



Providing Solutions for Energy Generation and Use

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e.on

The world's largest investor-owned power and gas company.



e-on

With annual sales of €56bn (\$71bn) and nearly 80,000 employees.

E.ON UK



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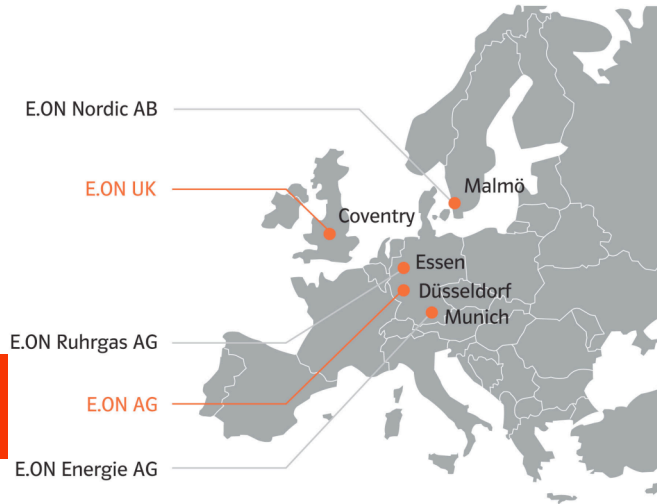
E.ON Nordic AB



E.ON Ruhrgas AG



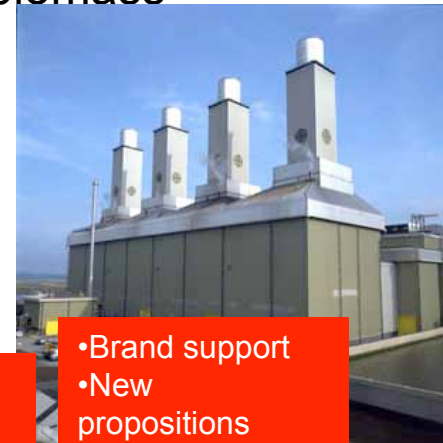
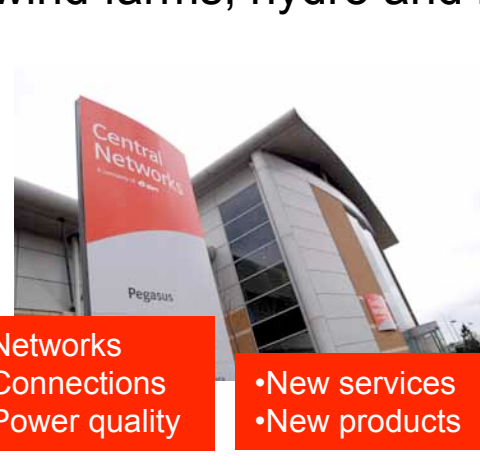
E.ON Energie AG



E.ON UK

Integrated UK energy business

- Wholesale
 - 10,900 MW of generating capacity
 - Combined Heat and Power – 14 sites
 - Renewables – over 20 operational wind farms, hydro and biomass
- Trading (Power, Gas and Carbon)
- Distribution – Central Networks
- Retail - **9m customers**



