A practical guide to electrification

For new buildings

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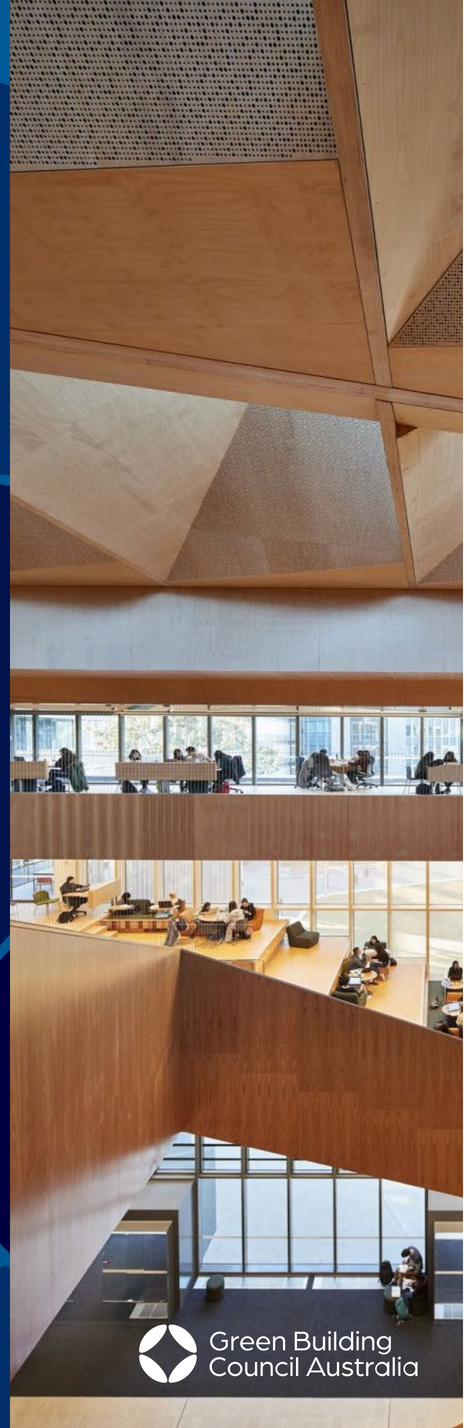
NSW GOVERNMENT

Building a sustainable future



Green Building Council Australia

Established in 2002, Green Building Council of Australia (GBCA) is the nation's authority on sustainable buildings, communities and cities. Our vision is for healthy, resilient and positive places for people. Our purpose is to lead the sustainable transformation of the built environment. GBCA represents more than 550 individual companies with a combined annual turnover of more than $46 billion.

Technical partner

Cundall is a global, independent, multi-disciplinary consultancy delivering sustainable engineering and design solutions across the built environment. We are proud of our contribution on many of Australia's leading green buildings and our engagement with industry to help drive sustainable outcomes Cundall is a founding signatory of the World Green Building Council's Net Zero Carbon Building Commitment, a Carbon Neutral certified business globally, and a One Planet endorsed company since 2012. In 2021 we launched Zero Carbon Design 2030 - an initiative to deliver zero carbon solutions on every project we do, with the end goal that after 2030 we will not work on any project that is not zero carbon.

Funding partners

The CEFC has a unique mission to accelerate investment in Australia's transition to net zero emissions. We invest to lead the market, operating with commercial rigour to address some of Australia's toughest emissions challenges. We're working with our co-investors across renewable energy generation and energy storage, as well as agriculture, infrastructure, property, transport and waste. Through the Advancing Hydrogen Fund, we're supporting the growth of a clean, innovative, safe and competitive hydrogen industry. And as Australia's largest dedicated cleantech investor, we continue to back cleantech entrepreneurs through the Clean Energy Innovation Fund. With $10 billion to invest on behalf of the Australian Government, we work to deliver a positive return for taxpayers across our portfolio.

The Department of Planning and Environment brings together specialists in urban and regional planning, natural resources, industry, environment, heritage, Aboriginal and social housing, and regional New South Wales.

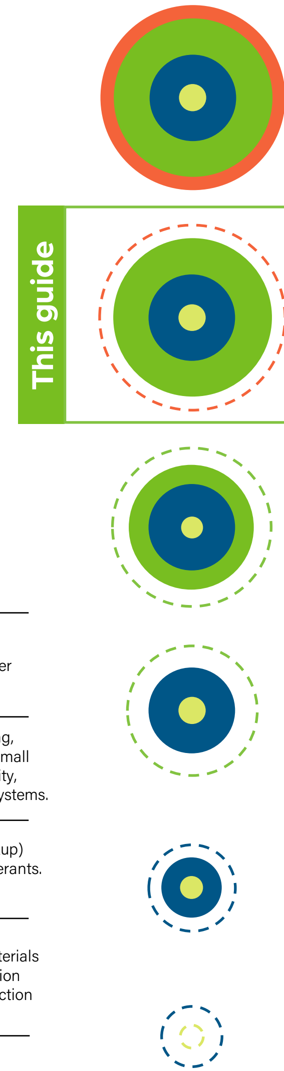

Image credit: Peter Clarke

How to use this guide

This guide outlines the steps involved in delivering an all-electric new building and the types of technologies that can be used today to replace natural gas systems with electric solutions. If you are a building owner, developer, facilities manager, consultant or building professional, this guide is for you.

Delivering Climate Positive Buildings

These are the steps needed to decarbonise buildings. This guide covers the first: how to eliminate fossil fuels for space heating, hot water, and cooking in new buildings. A second guide will be published focusing on existing buildings. We encourage you to apply all these steps in your project.



Standard building

Typical greenhouse gas (GHG) emissions due to energy use and construction.

Fossil fuel free

Eliminate natural gas for space heating, domestic hot water and cooking.

Highly efficient

Significantly reduce all building energy consumption through demand reduction, energy efficiency and effective controls.

Powered by renewables

Provide all electricity from 100% renewable sources – on-site and/or off-site.

Built with lower upfront carbon

Significantly reduce embodied carbon through design, construction activities and material/product selection.

Offset with nature

After reducing all GHG emissions as much as possible procure credible nature based offsets.

Legend

GHG EMISSIONS	USED FOR
Natural gas	Space heating, domestic hot water and cooking.
Electricity	Ventilation, cooling, lighting, pumps, small power, lifts, security, controls, and IT systems.
Other	Emergency (backup) power, and refrigerants.
Materials in construction	Emissions from products and materials used in construction and from construction activities.

A guide to electrification

Climate change, health and wellbeing, natural resource depletion, consumer preferences, investor demand - these are key issues that are impacting how we develop new buildings in our cities. A key challenge across all of them is how we move away from traditional solutions to deliver more sustainable and higher performing buildings.

If we are to reduce GHG emissions due to the operation of buildings and meet net zero carbon goals, new buildings must be fossil fuel free primarily by eliminating the use of natural gas.

An all-electric building comes with many benefits – from easy access to renewable energy, to healthy spaces for occupants. As we move into a decarbonised world, all-electric buildings are future-proofed from having to be refurbished to eliminate outdated technologies. They have less risk of becoming stranded assets.

In summary,

- Natural gas represents between 10% and 30% of building GHG emissions. The electricity grid is decarbonising rapidly, while the decarbonisation of the natural gas network is unlikely in the foreseeable future.
- Technologies are available to design out fossil fuels for all typical uses in a building today.
- Electrification makes sense from a cost perspective. It provides multiple benefits beyond just operational cost savings.
- Changes in Green Star and NABERS means that electrification is no longer a barrier to higher ratings.
- Corporate tenants and debt and equity investors are increasingly attracted to all-electric buildings powered by renewables.

All new buildings can be built to be all-electric today. The technologies and desire exist. There is no reason not to build them.

The most common uses of gas and fossil fuels in buildings that can be electrified are:

- Natural gas for space heating, domestic hot water and cooking
- Diesel for emergency and backup generators.

There are other sources of gas that are found in some buildings such as gas for high heat industrial processes, portable gas heaters in external spaces, gas for laboratory purposes or similar. While not the subject of the guide, building owners are encouraged to consider alternatives to natural gas where possible.

The case for electrification – the right solution today

Burning fossil fuels to generate heat, energy and to cook food has been the go-to solution since the industrial revolution. Natural gas boilers and cookers are the pinnacle of this technology in buildings and have previously offered lower carbon solutions than grid electricity generated using coal.

But we are seeing a revolution in clean energy to address the challenges of climate change, air quality and energy affordability. Electrifying buildings is an essential and relatively easy step to do this. The technologies already exist - the key challenges are changing perceptions and improving understanding of the benefits of electrification and how to implement it.

If a business case is required for an all-electric building, then the following factors can be considered:

- **Climate change**: all-electric buildings powered by renewables are the preferred pathway to decarbonise our built environment. Removing fossil fuels from buildings is necessary to reduce our climate change impacts. Electrification is also the best enabler to deliver buildings fully powered by renewables today.
- **Investor benefits: i**nvestors are looking for assets that are on a clear decarbonisation pathway. All-electric buildings that use renewable energy will be able to access sustainable finance.
- **Resilience and risk reduction**: as we move into a state of decarbonising the economy, there will be a need to retrofit assets and remove equipment using fossil fuels from service. An all-electric building is a step ahead, making it a more valuable and desirable asset, ready for the future.
- **Health and safety benefits**: using natural gas in buildings generates toxic air pollutants. Occupants are exposed to these pollutants. These impacts can increase asthma and exacerbate respiratory illnesses. All-electric services eliminate these pollutants, improving the health and wellbeing of building occupants.
- **Tenant and consumer preferences**: many organisations have clear aims to decarbonise and have public goals to do so before 2030. Natural gas and other fossil fuels are incompatible with these goals. An all-electric building will be more attractive to these organisations and consumers as well.

Each of these reasons is expanded in the next few pages, including valuable references that provide more information. Understanding the case for electrification will help create an accurate business case for an all-electric building.

The case for electrification – climate change

To minimise the risk of catastrophic climate change the average global temperature rise must be keep to below 1.5°C. According to the **Intergovernmental Panel for Climate Change (IPCC)**[1], the world has eight to ten years left before we cross this threshold unless we drastically reduce GHG emissions. If we don't, the effects of this warming will be dangerous, costly, and irreversible.

