IEAGHG

GHGT-17 Summary Brochure

20-24 October 2024
TELUS Convention Centre, Calgary, Canada

ghgt.info

Summary

Please note that AI technology was used in some sections of this publication to provide a concise summary.

GHGT-17 Background

IEAGHG is the guardian of the GHGT conference series. Held every two years, this conference series rotates between North America, Europe and Asia, and is hosted in an IEAGHG member country. The GHGT conference series is established as the principal international conference on greenhouse gas mitigation technologies, focussing on carbon capture, utilisation and storage (CCUS). GHGT-17 attracted 1547 attendees from 47 countries, making it the largest GHGT yet and hence the largest gathering of CCS experts to date! Each conference is an exciting forum for technical discussions related to the field of greenhouse gas control technology.

GHGT-17 was held in Calgary, Canada, at the TELUS Convention Centre. Hosted by Emissions Reduction Alberta (ERA), this event attracted 1547 attendees from 47 countries. During the conference, there were countless opportunities to network, connect and engage professionals from across the globe. Keynotes and plenary addresses were given by world leaders in climate change, policy, and CCUS, as well as over 350 presentations across 71 technical sessions and 500 poster presentations. In addition to the in-depth technical streams, brand new for this event was a business stream that explored effective strategies for deploying CCS technology, managing risk, financing, global regulations and more.

About the hosts

Emissions Reduction Alberta was created in 2009 to help deliver on the province's environmental and economic goals. ERA takes action on climate change and supports economic growth by investing in the pilot, demonstration and deployment of clean technology solutions that reduce GHGs, lower costs, attract investment, and create jobs in Alberta. ERA receives its funding from the Government of Alberta through the Technology Innovation and Emissions Reduction (TIER) Fund.

Our commitment to sustainability

The organisers of the GHGT-17 conference estimated that the event would produce approximately 745 tonnes of CO_2 equivalent emissions. This estimate includes emissions from activities such as transportation, materials, travel, catering, and accommodation. To demonstrate our commitment to sustainability, $37,000 worth of offsets were purchased through the Alberta Emission Offset Registry.

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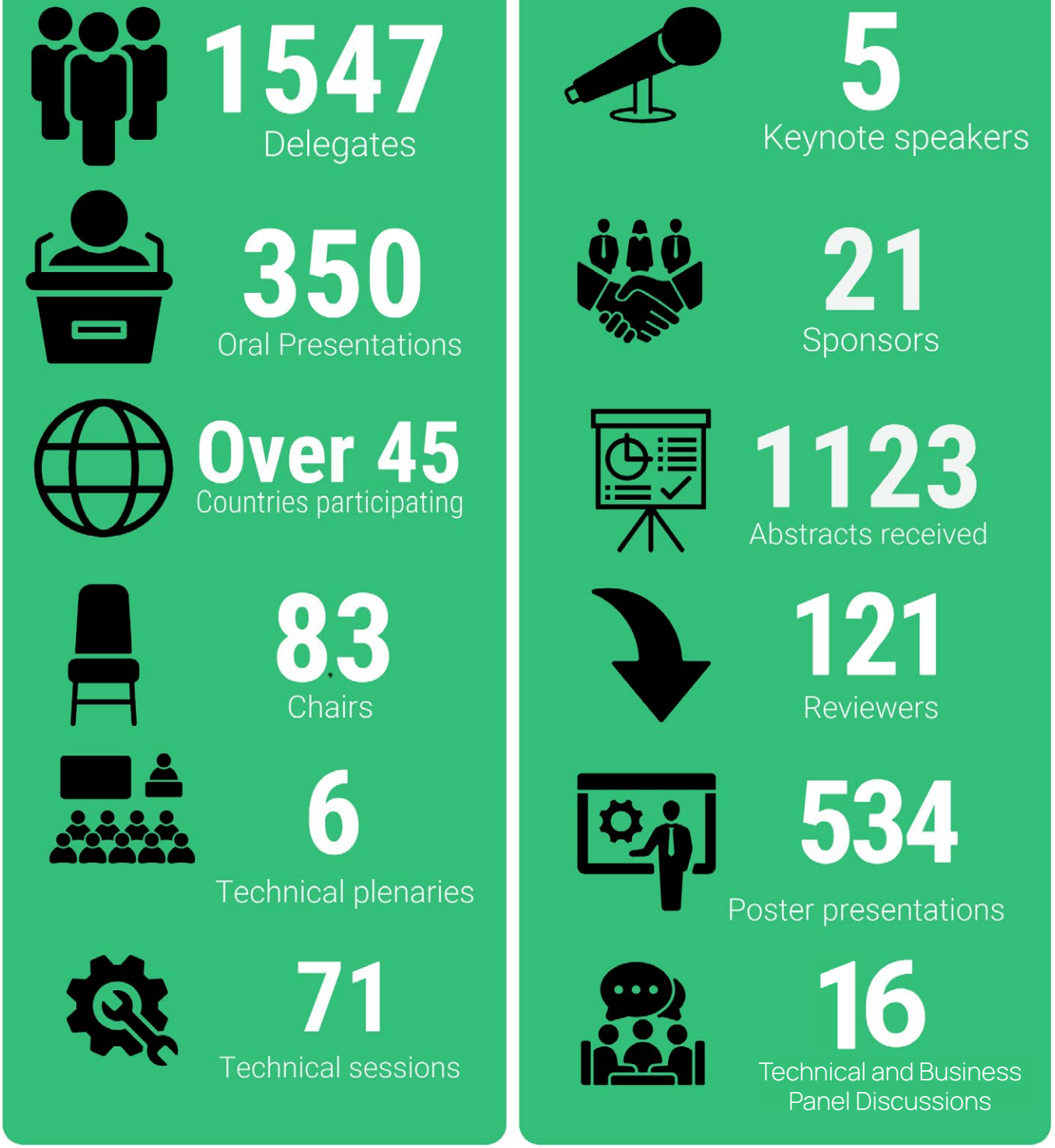
GHGT-17 Statistics



Committees

Steering Committee

- Tim Dixon, IEAGHG
- Chris Owttrim, Emissions Reduction Alberta (ERA)
- Mark Summers, Alberta Innovates
- Michelle Gurney, ERA
- Neil Wedin, ERA
- Matia Antulov, ERA
- Adam Battistessa, Government of Alberta
- Joanne Pawluk, ERA
- Suzanne Killick, IEAGHG

Organising Committee

- Suzanne Killick, IEAGHG
- Tim Wilson, IEAGHG
- Michelle Gurney, ERA
- Neil Wedin, ERA
- Joanne Pawluk, ERA
- Blair Hiltz, Venues West
- Lisa Harford, Venues West
- Anne Keller, Venues West

Technical Programme Committee

- Tim Dixon, IEAGHG
- Dr Saviz Mortazavi, NRCAN
- Prof Carlos Abanades, CSIC- INCAR
- Dr Mohammad Abu Zahra, GCCSI
- Prof Andrea Ramirez, Delft University
- Prof Sean McCoy, University of Calgary
- Prof Susan Hovorka, University of Texas
- Dr Lincoln Paterson, CSIRO
- Dr Matthias Raab, CSIRO
- Dr Paul Feron, CSIRO
- Dr Nicola Clarke, IEAGHG
- Suzanne Killick, IEAGHG

Keynote Introductions

Attendees of the GHGT-17 were welcomed by **Justin Riemer** (Chief Executive Officer of Emissions Reduction Alberta (ERA)) and **Colleen Waskewitch Runner** (Guest Services Manager of the Grey Eagle Resort Calgary) on Monday morning. Colleen acknowledged the land of the First Nations and provided a conference blessing. Justin then provided a brief introduction about Alberta's leadership in CCUS, with the Alberta Carbon Trunk Line (ACTL) being the largest CO_2 pipeline in the world. Large investments are currently being made by industrial companies to overcome the challenge of making CCUS economically viable. In addition, 11 different front-end engineering and design (FEED) studies are underway, with some of them nearing completion. However, more policy and regulatory certainty will be needed to get more CCUS projects off the ground. Justin also underlined the importance of extracting value by providing innovation rather than just extracting resources. Research needs to be harnessed to provide benefits for both the communities involved and the planet, the motto here being to "Think big."

