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 towards 2050, the world will undergo a massive transformation as we 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 while penetration of renewables into the overall energy mix remains somewhat limited. To be successful, industries need to come together to drive efficiency, economic prosperity, diverse social fabric, and environmental sustainability.

Carbon capture, utilization, and storage (CCUS) is an important emissions-reduction process 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 the ongoing technological advancements and government policy developments, the large-scale deployment of CCUS is coming closer every day.

Let’s create a cleaner future, together!

“A growing number of countries and companies are targeting net zero carbon dioxide 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 ten-fold increase from the previous decade […]. ”

– **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—as well as industrial processes such as the production of cement and steel are large producers of carbon dioxide (CO_2) emissions. CCUS involves technologies for the capture of CO_2 from fuel combustion and/or industrial processes—separating the CO_2 from other gases before it is emitted into the atmosphere, thus reducing the overall carbon dioxide emissions of the plant. The CCUS process, however, doesn't just end once emissions have been captured, it also includes the transport of this CO_2 via pipeline or ship, and its use applied as either a resource to create valuable products—construction materials and fuels—or for permanent storage deep underground in geological formations.

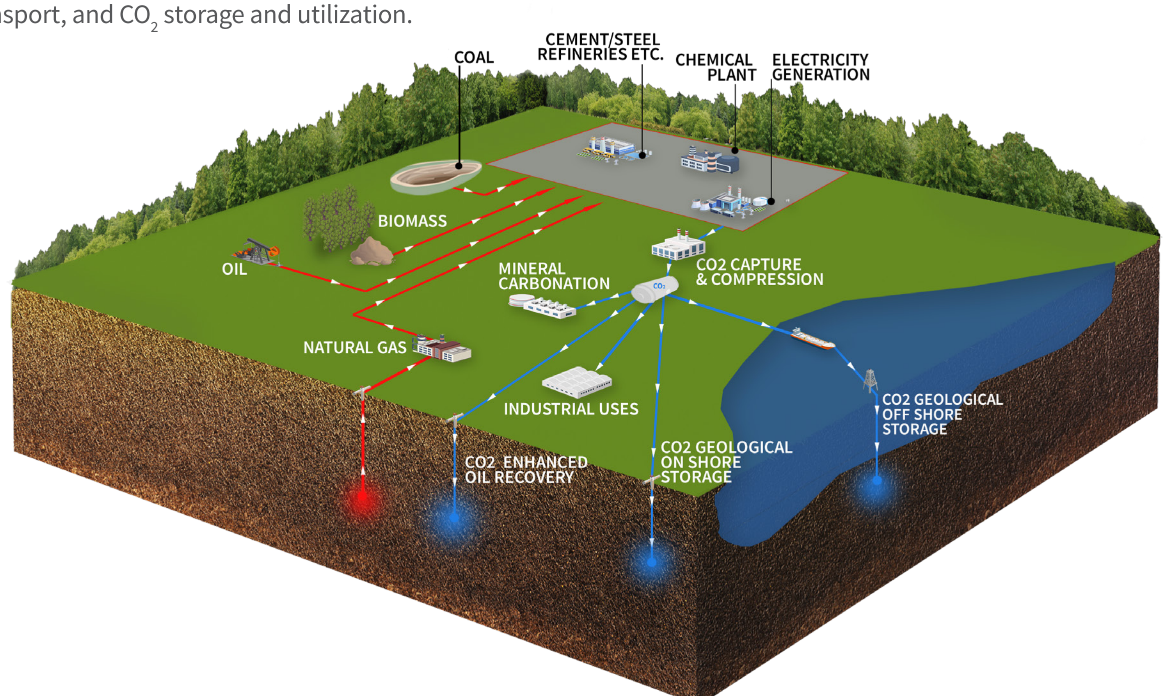
To meet emissions targets set out by the International Energy Agency (IEA) for 2050, a 50 percent reduction in global emissions from the levels in 2005 is required. As part of this effort, the deployment of CCUS technology, in conjunction with increases in energy efficiency and more environmentally sustainable sources of power, will be required. CCUS is identified as a key tool to achieving the emissions reduction. It is the only tool that has the capability to remove large volumes of CO_2 from the atmosphere.

