Green Building Council Australia

greenstar

A practical guide to electrification

For existing buildings

CUNDALL

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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

Cundall is a global, multi-disciplinary consultancy delivery sustainable engineering design solutions and ESG, Zero Carbon, and Existing Building advisory services across the built environment. We have contributed to many leading green buildings in Australia and across the world and continue to engage with industry to help drive sustainable outcomes. Cundall is a Carbon Neutral certified business global and is a founding signatory of the World Green Building Council's Net Zero Carbon Building Commitment. Our Zero Carbon Design 2030 initiative is to deliver zero carbon solutions on every project we do, with the end goal that all our projects after 2030 will be zero carbon.

Funding partners

cefc

The CEFC is a specialist investor at the centre of efforts to help deliver on Australia's ambitions for a thriving, low emissions future. With a strong investment track record, we are committed to accelerating our transition to net zero emissions by 2050.

In addressing some of our toughest emissions challenges, we are filling market gaps and collaborating with investors, innovators and industry leaders to spur substantial new investment where it will have the greatest impact. The CEFC invests on behalf of the Australian Government, with a strong commitment to deliver a positive return for taxpayers across our portfolio.

NSW GOVERNMENT

The mission of the Office of Energy and Climate Change is to accelerate NSW's transformation to a sustainable future. It will deliver key strategies and programs that focus on addressing some of the most significant issues facing our state including energy reliability, climate change and emissions reduction. Its work is integral to the state's economic recovery and a key pillar of NSW economic policy.

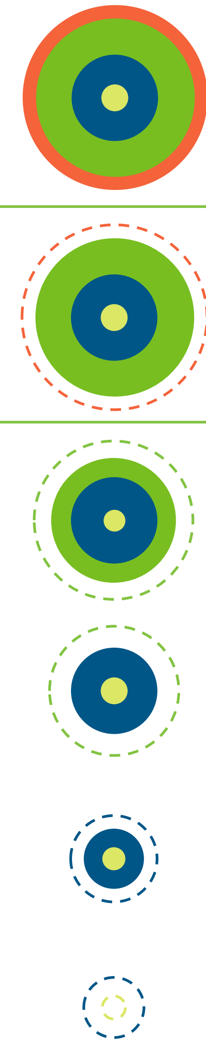
How to use this guide

This guide outlines the steps involved in retrofitting existing buildings to be all-electric 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.

A separate guide for New Zealand is available from the New Zealand Green Building Council

Delivering Climate Positive Buildings

The diagram shows typical steps to decarbonise buildings. This guide covers the first: how to eliminate fossil fuels for space heating, hot water and cooking in existing buildings. A separate guide is available focusing on new buildings. We encourage you to apply all these steps in every building in your portfolio.



Standard building

Measure typical greenhouse gas (GHG) emissions due to energy use and repair, maintenance & refurbishment.

This guide

Fossil fuel free

Eliminate natural gas for space heating, domestic hot water and cooking, both base building and tenants.

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.

Reduce embodied carbon

Significantly reduce embodied carbon through material/product selection during operations and refurbishment.

Offset with nature

After reducing all other 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 operation	Emissions from products, materials and activities for repair, maintenance and refurbishment.

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 operate and upgrade existing buildings in our towns and 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 significantly reduce operational greenhouse gas (GHG) emissions in the built environment and meet net zero carbon goals, it is crucial that existing buildings undergo a transition to be fossil fuel free, primarily by eliminating the use of natural gas.

Most buildings standing today will still be operational in 2050. Electrifying existing buildings now will ensure they are future-proofed for a decarbonised world.

Technologies are available to design out fossil fuels for all typical uses in a building today. An all-electric building comes with many benefits:

- Natural gas typically represents between 10% and 30% of building GHG emissions. The electricity grid is rapidly decarbonising and renewable electricity is readily procurable, while the decarbonisation of the natural gas network is unlikely in the foreseeable future.
- Separate bills for gas (consumption and standing charges) are eliminated, as are gas maintenance and safety checks.
- Healthier internal spaces are achieved by reducing gas combustion and leakage inside buildings.
- Corporate tenants and debt and equity investors with zero carbon goals are increasingly attracted to all-electric buildings powered by renewables.

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

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

There are other uses of fossil fuels that are found in some buildings such as gas for high heat industrial processes, portable gas heaters for external spaces, gas for laboratory purposes or similar and LPG for barbeques. While not the subject of the guide, building owners are encouraged to consider alternatives to all natural gas use wherever possible.

The case for electrification – the right solution today

Burning fossil fuels to generate heat and to cook food has been the go-to solution since the industrial revolution. Natural gas boilers and cookers are the pinnacle of this old 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 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.

In the business case for an all-electric building, 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 climate change impacts. Electrification is also the best enabler to deliver buildings fully powered by renewables today.
- Investor benefits: investors 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, potentially at lower interest rates.
- Resilience and risk reduction: as we move into a state of decarbonising the economy, the need to retrofit assets and remove equipment using fossil fuels from service will only become more important. An all-electric building is a step ahead, making it a more valuable and desirable asset, ready for the future.
- Health benefits: using natural gas for cooking in buildings generates toxic air pollutants. Occupants are exposed to these pollutants during combustion as well as due to leakage. These impacts can increase asthma and exacerbate respiratory illnesses. All-electric services eliminate these pollutants, improving indoor air quality.
- Tenant and consumer preferences: many organisations have set goals for zero carbon. 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 references that provide more information. Understanding the drivers and benefits for electrification will help in developing a business case to electrify an existing building and/or portfolio.

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 GHG emissions. It accounts for almost a quarter of total emissions in Australia. Of these emissions, natural gas use in buildings accounts for 15% [2] of all operational emissions (around 14 million tonnes of CO_2 a year). 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 emissions due to methane escaping to the atmosphere are three times more impactful over a 20-year period than over a typical 100 year span[a]. As noted above, the next ten years is critical.

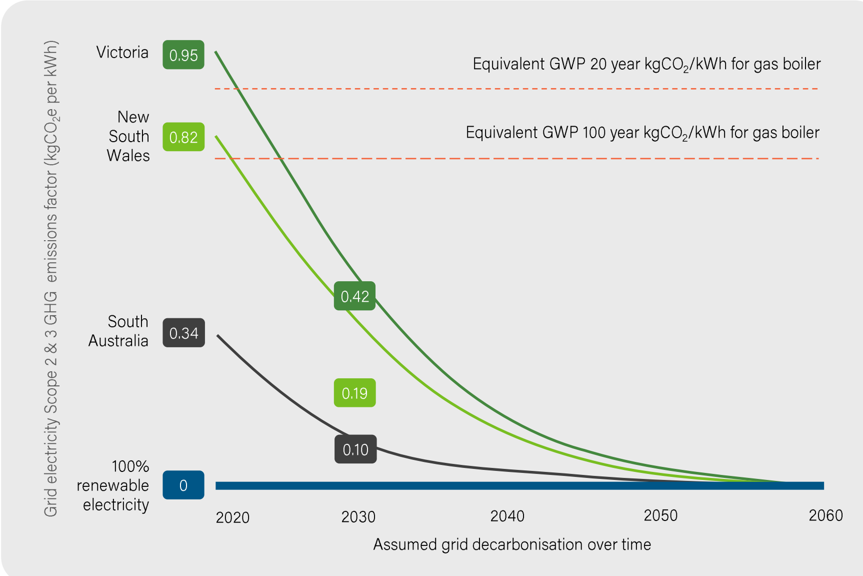
The IPCC noted in its latest report[1] that methane emissions should be reduced at a much faster rate than previously assumed. This formed the basis of the Global Methane Pledge[3] at COP26 in Glasgow.

