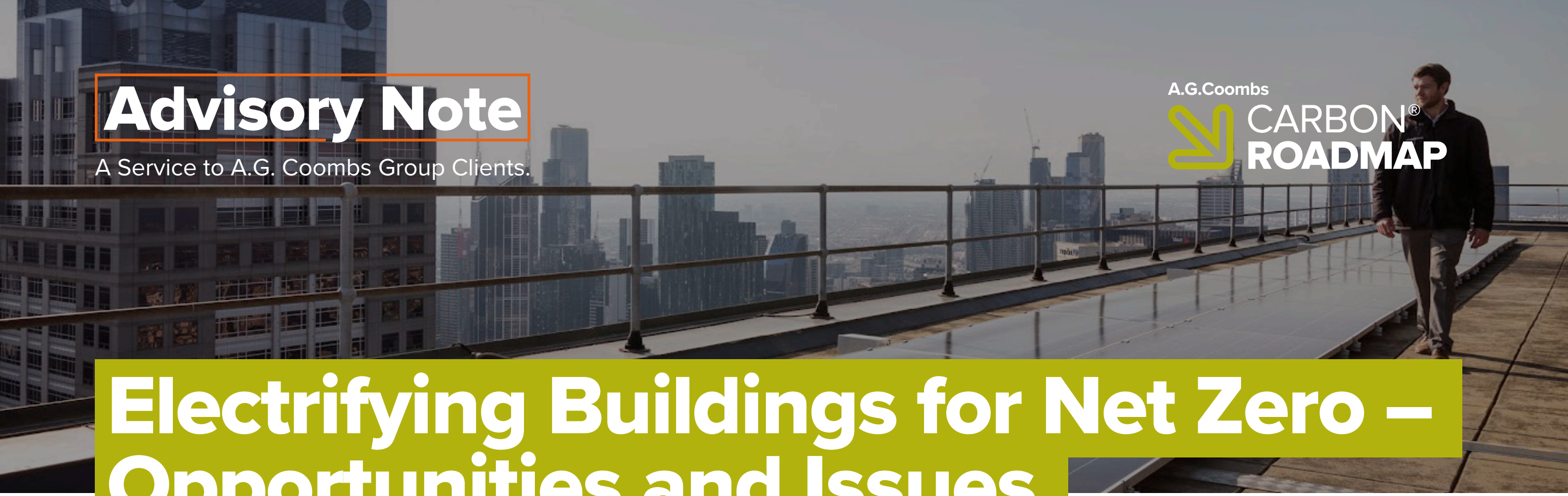

Advisory Note

A Service to A.G. Coombs Group Clients.

A.G.Coombs CARBON® ROADMAP

Electrifying Buildings for Net Zero – Opportunities and Issues

As businesses and building owners move toward reducing their emissions and achieving emissions targets, there is a growing requirement to convert buildings to be fully electric in order to decarbonise.

So Why Electrify?

The driver for electrification is not always the same for every building. For new buildings, it is an obvious choice to design and implement a system that does not rely on fossil fuels. However, for existing buildings the business case will vary.

The key benefits of electrification include:

+ Meeting the business emissions targets
+ Meeting Tenant requirements for All-Electric buildings
+ Ability to be powered by renewable energy sources
+ Changes in NABERS favouring All-Electric buildings
+ Future proof outgoings from rising gas tariffs

Fossil Fuels in Buildings

The most common use of fossil fuel in buildings is natural gas used for firing heaters to produce hot water for space heating, and domestic hot water heating. This typically represents between 10% and 30% of a building's Scope 1 and 2 greenhouse gas (GHG) emissions.

A number of buildings also rely on natural gas-powered cogeneration and tri-generation systems which provide on-site electricity generation and recover thermal energy to provide input to their heating and cooling systems. With the current emission factors used for NABERS ratings, these systems can currently provide an uplift to the building's NABERS energy rating.

Other fossil fuels that generally represent less than 1% of a buildings GHG emissions include gas cooking in kitchens and diesel use for standby or backup generators. Refrigerants also need to be considered with any NABERs Carbon Neutral Rating, however these do not impact a NABERs Energy Rating.