In order to successfully implement CCUS, there are multiple areas requiring detailed attention, not only to ensure a successful project from a technical perspective, but also to provide its most economical implementation. These areas include CO_2 capture technology selection and design, CO_2 transport, and CO_2 storage and utilization.

Our approach

We partner with our 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 always ensuring that health and safety is top of mind.

We're recognized for our deep understanding of our clients' processes, and when it comes to adding CCUS to your plant, this is a key differentiator. The intricate details of our client's processes, possible pretreatment requirements, and the connection of CCUS are well within our wheelhouse of expertise and capabilities, allowing us to determine how best to reduce your emissions footprint and monetize the CO_2 once captured. We've gained this know-how in part from our deep roots in acid gas removal from natural gas production, our gasification and post-gasification capture experience, 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 & Metals, and Infrastructure sectors, providing a full range of technology-driven, value-added solutions and services through a network of more than 60 permanent offices and over 9,000 staff 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 cost-effectively and sustainably reaching 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 right 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 when it comes to the safe transportation of carbon dioxide. Pipelines call for a sophisticated design that enables an uninterrupted supply of fluids to be safely transported while keeping environmental protection at the forefront. The transportation of CO_2 requires extraordinary precautions, as CO_2 in the presence of liquid phase water forms carbonic acid, which can corrode the piping used to transport the CO_2, and thus causing significant safety issues. Prior to transport, the CO_2 must be dehydrated to minimize the risk of corrosion and 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 risks associated include unstable flow and slugging and thus increasing the load on piping; a potential for cryogenic temperatures during de-pressurization as the vapour 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 modelling, 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. This includes 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 future 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.

Re-purposing, utilizing, and storing CO_2: completing the carbon cycle

To prevent the captured CO_2 from being released into the atmosphere, it must be re-purposed for industrial use or stored in deep underground formations. One option is to inject it deep into the underground such as 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 represents 37 percent less CO_2 than a conventional crude barrel, and currently represents the largest industrial use of CO_2. EOR, however, does have its limitations, requiring feasible geology and substantial infrastructure investment to move the 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, as well as in the permanent sequestration utilizing deep geological formations. As we progress along the energy transition and the world continues to consume fossil fuels, EOR can help to reduce the overall GHG impact of these fossil fuels, while at the same time providing a long-term storage solution for the CO_2.

In addition to underground storage in saline aquifers and for use in EOR, there has been a groundswell of technology development aimed at the beneficial utilization of CO_2. Much like with EOR, utilization technologies that re-purpose CO_2 for its use in other applications helps to 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 fuels (e.g. gasoline, 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 utilize experience 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
- Emissions reduction strategy and planning
- Decarbonization roadmapping
- Technology vendor selection
- System design and plant integration
- Solvent selection
- Process engineering and simulation
- Flue gas handling and pretreatment
- Heat rejection and recovery
- Balance of plant engineering
- 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

Re-purposing, utilization, and sequestering

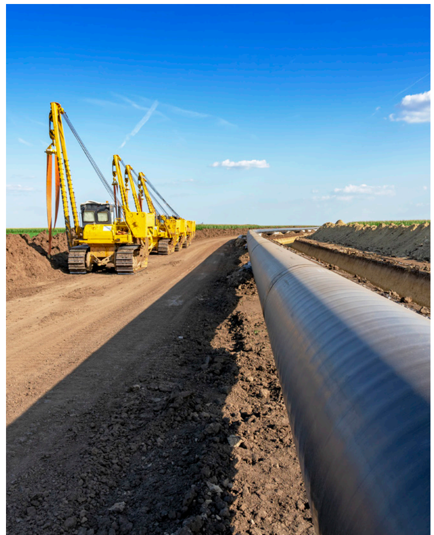
- Site selection
- Geological reviews
- Geotechnical modelling and testing
- Field development planning
- EOR modeling / screening
- Well design / completions
- Risk management
- Site monitoring during and after CO_2 injection
- CO_2 utilization option evaluation

Selected project experience

Air Liquide CO_2 recovery plant

Ontario, Canada
Carbon capture

- Designed two plants to recover CO_2 gas from existing ethanol production plants
- Plant capacity for both CO_2 plants was 300 t/d of liquified CO_2
- Process to recover, purify, and liquify CO_2 gas and store in liquid CO_2 storage tanks
- Truck and railcar loading stations allowed for distribution of liquid CO_2
- Design and field execution of balance of plant and integration of CCS vendor package into overall facilities



