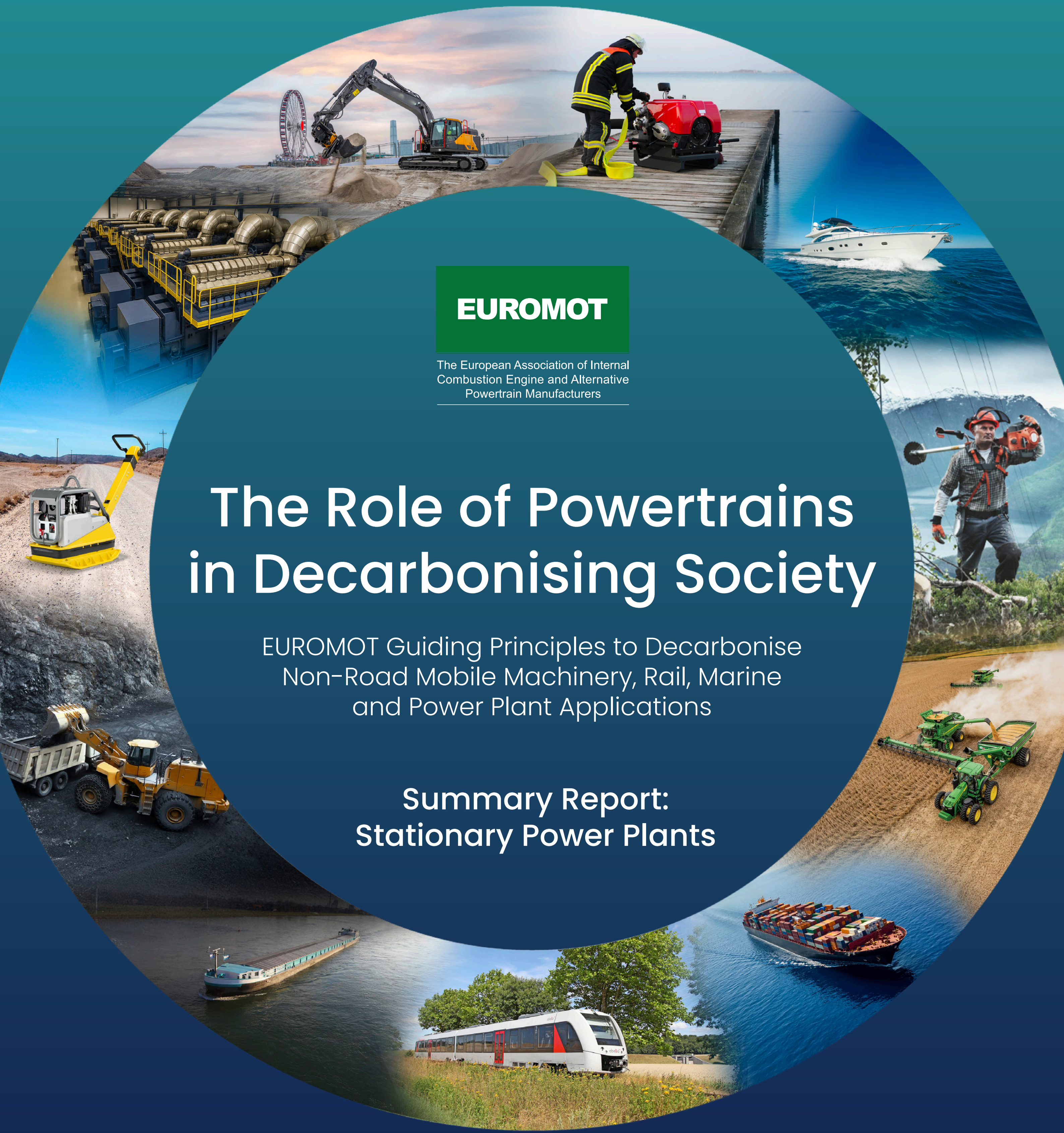

EUROMOT

The European Association of Internal Combustion Engine and Alternative Powertrain Manufacturers

The Role of Powertrains in Decarbonising Society

EUROMOT Guiding Principles to Decarbonise Non-Road Mobile Machinery, Rail, Marine and Power Plant Applications

