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Near Zero Emission Fossil Fuel Based Power Generation - R&D Activities within the EU

***COORETEC Workshop, Leipzig
10-11th March 2005***

***Angel Perez Sainz
Head of Unit
Energy Production and Distribution
DG Research
European Commission***



Directorate General for Research



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ENERGY OUTLOOK

(From WETO)

Without radical policy measures

- × **World energy system still relying by 90% on fossil fuels by 2030**
- × **World CO₂ emissions to grow more rapidly than energy demand (2.1% p.a.)**
- × **Oil production to increase by 65% over 2004-2030, gas and coal to double over the period**
- × **Electricity demand to increase by 3% p.a., much relying on coal and gas**





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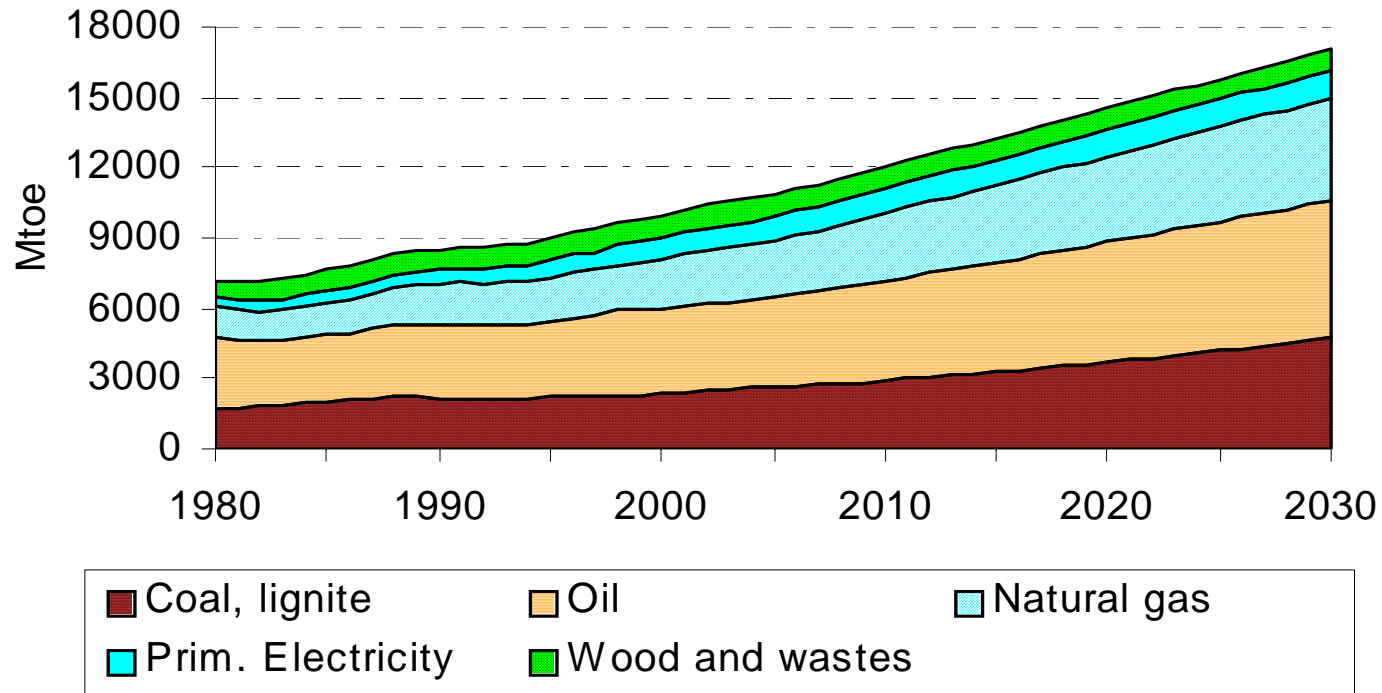
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ENERGY OUTLOOK

(From WETO)

Without radical policy measures

Still 90% fossil fuels worldwide by 2030





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EU ENERGY POLICY RESPONSE

× CLIMATE CHANGE

Kyoto Protocol entered into force on 16/02/05

- ✓ **GHGs - 8% over 2008 - 12 compared to 1990**
- ✓ **Burden sharing agreement (EU-15)**
- ✓ **On track so far**

But final target could be missed

- **ECCP identified cheapest routes**
- **ETAP for specific action**
- ✓ **EU Greenhouse Gas Trading Directive – trading started Jan 05**
- ✓ **“linking” directive transferring CDM and JI credits into the EU GHG trading directive.**
- ✓ **Kyoto is only a first step.**





