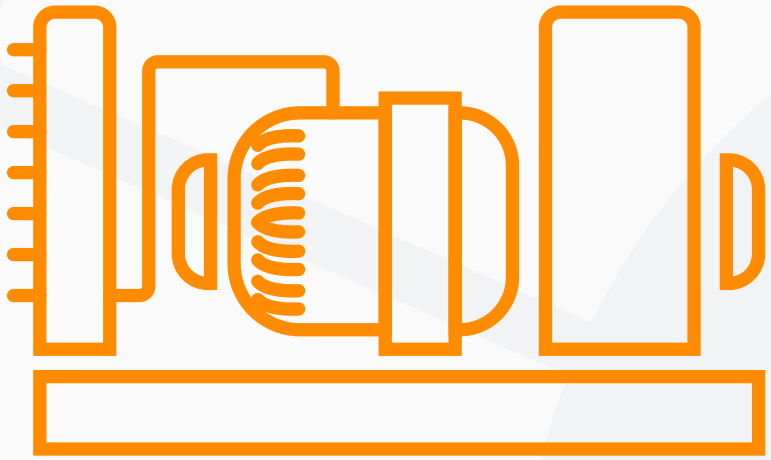


Alternative Fuel Gas Turbines

NZTTP Programme

OEUK Decarbonisation Conference October 2023

apollo

Net Zero Technology Centre

Technology Driving Transition

Net Zero Technology Transition Programme

Net Zero Technology Transition Programme

Offshore Energy Digital Architecture — Implementing a sector-wide data and infrastructure strategy to enable digitisation.

Data for Net Zero — Developing analytics to unlock energy transition action and deliver the world's first smart energy basin.

Advancing Remote Operations — Remote operations to create safer, more efficient and lower carbon operations.

OLTER — Enabling next generation robotics and autonomous systems for the offshore energy sector.

Energy Hub — Identifying key opportunities and technologies to deliver the nations future low carbon energy requirements

Hydrogen Backbone Link — Scotland in a leading role for the development of pan-European hydrogen infrastructure

Alternative Fuel Gas Turbines — Accelerating development of gas turbines capable of running on clean fuels.

7 integrated projects

£16.5m

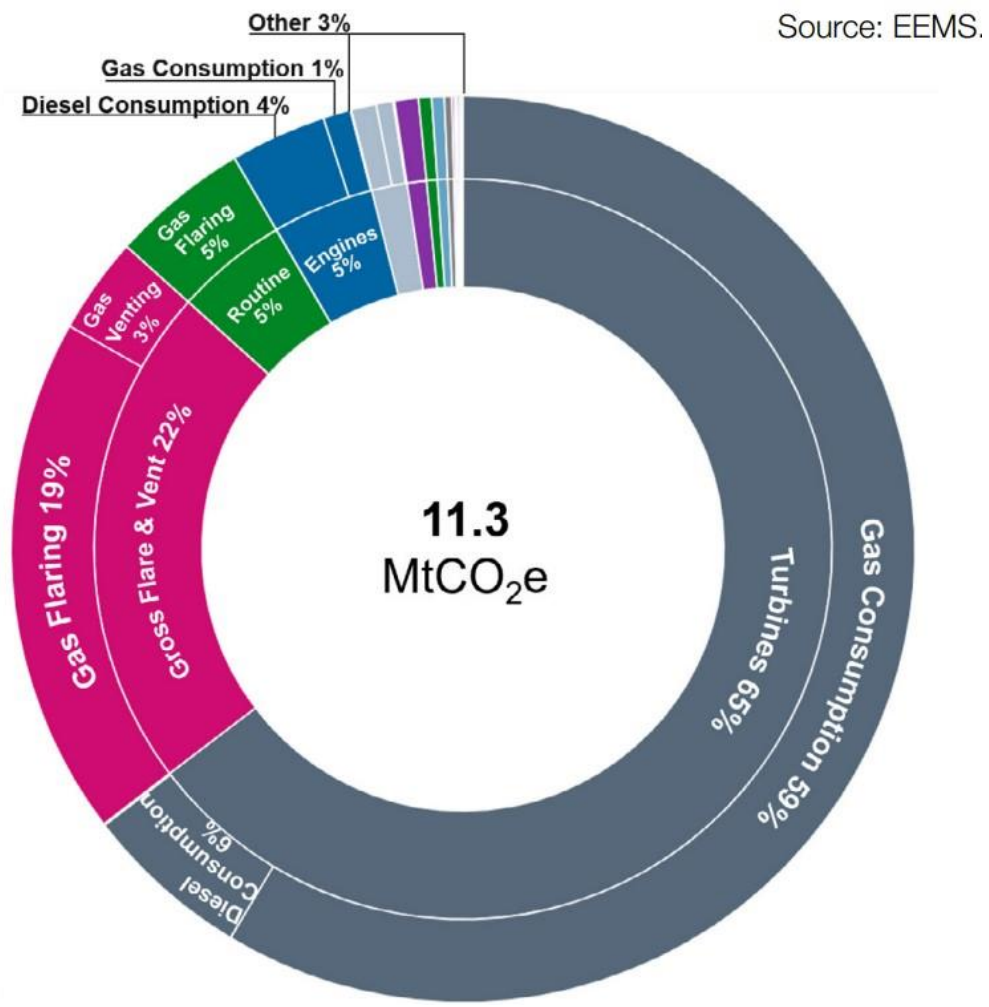
3 years

Industry matched

60+ Companies Organisation

6+ Supporting more than 1

North Sea Transition Deal Targets



GHG Emission Reduction from 2018 Baseline	Year
10%	2025
25%	2027
50%	2030
100% (Net Zero)	2050

ETF Alternative Fuels Gas Turbine – Key Objectives

Clean, remote power generation - Accelerating development of gas turbines (or reciprocating engines) capable of running on clean fuels.

Develop a zero-carbon fuel **retrofit** solution for aero-derivative gas turbines.

Anchor Scotland's existing gas turbine supply chain in this new market – by performing the R&D and developing the technology and skills locally.

Stimulate growth in the local alternative fuel production market by creating new local **demand**.

Create and sustain Scottish jobs in the gas turbine repair and maintenance sector, through exporting the technology and skills to other sectors and countries.

Extend field life and delay decommissioning of UKCS assets by improving operating efficiency.

