



Zero Emission Power Solutions

Diesel engine replacement



IN PERSON
EVENT

HYDROGEN TRANSPORT

CONFERENCE - EXHIBITION - NETWORKING

16 - JUN - 2022

LONDON

16th June 2022

Author: MC

Checked: JB



“...set five new world records achieving 148.166mph...in California 2009...”

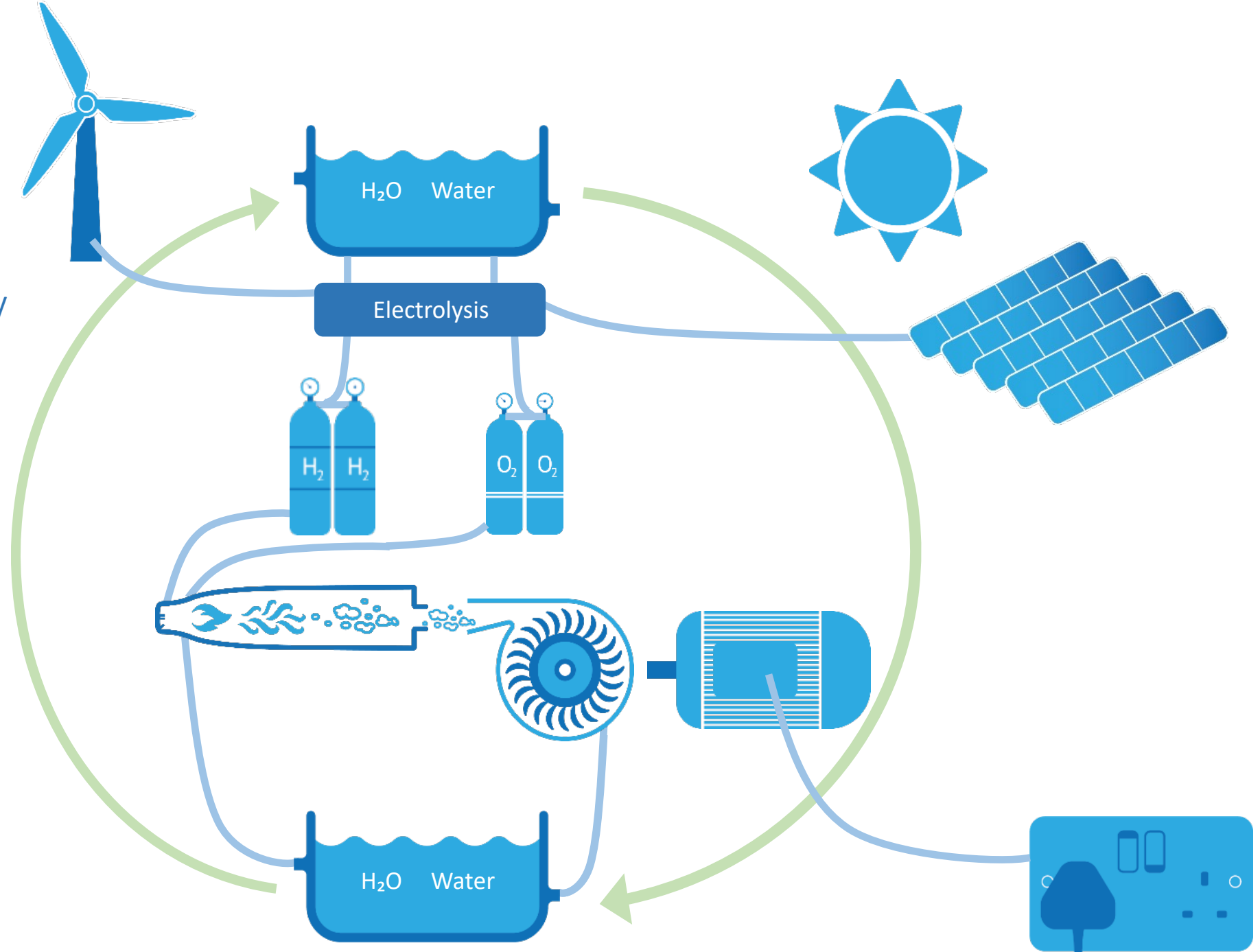


“...transforming water into
power...”



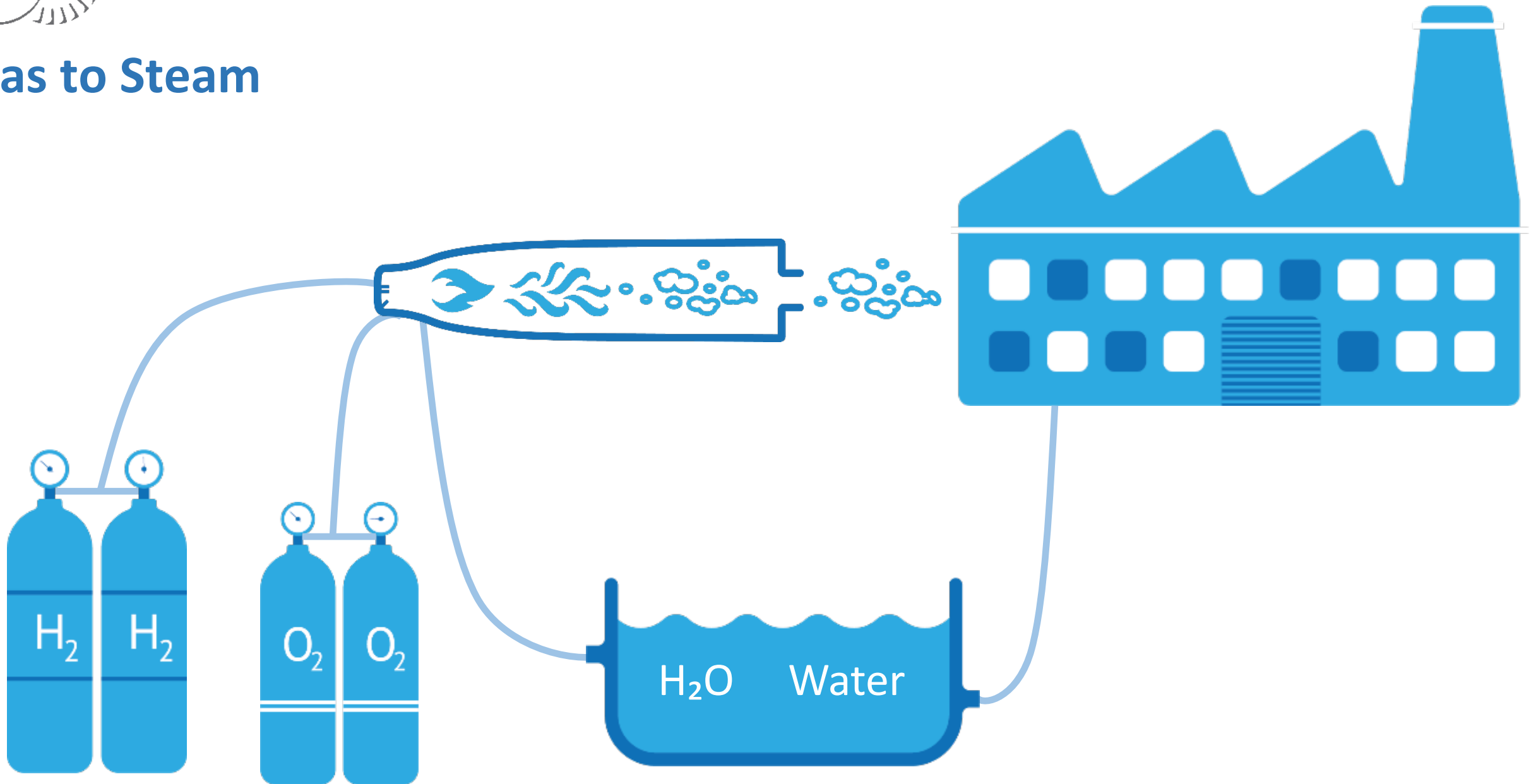
Steamology zero emission energy solutions address three markets with common technology:

- Gas to Steam for industrial applications
- Gas to Power 10 kW to 1MW
- Renewable Energy (RE) storage and power generation





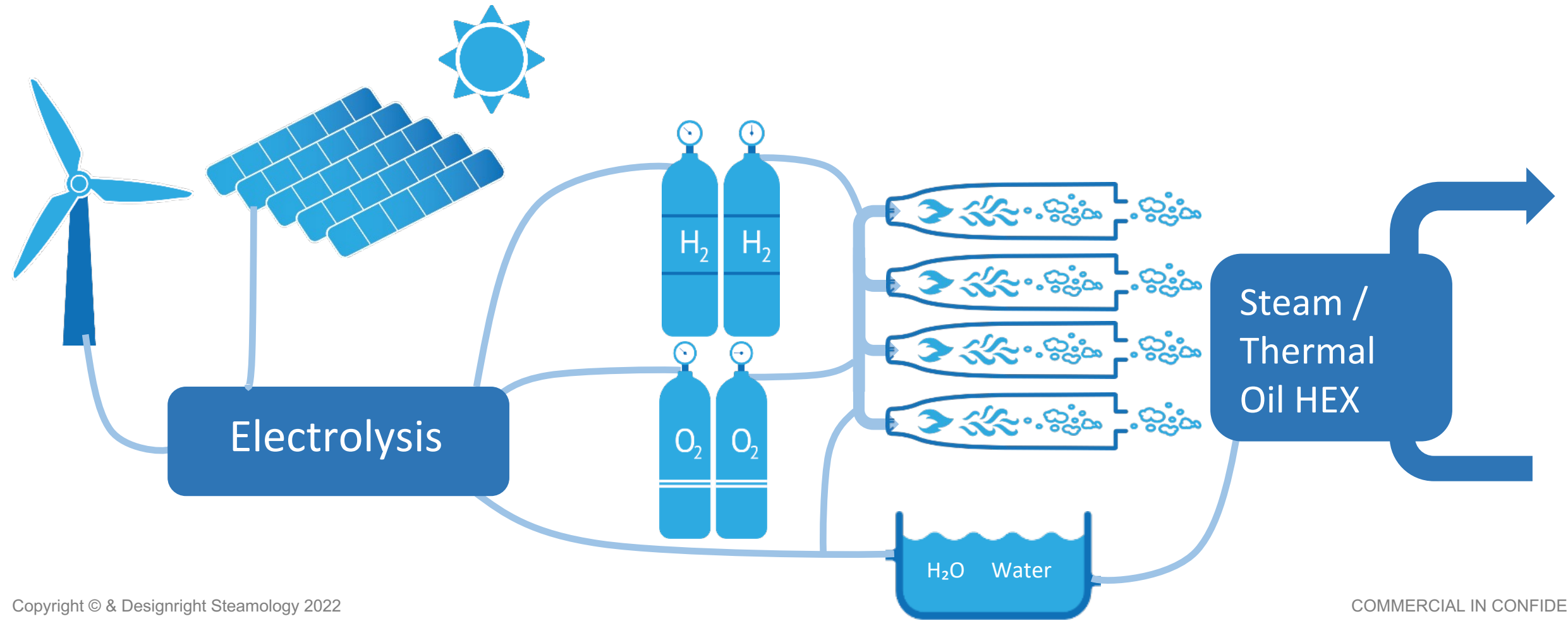
Gas to Steam





Zero Emission Industrial Thermal Oil Heating

Renewable Wind and Solar PV powers electrolysis providing hydrogen and oxygen gas to buffer storage. Hydrogen and oxygen fuels Steamology steam generators providing clean heat to thermal oil circuit





