



HTL Market Potential

NextGenRoadFuels

White Paper



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1 Introduction

This white paper is a natural successor to the “Go-to-Market” study of the NGRF project. While conducting interviews with key stakeholders from WWTPs, municipalities, oil refineries, and the marine sector, some market entry barriers have been identified for NGRF biofuels. Meanwhile, there are some new thoughts about exploiting the NGRF project in the future. For example, expanding feedstock beyond urban waste, integrating HTL with other innovative technologies, and evaluating market size and market access for HTL non-biofuel products.

Therefore, this white paper presents some key market aspects for the NGRF project including limited sewage sludge availability, concerns from the two conservative industries, WWTPs and oil refineries, the marine sector lacking international biofuel mandates or incentives, and the fact that HTL falls into the category of ‘recovery’ rather than ‘recycling’ in the EU Waste Hierarchy.

In addition, the NGRF project foresees a great potential of non-biofuel products with high value in the fertilizer and biostimulant market. European Commission may consider re-positioning HTL as a biorefinery solution that not only produces drop-in biofuels for the transportation sector but also recovered nutrients and recycling water for urban farming. Carbon dioxide can be captured from the gas product of HTL to offset existing CO₂ use in the oil industry such as enhanced oil recovery (EOR) or utilize the CO₂ in Power-to-X for producing methanol and Fischer-Tropsch fuels.

The objective of this white paper is to give an overview of our understanding of industrial concerns, regulatory barriers, and new market opportunities. We also hope to give suggestions in terms of removing these barriers and perhaps, to bring synergies with other technologies such as Power-to-X in the future to further improve the techno-economic analysis and lifecycle analysis of HTL projects in the future.



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2 Beyond Urban Waste to Diversify Feedstock Supply

The Go-to-Market Study had initially envisioned the early-stage rollout of HTL technology for biogenic MSW, including food waste, sewage sludge, and the wood portion of construction and demolition wastes (C&D). However, it narrowed to residential food waste, garden waste, and sewage sludge as these urban biogenic MSWs are the obligations of municipalities to manage, who are also under pressure of reaching the full treatment capacity in some densely populated cities in Europe. However, it turned out that sewage sludge is limited, especially in some countries like the Netherlands and Germany with an increasing trend of building more mono-incineration plants.

Meanwhile, the EU WFD amendment mandates to separate collect biowaste by 2023. Therefore, the initial build-out of HTL plants may primarily aggregate and process kitchen waste and garden waste until the existing mono-incineration plants reach the end of their life. Then, in a second stage, HTL would focus on processing a broader range of feedstocks to ensure the scale and impact including the commercial food waste and wood portion of C&D waste. In the longer-term, the learnings from the NGRF project in processing high nitrogen and ash-containing feedstock are applicable across multiple biogenic wastes, such as farmyard manure and slurry, pet faeces, and absorbent products (fibre).

Research of economic analysis and environment impact can be carried out on topics such as retrofitting existing facilities of anaerobic digestion (AD) and composting into depot-based pre-processing centers for a wide range of mixed feedstocks for future exploitation. Feedstock diversification will cope with situations such as feedstock supply chain risks. It is also an essential step towards a circular economy for the waste management industry by producing high value-added materials instead of combustion for heat and power generation.



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3 Conservative Industries

3.1 WWTPs

The wastewater treatment industry is very conservative, and it may take more than ten years to integrate HTL technology at WWTPs. In the Netherlands and Germany, there is an increasing trend of adding new capacity for AD in the WWTPs and mono-incineration for treating biosolids. The lifespans of these technologies are quite long. In addition, an HTL project with WWTPs will need to participate in the EU public tendering rules. Furthermore, WWTPs can be under a lengthy capital cycle subject to municipal planning and local policies that will also slow HTL's progression of entering the wastewater treatment market.

In general, the WWTPs are not familiar with HTL technology, which hinders HTL visibility as potential technology to handle sewage sludge, a complex feedstock with high protein, toxic components, and pathogens. WWTPs are not very interested in handling or managing HTL products, such as looking for HTL biofuels offtake. To WWTPs, the evaluation priorities of a new technology are 1) operating continuously (24/7), 2) significant reduction of biosolids volume.

