

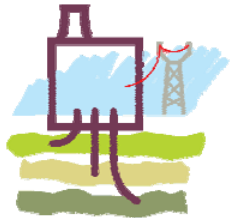
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GENEVA 26-28TH November 2006

Zero Emission Fossil Fuel Power Plant” ZEP European Technology Platform

Nick Otter

Co-ordinator of ZEP Platform
and

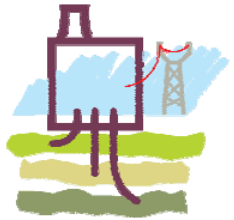
Director of Technology and External Affairs, ALSTOM Power Ltd



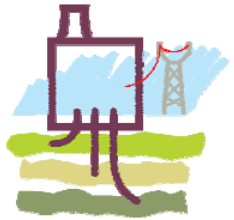
Contents of Presentation

- **AN OVERALL VIEWPOINT**
- **THE EUROPEAN INITIATIVE : ZEP**
- **THE WAY FORWARD : STRATEGY**
- **CONCLUDING REMARKS**





AN OVERALL PERSPECTIVE



Key Touchstones

▪ Importance of clean use of fossil fuels

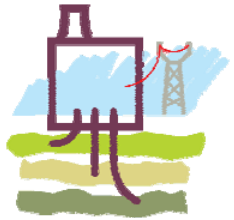
- a critical transitional issue in getting to a sustainable energy future
- an essential part of the portfolio

▪ Importance of accelerating the take-up of clean fossil

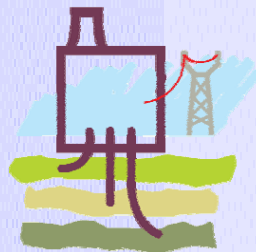
- need for incentives for early action on `zero emission` power plant
- stable financial and regulatory framework to get “many of a kind”

▪ 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

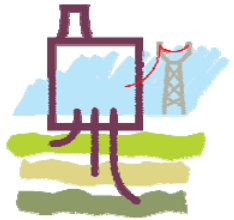


ZEP



“ZERO EMISSION FOSSIL FUEL POWER PLANT”

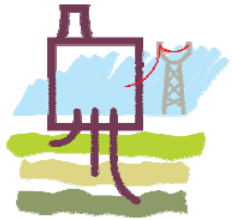
EUROPEAN TECHNOLOGY PLATFORM



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**

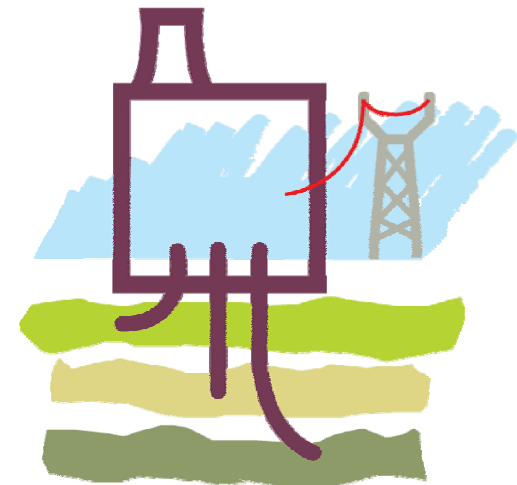
- Aiming for critical mass programme in Europe
- Established European Technology Platform with EC
- Primary task to set **technology agenda and deployment plan**
- Major input to EC FP7 (2007-2013)

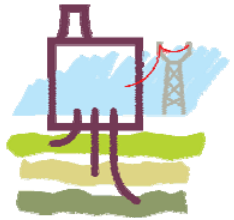
- **ETP “Zero Emission Fossil Fuel Power Plants”**