Summary Report: Stationary Power Plants

March 2026

The Role of Powertrains in Decarbonising Society

EUROMOT Guiding Principles to Decarbonise Stationary Power Plants

This document is one of a portfolio of decarbonisation reports produced by EUROMOT, which are:

1. EUROMOT Guiding Principles
2. Executive Summary
3. Full Report
4. Sector-specific Summary Reports:
   - Non-road Mobile Machinery
   - Forestry, Lawn and Utility Machines
   - Marine Inland Waterways Transport
   - Marine Seagoing
   - Marine Recreational Craft
   - Rail Transport
   - Stationary Power Plants

Contents

About EUROMOT

EUROMOT, the European Association of Internal Combustion Engine and Alternative Powertrain Manufacturers, represents the key manufacturers of internal combustion engines and alternative powertrains installed in Construction, Agriculture and Industrial; Forestry, Lawn and Utility; Marine; Rail; and Stationary power plant applications that are operating in Europe and globally.

Founded in 1991, we provide a recognised hub of expertise for businesses, authorities, regulators, and public stakeholders worldwide. In partnership with major sector associations and institutions, it is our mission to advocate better regulation, and to foster innovation that supports our sustainability and industry objectives.

Delivering reliable power for society at high energy conversion efficiency with low emissions remains a key objective of EUROMOT member companies. EUROMOT asserts internal combustion engines and alternative powertrains are a key enabler to address decarbonisation across multiple industry sectors. This can be achieved by continuing to advance the development of flexible highly efficient energy conversion systems capable of operating on various low and net zero greenhouse gas emissions energy carriers.

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EUROMOT Guiding Principles to Decarbonise Stationary Power Plants

This sector comprises power plants using reciprocating internal combustion engines (RICE). These are used predominantly for electrical power generation but also in Combined Heat and Power (CHP) installations. The electrical energy produced can be used as prime power for off-grid consumers, as part of a grid system, or for example to balance fluctuations in renewable generation and support rapid changes in electricity consumption. RICE plants are also used as emergency backup when other provisions fail.

Core Principles:

Technology neutrality:

- Facilitate a diversified energy mix and do not be tempted to force a single technology.
- Base overall GHG reduction objectives in each industry sector on Life Cycle Analysis (LCA) considering different end uses and do not focus solely on emissions at point of use.

Recognition of the needs of end users:

- Ensure the continued ability to deliver dependable power to perform the intended task wherever it is needed.
- Ensure the availability of new low or net zero greenhouse gas (GHG) energy carriers at competitive costs.
- Facilitate the availability and use of low and net zero GHG energy carriers suitable for existing in-use products.

Predictable global approach:

- Align activities and levels of ambition at international level recognising internal combustion engines, alternative powertrains and the applications in which they are installed are developed for global markets.

Key Factors that Determine Decarbonisation Pathways

Power plants using RICEs are predominantly used to generate electricity. This is complimentary to other methods of electrical power generation.

Decarbonisation is achieved by using fuels that give lower net GHG emissions. These are, progressively, reduced carbon fuels, low carbon fuels and renewable fuels.

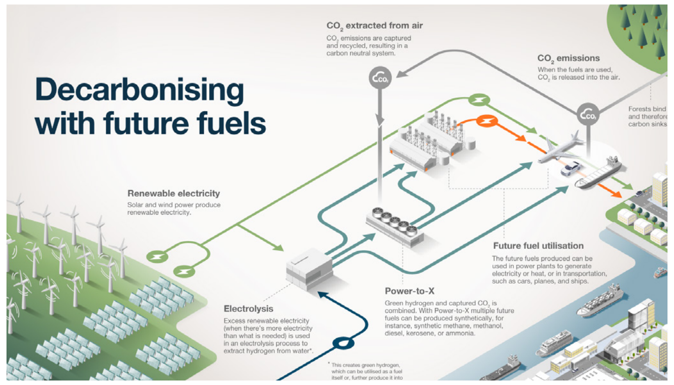
Output of power plant units ranges from **1 MW to 20 MW.** An installation may have multiple units.

