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The bioliq® Plant Is in Operation

KIT's Contribution to Research for the Energiewende

BY DR. SIBYLLE ORGELDINGER // TRANSLATION: MAIKE SCHRÖDER

Of all renewable energy sources, biomass is considered a multi-talent. The bioliq® process developed by KIT, for instance, does not merely convert biogenous residues into high-quality fuels. Linking of the bioliq® plant to the Energy Lab 2.0 also provides for a sustainable combination of power and heat generation with mobility.

Extending the use of renewable energies, increasing energy efficiency: These are two major objectives of the transformation of the energy system in Germany. They can be reached with the help of high-performance storage systems and smart grids ensuring stability and supply security. A platform on which scientists can conduct experiments and simulations to study how the different components of an economically efficient, reliable, and environmentally compatible energy system will interact is currently being established at KIT: The Energy Lab 2.0. It will integrate energy conversion, storage, and distribution facilities, energy consumers, electric, thermal, and chemical energy flows as well as new information and communication technologies. Shortly after the kickoff of the Energy Lab 2.0 (see LookKIT 04/2014), another important project started operation: The bioliq® pilot plant on KIT Campus North was commissioned over the complete process chain.

bioliq® (biomass to liquid Karlsruhe) is a process using dry residual biomass for the production of fuels and also of important basic substances for the chemical industry. The process consists of four stages: Fast pyrolysis, high-pressure entrained-flow gasification, hot gas cleaning, and synthesis. KIT executed the pilot project funded by the Federal Republic of Germany, the state of Baden-Württemberg, and the European Union in cooperation with several industry partners. Total investment costs amount to EUR 64 million.

