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Abstract

This revision replaces the original report dated 2010-08-02. A table of recommendations is now included in the concluding chapter 6. The table makes a distinction between EU regulations/incentives, national regulations/ incentives and new suggestions from ECCO.

A unique opportunity to achieving Carbon Capture and Storage in a faster and more economical way is to use CO_2 as a resource for Enhanced Oil Recovery or Enhanced Gas recovery (EOR/EGR). To facilitate and accelerate such development of CO_2 value chain, governments should adopt incentives schemes and/or regulations that encourage stakeholders to initiate such projects. A large panel of incentives already exists: however the challenge is to find the most efficient measures.

To encourage a wide portfolio of CCS projects, it is preferable to establish an incentive scheme common to all CCS projects, including EOR/EGR projects. However, if this is politically not feasible, specific time-limited incentives for CO_2 for EOR/EGR projects should be considered as a fall-back.

This paper reviews a range of tax incentives for CO_2 EOR: Tax exemption, volume exemption, measures on depreciation time, Tax credit, Modification of the basis on which the tax is assessed. This report also analyses how Member State could use regulations to require CO_2 for EOR and to stimulate third party access when assessing the oil field operator's Plan for Development and Operation (PDO). Additional revenues to the State arising from the increase of oil produced through CO_2 for EOR could also be earmarked to be used for future investments in CCS (for example infrastructure).

The report also covers issues as cross-border liabilities linked to the EU Emission Trading Scheme and long-term liabilities related to CO_2 storage. It also makes recommendations on the overall organization of the value chain

This report is deliverable D2.3.2 of Task 2.3.3 under WP2.3 “Strategies for implementation of CO_2 value chains“.

The task description related to this work states:
“Task 2.3.3 Recommendations for improving the regulatory framework and for optimizing the organization of value chain:
The task will make recommendations for improving the regulatory framework that is necessary to facilitate the establishment of CO_2 value chains in the near term. The recommendations will address liability issues, cross border regulations and emission trading schemes (like EU ETS, CDM and JI). Furthermore, it will make recommendations for an overall organization of the supply chain, in terms of access rights, trans-boundary transport and storage of CO_2 and rules for utilization/capacity allocation.”

With the objective to:
“Study of liability issues, cross border regulations and emissions trading schemes. Assessment of schemes for an overall organisation of the supply chain (access rights, trans-boundary transport, capacity allocation)”

Key words are:
- Regulatory framework
- Cross border regulations
- Emission Trading Schemes
- EOR
- Liability
- CCS incentives
- Third Party Access

The two tasks relating to this work in the original ECCO planning (in Annex 1 to the Grant Agreement) are as follows:
Task 2.1.3: Develop initial recommendations for case studies (PEL, SINTEF-ER with support from JRC, UNIZG-RGNF)
Building on the questions from Task 2.2.1 and the scenarios from WP2.1, a set of proposed case studies will be developed together with appropriate variants. Cases will be chosen to cover relevant issues both around the North Sea and also on-shore in Central/Eastern Europe. Recommendations of case studies to be pursued will be provided, with full descriptions and supporting arguments for their added value, in report D2.2.1.

Task 2.3.4: Recommendations for the facilitation, promotion and financing of the development of the infrastructure (PEL, with support from NTNU, VRD, STATOILHYDRO, INA and MOL)
Based on the outcome of the above mentioned tasks and the extrapolation of the results of the case studies, this task will provide recommendations on how best to promote and finance the development of the infrastructure to take advantage of the window of opportunity offered by the exploitation of near term EOR opportunities, taking into consideration commercial risks and economic uncertainties. It will explore the opportunities of funding schemes offered by private-public-partnerships, propose a business model for the CO_2 value chains, and will make recommendations on a favourable evolution of the carbon market in Europe to provide long term confidence to investors interested in exploiting CO_2 value chains.

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1 INTRODUCTION

The European Union (EU) has committed to reducing greenhouse gas emissions (GHG) by 20% within 2020 compared with 1990 levels and is offering to scale up this reduction to 30% provided other major emitters in the developed and developing world`s scale on their fair share of the mitigation effort under a global agreement. The European Parliament has also stated that GHG emissions must be reduced by 80% by 2050, a target reflecting the IPCC's statement that global GHG emissions have to be cut by 50-85% from current levels by 2050 if global warming is to remain below 2°C over pre-industrial levels.

Achieving this level of emission cuts will require a tremendous effort to transform society into a low carbon emitting economy. It can only happen using a portfolio of solutions. Even if an unprecedented increase in energy efficiency and massive deployment of renewable energy technologies will be vital in curbing emissions, they will not curb emissions quickly enough to prevent climate change. The use of Carbon Capture and Storage (CCS) as a mitigation strategy is therefore an essential bridge between today's energy system, which is mainly based on fossil fuel, and the long-term goal of relying solely on renewable energy [1],[2],[3],[4],[5],[6]. If CCS is implemented on a large scale there is a potential of capturing and storing 236 billion tonnes of CO_2 globally by 2050[7]. This corresponds to a 33 % reduction in global CO_2 emissions in 2050 compared to today's emission levels.

At present there are no major technical barriers that hinder full scale implementation of geological storage of CO_2. The success of CCS as a GHG mitigation strategy depends however on the regulatory framework established to govern its deployment[8]. Efforts are underway in the development of national and international rules and regulations for CCS projects[9],[10],[11].

A prerequisite for CCS is also the establishment of an infrastructure for CO_2 capture from large emission sources with transport and permanent storage in geological formations (the CCS value chain).

A unique opportunity to achieve CCS in a faster and more economical way is to use the captured anthropogenic CO_2 as a resource to enhanced petroleum production (Enhanced Oil Recovery or EOR). The deployment of this "early opportunity" has the potential to kick off the whole deployment of CCS[a],[12]. CO_2 for EOR makes CCS projects profitable, or, for low oil prices at least less costly[13].

CCS for EOR is however not currently economically viable in Europe and such projects will more likely only develop in the near term if oil companies are given sufficient incentives to initiate such projects or if oil prices rise to, and stays at levels where further extraction from mature fields is considered as economic by larger oil companies. This first mentioned

[a] Early opportunities" are described in the SRCCS (see list of references) (in footnote 12, page 44) as projects that are likely to "involve CO_2 captured from a high-purity, low-cost source, the transport of CO_2 over distances of less than 50 km, coupled with CO_2 storage in a value-added application such as EOR [enhanced oil recovery]."

scenario requires the support of governments in the form of incentive schemes and/or regulations.

This report will provide recommendations for improving the regulatory framework that is necessary to facilitate the establishment of CO_2 value chain in the near term, with particular focus on CCS for EOR. The recommendations address liability issues, cross border regulations and emission trading schemes. Recommendations are also made for an overall organization of the value chain in terms of access rights, trans-boundary transport and storage of CO_2 and rules for utilization/capacity allocation. The recommendations will also address some issues relating to the case studies identified in the ECCO deliverable D2.2.1.

This report has excluded all life cycle analysis in terms of emissions and costs relating to construction and facilitation of the value chain. It also excludes economic analysis of the incentives and how incentives can be coordinated to be most efficient[b], but recognize that incentives and other mechanisms, such as profit and risk sharing contracts, should be developed in a way that the CCS investment is profitable for all the participants in the value chain[13].

Incentives for pure EOR projects with no intention for permanent storage of CO_2 are not analysed.

[b] These topics will be covered in more detail through deliverable D2.3.4.

2 SETTING THE SCENE: CO_2 FOR EOR

2.1 Enhanced Oil Recovery and Enhanced Gas Recovery

Enhanced Oil Recovery (EOR) and Enhanced Gas Recovery (EGR) using CO_2 is a hydrocarbon recovery process that involves the injection of CO_2 to flood mature reservoirs and produce petroleum substances that would otherwise remain unrecoverable[c]. Its purpose is not only to restore formation pressure, but also to improve oil displacement or fluid flow in the reservoir. These methods are currently applied in USA[d], Canada[e], Abu Dhabi[f], Trinidad[g],[14], Turkey[h], China[i] and Hungary[j] mainly based on naturally occurring CO_2, but also CO_2 extracted from natural gas production or captured CO_2 from other industry such as thermal plants. In e.g. Trinidad and USA this has given rise to an extensive CO_2 transportation network. CO_2 in this context is traded as a valuable commodity.

Injecting CO_2 into a reservoir generally increases the oil recovery rate, thus increasing the value of the petroleum activity. Another driver for CO_2-based EOR is lack of the large volumes of water that is needed for efficient secondary recovery[k].
Ferguson et al. (2009) estimated, in a study of oil recovery by CO_2-EOR in the USA that between 6.7 percent and 18.9 percent of original oil in place is recoverable by CO_2-EOR[15]. Petrotrin documented incremental recovery ranges between 2 to 8% of the Original Oil in Place (OOIP) with predicted ultimate recoveries of 4-9% of the OOIP in their four EOR projects in Trinidad[14].

In Europe, EOR/EGR projects using CO_2 will more likely use anthropogenic CO_2 as there are no sufficient natural sources of CO_2. The use of anthropogenic CO_2 for EOR/EGR not only contributes to increase the ultimate oil recovery of mature oil fields but also contributes to significantly reduce emissions of GHG. CO_2 for EOR operations could be stored at a much greater proportion under suitable CO_2 pricing conditions[l].

