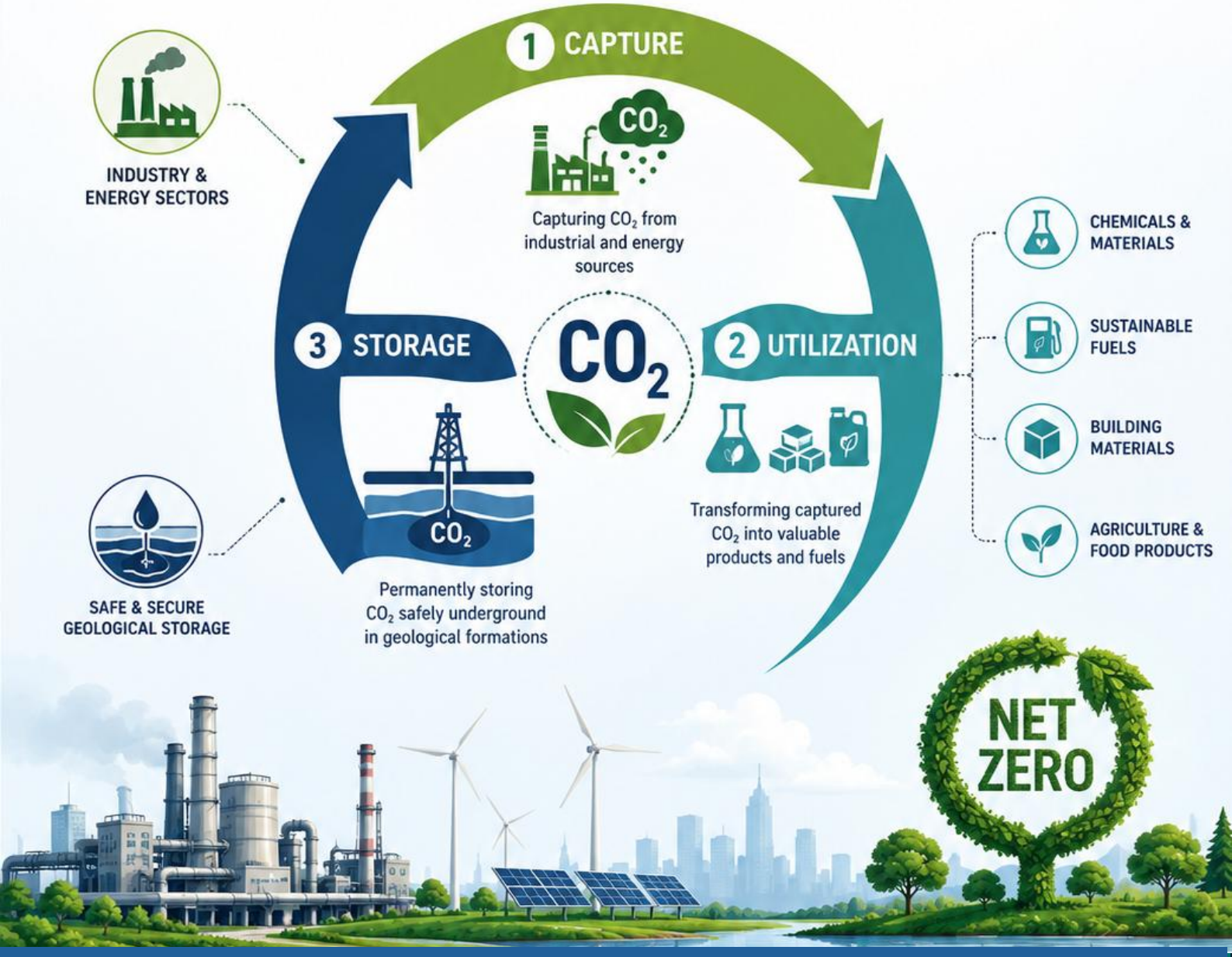
Confederation of Indian Industry

CIRCULAR CARBON CAPTURE, UTILIZATION AND STORAGE TECHNOLOGIES:

INNOVATIONS FOR A NET-ZERO FUTURE



CII COMPENDIUM 2026

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FOREWORD

India, as one of the world's largest and fastest-growing economies, stands at a pivotal juncture where sustained economic growth must go hand in hand with deep decarbonisation. The scale of our developmental aspirations, coupled with the imperative of climate responsibility, demands solutions that are both innovative and transformative. In this context, Carbon Capture, Utilisation and Storage (CCUS) emerges as a critical pathway to abate hard-to-mitigate emissions while enabling a pragmatic and inclusive tran sition toward net-zero.

The Confederation of Indian Industry (CII) has been actively advancing India's low-carbon transition through sectoral knowledge products and multi-stakeholder platforms that bring together government, industry, research institutions, and technology developers. This Compendium on Best Practices shaping Circular CCUS in India is a timely and significant contribution to that journey. It maps the emerging ecosystem of organisations working across the CCUS value chain and highlights practical insights from early deployments and pilot initiatives.

The recently launched CII Compendium showcases the collective efforts of diverse stakeholders driving the nation toward its net-zero ambitions. These organisations represent India's early but rapidly evolving CCUS landscape—spanning capture technologies, carbon dioxide utilisation pathways, geological storage research, and pilot-scale implementation efforts. Together, they demonstrate how innovation, collaboration, and policy alignment can unlock scalable solutions for industrial decarbonisation.

As India "faster" progresses on its climate and energy transition pathway, such knowledge resources play a vital role in accelerating learning, fostering partnerships, and scaling proven best practices. I extend my sincere appreciation to all the innovators, industry leaders, public sector undertakings, researchers, and technical experts featured in this Compendium for their unwavering commitment to environmental sustainability and their contribution to shaping a resilient, low-carbon future for India.

Mr Masood Maliick,

Chairman, CII National Committee on Waste to Worth Technologies 2026-27, Group CEO & MD, Re Sustainability Limited

ABOUT CII Compendium 2026

A Compendium on Best Practices shaping Circular Carbon Capture Utilisation and Storage (CCUS) in India

The Confederation of Indian Industry (CII) has been actively advancing India's low-carbon transition through sectoral knowledge products and multi-stakeholder platforms. Its compendium on the Best Practices shaping Circular Carbon Capture Utilisation and Storage (CCUS) in India maps the emerging ecosystem of industry leaders, PSUs, research institutions, and technology developers working across the CCUS value chain.

These organisations collectively represent India's early but rapidly evolving CCUS landscape spanning capture technologies, CO_2 utilisation pathways, geological storage research, and pilot-scale deployment initiatives.

A Compendium on Best Practices shaping Circular Carbon Capture Utilisation and Storage (CCUS) in India

1. Arya.ag

About the Organisation

Arya.ag is India's largest grain commerce and integrated agri-value chain platform, established in 2013. The company operates across 21+ states with visibility into 12,000+ verified storage points, enabling farm-gate storage, embedded finance, and market linkages for smallholder farmers and Farmer Producer Organizations (FPOs).

Arya.ag's vision is to build sustainable and equitable agricultural value chains where producers receive their rightful share, while its mission focuses on enabling sustainable market access, climate resilience, and financial inclusion. Its climate strategy centers on reducing food loss, strengthening decentralized infrastructure, promoting regenerative agriculture, and deploying digital Monitoring, Reporting, and Verification - MRV-enabled systems for climate-smart agriculture and carbon-linked value chains. Through Project UNNATI, Arya.ag is advancing nature-based carbon sequestration, sustainable land management, and resilient rural livelihoods.

CCUS Technologies and Solutions Portfolio

Arya.ag has developed a technology-led ecosystem integrating digital platforms, decentralized infrastructure, and regenerative agricultural interventions contributing toward carbon sequestration, GHG reduction, and climate resilience.

AryaShakti is a mobile-based farmer platform enabling farm digitization, climate advisory, sustainability tracking, commodity finance, warehousing access, and market linkages. The platform also functions as a digital farm diary supporting PoP (Package of Practices) documentation and future carbon accounting frameworks. It currently supports 100,000+ farmers across 200+ FPOs.

Prakshep is Arya.ag's proprietary satellite-based farm intelligence platform integrating geospatial analytics, climatic data, and field intelligence to monitor crop health, soil moisture, nutrient stress, and climate risks. The system provides predictive advisories, weather intelligence, and supports digital MRV systems required for carbon programs.

Prithvi Pro enables ESG-linked commodity traceability by integrating sustainability indicators such as GHG metrics, water-use efficiency, and climate-smart practice compliance into agricultural commerce.

