

# APGTF STRATEGY FOR TECHNOLOGY RD&D

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# Summary

- Background – global scene, UK scene, markets
- Proposes RD&D programme following White Paper for fossil and biomass
- Gives targets and timescales
- Outlines technology developments, underpinning research and demonstrations
- Proposes implementation plan
- Final report to DTI with recommendation for implementation

## AIMS OF STRATEGY

- Provision of affordable, acceptable and available low emissions power plant
- Provide UK industry with global market opportunities out to 2030
- Contribute to UK wealth creation and quality of life
- Help achieve CO<sub>2</sub> goals while providing security of supply

# Current approach for CO<sub>2</sub>

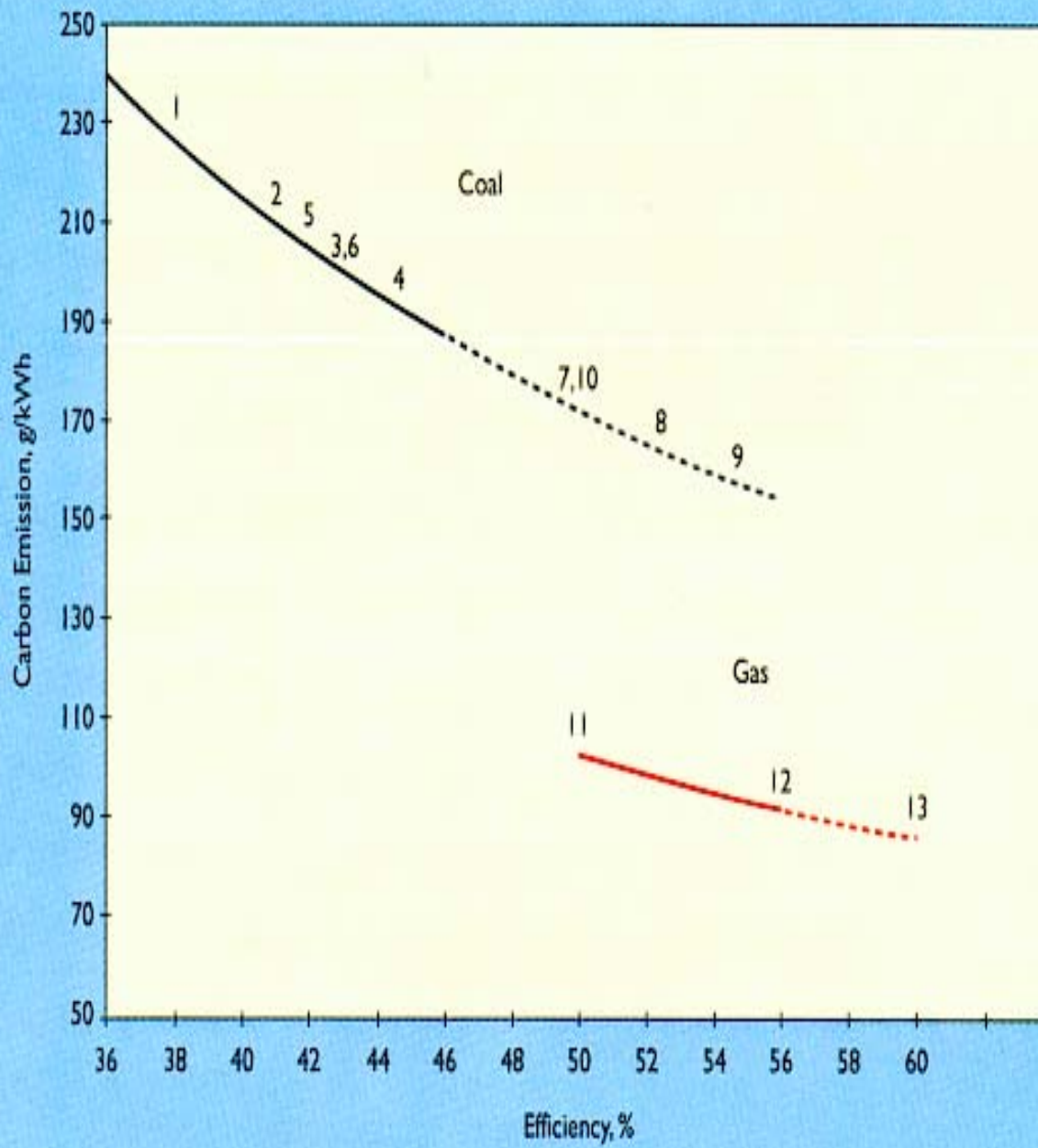
- Industry and government supported RD&D programme