•Social responsibility
•Corporate governance

•Risk management
•Reliability
•Availability
•Flexibility

•Scheduling
•Power trading
•Carbon trading

•Networks
•Connections
•Power quality

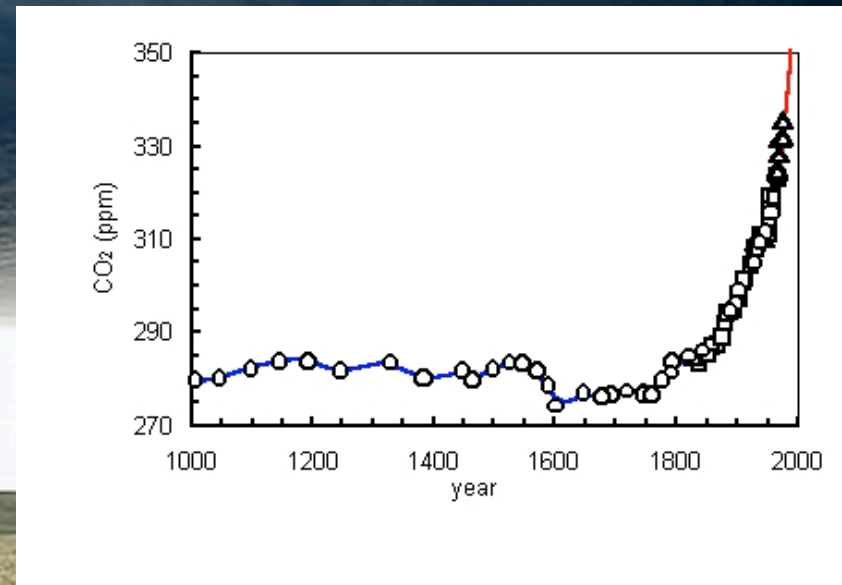
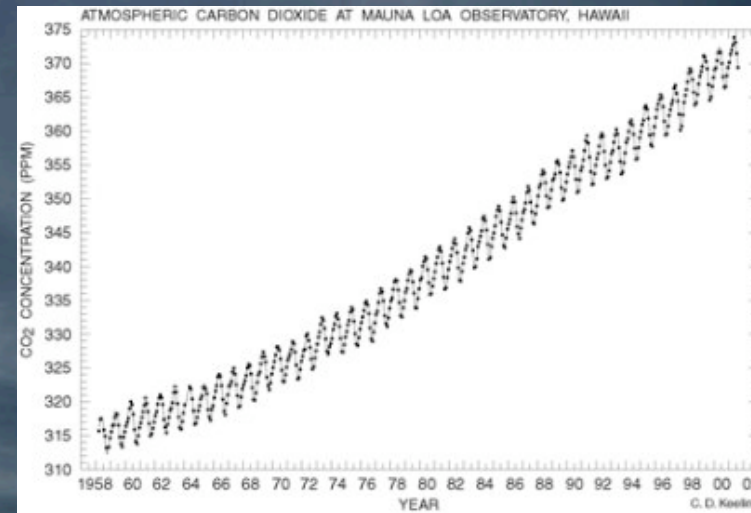
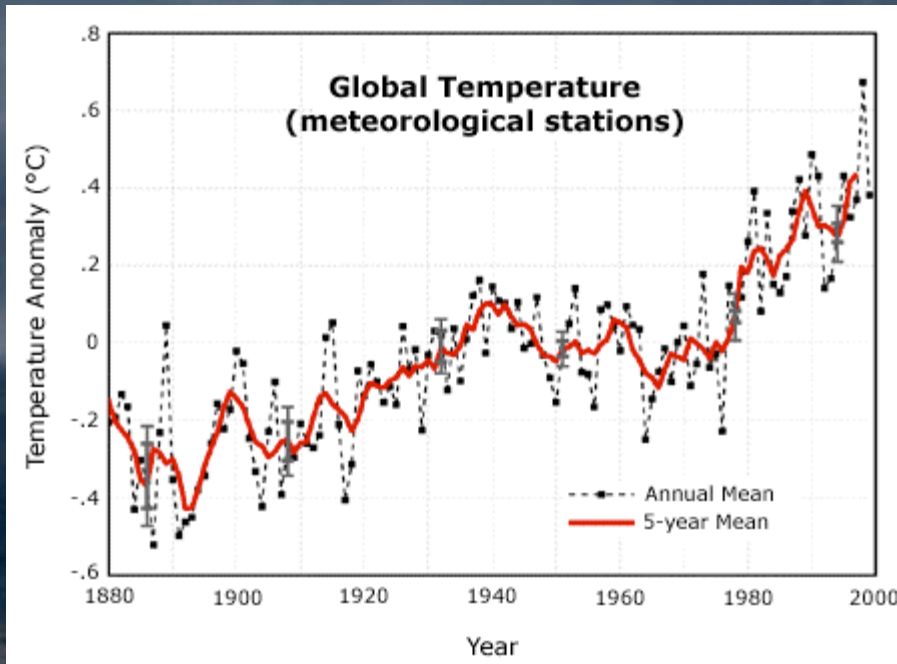
•New services
•New products

