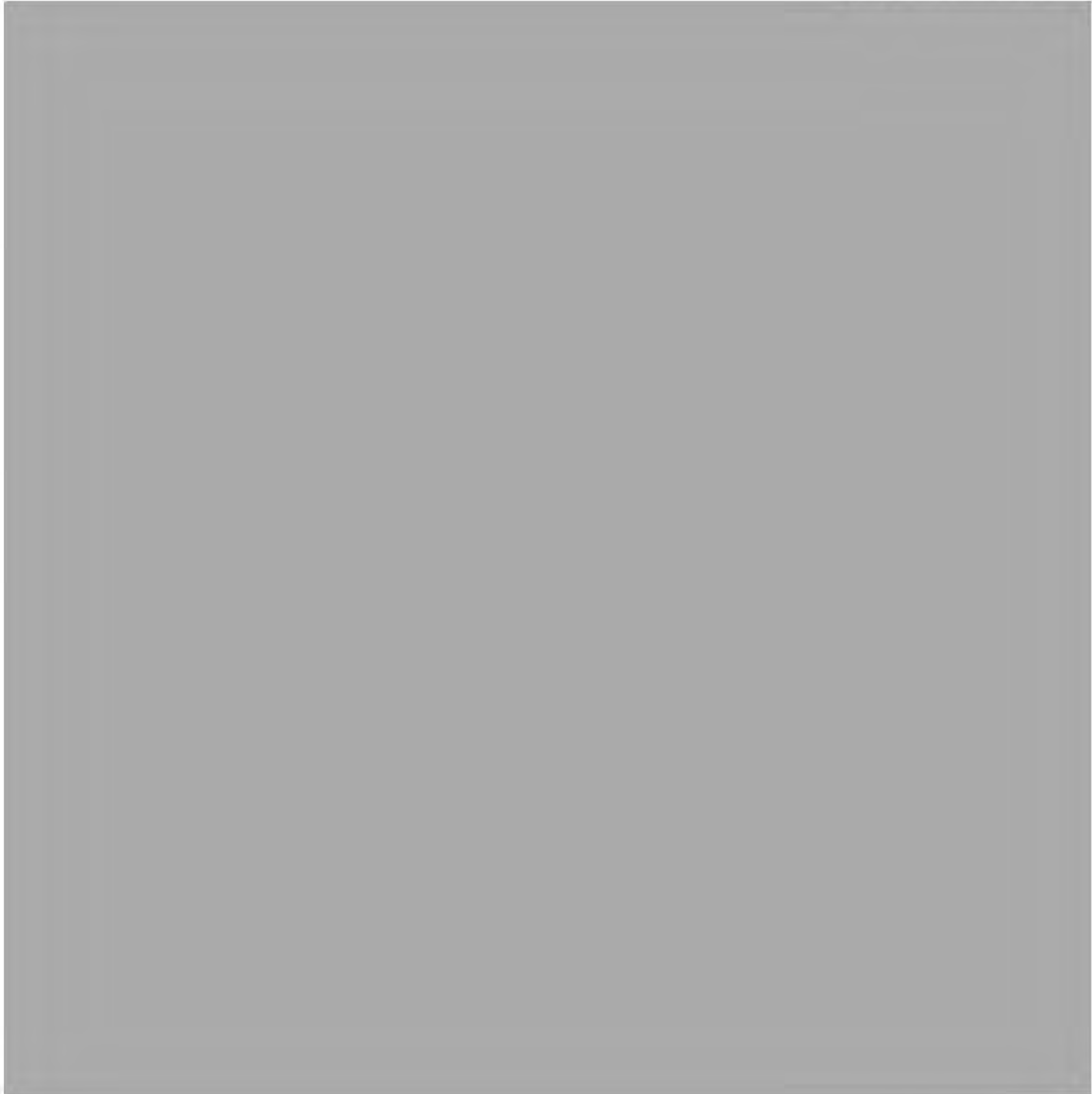
- ACIL Allen Consulting analysis (right) showed the significant savings different hypothetical households could make in Canberra by switching, and the further benefits of having solar PV to support this⁴². Note: this analysis does not consider changes in energy network tariffs.
- Appliances with cheaper upfront costs were found to make less financial sense of the long term due to reduced operational savings.

- This was especially true for space heaters as built-in electric heaters that use reverse cycle technology are more efficient but more expensive than portable alternatives. For cooktops, electric options had higher upfront and ongoing costs⁴².

For new builds, savings are greater

- For new builds, paybacks are more favourable due to the reduced need for retrofitting, gas disconnection fees or a connection fee to start with.
- This effect may, however, be reduced by increased electricity network requirements.
- Grattan analysis (below) showed that in Canberra, new all-electric houses would provide both capital and operational cost savings.⁵² For Ginninderry, they provided operational savings with a payback period of 3 years.

All-electric house	Dual-fuel house			Savings for all-electric house relative to dual-fuel house (\$)		
	Uses for gas	Heating choice	Cooling choice	Capital cost savings	Annual running cost savings	Savings over 10 years
Ducted RCAC	Cooking, hot water, space heating	Ducted gas	Ducted evaporative	2,350	802	9,787



Precinct scenarios

- Precinct scenarios
- Infrastructure implications
- Scenario benefits and disbenefits



Our scenarios

We have developed four scenarios that outline possible directions for the precinct. These scenarios have been developed with the following considerations in mind:

- What possible precinct-level arrangements or requirements might influence the energy infrastructure required for the precinct?
- Where might we be able to reduce or delay network upgrades required by Evoenergy or collaborate with them for mutual benefit?
- How might we reduce the peak energy demand for the precinct?

These scenarios provide the opportunity for a ‘thought experiment’ to inform future directions, but are not based upon engineering design or modelling work.

NOTE: The scenarios have not considered the potential for building thermal efficiencies or cool start taps which would reduce the thermal loads.

