East Gippsland Shire Council - Bairnsdale Aquatic and Recreation Centre

Electrification Foundation Paper
All-Electric Councils Information Group

Date: 17th November 2022

FGAdvisory

Disclaimer

Document Title:
Electrification Foundation Paper

Disclaimer
The information contained herein is based on a high-level assessment of six volunteer representative councils across Victoria. All advice and recommendations are general. Site-specific context has not been taken into consideration and thus all information contained within this paper including any and all estimated energy and emissions savings, opinion of probable cost, project complexity and risk are indicative only. FGA strongly recommend that each council conduct detailed site assessments at each facility prior to any works.

FGA believes that the information contained in this report is correct and that any opinions, conclusions or recommendations were reasonably held or made at the time of writing; however, FGA does not warrant their accuracy and disclaim all responsibility for any loss or damage that may be suffered by any person or group, directly or indirectly, from the use of this report.

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Acknowledgment of Country

FG Advisory and the All-Electric Councils Information Group acknowledge the Traditional Custodians of country throughout Victoria and Australia, and recognise their continuing connection to land, waters, skies, and community. We are inspired by and learn from knowledge and stories of Country.

FG Advisory and the All-Electric Councils Information Group pay respects to Traditional Custodians and their cultures, and to Elders past and present.

Electrification Foundation Paper

The Electrification Paper has been written by FG Advisory on behalf of the All-Electric Councils Information Group (AECIG) for the Victorian Local Government Sector.

It is recommended that councils use the Electrification Foundation Paper to develop a high-level overview of electrification opportunities within their portfolio, understand the technical feasibility, financial and operational implications of electrification upgrades and produce council-specific energy strategies.

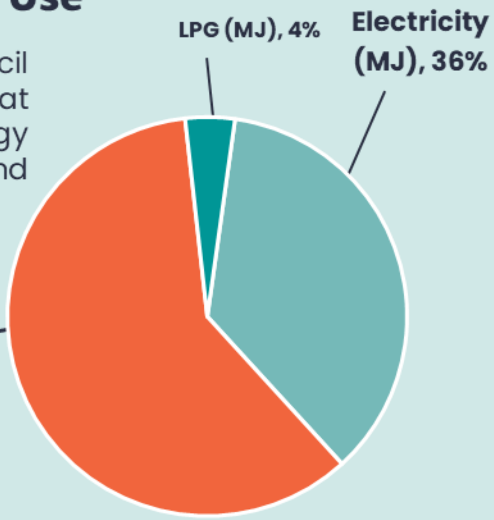
Key Benefits of Electrification

Electrification of gas infrastructure is a critical step in the reduction of council emissions and the attainment of Local, State and Federal Government Net Zero Emissions Targets. Adoption of fully electrified systems provides a range of additional benefits to councils and communities, including the following:

1	**Support the Achievement of Net Zero Emissions Targets and Minimise the Impact of Human Induced Climate Change**
2	**Reduce Risk of Financial and Operational Disruption**
3	**Improve Community Health and Safety**
4	**Access Innovative and Emerging Energy Technologies**

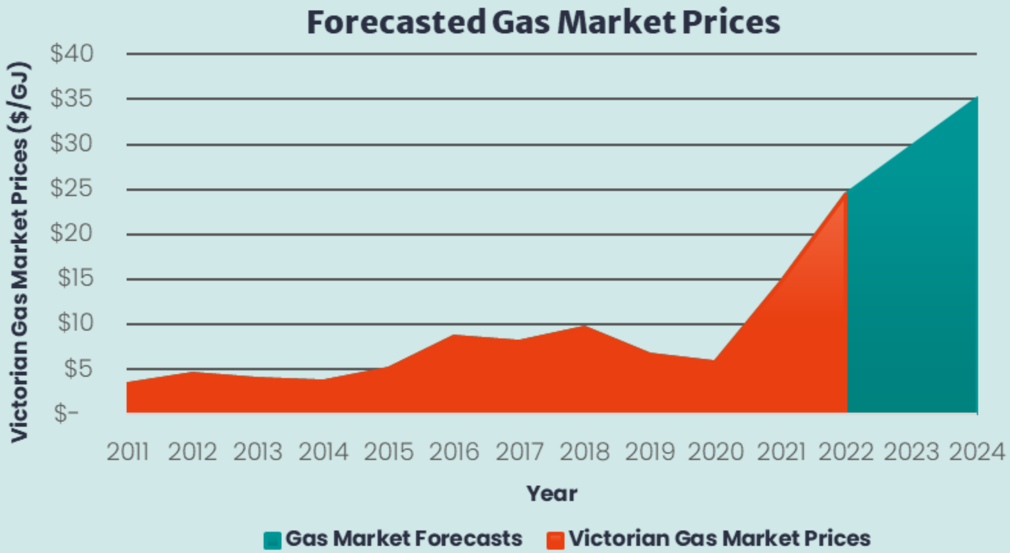
Victorian Council Energy Use

A review of representative council energy consumption identified that **over half** of council facility energy use comes from natural gas and LPG.



Business as Usual

Increasing demand and shifting energy geopolitics have led to significant market volatility and increases to gas costs. Future reliance on gas infrastructure will increase council exposure to volatile gas markets and mitigate the viability of on-site and off-site renewable energy sources to lower council energy costs.



Reliance on gas will require councils to purchase carbon offsets to attain Net Zero Emissions, further increasing operational costs and exposure to market risk.

The Victorian Energy Collaboration (VECO)

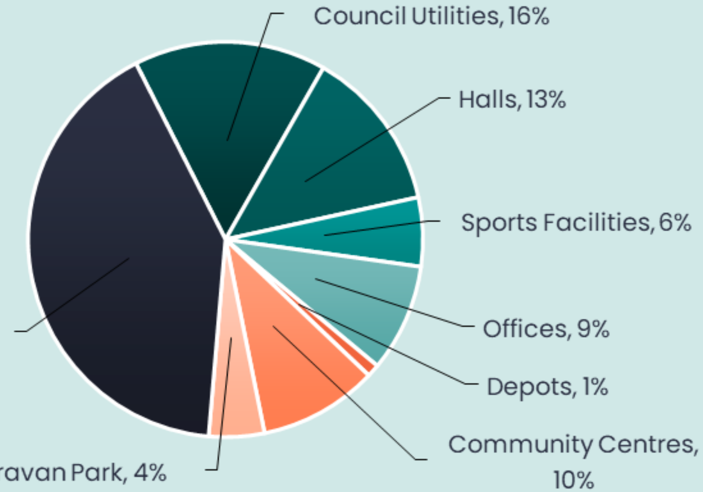
51
Councils

VECO is the largest emissions reduction project ever undertaken by the Local Government sector in Australia. 51 Victorian councils have partnered under one large-scale renewable energy contract to provide clean, renewably generated electricity produced from wind farms in Victoria.

Upgrading to fully electrified facilities will allow councils to use the renewably generated energy from VECO to power council owned infrastructure, including halls, sports facilities, community centres, pools, recreation centres and more, significantly reducing council emissions.

Victorian Council Facility Emissions

The Council Energy Review identified the following breakdown of council emissions:



Procurement and Financing

The following procurement and financing models may support councils pursuing facility electrification upgrades:

- **Energy-as-a-Service Models**
- **Energy Performance Contracting**
- **State Government Financing**
- **Australian Renewable Energy Agency (ARENA)**
- **Energy Innovation Toolkit**

Key Implementation Considerations

The following considerations may impact the viability of site electrification. Comprehensive site assessments should be conducted prior to upgrades to ensure all considerations are accounted for and do not adversely affect project cost, complexity, or completion timelines.

Electrical Infrastructure
- Electrical Capacity Constraints
- Changing Energy Resources
- Limited Energy Redundancy
- Increased Peak Demand

Facility-Specific
- Heritage Sites
- Structural Constraints
- HHW Retrofitting Requirements
- Spatial Limitations

Ongoing
- Revised Planning Permits
- Ongoing Facility Operation and Maintenance

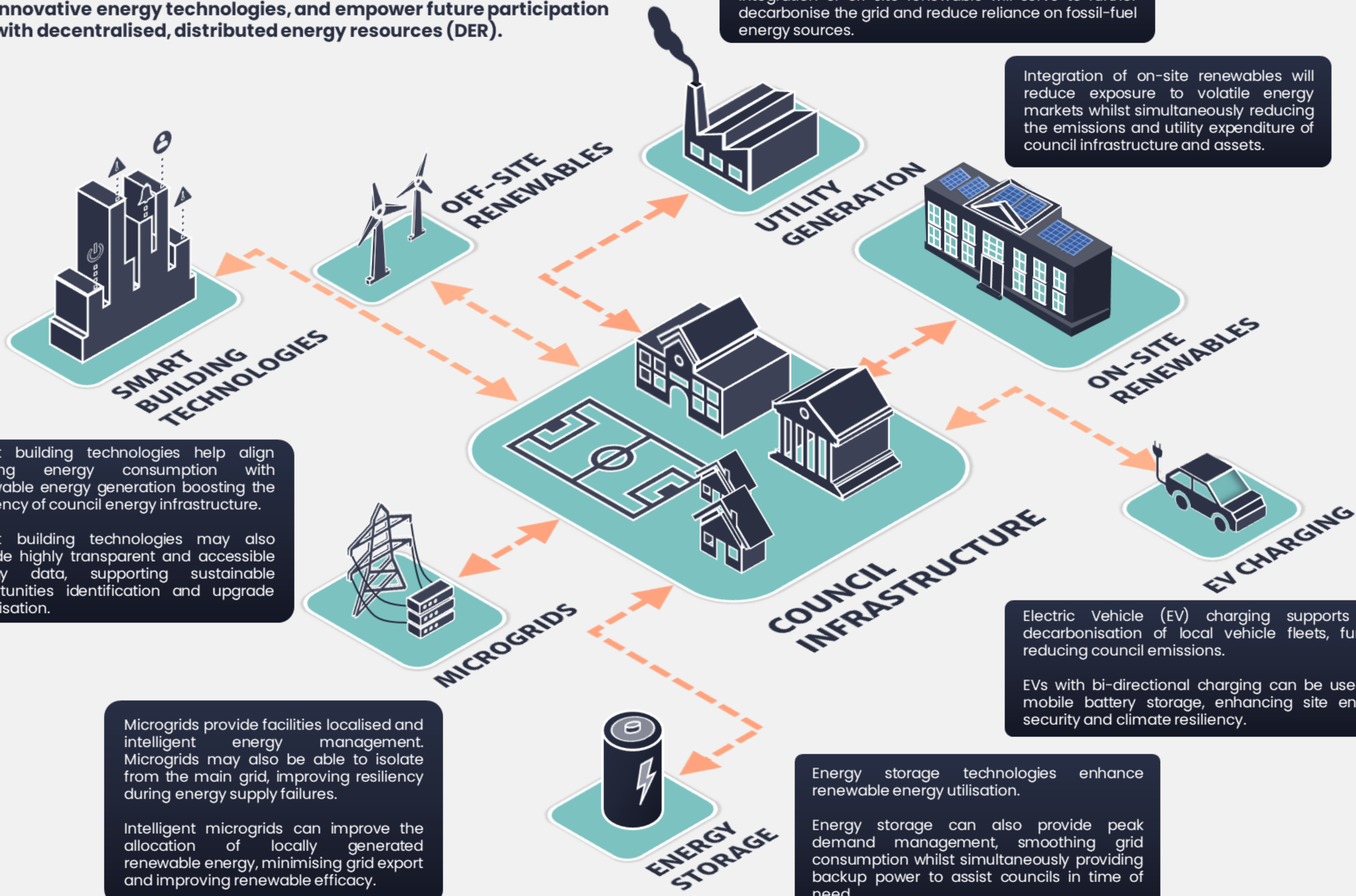
Beyond Electrification

Electrification of assets will allow councils to access emerging and innovative energy technologies, and empower future participation with decentralised, distributed energy resources (DER).

Centralised utility generation currently provides minimum energy firming to ensure the grid remains stable and functional.

Integration of off-site renewable will serve to further decarbonise the grid and reduce reliance on fossil-fuel energy sources.

Integration of on-site renewables will reduce exposure to volatile energy markets whilst simultaneously reducing the emissions and utility expenditure of council infrastructure and assets.



Smart building technologies help align building energy consumption with renewable energy generation boosting the efficiency of council energy infrastructure.

Smart building technologies may also provide highly transparent and accessible energy data, supporting sustainable opportunities identification and upgrade prioritisation.

Electric Vehicle (EV) charging supports the decarbonisation of local vehicle fleets, further reducing council emissions.

EVs with bi-directional charging can be used as mobile battery storage, enhancing site energy security and climate resiliency.

Microgrids provide facilities localised and intelligent energy management. Microgrids may also be able to isolate from the main grid, improving resiliency during energy supply failures.

Intelligent microgrids can improve the allocation of locally generated renewable energy, minimising grid export and improving renewable efficacy.

Energy storage technologies enhance renewable energy utilisation.

Energy storage can also provide peak demand management, smoothing grid consumption whilst simultaneously providing backup power to assist councils in time of need.

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Glossary of Terms	
Abbreviation	**Definition**
AC	Alternating Current
ACCUs	Australian Carbon Credit Units
AECFP	All-Electric Councils Foundation Paper
AECIG	All-Electric Councils Information Group
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ARENA	Australian Renewable Energy Agency
ASHP	Air Source Heat Pump
BMS	Building Management System
ESD	Environmentally Sustainable Design
DC	Direct Current
DER	Distributed Energy Resources
DHW	Domestic Hot Water
EaaS	Energy as a Service
EPC	Energy Performance Contract
ESC	Victorian Essential Services Commission
ESCO	Energy Service Company
EV	Electric Vehicle
GGB	Green Government Buildings
GHG	Greenhouse Gas
GWP	Global Warming Potential
HHW	Heating Hot Water
IEA	International Energy Agency
IRCA	Independent Review and Commissioning Agent
LPG	Liquified Petroleum Gas
M&V	Measurement and Verification
NEM	National Electricity Market
PPA	Power Purchase Agreement
PV	Photovoltaic
VEEC	Victorian Energy Efficiency Certificates
VEU	Victorian Energy Upgrades
VPP	Virtual Power Plant
WAGA	Western Alliance for Greenhouse Action
WSHP	Water Source Heat Pump

Table 1: Glossary of Terms

About The Electrification Foundation Paper

The Electrification Foundation Paper has been developed to support the degasification of council facilities across Victoria. Adoption of electrified technologies in lieu of gas will serve to reduce council scope 1 emissions, support the attainment of Local, State and Federal emission targets, and help abate the impacts of human-induced climate change.

The Foundation Paper is intended to assist council and facility stakeholders understand the extent of electrification opportunities across the council portfolio and provide guidance on the technical feasibility, financial implications and operational requirements of electrification upgrades.

Outcomes from the Foundation Paper will provide councils the requisite empowerment and knowledge to plan and deliver facility electrification that promotes effective, actionable, and technically guided uplift across the Victorian Local government sector. The Foundation Paper should further provide councils with the tools and knowledge to engage in broader advocacy and seek opportunities for electrification on a sector-wide scale.

Electrification Foundation Paper Authorship

The Electrification Paper has been written by FG Advisory on behalf of the All-Electric Councils Information Group (AECIG) for the Victorian Local Government Sector. The AECIG is led by Representatives from the Western Alliance for Greenhouse Action (WAGA) and Brimbank City Council and includes officers from the Victorian Greenhouse Alliances and a number of their member councils. The group has have served as the Steering Committee throughout the development of the Foundation Paper and Council Energy Review.

The Electrification Foundation Paper and Council Energy Review have been funded by Brimbank City Council through funds received from the Australian Renewable Energy Agency (ARENA) as part of the development of the all-electric St Albans Leisure Centre upgrades.

About The All-Electric Councils Information Group

The All-Electric Councils Information Group is a collaboration of local Victorian councils who have united to support the attainment of a fully electrified Local government sector by 2030.

Council Energy Review

The Electrification Foundation Paper has been developed in collaboration with a Council Energy Review. This review evaluated the extent of electricity, gas, and LPG (Liquefied Petroleum Gas) usage and associated assets across a representative group of Victorian councils.

Six representative councils were nominated to participate in the Council Energy Review to inform typical council energy usage patterns. These councils were chosen to ensure a diverse representation of councils across Victoria and provided a fair appraisal of the unique context and constraints faced by individual councils when pursuing electrification upgrades.

Outcomes from this assessment were used to inform opinion of probable costs, financial risk factors and implementation considerations, in addition to guidance on best-practice infrastructure upgrades and future opportunities adoption.

Figure 1: Nominated Councils Participating in the Council Energy Review

Guiding Principles

The primary aim of the Foundation Paper is to support and empower council stakeholders to pursue electrification upgrades through an assessment of electrification opportunities within the context of Victorian Local Government. The Foundation Paper provides guidance on the technical and commercial viability of electrification upgrades, supporting the realisation of a fully electrified Local government sector by 2030.

Adoption of electrified technologies is not the sole measure of success when pursuing electrification of council facilities. A list of additional principles informing the Foundation Paper are included below:

Support Achievement of Net Zero: Electrification of gas infrastructure accelerates the integration of renewable energy resources and high efficiency assets. These upgrades will support a reduction in council emissions and the ultimate attainment of net zero emissions.

Demonstrate Community Leadership: Engaging in electrification upgrades in support of sustainable uplift will demonstrate sector leadership and encourage industry, residents, and government organisations to pursue similar upgrades.

Promote Energy Security: The initiatives outlined in this paper not only support site electrification, but act to enhance the energy security of council facilities through renewable energy integration. This will minimise future downtime of facilities and support ongoing council operations during grid blackout events.

Improve Council Facilities: The guidance provided in this paper should serve to improve council facilities through installation of high quality, efficient assets. These upgrades will demonstrate industry best practice and deliver additional community wellbeing benefits through removal of gas infrastructure.

Foster Community Engagement: Council facilities are central to the heart of the communities they serve. This provides a key opportunity for councils to engage and educate the community and help promote a culture of sustainability action and awareness.

Support Council Collaboration: The Foundation Paper shall foster cooperation and partnership between councils, resulting in collaborative efforts to uplift the sector achieved through mass negotiation and economies of scale. Outcomes will support additional knowledge sharing to enable ongoing refinement and improvement to council works.

Enable Equitable Energy Uplift: The Foundation Paper supports equitable energy uplift, minimizing the disparity in energy quality and availability across Victoria and promoting a fair energy landscape with equal opportunities for all stakeholders.

Encourage Future Innovation: Use of new and emerging electric technologies and services should be prioritised where available to future-proof councils and drive innovation within the industry.

Deliver Cost Effective Outcomes: The guidance provided in the Foundation Paper is intended to encourage cost-effective degasification opportunities, minimising the financial barrier to facility electrification upgrades.

