

# Energy and Green House Gas Mitigation Technologies

Japan Society for the Promotion of Science-Imperial College London-University of Tokyo Symposium  
on Climate Change

Thursday 28<sup>th</sup> and Friday 29<sup>th</sup> September 2006



Imperial College London, South Kensington Campus, London SW7 2AZ



Imperial College  
London  
28<sup>th</sup> September 2006

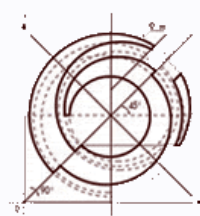
# **“Zero Emission Fossil Fuel Power Plant”**


## **a perspective on EU and International Initiatives**

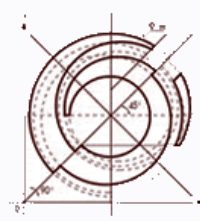
**Nick Otter**

Director of Technology and External Affairs, ALSTOM Power Ltd

**ALSTOM**

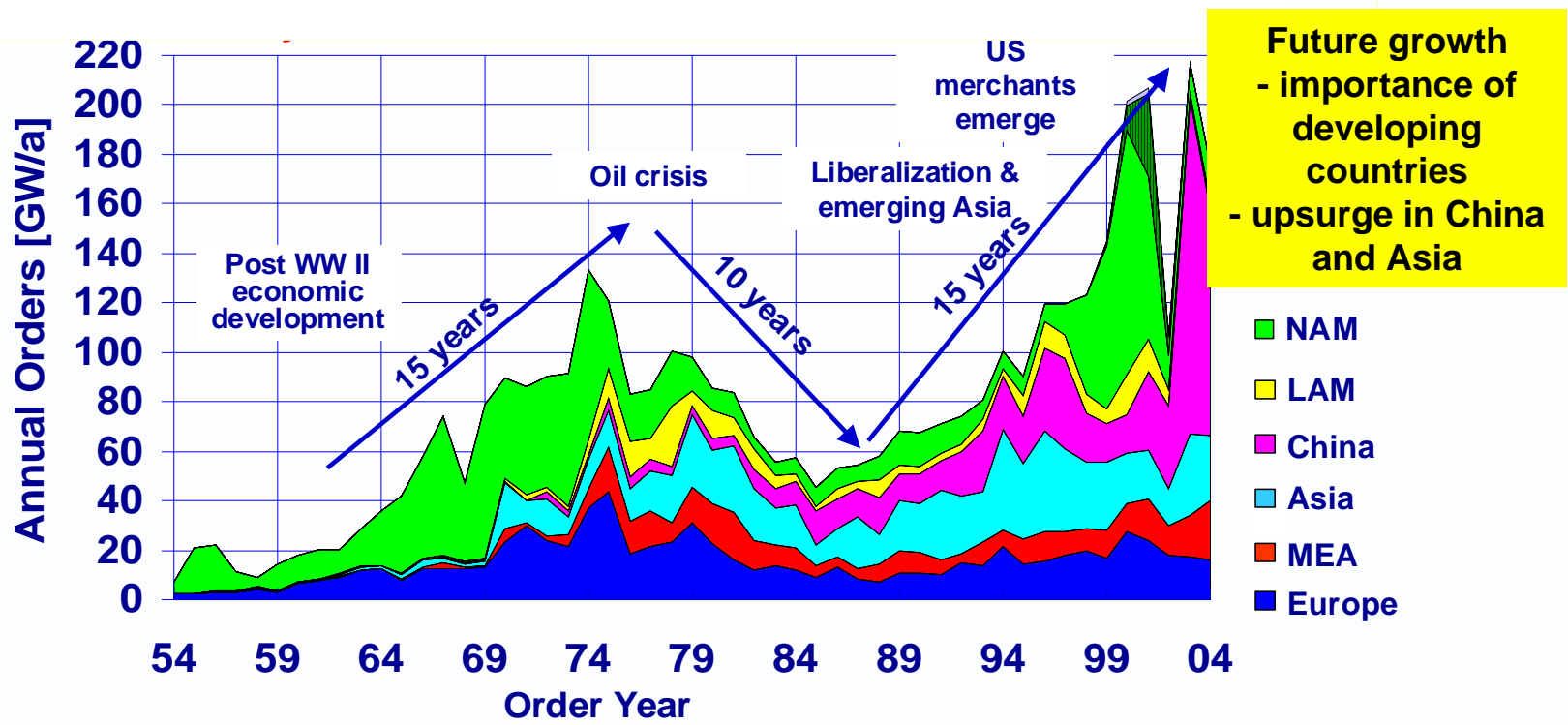


- **THE BACKGROUND : AN OVERALL VIEWPOINT**
- **THE EUROPEAN SCENE : ENERGY POLICY and FP7**
- **THE EUROPEAN INITIATIVE : ZEP** 
- **THE WAY FORWARD : STRATEGY & POSITIONING**
- **CONCLUDING REMARKS**



