



Carbon Capture, Utilisation and Storage (CCUS)

↳ Services and capabilities



→ The Power of Commitment

CCUS technology is imperative to the clean- energy transition, and GHD is at the forefront of CCUS delivery



With our CCUS capabilities spanning the entire value chain, from air to reservoir pore space, GHD is positioned to propel clients towards their ambitious future energy goals.

From carbon capture at the source, purification, compression and pipeline transport, right through to injection, we draw from our diverse technical and project expertise. And our experience across related future energy fields means that we can help integrate carbon capture with projects involving the beneficial utilisation of carbon, blue hydrogen and blue ammonia.

From feasibility through to execution and operations

As a connected team of advisors and engineers who work across the value chain, GHD is uniquely placed to expertly leverage future energy opportunities.

Our unique business model delivers strength for our clients, with deep expertise in subsurface engineering combined with our surface engineering team to deliver all elements of the CCUS cycle, from air to pore space, through to ongoing operational support and management.

Our team's demonstrated experience in CCUS technology and capability encompasses:

- Capture from a wide range of sources
- Processing, compression and pipeline transmission
- Storage, as required
- Subsurface injection
- Operations and monitoring

Committed to the energy transition

We're at the forefront of science and technology, supporting clients to achieve their carbon capture targets, while also helping to develop possible solutions for the use of CO₂ as a useful product and feedstock.

We are committed to understanding and delivering the very latest future energy solutions. Our CO₂ capture specialists are experienced in the extraction of CO₂ from a variety of industrial and power generation flue gas sources, as well as 'pre-combustion' concepts involving gasification, reforming, and the use of physical solvents.

Our pipeline design team has an exceptional understanding of the international design codes and standards, as well as ahead-of-the-curve design practices from emerging research. We are experienced in developing CO₂ pipeline networks, including the need to resolve gas composition questions, as well as designing CO₂ compression and mid-line booster pumping. Some projects have required interim refrigerated liquid storage and liquid transport of CO₂, which is relevant to the emerging trade in international CO₂, for example from carbon-constrained north Asia to available CO₂ reservoirs in Australia.

Our team offers full lifecycle services for CO₂ injection; including simulation and well engineering; assessment and testing; permitting and installation; and monitoring, measurement and verification.

Our end-to-end expertise means we can help clients confidently forge ahead with tailored, sustainable and commercially viable solutions. From geological modelling, to compositional reservoir simulation, as well as well engineering and petrophysics and geomechanics analysis, our subsurface division is the backbone of our CCUS capability, and our team's expertise in this field ensures all client solutions are grounded in genuine operational experience.

As we collectively succeed in minimising greenhouse gas emissions, GHD's role as an industry leader will start to include direct CO₂ capture projects, to start winding back historic damage and driving us towards a sustainable future.





The GHD difference

From exploration to demolition

The GHD difference is the value we deliver at every stage of the project lifecycle. Where a client is looking to innovate, we can confidently draw on our breadth of experience; our intimate knowledge across the CCUS spectrum means we can provide proactive counsel to help our clients realise their future energy solutions.

Our extensive future energy capabilities ignite big picture thinking, with our strategically integrated service model designed to bridge the divide from energy goals to genuine action and on-the-ground delivery. Our depth of knowledge gives us the ability to identify the distinct needs of each project as well as identifying future market opportunities, fast-tracking better outcomes for our clients and communities.

Supporting clients to succeed

We can help clients navigate the complexities of the industry, including regulatory bodies and emerging emissions targets, and CCUS legislation.

We have access to leading subsurface databases and the latest modelling software for evaluating, characterising and assessing sequestration geology globally, as well as hands-on experience designing and constructing specific permanent storage solutions and operational facilities.

While we simultaneously work to fast-track ultra low-carbon technologies such as green hydrogen, we recognise that the climate imperative, project economics and required scale will mean that 'blue' technologies involving CCUS will be essential in the race to net zero and beyond.



A strong future for CCUS



CCUS will be essential to the decarbonisation of hard-to-abate industries, such as steel and cement production, and GHD foresees the role of CCUS extending for decades in these sectors, long after power generation and energy industries are reformed by truly green technologies.

