Technology Collaboration Programme by iea

IEAGHG

8th Post Combustion Capture Conference Summary

Marseille, France
16-18 September 2025

March 2026 | 2026-TR02

IEAGHG

About the IEAGHG

Leading the way to net zero with advanced CCS research. IEAGHG are at the forefront of cutting-edge carbon, capture and storage (CCS) research. We advance technology that reduces carbon emissions and accelerates the deployment of CCS projects by improving processes, reducing costs, and overcoming barriers. Our authoritative research is peer-reviewed and widely used by governments and industry worldwide. As CCS technology specialists, we regularly input to organisations such as the IPCC and UNFCCC, contributing to the global net-zero transition.

About the International Energy Agency

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate is twofold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy. The IEA created Technology Collaboration Programmes (TCPs) to further facilitate international collaboration on energy related topics.

Disclaimer

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About IEAGHG

IEAGHG is one of the International Energy Agency's largest Technology Collaboration Programmes. With its 41 members, comprising 16 countries, the European Commission and 24 national and international organisations, IEAGHG operates at the forefront of CCUS/CDR development and deployment.

IEAGHG delivers advanced research into the development and deployment of CCUS/CDR and is trusted by governments and industry worldwide. As a source of cutting-edge CCUS/CDR information, IEAGHG furthers technology that reduces carbon emissions and accelerates the deployment of CCS projects. As CCS technology specialists, IEAGHG staff members regularly contribute to organisations such as the IPCC and UNFCCC, contributing to the global net-zero transition.

In the firm belief that sharing knowledge is vital to achieving net zero, IEAGHG hosts two of the world's leading CCUS/CDR conference series, the Greenhouse Gas Control Technology (GHGT) series and the Post-Combustion Capture Conference (PCCC) series. Furthermore, IEAGHG hosts an array of expert network meetings and workshops. These gatherings bring together recognised experts from across the disciplines to share the latest learnings, knowledge and expertise, and advance the development and deployment of CCS technology.

As a not-for-profit organisation, IEAGHG is committed to:

- Uphold the highest standards in the work it undertakes.
- Encourage collaboration between the public and private sectors.
- Deliver integrated, cost-effective solutions that drive down carbon emissions.

Scan the QR code to subscribe to essential news, updates and insights from IEAGHG on the CCUS/CDR sector

About TotalEnergies

TotalEnergies is a global integrated energy company that produces and markets energies: oil and biofuels, natural gas, biogas and low-carbon hydrogen, renewables and electricity. Our more than 100,000 employees are committed to provide as many people as possible with energy that is more reliable, more affordable and more sustainable. Active in about 120 countries, TotalEnergies places sustainability at the heart of its strategy, its projects and its operations.

Conference Background

The IEAGHG Post Combustion Capture Conference (PCCC) series, first organised in 2011 and held biennially since then, has established itself as the world's leading forum for advancing post combustion capture technologies. It provides an international platform for industry, academia, technology developers, policymakers, and financiers to examine progress, challenges, and priorities for deployment. As projects move to commercial scale applications, attention increasingly focuses on the issues that determine bankability and long-term performance, including cost reduction pathways, energy integration, emissions management, reliability, solvent management, materials and corrosion, and practical considerations for scale up and replication.

A core driver for the conference is the need to translate innovation into deployable solutions. Continued research and development are advancing next generation solvents, process configurations, and contactor designs, alongside alternative capture concepts. In parallel, plant operators and project developers are building operational experience, refining design choices, and establishing evidence on performance under realistic operating conditions which is essential for reducing uncertainty and supporting investment decisions.

The conference also recognises that post combustion capture must be assessed as part of an integrated value chain. Capture performance and cost are shaped by upstream and downstream interfaces. Discussions therefore extend beyond capture island design to include system level optimisation, flexibility, and the implications of evolving energy systems, industrial clustering, and shared infrastructure.

Ultimately, the PCCC aims to accelerate progress by connecting the research frontier with operational reality and deployment needs. It enables participants to identify priorities for research, development, and demonstration, share lessons learned from projects, test assumptions behind performance and cost claims, and build alignment on practical pathways to scale. By bringing together technical, commercial, and policy perspectives, the conference supports the overarching objective of delivering reliable, cost-effective post combustion capture at the scale required to meet climate goals.

The 8th event in the Post Combustion Capture Conference series (PCCC-8) was held on the 16 – 18 September 2025 and was jointly hosted by the IEAGHG and Total Energies, and sponsored by Mitsubishi Heavy Industries (MHI), Shell – Technip Energies, ION Clean Energy, Axens and Honeywell.

PCCC-8
Marseille, France

PCCC-7
Pittsburgh, USA

PCCC-6
Virtual Online

PCCC-5
Kyoto, Japan

PCCC-4
Birmingham, USA

PCCC-3
Regina, Canada

PCCC-2
Bergen, Norway

PCCC-1
Abo Dhabi, UAE

PCCC-8 in Numbers

240 Delegates (The largest PCCC to date)	**24** Countries Represented	**115** Technical Presentations	**26** Poster Presentations
9 Keynote Speakers	**3** Parallel Streams	**8** Technical Sessions	**6** Sponsors

Conference Sponsors

TotalEnergies

Carbon Capture Alliance

Mitsubishi Heavy Industries, Ltd.

Honeywell

Axens — Powering integrated solutions

ION Clean Energy

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Summary Review

The IEAGHG PCCC series accelerates global progress in carbon capture, utilisation and storage (CCUS), direct air capture (DAC) and bio-energy with carbon capture and storage (BECCS) by providing a trusted forum for sharing cutting-edge R&D, real-world operational insights and lessons from pilot-to-commercial-scale projects. By bringing together researchers, technology developers, industrial operators and policymakers, it helps align innovation with deployment needs, reduces technical and financial risk, and promotes the development of standards and best practices. The conference strengthens collaboration across sectors, informs policy and investment decisions with credible data and supports the scale-up of advanced capture technologies. Ultimately, this helps to enable faster, more cost-effective, and reliable deployment of carbon-removal and emissions-reduction solutions worldwide.

Plenary Session – PCCC-8

Building on this strong track record, the PCCC-8 technical programme comprised 115 oral presentations delivered across three parallel streams comprising a total of 24 technical sessions, marking the first time the series has run three streams and representing an increase of around 40% in oral presentations compared with PCCC-7, underscoring the breadth and depth of the conference. A further 26 posters complemented the oral sessions providing additional opportunities for technical discussion. In total, PCCC-8 attracted 240 delegates from 24 countries, making it the largest PCCC to date. The presentations were selected by the PCCC-8 Technical Committee from a pool of 166 abstracts across the spectrum of post combustion capture technologies.

The conference opened on the first day with a welcoming address from the Chair of PCCC, Keith Burnard, IEAGHG, who delivered the conference welcome and set out the objectives and context for the conference. On behalf of the co-host and sponsor, TotalEnergies, Philip Llewellyn welcomed delegates to Marseille and highlighted the importance of post combustion capture in the company's decarbonisation strategy. The third keynote of the day was delivered by Eadbhard Pernot, Zero Emissions Platform (ZEP), who shared his views on "CCS in Europe – Where Are We Headed", framing the European policy and project landscape for the discussions that followed.

The programme continued into the second day with a series of keynote speeches. Takashi Kamijo, MHI Heavy Engineering presented industry perspectives on the deployment of post combustion capture at scale. Gary Rochelle of the University of Texas at Austin provided an authoritative overview in his keynote, "What We Know and Do Not Know About Amine Oxidation", clarifying the current state of knowledge and the open questions that remain. Manuel Jacques, Technip Energies emphasised that today's CCS market demands confidence, bankability and risk reduction to enable investment at scale.

The conference culminated on the final day with keynote addresses from three speakers. Erik Meuleman, ION Clean Energy framed the urgency of carbon mitigation using the "world emissions clock" to illustrate the narrowing window for action. Hanna Knuutila, NTNU highlighted that the past decade has seen major advances in piloting and demonstration of solvent based CO_2 capture, while also pointing to areas where further innovation and validation are needed. Romain Roux, Axens emphasised the company's role as a technology provider supporting the transition to a lower carbon economy and underlined the importance of reliable, bankable capture solutions for industrial clients.

In total, nine keynote speakers anchored the programme, providing strategic and technical perspectives that complemented the content of the technical sessions. The support of the conference sponsors, including TotalEnergies, The Shell and Technip Energies Carbon Capture Alliance, MHI, Honeywell, Axens and ION Clean Energy, was instrumental in making PCCC-8 a success. Their contributions helped to ensure that the conference could offer affordable registration fees for delegates, while maintaining a robust technical programme and an excellent overall experience.

Special thanks are also due to all those involved in the organisation of PCCC-8, whose efforts enabled a productive and well-run event.

Conference Themes

Session 1A **Adsorbents** *Chair: Colin SNAPE*	Session 1B **FEEDs/ Commercial Deployment** *Chair: Jon GIBBINS*	Session 1C **Modelling Solvents** Chair: Eirik Falck DA SILVA
Session 2A **Adsorption Processes** *Chair: Bérénice MOROY*	Session 2b **Technical Economic Evaluations** *Chair: Keith BURNARD*	Session 2C **Modelling Solvents / Innovative Contactors** *Chair: Frank MORTON*
Session 3A **Advanced Amine Solvents & Processes** *Chair: Theo CHRONOPOULOS*	Session 3B **Direct Air Capture** *Chair: Caroline CLOUTIER*	Session 3C **Improved Contactors** *Chair: Majed SAMMAK*
Session 4A **Bench-Scale Amine Oxidation** *Chair: Gary ROCHELLE*	Session 4B **Comparing Technologies** *Chair: Philip LLEWELLYN*	Session 4C **Modelling/ Unsteady Operation** *Chair: Saquib SULTAN*
Session 5A **Emissions from Solvents** *Chair: Christophe BENQUET*	Session 5B **Other Applications** *Chair: Peter MOSER*	Session 5C **Heat Pumps & Thermal Integration** *Chair: Jorge MARTORELL*
Session 6A **Technology Demonstrations** *Chair: Karim ELAMAWY*	Session 6B **Proprietary Technologies** *Chair: Alexander VOICE*	Session 6C **High Capture/ Pushing PCC Limits** *Chair:Simon ROUSSANALY*
Session 7A **Performance Validation** *Chair: Mathieu LUCQUIAUD*	Session 7B **Open Solvents** *Chair: Lionel DUBOIS*	Session 7C **Reclaiming & Liquid Waste** *Chair: Rahul ANANTHARAMAN*
Session 8A **Facilities & Methods for Testing** *Chair: Mijndert VAN DER SPEK*	Session 8B **Membrane Separation** *Chair: Stephane JOUENNE*	Session 8c **Cement** *Chair: Abdul'Aziz ALIYU*

International Perspective

The IEAGHG Post Combustion Capture Conference (PCCC-8) series has proved to be far more than a showcase of cutting-edge research; each conference has served as a genuine meeting point of international expertise and experience. Bringing together perspectives from around the world, PCCC-8 provided a valuable forum for exchanging ideas, discussing shared challenges and exploring new avenues for collaboration in advancing post-combustion capture technologies. Of the nine keynote presentations that opened each day, two offered welcome addresses to set the tone for the event, while the remaining speakers provided distinct perspectives on CCUS – from global initiatives to project-level implementation. Together, they underscored the importance of knowledge transfer to reduce costs, accelerate deployment and ensure that CCUS fulfils its essential role in meeting global climate ambitions.

Keith Burnard delivered the conference's welcome address on behalf of IEAGHG. He opened by outlining the mission and scope of IEAGHG, an independent technical body within the IEA's Energy Technology Network since 1991. With 39 members representing more than 20 countries, IEAGHG provided technical evidence across the entire CCS value chain and supported international regulatory and standards development. Since its establishment, IEAGHG had published more than 360 technical reports. It also ran several well-respected global research networks, hosted major international conferences and operated the long-standing CCS Summer School. IEAGHG informed – not set – policy while maintaining strong engagement with global climate and energy organisations.

He then highlighted the growth and significance of the Post Combustion Capture Conference series, which evolved from a research network into a major biennial event co-hosted with local partners. PCCC-8, held with TotalEnergies, was the largest to date, drawing almost 240 delegates, 117 technical presentations, 24 posters, six sponsors and representation from 24 countries – surpassing all metrics from earlier PCC conferences. The conference brought together industry leaders, researchers and policymakers to showcase advances across all technology readiness levels, supported by sponsors including MHI Heavy Engineering, ION Clean Energy, Shell andTechnip Energies Carbon Capture Alliance, Honeywell and Axens.

Finally, Keith emphasised the rapid progress in post-combustion capture and the broader CCS landscape. He noted that research in the field remained strong, supported by active international collaboration through the International Test Centre Network (ITCN). The growing number of operational CCS projects further reflected the urgency underscored in the IEA Net Zero by 2050 roadmap. Operational facilities had grown from 30 in 2022 to a projected 65 in 2025, with capture capacity rising accordingly and expanding across sectors and regions. He noted key trends: strong global project pipelines, diversification into hard-to-abate industries and the scaling of direct air capture – including the emergence of large-scale plants like STRATOS – highlighting both momentum and the critical need for continued action.