Gas to Power

Zero emission - No CO₂, NOX, SOX, or particulates

High power and torque - 10kW to 1MW range, scalable and modular units

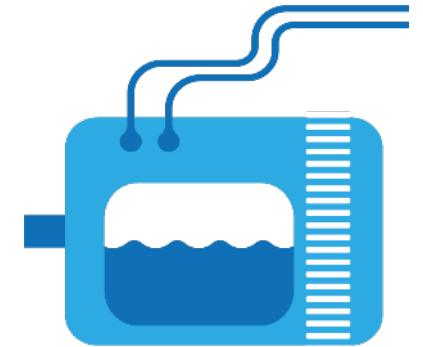
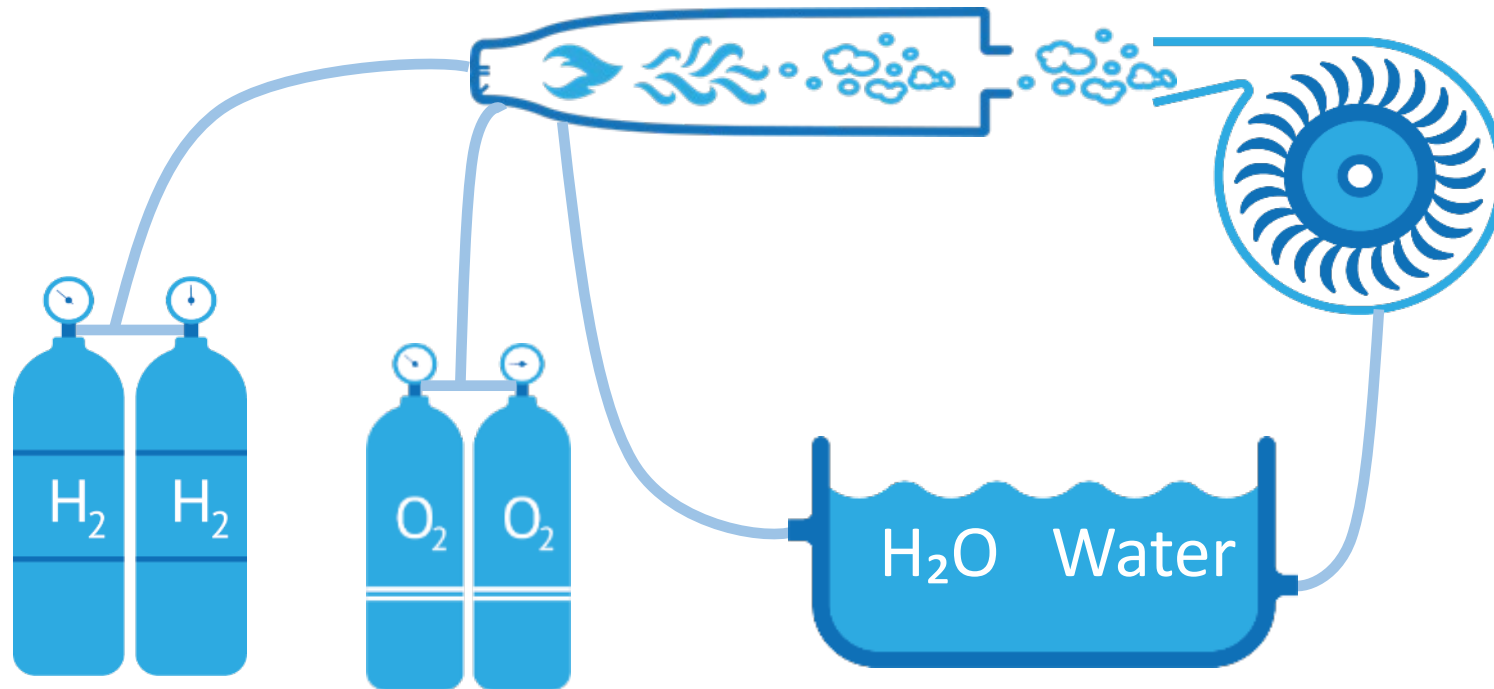
Low noise and thermal signature - Quiet vibration free operation, low temperature signature

Operating temperature agnostic - Functional in a wide range of environments

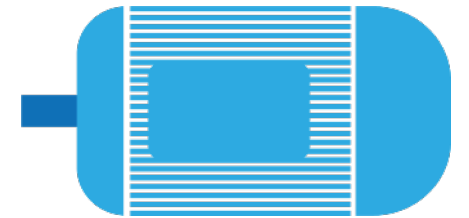
Low maintenance - Few moving parts made of standard engineering materials

No loss of performance over charging cycles – Long life and service interval

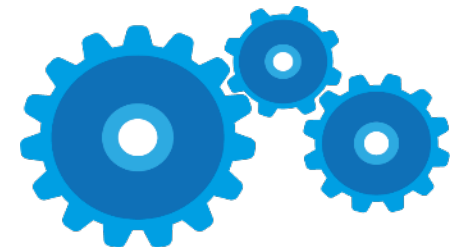
No toxic or scarce materials – No Pb, Sb, Cd, Li or rare earth elements



Hydraulic power



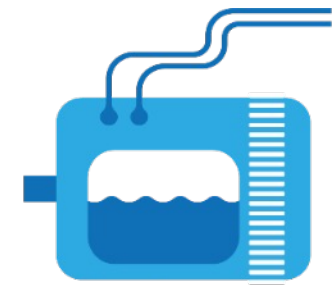
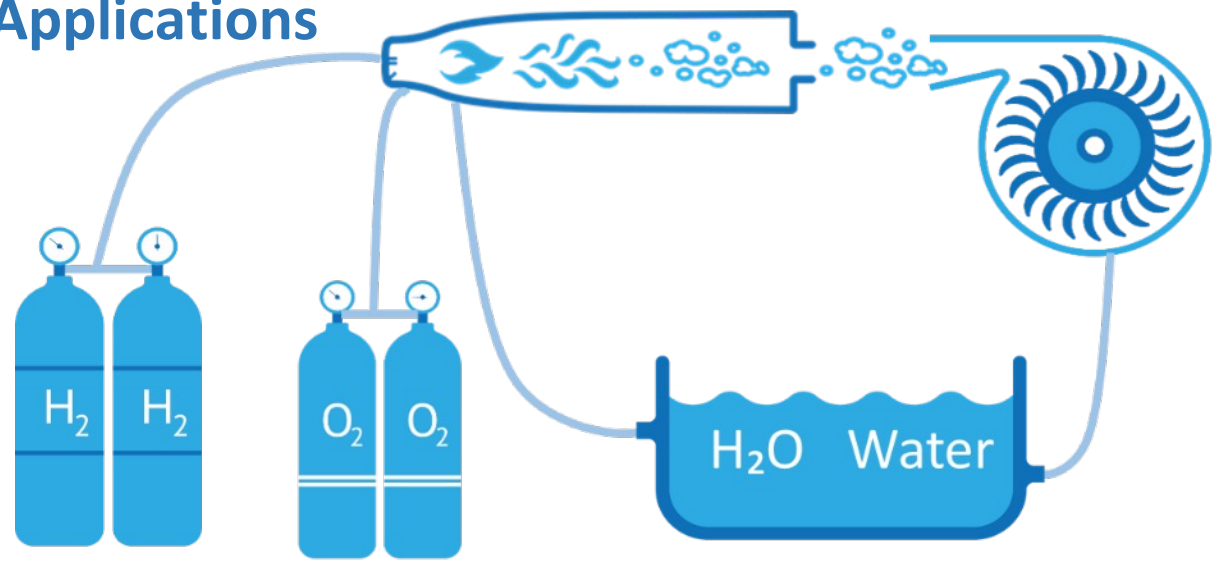
Electric power



