INTERNATIONAL AND EUROPEAN LEGAL ASPECTS ON UNDERGROUND GEOLOGICAL STORAGE OF CO_2

Caroline Wall[1], Christian Bernstone[2], Marie-Louise Olvstam[1]
[1]SwedPower AB (Vattenfall AB)
[2]Vattenfall Utveckling AB (Vattenfall AB)

Abstract

The international and European legal rules surrounding the concept of CO_2 storage is fragmentary. This causes legal uncertainty and is bound to slow investments down. Some of the existing rules, such as the OSPAR and London Conventions implies that CO_2 storage in sub seabed geological formations is not allowed for climate change mitigating purposes according to the current definitions of dumping of wastes. Even if absolute certainty about the exact application of a legal rule is not possible, it is necessary to know if an activity is lawful.

The concept of CO_2 capture and storage (CCS) is suitable for international or regional regulation first because the issue of climate change is global and second because the geological formations suitable for storage cover vast areas underground and does not follow state boundaries. If an accident would occur it can therefore not be ruled out that the consequences would be transboundary. National law has not been investigated in this paper and its influence on the concept of CO_2 storage is probably not negligible.

The concept of CO_2 storage needs to be a priority in the international agenda. To a certain extent it already is, but only as far as technical issues are concerned. It is time to involve also environmentalists, lawyers and the public, with little or no technical background. The future application and success of the concept will depend on scientists' ability to make it understandable to others and to stress the urgency with which the matter of climate change must be met. The "wait and see-" approach that many countries apply will inevitably delay this development.

Introduction

The purpose of this paper is to contribute in identifying the gaps in knowledge concerning the current relevant legislation directly concerned with the storage of CO_2, and current relevant legislation not directly concerned with CO_2 storage but which might have an impact on future legislation. Relevant legal principles that might influence future legislation, some of the many ongoing projects concerning CO_2 storage as well as papers and reports on regulating CO_2 storage have been studied, for example [1] [2] and [3]. This paper only deals with the international and European legal aspects of CO_2 storage. If a gap is found here, it might still be possible to fill it within the national legal system. There are examples of where the underground storage of substances, including CO_2, is covered by national law.

There are many ongoing projects where CO_2 storage is being tested and has been so for several years. All of these projects have one thing in common from a legal point of view; they are all storing CO_2 as part of an industrial process; i.e. the CO_2 is either used for enhanced oil recovery, or stored in connection to a CO_2 separation of natural gas with an initial too high CO_2 content to meet sales specifications. Mitigating emission of CO_2 as a greenhouse gas is a desired side effect, but not the main purpose of the storage activity. This distinction is very important from a legal point of view, since there are many cases in which no permit is required. No current CO_2 storage project has, as its sole purpose, the goal of mitigating CO_2 emissions. The main reason for this is that it is not yet economically viable.

From a legal perspective, the kind of storage must be determined. For Western Europe and North America the two main options are geological storage on land or offshore. Geological storage entails storage in unmineable coal seams, saline aquifers, and depleted oil or gas reservoirs. From a legal perspective, there is no significant difference between the types of geological storage, the distinction should be made between on- and offshore storage. This paper does not deal with ocean storage, which directly injects CO_2 into ocean waters, not in a sub-seabed aquifer.

This paper is based on work within the Vattenfall CO_2 Capture and Storage project "The Carbon Dioxide-free Power Plant", aiming at developing a commercial concept by 2015. The project is a Vattenfall Group initiative performed in close cooperation between Vattenfall Utveckling in Sweden, Vattenfall Europe Mining & Generation in Germany, and a large number of external partners, including several major manufacturers, other power companies, engineering companies and research providers and leading universities in Europe.

Why Legal Considerations are Important

When setting up a CO_2 storage project, the project will be affected by technical, economic and legal factors. Overall, the legal costs will be small, however, legal conditions might well determine if a project is possible at all and will determine the requirements that a project must fulfil. Because of the global, or at least multinational, nature of both climate change and geological storage, it is interesting to examine what international and European law has to say about this concept. Although national law always has an important role to play in each individual state, it appears reasonable to expect some kind of international agreement in the future setting standards for the development and practice of CO_2 geological storage.

There is no comprehensive international or European legal framework dealing with the issue of CO_2 storage. The legal rules that are or might be applicable are fragmentary and incomplete. The following section will present an overview of international and European rules that might be applicable and the resulting consequences.

