

Green and low emission propulsion concepts

Deliverable D4.5 - Version Final – 2023-11-22



Advanced, Efficient and Green Intermodal Systems

<http://aegis.autonomous-vessel.org/>



This project has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement N° 859992.



Document information

Title	Green and low emission propulsion concepts
Classification	Confidential

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Rev.	Who	Date	Comment
0.1	DM	2023-08-10	Document structure and expected content
0.2	DM	2023-09-14	Document sent to SO for review
0.3	DM	2023-11-19	Completion of report; ready for SO review
0.4	EJT	2023-11-21	Reviewed by SO
Final	DM	2023-11-22	Final revision to be submitted to the EC

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Table of Contents

- Executive Summary 4
- Definitions and abbreviations 6
- 1 Introduction..... 9
 - 1.1 Background..... 9
 - 1.2 Objectives and system boundaries 9
 - 1.3 Linkage to other work packages..... 10
 - 1.4 Maritime Transport: A Global Perspective..... 11
- 2 Regulatory Development..... 13
 - 2.1 IMO’s Revised GHG Strategy 2023 13
 - 2.2 Energy Efficiency and Carbon Intensity in Shipping: EEXI and CII 14
 - 2.3 Special Regulations of European Union 15
- 3 Analysis of Low Carbon and Renewable Marine Fuels..... 16
 - 3.1 DNV’s Maritime Forecast to 2050. Outlook on Ship Technologies and Fuels..... 16
 - 3.2 Solutions that can contribute to decarbonize shipping 16
 - 3.3 Status of fuel technology transition 18
 - 3.4 Fossil, Carbon-Neutral, and Carbon-Free Fuels..... 18
 - 3.5 Production Pathways..... 19
 - 3.6 Hydrogen 20
 - 3.7 E-fuels 21
 - 3.8 Assessing Greenhouse Gas and Air Pollution Emissions 23
 - 3.9 Overview of Well-to-Wake Emissions in Marine Fuels 23
 - 3.10 Addressing Air Pollution in Alternative Fuel Assessment..... 25
 - 3.11 Description of Fuels..... 25
 - 3.11.1 Ammonia 26
 - 3.11.2 LNG 27
 - 3.11.3 Methanol 28
 - 3.11.4 Hydrogen 29
 - 3.11.5 Biofuels..... 30
 - 3.12 Electrical Energy Storage Systems..... 30
 - 3.13 Battery characteristics..... 31
 - 3.14 Conclusions..... 34
- 4 Analysis of green and low emission propulsion technologies..... 36



- 4.1 Combustion-motor-mechanical propulsion 36
- 4.2 Fully Electric-driven Propulsion Concepts 38
 - 4.2.1 The Key Components of Electric Propulsion Systems 40
 - 4.2.2 Swappable containerized battery solution..... 41
 - 4.2.3 On-board Batteries as a Replacement for Ballast Tanks 44
 - 4.2.4 Shore Power Charging Solutions 47
 - 4.2.5 Shore Power Supply Infrastructure 51
- 4.3 Hybrid-Electric-driven Propulsion Concepts 57
 - 4.3.1 Operational Flexibility 57
 - 4.3.2 Operating Modes of Hybrid-Electric Propulsion 58
 - 4.3.3 Fuel Cells in Marine Applications 59
- 4.4 Propulsive Organs..... 61
 - 4.4.1 Azimuth Thrusters 61
 - 4.4.2 Controllable Pitch Propeller (CPP)..... 62
- 5 Propulsion Concepts Developed for the Designed Vessels within AEGIS 64
 - 5.1 Propulsion Concept for UC-A Vessels..... 65
 - 5.1.1 Propulsion Concept for UC-A mother vessel..... 66
 - 5.1.2 Propulsion concepts for UC-A daughter vessels..... 74
 - 5.2 Propulsion Concepts for UC-B Vessels 82
 - 5.2.1 Propulsion Concept of CEMT class IV RoRo Vessel 82
 - 5.2.2 Propulsion Concept of CEMT class II RoRo Vessel..... 84
 - 5.2.3 Propulsion Concept of CEMT class VI Vessel – transversal loading 86
 - 5.3 Propulsion Concepts for UC-C Vessels 88
 - 5.3.1 Short Sea Shipping RoRo Vessel – fully electric version 89
 - 5.3.2 Short Sea Shipping RoRo Vessel – methanol-combustion version..... 91
 - 5.3.3 Shallow water coaster 93
- 6 Conclusions..... 96
- Annex A. Extended data of AEGIS Vessels 98
- 7 References..... 107



Executive Summary

The Deliverable Report D4.5: "Green and Low Emission Propulsion Concepts," is a comprehensive document that covers various aspects of sustainable waterborne transport. The report comprises the following information:

The first section provides background information, outlines the objectives and system boundaries, explains the linkage to other work packages, and gives a global perspective on waterborne transport. The section regulatory development discusses the International Maritime Organization's (IMO) revised *Strategy on Reduction of GHG Emissions from Ships* [1], energy efficiency and carbon intensity in shipping, including EEXI and CII, and special regulations of the European Union.

