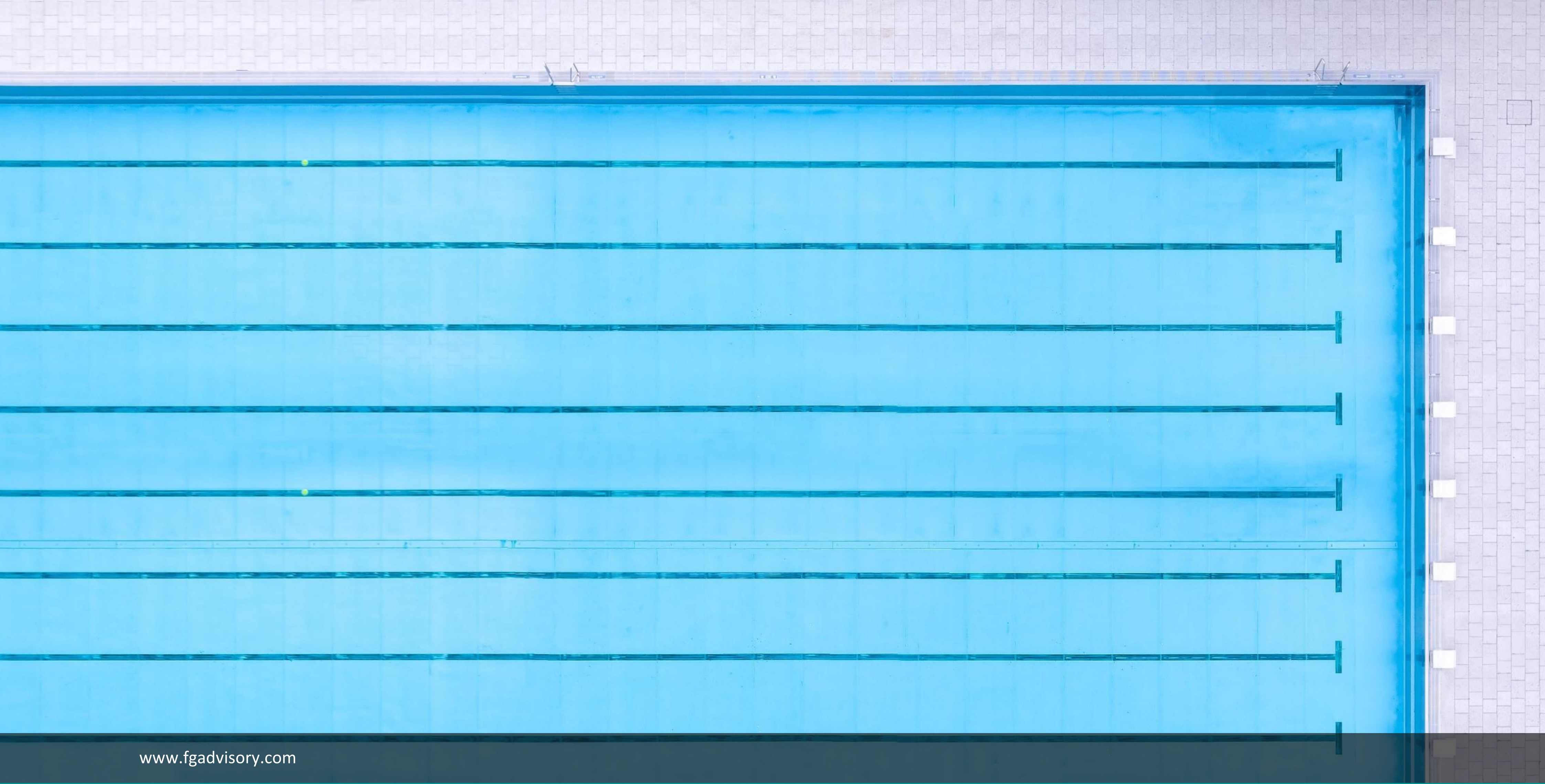

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Net Zero Pools Guide

NSW Government

Submission Date: 06/09/2022

Disclaimer

Document Title:
Net Zero Pools Guide

Disclaimer

The information contained herein is based on a high-level pre-feasibility assessment of 40 pool and aquatic centres across regional NSW. All advice and recommendations are general. Site specific context has not been taken into consideration and thus all information contained within this guide, including energy and emissions savings, project costs, complexity and risk are indicative only. FGA strongly recommends that each facility conduct detailed site assessments prior to any works.

FGA believe 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

The NSW Government and FG Advisory pay respect to the Traditional Custodians and First Peoples of NSW and Australia, and acknowledge their continued connection to their country and culture.

Table of Contents

Glossary of Terms	
Abbreviation	Definition
AC	Alternating Current
ACCU	Australian Carbon Credit Unit
AHU	Air Handling Unit
ASHP	Air Source Heat Pumps
BMS	Building Management System
CHW	Chilled Water
COP	Coefficient of Performance
D&C	Design & Construct
DC	Direct Current
DHW	Domestic Hot Water
DOL	Direct on Line
DTS	Deemed to Satisfy
DX	Direct Expansion
ECM	Energy Conservation Measure
ESC	Energy Saving Certificate
ESS	Energy Saving Scheme
EV	Electric Vehicles
FCU	Fan Coil Unit
GBCA	Green Building Council Australia
GWP	Global Warming Potential
HHW	Heating Hot Water
HVAC	Heating, Ventilation and Air Conditioning
LED	Light Emitting Diode
M&V	Measurement & Verification
NCC	National Construction Code
NEM	National Electricity Market
O&M	Operation & Maintenance
ODP	Ozone Depletion Potential
PE	Photelectric
PFC	Power Factor Correction

Glossary of Terms	
Abbreviation	**Definition**
PPA	Power Purchase Agreement
PV	Photovoltaic
VAV	Variable Air Volume
VFD	Variable Frequency Drive
VRF	Variable Refrigerant Flow
VRV	Variable Refrigerant Volume
VSD	Variable Speed Drive
WSHP	Water Source Heat Pumps

Table 1: Glossary of Terms

About This Guide

The Net Zero Pools Guide has been developed by the New South Wales (NSW) Government to help pool facilities within regional NSW realise opportunities for energy efficiency improvements across their portfolio. Identification of these opportunities will assist pools to reduce site energy usage, utility expenditure, and ultimately support these facilities on their pathway towards achieving net zero emissions.

This guide is intended to assist those involved with the planning, management, and operation of pool facilities to develop an understanding of generally applicable opportunities within the pools context. This guide provides a high-level overview of relevant opportunities, including potential emissions abatement, cost implications, project complexity, and risk.

Additional Resources

The Net Zero Pools Guide has been created in conjunction with two complementary resources, each intended to assist pool stakeholders at various points along their sustainability journey. The NSW Government recommends that users of this guide utilise these additional resources to supplement the information provided herein.

Pools Toolkit – An interactive online tool designed for pool facility managers and operators to gain an awareness of the type and extent of opportunities available within their unique portfolio context.

Business Case Templates – Detailed business case templates designed specifically for the context of pool facilities. Use of these templates will enable pool stakeholders to apply the information contained in this guide to streamline the process for future funding applications.

Developing an Action Plan

The NSW Government recommends that pool stakeholders utilise the Net Zero Pools Guide in coordination with the Pools Toolkit and Business Case Templates to develop a Net Zero Pools action plan.

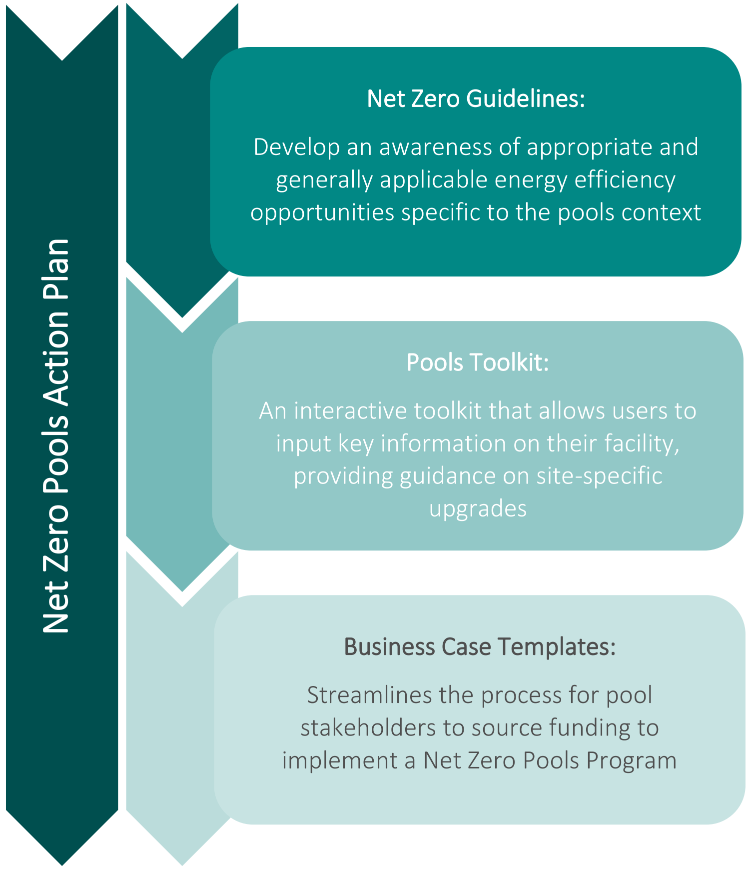


Figure 1: Net Zero Pools Action Plan

Key Principles

The central aim of this guide is to help those involved in the planning, management, and operation of pool facilities to develop an understanding of available energy efficiency opportunities to support the abatement of greenhouse gas emissions and achieve net zero operations.

Emissions abatement is not the only measure of success when pursuing sustainable outcomes for pools and aquatic centres. Additional key principles informing this guide include:

Drive Local Employment: Delivering site upgrade works provides an opportunity to utilise local employment and boost the local economy. The use of locally developed goods where available helps to support the community and improve future ease of maintenance.

Foster Community Engagement: Pools represent a shared resource that is central to the heart of the community. This provides a key opportunity for pool stakeholders to engage and educate the community and help promote a culture of sustainability action and awareness.

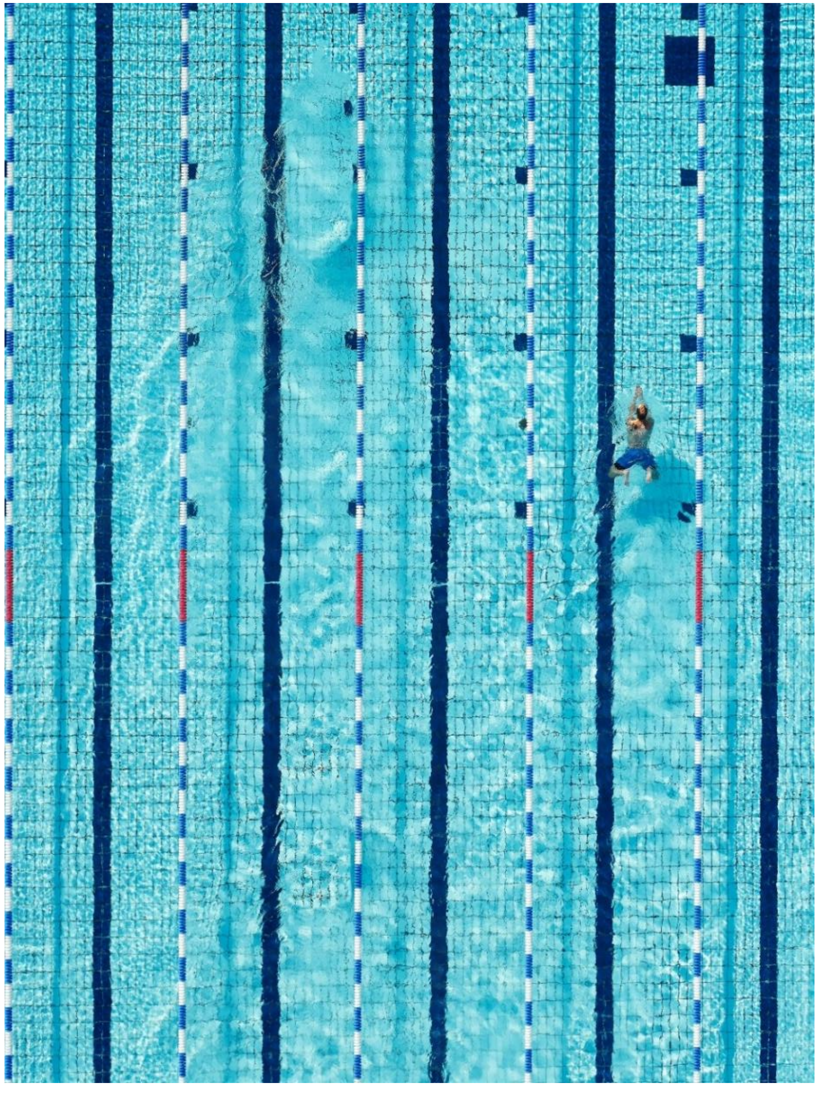
Improve Pool Comfort: The opportunities provided by this guide enhance pool facility comfort and ease of use, resulting in increased usage.

Promote Energy Security: The initiatives recommended within this guide not only support energy efficiency, but also enhance energy security to support ongoing pool operations.

