



ALGAESOL

Sustainable aviation and shipping fuels from microalgae and direct solar BES technologies

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Executive summary

This document describes the international collaboration strategies for the ALGAESOL project. The aim of this work is to ensure that the project consortium undertake collaboration activities with various external stakeholders, such as relevant EU projects and their consortium partners, to enrich communication and dissemination activities, and widen the impact of the project.

This report includes an overview of relevant international stakeholders, especially relevant EU projects, a first vision on possible future cooperation strategies, and a short overview of current activities regarding stakeholder engagement. In the follow up deliverable report, more detailed cooperation strategies with a long-term outlook that will be developed together with the identified partners, such as joint events and consultation, position papers or even on-site technology demonstrations in the later phase of the project, will be described.

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Introduction

The purpose of this document is to describe the international cooperation strategies that ALGAESOL aims to follow. This is to ensure that we can maximize the collective impact of the consortium and ensure early and wide adoption of the project results throughout the project and beyond. This document is the deliverable referred to in the Description of Action as D6.6. under WP6, task 6.3. International cooperation and stakeholder involvement.

In the first year of the project, the stakeholder landscape was analyzed to identify the best and most suitable collaboration opportunities. Afterwards, cooperation strategies with a long-term outlook will be developed together with the identified partners, such as joint events and consultation, position papers or even on-site technology demonstrations - in the later phase of the project. This document focuses on the stakeholder landscape, and the cooperation strategies will be mainly described in a follow-up document (Deliverable 6.7). We do already here describe some of the joint events and collaborations that have been undertaken in the first year. This document is also using the work, results and communication and dissemination strategies described in two earlier deliverable reports (Deliverable 6.1 and Deliverable 6.2) that describe the project's communication kit and the general communication and dissemination plan. Activities for general communication and dissemination will be aligned with the international cooperation activities to ensure the involvement of international partners in all exploitation and scale-up activities. This will result in early and wide adoption of ALGAESOL technologies and increase the export potential of European industry. Equally relevant for the collaboration strategies described in this document, as for the general communication and dissemination activities, is the fact that these should never jeopardize the potential protection of generated intellectual property (e.g. patent, product design) in the ALGAESOL project and further industrial application. Therefore, also for the collaboration and engagement activities described in this document, the same strict rules of prior notice to all partners will be applied, according to European Commission guidelines.

Project overview

With rising concerns over climate change and fossil fuel dependency, there is an increasing need for sustainable fuel alternatives. In this context, the EU-funded ALGAESOL project is exploring ways to convert sunlight into renewable fuels. The project will advance the current state-of-the-art by creating and consolidating new value chains for shipping and aviation fuels based on micro-algae and direct solar renewable fuel technologies. Various systems (biologic, photoelectrochemical, electrochemical, and bioelectrochemical) will be evaluated for the production of methane, methanol, and Sustainable Aviation Fuels (SAF). A schematic overview of the ALGAESOL project is shown in Figure 1. Targets are increased solar to chemical energy conversion efficiencies, microbial contamination control strategies, and improving algal strains to generate lipid superproducers that will facilitate extraction, followed by innovative purification and hydro-processing technology to create the fuels. Enhanced sustainability of the developed fuels is also based on a circular bioeconomy approach by using waste streams as resources, and about 80% of residual biomass generated in the ALGAESOL value chain will be re-circulated as input for the conversion process. Thus, through advanced systems, smart reactor designs, and a circular bio-economy approach, ALGAESOL will not only enhance fuel sustainability, cut production costs by a quarter and boost conversion efficiency, but also align with the European Green Deal by contributing to a European secure and competitive fuel supply chain. This initiative is expected to reduce environmental impact by 20% and strengthen Europe's leadership in green technology.

