

Business Asset Replacement Strategy

How-to Guide

Commissioned by EECA
August 2024



Asset Replacement Strategy – How-to Guide Executive Summary

Introduction

Process heat is responsible for 8% of New Zealand's gross greenhouse gas emissions (GHG) and one third of energy use. For New Zealand to meet [Paris Agreement commitments](#) and achieve net zero emissions, process heat systems need to become more efficient and transition to using renewable energy.

Asset management, which seeks to optimise assets across their lifetime can be used to drive decarbonisation. Both through enabling better understanding of asset performance, cost and risk and through adoption of Asset Replacement Strategies to plan for the eventual replacement of assets.

An Asset Replacement Strategy will optimise when an asset is replaced and the technology it is replaced with. A proactive approach to asset replacement will minimise cost and risk associated with a business's assets, improve asset performance and support the transition to renewable energy. However, without an asset replacement strategy, businesses risk making reactive decisions when assets fail, replacing technology like for like and locking in high cost and high emitting technology.

Purpose of the guide

The purpose of this guide is to:

- Build your understanding of asset replacement strategies and related concepts.
- Support you to develop a replacement strategy for your process heat assets.
- Improve this strategy over time as your understanding of your assets and asset management capability improves.

Objectives of an Asset Replacement Strategy

The key objectives of an asset management strategy are to:

- Deliver on your business objectives. Whether these are to increase production, reduce cost or to decarbonise, an Asset Replacement Strategy should support achievement of your objectives.
- Enable decarbonisation through better understanding of the performance, cost and risk of existing assets compared to low-emissions replacement technology.
- Improve asset management through proactively planning the replacement of assets, and through better understanding of asset performance and costs and better management of risks.
- Maintain your compliance with regulations like the [National Environmental Standard \(NES\)](#) for GHG emissions from Industrial Process Heat, the [Aotearoa New Zealand Climate Standards](#) and Local Government rules related to process heat.

Steps to developing your own Asset Replacement Strategy include:

01

[Understanding asset replacement strategy fundamentals](#)

Learn about asset performance, high level asset replacement strategies, replacement technology options and integrating asset management with your business priorities.

02

[Assessing your capability](#)

Understand your capability in developing asset replacement strategies, reactive and proactive decision making and moving improving analysis of your assets as your capability grows.

03

[Building your capability](#)

Build your understanding of asset performance, costs and risks and how to make good decisions about when to replace your assets and what to replace them with.

04

[Developing your asset replacement strategy](#)

Using the template provided build your own asset replacement strategy. Something is better than nothing, the worked example will help make a start.

05

[Continuous improvement](#)

Use the continuous improvement pathways to improve your Asset Replacement Strategies over time.

See the [Glossary](#) for descriptions of terms and abbreviations

Asset Replacement Strategy and its role in the decarbonisation of Aotearoa New Zealand

The strategic context

Energy represents 40% of New Zealand's greenhouse gas (GHG) emissions, with process heat making up around a third of overall energy consumption. Process heat is energy used specifically in industrial and manufacturing processes - for example, in turning wood into pulp and paper, processing milk into powder, or sanitising equipment.

Approximately 8% of gross GHG emissions are from process heat, primarily burning fossil fuels to produce heat for industry and for commercial space and water heating. For New Zealand to meet Nationally Determined Contributions (NDCs) by 2050 for GHG emissions, process heat needs to become more efficient and to utilise renewable energy.

Given the importance of process heat to New Zealand's GHG emission reduction goals, this how-to-guide focuses on transitioning process heat to renewable energy through better planning for the end of life and replacement of heat plant.



Transitioning to renewable energy

Asset management seeks to optimise performance, risk and cost of assets across their whole lifecycle and is integral to planning for a low-emissions future. This includes maintaining and operating heat plant for energy efficiency, optimising when to replace assets and planning the transition of assets to use renewable energy.

Asset Replacement Strategies involve analysing the condition and performance of existing assets, forecasting future needs, and developing a schedule for replacement based on factors such as expected lifespan, maintenance costs, technological advancements, and budget constraints. A well-designed asset replacement strategy starts before the Operational and Maintenance (O&M) phase, it considers life expectancy (expected useful life) and leverages data monitoring devices to track asset health and determine when an asset should be replaced.

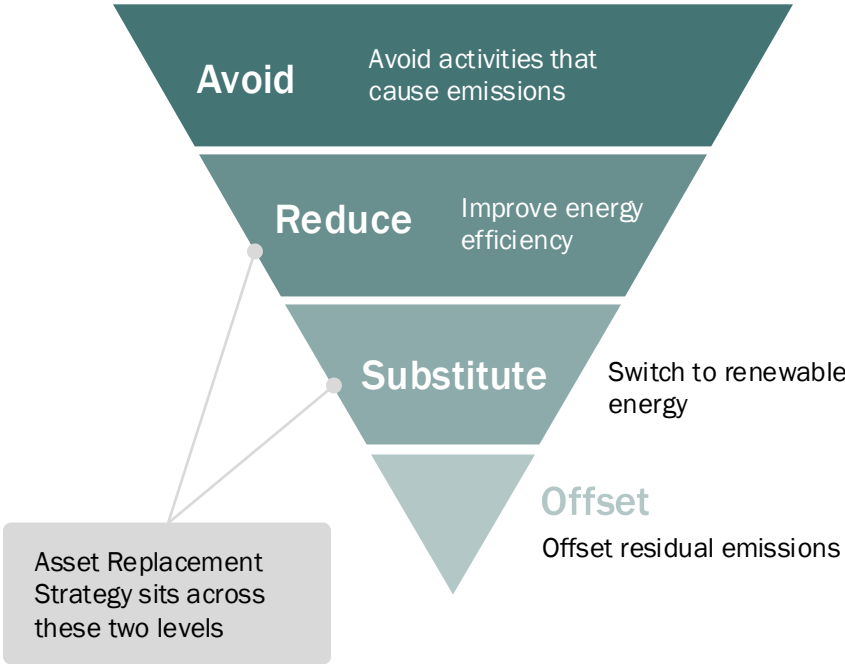
An Asset Replacement Strategy will optimise when an asset should be replaced and provide a plan for deciding what to replace it with. While large businesses may have dedicated asset management staff and systems, many smaller businesses may lack the same resources and expertise to develop an asset replacement strategy.

However, without an Asset Replacement Strategy, businesses risk making reactive decisions when the heat plant reaches end-of-life. In the worst case, heat plants fail during production necessitating a like-for-like replacement, locking those businesses into a high emitting and potentially high-cost asset. Without an Asset Replacement Strategy businesses can miss the opportunity to invest in lower carbon technologies which may also reduce whole-of-lifecycle costs and operational risks.

Enabling decarbonisation

Through better planning and decision making an Asset Replacement Strategy can support businesses efforts to decarbonise. An Asset Replacement Strategy will ensure underperforming assets are replaced with more efficient technology and that the switch to alternative technologies and renewable energy is made at the right time. An Asset Replacement Strategy addresses the reduce and substitute phases of the decarbonisation hierarchy and complements actions to reduce emissions like maintaining and operating plant for energy efficiency and ultimately offsetting hard to mitigate emissions (Figure 1).

Figure 1: The decarbonisation hierarchy



Purpose of this guide

The purpose of this **How to Guide** is to support businesses, particularly those with limited resources, to develop an asset replacement strategy or improve on existing Asset Replacement Strategies.

It covers the three main parts of an Asset Replacement Strategy including how to assess the current state and performance of assets, determine future state requirements, and identify replacement activities.

The **How to Guide** will:

- Provide context and background relating to what an Asset Replacement Strategy is, how to use it, and what the benefits are;
- Inform a self-assessment of capability level, to ensure guidance considers skills, knowledge, capability;
- Outlines the three parts of an Asset Replacement Strategy by capability level, to provide tailored guidance considering the current environment within the organisation; and
- Provides templates for businesses to develop their own Asset Replacement Strategy.



Using this guide

This guide is set out in five key steps and provides guidance catering for varying levels of Asset Replacement Strategy knowledge and systems. As the reader of this guide, you can choose to step through each step or navigate to the relevant section.

01

Asset replacement strategy fundamentals

Build your understanding of Asset Replacement Strategies their key concepts

02

Assess your capability

Assess the maturity of your business's asset management processes and Asset Replacement Strategies

03

Build your capability

Understand the components of an Asset Replacement Strategy and from beginner to advanced strategies

04

Write your own asset replacement strategy

You now have the tools to build an Asset Replacement Strategy tailored to your business's needs.

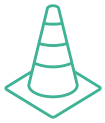
05

Continuous improvement

Use the continuous improvement pathways to enhance your businesses asset management processes and Asset Replacement Strategies.

Objectives of an Asset Replacement Strategy

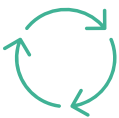
The primary objectives of an Asset Replacement Strategy are to:



Deliver on business objectives: Ultimately, Asset Replacement Strategy should align with and support the organisations business objectives. Whether the goal is to increase production capacity, improve product quality, expand into new markets, or reduce environmental impacts, asset replacement decisions should be guided by their contribution to achieving these broader goals.



