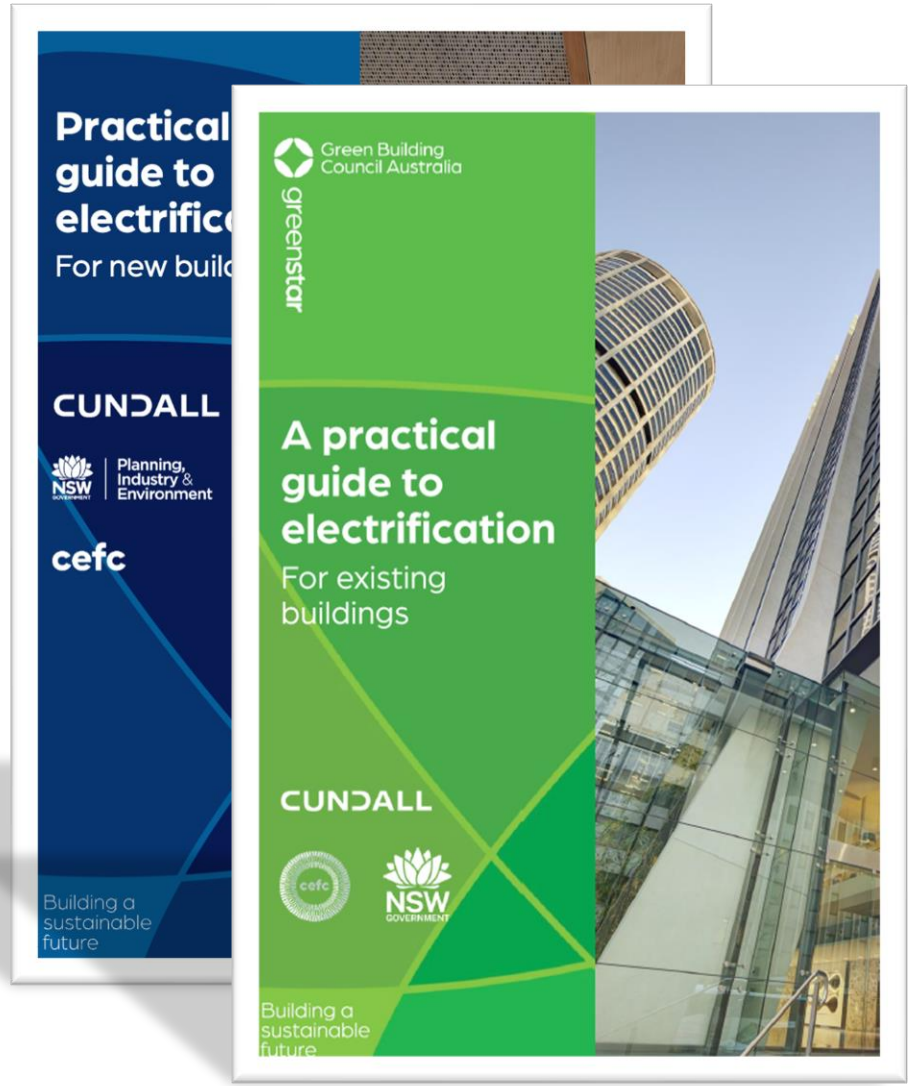
Green Building Council Australia

Building a sustainable future

A practical guide to electrification

For existing buildings



Practical guides to electrification

Two guides aim to overcome barriers to building electrification by:

- Educating industry practitioners in the process of delivering fully electric buildings
- Helping dispel misinformation, and
- Highlighting solutions for common difficulties.