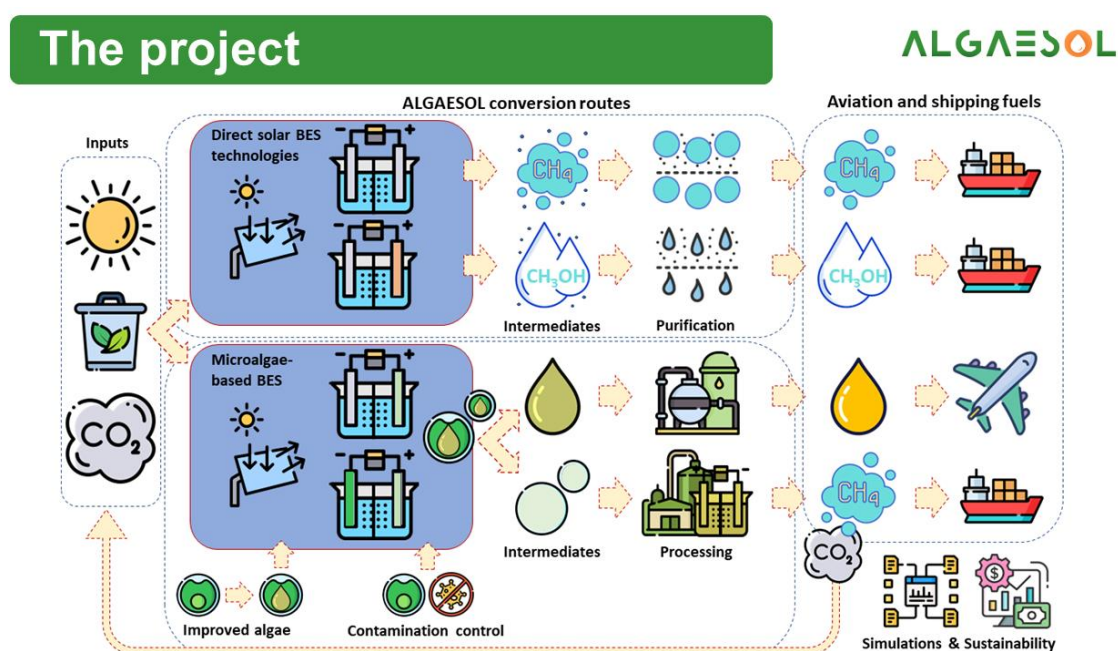


Figure 1. Schematic overview of the ALGAESOL project

Main outcomes and expected impact of the ALGAESOL project are:

- Contribute to a European secure and competitive fuel supply chain, by developing cost-effective, sustainable and renewable aviation and shipping fuels based on game-changing microalgae and direct solar fuel production and purification technologies.
- **Reduce aviation and shipping biofuel production costs up to 25%** and accelerate the replacement of fossil-based energy technologies.
- Enhanced sustainability of the developed fuels by using **waste streams**, as about 80% of residual biomass generated in the value chain will be reused as input in the conversion process.
- **Reduction of the environmental impact** of biofuel production **by up to 20%** compared to current state-of-the-art (SOTA) processes.

Stakeholder mapping

Key stakeholders for ALGAESOL come from a wide range of organizations, entities, groups and individuals from different sectors and backgrounds that work on sustainable fuel alternatives or in related fields and that have a vested interest in the outcomes and impacts of the ALGAESOL project as they are described in the paragraph above. This encompasses research institutions and universities, industry partners, end users and consumers, public and community groups, supply chain partners, media and communication platforms, environmental organisations, as well as local governments and municipalities and European Union Agency and bodies.

A description of each of these stakeholder groups is described below:

- **European Union Agencies and Bodies:** Especially CINEA, as the funding and managing body of the ALGAESOL project and related EU projects, but also other bodies responsible for environmental sustainability, research and innovation funding, and policy formation.
- **Research Institutions and Universities:** conduct essential research and provide scientific expertise and technological development relevant to the technological developments in the ALGAESOL projects, such as BES systems, microalgae-based processes, CCUS, general biotechnology/biochemistry/photovoltaics etc., but also value chain analysis and sustainability assessments.
- **Industry Partners:** companies in sectors such as renewable energy/fuels, renewable materials and chemicals production, CCUS, biotechnology, but also for example in agri-/aquaculture, and that can apply and commercialize the ALGAESOL technologies and products.
- **Environmental Organizations:** NGOs and other advocacy groups, including public and community groups, that are interested in the environmental impact and sustainability benefits of renewable energy/fuels production, renewable materials and chemicals production, or more specifically microalgae and BES technologies. This can help ensuring community engagement and public acceptance.
- **Investors and Funding Bodies:** organizations and individuals providing the financial backing to support the research, development, and commercialization of the project's outcomes and impact after the project is finished.
- **Local Governments and Municipalities:** collaborating on the implementation of renewable energy/fuels production, BES technology and/or algae-based solutions at regional and local levels, ensuring compliance with regulations, and addressing community needs.
- **Policy Makers and Regulators:** officials and bodies responsible for creating the regulatory frameworks that support or impact renewable energy initiatives, renewable materials and chemicals initiatives, biotechnology, etc.
- **End Users and Consumers:** industries and individuals who might use or benefit from renewable energy/fuels, or other products that could be made from ALGAESOL technologies, such as algae-based products in food supplements, food, feed, or materials.
- **Supply Chain Partners:** organizations involved in the sourcing, production, and distribution of materials and products related to the ALGAESOL developed technologies. For example, ALGAESOL does not develop photobioreactors for microalgae production, sensors, analytical instruments, etc., but these will be needed during and after the the project's lifespan.
- **Media and Communication Platforms:** apart from our own communication and dissemination partner, ALGAESOL project website and social media accounts, these external stakeholders can help with disseminating information about the project, raising awareness, and ensuring transparent communication with the public and stakeholders.

Each of these stakeholders plays a critical role in the successful development, implementation, and scaling of the ALGAESOL project.

European projects and platforms

Many of these stakeholders can be found in other project consortia that work on similar topics as addressed in the ALGAESOL project. To maximize the impact and efficiency of the ALGAESOL project, collaboration with other EU projects and engagement with other relevant external stakeholders should focus on strategic synergies and shared objectives. Here we will focus mainly on those that address similar main goals, but we do not exclude those that only show synergies on specific aspects of the suggested value chains in the ALGAESOL project. This could for example be those that work on the development of similar technologies, but for other goals than sustainable fuel alternatives.

In Table 1, a list is given that describes most of the European projects that are currently ongoing and that also work on the development of sustainable alternatives fuels. This list was drafted by the European Climate, Infrastructure and Environment Executive Agency (CINEA) as part of the Horizon Europe cluster meeting for aviation/maritime fuels and biomethane projects, organized by CINEA on the 15th of October 2024. Identifying synergies and fostering collaboration and information exchange between projects was one of the main objectives of this meeting, which is described in more detail in the paragraph on planned and ongoing activities.

