CARBON CAPTURE
LEGAL PROGRAMME

Case studies on the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide

Germany

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Foreword

The CCLP EU Case Studies Project

The Carbon Capture Legal Programme launched the 'EU Case Studies Project' in January 2010. The project analyses the implementation of Directive 2009/31/EC on the geological storage of carbon dioxide ('CCS Directive') in selected European jurisdictions - the United Kingdom, Germany, Poland, Romania, Spain and Norway. Each jurisdiction, for distinct reasons, provides an example of different approaches to the transposition and to CCS in general.

The objective of the project is to identify some of the more subtle nuances in different legal cultures and to provide a better understanding of the rationale for national decisions in specific aspects of the implementation of the Directive. In particular, the focus is on those areas where the Directive leaves room for Member States' discretion or is ambiguous or silent. The project also considers the policy and political context within which the national legal and regulatory framework for CCS has emerged. The studies are deliberately designed to move beyond formal transposition measures to reveal more of the underlying dynamics and tensions involved in national implementation. Such elements are often crucial in driving domestic legal developments. The way in which EU Directives are implemented often reflects distinct legal and administrative traditions, and the case studies seek to present these in order to provide better insights on the development of CCS regulation.

The outcome of the project is a series of reports from the six jurisdictions, based on key legal and policy questions and on a critical reading of the CCS Directive. The CCLP has coordinated the overall research and has carried out the UK case study. Independent experts have been commissioned to carry out research in Germany, Poland, Romania, Spain and Norway.

Background on the EU transposition process[1]

EU Member States have an obligation to adopt all appropriate measures to ensure the fulfilment of the obligations arising out of the Treaties governing the European Union or resulting from acts of the institutions of the Union.[2]

Directives are binding on Member States but only with respect to a result to be achieved, leaving considerable discretion to Member States as to the choice of form and methods to be used for their implementation. In contrast to regulations, the provisions of directives do not automatically become part of the national legal system, but require a national transposition process before doing so. In their transposition, Member States may rely upon existing law; amend existing legislation or pass wholly new legislation.

Each directive will specify a time limit for transposition, normally two years but sometimes three where complex administrative or legal changes are involved. The CCS Directive specified the date of 25 June 2011, which is just over two years after its coming into force.

The European Commission is in charge of ensuring the application of the treaties and the legal acts adopted by the institutions pursuant to the treaties.[3] To fulfil this duty, the Commission enjoys enforcement powers against Member States, which are carried out by means of an infringement proceeding.[4]

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[1] This paragraph is the extended version of a CCLP contribution to the International Energy Agency Carbon Capture and Storage- Legal and Regulatory Review- Edition 2 (May 2011). Available at www.iea.org/Papers/2011/ccs_legal.pdf.

[2] Treaty on European Union, Article 4.3. OJ C 191, 29.7.1992.

[3] Treaty on European Union, Article 17.

[4] Treaty on the Functioning of the European Union, Article 258. OJ C 115, 9.5.2008 (ex European Community Treaty, Article 226).

With respect to the transposition of directives, the Commission distinguishes between three categories of infringement proceedings:

a) non-communication cases, where a Member State fails to communicate to the Commission national laws or other measures transposing a directive within the specified time limit;
b) non-conformity cases, where the Commission considers a Member State's transposition of a directive into national law to be incomplete or incorrect;
c) 'bad application' cases, where the Commission feels that there has been a failure to apply a directive in practice, even though there has been correct transposition.

The formal stages of the infringement procedure consist of three phases:

a) a letter of formal notice from the Commission to the Member State, which then has two months to reply (pre-litigation);
b) a reasoned opinion issued by the Commission if the Member State's reply is not satisfactory, setting the details of the infringement and establishing a new deadline for compliance; and
c) referral to the Court of Justice of the European Union, if the non-compliance persists.

The Commission enjoys wide discretion as to when and whether to start an infringement proceeding, and a good deal of informal negotiation takes place to resolve the issue during the various stages of the process. In practice, however, once the deadline for transposition has passed without communication from the Member State, the Commission will automatically start an infringement proceeding based on a formal failure to communicate any national measures.

The vast majority of cases are settled without the need to refer them to the Court. If a case is brought before the Court and the Court rules against the Member State, the State must take all necessary measures to comply with the judgement.[5] If the non-compliance persists, the Commission can refer the case to the Court again, recommending a financial penalty. The Court then has the power to impose financial sanctions on the Member State. Further to amendments made under the Lisbon Treaty coming into effect in 2010, non-communication has been given increased priority, since the Commission is now entitled to request the application of such sanctions upon the first referral to the Court.[6]

[5] Treaty on the Functioning of the European Union, Article 260.2. (ex European Community Treaty, Article 228).
[6] Treaty on the Functioning of the European Union, Article 260.3. (ex European Community Treaty, Article 228).

Key findings of this report

- For some years, Germany has had a rather ambitious climate change strategy, which largely survived the change in government at federal level in 2009. On CCS, the German 2010 Energy Strategy states that CCS options will be explored in order to find out whether this is a reasonable technology. However, public opposition to CCS has influenced the political agenda on this issue and both government and political parties have been generally cautious about fully committing to it.

- In June 2011, Germany had not yet adopted a legal instrument to transpose the CCS Directive into national law, and therefore failed to comply with the deadline set by the Directive. The first transposition Bill was laid before the German Parliament in April 2009. But, after it had been approved by the Second Chamber ('Bundesrat'), the First Chamber ('Bundestag') could not reach agreement on it, against a background of public protests in some regions and nervousness about losing electoral votes. The Bill consequently lapsed. A second Bill (discussed in this report) was introduced to Parliament in April 2011 and, as of October 2011, was still under discussion.

- This second Bill (a) gives considerable discretion to the regions ('Länder') on whether or not to allow CO_2 storage within their territories and (b) provides a phase-in process for CCS in Germany, leading up to a comprehensive evaluation of experience with the technology in 2017. Until that time, only demonstration and pilot projects would be permitted. While the full implications of these provisions are still unclear, both the elements (a) and (b) seem to be in compliance with the Directive.

- The Bill is a dedicated piece of legislation, but also contains minor amendments to existing German administrative laws, designed to reconcile them with the adoption of CCS. The legislative technique used for the transposition consists of the drafting of an 'Articles-act': Article 1 of the Bill contains the new provisions on CCS (46 Articles), while the rest of the Articles amend existing legislation in order to transpose the parts of the Directive that amend existing EU laws. This legislative technique of integrating new provisions into the existing system of law follows a well-established procedure in German law-making.

- The objection of the German public to CCS is one specific difficulty that has never previously arisen in Germany with the transposition of other EU environmental laws. Other novel features of the CCS Directive, not previously seen in existing German environmental or energy law, are: the option of deciding not to authorise CCS at national or regional level; the requirement to submit draft national permits to the European Commission for a non-binding opinion; and the eventual transfer of legal responsibility to public authorities. Nevertheless, the implementation of these aspects is more likely to raise political issues than legal concerns.

- The Bill provides for close cooperation between administrations and agencies at both federal and Länder level. A federal technical agency will elaborate the basic conditions for selection of appropriate storage sites, while a federal environmental agency will handle the environmental effects of those sites. The federal Ministry for Economic Affairs will determine the safety of the geological formations, in conjunction with the Ministry for the Environment, and will establish a list of suitable sites in Germany. The exploration of the geological formations in order to find appropriate storage sites, the authorisation of storage activities and the pipelines for transporting CO_2 will all require a permit. That permit will be issued by the competent authorities in the Länder (regions), subject to agreement with the federal technical and environmental agencies mentioned above.

- With regard to public participation, the Bill largely relies upon existing German legislation, applying, as far as possible, to the different phases of CCS, the generally applicable German procedural provisions, including those on public participation.

- In September 2011, the Second Chamber of the federal Parliament ('Bundesrat'), which represents the Länder, rejected the second Bill. However, that in itself does not mean that the Bill has been conclusively rejected. It will go back to the First Chamber ('Bundestag') and, if that Chamber approves it, in normal circumstances it will be sent to a conciliation committee, drawn from both chambers, in order to find a compromise solution.

The Author

Ludwig Krämer studied law and history in Kiel, Munich and Paris. He served as a judge at the Landgericht Kiel from 1969 to 2004. From 1972 to 2004, he was delegated to the European Commission in Brussels, where he worked in the Environmental Directorate General. He was successively head of unit of legal affairs, of waste management and of environmental governance. From 2001 to 2004, he was responsible for transposing the provisions of the Aarhus Convention into EU legislation. In this capacity, he represented the EU in the different bodies of the Convention, including at the First Meeting of the Contracting Parties.

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1. General aspects

1.1 History of CCS in Germany

Germany is a federal state. At federal level, the responsibility for climate change issues lies with the Ministry for Environment, whereas the responsibility for energy matters lies with the Ministry for Economic Affairs. The Minister of Economic Affairs is responsible for CCS. The Länder (regions) have large competencies, in particular in relation to all questions which refer to land use, soil questions and the granting of permits of any kind. Furthermore, they have to implement the federal legislation.

Germany produces coal (lignite) which is largely used as an energy source. Coal is in particular found in Nordrhein-Westfalen and in Brandenburg. Since the beginning of the 21st century, public discussion started[7] around whether CO_2 from coal-fired power plants could be captured and stored in sub-surface places. The social-democratic party, traditionally strong in Nordrhein-Westfalen and in Brandenburg, favoured the use of coal for social (employment) reasons and was thus cautiously in favour of CCS technology. The conservative party (Christian-democrats) was in particular in favour of nuclear energy use, but had no fundamental objections against CCS. The Green Party came out strongly against CCS, as it saw in that technology the attempt to continue constructing coal-fired power plants, rather than to push for a quick transition to renewable energies.

In 2006, Vattenfall Company, one of the four big energy producers in Germany, started to build a pilot plant in Schwarze Pumpe (Brandenburg) which went into operation in 2008. The plant has a 30 MW capacity; it uses lignite as its energy source. The CO_2 is captured by oxyfuel combustion.[8] Since May 2011, a portion of the CO_2 has been transported, by road trucks to a place called Ketzin some 400 km away, where it is being stored underground as part of the CO_2SINK project.[9] The plant and the storage facility function, at present, without significant accidents or incidents.

In 2008, another of the four big energy companies, RWE, announced the construction, by 2014, of a CCS lignite-fired power plant at Goldenberg (Hürth, near Cologne) with a capacity of 450 MW and capture of 2.3 million tons of CO_2 per year. The CO_2 would be captured and transported, via a 600 km pipeline, to Schleswig-Holstein, where it would be stored in the underground. The plant received a permit in 2009. However, in Schleswig-Holstein, public authorities had not been aware of the storage intention. In the public, massive protests were raised and the storage of CO_2, as well as the construction of the pipeline, was opposed at the local, regional and Land level; all political parties supported this opposition. The Christian-democratic government of Schleswig-Holstein, originally cautiously in favour of the storage, changed its opinion and also opposed the storage plans.

In 2009, RWE suspended further work on the whole project, blaming the lack of a legislative framework and the lack of public acceptance of CO_2 storage and CO_2 transportation for this.[10]

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[7] The first publication which discussed CCS appears to be a study of the Rat für Nachhaltige Entwicklung (Council for sustainable development) of 2004: *Perspektiven der Kohle in einer nachhaltigen Energiewirtschaft* [perspective for coal in a sustainable energy economy] (Berlin, Rat für Nachhaltige Entwicklung, 2004).

[8] According to press information, the plant, working at full capacity, generates nine metric tons of CO_2 per hour. Reports of 2009 revealed that considerable parts of the captured CO_2 were released into the air, as at that time no storage site was available.

[9] The Ketzin site has a storage capacity of about 60,000 metric tons. It is intended to store there about 2,000 metric tons $CO_2$from the SchwarzePumpe plant. A truck load consists of about 23 metric tons of CO_2.

[10] See RWE, available at www.rwe.com/web/cms/de/2688/rwe/innovationen/stromerzeugung/clean-coal/igec-ccs-kraftwerk.

The main apprehension in the population in Schleswig-Holstein were the following: CO_2 leakage affecting health and safety of persons and property, environmental impairment, contamination of groundwater, land-use for the pipeline, the image of Schleswig-Holstein as a tourist region, the slow-down of the shift to renewable energies and the objection to becoming the deposit of coal-based power plants which were erected elsewhere in Germany.

In April 2009, the federal Government, which was by then composed of a coalition of the conservative (Christian democratic) and Social-democratic parties, submitted a bill on CCS to Parliament. The bill received a reserved welcome in the public. Environmental NGOs, but also federal environmental agencies, the farmers' union and numerous other bodies opposed CCS, which they saw as a technology that was neither safe nor well researched. They also viewed it as serving mainly as a means to continue the construction of coal (lignite)-fired power plants, which imposed, for thousands of years, a heavy burden on the taxpayer and which prevented the swift transition to renewable energies. Both the Federal Environment Agency (Umweltbundesamt) and the Expert Council on Environmental Issues (Sachverständigenrat für Umweltfragen) published rather cautious comments with regard to CCS technology.[11] The bill was welcomed mainly by industry and by circles close to economic interests.

The bill was discussed in the second Parliamentary Chamber (Bundesrat), which adopted a Resolution approving the bill, but suggesting a number of minor amendments.[12] In the first Chamber, the Bundestag, the political parties could not agree on a text. Schleswig-Holstein, a conservative-governed Land, requested a veto right for CCS, and some other conservative-governed Länder asked for further amendments of the Bill, as they were afraid that its adoption would favour the use of coal and make it more difficult to obtain a prolongation of the life-time of nuclear power plants in Germany. The bill was thus not discussed in the first Chamber and became obsolete with the general elections of September 2009.

1.2 Political and legal context for CCS technology

Germany has a number of rather ambitious and precise objectives with regard to climate change. There is a large consensus on most of them. These objectives were last brought together in a coherent programme[13] of 2007.[14] This programme, to a large extent, survived the change in government following the general elections of September 2009. After these elections, the new Federal Government adopted, in September 2010, an 'Energy Strategy' (Energiekonzept) which was intended to give orientations for the development of energy issues in Germany until 2050. This Strategy - which might be compared to a White Paper in the United Kingdom - contained extensive references to climate change problems, including reduction targets for greenhouse gas emissions for 2020 and 2050 which were more ambitious than the EU targets.

The nuclear accident in Japan in March 2011 led Germany to decide, in early summer 2011, the abandoning of nuclear energy.[15] The existing seventeen nuclear power plants will lose their permits between 2011 and 2022. This decision means a very considerable change in the German Energy Strategy which is at present being undertaken.

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[11] Umweltbundesamt, *CCS – Environmental Protection Framework for an Emerging Technology* (Dessau, October 2009). The opinion is attached in the annex. Sachverständigenrat für Umweltfragen (Expert Council on Environmental Issues) Abscheidung, Transport und Speicherung von Kohlendioxid. Der Gesetzentwurf der Bundesregierung im Kontext der Energiedebatte. Stellungnahme 13 vom 6.Mai 2009 (Capture, Transportation and Storage of Carbon Dioxide. The Governmental bill in the context of the energy debate. Position Paper 13 of 6 May 2009).

[12] Resolution of 15 May 2009, Bundesrats-Drucksache 282/2009.

[13] Integriertes Energie und Klimaschutzprogramm of 23-24 August 2007, available at www.bmu.de/klimaschutz/downloads/doc/40515.php.

[14] The term 'plan' is avoided in Germany because of the function of plans in the planned economy in the former East German State, and the negative implications of the term in the public opinion.

[15] Dreizehntes Gesetz zur Änderung des Atomgesetzes of 31 July 2011, Bundesgesetzblatt Part I no.43 of 5 August 2011, p.1704.

With regard to CCS, the Energy Strategy of 2010 declared[16] that CCS options would be explored in order to find out whether this was a reasonable technology. In a first stage, on the basis of CCS-legislation, only pilot and demonstration projects would be realised. Two new demonstration projects would be built until 2020. CCS technology was declared to open large technology export possibilities for German industry, as other countries such as China or India would also in future largely rely on coal, and would thus need CCS for climate change reasons. At the same time, this technology would allow some German industry sectors – steel and cement were mentioned – to better adapt to climate change.

1.3 The process for implementing Directive 2009/31

On 13 April 2011, the federal government, consisting of the conservative (CDU/CSU) and liberal (FDP) parties, laid before Parliament a new CCS Bill ('the Bill').[17] The main changes of this new Bill with regard to the 2009 project were, first, a provision which gave considerable discretion to the Länder to allow or not allow CO_2 storage on their territories, and, second, the marked emphasis on 'pilot phase' for the introduction of CCS. Indeed the Bill indicated that a comprehensive evaluation of experience with CCS technology would be made by 2017; until then, only demonstration and pilot projects would be authorised. At present, there is no further roadmap for the use of CCS.

No financial incentives were specifically earmarked for CCS. However, the general programmes for research and development, energy, climate change and economic issues in general are sufficiently broadly drafted to allow the granting of financial support from public sources already by now.