The built environment is a significant contributor to our national emissions. It accounts for almost a quarter of total emissions in Australia. Of these emissions, natural gas use in buildings accounts for 10% to 30% [2] of all operational emissions. Eliminating these emissions matters.

It is not only the amount of emissions that matter – there is a time impact as well. Emissions from the use of natural gas, or methane, include both the direct emissions from combustion in a building (Scope 1) and the emissions from its extraction, processing, and distribution (Scope 3). The Scope 3 emissions due to methane escaping the atmosphere are three times more impactful over a 20-year span than the CO_2 produced[a] when combusted.

The IPCC noted in its latest report[1] that methane emissions should be reduced at a much faster rate than previously assumed. This formed the basis of the Global Methane Pledge[3] at COP26 in Glasgow.

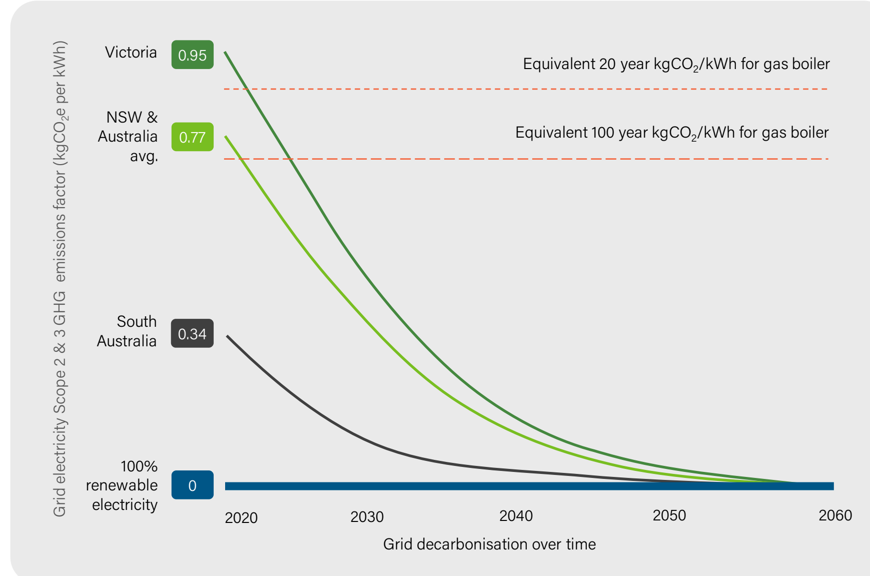
In buildings this means eliminating natural gas. Of the available alternatives to natural gas, including hydrogen biofuels, electrification is supported as the preferred path for buildings by the IPCC and the **International Energy Agency (IEA)**[4]. The Australian Government's Net Zero Strategy 'Australia's Long Term Emissions Reduction Plan'[5] also highlights electrification as a key technology available now for decarbonisation. NABES benchmarks will be regularly updated to use the latest electricity grid emission factors. As the grid decarbonises this will favour electrification as a means of improving ratings.

It is clear, electrification is a critical pathway on the decarbonisation journey to net zero buildings and precincts.

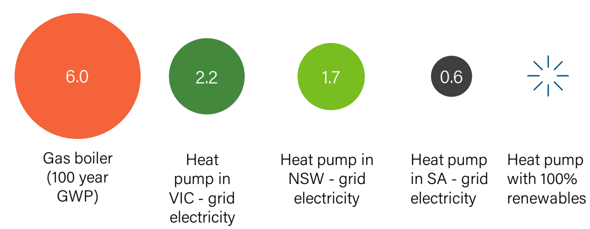
Other technologies and zero carbon fuels have a part to play in decarbonising our economy, but they are likely better used in other sectors such as transport and manufacturing processes.

The chart to the right shows the point at which the use of gas boilers becomes more carbon intensive than producing the same amount of heat using an average electric heat pump[b] when considering the projected rate of grid decarbonisation[6].

[a] As noted by the US EPA, when the Global Warming Potential (GWP) of methane is measured over 20 years (GWP20), the impact of methane is 84-87 times that of CO_2. If measured over 100 years (GWP100), the impact is 21 times that of CO_2. This is due to methane being shorter lived in the atmosphere before breaking down into CO_2 and water. This CO_2 continues to warm the atmosphere.



The bubbles below show the cumulative GHG emissions generated for an average heat pump and gas boiler in different states[c] over 25 years based on producing 1MWh of heat per year.



[b] Assuming a heat pump with an average coefficient of performance of 3 and a gas boiler with 90% efficiency.

[c] different states have different grid coefficients. In Australia, Victoria has the most emission intensive grid, with South Australia one of the cleanest.

What these charts outline is that any building being designed today that uses gas can emit far more than any well designed all-electric building even if this building did not procure renewables. When paired with on-site or off-site renewables, the GHG savings are even greater.

The case for electrification – investor benefits

Green, social, and sustainable bonds, green and sustainability-linked loans, and sustainability-linked bonds, resulted in global sustainable debt capital surpassing US$700 billion in 2021[7], a 30% increase compared to 2019.

Organisations such as the Clean Energy Finance Corporation (CEFC) and Climate Bonds Initiative are helping unlock investment capital to deliver enhanced sustainability performance.

With access to $10 billion to invest on behalf of the Australian Government, the CEFC invests to address some of Australia's toughest emissions challenges. Its property-related investment commitments include 'demonstration' projects with the ability to deliver best-in-class emissions performance through the use of renewable energy, energy efficiency and low emissions technologies - across new and existing commercial, industrial and residential buildings. A new CEFC program is seeking to substantially cut construction-related embodied carbon emissions, through the use of mass engineered timber as a greener alternative to conventional construction materials.

The Climate Bonds Initiative is an international organisation that works to mobilise the $100 trillion bond market for climate solutions. Several green bonds issued in Australia and New Zealand are financing low carbon commercial buildings. Recently, the Initiative recognised[8] Green Star's Climate Positive Pathway as an automatic compliance route due to its electrification requirements and energy reduction targets.

Sustainability linked loans are finance instruments in which the terms of the loan (like the interest rate) are linked to the borrower's environmental, social, and governance (ESG) performance. By late 2020 their global volume reached US$120 billion for the year[7]. An Australian example, Charter Hall, entered[9] into a $500 million loan with targets aligned to NABERS and Green Star.

Recently, the EU Taxonomy[10] for sustainable activities outlined how finance streams should be directed to deliver a decarbonised economy. While the guidance on the use of natural gas is limited, it is clear that all-electric buildings that are highly energy efficient comply with its requirements. This will help direct even more investor interest to these assets.

The case for electrification – resilience and risk reduction

Buildings that are not resilient to climate change or responding to changing regulatory and economic environments may end up as stranded assets[11]. At the very least, they may be uncompetitive in a sector that is rapidly responding to the climate change challenge.

The coming desirability for all-electric buildings is predictable. Over the past several decades policies have been introduced that resulted in buildings becoming more efficient. The Australian Government's own 'Long Term Emissions Reduction Plan' is already highlighting electrification as a desirable outcome. Policies to achieve this aren't far behind.

In 2017, the Taskforce for Climate Related Financial Disclosures recommended[12] that Boards of Directors review and analyse the potential for both physical risk and transition risk. Amongst the many recommendations was the consideration of an asset becoming a stranded asset due to its use of fossil fuels, its increased costs due to the use of costlier fuel sources and changing consumer habits and preferences for zero carbon.

Business leaders also have a financial responsibility to deliver assets that are affordable and represent value for money over the long-term. This includes being future-proofed for a changing climate and the potential future costs associated with carbon emissions. In 2020, 72% said they conduct a structured and formal review of environmental, social and governance (ESG) disclosures (up from 32% in 2018) while a further 25% evaluate non-financial disclosure informally[13].

Managing for the volatility of gas prices makes sense. Over the period of 2010 to 2021, wholesale and retail gas prices have risen significantly over the last 20 years[14]. Natural gas prices in Australia are linked to global prices. These are subject to major shocks, including geopolitical upheaval associated with the major gas producers such as Russia. Decoupling the operating costs of buildings from global politics is a key benefit of all-electric buildings.

Finally, there is the question of future-proofing assets. Installing natural gas system and infrastructure in new buildings will unquestionably result in needing to upgrade the building well ahead of its end-of-life. A typical gas boiler should last between 15 to 20 years without replacement. This means a building finished in 2025 would still have a working natural gas boiler in 2045. This is not consistent with a zero carbon future and it may be valued accordingly by the market.

The case for electrification – health and safety benefits

While natural gas is cleaner burning than other fossil fuels, it still produces a range of harmful pollutants including nitrogen dioxide, carbon monoxide and fine, toxic particulate matter.

While extraction and production are closely regulated, spills, and leaks of dangerous chemicals can occur and these can have significant impacts on human health[15]. Air pollution from gas processing, venting, and flaring can also impact air quality and nearby communities[16].

While those impacts seem far away, using natural gas in buildings can directly impact the health and well being of occupants and users[17]:

- When gas cooktops are used, pollutants are introduced into the kitchen. Good ventilation and modern exhaust fans can reduce harmful indoor air pollution but can't eliminate it.
- Kitchens with gas cookers are also hotter to be in, as the heat from gas combustion heats the kitchen as well as the pans. This results in a less thermally comfortable environment to be in.
- Recent research[18] has found that the effect of gas cooktops in homes on childhood asthma is comparable to the impact of passive smoking in the household.

Space and water heating with gas produces the similar pollutants. These have less impact within buildings as they are mostly (but not always) vented directly outside. While this mitigates the risk of these pollutants in an indoor environment, the building still contributes to the air pollution of our cities. Air pollution is an ongoing concern and thought to contribute to the deaths of almost 5000 Australians each year[19]. As the transport sector – a key contributor to urban air pollution – electrifies, emissions from gas powered buildings will play a proportionally larger role.

> "From a health perspective, as a doctor and mother, there's a double impact from gas. Not only is it a major source of health pollution in people's homes, but it's also a fossil fuel.

Dr. Kate Charlesworth, "Cooking with gas? Research finds health and emissions risks even when stoves are off", ABC news, 27 Jan 2022

The case for electrification – tenant and consumer preferences

Many organisations and governments have made clear public commitments to GHG emissions reduction targets. Demonstrating a commitment to keep global warming below 1.5ºC, and executing on it, is now a competitive advantage.

The World Green Building Council's (WorldGBC) Net Zero Carbon Buildings Commitment (NZCBC)[20] aims to create a market for net zero carbon buildings by 2030. As of September 2021, more than 30 organisations and governments from Australia have signed up.

