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European Research Priorities in Carbon Capture and Storage

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EU Strategic Policy Objectives

→ Lisbon Agenda

- Strategy for growth, jobs, social cohesion, sustainability

→ Energy

- Sustainable development
- Competitiveness
- Security of supply

→ Research

- Increasing research investment - to 3% of GDP
- Consolidating the European Research Area
- Strengthening research excellence



EU Most Relevant Policy Initiatives

- **Energy Package – an Energy Policy for Europe (Spring European Council 2007)**
 - Challenges for 2020 - the “*three 20s*”
- **The EU Electricity & Gas markets: third legislative package (September 2007)**
 - Unbundling, regulatory oversight and cooperation, network cooperation, transparency
- **Towards an European Strategic Energy Technology Plan – ‘SET Plan’ (November 2007)**
 - Technology is a key element in reaching energy and climate change policy objectives
http://ec.europa.eu/energy/res/setplan/communication_2007_en.htm
- **‘Climate action: Energy for a changing world’ (January 2008)**
 - Proposals to fight climate change and promote renewable energy in line with EU commitments
 - **Communication on Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels**
 - **Directive on enabling the legal framework of CCS**



Context

AN ENERGY POLICY FOR EUROPE

- **By 2020 – the three 20s:**

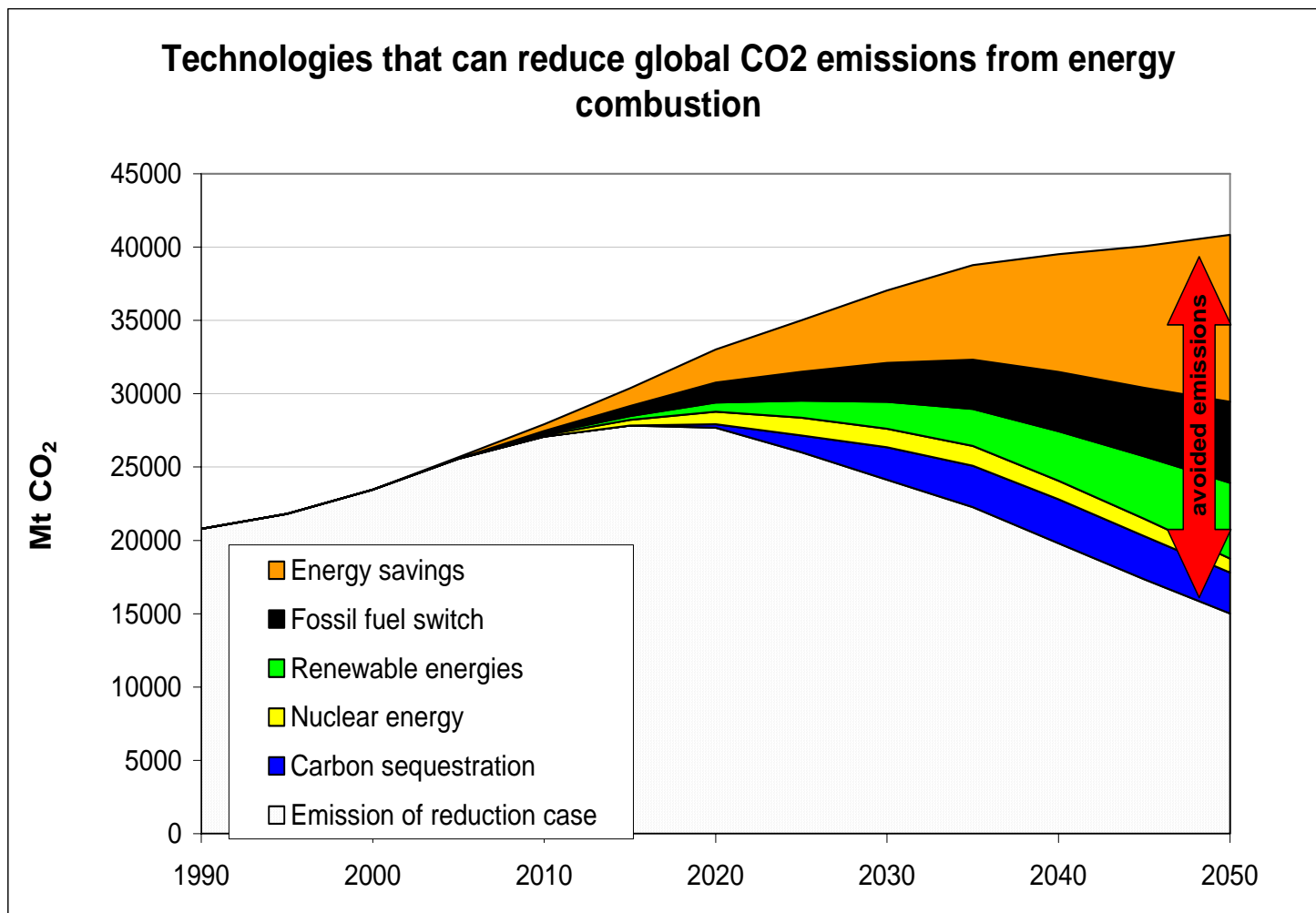
- 20% reduction in greenhouse gas emissions compared to 1990 levels (30% if global agreement)
- 20% reduction in global primary energy use (through energy efficiency)
- 20% of renewable energy in the EU's overall mix (minimum target for biofuels of 10% of vehicle fuel)