Neither the federal government nor the Länder indicated until now a political preference for onshore or offshore storage or for transportation of CO_2 to other countries. However, the public resistance against CO_2 storage is very considerable in Germany, in particular in the regions where CO_2 could be stored. This might lead in the future to giving preference to offshore storage or export of CO_2.

The Bill was discussed by the Länder Chamber of the German Parliament (Bundesrat) on 27 May 2011 and on 23 September 2011. The Bundesrat rejected the Bill altogether[18] and did not even ask to convene the conciliation committee which is composed of members of the Bundesrat and the Bundestag, and has the task to find a compromise solution. In a reaction to this Decision, the federal Government decided, on 26 October 2011, to appeal to the conciliation committee, which it may do by virtue of Article 77(2) Grundgesetz (German Constitution). The conciliation committee will discuss the Bill at its session of 8 November 2011. It is not yet possible to predict a timetable for the further discussions in the Bundesrat and the Bundestag, as the discussions in the conciliation committee may extend over several sessions.

There are, at present, only vague estimations concerning the available CO_2 storage capacity in Germany.[19] They range from 3 to 42 billion metric tons; the main sites would be empty gas

[16] See Bundesministerium für Wirtschaft und Technologie – Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Energiekonzept der Bundesregierung für die umweltschonende, zuverlässige und bezahlbare Energieversorgung, Chapter C "Kernenergie und fossile Kraftwerke" (Nuclear energy and fossil power plants), section 3 (p.16). (28 September 2010) available at www.bmu.de/files/pdfs/allgemein/application/pdf/energiekonzept_bundesregierung.pdf.

[17] See www.bmwi.de/BMWi/Redaktion/PDF/C-D/ccs-gesetzesentwurf,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf. The parliamentary and public discussion of this Bill was included in this study until 26 October 2011.

[18] Bundesrat, Beschluss of 23 September 2011, Drucksache 487/11.

[19] See, for this paragraph and the data mentioned, Bundesanstalt für Geowissenschaften und Rohstoffe: Gibt es genügend Speicherkapazitäten? (2011) available at

fields (2.75 billion tons), empty oil fields (0.13 million tons) and deep saline aquifers. It was noted in Germany that a Federal Agency changed its estimation for the storage capacity of deep saline aquifers from 20 billion tons (2005) to 6-13 billion tons (2010)[20]. As Germany tries at present to abandon nuclear energy altogether and heavily promote renewable energies, there are serious scientific voices which are of the opinion that CCS technology, which would be available at industrial scale only by 2025, should not be favoured, as this would mean an investment in fossil fuels technology; it is admitted, though, that at global level, CCS may have to play an important role for some decades.

There is one specific difficulty which the transposition of Directive 2009/31 raises and which was never encountered with the transposition of any other EU environmental directive.[21] This is the objection of the German public against CCS technology. The population in the areas where CO_2 could be stored is heavily opposed to the use of the technology in their region (Not-In-My-Backyard, or 'NIMBY', approach). Demonstrations took place, public surveys show the opposition, and statements by NGOs and citizens' initiatives call for opposing such storage, be it for pilot or demonstration purposes.

Germany has some tradition in public opposition to infrastructure projects: the construction of some nuclear installations had to be abandoned due to public opposition (Wackersdorf, Whyl); the opposition against a landfill for nuclear waste in Gorleben has existed for more than twenty years and has, until now, prevented a decision on the landfill's installation. In autumn 2010, massive public protests against a railway station and railway infrastructure project (Stuttgart 21) took place, which contributed to the loss of elections of the conservative party in the regional elections of March 2011, after forty years in power; for the first time ever in Germany, there will be a green prime minister in that region.

In 2009, public protests in Schleswig-Holstein against CCS led both the conservative and social-democratic regional parties to principally oppose CCS. This position was repeated after the publication, in 2011, of the federal bill. As there will be regional elections in Schleswig-Holstein in 2012, it would at present be difficult for any political party to change its position. Generally, political parties, be it at the regional or the national level, which favour nuclear or CCS technology – and these two technologies are often put on the same level in public discussions – run a strong risk of losing votes or even elections.

2. Important problems raised by Directive 2009/31

2.1 Limiting the field of application of the Directive in Germany

The Bill limits the application of Directive 2009/31 in Germany to the 'research, pilot and demonstration of technologies for the permanent storage of CO_2 in underground geological formations' (Article 1). In order to achieve this, it provides in Article 2 that only such CO_2 storage facilities may be authorised

a) for which a complete application was introduced before 31 December 2016;
b) which do not store more than three million metric tons of CO_2 per year; and

www.bgr.bund.de/cln_178/nn_1038778/DE/themen/Geotechnik/CO2-Speicherung/FAQ/faq_node.html?_nnn=true_nnn=true#doc1038; Wuppertal Institute for Climate, Environment and energy *Comparison of renewable energy technologies with carbon dioxide capture and storage (CCS)* (2010) available at www.wupperinst.org/uploads/tx_wiprojekt/RECCSplus_final_report.pdf.

[20] The reasons for this change in estimations were not discussed in public and are not known.

[21] See also above, p 9 and p 10: EU legislation never imposed on Member States the use of a specific technology.

c) which do not exceed an overall storage in Germany of more than eight million metric tons CO_2 per year.[22]

The federal government will report to Parliament before 31 December 2017 on the experience with the legislation and its application and possibly submit new legislation (Article 44).

These provisions limit the number of possible storage permits for CO_2, as well as their size. However, the Bill does not limit the operation of authorised storage sites, prescribe a specific technology or limit in any other way the use of CCS technology. The individual storage site, once it is authorised in Germany, may provide for the storage of CO_2 for an indefinite future. Thus, the Bill provides for a phase-in procedure of CCS in Germany, rather than a limitation of its application to research, pilot and demonstration projects whatever the precise wording of Article 1. This understanding is confirmed by the fact that the Bill is not limited in time: no expiration date is foreseen. It is not either foreseen that storage permits could be withdrawn, when the evaluation of 2017 comes to the conclusion that CCS is not a recommendable technology.

This legislative approach is compatible with Directive 2009/31. It was already mentioned that the Directive does not oblige Member States to introduce CCS technology on their territory. Then, a phased introduction of this new technology is not contrary to the objectives of the Directive. This interpretation also follows from Article 193 TFEU which allows Member States to introduce more stringent requirements than those laid down by EU legislation, in order to protect the environment. As Germany would be entitled to refuse the introduction of CCS altogether, it cannot be in breach of its obligations which flow from the EU Treaties by providing for a phased introduction of CCS.

In the public discussion of 2009 and 2010, environmental organisations sometimes claimed that the term 'storage' was misleading, as the CO_2 was to be disposed of definitely and not stored for further use. Some went so far as to argue that for the transport and the storage of CO_2, waste legislation should apply, instead of creating new, specific legislation.

2.2 Integration with existing legislation and innovation

The Bill is a dedicated piece of legislation for carbon capture and storage. However, it constantly tries to ensure the application of existing German administrative law provisions, sometimes by slightly modifying them in order to adapt them to the specificities of CCS.

The provisions of the Bill concerning the exploration of the geological formations follow, to a large extent, similar provisions of the Mountain Act (Berggesetz). The provisions of the permits for installations to capture CO_2, for the CO_2 transportation pipelines and for the CO_2 storage facilities refer to the German Act on Administrative Procedure (Verwaltungsverfahrensgesetz) and the Energy Act (Energiewirtschaftsgesetz). The provisions on liability refer to the Environmental Liability Act (Umwelthaftungsgesetz). The German legislation on environmental responsibility (Umweltschadensgesetz), on environmental impact assessment (Gesetz über die Umweltverträglichkeitsprüfung), on waste, and on fees and charges will slightly be amended in order to adapt it to the requirements of CCS.

The legislative technique to achieve the integration objectives consists of the drafting of an 'Articles-act' (Artikel-Gesetz): Article 1 of the Bill contains the new provisions on CCS, consisting itself of 46 Articles; Article 2 of the Bill amends the Act on Environmental Impact Assessment and transposes, at the same time, Article 31 of Directive 2009/31 into national law. Article 3 of the Bill amends the Act on Environmental Responsibility and transposes Article 34 of the Directive. Article 4 amends the German Waste Act and transposes Article 35 and 36 of the Directive. Article 7 amends the German Act on Industrial Installations and transposes Article 37

[22] The Bill is silent on exports of CO_2 for storage outside Germany. As the text stands, such exports would be possible.

of the Directive. Finally, Article 8 of the Bill amends the German provisions on large combustion plants and transposes Article 33 of Directive 2009/31. Article 32 of the Directive was not taken up by the Bill, because measures for water management come into the competence of the Länder; thus, to this extent, legislative acts by the sixteen Länder will be necessary.

This legislative technique of integrating new provisions into the existing system of law is a continuous trend in German law-making. There is a constant attempt in administrative, but also in civil and criminal law, to maintain – and, where necessary, further develop – the existing legal system, beginning with the German constitution and following the provisions of general federal legislation. This approach also allows, during the legislative procedure and during the public discussion of any bill, to concentrate on few specific topics, either because the new legislation provides for new, innovative elements, or because it is argued that the existing instruments, tools and mechanisms are not really appropriate for the new mechanism. Occasionally, there are some frictions in the German legal system. For example, the Mountain Act (Berggesetz) which is based on long-rooted practices on exploring and winning raw materials and precious metals or materials, favours the activities of economic operators more than the information and participation as well as property rights of citizens.

As far as can be seen, there are three novel legal issues which were raised by Directive 2009/31 and were not yet encountered in existing German environmental and/or energy legislation:

a) the possibility for a decision not to provide for CCS at national or regional level (Article 4(1) of Directive 2009/31) ;
b) the possibility of the Commission to give a non-binding opinion on a draft permit (Article 10 of the Directive);
c) the transfer of responsibilities to public authorities (Article 18 of the Directive).

Article 4(1) of Directive 2009/31

According to Article 4(1) of Directive 2009/31, 'Member States shall retain the right to determine the areas from which storage sites may be selected pursuant to the requirements of this Directive. This includes the right of Member States not to allow for any storage in parts or in the whole of their territory'.

This provision is, as far as can be seen, new in EU environmental law.[23] Also the way in which the Bill intends to transpose this requirement into German law, is completely new.

In the past, EU law did not impose on Member States an obligation to authorise or not to authorise certain industrial installations or activities. The most obvious example is that of nuclear power plants, where EU Member States remain free to decide whether they want to authorise the construction of such plants. There is only one exception in EU law which is the obligation of Directive 91/271 to provide for canalisation and for secondary waste water treatment in agglomerations of more than 2000 persons;[24] however, waste water from agglomerations existed anyway and the Directive only imposed a controlled treatment and disposal. While an explicit provision that Member States may prohibit CCS on their territory or on parts of it, is new in EU law, implicitly such a right for Member State existed in all areas, for example with regard to waste incinerators,[25] sky-scrapers, airports, ports or other infrastructure projects.

[23] The Commission proposal for a directive, COM(2008)18, did not contain such a provision. The Commission stated, however: 'The Commission addressed the economic, social and environmental implications of mandatory CCS in the impact assessment and concluded that at this time a mandatory requirement should not be imposed'.
[24] Directive 91/271 concerning urban waste-water treatment, [1991] OJ L 135/40.
[25] Greece and Ireland had, for decades, opposed the construction of waste incinerators, for policy reasons.

Legally, imposing obligations on Member States to provide for a specific industrial or infrastructure technology is not compatible with the subsidiarity principle of Article 5 TEU. Rather, Member States decide themselves whether they want to recur to a specific technology or realise a specific infrastructure. Where a Member State complies with its international and EU obligations for climate change, it may not be obliged, by EU law, to recur to a specific technology. Thus, Article 4(1) of the Directive does not contain a provision which changes the practice of EU environmental law drafting. Rather, its new element lies in the explicit mention of Member States' right to decide on the use of CCS technology.

The German Bill provides that the regions (Länder) may decide on areas where CO_2 storage would be allowed.[26] In this regard, the Bill is ambiguous. Indeed, according to Article 5 of the Bill, the Federal Ministry for Economic Affairs is to establish a list for the whole of the German territory of those areas which appear apt for CO_2 storage. The Länder may then decide in which areas CO_2 storage is permitted or prohibited. This could mean that the Länder only may select some areas from the federal list, where they are of the opinion that CO_2 is not appropriate; in the other areas of the federal list, CO_2 storage would then be possible. Conversely, the Länder could designate specific areas from the federal list, where CO_2 storage is possible. This would mean that at least in those designated areas, such a storage is permitted. This interpretation seems to be supported by the official explanatory memorandum to the Bill.[27]

However, the Bill does not explicitly state that the Länder have to select areas from the federal list, where they authorise or prohibit the storage of CO_2. Nothing in the Bill restricts the freedom for the Länder to designate areas. A Land may thus only designate such areas, where geologically, the ground is not apt to receive CO_2 storage, even if those areas are not included in the list drawn up by the Ministry for Economic Affairs. In this way, a Land may decide to remain free of CO_2 storage. There are political opinions expressed in Germany that a Land may also choose to not designate any land at all.[28] However, this opinion is contested; it would probably be against the spirit of the Bill.

The Bill, in its present wording, does not require a Land to give any reason for non-selection, and it does not have to justify a decision not to allow CO_2 storage within its area on any grounds such as geological unsuitability; however, discussions on this question are ongoing during the legislative process, and the final outcome in this regard is unclear.

While legally, the better arguments appear to plead for an interpretation of Article 2(5) which limits the Länders' choice to areas on the federal list, politically, the provision is understood in

[26] See the wording of the present Article 2(5) of the Bill. See 37 below.

[27] See Explanatory Memorandum to the Bill (n.11, above), comments to Article 2(5): "Die Vorschrift enthält.. ein Abwägungsgebot. Die energie- und industriebezogenen Nutzungsoptionen der Speicherstätten, die geologischen Besonderheiten und andere Interessen (z.B. Umwelt- und Torismusbelange) sind dabei zugrunde zu legen. In dem Umfang, in dem hierbei für potenzielle Speicherstätten ein Überwiegen entgegenstehender Belange begründet werden kann, ist ein Ausschluss möglich". (the provision contains.. a balancing requirement. For this, the options for using the storage sites for energy and industry purposes, the geological specificities and other interests (for example environment and tourism) shall have to be taken into consideration. To the extent that it is possible to justify the presence of overriding other interests with regard to storage sites, their exclusion is possible).

[28] See for example Mr.Bode, responsible minister for Niedersachsen, during the debate of the Bill in the Bundesrat of 23 September 2011, Bundesrat, Stenografischer Bericht 886.Sitzung 23 september 2011, p.398: "Legt man all das (all existing uses in the Land L.K.) auf einer Karte von Niedersachsen übereinander, kommt man zu einer sehr einfachen Aussage: Wir haben schlicht und ergreifend keinen Platz, bzw. dort, wo Platz vorhanden wäre, sind Risiken aus unserer Sicht heute nicht abwägbar, nicht ausgeschlossen.. [Article 2(5) of the Bill] ist aus unserer Sicht das effektivste, ja das einzige Instrument, um gesellschaftlichen Konsens zu erreichen. Das würde allerdings dazu führen, dass es in Niedersachsen CCS nicht geben würde".

Germany as leaving the Länder completely free to authorise or prohibit, on their territory, CO_2 storage.

Whatever the interpretation of Article 2(5) of the Bill is, the substance of this approach is very new in Germany. Until now, technologies were applied within the whole German territory, and no Land had the power to refuse or veto, for example, the construction of a nuclear power plant or another infrastructure project (motorways, high-speed trains, waste incinerators etc).

It can only be speculated on the reasons why the Bill introduced this clause. Early 2011, a map of geologically appropriate sites in Germany was made public. This map, produced by the Federal Agency for Geosciences on the basis of scientific findings, but largely without field exploration, was provisional and did not cover the whole German territory. It showed that most of the 408 sites included were located in Schleswig-Holstein and Niedersachsen, as well as in the North Sea adjacent to these two Länder. Both Länder, led by a conservative coalition government, were confronted with acceptance problems of the population and made numerous political representations to the conservative coalition government at federal level. Their main argument was that they refused to be the 'CO_2-WC' for those German Länder, where coal-fired (lignite-fired) power plants were to be constructed or retrofitted.[29] Their political pressure appears to have been successful in obtaining the insertion of the 'Länder-clause' in Article 2(5) of the Bill.

The consequence might well be that – according to the NIMBY principle - also in those Länder, where coal (lignite) is extracted and which are, in principle, open to the use of CCS technology (Brandenburg, Nordrhein-Westfalen, Sachsen), the resistance of the public against CCS will lead these Länder governments to refuse accepting CO_2 storage facilities, in order to avoid appearing, in the eyes of their electorate, as selling out the Land and being too open to the energy industry's interests. There seems to be a general tendency in German public opinion to require that storage facilities – such as for CO_2 or for nuclear waste – should best take place close to the location of the power plant.

The Commission's power to give an opinion on draft storage permits (Article 10 of Directive 2009/31)

Under EU environmental law, permits for industrial activities are granted by Member States.[30] It is new that the Member States must make the draft storage permits available to the Commission, in order to allow the Commission to give an opinion on that draft permit.