The use of CO_2 for EOR/EGR presents several other benefits. By increasing the ultimate oil recovery, governments increase their revenues through taxes and royalties. The additional hydrocarbon resources added by the EOR/EGR increase the security of energy supply by reducing the need for hydrocarbon import. EOR/EGR will contribute to decrease the need for

[c] Under primary recovery methods, less than 20% of the resources are recovered from a reservoir on average. The vast majority of oil fields still languish lower than 40% despite the availability of drilling and enhanced oil (EOR) technologies that have enabled some field to reach more than 70% recovery rates.
[d] E.g. the Rangely Weber field in Colorado (Chevron)
[e] E.g. the Weyburn Oil Field in southern Saskatchewan (Cenovus Energy)
[f] E.g. in the MENA region, (ADCO)
[g] Forest Reserve and Oropouche fields which are producing medium oil (API from 17 to 29) using industrial waste CO_2 from an ammonia plant (Petrotrin)
[h] E.g. the Bati Raman field which was producing heavy oil (API=12, viscosity=592 cp) using a natural CO_2 source
[i] E.g. the Shengli oil field in Eastern China
[j] E.g. the Nagylengyel heavy oil field using a natural CO_2 source (MOL)
[k] Historically most EOR projects use water and/or natural gas injection. Many of the existing CO_2-based EOR projects are in regions where there is limited access to water.
[l] up to 100% of the injected CO_2

new exploration for oil and gas. In addition it will decrease the postulated need to exploit unconventional hydrocarbon reserves which are likely to have significant environmental impacts, such as tar sands, oil shales and gas shales.

As a 2009 SPE paper inquired; "Why do recovery factors for the vast majority of oil fields still languish lower than 40%, despite the availability of drilling and EOR technologies that have enabled some fields to reach more than 70%?[16]

EOR would also present an early opportunity for CCS deployment by stimulating the entire CCS chain. The additional revenues generated from EOR could accelerate the selection of storage sites and the development of infrastructure and at the same time reduce investments by re-using the existing facilities when an EOR project is converted to a CCS project[m]. Additional side benefits for the CCS chain include an accelerated CCS learning curve (achieving early maturing of CCS-related technologies and possibly also lowering costs), further strengthening of the CCS market and promotion of manufacturers of capture technologies etc. to step in and compete for contracts.

However CO_2 for EOR is not currently economically viable in Europe. Partly because there are no natural sources of CO_2 in the northern Europe that are large enough to enable EOR to take place on a commercial scale offshore and secondly because the price on carbon emissions dictated by the EU ETS scheme is too low at the present time[n],[17]. There are also technical barriers: the CO_2 may require retrofit of the injection and extraction facilities at an oilfield in order to cope with the increased reservoir pressure[o] and corrosive nature of the mixture of CO_2 and formation water that is produced with the oil and gas. The CO_2 must be separated out, dehydrated, compressed and re-injected back into the oil field. While complicated, the good news is this is most likely the cheapest CO_2 available to the oil field operator.

A prerequisite to make CCS projects viable is to create sufficient value for delivered CO_2 to justify the costs of capture and transport and subsequently a market for CO_2 storage. Such market is non-existent at the present time and will more likely only develop in the near term if oil companies are given sufficient incentives to initiate enhanced oil and/or gas production using CO_2. This requires the support of governments in the form of incentive schemes and/or regulations.

[m] Additional revenues to the State could be earmarked for further investments in CCS like infrastructure, or be allocated to environmental investments.

[n] Leach (2010) shows however that, for an *individual* project, policies which raise the cost of CO_2 emissions, whatever effect they may have on other forms of sequestration or abatement, will not induce large increases in EOR-based sequestration. It means that oil prices will be a far stronger driver for CO_2 storage projects through EOR than carbon emission prices. The publication by Klokk et al. (2010) also concludes that the main value drivers for CO_2-EOR are the oil price and the EOR ratio. Additional drivers as e.g. in Croatia where local communities get their share of the income from produced hydrocarbons and thus creating an interest to maintain production could also have an impact. Note that for all these it is mainly revenue from increased oil recovery that will encourage investments rather than the avoided CO_2 emissions.

[o] In mature fields there are issues with well integrity (old tubulars, cement bond etc.) when reservoirs are re-pressurized. Drilling in re-pressurized mature fields might be challenging due to over-pressured and pressure-depleted zones.

A large panel of incentives already exists; however, the challenge is to find the most efficient measures. Attention should also be paid to the risk of accumulation of subsidies to fossil fuels[p]. An accumulation of incentives to CCS projects[q] could indeed result in delaying the transition to a low carbon economy at a later stage than necessary.

For a specific site the value of postponement of usage as CO_2 storage and the value of abandonment as opposed to further investments are economic hurdles that will influence EOR investment decisions.

2.2 EOR projects versus CCS projects

There are two types of CO_2 for EOR projects: pure EOR projects where CO_2 is injected in oil reservoir for the purpose of EOR, and EOR project with the aim of storing CO_2. This is done either during oil recovery or by continuing CO_2 injection after the end of oil production for storage purposes.

Different approaches are applied to CCS and EOR projects. In pure CCS projects, typically with storage in saline aquifer or depleted oil and gas fields, the prime objective is to store CO_2 and therefore to maximize the volume of CO_2 stored. The CO_2 producer will probably need to ensure a reliable delivery of CO_2[r] and will more likely enter into long term contract with transport and storage providers[s]. Incentives to the CO_2 producer to store CO_2 is provided through the EU ETS scheme by considering that the CO_2 stored is not emitted.

In EOR projects, CO_2 storage is rather an incidental outcome of the activity than its prime objective. CO_2 for EOR projects aim to maximize the production of oil and to minimize the amount of injected CO_2. The reason is that CO_2 has to be purchased and has, therefore, an economic value as such. The oil field operator will also need to ensure that they can obtain a secure and stable long term supply of CO_2.

When permanent storage is combined with EOR, the oil field operator would be both a CO_2 purchaser and a service provider. How this requirement will be addressed remains unclear. To address these particular points, the market might develop in such a way that the oil field operator will enter into two types of contracts: a contract of purchase of CO_2 and a contract for storing CO_2[t]. This would however depend on how the CCS chain is set up. If the CCS value chain is vertically organized (vertical integration) i.e all or several part of the CCS chain are handled by the same operator (for example the CO_2 producer) it would simplify the nature and number of contractual engagements and simplify issues on transfer of liabilities.

[p] In line with EU's pledge to phase out fossil fuel subsidies the Commission adopted a proposal for a Council Regulation on State aid to facilitate the closure of loss-making hard coal mines in the EU by 1st October 2014 on July the 20th 2010. Fossil fuel subsidies are often divided into "direct" subsidies which refer to government spending; tax reductions (i.e. taxes not collected) and R&D funding and "hidden" subsidies (e.g. favorable tax rates for oil and gas exploration).

[q] CCS project applied to plant powered by different type of fossil fuel as oil, natural gas and coal.

[r] This will depend on how individual business models are set up.

[s] Alternatively the CO_2 producer can handle the CCS chain on its own.

[t] The part of the CO_2 injected exceeding the need for CO_2 for EOR would be considered as "stored CO_2 " and be subject to compensation for the service provided. In addition the CO_2 which remains in the reservoir during and after the EOR/EGR period will be compensated for on e.g. a yearly basis (injected minus produced CO_2).

To sum up, CO_2 for EOR projects aims to maximize the production of oil and to minimize the amount of injected CO_2 while CO_2 storage objective is to maximize the volume of CO_2 injected. Those two approaches should be reconciled as much as possible when establishing incentive schemes for CCS.

The following developments are based on the principle that the same incentive scheme should be applicable to all CCS projects -including EOR projects- at least in the medium and long term. If additional incentives specific to EOR projects have to be adopted, they should be carefully considered both in regards to their nature and in regards to the period during which they should be available: although they would present the advantage to initiate EOR projects and thus benefit indirectly all CCS projects, it is important to avoid accumulation of subsidies to fossil fuels.

2.3 Current legal regime for CCS activities in EU

2.3.1 CCS in legislation

The Storage directive focuses mainly on storage issues. It provides a legal framework for the management of environmental and health risks related to CCS, including requirements on permitting, composition of the CO_2 stream, monitoring, reporting, inspections, corrective measures, closure and post-closure obligations, transfer of responsibility to the State and financial security. The Directive also amends a number of other EU laws with a view to establishing requirements on capture and storage operations and to removing existing legal barriers to the geological storage of CO_2.

The Storage directive is a minimum requirement directive, meaning that the detailed implementation is left to Member States. This can create incompatibilities and competitive distortion between Member States. A harmonized regime between Member States would be desirable.

2.3.2 CCS for EOR in EU legislation

The directive provides the inclusion of EOR activities in the CCS directive only when CO_2 injection is performed for permanent storage[u].