Power plant installations may consume several GWh of fuel energy per day.

Locations range from urban to remote (such as smaller islands).

Fuel is always delivered to the power plants.

Additionally, speed of deployment is an important consideration as power plants can have a long service life. Hence, the availability of drop-in low carbon and renewable fuels is needed.



Energy Carriers

The carbon intensity of energy carriers (fuels) depends on their provenance.

Fuels

Fossil fuels

Derived from ancient organic matter, fossil fuels like coal, oil, and natural gas are burned for energy. Their combustion releases greenhouse gases, contributing to global warming. Unlike renewable fuels, fossil fuels are finite and environmentally impactful.

Reduced carbon fuels

Fuels where the carbon footprint (CF) is lower than the fossil fuels they replace, for example natural gas replacing diesel/fuel oil; B20 biodiesel; E50 gasoline.

Low carbon fuels

Fuels where the CF is >70% lower than their fossil equivalent.

Non carbon fuels

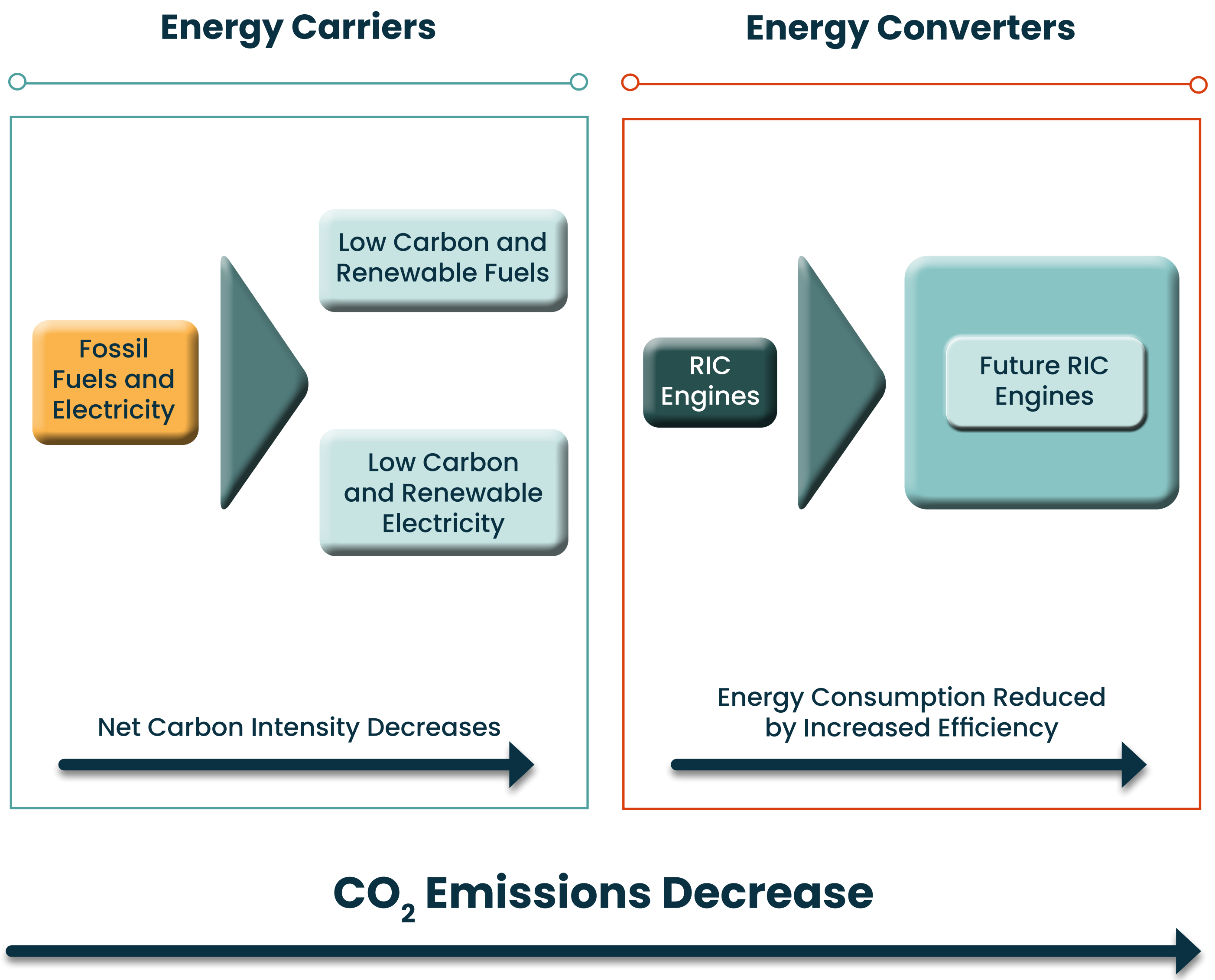
Fuels that do not contain carbon such as hydrogen and ammonia (not necessarily renewable).