Drive Local Employment: Delivering electrification upgrades provides opportunities to utilise local employment and boost the local economy. The use of locally developed goods where available supports the community and improves future ease of maintenance.

Foundation Paper Contents

The Electrification Foundation Paper has been separated into seven categories:

Part 1: Overview of Electrification

Summary of electrification, including benefits to councils and communities, facility operations, utility expenditure and the attainment of government emissions targets.

Part 2: Council Energy Use

Evaluation of council energy usage patterns, individual facility energy consumption and the extent of renewable technologies adoption.

Part 3: Electrification Opportunities and Technologies

Discussion on the opportunities and requisite technologies required to deliver facility electrification, including key benefits, limitations, and best-practice.

Part 4: Costs and Implementation

Guidance on key electrification implementation considerations and high-level opinion of probable costs, emissions impact, risk and complexity for typical council facilities.

Part 5: Procurement and Financing

Overview of procurement and financing opportunities to support council electrification upgrades.

Part 6: Electrification Risk Assessment

Evaluation of key electrification risks, potential response strategies and risk related opportunities.

Part 7: Future Opportunities

Discussion on future applications of electrified technologies, emerging and innovative energy solutions and potential benefits to council facilities.

Foundation Paper Limitations

The content provided in the Electrification Foundation Paper is general and based on broad design principles only. Individual site-specific context has not been taken into consideration, and hence all commentary on upgrades including energy and emissions savings, opinion of probable cost, project complexity and risk are indicative only. The Electrification Foundation Paper does not take into consideration the impacts from water consumption or waste. Prior to committing to any works, it is strongly recommended that each council conduct a detailed assessment of each relevant facility to understand the general applicability of these upgrades to their unique site context.

Part 1: Overview of Electrification

Part 2: Council Energy Use

Part 3: Electrification Opportunities and Technologies

Part 4: Costs and Implementation

Part 5: Procurement and Financing

Part 6: Electrification Risk Assessment

Part 7: Future Opportunities

Part 1: Overview of Electrification

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What is Electrification?

Electrification is the process of installing or replacing existing gas consuming assets with alternative technologies that consume electricity as a primary energy source.

Electrification, often referred to as degasification, presents a critical opportunity to reduce greenhouse gas (GHG) emissions by facilitating the transition to fully electrified facilities that can be powered solely through sustainably generated electricity.

Electrification and Emissions

Emissions are classified into the following three categories.

Scope 1

Scope 1 emissions are released as a result of a **direct** activity occurring on-site. For councils this typically refers to:

- Emissions resulting from burning gas to provide facility heating, domestic hot water, or cooking.

Scope 2

Scope 2 emissions are created by using purchased energy. These are referred to as **indirect** emissions as they are generated at a separate facility, such as a power station. The process of electrification shifts emissions from scope 1 to scope 2.

Examples of scope 2 emissions include:

- Emissions as a result of grid electricity consumption

Scope 3

Scope 3 emissions include all other **indirect** emissions arising from processes in the wider economy that cannot be directly controlled. This may include:

- Emissions arising from transport and disposal of waste
- Emissions through the supply chain of purchased goods
- Employees commuting to work

Benefits of Electrification

Electrification provides significant benefits to council facilities beyond financial payback and return on investment.

Electrification is a critical step on the journey towards net zero emissions and provides additional benefits to council climate resiliency, facility performance and overall community wellbeing.

The following key benefits are outlined below:

1	Support the Achievement of Net Zero Emissions Targets and Minimise the Impact of Human Induced Climate Change
2	Reduce Risk of Financial and Operational Disruption
3	Improve Community Health and Safety
4	Access Innovative and Emerging Energy Technologies

Net Zero Emissions Overview

Net zero emissions refers to a facility in which the quantity of emissions released to the atmosphere is balanced by the removal of an equivalent amount of emissions. In practice, net zero is achieved by minimising the total output of emissions through the implementation of electrified technologies, energy efficiency improvements and renewable energy integration, whilst offsetting any residual emissions that cannot be mitigated.

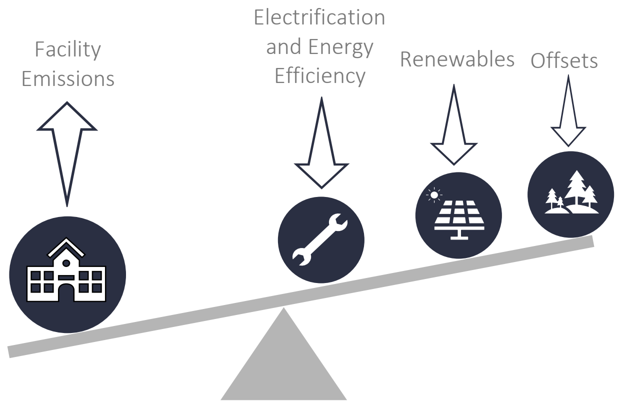


Figure 2: Net Zero Schematic

Within a typical council facility, a significant proportion of emissions occur due to consumption of gas. Hence, substantial steps towards net zero can be achieved by replacing gas assets with high efficiency electrical equivalents and implementing on-site and off-site renewable energy sources to minimise scope 2 emissions.

Grid Decarbonisation

Victoria's electricity grid is becoming increasingly decarbonised as a result of widespread renewable energy adoption and will continue to decarbonise in the foreseeable future.

Transitioning away from gas infrastructure towards electrified alternatives provides councils an opportunity to facilitate ongoing site emission reductions which can be further accelerated through installation of localised renewable energy sources such as solar PV.

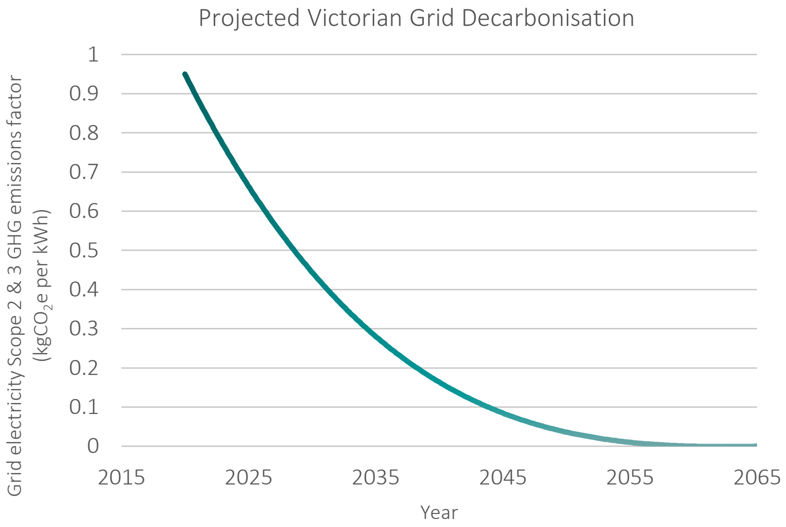


Figure 3: Predicted Victorian Grid Decarbonisation[1]

[1] Data from GBCA A practical guide to electrification for new buildings

Federal, State and Local Government Emissions Targets

Electrification of council assets is a critical step in the achievement of Federal, State and Local Government net zero emissions targets:

Federal Government Emissions Targets

Australia is a signatory to the 2015 Paris Climate Change Agreement. This pact created a global commitment to limit global average temperatures well below 2°C and to ensure global warming remains 1.5°C below pre-industrial levels.

To support the fulfillment of these goals, the Australian Federal Government have committed the following targets:

- Reduce emissions by **43%** below 2005 levels by 2030
- Attain **Net Zero Emissions** by 2050

Victorian Government Emission Targets

The Victorian Government have set the following accelerated targets above and beyond the Australian Federal Government:

- Reduce emissions by **28-33%** below 2005 levels by 2025
- Reduce emissions by **50%** below 2005 levels by 2030
- Attain **Net Zero Emissions** by 2050

FGA notes the continually increasing ambition of State Government sustainability commitments, such as those announced prior to the 2022 election may impact the State's sustainability commitments.

Local Government Emissions Targets

The Victorian Local Government sector has built on State emissions targets by setting additional net zero emissions targets. Commitments in the Local Government sector vary by council, however as a collective Local Government will play a critical role in the achievement of broader State and Federal targets.

Victorian Government Gas Substitution Roadmap

The Victorian Government has released a Gas Substitution Roadmap which provides a pathway to help Victorians embrace sustainable alternatives to gas consumption and improve access to an affordable, secure, reliable and safe energy supply.

More information can be found on the Gas Substitution Roadmap web page.

Figure 4: Federal and State Government Emissions Targets

Reduce Future Reliance on Carbon Offsets

Unlike electricity, the emissions arising from gas usage can only be abated through the purchase of carbon offsets.

As demonstrated in the energy management hierarchy, carbon offsets represent the least effective method to mitigate site emissions. Offsetting emissions involves purchasing Australian Carbon Credit Units (ACCUs). One ACCU embodies removal of one tonne of carbon dioxide from the atmosphere. To achieve net zero emissions, sites must purchase the equivalent number of offsets to emissions generated on site.

Carbon offsets are an annual, ongoing cost that provide little additional benefit to councils. ACCUs and other carbon credits may be traded on a commodity market, exposing councils to significant financial risk if the cost of credits increases.

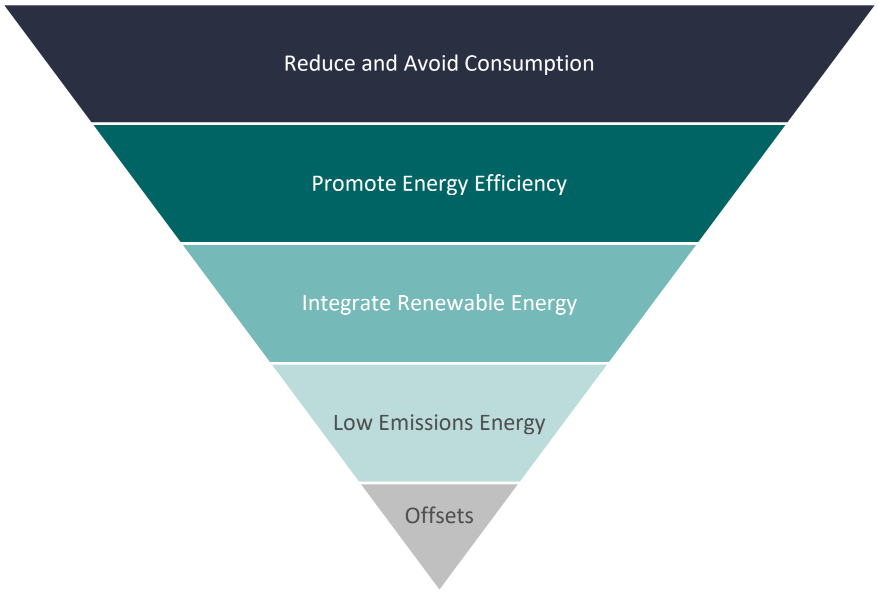


Figure 5: Energy Management Hierarchy

Minimise Broader Environmental Impacts of Gas

Gas is a non-renewable fossil fuel with an environmental impact beyond its emissions potential alone. Extraction, processing, and distribution of natural gas produces harmful impacts that have ongoing effects on the natural environment.

Emissions related to the production of natural gas are classified as scope 3. Although scope 3 emissions often fall outside of the boundaries of net zero commitments, these emissions continue to adversely impact the environment and contribute to human induced climate change.

Further emissions arise due to leakage in the manufacturing and distribution process. The Global Warming Potential (GWP) of methane (CH_4) released through leakage into the atmosphere is approximately thirty times more potent than the equivalent carbon dioxide (CO_2) produced from combustion when evaluated over a 100-year time horizon (GWP100). Methane absorbs more energy than CO_2 but has a shorter lifespan before breaking down, resulting in an enhanced GWP over the short-medium time horizon.[2]

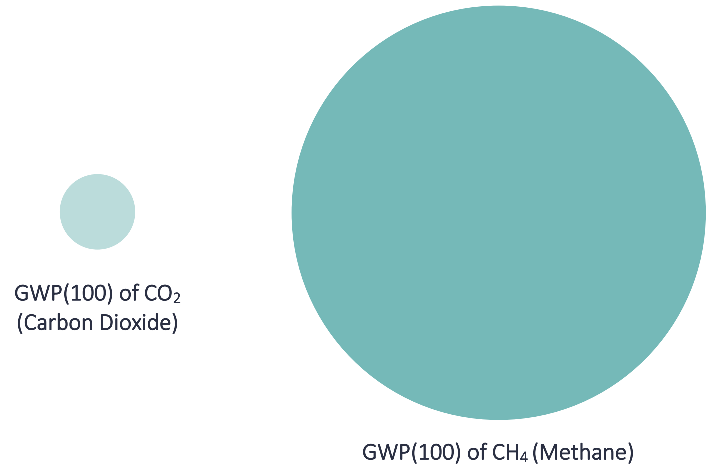


Figure 6: Relative Global Warming Potential of Carbon Dioxide and Methane over 100 Years

[2] Understanding Global Warming Potentials by the United States Environmental Protection Agency (EPA)

2 Reduce Risk of Financial and Operational Disruption

Alleviate Rising Energy Costs

Increasing energy demand and shifting energy geopolitics have led to increases in energy costs nationwide. This can have a significant impact on council expenditure due to the large number of facilities and high consumption sites.

Adoption of electrified technologies in conjunction with renewable energy adoption will serve to minimise energy related operational expenditure and simultaneously promote enhanced energy resiliency in the event of a grid blackout.

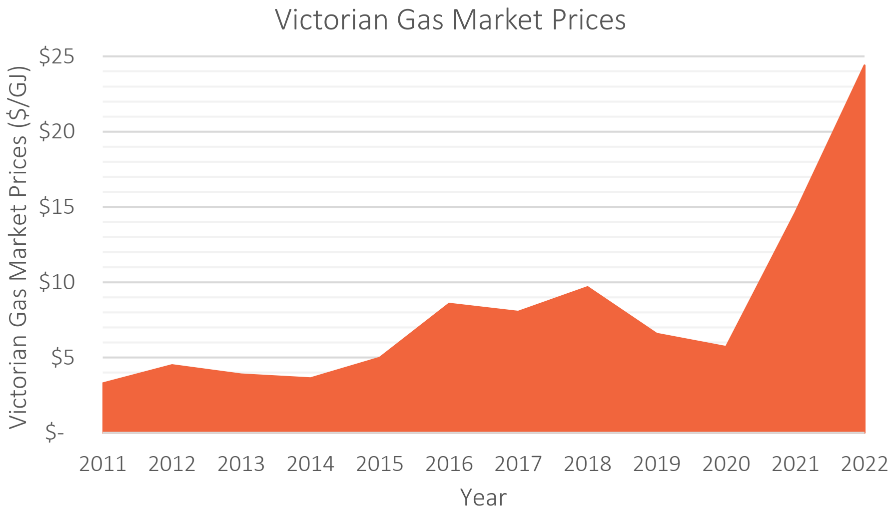


Figure 7: Rising Gas Market Prices[3]

Promote Climate Resiliency

As the impacts of climate change become increasingly pronounced, the risk of climate related extreme weather events occurring across Victoria will continue to grow. To ensure Victorians are adequately prepared for the future climate it is critical that councils prepare their facilities appropriately.

A common consequence of extreme weather events is damage to the electrical grid and associated energy blackouts. Energy in the time of crisis is a vital resource which can provide communities the following:

- News and event updates
- Communication outside of the affected areas
- Access to food and water
- Safe space for residents to shelter.

Electrification of council facilities is an important process to improve council climate resiliency. When integrated with on-site renewables and energy storage systems, electrified assets may continue to operate independently of grid energy supply and remain operational during blackout events.

Councils embarking on facility upgrades and electrification should consider the impacts of future climate induced extreme weather events on their communities when assessing new technologies. Additional solar PV, energy storage systems and power backups may become critical resources in a time of crisis.

[3] Data from Australian Energy Regulator

3 Improve Community Health and Safety

Reduce Health Impacts of Gas

Burning gas whether for heating or cooking produces a range of harmful pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2) and fine particulates. These pollutants reduce the quality of air within facilities and can pose a significant risk to community health and wellbeing through potential CO poisoning. **Recent surveys conducted by the Climate Council Australia identified that gas used for cooking is responsible for up to 12% of childhood asthma in Australia.**[4]

Locating gas assets where they can receive adequate ventilation can lower the risk of harmful indoor pollution but not eliminate it entirely. To effectively mitigate the risk, it is critical to use energy resources that do not pollute or adversely affect facility air quality.

Align with Shifting Community Preferences

As community pressure continues to mount for sustainable uplift, and the negative impacts of gas become further elucidated there has been a gradual shift in community and consumer preferences. This push to integrate sustainable clean technologies is likely to continue and councils may soon face rising pressure to adopt clean electrified technologies.

Councils wishing to future proof their infrastructure and align with changing community preferences should consider upgrading their facilities and installing best-practice electrified technologies. This may occur as part of a concentrated program of works or on an ongoing basis as equipment fails reaches end-of-life.

[4] Kicking The Gas Habit: How Gas Is Harming Our Health by Climate Council Australia

Case Study

Brimbank Aquatic and Wellness Centre, Brimbank City Council

Built on the old St Albans Aquatic Centre site, the Brimbank Aquatic and Wellness Centre is currently undergoing energy efficiency upgrades, demonstrating best practice through attainment of a 6 Star Green Star rating.

The 1,200 square-metre facility includes a 50 metre, 10 lane swimming pool, spas, saunas and a 24-hour gym.

With an emphasis on the electrification of legacy gas boilers and assets, the centre will be entirely electrically powered. This includes use of an 88,000 litre hot water storage systems that acts as a thermal battery.

Additional upgrades include a thermal energy system, solar PV, heat recovery and advanced building control systems.

Sharing lessons learnt, Brimbank City Council has offered the following: “Going all-electric cost us around $2.3 million – nowhere near the initial $6 million we estimated.”

Figure 8: Artist Impression of Brimbank Aquatic and Wellness Centre

4 Access Innovative and Emerging Energy Technologies

Distributed Energy Resources

Distributed Energy Resources (DER) are small-scale sources of decentralised energy occurring near the point of use. Key benefits of DER include:

- Reduction in grid emissions intensity
- Minimisation to facility electricity utility expenditure
- Improved grid reliability through high penetration of renewables
- Intelligent load management to better match supply and demand
- Reduction in reliance on centralised power stations

The electrification of building assets provides councils an opportunity to integrate DERs and promote holistic value across the portfolio. Detailed discussion on DERs and future opportunities is included in Part 7: Future Opportunities.

