METHANATION IN THE STEEL INDUSTRY

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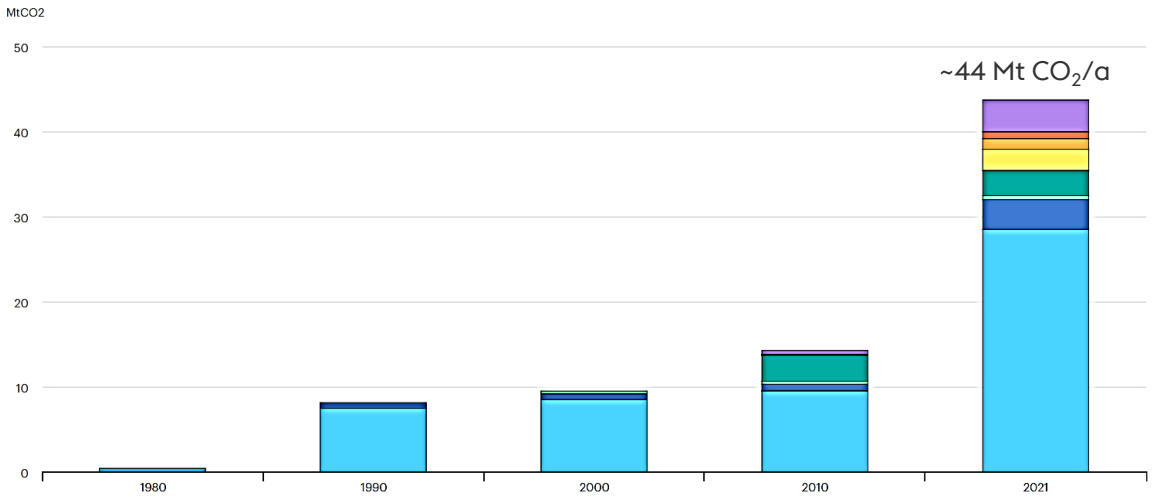
GLOBAL CCU/S FACILITIES
OVERVIEW



https://www.iea.org/data-and-statistics/charts/ccus-facilities-in-operation-by-application-1980-2021

Global CCU/S facilities in operation by application, 1980-2021

Natural gas processing
Fertiliser
Power generation
Bioethanol
Steel
Hydrogen
Chemicals
Synfuel

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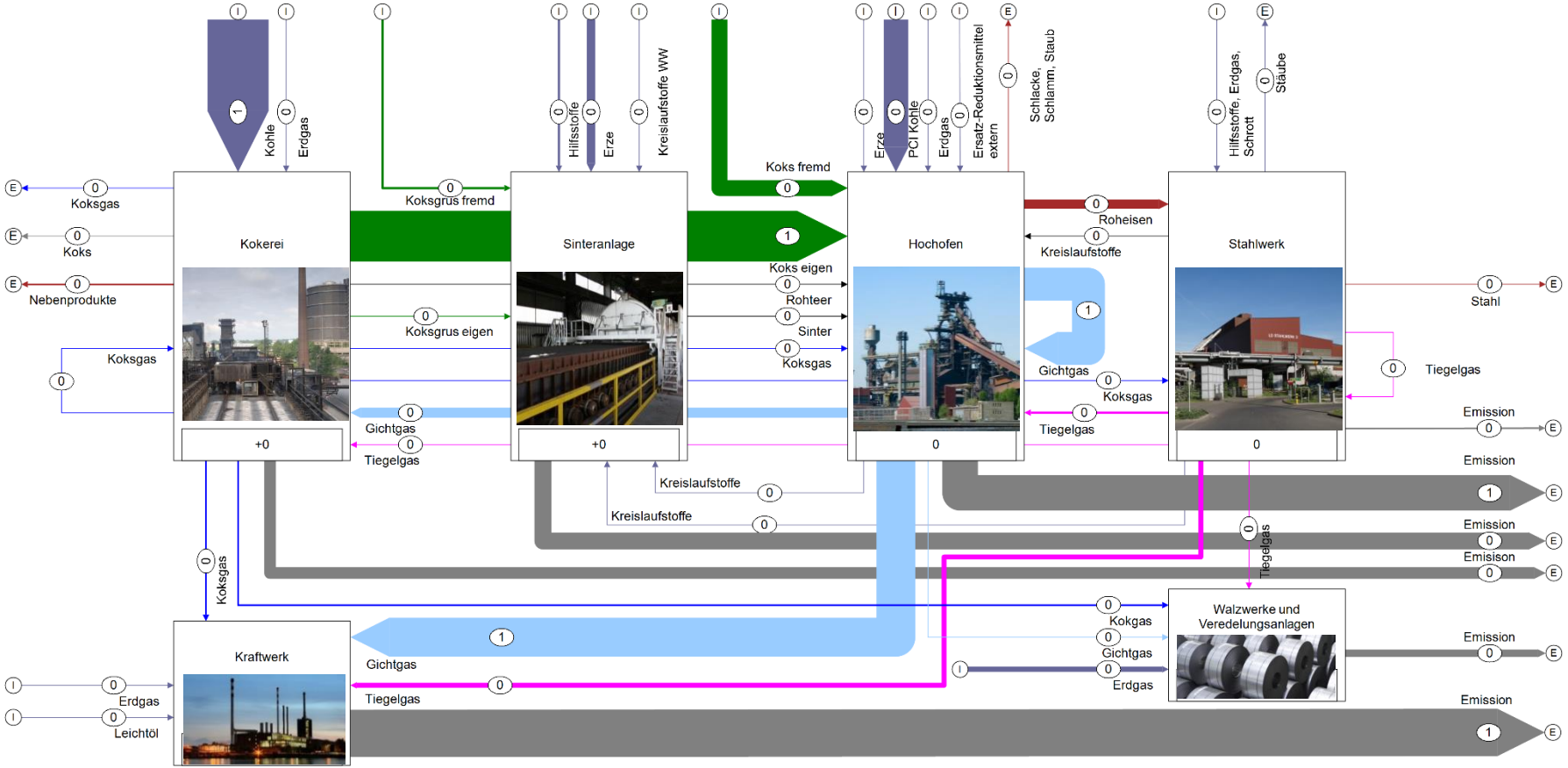