Relevant European Directives

IPPC-directive: Council directive 96/61/EC concerning integrated pollution prevention and control

The EU IPPC-directive [4] provides a list of large industrial installations that are required to undergo an authorisation procedure. This list does not include storage sites for CO_2. However, the directive indicates the general position within the Union that large industrial installations traditionally representing point sources of pollution must be subject to permit procedures during which environmental and other impacts of the installation can be investigated. Included in the list of installations needing authorisation are landfills receiving more that 10 tonnes of waste per day or with a total capacity exceeding 25 000 tonnes, excluding inert waste, and combustion installations with a rated thermal input exceeding 50 MW. These entries do not themselves have bearing on CO_2 storage, but indicates the EU view on storing waste (substances) in the ground as an activity that might pollute the environment and have impacts on humans and should therefore undergo prior authorisation. Also, combustion plants for power generation emits several other substances than CO_2 and is a source of pollution for other reasons than CO_2. Furthermore, two things should be noted. First, CO_2 is not traditionally regarded as a pollutant, which makes it difficult to predict the future applicability of the IPPC-directive. Second, a facility (site) for CO_2 storage would probably not be regarded as a part of the power generating combustion plant unless located on the same premises, thus not falling under applicability of the IPPC-directive. To sum up, it is not the direct applicability of the IPPC-directive that makes it interesting for CO_2 storage as it most certainly is not applicable, but the potentiality of applicability and the fact that there is in fact regulation that could be suitable for this new concept. However, it is likely that slight modifications and adaptations could be in order.

Water framework directive

It is not clear how the EU framework directive on water [5] will concern CO_2 underground storage. The purpose of the directive is to protect inland surface waters, transitional waters, coastal waters and groundwater within the EU. Among the objectives are to provide a sufficient supply of good quality surface and groundwater for sustainable use, to ensure a significant reduction in pollution of groundwater and to protect marine and territorial waters. The directive has river basin approach, which means that the Member States must set up appropriate governance arrangements, which can often be transboundary. CO_2 is planned to be stored underground in geological structures and *if* leakage occurs, CO_2 could have an impact on groundwater protected by the framework directive. According to the directive, groundwater should not be polluted at all. Therefore only very few quality standards are set and instead there is a precautionary approach with a prohibition on direct discharges to groundwater and a monitoring requirement aiming at detecting chemical changes in the water composition. For CO_2 underground storage, this means that in case a leakage causes a change (deterioration) in the groundwater quality, for example, a decrease in groundwater pH, could mean restriction in the activity. The directive is being implemented, but it is yet difficult to see the full consequences of it for CO_2 storage activities.

Waste

If a substance is classified as waste there will be a lot of regulation associated with this classification according to European law. In these situations, the holder of the waste is subject to more stringent rules. The waste directive addresses the Member States and the exact implementation may of course vary to some extent among the Member States. According to Art. 4 of the directive Member States shall take necessary measures to

ensure that waste is recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, and in particular, for example, without risk to water, air, soil and plants and animals. The main consequences are the increased requirements on documentation about the waste and requirements to hold permits for handling and transporting of waste. However, it must first be decided if a substance (product) is actually waste.

The EU framework directive on waste [6] offers a definition of what is to be identified as waste. The purpose of the waste directive is to approximate Member States laws with the objective of protecting human health and the environment and encouraging the recovery and use of recovered materials in order to conserve natural resources. According to Art. 1 of the directive 'waste' shall mean any substance or object set out in Annex 1, which the holder discards or intends or is required to discard, for example, substances which no longer perform satisfactorily, residues of industrial processes, residues from raw materials extraction and processing, and products for which the holder has no further use. Annex I to the directive offers a list of categories of waste where the last category includes any materials, substances or products which are not included in the above categories. This means that virtually anything that meets the definition in Art. 1 is waste. Apparently this definition is very broad and the few exceptions are given in Art. 2 and includes gaseous effluents emitted into the atmosphere. This exception is obviously not applicable in the case of CO_2 capture and storage, where the whole point of the operation is to refrain from emitting the gaseous effluent (CO_2) into the atmosphere. There is little doubt that captured (liquid) CO_2 for the main purpose of mitigating greenhouse gases, and where the CO_2 emanates from and industrial process, including energy generation, would be included in the directive's definition of waste. This is also the conclusion of other studies such as [3].