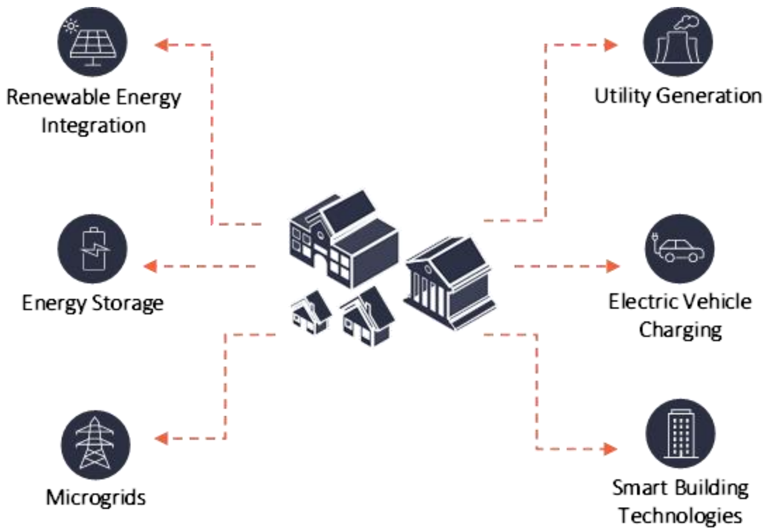


Figure 9: Overview of Distributed Energy Resources

Smart Energy Management Technologies

Intelligent energy management services are undergoing rapid growth and development. At present there are a large amount of emerging energy management technologies, which can offer the following services and benefits:

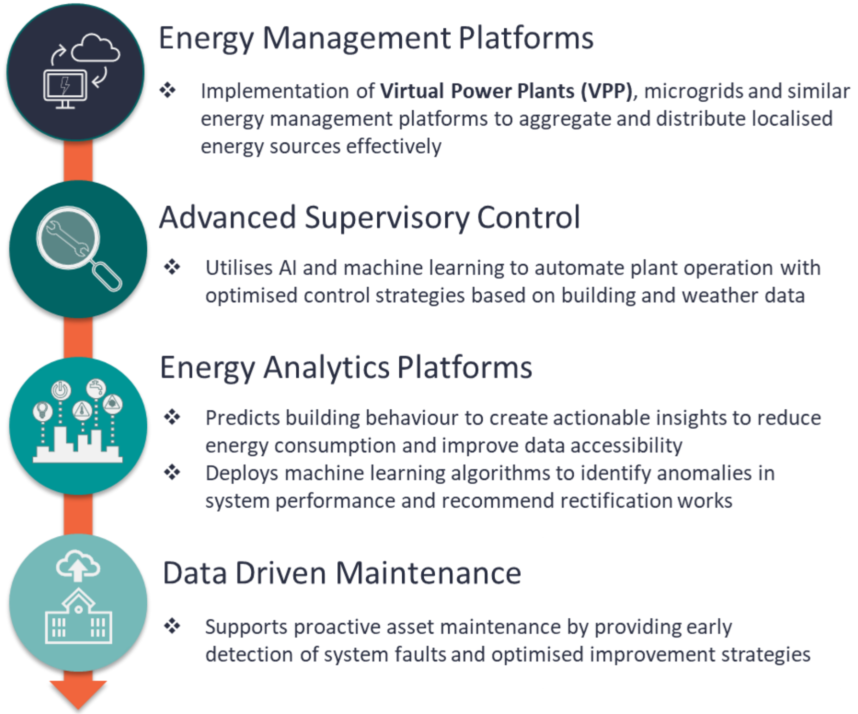


Figure 10: Example Smart Energy Management Technologies

Many of these technologies have not reached full market maturity, however are likely to become significant drivers in future smart energy transformation. Transitioning to best practice electrified systems with intelligent data monitoring capabilities will allow councils to leverage these technologies in the future and ensure they remain abreast of industry advancements.

Alternatives to Electrification

Biogas

Greener gas, otherwise known as biogas or biomethane, refers to the methane produced through fermentation of organic matter. Biogas is often referred to as a renewable form of energy as it is produced through organic fuels like food and agricultural waste.

Biogas is a valuable part of global emissions reduction efforts, and can provide the following key benefits:

- Capture stray methane that would otherwise escape to the atmosphere
- Biogas digestate can be used for crop fertiliser
- Reduce emissions in sectors which are difficult to electrify, including industrial and agricultural industries

Council stakeholders should be critically aware that use of biogas still produces ongoing emissions that contribute to climate change and that biogas will not present a viable long term solution to portfolio emissions reduction.

While providing value in the transition to electrified systems, use of biogas will always result in emissions production, compared to electrified systems which, when generated through renewable sources, is 100% emissions free.

Furthermore, analysis by the International Energy Agency (IEA) estimates that biogas has the potential to replace only up to 20% of the global gas demand, meaning that significant electrification is still be required to address climate change.

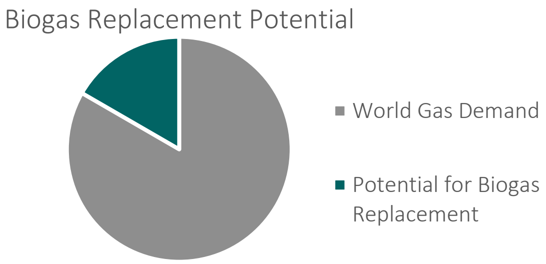


Figure 11: Biogas Replacement Potential[5]

Hydrogen Gas

Hydrogen gas can be used for energy storage or burnt to produce heating akin to gas. This versatility has resulted in increased interest in hydrogen as a pathway to replace natural gas with a low to zero-emissions alternative.

Hydrogen gas is typically generated through the extraction of hydrogen from liquid water, a process called hydrolysis. This process is energy intensive and requires a large amount of electricity. Depending on the source of electricity, hydrogen gas can be classified as 'green' or clean hydrogen, or as a range of colours, shown below:

Green – Wind, solar or hydroelectric

Grey – Gas

Blue – Fossil Fuels with Partial Carbon Capture

Brown – Brown Coal

Black – Black Coal

Figure 12: Colour Classifications of Hydrogen[6]

FGA notes that the hydrogen gas industry is still developing and at present is not viable for use within council facilities. Due to the conversion of energy required to produce hydrogen, system efficiencies of electrical assets will always remain higher and thus remain the superior option when pursuing degasification

Furthermore, use of hydrogen gas requires an additional step in the energy distribution process, requiring electricity to produce hydrogen that is then distributed to facilities for use. Using electricity directly eliminates this additional requirement, improving efficiency and minimising energy losses.

[5] Outlook for biogas and biomethane by the International Energy Agency

[6] What is Hydrogen by Climate Council Australia

Surf Coast Shire Council - Kurrambee Myaring Community Centre

Part 2: Council Energy Use

Council Energy Review

A review of council energy usage was conducted across a select group of Victorian Councils. This appraisal aimed to provide an overview of typical council energy consumption patterns and associated energy infrastructure.

The councils selected to take part in this assessment were carefully chosen to ensure they encompassed the diversity of Victorian councils and fairly characterised the unique context, infrastructure, and electrification constraints faced by individual councils.

Councils selected for inclusion within the Energy Review include:

- Brimbank City Council
- Moorabool Shire Council
- Surf Coast Shire Council
- East Gippsland Shire Council
- Moira Shire Council
- Yarra City Council

A total of 160 facilities were evaluated for the review, responsible for 15,500 tonnes of CO_2 emissions annually. Abatement of these emissions would be equivalent to taking almost 6,500[7] cars off the road annually.

Exclusions

The information contained herein is based on data provided by the six nominated councils who have volunteered to partake in the review. Councils with data shortfalls and/or extensive portfolios have provided a select range of energy data based on data availability and time constraints.

Where possible, extrapolations have been made using FGA's professional industry experience. Results should not be used to assess individual council energy usage. FGA strongly recommend that each council conduct detailed site assessments at each facility prior to any works.

Due to the effects of COVID-19 on council facility utilisation, energy data and emissions factors from 2019 have been prioritised where possible.

[7] Based on a 50% mix of fuel-efficient and less-fuel efficient cars from Energy.gov.au

Council Selection Criteria

The key considerations shown in Figure 13 were used during the selection process to ensure that the nominated councils were representative.

Municipality	• Nominated councils are geographically representative, including consideration towards metropolitan, regional, and rural councils.
Council Buildings and Infrastructure	• Representative councils contain all common building typologies and associated gas infrastructure.
Climate	• Variations in climate across Victoria are addressed through selection of councils geographically distributed across the State.
Spatial Requirements	• Council spatial availability that may impact the extent to which councils can pursue electrification upgrades.
Sustainability & Electrification Progress	• Selection of councils at varying points on their sustainability and electrification journey.
Gas Infrastructure	• The nominated councils contain a comprehensive range of gas infrastructure, including gas assets of varying size, type and age.
Electrical Infrastructure	• Existing council electrical infrastructure should be considered as this may impact the viability of electrification upgrades.
Council Size	• Variations in council size to ensure councils of all sizes are included in the assessment.

Figure 13: Council Energy Review Key Considerations

Rural, Regional and Metropolitan Councils

A key area of focus were the variances in energy and infrastructure type, availability, costs and access to maintenance across different council municipalities in Victoria. Rural, regional and metropolitan councils were selected for inclusion in the review to ensure these differences were captured.

Additional considerations and risks arising from the geographic differences in councils have been captured in Part 4 and Part 6 below.

Portfolio Energy Usage

Total Council Energy Use

Shown below is an overview of cumulative portfolio energy usage across the nominated councils.

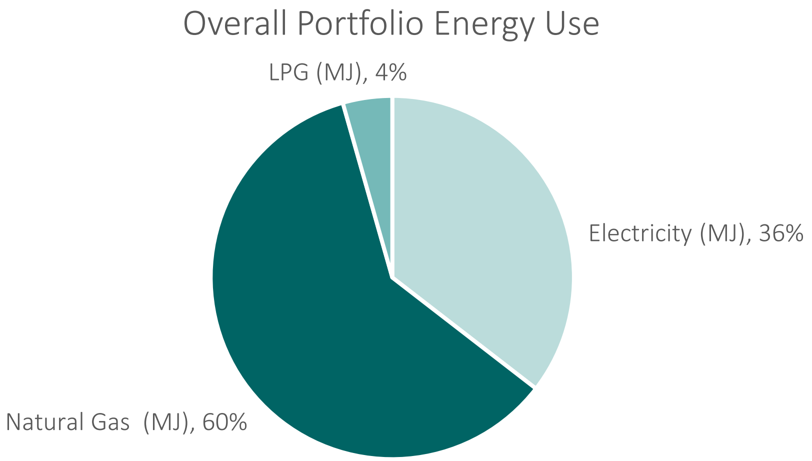


Figure 14: Council Energy Use Across all Representative Councils

As indicated, **60%** of council energy consumption occurs from natural gas. Electrical energy makes up **36%** of total council usage, followed by LPG at **4%.**

Facility Energy Distribution

The distribution of council energy use across facilities is shown in Figure 15. A total of **44 facilities** used natural gas, **29 facilities** used LPG and **156** facilities used electricity. Note that many facilities had a combination of natural gas, LPG and electricity usage.

As demonstrated, sites using natural gas consume a disproportionate amount of total energy compared to sites using only electricity or LPG, indicating that there are fewer, high consumption sites connected to natural gas.

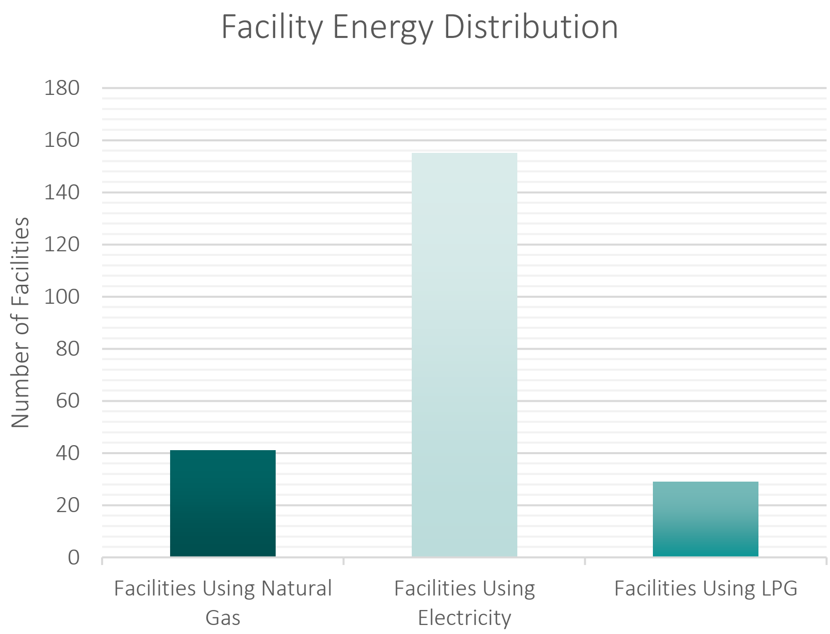


Figure 15: Council Energy Distribution

Further exploration of facility-specific energy consumption patterns is shown below.

Facility Energy Usage

Council Facility Categorisation

Council facilities were classified into the following categories:

Category	List of Facilities
Halls	❖ Town Halls ❖ Community Halls
Sports Facilities	❖ Sports Reserves ❖ Clubrooms ❖ Sports Pavilions
Offices	❖ Offices ❖ Civic Centres ❖ Information Centres
Depots	❖ Depots
Community Centres	❖ Libraries ❖ Community Centres ❖ Theatres ❖ Museums ❖ Men's Sheds ❖ Senior Citizens Centres ❖ Kindergarten/Preschool
Caravan Parks	❖ Caravan Parks
Aquatic and Recreation Centres	❖ Aquatic Centres ❖ Recreation Centres
Council Utilities	❖ Public Toilets ❖ Streetlights ❖ Car Parks ❖ Pillar Boxes ❖ Pumps ❖ BBQs ❖ Memorials

Table 2: Council Facility Categorisation

Average Facility Energy and Emissions

Figure 16 and 17 below provides an overview of energy consumption and emissions of council facilities, inclusive of electrical, gas and LPG.

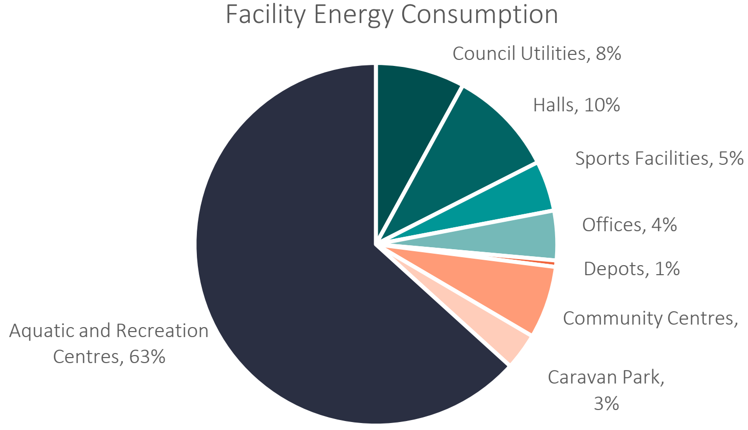


Figure 16: Energy Consumption of Council Facilities across all Representative Councils

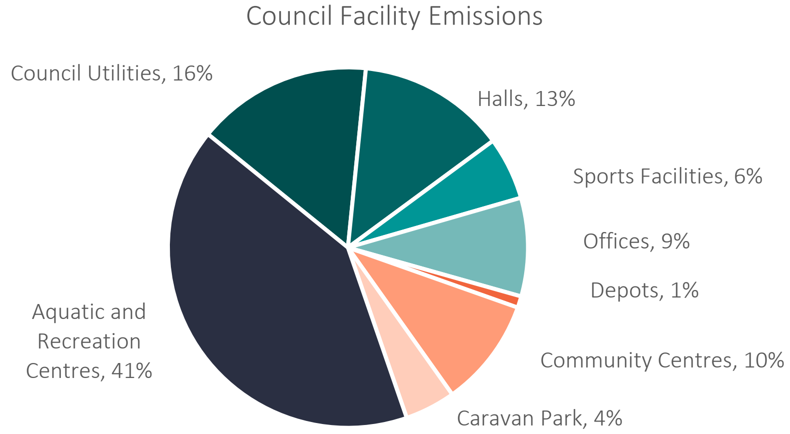


Figure 17: Emissions of Council Facilities across all Representative Councils

Further individual energy resource and facility-specific energy data is included in **Appendix A: Council Facility Energy Data.**

Distributed Energy Resources

The percentage of council facilities with renewable energy technologies is shown below. Further information of Distributed Energy Resources can be found in Part 7: Future Opportunities.

Battery Storage

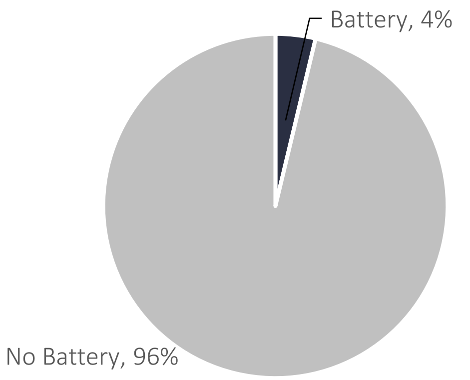


Figure 18: Percentage of Council Facilities with Battery Storage

Solar PV

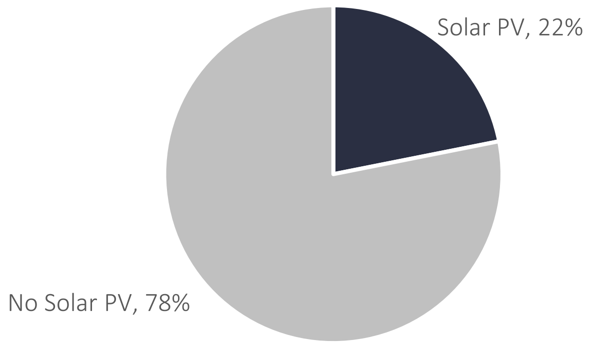


Figure 19: Percentage of Council Facilities with Solar PV

EV Charging Infrastructure

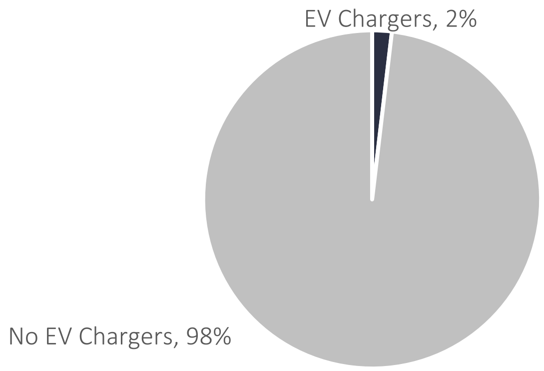


Figure 20: Percentage of Council Facilities with EV Charging Infrastructure

Data Limitations

A key outcome identified during the Council Energy Review was the lack of available asset and energy data. Limitations to data availability and accessibility can result in reactive and unpredictable maintenance and minimise councils' ability to strategically plan asset lifecycle upgrades. This can present significant barriers to electrified technology adoption as it limits councils planning towards current and future assets upgrades.