Next, **Kelly Thambimuthu** (Chair of the IEAGHG) presented the long history and background of IEAGHG and CCUS in Canada, starting with IEAGHG's formation in 1991, over the Weyburn-Midale project in 1996, to more recent IEAGHG reports and activities (e.g. the Summer School) highlighting the lessons learned from the Boundary Dam and Quest projects.

Since the last GHGT conference, the IPCC released its Synthesis Report of the 6th Assessment Report (AR6 SYR), establishing CCS as an option for emissions reductions from fossil fuels, with CO_2 injection and storage being considered secure and available in sufficient capacity. Similarly, the IEA highlights the importance of scaling and deploying carbon management technologies, next to other options like reducing deforestation, cutting non-CO_2 greenhouse gas (GHG) emissions and deploying renewable energy (RE).It is also important to keep in mind that energy technologies can have different efficiencies, so they need to be deployed smartly to align with the conference theme catalyst to net zero.

Tim Dixon (Director and General Manager of IEAGHG) welcomed all attendees and thanked the hosts and sponsors. He echoed Kelly in that we need CCS to achieve our climate goals. Tim made analogies to the Olympics, in that GHGTs bring nations and people together, and to marathons for the stamina required by the organising teams. This GHGT is the largest to date, with over 1,500 attendees and over 1,100 abstracts received. The CO_2 footprint of the conference will be calculated and offset by purchasing offsets from the Alberta Emission Offset Registry.

Mary Burce Warlick (Deputy Executive Director of the International Energy Agency (IEA)) highlighted that last year marked a record in global temperature history, with the 1.5°C threshold being temporarily reached. Thus, the net zero pathway has narrowed but the door remains open. Fossil fuel demand is expected to peak by the end of this decade and renewable energy is moving faster than governments can set targets. The strategic role of CCUS in clean energy transitions is to enable negative emissions, low-carbon hydrogen and other services/products. Existing skillsets of the fossil fuel industry workforce can be utilised in this transition but it is also important to increase indigenous participation and leadership in the carbon management industry. In order to get on track, we need to continue the recent momentum, move projects into operation and reduce project lead times.

Myles Allen (Professor of Geosystem Science, University of Oxford) established that we will emit more CO_2 than we can afford according to the carbon budget. CCUS is the only way we know to get permanently rid of CO_2. We are not going to phase out fossil fuels quickly enough to meet our climate goals. We will also need to address the passive response of the carbon cycle to CO_2 reductions/removals, i.e. the land and the oceans. Addressing the question what it takes to stop global warming, Myles highlighted that we need to burn less fossil fuels and/or replace them with renewable energy, store more carbon (e.g. also by reducing deforestation). Nature-based solutions can help but probably won't stem the main contribution, which would fall onto geological CO_2 storage.

However, currently only 0.1% of CO_2 is restored to the geosphere

and this share needs to grow significantly, to 30% or 1 trillion tCO_2 by 2100. This will be a challenge, as CCS is currently receiving only about 1% of the transition investment.

Talking about how to pay for CO_2 disposal, Myles mentioned the current dependence on direct subsidies, which are economically inefficient and politically vulnerable. Carbon pricing under emissions trading schemes (ETSs) is ineffective for technologies with high unit costs and/or long development times. Carbon takeback obligations (CTBOs) will likely be a better approach.

Jarad Daniels (Chief Executive Officer of the Global CCS Institute (GCCSI)) underlined that collaboration is key to global CCUS deployment. 50 facilities are currently in operation, 44 are in construction and 628 are in the pipeline. However, this is still some way off the targets to achieve geological net zero. Project derisking remains key to CCS investment and improved financing can be offset by inflation, interest rates, permitting and policy uncertainties. Potential tailwinds for CCS deployment include baseload power requirements, high-quality carbon credits and multilateral development banks. CCS legislation moved forward in several jurisdictions, including e.g. Brazil, Indonesia, Japan, Malaysia, South Korea and Western Australia. China is now doing CCUS at MTPA scale and offers tremendous opportunities.

Technical Plenaries

Technical Plenary 1

The technical plenary on Day 2 of the GHGT-17 conference featured two speakers. In order of appearance, these were Shell's **Onno van Kessel**, General Manager for CCS Development and Subsurface, and the World Bank Group's **Natalia Kulichenko-Lotz**, Program Leader, Sustainable Development. The speakers complemented each other very well, with Onno leading on the technical challenges faced in upscaling CCS from the million tonne (Mt) scale to the gigatonne (Gt) scale, while Natalia spoke on the challenges faced in introducing CCS to developing countries, economies where the greater part of the world's CCS deployment must be located if climate goals are to be achieved.

Fossil fuels currently account for over 80% of the global primary energy mix. To meet Shell's goal of reducing this share by 50%, a balanced and orderly transition is required. This transition must focus on accelerating low and negative carbon solutions to drive decarbonisation. The rapid growth of electrification and scaling up carbon removal technologies, CCS and direct air capture (DAC) will be essential to this transformation.

The successful implementation of CCS requires nine key enablers, such as strong policy frameworks to attract finance and investment, overcoming value chain dependencies, addressing technical challenges, and establishing industry standards.

Effective public consultation and a social license to operate are crucial, alongside overcoming the affordability gap for customers. The process also involves balancing the speed, quality, and cost of implementation, often necessitating trade-offs.

There are significant technical challenges in scaling up CCS technologies, particularly in large and diverse hubs where the transition from capturing megatons to gigatons of CO_2 becomes more complex. In the IEA Net Zero Emissions (NZE) scenario, around two-thirds of the 6 Gt of CO_2 to be captured by 2050 will need to come from emerging market and developing economies. Given the current state of CCS deployment, this is a daunting task.

For CCS to be widely adopted, an enabling environment is crucial. Technologies cannot be deployed without a social license to operate, which requires robust legal and regulatory frameworks. Furthermore, there must be comprehensive carbon management strategies at both national and sub-national levels, along with large-scale climate finance and new investment mechanisms to support the deployment of innovative climate and GHG-reduction technologies, particularly in World Bank client countries.

Developing countries will need support to create the necessary conditions for CCUS deployment. Establishing centres of excellence can help provide long-term development support. Continuity in government strategies and priorities is vital to the success of carbon management efforts, which can also be leveraged for broader development goals.

Technical Plenary 2

Day 3 opened with technical plenary 2, featuring insights from Sarah Forbes (US DOE) and Claude Lorea (GCCA) on carbon management and CCUS deployment.

Sarah Forbes, Director of the Office of Carbon Management Technologies at the US Department of Energy (DOE), highlighted the department's research and development initiatives in carbon management. As part of the Office of Fossil Energy and Carbon Management (FECM), the DOE's mission centres on tackling the climate crisis, with five key areas of focus: point source carbon capture; carbon dioxide removal technologies; carbon conversion technologies; CO_2 transport and storage; and hydrogen with carbon management.

