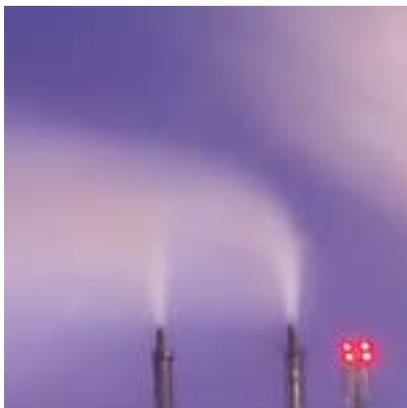


RPS

Carbon Capture and Storage



Working with RPS
to deliver a lower
carbon economy



RPS Group with its energy and environmental experience is unique in being able to provide its clients with broad support in developing their CCS projects.

- Integrated Carbon Management Services
- Technical and commercial counsel from source to sink
- Guidance in legislative and market developments
- Planning and consenting advice
- Environmental and monitoring assistance



CO₂ levels in the atmosphere need to be stabilised at 550ppmv in order to limit global temperature rises to 2°C, requiring a reduction in global emissions by 2100 of up to 70% compared to current levels. However, energy related annual CO₂ emissions are expected to rise from 27 GtCO₂ in 2005 to 42 GtCO₂ by 2030 alone.

On a global scale it is estimated that there is capacity to store up to 900 GtCO₂ in depleted oil and gas reservoirs and 10,000 GtCO₂ in saline aquifers, offering significant mitigation potential to climate change.

Source: IPCC, Special Report on CCS

Carbon Capture and Storage

Carbon dioxide (CO₂) is widely accepted to be a major contributor to global climate change. Our increasing demand for energy, combined with current dependency on fossil fuels, means that greenhouse gas emissions are likely to increase by as much as 55% by 2030 unless new climate change mitigation policies are introduced¹.

To move to a lower carbon economy, we need to implement technologies which offer significant mitigation potential as part of a broader, integrated carbon management strategy.

Carbon Capture and Storage (CCS) is the separation and capture of CO₂ from static atmospheric emitters prior to transportation to a storage location for long-term isolation from the atmosphere. Although various methods of storage have been proposed, the best understood is geological storage, where CO₂ is permanently stored deep underground.

Whilst there are currently few industrial scale examples of CCS, most of the technologies involved are well understood. The challenge is to harness these, together with the available regulatory and financial incentives, into viable projects.



¹IEA World Energy Outlook 2007

How can we help?

RPS offers a comprehensive suite of services across the integrated project lifecycle

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Technical



Planning



Regulatory



Markets

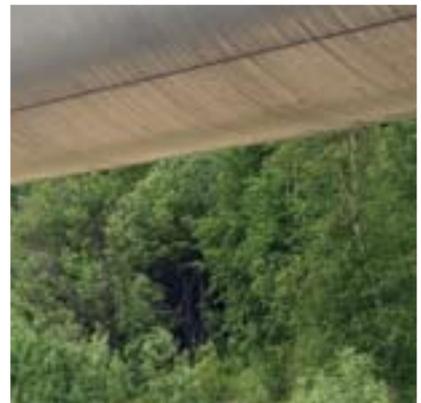
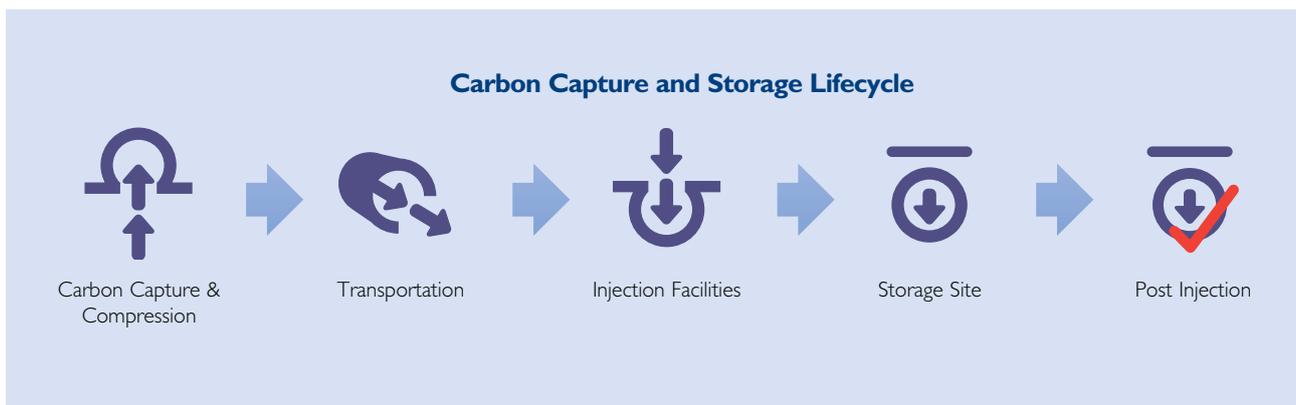