Table 1. European projects that share similar goals, work on similar technologies, feedstocks or end-products. Based on the table made by CINEA for the HE Cluster Meeting for Aviation Maritime Fuels and Biomethane Projects.

Project	Project long name Website	Project period	Brief abstract	End product	Technology used	Feedstock	Coordinator (partner overlap)
SUNERGY SUNER-C	SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals sunergy-initiative.eu/suner-c/	01.06.2022 – 31.05.2025	SUNER-C is an EU-funded CSA (Coordination and Support Action) under the umbrella of SUNERGY community. This CSA, with 4M € funding for 3 years will enable the creation of an innovation ecosystem, develop a technological roadmap and prepare for a large-scale research and innovation (R&I) initiative on solar fuels and chemicals.	The overarching objective of the SUNER-C CSA is to aggregate fragmented knowledge and develop the framework conditions to overcome scientific, technological, organizational and socioeconomic challenges to accelerate innovation and enable the required transition of technologies for solar fuels and chemicals from laboratory or demonstrator level to large-scale industrial and broad societal applications.			CEA
SusAlgaeFuel	Exploring the synergies between direct carbon-capture, nutrient recovery and next-generation purification technologies for cost-competitive and sustainable microalgal aviation fuel susalgaefuel.eu/	01.05.2024 – 30.04.2028	SusAlgaeFuel develops integrated approaches in a circular production model towards the first cost-competitive and efficient microalgal SAF.	Aviation fuel + protein serum + cellulose-rich biomass	a) Direct capture of CO ₂ from biogas upgrading from Anaerobic Digestion; b) bacterial contamination monitoring; c) cascading biorefinery; d) algae-specific thermocatalysis,	Microalgae	University College Dublin
Fuels-C	An integrated platform of novel cost and energy-efficient conversion technologies producing liquid and gaseous bioFUELS from sustainable biogenic residues validated for direct use in fuel Cells fuels-c.com/	01.06.2024 – 30.11.2027	Fuels-C aims to increase the availability of two liquid and two gaseous advanced biofuels for maritime and road transports, produced from biogenic organic wastes and CO ₂ .	CH ₄ , NH ₃ , formic acid and ethanol	Bioelectrochemically assisted CH ₄ and NH ₃ production, gasification, microbial electrosynthesis, and electroreduction.	Various biogenic residues (biodegradable and non-biodegradable)	LEITAT (LEITAT, UdG)

COCPIT	sScalable solutions Optimisation and decision tool Creation for low impact SAF Production chain from a lipid-rich microalgae sTrain cocpit-horizon.eu	01.10.2023 – 30.09.2027	COCPIT plans to deliver a decision-making tool for investors to evaluate the transformation of algal biomass into SAF using two alternative pathways.	Aviation fuel	Hydrotreated Esters and Fatty Acids + Hydro-Thermal Liquefaction.	Microalgae	Institut MINES-TELECOM (LEITAT)
FuelGae	Sustainable On-site and Innovative Technologies for Advanced Transport BioFuels from MicroalGae fuelgae.eu	01.10.2023 – 30.09.2027	FuelGae aims to develop a novel model of advanced liquid fuels (ALF) production from different CO ₂ emissions streams of two industrial sectors (biorefinery and energy intensive industries) through a microalgae pilot plant integrated into their infrastructure.	Aviation fuel + biochar	i) Selective production of microalgae to obtain polysaccharides or lipids, ii) alternative microalgal biomass treatments, iii) innovative catalytic upgrading systems from biocrude., iv) online microalgae sensor.	Microalgae + CO ₂	CSIC
BIOETHEROS	Collaborative Actions to Bring Novel Biofuels Thermochemical Routes into Industrial Scale biotheros.eu	01.10.2023 – 30.09.2026	BioTheRoS aims to promote sustainable biofuel production through two innovative thermochemical conversion processes, i.e. pyrolysis upgrading via hydrodeoxygenation, and Fischer-Tropsch synthesis from biomass gasification.	Fast pyrolysis biooil and hydrotreated pyrolysis oil	Pyrolysis upgrading through hydrodeoxygenation and Fischer-Tropsch synthesis from biomass gasification.	Non-food biomass feedstock	CERTH
CAPTUS	Demonstrating energy intensive industry-integrated solutions to produce liquid renewable energy carriers from CAPTUREd carbon emissionS captusproject.eu/	01.06.2023 – 31.05.2027	CAPTUS aims to make EII-derived CO ₂ an exploitable resource through the industrial demonstration of three promising CCU technologies, where the CO ₂ captured from cement, steel, and chemical plants will be valorised into different RE carriers.	Triglycerides, Bio-oils & Formic Acid	i) Bioprocess based on a two-stage fermentation to produce triglycerides in a steel plant, (ii) Lipids-rich microalgae cultivation followed by hydrothermal liquefaction to produce bio-oils in a chemical plant, and (iii) Electrochemical reduction of CO ₂ to produce formic acid in a cement plant.	CO ₂	CIRCE