Beyond R&D, the DOE engages in policy and analysis, engagement and federal partnerships to drive climate change mitigation efforts across all these technology areas.

Claude Lorea, Innovation and ESG Director at the Global Cement and Concrete Association (GCCA), discussed the role of CCUS in decarbonising the cement industry, emphasising the importance of concrete, one of the most widely used materials globally, and a critical component in climate resilience. However, as demand for concrete grows, so does the need to reduce its carbon footprint. 36% (1.3 Gt) of the required emissions reductions in the cement industry will depend on CCS.

Over the past three years, the number of CCS projects in the cement sector has surged, with 58 projects underway in 2024 and a combined capacity of around 25 million metric tons (Mt). Ms Lorea emphasized the importance of financing in supporting the transition to low-carbon cement, referencing initiatives like the UNIDO chain reaction and vision for finance motivation, which aims to motivate financial stakeholders. International collaboration is another key element, as international partnerships will be crucial for the cement industry to meet its emissions targets.

Technical Plenary 3

On day 4 of the GHGT-17 conference, technical plenary 3 kicked off with an address from **Rebecca Schulz**, the Alberta Minister of Environment & Protected Areas. Alberta is a leader in energy resources and currently has over 5 active CCS projects capturing and geologically storing CO_2 emissions, with many more projects in the pipeline. Minister Schulz advocated for close partnerships between government and industry to ensure that hard-to-decarbonise sectors can be a part of the solution.

Corwyn Bruce (Heidelberg Materials) shared the latest CCS developments at Heidelberg Materials, including the first carbon capture project on a cement plant. They have 8 large-scale CCUS facilities in development including the Brevik project in Norway, and a further 5 pilot and technology development projects. Mr Bruce highlighted the need for a strong business case and that with first-of-a-kind projects there is always a significant 'early-mover premium' and that as a result, capital funding is essential. These premiums include project risk, piloting, competitive FEED processes and contingency equipment.

Matthias Raab, CEO of CO_2CRC, a research organisation practising CCUS with commercially relevant demonstrations. They have the world's only deep research sub-surface facility and have trialled many technologies used in commercial projects today. Their recent research affirms that CCS is an essential technology for Australia to hit its 2050 net zero target.

Positively, Australia has more CCS policy drivers in place than ever before, including the Safeguarding Mechanism and the Future Gas Strategy, alongside international drivers such as the London Protocol. However, unlike in Europe and North America, there are no generous incentives for CCS and so project proponents must take 100% of the risk. Dr Raab emphasised that collaboration is key, involving government and industry both nationally and internationally.

Concluding Plenary: Future Leaders Forum – Leading the Charge for a Sustainable Future

Building on the success of the first future leaders panel at GHGT-16, this year's Future Leaders Forum was introduced by **Abdul'Aziz Aliyu** (IEAGHG), chaired by **Alex Cruz** (Baker Hughes) and comprised: **Shafira Anandita**, a PhD student from Singapore; **Luz Angela Serrano Herrera**, a chemical engineer from Buenos Aires; **Tanya Srivastava**, Senior CCS advisor at CEMEX; **Aisha Ibrahim**, an early career researcher PhD at the University of Sheffield; **Katia Piscina**, PhD student at Heriot-Watt University; **Ariel Plantz**, PhD student at the University of Texas, Austin and **Tristan Cloarec**, CO_2 and process innovation senior engineer at Lhoist.

Of these, Sharifa, Luz, Tanya and Tristan were students from the 2024 IEAGHG Summer School in Darwin, Australia. Education was a strong theme and education on climate change and mitigation technologies should be implemented from elementary level, and continuing. It is important to have a synergy between academia, government and industry, not only for education but to lead to human capital; the message should be spread that CCS is part of the solution and a worthy, exciting career option.

Regional geographies matter and CCUS will differ from region to region, with differences noticed most in developing countries. The panellists felt optimism for future deployment in the developing world, particularly as many emerging economies are eager to industrialise and decarbonise, although there is limited funding, a lack of climate education and missing regulatory frameworks which need to be improved. Even in countries with very supportive government, further incentives are needed to make CCUS profitable. Additional barriers were identified, such as data driven, informed decisions are critical and there is still a big challenge in data accessibility.

Closing Speeches

At the closing plenary of GHGT-17, **Tim Dixon** (IEAGHG) recognised a series of firsts from this GHGT, the largest to date with 1547 in attendance from 47 countries, with over 350 oral presentations and 500 poster presentations.

It was the first announcement of a large-scale funding award at a GHGT – DOE pledged $518 million to support 23 selected projects across 19 states (CarbonSAFE).

We ran the first business stream at a GHGT and the first session on Indigenous people and lands. There was the first short-notice discussion session on out-of-zone migration news, the first student poster award, the first IJGGC panel and – last but not least – the first new best paper award. **Chris Owttrim** (ERA) shared the three-year journey from the first pitch to host GHGT, through to the closing ceremony, recognising the many who contributed to this great opportunity to share Alberta's story and give a state of play on projects, with participation from researchers, policymakers, business leaders and cutting-edge technology.

The closing plenary ended with the announcement of the location of GHGT-18, and **Paul Feron** (CSIRO), **Linda Stalker** (CSIRO) and **Brendan Beck** (Australian Energy Producers) revealed that the next conference in the series would be going back to Australia, to the city of Perth, from 26-29 October 2026.

Key Technical Messages

Policy & Regulation

The key messages from these topics are:

- **Significant Challenge for Emerging Markets:**

The IEA's NZE scenario highlights that two-thirds of the 6 Gt CO_2 to be captured by 2050 must come from emerging markets and developing economies. This presents a significant challenge, given the current status of CCS deployment.

- **Need for an Enabling Environment:**

For CCS to be successfully adopted, an enabling environment is crucial. This includes establishing legal and regulatory frameworks, characterizing storage resources, developing carbon management strategies, and securing large-scale climate finance and investment mechanisms.

- **World Bank's Support for CCS Development:**

The World Bank's CCS Trust Fund has been instrumental in developing CCS enabling environments in nine countries. It has provided support in areas like knowledge management, capacity building, technical assistance, pilot funding, and business model development. Key successes include pilot projects in South Africa and the creation of storage atlases for South Africa and Nigeria.

- **Capacity Building is Essential:**

Building CCS capacity in developing countries before the technology becomes mainstream is vital. This includes assessing CCUS potential, developing economic models, and evaluating environmental and social impacts.

- **Cost Considerations for Low-Income Countries:**

Cost remains a critical factor for governments and private sector actors in low- and middle-income countries. Centres of excellence could help support long-term development and continuity in government strategies.

- **Linking Carbon Management to SDGs:**

Carbon management can contribute to achieving Sustainable Development Goals (SDGs), such as affordable and clean energy, decent work, innovation, and responsible consumption. Low- and middle-income countries can use carbon management for ongoing development, including generating and selling carbon credits and producing low-emission products.

- **Need for Increased Support:**

Ultimately, the message is that more support is needed for developing countries to build CCS enabling environments and leverage carbon management for both environmental and economic benefits.

- **Regulators:**

With the US EPA, there were presentations suggesting improvements to the Class VI regulations, both in terms of exempting aquifers to increase storage availability, and improving the permitting process and timeline. EPA also reported on experiences with regulating/reporting the greenhouse gas emissions of projects via Subpart RR, with 15 monitoring, reporting, and verification (MRV) plans being submitted in 2023. Also a new regulation, Subpart VV to report emissions from CO_2-EOR projects which use ISO 27916 to report CO_2 storage.