•Brand support
•New propositions
•EEC commitment



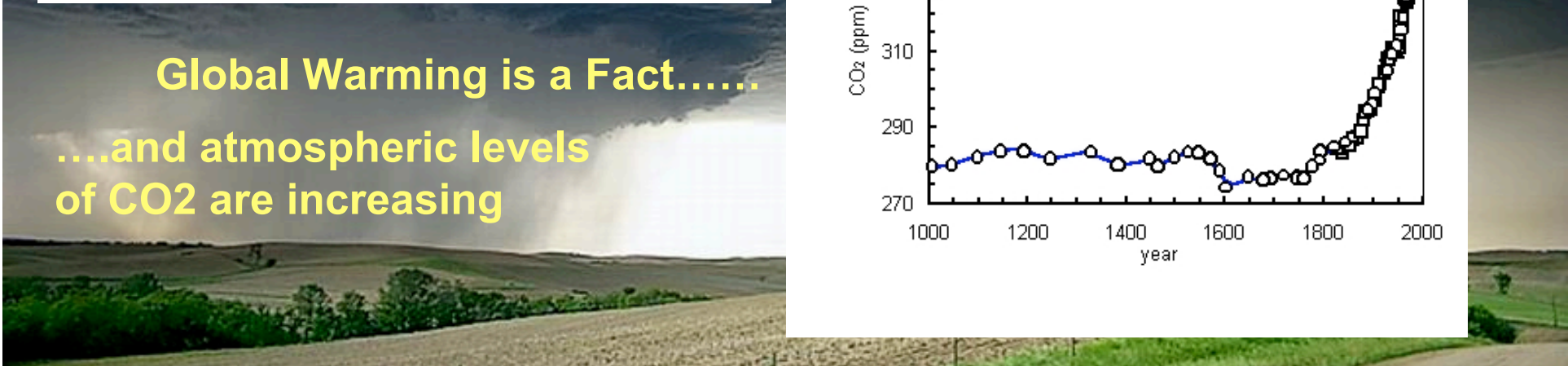
CO2 – A Powerful New

2005 –
← 381ppm

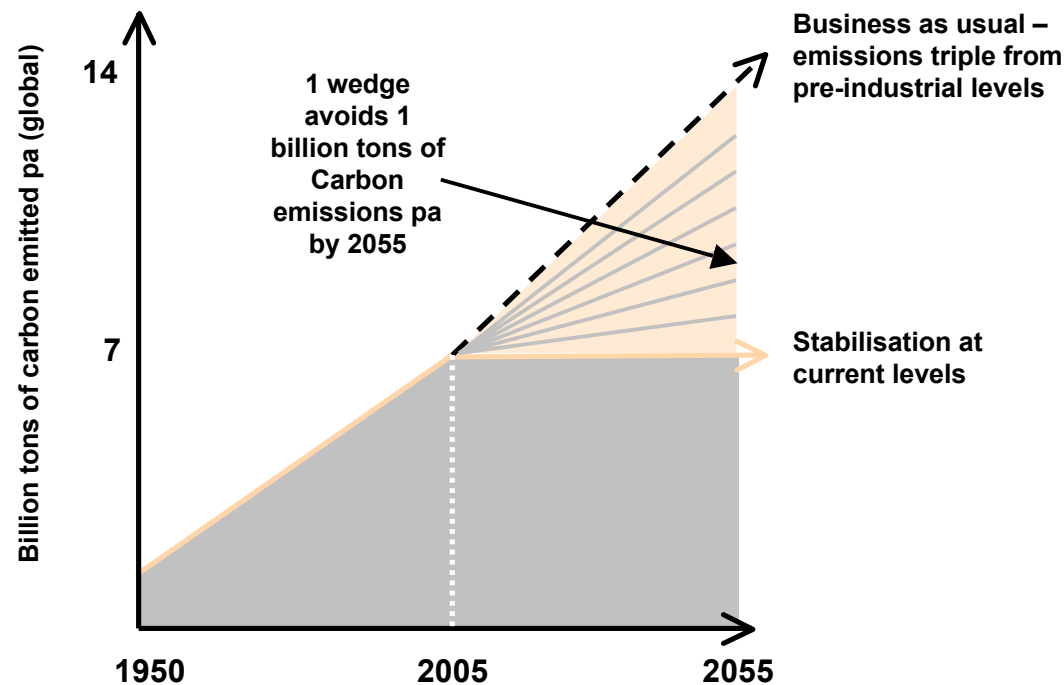


Global Warming is a Fact.....

....and atmospheric levels
of CO₂ are increasing



Schematic of range of actions required globally



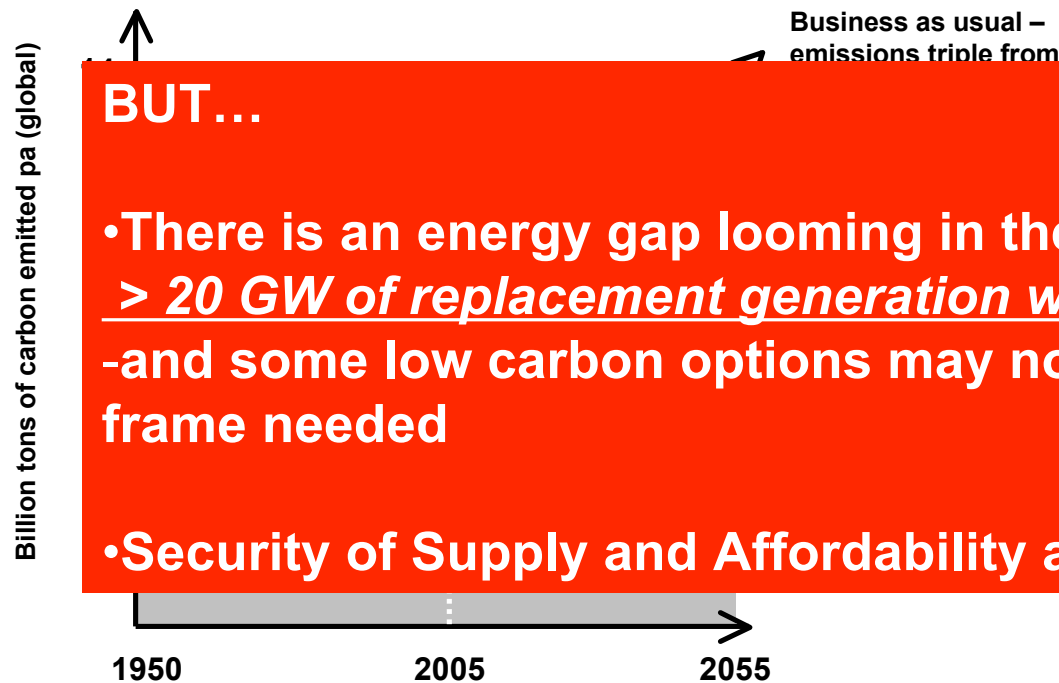
One “wedge is equivalent to any one of the following:

- A global shift from coal to gas
- Wide scale carbon capture and storage.
- Major investment in nuclear
- Increased use of renewables
- Wide scale adoption of small scale combined heat & power or fuel cells
- Energy efficiency measures.
- Transport – doubling fuel economy or halving the number of miles driven.

Schematic of range of actions required globally

One “wedge is equivalent to any one of the following:

- A global shift from coal to gas



BUT...

• There is an energy gap looming in the UK – > 20 GW of replacement generation will be needed by 2015 -and some low carbon options may not deliver in the time frame needed

