



IEA Greenhouse Gas R&D Programme



The status of CCS and issues surrounding CCS projects

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IEA Greenhouse Gas R&D Programme

Financing CCS - May 28th 2008



Overview

- IEA Greenhouse Gas R&D Program
- Energy Demand and Global Warming
- Fossil Fuel Consumption and Carbon Lock-in
- CCS, its Role and Technology Status
- CCS Policy and Regulation
- Current and Future CCS Projects
- Next Steps in Financing CCS



IEA Greenhouse Gas R&D Programme

- A collaborative research programme involving governments, industry and other bodies founded in 1991
- Aim is to:
 - Provide members with information on the role that technology can play in reducing greenhouse gas emissions.*
- Funding approximately \$2.5 million/year.
- Activities:- technical studies (>100), international research networks , facilitating and focussing R&D and demonstration activities
- Producing information that is:
 - Objective, trustworthy, independent
 - Policy relevant but NOT policy prescriptive
 - Reviewed by external Expert Reviewers
 - Subject to review of policy implications by members



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ALSTOM



CEZ GROUP



ConocoPhillips

Eni EniTecnologie

e-on

EPRI

ExxonMobil

REPSOL YPF



Schlumberger



Statkraft

STATOIL



VATTENFALL

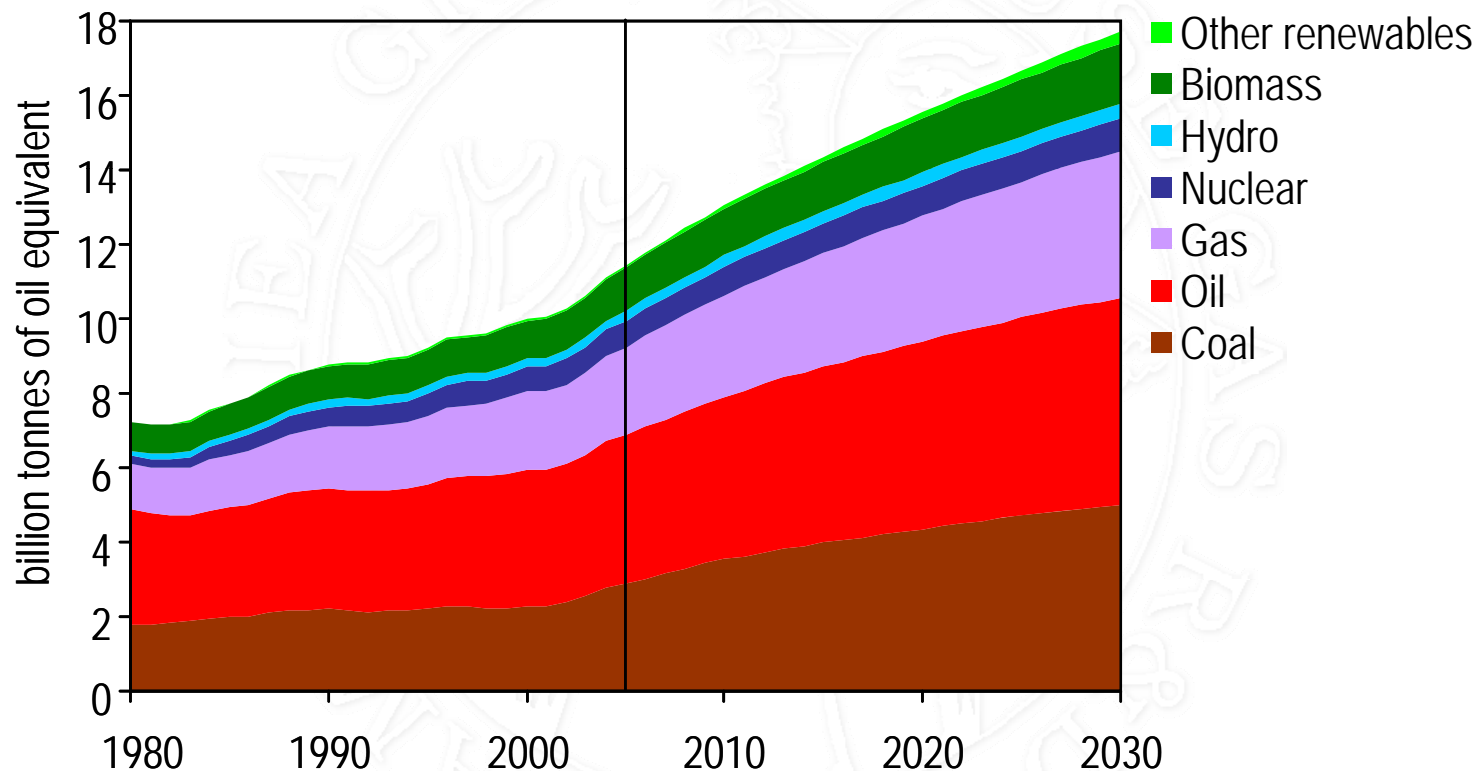


OPEC ORGANIZATION OF THE PETROLEUM EXPORTING COUNTRIES

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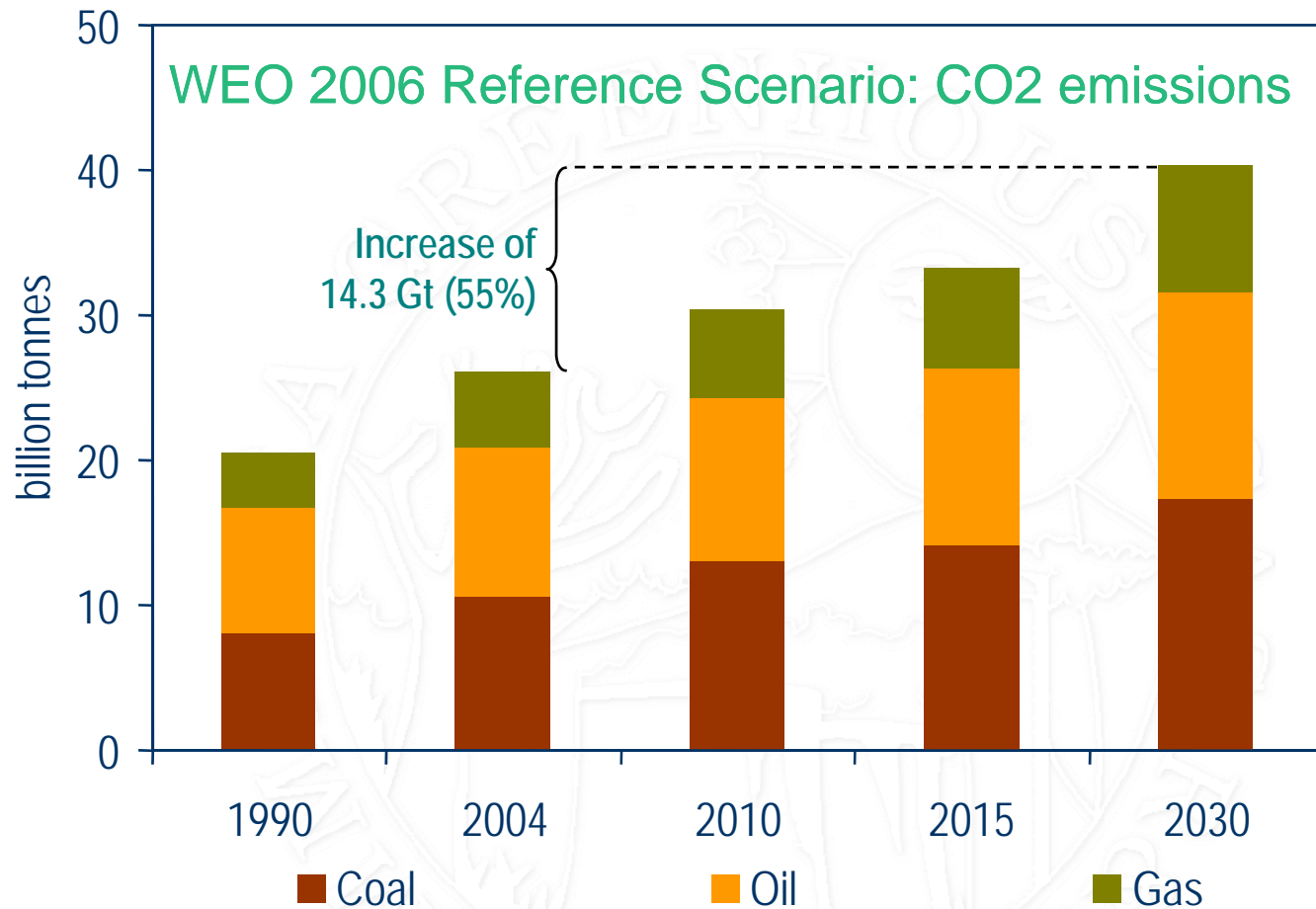
WEO 2007 Reference Scenario: World Primary Energy Demand



Global demand grows by more than half over the next quarter of a century, with coal use rising most in absolute terms



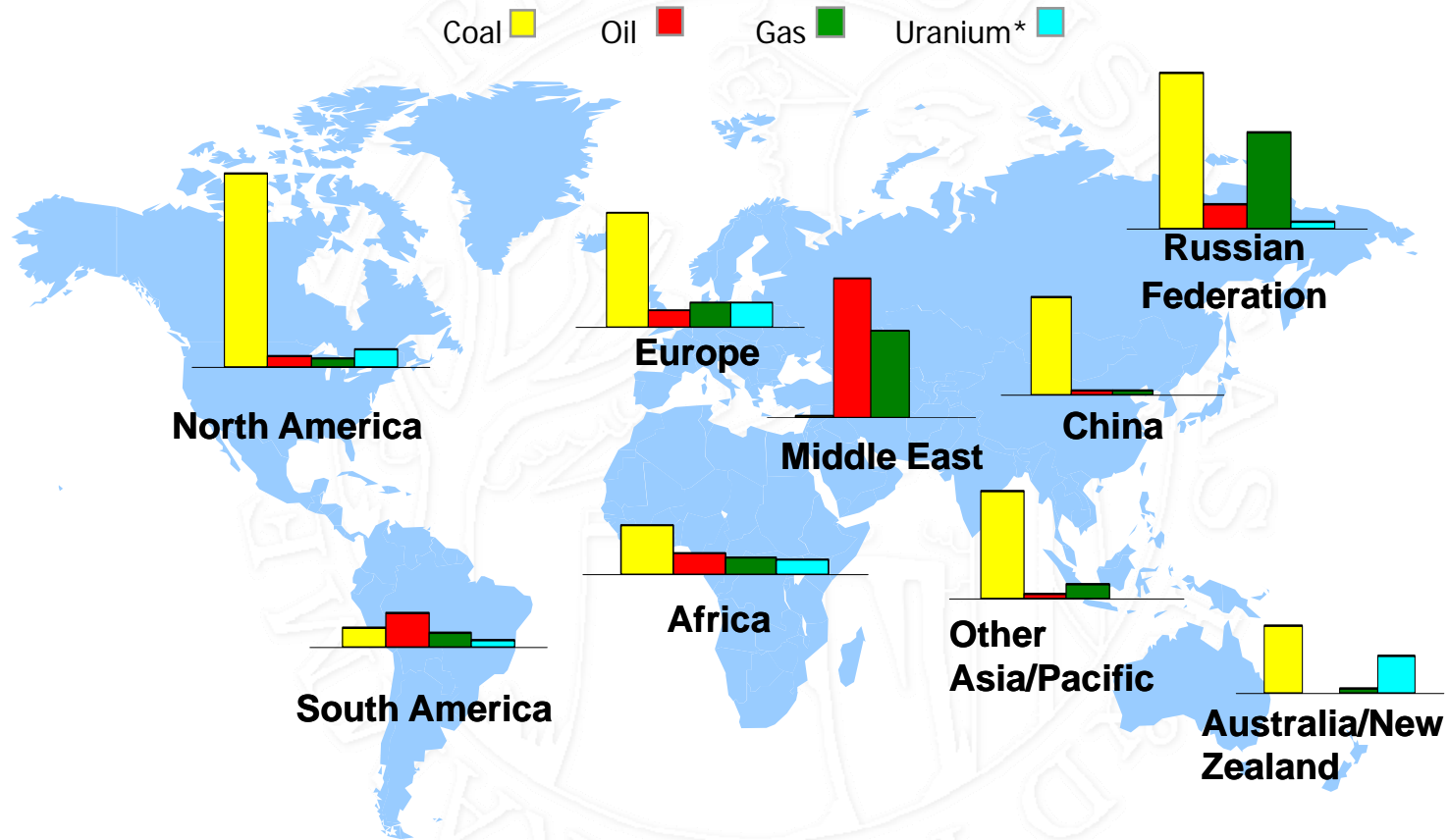
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Half of the projected increase in emissions comes from new power stations, mainly using coal & mainly located in China & India



