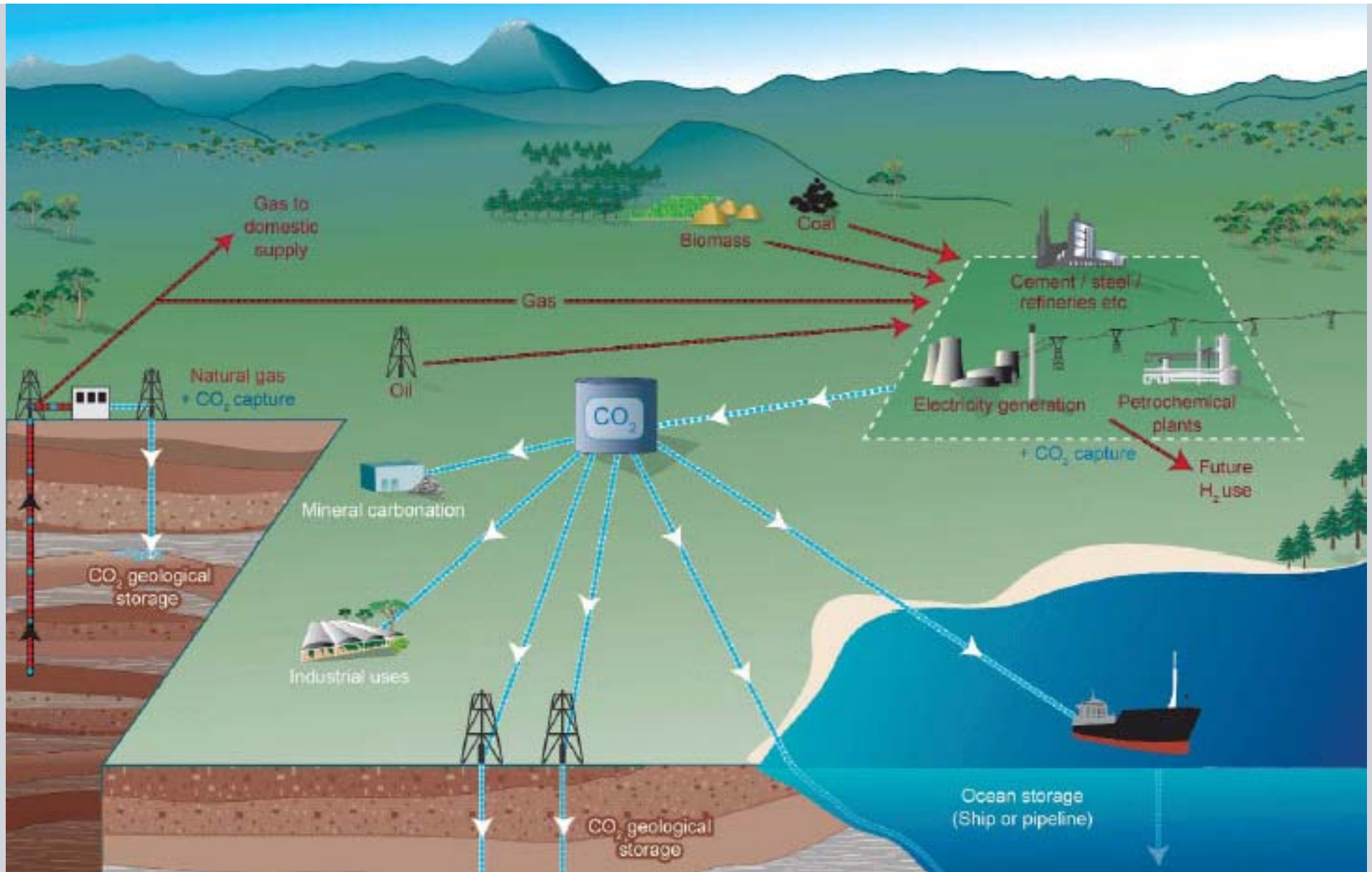


Carbon Capture & Storage (CCS) – A Technology Overview

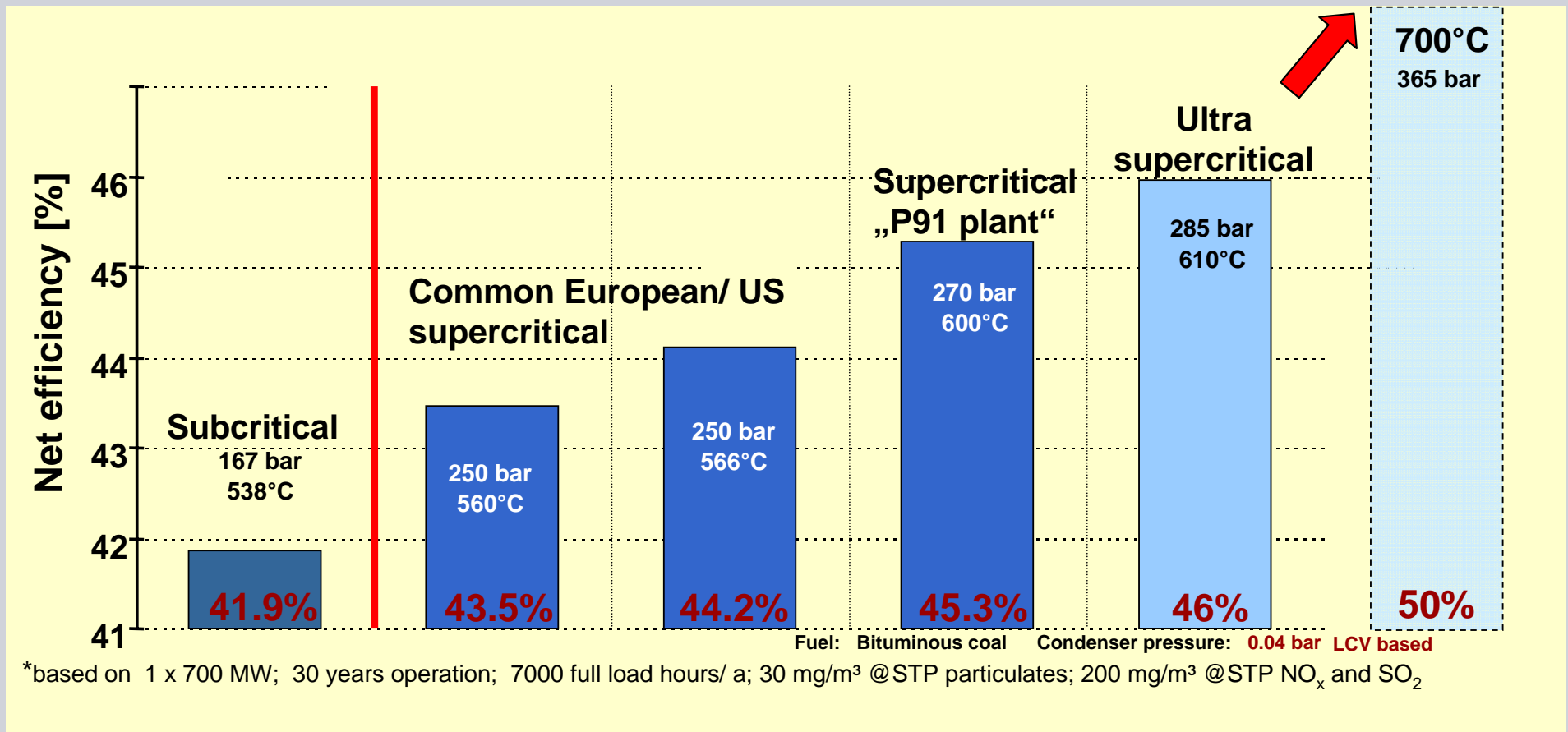
Dr. Klaus Willnow
Siemens Energy Sector

*UNECE Energy Week
Geneva, November 18, 2008*

The CCS Landscape



Steam parameters and corresponding efficiencies of a 700 / 800 MW plant



1%-point in efficiency reduces emissions by 2.4 Mio t CO₂*, 2000 t NO_x*, 2000 t SO₂*, 500 t particulates*
 reduces fuel costs by 2.4%