Collaborating for advantage

At GHD, we collaborate with industry leaders and our global team of experts to achieve the best outcomes from CCUS applications. From tapping into vast worldwide databases through to niche capability areas, our team is equipped to optimise CCUS solutions for our clients to achieve and surpass their net zero goals.

Case study of a key technology area

Fracture control is a vital area of CO₂ pipeline design. Until as recently as 2019, modified Battelle Two Curve methods were used to determine required steel toughness. Very recent research based on empirical testing suggests that such methods can be unconservative. GHD has been on the leading edge of very new design methods, consulting with the University of Wollongong to control the risk of fracture in both new pipelines and conversions of service to existing assets.

Our integrated services across the value chain

A competitive advantage

The GHD integrated services model provides a competitive advantage for our clients, supporting them through their future energy transformations. Our in-house technical authorities across the supply chain can add value from opportunity identification, site studies, community engagement and due diligence, to digital modelling, technology assessments, detailed design and commercial deployment.

Our hands-on experience across the CCUS lifecycle demonstrates our deep capabilities; including acquisition, CO₂ sequestration, transport, pore space storage, maximising utilisation and operational management.

Our key service offerings include:

- Environmental engineering
- UIC permitting
- Process engineering
- Capture technology
- CO₂ compression and pumping
- Facility engineering
- Pipeline engineering
- Flow assurance
- Subsurface engineering
- Reservoir engineer
- Geosciences - petrophysics
- Well engineering
- Well integrity
- Production technology
- Research engineering
- Technology management

1. ORIGINATION

- Co-create winning business strategy
- Identify opportunities for capital deployment (public and private capital)

2. COMMERCIAL DEVELOPMENT

- Business case development
- Service delivery options and financing strategy / commercial models for bankability
- Customer strategy and offtake support
- Commercial and technical feasibility
- Due diligence to inform buy side and sell side decisions



3. PLAN & DESIGN

- Technology assessment and selection
- Environmental planning and approvals
- Risk minimisation
- Environmental compliance support
- Environmental monitoring
- Site selection
- Social licence support: community and stakeholder engagement
- Concept design
- Pre-feasibility studies
- Front end engineering and design
- Multi-discipline engineering management
- Detailed design
- Systems integration
- Procurement support and tender development



4. CONSTRUCT & OPERATE

- Systems integration, risk and regulation
- Owners representative/ owners engineer role / project management
- Adoption of new technology risk
- Construction management and EPCM
- Supply chain resilience

5. DISPOSE / RENEW

- End of life services
- Asset closure strategies
- Alternative revenue streams
- Renewal / disposal strategies

OVERARCHING SERVICES

- Greenhouse gas assessments / carbon accounting
- Greenhouse gas assurance services
- Life cycle analysis
- Policy development and advice
- Environmental social and governance (ESG) frameworks

Drawing on the best of multi-sector innovation, consulting, data driven insights and technology to build value

Delivery under alternative risk/reward commercial models

Our work



Alberta Carbon Grid

This project is playing a critical role in meeting Canada's client objectives, and provides high-value jobs to support economic growth in the region. GHD provides all aspects of subsurface engineering and CO₂ sequestration facilities design to the Alberta CarbonGrid (ACG), a partnership of Pembina and TC Energy.

