Zero Emission Fossil Fuel Power Plant”
ZEP
European Technology Platform

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AN OVERALL PERSPECTIVE
Key Touchstones

- **Importance of clean use of fossil fuels**
  - a critical transitional issue in getting to a sustainable energy future
  - an essential part of the portfolio

- **Importance of accelerating the take-up of clean fossil**
  - need for incentives for early action on `zero emission` power plant
  - stable financial and regulatory framework to get “many of a kind”

- **Importance of addressing issue worldwide**
  - use of high efficiency technologies, and ........
  - ............ prepare the way `zero emission`
    - retrofitting of high efficient coal plant with capture to avoid “carbon lock-in”
    - how to ensure new plant is “capture ready”
    - increase use of low carbon technologies
ZEP

“ZERO EMISSION FOSSIL FUEL POWER PLANT”

EUROPEAN TECHNOLOGY PLATFORM
EC FP7 Technology Platforms

• A major new `instrument` for FP7
• Aim
  – To provide a means to foster effective public-private partnerships between research community, industry and policy makers in order to deliver impetus to mobilise research and innovation towards achieving a common goal
    ➢ Establishment of critical mass actions
    ➢ Deployment of technology
    ➢ Industrial leadership
• Energy Topics
  – Hydrogen and Fuel Cells (HFP)
  – Electricity Networks (SmartGrids)
  – Photovoltaics (PVTP)
  – Solar Thermal (ESTTP)
  – Biofuels
  – Zero Emission Fossil Fuel Power Plants (ZEP)
    ➢ Basis for Joint Technology Initiatives
    ➢ Strategic in nature for Europe

Embraces CCT and ZEPG themes in FP7
ZEP: Set Up and Vision

- **EU Clean Fossil Power Initiative**
  - Aiming for critical mass programme in Europe
  - Established European Technology Platform with EC
  - Primary task to set technology agenda and deployment plan
  - Major input to EC FP7 (2007-2013)

- **ETP “Zero Emission Fossil Fuel Power Plants”**
  - *Advisory Council* formed 21Jun05 comprising senior individuals from:-
    - 6 Generators
    - 6 Equipment suppliers
    - 5 Oil/Gas
    - 4 Researchers
    - 3 NGOs
  - Formally launched, Brussels 1Dec05
  - First General Assembly 12-13Sep06

**Vision Statement**

To enable European fossil fuel power plants to have zero emission of CO₂ by 2020
UNECE SUSTAINABLE ENERGY COMMITTEE
GENEVA 26-28TH November 2006

ZEP: Organisational Structure

Advisory Council

Coordination Group

Secretariat

Plants & CO₂-Capture
CO₂-Use & Storage
Infrastructure & Environment
Market, Regulation & Policy
Communication & Public Acceptance

Mirror Group of Member States

Strategic Research Agenda

Deployment Strategy

Timeframe: out to 2030+
### ZEP: Members of Advisory Council

#### Generators
- Kurt Haege, Vattenfall AB (Chair) - Germany
- Bernhard Fischer, E.ON Energie AG - Germany
- Santiago Sabugal Garcia, ENDESA Generation - Spain
- Johannes Lambertz, RWE Power AG - Germany
- Gennaro de Michele, ENEL - Italy
- Hakon Mosbech, ENERGI E2 A/S - Denmark

#### Equipment Suppliers
- Charles Soothill, ALSTOM (Vice-Chair) - UK
- Harry Lampenius, Foster Wheeler - Finland
- Iain Miller, Mitsui Babcock - UK
- Norbert Koenig, Siemens AG Power Generation - Germany
- Francois Jackow, Air Liquide - France
- Giuseppe Zampini, Ansaldo Energia SpA - Italy

#### Oil/Gas
- Gardiner Hill, BP (Vice-Chair) - UK
- Jean-Michel Gires, Total SA - France
- Philippe Lacour-Gayet, Schlumberger - France
- Graeme Sweeney, Shell Gas and Power - UK
- Arve Thorvik, Statoil - Norway

#### Research
- Olivier Appert, IFP (Vice-Chair) - France
- Antonio Valero, CIRCE (Vice-Chair) - Spain
- Niels Peter Christensen, GEUS - Denmark
- Josek Dubinski, CMI - Poland
- David Falvey, BGS - UK
- Frederic Hauge, The Bellona Foundation - Norway
- Kirsten Macey, Climate Action Network Europe - Belgium
- Stephan Singer, WWF International - Belgium

#### NGOs
ZEP : Member State Mirror Group

• Countries involved
  – UK Chair
  – Germany Vice-Chair
  – Norway Vice-Chair
• plus
  – Austria Denmark Finland France
  – Greece Italy Netherlands Poland
  – Portugal Spain Switzerland