New buildings released March 2022

Existing buildings released today

CUNDALL

Technical partner

cefc

NSW GOVERNMENT

Funding partners

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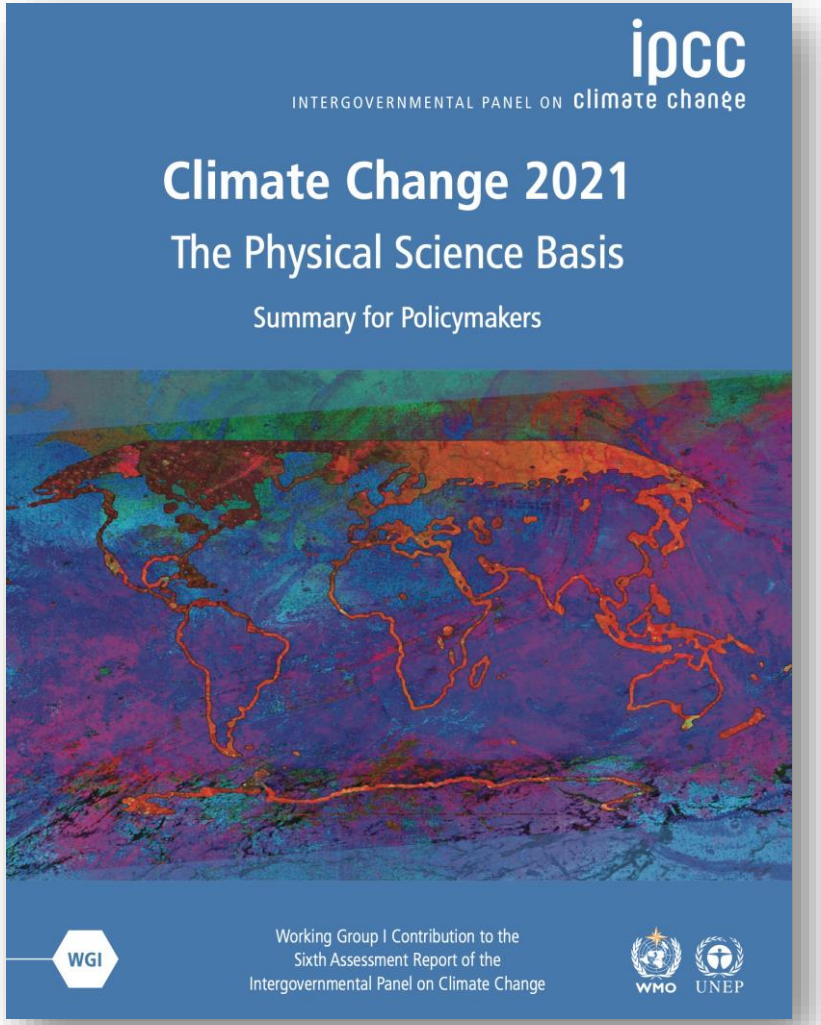
Why electrification?



> "Limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero emissions, along with strong reductions in other greenhouse gas emissions. **Strong, rapid and sustained reductions in methane emissions would also limit the warming effect**"
>
> IPCC – Sixth Assessment Report

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Why electrification?

