e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

Interreg North-West Europe

Co-funded by the European Union

More4Sustainability

Module 1

Introduction to Sustainable Asset management

IN PARTNERSHIP WITH

Learning objectives of this e-Learning

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- Understanding **importance of maintenance and asset management** for sustainability
- Apply **Sustainable Asset Management Framework** as basis for improvements
- Estimating scope 1 and 2 **CO emissions**$_2$
- Apply **proven methods and measures** to increase energy efficiency and reduce emissions
- **Develop strategy, objectives** and tactical approach with Roadmap
- Formulate **concrete approach** for emission reduction, including gas reuse and renewable energy generation.
- Conduct **self-assessment** to determine sustainability targets

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Training Content

Module 1 - Introduction to Sustainable Asset Management

Module 2 - Sustainable Asset Management Strategy & Objectives

Module 3 - Asset Portfolio Optimisation

Module 4 - Asset Health Optimisation

Module 5 - Energy Consumption Optimisation

Module 6 - Green House Gas Emisson Optimisation

Module 7 - Implementing Sustainable Asset Management

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Module 1

Introduction to Sustainable Asset Management

Module 1

Introduction to Sustainable Asset Management

1. Background to sustainability
2. The MORE4Sustainability Project
3. Scope and regulations on sustainability
4. The Sustainable Asset Management Framework
5. Results of the benchmark survey

EU Green Deal

Background to sustainability

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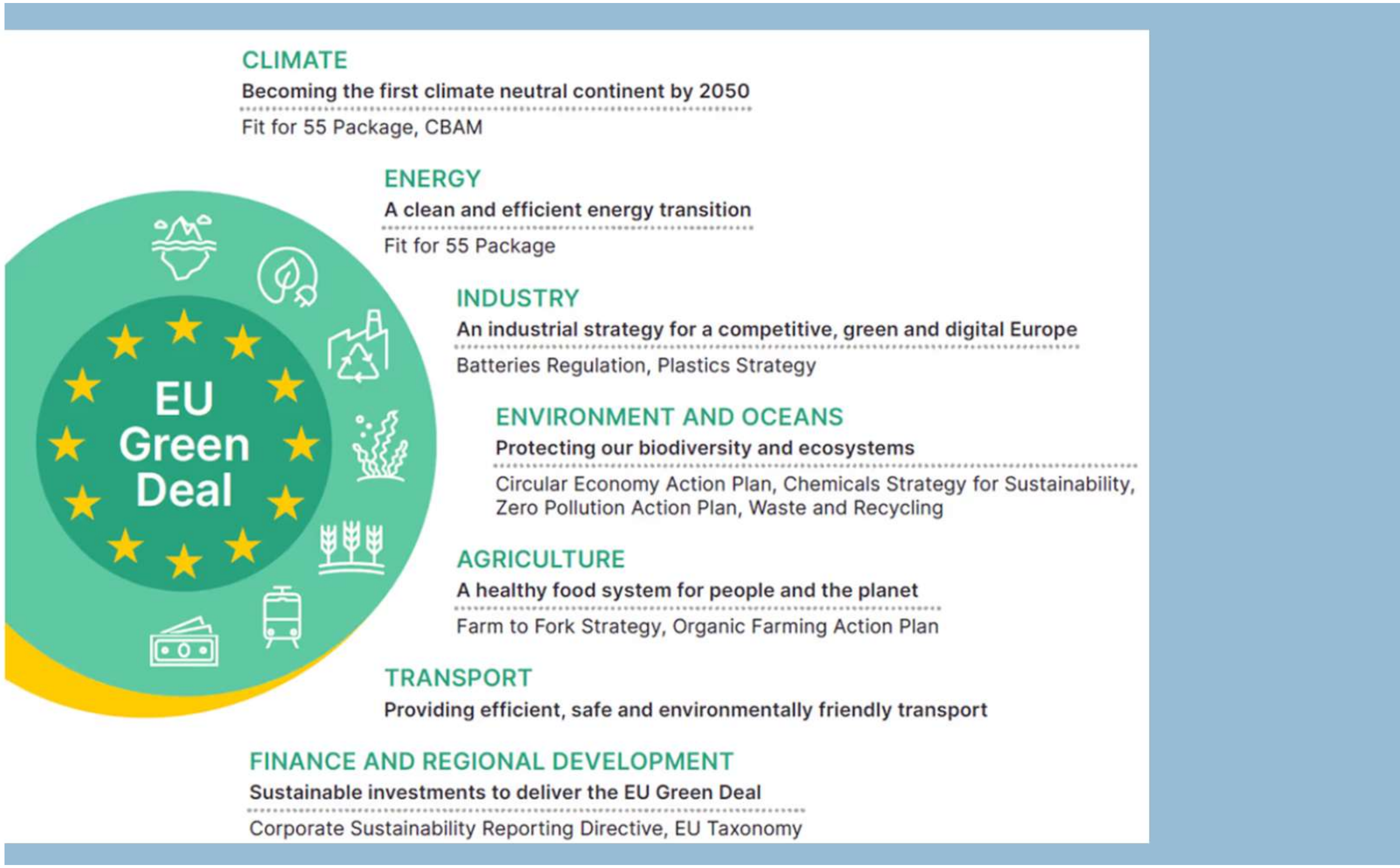
- A **climate neutral Europe** by 2050
- **"Climate change** is the greatest challenge of our time. And it is an opportunity to build a new economic model."
- "The green transition offers a **great opportunity** for European industry by creating markets for clean technologies and products."
- **"Nature** is an important ally in the fight against climate change."
- **Reducing greenhouse gas emissions** requires a higher share of renewable energy and greater energy efficiency.



'Setting the scene'

The importance of sustainability and energy efficiency for industry

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- Due to its high energy consumption, the North West European (NWE) region is a key focus area to achieve the EU target of **improving energy efficiency by 32.5% by 2030**.
- Industry is **the largest consumer of fossil fuels**. So there is great potential for improvement here.
- A new initiative called Sustainable Asset Management is helping factories and other industrial companies **improve energy efficiency and reduce CO_2 emissions**.

Attention sustainability from industry

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(European) **industry** is already working on **sustainability**:

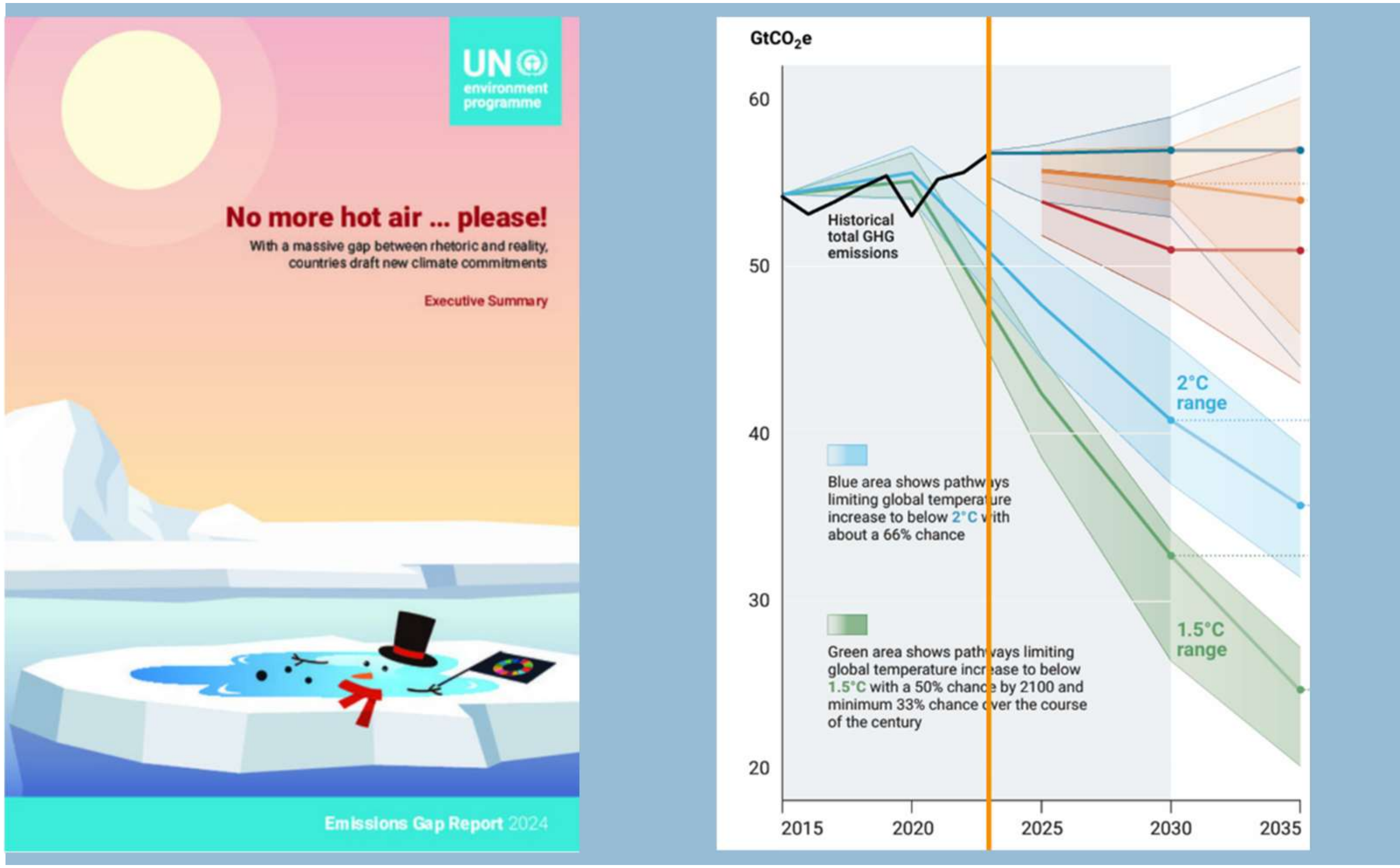
- **Net Zero programmes** developed and launched
- **Decrease in** energy consumption and CO2 emissions **deployed**

But…

- Progress is still **too slow**
- Deadlines will **not** be **met** this way

So…

- **Maintenance & Asset Management** should also be included in this
- To **integrate sustainability**



Module 1

Introduction to Sustainable Asset Management

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About MORE4Sustainability

Objectives

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- The project focused on **creating awareness and building capacity** for sustainable asset management
- An international benchmark study (within the industry) was conducted under to develop a **Roadmap for Sustainable Asset Management**
- This Roadmap contains a set of best practices and a practical approach to achieve **energy efficiency** improvement and reduction of **greenhouse gas emissions**
- The Roadmap also includes a **self-assessment & business case tooling**

Initiators

- Interreg NWE (North-West Europe) is a regional cooperation programme, co-funded by the **European Union**
- The Interreg NWE programme 2021-2027 promotes 'a **green, smart and equitable transition** for all NWE areas that aims to support balanced development and make all regions more resilient'
- The programme funds projects that contribute to the "green" transition of all NWE areas towards a **climate neutral, energy efficient and sustainable society**

BEMAS	NVDO	FVI	EMC2	mainnovation
Belgian Maintenance Association - lead partner organisation	Dutch Society for Purposeful Maintenance - project partner	Forum Vision Maintenance - project partner	EMC2 Competitiveness Cluster - project partner	Consultancy firm and experienced research agency - project partner - leading the execution

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Important laws and regulations

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Sustainable Development Goals United Nations

- In 2015, the UN created the 17 Sustainable Development Goals (SDGs)
- Goals focus on peace, prosperity and climate change
- SDGs link environment, social and economic development
- Examples: no poverty, clean energy, living under water

Sustainable Development Goals United Nations

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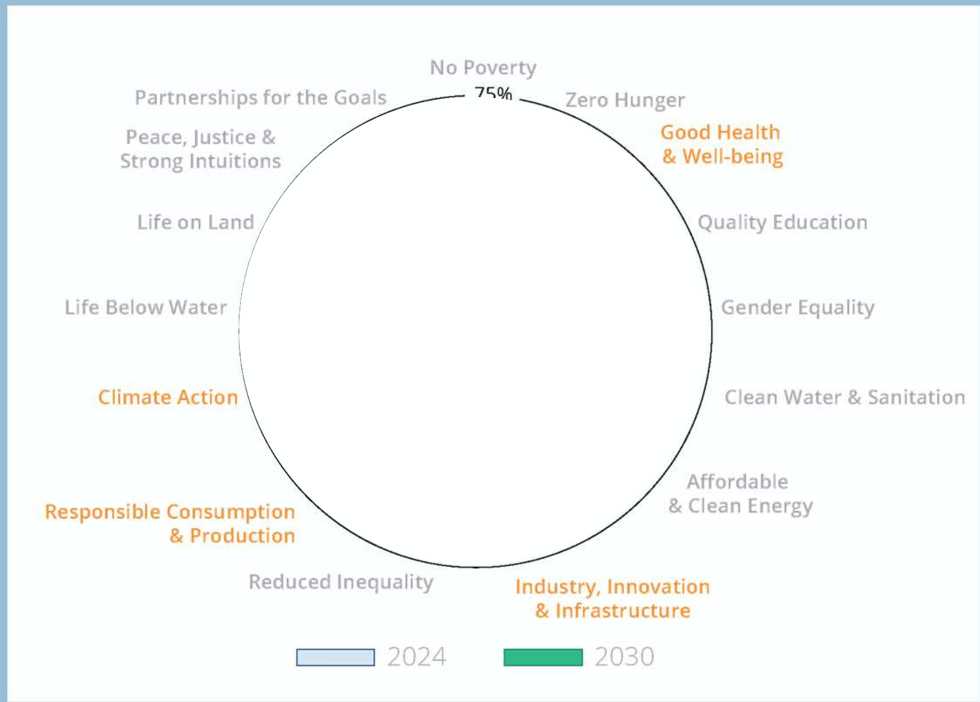
What UN sustainability goals is your organisation working on?



Sustainable Development Goals United Nations

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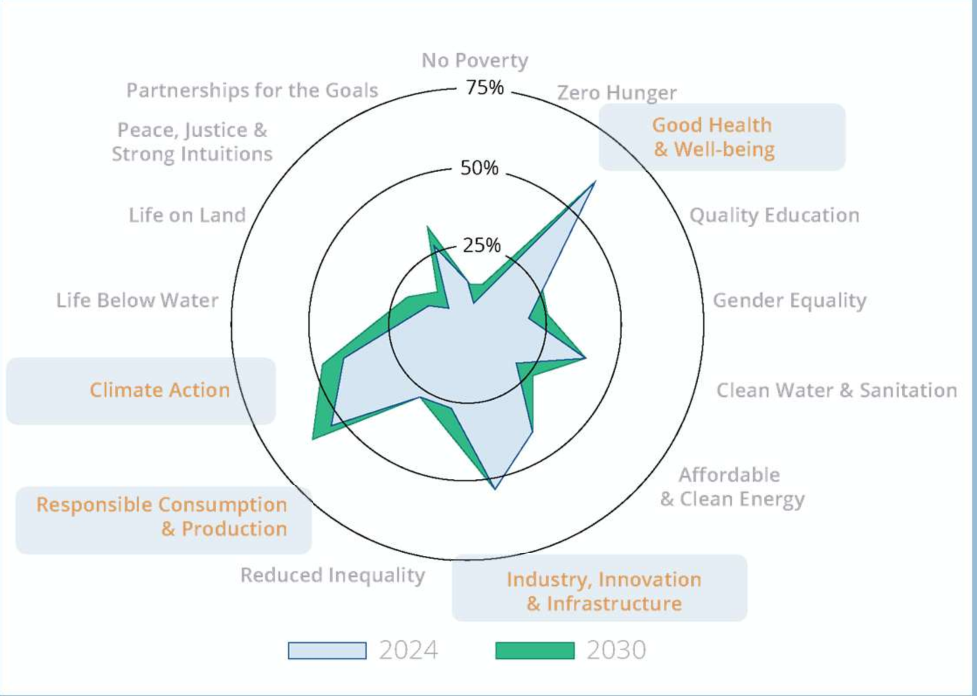
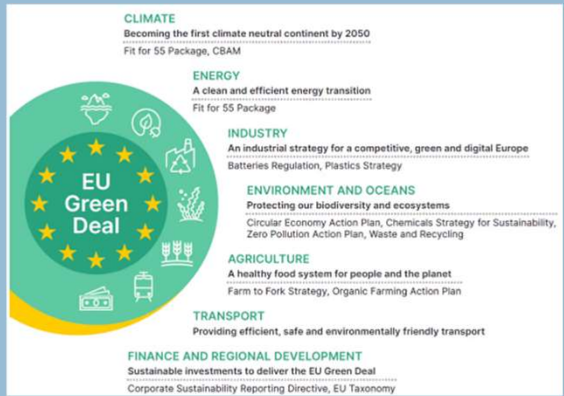
This is where early adopters are working on more

Of all the other sustainability objectives, particular attention is paid to the implementation of:

- 'Good Health and Wellbeing'
- 'Responsible Consumption and Production'
- 'Industry, Innovation and Infrastructure'
- 'Climate action'



Important laws and regulations



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- SDGs link environment, social and economic development
- Examples: no poverty, clean energy, living under water

EU Green Deal

- EU aims for climate neutrality by 2050
- Focus on zero emissions, circular economy and energy efficiency
- Encourages cleaner technologies and sustainable asset management.

Important laws and regulations

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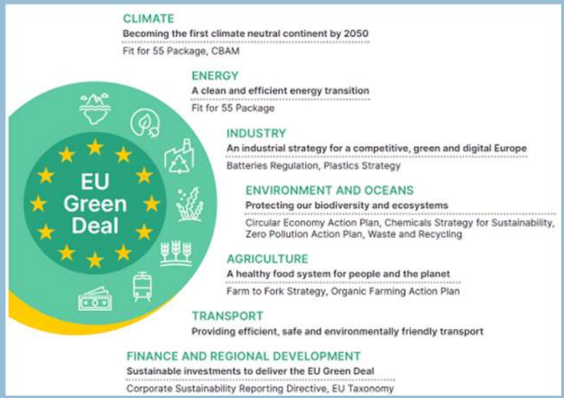

Corporate Sustainability Reporting Directive (CSRD)

- The CSRD commits companies to transparent sustainability reporting
- Goal: make reliable and comparable ESG information available
- Helps investors and consumers in sustainability evaluation
- Encourages a more sustainable economy in the EU

Important laws and regulations

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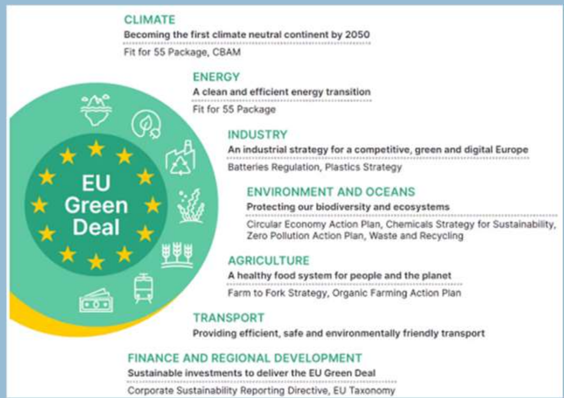

SCIENCE BASED TARGETS

Corporate Sustainability Reporting Directive (CSRD)

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- Helps investors and consumers in sustainability evaluation
- Encourages a more sustainable economy in the EU

Science-Based Targets Initiative

- Global emissions reduction framework according to climate science and Paris Agreement
- Cooperation between UNGC, WRI and WWF, among others
- SBTi provides a structured approach to regulation.
- SBTi participation strengthens trust and stakeholder relations
- Over 10,000 participating companies by early 2025

EU ETS

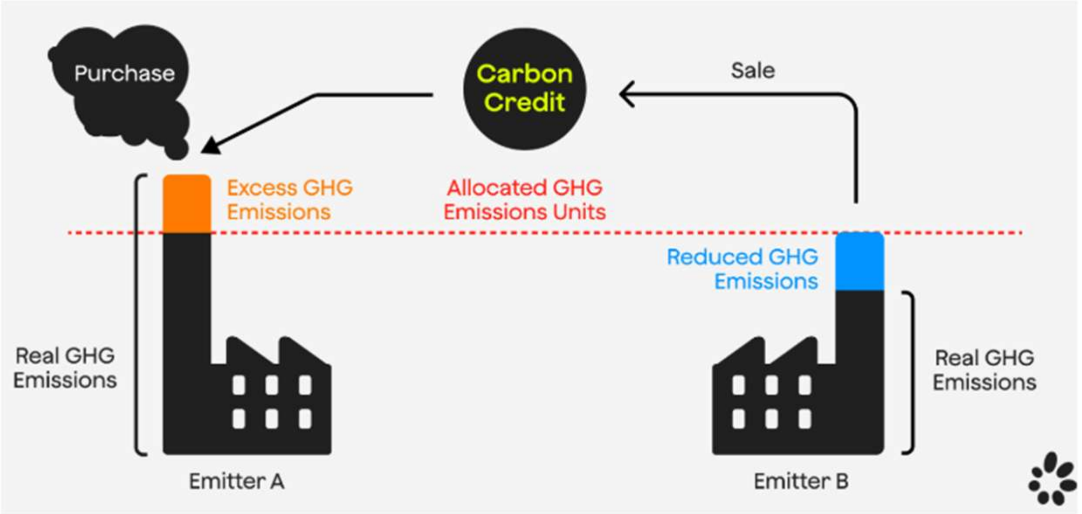
1. Emission allowances: The EU sets a limit on greenhouse gas emissions. This limit is divided into individual allowances, which allow the holder to emit a certain amount of greenhouse gases.

2. Allocation: These allowances are allocated to companies based on various factors, including historical emissions, and sector-specific benchmarks. Companies can buy and sell these allowances as needed.

3. Compliance: At the end of each year, companies must surrender enough allowances to cover their actual emissions. If they emit more than their allocated allowances, they have to buy additional allowances. If they emit less, they can sell their excess allowances.

The cap on emissions is slowly being lowered. The EU ETS legislation is aligned with the European Green Deal and part of the EU Climate Regulation.

The ETS price is currently (2025) around €80 per tonne of CO_2 . This price is expected to rise gradually as the cap decreases.



The EU ETS, or European emissions trading system, is designed to reduce emissions in an economically efficient way. The system works on the cap-and-trade principle, whereby a cap or limit is set on the total amount of emissions that can be emitted by the sectors concerned, and any unused allowances can be sold and/or traded.

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Influence Asset Management

Which emissions does Asset Management affect?

Scope 1: Direct emissions

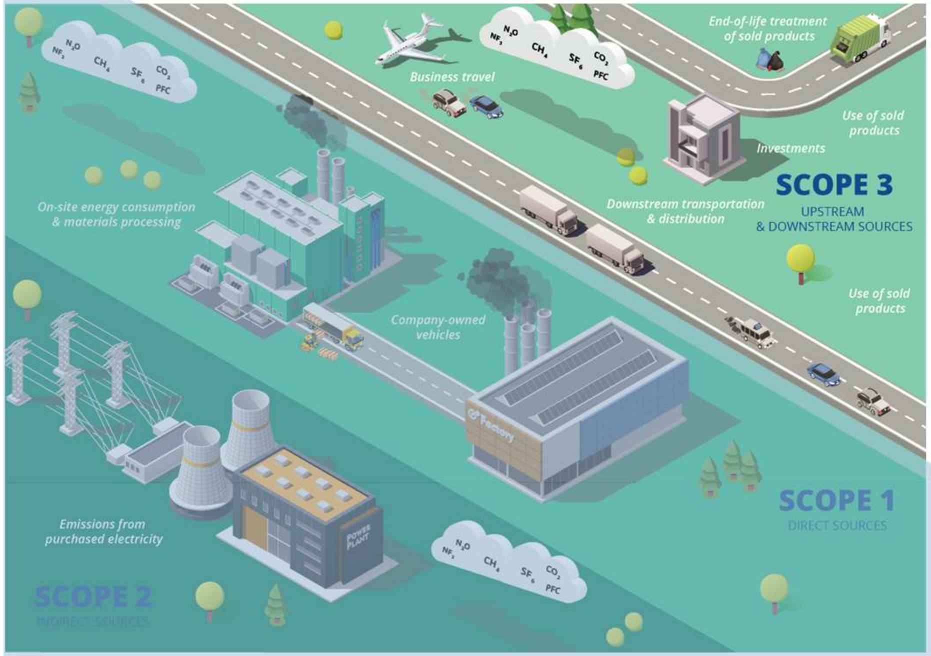
- All direct greenhouse gas emissions from sources owned by the organisation.
- Emissions from combustion processes and from industrial processes

Scope 2: Indirect emissions from electricity generation

- Indirect greenhouse gas emissions from generation of purchased electricity, heat, steam or cooling
- Emissions arise during production of the energy generated elsewhere but used by the organisation

Scope 3: Other indirect emissions

- All other indirect emissions that result from the organisation's activities but occur at sources not controlled by the organisation
- Emissions throughout the value chain, such as those from suppliers, product use and processing of products sold
- Scope 3 is often the largest source of emissions and can be complex to measure



Asset management influence

Calculation example CO emissions$_2$

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Factory

Assume a production facility based in the Netherlands.

The facility operates **steam boilers** and uses natural gas for heating.

The plant uses **grey electricity**.

Total consumption:

- 9 million m^3 natural gas
- 10 million kWh elecktricity

Calculation of scope 1 and scope 2 emissions

Scope 1:

Emission factor for natural gas: 1.779 Kg CO_2 per m^3 natural gas (standard Dutch emission factor).

Thus, direct emissions from natural gas consumption at the facility would be **16,011 tonnes of CO_2** .

Scope 2:

The emission factor for grey electricity is 0.448 Kg CO_2 per kWh in the Netherlands (the emission factor varies depending on the energy mix per region).

Indirect emissions from electricity consumption would thus amount to **4,480 tonnes of CO_2** .

Scope 1 emissions (use of natural gas): **16,011 tonnes of CO_2**

Scope 2 emissions (electricity consumption): **4,480 tonnes of CO_2**

This gives a total of **20,491 tonnes of CO_2** emissions for the plant.

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Sustainable Asset Management Framework

Four levels

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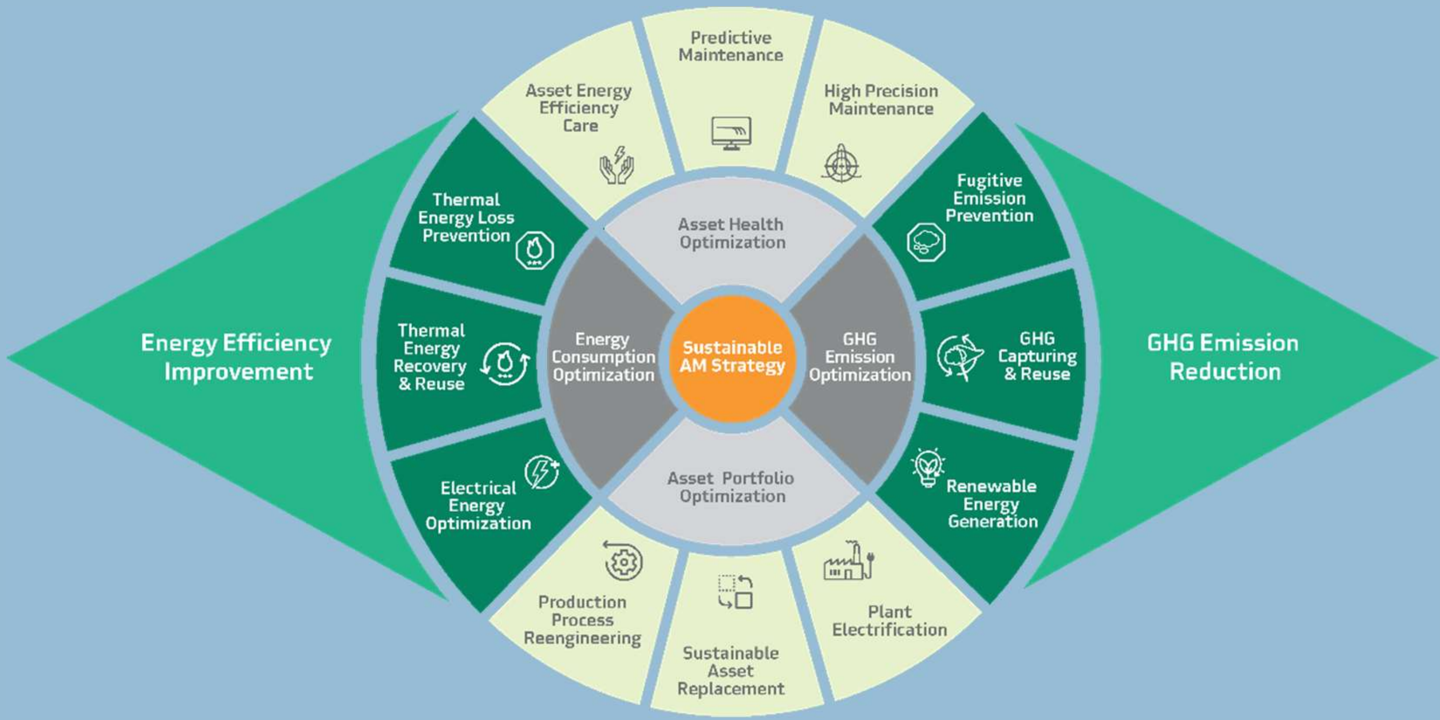


Sustainable Asset Management Framework

Tactical optimisation quadrants

Asset Portfolio Optimisation

- Have the right assets to achieve sustainability targets
- With lifecycle risk management

Asset Health Optimisation

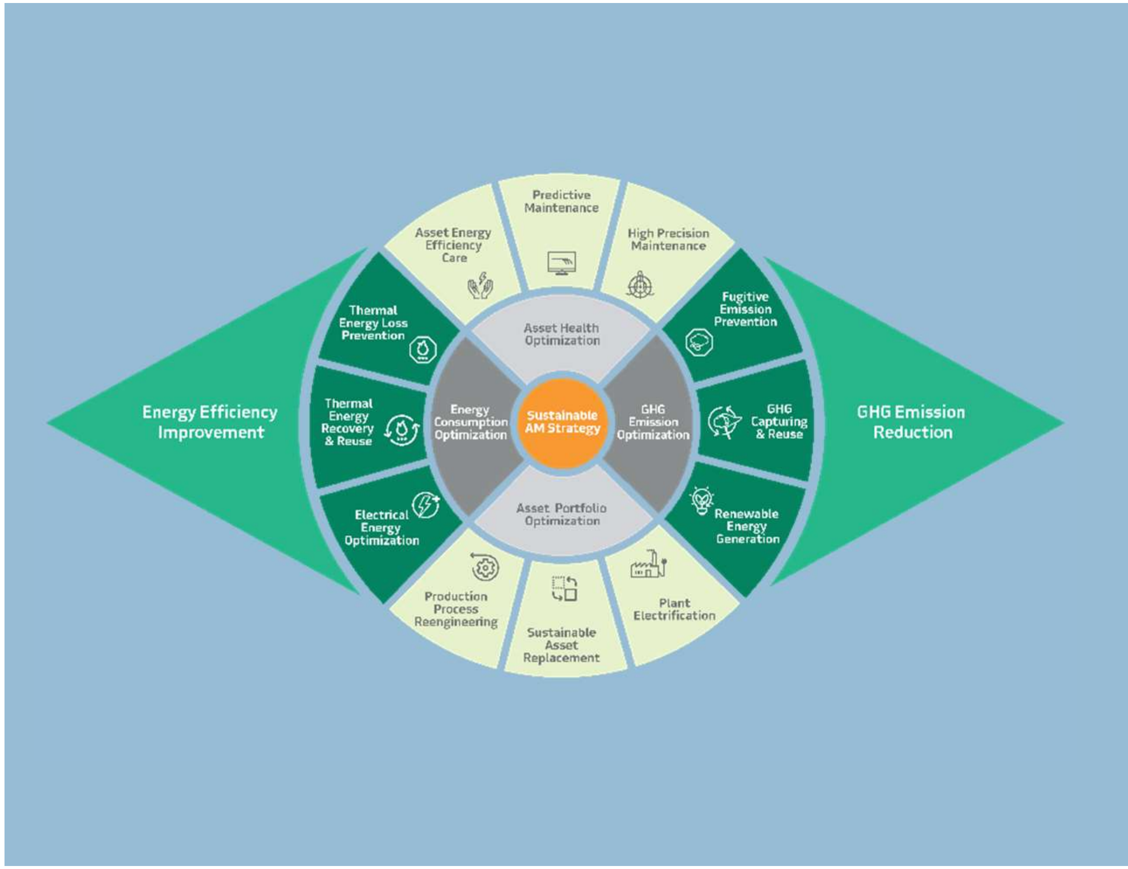
- Optimising the technical and operational condition of assets to avoid energy losses and unnecessary emissions
- Maintenance-related and operational focus areas

Energy Consumption Optimisation

- Maximising energy efficiency to achieve desired performance with minimum energy consumption
- Operational and technological focus

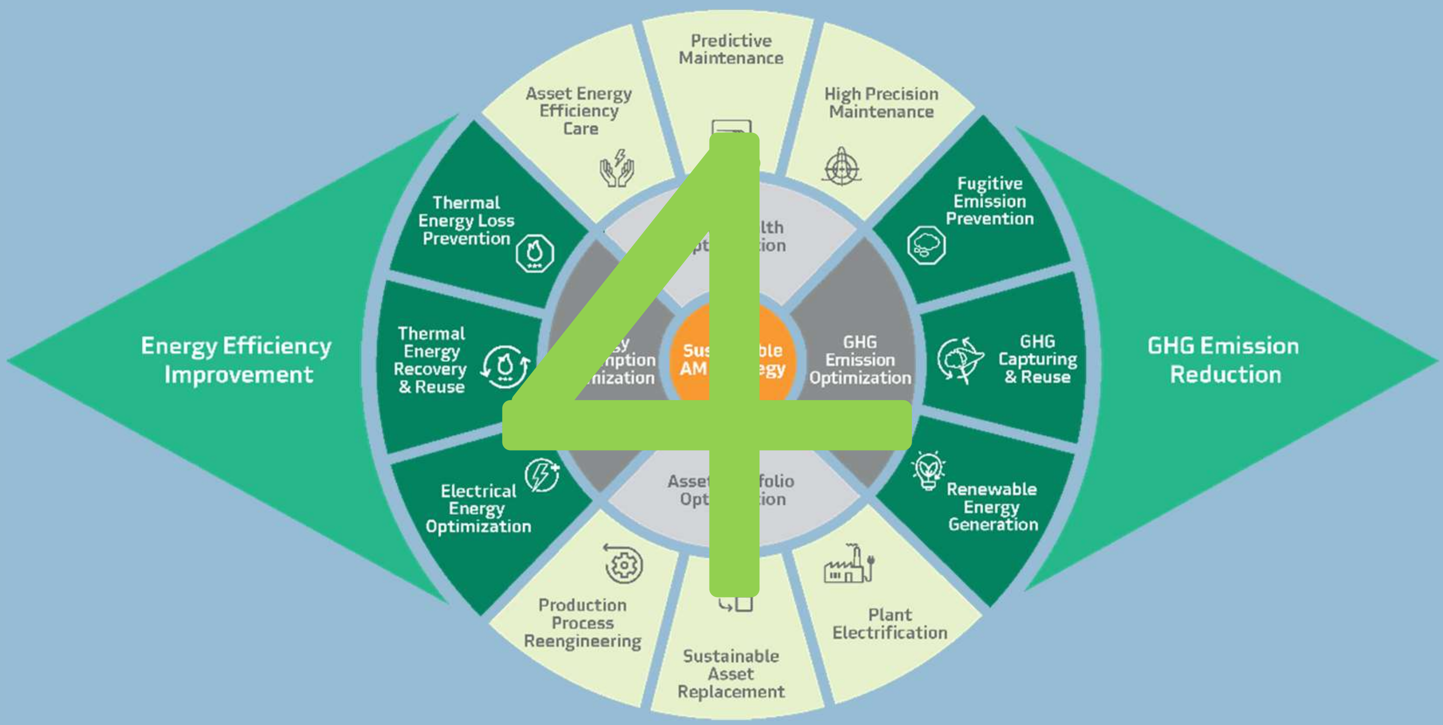
GHG Emission Optimisation

- Minimising greenhouse gas emissions generated from the entire production process (including internal energy generation)
- Focus on prevention and technology



Sustainable Asset Management Framework

Optimisation sequence



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Are the objectives being achieved?