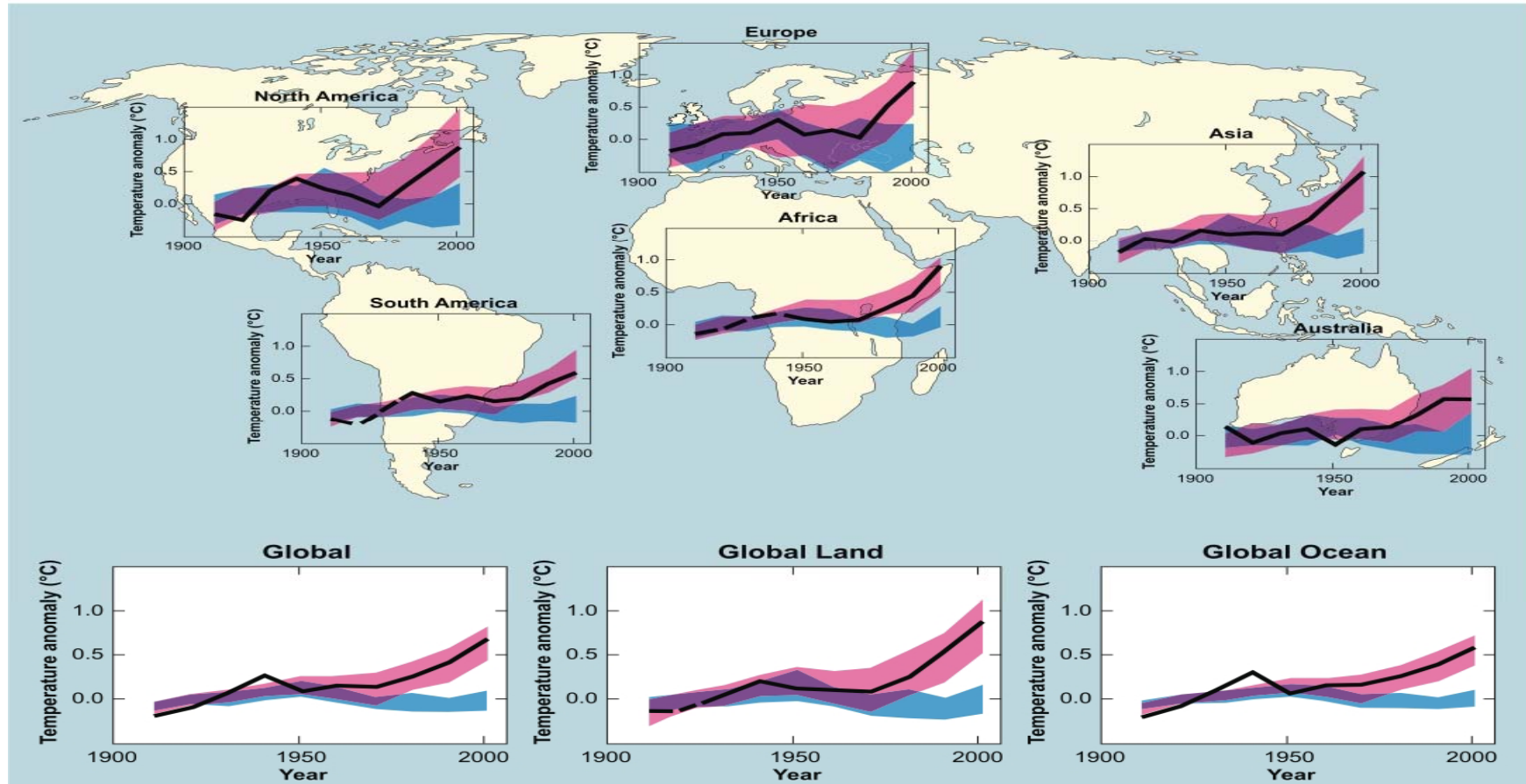
How much energy is left in the world?



