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The legal and political framework for CCS and its implications for a European Utility

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Abstract

During the last 10 years, CCS has been developed and is now widely accepted to be a key technology to significantly reduce the CO_2 emissions from the power sector and other large stationary emitters. To make use of the climate mitigation potential of CCS it is however required that some existing key challenges in terms of technology and legal aspects can be overcome. The proposed CCS directive for the European Union could provide the necessary legal framework if the directive is not overburdened by requirements which could not be justified for a technology in its demonstration phase. Like for renewable energies the development of clean fossil power generation technologies requires public support, as the risks for individual companies are just too high. The main critical points based on the adapted amendments by ENVI are related to liability and financial securities, the required composition of the CO_2 stream and the introduction of an emission performance standard for new coal fired power plants. All this points will be discussed with some details in this article. It is hoped that based on a constructive dialogue with the stakeholders a widely accepted solution can be found which would pave the road to a low carbon power generation future.

CCS directive, European Commission; CCS; liability, financial securities, emission performance standards, purity of CO_2

1. Introduction

A majority of scientists agree on the fact that climate change is a serious issue which has to be dealt with urgently. Based on the 4th Assessment Report of the IPPC [1] there is high evidence, that climate change is linked to the CO_2 concentration in the atmosphere. Most climate models predict that a doubling of the CO_2 concentration in the atmosphere compared to pre-industrial levels will lead to a rise in the global mean temperature by 2 to 5 °C. Total worldwide greenhouse gas emissions have been in 2005 about 27 Billion tonnes of CO_2. If those emissions remained constant at the current level, concentrations would more than triple until 2100 compared to pre-industrial levels. Worldwide CO_2 emissions from fossil fuel combustion in stationary point sources, that emit more than above 100 kt CO_2/year, sum up to annual CO_2 emissions of 13377 Mt CO_2/a of which the majority is linked to power generation, **figure 1**. This give a clear sign that the power industry should be concerned on how to deal with CO_2

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based on their business activities. So the power industry has taken up the challenge to find solutions to reduce the environmental impact of their business activities.

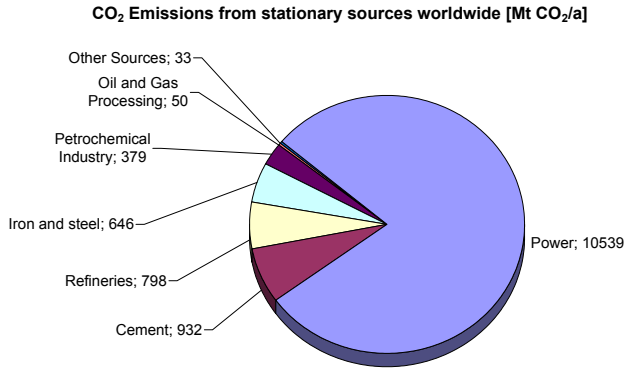

Figure 1: Worldwide CO_2 Emissions from stationary sources [2]

E.ON as an international major in power generation in Europe has therefore developed strategies and has set own targets to reduce the specific CO_2 Emissions from power generation. **Figure 2** shows the emission reduction target for E.ON's power generation portfolio and the possible options to achieve it. Starting from the specific emission value of 720 g CO_2 /kWh in 1990 we are going to reduce the specific emissions by 50 % until 2030. However this will require significant activities in R&D, demonstration and deployment for new and existing power generation technologies [3]. The main options identified to reach the reduction target are the increased used of renewable energie, such as wind (onshore and offshore), the increase of efficiency for coal and gas fired power plants (e.g E.ON's 50plus coal power plant Wilhelmshaven and the CCGT power plant Irsching with more than 60% electrical efficiency) and the introduction of CCS technologies to significantly reduce CO_2 emissions from coal and gas fired power generation CCS. In 2008, we have started a post combustion pilot program with 7 different technology providers at 7 different power plant sites to understand and evaluate this new technology and identify partners for the next size – the pre-commercial scale.