By the early adopters of this study

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What are the EU sustainability targets?

Energy efficiency
32.5% reduction
(2020 → 2030)

Greenhouse gas emissions
55% reduction
(1990 → 2030)

Are we going to make it?

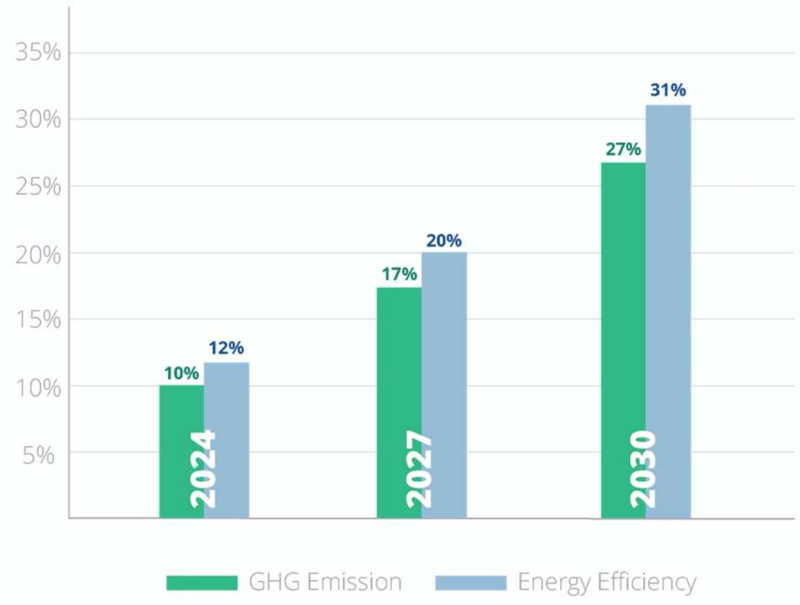
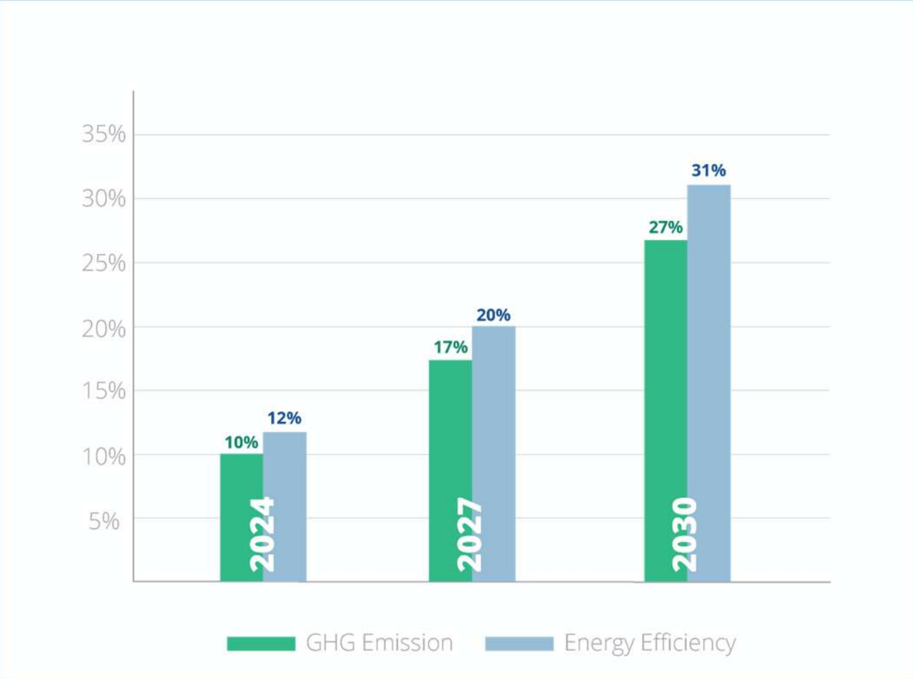


Figure 1.8 | The overall sustainability improvements 2024-2030 compared to 2020.

Goals within reach!



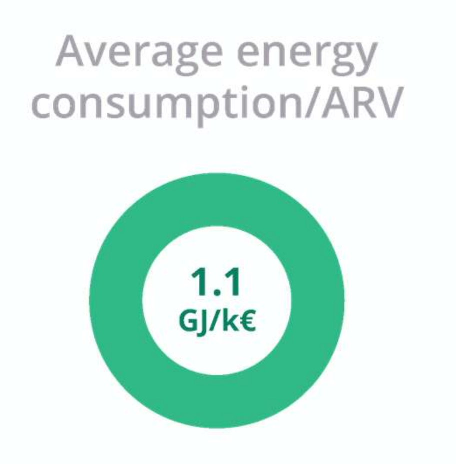
- Improvement of **10% every 3 years**
- Sustainable Asset Management **certainly contributes** to achieving objectives
- More result on **Energy Efficiency** improvement than Greenhouse Gas Emission reduction
- Many companies switched to **clean/green energy before 2020**
- Consequently, **decrease in energy consumption**, but no/less decrease in greenhouse gas emissions

Some sustainability characteristics

From the early adopters

How much energy is consumed?

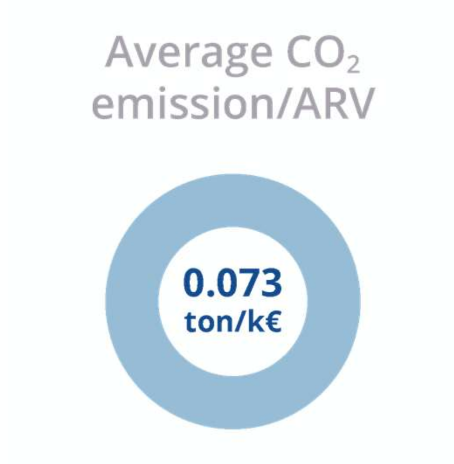
(average early adopters)



Average NWE household consumes 12.4 GJ per year

How much CO_2 -e emissions are caused?

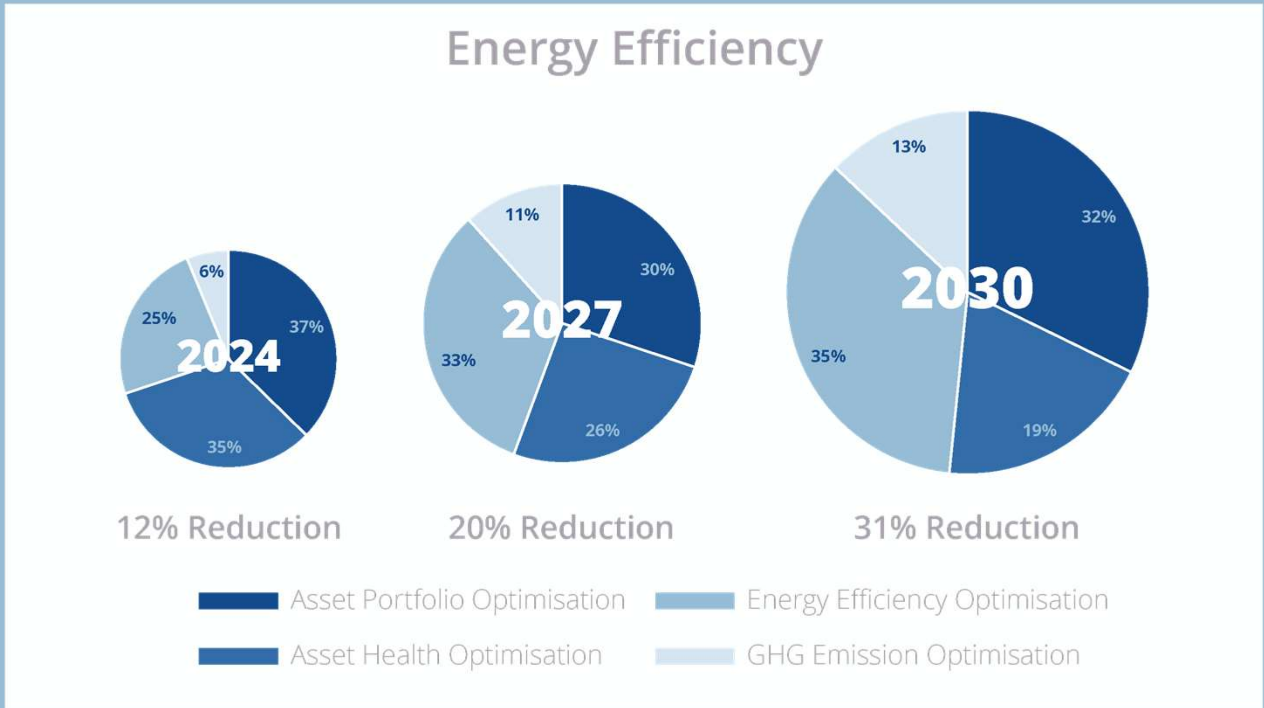
(average early adopters)



Similar to the CO2 uptake of a tree per day

Energy efficiency improvement

Relative contribution by Sustainable Asset Management quadrant

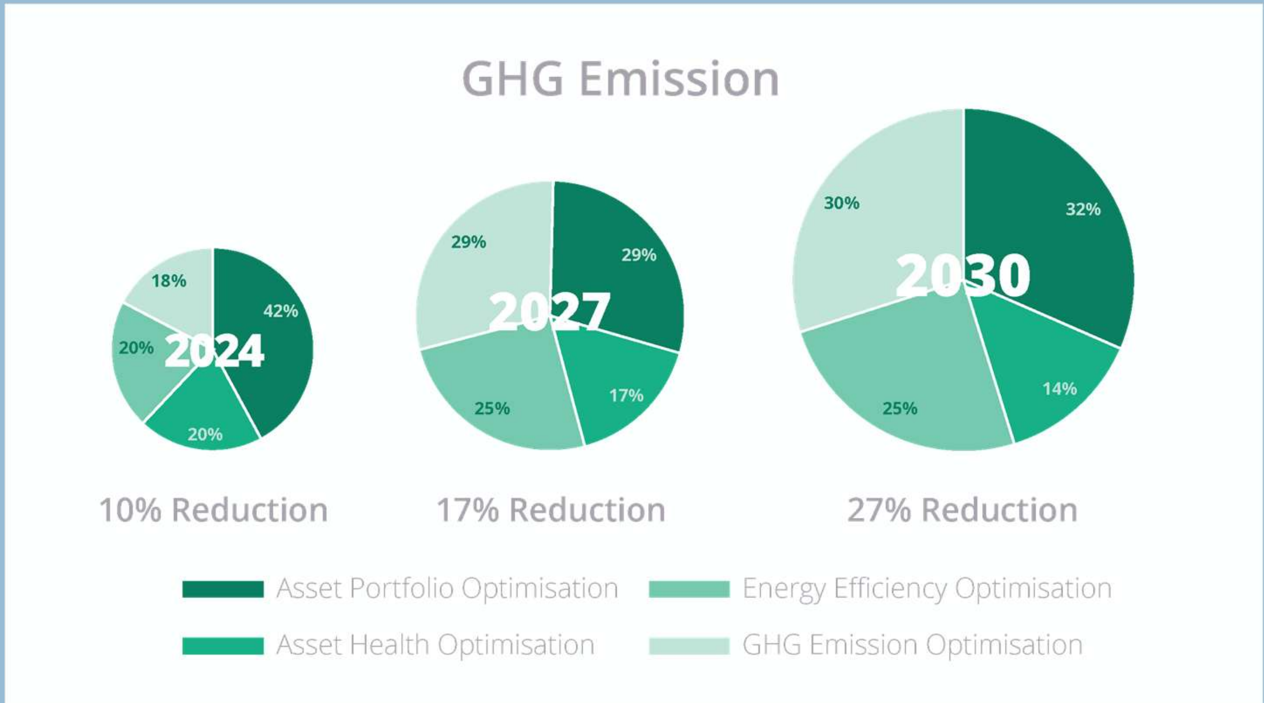


Which quadrants have the most impact on Energy Efficiency improvement?

- Most impact achieved with commitment to **Asset Portfolio Optimisation** and **Asset Health Optimisation**
- In future (from 2027 to 2030) **Energy Consumption Optimisation** increasingly important

Energy efficiency improvement

Relative contribution by Sustainable Asset Management quadrant



Impact on Greenhouse Gas Emission Reduction?

- Until 2024 most impact by far through **Asset Portfolio Optimisation**
- In the period 2024-2030, we see an emphatic increase in the share of **GHG Emission Optimisation**
- The share of Asset Health Optimisation and Energy Consumption Optimisation over the whole period remains **constant around 40%**

Optimisation sequence

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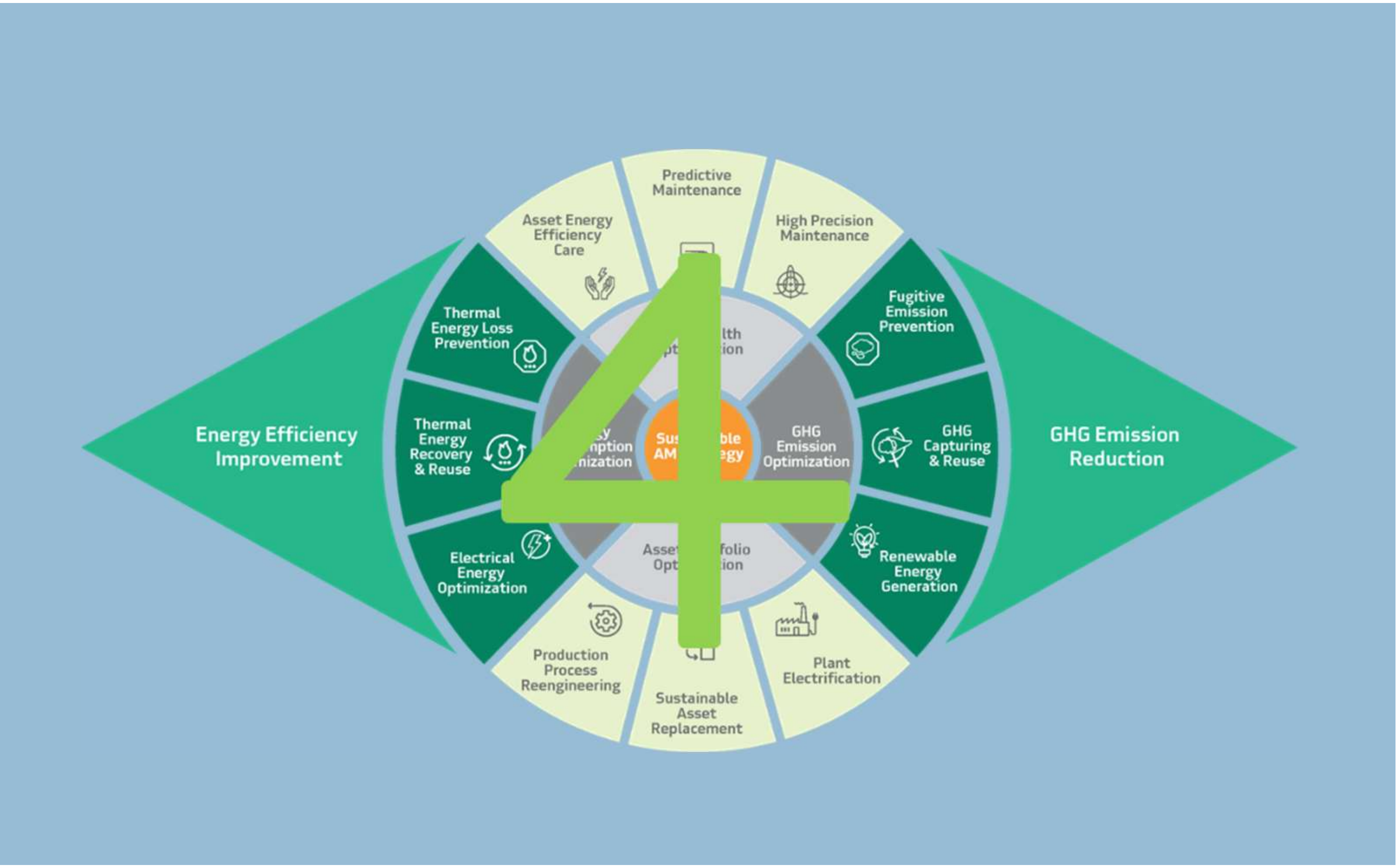

- **Confirmation** that early adopters are indeed adopting the explained sequentiality
- So the four in the framework is **a logical roadmap**
- Implementation need **not be strictly** in that order

e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 2

Sustainable Asset Management; Strategy and Objectives

Module 2

Sustainable Asset Management Strategy & Objectives

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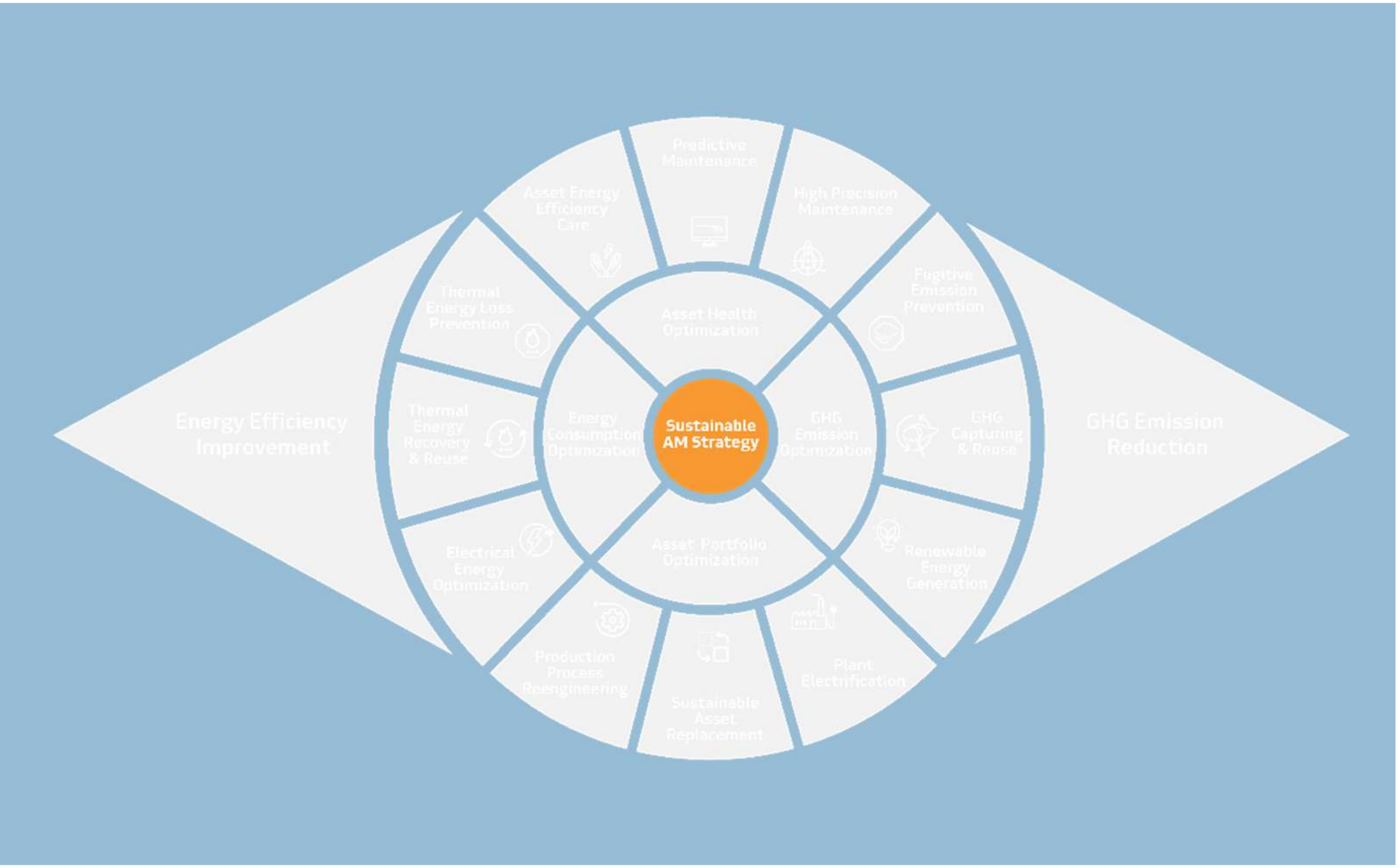
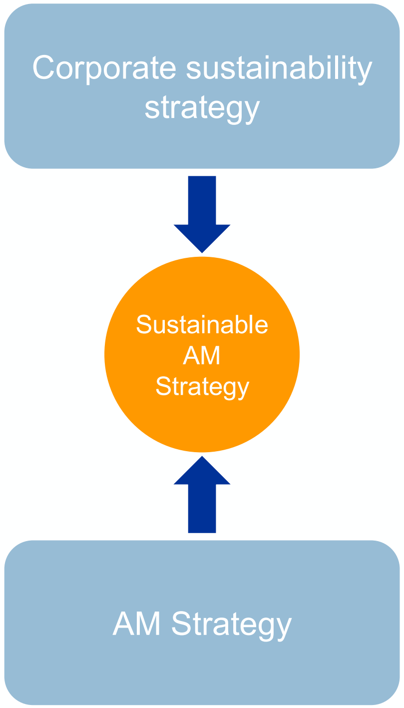
1. Strategy development
2. Tactical enablers

Strategy development

Coherence with other strategies





Importance of sustainability within Asset Management strategy

Strategic focus areas Sustainable Asset Management

- Among early adopters, sustainability is in the top three most important asset strategies
- Safety and technical plant availability are now a much higher priority

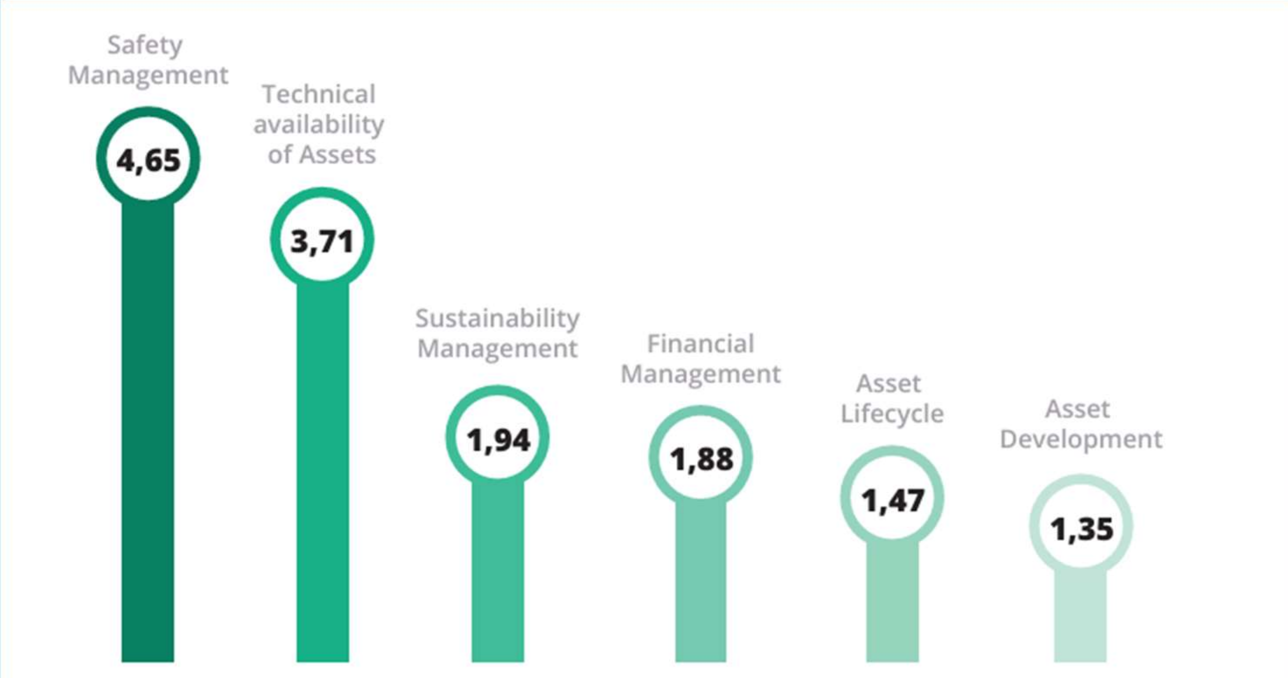


Figure 2.1 | Importance of Sustainability in Asset Management on a scale of 1 to 6 (lowest to highest priority).

Elements of sustainability strategy

- Four strategic elements were considered within the benchmark study
- Enquiries were made about importance and implementation rate of these elements
- Following are the explanations and results

[1)] Implementation rate: percentage of early adopters who have fully or partially implemented the element in question

Mission & Vision

Strategic focus areas Sustainable Asset Management

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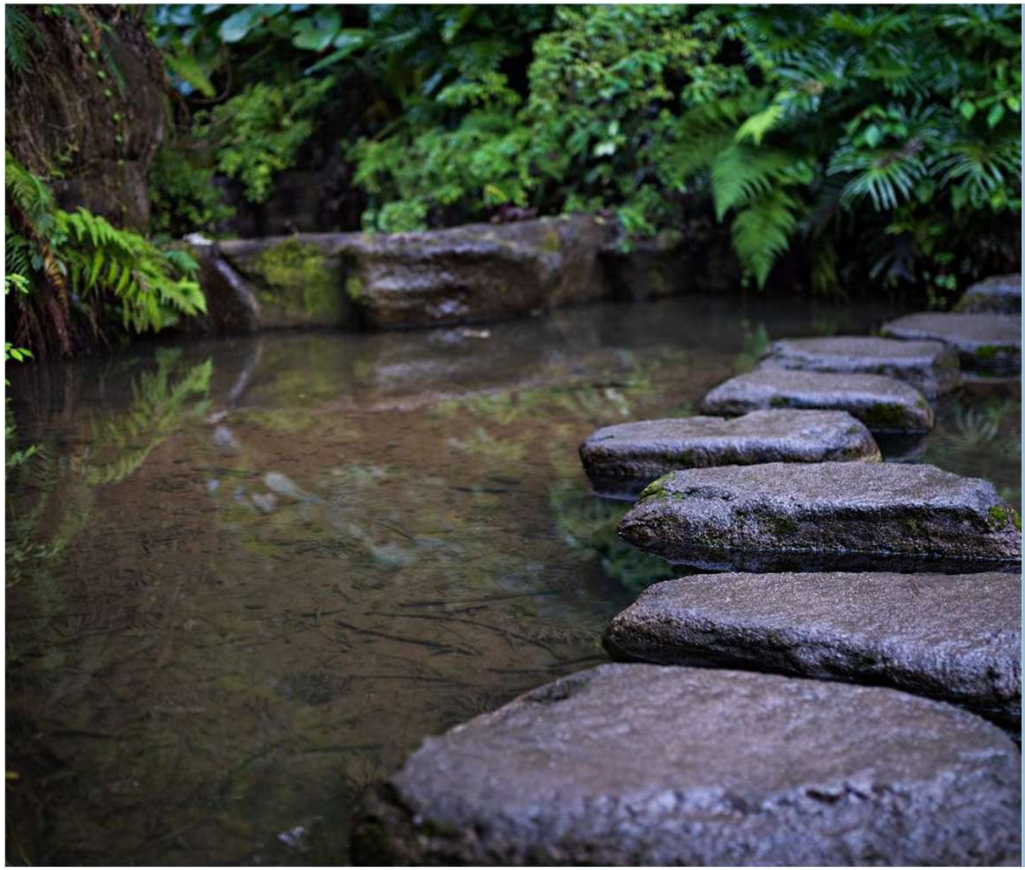
- Align with the company's sustainability principles
- Ensuring that sustainability becomes part of the identity and purpose of the Maintenance & Asset Management organisation
- Aligning sustainability Asset Management goals with business objectives



Sustainability culture

Strategic focus areas Sustainable Asset Management

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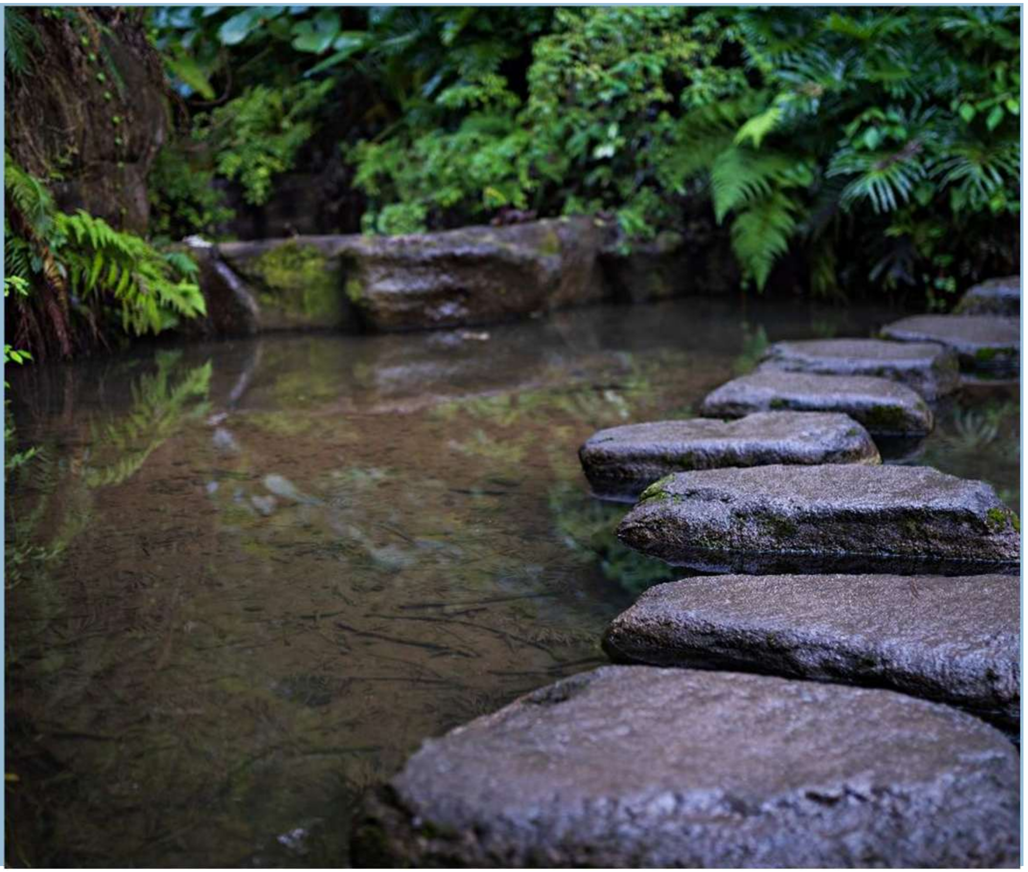

- Creating a sustainability culture within the organisation (this does not happen automatically)
- Means promoting a mindset, values and behaviour related to sustainability