Encourage Future Innovation: Use of new and emerging technologies should be prioritised where available to future proof pools and drive sustainable change within the industry.

Support Broader Council Outcomes: Pools are an integrated and embedded part of the broader Council portfolio and should assist their requisite councils to achieve broader sustainability ambitions.

It is recommended that pool stakeholders consider these key principles when planning future upgrades of their sites.



Part 1: The Value of Net Zero

Part 2: Understanding Your Emissions

Part 3: Electrification and Heat Pumps

Part 4: Asset Efficiency Upgrades

Part 5: Building Fabric Upgrades

Part 6: Renewable Technologies

Part 7: Behavioural Changes

Part 8: Next Steps

How to Use This Guide

The Net Zero Pools Guide has been separated into 8 distinct categories:

Part 1: The Value of Net Zero – Overview of Net Zero Emissions, current NSW and Australian Emissions Targets, and the context of emissions abatement within the broader community.

Part 2: Understanding Your Emissions – Discussion on the various categories of emissions, and the major sources of energy consumption within a pool facility.

Part 3: Electrification and Heat Pumps – Summary of the benefits of facility electrification and opportunities to transition energy usage away from fossil fuels to high efficiency heat pumps.

Part 4: Asset Efficiency Upgrades – Initiatives aimed at improving the energy efficiency of site infrastructure and assets.

Part 5: Building Fabric Upgrades – Opportunities to enhance building fabric, reducing unnecessary energy losses through the facility envelope.

Part 6: Renewable Technologies – Overview of renewable energy technologies within the portfolio, including solar and energy storage systems.

Part 7: Behavioural Changes – Additional measures that can be performed by pool managers and staff to further reduce site energy consumption.

Part 8: Next Steps – Recommendations to support pools on the next steps of their sustainability journey.

Limitations

The content provided in this guide are general and based on broad design principles for pools and aquatic centres. Individual site-specific context has not been taken into consideration, and hence all commentary on upgrades including energy and emissions savings, costs, complexity, and risks are indicative only. The Net Zero Pools guide does not take into consideration impacts from water consumption and waste. Prior to committing to any works it is recommended that each pool carry out a site-specific assessment to understand the general applicability of these upgrades to their unique site context.

Sustainability Upgrade Metrics

The following nomenclature has been used to provide quantifiable cost, emissions reduction and expected payback comparisons for opportunities and initiatives included throughout the guide:

Relative Capital Cost

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

Costs in AUD, Calculated at Time of Assessment

Emissions Reduction Potential

- Less than 1% Site Emissions
- 1 – 3% Site Emissions
- 3 – 5% Site Emissions
- 5% Site Emissions or Higher

Site Emissions Based on Annual Tonnes of CO_{2-e} Emissions

Expected Payback Period and Asset Useful Life

Short	5 Years or Less
Medium	5 – 10 Years
Long	10 – 20 Years
Extended	20+ years

Risk and Complexity Ratings

The following risk and complexity ratings have been used to assess the impacts of the opportunities included within the guide.

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

Table 2: Risk Ratings

Complexity Rating	Priority Description
Low	High-level coordination and planning only required. Technology is mature with demonstrated outcomes and processes. Pool patron 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. Pool patron 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 3: Complexity Ratings

Net Zero Pools Summary

The following section provides a high-level overview of all the opportunities included in the Net Zero Pools Guide:

Electrification

Electrification supports the transition of site energy usage away from legacy gas systems to high efficiency fully electrified alternatives. As the NSW electricity grid becomes increasingly decarbonised the replacement of gas assets with electric equivalents presents an opportunity to significantly reduce site emissions. When integrated with on-site renewables, asset electrification can further reduce electricity consumption, and utility expenditure.

Opportunity	Energy Management Hierarchy	Emissions Reduction	Capital Cost	Payback	Asset Useful Life	Risk Rating	Technical Complexity
Domestic Hot Water Heat Pumps	Integrate Renewable Energy	🌲🌲	$$	Long	Long	High	High
Space Conditioning Heat Pumps	Integrate Renewable Energy	🌲🌲🌲🌲	$$$$	Long	Long	High	High
Pool Heating Heat Pumps	Integrate Renewable Energy	🌲🌲🌲🌲	$$$$	Long	Long	High	High

Figure 2: Electrification Upgrades List

Asset Efficiency

Asset efficiency provide guidance on initiatives that improve the energy efficiency of existing site infrastructure. The replacement and upgrade of site assets can produce additional benefits, such as enhanced patron comfort, lowered system maintenance requirements and overall higher-quality infrastructure.

Opportunity	Energy Management Hierarchy	Emissions Reduction	Capital Cost	Payback	Asset Useful Life	Risk Rating	Technical Complexity
Lighting and Controls	Promote Energy Efficiency	🌲🌲	$$	Medium	Long	Low	Low
Variable Speed Drives	Promote Energy Efficiency	🌲🌲	$$	Short	Long	Low	Medium
Motor Efficiency	Promote Energy Efficiency	🌲🌲	$$$	Medium	Long	Medium	Medium
Voltage Optimisation	Promote Energy Efficiency	🌲	$$	Medium	Medium	Medium	Medium
Power Factor Correction	Promote Energy Efficiency	🌲	$$	Medium	Medium	Medium	Medium
Enhanced Filtration	Promote Energy Efficiency	🌲	$	Short	-	Medium	Medium
Setpoint Adjustment	Reduce and Avoid Consumption	🌲🌲	$	Short	-	Medium	Low
Ventilation Improvements	Promote Energy Efficiency	🌲🌲	$$	Medium	-	Medium	Medium

Figure 3: Asset Efficiency Upgrades List

Building Fabric

Building fabric improvements minimise unnecessary energy loss through the building envelope. This section includes initiatives pertaining to building insulation, glazing, pool covers, shell and pipework insulation. By minimising unnecessary energy losses, less energy is required to maintain comfortable operating temperatures within the facility.

Opportunity	Energy Management Hierarchy	Emissions Reduction	Capital Cost	Payback	Asset Useful Life	Risk Rating	Technical Complexity
Building Envelope	Reduce and Avoid Consumption	🌲🌲🌲🌲	$$$	Long	Long	Medium	Medium
Swimming Pool Covers	Reduce and Avoid Consumption	🌲	$$	Short	Medium	Low	Low
Outdoor Pipework Insulation	Reduce and Avoid Consumption	🌲	$	Medium	Short	Low	Low
Outdoor Pool Fences	Reduce and Avoid Consumption	🌲	$$	Medium	Medium	Low	Low
Pool Wall Insulation	Reduce and Avoid Consumption	🌲🌲	$$$	Long	Extended	Low	Medium

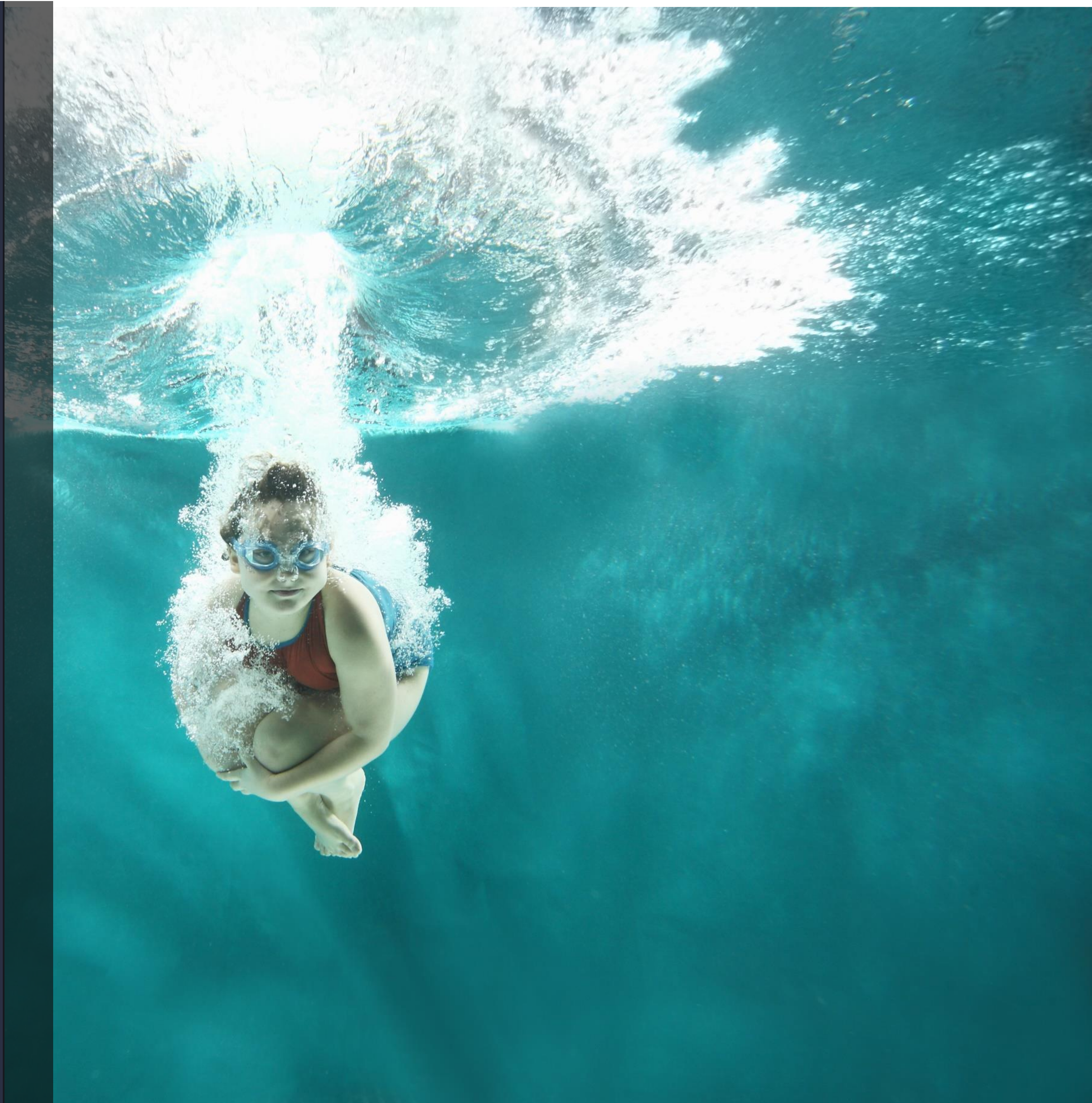
Figure 4: Building Fabric Upgrades List

Renewable Technologies

Renewable technologies reduce grid energy consumption through implementation of on-site renewable resources and smart energy management technologies. Renewable generation on-site supports additional opportunities, including energy storage, electric vehicle charging and localised microgrids. Pool facilities may also procure Power Purchase Agreements (PPAs) to further integrate renewable energy from off-site sources.

Opportunity	Energy Management Hierarchy	Emissions Reduction	Capital Cost	Payback	Asset Useful Life	Risk Rating	Technical Complexity
Solar Thermal Heating	Integrate Renewable Energy	🌲🌲🌲🌲	$$$	Long	Long	Low	Medium
Solar Photovoltaic	Integrate Renewable Energy	🌲🌲🌲🌲	$$	Medium	Long	Low	Low
Electric Vehicle Charging	Integrate Renewable Energy	🌲	$$	-	Medium	Medium	Medium
Energy Storage	Integrate Renewable Energy	🌲	$$$	Extended	Long	High	High
Microgrids	Integrate Renewable Energy	🌲🌲	$$$$	Extended	Long	High	High
Power Purchase Agreements	Integrate Renewable Energy	🌲🌲🌲🌲	$	-	-	High	Medium
Energy Metering and Management Systems	Integrate Renewable Energy	🌲	$$	Long	Long	Low	Medium

Figure 5: Renewable Technologies Upgrade List



Part 1:

The Value of Net Zero

The Value of Net Zero

Net Zero Overview

Net Zero refers to facilities in which the quantity of emissions released to the atmosphere are balanced by the removal of an equivalent amount of emissions. In practice, Net Zero is achieved by minimising the total amount of emissions through energy efficiency improvements and renewable energy integration, whilst offsetting remaining residual emissions.

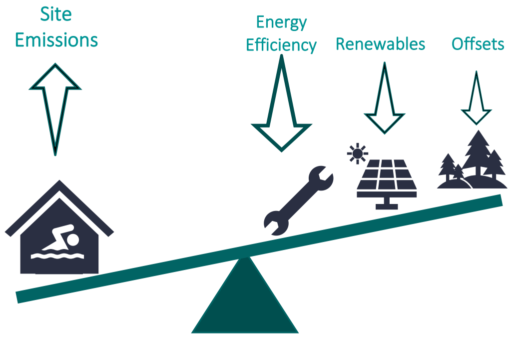


Figure 6: Net Zero Overview

Within a typical pool facility, the majority of emissions occur due to consumption of electricity and gas. Hence, significant steps towards net zero can be made by improving the energy efficiency of assets and equipment.

NSW's electricity grid is becoming increasingly decarbonised as a result of widespread renewable energy adoption. Transitioning away from gas infrastructure towards electrical assets provides an ongoing opportunity to minimise site emissions which can be accelerated through installation of photovoltaic (PV) solar and other renewable energy sources on site.

Persistent Savings

Energy, emissions, and costs savings resulting from sustainability improvements are ongoing over the lifetime of the upgrade. This results in savings being replicated year on year, producing significant incentives over the facility lifetime.