Enable decarbonisation: An Asset Replacement Strategy will bring focus to the performance assets, bringing forward replacement of poor performing or expensive to operate heat plant and the opportunity to replace with low carbon technology. It will also ensure decision making considers low-carbon technology and heat recovery opportunities presented by the end of life of related assets like chillers and air handling units. This reduces the risk of high-emissions technology being locked in by reactive decision making.



Improve asset management: Asset management is enhanced through better planning of when to replace assets and with what technology. An Asset Replacement Strategy ensures key information regarding asset performance, costs and risks are recorded and that replacement decisions are data driven. This enables better budgeting, forecasting and risk management. An Asset Replacement Strategy is a key tool for communicating asset management to stakeholders, ensuring asset replacement is budgeted for, data monitoring systems are in place and operation and maintenance of heat plant is optimised for the asset replacement strategy.



Improve operational efficiency and risk mitigation: Aging assets inherently pose a greater risk of breakdown and failure. This can disrupt operations and jeopardise the delivery of goods and services. Though good planning, aging assets can be replaced at the right time with better technology. Newer heat plants are more efficient and less likely to breakdown or fail. This minimises disruptions and sustains business performance in the long run.



Improve asset reliability: Aging assets often necessitate frequent repairs and maintenance interventions. Asset downtime can then trigger cascading effects across downstream processes, amplifying the financial burden associated with rectification. Through vigilant monitoring and timely replacement of deteriorating assets, businesses can mitigate downtime, enhancing operational resilience and cost-effectiveness.



Maintain compliance with regulations: Certain industries are subject to regulations that require the periodic replacement or upgrade of certain assets to ensure safety or environmental compliance. An Asset Replacement Strategy helps businesses stay in-line with these requirements. Process heat specifically is subject to the [National Environmental Standards \(NES\) for Greenhouse Gas Emissions from Industrial Process Heat Emissions and Local Government Rules](#). An Asset Replacement Plan inputs into an emissions plan and can support businesses in planning best practical options.



Introduction to asset replacement strategies

The purpose of an Asset Replacement Strategy is to optimise when an asset is replaced and what it is replaced with, ensuring that assets are replaced proactively rather than reactively as they fail.

Broadly there are three main strategies for when to replace an asset:

1. **Replace asset as scheduled**
2. **Defer asset replacement**
3. **Replace the asset early**

Within an Asset Replacement Strategy, understanding the best time to replace an asset is achieved through understanding the performance of an asset, its operating costs and the risk the asset presents to a business's operations.

Figure 2 depicts these strategies from the perspective of asset performance over time, however the same logic holds for the cost and risk.

Asset performance

An asset's performance relates to an asset's ability to perform the job intended. For process heat assets performance this will typically be how well a boiler produces steam or hot water, this includes its failure rate, [availability](#) and efficiency.

Performance is at a maximum when an asset is first installed and put into operation. This is because it's new, well-tuned, and has low levels of wear and tear. Performance then declines steadily over time.

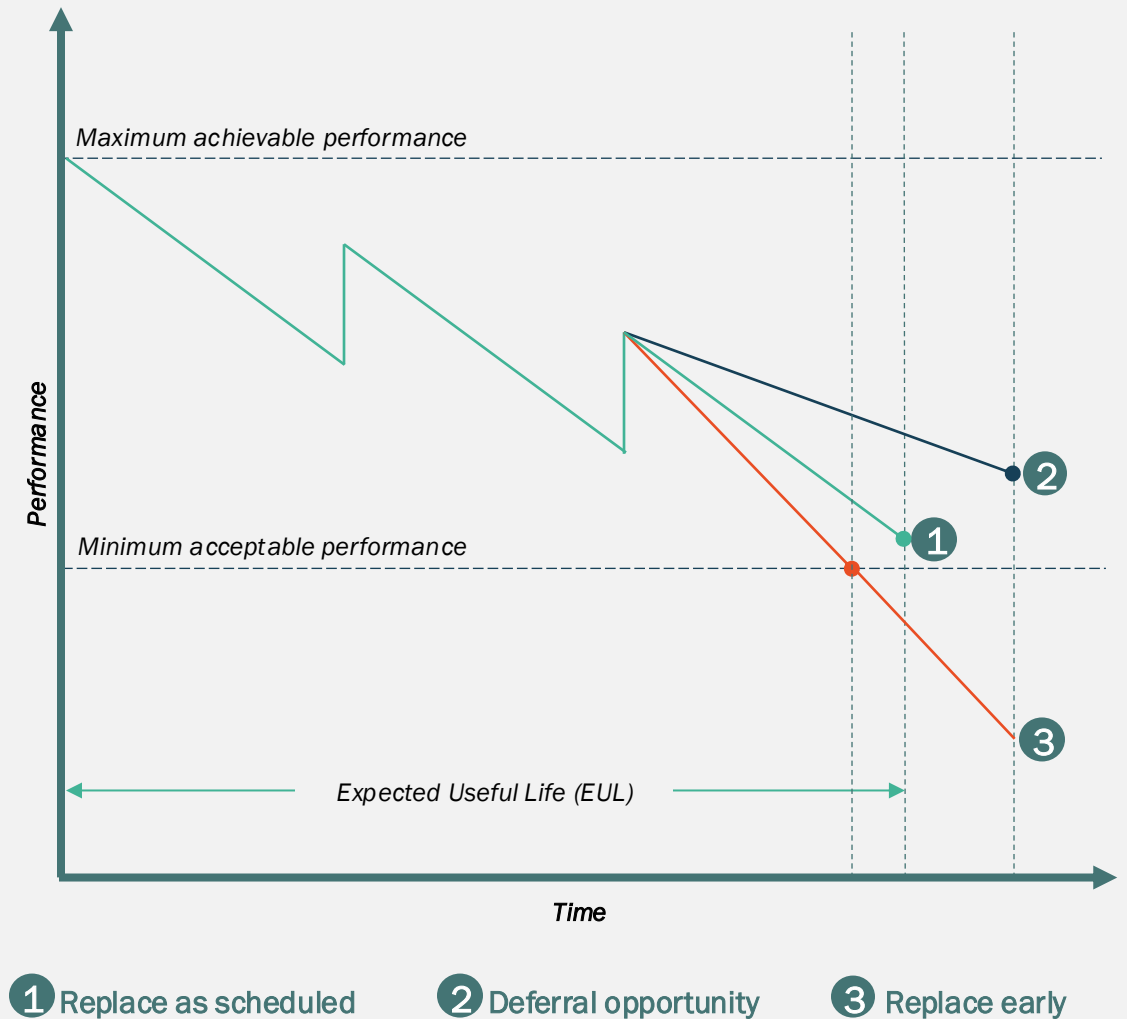
As the asset continues to be used, various factors such as usage, environmental conditions, and aging components can lead to a gradual decline in performance. This decline is often inevitable and is an unavoidable part of the asset's lifecycle.

Impact of preventative maintenance

Performance improvements can be made through preventative measures (i.e., **the performance spikes in Figure 2**) where performance temporarily increases after preventative maintenance is performed.

Preventative maintenance involves regularly scheduled inspections, and replacement of worn parts to prevent breakdowns and extend the useful life of the asset.

Figure 2: Asset performance over time



Introduction to asset replacement strategies (*continued*)

Asset Replacement Strategy

When to replace your asset

Replace asset as scheduled - As depicted in Figure 2, if performance declines as expected, the asset is replaced at the end of its expected useful life. However, if performance declines faster than expected replacement can be brought forward.

Defer asset replacement - For deferred replacement, businesses have options regarding how they address this decline. Businesses can choose to defer the decline by implementing regular maintenance practices, to keep the asset operating closer to its peak performance for a longer period. Alternately, they can accept the decline and simply budget for replacement or major repairs when the asset's performance falls below predetermined acceptable levels.

Replace the asset early - Where performance declines prematurely, replacement can be brought forward. The trigger for this is typically where the benefit of investing in on going maintenance and overhauls is greater than the cost of investment in a new asset.

What to replace your asset with

Deciding which technology to use when replacing an asset requires you to factor the performance of different technology options alongside the relative costs and risks the technologies pose to the business operations.

Once a decision has been made to replace an asset, the replacement strategy focuses on three options for replacing the asset. At a high level these include:

Strategy for Replacement Technology	Example technology
Like-for-like replacement	Gas boiler
Replace with upgraded technology	Condensing gas boiler
Replace with alternative technology	Heat pump Electrode boiler Biomass boiler

Each strategy requires different levels of analysis and is underpinned by different approaches to financing and other considerations relating to the supply of those assets.

Business priorities

Every business will have different drivers for asset replacement. At a high level, these factors in their decision making are performance, cost and risk. Each business will need to prioritise these factors and weigh these factors against each other when considering when to replace their assets and what technology to replace them with.