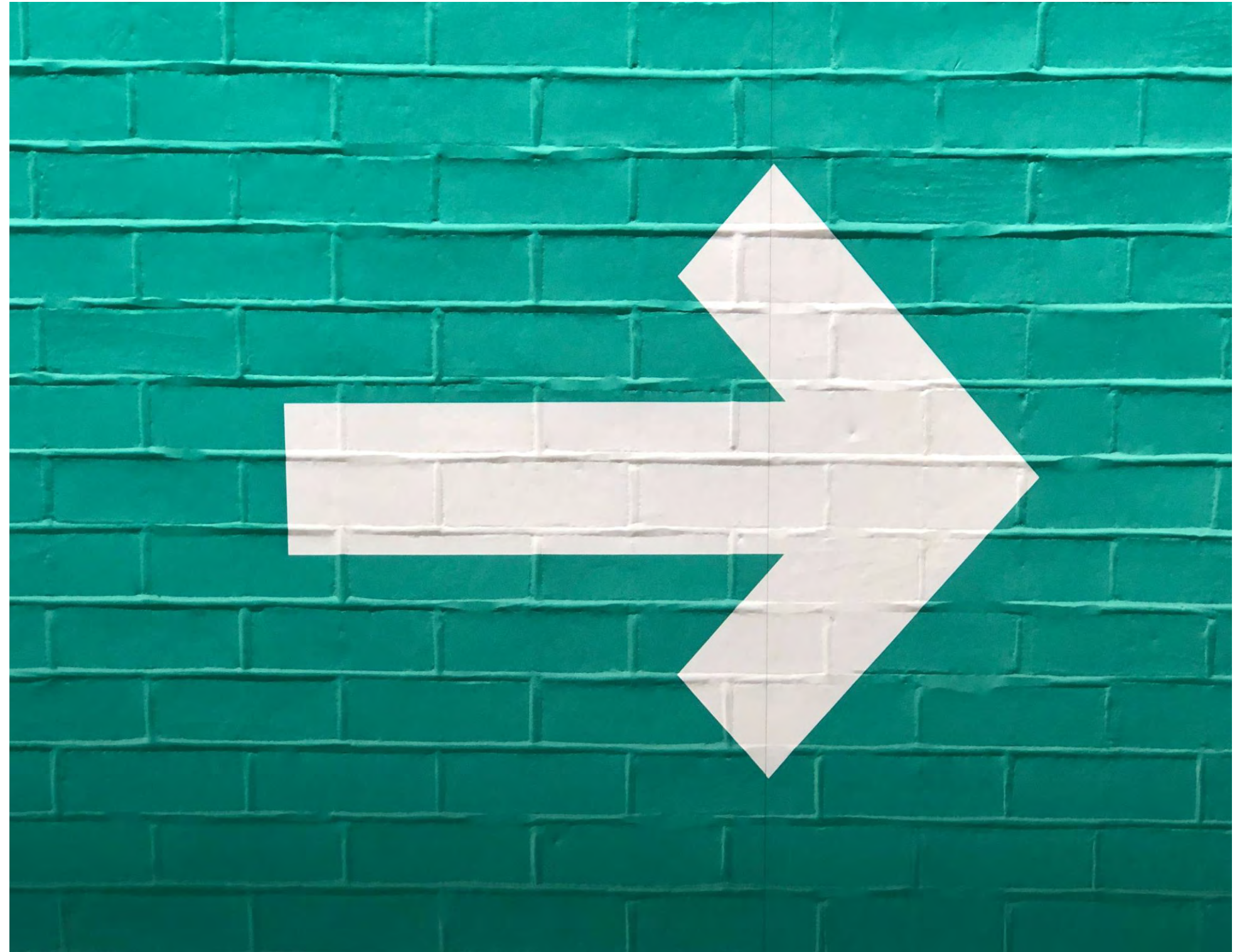


Image credit: Nick Fewings via Unsplash

1

Reference scenario

- Gas and electricity distribution networks in precinct and buildings.
- Meter reading and maintenance costs and liabilities for both networks.
- Some solar PV, demand management and batteries to match individual building needs.

2

'BAU' electric

- Scenario 1, except electricity distribution network only.
- Potentially higher capacity substation/s required to meet seasonal / peak demand profiles.

3

'Stretch' electric

- Scenario 2, with the introduction of a **simple energy framework for peak reduction** enabling widespread solar PV, battery and demand management uptake.

4

'Interconnected' electric

- Scenario 3, with the introduction of a **comprehensive energy framework for sharing energy and resources** enabling maximum adoption of solar PV to export from low density to higher density areas and more optimised use of distributed energy resources.

What could these frameworks look like?

The key variables for the scenarios are set out in the adjacent framework.

They include governance, technical or market variables that have implications on the precinct response and efficiencies.

The scenarios provided are framed with varying consideration against the framework.

Framework	What it means
Simple energy framework for peak reduction	<ul style="list-style-type: none"> • The simple energy framework could be a set of rules, requirements and features that enables, promotes and removes barriers to the: <ul style="list-style-type: none"> • Uptake of distributed energy resources such as batteries, vehicle to grid (V2G) infrastructure (or at least future-proofing) and solar panels • Reduction in overall energy consumption from grid through measures such as utilising energy efficient appliances, passive building design and introduction of solar panels • Reduction in peak energy demand such as through a centralised battery energy storage system • Demand management – responsive electricity consumption to reduce costs and strain on infrastructure, that is enabled and permitted to communicate with Evoenergy • Energy efficiency requirements for buildings beyond BAU
Comprehensive energy framework for sharing energy and resources	<ul style="list-style-type: none"> • The organised energy framework could build on the simple approach to include features that enable more interconnectivity within the precinct such as: <ul style="list-style-type: none"> • Movement/sharing of energy within the precinct • Extensive uptake of distributed energy resources • Uptake of centralised plant and equipment such as for heating and cooling • Ability for consumers to have increased exposure to the energy market • Maximised / oversized solar PV in low-density areas to export to high-density areas • The framework should be set up as an enabler for the best utilisation of current and future technologies and should not pigeon hole consumers into certain infrastructure requirements or remove competition • The framework could have optional participation for businesses and residents depending on the level of requirements • This framework could be set up or operated in different ways depending on the desired ownership models, precinct building typologies, expected demand profiles, infrastructure requirements and who would be captured by the framework. Examples include: <ul style="list-style-type: none"> • An embedded network owned and operated by a third party. They would own the energy infrastructure and act as the enabler for the above listed benefits* • Requirements for uptake of demand management technologies – such as home/business energy management systems that have a common interfacing requirement with the network (either Evoenergy or the embedded network operator) • Requirements for level of solar penetration in the precinct, to enable surplus generation in low density areas to be shared with higher density locations • A virtual power plant framework that enables businesses and residents the option for their distributed energy resources to interface with the network in a more collective manner • Options for businesses/residents to buy into centralised plant or distributed energy resources • <i>This is currently a regulation gap that the ACT Government should consider addressing</i>

What does this mean for....