Energy Management Hierarchy

The energy management hierarchy demonstrates various approaches to reducing facility emissions.

As shown it is most effective to reduce and avoid energy consumption altogether. Where consumption cannot be prevented, energy efficient assets should be prioritised. This will serve a dual purpose of minimising emissions and reducing operational costs.

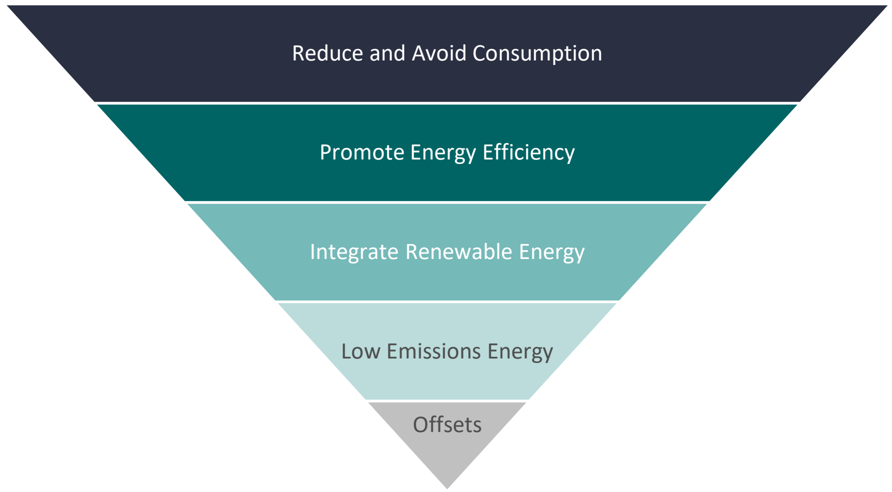


Figure 7: Energy Management Hierarchy

Carbon Offsets

Low emissions energy and carbon offsets represent the least effective method to mitigate 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, 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 the facility. ACCUs and other carbon credits may be traded on a commodity market, exposing pools to significant financial risk if the cost of credits increases.

State and Federal Emissions Targets

Federal 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

New South Wales Emission Targets

The NSW Government is committed to providing transparent, decisive, and responsible leadership on climate change. To achieve these aspirations, the NSW have set the following accelerated targets above and beyond the Australian Federal Government:

- Reduce emissions by **47%** to **52%** below 2005 levels by 2030
- Attain Net Zero by Emission 2050

New South Wales Energy Saving Scheme (ESS)

Established in 2009, the NSW Energy Savings Scheme (ESS) provides financial incentives to support the installation, or replacement of energy efficient assets.

When upgrades are implemented using services from an accredited provider, an energy savings certificates (ESCs) is created which can be traded for a discount on the cost of the energy saving activity. The number of ESCs created is determined by the amount of energy usage reduction.

More information on the ESC can be found at the link below:

[Energy Savings Scheme | Energy NSW]

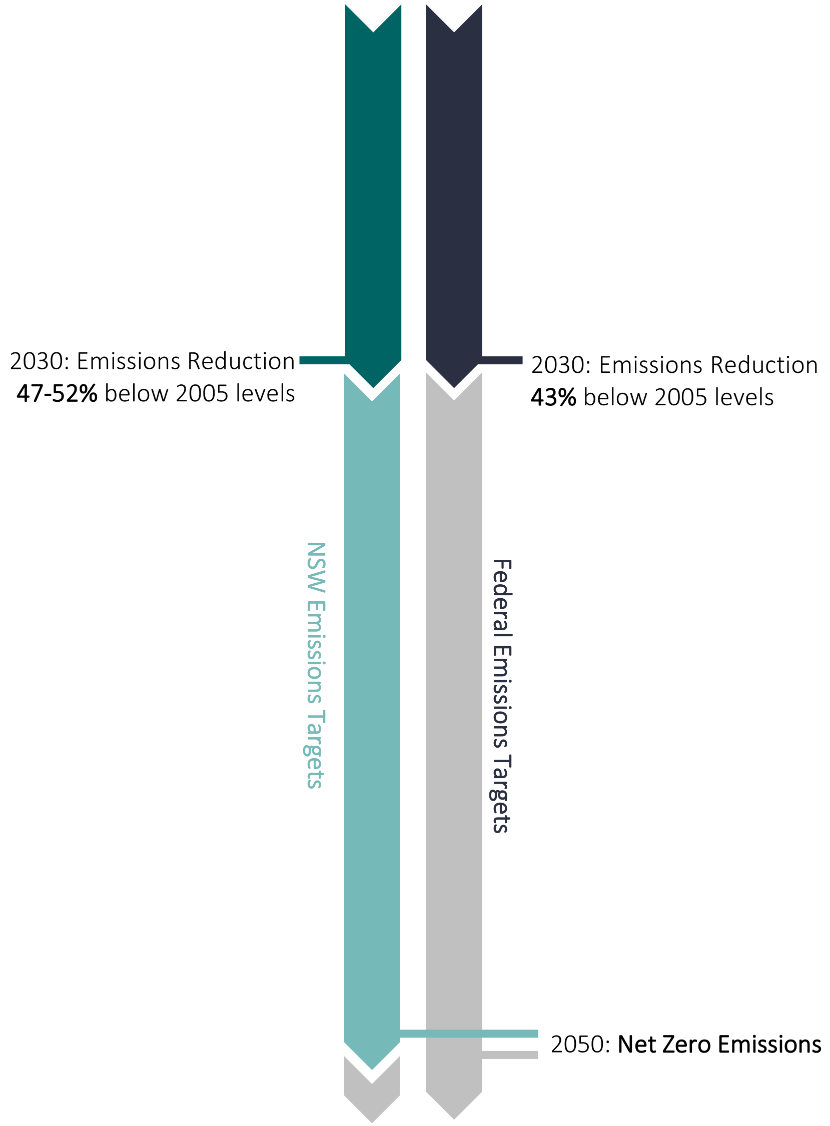


Figure 8: State and Federal Emissions Targets

Rising Costs of Energy

Increasing energy demand and shifting energy geopolitics have led to increases in energy costs nationwide. This can have a significant effect on aquatic centres due to their large energy consumption and often limited funding.

Implementation of the energy efficiency opportunities presented within this guide provide an opportunity for pools to reduce energy related operational expenditure and simultaneously promote energy security through the facilitation of on-site renewables.

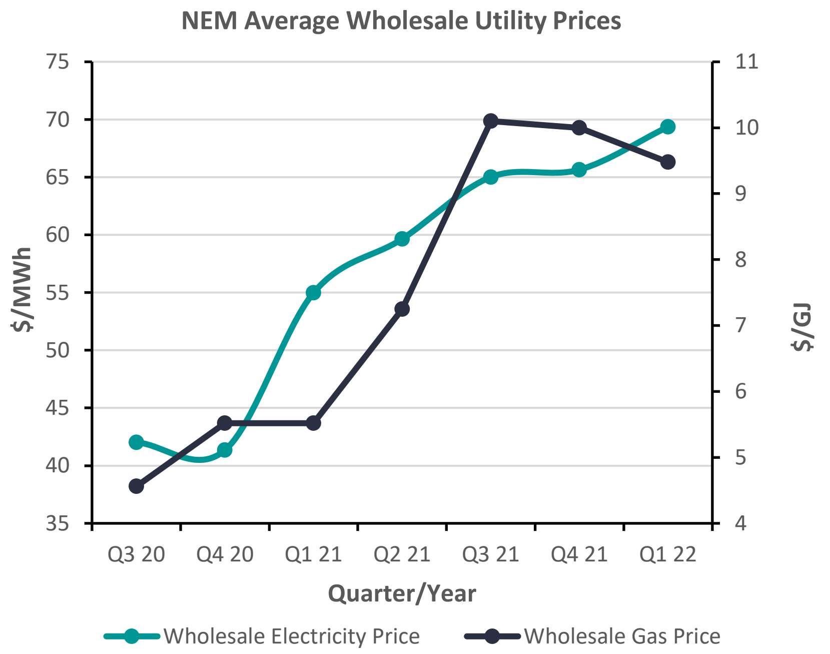


Figure 9: Changes to NEM (National Electricity Market) Average Wholesale Utility Prices

Net Zero Communities

As embedded parts of the community, pools and aquatic centres are uniquely positioned to have a significant impact on sustainable community engagement. Pools should aim to use site upgrades as an opportunity to promote community education and awareness, which may be achieved through the following:

Engagement
Efforts should be made to increase community engagement with the pool upgrades. This can be achieved by establishing clear goals with easy to understand metrics, such as emissions abated or percentage progress towards net zero. Tracking towards these goals should be made visible in thoroughfares and open spaces to provide transparency and increase awareness.

Education
Pools should aim to provide education on the changes within their facility. This will serve to demonstrate sustainable technology in practice. Providing transparency on pool upgrades may also reduce friction towards potential operational disruption as a result of these upgrades.

Endorsement
Demonstration of tangible sustainability technologies and outcomes should be made visible to the public to inspire patrons to make their own sustainability commitments. Relevant technologies like solar PV, lighting upgrades, and electric vehicle charging should be prioritised to promote replication at homes.

Pool Economic Benefits

Use of pools and aquatic centres provides ongoing health benefits that reduce the health risks associated with physical inactivity.

Reduction in healthcare costs due to pool utilisation provides additional economic benefits to the broader public. A commission by Royal Life Saving estimates that every pool visit creates economic benefits worth an average of $26.39.[1]

[1] Economic Benefits of Australia's Public Aquatic Facilities by Royal Life Saving

Part 2:

Understanding Your Emissions

Understanding Your Emissions

Scope 1, 2 & 3 Emissions

Prior to embarking on facility upgrades aimed at reducing emissions, it is critical to understand how emissions are generated and categorised

Emissions are classified into the following three categories:

Scope 1

Scope 1 emissions are released as a result of a **direct** activity that occurs on-site. For pools, this may refer to:

- Emissions resulting from burning natural gas to provide heating to pools or domestic hot water

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. 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 by the pool facility. This may include:

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

As this guide focuses on site energy consumption, scope 3 emissions have not been considered.

Embodied Emissions

Embodied emissions are the sum of greenhouse gas emissions required to manufacture, transport, and ultimately deliver a final product to the consumer. Embodied emissions take into consideration the emissions produced during the following key stages in the product lifecycle:

1. Extraction and processing raw materials
2. Manufacturing
3. Shipping and transport
4. Product disposal and end of life treatment

Embedded emissions are categorised as Scope 3 emissions. Although not included within the scope of this guide, they are an important consideration for facilities looking to further reduce their emissions footprint.

Industry Benchmarks & Performance Standards

A variety of industry benchmarks can be used to demonstrate best practice building construction and energy efficiency. Three common building performance rating systems used within Australia include:

Section J

Section J refers to the part of Australia's National Construction Code (NCC) that provides energy efficiency requirements for new buildings. Demonstration of Section J compliance can be performed through a Deemed-to-Satisfy (DTS) approach or through an energy model completed by a trained specialist.

New facilities are required to abide by Section J at a minimum to ensure ongoing energy efficiency and compliance with the NCC.

Green Star

Green Star is a holistic sustainability rating system for new buildings and major refurbishments. It is run by the Green Building Council Australia (GBCA). The Green Star rating scale encompasses the following ratings to measure building energy performance

1. Minimum Practice
2. Average Practice
3. Good Practice
4. Best Practice
5. Australian Excellence
6. World Leadership

Passive House

Passive House is a building energy efficiency standard that results in 90% reduction in heating and cooling to conventional buildings. Thermal comfort is achieved through passive measures including building envelope, passive solar heating, and optimal use of thermal insulation with minimal requirement for mechanical heating and cooling. This methodology can be applied to new and existing buildings.

Successful implementation of Passive House design has previously been achieved at several aquatic centres in the United Kingdom.

Case Study

Brimbank Aquatic and Wellness Centre, VIC

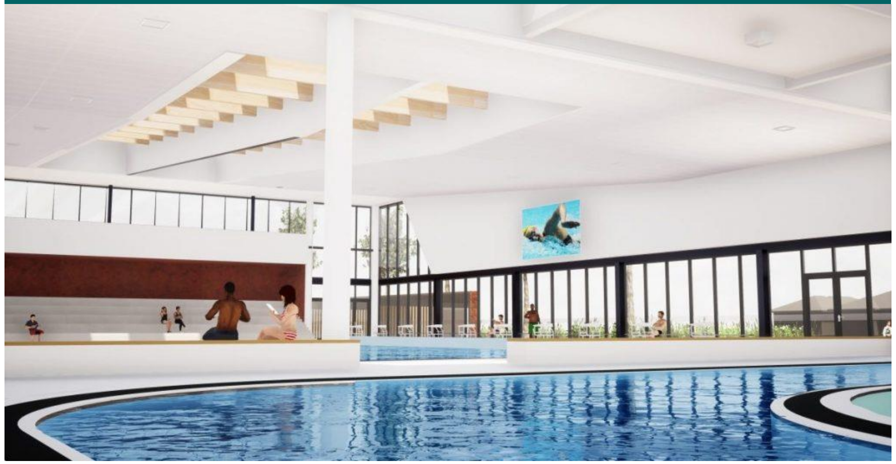
Built on the old St Albans Aquatic Centre site, the Brimbank Aquatic and Wellness Centre is currently undergoing energy efficiency upgrades, demonstrating best practice through attainment of a 6 Star Green Star rating.