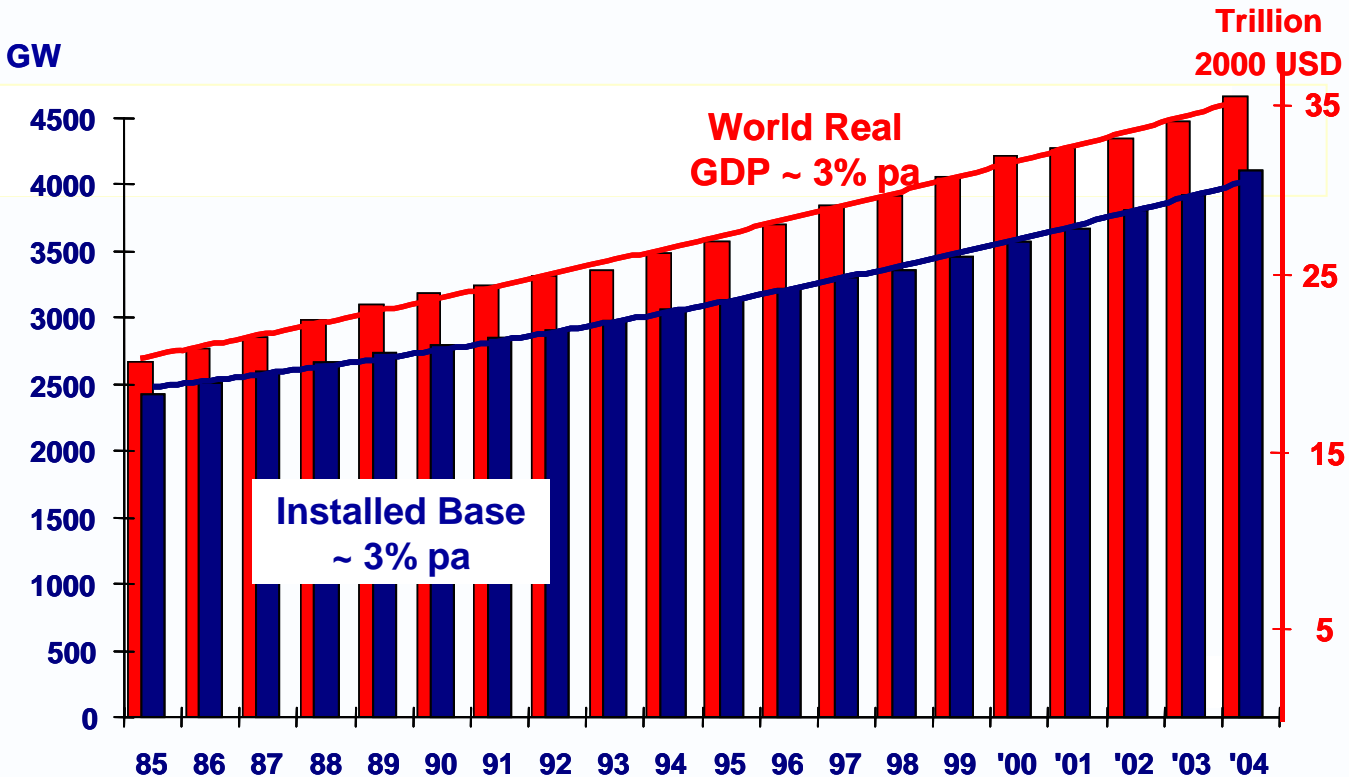
# AN OVERALL PERSPECTIVE

## Market Development 50 Years of Order Volumes by Regions



Significant market changes .....increased liberalisation, de/re-regulation and privatisation

