## RIVER

*Develops an Oxy-fuel combustion technology for internal combustion engines to virtually eliminate CO2 emissions. It recovers exhaust energy to improve fuel efficiency and this is combined with a carbon capture technology that stores the expelled CO2 as compressed gas in containers.*

## How the technology works

(1) **Oxyfuel combustion** is a combustion concept for Internal Combustion (IC) engines using pure oxygen as the primary oxidant to burn hydrocarbon fuels instead of air. The nitrogen component of air requires heating before combustion so by removing this element, fuel consumption can also be reduced.

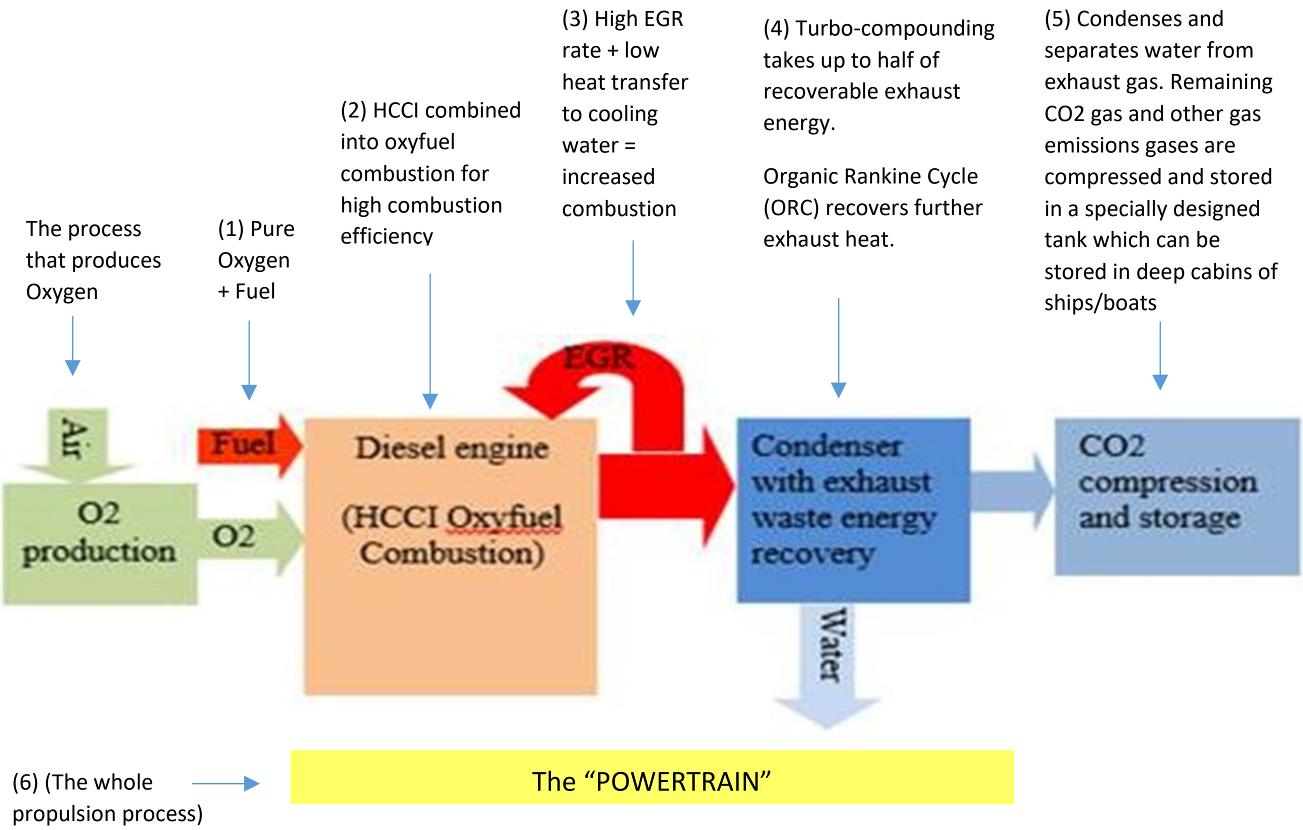
The entire process enables low cost post-combustion Carbon Capture and Storage (CCS) by separation of CO2 and steam using condensation.

(2) At the engine working stage, another new combustion technology **Homogeneous Charge Compression Ignition (HCCI)** combines with oxyfuel combustion to deliver high combustion efficiency. Under pre-mixed and homogeneous charge condition, the auto-ignition takes place with the progress of compression to obtain the required auto-ignition temperature.

(3) As it is "lean burn" (high **Exhaust Gas Recirculation (EGR)** rate or high air-fuel ratio for diluent) with low heat transfer to cooling water, the total combustion efficiency is higher than conventional combustion. For this research HCCI will mainly support the utilisation of pre-mixed charge with stoichiometric oxygen-fuel-EGR mixture

(4) Another technology which will support oxyfuel combustion for high energy efficiency is exhaust energy recovery based on **Turbo-compounding** and **Organic Rankine Cycle (ORC)**. A turbo compounding system will be fitted on the exhaust pipe up-stream to take up to half of the recoverable exhaust energy. Then an ORC system will recover further exhaust heat.

(5) Up to 99% of the exhaust content of oxyfuel combustion is CO2 and water. **Carbon capture technology (CCS)** condenses and separates water from exhaust gas. The remaining CO2 gas and other emission gases are compressed and stored in specially designed tank which can be stored in deep cabins of ships/boats.




(6) RIVER's Powertrain concept poses a number of control questions when compared to a conventional diesel engine. Project partners therefore, pay particular attention to refinement of integration and system controls.

Powertrain requires additional subsystems; <u>an exhaust gas splitter</u>, a <u>heat recovery unit combined with a compressor</u>, an <u>ORC expander with a hybrid drive</u> and a <u>CO2 recovery system that also uses recovered heat</u>.

The heat recovery unit may also have <u>heat storage with an optimum control strategy</u>, so the engine will be able to run at its maximum efficiency point most of the time, allowing the system to be highly efficient.