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CLIMATE CHANGE - POST 2012

Communication from the EC (February 2005) :
“Winning the Battle Against Global Climate Change”

Challenges : More drastic GHG reductions will be needed
max. 2°C increase, max. 450 ppmv,- 50 / 60% by 2050

- × **Participation Challenge:** Include all major emitters
 - ✓ share of EU-25 in world GHG emissions will decline to <10%
 - ✓ share of developing countries will expand to >50%
- × **Innovation Challenge**
 - ✓ *Pulling technological change:* Stimulate markets to promote adoption of new technology
 - ✓ *Pushing technological change:* Invest in knowledge economy to give EU a competitive edge in a low carbon future
- × **Adaptation Challenge**





Communication from the EC (February 2005) : “Winning the Battle Against Global Climate Change”

Conclusions

- × The inclusion of more policy areas:
 - ✓ widen scope of international action to cover all greenhouse gases and all sectors.
- × Enhanced innovation to transform energy and transport systems
 - ✓ **optimal mix of technology ‘push’ (RTD) and ‘pull’ (Market Stimulation) instruments**
- × The continued use of market based and flexible instruments
- × The inclusion of adaptation policies
 - ✓ More resources need to be allocated in the EU to adapt effectively to climate change
- × The broadening of participation
 - ✓ **Specific projects/ programmes with major emitting nations to improve energy efficiency or to promote development and adoption of low-carbon technologies**





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CLIMATE CHANGE - POST 2012

Communication from the EC (February 2005) : “Winning the Battle Against Global Climate Change”

*EC recommendations for a post-2012 EU Climate
Change Strategy: NEXT STEPS*

- × Immediate and effective implementation of agreed policies
Kyoto Protocol, ETAP, Energy Efficiency Initiative.
- × Increased public awareness
- × **More and better focused research
increased EU funding under the 7th Framework Programme**
- × Stronger co-operation with third countries
technology transfer, scientific R&D cooperation
- × European Climate Change Programme in 2005
 - ✓ energy efficiency,
 - ✓ RES,
 - ✓ the transport sector
 - ✓ **carbon capture and storage.**





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CLIMATE CHANGE – POST 2012

Fifteen Technology Options

Each potential reducing emissions by 3.6 Gt CO₂ per year by 2050

- ↘ Efficiency and conservation
 1. Improved fuel economy of vehicles
 2. Reduced reliance on cars
 3. More efficient buildings
 4. Improved power plant efficiency
- ↘ Decarbonization of Electricity and Fuels
 5. Substituting natural gas for coal
 6. Storage of carbon captured in power plants
 7. Storage of carbon captured in hydrogen plants
 8. Storage of carbon captured in synthetic fuel plants
 9. Nuclear fission
 10. Wind electricity
 11. Photovoltaic electricity
 12. Renewable hydrogen
 13. biofuels
- ↘ Natural sinks
 14. Forest management
 15. Agricultural soils management