switch to low C fuels

increasing plant efficiencies

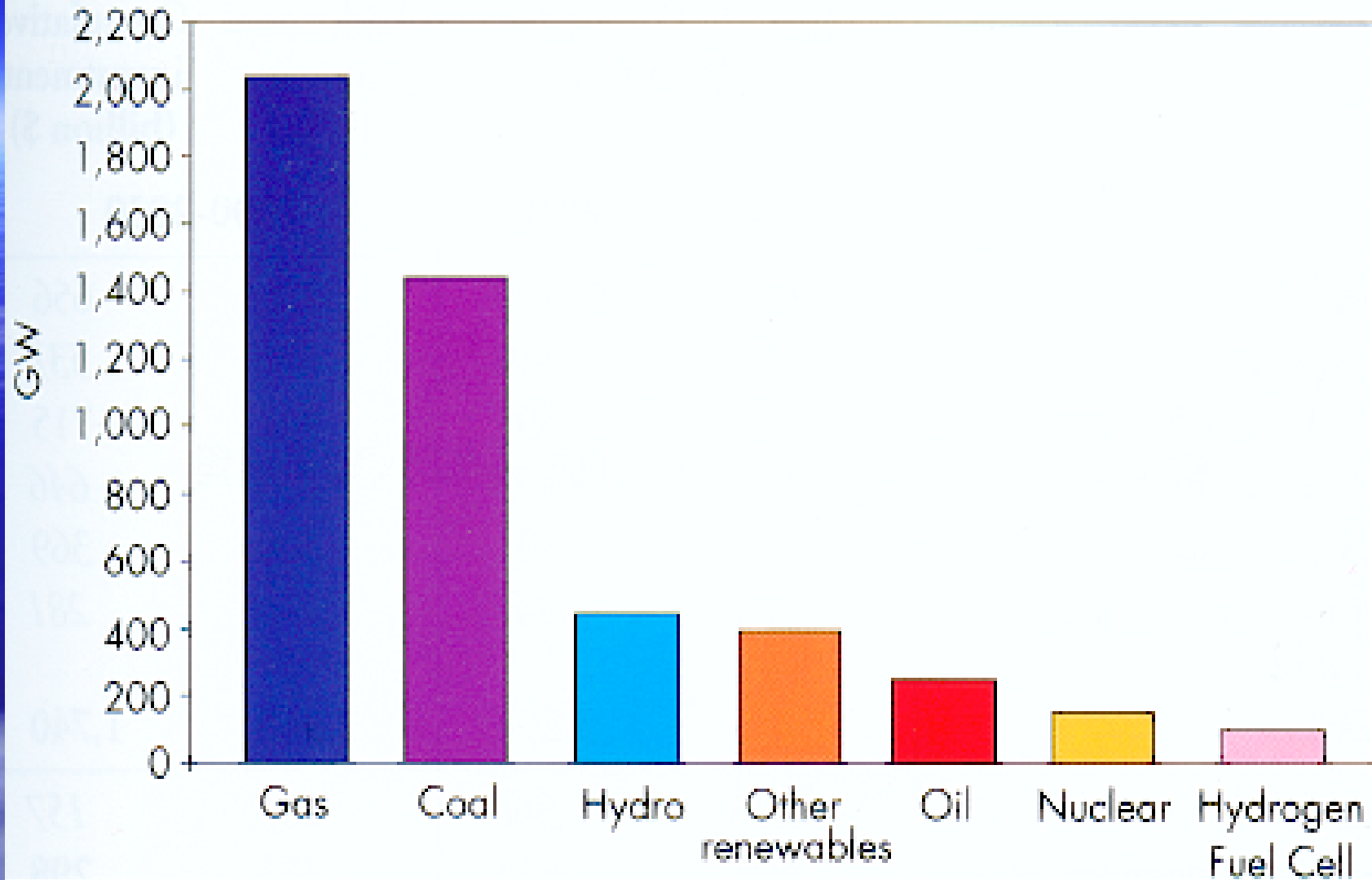
CHP

biomass



Plant type	Efficiency with cooling tower (%)	Source
1 Subcritical pf with FGD	38	typical
2 Subcritical pf with FGD	41	best available
3 Supercritical pf with FGD	43	typical
4 Supercritical pf with FGD	45	best available
5 PFBC	42	demonstration
6 IGCC	43	demonstration
7 PFBC (2010)	50	*
8 IGCC (2010)	53	*
9 Supercritical pf (2010)	55	*
10 ABGC (2010)	50	**
11 CCGT (early)	50	typical
12 CCGT (current)	56	typical
13 CCGT (2005)	60	***

\*Energy World, March 1997  
 \*\*Private communication  
 \*\*\*Power Generation, 10 October 1997



**World electricity capacity additions, 2000-2030**

(Source: IEA World Energy Outlook )