- **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**

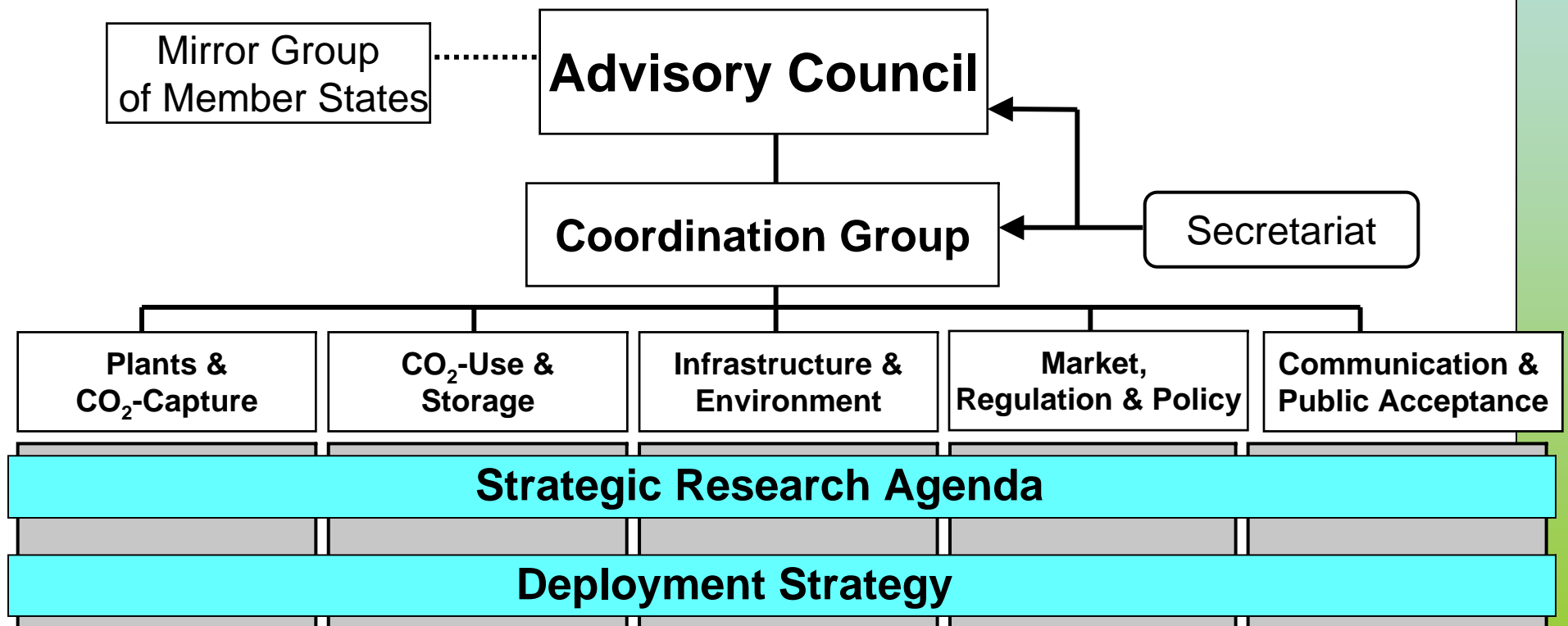
Vision Statement

To enable European fossil fuel power plants to have zero emission of CO₂ by 2020





ZEP: Organisational Structure



Timeframe : out to 2030+



ZEP: Members of Advisory Council

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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

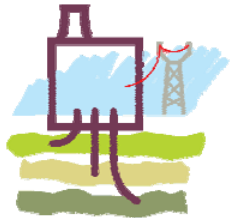
Gardiner Hill	BP (Vice-Chair)	: UK
Jean-Michel Gires	Total SA	: France
Philippe Lacour-Gayet	Schlumberger	: France
Graeme Sweeney	Shell Gas and Power	: UK
Arve Thorvik	Statoil	: Norway

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

NGOs

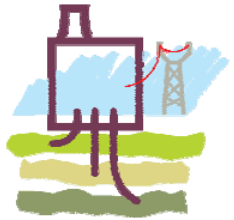
Frederic Hauge	The Bellona Foundation	: Norway
Kirsten Macey	Climate Action Network Europe	: Belgium
Stephan Singer	WWF International	: Belgium