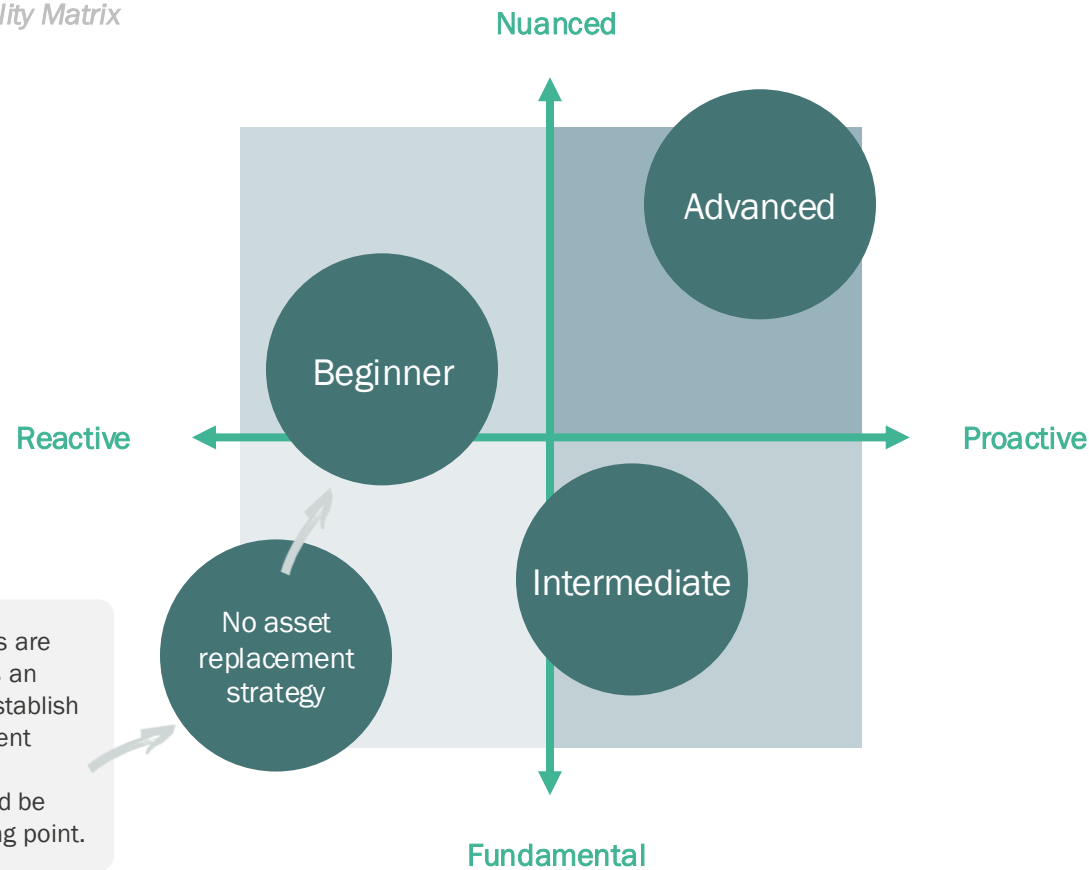
High level definitions of the key factors in decision making are in the table below:

Factors	Definition
Performance	<p>Asset performance relates to how well an asset produces outputs. This can include:</p> <ul style="list-style-type: none"> Asset efficiency, for process heat equipment this is typically it's thermal efficiency or how much heat (e.g. kg steam / hour) the asset can produce at capacity. Availability, or the proportion of time an asset is available for production taking into account time the asset is offline due to planned or unplanned maintenance and failures. Sustainability, including the GHG emissions associated with the asset, or other environmental impacts that may be a priority for the business like, air pollutants emitted, or potable water consumed in an asset's operation. Survivability, particularly how resilient the asset is to component failures and external impacts (e.g. power supply failure).
Cost	<p>Operational costs including:</p> <ul style="list-style-type: none"> Planned and unplanned maintenance costs and any consumables. Costs associated with failure or asset downtime. Energy costs (including carbon costs). <p>Operating costs of the asset can be combined with technology replacement costs to produce net present value (NPV) and/or marginal abatement cost curve (MACC) for different asset replacement options. This enables the comparison of asset replacement projects with other projects or specifically other GHG emission reduction projects across the business.</p>
Risk	<p>This includes:</p> <ul style="list-style-type: none"> Operational risks like production downtime due to an asset being unavailable. Health and Safety risks relating to the asset and those that operate they asset and could be impacted as it ages. Economic risks like increasing energy or carbon costs, or market demands for low emission products. Supply chain risks including supply chain risks associated with spare parts or other consumables, service technicians, replacement assets or fuel. This is a particular issue for solid fuels (e.g. wood pellets, wood chips and coal). Regulatory risks including business continuity if not able to access a resource consent through the RMA National Direction.

What is your asset management capability?

Asset management practices can vary, both by industry, and within the business. The Capability Matrix (Figure 3) maps the type of maintenance or interventions (proactive vs. reactive) businesses make against the maturity of decision-making (the use of fundamental vs. nuanced criteria) and allows you to assess your own asset management capability.

Figure 3: Capability Matrix



Understand where you sit on the matrix

Businesses can self-assess their asset management capability to understand where they sit in the matrix, this will enable them to assess opportunities to improve capability and to use the right Asset Replacement Strategy approach. To self-assess asset management capability, complete the following steps:

A

Refer to the statements on the next two pages (9 and 10), to determine where your business sits on each of the axes (note: an 'average' score may be appropriate e.g., a combination of reactive and proactive maintenance).

B

Use the location on each of the two axes to determine your capability rating (e.g., proactive maintenance or interventions, and fundamental decision-making will score 'Intermediate').

C

Refer to the relevant asset replacement strategy in section 3, based on your capability rating.

D

Optional: Assess if there is an opportunity to improve capability and use the asset replacement strategy applicable to one capability rating above (e.g., if you score 'Intermediate', then refer to the 'Advanced' asset replacement strategy).

