Success Story
COMET

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BE2020
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Utilisation of CO_2 from industry

The global emissions of CO_2-containing gases are steadily increasing, while the demand for additional carbon-based resources is growing at the same time. CO_2 is an alternative and valuable source of carbon, which is a suitable starting material for a variety of products. The use of CO_2-rich gases as a raw material for the European industry for the production of materials, chemicals and fuels could be a key solution for the reduction of greenhouse gases and the dependence on fossil imports.
In the project UseCO2, interesting value chains for the use of CO_2 were identified for the industry and the potential international markets were estimated.

Conversion technologies

A large number of different biotechnological and thermochemical conversion processes exist for the recycling of CO_2 to higher-quality products. After considering several advantages and disadvantages of several possible transformation routes, three promising biotechnological value chains were identified and evaluated:

- **PHB value chain:** CO_2 is used for the cultivation of cyanobacteria. After biomass growth, a nutrient limitation is induced which leads to an accumulation of polyhydroxybutyric acid (PHB) within the cells. The biomass rich in PHB is converted into biocrude and propylene in a hydrothermal condensation stage. The remaining aqueous phase contains mineralized nutrients which are recirculated into the cultivation chain.
- **Acetate value chain:** Acetobacterium woodii is used together with CO_2 and H_2 for the production of acetate by acetic acid fermentation. Acetate is an important basic chemical with a wide range of application possibilities. The current microbial production of organic acids is sugar-based, with the system presented in the project, no additional carbon source is necessary, since CO_2 is used as a carbon source.

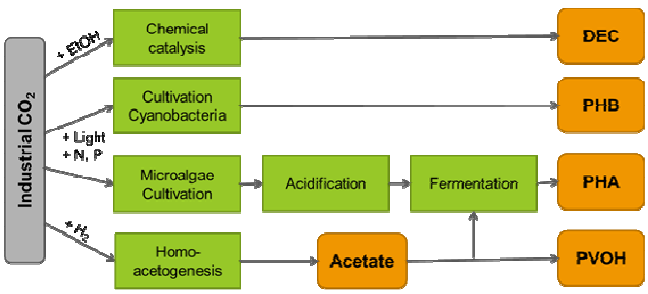

Fig. 1: Value chains for industrial CO_2 (copyright BIOENERGY 2020+)

bmwfw Federal Ministry of Science, Research and Economy
bmvit Austrian Ministry for Transport, Innovation and Technology

• **Biomass value chain:** This system uses a biorefinery approach. CO2, light and nutrients are required for microalgae cultivation. The nonspecific biomass produced is further processed into organic acids (such as acetic acid or propionic acid) in an acidification step and then converted into polyhydroxybutyric acid in a heterotrophic fermentation process. This is used for the production of biodegradable plastics. The fermentation residue is used for biogas and biomethane production.

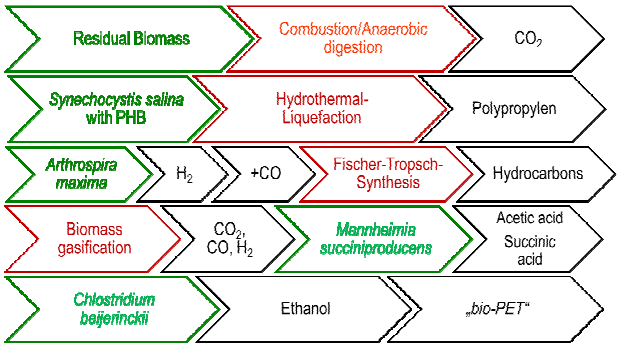

Fig. 2: Selection of possible hybrid utilization value chains (copyright: BIOENERGY 2020+)

In addition, a selection of possible hybrid utilization routes was investigated. Fig. 2 shows the systems consisting of thermochemical process steps (red) and biotechnological process steps / microorganism (green). Products and intermediate products are shown in black in Fig. 2.

The market potential for market volumes, applications, market sectors and market players was examined for the selected products diethyl carbonate (DEC), acetic acid / acetate and polyhydroxybutyric acid (PHB).

For example DEC will be used as an electrolyte for lithium batteries in the course of future enhanced electromobility. In the case of acetic acid, a very sharp fall in prices has been registered in Europe over the last ten years. PHB prices currently depend strongly on the price development of conventional plastics.

Impact and effects

Some of the defined and considered value chains can generate higher-quality products for the industry through biobased processes, thereby promoting the replacement of fossil by biobased materials. The interesting utilization paths stand out with certain advantages. These are processes that use industrial CO_2 directly and as the only source of carbon and whose generated products have high market potential and growing markets.
The UseCO2 project shows interesting fields of interest and promising value chains, which still pose further research requirements in the field of the use of industrial CO_2.

For the value chain via acetate, a follow-up COMET project could already be initiated with new company partners.

Contact and information
K1-Centre BE2020

BIOENERGY 2020+ GmbH
Inffeldgasse 21b, A-8010 Graz
T + 43 (316) 873-9201
E office@bioenergy2020.eu, www.bioenergy2020.eu

Project coordinator
Christoph Strasser

Project partners

Organisation	Country
voestalpine Stahl GmbH	Austria
EVN AG	Austria
BOKU IFA Tulln	Austria
AIT Tulln	Austria
TU Wien	Austria