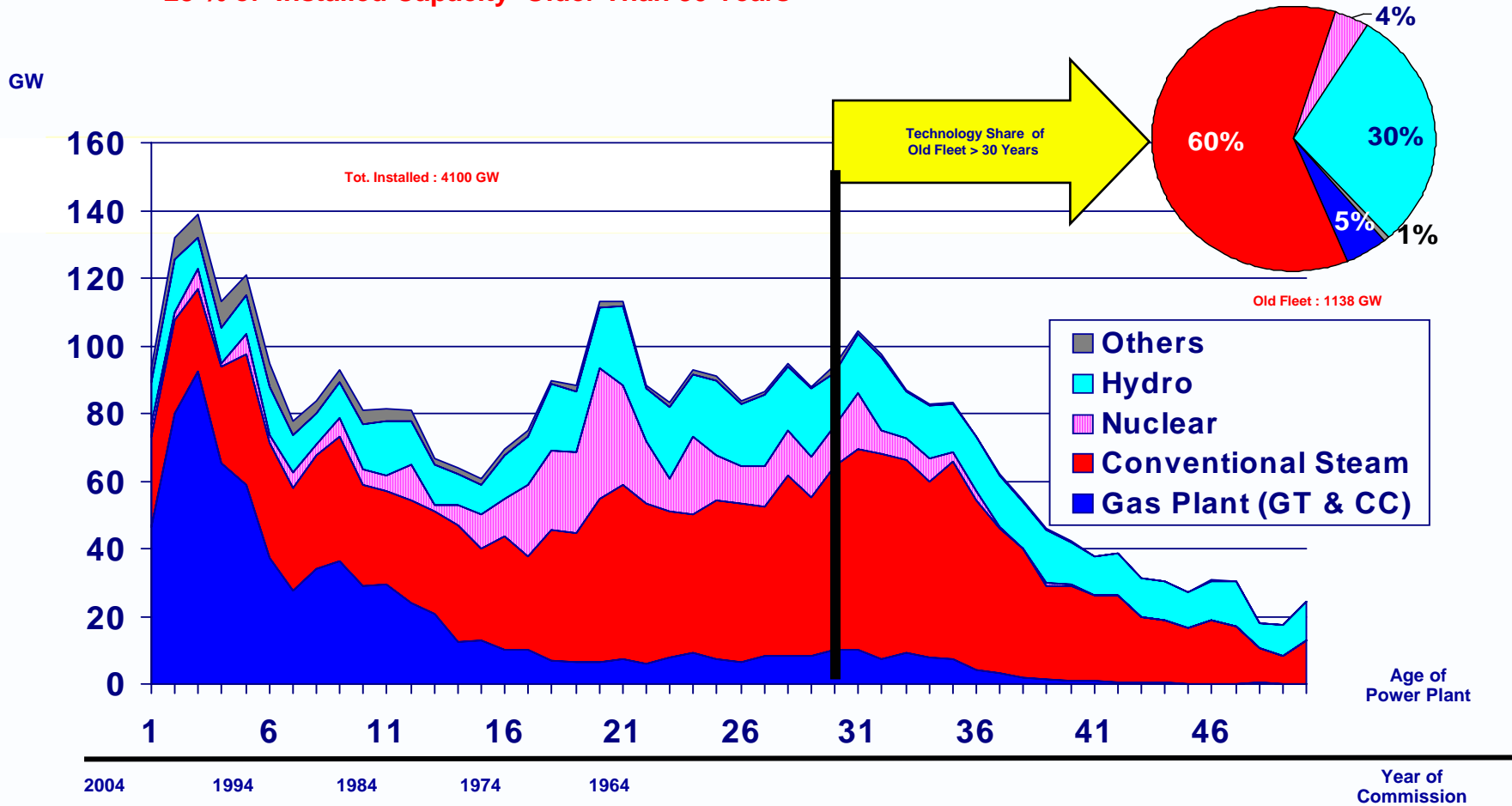
## Installed Base Growth ~linked to GDP



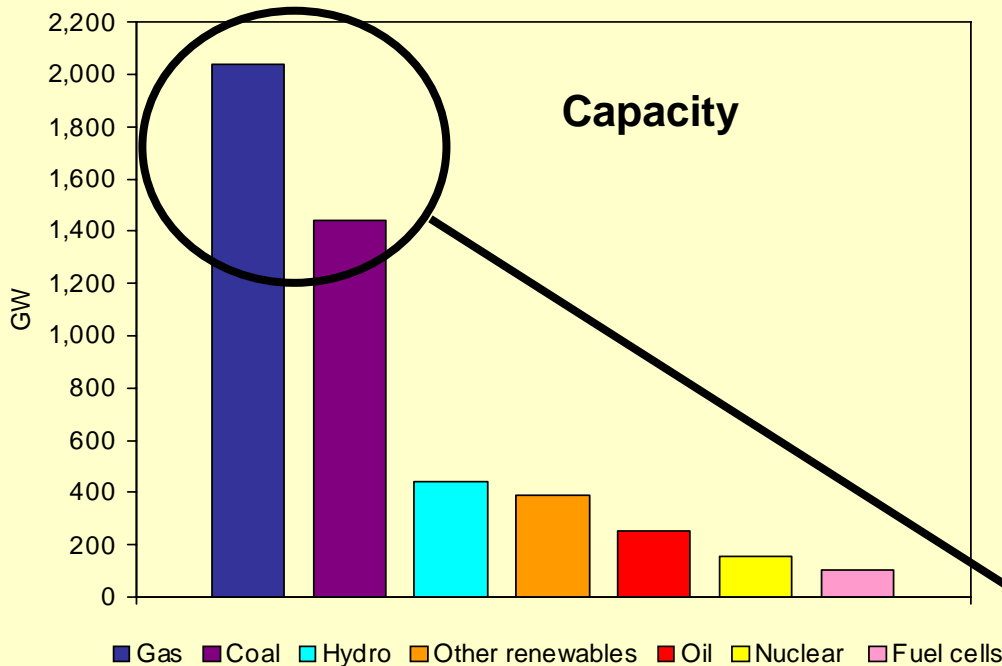
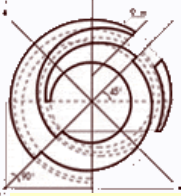
strong link between GDP growth and energy supply

# Installed Capacity

28 % of Installed Capacity Older Than 30 Years



Ageing Fleet – need for replacement/retrofit enhancement



**IEA projections of global power station build to 2030**

IEA World Energy Outlook 2004

- **Different needs world-wide**
  - uneven access to modern energy
- **Growth of Renewable Energy and increasing resurgence of nuclear but ...**

**Clean Combustion Technologies needed for new fossil fuel plants:  
2000 GW Gas  
+  
1400 GW Coal**

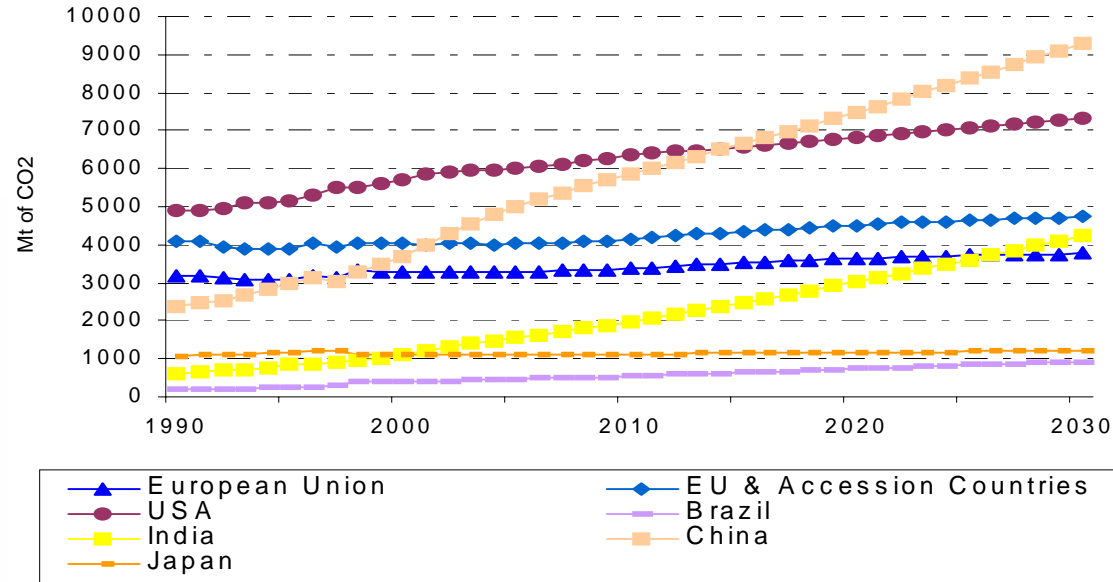
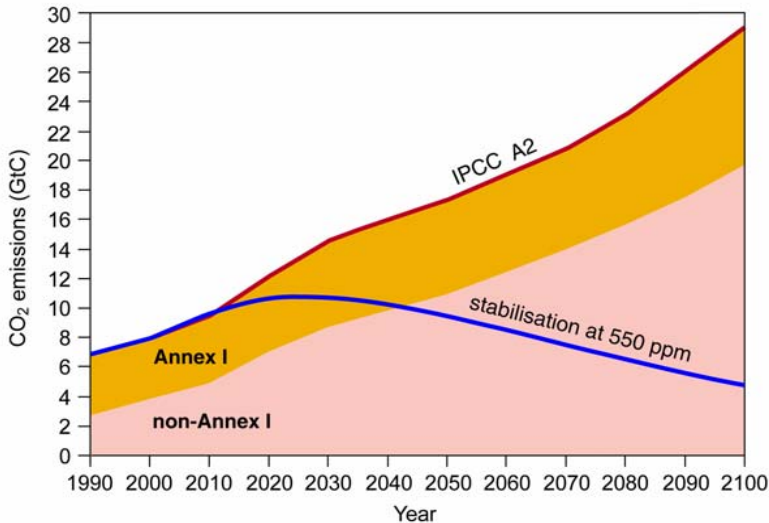


# Environmental Issues - 'longer term' aspects

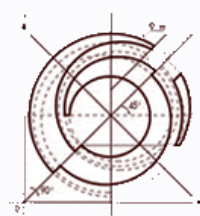
## ● Environment

- What happens post 2012?
- 60% GHG reductions by 2050?

