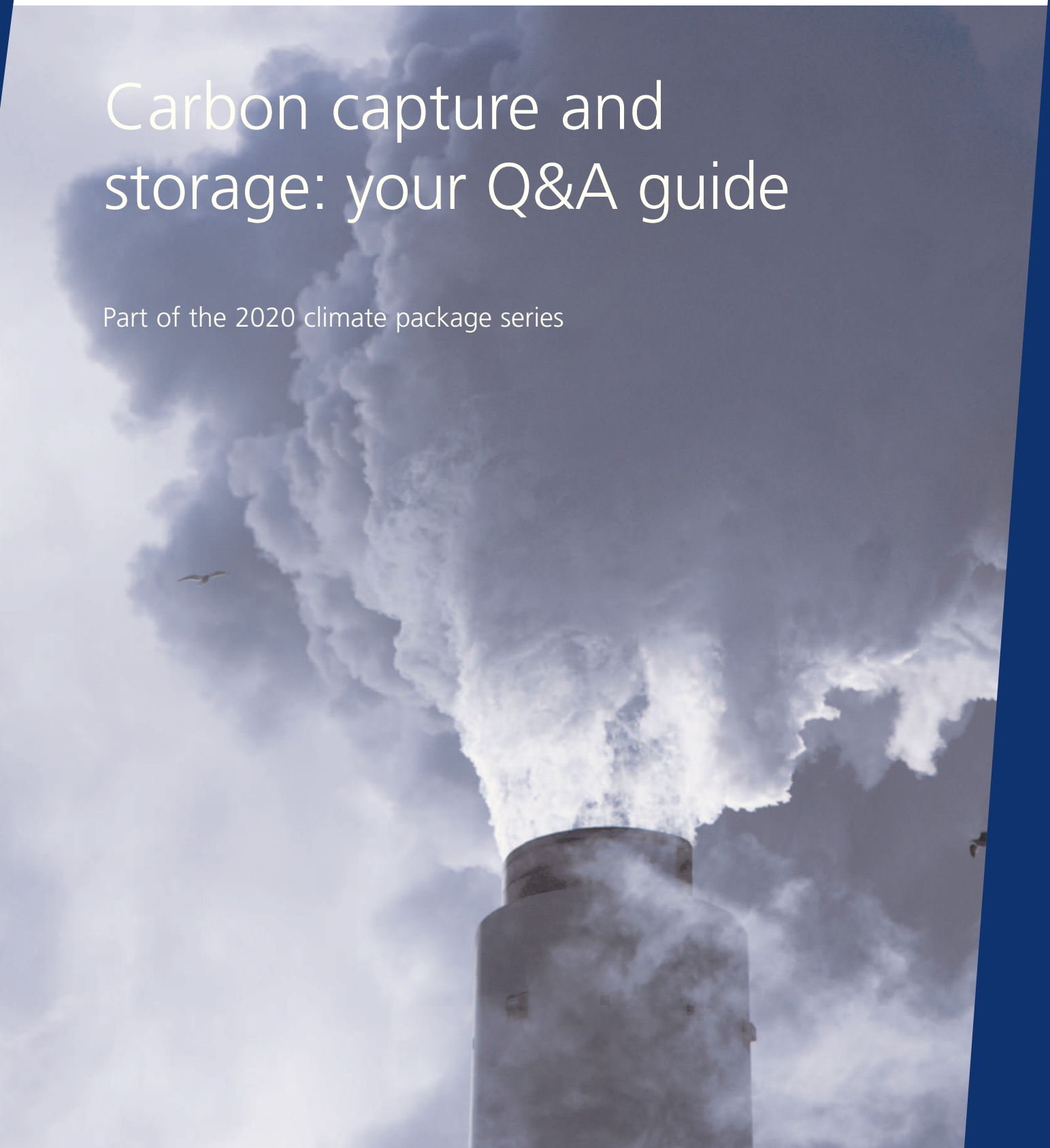
C/M/S/ Cameron McKenna

Carbon capture and storage: your Q&A guide

Part of the 2020 climate package series



"This is by far the best firm in the energy sector. It combines strength in regulatory and projects work, which makes it the leading player according to commentators".

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Introduction

When the Stern Review, back in 2006, estimated that carbon capture and storage (CCS) has the potential to contribute up to 28% of global carbon dioxide mitigation by 2050, the concept was still seen as something of a pipedream. Over the past three years, CCS has evolved rapidly; from being considered a marginal and unproven process there is now widespread acknowledgement that it will need to be an essential part of our decarbonised energy future.

The viability of CCS projects rests among other things on proving the technology on a commercial scale, on identifying suitable storage sites and transportation routes, on providing a facilitative legal and regulatory framework and on establishing a robust long-term revenue stream.

A variety of players have come together with the determination to demonstrate CCS and be in the first wave of CCS pioneers, from oil and gas exploration and production companies, utilities and other industrial players, service companies, EPC and O&M contractors, technology providers, network operators and shipping companies amongst others. For all of these players, the challenges and rewards from CCS are immense.

A spur to action has been the clarity of the signals (although, perhaps not yet the incentives) coming from policy makers. The EU has set itself a number of ambitious targets for the reduction of greenhouse gas emissions and the increased use of renewable sources in electricity production. CCS has been identified as a technology with the potential to contribute to both the EU's climate goals and its security of supply.

As part of its "2020 climate change package", the EU has adopted a Directive on the geological storage of carbon dioxide. Effective from 25 June 2009, the Directive aims to assist the deployment of CCS technology and to introduce a legal framework within which the environmental risks of CO2 storage can be regulated. Member States wishing to promote CCS projects will need to work within the framework of the Directive, but have considerable additional latitude on how to facilitate projects in their jurisdiction.

In the UK, CCS forms an important part of the Government's strategy for the development of a low carbon economy. The CCS demonstration competitions and recent legislative developments have stimulated the creation of a regulatory framework. The Energy Act 2008, for instance, introduces a licensing regime for CO2 storage and applies existing legislation to the rules governing decommissioning of offshore structures used for CO2 storage.

This briefing paper, which is part of CMS Cameron McKenna's 2020 Climate Package Series, provides an overview of the developing regulatory framework for CCS. It focuses on how the regulatory framework has evolved in the UK and the anticipated future developments as the Directive, as well as national policy and legislation are implemented.