Mechanical power



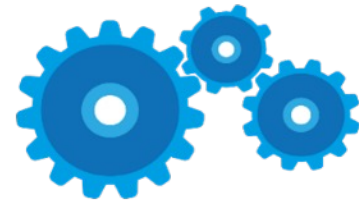
Gas to Power Applications



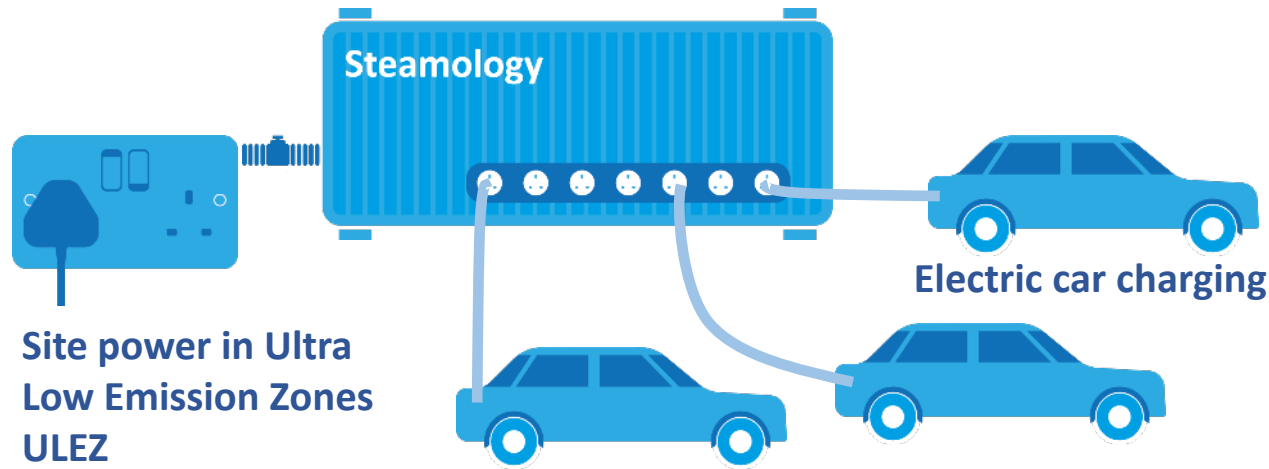
Hydraulic power



Electric power

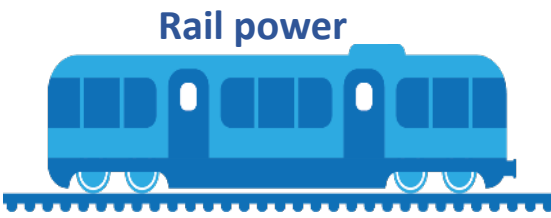


Mechanical power



Site power in Ultra Low Emission Zones ULEZ

Electric car charging



Rail power



Construction power



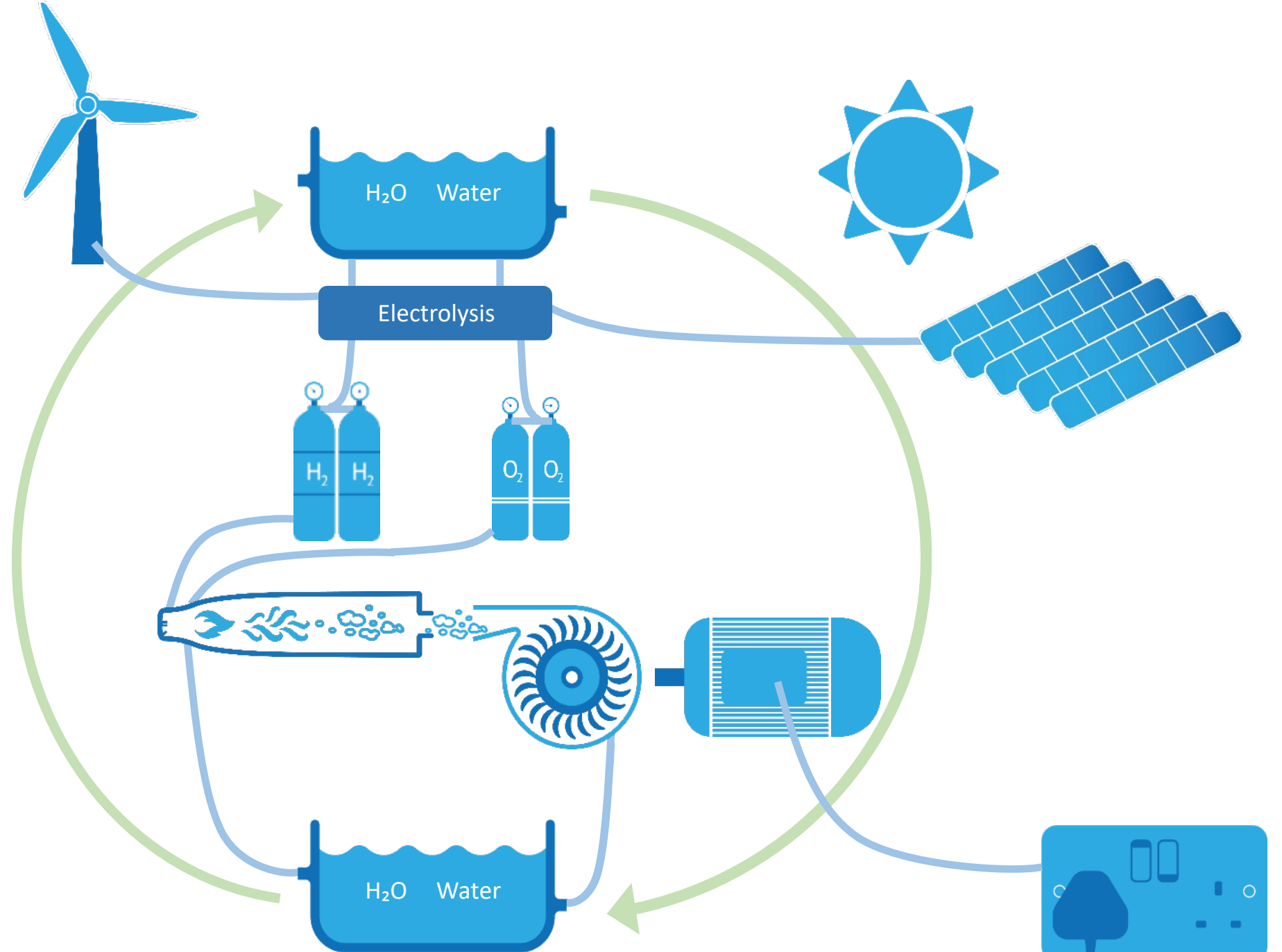
Haulage power



Marine power



RE Storage and Power





RE Storage and Power generator demonstrator



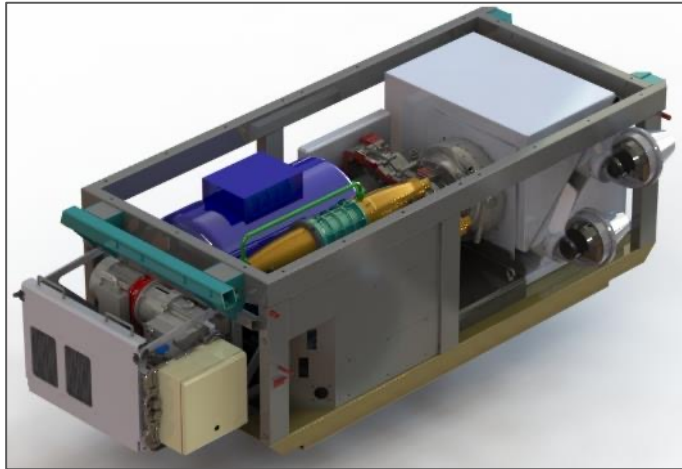




FOAK 2 Rail Decarbonisation

W2W Zero Emission Power System

100kW range extender



HM Government

We work with
Innovate UK

vivarail





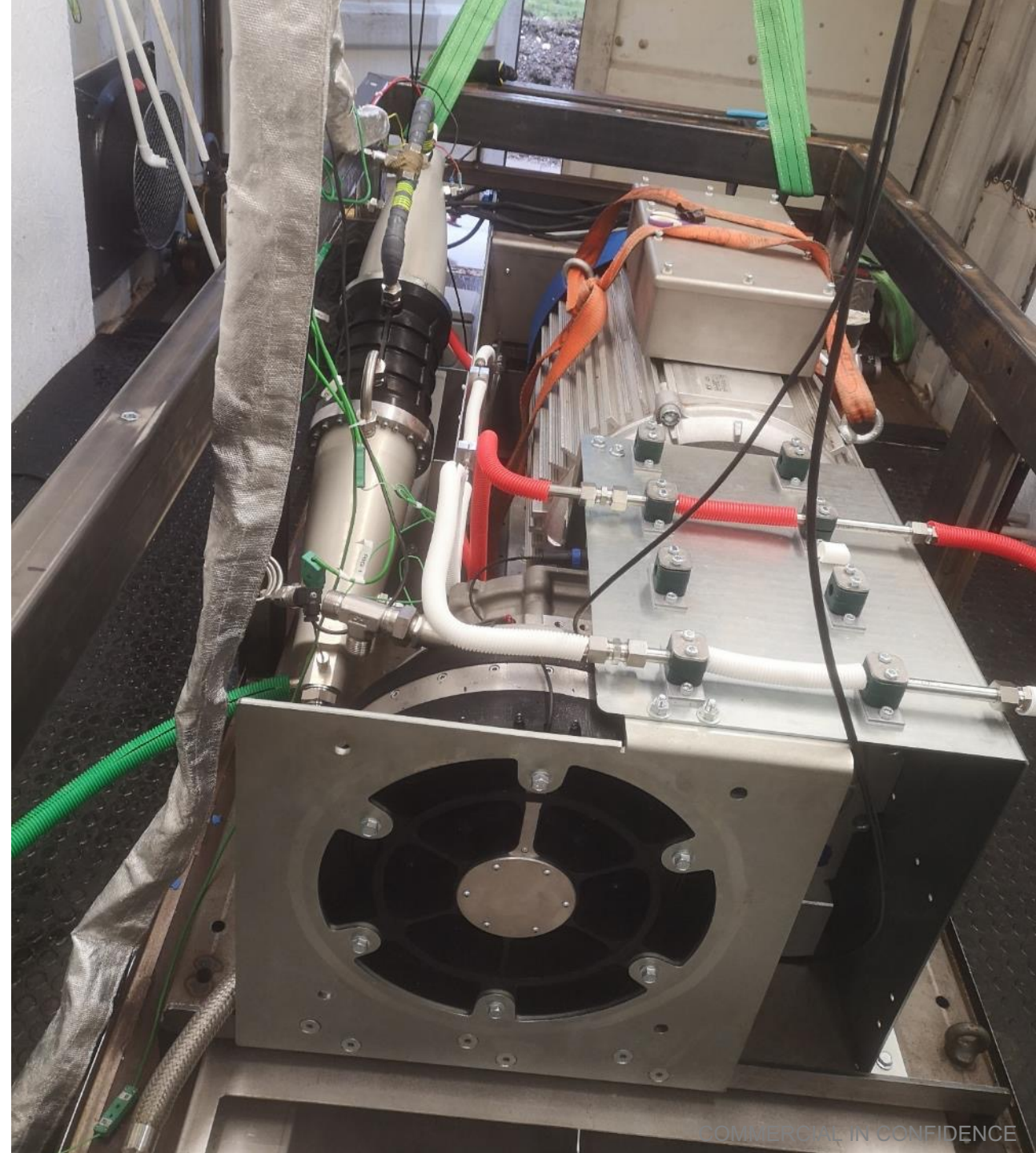
Rail Decarbonisation

Zero Emission 100kW range extender

Delivering 750V DC to traction motors or battery storage

Power raft is a modular Vivarail design to re-traction
Class230 London Underground rolling stock

Demonstrator delivered December 2019 tested with
electrical load bank





Steam Generator

Steam generators are rated ~100kW each

No moving components 'spanner friendly' maintenance

No exotic materials fully recyclable at end of long life

Steam is generated in seconds providing rapid torque response

Multiple steam generators can be arranged around a turbine, scalable power to MW output

Wide range of fuel purity

Only product of combustion is water, eliminating CO₂, NO_x, SO_x and particulates