KJ2021 Productionsprocess, CO_2 standardized

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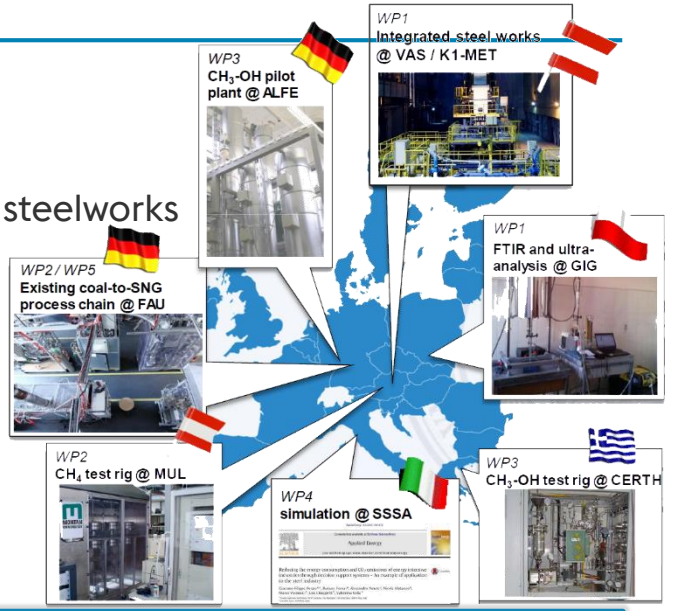
I3upgrade
RFCS Research Project

i³upgrade
intelligent integrated industries

- Integrated and intelligent upgrade of carbon sources through hydrogen addition for the steel industry
- Re-utilization and upgrade of fossil by-product gases in integrated steelworks
- Integration of dynamic synthesis (methane, methanol) in an integrate steelworks in combination with (renewable) hydrogen
- Advanced process control strategies for dynamic synthesis