**Forecasted CO<sub>2</sub> Increases**  
Source: EC/EEA, 2004



**Mitigating climate change : cannot ignore fossil fuels**



## ▪ Importance of clean use of fossil fuels

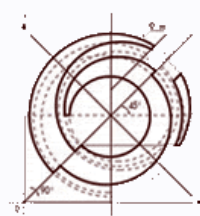
- a critical transitional issue in getting to a sustainable energy future
- an essential part of the portfolio

## ▪ Importance of accelerating the take-up of clean fossil

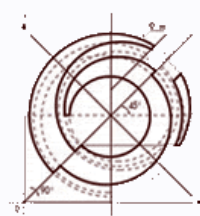
- need for incentives for early action on `zero emission` power plant
- stable financial and regulatory framework to get “many of a kind”

## ▪ 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

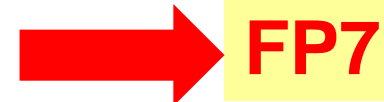


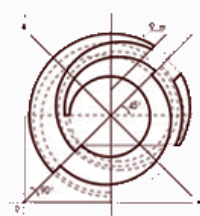
# THE EU ENERGY TECHNOLOGY SCENE



- **Energy Green Paper on a “European Strategy for Sustainable, Competitive and Secure Energy”**
  - drafted in 2005 and issued in early 2006
  - out for consultation until 28<sup>th</sup> September 2006
  - addresses 3 key areas of
    - Security of Supply
    - GHG/CO<sub>2</sub> Emissions
    - Competitiveness

- **Internal market**
  - towards a fully competitive market
- **Internal energy supply**
  - solidarity among Member States
- **Energy mix**
  - diverse efficient and sustainable
- **Environment**
  - integrated approach to tackling climate change
  - energy efficiency, renewable and low C energy
- **Energy Technology and Innovation**
  - a strategic approach
- **External relations**
  - coherent external energy strategy





## ● Budget and Timeframe

- agreed at EU Competitiveness Council 24<sup>th</sup> July 2006
- overall FP7 budget set at 49 billion euro
- timeframe now 7 years, 2007-2013
- approximately 40% increase over FP6

## ● Content

- overall themes agreed
- separate Energy and Environment themes
- FP7 `text` to EU Parliament for 2<sup>nd</sup> Reading in Oct/06

## ● Timing

- process on course for agreement by end of 2006
- initial call anticipated early 2007

## ● 10 Major Themes in FP7

m euro

- |   |             |
|---|-------------|
| – Health  | 6050        |
| – Food, Agriculture and Biotechnology                     | 1935        |
| – Information and Communication Technologies              | 9110        |
| – Nanosciences/technologies, Materials and New Production | 3500        |
| – <b>Energy</b>   | <b>2300</b> |
| – <b>Environment including Climate Change</b>             | <b>1900</b> |
| – Transport including aeronautics                         | 4180        |
| – Socio-economic Sciences and the Humanities              | 610         |
| – Space   | 1430        |
| – Security Technologies                                   | 1350        |

**Budget 32.3b euro**

## ● Over-arching Aims

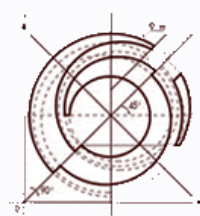
- To transform the current fossil-fuel based energy system into a more sustainable one based on a diverse portfolio of energy sources and carriers combined with enhanced energy efficiency
- To address pressing challenges of security of supply and climate change
- To increase competitiveness of Europe`s energy industries

## ● 10 Work Programme Topics

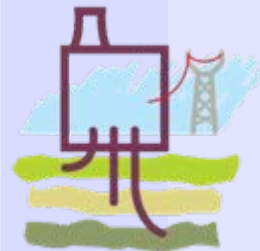
- Hydrogen and Fuel Cells
- Renewable Fuel Production
- Renewables for Heating and Cooling
- **CO<sub>2</sub> Capture and Storage for zero emission fossil fuel PG**
- **Clean Coal Technologies**
- Smart Energy Networks
- Energy Efficiency and Savings
- Knowledge for Energy Policy Making including International Co-operation



- **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**

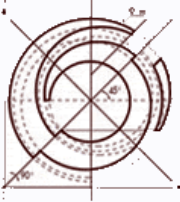


# ZEP



**“ZERO EMISSION FOSSIL FUEL POWER PLANT”**

**EUROPEAN TECHNOLOGY PLATFORM**

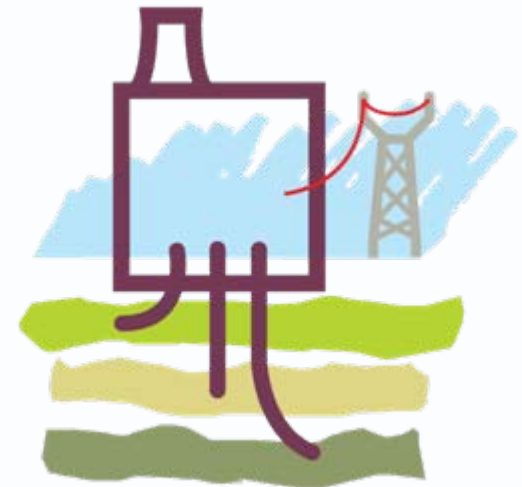


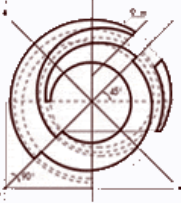
# Technology Platform ZEP: Set Up and Vision