The combination of CO_2 storage with EOR should not pose additional environmental risk to pure CO_2 storage as all the requirements of the directive on CCS would have to be met by any combined project. Indeed, just as for a non-EOR project, the initial site selection would have to respect the provisions of article 4, demonstrating that under the proposed condition of use there is no significant risk of leakage and no significant environmental or health risk. The same monitoring techniques would be employed. Rules on leakage are however applied differently to take account of the expected breakthrough of CO_2 under oil extraction. Indeed,

[u] In practice, such oilfields have the advantage of having a proven seal, which has already retained the oil contained over millions of years, and thus have a good chance of meeting the criteria for permanent storage.

additional sources of CO_2 generated by the EOR processing will have to be reported and accounted for in the national emission inventory[v].

As argued above, the CO_2 captured and permanently stored along the EOR activity will be considered as "not emitted" in the sense of the EU ETS directive and the CO_2 producer will be released from surrendering allowances. It leaves us however with the question whether the CO_2 producers will need to know in advance the « destination » or "the fate" of their CO_2 (whether it will be used for pure EOR projects or for CO_2 EOR projects with a view of permanent storage) in order to document that his CO_2 is not considered as emitted and that allowances have not to be surrendered[w].

As long as CCS projects are still under development and that we don't know what the value chain will look like (whether there will be separate value chain for EOR and a value chain for CCS or joint network), there are uncertainties about how the CO_2 producer[x] will document (for his emission reporting obligation) that his CO_2 has been permanently stored and therefore not emitted. This uncertainty should be clarified to avoid delay in investments decisions. The following documents should be considered as sufficient to document that the CO_2 is not emitted and to release the CO_2 producer from his obligation to surrender allowances: a) the contract of CO_2 delivery entered into between a licensed storage operator and/or with a licensed transporter of CO_2 (for storage purposes) or b) a certificate from the storage operator that the CO_2 delivered has been injected (the storage operator has a duty – according to the directive – to keep track on a register of all injection).

Several case scenarios developed by the D 2.2.1 ECCO project provide the use of buffer locations (aquifers) to take and store supplies of CO_2 which cannot be accommodated at the time of EOR. In practice, these buffer locations are however permanent storage as it will be very difficult to take out the CO_2 again. At present, a temporarily storage of CO_2 in aquifers for future EOR is considered a one way buffer[y].

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[v] Directive's recital 20, second sentence: *"In that case the provision of that directive concerning leakage are not intended to apply to quantities of CO_2 released from the subsurface installation which do not exceed what is necessary in the normal process of extraction of hydrocarbons and which do not compromise the security of the geological Storage or adversely affect the surrounding environment. Such releases are covered by the inclusion of Storage site in the EU ETS system".*

[w] This issue is different from the issue relating to leakage in the CCS chain and developed under point 4.1. According to the EU ETS, each part of the CCS chain is its own installations from the perspective of ETS reporting and will be liable to surrender allowances for the part of emissions that have occurred under their activity. Formally, the CO_2 producer only needs to secure control of the CO_2 mass balance within its own facilities. However, in the end, the business model needs to take the overall CCS chain into account.

[x] The producer would need to handle this if he is himself responsible for the storage operation, or if he has shares in the company which holds the storage operation license.

[y] Once in an aquifer the CO_2 will be technically and economically very challenging to produce. Extraction of CO_2 from a buffer aquifer at some later point in time would require a production well at a location different than the injection well as the injection point most probably will be down and away from the penetration of the aquifer seal to minimize the prospect for leakage. In addition CO_2 produced from a buffer aquifer would have to be dewatered and compressed to get back into the pipeline. Buffer storage in depleted gas fields face similar challenges, but may be more technically feasible.

A buffer storage aquifer location should therefore be properly selected to avoid any significant risk of leakage and environmental/health risks. Monitoring and rules on leakage should apply in the same way as for permanent storage sites. Clarification regarding the regime of buffer locations is recommended.

It is unclear whether other obligations required by the directive, such as the constitution of a financial guarantee or the contribution to the financial mechanism, would be applicable to EOR projects. It is, however, more likely that such conditions will only be required when the CO_2 for EOR project is converted to a CCS project. Clarification should however be made.

It is recommended that an EOR facility will be licensed as a storage facility from the beginning of the activity. Otherwise, the EOR operator would have difficulties to enter into contracts with both CO_2 producers and CO_2 transporters. Indeed, the CO_2 producer will have to document that his CO_2 produced is permanently stored by a licensed storage operator in order to be released from his obligation to surrender allowances (see point 2.3.2).
If a facility is licensed as a storage facility, the operator only needs to surrender allowances for platform emissions such as power generation, mechanical leaks, or any leaks from storage through wells or other pathways.

When an oil field is depleted after CO_2 for EOR activities, the oil-field operator can either decide to defer from the site and transfer it to a subsequent storage operator who will operate the site exclusively as a CO_2 storage site (a), or he can decide to close the field following field-closure procedures (b).

a) If the CO_2 used for EOR has been given ETS credits, the former oil-field operator should bear the responsibility in case of CO_2 leakage: however contractual arrangements could easily transfer the responsibility to subsequent CO_2 storage operator. Contractual arrangements would also decide who would bear the cost of decommissioning when the CO_2 storage site is closed later on.
b) If the EOR field is closed without being converted into a CO_2 storage site, one can expect that the authorities assessing the decommissioning plan of the petroleum depository will include specification on transfer of responsibility.

3 INCENTIVES TO PROMOTE CCS PROJECTS (INCLUDING EOR)

To achieve the deployment of CCS and encourage a wide portfolio of CCS projects, it is preferable to establish an incentive scheme common to all CCS projects (in the EU).

However, if this is politically not feasible, specific incentives for CO_2 for EOR projects should be considered as a fall-back for a given time[z]. They should however be re-considered when other, more general CCS incentives, are introduced.

3.1 General CCS incentives

The EU ETS constitutes a crucial instrument to incentivise CCS. Incentives through the EU ETS system are at present not sufficient to make CCS projects viable and to involve commercial participant in project investments, even under phase 3 of the EU ETS system (CO_2 price too low and too variable). Subsidies for CCS are therefore also provided by the EU in the form of the NER 300 (New Entrant Reserve), the European Energy Programme for Recovery (EEPR) and by stating that at least 50% of the revenues from auctioning allowances 'should' be used by MS for climate measures, including CCS[æ], [18], [19], [20], [21].

Some Member States have also adopted national support schemes, but the sum of all CCS subsidies fall well short of what is needed to make CCS more profitable than unabated fossil power options.

Additional incentives should therefore be provided. However such incentives should be carefully considered as they could result in delaying the transition to a low carbon economy at a later stage than necessary. They could also result in cross subsidies. The EU state aid rules will therefore be applied to avoid accumulation of aids.

Several reports and publications have covered the timing of incentives and the impact of the "CCS learning curve" on associated CCS costs. Most of these publications will not be mentioned in this report, but with regards to incentives for optimization of the CCS value chain the findings of Abadie and Chamorro (2008)[22] should be mentioned. Their study finds that the lower the CO_2 price volatility the earlier investments happen.

There is a range of alternative ways to stimulate investments in CCS - without putting the burden on public budgets. Two options are explained below to illustrate.

3.1.1 The Netherlands' CCS Task Force recommendation of a 'bonus-malus' scheme

To stimulate CCS investments without draining public funds, a bonus-malus scheme directed towards CO_2 producers could be introduced. The initiative comes from the Dutch government-appointed CCS Task Force which gave its advice in April 2010 on how to

[z] The initial timeframe should be clearly defined so that the industry can use it as basis for economic analysis and decision making.

[æ] For a presentation of subsidies for CCS demonstration projects, see Hoff et al. (2008) and Report 1: Projects Globally from the GCCSI (2009) – see reference list

incentivize CCS. The recommendation mentions several possible options, but favours a “bonus – malus” scheme combining 1) a CO_2 emission “norm” (grams per kilowatt-hour); and 2) creating economic incentives for reducing CO_2 emissions below this norm.
In other words, an ordinary subsidy scheme would be introduced to reward power plant emitting under a specific “norm” (bonus)[ø] while in parallel, a penalty – malus – for power plants emitting above the norm would be introduced[å].

The challenge is however to establish the appropriate level of the CO_2 norm so that “bonus” and “malus” balance out. The risk is that if the norm is put too high, too many plants would be eligible for the “bonus” and be a drain on public coffers, while if it is too low it would effectively serve as an extra tax on the power sector with “malus” outweighing “bonus”.
The advantage of this scheme is that it creates a long-term predictability for a high price on CO_2 emissions in the power sector, combined with a mechanism to automatically recycle revenues back to the sector.

3.1.2 Forward capacity market dedicated to low carbon electricity generation

A fresh report from April 2010 has described how a forward capacity market (FCM) for electricity generation (covering all kinds of power generation) has created in the US the required predictability for large investments in liberalized electricity market.[23]

An FCM is an administrative market, where the body responsible for the good operation of the system (in Europe known as the Transmission System Operator “TSO”) requests bids from power utilities for electrical output capacity (measured in watts). Utilities thus get paid not only for the electricity delivered to customers but also for the capacity (watts) made available to the system to prevent black-outs. The TSO recycles the cost of these payments to the utilities themselves, as each of them has to share the costs according to its market share. In other words, redistribution happens among the utilities themselves to incentivise the construction of new capacity.