CCS Deployment

- **Urgency of Reducing Fossil Fuel Dependency:**

Fossil fuels currently make up over 80% of the global energy mix, and to address climate change, this must decrease significantly in the coming years. Achieving decarbonization will require a balanced transition away from fossil fuels, with a strong focus on low and negative carbon solutions, such as Carbon Capture and Storage (CCS) and Direct Air Capture (DAC). Additionally, electrification needs to increase rapidly to meet future energy demand.

- **Key Enablers for CCS Deployment:**

Shell's CCS portfolio in North America, Europe, and Australasia showcases the importance of several enablers for effective CCS deployment. These include durable policy mechanisms to drive finance and investment, overcoming value chain dependencies, addressing technical complexities, defining industry standards, and ensuring public consultation. A social license to operate and overcoming the affordability gap for customers are also critical. Balancing speed, quality, and cost will require trade-offs to address the technical challenges of scaling up from megaton (Mt) to gigaton (Gt) levels.

- **The CCUS Zero Emission Network (ZEN):**

The ZEN initiative focuses on building an integrated CCUS value chain in the Baltic Sea region, connecting Germany, Denmark, and Sweden. The project aims to capture 20.1 million tonnes of CO_2 annually, with a combination of geological storage and utilization. It demonstrates the importance of effective business models, stakeholder engagement, and strong regulatory frameworks. The project advocates for incentives, regulatory reforms, and public-private partnerships to de-risk investments and support large-scale decarbonization efforts.

- **Collaboration and Scalability for Decarbonisation:**

The ZEN initiative highlights the potential of regional collaboration to drive decarbonization and unlock economic opportunities. It underscores the critical role of scalable and validated CCUS solutions in the transition to a low-carbon economy, emphasizing the need for robust infrastructure and regulatory frameworks to ensure long-term success.

Post-Combustion Capture

- Membrane Technology and Research, Inc. (MTR), with support from the U.S. Department of Energy, is advancing its Polaris™ membrane-based post-combustion CO_2 capture technology towards commercialization. The company is developing a 150-tonne-per-day pilot plant at the Wyoming Integrated Test Centre, marking a significant scale-up from earlier demonstrations. Expected to begin operations in late 2024, the project aims to address challenges like low CO_2 partial pressures and high capital costs, positioning MTR's membrane technology as a competitive alternative to traditional CO_2 capture systems.

- Carbon America successfully piloted its FrostCC™ cryogenic carbon capture technology at the National Carbon Capture Center, achieving Technology Readiness Level (TRL) 6. The system captured CO_2 with 99% efficiency and a purity of 99.97%, removing over 1,000 metric tonnes per year and pollutants like NOx and SOx. Using a modular design, FrostCC™ offers cost-effective scalability, reduced construction time, and eliminates the need for separate pollutant control units. The pilot confirmed the technology's scalability and reliability, with improvements needed in insulation and cooling capacity, paving the way for commercial and large-scale applications.

CCS for Industrial Sources

- The CCUS project at the Heidelberg Edmonton cement plant is Canada's most advanced large-scale post-combustion CCUS initiative and aims to be the world's first full-scale carbon capture application in a cement plant. Launched in 2019, it follows Heidelberg Materials' pioneering efforts in carbon capture, including the Brevik facility in Norway, set to begin operations in 2024-2025. Heidelberg has committed to storing 10 million tonnes of CO_2 by 2030, with Edmonton being the most advanced project. The Edmonton facility addresses unique cement production challenges, such as particulate-laden flue gas, through an innovative two-mode carbon capture process and hybrid cooling system. The project follows a cost-effective procurement model and aligns with Heidelberg's goal of achieving net-zero emissions in cement production. The Edmonton CCUS facility aligns with Heidelberg's "Concrete Promises" initiative to achieve net-zero emissions without offsets. Upon completion, it will mark a significant milestone for the cement industry, paving the way for net-zero carbon cement production globally.

CO_2 Utilisation

- Electrochemical carbon capture and utilisation (CCU) pathways were discussed, mostly at low TRL. Options like CO_2-based phase change materials (PCMs) for latent heat storage could compete with petrochemicals. Challenges include renewable energy intermittency and optimizing integrated capture and conversion processes.

- Biological CCU pathways were also presented, such as a Waste-to-Energy (WtE) plant with a Calcium Looping (CaL) process and methanol (MeOH) synthesis. High CAPEX and OPEX make MeOH production only profitable with low electricity costs. The Bio4Fuel project showed CO_2 reductions by using "blue" and "green" H_2 instead of "grey" H_2.

- GTI Energy is developing a catalytic membrane reactor to produce renewable liquefied petroleum gas (LPG) from CO_2 and renewable H_2. The system integrates MeOH and LPG synthesis, using a Na+-gated membrane to improve efficiency. The modular design supports cost-effective, scalable deployment, especially at stranded renewable energy sites. The membrane reactor demonstrates excellent performance stability during long-term operations and start-up/shutdown cycles, making it a practical solution for real-world applications. The system's modular design supports cost-effective renewables-to-liquids plants, reducing the need for extensive infrastructure and avoiding long-distance LPG transport.

Transport & Shipping

- As multiple emitters come on stream to supply CO_2 to a single storage location it is prudent to evaluate all possible synergies to create the most efficient and cost savings approach to transport. SINTEF presented a project evaluating maritime transport scenarios in the Haugaland Region of Norway considering four emitters with over 1.5 Mtpa CO_2 emissions. Cluster cooperation around logistics results in improved economics, and transport costs depend on CO_2 volumes, ship size, distance and ship pressure.

- Another paper given by SINTEF, evaluated the cost comparisons of low- vs mid-pressure transport of CO_2 in tanks that might be applicable to inland and maritime transport value chains. Results show that transport pressure has little impact for the inland transport mode, however low-pressure transport is more economic than mid-pressure in most maritime scenarios.

- 3% of global emissions are from international shipping, despite shipping being an efficient mode of long-distance transport of goods, and the International Maritime Organisation (IMO) has set a climate neutral target by 2050. The ACT funded EverLONG project presented a Life Cycle Assessment of Ship based Carbon Capture (SBCC) as a measure to reduce emissions. The advantages are that they are retrofittable and can be implemented in a short timescale. Take home messages include that SBCC can serve as one transition measure whilst other fuels develop and could account for 38-45% CO_2-eq avoidance.

Geological storage of CO_2

- **Pressure budgets and scaling up CO_2 injection:**

The importance of pressure space in CCS projects, particularly as they develop in the same basin and aquifer, was highlighted across several sessions. BEG emphasized that pressure space is a critical resource for scaling up CCS, as elevated pressure can pose both commercial and environmental risks. With over 50 CO_2 storage projects in development in the Gulf of Mexico, pressure space impacts storage calculations and project Area of Review. Other work supported the importance of pressure space, pressure management and collaborative strategies.

- **Imaging the overburden:**

Mini-streamer seismic surveys offer denser coverage and higher-resolution imaging, making them suitable for detecting CO_2 leakage, despite challenges in interpreting noise. A mini-streamer survey at the Sleipner CO_2 storage site showed improved seabed illumination, better detection

of gas anomalies, and clearer imaging of the CO_2 plume. While this technology holds promise for overburden monitoring, it requires careful interpretation to distinguish real leakage from noise and depends on baseline surveys and velocity models.