The third section analyses the possibilities to deploy low and renewable marine fuels, based on DNV's *Maritime Forecast to 2050* [2] it assesses various solutions to decarbonize shipping and reviews the status of fuel technology transition. Also, fossil carbon-neutral and carbon-free fuels, production pathways, hydrogen, e-fuels, and the assessment of greenhouse gas and air pollution emissions are evaluated. The section provides an overview of well-to-wake (WtW) emissions in marine fuels, addresses air pollution in alternative fuel assessment, and describes various fuels including their energy density, ammonia, LNG, methanol, hydrogen, and biofuels. Further electrical energy storage systems and battery characteristics are discussed in detail.

The fourth section analyses feasible green and low propulsion technologies. This covers combustion-motor-mechanical propulsion, fully electric-driven propulsion concepts, hybrid-electric-driven propulsion concepts, and propulsive organs like azimuth thrusters and controllable pitch propelled.

This analysis as well as the use case scenarios provide the foundation for the propulsion concepts of the developed AEGIS vessel concepts. It comprises detailed information for the propulsion concepts of the various developed vessel types categorized as UC-A, UC-B, and UC-C vessels.

The report concludes with interpretation of results, an evaluation of the advantages and challenges of different propulsion systems, developments and research needs, a summary of key findings and recommendations, and overall conclusions.

The project led to the successful conceptualization and development of the following vessel types and their corresponding propulsion systems, see Table 1:



Table 1: Overview of AEGIS vessels specifications

Vessel	Type	Capacity	Propulsion	Main Engine Output	Battery Capacity	Propeller, diameter	Service Speed
UC-A Mother Vessel	M/V, OTCV	1096 TEU	Hybrid propulsion; Dual fuel (Methanol/MGO) combustion engine (MAN V32/44CR)	12,000 kW	500 kWh in a 10 ft. container	Single screw, CPP, 5200 mm diameter	16 kn
UC-A 100 TEU Daughter Vessel	Fully Electric OCTV	106 TEU	Fully electric (two Electric Driven Azimuth Thrusters, Type: Schottel EcoPeller SRE 150)		Total 11,260 kWh (four 2,820 kWh/module)	Podded, fixed pitch, 1300 mm diameter	8 kn
UC-A 60 TEU Daughter Vessel	Fully Electric OCTV	56 TEU	Fully electric (two Electric Driven Azimuth Thruster: Schottel EcoPeller SRE 150)		Total 11,260 kWh (four 2,820 kWh/module)	Podded, fixed pitch, 1200 mm diameter	8 kn
UC-B CEMT Class VI Vessel	Fully Electric IWW RoRo, Class VI	69 trailers, 966 lane meters	Fully electric (two Electric Driven Azimuth Thruster: Schottel EcoPeller SRE 150)		15,840 kWh (three 5,280 kWh/module)	Podded, fixed pitch, 2500 mm diameter	8 kn
UC-B CEMT Class IV Vessel	Fully Electric IWW RoRo, Class IV	21 trailers, 357 lane meters	Fully electric (two Electric Driven Azimuth Thruster: Schottel EcoPeller SRE 90)		8,450 kWh (three 2,820 kWh modules)	Podded, fixed pitch, 1700 mm diameter	6 kn
UC-B CEMT Class II Vessel	Fully Electric IWW RoRo, Class II	10 trailers, 140 lane meters	Fully electric (two Electric Driven Azimuth Thruster: Schottel EcoPeller SRE 90)		5,630 kWh (two 2,820 kWh modules)	Podded, fixed pitch, 1200 mm diameter	6 kn
UC-C RoRo Methanol Vessel	M/V SSS RoRo	55 trailers, 730 lane meters	Hybrid propulsion; two dual fuel combustion engines (Wärtsilä 9L34DF)	4,500 kW each	-	Podded, fixed pitch, 2300 mm diameter	16 kn
UC-C RoRo Electric Vessel	Fully Electric SSS RoRo	50 trailers, 730 lane meters	Fully electric (two Electric Driven Azimuth Thruster: Schottel EcoPeller SRE 360)		Total 26,400 kWh (5 x 5,280 kWh/module)	Podded, fixed pitch, 2300 mm diameter	12 kn
UC-C Shallow Water Coaster	M/V Shallow Water Coaster	4250 DWT; 3,800 tons bulk; 156 TEU	Hybrid propulsion; Dual fuel (Methanol/MGO) combustion engine (Wärtsilä 6L32DF)	3,480 kW		Podded, fixed pitch, 1500 mm diameter	12 kn