Carbon Capture and Storage Lifecycle

Carbon Capture and Storage projects require the integration of a number of highly technical skills within an evolving regulatory and commercial environment.

RPS has a unique mix of planning, environmental, engineering, regulatory and sub-surface specialisms, that combine to assist clients in the effective design and implementation of CCS projects.

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RPS Credentials

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RPS has in-depth experience in applying planning and environmental assessment to large infrastructure projects across a wide range of industry sectors. In the energy industry, this expertise has been applied in related areas such as gas storage, onshore and offshore windfarms and LNG projects.

In all cases, high levels of exposure to planning systems, consultation, public inquiry and regulatory compliance are handled by a multi-disciplinary project team. This ensures all aspects are covered, the best possible information gathered and sound analysis made.



Recent project examples

- Advisory and project management to significant on and offshore wind farm developments; Mesa Power Pampa project, London Array
- Planning and environmental services for LNG importation and storage; Isle of Grain (NGT), South Hook (Exxon Mobil/ Qatar Petroleum)
- Planning, EIA and negotiation of regulatory approvals for the Gorgon project (Chevron)



Permissions, Licences & Consents

Like all major infrastructure projects, CCS developments require a range of consents and licences. These will only be issued once a coherent assessment of the environmental effects of the project has been undertaken.

Active consultation with all stakeholders, together with careful public education, will be required as part of the public enquiry process needed in many jurisdictions.

The need to secure the necessary permissions will apply across all stages and throughout the lifetime of the project, including:

- Construction of capture and compression facilities;
- Routing of pipelines to transport liquefied CO₂;
- Construction / adaptation of injection facilities;
- Licensing of CO₂ storage sites, onshore facilities and offshore activities;
- Establishment of responsibility for decommissioning and long-term liabilities associated with storage facilities.



RPS Credentials

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The transport of CO₂ is a sensitive issue and for this reason RPS integrates state of the art technology and specialised engineering with risk assessment capability. We can draw on proven international experience to provide a robust evaluation that leads to a practical solution.

Experienced engineers provide field-based assessments of pipeline routes, interfacing with key engineering contractors. Geological Information Systems allow visual recognition of complex spatial situations for route selection.

Communication with all interested parties is enabled via web-based systems, so generating a rigorous assessment of potential Health, Safety, Environmental and Social impacts. This helps differentiate between perceived and actual risk related to transportation of CO₂.



Recent project examples

- EIA for field development and export onshore Algeria (First Calgary Petroleum)
- Environmental management for the World Bank/ UNDP funded BTC and SCP pipelines (Government of Georgia)
- Planning, environmental, engineering and stakeholder management for Corrib Pipeline (Shell-Statoil-Marathon)



Transportation

CO₂ source and storage locations will rarely be in close proximity, leading to the need for a safe means of transporting captured CO₂. This will involve planning, specialised engineering and risk management, in addition to the broader environmental and planning issues mentioned earlier.

As was the case with the development of natural gas distribution systems, new CO₂ pipeline networks will evolve as the number of CCS projects increases.

Detailed evaluation of potential pipeline routes takes many factors into consideration:

- Topography and existing infrastructure along proposed routes
- Geotechnical surveys
- Seismic activity
- Environmental assessments
- Stakeholder consultation

CO₂ is already transported via high pressure pipelines, however, as the scale of infrastructure increases more populated areas may be impacted. In order to secure necessary rights of way, comprehensive HSE and risk mitigation policies will be obligatory.