# Future Energy Scene – UK

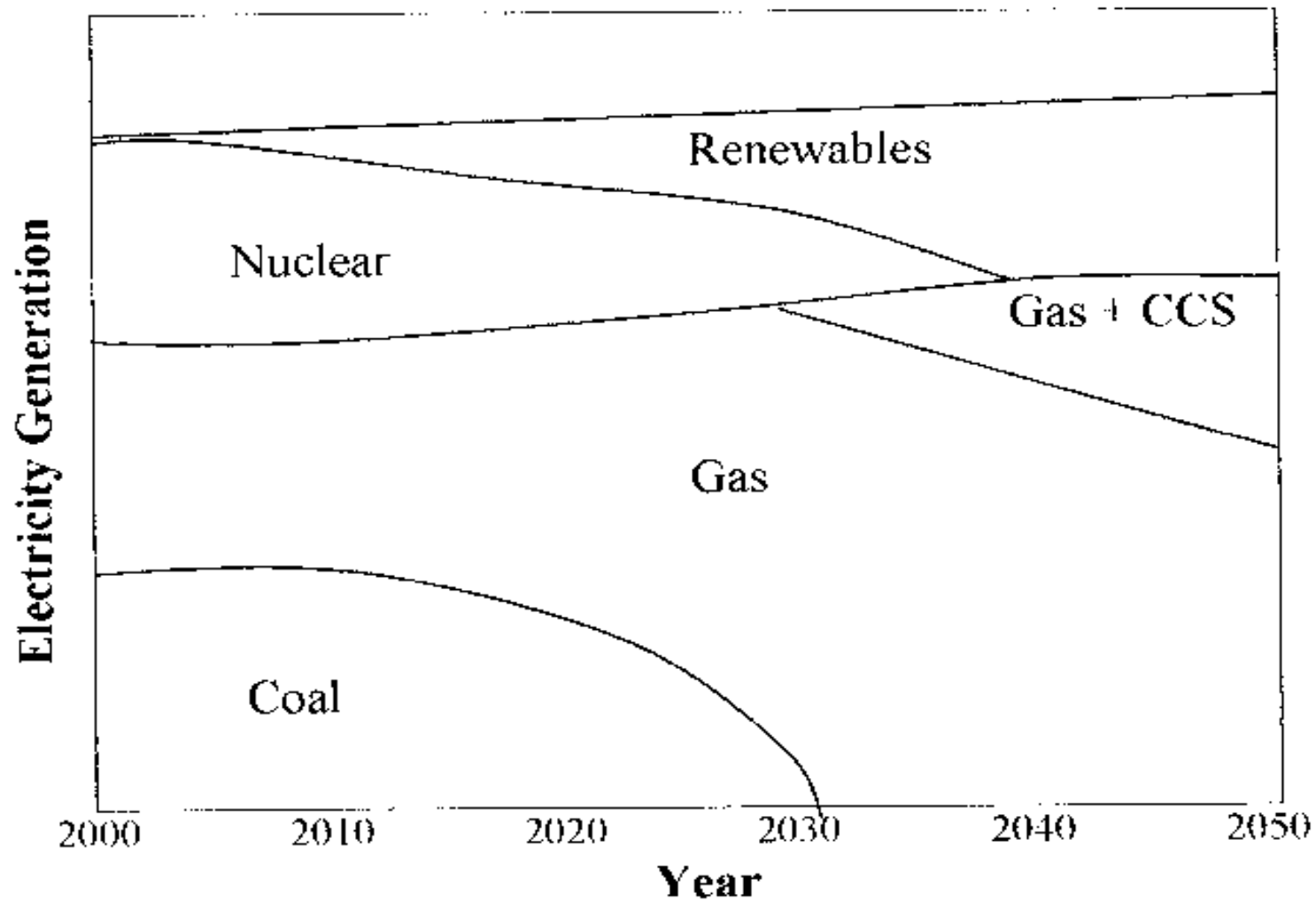
White Paper vision for 2020

- **Backbone – grid of large power stations**
- **More local generation eg wind, biomass**
- **More Chp and micro generation**
- **Gas will form a large part of energy mix**
- **Coal – either smaller, unless economic with reduced CO<sub>2</sub>**
- **LCPD for existing coal**
- **EU wide carbon emissions trading**
- **Existing nuclear almost gone**



**60% CO<sub>2</sub> reduction for 2050**

# Generation in the UK – no nuclear scenario (CCS – Carbon capture and storage)





## Enhanced oil recovery (EOR) - UK

- Use of captured CO<sub>2</sub> for EOR
- Potential win-win if economics right
- Possible lead option for demonstrating CCS
- Limited time window for its application

**Power plant with CCS linked to EOR ~ 2010+**

## CO<sub>2</sub> - Global

- Electricity growing & dominant source of CO<sub>2</sub>
- Expect requirement for CCS post 2030
- Social & legal issues with CCS
- Developing countries – increasing effic'y?