https://www.i3upgrade.eu/

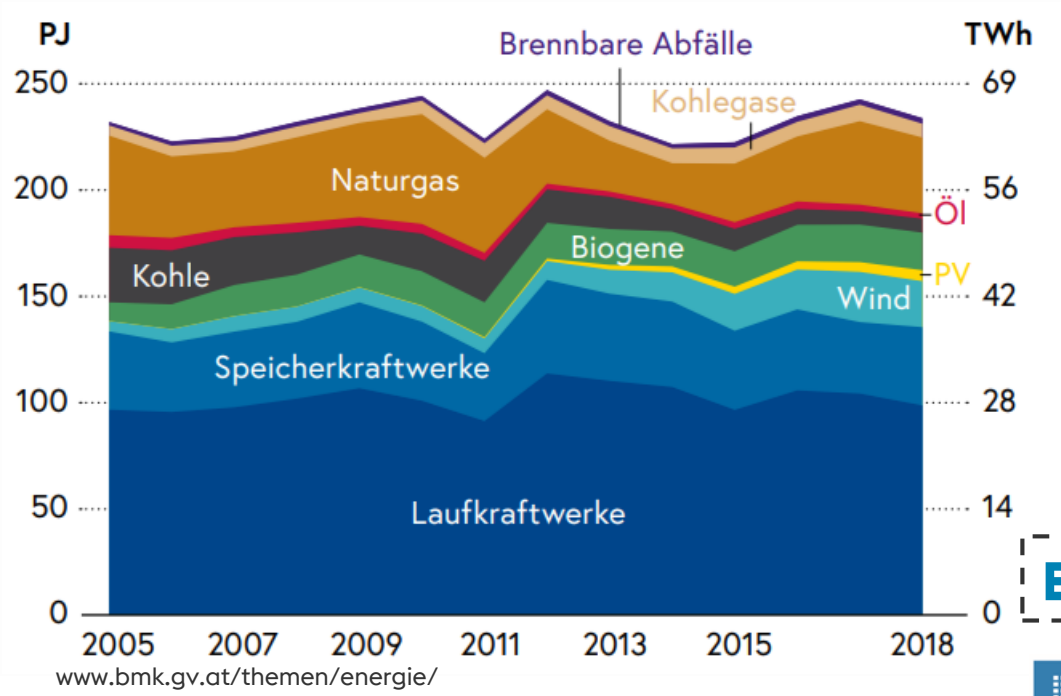
Project budget: 3.3 M€

Total EU-funding: 2 M€ (60 % funding)

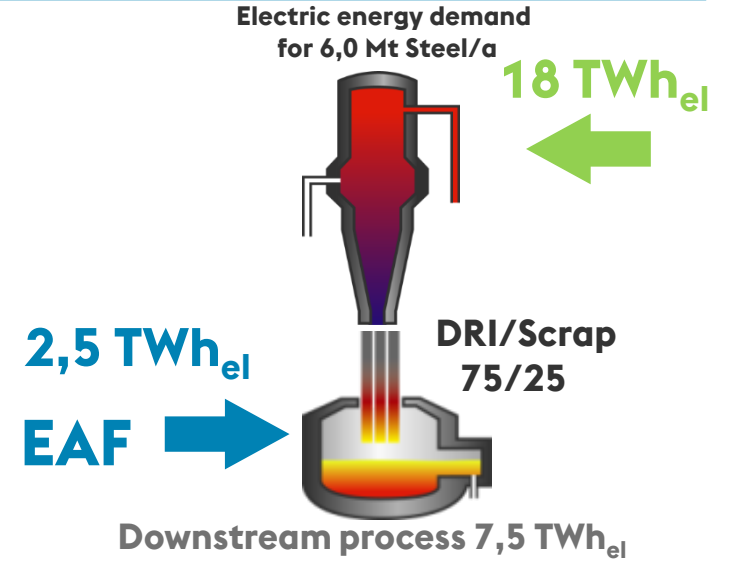
Project duration: 3.5 years (2018-2021)

Funding body: Research Fund for Coal and Steel (RFCS)