Quiet, vibration free

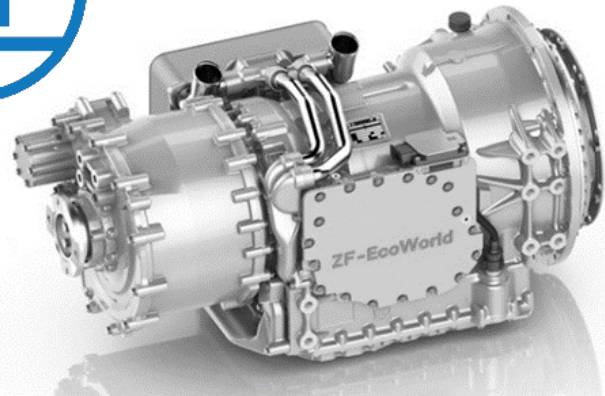
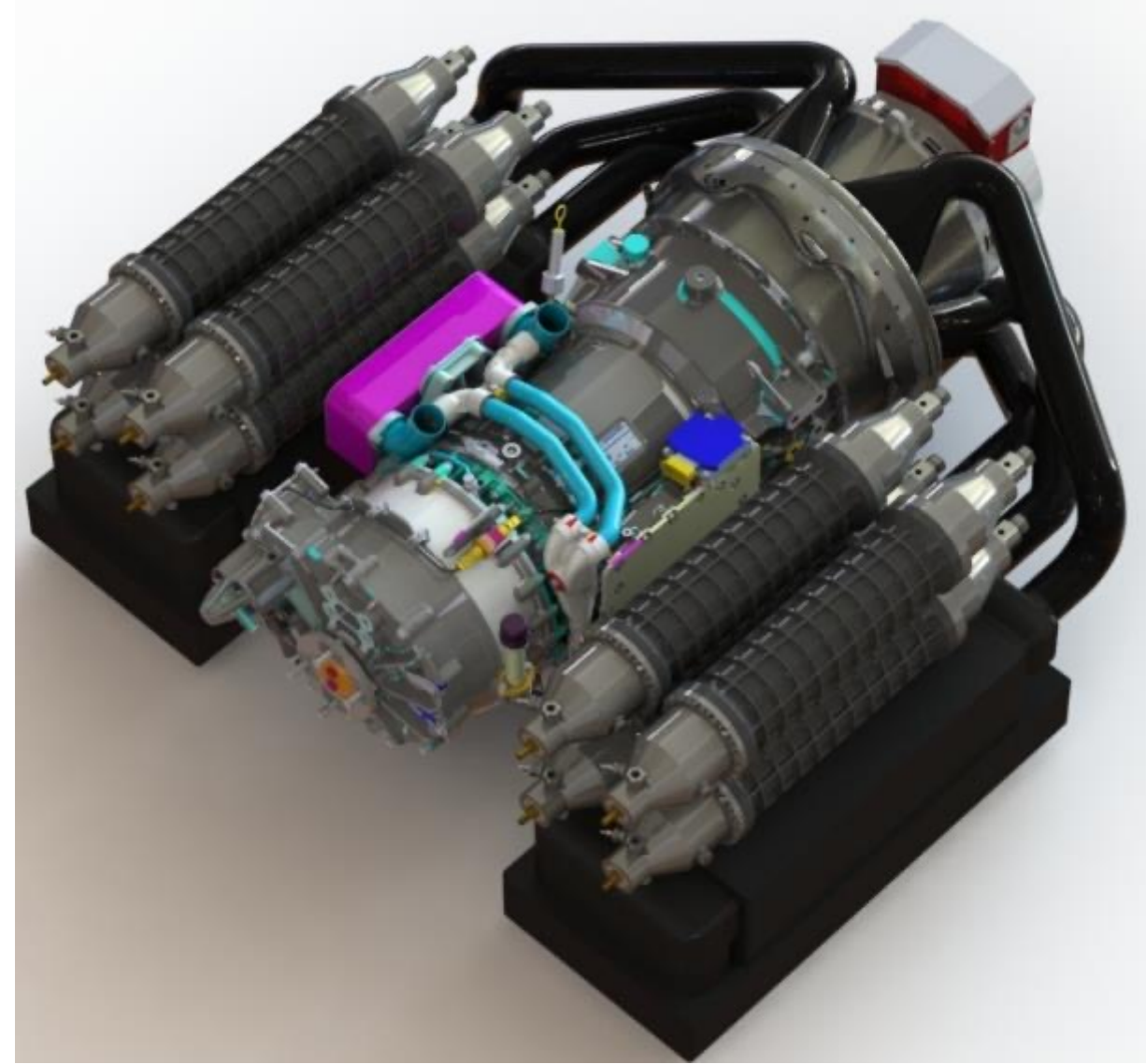




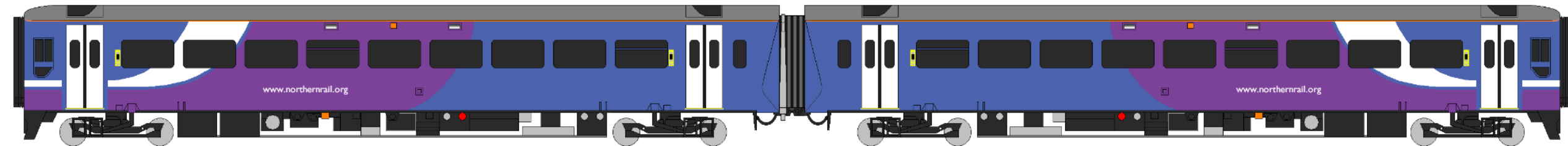
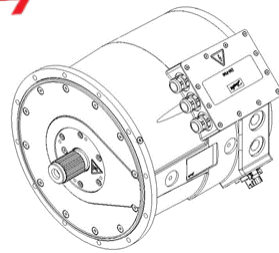
Passenger Rail Re-tractioning

Zero Emission Diesel Engine Replacement Drive Train

300kW Class 158 Passenger DMU diesel engine replacement



Danfoss

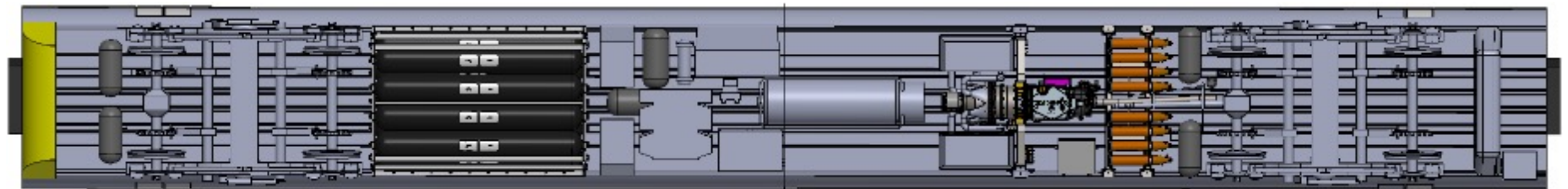
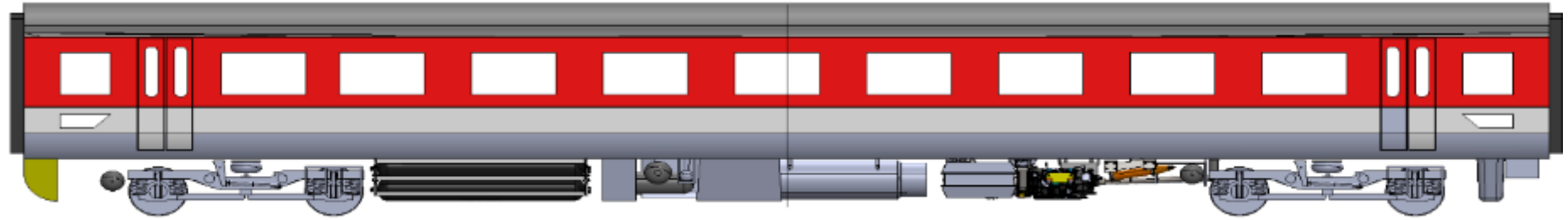
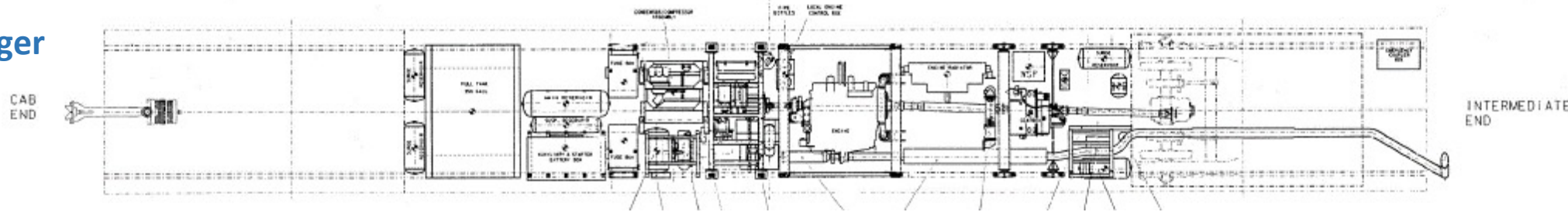
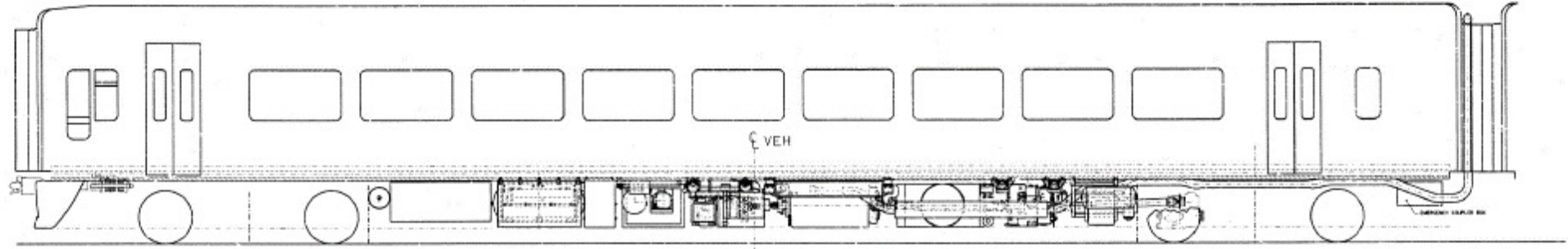




