Carbon Capture, Utilization, and Storage

Capability statement

HATCH

Achieving the world's sustainable transformation

The clean energy transition is well underway and, as we move toward 2050, the world will undergo a massive transformation in an attempt to achieve net zero emissions.

However, the shift from carbon-intensive fuels to renewables remains a challenge—hydrocarbon consumption and the world's hunger for energy sources continues to increase faster than renewables can be added into the overall energy mix. To be successful, industries need to collaboratively drive efficiency, economic prosperity, diverse social fabric, and environmental sustainability.

Carbon capture, utilization, and storage (CCUS) is an important emissions-reduction pathway that can be applied across industries—it is a tool that we believe will play a critical role in the world's sustainable transformation. For some processes—think industrial and fuel transformation—CCUS is one of the most cost-effective solutions available for large-scale emissions reductions. And with ongoing technological advancements and government policy developments, the large-scale deployment of CCUS could occur sooner than anticipated.

Let's create a cleaner future together!

"A sharp rise in the deployment of carbon capture, utilization, and storage (CCUS) technology is needed globally if countries are to meet net zero emissions targets designed to slow climate change […]. A growing number of countries and companies are targeting net zero carbon dioxide (CO_2) emissions by around the middle of the century in the wake of the 2015 Paris climate agreement. To reach that, the amount of CO_2 captured must rocket to 800 million tonnes in 2030 from around 40 million tonnes today […]. Up to $160 billion needs to be invested in the technology by 2030, a tenfold increase from the previous decade […]. To date, just 20 commercial projects are in operation, capturing around 40 million tonnes per year."

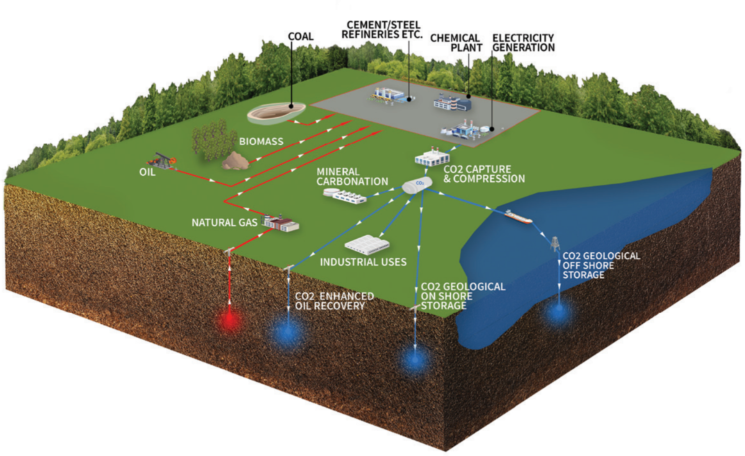
– **International Energy Agency**
extracted from Reuters paper entitled "Global Climate Goals 'Virtually Impossible' Without Carbon Capture," September 24, 2020

The possibilities are endless

The burning of fossil fuels—coal, natural gas, and oil—and industrial processes such as the production of cement, fertilizer, and steel produce large amounts of CO_2 emissions. CCUS involves technologies for the capture and separation of CO_2 from fuel combustion and/or industrial processes before it is emitted into the atmosphere, thus reducing the overall CO_2 emissions of the plant. Once captured, the CO_2 is transported via pipeline or ship to be applied as feedstock to create valuable products such as construction materials and fuels, or permanently stored deep underground in geological formations.

To meet emissions targets set by the International Energy Agency (IEA) for 2050, a 50 percent reduction in global emissions from 2005 levels will be required. As part of this effort, the deployment of CCUS technology, in conjunction with increases in energy efficiency and more environmentally sustainable sources of power, will also be required. CCUS plays a vital role in emissions reduction as it is the only technology capable of removing large volumes of CO_2 from the atmosphere.

In some countries, the deployment of CCUS may be the only option for achieving these critical targets, allowing for the continued use of fossil fuels, while removing +90 percent of CO_2 from flue gases prior to emissions being released into the atmosphere. The impact of this is significant, as CO_2 contributes to approximately 60 percent of total greenhouse gas (GHG) emissions on a global warming potential basis.



Successfully implementation of CCUS requires detailed attention in multiple areas to ensure a successful project from a technical perspective, while providing the most economical outcome possible. These areas include CO_2 capture technology selection and design, CO_2 transport, and CO_2 storage and utilization.