...those who inhabit the spaces for living, working or playing

Scenario	Implications
1: Reference scenario	<ul style="list-style-type: none"> • BAU for most Canberran community members • Provides freedom of choice between gas and electrical appliances • Currently addresses one of the ACT's greatest contributors to greenhouse gas emissions, at least until the gas network is decarbonised (if this occurs) • A known entity and practice for users, tenants and other stakeholders • Overall expect costs and energy bills to be higher due to two separate infrastructure networks with increased: <ul style="list-style-type: none"> • use of materials and equipment • metering requirements • maintenance • space allocation/easements
2: 'BAU' electric	<ul style="list-style-type: none"> • Reduced costs of a gas network infrastructure and increased costs of energy network infrastructure. • Increased electricity infrastructure costs potentially resulting in higher electricity consumption charges • Reduced freedom of choice as limited to electric appliances and in some case more expensive • Less choice and flexibility for uptake of distributed energy resources compared to Scenario 3 and 4 due to no framework in place to provide a collective approach • Supports community greenhouse gas reduction commitments or aspirations, if held • Reduction in greenhouse gas emissions due to 100% renewable electricity grid in the ACT
3: 'Stretch' electric	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> • Reduced electricity supply charges compared to scenario 2 through the introduction of measures to reduce the peak demand resulting in a smaller increase in electrical supply and distribution capacity • Reduction in energy consumption and increased thermal comfort through measures to increase the uptake of solar, energy efficient appliances, demand management and passive building design • Futureproofed precinct that enables choice and flexibility for current and future distributed energy resource technologies. • Tenant may be required to meet connectivity, efficiency or infrastructure requirements outlined in the energy framework
4: 'Interconnected' electric	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> • Possible further reduced electricity supply charges through further reduction in peak demand • Options for tenants to get involved in the movement and sharing of electricity and energy – this could result in further reduced energy consumption from the grid and hence lower costs • Enhanced precinct resilience through connected assets • Tenant may be required to meet connectivity, efficiency or infrastructure requirements outlined in the energy framework

What does this mean for....

...those who own the spaces

Scenario	Implications
1: Reference scenario	<ul style="list-style-type: none"> • BAU for landlords • Provides freedom of choice between gas and electrical appliances • Those who are financially able to install and utilise solar PV and batteries have some advantage • Less choice and flexibility for uptake of distributed energy resources compared to Scenario 3 and 4 due to no framework in place to provide a collective approach • Does not support sustainability commitments or aspirations, if held • Could enable future potential Hydrogen distribution network (if modified)
2: 'BAU' electric	<ul style="list-style-type: none"> • Less choice and flexibility for uptake of distributed energy resources compared to Scenario 3 and 4 due to no framework in place to provide a collective approach • Increased electricity infrastructure costs potentially resulting in higher electricity consumption charges • Reduction in greenhouse gas emissions due to 100% renewable electricity grid in the ACT, at least until the gas network is decarbonised (if this occurs) • Decarbonises their investment, reducing risk of carbon price impacts • Those who are financially able to install and utilise solar PV and batteries have an even greater advantage • Eliminates possible future Hydrogen use • Reduced need to maintain gas equipment and appliances
3: 'Stretch' electric	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> • Futureproofed precinct that enables choice and flexibility for current and future distributed energy resource technologies. • Further supports energy reduction commitments or aspirations • Further supports renewable energy uptake and reduction of greenhouse gas emissions • Landlord may be required to meet connectivity, efficiency or infrastructure requirements outlined in the energy framework • Selling point to businesses and residents of connected precinct
4: 'Interconnected' electric	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> • Increased selling point to businesses and residents of connected precinct • Further supports energy reduction commitments or aspirations, if held • Further supports renewable energy uptake and reduction of greenhouse gas emissions • Landlord may be required to meet connectivity, efficiency or infrastructure requirements outlined in the energy framework

What does this mean for....

...those who construct the spaces

Scenario	Implications
1: Reference scenario	<ul style="list-style-type: none"> • BAU for landlords • Does not support sustainability commitments or aspirations, if held • Need to allow space for both underground gas and electrical assets
2: 'BAU' electric	<ul style="list-style-type: none"> • Supports greenhouse gas reduction commitments or aspirations • Less complex infrastructure as only need to allow for electricity • Risk associated with less experience in constructing all-electric • Increased electrical infrastructure costs - it is noted that electricity supply and distribution capacity would likely increase 40-60% from the reference scenario to meet peak heating demand in winter. This is assuming heating is provided through reverse cycle split systems or heat pumps⁶⁰
3: 'Stretch' electric	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> • Supports energy reduction commitments or aspirations • Supports green house gas reduction commitments or aspirations • Potentially more onerous and costly requirements during the design and construction phase • Contractor required to meet connectivity, efficiency or infrastructure requirements outlined in the energy framework • Potentially reduced electrical infrastructure costs compared to scenario 2 through peak demand reduction measures
4: 'Interconnected' electric	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> • Further supports energy reduction commitments or aspirations • It may be desirable to as part of this scenario to have private energy connections between developments within the precinct, however this is currently not allowed for within the Canberra planning system and would need to be raised with the EPSDD early






What does this mean for....

...Evoenergy

Scenario	Implications
1: Reference scenario	<ul style="list-style-type: none"> • BAU for overall network regarding capex / opex • Limited ability to reduce capex network costs and deferment of network augmentations • Would enable future use of Hydrogen • Creates risk of stranded assets if electrification occurs in the future • Reduced ability to demand manage compared to electric scenarios
2: 'BAU' electric	<ul style="list-style-type: none"> • No need to provide or maintain a gas network • Limited ability to reduce network costs • Limited ability to reduce capex network costs and deferment of network augmentations • Electricity network capex increase - it is noted that electricity supply and distribution capacity would likely increase 40-60% from the reference scenario to meet peak heating demand in winter. This is assuming heating is provided through reverse cycle split systems or heat pumps⁶⁰ • Could reduce the potential for a future retrofit of a gas network to distribute of Hydrogen or carbon neutral gas. • Lower ability to demand manage compared to scenario 3 and 4
3: 'Stretch' electric	<p>As for scenario 2, except:</p> <ul style="list-style-type: none"> • Could enable deferment of electricity network upgrade for the Molonglo Valley • Measured ability to reduce network costs • Enables increased demand management options • Provides a futureproofed network for uptake of current and future technologies • May require development of interface requirements for improved demand management and increased distributed energy resources uptake
4: 'Interconnected' electric	<p>As for scenario 3, except:</p> <ul style="list-style-type: none"> • Measured ability to reduce network costs • Further increased demand management options • Provides a futureproofed network for uptake of current and future technologies • Could provide increased precinct resilience from network outages

What does this mean for....