How to understand where your asset management capability is

Unpacking 'Reactive' and 'Proactive' interventions

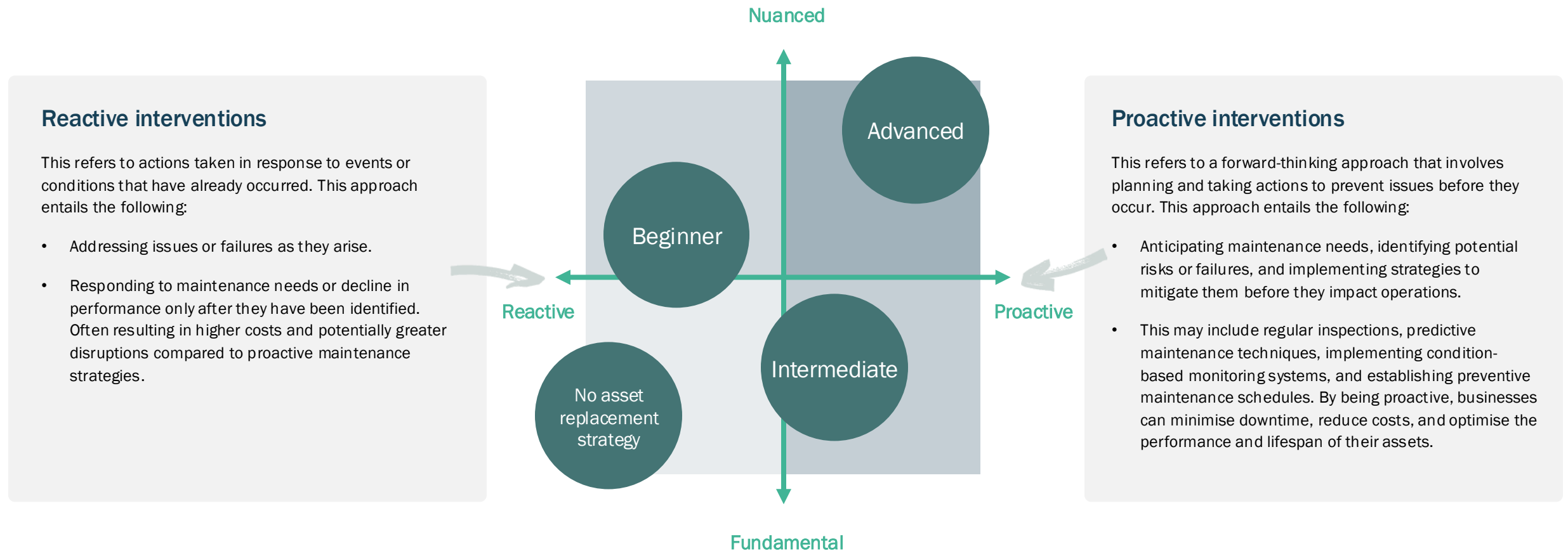


Figure 4: Capability Matrix

How to understand where your asset management capability is

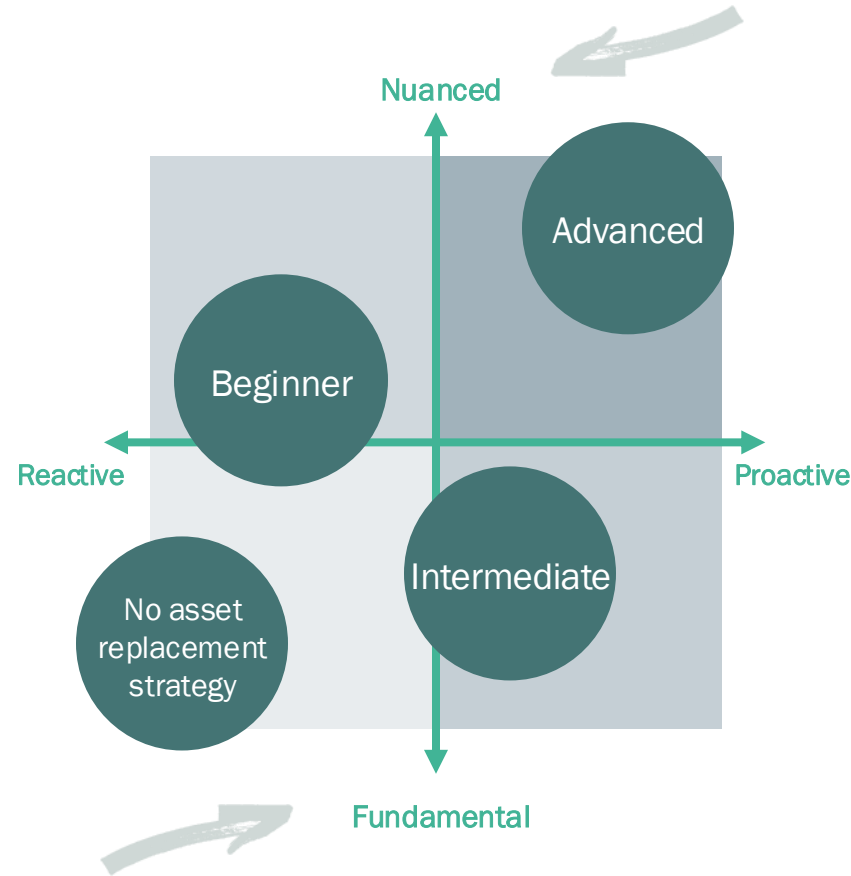
Unpacking ‘Nuanced’ and ‘Fundamental’ decision making

Fundamental decision making

Decision making based on fundamentals considers factors like performance, cost, and risk elements of the asset. However, it may not consider things like asset interactions, sustainability, availability and utilisation. Factors considered include:

- | | |
|--------------------|---|
| Performance | <ul style="list-style-type: none"> Age, i.e., age/time-based replacement. This considers an Expected Useful Life, or Design Life, with replacement being undertaken when Remaining Useful Life equals zero. Condition, i.e., condition-based replacement. This considers the condition of the asset or piece of equipment, where replacement may be triggered by the asset/equipment being in a poor or very poor condition. Condition rating may be informed by structural integrity, the presence of corrosion (surface, or structural), etc. Failure, i.e., failure-based replacement. Replacement may be triggered, where the number of failure events and frequency of failure becomes intolerable to the business/organisation, or the asset/equipment is no longer able to fulfill its intended function. |
| Cost | <ul style="list-style-type: none"> Operational expenditure, where the age and performance of the asset/piece of equipment may impact efficiency e.g., power draw, fuel usage etc. Maintenance expenditure, where older or poorer condition assets/equipment may result in performance issues requiring reactive maintenance, which can become expensive over time. Or older parts and components may become difficult or costly to obtain and replace. Acquisition cost, where advancement of technology or broader industry shifts (e.g., widespread adoption) may have significantly reduced the cost of replacement, vs. the original acquisition (purchase) cost. |
| Risk | <ul style="list-style-type: none"> Business continuity, where performance issues may be impacting business operations, and the ability to deliver services, or develop/manufacture products. Safety, where defects or potential failure could pose significant risk to the health and safety of staff and/or customers. |

Figure 5: Capability Matrix



Nuanced decision making

In addition to the ‘Fundamental’ criteria, more nuanced decision-making may be informed by considering further criteria. Applying more nuanced criteria is likely to ensure an optimal decision can be made, by considering:

- | | |
|--------------------|---|
| Performance | <ul style="list-style-type: none"> The mean time between failures is a measure of the reliability of a system or component, in this instance – an asset the business is evaluating. A high Mean Time Between Failure can mean fewer problems and costs, while a lower one could mean more frequent failure and expenses. Availability or utilisation (how effectively a business uses its assets to produce output) become unacceptable. Low availability signals frequent downtime, while high utilisation suggests nearing capacity, necessitating for larger asset or improved efficiency. |
| Cost | <ul style="list-style-type: none"> Replacement costs, this could reference the business’ costs when it comes to replacement of assets. These costs are nuanced as there might be no fixed costs and this could occur at any given time. Maintenance costs, this could also be reactive costs which can occur during maintenance tasks or failure events. Leading to repair events, which then have a flow on effect of time-lag and operational downtime. |
| Risk | <ul style="list-style-type: none"> Wider economic risks, including the outlook for changes in energy prices or economic downturn which may impact production or access to capital Reputational risk and specifically external pressure to decarbonise or to disclose efforts to decarbonise |

Introduction to capability pathways

Businesses will take different approaches to Asset Replacement Strategy depending on their current capability. As you increase your capability, your pathway may change.

The following section outlines what your capability looks like in practice, it recommends key metrics and objectives for each stage of your Asset Replacement Strategy and provides guidance on your replacement approach.

1 Select the **appropriate pathway** based on your self-assessed capability



2 Understand the **key factors** in deciding when to replace and asset. Your decision making will factor:

- Performance
- Risk management; and
- Cost

How nuanced your decision-making is will depend on your capability level.

3 Understand the **replacement approach** your business is likely to take at different levels of capability and how these decisions are driven. Specifically, your approach to:

Analysis

- Finance and other considerations



Asset Replacement Strategy decisions based on your capability

Use this guide if you are in the:

Beginner pathway

You are in the early stages of developing your asset management systems. You consider simple factors when considering when to replace assets. When asset performance shifts too far from targets you are likely to replace the asset with similar technology (i.e., like for like).

Businesses who are beginning to develop their understanding of asset replacement should consider simple factors in their replacement, for example, expected useful life of the asset based on a condition rating. A like-for-like replacement can then be made when these factors are too far from targets.

Through taking this simple approach you get the benefit of replacing assets at the right time. That is, you have a lower risk of asset failure, higher efficiency assets and lower maintenance costs. But potentially, you miss out on greater levels of cost reduction and decarbonisation through investing in better or alternative technologies.

Factors in your decision making

When do you replace your assets?

Performance

- **Asset age** – You keep a record of the age of your assets is. This is important as assets and their performance degrade over time and at end-of-life assets may become obsolete, adding cost and risk to maintenance and repairs.
- **Condition assessment** – You complete a general assessment of the condition of an asset to determine the need for preventative or remedial actions.
- **Asset capacity** – You record the total output of an asset based on measures important to the business (e.g., heat output, products manufactured, etc.).

Cost

- **Planned maintenance costs** – You keep a record of the costs of planned maintenance

Risk

- **Operational risk** – You consider the risk to business operations and production downtime from an asset being out of commission due to asset failure.

What do you replace your assets with?

Replacement Strategy

- **Like-for-like** – You will likely replace an asset with an equivalent product, missing the opportunity to reduce cost, risk and emissions through switching to a low emissions alternative.

Analysis

- **Simple payback period** – In selecting a time to trigger the replacement, you may calculate the payback period of the investment, based on cost and risk factors.

Finance and other considerations

- **Debt funding (loan)** – You may require a loan to complete the replacement. Interest rates and ongoing repayments should be considered here.
- **Procurement lead times** – You should consider how long it will take for a replacement to be procured and installed including engineering design, product lead times and infrastructure upgrades (factor this into their replacement plan). The business should not let the existing asset run to fail.
- **Suppliers & contractors** – You may procure and install an asset that may require suitably qualified professionals. If these parties are required, they should be planned for in your asset replacement strategy.

Asset Replacement Strategy decisions based on your capability

Use this guide if you are in the:

Intermediate pathway

At an intermediate stage of asset management and experience you assess performance, cost, and risk factors quantitatively. With data behind these decisions, you can consider how well an asset is operating and analyse performance trends.

In addition, With data behind decisions the timing of when to replace an asset is optimised to a greater extent than a beginner. In addition, consideration is given to using upgraded technology which can result in a greater reduction in operating costs than new technology alone. However, at an intermediate level you may miss out on the benefits of considering additional performance factors, interactions between assets and wider economic risks, and alternate technology.

At an intermediate level of capability, you include the factors in the following table in your decision making in addition to those in the beginner pathway.

Factors in your decision making

When do you replace your assets?

Performance

- **Asset efficiency** – With better data collection, you can compare Asset Capacity with required inputs. The resulting efficiencies provide a clearer picture of how productive an asset is in real terms and enables comparisons with other assets.
- **Failure frequency** – The number of failures an asset experiences can be an indicator of its performance. An increase in this measure over time may indicate a wearing asset approaching its end of life.

Cost

- **Unplanned maintenance costs** – As you increase your financial tracking capability, the amount of funding allocated to asset maintenance (that wasn't planned for) should be analysed. This can show where the asset condition is worse than expected, and degrading quickly.

Risk

- **Health & safety (H&S) risk** – An asset in poor condition is a risk to operators and people interacting with the system. If H&S events are becoming increasingly common, this may indicate an asset in poor condition and require replacement.

What do you replace your assets with?