Project Support – Phase 1

Alternative Fuel Gas Turbines
NZTTP Programme

The Scottish Government
Riaghaltas na h-Alba

SIEMENS energy

METHANOL INSTITUTE

apollo

XODUS

AECOM

* Engineering Contractors

RWG
REPAIR & OVERHAUL EXPERTISE

BUMIARMADA

eQ enQuest

NOV

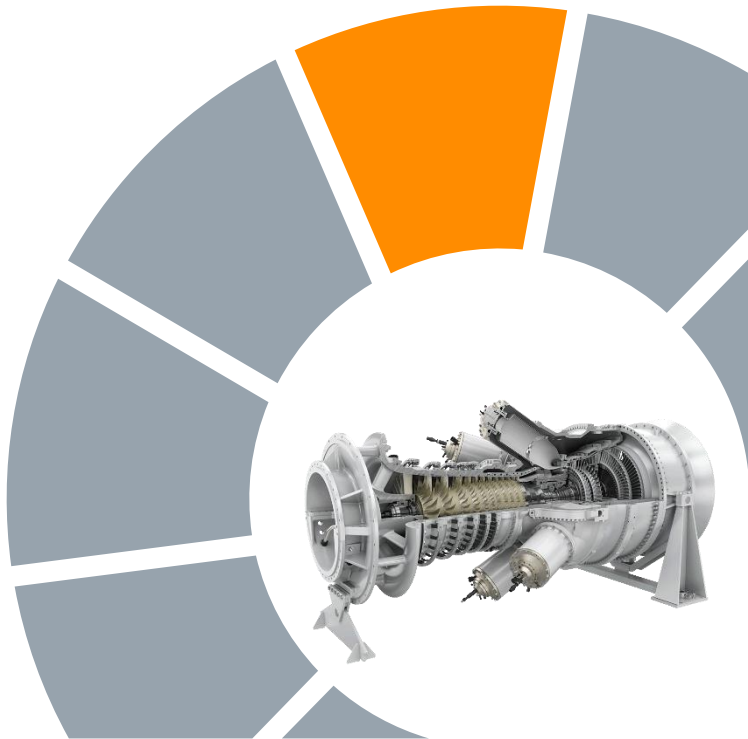
SERICAENERGY

Harbour Energy

oeUK

North Sea Transition Authority

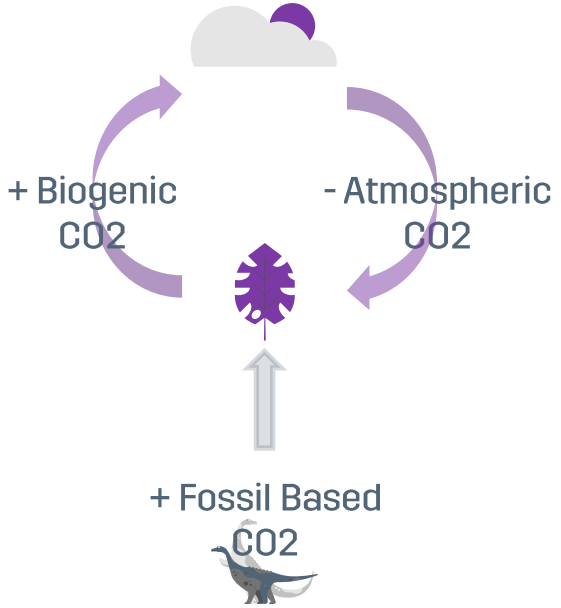
EQUANS

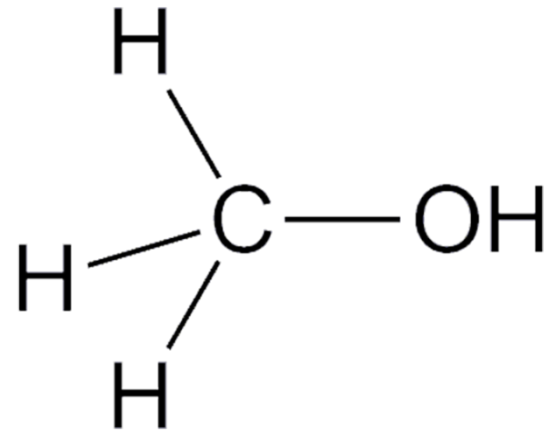


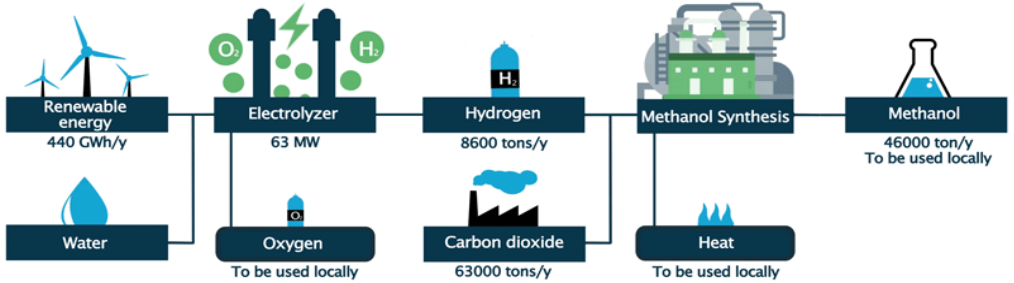
Green Methanol

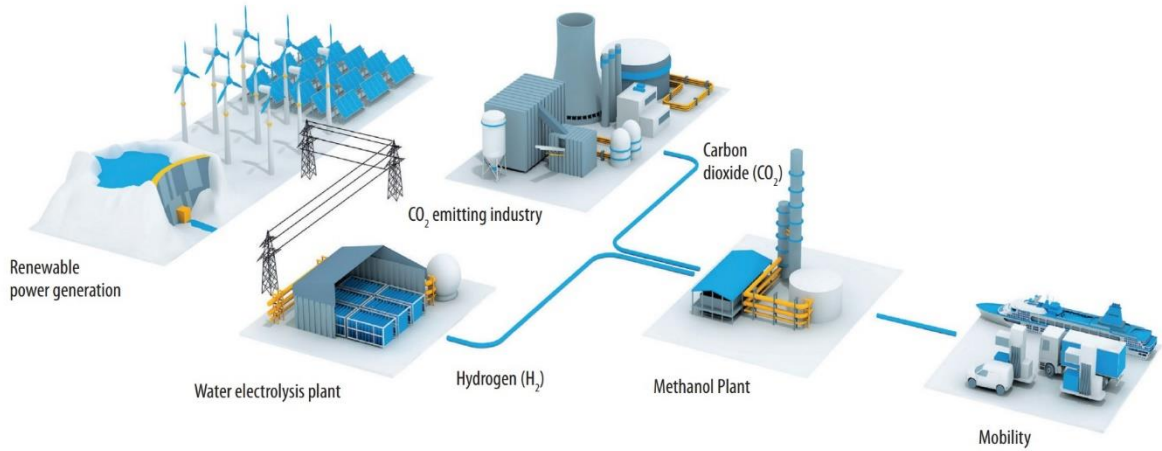
Alternative Fuel Gas Turbines
NZTTP Programme

- There are three types of methanol; conventional, bio and e-methanol.
- All three are have identical end product properties, with the differentiator being the production processes and input feedstocks.
- To be considered green, all feedstocks and energy used to produce the medium must be of renewable sources. *
- * Recycled carbon is included in this statement until 2035.



