PHOTOFUEL

Biocatalytic solar fuels for sustainable mobility in Europe

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A European research project on renewable energies

Photofuel will develop a next generation technology for the sustainable production of alternative, liquid transportation fuels. The challenge is to advance the base technology of microalgae cultivation in closed bioreactors by enabling phototrophic algae or cyanobacterial microorganisms to produce alkanes and alcohols, which are excreted to the culture broth for direct separation without cell harvesting. This thereby turns the microbial cells into self-reproducing biocatalysts allowing the process to directly convert solar energy, water and CO_2 into engine-ready fuel instead of being used to form biomass, as shown in the figure 1.

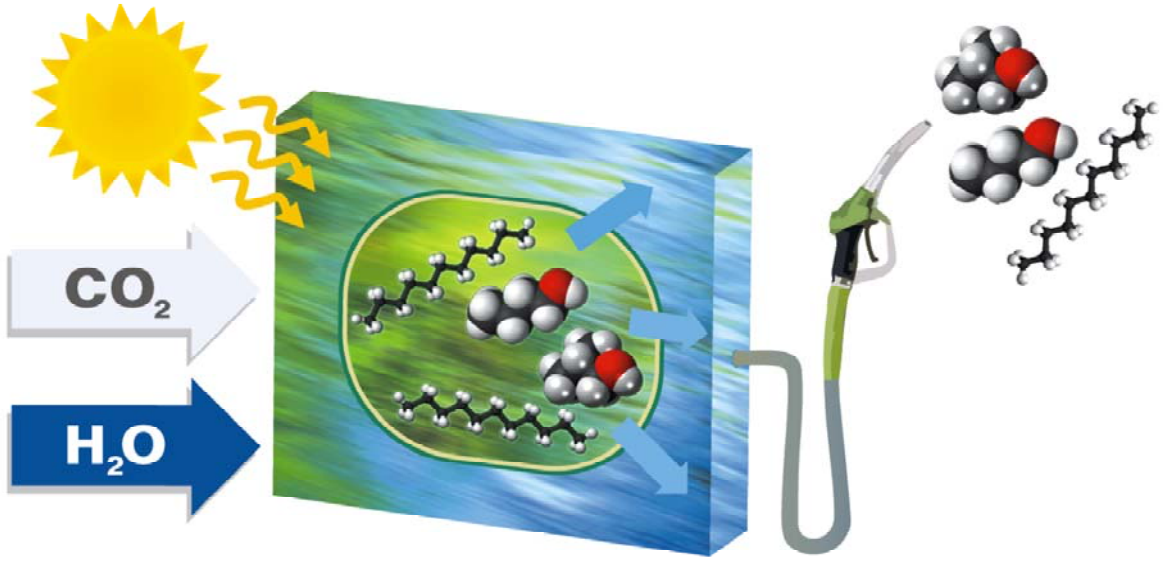

Figure 1: Overview of the biocatalytic conversion route from sunlight, CO_2 and water to solar fuels

Objectives

The overall objective of Photofuel is to make a significant contribution to the development of the field of biocatalytic production of solar fuels and to assess the broad impact of this novel approach to fuel composition and engine performance in the future. These activities are carried out as part of a joint industrial and academic consortium that encompasses all central but highly diverse areas of engineering (bio, chemistry, engines, assessment) and social science needed for this challenging task.

Major activities include the

- Development of advanced biocatalysts for the direct production of solar fuels
- Upscaling of cultivation volume and raw fuel production
- Upgrading/purification to fuel for blending and engine tests
- Analysis of risks, economic efficiency and environmental impact of the complete production pathway

This direct production of engine-ready fuel improves the energy efficiency of several steps along the chain: The biomass production is limited to the minimum needed to maintain the catalyst. This maximizes on the one side the flux of metabolic energy to fuel production and reduces on the other side the input demand e.g. for fertilizer. The energy-intensive cell harvesting is omitted as the biomass does not need to be dried prior to lipid extraction and trans-esterification of lipids is eliminated. For example, undecane is a drop-in fuel we expect to directly replace diesel or kerosene, while addition of butanol and octanol will alleviate the boiling point/vapor pressure problems of E5 and E10 gasoline without a need to exchange the already existing infrastructure for storage, distribution and utilization in vehicles.