If a FCM was dedicated to low carbon electricity generation for any sources not already covered by support mechanisms (such as feed in tariffs or green certificates), it would stimulate CCS investments by providing predictability for CCS investors[aa].

[ø] Say a CO_2 norm of 350 g/kWh is established and the cost of abating one tonne of CO_2 with CCS is €50, while the EU emission unit allowance (EUA) price is €20. In that case, a power plant reducing its emissions below 350 to 150 gram/kwh will get an extra “bonus” of €30 per tonne of CO_2 “saved” below the 350 gram norm (to find out the number of “saved” tonnes below the norm, you would in this case multiply 200 grams (350 minus 150) with the number of kilowatt-hours produced).
[å] A plant emitting 750 g/kWh would of course, under already adopted EU ETS rules, pay for the emission allowances (€20/tonne in our example). In addition, however, it would pay €30/tonne for CO_2 emitted above the norm (you would in this case multiply 750 minus 350 = 400 grams with the number of kilowatt-hours produced).
[aa] The originality of that system is that payment for electric capacity (not production) may be particularly relevant for CCS coal plants, which will not in the future be guaranteed to operate in base-load mode, and therefore not receive enough revenues through electricity production to cover their high CAPEX.

3.2 Specific incentives to promote CO_2 for EOR

If general CCS incentives are not politically feasible, specific incentives for CO_2 for EOR projects should be considered as a fall-back for a limited time period.

3.2.1 Tax incentives

When establishing a tax incentive scheme, it is important to avoid a system where tax incentives are too favourable to oil and gas companies. The accumulation of subsidies should be avoided. The scheme should also take into account the risk that oil companies underestimate resources at an early phase in order to maximize their profits while, at a later stage increasing recoverable resources due to EOR, EGR or IOR efforts.

The tax incentives should be designed to give to oil companies a reduction of their taxable revenues corresponding to the cost of capturing, transporting and storing each tonne of CO_2 minus the benefits of EOR/EGR. This principle should be the basis when assessing the different types of tax incentives.

The benefit of tax incentives should also be conditioned in a way that a monitoring and verification program demonstrates that at least 99% of the injected CO_2 will remain sequestrated for more than thousands of years. [26]

In 1979, the USA introduced a “tertiary incentive” scheme to maximise crude oil production from older oil fields and to reduce the costs associated with implementation of CO_2 for EOR projects[bb]. Similar incentives or modalities to assess taxes could be introduced in Europe. Below is a description of options that could be considered:

a) Tax exemption (general tax exemption or volume exemption): companies would be granted exemption or reduction in taxes for all oil produced through CO_2 for EOR. The tax would be applicable to all production from new fields as well as increased volume from existing fields. An alternative to this general tax incentive is to apply exemptions or tax reductions only to a specific volume of oil produced through CO_2 for EOR [cc],[24]. A volume price exemption may however encourage oil companies to underestimate the volume of oil that can be recovered without CO_2 in order to benefit from the taxes for a larger volume. A mechanism should be provided to avoid such situation.

b) Measures on depreciation time: the licences can also be given the opportunity to increase depreciation charges on investments directly tied to the use of CO_2 for EOR. A shorter depreciation time gives a lower taxable income in the period from initial investment to full write down and consequently a lower up-front taxation

[bb] The incentive scheme was done through the following mechanism: a) a volume price exemption b) exemption from tax profit c) exemption on all oil produced from a CO_2 flooded reservoir (ex in Texas where there is a severance tax exemption on all the oil that is produced from a CO_2 flooded reservoir)

[cc] In 2004, the Kon-Kraft (see reference list) tax project in Norway suggested different changes to the tax regime to promote increased value creation on the NCS. One of the project proposals was to give such a volume exemption. The government however did not support the proposal, most probably because the Ministry of Finance considered that such an exemption arrangement would result in reduced tax revenues with no real incentive for end of life production

c) Tax credit: a tax credit of about 15% (as in Texas) could apply to all costs associated with installing the CO_2 flood, CO_2 purchase and CO_2 operating costs for injection. When the credits are granted, the remaining 85% of the qualifying costs are expensed (or depreciated) normally.

d) Modification of the basis on which the tax is assessed: Taxation based on achieved oil price in the marketplace as opposed to an averaged fixed price as is the case today in Norway offers another measure that might reduce the oil companies' risk. This would enable companies to hedge their production and reduce further risk by selling oil on forward contracts without being taxed based on a potentially higher average fixed price assessment than actually achieved.

It should be considered how such tax incentives would be accepted under EU state aid rules, and whether further exceptions are needed to justify such state aid.
Tax incentives should only be given for a kick-off period until there are sufficient EOR projects to create a market for CO_2 storage. Then they may be phased out over time as compared to stopped immediately. They should also be reconsidered when other more general CCS incentives are introduced.

3.2.2 Earmarked revenues

Additional revenues to the state arising from the increase of oil produced through CO_2 for EOR could be earmarked to be used for further investments in CCS[dd], as for example to finance the establishment of pipeline infrastructure, to finance research, site selection and characterisations, monitoring improvements etc.

3.2.3 Regulations - Integrate EOR in the Plan for Development and Operation (PDO)

The petroleum concession system in Norway gives the authority the legal basis for controlling each phase of the petroleum activity, from the opening of an area to its closing. It is particularly through the PDO that the authority has the possibility to control and command the development of a petroleum deposit and to require the use of CO_2 for EOR. In practice, such requirement could be difficult to impose on a general basis as CO_2 for EOR requires a solution to several technical and economic issues, among which are where the CO_2 can be sourced, the commercial conditions of CO_2 purchased and the transport of CO_2.

However, in the early phase of CCS development, the authorities should at least set a condition in the PDO that the injection of CO_2 for EOR has been assessed and considered. If the assessment reveals that there is a potential for such use, the competent authority should then ensure that suitable space on the installation is set aside for the equipment necessary to perform injection and to capture and recycle the CO_2[ee]. This condition would be an “EOR ready” category similar to the “capture ready” referred to in the storage directive article 33. If for any reasons, a licensee decides not to start EOR using CO_2, the authority should be able to use its legislation to require a higher recovery rate.

[dd] Such hypothecation has proven unpopular with certain governments for oil tax revenues or equivalent
[ee] CO_2 produced together with oil and gas in addition to all CO_2 generated by EOR activity

If the situation can easily be solved for the development of new fields, it is more challenging for already existing fields. CO_2 injection for EOR purposes could be achieved if for example the reservoir data indicate that CO_2 injection would be useful or if CO_2 supply is easily available. In such situation, the challenge is whether the authorities can require, after the approval of the PDO, the injection of CO_2. This would be similar to the introduction of a condition of “EOR retrofit”.

If the use of PDO to require CCS-EOR is an option to consider, it can however be difficult to put into practice. If the proper financial incentives are given to the operator, it is more likely that such regulation would be unnecessary.

3.2.4 Reward stored volumes of CO_2

It could also be considered to give an incentive to support the purchase of CO_2 for permanent storage at EOR facilities, either by continuing CO_2 injection after ended hydrocarbon production or by injection at stratigraphic intervals which do not interfere with the hydrocarbon producing intervals. Such an incentive could be generalised to all CO_2 stored, but would have to be assessed against other incentives such as those mentioned above.

3.3 Regulation at international levels

The Clean Development Mechanism, is one of the three mechanisms provided under the Kyoto Protocol (beside the emission trade system and the joint Implementation), and aiming countries at fulfilling their climate commitments. The CDM is a project-based mechanism allowing companies to get extra credit by investing in projects in non-Annex I countries. As the ECCO project is by nature a European project, with focus on EOR in Europe, it appears out of the scope of this report to discuss CDM. For a good overview of CCS in CDM the reader is referred to “Report 3: Country Studies. International Policy and Legislation” published in 2009 by the global CCS Institute[25].

4 IMPROVE AND CLARIFY THE LIABILITY REGIME

If a storage site is carefully selected after comprehensive characterisation of the geology, the risk of leakage is very low. According to scientific studies, more than 99 percent of the CO_2 injected will remain stored after thousands of years. [ff],[26]

4.1 Liability linked to the EU ETS system

A crucial element of the newly designed ETS directive[27] is that it incentivises CCS by counting the stored CO_2 as an emission reduction under the ETS [gg]. To ensure the integrity of the ETS, a corresponding debit for any leaked emissions from the elements of the CCS chain is necessary. This has been ensured by deciding that from 2013 and onwards, installation capturing, transporting and storing CO_2 are covered by the EU ETS scheme[hh],[28]. These installations will only be able to carry out their activity if its operator holds a GHG emission permit.

The inclusion of CCS in the ETS has induced a need for monitoring and reporting guidelines in order to quantify any leakage occurring along the CCS chain from storage operations in the EU ETS. Although the implementation of guidelines was technically not required until 2013, the European Commission has recently issued a decision proposal amending Commission Decision 2007/589/EC[29], and setting out guidelines for monitoring and reporting requirements for all installations under the ETS. This document provides a crucial instrument to ensure the “safe implementation and consistent monitoring of CCS projects across Europe.”