TRANSFORMATION SCENARIO
ELECTRIC ENERGY PRODUCTION AUSTRIA



www.bmk.gv.at/themen/energie/



Electric energy demand 28 TWh$_{el}$

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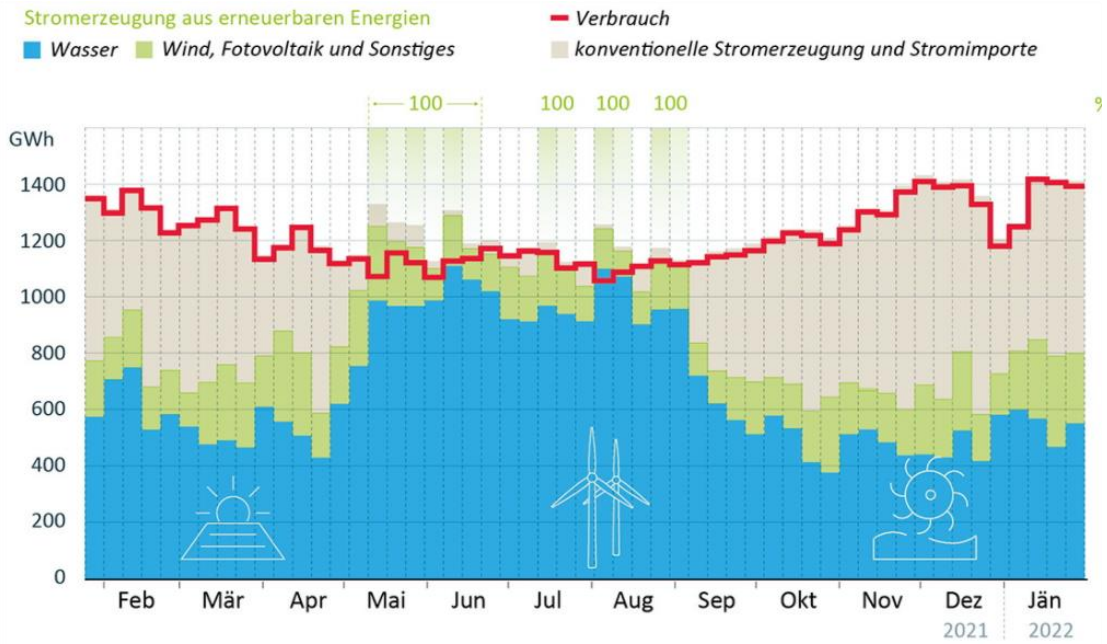
TRANSFORMATION SCENARIO
ELECTRIC ENERGY PRODUCTION AUSTRIA 2021



- Renewable electric energy can fully cover the electricity demand from May to August
- Approx. 20 TWh renewable electric energy necessary for 100 % supply in 2021
- Austrian government program 2020: 100 % renewable electric energy in 2030, climate neutrality in 2040

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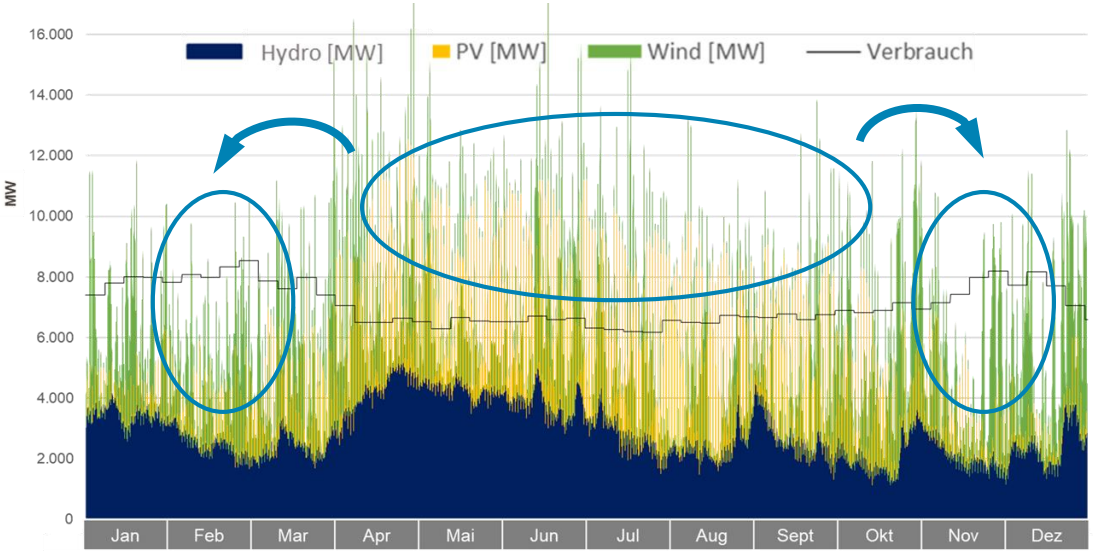
TRANSFORMATION SCENARIO
100 % RENEWABLE ELECTRIC ENERGY 2030



- Additional 27 TWh of new renewable electric energy generation capacities with high seasonal fluctuation in 2030
- 100 % renewable sources creates approx. 10 TWh excess energy over 6 months in summer period
- Sector coupling as key for stabilising the renewable energy system and chemical storage for the demand in the winter period

