PRESENTATION TO COAL RESEARCH FORUM
(Combustion and Advanced Power Generation Divisions)

Underground Coal Gasification Technology Overview and UK Initiatives

LEEDS, 22nd APRIL, 2009

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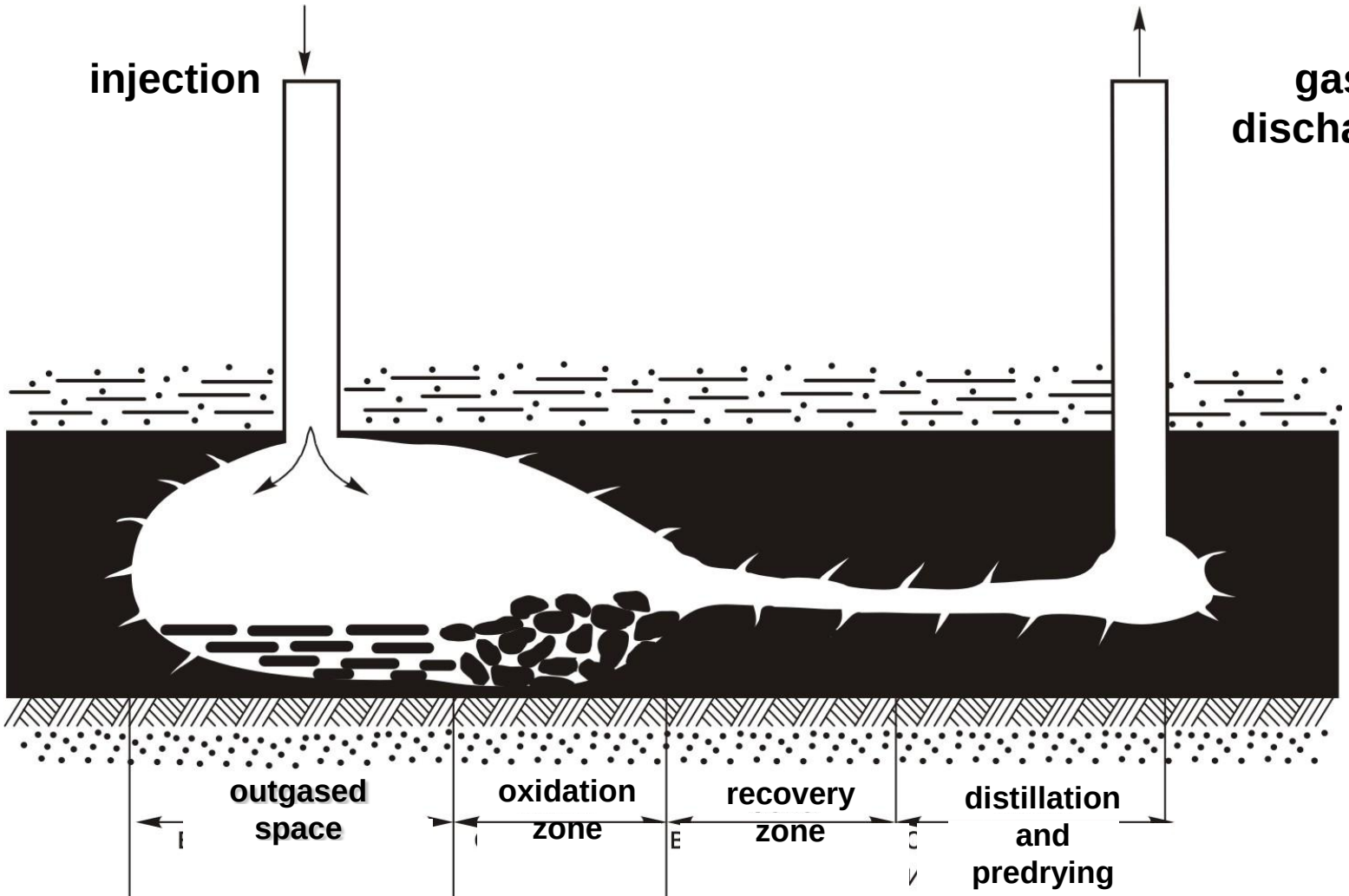
Senior Adviser
UCG Partnership

