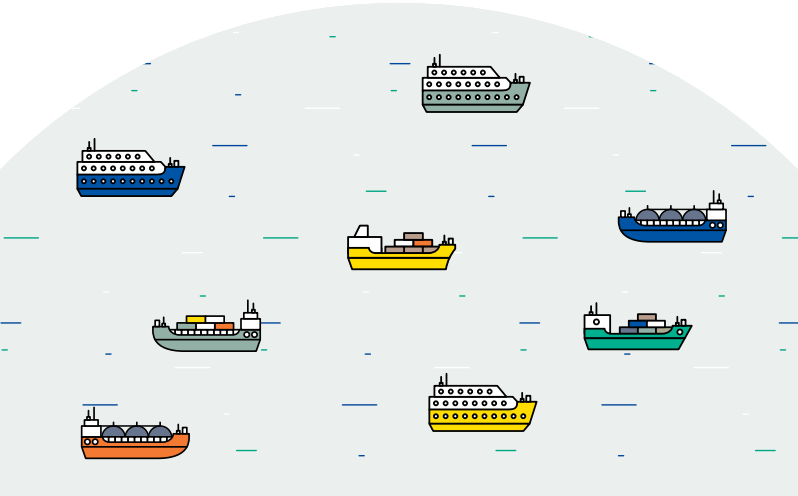
GREEN RAY

Clean Waterborne Transport



GREEN RAY is a **Horizon Europe project** that aims to **minimise methane slip** from **Liquified Natural Gas (LNG) vessels** to enable **clean waterborne transport.**

By developing **innovative technologies** for LNG engines that can be installed on **new and existing ships**, GREEN RAY is working to **reduce the negative impact** of waterborne transport and **protect human and environmental health**.

www.greenray-project.eu

From Cleaner Fuel to Climate Solution

As shipping shifts to **LNG vessels** for reduced emissions, **methane slip** – unburned methane escaping into the atmosphere – remains a critical issue. With a **warming potential 28 times higher than CO_2**, methane slip may offset the **climate gains of LNG**.

GREEN RAY addresses this challenge head-on by developing **cutting-edge technologies to significantly reduce methane slip, improve engine efficiency**, and ensure **European leadership in clean maritime innovation.**

Technologies

The project focuses on the assessment and mitigation of methane slip through the development of technologies for low-pressure dual-fuel engines.

These technologies will be demonstrated on both **new vessels and retrofitted ships**, targeting **TRL 7** (*system prototype in operational environment*).

MAC System

Methane Aftertreatment

An **after-treatment catalyst system** is installed within the vessel's exhaust system to convert **residual methane emissions into carbon dioxide**, a **less potent greenhouse gas**, thereby reducing the vessel's overall climate impact.

- **Combines a Sulphur Guard Bed (SGB)** and **Methane Oxidation Catalyst (MOC)**
- **Demonstrated high methane removal**, proven with real marine engine exhausts
- **Approved in Principle (AiP) by DNV** for onboard application

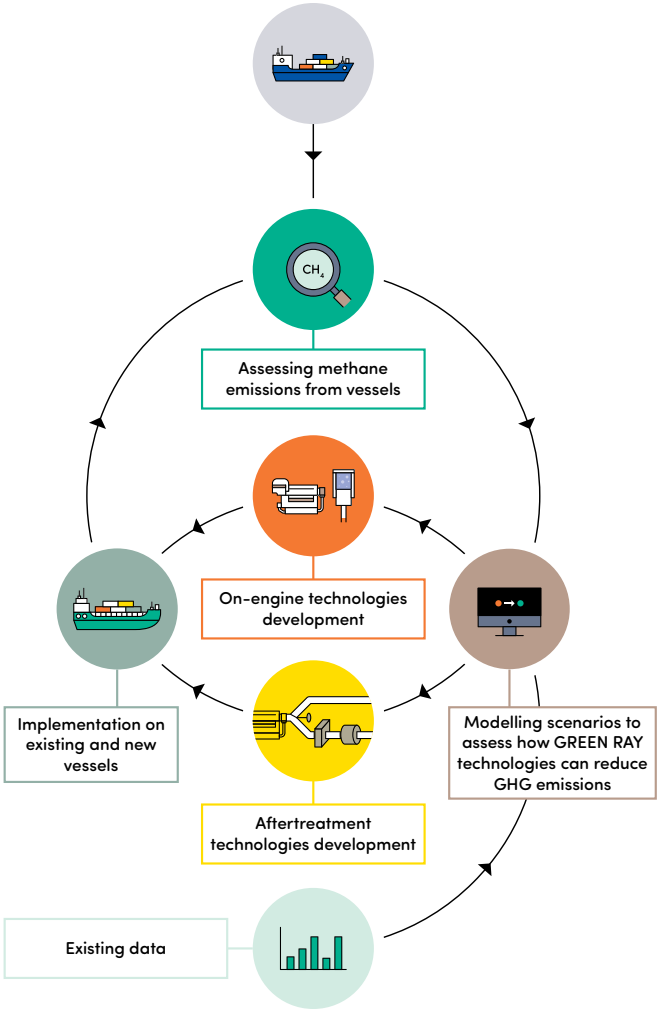
Four-Stroke Engine Upgrade

Wärtsilä 46TS-DF with NextDF

NextDF is an upgrade to the **Wärtsilä 46TS-DF** engine that offers an innovative solution to reduce engine emissions and comply with increasingly strict legislation. It features:

- **Advanced combustion control** that adjusts to fuel and air conditions, reducing unburned methane.
- **Enhanced valve timing and injector technology** for improved efficiency.
- **Smart air-fuel ratio control** to lower combustion temperature, cutting both NO_x formation and methane emissions.

With **methane emissions below 1.4%**, and **as low as 1.1%** across most load ranges, NextDF significantly outperforms the **3.1% default** set by **FuelEU Maritime** and **IMO guidelines**, helping operators reduce environmental impact and avoid penalties.


CH_4
Assessing methane emissions from vessels
On-engine technologies development
Implementation on existing and new vessels
Modelling scenarios to assess how GREEN RAY technologies can reduce GHG emissions
Aftertreatment technologies development
Existing data

KPI-Driven Impact

- **Up to 80% methane slip reduction** with the **MAC system**
- **Fuel savings & improved combustion efficiency with the Four-Stroke Engine upgrade**
- **Compliance** with **IMO GHG goals** and **EU Fit for 55** packages
- **TRL 7 demonstration**: Ready for **real-world deployment**
- **Enhanced competitiveness** of **EU marine tech suppliers**

Expected Impacts

- **Support the uptake of climate-neutral fuels** and **decarbonisation** of the shipping sector
- **Increase energy efficiency** and **reduce fuel consumption**
- **Enable clean and climate-resilient** inland waterway vessels before 2030
- **Eliminate harmful pollution** to air and water from LNG use
- **Strengthen the competitiveness** of European waterborne industries

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