- **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**

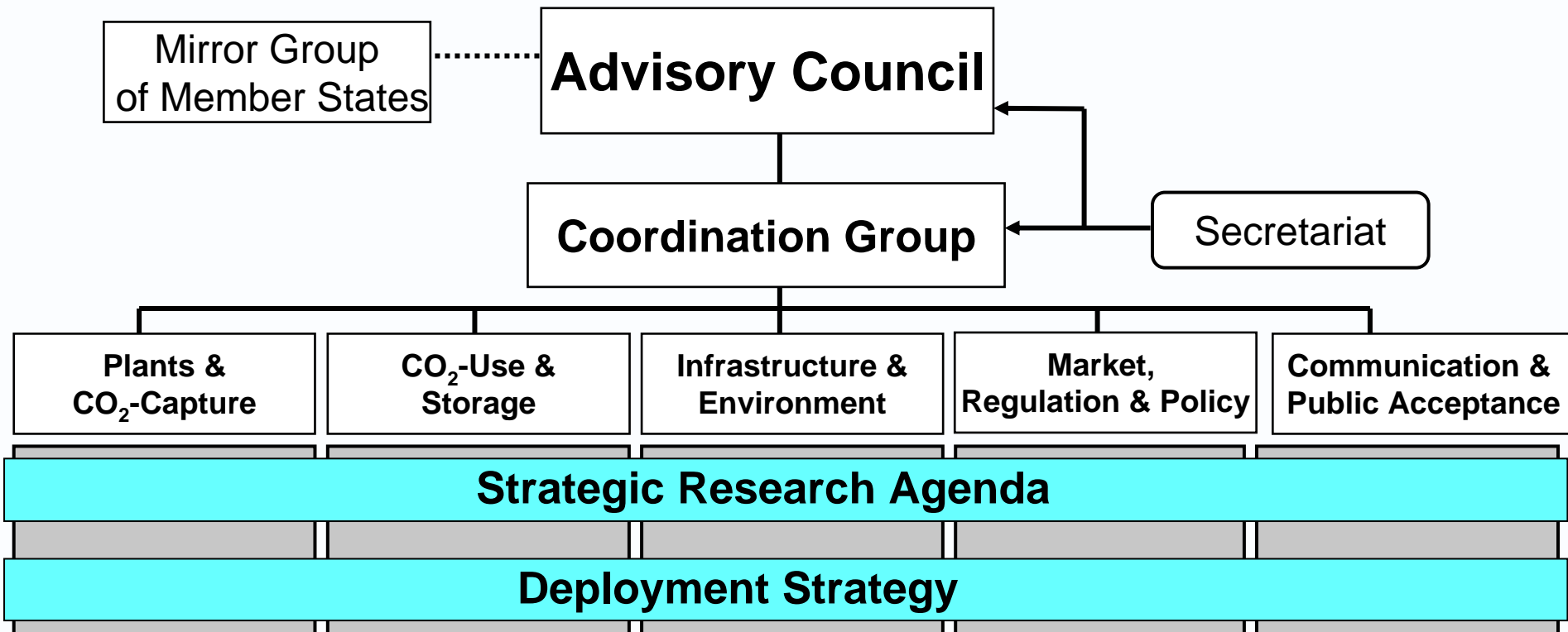
## Vision Statement

**To enable European fossil fuel power plants to have zero emission of CO<sub>2</sub> by 2020**

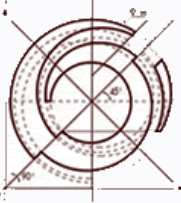




# Technology Platform ZEP: Organisational Structure



**Timeframe : out to 2030+**



# Technology Platform 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

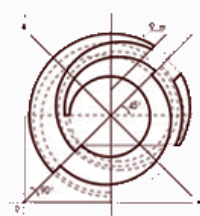
Gardiner Hill	BP (Vice-Chair)	: UK
Jean-Michel Gires	Total SA	: France
Philippe Lacour-Gayet	Schlumberger	: France
Graeme Sweeney	Shell Gas and Power	: UK
Arve Thorvik	Statoil	: Norway

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

## Research

## NGOs

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



### ● Countries involved

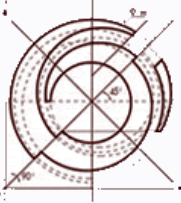
- UK Chair
- Germany Vice-Chair
- Norway Vice-Chair

plus

- |            |         |             |        |
|------------|---------|-------------|--------|
| – Austria  | Denmark | Finland     | France |
| – Greece   | Italy   | Netherlands | Poland |
| – Portugal | Spain   | Switzerland |        |

### ● Support from EC

- FENCO (Clean Fossil Energy) Co-ordination Action



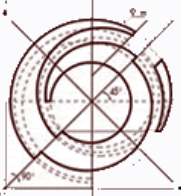
# Technology Platform ZEP: Organisation Engagement