Christiner, G., Die zentrale Bedeutung der Netze beim Umbau des Energiesystems. Presentation at the Renewable Energy conference, Klagenfurt (Austria), 2017

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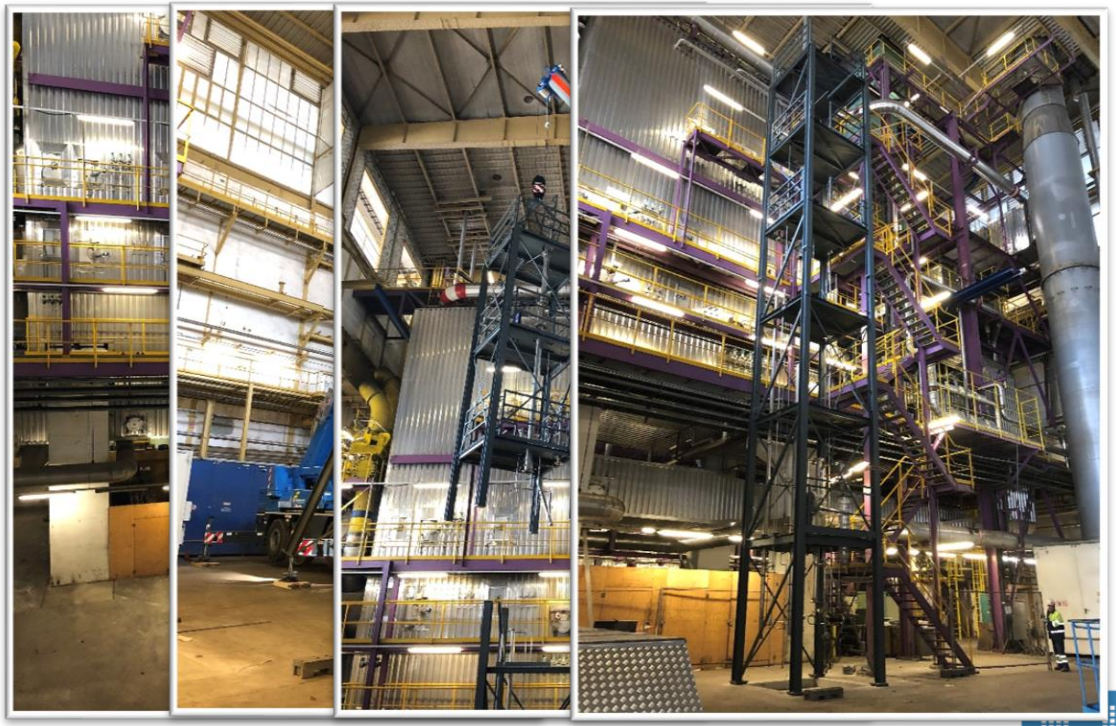
C-CED
CO_2 AMINE SCRUBBER

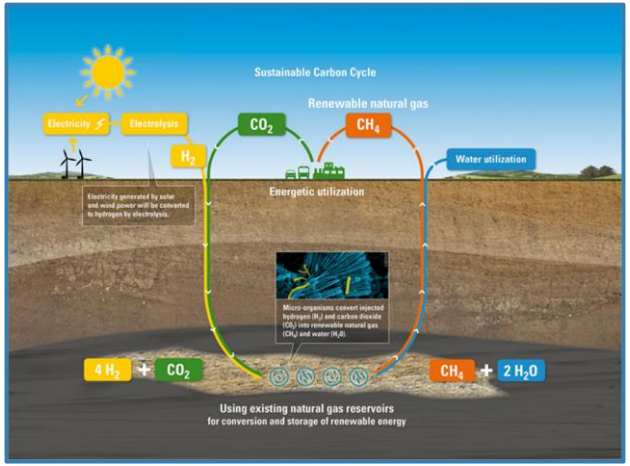


CARBON CYCLE ECONOMY DEMONSTRATION
C-CED

- Demonstration and coupling of various CO_2 capture and CO_2 utilization technologies
- CO_2 from various sources: BFG and power plant off gas (voestalpine) and biogas (Energie AG)
- Produce methane via methanation processes in pilot scale (geo- and bioelectrochemical)