R & D Structure and Collaborations and Partnerships

Arya.ag combines technology innovation, field implementation expertise, and ecosystem partnerships to build scalable climate-resilient agricultural systems.

Internal capabilities include satellite-based monitoring, climate-risk analytics, digital sustainability tracking, traceability systems, ESG-linked market integration, and MRV-ready carbon frameworks.

A major R&D focus is the continuous enhancement of digital MRV systems and Prakshep's satellite intelligence capabilities through AI/ML-enabled analytics, geospatial modelling, predictive climate-risk tools, and automated sustainability verification systems. Project-specific climate-smart Packages of Practices (PoPs) are developed in collaboration with agricultural universities, Krishi Vigyan Kendras (KVKs), agronomists, and farmer institutions. Arya.ag also collaborates with FPOs, financial institutions, development organizations, commodity buyers, and ecosystem partners.

Best Practices

Arya.ag has implemented multiple field-level climate-resilient interventions focused on emission reduction, circular agriculture, and sustainable biomass use. In Maharashtra, soybean farmers under KrushiSamrajya FPC adopted Broad Bed Furrow (BBF) during extreme Kharif 2025 rainfall across ~160 acres, reducing waterlogging and crop loss by up to 35% and safeguarding ~320 quintals of production. Under Dream Vision FPC in partnership with ADM, climate-smart soybean practices (BBF, IPM, soil testing-based nutrition) were combined with traceable procurement, improving yields, lowering input costs, and enabling ESG-linked market access.

In Gujarat, Viksit Vaso FPC aggregated ~366 MT of paddy residue and diverted it from open burning to biofuel production, generating additional farmer income and avoiding ~425 tonnes of CO_2 emissions. In Bihar, Bio-Resource Units led by Smart Farm Centre promoted vermicompost, vermiwash, Jeevamrutham, and biogas systems, reducing chemical fertilizer use by 30–40% while improving soil health and supporting rural bio-enterprises.

Future Roadmap and Alignment with Climate Goals

Arya.ag plans to scale climate-smart agricultural systems through expansion of Project UNNATI, regenerative agriculture, agroforestry, digital MRV systems, satellite-based monitoring, and ESG-linked supply chains. The organization also aims to expand carbon-linked financing opportunities and women-led implementation systems through CVRPs programme.

These initiatives align strongly with India's Net-Zero 2070 commitment and global climate goals by enhancing soil carbon sequestration, reducing agricultural emissions, minimizing food loss, strengthening climate resilience, and supporting nature-based climate solutions. Arya.ag's approach also contributes to SDGs related to poverty reduction, food security, gender inclusion, climate action, sustainable production, and ecosystem restoration.

2. Carbonetics Carbon Capture Private Limited

CARBONETICS CARBON CAPTURE

About the Organisation

Carbonetics Carbon Capture Private Limited was incorporated in 2023 and is headquartered in India, with a global operational mandate targeting hard-to-abate industrial sectors across Asia, the Middle East, and beyond. The company mission is to make carbon capture, utilisation, and storage (CCUS) both an environmental necessity and an economically sound choice for industry. They envision a world where decarbonisation is not a trade-off but a financially rational decision: achievable today, not decades from now. Carbonetics was founded on the conviction that the CCUS gap is not a technology problem but a deployment and bankability problem, and they exist to bridge that gap.

CCUS Technologies and Solutions Portfolio

Carbonetics operates as both a CCUS technology developer and project developer/operator. They design and improve proprietary carbon capture hardware and AI-based monitoring systems, while also structuring, financing, and running CCUS projects at client sites across industries. This integrated model ensures end-to-end accountability for emissions outcomes and aligns technology performance with commercial viability more effectively than standalone technology or project developers.

Carbonetics has developed two core technology assets. The first is IGNI1®, their modular, containerised carbon capture unit based on proven chemisorption technology, enhanced with their proprietary capture media. IGNI1® is engineered to fit within two standard 40-foot shipping containers, making it mobile, rapidly deployable, and scalable without bespoke civil construction. At full operation, IGNI1® captures up to 600 tonnes of CO_2 per annum directly from industrial emission streams. The second is CapNet®, a deep neural network that continuously monitors IGNI1® plant operations in real time, optimising energy consumption, predicting maintenance needs, maximising uptime, and generating the operational data that underpins project bankability over time.

R & D Structure and Collaborations and Partnerships

Carbonetics has a focused R&D function built on three pillars: capture media chemistry optimisation, CapNet® AI/ML model development, and financial engineering for CCUS project structuring. Insights from each IGNI1® deployment feed into continuous design improvements, creating an iterative innovation loop. The company also engages with

the broader CCUS research ecosystem and tracks guidance from the IEA, IPCC, and national climate bodies to keep its roadmap aligned with global best practices.

Best Practices

The most significant innovation Carbonetics has introduced is the De-Risking Framework — the Feasibility-First Deployment Model. This two-phase methodology addresses the central barrier to CCUS adoption: the gap between project bankability and operational data. In Phase 1, Carbonetics delivers a site-specific, AI-assisted Bankable Feasibility Report (BFR) covering emission source characterisation, technology fit assessment, regulatory and carbon credit mapping, financial modelling (IRR, payback period, carbon liability exposure), and a full risk matrix. In Phase 2, rather than waiting for project finance to close, we deploy IGNI1® under CCaaS (Carbon Capture as a Service) or Co-Invest terms, generating live operational data via CapNet® that continuously validates and strengthens the BFR. The result is a self-reinforcing loop: feasibility drives deployment, and live data de-risks full-scale financing.

Future Roadmap and Alignment with Climate Goals

Carbonetics' near-term roadmap is focused on scaling IGNI1® deployments across hard-to-abate sectors like cement, steel, chemicals, waste-to-energy, and oil & gas in India and across Asia and the Middle East. India's commitment to net zero by 2070, combined with its nationally determined contributions under the Paris Agreement, creates significant policy tailwinds for industrial CCUS. The company modular, containerised approach is ideally suited to India's industrial geography, where large centralised infrastructure is often impractical. Looking further ahead, they aim to expand into carbon utilisation pathways, converting captured CO_2 into value-added products and deepening the economic case for CCUS and supporting a circular carbon economy at scale.

3. Department of Earth Sciences, IIT Bombay

About the Organisation

UrjanovaC is a clean-tech startup founded in 2023 by IIT Bombay faculty members Prof. Vikram Vishal and Prof. Arnab Dutta. The company recently graduated from the IIT Bombay incubation ecosystem and is currently focused on the Indian market.
UrjanovaC is dedicated to decarbonizing hard-to-abate sectors, including steel, cement, power, and refineries. With patented CO_2 capture and utilization technology, UrjanovaC enables scalable, cost-effective emissions reduction without disrupting industrial operations, while converting CO_2 into valuable products and unlocking ESG and carbon-credit benefits. Vision is to pioneer transformative carbon management solutions that empower industries to achieve net-zero, drive sustainable growth, and secure a cleaner future for generations to come. They are working towards a mission to develop and deploy cutting-edge technologies that decarbonize hard-to-abate sectors, accelerate the clean energy transition, and create scalable impact through innovation, collaboration, and sustainability.

CCUS Technologies and Solutions Portfolio

UrjanovaC's patented, water-based, catalytic CCUS platform is designed for scalable decarbonization. At the core of the technology, CO_2 from flue gas or directly from air (DAC) is absorbed into an aqueous catalytic reactor containing UrjanovaC's proprietary catalyst. The reactor functions as a dual capture–conversion system, in which CO_2 is continuously processed in a closed loop and converted to a carbonate solution. The solution is then directed to a causticizer stage, where calcium ions are introduced to convert it into high-purity calcium carbonate (PCC) for industrial applications.
The system is designed as a closed-loop, recyclable process in which both the catalyst and the solution are continuously regenerated, ensuring high efficiency, low waste generation, and a long operational life. The platform is compatible with industrial conditions, including variable CO_2 concentrations and flue gas impurities (e.g., SOx/NOx), without requiring pre-treatment.

Key attributes of the technology include:

- CO_2 capture from both point sources (5–100% CO_2) and ambient air (0.04% CO_2)
- Integrated capture and utilization in a single aqueous catalytic system
- Conversion of CO_2 into value-added products such as calcium carbonate and other carbon-based chemicals
- Recyclable, non-toxic catalyst system based on earth-abundant materials
- Non-potable water-based, energy-efficient, and modular design suitable for retrofitting industrial plants
- High scalability with potential deployment from pilot to multi-ton and gigaton-scale applications

Overall, UrjanovaC's CCUS platform enables industries to convert CO_2 from a liability into a usable resource, supporting cost-effective, circular, and scalable industrial decarbonization.