Laws, regulations and standards

Strategic focus areas Sustainable Asset Management

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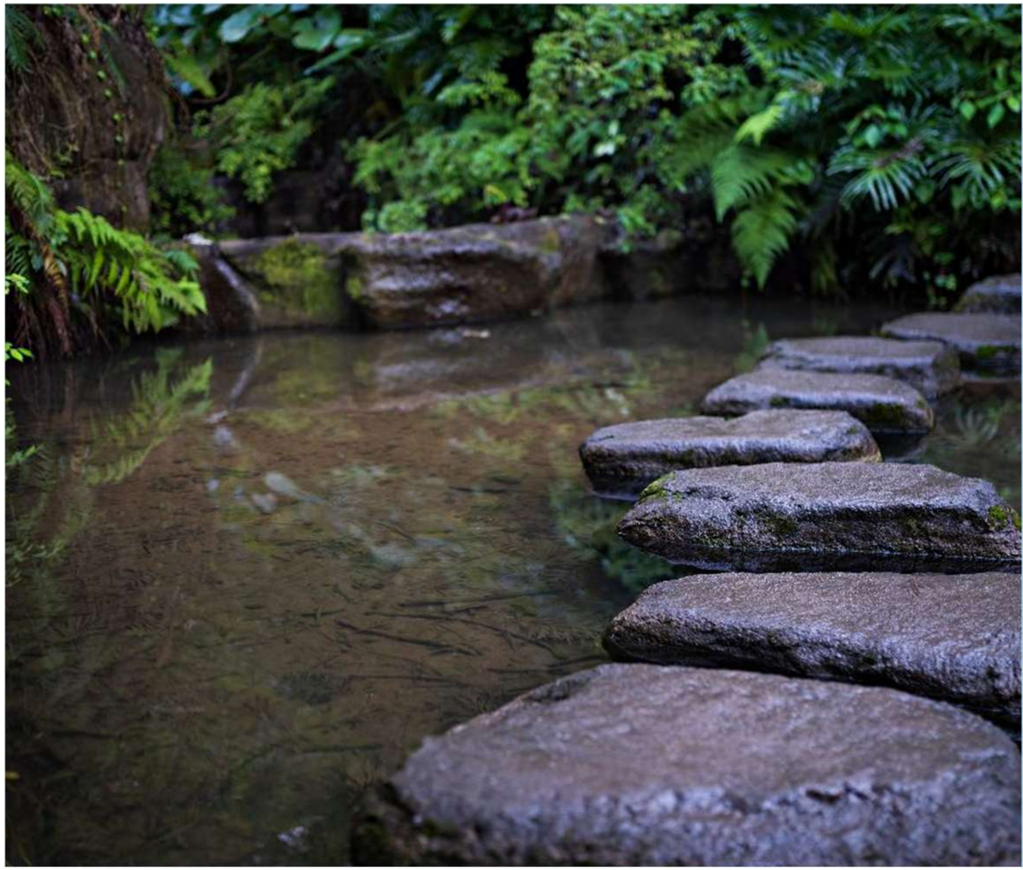
- Importance of complying with relevant sustainability regulations, standards and best practices
- Keeping abreast of trends and developments in Sustainable Asset Management
- Organisational embedding of monitoring laws & regulations and trends & developments



Performance measurement and reporting

Strategic focus areas Sustainable Asset Management

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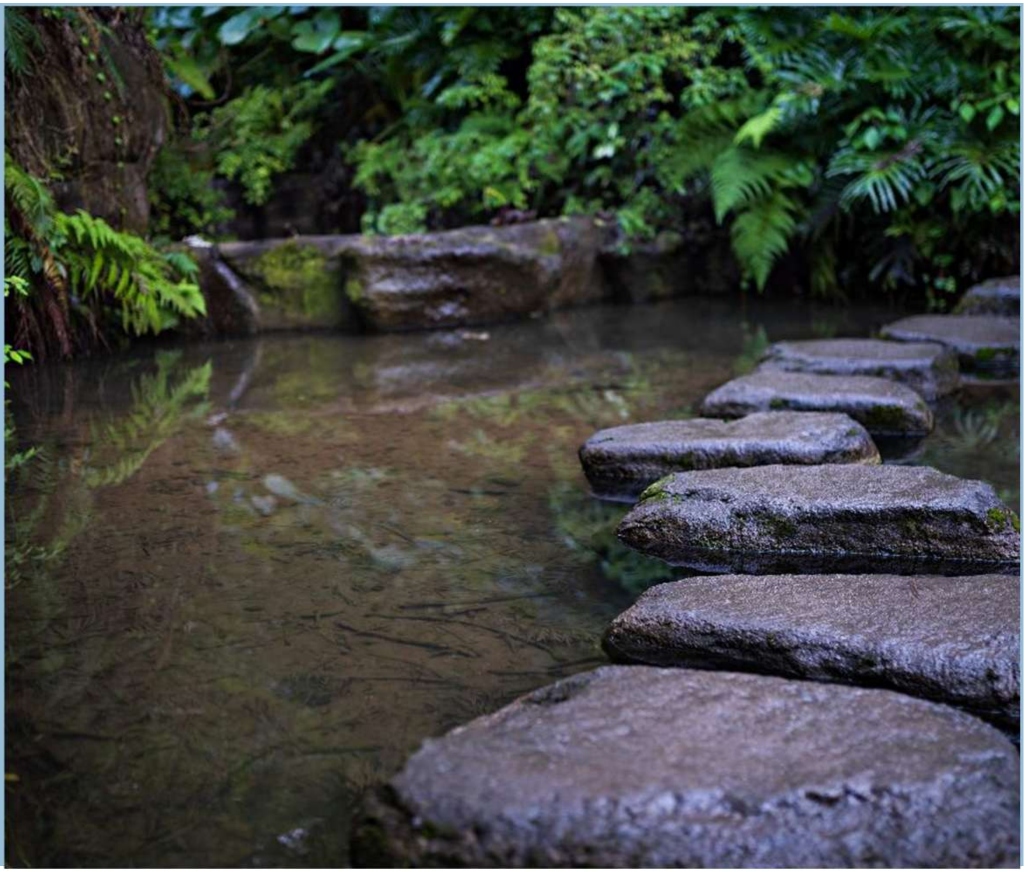

- Setting concrete sustainability performance standards (targets)
- Appoint Key Performance Indicators (KPIs) to measure sustainability performance
- Comply with internal and external reporting guidelines (including CSRD)
- Be able to prioritise against other Asset Management objectives

Reporting guidelines from CSRD

Environment, Social, Government (ESG)

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Climate and environment (E)

Energy efficiency of plants and optimisation of energy use.

- CO_2 emissions from installations (Scope 1, 2, 3) and reduction strategies
- Circular use of materials, maintenance strategies and life extension
- Biodiversity and pollution, e.g. emissions from asset operations

Social Responsibility (S)

- Safety and well-being of employees
- Impact of asset management on local communities and supply chains
- Transparency on sustainable investments and ethical sourcing of materials

Corporate governance (G)

Sustainability criteria in investment decisions for assets

- Sustainability risk management, e.g. climate adaptation of installations
- Board responsibility on sustainable asset management strategies

General

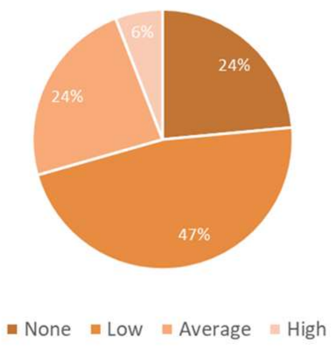
- From 2024 the CSRD will apply to large companies, later also to SMEs and non-EU companies

ESG (Environment, Social and Governance) factors

Benchmark survey results

Impact of sustainability on reporting

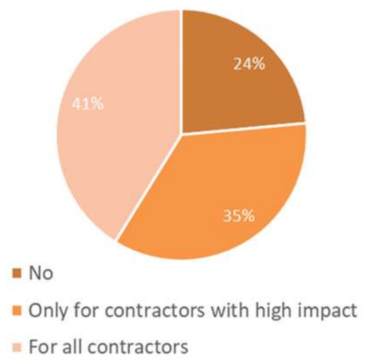
- How does sustainability reporting pressure compare with your M&AM reporting?



- Overall, reporting pressure is currently perceived as low on average
- Within many organisations, concrete sustainability reporting for Asset Management does not yet exist

Social Responsibility

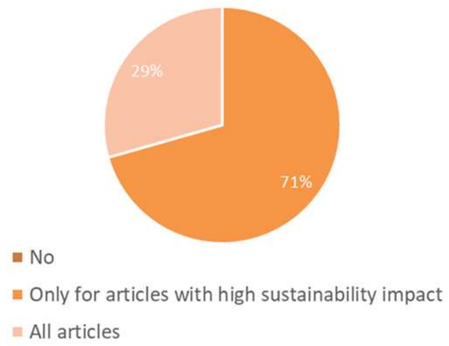
- Do you take sustainability into account when hiring **external capacity**?



- 76% of early adopters pay attention to sustainability when hiring external capacity (contractors)

Social Responsibility

- Do you take sustainability into account when purchasing **materials**?



- When sourcing materials, all early adopters are aware of applying sustainability considerations
- This is mainly focused on materials with high sustainability impacts

Implementation rate of strategic themes in practice 1)

Where are the early adopters?

- Early adopters are still **busy** implementing
- **Laws & regulations** important from the start
- **Instrumental aspects** are picked up first (alignment with strategy, reporting)
- Implementing a **sustainability** culture needs to catch **up**
- Sustainable Asset Management becoming more **integral part** of business strategy

[1)] Implementation rate: percentage of early adopters who have fully or partially implemented the relevant theme

Royal Swinkels

Case Sustainable Asset Management Strategy

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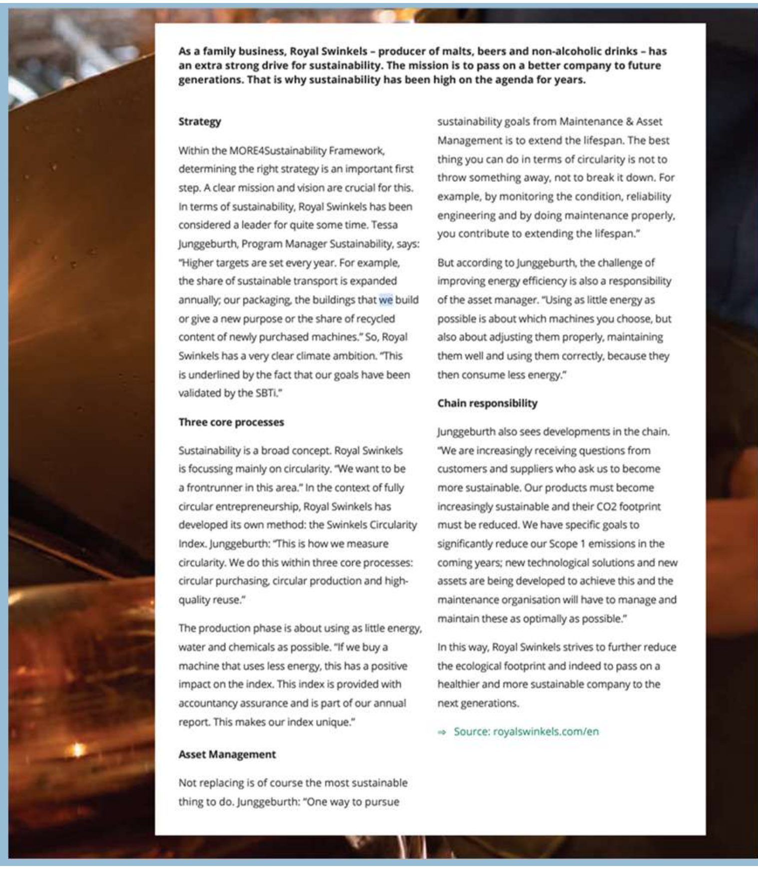
Objective:

"We want to pass on a more sustainable business to future generations!"

- A clear mission and vision are crucial in this respect. When it comes to sustainability, **Royal Swinkels** has long been regarded as a **leader**
- Higher targets are set every year, including an annual increase in the share of sustainable transport
- A very clear climate ambition, with targets **validated by SBTi**
- Swinkels developed its own **Circularity Index**, which measures circularity within three core processes: circular procurement, circular manufacturing and **high-quality reuse**."
- One way to pursue Maintenance & Asset Management's sustainability goals is to **extend the service life**
- The challenge of improving **energy efficiency** is also an asset manager's responsibility
- We have specific targets to significantly reduce our **Scope 1 emissions** in the coming years



As a family business, Royal Swinkels – producer of malts, beers and non-alcoholic drinks – has an extra strong drive for sustainability. The mission is to pass on a better company to future generations. That is why sustainability has been high on the agenda for years.

Strategy

Within the MORE4Sustainability Framework, determining the right strategy is an important first step. A clear mission and vision are crucial for this. In terms of sustainability, Royal Swinkels has been considered a leader for quite some time. Tessa Junggeburth, Program Manager Sustainability, says: "Higher targets are set every year. For example, the share of sustainable transport is expanded annually; our packaging, the buildings that we build or give a new purpose or the share of recycled content of newly purchased machines." So, Royal Swinkels has a very clear climate ambition. "This is underlined by the fact that our goals have been validated by the SBTi."

Three core processes

Sustainability is a broad concept. Royal Swinkels is focussing mainly on circularity. "We want to be a frontrunner in this area." In the context of fully circular entrepreneurship, Royal Swinkels has developed its own method: the Swinkels Circularity Index. Junggeburth: "This is how we measure circularity. We do this within three core processes: circular purchasing, circular production and high-quality reuse."

The production phase is about using as little energy, water and chemicals as possible. "If we buy a machine that uses less energy, this has a positive impact on the index. This index is provided with accountancy assurance and is part of our annual report. This makes our index unique."

Asset Management

Not replacing is of course the most sustainable thing to do. Junggeburth: "One way to pursue sustainability goals from Maintenance & Asset Management is to extend the lifespan. The best thing you can do in terms of circularity is not to throw something away, not to break it down. For example, by monitoring the condition, reliability engineering and by doing maintenance properly, you contribute to extending the lifespan."

But according to Junggeburth, the challenge of improving energy efficiency is also a responsibility of the asset manager. "Using as little energy as possible is about which machines you choose, but also about adjusting them properly, maintaining them well and using them correctly, because they then consume less energy."

Chain responsibility

Junggeburth also sees developments in the chain. "We are increasingly receiving questions from customers and suppliers who ask us to become more sustainable. Our products must become increasingly sustainable and their CO2 footprint must be reduced. We have specific goals to significantly reduce our Scope 1 emissions in the coming years; new technological solutions and new assets are being developed to achieve this and the maintenance organisation will have to manage and maintain these as optimally as possible."

In this way, Royal Swinkels strives to further reduce the ecological footprint and indeed to pass on a healthier and more sustainable company to the next generations.

⇒ Source: royalswinkels.com/en

Source: royalshops.com/en

Module 2

Sustainable Asset Management Strategy & Objectives

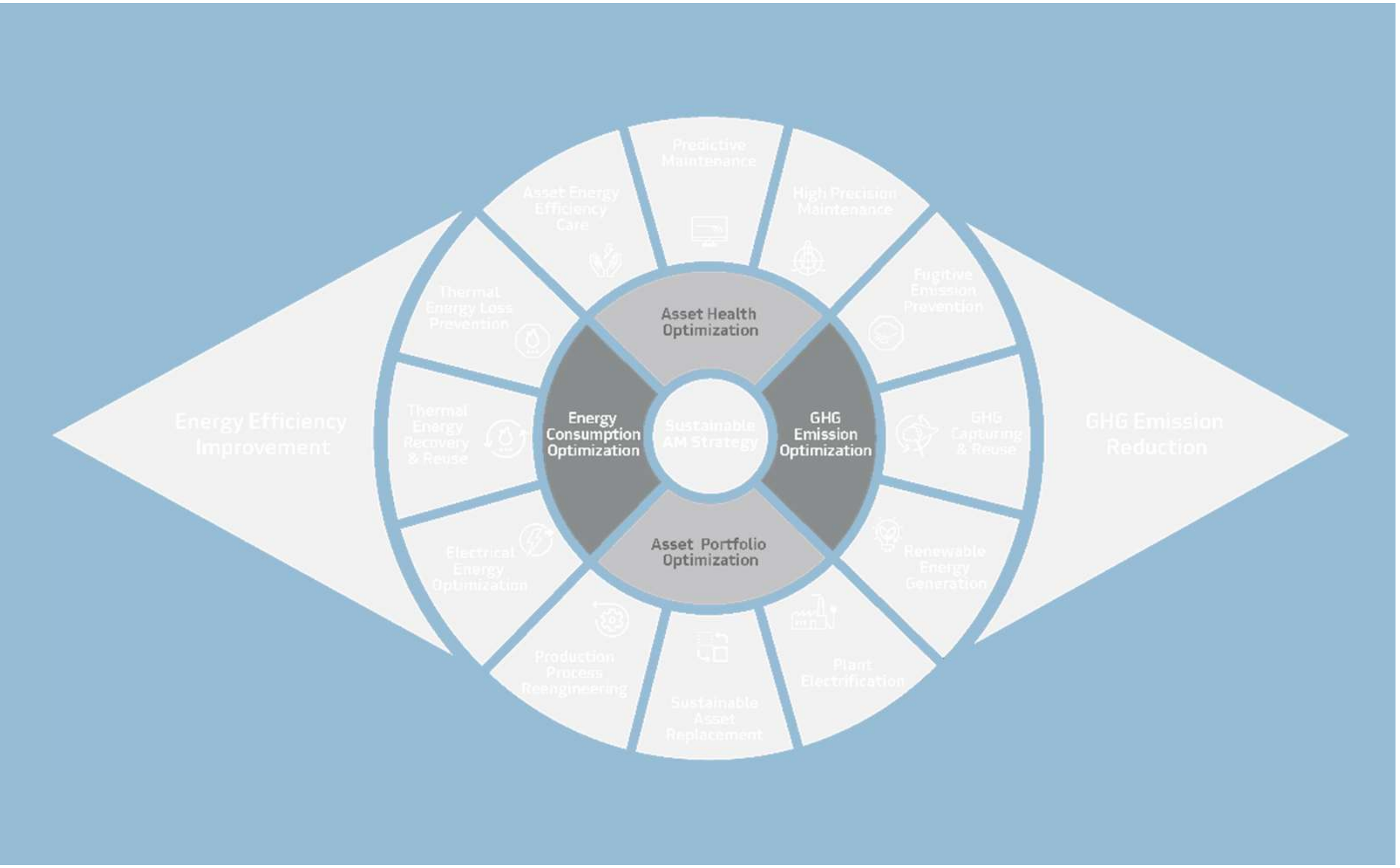
Interreg North-West Europe — Co-funded by the European Union

More4Sustainability

1. Strategy development
2. Tactical enablers

Tactical enablers

The 5 types of enablers



For each tactical focus area, **five topics** are important:

- **Processes** (or process optimisation)
- **Standards and norms**
- **Tooling** (IT systems)
- **Artificial Intelligence** (AI)
- **Training** (of employees)

Processes

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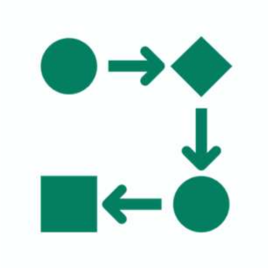
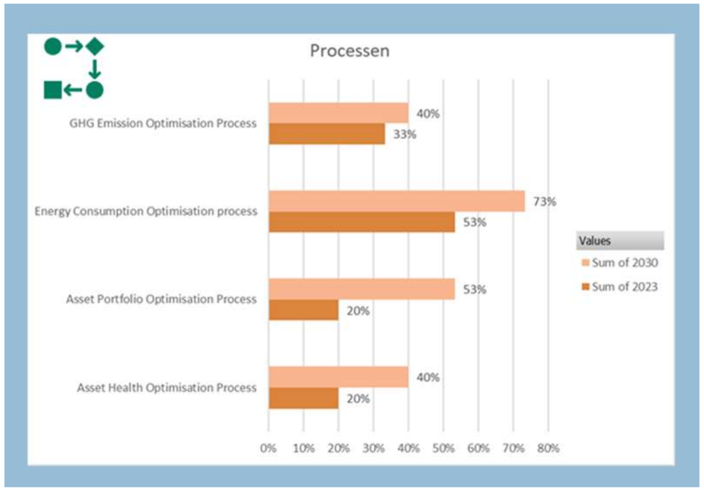
Objective

- Determine **how to** achieve sustainability goals
- Establishing **unambiguous** processes, process steps and procedures
- Establish **responsibilities** by function within these processes and procedures
- Focused on **managing** sustainability risks, implementing targeted improvement actions



Applications

- Develop a processes and procedures (or work instructions) as an integral part of the **quality system**
- **In line with** applied norms and/or standards (see next slide)
- Aligned with applied **IT systems** and tools



Standards and norms

Objective

- Establish **quality standards** to be applied
- Based on existing, widely **accepted standards** with regard to the four areas of concern within the quadrants

Applications

Asset Portfolio Optimisation Process

•**ISO 55000** standard for Asset Management

Asset Health Optimisation Process

•**ISO 18436** standard for condition monitoring and diagnosis of machinery

Energy Consumption Optimisation process

•**ISO 50001** standard for energy management

GHG Emission Optimisation Process

•**ISO 14001** standard for environmental systems

Other standards, if applicable to the topic in question, can also be applied

Implementation of ISO standards

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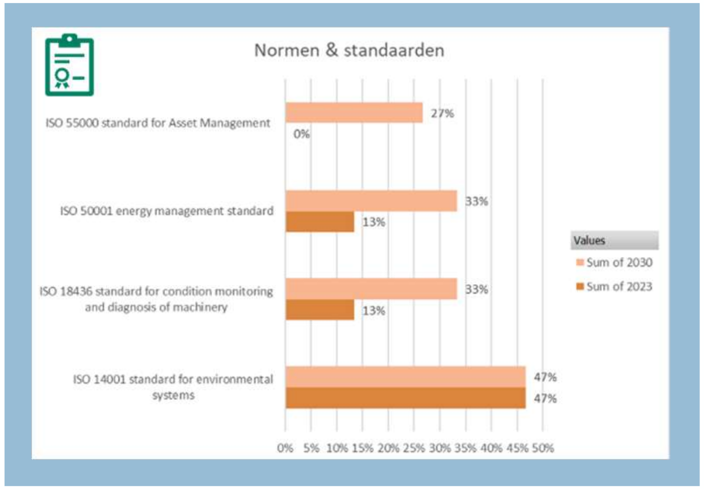
ISO 55000 - Asset management

- Focused on effectively managing physical and non-physical assets
- Emphasises strategic and risk-based approach to asset management
- Supports decision-making based on lifecycle management
- Integration with other management systems, such as ISO 9001 and ISO 14001
- Sets requirements for leadership and stakeholder engagement

ISO 18436 - Condition Monitoring and Diagnostics of Machinery

- Focuses on certification of personnel responsible for condition monitoring and diagnostics of machines
- Contains specific requirements for knowledge, skills and competences of technicians in vibration analysis, thermography, oil analysis and other techniques
- Aims to improve predictive maintenance and minimise breakdowns
- Helps companies increase equipment reliability



ISO 50001 - Energy management

- Aimed at improving energy performance and energy efficiency in organisations
- Introduces a systematic approach to monitoring, measuring and improving energy use
- Incorporates principles such as the Plan-Do-Check-Act (PDCA) cycle for continuous improvement
- Promotes compliance with energy management laws and regulations
- Can lead to cost savings and reduction of CO_2 emissions

ISO 14001 - Environmental management

- Focuses on minimising environmental impacts of business activities
- Requires a systematic approach to identifying and managing environmental risks
- Encourages compliance with environmental legislation and reducing waste, energy consumption and pollution
- Supports sustainability and corporate social responsibility (CSR)
- Based on the Plan-Do-Check-Act (PDCA) cycle for continuous improvement

Tooling & IT systems

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Objective

- Collection of data that can be used to perform **analysis** to **optimise** specific **performance** within a tactical focus area
- Monitoring realised performance for **reporting** purposes

Applications

Asset Portfolio Optimisation systems

- Enterprise Asset Management systems (**EAM**), Asset Investment Planning software (**AIP**), GIS **systems**

Asset Health Optimisation systems

- **EAM systems,** Condition Monitoring Systems **(CMS) ,** Predictive Maintenance **(PdM)** systems,

Energy Consumption Optimisation systems

- (Industrial) Energy Management Systems **(EMS),** Building Management Systems (BMS), integration of **SCADA** (Supervisory Control and Data Acquisition) systems with **IoT** (Internet of Things) **systems**

GHG Emission Optimisation systems

- Continuous Emission Monitoring Systems (**CEMS**), Industrial Emission Control Systems (**IECS**), Net Zero Planning Software,

Artificial Intelligence

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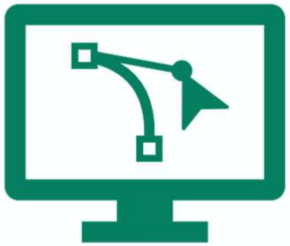
Objective

- Analysing energy consumption patterns, predicting peak loads and automating energy-saving measures and optimisation proposals
- Optimising production processes to reduce CO_2 emissions
- Analysing and forecasting maintenance needs to prevent breakdowns and potential emissions and energy losses

Applications

- Often already **integrated** into existing systems to optimise asset portfolios, asset health, energy consumption and greenhouse gas emissions
- Predictive maintenance systems, Asset performance management systems, Energy management & optimisation systems, Smart Building systems, Machine learning



IT systems and AI application

Implementation rate among early adopters

Asset Portfolio Optimisation systems

- Enterprise asset management systems (**EAM**)
- Asset investment planning software (**AIP**)
- **GIS** systems

Asset Health Optimisation systems

- **EAM systems**
- Condition monitoring systems **(CMS)**
- Predictive Maintenance **(PdM)** systems,

Energy Consumption Optimisation systems

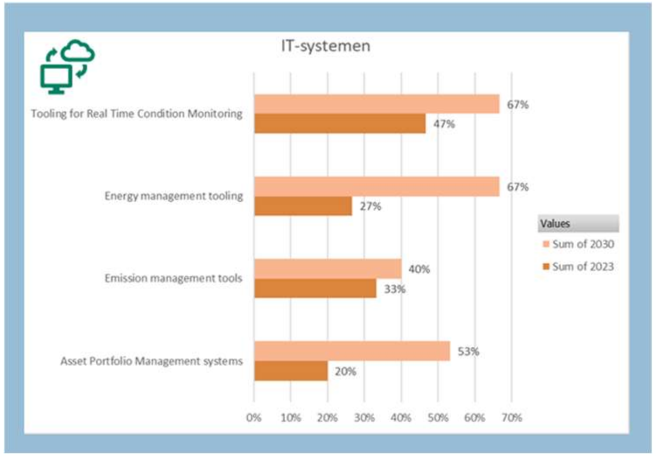
- (Industrial) Energy Management Systems **(EMS)**
- Building management systems (BMS)
- Integration of **SCADA** (Supervisory Control and Data Acquisition) systems
- Internet of Things (**IoT**) **systems**

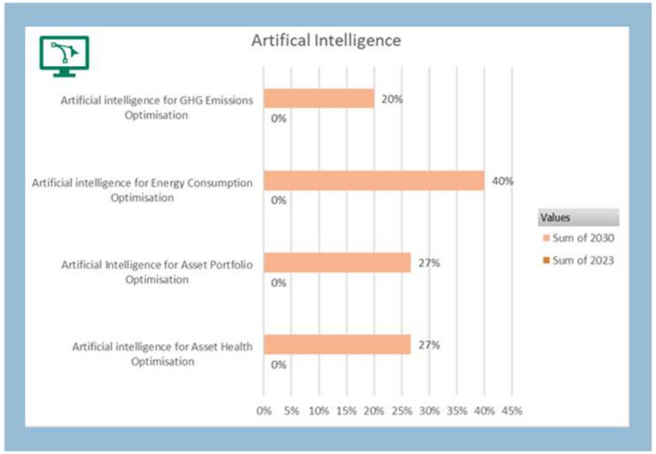
GHG Emission Optimisation systems

- Continuous Emission Monitoring Systems (**CEMS**)
- Industrial Emission Control Systems (**IECS**)
- Net Zero Planning Software

Artifical Intelligence

- Integration into the above systems
- Smart Building systems
- Machine learning





Training of employees

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Objective

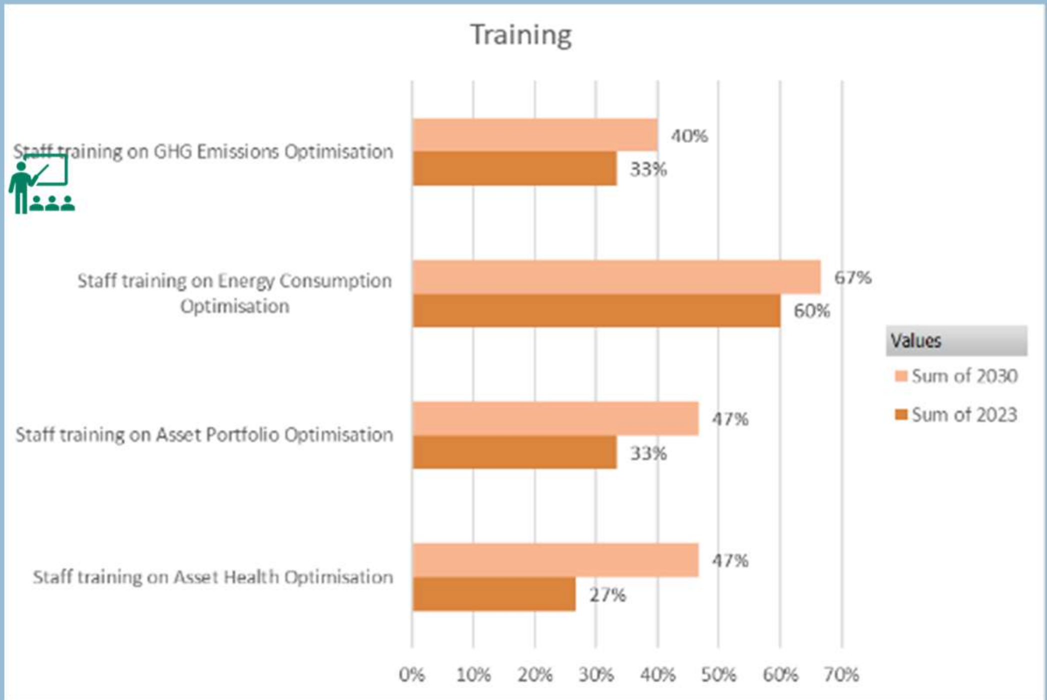
- Getting employees to a level where sustainability becomes part of their daily actions
- Familiarising employees with and being able to apply the uniform working method, procedures and related systems and methods
- Creating awareness about the usefulness, necessity and added value of sustainability within Asset Management

Applications

- Targeted training on IT systems to be applied within the four tactical focus areas of the Sustainable Asset Management Framework
- Training aimed at applying new methods within work processes

Training

Implementation rate of tactical enablers



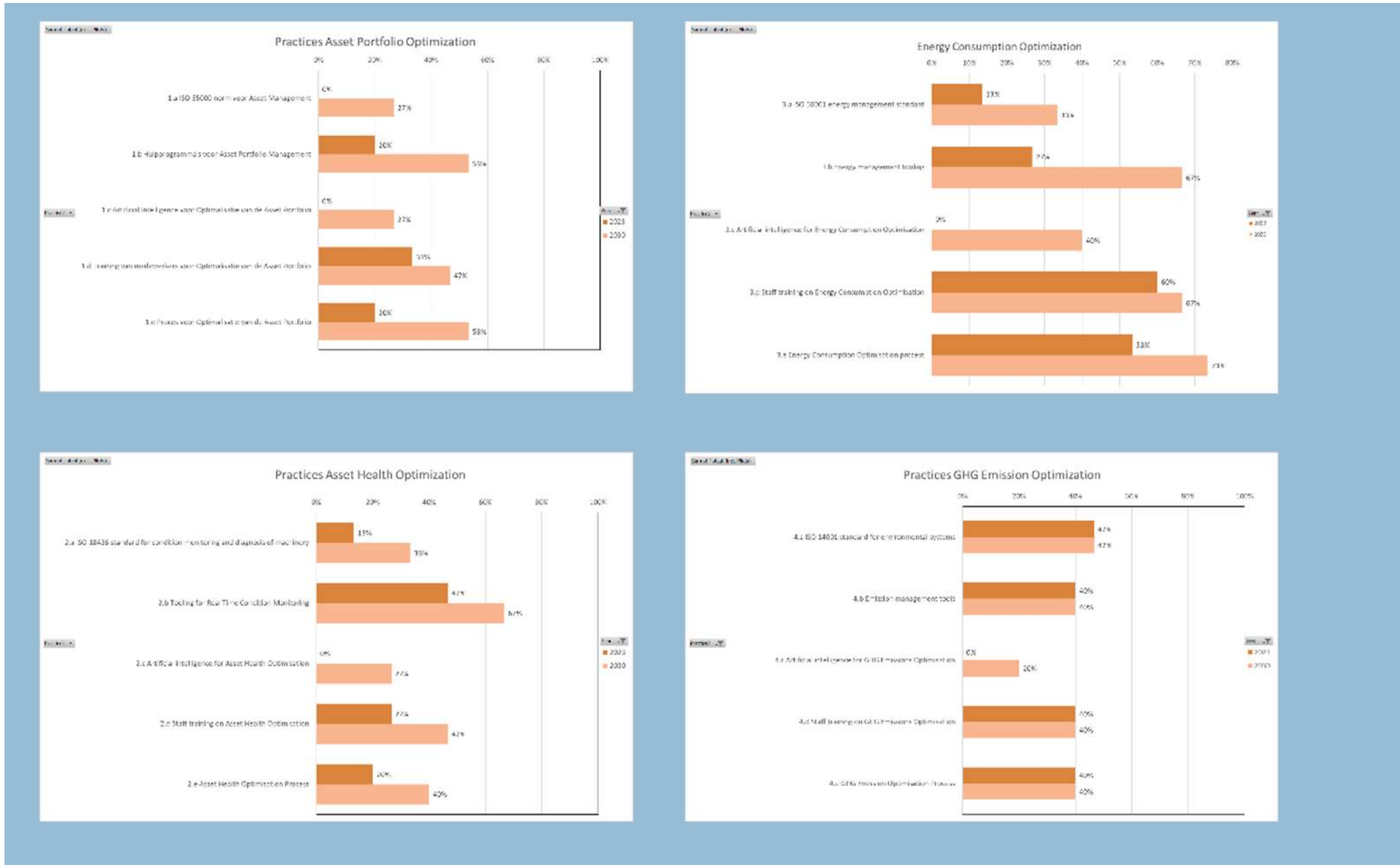
Training:

- The need for training is particularly seen in Energy Consumption Optimisation
- This is a topic that requires specific staff training
- For the other quadrants, the necessary skills are mostly in house and additional training seems less necessary

The four quadrants

Implementation rate

- From the results for each quadrant, we learn that the implementation rate for **Energy Consumption Optimisation** is by far the highest
- Asset Portfolio Optimisation is going to **grow** in the coming years though
- In addition, the focus on further developing GHG Emission Optimisation remains **relatively low**
- These results can be explained by the current **focus on Energy Efficiency** Improvement



e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 3
Asset Porfolio Optimisation