- Transport – drive for H<sub>2</sub> post 2020
- Fossil fuels likely source of H<sub>2</sub>

# Future Markets

- Next 30yrs, globally \$4000bn, 5000GW
- Drivers: cost regulation resources markets
- Challenges – privatisation  
- competition  
(USA, Japan, China etc)
- UK position – traditionally 10%

**Need strong, focussed RD&D programme to maintain position**

	<b>PROGRAMME</b>	<b>VALUE</b>
<b>USA</b>	<b>DoE Clean Coal Technology Demonstration Programme.</b>	<b>\$5.2B (total)</b>
	<b>Clean Coal Power Initiative</b>	<b>\$2.0B (federal)</b>
	<b>Power Plant Improvement Initiative</b>	<b>\$95M (federal)</b>
	<b>Fossil Energy Vision 21</b>	<b>\$220M (2001 budget)</b>
	<b>Coal Power Program Roadmap</b>	<b>\$10.7B (total proposed)</b>
	<b>FutureGen</b>	<b>\$1.0B (80% federal)</b>
<b>Japan</b>	<b>New Sunshine programme</b>	<b>£360m (1999 budget)</b>
<b>Germany</b>	<b>Coretec</b>	<b>not defined</b>
<b>Canada</b>	<b>Clean Coal Power Coalition</b>	<b>Phase 1 C\$5m Retrofit C\$500m Green field C\$1bn</b>