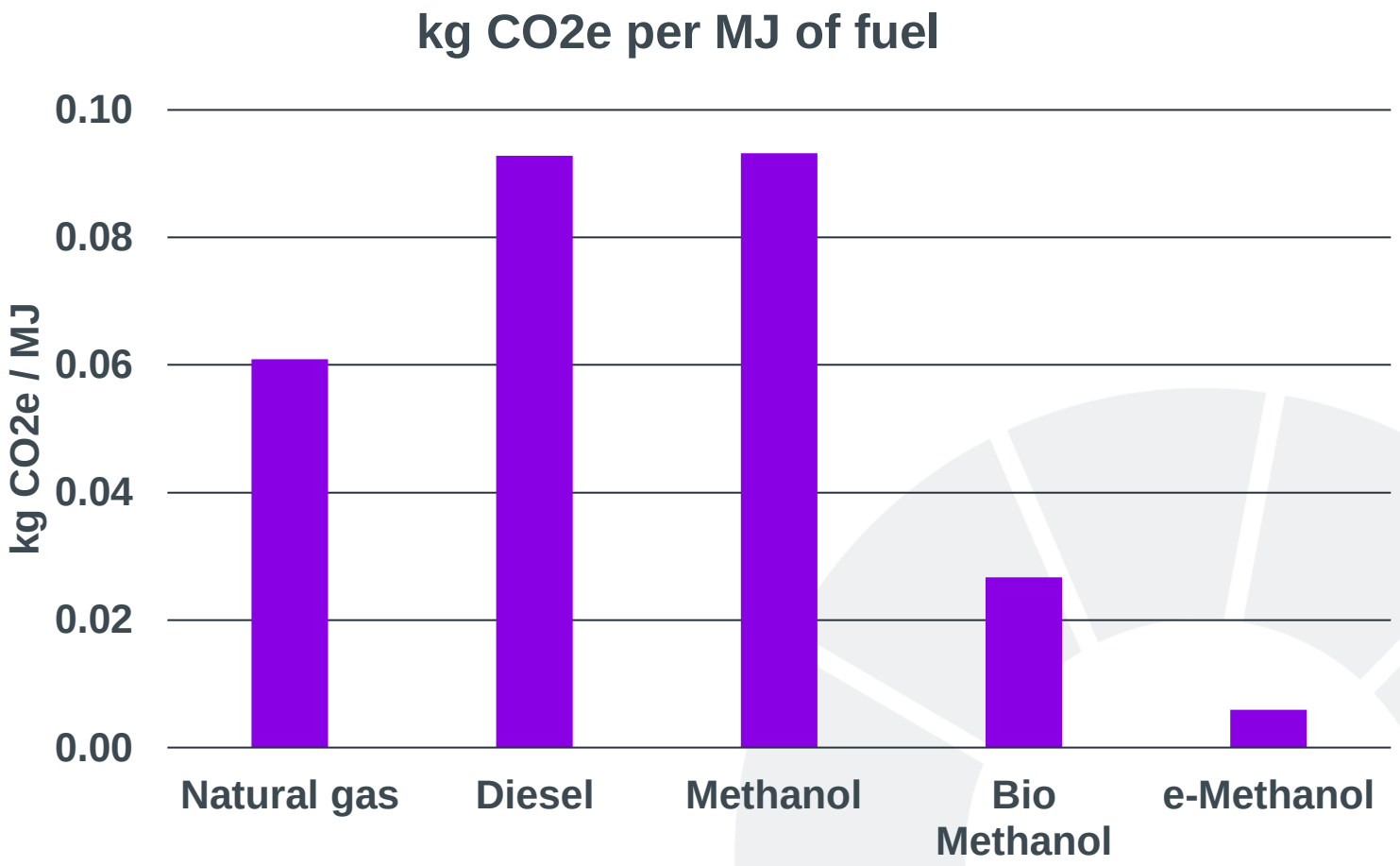






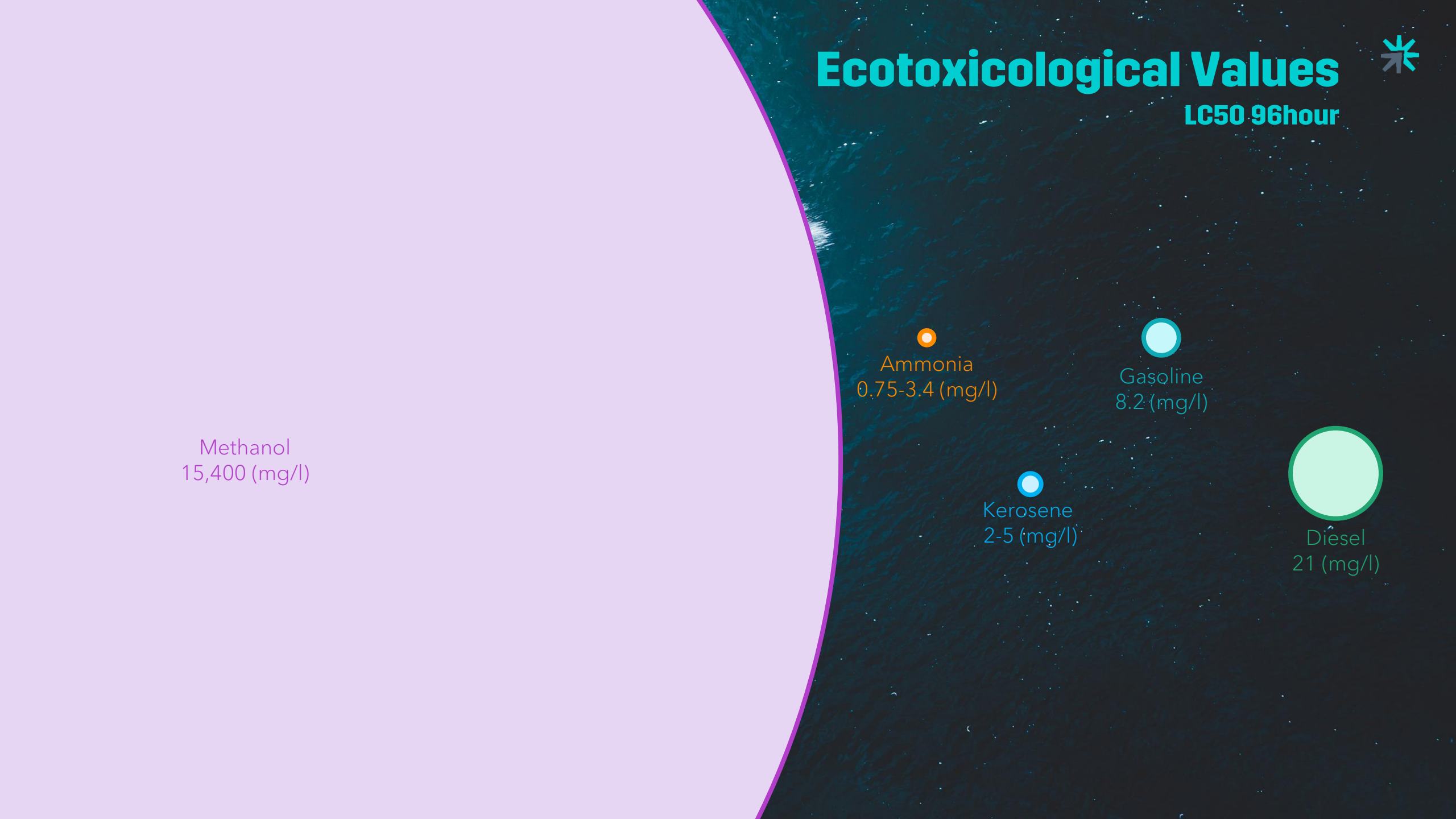
Green Methanol

- Methanol can be synthetically manufactured using green Hydrogen and captured CO2 (e-methanol) or created from Biomass (Bio-methanol)
- Proven up to 80% reduction in NOx from non-DLE gas turbines – improving air quality and reducing smog
- Methanol eliminates SO2, PM and smoke emissions
- Methanol burns cleaner and cooler than conventional liquid fuels, extending the field life of turbines