The 1200sqm 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 Councils has offered the following "Going all-electric cost us around $2.3 million – nowhere near the initial $6 million we estimated."



Pools Energy Balance

Pools are large energy consumers due to the significant amount of energy required to maintain specific water and environmental conditions. Pool water and environment heating alone can contribute up to 80% of site energy use and provides a key opportunity to reduce both energy costs and emissions.

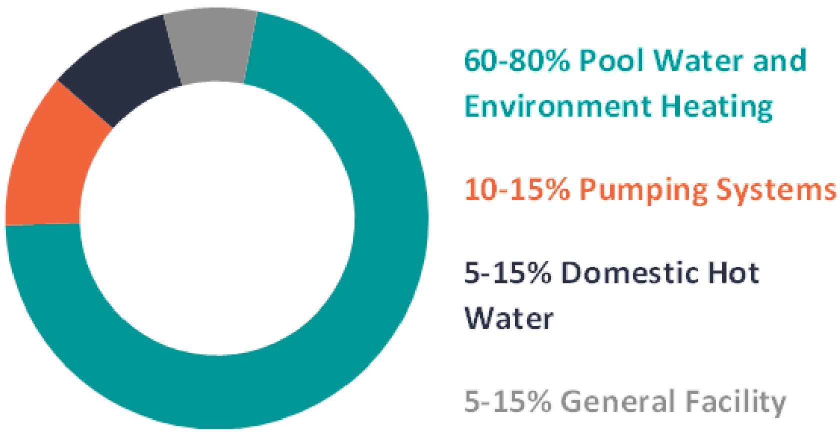


Figure 10: Typical Pool Facility Energy Usage (Outdoor and Indoor)

Water and Environment Heating (60-80%)

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.

Exposure to external conditions results in outdoor pools losing heat faster than indoor equivalents. This provides additional opportunity for pool stakeholders to reduce energy consumption through application of preventative heat loss measures for outdoor pools such as fences and pool solar blankets.

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

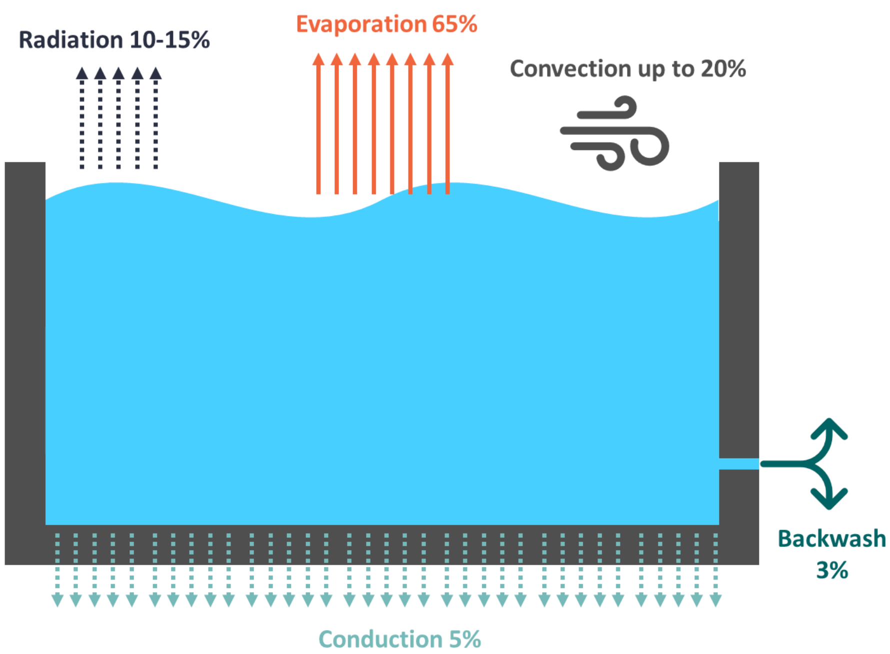


Figure 11: Typical Pool Heat Losses

Environmental 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.

Pumping Systems (10-15%)

Pumping systems are required to circulate water to ensure adequate filtration and heating. These pumps use large motors that can be energy intensive. Improving motor efficiency and reducing running speed can significantly reduce site energy consumption without noticeable impact on pool operations.

Domestic Hot Water (5-15%)

Domestic Hot Water (DHW) refers to heating water for amenities such as showers or taps. Minimising the energy lost in storage and improving the efficiency of heating technologies may yield substantial energy savings.

General Facility (5-15%)

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.

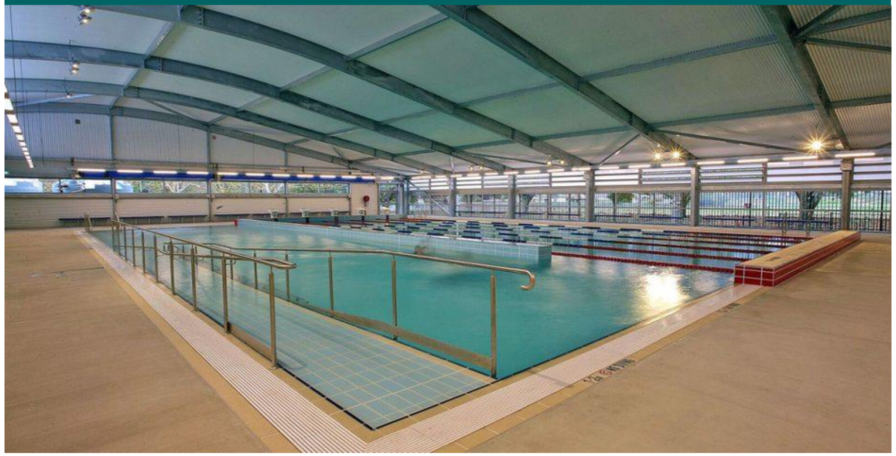
Case Study

JM Robson Aquatic Centre, NSW

In 2015, the Lithgow Aquatic Centre undertook a $6.5 million project to revamp its building envelope. Comprising a 50m outdoor and 25m indoor pool, new infrastructure allowed the centre to operate year-round despite the region's cold winters.

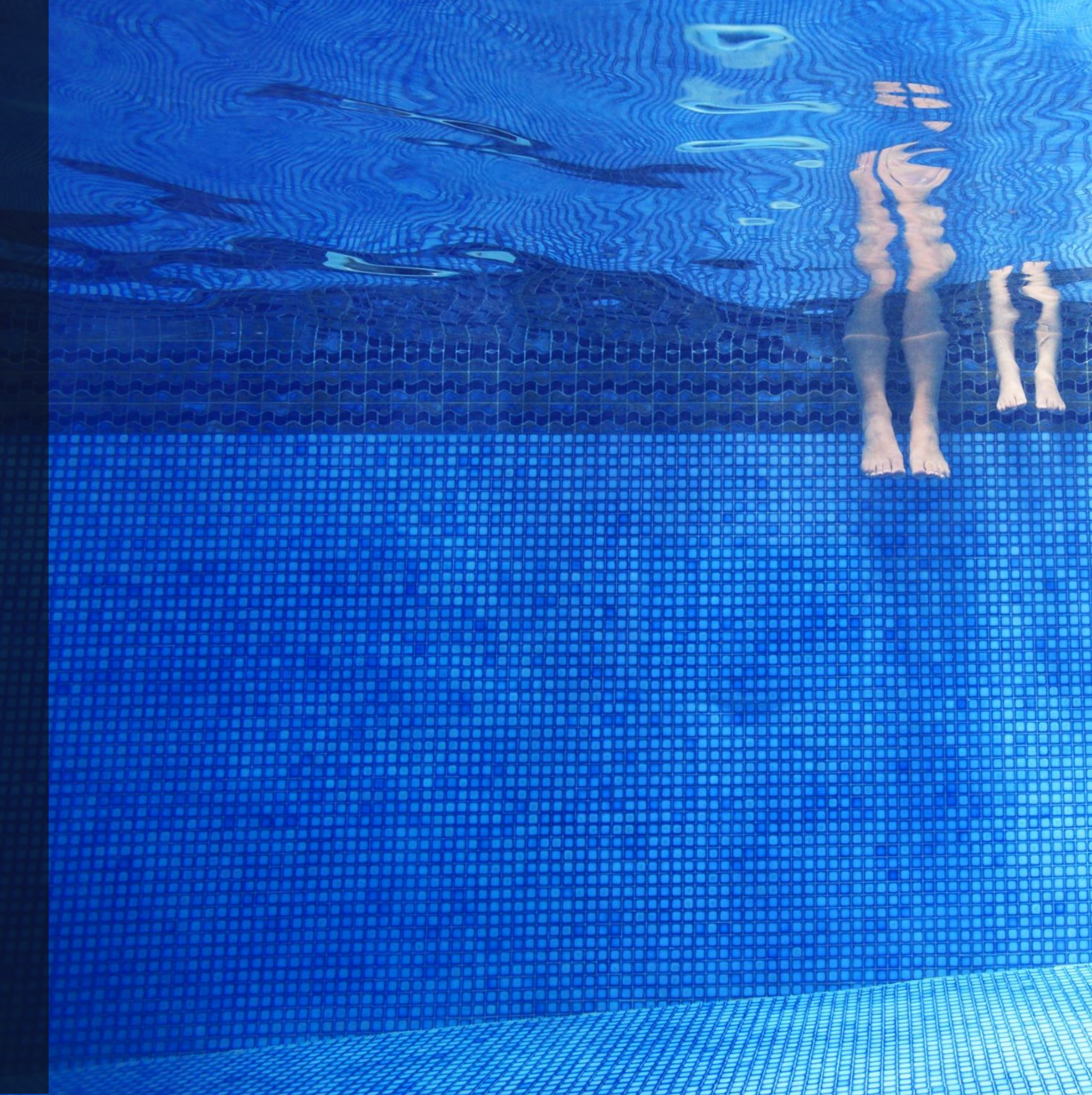
Building fabric upgrades included the addition of insulation to facility walls, ceiling and floors, double-glazed windows, and an angled roof to promote natural ventilation. Additional solar thermal systems were installed on the roof to maintain pool water temperature.

These upgrades drastically reduced site emissions and allowed the site to run effectively throughout the entire year.



Part 3:

Electrification and Heat Pumps



Electrification

Why Electrify

As the NSW electricity grid continues to adopt renewable energy technologies as shown in Figure 12, the volume of emissions produced per unit of electricity will decrease. This presents an opportunity to replace legacy gas fired boilers and other gas or LPG infrastructure with high efficiency electric equivalents to reduce operational emissions.

Electrification of pool assets provides the following benefits to pool facilities:

Environmental Impact – Natural gas is a non-renewable fossil fuel with an environmental impact beyond its emissions potential alone.

Energy Security – When integrated with on-site renewables and energy storage, electrified assets may continue to operate independent of grid energy supply, enhancing facility energy security.

Emissions Reductions – Emissions from electricity usage can be directly offset by renewable generation, whereas gas emissions can only be abated through the purchase of carbon offsets.

Lowered Costs – Using on-site renewable energy sources will minimise the costs required to run electric assets. Gas assets will continue to require ongoing utility costs and be subject to market volatility.

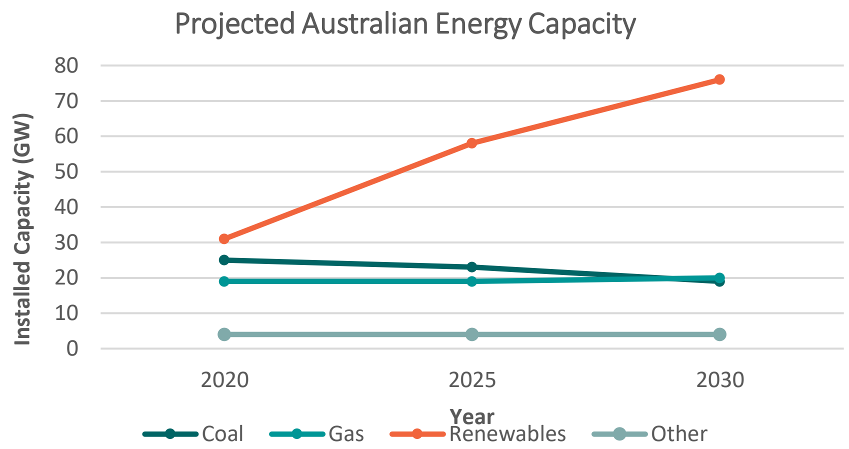


Figure 12: Projected Australian Energy Capacity[2]

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

Electrification and Heat Pumps

Within the pools context, gas and LPG assets are primarily used for heating purposes, including:

- Space (environmental) heating
- Domestic hot water heating
- Pool water heating

Heat pumps provide a highly efficient, reliable and cost effective alternative to gas infrastructure. Heat pumps are also versatile and can be scaled in size and demand to accommodate all of the above use-cases.

Technology Comparison

Heat pumps are more efficient than traditional heating sources. Other heating technologies generate heat during operation through electric resistivity or burning gas. These types of heating sources have an approximate efficiency of 100% and 70-80%, respectively.

Heat pumps do not directly produce heat, rather they transport heat between mediums. The Coefficient of Performance (COP) is used to describe a heat pumps efficiency. Typical heat pumps have a COP that ranges from 3 (300% efficiency) to 6 (600% efficiency) depending on the technology used.

