EUROPEAN COMMISSION
Community research

SEVENTH FRAMEWORK PROGRAMME

EC support to research and international cooperation in Carbon Capture and Storage

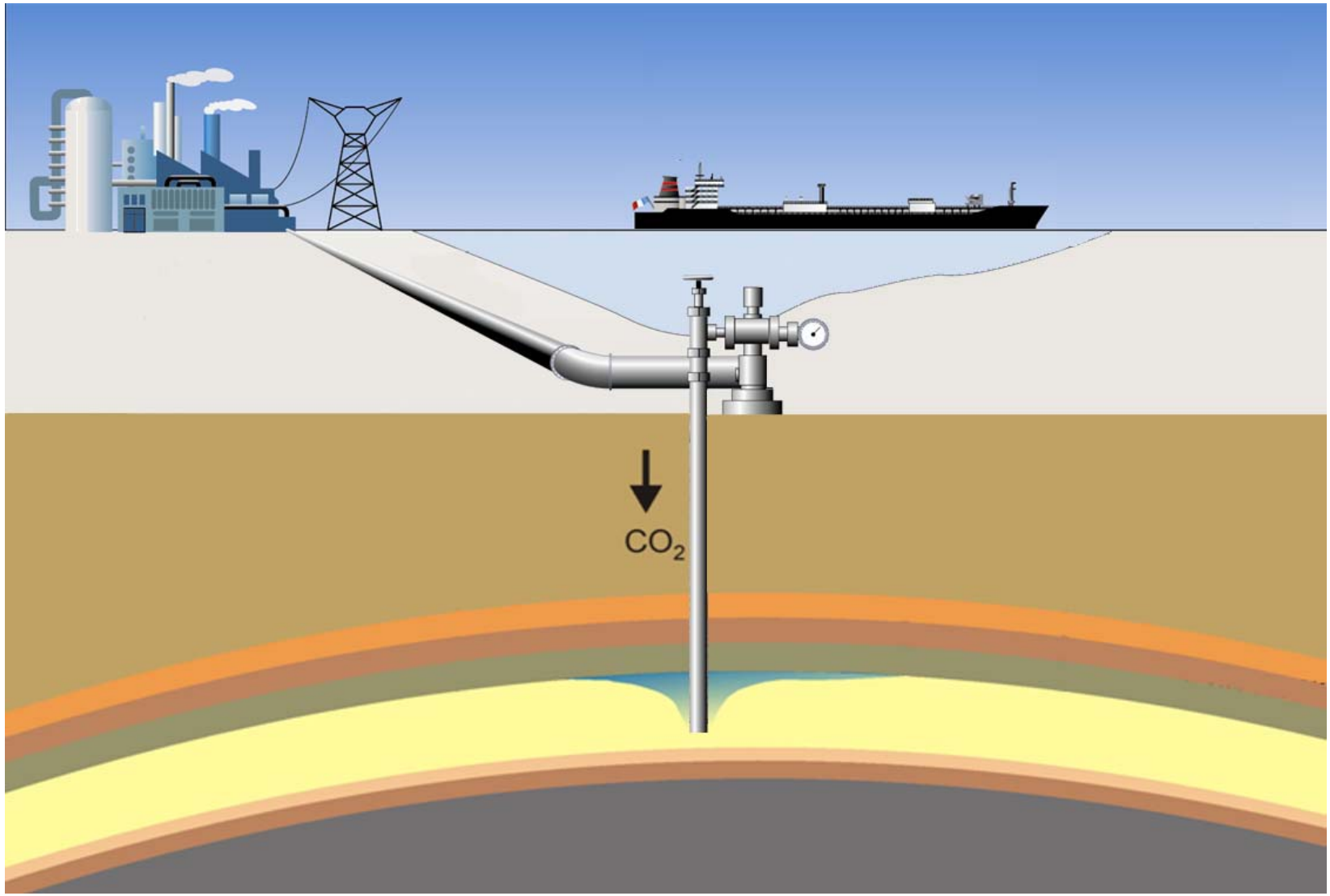
European Commission

Wiktor RALDOW

EUROPEAN COMMISSION
Community research

CO2 capture and storage (CCS)

