ENLENS: Energy Transition Through the Lens of SDGs

1. **Title**: **SAF from waste: towards a sustainable business model of upgrading waste into energy**

2. Name main applicant and co-applicants

Main applicant: Shiju Raveendran (n.r.shiju@uva.nl, associate professor, FNWI)

Co-applicant: Vittoria G. Scalera (v.g.scalera@uva.nl, associate professor, EB)

External collaborator: Sara Solis, Circular Economy Lead, Schiphol Airport.

3. Societal case

More than 80% of global energy demand still comes from fossil resources. It is critical to find alternatives and a potential feedstock is carbon-containing waste. ~ 5 tonnes of waste, including agricultural, food, plastic and other organics, were generated per EU inhabitant in 2020 [1]. Most are currently landfilled/incinerated. Their impact on human and environmental health is enormous. Upgrading waste into energy is a potential solution to avoid both waste and energy problems. This project, in collaboration with Schiphol airport, will explore the implementation of an original circular business model for the energy transition and has two key components: technical and business. The first looks at the feasibility of producing sustainable aviation fuels (SAF) from mixed waste and the latter looks at the development of a circular business model involving external partners. Developing SAF from waste, instead of incineration, is a key task to achieve the Schiphol's target to be net-zero in 2050. Our project links with SDG 12.5 (substantially reduce waste generation through recycling and reuse), 7.2.1 (increase the share of renewable energy), 13 (combat climate change and its impacts), 11. 6 (reduce the adverse per capita environmental impact of cities, focusing on waste management) and 17.17 (encourage and promote effective public-private partnerships).

4. Scientific case

Shiju Raveendran (SNR)'s lab is developing Hydrothermal Liquefaction (HTL) as a new technology to chemically upconvert waste streams into valuable products [2,3]. We are now applying HTL for recycling plastics waste within an EU-funded project, 'Plastice' [4]. *This project will explore the feasibility of HTL of mixed waste from Schiphol airport to synthetic oil, precursor for fuels (aviation, shipping)* (Figure 1) *and the implementation of this unique technology-oriented circular economy model.* Schiphol will provide waste samples from different airport locations which will be tested at our HTL lab (output 0.1 to 0.5 L of oil/day). The oil obtained will be characterized for aviation fuel quality. Currently, Schiphol incinerate the waste. On the business side, we will study how the collaborations between the different stakeholders of the project (i.e., Schiphol Airport, It's customers and suppliers, UvA, Amsterdam Gemeente) are structured and managed (relationships and the collaboration protocols), and how they develop over time to optimize the potential technological outcome, business and technical implementation, and business impact (i.e., knowledge exchange, Key Performance Indicators, project's revenues, improvement of air quality) [5-7]. A longitudinal case study with in-depth interviews will be conducted leveraging both semi-structured interviews with stakeholders and measures of financial and technological performance associated with the project's implementation.

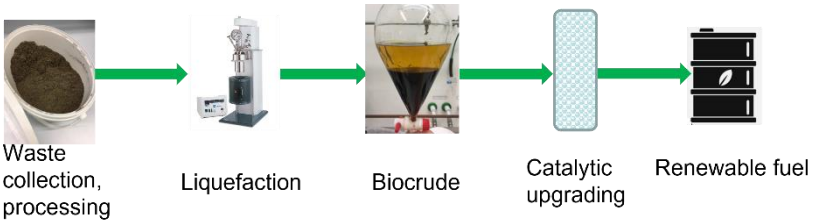

Figure 1. Liquefaction process to make renewable fuel

5. Contribution to the aims and success indicators of ENLENS.

A. How will your project evolve after the proposal research/activity. What is the long-term goal?

The feasibility study will offer new technical insights into the adoption of HTL, which represents the latest conversion technology, for a wider set of purposes. On the other hand, the collaboration between Schiphol and UvA will provide new theoretical and managerial insights on the management of university collaborations with public and private organizations for the energy transition aiming at designing technology-oriented circular economy models.

On the technical side, if the initial studies are successful, the collaboration with Schiphol is expected to continue in the form of a long-term project, which will study the optimization of the process on a lab-scale as well as on a

pilot scale. Schiphol airport has expressed its willingness to continue the collaboration, if the initial results are promising. The follow-up project has a high chance of sponsorship by Schiphol. We will also explore the possibilities to make a larger consortium by involving other key players in the energy sector, looking at technical, business, logistics and other aspects. The long-term perspective is of great interest to the management side of the project as it would allow us to steer and study longitudinally the evolution of the design and implementation phases of this original circular business model. This offers a unique opportunity as this allows us to look at the evolution of the circular business model, instead of focusing on a specific part of it (which is the typical approach adopted by the literature) [8,9].