The framework is examined according to the three principal components of CCS: capture, transportation and storage.

We hope you will find this a helpful guide to the rapidly changing regulatory landscape for CCS in the EU and the UK.

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Capture

If a company wishes to obtain a consent for the construction of a new generating station (under s36 Electricity Act 1989), will it need to consider CCS technology?

Yes. The Department of Energy & Climate Change (DECC) will not consent to any future applications for new combustion stations in England and Wales with a rated electrical output at or over 300MW unless they can be deemed 'carbon capture ready' (CCR). The Scottish and Northern Irish governments are separately considering the requirement for plants in their jurisdictions to be CCR.

What does 'carbon capture ready' mean?

DECC recently consulted on draft guidance for complying with its CCR policy. This draft guidance is referred to below.

Four factors should be assessed by the applicant and consenting body when determining whether a new combustion plant is carbon capture ready:

- technical assessment of storage;
- technical and economic assessment of transport;
- technical and economic assessment of retrofitting carbon capture technology; and
- whether there is sufficient space on or near the proposed plant for installation of carbon capture technology.

Will CHP and biomass plants be exempt from the CCR requirement?

No. All new generating stations in England and Wales with a rated electrical output at 300MW or over will be required to be CCR.

What does 'technical assessment of storage' mean?

When applying for a s36 EA consent operators must identify a preferred storage area of sufficient size to include 2 or more fields or aquifers in the "valid" or "realistic" categories (as set out in the DTI's report *Industrial carbon dioxide emissions and carbon dioxide storage potential in the UK*, published in October 2006). An operator may select an area beyond those covered by the DTI report provided a comparable level of assurance to that in the DTI report that the area is suitable is given.

Applicants must make a short, reasoned and written justification of their choice of proposed storage area, demonstrating that there are no foreseeable barriers to its use for CO2 sequestration.

What will happen if several applicants propose to use the same storage site?

If several applicants choose the same area, DECC will take account of the site's overall storage capacity.

Following CCS retrofit, will an applicant be bound to use the same storage site selected in its application?

No. Following CCS retrofit, an applicant may choose an alternative storage site from that selected at the CCR stage.

Will it be possible to avoid the 'assessment of storage' stage by contracting with a specialist storage operator?

No. It is anticipated that a storage market may develop in which combustion plant operators may enter commercial agreements with specialist CO2 storage operators. This will not be a means of applicants avoiding the requirement to specify a storage area.

Will an applicant for a s36 EA consent be required to obtain an exploration or storage licence before consent is granted?

No. There will be no requirement for applicants to obtain an exploration or storage licence in order to be CCR.

What does 'technical and economic assessment of retrofitting carbon capture technology' mean?

A technical feasibility study must be produced. This will be in the form of a written report and accompanying plant designs which make clear which capture technology the applicant expects to fit in the future and must be sufficiently detailed to enable the Environment Agency to advise DECC that there are no foreseeable technical barriers to retrofit.

Assessments can be made against the IEA reference document CO2 Capture Ready Plants and the advisory checklists annexed to DECC's consultation document *Guidance on Carbon Capture Readiness and Applications under Section 36 of the Electricity Act 1989*, published in April 2009.

Economic assessment is of the future likelihood of a retrofit being economically feasible at some stage during the proposed plant's operational lifetime, but not specifically when this might be.

Economic assessment will be based on a number of factors, in particular:

- future input fuel prices;
- electricity price levels;
- rising carbon emission prices; and
- likely capital and operating costs.

It is unlikely that consent would be granted if retrofitting were deemed not to be economically feasible.

When must retrofit take place?

It is currently proposed that new coal power stations should retrofit carbon capture technology to their full capacity within 5 years of CCS being independently judged as technically and economically proven. DECC anticipates CCS being proven by 2020. It is as yet unknown when other generating stations will be required to retrofit carbon capture technology.

What are the risks of retrofitting?

Carrying out material works on a relatively new plant will always be high risk. There will be a risk that the retrofit works will invalidate the warranties on the original plant and any delay in completing the retrofit will have an impact on revenues that is likely to be

disproportionate to the value of the retrofit work, so unlikely to be borne in full by the retrofit contractor. Consideration will need to be given to these issues when letting the contracts for the original plant in the hope that some of the risks can be mitigated.

How will it be determined whether there is 'sufficient space on or near the proposed plant for installation of CCS technology'?

There will not be any prescriptive guidelines on what constitutes sufficient space. Applicants should submit plans and supporting documents with their s36 EA application, which contain sufficient detail for DECC to be confident that sufficient space has been set aside for carbon capture technology retrofit. Individual assessments must be made based on the following factors:

- the type of capture technology likely to be used;
- the size/number of power generating units;
- the input fuel for the power units;
- ensuring safe storage of chemicals;
- avoiding congestion on site;
- whether CO2 processing will be on or off site; and
- progress in developing the capture technologies so as to reduce the space required.

Site plans must be submitted which show:

- footfall of the combustion plant;
- location of the capture plant;
- location of the CO2 compression equipment;
- location of any chemical storage facilities; and
- exit point of CO2 pipelines from the site.

Conceptual diagrams and a description of how the space will be used should also be submitted, as well as basic calculations of known volumes of CO2.

If granted consent, developers will be required to retain the additional space on or near the site for the carbon capture equipment and, if their application included plans for capture and compression of CO2 to be offsite, developers must retain their ability to build on that site in the future.

Will the consent process be held in private?

No. Assessments of CCR will be a public process and commercially sensitive information could be released to the public upon request.

What will be the main advisory body to DECC regarding storage issues?

The main advisory body on storage will be the Oil & Gas Division of DECC, with supplementary advice from the British Geological Survey, the Marine Management Organisation and the Health and Safety Executive (HSE).

What will be the main advisory body to DECC regarding the assessment of space and feasibility of CCS retrofit?

The Environment Agency will be the main advisory body to provide technical advice to the consenting body on the assessment of the space and technical feasibility of retrofit during the s36 EA process.

Which other bodies will advise DECC on CCR in s36 EA applications?