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

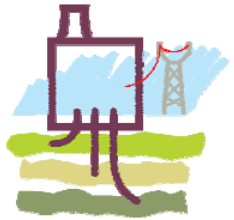


ZEP: Organisation Engagement

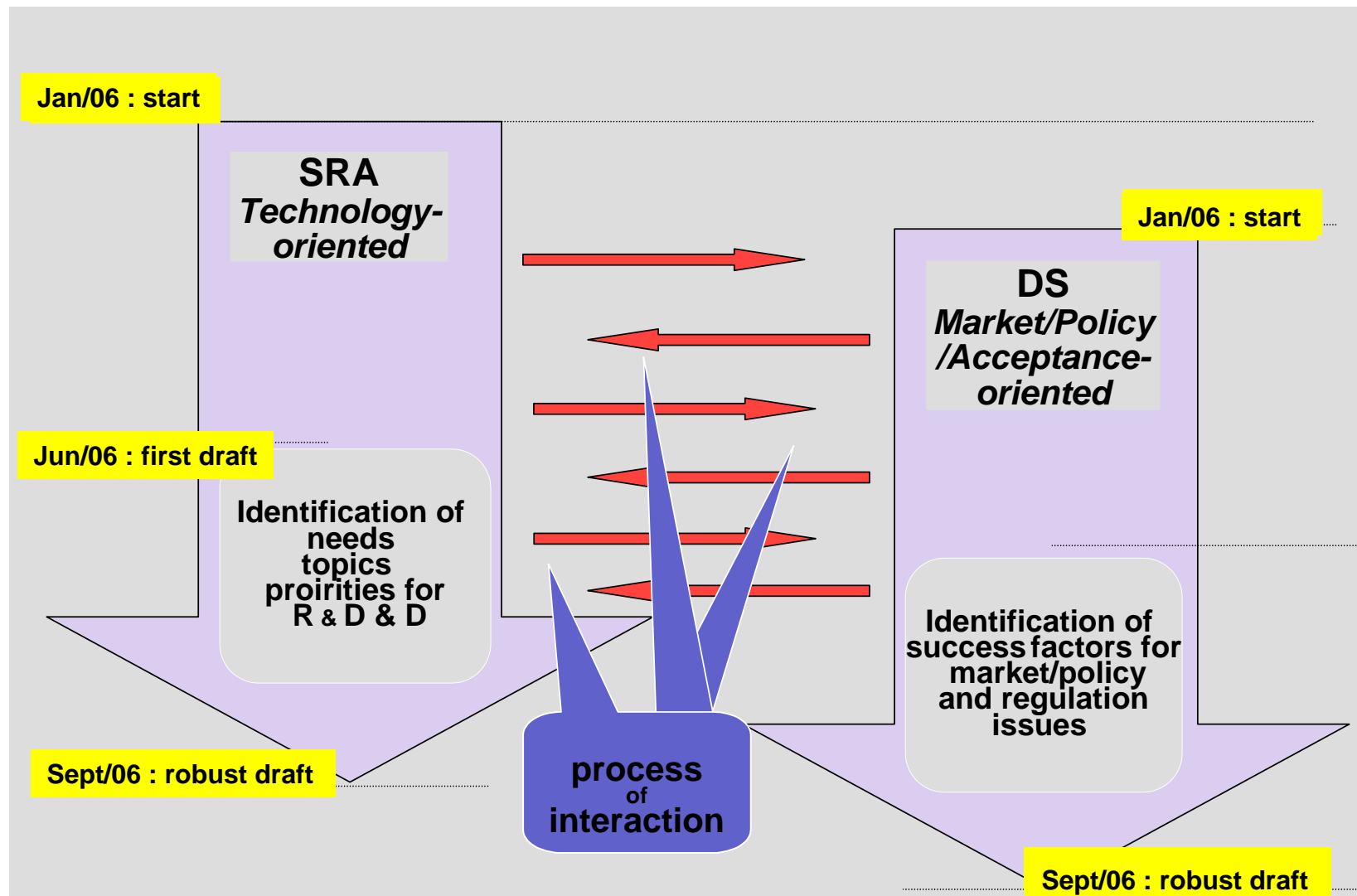
WG	1	2	3	4	5	Total	%
Generators	7	4	2	7	4	24	26
Suppliers	7	2	5	3	1	18	19
Oil/Gas&Infrastructure	2	3	7	2	2	16	17
Research	6	11	3	3	4	27	29
NGO	1	2	1	2	2	8	9
Total	23	22	18	17	13	93	
%	25	24	19	18	14		100

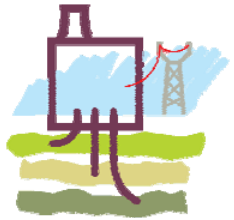
Involvement from >60 organisations

Industry ~60%
Research ~30%
NGO ~10%



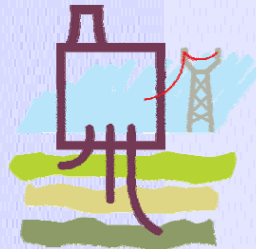
ZEP Action : Key Outputs and Timing





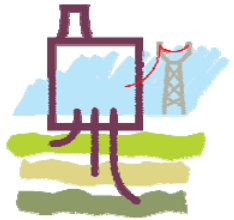
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ZEP



STRATEGIC RECOMMENDATIONS

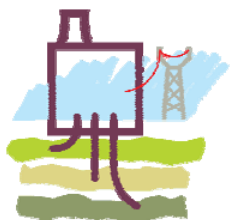
**Strong endorsement at ZEP General Assembly
Brussels 12-13th September 2006**