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

**Involvement from >60 organisations**

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



# Technology Platform ZEP: Country Involvement

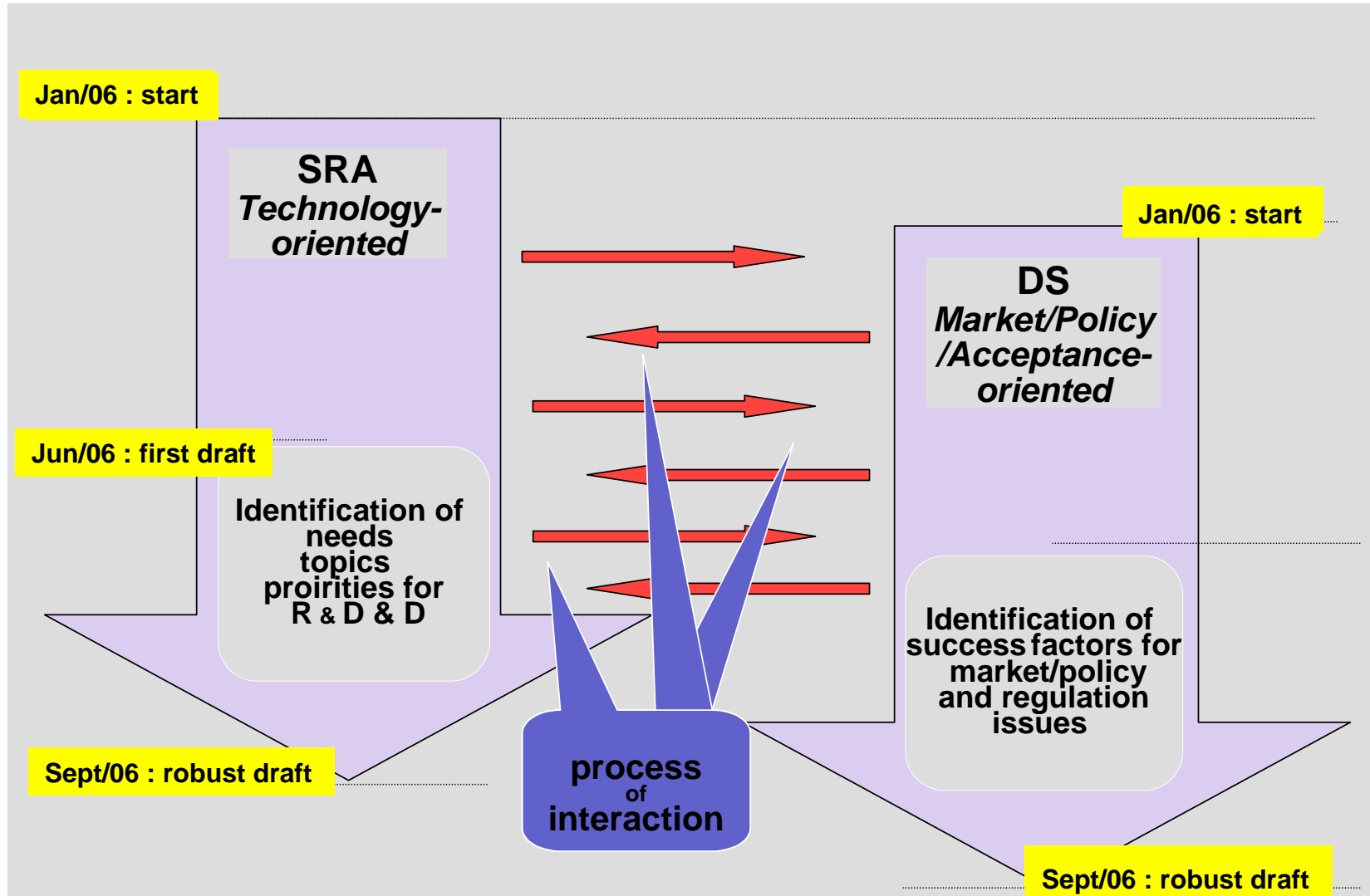


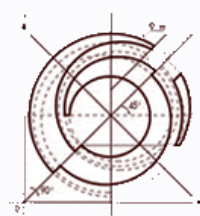
WG	1	2	3	4	5	Sum
Germany	3	6	2	4	2	17
France	3	3	1	2	3	12
Austria	1				1	2
Sweden	1				1	2
Finland	1		1			2
UK	4	1	3	2	1	11
Norway	1	3	2	2	1	9
Italy	1	2	2	3	1	9
Poland	1		1			2
Denmark	1	1				2
Spain	2	3	2	2	1	10
The Netherlands	1	1	1		1	4
Belgium	1			1	1	3
Greece	1	1	1			3
Slovakia		1				1
Portugal	1					1
Others			3			3
<b>Total</b>	<b>23</b>	<b>22</b>	<b>19</b>	<b>16</b>	<b>13</b>	<b>93</b>

<b>Member/Associated States</b>	<b>16</b>
<b>Others</b> (* Non EU person in EU companies)	<b>3</b>