Partners
RAG Austria AG (Project Coordinator)
ACIB GmbH, Axiom Angewandte Prozesstechnik GmbH
Energie AG, Energieinstitut an der JKU, K1-MET GmbH
BOKU (IFA Tulln), Verein WIVA P&G, voestalpine Stahl GmbH

Call:	3rd Call - Energy Model Region
Budget:	8.601.341 €
Duration:	4 years
Start:	Q3-2021



Schema für großtechnische Methanproduktion mittels natürlich vorkommender Mikroorganismen in einem ausgeförderten Gasspeicher (Quelle BOKU)

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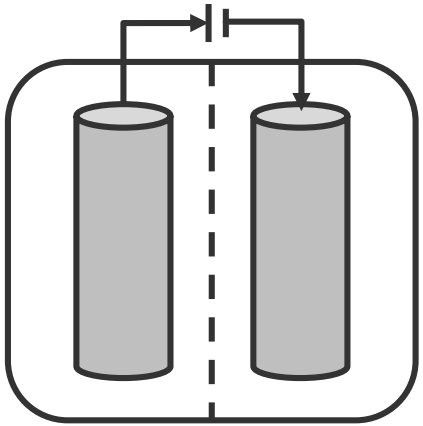
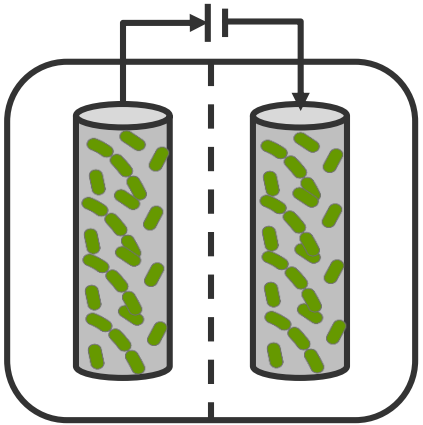
Bioelectrochemistry
DEFINITION

- Interdisciplinary research
- Conversion of chemical energy in electrical energy and vice-versa by employing electroactive microbes as biocatalysts

Microbes



Electrochemistry

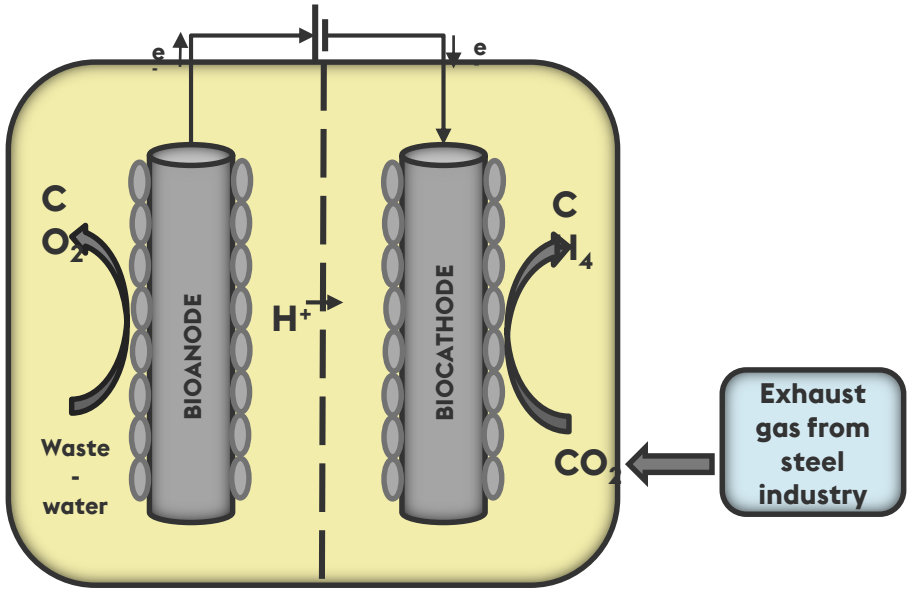


Bioelectrochemical system (BES)

LOCON

Low Energy CO_2 conversion and utilization at the example of steel industry

- Setup of a fully biocatalyzed electrochemical system
- Combination of organic substances oxidizing bioanode and CO_2 reducing biocathode to CH_4 in one system
- Methanation of „pure" CO_2
- Methanation of exhaust gas from steel industry



$C_6H_{12}O_6 + 6\ H_2O \rightarrow 6\ CO_2 + 24\ H^+ + 24\ e^-$ $\quad$ $CO_2 + 8\ H^+ + 8e^- \rightarrow CH_4 + 2\ H_2O$