The Science Based Targets Initiative[21] and RE100[22] (which requires the use of 100% renewable energy by 2030) have hundreds of global companies signed up to their programs.

A 6 Star Green Star Building[23] rating requires fossil fuels to be eliminated and all electricity from 100% renewables. This requirement cascades down to 5 star ratings in 2024 and 4 star ratings in 2027. Green Star is used by many ASX companies to identify green buildings to lease or occupy.

Influential commercial chefs are waking up to the opportunity and praising the benefits of induction equipment in their restaurants. The benefits are many, from cleaner, safer kitchens, to more comfortable environments to cook in. It turns out if you can't stand the heat in the kitchen, the best thing to do is to remove gas from it.

Consumers also want better options. ASBEC's Roadmap for Sustainable Homes[24] notes that consumers are looking for green and healthy homes and apartments. Health is a major concern, and as awareness grows on the link between poor health outcomes and cooking with gas, this impact and interest in all-electric homes will grow. Consumers are also becoming more safety-minded, with many noting gas stoves remain hot for some time after turning off and pose a fire risk.

Consumer preferences will change as environmental and health campaigns scale up. Already home renovation shows on TV are praising the benefits of induction, and an upcoming global campaign promoting its health benefits will likely change minds further.

Case study: PHIVE, 5 Parramatta Square

Location
Parramatta, NSW

Sector
Public & Community Building

Developer
City of Parramatta Council

Key electric features

Domestic Hot water

Space heating

Set to be the jewel in the crown of a transformed Parramatta Square, 5 Parramatta Square will become the permanent home of an enhanced City of Parramatta Library, as well as a place for delivering world-class community and cultural experiences.

Lead contractors, Built, won the project with a plan to make the building 100% electric. Full electrification was not part of the original reference design for the building but was a perfect fit for the City of Parramatta's net zero goals. The removal of natural gas as an energy source along with a renewable electricity power purchase agreement will make the operational energy of 5 Parramatta Square net zero carbon from day one.

As part of their winning tender, Built redesigned the reference building to optimise opportunities for energy savings and remove the need for gas. Features include:

- A variable refrigerant flow system and rooftop condensers instead of gas boilers and chillers. This removes the need for gas and cooling towers. No cooling towers also means that potable water consumption is reduced by 70%.
- A mixed mode ventilation system which uses a combination of natural ventilation from operable windows and mechanical heating and cooling. An energy recovery ventilation heat exchanger will pre-heat or pre-cool air coming in and out of the building. These reduce the building's HVAC energy by 35%.
- The building management system is linked to the Bureau of Meteorology and two local weather sensors to ensure optimal operation of the mixed mode ventilation system and the energy recovery ventilation system.
- An electric domestic hot water system and thermal storage will provide the hot water needed for the building's end of trip facilities and kitchenettes.
- To reduce the energy demand for domestic hot water, a hot water ring main delivery system was not included in Built's design. This means water will not be continuously heated and pumped around the building. Instead, local electric units generate hot water to taps that are rarely turned to hot.
- A 13-kW photo voltaic system.
- 5 Parramatta Square is targeting a 6 Star Green Star – Design & As Built certification and is due for completion by Easter 2022.

CASE STUDY

> For 5 Parramatta Square, we saw opportunities to optimise the building's design to include natural ventilation, reduce energy demand and remove the need for gas completely.
>
> JOE KARTEN | Head of Sustainability and Social Impact, Built

Case study: Nightingale 1

Location
Melbourne, Vic

Sector
Multi-unit residential

Developer
Nightingale and Breathe Architecture

Key electric features

Domestic Hot water

Space heating

Cooking

Encouraging people to make the switch to electric takes a shift in mindset – which is why Nightingale Housing hosts "induction inductions" to help homeowners understand the benefits of cooking without gas.

Designed by Breathe in active collaboration with its future residents, Nightingale 1 is carbon neutral in operation and fossil fuel free – which means no gas.

The 20-apartment building, which opened in 2017, boasts an 8.2 Star NatHERS average rating, which is around 200% higher than compliance under the National Construction Code.

The first step towards a 100% electric building is to reduce energy demand through good design. Nightingale 1's design – with high thermal insulation, a tight thermal envelope, passive ventilation and solar shading – eliminates the need for air-conditioning. Space heating is provided by heat pumps connected to hydronic heating.

The next step to electrification is to secure an affordable supply of renewable energy. The building's roof has an 18kW solar array, and the body corporate's embedded network supplies residents with 100% certified green power at wholesale rates. Nightingale 1 residents pay less for green power than most people pay for stranded (black) electricity.

Bonnie Herring, Breathe's Director of Architecture and Sustainability Lead, says Nightingale 1 was developed with "no gas, no question". Hydronic heating provides a "much more pleasant, radiant heat" than reverse cycle air-conditioning while induction cooktops are a "super-efficient technology".

Bonnie says the induction inductions, undertaken with the help of home appliances manufacturer Fisher & Paykel, help to "end the romance with gas".

"The inductions are a fun way to get residents excited about their cooktop and to help them understand how to manage the easy-to-control heat." A professional chef is invited into the resident host's home to share the secrets to induction, with neighbours also gathered to watch the demonstration and feast on the results.

Induction cooking is faster and up to 95% more efficient than gas, where as much as two-thirds of the energy is lost in heating the kitchen. "Induction cooktops are also up to 40% more efficient than ceramic cooktops as they only heat the pan and not the surrounding air or the cooktop's surface," Bonnie says.

Image credit: Kate Longley, Breathe Architecture

> People can sometimes take an all-electric building for granted. The induction inductions are community-building events that help residents understand the value of going all-electric.
>
> BONNIE HERRING | Director of Architecture and Sustainability Lead, Breathe Architecture

Image credit: Peter Clarke

Case study: Gillies Hall

Location
Mornington Peninsula, Vic

Sector
Student accommodation

Developer
Monash University

Key electric features

Domestic Hot water

Space heating

Cooking

The property team at Monash University knew that a high-performance fabric for Gillies Hall, an accommodation facility at the university's Morning Peninsula campus, would reduce the building's heating and cooling energy requirements, removing the need for gas.

Concept designs noted that using gas could make the building cheaper to build, but Monash University was firmly committed to an all-electric facility. The alignment with their net zero carbon commitment and the need to demonstrate the elimination of fossil fuels in multi-residential buildings was too important to ignore.

Ultimately, the fabric-first approach, a high-performance façade and an ERV heat exchanger which does a small amount of pre-cooling or pre-heating of air entering the building, have made this a very comfortable place to live, study and socialise.

Gillies Hall, completed in 2019, is the third of five all-electric buildings that Monash University has developed. "We are learning more with each project and the market is moving, too," says Dr Rob Brimblecombe, Manager, Engineering & Sustainability at Monash. "We still needed to convince a few people that all-electric was the way to go, and some of the equipment had to be sourced from overseas, but the barriers were smaller and fewer than our first electric project. For our most recent all-electric project, the Woodside Building for Technology and Design, it's exciting that we were able to source most of the equipment in Australia and all of the consultants and project stakeholders were on board with electrification from the start."

Case study: ACT Government Office

Location
Canberra, ACT

Sector
Commercial office

Developer
DOMA Group

Key electric features

Domestic Hot water

Space heating

Cooking

When the Doma Group won a design competition to build the new ACT Government Office Building in Canberra, full electrification was not part of the specification. But, when asked by the tenant if it was possible, they took on the challenge and delivered an all-electric building with a 5 Star NABERS rating.

The cold, Canberra winter mornings, and hot summer days posed a real challenge. However, Doma embraced the opportunity and worked closely with consultants to understand and overcome the challenges and manage the risks.

"There were 12 iterations of the design," says David Jameson, Senior Development Manager at Doma Group. "The changes we needed to make to the physical footprint of the plant room were significant. We also needed our tenant for the café on the ground floor to get on board with an electric kitchen."

The solution ended up being a combination of electric water-cooled and air-cooled heat pump chillers. The optimised chiller plant arrangement became a real asset, with their capacity to shift and provide both cooling and heating, deal with part load operation while managing peaks in summer and winter.

The building was completed in 2020 and energy performance is better than expected, though COVID-19 restrictions in the ACT have meant that there has not yet been the consistent occupancy needed to finalise a NABERS rating.

Case study: Burwood Brickworks

Location
Burwood, Vic

Sector
Retail centre

Developer
Frasers Property

Key electric features

Domestic Hot water

Space heating

Cooking

Electric vehicles

Frasers Property Australia set its sights high when developing Burwood Brickworks, a shopping centre in the 6 Star Green Star – Communities certified Burwood Brickworks precinct. The building itself is the most sustainable retail centre in the world having achieved Living Building Challenge® Petal Certification and aiming for a 6 Star Green Star – Design & As Built rating. These certification goals, and Frasers Property Australia's commitment to sustainability, drove the decision to target full electrification for the centre.

Frasers Property Australia has worked closely with tenants, particularly food and hospitality businesses, to understand and try to overcome some of the barriers. During feasibility, several anchor tenants were confirmed and were supportive of the goal.

"The big retailers are big influencers in their own supply chain. They were able to specify to their suppliers that they would need equipment for their stores that were electricity-ready rather than gas," says Stephen Choi, Living Building Challenge Manager, Frasers Property Australia.

"For smaller operators, this has been more challenging. Electric equipment – particularly for commercial cooking – can be more expensive to purchase or less available than traditional gas-powered equipment."

But improved efficiency of electric appliances, air quality and safety won many over. Access to electricity at a lower price than is offered by the big three energy retailers through the building's embedded energy network also helped.

> "For some tenants, the lack of gas has been a deal-breaker and that is something we need to address collectively across industries – from development level to supply chains. Governments have a role to play by setting a clear pathway for a transition to clean energy, including making it equitable for the various retail typologies, whether a shop is on a high street or in a retail centre.
>
> STEPHEN CHOI | Living Building Challenge Manager, Frasers Property Australia

CASE STUDY

A key element to Burwood Brickworks success was its early engagement with tenants to deliver all-electric outcomes.

There are many opportunities to influence tenants to join you on the journey to be part of an all-electric building.

Engage early with your major tenants

Key to this project's success was the early engagement with their anchor tenants, with the majors. The engagement was important – all-electric cooking systems require changes to their equipment, and can require more substantial electrical infrastructure provision. By having them commit early to this goal, they will have more time to adjust and adapt.