Annex II A and B of the waste directive lists disposal and recovery activities as they occur in practice, *inter alia* deep injection (for example, injection of pumpable discards into wells, salt domes or naturally occurring repositories). CO_2 is a substance that will inevitably occur as the result of fossil fuel combustion. The capture and compression of CO_2 are preparatory measures for its injection into underground geological formations for an indefinite period of time, i.e. disposal of CO_2 by deep injection into a naturally occurring repository. In light of these arguments it is probable that underground geological storage of CO_2 would be defined as disposal of waste according to European law.

The waste directive is addressed to the Member States of the EU, and although the Member States has a certain amount of freedom to implement the directive into national law, it must still be in compliance with the directive. This means that in the EU Member States there is for example, a requirement for undertakings that carries out deep injection activities to obtain a permit from the competent authority. According to Art. 9 of the waste directive such a permit should cover the types and quantities of waste, the technical requirements, the security precautions to be taken, the disposal site and the treatment method. The undertaking must also keep records on the waste, for example, of the quantity, nature, origin, and where relevant, the destination, frequency of collection, mode of transport and treatment method.

There is no indication that pure CO_2 would be classified as hazardous waste according to EU regulation, namely the hazardous waste directive [7]. However, the captured stream of CO_2 is likely to contain other substances than CO_2 that might render the stream hazardous. This subject is typically not dealt with in much detail in CCS related work. As new capture technologies are being developed the quality of the gas stream is not given in beforehand, i.e. there will be many considerations by R&D teams on to what CO_2 purity levels to aim at[1].

According to the waste directive, hazardous waste is waste featuring on a list drawn up in accordance with a certain procedure by the Commission and based on the annexes to the directive. The list, *the European waste catalogue*, takes into account the origin and composition of the waste and, where necessary, limit values of concentration. The catalogue lists waste according to their origin in categories, both hazardous and non-hazardous waste, for example, one category for wastes from power stations and other combustion plants (excluding waste incineration in this category). When specifying the wastes occurring from these operations flue gases are not included. Of course this is due to the fact that flue gases are normally emitted into the atmosphere and thus excluded from the definition of waste. Since there is no entry for flue gases in the waste catalogue,

[1] The purity of the captured CO_2 stream technically depends on the fuel and process technology used in the power plant, approach used for the capture process and to what extent additional combustion gas cleaning technologies are applied. Components expected to be present in the CO_2 stream mainly include water, sulphur-containing components (SO_2, H_2S, COS), nitrogen containing components (N_2, NO, NO_2), O_2, Ar, H_2, CO, hydrocarbons, metals and particulates.

captured CO_2 would fall under the non-hazardous "wastes not otherwise specified" entry. However, since the concept of capturing and storing CO_2 obviously has not been considered in the waste catalogue, it is still relevant to examine whether impurities in the captured CO_2 could cause the stream to be classified as hazardous waste (the decisive factors when deciding whether a waste product is hazardous or not is the properties and the amount of a specific substance). This examination would have to be done on a case-by-case basis, as levels vary depending on the method of capture and fuel used for combustion. With a high CO_2 content in the stream it is unlikely that it would be classified as hazardous waste according to EU law. Of course, there is no definition of what is a "high CO_2 content", but injection projects such as the Sleipner project inject a gas stream that contain 95% CO_2 [8].

There is additional EU legislation on transboundary transport of waste [9]. This regulation applies to shipments of waste within, into and out of the EU. Transport of waste within a Member State is a national responsibility. Each Member State should have a system for supervision and control that complies with minimum criteria in order to ensure a high level of protection of the environment and human health. The regulation on the transboundary transport of waste provides an extensive reporting procedure for anyone intending to ship waste for disposal from one Member State to another. This reporting procedure would be applicable in the case of an operator of a power plant intending to transport CO_2 to the operator of a storage site in another Member State. The regulation contains no restrictions on the mode of transport, and should therefore be applicable also on CO_2 transport in pipelines.