Article 34 Euratom Treaty provides that the Commission shall give a non-binding opinion on particularly dangerous nuclear experiments of a Member State and shall assent where the effects of the experiment could affect the territories of other Member States; however, in that case, the concertation with the Commission is limited to 'particularly dangerous experiments', thus, normally to nuclear tests. In Directive 92/43, Member States may authorise certain economic projects in designated Natura 2000 habitats; under certain conditions, they have to ask for a Commission opinion, before they authorise the project.[31] It is well known that in particular German economic operators would like to see this possibility by the Commission deleted, as they see in it an interference into the national planning system.

[29] A similar discussion has been going on for years with regard to a final disposal site for nuclear waste, where Niedersachsen – and numerous NGOs and citizen initiatives – argue that it is not fair to have this disposal site in Niedersachsen (Gorleben), whereas the nuclear power plants are placed elsewhere; the request is to have the nuclear waste disposed where the waste is generated (proximity principle).

[30] For dangerous products, permits are increasingly granted at EU level; see, for example, Reg 1829/2003 on genetically modified food and feed ([2003] OJ L 268/1), Reg 1907/2006 on chemical substances ([2006] OJ L 396/1) or Reg 726/2004 on pharmaceutical products ([2004] OJ L 136/1).

[31] Directive 92/43 on the conservation of natural habitats and wild fauna and flora ([1992] OJ L 206/7) Article 6(4).

Directive 2009/31 explains in Recital 10 that the possibility for the Commission to give an opinion was introduced, in order to increase the confidence in CCS technology. This is likely to be the reason why the Council adopted this provision: it might help overcoming public opposition or mistrust against CCS technology.
In practice, it is not likely that this provision will raise any difficulty in Germany.

Transfer of responsibility (Article 18 of Directive 2009/31)

German law does not know any legal provision that the responsibility for a facility is transferred, after a certain time, to the public authorities. It is clear, though, that such a transfer frequently happened in the past, for example for abandoned industrial sites or old landfills, where the original operator went out of business or ceased to exist. In these cases, the public authorities have to ensure, on the basis of general safety law (Polizeirecht) that such old installations or sites do not cause harm to humans or to the environment. In appropriate cases, the public authorities are obliged to take measures to minimise or even completely eliminate the risk. German law does not provide for a transfer of responsibilities to public authorities in the case of nuclear installations. The law prescribes a limitation period of thirty years after the damage occurred. Long-term radiation is likely to be taken care of by the public authorities and, at the end of the day, paid by the taxpayer.

In view of this situation, it is likely that the discussions in Germany on the transfer of responsibilities under the Directive or the corresponding Bill will be more of political than of legal nature. Several public statements in the past pointed to the fact that this responsibility might exist for thousands of years.[32] Another discussion point in the past was whether the responsibility should be transferred to the Land of the storage site or to the federal State. The Bill provides a transfer to a Land; some Länder are afraid of the financial burden.

According to Article 31 of the Bill, the operator may request the transfer of responsibility, at the earliest, thirty years after closure of the storage site; the Bill thus went beyond the minimum period of twenty years, established by Article 18(1.b) of the Directive.[33] The operator has to document in particular that the storage site is permanently sealed, that there are no leakages or significant irregularities and that the long-term safety of the storage facility is, according to the state of science and technique, ensured.[34] Furthermore, the operator must have contributed to the post-closure costs. This contribution consists of three per cent of the value of CO_2 emissions allowances under the CO_2 emissions trading systems of Directive 2003/87 that were saved by the storage; however, the contribution must at least cover the likely costs of monitoring the storage site for thirty years after the transfer of responsibility.

The competent authority may decide, at the request of the operator or at its own initiative, on a transfer of responsibility of the storage site at an earlier date than thirty years, provided the long-term safety of the storage site is ensured.

The Bill transposes all the elements of Article 18 of Directive 2009/31. It provides, in a rather hidden way, that the EU Commission should have the possibility to give an opinion on the draft decision to transfer responsibility to the public authorities. This is done by a reference, in Article 31(2) of the Bill, to Article 13(4) of the Bill; that Article 13(4) contains the requirement for the authority which grants the storage permit to obtain the opinion of the European Commission,

[32] In a published article by an ex-Secretary of State for the Environment, the long-term safety is considered to mean a safety for a period of up to one million years, See R Baake-C Ziehm 'CCS-Gesetzentwurfwiderspricht Europarecht und effektivem Klimaschutz' [CCS-Bill is in contradiction with EU law and effective protection against climate change] (2009) 11 *Solarzeitalter* 19, 23.
[33] Thirty years is the general period of prescription in German law, laid down in the German Civil Code and numerous other legislative acts.
[34] The term 'science and technique' (Stand von Wissenschaft und Technik) is stricter than the term 'state of technique' (Stand der Technik), as also scientific know-how shall have to be taken into account, even where this scientific finding is not yet practised by operators.

before the permit is granted. The reference in Article 31(2) to Article 13(4) makes the consultation of the Commission before the decision on the transfer of responsibility mandatory.

It is not likely that Article 31 of the Bill will raise significant legal concerns in Germany.

2.3 Administrative arrangements

The Bill is a framework legislation: it provides for close cooperation between federal and Länder administrations and federal and Länder agencies. A technical federal agency[35] elaborates the basics for appropriate storage sites, an environmental federal agency[36] evaluates the environmental effects of those sites. The federal Ministry for Economic Affairs determines the safety of the geological formations, concerting itself with the Ministry for the Environment, and establishes a list of appropriate sites in Germany. The exploration of the geological formations in order to find appropriate storage sites, the authorisation of storing and the pipelines for transporting CO_2, all require a permit. This permit is given by the Länder competent authorities, which have to concert with the federal technical and environmental agencies mentioned above.

Permits for exploring the subsurface must be granted, where the conditions laid down in the Bill are complied with. In contrast, the Länder may, by legislation, identify areas where CCS storage sites will be permitted, or where storage sites will not be permitted.[37] The storage of CO_2 outside an authorised site or in the water column shall be prohibited. Also the closure of a storage site requires a permit. The federal technical agency shall set up a publicly accessible register on existing and planned transportation pipelines for CO_2, all applications and permits granted for the storage of CO_2, and information on sites which were closed or where responsibility was transferred to the public authorities.

The Länder governments will play a key role in the implementation of the Bill. First, the agreement of the Länder Chamber (Bundesrat) is necessary for the adoption of the Bill. At present, two Länder governments which are governed by a conservative-liberal coalition (Niedersachsen and Schleswig-Holstein) announced that they would not authorise CO_2 storage in their respective Land; this announcement preceded the publication of the Bill and it is not clear whether it also refers to offshore storage. As the Bill provides that the Länder may designate areas where the storage is permitted or where it is prohibited. This provision might appease the Länder and make the adoption of the Bill possible. However, there are several regional elections in 2011 and 2012 and public pressure might influence the Länder governments' voting in the Länder Chamber.

Second, the Länder shall grant the storage permits. While they are obliged to take into consideration the assessment of the federal agencies with regard to technical and environmental aspects of a site, they may deviate from these assessments which they then have to justify. Their possibilities are less far-reaching for the exploration of sites, as they are obliged to grant a permit for exploration, where the conditions of the Bill are complied with. This will probably also refer to explorations in areas where the Land in question had declared the storage inadmissible, as the Land legislation might change in time. The Länder governments will, of course, rely to a large extent on the safety and environmental evaluations of their own technical and environmental agencies or authorities, and diverging opinions with those of the federal agencies are not excluded.

[35] Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Agency for Geosciences and Raw Materials).
[36] Bundesumweltamt (Federal Agency for the Environment).
[37] See Article 2(5) of the Bill: 'Die Länder können durch Landesgesetz bestimmen, dass eine Erprobung und Demonstration der dauerhaften Speicherun gnur in bestimmten Gebieten zulässig ist oder in bestimmten Gebieten unzulässig ist' [The Länder may decide, by way of legislation, that an exploration and demonstration of permanent storage is only permitted in certain areas or is not permitted in certain areas].

The Länder will not be able, under the present wording of the Bill, to entirely ban the capture, transportation or storage in their territory. Indeed, their powers under Article 2(5) of the Bill only refer to the *storage* of CO_2, not to its *capture* and *transportation*. Where an applicant complies with the provisions of the Bill, he has, under German administrative law, the legal right to obtain a permit for capture and transportation and may enforce this right through court proceedings. As for storage, it was mentioned above that the provision of Article 2(5) of the Bill is interpreted, in policy, as giving to the Länder the right of prohibiting CO_2 storage altogether.

The political possibility that onshore storage will be banned in Schleswig-Holstein and Niedersachsen is high; indeed, in Schleswig-Holstein, regional elections will take place in 2012 and public opinion is almost unanimously opposed to CCS, mainly for fear of damage to property and negative impacts on tourism. Niedersachsen, the region where the potential site for final disposal of nuclear waste, Gorleben, is situated, published a statement based on the regional geological agency's findings, according to which the ground in Niedersachsen was not safe to receive CO_2 storage; it is unlikely that this public statement will be reversed. In Brandenburg, a region with high lignite production, the regional government is, in principle, in favour of CO_2 storage, as this would allow the lignite power plants to continue operating. However, it is also faced with strong public opposition to CCS. Its first reaction after the publication of the Bill was that it did not wish to be the only Land which authorised the storage of CO_2, while other Länder, in particular Schleswig-Holstein and Niedersachsen, could successfully avoid such storage. Brandenburg would thus oppose the adoption of the Bill.

Article 42 of the Bill explicitly provides that the Länder may raise a tax on the storage of CO_2. It is not yet known, though, whether any Land will make use of this possibility. Unless the Bill provides otherwise, Länder legislation may not deviate from the procedural provisions of the Bill (Article 46 of the Bill).

2.4 Ownership of pore space

The Bill does not contain specific provisions regarding property. German law generally provides that the owner of ground is also the owner of the underground and thus of the pore space which might be suitable for CO_2 storage; however, the owner may not prohibit interferences which objectively do not disturb him.[38] The Bill assumes that this is the case with CO_2 storage, by providing in Article 14 that the land owner is obliged to tolerate ('dulden') the authorised CO_2 storage in underground geological formations. This might be seen differently by land owners; in the last instance, courts will have to decide on this issue.

The land owner is not liable for any damage caused by the storage. Where no alternative location for storage is possible and the project is in the public interest,[39] expropriation of the land may be decided by the competent public authority as the ultimate means. The conditions of expropriation favour the storage of CO_2, as the public interest is likely to be always accepted.

No differentiation is made in the Bill for onshore and offshore storage. For coastal seas (up to 12 nautical miles from land), the Länder are responsible for granting permits, while for the areas

[38] See Article 905 of the German Civil Code (Bürgerliches Gesetzbuch): 'Das Recht des Eigentümers eines Grundstücks erstreckt sich auf den Raum über der Oberfläche und auf den Erdkörper unter der Oberfläche. Der Eigentümer kann jedoch Einwirkungen nicht verbieten, die in solcher Höhe oder Tiefe vorgenommen werden, dass er an der Ausschliessung kein Interesse hat.' [The right of the owner of immovable property extends to the space above the surface and to the ground below the surface. However, the owner may not prohibit interferences which take place in such a height or depth that he has no interest in their exclusion].

[39] See Article 15 of the Bill: 'Ein Projekt dient dem Wohl der Allgemeinheit, wenn es für die Demonstration der dauerhaften Speicherung in Deutschland erforderlich ist und zum Zwecke des Klimaschutzes die Emission von CO2 in Deutschland dauerhaft vermindert wird.' [A project is in the general interest, when it is necessary for the demonstration of permanent storage in Germany and when for the purpose of climate change protection the emission of CO^2 in Germany is permanently reduced].

beyond that area (exclusive economic zone), the Federal Government is competent. In this area, thus, the Länder have no possibility to block any storage of CO_2.

2.5 Liability (Article 29 of the Bill)

According to Article 29 of the Bill, the operator is strictly liable for personal injury and property damage; this liability does not extend to responsibilities under the emissions trading legislation.[40] Where the storage facility was generally apt to cause the damage in question, it is presumed that the damage was caused by it; this means that the operator would have to prove that the damage was not caused by the CO_2 storage facility and its operation. Where two or more persons could be liable for damage and the person who caused the damage cannot be identified, all persons are jointly and severally liable. Among the liable persons, the responsibility is divided according to the likely participation in the causation of the damage.

The injured person has comprehensive information rights against the operator of a storage site and against the competent authorities that authorised the storage site. The maximum amount of liability is 85 million euros for personal injury and other 85 million euros for damage to property. Liability on other grounds, in particular on negligence by the operator, remains possible.

The Bill does not regulate questions of prescription.[41] As it allows the transfer of responsibilities, including liability, at the earliest after thirty years following the closure of the storage site, it must be presumed that the liability extends as long as the operator has not transferred responsibility to the public authorities.

Even after transfer of responsibility, the operator of the installations will remain responsible; however not towards the injured person, but towards the public authorities to which he transferred the responsibility. This 'indirect liability' applies, when the operator made, when he transferred responsibility, intentionally or by negligence, wrong statements towards the competent authority as regards the safety of the installation, leakages or other relevant aspects; or when it becomes apparent, after the transfer of responsibilities, that the operator did not comply with conditions for the construction or operation of the installation (Article 31(6) of the Bill). The competent authority may then ask the operator to pay all expenses which the competent authority incurred and which are connected to the operator's declarations or practice.

The Bill sharply distinguishes between liability towards other persons and their property and measures which damage the environment. While liability provisions are laid down in the German Liability Act, provisions on damage to the environment are laid down in the Act on Damage to the Environment[42] which transposed Directive 2004/35 into German law. The Bill amends this latter Act and includes the operation of CO_2 storage facilities into the list of activities which require restoration of the impaired environment (Article 34). The responsibility of an operator under the Act on Damage to the Environment expires after 30 years, unless the competent authority has, in the meantime, taken measures against the operator.

2.6 Transfer of responsibilities (Article 31 of the Bill)[43]

The operator of a CO_2 storage installation may request, at the earliest, thirty years after the closure of the installation that the responsibility for the storage installation be transferred to the Land, where the storage installation is located. This transfer must be accepted, when, according

[40] This provision also refers to Articles 8-16 and 18(1) of the Environmental Liability Act (Umwelthaftungsgesetz) of 10 December 1990 (Bundesgesetzblatt 1990 part I, p 2634), with later amendments, which thus also becomes applicable.

[41] Prescription is dealt with in Article 17 of the Environmental Liability Act which is, however, not referred to in Article 29 of the Bill.

[42] Act on Damage to the Environment (Umweltschadensgesetz) of 10 May 2007, Bundesgesetzblatt 2007, part I, p 666.

[43] See section 2.2 (c), above.

to the state of science and technique the long-term safety of the storage installation is guaranteed, and when the operator has paid a post-closure contribution. The long-term safety of the storage installation ensures that the stored CO_2 will be contained completely and for an unlimited time. The transfer includes

a) the obligation to provide for measures to prevent leakage and other impairments for humans and the environment,
b) liability for personal injury and damage to property;
c) obligations flowing from the Act on Greenhouse Gas Emission Trading
d) obligations flowing from the Act on Damage to the Environment.

The post-closure contribution must cover at least the costs of monitoring the installation for a further 30 years. It is calculated at three per cent of the value of the allowances under the Act on Greenhouse Gas Emission Trading which correspond to the quantity of CO_2 stored.

The competent authority may transfer the responsibilities earlier, provided the long-term safety of the storage installation is guaranteed and the post-closure contribution was paid.

2.7 Financial security (Article 30 of the Bill)

The operator is obliged to provide for financial security in order to be able to comply with his obligations under the Bill, his liability obligations and the obligations flowing out of the Act on greenhouse gas emission trading, furthermore including the costs for closure and post-closure.

The application only requires that the operator demonstrates his financial capacity. However, the permit may only be granted if the operator has given a financial security for the first year of the operation of the facility (Article 13(1) no.7 of the Bill). The exact amount of the security and when it must be made available shall be determined by the competent authority. The amount of the security shall be adapted annually.

The operator's obligation for financial security ends with the transfer of responsibility according to Article 31 of the Bill. The financial security shall be given either by an insurance, a bank guarantee or in another form admitted by law.

During the operation of the storage site, the principal problems are likely to arise when an incident or an accident occurs. Competent authorities might not fix the amount for the financial security too high, in order not to be accused of being over-regulatory. Whether then the available amounts will be sufficient, will depend on the nature of the accident or incident.

The way in which the Bill organises the financial contribution for long-term stewardship was discussed in section 2.2 (c) and 2.6, above. The principal issues which might arise from the application of Article 30 of the Bill stem from the long-term effect of CO_2 storage which is thought to be stored for an unlimited time-span, i.e. for hundreds or thousands of years eventually. After some time, though, the financial contribution of the operator will have lost its value, so that any damage or other impairment which might occur will have to be paid by the taxpayer.