According to the revised EU ETS, each part of the CCS chain will be liable to surrender allowances for the part of emissions that have occurred under their activity. This is the application of the polluter pays principle.

This liability scheme can however be challenging in a cross-border context as an installation, typically a storage site or a pipeline, covered by the EU ETS can cross several borders. The question will be to which national competent authority the ETS installation has to surrender allowances for the CO_2 emissions emitted and in case of leakage. This is particularly relevant for cross-border storage sites and cross-border pipelines. This issue is closely linked to the monitoring approaches to detect leakage as if no leakage is detected and measured, no allowances can be surrendered. The Member States of the competent authority that authorised the site will have a leading role here.

[ff] Raza (2006) found that basically all the CO_2 remains trapped once it has been injected into the sub-surface. These findings underline the potential of geological CO_2 storage of being a safe and effective CO_2 mitigation tool to fight climate change

[gg] The main long term incentive for the capture and storage of CO_2 (…) is that allowances will not need to be surrendered for CO_2 emissions which are permanently stored (…)

[hh] Guidance on Interpretation of Annex 1 of the EU ETS Directive, dated 18 march 2010 recommends the installation boundaries to be set as broad as possible

4.1.1 Cross-border pipelines

The commission draft guidelines basically adopt an input-output approach, the input being the CO_2 stream transferred into the pipeline and the output being the CO_2 stream transferred out of the pipeline[ii].

To ensure the integrity of the ETS system and that allowances are surrendered by the pipeline operators to the State having jurisdiction over it, three systems could be suggested:

- to require measurements whenever the pipeline crosses a new state : this method is however not cost-efficient
- to require that the quantity of measured emissions in an input-output approach is distributed between states on the prorata of the kilometres of pipeline crossing its territory.
- to regulate the issue by treaties

4.1.2 Cross-border storage site

For cross-border storage site, the following distinction should be made:

- situation where the storage is crossing States A, B and C and where there is only one injection point in State A (a)
- situation where the storage is crossing States A, B and C and where there are several injection points in States A, B and C (b)

a) When there is only one injection point in State A, the rule should be that the injection facility responsible for the leakage and being under the jurisdiction of State A should surrender allowances to that State A (wherever the leakage happens in the storage site). It assumes however that the States B and C agree to let State A take measurements and monitor the storage site on their territory. This could be achieved through treaties.

b) When there are injection points in several States, each State should remain liable for emissions during injection processing, but a joint liability should be established for any other leakage based on the prorata of the volume of CO_2 injected by each country.

In both cases, agreements between competent authorities in the concerned Member states are needed. This should presumably cover leakage issues.

4.1.3 Ships

Emissions from the propulsion of ships are yet not covered by the EU ETS. However, the use of shipping to transport captured CO_2 within a CCS chain would have to be included in order to maintain the integrity of the chain. If not, then only CO_2 delivered to a licensed storage facility could be eligible. The inclusion of CO_2 on board shipping in the ETS would also require the establishment of monitoring guidelines.

[ii] Emissions from CO_2 pipelines include mainly fugitive emissions, emissions from venting and potential leakages in the pipeline.

Assuming that satisfactory monitoring for the detection and quantification of leakage are in place, the question is to which state the ship would have to surrender allowances. If the common sense dictates that allowances should be surrendered to the state having jurisdiction over the ship, it can be difficult to apply in practice as the determination of « jurisdiction » is difficult to assess in international ship transport.

A more simple solution which is also well appropriate as long as shipping is not included in the ETS, would be to require the surrendering of allowances to the exporting Member State. Ships would need to provide a financial guarantee upon leaving port, which would be cancelled only upon certified delivery at storage site.

4.2 Other Liabilities (environmental damage, health and property damage)

The potential liability of operators involved in the CCS chain can not only be limited to their compliance with the EU ETS scheme (liability for climate change).

The operator can also be liable for damage to the local environment under the Directive (2004/35/EC) [jj]. The operator can also be liable under national legislation for aspects not covered by the Environmental Liability Directive (ELD)[kk] and for damage to person or to property. Such national legislation have the potential to result in major costs for operators such as decontamination of land and water, reinstatements of habitats and species, compensation payment for victims of bodily injury or losses in property values. Those legislations have also the potential to draw in other responsible parties such as site owners and the producers of the harmful/dangerous substance. They also offer fewer defences to liabilities and generally do not contain the limitation periods included in the ELD.

Therefore, the determination of who is liable in the CCS chain and the extent of the liability can be challenging. Variation between the regimes of responsibility between member states could create uncertainty for actors, particularly for cross border projects.

To provide certainty, a regime of responsibility and scope of responsibility between all actors involved in the CCS chain should be provided in the form of guidelines, based on the polluter pays principle.

Operators could however enter into contractual agreements to limit their responsibility.

4.3 Issues relative to the long term liability - Site transfer

In legislating for the long term liabilities of CCS storage, policy makers have to balance a) the operator's concerns about having a legal certainty and a liability limitation, and b) a need

[jj] The ELD directive applies only in narrow circumstances and provides that liability is statute barred after 30 years

[kk] The ELD directive applies only in narrow circumstances and provides that liability is statute barred after 30 years

to secure a high level of risk management and environmental protection and to convince public opinion that CCS is safe.

Although the Storage directive provides that the transfer of liability to the State occurs a minimum of 20 years after site closure and/or when the CO_2 condition is stable[ll], a closer look at the directive's provisions reveals that:

1) There are potential limits to the transfer of liability, with the result that the operator could still incur liabilities from certain sources even after the transfer has been completed: (for example bodily injury and property damage claims, actions relative to contaminated land and water pollution, claims brought by other parties under contract, unresolved litigation)

2) The authority can re-open the operator's responsibility after transfer when there has been fault on the part of the operator. [mm] The way the fault provision is worded could give the authorities a wide discretion to re-visit liability after transfer. For example the list of examples given for what could constitute a fault is a very "mixed bag" and it is not clear whether there has to be a causal connection between a specific fault and the relevant harm which becomes manifest after transfer (for example, could the fault include deficient data collection at the time of site selection?)[nn],[30].

3) The State can also postpone the transfer of the site, leaving the operator with an open-ended liability. Postponement could be grounded by a lack of stable conditions of the CO_2, that the operator has not completed remedial work, that there remains unresolved litigation etc.

Finally, there is a good chance in the long term that the State will have new environmental priorities other than CCS, which will compete to have public funds. As the transfer of liability is a public policy matter, it cannot be excluded that when CCS receives less attention or policy becomes less sympathetic to the operator, the State will try to find ways to re-open the financial responsibility of the operators, particularly by using the concept of fault or by limiting the scope of the transfer.

Although some "long term" legal uncertainty is inherent to many areas of commercial activity (any sector is potentially vulnerable to changes in policy regulation), open-ended and unlimited liabilities are a major barrier to entry for commercial organisations, particularly in the context of novel technologies and high potential political risk. Hence action by Member

[ll] According to article 18, the responsibility for the storage site is transferred 1) if when all available evidence indicates that the stored CO_2 will be completely and permanently contained 2) a minimum period of 20 years has elapsed, 3) financial obligations have been fulfilled 4) the site has been sealed and the injection facilities have been removed

[mm] according to article 18(7), "*in cases where there has been fault on the part of the operator, including cases of deficient data, concealment of relevant information, negligence, wilful deceit or a failure to exercise due diligence, the competent authority shall recover from the former operator the costs incurred after the transfer of responsibility has taken place*"

[nn] For further details, see http://www.ucl.ac.uk/cclp/ccsliable.php, addressing environmental liabilities issues

States to close off some of these uncertainties at this stage will encourage the participation of key players in the uptake of CCS.

As an alternative, Member State could decide when transposing the Directive into national law, to improve the operator's protection against liability and provide that the operator's liability after site transfer will not be re-visited (by deciding for example to add protection from civil claims or from statutory laws on environmental damages). However such provisions would have to be carefully considered so that the national liability regime does not appear as less stringent than that specified under the directive.

The establishment of a fund to mutualise the responsibility of storage operators could provide an adequate solution.

4.4 Establishment of a fund to mutualise responsibility of storage operators

To mutualise the responsibility of storage operators in case of leakage, both during the operational phase and after closing, a CO_2 storage Trust Fund could be established (either at a national level or at the EU level). Operators would have to pay a set fee per tonne of CO_2 injected into this fund, and the fee for each storage operator would be determined by the risk the storage operator carries[oo]. The fund would be used to cover for example liabilities or expenses not already covered by the required financial guarantee and any other liabilities that are potentially excluded from the transfer.

[oo] If the risks are deemed the same at any regulated site, a larger operator should cover a proportionately larger risk

5 ORGANIZATION OF THE VALUE CHAIN

5.1 Stimulate CCS through the regime of third party access

The Storage Directive provides the principle of open access to transportation networks as well as storage sites (principle of Third Party Access or TPA).

Access to storage and transport networks will be particularly important if CCS becomes mandatory as CO_2 producers will be required to store their CO_2 and will therefore need to have access to transport infrastructure and to storage sites.