Ecotoxicological Values

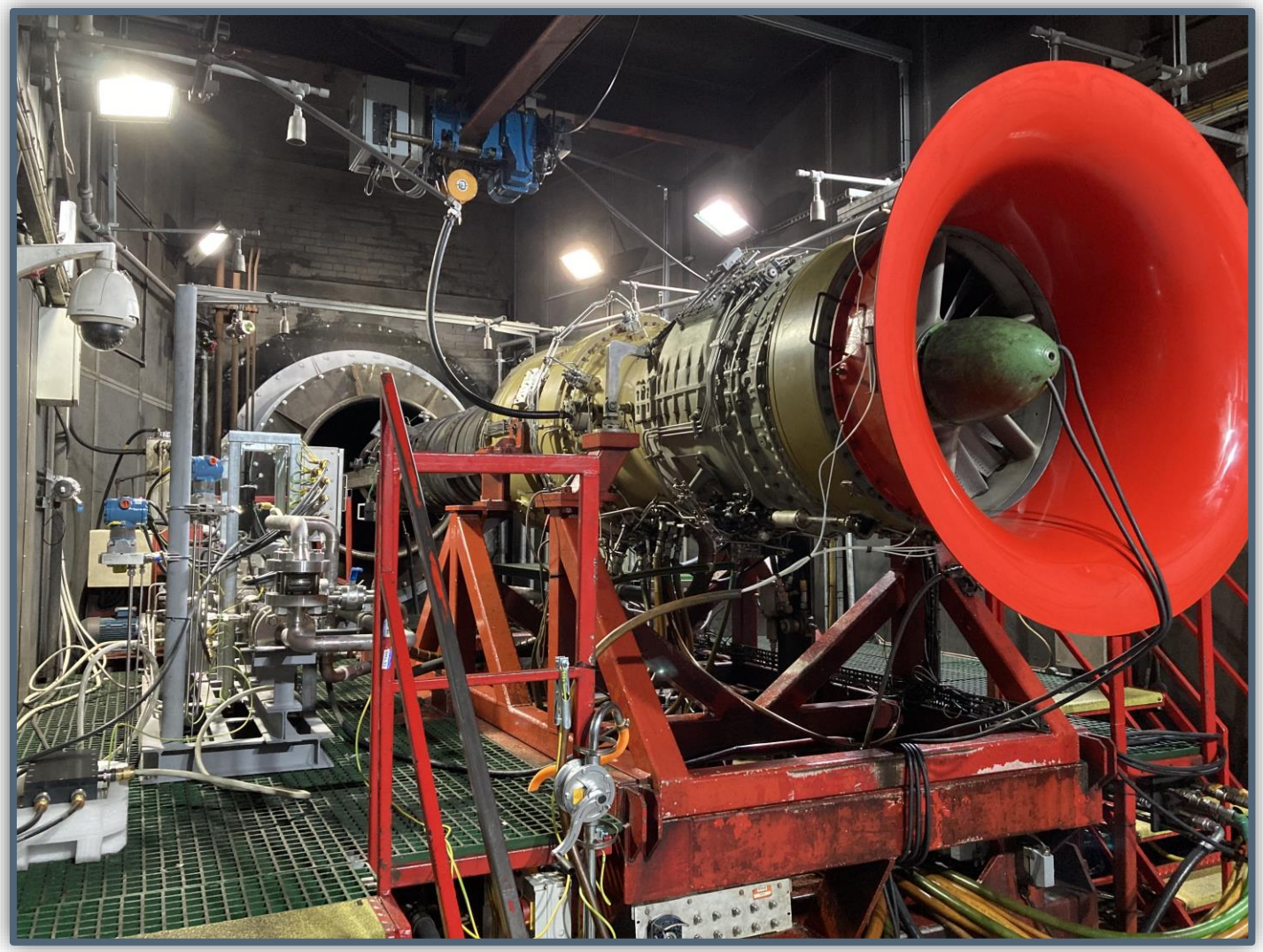
LC50 96hour



Bio-Methanol Demonstration Test – SGT-A20

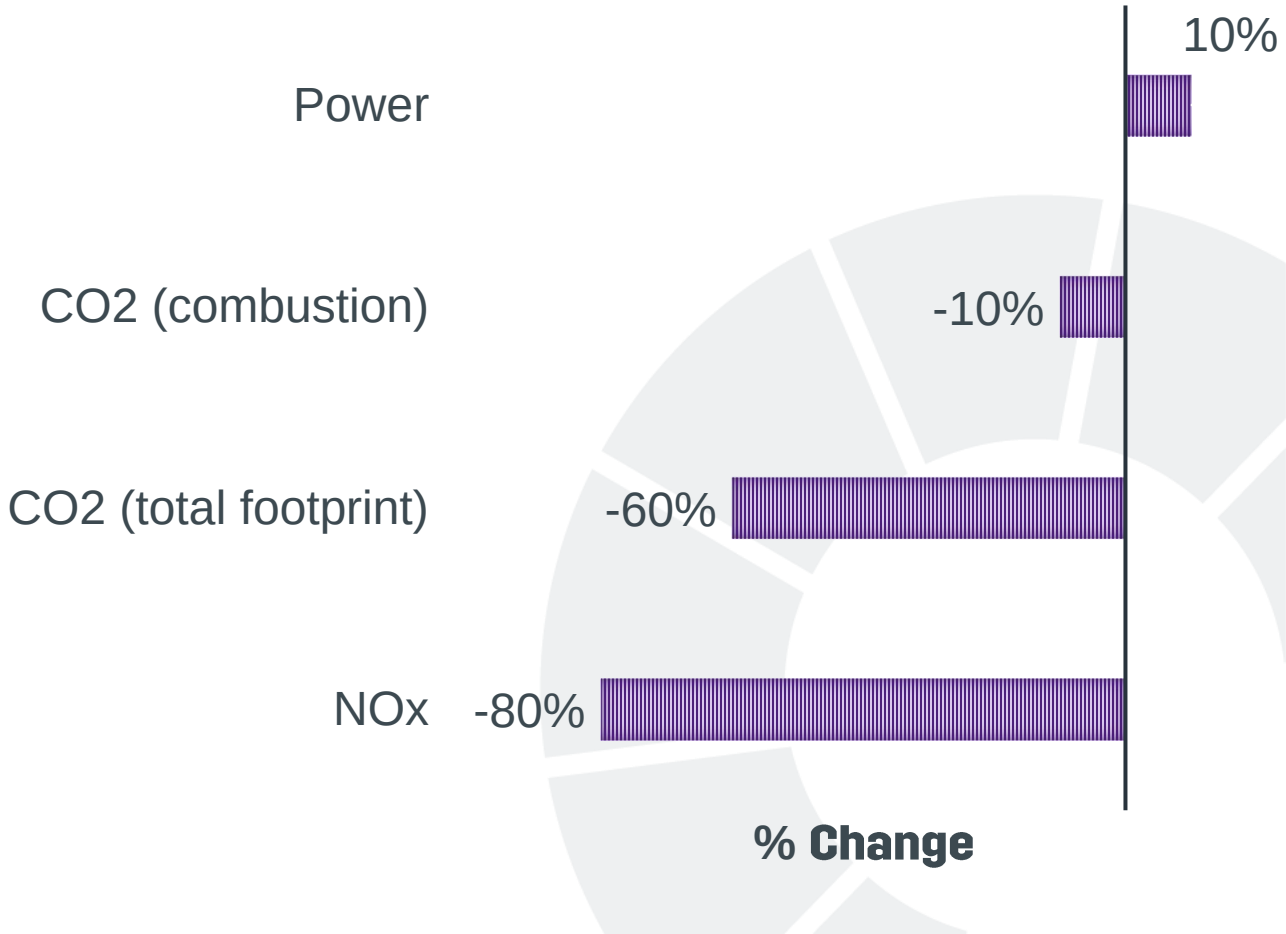
SIEMENS energy

Alternative Fuel Gas Turbines
NZTTP Programme



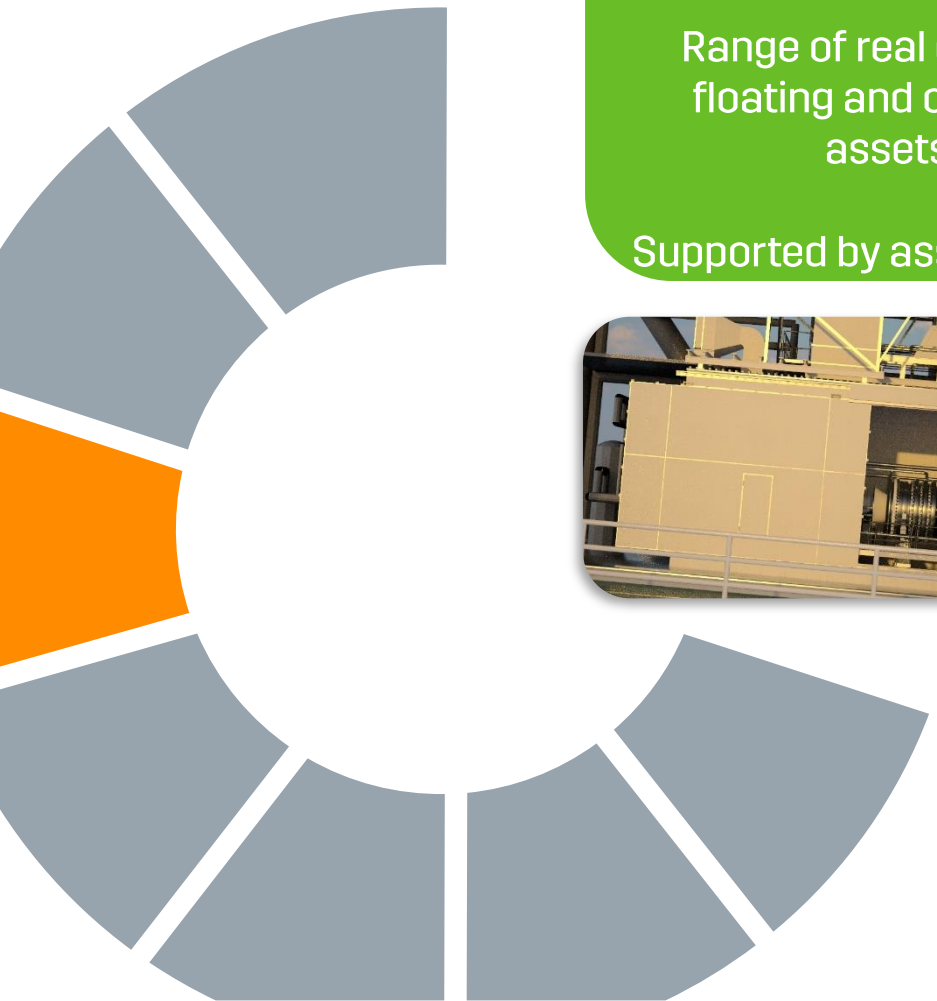
Bio-methanol test results

- 10% Power increase at same operating temperature ✓
- 80% NOx reduction ✓
- No impact on CO emissions ✓
- 10% CO2 reduction from direct combustion – total 60% reduction in total CO2 footprint of fuel ✓
- Operability ✓
- Start up on methanol fuel ✓
- Shutdown on methanol fuel ✓
- Demonstration of safe system and gas turbine operation ✓



Case Studies

Alternative Fuel Gas Turbines
NZTTP Programme



Investigation into the requirements and feasibility into converting to Alt Fuel

Range of real onshore, floating and offshore assets

Supported by asset owners

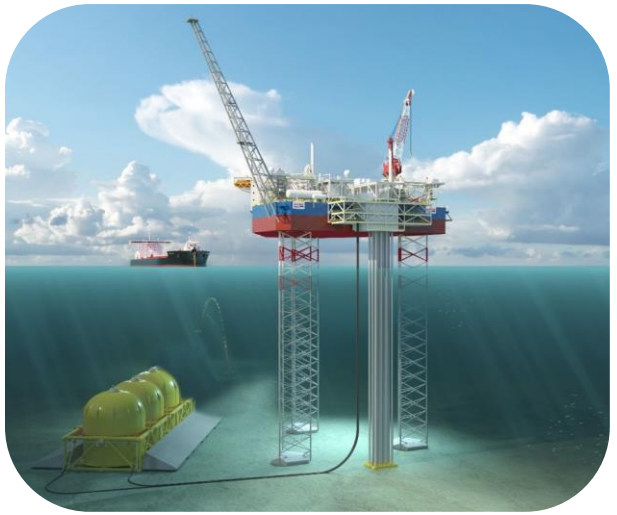
Regulatory Issues, Challenges and Opportunities

Safety Case Implications

Plant & turbine modifications

Technology Gaps

Logistics and Storage



Use the detail study outputs to identify options for future phases

Anonymise key findings and publish into the public domain

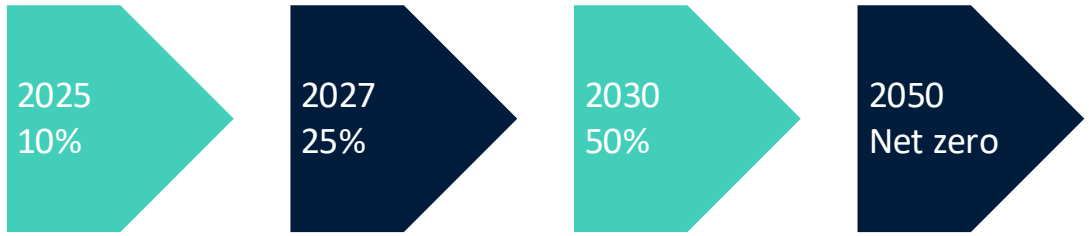
Can use the understanding of technology gaps to influence direction of wider NZTC

Oil and gas decarbonisation

- Asset located around 350km Northeast of Aberdeen
- Power is currently provided by 4 diesel/gas dual fuel engines
- Switching to an alternative fuel viewed as potential option to decarbonise power generation
- Project considered hydrogen, ammonia, methanol and alternative diesel