Absence of council energy data may present further obstacles to electrification. A lack of energy data restricts councils' ability to benchmarks assets and facilities. Thus, councils cannot evaluate high or low performing pieces of infrastructure limiting the resolution to which they can plan sustainable upgrades. Additionally, limitations to the availability of energy data means that councils are beholden to energy companies for accurate data reporting and lack the ability to query energy bills, identify opportunities for cost recovery and plan appropriately for the future.

Brimbank City Council - Community and Civic Centre

Part 3: Electrification Opportunities and Technologies

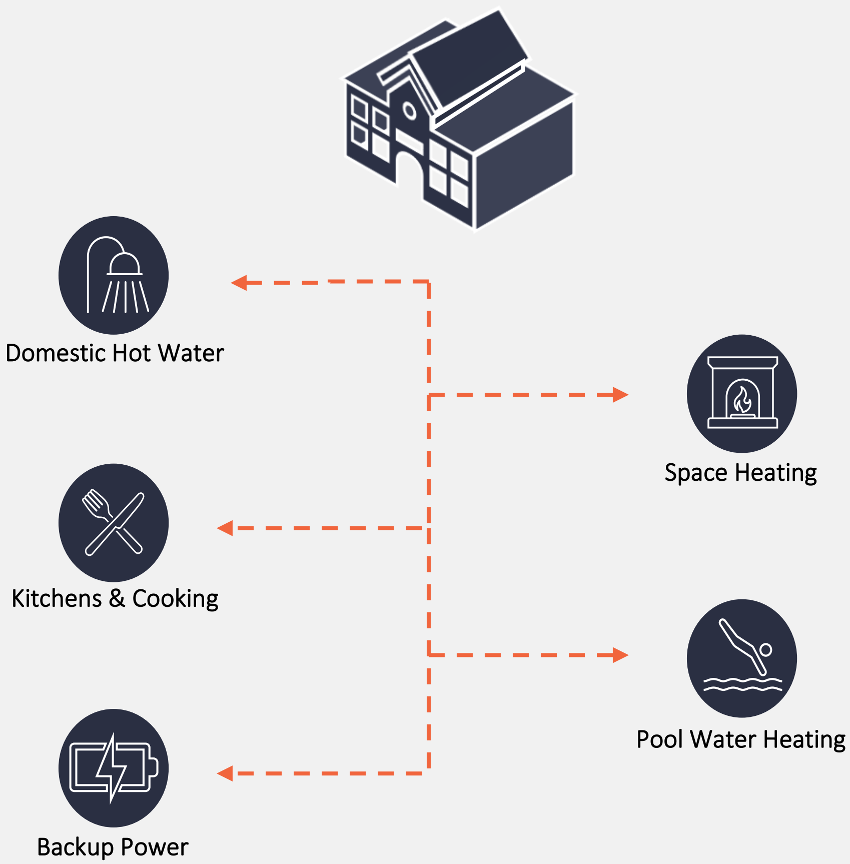
FGAdvisory

Electrification Opportunities

Natural gas and LPG are used for a variety of purposes within a typical council facility. Common gas using operations, relevant electrification solutions, key benefits and considerations are outlined in the following section.

Discussions on the requisite technologies underlying these opportunities are included in the Electrification Technologies section below.

Typical Gas Use Cases



Typical Asset Prioritisation

Figure 21 shows the typical hierarchy of gas assets from highest to lowest consuming. Councils looking to adopt a piecemeal approach to electrification should consider prioritising assets in the following order where practical, noting however that site specific consumption trends may vary.

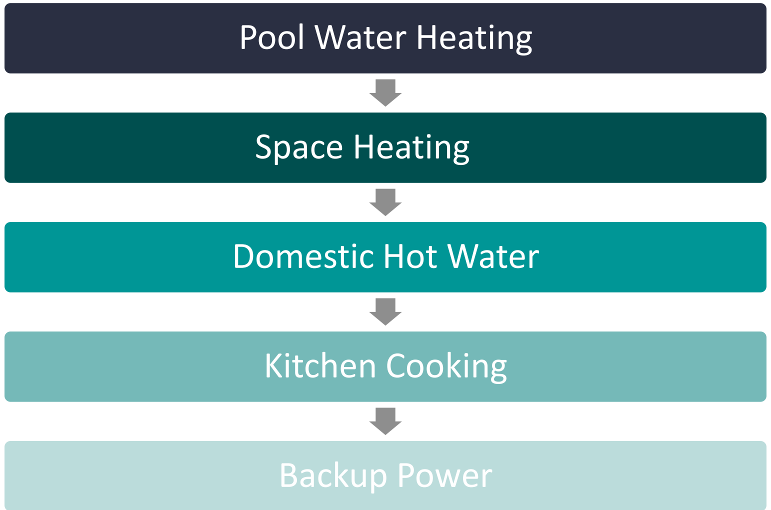


Figure 21: Typical Priority Order of Electrification

Mains vs Bottled Gas

A significant portion of council facilities continue to use bottled LPG in lieu of mains natural gas. Bottled gas is often more versatile than mains gas as it can be easily moved, may not require as significant piping infrastructure, and can be scaled up or down according to consumption requirements.

Provided there is sufficient existing electrical infrastructure, there are no significant variations in transitioning to electrified systems from bottled gas compared to mains gas. Where councils still require a high degree of energy portability and scalability, for example in caravan parks, battery storage systems may be utilised.

Due to ongoing rental fees and additional expenses, bottled gas is often more expensive than natural gas. Shifting to electrified assets may presents an opportunity to reduce council energy costs and enable equitable energy distribution and costs across the Local Government sector.

Domestic Hot Water

Domestic Hot Water (DHW) refers to heating water for amenities such as showers or taps. DHW can utilise a substantial proportion of council facilities energy consumption and has been traditionally obtained by using gas-fired hot water systems.

Alternative Technologies

Typical Gas Assets	Electric Alternatives
❖ Centralised gas boilers	❖ Heat pumps connected to thermal storage tanks
❖ Localised gas boilers (Instantaneous gas, gas storage)	❖ Instantaneous electric hot water systems ❖ Heat pumps with thermal storage tanks

Benefits and Opportunities

- Lower ongoing operational costs
- Potential integration of high efficiency heat pumps
- Improved air quality through reduction in air pollutants
- Reduced emissions and costs

Important Considerations

- Larger plant rooms required with access to natural ventilation
- May result in increased peak demand electricity charges
- Must be sized correctly to accommodate peak hot water demand. Installation of hot water storage tanks may alleviate peak hot water demand requirements

Capital and Operational Expenditure

Shown below is the typical investment and operational costs of DHW electrification compared to a gas equivalent.

↑ Capital Investment Costs

↓ Ongoing Operational Costs

Space Heating

Gas infrastructure is commonly used to provide environmental heating within a facility. Boilers burn gas to produce heat that is circulated throughout the facility using a combination of Heating Hot Water (HHW) piping, fans and ductwork.

Alternative Technologies

Typical Gas Assets	Electric Alternatives
❖ Centralised gas boilers	❖ Water/air source heat pumps
❖ Gas radiant/fire heating	❖ Electric radiators ❖ Water/air source heat pumps

Benefits and Opportunities

- Potential integration of high efficiency heat pumps
- Heat pumps can provide simultaneous heating and cooling
- Improved air quality through reduction in air pollutants
- Reduced emissions when integrated with renewable energy sources
- Quiet operation

Important Considerations

- Heat pumps may need to be installed in different locations to gas boilers and require access to natural ventilation
- May result in increased peak demand electricity charges
- Must be sized correctly to accommodate maximum heating demand
- May require retrofitting existing HHW piping and pumps to accommodate variances in HHW temperature output

Capital and Operational Expenditure

Shown below is the typical investment and operational costs of HHW electrification compared to a gas equivalent.

↑ Capital Investment Costs

↓ Ongoing Operational Costs

Kitchens and Cooking

Council facilities have traditionally been fitted with gas ovens and cook tops. These assets can be replaced with electric equivalents to further reduce site gas dependency.

Alternative Technologies

Typical Gas Assets	Alternatives
❖ Gas cooktops	❖ Induction cooktops
❖ Gas ovens	❖ Electric ovens
❖ Specialised gas burners (wok, flame, and char)	❖ Electric charcoal grille ❖ Electric grille with steam for moisture ❖ Induction wok burners
❖ Gas BBQ	❖ Electric BBQ ❖ Charcoal BBQ

Benefits and Opportunities

- Precise temperature control
- Induction cooktops can provide additional kitchen surface space
- Rapid cooling, minimising risk of burns
- Reduced indoor air pollution
- Easy to clean surfaces

Important Considerations

- Some cooking functions requiring flames may need localised fuel sources
- Electric cooking may require change to traditional cooking techniques
- Potential barriers to uptake due to community preference for gas

Capital and Operational Expenditure

Shown below is the typical investment and operational costs of electrified cooking compared to a gas equivalent.

Capital Investment Costs (↑)   Ongoing Operational Costs (=)

Pool Water Heating

Pools require a considerable amount of energy to heat and maintain specific environmental conditions. Pool water heating is typically provided by gas boilers, but opportunities exist to upgrade to heat pump and/or solar thermal systems. Additional information on the unique pool environment is included in Appendix B

Alternative Technologies

Typical Gas Assets	Alternatives
❖ Gas boilers	❖ Heat pumps ❖ Combined solar thermal systems

Benefits and Opportunities

- Installation of high efficiency heat pumps to minimise utility expenditure
- Heat pumps may provide simultaneous heating of pools and space cooling
- Improved air quality through reduction in air pollutants
- Reduced emissions when integrated with renewable energy sources
- Quiet operation
- Opportunities to use integrated pool water-heat pump systems or combined systems for DHW, HHW and pool water heating

Important Considerations

- Heat pumps may need to be installed in different locations to gas boilers
- May result in increased peak demand electricity charges
- Must be sized correctly to accommodate maximum heating demand
- Electrical infrastructure constraints may hinder heat pump upgrades due to the significant amount of energy required
- Specialised systems may be required to account for the high humidity and chemicals used by aquatic centres, incurring additional cost

Capital and Operational Expenditure

Shown below is the typical investment and operational costs of pool heating compared to a gas equivalent.

Capital Investment Costs (↑)   Ongoing Operational Costs (↓)

Backup Power

Diesel generators are a common solution to provide emergency power during electricity blackouts. Diesel consumption typically contributes less than 1% of emissions, however alternatives should be considered if councils wish to pursue full site electrification.

Alternative Technologies

Typical Gas Assets	Alternatives
❖ Diesel generators	❖ Battery storage, ❖ Hydrogen fuel cells

Benefits and Opportunities

- Reduces the reliance on natural gas in emergencies
- Battery power can be used year-round to manage peak demand
- Can integrate with broader council energy operations to provide load management and energy resource sharing.
- Future electric vehicles may be able to provide bi-directional charging to act as mobile batteries

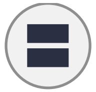
Important Considerations

- Hydrogen fuel cells are an emerging technology and may present unexpected long-term obstacles
- Battery storage systems may lose capacity over time

Capital and Operational Expenditure

Shown below is the typical investment and operational costs of backup power compared to a gas equivalent.

Capital Investment Costs



Ongoing Operational Costs

Electrification Opportunity Opinion of Probable Cost

The following opinion of probable costs are provided as an indication only to help inform councils. Costs are for technology supply only, and exclude installation, labour or necessary prior upgrades, and do not account for potential unforeseen cost increases due to the implementation considerations and risks identified in Part 4 and Part 6.

FGA does not warrant the accuracy of probable costs and disclaim all responsibility for any loss or damage that may be suffered, directly or indirectly. FGA strongly recommend that councils conduct facility specific appraisals and determine site-specific cost estimates prior to upgrade.

Domestic Hot Water

Opinion of Probable Cost	Use Case
$10,000-$30,000	Small-medium size community center, used for handwashing and limited showering, with approximately 500L storage

Space Heating

Opinion of Probable Cost	Use Case
$275,000-$625,000	Small-medium size community center for a 300-600kW central plant system, excluding requisite pumps, pipework, air handling units and/or fan coil unit replacements

Kitchens and Cooking

Opinion of Probable Cost	Use Case
$4,000-$8,000	Standard non-industrial 4-6 burner cooktop

Pool Water Heating

Opinion of Probable Cost	Use Case
$300,000-$550,000	400-500kWr air cooled medium efficiency heat pump

Backup Power

Opinion of Probable Cost	Use Case
$5,000-$18,000	Lithium-ion non-industrial battery with 5-15kWh nominal storage

Case Study

Yarra City Council Electrification Upgrades

In 2021, Yarra City Council began the process to fully electrify small council buildings and have currently completed electrification at over 20 sites. The upgrades were undertaken across a broad range of facilities and included the replacement of gas cookers, heaters and hot water systems with electrified alternatives.

Plans are underway to electrify larger council facilities with complex gas systems - such as libraries, leisure centres and town halls - by 2030. Along with community support on the transition to electric energy, Yarra City Council has reduced organisational emissions by over 70 per cent since 2008/09 and aims to achieve gross zero emissions by 2030."

Key outcomes of electrification:

- In 2022, the City of Yarra led the electrification of three council-owned, community-operated sites, with grant funding from Sustainability Victoria.
- Beyond the emissions reductions and cost savings achieved through these upgrades, there was significant opportunity for engagement and co-learning.
- Two sites which were fully electrified also accepted the offer to switch to Council's 100% renewable electricity contract. These changes meant these sites were operating with zero energy-related emissions!
- Induction cooktops were installed to replace gas stoves at several sites, which required the cookware to be updated. This was a minor yet unanticipated additional cost.

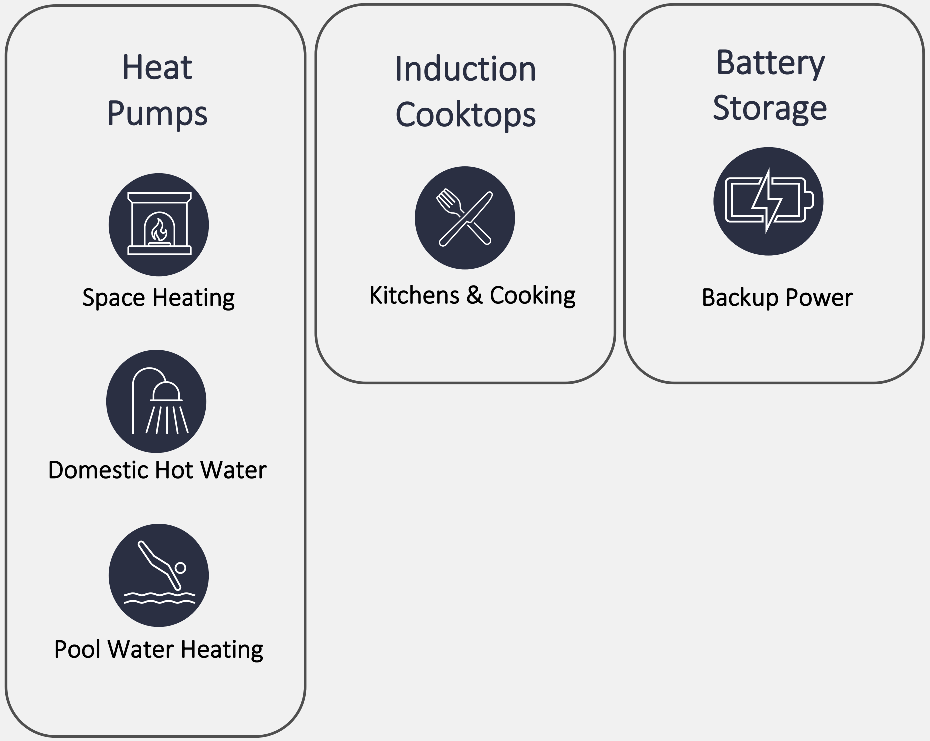
Figure 22: Richmond Town Hall

Electrification Technologies

This section provides an overview of the recommended technologies councils should adopt when embarking on portfolio electrification.

Although alternative electric technologies may exist, the following solutions are regarded as best-practice and should be prioritised where possible.

Typical Electrification Technologies and Use Cases



Heat Pumps

Introduction to Heat Pumps

Heat pumps are devices that utilise the refrigeration cycle to transfer heat between mediums. Due to their ability to move heat rather than to generate heat directly, heat pumps are significantly more efficient than traditional technologies such as gas boilers and electric resistive heaters.

Types of Heat Pumps

Air Source Heat Pumps (ASHP)

Air source heat pumps are optimised to transfer heat energy from the ambient air. These devices are generally installed on the roof of buildings or outside to increase airflow over the unit.

Typically, ASHPs are not as efficient as comparable water-source heat pumps. However, as they only require exposure to ambient air, they offer great design flexibility. ASHP are often used for domestic hot water or for small-medium heating and cooling demand.

Water Source Heat Pumps (WSHP)

Water source heat pumps differ from air source heat pumps as heat transfer occurs with a water loop rather than the ambient air. As a result, water source heat pumps are typically more efficient and provide greater peak performance. However, significant infrastructure is required to cool the water loop, adding additional cost, complexity, and risk. The water loop that exchanges heat with the heat pump can be cooled in a variety of ways, including with cooling towers, local bodies of water and ground sources.

Heat Pump Selection Criteria

Shown below is a high-level overview of heat pump selection criteria.

	Domestic Hot Water	Small – Medium Peak Demand	High Peak Demand
Air Source Heat Pump	X	X	
Water Source Heat Pump			X

Heat Pump Limitations

High Capital Costs

Quality heat pumps are typically capital intensive compared to gas alternatives, however increased prices may be offset through reduced energy usage and lifetime maintenance costs.

Refrigerant Leakage and Disposal

The refrigerant circulating throughout the heat pump can present significant health, safety and environmental impacts through leakage or incorrect disposal. Use of specialised CO_2 or ammonia heat pumps that use carbon dioxide or ammonia as the refrigerant can mitigate these risks, in addition to strict guidance on end-of-life disposal.

Space Conditioning Heating Hot Water Retrofit Requirements

The heating hot water produced by heat pumps is at a lower temperature than typical combustion boilers. To account for these differences, heating hot water piping and pumping infrastructure may require retrofitting to accommodate lower water temperatures. Typical upgrades may include installing larger diameter piping or pumps that increase flow speed which may incur additional project cost, complexity, and operational disruption.

