The R&D-Programme GEOTECHNOLOGIEN – a national platform for CO_2 storage initiatives in Germany

Dr. Ludwig Stroink, GEOTECHNOLOGIEN Coordination Office. Corresponding address: Telegrafenberg A6, 14471 Potsdam, Germany; Tel.: +49-331-288-1070; Fax.:+49-331-288-1077; e-mail: stroink@gfz-potsdam.de

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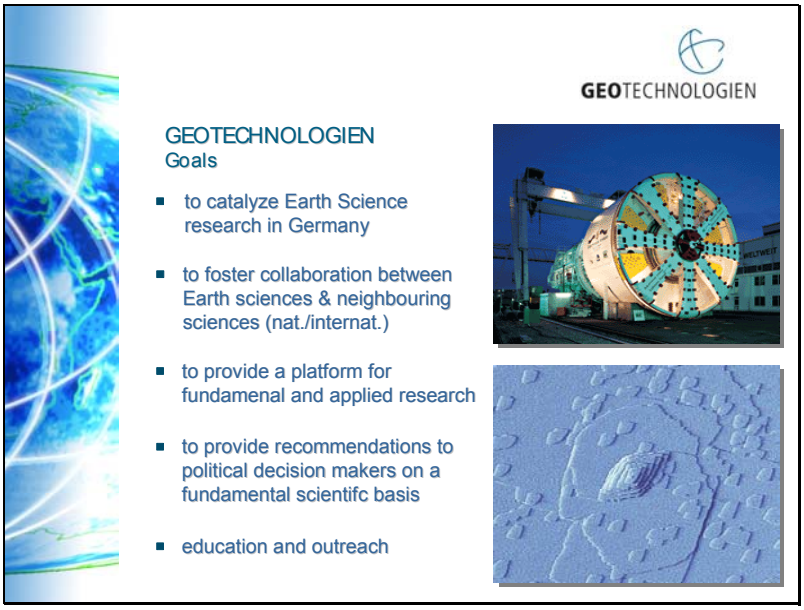


Fig. 1: Goals of the German R&D-Programme GEOTECHNOLOGIEN

It integrates a wide range of universities, research institutions as well as small and medium sized enterprises and the projects are normally embedded in international projects. The Programme designed to run over a 10 year period comprises 12 thematic priority areas of major scientific, societal and economic significance.

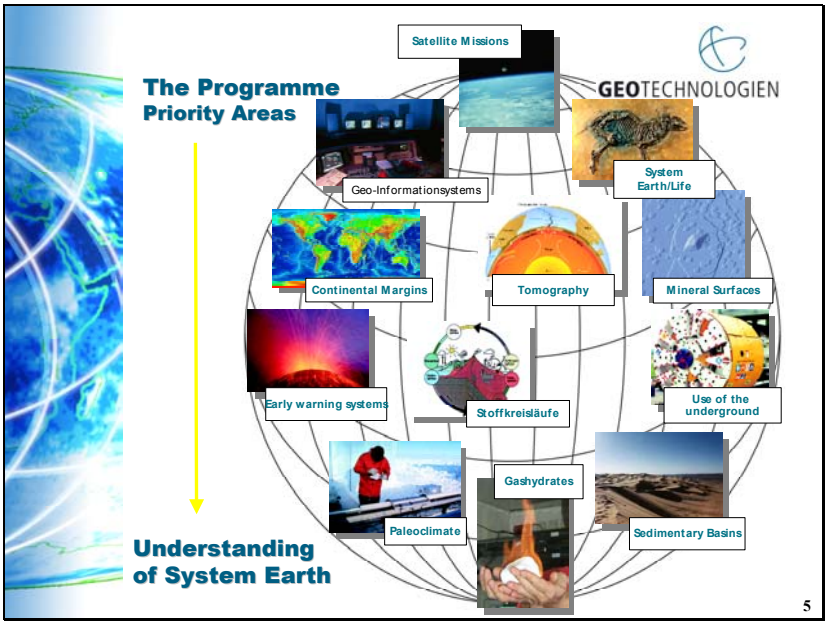


Fig. 2: Scientific Priority Areas of the R&D-Programme GEOTECHNOLOGIEN

GEOTECHNOLOGIEN aims at a better understanding of the complex processes underlying the system Earth and the development of new prevention strategies and negotiation options for a sustainable management of “Planet Earth”.