Supercritical STPPs are supporting emission reduction and fuel saving

Contribution of Steam Power Plant development towards environmental compliance

SIEMENS

1981

37.5 %

STPP efficiency

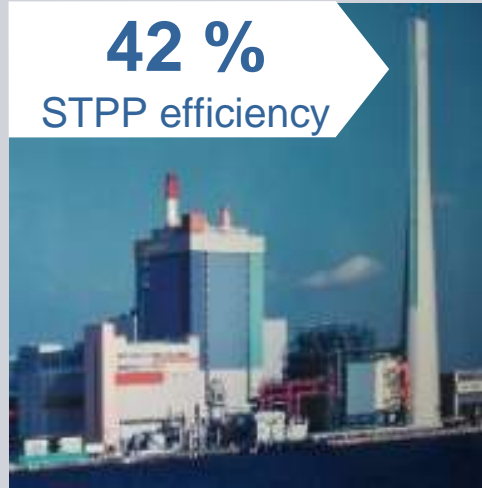


STPP Bergkamen
designed for 747 MW

2001

42 %

STPP efficiency

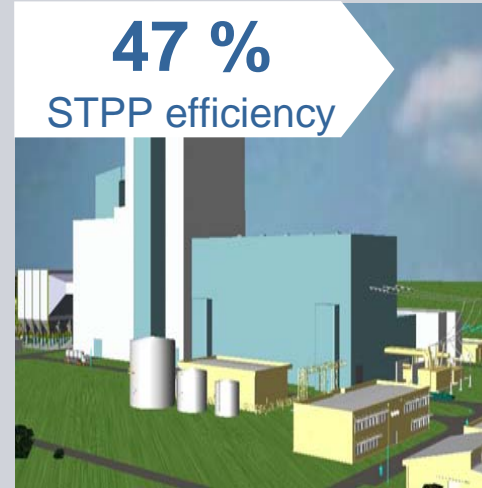


STPP Isogo 1
designed for 600 MW

2004

47 %

STPP efficiency



Reference STPP NRW
designed for 600 MW

2015

>50 %

STPP efficiency



STPP 50plus (E.ON)
designed for 500 MW

Reduction of CO₂ emissions

Basis

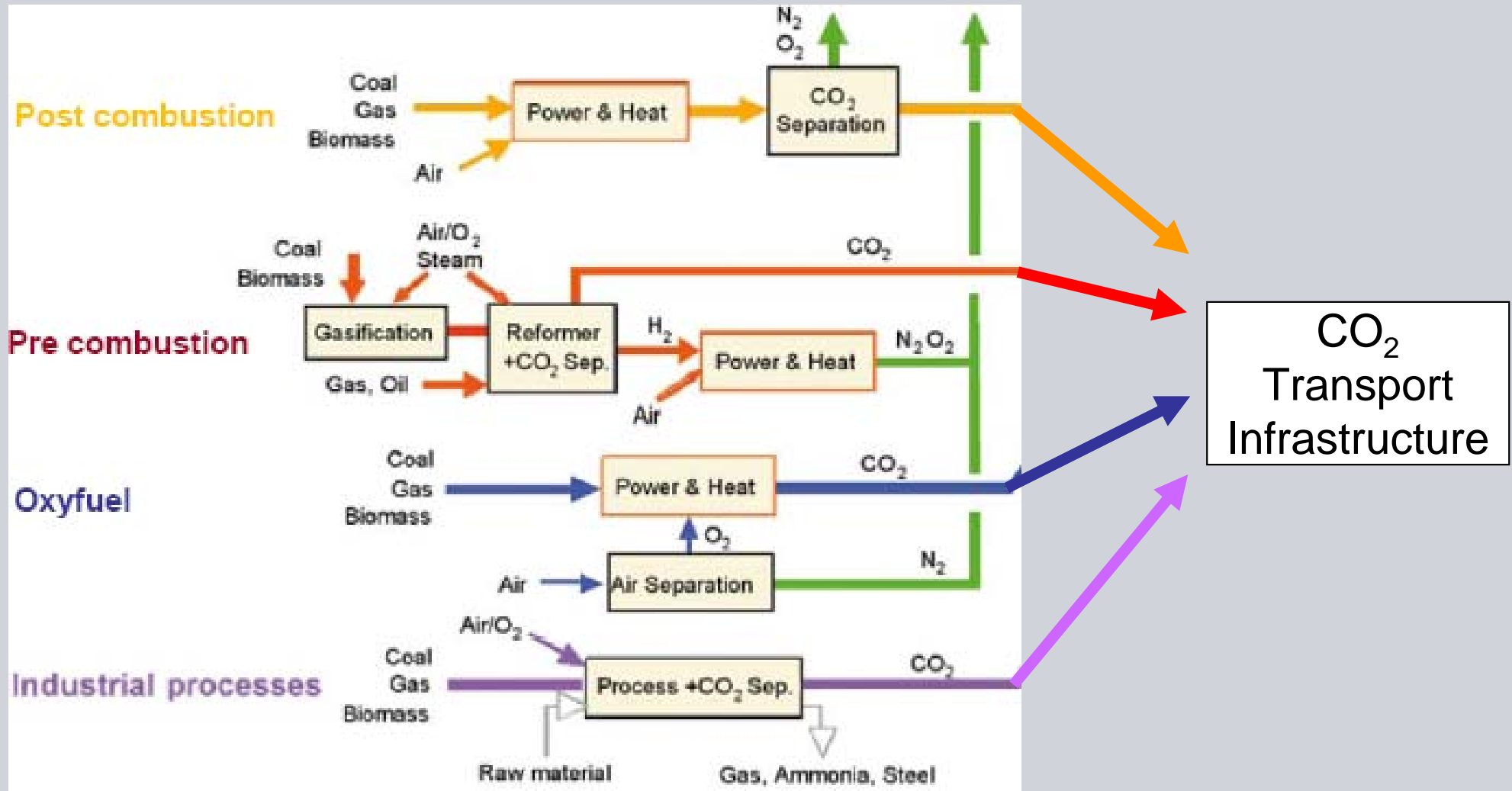