Our approach

We partner with clients to minimize implementation and operational risks while increasing stakeholder value through efficient project planning, analysis, and execution. And while our focus is to reduce the overall carbon footprint, we're committed to doing so while adhering to government policies, minimizing implementation and operational risks, and ensuring that health and safety are our top priorities.

We're recognized for our deep understanding of our clients' requirements, which is a key differentiator when considering CCUS technology. The intricate details of our client's processes, plant layouts with complex ducting networks, and pretreatment requirements – and how they connect with and affect CCUS -- are well within our wheelhouse of expertise and capabilities. This allows us to determine the best way to reduce your emissions footprint and monetize the CO_2 once captured. We've gained this know-how from our unparalleled experience in acid gas removal from natural gas production, gasification and post-gasification capture projects, and as part of our work in the blue hydrogen space. For 65 years, we've provided technological innovations and project execution in the Energy, Mining and Metals, and Infrastructure sectors, providing a full range of technology-driven, value-added solutions and services through a network of more than 65 permanent offices and over 10,000 staff members worldwide.

Capturing carbon with mature technologies

Among the various options for CO_2 capture, post-combustion capture using chemical absorption with reactive solvents is considered the most mature and viable technology as it can be retrofitted into existing facilities. Solvent-based carbon capture is the most commercially implemented technology for economically and sustainably achieving carbon emission reduction targets in industrial applications.

One of the challenges in implementing solvent-based carbon capture is its high-energy requirements for desorption of CO_2 from the amine post-absorption. The energy usage of the desorption step in the capture process represents about 70 to 80 percent of the energy required for a post-combustion CO_2 capture plant.

As we apply our experience with heat integration to help minimize these energy input requirements, we can determine the most appropriate solvent-based technology package with a high-absorption capacity and a lower regeneration cost to optimize your project. We're experienced in designing CO_2 capture facilities with the most commonly used alkanolamines (MEA, DEA, MDEA, DGA, etc.) and their mixtures. We also work closely with proprietary solvent licensors to help clients choose the best available technology package for their application.

Beyond reactive solvents, we're experienced in acid gas removal using physical solvents, as well as solid adsorbents and membranes. The economics of CO_2 recovery is strongly influenced by the partial pressure of CO_2 in the feed gas. Physical solvents can be impractical at low partial pressures due to the high cost associated with compressing the gas for physical absorption. However, if the gas is available at high pressure, such as it is in gasification and gas-to-liquids (GTL) plants, physical solvents can be a better choice than chemical solvents.

CO_2 pipeline installation at the Midale CO_2 EOR facility

Transporting carbon dioxide post-capture

Once captured, the carbon dioxide must be safely transported to its point of end use or sequestration. To achieve this safely, the CO_2 must be properly conditioned, compressed, and then transported via pipeline or ship.

Compression of CO_2 is performed in special compressor sets that can handle very large capacities. They are an integral part of a transportation system. Our engineers have the experience to provide the technical specifications so that these high-tech machines can be built and deliver on their intended performances.

A pipeline network is the most common method for safely transporting carbon dioxide. Pipelines call for a sophisticated design that enables an uninterrupted supply of fluids to be transported while keeping environmental protection and safety at the forefront. The transportation of CO_2 requires extraordinary precautions, as CO_2 in the presence of liquid phase water forms carbonic acid. This can corrode the piping used to transport the CO_2, thus causing significant safety issues. Prior to transport, the CO_2 must be dehydrated to minimize the risk of corrosion. Particular attention must be paid to proper material selection for the piping as an additional precaution. Implementing robust operating procedures also helps to avoid two-phase conditions and the potential for cryogenic temperatures. The amount of impurities in the CO_2 feedstock can have a significant impact on the fluid phase envelope. The associated risks include unstable flow and slugging, thus increasing the load on piping; a potential for cryogenic temperatures during depressurization as the vapor expands in the pipeline and; low temperatures in well tubing should the CO_2 be disposed into low pressure wells for storage and sequestration.

At Hatch, we're focused on mitigating operational challenges from fluid characterization, dynamic pipeline modeling, and the finite element analysis of specific areas of interest to ensure the safe operation of the transport system using our expertise in flow assurance, pipeline design, and technical safety. We have decades of experience in pipeline development that we apply to the transportation of CO_2, from feasibility studies through detailed design, permitting, construction, management, commissioning, and integrity monitoring.

Beyond pipeline infrastructure, the CO_2 receiving terminal is another key component of the transportation process. These types of facilities receive, and store, captured carbon dioxide prior to utilization and storage. These include ancillary facilities—incoming and outgoing interconnections, piping, and metering manifolds—containment areas, and any required hydraulic and pumping designs. By utilizing our expertise in terminal design, we can provide layouts that help reduce the overall cost of storage. Our experts are also adept at terminal master planning for future development so that facilities can easily accommodate expansion projects.