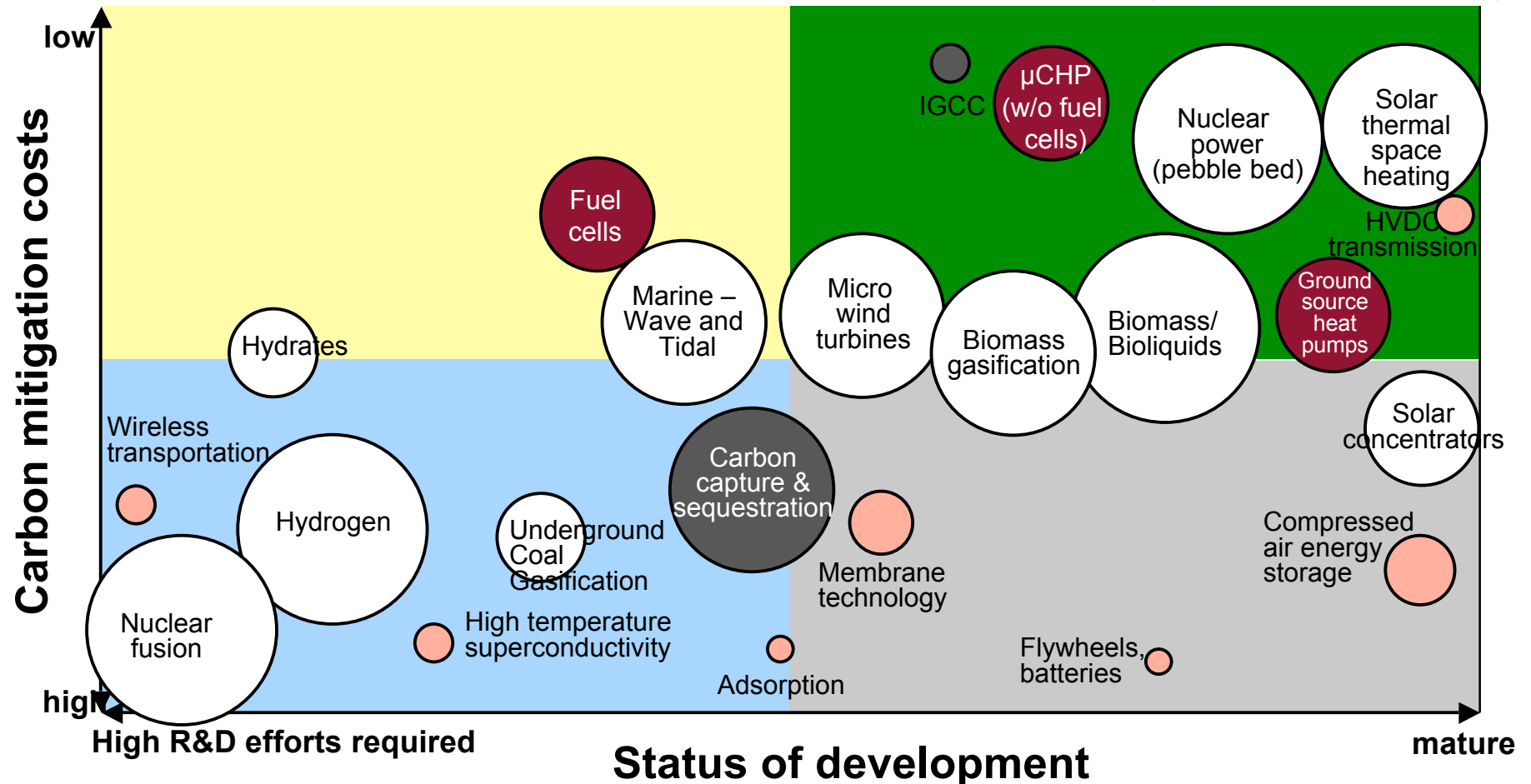
• Security of Supply and Affordability are two key issues

- Energy efficiency measures.
- Transport – doubling fuel economy or halving the number of miles driven.

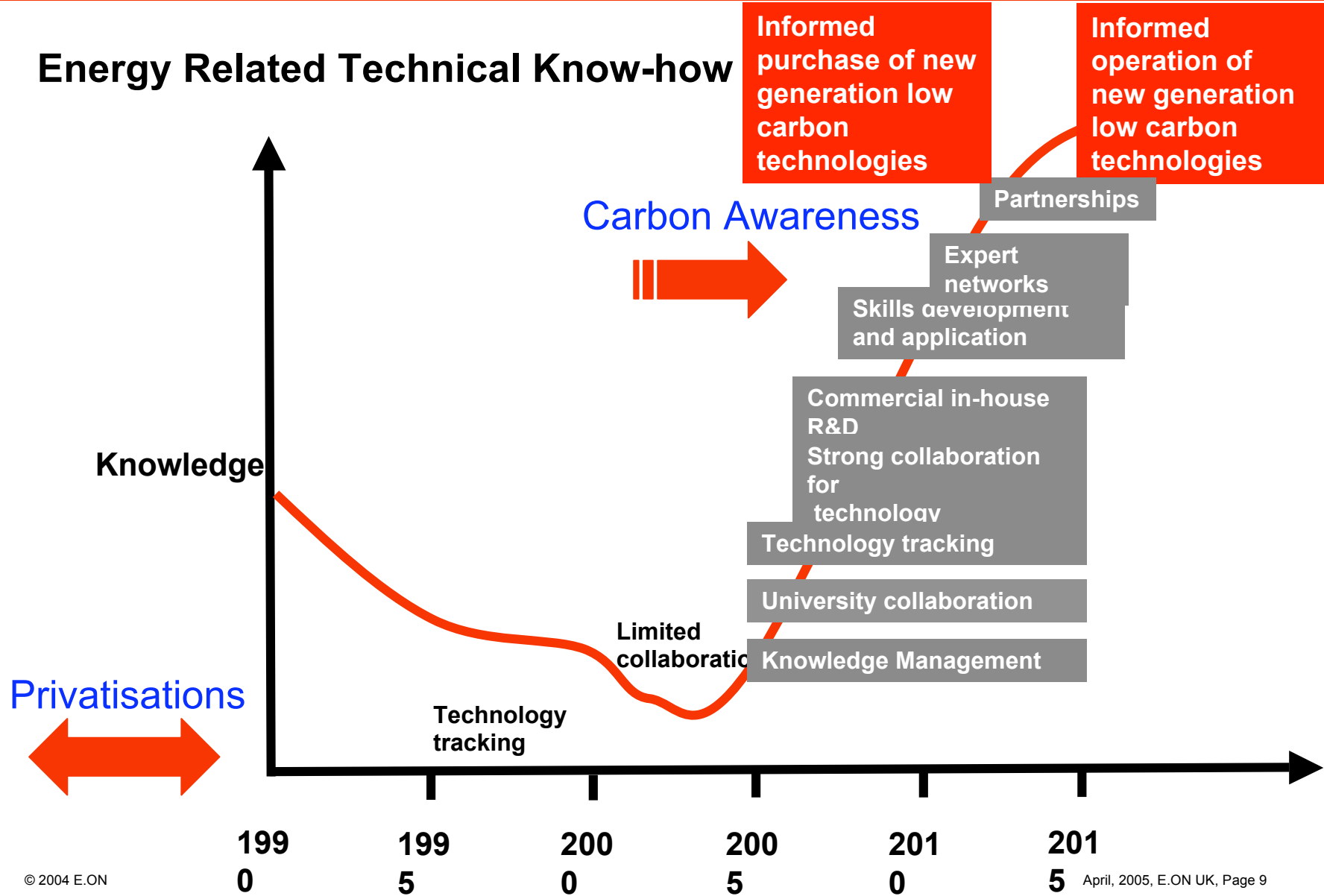
Carbon mitigation potential and cost of future technologies