...SLA objectives

- Legend*
-  Possible worsening from BAU
 -  Similar to BAU
 -  Possible improvement from BAU
 -  Improvement from BAU
 -  Most improvement from BAU

Scenario	Affordable living	Safe and healthy population	Social inclusion	Housing choice	Environmental sustainability
1: Reference scenario	BAU	BAU	BAU	BAU	BAU
2: 'BAU' electric	<ul style="list-style-type: none"> Cost savings anticipated during operation Those who can afford and are able to have solar PV benefit more through operational savings, while those who cannot miss out However, upfront affordability will depend on government support provided 	<ul style="list-style-type: none"> Elimination of risk from un-flued gas Mitigation of climate change and pollution provides better air quality and other health benefits 	<ul style="list-style-type: none"> Those who can afford and are able to have solar PV benefit more through operational savings, while those who cannot miss out Some cultures may feel excluded if gas bottle arrangements for some restaurants are not permitted 	<ul style="list-style-type: none"> Removes possibility of gas-based appliances, including hydrogen in the future 	<ul style="list-style-type: none"> Reduced greenhouse gas emissions Reduced energy infrastructure and therefore embodied carbon
3: 'Stretch' electric	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> Cost savings anticipated during operation due to reduced peak energy use If a large solar/battery were community-owned, this could provide an income to the community Upfront affordability will depend on government support provided 	As for scenario two	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> Opens wider discourse with the community/residents focused broadly on energy behaviour 	As for scenario two	<p>As for scenario two, except:</p> <ul style="list-style-type: none"> Decreased energy use and delayed need for infrastructure upgrades
4: 'Interconnected' electric	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> Further cost savings anticipated during operation for all tenants due to optimisation of 	As for scenario three	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> If any solar PV/battery was community-owned or a virtual power plant was introduced, this could create a sense of social cohesion 	As for scenario three	<p>As for scenario three, except:</p> <ul style="list-style-type: none"> Further decreased energy use and delayed need for infrastructure upgrades

Green gas

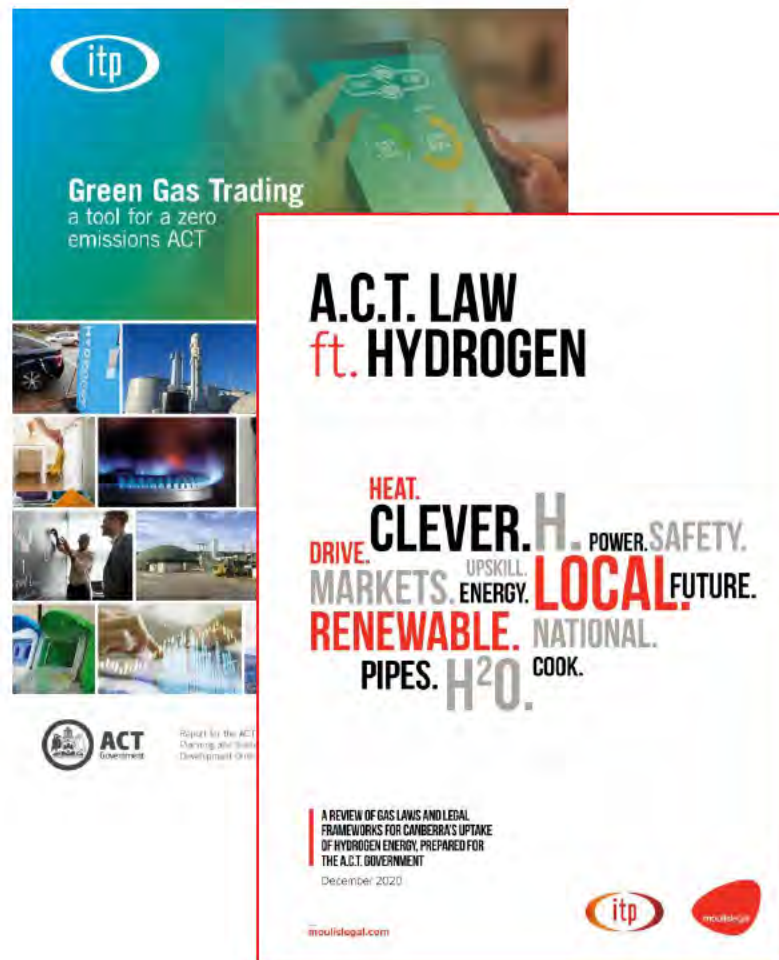
Green gas may have a future in our distribution network and change the BAU in the long-term

- The ACT Government, along with other governments nationally and internationally, is considering the feasibility of green gas – typically green hydrogen and biomethane – in the gas distribution network.

- Recent reports in the ACT (below left) highlighted that while no green gas strategy exists for the ACT:
 - Hydrogen does present an opportunity to decarbonise the network and transport⁵⁷, with up to 10% being able to be injected into the network with minimal modifications⁵⁷.
 - Biogas within the ACT from landfill gas, food and garden waste, and sewerage solids could meet 10% of the natural gas demand for the ACT. If garden waste currently composted contributed too, this could increase to 28%⁵⁷.
 - For 10% hydrogen in the network by composition, a 31 MW wind farm could provide electricity to produce sufficient green hydrogen. 100% substitution would require a 1 GW wind farm (around seven times larger than Capital Wind Farm adjacent to Lake George)⁵⁷.
- Overall, the adoption of green gas will depend on a combination of legislative, market and technology factors⁵⁸.
- The ACT will continue to explore this. The recent Parliamentary and Governing Agreement identified a commitment to consider injection of zero-emissions gas alternatives into the existing network⁵⁸.
- As part of any future work on hydrogen, safety and efficiency will need to be central considerations.

Green gas would alter the ‘BAU’ scenario

- While it is established that the Molonglo Commercial Centre will not have a gas distribution network, the use of green gas in the network would change the assessment in this Report, including by:
 - Reducing greenhouse gas emissions associated with scenario 1 and the ‘BAU’ technology options considered for the building typologies. This would likely be in a staged manner.
 - New appliances would become relevant, for example hydrogen-enabled cooktops for cooking. It is possible some residents and commercial kitchens would have a preference for these gas-based appliances.



Program and policy solutions

- Education
- Engagement
- Controls
- Incentives
- Energy modelling and planning
- Shared business models
- Energy efficiency



Gap analysis

In general, suitable technologies exist for all-electric developments

- Based on the assessment of technology options for all-electric buildings, it is evident there are suitable electric technologies for adoption within the Centre and that many of these technologies have several benefits.
- Areas where technologies do not perform as well as the BAU gas reference case include:
 - Upfront costs for reverse cycle systems, induction cooktops, air source heat pumps for domestic hot water, electric hot water boilers for space heating and electric storage for domestic hot water. This is balanced out by lower operational costs in some cases.
 - Cooking preferences where a commercial kitchen has a strong preference for at least some gas cooktops.

