2synfuel Newsletter

Turning sewage sludge into fuels and hydrogen

Issue 4 / July 2021

The TO-SYN-FUEL consortium is delighted to introduce its fourth newsletter edition

This newsletter reports the latest news and developments of the project that have occurred up to May 2021 and that were presented at the EUBCE 2021.
The H2020 To-Syn-Fuel project will demonstrate a new integrated process combining thermo-catalytic reforming (TCR®), with hydrogen separation through pressure swing adsorption (PSA), and hydrodeoxygenation (HDO), to produce a fully equivalent gasoline and diesel substitute. This technology promoted by To-Syn-Fuel will contribute to decarbonize the transport sector.

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1. To-Syn-Fuel project activities progress

Important updates on the project activities progress were presented during the virtual edition of EUBCE 2021 by Dr.-Ing. Robert Daschner, Head of the Renewable Energy Department at Fraunhofer UMSICHT and Project Management Officer. The Project Coordinator provided valuable insights both in a plenary session focused on Alternative Fuels, and in a dedicated workshop "To-Syn-Fuel project - Turning sewage sludge into fuels and hydrogen", accessible with the free Visitor pass registration on the event online platform until April 2022.

The main goal of To-Syn-Fuel is to produce **green hydrogen, green diesel and gasoline from sewage sludge**. Robert Daschner argued that this project is "a showcase for future sustainable investment across Europe", since a broad range of feedstocks can be processed: not only sewage sludge, but also other biogenic residues, like biowaste, digestate from anaerobic digestion, etc. Moreover, not only technical aspects, but also Life Assessment Cycle (LCA), business modelling, socio-environmental aspects and dissemination strategies are being developed.

As a long-term demonstration, by processing around 2.000 tons of dried sewage sludge, more than 200.000 liters of TCR® crude oil will be generated. The demonstration unit's capacity goes from 300 to 500 kg/hr, that is a pre-commercial scale already, and, as Robert Daschner stated, "this demonstration is really a first-of-its-kind perspective".
The system is placed in Hohenburg (Bavaria, Germany) and it is ready to operate. The main TCR® demonstrator's components are: the Auger Reactor, the Post Reformer, and the Product gas train.

> **"A showcase for future sustainable investment across Europe"**

Pilot plant for the To-Syn-Fuel project in Markt Hohenburg, district of Amberg-Sulzbach.
Credit: Fraunhofer UMSICHT

The TCR® technology, developed by Fraunhofer UMSICHT, consists of a two-stage reactor system: the feed enters the first reactor stage, the Auger reactor, with intermediate pyrolysis taking place at a temperature around 400°C, and it converts the feed to char and vapor. The char and the vapor then go to the second stage reactor, which is the post-reformer, and it is designed in a way that vapor flows through the char. As the char itself acts as a catalyst, no other catalyst is needed to be added in the catalytic reforming process, which takes place then. The char is extracted and sent to the storage system, while the syngas takes its way to the product treatment, which means that oil and water are condensed from the vapor and the gas is cleaned from dust: in this way, a dust-free and high-calorific value syngas, bio-oil and carbonisate are obtained.
Then, the produced syngas is processed in a containerized PSA unit, supplied by the project partner Hygear, for separating hydrogen. This hydrogen is used together with bio-oil in the so-called hydrotreatment (HDO) step to produce a hydrotreated bio-oil; this technology was provided by the project partner VTS.

By answering a question about the overall efficiency of the plant, Robert Daschner declared as follows: “Reliable answers will come with results, but what is known from pre-tests of small-scale experiments is that 90%-95% of the energy can be transferred from the feedstock to the products, and that around 10% of energy in feedstock is needed as heating energy”.

Robert Daschner shared first impressions and results of the plant commissioning phase and illustrated the upcoming steps of the project. “The demonstrator is in the final phase” – he announced – “Most of the equipment is already commissioned and functionally tested; all the utilities, like chillers and char silo are installed and in place, ready for operations, that are planned to start in next July”. Moreover, a demonstration day is planned in next September, as well as an European car tour taking place in spring-summer 2022, “to really show that the fuels that we are producing can be applied in the existing technologies and existing vehicles”.