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

Table 4: Typical Heating Technology Efficiencies

Domestic Hot Water Heat Pumps	
Emissions Reduction	**Capital Cost**
🌲🌲	$$
Risk	**Complexity**
High	**High**

Space Conditioning Heat Pumps	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$$$$
Risk	**Complexity**
High	**High**

Pool Heating Heat Pumps	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$$$$
Risk	**Complexity**
High	**High**

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.

Fully Electrified

Heat pumps can be fully electrified to replace legacy gas infrastructure and thus can be operated from on-site renewables and energy storage

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. 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 pool operations. Positioning equipment away from common areas lowers the impacts of noise and vibration, reducing disruption to patrons.

Case Study

Yarra Centre, VIC

Situated in the Yarra Ranges of Victoria, the Yarra Centre is an aquatic and leisure facility housing multiple pools and gyms. In 2021, the centre underwent significant upgrades which resulted in a reduction of 551 tonnes of CO_2 per annum, and an annual energy cost saving of just over $97,000.

The upgrades prioritised site electrification, including the replacement of boilers and heating hot water systems. With the addition of lighting upgrades and a new building automation system, the electrified systems were able to be predominantly run off a new rooftop solar PV array, reducing site emissions and costs.

Heat Pump Technology Overview

Heat pumps utilise the refrigeration cycle to transfer heat between mediums. Heat pumps can draw heat from a source (air or water) and transfer it to another location called the sink. This process can be reversed to facilitate cooling applications, where the system can transfer heat internal heat and deposit it externally. A typical heat pump is compromised of the following key components:

Refrigerant

Fluid (liquid or gas) that circulates through the heat pump, used to absorb and transfer heat from the source to the sink

Compressor

Compresses the refrigerant gas into a high-pressure vapour, increasing the refrigerant temperature. Compressors in two stage heat pumps can provide two levels of intensity to accomodate wider temperature bands.

Evaporator

Coil in which the refrigerant absorbs heat from the surrounding air. This process causes the refrigerant to turn into a vapour.

Condenser

Coil that provides heat to the surrounding environment. At this point the refrigerant condenses and becomes a liquid.

Expansion Valve

Regulates the flow of refrigerant through the system.

Reversing Valve

Changes the flow of refrigerant, allowing the system to switch between heating and cooling.

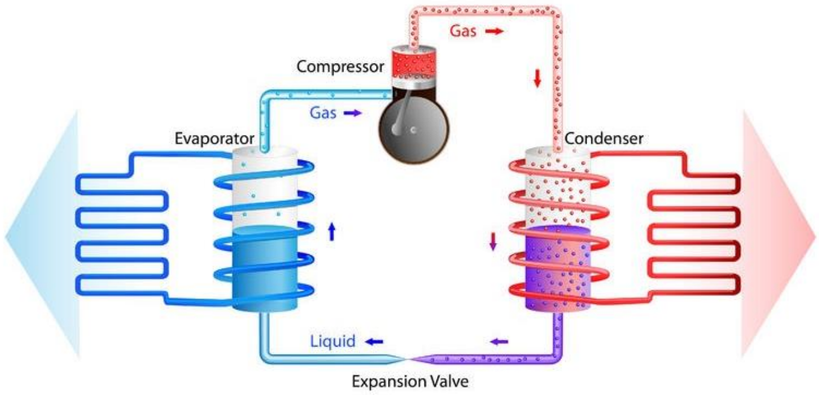


Figure 13. Refrigeration Cycle Diagram [3]

[3] Diagram from Energy Efficiency Council

Types of Heat Pumps

There are two predominant types of heat pump technologies. These technologies are functionally similar, however use different mediums (air and water) to transfer heat.

Air Source Heat Pumps (ASHP)

Air source heat pumps are optimized 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, ASHP's 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:

Cooling Towers

Rejected heat produced through the refrigeration cycle is absorbed by a water loop and pumped to a cooling tower to reduce its temperature. There are various types of cooling tower design, with selection dependent on site-specific requirements.

Water Bodies

The rejected water loop can be run through a local body of water in lieu of a cooling tower. The temperature difference between the rejected water loop and the ambient body of water cools the hot water loop (without mixing) which is then sent back to the heat pump for reuse.

The use of a body of water to cool the rejected water loop requires specific conditions including a neighbouring, accessible body of water, and thorough assessment of environmental impacts.

Geothermal (Ground-source)

The water loop can be run through the ground, allowing it to exchange energy with the surrounding earth prior to reuse by the heat pump.

Geothermal heat transfer is only applicable in geographical areas with appropriate geothermal conditions and may require significant excavation and land area. A site assessment should be conducted to ascertain the feasibility of each technology and choose an appropriate fit for purpose solution.

Key Considerations

When transitioning to heat pump systems, it is important that pools consider the following:

Site Electrical Infrastructure – Pools should ensure that the facility has sufficient electrical infrastructure and capacity to support high-demand electrical heat pumps. Where required, electrical infrastructure upgrades may incur additional design cost and complexity.

Changing Energy Sources – Implementation of heat pump technology will reduce pool reliance on gas and LPG. Stakeholders should be aware of the market impacts changing to electric only systems.

Operation and Maintenance – Changing infrastructure will necessitate changes to pool facility operation and maintenance. Staff should be aware of these changes and any new requirements to keep systems operational.

Energy Redundancy – Pools shall ensure that there is sufficient energy redundancy on site to minimise potential operational disruption. Energy redundancy may be assured through on-site energy storage, renewable energy generation or backup systems. This will allow pools to continue to operate during heat pump upgrades.

Heat Pump Refrigerants – The refrigerant used can present health, safety and environmental impacts through leakage or incorrect disposal. Use of specialised CO_2 or ammonia heat pumps can mitigate these risks.

Space Conditioning Retrofits – Heat pump heating hot water is at a lower temperature than typical combustion boilers. Facility piping and pumping infrastructure may require retrofitting to accommodate lower temperatures.

Increased Peak Demand – The high electrical loads required by heat pump may increase site peak demand, incurring additional expenses. This may place additional strain on grid infrastructure in regional centres.

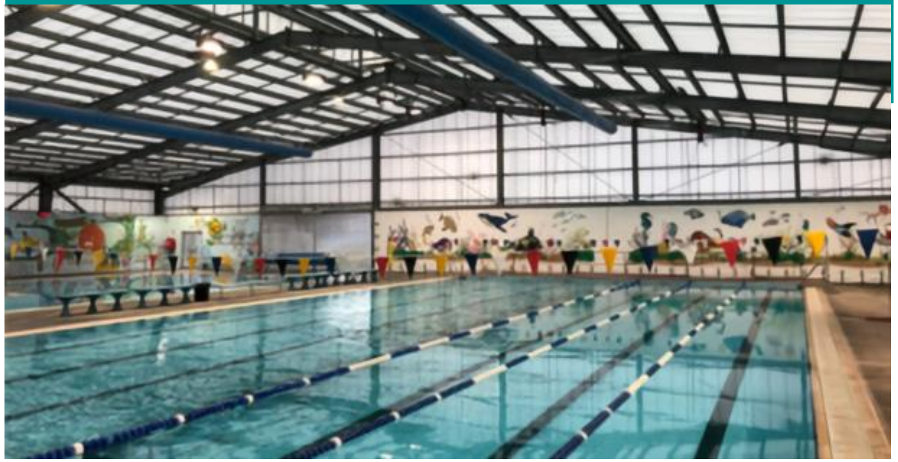
Case Study

Junee Recreation & Aquatic Centre, NSW

The Junee Recreation & Aquatic Centre, situated in Riverina, NSW, comprises 50m and 25m heated pools, an indoor stadium and gym. While the pool hall was already enclosed by a galvanised steel structure, the enclosure was found to be leaking, reducing overall heating efficiency.

An audit was undertaken to identify opportunities to improve the energy efficiency of the site. The pool facility underwent upgrades including boiler replacements, heat exchangers, VSDs and submeters. A BMS was installed to provide improved metering and equipment control.

The upgrades resulted in 16,800 kWh reduction in electricity consumption and a saving of approximately $25,000 annually.



Part 4:

Asset Efficiency Upgrades

Asset Efficiency

Part 4: Asset Efficiency provide opportunities for pools to improve the energy efficiency of existing assets or replace legacy systems with new, high efficiency equivalents. Opportunities related to asset efficiency improvements include:

Lighting and Controls

Lighting Technology

Upgrading ageing and outdated light fittings such as incandescent, fluorescent, or metal halide globes with high-efficiency Light Emitting Diodes (LEDs) is a common method of reducing facility energy consumption. LED's have an extensive lifespan, longer than traditional lighting systems, minimising ongoing maintenance and relamping costs.

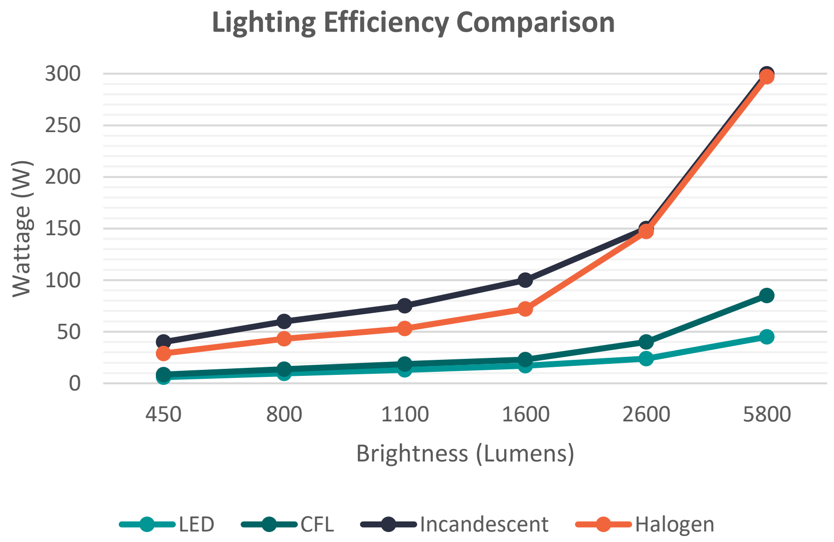


Figure 14: Lighting Efficiency Comparison

Lighting Controls

Energy consumption may be further reduced through installation of lighting controls. Scheduling programs can reduce lighting energy consumption by turning off lights when not in use. Transient zones such as staff rooms, corridors or change rooms may benefit from motion sensors to detect occupancy. PE (Photoelectric) sensors may be used to vary lighting intensity based on changing daylight levels.

Lighting & Controls	
Emissions Reduction	**Capital Cost**
🌲🌲	$$
Expected Payback Length	**Asset Useful Life**
Medium	**Long**
Risk	**Complexity**
Low	**Low**

Variable Speed Drives

Traditional direct-on-line (DOL) motors run at 100% speed irrespective of load, consuming a significant amount of unnecessary energy. Variable speed drives (VSDs) provide adjustable control of motor speed based on the required load.

This upgrade can be combined with optimised filtration and pumping, or ventilation upgrades to provide substantial facility energy savings.

Implementation of a motor VSD can provide the following additional benefits:

Reduction of Maximum Power Demand: Lowering the energy required by motors can reduce the peak demand required by the facility. This is especially pertinent to pools with large filtration and pumping systems

Minimised Stress on Components: Allowing motors speeds to vary minimises the stress on key components and can extend operational longevity.

Integration with Building Control Systems: VSD's can be integrated with Building Management Systems to provide remote operational capability, data tracking and integrate intelligent controls.

Reduction of Heat and Noise Levels: Motors running below 100% produce less heat, noise, and vibration.

VSDs can be retrofitted as a separate attachment onto most existing motors provided there is sufficient space. This provides a relatively low-cost opportunity to minimise plant energy consumption and emissions.

Variable Speed Drives	
Emissions Reduction	**Capital Cost**
	$$
Expected Payback Length	**Asset Useful Life**
Short	Long
Risk	**Complexity**
Low	Medium

Motor Efficiency Upgrades

Motors are used throughout pool facilities as part of pumps, fans, and compressors. The International Electrotechnical Commission (IEC) specifies four levels of motor efficiency:

- IE1 - standard efficiency
- IE2 - high efficiency
- IE3 - premium efficiency
- IE4 - super premium efficiency

Motors with higher energy efficiency can provide significant energy savings, as well as extended longevity. Australia mandates a minimum IE2 or IE3 efficiency level for motors ranging from 0.73kW to 185kW.

Due to the high capital cost and potential for significant operational disruption, pool facilities may benefit upgrading to high efficiency motors when legacy systems reach end of life.