The UCG Process

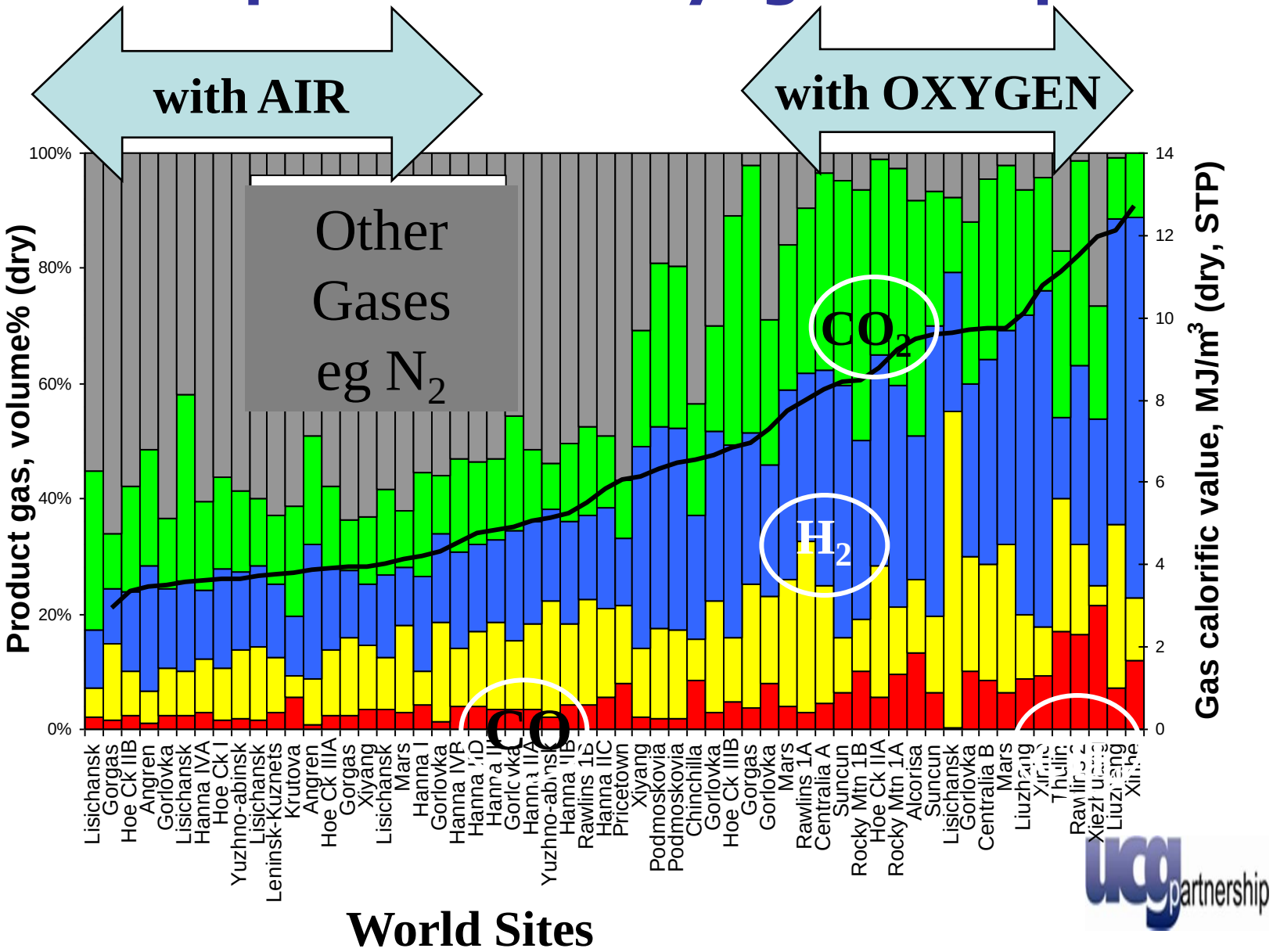


Key Variables: 1. The Coal – Nature, seam thickness, strata

2 Depth, - Hydrostatic Pressure

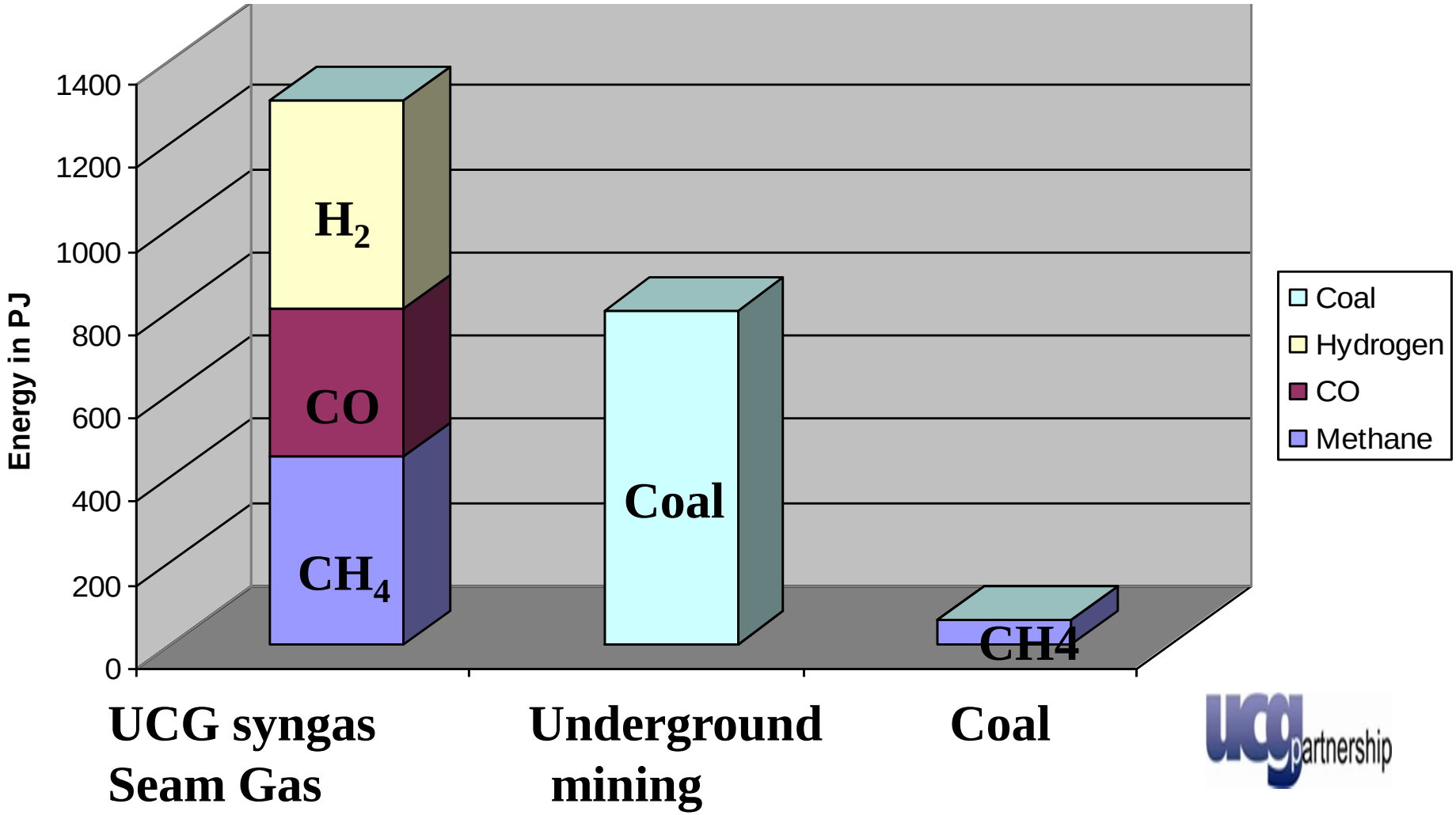
3. Oxidant – Oxygen content

Examples of UCG Syngas composition



UCG - Energy Recovery Comparison

Energy extraction by method for a typical Australian 12km^2 coal deposit



CO_2 Capture Advantages of UCG

- Pre Combustion Capture
- High CO2 Partial Pressure
  - smaller plant
  - physical absorbents possible
- Low-cost option for partial CO**2** removal
  - methane can remain in syngas
  - or methane can be shift converted to Co**2** and H**2**

Milestones of UCG Development

Angren, Uzbekistan

44 years of Commercial Operation
100 MW Steam Turbine

- **1866 Sir William Siemens suggests UCG**