Direct drive

Zero Emission Diesel
Engine Replacement Drive
Train

300kW Class 158 Passenger
DMU diesel engine
replacement

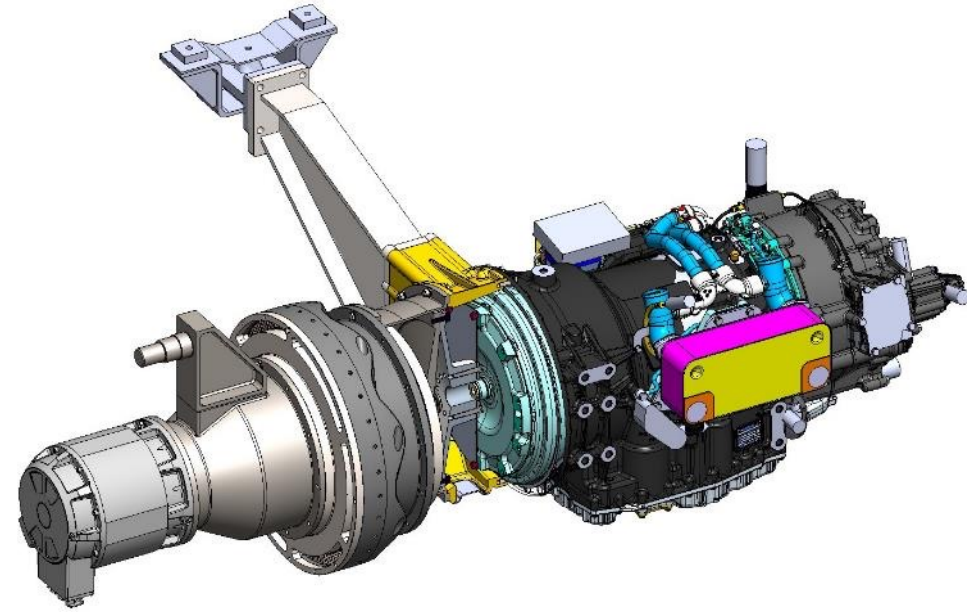




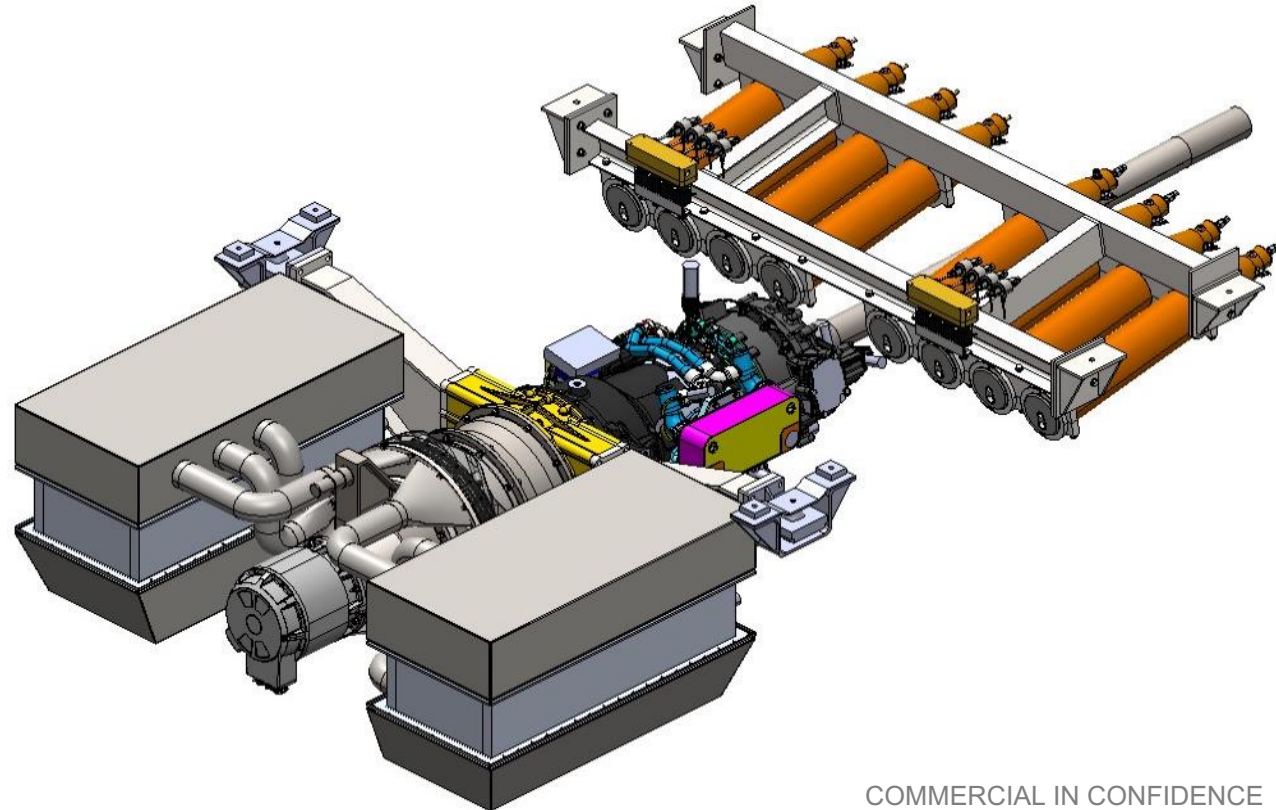
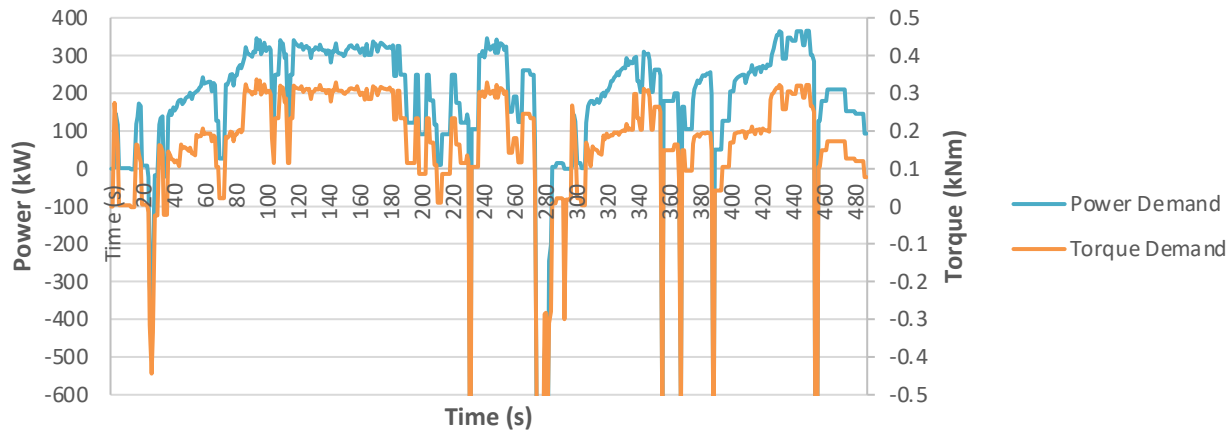
300kW Drivetrain

DMU replacement drivetrain with turbine, reduction, ZF EcoWorld transmission, Cardan shaft, condensers, auxiliary motor generator.

Scalable drivetrain to accommodate regenerative energy for passenger rail routes



Power and Torque Demand for Class 158 on Shrewsbury to Aberystwyth route





Zero emission rail freight power

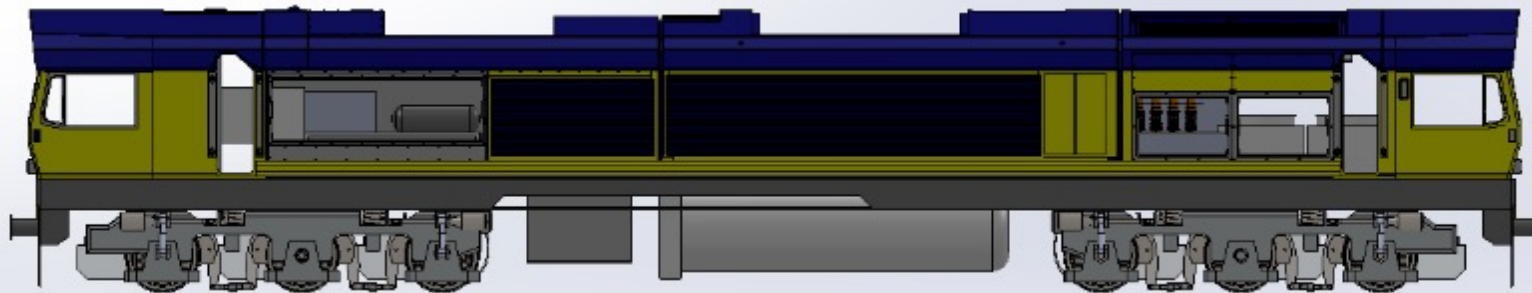
600kW Class 66 Freight steam electric turbine