Replacement Strategy

- **Upgrade to improved model** – You will have targets set for performance, cost, and risk factors. An improved model is likely to be selected as the replacement option, alternative technologies may also be considered.

Analysis

- **Net present value (NPV), internal rate of return (IRR)** – NPV's of different replacement scenarios can be calculated to understand if an investment is beneficial for the business. When investment in asset replacement is NPV positive, asset replacement is triggered.

Finance and other considerations

- **Lease & operate agreement** – Instead of purchasing a new asset outright, you might consider leasing, especially if the long-term future is unknown.
- **Upfront investment** – If you have planned and budgeted for a replacement, you can purchase a new asset outright.
- **Upgrade associated infrastructure** – An asset replacement is a good chance to upgrade related components in a business which can improve the overall efficiency of the wider system.
- **Site shutdown period** – You should consider how long a replacement installation will take and select an appropriate time where this downtime will have a minimal effect on the business's operations.

Asset Replacement Strategy decisions based on your capability

Use this guide if you are in the:

Advanced pathway

With an advanced understanding of asset replacement, you should have quantitative measures for factors relevant to your business's Asset Management Strategy. You can then make informed decisions based on the performance of your asset, the whole-of-life costs associated with operation, maintenance, wider risks to your business.

When replacing an asset, you consider alternative technologies and can compare replacing existing technology with alternatives on a whole of life basis. You consider supply chain constraints in relation to maintaining existing technology and sourcing alternative technologies. You assess alternative finance options and consider the end of life of assets.

With an advanced understanding of asset replacement, you are able to minimise whole of life costs and risk while maximising performance.

At an advanced level of capability, you include the factors in the following table in your decision making in addition to those in the beginner and intermediate pathways.

Factors in your decision making

When do you replace your assets?

Performance

- **Sustainability** – You consider the factors like GHG emissions associated with existing and replacement technologies and other environmental considerations like air pollution and water consumption.
- **Availability** – You monitor and aim to maximise the availability of your assets and seek to minimise planned or unplanned outages.
- **Survivability** – The ability of an asset to survive failures, and external impacts, is important to a business's outcomes. This could include redundancy or fail-safe operation of assets.

Cost

- **Energy costs** – With costs of energy fluctuating due to a variety of factors, a business should understand these costs over time along with the carbon costs. Upward trends in fuel costs could indicate a time to complete a fuel-switch. Measuring energy as an intensity measure and tracking this cost/use per product output to support continual improvement.

Risk

- **Economic risks** – In line with energy costs, businesses with an advanced understanding of Asset Replacement Strategies can integrate their knowledge of wider economic risks into their replacement approach.
- **Reputational & market access risks** – You should consider how your assets affect the business's reputation in the market. For example, replacement with a lower-carbon emissions alternative may increase favorability in a market where consumers are increasingly conscious about what they purchase.
- **Supply chain & regulatory risks** – Businesses should understand the supply of services and commodities required for the operation of their new asset, including spare parts or energy (relevant for wood pellet boilers for example) and any regulatory requirements for operation.

What do you replace your assets with?

Replacement Strategy

- **Technology change** – With a business understanding many factors related to their asset, and knowing its dependence on the economy, fuel supply, reputation, etc. – it should consider a technology change. This could look like the replacement of a natural gas-fired boiler with an electrode boiler run off electricity.

Analysis

- **Marginal abatement cost curve (MACC)** – To understand when different investments make the most financial sense, as a function of different economic scenarios, businesses develop MACC curves. This enables you to identify many different opportunities for asset replacements, and different wider business operation scenarios, and make the best decision based off their data.

Finance and other considerations

- **Alternative finance options** – You consider alternative finance options like [sustainability linked loans](#), grants or support for decarbonisation and [energy as a service](#).
- **Energy supply upgrade** – When completing a replacement with a technology change, you should complete due-diligence to ensure supporting infrastructure can support this change (e.g., electricity supply upgrade).
- **Operation & maintenance** – The whole-of-life cost of asset operation should be considered before selecting a replacement asset.
- **End of life** – You should plan for disposal of an asset upon its end of life, before installing the asset.
- **Interaction** – You consider the interaction of other assets and infrastructure with your process heat assets (e.g. chillers and air handling units)

Building Your Asset Replacement Strategy

Now that you understand your asset replacement capability, you can build on this to create an Asset Replacement Strategy for your business. This section includes guidance on key considerations for developing your Asset Replacement Strategy and a guided template where you can put your strategy into writing. Start by reading the key considerations and then filling in the template provided.

Key considerations for your asset replacement strategy

Pages 16 – 18 discuss key considerations, at different capability levels, for developing your Asset Replacement Strategy. This guidance follows the same “performance, cost, risk” structure the previous section but discusses these factors in relation to:

- **Current state** – Your understanding of the current state of your assets and the information and data you need to develop your Asset Replacement Strategy .
- **Future State** – The desired future state of your assets, how you want them to perform, how costs can be reduced, and their risk profile optimised.

Guidance also considers replacement strategies and strategies for selecting replacement technology.



Template for writing your asset replacement strategy

Write your own Asset Replacement Strategy using the template provided

Sections within your asset replacement strategy

Guidance on specific content to include

Example case study

Factors to include in your asset replacement strategy

Pathway specific guidance

1. Asset Information		
Factors	Content to include	Example
Asset Make and Model	(Make, model)	Thermal Tech 850
Rated output		850 kW
Fuel Source	(e.g. 2MWt)	Natural Gas
Output	(Natural Gas, LPG, Diesel, Fuel Oil, Coal, Electricity, Biomass)	Low pressure hot water at 80°C
Process Heat end use	(e.g. Low-pressure hot water) (i.e. Water heating, space heating, product drying etc.)	Aquatic centre water and space heating

2. Asset Performance		
Factors	Content to include	Example
Install date		2014
Expected lifetime	(Years)	25
Condition	(Years, detail whether the remaining useful life is based on the expected of new), detailing how this is measured	Good
Remaining useful life	(Detail the remaining useful life of the asset using a five-point system (e.g. 5 - excellent, 4 - good, 3 - fair, 2 - poor and 1 - very poor) where lifetime at purchase or the condition of the asset)	
Asset Efficiency	(Thermal efficiency of the asset (%) or m ³ hot water delivered per kWh)	15 years - based on a 20-year lifetime is 15 years 30 years - based on the condition rating of the asset
Failure Frequency	(Number of failures over the last year)	80% thermal efficiency, measured using a heat meter
Sustainability	(GHG emissions per annum, particulate emission rate) (Air quality particulate matter (PM2.5 and PM10))	1 failure which resulted in facility closing for a day 280 tonnes CO ₂
Availability	(Detail the ability of the asset to produce heat as it is required)	The boiler is available around 95% of the time, downtime includes an annual maintenance shut-down and an unplanned outage
Survivability	(Detail the loss of water supply, over temperature or over pressure events or loss of electrical supply)	The boiler has fail-safe mechanisms to prevent over pressure or over electrical power and water circulation.
Interaction	(Other assets the process heat asset interacts with or could interact with. Typically this includes chillers and air handling units, but could include other assets where there is potential for heat recovery)	The boiler currently supplies heat for water heating and air heating. Air handling units are reaching the end of life and will be replaced with units that have integrated heat recovery and heat pumps, this will reduce the heat load on the boiler and enable its replacement with a heat pump that can



Key considerations for your Asset Replacement Strategy

The following page provides key considerations you should have when writing your Asset Replacement Strategy.

Current state of your assets

The current state of assets should be assessed, to understand whether it is delivering value to the business and provide an indication of how much longer it is expected to deliver value. This should factor in considerations across performance, cost, and risk criteria. These factors can input into a future state assessment, and inform replacement decisions such as when to replace, how to replace, and what to replace it with.

Performance: As a beginner you should be looking to gain an understanding of the asset's performance, considering both historic performance and remaining useful life. Key questions for your Asset Replacement Strategy include:

- Has the asset been operating to an acceptable level of performance i.e., is the required level of output being achieved. Are setpoints being met?
- What is the remaining useful life? i.e., for how many years is the asset expected to operate to an acceptable level of performance? This can be determined by:
 - **Asset age:** Assess the difference between the expected useful life (how long the asset is expected to deliver value to the business, e.g., 20 years) and age (i.e., the difference between the installation/acquisition date and the current date).
 - **Condition:** Assess the remaining useful life, based on a condition rating (e.g., using a five-point rating system of excellent, good, fair, poor, very poor), where each condition corresponds to one fifth of the asset's expected useful life.

Cost: Here you are looking to understand ongoing costs required to operate the asset and its likely replacement cost. Key questions include:

- What are the operational costs of the asset? Are they acceptable or affordable? You should be considering running costs (e.g., electricity or fuel to run the asset), planned maintenance (e.g., services, or regulatory inspection/testing costs) and reactive maintenance (e.g., cost of repairs, if required).
- What is the estimated replacement cost of the asset and is it the best practicable option? This is important to understand, as technology advancements and economies of scale may lower the replacement cost compared to the original acquisition cost; and regulations may require adoption of the best practicable option to prevent or minimise adverse climate change effects.