CCR applications will be considered by DECC based on advice from the following bodies as appropriate:

- HSE;
- DECC economists;
- Local planning authorities;
- Natural England/Countryside Council for Wales;
- CAA;
- National Air Traffic Services;
- MoD;
- Welsh Assembly; and
- Greater London Authority.

What will be the reporting requirements for holders of s36 EA consents?

It will be a requirement of s36 EA consents that an operator reports regularly to DECC on the effective maintenance of the plant's CCR status. These reports will be required from within 3 months of when the plant begins to supply electricity to the grid and every 2 years thereafter until CCS retrofit occurs.

An operator's written report will need to:

- review its CCR status in light of relevant recent technical and regulatory developments;
- report on any actions it needs to take to ensure the plant can continue to be CCR;
- if it has not already taken these actions, specify when it plans to do so; and
- specify its position in relation to the need for a hazardous substance consent.

Will applicants for s36 EA consent be required to obtain a hazardous substance consent?

It may be necessary for an applicant for a s36 EA consent to apply for and obtain a hazardous substance consent (HSC) for its planned site.

An HSC will be necessary if operational CCS is likely to bring onto site chemicals and gases which are 'hazardous' under the Control of Major Accident Hazards Regulations 1999 and the Planning (Control of Major Accident Hazards) Regulations 1999.

When HSC is granted, HSE notifies the local planning authority (LPA) and they consult upon a distance from the site in which development will be restricted. As such, operators should

discuss their plans with the LPA at an early stage. The consultation distance should be determined in parallel with the s36 EA application.

It is likely that dense phase CO2 will be on site once captured CO2 is compressed for transportation. This is not currently considered hazardous but ongoing research will inform future decisions as to whether and to what extent CO2 should be defined as such. Applicants should discuss the fact that their CCR plant may result in dense phase CO2 being on site, which may require HSC in future, with their LPA.

The 2-yearly reviews of CCR status will be an opportunity for operators to assess the need for HSC or remit of an existing HSC.

If a developer uses, licenses-in, creates a new or enhances an existing invention, design, patent, technical process or other intellectual property right, for the purposes of a CCS project, will it (or its licensors) continue to be entitled to own, protect and commercially exploit those intellectual property rights to the exclusion of all other parties?

The Government has indicated in the project information memorandum for its first CCS demonstration project competition that, while ownership of intellectual property rights used by project developers in the course of the project will remain with the developer or its licensors, the developer will be required to commit to make it available to third parties to facilitate the deployment of CCS in the UK, Europe and internationally. The terms of any dissemination, exploitation and licensing of such intellectual property rights will form part of the negotiation and final bid assessment in relation to the project.

Participants in projects outside of the Government's competition (and any bid process for EU funding) will be able to own, protect and commercially exploit their intellectual property rights as they see fit.

Who will own the intellectual property rights in the data collected and models created in connection with carbon capture facilities? Can those rights be protected or will they be required to be disclosed and/or made available to third parties? What about other studies?

DECC has proposed that any relevant plant and site plans and supporting documents on the feasibility of retrofitting capture equipment would be submitted by operators as part of their s.36 EA application and would, therefore, be in the public domain. As such, while the operator may still "own" any intellectual property rights in the underlying data, the scope for commercially exploiting them may be significantly reduced, if not entirely removed. In DECC's view, an infringement of proprietary intellectual property rights through such dissemination and, therefore, any need to keep technical assessments confidential, is unlikely. Equally, where studies are commissioned and funded, it is likely to be a requirement of the funding that information from the studies is made publicly available in order to promote global understanding of CCS. Such studies are intended to reduce technical risk for CCS projects and give greater clarity on costs

Transport

What does 'technical and economic assessment of transport' mean?

When assessing the transport component of CCR, an applicant is required to demonstrate "no known barriers" to a broad transport corridor both onshore and offshore. The selected transport route may be amended following retrofit if a more appropriate and economic rate emerges by that time.

Transport of CO2 offshore to the storage site may be by pipeline or ship. Applicants for a s36 EA consent must demonstrate that a viable "way out" exists from the combustion plant for a CO2 pipeline to the point where the CO2 goes offshore. There should be a 1km wide corridor for the first 10km from the plant site and then a 10km corridor to the points on the coast where a pipeline may go offshore or CO2 may be loaded onto a ship.

There will be no need for an environmental impact assessment of the route at the CCR stage but such an assessment will be necessary when an operator comes to fit CCS and, therefore, needs to make another s36 EA application.

Piped CO2 is likely to be transported at very high pressure (70-100 bar). Applicants should treat CO2 as a 'dangerous fluid' for the purpose of the Pipelines Safety Regulations 1996.

If an applicant plans to load CO2 onto ships it must show that there are no barriers to complying with all relevant safety factors. Regulations of the Marine Coastguard Agency should be consulted.

If an applicant plans to pipe the CO2 from land to the offshore storage site, the applicant's assessment should also detail the route of the offshore pipeline to the storage site.

Factors to be taken into account for an economic assessment may include:

- technical specifications of any onshore pipeline;
- experience of natural gas industry and pipeline routes;
- allowance for route variations due to environmental sensitivities;
- experience with costs of offshore pipelines;
- length of the pipelines;
- any need for booster stations along the route; and
- experience and costs of LNG transport.

What will be the main advisory body to DECC regarding the transport component of CCR?

The HSE will be the main advisory body on the transport component of CCR. To date they have provided interim guidance on safety and CO2 pipelines.