Although the main purpose of the Storage Directive is to ensure a safe geological storage of CO_2 as a measure to combat global warming, it is interesting to note that the rules on TPA are not built on environmental considerations: their objective is to ensure competition in the EU energy market and constitute therefore the legal instrument providing competition in the electricity and heat market. This consideration might influence the way rules on TPA have to be interpreted.

According to the Directive, Member States are free to decide on how to determine their access regime and to create a suitable regime as long as it takes into account some general principles such as non-discrimination and transparency, available capacity and the applicable CO_2 reduction obligations.

The three main issues addressed in the Directive will be discussed below: 1) the determination of who is entitled to access 2) the scope or limitations of access right 3) the terms and conditions for access. The coordinated operation and development of the network (System Operator) will also be discussed.

5.1.1 Access rights to transport network and storage network

The Storage Directive[11] does not specify who is entitled to access, who is a user or potential user. This is left to Member States to decide. Indeed, *"Member States shall take the necessary measures to ensure that potential users are able to obtain access to transport networks and to storage sites for the purpose of geological storage of the produced and captured CO_2 in accordance with paragraphs 2, 3 and 4"* (article 21).

Clarification should be made to define the circle of those ("users", "potential users") entitled to require access. The circle of users could in theory include all the entities involved in the CCS chain, from the CO_2 producer to the transport operator and the storage operator.

However, the directive suggests that the users are those having the need to *"store the produced and captured CO_2"*. A literal interpretation of the directive suggests therefore that competitors to the network owner are not potential users in the sense of the directive as they do not have an independent need to *"store the produced and captured CO_2"*. This would mean for example that a storage operator, wishing to connect to an already established transport network (pipeline), could not require access to the network.

Clarification should however be made regarding the circle of those entitled to have a right to access. Member States should particularly consider whether:

- storage operators should have a right to access transport networks
- transport operators should have access to storage networks
- transport operators should have access to competitor transport networks
- storage operators should have access to other storage networks

Member States should also decide whether “access to storage locations” should include access to buffer locations.

Coordination between Member States would be desirable to reach harmonisation. If the designation of eligible customers varies between member states, rules should be established to decide according to which State’s rule a user is deemed eligible to access rights. Such rule could be that a user deemed eligible according to the criteria used in the ”pipeline State” or the ”storage State” must be granted access, irrespective of whether the customer is located in the pipeline State or not.

5.1.2 Scope of access rights – derogations from TPA

Limitation in the right to third party access is necessary for investment purposes. As building and operating sub-sea pipelines is technically complicated and extremely costly, an extensive right to unreasonable third party access could imperil both long term and large investments.

The Storage Directive provides therefore a list of possible reasons for derogations and allows Member States to take into account several factors that may require derogations when designing a regulatory regime for third party access. The reason for such refusal to access can be a) an incompatibility of technical specifications which cannot be reasonably overcome, b) if it necessary to respect the duly substantiated reasonable needs of the owner or operator of the storage site or of the transport network and the interests of all other users of the storage or the network or relevant processing or handling facilities who may be affected c) lack of capacity and d) if access would affect the national CO_2 reduction obligations.

If an operator refuses third parties access on the grounds of lack of capacity or a lack of connection, it is up to each Member State to take the measures necessary to ensure that the operator makes any necessary enhancements as far as it is economic to do so or when a potential customer is willing to pay for them, provided this would not negatively impact on the environmental security of transport and geological storage of CO_2.

Technical reasons: Denial due to technical reasons[pp] raises the question of what is considered to be “reasonable to overcome”. It is however more likely that if it requires large investments to remediate, it would not be reasonable.

Need of owner/operators/existing users: a facility operator is only obliged to provide access to the extent that there is capacity available. Since access may be denied if capacity has run

[pp] For example pressure, temperature, water in CO_2, CO_2 composition which is not compatible with the transport network or the specification for storage.

out, the way in which the capacity is allocated is therefore important. If the owner has the operative responsibility and allocates capacity to themselves or to connected companies in preference to other potential users, it could be considered as discrimination. Vertical integration should be avoided.

Climate obligations: It is up to the Member States to decide the proportion of CO_2 reductions that they intend to meet through CCS. If a Member State has already met its reduction obligations through CCS, the Directive suggests that third parties will not have any right to access under fair and open conditions. However, to achieve an efficient use of available capacity and allow storage of CO_2 from EU Member states, it would be preferable that Member States provide an access as wide as possible.

Although Member States shall ensure that potential users are able to obtain access to transport network and to storage site, the Directive does not give the right to a potential user to choose which transport network he wants to use. The user will be free to start negotiation with the operator of his choice but in case of refusal, he will not be able to require access to this infrastructure. The Member State will decide which transport network and which storage site should be used. It is assumed that the authority would ensure access to the infrastructure which is physically easiest to be connected to from the users.

5.1.3 Terms and conditions of access

The Storage Directive does not provide further regulation as to how the right of access should be carried out. There are no specific regulations on how terms and conditions for access are to be settled. Member States are therefore free to create a suitable regime.

In the EU legislation applicable within the gas sector, three different regimes of TPA are applicable, depending on the part of the gas chain: a regime for downstream pipelines, a regime for upstream petroleum pipelines and a regime for the subsoil gas storage facilities. Depending on the stage of the gas chain[qq], the access regime is either a regulated access or a negotiated access[rr].

In implementing the requirement on TPA in the Storage Directive, Member States could use a similar approach to the one provided in the EU gas legislation and decide to use existing legislation governing the upstream petroleum sector as regards to regulations on subsoil storage and/or upstream pipelines or the legislation governing the downstream gas sector. In Roggenkamp and Woerdman (2009)[31] it has been argued that CO_2 pipelines should be considered as “reverse” upstream pipelines and should be regulated in a similar way to upstream petroleum pipelines.

[qq] Regulated access is mandatory in the downstream pipeline sector while for gas storage and upstream pipelines, Member States can decide to apply and combine different regimes

[rr] Under a system of negotiated TPA the parties concerned negotiate the price and conditions for transporting the commodity, whereas under a regime of regulated TPA the governments or regulator sets in advance the transportation conditions and tariffs or the methodology to calculate them. One of the main differences between both regimes is the moment at which the competent authorities become involved.

This would entail that the oil and gas upstream regulatory and safety regime already applicable in Member States also applies for these pipelines. It would also mean that the regulatory regimes applying for third party access to pipelines can apply.

To facilitate and accelerate the use of existing infrastructure (when CO_2 is injected in a depleted oil field), pipelines should be qualified as ”reverse” upstream pipelines and be regulated in a similar way to upstream petroleum pipelines. This would entail that the oil and gas upstream regulatory and safety regime already applicable in MS also applies for these pipelines. It would also mean that the regulatory regimes applying for third party access to pipelines can apply.

Although we have experience with TPA rules in the gas sector, it is however more challenging to provide a rational regulation for a new CCS infrastructure than for a well-established infrastructure. The original TPA scheme for the gas (and electricity) market has indeed developed along with the development of this market and its infrastructure. The need for a flexible scheme which can easily be changed or developed seems particularly important for CCS as the CCS technology is still in the beginning of its development and it is difficult to predict what the CCS value chain will look like. This need for certain flexibility is, however, in conflict with the investors' need to have certainty about the way TPA will be organized and on which grounds access and/or refusal of access will be granted.

Moreover, depending on the choice made by Member States, this could impact the development of CCS in the EU. As described by Marta Roggenkamp[31]; "*Such diverse approach to CCS could imply that some Member States may be more attractive to store CO_2 than other Member States. Some CO_2 emitters might even consider storing the captured CO_2 in another Member State if that regime is more attractive. This would mean that the long-term liability for storing CO_2 also should be put on that other Member State*." Roggenkamp also considers that a number of parties interested in developing a subsoil CO_2 storage facility will depend on several aspects, of which the access regime in place; " *a favourable access regime may, for example, limit the interest to apply for a storage license and operate a storage facility. It is after all the operator/owner of the storage that is responsible for operating the storage reservoir and liable for any damage resulting from such storage. Why should a party invest in storage and apply for a storage permit if he has to provide third parties with access and remain liable for all damage? Although the storage fees should compensate the permit holder for all costs involved, it remains to be seen whether and how any long-term future liability can be taken into account while setting these tariffs".*

5.1.4 System operation

A network of interconnected pipelines is expected to be established under successive pipeline licences. The CO_2 producers will then connect to the downstream pipeline network. To achieve an efficient resource management a coordinated operation and development of the whole network is required. This coordinated operation and development, called "system operation", could be achieved in the same manner as it applies in Norway for the oil and gas market[32]:

The technical coordination requires first the coordination of CO_2 gas flows from different sources. Indeed, the power plants produce different CO_2 quality, but the quality of the comingled stream in the downstream pipeline network has to meet the quality specifications in the transportation contracts and in the storage site contract (and also if CO_2 for EOR).

Secondly, it requires a coordinated maintenance of the network. All the installations in the network will be physically linked. Consequently, the shut- down of individual installations for maintenance needs to be coordinated in order to avoid disturbing the other installations in the network. Thirdly, a coordinated planning of new capacity and or expansion of existing capacity in a view to meeting the future demand for CO_2 storage (or CO_2 for EOR) from the network is necessary.