Keith Burnard, Chair PCCC, IEAGHG

On behalf of TotalEnergies, **Philip Llewellyn** welcomed delegates to Marseille, highlighting the city's cultural richness, history and culinary identity, as well as attractions available beyond the conference agenda. He set the stage by positioning CCS and CCU within a wider industrial carbon-management framework centred on avoiding, reducing and compensating emissions. This aligned with TotalEnergies' multi-energy transition strategy, which prioritised low-emission project design, large-scale investment in renewables, a 40% reduction in Scope 1 and 2 emissions by 2030 and longer-term carbon neutrality by 2050.

Reflecting on the Lacq–Rousse CCS pilot (2010–2013), he noted that the project had proven the technical viability and safety of a complete CCS chain yet highlighted his view that public perception and political acceptance were the greatest barriers to progress. While societal concerns constrained early onshore deployment, he argued that today's environment had shifted markedly due to the momentum of major North Sea initiatives like Northern Lights, supported by governments and local communities. Shared regional infrastructure not only spread risk and expertise but also increased confidence among stakeholders and accelerates broader adoption.

Philip Llewellyn, Research and Technology Senior Advisor, TotalEnergies

Philip concluded by outlining TotalEnergies' global CCS strategy, which aimed both to decarbonise its own assets and to develop a competitive transport-and-storage business for external emitters. Key projects – including Northern Lights in Europe, Bayou Bend in the United States and partnerships across Asia – supported the company's goal of storing more than 10 Mt CO_2 per year by 2030. Emphasising the diversity of CO_2 sources, the role of impurities in determining capture complexity and the company's technology-agnostic approach, he stressed that while CCS chains were technically achievable, large-scale deployment would depend on overcoming societal, political and cost challenges through continuous innovation, collaboration and adaptation.

Eadbhard Pernot, Secretary General of the Zero Emissions Platform, shared his views on "CCS in Europe – Where Are We Headed?". He explained that while CCS technologies were technically mature, Europe risked repeating a pattern of setting high ambitions without ensuring sufficient delivery. Although several EU strategies – including the Industrial Carbon Management Strategy and the Net Zero Industry Act – laid out bold targets and clearer rules for storage development, permitting, transparency and infrastructure planning, these frameworks were often non-binding or financially unattractive for emitters. Companies faced rising carbon prices yet had limited opportunities to generate new revenue unless they could sell carbon dioxide removal (CDR) certificates, low-carbon products or captured CO_2. As a result, progress remained uneven and the real costs of capture, transport and storage continued to be high.

Eadbhard warned that Europe may fall short of its 2030 storage target, with most of the available capacity concentrated in the North Sea and very little in Central, Eastern and Southern Europe. Such geographic imbalance posed risks for industrial competitiveness in regions with restricted access to storage options. He noted that while new initiatives – such as the Industrial Decarbonisation Accelerator Act – aimed to stimulate investment and encourage the development of lead markets for low-carbon products, gaps persisted in implementation.

Looking ahead, he pointed to a forthcoming CO_2 market and infrastructure package intended to clarify rules for CO_2 networks and support project development. However, many essential details remained undefined, leaving the future success of European CCS reliant on policymakers' ability to turn broad strategies into practical incentives, balanced infrastructure and bankable projects.

Eadbhard Pernot, Secretary General of the Zero Emissions Platform

Takashi Kamijo, Chief Engineer at MHI Heavy Engineering, specialising in CCUS technology, presented "Our Journey and the Future: Achieving Decarbonisation through CO_2 Capture Technology," highlighting Japan's national CCS programme and MHI's global activities. Japan's initiatives, led by JOGMEC under the 2024 Act on Carbon Dioxide Storage Business, included nine projects targeting about 20 Mt CO_2/year across Japan and the Asia-Pacific region, with FIDs expected by FY2026. MHI was engaged in several efforts, including Japan's largest planned CO_2 capture plant for Hokkaido Electric Power (5,200 t CO_2/day), as well as major UK cluster projects such as HyNet's Padeswood cement capture facility, the Evero InBECCS retrofit and contributions to the Liverpool Bay transport and storage system. Additional collaborations included a CO_2 capture trial with ArcelorMittal and a partnership with SBM Offshore for FPSO-based capture modules.

Takashi emphasised MHI's ongoing R&D to reduce CAPEX, energy use, solvent degradation and emissions while improving technology maturity, scale-up and plant footprint. Activities include solvent testing, a new 5 t/day pilot plant using gas turbine flue gas and a joint development with ExxonMobil to lower capture costs and enhance the Advanced KM CDR Process™. He noted that although post-combustion CCUS deployment had historically been slow, momentum was increasing as technical and commercial hurdles – cost, supply chain, regulation, liability and financing – were progressively addressed. Feedback from KM CDR Process™ users continued to drive optimisation and reliability improvements.

Concluding that MHI remains a leading provider of post-combustion capture technology, Takashi said that the company was committed to enabling full-scale CCUS commercialisation. Through advancing technology readiness, supporting major CCS clusters, and collaborating globally, MHI aimed to help overcome remaining barriers and accelerate practical decarbonisation solutions.

Takashi Kamijo, Chief Engineer at MHI Heavy Engineering

Gary Rochelle presented on “What We Know and Don’t Know About Amine Oxidation”. An internationally renowned professor at the University of Texas at Austin, Gary emphasised that adapting conventional acid gas treatment to CO_2 capture dramatically increased cost, energy demand and emissions-related risk – particularly from amine oxidation driven by O_2 and NO_2. Drawing on more than two decades of research across multiple institutions, he highlighted well-established findings: Fe^{2+}/Fe^{3+} catalyses radical-driven oxidation, dissolved oxygen reacts with amines, NO_2 strongly accelerates oxidation in absorbers, and oxidation generates a broad range of degradation products including ammonia, organic acids and volatile amines. Stable amines such as piperazine (PZ) and 2-amino-2-methyl-1-propanol (AMP) show greater resistance, but when oxidation occurs hazardous pollutants can be emitted necessitating strong emission-control measures.

Gary Rochelle, Professor at the University of Texas at Austin

Gary explained that oxidation is known to occur in the hot rich line, in absorbers with degraded solvent and, likely, in strippers – where mitigation techniques such as N_2 sparging can reduce but not eliminate degradation. Equipment design, corrosion behaviour and solvent chemistry all influence Fe catalysis, while NO_2 must be removed through selective catalytic reaction (SCR) or chemical scrubbing. Despite progress, several uncertainties remain: the catalytic roles of metals beyond iron, detailed radical initiation pathways, the efficacy of inhibitors, the behaviour of more complex or proprietary amines, and the complete spectrum of oxidation products. Analytical capabilities continued to improve, yet gaps persisted in detecting small aldehydes, nitriles and larger transient intermediates across different solvent systems.

He concluded that minimising oxidation was essential for controlling emissions of ammonia, volatile amines, nitrosamines and hazardous air pollutants. Mitigation requires a combination of corrosion management, NO_x control, oxygen removal, optimised stripping conditions and improved water/acid-wash systems. Gary emphasised that while major progress had been made in understanding mechanisms, product formation and solvent stability, key knowledge gaps remained – but he expressed confidence that the amine-oxidation challenge would ultimately be solved within his lifetime!

Manuel Jacques, Technip Energies' Head of Early Engagement, emphasised that today's CCS market demanded confidence, bankability and risk reduction to enable investment at scale. The long-standing exclusive alliance with Shell – combining Shell's CANSOLV CO_2 capture technology with Technip Energies' engineering and project-delivery capabilities – aimed to deliver this certainty. Over more than a decade, the alliance had produced continuous improvements in CAPEX, OPEX, performance and integration, culminating in standardised Canopy[1] products and digital operational support designed to make CCS more affordable and more investable.

Manuel Jacques, Head of Early Engagement Technip Energies

[1] Canopy by Technip Energies is a flexible, integrated suite of post-combustion carbon capture solutions for any type of emitter.

A key message was that technology advancement and a product-centred approach were accelerating deployment. Manuel highlighted improvements in solvent formulations, equipment size, energy efficiency and process electrification, while leveraging cross-project learning, construction-friendly design, schedule efficiency and cost-driven engineering. By connecting clients, licensors, OEMs and construction partners across the supply chain, Technip Energies delivered integrated solutions that reduced design uncertainty and balanced risk. The Net Zero Teesside Power project illustrated this leadership, demonstrating world-first integration of a dispatchable CCGT plant with large-scale carbon capture – backed by robust solvent supply, licensor guarantees and strong operational support.

Finally, Manuel underscored Technip Energies' industry-leading CCS deployment pipeline, spanning pre-FEED, FEED, execution and operational projects worldwide. From early milestones like SaskPower's Boundary Dam to upcoming large-scale power and industrial CCS systems, Technip Energies had shown how coordinated partnerships and standardised, integrated solutions were turning decarbonisation concepts into real projects. Manuel's closing message was clear: delivering CCS at scale required bankability and confidence, and Technip Energies positions itself as a market leader capable of reducing risk and enabling practical, investable pathways to net-zero.

Erik Meuleman, ION Clean Energy's Chief Technology Officer, framed the urgency of carbon mitigation with the "world emissions clock," emphasising that global emissions continued to rise rapidly despite the growing deployment of CDR technologies. He highlighted the need for deep decarbonisation of point sources, arguing that advanced carbon capture on natural-gas-fired power plants could complement BECCS and even deliver near–direct-air-capture outcomes when designed for very high capture rates. The accelerating energy demand driven by AI and data centres further underscored the need for clean, firm, dispatchable power, and Erik pointed to NGCC (natural gas combined cycle) + CCS as a solution that could be deployed today, with major OEMs and project developers already preparing gas turbines and plants for high-capture configurations.

Erik positioned ION Clean Energy as a technology innovator with a commercially ready solution, backed by more than 20,000 hours of pilot operation across globally recognised facilities. ION's ICE-31 solvent demonstrated exceptional stability, extremely low emissions, and the ability to achieve 95–99.5% CO_2 capture with modest additional energy use – providing "deep decarbonisation" and even net-negative emissions in pilot conditions. He said that strong partnerships with EPCs, OEMs, energy companies and U.S. DOE–supported projects reinforced ION's bankability and readiness for large-scale deployment. The company's pilots at the National Carbon Capture Center (NCCC), Technology Centre Mongstad (TCM), Koch Engineered Solutions and Calpine's Los Medanos Energy Centre had proven its capability across multiple flue gas types and validated its economic and operational advantages for gas-fired power generation.

Erik Meuleman, Chief Technology Officer, ION Clean Energy

Finally, he highlighted extensive third-party validation showing that NGCC + advanced CCS could achieve life-cycle emissions comparable to, and in some cases lower than, renewable energy backed by storage. Studies from Carbon Direct, Lawrence Livermore National Laboratory and Sheffield University confirmed that, when upstream methane emissions were controlled and high (>99%) capture rates were used, NGCC + CCS became competitive in cost, reliability and carbon intensity – making it a compelling option for data centres and grid operators. Erik concluded that deep decarbonisation of point sources was technically and economically feasible today, slowed the global emissions trajectory significantly, and – when paired with BECCS or other CDR – could contribute to the net-negative pathways necessary to turn back the world emissions clock.

Hanna Knuutila, professor at NTNU, highlighted that the past decade had seen major advances in piloting and demonstration of solvent-based CO_2 capture, with campaigns expanding across a wide range of flue gas types and industrial sectors. Pilots now operated at scales from small experimental units to large facilities such as TCM capturing over 200 t CO_2/day. The research focus had shifted from simply measuring energy performance to generating high-quality data for validating steady-state, dynamic and process-control models, assessing long-term operability, and de-risking commercial deployment. Recent years had brought particular attention to waste-to-energy flue gases and to testing emission mitigation, analytical methods, CO_2 purity and solvent management techniques such as thermal reclaiming and ion exchange.

Hanna Knuutila, Professor at NTNU

A central theme of Hanna's presentation was the growing understanding of solvent degradation and nitrosamine formation, critical for safety, environmental performance and process reliability. She emphasised the importance of "closing the nitrogen balance" to confirm that all degradation pathways were understood and accounted for. Over the last decade, improved analytical methods and dedicated studies had allowed researchers to identify the vast majority of degradation compounds – more than 40 for CESAR1 (an aqueous solution of 2-amino-2-methylpropan-1-ol (AMP) and piperazine (PZ))[2,3] alone – enabling meaningful optimisation of operating conditions, pretreatment strategies, reclamation processes and online monitoring. This work had transformed degradation studies from a late-stage obstacle into a standard and essential component of early solvent development.

Finally, Hanna outlined significant progress in emission control, modelling and next-generation solvent development. Pilot campaigns had mapped volatile, aerosol and entrainment-based emissions, expanded online monitoring capabilities and produced deeper insights into CO_2 product purity. Rate-based models had become the standard, now incorporating aerosol behaviour and solvent degradation. Meanwhile, new solvents were being designed and characterised through rigorous laboratory work focused on cyclic capacity, degradation resistance, toxicity, cost, and key thermodynamic and

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[2] CO_2 Enhanced Separation and Recovery I FP7 I CORDIS I European Commission
[3] 10-CESAR-1-Solvent.pdf

kinetic properties. Hanna concluded that high-quality pilot data, advanced analytical methods, strong model development and systematic solvent innovation were collectively driving solvent-based CO_2 capture toward safer, cleaner and more commercially robust deployment.

Romain Roux, Axens' Vice-President of Decarbonisation & Consulting, emphasised the company's role as a comprehensive technology provider supporting the transition to a lower-carbon economy. He positioned the company's portfolio – spanning energy efficiency, low-carbon fuels, hydrogen and carbon capture – as an integrated value-chain offer backed by decades of solvent and process development within the IFPEN group. Among Axens' solutions, DMX™ stands out as the flagship post-combustion capture technology, complementing the long-established AdvAmine™ process for pre-combustion CO_2 removal.

