

OVERVIEW OF EU PERMITTING AND REGULATORY MECHANISMS OF STORING CO₂ IN UCG CAVITIES

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Abstract

The carbon capture and storage (CCS) is a basic part of worldwide efforts to limit global warming by reducing greenhouse-gas emissions. European Union's 27 member states have met the deadline to adopt a milestone CCS law, which will manage some of the environmental risks of CCS and regulate the underground storage of CO₂. Member states were obliged to transpose the obligations included in the EU CCS Directive into their national legislation by 25 June 2011. France, Spain and the UK were among the first to meet the deadline, along with Romania, Belgium, Denmark, Ireland, Latvia, Lithuania, Luxembourg, Austria and Finland. The European Commission enjoys enforcement powers through infringement procedures against Member States failing to comply with their obligation to implement EU law. However, the legal regulations concerning permanent storage of CO₂ in geological formations are not sufficiently developed because this technology is relatively new to global scale

1. Introduction

The broad deployment of low-carbon energy technologies could reduce projected 2050 emissions to half 2005 levels – and that CCS could contribute about one-fifth of those reductions. Reaching that goal, however, would require around 100 CCS projects to be implemented by 2020 and over 3 000 by 2050. CCS regulations need to manage the risks and liabilities of CCS, distinguishing between risks that should be assumed by the operator, those that can be mitigated through regulation, and those that can be transferred. Issues related to competition, climate regime commitments, tax policy, financial responsibility, property rights and international treaties also shape the CCS regulatory framework.

The CCS process is based on capturing carbon dioxide (CO₂) from large point sources, such as fossil fuel power plants, and storing it where it will not enter the atmosphere. The technology for

capturing and storing carbon dioxide takes place in three main stages. During the combustion of carbon fuels, mostly coal, called Oxyfuel, pulverized coal burning emits enormous quantities of carbon dioxide. Greenhouse gas is compressed to 1/500 of its original volume, which is very convenient for its transportation. In such liquid form it can be stored for several hundred meters underground in old depleted oil and gas fields.

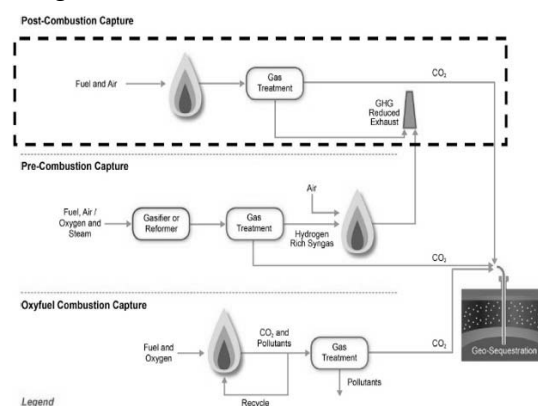


Fig. 1 The CCS process

- The first stage, the carbon capture, is the separation of CO₂ from the other gases produced when fossil fuel is burnt for power generation and in other industrial processes.
- At the second stage once separated, the CO₂ is compressed and transported to a suitable site for geological storage.
- The third stage is storage of CO₂ by injection into deep underground rock formations, often at depths of one kilometre or more. This stage is associated with long-term monitoring for safe storage of liquefied substance. It is considered that the liquefied CO₂ must be disposed of at least 800 meters underground to reach the so-called supercritical dense state that provides the potential for efficient utilization of underground storage space in the pores of sedimentary rocks.

2. CCS Regulations

2.1 Main international regulations with relevance for CCS

In the last few years, amendments to allow CO₂ injection and transboundary transportation of CO₂ have been made to two major marine treaties. Initially, OSPAR and The London

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Convention did not allow CO₂ storage, but these regulations were amended in 2007 to permit CO₂ storage under the seabed.

The London Convention, "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", protects the marine environment from human activities. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. It was amended in 2007 to allow CO₂ storage under the seabed. Eighty-five States have signed the Convention.

The OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North East Atlantic. The work is managed by the OSPAR Commission, made up of representatives of the Governments of 15 nations and the European Commission. It is a mechanism by which fifteen Governments of Europe cooperate to protect the marine environment of the North East Atlantic. The objective is to conserve marine ecosystems and safeguard human health in the North East Atlantic by preventing and eliminating pollution; by protecting the marine environment from the adverse effects of human activities; and by contributing to sustainable use of the seas.

2.2 Overview of CCS regulations in Europe

At Community level, a number of legislative instruments are already in place to manage some of the environmental risks of CCS and they should be used where possible. The European Commission has published a series of guidance documents on some of the more technically demanding aspects of the regime. These documents cover: the CO₂ storage life cycle risk management framework; characterisation of the storage complex, CO₂ stream composition, monitoring and corrective measures; criteria for transfer of responsibility to the competent authority; and financial security and financial mechanisms.

The EC CCS Directive 2009/31/EC on the geological storage of carbon dioxide entered into force in June 2009. It forms part of the EU's Climate Change Package, developed in the context of the recognised need for developed nations to achieve greenhouse gas emission reductions of 30% by 2020 and 60-80% by 2050. The Directive applies to geological storage of CO₂ within the territory of the Member States, their exclusive economic zones and on their continental shelves, thus envisaging storage both onshore and offshore. Member States retain the right not to allow storage in their territories, in whole or in part, although those that choose to permit storage must carry out an assessment of their

region's potential CO₂ storage capacity. Other aim of the Directive is the safe storage of CO₂, meaning the permanent containment of CO₂ to prevent and eliminate the possible negative effects on environment and human health.

The Directive focuses primarily on the storage aspect of CCS, it does briefly address the capture and transport elements. Importantly, CCS is removed from the scope of EU waste and water laws to provide certainty as to the legality of CCS activities. Through amendments to the EU's Emission Trading Scheme (ETS), however, efforts have been made to incentivise investment in CCS.

The capture process of CCS will primarily be regulated through incorporation within the EU's Integrated Pollution Prevention and Control (IPPC) Directive. The CCS Directive also lays down, through an amendment to the Large Combustion Plant (LCP) Directive, a 'Carbon Capture Readiness' (CCR) requirement.

Transport of CO₂ from capture facilities to storage sites is most likely to be through pipeline networks. The Directive addresses the transport aspect of CCS with few provisions, relying principally on national pipeline regulations, and property and planning laws, together with existing European legislation. Transport of CO₂ via pipeline will be subject to an EIA, as above with regard to capture facilities. While the Directive does not require a permit for pipeline transport of CO₂, any assessment carried out pursuant to the EIA Directive will need to be taken into account in the respective consenting procedures within the Member States.

Member States must ensure that potential users can obtain fair and open access to transport and storage facilities, on the basis of transparent and non-discriminatory criteria. In doing this, they can take into account certain factors, such as the storage and transport capacities that can reasonably be made available, the proportion of the Member State's CO₂ reduction obligations that it intends to achieve through CCS, the need to refuse access on grounds of technical incompatibility which cannot reasonably be overcome, and the need to respect the reasonable needs of storage and transport owners and operators, and of all other uses of the network.

The European Commission enjoys enforcement powers through infringement procedures against Member States failing to comply with their obligation to implement EU law. The Commission has discretion as to when, and whether to start the procedure, but the flexibility of negotiation is normally preferred over the burden of a formal infringement

procedure. However, when no national legislation is received by the deadline required, the standard procedure is for the Commission to automatically initiate the first stage of infringements proceedings – the sending of a formal letter to the Member State. Often the procedure needs go no further since this alone puts sufficient pressure on the Member State concerned. This has indeed been the case with the CCS directive. As of July 2011, the Commission had already initiated 25 infringement procedures for failure to communicate national transposition measures. Only Spain was considered to have fully transposed and Romania required a more careful assessment (and eventually was added to the list). Some cases have been already closed (Denmark, the Netherlands, Italy, France, Lithuania, Malta and Slovenia), but more cases are still open and under assessment, which is less encouraging. Bulgaria has successfully transposed the requirements of the Directive 2009/31/EC to the end of 2011.