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 has highlighted[5] electrification as a key technology available now for decarbonisation. The ACT Government has released an electrification pathway detailing the transition away from fossil fuel gas to reach the Territory's target of net zero emissions by 2045[6]. NABERS 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.

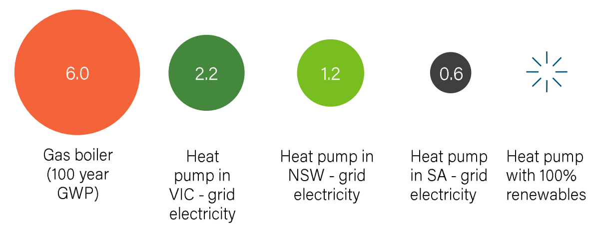
Zero carbon fuels, such as biofuels and green hydrogen, have a part to play in decarbonising our economy, but they are likely better used in other sectors such as transport and manufacturing processes.

[a] As noted by the Clean Energy Regulator, 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 28 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 chart above 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[5].

The bubbles below show the cumulative operational GHG emissions (tCO2e) generated for an average heat pump and gas boiler in different states[c] over 25 years based on producing 1MWh of heat per year.



What these charts outline is that any building that uses gas will emit far more than an all–electric building, even if the building did not procure renewable electricity. When paired with on–site or off–site renewables, the GHG emissions savings are substantial.

[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.

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.

Sustainability linked loans are finance instruments in which the terms of the loan (for example the interest rate, where lower rates are possible for good performance) are linked to the borrower's or project's environmental, social, and governance (ESG) performance. By 2021 their global volume reached US$350 billion for the year[7]. For example, in Australia, Charter Hall funded a $500 million loan with targets aligned to NABERS and Green Star[8].

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 using renewable energy, energy efficiency and low emissions technologies - across new and existing commercial, industrial and residential buildings. A new CEFC program in 2022 is also 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. Last year, the Initiative recognised[9] Green Star's Climate Positive Pathway as an automatic compliance route due to its electrification requirements and energy reduction targets.

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 energy efficient. The Australian Government's own 'Long Term Emissions Reduction Plan (2021)' highlights electrification as a desirable outcome. Policies to achieve this aren't far behind.

In 2017, the Taskforce for Climate Related Financial Disclosures (TCFD) 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, changing consumer habits and preferences for zero carbon. As the TCFD recommendations are being adopted by bodies such as the International Sustainability Standards Board (ISSB), which is part of the International Financial Reporting Standard Foundation, disclosing climate risk will become expected in all corporate reporting.

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[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 by utilising locally generated renewable electricity is a key benefit of all-electric buildings.

Finally, there is the question of future-proofing assets. Maintaining natural gas systems and infrastructure in current buildings means continued reliance on, and maintenance of, aging fossil fuel infrastructure, which may eventually be decommissioned.

The case for electrification – health and safety benefits

Natural gas produces a range of harmful pollutants including nitrogen dioxide, carbon monoxide and fine, toxic particulate matter.

During extraction and production, 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].

Using natural gas in buildings can directly impact the health and wellbeing 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 home or workplace.
- 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. Much of this impact is due to ongoing leakage from cooktops when they are not in use.

Space and water heating with gas produces 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 5,000 Australians each year[19].

> "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, 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 June 2022, 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.

Green Star Performance v2[23], the new rating tool for the operation of buildings, has already set clear targets to remove fossil fuels from buildings between now and 2040. This requirement starts in 2026 for 6 Star rated buildings and cascades down to all ratings by 2040 at the latest. Green Star is used by many organisations 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. See here.

If you can't stand the heat, get the gas out of the kitchen.

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 be influenced as environmental and health campaigns scale up. Already home renovation shows on TV are demonstrating the benefits of induction, and global campaigns promoting the health benefits of all-electric cooking will likely help change minds further.

Planning to electrify a portfolio

First steps

Set zero carbon goals

- Set a target date for the portfolio to be fossil fuel free (preferably well before 2040) as part of a Zero Carbon portfolio plan covering reducing energy consumption, renewable energy, embodied carbon, refrigerants and other operational GHG emissions.
- Implement a due diligence process for acquisitions that identifies and prices carbon reduction and includes electrification requirements to support achieving the Zero Carbon portfolio plan.
- Commit to no gas connections in new developments (see 'A Practical Guide to Electrification for New Buildings').

Prepare high level portfolio plan

- Review fossil fuel consumption across the portfolio, the uses for natural gas, and the type and age of gas equipment and systems.
- Identify who has control or ability (building owner and/or tenant) to remove gas from a building or tenancy.
- Prepare a feasibility study for each building, including types of electric technologies and any technical or spatial challenges (refer to 'six things to consider' section)
- Identify priority opportunities for the next five to ten years, including budget allowances, and align where possible with other upgrades or tenant refits planned across the portfolio.

Engage with tenants and users

- Identify any changes to central or local plant that may impact on tenants including service disruptions, lease clauses, energy costs and capital cost contributions.
- Where tenants use gas directly (e.g. gas cooktops) then engage with tenants to discuss benefits and costs of converting to all electric and discuss how gas could be phased out. Consider potential incentives and triggers (e.g. lease renewal, new fitout)
- Amend future leasing agreements to eliminate future gas connections, and work with current and prospective tenants to incentivise early electrification.

Between now and 2040

Prepare building plans

- Prepare a detailed electrification plan for each building – refer to "Electrifying a building over time" on the next page for further guidance.
- Identify potential trigger points, such as end of life of equipment, lease renewals, tenant fitouts and base building upgrades (e.g. lobby upgrade, new End of Trip facilities, EV charging rollout, etc.) and align electrification projects with these where possible.
- Integrate electrification with other zero carbon plans and strategies, such as Electric Vehicle charging rollout, installing on-site renewables and energy storage systems.

Deliver

- Integrate the building electrification plans into the asset management and upgrade plans and budgets for the portfolio. Implement the electrification projects at the earliest opportunity in each building.
- Continue to actively advocate and engage with tenants to speed up electrification of their tenancies – technologies are rapidly evolving, and initial resistance may soon be replaced with embracing the benefits.
- Communicate your plans with investors to demonstrate the benefits of all electrification. Identify if sustainable finance is available to help fund the projects.

Next steps

- Share your experiences and lessons learned with others and encourage tenants to do the same – the whole built environment needs to rapidly decarbonise, not just the leaders (the people reading this guide).
- Prepare a strategy to make the building more resilient and responsive to a changing electricity grid.
- If you sell a building before you can electrify it, then share the electrification plan with the purchaser. This helps ensure that the building you previously owned continues to be on a path to decarbonisation.

Electrifying a building over time

Review building systems

- Identify type and age of all fossil-fuel using equipment and associated infrastructure including in tenancies.
- Review asset plan and identify opportunities to integrate electrification projects with planned replacement or other upgrade projects.
- Conduct feasibility study of potential electrification strategies – refer to "six things to consider" section.
- Budget for consulting advice if needed to develop design and documentation.

Prepare the plan

- Engage (or use in-house) engineers to audit the existing natural gas systems and electrical infrastructure and prepare an electrification design and options report. The report should also identify opportunities to reduce energy use and peak electrical demand.
- Where tenants use gas (e.g. gas cooktops), discuss benefits and costs of converting to all electric. Consider potential incentives and triggers (e.g. lease renewal, new fitout) to speed up transition.
- Change new lease agreements to remove gas supply to tenancies.
- Align electrification works with other intervention points where possible. (See next page).

