

Where energies make tomorrow ●

Biofuels

Delivering sustainable alternatives
for the global energy transition



TECHNIP
ENERGIES

A leading player in the biofuels market

With more than 60 years of experience in biofuels, we bring the skills, creativity and agility to deliver top-rated projects to advance the global energy transition.

Leveraging our vast competencies from decades of working in the transformation of the energy sector, we offer our clients a wide range of services to deliver biofuels facilities, advanced biofuels production technologies and licensing.

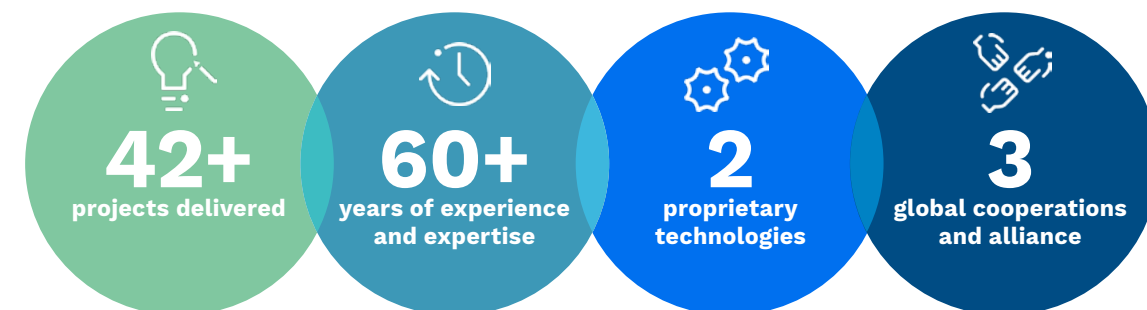
Driving the biofuels market with expertise and technology

Biofuels play an important role in the energy transition as

we move to sustainable solutions to reduce carbon and harmful emissions. Due to changing public policies, increased government incentives and growing consumer demand, biofuels have become an advanced solution for low-carbon energy, drawing the attention of oil and gas companies, the agroindustry, chemical companies and wood processing industries. Technip Energies has the know-how and experience to deliver biofuels production projects as sustainable energy alternatives. From feasibility studies and basic design to Front-End Engineering Design and full EPC project execution, we offer solutions that work.

End-to-end project management

Our engineering and end-to-end project management expertise is directly applicable to the biofuels market, particularly for biofuel refineries whether grass-roots facilities of repurposed conventional refinery units. We offer a wide range of services and proprietary and partnership-based technologies, including biodiesel and biojet fuel production technologies and first- and second-generation ethanol processes. We have extensive experience in the design and construction of bioethanol plants.



“Biofuels are some of the best developed sustainable options and a fast growing alternative for liquid fuels. Technip Energies is fully engaged in this sector with various service offerings and is convinced that biofuel projects will become viable, profitable green solutions for a wide range of industries”.

Andreas Bormann, VP Sustainable Chemistry Technical Line

→ Mastering classic technologies, while introducing new ones

MASTERING CLASSIC TECHNOLOGIES

- Hummingbird® (ethanol to ethylene, potentially to transportation fuels)
- Ethanol (1G) generation process
- Renewable fuels HVO production technologies

DEVELOPING INNOVATIVE TECHNOLOGIES

- Ethanol (2G) generation process
- Sustainable Aviation Fuel (SAF)
- Bio isobutene
- CO₂ capture and feedstock with renewable hydrogen to hydrocarbons

Worldwide project footprint



From concept to delivery

We offer a full range of design services from concept and basic design, including CAPEX estimates, to engineering and turnkey delivery. We work jointly with clients to successfully deliver biofuel projects, ancillary units and associated offsite and utility sections as sustainable energy alternatives.



Exceeding our clients' needs

Technip Energies offers proven and extensive experience and expertise in the biofuels market. We go above and beyond to support our clients in the design and delivery of mid-size to large-scale.



Proven experience in executing all types of refinery and biofuel plants worldwide including the world's largest biofuel plants

Leading alliances and partnerships

Leading design and complete engineering capabilities

Full project management and turnkey delivery

Due diligence in advanced biofuels projects (second generation)

In-house technologies for bioethanol and ethanol-to-ethylene production

Licensing BTG BIOLIQUEIDS pyrolysis bio-oil technology

Advanced proprietary technologies

Our expertise in integrating either proprietary or third-party licensed process technologies fosters early project engagement that can make a significant economic impact. We can begin at the conceptual design phase, through piloting, engineering scale-up to full commercialization. Our portfolio has developed through focused R&D, alliances and acquisitions.