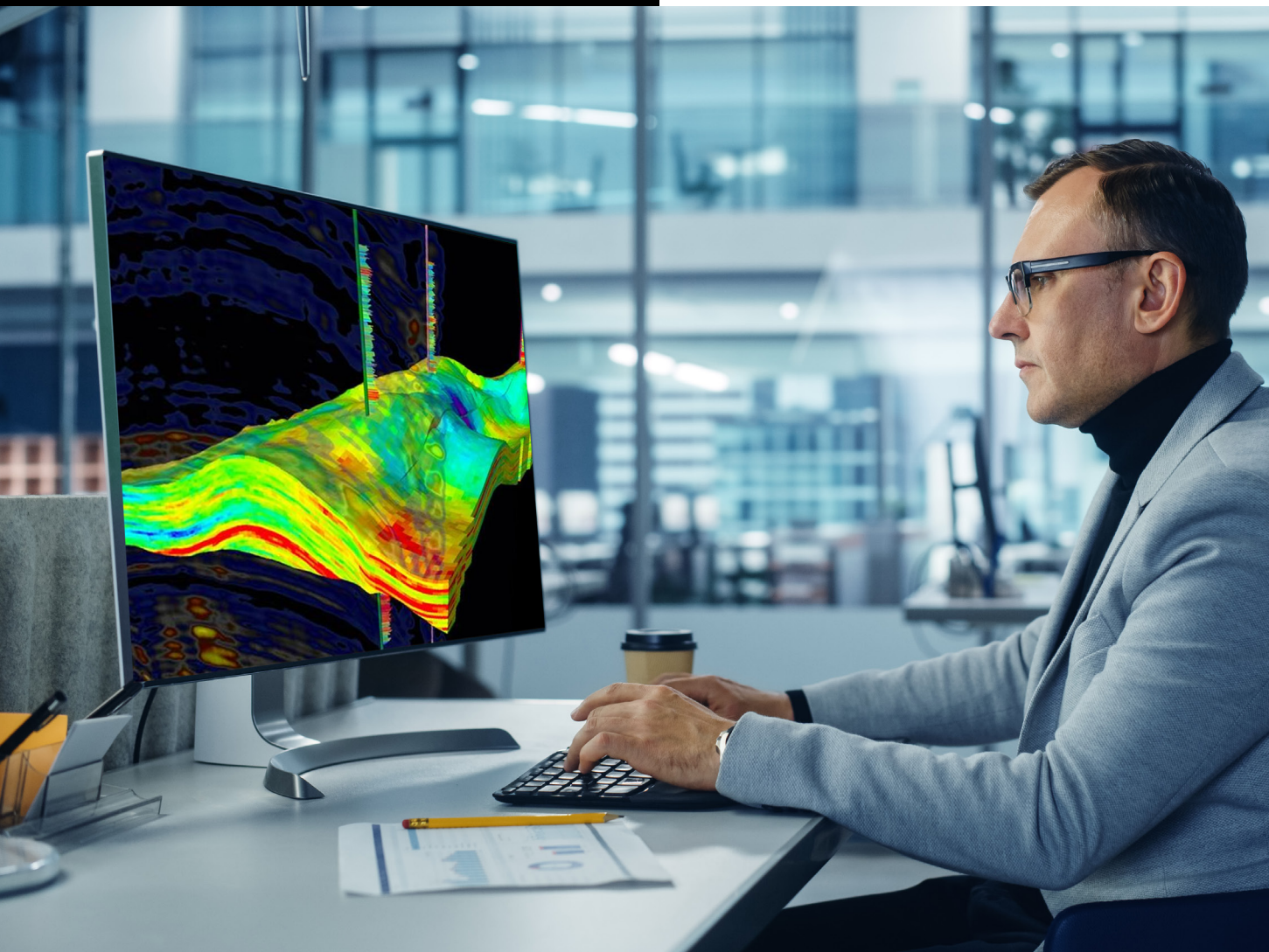
The ACG is a world-scale carbon transportation and sequestration system which, when fully constructed, will be capable of transporting more than 20 million tonnes of CO₂ annually – almost 10% of Alberta's industrial emissions. Designed to be an open-access system, the ACG will serve as the backbone of Alberta's emerging CCUS industry, connecting the Fort McMurray region, the Alberta Industrial Heartland, and the Drayton Valley region to key sequestration locations and delivery points across the province, and serving multiple industries.

GHD is providing subsurface assessment, siting for sequestration, geological modelling, compositional reservoir simulation, as well as well engineering and petrophysics and geomechanics analysis, to prove CO₂ sequestration capacity and injectivity and design of surface facilities for CO₂ injection, and Monitoring, Measurement, and Verification (MMV) systems.

Loy Yang B Power Station Decarbonisation Project

As one of the carbon footprint reduction options, carbon capture from flue gas was evaluated for the Loy Yang B Power Station, a coal-fired power station striving to achieve zero carbon emissions within the foreseeable future. A CCUS pathway was evaluated for the brownfields site, including:

- Technology maturity for carbon capture potential units (post combustion capture)
- Economic implications (capital and operating cost)
- Percentage of carbon emitted that is captured from the plant
- Technology submissions from various vendors were assessed.