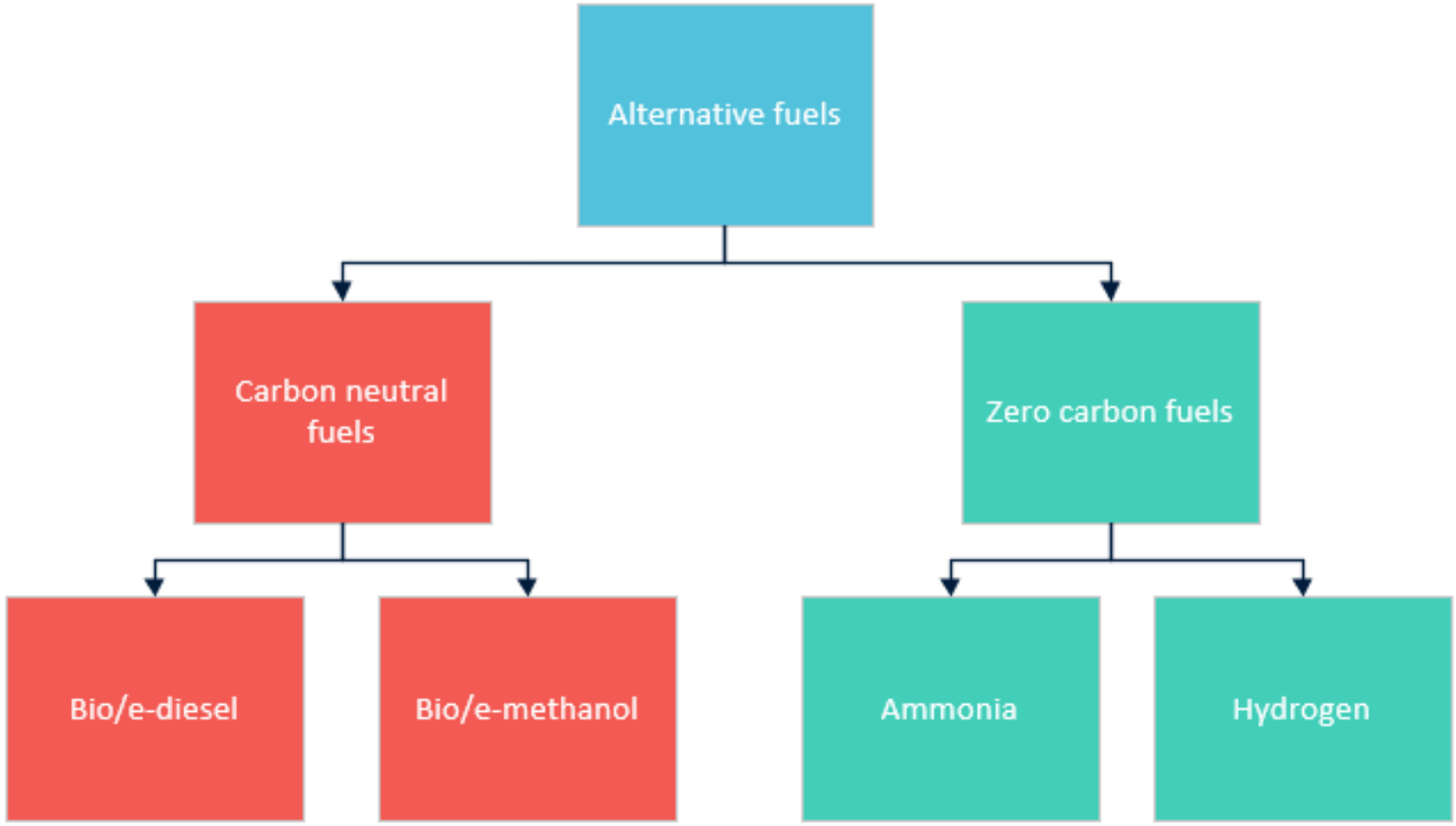
Motivation

- The North sea Transition Deal has outlined stringent targets to slash emissions.
- Growing public sentiment towards oil and gas is driving operators to reduce emissions to maintain their social license to operate.
- Easy to implement measures for reducing emissions are becoming exhausted.
- To achieve the targets set out in the NSTD measures such as electrification or switching to low carbon fuels will be required.
- Electrification is not a feasible option for all assets.
- Power is the single greatest contributor to GHG emissions in the sector

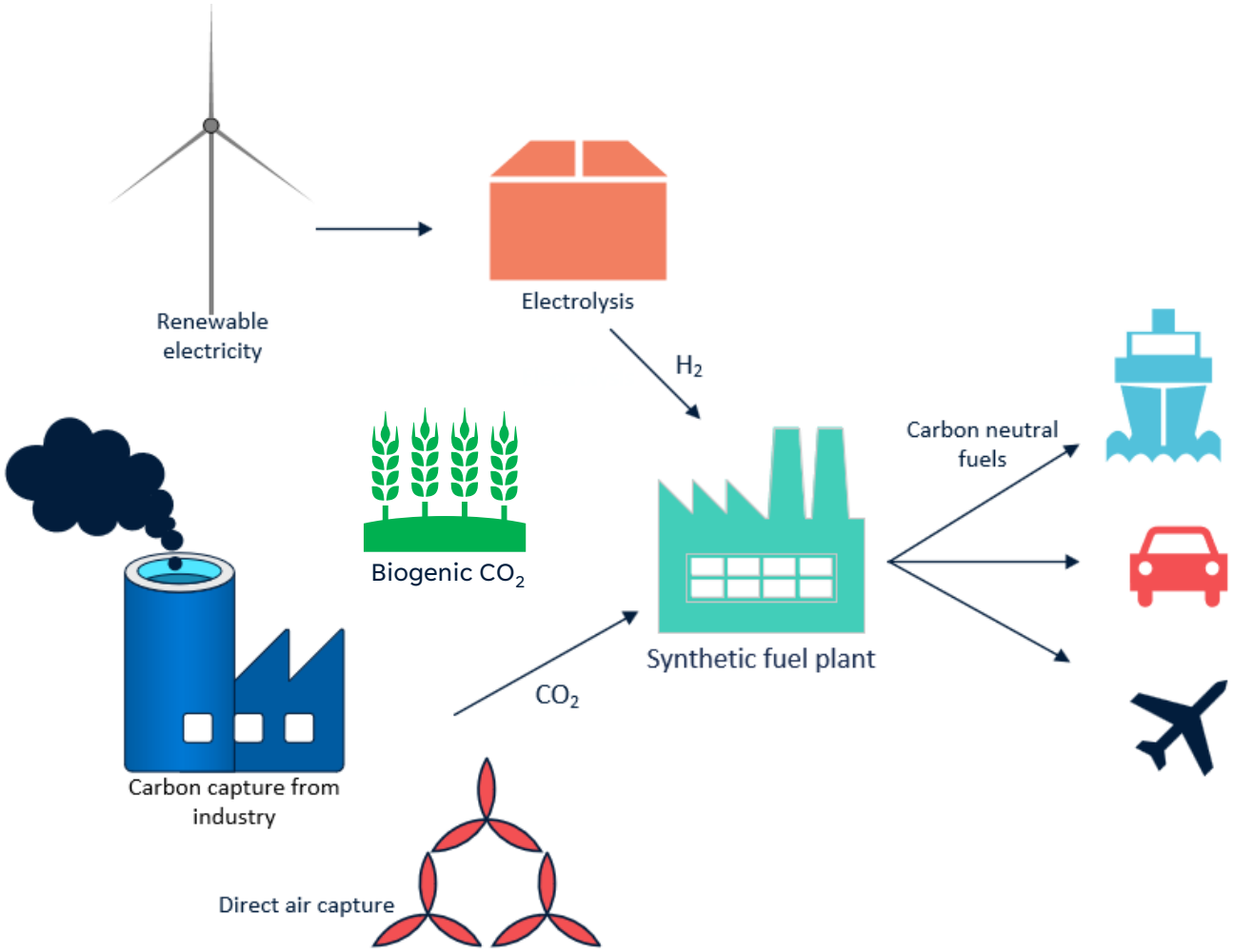


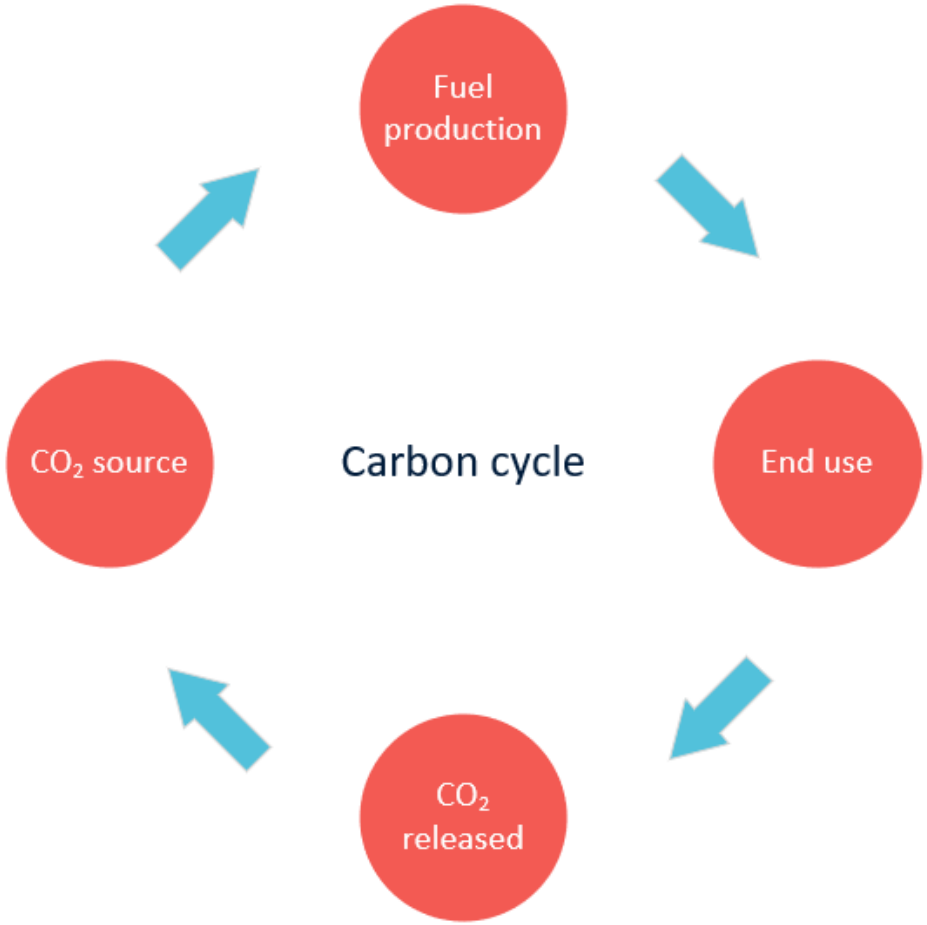
North Sea Transition Deal emission reduction targets