Since the demonstration site is ready to operate, the next months will be dedicated to make promotion into industry, technology and transport sectors. Some digital tools for site visiting are being planned by the project’s team, but the hope is having in-presence site visits from next September.

“Moreover, not only technical aspects, but also Life Assessment Cycle (LCA), business modelling, socio-environmental aspects and dissemination strategies are being developed”

2. EU R&I policy for renewable energy carriers

Introductive presentation to the online project workshop.
Credit: ETA-Florence Renewable Energies.

The opening of the workshop was held by Maria Georgiadou, Senior Expert in Renewable Energies R&I policies in the Directorate-General for Research and Innovation of the European Commission, with an overview on "EU R&I policy for renewable energy carriers" in the context of the European Green Deal EU Strategies.

Renewable energies have major opportunities to replace or substitute those from fossil origin in the power sector, heating & cooling sector, and also in transportation, industry and agriculture. Notably, Advanced renewable fuels, including synthetic and sustainable advanced biofuels, are needed to provide carbon-neutral solutions for transport and energy-intensive industrial sectors.

Maria Georgiadou highlighted main opportunities and challenges of the EU global leadership in renewable energy technologies. In short, from supporting renewable energy and renewable fuel technologies, the following impacts are expected:

- the availability of disruptive technologies in 2050;
- reduced costs and improved efficiency;
- de-risking the technologies for their commercial uptake;
- a better integration in energy consuming sectors;
- a reinforced European scientific basis and the European exploitation potential of these technologies;
- an enhanced sustainability of value chains;
- a more effective market uptake.

M. Georgiadou also claimed that "to support the growing market of advanced and renewable fuels, reaching competitiveness is needed through R&I to improve costs, performance and sustainability, so that they can immediately serve sectors like aviation. Consistent investments are needed into technology improvement, feedstock diversification, market uptake, coordinated R&I funding, and international cooperation."

New ideas must be supported for biofuels and renewable fuels. Under the concept of technology diversification, market uptake, and feedstock diversification, main support will be given to:

- hybrid catalytic conversion processes, combining any catalytic processes to convert renewable energy to carbon-neutral renewable fuels of biological or non-biological origin;
- cost-effective solutions to minimize carbon waste when we produce sustainable biofuel;
- demonstration of cost-effective advanced biofuel technologies that are integrated in existing industrial plants, with the aim to improve their economic viability by utilizing existing assets, also by providing socio-economic benefits;
- demonstration of innovative and cost-effective sustainable value chains for advanced biofuels or synthetic renewable fuels over the entire cycle from feedstock to end use. This means that we have to build these sustainable value chains in both cases and prove the value-adding needed steps of the value chain;
- fostering international cooperation to develop best practices and concepts along the entire value chain for accelerating scale-up of sustainable biofuels worldwide.

"Advanced renewable fuels, including synthetic and sustainable advanced biofuels, are needed to provide carbon-neutral solutions for transport and energy-intensive industrial sectors"

Finally, M. Georgiadou presented some remarkable ideas for the promotion of bioenergy and renewable energy carriers, and notably:

- large-scale CHP, using only biogenic residues and wastes
- development of industrial use of efficient and low emission combustion and gasification technological systems from biogenic residues and wastes. The overall target is to have zero pollution.

"Consistent investments are needed into technology improvement, feedstock diversification, market uptake, coordinated R&I funding, and international cooperation"

3. Conventional and innovative uses of municipal sludge in Europe

Serena Righi, from University of Bologna, provided an update on the conventional use of sewage sludge in Europe, with data from Eurostat and Environmental European Agency.

The presentation was introduced with some facts and figures about sewage sludge production in Europe, which reached 10 Mt of dry matter in 2018. More than 60% of the total was produced by Germany and by other Western European countries, while this share is lower in the Eastern European countries. This difference depends on many factors: first, on the total population, but also on the proportion of population connected to wastewater treatment plants, and on the type and efficiency of these plants.

Dried pelletized sewage sludge used as feedstock to produce green diesel and green gasoline.
Credit: ETA-Florence Renewable Energies.