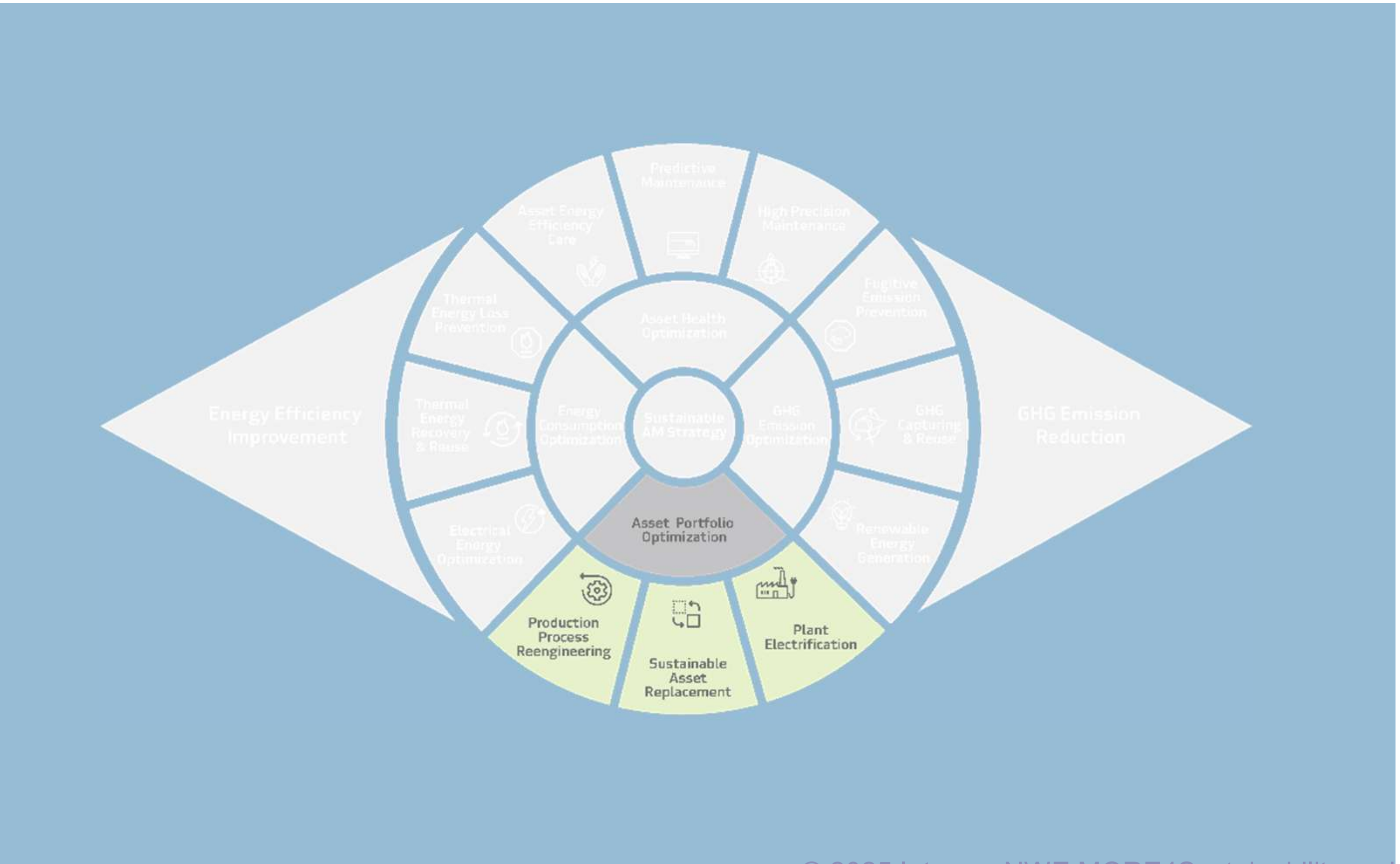
Module 3

Asset Portfolio Optimisation

1. Objectives and impact
2. Electrification of installations
3. Sustainable replacement of assets
4. Re-engineering the production process

Overall objective and measures

Asset Portfolio Optimisation



Objective of this quadrant:

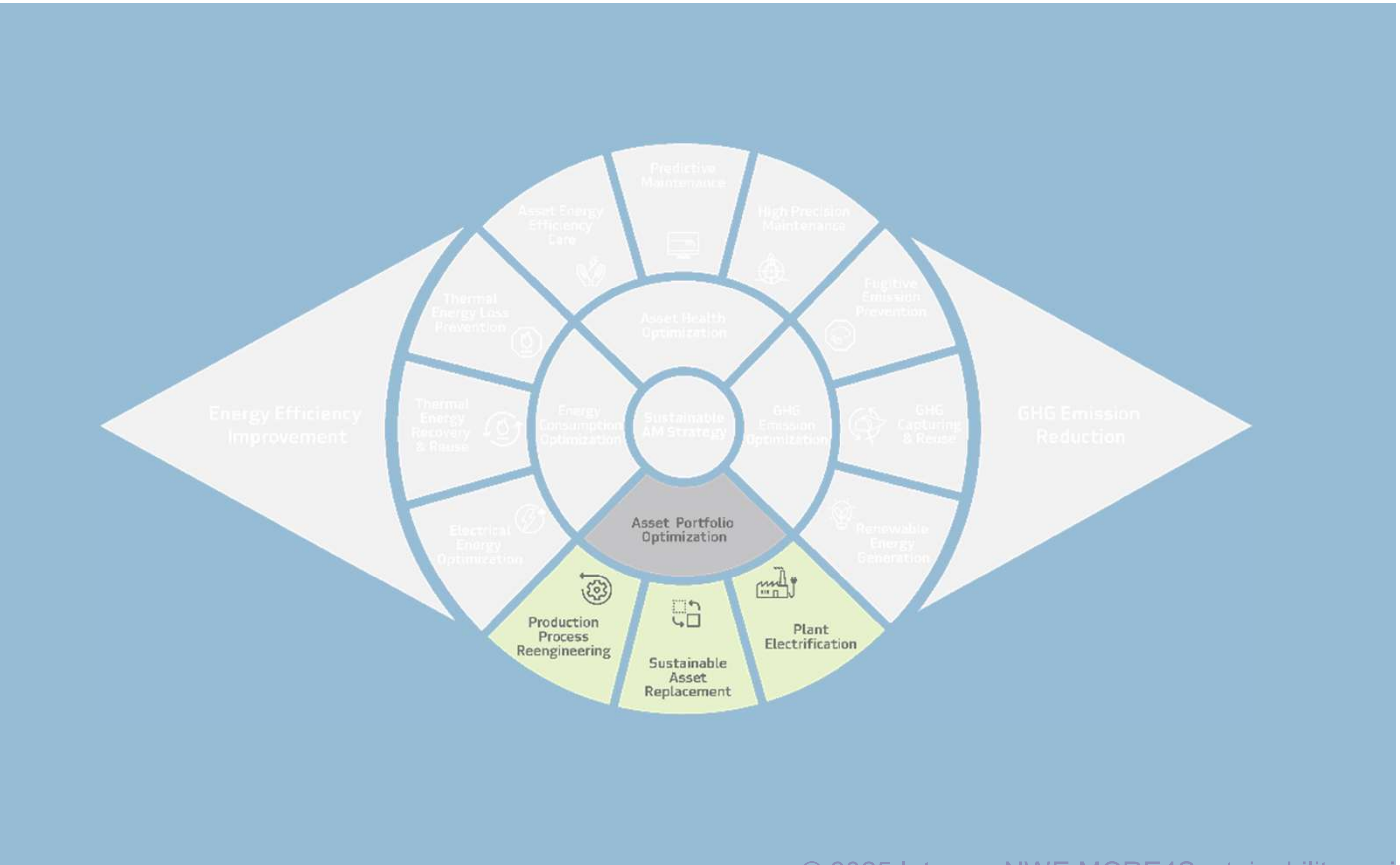
- Have the right assets to achieve sustainability goals
- With lifecycle risk management

Measures:

- From a sustainability perspective, strategically **evaluate** entire portfolio of physical assets
- Subsequently **replacing** unsustainable machines or
- **Upgrades** to more sustainable technologies lead to sometimes high investments

Focus areas

Asset Portfolio Optimisation



Characteristics of focus areas

Electrification of installations

- Transition from traditional fossil fuel-based energy sources, to electric power

Sustainable replacement of assets

- Replacing or upgrading existing assets with more sustainable and environmentally friendly alternatives using the same type of energy source

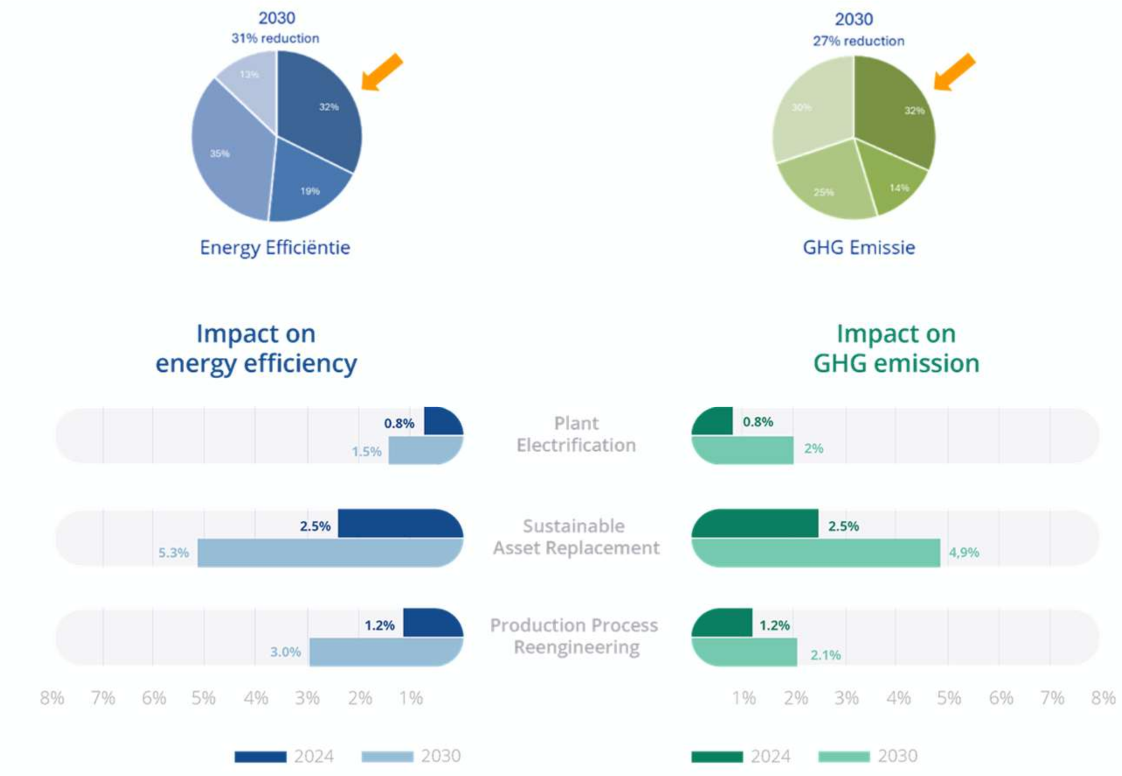
Re-engineering the production process

- Fundamentally redesigning and optimising production processes to achieve significant improvements in efficiency, productivity and sustainability

Impact on sustainability

Asset Portfolio Optimisation

- Realising sustainability improvements within this quadrant requires **high investments** on average
- But the **impact** on sustainability is **large**: about 1/3 of improvements in 2030 should come from Asset Portfolio Optimisation
- **Sustainable replacement of assets** has by far the most impact on both sustainability goals, in both 2024 and 2030
- **Re-engineering of production processes** will also be increasingly used in the coming years to meet improvement targets
- Electrification of plants has continued to hold **lower shares** for energy efficiency



Module 3

Asset Portfolio Optimisation

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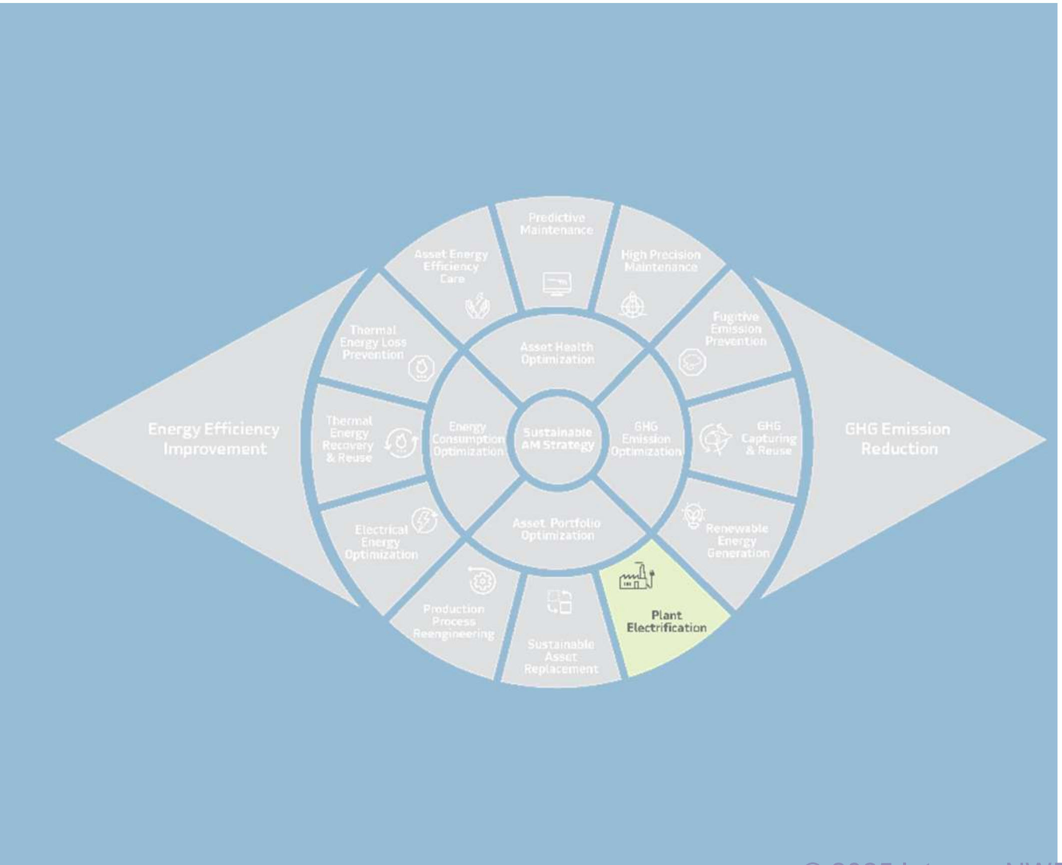
Electrification of installations

Asset Portfolio Optimisation



Characteristics focus area

- Electrification of Installations refers to the process of transitioning from traditional fossil fuel-based energy sources, to electrical energy
- So this is about replacing or supplementing mechanical systems and machinery powered by fossil fuels with electrically powered alternatives
- This can be achieved through the following measures:

Electric pumps

Electric Compressors

Electric Heating Elements

Electric vehicles and forklifts

Impact Electrification of Installations

Implementation rate early adopters

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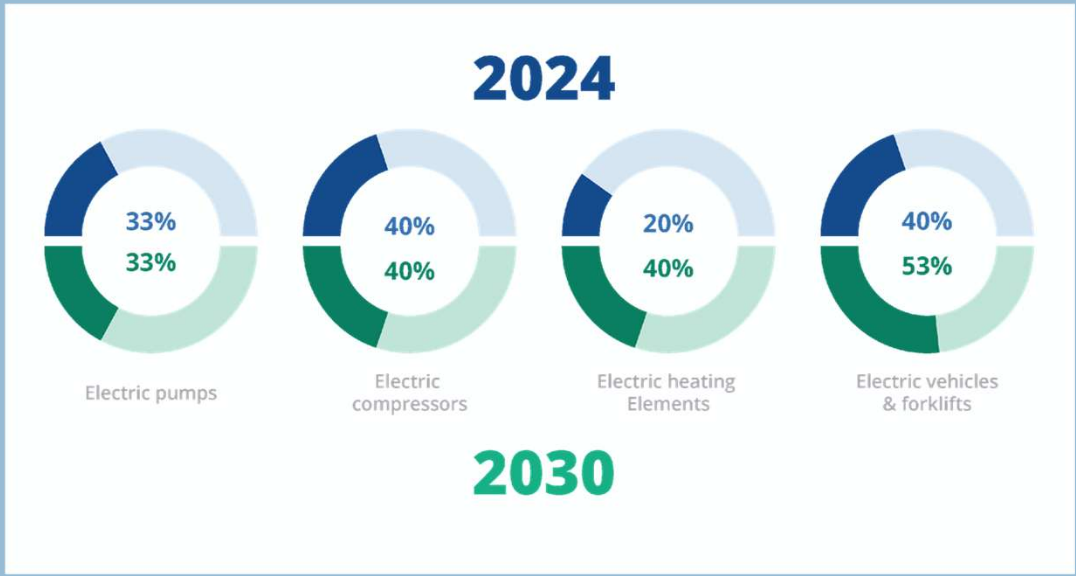
- Despite **popularity**, overall impact of this focus area is relatively low: from 0.8% in 2024 to 1.5 (energy efficiency) to 2% (GHG emissions) in 2030
- Of early adopters, over 50% expect **on-site vehicles** to be replaced by electrically powered vehicles by 2030
- This gives positive effect on **greenhouse gas emissions**
- The **remaining measures** have lower implementation rates
- Of these, most of the return may already have been achieved **in the past**



Isover Hybrid Glass Furnace

Plant Electrification

Objective:

Reduce CO2 emissions and improve energy efficiency in glass wool production at Isover in Etten-Leur, the Netherlands, by implementing the world's first **hybrid glass furnace**

Actions:

- Installation of a hybrid glass furnace capable of running **on** both **natural gas and electricity**
  Cooperation with Eneco to supply **renewable electricity** for the furnace

Performance:

- Reduction of total **CO2 emissions** by **~ 20%** for the next 10 years
  Reduction of **gas consumption** by ~ 50%
  Reduction of **energy consumption** by **~** 26%

Challenges:

- **High investment costs** for the new technology
  Ensure **stable supply** of renewable electricity
  Balancing the use of gas and electricity to optimise efficiency and emission reduction

Source: Isover Etten-Leur opens world's first hybrid glass furnace - Industrielings

La Lorraine Bakery Group

Oven Electrification

Interreg North-West Europe — Co-funded by the European Union

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Objective:

LLBG aims to be **CO_2 neutral** in **Scope 1 and 2** by **2039**, and in **Scope 3 by 2050.** LLBG aims to be at the forefront of sustainability in the bakery world

Big challenge is in the Agri chain; in the bread supply chain, a significant proportion of emissions come from agriculture.

In terms of Scope 1, LLBG is expressly looking at **electrifying large consumers of Energy** such as the Furnaces.

Actions:

- **Investing** in regenerative agriculture
  Electrifying ovens

Performance:

- Wheat produced using regenerative agriculture techniques leads to **40% CO_2 reduction for the wheat**

Challenge:

- Bread made in an electric oven has a less tasty, crispy exterior -> **trade-off between sustainability and customer desire**

Holland Malt

Completely emission-free malting plant

Objective:

Holland Malt, an internationally operating malting company, produces over **400,000 tonnes of Malt** annually. Corporate targets are **50% CO_2 reduction by 2030 for Scope 1 and 2** and **fully climate neutral** in the entire chain by **2050**. (SBTi affiliated)

Actions:

- **Complete electrification** of the production process
  Uses **heat pumps** and **green electricity** from North Sea **wind power**
- Largest heat pump project in the Netherlands; comparable to the consumption of 300,000 refrigerators

Performance:

- Saving **18 million m^3 of natural gas**
- CO_2 emissions savings of **33,000 tonnes**

Module 3

Asset Portfolio Optimisation

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1. Objectives and impact
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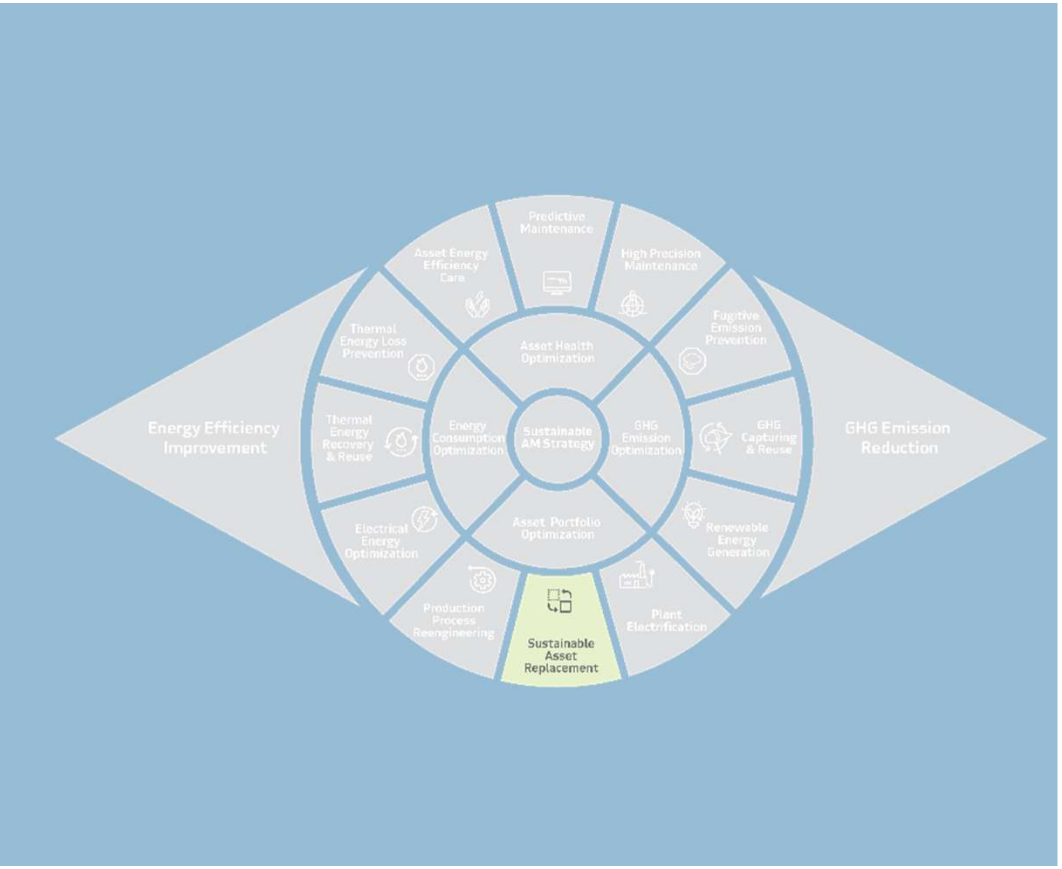
Sustainable replacement of assets

Asset Portfolio Optimisation



Characteristics focus area

- Sustainable replacement of assets refers to replacing or upgrading existing assets, such as equipment, machinery or facilities, with more sustainable and environmentally friendly alternatives using **the same type of energy source**, but with **better energy efficiency characteristics**
- We also call this **like-for-like**
- Replacing "dirty" machines with "clean" machines with high energy efficiency and low GHG emissions is the **simplest** way to work on sustainability
- Often **first step** towards sustainability when old machine has reached end-of-life
- At that point, the **additional investment** in sustainability **is not that high** because the replacement had to be done anyway

Sustainable replacement of assets

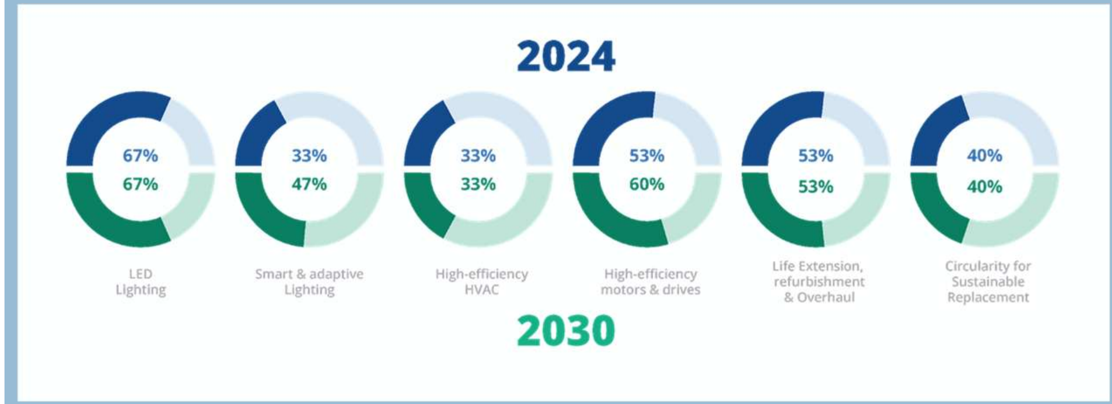
Possible measures?

LED lighting	Traditional lighting solutions (such as incandescent, fluorescent and halogen lamps) are being replaced by LED lighting technology
Smart and adaptive lighting	Advanced lighting systems that adjust the level and quality of light in an environment based on various factors, such as the availability of natural light, occupancy, time of day and specific user preferences or activities
High-efficiency HVAC	HVAC systems providing heating, cooling and ventilation with significantly higher energy efficiency than standard HVAC systems
High-efficiency motors and drives	Essential components in various applications operating with minimal energy losses, maximising efficiency and reducing electricity consumption
Lifetime extension, renovation and overhaul	Significantly improve machine sustainability by extending equipment life, reducing the need for virgin materials, reducing waste generation and improving energy efficiency
Circularity for sustainable replacement	Involves reconsidering how assets are replaced, with an emphasis on minimising environmental impact, maximising use of existing resources and ensuring that materials are effectively reused or recycled at end of life

Sustainable replacement of assets

Implementation rate early adopters

- Many **ageing assets** in North West Europe, **provides opportunities** for sustainable asset replacement
- Key reason for **highest impact** of this focus area within Asset Portfolio Optimisation
- Replacing with **LED lighting popular** (implemented by 70% of early adopters) and relatively accessible in terms of cost and complexity
- The use of **high-efficiency motors and drives** is another technology that is already in wide use
- Applying **life extension and circularity** for sustainable replacement mainly impacts **emissions scope 3**



EcoNation - LightCatcher

Case Sustainable Asset Replacement

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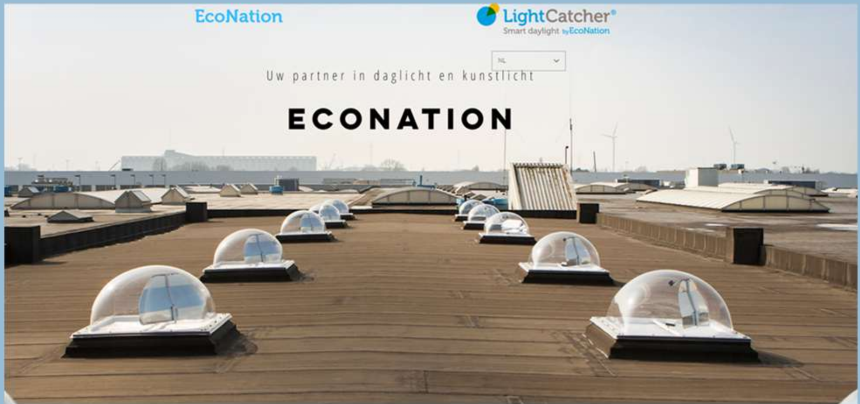

- EcoNation is a Belgian company specialising in intelligent daylighting systems.
- They developed the LightCatcher to make more efficient use of natural daylight in buildings.
- The system includes a smart light dome with a mirror that adjusts automatically.
- It captures, filters and amplifies daylight via a light shaft for optimal illumination.
- Reduces artificial lighting use, significantly lowering energy costs and CO2 emissions.
- Less artificial light also means lower maintenance costs of lighting installations.
- The double layers of air in the dome provide additional insulation and temperature stability.
- This saves on heating in winter and cooling in summer.
- Carglass installed 422 LightCatchers in a 40,000 sq m distribution centre.
- This installation saves 175 MWh of energy and 57.4 tonnes of CO2 emissions annually.

Source: www.econation.be/en

Module 3

Asset Portfolio Optimisation

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1. Objectives and impact
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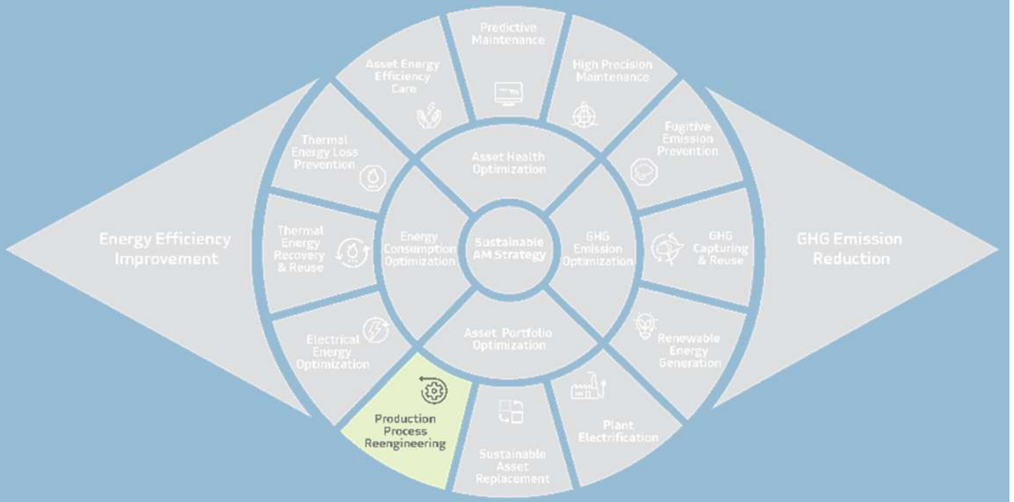
Re-engineering the production process

Asset Portfolio Optimisation



Characteristics focus area

- Fundamentally redesigning and optimising production processes
- Aimed at achieving significant improvements in efficiency, productivity and sustainability
- Ultimate goal from a sustainability perspective is to minimise resource consumption and reduce greenhouse gas emissions and energy consumption
- Also deployed to maintain or improve plant competitiveness
- Often also viewed from a company-wide view of production capacity and competitiveness

Re-engineering the production process

Possible measures

Process optimisation and redesign	Introduce technology upgrades and automation to minimise energy consumption, greenhouse gas emissions and waste generation, while maintaining or improving productivity and product quality
Switching to other products	Process of switching the production line from producing one product to another, more sustainable product. This process may involve several steps and modifications to machinery, equipment and operational set-ups to meet the specifications and requirements of the new product and improve sustainability performance
(Partial) plant closure	Closure of all or part of a production facility's operations. This may have various reasons, including restructuring of operations, reduction in demand for certain products, maintenance or upgrades of specific parts of the plant, or sustainability issues leading to scaling back operations
Construction of (a partial) new factory	Construction of an expansion of an existing production facility or of an entirely new plant. This approach is used to expand production capacity, introduce new product lines and/or adapt to new production technologies
Circularity in terms of redesigning production processes	Refers to fundamentally rethinking and redesigning production processes with the aim of minimising waste, maximising resource efficiency and creating sustainable products with a longer life cycle

Re-engineering the production process

Implementation rate early adopters

- Re-engineering the production process is a **complex and expensive measure**
- **If electrification** of plants **does not contribute sufficiently** to sustainability, this focus area could offer a solution
- We saw this earlier in the **growing impact** of re-engineering of production processes **between 2024 and 2030** (from 1.2% to 3% in terms of energy efficiency).
- The growing impact comes mainly from applying **Process optimisation and redesign**
- (Partial) **closure** is currently only considered as an option by a **minority of** early adopters
- However, many early adopters do complain about increasingly **stringent regulations**

Tata Steel - Electric furnace

Case study on Electrification of Installations

Project Overview

- Tata Steel Netherlands is replacing its largest blast furnace (BF7) and coking plant (KGF2) with a **new steel production line** based on **electric arc furnace technology** (EAF technology)
- The project aims to reduce **CO_2** emissions at the IJmuiden site by around **40%** by 2030

Energy Trade-offs

- Shift to EAF technology significantly increases consumptive of electricity
- Tata Steel will use renewable energy from nearby offshore wind farms to power the new steel production line
- A new connection to the 380 kV grid has a capacity of 8-9 TWh/year, of which Tata Steel uses **2-2.25 TWh/year**

Tata Steel moves forward with first phase of 'Green Steel' plan in the Netherlands

29 May 2024

Tata Steel Nederlands has taken a step toward decarbonizing its operations by awarding contracts for an electric-arc furnace (EAF) and direct reduction iron (DRI) plant at its site in IJmuiden in the Dutch province of North Holland.

Tata Steel Nederlands said on Monday May 27 that it had awarded contracts for the basic engineering of the EAF and DRI to two Italian companies – equipment supplier Danieli and system solutions specialist Tenova.

Part of the first stage of Tata Steel Nederlands' "Green Steel" plan, which it expects to be complete by 2030, the EAF will replace the site's largest blast furnace, BF7, while the DRI plant will replace one of the company's coke-making plants.

https://eurometal.net/tata-steel-moves-forward-with-first-phase-of-green-steel-plan-in-the-netherlands/

Thermal Vapor Recompressor- Suiker Unie

Production Process Re-engineering

The **thermal vapour recompressor** at Suiker Unie's factory captures and reuses excess steam from industrial processes, significantly reducing energy consumption and CO2 emissions in sugar production. It works in combination with a **multi-stage evaporation process** to maximise energy efficiency.

This solution is highly applicable for manufacturing companies, especially those with energy-intensive processes involving steam or evaporation

Suiker Unie has achieved almost 60% CO2 reduction compared to 1990, with a target of **75% reduction by 2030**. However, the specific contribution of the thermal vapour recompressor to this reduction is not mentioned.