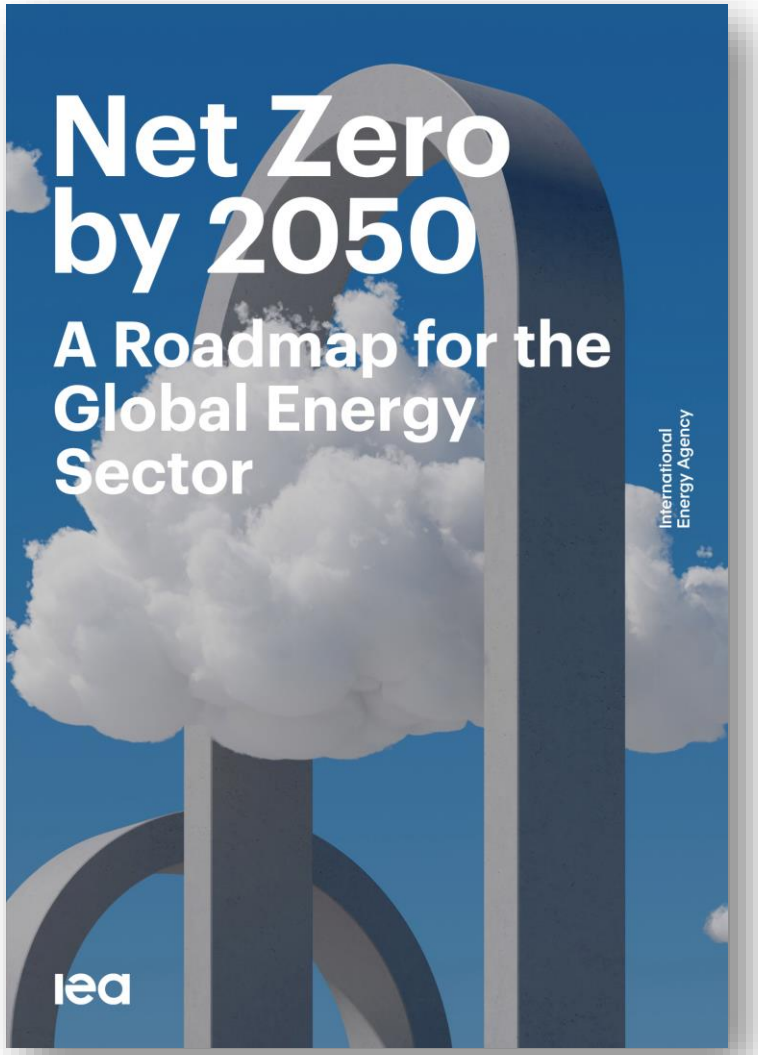
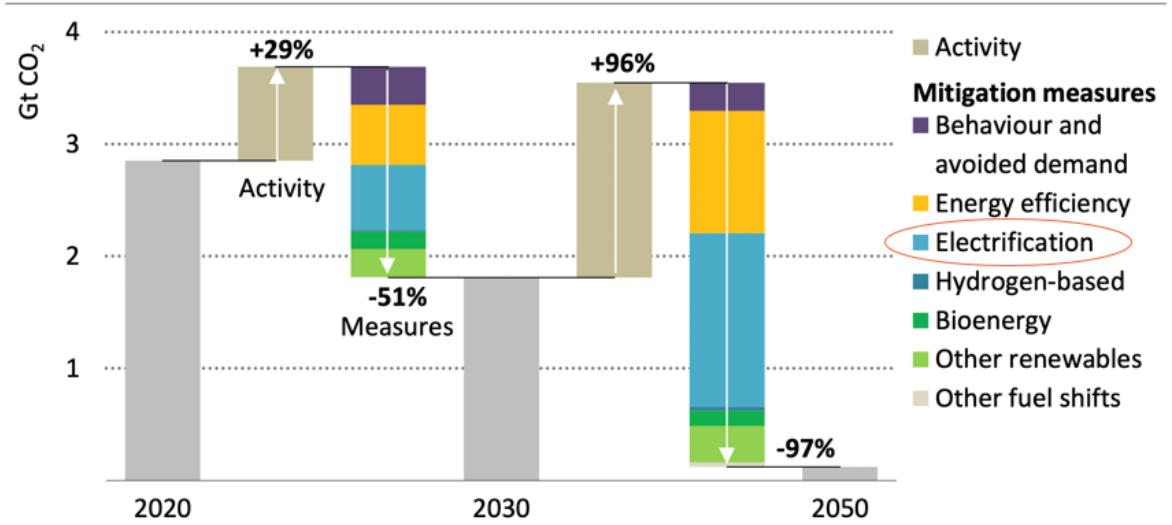


Figure 3.27 ▷ Global direct CO_2 emissions reductions by mitigation measure in buildings in the NZE



IEA. All rights reserved.

> "Electricity distribution is already well developed in many regions