Funding Programm
Biomass for Energy

SNG and LPG from biogenic waste materials –
technical feasibility and market potential

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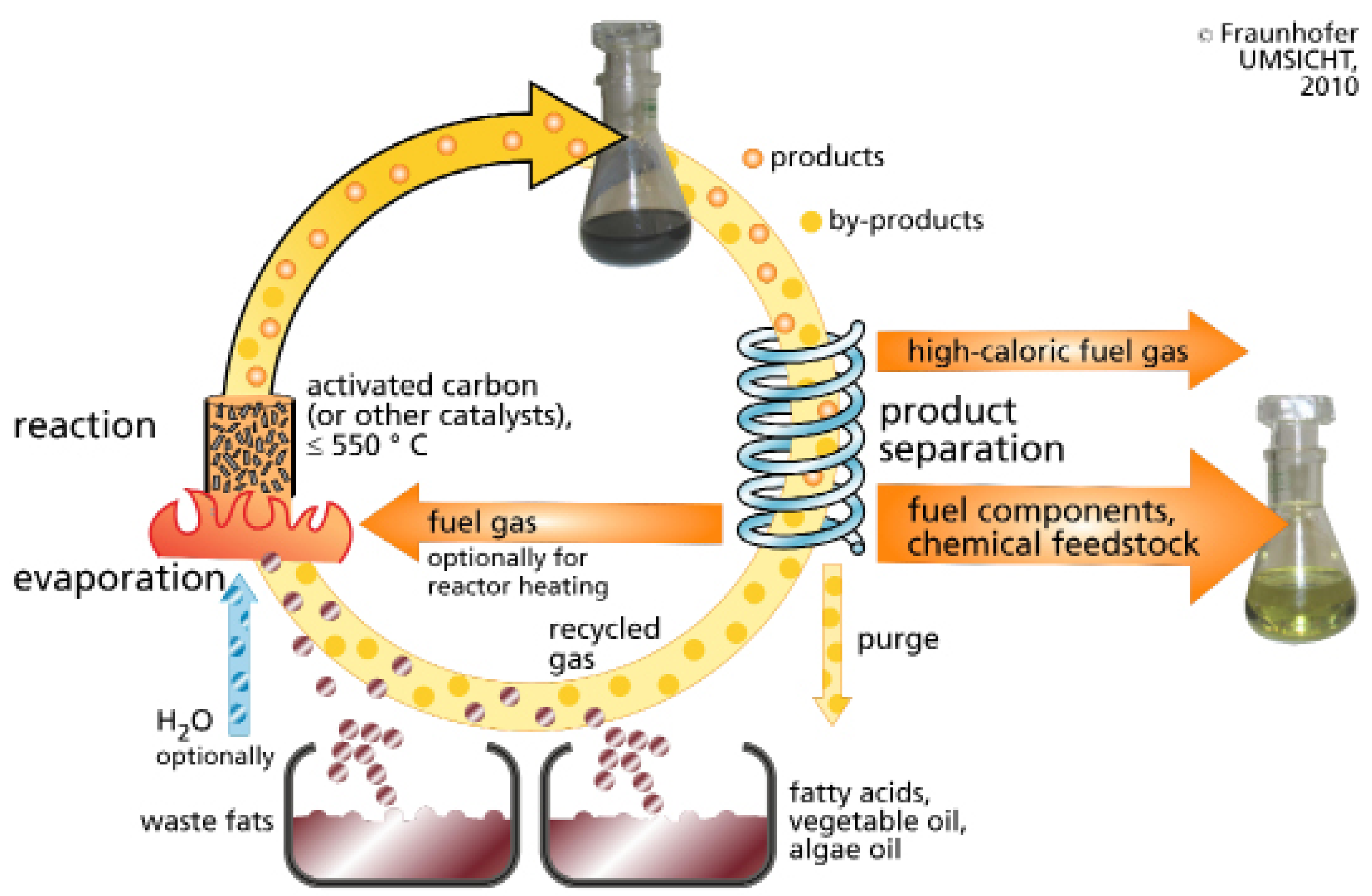
PROJECT DURATION
01.10.2009 - 30.11.2011

TOPIC
The project has explored the technical feasibility of producing high-grade hydrocarbon gas mixtures such as Substitute Natural Gas (SNG) or Liquefied Petroleum Gas (LPG) from bio-based oil residues and non-edible oils. Glycerol from biodiesel production, fatty acids and oil residues from the fatty acid and vegetable oil processing Industries were tested as potential feedstock substances.



AIMS
For the first time, the application of catalytic cracking for the specific conversion of vegetable oils and fats and their derivatives into fuel gases of high calorific value were investigated. The project has generated reliable information on which feedstock can be used for this purpose, suitable catalysts and process conditions and the achievable product qualities.

Based upon the experimental results, a potential study was carried out which portrays the most important end products and their applications and compares them to each other and to the competing feedstock utilization routes. With the products "bio-SNG" and "bio-LPG", the project eyes in particular both of the fuel grade gas mixtures of the mobility sector (Liquified Petroleum Gas LPG and Compressed Natural Gas CNG).

A special target product of the project is a mixture of fuel gas (LPG or similar gas composition) which can be used to upgrade bio-methane into bio-SNG for use in existing gas distribution systems.

Finally, the process development led to a preliminary basic design, thereby transfering the lab-scale process into small technical scale and production scale. Moreover, first reliable estimates of expectable costs of production were presented.

MEASURES
The catalytic cracking over micro- and mesoporous catalysts is a known process to transform vegetable and animal oil and grease as well as their derivates into oxygen-free hydrocarbon-compounds. Normally, gaseous hydrocarbons are formed as by-products. In this project, a lab scale plant for gas production by catalytic cracking was developed. Various feedstocks were tested by varying the process parameters and catalysts, and the products were examined by gas chromatography. Furthermore, it was tested experimentally to what extent the use of a substrate mix does effect the conversion.
Based upon laboratory results, the scale-up of the process into pilot and production scale were prepared. Setting up an ASPEN PlusTM flowsheet simulation has allowed calculating the most relevant mass and energy flows as well as first costing calculations.
This potential study has focused on the market potential of the bio-based LPG/SNG products which are not yet available on today's market. Appropriate first launching scenarios took possible synergies by blending the products with conventionally produced bio-methane/biogas into account.

RESULTS
Bio-based oil residues like average fats or free-fatty-acid-rich grease-trap contents, both from plant oil processing, turned out to be suitable feeedstocks for catalytic cracking. Using a gas-activated, granular activated carbon catalyst at 475 °C reactor temperature, energetic yields reached up to 52 % for the total gas phase and 47 % for the gaseous hydrocarbons. Still, the results indicate that a profitable implementation of the technology will require value creation from the liquid product as well. For example, introducing non-edible *Jatropha Curcas*-oil led to energetic yields of 55 % for the organic liquid product and 35 % for the gaseous hydrocarbons. Introducing glycerol turned out to be less favourable.
Typically, conversion over activated carbon leads to about 10 mol-% methane and about 5 mol-% ethane, propane, ethylene and propylene, respectively, in the gas product. Compared to liquid-phase-optimised operation, liquid phase composition shifts towards smaller hydrocarbons and aromatic compounds (without benzene). Quite in contrast, using a HZSM-5 zeolite catalyst led to 8 mol-% ethylene and 40 mol-% propylene in the gas product. The overall energetic yield of these two substances summed up to 51 %, while the organic liquid product, contributing another 32 % of energetic yield, mostly consisted of alkylated benzenes. Thus, producing chemical feedstock substances could well be an alternative, profitable route of gas-product-optimized catalytic cracking.

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