Alternative fuels

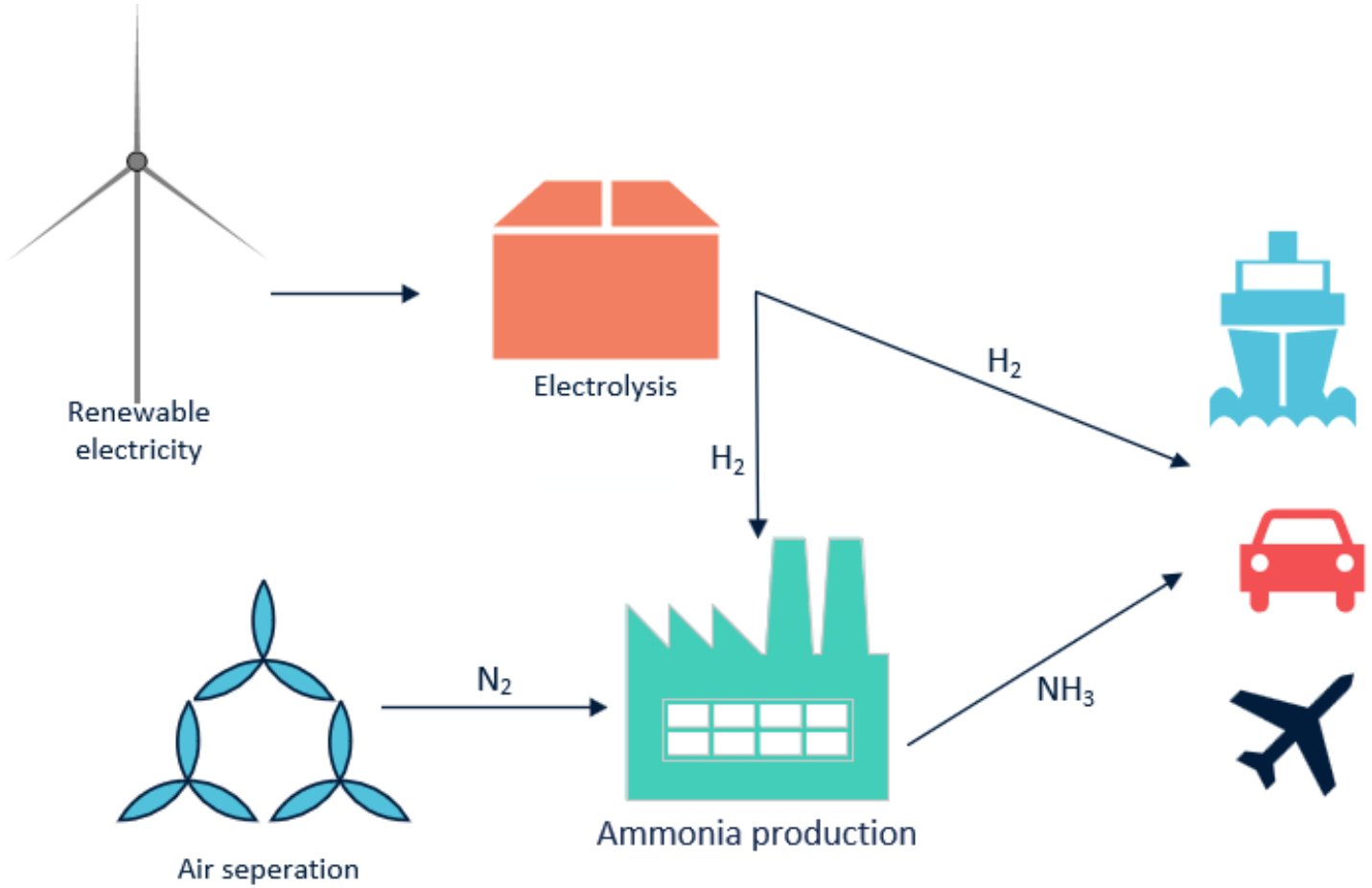


Carbon Neutral Fuels

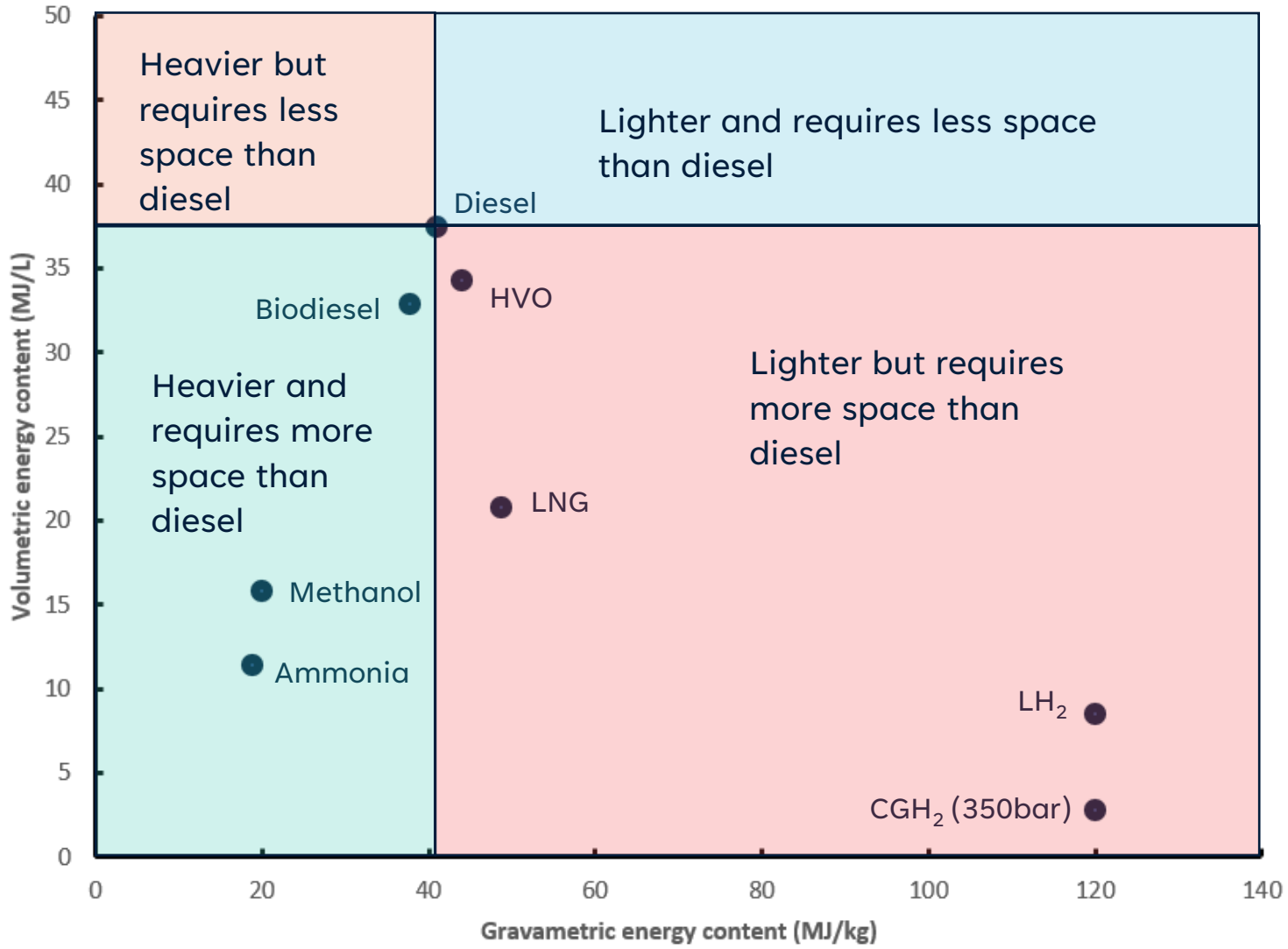




Zero Carbon Fuels

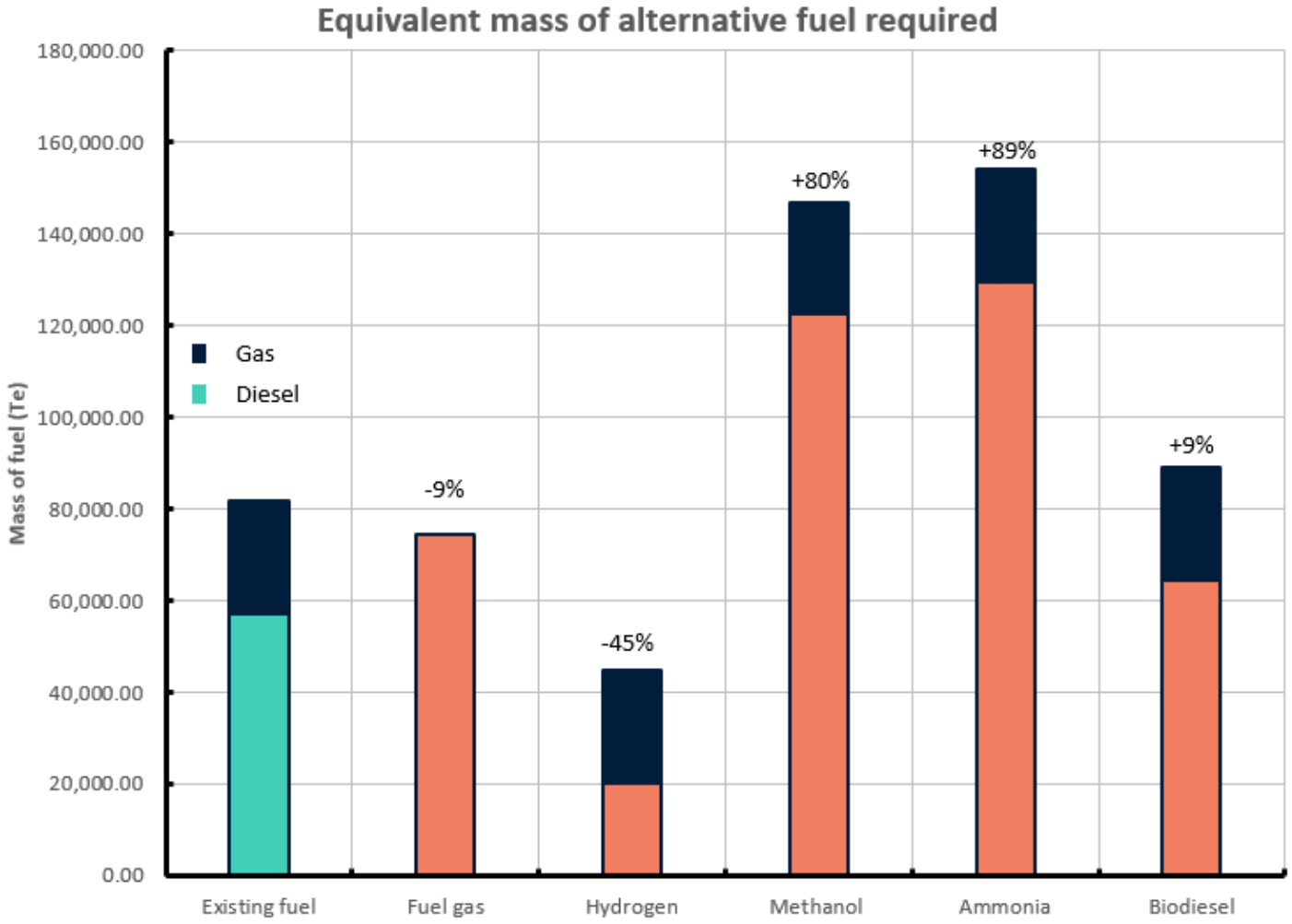


Fuel Energy Density

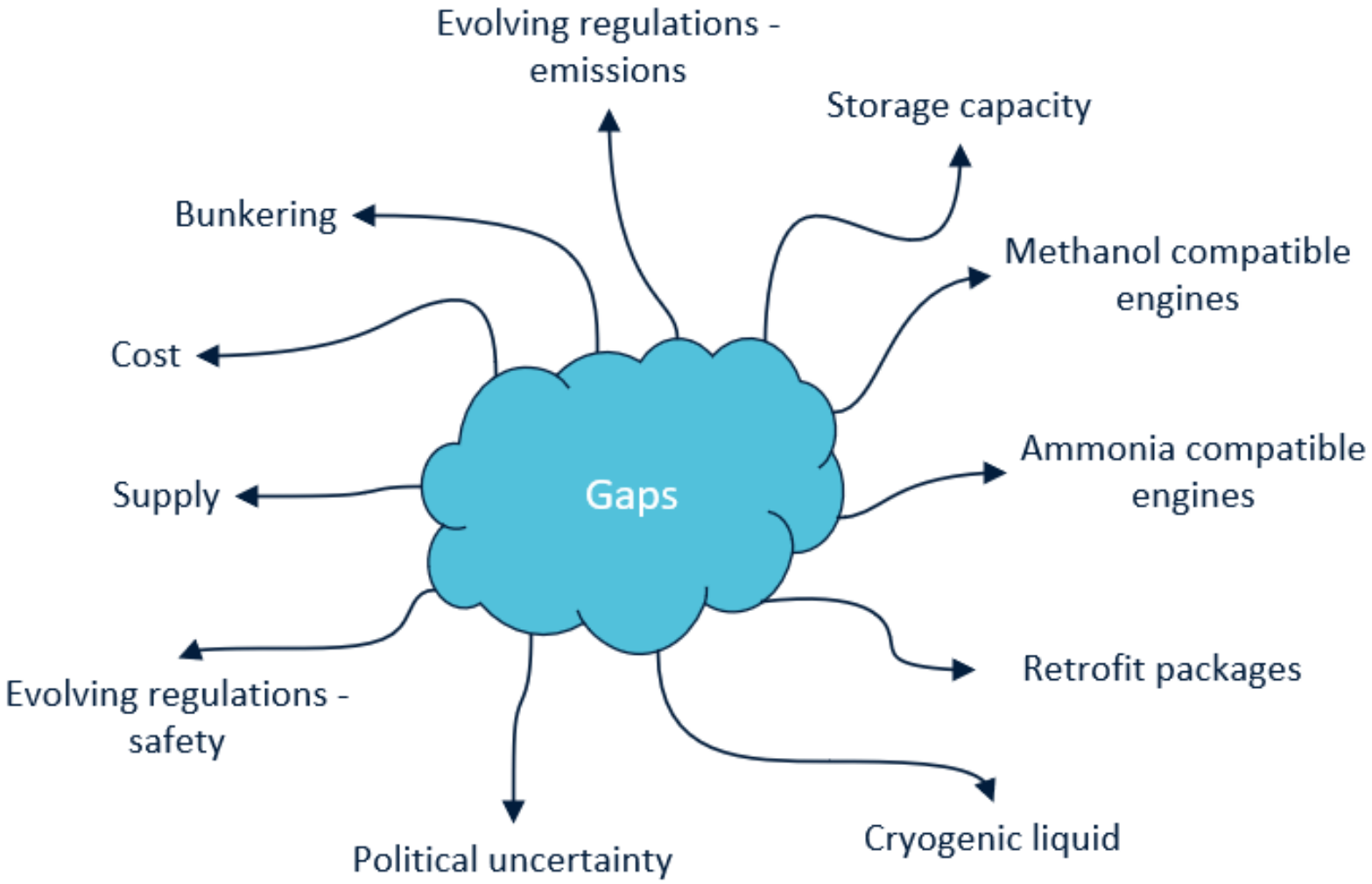


Equivalent mass

Fuel	Mass of fuel (Te)
Existing fuel (Diesel + fuel gas)	81,758
Fuel gas	74,287
Hydrogen (+fuel gas)	44,867
Methanol (+fuel gas)	147,002
Ammonia (+fuel gas)	154,166
Biodiesel (+fuel gas)	89,021



Challenges


Evolving regulations - emissions
Storage capacity
Bunkering
Methanol compatible engines
Cost
Gaps
Supply
Ammonia compatible engines
Evolving regulations - safety
Retrofit packages
Political uncertainty
Cryogenic liquid

Study results

Table 1 Scenario Ranking