R&D Structure and Collaborations and Partnerships

UrjanovaC develops catalytic CO_2 capture, utilization chemistry, reactor engineering, and CCUS scale-up technologies, with continuous validation through industrial pilots for rapid iteration and maturity.
The company is closely integrated with the NCoE-CCUS at IIT Bombay, where its founders serve as conveners. Scale-up is supported by EPC partners including Abhitech, Ingenero, Technip Energies, TOPSE, BALIEF, and Texol, enabling deployment readiness.
Co-founders Prof. Vikram Vishal and Prof. Arnab Dutta bring strong expertise in CCUS policy and catalytic CO_2 conversion, strengthening scientific leadership and global collaboration. Together, this positions UrjanovaC at the intersection of deep-tech R&D, industrial validation, and CCUS commercialization.

Best Practices

UrjanovaC's key innovation is an aqueous catalytic CCUS system that integrates CO_2 capture and conversion in a single reactor, eliminating solvent regeneration and enabling circular carbon utilization.
In pilots targeting 90% CO_2 capture and conversion, the system consistently achieves >97% performance and produces >95% pure food-grade PCC, directly used by industrial partners.
It delivers ~10× smaller space and energy footprint and ~10% lower net cost versus conventional systems, strengthening commercial viability.
A key milestone is the 3 TPD integrated CCUS system, validating continuous operation, catalyst recyclability, and end-to-end conversion at demonstration scale.
Pilots with BPCL, Coal India Limited, and GPIL demonstrate successful retrofit integration in live industrial settings. A structured MRV framework ensures transparent and verifiable performance tracking.
Together, these outcomes establish a retrofit-ready, high-efficiency CCUS platform that converts CO_2 into a usable industrial resource.

Future Roadmap and Alignment with Climate Goals

Short term (1–2 years): Pilot deployment across refinery, steel, cement, and power sectors; continuous industrial operation; expanded CO_2 utilization pathways; strengthened MRV systems. Medium term (3–5 years): Scale modular CCUS systems across industrial clusters; develop standardized units for SMEs and hard-to-abate sectors; expand internationally; build carbon credit monetization pathways. Long term**:** Position UrjanovaC as a global climate-tech leader in industrial decarbonization and carbon management, supporting India's Net-Zero 2070 goals and global climate targets through scalable, verifiable CO_2 reduction solutions.

4. Earthood Services Limited

About the Organisation

Earthood Services Limited was incorporated in 2012, in India. The company operates globally with a presence in India, the UK, Brasil, Russia, KSA, Turkey, and the UAE. As a carbon offset verification and sustainability solutions provider, Earthood's vision is to help businesses neutralize their carbon footprint through verified carbon offset solutions. The organization's mission is to lead the global transition to a sustainable future through industry expertise and technological innovation. Earthood is committed to supporting global efforts to mitigate climate change by integrating sustainable practices into clients' operations, which helps them earn carbon credits and contribute to a more environmentally sustainable future.

CCUS Technologies and Solutions Portfolio

Earthood Services Limited operates as a carbon offset verification and sustainability solutions provider, auditing the CCUS technology developers or projects. Their primary role in the CCUS landscape is as a Validation and Verification Body (VVB). Earthood verifies carbon credits from projects that reduce or remove carbon dioxide from the atmosphere. The organization ensures that these projects meet stringent standards to generate legitimate carbon credits. Earthood is accredited by several international bodies, including the United Nations Framework Convention on Climate Change (UNFCCC), ANSI (ANAB) and GAB – and hence approved by various standards like Verra, and the Gold Standard, to conduct these services across various sectors.

Earthood Services Limited has not developed or deployed CCUS technologies. Instead, their role is to provide validation and verification services for projects that utilize carbon capture and other climate mitigation technologies to generate carbon credits. While they do not develop the technology, they are an essential part of the ecosystem that supports CCUS projects. The company’s services give credibility to the carbon market and ensure the integrity of the carbon credits being traded.

R & D Structure and Collaborations and Partnerships

Earthood's R&D capabilities are focused on developing tech-integrated sustainability solutions even to cater the upcoming CCUS technologies. The company's main innovation is its proprietary digital platform, Earthlink, which automates data verification and streamlines carbon project management. Earthood’s R&D efforts also extend to its internal expertise, with a team of over 60 validators and verifiers who undergo a rigorous training program.

Best Practices

Earthood's best practices are in the validation and verification of carbon projects rather than in CCUS implementation. Best Practices and Innovations:

- Proprietary Digital Platform (Earthlink): Earthood's primary innovation is the Earthlink platform, a digital tool that streamlines the carbon project management process, automating data verification and providing real-time updates.
- Carbon Neutral VVB Status: Earthood became the first Carbon Neutral Validation and Verification Body (VVB), certified under PAS 2060:2014.
- Standardized Verification Process: Earthood follows a meticulous and transparent verification process, including desk reviews and on-site visits, to ensure that project claims are real, measurable, and "additional".
  Success Stories:
- Industry Recognition: Earthood was named the Best Verification Firm in the voluntary carbon market by *Environmental Finance* for two consecutive years.
- Global Project Portfolio: The company's portfolio includes over 4,000 carbon projects across more than 135 countries.
- Certified Carbon Neutrality: Earthood also certified the Delhi Metro Rail Corporation's Metro Bhawan as carbon neutral, which is a significant achievement in promoting sustainable infrastructure.

Future Roadmap and Alignment with Climate Goals

Earthood's future plans are focused on addressing the challenges of auditable CCUS technologies and more on scaling its services to meet the growing global demand for carbon and sustainability solutions.

- Scaling Plans: Earthood is expanding its global footprint to provide services in new regions, such as the Kingdom of Saudi Arabia through its strategic initiative with Saudi Aramco. They also plan to expand their service offerings to include ESG advisory and assurance, as well as decarbonization services.
- Alignment with India's and Global Climate Goals: By validating and verifying carbon projects, Earthood ensures that the carbon credits traded in the global markets are real and credible. This provides confidence to investors and helps drive financial flows toward projects that reduce greenhouse gas emissions. Earthood's offerings directly contribute to achieving net-zero emissions by helping businesses measure their carbon footprint and offset their residual emissions with high-quality carbon credits. The company itself has become the first Carbon Neutral Validation and Verification Body (VVB), demonstrating its commitment to the very goals it helps its clients achieve.

5. EcoEvolv

About the Organisation

Ecoevolution Experts Private Limited (EcoEvolv) is a sustainability consulting and carbon advisory firm established in 2023, dedicated to driving climate action and supporting organizations in their transition toward Net Zero emissions. Headquartered in New Delhi, India, EcoEvolv working with partners and clients in sectors such as renewable energy, waste management, agroforestry, and bioenergy.

EcoEvolv vision is to bridge the path toward a sustainable and low-carbon future by offering innovative, science-based solutions that align with global climate goals.

EcoEvolv mission is to accelerate climate change mitigation efforts by enabling businesses to identify, quantify, and reduce their greenhouse gas (GHG) emissions through carbon market mechanisms, ESG strategies, Carbon Capture, Utilization & Storage and decarbonization initiatives.

CCUS Technologies and Solutions Portfolio

EcoEvolv has not developed proprietary CCUS technologies but has been actively involved in the deployment and implementation of carbon mitigation projects that integrate carbon capture and utilization concepts within broader sustainability frameworks. EcoEvolv work focuses on facilitating and optimizing carbon reduction pathways through:

Waste-to-energy, Bio-based carbon capture projects, such as Bio-CNG and biogas-to-energy systems, where carbon capture and utilization significantly reduce GHG emissions.

EcoEvolv's technical team supports these initiatives by conducting feasibility studies, GHG emission reduction assessments, and carbon market registration, ensuring that the technologies deployed are both environmentally sound and aligned with international standards and also can provide the income to the project owner in order to meet the additional cost of the technology.

R & D Structure and Collaborations and Partnerships

EcoEvolv is not involve in the development of CCUS technology instead it is involved in the consulting and advocacy, hence R&D capability related to the technology development is not available with Ecoevolv.

