

Material technologies for post-combustion CO₂ capture and utilization network

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CCU-NET in short

The **CCU-NET** Nordic mobility program promotes the training of young researchers in the area **carbon capture and utilization** (CCU). The program is envisioned as key stepping stone towards the Nordic long-term goal of establishing a 100% renewable energy society. The mobility program supports and trains outstanding researchers working on CCU by advancing their skills in science, engineering and social competence.

Upcoming events

2nd Symposium of CO₂ capture, storage & Utilization (A CCU-NET Symposium) will take place on November 3 – 4, 2022 at University of Eastern Finland.

Past events

1st Symposium of CO₂ capture, storage & Utilization (A CCU-NET Symposium) took place on December 9-10, 2021, in Luleå University of Technology, Sweden. The symposia gathered researchers and engineers working on the CCU technologies and provided an excellent opportunity for networking.

Urgent actions on climate

change are needed to protect the planet from degradation. To meet the objectives of the Paris Agreement requires substantial decarbonization of the global economy by the end of this century and fundamental transformation of the global energy system.



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Technical University of Denmark (DTU)

DTU is at the academic and multidisciplinary forefront of the technical and the natural sciences with new initiatives in a number of demanding engineering disciplines, including sustainable energy technology and life science. DTU has about 6000 employees and educates 11.200 students

The Department of Energy Conversion and Storage (DTU Energy) has a matrix organization with sections and technology tracks with specific focus on a number of technologies, such as carbon capture and use (CCU), gas separation and storage, electrolysis & fuel cells, P2X, and their application in sustainable energy technologies.

The materials research in CO₂ capture and utilization at DTU Energy spans from modelling and autonomous materials discovery through the synthesis and characterization of liquid or solid-state sorbents for CO₂ capture to the exploration of new CO₂ capture and conversion processes driven by electrochemical reactions. DTU Energy has been leading or involved in several projects related to materials processing and CO₂ capture and conversion.

The section “Solid State Electrochemistry” is focusing on the development of functional materials and devices and has state of the art labs for the processing and characterization of advanced materials, testing of fuel cells/electrolyzers, membranes and membrane reactors. It has a long experience in materials synthesis, functionalization and tailoring of microstructural features.

Projects and publications related to CCU-NET

- The Danish Grand Solution project *HiGradeGas* - Highly Structured materials for upgraded biogas and storage, Innovation Fund Denmark, 2016-2021.
- *AddLight* - Advanced Metal-Organic Framework-Nanofiber architectures for conversion of CO₂ into hydrocarbons by solar light, Villum Experiment, 2022-2024.
- “MOF derived nanofiber structures for electrocatalytic conversion of CO₂”, Alliance PhD project with Technion (Israel), financed by DTU, 2020-2024.
- *CCU-NET*, Material technologies for post-combustion CO₂ capture and utilization network, Nordic Research Council, 2020-2024.
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- Y. Dou, W. Zhang, A. Kaiser, Electrospinning of metal–organic frameworks for energy and environmental applications (review), *Advanced Science*, (2020), 1902590.

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University of Oslo (UiO)

UiO is the largest University in Norway, having > 25 000 students. The Department of Chemistry at UiO is ranked as the premier academic research institute in chemistry in Norway.

The Catalysis section at the Department of Chemistry has five permanent scientific staff members, 3 permanent researchers and 2 engineers. The group hosts ~25 post docs, PhD and MSc students. Our laboratories comprise state of the art laboratories for material synthesis and characterization (XRD, NMR, HRMS, BET, TGA, FT-IR, ICP, Raman, UV-Visible-NIR, ICP, SEM), catalytic testing (steady state and transient experiments (SSITKA, TAP) at vacuum to 30 bar pressure) with on-line GC, MS and GCMS. We are frequent users of synchrotron radiation sources, especially at ESRF (Grenoble, France), and MAX-Lab (Lund, Sweden).

Projects and publications related to CCU-NET at UiO's Catalysis section

- Horizon-2020 project on CO₂ conversion, COZMOS (<https://www.aspire2050.eu/cozmos>)
- Two CO₂ conversion projects financed by the Norwegian Research Council, CO2LO (<https://app.cristin.no/projects/show.jsf?id=2515673>)
- CO2PCat, and are involved in 2 CCU-related networks, CCU-NET and Nord-CO₂ (<https://site.uit.no/nordco2/>).
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Luleå University of Technology (LTU)

LTU is a leading academic institution in science and technology in the Arctic region within several research domains and innovative education. At LTU, scientific and artistic research, as well as education, are carried out in close collaboration with international, national, and regional companies, public actors, and leading universities. The Luleå University of Technology has an annual turnover of SEK 1.9 billion. Today, we have around 1,815 staff and 19,155 students.