Fuel Option	Cost	Emissions	Technology
Bio/e-diesel			
E-methanol			
Ammonia			

Table 2 Scenario Ranking Criteria

Item	Cost (£10^6)	Emissions	Technology
Green	<5	Zero carbon emissions	Commercially available
Orange	5-10	Carbon neutral	Nearly commercially available (within 2 years)
Red	>10	Minor carbon emission reduction	Early development stages

Next phase

Objective – To provide all the information required to make a go/no-go decision on the use of an alternative diesel on the asset

Ambition – Carry out a field trial using an alternative diesel during 2024

Project elements:

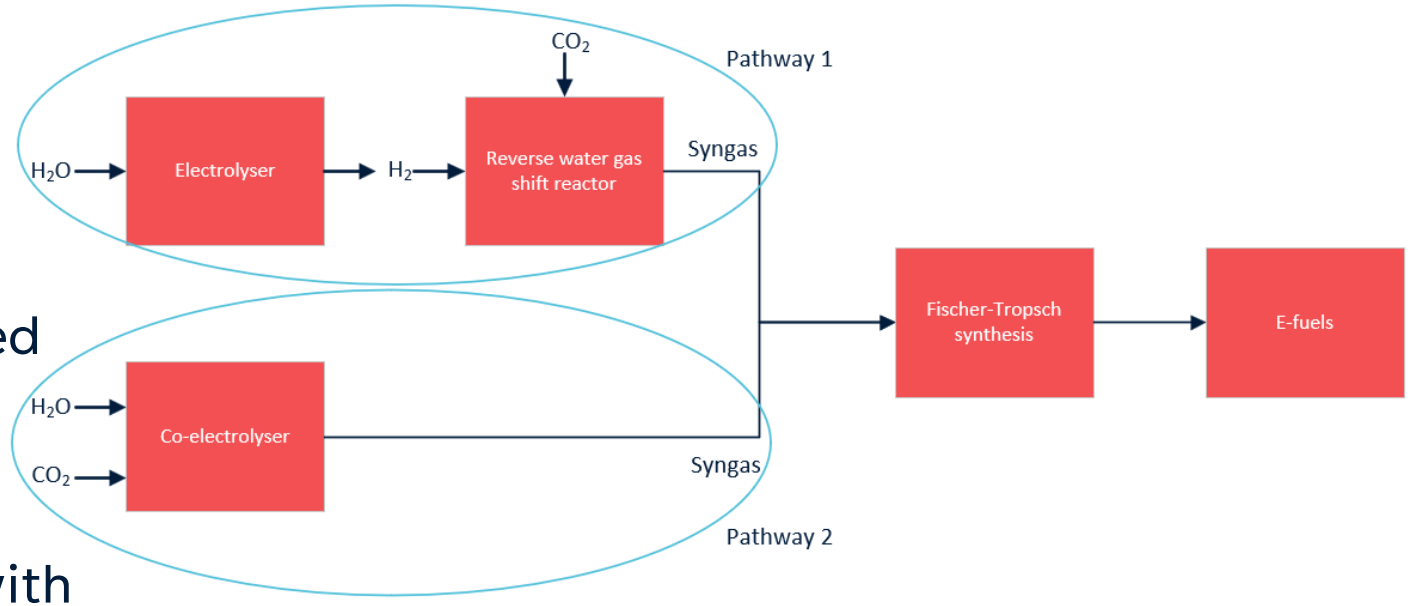
- Fuel blending evaluation
- Evaluate operational impacts
- Determine logistics and supply chain
- Techno-economic assessment

