

November 2024

2nd NEWSLETTER



SUSTEPS : SUSTAINABLE, SECURE, AND COMPETITIVE ENERGY THROUGH SCALING UP ADVANCED BIOFUEL GENERATION



48 Months



10 Countries



8 Work packages



11 Partners



**Estimated Project Cost
€3,000,000**

In this issue:

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2. SUSTEPS Technologies
3. Dissemination Highlights

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1. EXCITING PROGRESS UPDATE : ONE YEAR OF SUSTEPS!

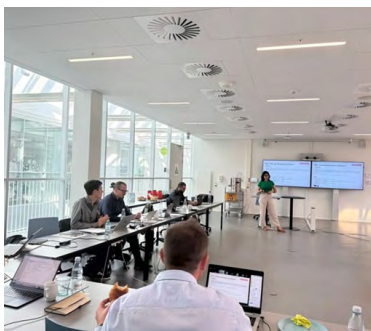
The first year of SUSTEPS is just over, and while the Project is still in its early stages, we are excited to present some initial research insights and milestones.

We just had our 12-month project meeting the last week of August! Hosted by SDU (University of Southern Denmark) in Odense, Denmark.

During the meeting, all partners showcased their major technical achievements and key results, providing insights into the project's progress in developing a new sustainable aviation fuel from microalgae.

Presentations were delivered both on site and virtually by Work Packages and Tasks leaders, followed by feedback from the coordinator and the consortium. We are excited to continue working together and achieve even greater results in the following period.

You can read insights about the project progress below:



- We are pleased to share that the first milestone of the SUSTEPS project has been successfully reached. Five interdisciplinary working group (IWG) meetings were held with the participation of over 20 global experts. Under the coordination of our partner ERINN, with support from the entire consortium, each IWG addressed key areas including microalgae cultivation, biomass conversion to crude biofuel, biocrude upgrading with Green Hydrogen Reinforcement, aqueous phase recycling/valorization and socio-economic/environmental aspects' investigation over the whole value chain.



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- TUBITAK has worked on the first draft of process modelling and currently is discussing with UNIFEI to complement the ASPEN process modeling at this stage. Both TUBITAK and ARDITEC have completed the initial literature review for life cycle assessment (LCA) studies aligned to susteps biorefinery. Collaborative sessions with our partners have allowed us to focus in particular on CO₂ capture and balance throughout the process, and define the functional unit, highlighting key required data for the setting of baseline data essential for developing a preliminary screening LCA.



- BOUN pre-screened several microalgae species for cultivation at small scale. Different samples have been shipped out to PSI for testing. Optimization strategies for CO₂ & wastewater-fed algae cultivation have been defined.
- TUBITAK collected 10 different wastewater samples from a municipal wastewater treatment plant in Istanbul. Physico-chemical analyses showed a high level of nutrient concentration. The samples were pre-treated with an UF membrane to remove turbidity and suspended solids, followed by UV to prevent bacterial growth. BOUN initiated studies on algae cultivation using pre-treated wastewater.

- Experimental set-up and design for algae growth, HTL and preliminary catalyst production.
- PSI conducted preliminary hydrothermal liquefaction tests to verify and validate the experimental and characterization methodology.
- For the valorization of gaseous streams, initial ASPEN simulations were carried out by FZJ. Catalytic upgrading was planned, first catalysts were Synthesized, and the tests will be carried out with a joint effort of KETJEN and TUBITAK.



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2. SUSTEPS LEVERAGING CUTTING-EDGE TECHNOLOGIES !

SUSTEPS is leveraging cutting-edge technologies to enhance project activities, our focus lies on improving both the environmental sustainability of biomass conversion and the quality of the sustainable aviation biofuel product.