HM Government



Innovate UK





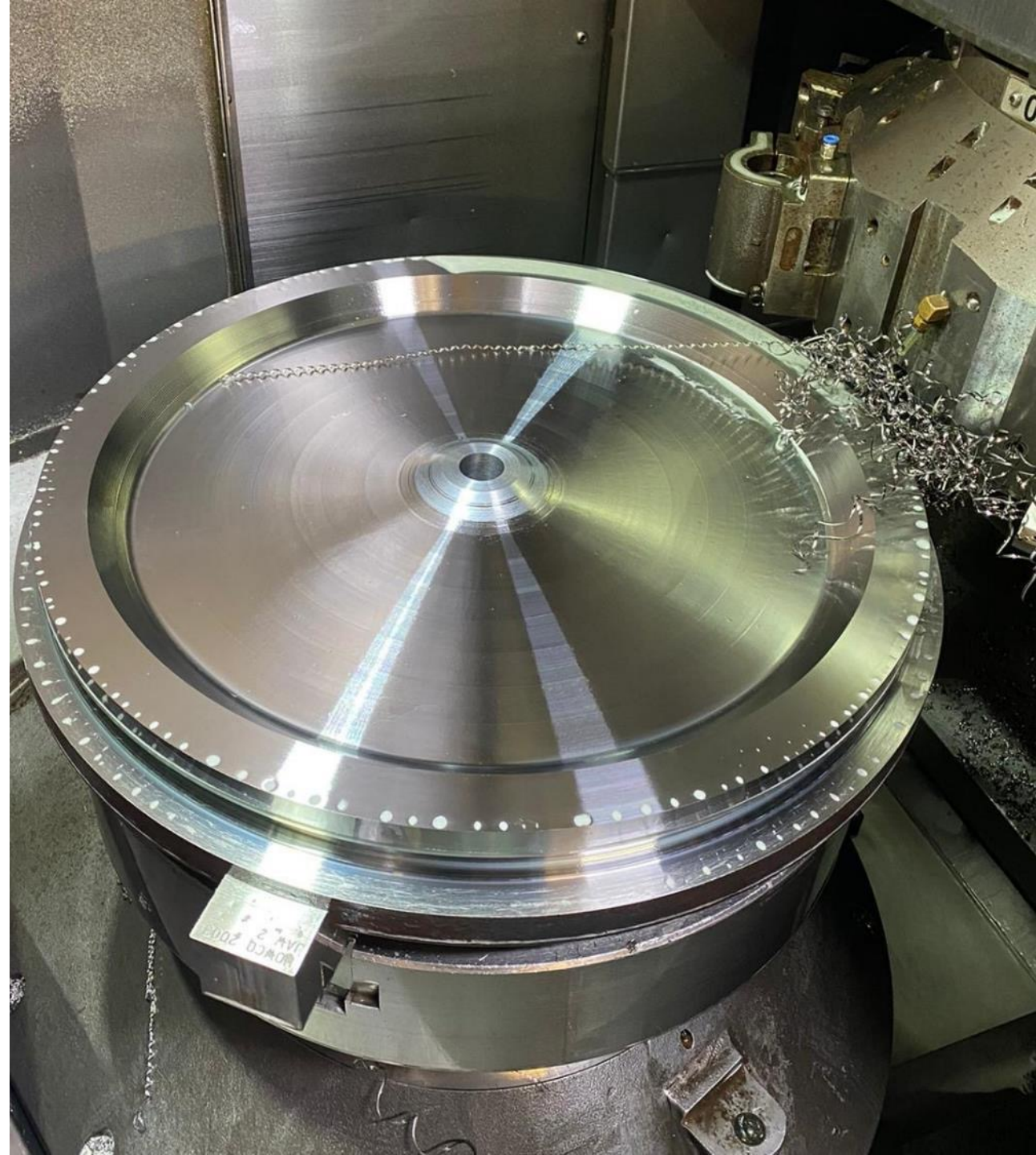
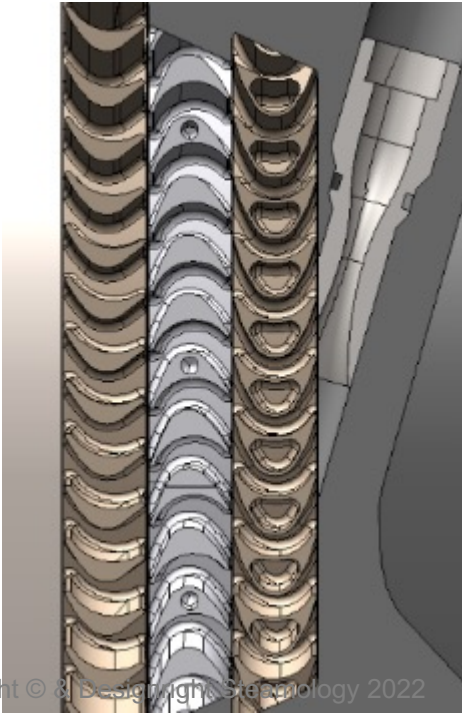
Turbine

Ø 600mm two stage impulse Curtis wheel turbine

Single component 9,125rpm

Standard materials handle low temperature steam ~110°C

Directly couple to reduction gearbox

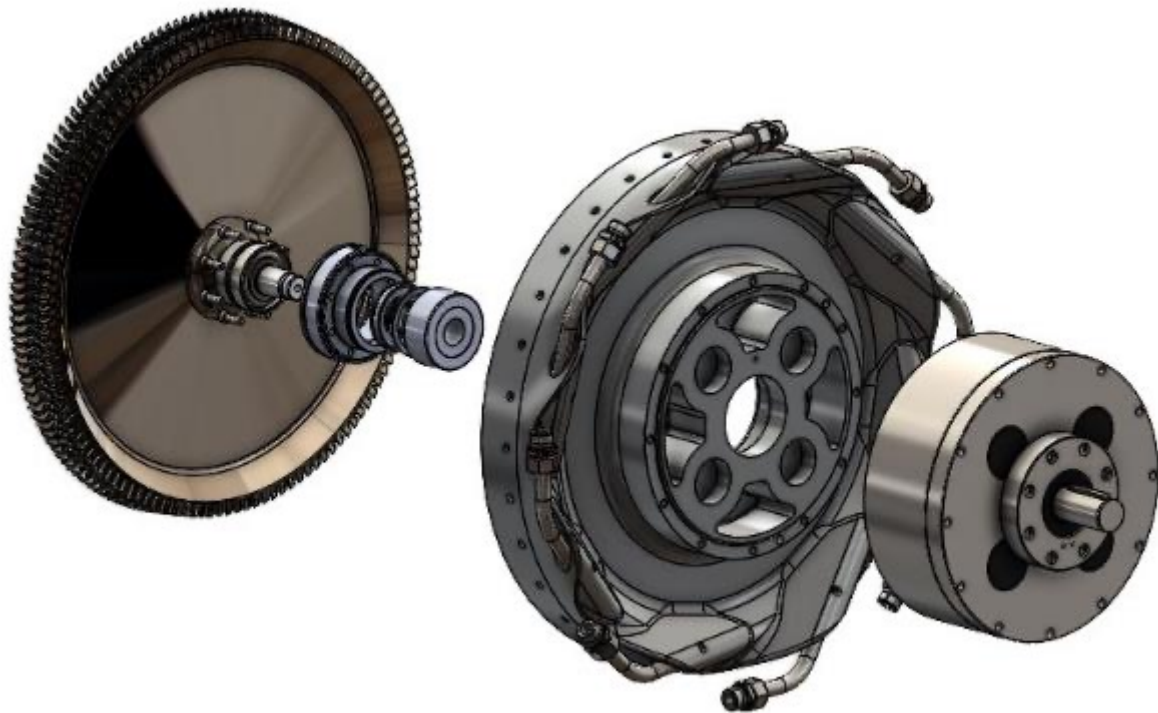




Turbine reduction

Turbine speed 9,125 rpm can be reduced as appropriate for electrical generators or conventional diesel engine transmissions

Parallel inline gears transmit high torque in simple efficient, compact arrangement





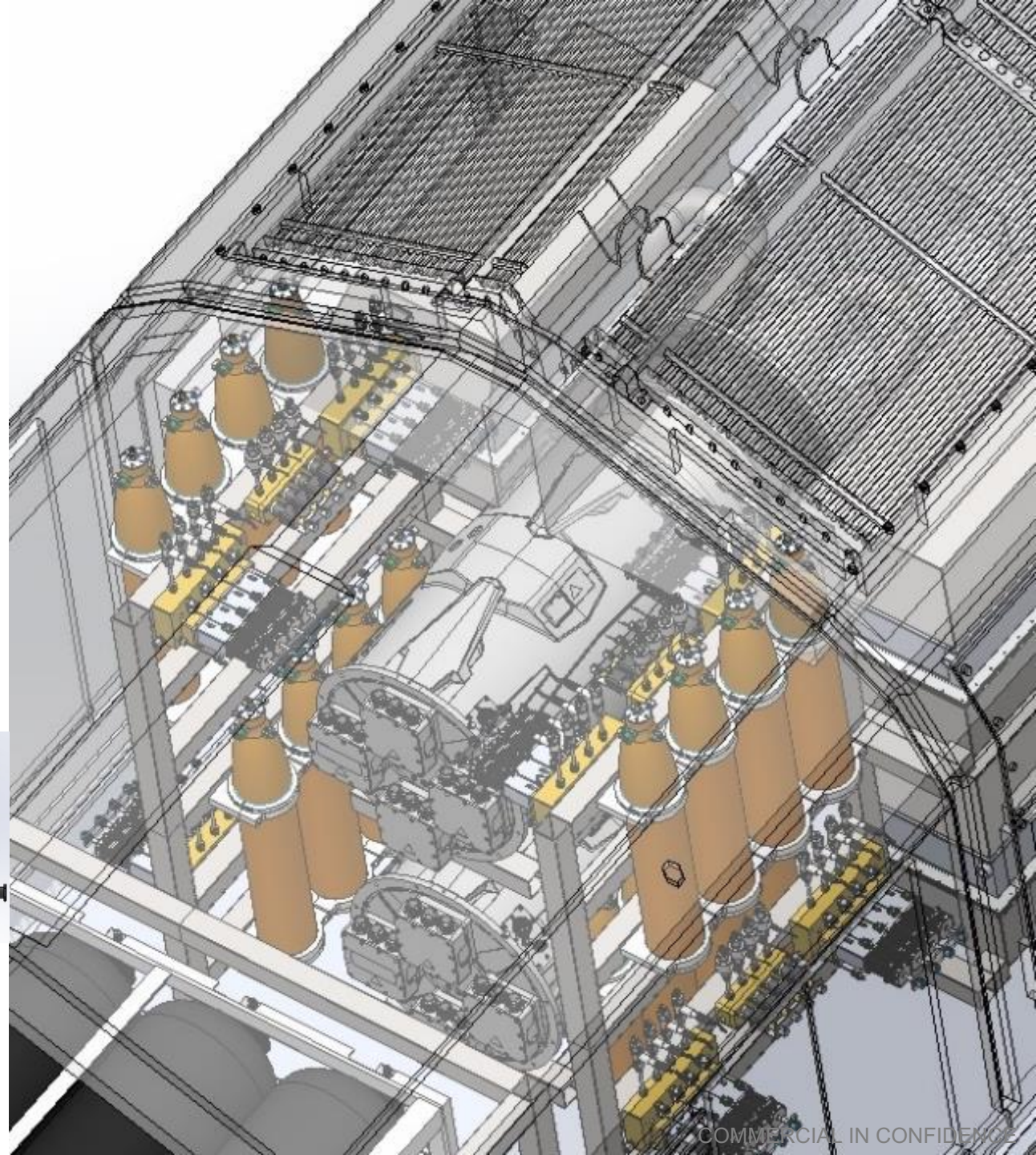
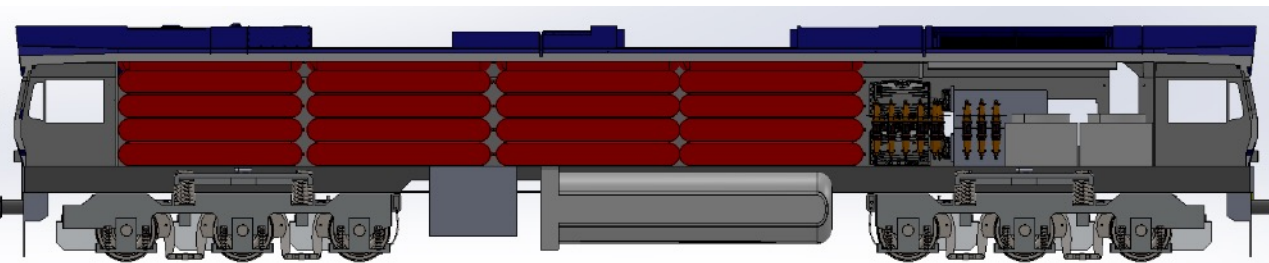
Zero emission rail freight power