Water Framework Directive (Directive 2000/60/EC) of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy had to be amended to allow for injection of CO₂ into saline aquifers for the purposes of geological storage. Any such injection is subject to the provisions of Community legislation on the protection of groundwater and must be in accordance with Directive 2000/60/EC and Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration

CO₂ is not expressly included in the Annex VIII list of main pollutants. However, that list is only indicative and CO₂ could still be classified as a pollutant under the WFD. If so its direct discharge into bodies of groundwater for storage would be prohibited.

With that in mind, the Directive on the geological storage of carbon dioxide (2009/31/EC) (CCS Directive) provides an additional exception to the prohibition which allows Member States to authorise injection of carbon dioxide streams for storage purposes into geological formations which 'for natural reasons are permanently unsuitable for other purposes'. This must be done in accordance with the terms of the CCS Directive. The exception is also qualified by the provision that CO₂ injection and storage does 'not compromise the achievement of the environmental objectives established for that body of groundwater.'

Exemptions from the strictest WFD objectives that may be relevant to CCS activities are as follows:

- Lower standards may be set where a body of water is so affected by human activity that the achievement of the objectives would be infeasible or disproportionately expensive. In this case, the environmental and socioeconomic needs served by the activity must not be achievable by other means, reasons must be given for the derogation and the highest possible standard maintained. This may apply to port areas from where CO₂ would be shipped or piped and sites previously developed for oil or gas extraction.

- Failure to achieve good groundwater status or prevent deterioration of a body of groundwater may be allowed where it results from alterations in the level of bodies of groundwater. Although potentially applicable to CCS activities, which could displace groundwater in geologic aquifers, this provision is more pertinent to measures regulating water supply and management for human use, so may not be relevant to CO₂ storage.

- The marine scope of the WFD is 12 nautical miles from the coast for surface waters only; hence it would not apply to sub-sea aquifers beyond that distance, such as those proposed for CO₂ storage in the North Sea.

Groundwater Directive (Directive 2006/118/EC)- As daughter legislation of WFD 2000/60/EC, the Groundwater Directive strengthens and builds on provisions contained within the WFD relating to groundwater. It complements the earlier directive in aiming to 'to prevent the deterioration of the status of all bodies of groundwater'. In particular, the Directive details the procedure for assessing groundwater chemical status and provides criteria for identifying and preventing significant and sustained upward trends in groundwater pollution. The Directive defines "significant and sustained upward trend" as any statistically and environmentally significant increase of concentration of a pollutant, group of pollutants, or indicator of pollution in groundwater".

While CCS activities would not seem to be primarily affected by provisions in the Groundwater Directive, which are more directly concerned with nitrates and pesticides, injection of CO₂ streams could potentially be regulated under Article 6(1)(b), where Member States decide that CO₂ fell within the definition of 'hazardous substance'. However, Article 6(3)(a) of the Directive ensures that the exemptions given to particular activities in Article 11(3) (j) of the WFD also apply to the daughter provisions. This would include the amendment exempting CCS activities made to the WFD by

the Directive on the geological storage of carbon dioxide (2009/31/EC) - CCS Directive.

In the European Union, both member states and the European Commission are involved in regulating CCS, with countries required to put in place measures that reflect EU-level directives and regulations. In the case of CCS, this primarily means meeting the CCS Directive, but the EU Emission Trading System (EU ETS) Directive also applies. The CCS Directive had to be transposed into Member state law by June 2011. This process allowed each country to develop a CCS framework that takes into account its particular circumstances, while ensuring that all member states share some core framework elements. When developing a CCS legal and regulatory framework, it may be most easily regulated by modifying frameworks that are already in effect - jurisdictions of oil and gas production, which is similar to some components of CCS. The European Union, which has amended the EU Emission Trading System Directive to fully include CCS from 2012, has also allocated the revenue from the sale of 300 million EU ETS allowances to support CCS and novel renewable technologies - 12 CCS and innovative renewable energy demonstration projects to start operating by the end of 2015, in the power and industrial sectors. In the EU the emissions trading scheme (EU ETS) puts a price on CO₂ emissions, but at the moment the price of buying an emission allowance is cheaper than the cost of building a coal or gas power plant with CCS. The EU will reduce the number of emission allowances gradually in the years to come, and that will increase the price of emission allowances. Eventually, the cost of emitting CO₂ will be higher than the cost of CCS, and when that happens, industry will start to build CCS projects.