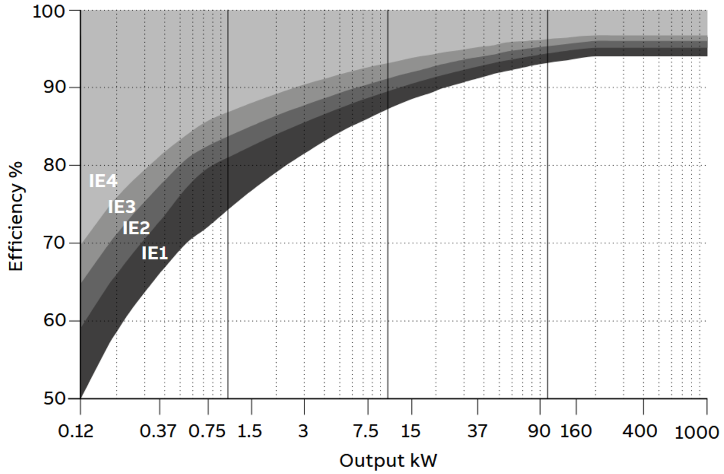


Figure 15: Typical Motor Efficiency Curve[4]

Motor Efficiency Upgrades	
Emissions Reduction	**Capital Cost**
	**$$$**
Expected Payback Length	**Asset Useful Life**
Medium	**Long**
Risk	**Complexity**
Medium	**Medium**

[4] Diagram from IEC 60034-30-1

Voltage Optimisation

Whilst the supply voltage in NSW is 230V, it is often delivered within a range of +10% to -6%, or 253V to 216V. This imbalance results in excess electricity being provided to pool facilities, resulting in increased energy consumption, emissions, and cost. This can be alleviated using a voltage optimiser, which ensures that the optimum voltage is supplied to the facility. Excess voltage is returned to the grid at no additional cost.

Additional benefits of voltage optimisation include:

- Reduced equipment maintenance requirements
- Overall increase in equipment lifetime
- Improved site power quality
- Reduced energy usage, emissions, and energy bills

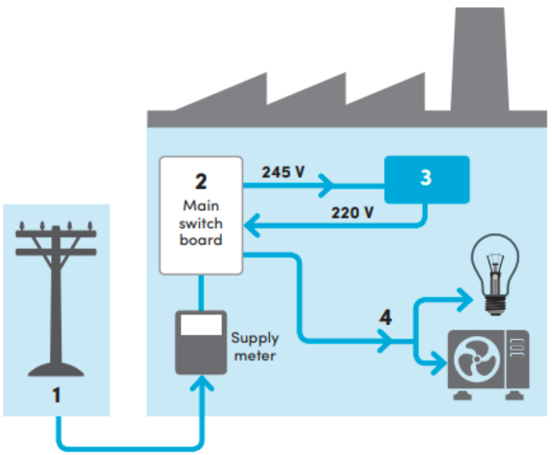


Figure 16: NSW Energy Delivery with Voltage Optimisation[5]

Voltage Optimisation	
Emissions Reduction	**Capital Cost**
🌲	$$
Expected Payback Length	**Asset Useful Life**
Medium	Medium
Risk	**Complexity**
Medium	Medium

[5] Diagram from NSW Office of Heritage and Environment Voltage Optimisation Guide

Power Factor Correction (PFC)

Power factor is a ratio of working power measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). PF is a measure of useful work output based on electrical energy input. The ideal power factor is one, also described as unity. Any power factor below unity means that extra energy is being used than actually required to meet electrical loads on site.

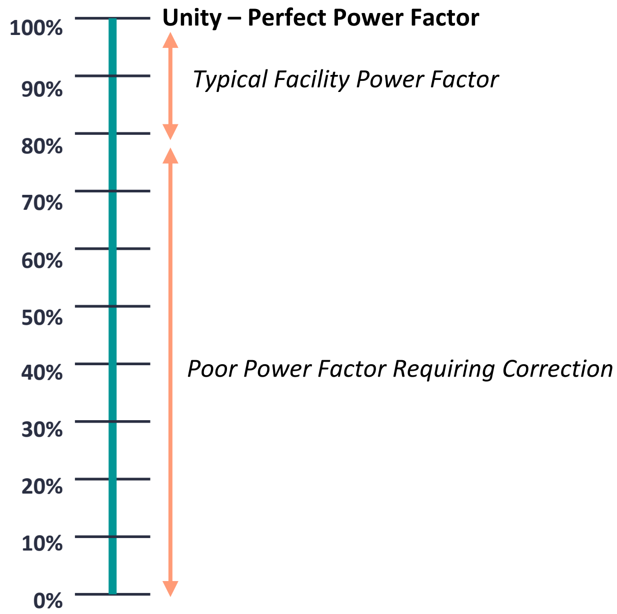


Figure 17: Power Factor Scales

Poor power factor can be caused by a variety of different conditions, typically motors that create a large inductive system load. Correcting poor power factor is achieved by installing additional capacitors on site. Facility power factor, the size of corrective capacitors and the optimal installation location can be determined by a qualified specialist.

Although PFC will not significantly reduce site emissions, it can serve to reduce pool electrical utility costs.

Power Factor Correction	
Emissions Reduction	**Capital Cost**
	$$
Expected Payback Length	**Asset Useful Life**
Medium	Medium
Risk	**Complexity**
Medium	Medium

Enhanced Filtration

Optimise Filter Backwashing

Filter backwashing is often conducted based on a fixed time schedule. This can result in unnecessary backwashing, wasting energy and water resources.

Optimised filter backwashing can be achieved by analysing the water contaminant levels and only backwashing when required. Pressure sensors placed on the filters can measure the gradual pressure drop as the level of contaminant grows. At a pre-selected level of pressure, a backwash can be induced.

Most filter manufacturers provide guidance on the optimal pressure drop for filter backwashing.

Updated Media Filter

The type of media filter used in the filter can impact pool filtration energy usage. Filters with finer particulates can limit water flow and hence require more pump energy. Different media filters also require varying backwash frequencies which can produce a nominal reduction in energy consumption.

Glass media filters are recommended due to their ability to capture small particulates as low as 3-5 microns, and reduced backwashing frequency, saving energy and water.

It is important to note that the type of media filter in use, sand, glass or other will have impacts on pool bacteria growth, maintenance requirements and costs, and therefore careful consideration should be made to ensure that media selection suits individual facility requirements.

Enhanced Filtration	
Emissions Reduction	**Capital Cost**
🌲	$
Expected Payback Length	**Asset Useful Life**
Short	-
Risk	**Complexity**
Medium	Medium

Setpoint Adjustment

Increase Indoor Pool Hall Air Temperature

Increasing indoor air temperature whilst maintaining relative humidity reduces pool evaporation, minimising pool heating losses.

Increasing indoor pool air temperature may require additional energy usage. A balanced approach should be taken to ensure the increased energy consumption from raised air temperature does not exceed energy savings from reduce pool heating losses.

Pool managers should also consider occupant comfort when implementing changes to make sure comfortable indoor condition are maintained.

Increase Relative Humidity Set Point

Higher indoor relative humidity will also reduce heat loss from pool evaporation. The ideal relative humidity is typically between 50-60%.

When adjusting pool relative humidity it is important to consider pool facility maintenance and operation. Excessive humidity may result in increased condensation on window, walls or voids. This may promote the growth of mould or exacerbate corrosion.

Occupant comfort should also be considered to ensure the conditions of the pool remain comfortable

Pool Temperature Adjustment

The reduction of pool heating temperatures by even a 1-2°C margin can have a substantial impact on energy usage due to the large amount of energy pool required to heat pools

Changes to pool temperature can be made on a seasonal basis or based on daily or weekly schedules to accommodate which patrons are using the pool at a given time such as children or seniors.

When adjusting pool heating temperatures it is important to ensure that changes do not adversely impact pool comfort conditions as this may reduce community utilisation.

General Setpoint Adjustment

Facilities can further reduce energy consumption through reducing temperature and ventilation setpoints in other areas of the pool including offices, lobbies, corridors and changerooms.

Care should be taken to ensure that the climate in these areas remains comfortable, fit for purpose and comply with generally applicable building standards.

Setpoint Adjustment	
Emissions Reduction	**Capital Cost**
🌲🌲	$
Expected Payback Length	**Asset Useful Life**
Short	-
Risk	**Complexity**
Medium	Low

Ventilation Improvements

Air Distribution

Airflow over the surface of the pool can cause considerable pool heat losses due to increased convection and evaporation.

Modifying air distribution such as the location and direction of air supply diffusers will minimise heat and water loss, reducing the demand for pool heating and water consumption.

Economy Cycle

Introducing controls that allow for return air to be combined with the incoming outside air will reduce the heating demands. The return air damper position can be modulated based on outside air ambient conditions as well as pool hall conditions such as temperature, relative humidity, and CO_2 levels.

Exhaust Air Heat Recovery

Installing a heat recovery system allows warm exhaust air discarded from the facility to be reused to pre-heat the outside air entering the air handling unit (AHU).

Latent Heat Recovery Systems

Exhaust air from pool facilities typically has a high moisture content. Certain heat recovery systems are able to capture additional latent heat in these water particles to boost the efficiency of the heat recovery system.

The moisture captured by these heat recovery systems may present additional maintenance requirements and reduce asset longevity. This may be offset by the additional savings created through the reduced site energy costs. Care should be taken when selecting the exhaust air heat recovery system to ensure it is site suitable and fit for purpose.

Ventilation Improvements	
Emissions Reduction	**Capital Cost**
🌲🌲	$$
Expected Payback Length	**Asset Useful Life**
Medium	-
Risk	**Complexity**
Medium	Medium

Part 5:

Building Fabric Upgrades

Building Fabric

Part 5: Building Fabric provides guidance on methods to improve insulation across the facility to minimise unwanted energy loss. This reduces site emissions, energy and utility expenditure as well as improving comfort conditions for patrons.

Building Envelope

Building Sealing (Airtightness)

Effective building sealing can improve energy performance by reducing the volume of conditioned air lost through the building envelope. This reduces the amount of energy used by Heating, Ventilation and Air Conditioning (HVAC) equipment.

Effective building sealing can be achieved by reducing air transfer through gaps or holes in the building façade. Smaller gaps can be sealed through caulking and airtightness tapes, whereas larger areas may be sealed by installing airtight barriers.

Sealing can also improve indoor conditions by stopping cold drafts entering the building during winter, or hot gusts during summer. Effective sealing will also reduce outside particulates like pollen or smoke, improving overall air quality.

Building Insulation

The effectiveness of the building envelope can be improved by installing additional insulation in walls, voids, and ceiling spaces. Building insulation acts as a shield to outside conditions, stopping external heat transfer on hot days and trapping internal heat on cool days. Minimising the extent to which unwanted heat is gained or lost will reduce the intensity and load at which HVAC equipment is required to run.

Building Glazing

Windows can be replaced with low-emissivity double or triple glazed equivalents that contain an argon-filled gap, minimising heat transfer. Facilities should ensure that the window frames are thermally broken to avoid heat transfer via thermal bridging.

Window tinting can further mitigate the heat transfer from the sun. This should be implemented strategically placed based on the orientation of the windows in relation to direct sunlight and with indoor heating in mind.

Building Envelope	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$$$
Expected Payback Length	**Asset Useful Life**
Long	Long
Risk	**Complexity**
Medium	Medium

Swimming Pool Covers

Effective use of pool covers can significantly lower pool heat losses. This provides a low-cost and simple method to reduce pool energy consumption.

Implementation of pool covers should be coupled with updated shutdown procedures to ensure that pool covers are utilised when pools are not in use.

Pool covers may produce the following additional benefits:

- Reducing pool evaporation, lowering site water consumption
- Preventing pool chlorine degradation from solar UV
- Stopping leaf litter and other debris from collecting in pools

Solar Blankets

Pool solar blankets are a type of pool cover with air bubbles that trap solar heat. Captured heat is then transfer to the water, reducing the demand on active heating methods.

Solar blankets are especially important for outdoor non-heated pools as they can marginally increase pool temperature without the need to install significant heating infrastructure.

Swimming Pool Covers	
Emissions Reduction	**Capital Cost**
🌲	$$
Expected Payback Length	**Asset Useful Life**
Short	Medium
Risk	**Complexity**
Low	Low

Outdoor Pipework Insulation

Insulating outdoor heating pipework reduces the heat loss to the surrounding ambient environment.

It is recommended that this measure be implemented if the annual outside temperature on average is lower than the pool temperature by at least 10°C.

Outdoor Pool Fences

The installation of fences around the edge of outdoor heated pool helps to reduce convective heat losses by minimising wind flow over the pools. This can additionally reduce wind chill factor and improve pool safety.

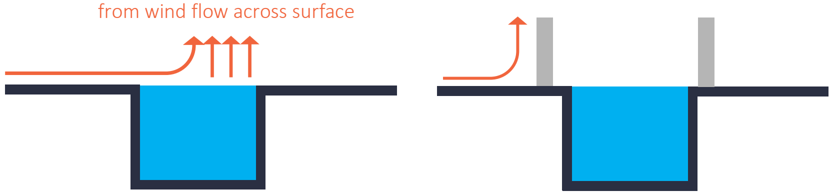


Figure 18: Convective Losses Without and With Outdoor Pool Fences

Pool Wall Insulation

The installation or upgrade of insulated pool walls can reduce conductive heat losses.

Updates to the pool shell can incur extended operational downtime. Facilities may wish to consider upgrading pool insulation during major pool renovations or at asset end of life.

Outdoor Pipework Insulation	
Emissions Reduction	**Capital Cost**
🌲	$
Risk	**Complexity**
Low	Low

Outdoor Pool Fences	
Emissions Reduction	**Capital Cost**
🌲	$$
Risk	**Complexity**
Low	Low

Pool Wall Insulation	
Emissions Reduction	**Capital Cost**
🌲🌲	$$$
Risk	**Complexity**
Low	Medium

Part 6:

Renewable Technologies

Renewable Technologies

Part 6: Renewable Technologies outlines initiatives that reduce grid electrical consumption through implementation of on-site renewables and smart energy management technologies.