Packaging ~2.4MW steam electric freight re-tractioning

Initial storage models ~13MWhr in single cab configuration

Danfoss Editron range permanent magnet motor generators

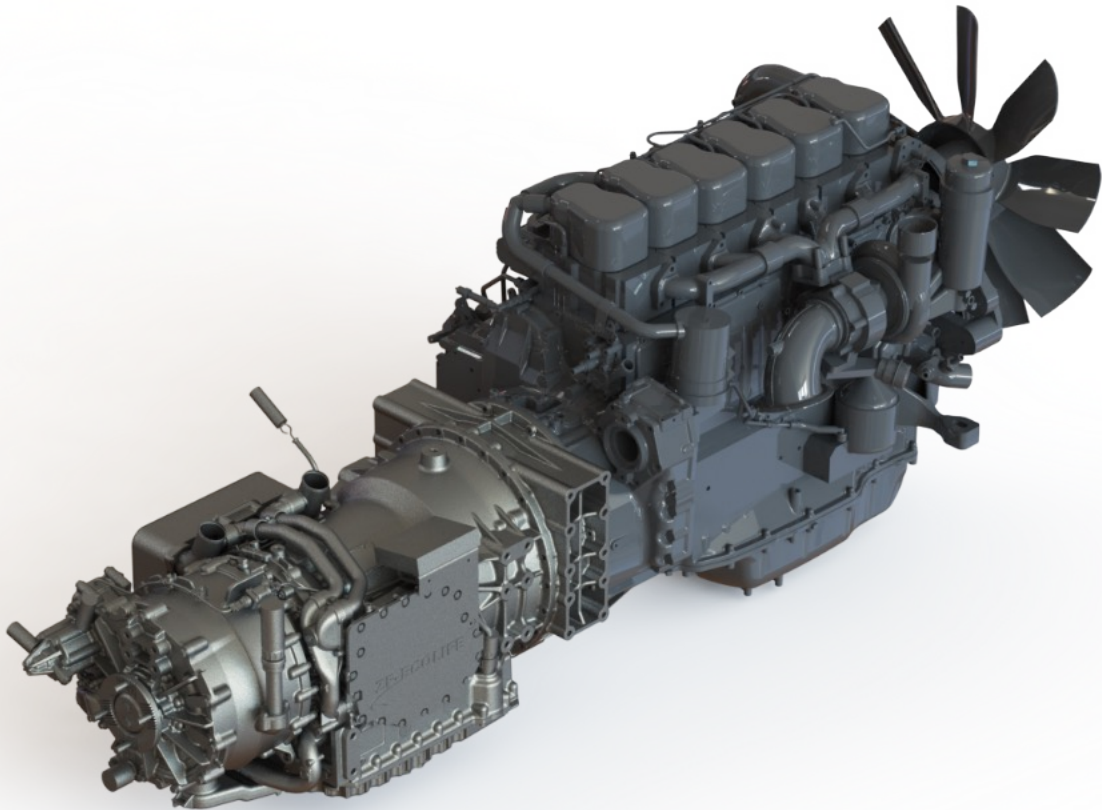
Electric compressor Gardner Denver, Atlas Copco



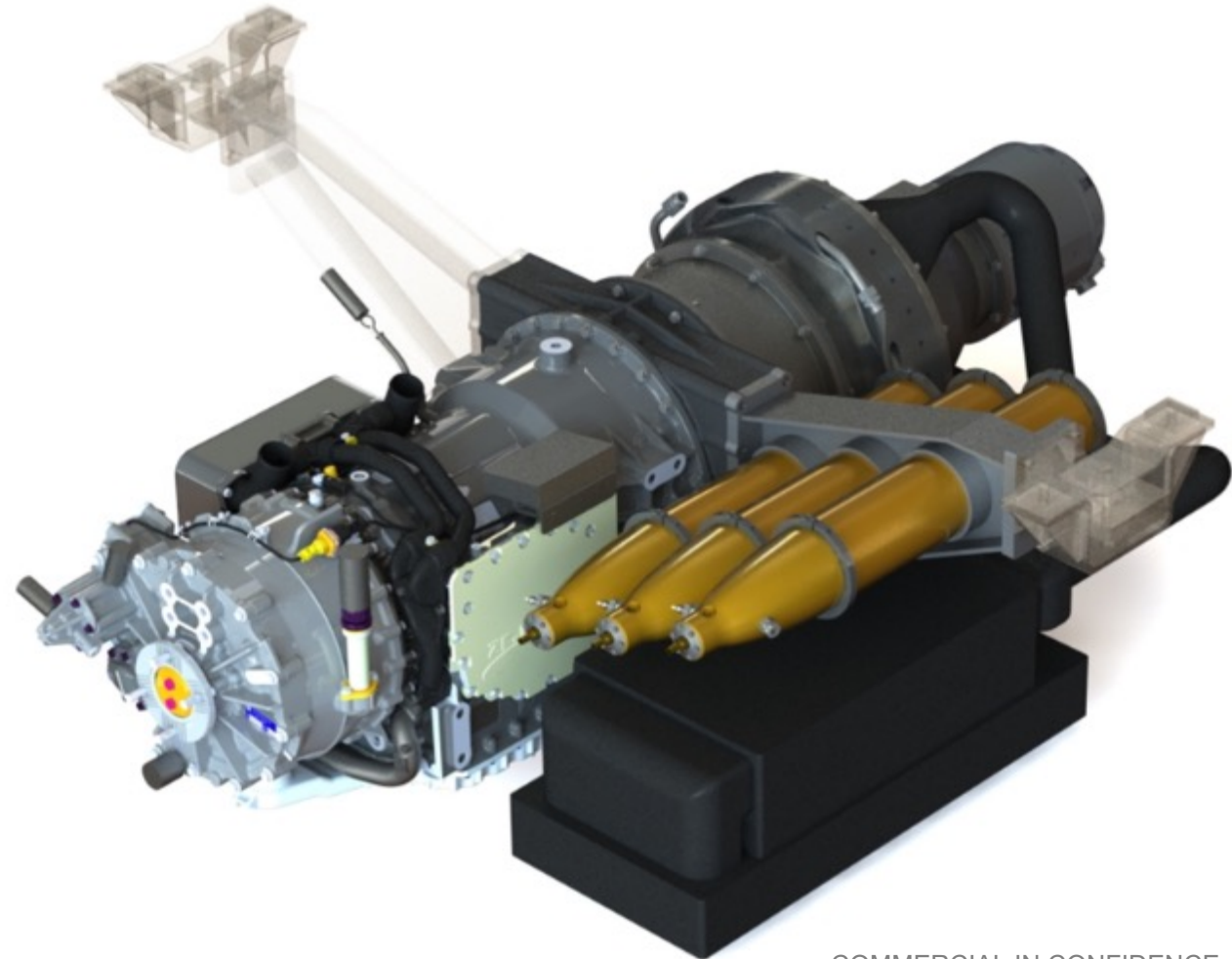


Diesel engine replacement

Scalable and modular power solutions, embracing the hydrogen economy, eliminating emissions, replacing fossil fuels and fossil fuel engines.



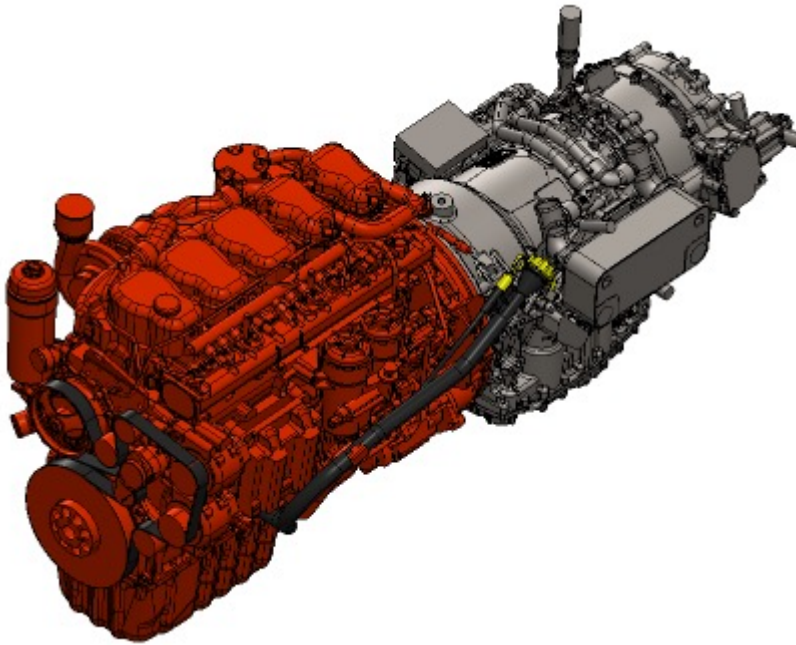
Steamology deliver quiet clean power to MW scale



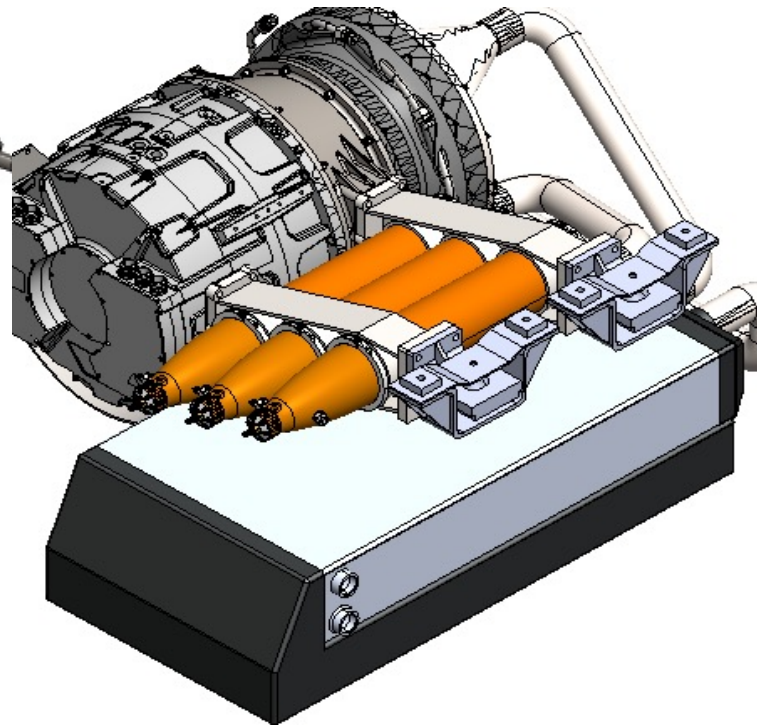
Size comparison

Comparison of Steamology technology with mechanical and electrical drive with conventional diesel and hydrogen fuel cells