Sources: BP Statistical Review 2005; WEC Survey of Energy Resources 2001; Reasonably Assured Sources plus inferred resources to US\$80/kg U 1/1/03 from OECD NEA & IAEA Uranium 2003; Resources, Production & Demand updated 2005; *energy equivalence of uranium assumed to be ~20,000 times that of coal



Global warming



 models using only natural forcings
 models using both natural and anthropogenic forcings

 observations

©IPCC 2007: WG1-AR4



Predicted Future Global Warming

Characteristics of stabilization scenarios

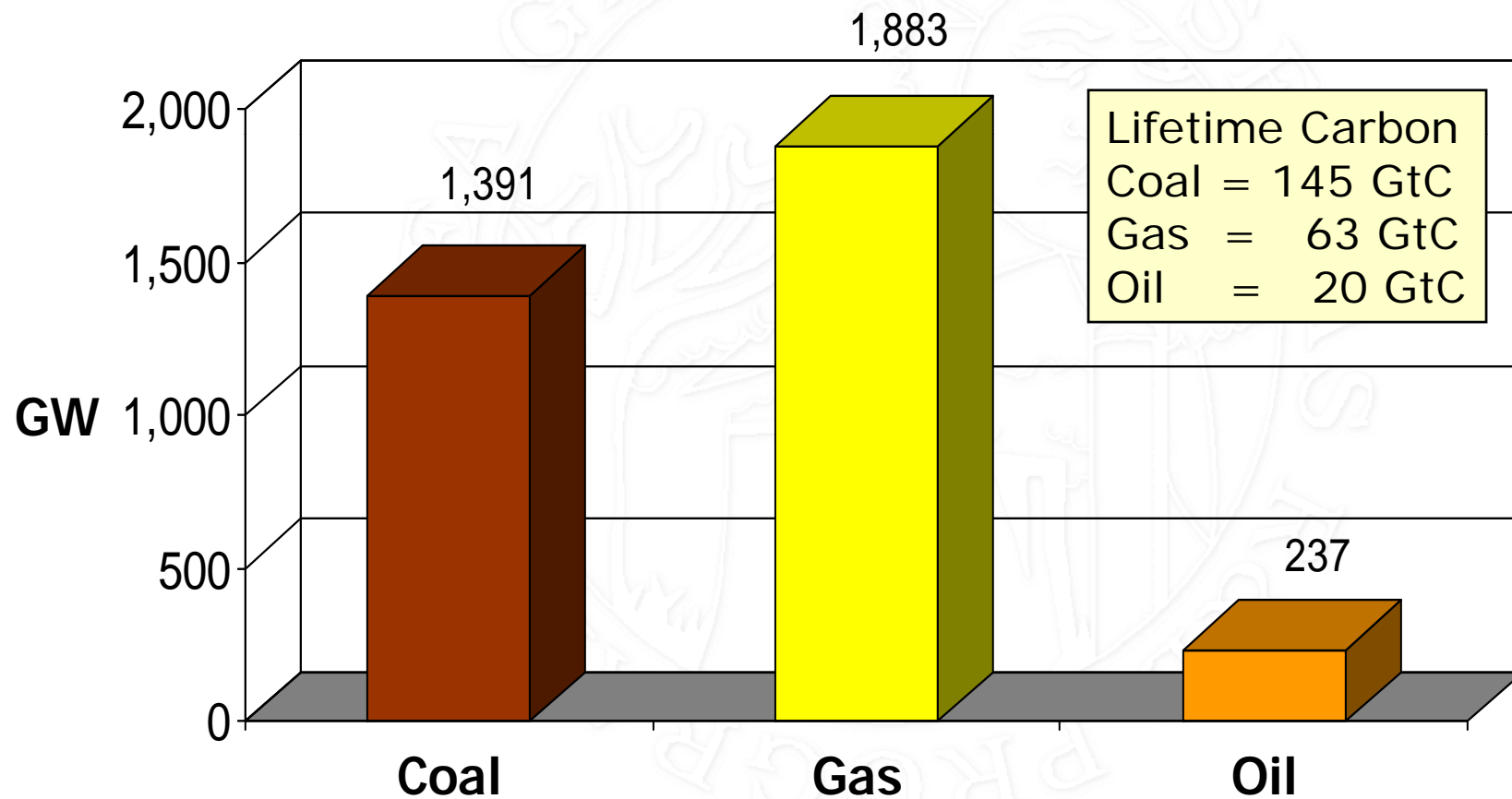
Stabilization level (ppm CO ₂ -eq)	Global mean temp. increase at equilibrium (°C)	Year CO ₂ needs to peak	Year CO ₂ emissions back at 2000 level	Reduction in 2050 CO ₂ emissions compared to 2000
445 – 490	2.0 – 2.4	2000 - 2015	2000- 2030	-85 to -50
490 – 535	2.4 – 2.8	2000 - 2020	2000- 2040	-60 to -30
535 – 590	2.8 – 3.2	2010 - 2030	2020- 2060	-30 to +5
590 – 710	3.2 – 4.0	2020 - 2060	2050- 2100	+10 to +60
710 – 855	4.0 – 4.9	2050 - 2080		+25 to +85
855 – 1130	4.9 – 6.1	2060 - 2090		+90 to +140

- ◆ Mitigation efforts over the next 2-3 decades will have a large impact on opportunities to achieve lower stabilization levels