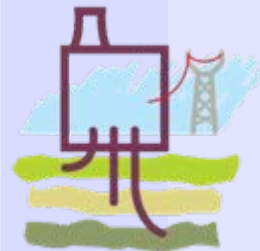


# ZEP ETP Action : Key Outputs and Timing





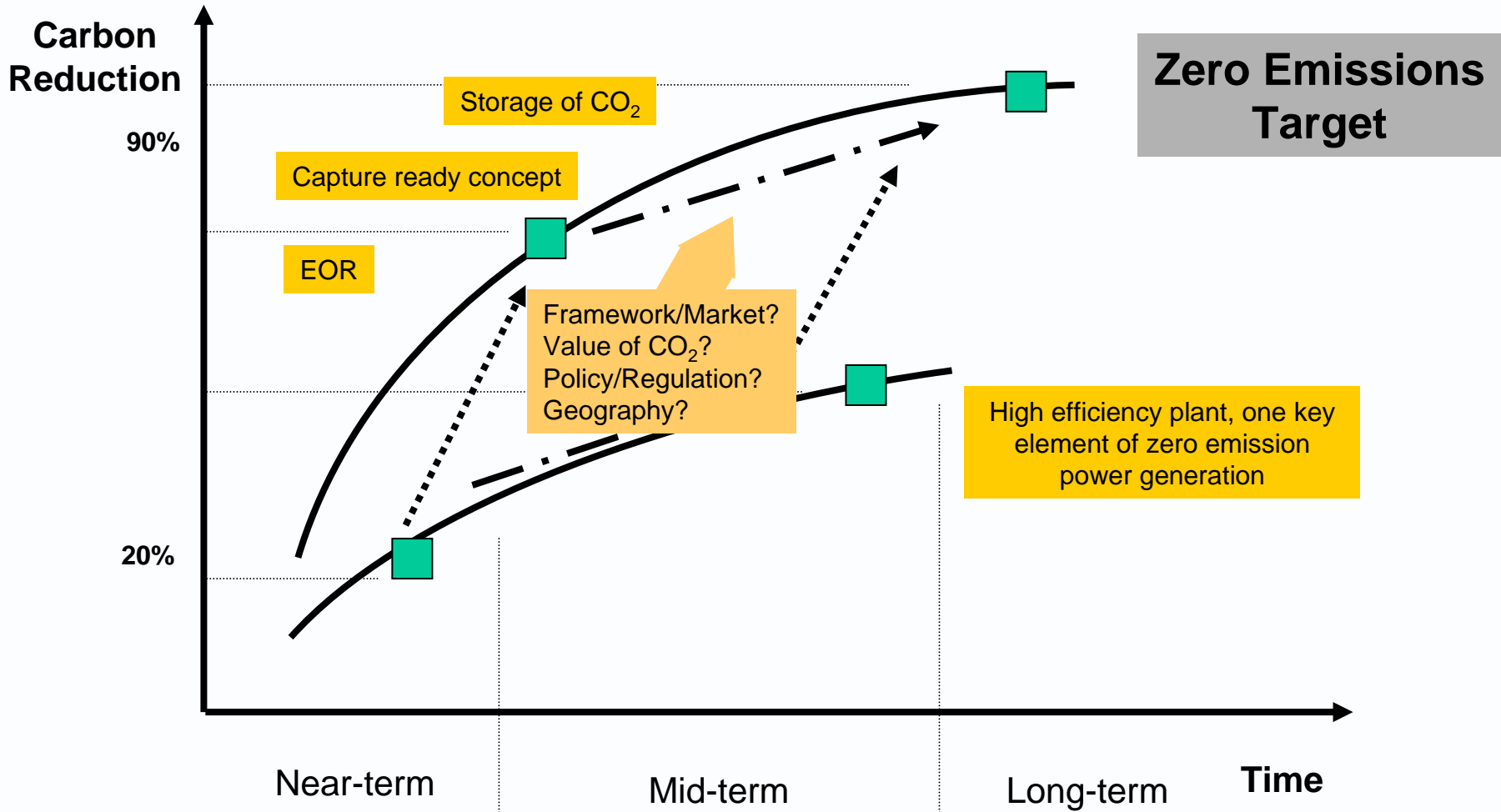
# ZEP



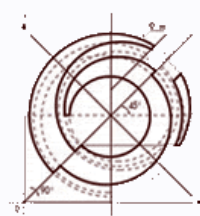
## STRATEGIC RECOMMENDATIONS

**Strong endorsement at ZEP General Assembly  
Brussels 12-13<sup>th</sup> September 2006**

# Pathway to zero emission power for fossil fuels

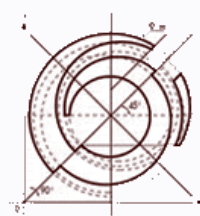


an integrated approach to `zero emission`



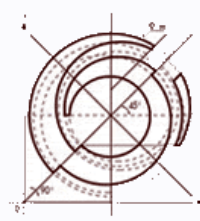
**The Strategic Research Agenda** describes a collaborative programme of technology development for reducing the costs and risks of deployment

- *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.*



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

- *Kick-starting the CO<sub>2</sub> value chain with urgent short- and long-term commercial incentives*
- *Establishing a regulatory framework for the geological storage of CO<sub>2</sub>*
- *Gaining public support via a comprehensive public information campaign:*
- *Establishing robust RD&D funding under the FP7 and national programmes (linked to Strategic Research Agenda recommendations):*
  - Improve energy conversion efficiency, reduce cost and reduce scale-up risk of CO<sub>2</sub> capture technology
  - Undertake EU-wide mapping of large CO<sub>2</sub> sources and geological storage
  - By 2008, establish a Joint Technology Initiative as part of a portfolio of mechanisms for maximising European co-operation.



# INTERNATIONAL LINKAGES

- Carbon Sequestration Leadership Forum (CSLF)

- Technology Route Map
- Project Initiation and Review Panel
- Stakeholder engagement through projects

- G8 Action Plan

- Financial Mechanisms/World Bank
- `Capture Ready` Technology/IEA

- EU/UK China Zero Emission Plant

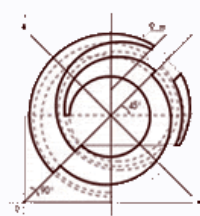
- DEFRA/DTI Initiative through EC
- Feasibility study leading to demonstration of Near Zero Emissions Coal plant (NZEC)

- IPCC Special Report on CCS

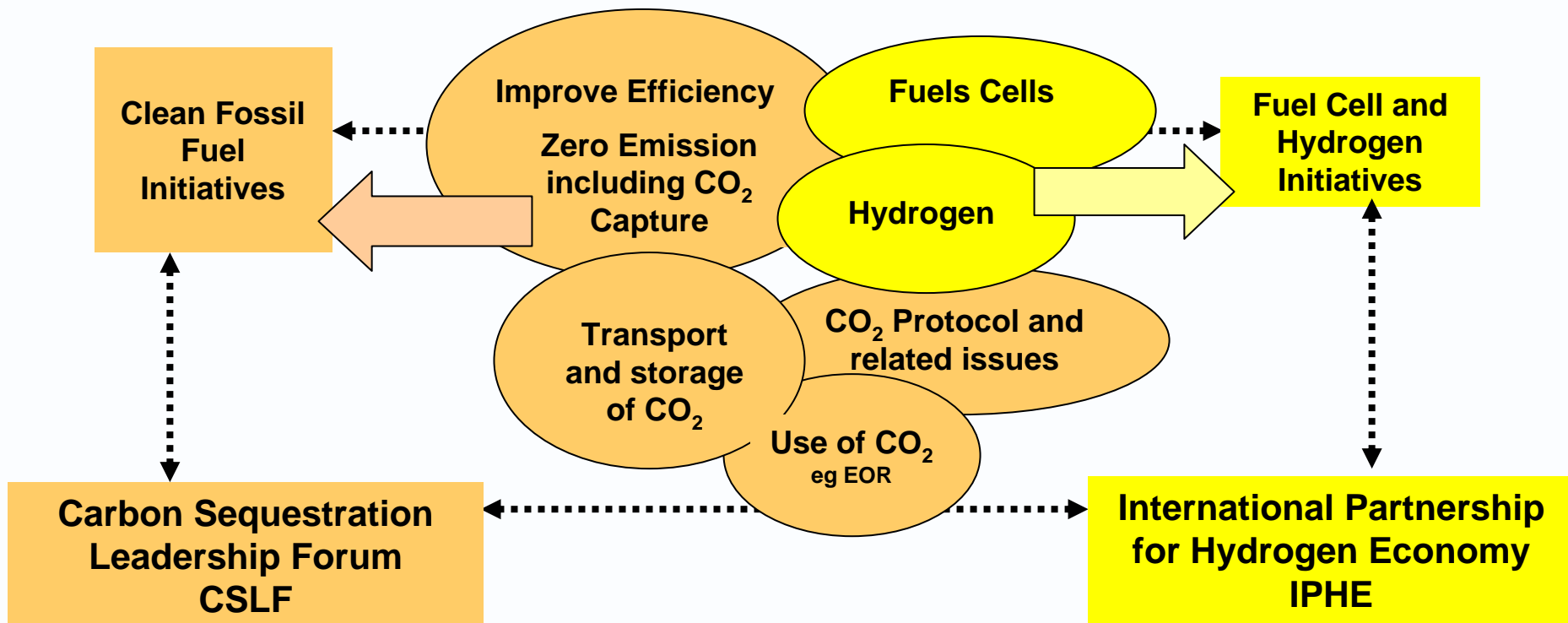
- Summary for Policy Makers agreed Sept05