ENHANCING MICROALGAE BIOFUEL PRODUCTION : INNOVATIVE REACTOR DESIGN AND GENETIC ENGINEERING FOR MAXIMIZED CO₂ CONVERSION AND LIPID-RICH BIOMASS

Downscale photobioreactors : Currently under construction, these reactors will be implemented to mimic the natural variations in illumination and temperature that affect outdoor large scale algal cultures. This setup will allow us to design more robust operating procedures and control strategies to maximize CO₂ conversion efficiency and biomass productivity.

Directed evolution : It is a powerful tool for enhancing microalgae's ability to capture CO₂ and convert it into lipids suitable for hydrothermal liquefaction (HTL) to produce biofuels.



- **Enhanced CO₂ Capture :** Directed evolution techniques can target specific genes and enzymes involved in a microalgae's carbon fixation process. By introducing mutations and selecting for desired traits, we can create strains with increased efficiency in capturing CO₂ from the environment.
- **Lipid Channeling :** Another focus of directed evolution is manipulating metabolic pathways within the microalgae. By targeting genes responsible for lipid production and storage, we can create strains that channel more captured carbon towards the formation of triacylglycerols (TAGs), the primary component of algal oil. This not only increases the overall lipid content but also optimizes the biomass for HTL conversion. HTL thrives on lipid-rich feedstock, and a higher TAG content translates to a more efficient biofuel production process.



- **Stress Tolerance :** Directed evolution is also used to improve a microalgae's tolerance to environmental stresses like high CO₂ concentrations or fluctuations in light and temperature. These stresses can sometimes hinder their growth and CO₂ capture efficiency. By engineering strains with improved stress tolerance, we can ensure optimal performance even in large-scale cultivation systems with high CO₂ input.



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OPTIMIZING THE CONVERSION OF MICROALGAE INTO DEMETALLIZED BIOCRUDE USING AN IMPROVED CATALYTIC HYDROTHERMAL LIQUEFACTION (CHTL) ROUTE

Key innovations measurable and verifiable, ensuring that our enhancements to the HTL system are both practical and impactful :

- **Optimized HTL system** : We are refining the HTL system to enhance biocrude yield, and to improve the extraction of brine and recovery of catalysts. This involves identifying the best HTL reaction parameters, such as temperature, residence time, and recycling of catalyst-containing brine.
- **Unique HTL and salt separation system** : This system, tested at a laboratory scale with a flow rate of 1.5 l/h, has demonstrated the capability to maximize biocrude yield. Additionally, at least three valuable compounds will be extracted from the effluents for further valorisation.



Fuel synthesis

In this research we recognized the importance of integration of reforming technology into the synthesis pathways to be able to enhance the yield of desired product fraction. In SUSTEPS process, a light fraction is separated and sent to the reforming unit that converts the undesired hydrocarbons into fresh synthesis gas which can optionally be adjusted with a water-gas shift reactor.

This reintegration enhances the overall yield of the higher valuable liquid products. Previous reforming reactors in the class of several kw thermal power were developed at FZJ. A reformer is a compact piece of device with high space velocities.

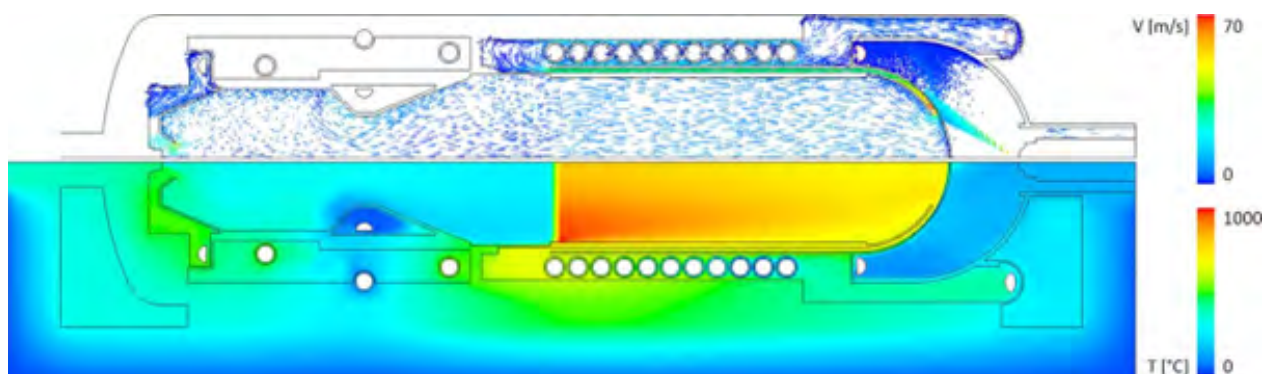
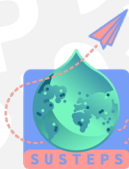