Deliver

- Prepare design, specifications and drawings for the electrification works including mechanical, electrical and hydraulics systems. Engage an architect if changes to floor plans or facades are required.
- Engage other specialists as required, e.g. acoustics, building certifiers.
- Implement the works, staging as required, to align with other projects in the building.

Continuous improvement

- Fine tune the building systems and controls to optimise energy efficiency and reduce peak demands.
- Identify any remaining non-electric equipment in the building, and plan to remove before 2040.
- Provide training to facilities management staff and update building manuals.

Intervention points for electrification

There are key points in the lifetime of a building that provide opportunities to implement electrification projects at the same time. These include:

End-of-life replacement

When gas equipment is nearing the end-of-life, change to all electric. This may not always be a simple like-for-like replacement due to the way the systems work. (See pages 16 – 24).

Tenant refit or lease renewal

As tenancies are refreshed or renewed, existing gas connections should be removed. This will require discussion with tenants that currently use natural gas systems, primarily for cooking, but could also include other specialist uses such as laboratories.

End-of-trip facilities refresh

In commercial offices these are often a major user of domestic water. Consider the potential for a dedicated localised electric heat pump system for these (together with water efficiency to reduce hot water demand) and point of use electric water heaters for bathrooms elsewhere in the building.

Common area or lobby upgrades

Refreshing the building's lobby and common areas provides an opportunity to undertake electrification works by integrating them into the overall capital works budget.

Electrical infrastructure upgrades

Installing electric vehicle chargers and renewable energy and energy storage systems provides an opportunity to review, and where required upgrade, the electrical infrastructure to accommodate electrification of natural gas systems.

Stakeholders

Everyone has a part to play in advocating for all-electric existing buildings. In addition, all stakeholders can take specific actions as per the below:

	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.
	Owners	Promote the benefits of electric buildings, and seek to own, procure and build only all-electric buildings. Ensure any owned existing assets are electrified as promptly 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 and designers to convert to all-electric buildings, including measures for grid stability and assessing electrical capacity versus actual demand.
	Professional services	Design to convert existing buildings to be all-electric and be familiar with different design solutions and emerging technologies. Advocate for zero carbon solutions.
	Builders & Trades	Become familiar with all-electric systems and how to install in existing buildings. Prepare alternative all-electric solutions when bidding on refurbishments and building upgrades.
	Leasing & Sales Agents	Engage with existing and 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 electrical demands of the building. Also advocate for the safer solution that fully electric buildings provide.
	Tenants & Occupants	Ask for fossil fuel free solutions. For retail food and beverage look at the benefits of switching to all-electric for cooking. Electrification is consistent with the net zero carbon targets to which many corporates and governments are now committed.

Seven key issues to consider when electrifying an existing building or portfolio

This next section provides you with key questions to identify the current state of the building, and information to help you understand the systems, impacts and potential solutions.

Systems

- Space heating
- Domestic hot water
- Cooking
- Other systems
- Electric vehicles

Impacts

- Electrical capacity
- Space & location

How to electrify a building: Alternatives to natural gas

Space heating

Space heating is often provided using centralised gas boilers to generate hot water which is then circulated to emitters, such as heating coils in air handling units, to heat spaces. Gas boilers are also often used to inject heat into condenser water systems connected to water sourced heat pumps. Localised gas systems include radiant and direct heaters.

Electric alternatives

Gas	Alternative
Gas boiler (central)	• Heat pumps • Variable Refrigerant Flow (VRF) system (heating and cooling)
Gas radiant	• Electric radiant
Gas ducted / fire / heater	• All of the above

Impacts and benefits

Switching from gas boilers to electric heat pumps is likely to have the following impacts and benefits in existing buildings:

Space and location	• More space needed • Natural ventilation needed
Electrical capacity	• Potential increase in peak electrical demand
Other	• Potential impact on existing heating hot water pipes, pumps and coils
Energy costs	• Lower operating costs
Health	• No air pollutants from gas
GHG emissions	• Zero (with renewables)

Key questions

1. What gas systems are used to provide space heating?
2. When are they due for replacement?
3. Do you have suitable space available to install an electric system?
4. Do you have sufficient electrical capacity in the main switchboard and substation?

Technical considerations

Space and location

Air source heat pumps require more plant room space than gas boilers to produce the same heat output. They also require good natural ventilation in order to extract heat from the air. This is why condenser units for reverse cycle air conditioners are typically located on roofs or apartment balconies. Refer to the Space and location section for further details.

Electrical capacity

Replacing gas systems with electric alternatives will increase the demand for electricity during heating periods. This may impact on the electrical infrastructure in the building, although in many buildings the electrical demand for cooling systems in summer will be higher than the electrical demand of heating systems in winter. Refer to the Electrical capacity section for further details.

Other considerations

The amount of heat that can be delivered via heating hot water is a function of water temperature (°C) and flow rate (l/s) - the lower the temperature, the more flow is required to deliver the same heating energy.

In existing buildings, the flow and return temperatures in the heating hot water system may have been designed for the higher temperatures able to be generated by gas boilers (e.g. 80°C). In some buildings steam is used. To maximise energy efficiency, heat pumps generate lower temperature hot water (typically 40-45°C). Depending on the system design, a switch to heat pumps may require pipes, pumps and heating coils (in AHUs and/or ducts) to be replaced. In some cases, shifting to local rather than central solutions may be warranted.

Lowering heating hot water temperatures has other benefits including:

- Reducing health and safety risk for maintenance workers.
- Potential to use waste heat from chillers to provide heating during mid-season and avoid running heating and cooling systems independently.

Some dehumidification systems in commercial air conditioning systems use gas generated heating hot water to reheat the air after it has been cooled to reduce moisture. When gas boilers are removed then 'free reheat' should be investigated, including using waste heat from chillers instead of a like-for-like approach using heating hot water from the new heat pumps.

Optimising and tweaking controls of heat pumps will also be important. They must be set up properly, otherwise inefficiencies will also occur.

How to electrify a building: Alternatives to natural gas

Domestic hot water

Domestic hot water is typically provided using gas boilers, particularly in centralised systems. Decentralised domestic hot water systems can be either gas boilers or instantaneous electric.

Electric alternatives

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

Impacts and benefits

Switching from gas boilers to electric heat pumps is likely to have the following impacts and benefits in existing buildings:

Space and location	• More space needed • Natural ventilation needed
Electrical capacity	• Potential increase in peak electrical demand
Other	• Increase hot water storage in central systems • Consider use of small electric heaters at point of use
Energy costs	• Lower operating costs
Health	• No air pollutants from gas
GHG emissions	• Zero (with renewables)

Key questions

1. What gas systems are used to provide domestic hot water?
2. When are they due for replacement?
3. Do you have suitable space available to install an electric system?
4. Do you have sufficient capacity in the main switchboard and substation?
5. Is the system central or local?

Technical considerations

Space and location

Air source heat pumps and thermal storage tanks require more plant room space than gas boilers to produce the same daily and peak hour hot water volumes. They also require good natural ventilation in order to extract heat from the air. Refer to the Space and location section for further details.

Electrical capacity

Demand for domestic hot water is typically consistent all year round. The electrical load to generate the hot water could occur during the building peak electrical demand period. Replacing gas systems with electric alternatives is therefore likely to increase the demand for electricity in the building. This can be managed through thermal energy storage and energy demand management to shift the peak. Refer to the Electrical capacity section for further details.

Other 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 mitigate this, heat pumps can be designed to meet the daily demand with storage tanks to manage the peak hourly demand.