The main types of sewage sludge management in Europe are agricultural use, composting, landfilling, and incineration. At European level, land application as soil amendment is today the main route for sewage sludge recovery: about 50% of sewage sludge is spread on agricultural soil, while 28% is incinerated, and 18% is still employed in landfill. Also, relevant differences in management emerge among EU countries.

It is foreseen that sewage sludge production in Europe will increase, due to several factors: an increasing population, a higher proportion of population connected to wastewater treatment plants, and more stringent requirements for the quality of their effluents.

In front of these data, two actions are needed: to minimize the sewage sludge production, and to valorize it, following the policies of the Waste Framework Directive, the Circular Economy action plans, and the Bioeconomy Strategy of the EU. By following this pathway, as Serena Righi underlined, "wastewater treatment plants have turned from facilities for protection of human health and environment to biorefineries".

"It is foreseen that sewage sludge production in Europe will increase"

4. Consumers' perception towards synthetic fuel products

Ariadna Claret i Carles, Researcher and Project Manager at Leitat Technological Centre presented the main findings of a study on consumers' perception towards synthetic fuel products. A complete and public report on this research is available at Deliverable D5.1: Description of consumer perceptions towards synthetic fuel products. This study is part of the social impact assessment that will be performed during the To-Syn-Fuel project.
This study was mainly based on a survey addressed to the potential consumers of synthetic fuels, which reached about 250 respondents.

The consumers' perception of synthetic fuel products was described with respect to different aspects:
- the knowledge of potential consumers towards synthetic fuels and biofuels;
- their perception concerning environmental benefits in implementing the use of sustainable synthetic fuels;
- the main barriers that constrain the implementation of synthetic fuels in the fuels market;
- the willingness of potential consumers to pay more for a more sustainable fuel.

The first section of questions in the survey aimed to identify the respondent's profile, as a potential consumer of synthetic fuel. Most of respondents are males aged 30-39, coming from Italy, with an education degree at Master level; almost all are drivers, with a high share of diesel-cars users, while 22% uses advanced alternative fuels. Concerning the knowledge about biofuels and synthetic fuels, 80% of respondents consider themselves as familiar with biofuels, and 56% with synthetic fuels.

The analysis of the survey's results shows some valuable trends in the potential consumers' perception towards synthetic fuels. Potential consumers felt that waste from biomass, notably agricultural waste and sewage sludge, are the most sustainable raw materials to be used in the production of synthetic fuels: this means that, apart that synthetic fuels derived from waste of biomass bring environmental and socio-economic benefits, the potential consumers have also this perception.

"The prevalent opinion is that synthetic fuels could replace conventional fuels in the future"

The CO2-neutral crude oil from the Fraunhofer TCR® process can be processed into standard-compliant fuels.
Credit: Fraunhofer UMSICHT

By recognizing the advantages of sustainable synthetic fuels compared to conventional ones, potential consumers seem willing to use them in their vehicle and also to pay a premium for a more environmentally and socially sustainable fuel. Although, the prevalent opinion is that synthetic fuels could replace conventional fuels in the future, not immediately. According to the potential consumers opinion, the main problem of synthetic fuels to reach the market implementation is detected in the lack of policy adequacy to solve the current barriers to fully implement their use.

It is concluded that clear and understandable communication strategies, initiatives and tools are needed to provide necessary information to potential consumers about synthetic fuels (including their benefits and impacts) to promote its use. Based on the results of this survey, it seems that To-Syn-Fuel technology and products would be well accepted by potential consumers.

About the project

The consortium with 11 partner organisations has brought together some of the leading researchers, industrial technology providers and renewable energy experts from across Europe, in a collaborative, committed and dedicated research effort to deliver the overarching ambition. Partners include: Engie Services Netherlands NV, HyGear Technology and Services BV (The Netherlands), Fraunhofer UMSICHT, Verfahrenstechnik Schwedt GmbH, Martech GmbH (Germany), Alma Mater Studiorum – University of Bologna, Eni SpA, ETA–Florence Renewable Energies (Italy), University of Birmingham, WRG Europe Ltd (UK) and LEITAT (Spain). The project has a total duration of 65 months from May 2017 to September 2022 and will be funded by the European Union under the Horizon 2020 programme.

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Disclaimer

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 745749.