CIRCULAIR	Circular fuel supply for air transport via negative emission HTL conversion project-circulair.eu	01.01.2023 – 31.12.2026	CIRCULAIR designs an integrated pathway that produces cost-effective aviation biofuels based on hydrothermal liquefaction (HTL) of abundant agricultural residues (manure, straw) through thermal coupling of HTL conversion with exothermic wet oxidation of the HTL process water. The project will also develop innovative approaches to upgrading HTL biocrudes to jet fuel and accelerating the approval of HTL-derived fuels for use in civil aviation. Coupling with green hydrogen generation enables almost complete biomass utilisation and yields methanol as a main by-product.	Aviation fuel	Thermal coupling of hydrothermal liquefaction (HTL) conversion	Agricultural residues and lignocellulosic crops	Bauhaus Luftfahrt
Circular Fuels	Production of sustainable aviation fuels from waste biomass by coupling of fast pyrolysis with solar energy circularfuels.eu	01.07.2023 – 30.06.2027	Circular Fuels aims to demonstrate the first coupling of concentrated solar heat with fast pyrolysis of biobased waste materials to produce sustainable aviation fuels. This novel process will convert cheap and abundant waste wood and agricultural residues into renewable bio-oil using solar-assisted fast pyrolysis, eliminating combustion, and valorising by-products. Additionally, the project will utilise solar PV to produce the required processing hydrogen via water electrolysis. Furthermore, it will use green hydrogen to stabilise and upgrade the pyrolysis oil. Fractionation by distillation should yield high percentages of jet fuel and other valuable fractions.	Jet fuel (bio-oil)	Solar-assisted fast pyrolysis + solar PV-assisted water electrolysis + pyrolysis oil upgrade with green H ₂ .	Waste wood and agricultural residues	Aalto University
FUEL-UP	Production of advanced bioFUELS via pyrolysis and UPgrading of 100% biogenic residues for aviation and marine sector, including full valorisation of side streams fuelup-project.eu	01.01.2024- 31.12.2027	FUEL-UP aims to produce renewable SAF and marine fuels from forestry residues through pyrolysis.	Aviation fuels, marine diesel and marine fuel Naphtha/Bio-methanol	Stabilisation, deoxygenation, hydrodeoxygenation, hydrotreatment and hydro-isomerisation.	Forestry residues	SINTEF

ICARUS	International cooperation for sustainable aviation biofuels icarus-biojet.eu	01.10.2023 – 30.09.2026	Icarus aims to improve three Sustainable Aviation Fuel (SAF) production routes (biocrude from hydrothermal liquefaction to SAF, isobutanol from lignocellulosic biomass to SAF and synthetic Fischer-Tropsch from biomass gasification).	Aviation fuel	Hydrothermal liquefaction, synthetic Fischer-Tropsch.	Lignocellulosic biomass (sorghum mix cropped with legumes and cover crops)	LNEG
REFOLUTION	Refinery integration, scale-up and certification for aviation and marine biofuels production refolution.eu	01.01.2023 – 31.12.2026	REFOLUTION aims to develop cost-effective production of advanced biofuels for the aviation and marine sectors by transforming bio-oils produced from fast pyrolysis into advanced biofuels through intermediate process steps and downstream co-processing technologies.	Aviation and shipping fuels	Fractionation & stabilisation combined with downstream co-processing technologies.	bio-oils produced from fast pyrolysis	SINTEF
SUN-to-LIQUID II	SUNlight-to-LIQUID - Efficient solar thermochemical synthesis of liquid hydrocarbon fuels using tailored porous-structured materials and heat recuperation sun-to-liquid-2.eu/	01.11.2023 – 31.10.2027	SUN-to-LIQUID II aims at the optimization of a high-flux solar concentrating heliostat & tower system, the development and integration of novel 3D structured reactants and implementation of high-temperature heat recovery within the solar-thermochemical system.	Aviation fuel	Solar-thermochemical fuel technology.	Sunlight, water and CO ₂ .	Bauhaus Luftfahrt
SUSTEPS	Sustainable secure and competitive energy through scaling up advanced biofuel generation susteps.eu/	01.09.2023 – 31.08.2027	SUSTEPS aims to contribute to cost-effective and more sustainable large-scale production of sustainable algae-based biofuels by developing and validating a bio-refinery concept that efficiently produces sustainable biofuel from non-food/feed microalgae via CO ₂ fixation from high-emission facilities and through feeding on nutrient-rich wastewater, thereby minimising biomass production costs and utilising harmful CO ₂ emitted from energy-intensive activities	Biogasoline, biojet fuel + biodiesel, biochar	hydrothermal liquefaction + biocrude upgrading (Hydrodemetallization, hydroprocessing, fractionation, hydrocracking).	Microalgae, wastewater, CO ₂ , H ₂	Tubitak