Carbon Capture Concept Study

BIOFUELS FACILITY (CONFIDENTIAL CLIENT)

As part of a biofuels concept study (gasification and Fischer-Tropsch facility), the potential capture of carbon from the produced synthesis gas was investigated. The technology groups that were investigated included absorption, adsorption and cryogenic and membrane separation technologies. For each of these, the capex and opex, volume of CO₂ and conditions (that is CO₂ purity, pressure and temperature) was assessed for each technology group, as well as specific units within each of the technology groups. In addition, geological, chemical and mineral carbon sequestration was briefly investigated to determine the advantages and disadvantages of each.



Carbon Transport and Storage Company (CTSCo) Project

GHD has had a long-term association with a geosequestration demonstration project being developed by CTSCo. The project plans to deliver liquid CO₂ captured from a post-combustion system at the Millmerran Power Station to a tank storage facility at EPQ 10 near Wandoan in Queensland, Australia. CO₂ will be injected over a period of nominally three years into the Precipice sandstone formation, to verify the feasibility and security of the reservoir and subsequently enable commercial-scale injection. GHD initially provided pipeline flow simulation and risk assessment services, which progressed to a full

FEED design of the storage facility in 2019. Since then, GHD studied the possible use of spoolable composite pipelines as an alternative to liquefied road tanker transport and in

2020, GHD was engaged to perform the Environmental and Social Impact Assessment Study for the project.

Blue Ammonia Project

CONFIDENTIAL CLIENT

GHD was engaged in 2021 by a Tier 1 coal producer to perform pre-feasibility study work for a project to develop a black coal resource in Queensland into a blue ammonia product for export to international energy markets. The project is expected to generate ~10 million tonnes per annum of carbon dioxide as a Scope 1 emission, and this is to be captured, compressed and purified before being transported via pipeline (~300km) to a suitable georeservoir comprising saline aquifers. GHD scoped and costed all aspects of the project from capture to reservoir pore space, including OPEX and risk assessments.

Cooper Basin CCS

SANTOS

GHD and PACE worked together on the Santos Cooper Basin CCS project, with the aim to sequester approximately 1.7 Mtpa CO₂ currently vented from the Moomba Gas Plant and inject it into low pressure gas reservoirs for permanent storage. The Moomba Gas Plant processes gas from the Cooper Basin, including CO₂ separation, and exports sales gas to the east coast of Australia.

GHD led this comprehensive FEED, which included:

- Hydraulic modelling, phase change avoidance and accounting for density variation with temperature.
- Depressurisation modelling to determine minimum design temperature
- Atmospheric dispersion modelling
- Detailed materials selection, to withstand NACE Region 3 sour service and carbonic acid attack.
- Detailed assistance to the client in finalising a moisture specification for the supercritical CO₂, in order to control corrosion and hydrates. The outcome was more stringent than most European and US specifications that we benchmarked against.
- Detailed fracture control design, accounting for the properties of supercritical CO₂. PACE provided numerical modelling and simulation of CO₂ flow assurance from capture through to injectivity in the reservoir and wellbore including CO₂ phase management plan across all operating modes, including in the wellbore and near-completion reservoir, over the project lifecycle.

PACE also provided support to pipeline mechanical design (fracture ductile) via depressurisation simulations of CO₂ with a range of impurities and reviewed the impact of impurities into the operability of the transportation system.