EcoEvolv is in collaboration with:

- Government Body: Uttar Pradesh Renewable Energy Department (UPNEDA), Municipal Corporation Ghaziabad, Municipal Corporation Mathura Vrindavan, Ministry of Housing and Urban Affairs
- Academic Institutions: Indian Institute of Technology Delhi, GB Pant University, Amity University
- Internation Partners: CRES (for Renewable Energy Sources and Saving), Greece

Best Practices

While EcoEvolv's focus lies primarily in bio-based carbon capture and utilization (CCU) rather than large-scale geological storage, the organization has successfully implemented several innovative approaches and best practices that align closely with the CCUS value chain — particularly in capture, utilization, and emission avoidance.

Future Roadmap and Alignment with Climate Goals

Since Ecoevolv is actively involved in the advocacy, consulting and carbon market, we would like to team up with engineering firms, capture technology providers, and oil & gas / storage players for transport & permanent storage globally in the related fields.

6. GAIL

About the Organisation

GAIL incorporated in August 1984 as a Central PSU under the Ministry of Petroleum & Natural Gas is India's leading Natural Gas company, with a robust and diversified presence across the entire Natural Gas value chain and beyond. Its operations encompass the Transmission and Marketing of Natural Gas, Production of Liquefied Petroleum Gas (LPG) and other Liquid Hydrocarbons, LPG Transmission, Polymer production and Marketing, City Gas Distribution, LNG sourcing, Shipping and Regasification, Renewable Energy initiatives and upstream Exploration & Production activities.

CCUS Technologies and Solutions Portfolio

GAIL's operations cover a wide spectrum of businesses, including Natural Gas Transmission & Marketing, Production of LPG & Other Hydrocarbons, LPG Transmission, Polymers, City Gas Distribution (CGD), LNG Sourcing, Shipping & Regasification, Renewable Energy Initiatives, Exploration & Production and CBG.

R & D Structure and Collaborations and Partnerships

In recent years, GAIL has taken a leadership role in innovation and sustainability, particularly in carbon capture, utilization, and storage (CCUS), and in developing pathways for low-carbon fuels such as methanol, DME (Dimethyl Ether), and sustainable aviation fuel (SAF). In this regard, GAIL has successfully commissioned a microalgae-based CO_2 capture plant of 01 TPD (Tonnes Per Day) capacity at its Petrochemical Plant at Pata (U.P). Currently, trial run is going on to validate the results.

Best Practices

GAIL has launched multiple R&D and pilot projects with reputed academic and research institutes. These include: -

- GAIL is pursuing a research project with IISER, Tirupati for the conversion of CO_2 into polycarbonate diols.
- GAIL has also implemented a pilot project at Pata facility to capture the CO_2 using microbial algae.
- GAIL also focussing on capture of CO_2 from flue gases and pursues R&D project for large-scale synthesis of porous organic polymer based solid adsorbents with IIT-Hyderabad.

- GAIL is also developing a Scalable and Energy Efficient Technology for Moisture Resistant CO_2 Removal from Natural Gas Turbine Flue Gas Stream, with BITS Pilani Hyderabad Campus
- GAIL is also developing efficient catalysis for hydrogenation of CO_2 to synthetic natural gas (e-methane) in collaboration with CSIR-IIP, Dehradun.
- GAIL is Developing of an anaerobic digester system for generation of enriched Methane from Food waste, in association with CSIR-IICT, Hyderabad.
- Further, to promote circular economy, GAIL has established a pilot plant of 1TPD for chemical recycling of waste plastics into Diesel and Gasoline at Dehradun in association with CSIR, IIP, Dehradun.

Future Roadmap and Alignment with Climate Goals

GAIL is positioning itself as a frontrunner in India's clean energy transition by exploring conversion of CO_2 to Sustainable Aviation Fuel (SAF) to support decarbonization of hard-to-abate sectors. We are also expanding its renewables portfolio, including wind and solar projects. GAIL is also working towards strengthening global partnerships to access frontier technologies in CCUS and hydrogen economy. We aim to play a leadership role in building sustainable energy infrastructure that aligns with India's Net Zero ambitions. GAIL's journey reflects how a traditional natural gas company is reinventing itself as a sustainability-driven energy leader. By integrating innovation, partnerships, and best practices, GAIL is laying the foundation for India's low-carbon future while continuing to fuel the nation's economic growth.

2 nos. Raceway Reactor at GAIL, Pata

2 nos. Raceway Reactor at GAIL, Pata

CO_2 Sparger Assembly

Generation of Algae

7. Indian Oil Corporation Limited

About the Organisation

Indian Oil Corporation Limited (IOCL), established in 1959, IOCL is India's largest integrated energy company, operating across refining, pipelines, marketing, petrochemicals, natural gas, and emerging energy sectors. Committed to energy security and a low-carbon future, IOCL has set a target to achieve net-zero operational (Scope 1 and 2) emissions by 2046 through energy efficiency, renewable energy, hydrogen, CCUS, and cleaner fuels.

CCUS Technologies and Solutions Portfolio

a) Enzyme-Assisted CO_2 Capture Technology (eCO_2Sorb)

IndianOil has developed an advanced enzyme-assisted, solvent-based CO_2 capture technology named eCO_2Sorb. This technology utilizes proprietary enzymes and solvents that work synergistically to enhance CO_2 capture efficiency while significantly reducing the energy required for solvent regeneration.

b) **Direct Air Capture Technology (eCO_2DAC)**

IndianOil has also developed an advanced sorbent-based Direct Air Capture (DAC) technology, named eCO_2DAC, at the pilot scale. This system employs a proprietary solid sorbent with high affinity and selectivity for atmospheric CO_2, enabling efficient capture even at low concentrations (≈ 0.04% CO_2 in air). The captured CO_2 is regenerated using a low-temperature desorption process, minimizing energy consumption. The recovered CO_2 is further utilized for microalgae cultivation, supporting bio-based carbon utilization pathways.

c) **Accelerated CO_2 Mineralization Technology**

IndianOil has developed an accelerated biocatalytic CO_2 mineralization process that converts gaseous CO_2 into nano-sized, value-added carbonates through a low-energy pathway (Fig.4). The process employs specialized biocatalysts to enhance the kinetics of mineral carbonation, reducing the overall Hydraulic Retention Time (HRT) and improving CO_2 conversion efficiency.

d) **CO_2 Utilization in Refinery Wastewater Treatment**

IndianOil has innovatively developed a CO_2-based pH control process for refinery wastewater and cooling water systems. The method involves injecting CO_2 directly into wastewater streams to achieve effective pH adjustment, eliminating the need for conventional acid-based neutralization agents.

e) **CO_2-to- Acetic Acid Projects**

IOCL is exploring CO_2-to-Chemicals (Acetic Acid) as a key utilization pathway. In this direction, two projects at Panipat and Paradip are being submitted to Government (MoP/NITI Aayog), with capacities of 440 TPD and 348 TPD, respectively, further strengthening IndianOil's CO_2-to-chemicals portfolio.

R & D Structure and Collaborations and Partnerships

Collaboration with IITB: Biocatalytic CO_2 fixation for continuous manufacturing of fatty acids. Collaboration with TFL: Commercial demonstration of CO_2 capture technology.

Best Practices

IndianOil has implemented several innovative and sustainable CCUS practices across its operations. A key success story is the commercial demonstration of the eCO_2Sorb technology at a 170 MT/day CO_2 capture plant, achieving a 21% reduction in specific steam consumption, thereby lowering the overall cost of CO_2 capture.

Future Roadmap and Alignment with Climate Goals

- IOCL is exploring CO_2-to-Chemicals (Acetic Acid) as a key utilization pathway. In this direction, two projects at Panipat and Paradip are being submitted to Government (MoP/NITI Aayog), with capacities of 440 TPD and 348 TPD, respectively, further strengthening IndianOil's CO_2-to-chemicals portfolio.
- Embed CCUS within IndianOil's Net-Zero 2046 roadmap for operational (Scope 1 and 2) emissions, integrating with efficiency, renewables, hydrogen, and biofuels to deliver cumulative emission.
- Develop CCUS-biofuel hubs that abate emissions and supply low-carbon fuels into national blending programs.

Fig.1. Enzymatic CO_2 capture pilot plant

Fig.2. Commercial demonstration of eCO_2Sorb at a fertilizer plant at Tuticorin

Fig.3. Integrated Direct Air Capture (DAC) Pilot plant for CO_2 capture and its utilization in microalgae growth.

Fig.4. CO_2 mineralization setup

8. Jindal Steel & Power

About the Organisation

Established in 1979, the organization operates as a premier integrated steel producer in India. Major manufacturing complexes are strategically located in Angul (Odisha) and Raigarh (Chhattisgarh). The company embodies the philosophy of industrial self-reliance. It currently commands a steelmaking capacity of 9.6 MTPA. The Angul complex is envisioned to become the largest single-site steel plant in the region.