Additional regulations might be required. When the EU endorsed the energy package in 2008, the possibility of including an Emission Performance Standard (EPS) that sets a ceiling on CO₂ emissions from power production was discussed. A suggestion was made to include an EPS of 350 grams CO₂ per kWh, which would have banned coal power plants without CCS. However, the suggestion to include EPS in the EU energy package failed.

Liability for localised environmental damage under the Environmental liability Directive is complemented by financial liability under the EU ETS for 'climate damage'. Operators will be required to surrender purchased EU emissions allowances in respect of any leaked CO₂. It has been noted that the requirement to purchase allowances is not a penalty in itself, and there is the potential for perverse incentives should the price of

carbon allowances fall below a level which would address any financial gain of non-compliance.

Civil liability for harm to individual human health such as personal injury together with private rights relating for example to property damage will also fall to be addressed outside the CCS Directive, though in this case under existing national laws.

The IPPC Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control, which sets out the main principles for the permitting and control of installations based on an integrated approach and the application of best available techniques (BAT) which are the most effective techniques to achieve a high level of environmental protection, taking into account the costs and benefits. In essence, the IPPC Directive is about minimising pollution from various industrial sources throughout the European Union. Operators of industrial installations operating activities covered by Annex I of the IPPC Directive are required to obtain an environmental permit from the authorities in the EU countries. The IPPC Directive is suitable for regulating the risks of CO₂ capture to the environment and human health and, as a result, should be applied to the capture of CO₂ streams for the purposes of geological storage from installations covered by that Directive. Combustion installations, except small ones, are covered by the IPPC Directive. IPPC imposes a permitting regime on a range of specified industrial activities, controlling the release of contaminants into air, water and land. As such, all operators of capture installations will be required to obtain a IPPC permit, which will demand the use of 'best available techniques' (BAT) for CO₂ capture, impose clean-up requirements in cases of unauthorised release and site closure, and involve important rights to public participation. Operators will also be required to carry out an assessment of the likely significant effects on the environment of any capture facilities in accordance with the provisions of the Environmental Impact Assessment (EIA) Directive. Importantly, public consultation will be required, and the assessment carried out must be taken into account when permitting the facility under IPPC.

The Environmental Impact Assessment Directive (EIA Directive 85/337 EEC as amended by 97/11/EC and 2003/35/EC) introduced a Europe-wide procedure to ensure that environmental consequences of projects are

identified and assessed before authorisation is given. The public can give its opinion and all results are taken into account in the authorisation procedure of the project. The public is informed of the decision afterwards. It has become an integral and vital part of the planning of development projects, and requires the submission of an EIA with the application for development consent. This Directive applies to the assessment of the environmental effects of public and private projects which are likely to have significant effects on the environment. It affects the execution of "construction works, other installations or schemes and for the interventions in the natural surroundings and landscape including the extraction of mineral resources". Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment should be applied to the capture and transport of CO₂ streams for the purposes of geological storage. It should also apply to storage sites pursuant to this Directive. This Directive should apply to the geological storage of CO₂ within the territory of the Member States, in their exclusive economic zones and on their continental shelves. The Directive should not apply to projects with a total intended storage below 100 kilotonnes, undertaken for research, development or testing of new products and processes. This threshold would also seem appropriate for the purposes of other relevant Community legislation. The storage of CO₂ in storage complexes extending beyond the territorial scope of this Directive and the storage of CO₂ in the water column should not be permitted.

Member States should retain the right to determine the areas within their territory from which storage sites may be selected. This includes the right of Member States not to allow any storage in parts or on the whole of their territory, or to give priority to any other use of the underground, such as exploration, production and storage of hydrocarbons or geothermal use of aquifers.