Source: Pacala, S, Socolow, R.2004. Science Vol 305: 968-972



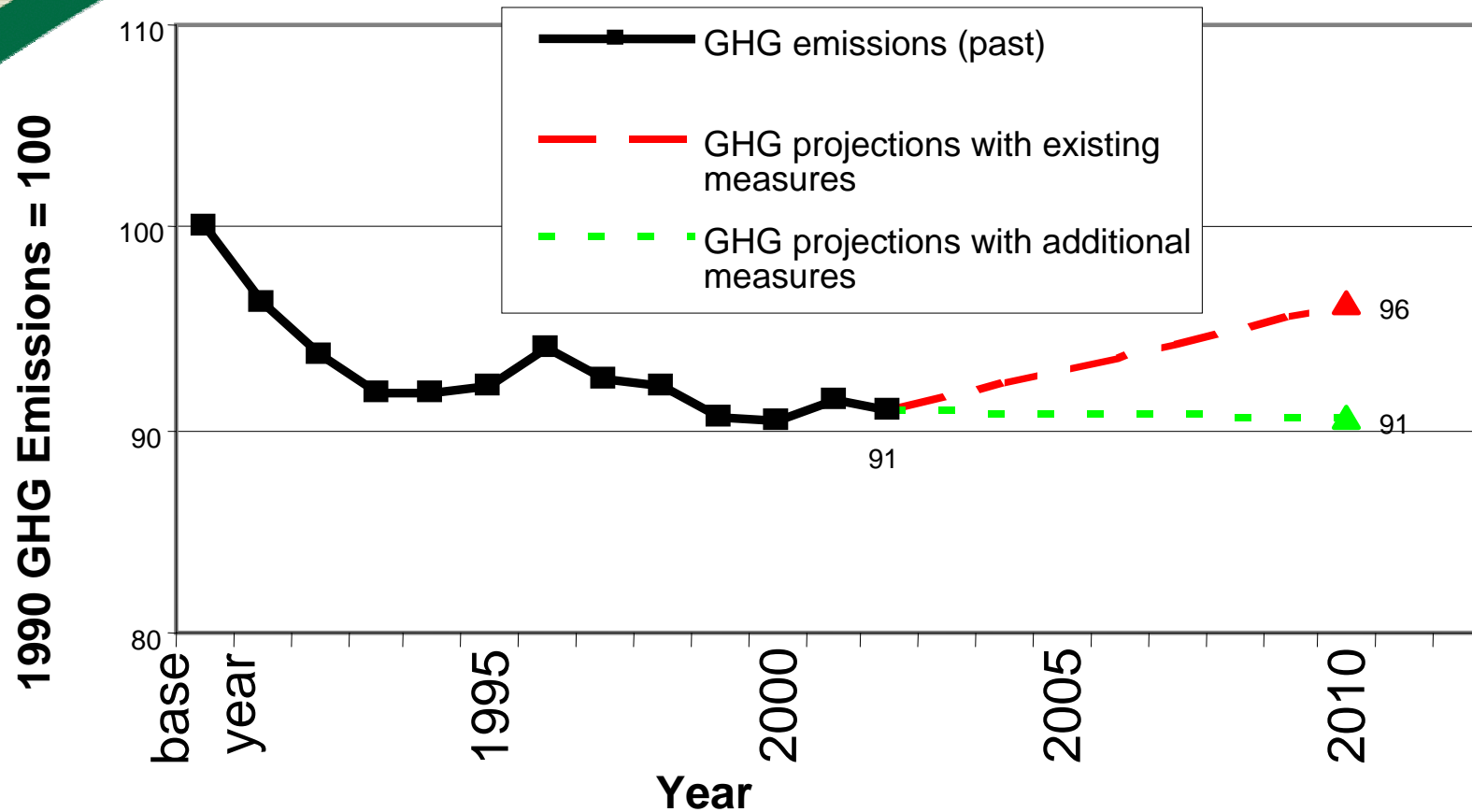


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CLIMATE CHANGE-KYOTO

EU-25 greenhouse gas emissions until 2002 and projections until 2010



Note: 1990 is the base year for most Member States for CO₂, methane (CH₄) and nitrous oxide (N₂O) but 1995 for fluorinated gases. The base year for CO₂, CH₄ and N₂O for Hungary is the average of 1985-1987, for Slovenia 1986 and for Poland 1988; the base year for fluorinated gases is 1990 for France and Finland

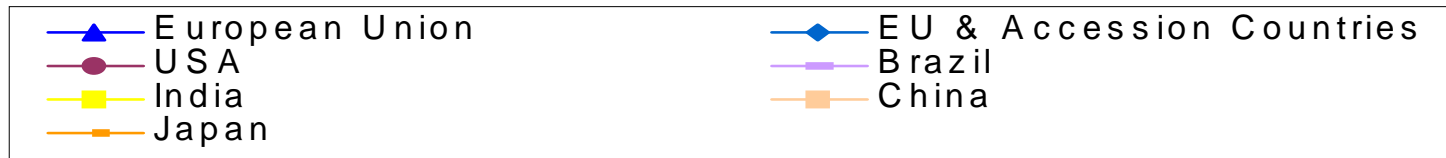
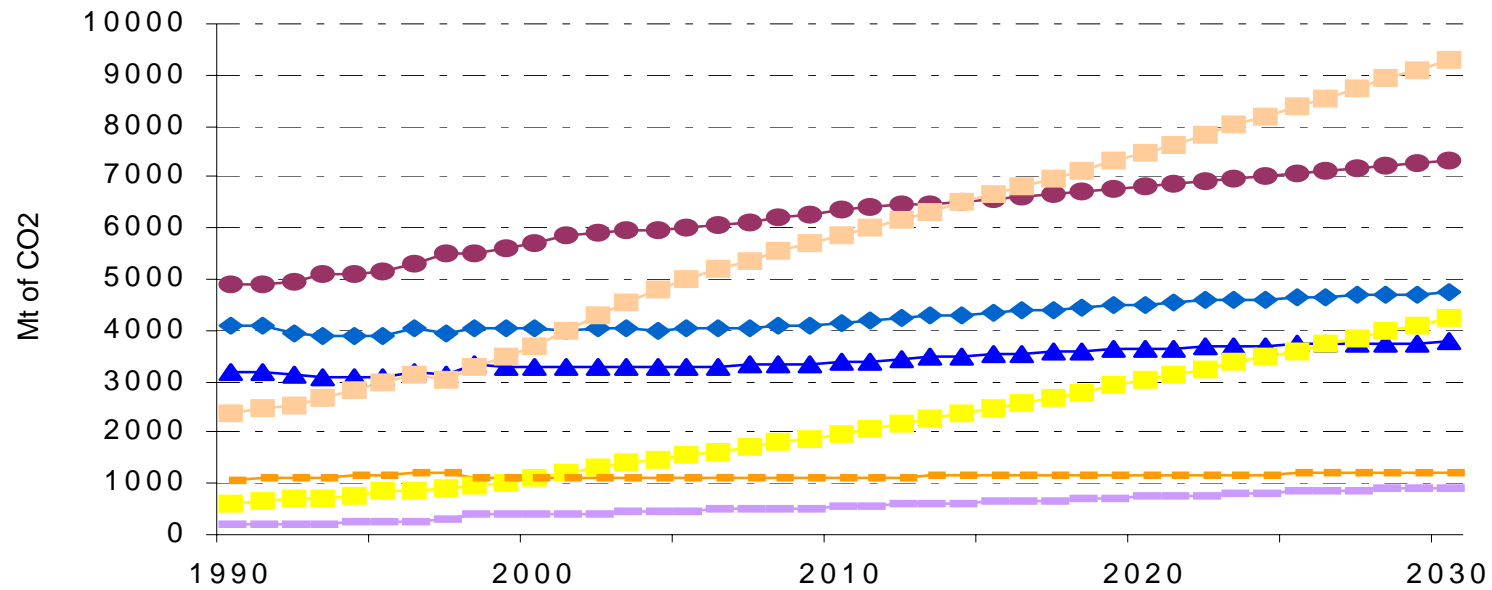




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Energy Related CO₂ Emissions (WETO - EC DG RTD)





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EU ENERGY POLICY RESPONSE

- × **Security of supply - Green Paper on Security of energy supply**
(Issued Nov. 2000)
 - ✓ **Rising import dependency**
 - ✓ **Diversification is key**
 - ✓ **No option to be ruled out**
 - ✓ **Need to act on orienting demand**
- × **Energy Efficiency**
 - ✓ **Directive on cogeneration of heat and power (2004)**
 - ✓ proposal in 2003 for a **Directive on the promotion of end-use efficiency and energy services** to enhance the cost-effective and efficient end-use of energy in Member States
 - ✓ **Green Paper (2005)**





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EU ENERGY POLICY RESPONSE

× RES

- **RES White paper 1997**: increase share of RES from **6% to 12%** of gross consumption **by 2010**
- **RES-e DIRECTIVE 2001** : to establish a framework to **increase the share of green electricity from 14% to 22%** of gross electricity consumption **by 2010**
- **Directive on liquid biofuels (May 2003)**
targets: **2% by 2005; 5.75% by 2010**
- **White Paper on European Transport Policy (2001)**
(20% substitution of diesel and gasoline by alternative fuels by 2020)





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EU RESEARCH STRATEGY ON CLEAN FOSSIL FUEL BASED POWER GENERATION

- **Projects in FP5** on gas turbines, combustion and combined cycle technologies emission reductions and Carbon Capture and Storage, **S-M, M-L**
- **Projects in FP6** on Carbon Capture and Storage in association with cleaner fossil fuel power plants
- **Growth Initiative – “Quickstart” Programme**
Hypogen – large scale test facility for production of hydrogen and electricity; from decarbonated fossil fuels
- **Co-ordination of member states activities, ERA-NET (FENCO)**
- **International Cooperation / Participation to the “The Carbon Sequestration Leadership Forum”**
- **FP7 – new scope and instruments!**





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Complementarities with energy efficiency and Renewable Energy Sources