Provide incentives to tenants or occupants to switch

The decision to electrify the building may result in tenants or occupants having to pay more for the relevant equipment. While major tenants may be able to absorb the upfront costs, smaller tenants may need assistance to be able to procure that equipment. Incentives to help with this procurement may be necessary until this equipment becomes more common and lower cost.

If a project establishes that gas will not be permitted for heating or hot water, then bringing gas into a space or a specific building becomes both a capital cost and an ongoing additional cost further deterring tenants from wanting gas.

Partner with equipment manufacturers to deliver all-electric equipment

Until all-electric equipment, particularly induction cooktops, becomes more common, there will be a need to inform tenants and occupants on the benefit of this equipment, and to assist in training them. Equipment manufacturers can provide training and help deliver relevant marketing material.

Restaurants and chefs recognise the value of induction cooking

Image credit: Kate Longley, Breathe Architecture

Stokehouse chef Jason Staudt welcomes the shift saying "the combination of cooking over wood, with the cleanliness and sustainability of induction is absolutely the future".
"As much as I love gas, induction has advanced in so many ways. It's more powerful, the cleaning is easier, and the cooking is more accurate."

JASON STAUDT Chef, Stokehouse, 'No longer cooking with gas: how a shift to induction cooking could affect Victorian homes and restaurants', Good Food Online, May 11, 2021

We use induction cooktops in the kitchens at Rockpool Bar & Grill, Spice Temple and Rosetta," he says. "They're far easier to clean down after use, which is one of the main reasons we chose induction over gas. With induction you're no longer a slave to an incredibly dirty gas stove top with multiple fittings that have to cool down and be dismantled ahead of cleaning. There is far more elbow grease involved when cleaning a gas top."

NEIL PERRY | Chef, 'Gas v induction cooktops' what is your pick? Good Food Online, May 3, 2017

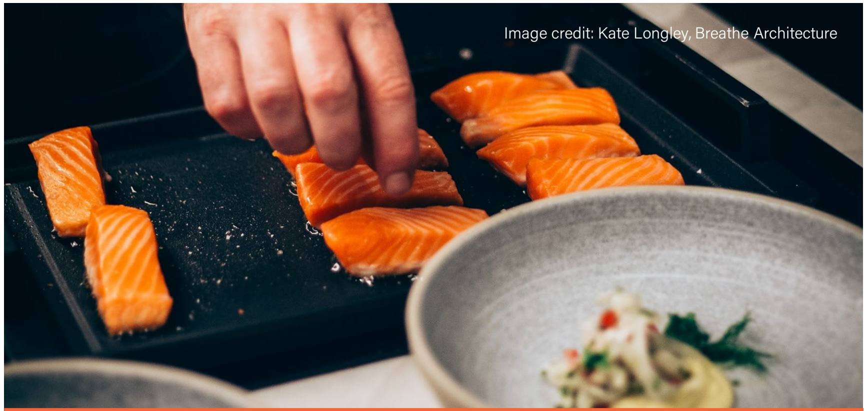


Image credit: Kate Longley, Breathe Architecture

Greater energy efficiency means kitchens save money not only on the cost of fuel, but on airconditioning too. For Wakuda, the higher costs of installation have been offset by the "lower cost of ownership. We have a safer, cooler, more energy efficient kitchen," he says.

TETSUYA WAKUDA | Chef, Tetsuya, 'Electric currents', Restaurant & catering, December 13, 2016

"If I had the choice, all of our restaurants would be induction only, there's no difference in the quality of food you can produce. Unfortunately, many of the buildings our restaurants sit in did not have the foundations for induction cooking because they're so old."

NATHAN TOLEMAN | CEO, Mulberry Group, 'No longer cooking with gas: how a shift to induction cooking could affect Victorian homes & restaurants', Good Food Online, May 11, 2021

"It [induction cooking] is a new thing for me, but the idea is to have an ambient kitchen." says chef, Martin Benn. "Gas stoves makes the kitchen go really hot, but we want to have more of an ambient 24C so the chefs aren't too hot when cooking and the food stays at the right temperature."

MARTIN BENN | Chef, Society, 'Cooking up a dream kitchen: Martin Benn's Society restaurant in Melbourne', The Australian, May 7, 2021

How to electrify a building: Alternatives to natural gas

Space heating

Gas	Alternative
Gas boiler (central)	• Heat pumps • Reverse cycle air conditioning
Gas radiant	• Electric radiant
Gas ducted / fire / heater	• All of the above

Impacts and benefits

Space	• Larger plant room needed • Natural ventilation needed
Capital costs	• Higher initial investment
Energy costs	• Lower operating costs
Health	• No air pollutants
GHG emissions	• Zero (with renewables)

Technical considerations

Replacing gas boilers with heat pumps opens up opportunities for efficiencies through integrated system design (see here).

Opportunity

Using lower temperature heating means that you can recover heat from chiller condenser water prior to its rejection to cooling towers during periods when the building may need heating in some areas and cooling in others. Heat pumps can also be used for both heating and cooling, whereas gas is used for heating only. Sydney Opera House has used condenser water from sea water chillers to provide space heating for over 40 years.

In buildings with very low demand for space heating, it may be more effective to use direct electric systems instead of heat pumps.

Domestic hot water

Gas	Alternative
Gas boiler (central)	• Heat pumps with thermal storage tanks
Gas boiler (local)	• Instantaneous electric • Heat pump

Impacts and benefits

Space	• Larger plant room needed • Natural ventilation needed
Capital costs	• Higher initial investment
Energy costs	• Lower operating costs
Health	• No air pollutants
GHG emissions	• Zero (with renewables)

Technical considerations

Gas boilers are often sized to meet the peak hot water demand. A like for like capacity replacement with heat pumps would lead to more space needed and a higher peak electricity demand. To avoid this, heat pumps can be designed to meet the daily demand with storage tanks to manage the peak hourly demand. Regardless, heat pumps will still require additional space in the plant room (see here).

Thermal storage pre-heat tanks connected to the condenser water loop can also help capture waste heat from chillers before rejection to cooling towers.

Opportunity

Storage tanks can be designed to act as a thermal battery allowing heat pump operation to be optimised to match on-site renewable electricity peak generation, or as part of an electrical demand management system.

Commercial cooking

Gas	Alternative
Gas cooktop	• Induction
Flame & char	• Electric charcoal grille • Portable green hydrogen cooktop • Electric grille with steam for moisture
Wok burner	• Induction wok burner
Gas oven	• Electric oven • Electric steam oven

Impacts and benefits

Space	• Smaller extract ducts • Smaller kitchen possible
Capital costs	• Higher initial investment
Energy costs	• Similar
Health	• Better indoor air quality & more comfortable temperature
GHG Emissions	• Zero (with renewables)

Considerations

Alternative electric approaches exist for cooking styles that need flame. When needed, localised fuel sources, preferably using a renewable biofuel or biogas, can be used. Discussing with potential retail tenants and agents early the benefits of all electric kitchens, can help lessen concerns as the industry transitions over the next few years (see here).

Opportunity

Commercial kitchens and retail food and beverage use some gas for cooking. This is changing as the many benefits of all electric kitchens become apparent. Chefs are now training to use all-electric equipment and changing cooking techniques to suit. Those that do are finding all electric kitchens provide a safer, healthier, and more productive kitchen.

Domestic cooking

Gas	Alternative
Gas cooktop	• Induction
Gas oven	• Electric oven
Gas BBQ	• Electric or charcoal BBQ

Impacts and benefits

Space	• No change (induction cooktop can provide extra workspace)
Capital costs	• Higher initial investment
Energy costs	• Similar
Health	• Better indoor air quality • Reduced risk of burns
GHG Emissions	• Zero (with renewables)

Opportunity

Over the past 20 years cooking with gas has been marketed as a sales feature for houses and apartments. Sales agents for developers have typically been reluctant to only provide induction cooktops in new development citing customer expectations for gas. This has been a major barrier to removing gas, even with developers committed to net zero carbon by 2030. The risk of losing out on potential sales due to not having a gas cooktop can override corporate zero carbon commitments. This attitude is changing.

Instead of fearing change, sales agents and developers can sell the many benefits of modern induction cooking to purchasers: precise temperature control, no hot surfaces (safer), easier to clean and no indoor air pollution. A modern home shouldn't feature 100 year old technologies as a major selling point! (see here).

How to electrify a building: Backup power and other uses

Backup and emergency power

Many buildings have diesel generators for emergency power during electricity blackouts. While diesel consumption accounts for less than 1% of the operating GHG emissions, over time it will need to be phased out to deliver fully zero carbon buildings.

Some alternatives to diesel generators that could be considered are outlined below. As it may be some time before these become commercially viable, future proofing buildings for emerging technologies is a prudent approach.

Biofuel generator

There are long term storage issues with replacing diesel with biodiesel. Fuel tanks need to be designed for biofuel. Higher blends of biofuel in diesel will be developed over time.

Hydrogen fuel cell

Hydrogen fuel cells generate electricity and heat via a chemical reaction. Only green hydrogen is zero carbon.

Battery Storage

Large battery storage solutions in buildings will become more viable in the future. They would likely need to be used in conjunction with other systems as a power outage may not occur when the batteries are fully charged.

Other uses of natural gas in buildings

There are a range of specialist uses in some buildings without a simple alternative to fossil fuel use. In these cases, effort should be made to find a replacement, or design the building for easy adaptability in the future. Some examples are:

Steam in hospitals

Steam is used for sterilisation and typically generated by using gas. Alternatives include dry heat, chemical, plasma gas and vaporised hydrogen peroxide sterilisation.

Laboratory bunsen burners

Gas bunsen burners can be replaced with electric versions of portable burners. While the latter use butane/propane/LPG, they are easier to replace in the future with green fuel sources.

Industrial processes

While outside the scope of this guide, green hydrogen will be an important energy source to decarbonise industrial processes with high heating requirements such as steel production.

Electric vehicles

Transport is undergoing a major transformation towards electric technology. Consumer demand for electric vehicles (EVs) is increasing, with battery electric and plug in hybrid vehicles projected to make up 50% of new light vehicle sales in New South Wales[25] and Queensland[26] by 2030. State and Federal[27] governments are taking action to support investment and uptake of low emission vehicles and the charging infrastructure.