Solar Thermal Heating

Solar thermal systems harness energy from the sun to provide heating for pool facilities. Within the pools context solar thermal systems are often used to deliver heating for pool water, but solar thermal technology may also be used for 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.

Combined Solar Thermal Systems

Standalone solar thermal systems can be installed without additional heating infrastructure to marginally uplift to pool temperatures without requiring significant site upgrades. Alternatively, solar thermal systems may be installed in conjunction with heat pumps to lower overall heating demand and thus reduce energy usage.

In some instances solar collector plates can be integrated with solar PV panels to collect surplus heat energy. This has the added benefit of lowering the temperatures of the solar panel, increasing efficiency and the total amount of renewable energy generated.

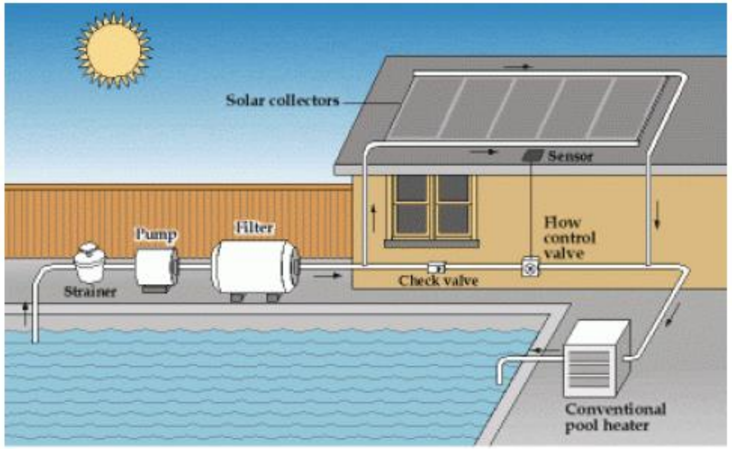


Figure 19: Typical Combined Solar Thermal System Configuration[6]

Solar Thermal Heating	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$$$
Expected Payback Length	**Asset Useful Life**
Long	Long
Risk	**Complexity**
Low	Medium

[6] Diagram from Energy.Gov

Solar Photovoltaic (PV)

The photovoltaic effect refers to the conversion of light photons into an electric current using specialised semiconductor materials. Electricity produced using this method is referred to as a solar photovoltaic, or solar PV. Installation of solar PV provides a clean, renewable, and relatively low-cost form of energy.

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 pools prioritise energy intensive activities within 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 Photovoltaic (PV)	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$$
Expected Payback Length	**Asset Useful Life**
Medium	Long
Risk	**Complexity**
Low	Low

Types of Solar PV

There are several of types of solar PV systems, including:

Rooftop Solar
Installing solar PV on building rooftops provides an effective and inconspicuous location for solar PV. Due to the location above street level shading on panels is reduced, improving overall generation. Solar panels installed on North facing rooftops should be prioritised to maximise the amount of electricity generated.

Carport Solar
Simple structures and canopies can be built over carparks to provide an integrated method of shading and on-site energy generation. Carport solar provides an efficient method of capturing solar energy over a traditionally non-usable space. Enhanced synergy can be achieved by integrating electric vehicle chargers that feed primarily from the carport solar, providing a highly integrated and efficient charging solution.

Ground Mount Solar
Ground mount solar arrays may be installed where large areas of land are available to the pool facility. Due to the size of the arrays, ground mount solar can produce a significant amount of energy which can be used by the pool, captured in energy storage or exported back to the grid.

Tracking Solar
Solar systems can be designed on single or dual axis racks that track the movement of the sun. These systems are able to pivot to take advantage of the sun as it moves across the sky throughout the course of the day. The addition of tracking technology will increase the cost and complexity of operation, whilst introducing additional maintenance requirements. These systems require careful consideration prior to installation.

Electric Vehicle Charging

As uptake of Electrical Vehicles (EV) becomes increasingly prevalent in Australia, adoption of EV charging stations are becoming an increasingly viable opportunity for pool facilities. Installation of electric vehicle infrastructure will provide patrons an opportunity to charge their vehicle whilst at the pool or can be reserved for staff to charge their vehicles at work.

Adoption of electric vehicle charging may promote EV uptake within communities or encourage additional pool usage for those already owning EVs. Implementation of charging infrastructure will also visibly demonstrate the pools 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 the pool facility.

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

Types of Chargers

There are a variety of EV chargers that are available, which vary in terms of charging speed, application, and overall power capacity. EV chargers also can provide charging through AC (Alternating Current) or DC (Direct Current) power.

It is important that pools consider their unique context 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.

Electric Vehicle Charging	
Emissions Reduction	**Capital Cost**
	$$
Expected Payback Length	**Asset Useful Life**
-	Medium
Risk	**Complexity**
Medium	Medium

Energy Storage

Local on-site energy storage provides pools 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 such as thermal storage or compressed air systems can be used.

Energy storage systems provide the following benefits:

Renewable Energy Storage – Surplus electricity produced by onsite renewable generation, including solar PV, may be stored for future use. This maximises the effectiveness of the renewable resource, reducing pools expenditure and reliance on electricity from the grid.

Demand Response – 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 site.

Energy Security – Energy storage will improve the energy security of pools and allow facilities to continue to operate during outages and blackouts.

Energy Storage	
Emissions Reduction	**Capital Cost**
	$$$
Expected Payback Length	**Asset Useful Life**
Extended	Long
Risk	**Complexity**
High	High

Case Study

North Sydney Olympic Pool, NSW

In 2015 the North Sydney Olympic Pool underwent upgrades to many of its heating systems in order to improve efficiency.

The site includes five pools in total, as well as a gym, sauna, and other recreational amenities. The existing facility used various heating systems, including electric heat pumps, gas boilers, a gas-fired cogeneration and a solar thermal system.

A sub-metering plan was put in place to quantify energy usage and flow, and subsequently identify energy efficiency opportunities. Upgrades included optimising heating system controls, integration of temperature sensors, VSD installation, and an upgraded BMS interface and temperature control settings.

The project took two years to complete, with a payback of 2.6 years and with an annual energy savings of 1144 GJ.

Microgrids

Microgrids are localised energy grids that may 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.

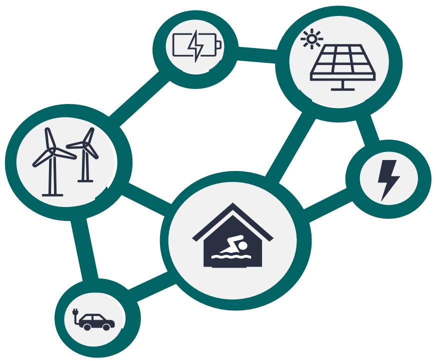


Figure 20: Example Microgrid Connectivity

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.

Key Benefits

Micrograds can provide the following benefits to pools and the broader connected community.

Support Renewable Energy Resources – Micrograds 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 pool and hall temperatures in the case of a blackout, reducing the energy required to restore the facility to adequate operating temperatures.

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.

Microgrids	
Emissions Reduction	**Capital Cost**
🌲🌲	$$$$
Expected Payback Length	**Asset Useful Life**
Extended	Long
Risk	**Complexity**
High	High

Power Purchase Agreements

Power Purchase Agreements (PPAs) 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 pools exposure to volatile energy markets.

PPA's are often used in conjunction with site specific energy efficiency upgrades. Remaining site electrical consumption that cannot be reduced further can be delivered through a PPA. This will significantly reduce facility emissions and enable pools to attain net zero status.

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 and carefully assess the state of the market at the time of procurement.

Power Purchase Agreements	
Emissions Reduction	**Capital Cost**
🌲🌲🌲🌲	$*
Expected Payback Length	**Asset Useful Life**
-	-
Risk	**Complexity**
High	Medium

**PPA's do not have a direct capital cost, however may require administration and setup fees*

Case Study

City of Newcastle Power Purchase Agreement

In 2019 the City of Newcastle awarded a 10-year Power Purchase Agreement to purchase 100% renewable electricity from the state's largest windfarm.

The agreement will enable the City of Newcastle to become the first local government in NSW to transition to 100% clean, renewable energy. The contract will additionally serve to save rate payers in the order of $1.8 million over the lifespan of the 10 year contract.

The Power Purchase Agreement will act in alignment with the council's existing sustainability initiatives, including a half megawatt of existing rooftop solar and solar farm at the councils waste management facility.

Energy Metering and Management Systems

Energy Management Platforms

Energy management systems can streamline facility energy usage, enhancing data accessibility and transparency whilst supporting the identification of opportunities for improvement.

Energy management platforms can provide a wide range of functionality. It is important that pool facilities consider which platforms are most appropriate based on individual needs and existing infrastructure on site. Common benefits provided by energy management platforms 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	Energy management platforms 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	Energy management platforms may offer centralised portals for site energy usage and billing, allowing facilities to track their consumption and costs, enabling pools to future plan accordingly.
Facility Benchmarking	Determining a standard benchmark for pool energy usage will allow facility managers to assess the efficiency of their sites year on year. Facility benchmarking will also allow pools to compare energy usage against similar 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.

Case Study

Bega Memorial Pool, NSW

The Bega Memorial Pool is an outdoor pool in the Bega Valley Shire Council which operates over the six-month summer season. An energy audit was conducted in response to high energy operating costs.

A solar array was installed to replace the smaller, older array, as well as VSD installation for the filtration pumps. These initiatives resulted in over $10,000 in savings each year, and a reduction in gas emissions by almost 53 tonnes annually,

Metering

Meters are used to measure the consumption of electricity, water, or gas across a site. Understanding usage patterns will allow pools to identify opportunities for improvement and strategically plan future utility management.

There are several different types of meters:

Utility Meters – Utility meters, often referred to as authority meters, are situated at the connection interface between the site and the relevant authority (electrical, gas or water). Readings from utility meters are used by authorities to charge for site consumption. All utility meters contain a unique identification number. Electricity meters use a National Meter Identifier (NMI), whereas gas meters have a Delivery Point Identifier (DPI) or in some instances a Meter Identification Reference Number (MIRN).

Submeters – Submeters are additional meters located within the portfolio. Submeters are often referred to as 'behind the meter' as they measure energy usage after the utility meter connection point. Submeters are installed to increase the resolution of site energy consumption and can be strategically installed to measure the consumption of specific assets.

Virtual Meters – Virtual meters are used to consolidate metering data from two or more downstream meters. This is completed through software on an energy management platform, and do not require physical installation. Virtual meters can be useful as they can provide a high-level summary of energy consumption for multiple assets.

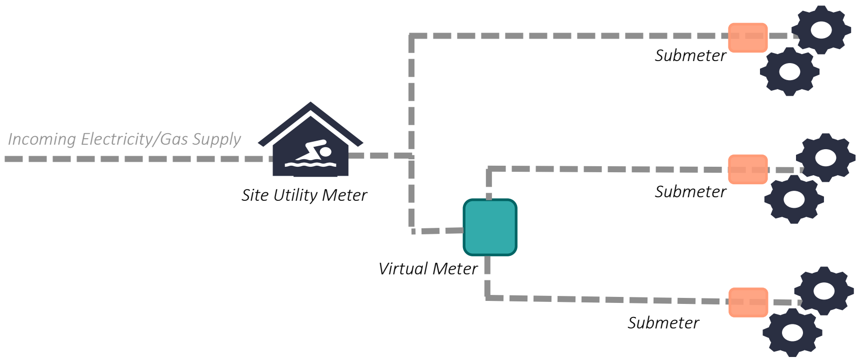
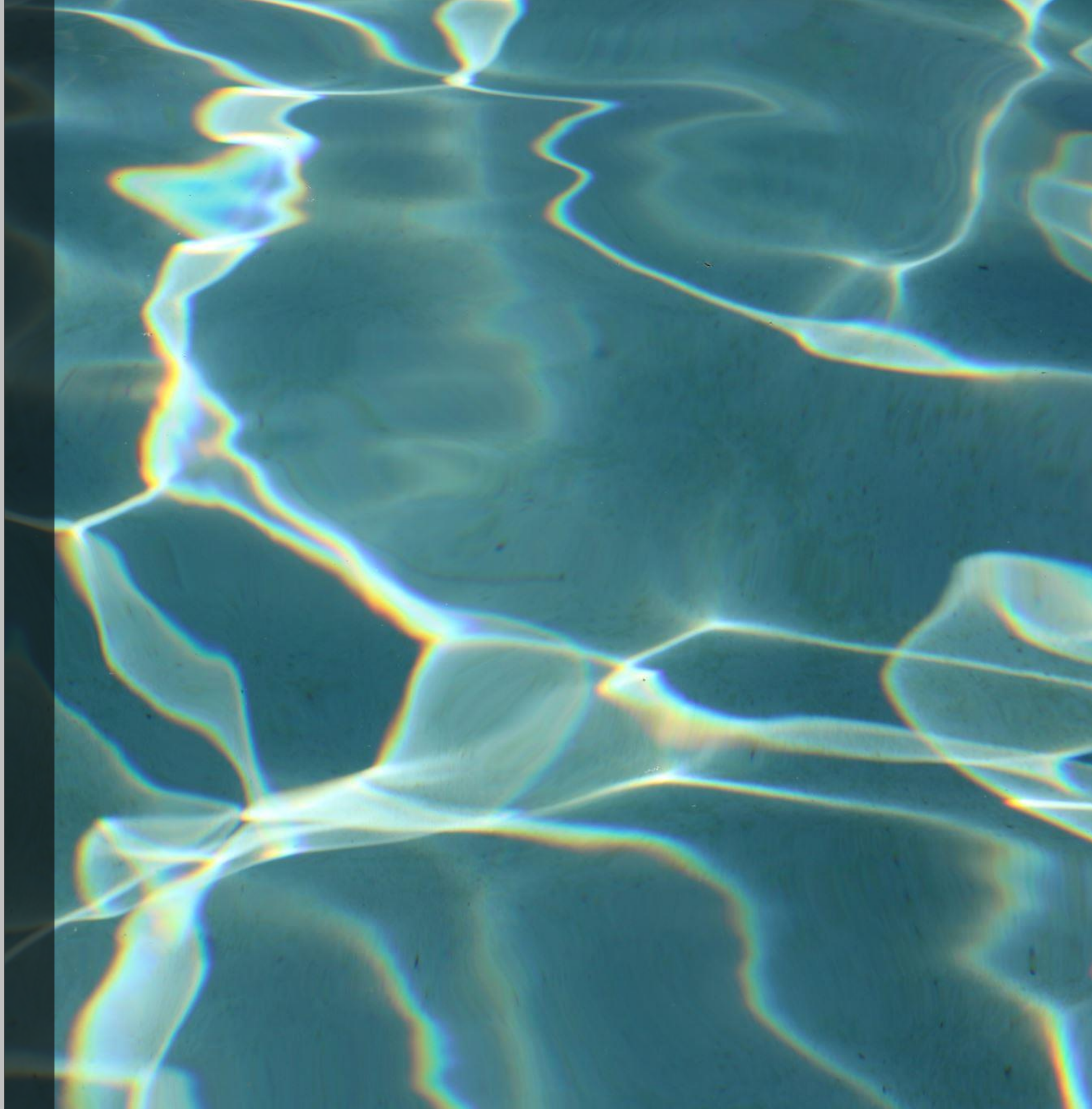