technologies

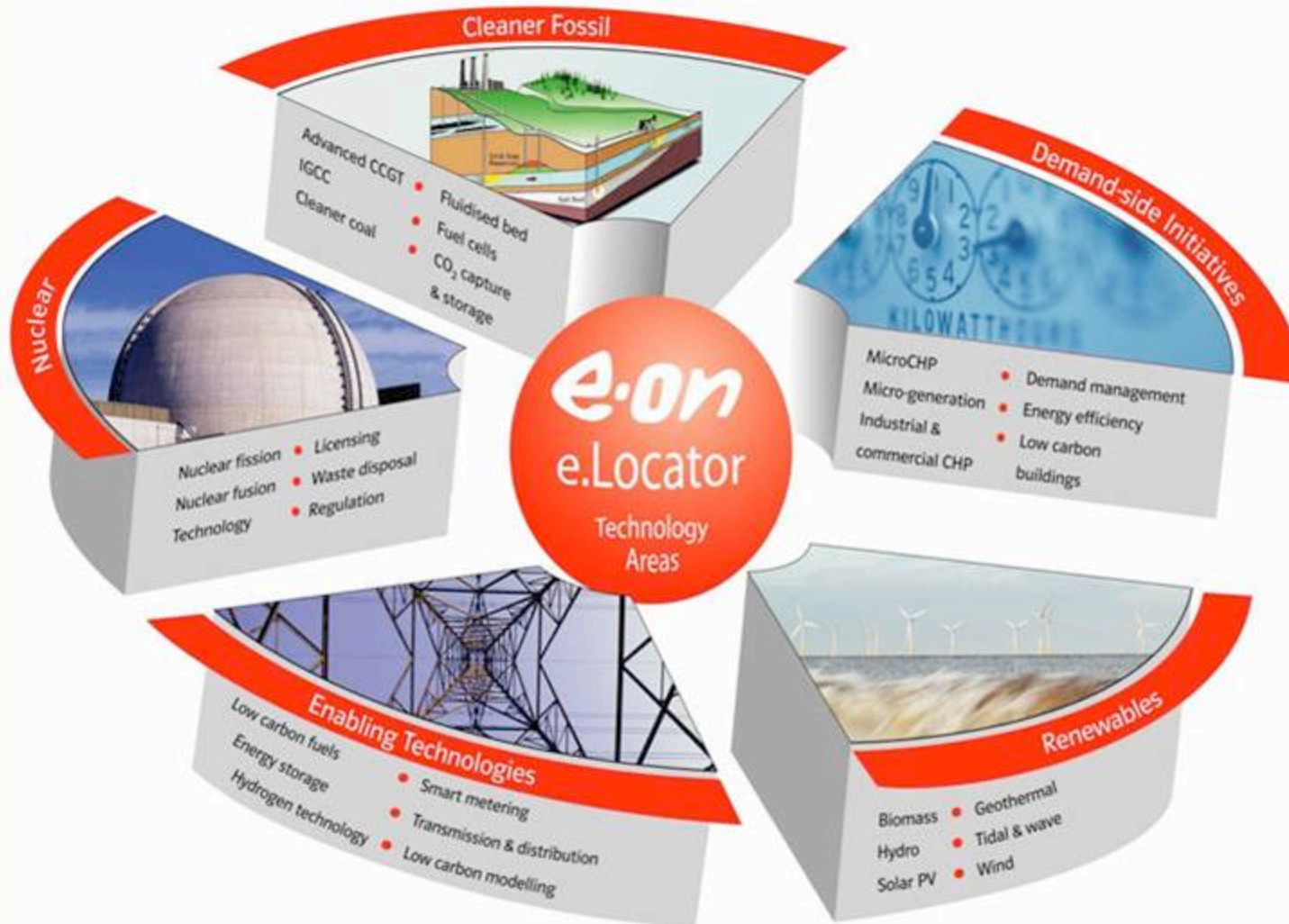
- new/ advanced fuels
- energy efficiency enhancements
- Optimisation of energy systems
- Clean coal technology