Environmental liability Directive. The first EC legislation whose main objectives include the application of the "polluter pays" principle, this Directive establishes a common framework for liability with a view to preventing and remedying damage to animals, plants, natural habitats and water resources, and damage affecting the land. The liability scheme applies to certain specified occupational activities and to other activities in cases where the operator is at fault or negligent. The public authorities are also responsible for ensuring that the operators responsible take or finance the necessary preventive or remedial measures themselves. Liabilities other than those covered by this Directive, Directive 2003/87/EC and Directive

2004/35/EC, in particular concerning the injection phase, the closure of the storage site and the period after transfer of legal obligations to the competent authority, should be dealt with at national level.

New combustion plants with an output of 300 MW or more should be capable of being fitted later (retrofitted) with capture technology, i.e. Carbon Capture Ready (CCR) by setting aside suitable space on the site for the necessary capture and compression equipment. The CCR requirement will only be imposed, however, if three conditions apply: suitable storage sites are available and both transport facilities and the retrofit of capture technology are technically and economically feasible. Notably, there are no potential timescales for the retrofit for CCS, and there is no mechanism for requiring an actual retrofit in the future. The legal ground for the legislative concept of the CCR (Carbon Capture Readiness) is Article 9a of the LCP (Large Combustion Plants) Directive. It was added by the Article 33 of the CCS Directive (the Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (OJ L 140, 5.6.2009, p. 114)) and is repeated by the Article 36 of the newly passed Directive of the European Parliament and of the Council on industrial emissions (the IED Directive, see: European Parliament legislative resolution of 7 July 2010).

Member States shall ensure that operators of all combustion plants with a rated electrical output of 300 megawatts or more for which the original construction licence or, in the absence of such a procedure, the original operating licence is granted after the entry into force of Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide, have assessed whether the following conditions are met: suitable storage sites are available, transport facilities are technically and economically feasible and it is technically and economically feasible to retrofit for CO₂ capture. If certain conditions are met, the competent authority shall ensure that suitable space on the installation site for the equipment necessary to capture and compress CO₂ is set aside. The Directive addresses CCS and requires applicants for new combustion power stations to carry out an assessment of whether suitable storage is

available as well as technical and economical assessments of transport and retrofitting CCS technology.

Council Directive 99/31/EC of 1999 on the landfill of waste entered into force on 16.07.1999. The objective of the Directive is to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste, by introducing stringent technical requirements for waste and landfills. The Directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land. The Landfill Directive's definition of waste reflects that of the Waste Framework Directive (Directive 2006/12/EC) and thus depends upon whether captured CO₂ is to be considered waste for the purposes of that Directive.

The Landfill Directive contains other definitions, which may prove to be relevant to the storage of captured CO₂. The term “underground storage” is defined in the Directive as “a permanent waste storage facility in a deep geological cavity such as a salt or potassium mine”, “Liquid waste” is defined as “any waste in liquid form including waste waters but excluding sludge”, the definition of “inert waste” may also be of significance for CO₂ that is to be stored; “waste that does not go undergo any significant physical, chemical or biological transformations”. Inert waste will not dissolve, burn or otherwise chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution, or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater’.

Member States may declare, without prejudice to the Waste Framework Directive, that underground storage may be exempted from certain requirements of the Directive. These provisions include, amongst others, closure and aftercare procedures, certain water control, leachate management and meteorological monitoring requirements.

The key issue to consider, with regard to CCS, is whether this activity constitutes landfill for the purposes of the Directive. A paper prepared for the European Commission by a consortium of environmental experts in February 2007, highlighted the necessity of clarifying this issue. The report highlighted the list of waste disposal

activities provided in Annex IIA of the Waste Framework Directive, which would seemingly apply to CCS activities: D1 Deposit into or on to land (e.g. landfill, etc); D3 Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories); D7 Release into seas/oceans including seabed insertion.