CO_2 EOR pipeline

British Columbia, Canada
Transportation

- Feasibility study for the capture and delivery of process CO_2 from the Horn River area to British Colombia and Alberta oil fields for EOR.
- Route selection and cost estimate for approximately 1,100 km NPS 20-inch diameter CO_2 pipeline with a maximum allowable wellhead pressure (MAWP) of 2,150 PSIG
- Preparation of capital and operating costs for the compressor/ dehydration stations, capital and operating costs of the pump stations.
- Optimization study to determine the CO_2 pipeline size, design, and operating pressure

Alberta Saline Aquifer project

Alberta, Canada
Re-purposing, utilizing, and storing

- First project of its kind in Canada to play major role in advancing industry and government knowledge of carbon-dioxide sequestration
- First step is demo project in Alberta (selected as one of three projects funded by Alberta CCS fund $2 billion)
- Capacity: 1,000-3,000 t/day CO_2
- Primary objective to establish large-scale, long-term commercial CO_2 storage operation
- Hatch is part of the project steering committee and nominated as surface facilities engineer to handle CO_2 received from third parties that needed to be pumped downhole into saline aquifer

Midale CO_2 EOR facility

Saskatchewan, Canada

Transportation, Re-purposing, utilizing, and storing

- EPCM services for >5 years
- Facilities included two 1,400-HP CO_2 recycle gas compressors
- 25-kilometer pipeline spur from Dakota Gasification Company's main pipeline to Midale facility
- CO_2 receiving terminal with 1,750 t/day capacity of sour dense phase CO_2 pumps
- Field facilities included all production/injection satellites and production/injection pipelines
- At the time of execution, Midale was Canada's second largest greenhouse gas sequestration project

Weyburn CO_2 Enhanced Oil Recovery project

Saskatchewan, Canada

Transportation, Re-purposing, utilizing, and storing

- Conceptual design through execution phase for facility
- CO_2 receiving terminal, distribution pipelines, and satellite injection systems
- CO_2 compressor design and installation
- At time of execution, it was the world's largest greenhouse gas sequestration project
- Involvement dates back to the initial phases of both the Weyburn and Midale CO_2 floods in Saskatchewan.
- Since its inception in 2000, more than 30 million tonnes of CO_2 have been stored 1.5 kilometers underground in Weyburn, and in the lifespan of the projects, it is anticipated that Weyburn-Midale will capture over 40 million tonnes of CO_2.

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 30 million tonnes of CO_2 have been stored 1.5 kilometres underground in Weyburn, and during the lifespan of the projects it is anticipated that Weyburn-Midale will capture over 40 million tonnes of CO_2.

Key offerings

Climate change strategy and decarbonization roadmaps

We're 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. Our multi-disciplinary team of subject matter experts combine capabilities in low carbon and renewable energy, petrochemical and metallurgical processing, resilient infrastructure, climate change policy, and decarbonization technologies to help you achieve your sustainability goals. 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. Using a proven, structured framework, we validate and prioritize the opportunities to create your customized decarbonization roadmaps that delivers maximum impact.

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 pre-treatment 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 flue gas draft systems, having delivered projects for thermal power, metallurgical, industrial minerals, and other facilities.

System design and plant integration

Integration is fundamental to our success. Together with our CCUS specialists, we deploy process specialists to our client's operations, giving them first-hand knowledge of processes (like smelting plants or gasifiers). This enables us to define the right system design and identify the specific requirements for the integration of CCUS into your operation.

Combustion engineering

Hatch has successfully implemented multiple combustion optimization, fuel conversion, and oxy-fuel and alternative fuels firing projects. These assisted our clients to improve the 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 investigates 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 20-50 percent of the total installed cost of a project. 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 and away from the effects of adverse weather and impaired productivity factors, and into established module yards, resulting in increased schedule and cost certainty. Our extensive experience in developing project execution strategies utilizing modularization includes the development of innovative logistical solutions that enable module transport and installation. Our module and front-end implementation team specifically focuses on developing modularization strategies for projects 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 lifecycle 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.

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