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North-West Europe
RIVER
European Regional Development Fund

Welcome

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RIVER Kick Off Meeting
Case Study
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Engine Options for application of Technology

There are inboard and outboard engines that range from a few kW to more than 100 kW used in inland waterways and lakes.

Outboard engines have been used in small recreational boats and small fishing boats traditionally, but now are being used in push boats and high-speed boats.

The characteristics of the use and configuration also differ significantly between outboard engines and inboard engines.

Two example cases are put forward in this document for demonstration of the technology.

- Case 1 is based on a small 24 kW inboard engine that are used in small boats.
- Case 2 is based on a commercial inboard engine of 74 kW similar to a Dutch barge.

These engines have been selected based on inland waterway usage data.
The technologies are representative of the current use of boats in UK.

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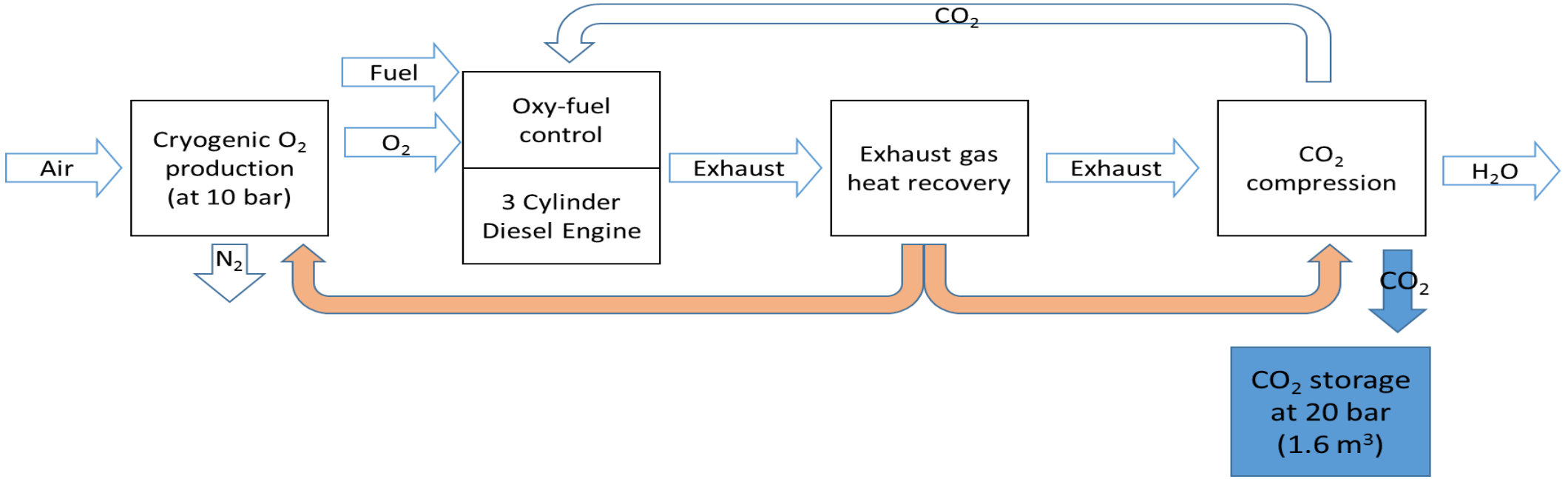
Case 1: Inland Waterways Day Motor Boat (19496 units in the UK 24 kW –Diesel)

The experimental set up

The engine is used at a load factor of 60 % with an average use of 6 hours daily.
This results in the production of 97 kg of CO_2 per day and if stored at 20 bar pressure, the volume of the on board CO2 storage will be 1.6 m^3.
There is no need to store the whole volume of Oxygen as it will be consumed in the engine.

However, the oxygen generation rate should match this demand.

3 cylinders Diesel Engine



Case 1: Inland Waterways Day Motor Boat (19496 units in the UK 23.4 kW –Diesel)

Annual Savings

The boat will use a total of 10735 l of fuel and produce 27,173 kg of CO_2 annually.

In Britain alone, if this is extrapolated to more than 19000 boats of this nature that are in use, that will save more than 529,764 tons of CO_2.

This is only for the day boats. There are other types where the technology can be readily deployed.

Table 1 shows a summary of figures projected based on usage statistics in the UK.