CO₂ is not classified as a dangerous substance under the Seveso II Directive 96/82/EC on the major-accident hazards, and CCS sites are not covered by the directive’s requirements. The inclusions of CO₂ would impede the development of CCS as a greenhouse gas mitigation measure. This decision assumes that the CCS Directive imposes very strict safety requirements for the operators of CCS sites. The Seveso III Proposal still excludes carbon dioxide from its scope. There could be a major accident hazard potential if CO₂ is used in large quantities, in particular from the transport and storage of large quantities of CO₂ or use in industrial-scale fire extinguishing plants. CO₂ is a colourless and odourless gas which is heavier than the breathing air. It can cause asphyxiation and could therefore cause serious damage to human health and the environment. Nevertheless the Commission has not included storage (under- or aboveground) of large amounts of CO₂ within the scope, arguing that CO₂ is not classified as a dangerous substance as such, and more importantly “that CCS schemes are only at an early stage, it is premature to judge on whether a major accident hazard would emerge should the technology be widely used in the future”, and that “further development of the technology will help to better understand potential risks”. The CCS Directive does not deal with safety related aspects, several important and necessary elements such as the taking into consideration of CCS-installations during the land use planning, development of a major accident prevention policy, the drafting of safety reports and emergency plans are missing. The major reason to include or to exclude a certain installation within the scope should be the major accident potential constituted by the substances stored or treated in that establishment. Carbon Dioxide becomes in effect a dangerous substance if liberated in large amounts.

3. Conclusions

Unless CO₂ emissions reduce by 50% by 2030, average global temperature is likely to rise by 2.4°C to 6.4°C by 2100. If we fail to keep below 2°C, devastating – and irreversible – climate changes will occur. Yet with world energy demand expected to double by 2030, and renewable energy to make up only ~30% of the energy mix by this date, fossil fuels will be an important energy resource for many years to come. Any delay in the roll-out of CCS could not only lead to unnecessary CO₂ emissions, but additional costs, as instead of being able to apply it to the current pipeline of coal plants, a retrofit would be required, increasing the cost of achieving the same emissions reduction. With decisions on new plant build being made now in Europe, it is therefore vital not staying locked into an infrastructure that is not optimised for CCS. Indeed, every year that CCS is delayed is a missed opportunity to reduce CO₂ emissions. CO₂ concentrations are already rising at over 2 ppm a year and it is estimated that delaying the implementation of CCS by just 6 years would mean CO₂ concentrations increasing by around 10 ppm by 2020. As a global solution to combating climate change, CCS could therefore also boost European industry, creating new jobs and promoting technology leadership.

References

1. *Directive on mining waste management (2006/21/EC)*;
2. *Directive 2008/50/EC relating to air quality*;
3. *Directive on CCS 2009/31/EC* concerning the storage of carbon dioxide in geological formations;
4. *Directive on the quality of petrol and diesel fuels 98/70/EC* of 13.10.1998;
5. *Directive 2009/30/EC*;
6. *Directive 97/11/EC* amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment;
7. *Directive 2003/105/EC* on the control of major-accident hazards involving dangerous substances;
8. *Directive 99/31/EC on the landfill of waste*;
9. *Directive 93/12/EEC* relating to the sulphur content of certain liquid fuels;
10. *EU ETS Directive 2003/87/EC* establishing a scheme for greenhouse gas emission allowance trading within the Community for the European Union emissions trading system;
11. *EU ETS Directive 2009/29/EC* amending Directive 2003/87/EC to improve and extend the greenhouse gas emission allowance trading scheme of the Community;
12. *Environmental Impact Assessment Directive (EIA Directive 85/337/EEC)*;
13. *Environmental liability Directive (ELD 2004/35/EC)* on environmental liability with regard to the prevention and remedying of environmental damage;
14. *Groundwater Directive (2006/118/EC)* on the protection of groundwater against pollution and deterioration;
15. *Large Combustion Plants Directive (LCPD 2001/80/EC)*;
16. *Regulation №. 2216/2004* of the EC, a national register for maintaining registration of the issuance, ownership, transfer and cancellation of greenhouse gas emission permits;
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22. *Water Framework Directive (2000/60/EC)*, establishing a framework for Community action in the field of water policy.