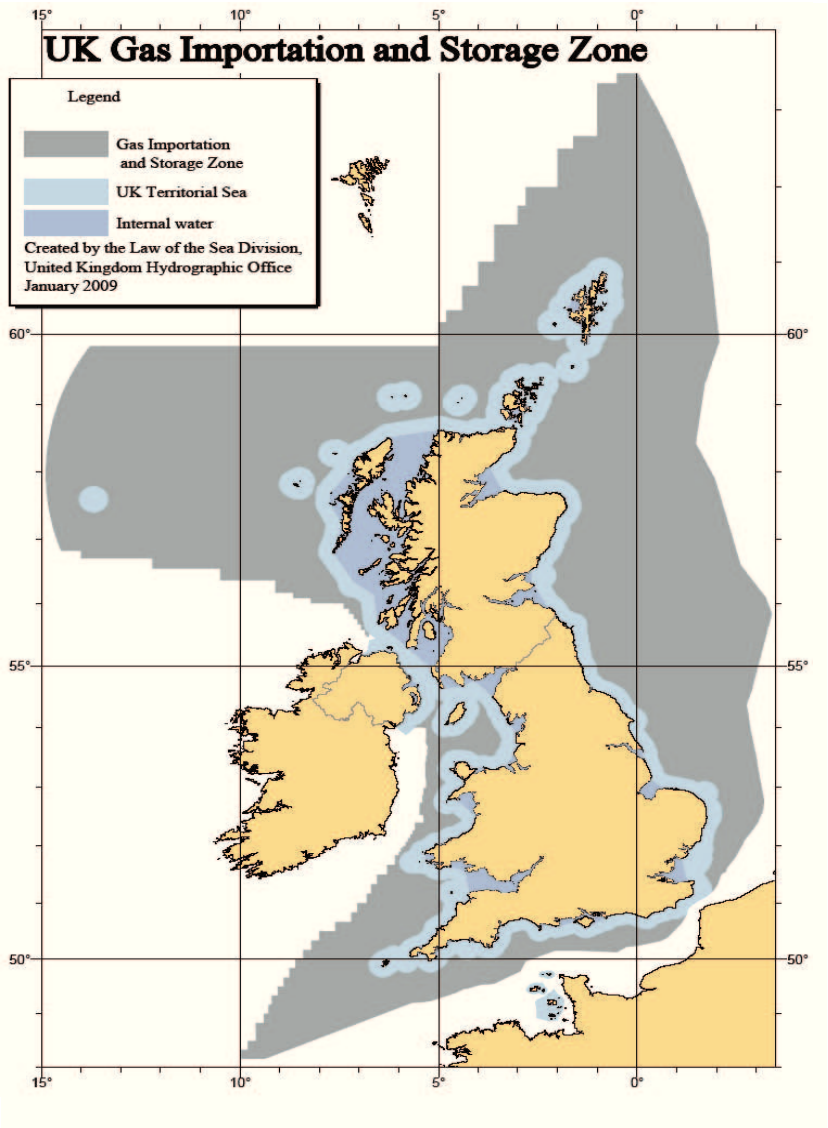
Storage

Licensing

Where will storage of CO2 be permitted in the UK?

Currently, CO2 storage is only permitted offshore within the UK territorial sea or Gas Importation and Storage Zone (GISZ). The GISZ is an area from the edge of the territorial sea out a further 188 nautical miles (within the UK continental shelf).

The Government will initially only allow offshore storage of CO2. It will review the case for onshore storage of CO2 as and when warranted by any interest that might be expressed in it in the future.



The United Kingdom Hydrographic Office

Which sites will be considered for storage of CO2?

The suitability of a geological formation for storage is determined through an assessment of the site pursuant to specified criteria set out in Annex I of the Directive, which can be seen in Appendix 1 to this brochure.

Will a licence be required for the exploration of potential storage sites?

Yes. Where exploration is required in order to determine the adequacy of a site for CO2 storage, such exploration must only be carried out with an exploration licence. There will be a single exploration licence for the offshore sub-surface area whatever the purpose of the exploration. These will be based on those currently used for petroleum exploration.

Exploration licences must:

- be available to all entities with the necessary capabilities and granted or refused on the basis of objective, published and non-discriminatory criteria;
- not exceed the period necessary to carry out the exploration for which they are granted (although they can be extended if necessary);
- be granted in respect of a limited volume area; and
- grant an exclusive right to the holder to explore the particular site.

Exploration licences may be withdrawn if an operator makes insufficient progress in exploiting its exploration rights.

It will also be necessary to obtain property access rights from The Crown Estate before undertaking intrusive exploration of the seabed.

Will a licence be required for storage of CO2?

Yes. A licence will be required for carrying out the following activities within the territorial sea or the GISZ:

- the storage of CO2 with a view to its permanent disposal;
- temporary storage of CO2 (if an interim measure prior to its permanent disposal);
- conversion of a natural feature to a CO2 storage site; and
- establishment or maintenance of an installation for any of these purposes.

It will also be necessary for a storage site operator to obtain a lease or authorisation from The Crown Estate in order to make use of the seabed or spaces beneath it.

What will be the licensing authority in the UK?

Licences are to be granted by DECC or the Scottish Ministers in the case of activities in the territorial sea adjacent to Scotland.

DECC, the Scottish Ministers and The Crown Estate intend to enter into a formal agreement regarding the way they will work together to facilitate offshore CO2 storage. The aim is to create a 'one stop shop' for acquiring the necessary authorisations. As part of the agreement, the Government will underwrite liabilities The Crown Estate may incur as landowner.

What information will be required in a licence application?

DECC/the Scottish Ministers have not yet published a standard form application document. Under EU legislation, a CO2 storage licence application will require at least the following information to be provided:

- the name and address of the potential operator;
- proof of the technical competence of the operator;
- the characterisation of the storage site and storage complex and an assessment of the expected security of the storage;
- the total quantity of the CO2 to be injected and stored, as well as the prospective sources and transport methods, the composition of CO2 streams, the injection rates and pressures, and the location of injection facilities;
- a description of measures to prevent significant irregularities;
- a proposed monitoring plan;
- a proposed corrective measures plan; and
- a proposed provisional post-closure plan.

What will happen if my storage site or installation lies partly in England and partly in Scotland?

DECC and the Scottish Ministers intend to enter into an agreement that commits them to similar principles of co-operation and describes the way in which storage sites and pipelines that cross regulatory boundaries will be administered.

Will an applicant for a storage licence be required to provide any financial security?

Yes. Potential operators will need to provide proof of financial security as part of the application for a storage licence. As such, companies wishing to carry out storage activities may need to secure funding ahead of applying for a permit to do so. However, the financial security need only be valid and effective at the moment before injection of CO2 commences.

There are two categories of liability for which financial security will be required:

- operational liabilities, i.e. those that will definitely arise such as costs of sealing the site and monitoring after closure; and
- contingent liabilities, i.e. those that only arise if CO2 migrates beyond the store's boundaries and damages adjoining property or the environment.