2.8 Conflicting uses of the storage site

The Bill does not contain any provision concerning the interaction between CCS activities and other potential or existing uses of the subsurface. It determines in Article 7 that applications for a permit to explore geological formations shall be decided on in the order in which the application and the complete accompanying documents were submitted. Where two or several applications refer to the same potential storage site, the application which best corresponds to the purposes of the Bill shall be decided first. When these applications are equivalent, the decision shall concern the application which first was capable of being authorised. During the

duration of the exploration permit, no other use of the storage site which could impair the storage of CO_2 may be permitted.

With regard to the permit to construct and operate a storage facility, the owner of an exploration permit has priority over all other applicants (Article 12(4) of the Bill).

German law contains a relevant specificity which might play a significant role in future discussions. Indeed, the Act on Mountains (Berggesetz) allows persons to apply and obtain a permit for exploring precious metals or materials in the soil. In a field, where such a permit has been granted, its owner has the exclusive right to explore geological formations, and no other exploration of the subsurface may take place. In Schleswig-Holstein, a private energy company (RWE-DEA) has received a permit to search for 'sole' – a liquid mixture of salt and water - in more than half of the total territory (8,300 km²) of that land. As the winning of sole is of no economic interest, there is the strong suspicion in the public that the permit was applied for, in order to obtain the possibility to search for appropriate CO_2 storage sites. The consequence of this situation is that in the area covered by the permits for RWE-DEA, no search for storage sites for compressed air energy storage or natural gas may take place.

Article 45 of the Bill provides that procedures for an exploration permit which refers to the search for precious materials, 'in particular of sole', in potential storage complexes, may be continued, where this is requested and provided that the necessary documents for the application of the exploration permit are submitted. This provision appears to allow RWE-DEA to guard the exclusive exploration possibility in parts of the Schleswig-Holstein territory.

Under general German administrative law, once a permit can no longer be challenged in court, it cannot be subject to requests for injunction to not execute the project or not use the permit.[44]

Politically, the Länder Schleswig-Holstein and Niedersachsen in particular had raised concern with regard to conflicting uses of storage sites. Indeed, these two Länder heavily invested in and promoted wind energy and want to use subsurface storage sites for Compressed Air Energy Storage (Druckluftspeicher). As they have now the possibility to prevent the use of CCS on their regional territory, it is not likely that they will insist on a provision on conflicting uses.

Other uses, such as Enhanced Oil Recovery (EOR) or natural gas storage did not play any significant role in the past public discussion in Germany. The public register which is set up under the Bill shall also contain information as to whether the CO_2 storage site may be used for other purposes, 'in particular for geo-thermal' (Article 6(2) no.6 of the Bill).

2.9 Public participation and access to information

With regard to public participation, the Bill largely refers to existing German legislation. It tries as much as possible to apply to the different stages of the CCS the generally applicable German procedural provisions, including those on public participation.
Installations for capturing CO_2 which capture more than 1.5 million metric tons of CO_2 per year require an environmental impact assessment; installations which capture less CO_2 require an environmental impact assessment, when significant environment impacts are likely. Pipelines for transporting CO_2 with a length of more than 40 km and a pipe diameter of 800 mm or more have to undergo an environmental impact assessment. Other pipelines have to be assessed whether significant environmental impacts are likely. Storage installations for CO_2 all have to undergo an environmental impact assessment.

The Bill provides for an amendment of the Act on Environmental Impact Assessment, in order to lay down these requirements (Article 2 of the Articles Bill). Under the environmental impact assessment procedure according to the Act, participation rights of the public are foreseen, in conformity with the requirements of EU Directive 85/337.

[44] Article 75(2) Act on Administrative Procedures (Verwaltungsverfahrensgesetz).

The application for exploring geological formations requires a permit. The application and the accompanying documents must be made available to the public during one month in a publicly accessible building of the area under which the geological formation to be explored is situated. The public must be informed of the accessibility of the application documents. Objections against the application may be introduced within two weeks after the end of the one month period. Later objections are precluded. Objections which are raised shall be discussed and decided upon during the permit procedure.

Pipelines for the transportation of CO_2 and storage facilities for CO_2 need a permit. The provisions of the German Act on Administrative Procedures apply to both procedures. The Act on Administrative Procedures contains detailed rules for public participation: the application and the accompanying documents must be made publicly available for one month, in a municipality of the area where the installation will be constructed or which is crossed by the pipeline. The population must be informed of this disclosure and must be informed that objections against the project in question may be raised within two weeks after the end of the disclosure period. Afterwards, objections will no longer be admitted. The decision on the permit will have to discuss any objection raised.

The administrative decision to grant a permit for the CO_2 pipeline or the CO_2 storage facility may be tackled before the administrative courts. According to German administrative law, however, the applicant must be affected in his or her individual rights by the decision. This is normally the case, where the applicant is landowner, as his property right might be affected by a pipeline. Whether this would be the case for the storage facility, is not clear. During the public demonstrations in some parts of Germany, landowners argued sometimes that a storage facility affected their property rights. The final decision on this question would be with the courts.

With regard to information, the Bill does not contain specific provisions; insofar as the general German provisions on access to information will be applicable, which comply with the requirements of Directive 2003/4 on public access to environmental information. Furthermore, Article 6 of the Bill charges the Federal Agency for Geosciences and Raw Materials (Bundesanstalt für Geowissenschaften und Rohmaterial) to set up a publicly available register which shall list:

a) all existing and planned transportation lines for CO_2;
b) all applications and permits granted for the storage of CO_2;
c) information on sites which were closed or where responsibility was transferred to the public authorities.

Details of the register shall be laid down by regulations.

No further administrative or institutional arrangements with regard to public information and participation are made by the Bill.

3. Discretionary and ambiguous provisions in Directive 2009/31

3.1 The field of application of the Directive

Directive 2009/31 does not apply to geological storage of CO_2 with a total intended storage below 100 kilotonnes undertaken for research, development or testing of new products and processes (Article 2(2)). The German Bill explicitly applies to the storage of CO_2 for research purposes (Article 3(3)). The Bill will apply to any geological storage of CO_2, whatever its quantity. Storage for research purposes mainly follows the general provisions, though Articles

36 to 38 contain some derogations. It is notable that the results of any research must be made available to the Federal Agency for Geosciences and Raw Materials.

The Bill does not provide for enhanced hydrocarbon recovery (EHR), but is limited to CO_2 storage.

3.2 The selection of storage sites (Directive 2009/31, Article 4)

The Bill entrusts the Federal Agency for Geosciences and Raw Materials to establish the basis for an assessment of those geological formations which appear appropriate to serve as storage sites (Article 5). In this, the Agency shall cooperate with the authorities of the Länder which shall put at the disposal of the Agency the necessary geological scientific data. On this basis and on the evaluation of the potential environmental impacts of CO_2 storage, the federal Ministry for Economic Affairs shall establish an 'assessment' of appropriate sites. The Ministry shall consult the Ministry for the Environment and hear the Länder before publishing his assessment.

Article 4(4) of Directive 2009/31 provides that a geological formation shall only be selected as a storage site, 'if under the proposed conditions of use there is no significant risk of leakage, and if no significant environmental or health risk exists'. This provision was not taken over by the Bill. The Ministry of Economic Affairs is thus not bound to limit his selection to sites without a 'significant risk'.

Also Article 4(3) of Directive 2009/31 and its annex I were not taken over by the Bill. An Annex I of the Bill which corresponds to Annex I of Directive 2009/31, only refers to the application and the decision on the exploration permit, but not to the selection of storage sites.

3.3 Exploration permit (Directive 2009/31, Article 5)

The Federal Agency of Geosciences and Raw Materials shall, when it assesses the geological formations, also assess future potential conflicts of use (Article 5(2) no 7 of the Bill).

The Bill deals in detail with the 'necessary capacities' of an application (Article 7 of the Bill): the applicant must possess the necessary financial capacity, submit an exploration programme, possess the necessary technical competence, and be personally reliable; unnecessary damage to the land must be avoided, other permits and water permits may not be impaired, health and property of persons shall be ensured, the environment be preserved and unnecessary waste generation avoided, and no other overriding public interests oppose the exploration. For offshore exploration, other specific conditions are laid down. These require that the safety and freedom of marine transport are not impaired, that the marine environment is not negatively affected, that the placing, maintenance and operation of cables and pipelines is not disturbed, scientific research not impaired more than unavoidable and that fishing activities are not disproportionately impeded (Article 7(1) no 7 of the Bill).

The exploration permit shall be given for the time necessary to explore the geological formations. It may not extend beyond 31 December 2015. During the existence of the permit, exploration of the same geological formation for other uses is not allowed (Article 7(5) of the Bill). Details of 'financial capacity' and 'technical competence' of the permit holder are not laid down in the Bill. There are no specific provisions regarding an injection test.

3.4 Storage permit (Directive 2009/31, Article 6)

The necessary capacities of the applicant for a storage permit are essentially the same as for the exploration permit (Articles 13 and 14 of the Bill); they refer in particular to the financial capacity, the technical competence of the applicant and the documents which must be submitted in support of the application: the safety concept, the monitoring concept, closure and post-closure concept and the documents referring to the environmental impact assessment. In contrast, the terms of 'operator' and 'conflicting uses' are not defined or further elaborated.

The permit may only be granted when the long-term safety of the storage facility according to the 'state of science and technique' (Stand von Wissenschaft und Technik)[45] is ensured and measures are taken to prevent damage to humans or the environment.

3.5 Application for a storage permit (Directive 2009/31, Article 7)

The Bill has to attach to its application a safety concept (Sicherheitskonzept) which must contain, according to Article 19 of the Bill, a description of measures to prevent significant irregularities (Article 12(2) no.1 of the Bill). Furthermore, the applicant has to submit a detailed description of the facility and the techniques used, information on the quantity of CO_2, its provenance and composition, injection rates and pressure, the likely development of pressure in the storage complex, the release of substances and the displacement of formation waters, a monitoring plan, provisional closure and a post-closure plans and the documents required under the environmental impact procedure.

These obligations comply with the requirements of Article 7 of Directive 2009/31.

3.6 Conditions for storage permits (Directive 2009/31, Article 8)

As Directive 2009/31 is based on the present Article 192 TFEU, Member States have the possibility to fix supplementary conditions for storage permits, where these conditions aim at a better protection of humans and the environment (Article 193 TFEU).

Article 13 of the Bill provides for the following conditions for the granting of a storage permit: (1) public interests are not affected and overriding private interests do not oppose the permit; (2) the long-term safety of the storage is ensured; (3) there is no potential risk for humans and the environment; (4) measures are taken to prevent such risks; (5) the documentation which was submitted complies with the legal requirements; (6) the CO_2 stream corresponds to the requirements laid down in the Bill; (7) the applicant has submitted the financial guarantee for one year; (8) other general interests do not oppose the storage.

The competent authority is obliged to take into consideration opinions from the European Commission, provided these arrive within four months of transmission of the draft permit decision to the Commission (Article 13(4) of the Bill).

The Bill does not refer to possible pressure interactions; the existing provisions with regard to the safety of the storage seem sufficient, though.

3.7 Content of the storage permit (Directive 2009/31, Article 9)

The Bill (Article 13(2)) is less specific than Article 9 of Directive 2009/31, as regards the enumeration of the content of the permit. The following differences were identified:

a) no information concerning the hydraulic unit is requested;
b) no requirement for the CO_2 stream acceptance procedure is laid down;
c) the approved monitoring plan need not be mentioned. It follows from Article 20 of the Bill that the operator is obliged to elaborate a monitoring plan and to update it. However, the Bill does not require that the monitoring plan be approved by the competent authorities. Also, the approved plan need not be included in the storage permit.
d) reporting requirements of the operator (Article 22(3)of the Bill) need not be laid down in the permit;
e) the requirement of notifying the competent authorities in the event of leakages or significant irregularities (Article 23 of the Bill) need not be laid down in the permit;
f) the Bill does not mention the requirement to implement the corrective measures plan in the event of leakages or significant irregularities;

[45] See, on this term, 34 above.

g) the conditions for closure and the approved provisional post-closure plan need not be laid down in the permit;
h) the requirement to establish and maintain the financial security need not be laid down in the permit.

Overall, the Bill only establishes minimum requirements for the content of the permit ('Shall contain…in particular'). Most of the obligations of the operator are laid down in the Bill itself, but are not required to be included in the permit.

3.8 Commission review of the permit (Directive 2009/31, Article 10)

Article 13(4) of the Bill completely takes over the provisions of Article 10 of the Directive, without additions.

3.9 Changes, review, update and withdrawal of storage permits (Directive 2009/31, Article 11)

The Bill provides that any substantive change of the storage facility requires a new permit (Article 11). It does not specify what a 'substantive change' is.

Where the permit is withdrawn, the competent authority should require the closure of the facility (Article 16). It is entitled to close itself the facility and take the necessary post-closure measures. When the storage facility is to be taken over by a third party, the competent authority shall examine whether a new permit may be issued. Until the issuing of a new permit in favour of that third party, the authority shall itself monitor the facility, at the expense of the former operator.

The Bill does not contain the general obligation of the competent authority, laid down in Article 11(4) of Directive 2009/31, to temporarily take over the legal obligations flowing from the storage permit. Rather, it limits this obligation to cases, where a third party intends to take over the storage facility.

3.10 CO_2 stream acceptance criteria and procedure (Directive 2009/31, Article 12)

Article 24 of the Bill completely takes over all obligations laid down in Article 12 of the Directive. As regards the 'overwhelming' part of CO_2 in the CO_2 stream, the Bill provides that the CO_2 component is 'as high as achievable according to the state of technique of the specific installation and with appropriate efforts'. The Explanatory Memorandum of the Bill explains that this is meant to constitute a minimum standard which enables different procedures, conforming to the different procedures of capturing CO_2. This wording does not appear to constitute an incorrect transposition of Article 12 of the Directive, as the term 'overwhelmingly' of Article 12 is equally general. However, the concrete results of the German practice might lead to the conclusion that the CO_2 in a specific case does not consist overwhelmingly of CO_2.

The Bill also provides that the CO_2 stream may not contain waste or other parts which are intended to be disposed; it may only contain substances which are necessary for better monitoring compliance or which stem from the capturing and transport process; any such substances may not create risks for humans or the environment

The Commission guidance is not mentioned in the Bill.

Article 24 of the Bill also obliges the operator regularly, and at least every six months, to inform the competent authority of the composition of the CO_2 stream and the name of the installations where the CO_2 was captured.

3.11 Monitoring (Directive 2009/31, Article 13)

Articles 20 and 21 of the Bill require the operator to elaborate a monitoring plan (Überwachungskonzept) which contains all the elements mentioned in Article 13 and Annex II of

Directive 2009/31. The Bill does not further specify the general terms of the Directive. It puts the emphasis on the conditions of the storage permit and requests the operator to make sure that all these conditions are continuously respected. It also allows the competent authority to impose supplementary conditions (Article 21(1) of the Bill).

However, no specific mention is made of the monitoring of the injection facilities and of the surrounding environment. Furthermore, the Bill does not mention that the plan is to be approved by the competent authority. Only changes in the plan need be approved (Article 20(2) of the Bill). However, the monitoring plan has to be added to the application for a storage permit. The permit itself may only be granted when the documentation attached to the application is complete and corresponds to the legal requirements (Articles 13 and 12 of the Bill). Legally, though, the storage permit does not include the approval of the monitoring plan.

3.12 Reporting by the operator (Directive 2009/31, Article 14)

Article 22(3) of the Bill requires the operator to report at least once a year on the results of his monitoring, and to submit the data received; he further shall report on the technology used for the storage.

According to Article 24(2), the operator shall report at least every six months on the quantity and properties of the CO_2 which was injected into the storage site.

Article 30(3) of the Bill provides that the operator demonstrates to the competent authority at least once a year the existence of the financial security.
The operator is also obliged to inform the competent authority at least once a year of all information which allows the control, whether the permit requirements are respected, and, furthermore, of facts which increase the knowledge of CO_2 in the storage site (Article 22(3) of the Bill.

3.13 Inspections (Directive 2009/31, Article 15)

The Bill provides for routine inspections ('Kontrollen') at least once a year (Article 28(3) of the Bill). It does not explicitly provide for any inspections after the closure of the facility, though it obliges the competent authority to also monitor the closing of the facility (Article 28(1) of the Bill).

Non-routine inspections ('Zusätzliche Kontrollen') are to be made, when the competent authority learns of leakages or significant irregularities, non compliance with the Bill or its implementing provisions or the permit or with subsequent permit conditions, furthermore, where it is necessary to investigate information from third parties on significant negative environmental effects (Article 28(3) of the Bill). The competent authority is obliged to make the inspections; however, it has discretion on the questions when irregularities or non-compliance with legislation or the permit are significant, or whether third-party information is sufficiently serious.

The provisions on the inspection report and its publication correspond to those of Article 15(5) of Directive 2009/31 (Article 28(6) of the Bill). However, both the provisions of the Directive and of the Bill are not in compliance with the provisions of the Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters, insofar as they give public access to the inspection report only two months after the end of the inspection. The Aarhus Convention does not contain such a time limit, but only contains restrictions for enquiries of a criminal or disciplinary nature. CO_2 storage site inspections are not enquiries of criminal or disciplinary nature.