- **1888 D Mendelev proposes directional drilling**
- **1909 First UK Patent Granted**
- **1912 Sir William Ramsay suggest Co. Durham Trial**
- **1913 Lenin writes article in Pravda**
- **1933 – 41 UCG Trial in USSR**
- **1946 – 1996 Operations in USSR**
- **1949 – 1960 Early European Trials**
- **1958 – 1959 NCB Trial conclude At Newman Spinney**

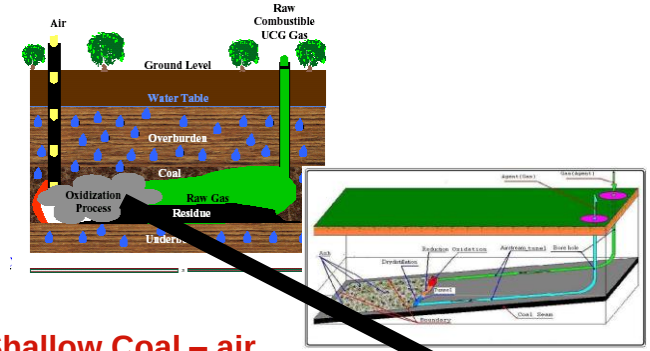
Milestones of UCG Development

Bloodwood Creek
Carbon Energy
Commercial Scale UCG plant

- **1972 - 1989 US Programme of Trials**
- **1980 onwards Many Chinese Trials**
- **1992 – 1998 EU Tri nation trial, Spain**
- **1999 – 2004 Coal Authority DTI Feasibility Study)**
- **1999 – 2003 Trial at Chinchilla, Queensland**
- **2005 UCG Partnership Formed**
- **2009 100 day trial at Bloodwood Creek, Australia.**