- **Well-related risk:**

The risk of CO_2 leakage through new or existing well bores is a significant concern, and several studies have focused on this issue. One approach involves a fast well integrity simulator that models factors like cement curing, well fatigue, and leakage across geological layers. This tool helps assess well failure probability and incorporates sensitivity analysis to identify key factors influencing well integrity, which is useful for decision-making on legacy wells near CO_2 storage sites. Another effort includes developing a legacy well handling toolbox for identifying leakage paths in poorly documented wells and assessing the environmental impact of potential leakage. This work also highlights the need for realistic risk scenarios and appropriate risk tolerance criteria. Additionally, a new cost-effective near-surface monitoring system paired with machine learning was demonstrated in a field-scale experiment, showcasing its potential for CO_2 and water leakage detection.

- **Capture and storage projections by 2030 in Europe:**

Build out of capture and storage to meet mandated targets is multifactorial and projecting whether those targets are going to be met depend on a variety of factors and can lead to a wide range of potential outcomes. The SCCS presented a case study on European likely storage capacity in 2030 based on 33 announced projects and compared to the expected demand from capture projects across the region. Drilling into high (P10), best (P50) and low (P90) estimates and how much CO_2 a project expects to inject annually. The P50 forecast for the EEA and UK combined by 2030 is 60 Mtpa, 25% less than the 80 Mtpa aggregated net zero target for the EU and UK, most of the storage is located in the UK, Norway, Denmark and the Netherlands. The timing from appraisal to operation is evaluated and matched to the capture demand, with mean demand for Europe in 2030 oversubscribing the P10 (high) estimates by almost 20%.

Negative Emissions / Carbon Dioxide Removals

The "Roads to Removal" report by Lawrence Livermore National Laboratory (LLNL) highlights that the US could remove 1 billion tonnes of CO_2 by 2050, creating 400,000 jobs, at a cost of $129 billion, with each region contributing to this goal. The report also addresses trade-offs such as water demand and traffic impacts, stressing the importance of prioritizing vulnerable communities.

- MRV (Monitoring, Reporting, and Verification) of carbon dioxide removal (CDR) is crucial for tracking climate actions and ensuring high environmental integrity. Key challenges include selecting baselines, ensuring additionality, and addressing carbon reversals.
- The US Methane Task Force has invested $350 million in 14 projects, aiming to reduce methane emissions, which have cost $40 billion in lost value over the last decade.
- The NETL sorbent DAC study showed increased costs due to sorbent pricing and water co-adsorption, with room for optimization.
- Artificial carbon trees face challenges such as high costs and geographic variability, with current costs at $1,800–$4,000 per tonne of CO_2. Cost reductions could be achieved through sorbent improvements and modular designs.

- Electrochemical DAC faces high costs, especially for membranes and catalysts, with potential solutions involving hybrid batteries.
- The panel on CDR markets highlighted key findings from recent work by IPCC, IEA, and "The State of CDR" report. The CDR gap results in a lack of market activities and diversity and investments. Currently, large tech companies dominate the market, and while fragmentation in certification exists, strong standards will likely prevail. Canada launched a GHG offset system in 2022, with credits expected in 2025.
- ACCESS project updates show that many Waste-to-Energy (WtE) plants are considering CCS, but integration challenges remain.
- ERW (Enhanced Rock Weathering) costs around $375/t$CO_2$, with significant variation by location, particularly in Mexico and Central America due to infrastructure challenges.
- A new H2-looping system for ocean-based CDR requires extensive pre-treatment , but energy demand could be reduced through co-location with desalination plants.

Costs

- Three CO_2 capture approaches were assessed for low-concentration industrial emissions (0.04–4%)
  - Post-combustion capture using monoethanolamine absorption (MEA-ABS): A mature, well-established technology optimized for flue gases with moderate CO_2 concentrations.
  - DAC-based post-combustion capture (alkali absorption combined with calcium looping (ALK-ABS) & temperature vacuum swing adsorption (TVSA)): Originally developed for direct air

capture but adapted for low-concentration point sources.
    - Offsetting emissions via DAC: Instead of capturing emissions at the source, CO_2 is removed directly from the atmosphere.
- Cost and Feasibility Insights
    - MEA-ABS is the most cost-effective for flue gases with CO_2 concentrations above 1% and flow rates exceeding 500 t/h, benefiting from established technology and efficient kinetics.
    - ALK-ABS is more economical for lower flow rates (<500 t/h), making it a better fit for smaller industrial operations.
    - TVSA has the highest levelized cost of capture (LCOC) due to gas velocity constraints, requiring many columns to process large gas flows, leading to high capital investment.
- Capture Rate Constraints Impact Cost-Effectiveness
    - Point-source capture requires a fixed capture rate, limiting flexibility in optimizing costs.
    - DAC applications allow for flexible capture rates, meaning costs can be better controlled.
- Economic Viability of Carbon Offsetting
    - For flue gases with CO_2 concentrations below 1%, purchasing carbon dioxide removal (CDR) credits is more cost-effective than direct capture, particularly for small-scale operations or industries relying on carbon-intensive heat sources.
    - This is due to transport and storage costs (~$105/t$CO_2$), which make point-source capture less competitive at lower CO_2 concentrations.

Public Perception & Communication

- In developing countries, centres of excellence can act as key hubs to facilitate long-term deployment of CCS technologies, supporting both economic growth and sustainable resource management.
- When engaging with the public, it's crucial to highlight the balance between the costs, benefits, and risks of CCS, ensuring transparency and clarity.
- The principles of justice in climate mitigation emphasize that climate change disproportionately impacts vulnerable nations and economically marginalized communities, making equitable solutions essential.
- Workforce development remains a significant challenge for the CCS sector, requiring focused efforts to build expertise and capacity.
- Public perceptions of CCS remain largely unchanged, with most individuals holding neutral views, provided they are not directly impacted.
- Public opinion consistently revolves around costs and benefits, often driven by NIMBY (Not In My

Backyard) or NUMBY (Not Under My Backyard) sentiments.

- Community engagement must be an ongoing, proactive commitment to ensure understanding and support for CCS initiatives.

Discussion Panels

Panel Discussion 1: Advancing Carbon Management in Developing Countries

This panel, organized and moderated by **Rachael Moore** (World Bank), built upon discussions from GHGT16 on industrial decarbonization in developing countries using CCS. Panellists shared insights on project development, financing challenges, and the role of multilateral organizations in supporting CCS initiatives.

Key Insights from Panellists

- **Belladonna Troxylon Maulianda** (Indonesia CCS Center) – Highlighted Indonesia's legal and regulatory progress in CCS, emphasizing the need for technology transfer and scholarships to develop local expertise.
- **Lorez Des Vignes** (Ministry of Energy, Trinidad and Tobago) – Discussed ongoing assessments of onshore and offshore storage resources, supported by Green Climate Fund financing for saline aquifer evaluations.
- **Nathália Weber** (CCS Brasil) – Provided updates on onshore CCS initiatives, particularly efforts to integrate CCS into ethanol production, and stressed the importance of stakeholder engagement to build trust.
- **Carl Greenfield** (IEA) – Underscored the need for robust legal and regulatory frameworks, the availability of climate finance, and mechanisms to lower capital costs for CCS projects in developing economies.
- **Natalia Kulichenko-Lotz and Sadesh Sookraj** (World Bank, IFC) – Outlined the World Bank's CCS efforts, their focus on carbon credits, and the establishment of a CCS hub within the International Finance Corporation (IFC).
- **Tim Dixon** (IEAGHG) – Spoke on capacity building through the IEAGHG International CCS Summer Schools, which have trained over 750 alumni, a quarter from developing countries. He also introduced the Global Network of Centres of Excellence in Developing Countries, which recently held a meeting with five participating centres.