Thermal storage pre-heat tanks connected to the condenser water loop can also help capture waste heat from chillers before rejection to cooling towers. Thermal storage can also help with demand response serving as a way to store renewable energy generated during the day as heat to use during other times.

Local vs centralised 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 consider the energy efficiency of heat generation, pumping energy, pipework and standing losses, and peak electrical demand.

In buildings with a mix of domestic hot water demand, such as commercial buildings with an end-of-trip facility with showers (high demand) and bathroom wash basin taps (low demand) a combination of systems can be used - heat pumps located near to the high demand and point of use heaters for the distributed low demand.

Explainer: Heat pumps and refrigerants

A technology for the electrification of buildings is heat pumps. These use refrigerants which have a GHG emissions impact if they leak to the atmosphere, and this needs to be considered in whole-of-life carbon footprint assessments.

What is a heat pump?

A heat pump is a device that uses the refrigeration cycle to move (pump) heat from one place to another. A compressor, typically powered by an electric motor, pumps a refrigerant around a piped circuit containing an evaporator (which absorbs heat), an expansion valve and a condenser (which rejects heat).

There are two main types of heat pumps:

- Air-source – the heat pump extracts or rejects heat to the outside air.
- Ground-source –the heat pump extracts or rejects heat to either the ground, or to a large body of water (lake, sea, river, etc.).

A common type of heat pump is a fridge which removes heat from the food stored inside the fridge and transfers it to the back of the fridge (which gets warms).

Managing refrigerant impacts – today and in the future

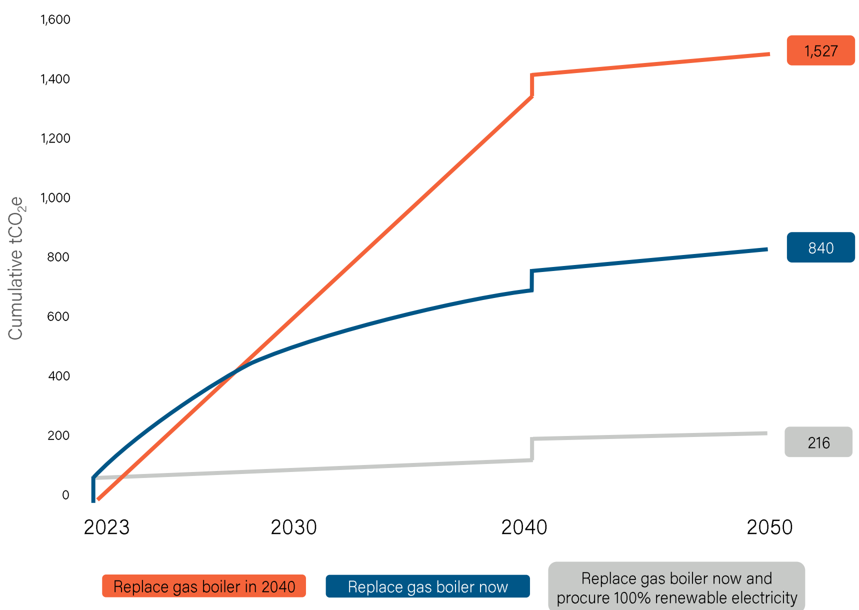
Many heat pumps use a class of refrigerants called Hydrofluorocarbons (HFCs). While these refrigerants have a zero Ozone Depletion Potential (ODP) they can have a high Global Warming Potential (GWP), ranging from under 100 to well over 2,000 (i.e. over 2,000 times more potent than CO_2). However, due to the relatively small volume of refrigerants and leakage to atmosphere, the overall GHG impact from refrigerants can be small, particularly if heat pumps using low GWP refrigerants are selected.

In 2016, the Montreal Protocol, which successfully phased out ozone depleting refrigerants, was updated to require the gradual phase-down of high-GWP HFCs by 2036[25]. Green Star Buildings considers refrigerants with a GWP less than 10 to be low GWP.

There are heat pumps available today that use natural refrigerants such as ammonia or carbon dioxide (CO_2). Using CO_2 as a refrigerant has many benefits, one of which is its low GWP of 1 compared to HFC refrigerants. Chillers are already available with very low GWP (<2) Hydrofluroolefins (HFOs) refrigerants, and heat pumps using these are also under development.

Replace early, or replace late? The carbon impacts.

Replacing gas boilers before their end of serviceable life requires consideration of the whole of life carbon impacts as well as the cost. The chart below provides an example assessment of the operating energy emissions, the embodied carbon of the equipment and assumed refrigerant leakage for a space heating gas boiler in a typical Sydney office building for three scenarios – replace with a heat pump in 2040, replace now and use grid electricity, and replace now and procure 100% renewable electricity.



Assumptions: 4.5 star NABERS Energy office base building in Sydney CBD with 20,000m2 NLA, 13% of energy is gas for space heating, NSW natural gas GHG coefficients and grid electricity decarbonisation as per page 6, gas boiler efficiency = 90%, heat pump CoP = 3, new heat pumps installed in 2040 for all scenarios, refrigerant GWP = 124 (in 2023) and 41 (in 2040), 9% annual refrigerant leakage rate, embodied carbon of 11 kgCO2e per kg of equipment (source: CIBSE).

How to electrify a building: Alternatives to natural gas

Cooking

Cooking is often provided using gas cooktops and other equipment in commercial and domestic kitchens. However, electric alternatives, including induction technologies, have significantly improved over the past few years to become more attractive and affordable.

Electric alternatives

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

Impacts and benefits

Moving from equipment that uses gas or other fossil fuels is likely to have the following impacts and benefits on existing buildings.

Space and location	• Smaller extract ducts • Smaller kitchen possible
Electrical capacity	• Increase in peak electrical demand
Capital costs	• Higher initial investment
Energy costs	• Lower operating costs
Health	• Better indoor air quality & more comfortable temperatures in kitchen • Reduced risk of burns
GHG Emissions	• Zero (with renewables)

Key questions

1. Is gas or other fossil fuels directly used to provide cooking?
2. Would installing electrical cooking throughout increase the annual peak electrical demand of the building?
3. If tenants own and install the cooking equipment:
    a. How long is the tenancy lease for?
    b. Have you engaged with existing or prospective tenants about switching to all electric?
    c. If natural gas were to be removed from the building, could the tenant use portable fuel sources (e.g. bottled gas) for flame cooking?

Technical considerations

Technical requirements

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).

When converting kitchens to all electric also consider the potential to reduce supply and exhaust ventilation flow rates. This can save fan and cooling energy, create quieter spaces and reduce material use in the fitout.

Location and space

Induction cooktops save space, creating additional workspace when not used for cooking, and, through their controllability, being able to replace other specialist equipment.

Benefits and other reasons to electrify

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. The next page outlines the reasons why and the financial benefits.

In domestic settings, consumers (and developers) are increasingly aware of the improved health and safety, ease of cleaning, and better controllability of induction cooking and making the switch from gas. As interest in avoiding the impact of indoor air pollutants associated with combustion and methane leakage from gas cooktops grows, the pace of the transition is likely to increase.

Retrofitting a commercial kitchen

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 study by North Sydney Council in 2022[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	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	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	90%	3 min 35 sec (0.5L water)	36,035 MJ	59%	$789	$6,500	
Deep fryers	Gas	• Hard to clean	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	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	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	76%	-	26,658 MJ	78%	$584	$10,970	

[d] With thanks to North Sydney Council for allowing us to use this information.

Other systems

Key questions

1. What other gas or fossil fuels are used in the building?
   a. For each of those systems, what is their expected life?
   b. Are there other alternatives that can be considered?
2. How much energy do these systems consume?
3. Is there a business case to bring the replacements forward in alignment with your zero carbon strategy?