## Technology Development Strategy

- Needs to consider coal, gas and biomass (short, medium and long term)
- 2 elements to programme for new & retrofit:
  - increasing plant efficiencies (E)
  - near to zero emissions with CCS goal (C)

E – own markets + precursor to (C)

E – should carry on from existing programmes

C – needs to meet timescales for EOR & CCS

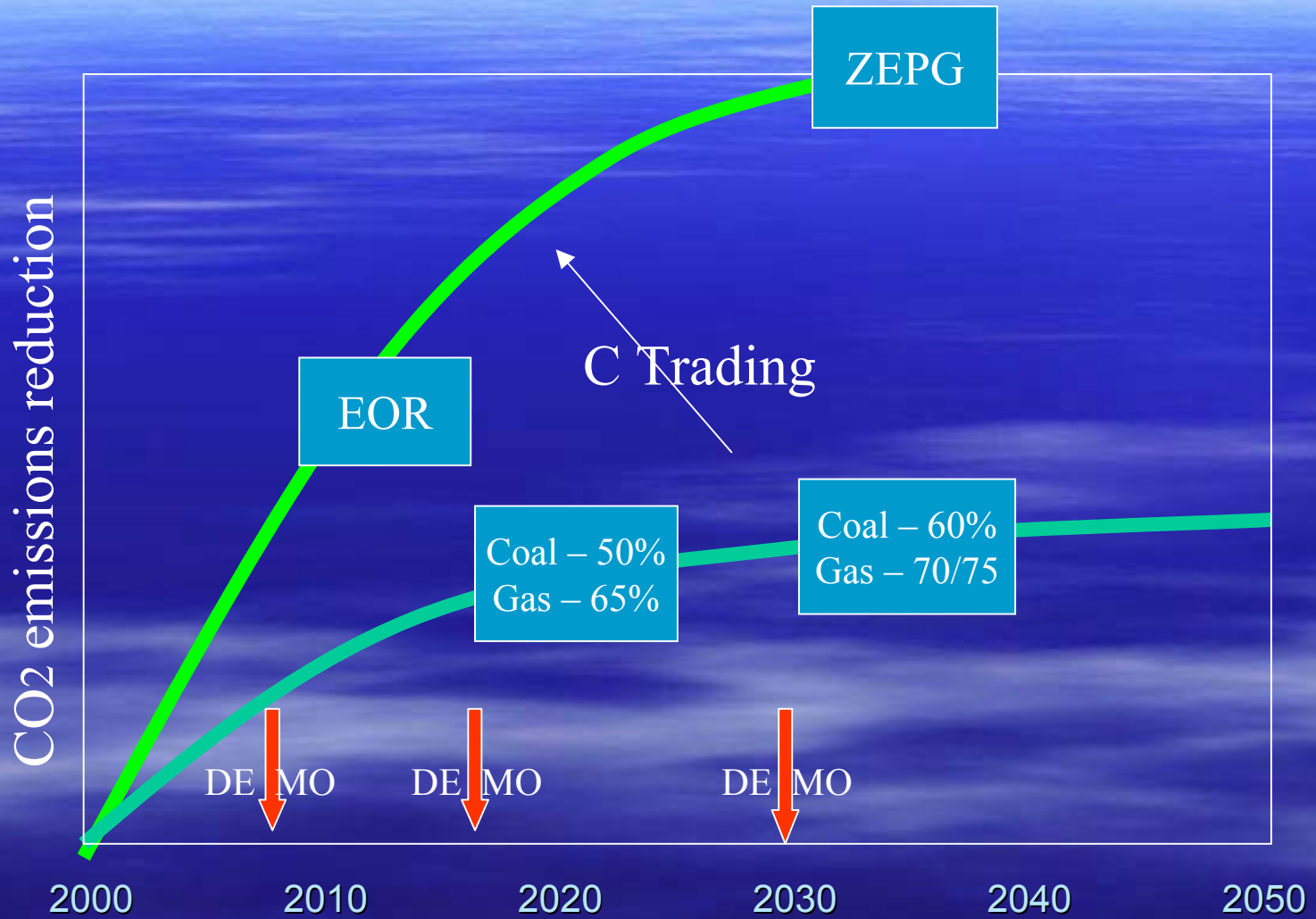
Efficiency programme targets

	2005+	2015+	2030+
Electrical eff'y on coal	BAT	50%	60%
Electrical eff'y on gas	BAT	65%	70-75%
NOx, SOx, particulates	BAT	Near zero	
RAM	BAT	Better than current values	
Costs	Cost effective generation	Cost effective generation	