Renewable fuels

Fuels of biological or non-biological origin where the stored energy comes from renewable sources; either solar energy via photosynthesis or from renewable electricity. The EU Renewable Energy Directives (REDs) require the Carbon Footprint (CF) of renewable fuels to be >70% lower than their fossil equivalent.

Decarbonisation Journey

How sector decarbonisation will result by combining efficient energy converters with an increasing panel of low carbon and renewable energy.



Use Case Examples

The following section presents a selection of examples that demonstrate the fundamental principles of decarbonisation.

These examples are not exhaustive, and do not represent the only pathways to decarbonisation for each type of machine.

Each of these machines may require different powertrain technologies offering pathways to decarbonisation for different use cases.

Important Criteria for Assessing Decarbonisation Pathways

Key Criteria*	Use Case Evaluation		
Energy use	Low	Is a large amount of energy used for the example task?	High
Work intensity	Low	Is the average power the machine is working at a high percentage of its maximum output power?	High
Type of use	Sporadic	Is the machine running for a high proportion of the task duration, or for a small portion?	Continuous
Availability of electricity on site	Available	Is electricity at a usable voltage and power available at the site of use of the machine?	Not available
Predictability of deployment	Pre-planned	Can the task be planned well in advance, or is it required to act urgently depending on circumstances?	Un-planned
Location of site	Adjacent to infrastructure	Is the machine being used in an area with infrastructure and service availability or any area without these?	Remote from infrastructure
Time on site	Extended	Is the time a machine is on site short i.e. days or weeks, or long i.e. months or years?	Short
Required machine mobility	Low	Does the machine used for the task move around the site (>100 m) or does it stay in one position?	High
Minimise refuelling/ recharging	Infrequent	Is it important to complete task without significant downtime for refuelling/recharging	Fast

*Terms used to explain the use case evaluations found in the following examples.

Stationary

Example 1: Microgrid for Remote Rural Communities or Individual Facilities

Use description:

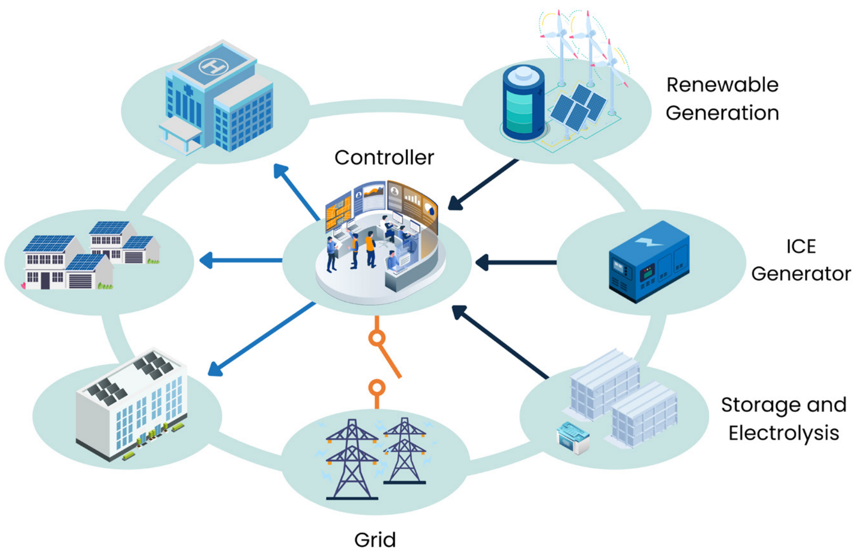
A smaller electrical generating and distribution system for an isolated small town, island or rural area, industrial facility, or data centre. Reciprocating Internal Combustion Engine (RICE) generators are used and can be supplemented with renewable generation.