One of the most recently started topics is the Utilisation and Protection of the underground. The evaluation of the economic and ecologic perspectives of CO_2-Sequestration is one scientific target.

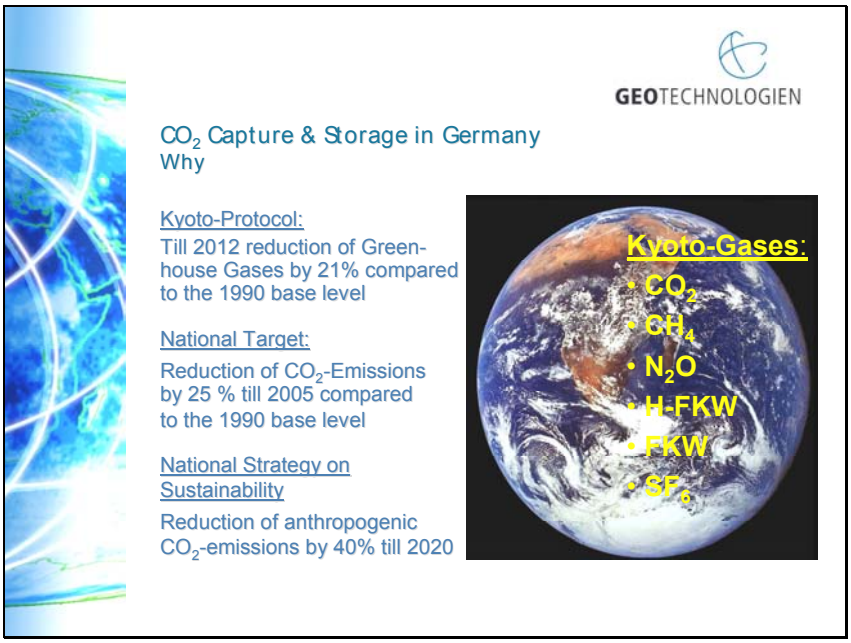


Fig. 3: Why CO_2 Capture and storage

According to the commitments of the Kyoto protocol the EU countries are challenged to reduce the emission of carbon dioxide (CO_2) by 8 % from 1990 levels till the period 2008-2012. For Germany this means a reduction of greenhouse gases by 21% till this period. But the government went still beyond this goal. In October 2000 they released a national climate protection programme with a national target to reduce the anthropogenic CO_2 emissions by 25% until 2005. A further aim is to achieve a reduction of 40 % for the year 2020 under the precondition that the EU reduces greenhouse gas emissions by 30%. and by 40% till 2020.

In the early 90´Germany was quite successful in reducing the CO_2 emissions. In the first five years they drop by 13 % or 150 Mio. t of CO_2. However, a considerable part of this initial progress was directly connected with the break-down of the smokestack industries (heavy industry) in former Eastern Germany and the consequences of economic restructuring. For the last 8 years the CO_2 emissions remained nearly static with a small decline of only 4 %.

The overwhelming part of this greenhouse gas is emitted by Power Plants (44%).Traffic follows with 20 %, Industry with 19 and the Private sector emitted 14 CO_2 in 2003.