In the context of waste it is also appropriate to mention the directive on landfill of waste [10]. This directive offers a definition of underground storage as a permanent waste storage facility in a deep geological cavity such as a salt or potassium mine. Under a strict literal interpretation of this definition, underground CO_2 storage in for example a saline aquifer would not fall within this definition since a saline aquifer is not a cavity, i.e., the directive is not applicable to underground storage. However, in establishing criteria and procedures for the acceptance of waste at landfills the Council has decided [11] on criteria also for underground storage. These criteria provide that for the acceptance of waste in underground storage site, a site-specific safety assessment must be carried out. Waste may only be accepted if it is compatible with the safety assessment. The requirements for the safety assessment emphasizes the importance of the geological barrier and states that the ultimate objective for the final disposal of wastes underground is the isolation of the waste from the biosphere. A site-specific risk assessment must therefore be carried out identifying the hazard, the receptors, the pathways by which substances from the wastes may reach the biosphere and an assessment of the impacts of the substances that may reach the biosphere. In the light of the risk assessment, wastes that may undergo undesired physical, chemical or biological transformation after it has been deposited must not be disposed of in underground storage. Consequently certain wastes have been excluded from underground storage, for example, liquid waste.

As mentioned, storage of substances (waste) in an aquifer is not underground storage according to the definition of the landfills directive since an aquifer is not a cavity. However, from the criteria established by the Council's decision it is obvious that the purpose behind this regulation is to protect the biosphere and the environment from the substances stored and unwanted effects in case of their release. It seems likely that at the time of defining underground storage of waste, storage in aquifers was not considered. It should be considered that this regulation in its present wording might apply to storage in aquifers as well.

CO_2 will probably be stored as a supercritical fluid, but it is a gas at atmospheric pressure and temperature. It will be of decisive importance that the stored state is liquid, since the prohibition on underground storage of liquid waste. Consequently, the question is whether a liquid is decided to be a liquid at atmospheric pressure and temperature or in the state where it is actually stored.

Relevant International Conventions and Protocols

London Convention and 1996 Protocol

If CO_2 storage will take place offshore there are also some international conventions that should be taken into consideration when determining above all, the lawfulness of the operation. These conventions should already be implemented into national law in the contracting states so the following discussion is applicable on "state" level, as international law and conventions are only binding on states and not private parties.

It should be noted that other conventions than those accounted for in this paper has bearing on CO_2 storage for example, the UN Law of the SeaTreaty (UNCLOS) [12] and as a climate change mitigating option, the UN

framework Convention on Climate Change (UNFCC) [13]. Particularly the UNFCC has provisions in favour of CO_2 underground storage.

The London Convention [14] is a global convention and applies to both territorial and the high seas. The purpose is to prevent pollution by prohibiting and preventing dumping of wastes. The Convention has been amended many times and in the latest 1996 Protocol, the amendments have been codified and additional changes incorporated. The Protocol has not yet entered into force but will do so once the required number of states has ratified it and when it does it will replace the current version of the London Convention. The Convention in its current wording contains a general prohibition on dumping (deliberate disposal) of waste and other matter from vessels, aircraft, platforms, or other man-made structures at sea. There are exceptions to the prohibition for specific categories of waste in the so-called reverse list, and they may still be considered for dumping. The reverse list does not seem to have an entry under which CO_2 could fall, when stored for climate change mitigating purposes. Some disposal of waste is permitted; a waste arising from normal platform operation or other man-made structures is not forbidden. Additionally, with proper authorization, the placement of waste or other matter for purposes other than disposal (i.e. scientific research) is allowed.

In summary, CO_2 captured from an oil or natural gas extraction operation and stored offshore in a geological formation would not be considered dumping, and would be allowed under the Convention. If, on the other hand, CO_2 is captured from fossil fuel burning power plant on land, shipped by vessel to the point of injection for the purpose of mitigating climate change, (i.e. not for industrial purposes), this would not be allowed under the Convention. However, if CO_2 were to be injected for an industrial purpose, i.e. enhanced oil recovery, it would not be considered dumping of waste and *would be allowed* by the Convention. The case of CO_2 being captured on land and transported by pipeline to the point of injection represents a grey area, but would probably be excluded since this procedure would not involve “disposal at sea”.