Heat Pump Key Benefits

Heat pumps offer the following key benefits over gas heating technologies:

Efficiency

Heat pumps do not produce heat directly; they instead operate by transferring heat between environments. This allows them to be more far efficient than traditional heating sources. The typical efficiencies of heating infrastructure include:

- Gas Boilers 70-80%
- Electric Resistive Heaters 95-100%
- Air Source Heat Pumps 300-500%
- Water Source Heat Pumps 400-600%

Low Operating Costs

Due to the increased efficiency, low maintenance and extended asset lifetime, heat pumps offer a lower overall operating cost than gas equivalents.

Versatility

Heat pumps can deliver both heating during winter and cooling during summer. This minimises the need to install additional single purpose assets on site, lowering capital investment costs.

Dual Purpose

The rejected heat from the refrigeration cycle may be utilised for heating purposed. This allows heat pumps to simultaneously deliver heating and cooling services, improving the overall versatility and efficiency of the system.

Quiet Operation

Heat pumps can be installed on building rooftops or located away from council operations. Positioning equipment away from common areas lowers the impacts of noise and vibration and reduces community disruption.

Induction Cooktops

Induction cooktops heat cookware through the principle of magnetic induction. An electrical current is passed through a copper coil that sits under the cooktop surface which induces a fluctuating electromagnetic field. This in turn produces a magnetic field within the cookware, resulting in the production of heat.

This method of heat transfer minimises energy losses with the ambient air, resulting in a more efficient cooking and a cooler cooking experience.

Other Types of Cooktops

Electric Resistive Cooktops

Electric cooktops transfer heat via hot metal coils rather than hot flames or magnetic induction. The coils are heated by electrical resistivity, this heat is then transferred through physical contact with the cookware. Electric resistive cooktops are more efficient than gas burners, however still less efficient than induction cooktops.

Induction Cooktop Limitations

Specific Cookware Requirements

Induction cooktops require ferromagnetic-compatible cookware to work properly. Facilities fitted with induction cooktops should ensure that appropriate cooking equipment is provided which may incur additional initial expense.

Alternative Cooking Styles

While induction cooking provides a high level of versatility there are some cooking styles which cannot be used. Cooking styles involving an open flame such as charring cannot be replicated and may require temporary gas usage.

Induction Cooktops Key Benefits

Induction cooktops offer the following key benefits over other cooking methods:

Efficiency

Induction cooktops are generally more efficient than gas and electric resistive alternatives. Typical efficiencies of cooktops include:

- Gas cooktops 30-50%
- Electric resistive cooktops 75-80%
- Induction cooktops 85-90%

Precise Temperature Control

Due to the nature of the technology, heat transfer can be carefully controlled and stops as soon as the burner is turned off, reducing the risk of overcooking.

No Indoor Pollutants

As induction cooktops are purely electric, they produce no indoor pollution, resulting in a cleaner and safer cooking space,

Low Operating Costs

Induction cookware operate more efficiently than gas burners and can be connected to renewable energy sources to provide reduced operating costs.

Increased Kitchen Space

When not in use, induction cooktop surfaces can be used as a kitchen preparation area. Induction cooktops are often flatter than other cooktops, making them easier to clean.

Safer to Use

As the source of heat in induction cooking is the cookware itself, the cooktop surface remains cool. This is a safer alternative to both electric and gas cooktops, providing a cooler working environment and reducing the risk of burns.

Battery Storage

With the widespread deployment of solar PV systems, the development of battery storage technologies has rapidly increased. Battery storage systems are effectively smart battery banks used to store electrical energy for use at optimal times and as backup power to essential services.

Battery energy storage systems are commonly, although not exclusively, installed to complement onsite generation systems such as Solar PV systems. They typically contain the following key components:

Battery Modules – Battery modules can consist of one or more lithium battery cells in an array. These can be connected in series or in parallel to match the capacity and voltage requirements of the supported system. Batteries often come in pre-assembly setups but are also available standalone depending on the system requirements.

Battery Management Module – Battery management modules contains the electronics required to manage the charge and discharge of battery modules. These are typically integrated into the pre-assembled battery energy storage systems.

Battery Management System (BMS) – Battery management systems are integral component of most battery energy storage systems. It monitors and manages the electric and thermal states of connected batteries to ensure batteries operate within safety limits. The BMS may also manage the charging and discharging of the battery system.

Power Conversion Equipment (PCE) – Power conversion equipment is required to convert DC (Direct Current) power from batteries to AC (Alternating Current) power compatible with the site's electrical system. The device ensures the supplied electrical energy is at the correct voltage and frequency. PCEs can be standalone equipment or be in-built in pre-assembled battery energy storage systems. Solar PV systems typically come with dedicated inverter modules that needs to be compatible with the battery energy storage system.

Grid Protection Devices – Grid protection devices are installed to allow export of electrical energy to the grid typically for sites with on-site generation systems such as Solar PV systems. It serves to ensure the electrical supply generated matches the grids electrical supply so that the grid is not negatively impacted by the exported electricity.

Other Types of Energy Backups

Hydrogen Fuel Cells

Hydrogen fuel cells produce heat and electricity via chemical reaction between hydrogen and oxygen. Hydrogen fuel cells remain an emerging technology and as such are not currently recommended for council implementation.

The source of hydrogen is another critical consideration as hydrogen produced through coal or gas electricity has a large emissions footprint

Battery Storage Limitations

High Capital Costs

The costs of these solutions are directly affected by the amount of battery cells required to meet site demands. Depending the size of the electrical loads on site and the load profile, solutions may not be cost-effective, particularly if oversized. Careful analysis is required during design periods to achieve the most optimal cost-effective solution.

Battery storage costs may be offset by through peak demand management, better utilisation of on-site renewable energy and subsequent grid exports.

Chemical Hazards

Battery storage systems are typically safe for installation, but care is still required to assess and manage the hazards from the chemicals inside batteries. It is often recommended to ensure batteries are stored in well ventilated areas and regularly maintained to reduce any risks to the facility.

Space Requirements

Depending on the capacity required to support systems on site, the amount of dedicated space to house the batteries can be an area of concern, especially for larger sized units where weight also becomes an impacting factor. The space required need to be compliant with National Construction Code requirements with adequate fire-rated enclosures and ventilation systems where applicable. Installation of safety barriers and fencing needs to be considered to prevent unwanted access to the system.

Technology Maturity

Battery storage technology is a rapidly developing industry and as such battery storage technologies have not yet reached full market maturity. Future advancements in battery storage technologies may limit the long-term effectiveness of immediate purchase, resulting in reduced return on investment and an early adopter tax.

Recharging Capacity

The recharging capacity of installed battery storage declines with the number of recharge cycles, limiting the long term capabilities of the battery.

Battery Recycling

Batteries contains chemicals that can be hazardous and cause damage to the environment if not disposed of properly. There are methods of recycling batteries available to minimise the effect on people and the environment. The solution designed for any type of battery energy storage systems need to consider the end-of-life management plan of batteries.

Battery Storage Key Benefits

Battery storage technologies provide the following benefits:

Reduced Grid Reliance

Where solar PV systems can generally only reduce the amount of power received from the grid during the daytime, battery energy storage systems can complement such systems to discharge any stored energy during non-daylight hours and reduce electricity imported from the grid.

Reduce Pressure on Electricity Network

The implementation of battery storage system not only provides benefits to council facilities but also reduces the growing demand on the grid especially during peak periods. The more demand that can be provided by solar PV and battery storage systems, the less pressure there is on the grid.

Peak Shaving & Load Leveling

Advanced battery management systems can determine the optimal time to store and discharge energy to meet peak demand. Electrical costs can be reduced by storing energy from the grid during off-peak periods where charges are lower and discharging during peak periods to avoid high peak charges.

Back Up Energy Supply

The stored electrical energy in the batteries can be discharged during grid blackout events to keep critical systems operating. This is especially pertinent for councils looking to improve facility climate resiliency as sites can continue to operate during extreme weather events.

Low Maintenance Backup Power Solution

Battery storage systems are generally low maintenance assets for backup power solutions due to the lack of mechanical parts. The advanced battery managements systems will automatically monitor the state of the system and notify when maintenance and repairs are required.

Moorabool Shire Council - Bacchus Marsh Library

Part 4: Cost and Implementation

Key Implementation Considerations

The following is a broad list of implementation considerations that may impact the viability of site electrification. Comprehensive site assessments should be conducted prior to business case development to ensure these considerations are accounted for and do not adversely affect project costs, complexity, or completion timelines.

1	**Heritage Sites**	Heritage buildings, or buildings containing heritage overlays may present additional challenges when pursuing site electrification. Limitations to the extent of facility upgrades may result in added project cost, risk and technical complexity and may require specialised contractors to complete the works.
2	**Spatial Constraints**	Facilities with limited spatial tolerances may present additional hurdles to site upgrades. Heat pumps and other electrified technologies often require installation in different locations to gas-fired assets, which may not be feasible within spatially constrained sites. Limitations to the extent of rooftop availability may additionally limit the extent to which heat pumps and solar PV can be installed, reducing the business case for renewable uptake, and increasing electrification payback.
3	**Electrical Infrastructure Constraints**	Upgrading to electrified systems in lieu of gas infrastructure will place additional strain on the electrical grid. Care should be taken to ensure that the facility electrical infrastructure has the capacity to allow for these upgrades prior to implementation. This is especially pertinent to sites which will require significant electrical assets, such as pools and aquatic centres, as these will place greater demand on the electrical network.
4	**Space Conditioning Retrofits**	The heating hot water produced by heat pumps is often at a lower temperature than gas boilers. To account for these differences, heating hot water piping and pumping infrastructure may require retrofitting to accommodate lower water temperatures. Typical upgrades may include installing larger diameter piping or pumps that increase flow speed which may incur additional project cost, complexity, and operational disruption.
5	**Structural Constraints**	A thorough structural analysis should be conducted to ensure that the facility can withstand the additional weight loads of electrified technologies. Particular consideration should be taken to rooftops to confirm that they are fit for purpose and can safely carry the additional weight of solar panels and heat pumps.
6	**Revised Planning Permits**	The facility upgrades required to implement electrified technologies may require planning permits and approvals. This can delay project timelines, which may result in additional program costs, resourcing and planning.
7	**Changing Energy Sources**	Implementation of heat pump technology will reduce reliance on natural gas and LPG. Stakeholders should be aware of the market impacts changing to electric-only systems.
8	**Operation and Maintenance**	Changing infrastructure will necessitate changes to council facility operation and maintenance. Staff should be aware of these changes and any new requirements to keep systems operational.
9	**Energy Redundancy**	Councils shall ensure that there is sufficient energy redundancy on facility sites to minimise potential operational disruption. Energy redundancy may be assured through on-site energy storage, renewable energy generation or backup systems. This will allow facilities to continue to operate during upgrades.
10	**Increased Peak Demand Charges**	The high electrical loads required by heat pumps may increase site peak demand, incurring additional expense from electricity retailers.

Table 3: Key Electrification Implementation Considerations

Implementation Considerations Graphic

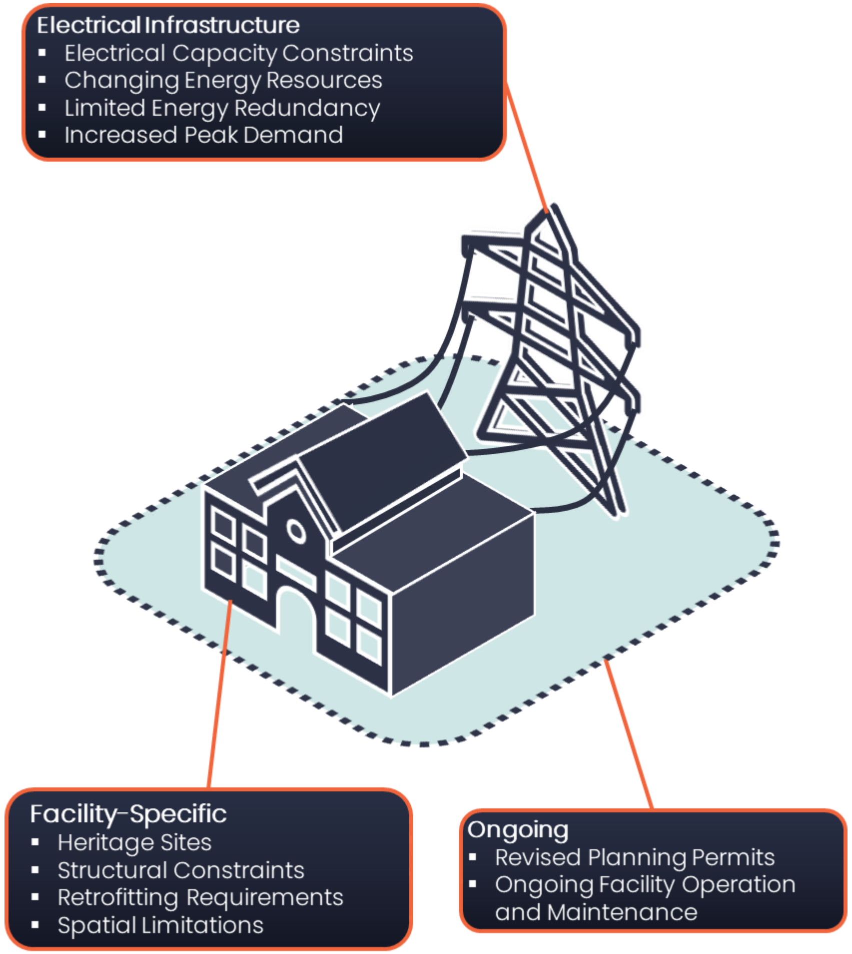


Figure 24: Key Implementation Considerations Graphic

Case Study

Tambo Crossing Community Facility, East Gippsland Shire Council

Following summer bushfires over 2019 to 2020, the development of a new facility for fire recovery and local resilience was identified as a high priority. Completed in 2022 as a collaboration between Bushfire Recovery Victoria and East Gippsland Shire, the facility acts as a central meeting place for the Tambo Crossing Community and provides emergency vehicles and equipment, a meeting room, kitchen, amenities as well as backup batteries and generators.

Funded by the Victorian Government's Local Economic Recovery Program, the facility is powered primarily by solar PV. The facility is completely off-grid and fully electrified, aiming to provide reliable access to essential amenities during blackout periods and acting as a central gathering place for the community.

Emissions Impact and Relative Cost Nomenclature

The following nomenclature has been used to provide an overview of probable cost and emissions reduction impact resulting from facility electrification.

The opinion of probable cost and emissions reduction estimates provided below are indicative only and based on data collected from the Council Energy Review.

FGA note that individual site conditions and contexts will vary, and strongly recommends that councils complete a detailed assessment of site infrastructure and cost planning prior to embarking on electrification upgrades.

Relative Capital Cost

Relative capital costs include the fees required to appropriately assess, plan, design, implement and verify electrification upgrades. FGA note that due to significant market upheaval, costs are likely to change in the short-medium term and recommend that updated costs are developed for each facility during the project planning and assessment phases.

- $ Low
- $$ Medium
- $$$ High
- $$$$ Very High

Emissions Reduction Impact

Emissions reduction impact is based on the quantum of tonnes of CO2-e shifted from scope 1 to scope 2. It is assumed that through integration of renewable energy sources in addition to the ongoing decarbonisation of Victoria's energy grid these emissions will be abated in the short-medium term.

- Minimal Council Emissions Reduction
- Medium Council Emissions Reduction
- Large Council Emissions Reduction
- Significant Council Emissions Reduction

Risk and Complexity Ratings

The following risk and complexity ratings have been used to assess the impacts of electrification for different council facilities

Risk Rating	Priority Description
Low	Issues are localised with minor or negligible impact on council operations. No major service disruptions, however, may result in administrative issues.
Medium	Issues may lead to significant operational impacts and may impact the broader community. Issue may affect the performance of facility assets and services. Issues will require consideration in the design phase.
High	Issue may lead to substantial disruption of services and may require complete facility shutdown during the implementation period. Issue requires serious consideration in the design phase.

Table 4: Electrification Risk Ratings

Complexity Rating	Priority Description
Low	High-level coordination and planning only required. Technology is mature with demonstrated outcomes and processes. Community disruption may be negligible.
Medium	Supporting systems and infrastructure are required, creating additional dependencies. Detailed design is required with an additional assessment of technical capacity. Technology has limited maturity. Community disruption may be considerable, however temporary.
High	Multiple layers of supporting systems are required, creating multi-layered dependencies. Delays in set up may create problems for contingent systems and create significant operational disruption.

Table 5: Electrification Complexity Ratings

Emissions Impact and Relative Cost

Facility Type	Typical Facility Energy Infrastructure	Typical Natural Gas and LPG Usage	Electrification Upgrade Costs	Emissions Reduction Impact	Risk Rating	Complexity
Halls	❖ DHW Boilers ❖ Space Heating Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**4%** Total Council Natural Gas Usage **4%** Total Council LPG Usage	$$$	🌲🌲🌲	Medium	Medium
Sports Facilities	❖ DHW Boilers ❖ Space Heating Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**1%** Total Council Natural Gas Usage **33%** Total Council LPG Usage	$$	🌲🌲	Medium	Medium
Offices	❖ DHW Boilers ❖ Space Heating Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**0%** Total Council Natural Gas Usage **0%** Total Council LPG Usage	$	🌲	Medium	Low
Depot	❖ DHW Boilers ❖ Radiant Heaters ❖ Energy Backups	**0%** Total Council Natural Gas Usage **0%** Total Council LPG Usage	$	🌲	Low	Low
Community Centres	❖ DHW Boilers ❖ Space Heating Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**5%** Total Council Natural Gas Usage **6%** Total Council LPG Usage	$$$	🌲🌲🌲	Medium	Medium
Caravan Park	❖ DHW Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**0%** Total Council Natural Gas Usage **21%** Total Council LPG Usage	$	🌲🌲	Low	Low
Aquatic and Recreation Centres	❖ Pool Water Heating ❖ DHW Boilers ❖ Space Heating Boilers ❖ Kitchens and Cooking ❖ Energy Backups	**90%** Total Council Natural Gas Usage **35%** Total Council LPG Usage	$$$$	🌲🌲🌲🌲	High	High
Council Utilities	❖ Public Toilets ❖ Street Lights ❖ Car Parks ❖ Pillar Boxes ❖ Pumps ❖ BBQs ❖ Memorials	**0%** Total Council Natural Gas Usage **1%** Total Council LPG Usage	$	🌲	Medium	Low

Table 5: Emissions Impact and Opinion of Probable Cost

Business As Usual Scenarios

Reducing Utility Expenditure

Increases to energy costs nationwide has had a significant impact on council utility expenditure due to the large number of council-owned, high consumption facilities. This has yielded increased attention on portfolio energy infrastructure and consumption.