Considerations

New buildings should be designed for the additional electrical loads and space requirements needed to accommodate the expected uptake of electric vehicles.

The critical step – pairing electric buildings with renewable energy

All-electric buildings provide a simple way to be powered by 100% renewables using electricity generated either on-site or off-site.

Every state and territory in Australia has established net zero carbon by 2050 targets, which is likely to result in electricity grids decarbonising at a much greater rate than has occurred to date (see page 6). The closure of coal fired power stations, together with the increasing investment in solar and wind power, will be the primary drivers of this transition.

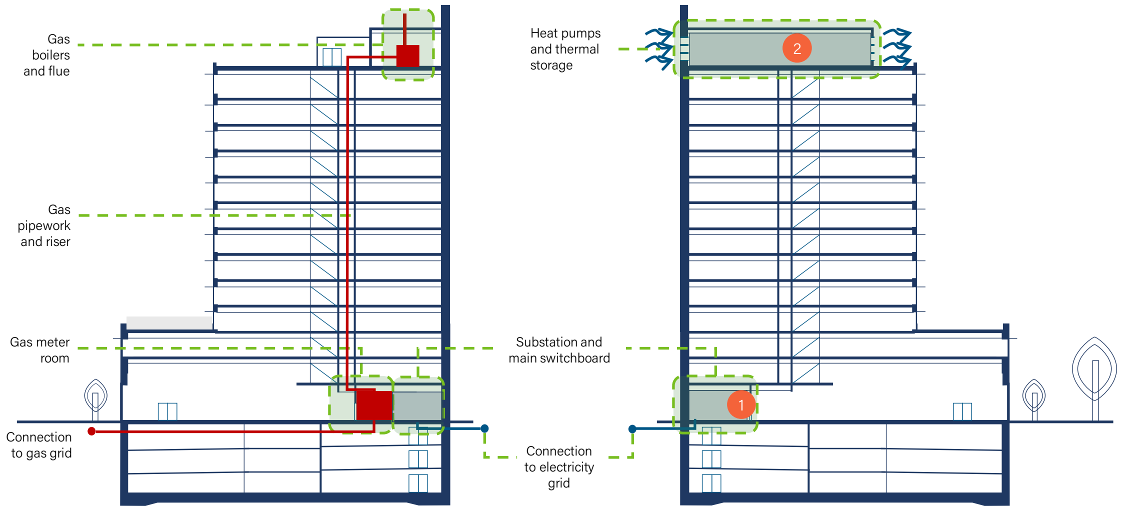
While it is difficult to predict the exact rate of grid decarbonisation due to increased renewable penetration, individual building owners and tenants can already purchase 100% renewable electricity including through Power Purchase Agreements (PPAs) and certified GreenPower.

While there are some rules that need to be followed, procuring off-site renewables is becoming easier and cheaper. Green Star[28], and NABERS[29] both recognise the purchase of renewables as options to reduce or eliminate GHG emissions. The NABERS Renewable Energy Indicator[30] will bring additional transparency to the purchase of renewables.

There are also other potential opportunities if renewables are installed on-site. Through a building's embedded network, the building owner may be able to offer renewable electricity to occupants, creating an opportunity to also generate revenue.

Design considerations in all-electric buildings

Designing an all-electric building involves careful consideration of how to integrate the systems and find opportunities for efficiencies.

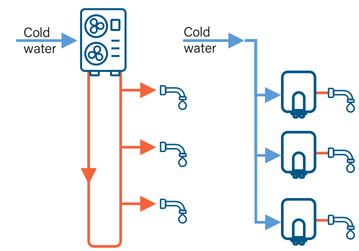


Gas equipment in a typical building
The items in red are not needed in an all-electric building

Equipment and considerations in an all-electric building

Local or central hot water systems

In buildings with low distributed demand for domestic hot water, local electric point of use heaters can be considered. Local systems can result in an increase in peak electrical demand compared to a central system. When evaluating the cost-benefits also consider the energy efficiency of heat generation, pumping energy, pipework and standing losses, and peak electrical demand.



Central heat pumps

Localised heating

1 Substation considerations and peak demand

Depending on space heating, domestic hot water, and cooking demand, the substation size may need to be increased.

In most climates in Australia, the peak demand for cooling will be higher than the peak demand for heating. But in colder climates where heating demand exceeds cooling demand then there may be a need to consider how to manage the building's peak heating loads.

Thermal storage tanks can be used to reduce peak load and increase resilience. Storage tanks can also act as a thermal battery allowing heat pump operation to be optimised to match on-site renewable electricity peak generation, take advantage of lower off-peak electricity tariffs, and form part of an electrical demand management system.

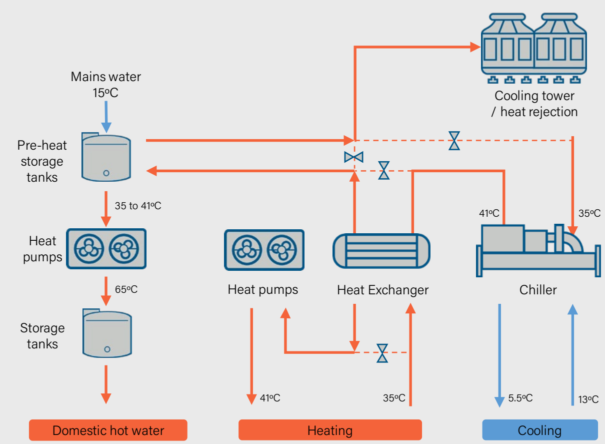
2 An all-electric plant room in detail

Integrated systems
All-electric buildings can be designed to take advantage of the lower heating hot water temperatures required for heat pumps. The diagram to the right illustrates one potential configuration for heat recovery from chillers.

Plant size
In general, electric equipment (**heat pumps** and **storage**) needs three to five times more space than gas equipment for the same amount of heat. Good cross ventilation is also required unless ground source heat pumps are used.

Space heating
Replacing gas boilers with heat pumps means keeping the heating hot water temperature to around 41°C. This typically requires slightly larger heating coils in air handling units for the heat transfer.

Domestic hot water
Domestic hot water typically needs to be stored at 65°C to avoid legionella risk. This reduces the efficiency of heat pumps used for domestic hot water compared to space heating. To reduce the number of heat pumps required, heat pumps are designed to meet the daily demand supported by storage tanks to help with the peak hourly demand. Thermal storage pre-heat tanks can also be used to capture waste heat from chillers and/or water sourced VRF systems.



Key cost and savings implications

	Area	Gas requirement	Electric requirement	Cost/Savings	Commentary
Capital	Heat generation equipment[1]	Gas boilers	Heat pumps and thermal storage	$$	The cost of heat pumps (plus storage tanks for DHW) will be higher than gas boilers. The cost of heat pump systems are likely to decrease as they become more widely used.
Capital	Plant room space	Boilers can be located internally or externally	Heat pumps can be located inside or outside. Good ventilation is required for air source heat pumps.	$	Heat pump systems typically require three to five times more floor area than gas boiler systems. The cost of this floor area depends on its location in the building with roof plant likely to have the least cost impact. For internal plant rooms, natural cross ventilation will be required which will influence the configuration and location of the plant rooms, and the design of the plant room façade (e.g. louvres).
Capital	Risers and reticulation	Gas risers, pipework, sub-meters and exhaust flues	Standard electrical infrastructure and risers. (already provided)	$	In addition to cost savings from removing the gas pipework, there are potential space savings due to eliminating risers, flues and metering.
Capital	Energy supply infrastructure	Gas meter room and connection to gas grid (or LPG tanks)	Substation and main switchboard (already provided)	V	Depending on the system size, there may be costs to increase the capacity of the main switchboard or substation. Costs for installing gas infrastructure are frequently paid as capital contributions to network owners, in addition to the actual metering and billing charges.
Operating	Supply charge	Daily supply charge for gas	No change to supply charge to provide electricity to the building	$	Daily supply charges for gas can be 20% to 40% of the total gas bill depending on usage.
Operating	Peak demand charges	-	Potential increase in peak demand consumption charges	$	For domestic hot water, there is potentially a small increase in peak demand charges, which can be mitigated through demand management control and thermal storage. For space heating, the heat pumps typically have lower demand than the cooling system (chillers) and therefore do not typically increase the peak electrical demand.
Operating	Consumption charges[2]	-	-	$	In 2020 a well-designed heat pump system should have lower energy consumption costs than a gas system. However, this all depends on time of use and the tariffs negotiated by the building owner/operator. Predicting future energy costs for gas and electricity is notoriously difficult. Various projections can be used to test the different cost differentials between the two.
Carbon	Cost for carbon neutral[3]	$20 to $50 per tCO_2 for Australian nature-based carbon offsets in 2021.	Renewable electricity procurement	$	Offsetting natural gas is not a zero carbon solution as it is an emission source that can and should be eliminated. The true cost of carbon abatement is projected to increase significantly this decade, and the cost of offsets will follow this trend. In comparison, the increased cost of renewable electricity, if purchased via a large Power Purchase Agreement (PPA) can be marginal compared to conventional electricity tariffs. Renewable electricity is projected to become cheaper over time compared to the costs of offsetting.

Legend

$ (green)	< 5% in savings
$ (red outline)	< 5% in cost
$$	5% to 15% in cost
V	Depends on circumstance

Notes

1. Expected life of a heat pump is between 10 to 15 years, and a boiler is 15 to 20 years. Net present value costing, including expected life and replacement, will depend on many variables and assumptions used in the whole-of-life cost model.
2. Comparing consumption charges requires consideration of time of use and the purchasing power of the organisation. Heat pumps and thermal storage can be used to take advantage of cheap electricity generated from renewables during the daytime.
3. Another aspect to consider is the cost to convert a gas boiler system to heat pumps in the future as the demand for zero carbon, fossil fuel free buildings increases. This cost should be considered in risk assessment and life-cycle costing scenarios.

Commercial kitchens

From wok cookers to griddles, the range of induction equipment available has increased significantly in recent years as has their popularity.

Induction cooktops have flat surfaces that can be used as extra workspace for food preparation when not being used for cooking. They are significantly easier and quicker to clean than gas burners with less cleaning chemicals required. They don't get hot and can be wiped down immediately – this means less time to clean the kitchen at the end of a shift. Induction cooktops can also be used for multiple types of cooking due to the ability to control to set temperatures, reducing the amount of specialist equipment required which can deliver space and cost savings.