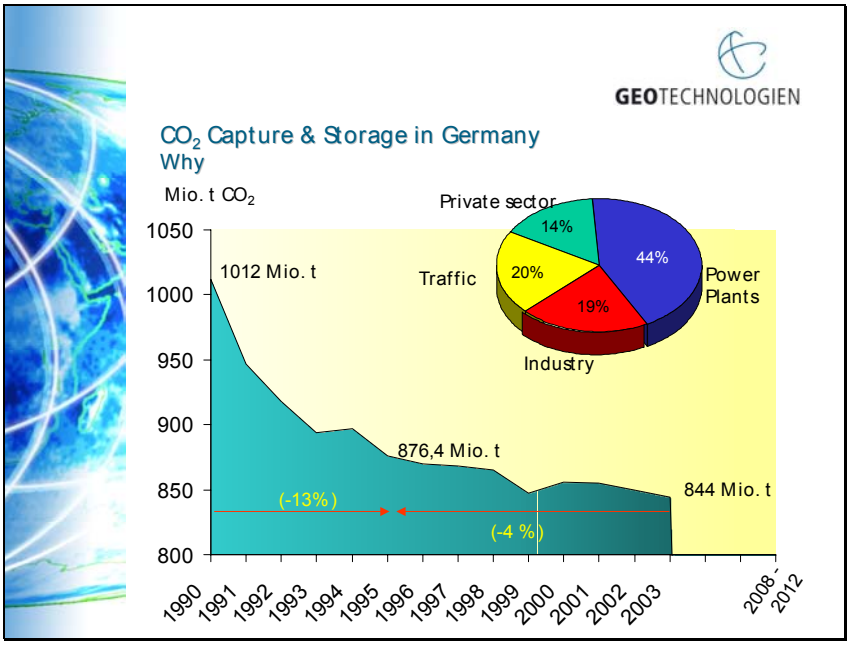


Fig. 4: Energy related CO_2 emissions in Germany (1990-2003)

Through the next decades coal will continue to be of vital importance in the national energy mix of Germany. Despite an expected increase of renewable energies, water, wind or biomass will not supply the necessary volume of energy services by the mid 20s.

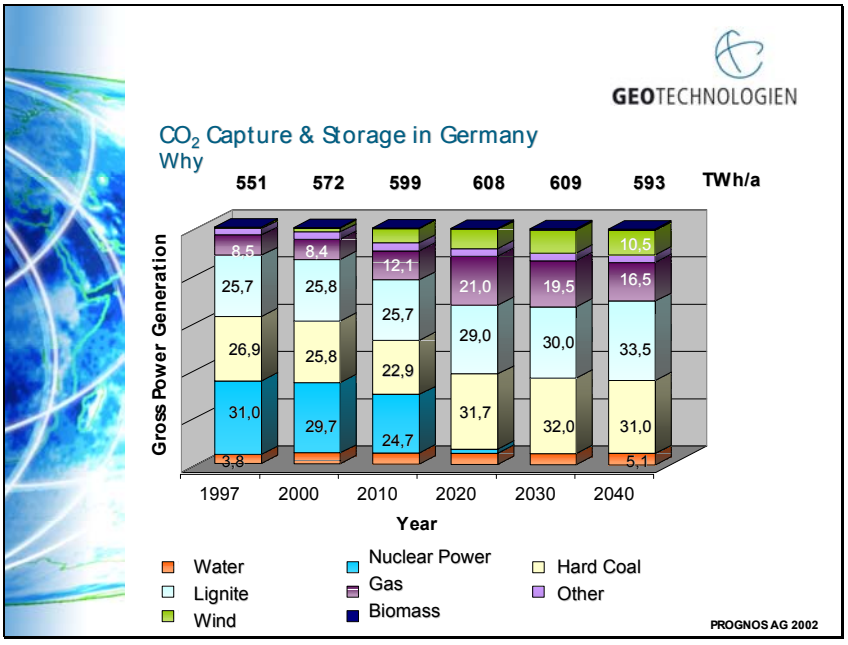


Fig.5: Possible future energy mix in Germany

Given the medium and long-term requirements of climate protection, coal can only make an important contribution to the sustainable energy industry, if the CO_2 released during its consumption is minimised or does not reach the atmosphere at all. This option is offered first by more efficient power station technology or, the long term option, CO_2 sequestration. Capture and storage of CO_2 could be an important bridge in the transition from the age of fossil fuels to that of renewable energies.