BIOCTANE	Synergetic integration of biotechnology and thermochemical catalysis for the cascade conversion of organic waste to jet-fuel bioctane.eu	01.11.2022 – 31.10.2026	BIOCTANE aims to develop and optimise an innovative process for converting organic waste materials containing high amounts of water (e.g. food waste and organic material waste from the food processing industry) into carbon-neutral, market-ready drop-in jet-fuels. Combining biotechnology and hydrothermal gasification, researchers will convert complex organic waste into platform molecules. A novel one-pot synthesis process will be developed to convert these molecules to hydrocarbon molecules (jet fuel).	Aviation fuel	Biotechnological processing of biowaste and hydrothermal gasification technology + multifunctional catalytic synthesis.	Organic wastes (e.g. food-waste, organic material from the food processing industry)	IMDEA
CARBIOW	Carbon negative biofuels from organic waste carbiow.eu/	01.10.2022 – 31.03.2026	CARBIOW develops novel technologies to exploit new hard-to-utilise bioenergy sources for the production of biofuels (aviation (kerosene) and marine (light alcohol blend)).	Aviation (kerosene) and marine (alcohols) biofuels	Torrefaction + oxygen-blown gasification in oxygen carrier aided systems + Fischer-Tropsch.	Organic fraction of municipal solid waste and residues from biorefinery and biological processes	TECNALIA
BUTTERFLY	Biomass utilized to the extended portfolio of renewable fuels with large yields butterfly-horizon.eu	01.07.2023 – 31.10.2026	BUTTERFLY plans to enable the flexible and sustainable production of renewable DME (rDME) and synthetic natural gas (SNG) from feedstocks of biological and non-biological origin, targeting sectors like shipping and steel	Dimethyl ether (DME) and synthetic natural gas (SNG)	Integration of indirect gasification with sorption-enhanced DME synthesis followed by methanation.	residual/waste biomass (e.g. forest and agriculture residues, recovered or post-use wood, wastes/residues of non-biological origin such as ASR & SRF)	TNO
E-TANDEM	Hybrid tandem catalytic conversion process towards higher oxygenate e-fuels e-tandem.eu/	01.11.2022 – 30.04.2026	E-TANDEM develops a hybrid process to convert CO ₂ , water and renewable energy to higher oxygenate e-fuels that integrates three types of catalysis.	Higher oxygenate e-fuels	Electrocatalysis, co-electrolysis + solid thermocatalysis + molecular chemocatalysis.	CO ₂ , water and renewable power	CSIC

FLEXBY	Flexible and advanced Biofuel technology through an innovative microwave pYrolysis & hydrogen-free hydrodeoxygenation process Flexby.eu	01.05.2024 – 30.04.2028	FLEXBY intends to produce biofuel using biogenic waste from microalgae cultivated in domestic wastewater as well as the oily sludge from refineries.	Bio-liquid, pyro-gas, and bio-char	Microwave pyrolysis treatment, Hydrogen-free Hydrodeoxygenation, steam-reforming water gas-shift process + preferential CO oxidation.	Microalgae, sewage sludge and industrial oily sludge	IDENER
FUELPHORIA	Accelerating the sustainable production of advanced biofuels and RFNBOs - from feedstock to end-use fuelphoria.eu	01.10.2023 – 30.09.2027	FUELPHORIA demonstrates the establishment of sustainable complete value chains for advanced biofuels and RFNBOs for providing Europe with sustainable, secure and competitive energy supply schemes.	CH ₄ , medium / long chain hydrocarbons, esters, and light alcohols	Chemical, electrochemical, biological, thermochemical, and photobiological processes.	CO ₂ , digestate, urban/ municipal biowaste	CERTH
FuelSOME	Multifuel SOFC system with Maritime Energy vectors Fuelsome.eu	01.09.2022 – 31.08.2026	The FuelSOME aims to design and develop a multi-fuel Solid Oxide Fuel Cell (SOFC) system optimized for maritime applications, particularly for deep-sea shipping, and to assess the viability of utilizing hydrogen, ammonia, and methanol, sourced from renewable energies or waste streams, as fuels.	Electricity and heat	Solid Oxide Fuel Cell (SOFC).	Ammonia, methanol, hydrogen	AVL List
M2ARE	Maritime Methanol: Adaptable, Renewable and Environmentally-friendly m2are.eu	01.12.2023 – 31.05.2027	M ² ARE develops and demonstrates a novel process for “Maritime Methanol”, a new grade of low-cost green methanol based on biogenic CO ₂ and renewable H ₂ , to support the needs of the global shipping sector to reduce their CO ₂ emission.	Maritime Methanol	Pillow plate heat-exchanger reactor.	CO ₂ + H ₂	AIR Liquide
NextFuel	Industrialising eSMR to Supply the Next Shipping Fuels nextfuel-project.eu	01.12.2023 – 31.11.2028	NextFuel aims to introduce a new approach to methanol production by piloting the use of an electrically heated steam methane reformer (eSMR) instead of the conventional method, which involves firing natural gas in a fired reformer.	Synthesis gas	Electrically heated stream methane reformer.	Biogas	GASNOR

POSEIDON	Propulsion Of Ships with E-Methanol In favour of the Decarbonisation Of Naval transport www.eifer.kit.edu/european-project-poseidon-paving-the-way-for-the-decarbonization-of-european-shipping-sector-with-synthetic-methanol/	01.09.2023 – 31.08.2027	POSEIDON aims to facilitate the use of e-methanol as e-fuel in shipping by demonstrating two complementary CO ₂ valorisation routes and demonstrating the implementation of e-methanol value chains in the port areas of Valencia and Thessaloniki.	Synthetic methanol	Power-to-e-methanol	CO ₂ (biogenic from a biogas plant and industrial plant) and H ₂	EIFER
SOMMER	Solar-Based Membrane Reactor For Syngas Production sommer-project.eu	01.11.2023 – 31.10. 2027	SOMMER seeks to develop a carbon-neutral pathway for syngas production by integrating solar energy into a catalytic membrane reactor to split water and CO ₂ .	Syngas	Single-step CO ₂ and H ₂ O thermochemical conversion process, a dual-phase composite membrane and a concentrated solar thermal plant.	CO ₂ + H ₂ O	DLR
UP-TO-ME	Unmanned-Power-to-Methanol-production up-to-me.com	01.11.2022 – 31.10. 2025	UP-TO-ME targets a ground-breaking change in decentralized fully autonomous Power-to-Methanol production for hard to electrify applications, like marine vessels.	e-methanol + biomethane	CO ₂ capture, synthesis to methanol with 3D-printed reactors and column packings designed using highly advanced Computational Fluid Dynamics.	Biogas	VTT
VERGE	Versatile and direct e-fuel and fertiliser generation from renewable electricity cordis.europa.eu/project/id/101084253	01.11.2022 – 31.10. 2025	VERGE develops a distributed renewable energy technology based on directly utilised intermittent renewable energy that produces liquid ammonia from air and water.	Liquid ammonia	Electrocatalysis, Polymer Electrolyte Membrane.	REN, H ₂ O, N ₂	VITO