compared to essentially nonexistent hydrogen infrastructure"
>
> IPCC – Sixth Assessment Report 'Mitigation of Climate Change'

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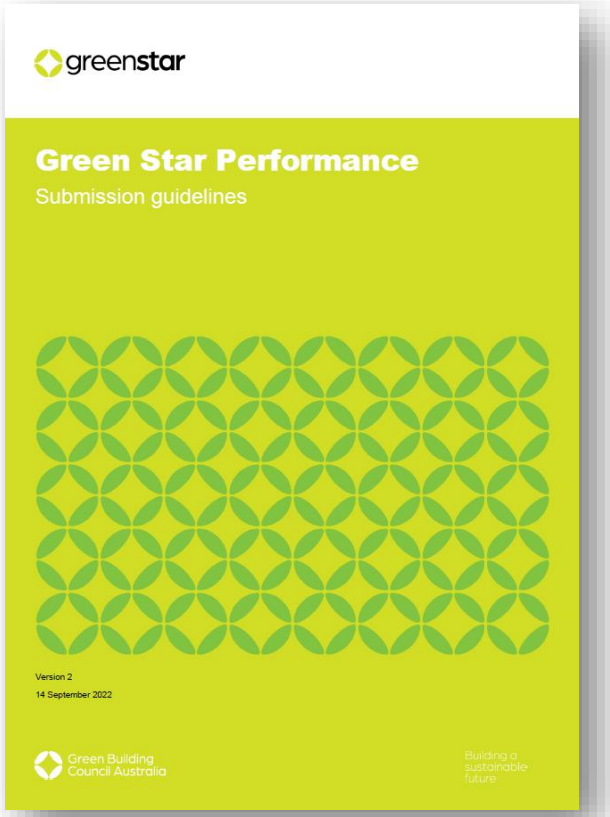
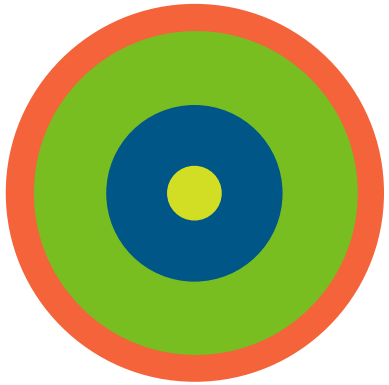
Why this guide?