Risk: Establish an understanding of the risk associated with continuing to operate the asset, and whether the organisation has an appetite for this:

- What would the level of operational downtime be if this asset were to fail, and to what extent does this impact business operations, production or service provision (e.g., space and water heating)?
- What are the potential health and safety risks associated with this asset, and does its current age or condition present a potential health and safety issue to operators, staff, customers and/or the community?
- Reputational and regulatory risks and whether for example, the ongoing use of fossil fuels or potential H&S incidents in relation to heat plant pose a risk to your business's reputation and continuity.

Desired future state of your assets

The desired future state of assets should be considered. Any required changes from the current state should be documented in your asset replacement strategy. This may include answering questions such as:

- Are current performance level satisfactory? Are different levels of performance required? This may be based on forecast demand or need for an output or service and consider additional performance levels.
- Is there an opportunity to lower costs? This may be through exploring options that require less maintenance (e.g., longer service intervals), or have lower running costs (e.g., achieved via an alternative fuel source such as electricity etc.). EECA's cost assessment tool can be used for estimating operating costs for different boilers.
- Is there an opportunity to reduce risk? This may consider replacing unreliable equipment before end of life or upgrading assets to make them safer to operate.

Use this additional guidance if you are in the:

Beginner pathway

When to replace your assets

When to replace it: The timing of asset replacement is informed by the current state assessment, and you consider whether future operations may require early replacement or will support deferral of asset replacement.

What factors could change: What changes could trigger a change to when the asset is replaced? For example, increasing energy and carbon costs, a failure requiring investment in existing heat plan or supply chain risks where parts are no longer available, are becoming expensive or face extended lead times.

What to replace your assets with

What to replace it with: You select a replacement option that best meets your future needs and is a suitable balance of performance, cost, and risk.

This may be either a like-for-like replacement, when historic performance of the existing asset is acceptable, or an upgrade, where additional performance, lower cost or lower risk is required or desired. Noting that regulations prevent the like for like replacement of some process heat technology like new coal boilers and may require the best practicable option to be adopted for fossil fuel heat devices.

How to replace it: debt-funding may be appropriate to fund your asset replacement, as an alternative to funding through retained earnings.

Other factors that should be considered include the lead time (i.e., how long the asset will take to be procured), supporting infrastructure/equipment (e.g., any changes that are required to enable the installation and ongoing operation of the asset), and any required spare parts or tools.

Key considerations for your Asset Replacement Strategy

The following page provides key considerations you should have when writing Asset Replacement Strategy.

Current state of your assets

At the Intermediate Stage, it is assumed that you are applying learnings from the Beginner Pathway. You are beginning to adopt a more structured approach, utilising data to establish the performance, risk, and cost criteria which enables planned maintenance and replacement planning.

Performance: You gather data and use this to create performance and failure metrics to optimise performance of assets. You need to consider:

- How can we improve the assets' efficiency, through the collection of data on capacity, energy usage, output etc.?
- How can we utilise data on failure frequency to gauge the performance of our assets? E.g., an increase in failures over time could signal an asset's end of life. How can we identify potential indicators of deterioration (e.g., estimating wear and tear through vibration and noise sensing, thermal imaging surveys, pressure drops, reduction in efficiency or output etc.)

Cost: The business is progressing further by increasing their tracking capabilities. You need to consider:

- How can we leverage improved financial tracking capability to analyse and address unplanned maintenance costs and cost trends?
- What insights can be gained from such analysis to identify areas where asset condition is deteriorating rapidly and requires proactive intervention?

Risk: Establish an understanding of the risk associated with continuing to operate the asset, and whether the organisation has an appetite for this.

- How can we proactively assess and address the health and safety risks associated with assets that are in poor condition?
- Are there any indicators the business can monitor to detect an increase in health and safety events? (signalling the need for intervention).

Desired future state of your assets

At intermediate capability, you will be setting targets for performance, cost and risk. Deviation from these targets can show when asset replacement is needed.

You should have good data to inform decision-making and are monitoring performance, cost and risk more proactively than a beginner. Your systems are optimised compared to a beginner and you can answer the following questions:

- Does performance need to change in the future? This may be based on asset functionality (do your assets still meet operational needs?), units produced (is measured output consistent with expected output?) and asset condition (are your assets still fit for purpose? How does current output compare to ideal or expected output?).
- Do you need to set future spending targets? This may be through identifying unavoidable spending levels and adding a buffer. Planned maintenance should align with recommended schedules and tasks, while unplanned maintenance demands further thought.
- Is there an opportunity to increase the safety of your workers and assets where defects or potential failure could pose significant risk to health and safety of staff and/or customers? Is there an opportunity to improve air quality?
- Is there an opportunity to plan for performance issues with business continuity plans? (e.g., supply chain disruptions and regulatory compliance).

Use this additional guidance if you are in the:

Intermediate pathway

When to replace your assets

Based on the current and future state assessment, determine the activities required to enable replacement. This may include:

When to replace it: the trigger for asset replacement depends on the disparity between NPV figures. Determining the optimal time for asset replacement by calculating NPV (forecasts whether an investment in replacement will yield positive returns, triggering replacement when NPV exceeds a set threshold).

What to replace your assets with

What to replace it with: While a less experienced business may consider an upgrade to the existing system, a like-for-like replacement (noting regulatory requirements), or simply disposing of the asset where it's no longer required (the potential for component reuse or resale should be evaluated), a business with more data behind it should consider improved and/or innovative models/technologies for their replacement.

How to replace it: The appropriate measures may include a lease agreement (lease agreements often include service provisions, purchasing a used asset (under-utilised machinery is often auctioned or sold below market value), capital investment (where a new asset has been budgeted for and can be replaced). Other factors that should be considered include upgrading associated infrastructure (services into and out from the asset such as air, water, power, and gas), shutdown period, and potential downtime required for safe installation and commissioning.

Key considerations when writing your Asset Replacement Strategy

The following page provides key considerations you should have when writing your Asset Replacement Strategy.

Current state of your assets

It is assumed that you have applied learnings from both the Beginner Pathway and Intermediate Pathway. You have a high level of maturity in your approach to asset management. Performance, costs and risk considerations are fully integrated into your decision-making processes. Decision-making is based on quantitative and qualitative data and leads to investments in assets that align with your business's strategic objectives.

Performance: You take a best practice approach to performance cost and risk to deliver on business objectives and can answer the following questions:

- How do your process heat assets support your business's sustainability aspirations and meet both market and regulatory requirements? (e.g. carbon emissions are considered in assessing the performance of an asset).
- How can you maximise the availability (proportion of time an asset is available to use) of the assets compared to the survivability (ability for the asset to survive failure and external impacts)?
- How can you leverage advanced assets/equipment and/or new technologies to improve operational efficiency or optimise processes/workflows? This may apply to both existing and new assets/systems.

Cost: You have a better understanding of the

operational costs of your assets and can take advantage of opportunities to reduce costs through investing in technologies to further decarbonise.

Key questions regarding cost include:

- How can you consider alternative energy and carbon costs against the costs associated with overhauling and extending the life of existing assets?
- What is the outlook for existing fossil fuel costs versus electricity or biomass?
- How can decarbonising your business improve market positioning of the business and profitability?

Risk: The business is evaluating external risks that could harm the business, and continuity of operating the asset. Key questions regarding risk include:

- Could lower-carbon process heat technologies change customer perceptions in an increasingly carbon conscious market?
- How does extended downtime of assets affect your overall business continuity?
- Are there reputational, supply chain or regulatory risks to the business in continuing to use fossil fuels? Are you required to disclose these risks by the [Aotearoa New Zealand Climate Standards](#) or [Climate Leaders Coalition](#), or comply with the [National Environmental Standard](#) for GHG emissions from industrial process heat?

Desired future state of your assets

Whole of life thinking is the main difference between beginner and advanced capability. You have a more nuanced understanding of performance, cost and risk measures for the business and can answer the following questions:

- Does your business track environmental performance measures for process heat including fuel and energy consumption, water consumption air pollutants emitted?
- How is this the collected data integrated into your business's asset management plans?
- Is there an opportunity to leverage alternative funding such as [green loans](#), sustainability linked loans, government funding, energy as a service contracts to enable decarbonisation?
- Are wider risks to your business being considered? This could include geopolitical risks like changes to trade policy, climate risk, both physical and transitional. Could regulatory changes aimed at reducing GHG emissions necessitate the replacement of high-emission assets with greener alternatives?
- Similarly, could advancements in renewable energy technologies render certain assets obsolete, requiring their replacement?
- Are there upside risks that you should consider? Could improvements to process heat technologies improve their return on investment or lower their risk profile and enable you to bring forward asset replacement?

When to replace your assets

When to replace it: You consider replacement if performance factors such as availability or utilisation become unacceptable, or to meet regulatory requirements. Low availability signals frequent downtime, while high utilisation suggests nearing capacity, necessitating a larger asset or improved efficiency. You can use a MACC curve to prioritise different decarbonisation opportunities.

What to replace your assets with

What to replace it with: You consider different technologies and integration with other assets, as there are often synergies with other assets that can be made that will augment productivity and efficiency. This could look like the replacement of a natural gas-fired boiler with an electrode boiler run off electricity, recovering heat from chillers and/or installing air handling units with integrated heat recovery and heat pumps.