Figure 3. A cross-section of a reformer showing velocity and temperature profiles based on simulations modelled by JÜLICH team with Ansys Fluent.



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ADVANCING HYBRID SEPARATION TECHNOLOGIES FOR WATER PURIFICATION AND HIGH-VALUE COMPOUND RECOVERY

The water purification represents a fundamental step to bring the overall SUSTEPS process closer to industrial acceptance. SDU's expertise in process separation, synthesis and modelling will contribute to defining the boundaries in the convenience of applying different *membrane configurations combined with chromatography*. Detail design of experiments, material testing, and data collection will allow the definition of predictive models for a possible future implementation of this technology. This is crucial as water conservation and optimization combined with optimal usage of bioresources have economic and societal implications that cannot be overlooked if the overall process is to be viable.

DEVELOPING ADVANCED CATALYSTS FOR EFFICIENT UPGRADING OF ALGAE-DERIVED BIO-OILS



Catalyst Test Sytem

- A comprehensive upgrading process containing hydrodemetallization.
- Two-staged catalytic hydrotreatment, fractional distillation and hydrocracking.

With this novel technology, biofuel quality will be enhanced and the desired products having similar qualities to those of standard fuels will be maximized. One of the main challenges is to attain a significant level of denitrogenating, which will be overcome with a comprehensive multi-step catalytic process. Biofuel distillation and heavy fraction hydrocracking processes will be optimized to maximize the desired biofuel fractions especially SAF.



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3. COMMUNICATION AND DISSEMINATION HIGHLIGHTS

SUSTEPS VIDEO HAS BEEN LAUNCHED. WATCH IT NOW !

This October, SUSTEPS released an introductory video to clearly present the challenges it addresses and how the consortium will work on it. The video serves as a key element of the marketing strategy. Its purpose is to raise awareness and emphasize the project's impact through a conceptual design. The video is aimed at a broad audience, encompassing not only scientists and researchers but also the general public and other stakeholders worldwide.



This video can be found on [YouTube](#) and [SUSTEPS website](#).

JOINING FORCES FOR SUSTAINABLE ALGAE-BASED FUELS : COLLABORATIVE SYNERGIES WITH EU-FUNDED PROJECTS

- In October the 15th, our SUSTEPS coordinator participated in the **Aviation and Maritime fuels cluster meeting** organized by CINEA – European Climate, Infrastructure and Environment Executive Agency. SUSTEPS presented the project and ambitious goals for building a Sustainable & Innovative SAF Biorefinery. The poster showcased how our consortium is advancing toward key milestones, pushing the boundaries of renewable aviation, focus on CO₂-fed algae cultivation, green hydrogen-coupled upgrading of the high-oil-yield biocrude, aqueous stream valorisation, for a sustainable, scalable, and safe biofuel production.

As part of our recent engagements, SUSTEPS will join several EU-funded projects focused on advancing algae value chains for sustainable fuel production. This collaborative effort will include FUELGAE, ICARUS, SUSTALGAEFUEL, COCPIT, SUSTEPS, and CAPTUS, aiming to maximize synergies and accelerate impact. This initiative represents a strategic step towards driving impactful outcomes in sustainable fuel research and development.