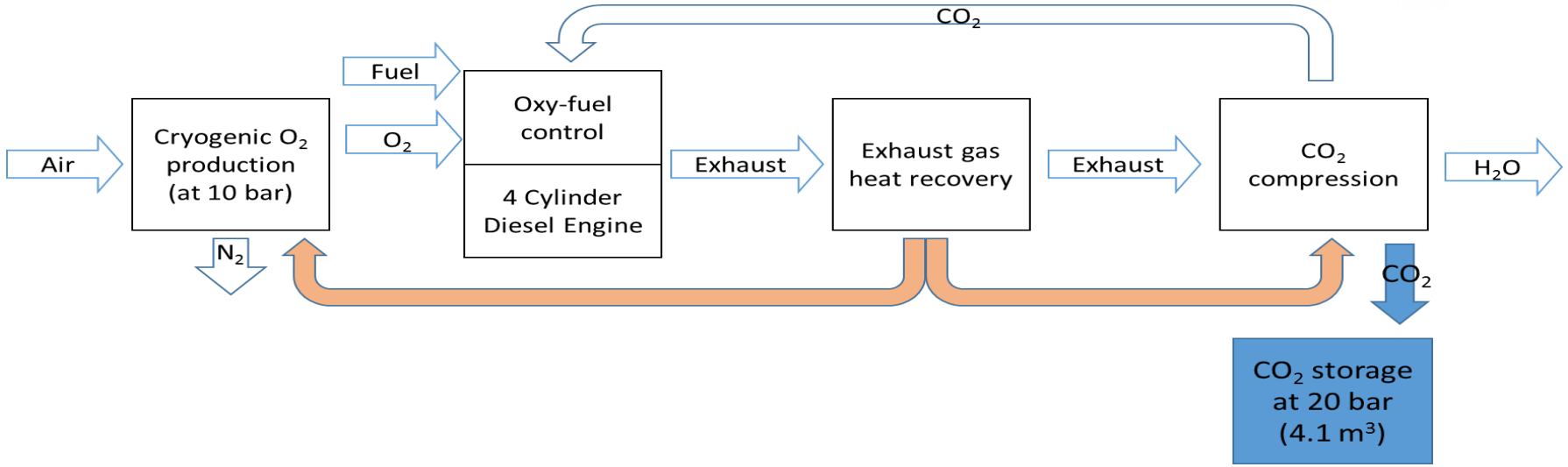
Annual Hours	Rated Power (kW)	Load Factor	Annual Output (kWh)	Annual fuel consumption (l)	Annual CO_2 (kg)	CO_2 storage volume (m^3) @20 bar
1680	28	0.60	28627	10735	27173	1.59

Table 1 CO_2 figures

Case 2: Inland waterways – Diesel Power boat (10325 units in UK 74 kW Diesel)

The technology used will not differ from that of a smaller horsepower outboard unit. Oxygen production will be done using cryogenic distillation at high pressure. So produced Oxygen will be used in the engine that will operate as an oxyfuel engine. Some CO_2 will be recycled through to the cylinder as make up volume. Exhaust gases run through an exhaust heat recovery bottoming cycle that produces energy that will be consumed in the compressors both for compressing incoming air and compressing CO_2 after combustion. CO_2 will be separated in the compression process and will be stored in a chamber. Based on the daily use of the vessel, the size of CO_2 stare tank is estimated at 4.2 m^3.

4 cylinders
Diesel engine



Case 2: Inland waterways – Diesel Power boat (10325 units in UK 74 kW Diesel)

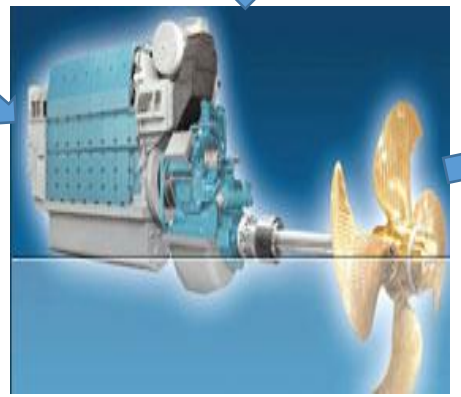
Annual Savings

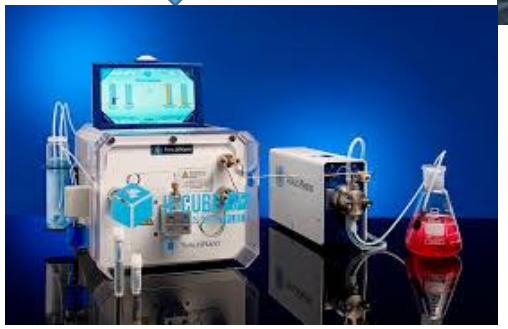
Use of the boat at 60 % load over 1680 hours of operation results in 70.8 tons of CO_2 per vessel that accounts for 2 million tons in total for the fleet in the UK. The boat will use a total of 27972 l of fuel and produce 70803 kg of CO_2 annually. In Britain alone, if this is extrapolated to more than 23000 boats that are in use of this nature that will reduce more than 1.6 million tons of CO_2. Table 2 shows a summary of figures projected based on usage statistics in the UK of this type of vessels.

Annual Hours	Rated Power (kW)	Load Factor	Annual Output (kWh)	Annual fuel consumption (l)	Annual CO_2 (kg)	CO_2 storage volume (m^3) @20 bar
1680	74	0.60	74592	27972	70803	4.14

Table 2 CO_2 figures

Installing and Testing Engines in An Operational Environment



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Thank you!