- **By 2050 : indicative 60 to 80% reduction in GHG**

energy for a changing world

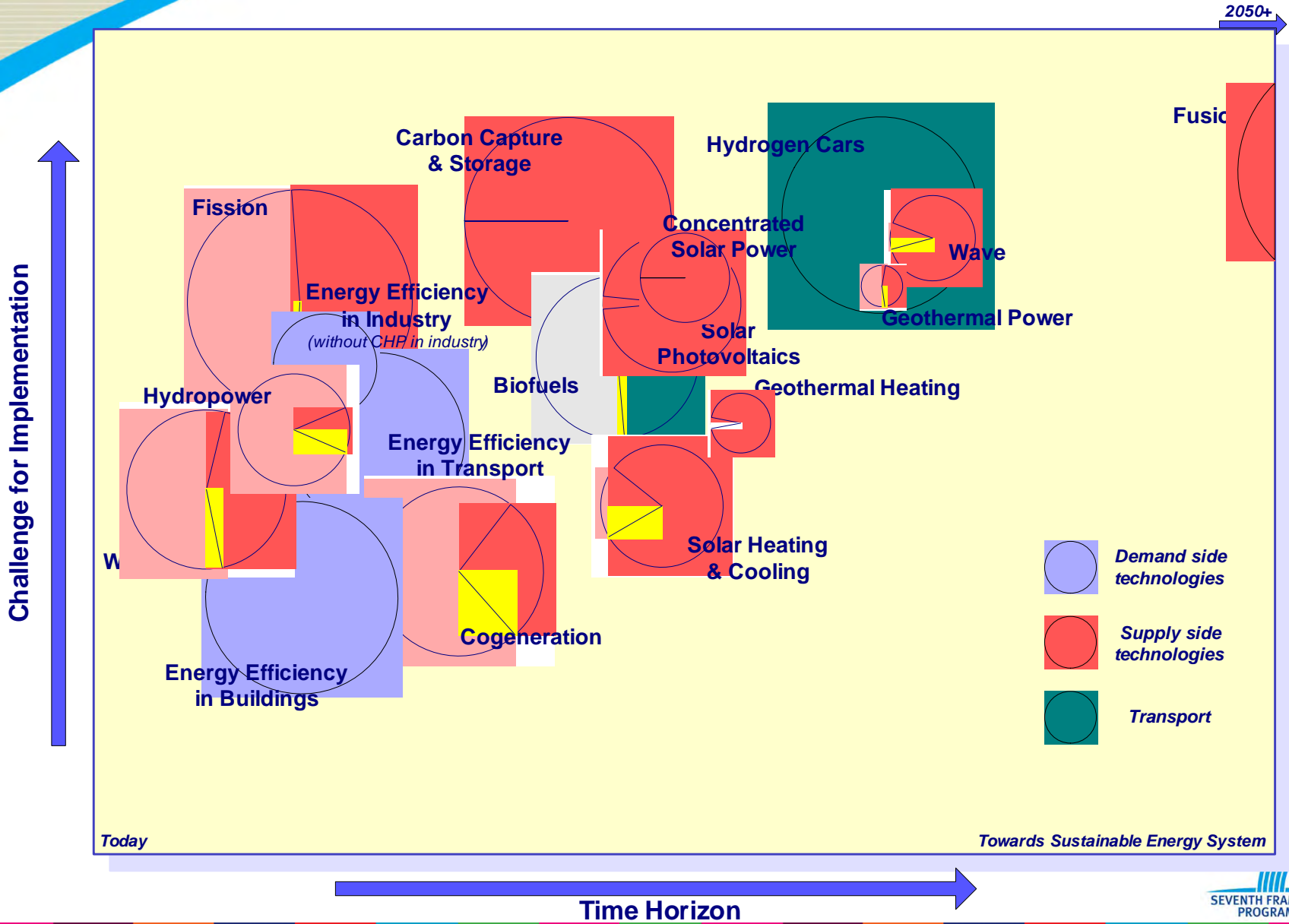


Possible reduction pathways exist, but no consensus on the best way forward





Potential contribution of technologies





→ Technology is vital to achieve the Energy policy objectives

- accelerate the development and deployment of low-carbon technologies of the future
- strengthening the industrial research and innovation, by aligning European, national and industrial activities;

→ Intrinsic weaknesses in energy innovation:

- long lead times, incumbent technologies, system inertia
- no natural market appetite nor a short-term business benefit for new energy technologies
- social acceptance issues and up-front integration costs



Overview of measures

→ Joint Strategic Planning and Governance:

- **Steering Group and Information system**

→ Effective Implementation:

- **European Industrial Initiatives:** strategic technology alliances
- **European Energy Research Alliance**
- **Trans-European Energy Networks and Systems of the Future** – transition planning

→ Increase in Resources - both financial and human

→ New and reinforced International Cooperation

- Developing and emerging economies



Need for European governance:

Decision-makers in the MSs, industry, research and financial communities communicate and take decisions in a more structured & mission-oriented way, together with the EC

➤ **Steering Group on Strategic Energy Technologies** (early 2008)

- ✓ EC + MSs
- ✓ Mandate: to conceive joint actions, make resources available and monitor and review progress towards reaching the common objectives

➤ **Information system**

- ✓ Open-access information and knowledge management system

Energy Technology Summit (first half of 2009): to take stock, to engage industry and researchers, and internationally



- **European Industrial Initiatives:** strategic technology alliances (*cont'd*):
 - ✓ **CO₂ Capture, Transport and Storage** –
focus: whole system requirements, including efficiency, safety and public acceptance

➤ **European Energy Research Alliance**

- ✓ Building on excellent research teams
- ✓ Opening a structured dialogue in 2008
- ✓ From collaborating on projects towards implementing European programmes – to align with SET Plan priorities

➤ **Trans-European Energy Networks and Systems of the Future**

- ✓ Multidisciplinary approach
- ✓ Planning and developing future infrastructures and policies
- ✓ E.g. Long distance electricity transmissions grids, CO₂ transport and storage and hydrogen distribution

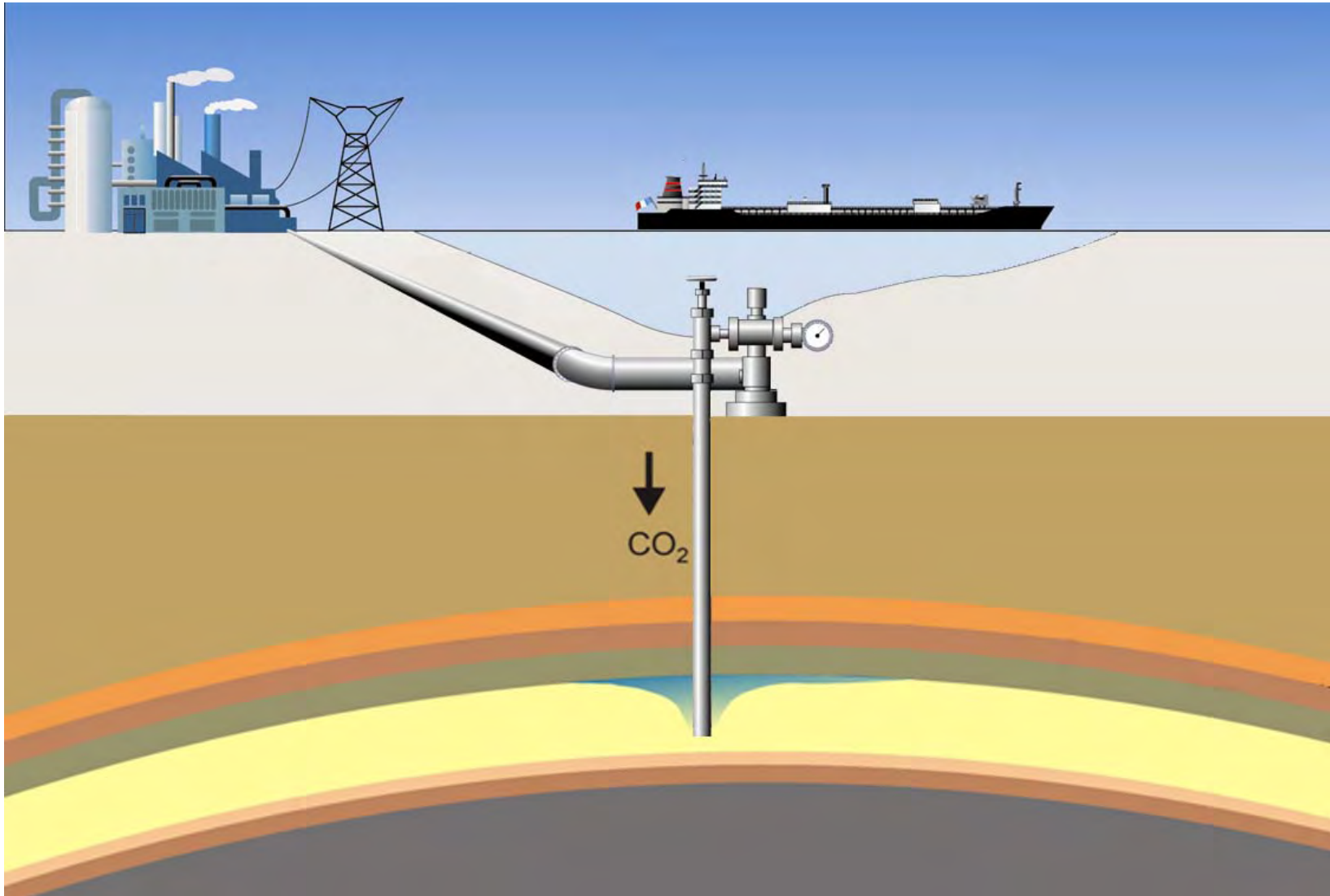


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CO₂ capture and storage (CCS)

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



Source:
CO₂-SINK



Overcoming hurdles

Enabling regulatory framework for CCS

- ✓ Amendment of the London Protocol and the OSPAR Convention to allow the storage of CO₂ 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
- ✓ Use of Structural and Cohesion Funds
- ✓ Making plants bankable:
 - European Investment Bank (EIB),
 - European Bank for Reconstruction and Development (EBRD)

Ancillary initiatives

- ✓ Capture-readiness, retrofitting schedule, CO₂ infrastructure

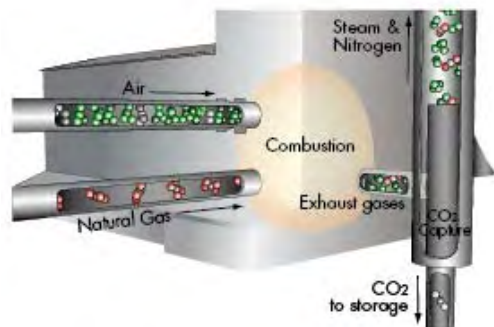
Boosting and better coordination of R&D efforts in the EU



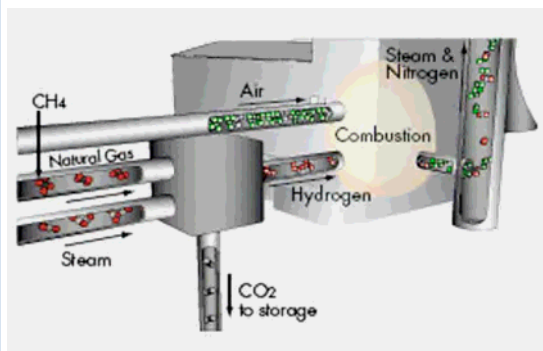


Capture technologies

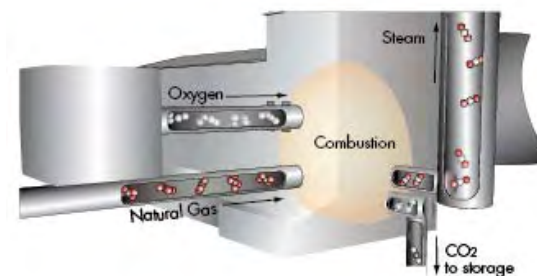
Focus on 3 basically different options



Post-combustion



Pre-combustion



Oxyfuel process



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Storage options

Focus on 3 basically different options:
Oil and gas fields; aquifers; coal layers





Highlights of CCS Activities under past 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 2005
- Coordination of member states research activities, ERA-NET (FENCO)
- International Cooperation: member of the Carbon Sequestration Leadership Forum



The Commission supports all different capture and storage options

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



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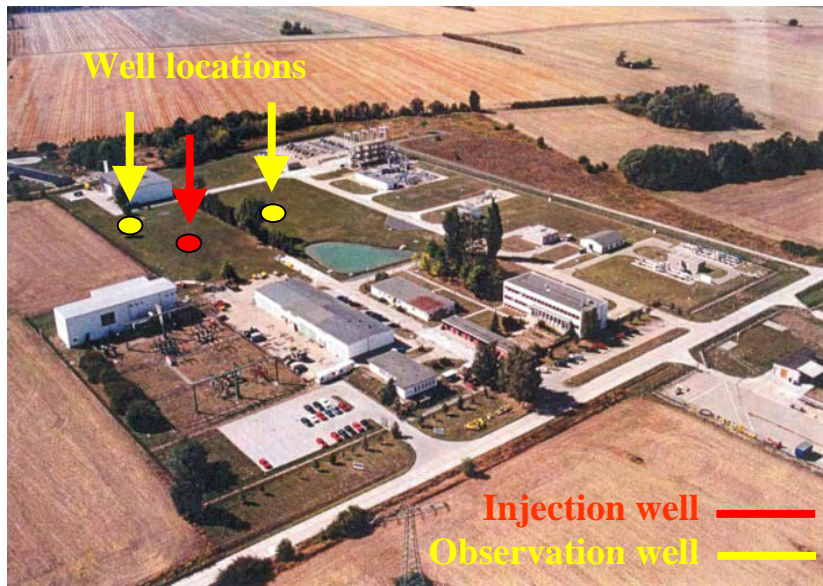
CO₂SINK



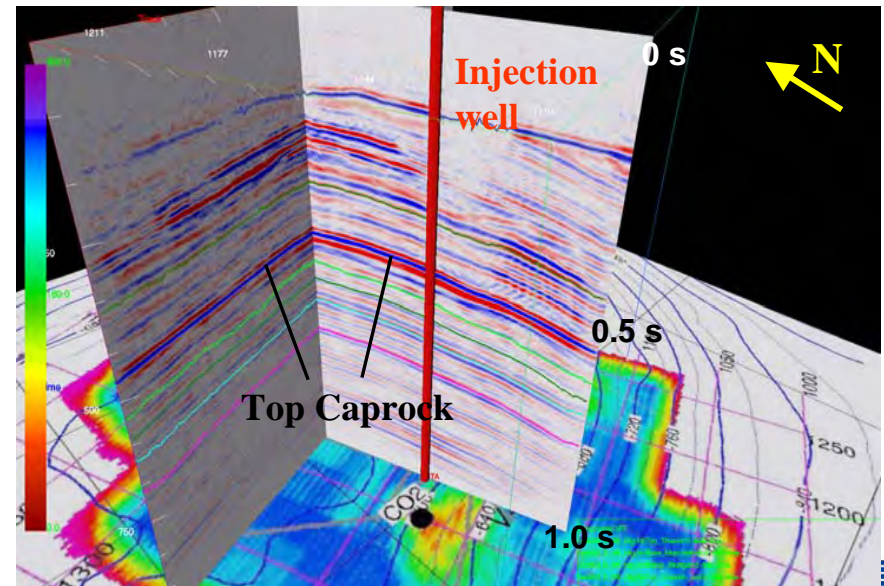
Test facility for capture and sequestration of CO₂

Objective: set up a full-scale CO₂ storage test site on land to

- advance understanding of science and processes in underground storage of CO₂
- provide real case experience
- develop best practice guidelines for geological storage of CO₂



Injection Site



Seismic 3D Baseline Survey



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CASTOR CO₂ from capture to storage

Esbjergværket



Esbjerg power plant
Capacity: 1 t CO₂ / h
5000 Nm³/h flue gas (coal combustion)
In operation since early 2006



SEVENTH FRAMEWORK
PROGRAMME



Implemented jointly by DG Research and DG TREN

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

R&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

R&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.



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; ...



Specific International Cooperation Actions (SICA)

- o Topics for Collaborative Projects especially designed and devoted to the international cooperation with targeted ICPC
- o 2 EU + 2 ICPC
- o Address problems, on the basis of mutual benefit, of shared interest and importance e.g. the environment consequences of energy policies, energy supply inter-dependency, technology transfer and capacity building



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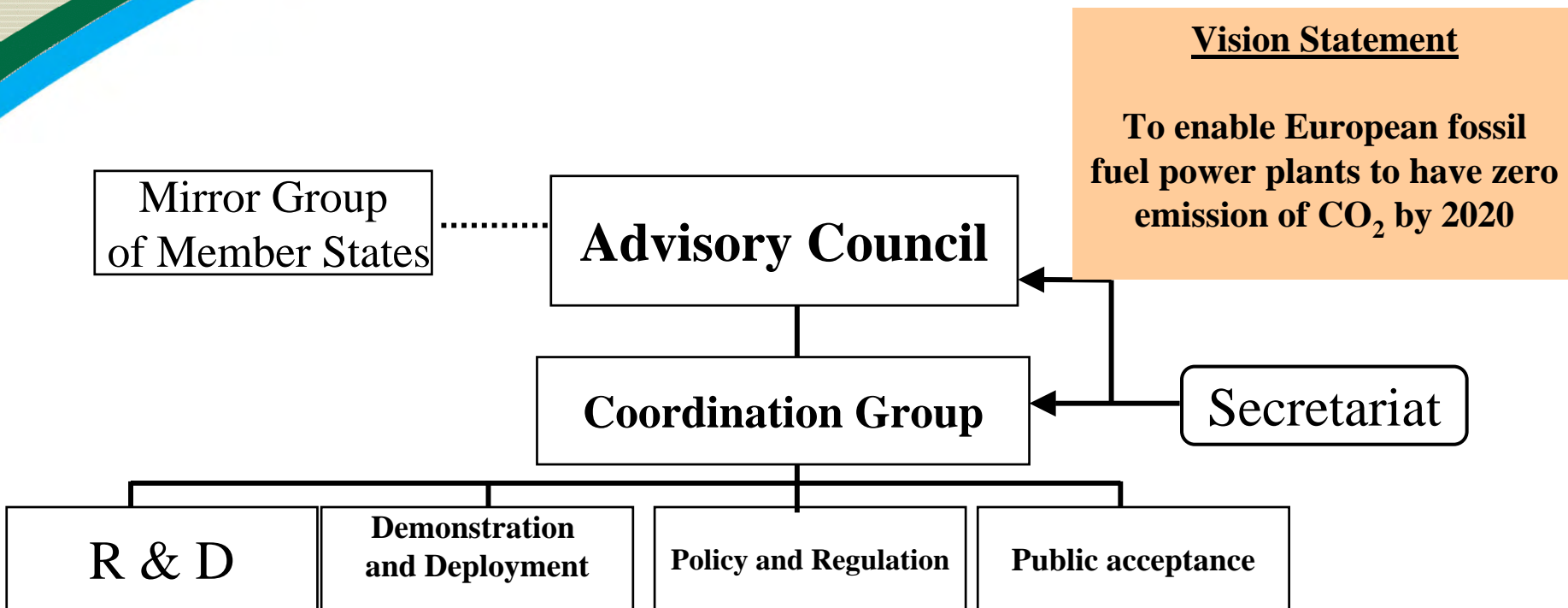
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FP7 2nd call