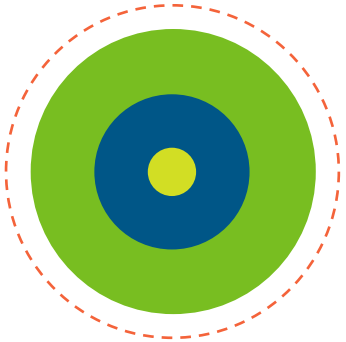


Delivering Climate Positive Buildings



Standard building

Electrification guide

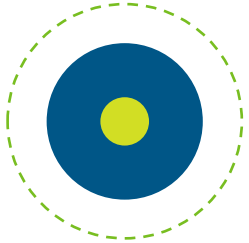


Fossil fuel free

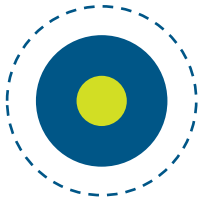
Eliminate natural gas

Space heating | Domestic hot water | Cooking

Highly efficient



Powered by renewables



Reduce embodied carbon

Offset with nature

Legend

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

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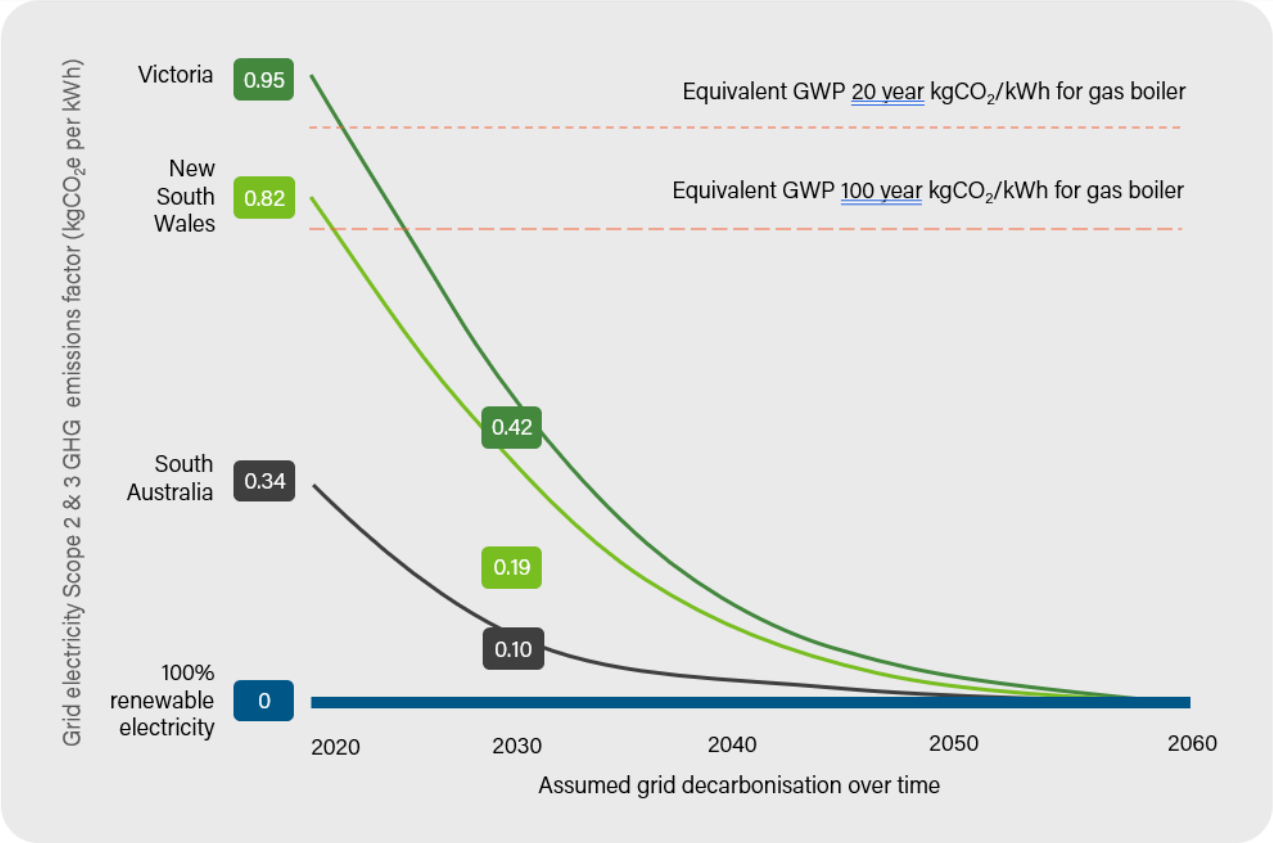
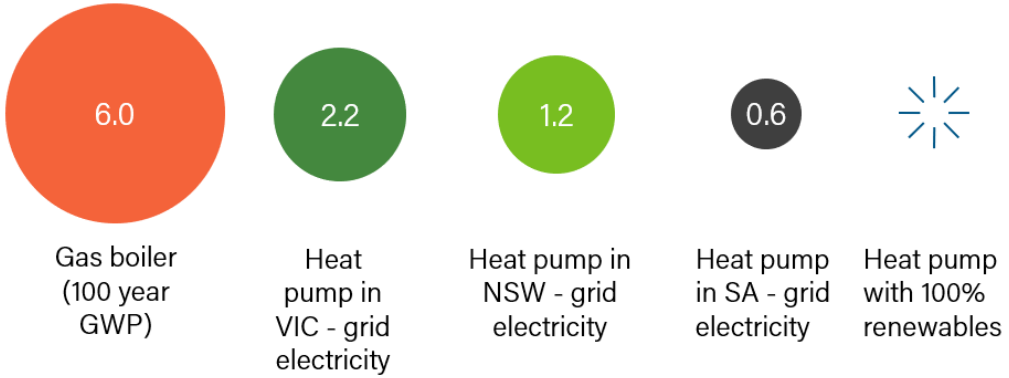
The case for electrification