A core message of Romain's presentation was the maturity and proven performance of DMX™. Developed since 2010 and demonstrated at industrial scale in ArcelorMittal's Dunkirk plant (0.5 t CO_2/h), the technology used a proprietary de-mixing solvent that enabled high capture rates, low energy consumption, robust operability and high-purity CO_2 production. After two years of successful operation, DMX™ was now commercially available, suitable for flue gases of varying compositions and flow rates, and applicable across numerous industrial sectors through mobile pilots, modular units and tailor-made large-scale systems.

Romain Roux, Vice-President of Decarbonisation & Consulting, Axens

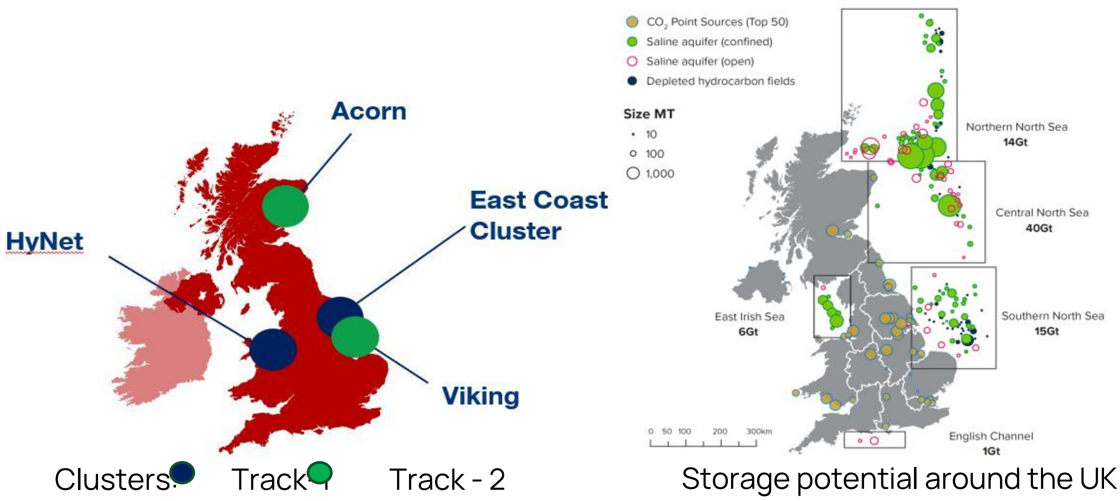
Finally, Romain highlighted Axens' ability to deliver end-to-end CCUS solutions, covering pretreatment, capture, conditioning, compression, and onward routes to utilisation or storage. Through the combined expertise of Axens, IFPEN and partners, the company provided licensing, engineering, modularisation, products and operational support, ensuring clean, dry CO_2 ready for fuels, chemicals, EOR, liquefaction or sequestration. The concluding message: DMX™ was a validated, versatile and scalable carbon-capture technology embedded within a fully integrated CCUS offering.

Technical Highlights

UK CCUS Programme – Route to CCS Cluster Final Investment Decision (FID)

The United Kingdom is uniquely positioned to become a global leader in CCUS, with an estimated 78 billion tonnes of geological CO_2 storage capacity, one of the largest in Europe and decades of extensive North Sea oil and gas infrastructure that can be repurposed at relatively low cost. The government's 2050 Net Zero Strategy identifies CCUS as essential for decarbonising industry and power, producing low-carbon hydrogen, and delivering engineered negative emissions. By focusing on geographically concentrated industrial clusters, the UK can connect multiple high-emission sites to shared CO_2 pipeline networks and large-scale offshore storage, achieving significant economies of scale.

This vision is now backed by firm action: in October 2024 the UK government committed £21.7 billion over 25 years to the two Track-1 clusters; HyNet North West and the East Coast Cluster. HyNet (led by ENI) will initially transport up to 4.7 Mtpa of CO_2 for storage in Liverpool Bay, while the East Coast Cluster's Northern Endurance Partnership (BP, Equinor, TotalEnergies)



Rivadeneira, A. 2025, *UK CCUS Programme: Route to CCS Cluster Final Investment Decision FID*, conference presentation, IEAGHG Post Combustion Capture Conference 8, Marseille, September 2025, [Affiliation: Department for Energy Security and Net Zero].

Figure 1: UK Industrial CCUS Clusters by Track (left) and map showing UK's storage potential (right)

will move an initial 4 Mtpa from Teesside and the Humber to secure North Sea storage, with capacity scaling to over 20 Mtpa by the mid-2030s. Flagship projects already in execution include Net Zero Teesside Power (up to 860 MW gas-fired power with CCUS from 2028), EET Hydrogen's 350 MW blue hydrogen plant, and the UK's first CCUS-enabled energy-from-waste facility at Protos.

These projects are made investable through four innovative, government-backed business models that de-risk first-of-a-kind deployment and attract private capital:

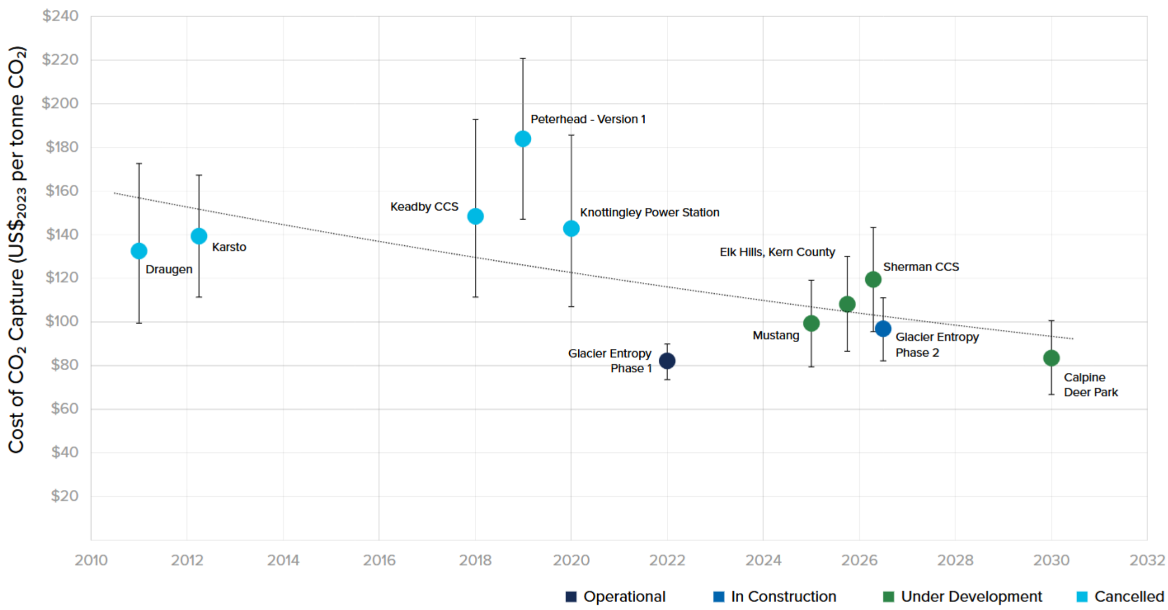
- Transport and Storage Regulatory Investment (TRI) Model
- Dispatchable Power Agreement (DPA)
- Industrial Carbon Capture (ICC) Business Model
- Hydrogen Production Business Model (HPBM)

The UK's current momentum stands in marked contrast to the stalled projects of 2008-2021. Three decisive lessons that now underpin success include a deliberate cluster-first sequencing approach, a deliberately unbundled value chain that allows specialised players to emerge, and a willingness by government to absorb the cross-chain and first-mover risks that private capital cannot bear alone. These hard-won insights, combined with the £21.7 billion commitment to the Track-1 clusters, have transformed CCUS from perennial promise into deliverable reality.

Looking ahead, the immediate priority is to bring the East Coast and HyNet clusters to full scale while advancing the Track-2 projects. Acorn (led by Storegga) and Viking (led by Harbour Energy) have already been identified as the preferred transport-and-storage providers for the next wave, pending final value-for-money confirmation expected in 2026.

Advancements in CCS Costs: Trends and Strategies for Cost Reduction

Partial pressure sets the tone for capture design. Higher CO_2 partial pressure reduces the size of key equipment, lowers energy demand, and widens the range of viable capture technologies. In terms of capture fraction, a higher capture rate delivers a larger CO_2 output for a relatively stable capital expenditure, resulting in a lower cost of capture on a per-tonne basis. As the capture fraction approaches 100%, however, costs begin to rise again due to the increasing energy required to capture the final few percentage points of CO_2. Figure 2 illustrates a clear downward trend in capture costs; recent designs consistently undercut earlier projects. Greater availability of open project data will further validate this decline and accelerate reductions through learning and improved financing.



Barlow, H. 2025, *Advancements in CCS Costs: Trends and Strategies for Cost Reduction*, conference presentation, IEAGHG Post Combustion Capture Conference 8, September 2025. [Affiliation: Global CCS Institute].

Figure 2: Trends in Costs – Natural Gas

Understanding why costs fall starts with the main drivers. Partial pressure and capture fraction are central, but costs also depend on technology choice, plant scale, local prices for power and natural gas, any additional flue-gas clean-up required, and location-specific factors such as materials, labour, and permitting timelines. Project context matters too, retrofit versus new-build, and greenfield versus brownfield sites.

Several strategies can drive costs lower. Economies of scale reduce unit capital costs as CO_2 throughput increases, while modularisation can shorten schedules and limit on-site risk. Heat integration reduces energy use and subsidised, or lower-cost, finance lowers the cost of capital. **Learning-by-doing is a powerful cost-reduction mechanism, but limited deployment to date has slowed expected learning curves; accelerated build-out and systematic knowledge-sharing will significantly speed up progress.** Technology innovation remains the largest lever, from novel solvents and new capture pathways to process optimisation and upstream reconfiguration.

Furthermore, the publicly available engineering design study reports sponsored by the U.S. Department of Energy contain valuable information that can guide future system design, spur research and development, and accelerate learning rates.

Design and Optimisation of Intensified Rotating Packed Bed (RPB) Absorbers for Carbon Capture in Natural Gas Power Plants

Packed column absorbers and strippers remain the industrial benchmark for CO_2 capture, but rotating packed beds use high centrifugal fields to intensify gas-liquid mass transfer, which can shrink equipment size and raise efficiency. For natural gas power plant flue gas, four absorber designs were assessed.

- One RPB absorber: tested with MEA at 55 and 75 wt%; using 75 wt% MEA reduced absorber size by about 5% and cut rotor energy by about 38% due to lower solvent flow and a smaller RPB.
- Two RPB absorbers in parallel: the flue gas is split so each unit handles half the flow; raising rotor speed reduces size but increases energy, and operating at 200 RPM uses about 41.3% less rotor energy than 300 RPM.
- One RPB absorber with exhaust gas recirculation (EGR): an EGR rate of about 35.44% lifts the flue gas to around 6 vol% CO_2, operated with 75 wt% MEA.
- Two RPB absorbers in parallel with EGR: with 75 wt% MEA, this configuration achieves above 90% capture and up to four times smaller units; however, energy rises with rotor speed, and 200 RPM saves about 38.5% compared with 300 RPM.

EGR, MEA concentration, and rotor speed are the dominant performance levers. The best performance was achieved with the design consisting of 2 RPB absorbers, EGR and 75 wt% MEA, delivering above 90% capture and smaller RPB size (up to 4 times smaller). Packing choice is also critical: higher porosity and surface area help, and wire mesh shows about half the pressure drop of Expamet while maintaining efficiency, giving the best overall balance[4].

Novel Water-Lean Solvent for Energy-Efficient CO_2 Capture

The Research Institute of Innovative Technology for the Earth (RITE) has advanced CO_2 capture technologies through the development of novel water-lean solvents, targeting energy-efficient solutions for high-emission sectors like integrated steelworks. The R&D strategy emphasizes materials with reduced viscosity, an expanded CO_2-rich to lean-phase window, and regeneration at lower temperatures, alongside key performance attributes such as rapid absorption kinetics, high cyclic CO_2 capacity, and minimal heat requirements for desorption (Table 1).

Experimental and computational methods guided the selection and formulation of amines, optimizing concentrations and blends to enhance overall efficiency. The resulting water-lean solvents demonstrate superior metrics: increased cyclic capacity via accelerated desorption rates boosts CO_2 recovery, while simultaneous reductions in reaction heat lower thermal energy demands. Compared to conventional aqueous

[4] Otitoju, O. 2025, *Design and optimisation of intensified rotating packed bed RPB absorbers for carbon capture from natural gas power plants.* Conference presentation, IEAGHG Post Combustion Capture Conference 8, Marseille, September. University of Sheffield

monoethanolamine (MEA) systems, these solvents achieve regeneration energies of approximately 2.0 GJ/t-CO_2, notably lower than MEA benchmarks.