In Germany, however, too little research is currently being made on the possibilities offered by this technology. Only single research activities have been involved in

international activities, mainly in the frame of the 5 Framework Programme of the European Commission.

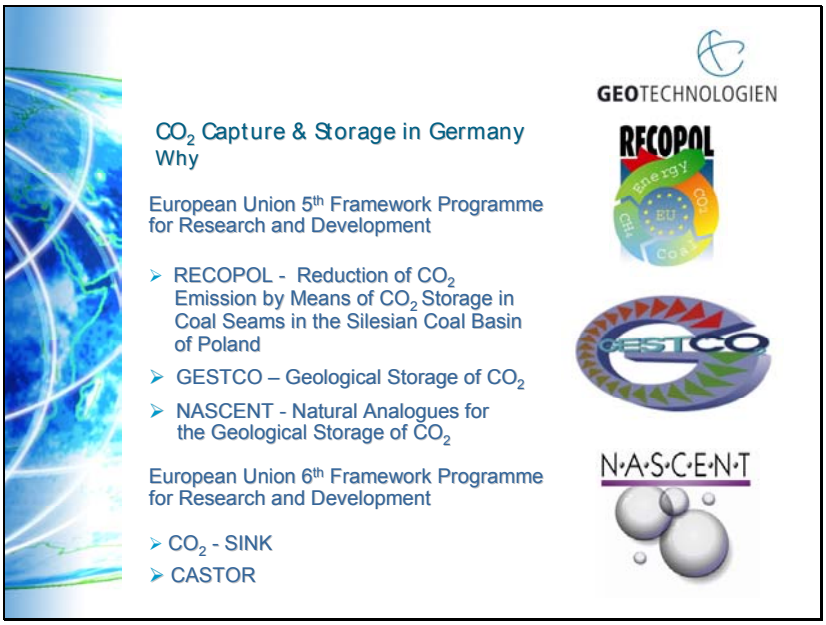


Fig. 6: International research programmes with German participation

Regarding the preliminary results, CO_2 storage in Germany is promising in different regions and geological formations.

The prime choice for CO_2 storage in Germany are depleted and active gasfields (the most important ones are marked with red circles) in Permian and Triassic sandstones of the North and Middle German Sedimentary Basin. They are proven gas tight and from the economical point of view they are very interesting due to the combination of CO_2-storage and the enhancement of the recovery of residual (methane) gas. The storage capacity in German gas fields (including existing gas reserves) is estimated on 2.5 Megatons CO_2. (1 megaton=10^6 tons; 1 gigaton: 10^9 tons).

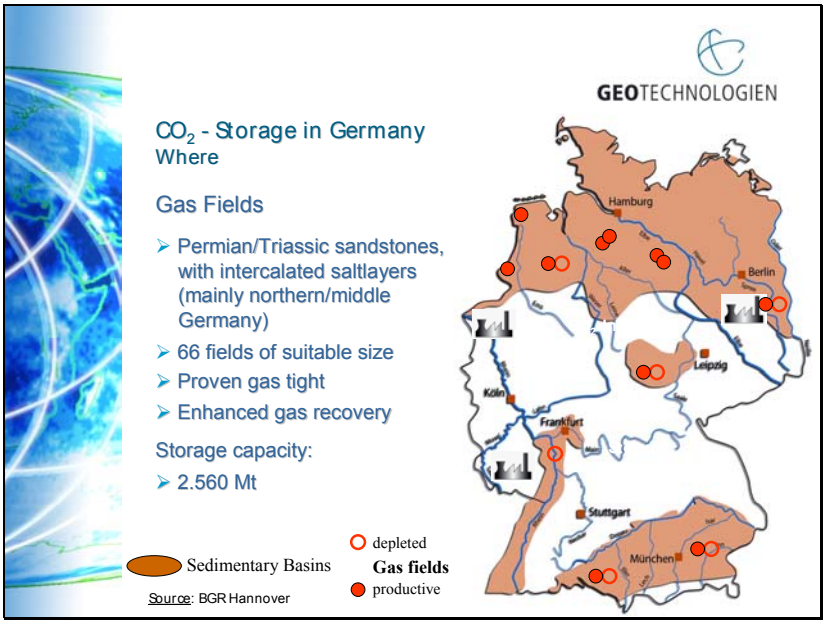


Fig. 7: Distribution of the most prominent sedimentary basins in Germany and possible localities for CO_2 storage in depleted gas fields

An even much larger storage potential could be provided by deep saline aquifers. With an estimated storage capacity of 16.000 Mt they provide enormous capacities, but the potential risks seems much higher and legal aspects are till now completely unknown.