SRA Recommendations

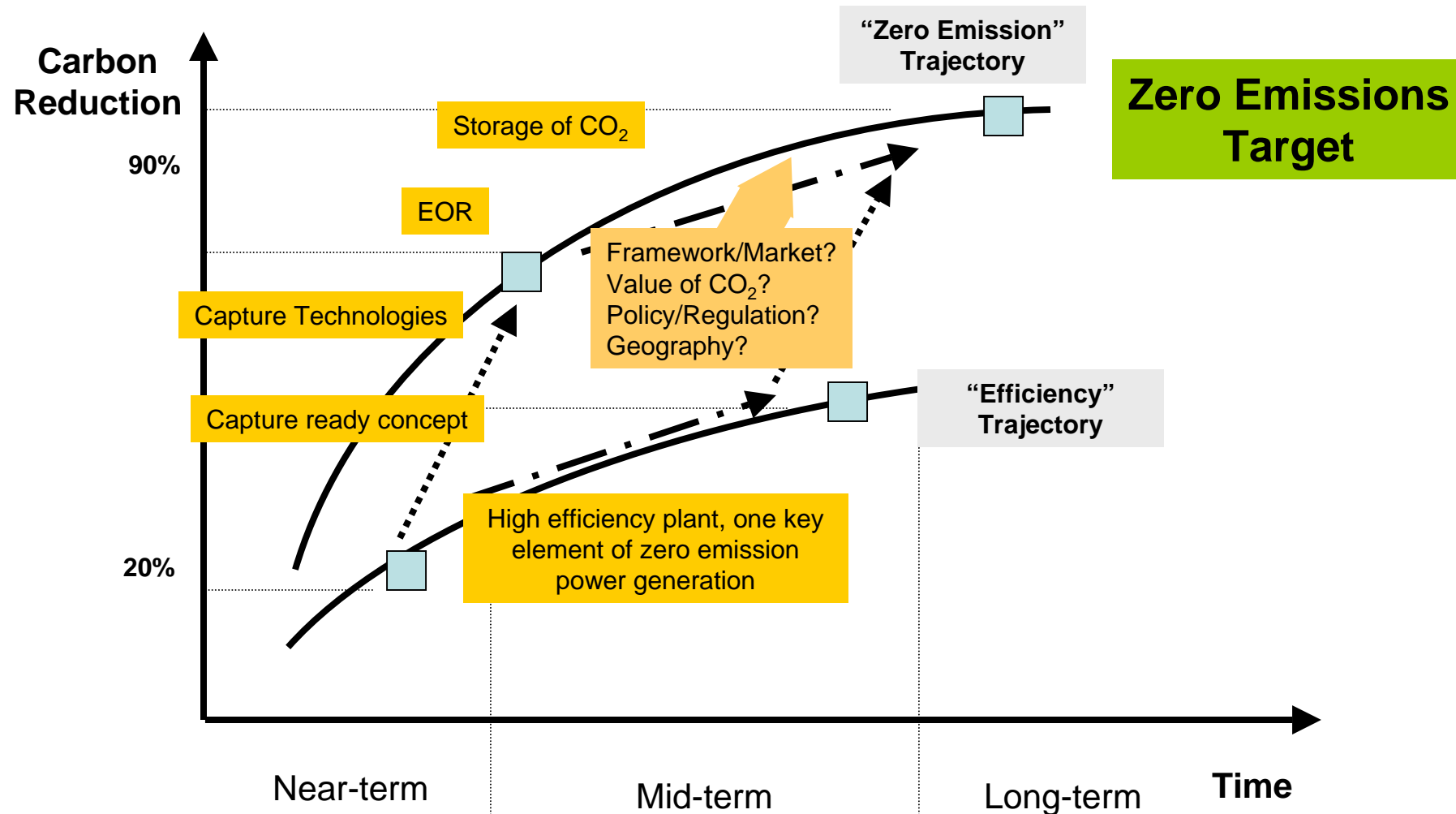
The Strategic Research Agenda describes a collaborative programme of technology development for reducing the costs and risks of deployment

- *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.*

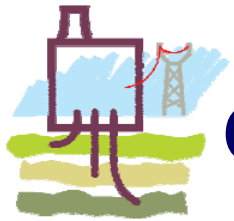


Pathway to zero emission power for fossil fuels

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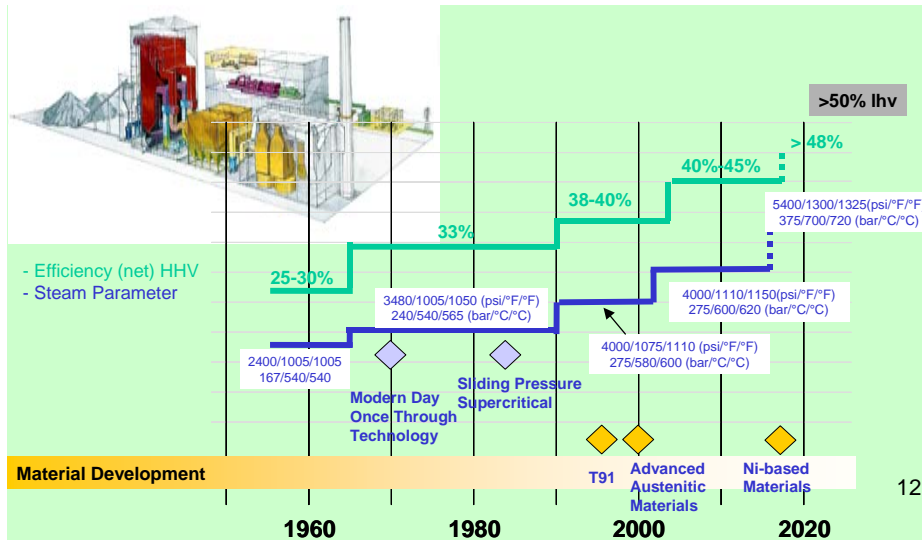