How to replace it: You consider the end of life of your assets, planning for disposal of an asset before its installation. Your operation and maintenance of assets take a whole of life cost perspective recognising that that keeping obsolete assets can lead to high maintenance costs and lower productivity. You consider supply chain issues and consider alternative ways to finance your projects including:

- Grants or co-funding options
- Green and sustainability linked loans
- Energy as a service contracts

Template to start your Asset Replacement Strategy

To create your own Asset Replacement Strategy populate slides 19-24 with your company data and save to your computer.

1. Asset Information

Factors	Content to include	Example
Asset Make and Model		Thermal Tech 850
Rated output		850 kW
Fuel Source		Natural Gas
Output		Low pressure hot water at 85 °C
Process Heat end-use		Aquatic centre water and space heating



A template to start your Asset Replacement Strategy

2. Asset Performance

Factors	Content to include	Example
Install date		2014
Expected lifetime		25
Condition		Good
Remaining useful life		15 years - based on a 25-year lifetime is 15 years 20 years - based on the condition rating of the asset
Asset Efficiency		80% thermal efficiency, measured using a heat meter
Failure Frequency		1 failure which resulted in facility closing for a day
Sustainability		280 tonnes CO _{2e}
Availability		The boiler is available around 95% of the time, downtime includes an annual maintenance shut-down and one unplanned outage
Survivability		The boiler has fail-safe mechanisms to prevent over pressure or over temperature events, however the system is vulnerable to loss of electrical power and water circulation.
Interaction		The boiler currently supplies heat for water heating and air heating. Air handling units are reaching the end of life and will be replaced with units that have integrated heat recovery and heat pumps, this will reduce the load on the boiler and enable its replacement with a heat pump that can heat the water.



A template to start your Asset Replacement Strategy

3. Asset Costs

Factors	Content to include	Example
Planned maintenance costs		\$10,000
Reactive maintenance costs		\$5,000
Cost of asset downtime		\$4,000 - \$8,000 per day for failures lasting any more than two hours
Energy & carbon costs		\$130,000
Expected replacement cost of the asset		\$300,000
Expected replacement cost with upgraded or alternate technology		\$500,000 - Heat Pump
Expected operating costs of alternate technology		\$80,000



A template to start your Asset Replacement Strategy

4. Operational Risks

Factors	Content to include	Example
Risk of asset failure		<p>The boiler is essentially for maintaining the heat of pools and the air temperature and humidity of the pool halls. Without heating the pools will lose temperature and without the ability to air-condition the pool halls the facility will need to shut causing a loss of revenue and a loss of service to the community.</p> <p>As the boiler is relatively new, failures like this are unlikely, however as there is no back-up any failure during opening hours and unless it is only of very short duration, could result in pool closure.</p>
Health and Safety risks		<p>As a low pressure, low temperature system, the main health and safety risks are confined to hot surfaces in the immediate area of the boiler. As the boiler is housed in a separate room to other plant and access is restricted health and safety risk is minimised.</p>
Number of incidents related to asset		<p>Pool staff had been using the boiler room as a drying room. This represented an unsafe condition where people unfamiliar with the boiler room and hazards and without required PPE (personal protective equipment) were accessing the area. Access has since been restricted to facilities management staff and contractors.</p>
Advanced Risks		<p>While natural gas prices have doubled in recent years, electricity prices have also increased, further increases could reduce the return on investment in heat pumps. However, this needs to be balanced against the reputational risk of continuing to burn fossil fuels in a climate crisis, along with future gas supply availability risks.</p> <p>Switching to heat pumps may create supply chain risks as heat pumps are more complex and parts have longer lead times. This can be mitigated to an extent by working with local manufacturers and ensuring they carry enough parts and consumables.</p>



A template to start your Asset Replacement Strategy

5. Asset Replacement Strategy



Factors	Content to include	Example
When will the asset be replaced?		<p>Replace Early</p> <ul style="list-style-type: none"> Natural gas prices have increased by 100% in recent years, making alternatives like heat pumps attractive. When capital is available, the intention is to install a heat pump to heat the pools within the aquatic centre. Air heating will be switched to heat pumps when air handling units reach end of life in the next five years. New Air Handling Units will have integrated heat recovery and heat pumps for conditioning the air.
Trigger for different strategies		<p>Replace as scheduled</p> <ul style="list-style-type: none"> The boiler is in good condition, has no major operational risks and potentially has another 20 years of useful life. Should natural gas prices reduce, or electricity prices increase then the switch to heat pumps for water heating could be deferred.

A template to start your Asset Replacement Strategy

6. Asset Replacement Strategy (continued)



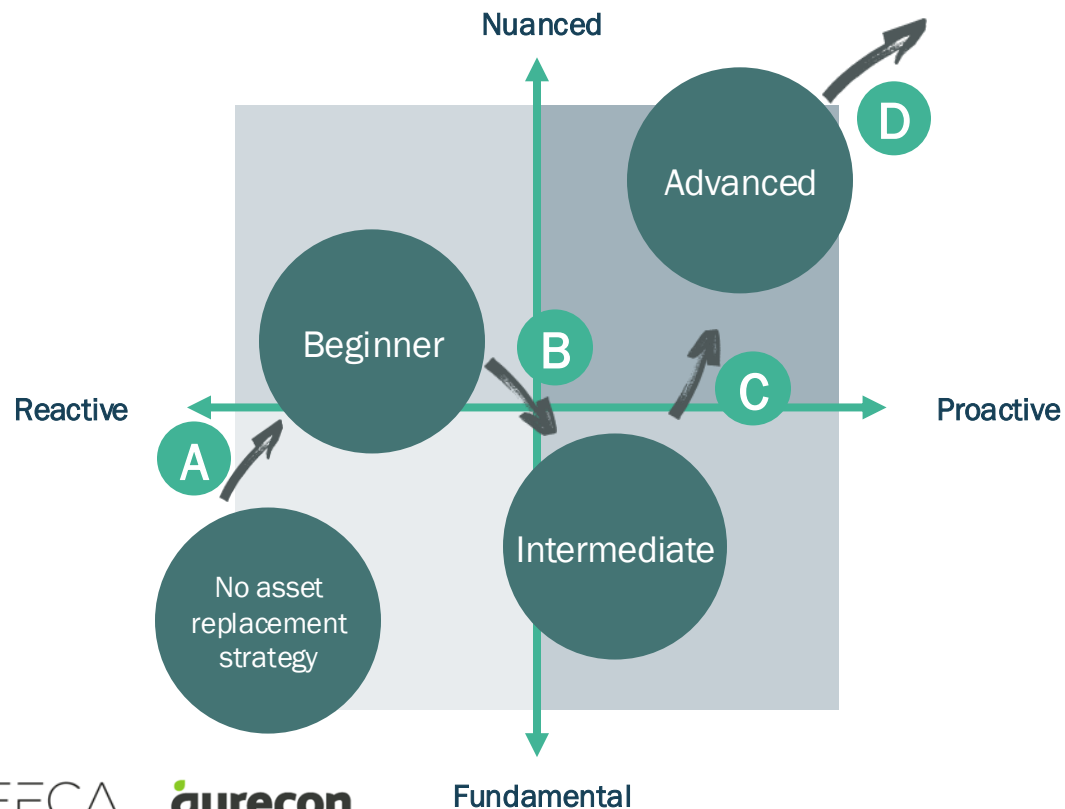
Factors	Content to include	Example
Analysis		<p>NPV Analysis - Replacing the boiler before it's end of life, with heat pumps for individual pools and heat pumps integrated with new air handling units, has a higher net present value than replacing the boiler at end of life.</p> <p>MACC analysis - The site has already had considerable investment in decarbonisation initiatives, including building management system upgrades, LED lighting, variable speed drives on pumps and new pool covers. Remaining opportunities include the replacement of the gas boiler with heat pumps and the installation of solar PV (photovoltaic). Replacement of the boiler has a lower cost of carbon abatement than solar PV and hence is being prioritised ahead of investment in solar.</p>
Finance		<p>The project is funded through a combination of retained earnings and additional debt. Alternate financing opportunities were investigated, particularly energy as a service, however this increased the overall cost of the project.</p>
Other considerations		<p>The cost of electricity supply upgrades has been factored into the NPV analysis. At end of life the main components of the heat pump will be recycled by the manufacturer and refrigerant destroyed.</p> <p>Engineering design has been completed and procurement lead times are around six months due to the need to source heat pump components from Europe. However, the units themselves are assembled locally which reduces supply chain risks and utilises local suppliers and contractors.</p>
Replacement technology		<p>The existing boiler will be replaced by alternate technology, heat pumps for heating pool water and a new AHU (air handling unit) with integrated heat recovery and heat pump.</p>

Improving your capability over time

Performance should be monitored over time, to identify if there is a need for further improvement. The [Plan-Do-Check-Act](#) cycle is a useful framework to structure continuous improvement. Regarding asset replacement strategies, a plan is put in place to improve asset performance and an organization's asset management capability. The plan is implemented and regularly monitored, to understand whether:

1. The asset is operating within expectations for performance, cost, and risk and,
2. whether the organisation's capability is sufficient, (i.e., if further investment in capability improvement is required or would be of value).