Potential sources of fossil fuels in your building

- Steam
- Laboratory equipment
- Industrial processes
- Backup and emergency power
- Cogeneration equipment

Other uses of natural gas in buildings

There are a range of specialist uses in some buildings and not all of these have a simple alternative to fossil fuels. 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

Alternatives to bunsen burners connected to a central gas system include portable burners using butane/propane/LPG canisters and electric bunsen burners.

Industrial processes

While outside the scope of this guide, green hydrogen produced from renewable energy sources is predicted to become an important energy source to decarbonise industrial processes with high heating requirements such as steel production.

Backup and emergency power

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

Some alternatives to diesel generators that could be considered are outlined below.

- Biofuel
- Batteries
- Green hydrogen

Cogeneration equipment

Gas fired cogeneration systems (generating heat and electricity for use in buildings) were, for many years, considered a low carbon transitional technology as they reduced the consumption of grid electricity and also provided a source of heat. In trigeneration systems, the heat generated was used to drive an absorption chiller to make use of the heat during periods when heating is not required.

The benefit of running a cogeneration system relies on natural gas being relatively cheaper than grid electricity, making efficient use of the heat generated all year round, and the grid electricity network not decarbonising rapidly. In many buildings with existing cogeneration systems these conditions are no longer being met.

Removing cogeneration may simply be a case of turning it off and then removing it from the building. However, in some cases the system may form an integrated part of the emergency power back-up, the overall heating capacity and/or the overall cooling capacity (including low load cooling). Careful consideration of how to decommission the cogeneration system may be necessary, including increasing emergency generation, heating systems and/or electric chiller capacity as required. However, there are benefits as well, with plant space becoming available for other uses.

From a climate impact perspective, cogeneration systems should be phased out quickly from all buildings.

Electric vehicles

Retrofitting electric vehicle charging points

While not the subject of this guide, retrofitting electric vehicle (EV) chargers into a building can serve as a potential intervention point to electrify other systems. This is because the work required to assess and potentially upgrade the electrical capacity or demand is similar to that which is needed to electrify other building systems.

There are a number of elements that must be taken into account when considering EV charging:

- Number of car spaces to have charges (now and in future as car fleet changes)
- Type of charges (rapid charge vs trickle charge)
- Control of charging including demand management
- Aligning time of charging with onsite renewable energy and/or peak tariff periods
- Electrical system capacity.

All of these have implications on the loads that will be introduced into the building. In non-residential buildings, there may be a mixture of limited overnight charging, dedicated short term charging bays, and dedicated fast chargers. In residential buildings, the expectation might be for all occupants to have dedicated overnight charging, with a limited number of fast charging bays for emergencies or visitors.

In most cases, EV charging will induce significant demand in a building. The demand requirements may be in excess of the building's capacity, particularly when combined with other electrification measures (refer to Electrical capacity section). While energy efficiency measures can help in driving other loads down, a smart load management system will be required for the EV charging system. The smart load management system monitors power consumption and peak times and manages the amount of electricity supply available for charging. The load management system can also help shift charging to a time when renewables are strongest or when electricity prices may be low.

There are a number of dedicated guides to help you in retrofitting EV charging in existing buildings. For Australia, the NSW Government recently published a guide to make commercial and residential buildings EV ready.

Electrical capacity

The electrical capacity of a building is a potential challenge to removing gas and switching to all electric systems. This section provides an overview of some of the issues to consider, and why the issue may not be as big a barrier as first thought.

Key questions

1. What is the electrical capacity of the existing substation and main switchboard?
2. What is the actual annual peak electrical demand in the building based on historical data when the building is operating normally (i.e. not during Covid)?
3. How much measured spare capacity is there when the current annual peak demand occurs?
4. Are there any other proposed changes to the building that will change existing electrical demand (increasing it by electrifying, or decreasing it through energy efficiency and demand management)?
5. Is other space available for electric systems that can't be installed in existing plant rooms or the main switch room?
6. What impact would there be from including electric vehicle charging on the building's switchboard capacity or substation?

Terminology

Substation

Converts high voltage electricity from the grid down to a lower voltage for use in buildings via a transformer. Substations and transformers can be located in the street, on poles or inside larger buildings

Main switchboard (MSB)

Located inside the building this is the hub from which the electricity supply to the building is distributed to other switchboards and includes circuit breakers, meters, power factor correction and other controls.

Annual peak electrical demand

This is the highest power load (measured in kW) that occurs in the building at a moment in time during the year. It often occurs on the hottest day of the year when all cooling systems are switched on. If the peak electrical demand exceeds the electrical system capacity, then it trips out the electrical supply. This is why systems are often designed with lots of spare capacity that isn't used.

Managing peak demand

Space heating

The peak demand for heating (winter) does not occur at the same time as the peak demand for cooling (summer). Switching from gas boilers to heat pumps for space heating typically does not increase the annual electrical peak in most climate zones in Australia. An exception may occur if heat pumps are used for reheat as part of the dehumidification process.

Domestic hot water

The electrical demand for domestic hot water is typically consistent all year round. To reduce peak electrical demand consider thermal storage in central systems. For point of use systems, the installed capacity can be quite high so review the load diversity assumptions when calculating the peak electrical demand.

Cooking

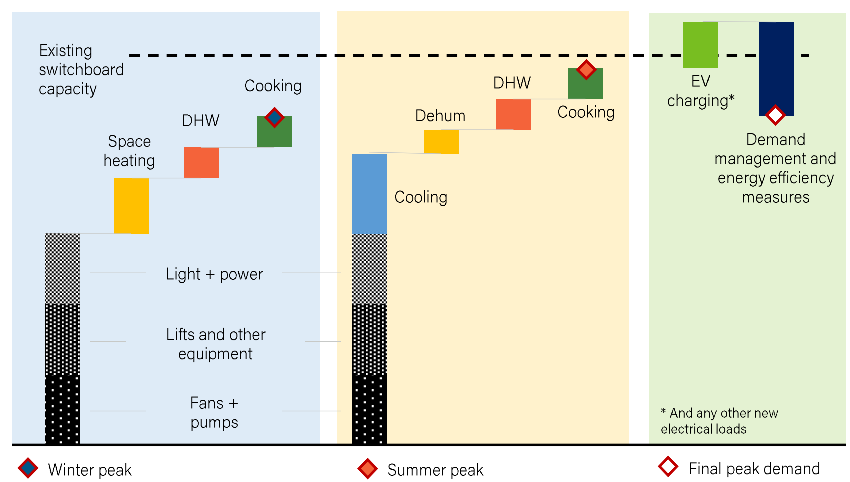
The use of all-electric cooking is still evolving and further data on peak electrical demand and load diversity, particularly in shopping centres and apartments with multiple kitchens, will become available over time.

Electric vehicles

The transition to electric vehicles (EV) will see an increase in the number of buildings providing vehicle charging points. A plan should be developed to manage the peak electrical loads due to EV charging as part of an overall building electrification strategy.