The 1996 Protocol adds two important changes to the content of the Convention. First, a clarification of the definition of dumping, second, an extension of the exceptions from what is considered dumping. The new definition of dumping reads “any *storage* of wastes or other matter *in the seabed and the subsoil thereof* from vessels, aircraft, platforms or other man-made structures at sea” (changes in italics). This change would probably imply that the transport of CO_2 by pipeline to the point of injection and the subsequent injection would be considered dumping and thus prohibited under the Protocol. The extended exclusion provides that disposal or storage of wastes directly arising from, or related to the exploration, exploitation and associated off-shore processing of seabed mineral resources is not covered by the provisions of the Protocol. These changes imply that CO_2 derived from non-marine sources and stored in the subsoil offshore will be forbidden under the dumping prohibition, whereas CO_2 derived from of natural gas extraction and stored in the subsoil it will be allowed. The evaluation of whether a storage activity is allowed under the Protocol or not is made strictly on the basis of the origin of the CO_2 *and not* the potential environmental impacts of the storage or, for that matter, of emitting it into the atmosphere.

OSPAR Convention

The Convention for the Protection of the Marine Environment of the Northeast Atlantic is commonly referred to as the OSPAR Convention [15]. This regional convention covers the northeast Atlantic, the North Sea and waters between Sweden and Denmark. The purpose of the Convention is to protect the maritime environment, including the seabed and its subsoil. The contracting parties are required to take all possible steps to prevent pollution from dumping and incineration of wastes, and pollution from land-based and offshore sources. The OSPAR Convention’s scope of application is broader than that of the London Convention, and the structure and the content, with regard to CO_2 storage, of the OSPAR Convention are very similar. The definition of dumping is almost identical to that of the London Convention in its current wording and also provides the same exclusions from application. That is, wastes incidental to or derived from the normal operation of for example, offshore installations[2], and placement of matter for another purpose than the mere disposal of it and for another purpose than that it was originally designed for, still providing it is in accordance with the Convention.

The interpretation of the OSPAR Convention is far from clear, but it appears to be similar to the London Convention. This means that emphasis is placed on the method or intention by which the substance (waste), in this case CO_2, is injected and stored and not the resulting environmental impact and effect on the marine

[2] Offshore meaning an installation for the exploration, exploitation and appraisal of hydrocarbons, as opposed to offshore meaning an installation at sea and the contrary to on land.

environment. Potentially, different levels of environmental harm could be treated the same, while different emplacement methods with similar environmental outcomes could be treated differently.

Other regional agreements for the protection of regional marine waters exist for the Baltic and the Mediterranean Sea, but are not discussed here. These areas are not of such immediate interest for CO_2 storage as the North Sea area, partly because there is so much offshore activity going on there already.

Gaps in legislation

It is clear that the current international and European legislation on CO_2 storage is incomplete and fragmentary. This is no wonder since the concept is new, and the only projects currently running are more or less research projects where the storage is a "side effect" of an industrial activity. The major concern is therefore to establish a legal framework for CO_2 storage activities that does not fall under research and development, injection for industrial purposes or in any other way as part of an industrial process. At this point, neither international nor EU law provides a requirement for authorisation of CO_2 storage and injection facilities. However, it seems likely that such a requirement will be introduced as soon as more CO_2 projects start in Europe possibly by introducing it in the IPPC-directive and the directive on environmental impact assessments [16]. Most Member States of the EU should already be relatively well equipped to handle such an authorisation procedure due to the implementation and applicability of the IPPC-directive.

However, there is more to a CO_2 storage project than an authorisation or permit. There should be some legal rules establishing for example, criteria for the selection of storage sites, requirements for the monitoring of the storage location, and eventually the abandonment of the wells. Some rules are of a more technical nature and would probably not have to be established by law, but by organisations, authorities or possibly by the operators themselves. It would be preferable if the regulations would at least be on the European level as it would harmonize application and promote competition. Other issues that have not been dealt with in this paper are issues of ownership or right of disposal of the wells and storage sites and the linked question of concession for exploring if an aquifer and potential storage site is suitable for storage. This might not be an issue for international or European but rather for national law.

The risk of damages can never be entirely excluded and although the liability for damages caused during the injection phase of the well might not pose a real gap in legal knowledge, the long-term liability does. It cannot be ruled out that damages due to for example, diffuse leakage may occur even a long time after injection has ceased. It seems unreasonable and impractical for the operator to remain liable for decades or even centuries after the activities have stopped. The operator might not even exist as a legal entity anymore. Some kind of transfer of liability or the setting up of funds would be necessary. Another aspect of the liability that needs consideration is the question of who is to be liable for damages in the case of several operators injecting into the same aquifer. Some aquifers are very large, and cross national boundaries. If it is possible to imagine that more than one operator is injecting CO_2 into the same aquifer it might be that a leakage or damage caused can not be traced back to any of the operators. In this case there should be a system for joint liability.

