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KEROGREEN

"Production of Sustainable aircraft grade Kerosene from water and air powered by Renewable Electricity, through the splitting of CO₂, syngas formation and Fischer-Tropsch synthesis"

Project No: 763909

Deliverable D7.4

Electronic documentation of the second workshop

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Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Deliverable Nature

Nature of Deliverable		
R	Report	x
P	Prototype	
D	Demonstrator	
O	Other	

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Changes with respect to the DoA

Issue	Comments
Event place and topic	Remote event due to corona pandemic. Topic adjusted to the requirements of event (co-organised event bringing together 10 EU H2020 projects)

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1 Introduction

The present deliverable reports on the second workshop in the framework of the KEROGREEN project. The workshop was originally planned to be organised at KIT as “own-project” event and focusing on “sector coupling as new ways from CO₂ to fuel”. However, as EC-INEA representatives suggested in 2019 H2020 consortia to organise joint events on common topics, KEROGREEN consortium decided to be part of a larger event and accepted to co-organise together with 10 other EU-Projects an international workshop on “CO₂ Capture and Utilization”. Due to the pandemic the event was held remotely on February 16 and 17, 2021.

2 Workshop Organisation

The workshop was co-organised by 11 EU projects (see list below) and the Eindhoven University of Technology under the lead of Prof. Dr. Eng. Fausto Gallucci, Dean of the Department of Chemical Engineering and Chemistry and Professor at the Eindhoven University of Technology, who chaired the Workshop Program Committee. This committee was formed by a local organisation committee of 9 members (see [details here](#)) and representatives of the participating EU projects. Concerning KEROGREEN both the project coordinator Adelbert Goede (DIFFER) and Prof. Roland Dittmeyer (KIT) supported the coordination and organization.

The initial idea of the workshop emerged after an EC-INEA event organised September 2019, bringing together several like-minded EU projects funded by the Agency. This was followed by bilateral discussions driven by Prof. Gallucci, who took charge of the overall event organisation. Several telephone conferences were organised since July 2020 in order to discuss the content and define contributors. Each EU project was asked to recruit invited speakers and propose 1 to 2 internal representatives for oral presentations.

The objective of the workshop was to bring together researchers and members of various organizations involved in EU-funded projects devoted to CO₂ capture and utilization in order to exchange the latest results in their R&D work. This creates a good opportunity for a direct peer-review of the methods and results obtained, creation of new contacts for future collaboration and creation of new project ideas for future work at European level.

The workshop was targeted at academia, research organisations and industry working in fields related to CO₂ capture, storage and utilization. All participants were invited to contribute their views on the topic and to present their research in the form of a poster.

2.1 Co-organising EU projects and sponsors

Below you can find information regarding the 11 EU projects co-organising the workshop.

N°	Acronym	Project Title	Website	Grant agreement
1	MEMBER	Advanced MEMBranes and membrane assisted procEesses for pre- and post-combustion CO2 captuRe	https://member-co2.com/	760944
2	CARMOF	TAILOR-MADE 3D PRINTED STRUCTURES BASED ON CNTS AND MOFS MATERIALS FOR EFFICIENT CO2 CAPTURE	https://carmof.eu/	760884
3	BIOCOMEM	Bio-based copolymers for membrane end products for gas separations	https://www.biocomem.eu/	887075
4	C2FUEL	Carbon Captured Fuel and Energy Carriers for an Intensified Steel Off-Gases based Electricity Generation in a Smarter Industrial Ecosystem	https://c2fuel-project.eu/	838014
5	COZMOS	Efficient CO2 conversion over multisite Zeolite-Metal nanocatalysts to fuels and OlefinS	https://www.spire2030.eu/cozmos	837733
6	eCOCO2	Direct electrocatalytic conversion of CO2 into chemical energy carriers in a co-ionic membrane reactor	https://ecocoo.eu/	838077
7	CO2Fokus	CO2 utilisation focused on market relevant dimethyl ether production, via 3D printed reactor- and solid oxide cell-based technologies	https://www.co2fokus.eu/	838061
8	C4U	Advanced Carbon Capture for steel industries integrated in CCUS Clusters	https://c4u-project.eu/	884418
9	REALISE	Demonstrating a Refinery-Adapted Cluster-Integrated Strategy to Enable Full-Chain CCUS Implementation	https://realiseccus.eu/	884266
10	CONVERGE	CarbON Valorisation in Energy-efficient Green fuels	https://www.converge-h2020.eu/	818135
11	KEROGREEN	Production of Sustainable aircraft grade Kerosene from water and air powered by Renewable Electricity, through the splitting of CO2, syngas formation and Fischer-Tropsch synthesis	http://www.kerogreen.eu/	763909

In addition to the Eindhoven University of Technology, the event was supported by the Dutch Research Council [NWO](#) as well as the journal [processes](#).