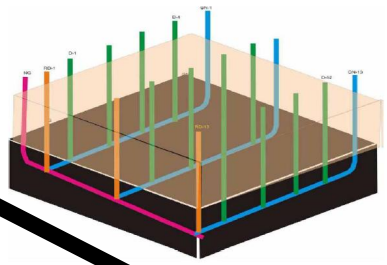
Technology Trends for UCG

surface



Shallow Coal – air blown

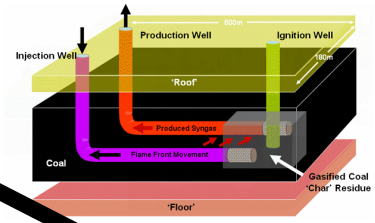
Thermal plant, power gen,



Shallow Depth

Enriched air, O2

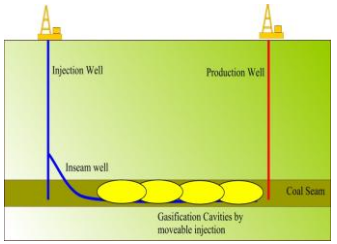
For GTL



Medium Depth

Enriched air, O2

For GTL, Fertilisers



Deep Coal, O2

UCG CCS

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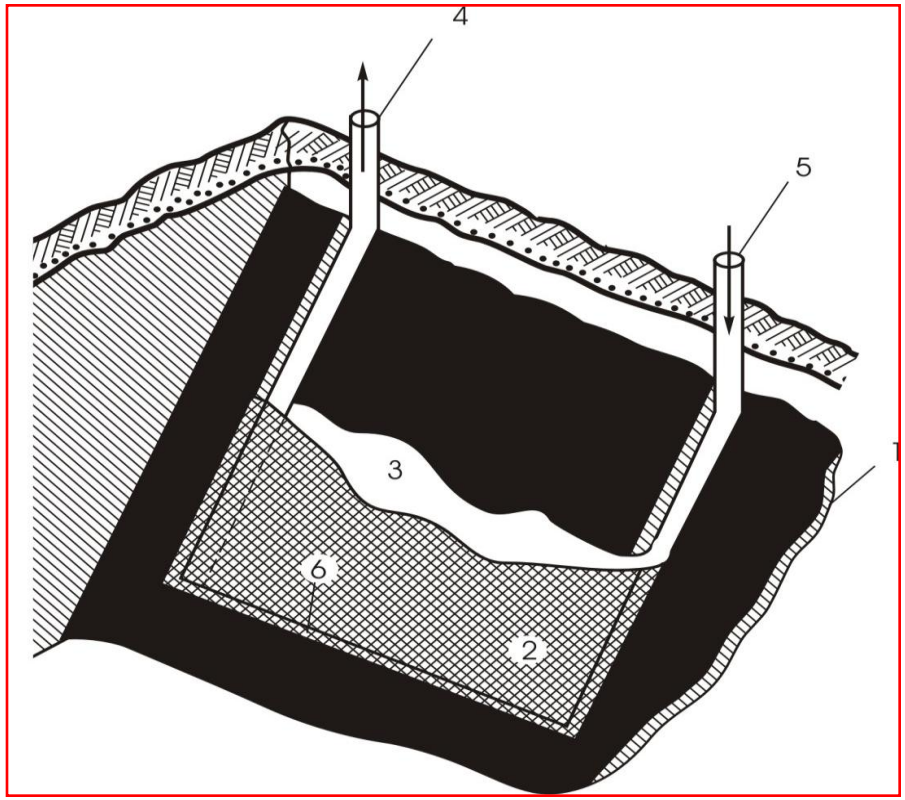
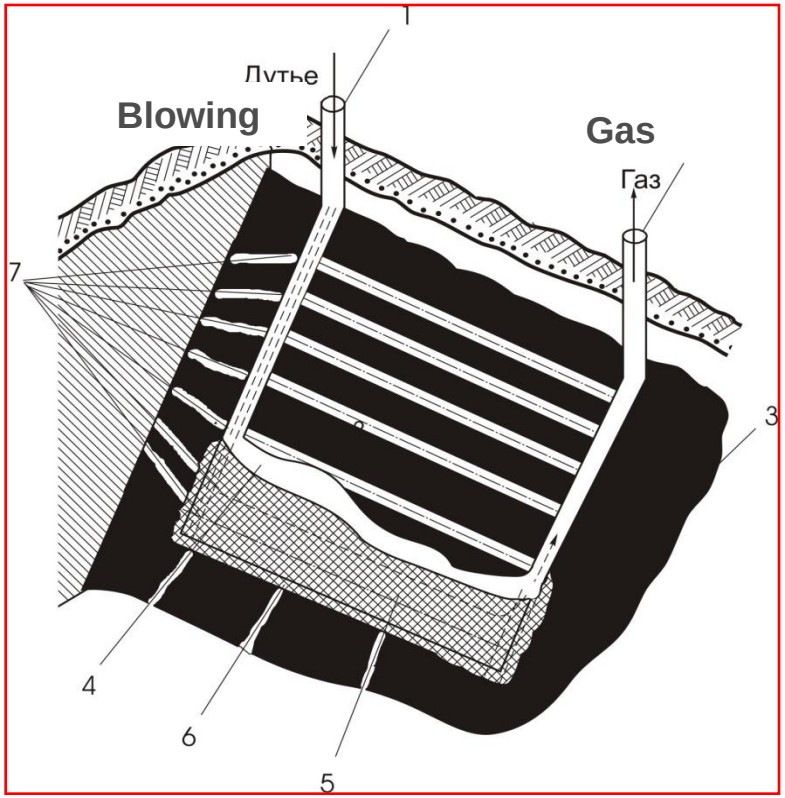
Underground gas generator. "Flow" method