- ✘ CO₂ C+S sometimes seen as an obstacle to the development of RES
- ✘ RES and energy efficiency need to be strongly supported, but will not be sufficient in the short to medium term, both in developed and developing economies
- ✘ Projections indicate fossil fuels are here to stay and will be used, especially in economies in transition
- ✘ RES, energy efficiency and CO₂ C+S are complementary
 - ✓ from a timing point of view
 - ✓ from a generation mix point of view
 - ✓ from a costing / competition point of view
 - ✓ to ease the penetration of hydrogen as a vector





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CO₂ C+S R&D POLICY

A Priority in Long Term Energy R&D in FP6 (2002-2006)

- ✘ *Capture and sequestration of CO₂, associated with cleaner fossil fuel plants.*
- ✓ *Targets: reduce the cost of CO₂ capture from 50-60 € to 20-30 € per tonne of CO₂ captured, whilst aiming at achieving capture rates above 90%, and assess the reliability and long term stability of sequestration.*





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CO₂ C+S R&D Policy

× Capture R&D – Objectives

✓ 70-80 % of total cost - therefore primary objective is to decrease the cost of capture (to below 20 €/ton).

✓ Capture R&D - Ways:

- pre-combustion capture
- post-combustion capture
- Oxyfuels

× Sequestration R&D - Objectives

- ✓ to study long term stability;
- ✓ to study safety aspects;
- ✓ to build public confidence to ensure acceptability;
- ✓ to map geological storage potential.





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CO₂ C+S R&D Policy

✘ Sequestration R&D - Ways:

- ✓ geological (saline aquifers, depleted oil and gas fields, unminable coal beds, EOR, ECBM);
- ✓ chemical;
- ✓ other innovative ways.

✓ Other ways

- oceans - environmentally questioned in Europe;
- biospheric sinks - doubtful long term value.





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× An FP5 Flagship Project : SACS2

- ✓ Support of European teams monitoring the behaviour of CO₂ injected in the Sleipner project in the North Sea. This is providing useful data on transport rates, geophysical properties and potential leakage and/or natural sealing mechanisms.
- ✓ Has delivered a BEST PRACTICE manual
- ✓ EC Funding 1.2 m€ - Cost 2.1 m€
- ✓ Co-ordinator STATOIL
- ✓ Started 1 April 2000 for 24 months