From minimizing the risk of working in extreme environments and remote locations, to aiding in obtaining the necessary regulatory approvals, to maintaining pipeline integrity, our experts are ready to support your post-capture needs.

Repurposing, utilizing, and storing CO_2: completing the carbon cycle

To prevent the captured CO_2 from being released into the atmosphere, it must be repurposed for industrial use or stored in deep underground formations. One option is to inject it deep into the underground in saline aquifers, for permanent storage.

Another option, and what is currently the most widely employed form of use, is through enhanced oil recovery (EOR). The IEA reports that each barrel of oil produced by EOR has 37 percent less CO_2 than a conventional crude barrel. This is currently the largest industrial use of CO_2. However, EOR has limitations as it requires feasible geology and substantial infrastructure investment to move CO_2 from the point of production to place of use and/or sequestration. We've been at the forefront of the first wave of reducing CO_2 emissions through a number of carbon capture and sequestration projects for EOR, and work requiring permanent sequestration utilizing deep geological formations. As we progress along the energy transition and the world continues to consume fossil fuels, EOR can help reduce the overall GHG impact of these fossil fuels, while simultaneously providing a long-term storage solution for CO_2.

In addition to underground storage in saline aquifers and use in EOR, there has been a groundswell of technology development aimed at the beneficial utilization of CO_2. As with EOR, utilization technologies that repurpose CO_2 for use in other applications help offset the high costs of carbon capture by providing a value-added product. Examples include algae cultivation and use as a feedstock for methanol, formic acid, urea, concrete building materials (CO_2 mineralization), soda ash, limestone, polymers, food and beverages, and novel materials such as carbon nanotubes. With viable capture and utilization options, it is foreseen that CO_2 can become an increasingly valuable commodity, which could result in further reductions in global emissions.

Some emerging options that are gaining attention include reverse water gas shift (RWGS) to reform CO_2 to produce syngas (H_2 and CO) as building blocks for synthetic fuel (e.g., jet fuel) and chemicals. This approach can result in lower overall feedstock and fuel consumption when compared to conventional natural gas reforming for hydrogen generation, lower CO_2 emissions (up to 15 percent), and a smaller reformer unit, thereby contributing to savings in both capital investment and operating expenses.

Similarly, the theme of electrolysis and renewable energy integration to eliminate natural gas as a feedstock for the production of "e-fuel" (electricity-to-fuel) is gaining momentum. This approach aims to produce hydrogen and water from renewable power through electrolysis and then combine the green hydrogen with captured CO_2 to produce syngas.

Our team of specialists apply unmatched experience, expertise, and analytical tools to create a fully integrated CO_2 utilization solution, from the conceptual level through to design and implementation.

Service streams

Carbon capture

- Climate risk assessments and resilience planning
- Decarbonization roadmapping
- Emissions reduction strategy and planning
- Technology selection
- Solvent benchmarking and selection
- Balance of plant engineering
- System design and plant integration
- Process engineering and simulation
- Flue gas handling and pretreatment
- Ducting system design
- Heat rejection and recovery
- Brownfield construction
- Modularization

Transportation

- Pipeline systems and associated infrastructure
- Compressor stations and dehydration units
- Field devices
- Metering and valve stations
- Lease automatic custody transfer (LACT) units
- Pipeline stress analysis
- Horizontal directional drilling
- Trenched and trenchless technologies
- Intermediate storage in vessels
- Transloading into alternative forms of transportation such as rail, truck, or ship

Repurposing, utilization, and sequestering

- Site screening and selection
- Geological reviews
- Geotechnical modeling and testing
- Confinement reviews
- Plume modeling
- Effective mass storage calculations
- Field development planning
- EOR modeling / screening
- Well design / completions
- Risk management
- Site monitoring during and after CO_2 injection
- CO_2 utilization option evaluation

Selected project experience

MEG Energy Christina Lake SAGD Post-Combustion CO_2 Capture

Alberta, Canada

Carbon capture & transport

- Conceptual study to evaluate CO_2 capture from flue gas from multiple once-through steam generators (OTSGs).
- A FEL-1 level of design was developed for an amine-based capture system inclusive of flue gas draft system design, CO_2 compression and dehydration, and CO_2 pipeline as well as initial capital and operating cost estimates.