Technology targets for fossil fuel plant with CCS

	2005+	2015+	2030+
Electrical eff'y on coal	BAT	50%	60%
Electrical eff'y on gas	BAT	65%	70-75%
Carbon capture penalty	BAT	-9%	-(6-7)%
NOx, SOx, particulates	BAT	Near zero	
RAM	BAT	Better than current values	
Costs	Cost effective generation & EOR	Cost effective generation	

# Technology Development Time Lines



# Technology Development - Demonstrations

Culmination of each phase should be a Demo:

**Advanced high efficiency coal plant ~ 2005+**

(new or retrofit with/without EOR)

**Low emission power plant ~ 2015+**

(include CCS or be CCS ready)

**Zero emission power plant ~ 2030**

(include CCS and H2 if H2 commercial)



# The Technologies

- Power plant

  - Pf + fgd

  - IGCC

  - GTs

  - Fuel cells

- CO<sub>2</sub> capture

  - Post combustion (pf and GTs)

  - Pre-combustion (gasification)

  - Oxyfuel (pf and GTs)

# CO<sub>2</sub> Abatement Cost Comparison (£/tC 2020/25)

Energy Efficiency	-250 to 35
Renewable Energy	
- Onshore Wind	-40 to 130
- Offshore Wind	160 to 480
- Energy Crops	135 to 185
- Wave	120 to 430
- Tidal	250 to 690
- PV	2,200 to 3,200
New Nuclear	105 to 180
CO <sub>2</sub> Capture and Storage	
- EOR	48 to 183
- Storage in Depleted Gas Fields	125 to 341