Involves separation of CO2 from industrial and energy related sources, transport to a storage location, underground storage, and monitoring



Source:
CO2-SINK

EUROPEAN COMMISSION
Community research

Key hurdles to CCS at present

- ✓ Regulatory framework
- ✓ High investment and operating costs
- ✓ Missing CO_2 infrastructure
- ✓ Completion of technology development

EUROPEAN COMMISSION
Community research

Overcoming hurdles

Enabling regulatory framework for CCS

- ✓ Amendment of the London Protocol and the OSPAR Convention to allow the storage of CO_2 under the seabed as from 2007
- ✓ Proposal for a Directive on the geological storage of carbon dioxide

Providing incentives addressing CCS economics

- ✓ Emission Trading Scheme as the key instrument
- ✓ New guidelines for state aid for environmental protection
- ✓ Additional instruments, esp. for making plants bankable:
  European Investment Bank (EIB),
  European Bank for Reconstruction and Development (EBRD)

Ancillary initiatives

- ✓ Capture-readiness, retrofitting schedule, CO_2 infrastructure

Boosting and better coordination of RTD and demonstration efforts in the EU

EUROPEAN COMMISSION
Community research

Highlights of CCS Activities under Framework Programmes

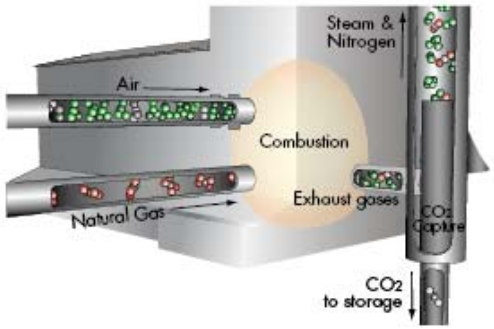
Activities under FP5 and FP6 (1998-2006)

- Projects on Capture and Storage worth more than 170 M€
- European Technology Platform on Zero Emission Fossil Fuel Power Plants launched on 1 December 2006
- Coordination of member states research activities, ERA-NET (FENCO)
- International Cooperation: member of the Carbon Sequestration Leadership Forum