The results of this project will have important implications outside the Schiphol-UvA collaboration, as the technological developments are of great importance for other national and international airports that are looking for a circular and more sustainable technical-business model. Further, the results can apply to other fuel/energy-intensive industries that are diversifying their energy sources, including synthetic crude.

In view of the recent developments about the collaboration with fossil fuel sector, we have already checked with the faculty about this project (email communication with Mr. Peter van der Donk). Our project is about replacing fossil fuels with renewable and sustainable fuels. Moreover, the moratorium of the UvA is limited to companies that EXTRACT fossil fuel from the earth, which is not applicable for Schiphol. Therefore, the advice is that the project can proceed.

B. Why and how does your project contribute to the UvA-community of interdisciplinary research and ENLENS more specifically?

The project proposes a collaboration between UvA FNWI and EB to study the technical and managerial aspects of a technology-driven collaboration with the aim of developing a technology-oriented circular economy model. The interdisciplinary approach is needed as the technological and managerial aspects of the collaboration are uniquely intertwined: on the one hand the technology is the core objective of the collaboration, but the implementation of such technology has major implications for one of the partner (Schiphol)'s business model. This context provides an ideal setting to study how the achievement of SDGs 7, 11, 12 and 13 are strongly dependent on a well-functioning and managed collaboration (SDG 17).

C. ENLENS aims at broadening the community beyond the group of project PI's. Describe how your project will contribute to this goal, with at least one of the following:

C1 Collaboration with and contributions by external stakeholders, e.g. agreed new collaboration with external stakeholders; inside-out or outside-in (preferred); in cash/in kind contribution of stakeholder

Schiphol airport has already committed their willingness to support this project, if initial results are promising. The usage of waste to produce fuel is of very interesting for them as they are currently paying a waste collecting company to take it away and incinerate. Besides samples and the knowledge on different aspects of waste and fuels, Schiphol might contribute also in cash; the discussions are in progress. Involvement by more partners such as Argent Energy, Port of Amsterdam, Gemeente Amsterdam and Provincie Noord-Holland are also anticipated. The preliminary exchange of interest has been done and this ENLENS grant will provide momentum to their involvement.

C2 Effective links with education, how will education take advantage of this project; e.g. how specific students will participate in interdisciplinary research or how results are disseminated through lectures in some course.

SNR is coordinating and teaching the Green and Industrial Chemistry course at HIMS. The course considers real-life examples of 'greening' the current chemical processes. This project is a perfect example to include in this course. The collaboration between UvA and Schiphol will be proposed to the EB students participating the MSc Business Administration program also. The students will also be made aware of the ENLENS programme.

C3 Outreach and dissemination (how will you contribute to the outreach of ENLENS and/or to UvA-Sustainability in general?)

We will aim for at least a joint open access publication involving both technical and business aspects, as well as one or more presentations at interdisciplinary conferences like GRONEN (http://www.gronenonline.com/_gronen1/) or ARCS (Alliance for Research on Corporate Sustainability, https://corporate-sustainability.org/). We will also disseminate the results and other aspects by news items in social networking sites, leveraging also the EB platform "A Sustainable Future" (https://asf.uva.nl/), with due credit to ENLENS. We also plan to organize an interdisciplinary workshop involving different faculties,

collaborators such as Schiphol airport and other potential stakeholders such as Port of Amsterdam, Amsterdam Gemeente etc.

6. Budget - Specify requested amount, specify how it will be used, in total and per faculty - Why can this project not be paid by normal budgets?

The PIs from both faculties (FNWI and EB) request an amount of 15 k€ each. This amount will be used to support the time of personnel, the lab cost (for FNWI), and for organizing a workshop and knowledge dissemination (e.g., conference presentations). Since this is an exploratory and interdisciplinary project, its funding from 'normal budgets' is difficult. The budget will be spent as described below:

FNWI	
Time of a postdoc, lab expenses, contribution towards joint workshop organisation	€ 15000
EB - Faculty of Economics and Business	
Research Assistance (part-time: 20h/week; hourly rate UvA StudiJob: € 55/hour gross and including UvA overhead), Open access articles, joint workshop organisation	€ 15000
Total budget:	***€ 30000***

7. References:

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