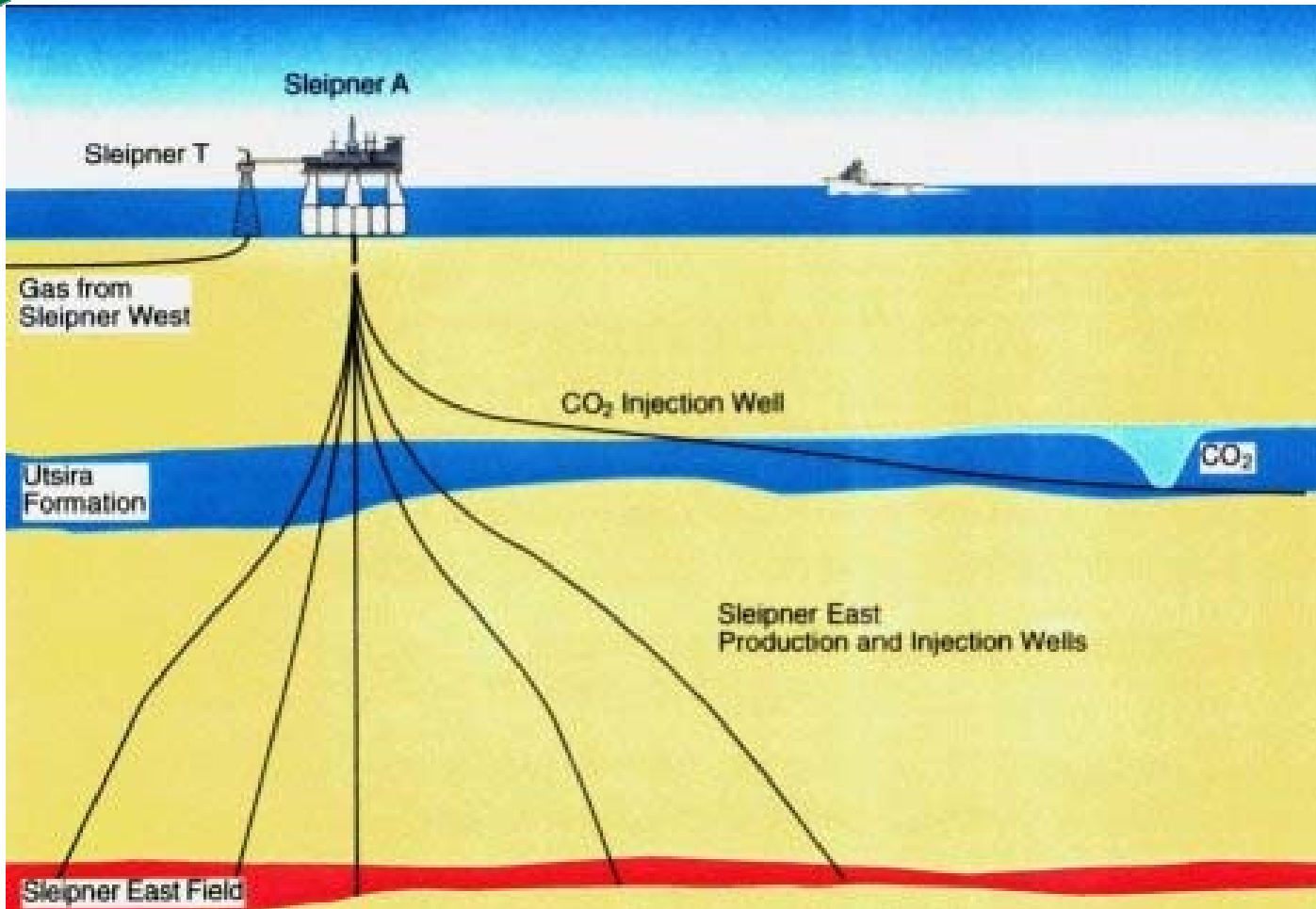


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Sleipner - CO₂ injection into the Utsira formation -

source : Statoil.





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FP6 – on-going projects IP

Acronym	Funding	Co-ordinator	Started
<i>CO2SINK</i>	8.7 m€	Postdam Research C.	1/4/2004
Duration : 60 months	No of partners : 14	No of EU Countries :.8	

Main Objectives:

- × Pilot scale capture and storage test of CO2 in an existing natural gas storage facility in the Berlin area and in a deeper on-land saline aquifer.
- × Intensive monitoring of the fate of the injected CO2 by using:
 - ✓ a broad range of geophysical and geochemical techniques,
 - ✓ the development and benchmarking of numerical models,
 - ✓ definition of risk assessment strategies

ENCAP	10.7 m€	Vattenfall	1/3/2004
Duration : 60 months	No of partners : 33	No of EU Countries :9.	

Main Objectives:

- × provide pre-combustion decarbonisation technologies in power cycles operated by natural gas, residue oil, hard coal and lignite with the objective :
 - 1) at least 90% capture rate for CO2
 - 2) 50% capture cost reduction of the current cost level per tonne of CO2 captured





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FP6 – on-going projects IP

Acronym

Funding

Co-ordinator

Started

CASTOR

8.5 m€

IFP

1/2/2004

Duration : 48 months

No of partners : 30

No of EU Countries :12.

Main Objectives:

- × reduction in post-combustion capture costs, from 50-60 €/ton of CO₂ to 20-30 €/ton of CO₂
- × establish methods for the safety and security of underground storage sites and monitor the stored CO₂ in a reliable and cost-effective way.
- × Integrated strategy connecting capture, transport and storage options for Europe

STREP

ISCC

1.9 m€

Univ. Stuttgart

1/1/2004

Duration : 36 months

No of partners : 14

No of EU Countries :7

Simultaneous gasification and carbon capture of brown coal

Main Objectives :

Detailed definition of an environmentally friendly, highly efficient coal technology producing a highly enriched H₂ product gas and in situ CO₂ capture;





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FP6 – on-going projects

NOE

Acronym

CO2GEONET

Funding

6 m€

Co-ordinator

BGS

Started

1/4/2004

Duration : 60 months No of partners : 13

Participating EU Countries : UK, DE, FR, DK, NO,NL, IT

Integration of a critical mass of 13 research institutes in the area of underground CO2 storage, covering

- predictive numerical tools
- rock and fluid behaviour experiments
- enhanced hydrocarbon recovery
- monitoring techniques
- risk and uncertainty management





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FP6 – Third call – deadline 8th Dec 2004

- CO2 capture and hydrogen production from gaseous fuels (IP)
- The monitoring and verification of CO2 geological storage (IP)
- Preparing for large scale H2 production from decarbonised fossil fuels including CO2 geological storage (IP) **(HYPOGEN PHASE1)**
- Advanced separation techniques (STREP)
- Mapping geological CO2 storage potential matching sources and sinks (STREP)
- European co-ordination and networking activities in CO2 capture and storage (CA)





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Co-ordination of Member States Activities

- ✘ As part of its ERA strategy, FP6 provides ways to co-ordinate MS activities in block III of the framework programme:
 - ✓ An ERA-NET SSA (FENCO) has been running on the co-ordination of large scale power generation programmes, lead by Germany (BMWA) and the UK (DTI).
 - ✓ An ERA-NET CA programme will begin this year involving at least 13 Member States
 - ✓ Potential for a future Art.169 Action (under FP7?)