EUROPEAN COMMISSION
Community research

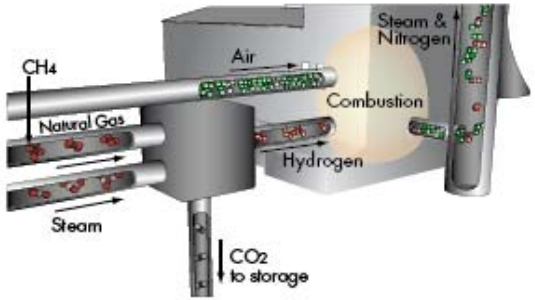
Capture technologies

Focus on 3 basically different options



Post-combustion

CO_2 separated from exhaust gas by absorption



Pre-combustion

CO_2 separated from fuel gas by steam reforming

Hydrogen production and/or combustion

Oxyfuel process

O_2 separated from air before combustion

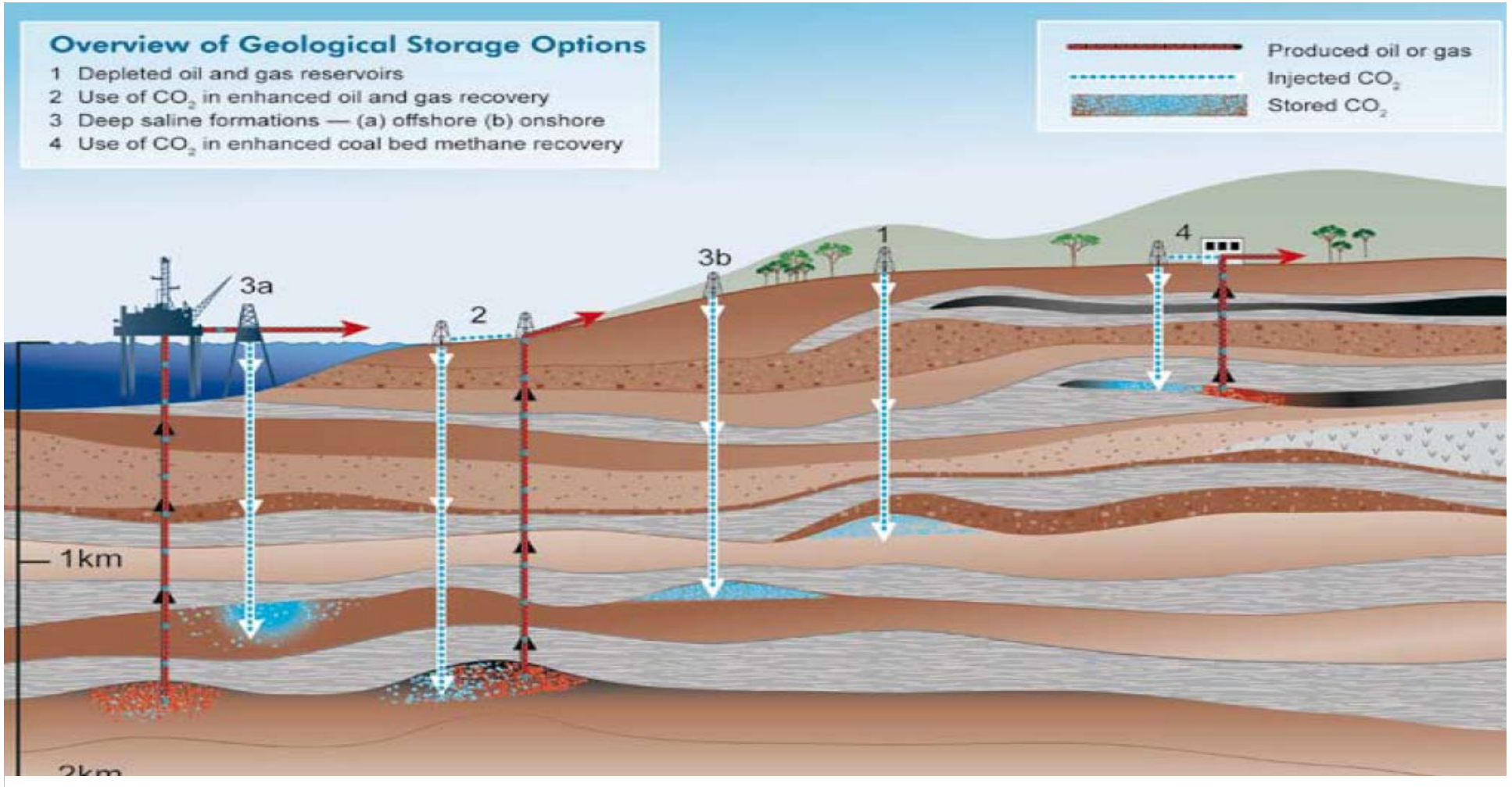
Illustrations: IEA Greenhouse Gas R&D Programme

EUROPEAN COMMISSION
Community research

Storage options

Focus on 3 basically different options:

Oil and gas fields; aquifers; coal layers



Ref: COCRC, IPCC Special Report on CCS, http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

EUROPEAN COMMISSION
Community research

The Commission supports all different capture and storage options

Project Acronym	Title	EU funds (M€)	Coord
CO2SINK (IP)	In-situ laboratory for capture and sequestration of CO_2	8.7	Postdam Research (DE)
ENCAP (IP)	Enhanced capture of CO_2	10.7	Vattenfall (DE)
CASTOR (IP)	CO_2 from capture to storage	8.5	IFP (FR)
CO2GEONET (NoE)	Network of excellence on geological sequestration of CO2	6.0	BGS (UK)
CACHET (IP)	CO2 capture and hydrogen production from gaseous fuels	7.5	BP (UK)
DYNAMIS (IP)	Preparing for large scale H2 production from decarbonised fossil fuels with CO2 geological storage	4.0	SINTEF (NO)
CO2REMOVE (IP)	The monitoring and verification of CO2 geological storage	8.0	TNO (NL)

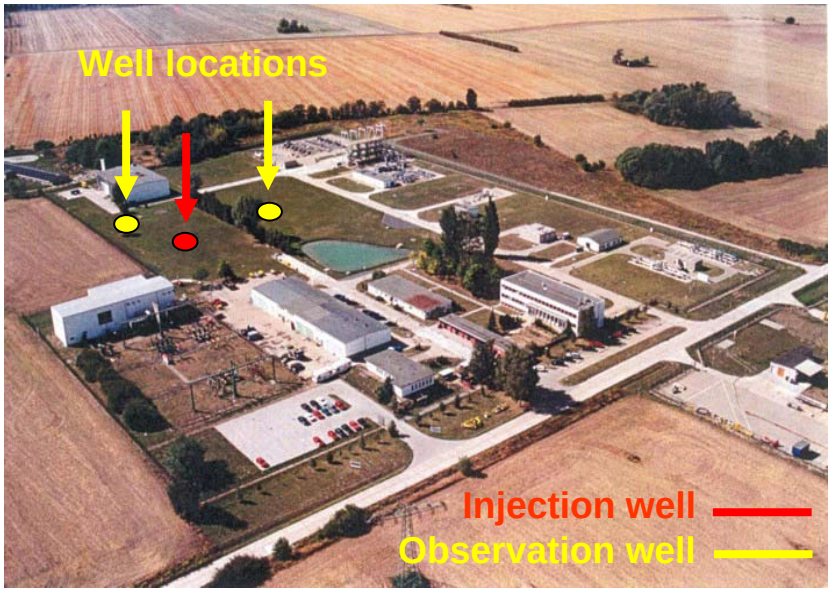
EUROPEAN COMMISSION
Community research

CO_2SINK

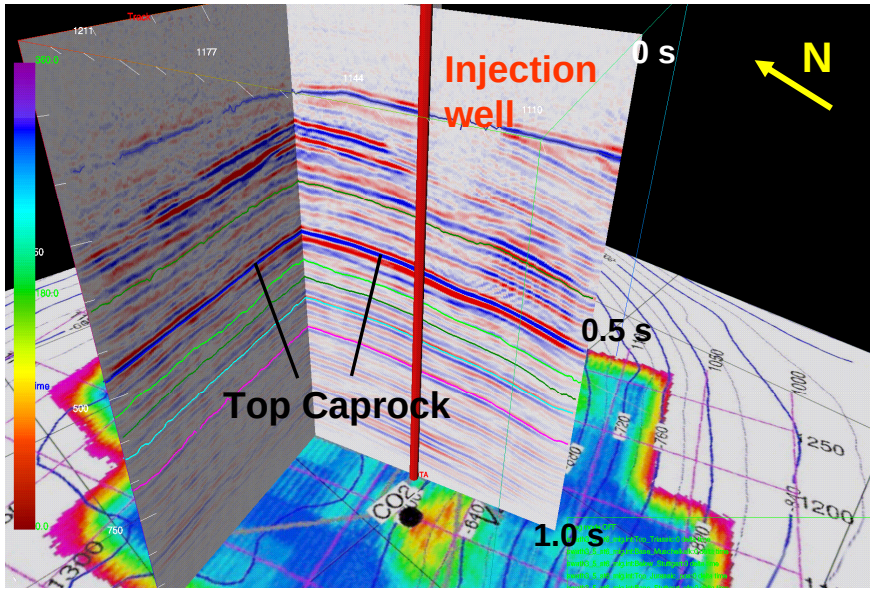
Test facility for capture and sequestration of CO_2

Objective: set up a full-scale CO_2 storage test site on land to

- advance understanding of science and processes in underground storage of CO_2
- provide real case experience
- develop best practice guidelines for geological storage of CO_2



Injection Site



Seismic 3D Baseline Survey

EUROPEAN COMMISSION
Community research

CASTOR
CO_2 from capture to storage

Esbjergværket

Elsam
essential energy

Esbjerg power plant
Capacity: 1 t CO_2 / h
5000 Nm3/h flue gas (coal combustion)
In operation since early 2006

EUROPEAN COMMISSION
Community research

CACHET
CO_2 Capture and Hydrogen Production from Gaseous Fuels

Objective

- **To develop technologies to significantly reduce the cost of CO2 capture from natural gas with H2 production**.

Main Targets

- **To reduce the cost of CO2 capture from current levels to €20 – 30 per tonne**
- **Integration of the CO2 capture technologies with H2 production systems for power generation and fuel applications**

EUROPEAN COMMISSION
Community research

CO2ReMoVe
CO2 Geological Storage: R&D on Monitoring and Verification

Objectives

- ✓Develop and test methods for initial site evaluation
- ✓New tools for monitoring storage and possible well and surface leakage
- ✓New tools to predict long term behavior and risks
- ✓A generic risk assessment methodology for different sites and time-scales
- ✓Guidelines for best practice

research
monitoring
verification

EUROPEAN COMMISSION
Community research

Energy Theme in FP7

Implemented jointly by DG Research and DG Energy and Transport

- Hydrogen and fuel cells
- CO2 capture and storage technologies for zero emission power generation
- Renewable electricity generation
- Clean coal technologies
- Renewable fuel production
- Smart energy networks
- Renewables for heating and cooling
- Energy savings and energy efficiency
- Knowledge for energy policy making

CO2 Capture and Storage (CCS) technologies for ZEP generation

RTD&D to drastically reduce the environmental impact of fossil fuel use

- ✓ Capture: techniques for both new and retrofit power generation applications. Cost of capture should go down to ~15€ per ton of CO2.
- ✓ Storage: safety of geological CO2 storage at all timescales, including liability issues, for different underground storage options
- ✓ Integrated approach to capture, transport and storage

Clean Coal Technologies

RTD&D to substantially improve plant efficiency, reliability and cost

- ✓ Coal conversion:
  - ✓ mainstream technologies - pulverised fuel combustion, gasification – as well as liquefaction and fluidised bed technologies,
  - ✓ applied to solid hydrocarbons, such as hard coal, lignite and/or oil shale, including co-utilisation of biomass.
- ✓ Coal-based polygeneration: conversion of solid hydrocarbons into power and/or heat, possibly coupled with the production of secondary energy carriers including hydrogen as well as gaseous or liquid fuels.

EUROPEAN COMMISSION
Community research

Clean Power Generation in FP7
Energy 5&6

Cross-cutting actions:

- ✓ Integrated zero emission solutions: high-efficiency conversion technologies coupled with CO2 capture and storage
- ✓ (Pre-)regulatory issues for CCS and zero emission power generation; international cooperation; socio-economic assessments; …

EUROPEAN COMMISSION
Community research

International Cooperation

- **The International Energy Agency (IEA)**
  - ✓ Participation in *Greenhouse Gas Implementing Agreement.*
  - ✓ Participation in the *Clean Coal Implementing Agreement.*
  - ✓ Participation in *IEA Working Party on Fossil Fuels*

- **Membership in the Carbon Sequestration Leadership Forum**

- **Bilateral cooperation in the frame of agreements on science and technology with e.g. US, Japan, China, India, Canada, Australia……**

EUROPEAN COMMISSION
Community research

An EU Flagship Programme

A European Industrial Initiative within the SET Plan

Objectives

- ✓ A set of full-scale, integrated CCS research and demonstration projects covering a wide range of CCS technologies, EU-wide
- ✓ Better coordination between the projects and the portfolio of research activities
- ✓ Better definition of the priorities
- ✓ Faster knowledge generation arising from a better sharing of experiences

EUROPEAN COMMISSION
Community research

An EU Flagship Programme
Making CCS commercially viable by 2020

First Steps: Umbrella structure for the Flagship Programme

- ✓ Setting up a portfolio of projects including (up to 12) large scale demonstration projects
- ✓ Providing coordination, exchange of information and sharing of experience among the projects
- ✓ Promoting common monitoring and verification methods at the various sites
- ✓ Promoting a common approach to public acceptance issues
- ✓ Ensuring a European identity for the participating projects

EUROPEAN COMMISSION
Community research

Summary

Carbon Capture and storage is an important part of the sustainable solution. Europe needs to:

- ✓ Boost investment on research, development and demonstration of CCS technology
- ✓ Introduce a stable legal and regulatory environment, including incentives, to make CO2 capture and storage a reality
- ✓ Continue to integrate fragmented, private and public (national, European) efforts
- ✓ Face jointly as Europeans the challenges and opportunities of international cooperation and global competition