Source: IPCC 2007



Carbon Lock-in - New and replacement fossil fueled power plants 2003-2030





World Energy Outlook 2007 summary

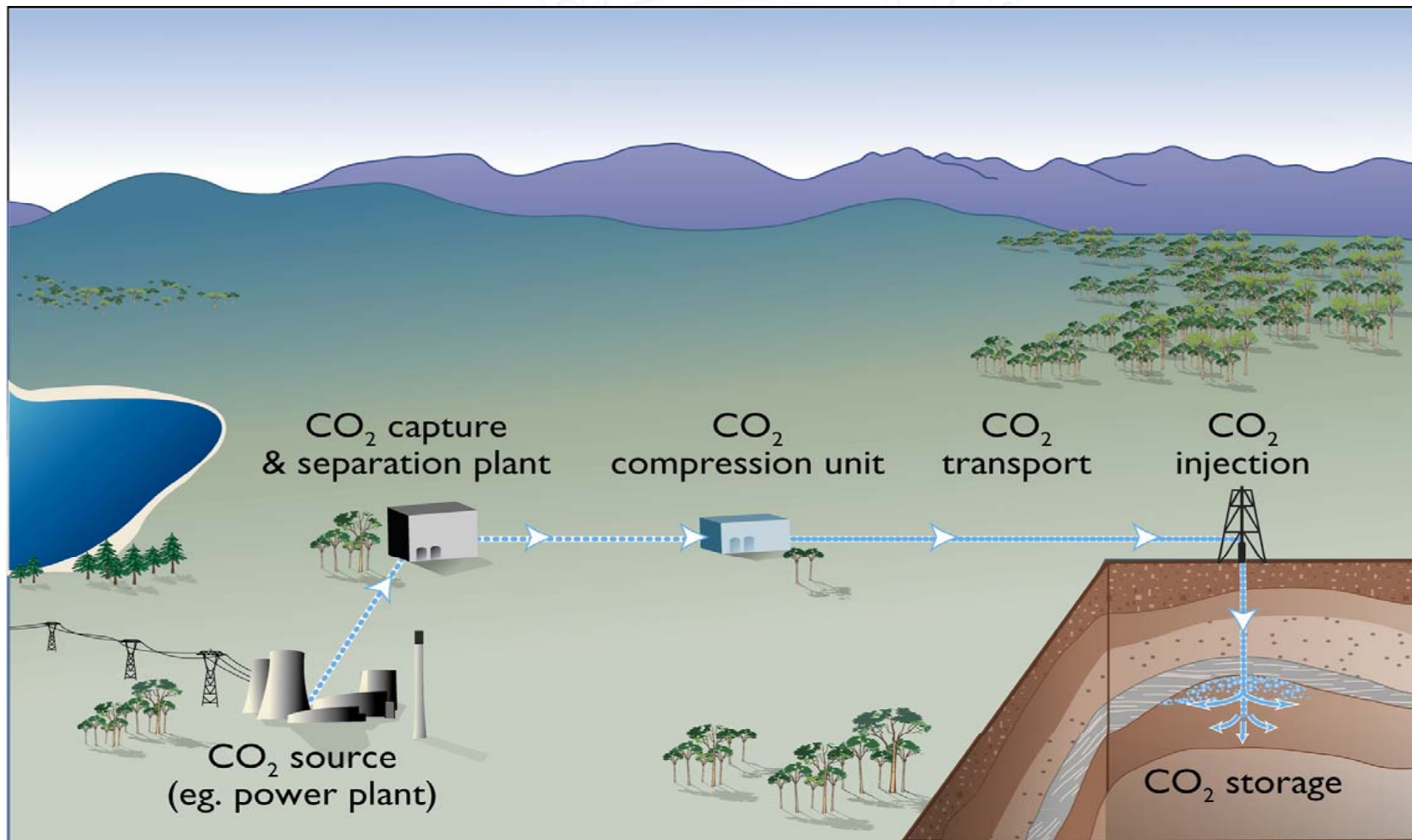
- Global energy system is on an *increasingly* unsustainable path
- China and India are transforming the global energy system by their sheer size
- Challenge for *all* countries is to achieve transition to a more secure, lower carbon energy system
- New policies now under consideration could make a major contribution

Next 10 years are critical

- The pace of capacity additions will be most rapid
- Technology will be “locked-in” for decades
- Growing tightness in oil & gas markets