The Aarhus Convention was ratified by the EU[46] and is thus, according to Article 216(2) TFEU, binding on the EU institutions and on EU Member States. The Court of Justice stated on several

[46] Decision 2005/370, [2005] OJ L 124 p 1.

occasions that the provisions of an international convention that was concluded by the EU, prevail over secondary EU legislation.[47] This means that Directive 2009/31 may not reduce the rights which are granted to citizens under the Aarhus Convention and thus may not introduce a two months delay.

3.14 Measures in case of leakage or significant irregularities (Directive 2009/31, Article 16)

The operator shall immediately inform the competent authorities in the event of leakages or significant irregularities and take the necessary corrective measures (Article 23 of the Bill). There is, though, no obligation to notify the competent authorities of Directive 2003/87 in cases of leakages or risk of leakages.

Article 19 of the Bill requires the operator to establish a 'safety plan' (Sicherheitskonzept) which must be submitted together with the application for a storage permit. However, the Bill does not provide that the safety plan be approved. The safety plan is also not contained in the storage permit, which must contain measures to prevent leakages and significant irregularities, but does not mention corrective measures (Article 13).

The safety plan shall document the long-term safety of the storage site, the exclusion of risks for humans and the environment, and taking of the necessary preventive means against significant irregularities. It shall describe measures to prevent and correct leakages and other significant irregularities. The safety plan shall be accompanied by an opinion of the Federal Agency for Geosciences and Raw materials, and of the Federal Environment Agency.

Overall, the safety plan is equivalent to the 'corrective measures plan' required by Directive 2009/31.

The competent authority may ask for the taking of other corrective measures than those of the safety plan (Article 28(4) of the Bill). The Bill provides that the authority may take the measures itself, when the operator has not taken the corrective measures within a reasonable time-span which is fixed by the authority; the authority then shall recover the costs incurred (Article 28(5) of the Bill). Recovery of costs in practice is done in Germany in the way that the competent authority charges a third party to execute certain measures, pays this third party and recovers the cost from the operator.

The operator has the right of appeal against the decisions of the competent authority. However, his appeal has no suspensive effect (Article 28(5) of the Bill).

As mentioned, the enhanced hydrocarbon recovery is not covered by the Bill.

3.15 Closure and post-closure obligations (Directive 2009/31, Article 17)

Closure of a storage site requires a permit (Article 17 of the Bill). The operator is obliged to apply for the closure permit, when the quantity of CO_2, which was fixed in the permit, has been stored. For the authority to decide on the closure without an application, the storage permit has to be repealed (Article 16). The operator shall then proceed according to the updated safety plan and the updated post-closure plan.

The competent authority may withdraw the storage permit at any moment, once a condition which was essential for the granting of the permit no longer exists; it shall then decide on the closure of the site (Article 16).

In all cases, the authority may recover the costs incurred for the post-closure measures.

[47] Court of Justice, case C-344/04 IATA and ELFAA, with further references.

The Bill does not require the informing of the competent authority of Directive 2003/87. It does not either refer to preventive and remedial actions pursuant to Directive 2004/35.

3.16 Access to transport network and storage sites (Directive 2009/31, Article 21)

Article 33 of the Bill takes over the terms and conditions of Article 21 of Directive 2009/31. Access to the storage site or the transport network may be refused for lack of capacity or binding legal grounds. These legal grounds are not further specified. The operator is obliged to increase the capacity of his installations if this is economically reasonable or when the third party asking for access takes over the costs. On request, he also has to specify the cost of the increase of capacity.

Details for economic and technical questions regarding access may be laid down by regulations.

3.17 Dispute settlement (Directive 2009/31, Article 22)

The Bill charges the Federal Net Agency (Bundes-Netzagentur) with solving disputes concerning transportation lines *and* storage sites, and taking decisions with regard to access disputes (Article 34 of the Bill). Its decisions may be appealed to the High Appeals Court (Oberlandesgericht) of the Land where the installation is located (Article 35).

3.18 Transboundary cooperation (Directive 2009/31, Article 24)

The Bill establishes a number of competent authorities which are situated at the Länder level. Regional law decides which specific authority is responsible in the different situations. There are no specific requirements for transboundary cooperation.

EU legislation relevant for such cooperation is in particular Directive 85/337 on environmental impact assessment, the Espoo Convention on transboundary environmental impact assessment, which was concluded by the European Union, Directive 2010/75 on industrial emissions, and the Aarhus Convention on access to information and participation in decision-making.

3.19 Registers (Directive 2009/31, Article 25)

The Register which the Bill introduces (Article 6 of the Bill) is not established by the different competent authorities but is a central register for the whole of the territory of Germany. The Länder are obliged to transmit the relevant data to the Federal Agency for Geosciences which is the responsible body for the register. The register is publicly accessible. It will contain:

a) all CO_2 transport lines which were applied for or permitted;
b) all CO_2 storage permits which were applied for or granted;
c) information on storage sites which were closed or where responsibility was transferred to a public authority.

The register shall in particular contain maps which show the geographic extension of the sites, information on other possible use, in particular that of geo-thermal energy, and the permanent environmental impacts.

3.20 Penalties (Directive 2009/31, Article 28)

The Bill contains a catalogue of pecuniary sanctions of non-criminal nature (Ordnungswidrigkeit) (Article 43 of the Bill). The sanctions are expressed in euros and may reach a maximum of 50,000 euros. The application of the general criminal law is not excluded, though the same infringement cannot be treated as a crime, once it is treated as Ordnungswidrigkeit.

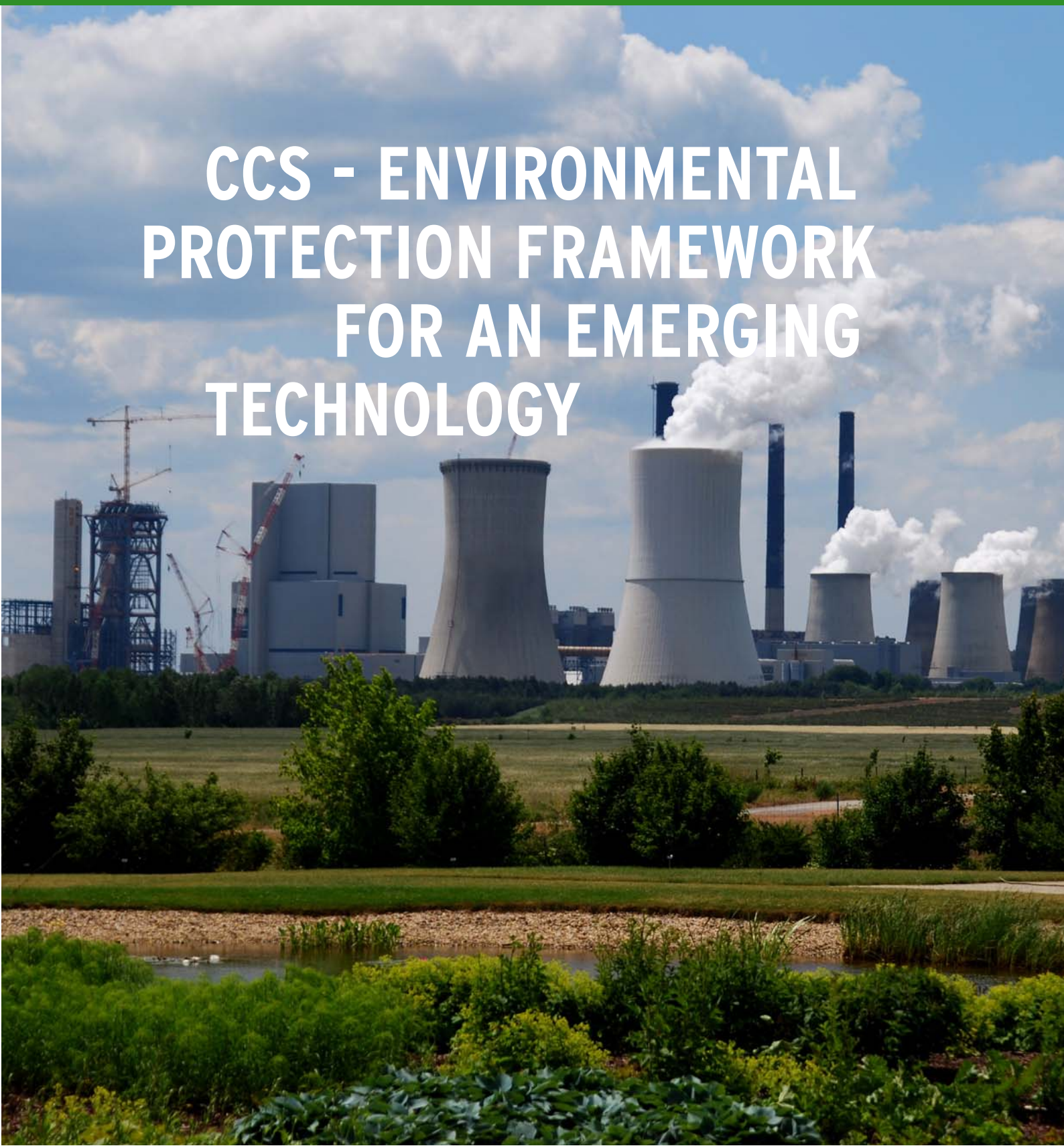
Against the decision to impose a sanction, appeal to the courts is possible.

4. Conclusions

In the light of the still provisional status of the German legislation, the author has decided to leave the conclusions to a later date when legislation will be into force. The CCLP will publish an updated version of this report in due course.

Annex: Opinion of the Bundesumweltamt on CCS of October 2009 [48]

[48] Available at http://www.umweltdaten.de/publikationen/fpdf-l/3867.pdf



CCS - ENVIRONMENTAL PROTECTION FRAMEWORK FOR AN EMERGING TECHNOLOGY

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For our Environment

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CCS –
Environmental protection framework for an emerging technology

Update of the German Federal Environment Agency's position paper on the technical capture and geological storage of CO_2

With this paper, the German Federal Environment Agency (Umweltbundesamt, UBA) updates[1] its position paper of 2006[2] on the technical capture and geological storage[3] of carbon dioxide (CCS: carbon capture and storage).

After a brief description of the development status of the process steps of capture, transport and geological storage of carbon dioxide (CO_2) in Chapter 1, we look into the possible risks for human health and the environment (Chapter 2), which up to now have been little discussed or researched. These risks will largely depend on the integrity of storage sites. On the assumption of functioning capture technology at cost-effective conditions, the capacity of available and secure storage sites will decisively determine the scale of possible greenhouse gas emission reductions through CCS (Chapter 3). In examining storage capacity, it has always to be considered that the geological storage of CO_2 can compete with other uses of underground geological formations, such as geothermics or compressed-air and natural-gas storage (Chapter 4). The Federal Environment Agency takes the view that these factors determine the role that CCS can play as an additional climate protection measure (Chapter 5).

In Chapter 6 we show how CCS, in its application, should be integrated into emissions trading. CO_2 emission reduction should in our view only be acknowledged when it is effectively and demonstrably ensured through permanent storage. Chapter 7 deals with necessary reforms of liability law, which legislators should undertake in order to assign the dangers and risks of CCS to those responsible for them. In Chapter 8, we summarize the fundamental demands on legislators, while Chapter 9 is devoted to issues concerning the source and application of funds for research and development.

1 What is CCS?

- The objective of CCS technology is the reduction of CO_2 emissions into the atmosphere, which occur, above all, in the combustion of fossil fuels at large point sources.
- The climate-protection effect of CCS requires a functioning process chain comprising capture, transport and permanent storage.
- CCS is not yet available. None of the above three steps is presently sufficiently developed. It is therefore not clear whether CCS could be an option for large-scale CO_2 emission reduction and thus a significant climate protection measure.

Climate-policy background

The control of climate change is one of the key challenges of the 21st century. The Intergovernmental Panel on Climate Change (IPCC) has demanded that the global average temperature should not increase by more than 2 °C compared to the pre-industrial level.[4] Only on the basis of this limitation will the consequences of global climate change – among others, the number of people directly affected by coastal flooding, aridity and extreme weather conditions, flora and fauna threatened with extinction, damage to coral reefs and the risk of damage to infrastructure and agricultural production – be controllable on the basis of current scenarios. This 2° C stabilization target for the earth's temperature initially requires a successful turnaround by 2015 to globally decreasing greenhouse gas emissions. Beyond that, global CO_2 emissions would have to fall by 50 – 85% by 2050, compared to the level of the year 2000[5].

[1] The editorial deadline was Oct 5th 2009.

[2] UBA, 2006

[3] The German Federal Government's CCS bill speaks of permanent storage (dauerhafte Speicherung). The word "Speicherung" – i.e. storage – is also commonly used in German publications, although in German mining law it stands for fixed-term, temporary storage. In effect, with CCS a "deposit" or "disposal" is involved, terms that would also be more appropriate. In this paper we nevertheless fall into line with the use of "(permanent) storage" in connection with CCS.

[4] IPCC, 2007

[5] IPCC, 2007

In order to reach these targets, industrialized countries – as the present main emitters of greenhouse gases – will have to shoulder greater burdens than the developing countries. Industrialized countries will have to achieve emission reductions of 80-95%, compared to 1990 levels, by 2050[6]. Germany must accordingly reduce its greenhouse gas emissions from around 1.2 billion tonnes of CO_2 equivalent in the year 1990 to about 0.06 - 0.24 billion tonnes CO_2 eq. by 2050. By 2008, Germany had already reduced its greenhouse gas emissions, compared to 1990, by 23% to approximately 0.96 billion tonnes CO_2 eq., and has set itself an interim reduction target of at least 40% by 2020 in the case of global and comprehensive agreement for the period after 2012.

The main source of CO_2 emissions is energy conversion, which up to now, both in Germany and globally, has been dominated by the combustion of fossil fuels. There is no doubt that successful climate policy is only possible with a substantial reduction of these greenhouse gas emissions.

Priority should therefore be given to the development of the energy system (energy conversion and use; cf. Chapter 5) that satisfies sustainability criteria[7] and avoids CO_2 emissions before they arise. The possible contribution of CCS should be discussed with this in mind.

Principle of CCS technology

The objective of CCS technology is the reduction of CO_2 emissions into the atmosphere from the combustion of fossil fuels. In plants with CCS technology, CO_2 still arises in the combustion of fossil fuels (due to increased specific energy consumption, in fact up to 40% more[8]); CCS is intended, however, to permanently keep 65 - 80% of the CO_2 out of the atmosphere and thus prevent its adverse effect on the climate[9]. Whether CCS can fulfil this promise has not yet been clarified and is currently the subject of numerous research and pilot projects.

CO_2 must be captured at the place of occurrence (mostly a power plant), transported to the storage site and securely and permanently stored in suitable, deep underground geological formations. Only the effective interaction of all process steps will enable a contribution on the part of CCS towards the reduction of CO_2 emissions.

CCS technology has not yet been fully developed. There is worldwide no example of the large-scale application of the overall process from capture in the power plant to storage, or experience with the capture of the complete CO_2 flue-gas stream at a power plant.

Development status of the process step "CO_2 capture"

Previous experience with CO_2 capture relates to other forms of process engineering, such as the separation of CO_2 from extracted natural gas, or to small-scale pilot projects, such as in Schwarze Pumpe in the federal State of Brandenburg, in which much smaller quantities of CO_2 arise than in large-scale operations.[10] Estimates of the capital expenditure, energy and expendable materials required by this technology, estimates of achievable efficiency, capture rate and purity of the CO_2 flue-gas stream, as well as statements on the reliability of the technology and its effect on the operational availability of the power plant and thus power supply security, are all fraught with great uncertainty[11]. There is still a considerable need for research and development. Commercial availability is therefore not to be expected before the year 2020.[12]

Development status of the process step "transport"

The transportation of the CO_2 gas stream is technically unproblematic, with high demands placed on the purity of CO_2 in order to avoid corrosion. With pipelines and tankers this is nowadays common practice. Transportation involves, however, great costs and high consumption of resources, and CO_2 storage should therefore ideally take place close to the power plant where it is captured. It is the large quantities that present major challenges for transportation and storage for fully-fledged CCS application.

Should CCS, for example, contribute 10% to the required worldwide reduction of CO_2 emissions (this would be around 1.5 billion tonnes annually and corresponds to about one-third of the CO_2 production of fossil-based power plants), this would amount – compressed to storage pressure – to a CO_2 volume of around 3 million cubic

6 IPCC, 2007
7 Enquete-Kommission, 1998
8 IPCC, 2005
9 WI et al., 2007
10 Vattenfall, 2008
11 MIT, 2007
12 McKinsey, 2008

metres. By contrast, worldwide annual production of crude oil amounts to around 5 billion cubic metres. The required new transport system for CO_2 would thus have to cope with quantities of a similar size.[13].

Development status of the process step "geological storage"

The leakage-free geological storage of CO_2 on a permanent basis – that is, over very long periods of time – is a new technology. As yet, no detailed knowledge exists regarding large-scale feasibility and actual effects, or monitoring and inspection. For this reason, a precautionary approach is advisable.