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HYPOGEN

- ✘ The Quick-start Programme of the European Initiative for Growth identifies the Hydrogen Economy as one of the key areas for investment in the medium term (2004-2015). In particular, two main programmes are planned in this field:
 - ✓ *Hypogen* – large scale test facility for production of hydrogen and electricity; from decarbonated fossil fuels
 - ✓ *Hycom* - a limited number of “hydrogen communities” around the Union, using hydrogen for heat and electricity production and as fuel for vehicles.
- ✘ A pre-feasibility study (JRC / ESTO) report was made
- ✘ Outcome of the evaluation of the 3rd FP6 Call





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INTERNATIONAL

× **Involvement in IEA activities**

- ✓ Working Party for Fossil Fuels
in defining its ZETS (Zero Emission Technology) strategy
- ✓ Greenhouse Gas Implementing Agreement
specifically looking at CO₂ C+S
- ✓ Clean Coal Center Implementing Agreement
which has many CO₂ C+S activities

× **The Carbon Sequestration Leadership Forum**

- ✓ A US initiative, 15 member countries, including the UK, Italy, Germany, France and Norway, plus the EC.
- ✓ A charter to promote research in CO₂ C+S, signed in Washington on June 25, 2003 .
- ✓ Preparatory and co-ordination meetings with Member States held before each CSLF event)





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7th FRAMEWORK PROGRAMME

Energy Research in FP7

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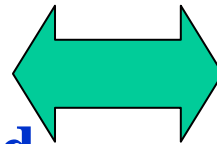
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RTD policy drivers

LISBON
(March 2000)

**Most competitive and
dynamic knowledge-
based economy by
2010**



BARCELONA
(March 2002)

**Need to boost RTD
Aim: 3% of EU GDP
by 2010 (2/3 private)**

**BUILDING THE EUROPE
OF KNOWLEDGE**
European Research Area





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Cooperation – Collaborative Research

Possible Thematic Priorities

1. Health
2. Food, agriculture and biotechnology
3. Information and communication technologies
4. Nanoscience, nanotechnologies, materials and new production technologies
5. Energy
6. Environment and climate change
7. Transport
8. Socio-economic sciences and the humanities
9. Space and Security research





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Cooperation Collaborative research actions – support schemes

**Collaborative
research**

**Joint Technology
Initiatives**

**Coordination of national
research programmes**

**ERA-NET
ERA-NET+
Article 169**

**International
Cooperation**





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Energy

Proposed Priorities topics:

- × Hydrogen and fuel cells
- × Renewable electricity generation
- × Renewable fuel production
- × Near zero emission power generation
- × Smart energy networks
- × Energy savings and energy efficiency
- × Knowledge for energy policy making





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Clean Power Generation in FP7

Key considerations (Valid for the EU and worldwide)

- × **Fossil fuels, projected to be an important part of power generation mix in the decades to come**
- × **Environmental compatibility is a « sine qua non conditio » : need to drastically reduce CO2 emissions for transition to sustainability**
- × **Huge projected demand for new generation capacity : European industry should be highly competitive**





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Clean Power Generation in FP7 (proposal)

**Goal: Near zero emission power generation
(Drastic reduction of emissions, mainly CO₂)**

× Means :

- ✓ **Pursue and enhance efforts on « breakthrough » CO₂ capture and storage technologies**
- ✓ **Address increased plant efficiency as a key enabling factor to compensate costs (and efficiency losses) of applying CCS technology**





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Tentative Timetable for FP7

06/04/05

Commission – Adoption of FP7 proposals

09/05

Commission – Proposals on SPs and Rules for participation and dissemination

Late 2005

Commission – Proposals under Articles 169 and 171 and Executive Agencies

01/06

Council – Common position

06/06

Council and EP – Adoption of FP and Rules

07/06

Council – Adoption of the SPs





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Technology Platforms - concept

Stakeholders getting together to define a Strategic Research Agenda on a number of strategically important issues with high societal relevance where achieving Europe's future growth, competitiveness and sustainable objectives is dependent upon major research and technological advances in the medium to long term.