- **Climate change**
- **Investor benefits**
- **Resilience and risk reduction**
- **Health and safety benefits**
- **Tenant and consumer preferences**

When does electric become lower carbon than gas?



Assumes a heat pump with an average coefficient of performance of 3 and a gas boiler with 90% efficiency.



GHG emissions over 25 years to produce 1 MWh of heat annually.

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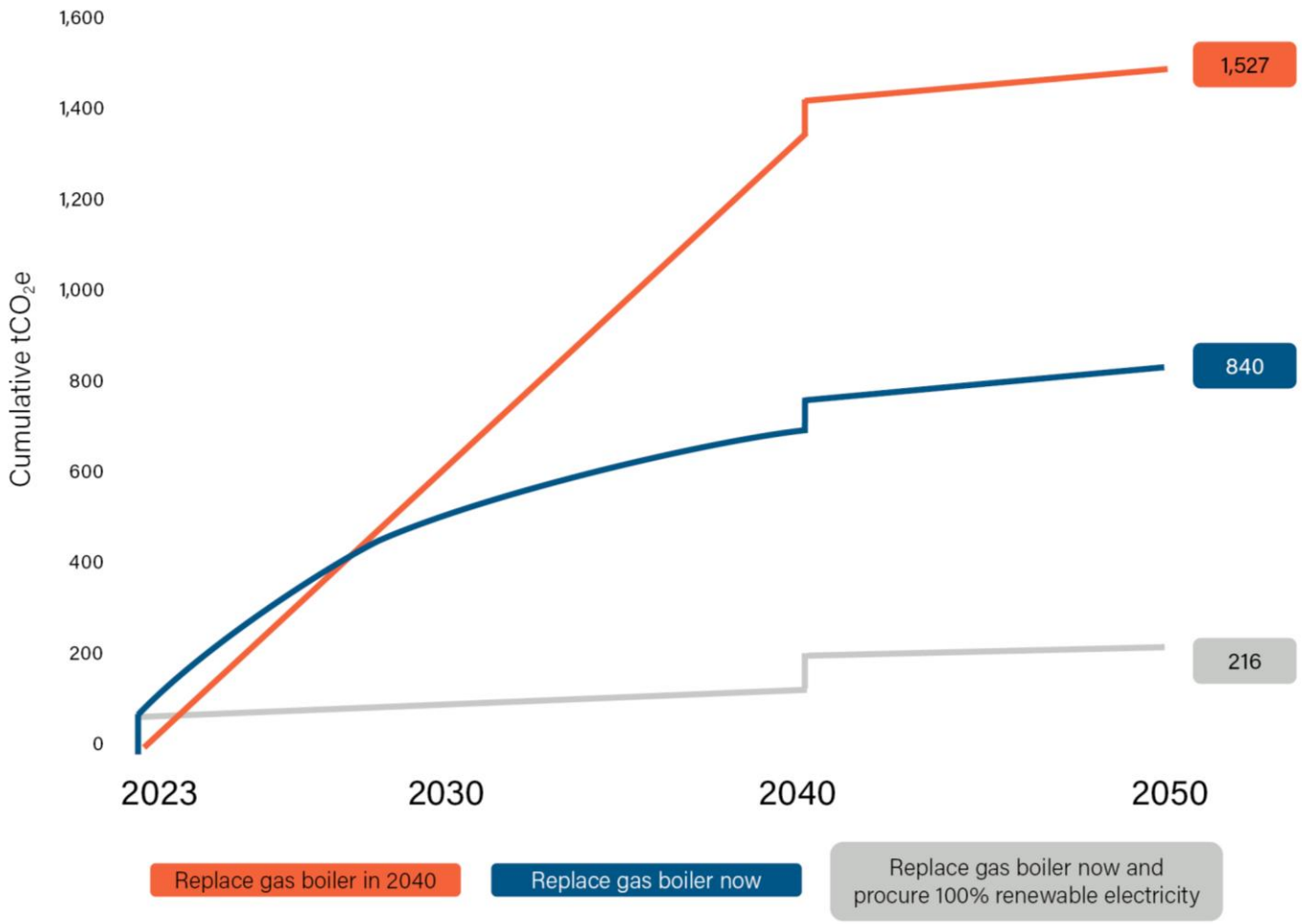
What about embodied carbon of equipment?



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).

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Planning to electrify a portfolio

First steps

Set zero carbon goals

- Zero Carbon portfolio plan
- Due diligence process
- No gas in new developments

Prepare high level portfolio plan

- Review fossil fuel use, equipment & systems
- Prepare feasibility study
- Identify priority opportunities

Engage with tenants and users

- Identify impacts
- Discuss benefits & costs
- Amend future leasing agreements

Between now & 2040

Prepare building plans

- Electrification plan
- Identify intervention points
- Integrate with other strategies

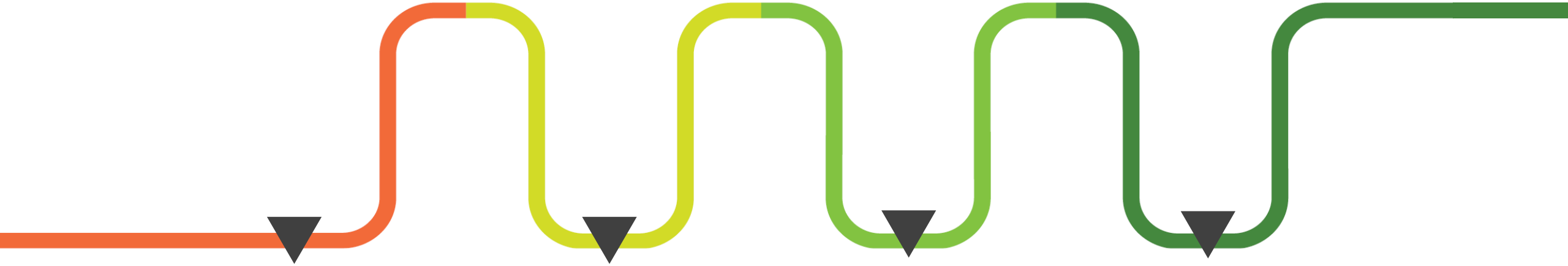
Deliver

- Integrate plans
- Actively engage with tenants
- Communicate plans to investors

Next steps

- Share learnings
- Prepare strategy for resilience
- Share plan with purchaser

Electrifying a building over time



Review building systems

- Identify all fossil-fuel using equipment & infrastructure
- Review asset plan & opportunities with planned replacement or other upgrade projects.
- Conduct feasibility study of potential electrification strategies
- Budget for consulting advice

Prepare the plan

- Audit existing systems infrastructure & prepare design and options report.
- Discuss benefits & costs with tenants
- Amend new lease agreements
- Align electrification works with other intervention points

Deliver

- Prepare design, specifications and drawings for the electrification works
- Engage other specialists as required
- Implement the works

Fine tune

- Fine tune the building systems and controls
- Identify and plan to remove any remaining equipment before 2040.
- Provide training and update building manuals.