ALFA	Scaling up the market uptake of renewable energy systems by unlocking the biogas potential of agriculture and livestock farming alfa-res.eu	01.11.2022 – 31.10. 2025	ALFA supports 50 livestock farmers in six EU countries in installing biogas systems by analysing local livestock value chains and providing them with a series of demand-driven financial, business and technical support services.	Biogas	Anaerobic digestion.	Residues from agricultural and feedstock farming	QPlan international
BIOMETHAVERSE	Demonstrating and Connecting Production Innovations in the BIOMETHAnE uniVERSE biomethaverse.eu	01.10.2022 – 31.03. 2027	In the BIOMETHAVERSE demonstrators, CO ₂ effluents from anaerobic digestion or gasification and other intermediate products will be combined with renewable hydrogen or renewable electricity to increase the overall biomethane yield. All demonstrated production routes consider a circular approach for energy and material use.	Biomethane	5 pathways investigated: 1. In-situ and Ex-Situ ElectroMethanoGenesis 2. Ex-situ Thermochemical/catalytic Methanation 3. Ex-Situ Biological Methanation 4. Ex-Situ Syngas Biological methanation 5. In-situ Biological Methanation.	All types of feedstocks	ISINNOVA
BIOSTAR2C	Removing Technical Barriers to Biomethane STAndardisation Phase 2C gerg.eu/biostar2c/	01.01.2023 – 31.12.2025	BIOSTAR2C aims to remove the barriers that impede biomethane introduction into gas networks and vehicles. Project work will help ensure that biomethane injection costs are optimised and will increase confidence in investing in biomethane production and injection.	Biomethane	Technical barriers identified by CEN/TC 408.	Biogas & biomethane	GERG
CarbonNeutralLNG	Truly carbon neutral electricity enhanced synthesis of liquefied natural gas (LNG) from biomass carbonneutrallng.eu	01.11.2022 – 31.10.2025	CarbonNeutralLNG delivers truly carbon-neutral bioLNG by harnessing low-cost renewable electricity in a proposed hybrid process that combines chemical catalytic with biological methanation and electromethanogenesis to directly convert the electrical current to methane via anaerobic respiration in microbes.	Liquefied Natural Gas (LNG) from biomass	Sorption enhanced e-gasification, additively manufactured “Chemical Catalytic Raw Methanation” and a “Biological Methane conditioning” by means of biological methanation and electro-methanogenesis.	Biomass residues (not further specified)	Friedrich-Alexander University Erlangen-Nürnberg

GreenMeUp	Green biomethane market uptake greenmeup-project.eu	01.08.2022 – 31.07.2025	GreenMeUp facilitates the wider market uptake of biomethane in the European energy and transport sectors by strengthening the market in countries with slow development rates.	Biomethane	Anaerobic digestion + upgrading & thermal and hydrothermal gasification.	All types of feedstocks (depending on the target country)	CRES
HYFUELUP	Hybrid biomethane production from integrated biomass conversion hyfuelup.eu	01.11.2022 – 31.10.2026	HYFUELUP demonstrates a flexible pathway for efficient and cost-effective biomethane production through thermochemical technologies combined with renewable hydrogen.	Biomethane	Innovative thermochemical processes to be demonstrated: 1. sorption-enhanced gasification coupled with syngas or flue gas clean-up 2. fluidised-bed methanation of either syngas or flue gas with the dynamic addition of hydrogen.	Dried digestate sludge with lignocellulosic materials (woody biomass, namely wood and forestry waste)	BIOREF
Metharen	Innovative biomethane system integration boosting production while managing renewable energies intermittency metharen.eu	01.11.2022 – 31.10.2027	METHAREN aims to demonstrate a cost-effective, innovative, more sustainable and circular biomethane production system enabling renewable energy sources intermittency management by improving: i) the biogas plant efficiency; ii) flexibility and energy management for RES integration; iii) the circularity approach for sustainable production and iv) innovative business models and adapted policies.	Biomethane	Combination of gasification, methanation and a reversible combination of gasification, methanation and a reversible SOEC system (SOEC) system.	Biowaste	Technip energies
SEMPRE-BIO	Securing domestic production of cost-effective biomethane sempre-bio.com	01.11.2022 – 30.04.2026	SEMPRE-BIO project develops novel and cost-effective biomethane production solutions and pathways, setting up three European biomethane innovation ecosystems (Belgium, Spain and France).	Biomethane	Different technologies are addressed: pyro-biomethanation (syngas biomethanisation), proton exchange membrane electrolysis (PEMEL), biomethane upgrading by solid cryogenic, etc.	Novel feedstock for biomethane (non-digestible biomass, e.g. woody biomass)	CET-AQUA