Key Takeaways

CCS integration into National Climate Strategies

- CCS should be incorporated into Nationally Determined Contributions (NDCs) and Technology Needs Assessments (TNAs) to unlock climate finance and international support.
- The example of Trinidad and Tobago was highlighted, where the initial exclusion of CCS experts from TNA development was later corrected, enabling Green Climate Fund (GCF) funding for CCS assessments.

Carbon Markets and Financing CCS Deployment

- Voluntary carbon markets (VCMs) for bioenergy with CCS (BECCS) offer potential but must scale up, improve verification processes, and align methodologies with established CCS frameworks.
- Article 6.4 of the Paris Agreement and its new Standard on Removals and CCS will facilitate international compliance carbon markets, helping to drive investment.
- The private sector requires regulatory certainty to participate effectively in CCS projects, with clear financial incentives and risk mitigation strategies.

Technology Transfer and Capacity Building

- There is a critical need for knowledge sharing and training in CCS technologies, particularly in emerging markets.
- Efforts like the IEAGHG CCS Summer Schools and the Global Network of Centres of Excellence play an essential role in developing local expertise.
- Technology transfer should be collaborative and equitable, ensuring that developing nations maintain ownership and control over their storage resources.

Challenges and Opportunities for CCS in Developing Countries

- Many developing countries are in early-stage storage resource assessment, requiring support for geological studies and regulatory frameworks.
- Multilateral organizations, including the World Bank and the IEA, can provide critical funding and policy guidance.
- Stakeholder engagement is essential to building trust and public acceptance, particularly in sectors like BECCS and industrial decarbonisation.

The discussion reinforced that **CCS is a crucial tool for industrial decarbonisation in developing economies**, requiring coordinated policy support, financial mechanisms, and international collaboration to overcome economic and regulatory barriers.

Panel Discussion 2: Raising Ambition to Accelerate Carbon Management

Moderated by **Juho Lipponen** (CEM CCUS & MI CDR Coordinator), this panel brought together government and industry leaders to discuss the ambition of reaching gigatonne-scale CO_2 capture by 2030. Panellists assessed progress, challenges, and necessary actions to expand CCS/CCUS deployment at the required pace.

Government Perspectives on Carbon Management

Government representatives — including **Adam Battistessa** (Alberta), **Tyler Chapman** (Canada), **Faisal Qurooni** (Saudi Arabia), and **Mark de Figueiredo** (United States) — shared current CCS efforts in their jurisdictions:

- Canada emphasized its vast storage potential and the possibility of exporting "blue" hydrogen.
- Saudi Arabia highlighted carbon utilisation opportunities, such as synthetic fuel production, supported by R&D investment.
- The U.S. discussed the need to expand CO_2 transport and storage infrastructure, prioritizing long-term strategic regions.

While progress was acknowledged, all agreed that achieving gigatonne-scale CCS would require accelerated action, expanded policy frameworks, and stronger incentives.

Industry Perspectives on CCS/CCUS Deployment

Industry leaders - including **Claude Loréa** (GCCA), **Iain Macdonald** (OGCI), and **Stefano Tondo** (ArcelorMittal) - outlined the role of CCS in their respective sectors:

- Cement & Concrete (7% of global CO_2 emissions) – GCCA's roadmap aims for 36% CCS-based reductions by 2050, with 58 CCS projects capturing 25 Mt CO_2 announced and another 26 Mt in the pipeline (primarily in the U.S. and China).
- Oil & Gas – OGCI focused on de-risking CCS projects, aligning CCS with a transition to a circular economy and gradual fossil fuel phaseout.
- Steel – ArcelorMittal emphasised CCS as one of multiple solutions, with efforts to reduce raw material use and replace coal with natural gas where possible.

Key Challenges and Actions Needed for CCS Scale-Up

To accelerate CCS/CCUS deployment, both governments and industries must address the following:

1. Stronger Business Cases & Market Demand – Policies must create demand for low-carbon products, ensuring commercial viability for CCS projects.
2. Supportive Regulatory & Accounting Frameworks – Clear carbon pricing, incentives, and accounting methodologies are critical to drive investment.
3. Social Acceptance & Public Engagement – Achieving a social license to operate requires effective stakeholder consultation and transparent communication.
4. Storage Readiness & Characterisation – Beyond Canada's well-mapped storage, many regions face challenges in identifying and assessing secure storage sites.
5. International Collaboration – Cross-border partnerships between governments, industries, and research institutions will be key to overcoming barriers.

Closing remarks

Jarad Daniels (GCCSI CEO) concluded by reinforcing that governments and industries must work together to increase CCS ambition and scale rapidly. CCS is crucial for achieving net-zero, and platforms like CEM CCUS, MI CDR, IEAGHG, and the CMC are driving efforts to move from first-of-a-kind to nth-of-a-kind deployment as swiftly as possible.

The session underscored that while momentum is building, the pace must dramatically accelerate to meet global climate targets.

Panel Discussion 3: What is Needed to Make CCS a Success Across Regions?

This panel session explored the diverse narratives shaping CCS deployment worldwide. Moderated by **Sean McCoy** (University of Calgary) and **Matthias Raab** (CO_2CRC), the discussion featured insights from **Carl Greenfield** (IEA), **Mark McCallum** (LETA), **Belladonna Troxylon Maulianda** (Indonesia CCS Center), **Candice Paton** (Enhance Energy), and **Sarah Forbes** (US DOE). The session highlighted regional progress, key drivers, and the challenges that must be addressed to scale CCS effectively.

Regional Progress and CCS Drivers

- United States & Canada: The Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA) have fuelled a surge in CCS projects, with enhanced oil recovery (EOR) playing a transitional role. Alberta is a key region where EOR is paired with permanent storage solutions.
- Global CCS Pipeline Expansion: Currently, 90% of future projects focus on CO_2 storage, supported by policies such as 45Q tax credits (U.S.), the EU Innovation Fund, and Canada's investment tax credits.
- European Union: While the EU's current CCS capacity is only 5% of the global total, this is expected to rise to 25% by 2030 due to ambitious policies and funding mechanisms.
- Indonesia as an Emerging CCS Hub: With 577.8 gigatonnes of storage capacity, a strong industrial base, and strategic regional positioning, Indonesia is leveraging international partnerships—such as the cross-border CCS agreement with Singapore—to become a CCS leader in the Asia-Pacific region.
- Australia & Regional Collaboration: Australia is advancing CCS through cooperative efforts with Japan on capture technologies and Indonesia on storage solutions. Additionally, large-scale CO_2 shipping initiatives are being explored to facilitate storage across regions with limited capacity.

Challenges and Pathways to CCS Success

To accelerate CCS/CCUS deployment, governments and industries must address the following:

1. Demonstration & Cost Reduction – Further demonstrations of CCS in hard-to-abate sectors are necessary, alongside reducing costs and de-risking technologies to encourage broader adoption.

2. Integrated Decarbonisation Strategies – CCS is part of a suite of solutions; its role must be tailored to complement other low-carbon technologies.
3. International Collaboration & Knowledge Sharing – Cross-border partnerships are essential to accelerating deployment and overcoming regulatory and technical barriers.
4. Private Investment in Developing Regions – In the absence of strong government subsidies, private sector engagement is key for advancing CCS projects in emerging markets.
5. Public Perception & Misinformation – Clear communication and transparency are needed to address misconceptions and build stakeholder trust.
6. Community Engagement & Local Context – Public education and demonstrating the economic and environmental benefits of CCS are vital for securing local support.