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Key issues to consider when electrifying

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.

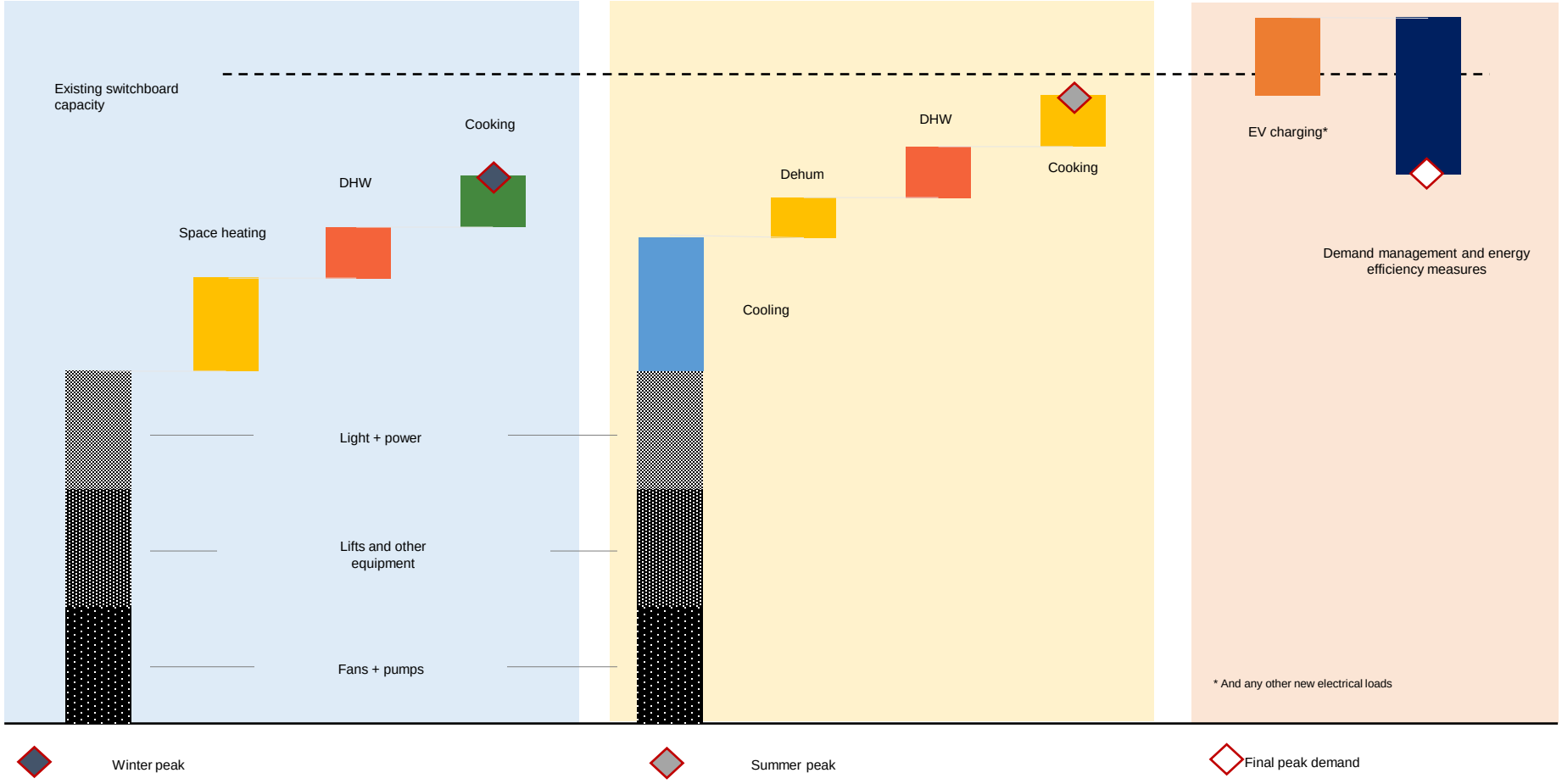
Lowering heating hot water temperatures has other benefits including:

- 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.

