Synthetic fuels from CO\textsubscript{2} and renewable electricity can make a significant contribution to achieve CO\textsubscript{2}-neutral mobility.

The E-Fuel Synthesis Plant (Power-to-Liquid)

In order to drastically decrease the CO\textsubscript{2} emissions of the transport sector while still ensuring global transportation of goods and people, CO\textsubscript{2}-neutral alternatives for the fossil fuels are required. While e-mobility will play a significant role in the future of individual mobility, heavy load and long distance transportation as well as aviation will depend on the high energy density of liquid fuels. This is why CO\textsubscript{2}-neutral synthetic fuels are urgently needed.

With the Power-to-Liquid synthesis plant, CO\textsubscript{2} together with H\textsubscript{2} can be converted first into synthesis gas (H2/CO mixture) and further into hydrocarbon molecules in a second reactor. These molecules can be considered as a raw product for the final synthetic fuels. In order to increase the yield of the desired liquid product as well as to optimize the fuel properties, a product upgrade step is integrated in the containerized synthesis plant.

The centerpiece of the E-Fuel Synthesis Plant is an ultra compact microstructured chemical reactor, which was developed and commercialized by INERATEC GmbH, a spin-off company of KIT. The special features of the reactor allow for a highly efficient conversion of the synthesis gas into hydrocarbon molecules. The microstructured reactor module shown in the photo can produce up to 200 liter of the product per day. More modules can be added and combined, and thus, the capacity can be tailored easily.
The Microstructured Synthesis Reactor

This synthesis gas is then transferred to the ultra-compact microstructured synthesis reactor. Here, via the Fischer-Tropsch synthesis, hydrocarbon molecules of different chain lengths are produced. This is the raw product for the final e-fuels. One key feature of this advanced reactor technology is that the heat, which is generated during the chemical reaction, is extracted efficiently by generating steam. This does not only allow to precisely control the reaction but also to use the steam in other steps of the Power-to-Liquid process chain and, thus, helps to increase the overall efficiency.

The Product Upgrade

The last step in this process chain within the containerized synthesis plant of the Energy Lab 2.0 is the product upgrade, which not only increases the yield of the desired liquid e-fuel but also optimizes the fuel properties. After a final distillation, the different e-fuels, i.e. synthetic kerosene, diesel or gasoline are obtained.