Councils looking to minimise energy costs should prioritise facility electrification in addition to energy efficiency upgrades and renewables integration. These upgrades serve to simultaneously migrate energy usage to electric only, reduce the amount of electricity required to operate facilities and offset remaining usage with locally generated energy.

Asset Efficiency Upgrades

Typical energy efficiency upgrades may include (but are not limited to):

- Lighting upgrades to high efficiency Light Emitting Diodes
- Lighting control upgrades to improve time-of-use
- Building envelope upgrades minimising energy lost through the building façade. Building envelope upgrades may include improvements to glazing, insulation and stopping air leakage.
- Building Management System (BMS) tuning to optimise equipment runtime and calibrate setpoint temperatures appropriately
- Asset lifecycle replacement, ensuring inefficient and outdated assets are replaced with high efficiency modern alternatives
- Thermal storage tank upgrades to ensure water for DHW or HHW is stored at an appropriate temperature and well insulated.

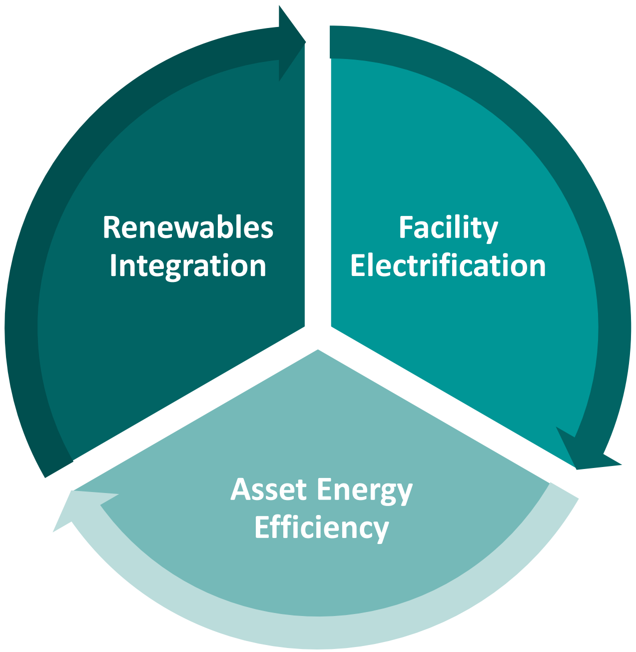


Figure 25: Recommended Facility Energy Upgrades

Asset Lifecycle Replacement

Ongoing asset lifecycle replacement may provide councils an opportunity to electrify their portfolio without requiring major capital investment.

Ensuring that all new replacement assets are high-efficiency, electric only systems will allow councils to gradually uplift their portfolio without need for an extensive project at additional costs.

Councils looking to embed electrification as part of ongoing business as usual should consider the following:

- Develop or update existing building design standards to ensure that all procurement and installation protocols align with this electrification strategy.
- Conduct site assessments of each facility to confirm this methodology is suitable, and no unforeseen circumstances or key implementation considerations may hinder the effectiveness of upgrades.
- Ensure all stakeholders are appropriately advised to mitigate the risk of accidental breaches to procurement policies
- Provide adequate training to facility managers and stakeholders to ensure they are appropriately trained with the new technologies.

Hybrid Systems

Gradually replacing assets as they reach end of life will ensure that for the short-medium term there are both electrical and gas assets on-site. These hybridised systems can improve energy redundancy and reduce friction experienced during the electrification transition stage.

FGA notes that hybrid systems present only a short term solution, and that maintaining hybrid systems long-term can produce additional system complexity, costs and emissions. Hybrid systems require more complex control to ensure decarbonisation is achieved. It is recommended that hybrid systems are only maintained during the transition period to new electrified assets.

[8] Labor Federal Budget 2022

Future Gas Costs

The cost of gas is expected to rise by **44% over the next 18 months**[8] due to a combination of ongoing energy geopolitics, inflation, and worldwide energy shortages. Due to the nature of the technology, councils cannot significantly improve gas efficiency without directly replacing assets at significant cost. Furthermore, unlike electrical assets, gas usage cannot be offset with locally generated energy.

Therefore, future adoption of gas assets will result in ongoing operational cost increases, limited agency to optimise site energy usage and reliance on increasingly volatile gas markets. By contrast, electrification of assets may incur additional upfront expenses and reliance on similarly volatile electrical markets but will simultaneously provide councils the ability to improve site energy efficiency and integrate on-site generation resulting in greater energy agency and lower costs. Furthermore, use of renewably generated electricity in lieu of gas will avoid the requirement for councils to purchase carbon offsets, further minimising council operational costs.

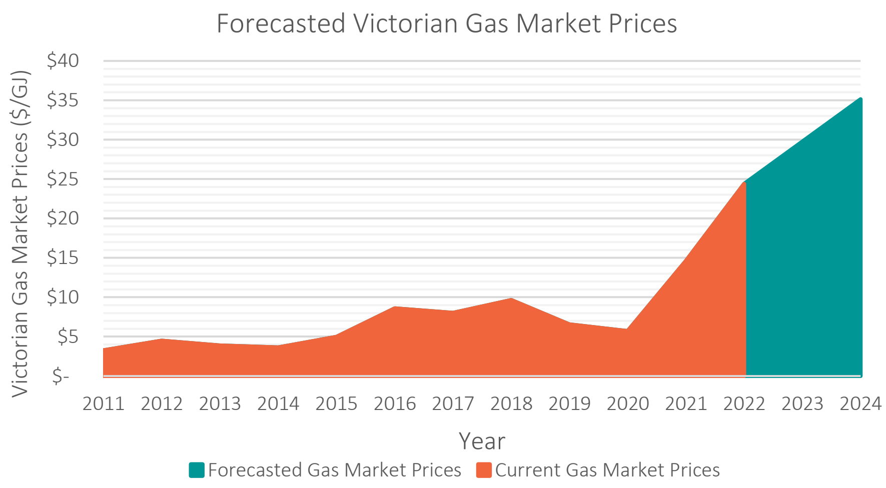


Figure 26: Forecasted Victorian Gas Market Prices[9]

[9] Data from Australian Energy Regulator with forecast rates from Labor Budget 2022

Implementation Flow Chart

FGA note that the Implementation pathway provided is generally applicable only. Order, sequencing, and staging will depend on individual council and facility context, the type and extent of upgrades and additional risk factors that may influence project completion.

Business Case Development

It is recommended that council stakeholders utilise the Electrification Foundation Paper to develop a high-level overview of site specific electrification opportunities and produce a council specific energy strategy. This energy strategy will include facility prioritisation, future use cases and development of sustainability policy to ensure future upgrades are consistent across the portfolio and have sustainable outcomes embedded in all major projects moving forward.

FGA recommend that each facility conduct a site-specific appraisal to determine the applicability and validity of the opportunities provided. Depending on the extent of proposed upgrades, energy audits may be conducted to develop a thorough understanding of facility energy consumption and identify further opportunities for improvement.

Once council stakeholders have developed understanding and planning of electrification opportunities relevant to their site it is recommended that they complete a business case to source funding for future upgrades.

Electrification Upgrades

Once funding approval has been received it is recommended that councils engage an appropriate consultant/s to complete a comprehensive site assessment to support future planning, design and implementation phases.

Following the site assessment, council stakeholders consultants can embark on the design and planning stage to develop upon the identified opportunities and maximise value. Post design and planning, councils will embark on tendering of services and subsequent construction/implementation of all upgrades.

Council Knowledge Sharing

After the upgrades have been completed it is important to verify the effectiveness of the upgrades and determine total energy, emissions and cost reductions to support future electrification upgrades and knowledge sharing between councils.

Yarra City Council - Fitzroy Town Hall

Part 5: Procurement and Financing

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Procurement and Financing Models

Energy as a Service

Overview

Energy as a Service (EaaS) is a business model whereby facilities pay an Energy Service Company (ESCO) to provide and manage site energy consumption and associated assets. Sites typically pay a recurring fee in exchange for the provision of energy, maintenance, and upgrades to site infrastructure.

Key Benefits

Low Capital Investment – EaaS typically use subscription-based billing which occur over the lifetime of the contract. This provides a key opportunity for councils to upgrade site assets through the EaaS model without requiring large upfront capital investments.

Energy Efficiency Improvements – ESCOs are incentivised to lower facility energy consumption through upgrades and improvements to site energy efficiency. This produces dual benefits to the ESCO and facilities who receive energy upgrades as an embedded part of the service.

Market Volatility Protection – Ongoing fees for EaaS are typically established at the contract onset, sheltering the facility from energy market volatility and price increases. The market risk is instead borne by the ESCO.

Energy Analytics and Insights – EaaS often introduces advanced energy analytics platform to better track utility consumption, expenditure and make operational improvements.

Renewable Energy Integration – EaaS providers often manage the installation of renewable energy sources to further minimise utility expenditure, improving the extent of renewable energy adoption with limited risk and costs borne by councils.

Energy Performance Contracting (EPC)

Overview

An EPC is a form of contracting where an ESCO is engaged to improve the overall energy efficiency of a facility. The EPC ensures guaranteed energy savings over an agreed term. This allows councils to recover the capital expenditure required by the upgrade through the energy savings delivered through the project and presents a low risk opportunity for councils to upgrade and improve their facilities.

The EPC model provides turn-key end-to-end services with guaranteed savings outcomes. There is also opportunity to leverage the significant work the Victorian Government has done in their Greener Government Buildings Program to aid in the delivery of efficiency measures. The model leverages specialist energy services companies with expertise in energy audit, design, construction and performance measurement & verification. Opportunities that can be accessed through Greener Government Buildings include:

- Lighting & Control Upgrades
- HVAC Asset Upgrades
- Solar PV Installation
- Building Management Controls and Automation Improvements

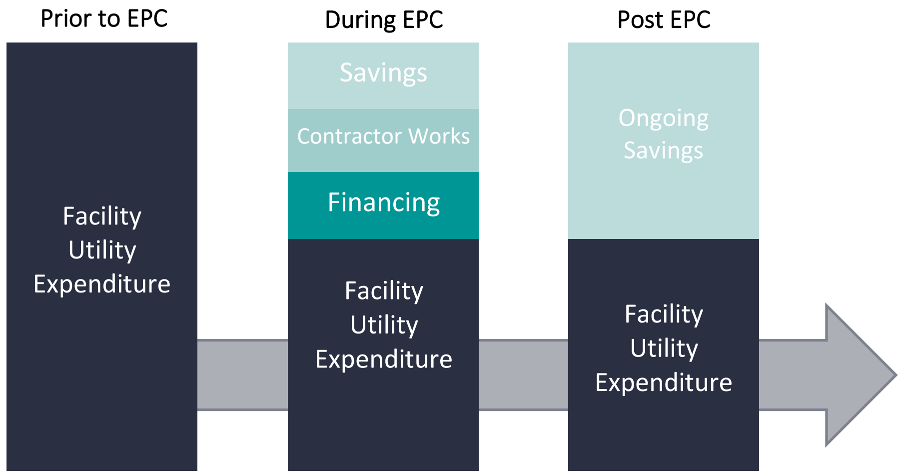

Figure 27: Energy Performance Contracting Model

Victorian and Federal Sustainability Endorsements

State Government Financing

External financing for electrification initiatives can be explored through the following government departments:

- Department of Treasury and Finance
- Department of Environment, Land, Water and Planning

Australian Renewable Energy Agency (ARENA)

ARENA was created by the Australian Government in 2012 with $2 billion of funding to co-invest in projects that improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia. ARENA exists to accelerate the affordability of new technologies and build investor confidence in renewable energy projects, and prioritises investment that:

- Integrate renewables into the electricity system
- Accelerate the development of hydrogen technologies
- Support industry to reduce emissions

Energy Innovation Toolkit

The Energy Innovation Toolkit is a service offered by the Australian Government to support the development of innovative energy technologies and business models. The toolkit offers guidance on the implementation of new and emerging technologies and supports proof-of-concept trials that offer limited time regulatory relief that enable technologies to be tested in a real-world environment.

Victorian Energy Upgrades (VEU) Scheme

Councils can participate in the Victorian Energy Upgrades (VEU) Scheme (previously 'VEET') to partially fund energy efficiency upgrades. This enables councils to claim Victorian Energy Efficiency Certificates (VEECs) for approved technologies, products and services.

Commercial entities such as councils can generate VEECs for water/space heating and cooling upgrades or through a project based assessment approach.

More information can be found on the VEU Website.

Activity	Description
44A	Decommissioning one or more gas-fired hot water boilers or gas-fired water heaters and installing an air source heat pump water heater
44B	Decommissioning one or more electric resistance hot water boilers or electric resistance water heaters and installing an air source heat pump water heater
44C	Installing an air source heat pump water heater

Table 6: VEU Commercial Heat Pump Upgrade Activities

FGA understands that the VEU program is currently conducting industry consultation and may announce program updates in the near future.

Commercial and Procurement Considerations

Consultant Selection

Appropriate consultant nomination will have a significant impact on final project outcomes. Selection of consultants lacking the requisite experience with electrified technologies may result in additional project complexity, costs and poor infrastructure that cannot meet councils requirements.

Councils should prioritise consultants with demonstrated experience in sustainable electrification upgrades, who are aware of the complexities, challenges and key implementation considerations specified in Part 4.

Of note, the unique environmental and heating conditions required by pools and aquatic centres require specialised consultants who understand the additional infrastructure challenges posed and can plan accordingly.

Failure to select appropriately qualified consultants may result in ineffective, expensive and subpar systems that fall below industry best practice and fail to capitalise on the additional benefits that electrified technologies provide.

Sustainability Policy and Framework

It is recommended that councils develop Sustainability Policies and Guidelines focused on energy and emissions to ensure that future works align with each council's sustainability and emissions targets. Policies should at minimum:

1. Provide compliance guidelines for the future replacement of assets to ensure new assets are electric only, energy efficient and align with previous upgrade works
2. Establish key priority areas and a resulting action plan to achieve holistic emissions reduction and resource management targets.
3. Guide capital works and facility refurbishments.
4. Embed sustainability in council business as usual
5. Establish a framework for sustainability Policy and Objectives review, to ensure alignment with current best-practice.

Design & Construction Standards

FGA recommends that councils adopt and issue Design and Construction Standards to ensure quality and compliance during the design, commissioning and handover phases of new construction and major electrification retrofits.

In addition, it is recommended that regular review and maintenance of the Standards is conducted in accordance with updates to industry best practice and market evolution.

Independent Commissioning Agent

As a complementary measure to the Design Standards, engagement of an engineering design Independent Review and Commissioning Agent (IRCA) for high value, high risk projects would help to ensure desired outcomes are achieved.

In particular, the IRCA's role during commissioning is critical in tuning major electrical, mechanical systems and building management systems to perform to an intended energy efficiency standard.

East Gippsland Shire Council - Omeo Service Centre

Part 6: Electrification Risk Assessment

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Electrification Risk Categories

Shown in Figure 28 below is an overview of risk categories that require careful consideration when pursuing electrification upgrades:

Cultural and Community	• Implementation may cause cultural harm and/or adversely impact the wellbeing of the general community
Financial	• Project has risk of exceeding preliminary budgets, placing additional stress on council resourcing
Technical	• High technical complexity and lack of demonstrated product maturity may delay project completion and create additional challenges
Operational	• Upgrades may cause disruption to facility and council operations
Procurement	• Issues with supply chain may cause delays in procurement, hindering completion of projects and extending project completion targets
Compliance and Regulation	• Upgrades present risk of non-compliance and/or stray from regulatory standards or industry practice
Project Complexity	• Project complexities likely to impact contingent systems and create impacts to interdependent systems and operations
Business-as-Usual	• Upgrades may adversely impact future council facility operation and business-as-usual scenarios
Environmental and Sustainability	• Electrification upgrades may adversely affect the surrounding environment and/or hinder the attainment of council sustainability targets

Figure 28: Electrification Risk Categories

Electrification Risk and Opportunities Register

Shown below is a register of risks that may impact future council facility electrification. FGA recommend that councils conduct a detailed assessment of site infrastructure to determine and address potential risks prior to implementation.

Item	Risk Category	Description	Risk Response Opportunity
1	Technical / Financial	Electrical infrastructure constraints may limit the viability of electrification upgrades and increase the cost of upgrades.	A thorough electrical assessment should be conducted at the planning stage to assess site electrical capacity and plan for electrical upgrades if required.
2	Project Complexity	Heritage listed buildings may present challenges when installing new systems and technologies.	Uplift of heritage or important cultural sites will require consideration during the assessment stage and may require specialist consultants and contractors.
3	Business-as-Usual	Electrification of gas-fired assets increases reliance on grid power, leading to complete failure of all assets in the event of a power outage.	Councils are recommended to install solar PV and energy storage systems to mitigate grid reliance. Additionally, councils to ensure that all emergency loss-of-power protocols are updated to address newly electrified assets. Requirement of battery storage and/or generators should be assessed for critical facilities.
4	Technical	Significant retrofitting may be required when upgrading boilers to heat pumps due to the lower temperature of HHW produced from heat pumps.	Thermal heat loads of facilities to be evaluated during project assessment and concept design to determine viability of current infrastructure and extent of potential retrofits to HHW systems.
5	Operational	High complexity projects may result in extended operational downtime, creating friction with community as facilities become unavailable.	The implementation of all proposed upgrades to be carefully planned to ensure minimal facility downtime. Councils should look to upgrade facilities during low occupancy periods (i.e., aquatic centres in winter) to reduce pushback from the community.
6	Project Complexity	Insufficient supporting infrastructure such as outdated BMS platforms may result in performance shortfalls and cost overruns. Integration issues may occur between legacy and new equipment.	Thorough assessment of current infrastructure and assets to be conducted at the project assessment phase. Outdated systems and infrastructure to be replaced or upgraded to accommodate new assets and reflect industry best practice.
7	Project Complexity	Potential spatial constraints in risers and roof spaces may inhibit proposed works or increase costs.	Spatial risks are to be assessed in the detailed design phase of relevant works.
8	Project Complexity	Rooftops may not provide sufficient structural support for solar and mechanical asset weight and wind loading.	Structural risks are to be assessed in the detailed design phase of relevant works.
9	Operational/ Business-as-Usual	Facility managers and other council stakeholders may hinder electrification upgrades through lack of understanding or misgivings about technical maturity.	Key stakeholders to be briefed on the value of electrification prior to works. Potential risks should be clearly provided to improve project transparency and minimise stakeholder concerns during implementation and future use.