Figure 21: Typical Metering Infrastructure Overview

Energy Metering and Management Systems	
Emissions Reduction	**Capital Cost**
🌲	$$
Expected Payback Length	**Asset Useful Life**
Long	Long
Risk	**Complexity**
Low	Medium

Part 7:

Behavioural Changes



Behavioural Changes

Energy Awareness Training

Energy awareness is a key tool in helping reduce pool energy use. Encouraging staff to turn off equipment when not in use, or placing pool covers when closing the facility is an inexpensive way to save energy and minimise utility costs.

Staff sustainability education should promote a culture focused on energy and emissions reductions, whereby staff actively prioritise actions that support the facility towards achievement of net zero. Providing sufficient training to staff can serve to alleviate frustrations as a result of operational changes or disruption.

Energy Efficiency Shutdown Procedure

If the facility is only open for part of the year or has irregular operating hours, consider updating pool closure procedure to embed energy saving measures. For example, ensure that all non-essential equipment such as fridges that contain non-perishable items, lights and audio-visual systems are turned off at the switch.

Shutdown procedures can also ensure that pool covers are used appropriately to further reduce pool energy losses.

Preferred Purchasing Policies

Embedding sustainability criteria as part of the procurement process when replacing end-of-life assets will gradually improve the overall pool energy efficiency This is an effective method of providing site uplift without requiring significant capital investment.

Sustainable procurement can be attained by ensuring that all new assets demonstrate a minimum efficiency rating; typically indicated by the appliance Energy Rating label or the coefficient of performance for heat pumps.

Ensuring that all new assets correlate with the pools broader strategic objectives will future proof new assets and limit the extent to which assets in good condition are replaced as they do not meet minimum sustainability performance.

Case Study

Eurobodalla Shire Council Pools, NSW

Situated in the South Coast Region of NSW, the Eurobodalla Shire Council sought to implement upgrades at a number of their pool sites, including Narooma Pool, Moruya Pool and the Moruya Administration Building.

The upgrades included a complete pool hall air handling unit upgrade with four-pipe heat pumps, a 202 kW solar PV onsite generation, higher efficiency pumps and VSDs, and a new BMS and metering system.

Overall electricity consumption was reduced by 68.5%, as well as energy savings reaching almost $137,000 and 631 tonnes of $CO_{2\text{-}e}$ per annum.

Equipment Sequencing

Where there are multiple of similar assets on-site, for example pool heating systems, it is beneficial to stage the start-up sequence by prioritising energy efficient equipment first. This will ensure that legacy, inefficient equipment is only activated when required.

Efforts should be made to prioritise electrical equipment in favour of gas or LPG systems, as these assets can run directly off renewable energy.

Outsourced Management

Outsourced management may incur higher energy costs as outside managers may have no incentive to reduce site energy usage.

If a third party manages the pool, consider embedding energy efficiency outcomes within the contract. Split incentives can be an effective way to encourage third party contractors to consider energy efficiency alongside maintenance and uptime requirements

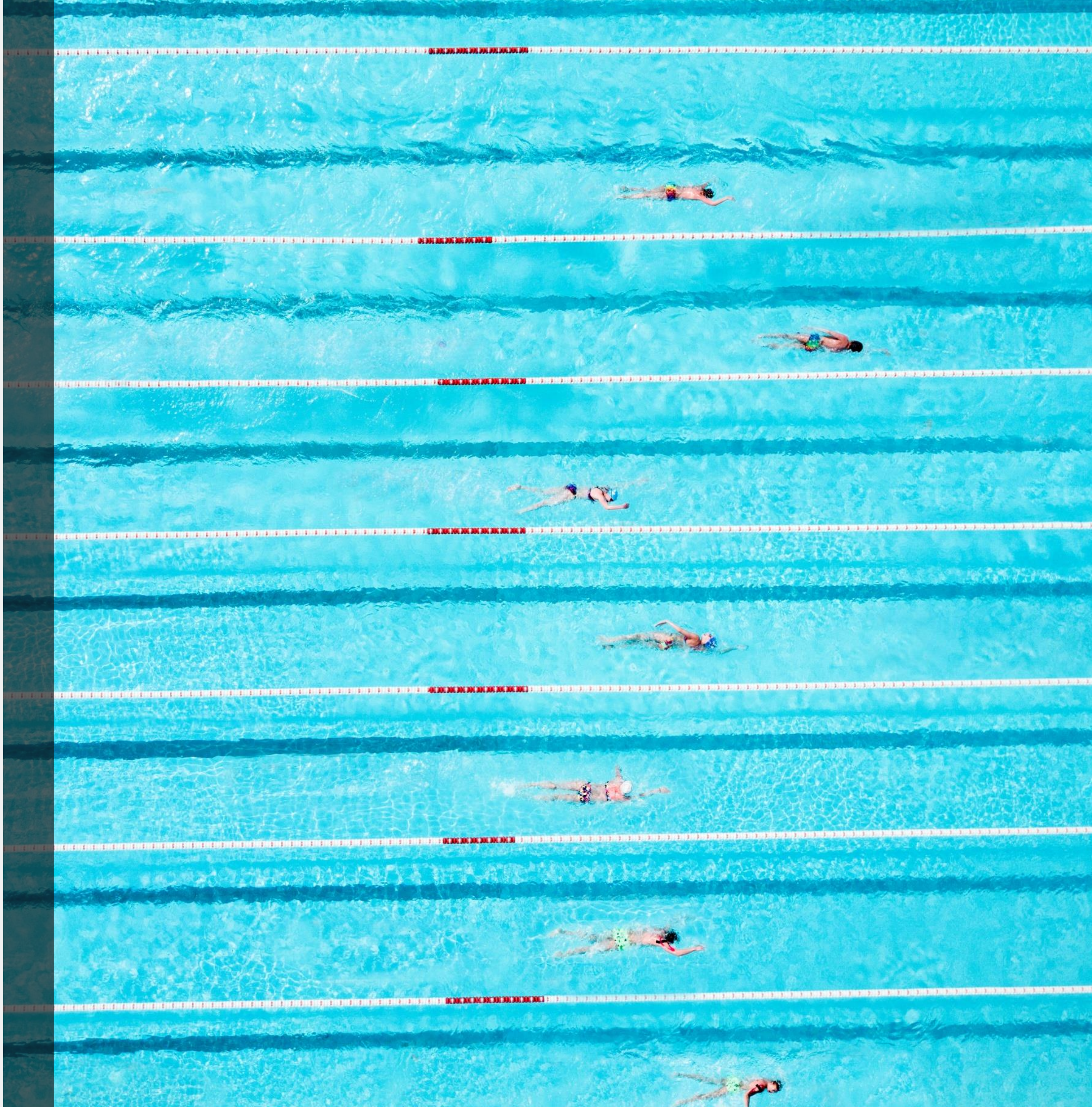
Maintenance

Regular maintenance of major energy consuming assets may reduce equipment downtime, operational costs and mitigate unnecessary energy usage caused by plant faults. Implementation of the following framework may help improve site maintenance outcomes.

Remove Obstructions	• Ensuring airflow around equipment is unobstructed, in particular air source heat pumps • Removing obstructions enables improved equipment inspection and supports early identfication of faults
Clean Assets	• Cleaning the equipment may help improve their operation. Assets to prioritise include heat pump condensers and solar PV panels • Cleaning should be conducted in accordance with manufacturer recommendations, annually at a minimum.
Correct Operation	• Operating assets as specified by the manufacturer directions will support optimal operational outcomes
Maintenance Program	• Implementing a routine maintenance schedule will ensure asset maintenance is not missed • Keeping a log of maintenance work can help develop trends and identify unreliable assets

Part 8:

Next Steps



Next Steps

The NSW Government note that the next steps and upgrade pathway provided is generally applicable only. Order, sequencing and staging will depend on individual pool context, the type and extent of upgrades and any additional factors that may influence project completion.

Preliminary Next Steps

It is recommended that pool stakeholders utilise the additional resources developed in collaboration with the Net Zero Pools Guide, including the Pools Toolkit and Business Case Templates, to develop a high-level overview of site specific upgrade opportunities.

The NSW Government recommend that each facility conduct a site-specific appraisal to determine the applicability and validity of the recommendations provided in these resources. 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.

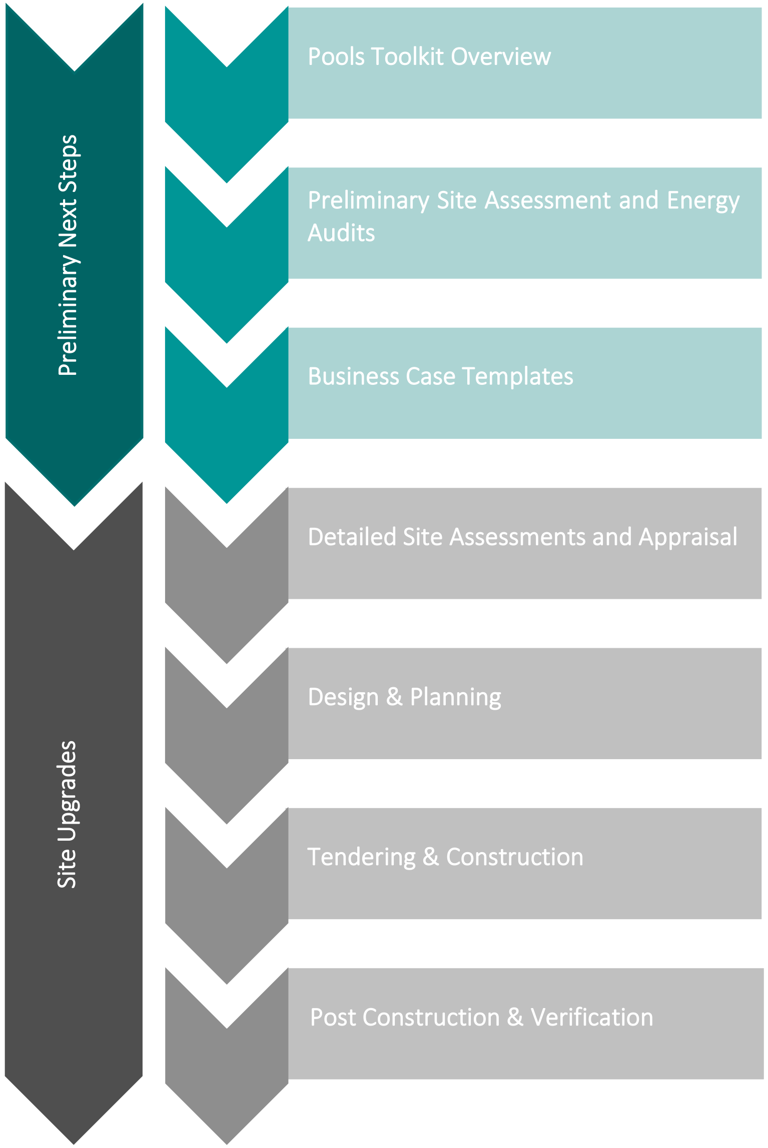
Once pool stakeholders have developed an understanding of opportunities relevant to their site, and confirmed they are site suitable, it is recommended that they complete a business case to source funding for future pools upgrades.

Site Upgrades

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

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

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 upgrades and knowledge sharing.



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