The seven-stage evaporation process alone **saved 14% of** the process' **energy requirements**. With the addition of the thermal vapour recompressor**, residual heat loss is now almost zero.**

This project shows how innovative technology can significantly reduce energy consumption and CO2 emissions in the sugar production industry, contributing to **Royal Cosun**'s goal **of becoming carbon neutral by 2050**.

https://www.twence.nl/projecten/grolsch-managerduurzaamheid

ENI - Partial plant closure

Production Process Re-engineering

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Objective:

Transforming ENI's chemical division (Versalis) into a more **sustainable and efficient operation**, reducing CO_2 emissions and **improving energy efficiency**.

Actions:

- **Closure** of 2 squatters and 1 PE production facility in Italy.
- **Investing 2 billion** in Green technology and initiatives tbh circular economy.
- Develop a new type of cracker that **can** convert **bio-based raw materials** in addition to traditional raw materials.
- Expanding production of bio-based products and recycled polymers.

Goals:

- Reduce Scope 1 and 2 emissions by **50% in 2030** compared to 2018.
  By 2030**, 40%** of products produced should be **renewable or circular**.

ENI thus takes a big step towards changing to more sustainable production and products


Eni's chemicals unit opens new recycled plastic production plant

By Reuters

March 24, 2025 7:23 PM GMT+1 · Updated 24 days ago

Aa

Eni reorganises chemicals business: closes 2 crackers and PE production, invests 2 billion in 'green' - Industrielings

e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 4
Asset Health Optimisation

Module 4

Asset Health Optimisation

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1. Objectives and impact
2. Asset Energy Efficiency Care
3. Predictive Maintenance
4. High Precision Maintenance

Overall objective and measures

Asset Health Optimisation

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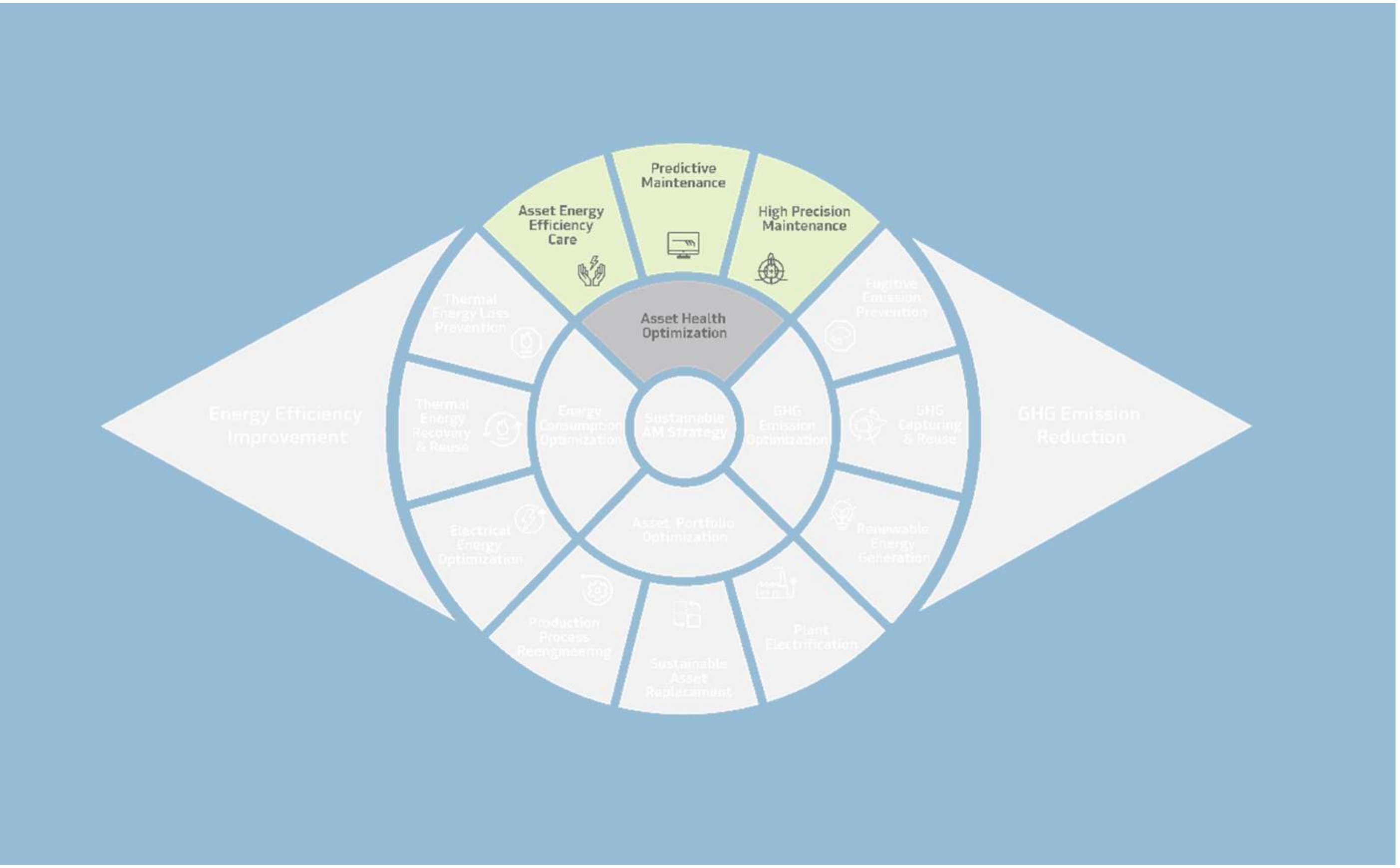


Objective of this quadrant:

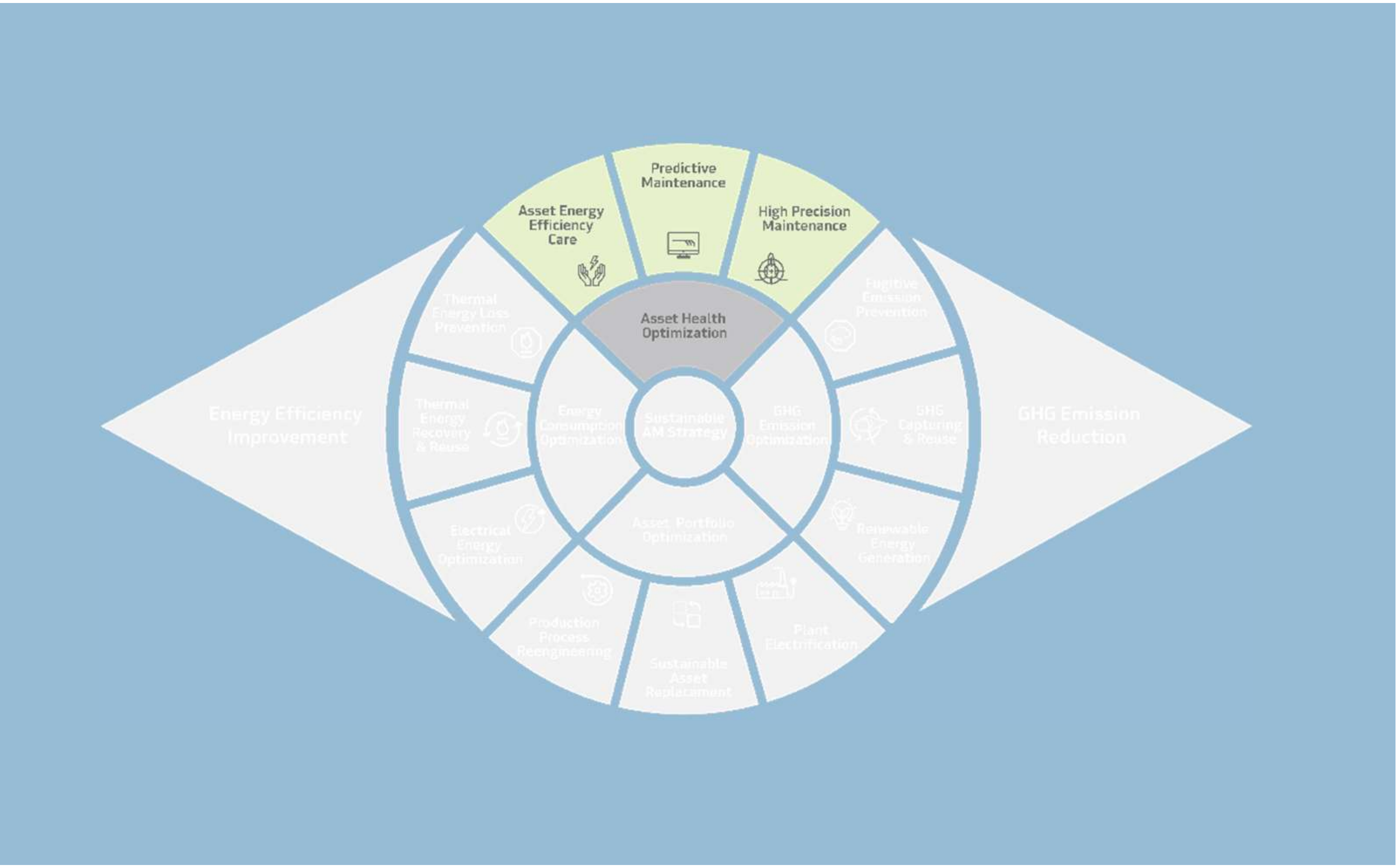
- Aimed at optimising asset condition due to sustainability reasons
- To improve asset condition and performance and extend the life of assets

Measures:

- Carrying out defined maintenance correctly
- Optimising existing maintenance
- Proper adjustment and setting of machines

Focus areas

Asset Health Optimisation



Characteristics of focus areas

Asset Energy Efficiency Care

- Is derived from Operator Asset Care, which involves proper maintenance and alignment of machines

Predictive maintenance

- Focuses on making failures predictable by using smart algorithms based on condition data, production data, maintenance data and environmental data

High Precision Maintenance

- Maintenance techniques with emphasis on accuracy, adherence to strict tolerances and perfect machine balancing

Impact on sustainability

Asset Health Optimisation

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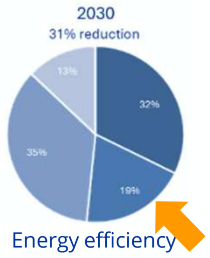
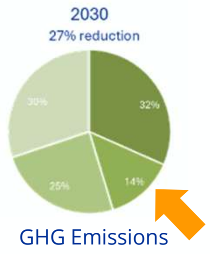
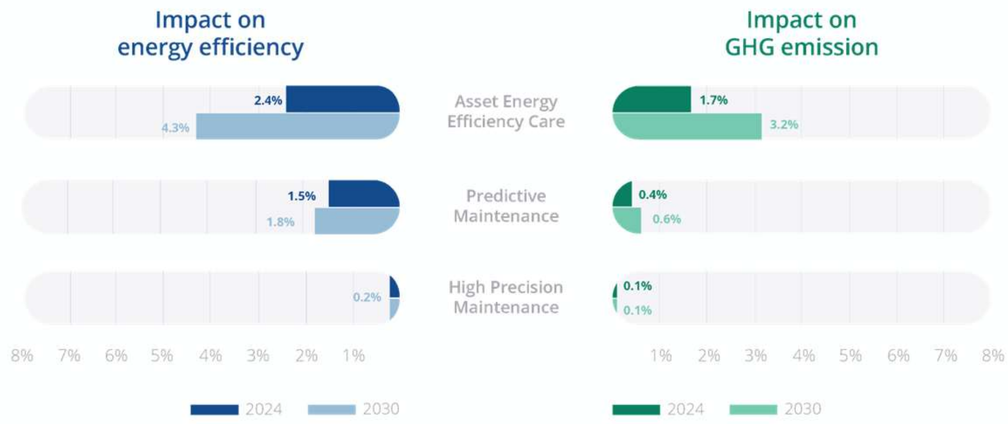




- Earlier, we saw that the **impact of Asset Health Optimisation** on sustainability goals is **smaller** than the impact of the other quadrants
- Nevertheless, we can conclude from the benchmark study that **Asset Energy Efficiency Care** makes a decent contribution to asset sustainability in absolute terms: up to **4.3%** on energy efficiency and **3.2%** on greenhouse gas emissions **by 2030**
- **Predictive Maintenance** and **High Precision Maintenance** are seen much **less** by early adopters as **effective** sustainability **measures**
- Despite all the attention and expectations, Predictive Maintenance does **not** seem to play **a significant role** in sustainable asset management in the medium term



Module 4

Asset Health Optimisation

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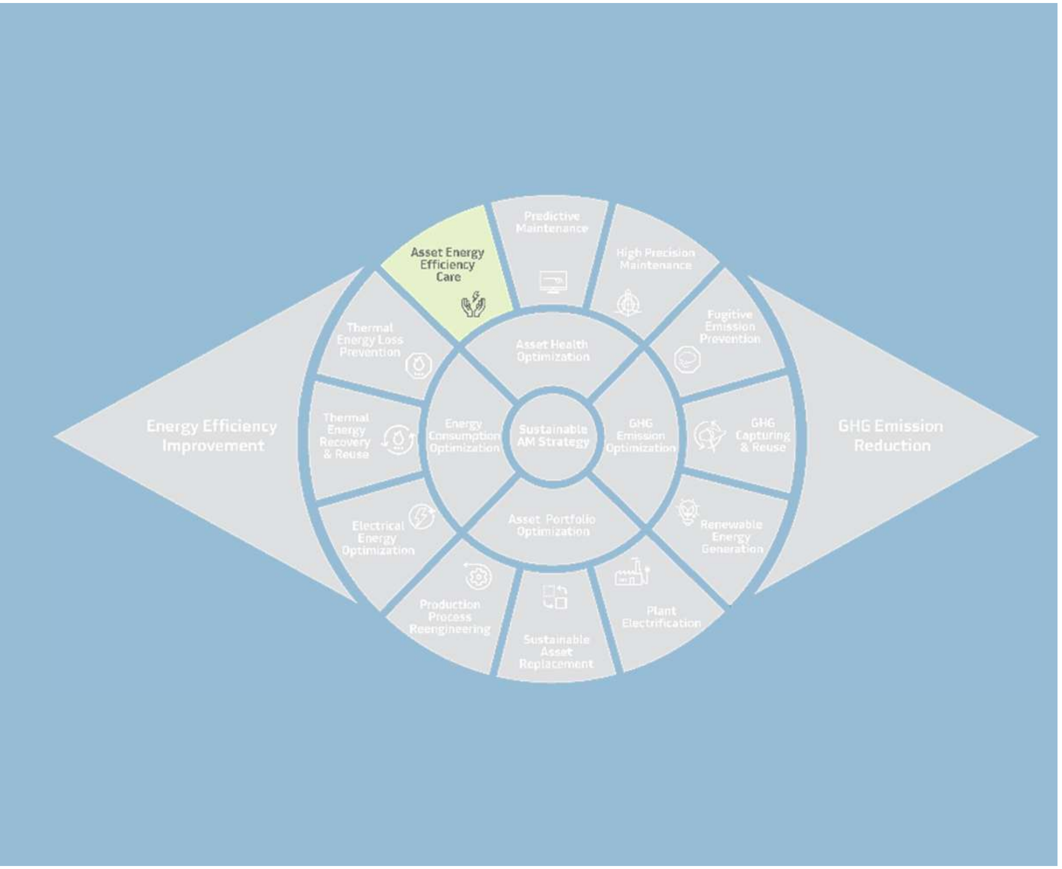
1. Objectives and impact
2. Asset Energy Efficiency Care
3. Predictive Maintenance
4. High Precision Maintenance

Asset Energy Efficiency Care

Asset Health Optimisation



Characteristics focus area

- Asset Energy Efficiency Care (AEEC) generally refers to the **care and maintenance of assets** to optimise energy efficiency, reliability and performance
- This concept includes various controls, maintenance activities and good practices aimed at ensuring **constant normal operation** at the **optimal energy efficiency level** of energy-consuming assets, allowing them to operate at their highest efficiency levels while minimising energy waste and costs
- Allows organisations to **reduce energy consumption** and improve overall sustainability efforts

Asset Energy Efficiency Care

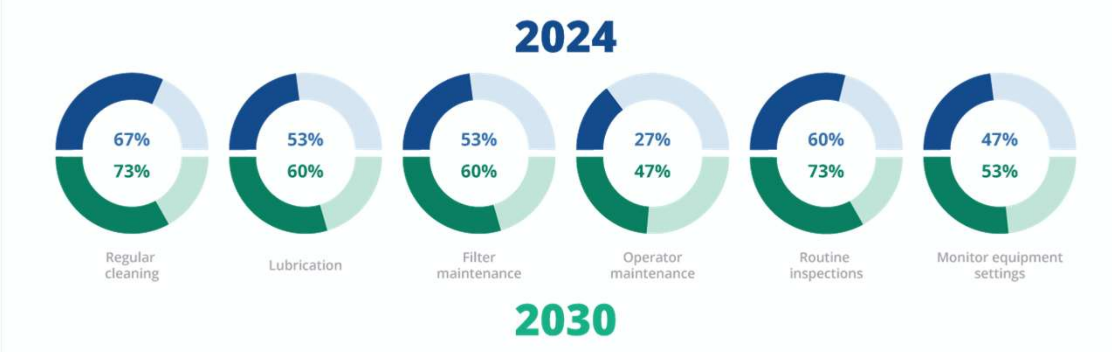
Possible measures?

Regular cleaning	Preventing energy inefficiencies by regularly cleaning machinery and equipment (such as electric motors, sensors and instruments) used in the production process
Lubrication	Apply the right type and amount of lubrication to reduce friction and wear
Filter maintenance	Checks for clogged filters and also cleaning and periodic replacement of filters used in various equipment, machines or systems within production processes
Operator Maintenance	Also called autonomous maintenance. Refers to the practice whereby front-line operators assume responsibility for the routine care, inspections and minor maintenance of equipment and machinery
Routine inspections	Carrying out frequent inspections to identify and address problems such as leaks, misalignment or equipment wear and tear. Or checking installations that affect energy efficiency, such as switching off unused equipment
Monitor equipment settings	Ensure optimal settings in terms of temperature, speed, pressure and flow rate for optimum energy efficiency

Asset Energy Efficiency Care

Implementation rate early adopters

- The study shows that **all measures** are **applied** in practice by the at least half of early adopters
- This is explained by the idea that most measures are part of the **regular maintenance process**
- Due to the wide application of measures within this quadrant, the significant impact of Asset Energy Efficiency Care on sustainability is **logical**
- **Regular cleaning** and **Routine inspections** are most commonly used (in almost 75% of cases)
- The implementation rate of **operator maintenance** is **lower** and is explained by the fact that not all factories have operators on the production line



Shell's efforts to improve energy efficiency

Case study: Asset Energy Efficiency Care

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The article discusses Shell's efforts to improve energy efficiency and reduce CO2 emissions at their Pernis refinery near Rotterdam, the Netherlands

Objective:

To improve energy efficiency, reduce CO2 emissions and cut costs at one of the world's largest refineries

Actions:

- Introduced a computer software system in 2009 to **visualise** refinery processes **and** uncover **inefficiencies**
- Development of a software tool in 2010 to prioritise the top five inefficiencies and express them in financial terms
- The system was further improved in 2011 to identify areas exceeding efficiency targets
- Implementation of **daily meetings** between technology and operational teams to focus on efficiency improvements

Performance:

- Reduced energy costs by about $1.5 million a year
- Since 2009, energy savings and CO2 emission reductions are equivalent to taking about 50,000 cars off the road each year

Source: Royal Dutch Shell plc Sustainability Report 2012 - Focus: Improving energy efficiency at Pernis refinery

Focus:
Improving energy efficiency at Pernis refinery

Our Pernis refinery in Rotterdam, the Netherlands, has used an innovative approach to improve energy efficiency.

Our Pernis refinery near Rotterdam in the Netherlands is one of the largest in the world. It transforms crude oil into a range of important products. These include petrol, diesel, jet fuel, heating oil and lubricants, as well as petrochemical raw materials that are used to make essential everyday items.

Pernis operates continuously, refining about 20 million tonnes of crude oil a year, equivalent to around 400,000 barrels a day. This means it is processing 750 litres of crude oil a second. The refinery sits at the heart of a major industrial complex, which includes a port for the delivery of crude oil in large tankers, and plants to make chemical products derived from oil. The whole complex covers 550 hectares, equivalent to 1,000 football fields. Its 160,000 km of pipeline, if laid end to end, would circle the globe four times.

Refining oil requires large amounts of heat, and therefore energy. At Pernis, the energy comes from natural gas. Most of it is used to heat the oil directly, with the rest used to power two plants that create steam and electricity. In recent years we have been working hard at Pernis to improve energy efficiency, to cut CO2 emissions and reduce costs. Given the size of the refinery, even relatively small improvements can have a significant impact.

Each refinery has different characteristics because of varying size and complexity. Operators need to manage temperatures, pressures and also the rates at which liquids and gases are flowing through pipes. The challenge to improving energy efficiency is to keep the different parts of the refinery working together at optimum levels.

Module 4

Asset Health Optimisation

1. Objectives and impact
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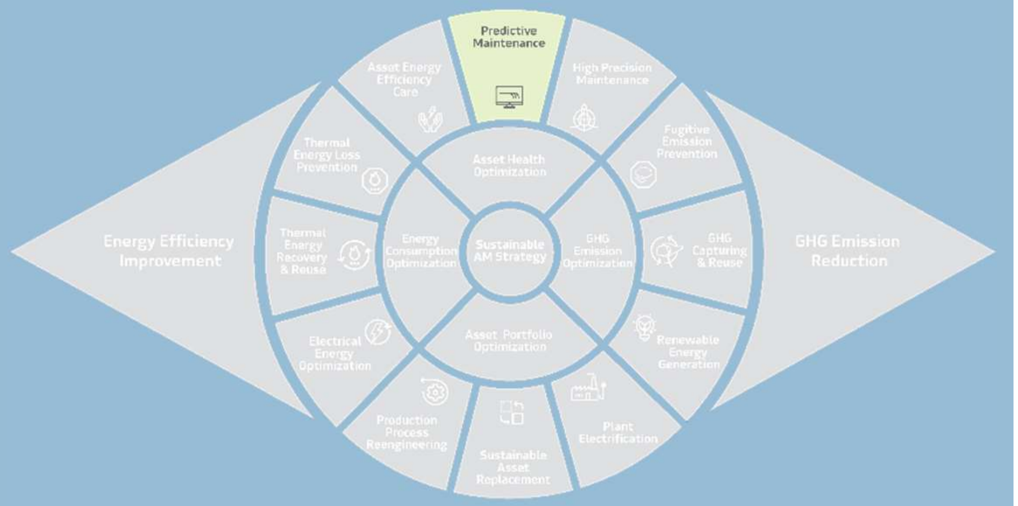
Predictive Maintenance

Asset Health Optimisation



Characteristics focus area

- Predictive maintenance is a **proactive maintenance strategy**
- Uses handheld devices, sensors and IoT infrastructure to perform data analysis, to assess and **predict when equipment will fail**
- This prediction takes place based on **analysis of data and measurements** performed by human experts and/or by Machine Learning algorithms and Artificial Intelligence
- This makes it possible to **reduce** the **period** that assets run with **sub-optimal energy efficiency** or with **increased** levels of **greenhouse gas emissions**

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Predictive Maintenance

3 forms of predictive maintenance

Predictive maintenance based on condition monitoring

- Visual inspections, use of measuring instruments and
- Real-time monitoring based on offline condition data (from portable devices or mounted sensors) and/or
- Online condition data
- Analysis of all this data to arrive at a prediction of technical failure

Predictive maintenance based on integral data analysis

- More data is collected and analysed than just condition data
- Additional data, such as process data (from sensors and DCS, MES or MOM systems[1)]) and environmental data
- To predict future behaviour, potential failures and residual equipment life

Predictive and Prescriptive maintenance

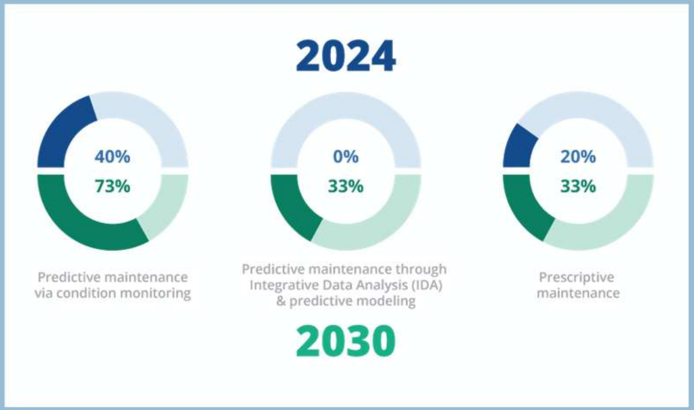
- Also called prescriptive maintenance
- Data analytics, machine learning and other artificial intelligence (AI) deployed to predict technical failure and automatically generate the mitigation measure
- The key feature of prescriptive maintenance is the ability to make actionable recommendations based on predictive analytics, historical data, real-time data entry and advanced algorithms

[1)] DCS = Distributed Control System MES = Manufacturing Execution System MOM = Manufacturing Operations Management

Predictive Maintenance

Implementation rate early adopters

- As indicated earlier, the impact of predictive maintenance is **not very high**
- It becomes clear that among early adopters, the **implementation rate** of predictive maintenance **in 2024** is **still low** (below 40%)
- Only **option 1**, Predictive maintenance based on condition monitoring, is **more widely used** in 2030
- **Advancement** to more complex forms of forecasting does not (yet) seem feasible for many companies
- The latter is confirmed by other studies on the subject[1)]



[1)] Predictive Maintenance 4.0, Beyond the hype: PdM 4.0 delivers results (2018)

Case Sitech

Predictive Maintenance

- Sitech is a **service company at Chemelot in Geleen**, specialising in maintenance, engineering, turnarounds and projects within the process industry, offering its services to around 60 chemical plants in the southern Netherlands.
- The Sitech **Asset Health Centre** focuses on digitising the process industry to improve safety, reliability, performance and energy consumption.
- The **Condition Based Monitoring solution** is scalable and applicable to both new plants and ageing plant assets.
- Predictive maintenance provides insight into plant processes via **real-time monitoring**, making maintenance more predictable and plannable.
- With vibration sensors, infrared cameras and ultrasonic measurements, **anomalies** are **detected early** to prevent breakdowns and downtime.
- **Unexpected flare incidents** are reduced as real-time data provides early warning of potential disruptions in the production process.
- By predicting breakdowns, as with pumps, replacements can be planned within regular maintenance, reducing costs and downtime: one pump can **save** up to **€60,000 a year** through predictive maintenance with relatively **low investment**.
- Models can track multiple devices of the same type, regardless of manufacturer or exact specifications, thanks to common physical operation.
- Similar sensors and algorithms are usable for all rotary pumps and heat exchangers due to their shared technical principles.
- Although energy saving is often not a main goal, **36% of companies** do **experience energy savings** through Predictive Maintenance 4.0.

Case Story

The many benefits of predictive maintenance

Sitech is a service company in the field of maintenance, engineering, turnarounds and projects. The company is located on the Chemelot site in Geleen. This industrial estate in the south of the Netherlands is home to approximately 60 chemical factories.

At the Sitech Asset Health Center the focus is on digitising the process industry. The company has shown that digitisation in manufacturing helps to improve safety, performance, reliability and energy consumption. The Sitech Asset Health Center is a scalable, Condition Based Monitoring solution, which can be implemented plant-wide at new facilities and for aging assets.

By applying predictive maintenance Sitech provides insight into how factories operate. Based on real-time monitoring and technologies such as vibration sensors, infrared cameras and ultrasonic measurements, deviations can be detected faster to prevent failures and downtime. Also unplanned flaring events can be reduced significantly because real-time monitoring alerts process engineers to potential issues early so they can prevent them from becoming an unexpected failure or serious processing inefficiency that causes a flare event.

By predicting when, for instance, a pump will fail, it enables companies to include replacement activities in the regular maintenance schedule and thereby reduce downtime. This way annual savings of around 60,000 euros can be realised just for one pump, while the sensors and model development only cost a fraction of that.

It is also possible to use a model which observes all pumps of a certain type or all heat exchangers at a site. Even though rotary pumps, for example, may have different manufacturers and different specifications, they all operate on the same physical principles. It is possible to use similar sensors and models for all rotary pumps.

In the 2018 report about Predictive Maintenance 4.0 – where the Sitech Asset Health Center was presented in a case story – one of the conclusions was: energy savings are barely mentioned as the primary goal for adopting Predictive Maintenance 4.0. However, results of the market survey show that PdM 4.0 can generate very significant benefits in terms of energy savings. 36% of 268 surveyed companies said they've experienced energy savings as a result of implementing predictive maintenance.

→ Source: www.sitech.nl and "Predictive Maintenance 4.0", PwC and Mainnovation, 2018.

Source: www.sitech.nl and "Predictive Maintenance 4.0", PwC and Mainnovation, 2018.

Module 4

Asset Health Optimisation

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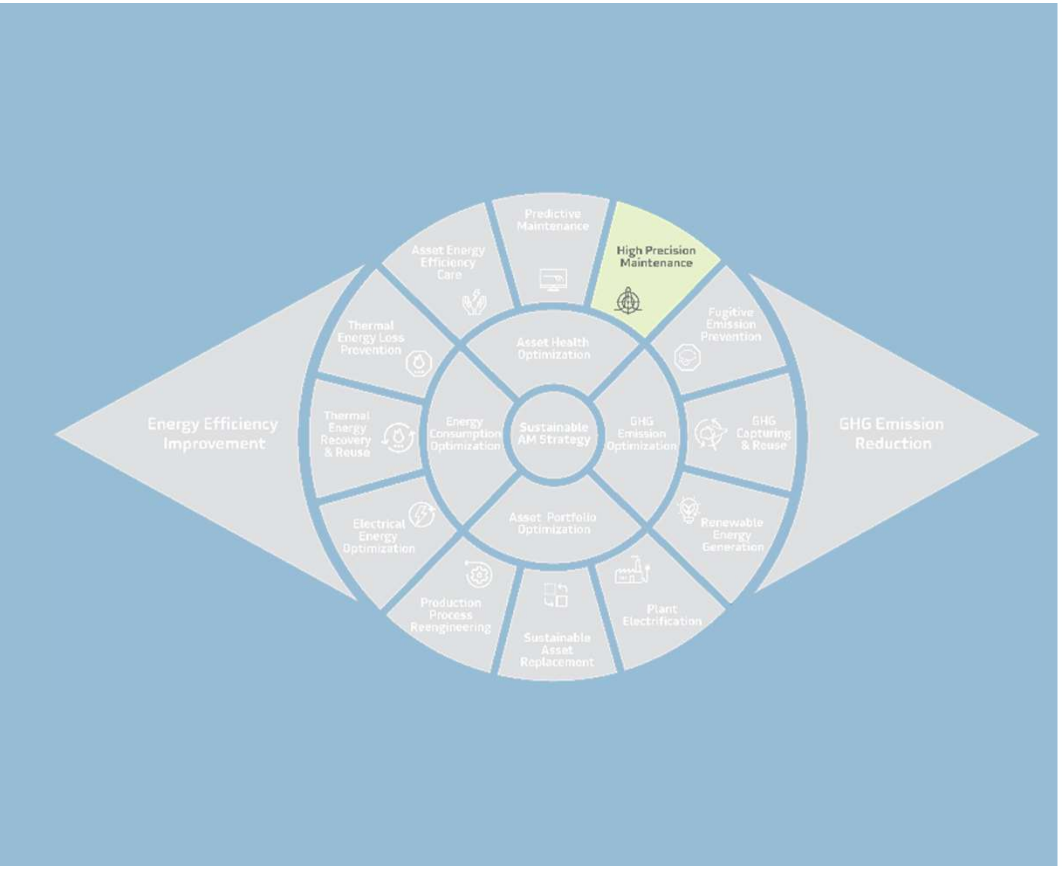
High Precision Maintenance

Asset Health Optimisation



Characteristics focus area

- Maintenance practices applied to machinery and equipment with an emphasis on **accuracy**, meticulous attention to detail and adherence to **strict tolerances** inspired by the 6-Sigma approach
- The aim is to ensure that the equipment operates **within the optimal parameters**, reducing wear and tear, extending its lifetime and preventing unexpected downtime
- By ensuring that equipment operates within optimum performance parameters and **reducing friction and imbalance**, high-precision maintenance leads to significant energy savings

High Precision Maintenance

Possible measures?

Precision measurements	Use of high-precision measuring instruments to very accurately assess the condition and performance of machines and components. These include coordinate measuring machines (CMMs), optical measuring equipment and precision slide gauges.
Precise laser alignment	Use of laser alignment systems to correctly adjust shafts and other components to operating temperatures
Accurate calibration of instruments	Calibration involves the process of verifying and adjusting the accuracy of instruments and equipment
Managing tight tolerances	Achieving precise fits and close tolerances, especially at operating temperatures
Quality assurance	Implementation of rigorous quality control and assurance processes to verify the accuracy and reliability of maintenance activities. This includes conducting thorough inspections, tests and verifications to meet quality standards and specifications
Clear maintenance instructions	Ensure that maintenance procedures and work instructions are unambiguous and accessible to appropriate personnel that support high-precision adjustment (balancing, tension, torque) of critical components (such as belts, rotating parts and bolts).