As an alternative to pipelines, shipping of liquefied CO₂ via tanker may be an option, comparable to current LNG and LPG transportation. This will require its own risk mitigation policies.



RPS Credentials

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RPS offers an exceptional range of international subsurface experience, from reservoir screening to field development. We have conducted numerous projects for CCS purposes at asset and regional scales, for both pure and EOR sequestration.

RPS geoscientists work closely with our petroleum engineering team to develop comprehensive models of potential storage sites.

To better simulate the distinct characteristics of injecting supercritical CO₂ and assist accurate forecasts of diffusion through a storage site, RPS has developed proprietary software to complement industry standard tools.

Consideration of both the technical and economic feasibility of CCS is central to our studies, with a focus on optimising both CO₂ injection for Enhanced Oil or Gas Recovery and long-term CO₂ storage.



Recent project examples

- Screening of Western Canada Sedimentary Basin and UKCS for CO₂-EOR potential (Alberta Geological Society and BERR)
- Geological interpretation and reservoir modelling for Otway Basin pilot project, Australia (CO2CRC)
- Petroleum Engineering advisor to the EERC as part of the Plains CO2 Reduction Partnership



Storage Evaluation

Depending on scale and location, various geological sites are suitable for long term storage of CO₂, including:

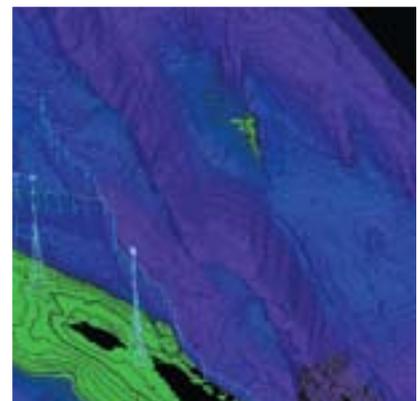
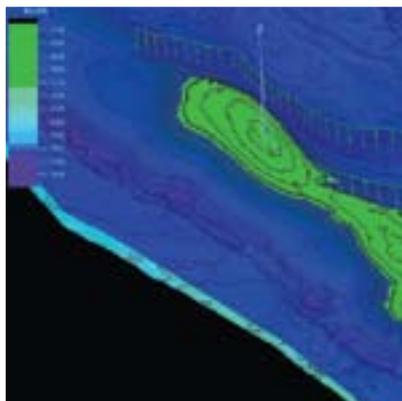
- Depleted oil/ gas fields
- Saline aquifers
- Deep coal seams
- Salt caverns

Locating and assessing appropriate sites is a critical step in planning any CCS project and involves multiple technical disciplines.

- Subsurface imaging to map and model structural traps and tectonic influences
- Computer simulation of reservoir dynamics to predict diffusion of the CO₂ during and post-injection.
- Identification of potential thermal fracture or solid hydrate precipitation
- Geomechanical appraisal of cap-rock integrity
- Geochemical analysis of CO₂ interaction with formation water and/or mineralogy

Long term security of storage can only be assured through in-depth knowledge of all aspects of the site, including its history. Enhanced Oil Recovery (EOR) projects may also be suitable for long term storage of CO₂, albeit that the additional value associated with such projects may be impacted by more complex regulatory and monitoring requirements.

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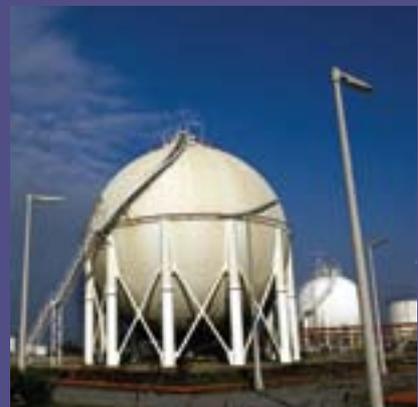
RPS Credentials

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RPS provides integrated engineering design across multiple industry sectors, with significant experience of gas storage, gas transportation and associated infrastructure.

We play an invaluable role at the interface between structural engineering, civil engineering, building services and geotechnics. Our range of services encompasses design, procurement, validation and commissioning in complex and highly regulated environments.

RPS has years of experience in the provision of well planning, well engineering and design, construction, execution, management and post well project close-out. This experience has been gained on more than 7000 wells world-wide.