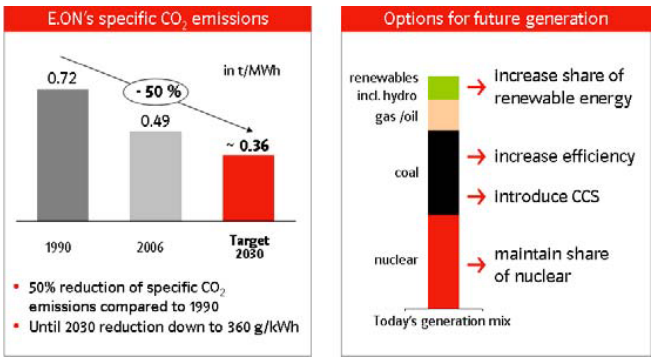

Figure 2: E.ON reduction targets for specific emissions from power generation

However, not only scientists and utilities are concerned about climate change but also it is now widely accepted in Europe that climate change is a serious problem which has to be dealt with by all stakeholders. A recent survey [4] conducted for the European Parliament revealed that 90% of European Citizens see climate change as a fairly or

very serious problem, **figure 3**. Even if opinions show slightly different result in the member states, there is a large consensus that action is required.

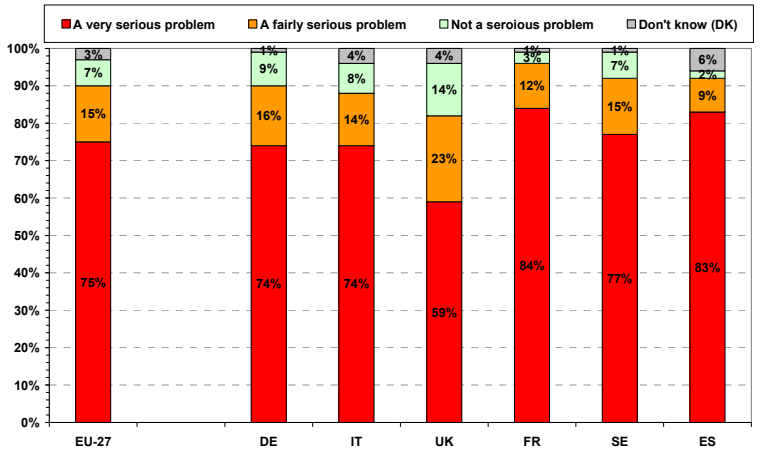

Figure 3: The importance of global warming as seen by the citizens of the EU [4]
Question answered: And how serious a problem do you think global warming / climate change is at this moment? Please use a scale from 1 to 10, 1 would mean that it is not a serious problem at all and 10 would mean that it is extremely serious.

Even if not yet widely known in the general public carbon capture and storage (CCS) has become an important part of the solution for the next decades. There has been gained a significant amount of CO_2 storage experience on projects such as Sleipner, In Salah or Weyburn, but there still remains the necessity to make CCS mature in terms of technology and costs. In addition there is a need to develop a legal framework for the technology which could be partly based on existing regulations but needs to be adapted and extended to cover all the relevant aspects.

One key element to make CCS legally available is the draft of a directive for the geological storage of CO_2 [5] which had been published in January 2008 by the European Commission as part of the so called “Green Package”, a bundle of measures to address climate change. The German power industry, which strongly supports the Commission in its target to significantly reduce the CO_2 emissions from power generation, supported over the last view months actively the work on and the discussions about the proposed directive.

Just before the completion of this article, the Environmental Committee of the European Parliament voted on October 7, 2008 on the proposed amendments to the directive [6] and will soon start the discussions with the European Council to complete the work on the directive under the French presidency of the EU.

2. Legal aspects for storing CO_2 in Germany and the proposed CCS directive

Under existing legislation in Germany, it is actually not allowed to store CO_2 underground. However there are actually two projects under way in Germany, where CO_2 is injected underground. One is the well known R&D project in Ketzin and the other one is a project for enhanced gas recovery (EGR), in which, from the permitting perspective, the CO_2 is used as an auxiliary substances to enhance the hydrocarbon production. This procedure could be permitted under the existing German Mining Law (“Bergrecht”). It is also impossible to get explorations permits for possible CO_2 storage site under the existing mining law. Instead one manages with the exploration permit awarded for the exploration of saline brine.

