

# Workshop "Widening the perspective on Circular Carbon: from potentials to practical experience"

Online, February 29<sup>th</sup>, 2024

On Thursday, February 29<sup>th</sup>, 2024, from 2 to 5 pm CET, **more than 40 experts** gathered online at the **IETS Task 21 Subtask 2 Circular Carbon** workshop under the theme "Widening the perspective on Circular Carbon: from potentials to practical experience". The workshop was a **very successful start to the networking activities**, as it met with great interest and attracted numerous participants during the three-hour event.

It was the first workshop of the initiative and was designed as an **international networking event**, to provide the audience and the twelve speakers a comprehensive overview of diverse activities of the Circular Carbon landscape and to identify possible collaborations. The workshop was organized by the Subtask 2 management, the Energieinstitut an der JKU, in collaboration with the C-CED project and the cross-cutting activities of IEAGHG, IEA Hydrogen, and IEA Bioenergy.

**Activity "networking"**

Objective for today

- Broad overview about topics and research done
- A big "thank you" to all the support! → secretariats, speakers, ...
- Goal 1: **knowing** each other
- Goal 2: identify further **needs** of exchange
- Goal 3: identify **means** of further exchange

Technology Collaboration Programme  
by IETS

**Individual CCU pathway strengths and weaknesses**

Other Impacts  
Concentration:  
● Positive  
● Neutral  
● Negative

Average of scores for energy demand, water & land use, waste & environmental impacts

Mitigation Potential (see slide)  
● Small  
● Medium  
● Large

Conclusions:

- Building materials and fuels have a greater total mitigation potential than polymers and chemicals due to the **larger addressable market size** of commodities.
- For fuels and chemicals, current market drivers for CCU are typically **not sufficient to justify the cost premium** and incentivize large scale market uptake.
- The routes considered within **building materials** and **polymers** categories were found to have **greater potential** under existing market drivers.
- Many routes are technically **well-developed** with some ready for commercial deployment, but deployment factors could **constrain global scale-up** (e.g., access to waste residues, availability of renewable electricity).
- There are a range of **potential co-benefits** for CCU routes (reduce fossil use, re-use of waste, safer production) but there can also be **trade-offs** (high energy demand, land-use, water use).

ERM Widening the Perspectives on Circular Carbon: CCU as a Feedback

At its core, the **aim of the IETS Task 21 Subtask 2 Circular Carbon** initiative is to adopt a systemic perspective on carbon capture within industrial settings. While the Subtask focuses on industrial topics, it aims to also provide a holistic overview by means of exchange with thematically related projects/tasks from other IETS Tasks or IEA TCPs.

The **main objective** of the workshop was to provide a broad overview of the different activities, to identify areas of overlap and to initiate discussion on possible future networking activities. The workshop focused on fostering links at the task and project level, with no intention of coordinating TCP collaboration as a whole. To support the achievement of this goal, an online Google document was created to support the discussion and the Zoom chat. Participants could contribute their ideas on the following topics: further needs of exchange, means of further exchange and contradicting/equal results. Additionally, the participants were motivated to ask questions and to discuss after each presentation.

The workshop was opened by the subtask manager Simon Moser and the Chair of the IETS TCP Johanna Mossberg. Simon Moser gave a short overview of the subtask and the programme. He informed the audience about the objectives of the meeting and motivated them to actively participate in the workshop. Johanna Mossberg gave a short presentation on the IETS Technology Collaboration programme with the main facts and figures to get all participants on board with the overall aim of the TCP.

## The first block reports on Circular Carbon theory and principles.

The first speaker of this session, **Hans Böhm** from the Energieinstitut an der JKU, presented some results of the CaCTUS project in his presentation "**Potentials for carbon circularity: matching future emissions and demands**". The project carries out an in-depth assessment of the potential contribution of CCU and CCS to Austria's long-term climate goals. Even in a climate-neutral energy system, CO<sub>2</sub> will be emitted in the future. At the same time, there is still a demand for carbon in products. The main barriers to CCU are considered to be the high costs vs the direct economic benefits, the technical challenges of process integration, competition with CCS, insufficient recognition of the net CO<sub>2</sub> reduction potential of CCU beyond the use of fossil resources, and the scarcity of renewable resources. Success factors include increased investment in the technologies (to enable technological learning and cost reductions), the development of local or European value chains to increase partial independence from external resources, the use of synergies/industrial symbiosis to build clusters and new collaborations, and the establishment of supra-regional carbon markets.

**Christian Bang** from Ea Energy Analyses gave insight into the IEA Bioenergy BECCUS Inter-task-projects. The projects, under the IEA TCP, look into the opportunities of capturing carbon dioxide from energy or industrial installations that use biomass as a feedstock, and either using or sequestering the CO<sub>2</sub>. The title of the presentation was "**CCS/CCU/negative emissions and bio-based value chains/concepts**". Combined, BECCUS 1.0 & 2.0 aim to provide a holistic picture of technology options and a broader systemic view. Primary factors for determining successful BECCUS deployment are seen in the technology readiness and supply chains, business model viability and the current and expected policy design. Many of the individual technology components can largely be considered proven. There are country differences in the speed of project implementation, which is primarily related to incentive schemes and the removal of barriers.