Sources: IAG, FES/MARKAL, FES

# Themes for RD&D – Basic Research

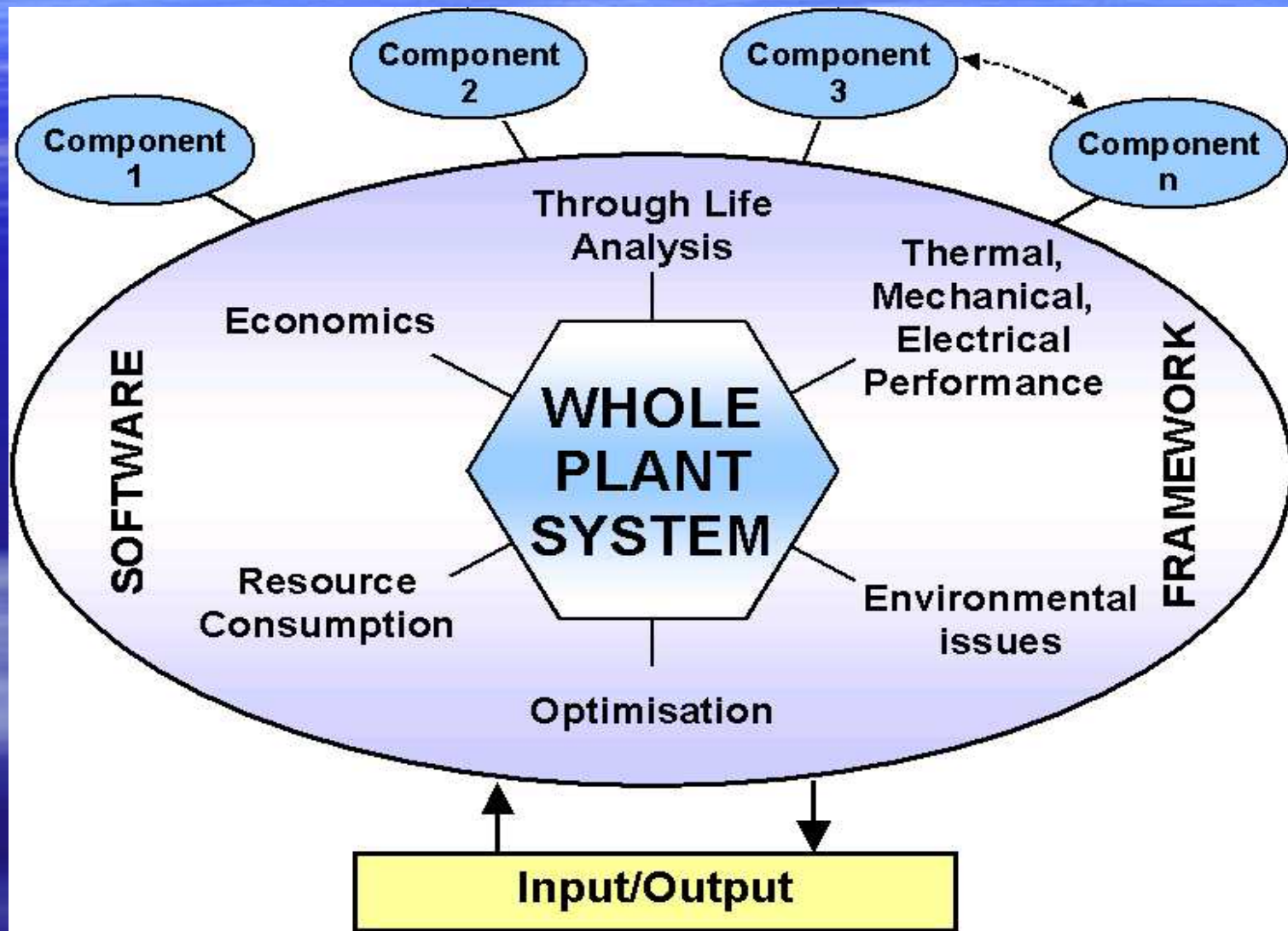
Technology	Com	Mat	ECh	Cat	Mem	C&I	FSc	Man	Mod	CLI	Ele	Car	Aer
Gasification		X		X	X	X	X	X	X	X			
Fuel Cells		X	X	X	X	X		X		X	X	X	
GTs	X	X		X		X		X	X	X	X		X
Pf	X	X		X		X	X	X	X	X			
Novel cycles	X	X	X	X	X	X	X	X	X	X			
Carbon Management	X	X		X	X	X	X						

# RD&D Theme – Components & Technologies

- Combustion
- Biomass + cofuelling
- Gasification
- Emissions control
- Membranes
- Component integrity
- Control systems
- Plant manufacture
- etc

# RD&D Theme – Virtual Demonstration

(computer systems for accurate plant modelling)