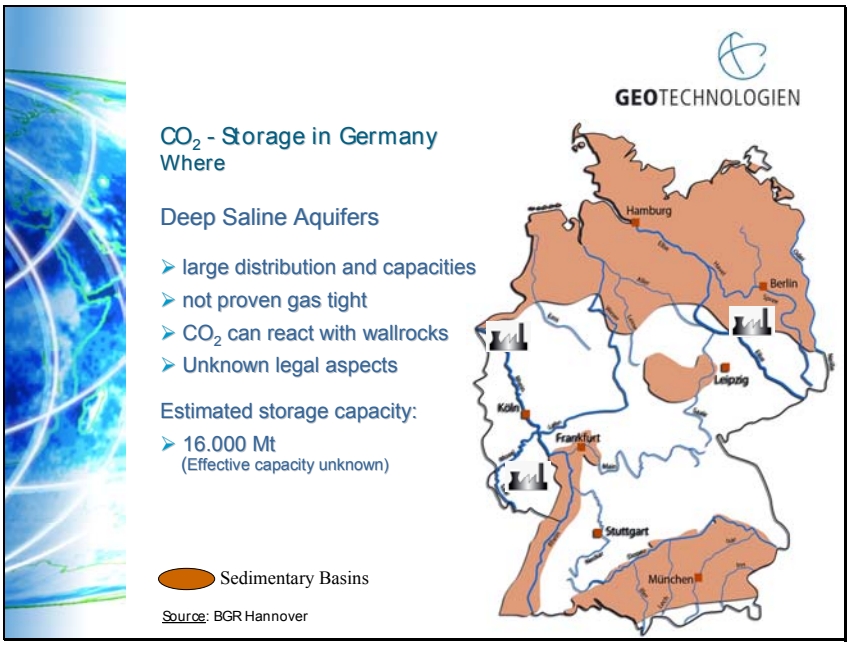


Fig. 8: Distribution of the most prominent sedimentary basins in Germany

On the other side depleted oil fields have just a restricted storage capacity. 110 Mt when known reserves are included. However, they could become an interesting economical option for Enhanced Oil Recovery (EOR), in combination with emission trading or future tax savings.

