Federal Ministry
of Education
and Research

CO_2WIN
Use Carbon Sustainably

Bio-UGS – Biological conversion of carbon dioxide and hydrogen to methane

CO_2 as a sustainable source of carbon - Pathways to industrial application (CO_2-WIN)

The project "Bio-UGS" investigates the targeted conversion of carbon dioxide and green hydrogen to methane in underground gas storage facilities by using natural existing microorganisms. This shall reduce the dependency on imported fossil fuel and help to develop a circular economy for CO_2 from industrial processes and a storage concept for hydrogen from renewable energies. The project is funded as part of the funding measure "CO_2 as a sustainable source of carbon – Pathways to industrial application (CO_2-WIN)". The measure supports projects that utlilize carbon dioxide as raw material for the German economy.

Synthetic methane from green hydrogen and industrial CO_2

With enhanced integration of wind and solar energy, the demand for large-scale and efficient storage facilities increases to compensate for fluctuations in energy generation and demand. At the same time, CO_2 is produced as a waste product in numerous industrial processes, whose impact on the climate shall be reduced.

Existing large-volume natural gas storage facilities provide the potential for biological natural gas formation. By commingling CO_2 and green hydrogen injection, synthetic methane will be created by using naturally occurring microorganisms as bio-catalyst. For this process, the existing infrastructure can be used for large-scale conversion processes, and CO_2 can be recycled.

Hence, the porous underground gas storage facilities will be converted from large-scale physical energy storage to bio- and geochemical process facilities.

Methanation test rig.

Biological methanation in UGS

The leading research foci are the investigation of mineralogical-chemical reactions in reservoir rocks and their influence on the methanation and the determination of the stimulation potential of an H_2-CO_2-exposition on microbial reservoir communities. The bio-methanation is investigated in extensive laboratory tests with representative rock- and fluid samples of German porous underground gas storage facilities under real pressure, temperature, and saline conditions.

Amongst others, the stimulation of positive as well as inhibition of negative (side) processes of bio-methanation is investigated. An example is the influence of impurities in the reactants.

Further, risks regarding the integrity of the storage reservoir and boreholes including limiting measures are assessed. The microbial methane generation in laboratory tests is up-scaled to field scale by numerical reservoir simulation and recommendations for economical storage regimes are made, also considering the expected technical risks.

Based on these findings, a catalog of recommendations for field tests including selection criteria for suitable locations will be developed.

Project team, results, utilization

The project is carried out by partners from research institutions and industry to ensure practical applicability and well-founded basic knowledge. The team of experts consists of geoscientists and biologists with extensive expertise and technical know-how.

The interest in the project results with respect to storage operators is already very high: multiple national and international companies have assured their support for the project in form of result validation or by providing sample material.

The project is structured into four sub-projects: DBI Gas- und Umwelttechnik GmbH (DBI Gas and Environmental Technologies Ltd) carries out gas quality studies and reservoir simulation of the bio-methanation processes based on provided samples and mineralogical-geochemical investigations by Friedrich-Schiller-University Jena. Isodetect GmbH is responsible for the analysis of the bio-methanation reactions using isotope-chemical and molecular-genetic analyzes and creates a monitoring concept for the field application. MicroPro GmbH examines the stimulation and optimization of microbial processes in the laboratory and carries out the corresponding risk assessment.

Insight: laboratory microcosms.

Funding initiative
CO_2 as a sustainable source of carbon –
Pathways to industrial utilization (CO_2-WIN)

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Bio-UGS – Biological conversion of carbon dioxide and hydrogen to methane in porous underground gas storage facilities

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Contact
Dipl.-Ing. Hagen Bültemeier
DBI Gas- und Umwelttechnik GmbH
Karl-Heine-Straße 109/111
04229 Leipzig, Germany
Phone: +49 3731 4195343
E-mail: hagen.bueltemeier@dbi-gruppe.de

Project partner
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