High Precision Maintenance

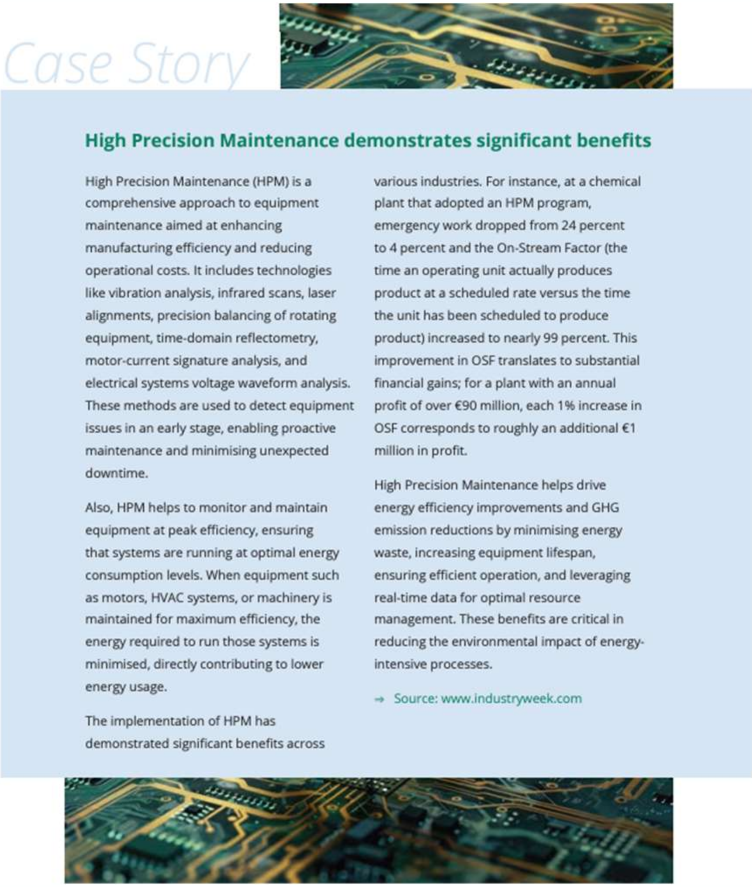
Implementation rate early adopters

- High Precision Maintenance (a term coined by Intel in 2006) is a **relatively new application** that still has few followers
- Nevertheless, the benchmark study shows that partial elements are indeed being put into practice, but an **implementation rate around 30%** by 2030 is low compared to measures from other focus areas
- Notable is the **growing popularity** rounding **laser alignment** (from 20% in 2024 to 33% in 2030)

[1)] Predictive Maintenance 4.0, Beyond the hype: PdM 4.0 delivers results (2018)

Case story

High Precision Maintenance



Case Story

High Precision Maintenance demonstrates significant benefits

High Precision Maintenance (HPM) is a comprehensive approach to equipment maintenance aimed at enhancing manufacturing efficiency and reducing operational costs. It includes technologies like vibration analysis, infrared scans, laser alignments, precision balancing of rotating equipment, time-domain reflectometry, motor-current signature analysis, and electrical systems voltage waveform analysis. These methods are used to detect equipment issues in an early stage, enabling proactive maintenance and minimising unexpected downtime.

Also, HPM helps to monitor and maintain equipment at peak efficiency, ensuring that systems are running at optimal energy consumption levels. When equipment such as motors, HVAC systems, or machinery is maintained for maximum efficiency, the energy required to run those systems is minimised, directly contributing to lower energy usage.

The implementation of HPM has demonstrated significant benefits across various industries. For instance, at a chemical plant that adopted an HPM program, emergency work dropped from 24 percent to 4 percent and the On-Stream Factor (the time an operating unit actually produces product at a scheduled rate versus the time the unit has been scheduled to produce product) increased to nearly 99 percent. This improvement in OSF translates to substantial financial gains; for a plant with an annual profit of over €90 million, each 1% increase in OSF corresponds to roughly an additional €1 million in profit.

High Precision Maintenance helps drive energy efficiency improvements and GHG emission reductions by minimising energy waste, increasing equipment lifespan, ensuring efficient operation, and leveraging real-time data for optimal resource management. These benefits are critical in reducing the environmental impact of energy-intensive processes.

→ Source: www.industryweek.com

- High Precision Maintenance (HPM) is **a maintenance approach** that increases efficiency and reduces operational costs through precise, advanced analytical methods.
- HPM includes techniques such as vibration analysis, infrared scanning, laser alignment, precision balancing, reflectometry and analysis of electric current and voltage signals.
- These technologies detect problems early, enabling proactive maintenance and reducing unexpected downtime.
- HPM **optimises energy consumption** by maintaining equipment at maximum efficiency, leading to lower energy costs.
- Properly maintained engines, HVAC systems and machinery **consume less energy**, resulting in direct energy savings.
- HPM shows significant results in industries; for example, a chemical plant saw **emergency maintenance drop from 24% to 4%.**
- The On-Stream Factor (OSF) at this plant rose **to almost 99%,** greatly increasing production efficiency.
- A 1% increase in OSF yields about **€1 million extra profit** for an annual profit of €90 million.
- HPM **promotes energy conservation** and reduces greenhouse gas emissions by minimising energy waste and extending asset life.
- By using **real-time data**, HPM enables efficient resource management and contributes to sustainability.

Source: www.industryweek.com

Case High Precision Maintenance

Energy saving through contactless magnetic coupling

Interreg North-West Europe
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Working with Zytec, Spie has developed a new type of coupling. At most industrial sites, rotating equipment is too large for the requirement. To address this, a throttling valve is installed, which wastes energy.

Contactless Magnetic Coupling:

- The magnetic coupling alternative allows the rotational speed to be reduced for exact conditions, reducing energy consumption by 15% or more on average, depending on the installation. The lack of direct physical contact also significantly reduces vibration, protecting bearings and seals from damage.

Case:

- EMMTEC has been using two couplers since August 2019. In their systems, they see energy savings and vibration reduction visibly improving, and since the installation, electricity consumption has decreased and less maintenance is needed on the pump and control valves.

Performance:

- EMMTEC Services, after installing 2 couplings, is already experiencing energy savings of 19.2% and a CO_2 emission reduction of 142 tonnes per year, an equivalent of 101 households

Source:SPIE ensures energy savings thanks to contactless magnetic coupling | SPIE

e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 5
Energy Consumption Optimisation

Module 5

Energy Consumption Optimisation

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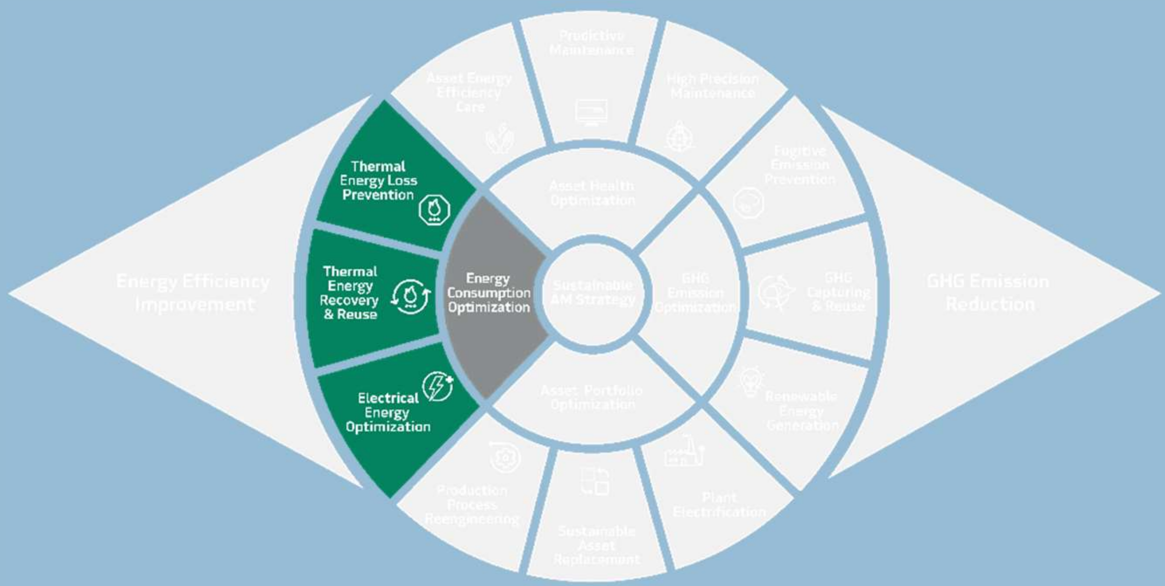
1. Objectives and impact
2. Optimisation of electrical energy
3. Recovery and reuse of thermal energy
4. Preventing thermal energy losses

Overall objective and measures

Energy Consumption Optimisation



Objective of this quadrant:

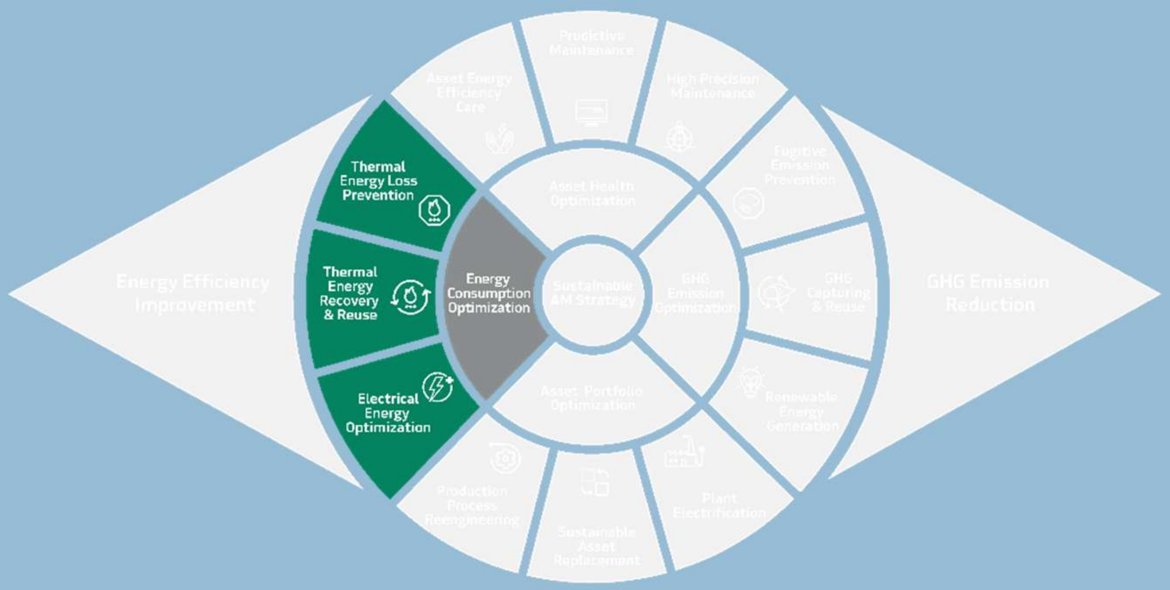
- Aimed at maximising energy efficiency and minimising energy waste in various systems, processes and activities
- The aim is to achieve the desired level of performance or production output and with as little energy consumption as possible

Measures:

- Preventing unnecessary consumption of electricity
- Capture and/or reuse residual energy from the production process
- Prevention of energy losses

Focus areas

Energy Consumption Optimisation



Characteristics of focus areas

Optimisation of electrical energy

- Maximising electricity consumption efficiency or avoiding unnecessary electricity consumption

Recovery and reuse of thermal energy

- This focus area concerns the capture and reuse of waste heat generated during industrial processes, HVAC systems or other energy-intensive operations

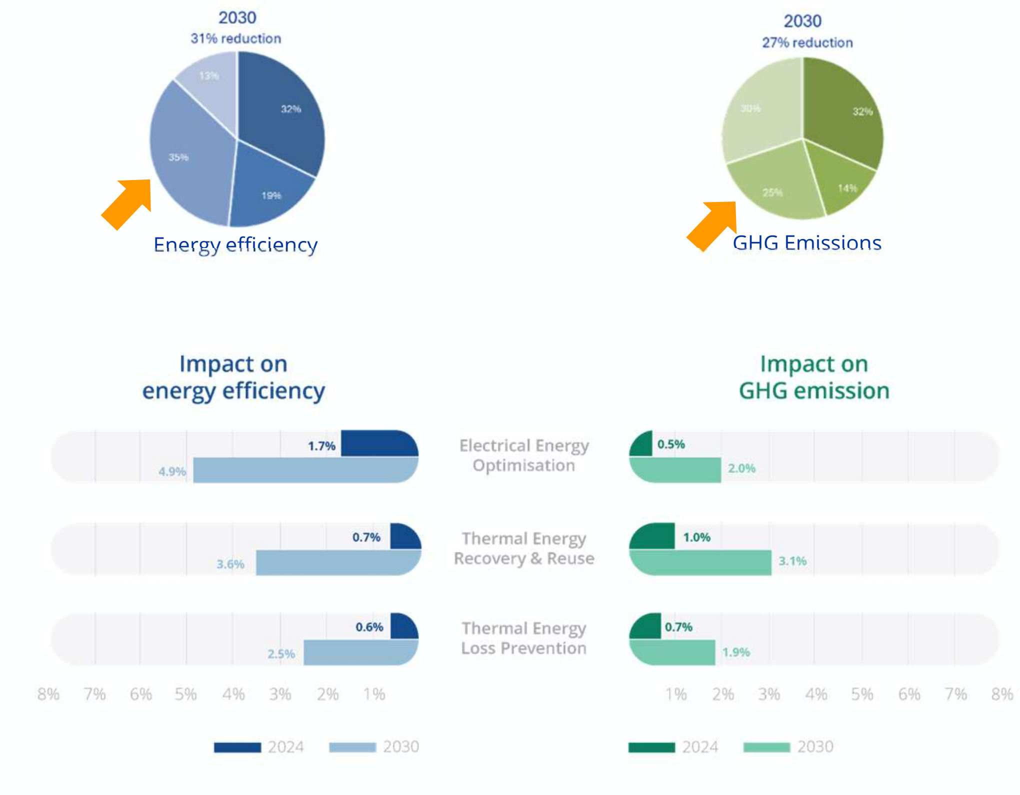
Preventing thermal energy losses

- With this, we focus on minimising or eliminating unnecessary heat loss from industrial processes, equipment or buildings

Impact on sustainability

Energy Consumption Optimisation

- The benchmark data shows that between 2024 and 2030**, all measures** within this quadrant will experience a major development
- **Impact rises sharply** from 3% to 11% energy efficiency improvement and from 2.2% to 7% for greenhouse gas emission reduction in 2030
- The benchmark study shows that **Electric Energy Optimisation** has the highest impact on Energy Efficiency Improvement. Because of the focus on electric energy, the impact on GHG emissions is limited here
- On the other hand, according to the study, **Recovery and reuse of thermal energy** again has a **more significant impact on GHG Emission Reduction** because heat generation is often still done with fossil fuel via boilers or industrial burners on the site itself
- What is clear is that this quadrant will be a **key pillar** in achieving sustainability goals



Module 5

Energy Consumption Optimisation

1. Objectives and impact
2. Optimisation of electrical energy
3. Recovery and reuse of thermal energy
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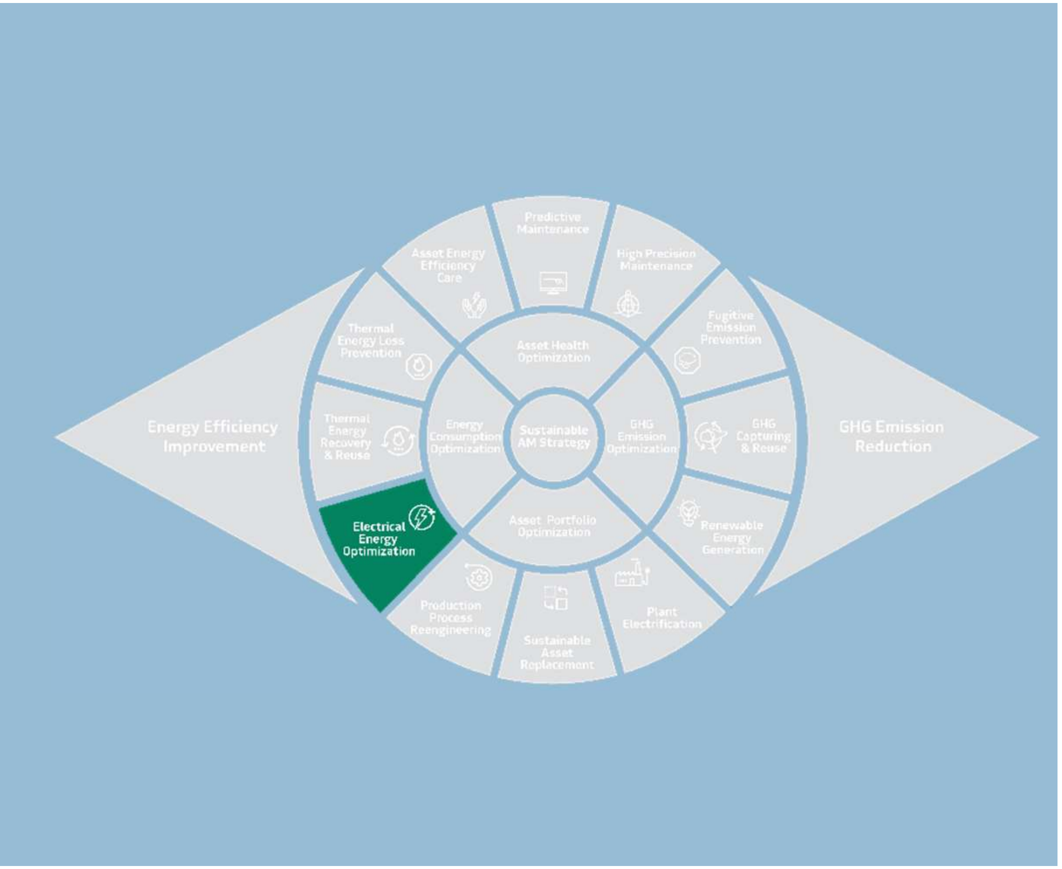
Optimisation of electrical energy

Energy Consumption Optimisation



Characteristics focus area

- This includes **maximising the efficiency** of electricity consumption by appliances and machines
- The focus for this includes preventing **unnecessary electricity consumption** and **more energy-efficient** settings
- This will reduce the greenhouse gas emissions associated with generating the required electricity

Optimisation of electrical energy

Possible measures?

HVAC optimisation	Optimising heating, ventilation and air conditioning systems, for example by reducing temperatures, optimising airflow and using programmable thermostats to create comfortable indoor temperatures
Lighting Upgrades	Replacing traditional incandescent and fluorescent lamps with energy-efficient lighting systems that use less energy, last longer and produce less heat
Optimising electric motor and drive systems	Use of variable speed drives to control motor speed and match power to demand reducing energy consumption during part load. Especially targeted at devices upgraded to higher electrical energy efficiency
Load balancing	Adjusting the distribution of power across different systems or components to avoid overloads and ensure that each component is working optimally
Power Factor Correction	Improving the power factor in an electrical system to reduce the amount of idle and useless power

Optimisation of electrical energy

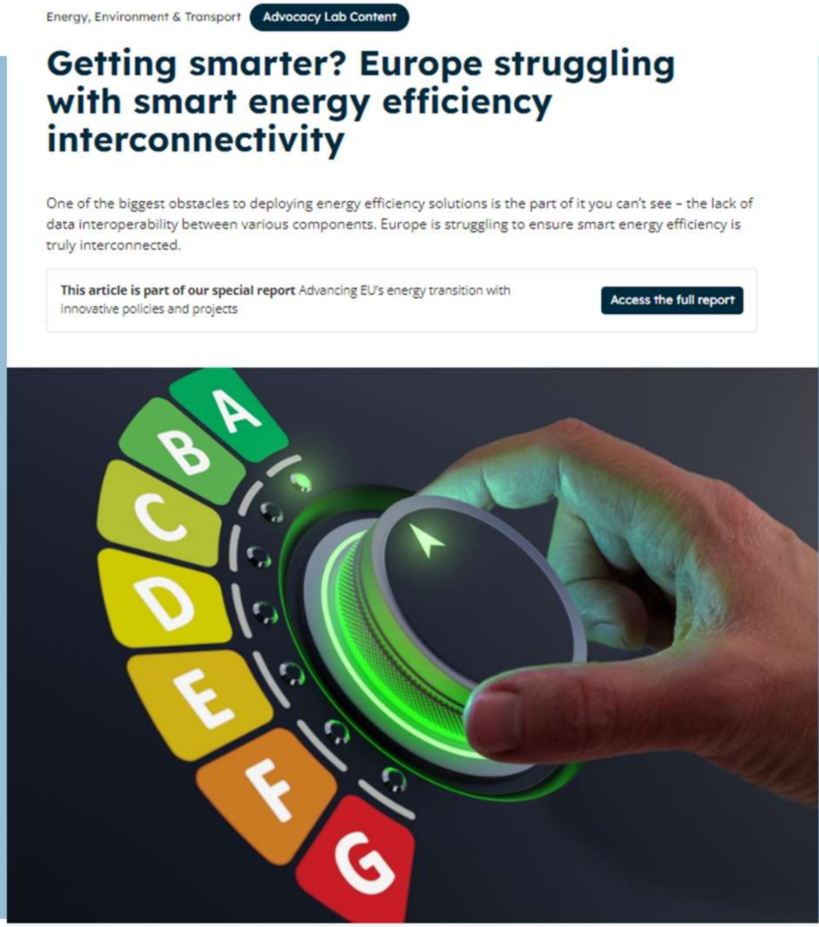
Implementation rate early adopters

- This focus area has the greatest impact on sustainability improvements
- The benchmark results show that only in the application of **HVAC optimisation** is **reasonable growth** still anticipated by the early adopters
- **Upgrading lighting** and **optimising motors and drives** is **already applied** by the majority and thus seen as an important option for Electrical Energy Optimisation
- In particular, **load balancing** and **power factor correction** lag behind in this which can be explained by the **relative unfamiliarity** of these measures
- Moreover, these measures have a fair degree of **complexity** and older systems are not designed for active load balancing, for example

[1] Predictive Maintenance 4.0, Beyond the hype: PdM 4.0 delivers results (2018)

Smart Energy Efficiency Systems

Optimisation of electrical energy


Energy, Environment & Transport Advocacy Lab Content

Getting smarter? Europe struggling with smart energy efficiency interconnectivity

One of the biggest obstacles to deploying energy efficiency solutions is the part of it you can't see – the lack of data interoperability between various components. Europe is struggling to ensure smart energy efficiency is truly interconnected.

This article is part of our special report Advancing EU's energy transition with innovative policies and projects Access the full report

"InterConnect" project: an EU initiative aimed at improving energy efficiency through smart systems.

Objective:
- To improve energy efficiency and optimise electricity consumption by resolving data interoperability issues between different smart energy components

Actions:
- Developing solutions for smart homes, buildings and electricity grid.
- Implementation of large-scale pilot projects
- Launch funding calls for innovative energy efficiency projects.

Performance:
- Funding awarded to projects that improve grid stability and reduce energy costs; including €2.2 million to SMEs

Source: Getting smarter? Europe struggling with smart energy efficiency interconnectivity - Euractiv

Module 5

Energy Consumption Optimisation

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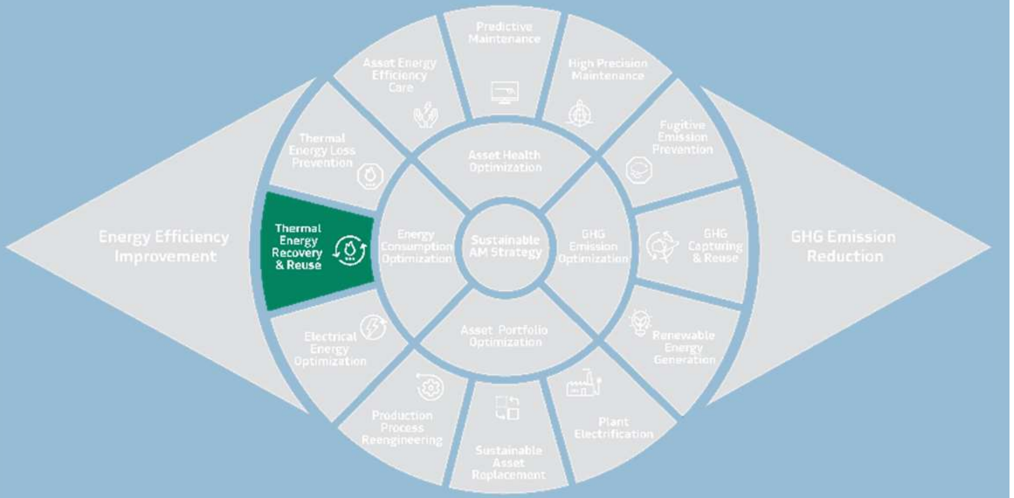
Recovery and reuse of thermal energy

Energy Consumption Optimisation



Characteristics focus area

- This focus area concerns the **capture of waste heat** generated during industrial processes, HVAC systems or other energy-intensive operations
- To **then use** this waste heat to meet heating, cooling or other energy needs **within** the same facility **or** in nearby applications **outside the facility**

Recovery and reuse of thermal energy

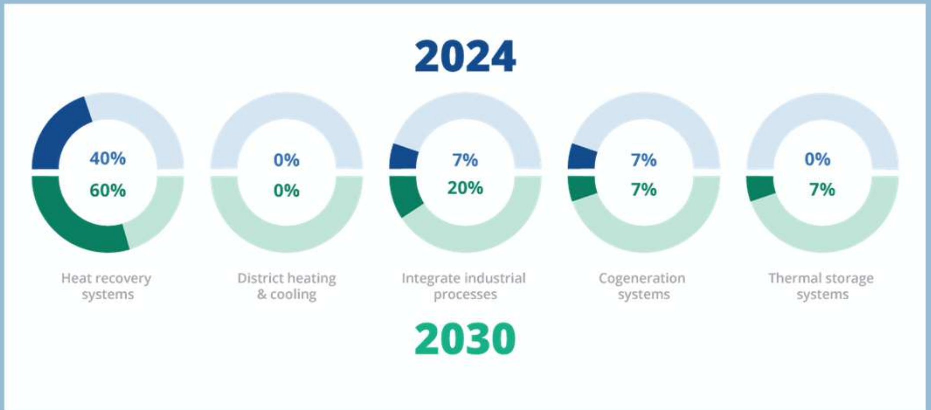
Possible measures?

Heat recovery systems	Such as heat exchangers, to capture waste heat from exhaust gases, process streams or equipment cooling systems and use it for heating, pre-heating or other industrial processes
Combined heat and power (CHP) systems	These systems can be used to simultaneously generate electricity and recover waste heat for heating or cooling purposes
District heating and cooling networks	Set up to exchange waste heat or cold with nearby industrial facilities, commercial buildings or residential areas that need heating or cooling
Integration of industrial processes	To use waste heat from one process within the facility as a heat source for another process by implementing process cascade or heat cascading strategies, for example
Implementation of thermal energy storage systems	To store excess heat during periods of low demand and release it when needed. This includes the installation of heat pump systems to upgrade waste heat to higher temperatures suitable for heating or industrial processes

Recovery and reuse of thermal energy

Implementation rate early adopters

- In particular, the impact of this focus area will be on reducing greenhouse gas emissions
- The benchmark survey shows that the deployment of **heat recovery systems** is by far the most **widely adopted** within this focus area (60% of early adopters by 2030)
- Heat recovery systems are **relatively cheap** compared to the other options within this focus area
- Often, **integration with other industrial processes** of other companies is already included in the **design phase of a plant**
- This option, and that of connecting to district heating, only become interesting when **(commercial) opportunities** arise to realise this later on
- So from a sustainability perspective, this is **difficult to deploy planned as** a measure



[1)] Predictive Maintenance 4.0, Beyond the hype: PdM 4.0 delivers results (2018)

EU-funded ETEKINA project

Recovery and reuse of thermal energy

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A good example is the ETEKINA project, which focused on innovative waste heat recovery systems for industrial processes

Objective:

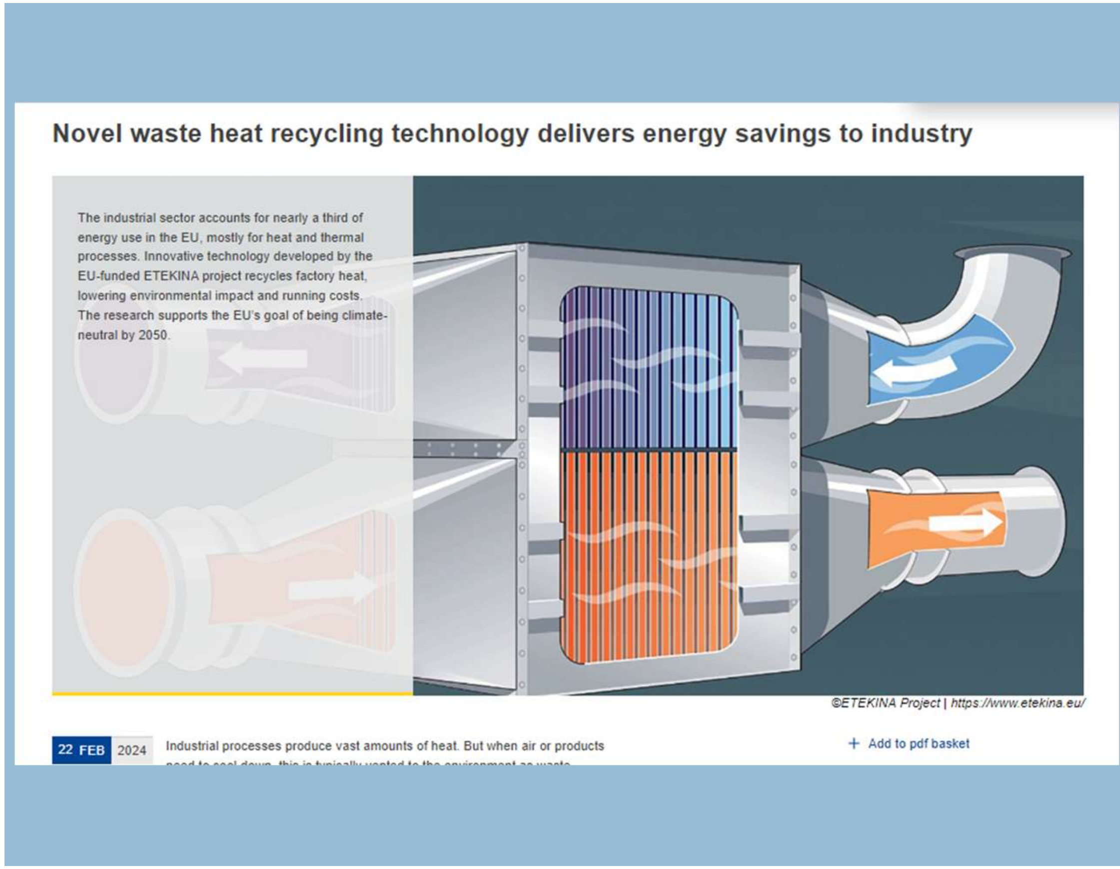
- Develop and implement heat pipe heat exchangers (HPHEs) for waste heat recovery in energy-intensive industries, reducing energy consumption and carbon emissions.

Actions:

- Design and manufacture HPHEs for three industrial sectors: aluminium, steel and ceramics.
- Prototypes implemented in three pilot plants across Europe.
- Collaboration with industrial partners to ensure system compatibility with existing processes.

Performance:

- **Reduced waste heat energy** by at least **40%** in all industries involved.
- Achieved **return on investment** ranging from **9 to 24 months**
- Successfully installed systems that continue to operate and deliver significant savings.


Novel waste heat recycling technology delivers energy savings to industry

The industrial sector accounts for nearly a third of energy use in the EU, mostly for heat and thermal processes. Innovative technology developed by the EU-funded ETEKINA project recycles factory heat, lowering environmental impact and running costs. The research supports the EU's goal of being climate-neutral by 2050.

©ETEKINA Project | https://www.etekina.eu/

22 FEB 2024 Industrial processes produce vast amounts of heat. But when air or products

+ Add to pdf basket

Source: Novel waste heat recycling technology delivers energy savings to industry | Research and Innovation

Case Stora Enso-Volvo Cars Ghent

Recovery and reuse of thermal energy

- Stora Enso and Volvo Cars Gent are collaborating on an **underground heat network** to reuse waste heat from biomass.
- **Residual heat** from Stora Enso is used by Volvo to dry cars in the spray and paint department.
- The Stora Enso mill in Evergem produces 550,000 tonnes of paper from waste paper every year.
- **Two bio-CHPs** supply process steam as well as covering more than 70% of Stora Enso's electricity needs. The bio-CHPs convert internal sludge and external biomass into electricity and process heat.
- The **4 km** underground heat network transports leftover residual heat from Stora Enso to Volvo Cars Ghent.
- Volvo uses this renewable heat to make their **production processes more efficient** and **reduce fossil energy consumption**.
- Water is **heated to 135°C** and flows to Volvo; cooled water returns to Stora Enso to reheat.
- The heat supply has a **capacity of 25 MW**, comparable to the consumption of 5,000 households.
- Antea Group handled the technical design, permitting process and selection of a suitable contractor according to the set quality standards.

Source: www.media.volvocars.com/ global/en-gb/media/pressreleases/

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Case Story

Use residual heat as a renewable energy source

Stora Enso, supplier of sustainable packaging and materials, and **Volvo Cars** Ghent started a collaboration a few years ago for the construction of an underground heating network with the aim of exchanging residual heat. By connecting the Stora Enso site in Evergem to the Volvo Cars Ghent, the recovered residual heat from biomass could be used by Volvo Cars to dry cars in the spray and paint department.

The Stora Enso factory annually produces 550,000 tonnes of paper for newspapers and magazines, based on wastepaper. The factory has two high-performance bio combined heat and power (CHP) power plants, which not only supply all the process steam required, but also provide more than 70% of its electricity needs. Stora Enso wanted to make the excess residual heat available to Volvo Cars Ghent via an underground heating network (length 4 km). This allowed Volvo to efficiently use the residual heat for their production processes and significantly reduce fossil energy consumption.

The heat network makes smart use of two Stora Enso bio-CHP plants, which convert internal sludge and external biomass into electricity and process heat. This generated energy heats up water to 135°C, which is then transported to Volvo Cars Gent to reach the desired temperature in the buildings and spray booths. The cooled water returns to Stora Enso, where it is reheated.

The (green) energy supplied has a capacity of 25 MW, the equivalent of the energy needs of 5,000 homes. Antea Group was responsible for the technical design, the permitting process and selecting the best contractor meeting the specified requirements and quality standards.