Visualising peak demand in a building

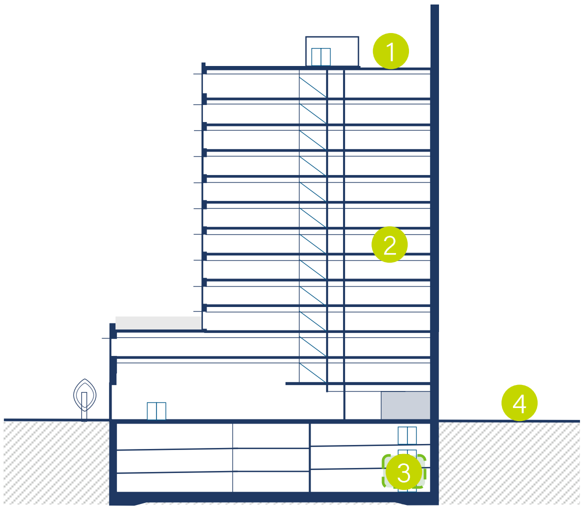
This illustrative chart shows how to evaluate the winter and summer peaks after electrification compared to the annual capacity of the building.



Space and location

Converting an existing building to be all-electric will typically require considering where the heat pumps for space heating and domestic hot water can be installed. The location of the existing plant rooms will influence what building modifications may be required.

Space and location considerations



Plant location opportunities and challenges

What else to consider when moving the plant room

If you need to relocate the heating hot water or domestic hot water central plant then consider the following:

- How will the plant be connected to the central reticulation pipework?
- Can the length of new pipework be minimised to reduce pipework heat losses and pumping energy?
- Can distributed domestic hot water systems (or a hybrid system of central and distributed) be adopted if there is limited opportunity to find additional space?

	Space for plant	Ventilation	Building structure
1. Plant on roof (external)	Roofs often have additional space although need to check height restrictions and potential visual impacts.	Natural ventilation is typically easily achievable on roofs.	Concrete roofs will typically be able to support the plant. Lightweight roofs may require structural strengthening.
2. Plant room inside building	Internal plant rooms may need to be extended which may not be practical.	If the plant room is on the perimeter then additional louvres may suffice to provide adequate cross ventilation. Internal plant rooms may need to be relocated or plenums installed to provide adequate ventilation.	Plant rooms will typically have sufficient capacity, but if the plant room is extended to other parts of the floor the structure will need to be checked.
3. Plant room in the basement	As per 2	Providing adequate ventilation to air source heat pumps in basements will often be a significant challenge. Finding alternative locations for the heat pumps will typically be necessary, although the basement space can be used for thermal storage.	As per 2
4. Plant room outside the buildings	External space for plant is highly dependent on the building type and location. Will be challenging in city centre locations.	Natural ventilation is typically easily achievable in external locations.	Review the load requirements and provide appropriate foundations and slabs.

Notes

1. The table above provides generic advice. Each building is unique and requires detailed evaluation of the spatial and ventilation requirements by a mechanical engineer, and a qualified structural engineer for structural requirements.
2. Changes to the building envelope (e.g. new louvres) or locating plant on the roof may require planning permission and evaluation of potential visual and noise impacts on neighbours.

CASE STUDY

Case study: 600 & 678 Victoria Street

Location
Melbourne, Vic

Sector
Commercial

Developer
Salta Properties

Consultant
Building-Performance

Optimising assets for today and tomorrow

Planned lifecycle upgrades triggered a decision to replace chillers and offset gas-powered boiler systems with heat pump systems at 600 and 678 Victoria Street in Richmond, Victoria. The buildings are both multi-tenanted A-Grade commercial assets owned by Salta Properties, one of Australia's largest privately owned companies.

The upgrade projects were managed by Building-Performance. "Achieving 100% electrification should be a priority for every building, but we must also recognise that we can do this over a period of time. Every gas asset should have a long-term strategy for replacement and those approaching the end of their economic life must be reviewed for how they can be electrified. This approach creates a sustainable and economically sound route to decarbonisation. These projects showed we have dramatically minimised the dependency on gas through heat pump technology, but we won't decommission boilers until the end of their economic life," says founder of Building-Performance, Liam Murray.

Initially, the final temperature of the peak load system (less than 2% of heating demand) will be achieved using boilers. This is because the difference between water in the pipes and room temperature (the delta T) with heat pumps is not large enough to use the existing pipework. Within three years, both sites will decommission their boilers and switch to electric calorifiers that will provide a high temperature injection to help the peak load system reach the required final temperature.

Key electric features

Domestic Hot water

Space heating

Additional buffer tanks were required for both upgrade projects meaning that plant room space needed to be found and structural support added.

Despite the challenges, upgrading the systems to electric represents a significant step towards achieving net zero operations for the buildings and owner, Salta Properties, has had several other benefits, too.

The new system provides significant storage of both hot and cold water which helps avoid the impacts of peak demand periods. It also helps to enable the installation of photovoltaic systems that will be added to the buildings over the coming years to buffer future energy demands.

The projects have also been valuable in demonstrating how retained assets and infrastructure will need to be managed and upgraded in the future to meet a range of goals, including optimal building performance.

> Salta Properties is committed to future proofing our assets and mitigating risks, including the impacts of a changing climate, for our tenants and other stakeholders. All new developments at Salta are fully electric and electrification of our existing assets has an important role to play, starting with upgrading existing systems such as those at 600 and 678 Victoria Street.
>
> NIKKI PATON | Head of Sustainability and Operations Strategy, Salta Group

CASE STUDY

Case study: Vicinity Centres Portfolio

Location
Australia

Sector
Retail

Developer
Vicinity Centres

Consultant
Cundall

Vicinity Centres, one of Australia's leading retail property groups has 61 retails assets under management and a target of net zero carbon emissions for the common mall areas of their wholly-owned retail assets by 2030.

Vicinity recognises that electrification will play a central role in its decarbonisation journey (along with energy efficiency, renewable energy and lastly, carbon offsets), so they are currently investing in work that will help them to understand the opportunities and challenges for electrifying their diverse portfolio. Cundall are working with Vicinity to examine the importance and benefits of electrifying their existing assets and to develop feasibility studies for five different types of assets represented in the portfolio. This includes heritage buildings, small 'neighbourhood' shopping centres, larger regional shopping centres and large 'shed' type centres, such as DFOs.

The work will focus on what technology will be needed, space requirements and cost estimates – all key considerations for planning upgrades to existing assets.

Having the right knowledge and resources to effectively engage with tenants will be critical, particularly those in food and hospitality where cooking with gas is currently the norm. This work will help to inform internal and external stakeholders of the importance of electrification and the benefits that it can deliver.

Key electric features

- Domestic Hot water
- Space heating
- Cooking

> "We are working with Cundall to develop a bespoke roadmap that will put Vicinity in the best position to integrate electrification into capital expenditure planning and to maximise the opportunities that arise in planning and budgeting processes. We want to be able to make the most of every decision point for both existing buildings and new developments to ensure we are electric wherever possible.
>
> MATEA ČEHOVIN | Sustainability Manager – Environment, Vicinity Centres

CASE STUDY

Case study: 275 Kent Street and 8 Chifley Square

Location
Sydney, NSW

Sector
Commercial

Developer
Mirvac

In 2014, Mirvac set an ambitious target to be net positive in carbon by 2030 for our scope 1 and 2 emissions.

But targets aren't much without a plan. So, in 2019 we published Planet Positive - Carbon, our approach to help us reach this goal.

In 2021, Mirvac reached its net positive carbon target nine years early, by maximising energy efficiency, purchasing renewable electricity, investing in a small amount of high-quality, community focussed carbon offsets and progressing electrification across our portfolios.

When the end of trip (EoT) facilities at 275 Kent Street and 8 Chifley Square were due to be enhanced, there was a key focus on avoiding gas use for hot water and instead using an electric heat pump which aligned with our electrification strategy. However, there were a few challenges to overcome.

Firstly, space availability. At 275 Kent Street, the heat pumps were installed next to the EoT in a dedicated plant room, but at 8 Chifley Square, a car park space had to sacrificed as there was insufficient plant room space close to the EoT facilities.