Area 5/2: CO₂ Capture and Storage / Storage

- **Topic 5/2/1: CCS capacity building with the large emerging economies (EE)** : research aimed at first global estimate of the CO₂ storage capacity in large EE, matching sources and sinks (SICA)
- **Topics 5/2/2: CO₂ Transport and storage infrastructure development**
 - work should cover the infrastructure needed for CO₂ storage and transport. It should address the societal, legal, environmental, financial and technical aspects.
- **Topic 5/2/3: CCS – Public acceptance**

the aim is to study the acceptance of CO₂ capture and storage technologies in the general public
- **Topic 5/2/4: Development of a suitable methodology for the qualification of deep saline aquifers for CO₂ storage**
 - Expected impact: site qualification methodologies serving the regulatory process;



<http://www.zero-emissionplatform.eu/>



The ZEP 2007

10 – 12 large scale demonstration plants that will be in place and operational by 2015 across Europe (SRA/SDD)

Adopts the idea of a **flagship programme** of demo plants to ensure, exchange of information, EU geographical balance and demonstration of different types of capture technologies and storage sites

2007 Spring European Council

- target of 20% cut in greenhouse gas emission
- Enable low-CO₂ power generation from fossil fuels by 2020
- Up to 10-12 demo plants in operation by 2015

November 2007 Strategic Energy Technology Plan

- R&D efforts to focus on low carbon technologies
- CCS one of the strategic technologies, large demos priority

23 January 2008 Commission adopts CCS communication/ Directive

- Enabling legal framework on CCS
- Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels



Directive for enabling the legal framework for carbon capture and storage

Key issues raised

Environmental security of CCS
Liability and long-term stewardship
Removing barriers
Providing incentives
Enabling versus mandating (ETS)

CO₂ Capture and transport is regulated by existing directives

CO₂ storage, is the main focus of proposed Directive

Site location

Member States have sole right to decide

Site selection

- prior assessment of the site
- assessment should show that under the proposed conditions of use, there is no significant risk of leakage or impacts on human health or the environment.



Liability

- measures in case sites do leak (ELD applies, surrender ETS allowances)
- Transfer of responsibility to the state once the site is safely closed and sealed with no risk of leakage for indefinite time

ETS

- CO2 captured, transported and safely stored considered as not emitted
No allocation to capture, transport and storage.
- ETS auctioning revenues major potential source of funding for CCS demonstration.
- Monitoring plan to confirm expected behaviour of CO2 in site and detect leakage integrated with monitoring and reporting guidelines under EU-ETS

No mandatory CCS at this stage:

Let the market work: The revised ETS will ensure a robust carbon price and action on demonstration will bring CCS costs down



Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels

A European Industrial Initiative for CCS

Objectives

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



⇒ ***Proven technology, lower costs, full scale deployment***



First Steps to the EII: The CCS Project Network

- ✓ *Developing a portfolio of large scale demonstration projects*
- ✓ *Providing coordination, exchange of information and sharing of experience among the projects*
- ✓ *Promoting continuous research*
- ✓ *Promoting a common approach to public acceptance issues*
- ✓ *Ensuring a European identity for the participating projects*



Call for Tender in spring 2008 for establishing a Secretariat for the CCS Project Network.

Main activities of the Secretariat:

- ***Defining and revising selection criteria for the demo projects***
- ***Organisational Support / Coordination of CCS demonstration projects***
- ***Information and Communication***
- ***Actions to increase public acceptance***
- ***Actions to increase International Cooperation***
- ***Provision of consulting services to projects***