Table 1: Selected three water-lean solvent performances

Selected Water-lean Solvent	Absorption[a]/ Desorption[b] Rate (g/kg/min.)	CO_2 Loading[c] @ 40 °C (g/kg)	Cyclic Capacity[d] @ (40-90) °C (g/kg)	CO_2 Recovery[e] (%)	Heat of Absorption[f] (kJ/mol-CO_2)	Specific Heat[g] (J/gK)
Water-lean solvent_22	1.35/10.8	125	114	91	63.1	3.1
Water-lean solvent_19	1.40/10.8	124	120	97	64.9	3.0
Water-lean solvent_9	1.32/10.6	123	110	89	66.1	2.9
Aq. MEA_30wt% (Ref.)	2.38/2.38	119	35	29	86.9	3.75

[a]CO_2 absorption rates were calculated at 50% of the 120-min CO_2 loading at 40 °C and [b]desorption rates were calculated at the average of the initial 10-min CO_2 loading at 90 °C; [c]120-min CO_2 loading at 40 °C; [d]difference between CO_2 loadings at 40 and 90 °C; [e](c/b) ×100%; [f]Heats of reaction were measured at 40 °C and atmospheric pressure; [f]Specific heats of all water-lean solvent and aq. 30wt% MEA solutions were measured at 40 °C and atmospheric pressure.
Chowdhury, F A. 2025, *Results of RITE's novel water lean solvent for energy efficient CO2 capture*, conference presentation, IEAGHG Post Combustion Capture Conference 8, Marseille, September 2025. [Affiliation: Research Institute of Innovative Technology for the Earth RITE].

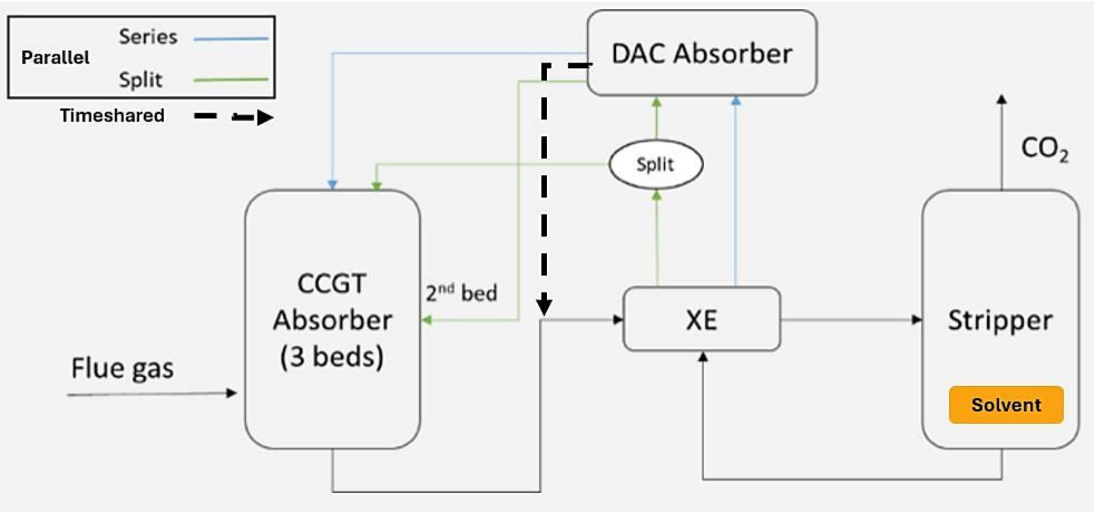
This innovation positions water-lean solvents as a viable pathway for scalable, energy-optimised CO_2 abatement, with potential for broader industrial adoption by minimizing operational penalties and improving process economics.

MEA-based direct air capture and validation of process model for future integration with post combustion capture

Direct air capture (DAC) using MEA is demonstrated, along with validation of a process model for future integration with post-combustion capture. The CoDAC concept uses the same amine for air and flue gas capture, enabling either parallel or time-shared operation. Building on Michailos et al. (2022), the configuration targets a specific reboiler duty of about 3.6 GJ per tonne of CO_2, comparable to standalone post combustion capture. A once-through DAC absorber, a conventional counter current absorption column is adopted, which has a much greater driving force for mass transfer compared to a pump-around absorption column but needs much lower liquid-to-gas ratio for air capture than from flue gas capture

Vapour liquid equilibrium indicates a workable loading window of about 0.1 to 0.3 mol CO_2 per mol MEA for air at 420 ppm, with the lean loading of about 0.1 achievable at desorber pressure near 2.4 bar. Air operation leads to lower absorber temperatures due to cool inlet air, evaporative cooling and the low CO_2 concentration, so model validation at these conditions is essential.

A laboratory rig at the University of Sheffield uses low liquid BX packing in short columns with expected flow rates for DAC capture in the order of about 0.2 to 0.4 L/min, resulting in a liquid-to-gas ratios of about 0.02 to 0.1 kg solvent/kg air. A standalone thermal reclaimer is available which can be used to regenerate solvent.



Joel, L. 2025, *Demonstration of MEA based direct air capture and validation of a process model for future integration with post combustion capture*, conference presentation, IEAGHG Post Combustion Capture Conference 8, Marseille, September 2025. [Affiliation: University of Sheffield].

Figure 3: CoDAC (Proposed by Michailos et al, 2022) integration schematic: MEA DAC coupled with CCGT post combustion capture.

Preliminary campaigns without regeneration show outlet CO_2 typically 200 to 300 ppm and confirm the central design rule that lowering the liquid-to-gas ratio increases solvent loading uplift whilst there is no significant penalty in the outlet CO_2 concentration. Tests have shown that at liquid-to-gas ratios of 0.025, there is a need to set up a system for higher gas velocities or lower liquid flowrates. Data from this study is indicative, and more tests are expected to furnish firm results.

Ongoing work is aimed at finalising model validation with lab data, and will address amine carryover, water losses and degradation in the system for longer runs.

Biological contamination in direct air capture systems

DAC systems are susceptible to biological contamination from atmospheric and local environmental sources, including pollen, dust, grass clippings, insects, algae, and fungi, spanning large particles, small particulates, and micro-particles. In Lexington, Kentucky, site-specific conditions exacerbate risks, with elevated tree pollen in spring, insect activity from late spring through summer, and proximity to agricultural fields involving spring planting (e.g., hay) and summer harvesting.

Testing was conducted over three 500-hour phases: Phase I (May, tap water control), Phase II (June–July, 0.3 M KOH), and Phase III (July–August, combined tap water and 0.3 M KOH). Maintenance involved cleaning fan screens and particulate filters every 100 hours, with solution samples plated on potato dextrose agar (72-hour incubation) to assess bacterial and fungal growth. At phase endpoints, solutions were filtered, and filters weighed to quantify contamination profiles.

Key findings included slime accumulation in tubing (likely zooplankton, confirmed via microscopy), bacterial or fungal growth in 80% of tap water samples, and fungal proliferation in KOH solutions after 200 hours of runtime, evidenced by sporangia, spores, and bacterial colonies. Insects such as thrips (1.5 mm × 0.25 mm), lepidopteran scales, and arachnids were collected primarily from the DAC reservoir, where the majority of biological mass was sub-370 μm. Complete removal of contaminants necessitated filtration down to 0.45 μm.

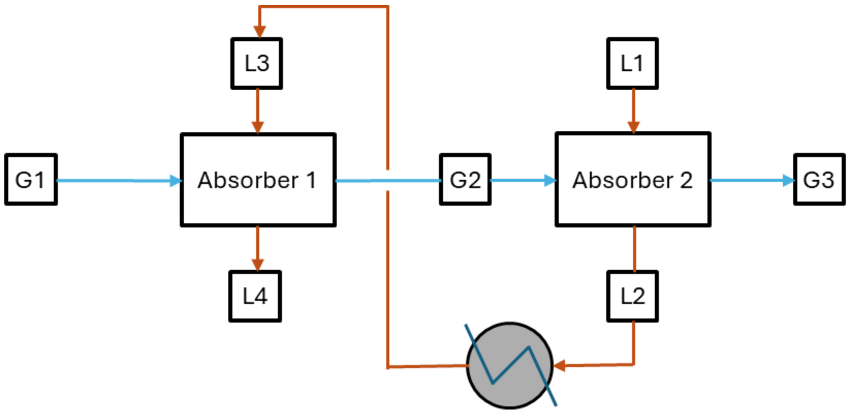
These **results underscore that macroscopic and microscopic biocontamination can cause filter and spray nozzle plugging in DAC systems, even in alkaline environments (e.g., KOH). Fungal growth persists at elevated pH levels, highlighting the need for multi-stage filtration to ensure sustained operation.** Contamination profiles are highly influenced by local and seasonal factors, emphasizing robust design adaptations. Ultimately, biological ingress remains an inherent challenge, as environmental contaminants inevitably infiltrate DAC infrastructure.

Crossflow Absorber (XFA) for Modular, Engine-Based Carbon Capture

Crossflow absorbers are being developed as a compact alternative to traditional counter- current scrubbers for post- -combustion carbon capture.[5] In a crossflow unit, the gas stream flows horizontally through the packing while the solvent flows vertically; this arrangement allows the absorber to operate- across a wide range of fluid flow rates and process larger volumes of gas more quickly than counter-flow designs. Because the gas does not have to pass through a tall, packed column, cross-flow absorbers experience much lower pressure drops 16–50% lower in some experiments which lowers energy consumption[6]. Their horizontal configuration also enables modular, containerised

[5] Abreu, M. 2025, *Crossflow CO_2 absorption: solvent performance comparison.* Conference presentation at IEAGHG Post Combustion Capture Conference 8, September 2025. [Affiliation: TotalEnergies].
[6] Labib, M M A 2024, *Crossflow absorber characterisation for the direct air capture of carbon*, PhD thesis, The University of Edinburgh. DOI: 10.7488/era/5461. Available at: https://hdl.handle.net/1842/42908 [Accessed 12 November 2025].

layouts rather than tall, vertical towers. The research effort therefore focuses on three core objectives: *reducing system size*, *lowering cost* and *improving performance* in engine -based carbon capture. A process model for cross flow absorption is provided in Figure 4.



Cownden, R. 2025, *A process model for crossflow CO_2 absorption*, conference presentation, IEAGHG Post Combustion Capture Conference 8, September 2025. [Affiliation: University of Sheffield]

Figure 4: A process model for crossflow CO_2 absorption

Aramco has developed a second-generation cross flow absorber (XFA) for modular engine-based capture that delivers about a 160% performance gain over the initial design through optimised packing and improved liquid and gas distribution. This evolution underpins FluxBox, reported as the world's most compact post-combustion capture system. Reported project milestones include a tenfold reduction in modular system volume compared with conventional setups, an absorber about 20% smaller than a vertical column, about 50% lower cost than a hollow fibre membrane contactor, and more than 95% lower pressure drop which reduces operating cost. Ongoing aspect ratio trade off work supports scale up while retaining compactness.[7]

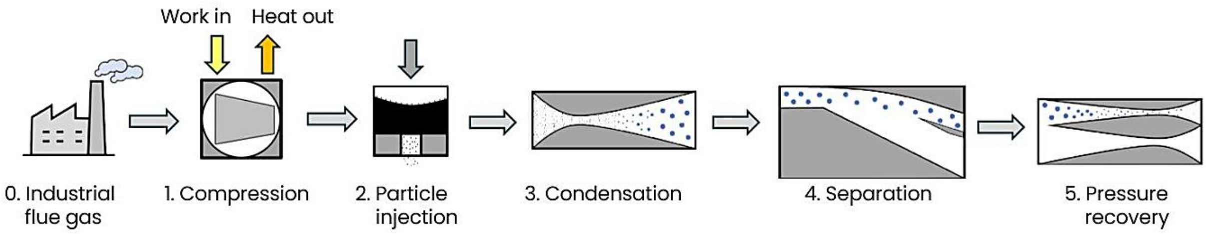
Supersonic Carbon Capture Technology

Supersonic carbon capture represents an innovative post-combustion approach to CO_2 separation, using high-velocity flows to condense and isolate CO_2 from flue gas streams. The technology has been validated at lab-scale and is supported by numerical simulations that indicate competitive performance at industrial-scale, offering a compact alternative to conventional capture systems. By exploiting rapid expansion and cooling under supersonic conditions, it promotes efficient CO_2

[7] Voice, A. 2025, *Development of cross flow absorber XFA for modular engine-based carbon capture*, Conference presentation at IEAGHG Post Combustion Capture Conference 8 (PCCC-8), Marseille, France, September 2025. [Affiliation: Aramco]

condensation onto suspended particles, with the potential to simplify the capture process for power generation and industrial applications.

The process (Figure 5) begins with compression of the flue gas to between 5 and 20 bar, depending on CO_2 concentration, followed by heat recuperation in exchangers to bring the gas close to ambient temperature, allowing this heat to be reused elsewhere in the plant. Inert solid particles of controlled size and density are injected into the flow, which is then accelerated through a contoured nozzle to around three times the speed of sound, causing the temperature to drop below about minus 130˚C and enabling CO_2 to condense on the particles. A convex corner introduces expansion waves that turn and further cool the flow, while particle inertia causes them to deviate from the gas and be diverted by a separator plate that splits the streams. The flow is kept supersonic until this separation is complete to avoid CO_2 sublimation.