- Space and design requirements for reverse cycle systems and air source heat pumps for DHW.
- Potential refrigerant impacts.
- Potential acoustic issues of air source heat pumps or mechanical equipment not appropriately insulated from occupants.

Peak load on the electricity distribution network will be high

- Based on both interviews and the assessment, the peak load for the Centre, particularly in winter, is a concern.

The barriers identified highlighted the need to engage with stakeholders

- Based on the assessment of barriers, socio-cultural factors are critical in implementation of all-electric precincts.
- Lack of knowledge, experience or existing behaviours were amongst the socio-cultural barriers identified, and highlight the importance of engaging with stakeholders.

- Similarly, the perception that all-electric is not cost effective is able to be addressed through engagement with stakeholders as well.
- Some types of residents and businesses may require additional support and short-term financial incentives, including:
 - People who rent
 - Elderly residents
 - Low income households
 - Small businesses and retailers
 - Businesses currently reliant on gas for their core offering

Some businesses may not want to locate in the precinct, such as:

- Some restaurants who consider gas too central to their core offering – for example, those who use woks but do not want to use e-woks or Indian restaurants serving Chapati.
- Some businesses who rely on steam generation and are not willing to pay for or able to install equipment for high electric loads – for example, this was the case for a commercial laundry facility at Burwood Brickworks.

Various interventions exist to address these

The following pages detail possible interventions to address these gaps and barriers, covering:

- Education
- Engagement
- Controls
- Incentives
- Energy modelling and planning
- Shared business models
- Energy efficiency

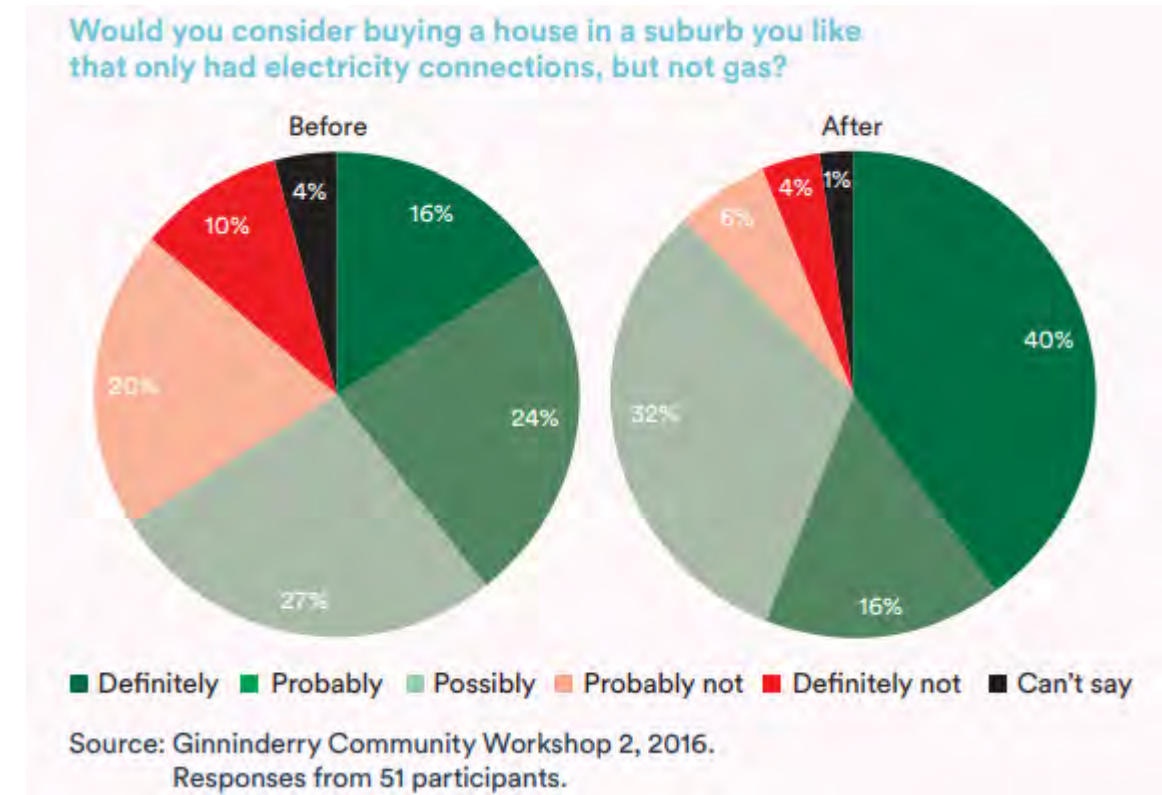
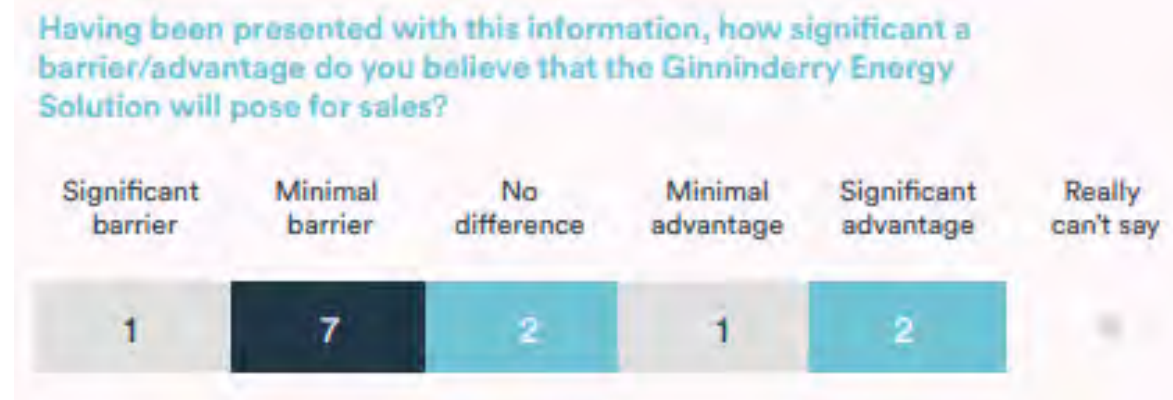
Education and engagement

Education will be key to informing potential residents and tenants

- A more effective transition in cooking technologies may be achieved if a learning/communicating/testing space is provided for households and commercial kitchens to negotiate existing values, while opening up possibilities for changing cooking practices⁴⁰.
- For commercial kitchens, a large induction cooktop could be made available for restaurants to test new menu options or techniques before signing tenancy agreements. This has been a successful approach for residents in Ginninderry, where the cooktop used is a small, residential scale cooktop.
- This could be supported by CIT’s new campus in Woden which will have commercial-scale induction cooktops for teaching purposes.