Conclusion

The panel underscored that while significant progress is being made in CCS deployment, achieving scale requires a combination of investment, technology innovation, supportive policies, and international collaboration. If these elements align, CCS can become a cornerstone of global carbon management efforts, helping nations meet their net-zero goals.

Panel Discussion 4: Let's Get Real About Carbon Dioxide Removal (CDR)

Moderated by **Saviz Mortazavi** (NRCan), this panel brought together experts from academia, policy, and industry to discuss the urgency, challenges, and opportunities in scaling CDR to meet global climate targets. The panel included **Sean McCoy** (University of Calgary), **Mark de Figueiredo** (US DOE), **James Fann** (International CCS Knowledge Centre), **Paul Feron** (CSIRO), and **Grace Meikle** (Emissions Reduction Alberta).

Why CDR is Critical for Climate Goals

With global emissions on track to exceed the carbon budget required to limit warming to 1.5°C by the mid-2030s, CDR is essential for removing accumulated CO_2 from the atmosphere. The panel emphasized that scaling CDR is necessary to complement emissions reductions and achieve net-zero targets.

Key Takeaways from the Panellists

- Innovation & Market Development: Sean McCoy highlighted the need for cost-effective solutions, transparent carbon accounting, and clear market mechanisms for both voluntary and compliance sectors. He cautioned against overestimating CDR's potential without acknowledging practical constraints.
- U.S. Government Initiatives: Mark de Figueiredo outlined the U.S. Department of Energy's (DOE) CDR initiatives, including:
  - $3.5 billion for Regional DAC Hubs
  - $45 million SEA-$CO_2$ programme for marine CDR
  - $35 million CDR Purchase Pilot Prize to stimulate demand
  - Voluntary purchasing challenges to encourage private sector involvement
- Economic Viability & Industry Integration: James Fann stressed the importance of aligning CDR strategies with industry practices and ensuring economic feasibility to drive adoption.
- Australia's CDR Potential: Paul Feron highlighted Australia's vast storage capacity, land resources, and existing carbon markets as key enablers for CDR deployment. He showcased DAC projects like Airthena™, CarbonAssist™, and ACOHA.
- Measurable Outcomes & Policy Support: Grace Meike emphasized accountability in CDR projects and the need for policy frameworks that incentivise innovation while ensuring transparency.

The Path Forward: Balancing Urgency and Practicality

The panel identified several key actions to accelerate CDR deployment:

1. Significant Investment: Scaling CDR will require billions in public and private sector funding to support infrastructure and technology development.
2. Stronger Policy & Collaboration: Governments must implement supportive policies, while international cooperation is essential for knowledge-sharing and cross-border deployment.
3. Public Awareness & Engagement: Transparent communication and education initiatives are needed to address misconceptions and build public support for CDR solutions.

Reflections & Next Steps

The discussion concluded with cautious optimism, recognising that while CDR has advanced beyond theory, large-scale deployment remains in its early stages. While scalable, CDR methods still face deployment barriers that must be addressed to achieve significant climate impact. Expanding both innovative and conventional CDR approaches will be critical to meeting global climate goals.

Panel Discussion 5: Strategies for CO_2 Purification

This session convened leading experts to explore the critical challenges of CO_2 purification, an essential component in the CCUS value chain. Chaired by **Owain Tucker** (Shell), the panel featured insights from **Ray McKaskle** (Trimeric Corporation), **John Woods** (Wood), and **Richard Porter** (University College London), addressing key technical hurdles, emerging solutions, and industry knowledge gaps.

Key Discussion Points

- CO_2 Stream Complexity & Contaminant Challenges: Owain Tucker set the stage by comparing CO_2 purification to managing an unruly crowd, where multiple impurities introduce significant operational and economic challenges. He highlighted corrosion risks, with rates exceeding 10-50 cm/year depending on contaminants and feedstock. The discussion underscored the need for tailored purification strategies, metallurgy considerations, and regulatory alignment to support cost-effective decision-making.
- Managing Impurities & Upstream Pollution Control: Ray McKaskle emphasised dehydration as a fundamental purification step to prevent hydrate formation and system failures. He addressed oxygen contamination, describing its disruptive effects on CO_2 streams, from increasing corrosivity to accelerating solvent degradation. McKaskle advocated for improving upstream pollution control to enhance capture efficiency while reducing other pollutants.
- Cost-Effective Conditioning Technologies: John Woods outlined methods for selecting purification technologies tailored to CO_2 pipeline and shipping requirements. He identified key knowledge gaps, such as the removal of benzene, toluene, ethylbenzene and xylene (BTEX) compounds, volatile organic compounds (VOCs), and hydrocarbons, as well as the use of membrane separation for contaminants. His presentation also explored strategies for handling heavily contaminated streams, particularly through specialist adsorbents and catalysts.
- Storage Risks & Mitigation Strategies: Richard Porter highlighted physical and chemical risks associated with CO_2 impurities in storage, including decompression risks, hydrate formation, and reservoir integrity concerns. He underscored the need for accurate modelling and reactive flow simulations to predict interactions between CO_2 impurities and storage formations. Porter proposed cost-saving solutions, such as shared purification infrastructure and impurity-tolerant catalysts for CCU applications.

Conclusion & Industry Implications

The panel discussion reinforced the need for flexible and innovative purification strategies to ensure the success of CCUS projects. Key takeaways included:

- The necessity of impurity-specific purification approaches to mitigate corrosion, improve capture efficiency, and optimise transport and storage.
- The role of cost-effective purification technologies in reducing operational expenses and ensuring regulatory compliance.
- The importance of continued research into impurity management, including improved injection strategies and new catalyst development for CCU applications.

This session underscored the urgency of collaborative efforts between industry, researchers, and regulators to refine CO_2 purification processes, driving CCUS deployment forward efficiently and sustainably.

Panel Discussion 6: Trends in research in carbon capture, removals, transport, usage, and storage

The final technical panel of GHGT-17 featured editors from the International Journal of Greenhouse Gas Control (IJGGC), providing an overview of the journal's history, publication trends, peer review process, and future direction. **Sam Krevor** (Editor-in-Chief, Imperial College London) was joined by **Sarah Gasda** (NORCE), **Abigail Gonzalez Diaz** (INEEL), and **Matteo Romano** (Politecnico di Milano) to discuss their experiences as editors and key research trends in CCS.

Key Highlights

- IJGGC History & Growth: The journal was established in 2007 following the IPCC Special Report on CCS, with strong ties to the GHGT series. It has seen fluctuating publication volumes, peaking around 2015, with expectations of renewed growth in response to the recent rise in CCS projects.
- Research Trends:
  - Storage: Increase in machine learning applications, decline in CO_2-EOR studies, and rising interest in mineralisation due to funding incentives.
  - Capture: Contributions primarily from China, the US, Japan, and Poland, covering diverse

technologies and applications.
    - Systems Analysis: BECCS-related studies are increasing, while traditional CO_2 capture from power generation is declining. AI-driven research is shaping the field, reducing the number of non-insightful review papers.
- Editorial Perspectives: The panel discussed the value of being an editor, including expanding professional networks, shaping research discussions, and maintaining high review standards. They also reflected on the challenges of peer review, balancing the pressure to publish with quality control.
- Future Plans: The IJGGC aims to launch a special issue reflecting on 20 years since the IPCC CCS report, enhance the editorial team, improve publishing times, and introduce a new best paper award.

The discussion reinforced the journal's critical role in advancing CCS research and its commitment to fostering high-quality publications that support global climate goals.