The economic coordination will include the allocation of transportation capacity and storage capacity to the different users of the network. It will also entail the stipulation of transportation and storage tariffs: i.e. the price for transportation capacity and the price for storage capacity.

The above-mentioned aspects of technical coordination promote short term and long term security of supply while the economic coordination is necessary to achieve efficient and non-discriminatory access for users to the network.

As argued previously, it is difficult at present to assess what the CCS value chain will look like and how it will be organized as the CCS market is only in the beginning of its development. It is particularly uncertain whether the value chain will be vertically integrated, i.e. same operators/owners for capture, transport and storage (operator covering all functions in the CCS chain). Such vertical integration can be an attractive commercial arrangement to companies, but could create competition distortion and may need to be regulated. Indeed, in order to protect itself against competition in the market, a storage site operator engaged in transport activities might have an incentive to charge excessive transport tariffs to CO_2 producers basing their activities on third parties access.

To avoid situation of ownership structures resulting in competition distortion, it should be considered to organize the transport system operator as a company with no commercial interests in the CO_2 market and that all aspects of the system operation are conducted in a neutral manner (as is the case for the electricity and gas markets).

As described above, the system operator would manage the capacity allocation (capacity physically available at any time, capacity rights under existing contracts) and the coordination of CO_2 flows in a similar manner to what is done for other infrastructures such as airfields and ports. The CO_2 producers would have to follow the instructions given by the system operators in order to avoid operational disturbance or deterioration of the pipeline/storage site due, for example, to corrosion.

To achieve better transparency and non-discrimination in the access to infrastructure, Member States should ensure that information and conditions of access (guidelines and tariff, commercial conditions) are published. This could be done through daily publication of booking capacity, web publication of entering and exit point and information on the CO_2 composition (See Marathon case IP/04/573 s2-3[33]).

5.2 Stimulate TPA through the assessment of the Plan for Development and Operation

The petroleum concession system in Norway gives the competent authority the legal basis for controlling each phase of the petroleum activity, from the opening of an area to its closure. The authority can stimulate third party access through injunction and prohibition when assessing the oil field operator's Plan for Development and Operation (PDO).

The PDO is for these reasons an essential tool for controlling the petroleum production. If the chosen development solution presented in the PDO does not account for TPA, it could result in extra costs, investments and time-consuming building to make access possible. It can also result in such inconvenience for the right holder that the modification will not be acceptable or possible. It is clear that it is less costly to choose a solution that is over-dimensioned than to make the necessary modifications and building when the installation is already in use.

Requirement that the new building has to take account of future use, relies however on the predictability of facts, i.e. that there will be fields developed in the area that will have the need for third party access.

This same controlling tool could be used for CO_2 storage activities. The competent authority would require, prior to the development of the storage field, an assessment relative to third party access. Such regulations would limit issues on lack of capacity.

For existing fields, if the PDO is already approved, does the authority have the possibility to review the plan and make a post requirement for TPA? If the authority could discretionarily withdraw decisions and set new conditions, it would result in too much insecurity for stakeholders. At the same time the authority needs to control the use of the petroleum resources and it could be relevant to review licences.

6 SUMMARY OF MAIN RECOMMENDATIONS FOR IMPROVING THE REGULATORY FRAMEWORK AND FOR OPTIMIZING THE ORGANIZATION OF THE CCS VALUE CHAIN

		Type	Description	Recommendations	Are these existing policies or new recommendations ?
Financial Incentives	Current general incentive schemes applicable to all CCS project	Emission Trading Scheme/ EU subsidies/ States subsidies	• EU - ETS • NER 300 • EERP • 50% of revenues from auctioning allowances to be used by MS for climate measures, including CCS • Direct subsidies at national level	• Insufficient incentives to encourage wide deployment of CCS. • Recommendation to establish incentive schemes common to all CCS projects, including EOR projects, to encourage a wide portofolio of CCS projects. • If not politically feasible, specific incentives for CO_2 for EOR to be considered as a fall-back for a given time (time to be clearly defined).	Existing policies (EU policy / National policies)
	Additional general incentives to be considered (example)	Capacity Market	Create a Forward Capacity Market to low carbon electricity generation for any sources not already supported by support schemes (such as feed in tariffs or green certificates)	Stimulates CCS investments and gives predictability to investors	Proposal in this report - Adaptation of traditional FCM
		Bonus Malus Schemes	Scheme directed towards CO_2 producers. Power plant emitting under a specific norm are rewarded (bonus). Power plant emitting above a specific norm are penalized (malus)	Creates long term predictability for a high price on CO_2 emission in the power sector	Proposal in this report - Suggested by the Netherlands' CCS task force recommendation
		Reward stored volume of CO_2 for permanent storage through delivered CO_2 price support	Directed toward storage operators		Proposal in this report
Financial Incentives	Specific tax incentives for CO_2 for EOR	Options to consider	• Tax exemption/tax reduction • Shorten depreciation time • Tax credit • Modification of the tax basis	• Applicable only for a kick-off period – until sufficient EOR projects have created a market for CO_2 storage. To be reviewed if more general CCS incentives are introduced. • Need to avoid accumulation of	Proposal in this report - Recommendations mainly based on similar tax incentive schemes in US

				subsidies. • Verify compliance with State aid rules	
		Tax exemption/reduction	• Grant tax exemption or reduction for all oil produced through CO_2 for EOR • Alternatively only for a specific volume of oil produced through CCS for EOR	Consider risk that oil companies under-estimate their resources recoverable without CO_2 in order to maximize profits	Id.
		Period of depreciation	Shorten depreciation time on investments directly tied to the use of CO_2 for EOR	• Gives lower taxable income in the period from initial investment to full write down and consequently a lower up-front taxation	Id.
		Tax credit	A tax credit could apply to all costs associated with installing the CO_2 flood, CO_2 purchase and CO_2 operating costs	With a tax credit of 15% granted, the remaining 85% of qualifying costs would be depreciated normally	Id.
		Modification of the tax basis	Base taxation on the achieved oil price in the market place rather than on an averaged fixed price	Enables companies to hedge their production and reduce further risk by selling oil on forwards contracts without being taxed based on a potentially higher average fixed price assessment than actually achieved	Id.
	Regulation for CCS for EOR	Earmarked revenues	Earmark additional revenues to the State arising from the increase of oil produced though CO_2 for EOR for further investments in CCS	Allows to finance the establishment of pipeline infrastructure, research, site selection etc	Proposal in this report
		• Plan for Development and Operation. • EOR ready-EOR retrofit	• Set as a condition in the POD that CO_2 injection for EOR has been assessed and considered. • Require, when applicable, a condition of "EOR ready" for new fields and "EOR retrofit" for existing fields.		Proposal in this report
CCS - Liability issues		Cross border liabilities	Encourage countries to involve in cross border projects by giving certainties regarding the allocation of EUA in case of leakage.	Define guidelines for allocation of risk between countries in cross border projects (cross border pipelines, cross border storage sites and ships transporting CO_2)	Proposal in this report
		Long term liability/transfer		• Favour the transfer of all liabilities, including liabilities to third parties • Define mechanism to avoid the unfair delay of transfer to the State	Proposal in this report

		Trust Fund	• To be established either at national of EU level and financed by operators by way of a fee per tonne of CO_2 injected. • Fund to be used to cover liabilities or expenses not already covered by the financial guarantee and any other liabilities that are excluded from the transfer	Establish a Trust Fund to mutualise responsibility of storage operators	Proposal in this report
		Financial guarantee/contribution		Clarify whether the constitution of a Financial Contribution and Financial guarantee are applicable for CO_2-EOR	Proposal in this report
Organisation of the Value chain		Buffer location		• Clarify the regime of buffer location to avoid any significant risk of leakage and environmental health risks • Clarify Third party access to buffer location	Proposal in this report
		Vertical integration versus independent TSO	• Need to avoid situation of ownership structure resulting in competition distortion • Independent TSO could manage capacity allocation and coordination of CO_2 flows.	• Assess the potential effects of vertical integration on competition. • Consider the establishment of independent TSO • MS to ensure transparency and non-discrimination in the access to infrastructure (information and condition of access to be published)	Proposal in this report
		Third party access	• Need for flexible mechanism as infrastructure not yet established. • The Norwegian petroleum concession system gives the competent authority the legal basis for stimulate third party access through injunction and prohibition when assessing the POD	• Need to clarify the circle of those who are entitled to require access to transport and storage network • Clarify access to buffer location • Use the approach of EU gas legislation • Stimulate TPA through the assessment of the PDO	Proposal in this report
		Licencing	Ensures that the EOR operator can enter into contracts with both CO_2 producer and transporters	License the CO_2-EOR facility as a storage facility from the beginning of the activity	Proposal in this report

General CCS incentive (section 3.1)

To achieve the deployment of CCS and encourage a wide portfolio of CCS projects, it is preferable to establish an incentive scheme common to all CCS projects. If a general incentive scheme for CCS is politically not feasible, specific incentives for CO_2 for EOR projects should be considered as a fall-back for a limited period. They should however be re-considered when other, more general CCS incentives, are introduced.

