



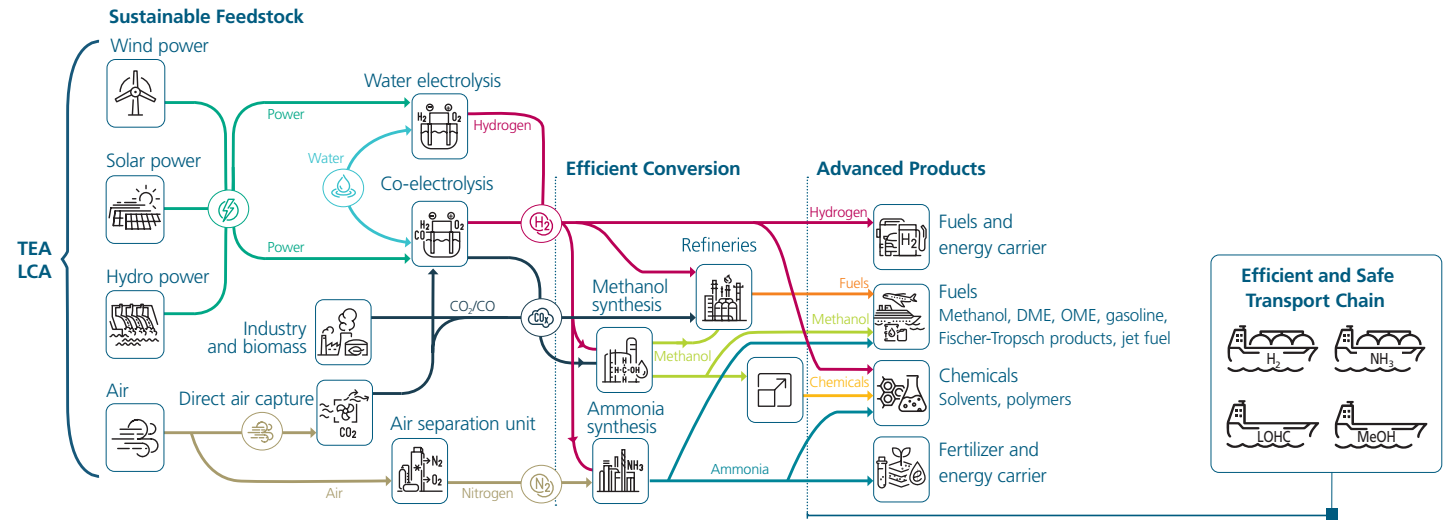
**Power to Liquids**

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Sustainable Production  
of Chemicals, Energy  
Carriers and Fuels

# Sustainable Production of Chemicals, Energy Carriers and Fuels

Power to Liquids (PtL) denotes the conversion of sustainable hydrogen and CO<sub>x</sub>/N<sub>2</sub> to energy carriers such as methanol and ammonia, which can also serve as platform molecules for the chemical industry or as clean fuels reducing CO<sub>2</sub> and local emissions such as soot/NO<sub>x</sub>. PtL contributes to decarbonization of all energy economy sectors.



Power to Liquids process chain. © Fraunhofer ISE

## Our Offer

- development and engineering of efficient, cost optimized processes using CO<sub>2</sub>/CO or N<sub>2</sub> and H<sub>2</sub> feeds
- in-house design, construction, programming, and operation of fully automated, remote-operated mini and pilot plants for PtL production
- design, test, and characterization of catalysts for PtL processes
- assessment of PtL process chains with state-of-the-art steady state and dynamic simulation platforms
- investigating sorption enhanced reactor technologies and standardized tests of sorbents for PtL syntheses and direct air capture
- techno-economic feasibility studies assessing the potential of PtL processes for your business case
- life cycle assessments

Since 2012 Fraunhofer ISE has been performing detailed investigations along the PtL process chain. We currently focus on methanol, oxymethylene ethers (OME), dimethyl ether (DME), sustainable aviation fuels (SAF), and ammonia.

Based on our unique chemical and engineering expertise, we can provide complete system solutions to the process, chemical, transport, finance, and energy industries.

We focus on technology development with our more than two decades of experience in thermochemical processes. Our R&D aims to facilitate industrial deployments based on scientifically solid technologies that are transferable to industrial scale. Our developments help to bridge the gap between conceptual research and commercialization as demonstrated by our technologies such as π-COMET® and INDIGO.

Selected references:

- Tailor-made process intensification focusing on reactive distillation technologies based on experimentally validated simulation models. As a result, we obtained >99 % pure DME from raw methanol (INDIGO technology, patent pending).

- The π-COMET® reactive distillation technology (patent pending) was applied together with industrial partners to achieve the first European production of OME in an industrial environment. The product quality was standards compliant.
- Process material and energy integration, optimization, and conceptual engineering of several OME processes reflected our capabilities in that domain in the BMBF-funded NAMOSYN project.
- In the Carbon2Chem® project, our automated methanol miniplant ran for more than 5000 h using cleaned steel mill gases in an industrial environment.

## Techno-Economic and Life Cycle Analysis

Fraunhofer ISE analyzes and optimizes complete PtL processes from the renewable source to the final application. In addition, we assess product logistics, determine ideal boundary conditions, and advise our customers by comparing different production routes.

## From Plant Design to Operation

Using data from validated experiments, we design custom mini and pilot plants (~1–10 L/h), develop ISO 10628 compliant flowsheets, compile bills of materials, write control software, and build plants for use in our own state-of-the-art labs or for remote operation at our partners' facilities.

## Catalyst and Component Tests

Having operated kinetic reactors for many years, we offer rapid and qualified catalyst screening and characterization. Kinetic models can be established based on experimental data, allowing robust process scale-up. Process equipment such as reactors, distillation, and absorption units can be tested in our plants and directly validated using our models.

## Process Simulation and Modeling

Using state-of-the-art simulations, we offer reliable leveled cost estimations of PtL products. Our detailed scientific understanding of the different process steps is key for our economic models. We develop and benchmark new processes, also taking into consideration environmental impact assessments.

Our tools:

- ASPEN® Plus and CHEMCAD®
- X-Visual Plant Engineer
- Development of P&IDs according to DIN-EN-ISO 10628 and DIN-EN-ISO 62424
- MATLAB®/Simulink®
- Ansys Fluent®
- Umberto®

*3D illustration of the unique structured-packing pressure distillation/absorption column at Fraunhofer ISE (DN50 up to 40 bar). © Iludest Destillationsanlagen GmbH*



## For Further Information



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02-252330-23