System employed:

RICE generator plant of **1-20 MW** output size operating on gaseous or liquid fuels. The microgrid could use renewable baseload generation by wind and solar, balanced with a RICE using low carbon fuels, moving to renewable, gaseous or liquid fuels.

Decarbonisation pathways:

Low carbon fuels, moving to renewable, gaseous and liquid fuels. This includes hydrogen, ammonia and e-methanol, as well as fuels of biological origin. The microgrid could use renewable base load generation by wind and solar, balanced with a RICE generator. This could be supported with short-term battery storage, or with longer term surplus generation stored chemically as hydrogen or e-fuels. The heat from the engines may also be used for building heating where this is feasible.



Evaluation Criteria	Use Case Evaluation		
Energy use	Low	● (near high)	High
Work intensity	Low	● (near high)	High
Type of use	Sporadic	● (mid)	Continuous
Predictability of deployment	Pre-planned	● (near un-planned)	Un-planned
Time on site	Extended	● (extended)	Short

Stationary

Example 2: Main Grid Support in Renewable Generation Systems

Use description:

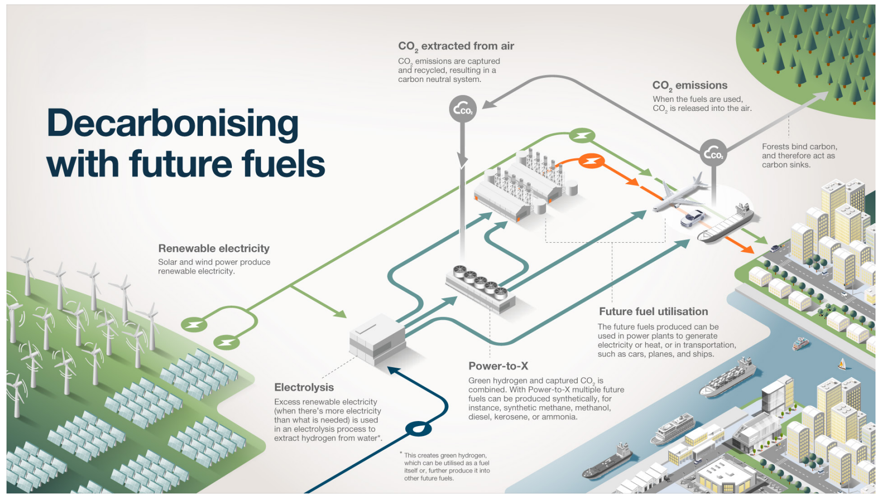
As renewable energy generation varies depending on the availability of wind, solar or other natural energy sources, it is necessary to have other dispatchable power sources that can be started and stopped quickly. This can be, for example, RICE generators. These are strong candidates for balancing power supply due to their fast start-up times and rapid load response, compared to other power sources. The heat generated can also be recovered for different CHP applications.

System employed:

Multiple engine powered generators each with **1-20 MW** output.

Decarbonisation pathways:

Engines are operated for fewer hours when renewable ratios of grids increase, thereby decreasing system level GHG emissions. Fuels for the RICE generators can vary from using fossil derived fuels to low carbon and then renewable fuels, both gaseous and liquid. Most gas engines can be modified to transition to hydrogen fuel when hydrogen becomes available. Grid system optimisation and demand management may also be applicable.