Electrical capacity



How to evaluate the winter and summer peaks after electrification compared to the annual capacity of the building.

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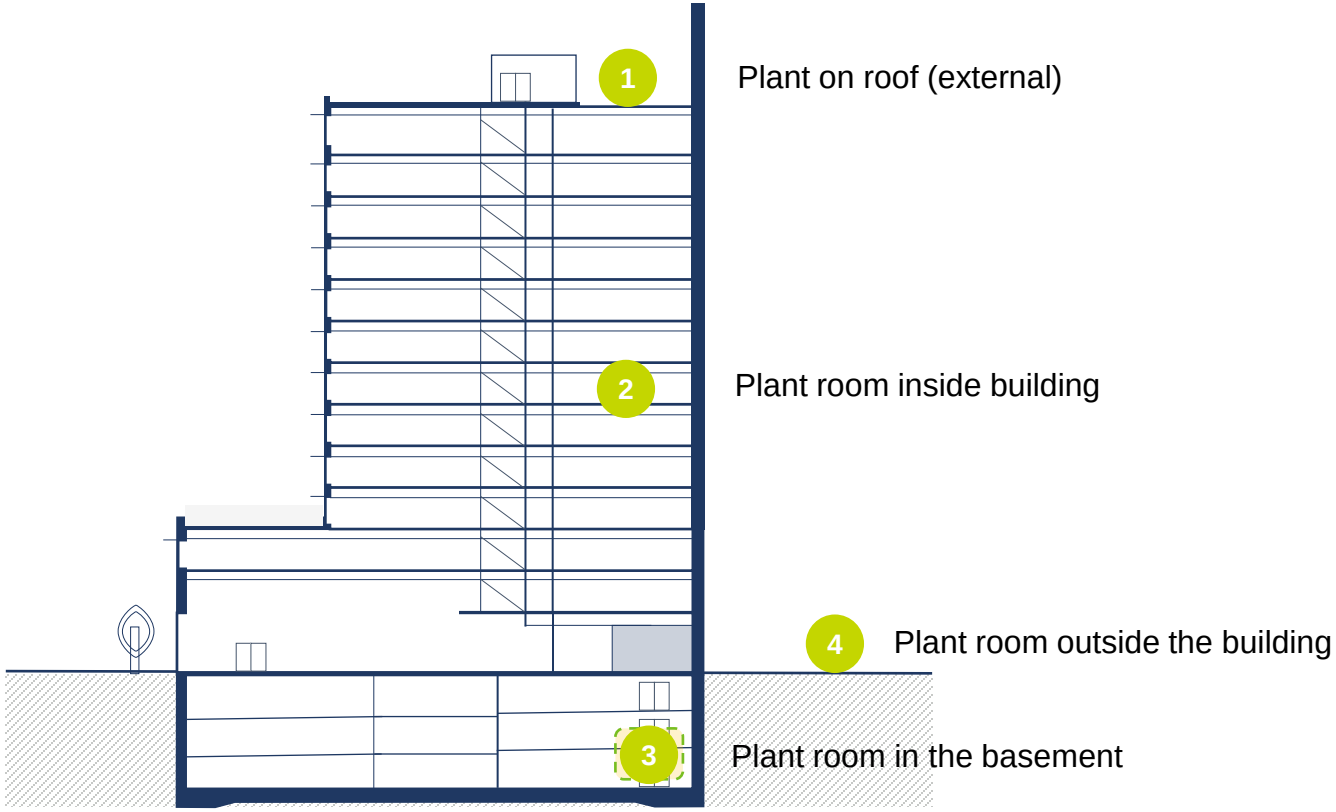
Space and location

Key issues to consider:

- Space for plant
- Ventilation
- Building Structure
- Visual impacts
- Acoustics
- Connection to existing systems if plant relocated



Plant location opportunities and challenges

The guide also covers:

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.

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	By 2030	By 2035	By 2040
buildings that seek this rating	buildings that seek this rating	buildings that seek this rating	buildings that seek any rating
6 star World Leadership	5 star Australian Excellence	4 star Best Practice	1–3 star
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 en

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Supporting Australia's net zero transition

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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.

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Plus some great case studies

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 be 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 DALIN | Sustainability Manager, Mirvac

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 59 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

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Acknowledgements

- Better Buildings Partnership
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- Mirvac
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- QuadReal Property Group
- Salta Properties
- Vicinity Centres

Thank you

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