Chartrand, D. et al, Grebe, A., Fukushima, G., Bonenfant, L. and Brouillette, M. (2025) *Supersonic point source capture*. conference presentation, IEAGHG Post Combustion Capture Conference 8, September 2025. [Affiliation: Université de Sherbrooke]

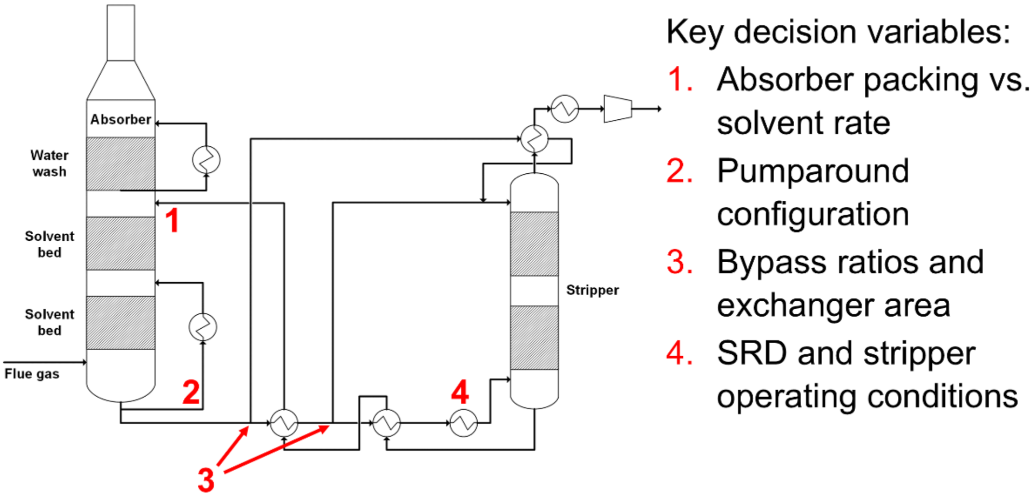
Figure 5: System overview: Supersonic point source capture (PSC)

Both the CO_2-rich and CO_2-lean streams are then gradually decelerated and brought back towards ambient pressure and temperature in an efficient manner that limits recompression requirements. In the CO_2 rich stream, CO_2 sublimates as the flow slows and is routed to subsequent compression and storage, while the particles are recovered and reinjected into the system. The CO_2 lean stream is returned to atmospheric pressure and released to the atmosphere. Experimental results from tests with the integrated nozzle confirm CO_2 condensation onto the injected particles and their effective separation with an optimised separator, while numerical simulations support the compact and simple design, demonstrating the technical viability of the supersonic capture concept.

Rainier Model Optimization of the PZAS CO_2 Capture Process

Rainier is an equation-oriented process-modelling framework for simulation and optimization of post-combustion amine scrubbing. Implemented in gPROMS Process®, it identifies cost-optimal equipment design parameters and steady-state

operating conditions for capture applications based on specified targets, such as flue gas composition, flow rate, and CO_2 capture level.



Martorell, J L, et al. (2025) *Process design optimisation model for amine scrubbing*. Paper presented at the IEAGHG 8th Post Combustion Capture Conference, September 2025, [Affiliation: McKetta Department of Chemical Engineering, The University of Texas at Austin].

Figure 6: PZAS flowsheet and key decision variables for Rainier optimisation

In the work by Martorell et al. (2025), the Rainier model simulates CO_2 capture using the Piperazine with Advanced Stripper (PZAS) process as applied to a natural gas combined cycle (NGCC) power plant. A rate-based CO_2 absorption model is presented and validated against pilot-scale experiments at the National Carbon Capture Center (NCCC). The equation-oriented model with rate-based mass transfer and appropriate simplifications accurately represents absorber performance, achieving <2% error in NTU prediction for NCCC pilot plant cases, though temperature-profile predictions show greater error (<5°C for Rainier vs. <2°C for Independence; Abreu, 2024). A surrogate model for k'_{g,CO_2} does not require simulating boundary layers and interfacial properties. Preliminary results are presented for the balance of the process (heat exchangers and stripper) in preparation for proceeding with the full-flowsheet optimization. However, VLE flash is challenging in equation-oriented models, and further work is needed to make the full-flowsheet model solve reliably for optimization tasks.

Decarbonisation of offshore operations using a centralised CCS energy hub

Decarbonisation of offshore oil and gas operations can be achieved by centralising heat and power generation in a shared energy hub based on CCS, with the Norwegian

Continental Shelf used as a case study.[8] The hub supplies electricity and heat to multiple platforms and sends captured CO_2 to storage. Centralising services can improve the match between power demand and supply, reduce redundant equipment, benefit from larger scale and improve security of energy supply, and is particularly relevant where power from shore is technically or economically challenging.

Weight of equipment is a major driver of capital cost in offshore applications. Compact CO_2 capture and conditioning solutions that reduce weight by about 50% can lower CO_2 avoidance costs (CAC) by up to about 8%. A CCS energy hub configuration can avoid up to about 90% of CO_2 emissions with an avoidance cost near 350 EUR per tonne.

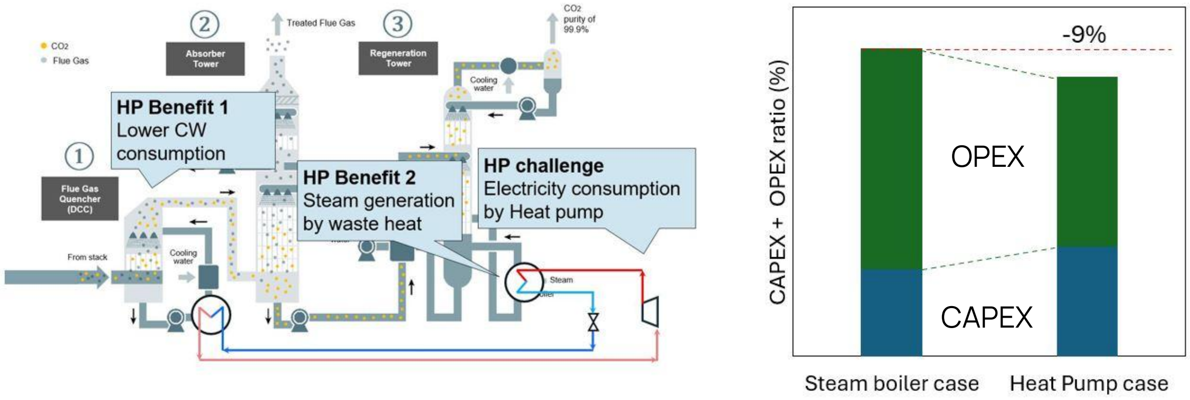
Higher CO_2 taxation levels are required to make CCS-based hubs economically attractive, and continued development of compact capture technologies is important. Electrification from shore can in some cases offer lower-cost emission reductions, but constraints such as limited grid infrastructure in remote areas and competition for electricity demand need to be considered.

Impact of heat pump integration on CO_2 capture plant costs

In the ongoing efforts to make capture economically viable, integrating heat pumps into post-combustion CO_2 capture plants is studied. The core innovation lies in replacing traditional steam-heated reboilers with electrically driven heat pumps to regenerate the amine solvent.

An MHI study reveals a classic trade-off as shown in Figure 7, the heat pump configuration carries a significant capital expenditure penalty of approximately 27% compared to the conventional steam boiler case, driven primarily by the cost of the heat pump. However, this upfront increase is more than compensated by operational expenditure savings. Under representative European energy prices of 100 €/MWh for electricity and 12 €/MMBTU for natural gas, the heat pump case achieves a 24% reduction in operational expenditure.

[8] Anantharaman, R. (2025) 'Techno economic benchmarking of a decarbonised energy hub for offshore power supply', Conference presentation at IEAGHG Post Combustion Capture Conference, Marseille, France, 2025, [affiliation: SINTEF Energy Research].



(a) (b)

Otani, A. (2025) 'Techno economic study of CO_2 capture plant with heat pump', paper presented at IEAGHG Post Combustion Capture Conference (PCCC-8), Marseille, France, 2025, Mitsubishi Heavy Industries EMEA Limited.

Figure 7. (a) KM CDR Process™ with Heat Pump Concept (b) Total Cost of CO_2 Capture: Steam Boiler vs. Heat Pump Case (-9% with Heat Pump)

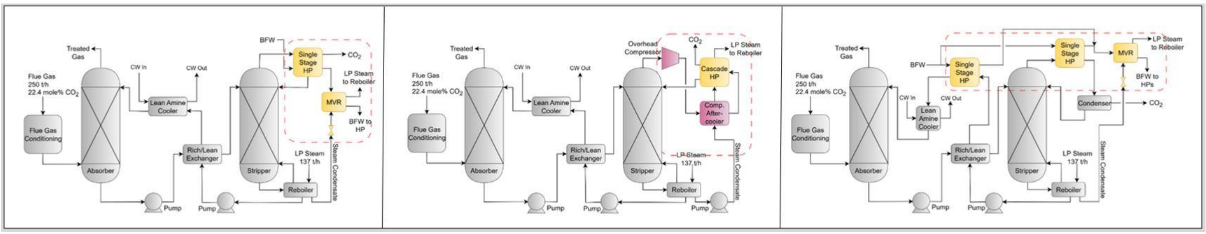
When CAPEX is annualized over a 25-year plant life and using a 6.8% discount rate at 90% availability, the heat pump integration reduces the total cost of CO_2 capture by roughly 9% compared to the conventional steam boiler approach. This outcome demonstrates that, in regions where electricity is competitively priced relative to steam, heat pump integration can have an economic advantage. A critical insight from the analysis is the sensitivity of the business case to the electricity-to-steam price ratio. At current European price levels, the OPEX benefits fully offset the CAPEX increase, but the viability would diminish in markets with significantly more expensive power. MHI therefore emphasises the value of a cost-matrix screening tool that allows rapid assessment of heat pump feasibility across different price scenarios and plant conditions.

Further work aims to investigate how key flue gas parameters and inlet flue gas temperature affect the coefficient of performance (COP) and the cost matrix. The effect of H_2O concentration in the flue gas has already been evaluated and shows only a limited impact within the study range.

In a similar study, Natural Resources Canada compared natural-gas low-pressure (LP) steam boilers against high-temperature heat pumps (HTHPs) that supply 100% of reboiler steam for an ~800 kt/y amine-based CO_2 capture plant. Three HTHP configurations were evaluated:

- Scenario 1: Multiple heat sources: one single-stage high-pressure (HP) cycle on stripper overhead stream + MVR fed from the HP and steam condensate from the reboiler outlet

- Scenario 2: Single heat source: one cascade HP cycle on compressed stripper overhead stream (to boost heat duty) that directly produces steam at target temperature.
- Scenario 3: Multiple heat sources: single-stage/economizer HP cycles on both stripper overhead and lean amine streams + mechanical vapour recompression (MVR) fed from the two HPs and steam condensate from the reboiler outlet.



Navarri, P (2025), 'Integration of high temperature heat pumps for steam generation in amine-based CO_2 capture: a techno economic study', paper presented at the IEAGHG Post Combustion Capture Conference, Marseille, France, September 2025. [affiliation: CanmetENERGY, Natural Resources Canada].

Figure 8: HTHP case studies (Scenario 1, 2 and 3)

The cost per tonne CO_2 captured is as follows:

- NG boiler baseline: 112.4 USD/t
- Scenario 1: 169.6 USD/t (+51%)
- Scenario 2 (cascade): 176.9 USD/t (+57%)
- Scenario 3 (multi-source): 152.5 USD/t (+36% – best performing)

All HTHP cases incur 18–28% higher CAPEX and significantly higher OPEX due to electricity demand, making the NG boiler cheaper today. However, HTHPs eliminate on-site fossil fuel use, reduce cooling water demand, and cut ~5,500 t/y direct CO_2 emissions, rendering them far more sustainable and future-proof under carbon pricing. HTHPs are likely to become competitive in low-electricity-cost Canadian provinces (Québec, BC, Manitoba) by accounting for upstream emissions from both natural gas and electricity and regional variations in energy prices through sensitivity and uncertainty analysis, while also considering the cost of avoided as well as captured CO_2 and exploring non-hydrocarbon or natural refrigerants such as NH_3.

All HTHP cases incur 18–28% higher CAPEX and significantly higher OPEX due to electricity demand, making the natural-gas boiler cheaper at present. However, HTHPs eliminate on-site fossil fuel use, reduce cooling water demand, and cut ~5,500 t/y direct CO_2 emissions, making them more sustainable and future-proof under carbon pricing. HTHPs are likely to become competitive in low-electricity-cost Canadian provinces such as Quebec, British Columbia and Manitoba, especially when upstream emissions from natural gas and electricity and regional variations in energy prices are taken into account, the cost of avoided as well as captured CO_2 is considered, and non-hydrocarbon refrigerants such as NH_3 are explored.

In principle, heat pumps can provide the full reboiler duty where suitable waste heat is available, although cases with only partial coverage may achieve a higher coefficient of performance, so techno-economic sweet spots need to be identified. Ongoing work is developing a predesign tool with MINES Paris to map these opportunities, with techno-economic optimisation and close collaboration with compressor manufacturers and capture unit licensors seen as important next steps for compression schemes tailored to heat generation[9].

Mixed Salt Process (MSP)

In terms of technology validation, ongoing pilot work on the analytical methods validation at NCCC using Mixed Salt Process (MSP) is being carried to study plant sensitivity to primary parameters such as flue gas flow rate, liquid flow rate to the regenerator, and regenerator temperature, and to secondary parameters such as liquid recirculation in the absorption columns and the water-wash loop. The programme also evaluates process robustness through system responses to transient and ramp operations and extended testing and validates plant performance at baseline operation with a CO_2 capture rate of about 90%. These tests are aimed to push the Mixed Salt Process toward TRL 6.[10]

Electrochemical CO_2 Capture

Electrochemical CO_2 capture is now being demonstrated at industrial sites in Europe in projects such as ConsenCUS, ASGREEN, and Innovandi, building on earlier work in $CCCH_2$. The core innovation, as implemented in ConsenCUS, eliminates amines and thermal regeneration, and instead, flue-gas CO_2 is absorbed into a potassium hydroxide (KOH) solution in a conventional packed absorber. The CO_2-rich solution is sent to the acidic compartment of an electrochemical cell equipped with bipolar membranes (BPM). BPM-catalysed water dissociation lowers the pH, triggering CO_2 desorption at ambient temperature without external heat and pure gaseous CO_2 is then separated from the regenerated solution.