The legal knowledge gap surrounding underground CO_2 injection is significant. An operator can provide the knowledge on technical requirements, planned monitoring and safety measures, models, risk assessments etc, and present the proposed activity in an application for a permit, but presently it will be up to a regulatory body or likely, a court to decide if all these measures are enough to protect human health and the environment and if the risk is acceptable. This situation changes if the Commission and the Member States of the EU decide on introducing new or revised legal rules that will make the condition of CO_2 storage clear.

Route Forward

So far, projects concerning CO_2 capture and storage have been projects for research and development an industrial process. The projects have been made possible through public and private funding, tax incentives or economic profit (enhanced oil recovery). If the concept of CO_2 capture and storage is to take a step forward and become an option for mitigating climate change, it has to become economically viable without being part of an industrial process. CO_2 storage for enhanced oil recovery purposes simply will not use the amounts of CO_2 to make a difference in a global perspective. Consequently, there needs to be an economic support system to encourage investments to take off. In Europe the emissions trading regime will eventually put a price tag on each ton emitted CO_2, however it remains uncertain how much it will actually cost. This uncertainty adds to the reluctance to invest. The route forward should concentrate on developing applicable rules for CO_2 capture, transport and storage. Since the transport and storage parts of the operation are likely to include more that one

country it would be appropriate to establish internationally consistent rules. The fact that climate change is a global problem also argues for a set of common rules. The concept of CO_2 storage needs to be a priority in the international agenda. To a certain extent it already is, but only as far as technical issues are concerned. It is time to involve also environmentalists, lawyers and the public, with little or no technical background. The future application and success of the concept will depend on scientists' ability to make it understandable to others and to stress the urgency with which the matter of climate change must be met. The "wait and see-" approach that many countries apply will inevitably delay this development.

A common ground for legal rules has to be found. All stakeholders must ask themselves what this concept is actually for, the risks society is willing to accept in order to continue using fossil fuels and if the knowledge needed is available to make a well-considered decision.

It is probably not appropriate for all rules and requirements concerning CO_2 storage to be legal rules decided by parliament or other elected assemblies. More technically oriented issues, such as material selection, construction requirements, intervals and methods of monitoring, could be agreed upon by standards organisations in cooperation with state authorities and regulatory bodies.

Conclusions

The concept of CO_2 storage is not very well covered in international and European law. It is very difficult to determine if the existing rules are actually applicable and what the consequences will be if they are. In the case of the IPPC-directive, which is not applicable in its current wording, the consequences are clear, as there is a prescribed authorisation procedure. However since CO_2 storage is not included in the scope, i.e. included in the list of installations for which authorisation is required, some uncertainty remains, although the rules themselves could be appropriate for CO_2 storage.

The application and interpretation of the OSPAR and London Conventions is unclear and uncertain. From an environmental point of view it seems illogical that it is the method or purpose of injection of CO_2 that is decisive for the lawfulness of an activity that most likely will have the same environmental effects. CO_2 leakage from a storage site where CO_2 has been injected for enhanced oil recovery purposes will reasonably have the same consequences as leakage of CO_2 injected for climate change mitigating purposes. Companies wanting to reduce their CO_2 emissions should not be prevented from doing so only because they cannot find an industrial purpose to do so.

One of the main problems is that the lack of regulation will serve as a hindrance for initiation of projects with the sole purpose of reducing climate change. Legal uncertainty will make companies and investors reluctant to make the necessary long-term financial commitments that are needed. If CO_2 capture and storage is going to be a large-scale concept in a not so distant future for mitigating climate change, the legal issues and requirements need to be an area of priority. One initiative that is worth mentioning in this context is the Carbon Sequestration Leadership Forum and the IEA organizing a workshop in July 2004 in Paris on legal issues.

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Notes: This paper is based on the findings of an internal report written within the Vattenfall CO_2 Free Power Plant Project called *Gap-analysis on the legal aspects of underground geological storage of CO_2 from an international and European perspective.*