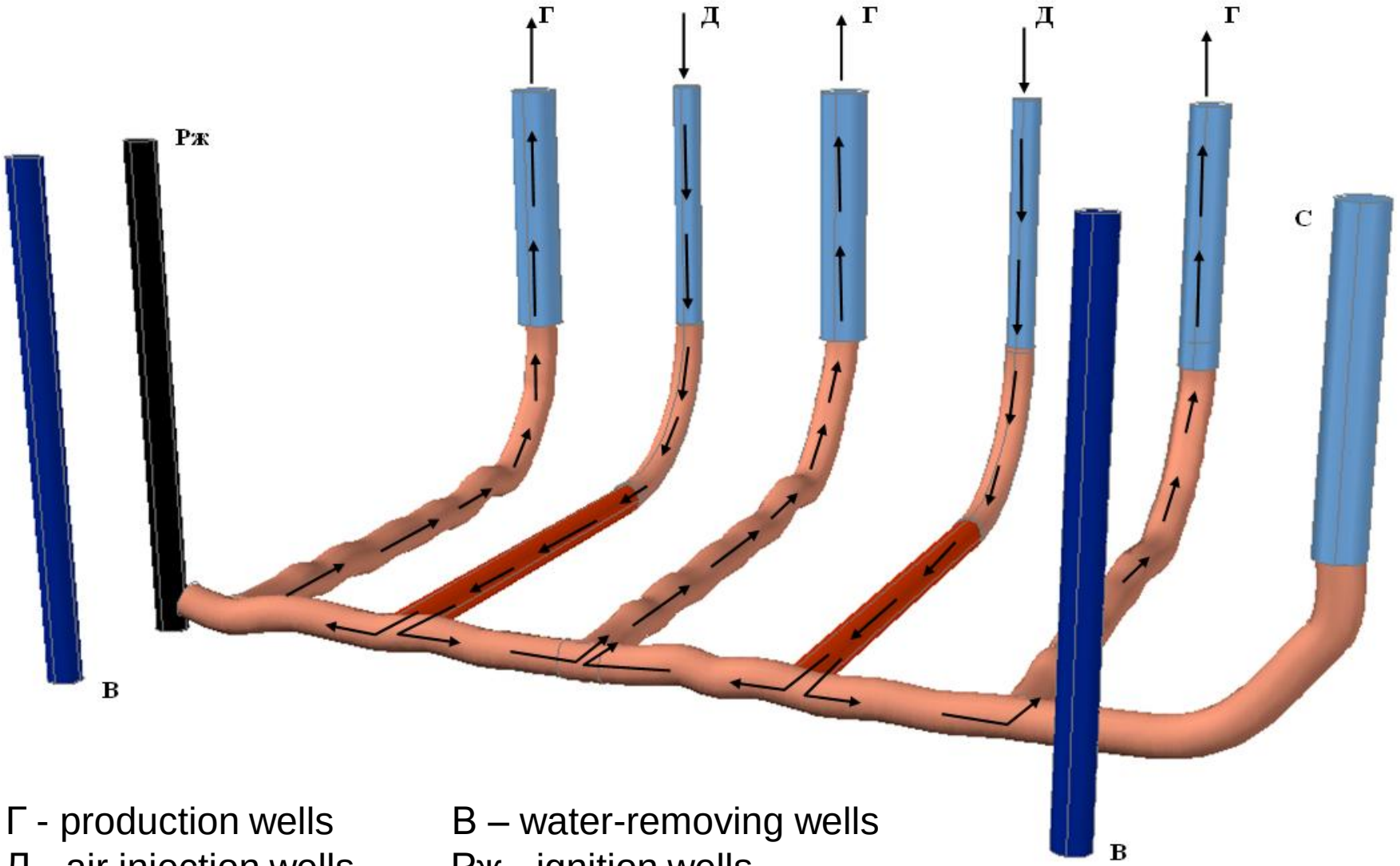
1 — coal seam
2 — slag and collapsed roof formations
3 — combustion face
4 — production well
5 — air injection well
6 — initial combustion drift