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[9] Hagi, H et al (2025), 'Optimising the integration of heat pumps in solvent based post combustion CO_2 capture plants', Conference presentation at the IEAGHG 8th Post Combustion Capture Conference (PCCC 8), Marseille, France, September 2025, [Affiliation: TotalEnergies OneTech and MINES Paris].
[10] Pachitsas, S 2025, 'Mixed Salt Process MSP and analytical methods validation in pilot plant using real flue gases', Conference presentation at the IEAGHG Post Combustion Capture Conference (PCCC-8), Marseille, France, September, Baker Hughes.

A current demonstration unit (100 kg CO_2/h) operates on real flue gases (3–20 vol% CO_2) and features a 10m absorber column, two electrochemical stacks (126 cell pairs each), and a maximum current density of 1,000 A/m^2. **A Key performance insight is that the specific energy consumption (SEC) for electrochemical CO_2 capture is currently higher than conventional thermal amine systems. SEC rises with current density but falls with higher inlet P_{CO_2}. Laboratory setups have shown potential to reduce SEC up to 2 GJ/tonne CO_2.**[11]

Metal-Organic Frameworks (MOF) Scale up

Pilot-scale trials are beginning to close the gap between materials innovation and industrial carbon capture for metal-organic frameworks (MOFs). MOFs are highly porous, sieve-like materials with high CO_2 uptake, lower regeneration energy than amine solvents, and good thermal and chemical stability. Until recently, their industrial use has been limited by concerns about scale and cost rather than fundamental performance.

The MONET project, funded by the UK Department for Energy Security and Net Zero under the CCUS Innovation 2.0 competition, is demonstrating a Promethean MOF-based capture system on industrial flue gas with a design capacity of around 0.5 to 1 tonne of CO_2 per day. The work has shown that the MOFs can operate in a pilot-rig under industrial flue gas.

At the same time, it has highlighted important gaps, including regeneration difficulties linked to pilot-rig design, which limited reliable cycling tests. Findings underline the need for more controlled and systematic testing and closer collaboration with engineering contractors and technology developers, with the next step focused on systematic performance evaluation of MOFs to bridge the remaining gap between laboratory results and pilot-scale operation.[12]

Regenerative Froth Contactor (RFC)

The regenerative froth contactor (RFC) is a breakthrough co-current gas–liquid contactor that intensifies absorption by deliberately creating and controlling a pulsed froth hydrodynamic regime. Millions of rapidly forming and collapsing bubbles/droplets deliver up to 10× higher mass-transfer rates than conventional packed or tray columns, while using corrugated screen packing (CSP) to generate and control the froth.

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[11] Vinjarapu, S H B et al., (2025), 'Electrochemical CO_2 capture: demonstration of new technology at industrial sites across Europe', Conference presentation at the IEAGHG Post Combustion Capture Conference (PCCC-8), Marseille, France, September 2025. [Affiliation: Technical University of Denmark DTU].

[12] Goel, C 2025, 'Pilot scale demonstration of MOF sorbents: bridging materials innovation and industrial carbon capture', Conference presentation at the 8th Post Combustion Capture Conference (PCCC-8), Marseille, France, September 2025. [Affiliation: Promethean Particles].

The concept can handle viscous and fouling systems and is intended to intensify gas liquid absorption, offering up to about ten times higher mass-transfer efficiency than conventional equipment, with reduced column diameter and bed depth. It is presented as a versatile option for challenging applications including pre- and post- combustion capture and natural gas processing.

To support scale-up, Industrial Climate Solutions (ICS) has built robust testing capabilities around the RFC. Hydrodynamic behaviour is studied in an air-water loop to map the froth regime and pressure drop, using dedicated computer-vision methods. The rig is also equipped with advanced fluid-property characterisation and additive screening. The pilot capture loop with both absorption and regeneration is used to demonstrate RFC performance under simulated industrial conditions, allowing continuous assessment of capture behaviour and the development of proprietary know-how with full control over experimental design.[13]

Chilled Ammonia Process (CAP)

The Chilled Ammonia Process (CAP) is a chemical absorption technology for CO_2 capture that uses an inorganic aqueous ammonia-based solvent containing dissolved ammonium carbonate, ammonium bicarbonate and ammonium carbamate.

In total, CAP has accumulated more than 22,000 operating hours with capture rates above 90% and has been successfully demonstrated at TCM at an 80 kilotonne-per-year scale on both combined heat and power and RFCC flue gas streams.

The tests have consistently met or exceeded performance targets on the two flue-gas compositions and have proven extremely low ammonia emissions (ammonia emissions were maintained at 1 to 2 ppm, meeting the 2 ppm limit). The tests demonstrated plant availability of >95% for most of both campaigns – commercial-grade reliability and has generated the high-quality, long-duration dataset required for confident design of full-scale plants. With these results, CAP is one of the most rigorously validated non-amine CO_2 capture technologies available today and is fully ready for commercial deployment across power and heavy industry.[11]

Compact Carbon Capture

Compact Carbon Capture (CCC) is a process-intensification approach that replaces the static absorber and regenerator of conventional solvent-based systems with rotating packed beds in a rotating absorber and desorber (Figure 9). **Centrifugal forces greatly**

[13] Benquet, C 2025, 'Baker Hughes' carbon capture technologies portfolio', Conference presentation at the IEAGHG 8th Post Combustion Capture Conference (PCCC-8), Marseille, France, September 2025. [Affiliation: Baker Hughes].

increase vapour–liquid contact and reduce residence time, enabling high mass-transfer rates, smaller column diameters. The concept targets at least 95% capture for flue gases with around 10% CO_2, with significant reductions in equipment size, capital cost, and operating cost through lower solvent inventory and higher CO_2 product pressure. **CCC is aimed at small- to medium-scale applications in the 50 to 200 ktpa range, including waste-to-energy, steel, and cement plants, and is designed as a modular, ready-to-install package.**

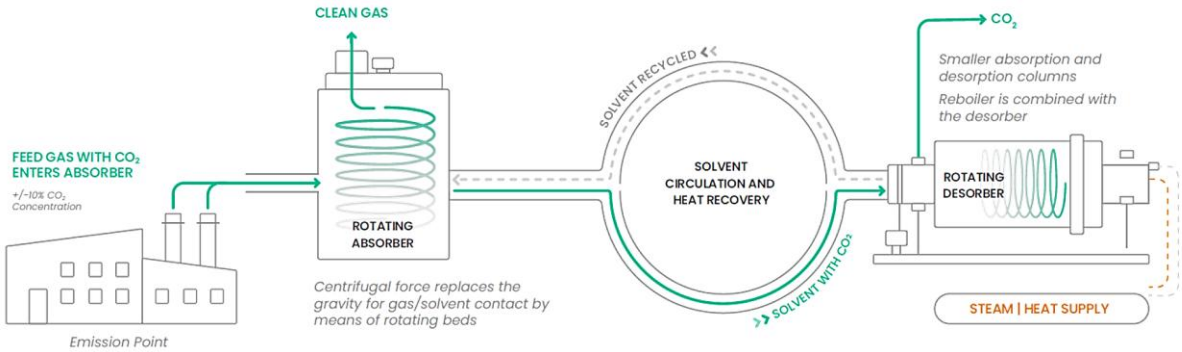

Figure 9. Compact Carbon Capture (CCC) focuses on Process Intensification[11]

The development pathway for CCC runs from early rotating desorber wheel (RDW) tests at about 5 tonnes per day between 2008 and 2014, through a 1.7 tonne-per-day crossflow absorber (CFA) lab rig in 2016–2017, to an integrated 5 tonne-per-day pilot plant combining CFA, RDW, and balance-of-plant from 2017 to 2021. From 2022 to the present, a 15 TPD demonstration plant has been operating on real industrial flue gas, advancing it to TRL 7.[11]

BECCS demonstration in Japan

A large-scale BECCS-ready CO_2 capture demonstration plant – currently the largest operating biomass CCS facility in the world – has been deployed at the Mikawa Power Plant, which operates a boiler firing 100% biomass. The capture unit is fully integrated with the host plant and draws regeneration steam from an extraction line on the existing steam turbine, removing the need for an auxiliary boiler or external heat source. It captures about 600 tonnes of CO_2 per day, corresponding to more than half of the plant's total emissions.

Ongoing and planned work includes more detailed parametric testing with variations in solvent and flue-gas temperatures and replacing the existing absorber packing with a next-generation high-capacity structured packing, with performance evaluated before and after the change. As one of the largest and most established biomass CCS installations worldwide, the Mikawa plant now serves as a key reference for commercial-scale BECCS using conventional amine technology and helps to reduce the perceived risk of delivering negative emissions from sustainable biomass.[14]

STRETCHER Method for Ultra-High Capture Rates with Low Energy Requirements

The STRETCHER (System Tuning for Regenerator Efficiency and Target Capture with High Exit Rich) method is a control and optimisation strategy for solvent-based CO_2 capture that aims to achieve very high capture rates with low energy use. The key features of the STRETCHER method can be summarised as follows:

- Produce the lowest possible lean loading without wasted energy for a given desorber pressure (and hence temperature range) by operating at the desorber inflection point.
- Use the lean solvent flow rate that gives the optimum combination of capture rate and rich loading, and hence specific reboiler duty for that lean loading, given the absorber corner constraints.
- Use lean and rich solvent storage to allow the desorber and absorber to be operated with the most rapid possible feedback and so be optimised independently in the short term, while obviously still also balancing in the long term.

Solvent storage is useful to implement STRETCHER effectively (as well as to maintain capture during start-stop and for market arbitrage).

Further, the COGENT (Capture Operation with Greater Economy for Net-zero Targets) project, led by the UK-China (Guangdong) CCUS Centre in collaboration with the Guangdong Carbon Capture Test (GCCT) Platform and the University of Sheffield/UKCCSRC, aimed to demonstrate post-combustion carbon capture technology operating at up to 100% CO_2 capture efficiencies in natural-gas and biomass plant applications. This large-scale pilot testing was conducted at the Guangdong Carbon Capture Test platform, utilising a combination of optimising the lean loading of the amine solvent and simultaneously controlling the lean flow to the absorber. The goal was to maximise CO_2 capture rates while minimising energy penalties.

COGENT Phase 2 aims to add real-time lean and rich solvent loading measurement using UK-designed instrumentation and also ppm-level exit CO_2 measurements; it will also implement reclaiming (with desorber-venting reclaimer), reboiler/desorber pressure-

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[14] Shibata, R, et al., (2025). 'Parameter test results of large scale BECCS ready CO_2 capture demonstration plant (MOEJ's Sustainable CCS Project)', Conference presentation at the IEAGHG 8th Post Combustion Capture Conference PCCC 8, Marseille, France, September 2025. [affiliation: Toshiba Energy Systems and Solutions Corporation].

fluctuation smoothing (temperature and flow restriction), increase desorber operating pressure to 2.4 bara, and demonstrate continuous high capture for 100 hours.

Plans for COGENT Phase 3, currently under development for 2026, include adding rich solvent storage (the plant already has a lean buffer tank), using air dilution for low-CO_2 flue gas (gas power plant level), and maintaining continuous high capture during simulated CCGT stop/start and flexible operation.

In the longer term, the programme will progress to the Advanced Capture Exemplar (ACE) pilot, designed for continuous reclaiming and sustained 100% CO_2 capture under continuous operation.[15]

High Performance Mixed Matrix Membranes Design

Mixed-matrix membranes (MMM) combine a continuous polymer with dispersed filler particles to achieve gas-separation performance beyond that of polymers alone. The MMM study[16] shows that platonic particles with lower sphericity improve permeability and selectivity compared with spherical fillers, especially at higher filler loadings and when the fillers are much more permeable than the polymer. Shape effects become more pronounced as loading and the filler-to-polymer permeability ratio increase, and lower-sphericity particles give higher membrane selectivity at similar permeability ratios. Assessing gas transport in membranes using voxelised three-dimensional structures is highlighted as an efficient way to study how particle geometry influences performance.

The study concludes that filler-particle arrangement and the overlap of defect regions are key sources of uncertainty when predicting membrane permeability and selectivity. The impact of interface thickness and filler volume fraction on performance should also be evaluated with explicit consideration of filler shape. Accurate characterisation of incompatibility at the polymer–filler interface, and its impact on mixed-matrix membrane performance, lies beyond the scope of simple empirical models or fits based only on experimental data. These geometric and interfacial effects can be captured more reliably by integrating voxelised structures into the computational framework.

