UK & EU
CCS state of activity

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SCOTTISHPOWER

Largest UK whole chain research group
15 CCS academics, $21M grants

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Projects
Storage
Problems
Outlook

EU and UK aim: 80% CO2 reduction by 2050

Scottish Centre for Carbon Storage
www.geos.ed.ac.uk/research/sccs.html

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Fundied projects: Oct 2009

**EU € 1.05 Bn (6 coal plant) (12)**

Jaenschwalde Germany, Rotterdam Netherlands, Belchatow Poland, Compostilla Spain, Hatfield UK, Porto Tolle Italy

**USA $ 1.4 Bn (12 industry)**

- **Air Products Inc.** steam methane reformer Port Arthur, Texas. 1Mt CO2/yr EOR
- **Daniels Midland Corp** amine capture CO2 to Mt. Simon Sandstone aquifer
- **Memorial Institute, Pacific NW Division** Fluor & Boise paper black liquor to deep basalt
- **C6 Resources** Shell & LBNL industrial to 10,000ft saline formation 1Mt/yr
- **CEMEX Inc.** RTI Int cement dry sorbent 1Mt
- **ConocoPhillips** Sweeney refinery Tx, Petcoke IGCC 5Mt to oilfield
- **Leucadia Energy Denbury** 4Mt/yr co-generation petroleum coke-to-methanol project Lake Charles, La. EOR Hastings Tx
- **Leucadia Energy** PetCoke gasify 4Mt/yr Moss Point Miss
- **Praxair BP Denbury** H2 refinery 1Mt/yr
- **Shell Chemical** industrials 1Mt Baton Rouge
- **University of Utah** 1Mt/yr Kansas EOR & aquifer
- **Wolverine Power** 300kt CFB coal

**Alberta $ 2 Bn (power plant)**

- PIONEER ammonia retrofit 1Mt/y
- QUEST - Scotford tar sands 1.2Mt/yr

**Australia $ 2 Bn (power plant)**

- ZeroGen 400MW; Wandoan 355MW
- Gorgon offshore $840M

**UK 1 (4) £ 1-4 Bn ? (coal plant)**

1 - 4 projects TBC - extra levy (tax)
Capture, transport

- UK Govt research councils > £30M on capture (efficiency, combustion)
- Worlds largest Oxyfuel test by Doosan, Renfrew
- Small slipstream amines ScottishPower
- Planned 5 MW amine slipstream on coal
Coal & CO2: Public UK, NL & D

Breaking news: Kingsnorth Six found not guilty!

Posted by bex on 10 September 2008.

Five of the 'Kingsnorth Six' at the top of the 200m chimney

See all trial updates. [link]

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UK storage very large

CO2 capacity in top 13 states

- Scotland: unproven
- England

mid-range values from EU FP6 GeoCapacity
Storage capacity ranges

- Static formation 2% effective 1328 Mt CO₂

- Open formation with heterogeneity 0.56 % effective store 375 Mt CO₂

- Closed formation, with pressure limit 0.2 % effective 155 Mt CO₂

- Closed formation with water production stores 375 Mt CO₂

Dynamic capacity 10 - 30 % of static estimate
Few large, or many small stores?

Continental pipes to offshore $8 Bn/yr income?

MAJOR RISK

Needs REAL TESTS
UK CO₂ capture proposals 2007

12.9 GW, 20% UK baseload

- Peterhead 1.5 Mt/yr gas SSE/RP
- Longannet 10 Mt/yr coal SP
- Cockenzie 4.1 Mt/yr coal SP
- Blyth 2.4 GW coal RWE
- Tees-side 10 Mt/yr coal PE
- Ferry Bridge 10 Mt/yr coal SSE
- Immingham 1.2 GW CHP Conoco
- Hatfield 900 MW Powerfuel
- Killingholme 900MW coal E.ON
- Kingsnorth 1.6 GW coal E.ON
- Tilbury 1.4GW coal RWE

Before BERR clarification
UK competition
CCS Oct 2009
0.4 GW, soon after 2014
Longannet 2.4 GW coal SP
(10 Mt CO2/yr)
FEED study 2 x £45M in January. Award contract late 2010
Operational end 2014, 400MW. ELECTION 2010 ==> 5GW?
Kingsnorth 1.6 GW coal E.ON
Tilbury 1.4GW coal RWE
Future outlook
Emissions Performance Standards

- Direct focus on CO2
- Places the problem with generators (like EU)
- Needs less government time and expertise
- Old coal will close by LCPD 2015, IED 2022
- Separate track for gas
- Coal and gas EB2010

Need DESIGN to keep coal in the mix - cheap security
Separate coal and gas standards
Future: system demand variability

Based on history, projected to 2030

Renewables (wind) are variable. Very cold or very hot ==> no wind for a week

Either: disconnect / manage demand (for several days)

Either: build electricity / heat / potential energy storage

Or: build 100% backup fossil plant. Variable operation, less efficient CCS, more g/kWhr

Payment for on-call capacity. More CCS may be ‘cheaper’ capex than more renewables
Technical

- **Dynamic storage** capacity - volumes / pressure
- Injection **hydrates** in pressure depleted gasfields
- **Density inversion** of scCO2 relative to saline water
- Accessing **compartmentalised** aquifers
- Any role for **EOR** offshore?
- Designing capture clusters **transport** to large stores
- Improved **monitoring** for offshore storage > 1km
Summary

• CCS projects are emerging, slowly, mostly coal power
• TWO UK coal projects in the frame (Longannet, Hatfield)
• Commercial enticements, for CCS, for EOR
• Minimum will enable learning - but needs sharing
• Capture >> storage research - public perception
• Dealbreakers - Capacity, Basin pressure, no EOR …
• EPS ramping, Operation in renewables grid un-solved