EU and China Partnership on Climate Change

EU-China MoU on NZEC

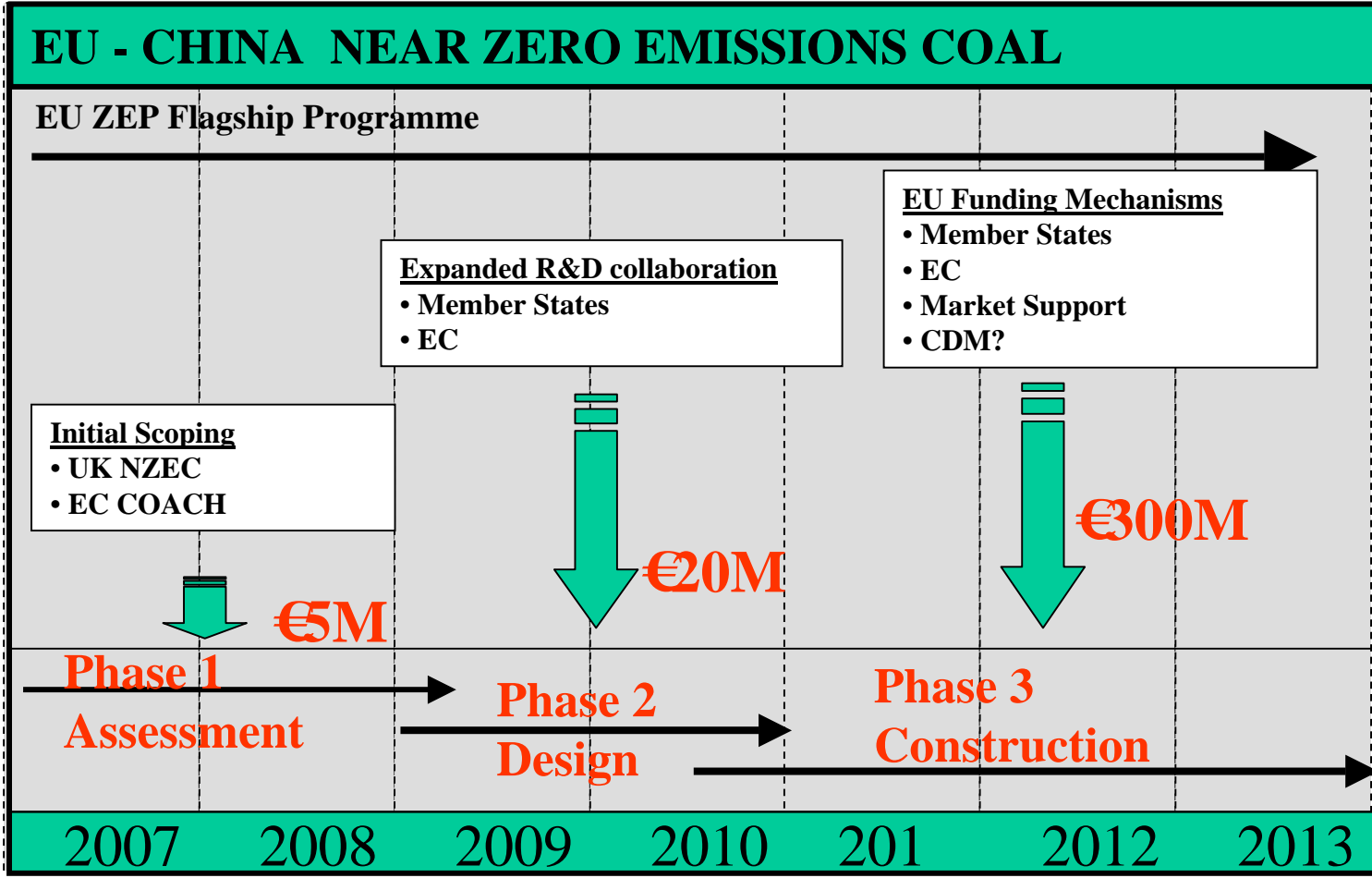
20 Feb 2006 Signature of the EU-China MoU in Shanghai by Ma Songde,
Vice Minister MOST and Mr. Piebalgs EC

EU-China Cooperation foresees three phases :

- Phase 1:** *Exploring the feasibility of, and options for, near-zero emissions coal technology in China through carbon dioxide capture and storage;*
- Phase 2:** *Defining and designing a demonstration project; and*
- Phase 3:** *Construction and operation of a demonstration project.”*

The EU-China MoU focus on PHASE 1 .

It will interface with the UK-China MoU on NZEC





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

- ✓ Create conditions for investments in a series of full scale demonstration plants
- ✓ Boost investment on R&D in CCS technology
- ✓ Introduce a stable legal and regulatory environment, including incentives
- ✓ Continue to integrate fragmented, private and public (national, European) efforts
- ✓ Face the challenges and take advantage of the opportunities of international cooperation and global competition



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Thank you for
your attention