- 11.8%

- 20.2%

- 25.0%

Increasing efficiency is the key driver to more environmental friendly STPPs, suppliers and generators need to strive for

Step 1: The Carbon Capture

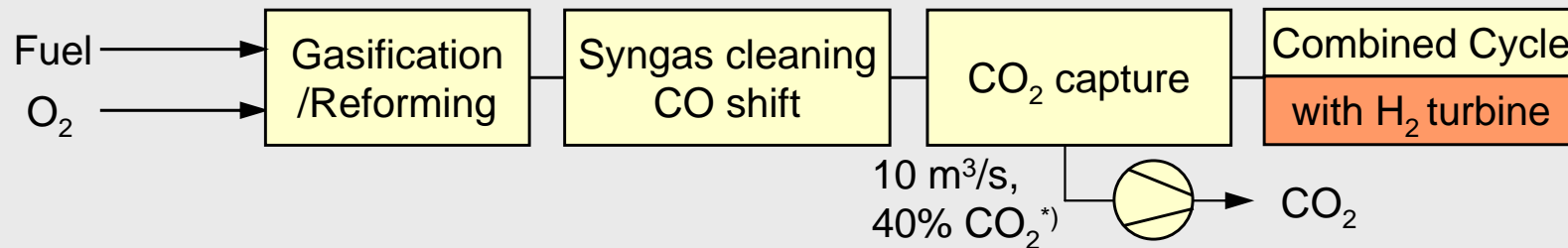


The three technology pathways for CCS in power plants

Research needs
Conventional

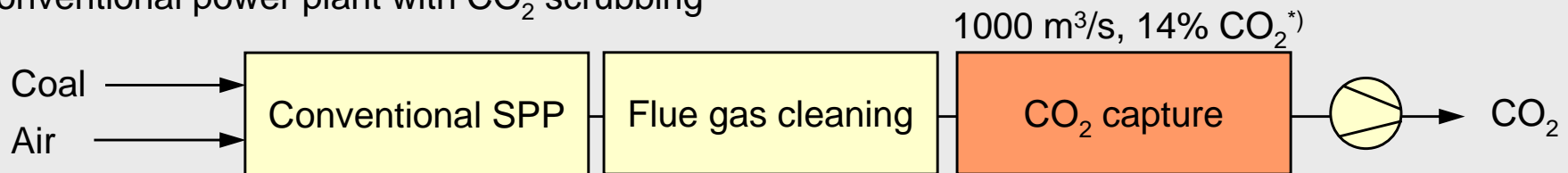
CO₂ Capture before Combustion (Pre-combustion)

IGCC process (coal) or IRCC process (natural gas)



CO₂ Capture after Combustion (Post-combustion)

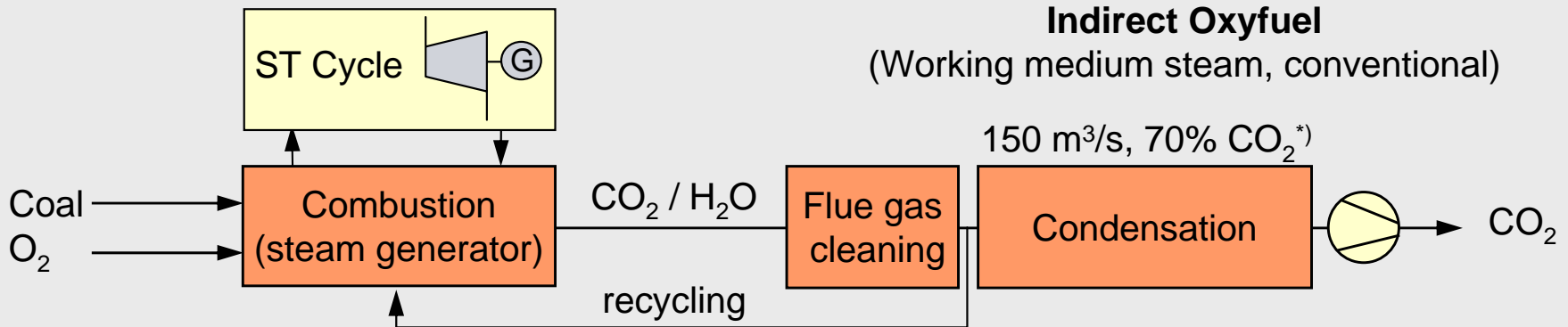
Conventional power plant with CO₂ scrubbing