The Department of Engineering science and mathematics comprises different divisions and research subjects having well-established modern facilities in the area of tribology, materials, energy, electricity, fluid theory, strength theory, wood, and bionano composites. The *material science division* in the Department of Engineering science and mathematics focuses on the development of materials, modeling, and simulation for various applications including green energy, carbon capture, and utilization, hydrogen production and storage, fuel cell, corrosion, steel, electrolysis, and novel materials for sustainable development. The research subject Engineering materials (EM) is committed to the development of new materials for various applications and to solving industrial problems. Regarding carbon capture and utilization, EM has established lab facilities for carbon capture and utilization where testing of novel materials for carbon capture and conversion is carried out. The research is focused on the design of new materials for efficient carbon capture and conversion into useful chemicals. In addition, the EM has state-of-the-art equipment for various characterizations such as SEM, TGA, high-pressure TGA, micrometric surface area analyzer, and optical microscope.

Projects and publications related to the CCU-NET at LTU:

- *CCU-NET*, Material technologies for post-combustion CO₂ capture and utilization network, Nordic Research Council, 2020-2024. Under the umbrella of CCU-NET, we are working on the catalytic conversion of CO₂ into fuels.
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University of Eastern Finland (UEF)

UEF, located in Kuopio and Joensuu, was founded in 2010 after a merge of University of Kuopio and University of Joensuu. It has approximately 15 000 students and 2500 staff members and it is ranked among the world's top young universities. UEF has approximately 1600 doctoral students and awards nearly 170 PhD degrees annually.

The CCU-NET mobility project fits UEF profile research area of *sustainable governance of natural resources* and the research carried out Sustainable Materials Group at Fine Particle and Aerosol Technology Laboratory (www.uef.fi/fine). FINE lab is among the top aerosol technology groups in the world and has currently 20 employees, 13 with doctoral degree and 7 PhD students. FINE is part of the Aerosol Physics, Chemistry and Toxicology Research Unit (ILMARI, www.uef.fi/ilmari) and has state-of-art pilot facilities for production of tailored functional nanomaterials (e.g., metals, metal oxides, carbon nanostructures and coated metal particles) for industry (Funktiomat, www.uef.fi/fine/funktiomat-pilotti). The laboratory has also access to the state-of-the-art characterization facilities including optical and electron microscopy, X-ray crystallography, Raman and FTIR spectroscopy, surface area and thermogravimetric analysis, etc. hosted by SibLabs. In addition, a new X-ray photospectroscope will be installed in autumn 2022.

Projects and publications related to the CCU-NET at UEF:

- Academy of Finland C1 value programme project "MOFs catalyzed direct gas-phase reactions for the conversion of C1 compounds" (<https://sites.uef.fi/fine/front-page/main-on-going-research/mofc1/>).
- Academy of Finland doctoral project "Photoactive graphitic nano carbons from sustainable precursors for renewable energy production" (<https://sites.uef.fi/fine/front-page/main-on-going-research/fografna/>).
- Academy of Finland Research Fellow project "Induction synthesis of functionalized carbon nanostructures from biomasses and application studies" (<https://sites.uef.fi/fine/front-page/main-on-going-research/biograph/>).
- UEF doctoral school project "Catalytic metal-organic-framework structures for clean air and water"
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Material technologies for post-combustion CO₂ capture and utilization network

1st Symposium of CO₂ capture, storage & Utilization (CCU-NET Symposium)

The research group from LTU successfully organized a *symposium on carbon capture and utilization* with the participation of students, researchers, and Professors from different universities and industry backgrounds on December 9-10, 2022. The event was hosted by LTU in connection to the CCU-NET project with the theme of distributing knowledge, sharing research expertise, and training young researchers. The symposium comprised different sessions including carbon capture, CO₂ conversion, catalysis and separation, and synthesis and sustainability for consecutive two days. Each session was chaired by renowned Professors from different universities. Different keynote speakers presented their research and expertise in the field of CO₂ capture and conversion and highlighted the numerous real challenges. Indeed, it was a great event to learn about modern research trends at CCU and an especially good opportunity for PhDs, postdocs, and junior researchers to share, learn, and get feedback from well-renowned Professors with extensive research experience. Further, participants were amused by the super nice freezing and snowy weather of Luleå with beautiful snowfall. Some of the highlights of the event can be seen in the pictures below.

New project grant under the umbrella of CCU-NET

We would like to welcome Dr. Yujie Zhao who has started in May 2022 in the Department of Energy Conversion & Storage for a 2 year postdoc in a new Villum Experiment project (granted by The Velux Foundations). She will also join the CCU-Net team and work under the supervision of Associate Professor Andreas Kaiser. The title of the project is “Advanced Metal-Organic Framework-Nanofiber architectures for conversion of CO₂ into hydrocarbons by solar light”. For more information, please visit the following VELLUX FOUNDATIONS webside or contact project manager Prof. Andreas Kaiser: