



# CARMA

## Carbon Dioxide Management in Swiss Power Generation

This project started in 2008.

### Scope of project

Carbon dioxide (CO<sub>2</sub>) capture and storage (CCS) is a set of technologies for the capture of CO<sub>2</sub> from its anthropogenic point sources, its transport to a storage location or treatment plant, and its isolation from the atmosphere. This is only one, though very important, option in a portfolio of actions to fight the increase of atmospheric CO<sub>2</sub> concentration and to mitigate the greenhouse effect and climate change, while at the same time allowing for the continued use of fossil fuels. Deployment of CCS technologies is expected to be limited in the next 5 to 10 years, but to provide a significant CO<sub>2</sub> sink in at best 20 years from now. Capture of CO<sub>2</sub> using existing separation techniques can be applied to large point sources, i.e. power plants or industrial plants; CO<sub>2</sub> can be easily transported over large distances using pipelines and ships; CO<sub>2</sub> storage can take place in geological formations, and by fixing it in mineral carbonates, the so-called mineral carbonation.

### Summary of project

There are at least three reasons why we should consider CCS in Switzerland. First, fossil fuel based power generation is one of the candidate options in the Swiss energy roadmap. Secondly, reduction of CO<sub>2</sub> emissions is a global issue and requires concerted international action; new technology and know-how developed within this

project would have a global value and could be commercialized and implemented worldwide. Finally, we argue that even though significant additional cost and energy penalties are associated with the implementation of CCS, this technological option will be needed to bridge the gap until CO<sub>2</sub>-free/neutral energy technologies are able to become the most prominent primary energy source.

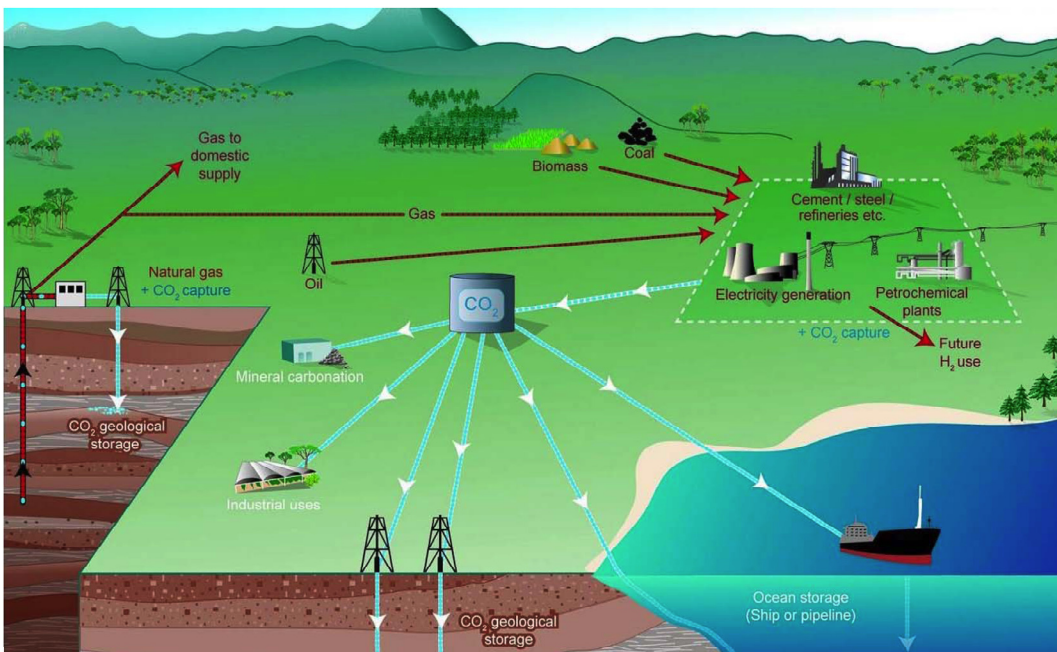


Figure 1: Overview over the concept of carbon dioxide capture and storage (IPCC, 2005).

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**Project Partners**  
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FHNW  
PSI

Based on this analysis, the aim of the CARMA project is twofold. On the one hand we intend to explore the potential for and the feasibility of the deployment of CCS in Switzerland within the framework of future energy scenarios. On the other hand we aim at exploiting available expertise to develop new CCS technologies and know-how, which might be applied in and also outside of Switzerland.

## Goals and activities

In particular, CARMA main objectives, which will be pursued by a team of scientists mostly from ETH Zurich, EPF Lausanne and Paul Scherrer Institute, are as follows:

- To assess the potential role of CCS in Switzerland, by a life cycle analysis of the material and energy fluxes and an economical evaluation of the different options for new (fossil fuel) power plants with the associated fuel cycles. Various alternatives for reducing CO<sub>2</sub> emissions will be ultimately examined through a multi-criteria decision analysis covering a broad range of environmental, economic and social criteria.
- To study new concepts for zero emission fossil fuel power plants based on the pre-combustion CO<sub>2</sub> capture scheme. The focus will be on the combustion of hydrogen from an experimental and a modeling point of view. The experimental study will be complemented by a thermo-economical analysis of pre-combustion capture systems.
- To assess the applicability of geological storage of CO<sub>2</sub> in Switzerland, either in saline aquifers or in coal seams, including risk analysis and seismic hazard. Ultimate goal as a follow-up of this project and based on its results will be a CO<sub>2</sub> injection field test in Switzerland.
- To develop a new mineral carbonation process that would lead to a drastically different approach to CO<sub>2</sub> storage, with higher cost and energy penalty but also a better promise of permanent storage than geological storage.
- To explore the legal issues associated with capture, transport and storage of CO<sub>2</sub>, including accounting aspects, and to determine the public and institutional understanding and acceptance of CCS in Switzerland.

These goals will be achieved within the three years of the project plan.

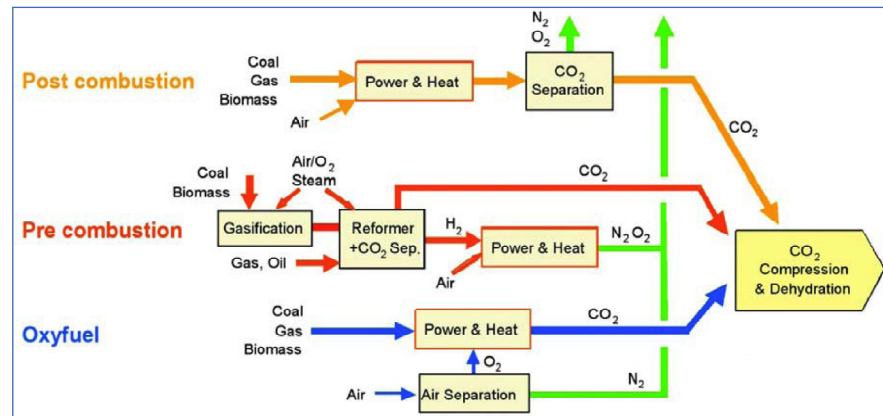


Figure 2: Schemes of the three possible approaches towards CO<sub>2</sub> capture in fossil fuel-fired power plants (IPCC, 2005).



Figure 3: Prospective areas in sedimentary basins where suitable saline formations, oil or gas fields, or coal beds may be found (IPCC, 2005).