So, to make CCS possible in Germany, the legal framework has to be adapted which will follow the European Directive for the geological storage of CO_2. The European Commission which is strongly pushing the application of

CCS to reach European emission reduction targets is working on the development of a European Demonstration program with 10 to 12 large scale power plants with CCS operational by 2015. However, to make this happen, the fast adoption of the CCS directive is a prerequisite to achieve this target, as the directive has to be transferred into the national law of the member states which takes additional time for implementation. A recent study by the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP[2]) estimated that the permitting process of a CCS power plant including pipeline and storage would require at least 7 to 10 year for completion. So projects that should start operation in 2015 should be already in the planning process at the time this paper has been written.

However, the CCS directive proposed by the European Commission as part of the green package in January 2008 is still underway. On October 7th, 2008 the Environmental Committee of the European Parliament has voted on the large number of proposed amendments.

3. The proposed CCS Directive from an Utility Perspective

The aim of the directive to provide the legal framework for storing CO_2 in Europe is seen as a major step forward to make clean power possible in the future. However it should be seen, that there is also a high risk to overburden the regulation and therefore building up new barriers for the upcoming CCS Technology. Some parts of the proposed regulation could lead to technical barriers which could not be overcome or to requirements which significantly would increase the costs for CO_2 storage, making CCS uneconomic compared to unabated power generation.

Technical barriers base on the draft text of the CCS directive are mainly related to absolute requirements, which could not be fulfilled by technical systems such as no H_2S in the CO_2 stream (meaning 0.00000%) or not any leakage (meaning 0.00000%). There is a general agreement that leakages or unwanted components in the CO2 stream should be reduced to a minimum, which takes into account the technical feasibility, the technical requirements and economic impacts. There are no technologies without any risk but this should only mean that risks should be mitigated as far as possible and to limit the possible damages which might occur in case of failure.

In the following subparagraphs, three key concerns from a utility perspective are discussed in regards to the proposed CCS directive and the Amendments voted for by the Environment Committee of the European Parliament.

3.1. Liability and Financial Securities

The CCS directive includes the regulation of liability issues and the request for financial guarantees which should cover the possible risks stemming from the operation of the storage and in addition the risks arising from the ETS directive meaning the costs for purchase of certificates for each tonne of CO_2 lost due to a leakage from the storage site. However the draft directive does not include values for the share of stored of CO_2 that might be at risk to leak out from a storage site. Based on previous experience and based on the special report of the IPPC, leakage rates are expected to be below 0.01%. However some governments have already signaled that they want a much higher fraction of the stored CO_2 to be backed up by financial securities and values of up to 100% have been proposed. **Table 1** summarizes the implications of such claims. Depending on the certificate price and the assumed possible leakage rate, the additional cost would be as high as 4.16 Euro per tonne of CO_2, a value which would increase the estimated storage cost by about 50 %. Compared to this costs arising from the inclusion into the ETS directive, the possible costs to financially secure the risks based on faulty equipment to humans and the environment can be nearly neglected.

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[2] The ZEP is formed by member of the European Commission, European industry and NGOs. Scientists and environmentalists have united to enable European fossil fuel power plants to have near zero CO_2 emissions by 2020 (www.zero-emissionplatform.eu).

Table 1: Additional cost based on required financial security for storage of CO_2.
(Base assumptions: 45 years operation and 55 years post closure period; interest rate 5%, security for full storage capacity given before start of storage)

Additional Costs based on required financial security [Euro-cent/ Tonne CO_2]	Share of storage volume to be underlined with financial security			
	0.01%	0.10%	1.00%	10.00%
5 [Euro/ Tonne CO_2]	0.05	0.52	5.21	52.10
10 [Euro/ Tonne CO_2]	0.10	1.04	10.42	104.20
20 [Euro/ Tonne CO_2]	0.21	2.08	20.84	208.40
30 [Euro/ Tonne CO_2]	0.31	3.13	31.26	312.60
40 [Euro/ Tonne CO_2]	0.42	4.17	41.68	416.81

3.2. Composition of CO_2 streams

A second important point in the proposed directive is the composition of the CO_2 stream. In the original text of the European Commission only a limited specification was given, using the term overwhelmingly. If this would be transferred in a percentage value this could be interpreted as at least 50%. Such a low value could however have some impacts in regards to the public acceptance of the CO_2 injection, if a significant part of the stream would be not CO_2 but other substances, even if the majority of other components would be water and nitrogen which do not cause any problems from a security point of view. However this has lead to amendments proposing a clearly specified percentage level for the purity of the CO_2 stream to be transported and injected. The 90% level which had been proposed to specify the purity more clearly have found a broad acceptance in the power industry, however the Environmental Committee has voted for a specification of article 12 of the directive in the following way: "A CO_2 stream shall consist of not less than 95%, of carbon dioxide and shall not contain corrosive substances such as H_2S and SO_2. This level may be revised under the review procedure provided for in Article 36a in the light of future scientific evidence."

A CO_2 purity level of 95% might be able to be reached for Post- and Pre-Combustion processes which acceptable efforts; Oxy-fuel processes would require significant additional purification steps. However up to now it is not fully understood, which purities might be required for the security and the resistance of the transport infrastructure and for the smooth operation of the compression equipment. There is actually also very little experience regarding the requirements for the purity, based on the selected storage site. Different storage settings might require different qualities of CO_2. Therefore a lower limit such as 90% purity in the first phase would be seen more practical and together with the proposed revision clause which we fully support would be inline with the requirements of a technology under development and demonstration.

As pinpointed in the introduction to this chapter, the requirement that no H_2S or SO_2 is contained in the CO_2 stream does not make technical sense, as both are combustion products and would therefore be in traces part of the CO_2 stream. Instead it would be much more constructive no to specify other components in the first phase but to set maximum concentration of such components based on experience from the first demonstration period during the review process. Even without a clear legal specification, the composition of the CO_2 stream is limited by technical conditions that have to be met. For example the remaining share of sulfur components after the desulphurization plant has to be much lower compared to conventional power plants to avoid the highly unwanted solvent degradation in the CO_2 absorption process. The compression process of the CO_2 stream up to 110 bars also requires a high purity of the CO_2 stream to have a clearly defined compression process. For the transport part there is also a trade off between expensive materials and the treatment of the CO_2 stream. However there is still a lot of uncertainty and therefore the fixation of limits which could be not fact based should be avoided and instead they should be fixed, based on gained experience.

3.3. From Capture Readiness to Emission Performance Standards and Mandatory CCS

As indicated in the previous chapters, the CCS technologies are still neither technically nor commercially ready yet, however CCS promises to help to significantly reduce the CO_2 emissions into the atmosphere. However is the technology is not ready yet, there is some need to be prepared for that power plants built during the coming years could be retrofitted with CCS as soon as the technology is technically and commercially available. In Germany there is a need to replace up to 50% or up to 60 GW of existing power plants until 2030 [7]. In [8] a more detailed picture is given for the power plants to be replaced, based on their age, **Figure 4**.