VALUE4FARM	Sustainable renewable energy VALUE chains for answering FARMers' needs value4farm.eu	01.09.2023 – 28.02.2027	VALUE4FARM aims to revolutionise farming practices and drive the defossilisation of agriculture by matching the energy needs of local farmers with three renewable-based local value chains centered around biogas.	Biomethane, REN	Intercooled regenerative reheat gas turbine cycle, flameless combustion, oil-free Organic Rankin Cycle loop with a microturbine expander.	Residual streams	INAGRO
S2B Solar to Butanol	Solar to Butanol – Solar Butanol Production by Solid-state Photosynthetic Cell Factories s2b-project.eu/	01.10.2024 – 30.09.2028	S2B represents a significant breakthrough by developing the next generation photosynthetic microbes that efficiently produce butanol, shifting conventional microbial suspensions to an artificial leaf architecture. This innovative approach enhances the efficiency and longevity of solar-driven biocatalysis, making the process far more effective. The project aims to drastically improve the production of n-butanol, a versatile fuel and chemical feedstock, using engineered cyanobacteria and sunlight.	Butanol	Photosynthetic microbes, integrated with waste effluent use and direct air capture.	Solar energy, waste effluent, CO ₂	Turku University
SUNPERFORM	Synthetic biology United with Nanotechnology – A Biohybrid Approach to Improve Light-harvesting and CO ₂ Fixation for High Performance Sustainable Solar Fuel Production doi.org/10.3030/101172946	01.11.2024 – 31.10.2028	SUN-PERFORM will address low solar-to-fuel conversion efficiency, low production rates and prohibitively high costs through an innovative biohybrid approach based on innovations in nanotechnology and synthetic biology. SUN-PERFORM aims to: 1) to develop artificial nanocrystal light-harvesting systems, to efficiently harvest a larger part of the solar light spectrum, 2) to generate advanced microalgal solar cell factories, by introducing synthetic pathways for a more efficient, rapid conversion of light energy and CO ₂ into lipid fuel precursors.	Sustainable Aviation Fuel	Artificial nanocrystal light-harvesting systems and microalgal solar cell factories.	Solar energy, CO ₂	Wageningen University

Other stakeholders

ALGAESOL Advisory Board

The support of the External Advisory Board (EAB) will ensure market valid decisions during the technical specification phase of the project, confirm the continuity of high-quality objectives at mid-term and support for flawless result exploitation and shift towards potentially new innovative products at the end of the project. The EAB (under Non-Disclosure Agreement) modus operandi is: i) strategic advice in technology processes, IPR environment and dissemination activities; and ii) periodic meetings with all consortium partners. The EAB further acts as ambassador for ALGAESOL solutions to external stakeholder groups and industry and will have a significant role in fostering the international cooperation aspect of the project, which is to be reflected in its composition.

Potential candidates have been contacted, representing relevant research institutes and universities worldwide, European industry and associations. After the NDAs are officially signed, the list of all members will be updated.

Other international stakeholders and initiatives

Other relevant initiatives that have been identified as possible interesting stakeholders are

- WAITRO
 - ALGAESOL partner LEITAT is a regional focus point of the WAITRO association, gathering international partners active in the areas of renewable energies, climate change, alternative fuels, among others.
- IEA Advanced motor fuels
 - ALGAESOL partner DTI is a partner in IEA AMF and Strategy & Technology subcommittee chair. AMF is one of the actors putting transport on track to sustainability and reducing the environmental impacts from transport. Established in 1984, AMF has a strong international network that serves to foster collaborative research, development, and deployment (RD&D) and to provide unbiased information on clean, energy-efficient, and sustainable fuels and related engine and vehicle technology.
- IEA Bioenergy
 - IEA Bioenergy is a Technology Collaboration Programme (TCP) set up in 1978 by the International Energy Agency (IEA) with the aim of improving cooperation and information exchange between countries that have national programmes in bioenergy research, development and deployment.
- SESA
 - LEITAT is involved in this H2020 project on Smart Energy Solutions for Africa, focused on AD-BES development with low-cost materials and capacity building in Africa.
- The jointly funded AU-EU Research & Innovation Partnership on Climate Change and Sustainable Energy (CCSE)
 - Under this initiative NORCE is a partner in the LEAP-RE project focused on energy systems for rural areas and coordinates the CONFER project which aims to co-develop dedicated climate services for the water, energy and food security.

Cooperation and other stakeholder engagement strategies

By ensuring collaboration among EU project consortia, as well as with other external project stakeholders, we amplify the strengths of our individual projects, foster innovation and enhance efficiency, while achieving broader strategic goals for the development of sustainable aviation and shipping fuels.

Most of this will be discussed in the following update of this deliverable, but here and in the below paragraphs we would like to give already a short overview of the cooperation and stakeholder engagement strategies and actions that we have performed in the project thus far and are planning to use in the future.

In the Dissemination and communication plan, the strategy for disseminating the results of the ALGAESOL project to the European research community and for effectively communicating about the project, its achievements, and partners, is described ensuring maximization of the visibility and impact of ALGAESOL. Part of the described strategies in that deliverable are relevant also in this deliverable, where here we focus specifically on the collaboration with international stakeholders and the communication about the project and dissemination of its results in that light.