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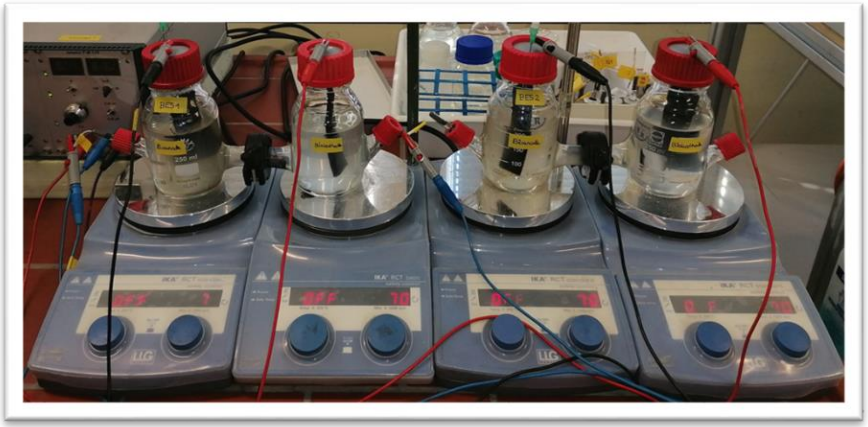
LOCON
Methodology

- Substrate

  Bioanode
  - 3x per week
  - 1 g/L acetate

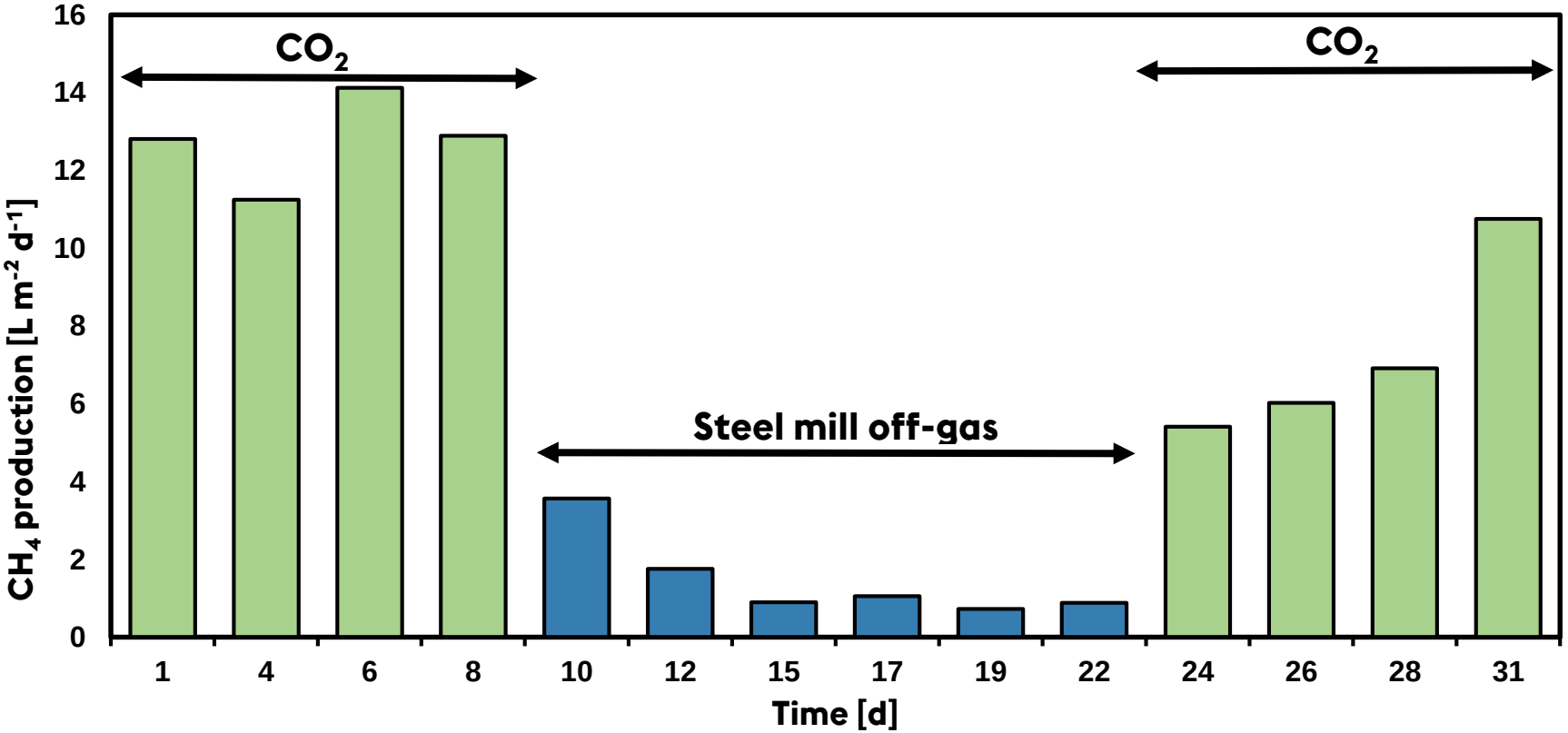
  Biocathode
  - 3x per week
  - 99.99 Vol% CO_2 / steel mill off-gas