A presentation about **the role of hydrogen in CCU** was held by the Chair of the IEA Hydrogen TCP **Paul Lucchese** from CEA. The Hydrogen TCP is a global collaboration for research and innovation in hydrogen technology. Paul Lucchese emphasised the importance to combine all available technologies and energy sources - including energy efficiency, renewables, nuclear, CCS and CCU, electrification and smart grids, and hydrogen. This will require more research and development and innovation, increased international co-operation and the unlocking of funding and private investment.

The last speaker of this block was Amelia Mitchell from ERM about the IEAGHG study "**CO<sub>2</sub> as a Feedstock: Comparison of CCU Pathways**". Within this study a holistic assessment of commodities from CO<sub>2</sub> utilisation was undertaken. Products from CO<sub>2</sub> utilisation need to compete with existing products and penetrate markets. Therefore, it is important to demonstrate product suitability, to develop market interest and product demand and to achieve cost-competitiveness. The varying mitigation potentials of different commodities from CO<sub>2</sub> utilization were highlighted as well as technical readiness and potential co-benefits and trade-offs were outlined as factors influencing the deployment and scalability of CO<sub>2</sub> utilization routes.

## The second block covered practical examples and implementations.

The C-CED project (Circular-Carbon Economy Demonstration), an Austrian flagship project, which aims for the demonstration and coupling of various CO<sub>2</sub> capture and CO<sub>2</sub> utilization technologies to establish a sustainable and closed carbon cycle, while including an inter-seasonal storage function for renewable energy informed about **carbon capture in integrated steel plants (Michael Derntl, K1 Met)** and gave an **overview and results from the project**. The audience got informed about the current status of the underground conversion of CO<sub>2</sub> to biomethane by **Benedikt Hasibar** from RAG. The demonstration site is prepared for injection of CO<sub>2</sub> from steel mill off-gas and biogas plant and the first filled bundles of captured CO<sub>2</sub> stand ready for transportation. Main barriers for CCU identified in the project are that it is not economically feasible in the current system, the equal treatment of CCU products with fossil products and the lack of infrastructure for H<sub>2</sub> and CO<sub>2</sub>. Overcoming these barriers is therefore essential to success.

**Jawad Elomari** from SINTEF gave an insight in the **PyroCO<sub>2</sub>** project. The project demonstrates the scalability and economic viability of CCU using innovative biotechnology to make climate-positive

acetone from industrial CO<sub>2</sub> and renewable electricity derived hydrogen for the chemicals, fuel additives, and materials markets.

The third block was about the impact assessment.

**Remko Detz** from TNO informed about the "**State of the art and future perspective of electrochemical CO<sub>2</sub> conversion**" (IEAGHG project). Main barriers for CCU identified include the lack of economic competitiveness in electro conversion routes compared to alternatives, high costs mainly driven by capital expenditure (CAPEX), low efficiency and power density in current processes, and the challenge of reducing greenhouse gas emissions without substantially increasing investment costs in ethylene production via electrochemical routes. Success factors are that electrochemical conversion technologies can produce different products, a potential steep learning of the HT pathways, the LT formic acid and HT CO production seem really promising, that if CAPEX reduces costs go down and the added value of avoiding CO<sub>2</sub> emissions.

**Daniele Ferrario** from Politecnico di Torino presented the results from Net-zero heavy industry. The topic was "**Towards reduced, zero or negative heavy industry plants: a techno-economic and environmental integrated assessment**".

The last speaker of this block and the workshop was **Susan Fancy** from the University of Michigan, who gave insights from the Global CO<sub>2</sub> initiative about "**LCA for CO<sub>2</sub> capture and conversion**". Ms. Fancy stated that assessments are complicated due to multi-functionality options for CO<sub>2</sub> as product, co-product, or waste. Rigorous and transparent assessments are more important than ever to guide R&D and to prevent greenwashing. Current issues on the LCA and TEA are data (which should be open source in order to be comparable), the social lifecycle assessment (implement alongside LCA and TEA), the communication of LCA results to communities, system level view and opportunity costs as well as the general confusion regarding carbon accounting and LCA.

## Conclusion

The presentations explained the work done in the project/task/TCP, the focus, the main barriers identified for CCU, the success factors and requirements for future implementation and the potential interaction of the results with other Tasks/TCPs/projects.

In general, it can be said that there were **hardly any contradictory results** and there are some **thematic overlaps** that go beyond the different tasks or project, which **makes networking even more important**.

The various presentations and projects have shown that the following conclusion can be drawn:

- The limited availability of "easy-to-capture" CO<sub>2</sub> sources suggests a potential constraint on fully realizing CCU's capacity.
- Moreover, the current regulatory and market landscape presents hurdles, rendering CCU economically unviable.
- However, there is optimism regarding technological advancement, with the expectation that significant learning will lead to substantial reductions in CCU product costs over time.
- These points collectively highlight the complexities involved in scaling up CCU initiatives while emphasizing the importance of innovation and regulatory adaptation in unlocking its full potential.

In general, this workshop was exclusive (i.e. participation by invitation only), but addressed a broad audience, including TCPs, TCP's task managers of tasks focussing circular carbon in a broad sense, groups engaged in these tasks, as well as invited experts and speakers from relevant projects. The workshop was an **important first step** in providing stakeholders with a holistic understanding and promoting exchange with thematically related projects and tasks from various IETS tasks or IEA TCPs.