Integrated CO₂ Capture (Indirect Oxyfuel)

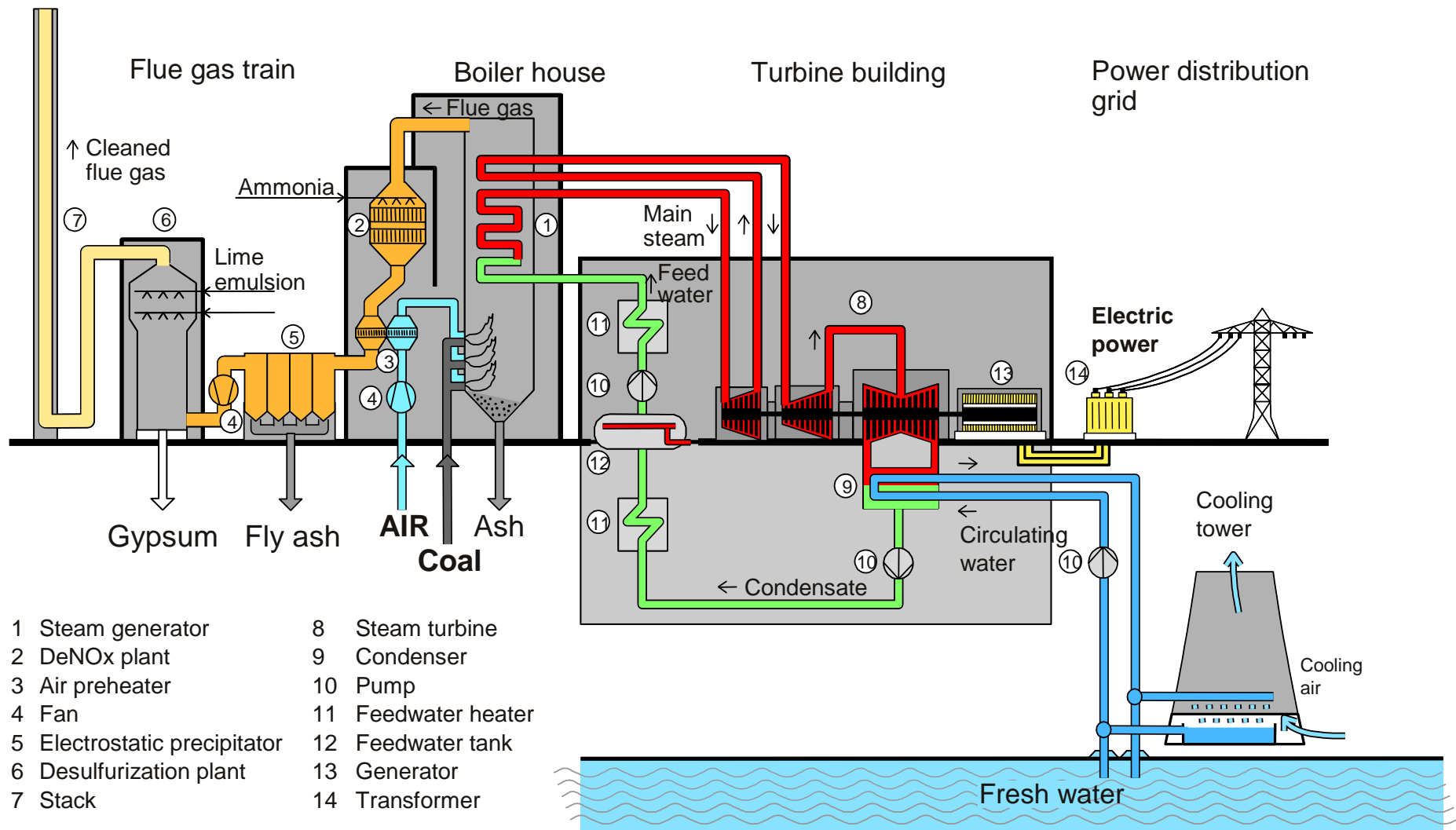
Indirect Oxyfuel

(Working medium steam, conventional)



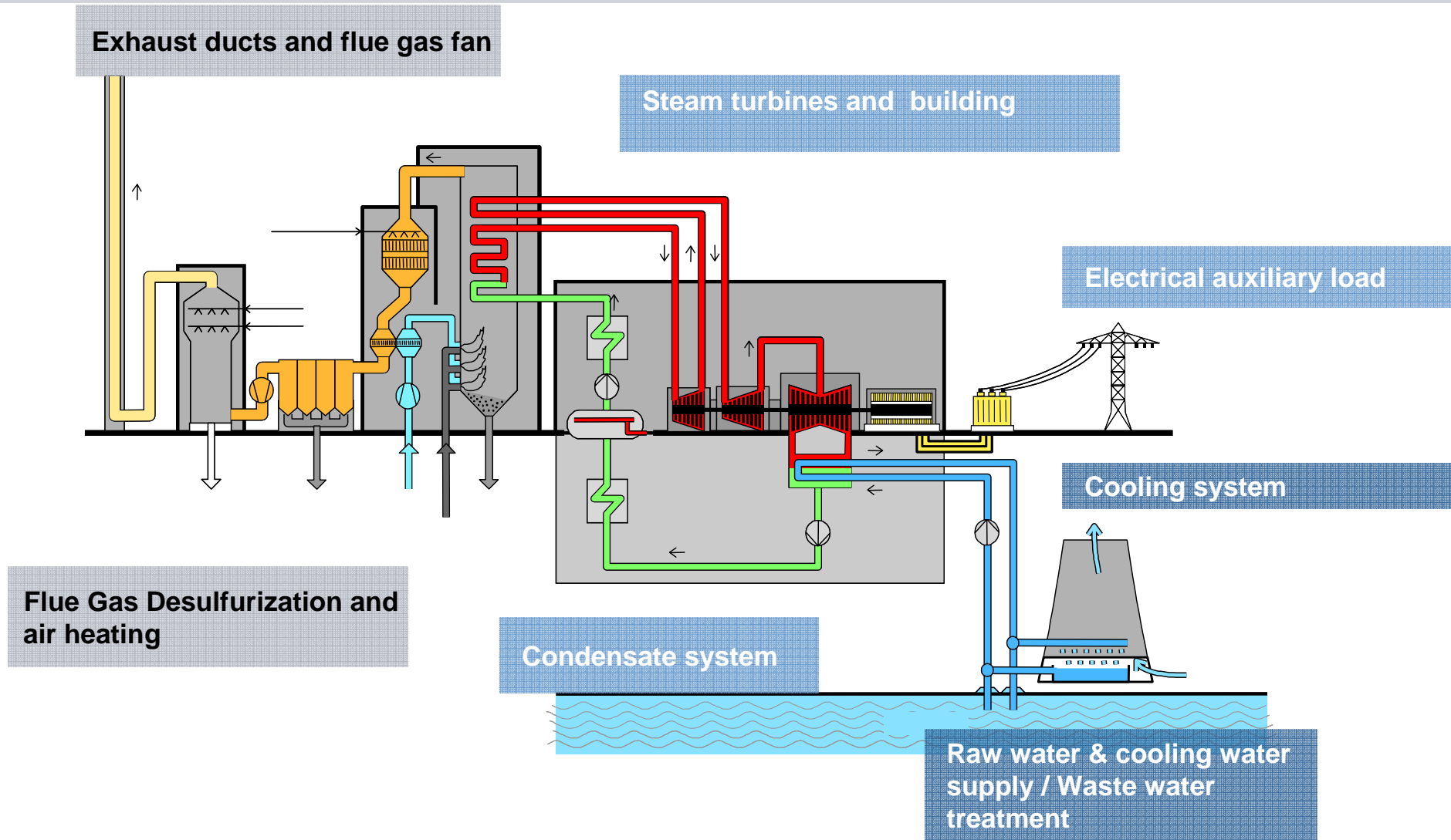
*) typical for 700 MW class

Capture Ready for a