Workshops have been shown to be highly effective in Ginninderry research with ARENA

- The data on the right shows responses from Canberra builders before and after a workshop on electric suburbs.
- Of 13 builders, all but 1 either already recommended electric over gas solutions for heating, hot water and cooking, or would following the workshop.
- Following the workshop, the buildings also agreed it was:
 - “no or minimal extra hassle to offer house designs that would work in a suburb without gas mains”
 - and that they were:
 - “confident or slightly confident in selling benefits of all-electric homes”³³.



Education and engagement

Educational and awareness will be valuable for businesses

- Interviews highlighted the lack of awareness of electric options and the desire of small businesses to be informed of their options.
- Areas that information would be particularly useful for prospective tenants and business owners include:
 - Comparison of lifetime costs for technology options
 - Design Guidelines detailing design and installation requirements and options
 - Examples of prior use of electric technologies, particularly cooking technologies
 - Comparison of maintenance requirements
 - Fire, health and environmental risks of refrigerants.

Consultation with businesses should occur early and regularly

- This consultation should begin with prospective tenants and business owners with the retail leasing team during preliminary discussions.
- Smaller businesses in particular will require ongoing consultation.
- A point of contact (in some developments called an ‘eco-concierge’) is one way to provide ongoing support and information to businesses.

Education does not have to stop once decisions are made

- Simple data monitoring and visualisation could be implemented to communicate the benefits of technologies within the precinct. For example, meters on cooktops could provide users with information on energy use or emissions reduction over the appliance’s use.
- At a precinct level, this could be used to both inform and create a sense of social cohesion.

Education can also apply to industry

- The ACT's Climate Change Strategy includes a focus on creating a 'just transition'.
- The Spark program at Ginninderry is one example of an initiative that is enabling this within the sustainability transition, while also providing training and education experiences to disadvantaged Canberrans. The program targets a variety of vocations and involves a variety of partners including CIT who provides training opportunities.
- A similar program could be developed for the Molonglo Commercial Centre or across Canberra more broadly, that provides structured opportunities within the sustainable built environment.

Messaging is key and should go beyond 'green'

- There are many benefits to all-electric precincts, though people may be wary or not fully understand the term 'all-electric' or the benefits of all-electric technologies.
- For example, with induction cooktops, instead of being pitched as an electric technology, they can be described as 'zero-carbon ready, cleanable, modern, child-safe, ultra-rapid and high-spec induction stoves' - something that people could want due to many different motivations.

Controls and incentives

Controls can be introduced to restrict stakeholders

- Stakeholders will already be limited by the absent gas network connection, however further restrictions could be put in place.
 - Like for Ginninderry, this could include requirements for solar PV, batteries and demand management technologies that limit the peak energy demand for the area.
 - The ACT Government could consider restricting the use of gas cylinders on commercial sites. This could be considered on a case-by-base basis, for example by allowing restaurants who for whom gas is central to their core output to use a small portion of gas.
 - It is recommended that restrictions on refrigerants (to Class A only) are implemented as part of this.
- Greater energy efficiency in the buildings could also be mandated to reduce energy peaks and promote good design outcomes. This could be by:
 - Consideration of the building thermal efficiencies, water efficiencies both in the averages and the peaks will reduce the thermal load gaps from a demand side, offsetting the technology / costs of servicing with alternatives (see page 88 for more).
 - Considering building orientation and passive design features will also reduce loads (see page 89 for more).
 - Considering controls to encourage thermal storage to avoid emerging thermal electrical peaks (avoiding instant electrical).
- Incentives have been effective in residential developments to date*
- The Home Energy Rebate Program enables Whitlam residents to receive a rebate when they meet minimum requirements (electric heating and cooling, EV charging point, solar PV and more)⁵³. Residents in Whitlam have been concerned about losing gas for cooking, while other requirements were palatable.
 - Under an extended Energy Efficiency Improvement Scheme (EEIS), some households are eligible for a rebate of up to \$5,000 when replacing gas heating with efficient electric heating⁵⁴. Further options, including interest-free loans or other innovative financing, are also set to be trialled.
 - Ginninderry adopted a both controls and incentives, which was an effective approach. They provided a landscape package as an incentive to the community -an alternative could be to direct this towards energy efficiency measures that further reduce costs.
- Actsmart are a likely partner for the Centre in providing incentives. They work with small businesses (classified as having less than 20 staff or less than \$25,000 p.a. in electricity costs), to help transition from inefficient electric equipment to efficient electric equipment, and gas appliances to efficient electric systems by providing free energy audits and reporting highlighting upgrade opportunities and rebates up to \$5,000 on a 50/50 co-contribution basis⁹.
 - Actsmart are investigating the possibility of providing additional, or targeted rebates specifically for gas to electric transition projects, although this is in very early-stage discussions⁹. This could provide significant support to smaller businesses concerned about upfront costs in the Centre.

Energy modelling and planning

The ACT Government could de-risk the investment for developers and tenants by completing some preliminary modelling

- As part of development of a masterplan or concept for the Centre, energy modelling and development of an energy strategy for the precinct would help inform the approach to developers and other stakeholders.
 - This would require certain details of the Centre to be confirmed (or at least estimated) including approximate floor plans.
 - This could enable the estimation of costs and benefits, and would:
 - Attract large interstate developers from Canberra who have strong all-electric or net zero commitments
 - Inform smaller, local developers on the anticipated standard.
- This process could also reduce the perceived risk by developers by providing early engagement with Evoenergy, before developers are involved. Modelling would be required to inform when updates to the network could be delayed to by following a scenario 3 or 4 type approach. This could also inform what the likely purpose and benefit of a large battery, potentially community-owned, in the precinct would be.
 - An approach similar to Ginninderry where a 'working party' was formed with Evoenergy could be appropriate.
 - Heat mapping could be conducted to identify where there are opportunities to match heating and cooling within the precinct.
 - This strategy should also have a focus on business continuity and resilience, as these are key concerns for retailers.
- Energy planning should consider lifecycle costs*
- In developing an approach to energy in the precinct, affordability should be a key consideration.
 - There are several cost savings to be had during operations, however these often come with greater upfront costs.
 - Actsmart currently provide advice to customers to combine energy upgrades with installation of solar PV and batteries. This approach may result in attractive payback periods as solar and batteries compensate for the increased electricity consumption, may avoid changes to the customer's electricity tariff and manage the peak demand thereby avoiding higher peak demand charges⁹.
- This process could also inform which 'scenario' or elements of the scenarios are most beneficial for the Centre and what governance arrangements might be most appropriate, given the number of directions available.