Carbon Capture Technology Landscape Study – Whitecap Resources

Saskatchewan, Canada

Carbon capture

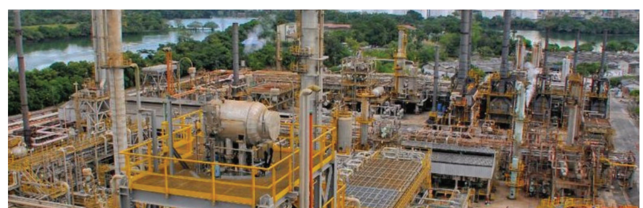
- Study to provide a high-level overview of the major carbon capture technologies inclusive of their respective technology statuses and readiness levels, suitability for industrial applications, and relative costs.
- Trade-off studies for other decarbonization pathways were also included, comparing coal and natural gas fired power production coupled with carbon capture against blue hydrogen, solar power production alternatives.

Gas Processing Facility Post-Combustion CO_2 Capture

Alberta, Canada

Carbon capture & transport

- Feasibility (Pre-FEED) study for the installation of carbon capture technology and compression at a 400 MMSCFD gas processing facility.
- Project objective is to capture a minimum of 90% of the CO_2 emissions from both the gas processing facility and the cogeneration units, a total of 16 emission sources, requiring a complex ductwork system.
- The captured CO_2 will then be transported via compression / dehydration equipment into a 30 km pipeline to an offsite reservoir.



Ecopetrol Barrancabermeja Refinery Blue Hydrogen & Carbon Capture

Colombia

Carbon capture

- Conceptual study, flow scheme development and technology licensor selection for production of blue hydrogen through gasification.
- Flow-scheme development, technology landscape study and selection for capture of CO_2 from multiple refinery emission sources, including the evaluation of pre-combustion and post-combustion capture.
- A FEL-1 level of design was produced as well as developing initial capital and operating cost estimates to support Ecopetrol in evaluating techno-economical drivers to move the concept to the next engineering phase.

Weyburn CO_2 Enhanced Oil Recovery Project

Saskatchewan, Canada

Transportation, utilization, and storage

- Conceptual design through execution phase for the facility.
- CO_2 receiving terminal, distribution pipelines, and satellite injection systems.
- CO_2 compressor design and installation.
- Surface facilities at the Central Process Unit included inlet separation, Free Water Knockouts, two 6000-HP CO_2 recycle compressors, CO_2 dehydration, and produced water injection.
- Subsequent expansion included the installation of a two-stage, 17,500-HP centrifugal electric drive CO_2 recycle gas compressor with a capacity of 100 million scf per day and the following: Two parallel triethylene glycol dehydration units; 2 two-phase separators, inter-stage, discharge and recycle aerial coolers; incineration of dehydrated regenerator off gas; utilities to support the new equipment included instrument air, nitrogen, mcc, transformer, emergency generators and fuel gas.
- Weyburn remains the world's largest anthropogenic CO_2 sequestration project.

Our experience working with the CCUS industry goes back 20 years, dating back to the initial phases of the Weyburn CO_2 Enhanced Oil Recovery Project and the Midale CO_2 EOR facility in Saskatchewan. Since its inception in 2000, more than 37 million tonnes of CO_2 have been stored 1.5 kilometers underground in Weyburn, and an additional 2 million tonnes are stored each year as part of the CO_2 enhanced oil recovery.

Key offerings

Climate change strategy and decarbonization roadmaps

Hatch is committed to partnering with you to develop your climate change strategy and decarbonization roadmap, and to design and build practical solutions that meet your sustainability objectives. You benefit from a multidisciplinary team of subject matter experts in low carbon and renewable energy, petrochemical and metallurgical processing, resilient infrastructure, climate change policy, and decarbonization technologies. Our approach creates an inventory of emissions sources and leverages the diversity of subject matter experts to populate a pipeline of carbon and energy reduction opportunities across the value chain. In partnership with our clients, and using a proven, structured framework, we validate and prioritize the opportunities to create customized decarbonization roadmaps that deliver maximum impact.

System design and plant integration

Integration is fundamental to our success. Together with our CCUS subject matter experts, we deploy process specialists to our client's operations, giving them firsthand knowledge of processes such as upstream facilities, refineries, gasifiers and smelting plants. This enables us to define the right system design and identify the specific requirements for the integration of CCUS into your operation.

Technology development and commercialization

With a portfolio of over 40 unique solutions in the Energy, Mining & Metals, and Infrastructure sectors, and over 30 active development projects, much of our experience has involved the development of new processes from the pilot plant stage to full design, procurement, construction, commissioning, and start-up. We've provided engineering services for over 80 pilot plants on behalf of our clients and have provided technology development, commercialization, and engineering support for first-of-a-kind technologies and processes, including in the fields of gasification, unconventional oil extraction, CO_2 sequestration, pyrometallurgy, and hydrometallurgy.