Item	Risk Category	Description	Risk Response Opportunity
10	Technical/ Financial	Advancements in other technologies may limit the long-term effectiveness of the proposed electrified assets resulting in reduced return on investment. Limited market maturity of certain technologies may result in an early adopter tax when upgrading	Councils should perform a thorough market analysis to determine the range of market opportunities during project assessment. Councils should remain abreast of ongoing technological changes to ensure systems remain up to date and to capitalise on new innovations.
11	Financial/ Business-as-Usual	Reliance on a sole energy market may increase future energy costs and restrict councils from balancing risk profiles.	Implementation of on-site solar PV will limit exposure to market volatility. Councils may wish to participate in long term energy contracts, including Power Purchase Agreements (PPA) to hedge energy prices and ensure electricity is sourced renewably.
12	Environmental and Sustainability	Refrigerant emissions from heat pumps may cause significant environmental harm if disposed of incorrectly.	Councils to ensure that all works and contractors abide by the relevant Australian Standards regarding refrigerant disposal. Councils may wish to adopt enhanced ESD (Environmentally Sustainable Design) sustainability standards to further safeguard against refrigeration leakage.
13	Environmental and Sustainability	Replacement of electrified technologies before existing end-of-life may create additional waste.	All equipment to be disposed of responsibly and recycled where possible. Where possible systems at end-of-life should be prioritised for replacement.
14	Environmental and Sustainability	Plateaus in grid decarbonisation may not produce the expected emissions reductions from electrification.	Councils should stay up to date with the evolving energy and sustainability landscape to determine alternate solutions if there are shortfalls in grid decarbonisation. Councils may wish to acquire a PPA to guarantee energy use is net zero.
15	Operational/ Business-as-Usual	Changes in technology will require facility staff to adapt to new maintenance and asset renewal routines. Additional maintenance costs may be required to maintain new technologies due to lack of embedded asset knowledge	Councils should provide new training to key stakeholders to transmit knowledge on new infrastructure and minimise the risk of operational disruption.
16	Compliance and Regulation	Risk of non-compliance with changing State and Federal emissions and sustainability targets.	FGA recommend that councils remain up to date with changing energy and sustainability targets to limit the risk of non-compliance. Participation in sustainability alliances and organisations will serve to promote awareness of shifting expectations within councils.
17	Procurement	The effect of the COVID-19 pandemic may hinder the procurement of services and technologies.	The procurement of all services and technologies is to be considered within the context of COVID-19. Contractors with evidence of continued, uninterrupted operation throughout the lockdowns are to be favoured. Added contingency in procurement and delivery timelines to be included.
18	Technical	Limited access to innovative technologies may inhibit regional and rural councils, creating an uneven energy landscape.	Councils should prioritise inter-council cooperation and partnership to access mass negotiation and economies of scale. Metropolitan councils with better access to innovative technologies should work with regional and rural councils to provide knowledge sharing and improve the accessibility of new technologies,
19	Financial/ Business-as-Usual	Additional peak demand from electrical assets may incur further expense from electricity retailers.	Electricity rate modelling should be conducted during the assessment phase to develop future cost estimates.
20	Procurement	The facility upgrades required to implement electrified technologies may require planning permits and approvals, delaying project timelines, which may result in additional program costs, resourcing, or planning.	List of required permits and approvals to be provided during project assessment stage. Permits to be acquired at project inception. Added contingency in procurement and delivery timelines to be included.

Item	Risk Category	Description	Risk Response Opportunity
21	Financial	Expected ongoing electricity and natural gas price volatility, driven by political risk, decentralisation of energy resources, and the closure of major coal fired power stations, may impact anticipated cost savings.	Modelling should be applied to estimate cost savings based on predicted future market rates, asset utilization and energy consumption. Modelling should be continually updated as additional data becomes available.
22	Cultural and Community	Previously sustainable uplift programs may result in low engagement within communities.	Providing education on the benefits of electrification and sustainable uplift provides an opportunity to foster a culture of sustainability and promote residents to pursue electrification at home.
23	Financial	Existing gas contracts may charge additional costs when exiting early	Consideration should be made to contract exit fees when prioritising site electrification works. New gas contracts should stipulate no exit fees to reduce costs for future electrification works.
24	Financial/ Business-as-Usual	Changes to typical asset lifecycles may incur additional future costs	Assets nearing end-of-life and requiring upcoming renewal should be prioritised for replacement where feasible.
25	Environmental and Sustainability	The COVID-19 pandemic may result in unexpected changes to facility utilisation resulting in variations to the expected energy usage and emissions abatement.	Modelling should be applied to estimate the changes caused by the COVID-19 pandemic on facility usage, asset utilization and energy consumption. Modelling should be continually updated as additional data becomes available
26	Compliance and Regulation	Risk of non-compliance with changing building standards regulations.	Councils to ensure that all works and contractors abide by the relevant Australian Standards. Councils may wish to develop D&C standards or use an Independent Review and Commissioning Agent to ensure works are compliant.
27	Procurement/ Project Complexity	Inexperienced contractors and maintenance personnel may be inexperienced with lower maturity, low-emissions technologies resulting in increased construction timeframes and potential loss of building service	Comprehensive asset-specific operation and maintenance training to be supplied to all relevant personnel, with particular emphasis on low maturity technologies. Contractors and sub-contractors to be vetted based on experience.
28	Project Complexity	Increase cost of works and result in delays to the program may occur due to asbestos.	HazMat register to be provided to contractors during the tender stage of relevant works.
29	Procurement	Global silicon shortages may hinder the procurement of technologies, resulting in delays to project implementation or increased costs.	Silicon supply chain to be considered in selection of new technologies. Added contingency in costings, procurement and delivery timelines to be included.
30	Operational/ Business-as-Usual	Local trades in regional and rural areas may lack the requisite training to adequately maintain and service new electrified technologies	Councils to assess the level of training required to maintain new technologies and confirm local trades will be able to provide ongoing maintenance and support. Where local services may be unsuitable, councils to factor in cost and complexity of resourcing from neighbouring regions.

Table 7: Electrification Risk and Opportunities Register


City of Yarra - Fitzroy North Community Battery

Part 7: Future Opportunities

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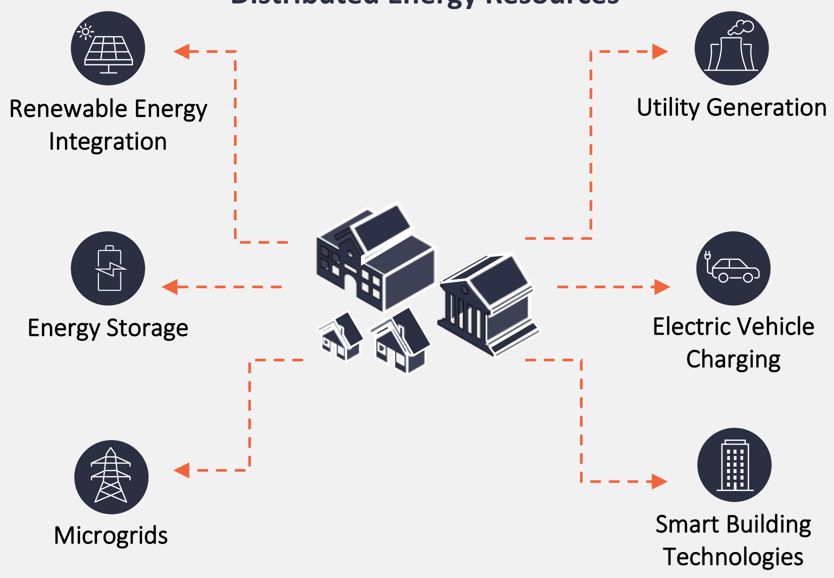
Distributed Energy Resources

Distributed Energy Resources (DER) describe decentralised energy generation from small-scale sources occurring near the end point of use.

Key Benefits of DER include:

- Reduction in grid emissions intensity, supporting the achievement of Net Zero Targets
- Reduction in electricity utility expenditure
- Improved grid reliability through high penetration of renewables
- Intelligent load management to better match supply and demand
- Reduce the reliance on centralised power stations

The electrification of building assets provides councils an opportunity to partake in DER's to provide widespread value across their portfolio. Many councils are already participating in the DER ecosystem, capitalising on increasing solar PV, battery storage and electric vehicles across their portfolio. Examples of DER's are shown below, with further commentary provided for each resource:



Electric Vehicle Charging

As the uptake of Electrical Vehicles (EVs) becomes increasingly prevalent in Australia, adoption of EV charging stations is becoming a viable opportunity for councils.

Adoption of electric vehicle charging may promote EV uptake within communities or encourage additional usage of council facilities for those already owning EVs. Implementation of charging infrastructure will also visibly demonstrate council's sustainability focus and drive increased sustainability engagement elsewhere in the community.

Bi-Directional Charging

Bi-directional charging may provide a valuable future application of EV charging. Bi-directional charging technology allows the electric vehicle to act as mobile battery storage, which can be used to provide power back to facilities when required.

This can be important to facilities at risk of blackout, or which may experience frequent electrical related disruptions. Bi-directional charging can enhance energy security and help councils plan for extreme weather or climate events to ensure essential services continue to operate.

Types of Chargers

A variety of EV chargers exist which vary in terms of charging speed, application, and overall power capacity. EV chargers also can provide charging through AC or DC power.

It is important that councils consider the unique context of their facilities and the needs for charging within the community to ensure the correct types of charging infrastructure is installed. Factors to consider include the current and future type of EVs in the community, associated charging requirements, charging speeds and general facility electrical infrastructure to ensure there is sufficient capacity.

Renewable Energy Integration

On-Site Renewables

Installation of on-site renewable energy sources can support councils reduce grid energy consumption, emissions and utility expenditure. Adoption of on-site renewables should be prioritised with electrification upgrades where practical to offset the energy usage of newly electrified assets. Types of on-site renewables may include:

Solar PV

The most common localised form of renewable energy is solar photovoltaic (solar PV) systems. Solar PV converts the sun's light into electricity through the photoelectric effect, and can readily be integrated on rooftops, carports and large areas of open land as a ground mount array.

Modern solar PV systems have undergone major innovations over the last decade. Technological developments have increased the amount of energy produced per panel, improved operational longevity and reduced upfront costs. This has vastly improved payback on solar installations, with a paybacks as low as of 5-6 years.

Solar generation peaks during the middle hours of the day when there is maximum access to sunlight. It is recommended that councils prioritise energy intensive activities at these times to maximise renewable energy usage and reduce the quantity of export back to the grid. Solar systems may be combined with energy storage systems to capture surplus energy for reuse at a later time, improving system efficiency and lowering utility expenditure.

Solar Thermal

Solar thermal systems harness energy from the sun to provide heating facilities. Solar thermal systems are often used to deliver heating for pool water, but solar thermal technology may also be applied to domestic hot water or space heating applications.

Pool or heating hot water is pumped through solar collector plates which can be installed on rooftops or nearby areas of land. The water absorbs solar heat and is then pumped for use back through the facility. Since solar thermal systems utilise solar energy for heating they have low ongoing utility costs, making them an appealing option for low cost, low emissions heating.

Off-Site Renewables

Where a facility's energy demand cannot be met by on-site renewable technologies, off-site renewables may be utilised to further reduce emissions. Common off-site renewables include large solar farms or onshore/offshore wind farms.

Councils can ensure they receive renewably generated electricity from the grid by entering into a power purchase agreement (PPA). PPA's are agreements between an entity and an energy generator to purchase direct renewable energy at an agreed long term rate. These agreements often extend for several years and can minimise exposure to volatile energy markets.

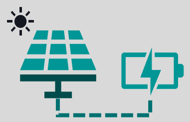
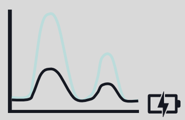
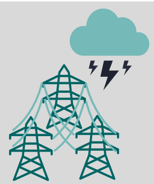
PPA's are often used in conjunction with electrification upgrades to ensure that the whole facility can be powered through this renewable energy source and remove any lingering sources of emissions from gas usage.

PPA procurement requires careful consideration of the current energy market, cost, contract period and risk to ensure a tailored selection. To mitigate the risk involved with PPA procurement, a detailed option analysis should be conducted prior to engagement to carefully assess the state of the market at the time of procurement.

Opportunities may exist to enter into a shared energy contract between multiple councils, similar to the Victorian Electricity Collaboration (VECO). This would provide councils the economy of scale to negotiate better contractual agreements and serve to further council collaboration and resource sharing.

Energy Storage

Local on-site energy storage provides councils the opportunity to capture and store electricity for reuse at later point. The most common form of energy storage is through battery technologies, although other storage solutions can be used such as thermal storage or compressed air systems. Key benefits of energy storage include:

Renewable Energy Efficiency Improvements	Surplus electricity produced by onsite renewable generation, may be stored for future use. This maximises the effectiveness of the renewable resource, reducing expenditure and reliance on electricity from the grid.	
Reducing Peak Demand	The cost of electricity fluctuates throughout the day, depending on the interrelation between demand and production. Energy storage may capture electricity from the grid when prices are low and expend this energy when costs peak, thus minimising utility costs for the facility.	
Energy Security and Climate Resiliency	Energy storage will improve the reliability of energy sourcing and allow facilities to continue to operate during outages and blackouts.	
Virtual Power Plant Integration	Virtual power plants (VPP) are a network of facilities that have energy storage connection through smart technology. By either releasing energy into the grid or storing energy from it, facilities as part of a VPP enable more reliable use of renewables, reduce reliance on fossil fuels and ultimately deliver cheaper electricity.	

Utility Generation

Utility generation refers to the centralised energy generation systems that power the grid. Current centralised utility sources are often coal or gas fired and thus non-renewable, however these plants are critical as they provide a minimum energy firming to ensure the grid remains stable.

Centralised utility generation will remain a critical part of the Australian energy network for the foreseeable future. However, the prevalence of large-scale renewable generation and energy storage systems is predicted to result in these plants gradually producing a lower portion of the total grid supply.

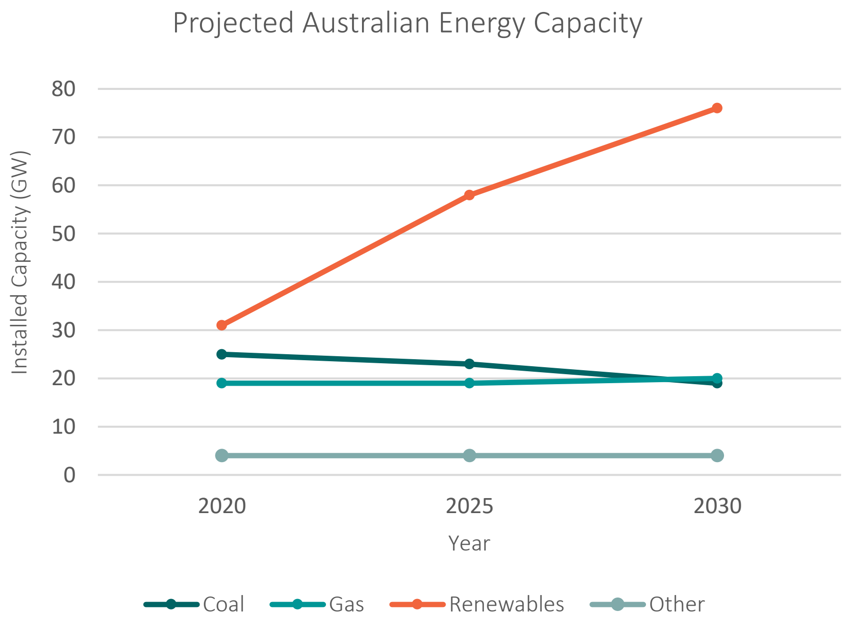


Figure 29: Projected Australian Energy Capacity[10]

[10] Data from Australian Government: Australia's Emissions Projections 2020

Microgrids

Microgrids are localised energy grids that may be able to disconnect and function independently from the main electricity grid. Microgrids are often connected to a range of smaller power systems in the vicinity, including renewable energy sources, battery storage and electric vehicle charging infrastructure.

Microgrids can serve a single facility or include multiple independent customers within the area. The size of the microgrid may range from a few hundred kilowatts to a few megawatts of capacity. They can either be used in conjunction with, or independently to, the main grid, serving to either displace or supplement broader grid services.

Microgrids can provide the following benefits to councils and the broader connected community:

Support Renewable Resources	Microgrids can be used in conjunction with renewable energy sources, alongside energy storage systems to balance usage and production and maximise the benefits of both systems.
Minimise Electrical Losses	The distances travelled from a centralised power station results in significant line losses. Introduction of a localised microgrid reduces travel distance, thus minimising losses and reducing overall demand.
Enhance Grid Resilience	As microgrids run independently to the main grid, they can act as a redundant power supply in the case of an outage. This can have follow on benefits in maintaining facility operations in the case of a blackout, reducing the energy required to restore the facility to adequate operating conditions.
Improve Local Power Supply Demand	Microgrids can help reduce main grid congestion when placed strategically within a broader power system. This improves grid reliability and efficiency, lowering the peak power requirements and thereby reducing electricity prices.

Smart Building Technologies

Smart building technologies aid in aligning building energy usage to the energy provided to, or generated by, the site. These solutions can streamline facility energy usage, enhancing data accessibility and transparency whilst supporting the identification of opportunities for improvement. Common benefits provided by smart building technology include:

Measurement & Verification of Upgrades: Measurement & Verification (M&V) is a standardised protocol for assessing the efficacy of energy efficiency upgrades. M&V is valuable to close the loop between design and performance and highlight future opportunities for improvement.

Early Identification of Asset Faults: Smart building technologies can provide early notice if any assets are in fault. Faulty assets often use significantly higher energy, thus early detection can save facility emissions and costs. Early fault detection increases the proactivity of asset maintenance, reducing the reactivity of the system.

Streamlined Billing Processes: Smart building technologies may offer centralised portals for site energy usage and billing, allowing facilities to track their consumption and costs, enabling councils to make future plans accordingly.

Facility Benchmarking: Determining a standard benchmark for energy usage will allow facility managers to assess the efficiency of their sites year on year. Facility benchmarking will also allow council facilities to compare energy usage against comparable sites, to share knowledge, determine standard consumption patterns and encourage uplift.

Enhanced Data Accessibility and Transparency: Improved metering and management will improve the granularity of energy data collected and display energy data in an accessible, user-friendly format. This will provide greater energy transparency across the portfolio, allowing low-performing assets to be identified for rectification.

Smart building technologies commonly require a Building Management System (BMS) to be installed prior to implementation. FGA recommends that councils should pursue the adoption of a highly optimised BMS prior to the integration smart building technologies,

Appendix

Appendix A: Council Facility Energy Data

Energy Resource Breakdown

The following graphs provide a breakdown of facility usage across each energy resource.