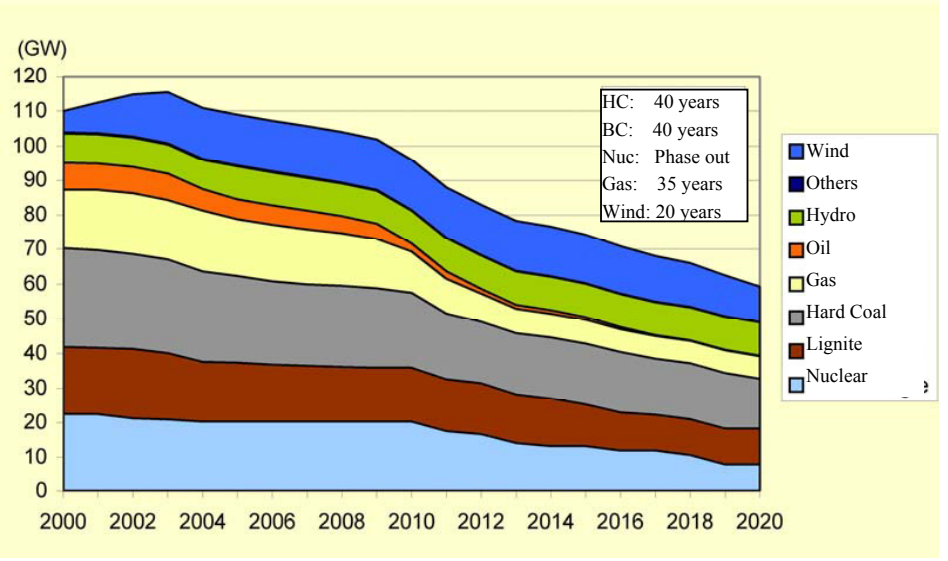

Figure 4: Capacity retirement graph of German power plants by energy source [STE, 2006]

Therefore if CCS should play a major role for emission reductions from 2020 onwards, the new build power plants should be ready to be retrofitted with CCS. Therefore the requirement for new power plants to be capture ready as proposed by the Commission in the draft directive would be a logical step. E.ON already started to obtain certification form the independent TÜV organization that E.ON new power plants are capture ready. In September 2008, the two new build power plant projects in Antwerp and Wilhelmshaven received the Capture Ready Certificates from the TÜV NORD, **figure 5**.

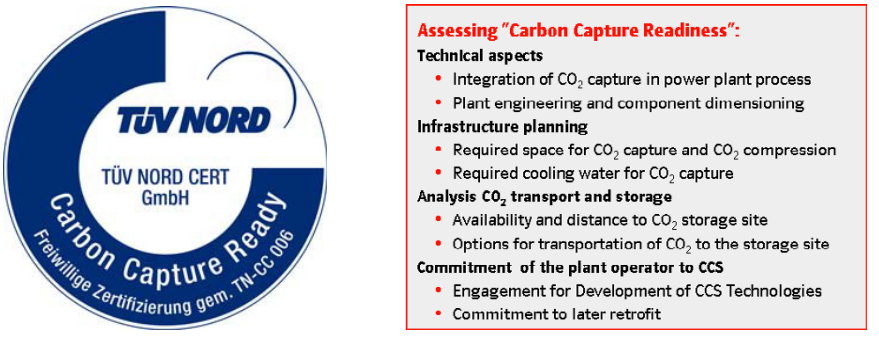

Figure 5: Capture Ready Certificate obtained for E.ON new built projects Wilhelmshaven and Antwerp

Unfortunately, the Environmental Committee of the European Parliament (ENVI) was not satisfied by the capture ready requirement from the Commission proposal and instead voted to introduce a new emission performance standard for CO_2. The agreed on that "*Member states shall ensure that from 1 January 2015 the operating permit for all electricity-generating large combustion installations with a capacity greater than 300 MW granted a construction permit or, in the absence of such a procedure, granted an original operating permit after 1 January 2015 include conditions requiring compliance with an emission performance standard of 500 g CO_2/kWh"*. If this standard would be finally adopted as part of the directive, this would mean that from 2015 new coal fired power plants would only be possible if equipped with CCS. Gas fired plant and smaller sized plants would be not concerned from this obligation as a gas fired combined cycle plant emits around 350 to 400 g CO_2/kWh. Therefore an emission performance standard of 500 g CO_2/kWh is equivalent to mandating CCS for new coal power plants in 2015 at a time, when the CCS technology will not be technically proven and sufficient storage sites are not fully explored and deployed. Therefore, risk for investments would be by far too high to build new coal power plants. Even if renewable electricity generation would increase as expected it is unclear where the sufficient amounts of gas could come from at affordable prices, taking into account also issues of security of supply. Instead old and inefficient coal fired power plants will continue to be operated instead of replacing them by state of the art coal plants, typically increasing the electrical efficiency from 30 to 35% to 46 to 50%, which would have a larger impact on CO_2 emission reductions.