To tackle these questions at scale, a demo project with WWTPs and possibly involve a credible EPC (engineering, procurement, and construction) contract will be an essential step to bring HTL technology into the wastewater treatment industry. However, such a demo project may appear to be high risk for WWTPs to invest in due to the technology seems too advanced. Public funding of about €50 M to €100 M will be needed to move a demo project forward.

3.2 Oil Refineries

Co-processing HTL biocrude with existing oil refineries to produce finished fuels is one of the entry market pathways. However, catalyst deactivation, plugging, and biocrude quality consistency are significant concerns for oil refineries, and should be addressed by further research. In addition, HTL biocrude derived from sewage sludge contains nitrogen, which increases the uncertainty and risks for co-processing.



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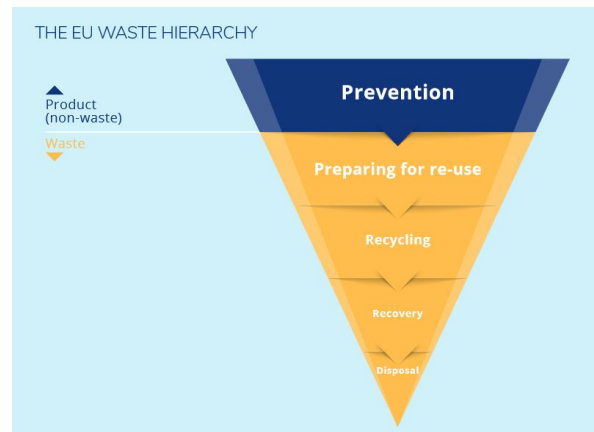
Currently, co-processing is mainly practiced at a pilot scale with less than 10% renewable feedstock. However, some oil refineries in Sweden have revamped blending ratio to achieve 85% co-processing of renewable feedstock such as tallow and raw tall oil. This gives a reference for increasing the blending rate of HTL biocrude for co-processing. The NGRF project has significantly advanced state of the art in upgrading nitrogen containing HTL biocrude. The advancements include process design (guard bed, staged conversion/graded beds & parameters), new catalysts, new reactor types, etc. More work can be done to further increase HTL biocrude yield, improve NGRF biocrude to a more upgradable quality, and eventually optimize the process design for co-processing with oil refineries at higher blending rates.



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4 EU Waste Hierarchy

HTL falls into the recovery (of energy) hierarchy according to the EU Waste Hierarchy definition. However, there is a good reason to request the European Commission reconsider it as a biorefinery solution, that fits better into the recycling category as it is a true resource-efficient circular waste management technique with a low carbon footprint. The HTL process not only produces liquid biofuels but also recycles nutrients, CO₂, and water. The aqueous product of the HTL process accounts for over 80% wt. of total output materials when using sewage sludge and food waste as feedstock. In addition to recovered phosphorus, the soluble protein fraction contains nitrogen in organic form (free amino acids, peptides) that can be used as biostimulant for plants. In the European market, the estimated value of biostimulant was US\$ 1.5-2 billion in 2022 (EBIC, 2021). In this case, HTL biofuels might be more of a by-product for road transportation compared to non-biofuel products recycled from biogenic wastes.



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5 About NextGenRoadFuels

The NextGenRoadFuels partnership provides significant technological advancements within the entire value chain, especially for low-value biogenic wastes through efficient and sustainable processing. The focused drop-in quality synthetic gasoline and diesel fuels are to facilitate strategic decision-making for and implementation of future European energy infrastructure.

6 Bibliography

EBIC. (2021). *Economic Overview of the European Biostimulants Market*. Retrieved Oct 18, 2022, from <https://biostimulants.eu/highlights/economic-overview-of-the-european-biostimulants-market/#:~:text=The%20EU%20biostimulants%20industry%20is%20the%20market%20leader&text=Estimates%20of%20the%20value%20of,1.5%2D2%20billion%20in%202022.>



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