Integrated strategy for `zero emission`

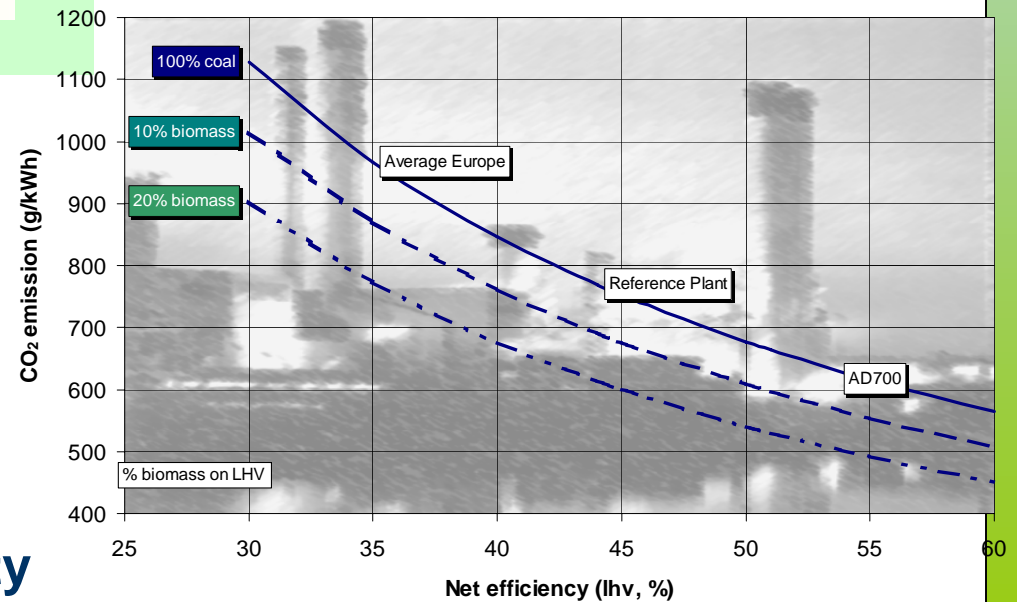


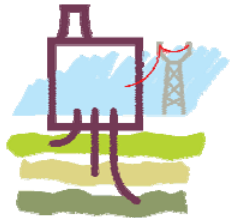
Carbon Abatement Technologies

Efficiency Improvement

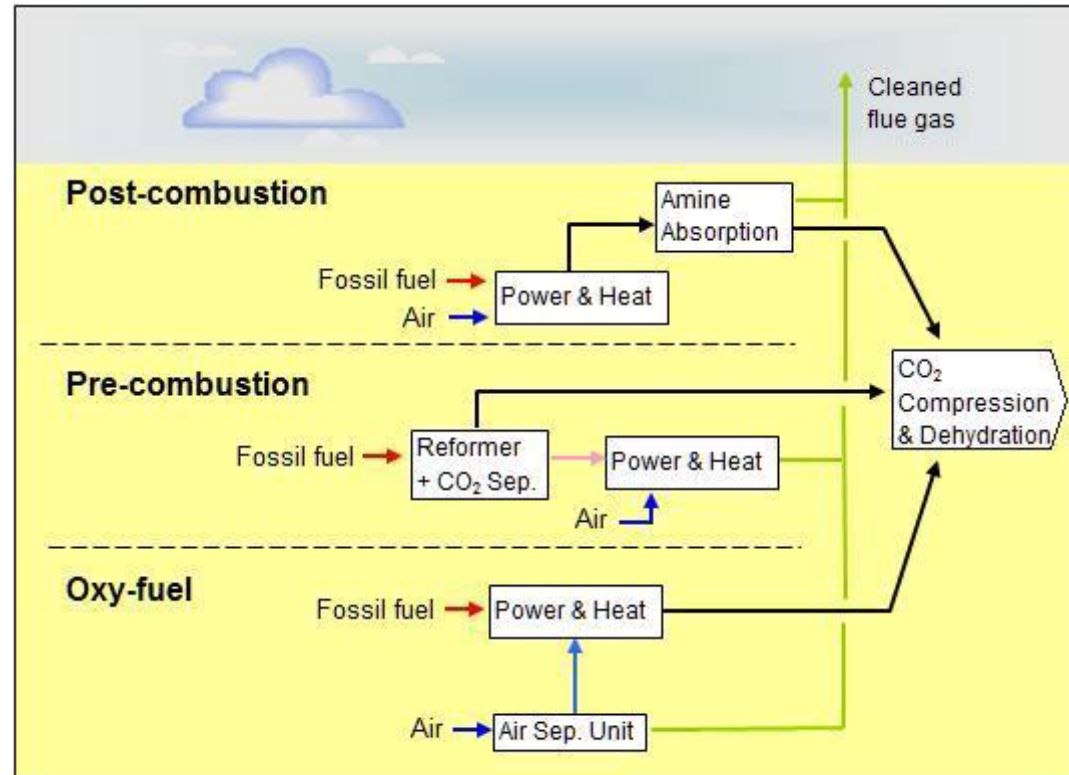


Co-firing/Fuel Flexibility

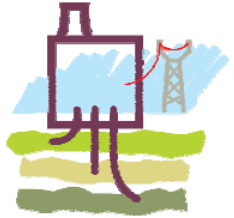




Carbon Capture Technologies



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

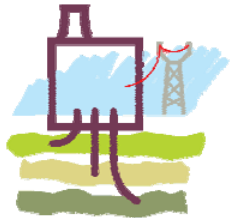