Value is also a key consideration. Heat pump systems typically have higher purchase and installation costs requiring additional funds to be committed in capital expenditure budgets, but any additional costs need to be considered in the context of future proofing assets rather than a narrow return on investment focus.

Key electric features

- Domestic Hot water
- Space heating

Electrification projects can be more complex so stakeholders involved in the decision making, planning and delivery of projects should be involved as early as possible.

Despite the challenges, these projects are delivering significant benefits. Not only are these upgrades an important step on the journey to decarbonising Mirvac's portfolio, they are also clearly demonstrating the feasibility of electrification and generating important learnings for subsequent projects.

Key benefits include:

- Removing fossil fuel use and the associated carbon emissions from the operation of the EoT facilities at 275 Kent Street and 8 Chifley Square.
- At 275 Kent Street data shows that the heat pumps are already realising operational cost savings.
- Modelling is underway for replacing gas systems with heat pumps for entire buildings with indications of more operational cost savings to be made.
- Future proofing assets and reducing carbon offset requirements.

> "By designing, creating and managing high quality, energy efficient buildings operating on renewable energy, we not only reduce our own emissions and impact, but we can also demonstrate the benefits of working as a 'force for good', inspiring and influencing others to do the same.
>
> DAVID PALIN | Sustainability Manager, Mirvac

CASE STUDY

Case study: QuadReal Property Group

Location
International, Canada

Sector
Commercial, Industrial, Residential

Developer
QuadReal Property Group

QuadReal reduces reliance on carbon through innovative assessment

QuadReal Property Group is a global real estate investment, operating and development company headquartered in Vancouver, Canada, with a growing portfolio of real estate assets in Australia, as well other countries around the world. Currently, there is a portfolio wide effort underway to reduce QuadReal's carbon footprint and dramatically increase energy performance.

Turning data into solutions

At one of QuadReal's office buildings, Park Place in Vancouver, the Building Operations team conducted energy studies which indicated the property's energy usage and costs could be reduced with the installation of a heat recovery system. Two heat recovery chillers were installed to allow waste heat from the cooling systems to be captured and re-used to heat other parts of the building. The heat recovery chillers act as heat pumps to deliver heating, a process that significantly reduces water usage, steam consumption and greenhouse gas emissions. The system delivers an annual energy cost saving of over $110,000 AUD.

Commerce Court, an iconic, multi-building complex in the heart of Toronto's financial district is connected to a district energy loop project that uses deep lake water for cooling. Recently, while assessing the buildings natural gas-based heating equipment that was coming to its end-of-life, the team began searching for a low carbon solution.

Key electric features

Space heating

QuadReal proposes to utilise the waste heat loop from the district cooling system and through on-site heat pumps upgrade the heat to provide all the heating needed for over a million square feet of office space at Commerce Court. This would reduce the annual carbon emissions of the complex by 6,000 tonnes.

These are just two examples of how QuadReal is evaluating its portfolio, reducing its overall carbon footprint and working towards its goal of building better, smarter and more sustainable properties.

> "As a part of our commitment to reducing our environmental footprint we invest in innovative solutions. One innovation is to track all-natural gas using equipment in our energy management software and begin zero carbon pathway assessments three years ahead of end of life of that gas equipment. We project this will double our pace of portfolio carbon reduction from 2% per year to 4% per year.
>
> JAMIE GRAY-DONALD | Senior Vice President, Sustainability & Environmental, Health & Safety, QuadReal

CASE STUDY

Case study: Kawakawa, Dargaville & Kaitaia hospitals

Location
Northland, New Zealand

Sector
Health

Developer
Te Whatu Ora Health New Zealand – Te Tai Tokerau (formerly the Northland District Health Board)

Te Whatu Ora Te Tai Tokerau has committed to halving their emissions by 2030 from their 2016 baseline and to reach Net Zero carbon emissions before 2050.

As part of its decarbonisation strategy, Te Whatu Ora replaced a centralised diesel boiler at Kawakawa hospital with modern heat pumps. This electrification project was so successful that the boilers at Dargaville and Kaitaia hospitals quickly followed suit.

Each new system can operate independently, providing each building with its own source of domestic hot water and heating with the replacement of the old diesel boilers resulting in immediate energy savings. The energy performance of the 3 hospitals improved from over 300 kWh/m2 per year to between 111 and 182 kWh/m2 per year representing a 40% to 60% reduction in energy consumption.

The heat pumps can be adjusted in response to seasonal variations, building occupancy and the fact that not all wards are open day and night.

The electrification also meant that the steam reticulation pipes to the boilers could also be removed – a common source of energy and carbon savings as these pipes continuously lose heat.

Key electric features

- Domestic Hot water
- Space heating

Dargaville hospital is expected to save $111,000 on energy costs and $41,600 on maintenance. Kaitaia expected to save $89,000 on annual energy costs and $53,900 on maintenance. Diesel savings at both hospitals was 282,000 litres, leading to a carbon saving of 794 tonnes a year representing a reduction in carbon emissions of over 70% prior thanks to the electrification projects.

Aside from the clear financial benefits, the electrification projects have gone a long way towards reducing the use of stationary diesel on the three sites and in turn significantly reducing carbon emissions.

Case study: 22 The Terrace

Location
Wellington, New Zealand

Sector
Commercial

Developer
Stride Property Group

The revitalisation of 22 The Terrace demonstrates how a seismic strengthening project of a stereotypical commercial building in New Zealand can represent an opportune time to significantly improve the building's environmental performance and decarbonise building operations through electrification.

22 The Terrace is a late 1980's office building which received a full building refurbishment, including:

- Earthquake strengthening to 100% new building standard (NBS) to improve the building resilience.
- Upgrade of the building thermal envelope to reduce heating and cooling loads and improve thermal comfort.
- Replacement of the existing gas boilers with all electric heating and domestic hot water heat pumps.

Sustainability consultants Beca carried out a comprehensive review of energy efficiency initiatives to inform the Green Star and NABERSNZ 5 Star strategy. This helped steer the services design away from the existing fossil fuel infrastructure towards new energy efficient electric air source heat pumps. The removal of all fossil fuelled systems from the building, new energy efficient HVAC and lighting systems, and retrofit to the building thermal envelope, resulted in an estimated 73% reduction in annual operational carbon emissions.

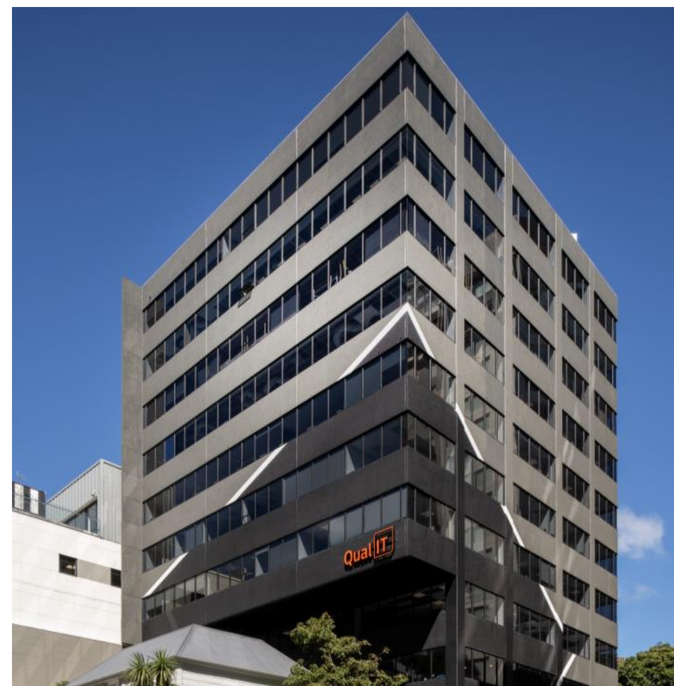
Key electric features

Domestic Hot water

Space heating

To support the increased electrical load, the main switchboard, already at the end of its economic life, was upgraded along with a new sub-main installed to support the new air source heat pumps located on the roof of the building. The existing transformer was able to be reused with careful assessment of the electrical loads and the installation of a load management system for the EV charging infrastructure which adjusts the rate of EV charging in real time to keep the transformer loading within the existing capacity.