Induction cooktops save energy. Compared to gas burners, which are regularly left on during cooking, when a pan is lifted off the induction surface the electricity consumption stops. Induction cooktops, by turning the pan itself into the heat source, also emit much less direct heat into a kitchen which can reduce the size, space requirements and energy consumption of kitchen ventilation and space cooling systems.

The quality, speed, heat and benefits are now equivalent or better than gas options. However, the upfront costs can be higher. A report from North Sydney Council[D] analysed a potential transformation of the North Spoon Café from gas to all-electric. The information below summarises the findings of equipment and operating costs. The bottom line? **Any increased capital costs are paid back in a few short years.**


Single-phase induction oven range


Induction wok cooker range


Commercial induction range cooker

		Issues	Power rating	Cooking efficiency	Heating / preheat time	Annual energy consumption	Estimated annual energy use reduction	Annual cooking energy cost	Product cost	Payback period
Cooktops	Gas burner w/ oven	• Hard to clean • Fire risk • Adequate ventilation needed	150 MJ/h	53%	5 min 49 sec (0.5L water)	120,598 MJ	-	$2,641	$3,199	2 years
Cooktops	Induction w/ oven	• Easy to clean • Reduced burn risk • No fumes released	45 MJ/h	90%	3 min 35 sec (0.5L water)	36,035 MJ	59%	$789	$6,500	
Deep fryers	Gas	• Hard to clean	60 MJ/h	50%	14 min (to 190°C)	68,913 MJ	-	$1,509	$3,220	0 years
Deep fryers	Induction	• Easy to clean • Food is evenly cooked • More visually appealing	25.5 MJ/h (2 units)	90%	8 min 34 sec (to 190°C)	29,288 MJ	58%	$641	$2,000	
Griddle/chargrill	Gas	• Hard to clean • Fire risk • Adequate ventilation needed	114 MJ/h	22%	-	120,598 MJ	-	$2,641	$4,789	3 years
Griddle/chargrill	Induction	• Easy to clean • Evenly cooked food • Reduced burn risk • No fumes released	25.2 MJ/h	76%	-	26,658 MJ	78%	$584	$10,970	

[D] With thanks to North Sydney Council for allowing us to use this information. The report will be published later this year.

Considering costs and benefits

The comparison of an all-electric building to a building using natural gas should take into account a range of whole-of-life factors. It should also take into account the critical environmental costs and benefits, value impacts over time, and other opportunities. While it is difficult to assign specific costs and benefits for all buildings in a guide, the items below help ensure the most relevant issues are considered.

A Infrastructure costs in a typical building

A building with natural gas requires equipment and infrastructure which is not needed in an all-electric building:

- Gas infrastructure, including pipework connection to the gas grid and metering.
- Boilers, heaters, gas cooktops and local exhausts.
- Gas risers.

B Energy and carbon costs

Typical costs include:

- Gas standing charges.
- Gas consumption costs.
- Carbon offsets (for carbon neutral).

C Lifecycle costs

A building with gas is encumbering the building owner with future conversion costs. These costs include:

- Increased carbon offset costs over time.
- Future replacement of gas systems including cost to upgrade electrical infrastructure, increase plantroom areas, and replace any heating systems not designed for lower temperature heating hot water.
- Management costs from multiple energy contracting and sources.

D Other impacts

Direct and indirect impacts that should also be considered for gas in buildings include:

- Impact on occupant health.
- Near term climate change impacts due to methane over next 20 years.
- Investor perceptions of a potential stranded asset.
- Misalignment with corporate and tenant net zero carbon commitments.
- Misalignment with global and domestic frameworks like Green Star, GRESB, and others, and reduced performance in NABERS Energy over time.

1 Infrastructure costs in an all-electric building

All-electric buildings need the following infrastructure:

- Electric heating (typically heat pumps) and electric cooking (including induction cook tops).
- Additional plant room area and louvres for ventilation in internal plant rooms.
- Potential increase in electrical infrastructure capacity including the substation.

2 Energy and carbon costs

- Electricity demand charges.
- Electricity consumption costs (including time of use).
- Cost of renewable electricity (for zero carbon).

3 Other impacts

In the transition to all-electric buildings, other impacts to consider include:

- Retail and commercial tenant awareness on the benefits of all-electric commercial equipment. The smaller kitchen may mean more front of house space.
- GHG emissions due to refrigerant leakage from heat pumps (and any carbon offsets to be purchased).
- Some capital cost savings realised by landlords in removing gas infrastructure to kitchens/F&B tenancies may need to be passed on to the tenants to help with their increased capital cost of purchasing induction cooktops compared to gas cooktops.

4 Environmental benefits

All-electric buildings have the following benefits:

- No GHG emissions from natural gas.
- With renewable electricity, no emissions due to electricity.

5 Resilience, regulatory, and market benefits

All-electric buildings:

- Will not require future upgrades to remove fossil fuel infrastructure.
- No gas equipment maintenance trades required.
- Will be more attractive to investors with zero carbon targets/goals.
- Support building owners and tenants and reporting (including TCFD) to meet their net zero carbon commitments.
- Meet the trajectories set by Green Star around energy source and are future-proofed as NABERS Energy changes to reflect the climate impact of fossil fuel use.

6 Health, wellbeing, and occupant satisfaction

All-electric buildings:

- Contribute to cleaner air in our cities
- Provide cleaner indoor air and safer spaces in commercial and domestic kitchens
- In retail settings, enables more cleaner, safer, cooler and less cluttered kitchens.

When considering the business case:

For a typical building with gas, include:

- Costs from **A + B**
- Lifecycle costs from **C**
- Costs and impacts on the environment, brand and asset from **D**

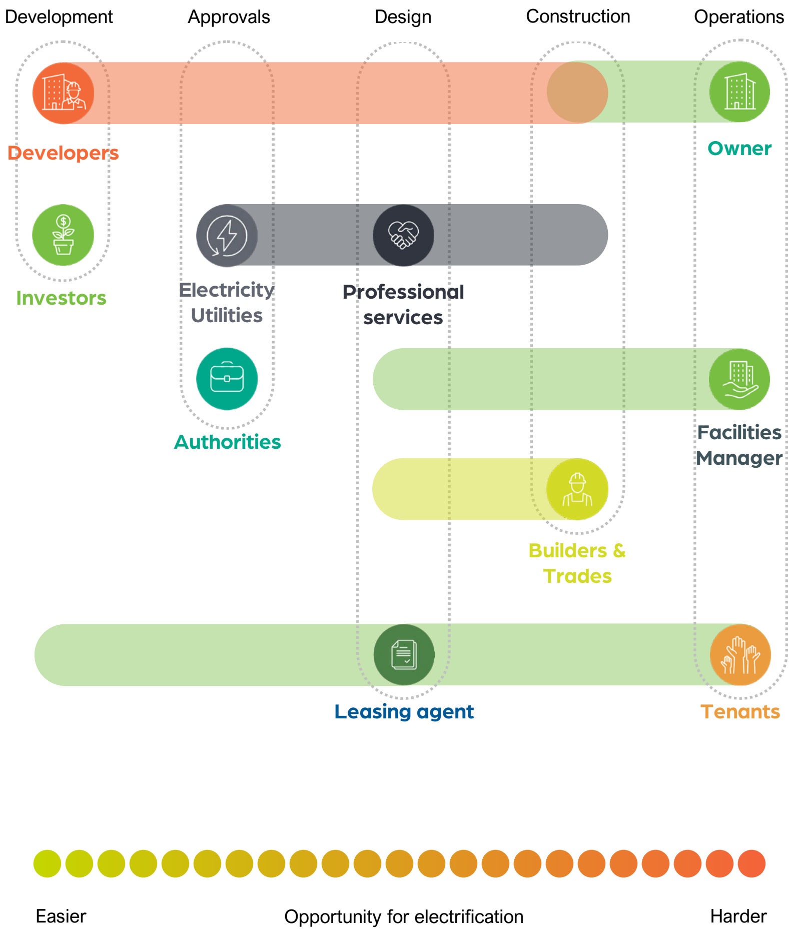
For an all-electric building, include

- Costs from **1 + 2**
- Other impacts from **3**
- Benefits from **4 + 5 + 6**

Your role in electrification

Everyone involved in the delivery of new buildings has a role to play in the electrification of buildings.

It ideally starts with the project brief, but until the design is locked in for construction there are always opportunities to switch a design to be fossil fuel free.



Stakeholders

Investors	Establish a policy to only invest in buildings that are zero carbon and fossil fuel free. For existing buildings insist that a zero carbon transition pathway is provided and implemented.
Developers	Set a policy for new buildings to be zero carbon and fossil fuel free. If this is not possible yet, then ensure the design can easily transition to be all-electric as soon as possible.
Authorities	Review policies and procedures to ensure they don't encourage or mandate that natural gas has to be provided to buildings or precincts.
Electricity Utilities	Support building owners/developers and designers to deliver all electric buildings, including measures for grid stability and avoiding over-design of electrical capacity.
Professional services	Design the buildings with all-electric systems and be familiar with different design solutions and emerging technologies. Advocate for zero carbon solutions.
Builders & Trades	Challenge design assumptions that assume fossil fuels are required. Prepare alternative all-electric solutions when bidding.
Leasing & Sales Agents	Engage with potential tenants and purchasers to advocate for all-electric cooking solutions. Be prepared with evidence to demonstrate the benefits.
Facilities Manager	Ensure that the building is running to its maximum potential, creating a comfortable environment and managing the peak energy demands of the building.
Tenants & Occupants	Ask for fossil fuel free solutions. For retail F&B look at the benefits of switching to all-electric for cooking. Electrification is consistent with the net zero carbon targets that many corporates and governments have now committed to.
Owners	Promote the benefits of electric buildings, and seek to own new electric buildings. Ensure any owned existing assets are electrified as promptly as possible.

Marketing an all-electric building

Investors

An all-electric building is ready for the decarbonisation of the grid, particularly if the building is also highly efficient and powered by renewables. A building that achieves these is likely to be aligned with the latest science and recommendations from the following organisations:

- The Intergovernmental Panel for Climate Change (IPCC)
- International Energy Agency's net zero roadmap (IEA)
- Taskforce for Climate-related Financial Disclosures (TCFD)

This building would also likely be aligned with the requirements of the **Climate Bonds Initiative**, particularly if it has also achieved a 6 star **Green Star Buildings** rating.