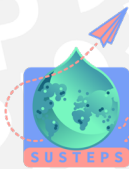


You can find already the related initiatives in our webpage: <https://susteps.eu/related-initiatives/>



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3. COMMUNICATION AND DISSEMINATION HIGHLIGHTS

- SUSTEPS is participating in **AlgaEurope 2024**, a major event dedicated to the algae industry, taking place from **December 10th to 13th, 2024** in **Athens, Greece**.

For years AlgaEurope has been one of the most global comprehensive conferences about science, technology and business in the Algae Biomass sector organized by industry professionals. Our partner [BOUN University](https://www.boun.edu.tr/) EABA member is co-organising the event and will join the event presenting a poster about progress on microalgae cultivation. Stay tuned and find the takeaways from this event here: <https://algaeurope.org>.

- We are thrilled to announce our involvement in a series of regular meetings and workshops with our sister project - CAPTUS, aimed at advancing innovative technologies in algae Hydrothermal Liquefaction (HTL). This collaboration will focus on enhancing the algae HTL processes, with a particular emphasis on the essential steps involved in upgrading HTL-oil. The first meeting will take place on December 3rd which will lead to more cooperation.

CREATING A PORTFOLIO OF R&I PROJECT RESULTS TO ENHANCE IMPACT

In September, SUSTEPS and ALFAFUELS (Horizon Europe European project which seeks to develop innovative Sustainable Aviation Fuels (SAF)) held a virtual meeting to explore potential collaboration opportunities. Both teams agreed to apply for the [Horizon Results Booster \(HRB\)](#). The Horizon Results Booster addresses projects eager to go beyond their Dissemination and Exploitation (D&E) obligations under Horizon 2020 and Horizon Europe - steering research towards strong societal impact and concretising the value of R&I activity for societal challenges. The HRB accepted the application on October 18th, and soon both projects will benefit from assistance and guidance in creating a results portfolio, developing and executing a common dissemination strategy, and improving the existing exploitation plan.



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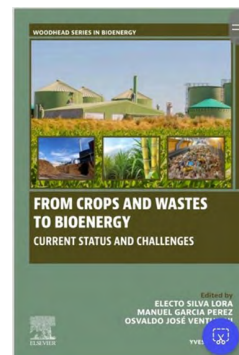
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3. COMMUNICATION AND DISSEMINATION HIGHLIGHTS

SUSTEPS FEATURED IN RECENTLY SUBMITTED ELSEVIER BOOK ON BIOENERGY

The book entitled *From Crops and Wastes to Bioenergy*, is a dedicated collaboration between our partners at UNIFEI (Federal University of Itajubá) and co-authors from Washington State University (WSU) in the United States, which delves into innovative approaches for converting agricultural resources, biomass and waste into sustainable bioenergy solutions. Among the significant contributions in this book, the chapter 20 highlights key initiatives and scaling up case studies including SUSTEPS Project, which are pivotal in advancing SAF biorefinery. The book is set to be released in January 2025, and its timely content is sure to inspire and inform readers around the world.



EXCITING UPCOMING EVENTS FOR SUSTEPS TO SHOWCASE PRELIMINARY RESULTS !

| | | |
|---|-----------------|--------------------------|
| BIOKET - The Global Bioeconomy's Key Enabling Technologies. Conference & Exhibition | March, 2025 | Brussels, Belgium |
| XI International Conference on Life Cycle Assessment in Latin America | April , 2025 | Ciudad de México, México |
| European Biomass Conference & Exhibition – EUBCE 2025 | June, 2025 | Valencia, Spain |
| Biofuels International Conference & Expo 2025 | June, 2025 | Brussels, Belgium |
| International Conference on Biofuels and Bioenergy | September, 2025 | Rome, Italy |

Thank you for reading ! We hope you enjoyed the second edition of our newsletter and will continue to follow us in the future !

We invite you to sign up for our upcoming newsletter and stay updated ([here](#)) :



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