Steam Power Plant

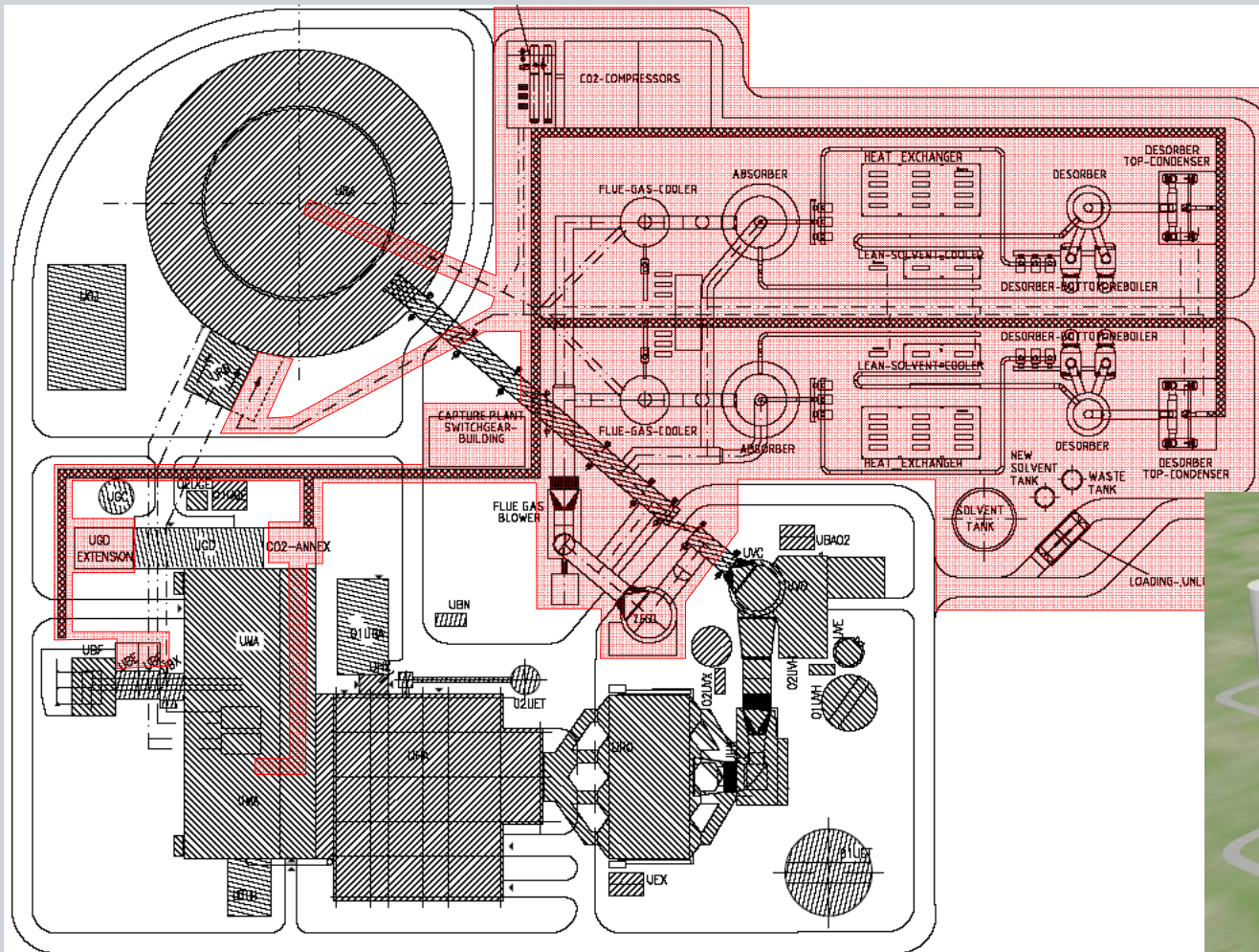


“Capture Ready Requirements”