Pre-FEED Study for a blue hydrogen pipeline

SANTOS

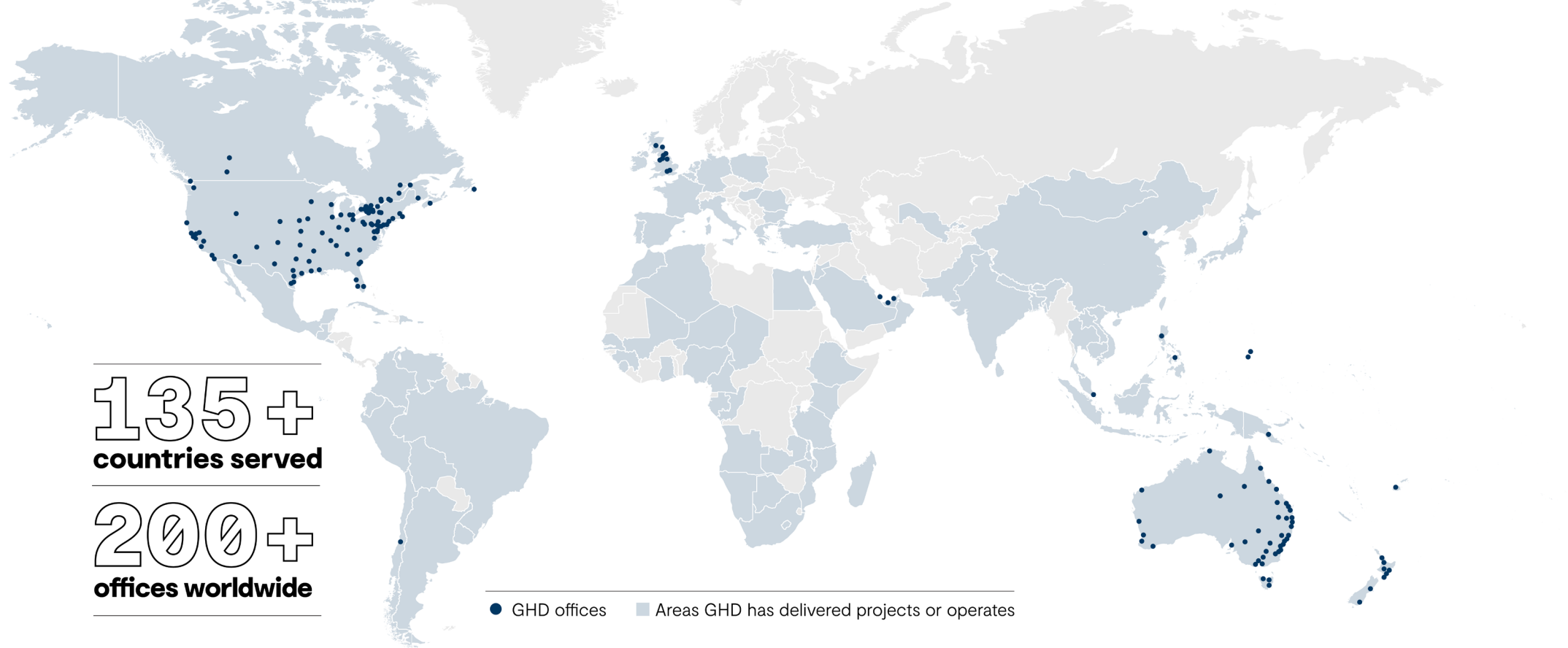
GHD worked with Santos to deliver two blue hydrogen-related studies that have potential to pave the way to large scale export of hydrogen while also decarbonising its operations in the Cooper Basin, South Australia.

This concept study was focused on the production of hydrogen from natural gas and includes preliminary

technology selection with a focus on identifying suitable options that facilitate maximum CO₂ capture on a lifecycle basis and thereby produce hydrogen with the lowest carbon footprint. To reach international markets, a 650km hydrogen pipeline was identified to handle the flow of 800 tonnes per day.

Integration into the current Cooper Basin operation, pathway to regulatory approvals and a cost estimate were also included in the scope.





About GHD

GHD recognises and understands the world is constantly changing. We are committed to solving the world's biggest challenges in the areas of water, energy and urbanisation.

We are a global professional services company that leads through engineering, construction and architectural expertise. Our forward-looking, innovative approaches connect and sustain communities around the world. Delivering extraordinary social and economic outcomes, we are focused on building lasting relationships with our partners and clients.

Established in 1928, we remain wholly owned by our people. We are 10,000+ diverse and skilled individuals connected by over 200 offices, across five continents – Asia, Australia, Europe, North and South America, and the Pacific region.

Find out more about us at ghd.com

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