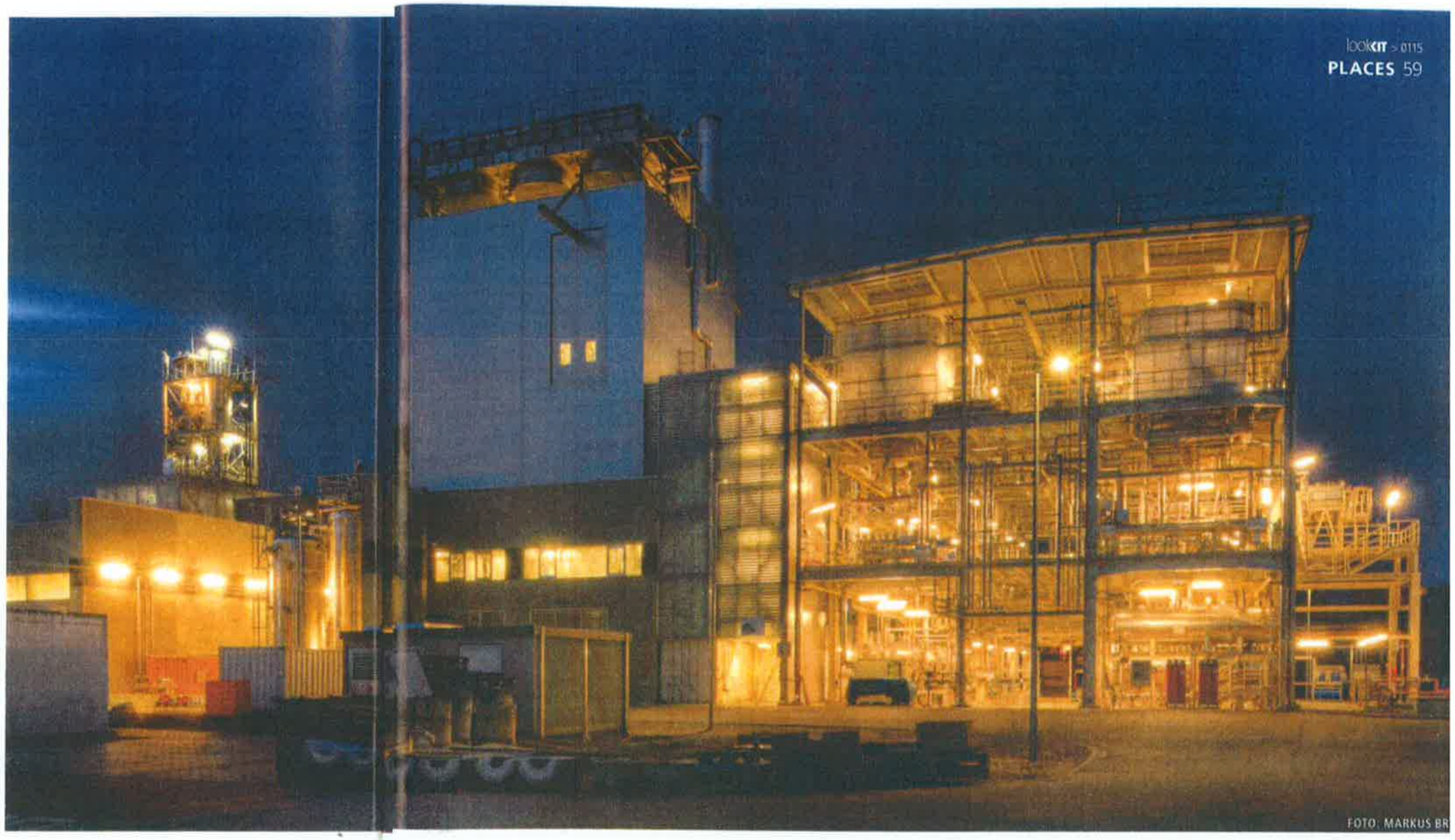

FOTO: MARKUS BR

The bioliq® process is based on residues from agriculture and forestry, such as straw, hay, and wood waste, and on residues from landscape work. This material can be used neither as food nor as feedstuff. No additional cultivation areas are needed. Hence, the frequently discussed conflict between "tank and table" is avoided.

The bioresidues used have one drawback, however – their low average energy density of 2 gigajoules per cubic meter. Moreover, they arise in a widely distributed manner. Transportation over longer distances to a central processing plant would be neither economically nor ecologically reasonable. The bioliq® concept solves this problem by combining decentralized processing with centralized large-scale production. First, the residual biomass is converted into a crude oil-like substance by fast pyrolysis at decentralized plants. This so-called biosyncrude has an energy density of 25 gigajoules per cubic meter. Hence, transportation over longer distances to a central processing plant is reasonable from the economic point of view.

A high-pressure entrained-flow gasifier converts the biosyncrude into a tar-free synthesis gas at temperatures above 1200°C and pressures of up to 80 bar. The synthesis gas mainly consists of carbon monoxide and hydrogen. Downstream hot gas cleaning is designed to remove impurities, such as particles, chlorine, and nitrogen compounds, from the synthesis gas. The downstream synthesis stage produces customized fuels or basic chemical products. The bioliq® pilot plant has already produced high-quality gasoline that is environmentally compatible, fully engine-compatible, and can be combined easily with other fuels. Its output is about 1 ton of fuel per day. Still, refueling at the bioliq® plant is not possible.

FOTO: ANDREA FABRY

Forschung für die Energiewende
Spit aus Stroh

Research for the ‚energiewende'
Gasoline from straw

The gasoline produced will be subjected to various tests. Having commissioned the complete process chain, KIT scientists are now working on the precise balancing of the technologies in terms of materials and energy flows. On this basis, the processes will be optimized. The industry partners of the bioliq® project are to be enabled to transfer the technologies to the scale of commercial production. In addition, the bioliq® pilot plant will be used as a research and development platform and linked to the Energy Lab 2.0. The synthesis gas produced by the high-pressure entrained-flow gasifier can also be used for power generation, which will make power plants less dependent on fossil fuels and more flexible and environmentally compatible in operation. Within the Energy Lab 2.0, a gas turbine and a generator will be used for this purpose. The German Aerospace Center (DLR) will contribute a combustion system for rapid load cycling and the efficient use of various fuels.

FOTO: ANDREA FABRY

FOTO: ANDREA FABRY

Mark Eberhard in der Anlage

Mark Eberhard in the plant

Another option consists in converting the synthesis gas into components that may be refined to synthetic diesel fuel or kerosene by means of the Fischer-Tropsch synthesis. Methanation of the synthesis gas allows for the production of "synthetic natural gas" (SNG). It is similar to natural gas and can be used for heat production, co-generation of power and heat, and as a fuel.