New UCG technology. Scheme of underground gas generator unit



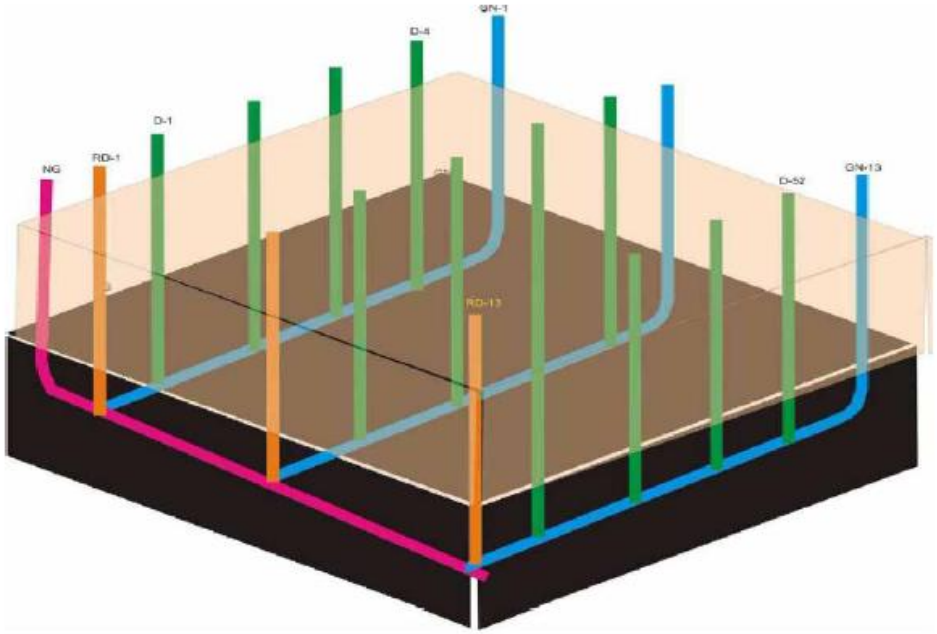
1 — air injection well, cased in coal seam
2 — production well without casing in coal seam
3 — coal seam
4 — reaction channel
5 — slag and collapsed roof formations
6 — initial gasification channel
7 — points of air injection moving along the well

New Gas Generator Construction



Г - production wells
Д - air injection wells
В – water-removing wells
Рж - ignition wells
С - linking horizontal well

Sasol UCG Pilot test



- Site located at edge of Secunda CTL plant
- 160m depth,
- Oxygen fed
- Linked Vertical Well arrangement
- Well construction underway Sep08

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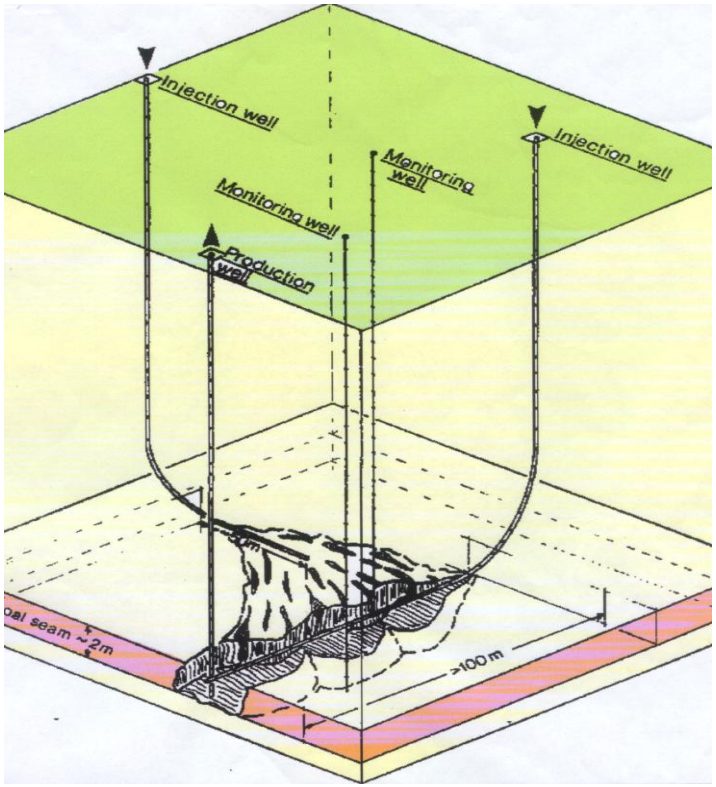
European UCG Trial at 550m Depth (1992-1999)



- Two successful ignitions, and seven satisfactory manoeuvres of the CRIP moveable injection system.
- Directional drilling produced satisfactory well construction.
- Gasification at greater depth enhances methane formation and cavity growth.
- The engineering operated satisfactory and the process is controllable, stopped and restarted.
- No evidence of contamination spread beyond the cavity or subsidence was observed.