⇒ Source: www.media.volvocars.com/ global/en-gb/media/pressreleases/

Twence - Hot water supply

Recovery and reuse of thermal energy

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- Twence will **supply residual heat** from its waste incineration plant **to** Grolsch brewery, **eliminating the need for natural gas** in the **brewing process**. This includes the construction of a pipeline to transport hot water between the two facilities
- The project has received approval and construction is about to begin. It is expected **to** be **operational by 2022**
- Solution is **highly applicable** for manufacturing companies, especially those with high heat requirements in their production processes
- The project is expected to **reduce** Grolsch's **CO_2 emissions** by **72%**, equivalent to about **12,000 tonnes of CO_2 per year**
- The project will replace around **3 million cubic metres of natural gas** annually at the Grolsch brewery. However, no specific percentage is given for the total reduction in energy consumption.
- The showcase for this research is the **cooperation** between **waste processing company Twence and Grolsch brewery** in Enschede. This project shows how industrial symbiosis and waste heat recovery can significantly reduce CO_2 emissions and fossil fuel consumption in production processes.

72% CO2-reductie door aanleg warmteleiding

Met de levering van warmte van Twence naar Grolsch wordt tweederde van de warmtebehoefte van de bierbrouwer ingevuld. Door de krachten in de keten te bundelen, zorgen we samen voor een duurzame energievoorziening in onze regio.

Source: https://www.twence.nl/projecten/grolsch-managerduurzaamheid

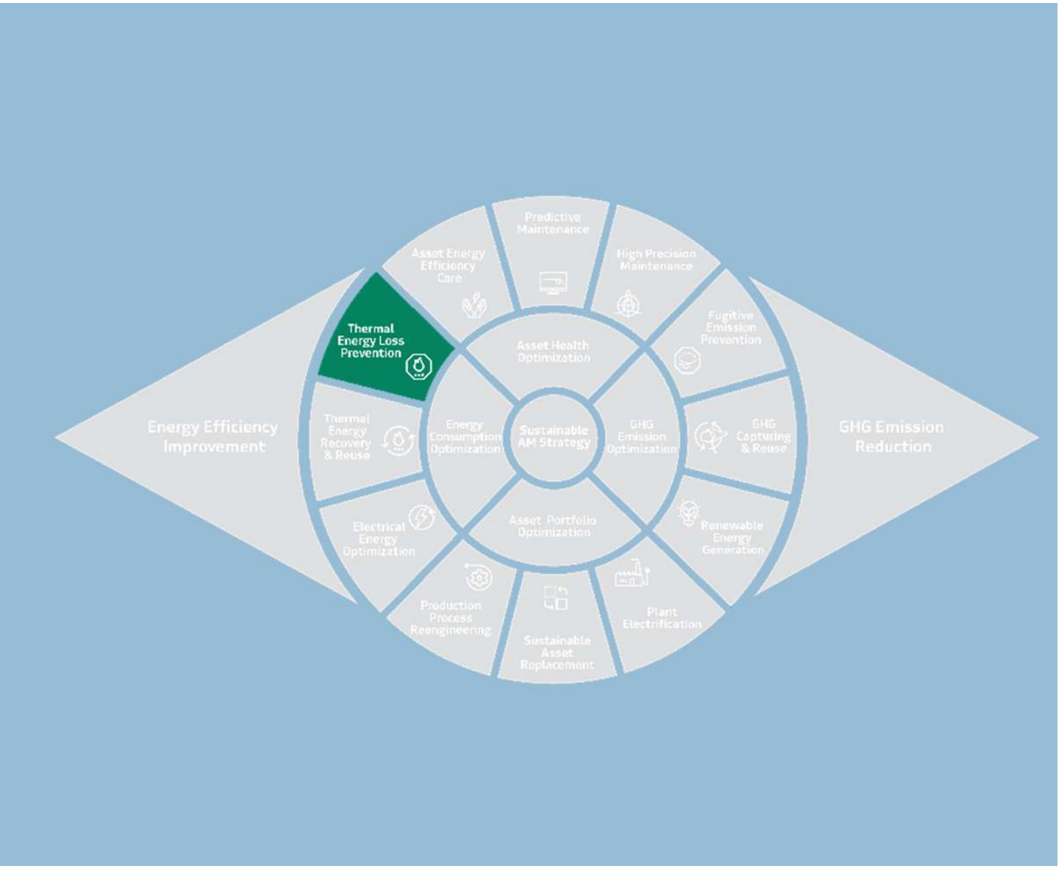
Module 5

Energy Consumption Optimisation

1. Objectives and impact
2. Optimisation of electrical energy
3. Recovery and reuse of thermal energy
4. Preventing thermal energy losses

Preventing thermal energy losses

Energy Consumption Optimisation



Characteristics focus area

- With this, we focus on minimising or **eliminating unnecessary heat loss** from industrial processes, equipment or buildings
- It involves **detecting** places where heat losses occur
- In addition, **eliminating** such heat losses through repair and/or structural measures

Preventing thermal energy losses

Possible measures?

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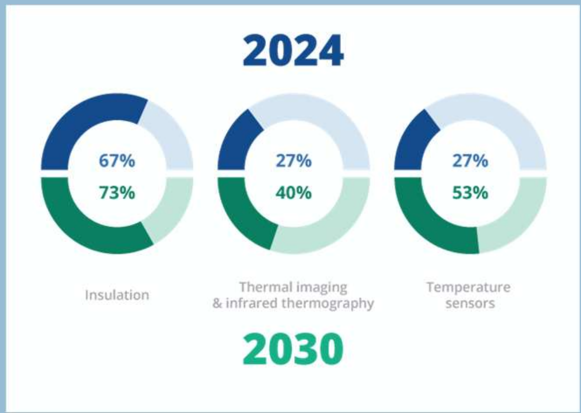
Insulation	• Properly insulate equipment, pipes, ducts, tanks and building envelopes to reduce heat transfer and minimise thermal losses • Insulation materials such as foam, fibreglass, mineral wool and reflective coatings help maintain temperature stability and prevent energy wastage
Thermal imaging and infrared thermography	• Thermal imaging cameras and infrared (IR) thermography are often used to detect heat leaks by capturing thermal images of surfaces and identifying temperature variations • Hot spots, cold spots and areas with thermal bridges indicate possible locations of heat loss that require further investigation
Temperature sensors	• Temperature sensors are used to measure surface temperatures and detect deviations from expected values, indicating possible heat leakage points • Wireless or wired temperature sensors can be installed in critical areas to continuously monitor temperature fluctuations and identify anomalies

Preventing thermal energy losses

Implementation rate early adopters

- **Preventing heat losses** is going to develop into a major focus area in the coming years and contribute up to **30%** to the **reduction** of **greenhouse gas emissions**
- The benchmark results show that applying **insulation** is not new: already **by 2024, almost 70%** of early adopters had fully applied it
- This method is thus considered **relevant**
- We are also seeing growth in the introduction of **temperature sensors**
- This is stimulated by the fact that on more and more industrial equipment these types of **sensors** are fitted **as standard**
- Through **smart links** with energy management systems, anomalies are therefore easy to detect



1) Predictive Maintenance 4.0, Beyond the hype: PdM 4.0 delivers results (2018)

Air leak detection -Royal A-ware Bouter Cheese

Case study - Preventing thermal energy losses

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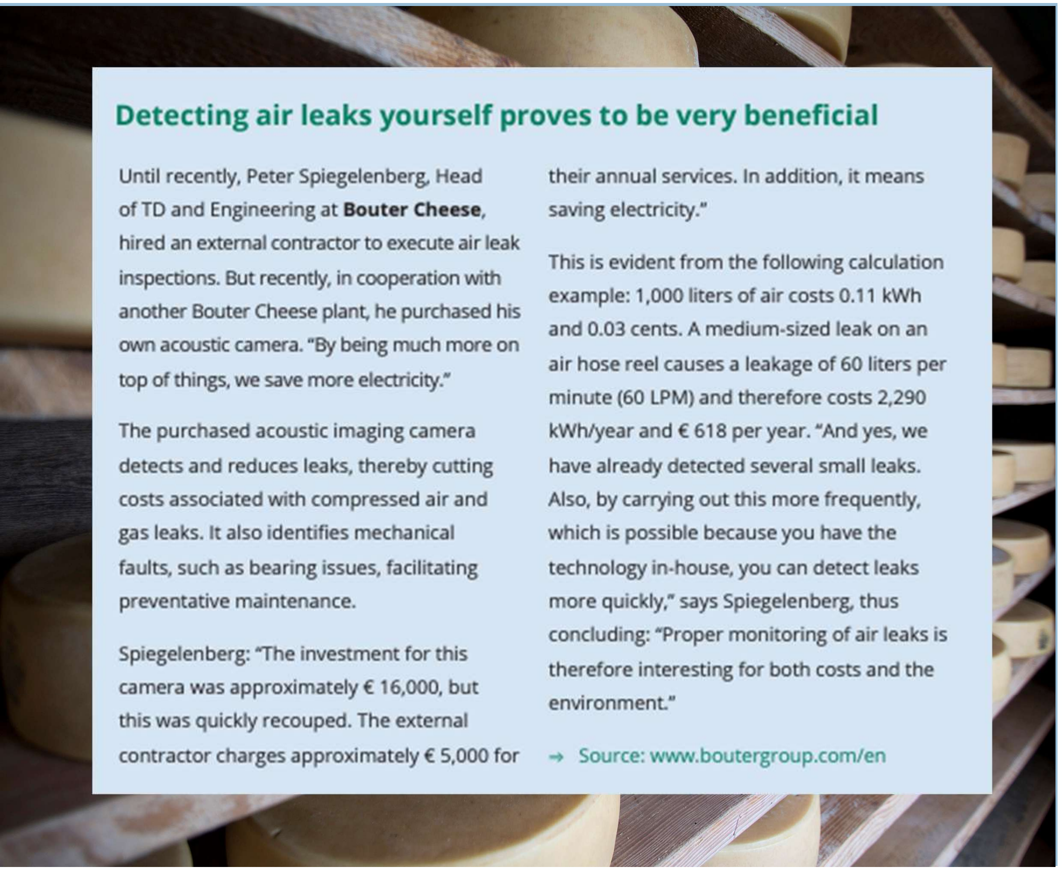

Detecting air leaks yourself proves to be very beneficial

Until recently, Peter Spiegelenberg, Head of TD and Engineering at **Bouter Cheese**, hired an external contractor to execute air leak inspections. But recently, in cooperation with another Bouter Cheese plant, he purchased his own acoustic camera. "By being much more on top of things, we save more electricity."

The purchased acoustic imaging camera detects and reduces leaks, thereby cutting costs associated with compressed air and gas leaks. It also identifies mechanical faults, such as bearing issues, facilitating preventative maintenance.

Spiegelenberg: "The investment for this camera was approximately € 16,000, but this was quickly recouped. The external contractor charges approximately € 5,000 for their annual services. In addition, it means saving electricity."

This is evident from the following calculation example: 1,000 liters of air costs 0.11 kWh and 0.03 cents. A medium-sized leak on an air hose reel causes a leakage of 60 liters per minute (60 LPM) and therefore costs 2,290 kWh/year and € 618 per year. "And yes, we have already detected several small leaks. Also, by carrying out this more frequently, which is possible because you have the technology in-house, you can detect leaks more quickly," says Spiegelenberg, thus concluding: "Proper monitoring of air leaks is therefore interesting for both costs and the environment."

→ Source: www.boutergroup.com/en

- **Peter Spiegelenberg** hired an external contractor for air leak inspections, but has now purchased an **acoustic camera**.
- The camera detects **small air leaks**, reducing **compressed air losses** and electricity costs.
- It can also identify **mechanical defects**, such as **bearing problems**, for **preventive maintenance**.
- The investment in the camera was **€16,000**, but quickly pays for itself.
- The external contractor cost **€5,000** annually, which is now being saved.
- Thanks to continuous leak detection, **electricity** is also **saved**.
- **Calculation example**: 1,000 litres of air costs **0.11 kWh** and **0.03 cents**.
- A **medium leakage** of 60 litres per minute costs **2,290 kWh and €618 per year**.
- **Small leaks** have already been **discovered** and fixed with the new camera.
- As the technology is now **in-house**, leaks can be **detected faster**.
- **Regular monitoring** of air leaks reduces costs and environmental impact.
- Spiegelenberg concludes that **leak detection** is **beneficial for both energy efficiency and the environment**.

e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 6

Green House Gas Emission Optimisation

Module 6

Green House Gas Emission Optimisation

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1. Objectives and impact
2. Prevention of fugitive emissions
3. Capture and reuse of greenhouse gases
4. Generation of renewable energy

Overall objective and measures

GHG Emission Optimisation

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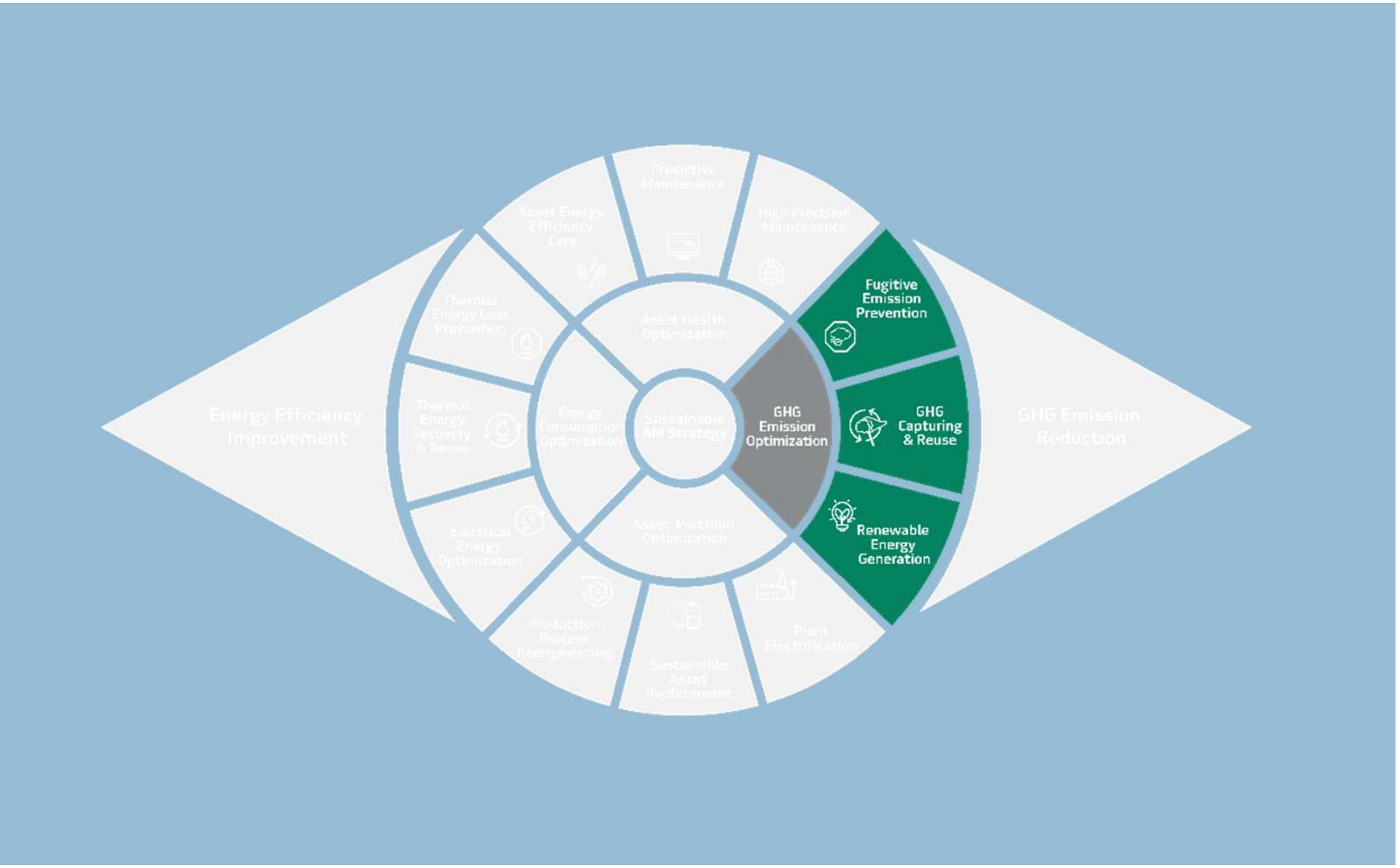

Objective of this quadrant:

- Capture greenhouse gases as a by-product of the production process and reduce their emissions
- Preventing production of greenhouse gases by applying renewable energy

Measures:

- Implementing technological innovations to reduce emissions of CO_2 and other greenhouse gases
- Using greenhouse gases as feedstock for other production processes or applications
- Swapping fossil energy production systems for renewable energy production systems

Focus areas

GHG Emission Optimisation

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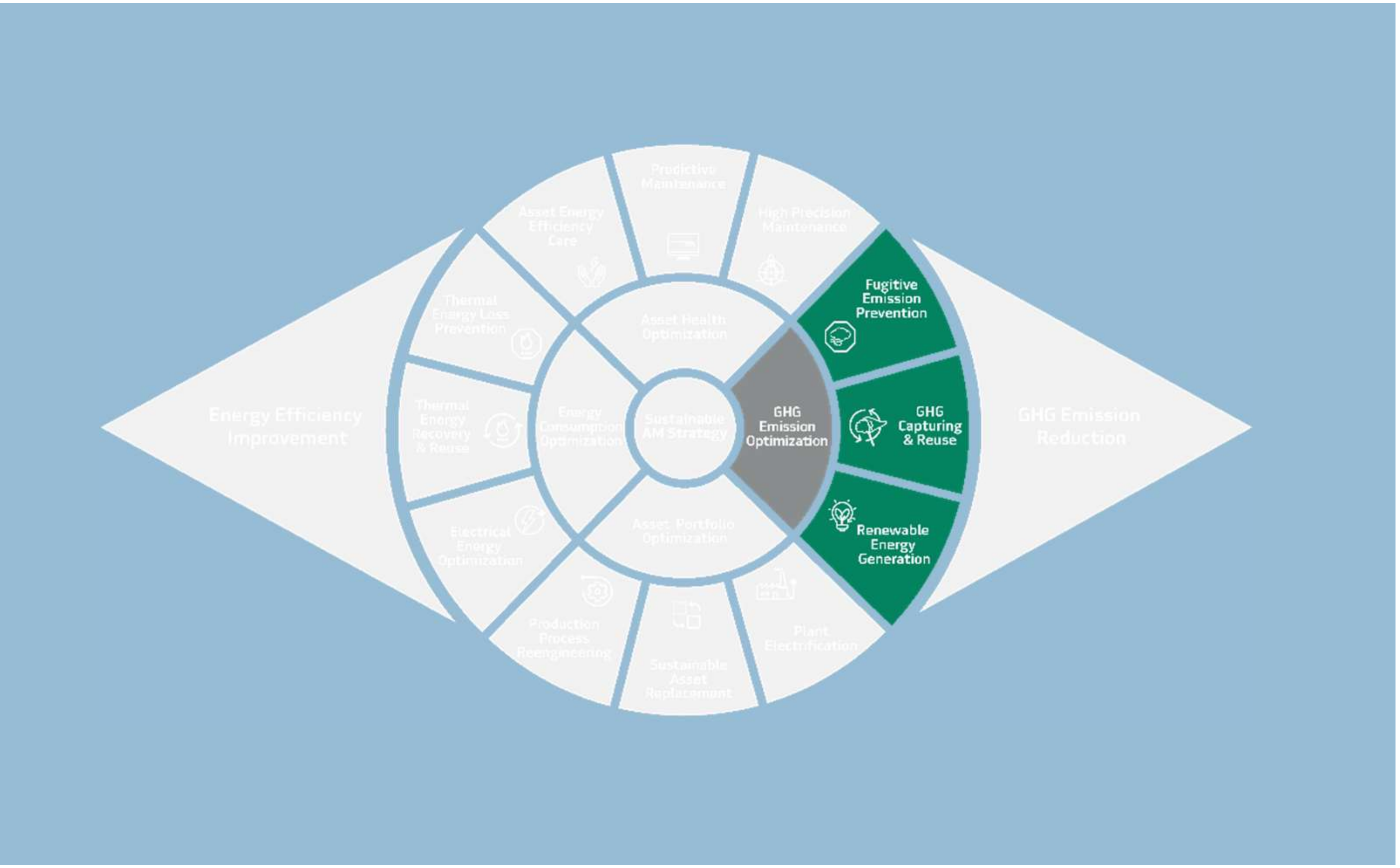

Characteristics of focus areas

Prevention of fugitive emissions

- Measures implemented to minimise or eliminate the release of fugitive emissions (greenhouse gases other than CO_2) into the atmosphere

Capture and reuse of greenhouse gases

- Capturing greenhouse gases emitted from industrial processes
- (Re)use of these gases in other applications

Generation of renewable energy

- Self-producing electricity or other forms of energy using renewable energy sources

Impact on sustainability

GHG Emission Optimisation

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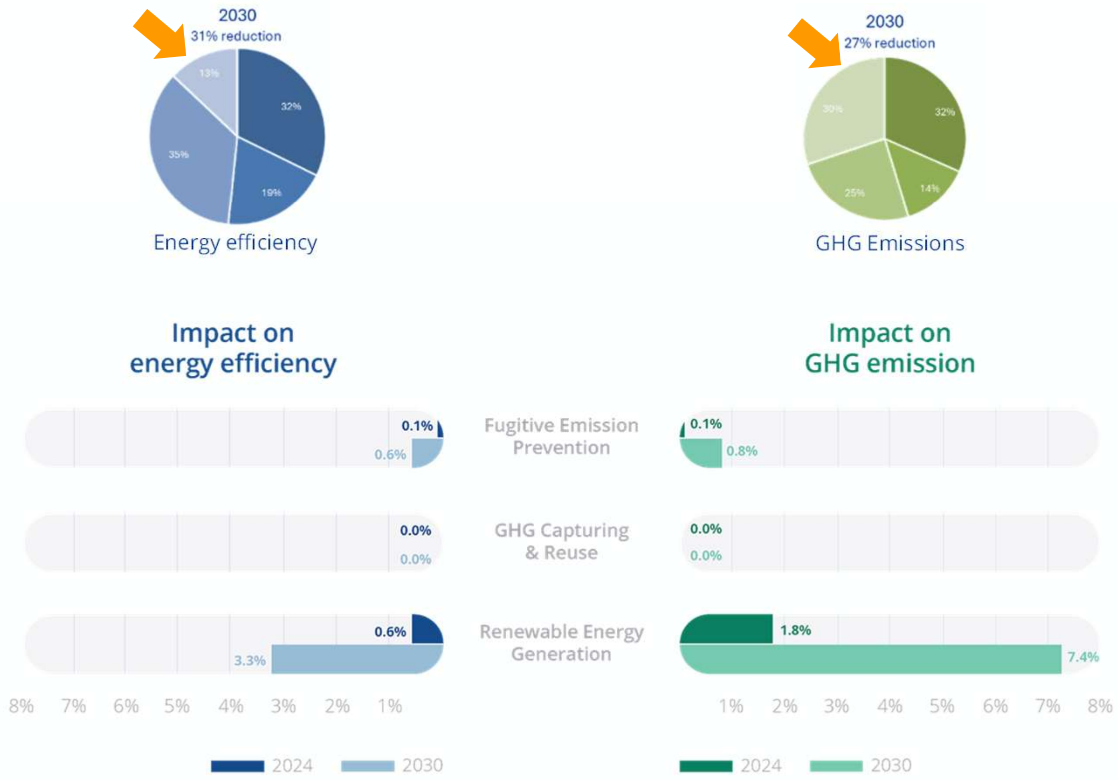
- The impact of this quadrant on sustainability improvements is obviously mainly on the **reduction of greenhouse gas emissions**
- The share of total emissions reduction grows from 18% in 2024 to 30% in 2030 among early adopters which ultimately accounts for **over 8% reduction** in total emissions compared to 2020
- The benchmark study shows that this stems almost entirely from the **introduction of renewable energy sources** saying goodbye to fossil fuel energy production systems
- **Preventing fugitive emissions** of other greenhouse gases has **limited impact** and is hardly growing
- Capture and reuse of greenhouse gases plays no significant role among early adopters



Module 6

Green House Gas Emission Optimisation

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1. Objectives and impact
2. Prevention of fugitive emissions
3. Capture and reuse of greenhouse gases
4. Generation of renewable energy

Prevention of fugitive emissions

Energy Consumption Optimisation

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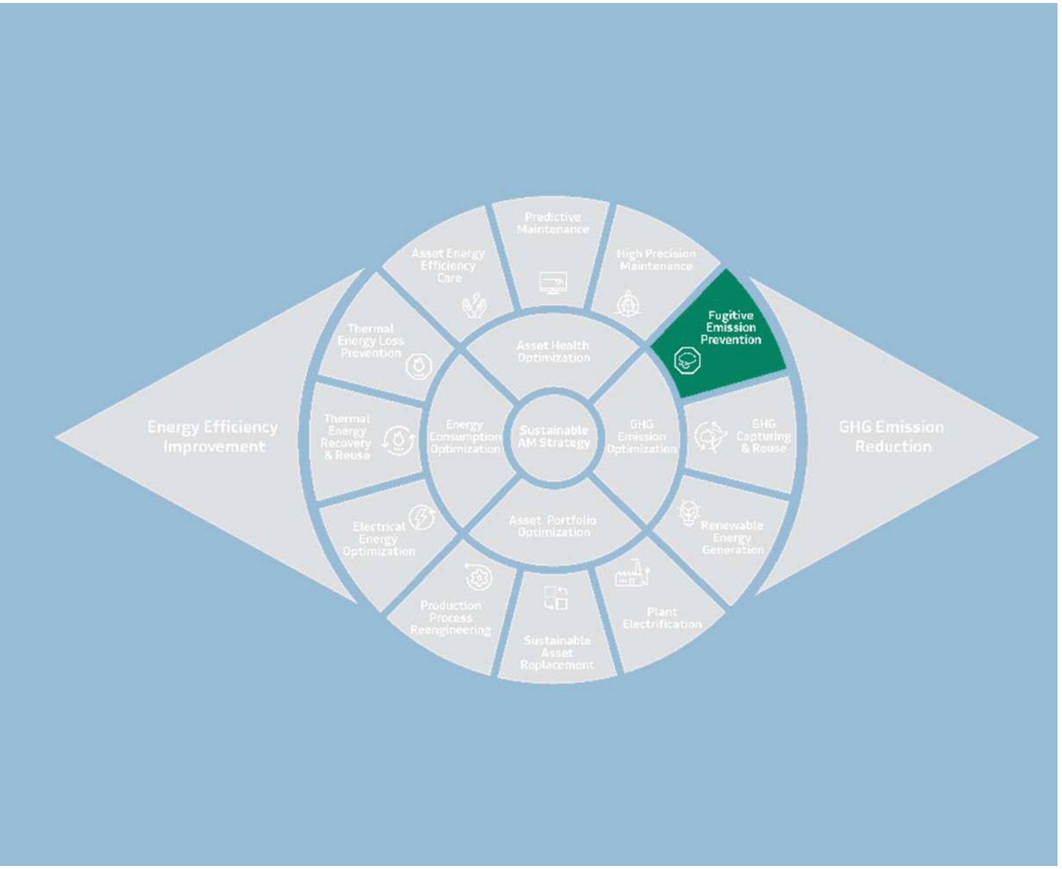

Characteristics focus area

- Measures implemented to minimise or eliminate the release of fugitive emissions (**greenhouse gases other than CO_2) into the atmosphere**
- Fugitive emissions are **unintended discharges** of gases, vapours or particulates from industrial equipment, processes or facilities that occur outside controlled emission points such as chimneys or vents
- Besides achieving sustainability targets, this is an important area to comply with **environmental laws and regulations**

Prevention of fugitive emissions

Possible measures?

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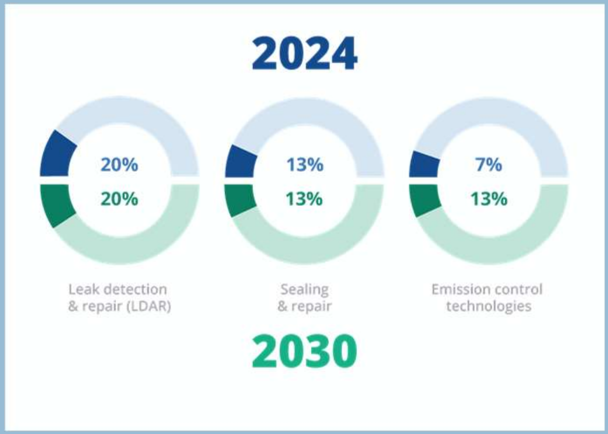
Leak detection and repair (LDAR)	• Implementation of leak detection programmes to **identify** and immediately address sources of fugitive emissions • This may include the use of online and offline **leak detection tools** such as gas detectors, infrared cameras or ultrasonic leak detectors to detect leaks in equipment and piping systems
Sealing and repair	• Ensuring that seals, gaskets and other components are **properly installed, maintained** and replaced as necessary to prevent leaks and emissions • This can include using high-quality sealing materials and using the right installation techniques • Proper **training of technicians** is a must for this
Emission control technologies	• Using vapour recovery units, flares, thermal oxidisers, scrubbers and other technologies to capture and destroy fugitive emissions before they are released into the atmosphere • These systems help minimise the environmental impact of fugitive emissions and may be **required by regulators** in certain industries

Prevention of fugitive emissions

Implementation rate early adopters

- The benchmark survey shows that **Leak Detection and Repair (LDAR)** is the most widely used application within this focus area
- Application of these measures is mainly done **for reasons of environmental safety and environmental legislation** and less to achieve reduction of GHG emissions
- This explains the **low implementation rate (20%)** of this type of system
- In addition, the results show that early adopters also **do not** expect **growth** in the adoption of these measures
- Application of the measures within this focus area is strongly related to the **type of production process** and the likelihood of volatile gas generation: in chemistry, this plays a greater role than within assembly processes



Fugitive emissions in the process industry

Article - Prevention of fugitive emissions

The article discusses the issue of fugitive emissions in the process industry, focusing on control valves as a major source

Objective:

Reduce fugitive emissions, especially from control valves, to minimise environmental impact and improve operational efficiency.

Actions:

- Implementation of UReason's **Control Valve App** for data-driven valve diagnosis
- **Continuous monitoring** of valve performance to identify problems early on
- Using **predictive maintenance** to address problematic valves
- Targeting high-risk areas and **potential 'super emitters'**

Achievements:

- Control valves, which represent **only 1%** of a facility's total installed **assets**, account for about **60% of** a plant'**s fugitive gas emissions** (70% in refineries)
- Improved precision in process control, leading to **reduced energy waste and emissions**


Fugitive Emissions in the Process Industry - Control Valves Play a Big Part

Fugitive emissions, the unintended releases of gases or vapors from pressurized equipment, are a major concern in industries like Oil & Gas, Chemical Manufacturing, Petrochemical, Energy and so on. These emissions typically escape through leaks in valves, connections, seals, and other components. Due to their elusive nature, controlling fugitive emissions is both a challenge and a necessity for reducing environmental impact and enhancing operational efficiency.

Source: Fugitive Emissions in the Process Industry - Control Valves Play a Big Part

Module 6

Green House Gas Emission Optimisation

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1. Objectives and impact
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Capture and reuse of greenhouse gases

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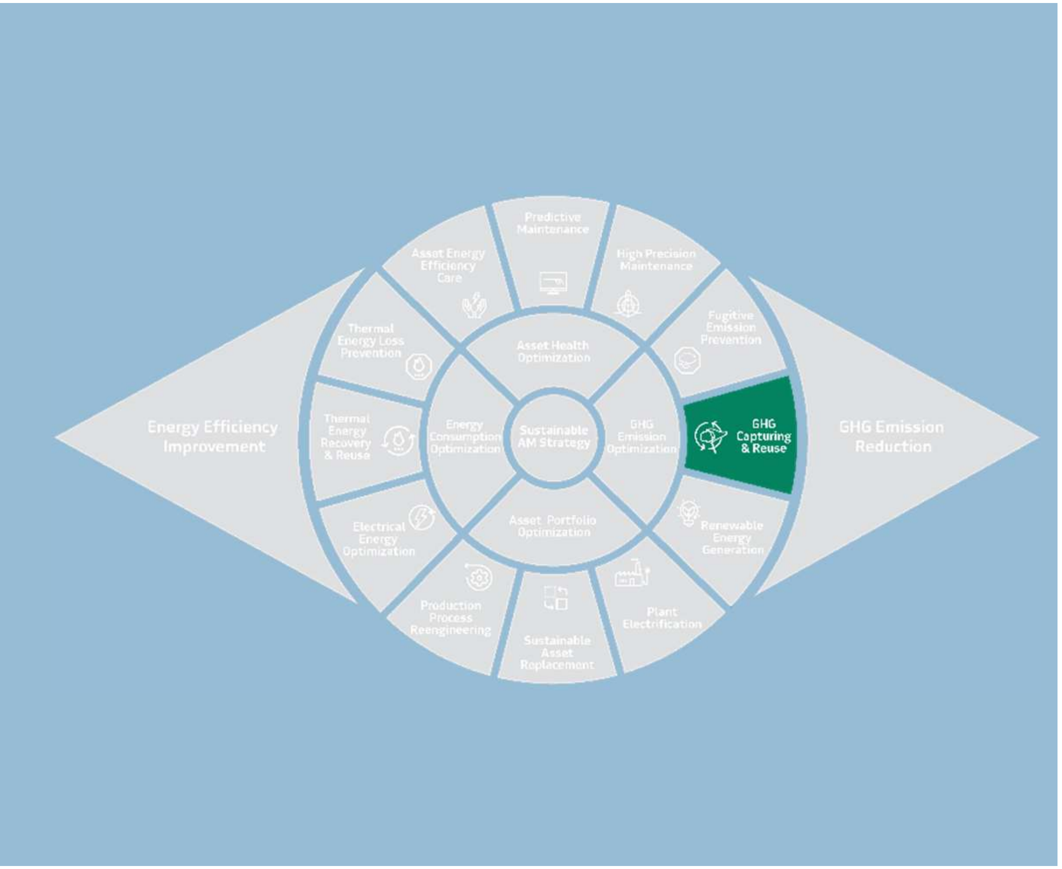

Characteristics focus area

- Capturing carbon dioxide (CO_2) and other greenhouse gases emitted by industrial processes or power generation facilities
- Using or reusing these captured gases in different applications to reduce overall emissions
- These applications may include internal applications within the plant or external applications involving links to other parties' processes

Capture and reuse of greenhouse gases

Possible measures?

