Carbon Dioxide Capture and Storage as a sequestration strategy

Assessment by Germanwatch

There are two major strategies of carbon sequestration: 1.) Enhancing the uptake of carbon by the biosphere, e.g. by planting trees. 2.) Using technologies of Carbon Dioxide Capture and Storage (CCS) in the process of producing electricity or hydrogen. The latest studies and scenarios show that the development and deployment of CCS could significantly assist in stabilizing the rising atmospheric concentration of greenhouse gases. However, this new technology which is still in a prototype stage has several flaws. In the assessment presented here, the pros and cons of CCS are weighed from an NGO viewpoint, evaluating the three specific processes of capture, transport, and storage of CO_2. CCS is evaluated within the broader portfolio of climate-policy instruments as a serious option to prevent climate change. This assessment is based on technological and scientific information documented in the report of an IPCC workshop held in Regina, Canada, November 2002.[1]

A General Assessment

1. The technology of CCS is a new and inexperienced option for climate protection within the debate on climate change. Due to the growing severity of the middle- and long-term scenarios on climate change, it is important for Germanwatch to evaluate every proposal impartially. Such an evaluation should be completed, keeping in mind the following criteria:
   - Social compatibility (not reduced to acceptance only)
   - Ecological compatibility
   - Inter-generational compatibility and
   - Economic compatibility (not reduced to the perspective of businesses)

2. In general it can be concluded that CCS is an "end-of-the-pipe technology", which implies that the energy efficiency of power plants with carbon dioxide capture diminishes significantly. Hence, the application of carbon dioxide capture results in a higher consumption of fossil fuels. This leads to rising system costs for energy, thus appearing an economic burden on climate protection. CCS therefore stands in contrast to labored advancements on energy efficiency and the promotion of renewable energies - along with the reduction of costs. From an ecological point of view, it is problematic that capturing CO_2 is generally energy intensive, increasing net energy use as opposed to reducing it.
3. This reason alone limits the potential for CCS technology to contribute to a sustainable strategy to preventing climate change. A more comprehensive approach to climate change prevention has to focus on the massive increase of energy efficiency as well as renewable energy sources.

   Focusing only on the storage of CO_2, without massively expanding the energy efficiency of society, achieves neither climate protection nor sustainable economic development.

   The CCS technology is only (and most) economically efficient in huge central power plants. But it is critical to determine whether CCS actually could play a complementary role, or if it is used by

[1] See www.climatepolicy.info/ipcc/ipcc-ccs-2002 for full conference report. A paper in German, summarizing the workshop report and including the assessment by Germanwatch presented here can be accessed at www.germanwatch.org/rio/ccs04.htm.

the public utility companies to justify the continuation of the existing unsustainable structures of energy supply. If the latter is true, in the long run, CCS could undermine a timely transition to the efficient and economical use of electricity.

4. In the foreseeable future, CCS might compete with a large-scale use of renewable energies on a global scale. In doing so, this new technology could complicate or even prevent the path towards a solar based post-fossil fuel era. This is especially true if the costs for CCS decrease before the cost for renewable energies are assuredly falling as well. Such a development would be counterproductive.

   Especially when it comes to the assignment of public funds, Germanwatch gives preference to the fast dissemination of renewable energies. Spending public funds for scientific innovations on CCS rather than renewable energy technologies would be counterproductive.

5. It is still uncertain if the diffusion of energy efficiency and renewable energies are going to take place on a large scale fast enough to achieve the necessary decrease of CO_2 emissions (by applying only these new technologies). Furthermore scientific evidence asserts that the emission of anthropogenic greenhouse gases could lead the global climate into a dramatically unstable situation. In case of an "emergency plan", significant amounts of CO_2 would need to be extracted from the atmosphere. (This scenario could be realized in combination with the application of biomass use and CCS.) CCS could be applied here in the form of a "bridge technology". Nevertheless, a decision "pro CCS" should not automatically shift the focus of research and development unilaterally to this "end-of-the-pipe technology".

6. It is not possible to derive a long-term strategy for the use of coal as an energy source for Europe, even if geological sequestration is taken into account. Scenarios by the German Advisory Council on Global Change (WBGU) focus on stabilizing the climate below the dangerous level of 2 degrees Celsius warming compared to pre-industrial levels (generally thought to be equivalent to stabilize the CO_2 concentration below or at 450 ppm, although recent research suggests that climate sensitivity is higher, meaning that 2 degrees might already be reached with a considerably lower CO_2 concentration). The WGBU scenarios expect a further increase of coal use only in regions or countries, such as China and India, with large natural coal resources where they can be used at low energy cost. Yet all recommendations by the WBGU suggest phasing out the use of coal by the mid 21st century or at least reducing the current level of coal use.

7. At the present time it cannot be predicted if a market place for hydrogen with a significant market share of world energy use is going to be established within the next twenty (to thirty) years. But if an advanced hydrogen market occupies an important part of the world energy market, CCS would then become more competitive with the production of hydrogen than with the production of electricity because the latter is more expensive.

8. The cost assessment for the processes of capturing and transporting CO_2 during CCS is relatively well understood. Industrial plants with comparable components of these processes are already standardized and have been applied in many cases. This stands in contrast to the final storage of the captured CO_2 as well as many other new technologies, e.g. photovoltaics.

B Storage of Carbon Dioxide

9. In a narrow sense, scientific statements about the long term security of the storage of CO_2 cannot be given because they are not falsifiable - which is a strict criterion for scientific conclusions. Therefore the sequestration of carbon dioxide on a large scale (which resembles to geoengineering) needs to be recognized as a spacious experiment with a highly uncertain outcome.

10. Uncertainties regarding the long-term security differ widely and are depending on the actual scene and location of the storage site. The uncertainties as well as the ecological risks for marine CO_2 storage are very high. Germanwatch thus does not consider acceptable the option of marine storage of carbon dioxide. In case the CCS technology becomes inevitable, the possibility of

geological storage would have to be considered and should be preferred in the future. The WBGU regards CO_2 storage in geological deposits as a "bridge technology", highlighting that the application of this bridge technology should be brought to an end at 2100 latest. The total mass of CO_2 which can be stored in a safe way was quantified by WBGU as 300 GtC. For Germanwatch the best guarantee that CCS remains a bridge technology only is to set high standards for storage sites evaluated as safe so that this reservoir is limited.

11. In general, only secure geological deposits are acceptable and preferable. However, uncertainties related to long-term security and storage could best be responded to with a strategy of insurance, such as a warranted liability. Without such a price signal from the insurance sector, the risks and real costs of a potential sequestration strategy could easily become visible. This insurance strategy would be a strong incentive and should be considered in the process of ensuring the ability for geological deposits to safely store CO_2.

C Capture of Carbon Dioxide

12. The capture of carbon dioxide can be done in three different ways: post-combustion capture of CO_2, pre-combustion capture of CO_2, and Oxyfuel combustion**.** In the case that the CCS technology will be introduced and applied to the process of power generation in the future on a large scale, it is to be expected that pre-combustion capture will be economically favorable.
13. As long as the process of combustion with pure oxygen is not technically applicable, the emissions from coal-fired power stations will not be free of CO_2 but rather contain 70 to over 100g CO_2/kWh. Even gas power plants still would emit about 40g CO_2/kWh after the process of CO_2 capture.

D Transport of CO_2

14. Transportation of captured CO_2 is inexpensive and relatively safe. Actually, it appears even more expensive to transport electricity than to transport the amount of carbon dioxide captured in the process of producing it.

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