Electrifying Post Combustion Carbon Capture

Electrifying post-combustion carbon capture is explored as a route to decarbonise industry beyond direct process electrification. By replacing combustion-based steam

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[15] Gibbins, J, et al. 2025, '*A demonstration of the STRETCHER method for ultra-high capture rates with low energy requirements*', Conference presentation at the IEAGHG 8th Post Combustion Capture Conference (PCCC-8), Marseille, France, September 2025. [Affiliation: University of Sheffield and UKCCSRC].
[16] Ghasemi, M., Sarkisov, L. and Babaei, M., 2025. *Design strategies for enhancing gas separation with high performance mixed matrix membranes*. Conference presentation at the 8th Post Combustion Capture Conference (PCCC-8), Marseille, France, September 2025. [Affiliation: University of Manchester]

generation with electrical options and using low-carbon power, fully electrified capture can avoid additional fossil-fuel use, lower the energy penalty of capture systems, and better match flexible, renewable electricity supply. The study compares several electrified options against conventional MEA-based capture.

Among the electrified post-combustion carbon capture pathways, integrating heat pumps with conventional MEA stands out as the clear near-term winner. It delivers an immediate 54–59% reduction in the levelised cost of capture compared with traditional steam-driven MEA, while cutting total energy input by approximately 60%. Leveraging proven technology, this option offers the strongest and most deployable cost advantage in the near term.

For long-term robustness, oxyfuel combustion combined with capture emerges as the top performer. By 2050 it achieves the lowest cost at around 45 €/t CO_2 (−64 % versus 2025 levels), requires the least energy overall, and exhibits the smallest regret across more than 1,000 future scenarios spanning electricity prices, carbon prices, and technology uncertainties.

Membrane-based separation becomes highly competitive as the grid decarbonises. It reaches approximately 49 €/t CO_2 by 2050 (−65 % cost reduction) and already today requires roughly 35 % lower total CAPEX than conventional MEA. Its performance improves further with abundant cheap renewable electricity, giving it strong upside potential.

In contrast, conventional standalone MEA is increasingly left behind, achieving only a ~36% cost reduction by 2050 and carrying the highest regret risk because the steam reboiler remains its dominant energy and cost penalty. Vacuum swing adsorption (VSA) is rarely the optimal choice: even in 2050 its capture cost stays high at ~89 €/t CO_2, and its total CAPEX is about 56% higher than MEA, limiting its competitiveness despite modest electricity consumption.[17] Figure 10 shows the distribution of capture cost regret for each pathway across the scenario ensemble.

[17] Salman, M et al. (2025) *Electrifying post combustion carbon capture: how future energy scenarios reshape techno economic performance*. Conference presentation at IEAGHG Post Combustion Capture Conference 8 (PCCC-8). [Affiliation: Université de Liège]

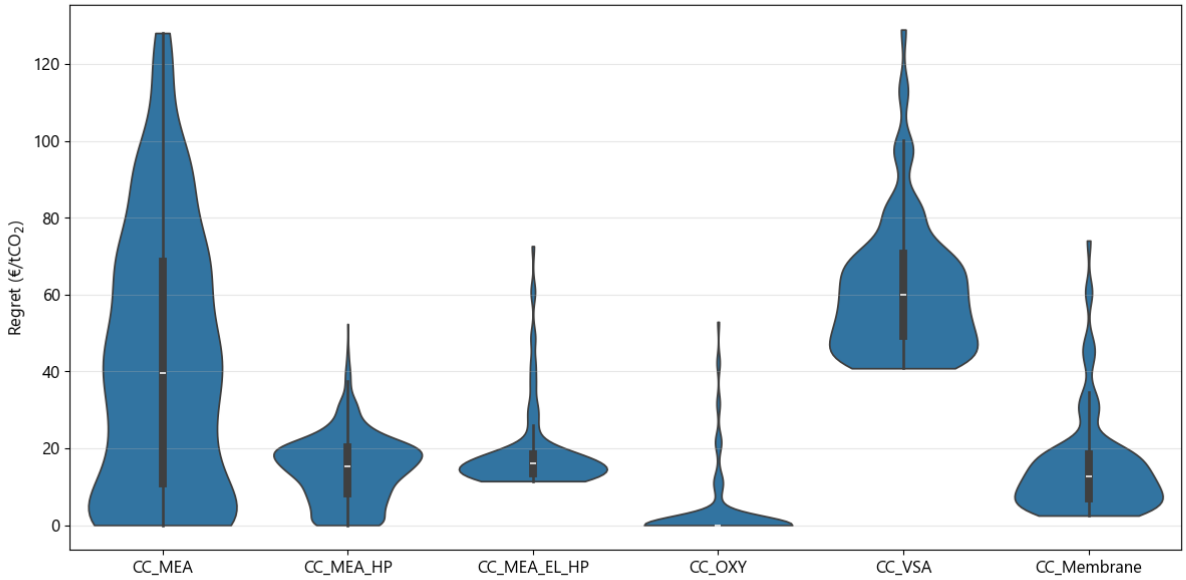


Figure 10. Distribution of capture cost regret for alternative capture pathways. [14]

The regret analysis quantifies the performance loss of a given option compared to the best-performing option under each scenario. Narrow, low violins close to zero indicate technologies that remain near optimal in most future scenarios, while tall, wide distributions reveal options that are frequently far from the least cost choice.

Networking, social events and side meetings at PCCC-8

On the evening of 15 September 2025, the PCCC 8 welcome reception was held on the Garden Roof Terrace of the Mercure Marseille Centre Vieux Port Hotel. The open-air space and pleasant September weather provided a relaxed setting for delegates to network ahead of the technical programme. Delegates enjoyed drinks and canapes in the warm September evening. As is often the case in the CCS community, there was a strong sense of familiarity as many long-standing colleagues reconnected, and it was also very encouraging to see and network with a growing number of CCS early career professionals.

During conference lunches, delegates enjoyed beautiful views from the lunch venue of Notre Dame de la Garde, an iconic Marseille landmark and one of the city's most recognisable and visited sites, perched on the highest natural point of the city.

The gala dinner on the evening of 17 September, generously hosted by TotalEnergies, took place at the Palais de la Bourse, 4 rue Beauvau, 13001 Marseille. This nineteenth century building, with its grand facade, high ceilings and formal trading hall, provided an impressive backdrop and a reminder of Marseille's long-standing role as a commercial and maritime gateway. The dinner itself was a lively occasion, with delegates unwinding over a four-course meal and drinks in a setting that encouraged both informal discussion and reflection on the week's themes. During the evening, Tim Dixon, General Manager of IEAGHG, took the opportunity to recognise the contributions of Keith Burnard, IEAGHG on the occasion of his retirement, acknowledging his unwavering dedication to IEAGHG and his role as chair and technical lead for the PCC conferences in Birmingham USA 2017, Kyoto Japan 2019, the virtual meeting in 2021, Pittsburgh USA 2023 and Marseille France 2025. The dinner was also used to recognise the outstanding organisational work of IEAGHG's events manager Suzanne Killick who has delivered four GHGT conferences from GHGT 14 to GHGT 17, fifteen IEAGHG Executive Committee meetings and five PCC conferences, with PCCC-8 marking her final event before retirement.

No gala would be complete without a touch of levity, and the dance floor soon beckoned with vibrant music, inviting delegates to showcase their moves in a moment of pure, light-hearted release. It turns out that there are some very capable steppers in the CCS community.


PCCC-8


PCCC-8

Where are we now and what's next?

Post-combustion capture (PCC) and carbon dioxide removal (CDR), via direct air capture (DAC) and bio-energy with carbon capture and storage (BECCS), are increasingly recognised as complementary pathways for mitigating climate change. Post-combustion capture involves capturing CO_2 from exhaust gases of power plants and industrial facilities, allowing emissions to be reduced at the source. DAC and BECCS, on the other hand, remove CO_2 from the atmosphere or from biomass-based processes, enabling net-negative emissions. Together, these technologies address both ongoing emissions and legacy atmospheric CO_2, which is essential for meeting ambitious climate targets.

In recent years, post-combustion capture has moved beyond demonstration projects into early commercial deployment. Global capture capacity now exceeds 50 Mt CO_2/year, supported by multiple operational CCS facilities in Europe, North America, China, and Australia. Notable projects include cement and gas processing plants retrofitted with capture units, as well as power plants integrating advanced amine solvents and more compact capture designs. These developments reflect significant technical improvements, including solvents with lower energy requirements, modular absorber designs and improved material stability. Despite progress, the technology remains energy-intensive, and infrastructure for CO_2 transport and storage continues to limit broader deployment. Policy support and carbon markets have been critical in making projects financially viable.

DAC has emerged as a leading CDR pathway, with first-generation commercial facilities now operational. Climeworks' Mammoth plant in Iceland, using geothermal energy for CO_2 mineralisation, currently captures tens of thousands of tonnes of CO_2 annually, marking a step toward industrial-scale atmospheric removal. The STRATOS project in Texas, planned to capture 500,000 tonnes per year, exemplifies the next generation of large-scale DAC, combining modular design with secure geological storage. While DAC is highly flexible in siting and can target residual emissions from hard-to-abate sectors, it remains capital- and energy-intensive. The rapid pace of investment, particularly via voluntary carbon markets and corporate procurement of removal credits, is driving cost reductions and accelerating deployment.

BECCS is the most mature negative-emissions technology, although its current deployment is small. A few commercial-scale facilities capture CO_2 from biomass-fired power plants and industrial sites, storing it in geological formations – with notable examples of BECCS facilities today being the Drax Power Plant and the Illinois Industrial CCS Project. BECCS provides both energy and net-negative emissions if biomass feedstocks are sourced sustainably. The main limitations are the availability of biomass without competing with food production, the complexity of integrating CCS into bioenergy plants and verifying the net carbon benefit across the supply chain.

Overall, post-combustion capture is transitioning from niche applications to broader industrial use, and DAC and BECCS are beginning to demonstrate commercial feasibility. The combination of these approaches represents one of the few pathways capable of reducing ongoing emissions while removing CO_2 from the atmosphere. Yet the scale of deployment remains far below what is required to meet net-zero targets. The effectiveness of these technologies will depend on rapid scale-up, lowering costs, securing sustainable biomass for BECCS, expanding CO_2 transport and storage infrastructure and maintaining supportive policy frameworks. If these conditions are met, post-combustion capture alongside DAC and BECCS could play a central role in a global strategy for decarbonisation and net-negative emissions.

Listed below are some of the ways the IEAGHG Post Combustion Conference series can take us beyond where we are now by supporting the development, upscaling and deployment of post-combustion capture technologies, as well as broader CCUS, DAC and BECCS solutions:

1. Accelerating technical innovation in CO_2 capture

- Provides a global forum where researchers present the latest breakthroughs in solvents, sorbents, membranes, process intensification and system integration.
- Enables rapid dissemination of experimental results, reducing duplication of effort and speeding up the identification of promising technologies.
- Encourages benchmarking and standardisation of performance metrics, which helps laboratories and developers compare results more meaningfully.

2. Bridging the gap between research and deployment

- Details case studies from pilot and commercial projects, offering real-world operational data on capture efficiency, energy use, degradation issues and O&M.
- Provides insights on scale-up challenges such as materials stability, corrosion, flue-gas variability and integration with power and industrial processes.
- Reduces risk for new projects by allowing developers to learn from lessons and failures shared by operators and vendors.

3. Strengthening collaboration across industry, government and academia

- Connects equipment suppliers, power and industrial operators, policymakers, research institutes and investors.
- Helps align R&D priorities with market needs and emerging policy frameworks, improving the path to commercialisation.
- Facilitates partnerships and joint projects, including international collaborations and shared-testing facilities.

4. Informing policy, standards and best practices

- Presentations and discussions feed into IEAGHG technical studies, which policymakers use to design support mechanisms and regulatory frameworks.
- Promotes the development of best-practice guidelines on monitoring, solvent management, safety and environmental performance.
- Supports long-term planning by providing credible cost and performance data used in national and international modelling.

5. Extending knowledge beyond post-combustion capture to CCUS, DAC and BECCS

Although focused on post-combustion capture, the conference increasingly contributes to:

- CCUS: Through capture-testing that informs full-chain project design, capture–compression integration and cross-sector applications (cement, steel, refining).
- DAC: Through sharing advancements relevant to DAC (e.g., sorbent degradation, low-grade heat integration, contactor design and process intensification).
- BECCS: By addressing operational challenges specific to biomass flue gases (e.g., lower CO_2 concentration, impurities) and enabling lessons from power and industrial integration.

6. Supporting future large-scale deployment

- Builds a shared evidence base for investors and developers, increasing confidence in cost trajectories and technology readiness.
- Highlights opportunities for modular designs, compact capture systems and solvent advancements that make capture more viable for distributed and hard-to-abate sources.
- Encourages a long-term vision for achieving regional and global net-zero strategies, in which CCUS, DAC and BECCS all play critical roles.