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Capture technologies	• Methods to capture CO2 and other greenhouse gases emitted from industrial sources. • Common capture technologies include post-combustion capture, pre-combustion capture and oxy-fuel combustion
Transport and storage	• Transport captured greenhouse gases to storage sites where they can be safely stored underground or used in other applications • One example is long-term storage where CO2 is injected into geological formations, such as depleted oil and gas reservoirs
Use and conversion	• Recovery of captured greenhouse gases in applications internally or externally rather than releasing them into the atmosphere • Examples include using CO2 to produce synthetic fuels, as carbon dioxide in soft drinks and as 'fertiliser' in greenhouse farming
Biological conversion	• Deploy biological processes, such as algae cultivation or microbial conversion, to capture CO2 and convert it into biomass or other valuable products.

Capture and reuse of greenhouse gases

Implementation rate early adopters

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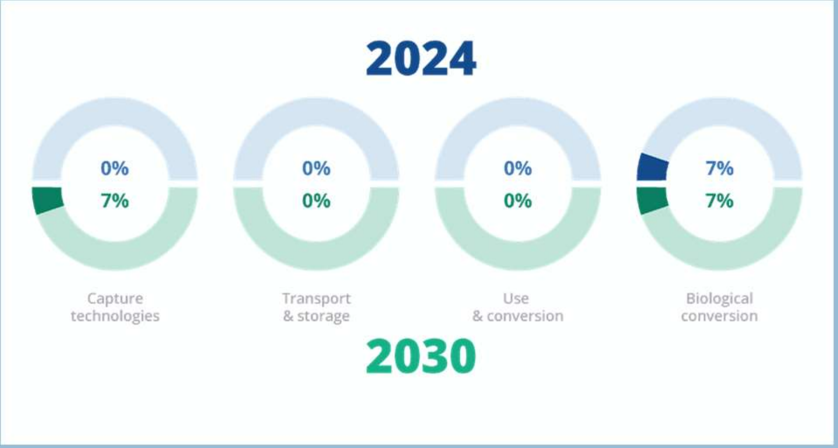
- The benchmark study confirms the picture that these **capture and reuse** applications are currently used **to a very limited extent** (only 7%)
- Due to the potential large impact on sustainability, these measures do receive a lot of attention and are often started from private and public partnerships
- In analogy with the conclusion in the previous chapter around Recovery and reuse of thermal energy, it can also be argued here that these types of technologies are **difficult to plan for from a sustainability perspective** and are deployed more from commercial opportunities



Carbon Capture and Storage (CCS) Project- Zeeland Refinery

Case - Capture and reuse of greenhouse gases

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- **Air Liquide Engineering & Construction** is supporting the decarbonisation of Zeeland Refinery by implementing a carbon capture and storage solution
- This project aims to capture and transport CO2 emissions from the refinery's hydrogen production units for **permanent storage** under the North Sea
- The project is in **progress**. Air Liquide has been selected to provide the technology, but implementation is not yet complete
- This solution is applicable to **manufacturing companies**, especially those in energy-intensive industries **with significant CO2 emissions**
- The project is expected to capture **800,000 tonnes of CO2** annually, representing about **90% of the** refinery'**s emissions**
- The showcase for this research is the Carbon Capture and Storage project at **Zeeland Refinery** in the Netherlands
- This project demonstrates the practical application of CCS technology in the refining industry and its potential for significant CO2 emission reductions
- It is part of the **larger Porthos project**, which aims to transport and store CO2 from various industrial sources in the Rotterdam port area

Source: https://engineering.airliquide.com/air-liquide-engineering-construction-supports-decarbonization-zeeland-refinery

CO_2 capture at a waste incineration plant

Case - AVR

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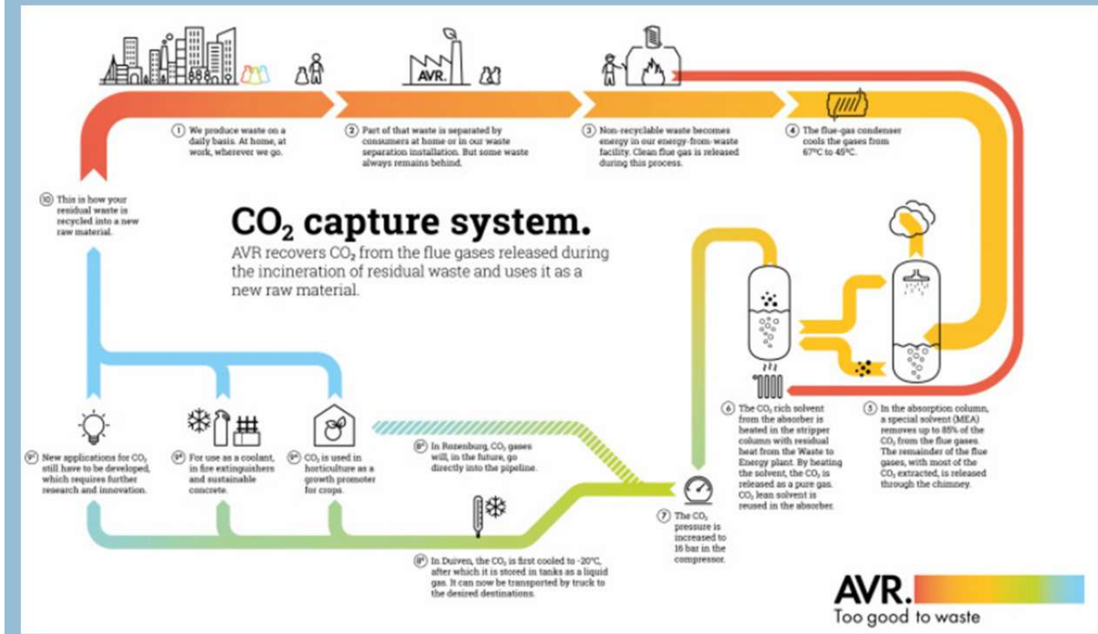
- **AVR has a large waste incineration plant.** A carbon capture solution has been implemented here
- CO_2 released from household waste incineration is **captured**
- The CO_2 is reused or used as raw material in a number of different places:
  - In **horticulture**
  - As gas in **fire extinguishers**
  - As a raw material for **sustainable concrete**
- In addition, R&D projects for possible new applications of captured CO_2
- This installation leads to savings of **60,000 tonnes of CO_2** per year



[CO_2 capture plant - AVR - Too good to waste]

Module 6

Green House Gas Emission Optimisation

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Generation of renewable energy

Energy Consumption Optimisation

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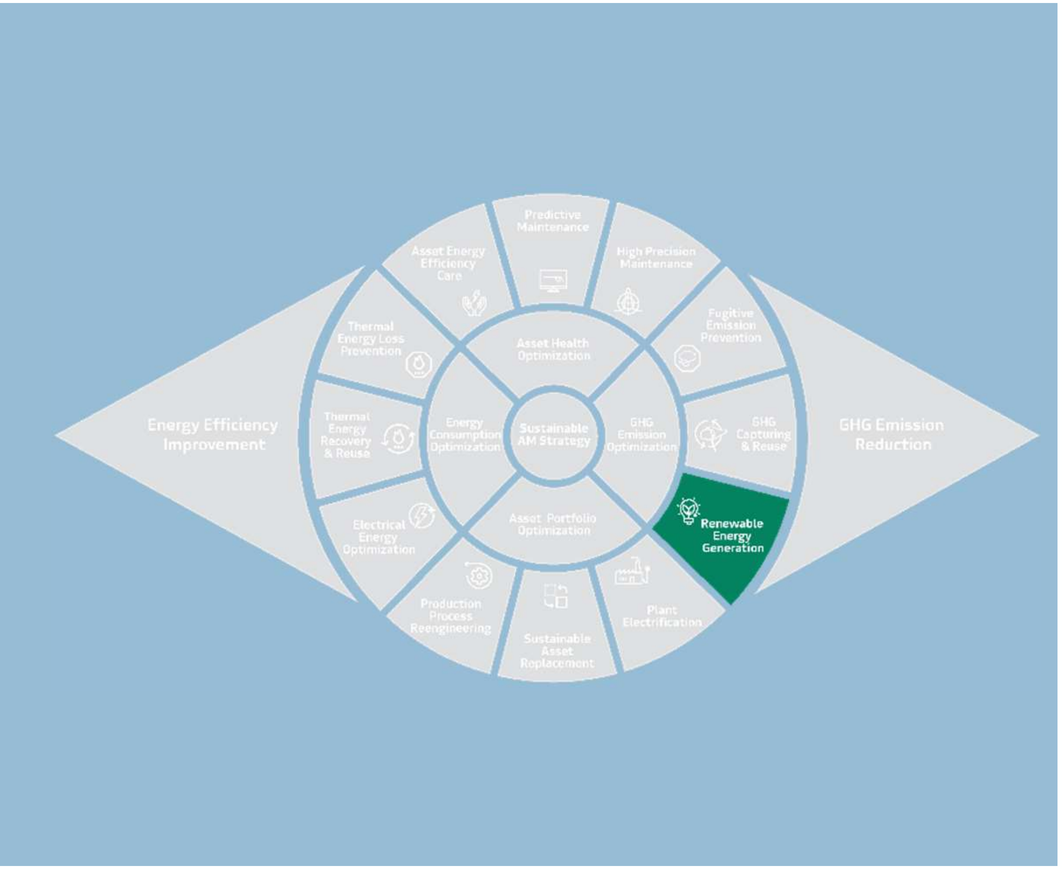

Characteristics focus area

- Self-producing electricity or other forms of energy using renewable energy sources
- Reducing on-site greenhouse gas emissions (scope 1),
- Might also lead to lower consumption of purchased electricity and therefore also impact on scope 2

Generation of renewable energy

Possible measures?

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Solar energy systems	• Through photovoltaic (PV) panels that convert sunlight directly into electricity • Through concentrating solar power (CSP) systems that concentrate sunlight on a receiver, converting it into heat (thermal energy). The heat can be used directly or converted into electricity
Wind Energy Systems	• Using the kinetic energy of the wind to turn turbines, which then convert the wind's energy into electricity
Biomass Energy Systems	• Heat or electricity is produced by burning organic materials such as wood, agricultural residues or waste biomass • Biomass can also be converted into biofuels, such as ethanol and biodiesel for use in transport or heating
Geothermal Energy Systems	• Generating geothermal energy by harnessing heat from the earth's interior • This is mostly done using geothermal heat pumps to heat and cool buildings

Generation of renewable energy

Implementation rate early adopters

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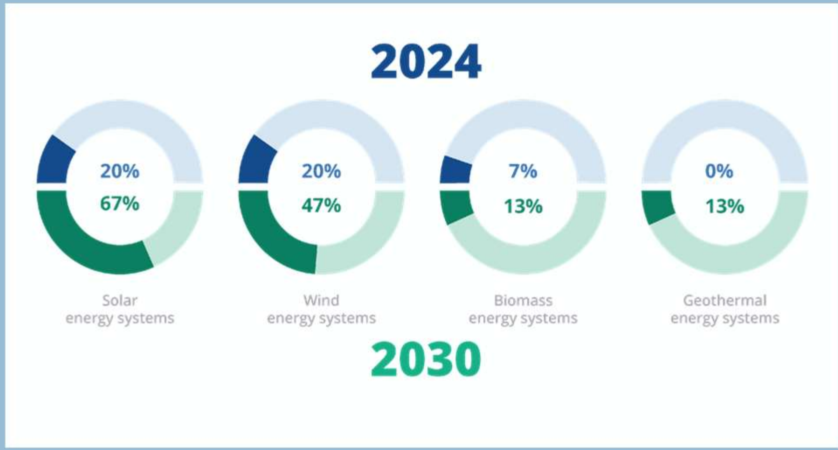
- The last focus area within this quadrant, **Generation of renewable energy**, does get **a lot of use**
- We saw earlier that the **impact on** reducing **greenhouse gas emissions** in particular is large: accounting for **over 7% reduction** in 2030 compared to 2020
- The commissioning of **solar panels and wind turbines** on own sites is going to make a difference for **50-70% of early adopters** in this by 2030
- Applying **biomass and geothermal** energy systems does **not** seem to be **an option for** early adopters **for the time being,** with an implementation rate of less than 15%



Solar panels projects- Royal Cosun

Case - Renewable energy generation

- Royal Cosun has received green funding to carry out several CO2 reduction projects at its production facilities that will contribute to its ambition of becoming CO2 neutral by 2050. They include energy efficiency measures and renewable energy generation.
  One of the projects is a project of over **28,000 solar panels** on a **7-hectare** solar meadow as part of the Cosun Solar Park that covers a total of 17 hectares
  The project is expected to reduce **CO2 emissions by 5.1 million kg** per year
  9.2 million kWh of renewable energy will be generated per year, providing green power to the speciality factories of subsidiary Cosun Beet Company
- This 9.2 million kWh per year is equivalent to the energy consumption of about **3,250 Dutch households**
  The calling card of this study is Royal Cosun's implementation of several CO2 reduction projects at its production facilities, financed by **green financing** from BNP Paribas. This shows how production companies can use sustainable financing to implement large-scale emission reduction initiatives

Royal Cosun achieves 5.1 million kg CO2 reduction per year with green financing from BNP Paribas

- The green financing concerns a new lease construction by BNP Paribas for a project of more than 28,000 solar panels on a 7-hectare solar meadow;
- The 7-hectare solar meadow will reduce CO_2 emissions by 5.1 million kilograms a year and is part of the 17-hectare Cosun Solar Park;
- Every year, 9.2 million kWh of renewable energy is generated to supply the speciality factories of the subsidiary Cosun Beet Company with green energy.

Source: https://www.cosun.nl/nieuws/royal-cosun-realiseert-co2-reductie-van-51-miljoen-kg-per-jaar-met-groenfinanciering-bnp-paribas/

RWE - Green Hydrogen

Renewable Energy Generation

Objective:

RWE wants to build a 100 MW electrolyser at Eemshaven to produce green hydrogen on a large scale and contribute to the decarbonisation of industry.

Actions:

- Build **100 MW** electrolyser
- **Renewable wind energy** from the North Sea
- Construction scheduled to start in 2025

Goals:

- Annual production of **15,500 tonnes of** Green Hydrogen per year
  Equals savings of **156,000 tonnes of CO_2** per year
- Thus contributes to the Netherlands' goal of having 4 GW of electrolysis capacity available by 2030

RWE's green hydrogen ambitions for Eemshaven region strengthened by plans for 100MW electrolyser

De 100 MW OranjeWind elektrolyser staat gepland ter hoogte van de Magnumcentrale in de Eemshaven.

RWE gets permit to build 100 MW electrolyser at Eemshaven - ***Industrielings***

DENS: hydrozine as CO_2 neutral energy carrier

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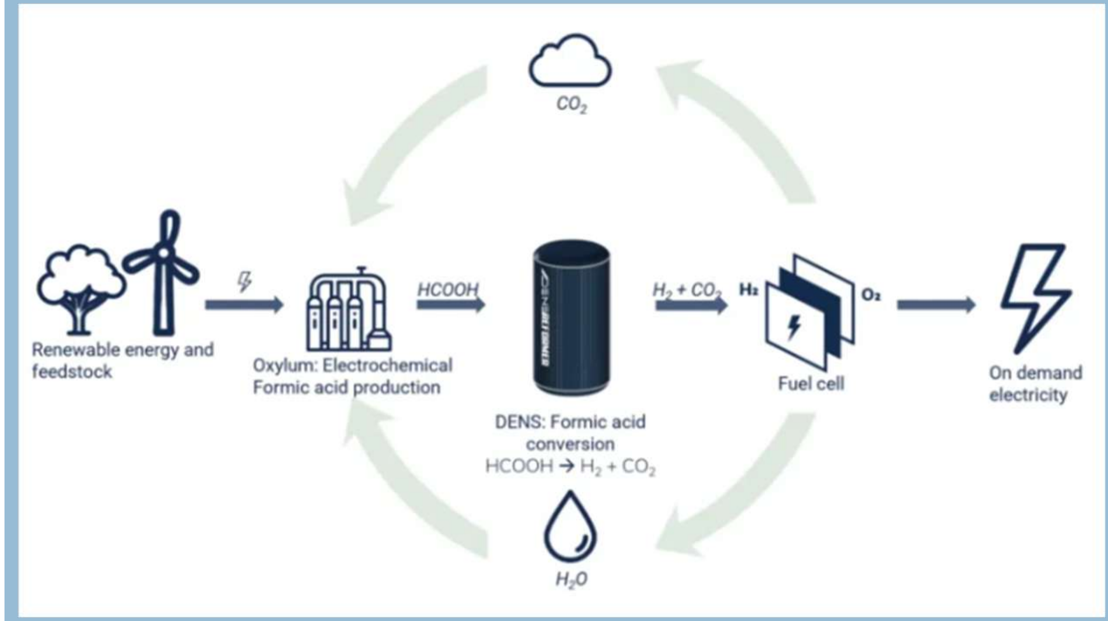
- Wind and Solar energy have a volatile nature, making efficient energy storage crucial. Hydrogen is promising, but storage and transport are expensive and complex.
  An alternative is **formic acid (Hydrozine**); less volatile, less toxic and easier to store.
  The companies **Oxylum (Belgium)** and **DENS (Netherlands)** are working together on an innovative solution.
  Oxylum converts $CO_{2,}$ renewable electricity and water into **formic acid**
- DENS converts formic acid into hydrogen and CO_2
  The gas mixture drives a **fuel cell** using oxygen from outside air. This process takes place at low temperature, so **no harmful substances** are formed.
- The electricity generated can be purchased as required
- This process is a closed cycle, and **100% renewable**



Source: https://www.dens.nl

e-Learning: How to Improve energy efficiency and emissions through Sustainable Asset Management

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Module 7
Implementing Sustainable Asset Management

Module 7

Implementing Sustainable Asset Management

1. Implementation Roadmap
2. Culture change

Overview Implementation Road Map

6 steps

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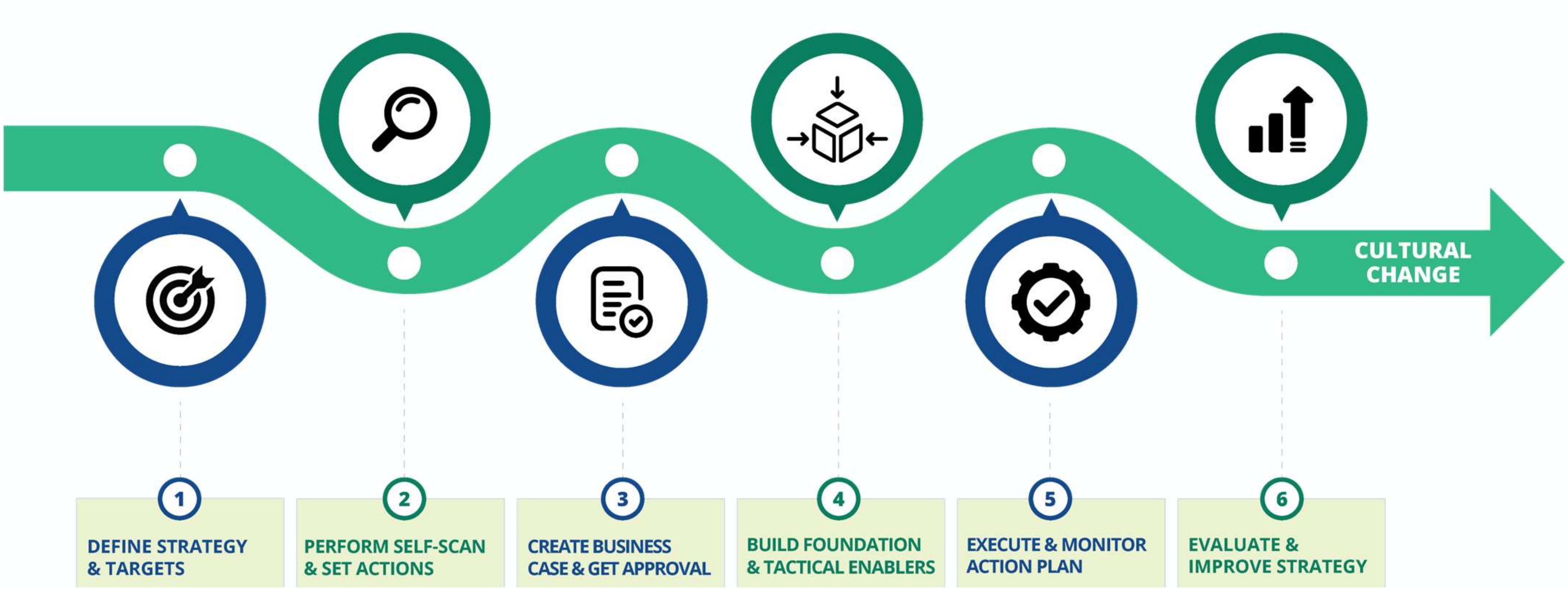

Defining Strategy & Goals

Step 1

1.
Defining Strategy
& Goals

- Understanding corporate sustainability strategy and goals
- Translating business strategy into Asset Management domain
- Define provisional targets for Energy Efficiency & Greenhouse Gases
- Adding sustainability to Strategic Asset Management Plan (SAMP)
- Align preliminary goals with other Asset Management goals

Perform Self Scan & Determine Actions

Step 2

1. Defining Strategy & Goals

2. Perform Self Scan & Determine Actions

- Analyse the current situation
- Identify areas for improvement with regard to sustainability
- Draw up an action plan and determine the expected impact on Energy Efficiency and Greenhouse Gas Emissions
- Determine the required investment and operational costs of this plan
- Adjust SAMP and Asset Management targets for Energy Efficiency & Greenhouse Gas Emissions

Self Scan

Implementation rate versus Early Adopters

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- 12 focus areas Sustainable Asset Management Framework
- Understanding implementation rates of early adopters
- Inventory current implementation rate of methods
- Determine target implementation rate in 2030
- Compare this with implementation rate of early adopters
- Define actions/projects to be carried out

	% Early adopters with full implementation	Current Implementation Level	Target Implementation Level 2030	Description of action
1.1 Plant Electrification				
1.1.1 Pumps	33%	0. Not Implemented	0. Not Implemented	
1.1.2 Compressors	40%	1. Pilot Implementation	1. Pilot Implementation	
1.1.3 Heating elements	40%	0. Not Implemented	0. Not Implemented	
1.1.4 Vehicles and forklifts	53%	3. Fully implemented	3. Fully implemented	
1.1.5 Other	0%	0. Not Implemented	0. Not Implemented	
1.2 Sustainable Asset Replacement				
1.2.1 Led Lighting	67%	1. Pilot Implementation	3. Fully implemented	Replacement of all lighting by LED
1.2.2 Smart and adaptive lighting	47%	0. Not Implemented	0. Not Implemented	
1.2.3 High-efficiency HVAC	33%	1. Pilot Implementation	3. Fully implemented	
1.2.4 High-efficiency motors and drives	60%	1. Pilot Implementation	2. Roll out	Replacement of 10 motors
1.2.5 Life extension, refurbishment and overhaul	53%	1. Pilot Implementation	1. Pilot Implementation	
1.2.6 Circularity for sustainable replacement	40%	0. Not Implemented	0. Not Implemented	
1.2.7 Other	0%	0. Not Implemented	0. Not Implemented	
1.3 Production Process Reengineering				
1.3.1 Process optimization and redesign	53%	0. Not Implemented	0. Not Implemented	
1.3.2 Product conversion	27%	1. Pilot Implementation	1. Pilot Implementation	
1.3.3 (Partial) plant closure	7%	0. Not Implemented	0. Not Implemented	
1.3.4 Building (a partial) new factory	27%	2. Roll out	2. Roll out	
1.3.5 Circularity from process reengineering	13%	0. Not Implemented	0. Not Implemented	
1.3.6 Other	0%	0. Not Implemented	0. Not Implemented	
2.1 Asset Energy Efficiency Care				
2.1.1 Regular cleaning	73%	0. Not Implemented	0. Not Implemented	
2.1.2 Lubrication	60%	1. Pilot Implementation	3. Fully implemented	New lubrication service supplier
2.1.3 Filter maintenance	60%	0. Not Implemented	0. Not Implemented	
2.1.4 Operator maintenance	47%	1. Pilot Implementation	1. Pilot Implementation	
2.1.5 Routine inspections	73%	3. Fully implemented	3. Fully implemented	
2.1.6 Monitor equipment settings	53%	2. Roll out	2. Roll out	
2.1.7 Other	0%	0. Not Implemented	0. Not Implemented	
2.2 Predictive Maintenance				

Self Scan

Intended impact versus Early Adopters

	% Early adopters with full implementation	Current Implementation Level	Target Implementation Level 2030	Description of action	Required Investment (€)	Additional annual costs (€)	Energy Efficiency Improvement 2030	GHG Emission Improvement 2030
1.1 Plant Electrification							Early Adopters = 1,5%	Early Adopters = 2,0%
1.1.1 Pumps	33%	0. Not Implemented	0. Not Implemented					
1.1.2 Compressors	40%	1. Pilot Implementation	1. Pilot Implementation					
1.1.3 Heating elements	40%	0. Not Implemented	0. Not Implemented					
1.1.4 Vehicles and forklifts	53%	3. Fully implemented	3. Fully implemented					
1.1.5 Other	0%	0. Not Implemented	0. Not Implemented					
1.2 Sustainable Asset Replacement							Early Adopters = 5,3%	Early Adopters = 4,9%
1.2.1 Led Lighting	67%	1. Pilot Implementation	3. Fully implemented	Replacement of all lighting by LED	100.000			
1.2.2 Smart and adaptive lighting	47%	0. Not Implemented	0. Not Implemented					
1.2.3 High-efficiency HVAC	33%	1. Pilot Implementation	3. Fully implemented					
1.2.4 High-efficiency motors and drives	60%	1. Pilot Implementation	2. Roll out	Replacement of 10 motors	300.000		1,0%	1,0%
1.2.5 Life extension, refurbishment and overhaul	53%	1. Pilot Implementation	1. Pilot Implementation					
1.2.6 Circularity for sustainable replacement	40%	0. Not Implemented	0. Not Implemented					
1.2.7 Other	0%	0. Not Implemented	0. Not Implemented					
1.3 Production Process Reengineering							Early Adopters = 3,0%	Early Adopters = 2,1%
1.3.1 Process optimization and redesign	53%	0. Not Implemented	0. Not Implemented					
1.3.2 Product conversion	27%	1. Pilot Implementation	1. Pilot Implementation					
1.3.3 (Partial) plant closure	7%	0. Not Implemented	0. Not Implemented					
1.3.4 Building (a partial) new factory	27%	2. Roll out	2. Roll out					
1.3.5 Circularity from process reengineering	13%	0. Not Implemented	0. Not Implemented					
1.3.6 Other	0%	0. Not Implemented	0. Not Implemented					
2.1 Asset Energy Efficiency Care							Early Adopters = 4,3%	Early Adopters = 3,2%
2.1.1 Regular cleaning	73%	0. Not Implemented	0. Not Implemented					
2.1.2 Lubrication	60%	1. Pilot Implementation	3. Fully implemented	New lubrication service supplier		20.000		
2.1.3 Filter maintenance	60%	0. Not Implemented	0. Not Implemented					
2.1.4 Operator maintenance	47%	1. Pilot Implementation	1. Pilot Implementation				1,0%	1,0%
2.1.5 Routine inspections	73%	3. Fully implemented	3. Fully implemented					
2.1.6 Monitor equipment settings	53%	2. Roll out	2. Roll out					
2.1.7 Other	0%	0. Not Implemented	0. Not Implemented					
2.2 Predictive Maintenance							Early Adopters = 1,8%	Early Adopters = 0,6%

Total action plan - Focus Areas		**400.000**	**20.000**	**2,0%**	**2,0%**

Self Scan

Strategic & Tactical enablers versus Early Adopters

- Strategic development points
- Tactical enablers:
  - Processes
  - Standards and norms
  - IT systems
  - Staff training
  - Artificial Intelligence (AI)
- Implementation rate now and in 2030
- Investment and annual costs

	Current Implementation Level	Target Implementation Level 2030	Description of action	Required Investment	Additional annual costs
0.1 Strategy					
0.1.1 Alignment of mission, vision and values					
0.1.2 Sustainability culture					
0.1.3 (Legal) compliance and standards					
0.1.4 Performance measurement and reporting					
0.2 Processes					
0.2.1 Asset Portfolio Optimisation process					
0.2.2 Asset Health Optimisation process					
0.2.3 Energy Consumption Optimisation process					
0.2.4 GHG Emission Optimisation process					
0.3 Standards					
0.3.1 ISO 55000 standard for Asset Management					
0.3.2 ISO18436 standard for condiion monitoring					
0.3.3 ISO 50001 standard for energy management					
0.3.4 ISO 14001 standard for environmental systems					
0.4 IT systems					
0.4.1 Asset Portfolio Management systems					
0.4.2 RealTime Condition Monitoring systems					
0.4.3 Energy Management systems					
0.4.4 Emission Management systems					
0.5 Staff training					
0.5.1 Staff training on Asset Portfolio Optimisation					
0.5.2 Staff training on Asset Health Optimisation					
0.5.3 Staff training on Energy Consumption Optimisation					
0.5.4 Staff training on GHG Emission Optimisation					
0.6 Artificial Intelligence					
0.6.1 AI for Asset Portfolio Optimisation					
0.6.2 AI for Asset Health Optimisation					
0.6.3 AI for Energy Consumption Optimisation					
0.6.4 AI for GHG Emission Optimisation					
Total					
Total action plan - Strategy & Tactics				0	0

Developing Business Case & Consent

Step 3

1. Defining Strategy & Goals
2. Perform Self Scan & Determine Actions
3. Developing Business Case & Getting Consent

- Analyse plant energy costs
- Analyse costs for Greenhouse Gas Emissions
- Calculate returns from improvements on Energy Efficiency and Greenhouse Gas Emissions
- Calculate Business Case indicators:
    - Return on investment (ROI)
    - Net Present Value (NPV)
    - Pay Back Period (PBP)
- Ask permission for the action plan

Cost

Business case development

Determining energy costs

A plant with a replacement value of EUR 300M and a maintenance budget of EUR 6M has the following energy consumption:

- Gas: 9,000,000 m3
- Electricity 10,000,000 kwh

Energy costs:

- Gas: 9,000,000 m3 x EUR 0.75/m3 = EUR 6,750,000
- Electricity 10,000,000 kwh x EUR 0.23/kwh = EUR 2,300,000

- **Total energy consumption**: **EUR 9,050,000**

Determining costs CO2 emissions

Based on this energy consumption, the following CO2 emissions:

- Gas: 9,000,000 m3 x 1.779 kg CO2/m3 : 1000 = 16,011 tonnes
- Electricity: 10,000,000 kwh x 0.448 kg CO2/kwh :1000 = 4,480 tonnes

- **Total CO2 emissions**: 20,491 tonnes

Cost CO2 emissions:

- Market value of CO2 **allowances** through EU Emission Trading System (ETS)
- Value for this example: **68 EUR/tonne CO2**

- **Total CO2 emissions**: 20,491 tonnes x 68 EUR/tonne CO2 = EUR 1,**393,388**

Revenue

Business case development

	% Early adaptors with full implementation	Current Implementation Level	Target Implementation Level 2030	Description of action	Required Investment	Additional annual costs	Energy Efficiency Improvement 2030	GHG Emission Improvement 2030
Total action plan - Focus Areas					400.000	20.000	2,0%	2,0%

Revenues reduce energy consumption

- Energy efficiency: 2% improvement
    - 2% x EUR 9,050,000 = EUR 181,000

Proceeds reduce CO2 emissions

- CO2 emissions: 2% reduction
    - 2% x EUR 1,393,388 = EUR 27,878

Total revenues: EUR 208,868

Business case

Overview

Current Energy Costs	Energy Efficiency Improvement 2030	Annual Saving in 2030		ROI		
9.050.000	2,0%	181.000		47%		
Current GHG Emission Costs	GHG Emission Improvement 2030	Annual Saving in 2030		NPV	Discount Factor	Period (years)
1.393.388	2,0%	27.868		1.058.387	5%	10
Total Investments	Total Annual Costs	Total Saving in 2030		PBP (years)		
400.000	20.000	208.868		2		

Building Fundamentals & Tactical Enablers

Step 4

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1. Defining Strategy & Goals
2. Perform Self Scan & Determine Actions
3. Developing Business Case & Getting Consent
4. Building Fundamentals & Tactical Enablers

- Selecting relevant standards and norms (ISO)
- Implementing and/or optimising work processes
- Implementing and/or optimising IT tools
- Training and educating employees in sustainability focus areas
- Implementing Artificial Intelligence (AI) where possible and necessary

Implement & monitor Action plan

Step 5

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1. Defining Strategy & Goals
2. Perform Self Scan & Determine Actions
3. Developing Business Case & Getting Consent
4. Building Fundamentals & Tactical Enablers
5. Implement & monitor Action plan

- Implement actions related to Asset Portfolio Optimisation
- Implement actions related to Asset Health Optimisation
- Implement actions related to Energy Consumption Optimisation
- Implement actions related to Greenhouse Gas Reduction Optimisation
- Monitor the progress and results of the action plan

Evaluate & Improve Strategy

Step 6

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1. Defining Strategy & Goals
2. Perform Self Scan & Determine Actions
3. Developing Business Case & Getting Consent
4. Building Fundamentals & Tactical Enablers
5. Implement & monitor Action plan
6. Evaluate & Improve Strategy

- Evaluate progress and cost of action plan
- Evaluate Energy Efficiency and Greenhouse Gas Reduction targets
- Improve sustainability strategy
- Update the Action Plan and Business Case

Culture Change

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1. Defining Strategy & Goals
2. Perform Self Scan & Determine Actions
3. Developing Business Case & Getting Consent
4. Building Fundamentals & Tactical Enablers
5. Implement & monitor Action plan
6. Evaluate & Improve Strategy

Culture Change

- Creating support by involving employees
- Showing ownership
- Choices for objectives
- Rewarding sustainable behaviour
- Transparency in results
- Clear communication

>> Sustainability from policy to practice

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