Energy Related Technical Know-how



Low Carbon Solutions



Distributed generation & demand si

Demand-side reviews

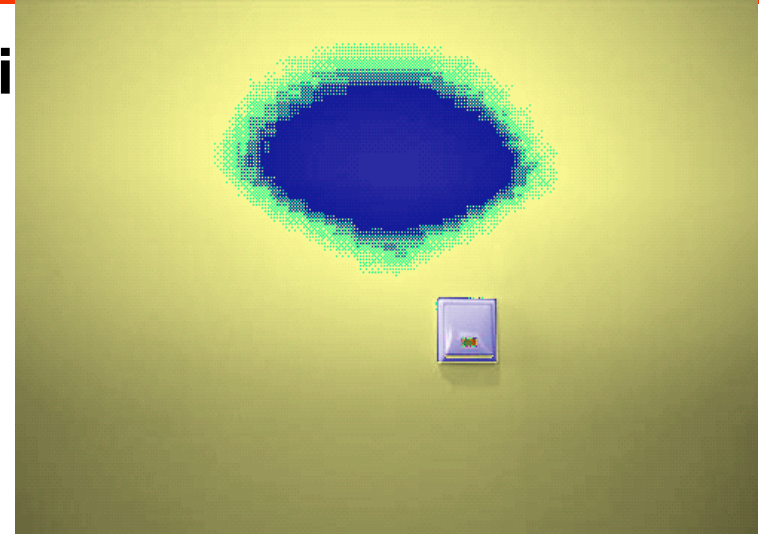
- Demand-side issues, measures and technologies

DG & active load management

- Intelligent active energy management for small energy zones

Demand-side buildings

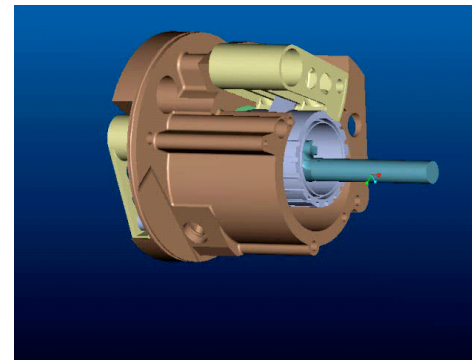
- Low carbon solutions for existing commercial buildings
- Catalogue of low carbon domestic and commercial technologies



Distributed generation & demand side

Micro generation

- Home wind turbine trials and demonstration – Nottinghamshire, Leicestershire and Staffordshire
- Major technical review of WhisperGen technology and other mCHP options
- Ongoing technical support to Retail and Energy Services in delivering low carbon product incubation process for novel technologies – eg ground-source heat pumps



Enabling Technologies

Electricity transmission and distribution

- Connection challenges for renewables

Low carbon market modelling

- New market modelling techniques
- Construct low carbon technology market model

Energy storage

- DTI Innovation Project - Develop 1MW x 4MWh battery (2006-2008), install on CN 11kV network and operate (2008-2010)
- Flow battery storage technology development - Pilot-scale (5kW) evaluation and analysis of potential

benefits



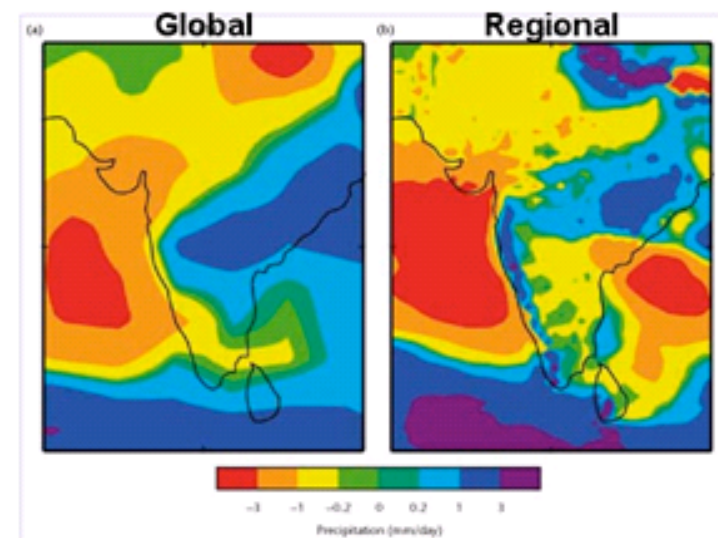
Renewables

Wind

- Valuing wind capacity and its affect on the Wholesale Market
- Steering Group of SUPERGEN Wind Consortium – setting UK University agenda and priorities
- Develop tools to understanding wind turbine blade stress profiles to inform NDT strategy

Climatology

- Scoping study to refine Met Office climate forecasting model for long term renewable resource prediction



Renewables

Marine

- Review of Tidal technology & opportunities
- Develop strategy for estimating energy yield
- Build capability in energy yield assessment



Other

- Technology tracking: e.g. low-head hydro, solar thermal & geothermal



Cleaner Fossil – Carbon Abatement Technologies (CATs)

Carbon Capture

- Collaboration with University of Regina on amine scrubbing for post-combustion capture
- EU FP6 CASTOR project – assessing technologies for CO2 capture, follow on collaboration on whole plant engineering and integration

CO2 transportation & storage

- UK site study – British Geographical Survey
- Collaborate with major oil companies and other stakeholders via membership of CCSA & IEA GHG Association

IGCC

- EU collaborations: CACHET (CO2 capture by pre-combustion) & DYNAMIS (benchmarking competing IGCC processes)