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Project Plan

The project addresses the complete value chain: The development of biocatalysts, upscaling of cultivation volume, separation of the produced fuel compounds from the broth, upgrading of the raw products to fuel compounds, blending of engine-ready fuels, test in EURO6-engines and assessment of technology risks, economic effect and environmental impact. The results are merged to a plan for business development.

WP 2 is dedicated to the advancement of biocatalysts developed on base of two cyanobacterial strains and one microalgae by three European universities. In an iterative cycle biocatalysts are constantly upscaled and assessed in WP3. The best performing strain(s) are selected by the Photofuel consortium and jointly improved in the last 18 month of the project.

WP 3 assesses and cultivates the biocatalysts, their wild-type base strains and a naturally hydrocarbon producing microorganism as reference. The cultivation volume of the biocatalysts is upscaled in several steps to a final volume of 5m³ for outdoor production of fuel compounds. A dedicated control strategy and fuel separation process from the broth is developed. Options to recycle water, nutrients and energy as well as sanitation are studied.

WP 4 analyses and upgrades the crude biocatalyst products from WP 3. These are blended with fossil fuels and other biofuels to on-spec, engine-ready solar diesel and gasoline fuels.

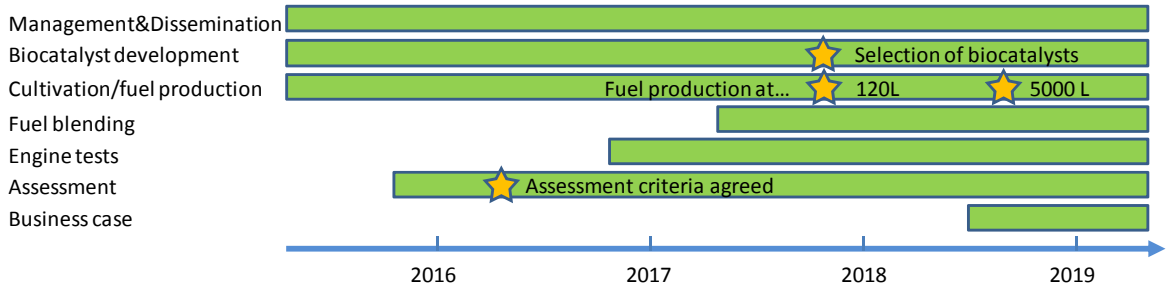
WP 5 studies the engine performance of solar fuel blends, prepared in WP 4 according to expectations of both WP on the composition of fuels in the future. Tests are performed in gasoline- and diesel engines of the coming EURO6 norm, representing passenger vehicles and trucks.

WP 6 assesses the Photofuel pathway: Techno-economic risks, risk perception and acceptability are one part. The analysis of the economical performance and environmental impacts of the Photofuel pathway enable the comparison to other existing or developing processes for the production of fossil and renewable fuels.

WP 7 summarises the project results for the preparation of a business development plan.

WP 1 disseminates the project results in press, on conferences and workshops and includes project management and administration.

WP's & Major Milestones



The final goal is to advance the solar fuel technology towards the aim of highly sustainable production of drop-in fuels on arid or marginal land. Economically and environmentally sustainable large-scale systems for geographically independent conversion of solar radiation into chemical energy would support rural communities and substitute significant shares of fossil energy for the benefit of Europe and many other regions.

Status July 2015

Photofuel started 1st May 2015. The Kick-Off meeting was held from 1st to 2nd July 2015 in Braunschweig at Volkswagen.

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Information

Budget	6 million EUR	**Funding**	6 million EUR
Duration	48 Months	**Start**	May 2015
EC-DG	Research	**Priority Area**	Renewable energies
Contract No.	640720		

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Partners

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