2.2 Program and speakers

The event lasted two days and included several plenary sessions as well as three individual sessions each time with two parallel groups. The event was ended by a general round table discussion.

Details below.

PROGRAM DAY 1

Breakup Room 1		Breakup Room 2	
Opening & Plenary sessions (chairperson Fausto Gallucci)			
9:00-9:30	All coordinators - Introduction to projects		
9:30-10:00	Dr. E. De Coninck (CTO ArcelorMittal) - The zero Emission Plant		
10:00-10:30	Dr. Walter Eevers (CO2 Value Europe)		
10:30-11:15	Coffee break and posters		
Session 1A (chairperson Jose Luis Viviente)		Session 1B (chairperson Camel Makhloufi)	
11:15-11:35	Dr. O. David - A review of the membrane development steps from material to final product	Dr. M. Noponen and Dr. X. Sun - High temperature electrolysis and co-electrolysis	
11:35-11:55	Dr. V. Spallina - System simulation for integration of CO ₂ capture technologies into steelworks and CCUS clusters	Prof. J Serra - Direct electrocatalytic conversion of CO ₂ into chemical energy carriers in a co-ionic membrane reactor	
11:55-12:15	Dr. M. Saric - Methanol membrane reactor: modelling and experimental results	Dr. V. Middelkoop - CO2Fokus at a glance: CO ₂ utilisation focused on DME production, via 3D printed reactor and solid oxide cell based technologies	
12:15-12:35	Dr. Adam Deacon - Realising the potential of MOFs through efficient scale-up	Dr. M. Tsampas - The KEROGREEN CO ₂ plasma route to CO and alternative fuels	
12:35-12:55	Dr. M. Etxeberria-Benavides - PBI based mixed matrix hollow fiber membranes for pre-combustion CO ₂ capture	Dr. G. Bonura - 3D-printing in catalysis: Development of efficient hybrid systems for the direct hydrogenation of CO ₂ to DME	
12:55-14:00	Lunch break		
Plenary session (chairperson Fausto Gallucci)			
14:00-15:00	Dr. Angels Orduna (Spire 2030)		
Session 2A (chairperson Giampaolo Manzolini)		Session 2B (chairperson Vesna Middelkoop)	
15:00-15:20	Dr. G. Garcia - LCA and TEA of the COZMOS technology	Dr. M. Sleczkowski and Dr. Pablo Ortiz - Turning gas separation membranes green with biobased block copolymers	
15:20-15:40	Dr. A. Mattos or Dr. A. Mitchell - How can public policy and business model innovation be developed to address challenges of CCUS and realise the opportunity?	Dr. A. Benedito - CARMOF Project: a CO ₂ capture demonstrator based on membrane and solid sorbents hybrid process	
15:40-16:00	Dr. L. Engelmann - Perception of CO ₂ -based fuels and their production in international comparison	Dr. R.H. Heyn - Introduction to the COZMOS project	
16:00-16:20	Dr. N. Dunphy - Social studies in REALISE project	Dr. L. Petrescu - Converge technology for efficiency methanol production with negative CO ₂ emissions: energy and environmental analysis	
16:20-17:05	Coffee break and posters		

