newsletter

CCS – Carbon capture and storage

The CCS directive published in spring of 2009 in the Official Journal of the European Union established an official legal framework at EU level for the technology of CCS (carbon capture and geological storage). The objective of this bridge technology is to facilitate climate-compatible utilisation of fossil fuels in future, in particular coal. A public debate is currently under way on the risks associated with this approach. It is focusing on the issue of sustainability and the safety aspects of long-term geological storage of CO_2.

Introduction

CCS stands for "carbon capture and storage", a chain of technical procedures by which CO_2 is separated out of industrial processes (mainly processes associated with fossil fuel power plants) and is subsequently stored on an indefinite basis (sequestration).
The goal of CCS technology is to reduce the atmospheric impact of CO_2 emissions resulting from the combustion of fossil fuels. The constant increase in energy consumption worldwide, especially within the emerging economies, has caused a strong rise in the use of fossil fuels over the last 20 years, even despite energy-saving measures. The need for an overall reduction of energy consumption and greater reliance on renewable sources of energy is undisputed. The technology enabling the capture of the CO_2 resulting from combustion processes in fossil fuel power plants and subsequent long-term CO_2 storage is also regarded as necessary, at least as an interim solution, for achieving a significant reduction in the CO_2 emissions produced by the use of fossil fuels, especially coal, in the coming decades. Moreover, the introduction of CCS technology is an interesting prospect because of the positive treatment the resulting CO_2 deposits will receive within the emission certificate trading scheme, as foreseen by the EU directive on CCS.

Process and technology

Separation within the power plant

There are currently three main CO_2 capture processes favoured for power generation, and each has a specific set of advantages and disadvantages.

- Post-combustion capture – involves separating the CO_2 from other exhaust gases after combustion of the fossil fuel by passing the flue gas gas through a cleansing liquid (amine solution). The CO_2 bonds with the amines in the solution while other gases continue up through the flue. Post-combustion capture relies on downstream separation technology and is therefore particularly suited for retrofitting of existing fossil fuel power plants.
- Pre-combustion capture (coal gasification) – involves separating CO_2 before the fuel is burned through a complex process of gasification in which the coal is transformed into a mixture of hydrogen and carbon monoxide. The carbon monoxide is then oxidised with water vapour to create CO_2 and the hydrogen is used to generate power.

- Oxyfuel combustion or "oxyfiring" – involves the combustion of coal in pure oxygen rather than air. The oxygen has to be produced in advance in an air separation system, which itself is an energy-intensive procedure. The exhaust gas consists primarily of CO_2 und water vapour and contains neither nitrogen nor nitrogen oxides. Once the water vapour has condensed, the CO_2 is available in a highly concentrated form.

The described methods of CO_2 separation consume major quantities of additional energy, which negatively impacts on the efficiency of the power plant and substantially increases the price of the energy/electricity produced.

CO_2 transport

Since the geological formations suitable for underground storage of CO_2 will seldom be in the direct vicinity of the power plant, following the separation procedure, the CO_2 will have to be moved to suitable repositories. The CO_2 has to be specially treated and concentrated to make it transportable. Given the large quantities of gas to be transported, a pipeline solution would seem to be the most efficient and economical option. Depending on the location, transport by tankship may also be feasible. Basically, the technology involved in the transport of CO_2 may be regarded as market-ready. However, because of the huge volumes of gas to be moved, CO_2 transport entails major logistical and economic challenges. In the US, a large network of pipelines carrying CO_2 has been in operation for over 30 years.

CO_2 storage

Long-term storage of the CO_2 is the final step in the CCS process, and it is the step which has been the least researched and is the least technically mature. Geological formations currently harbour the greatest potential as an option for storing CO_2. Geological storage sites that are feasible as CO_2 repositories include, for example, salt deposits, exhausted natural gas and oil fields, unmineable coal beds, salt-water-bearing rock strata (saline aquifers) and deep-lying groundwater reservoirs.

To come into question as a CO_2 repository, a storage site must offer sufficient capacity and possess the physical properties required to be able to accommodate large amounts of CO_2 and permit uninterrupted storage of the CO_2 over a very long time period.

CO_2 storage has been practiced to a limited extent in the oil and gas industry for some time already. Since the 1970s, oil sites in the US have been injected with CO_2 as a way of enhancing extraction. A network of pipelines over 3,000 km long is used for this purpose. In order for CCS to work as a climate protection measure, however, far vaster amounts of CO_2 would have to be stored than is currently the practice in the oil industry.

To help fill the gaps in knowledge about technical safety and feasibility in this field, numerous research and development projects throughout the world are pushing ahead to learn more about long-term CO_2 storage.

Conclusion

From a global perspective, CCS would indeed seem to possess the potential to make a significant contribution to mitigating global warming. Utilisation of CO_2 capture technology in fossil fuel power plants and subsequent CO_2 storage on a large scale is not likely to be practicable for at least another 10 to 15 years, however.
At present, only small-scale pilot operations exist with comparatively little capacity. The costs of CCS are relatively high as compared to other technological measures serving climate protection. With current technology, CO_2 separation lessens the efficiency of the power plant by about 10% . The transport and storage of the CO_2 require yet a further input of energy.

Above and beyond the establishment of a relevant legal framework, the acceptance of this technology by society is a key prerequisite for being able to create and operate CO_2 repositories. At present, the general public is largely unfamiliar with the capture and geological storage of the CO_2 emitted by power plants by means of CCS technology. The perception of risk by the public can have major and unexpected impacts on planned large-scale technology projects. In particular, technologies like CCS, which entail risks that are in part difficult to assess and may represent a long-term hazard to human health and the environment, are likely to evoke social opposition. Gradual leakage of CO_2 from a storage site could endanger groundwater, soil, flora and fauna, and in the event of a sudden release, there would always be a risk of asphyxiation for humans and animals.
For the companies storing the CO_2 and the operators of the storage sites, there is not only the liability risk in case of a CO_2 release, but also the corporate risk represented by the possible loss of emission rights.

Information for the underwriter

For the initial steps in the CCS process – capture of CO_2 at the power plant, transport and operation of an injection system at the repository site – existing insurance products can generally be modified on the basis of an individual risk assessment so as to make them suitable. From an underwriting perspective, providing insurance protection for long-term storage of CO_2 in geological repositories is problematic for several reasons, the main one being the long timeline involved. In particular, the gradual escape of CO_2 over an extended period, e.g. as a consequence of insufficiently sealed borings or fissures in the rock, may result in diverse kinds of damage, such as acidification of groundwater or soil. Adequate insurance products have yet to be developed for the geological storage of CO_2.

For underwriting purposes, an individual risk assessment for each storage site is recommended, because at each site, unique, non-transferable risk parameters will exist.

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