In the CCS process, geological storage presents the most uncertainties and potential adverse effects on the environment. There are worldwide few reference examples. Besides a number of small pilot storage sites – such as in Ketzin[14] in the federal State of Brandenburg – there are presently four major storage projects, which each inject a maximum of about 1 million tonnes of CO_2 per year in subterranean formations for the purpose of geological storage. These projects are located in Norway (Sleipner and Snoevit), Algeria (In-Salah) and Canada (Weyburn)[15]. On the basis of the exemplary calculation in the above section on transport involving 1.5 billion tonnes of CO_2 annually, 1,500 storage projects of this size would be required. Other projects – above all, in the USA – that use CO_2 injection for the purpose of enhanced oil recovery cannot serve as a reference from the point of view of storage, since no monitoring of CO_2 containment takes place.

Monitoring and post-storage maintenance

As yet, no appropriate monitoring methods exist for the comprehensive monitoring of stored CO_2. Initial research is being carried out, for example, in Ketzin[16] Mere surveillance from the earth's surface – for example, with seismic methods – is insufficient. There is a lack of technical know-how concerning monitoring at great depths with the required accuracy. Long-term forecasts on the basis of measurements are therefore a necessary addition to such measurements. Monitoring of leakage and quantitative measurement of CO_2 leakage has primarily to be carried out at storage depth at the storage site. Besides CO_2, leakage of natural gas and formation water, which are present in storage sites and are displaced by the injected CO_2 stream, has to be monitored. From this, important pointers emerge regarding potential leakage paths and the localization of possible storage-site vulnerabilities. Furthermore, indirect effects of storage have to be investigated, such as an increase in pressure on surrounding (subterranean) space.

Finally, as provided for in the Federal Government's bill on the regulation of capture, transport and permanent storage of carbon dioxide,[17] storage site operators have to lay down post-storage measures and technical contingency plans at the time of commencing operations, in order that they and the authorities can react appropriately in the case of leakage or accidents. It is still unclear, whether post-storage remediation measures will be available in the case of leakage, and if so, which measures.

2 Possible risks of CCS technology for human health and the environment

- Storage integrity and additional adverse environmental effects from capture, transport and storage are important factors concerning the environmental performance of CCS technology.
- Effective monitoring of qualitative and quantitative demands on storage integrity is a prerequisite for the acceptability of environmental effects.
- CCS will significantly increase CO_2 emissions per produced unit of energy through energy expenditure on capture, transport and storage.

In assessing a new technology – as here with CCS technology – relevant effect categories[18] for the protection of human health and the environment have to be examined, as developed and updated by the Federal Environment Agency for assessment in environmental performance evaluations.

Human exposure

Carbon dioxide (CO_2) is not classified as toxic (according to CLP Regulation EC 1272/2008). It is

[13] IEA, 2008 and internal calculations

[14] GFZ, 2008

[15] BMWi et al., 2007

[16] GFZ, 2008

[17] Bundesregierung, 2009; Parliaments approval was not achieved during the 16th legislative period. A new bill from the federal government could deviate from the text considered here.

[18] UBA, 1999: Bewertung in Ökobilanzen. Texte 92/99

colourless and odourless, non-flammable and in low concentration a constant gaseous component of ambient air. CO_2 has a higher density than air, however, and can therefore collect in low-lying areas or basement rooms, where it can displace oxygen. Possible consequences are high CO_2 concentrations, which in the case of prolonged human exposure can cause breathlessness and, in extreme cases, asphyxia. Risks for human health are therefore only possible in the case of substantial leakage as a result of accidents during transportation and storage.

With proper handling of CO_2 during capture, transport and storage,[19] release in concentrations that pose a risk to human health is not to be expected.

Effects on the environment

Adverse effects on the environment may be a result of storage-site leakage. Leakage increases concentrations of CO_2 in subsurface air, and can therefore inhibit the breathing of plant roots and result in their dying off. Released CO_2 not only reduces the pH value of ground-, capillary and seepage water, it can also trigger geochemical processes and reactions (for instance, acidification, the release of calcium from limestone and the mobilization of heavy metals). The consequences are toxic effects on soil organisms and plants, the occurrence of which is to be expected primarily at a local level and on a small scale. Contamination and admixture of other substances in the injected CO_2 stream may also cause adverse effects on the environment. The precise significance of such effects cannot presently be assessed.

Injection of the CO_2 stream may lead to changes in groundwater chemistry, and can also have an adverse effect on groundwater. As a result of CO_2 injection, subterranean pressure regimes change, whereby formation water is displaced from the storage site and can have an adverse effect on aquifers above the storage site. With the storage of CO_2 in saline aquifers, large quantities of salty groundwater are displaced that can permeate into aquifers containing fresh water.

In unfavourable circumstances, salty groundwater can reach the earth's surface and result in salinization of soils and surface waters. Such contamination is unacceptable on the grounds of environmental protection, and has to be prevented in accordance with EU and German water legislation.

In the marine environment, the injection of CO_2 leads to a reduction in pH value and, as a result, to adverse ecological effects.[20] Corals, for instance, can no longer, or only inadequately form a calcareous skeleton. In accordance with international agreements on the protection of the marine environment, the injection of CO_2 into the ocean water column or onto the sea floor is prohibited.[21] Unavoidable leakage during the proper operation of a sub-seabed CO_2 storage site should not have an adverse effect if it increased the natural CO_2 stream only marginally (< 10%). For the continental shelf this corresponds to a maximum tolerable leakage of 10 tonnes of CO_2 per square kilometre and year[22].

The more CO_2 is injected into subterranean geological formations on the grounds of climate protection the more the potential risks of adverse environmental effects increase. Our state of knowledge is far removed from that required to confront one environmental effect with another.

Effects on the climate

The greenhouse effect is an additional effect category for the assessment of CCS technology, in so far as the technology is particularly intended to mitigate climate change. The criterion for whether CCS technology has an influence on the greenhouse effect – that is, is of benefit to the climate – is the permanent impermeability of the storage site.

Even small rates of leakage could cast doubt on the benefit for climate protection. It is essential that leakage is understood to be the migration of the stored fluid from a geological formation through the cap rock, and that release into the atmosphere is not a prerequisite.[23] In assessing

[19] Our statement is based on the assumption that the capture of CO_2 in more or less pure form takes place, and that no relevant admixture or other harmful gases occur. In accordance with international regulations (London Protocol/OSPAR Agreement), there is an obligation to minimize contamination. To ensure the largely pure form of the CO_2 stream, corresponding demands on capture have to be standardized in the law governing industrial plants.

[20] WBGU (2006)

[21] UBA (publisher) 2008

[22] UBA (publisher 2008

[23] The Federal Environment Agency regards the assumption of leakage in the case of migration from a geological storage site formation as necessary on precautionary grounds, since in this case there is the risk of adverse effects on the environment and of direct release into the atmosphere. The Specific Guidelines of the London Protocol on disposal of CO_2 streams into sub-seabed geological formations also define leakage as migration from a geological formation (cf. No. 6.7, London Protocol, 2007).

the effect of CCS as a mitigation measure, it has to be borne in mind that activities within the CCS process chain (cf. Chapter 1) significantly increase CO_2 emissions. Were only the same quantity of CO_2 to be contained in the storage reservoir as that additionally produced by CCS technology, CCS would then have no climatic benefit. The stored CO_2 must therefore remain in the storage site for a long period of time. In terms of figures, with a maximum allowable annual leakage rate of 0.01%, after 1000 years 90.5% of the initially stored CO_2 would still be contained in the storage site.[24]. Were leakage not to exceed this rate, the benefit to the climate would be ensured.

Use of nature

The criterion of "use of nature" is important to the extent that the availability of suitable storage sites for captured CO_2 is finite. Moreover, the issue of competing use can arise with regard to another sustainable energy resource, namely geothermics, or the storage of compressed air and natural gas (cf. Chapter 4). The construction of a pipeline network for the transport of CO_2 would also require substantial use of nature.

Consumption of resources

Finally, "consumption of scarce resources" has to be regarded as a relevant effect category for the assessment of CCS technology. The application of CCS technology increases the consumption of fossil fuels, whose availability is limited, by up to 40%. Due to the expenditure of energy on CO_2 capture, transport and storage, CCS requires considerably more fuel per produced unit (for example, kilowatt hour of electricity). This additional expenditure of energy not only depletes fossil resources more quickly, but in fact also increases CO_2 emissions and lays further claim to nature and landscape for additional mining and other upstream operations.

As far as possible effects on the environment and human health are concerned, it has not yet been clarified whether, and to what extent, the emission fractions of other atmospheric pollutants will change, compared to a power plant with the same electrical power but without a CO_2-capture installation. The additional fuel consumption for the capture and transport of CO_2 increases the quantity of atmospheric pollutant emissions. We do not assume that this additional CO_2 will be stored together with captured CO_2, since regulations demand, and power plant operators strive for as pure a CO_2 stream as possible, especially for the purpose of avoiding corrosion damage in the CO_2 transport network. From the point of view of environmental quality standards it is essential that pollutant emission fractions caused by the application of CCS technology do not exceed the emissions of conventional energy conversion.

3 Storage capacity

- Secure and sufficiently large storage sites in close proximity to capture plants are a pre-condition for the climate protection efficacy of CCS. Were there to be insufficient secure storage sites, all efforts towards further development of CCS would be dispensable.
- In the choice of storage sites, great demands have to be made on impermeability, in order to ensure their integrity.
- Quantification and localization of storage capacities in Germany, the EU and globally have up to now been too imprecise.

Storage capacity is a fundamental pre-condition

The extent to which CCS actually contributes towards climate protection is determined – apart from the applicability of capture technology – above all by the capacities of suitable storage sites that are actually available. Disposal – that is, the permanent geological storage of CO_2 – is the key component of CCS; emission reduction can only be achieved insofar as CO_2 is permanently and securely stored.

In contrast to capture plants and transport facilities, storage sites are defined by natural conditions. Natural CO_2 deposits, as well as crude oil and natural gas deposits that have partly contained CO_2 over long periods, show that there are geological formations that are able to retain CO_2 underground. Crude oil and natural gas deposits can be more favourable storage sites than other formations such as aquifers containing salt water, since besides their proven impermeability they are also more thoroughly investigated and might have fewer side effects such as displaced water. It is foreseeable, however, at least as far as Germany is concerned, that crude oil and natural gas deposits will be insufficient. The question concerning available capacities of suitable storage sites is therefore still unanswered. Here, the

[24] The geological and geochemical binding affinities of

regulation in the CCS bill could be helpful, which provides for analysis and assessment of storage potentials in Germany by the Federal Ministries of Economics and the Environment.

Besides their geotechnical suitability, the size, location and temporal availability of storage sites must be matched to the respective emission sources – that is, to power plants during their total lifespan. A power plant that emits 10 million tonnes of CO_2 per year requires, over its service life of 40 to 50 years, storage sites with a capacity of about 400 to 500 million tonnes. On the grounds of economic and energetic efficiency, emission source and storage site should not lie too far apart, since recompression of CO_2 is expensive and involves great expenditure of energy.[25]. This issue could influence decisions on the location of future power plants.

Finally, a storage site must be available at the time required. A crude-oil or natural-gas field, which is still in operation, is available for permanent storage of CO_2 only under certain conditions. The practice, primarily in the USA, of using CO_2 for enhanced oil recovery (EOR) does not guarantee the acceptance of quantities arising at the emission source, since in this case the quantity of applied CO_2 is orientated towards production requirements. There is also the risk that CO_2 will re-enter the atmosphere with produced hydrocarbons, should it not be removed from the hydrocarbon stream and re-injected. The prerequisite for subsequent use as a CO_2 storage site is that the infrastructure – that is, boreholes, conveyor systems and, possibly, pipelines – is still intact. Particularly in the case of sub-seabed crude-oil and natural-gas deposits, the period between the end of production and the dismantling of drilling rigs can be quite short. The cost of reconstruction would in this case make the storage site more expensive, and give rise to further adverse environmental effects through the consumption of resources and expenditure of energy.

Demands on the selection of storage sites

The careful selection of storage sites is decisive for the security and efficacy of CCS. Storage security depends essentially on the site-specific characteristics of geological formations. Furthermore, the question of the long-term security of bore plugs is of key importance. Each potential storage site requires detailed characterization in order to ascertain not only its suitability but also the probability of leakage. At the same time, it has to be considered that drilling into storage sites and the large-scale injection of CO_2 involves the risk of triggering seismic events, which – for example through the formation of cracks – increase the risk of leakage, independent of prior geotechnical and tectonic conditions. CO_2 and other contaminants contained in the gas stream react with the rocks of the storage site's geological formations and can further impair storage security. The central instrument for assessing the suitability of a geological formation as a storage site is modelling of its characteristics. The insights thus gained must flow into the approval of storage operation.

The appropriate selection, operation and monitoring of storage sites are of great importance, also because specific opportunities for repair – for example, to seal discovered leakage – at present hardly exist. Furthermore, less ambitious standards and possible leakages at a storage site would jeopardize general acceptance of CCS. In each case, the storage of CO_2 should only take place following official authorization of the storage site and approval of the storage process. The requirement to obtain a permit is accordingly laid down in the EU CCS Directive[26] and in the German CCS bill.

Storage site capacities should be explored

Specific geological exploration is not far enough advanced to allow reliable statements on the capacities of suitable storage sites. The Federal Institute for Geosciences and Natural Resources (BGR) is currently working on a register of possible storage sites in Germany[27]. The register, together with further investigations – such as the investigative drilling of possible geological formations – should allow more precise estimates of Germany's storage potential than those previously made by the BGR (22 ± 8 billion tonnes of CO_2) and the localization of storage sites.[28] Up to now, such quantification has merely concerned theoretical potentials, and the extent to which these will be reflected in more realistic scenarios on usage is still unclear. These investigations must also consider the long-term or even

[25] In the case of natural-gas transportation, it has to be assumed that recompression is essential after about 150 to 200 km.

[26] EU, 2009a

[27] BGR, 2008

[28] By comparison: Power plants subject to emissions trading emit about 350 million tonnes of CO_2 per year.

permanent use of storage sites and possible competition with other uses (cf. Capital 4).

The Federal Environment Agency recommends that large-scale CO_2 capture be pursued only on the basis of the most thorough evidence of suitable storage sites. Only then will it be possible to assess how much CO_2 emission can actually be reduced by CCS technology. This assessment would help to avoid misdirected capital expenditure in capture technology and transport infrastructure.[29] Time schedules for possible large-scale introduction of CCS must take account of the time required for geological exploration of storage sites.

4 Competing uses

- The permanent storage of CO_2 may not hinder or restrict sustainable uses such as geothermal heat and power production.
- Spatial planning is required to avoid conflicts concerning the use of geological formations between CCS and other, above all sustainable forms of use.

The use of extensive subterranean spaces for permanent storage of CO_2 over thousands of years can restrict or preclude other future uses for energy supply, such as geothermics and compressed-air or natural-gas storage, and consumes a limited resource. There is the additional risk of adverse environmental effects (cf. Chapter 2), not least that leakages could represent future sources of CO_2. In this respect, a conflict arises between the potential benefits of CCS for climate protection and compatibility with sustainable energy policy and, in particular, the principle of generational equity.[30]

Prioritization of geothermics over CO_2 storage

The storage of captured CO_2 will be carried out preferably in former crude-oil and natural-gas fields, as well as in deep saline aquifers at depths of 1,000 to 5,000 metres. Certain geological regions, such as the North German Basin[31], are suitable in many places, due to their characterization, not only for CO_2 storage but also for geothermal use. A study carried out by the Office of Technology Assessment at the German Bundestag (TAB) estimates the technically utilizable supply potential for deep geothermics in the North German Basin at a total of 20,200 TWh electricity and 62,800 TWh heat[32]. The sites for economically and ecologically optimized utilization of geothermic potential in the North German Basin have still to be investigated. In wide areas of this region, however, the development of geothermics and CO_2 storage, both of which enjoy political support, are mutually exclusive on legal (Federal Mining Law) and security (see below) grounds.

Competition for the permit for prospecting a particular site could be resolved by subterranean spatial planning and the allocation of subterranean space on the basis of varied geological, infrastructural as well as economic and ecological criteria. Taking account of the principle of prioritization of sustainable uses put forward by the Federal Environment Agency, such subterranean spatial planning would have the result that sites suitable for geothermal heat and power production would not be accessible, or only of limited accessibility for the storage of CO_2.[33] Moreover, a safety clearance would have to be provided for, in order not to endanger other real or potential uses, such as geothermal reservoirs, groundwater resources or thermal-water wells. Injection of CO_2 into the storage horizon leads to wide-ranging subterranean pressure changes, so that minimum clearances between CO_2 storage sites and other uses would be essential for safety reasons.[34]

Due to safety demands on cap rocks above potential CO_2 storage formations, concurrent use of deep geothermics and CO_2 storage at diffe-

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29 In the present debate, the argument is often heard that one could build "CCS-ready" or "capture-ready" power plants, and initially operate them without CO_2 capture, yet at the same time design them in such a way that CO_2 capture, on becoming technically available, could then be retrofitted. The "capture-ready" concept is unsound, however, since even if capture were to be realized, the storage and transport of CO_2 might prove to be impossible. Verification of "capture readiness" must therefore cover not only corresponding facilities at the power plant, but also proven, secure and adequate storage potential as well as substantiated transport infrastructure. Such evidence cannot presently be put forward. Irrespective of that, "CCS-ready", precisely defined, provides no guarantee that, even with given feasibility, retrofitting will take place regardless of its economic efficiency.