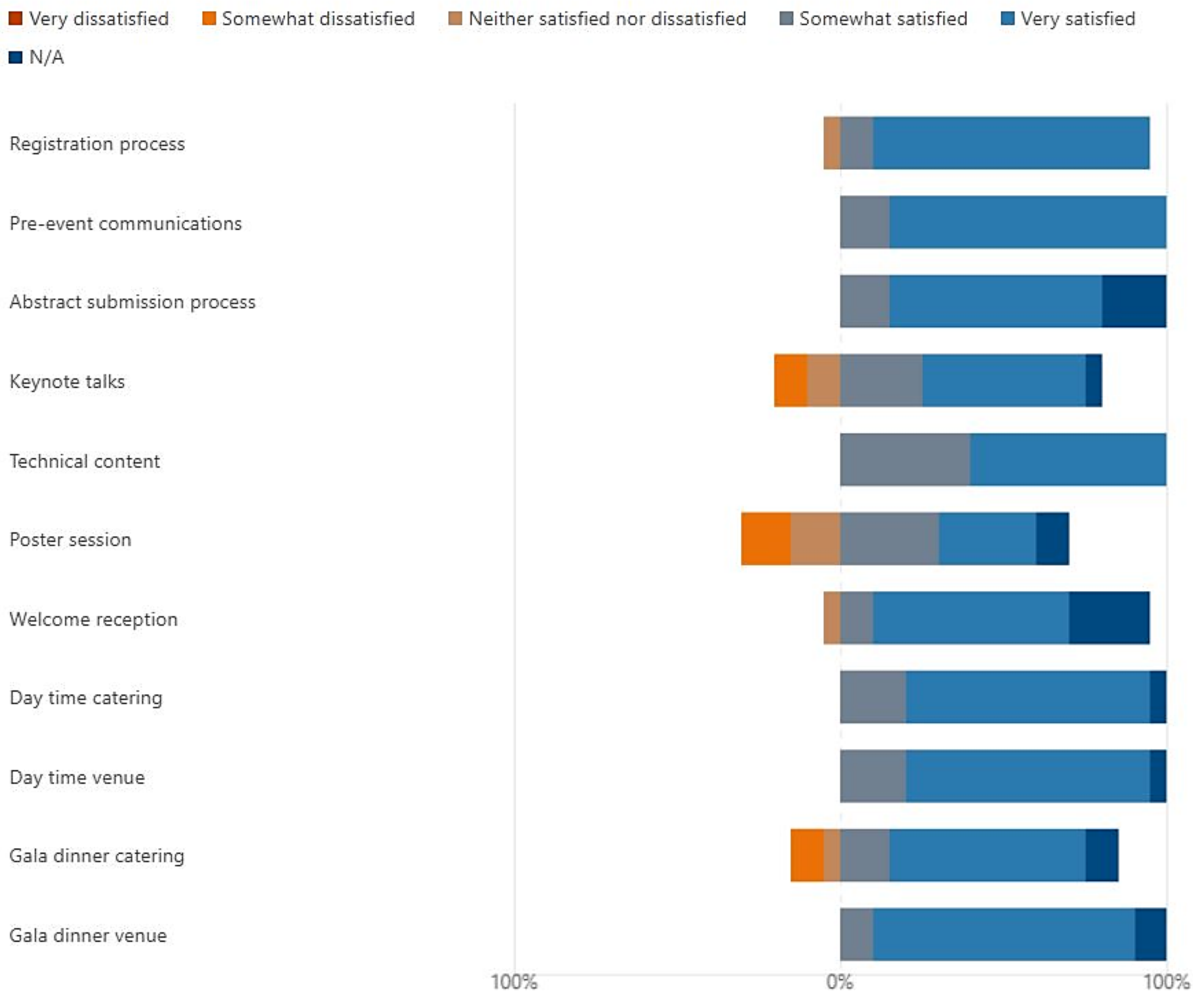
In summary, the IEAGHG PCC Conference series acts as a global catalyst for innovation, collaboration and informed decision-making, helping to advance the technical, economic and policy conditions necessary for the widespread deployment of CCUS, DAC, and BECCS.

PCCC-8 through the Lens

Photography by Sébastien Delarque

PCCC-8 Delegate Feedback

A sample of delegate satisfaction ratings from the post conference feedback survey is summarised in the figure below.



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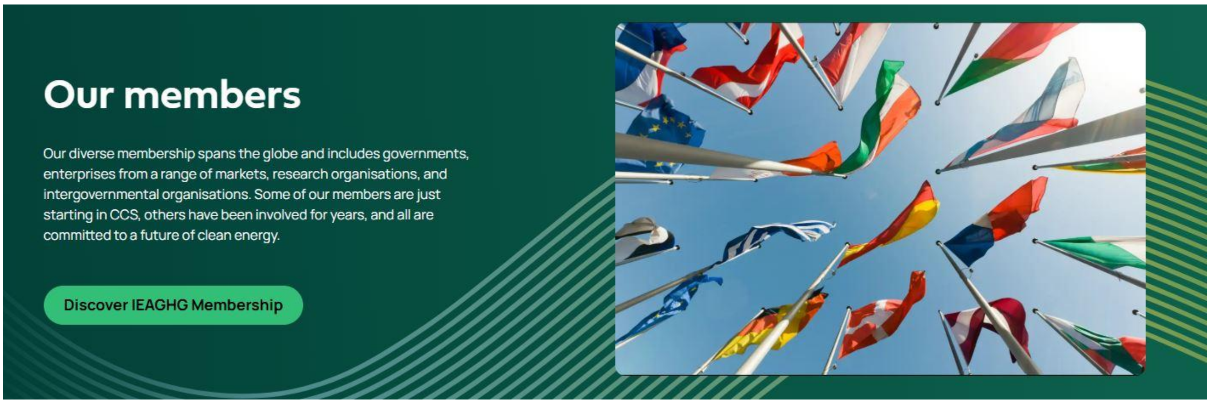

Reviewers for PCCC-8 abstracts

Advances in Separation Technologies

Ms Layla Al Ibrahim (Saudi Aramco), Mr Hossein Anisi (The University of Melbourne), Mr Loris Baggio (Université de Liège), Ms Camilla Barbieri (Politecnico di Milano), Mr David Chartrand (Université de Sherbrooke), Ms Xinyue Chen (The University of Texas at Austin), Dr Firoz Chowdhury (Research Institute of Innovative Technology for the Earth, RITE), Mr Romain Close (CRM Group), Dr Diego Di Domenico Pinto (Hovyu B.V.), Dr Zhenchang Fang (Shanghai Jiao Tong University), Dr Javier Fernandez Garcia (IQS School of Engineering), Ms María García Atencia (GasN_2), Mr Mehdi Ghasemi (The University of Manchester), Ms Lisa Katharina Hassel (Technische Universität Darmstadt), Mr Adrien Houzé (University of Mons, UMONS), Miss Aisha Ibrahim (University of Sheffield), Mr Daigo Inakazu (Mitsubishi Heavy Industries Ltd.), Dr Saravanan Janakiram (Aqualung Carbon Capture AS), Ms Hyunyoung Jung (Waseda University), Prof Nobuhiro Kanomata (Waseda University), Dr Adam P. Karcz (Industrial Climate Solutions), Dr Shreenath Krishnamurthy (SINTEF Industry), Mr Nicholas Landon (University of Nottingham), Dr Alain Ledoux (LSPC INSA Rouen), Dr Wei Li (University of Nottingham), Dr Takashi Makino (Japanese National Institute of Advanced Industrial Science and Technology), Ms Rose McCarthy (University of Leeds), Dr Frantisek Miksik (Nagoya University), Ms Chelim Min (Seoul National University), Mr Benas Mockus (NTNU), Dr Peter Moser (RWE Power AG), Ms Maëlle Nisolle (IFP Energies nouvelles), Mr Georgios Oikonomou (NTNU), Mr Tomoyuki Onomura (Inpex Corporation), Ms Célia Pasté (University of Mons), Ms Ariel Plantz (The University of Texas), Mr Marcin Pokora (University of Sheffield), Ms Juliette Poupeney (Revcoo), Mr Nicolas Renard (Ardent), Mr Fred Rugenyi (Technology Centre Mongstad), Dr Ilia Sadykov (Empa), Ms Meng Shi (SLB Capturi), Dr Eirik Falck da Silva (SINTEF), Dr Biao Sun (Curtin University), Dr Jesse Thompson (University of Kentucky, IDEA), Dr Sara Vallejo Castaño (Wetsus), Mr Damien Verdonck (University of Mons), Dr Alexander Voice (Aramco Americas), Dr Nicholas Stiles Wilkins (Svante Technologies Inc.), Dr Liu Yang (Shanghai Jiao Tong University) and Prof Bohak Yoon (Baylor University).

Commercial and Demonstration Activities

Mr Aditaya Akheramka (IPA Global), Mr Romain Béard (TotalEnergies One Tech), Mr Christophe Benquet (Baker Hughes), Dr Frederick Closmann (The University of Texas), Mr Richard Deutsch (UK Department for Energy Security and Net Zero), Prof Jon Gibbins (University of Sheffield), Dr Chitrakshi Goel (Promethean Particles Ltd), Mr Daigo Inakazu (Mitsubishi Heavy Industries, Ltd.), Dr Teruhiko Kai (Research Institute of Innovative Technology for the Earth, RITE), Mr Erik Meuleman (ION Clean Energy), Dr William “Will” Morris (Wyoming Integrated Test Center), Mr Thibault Mousseau (LHEEA), Ms Randi Neerup (Technical University of Denmark), Mr Michael Ownsworth (University of Sheffield), Dr Koteswara Rao Putta (Technology Centre Mongstad), Mr Ryosuke Shibata

(Toshiba Energy Systems and Solutions Corporation), Dr Sai Hema Bhavya Vinjarapu (Technical University of Denmark), Dr Adriaen Verheyleweghen (Cybernetica AS) and Mr Ahmad Wakaa (Technology Centre Mongstad).

Cost and Economic Assessment

Dr Simon Roussanaly (Sintef Energy Research), Dr Majed Sammak (GE Vernova), Dr Hirotaka Isogai (Waseda University), Mrs Elettra Vantaggiato (Sintef Energy Research), Dr Sally Homsy (National Energy Technology Laboratory), Mr Arijit Alip Upadhyay (Swiss Federal Laboratories for Materials Science and Technology, Empa), Mr Hugh Barlow (Global CCS Institute), Dr Daniele Ferrario (Politecnico di Torino), Dr Luca Riboldi (Sintef Energy Research), Mr Sina Hoseinpoori (Chalmers University of Technology), Mr Daigo Inakazu (Mitsubishi Heavy Industries, Ltd.), Mr Sotirios Efstathios Antonoudis (CERTH), Mr Muhammad Salman (Université de Liège), Dr Gregory Hackett (National Energy Technology Laboratory), Director Technical Services Shannon Timmons (International CCS Knowledge Centre), Mr Timothy Fout (US Department of Energy) and Mr Leonardo Varnier (University of Padova).

Environmental Impact and Sustainability

Dr Vanja Buvik (SINTEF), Ms Keemia Abad (University of Kentucky Institute for Decarbonization and Energy Advancement), Mr Timothy Fout (US Department of Energy), Dr Rafael Gonzalez Olmos (Universitat Ramon Llull), Dr Frederick Closmann (The University of Texas), Prof Gary Rochelle (The University of Texas at Austin), Mr Alexander Reyes Andersson (Technology Centre Mongstad DA), Mr Aniekeme Edet (Society of Petroleum Engineers), Dr Lee Stevens (University of Nottingham), Mr Laurent Thomas (Shell Catalysts and Technologies), Mr Diego Morlando (Norwegian University of Science and Technology) and Dr Baptiste Languille (University of Oslo).

Process Applications

Dr Yihang Liu (Shanghai Jiao Tong University), Ms Keemia Abad (University of Kentucky), Dr Haftom Weldekidan (CSIRO), Mr Paul De Joannis (EDF R, D / LRGP Nancy), Dr Yuki Kohno (National Institute of Advanced Industrial Science and Technology), Mrs Suzanne Killick (IEAGHG), Prof Mathieu Lucquiaud (University of Sheffield), Mr Teja Schmid McGuinness (Lhoist), Mr Lucas Joel (University of Sheffield), Prof Meihong Wang (University of Sheffield), Prof Armin Wisthaler (University of Oslo), Dr Rahul Anantharaman (SINTEF Energy Research), Dr Moushumi Sarma (University of Kentucky), Dr Simon Roussanaly (SINTEF Energy Research) and Dr Donghoi Kim (SINTEF Energy Research).

Process Configurations

Ms Abby Gale Lara (Svante Technologies Inc.), Dr Hayato Hagi (TotalEnergies OneTech), Dr Daniel Mullen (SSE Thermal), Mr Lucas Joel (University of Sheffield), Mr Sander Balkenende (Fluor), Prof Armin Fricke (CGC Capital Gain Consultants GmbH), Mr Mohamed Medhat Ewais Ibrahim (Mohammed VI Polytechnic University), Mr Hugh Barlow (Global CCS Institute), Mr Jon Isley (Fluor), Dr Ruiqi Wang (Durham University) and Dr Philippe Navarri (Natural Resources Canada).

Process Modelling

Dr Saeed Talei (Miskolc University), Mr Arnaud Henrotin (University of Mons), Mr Ryan Cownden (University of Sheffield), Dr Fariborz Shaahmadi (Heriot Watt University), Dr Diego Di Domenico Pinto (Hovyu B.V.), Mr Prashanth Chandran (Optimized Gas Treating), Dr Miguel Abreu Noia Torres (TotalEnergies), Mr Oliver Stratil (Instituto Químico de Sarriá), Mr Can Demir (Technical University of Denmark, DTU), Ms Layla Al Ibrahim (Saudi Aramco), Dr Ali M. Sefidan (Aalto University), Dr Benjamin Claessens (Aix Marseille University), Dr Lionel Dubois (University of Mons), Mrs Maryam Nasiri Ghiri (University of Central Lancashire), Dr Antoine Verhaeghe (University of Mons), Mr Diego Morlando (Norwegian University of Science and Technology), Dr Hanne Kvamsdal (SINTEF), Dr Thor Mejdell (SINTEF Industry), Mr Jorge Martorell (The University of Texas at Austin) and Mr Luca Bertoni (Utrecht University).

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