The organization operates with a science-based climate vision. It has formally committed to achieving net-zero emissions by 2047. A rigorous medium-term target has been established. The company aims to reduce its CO_2 emission intensity by 30% by 2030, benchmarked against a 2005 baseline. For the fiscal year 2024-25, absolute Scope 1 emissions were reported at 21.49 million tonnes CO_2e. Scope 2 emissions stood at 1.01 million tonnes CO_2e. This translates to an emission intensity of 2.79 tCO_2e/tcs. The decarbonisation mandate is deeply integrated into corporate governance. Climate-related Key Performance Indicators (KPIs) are embedded into executive compensation. Financial incentives are directly linked to absolute and intensity-based greenhouse gas (GHG) reductions.

CCUS Technologies and Solutions Portfolio

The organization occupies a dual role in the CCUS ecosystem. It acts as both a primary technology developer and an industrial-scale project operator. A dedicated CCU&S Department drives this mandate. This department is exclusively tasked with the evaluation, implementation, and scaling of low-emission technologies and onsite carbon utilization frameworks. By embedding carbon capture directly into metallurgical processes, the company provides a live commercial testbed. This proves the viability of industrial-scale CCUS deployment in emerging economies.

The Coal Gasification Plant – Direct Reduced Iron (CGP-DRI) facility at Angul represents the pinnacle of deployed technology. It is recognized as the world's first and largest operational unit of its kind. The CGP-DRI route utilizes coal gasification to produce synthesis gas (syngas) for iron ore reduction. This specific architecture inherently facilitates highly efficient pre-combustion carbon capture. The facility integrates a dedicated Carbon Capturing Unit (CCU). This unit captures 3,000 Tonnes Per Day (TPD) of CO_2 directly from the gasification stream. In total, the Angul plant possesses the capacity to capture 3,600 TPD of CO_2. This establishes a robust and scalable foundation for downstream carbon utilization.

R & D Structure and Collaborations and Partnerships

Overcoming the technical barriers of CCUS requires extensive collaboration. The organization has forged strategic alliances across academia, government, and international borders.

- **Academic Partnerships:** Collaborations with IIT Bombay focus on advancing electrocatalytic CO_2 conversion. Partnerships with IIT Kharagpur and the Indo-German Centre for Science and Technology have yielded successful prototypes for ceramic additives utilizing captured carbon.

- **Biomanufacturing Hub:** The company is establishing a CCUS-biomanufacturing hub. This initiative involves the Department of Biotechnology (Government of India), Gujarat Biotechnology University, and Canadian institutions, including the University of Alberta and the University of Guelph. The focus is on developing smart proteins and advanced bio-materials.
- **Governmental Synergy:** R&D efforts are deeply aligned with national objectives. The organization collaborates closely with the Ministry of Steel and the Ministry of Coal. Projects align with national BioE3 policies and the broader National Green Hydrogen Mission.

Best Practices

The implementation strategy reveals critical best practices for the heavy industry sector.

- **Pre-Combustion Optimization:** Capturing carbon from the syngas stream in the DRI process is highly efficient. It avoids the complexities of post-combustion capture from Blast Furnace flue gases. This results in higher capture efficiencies at a lower energy penalty.
- **Water-Energy Nexus Management:** Utilizing RO reject water in the CO_2-to-ethanol pilot demonstrates profound resource efficiency. It ensures that CCUS deployment does not exacerbate freshwater scarcity in industrial zones.
- **Waste-to-Value Circularity:** Utilizing BOF slag for mineral carbonation solves two challenges simultaneously. It mitigates CO_2 emissions and neutralizes hazardous metallurgical waste. The resulting material is safe for road construction, validated through partnerships with the CSIR-Central Road Research Institute (CRRI).

Future Roadmap and Alignment with Climate Goals

Future CCUS trajectories are mapped directly to India's Net-Zero 2070 goals. The organization envisions establishing a regional hub-and-cluster model by 2045. Permanent geological sinks are being explored within a 100 km radius of integrated plants. This will drastically reduce transportation and sequestration costs.

Capacity expansion is paired with decarbonization. Viability Gap Funding (VGF) from the Ministry of Coal has been secured to expand the coal gasification footprint to 2 MTPA. This expansion integrates a new 30 TPD CCU plant. Concurrently, the firm is pioneering the transition toward green hydrogen. MOUs have been signed to inject hydrogen into vertical shaft DRI units. This partially substitutes fossil-derived reducing gases. It acts as a complementary hybrid pathway alongside CCUS scaling.

CCUS Operational Metric / Initiative	Current Status / Deployed Capacity	Strategic Target / Future Trajectory
Total Carbon Capture Capacity	3,600 TPD (Angul Complex)	Expansion via new 2 MTPA CGP facility
BOF Slag Mineral Carbonation	Pilot scale (>8% CO_2 capture efficiency)	>100,000 tonnes/year theoretical storage
CO_2 to Ethanol/Chemicals	Bench/Pilot scale (electrocatalytic)	1 TPD commercial demonstration
Biological Algae Utilization	2,000 TPD CO_2 directed to bioreactors	Scale to Sustainable Aviation Fuel (SAF)
Geological Storage (CCS)	Feasibility and mapping phase	Regional hub-and-cluster deployment by 2045

9. LanzaTech

About the Organisation

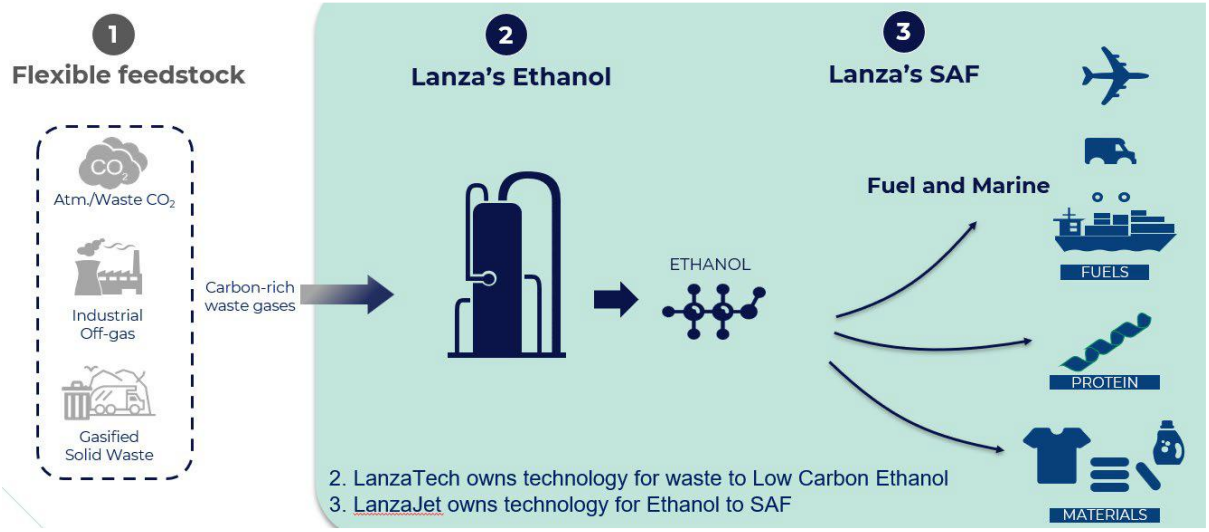
LanzaTech was founded in 2005 in New Zealand, with current headquarters in Skokie, Illinois, USA. India office by the name of LanzaTceh Private Limited was incorporated in 2012. Key Operational Regions: United States, China, India, Europe, Middle East LanzaTech's mission centers on carbon recycling — capturing waste carbon emissions and converting them into valuable sustainable materials, thereby reducing reliance on fossil-based feedstocks and contributing meaningfully to climate change mitigation.

CCUS Technologies and Solutions Portfolio

Core Technology: Gas Fermentation Platform

LanzaTech's proprietary gas fermentation platform converts industrial emissions, syngas, and captured CO_2 into valuable products such as ethanol, sustainable aviation fuel (via LanzaJet), proteins, and other biochemicals.

The technology progressed from lab scale (2005) to commercial deployment (2018) and today powers six commercial ethanol plants globally, supplying fuels and consumer products including textiles, packaging, and home care products.