Oxyfuel

- Modification of the 1MW CTF for oxyfuel firing - RFCS EU collaboration



E.ON UK has a potentially viable CCS project at Killingholme

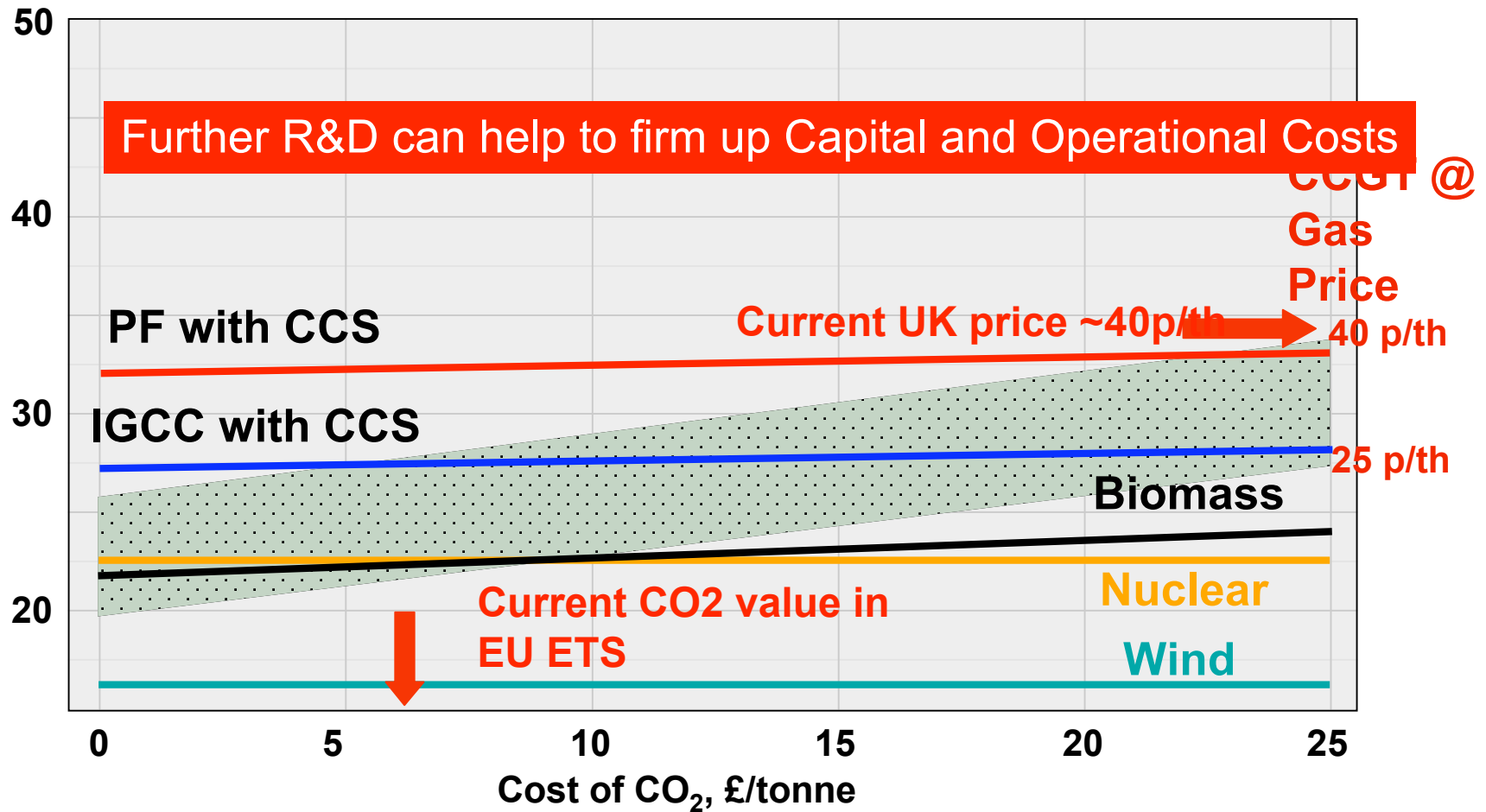
Overview

- Killingholme will nominally be a 450MW IGCC+CCS fuelled on coal
- Built on or close to the existing Killingholme site
- Multiple CO₂ storage options identified in the Southern North Sea
- Full FEED Study due for completion May 2008



Price Estimates - EPRI Analysis for 2020

Levelized Cost of Electricity, £/MWh



Overview of CATs Research Agenda

Efficiency improvement for power plant

- **boilers, turbines, IGCC**

Co-use of biomass

- **cofiring, co-gasification, ...**

Carbon dioxide capture

- **post-combustion, pre-combustion, oxyfuel**

Carbon dioxide transport and storage

- **Pipelines, Ships, EOR, depleted gas fields, saline aquifers, unmineable coal seams**

Improved performance, economics, safety, environment and public awareness

Efficiency Improvement for Power Plant

Plant efficiency
% NCV

55

50 – 55%

Target

ISSUES

- Materials, fabrication, inspection, monitoring and life assessment technologies for progressive increases in steam temperature and pressure to 350 bar and 750°C
- Particular issues relating to high nickel alloys
- Utilisation of waste heat

30

Old Plants

30%

1960

1980

2000

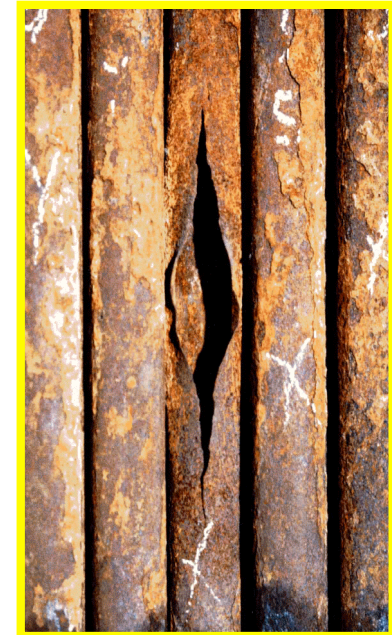
2020

Year



Co-use of Biomass

- Advanced cofiring or co-gasification (up to 20% or more by heat input), including corrosion, slagging and fouling issues
- Efficient preparation and processing of biomass energy crops (e.g. pelletisation, torrefaction)
- Other cycles using biomass (e.g. biomass feedwater heating)



Carbon Dioxide Capture Technologies

Post-combustion (scrubbing)

- Process optimisation
- New and less energy intensive solvents (e.g. amines, chilled ammonia)
- Avoidance of solvent degradation