All measures defined - reference Siemens steam power plant layout SSP5-6000



Power plant with integrated post-combustion CO₂ Process designs and ideas



Siemens Process and Solvent development and optimization



Conceptual design of a post combustion capture unit

Step 2: CO₂-Transport

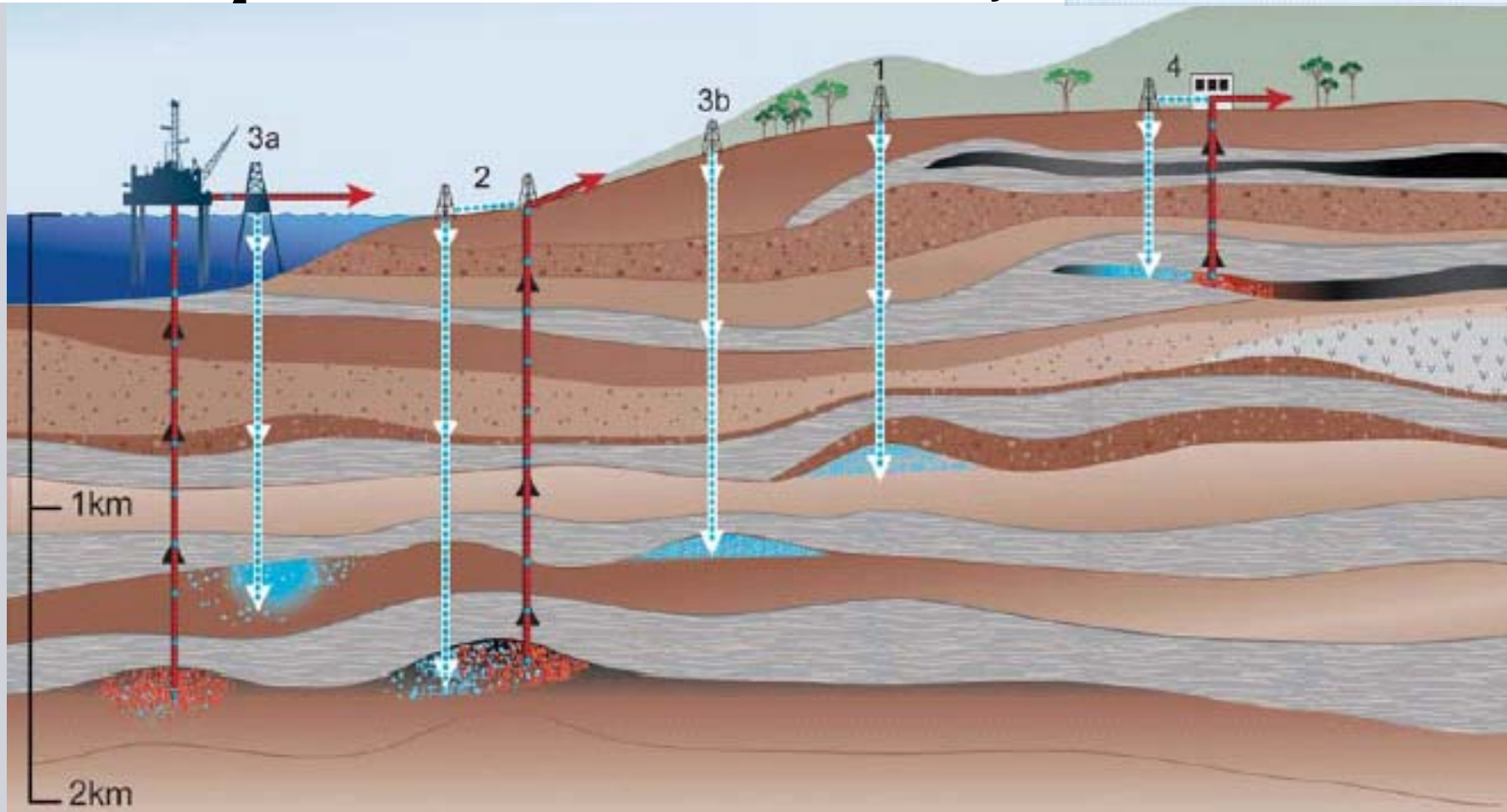


- Mostly the power plants are not situated close to storage sites. The transport of CO₂ sometimes over long distances has to be prepared.
- The CO₂ captured in the power plants will be compressed to liquid equivalent to natural gas for transport primarily in pipelines. The transport by ship or lorry is also feasible.

Step 3: CO₂-Storage

Overview of geological storage options

1. Depleted oil and gas reservoirs
2. Use of CO₂ in enhanced oil and gas recovery
3. Deep saline formations – (a) offshore (b) onshore
4. Use of CO₂ in enhanced coal bed methane recovery



Courtesy of CO2CRC

Step 3: CO₂-Storage

Potential underground locations worldwide



Source: IPCC Special Report on Carbon Dioxide Capture and Storage

Step 3: CO₂-Storage Projects worldwide



Source: IPCC Special Report on Carbon Dioxide Capture and Storage

Summary

1

Increase of efficiency is crucial to balance the efficiency losses caused by CCS.

2

In the CCS chain carbon capture is a technology issue, carbon storage is a geological and monitoring issue.

3

CCS is a feasible technology option, first demonstrations have been started to get experiences for the operation.

4

Large-scale demonstration and further R&D is necessary to limit the risks and lower the overall costs.

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