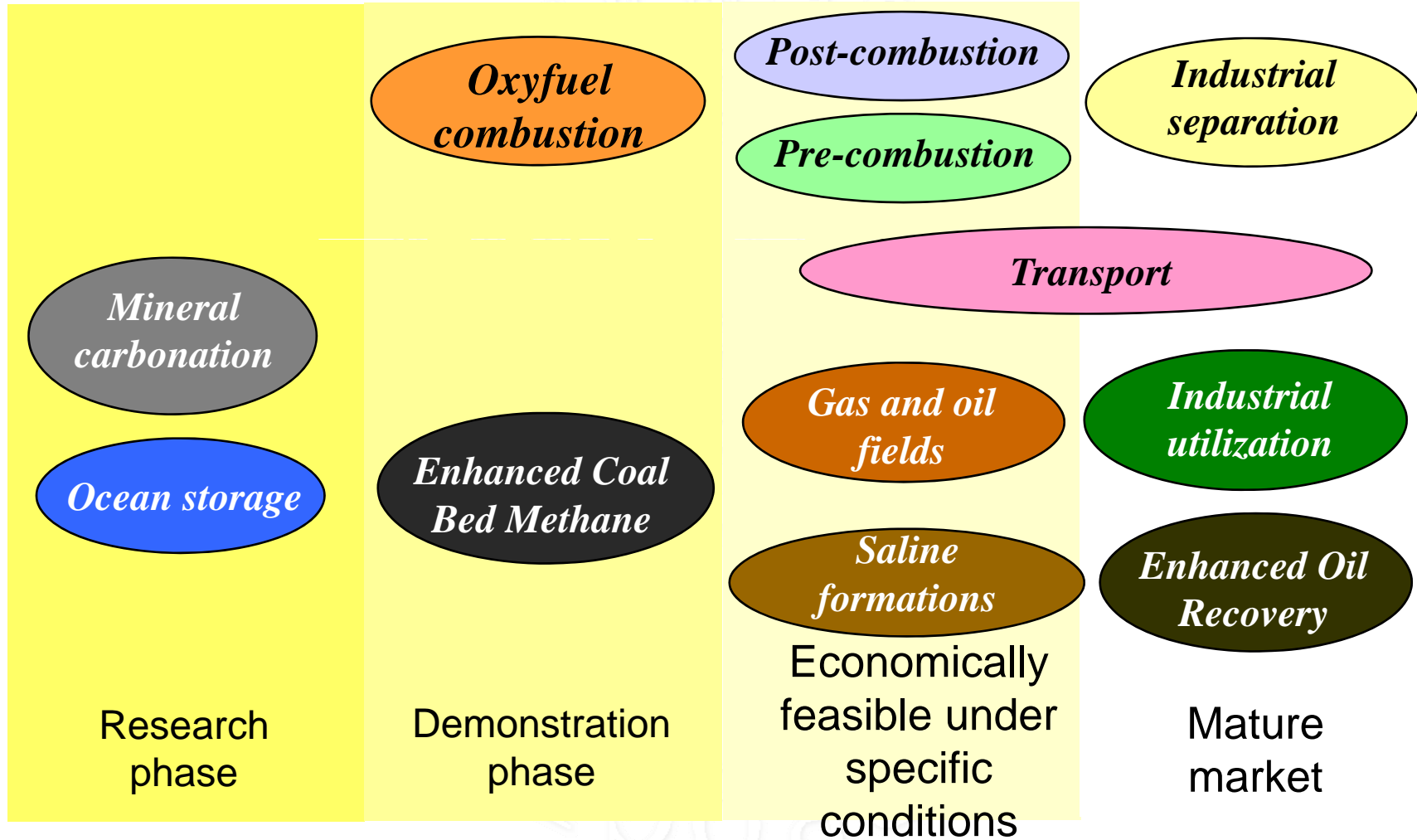


CCS technology components



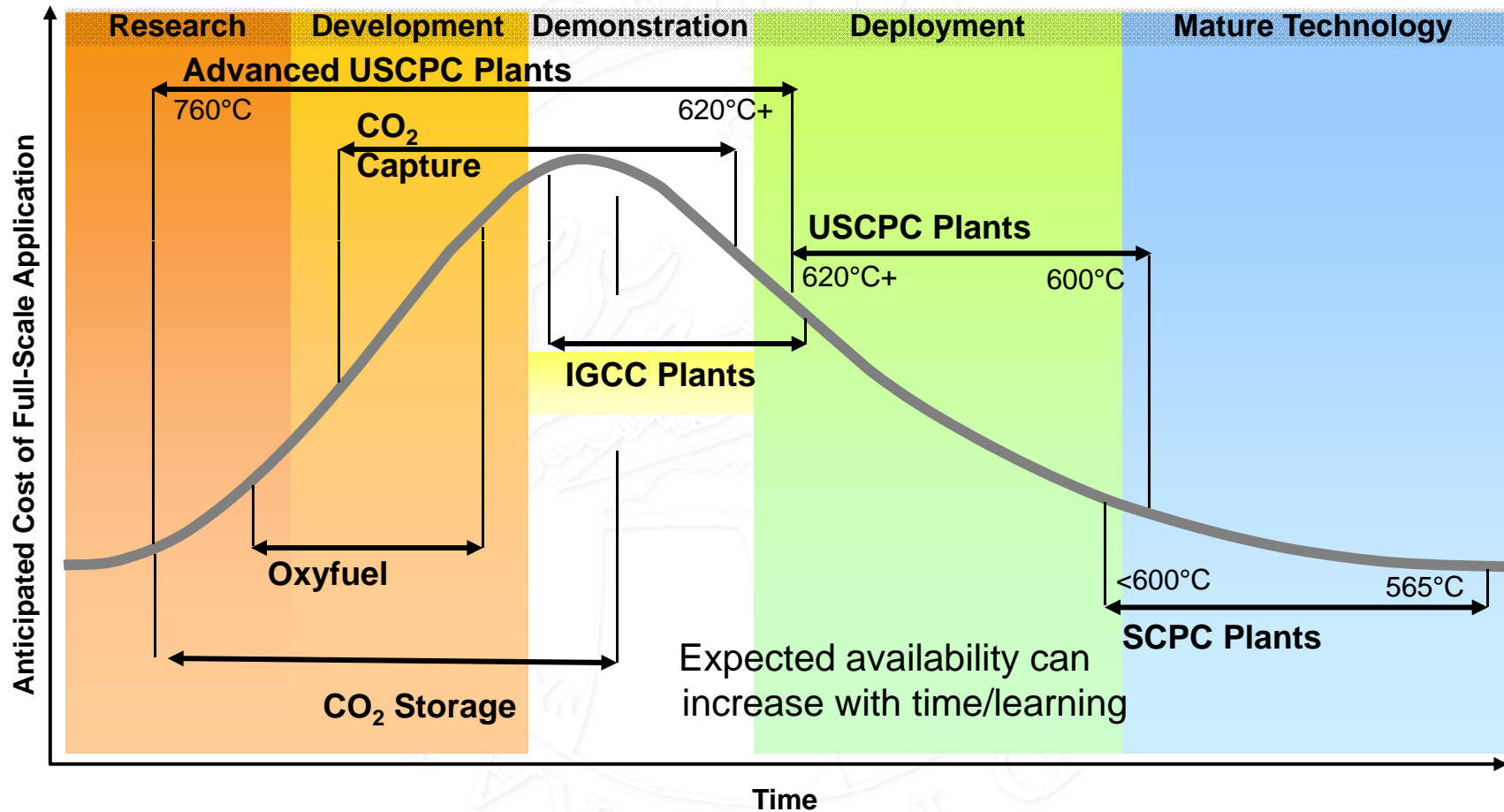


Maturity of CCS technology





CCS in coal-fired power generation



Not all technologies at the same level of maturity.