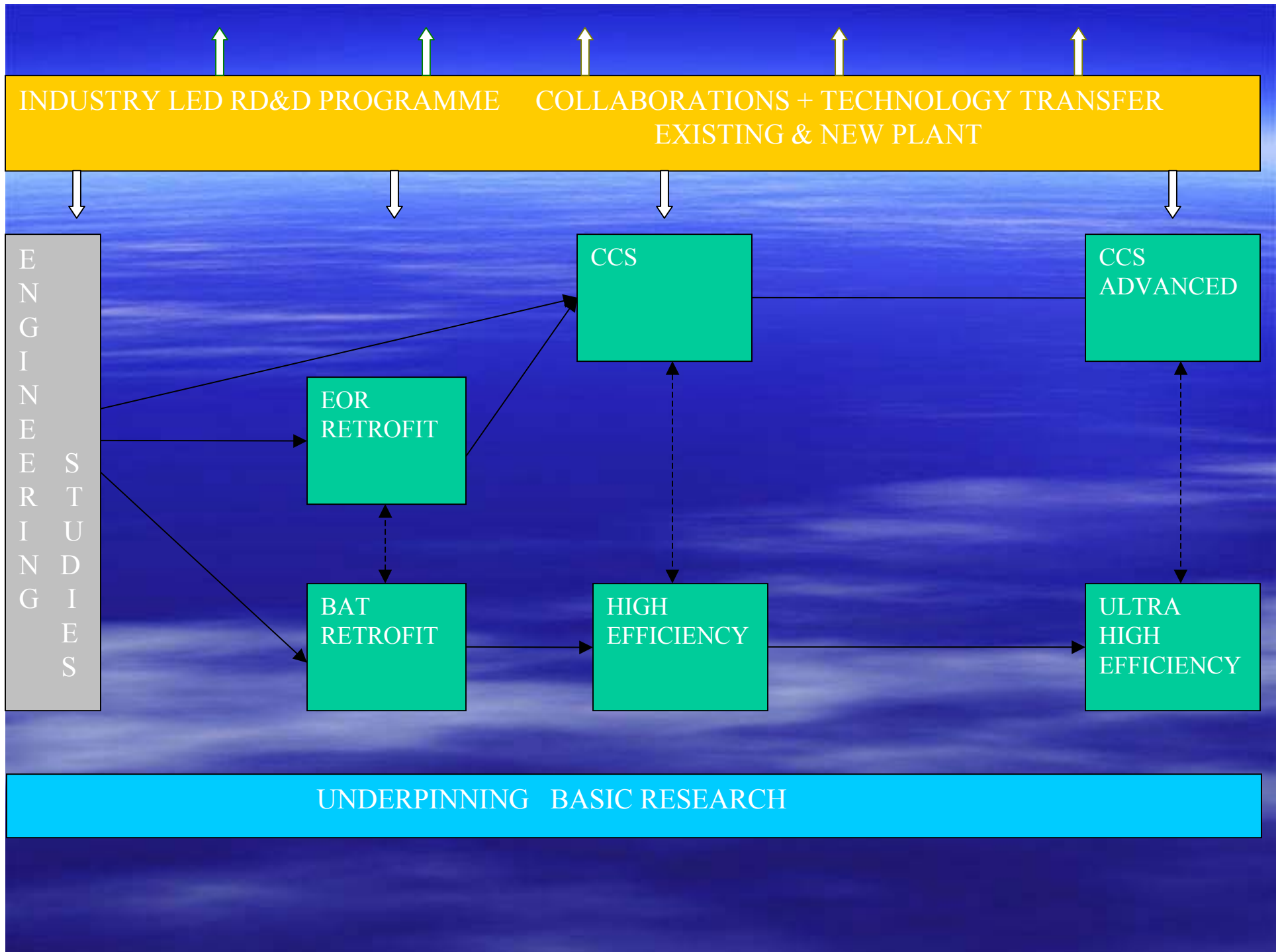


# RD&D Theme – Physical Demonstration

- Demonstration of components, systems and whole plant (nationally and abroad)
- First Demo target could be retrofit:
  - advanced supercritical retrofit      CO2 scrubbing  
oxyfuel firing  
without capture
  - coal gasification retrofit      pre combustion capture  
without capture
  - CCGT retrofit  
scrubbing      post combustion

# Other supporting RD&D

- **Systems analysis** – evolution with time
- **Social research** – eg public acceptability
- **Suitability of CO<sub>2</sub> storage**
  - development of models to examine integrity of long term storage
  - greater knowledge base for EIA of consequences of CO<sub>2</sub> release





# Implementation

- **Industry led RD&D programme**
  - existing programmes to continue
  - engineering/economics studies for demos
  - participation in international programmes
- **University research programme**
  - feed into Energy Research Centre, EPSRC etc
- **Technology Transfer & export promotion**
  - engage future customers + export opportunities
- **Measures for closer industry/academe cooperation**
  - encourage development of new technologies and skills