The reason for this is simple – the building is less likely to become a stranded asset as it features no fossil fuels and has the capacity to draw its entire energy from renewable electricity generated in Australia.

Corporate and government tenants

An all-electric building has many features that make it valuable for corporate and government tenants. In addition to the above, and as noted elsewhere in the guide, all electric-buildings:

- Enable the tenants to use 100% renewable electricity, which is the best mechanism they can use to meet their net zero carbon targets. This also reduces their climate-related risks and supports reporting on property emissions and transition strategies.
- Are cleaner and better. They pollute our towns and cities less and provide healthier and safer workspaces in kitchens.
- Align with the expectations set by GBCA's Climate Positive Pathway for new buildings and meet the latest Green Star Buildings requirements for energy sourcing (see here).

Marketing all-electric kitchens to domestic buyers and retail tenants

Retail tenants

The new generation of all-electric kitchens deliver many benefits:

- Commercial kitchens are often hot, noisy environments with lots of activity and stress. Induction cooktops put much less heat, noise and air pollutants into the kitchen than gas burners helping create calmer, quieter and cooler workplaces for kitchen workers.
- Energy consumption is lower. When a pan is lifted from an induction cooktop the energy consumption stops. Lower heat means lower energy for ventilation and cooling of the kitchen.

- Induction cooktops are also quicker to clean at the end of the day. There is no waiting for cooktops to cool down then scrubbing burners and lining with foil. Factor in the labour cost savings when preparing a business case.
- Induction cooktops can be used as extra workspace for food preparation when not being used for cooking. They can also be used for multiple types of cooking due to the ability to control to set temperatures, reducing the need for specialist equipment. Smaller back of house allows for more front of house space, so there is an opportunity for more sales.

Retail and commercial electric kitchens will become standard over the next 5 years as the market changes. It's best to be ready for the change and not have outdated infrastructure when a new building opens.

Domestic buyers and tenants

Cooking with gas has been marketed as a sales feature for houses and apartments creating customer expectations for gas in the kitchen. But consumer attitude is changing, providing an opportunity to capitalise on the many benefits for induction cooking. Messages to consider include:

- Induction kitchens are healthier, safer, and give you more control.
- Gas stovetops emit toxic, carcinogenic gases that can increase asthma and respiratory illnesses similar to the impact of passive smoking. Exhaust fans don't get rid of all of these, so avoid the problem altogether and use induction.
- Ever wondered why your kitchen is so hot? Natural gas kitchens heat the air, not just your food. Your new induction cooktop gives you great control as all the heat goes where it should – your pan.
- You'll save money on bills as your induction cooktop is more efficient.
- Your induction cooktop is child safe as the surface of an induction cooktop does not stay hot! No burning small hands on the stove.
- Your cooktop is also an extra flat surface that you can use to prepare food on when not cooking, and cleaning it is a breeze.
- You can cook anything on it. World-class chefs of all cuisines are moving to all-electric kitchens. They can do it - so can you!

Green Star and all-electric buildings

Launched by Green Building Council of Australia in 2003, Green Star is an internationally recognised rating system setting the standard for healthy, resilient, positive buildings and places. In summary, Green Star aims to:

- Reduce the impact of climate change
- Enhance our health and quality of life
- Restore and protect our planet's biodiversity and ecosystems
- Drive resiliency in buildings, fitouts, and communities
- Contribute to market transformation and a sustainable economy

A Climate Positive Built Environment

Green Star Buildings, introduced in late 2020, aims to deliver healthy, resilient, and positive places for people and nature, built responsibly, and showcasing leadership. Key to the rating tool is delivering buildings that meet or exceed what is required to meet a 1.5C trajectory. To achieve this, Green Star Buildings introduced requirements for new buildings be 'Climate Positive' which includes being fossil fuel free with no natural gas for space heating, domestic hot water and cooking.

To get a world-leading 6 Star rating, any new building or major refurbishment must be fossil fuel free. For projects registering after 2023, this requirement will apply to 5 Star ratings and after 2026 to 4 Star ratings. The requirement also applies to any building that is finished on or after 1 January 2030 irrespective of the year of registration.

The requirement is part of Green Star Building's **Climate Positive Pathway.**

From 2020 onwards buildings that seek this rating

6 star World Leadership

will need to be *Climate Positive*

From 2023 onwards buildings that seek this rating

5 star Australian Excellence

will need to be *Climate Positive*.

From 2026 onwards buildings that seek this rating

4 star Best Practice

will need to be *Climate Positive*.

NABERS and all-electric buildings

NABERS is a simple, reliable sustainability rating for the built environment. Like the efficiency star ratings that you get on your fridge or washing machine, NABERS provides a rating from one to six stars for buildings efficiency across:

- Energy
- Water
- Waste
- Indoor environment

This helps building owners to understand their building's actual measured performance compared to other similar buildings, providing a benchmark for progress.

Supporting Australia's net zero transition

Emissions factors, also known as the National Greenhouse Accounts (NGA) factors, are used in NABERS Energy ratings to enable the comparison of the emissions associated with the use of different energy sources. The emissions related to grid electricity use have been falling year-on-year with the increased amount of renewable energy in the grid.

To ensure that NABERS Energy ratings accurately reflect the latest emissions related to different energy sources, NABERS has updated the emissions factors used to calculate NABERS Energy ratings for all building types in July 2021.

After the initial July 2021 update, the NGA factors will be reviewed and updated periodically. NABERS will provide more details on the frequency of review very soon.

To enable users to calculate the NABERS rating using the updated NGA factors, a rating prediction tool is available on the NABERS website. Users can predict future NABERS ratings using projected emissions factors.

Based on these changes, all-electric buildings should be able to achieve their desired rating.

From 2022, NABERS will introduce a Renewable Energy Indicator[30], which will transparently disclose the amount of renewable energy used by a building. Only all electric buildings running on 100% renewables will able to get 100% on the indicator.

National Construction Code – Section J

The National Construction Code of Australia includes an energy efficiency provisions in Section J. This requires buildings to achieve energy use targets, which are demonstrated through either meeting Deemed to Satisfy requirements or undertaking energy modelling. It is primarily focused on the thermal performance of the building fabric and the energy efficiency of building services.

The GHG benefit of heat pumps compared to gas boilers is not considered, nor is the potential for future grid decarbonisation over the life of the building included at the time of certification. The energy modelling protocol uses a reference building compared to the actual building, and due to the calculation methodology at the time of writing, gas boilers can provide a less onerous pathway to compliance in some states. This will change as the grid further decarbonises.

BASIX (NSW only)

The Building Sustainability Index (BASIX) requirements apply to all residential dwelling types and are part of the development application process in NSW. All apartment buildings and homes must undertake a BASIX assessment to get development approval.

BASIX is in currently undergoing a review to ensure that all-electric buildings are better supported.

GRESB

GRESB is an investor-driven organisation committed to assessing the ESG performance of real assets globally. More than 200 members, of which nearly 60 are pension funds and their fiduciaries, use the GRESB data in their investment management and engagement process, with a clear goal to optimise the risk/return profile of their investments.

GRESB has indicated over the past few years an interest in driving better performing assets. GRESB have highlighted that driving assets to net zero carbon is a key concern. All-electric buildings have a better opportunity to perform in this space in the future.

Climate Bonds Initiative

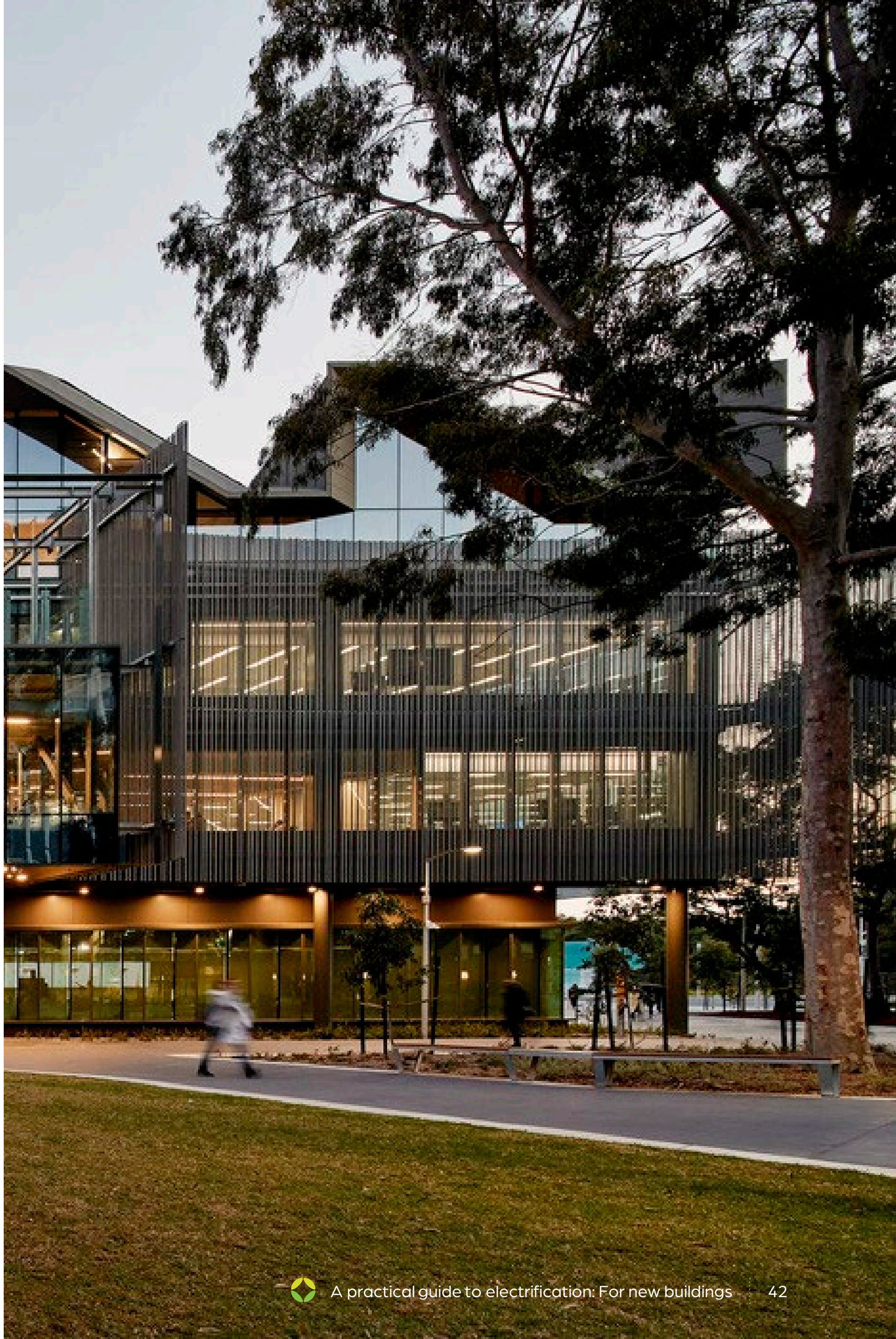
Climate Bonds Initiative (CBI) is an investor-focused not-for-profit, working to mobilise global capital for climate action. It administers the Climate Bonds Certification Scheme.