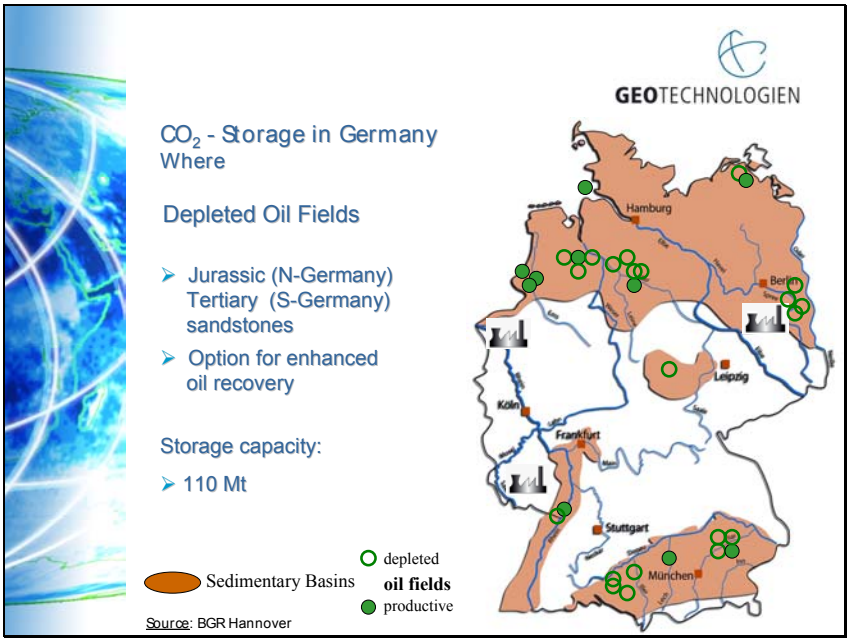


Fig. 9: Distribution of the most prominent sedimentary basins in Germany and possible localities for CO_2 storage in depleted oil fields

A promising opportunity especially in Germany might be the storage of CO_2 in deep unminable coal seams in combination with coal gas production. Huge coal deposits

are known from the Ruhr and Saar-district, offering an estimated storage capacity of 6000 Mt. However, the unknown adsorption potential of coal under deep subsurface conditions and the unknown injection rates in low permeable coals still require a lot of research.

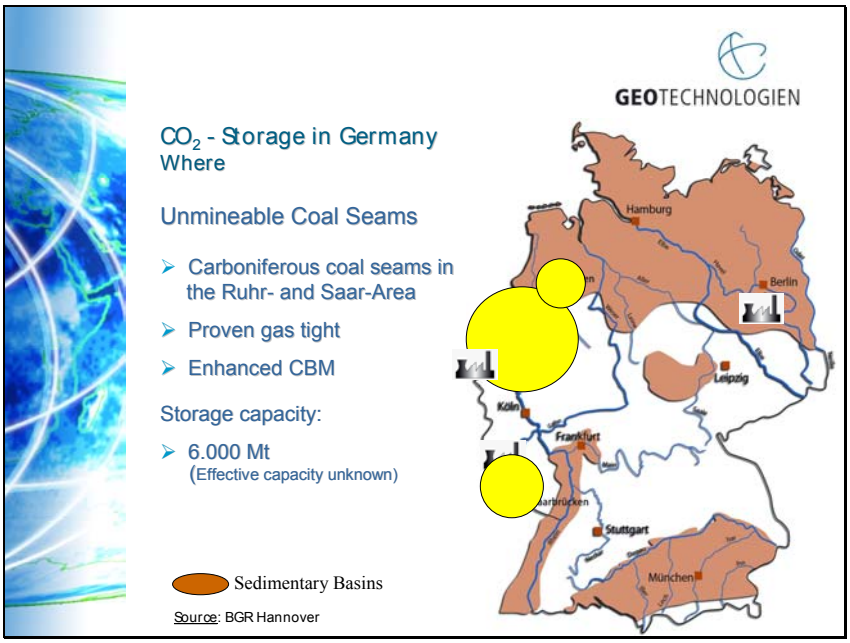
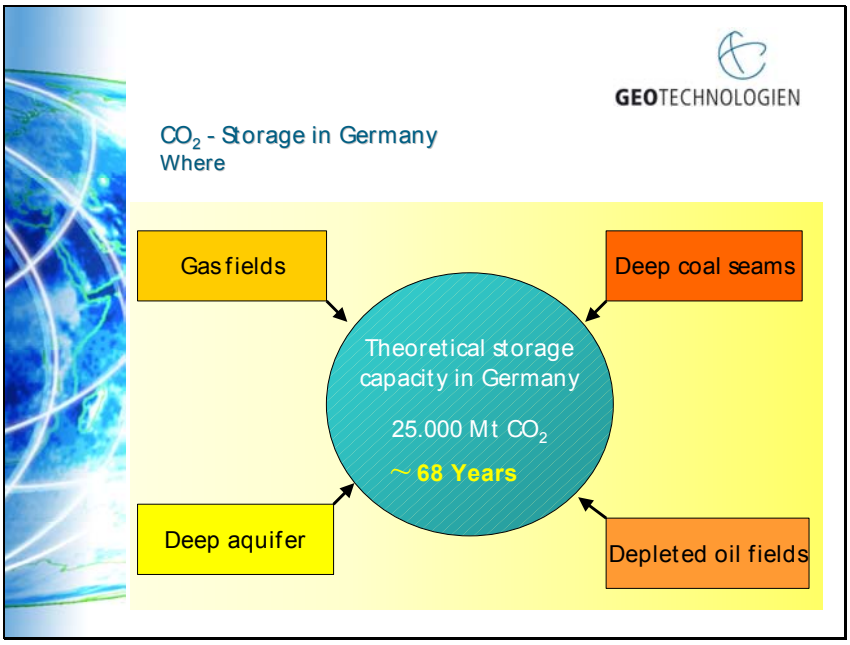