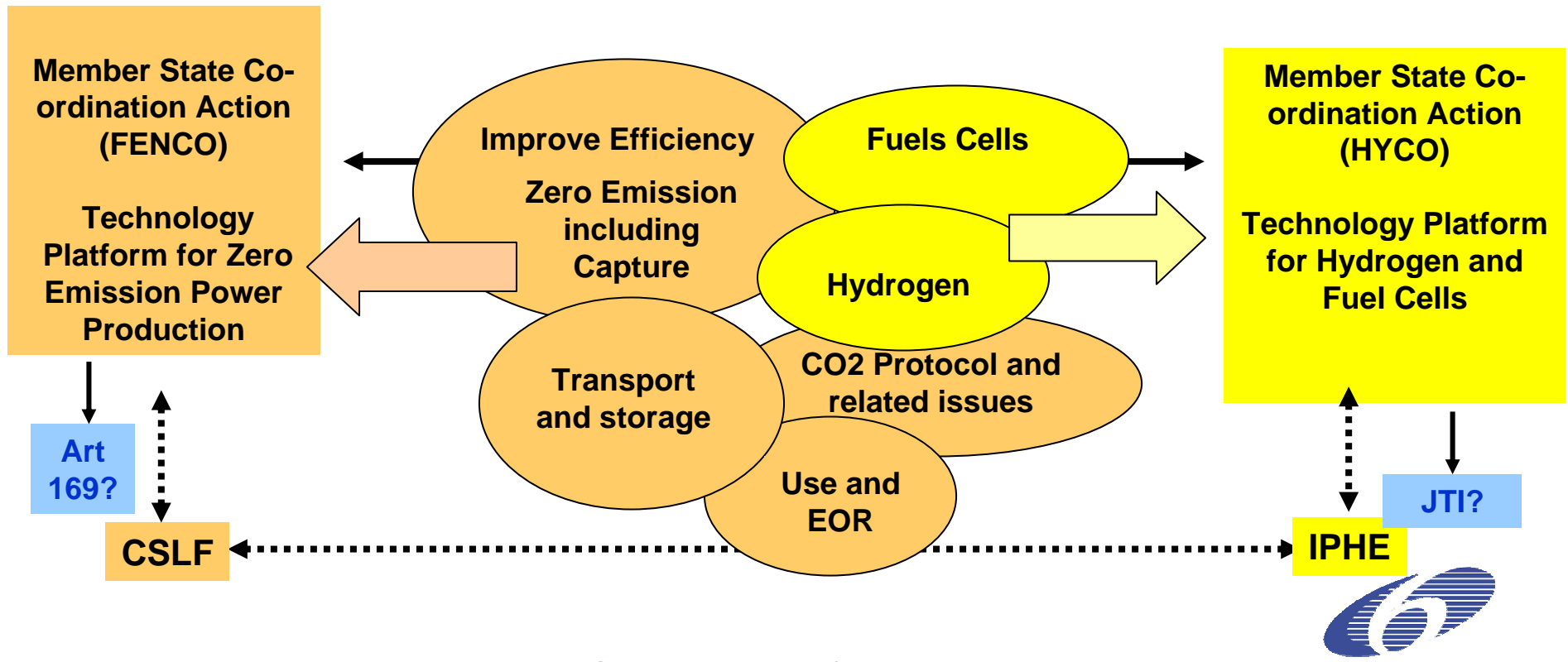


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Technology Platforms

As part of an overall strategic framework with clean fossil fuels as a key element of a sustainable energy portfolio



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Technology Platforms in FP7

- ✘ **Strategic Research Agendas of technology platforms will be used to help define research priorities – mostly using FP6-type instruments**
- ✘ **In a few cases, the scale of the challenge justifies a different approach:**
 - ✓ **Joint Technology Initiatives**





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Stay Informed

Energy Research on Europa

http://europa.eu.int/comm/research/energy/index_en.html

CORDIS 6th framework programme – EC research programmes and projects

<http://www.cordis.lu/fp6/>

Energy helpdesk:

rtd-energy@cec.eu.int





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*Thank you for
your attention*

Angel Perez Sainz

European Commission

Directorate General for Research

Energy Production and Distribution Unit

Rue de la Loi 200 – CDMA 5-199

B - 1049 - Brussels - Belgium

phone : 32-2-29-61596

fax : 32-2-29-64288

email : angel.perez-sainz@cec.eu.int