Electricity

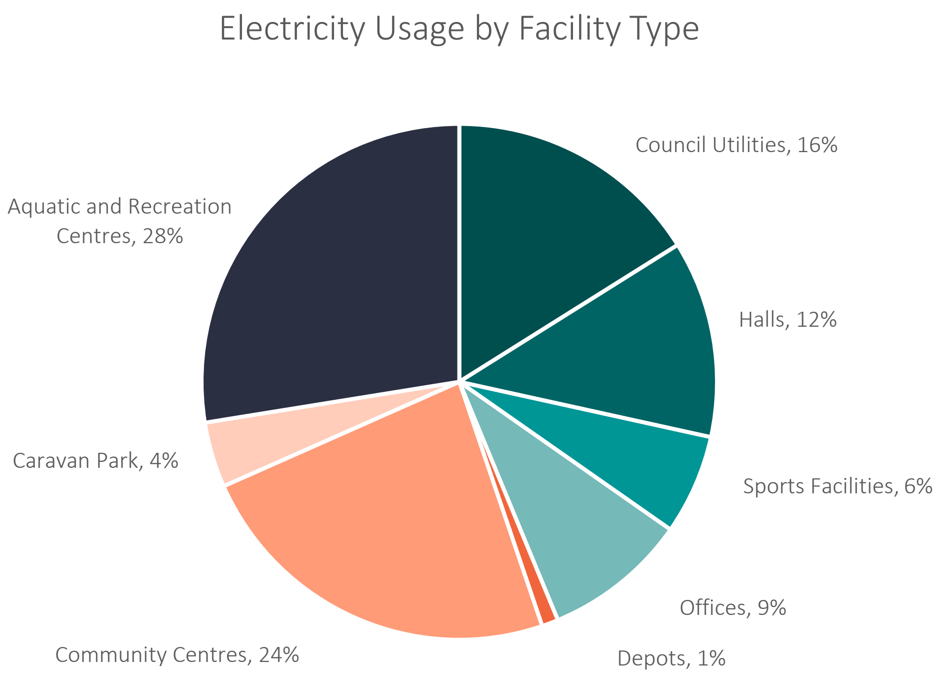


Figure 30: Facility Electricity Usage Breakdown

Natural Gas

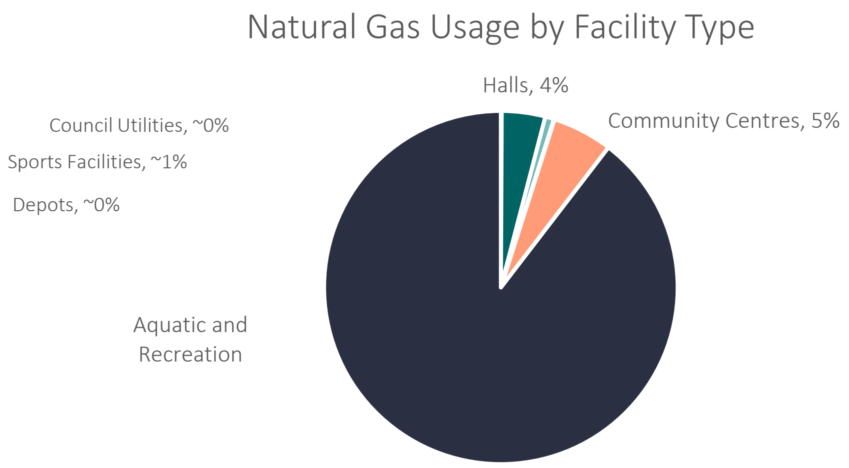


Figure 31: Facility Natural Gas Usage Breakdown

Liquified Petroleum Gas

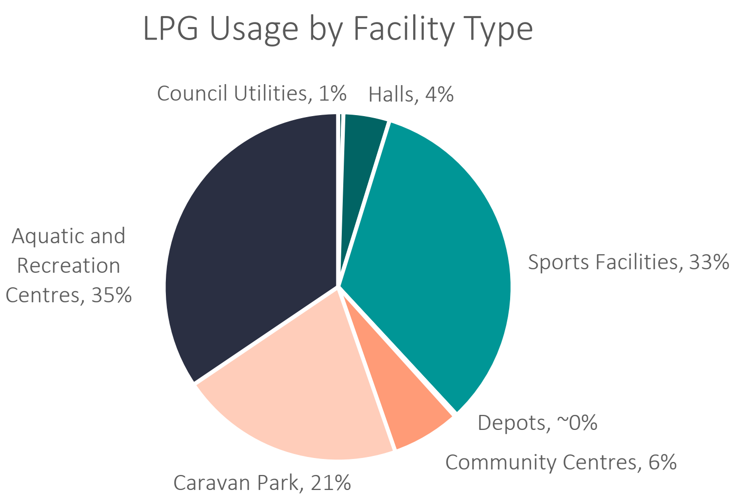


Figure 32: Facility LPG Usage Breakdown

Per Facility Breakdown

Council facilities have been broken down into categories as specified in **Part 2: Council Energy Usage**. The following graphs provide a breakdown of energy usage across each facility type.

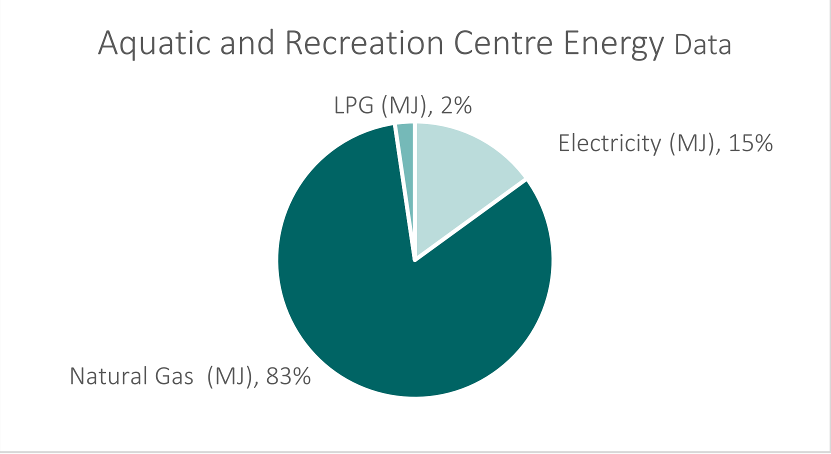


Figure 33: Aquatic and Recreation Centres Energy Use Breakdown

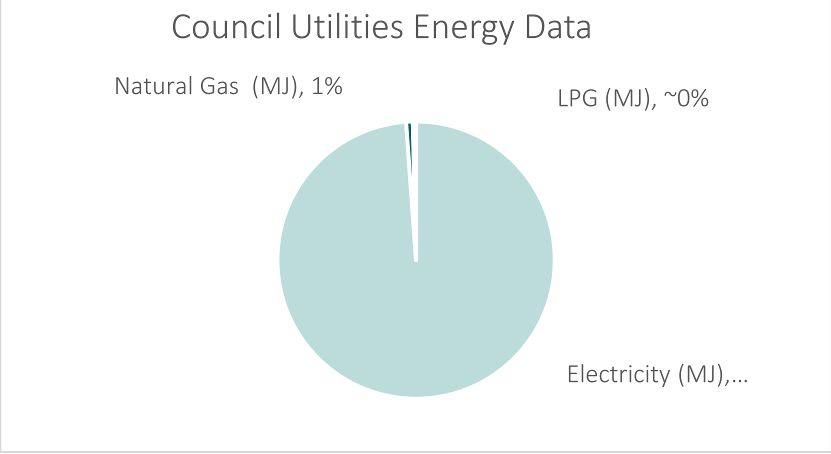


Figure 34: Council Utilities Energy Use Breakdown

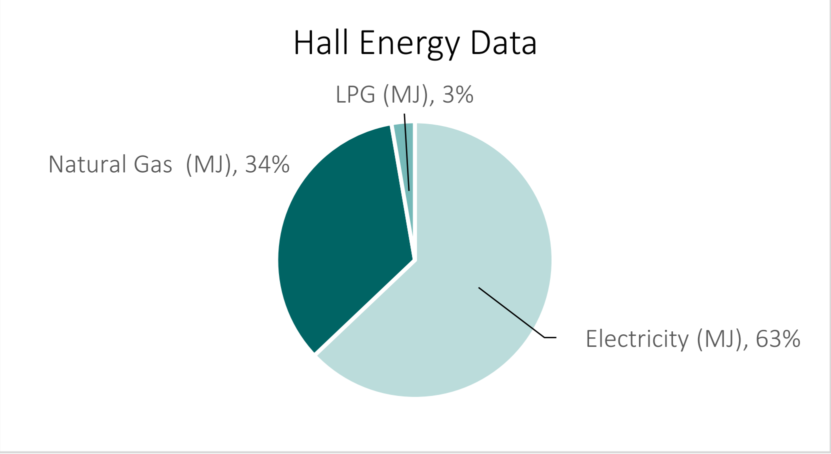


Figure 35: Council Hall Energy Use Breakdown

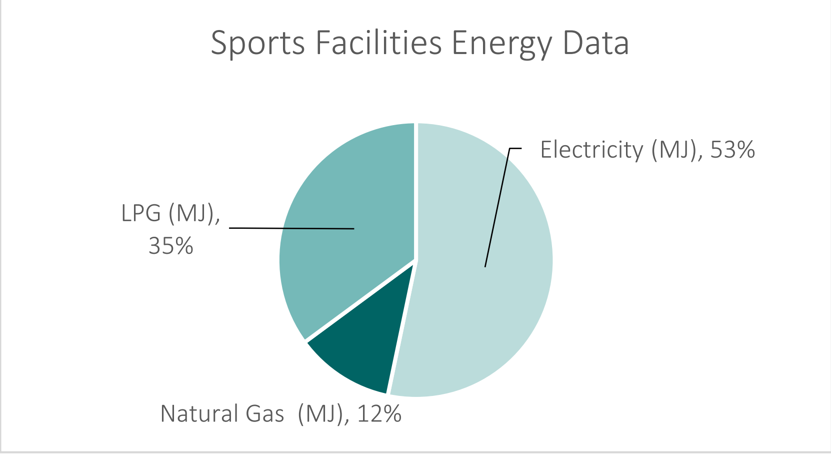


Figure 36: Council Sports Facilities Energy Use Breakdown

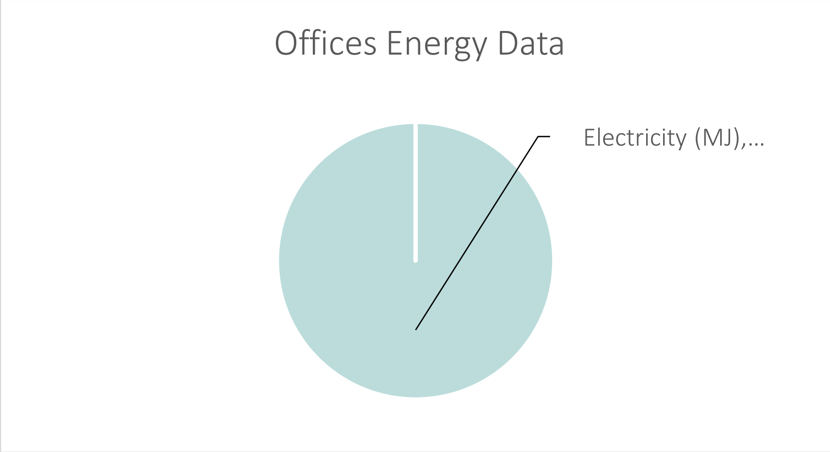


Figure 37: Council Office Energy Use Breakdown

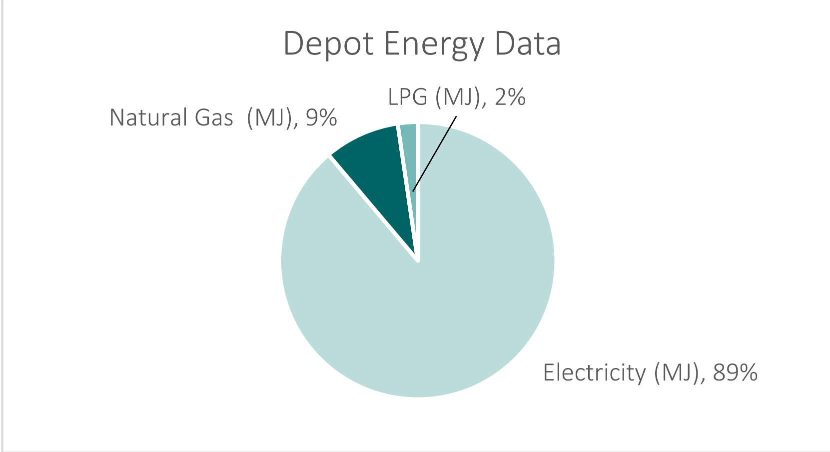


Figure 38: Council Depot Energy Use Breakdown

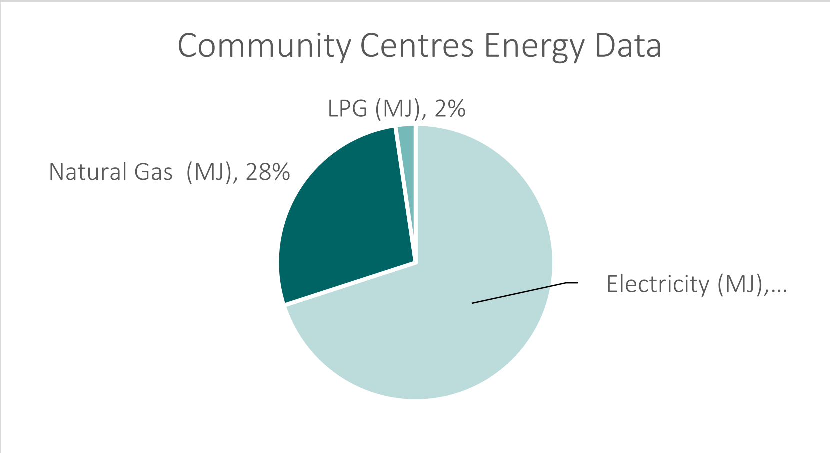


Figure 39: Council Community Centre Energy Use Breakdown

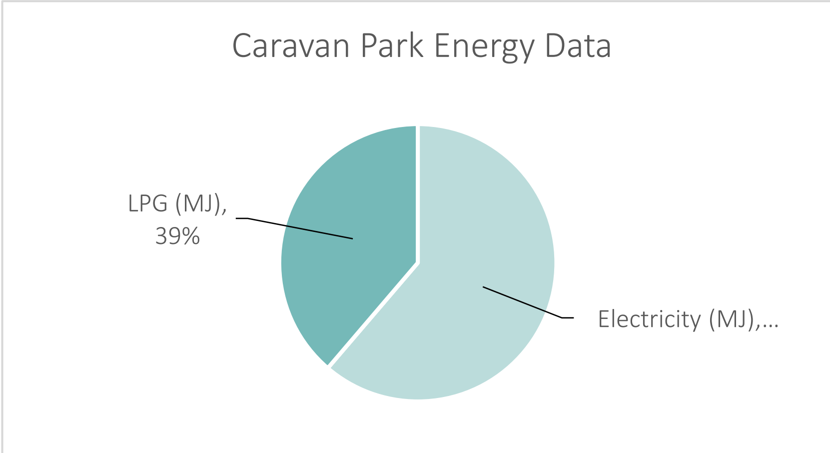


Figure 40: Council Caravan Park Energy Use Breakdown

Appendix B: Aquatic Centres Energy Balance

Pools and aquatic centres are a significant contributor to council energy usage and emissions. Outcomes from the Council Energy Review identified that Aquatic and Recreation Centres were responsible for 65% of total energy use across the nominated councils portfolio. This is due to the substantial amount of energy required to maintain specific water and environmental conditions. A typical pools energy balance is shown below:

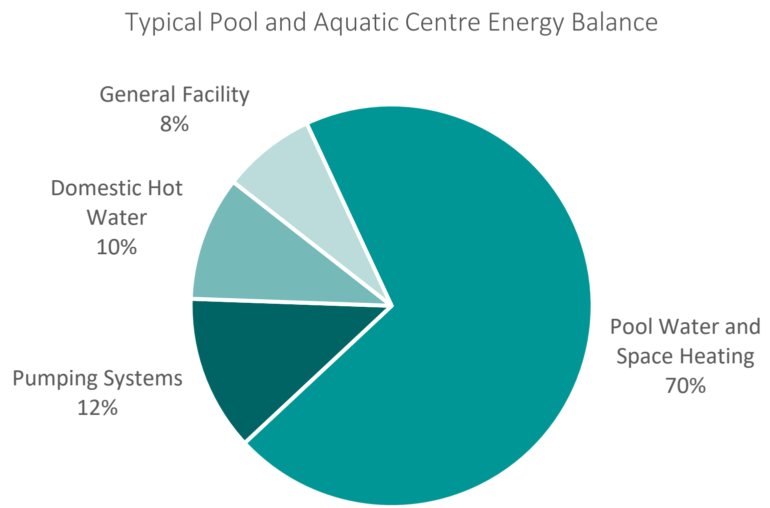


Figure 41: Typical Pool Facility Energy Usage (Outdoor and Indoor)

Pool Water Heating

Pool water heating is carefully controlled to ensure that the facility remains comfortable for use. Due to the large thermal mass of the pool, heating requires a substantial amount of energy, and therefore a significant amount of gas.

Pools that are not effectively insulated can quickly lose their energy through the following mechanisms:

- Evaporation
- Radiation
- Convection
- Conduction
- Backwash

Councils looking to electrify pools and aquatic centres should prioritise the pool water heating systems as these are often the largest gas consumers.

Space Heating

The indoor environment of the pool is critical to maintaining comfort conditions, minimising pool heat losses and mitigating moisture ingress. The temperature and humidity of the indoor environment should be carefully monitored to limit the extent that water can evaporate from the pool.

Environmental heating must be balanced with adequate ventilation to limit the undesirable effects caused by the warm, moist air. Poor environmental conditioning can lead to condensation forming on the building structure, promoting the development of mould or corrosion. Pools also require ventilation to reduce carbon dioxide build-up and reduce the odour of chlorine and other chemicals.

Effectively controlling the temperature and humidity of the pool environment can reduce the amount of heating input required. However, care should be taken to maintain the quality and conditioning of heating to ensure that the pools remain comfortable for use and does not promote damage to the facility. Transitioning to heat pumps in lieu of gas boilers provides councils an opportunity to further mitigate facility gas consumption.

Pumping Systems

Pumping systems are required to circulate water to ensure adequate filtration and heating. Pumps use electricity only and thus do not contribute to pool gas consumption, however improving motor efficiency and reducing running speed can significantly reduce general site energy consumption without noticeable impact on pool operations.

Domestic Hot Water

Domestic Hot Water (DHW) systems often consume gas. Minimising the energy lost in storage and improving the efficiency of heating technologies by transitioning to gas alternatives may yield substantial costs savings in addition to reducing emissions.

General Facility

Additional subsystems may include facility lighting, kitchen appliances and general office equipment. Replacement with energy efficient equivalents and optimising time of use may provide additional energy efficiency improvements.

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