Shared business models

Business models that align more closely with the circular economy framework may provide triple bottom line benefits in the Centre

- The circular economy framework aims to decouple resource consumption from growth and community value.
- Many of the business models compatible with the circular economy remove the requirements for ownership of products or assets, thereby reducing the need for large investments upfront, while also providing other environmental and economic benefits⁵⁵.
- Given the benefits of installing solar PV and batteries alongside all-electric buildings, but also the concerns over affordability of these, these 'circular business models' should be considered.
- An embedded network would be one way to work towards this, with leasing and community-owned resources as other options.

The Centre could facilitate leasing arrangements for roof space of for solar PV

- Through leasing, consumers commit to paying a certain amount of money for the use of the panels. Leasing solar PV systems is popular in some specific overseas markets, but not in Australia. This is largely due to differences in policy, and the relative attractiveness of purchasing rather than leasing.
- Leasing does, however, provide an opportunity to increase the utilisation of individual panels while making solar PV more accessible. Particularly among renters or low-income households, leasing has the potential to provide a flexible and efficient way to use renewable energy. Additionally, the manufacturer and owner of the panel will be incentivised to ensure a long lifespan and high-quality repairs and maintenance.
- In California, there was a rapid uptake in leasing arrangements in 2009 due to the decrease in incentives for upfront purchasing of panels which made leasing more attractive than purchasing.
- As outlined on page 36, this would be particularly attractive to households earning under \$60,000 p.a.
- Currently, apartment owners or other residents who do not control their roof find it difficult or impossible to place solar PV on their buildings. By enabling these groups to more readily negotiate for this, solar PV with high utilisation rates due to sharing between building users could be achieved.
- Power Purchase Agreements (PPA) offer an alternative to leasing, and ownership, whereby consumers commit to buy a certain number of kWh of energy from a provider.

Community-owned renewable energy could support the Centre's energy ambitions

- At a local level, more and more communities around Australia are developing, executing and benefiting from solar PV projects independently. community-owned renewable energy provides these communities with ownership over the resource, which increases the accessibility and affordability of solar PV, while also enabling individuals to collectively act against climate change.
- The ACT currently has the largest community-owned solar farm in Australia in the Majura Valley Community Solar Farm⁵⁶
- The Molonglo Valley community could be provided the opportunity to invest in a community-owned solar farm and potentially a large battery that supports the Centre to reduce its peak load or provides some other service to the network.

Energy efficiency & thermal networks

A thermal network could be considered, however energy efficiency would likely be a higher priority

- Given the gas network in the ACT serves predominantly a thermal need with around 77% used for space heating and 21% water heating, there may be value in considering transferring heat through a thermal network in the denser parts of the centre. This could assist in reducing the demand on the network and the peak loads. It typically targets hot water, as space heating is highly seasonal.
- This could benefit from the pairing of waste heat with heat demand. It could be an opportunity if a significant source of heat, such as a data centre, large scale solar thermal or a centralised water source heat pump was located in the precinct.

- However, challenges with these systems include costs, losses and operational burden, and the importance of density within the precinct. In some climates, pairing office and residential spaces is sufficient as office spaces require year-round cooling, though this is likely not applicable in Canberra.

Thermal energy efficiency should, therefore, be a high priority for the precinct

- Designing buildings and precincts passively can reduce heating and cooling loads, thus reducing energy consumption. This can have positive environmental and economic impacts.
- Building massing should be assessed as it alters facade solar loads and can influence the local microclimate.
- Building envelope performance, including thermal insulation and glazing performance, building sealing and ventilation strategies are also key. Some building technologies operate effectively only when the building is effectively sealed, for example.

- Passive design measures are likely to become more normalised over the coming years, regardless. As part of their net zero trajectory for 2028, the Australian Building Code Board is examining thermal efficiency standards for buildings in Australia. Their current approach considers a 7 star equivalent NatHERS performance for Canberra⁵⁹.
- The increasing stringency of building rating systems such as Green Star and NABERS also encourage energy efficiency through passive design measures.
- Well sealed buildings also enable effective operation of air to air heat recovery systems which can further reduce heating requirements by reducing waste heat.

Space, acoustics and safety should be considered alongside efficiency

- Outside of thermal energy efficiency, other design measures will improve the performance of all-electric equipment.

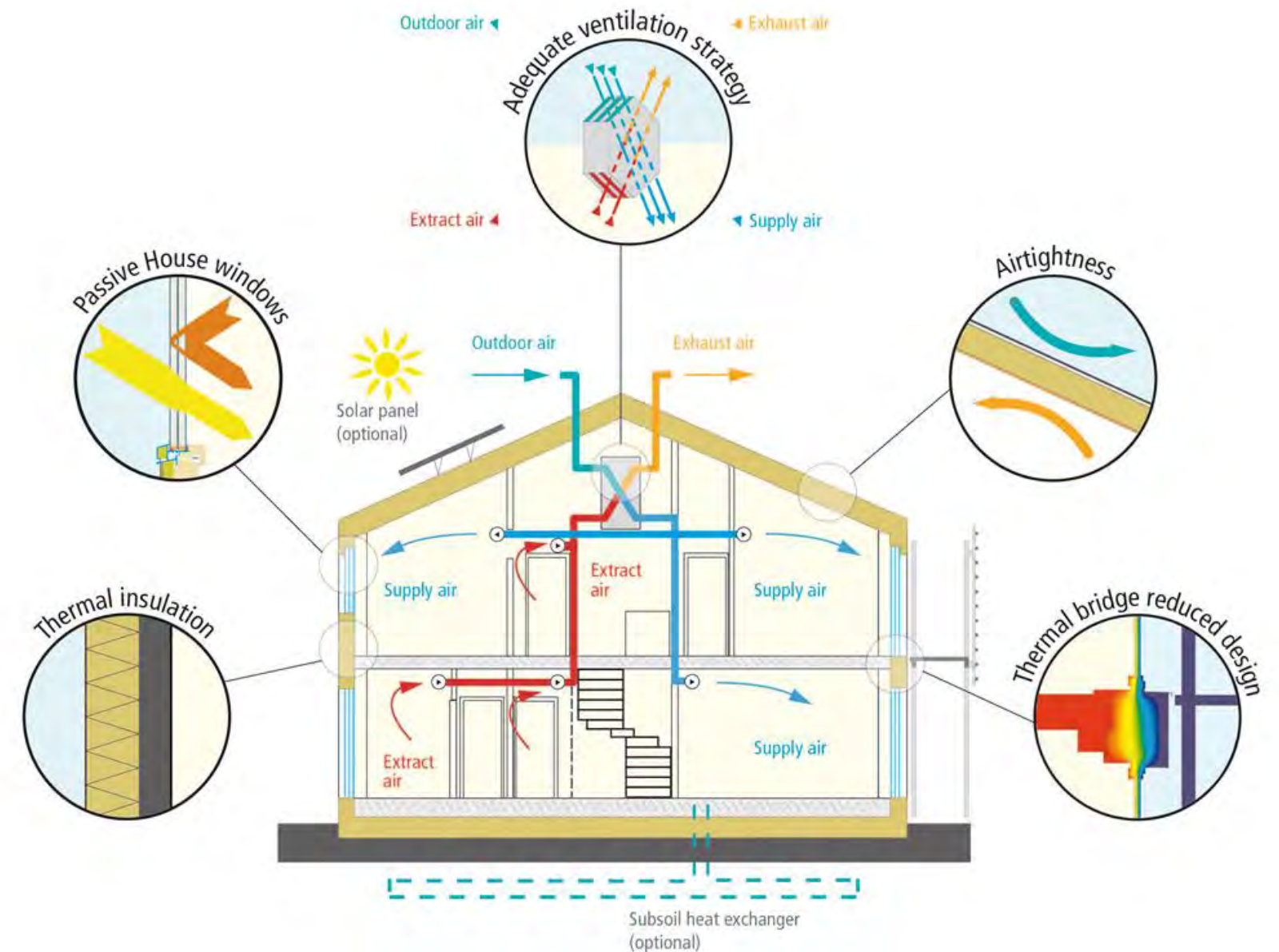
- Other possible design considerations include:
 - Allowing appropriate space and acoustic treatments for equipment.
 - Locating air source heat pumps in warmer locations to limit performance reduction in the Canberra climate.
 - Centralising equipment that uses refrigerants to minimise and centralise leaks and detection equipment.