Evaluation Criteria	Use Case Evaluation	
Energy use	Low	High
Work intensity	Low	High
Type of use	Sporadic	Continuous
Predictability of deployment	Pre-planned	Un-planned
Time on site	Extended	Short

Stationary

Example 3: Auxiliary Generator for Emergency Use or Backup Use

Use description:

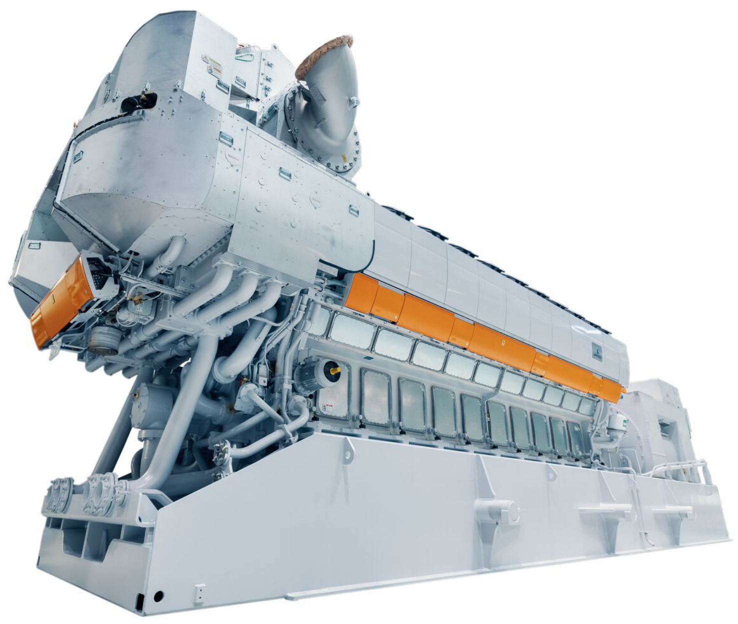
Backup generators for hospitals. The installed auxiliary generator, running on fuel stored on site, helps to maintain power in an emergency scenario. A highly energy-dense fuel is essential for safety and capacity. Local regulations may require emergency power plants to run for 7, 14 or 30 days.

System employed:

RICE powered electrical generator. Power output of engine unit will depend on the hospital size, typically **1-10 MW**.

Decarbonisation pathways:

Current diesel fuel use can be replaced with low carbon, moving to renewable liquid fuels. Drop-in fuels with high energy density are particularly suited to emergency plants.



Evaluation Criteria	Use Case Evaluation	
Energy use	Low	High
Work intensity	Low	High
Type of use	Sporadic	Continuous
Predictability of deployment	Pre-planned	Un-planned
Time on site	Extended	Short

Stationary

Example 4: Primary and Backup Power for Data Centre

Use description:

Backup or prime power generators for data centres. Data centres are typically supplied by grid electricity, but they need a reliable backup solution in case of a grid failure. In this scenario, power is supplied by using the installed backup generators running on diesel or gas fuel. Gas engines are becoming more attractive, because they can run continuously as well as providing backup power at lower emissions.

System employed:

RICE powered electrical generators. Power output will depend on the data centre size. Typically engine systems of **1-100+ MW** output are used.

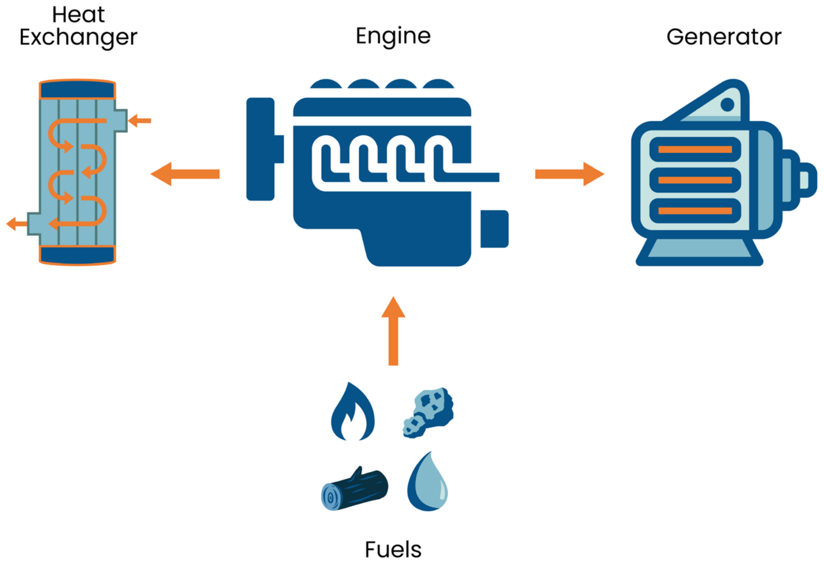
Decarbonisation pathways:

Current diesel use can be replaced with renewable liquid fuels. Gas engines can also be H2 modified.