30 UBA, 2006

31 The North German Basin constitutes a large geological formation, which stretches from southern Lower Saxony into the North and Baltic Seas as well as into neighbouring countries to the east and west. The spread in northern Germany largely corresponds to the North German Plain.

32 Büro für Technikfolgenabschätzung, 2004

33 WI et al., 2007

34 Rutqvist et al., 2007

rent depths above each other must be ruled out. For stored, supercritical CO_2 would disperse over a wide area underneath the cap rock formation. With the storage of large quantities of CO_2 the result would be CO_2 concentration in a layer of low thickness but wide range.[35] Deep subterranean formations on a large-scale would thus become unavailable for other uses for an unforeseeable period of time. The accelerated development of geothermal electricity and heat production – that is desired on the grounds of climate protection – in regions used for CO_2 storage would thus no longer be possible. The subsequent penetration of CO_2-filled horizons with geothermic boreholes would involve a high risk of leakage and substance mobilization, and could therefore not be undertaken. The basic possibility of drilling around a CO_2 storage site could not be considered, for the risk of compromising storage site integrity would be considerable, and the greatly increased technical investment as well as the resulting substantial increase in costs would prevent or greatly restrict the building of geothermal power plants.[36] Furthermore, the great technical effort involved would impair the environmental performance of the construction phase of a geothermal power plant.

5 The role of CCS in climate protection

- Germany can attain its climate protection targets, also in the long term, without CCS; namely, with substantial energy savings, increases in energy efficiency[37] and the systematic use of renewable energy sources.
- The objective of energy policy must therefore be the sustainable and thus climate-compatible development of the energy system. This may not – as is laid down in the EU CCS Directive[38] – be curtailed through development of CCS. The use of fossil fuels would not be sustainable even with CCS technology.
- CCS could become significant as a bridging technology for a transitional period, in order to attain national climate protection targets, should measures for an increase in energy efficiency and greater use of renewable energy sources not produce the desired effects.
- Countries with large coal and crude oil reserves, and countries whose general set-up does not allow a rapid switch to sustainable development, or whose energy requirements are greatly increasing, also set great hopes in CCS for the reduction of CO_2 emissions. For realization, however, they are dependent on technology transfer.

Sustainable development of energy systems – savings, efficiency and renewable energy sources

Sustainable development[39] of energy supply and use can be achieved by 2050 on the basis of the following basic principles:

1. Energy demand is dependent on the energy service; that is, the energy required for the intended effect.
2. Societal behavioural patterns (for example, consumer behaviour and development planning, such as land-use regulation as well as infrastructural and building measures) are critically examined in terms of energy consumption and modified. At the same time, it is not the standard of living that is on trial, but rather its energy intensity.
3. Energy is converted and transported as efficiently as possible and utilized with efficient techniques; as a result of which substantial energy-saving potentials arise as well as cost benefits for society.

[35] Ennis-King and Paterson, 2003

[36] Frick et al., 2007

[37] An increase in energy efficiency implies combining the chosen energy services (for example, light or heat) with the least possible use of primary energy; that is, cutting back losses across the entire conversion chain. Beyond that, energy savings can also be achieved by a reduction in energy needs, by making use of fewer energy services (for example, by not heating or leaving lights turned on in unoccupied rooms).

[38] EU Directive on Geological Storage of Carbon Dioxide (EU, 2009a), Recital 4.

[39] Here, the comprehensive approach of sustainable development applies, which seeks to realize the principle of generational equity by way of equal consideration of environmental factors – such as climate protection – and social or economic factors, in order to be permanently sustainable (Nationale Nachhaltigkeitsstrategie, Bundesregierung, 2002). The Federal Environment Agency described in detail in its CCS position paper (UBA, 2006) the extent to which CCS can satisfy the guiding principles of sustainability (Enquete-Kommission, 1998). Due to the additional use of fossil resources and the finiteness of storage capacities, CCS violates the principle of economical, efficient and conservative treatment of scarce, natural resources. Sustainable development demands that natural assets be not utilized to an extent greater than their ability to regenerate or provide substitute resources (Bundesregierung, 2002). Uncertainty and lack of experience of the possible adverse effects of CCS on the environment and human health endanger the basic principle of precaution, which is intended to guarantee that we do not burden the ecosystem with more pollutants than it can bear, and to avoid dangers and unwarranted risks to human health (Bundesregierung, 2002). Generational equity would be at risk were CO_2 storage sites to become significant sources of CO_2 in future.

4. Energy demand, markedly reduced in accordance with principles 1 to 3, is basically met with renewable energy sources. The conversion of fossil energy sources is dominated by cogeneration of heat and power.

Were these basic principles to be put into effect parallel to demands for essential CO_2 emission reduction, the operation of additional coal-fired power plants and thus CCS would be dispensable. The 'Lead Study 2008' of the Federal Environment Ministry (BMU)[40] put forward possible scenarios for such a development in Germany, while retaining the statutory phasing out of the use of nuclear energy in Germany. Setting the course of future energy policy in a consistent manner, and the equally consistent implementation of decisions taken on the basis of the above basic principles, are the prerequisite for such a scenario. The success of this course of action will require great efforts on the part of policy-makers, industry and consumers, including continuous re-examination of underlying scenarios with regard to the probability of their realization, forecast potentials and achieved progress or suffered set-backs.

CCS – a complementary climate protection measure

Should it not be possible, on technical, economic or political grounds, to maintain necessary progress in energy policy and the dynamics of realization of a sustainable energy system, or should new scientific findings show that more ambitious climate targets are required, policy-makers – also in Germany – will have to consider additional climate protection measures.

Countries with their own coal reserves, emerging countries with rapidly increasing demand for energy and countries with large reserves of crude oil frequently set other political priorities, and will continue in the long term to make use of fossil energy resources. Where the basic conditions for consistent transition to sustainable development of the energy system are lacking, it will be necessary to secure climate protection targets by strengthening existing measures or by employing additional CO_2 mitigation measures and, above all, by reducing the CO_2 intensity of power plants.

CCS is also to be considered as a potential emission reduction measure. Although CCS comes too late for realization of the necessary turnaround to a worldwide reduction in greenhouse gas emissions in the coming years,[41] it could later support the declining trend, should this technology actually become available.

Availability of CCS requires utilizable and secure storage sites of sufficient size and abundance (cf. Chapter 3), which do not compete with the sustainable development of the energy system (above all, with geothermics) (cf. Chapter 4). Furthermore, capture technology has to be sufficiently developed, economically efficient and available in time. The development of the technology offers opportunities for export to countries with corresponding needs.

The environmental effects of all three process steps of CCS should be evaluated in a life-cycle analysis, including upstream chain, storage site exploitation and post-storage activities (cf. Chapter 2). Only against the backdrop of the results of such an environmental performance evaluation could it be decided whether CCS can play a role, and if so, what role. Since not only fossil resources but also geological storage sites are finite, even with a positive assessment CCS is in any case a possibility only for a transitional period.

6 CCS and emissions trading

- As provided for in the amendment of the EU Emissions Trading Directive[42], CCS is to be integrated into the EU emissions trading system with effect from 2013.
- Operators of power plants should surrender emission allowances for all CO_2, including captured CO_2, produced by these plants.
- Power plant operators will be issued with CO_2 emission credits only for successfully and permanently stored CO_2, since only then will a climatic benefit arise.
- Control of the CO_2 stream in CCS process chains has not yet been adequately regulated.
- CO_2 and other substances of climatic relevance must be treated as emitted as soon as they pass through the cap rock of the storage site. Upper limits of estimates of CO_2 leaked from storage sites take account of uncertainty factors.
- Monitoring costs for integration into emissions trading have to be borne by operators.

[40] BMU, 2008

[41] WI et al., 2007

[42] EU, 2009b

Emissions trading as an economic incentive mechanism

CCS does not yield a profit, but gives rise to additional costs for the capture and storage of large quantities of CO_2, as well as from increased demand for primary energy from plants as a result of this technology. Additional costs would be borne by plant operators only were statutory requirements to compel them to do so, or additional economic incentives exist.

Economic incentives are provided by CO_2 emissions trading, by means of which CO_2 emitted into the atmosphere is given a price. The inclusion of CCS in emissions trading enables plant operators to adequately account for securely stored – that is, non-emitted – CO_2.

This way, CCS technology becomes an option for the reduction of CO_2 emissions. It should, however, rank equally with other technical mitigation options utilized by companies to reduce CO_2 emissions, such as measures for an increase in plant efficiency or fuel switching. CCS would become accepted, were CCS-related additional costs to be lower than the cost of other measures for CO_2 emission reduction, or the cost of purchasing emission allowances.

Emissions trading or regulatory control?

As an alternative or complementary to the economic incentive system of emissions trading, legislators could make CCS mandatory. The mandatory introduction of CCS was also the subject[43] of debate on the EU Climate Package,[44] but was ultimately rejected. The Federal Environment Agency is opposed to the prescribing of CCS capture, since it is not yet foreseeable whether large-scale utilization will be possible, or whether evidence of sufficient and secure storage capacities can be provided. A CCS obligation would lead to commitment to a technology that, against the backdrop of uncertainties and gaps in knowledge, would be premature, and would contribute, moreover, to privileging an option that is not yet fully developed. Furthermore, the environmental effects and their possible avoidance, have not yet been sufficiently investigated (cf. Chapter 2). The danger of a breach of safety and environmental demands on CCS would therefore arise. Instead, we support the role of emissions trading in the realization of CCS technology, where market participants take a decision, based on entrepreneurial considerations, on how they fulfil their emission reduction obligations in line with a specified limit ("cap"[45]) on emissions. The prerequisite, however, is that emissions trading offers a long-term perspective on periods of time that correspond with the capital expenditure cycle in the power-plant sector, and that a steadily-reduced cap likewise projects long-term and ambitious climate goals.

Legislators should limit their role at the present stage to regulating demands on the employment of CCS and, in particular, to laying down environmental demands, with a view to enabling market participants to employ CCS, but at the same time leaving the decision on CCS to them (cf. Chapter 8).

Should it in future become apparent that the market is not implementing emissions trading signals, or should EU emissions trading not impose a cap that is appropriate to climate protection targets, in order to considerably reduce power plant emissions it would be up to legislators to adopt other necessary measures for the attainment of climate protection targets. These could include an obligation to make use of CCS technology.

Fundamental system variables of emissions trading with CCS

From our point of view, the planned inclusion of all installations for the employment of CCS in the EU emissions trading system from 2013 – with the exception of integration of the entire transportation network – is justified. From the environmental point of view, detailed specifications have to be set for integration of CCS into emissions trading, which, however, are not laid down in the legislation.

All installations that burn fossil energy resources for energy conversion, and thus produce CO_2, have basically to be treated equally in emissions trading. At present, this means that from commencement of the third trading period in 2013 operators of such plants, in so far as these produce electrical energy, will not receive free allocation of emission allowances, but will have to purchase allowances (certificates) on the market or at auction. This also applies to installations for the capture, transport and storage of CO_2.

[43] Davies, 2008, p. 76: Amendment 126

[44] EC, 2008b

[45] Here, the total quantity of emission allowances applicable throughout the EU, which is laid down for greenhouse gas emissions covered by EU emissions trading.

This view is also shared by the European Commission and is to be welcomed.

Legislators should make emissions trading predictable on the part of all involved parties, and not encumber the system by cutting the cap – beyond the already planned flat rate of 1.74% per year – in line with the coming into operation of functional CCS installations. For the putting into operation of CCS installations was already take into consideration in projections of greenhouse gas emissions with the apportionment of emission reduction contributions to the emissions trading sector and remaining sectors up to 2020[46]. Moreover, the ex ante principle applicable in emissions trading speaks against subsequent adjustment of the cap as a reaction to certain technological developments, since this would impair the planning ability of involved parties and introduce substantial uncertainties into the system. The specified cap should project climate policy goals, irrespective of the technology employed for their realization.

Reduction of system and implementation costs through the balancing of CO_2 streams

On examining the CCS process chain, it has to be ensured that future regulations keep the cost of implementation on the part of companies and authorities effective and efficient. This applies, above all, to monitoring. The recording of CO_2 emissions during transportation from the source to the storage site could result in very high bureaucratic and operative costs. Based on a likely complex network of pipelines connected with several CO_2 sources and storage sites as well as varied responsibility of different parties for individual pipeline sections, CO_2 streams would have to be measured and documented at every transfer point; otherwise, emissions could no longer be clearly assigned.

We regard it as proper that CO_2 producers (for example, power plants) have to surrender emission allowances for all CO_2 produced, whether captured or emitted into the atmosphere, and that this is therefore treated as released. In return, storage site operators should receive emission allowances for stored CO_2 in the amount of the verified, permanently stored quantity. Costly monitoring of pipeline networks or other transport systems could thus be dispensed with. Only compressor stations operated for the transportation of CO_2 would have to be integrated into emissions trading. This approach is adopted approximately in the CCS bill with its "storage-site receipt approach"; according to which, a primary producer of CO_2 can only assert a claim, within the framework of emissions reporting, to the quantity of carbon dioxide that has been verifiably and securely stored. In this case, too, extensive control of the transport pipeline is unnecessary. Since pursuant to the CCS bill, however, emission allowances are not issued to a storage site operator, but instead a reduction of the primary producer's obligation to surrender emission allowances effected in the amount of the stored quantity of CO_2, clear assignment of storage site and power plant must be possible, which would hardly be possible in the case of a potentially complex pipeline network.

Beyond that, it would have to be ensured that CO_2 is not transported beyond EU borders, in circumvention of the obligation on the part of plant operators to surrender emission allowances, or contracting states subject to obligations under the Kyoto Protocol. Transboundary CO_2 transportation must not lead to a weakening of the requirement for the surrendering of emission allowances by plant operators responsible for CO_2 emission. EU regulations deal inadequately with this latter circumstance, and thus endanger the cost-efficient reduction of greenhouse gas emissions that is intended with emissions trading.

Combination with biomass – consideration of stored CO_2 from biomass combustion

A reduction in the total quantity of CO_2 in the atmosphere can be connected with the capture and storage of CO_2 from the combustion of sustainably produced biogenic fuels (negative emission).[47] The IPCC also demands[48] that CO_2 from the combustion of biogenic materials, which is captured and stored, not only leads computationally to negative emission in the total system, but has also to be accounted for in the CO_2 balance. The issuance of emission allowances to storage site operators for the secure storage of CO_2 – in the manner proposed by the Federal Environment Agency – rewards the application of CCS in biomass combustion, since the particular primary energy source, from which CO_2 derives, is irrelevant to the issuance of emission allowances.

[46] EC, 2008a

[47] WBGU, 2006, 2008

[48] IPCC, 2005

Determination of CO_2-leakage from storage sites and the treatment of uncertainties

The precise quantification of leakage of greenhouse gases from storage sites is of decisive importance for sound integration of CCS into emissions trading. Established measurement technology presently allows only imprecise quantification. It has therefore to be ensured that for the integration of CCS into emissions trading not only all emissions – including expected leakage from storage sites – but also uncertainties in the quantification of released greenhouse gases are considered in determining the quantity of emission allowances that have to be surrendered for the storage site. Adjustments to reported emissions for uncertainties, on the basis of which the requirement to surrender emission allowances ultimately results, have to be measured in such a way that they comply with the maximum permissible 1.5% uncertainty – demanded for large power plants in the monitoring guidelines for emissions trading[49] – in determining the quantity of allowances to be surrendered[50]. Uncertainties in excess of 1.5% should therefore entail an increase in the quantity of emissions allowances that have to be surrendered, in the form of a conservative adjustment of the initially determined emission quantity[51]. This way, it can be guaranteed that emissions are not underestimated.

Were actual CO_2 leakage from storage sites to be undervalued, this would amount to unjustified support of large power plants that capture CO_2. In the end, they would be at least indirectly absolved from part of the environmental pollution for which they are responsible, and would then come to enjoy a financial privilege that operators of power plants that – for instance, on economic grounds – renounce the use of CCS technology could not take advantage of.

Monitoring has to take place at the cap rock of a storage site; otherwise, diffuse leakages could remain undetected and result in storage site operators remaining (wrongfully) exempt in part from the existing requirement to surrender greenhouse gas emission allowances. With direct measurement at the cap rock, the storage site operator might receive no emission credits for released greenhouse gases that ultimately, however, do not reach the earth's surface and enter the atmosphere. In view of the otherwise threatening unjustified advantage, and the resulting weakening of the pollutant-pays principle, we regard this as justified.

Displaced greenhouse gases must be adequately considered in emissions trading

The greenhouse gases to be accounted for include not only injected CO_2, but also, where applicable, other gases – such as methane – that are displaced from the storage reservoir by this CO_2. The greenhouse effect of one kilogram of methane over a period of 100 years is 23 times greater than that of one kilogram of CO_2. The storage of CO_2 must not lead to the situation that the climate is additionally polluted with displaced methane.