Within the framework of the Energy Lab 2.0, the large-scale bioliq® plant will be integrated into the local power grid of KIT together with other producers and consumers. Research will be aimed at developing and optimizing the control of such local grids and their connection to supraregional grid structures.

Investments in the bioliq® project total about EUR 64 million. Nearly 50% (about EUR 29 million) are funded by third parties. The Federal Ministry of Food and Agriculture (BMEL) contributed EUR 27 million, the Baden-Württemberg Ministry of Science, Research, and the Arts (MWK) financed EUR 1 million, and the European Regional Development Fund (ERDF) funded EUR 1 million. The BMEL funds were supplied via the funding agency Fachagentur Nachwachsende Rohstoffe e.V., FNR, while the ERDF funds were made available via the Baden-Württemberg Ministry of Finance and Economics (MFW).

Of the remaining investment costs, KIT and the Helmholtz Association finance EUR 24 million, the industry partners fund EUR 11 million. The industry partner of stages I (pyrolysis) and II (gas production) is Air Liquide Global E&C Solutions Germany GmbH, Frankfurt (formerly Lurgi GmbH). For the conditioning and storage system, the industry partner is MAT Mischanlagentechnik GmbH, Immenstadt-Seifen. The industry partner of stage IIIa (hot gas cleaning) is MUT Advanced Heating GmbH, Jena. Stages IIIb and IV (fuel synthesis) are implemented in cooperation with Chemieanlagenbau Chemnitz GmbH. Construction of all four stages required 50 km of cable, 12 km of pipeline, 250 motors, 40 pumps, and 1500 tons of steel. Engineers spent more than 100,000 hours constructing the plant. ■

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FOTO: MARKUS BREIG

Die bioliq®-Anlage ist in Betrieb

Ein Beitrag des KIT zur Forschung für die Energiewende

Das am KIT entwickelte Verfahren bioliq® (Biomass to Liquid Karlsruhe) nutzt trockene Restbiomasse, um hochwertige Kraftstoffe sowie Grundstoffe für die chemische Industrie herzustellen. Der Prozess umfasst mehrere Stufen: Schnellpyrolyse, Hochdruck-Flugstromvergasung, Heißgasreinigung und Synthese. Das KIT hat das von Bund, Land und EU geförderte Pilotprojekt mit mehreren Industriepartnern realisiert; die Gesamtinvestition beträgt 64 Millionen Euro. Weil das bioliq®-Verfahren auf Reststoffe aus der Land- und Forstwirtschaft wie Stroh, Heu und Holzabfälle zurückgreift, die sich weder als Nahrungs- oder Futtermittel eignen noch zusätzliche Anbauflächen belegen, vermeidet es den Konflikt zwischen „Tank und Teller". Das bioliq®-Konzept löst zudem das Problem der geringen Energiedichte der eingesetzten Restbiomasse, indem es dezentrale Verarbeitung und zentrale großtechnische Herstellung kombiniert.

Als Forschungsplattform bildet die bioliq®-Pilotanlage das Rückgrat des am KIT entstehenden Energy Lab 2.0, das Energiewandlung, -speicherung, -verteilung und -nutzung, elektrische, thermische und chemische Energieströme sowie neue Informations- und Kommunikationstechnologien integriert. Das bei bioliq® produzierte Synthesegas lässt sich auch zur Stromerzeugung einsetzen. Im Energy Lab 2.0 werden dazu eine Gasturbine und ein Generator eingesetzt. Eine weitere Möglichkeit besteht darin, das größtenteils aus Kohlenmonoxid und Wasserstoff bestehende Synthesegas über die Fischer-Tropsch-Synthese in gasförmige oder flüssige Kohlenwasserstoffe umzuwandeln und diese zu Gas, Flüssiggas, Diesel oder Kerosin zu veredeln. Über Methanisierung lässt sich aus dem Synthesegas Synthetic Natural Gas (SNG) herstellen. Dieses ist dem Erdgas ähnlich und lässt sich wiederum zur Wärmeerzeugung, zur gekoppelten Erzeugung von Strom und Wärme sowie als Kraftstoff nutzen. ■

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