After EPRI and others



Role of CCS in climate change mitigation

- IPCC Special Report (2005) – CCS contributing between **15-55%** of CO₂ mitigation to 2100 and reduces mitigation costs by >30%
- IEA Technology Perspectives (2006) – CCS **20-28%** of mitigation to 2050. Second only to energy efficiency.
- Stern Report (2006) – CCS ~**10%** mitigation by 2025, ~**20%** by 2050. Marginal mitigation costs without CCS increase by ~60%.
- EC (2008) – Cost of meeting climate change commitments to 2030 will be 40% higher if CCS is not included.



International Policy Developments

- International acceptance of CCS was seen as a major barrier to CCS deployment 2 years ago
- Situation has changed significantly in the last year
- Main International Environmental Treaty is the Kyoto Protocol
 - CCS accepted as a mitigation option in 2007
- Key International Marine Treaties, London Convention/OSPAR adopted amendments to allow CCS in sub sea geological structures
- EU Emissions Trading Scheme permits CCS with full acceptance planned from 2013

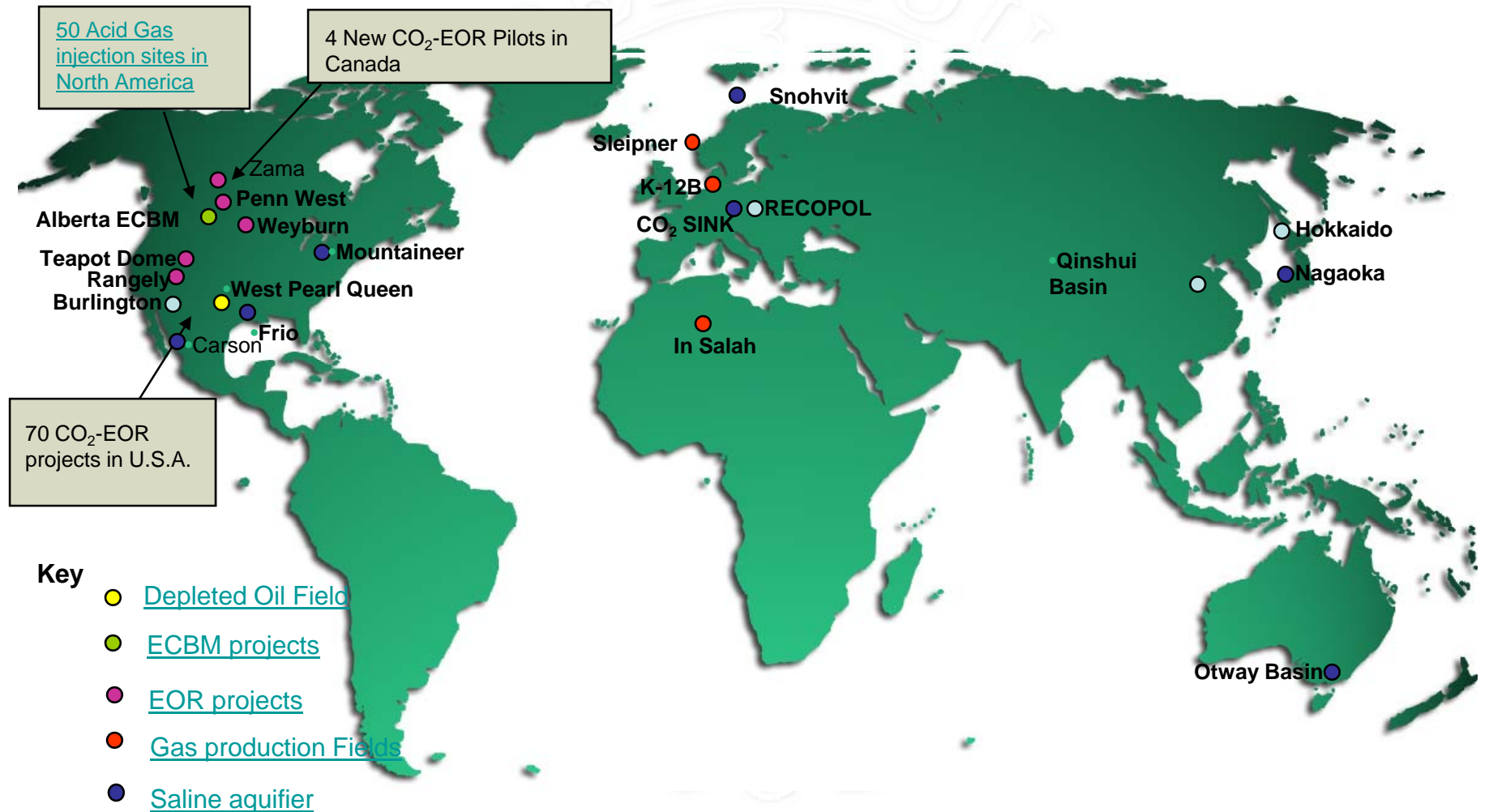


Development of CCS regulations

- USA – Existing Underground Injection Control programme for ground water protection adapted for pilot projects
 - Interstate Oil and Gas Compact Commission has developed recommendations for regulations for CO₂ storage at a State Level
 - USEPA are developing Federal level regulations for CO₂ storage
- Australia
 - Adapting Federal oil and gas laws, draft regulations for comment
 - State of Victoria has a consultation document for CCS, considering regulations
 - Queensland considering regulations
- Canada
 - Canada – acid gas injection and CO₂-EOR already permitted in states like Alberta
 - Federal Task Force developing CCS regulations
- Japan
 - Adapted marine laws but has no oil and gas laws to adopt for CCS
- Most existing laws cover; permitting, construction, operational and abandonment phases but NOT post closure