Business Stream

GHGT-17 introduced an exciting new business stream in addition to the main technical programme, giving delegates the opportunity to access sessions dedicated to business strategy. This stream was less technical and aimed at business leaders, policymakers, regulators and financiers. Attendees learnt real-world strategies from trail-blazing projects, proven methods to de-risk CCS projects, breaking through commercialisation barriers and scaling-up of technology, among many other facets.

Panel 1: Creating the Pathway to Final Investment Decision – A Canadian Case Study on CCS

This talked about Canadian CCS projects that were on the path to or have achieved final investment decisions (FID) speakers share how business cases were developed. The panel highlighted insights gained by the international knowledge centre, government of Alberta, ERA and global CCS experts.

Panel 2: Unique Sector Considerations on Developing Carbon Management Projects

The panel discussed how different industry sectors needed carbon management as part of their decarbonisation efforts even though the strategies they have adopted are different. They discussed how key sectors such as cement, steel, BECCS and WtE approach carbon management. It also discussed cross-industry partnerships and collaboration.

Panel 3: Navigating Carbon Markets, Removals and Carbon Capture: State of Play and Outlooks

This panel discussed what were the biggest policy, pricing and industry trends across today's largest carbon markets and how are compliance and voluntary carbon markets different. Also, the current state of crediting standards/protocols for carbon removal and CCS.

Panel 4: Commercial and Business Risks: Proven Strategies for Success

The panel discussed CCS projects and their complex commercial and business risks and how they differ across jurisdictions, especially if at different stages and have multiple partners. They discussed how the risks were addressed and who was responsible, and covered what insurance products were available to deal with the commercial risks.

Panel 5: Learning from Leaders: Sharing Success in Western Canadian CCS (Fireside Chat)

This talk from industry leaders shared their personal experiences developing the Quest Carbon capture and storage facility, Enhance Clive CO_2 storage facility, Alberta Carbon trunkline project and IEAGHG Weyburn-Midale monitoring project.

Panel 6: Indigenous Collaboration in CCS Projects: A Case Study from Canada (Fireside Chat)

The group held a thought -provoking fireside chat exploring the vital role of Indigenous communities in CCS projects. It delved into how Indigenous organisations were participating in CCS initiatives highlighting successful partnerships and emerging opportunities.

Panel 7: Partnering for Success: Accelerating CCS Deployment Through Collaboration

The panel discussed how developing CCS projects their complex nature falls outside the normal scope of business industries whilst remaining a critical tool for reducing emissions. They shared best practices and lessons learned planning and developing the infrastructure and capital required.

Panel 8: Next Generation CCS Technologies: Breaking through Barriers of Commercialization and Scale Up

The panel discussed how the next generation CCS technologies that may offer cost, energy and environmental advantage over conventional options. They covered how this could transform the landscape for CCS, and the associated challenges of scale up commercialization. They heard how these companies are taking an idea from the lab to market, and what's needed to move from demonstration to full commercial development.

Panel 9: From Concept to Reality: How will we Actually Build the Projects that Get to FID?

The panel discussed of how getting to FID is a monumental achievement in the CCS space. But then covered what happened next, how you deal with the training to get enough skilled labour to develop the human capital to build the projects. How companies develop secure supply chains that they can count on and what are the lessons learned.

Panel 10: Best Practices from Alberta and Canada

This was a knowledge sharing session presenting lessons learned and best practices from 11 industrial FEED studies co funded by ERA and NRCAN, as well as the $160M investment in CCUS technology development over the past fifteen years.

Green Awards

These awards are given out at each GHGT conference to a person or persons amongst us who have risen above their peers in making vital, significant and sustained contributions towards progressing CCS/CCUS and in enhancing our understanding of the process of mitigating GHG emissions.

For the CCS/CCUS community this is our equivalent of the Nobel prize for contributions to the field. If you prefer a sports analogy, they are our Olympian gold medallists. Since the awards commenced in 1996, there have been 15 Green laureates.

This year, the Green Award was proudly given to Gary Rochelle (University of Texas at Austin) and Mona Mølnvik (SINTEF Energy Research).

Concluding Remarks

CCUS is Essential but Needs Acceleration
CCUS is widely recognised as critical to achieving climate goals, especially for hard-to-decarbonise sectors like cement and power. Yet, deployment remains far behind what is needed. Urgent scaling, policy certainty, investment, and supportive regulatory frameworks are required to move from Mt to Gt levels of CO_2 capture.

Enabling CCS in Emerging Markets is Critical but Challenging
Two-thirds of CO_2 capture by 2050 must occur in developing countries, yet these regions face significant hurdles due to a lack of enabling policy, regulation, infrastructure, and financing. Capacity building, regulatory frameworks, and targeted support are essential to bridge this gap.

Scaling CCS Requires Coordinated Policy, Investment, and Innovation
Effective deployment hinges on a combination of durable policy mechanisms, public-private partnerships, regulatory certainty, and access to finance. Technical solutions must be backed by real-world infrastructure, stakeholder collaboration, and a social license to operate.

Policy, Finance, and Collaboration are Enablers
Across the board, speakers emphasised the need for strong policy frameworks, innovative financing, and international collaboration. Successful CCUS deployment depends on reducing project risk, incentivising early movers, and aligning government and industry strategies—especially in emerging and developing economies.

Cost Remains a Major Barrier—But Strategic Choices Improve Feasibility
The economics of CCS vary by application. For low CO_2 concentration sources, DAC and offset credits may be more viable. Centres of excellence, modular designs, and flexible capture rates offer ways to reduce costs and improve scalability, particularly in low-income countries.

Public Trust, Communication, and Equity are Central to Success
Public perception remains cautious and often neutral. Clear communication of CCS benefits and risks, ongoing community engagement, and a focus on climate justice—especially in marginalized regions—are necessary to secure broad support and equitable deployment.

Regional Leadership and Opportunity
Alberta, Australia, the US, and several Asian nations were highlighted for advancing CCUS initiatives, with Alberta positioning itself as a global leader. There are growing opportunities, especially in developing regions, but also gaps in funding, education, and regulatory support that must be addressed.

Technological Advancements are Expanding CCS Potential Across Sectors
Progress in post-combustion, cryogenic, membrane, and electrochemical technologies, as well as industrial applications like cement, is helping CCS scale. Innovations in utilisation (e.g., renewable LPG synthesis) and storage (e.g., pressure management, monitoring) are also key enablers.

Technology and Innovation Must Align with Society
Beyond technical innovation, speakers stressed the need for a social license to operate, community benefits, and indigenous inclusion. Equally important is building human capital through education and cross-sector synergy to inspire the next generation of climate leaders.

GHGT-17 Marked a Turning Point
GHGT-17 was the largest conference in the series to date and introduced many firsts – from student poster awards to indigenous-focussed sessions and major funding announcements. It signalled a growing maturity and momentum for the global carbon management community.

Social Activities

Welcome Reception

Gala Dinner

Performances from First Nation Dancers

Run Club

Line Dancing

GHGT-17 Field Trips

1. Containment & Monitoring Institute (CaMI) facility and Dinosaur Provincial Park.
2. Alberta Carbon Conversion Technology Centre (ACCTC) and Canadian Pacific Kansas City.
3. Heidelberg Materials and Blindman Brewing.
4. Quest Carbon Capture and Storage facility, Shell Scotford Complex, Fort Saskatchewan.

GHGT-18 PERTH

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Thank You

The conference papers are available in the conference proceedings on the GHGT website at ghgt.info/past-ghgts/. Alternatively they can be accessed directly from the SSRN website.