Post Combustion CO₂ Capture

**New plant
and retrofit
application**

- **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

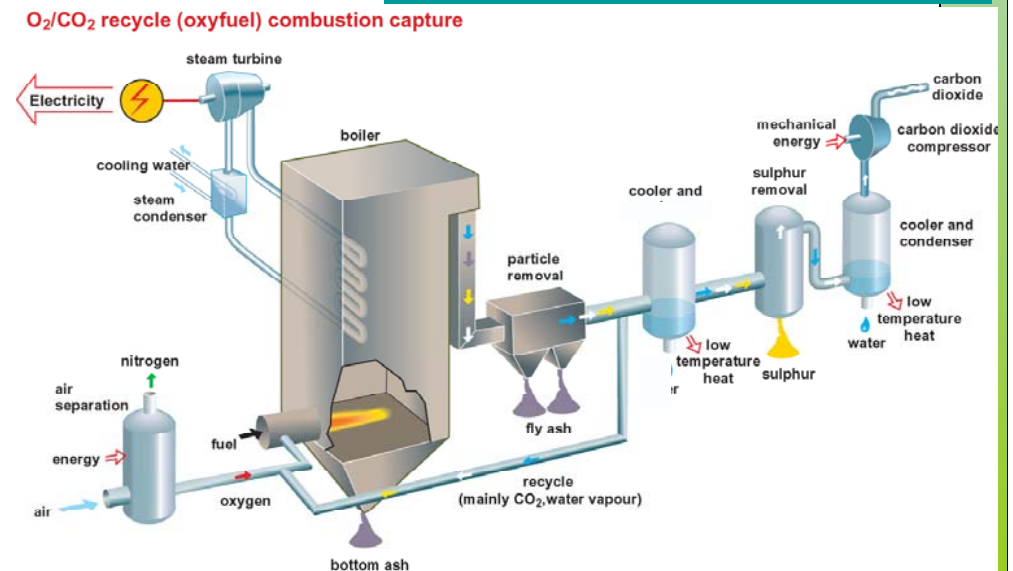


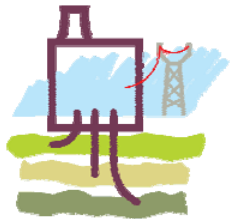
Oxygen-Fired Combustion

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

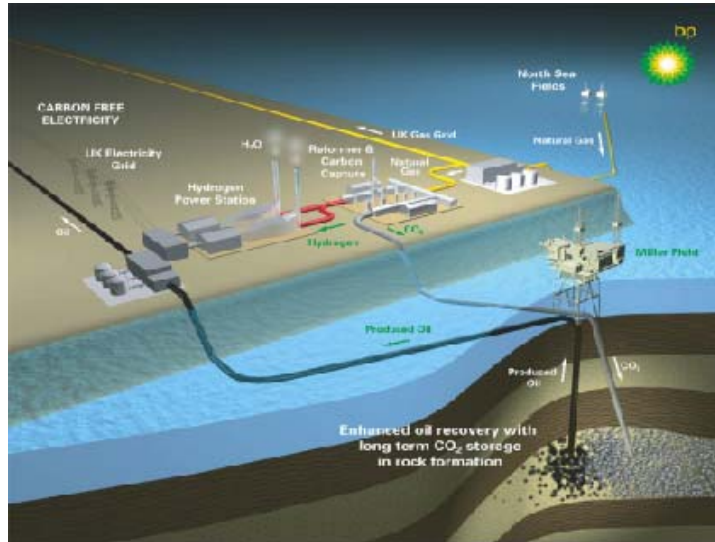
30 MWth Schwarze Pumpe Vattenfall





Pre-combustion Capture

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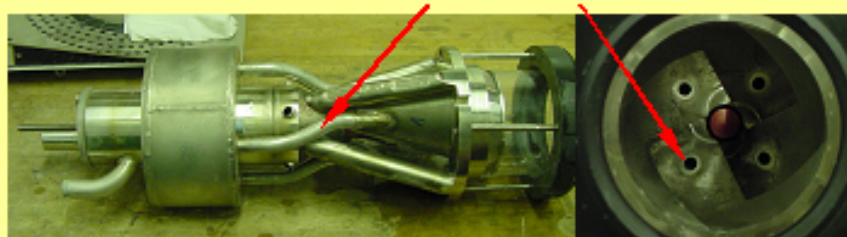