Energy efficiency – Passive House

Passive House could be adopted as a Canberra trial, or at least inspire improved thermal performance

- Passive House is a sustainable building standard developed in Europe. There's been growing uptake in larger scale buildings as the standard becomes more popular in Australia and it is notably popular for detached housing.
- There are a number of large-scale projects currently certified in Australia, including a student residence with 150 single occupancy units and a 15,000m² learning building, both at Monash University.

- The standard focusses on a passive approach to improving the performance and thermal comfort of buildings, using an envelope first methodology. There are five defining principles of Passive House, including airtightness, ventilation with heat recovery, high performance windows, reduction of thermal bridges and high-performance insulation.
- Passive House could be tested on some priority buildings within the precinct, where space heating and wellbeing are priorities.



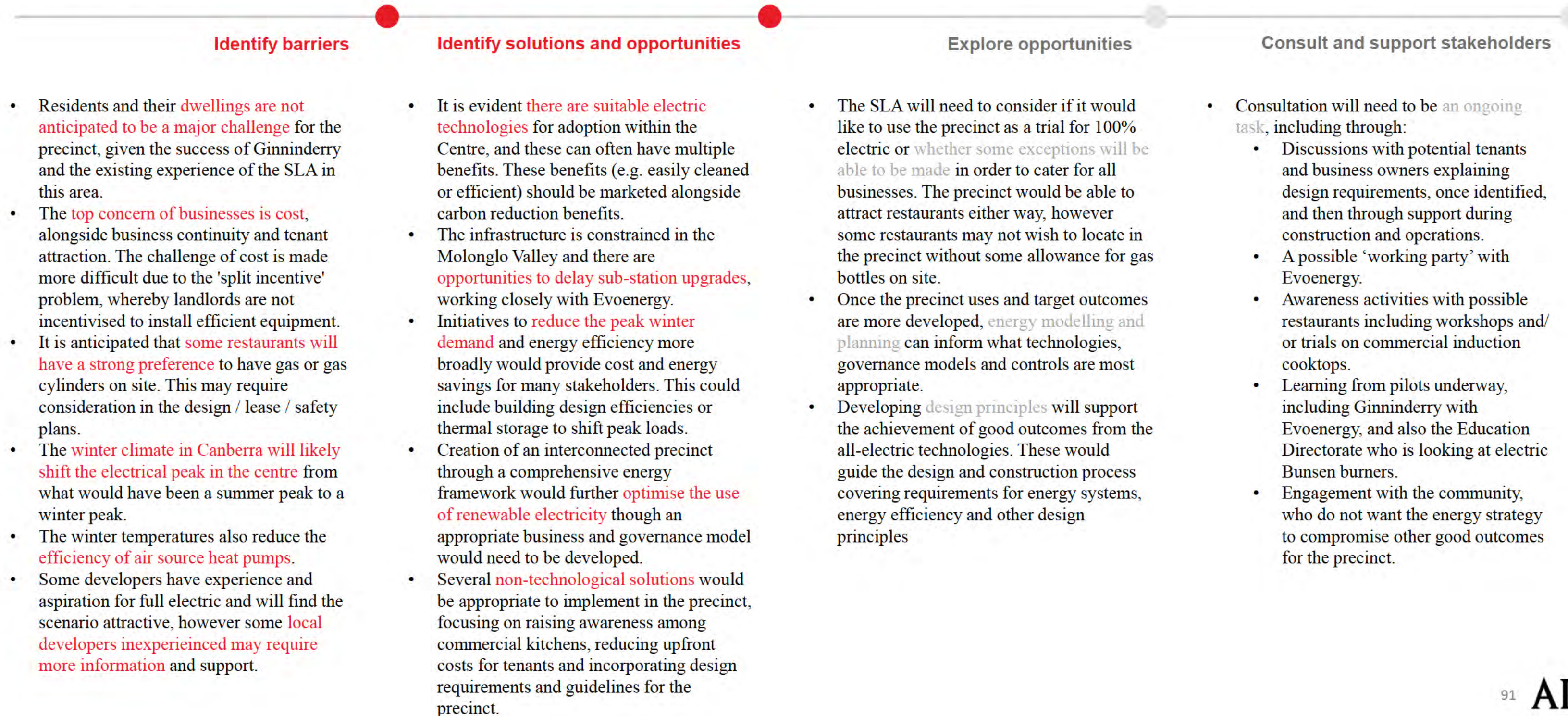
Conclusion

- Summary
- References



Conclusion

This Report has **identified barriers, solutions and opportunities** for the Molonglo Commercial Centre based on its gas-free mandate. Key findings are summarised below, alongside the recommended steps for the SLA to explore these opportunities, and consult and support stakeholders moving forward for the precinct.



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