 Australia	 Japan
 Brazil	 Mexico
 Canada	 Netherlands (new)
 China	 Norway
 Colombia	 Republic of Korea (new)
 Denmark (new)	 Russian Federation
 European Commission	 Saudi Arabia (new)
 France (new)	 South Africa (new)
 Germany (new)	 UK
 India	 USA
 Italy	 Greece (applied)

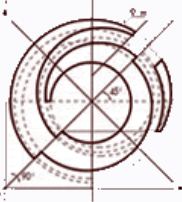
**Thrust for co-ordination and interaction internationally**



- Part of an overall strategic framework addressing clean fossil fuels as a key element of a sustainable energy portfolio

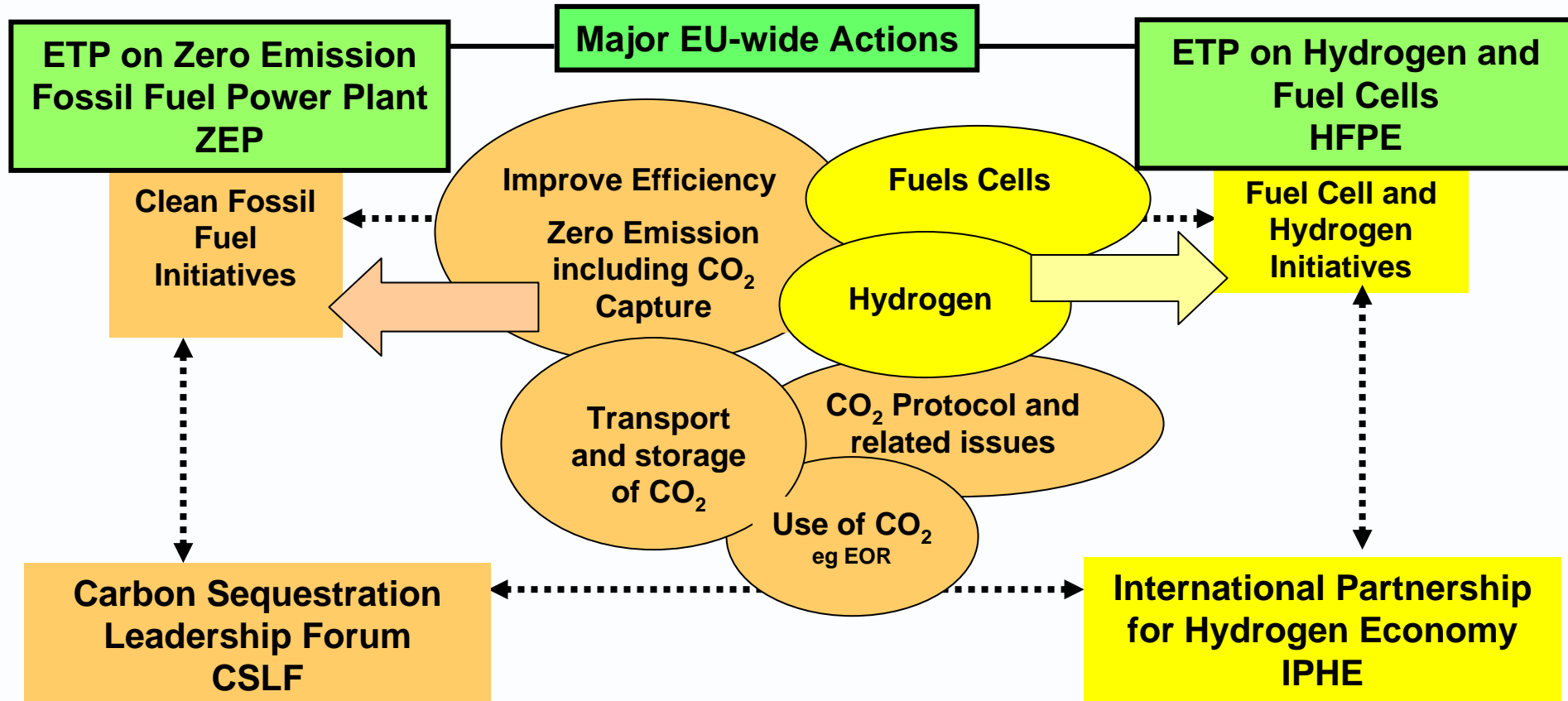


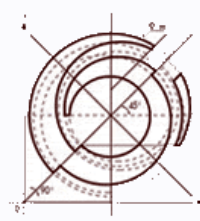




# European Response

- Part of an overall strategic framework addressing clean fossil fuels as a key element of a sustainable energy portfolio





# CONCLUDING REMARKS

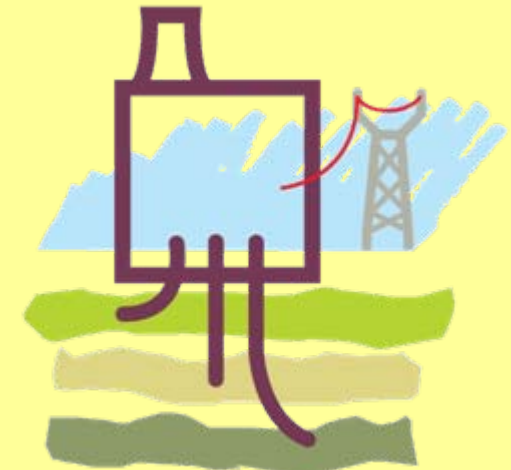


# ZEP ETP :

## 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
    - All fossil fuels

- An 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](http://www.zero-emissionplatform.eu)

- A major input to help set the deployment agenda

The Alstom logo features the word "ALSTOM" in a bold, sans-serif font. The letters "A", "L", "S", "T", and "M" are dark blue, while the "O" is a red circle with a white center. The logo is set against a white background that is partially framed by a large red arc on the left and top. The background of the entire image consists of vertical blue stripes of varying shades and some faint white curved lines.

**ALSTOM**

[www.alstom.com](http://www.alstom.com)