Recently, CBI approved two of the Green Building Council of Australia's rating tools as compliant with green bonds certification under the Climate Bonds Standard. Green Star was recognised because the rating system is driving highly efficient, fossil fuel free buildings powered by renewables.

Science Based Targets Initiative (SBTI)

The Science Based Targets Initiative (SBTI) is a partnership between the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF) and Climate Disclosure Project (CDP). The SBTi call to action is one of the 'We Mean Business Coalition' commitments.

SBTi has begun publishing guidance on net zero claims. Key to this guidance is the need to decommission or not install fossil fuel infrastructure. All-electric buildings are in line with this guidance.



Myths and barriers

We interviewed many stakeholders. These are answers to common questions we heard.

Using electricity isn't greener – we're still burning coal

The purpose of electrifying buildings is two-fold: enable procurement of off-site renewables, and to ensure we aren't locking in fossil fuel infrastructure for decades to come. Consider that electricity networks are decarbonising more rapidly than the most optimistic projections. By 2030, 69% of the electricity market is projected to be renewables – it doesn't make sense to finish a building in the next few years that will be using carbon intensive fossil fuels for the next 20+ years.

What about green gas and hydrogen?

Transforming the gas network and buildings to use green hydrogen or biofuels is much more difficult than adding renewables to the electricity grid. The current gas network would need to be replaced to carry 100% hydrogen (or it would leak, as the hydrogen molecules are smaller than methane), and every building in the network would need to have its equipment replaced prior to switching over to hydrogen.

Also consider that it takes three times[31] as many renewables to create green hydrogen as it does to power something with electricity. It is not worth that effort to pipe it to buildings to generate heat. Better to use hydrogen and biofuels for sectors that cannot easily electrify, like manufacturing.

What about carbon offsets?

Offsets should only be used after direct emissions reduction measures have been considered, such as to address upfront carbon emissions. Most net zero carbon standards will not allow offsets for natural gas in new buildings. With increased demand, the price of offsets can be expected to increase compared to the cost of renewable electricity which is decreasing.

The cost of heating with electric is more than with gas

There are three factors to consider that affect costs: equipment efficiency, connection fees, and running costs. Heat pumps are significantly more efficient than gas boilers and heaters, making electric options increasingly more competitive. While gas and electricity prices can fluctuate, removing gas means that you are avoiding connection costs. Finally, a well-designed electric system can take advantage of lower electricity prices at different times of day to heat water to be used at a later time.

We don't have the for all electric design

Heat pumps typically take up more space than gas boilers in plant rooms, but avoid the need for gas pipe reticulation, ventilated gas risers and gas meter rooms. Early planning can mitigate these impacts.

The technology isn't sufficiently mature

Heat pumps and induction equipment have been around for many years, are technically robust and readily available. Induction cooking is becoming increasingly common in Europe and Asia. With the increase in demand the pace of innovation is only likely to increase further.

The electrical infrastructure capacity isn't large enough to accommodate all electric design

The increased electrical demand associated with switching from natural gas will depend on the size, location, system design and use of the building. It may have an impact on the substation size.

For the national grid though, the electrification of all sectors will drive the necessary expansion to accommodate buildings and other sectors' demand. In fact, buildings may serve as part of a smarter national grid including demand management and energy storage.

Tenants and home owners only want gas

As induction cooktops become more common, their benefits to users and building occupants have become apparent – better control, safer, easier to clean, less heat in space and better air quality. As more people become familiar with induction the perception that gas is the best way to cook will change.

Electric cooking isn't as controllable particularly in commercial kitchens

Induction cooking is faster (up to 60% more efficient energy transfer) and provides instant response to changes in controls. There are far more choices becoming available as more equipment comes to market, technologies evolve to meet consumer expectations and training on how to adapt to different equipment is provided. Leading chefs agree, with induction cooktops used in their restaurants.

Induction woks are not commercially available in Australia

Demand for high power induction woks for Asian cooking is increasing in Australia. Many leading suppliers are looking at options to import them from the UK and China to meet this demand. As demand increases, so will availability.

Legislation and planning penalise switching to all electric

The National Construction Code Section J energy model pathway can result in a small penalty for switching to electricity if the building isn't designed to be efficient. A good design will avoid this penalty. NatHERS does not penalise electric buildings at all.

Design rating tools penalise switching to all electric

Green Star Buildings (and its legacy versions) rewards making buildings fossil fuel free. It is also mandatory for buildings targeting 6 star and will be mandatory for buildings registering for 5 star after 2023 and 4 star after 2026. Future versions of Green Star Communities and Interiors will adopt similar principles.

Operational / performance rating tools penalise all electric buildings

Higher NABERS Energy ratings were, until 2021, harder to achieve with electric heat pumps than with gas boilers. The recent revision of the carbon coefficients for grid electricity will reduce this impact. The regular update every 5 years will reflect the decarbonisation of the electricity grids in each state and territory.

Green Star Performance will be updated in 2022 to include requirements to be fossil fuel free for higher star ratings, with a transitional approach adopted for existing assets.

I have to install natural gas to my building – it's the law!

There are no blanket requirements in Australia to connect a building to the natural gas network. The last jurisdiction, ACT, removed this requirement from their planning legislation in 2019. However, there are still some processes, such as in Victoria, where a gas authority may request that a gas connection is a condition of development approval. This is changing and may not be a problem in the near future.

Should I build gas now and convert later?

Designing an asset today, with the aim to convert in the future, means providing the plant room areas required and the electrical demand capacity. Once you've provided the future space and capacity why would you still install gas?

Appendix: Valuable terminology

Carbon offset

A carbon offset refers to a mechanism that is used to compensate for emissions that occur elsewhere. Australia's Climate Active program has clear rules as to what constitutes a valid offset. Offsets are considered a measure of last resort – they should be used to address unavoidable emissions such as Scope 3 emissions. Natural gas use in new buildings is not considered unavoidable.

Emission scopes

A mechanism for classifying different sources of greenhouse gas emissions used in carbon accounting[32]. There are three 'scopes':

- Scope 1 covers direct emissions from owned or controlled sources. In a building this is typically emissions from burning fossil fuels (e.g. diesel, natural gas and LPG) and leakage of fluorinated gases such as refrigerants.
- Scope 2 covers indirect emissions from the consumption of purchased electricity, steam, heating and cooling.
- Scope 3 covers activities not owned or controlled by the reporting organisation. This includes production of fuels, electricity transmission losses, embodied carbon in construction and maintenance (including materials and products), tenant energy consumption, waste treatment, water treatment and travel to/from the building.

GWP

Global Warming Potential (GWP) is a measure of the energy 1 tonne of a greenhouse gas will absorb over 100 years compared to the emissions of 1 tonne of carbon dioxide (CO_2). The GWP of CO_2 is 1. GWP of natural gas is 21.

Heat pumps

A heat pump is an electrical device that provides heating or cooling depending on which way the refrigerant flows around the system. There are two types of heat pumps based on what the evaporator (heat source) and condenser (heat delivery) are connected to.

- 'Air source' relies on outside air to heat the evaporator which transfers heat to the condenser. Air source is commonly used across temperate and warm climate zones in Australia.
- 'Ground source' uses water in pipes to transfer heat from the ground, aquifers or water bodies to the heat pump condenser.

Hydrogen

Hydrogen is a fuel that can be used to generate heat through combustion (similar to gas) or used in fuel cells to create electricity through a chemical process. There are three common ways to produce hydrogen fuel:

- **Green hydrogen**, produced from renewable energy. It is the only form of hydrogen that can be considered low carbon.
- **Blue hydrogen**, produced from fossil fuels whose emissions have been captured. This is untested technology at scale and lifecycle studies[33] have shown it to be emissions intensive due to fugitive emissions.
- **Grey or brown hydrogen**, produced from fossil fuels. Emissions intensive and the most common type of hydrogen.

Renewable energy

Renewable energy is any source of energy that can be used without depleting its reserves including sunlight or solar energy, wind, wave, biomass, and hydro energy. They are generally classified as on-site renewable energy (where the generator is connected behind the meter), or off-site (where the generator supplies to the grid and this electricity is procured). Off-site procurement is a valid method of procuring renewables through a contract that produces large generation certificates (LGC) that can be traced and have been retired to the regulator. More information can be found here.

Terminology to use when making claims

Net zero carbon

A net zero carbon building is one where there is a balance between the amount of greenhouse gas produced and the amount removed from the atmosphere on a net annual basis. It is a technical, though open-ended term. Its use must be accompanied by the focus on emissions, e.g. net zero in operations, net zero for construction, etc.

Net zero claims are often unverified, and there is no agreed standard that defines them at this stage.

Carbon neutral

Climate Active

A carbon neutral building, as defined in the Australian Government's Climate Active standard[34], is a building that:

- Meets an energy consumption target
- Measures water consumption and operational waste
- Calculates its emissions based on the above information
- Uses renewable energy and/or eligible carbon offsets to settle its carbon account to zero.

Climate Active Carbon Neutral claims are third party verified.

Climate Positive

greenstar

The Climate Positive pathway[35] in Green Star Buildings requires buildings to:

- Meet an energy consumption target
- Meet an embodied carbon target
- Be fossil fuel free for space heating, domestic hot water and cooking
- Purchase 100% renewable electricity (scope 2 GHG)
- Purchase nature based offsets* for refrigerants and defined scope 3 emissions

Green Star Climate Positive claims are verified by an independent third party assessment process.

** – these have to be eligible under Climate Active, but are limited to nature based offsets or similar carbon removal offsets. More information can be found here[4].*

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