Key deployments include the world's first commercial gas fermentation plant at Shougang Steel (China), ArcelorMittal's steel plant in Belgium, IndianOil's Panipat

refinery, NTPC's CO_2-to-ethanol project in India, the LanzaJet Freedom Pines SAF facility in the U.S., and a municipal waste-to-ethanol project with SEKISUI in Japan.

R & D Structure and Collaborations and Partnerships

LanzaTech's R&D hub in Skokie, Illinois, focuses on microbiology, synthetic biology, fermentation engineering, and process scale-up, supported by pilot facilities and AI-driven strain development capabilities. The company collaborates closely with the U.S. DOE, ARPA-E, leading universities, and national laboratories, while also participating in international research programs, reflecting a strong global innovation ecosystem.

Best Practices

LanzaTech's flagship achievement is the world's first commercial gas fermentation plant in China, which proved the viability of converting industrial emissions into valuable products at scale. Through its CarbonSmart™ platform, captured carbon has also been transformed into products such as apparel, fragrances, and sustainable aviation fuel, showcasing the potential of a circular carbon economy.

Future Roadmap and Alignment with Climate Goals

LanzaTech is well positioned to support India's Net-Zero 2070 goals and industrial decarbonization efforts. Its partnership with IndianOil at Panipat demonstrates the viability of its technology in India and provides a foundation for expansion across steel, refining, waste management, and coal gasification sectors.

By converting industrial waste gases and carbon emissions into ethanol, C2 derivatives, and sustainable aviation fuel (SAF), LanzaTech enables both emissions reduction and value creation. The technology also supports India's ethanol blending targets without competing with food crops, with a commercial project already underway to produce ethanol from sugarcane bagasse.

LanzaTech remains committed to collaborating with government, industry, and research partners to deliver scalable carbon utilization solutions aligned with India's climate and energy priorities

10. netZERO Services Private Limited

About the Organisation

netZERO Services was established in 2023 and commenced operations in December 2024. The organization operates in the carbon credits, climate solutions, and environmental markets space, supporting industries and organizations in achieving their emissions reduction and sustainability goals.

The company works as an integrated climate solutions platform that bridges industries, project developers, technology providers, and implementation partners to develop scalable climate mitigation projects and facilitate participation in global carbon markets. In addition to carbon credit project development and commercialization, netZERO Services also provides Extended Producer Responsibility (EPR) solutions to obligated entities under the Government of India's EPR framework.

The company supports hard-to-abate sectors by connecting industries with technology, carbon finance, and implementation partners, backed by robust MRV systems. Its mission is to accelerate scalable carbon reduction and removal solutions aligned with India's net-zero ambitions and global climate goals.

CCUS Technologies and Solutions Portfolio

Within the CCUS ecosystem, netZERO Services acts as a climate project developer and carbon markets facilitator, working with technology providers and implementation partners to assess mitigation technologies, evaluate emissions reduction potential, structure carbon credit projects, and Supporting project documentation and MRV frameworks. Facilitating commercialization of environmental attributes

The company is currently supporting an algae-based Direct Air Capture (DAC) project focused on atmospheric CO_2 removal. Beyond CCUS, netZERO Services develops projects across afforestation and reforestation, blue carbon, alternate wetting and drying (AWD), biomethanisation, electric mobility, and circular economy initiatives, driving carbon sequestration, methane avoidance, emissions reduction, and ecosystem restoration.

R & D Structure and Collaborations and Partnerships

netZERO Services has in-house expertise in carbon market research, project feasibility assessment, climate policy analysis, methodology evaluation, MRV system

development, and sustainability strategy implementation. The organization works closely with technology providers, project implementation agencies, sustainability consultants, environmental infrastructure companies, industry stakeholders, and validation and verification bodies. Through these collaborations, netZERO Services continuously evaluates emerging climate technologies and carbon market opportunities that support India's decarbonization journey.

Best Practices

netZERO Services follows a high-integrity project development approach emphasizing:

- Robust MRV systems
- Data transparency
- Independent validation and verification
- Community-linked sustainability outcomes
- Alignment with international carbon standards

Future Roadmap and Alignment with Climate Goals

netZERO Services aims to expand its role in climate mitigation and carbon removal by scaling carbon projects and technology-enabled sustainability solutions. Its future focus includes carbon removal and CCUS-linked projects, nature-based sequestration, industrial decarbonization, circular economy and waste-to-resource initiatives, sustainable agriculture, and ecosystem restoration, along with active participation in Indian and international carbon markets. The organization's long-term strategy aligns with India's Net-Zero commitments and global climate goals by advancing carbon sequestration, emissions reduction, ecosystem restoration, climate resilience, sustainable community development, and broader environmental market transformation.

11. Net Zero Think

About the Organisation

Net Zero Think is a climate solutions company enabling businesses, governments, and institutions to achieve their net-zero and sustainability goals. Since 2022, they delivered cutting-edge solutions in the areas of research, GHG accounting and auditing, ESG strategy, decarbonization, and carbon markets. Through their global Climate Innovation Community, certified training programs, and sector-specific research, the company drive impactful climate action and build long-term capabilities. With a strong presence in India and growing international collaborations, The company transform climate ambition into measurable outcomes.

At Net Zero Think, their vision is to become leader in climate change solutions and contribute towards achieving net zero & SDGs targets. And Mission is to transform the various industries and help their clients & partners, achieve net zero and sustainability goals.

CCUS Technologies and Solutions Portfolio

Net Zero Think Pvt Ltd does not directly develop CCUS hardware technologies; rather, the company focus is on designing, deploying, and enabling frameworks and digital solutions that support CCUS adoption at scale. We are advancing research to develop methodologies and tools for carbon accounting, verification, and certification that recognize CCUS as a key decarbonization pathway. These solutions help industries quantify captured CO_2, validate storage integrity, and link verified reductions with carbon markets and sustainability disclosures.

In collaboration with technology developers and research institutions, we support prefeasibility and feasibility studies for CCUS in hard-to-abate sectors such as steel, buildings, and power. Through these initiatives, Net Zero Think enables CCUS technologies to evolve from experimental concepts into bankable solutions, contributing credibly to corporate net-zero commitments and national climate goals

R & D Structure and Collaborations and Partnerships

Net Zero Think has a team of researchers and technocrats dedicated to advancing climate and decarbonization solutions. At present, they are actively exploring collaborations with government agencies, academic institutions, and international partners to strengthen their R&D capabilities and accelerate the development of impactful, scalable innovations.

Best Practices

Globally, CCUS has delivered notable success stories that offer valuable lessons for India's net-zero transition. Projects such as Norway's Sleipner field and the U.S. Petra Nova project have demonstrated the technical feasibility of capturing and storing millions of tonnes of CO_2 from industrial and power facilities. In Canada, CCUS has been successfully applied in enhanced oil recovery (EOR) and deep saline aquifers, illustrating both utilization and permanent storage pathways.

Best practices emphasize integrated project planning, covering capture, transport, and storage within a unified framework to enhance cost-effectiveness and reliability. Innovations such as modular capture units, low-cost sorbents, and digital monitoring systems are improving scalability, efficiency, and transparency, providing a strong foundation for broader CCUS deployment globally and in India

Future Roadmap and Alignment with Climate Goals

Net Zero Think aims to scale CCS through feasibility studies, digital MRV platforms, and industry–policy collaborations. The company plan to develop cluster-based CCUS hubs for hard-to-abate sectors, aligning with India's 2070 Net-Zero target and global climate goals by ensuring credible, scalable, and finance-ready carbon reduction solutions.

12. ProClime

About the Organisation

ProClime is a full-stack climate company, globally headquartered in Singapore with its India corporate office in Chennai. Primarily active in Carbon Project Development, Carbon Trading, Climate Investments and Advisory Services, its present activities are concentrated in South Asian countries with a forward vision to expand into Africa and South-East Asia.

CCUS Technologies and Solutions Portfolio

ProClime, with its primary business in Carbon Project Development and Climate Investment, continuously works with technology developers to identify and scale quality durable carbon removal technologies that meet ProClime's 8 Core Pillars of Additionality, Transparency, Longevity, Permanence, High Integrity, Strong Governance, Compelling Narrative and Sound Financials.

ProClime is presently active in the commercial deployment of durable carbon removal technologies, specifically Biochar Carbon Dioxide Removal (CDR) and Enhanced Rock Weathering (ERW), in partnership with Governments. These are high-permanence removal pathways, distinct from nature-based solutions. It is also actively working to bring a few indigenously developed CCUS technologies, with partners at various stages of development, for future commercial deployment.