This project demonstrates how recycling existing building stock can minimise life cycle carbon emissions from upfront and operational carbon emissions through strategic retrofit and electrification of the existing fossil fuelled infrastructure. This building highlights that electrification is not the preserve of Premium and A-Grade assets but is a sound portfolio strategy across all parts of the building market.



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," says Neil Perry. "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

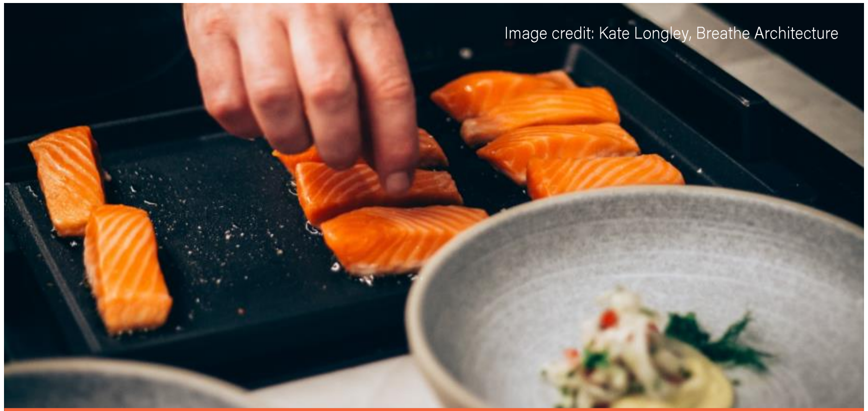


Image credit: Kate Longley, Breathe Architecture

Greater energy efficiency means kitchens save money not only on the cost of fuel, but on air conditioning 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 24°C 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

Marketing an all-electric building

Investors

An all-electric building is ready for the decarbonisation of the electricity 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 Performance rating.

The reason why an all-electric building is aligned with these frameworks is simple – the building 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.
- Reduce pollution in our towns and cities 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 Performance requirements for energy sourcing in existing buildings (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 reduced 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 few years as the market changes. Your existing building should be ready to assist tenants who are on this journey.

Domestic buyers and tenants

For many years 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:

- Induction kitchens are healthier, safer, and give you more control.
- Gas stovetops emit toxic 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 safer for children as the surface of an induction cooktop does not stay hot! Much less chance of 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 GBCA 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 Performance v2, introduced in 2022, 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 1.5°C trajectory. To achieve this, Green Star Performance v2 introduced requirements for buildings to transition to 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 building in operations must be fossil fuel free by 2026. This requirement will apply to 5 Star ratings by 2030, with all ratings to be fossil fuel free by 2040.

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

By 2026 buildings that seek this rating	**By 2030** buildings that seek this rating	**By 2035** buildings that seek this rating	**By 2040** buildings that seek any rating
6 star	**5 star**	**4 star**	**1–3 star**
World Leadership	Australian Excellence	Best Practice	
Must be fossil fuel free	Must be fossil fuel free	Must be fossil fuel free	Must be fossil fuel free

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 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. The next update is scheduled for 2025.

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, as NABERS is now using more accurate, lower factors for electricity than it used to.

From 2023, NABERS will introduce a Renewable Energy Indicator[26], 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.

Other frameworks promoting electrification

In addition to Green Star and NABERS, other international frameworks will drive the delivery of all-electric existing buildings rapidly. These are the top three.

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.

In 2021, CBI approved two of the GBCA'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 part of the 'We Mean Business' coalition, 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).

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.

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 has highlighted that driving assets to net zero carbon is a key concern. All-electric buildings will have a better opportunity to perform in this space in the future.

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 use of on-site and 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, 82% 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 hydrogen?

Transforming the gas network and buildings to use 100% green hydrogen or biofuels is typically more difficult than adding renewables to the electricity grid.

Much of 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 buildings in the network would need to have their equipment replaced prior to switching over to hydrogen.

It also takes three times[27] as many renewables to create green hydrogen as it does to power something with electricity. While hydrogen production will become more efficient with new technologies being developed, there will still likely be an energy loss compared to direct electrification through renewables.

Over the longer term, in certain locations with large seasonal heating loads, green hydrogen may be competitive when factoring in peak demands on the electricity grid. This will only occur if the production of green hydrogen becomes more efficient and costs come down. For now, a better use for hydrogen and biofuels is in sectors that cannot easily electrify, like manufacturing.

What about green gas?

There is very limited supply of biogas into the national gas grid and this is unlikely to change in the foreseeable future. Like hydrogen, it's better to use biofuels in manufacturing, processes and transport.

What about carbon offsets?

Offsets should only be used as a last resort after all practical direct emissions reduction measures have been implemented. 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 generating renewable electricity which is decreasing.

The cost of heating with electricity 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 and gas servicing and safety check costs. A well-designed electric system can also 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 space for all electric design

This can be a challenge in existing buildings but there is usually a solution to be found. See Space and location section and the case studies.

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. Adding all electric systems, combined with demand management controls can avoid having to upgrade the electrical supply to the building.

Tenants and home owners only want gas

As induction cooktops become more common, their benefits to users and building occupants are becoming more widely appreciated – 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 increasingly 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.

Operational rating tools penalise switching to all-electric

Green Star Performance rewards making buildings fossil fuel free. It is also introducing mandatory requirements for buildings targeting 6 star to be fully electric by 2026 and has announced requirements for the other star ratings that will stagger over time between now and 2040.

Higher NABERS Energy ratings were, until 2021, harder to achieve with electric heat pumps than with gas boilers. The 2022 revision of the carbon coefficients for grid electricity will reduce this impact. These will be updated regularly and reflect grid decarbonisation in each state and territory.

I run the risk of breaking my NABERS ratings lease requirements if I electrify!

Based on the latest update to NABERS, this will be unlikely if the refurbishment is carried through carefully. Furthermore, electrifying a building is something that you should undertake over time, and part of that undertaking is to engage with your tenants about the benefits of electrification as part of net zero carbon strategy.

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

There are no mandatory 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. Victoria's Gas Substitution Roadmap outlines changes to the Victoria Planning Provisions to remove gas connection requirements for new residential subdivisions.

Should I keep using gas now and convert later?

If the opportunity to electrify exists now, take it! The benefits of electrification are significant, from health to climate. Also, costs for electric equipment are coming down as the technology has become more mature. Finally, investor, tenant and consumer preferences are shifting. The question that you should be asking is, why haven't I electrified yet?

Appendix: terminology

Carbon offset

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

Emission scopes

A mechanism for classifying different sources of GHG emissions used in carbon accounting[28]. 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 28.

Hydrogen

Hydrogen is a fuel that can be used to generate heat or electricity 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[29] 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.

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 for buildings at this stage.

Carbon neutral

A carbon neutral building, as defined in the Australian Government's Climate Active standard[30], 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

The Climate Positive pathway[31] in Green Star Performance requires buildings to:

- Meet an energy consumption 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.*

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