Existing arrangements for the decommissioning of offshore structures (e.g. oil and gas production facilities and offshore wind farms) will be replicated for operational liabilities that will arise in CO2 storage. These require an independent financial guarantee to be provided, but only if DECC/the Scottish Ministers are not satisfied that the operator will be able to meet such costs from its own assets. Parent company guarantees will not be acceptable.

Contingent liabilities may be guaranteed by either commercial third party insurance or an industry-wide mutual insurance arrangement or an alternative providing the necessary equivalent level of protection. The financial security may be reduced over time if the risks of leakage and the cost of storage can be shown to have decreased.

The financial security will need to be in place until responsibility for the site is transferred to the State, which will be for a period of at least 20 years from the end of injection unless there is sufficient evidence of permanent containment of CO2. DECC has indicated that this 20-year period will be the presumption but this is rebuttable.

At the point of transfer of responsibility for the site to the State, the only remaining obligations will be for post-transfer monitoring. The type and duration of this monitoring will depend upon the nature and behaviour of the store during its operational period. A transfer fee is payable to cover monitoring costs for a period of at least 30 years (the size of the fee to be determined on a case-by-case basis).

What factors will be taken into account when considering licence applications?

DECC/the Scottish Ministers will publish regulations setting out their requirements relating to the grant of licences. These may include rules on the types of applicant, the application process, information to be included in an application, any fees payable and financial security requirements.

Storage licence applications and all related material must be forwarded to the Commission by the licensing authorities within one month of receipt. The Commission may issue a non-binding opinion on the draft decision to award a storage licence within 4 months. If the final decision of a licensing authority differs from the Commission's opinion the licensing authority must state its reasons for this.

DECC/the Scottish Ministers may only issue a storage licence if satisfied that:

- all requirements of relevant legislation are met;
- the operator is financially sound, technically competent and reliable to operate and control the site, and professional and technical development and training of the operator and its staff are provided;
- if there is more than one site in the same hydraulic unit, the potential pressure interactions are such that both sites can simultaneously meet legislative requirements; and
- it has considered any opinion of the Commission on the draft licence.

Will the holder of an exploration licence for a site have priority for the granting of a storage licence for the same site?

Yes. A holder of an exploration licence for a site will have priority for the granting of a storage licence provided that exploration of that site is completed, all conditions in the exploration licence have been complied with and the application for a storage licence is made while the exploration licence is still valid.

Will the holder of a petroleum licence for the area covered by a potential CO2 storage site have priority for the granting of a storage licence for that area?

Yes. When issuing CO2 storage licences, it will be recognised that incumbent petroleum rights holders will be best placed to undertake storage, but if the incumbent fails to develop storage opportunities there will be no delay in allocating sites to alternative operators.

Is there a risk that storage licences will be issued to the detriment of existing petroleum licence holders?

No. A third party will not be able to obtain storage rights where such rights would interfere with the commitments and investment of the incumbent petroleum rights holder.

Storage arrangements will allow multiple uses of the offshore area, so long as these do not conflict. It will be for regulatory agencies to decide if there is a conflict. In the event of a conflict, priority will be given to petroleum production and gas storage over CO2 storage.

What terms and conditions will be incorporated into storage licences?

Under EU legislation, the minimum information that must be contained in a storage licence will be:

- the name and address of the operator;
- the precise location and delineation of the storage site and storage complex, and information concerning the hydraulic unit;
- the requirements for storage operation, the total quantity of CO2 authorised to be geologically stored, the reservoir pressure limits, and the maximum injection rates and pressures;
- the requirements for the composition of the CO2 stream and the CO2 stream acceptance procedure and, if necessary, further requirements for injection and storage in particular to prevent significant irregularities;
- the approved monitoring plan, the obligation to implement the plan and requirements for updating it, as well as the reporting requirements;
- the requirement to notify DECC/the Scottish Ministers in the event of leakages or significant irregularities, the approved corrective measures plan and the obligation to implement the corrective measures plan in the event of leakages or significant irregularities;
- the conditions for closure and the approved provisional post-closure plan;
- any provisions on changes, review, updating and withdrawal of the storage licence; and
- the requirement to establish and maintain financial security.

DECC/the Scottish Ministers are to publish regulations setting out the types of terms and conditions to be included in the licences. Appendix 2 sets out the current proposals for offshore storage licences.

What are the implications of storing CO2 without a licence or in breach of the terms of a licence?

It will be a criminal offence to carry out offshore CO2 storage without a licence or in breach of a licence's terms.

If a licence holder fails to comply with a licence provision, DECC/the Scottish Ministers may direct it to take necessary steps to comply with the provision. If the licence holder fails to take such steps, DECC/the Scottish Ministers may carry out the necessary steps themselves or instruct another person to do so. Costs plus interest on that sum may be recovered from the licence holder.

Will licence information be publicly available?

Yes. DECC must maintain a public register containing information relating to licences. The type of information is to be prescribed by further regulations made by DECC.

When may a licence be terminated and what are the consequences of termination?

DECC/the Scottish Ministers are to make regulations relating to when licences may be terminated and the obligations of those licensing authorities for a site after a licence is terminated. These regulations will include financial arrangements relating to closed storage facilities.

DECC/the Scottish Ministers must review and, where necessary, update (or as a last resort withdraw) a storage licence:

- if it has been notified or made aware of any leakages or significant irregularities; or
- if the operator's reports or environmental inspections show non-compliance with the licence conditions or risks of leakages or significant irregularities; or
- if it is aware of any other failure by the operator to meet the licence conditions; or
- if it appears necessary on the basis of the latest scientific findings and technological progress; or
- five years after issuing the licence and every ten years thereafter.

If a licence is withdrawn, the licensing authorities must either issue a new licence or close the site. Until a new licence is issued, the licensing authority may take over all legal obligations and continue CO2 injections. If the site is closed, the licensing authorities are responsible for all post-closure obligations and may recover any costs incurred from the operator.

How will the size and shape of a licensed storage site be defined?

Storage sites will be licensed as 3-D geological spaces. If the space forms part of a larger geological structure, further assessment will be needed based on practical experience and understanding of the behaviour of injected CO2.

What decommissioning requirements will apply to storage sites?