There is a range of alternative ways to stimulate investments in CCS - without putting the burden on public budgets. The Netherlands' CCS Task Force recommendation of a 'bonus-malus' scheme and the Forward capacity market dedicated to low carbon electricity generation are two interesting options that should be considered.

Specific incentives for CO_2 for EOR as a fall-back and for a limited period (section 3.2)

Additional financial incentives for CO_2 for EOR projects should be carefully considered as they could result in delaying the transition to a low carbon economy at a later stage than necessary. They could also result in cross subsidising. The EU state aid rules will therefore be determinant to avoid accumulation of aids.

Tax incentives (section 3.2.1)

The tax incentives should be designed to give oil companies a reduction of their taxable revenues corresponding to the cost of capturing, transporting and storing each tonne of CO_2 minus the benefits of EOR/EGR. This principle should be the basis when assessing the different types of tax incentives.

The benefit of tax incentives should also be conditioned in a way that a monitoring and verification program demonstrates that at least 99% of the injected CO_2 will remain sequestrated for thousands of years. [26]

A tax incentive scheme should take into account the risk that oil companies underestimate resources at an early phase in order to maximize their profits while at a later stage increasing recoverable resources due to EOR and/or EGR efforts.

A range of tax incentives can be considered: Tax exemption, volume exemption, measures on depreciation time, Tax credit, Modification of the basis on which the tax is assessed.

Active use of the Plan for development and Operation (section 3.2.3)

Member States should consider to require CO_2 for EOR and to stimulate third party access through injunction and prohibition when assessing the oil field operator's Plan for Development and Operation (PDO).

Earmarked revenues (section 3.2.2)

Additional revenues to the State arising from the increase of oil produced through CO_2 for EOR could be earmarked to be used for future investments in CCS (for example infrastructure).

Cross border issues and liability issues linked to the EU ETS (section 4.1)

For cross-border projects, clear rules should be provided to identify the State to which facilities have to surrender allowances in case of leakage. Different rules might be necessary to cover situations of leakage occurring in cross border pipelines, in cross border storage site and through transport by ship. Agreements between competent authorities in the concerned Member states could also solve such issues.

As long as shipping is not included in the ETS a requirement of surrendering allowances to the exporting Member State could be implemented. Ships would need to provide a financial guarantee upon leaving port, which would be cancelled only upon certified delivery at storage site.

Liabilities related to environmental, health and property damage (section 4.2)

In addition to liabilities under the EU ETS scheme and ELD, the operator can also be liable under national legislation for additional aspects and for damage to person or to property. National legislations also have the potential to draw in other responsible parties such as site owners and the producers of the harmful/dangerous substance. They also offer fewer defences to liabilities and generally do not contain the limitation periods included in the ELD. To provide certainty, a regime of responsibility and scope of responsibility between all actors involved in the CCS chain should be provided in the form of guidelines, based on the polluter pays principle. Operators could however enter into contractual agreements to limit their responsibility.

Long-term Liabilities issues (section 4.3)

A closer look at the Storage directive's provisions reveals that a) There are potential limits to the transfer of liability, with the result that the operator could still incur liabilities from certain sources even after the transfer has been completed b) The authority can re-open the operator's responsibility after transfer when there has been fault on the part of the operator c) The State can postpone the transfer of the site, leaving the operator with an open-ended liability.

Although some "long term" legal uncertainty is inherent to many areas of commercial activity (any sector is potentially vulnerable to changes in policy regulation), open-ended and unlimited liabilities are a major barrier to entry for commercial organisations, particularly in the context of novel technologies and high potential political risk. Hence action by Member States to close off some of these uncertainties at this stage will encourage the participation of key players in the uptake of CCS.

As an alternative, Member State could decide when transposing the Directive into national law, to improve the operator's protection against liability and provide that the operator's liability after site transfer will not be re-visited (by deciding for example to add protection from civil claims or from statutory laws on environmental damages). However such provisions would have to be carefully considered so that the national liability regime does not appear as less stringent than that specified under the directive.

The establishment of a fund to mutualise the responsibility of storage operators could provide an adequate solution.

Trust Fund (section 4.4)

To mutualise the responsibility of storage operators in case of leakage, both during the operational phase and after closing, a CO_2 storage Trust Fund could be established (either at national level or at the EU level). Operators would have to pay a set fee per tonne of CO_2 injected into this fund, and the fee for each storage operator would be determined by the risk the storage operator carries. The fund would be used to cover for example liabilities or expenses not already covered by the required financial guarantee and any other liabilities that are potentially excluded from the transfer.

Organization of the value chain and System operator (section 5.1.4)

It is difficult at present to assess what the CCS value chain will look like and how it will be organized as the CCS market is only in the beginning of its development. It is particularly uncertain whether the value chain will be vertically integrated, i.e. same operators/owners for capture, transport and storage (operator covering all functions in the CCS chain). Such vertical integration can be an attractive commercial arrangement to companies, but could create competition distortion and may need to be regulated. Indeed, in order to protect itself against competition in the market, a storage site operator engaged in transport activities might have an incentive to charge excessive transport tariffs to CO_2 producers basing their activities on third parties access.

To avoid situation of ownership structures resulting in competition distortion, it should be considered to organize the system operator as a company with no commercial interests in the CO_2 market and that all aspects of the system operation are conducted in a neutral manner (as the case for the electricity and gas markets).

The system operator would manage the capacity allocation (capacity physically available at any time, capacity rights under existing contracts) and the coordination of CO_2 flows in a similar manner to what is done for other infrastructures such as air fields and ports. The CO_2 producers would have to follow the instructions given by the system operators in order to avoid operational disturbance or deterioration of the pipeline/storage site due, for example, to corrosion.

To achieve better transparency and non-discrimination in the access to infrastructure, information and conditions of access (guidelines and tariff, commercial conditions) should be published. This could be done through daily publication of booking capacity, web publication of entering and exit point and information on the CO_2 composition.

Third party access (section 5)

In the early phase of CCS, where the infrastructure is not yet established, rules on TPA should offer sufficient flexibility to adapt to the development of the infrastructure and of the market, and at the same time offer sufficient certainty to investors about the way TPA will be organized and on which grounds access and/or refusal of access will be granted.

Member States should endeavour to reach harmonisation when determining the TPA regime as variation between states could impact the development of CCS in the EU ; for example regarding the circle of those entitled to have a right to access, the scope or limitation of access rights and the terms and condition of access.

In implementing the requirements on TPA in the storage directive, Member States could use a similar approach to the one provided in the EU gas legislation. To facilitate and accelerate the use of existing infrastructure (when CO_2 is injected in a depleted oil field), pipelines should be qualified as ”reverse” upstream pipelines and be regulated in a similar way as upstream petroleum pipelines. This would entail that the oil and gas upstream regulatory and safety regime already applicable in MS also applies for these pipelines. It would also mean that the regulatory regimes applying for third party access to pipelines can apply.

Other recommendations

As long as CCS projects are still under development and that we don’t know what the value chain will look like (whether there will be separate value chain for EOR and a value chain for CCS or joint network), there are uncertainties about how the CO_2 producer will document (for his emission reporting obligation) that his CO_2 has been permanently stored and therefore not emitted. This uncertainty should be clarified to avoid delay in investments decisions. The following documents should be considered as sufficient to document that the CO_2 is not emitted and to release the CO_2 producer from his obligation to surrender allowances: a) the contract of CO_2 delivery entered into between a licensed storage operator and/or with a licensed transporter of CO_2 (for storage purposes) or b) a certificate from the storage operator that the CO_2 delivered has been injected (the storage operator has a duty – according to the directive – to keep track on a register of all injection).

Even though buffer locations may not be meant to store CO_2 permanently, buffer aquifers should still be considered as permanent storage. At present, a temporarily storage of CO_2 in aquifers for future EOR is considered a one way buffer. Once in an aquifer the CO_2 will be technically and economically very challenging to produce. A buffer storage aquifer location should be properly selected to avoid any significant risk of leakage and environmental/health risks. Monitoring and rules on leakage should apply in the same way as for permanent storage sites. Clarification regarding the regime of buffer locations is recommended.

IN CONCLUSION

The CCS Directive has surfaced many issues described above. Economic incentives are necessary to overcome some of the difficult issues such as long term liability of CO_2 storage, TPA to pipelines and storage, and cross border liabilities of leaked CO_2. While the EU ETS and other European and national demonstration schemes will be used to encourage CCS, the strongest incentive known to encourage CCS developments is the use of CO_2 EOR. The unknown is how the income from this level of oil production might be used to address the massive costs of CO_2 capture, transport and storage while addressing the unprecedented levels of risks that are placed on storage operators with respect to long term leakage.

ACRONYMS

CAPEX	Capital expenditures
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
EERP	European Energy Recovery Package
EGR	Enhanced Gas Recovery
ELD	Environmental Liability Directive
EOR	Enhance Oil Recovery
EU	The European Union
EU ETS	European Union Emission Trading System
FCM	Forward Capacity Market
GHG	Greenhouse gas
IOR	Increased Oil Recovery
JI	Joint Implementation
MS	Member States
NER	New Entrant Reserves
PDO	Plan for Development and Operation
R&D	Research and Development
TSO	Transmission System Operator

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