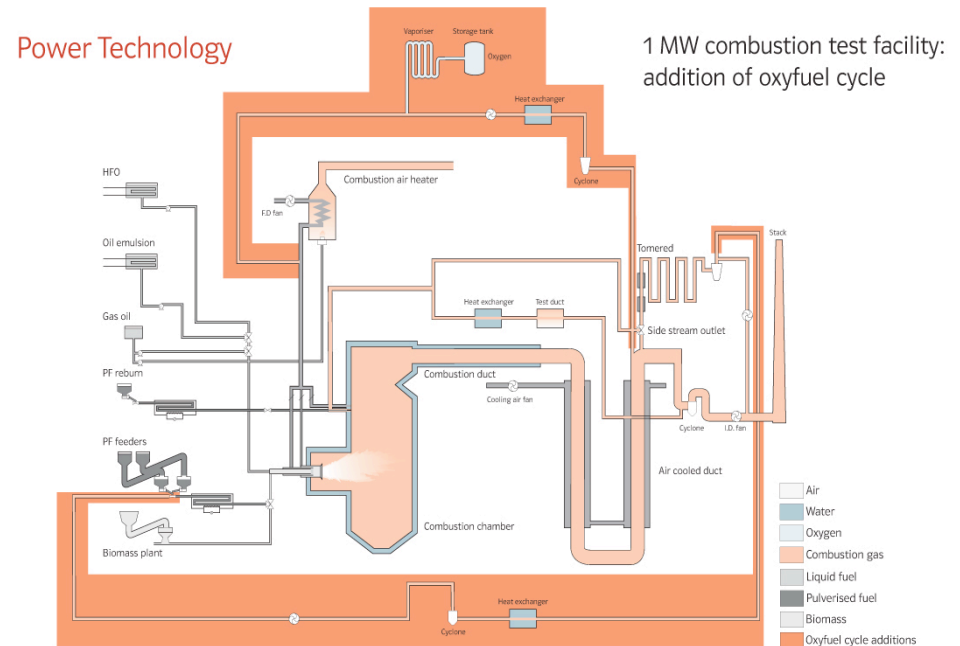
Pre-combustion Capture

- Gasification : process integration/optimisation, improved availability
- Gas cleaning : improved reliability
- Gas conditioning : CO₂ capture : integration and optimisation of shift conversion and CO₂ capture processes, conditioning of H₂ fuel gas stream for GT
- Gas turbine : Premix burners for hydrogen requiring
- Air separation unit : Process optimisation, improved absorbents for contamination removal, high efficiency packings for distilling fluids close to supercritical conditions

Carbon Dioxide Capture Technologies

Oxyfuel combustion

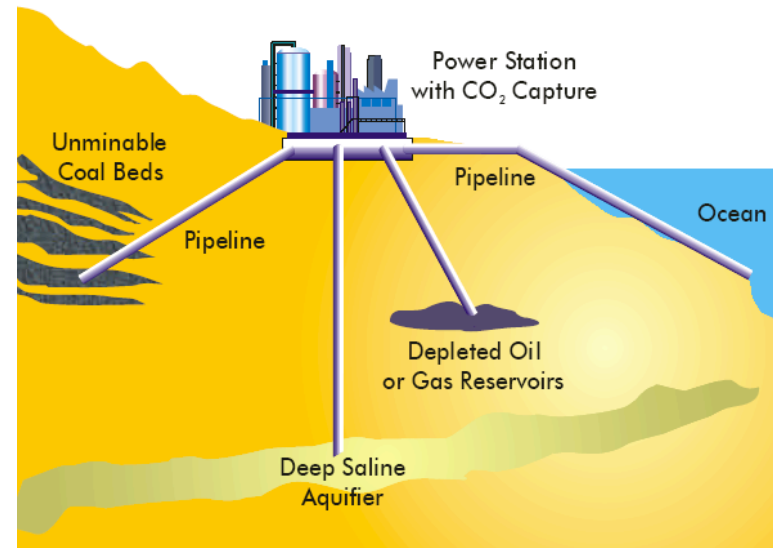
- Process optimisation – including start-up/shut-down
- Combustion chemistry and kinetics
- Heat transfer prediction
- Materials for oxyfuel environment, corrosion issues
- Ash properties
- Flue gas cleaning to meet CO₂ specifications
- ASUs
- Flue gas cleaning and conditioning



Carbon Dioxide Transport and Storage

Transport

- Corrosion behaviour of pipelines as a function of material, temperature, etc
- Alternative materials, joining technologies, sealing technologies
- Crack formation and growth
- Technologies for CO₂ ships



Carbon Dioxide Transport and Storage

Storage

- Gather experimental data and develop proper modelling and measuring, monitoring and verification techniques, together with knowledge and methods on trapping, rock and fluid properties, stability/integrity and CO₂ mobility
- Assess / develop cost-effective methods for managing impact of sub-surface uncertainty on performance prediction and risk.
- Develop database of equilibrium and kinetic data for use in coupled geochemical modelling of storage systems.
- Develop remote sensing techniques that give improved characterisation of stability of storage sites e.g. geomechanical properties for fault stability
- Assess potential for storage in saline aquifers e.g. develop atlas of seal and saline formation properties for North Sea
- ECBM /UCG – real absorption capacity of coal as function of depth and permeability

Conclusions

- **The technology options for a low carbon future are extensive and cover the entire electricity supply chain**
- **Many are still some way from the marketplace and need significant R&D**
- **There are a range of materials issues associated with the candidate technologies from the development and characterisation of exotic nickel based alloys to withstand steam temperatures of greater than 700°C to porous materials capable of storing hydrogen in large quantities**