Recent project examples

- Delivery of the gas pipeline network to West Ireland (Awarded Best Civil Engineering Project in Ireland 2003)
- US CO₂-EOR well engineering review (Mobil-MEPTec)
- Environmental and engineering management for Isle of Portland and Lame Loch gas storage facilities (Portland Gas)

Injection and Facilities Engineering

Injection of CO₂ into deep geological formations utilises technologies that have been developed by the oil and gas industry over many years.

Well drilling and completions technologies have been developed for optimal performance under extreme operating conditions such as high pressure, temperature and difficult chemical environments.

Gas storage and transportation infrastructure projects also provide valuable experience when considering facilities designed and engineered to accommodate CCS.

As producing fields approach the end of economic life, it is feasible that existing infrastructure could be converted for CCS purposes. However, to make the most of this potential there needs to be an integrated approach from power generation, infrastructure and asset owners.



RPS Credentials

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RPS has established an excellent reputation for HSE and risk management services to the oil and gas, chemical, power, FMCG, manufacturing, nuclear and defence sectors.

We combine sector specific regulatory and operational knowledge with experience of sector-specific best practice.

RPS supports all phases of an installation from conceptual design through to decommissioning, providing all services to deliver an installation's Safety Case and ongoing safe operation.

Ongoing MMV draws on a number of RPS disciplines such as stack monitoring, geohazards, meteorological, oceanographic and environmental sampling consultancy services.



Recent project examples

- MMV design and implementation guidance to EERC regarding Zama Acid Gas EOR project, Canada (Apache)
- Primary air quality consultants to Port Arthur Refinery expansion, Texas (Motiva Enterprises)
- Qualified under MCERTS scheme for regulatory monitoring of air, water quality, flow measurement and chemical testing

Monitoring and Verification

A comprehensive strategy for Monitoring, Mitigation and Verification (MM&V) is required at all phases of a CCS project to ensure the safe transportation, injection and long-term storage of CO₂.

- Prior to injection, baseline models of the site are created for future reference against chemical or structural changes
- During operation, all stages from transportation through to storage are assessed for signs of deterioration and/or leakage, whilst actual volumes of CO₂ injected are recorded
- Post-injection, the storage site is monitored over an extended period of time to verify that the CO₂ remains securely stored

MM&V capability will give surety to regulators and local government who must approve large CCS projects by providing confidence in the volumes of CO₂ stored, to ensure safety, environmental and commercial viability.



Facilitating market and regulatory relations

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Evolving Frameworks and Markets

Policy makers need to work in conjunction with the private sector and financial markets to remove barriers to CCS.

A number of regulatory and legal issues currently impede CCS development, including:

- Access rights to geological sites,
- Surface and sub-surface property rights,
- Multiple party injection issues,
- Hydrocarbon and mineral rights,
- Transboundary movement of CO₂,
- Project finance and risk,
- Legacy liability issues,
- Compliance with national & international agreements.

The increased profile of this technology has resulted in an extraordinary amount of legal development at regional, national and international levels.

Carbon markets have a predominant European focus through the EU-ETS, the first mandatory CO₂ cap-and-trade system, which has been in operation since 2005.

Recent European commission proposals include measures to support CCS under the EU-ETS, which when implemented will significantly increase CCS positioning within the financial markets.

Both the USA and Australia are examining the introduction of similar market schemes, which would significantly increase the liquidity for carbon trading.

We recognise the importance of a legal framework for CCS and have established a close relationship with UCL Law Department who are acknowledged as experts in this developing field.



A partner to deliver results

RPS is uniquely positioned to facilitate Carbon Capture and Storage. We have a proven international track record in delivering integrated infrastructure projects. We routinely provide support to our clients, through strategic guidance, feasibility planning and specialised technical, commercial and operational advisory services.

Our experience in managing major, complex, multi-disciplinary projects ensures that our project teams have the correct expertise for each stage of the Carbon Capture and Storage lifecycle.

We can call on years of general and specific experience to help our clients in the visualisation, conceptualisation and implementation of CCS and CO₂-EOR projects.

By providing most of the required skills under one roof we can save our clients time and money as they tackle this important and emerging issue.

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