European Working Group on Underground Coal Gasification

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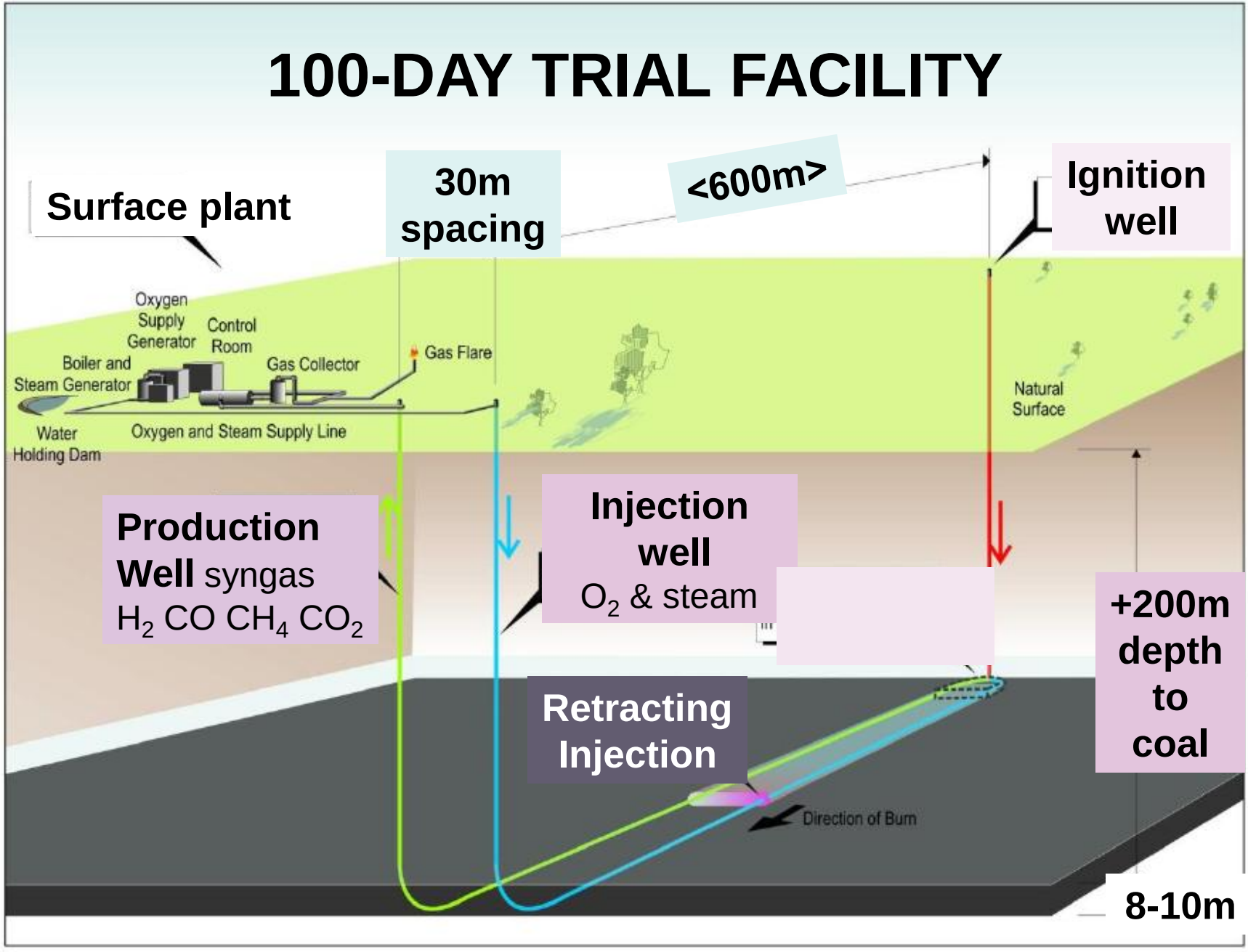
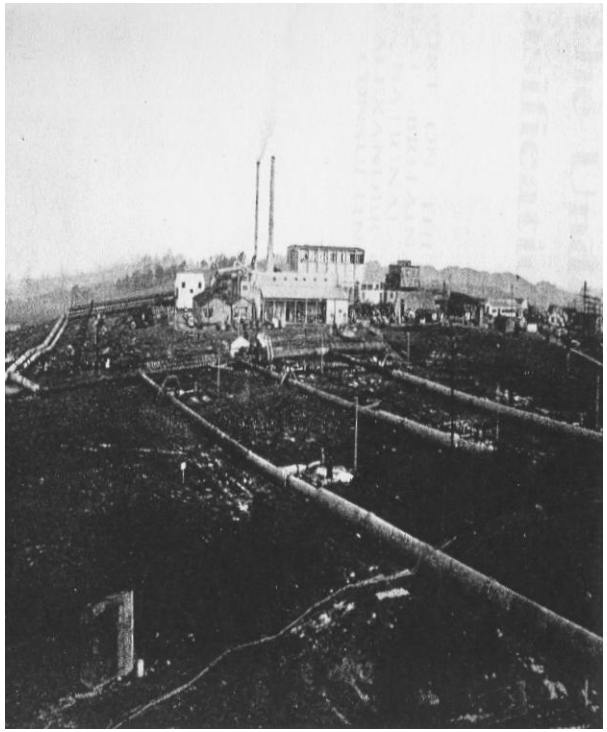