Corrective actions can then be made to ensure assets are operating efficiently, that costs and risks are being managed and capability is continuously reviewed.



A No Asset Replacement Strategy to Beginner

Performance monitoring should be ongoing, as needed, to address immediate concerns and maintain operational efficiency. However, it's also important to schedule in-depth reviews on a semi-regular basis, (i.e., every 12 months). This timeframe allows for a comprehensive analysis of performance trends and patterns over an extended period. A longer timeframe ensures that sufficient data can be collected and analysed to provide a more accurate assessment of performance, enabling informed decision-making and strategic planning. A 12-month timeframe enables sight of possible seasonal or production peak trends which will show how equipment needs may differ.

B Beginner to Intermediate

Based on performance monitoring, the business should assess whether a change in the asset/equipment and a change in the operation of the asset/equipment (i.e., through investment in capability improvement) is required. The aim is to determine whether such changes are not only required but also if they would add value to the organisation by improving overall operational efficiency, reducing costs, mitigating risks, or enhancing the asset's performance and longevity.

C Intermediate to Advanced

For a business, it's important to recognise that constantly striving for continuous improvement, progressing from Beginner to Intermediate to Advanced levels and beyond, may not always be cost-effective or feasible. In some cases, maintaining a "lower" capability level, such as beginner or intermediate, may be appropriate for making well-informed decisions and achieving objectives in a cost-effective manner. This approach allows businesses to effectively balance performance, cost, and risk, ensuring that resources are allocated optimally to achieve desired outcomes.

D Advanced onwards

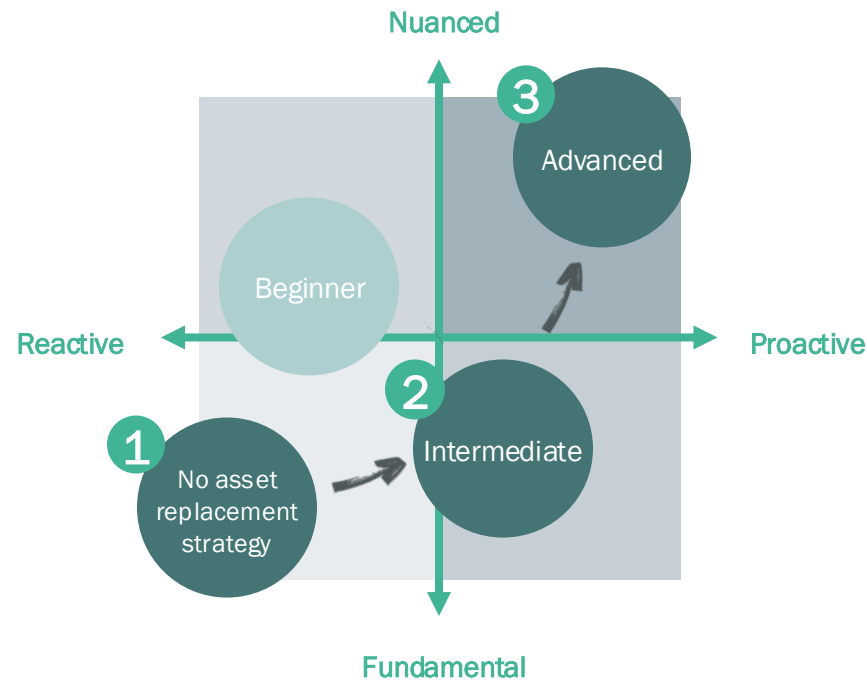
Businesses aiming to enhance their asset reliability and sustainability can leverage large-scale data and digital systems for asset monitoring. They should implement ongoing asset replacement strategy reviews and fit for purpose benefits management plans while integrating broader asset management, emissions reduction, and climate risk resilience strategies for further advancement.

Staged improvement pathways

There are different ways in which businesses starting in earlier capabilities build their capability to get to advanced capability. The examples here illustrate two possible staged improvement pathways.

Staged improvement pathway one

Improvement Pathway one is a standard pathway that progresses from Beginner to Intermediate to Advanced stage for a business to achieve their Asset Replacement Strategy. This would be through a staged approach usually over a period, typically 12 months or longer. The business would adopt a gradual phased approach, rather than making changes instantly/rapidly, allowing for comprehensive adjustments to their assets. The business would go through the performance, cost, and risk criteria to make changes at each level before progressing to the next stage.



Staged improvement pathway two

Improvement Pathway two represents an advanced alternative that the business may explore to elevate their Asset Replacement Strategy to meet and align with their strategic objectives. This pathway will allow the business to go from Beginner to Advanced criteria swiftly, the key would be through a combination of strategic planning and a commitment of improving asset management practices.

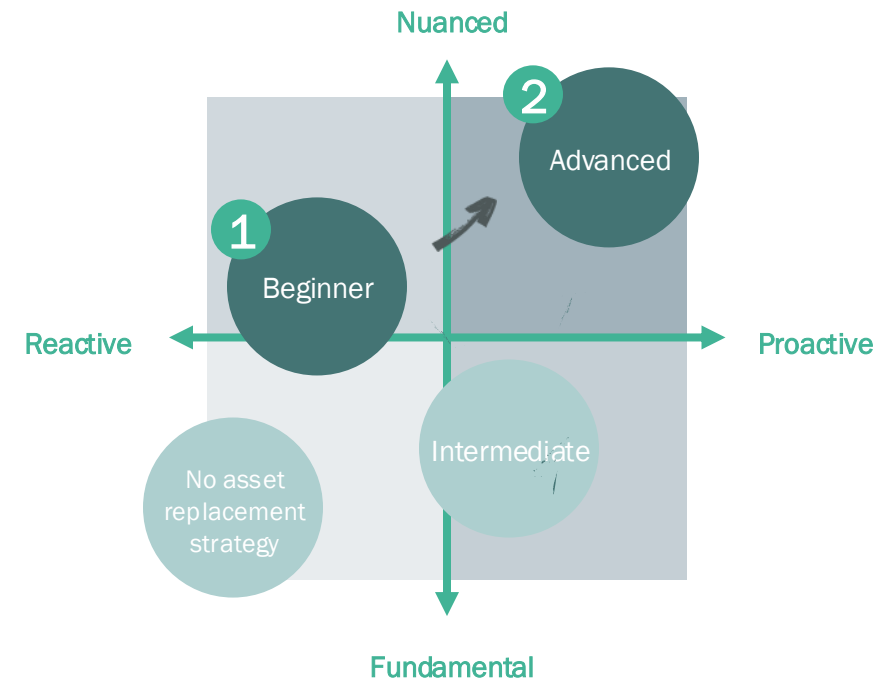


Figure 7: Capability Matrix

Term	Definition
Asset Efficiency	Inputs required to deliver an output. In process heat this could be the thermal efficiency of the heat plant.
Availability	The proportion of time an asset is in an operable condition to produce its desired outputs.
Condition Assessment	Assessment of the condition of an asset (e.g., via visual inspection) to help estimate its remaining useful life.
Energy as a service contract (ESCO)	ESCO's are an alternate means to finance energy projects, where a 3 rd party owns the energy plant and sells energy or energy services from it. In relation to process heat, these are typically contracts to purchase heat in the form of hot water or steam, where a 3 rd party owns the process heat plant.
GHG	Greenhouse gas emissions [usually measured as carbon dioxide equivalent (CO ₂ -e)]
Internal Rate of Return (IRR)	The annualised compound rate of return of an investment. For process heat investments, the internal rate of return would consider the cost of a project and any cost savings that it generates. Further information can be found here .
Marginal Abatement Cost Curve (MACC)	This is an assessment of the cost of all decarbonisation opportunities available. For a business these generally range from no cost initiatives that reduce cost immediately (like switching off equipment not in use) to initiatives that increase cost like offsetting. MACC curves enable prioritisation of decarbonisation opportunities. Further information can be found here .
Nationally Determined Contribution (NDC)	New Zealand's emission reduction targets under the Paris Agreement. Aotearoa New Zealand has an international target to reduce net emissions to 50 per cent below gross 2005 levels by 2030 (Ministry for the Environment).
Net Present Value (NPV)	The sum of all the cashflows relating to an investment that have been discounted to their present value. For process heat investments cashflows include upfront investment and operational costs like energy, maintenance and consumables and the discount rate would be a business's cost of capital. Further information on net present value can be found here .
Paris Agreement commitments	See "National Determined Contribution (NDC)"
Plan-Do-Check-Act cycle	The Plan-Do-Check-Act cycle is a continuous improvement framework that features in ISO management standards and Lean manufacturing frameworks. Further information can be found here .
Preventative Maintenance (or planned maintenance)	Maintenance activities that can be planned and scheduled ahead of time, which are undertaken to ensure the asset realises its' expected useful life (or design life) and minimises the likelihood of asset failure.
Simple payback	The number of years it takes to pay back an investment or the cost of an investment divided by the annual return.
Survivability	Resilience of an asset is to component failures and external impacts (e.g. power supply failure).
Sustainability linked loans	These loans are likely to provide more favourable lending terms to businesses, and in return, may have sustainability-linked conditions or targets that the business needs to meet, like reduction in GHG emissions.