The provisions of the Petroleum Act 1998 relating to abandonment of offshore installations will be applied to CO2 storage installations. As a result, operators of such installations (and their affiliates), as well as other parties with an interest in the site or installation, may be required by a notice pursuant to s29 of the Petroleum Act 1998 to submit abandonment programmes to DECC or the Scottish Ministers and must decommission the installations in a timely manner after operations have permanently ceased.

Parties in receipt of a s29 notice are jointly and severally liable for submitting an appropriate abandonment programme to DECC/the Scottish Ministers within a specified time frame.

An abandonment programme should contain an estimate of the cost of the measures proposed, specify the times within which those measures are to be taken and, where an installation or pipeline is to remain in position or be only partly removed, include provision for maintenance where necessary. It must deal with, where appropriate, both removal and disposal of an installation or pipeline.

In the event of the failure to either submit a programme or carry it out, DECC/the Scottish Ministers may carry out the work and recover their costs from those given the s29 notice or may require a wide range of other persons (including ex-owners and their affiliates) to carry it out.

Do the licence requirements apply to CO2 storage which forms part of an enhanced hydrocarbons recovery scheme?

If CO2 is stored as a result of enhanced recovery it will be treated in the same way under the EU-ETS as CO2 stored as a result of dedicated storage activity. For enhanced recovery projects to claim EU-ETS credits, they must comply with both petroleum and CO2 storage licensing requirements. If an operator wishes to undertake CO2 enhanced recovery, but not to claim EU-ETS credits, it only needs to comply with the petroleum licensing requirements.

Operation, closure and post-closure

Are there any requirements for the chemical composition of the CO2 stored?

Yes. A CO2 stream must consist "overwhelmingly" of carbon dioxide, although it may contain associated substances from the source, capture or injection process and trace substances added to assist in monitoring and verifying CO2 migration. The acceptability of the CO2 stream will be based on a risk assessment of its impact on site integrity and risk to the environment or human health. Operators must keep a register of the quantities and properties of CO2 streams delivered and injected.

What are the monitoring obligations of a storage site operator?

Operators are obliged to monitor storage sites for significant irregularities and CO2 leakage and migration, as well as detecting any significant adverse effects for the surrounding environment, human populations or users of the surrounding biosphere. In addition, monitoring should compare the actual and modelled behaviours of the CO2 in the storage site, assess the effectiveness of any corrective measures and update the assessment of the safety and integrity of the storage site in the short and long term. Such monitoring will be based on a monitoring plan submitted with the operator's licence application. The plan must be updated at least every 5 years and approved by DECC/the Scottish Ministers.

What are the reporting obligations of a storage site operator?

At least once a year, operators must submit the results of their monitoring to DECC/the Scottish Ministers, together with the quantities and properties of the CO2 streams delivered and injected, proof of the putting in place and maintenance of the financial security required and any other information DECC/the Scottish Ministers consider relevant.

Operators must notify DECC/the Scottish Ministers immediately in the event of any significant irregularities or leakages.

Will the licensing authorities be permitted to inspect storage sites?

Yes. DECC/the Scottish Ministers must carry out routine inspections at least once a year until 3 years after closure and then every 5 years until transfer of responsibility to the relevant authority, together with such non-routine inspections as are necessary. A report setting out the results of the inspection must be prepared and made publicly available within 2 months of the inspection.

DECC/the Scottish Ministers may appoint persons to act as inspectors to assist in carrying out their functions and may make regulations relating to their powers and duties and the assistance to be provided to them.

What steps must an operator take in the event of CO2 leakage?

If there are significant irregularities or leakages, the operator must immediately notify DECC/the Scottish Ministers and take the necessary corrective measures. If the operator fails to take the necessary corrective measures, DECC/the Scottish Ministers must take the measures and can recover costs from the operator.

The commercial incentive for storage derives from the fact that it will not be necessary to purchase EU-ETS credits for stored CO2. It is considered right, therefore, that the operator is financially liable if the CO2 subsequently leaks, irrespective of the cause.

Will an operator remain responsible for a storage site once it has been closed?

The time period after which responsibility for a storage site will transfer to the State will be decided by DECC/the Scottish Ministers on a case-by-case basis and depending on the behaviour of the store during operation and after storage has come to an end; although a minimum period of 20 years will be taken as a reference point.

Once a storage site is closed, the operator will remain responsible for on-going monitoring, reporting and corrective measures, as well as all obligations regarding the surrender of allowances in the case of leakage and all preventative and remedial action. The operator must submit a post-closure monitoring plan for approval by DECC/the Scottish Ministers.

Responsibility for a closed site will transfer to DECC/the Scottish Ministers when:

- all available evidence indicates that the stored CO2 will be completely and permanently contained;
- a minimum period of at least 20 years has elapsed, unless DECC/the Scottish Ministers decide before then that the CO2 has been permanently contained;
- the site has been sealed and the injection facilities have been removed; and
- the operator has made a financial contribution towards the anticipated cost of monitoring for a further period of 30 years after transfer, taking into account the initial characterisation of the site and subsequent history of the store.

If DECC/the Scottish Ministers are satisfied that the first two conditions have been met, they shall prepare a draft decision of approval of the transfer of responsibility. This draft decision of approval shall be notified to the Commission which, in turn, may issue a non-binding opinion on it within 4 months of receipt. When DECC/the Scottish Ministers are finally satisfied that all the conditions have been complied with, they shall adopt the final decision and notify the operator and the Commission. If the final decision differs from the Commission's opinion, DECC/the Scottish Ministers must state the reasons for such difference.

If there has been fault on the part of the operator, including the provision of deficient data, the concealment of relevant information, negligence, wilful deceit or failure to exercise due diligence, DECC/the Scottish Ministers may recover from the operator any costs incurred after the transfer of responsibility has occurred.

Will information regarding closed storage sites be publicly available?

Yes. DECC will set up a public register of all closed storage sites.

Appendix 1

Annex I of the Directive

Criteria for the Characterisation and Assessment of the Potential Storage Complex and Surrounding Area

The characterisation and assessment of the potential storage complex and surrounding area referred to in Article 4(3) of the Directive shall be carried out in three steps according to best practices at the time of the assessment and to the following criteria. Derogations from one or more of these criteria may be permitted by the competent authority provided the operator has demonstrated that the capacity of the characterisation and assessment to enable the determinations pursuant to Article 4 is not affected.