RWE Power
Lighthouse Project of RWE's Climate Strategy:
The zero-CO₂ power plant



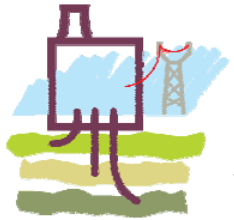
ENCAP: pre-combustion carbon capture.

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

Axial fuel injection (independent of NG LPM system).

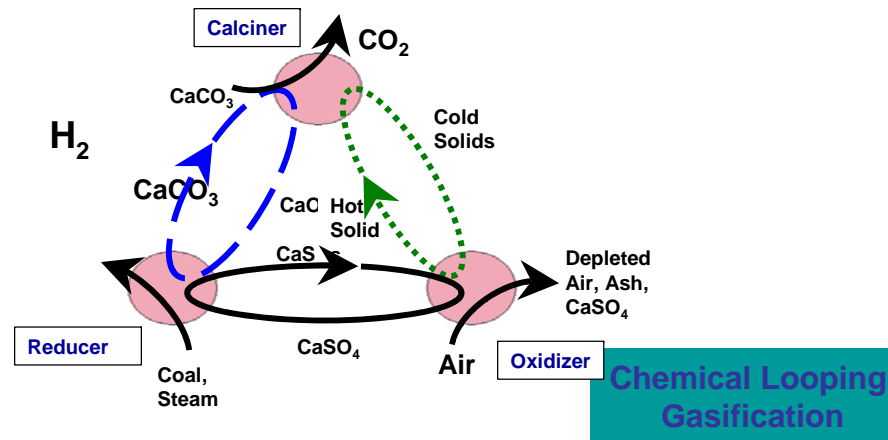
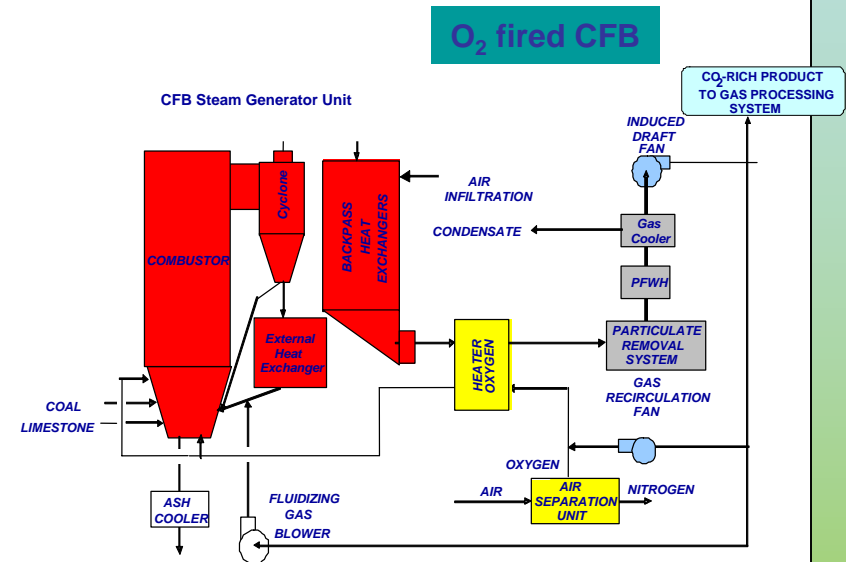
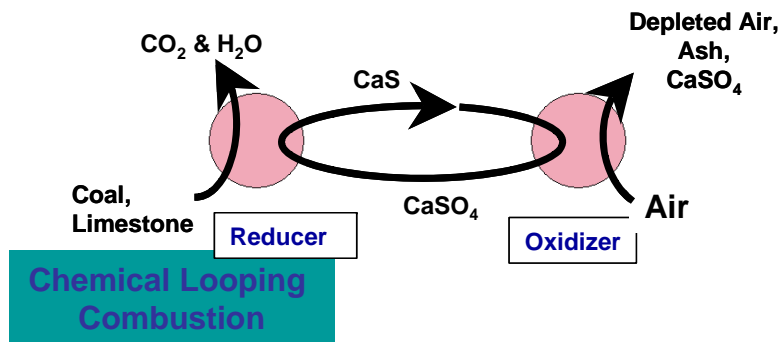