Flue gas handling system design

Flue gases can be difficult to handle as they tend to be hot and corrosive and contain heavy loadings of potentially sticky dusts and other condensables. Additionally, high SOx and NOx contents can limit the effectiveness of the solvents in the carbon capture system and may necessitate pretreatment of the gas stream. Each gas cleaning process and unit operation has unique characteristics that must be understood when selecting equipment. Our gas quality control team has extensive experience in challenging applications such as designing complex flue gas draft systems, having delivered projects for thermal power, metallurgical, industrial minerals, and other facilities.

Combustion engineering

We have successfully implemented multiple combustion optimization, fuel conversion, and oxy-fuel and alternative fuels firing projects. These have helped clients improve their economy of operation, reduce pollutants, minimize carbon footprint, improve safety, and ensure compliance. With decades of experience in solving real-world combustion challenges, clients benefit from our unique ability to apply advanced simulation and analysis techniques within the context of a team of process and operations experts.

Heat rejection and process integration design

Heat integration and rejection are critical components to properly integrating a carbon capture unit within a facility. Unoptimized designs can result in unnecessary capital and operational costs that can significantly hinder the economic performance of a project. Our energy optimization team uses the pinch analysis technique for conducting process integration studies. The pinch analysis technique provides tools that investigate energy flows within a process and identifies the most economical way of maximizing heat recovery and minimizing the demand for external utilities (e.g., steam and cooling water). This includes opportunities such as reducing operating costs, debottlenecking processes, improving efficiency, and reducing capital investment.

Utilities and offsites

Support facilities that make up utilities and offsites (U&O) typically account for 20 to 50 percent of the total installed cost of a project, with flue gas handling, compression/drying of the CO_2, and the water treatment and steam systems making up a large portion of this. Ensuring that the project U&Os are optimally designed is important to the overall project economics; however, there are significant risks to the operability of a carbon capture unit if they are not sized properly. Our subject matter experts are knowledgeable across multiple industries and applications and are well-practiced in the design and execution of U&O facilities from conceptual design through execution, including expansion and long-range planning. We've recently designed and delivered U&O for several CO_2 capture facilities, integrating seamlessly with the technology vendor carbon capture packages.

Brownfield integration and construction execution

Our clients are often faced with constraints to complete plant upgrades, expansions, and refurbishments on time and with minimal impact on operations. To manage these constraints, we utilize innovative technologies to ensure the new engineering designs interface correctly with the existing systems and infrastructure. Technologies such as laser scanning and spherical photo montages significantly improve the design efficiency, effectiveness, and accuracy. Applying these technologies and the knowledge of our highly experienced construction personnel allows us to not only integrate facilities into challenging brownfield environments, but to do so with the least amount of disruption to ongoing operations.

Modularization

Employing a modularization strategy can reduce overall capital cost by removing hours out of project sites, away from the effects of adverse weather and impaired productivity factors and into established module yards. This resulted in increased schedule and cost certainty. Our extensive experience in developing project execution strategies utilizing modularization includes employing innovative logistical solutions that enable module transport and installation. Our module and front-end implementation team specifically focuses on developing modularization strategies that bring cost, schedule, risk, safety, and quality benefits to the project.

Environmental assessment and permitting

Project delays due to environmental permitting issues can be very costly. Permitting complications can be caused by a number of issues, including poor planning and communication, the variety of regulatory authorities involved, diverse stakeholder sentiments, and the scope of permits overlapping project and business unit boundaries. Even small changes in the environmental impact profile at a site can have significant ramifications, not only for the project being developed, but also for the existing operations. We understand how projects are executed and how best to integrate environmental permitting processes into the project life cycle by working seamlessly with other disciplines to reduce the risk of schedule delays and to achieve positive outcomes. Our engineers, environmental specialists, and social management professionals work directly with client project teams to prepare and execute an optimum permitting strategy.

HATCH

About Hatch

Whatever our clients envision, our engineers can design and build. With over six decades of business and technical experience in the mining, energy, and infrastructure sectors, we know your business and understand that your challenges are changing rapidly.

We respond quickly with solutions that are smarter, more efficient, and innovative. We draw upon our 9,000 staff with experience in over 150 countries to challenge the status quo and create positive change for our clients, our employees, and the communities we serve.

hatch.com