Where businesses currently claim Net Zero Carbon, Carbon Neutral or Climate Positive, they are often enabling this via eligible carbon offsets. These carbon offsets should be viewed as a measure of last resort to offset the emissions produced throughout the operation of the building. Whilst carbon offsets are currently recognised by rating schemes to offset fossil fuel emissions, this is not expected to be a long-term situation.

Grid Decarbonisation

At the time of writing, where the electricity grid relies mostly on coal fired power power stations, the use of natural gas for space heating and domestic hot water is generally considered to generate less emissions compared to an equivalent energy efficient electric heat pump system.

This is changing as the electricity grid decarbonises.

Grid decarbonisation relates to the decreasing of emissions per unit of electricity generated via the use of renewable energy sources and reduction in use of coal powered power stations throughout the Country.

Grid decarbonisation coupled with improvements in electric technology will mean that the extent of emissions required for electric retrofit options will be less than the gas powered equivalent. Electrifying already makes sense now where on-site renewable energy can offset any additional electrical power requirements or the grid is already operating on 100% renewable energy (e.g. ACT).

What are the Key Retrofit Considerations?

Space Heating Retrofit Considerations

Electrifying space heating systems can be challenging where natural gas is to be removed from the building.

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Small buildings are less complex with smaller and sometimes decentralised systems, whilst medium to large buildings that rely on larger central gas-fired heating hot water systems can be complex.

The most commonly considered retrofit option is electric heat pumps which utilise the refrigerants vapour compression cycle to convert electrical input power to thermal energy. There are multiple heat pump options available in the market with significant technology advances over the recent years. Depending on the equipment capacity and building design, the following options are available that meet most buildings' heating requirements:

+ 2-pipe low-temperature air sourced heat pumps. These can range from small systems to large systems (>2000kW) where low-temperature coils are installed and provide a high Coefficient of Performance (COP).
+ 2-pipe high-temperature air sourced heat pumps. These are available in small modular arrangements and can meet existing 80deg.C coil design temperatures. High temperatures come at a cost to the upfront installation cost as well as energy efficiency.
+ 4-pipe low-temperature air sourced heat pumps. Similar to 2-pipe low-temperature air sourced heat pumps the options vary significantly whilst also providing the benefit of simultaneous heating and cooling for the highest COP option available.
+ Air sourced heat pumps combined with water-to-water 'booster' heat pumps delivering high temperature water. These systems are suited for large systems (>1000kW) and where 80 deg.C water is required.
+ Variable refrigerant volume/flow systems. These systems are suited for smaller installations and where the entire heating plant infrastructure can be replaced.

The following key aspects should be considered when looking at replacing gas-fired water heaters with electric heat pumps:

+ Delivery temperature. Traditionally older buildings are designed with an 80 deg.C water temperature whilst more modern buildings were selected at lower temperatures of between 50 to 60 deg.C. The lower the building heating hot water temperature, the more options are available with regard to heat pump technology and the more efficient the hot water plant will be.
+ Additional plant spatial requirements. Heat pumps prefer to operate outside, where the refrigeration circuit utilises the ambient air to introduce the heat into the system. This outdoor space needs to consider access for maintenance, proximity to building occupants and neighbouring buildings where noise could be an issue and distance to the existing plantroom where lengthy pipework infrastructure may be required to connect the systems.
+ Electrical infrastructure. A review of the electrical infrastructure is required to assess the impact of the additional electrical equipment and where the electrical supplies will come from. This could mean new electrical switchboards, upgrade of main switchboards or even for large facilities, impact on the building substation size.
+ Plant capacity. Is the existing plant oversized or is it required for morning warm-up? Is the electrification of the plant required to meet the entire heating capacity for the building on a design day or is partial electrification an option?
+ Extent of pipework, coil and pump infrastructure upgrade works. Most heat pumps operate with temperature differentials of around 8 – 10 deg.C whilst traditional heating hot water systems operate at around 20 deg.C TD. This could mean a complete upgrade of the pipework, coil and pump infrastructure with most heat pumps or otherwise there is a cost premium for heat pumps that can operate at higher TDs.
+ Structural and acoustic impact. Heat pumps require more space and are heavier than their gas-fired plant equivalents. A structural and acoustic engineer will be required to assess any impact on the buildings structure and additional noise impact to both building occupants and neighbours.
+ Building and plant life cycle. The intention to fully electrify assets is to align the retrofit with the end-of-life replacement of the gas-fired asset. Further options can be realised if the building heating coils are also being replaced and selected to suit the heat pumps whilst further options may be available should the cooling plant also require replacing combining both systems.

