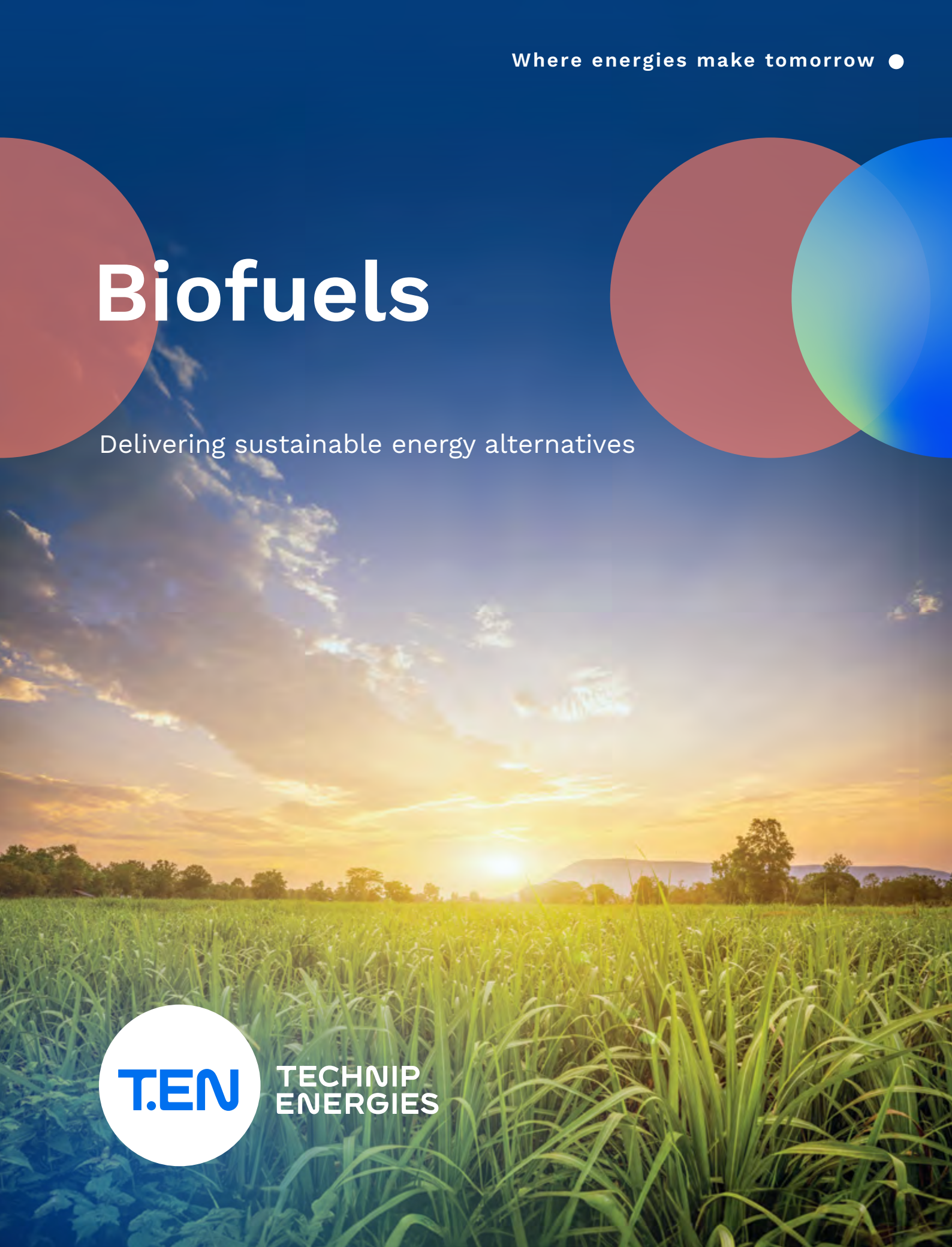
Where energies make tomorrow

Biofuels

Delivering sustainable energy alternatives



T.EN TECHNIP ENERGIES

Extensive experience in the biofuels market

With more than 60 years of experience in biofuels, we bring the skills, technologies and industry knowledge to deliver sustainable projects to meet the needs of the transportation industry.

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 aviation transportation, electricity generation and heating 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