In the case of "displaced greenhouse gases", the responsible storage site operator would have to accept these equivalent greenhouse gas emission loads in the form of a requirement to surrender emission allowances. EU statutory requirements have not yet addressed this issue. Insofar as displaced methane is verifiably and completely recorded and utilized, the storage site operator is not required to surrender emission allowances. Were the methane not to be utilized, it would have to be ensured that the storage site operator surrenders an equivalent quantity of emission allowances. As in the case of the measurement of CO_2, uncertainties in quantification would be at the operator's expense.

7 Questions of liability

- Ambitious liability regulations are required for the employment of CCS technology.
- Potential damage is widely varied and not yet adequately researched.
- Regulations must contain provisions on dealing with such damage.

The operator must ensure remediation of damage and bear the resulting costs

Those who employ CCS are responsible for possible damage, which we have described in Chapter 2. This follows from the polluter-pays principle. In the case of damage to private property and environmental assets – such as soil, ground-

[49] EC, 2007

[50] This is in accordance with the current discussion in the EU on the treatment of uncertainties in the quantification of storage site leakage.

[51] Emissions to be reported are determined as follows: reported emission = measured emissions*(1+actual uncertainty-0.015)

water and other water bodies as well as biodiversity – the operator of the responsible facility (power plant, transport system or storage site) must carry out reasonable remediation, irrespective of the question of fault, and also bear the resulting costs. The Federal Environmental Liability Act (Umwelthaftungsgesetz), for example, provides for such fault-free liability (so-called strict or absolute liability) for the realization of risk exposure in the operation of particular installations. Both the Federal Mining Act (Bundesberggesetz) and the Federal Genetic Engineering Act (Gentechnikgesetz) contain examples of strict liability. They already sanction risks emanating from a facility or behaviour that to some extent exhibits great damage potential. The idea rooted in these regulations is applicable to a CO_2 storage site. In cases involving damage to the private property of third parties it is necessary, furthermore, to ease the burden of proof concerning the causing of damage; for example, in the form of presumption of cause. This makes it easier for those affected by damage to enforce their claims. Here, too, the three above-mentioned Acts, with their presumption of cause (in particular Article 34 of the Genetic Engineering Act and Article 120 of the Federal Mining Act), could serve as a model on account of their stringency.

Responsibility of the state at the earliest 50 years after closure of a storage site

Following cessation of storage operations the operator should remain responsible for the closed storage site. He must, above all, continue the monitoring of leaked CO_2 and other such substances. The closure of a storage site alone does not relieve the operator of his responsibility. Ultimately, responsibility for a storage site – with monitoring and possible remediation obligations – should pass to the state, but only if CO_2 and other substances remain permanently and completely contained in the storage site, so that no climatic effects can develop and no adverse local environment effects threaten. The site operator could otherwise shuffle off too many risks to the state and thus the taxpayer. The state should only take on long-term responsibility for a storage site. We advocate the transfer of responsibility only after expiration of a relevant period of time – at least 50 years during which no leakage has been detected – following closure of a storage site. Site closure on the one hand and transfer of responsibility on the other are dependent on proof of storage-site integrity. These demands guarantee that responsibility may only pass to the state in respect of a storage site for which the operator has substantiated impermeability over a prolonged period of time. It is also important to lay down that in the case of gross negligence or wilful intent the operator may be held liable for the occurrence of risk or damage even after expiration of that period of time.

Create adequate financial security for risks

The storage site operator has to deposit adequate financial security for the financing of necessary measures, from site monitoring to the surrendering of emission allowances for leakage and remediation of damage. This lowers the risk (for example, that associated with insolvency) that the respective operator will not be in a position to financially compensate damage.

Such security may only be completely released at the moment of transfer of responsibility to the state, and not already on closure of the site. Damage can occur after cessation of storage or following closure of the site. It should be ensured that the period from cessation of CO_2 injection to transfer of responsibility to the state is sufficiently long, in order, on the basis of experience gathered during this period, to be able to guarantee storage site impermeability with as much certainty as possible.

The site operator should compensate the state for its assumption of responsibility. This compensation is linked to the financial security mentioned above. Payments should flow into a liability fund, out of which the authorities can meet costs incurred in connection with post-closure maintenance, and also take appropriate account of the risk of damage. Payments can be made regularly during operation of the storage site, or in a single sum on the transfer of responsibility to the state.

8 Statutory framework

- he statutory framework should enable environment- and health-compatible CCS projects; it should not, however, promote them.
- The precautionary and the polluter-pays principles must apply.
- The entire CCS process chain requires regulation.

Objective of a statutory framework

A statutory framework[52] for CCS should solely enable CCS projects that meet stringent demands concerning environmental, climate and health protection. The statutory framework should serve neither to hinder nor to promote CCS projects. It must pursue an approach that encompasses all environment media, since the effects of CCS technology can affect the climate, atmosphere, water and soils. The precautionary principle has to apply, above all in view of considerable uncertainties concerning environmental effects and the long periods during which CO_2 is to be stored. Pivotal, too, is the polluter-pays principle. Those who employ CCS technology in order to fulfil their emission reduction obligation within the framework of emissions trading must bear its risks and its costs, and they may not load them onto the general public.

Key demands on a statutory framework for CCS

The following demands on a statutory framework for CCS technology from an environmental protection perspective are derived from the preceding chapters.

- The statutory framework should not require employment of CCS in existing or new power plants (cf. Chapter 6).
- Subterranean spatial planning should undertake the allocation of subterranean space on the basis of varied geological, infrastructural as well as economic and ecological criteria. Such subterranean spatial planning is appropriate for preventing the endangering of other, in particular sustainable uses of subterranean formations (cf. Chapter 4).
- In deciding on the approval of operation of a CO_2 storage site, the competent authority should be given scope in the weighing of interests. We welcome the fact that the CCS bill provides for this. The manifold public and private concerns that speak for and against a CCS project can thereby be considered and weighed up in the decision-making process. Should subterranean spatial planning not be undertaken, competing sustainable use should be included in the weighing up of interests with its respective weighting.
- The statutory framework must set high demands on the security of CO_2 storage sites in the interest of the environment, the climate and health protection. It should rule out leakage that endangers the climate benefit or involves a risk to human health and the environment for an infinite period. The climatic benefit of CCS from a technical point of view would not be guaranteed, were the rate of annual CO_2 leakage to exceed 0.01%. Compliance with demands is to be substantiated with a forecast based on geological characterization of the storage site in line with the state of science and technology.
- In order to avoid local adverse environmental effects, a still-lower leakage threshold could be necessary. The laying down of precise limit values is, in part, not possible, since the technology is still being developed and fundamental knowledge on environmental effects is lacking (cf. Chapter 2). New insights have to be followed in future by enforceable demands.
- The statutory framework should set high demands on the purity of CO_2 streams intended for storage. The CO_2 stream may contain no substances and substance concentrations whose storage raises the fear of adverse effects on the security of the storage site, or on human health or the environment. The statutory framework should also prohibit the disposal of wastes and other materials with the CO_2 stream.
- In line with EU and German legislation on water bodies, the discharge of salty groundwater displaced from the CO_2 storage site into aquifers containing fresh water must be prevented.
- Operators must be required to ensure a high level of protection during operation of the storage site. The statutory framework should require operators to take precautionary measures to guard against risks to human health and the environment during storage operations that correspond to state of science and technology. We welcome the fact that the CCS bill provides for dynamization. Should leakage, risks of leakage, dangers or risks to man or the environment occur – regardless of the substance or event that gave rise to them – the statutory framework must require operators to remedy the cause and bear the resulting costs up to the transfer of responsibility to the state.
- The statutory framework must oblige operators of storage sites to provide effective monitoring and formulate specific demands for this purpose. These demands should be of a dynamic nature, so that operators adopt technical advances in monitoring and adjust their existing monitoring measures accordingly.
- Operators should be required to submit detailed concepts during approval procedures for

[52] See the final section of this chapter on the Federal Government's bill.

storage-site operation, measures for the prevention of dangers and risks, as well as for monitoring, storage-site closure, and post-closure maintenance, and to update such concepts in line with the state of science and technology.

- Besides laying down pre-conditions for the long-term responsibility of the state for a storage site, and the creation of reserves for contingent liabilities (cf. Chapter 7), the statutory framework should also provide for liability in respect of such damage as does not have to be remediated pursuant to the EU Directive on Environmental Liability. This concerns, for example, flora and fauna that do not fall under EU law on the protection of species.

Development of a statutory framework

International agreements on the protection of the marine environment (OSPAR, London Protocol) prohibit CO_2 storage in the ocean water column. Sub-seabed storage is basically permitted, but high demands are set on the protection of the marine environment. The European Parliament and the Council of the European Union have adopted the Directive on the Geological Storage of Carbon Dioxide[53], which came into effect on 25 June 2009. The directive creates new legislation on CO_2 storage. Among other things, it lays down a requirement for approval of CO_2 storage sites, material demands on their selection and operation as well as post-closure measures. The directive further regulates access to the CO_2 transportation network and adapts existing EU legislation, including the Environmental Impact Assessment Directive, accordingly.

German law has to regulate the entire CCS process chain comprising capture, transport and storage. It has to take into account the requirements of international agreements on the protection of the marine environment as well as EU requirements, and it must fill the gaps in such requirements. In so doing, the objectives mentioned in this chapter have to be pursued and key demands on a statutory framework have to be met.

With CCS technology, climate and environmental protection are of prime importance, so that regulations under environmental law must form the focus of the German statutory framework. Due to the novelty and the risks of CO_2 storage, a specific statutory framework is required.

We regard orientation towards the Federal Mining Act as inappropriate. On account of its purpose, the Federal Mining Act does not lay down environmental law, and environmental protection is not given the consideration in its specific provisions that is necessary for the regulation of CCS.

The Federal Environment Agency therefore welcomes the fact that the Federal Government's CCS bill has the intention of regulating the storage of CO_2 in a separate Carbon Dioxide Storage Act. Besides storage, the CCS bill also regulates the other steps in the CCS process chain, namely capture and transport. Among other things, it

- provides for a planning approval procedure with latitude in the weighing of interests,
- requires submission of proof of security by operators, with which the long-term security of the storage site, the averting of danger and required precautions in line with the state of science and technology have to be substantiated,
- requires operators to readjust activities and installations in such a way that long-term security, the averting of danger and precautionary measures are ensured in accordance with the latest developments in science and technology,
- requires adjustment of the concept, according to which the operator monitors the storage site, and of concepts for storage-site closure and post-closure maintenance, in line with the state of science and technology, and
- requires legislators to regularly examine whether regulations concerning demands on the storage of CO_2 need to be amended to take account of the state of science and technology.

[53] EU, 2009a

9 Research on CCS – Emphases and funding

- Before wide use of CCS becomes an option, technological development is required and critical questions concerning environmental protection and the statutory framework have to be clarified. For this purpose, the promotion of research is necessary.
- Financial support must not hinder the promotion of energy efficiency measures and the further development of renewable energy sources.
- With CCS, storage-site exploration, investigation of effective monitoring and post-closure maintenance as well as the relation to other uses (for example, geothermics) should be the main focus of research.
- Proceeds from the auctioning of CO_2 emission allowances should be used to fund research.
- Allocation of additional emission allowances within the framework of emissions trading is not an appropriate funding instrument.
- Global transfer of technology and knowledge is essential.

Clarification of the suitability of CCS as a climate protection measure

In order to attain climate protection targets, all CO_2 emission reduction options have to be examined. Rapid clarification of technical viability and the required statutory and economic frameworks should be undertaken, in order to judge whether CCS could be a complementary climate protection measure. The specific environmental effects of the entire life-cycle of large-scale realization and resulting ecological demands are of decisive importance for the assessment of CCS. A fundamental condition for promotion of research is, however, that it does not hinder prioritized research and development of sustainable climate protection options (technologies and other measures); in other words, it should be in due proportion to the promotion of sustainable options such as renewable energy and energy-saving schemes.

Set the right emphases for research

CCS functions only in the process chain as a whole, from capture to transport and finally to storage. Research is therefore necessary on all three steps in the chain. It is particularly important from the climate protection point of view to clarify, to what extent secure and environment-compatible storage sites exist. Subterranean exploration should be designed in such a way that generally accessible knowledge of geological formations and their petrochemical and hydrochemical properties is improved, and thereby other uses – for example, geothermics as well as natural-gas and compressed-air storage – served. Further research should focus on appropriate monitoring methods and post-leakage measures. It has to be guaranteed, of course, that knowledge gained with the help of public funds should also be made and remain available to the general public.

Research funds from the proceeds of auctions of emission allowances

Proceeds from the auctioning of emission allowances within the scope of the European emissions trading scheme should ideally be wholly directed towards climate protection. In the third trading period from 2013 to 2020, annual proceeds of around 20 billion euros are to be expected from the auctions, depending on the price and volume of auctioned allowances.[54] Although only at least 50% of these proceeds, as provided for in the new Emissions Trading Directive, should be made available by Member States for the financing of climate protection measures, this is still equivalent to 10 billion euros per year, or a total of 80 billion euros of support funds over the third emissions trading period. A reasonable proportion of this amount, on the basis of the above-mentioned prioritization, should be made available for research into the environmental effects of CCS and for the development of diverse CCS demonstration projects.

Grounds for rejecting the funding of demonstration plants with emission allowances

Besides direct funding from auction proceeds, the EU Directive provides for special funding – beyond the crediting of stored CO_2 as "non-emitted" – of CCS in emissions trading for up to 12 CCS demonstration projects. For this purpose, the Directive provides for up to 300 million emission allowances (EUA) from the "New

[54] This figure is based on the assumption that an annual EU-wide total of approximately 1 billion emission allowances will be auctioned at a price of 20 euros per tonne. This assumption is based on the impact assessment of the European Commission's Climate Package of 23.01.2008 and on current information regarding both the final details of the new ETS directive 2009/29/EC and recent developments on the ETS market.

Entrant Reserve" [55] to be made available to operators of CCS demonstration projects. In addition, with these 300 million EUA, demonstration projects on "innovative renewable energy technologies" in the EU should also be funded.

Funding on this scale threatens to disturb the relation to other climate protection measures.[56] In every case, promotion should be limited to additionally required capital expenditure and should not subsidize operating costs. The Federal Environment Agency regards the described approach as inappropriate for two reasons.

Firstly, the proposed funding from the reserve for new installations contravenes the fundamental idea of emissions trading, namely that the market should discover, on a technologically neutral basis, the most favourably priced CO_2 reduction option. The Federal Environment Agency rejects explicitly the "overloading" of emissions trading with other tasks, such as the subsidization of particular technologies, for example CCS.

Secondly, the reserve amounts – at present estimates – to not more than 700 - 750 million EUA. The proposed funding of 300 million EUA therefore represents a substantial reduction in the amount of EUA available for new installations and capacity extensions. Whether the remaining 400 - 450 million EUA will suffice for the original purpose of gratuitous allocation for new installations and capacity extensions is at the very least uncertain.[57] Since a "reserve replenishment mechanism" does not exist, on depletion of the reserve no EUA would then be available for allocation to further new installations or capacity extensions. This could represent a considerable obstacle to such capital expenditure, not least because of competition from outside Europe.

Integration of CCS into the global carbon market – the present status of discussion

The clean development mechanism (CDM), a project-based instrument of the Kyoto Protocol, allows the offsetting of emission reduction in developing countries against reduction obligations in industrialized countries and companies. Certain countries strongly argue the case for compensating of emission reductions that have been achieved in individual projects with the help of CCS. Particularly those that have appropriate geological formations – above all, countries with crude oil and gas reserves – have a distinct interest in this. Many countries expect deployment of this technology within the scope of technology transfer agreed within the framework of the UN Framework Convention on Climate Change and the Kyoto Protocol. Other parties to the Framework Convention regard CCS as competition for more attractive CDM projects with renewable energy or energy efficiency, which make a greater contribution to the sustainable development of their countries. The EU supports recognition of CCS in the CDM, provided that the highest quality standards are met, and proposes pilot projects, restricted in both number and volume, in the period up to 2012. These should help to gain on-site experience with the planning and execution of such projects with the co-operation of national institutions. The UN conference of contracting states in Pozna?, Poland in December 2008 was unable to agree on basic admissibility of CCS to the CDM. The discussion will be continued in the period leading up to the next conference of contracting states in Copenhagen in December 2009.

The EU is among the few parties that can provide the funds required for the development of new technologies such as CCS, while emerging and developing countries will be dependent on technology transfer. This applies, however, also to sustainable development paths, whose support, in the opinion of the Federal Environment Agency, has priority.

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[55] The original – and primary – purpose of the NER is to make available EUA for allocations to new installations and capacity extensions in the industrial sector and for defined plants for cogeneration of power and heat.

[56] For example, at an auction price of 20 euros per tonne, 300 million EUA are equivalent to 6 billion euros.

[57] Moreover, there is the possibility of a further reduction in the reserve due to the allocation for power plants in the Baltic States in connection with the closure of the Ignalina nuclear power plant in Lithuania.

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