• Support from EC
  – FENCO (Clean Fossil Energy) Co-ordination Action

Engagement with Governments
## ZEP: Organisation Engagement

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Involvement from >60 organisations

- **Industry** ~60%
- **Research** ~30%
- **NGO** ~10%
ZEP Action: Key Outputs and Timing

SRA Technology-oriented

Jan/06: start

Identification of needs
topics priorities for R & D & D

Jun/06: first draft

Identification of success factors for market/policy and regulation issues

Sept/06: robust draft

DS Market/Policy/Acceptance-oriented

Jan/06: start

process of interaction

Oct/05: start

Apr/06: final version

final version: June/06

Start: Dec/05

Jan/06: start

Jun/06: first draft

Sept/06: robust draft
Strong endorsement at ZEP General Assembly
Brussels  12-13\textsuperscript{th} September 2006
SRA Recommendations

The Strategic Research Agenda describes a collaborative programme of technology development for reducing the costs and risks of deployment.

- **Urgently implementing 10-12 integrated, large-scale CCS demonstration projects Europe-wide**

- **Developing new concepts already identified, but not validated, for demonstration by 2010-2015 and implementation beyond 2020**

- **Supporting long-term exploratory research into advanced, innovative concepts for implementation of next-generation technology by 2050**

- **Maximising cooperation at national, European and international level**

- **Strengthening and accelerating R&D priorities to support the Strategic Deployment Document, informed by experience from demonstration projects and parallel R&D projects.**
Pathway to zero emission power for fossil fuels

- **Near-term**: High efficiency plant, one key element of zero emission power generation.
- **Mid-term**: Capture ready concept.
- **Long-term**: Storage of CO₂, EOR, Capture Technologies.

**Zero Emissions Target**

**Integrated strategy for `zero emission`**
Carbon Abatement Technologies

Efficiency Improvement

Co-firing/Fuel Flexibility
Carbon Capture Technologies

- Accepted need for a portfolio approach
- All technologies need to be addressed
- Retrofit and new plant application
Post Combustion CO₂ Capture

- **Amine Based Systems**
  - Further Improvements in Solvents
  - Application of Membranes Technologies

- **Ammonia**
  - Lower than Amine Cost and lower steam use than for Amine

- **Frosting**
  - Uses refrigeration principle to capture CO₂ from Flue Gas.

Focused on Reducing Cost and Power Usage
Oxygen-Fired Combustion

Near/mid-term solution for CO₂ capture

- Uses commercially available air fired PC technology
- O₂ production by commercial cryogenic air separation
- CO₂ cleanup, compression, and liquefaction
- Intermediate step leading to advanced processes
Pre-combustion Capture

ENCAP: pre-combustion carbon capture.

- Goal: Develop lean-preamixed H₂ burner
  - fuel-flexibility
    (NG/oil/H₂/syngas)

Axial fuel injection (independent of NG LPM system).

Link to Hydrogen Production
Advanced Capture Processes

- Oxygen Fired CFB
- Chemical Looping
  - Combustion
  - Gasification

**Chemical Looping Combustion**

**Chemical Looping Gasification**

**O₂ fired CFB**
CO₂ Storage

Key Issues

- Cost Reduction
- Public Acceptance
- Safe and Effective Storage
- Developing the Legal, Regulatory & Fiscal Framework

Safety and acceptance of CO₂ storage
The Strategic Deployment Document outlines how to accelerate the market for efficient zero emission power production.

**SDD Recommendations**

*Kick-starting the CO₂ value chain with urgent short- and long-term commercial incentives*

*Establishing a regulatory framework for the geological storage of CO₂*

*Gaining public support via a comprehensive public information campaign:*

*Establishing robust RD&D funding under the FP7 and national programmes:*
  - Improve energy conversion efficiency, reduce cost and reduce scale-up risk of CO₂ capture technology
  - Undertake EU-wide mapping of large CO₂ sources and geological storage
  - By 2008, establish a “Joint Technology Initiative” as part of a portfolio of mechanisms for maximising European co-operation.
CONCLUDING REMARKS
A major initiative addressing a key issue
- Setting pathway for zero emission fossil fuel power generation
- Important in European and global context
- Technology applicable for world application
  - Retrofit
  - New plant

A major action involving all stakeholders
- Appropriate industrial sectors
  - Generation
  - Oil/gas companies
  - Equipment suppliers
  - Fuel providers
- Research community and technology providers
- NGOs
- Governments

Major input to shaping of FP7 Work Programme
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