Step 1: Data collection

Sufficient data shall be accumulated to construct a volumetric and three-dimensional static (3-D)-earth model for the storage site and storage complex, including the caprock, and the surrounding area, including the hydraulically connected areas. This data shall cover at least the following intrinsic characteristics of the storage complex:

(a) geology and geophysics;

(b) hydrogeology (in particular existence of ground water intended for consumption);

(c) reservoir engineering (including volumetric calculations of pore volume for CO2 injection and ultimate storage capacity);

(d) geochemistry (dissolution rates, mineralisation rates);

(e) geomechanics (permeability, fracture pressure);

(f) seismicity;

(g) presence and condition of natural and man-made pathways, including wells and boreholes which could provide leakage pathways.

The following characteristics of the complex vicinity shall be documented:

(h) domains surrounding the storage complex that may be affected by the storage of CO2 in the storage site;

(i) population distribution in the region overlying the storage site;

(j) proximity to valuable natural resources (including in particular Natura 2000 areas pursuant to Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds(1) OJ L 103, 25.4.1979, p. 1. and Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora(2) OJ L 206, 22.7.1992, p. 7., potable groundwater and hydrocarbons);

(k) activities around the storage complex and possible interactions with these activities (for example, exploration, production and storage of hydrocarbons, geothermal use of aquifers and use of underground water reserves);

(l) proximity to the potential CO2 source(s) (including estimates of the total potential mass of CO2 economically available for storage) and adequate transport networks.

Step 2: Building the three-dimensional static geological earth model

Using the data collected in Step 1, a three-dimensional static geological earth model, or a set of such models, of the candidate storage complex, including the caprock and the hydraulically connected areas and fluids shall be built using computer reservoir simulators. The static geological earth model(s) shall characterise the complex in terms of:

(a) geological structure of the physical trap;

(b) geomechanical, geochemical and flow properties of the reservoir overburden (caprock, seals, porous and permeable horizons) and surrounding formations;

(c) fracture system characterisation and presence of any human-made pathways;

(d) areal and vertical extent of the storage complex;

(e) pore space volume (including porosity distribution);

(f) baseline fluid distribution;

(g) any other relevant characteristics.

The uncertainty associated with each of the parameters used to build the model shall be assessed by developing a range of scenarios for each parameter and calculating the appropriate confidence limits. Any uncertainty associated with the model itself shall also be assessed.

Step 3: Characterisation of the storage dynamic behaviour, sensitivity characterisation, risk assessment

The characterisations and assessment shall be based on dynamic modelling, comprising a variety of time-step simulations of CO2 injection into the storage site using the three-dimensional static geological earth model(s) in the computerised storage complex simulator constructed under Step 2.

Step 3.1: Characterisation of the storage dynamic behaviour

At least the following factors shall be considered:

(a) possible injection rates and CO2 stream properties;

(b) the efficacy of coupled process modelling (that is, the way various single effects in the simulator(s) interact);

(c) reactive processes (that is, the way reactions of the injected CO2 with in situ minerals feedback in the model);

(d) the reservoir simulator used (multiple simulations may be required in order to validate certain findings);

(e) short and long-term simulations (to establish CO2 fate and behaviour over decades and millennia, including the rate of dissolution of CO2 in water).

The dynamic modelling shall provide insight into:

(f) pressure and temperature of the storage formation as a function of injection rate and accumulative injection amount over time;

(g) areal and vertical extent of CO2 vs time;

(h) the nature of CO2 flow in the reservoir, including phase behaviour;

(i) CO2 trapping mechanisms and rates (including spill points and lateral and vertical seals);

(j) secondary containment systems in the overall storage complex;

(k) storage capacity and pressure gradients in the storage site;

(l) the risk of fracturing the storage formation(s) and caprock;

(m) the risk of CO2 entry into the caprock;

(n) the risk of leakage from the storage site (for example, through abandoned or inadequately sealed wells);

(o) the rate of migration (in open-ended reservoirs);

(p) fracture sealing rates;

(q) changes in formation(s) fluid chemistry and subsequent reactions (for example, pH change, mineral formation) and inclusion of reactive modelling to assess affects;

(r) displacement of formation fluids;

(s) increased seismicity and elevation at surface level.

Step 3.2: Sensitivity characterisation

Multiple simulations shall be undertaken to identify the sensitivity of the assessment to assumptions made about particular parameters. The simulations shall be based on altering parameters in the static geological earth model(s), and changing rate functions and assumptions in the dynamic modelling exercise. Any significant sensitivity shall be taken into account in the risk assessment.

Step 3.3: Risk assessment

The risk assessment shall comprise, inter alia, the following:

3.3.1. Hazard characterisation - Hazard characterisation shall be undertaken by characterising the potential for leakage from the storage complex, as established through dynamic modelling and security characterisation described above. This shall include consideration of, inter alia:

(a) potential leakage pathways;

(b) potential magnitude of leakage events for identified leakage pathways (flux rates);

(c) critical parameters affecting potential leakage (for example maximum reservoir pressure, maximum injection rate, temperature, sensitivity to various assumptions in the static geological Earth model(s));

(d) secondary effects of storage of CO2, including displaced formation fluids and new substances created by the storing of CO2;

(e) any other factors which could pose a hazard to human health or the environment (for example physical structures associated with the project).

The hazard characterisation shall cover the full range of potential operating conditions to test the security of the storage complex.

3.3.2. Exposure assessment - based on the characteristics of the environment and the distribution and activities of the human population above the storage complex, and the potential behaviour and fate of leaking CO2 from potential pathways identified under Step 3.3.1.

3.3.3. Effects assessment - based on the sensitivity of particular species, communities or habitats linked to potential leakage events identified under Step 3.3.1. Where relevant it shall include effects of exposure to elevated CO2 concentrations in the biosphere (including soils, marine sediments and benthic waters (asphyxiation; hypercapnia) and reduced pH in those environments as a consequence of leaking CO2). It shall also include an assessment of the effects of other substances that may be present in leaking CO2 streams (either impurities present in the injection stream or new substances formed through storage of CO2). These effects shall be considered at a range of temporal and spatial scales, and linked to a range of different magnitudes of leakage events.