R & D Structure and Collaborations and Partnerships

ProClime does not directly engage in technology research, but engages in operational research of laboratory-proven technologies for commercial deployment, standardising them across product, process, and environmental attributes to ensure market readiness.

Future Roadmap and Alignment with Climate Goals

ProClime's future plans include developing South Asia's largest platform to scale various durable carbon removal technologies, of which CCUS forms an integral part. This is directly aligned with India's Net-Zero commitments and the growing global demand for high-integrity, permanent carbon removals.

13. SGS India Private Limited

About the Organisation

SGS India Pvt. Ltd., established in 1950 as part of the globally renowned SGS Group headquartered in Geneva, Switzerland, operates across all major industrial regions of India, including Mumbai, Delhi NCR, Chennai, Bengaluru, and Ahmedabad. SGS mission is to enable a better, safer, and more interconnected world through independent verification, testing, inspection, and certification services. Aligned with its global sustainability goals, SGS supports climate action by helping industries measure, manage, and reduce greenhouse gas emissions, driving the transition toward net-zero through science-based and data-driven solutions.

CCUS Technologies and Solutions Portfolio

SGS India Pvt. Ltd. acts as an independent verifier, technical consultant, and knowledge partner in the Carbon Capture, Utilization, and Storage (CCUS) ecosystem. It supports GHG baseline assessments, emission quantification, technology validation, and performance verification of CCUS projects. SGS also enables robust MRV systems aligned with ISO 14064 and IPCC guidelines, ensuring transparency and compliance.

The organization collaborates with industry and research partners in India to develop feasibility studies and carbon accounting frameworks for CCUS deployment. While not a hardware developer, SGS plays a key role in verification, assurance, and quality control across CCUS value chains, including capture readiness assessments, MRV design, utilization verification, and storage integrity audits. It also leverages digital tools such as SGS Inspire™ for advanced data validation and lifecycle assessment.

R & D Structure and Collaborations and Partnerships

SGS operates several Centers of Excellence (CoEs) and state-of-the-art laboratories that support climate and environmental research globally.
In India, SGS R&D teams collaborate with:

- **Government and Industry Bodies:** Bureau of Energy Efficiency (BEE), Ministry of Environment, Forest and Climate Change (MoEFCC), and NITI Aayog for policy-aligned sustainability programs.
- **Academic Institutions:** Technical support partnerships for developing carbon capture readiness frameworks.
- **International Collaborations:** Participation in multi-country initiatives on MRV harmonization and carbon accounting interoperability.

SGS R&D capabilities focus on emissions analytics, lifecycle impact assessments, and data-driven sustainability technologies.

Best Practices

SGS follows a rigorous approach to ensure credibility and operational excellence in CCUS engagements. Key best practices include:

- **End-to-End MRV Frameworks:** From capture quantification to long-term storage monitoring.
- **Lifecycle-based Carbon Accounting:** Ensuring that net climate benefits are accurately measured.
- **Third-Party Assurance and Verification:** Enhancing investor and regulatory confidence in CCUS data.
- **Digital Traceability Tools:** Using cloud-based dashboards and blockchain-ready data systems to maintain audit-ready documentation.

SGS success stories lie in enabling clients to demonstrate credible emission reductions and readiness for large-scale CCUS adoption.

Future Roadmap and Alignment with Climate Goals

SGS aims to play an increasingly strategic role in scaling CCUS technologies and capacity in India, aligned with national and global Net-Zero commitments. SGS roadmap includes:

- **Expanding CCUS Verification Services:** Supporting commercial-scale CCUS projects with credible MRV and assurance.
- **Capacity Building and Training:** Empowering industries and regulators through CCUS awareness and competency development programs.
- **Digital Transformation:** Enhancing data-driven monitoring systems for CCUS transparency and traceability.
- **Partnership Development:** Engaging with policy-makers, technology developers, and academia to co-create pathways toward industrial decarbonization.

By bridging technology assurance with policy frameworks, SGS remains committed to accelerating India's low-carbon transition and achieving the 2070 Net-Zero vision.

14. S.S. Gas Lab Asia Private Limited

About the Organisation

S.S. Gas Lab Asia Pvt. Ltd. (GAS LAB Asia) is India's pioneering and longest-established carbon capture and CO_2 technology companies, with engineering roots dating to 1980 and a corporate lineage going back to 1923. Headquartered in the Delhi-NCR region with manufacturing in Greater Noida, the company designs, builds and commissions CO_2 generation, capture, recovery, purification, liquefaction and utilization systems, along with biogas upgrading, nitrous oxide (N2O) and cryogenic equipment, for clients on five continents, from Chile to South Korea and Taiwan, Australia to Uzbekistan, and across the Middle East and Africa to Sierra Leone. GAS LAB Asia is a women-led enterprise, headed by its Chairperson and Managing Director, Mrs Jayanti Goela, and holds active Udyam (MSME) registration. The company mission is practical innovation for industrial gases: helping industry convert process and combustion emissions into purified, usable CO_2, so that carbon becomes a managed resource within a circular carbon economy rather than a waste stream.

CCUS Technologies and Solutions Portfolio

GAS LAB Asia is a technology developer and an engineering and equipment supplier across the capture-and-utilization value chain. We engineer, fabricate and commission complete plants for CO_2 capture, recovery, purification, liquefaction and utilisation, and supply purified CO_2 for a wide range of productive end uses. GAS LAB follows a utilization-first philosophy. Having worked on CO_2 utilization technologies across the world, we believe in extracting the maximum value from every tonne of captured CO_2 and in making capture projects financially self-sustaining rather than a cost of compliance. They are technology-agnostic on the capture front, and they focus is on turning captured carbon into a usable, revenue-generating resource.

The company deployed portfolio spans the full CO_2 value chain. On capture, they supply solvent-based, cryogenic and hybrid CO_2 capture systems across both fossil and biogenic sources, configured to deliver food-grade CO_2 so that the captured stream commands the highest possible value. These feed CO_2 purification and liquefaction systems producing food, beverage and industrial-grade CO_2. They also build biogas upgrading systems that produce CBG using solvent, pressure-swing adsorption (PSA) and water-absorption routes with integrated CO_2 recovery. On utilization, their CO_2 utilization systems for water treatment are an area of global leadership: GAS LAB has done pioneering work in using CO_2 in place of harmful mineral acids for water treatment, particularly across Asia. The portfolio is completed

by high-purity N2O systems for medical and semiconductor use, dry-ice production, and cryogenic CO_2 and LNG storage, transport and vessel equipment, all fabricated in-house to ASME U-stamp, CE and PESO standards.

R & D Structure and Collaborations and Partnerships

R&D is led by the Dr. S S Aggarwal Centre for Research, GAS LAB's in-house R&D centre established in 2014 and recognised by the Department of Scientific and Industrial Research (DSIR) in 2017, India's first private R&D centre dedicated to carbon capture and CO_2 research. The centre studies and simulates capture and utilisation processes, including software-based process modelling and energy optimisation, and has collaborated with leading Indian and international universities on CO_2 technology, among them Technische Universitaet Kaiserslautern (Germany), NIT Warangal and IIT Delhi. GAS LAB Asia is a member of the CII Task Force on CCUS (2026-27) and co-chairs the CCUS forum at the India Federation of Green Energy (IFGE) platform.

Best Practices

The company defining practice is to engineer capture and utilization together rather than in isolation. Standardised, modular CO_2 recovery and liquefaction packages shorten delivery timelines and improve reliability, while integrating captured CO_2 directly into productive end uses gives every project a clear commercial use case. Deployed utilisation spans food and beverage, agriculture and horticulture, water treatment and desalination, power, and oil and gas. A continuing focus is reducing the specific energy demand of solvent-based capture through process and solvent optimisation, which directly improves utilisation economics.

Future Roadmap and Alignment with Climate Goals

GAS LAB Asia positions itself as India's first and leading CCUS technology company: an indigenous, India-built technology base in a field still dominated by expensive imported systems. With global energy and foreign-currency costs pushing the price of imported CCUS technology steadily higher, home-grown Indian technology is the single most effective lever for keeping CCUS implementation costs low enough to scale. Building on this, we intend to scale their modular capture-to-utilization model, develop a modular mineral-carbonation (MC-series) concept for the emerging Indian carbon market, and continue expanding biogas-to-CBG capacity in line with the SATAT programme, while deepening R&D at the Dr. S S Aggarwal Centre for Research and broadening AI-enabled operation with Carbonetics. These plans align directly with India's CCUS mission and the announced INR 20,000 crore allocation, and with the national Net-Zero-by-2070 goal, by lowering the cost and raising the usability of captured CO_2 in hard-to-abate sectors.