For most existing buildings, the following items should be questioned now to future-proof the building when the plant is proposed to be electrified:

+ Can you replace your building heating coils with low entering temperature coils to provide more flexibility with heat pump plant options?
+ Do you have sufficient thermal energy and electrical metering facilities and trending available to provide input into the plant replacement design?
+ Is your building relying on any on-site cogeneration systems for heating the building that will no longer be available in the future?
+ Do you have valuable rooftop real-estate that will require a trade-off between installation of heat pumps and solar PV?

Domestic Hot Water Retrofit Considerations

Electrifying domestic hot water (DHW) systems is becoming a much more common practice. Heat pump technology is the most common option ensuring the system can deliver above 60 deg.C water to satisfy Australian Standards where water is being stored.

Similar to the heating hot water systems, the following key items need to be considered:

+ Additional spatial requirements for heat pumps. This is either outdoor space or in a well-ventilated plantroom.
+ Increased electrical demand on the building's electrical infrastructure.
+ Structural impact associated with the additional weight of plant.
+ Design and integration to the existing hot water system/s.

Additional initiatives should also be reviewed as part of any domestic hot water retrofit project including the potential to resize the plant based on the connected fixtures and the ability to integrate initiatives such as solar PV or solar evacuated tubes to reduce the reliance on the electricity supply grid.

Cogeneration and Trigeneration System Considerations

The other major fossil fuel systems in some larger commercial buildings are cogeneration and trigeneration systems. With increasing gas tariffs these systems are becoming less favourable financially and as the grid decarbonises, they will also become less favourable from an emissions and consequentially a building energy rating perspective.

Building owners should start to plan the decommissioning process for these systems taking into account the life cycle of the plant, rebuild costs, NABERS impact both short and long-term and whether additional heating or cooling plant is required to meet the buildings peak demands. If the trigeneration/cogeneration plant also provides standby power to the building, an alternative source of essential power should be considered.

Standby Generators Considerations

Electrification of the diesel generators is likely to be a much longer-term solution as technology will evolve and we move away from diesel standby generators. Currently some options include biofuel generators and hydrogen fuel cells.

As standby generation systems are typically responsible for less than 1% of the buildings GHG emissions, these are considered lower priority in the larger scheme of building electrification.

So, What Next?

What are the next steps involved to electrify your building? Each building needs to be assessed with regard to their specific retrofit options in order to remove the need for fossil-fuel consuming plant and equipment.

The following outlines the potential steps to prepared for building degasification and electrification:

1. Identify the building's fossil fuel powered assets. What is their relative Scope 1 GHG impact? What is their condition, where are they on their life cycle?

2. Engage with specialist consultants experienced in degasification and electrification to:

+ Assess the available options to fully electrify the associated assets.
+ Review building heating and cooling load profiles from historic BMS trend data to assist with designing new system.
+ Fully understand the impact of any proposed major electric plant. This may require inputs from electrical engineers, acoustic engineers, building surveyors, structural engineers, town planners and quantity surveyors.
+ Provide input into building services upgrade works.
+ Determine the most appropriate roadmap for degasification and electrification of the building to meet Net Zero goals.
+ Prepare a program, detailed cost plan and project management and procurement plan for the works.

For more information on degasification and electrification of buildings, contact A.G. Coombs Advisory:

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