PROGRAM DAY 2

Breakup Room 1		Breakup Room 2
Opening & Plenary Sessions (chairperson Fernanda Neira D'Angelo)		
9:30-10:00	All coordinators - Introduction to projects	
10:00-11:00	Dr. K. Bakke - Northern Lights – concept, plans and future	
11:00-11:45	Coffee break and posters	
Session 3A (chairperson José Serra)		Session 3B (chairperson Oana David)
11:45-12:05	Dr. A. De Paula Oliveira - SER and SEWGS for CO ₂ capture: experimental results	Msc. A. Sliousaregko - Industrial membrane requirements for CO ₂ removal from different gas mixtures - Current practices and developments
12:05-12:25	MSc. S. Poto - Membrane reactors for DME production	Dr. I. Kim - Technologies demonstration in REALISE
12:25-12:45	Dr. U. Olsbye - Catalyst development within the COZMOS project	Dr. N. Kanellopoulos - Hybrid VTSA pilot plant and design of industrial demo plant for CO ₂ capture
12:45-13:05	Dr. S. Krishnamurthy - CO ₂ capture using 3D printed PEI adsorbents supported by carbon nanostructures	Mr. Paul Cobden and Prof. C. Abanades - Pilot preparation for demonstration in the C4U project
13:05-13:25	Dr. S. Perez - Process intensification in the conversion of CO ₂ with a milli-structured reactor	Mr. T. Swinkels - Decentralized FA based power generators
13:25-13:45	Dr. F. de Sales Vidal Vazquez - The KEROGREEN syngas route to alternative fuels and chemicals	Dr. L. Roses - Design and development of a membranebased post-combustion CO ₂ capture system
13:45-14:30	Lunch break	
14:30-15:30	Round table and questions - closure (chairpersons Fausto Gallucci and Fernanda Neira)	

Two oral presentations of KEROGREEN related content were presented by consortium members:

- M. Tsampas from DIFFER (Session 1B)
- F. Vidal Vázquez from KIT-IMVT (Session 3A).

Presentations are available in the [final report](#) (respectively starting on page 212 and page 550). In addition, three posters on the project approach and results have been presented by consortium members:

- [“Development of solid electrolyte cell by spray coating”](#) by M. Jacobs (VITO)
- [“Experimental investigation of the sorption-enhanced water-gas shift reaction for continuous syngas production in jet fuel synthesis”](#) by T. Stadler (KIT-IMVT)
- [“KEROGREEN - A plasma-driven approach for fuel production”](#) by S. Welzel (DIFFER).

2.3 Event website and promotion

A dedicated event website has been coordinated by the University of Eindhoven (<https://iwccu.org/index.php>). Beside an overview of the program and partners and sponsors, the website gives access to all the presentations, posters, and additional resources as well as to the [final report](#), which contains all the event-related information.

All participating EU project members and the University of Eindhoven broadly disseminated the event within their networks.

3 Workshop implementation

In total 256 persons from more than 70 (EU and non-EU) countries participated in the workshop.

Eleven projects took part in the workshop, which gave the opportunity to have a good overview of many different technologies involved in the full process chain of CO₂ capture and utilization. These

technologies considered both CO₂ from biomass and from fossil fuel sources. The following topics were presented and discussed during the workshop:

- CO₂ capture:
 - o Membrane separation using different materials.
 - o Adsorption using solid sorbents.
 - o A 3D-printed materials in an adsorption system.
 - o Absorption using 2nd generation amine-based sorbent.
- Syngas production:
 - o Co-electrolysis.
 - o Combination of CO₂ plasmolysis, O₂ separation and sorption-enhanced Water-Gas Shift.
- Hydrogen production:
 - o Combination of biomass gasification and sorption enhanced Water-Gas Shift.
 - o Solid-oxide electrolysis.
- CO production:
 - o Combination of CO₂ plasmolysis, O₂ separation and Pressure-Swing Adsorption.
- Hydrogen compression:
 - o Electrochemical compression.
- Fuel or chemicals production:
 - o Methanol synthesis using membrane reactor.
 - o Kerosene production by combination of Fischer-Tropsch synthesis and hydrocracking of hydrocarbons.
 - o CO₂ methanation using 3D-printed heat-exchanger reactors.
- CO₂ transport and storage:
 - o CO₂ liquefaction.

Presentations and posters have been shared after the event via the website.

In addition, a [special issue](#) "Advances in CO₂ Capture and Conversion" has been published after the Workshop in the journal *processes*.

4 Summary and conclusion

The workshop received high number of participants (256 participants) from over 70 countries despite the pandemic and thus, only the participation online was possible. The workshop presented the latest results with high quality oral and poster presentations from the 11 EU-funded projects involved. This presentation led to fruitful discussion among the participants. In particular, two oral presentations and three poster presentations were delivered by the KEROGREEN project, which received a good level of attention. The material of all presentation has been published on the webpage of the event and distributed.