The emission performance standard proposed would also open up possibilities to challenge the limit value by operation regime and fuel mix. Capturing only parts of the flue gas stream, mixing coal with biomass, or operating the plant only in half of the time with capture would enable the plant to comply with the emission performance standard but without using the full reduction potential of CCS and at the same time selecting not the most economic measures to reduce the CO_2 emissions. Therefore from a utility perspective, the capture ready requirement seems to be the only adequate way to avoid a look in situation in the near future.

4. Public Support for CCS Demonstration in Europe

CCS Technology has been identified as an important part of the solution to limit climate change. To make the technology market ready a significant amount of R&D is necessary to further develop the technology and to make it ready for the market. Utilities worldwide are investing in pilot projects to test the technologies under real conditions. For e.g. E.ON has started a unique portfolio of 7 pilot projects with different partners to test and develop post combustion technologies. The next step to take would be to test CCS technologies at pre-commercial scale, meaning at sizes above 100 MW_{el}. However, such demonstration plants will encounter significant costs due to the nature of the first of its kind plants and the risks involved. It is estimated that the economic gap of such a demonstration plant would be between 500 and 1000 Million Euro, depending on technology, fuel type, certificate price and a number of site specific factors. It is obvious from the size of the additional investment, that parts of the costs should be covered by public funding, as there is a common interest of society to develop low carbon technologies. For the fast deployment of the CCS technology, the EU Commission has proposed a flagship program with 10-12 demo projects.

As member states have been seen to be reluctant to provide public money for the flagship program, the decision of the ENVI Committee of the European Parliament to provide a significant amount of money from the ETS for the demonstration program have been taken up by utilities with some hope. The ENVI proposed to reserve 500 Million allowances from the new entrant reserve to co-finance the 10-12 demonstration projects in Europe. The next important step will now be to define the rules and procedures how the support the demonstration projects. Allocation of funding should be made in an open bidding process taken into account the different technologies, fuels and other factors to be demonstrated. Support should be given only to projects which demonstrate the full CCS chain from capture over transport to storage. Therefore the funding should not be allocated to a single part of the CCS demonstration chain (e.g. the storage) but to a full project proposed by a single applicant or a consortium of different companies. As a core point of the flagship program is technology demonstration and costs and avoided emissions depends on process, fuel type and project location (including transport distance and storage site), it seems not appropriate to allocate the funding based on avoided CO_2 emissions as this would mean that project which are using

dirty fuels such as lignite and using inefficient processes producing more CO_2 would receive more funding than other project.

In a second step decision is also needed, if the funding should be provide in form of certificates reserved from the new entrants reserve or if they should be centrally auctioned and the net profit is then allocated to the demo projects. As most of the additional cost for CCS projects are stemming from additional investment cost at the beginning of the project, a major share of funding would be best given as upfront investment support. These could be done by an open tender process organized by the Commission. In addition this would also remove the CO_2 certificate price risk from operators and would avoid possible profits, is the price for emission certificates would increase significantly over time.

To make sure that the 10 to 12 demo projects could be started up in 2015 it is necessary, that the tender process for the allocation of public funding starts very soon to be able to complete the process until the next summit in Copenhagen. With a successful completed tender process, the EU would have a good starting position to convince the international partners that urgent measures are no required.

5. Conclusions

The proposed CCS directive is large step forward to the application of CCS technologies. However there remains significant uncertainty about the final outcome of the decision process at the European level and finally the putting into practice at member state level. The ENVI Committee has decided on amendments to the CCS directive which includes some critical elements which might hinder the wanted development of CCS and at the same time giving strong support for the CCS demo projects by adopting the ETS amendment to provide the financial support for the demo projects from the ETS.

Therefore, there is a good chance, that Europe could position itself as a leader in climate change mitigation, developing and using a wide spread of low carbon technologies. As we are running out of time, a constructive and target oriented and flexible approach should be the basis to make CCS technology commercially viable until 2020.

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