Evaluation Criteria	Use Case Evaluation	
Energy use	Low	High
Work intensity	Low	High
Type of use	Sporadic	Continuous
Predictability of deployment	Pre-planned	Un-planned
Time on site	Extended	Short

Stationary

Example 5: Provision of Heat and Power for Small Village



Use description:

Provision of electricity and heat for a community or facility such as a village, office block or small factory.

System employed:

RICE powered electrical generator of **1-10 MW** with a similar amount of heat available. Fuelled by diesel or natural gas.

Decarbonisation pathways:

Current diesel or natural gas use can be replaced with low carbon, moving to renewable, liquid or gaseous fuels.

Evaluation Criteria	Use Case Evaluation		
Energy use	Low	●─ (near high)	High
Work intensity	Low	●─ (near high)	High
Type of use	Sporadic	●─ (near continuous)	Continuous
Predictability of deployment	Pre-planned	●─ (near pre-planned)	Un-planned
Time on site	Extended	● (at extended)	Short

Conclusion

Stationary power plants are an important enabler of decarbonisation across society. Their primary purpose is to balance variable renewable generation with demand to ensure power availability and grid reliability.

Where no electric grid or renewables are available, they are used as a prime power source. They are also essential as an emergency backup to maintain critical services such as keeping hospitals running when other power sources fail, for example when natural disasters destroy grid connections.

Decarbonisation of these high-power, energy-efficient power plants can be achieved by using low carbon fuels before moving to renewable fuels. The engines in these power plants are adaptable to a wide range of fuels. The choice of fuels to decarbonise each installation will depend on its location and the local fuel options available.

Recommendations

Manufacturers are developing powertrains that support decarbonisation of all the sectors in which they are used. For successful deployment of these technologies, policy and regulation need to be technology neutral, recognising the need for the full array of decarbonisation pathways, and assessing them on life cycle basis (LCA method).

Policy needs to enable supply and distribution of low carbon and renewable fuels. This includes production of drop-in low carbon and net zero fuels for use in existing plant. This will be critical to balance decarbonisation with the continuing need for dependable power across society.

Appendix: Definitions

Life Cycle Analysis (LCA) is a method of calculating the total CO_2e emissions from a product, including other emissions such as nitrous oxide (N_2O) and methane (CH_4), during its full lifecycle. That is throughout manufacture, use and disposal.

Well to Wheel, (or Well to Wake for marine) (WtW), or Well to X (WtX) emissions is the total (net) emissions generated when a fuel or energy carrier is created (such as when it is extracted from the ground or grown as a biological feedstock), when its energy has been converted in a machine and its end products emitted (e.g. CO_2 and water from burning a hydrocarbon fuel).

GHG Emissions CO_2 is the predominant Greenhouse Gas for this sector, but this also encompasses other GHGs such as nitrous oxide and methane, normally defined as CO_2 equivalent (CO_2e) when using the GWP100 definition (the global warming potential of a specific greenhouse gas over 100 years).

Energy Carriers are fuels and electricity (including batteries) containing stored energy that can be converted to other forms of energy which can then be used to power machines and power plants.

Energy Converters are the devices that convert energy from stored chemical energy (fuels) or electricity to mechanical energy – generally engines or motors (such as internal combustion engines, electric motors, hydrogen fuel cells combined with electric motors, hydraulic pneumatic motors, and hybrid systems).

Conversion Efficiency is the energy out of a converter divided by the energy input. For example, the mechanical energy at the flywheel, divided by the stored energy available in the fuel used.

Operational Efficiency is a measure of the work a powertrain application can do compared to a theoretical maximum or to the incumbent powertrain's performance. For example, operational efficiency is reduced if a proposed powertrain reduces the payload of a goods carrying vehicle, or if the use time available is reduced by increased refuelling times.

Acknowledgements

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