Hummingbird® ethanol-to-ethylene technology

Our proprietary Hummingbird® is a key technology for Sustainable Aviation Fuels via the Alcohol-to-Jet route.

A key aspect of this advanced technology is its proprietary catalyst resulting in a lower temperature, higher pressure

and more selective process compared to traditional ethanol dehydration processes that use alumina-based catalysts. Designed to process hydrous or anhydrous fuel grade ethanol, it produces polymer grade ethylene with a selectivity of more than 99 percent and provides companies an

alternative chemical pathway as a building block for a biorefinery. Hummingbird® has been selected by LanzaTech for a first commercial demonstration-scale biorefinery to manufacture sustainable aviation fuel.

First-generation ethanol process (1G)

Technip Energies' proprietary first-generation ethanol technology has been successfully employed in hundreds of projects throughout the world. Our 1G process, based on Speichim's legacy technology, is suitable for beverage and fuel ethanol applications. The quality of the beverage alcohol is considered a benchmark in the industry. Our ethanol technology can process a complete range of first-generation raw sugar

and starchy materials, including molasses and starch effluents. Our exclusive design for static columns trays enables the production of high quality products. The technology also offers an energy efficient process for lower steam consumption rates. Our ethanol process can be coupled with our Hummingbird® technology to transform ethanol into green ethylene.

We offer a very flexible approach for new grass root plants, as well as revamps and debottlenecking of existing facilities or associated product upgrades. We license our proprietary technology. We can also provide a full range of engineering services as well as technical assistance services for the start-up and troubleshooting of installations.

Alliances and partnerships

Top-tier technology centers in the USA and Europe

Renewable fuels HVO production technologies

Technip Energies provides front-end loading (FEL) services for Neste's NEXBTL projects through our established partnership. The agreement also covers Technip Energies' participation during the execution phase of future NEXBTL™ projects. This technology allows the conversion of second-generation feedstock like

vegetable oil or waste fat, into renewable diesel and other renewable products. It provides an efficient and sustainable solution in the fuels sector while addressing environmental concerns. The technology allows production of renewable diesel and Sustainable Aviation Fuel (SAF) that helps reduce greenhouse gas emissions over the

lifecycle of the fuel compared to conventional fossil diesel and jet fuel. This partnership is a result of our long-term collaboration, illustrated by the successful delivery of two world-scale renewable fuels units in Rotterdam and Singapore and the ongoing expansion of Neste's renewable products facilities at the same sites.

Second-generation ethanol process (2G)

Technip Energies and Clariant have signed a cooperation agreement for Sunliquid® cellulosic ethanol technology licensing. This technology converts agricultural residues, woody materials, or municipal solid wastes into advanced biofuel. It features the production of enzymes and

yeasts in-situ and simultaneous fermentation of C5/C6 sugars to ensure the best-in-class commercial performance. It is employed in Clariant's full-scale industrial plant in Romania and treats a wide range of feedstocks. We work together to develop collaboration models to accelerate the

adoption of 2G processes into the industry.

The process can be coupled with our Hummingbird® technology to transform ethanol into green ethylene or other sugar-derived chemicals using other proprietary technologies in our portfolio.

BTG Bioliquids fast pyrolysis oil

We deliver complete turnkey fast pyrolysis bio-oil (FPBO) units that convert lignocellulosic non-food biomass to a transportable liquid bio-oil. This second-generation bio-oil can be used as a sustainable alternative to fossil fuels to produce renewable energy and chemicals.

The FPBO plants are built with BTG Bioliquids' patented FPBO licensed technology. All kinds of lignocellulosic biomass residues that do not compete with the food chain can be used. The bio-oil is easy to store and transport and can be conveniently used in versatile applications in a bio-based economy, including heat, power,

transportation fuels and in biorefineries. We offer EPC services with core components of the plant based on BTG Bioliquids' FPBO technology. The pyrolysis plant is based on a modular design that enables quick project execution and fast installation. So far, three plants are in operation.

Badger Technology Center in Weymouth, MA, USA

With an experienced staff and a proven track record of successful process commercializations, the Badger Technology Center provides bench, pilot and demonstration scale services for the development of chemical process technologies, in particular for the Hummingbird® technology. Our lab and engineering teams work together to generate highly accurate data that allows clients and partners to

cost effectively extend their research and development capabilities.