Planned and ongoing activities

- Introduction presentations of relevant EU projects during ALGAESOL consortium meetings and vice versa.
 - During the 2nd bi-annual consortium meeting, the coordinators of the EU projects SUNER-C, S2B Solar to butanol, COCPIT and FUELS-C presented their projects and a panel round table was organized to discuss synergies and possible collaboration strategies.
- Organizing workshops, seminars and/or other activities together with relevant EU projects and other international stakeholders, providing a platform for stakeholders to exchange ideas, collaborate and generate solutions.
 - During the first consortium meeting in Bergen, we organized a site visit to Technology Centre Mongstad (TCM), the world's most advanced and flexible test arena for CO₂ capture technologies.
 - During the HE cluster meeting for aviation/maritime fuels and biomethane projects, organized by CINEA, ALGAESOL was presented by the coordinator. During this workshop, key European Commission R&I relevant policy developments were presented, synergies and collaborations and information exchange between projects was fostered, and joint communication and/or dissemination activities were discussed.
 - At the Pathways to Energy Transition Workshop in Prague, Czech Republic, organised by AMIRES, ALGAESOL was represented by our partners from Universitat de Girona, SimTech and AMIRES. Together, they engaged in meaningful discussions with other participants, fostering connections and spreading the vision of ALGAESOL and sustainable fuels even further.
 - At the second Stakeholder Workshop organized by the EU project NET-Fuels to discuss technologies for renewable fuels and energy, LEITAT represented the ALGAESOL project and contributed by giving a presentation on the bioelectrochemical methanation technology.
 - ALGAESOL was represented at the Sustainability meets Scalability: Joint EIC – SUNERGY Roadmapping Event on Renewable Hydrogen, Fuels and Chemicals, where representatives from NORCE and LEITAT contributed to lively discussions and presented the ALGAESOL project.
 - During the upcoming 3rd bi-annual consortium meeting, a workshop will be organized together with other EU projects and local and regional stakeholders.
- External Advisory Board meetings

- Project website (<https://algaesol.eu/>) and social media posts (<https://www.linkedin.com/company/algaesol-eu/>), offering regular updates on project progress, activities, sharing successes and inviting for stakeholders input and feedback.
- ALGAESOL newsletter (<https://algaesol.eu/newsletter-signup/>), established to gather stakeholder contacts throughout the project. Here we can also share relevant information from other relevant EU projects, to make our newsletter a richer, more dynamic resource for our stakeholders, adding value beyond the scope of the ALGAESOL project. If other projects do the same, we also expand our audience.
- Policy and regulatory roundtables
- Training and capacity building together with other EU projects

Communication tools and channels

Regarding communication methods and channels, we also refer to the Deliverables 6.1 “Initial communication kit” and 6.2 “Dissemination and communication plan”. The first describes the communication kit that was developed for the ALGAESOL project and shows the initial communication materials that have been developed – the project fact sheet, project flyer/leaflet, and project website –, which can also be used within the collaboration strategies as described in this deliverable for communication with international stakeholders. The Dissemination and communication plan has described the various tools and channels that the project will use for the dissemination and communication strategies with all stakeholders, not only the ones described in this document. Here we highlight those channels and tools that are mostly relevant for the international cooperation strategies in Table 2.

Table 2. ALGAESOL Dissemination Targets, tools and channels, specifically targeting the stakeholders relevant for international cooperation strategies

Targets	Tools and channels		KPIs
European projects	Clustering	with relevant European projects and initiatives (selected from those shown in Table 1) will be pursued to support mutual learning from the results and implementation of best practices.	2 clustering meetings attended per year, links set up with 3 projects
International stakeholders	Joint networking events	with identified international initiatives and networks that could support early adoption of project results in prioritized locations worldwide	At least 1 event per year co-organized, links set up with 4 initiatives

Timeline

In this first phase of the project, and as the project results are being generated, the cooperation and stakeholder engagement activities are focused on building awareness about the project and its goals among other EU projects, their consortia and other relevant stakeholders. We have started exchange of information with EC services and other projects, both EU and national, and begun discussion on coordination of methodologies, and joint technical efforts, e.g. on standardization.

In the next phase, the timeline will be more correlated to the key project results, and actions will be addressed to joint communication and dissemination activities to generate a multiplier effect. NORCE, with support of AMIRES, will lead this stage, while the different collaboration and stakeholder engagement activities will be executed by all project partners throughout the remainder of the project.

Expected impact and outcomes

Expected outcomes from the collaborations and stakeholder engagement are:

- Informing consortium partners from both projects about possible collaboration and ensure that all partners can follow the news updates, social media and newsletters.
- Share/re-post/link to news and other information from collaboration partners to ensure a wider audience is reached.
- Invite collaborating consortium partners to co-organise workshops and other events, to create a larger impact and prevent stakeholder burn-out.
- Increase project visibility to ensure the successful uptake and adoption of the developed technology by relevant stakeholders at the end of the project
- Strengthen collaboration among EU projects, institutions, and companies to drive greater adoption of biofuels and advance Europe's position in the sector.
- Facilitate knowledge exchange and strengthen research and innovation capacities in the field of sustainable biofuel production.
- Gather stakeholder needs to ensure the development of technologies that address societal demands and are suitable for market integration.

Conclusions

The international cooperation strategies outlined in this document have been designed to assist the ALGAESOL consortium partners in executing the different collaboration and stakeholder engagement activities throughout the project's lifetime. This report includes an overview of relevant stakeholders, a short overview of current activities regarding stakeholder engagement and a vision on possible future cooperation strategies.