15. Tata Consulting Engineers Limited

TATA CONSULTING ENGINEERS LIMITED

About the Organisation

Tata Consulting Engineers Limited (TCE), established in 1962 as part of the Tata Group, is a leading multidisciplinary engineering consultancy headquartered in Mumbai with offices across India and global operations in the Middle East, Southeast Asia, Africa, and the USA.TCE serves sectors including power, oil & gas, chemicals, infrastructure, water, and industrial facilities, offering engineering design, project management consultancy (PMC), and owner's engineering services.
With over six decades of experience, TCE supports India's energy transition by integrating low-carbon solutions such as carbon capture, utilization, and storage (CCUS), aligned with India's NDCs and net-zero 2070 goals.

CCUS Technologies and Solutions Portfolio

Tata Consulting Engineers Limited (TCE), plays a multi-faceted role in the CCUS ecosystem as a technology integrator, engineering consultant, and project development advisor, covering the full project lifecycle from feasibility studies to EPC support and construction management.

TCE integrates proven CCUS technologies into project-specific designs and provides FEED, detailed engineering, and owner's engineering/PMC services for capture plants, CO_2 compression, transport, and storage systems. It also supports policy and framework development in collaboration with government and industry stakeholders.

Its CCUS expertise spans energy-intensive sectors such as power, steel, cement, and refining, including post- and pre-combustion capture (amine, SMR/ATR integration), membrane and PSA systems, CO_2 utilization pathways (methanol, urea, EOR), and CO_2 transport and storage solutions. TCE's strength lies in applied engineering innovation, including retrofit design templates for thermal power plants, integration of blue hydrogen with CCS in industrial facilities, and contributions through technical publications and industry forums.

R & D Structure and Collaborations and Partnerships

Tata Consulting Engineers Limited (TCE) focuses its CCUS R&D on advanced process simulation and system design using tools such as Aspen Plus, HYSYS, and Ansys to develop integrated capture and utilization solutions. It collaborates with academic and government institutions (including IITs and CSIR labs) on CO_2 conversion into value-added chemicals, and works with global technology licensors to adapt CCUS technologies for Indian operating conditions.

TCE has supported CCUS projects across study, FEL, Pre-FEED, and detailed engineering stages, including CO_2 compression and dehydration projects in North America, flue gas handling studies, greenfield systems, clean ammonia projects, and green methanol (~10 TPD) concepts.

Overall, its role is focused on engineering and advisory support to enable scalable CCUS project development and implementation.

Best Practices

Tata Consulting Engineers Limited (TCE) applies practical CCUS engineering best practices across capture, transport, and integration. In capture, it focuses on scalable CO_2 compression and dehydration systems, brownfield integration with existing plant utilities, and phased project development (study to detailed engineering) to reduce project risk. It also optimizes energy integration between capture units and host facilities to minimize energy penalties.

In transport, TCE designs dense-phase CO_2 pipelines accounting for phase behaviour, impurities, and safety to ensure reliable operation. Across the value chain, it emphasizes CO_2 conditioning to meet transport, storage, and utilization requirements.

A key example includes support for a green methanol project integrating captured CO_2 with hydrogen and synthesis systems at pilot scale, along with licensor coordination and project management. TCE also works with academic partners to scale CCUS technologies from lab to pilot implementation.

Future Roadmap and Alignment with Climate Goals

Tata Consulting Engineers Limited (TCE) is scaling its CCUS strategy in line with India's Net-Zero 2070 goals through practical, sector-focused solutions. Its focus includes developing standardized Pre-FEED and FEED frameworks and tailored CCUS solutions for hard-to-abate sectors such as cement, steel, and fertilizers. TCE is also strengthening capabilities in integrating CCUS with blue hydrogen pathways aligned with the National Hydrogen Mission.

The company is exploring cluster-based CCUS models to enable shared capture, transport, and storage infrastructure across industrial emitters, in collaboration with stakeholders and government bodies. In parallel, TCE is advancing digital and simulation-driven engineering tools to support integrated design, with an overall emphasis on scalable, implementable CCUS deployment through engineering and ecosystem collaboration.

16. Tata Steel Limited

About the Organisation

Tata Steel Limited was established in 1907 by visionary industrialist Jamshedji Nusserwanji Tata and is one of the oldest and most diversified integrated steel producers globally. Since its inception, the organization has embedded environmental and social responsibility into its business philosophy, with Environmental, Social, and Governance (ESG) principles forming an integral part of its operational DNA. Tata Steel has evolved into a geographically diversified global steel manufacturer with an installed production capacity of approximately 31 million tonnes per annum (MTPA). Tata Steel's core operations are in India, with major integrated steel plants at Jamshedpur and Gamharia (Jharkhand), and Kalinganagar and Meramandali (Odisha). It also operates in Europe (IJmuiden, Netherlands; Port Talbot, UK) and Southeast Asia (Thailand).

This diversified footprint strengthens global supply chains while enabling region-specific decarbonisation strategies aligned with local regulations and climate policies. Tata Steel aims to achieve net-zero carbon emissions by 2045 across its global operations. This target aligns with the Tata Group's Project Aalingana and supports the company's transition to low-carbon steelmaking technologies.

CCUS Technologies and Solutions Portfolio

Tata Steel is primarily an industrial host and early adopter of CCUS/CCU technologies, while also contributing as a technology co-developer and research partner through industry–academia collaborations.

At its Jamshedpur plant, Tata Steel commissioned India's first blast furnace gas-based CO_2 capture facility (5 TPD) and pioneered the use of captured CO_2 for bottom tuyere injection in LD vessels, advancing circular carbon economy practices and reducing steelmaking emissions.

R & D Structure and Collaborations and Partnerships

Tata Steel's DSIR-recognized R&D Centre in Jamshedpur is equipped with advanced facilities supporting new materials, environmental technologies, and CCUS research.

The company collaborates extensively with CSIR/DST labs, IITs, IISERs, startups, and global research institutions, while operating Centres of Excellence with IIT (ISM) Dhanbad, IIT Madras Research Park, and the Henry Royce Institute to drive innovation in mining, mobility, advanced materials, and decarbonization.

Best Practices

Tata Steel's 5 TPD CO_2 capture plant at Jamshedpur serves as a pilot to generate operational insights and support the scale-up of integrated CO_2 capture and utilisation solutions. That is essentially a 'monitor → learn → scale' approach.

Tata Steel has embedded climate-risk assessments into its Enterprise Risk Management framework, aligned with global disclosure standards such as IFRS S2, TCFD, and TNFD. As a member of ResponsibleSteel, the company demonstrates its commitment to responsible and low-carbon steel production through a globally recognized stakeholder framework. Its governance structure, led by a Board-level Safety, Health & Environment Committee and a CEO-chaired Apex Safety Council, provides strong oversight of safety, environmental performance, and the deployment of CCUS initiatives.

Future Roadmap and Alignment with Climate Goals

Steel decarbonization requires abating around 2.5–3.0 tonnes of CO_2 per tonne of crude steel produced. To support its net-zero 2045 target, Tata Steel is pursuing both Carbon Direct Avoidance (CDA) using low-carbon reductants such as hydrogen, syngas, and methane and CCUS as CO_2 can be captured from steel mill off gases and then stored or converted into value-added products.

To enable CCUS, Tata Steel is working to develop different pilot units and operational experience from the pilot unit would enable larger CCUS plants, and the next step would be scaled-up facilities of CO_2 capture integrated with utilisation avenues.

Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society through advisory and consultative processes.
CII is a non-government, not-for-profit, industry-led and industry-managed organisation, with over 10,500 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 332 national and regional sectoral industry bodies.

For more than 130 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with the Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialised services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains, including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2026-27, CII has identified "Accelerating Competitiveness: Growth, Resilience, Inclusion, Sustainability, Trust" as its theme, prioritising five key pillars. During the year, CII will align its policy advocacy, institutional initiatives, partnerships, and outreach to support Indian industry in strengthening these five interconnected pillars of competitiveness.

With 70 offices, including 12 Centres of Excellence, in India, and 9 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 255 counterpart organisations in 102 countries, CII serves as a reference point for Indian industry and the international business community.

Confederation of Indian Industry
The Mantosh Sondhi Centre
23, Institutional Area, Lodi Road, New Delhi – 110 003 (India)
T: 91 11 45771000
E: info@cii.in • W: www.cii.in

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