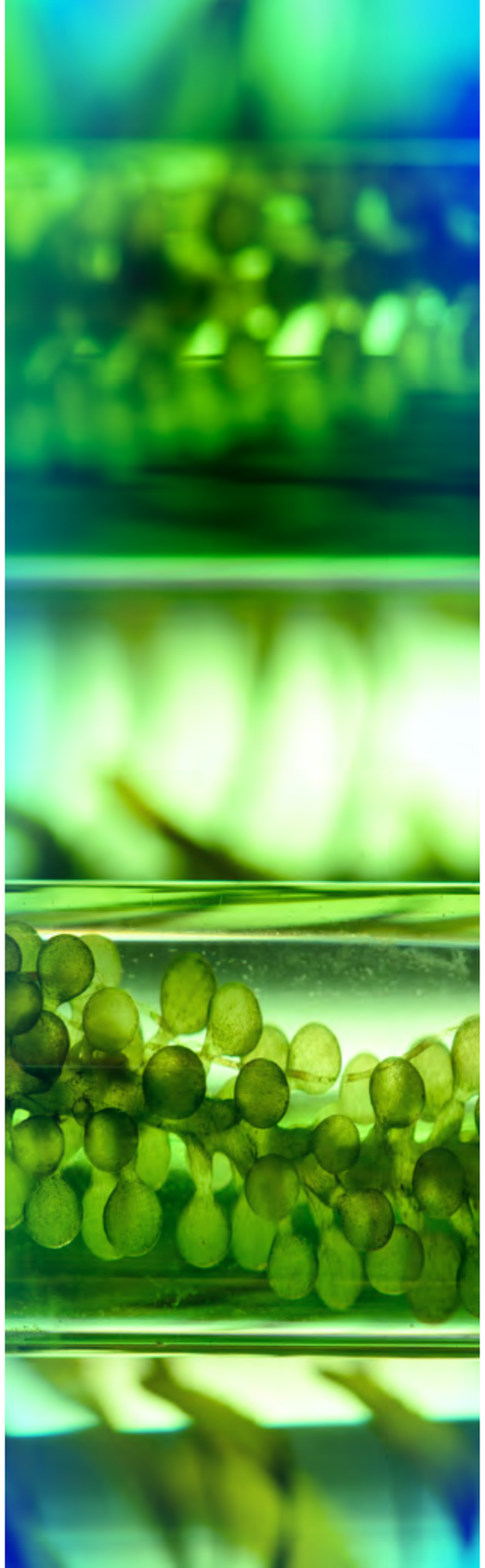
Our engineering and end-to-end project management expertise is directly applicable to the biofuels market, particularly for biofuel refineries whether grass-roots facilities of repurposed conventional refinery units. We offer a wide range of services and proprietary and partnership-based technologies, 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.

45+
projects delivered

60+
years of experience and expertise

2
proprietary technologies

4
global cooperations and alliance



> “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.”
>
> Steve Moran, VP Sustainable Fuels Market Technip Energies

Mastering classic technologies and developing new ones

CLASSIC TECHNOLOGIES

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

INNOVATIVE TECHNOLOGIES

- Ethanol (2G) generation process
- Alcohol-to-Jet
- Bio isobutene
- CO_2 capture and feedstock with renewable hydrogen to hydrocarbons

Global 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 client 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 projects.

- Proven experience in executing all types of refinery and biofuel plants worldwide including the world's largest biofuel plants
- Leading strategic alliances
- 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 BIOLIQUIDS 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 LanzaJet 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 grassroot 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 trouble-shooting of installations.

Strategic Alliances

Alcohol-to-Jet sustainable aviation fuel

Technip Energies and LanzaJet have formed an exclusive collaboration combining our proprietary Hummingbird technology, which converts ethanol-to-ethylene, with LanzaJet's alcohol-to-jet technology, which can reduce greenhouse gas emissions by up to 70 percent. The first plant, at LanzaJet's Freedom Pines Fuels in Soperton, Georgia, opened in January 2024, and will produce 10 million gallons/year of AtJ.

Advanced ethanol process (2G and 3G)

Technip Energies is also involved in the design and execution of first of a kind plants to produce advanced ethanol. These technologies convert agricultural residues, woody materials, solid wastes or waste gases into ethanol using fermentation processes and engineered microorganisms. Our 1G ethanol know-how coupled with our design and engineering capabilities strengthen our position in this field. We work together with 3rd party licensors to accelerate the adoption of 2G/3G processes into the industry.

Top-tier technology centers

Badger Technology Center, 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
- On-line GC and continuous process analyzers
- Fixed, fluid, and trickle bed reactors
- Batch and CSTR systems
- Pressure and vacuum distillation for recycle and product recovery
- Advanced analytical capabilities
- GC FID/TCD, HPLC, GC-Mass Spec
- Ion Chromatography
- VLE Determination
- Corrosion Testing

Our key project references

FREEDOM PINES FUELS ALCOHOL-TO-JET FACILITY

- **Contract:** First commercial plant for Technip Energies licensed Hummingbird® technology
- **Award:** 2024
- **Client:** Lanzajet
- **Location:** Georgia, USA
- **Capacity:** 30 KTA Hummingbird® unit

Developed a PDP for a 30 KTA as part of the LanzaJet integrated facility to convert bioethanols into alcohol-to-jet Sustainable Aviation Fuels.

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

Technip Energies delivered a plant in the Maatsvlaske 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 270 kTPA 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 Pyrolysus bio-oil will be processed in a nearby Preem refinery to produce advanced biofuels.

LA MEDE BIOREFINERY

- **Contract:** EPsCm
- **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 Mede 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.

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 grassroot HVO facility for the production of sustainable aviation fuel (SAF), based on Haldor Topose technology for hydro-processing and Desmet Ballestra for the pre-treatment unit.

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