Fig. 10: Distribution of the most prominent sedimentary basins in Germany and possible localities for CO_2 storage in unmineable coal seams

Concluding: In Germany there are four options for underground CO2 storage: Gas fields, Deep aquifers, depleted oil fields and deep coal seams. The theoretical storage capacity is according recent estimations approximately 25.000 Mt. By a recent annual emission rate of all coal power plants of 370 Million tons of CO_2 this capacity would reach to store CO_2 for the next 68 years.



However, to receive reliable results on the safety and economic value of CO_2 capture and storage, intensive research especially on the field of CO_2 storage is still necessary. This involves

- The quantification of storage capacities of potential rock formations
- A better understanding of the distribution of CO_2 in the underground
- How does CO_2 interact with the carrier rocks, cap rocks and the groundwater
- reliable monitoring technologies
- Physical and mechanical parameters of reservoir and cap rocks
- A commercial feasibility study
- Detailed studies on legal aspects.

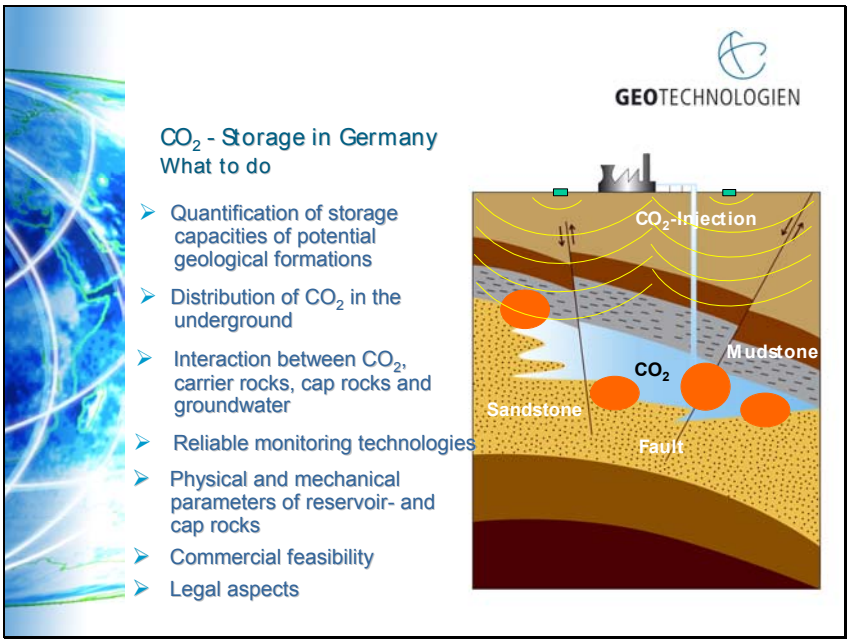


Fig. 12: Important research areas to decide on the safety and usefulness of underground CO_2 storage

Under the umbrella of the R&D-Programme GEOTECHNOLOGIEN, recently a national initiative concerning the safety and ecologic and economic value of geological sequestration of CO_2 has been started. After a public call, project proposals will be internationally reviewed in the next few months. The start of the integrated studies, incorporating research institutes as well as companies, is scheduled for late 2004/early 2005. Collaboration with similar studies, both in Europe and USA are already existing, but will be improved once the different projects are started.