- Potential
  - +400 mV vs. Ag/AgCl at bioanode

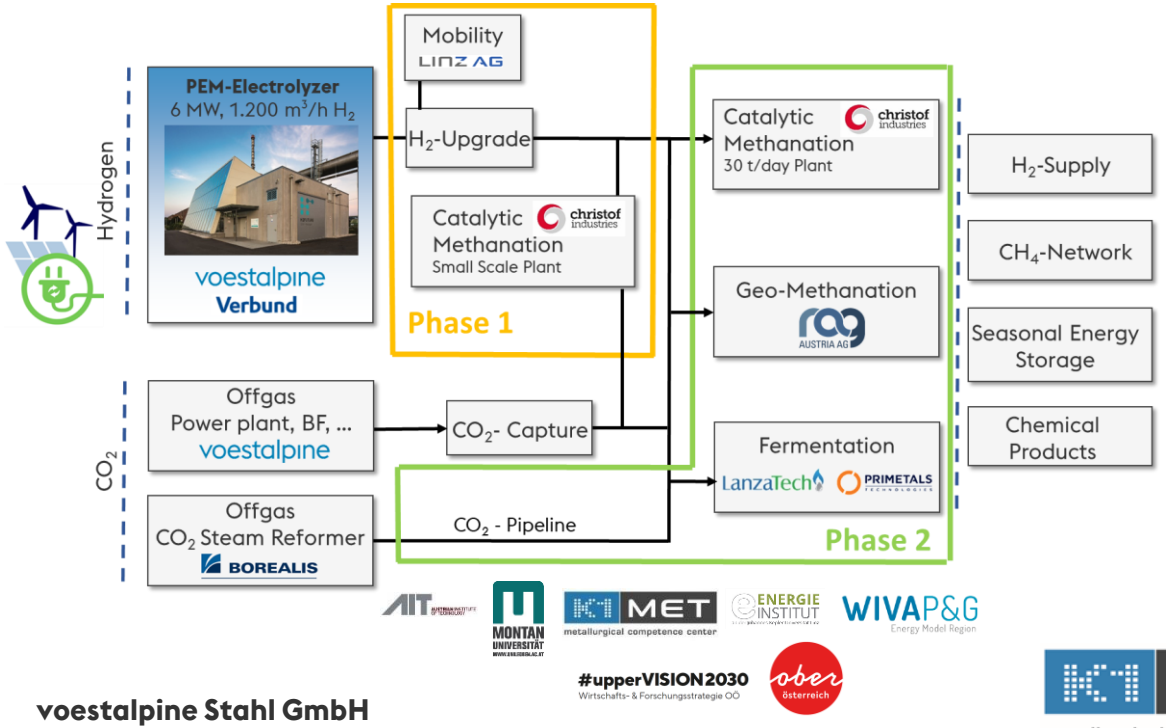


- Monitoring
  - Bioanode: pH, COD removal, current
  - Biocathode: pH, CH_4 production

LOCON
Results



BREAKTHROUGH TECHNOLOGY
HYDROGEN AND CARBON MANAGEMENT



- CO_2 capture at industrial sites → transformation of H_2/CO_2 to hydrocarbons → use in different sectors and storage
- The region Upper Austria has an USP for sector coupling with a significant concentration of energy intensive industrial sectors
- Systematic approach for the renewable energy system from production to use and storage

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Thank you

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