Port decarbonisation

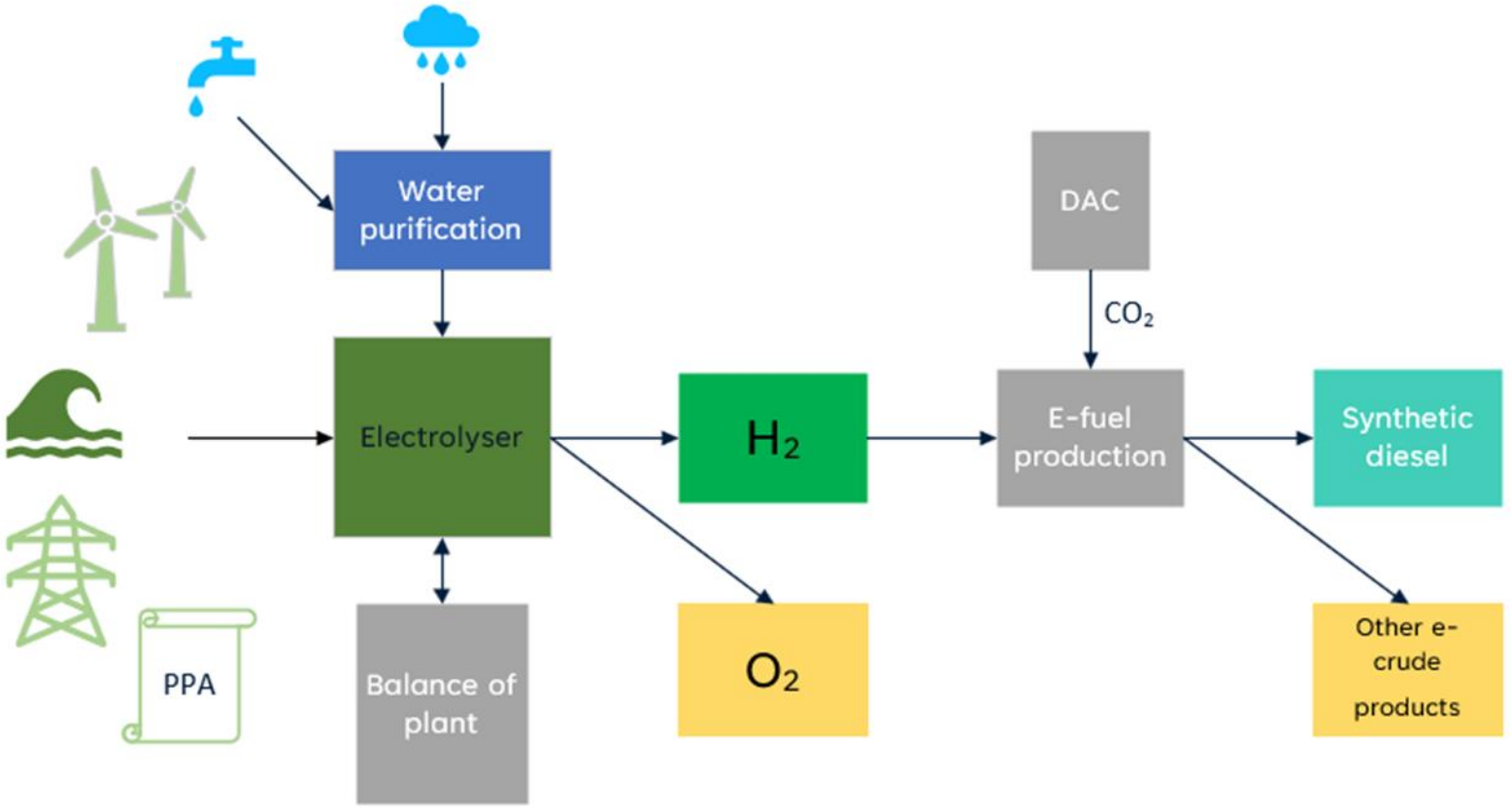
- UK's largest energy port looking to decarbonise their operations whilst looking to support the wider maritime sector transition to clean fuels
- Project looked at 2 different scenarios:
  - Local port decarbonisation
  - Decarbonising vessels to serve future floating offshore wind
- Project considered cutting edge technology for the manufacture of alternative fuels and looked at feedstock and power requirements to meet current and projected fuel demands

Project elements

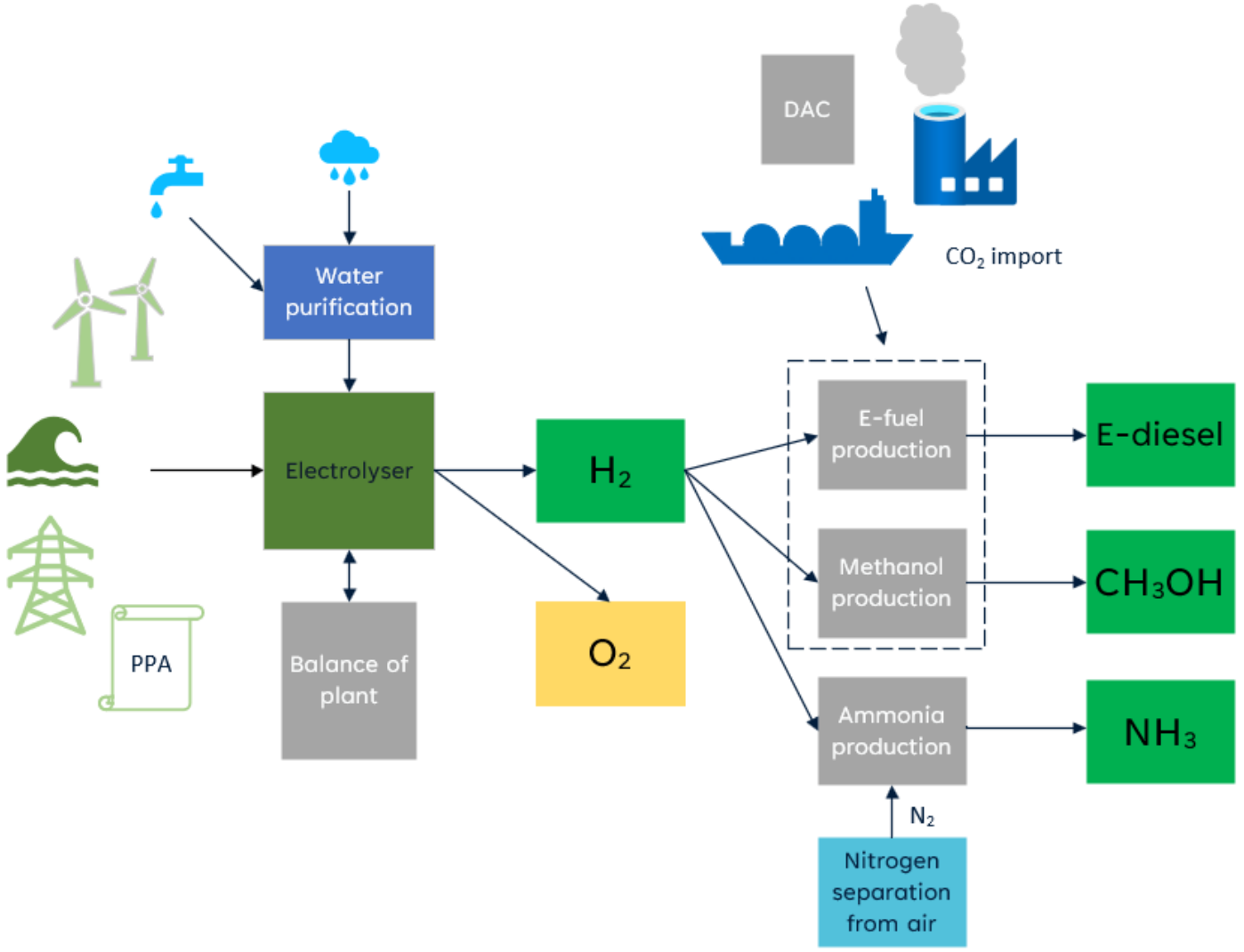
- Site assessment for increasing renewable power generation
- Assessment of site for locating fuel production, storage and refuelling equipment
- Investigation into all equipment required including H_2 production, derivative production and CO_2 capture
- Exploring opportunities to partner up with nearby industry to increase project security and improve efficiency



Port scenario outcome



Future offshore wind scenario



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