Most importantly is the access provided to an experienced research team dedicated to the development of novel process technologies.

EQUIPMENT

- Ten 24/7 fully automated pilot plants y On-line GC and continuous process analyzers y Fixed, fluid, and trickle bed

reactors y Batch and CSTR systems y Pressure and vacuum distillation for recycle and product recovery

- Advanced analytical capabilities y GC FID/TCD, HPLC, GC-Mass Spec
- Ion Chromatography y VLE Determination y Corrosion Testing



Our key project references

NESTE DNEXBTL



- **Contract:** EPCM
- **Award:** 2010 / 2018
- **Delivery:** 2017 / 2023
- **Client:** Neste
- **Location:** Singapore
- **Capacity:** 800,000 t/year of biodiesel each

Technip Energies delivered a plant that integrated into the existing industrial infrastructure and makes use of local site utilities, port and storage services. The Singapore plant extension to 1,3 Mta was been awarded to Technip Energies in December 2018.

NESTE NEXBTL



- **Contract:** EPCM
- **Award:** 2008/ 2018/ 2021
- **Delivery:** 2011 / ?
- **Client:** Neste
- **Location:** The Netherlands
- **Capacity:** 800,000 t/year of biodiesel each

Technip Energies delivered a plant in the Maatsvlakte area of the Port of Rotterdam that offers synergy opportunities with nearby chemical plants. In 2021, Technip Energies has been awarded two new contracts for the development of a renewables production platform in Rotterdam, the Netherlands, as part of the existing Partnership Agreement between Neste and Technip Energies.

GALP NEW HVO UNIT



- **Contract:** FEED
- **Award:** 2021
- **Delivery:** 2022
- **Client:** Galp
- **Location:** Portugal

New HVO Unit (biofuels) to produce 270kTPA bio-diesel and bio-jet based on renewable feedstock (animal fat, vegetable oils, etc.) in Galp's Sines refinery

PYROCELL



- **Contract:** EPC
- **Award:** 2019
- **Delivery:** 2021
- **Client:** Pyrocell AB
- **Location:** Sweden

Technip Energies built a plant on Setra's sawmill plot using sawdust as feedstock. Fast Pyrolysis bio-oil will be processed in a nearby Preem refinery to produce by Preem to produce advanced biofuels.

LA MEDE BIOREFINERY



- **Contract:** EPCm
- **Delivery:** 2019
- **Client:** TotalEnergies
- **Location:** France
- **Technology:** Axens Vegan® technology

Technip Energies transformed existing facilities into a HVO biofuels plant (palm oil and used oil) based on Axens Vegan® technology. The plant also includes a pretreatment unit based on Alfa Laval technology. The project involved the conversion of TotalEnergies's La Mède crude oil refinery into a 500,000 tpa biorefinery facility, the first of its kind in France and one of Europe's largest

CLARIANT 2G ETHANOL



- **Contract:** Basic Engineering Design
- **Project timeline:** 2021
- **Client:** Clariant
- **Location:** Poland
- **Capacity:** 25,000 t/year
- **Technology:** Sunliquid® technology

Technip Energies has executed the Basic Engineering Design as a part of the technology license package sold by Clariant for the construction of a 2G ethanol plant in Poland.

KUANTAN PORT PROJECT

- **Contract:** Assistance in the detailed engineering of the methyl ester trans-esterification plant
- **Project timeline:** 2012-2015
- **Client:** KNM Process Systems Sdn Bhd
- **Process:** Axens (Esterip – h)
- **Location:** Malaysia
- **Capacity:** 250,000 t/year of biodiesel

Technip Energies has been awarded a contract by KNM Process Systems Sdn Bhd to provide assistance in the detailed engineering of the fatty acids methyl ester transesterification¹ unit for a biodiesel² production plant to be located at the port of Kuantan in Malaysia.

SKYNRG SUSTAINABLE AVIATION FUEL (SAF)

- **Contract:** FEED
- **Award:** 2019
- **Client:** SkyNRG
- **Location:** The Netherlands

Technip Energies developed the Front-End Engineering Design for this first-of-a-kind grass-root HVO facility for the production of Sustainable Aviation Fuel (SAF), based on Haldor Topsoe technology for hydro-processing and Desmet Ballestra for the pre-treatment unit.



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