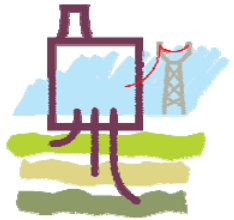
Link to Hydrogen Production



Advanced Capture Processes

- Oxygen Fired CFB
- Chemical Looping
 - Combustion
 - Gasification



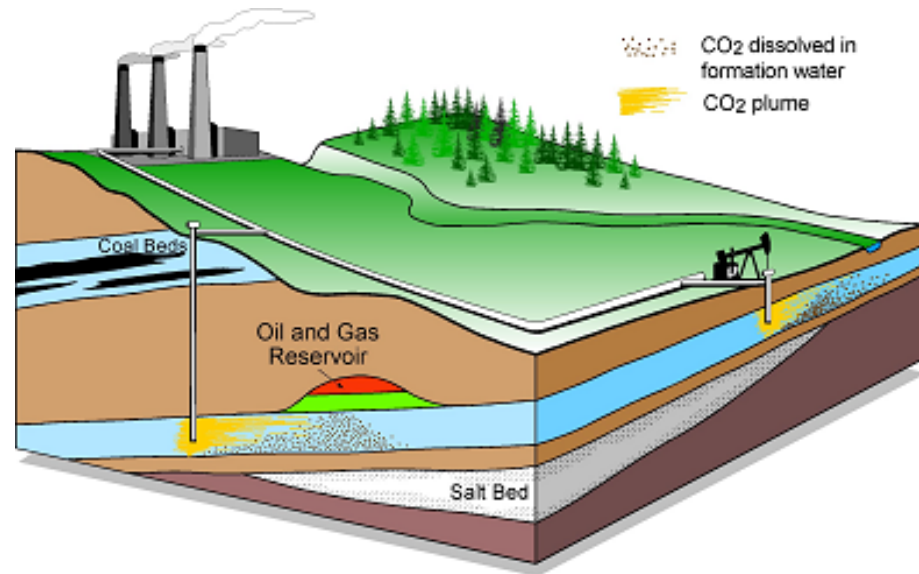


CO₂ Storage

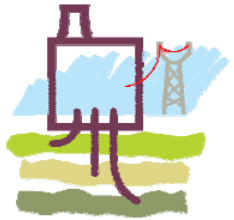
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Key Issues

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



Safety and acceptance of CO₂ storage



SDD Recommendations

The Strategic Deployment Document outlines how to accelerate the market for efficient zero emission power production.

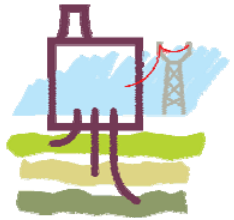
Kick-starting the CO₂ value chain with urgent short- and long-term commercial incentives

Establishing a regulatory framework for the geological storage of CO₂

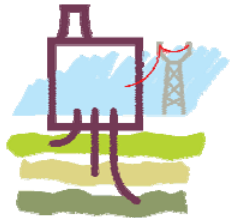
Gaining public support via a comprehensive public information campaign:

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.*



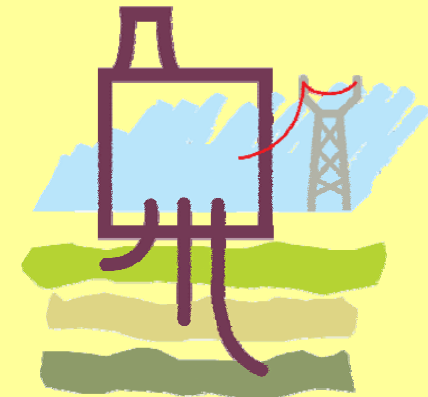
CONCLUDING REMARKS



ZEP : Summary

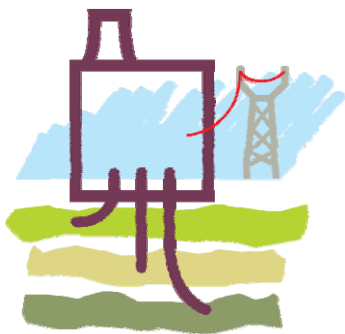
- A major initiative addressing a key issue
 - Setting pathway for zero emission fossil fuel power generation
 - Important in European and global context
 - Technology applicable for world application
 - Retrofit
 - New plant

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



www.zero-emissionplatform.eu

- Major input to shaping of FP7 Work Programme



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