3.3.4. Risk characterisation - this shall comprise an assessment of the safety and integrity of the site in the short and long term, including an assessment of the risk of leakage under the proposed conditions of use, and of the worst-case environment and health impacts. The risk characterisation shall be conducted based on the hazard, exposure and effects assessment. It shall include an assessment of the sources of uncertainty identified during the steps of characterisation and assessment of storage site and when feasible, a description of the possibilities to reduce uncertainty.

Appendix 2

Summary of Measures to be Included in a Carbon Dioxide Storage Permit

A permit will place an obligation to retain CO2 within defined geological boundaries.

A permit will place the operator under a general obligation to protect the marine environment from pollution.

A permit will be subject to a property access agreement with The Crown Estate.

A permit will apply during both the injection and post-injection period, although some of its conditions may vary in those periods.

A permit will place an obligation on the licensee to undertake the licensed activities in a way that does not interfere with other uses of the sea, the seabed or the sub-seabed geological space. Such obligations are commonly found in other offshore licensing arrangements. They might include for example, a duty to consult and maintain effective communication with fishing interests, to refrain from activities that unjustifiably interfere with navigation or fishing and other commercial interests, to deal promptly with compensation claims, to give MoD 6 months' notice of installation movements and 6 weeks' notice of a seismic survey, to maintain and install underwater beacons to MoD specifications.

A permit will provide for the regulatory authority to withdraw, suspend or vary a licence (for example if actual performance of the store differs significantly from modelling predictions).

A permit will provide the regulatory authority with 'step in' rights. These will enable the regulator to undertake duties under the permit or remediate environmental pollution, where the licensee fails to do so and recover the cost from the licensee including by using the financial security.

A permit will specify certain key operating parameters of the store. These will include the total quantity of CO2 to be injected and stored, the prospective sources and transport methods, the injection rates and pressures and the location of injection facilities.

A permit will specify the composition of the CO2 stream. This will include the maximum permitted concentrations of incidental associated substances. Records regarding the CO2 stream will also have to be kept.

A permit will contain conditions about the drilling and plugging of boreholes. Typically these will replicate conditions that already apply through the petroleum licensing arrangements and will include, for example, prohibiting the drilling and plugging of boreholes without agreement, obligation to keep geological information and samples and to provide access to that information by the regulator and NERC and an obligation to notify the regulator in the event that any petroleum, water, mines or workable seams of coal are encountered.

A permit will be reviewed 5 years after issue and then at least every 10 years.

A permit will require an agreed monitoring plan to be implemented. The purpose of the monitoring will be to compare that actual behaviour of the store with the modelled

behaviour, to detect any leakage of CO2 beyond the limits of the store, to enable the UK Government to comply with any requirements under international agreements and to detect any significant irregularities or adverse effects on the surrounding environment.

A permit will require an agreed modelling programme to be carried out and the results made available to the regulatory authority. The aim of the model is to simulate the behaviour of the store, and the model will be refined according to the results of the monitoring arrangements. A permit will also place an obligation on the operators to refine the model to incorporate improvements in predictive modelling.

A permit will require the operator to provide regular reports to the competent authority and for specified records to be kept in specified formats and in specified locations and for these to be available to the regulator on request.

A permit will set out notification obligations in the event of a substantial change or significant irregularity in the storage site. These will include: a breach of a condition of the permit; an event causing, or which may cause, significant or continuous loss of CO2; an event causing, or which may cause, pollution; where significant environmental detriment from the activity becomes apparent and any substantial change in operation that requires variation to the permit.

The permit holder will be under an obligation to maintain an approved financial security for meeting duties under the permit and also the decommissioning obligations agreed as part of the decommissioning plan.

A permit will specify the conditions that have to be met for the licence to be surrendered and the responsibility transferred to the competent authority. It will also place an obligation on the licensee to maintain a closure plan that demonstrates how and when the facilities will be decommissioned and the store secured.

A permit will place an obligation on the licensee to undertake activities to high standards of management and control. This will include satisfying the regulatory authority that decisions and activities during the licensed period are taken with proper regard to the long-term safety and security of the store including after transfer of responsibility has passed to the competent authority.

A permit will include arrangements for routine and non-routine inspections and place an obligation on the licensee to cooperate with inspectors carrying out their duties.

A permit will require the preparation and maintenance of a Risk Management Plan. The plan will incorporate site selection and assessment, monitoring and reporting plans, mitigation and remediation options plans, and a site delicensing plan which will be updated as necessary to maintain its effectiveness.

A licence will require the submission of a CO2 Storage Development Plan to BERR for approval on the location, design, intended storage volumes and other stipulated matters of the intended storage site and facilities. There will be conditions in the permit that require it to be surrendered in the event of insufficient progress against this Plan.

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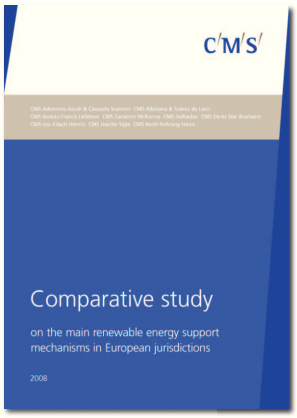

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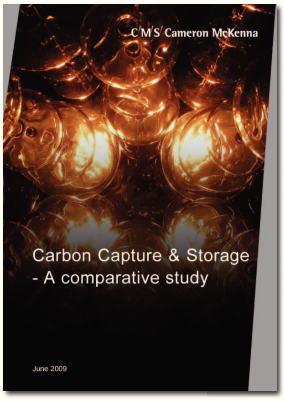
The publication of this report is due in **August 2009**.



Carbon Capture & Storage policies have been driven by the European Union and this report provides an overview of the overriding regime together with comparable features of the national CCS policies and frameworks in the European jurisdictions that have been the most active in driving CCS Projects.

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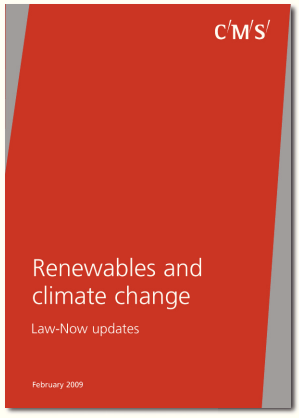

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