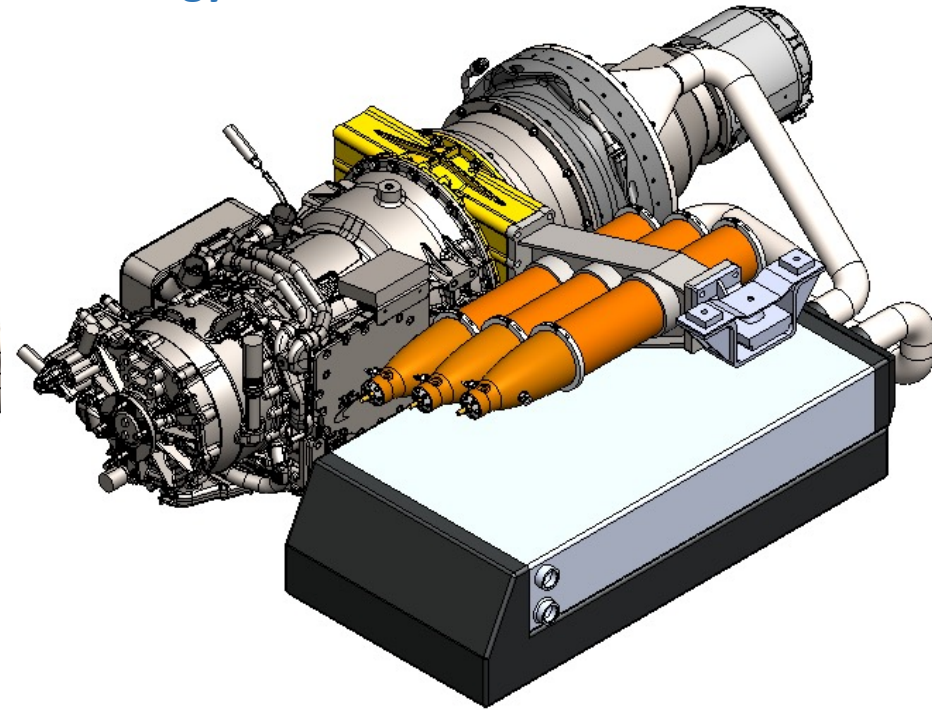
Typical 300kW Diesel



Steamology 300kW electric drive



Steamology 300kW mechanical drive





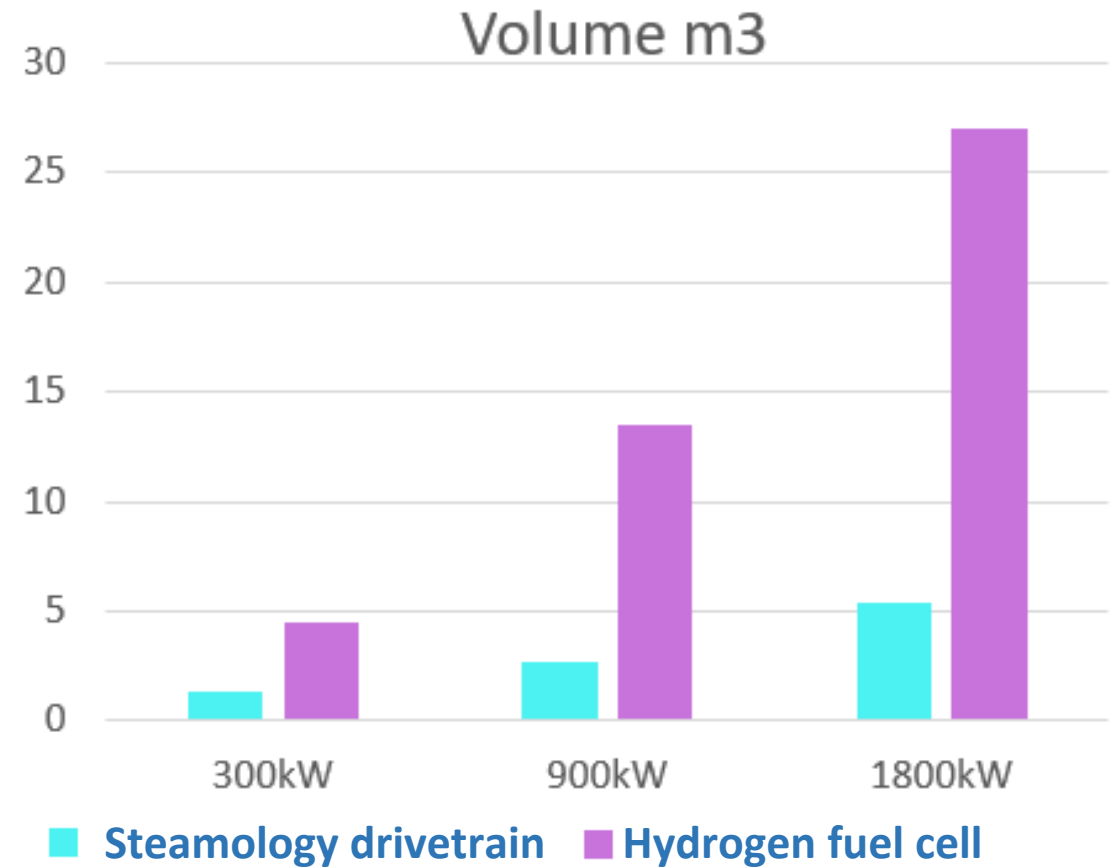
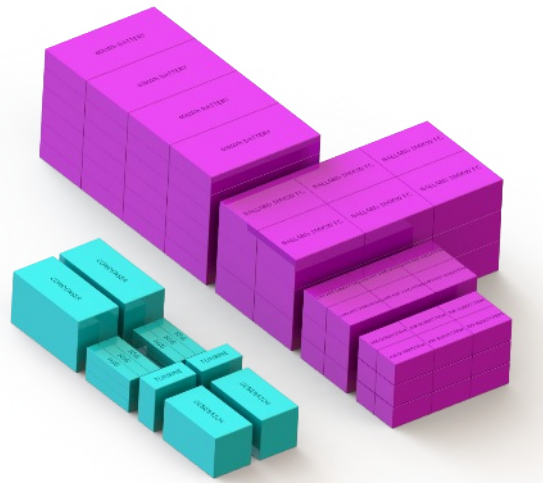
Size comparison

We have selected 300kW, 900kW and 1800kW to illustrate the increase in Steamology energy density (kW/m^3) with power output.

Fuel cell and battery systems increase in size and cost indirect proportion to power output

Energy Density

Fuel cell- $66\text{kW}/\text{m}^3$ Steamology range 214 to $333\text{kW}/\text{m}^3$



This volume comparison shows the volume m^3 of drivetrains for typical Steamology and hydrogen fuel cell systems



Department for Transport

Clean Maritime Demonstration Competition

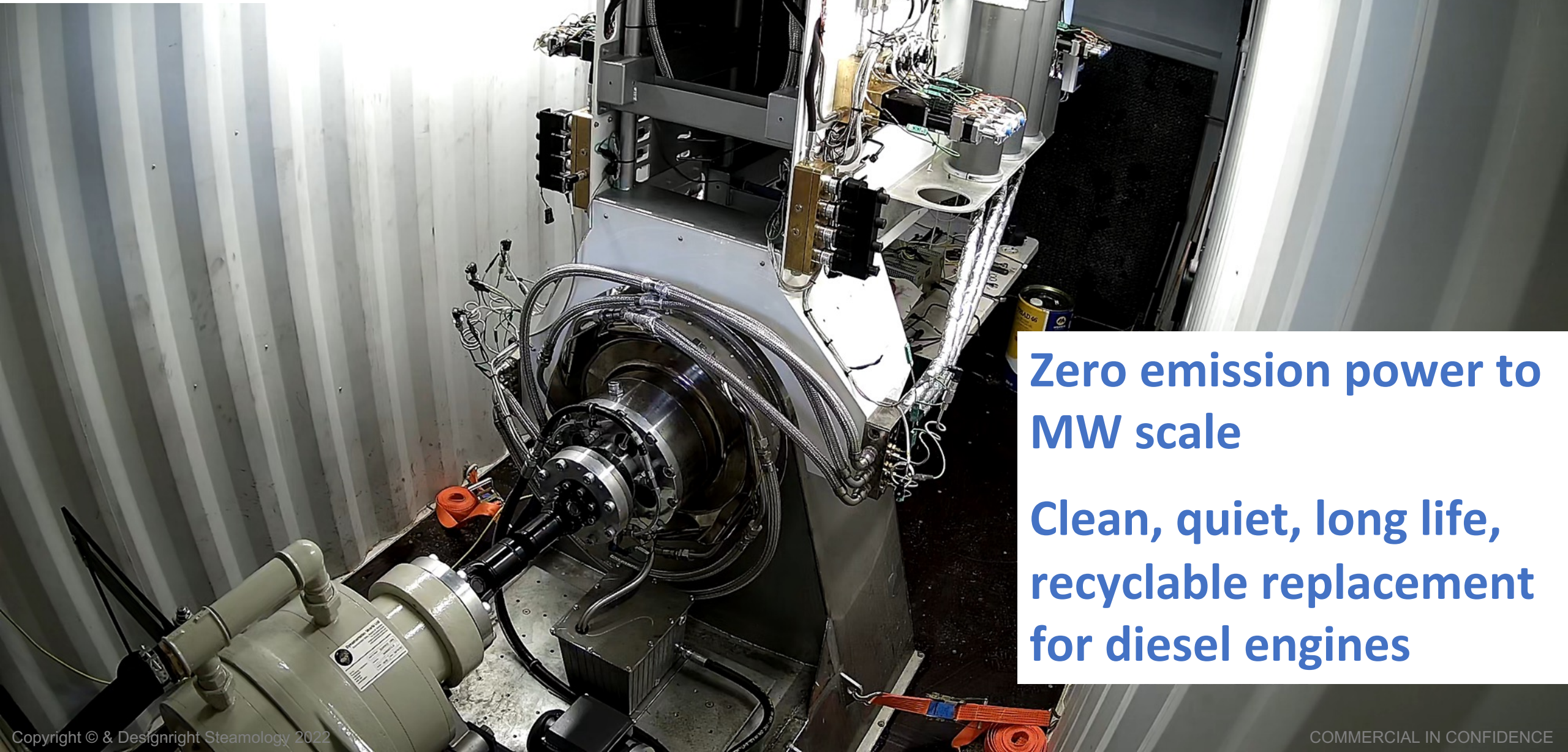




Department for
Business, Energy
& Industrial Strategy

Red Diesel Replacement Phase 1





**Zero emission power to
MW scale**

**Clean, quiet, long life,
recyclable replacement
for diesel engines**

Questions...