Current CO₂ Injection and Storage Projects

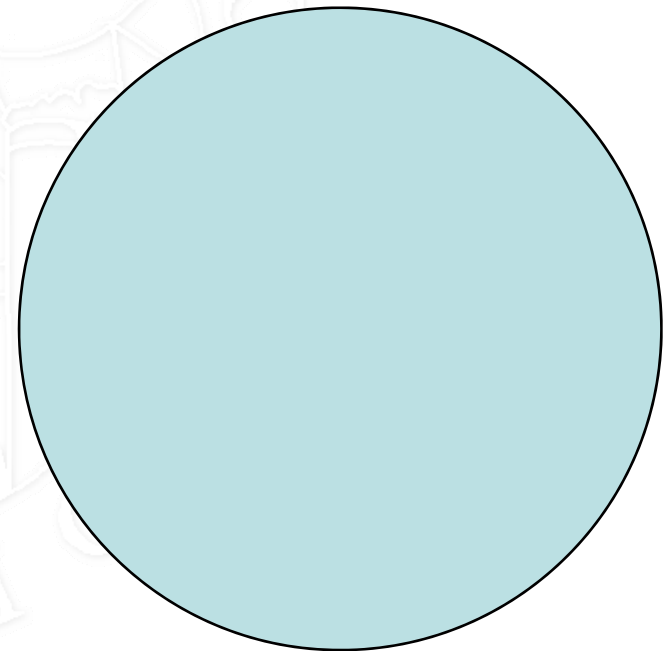




Size matters!

Cumulative globally sequestered CO₂ → •

Cumulative global need to sequester CO₂ →





Proposed Integrated CCS Projects

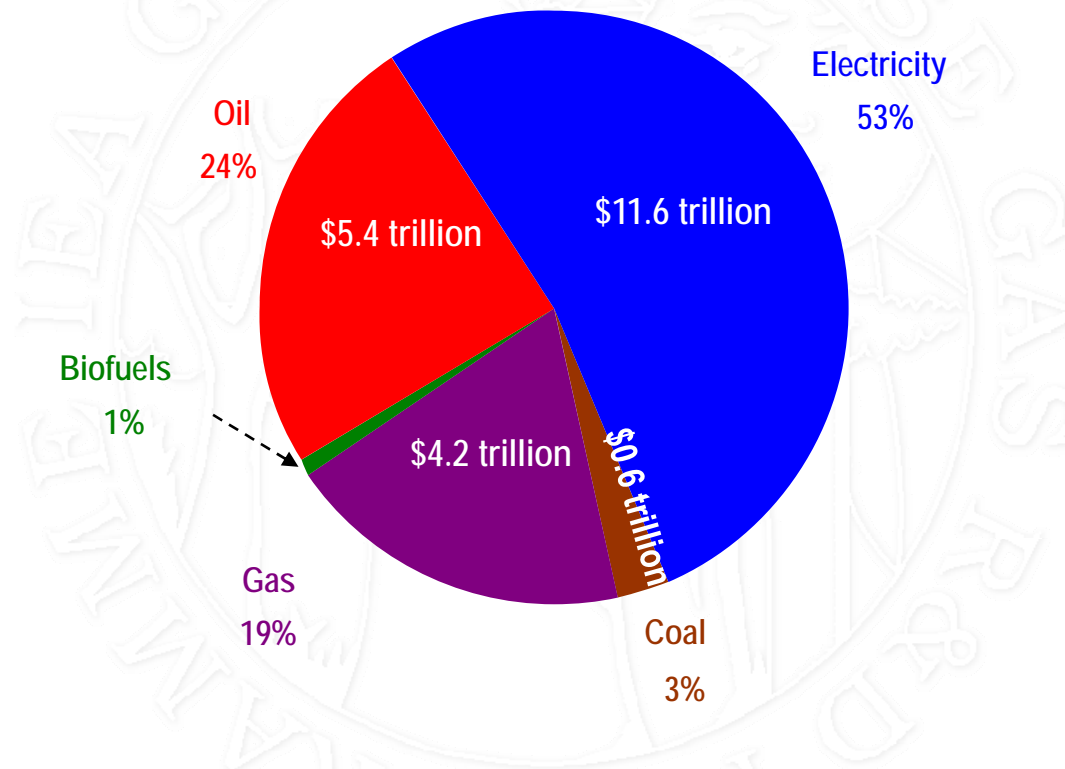


Key

- Industrial Processes
- Pre-Combustion Capture
- IGCC
- Oxy-Fuel
- Post-Combustion



IEA WEO 2007 Reference Scenario: Cumulative Investment, 2006-2030



Total investment = \$21.9 trillion (in \$2006)



CCS Commercialization

- Too few large scale demonstrations to accelerate deployment of CCS technologies
- This approach could result in risk of project failure
- High profile failures concerning CCS projects will result in a reluctance to invest in the deployment of CCS technologies
- We need a path forward to rapid commercialisation of CCS



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Thank You!

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Recent Project Developments in US.....

- Reconfigured FutureGen
- Hydrogen Energy – DF2
- USDOE Regional Carbon Sequestration Partnerships
 - 7 pilot to demonstration scale CCS projects
 - Storing between 1Mt and 5Mt of CO₂
 - 21.9Mt stored total of CO₂
 - Up to 5Mt CO₂ stored/year total



Recent Project Developments in EU.....

- UK
 - CCS demo – full scale, coal, post-combustion, offshore storage
- Germany
 - Ketzin - injection
 - RWE planning a 450 MWe coal fired IGCC project with on-shore storage
 - Vattenfall have built a 30 MW CO₂ capture pilot plant
 - Plans to build a 300MW demonstration project in Germany
 - EON and Siemens – CO₂ capture pilot plant
- France
 - Lacq Project. Total. 2008. Oxyfuel. 150kt - CO₂ aquifer. 27km pipeline
- Netherlands
 - CO₂ injection into K12B field
 - NUON _ IGCC CO₂ capture