100-DAY TRIAL FACILITY
Surface plant
30m spacing
<600m>
Ignition well
Oxygen Supply Generator
Control Room
Boiler and Steam Generator
Gas Collector
Gas Flare
Natural Surface
Water Holding Dam
Oxygen and Steam Supply Line
Production Well syngas
H_2 CO CH_4 CO_2
Injection well
O_2 & steam
+200m depth to coal
Retracting Injection
Direction of Burn
8-10m coal

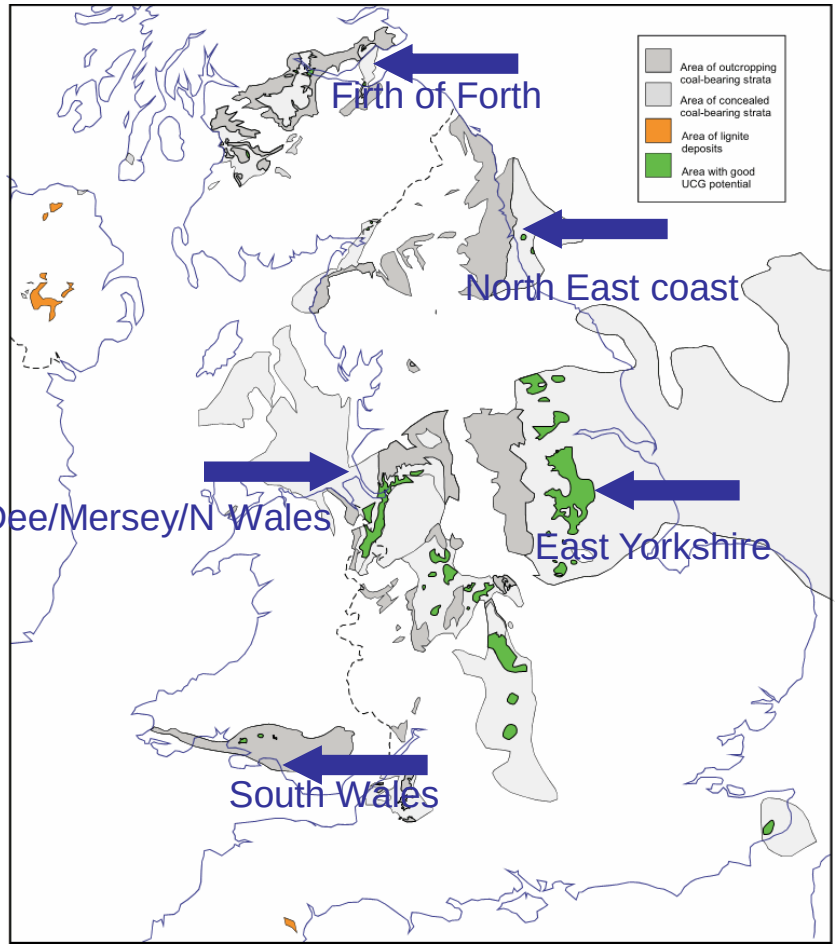
Milestones of UCG in the UK



NCB Newman Spinney

1912 Sir William Ramsey proposes trials in Durham
1949 – 50 Bore hole trials
1958-59 NCB trials conclude at Newman Spinney
1992 Decision to participate in EU study (no suitable UK site offered)
April 99 Energy Paper 67 supports UCG
June 99 DTI grants Coal Authority £15 mill for UCG study
Jan 00 UCG London Conference by Coal Authority
Oct 01 50th Robens Lecture includes UCG
Oct 03 UCG Conference by DTI
Oct 04 Publication of DTI report on UCG in the UK
Dec 05 Formation of UCG Partnership, and first UCGP Conference
Feb, 07, 08, 09 2nd /3rd /4th UCGP International Conference on UCG.
Feb 09 First UK UCG Licence granted

Areas of the UK Suitable for Commercial UCG



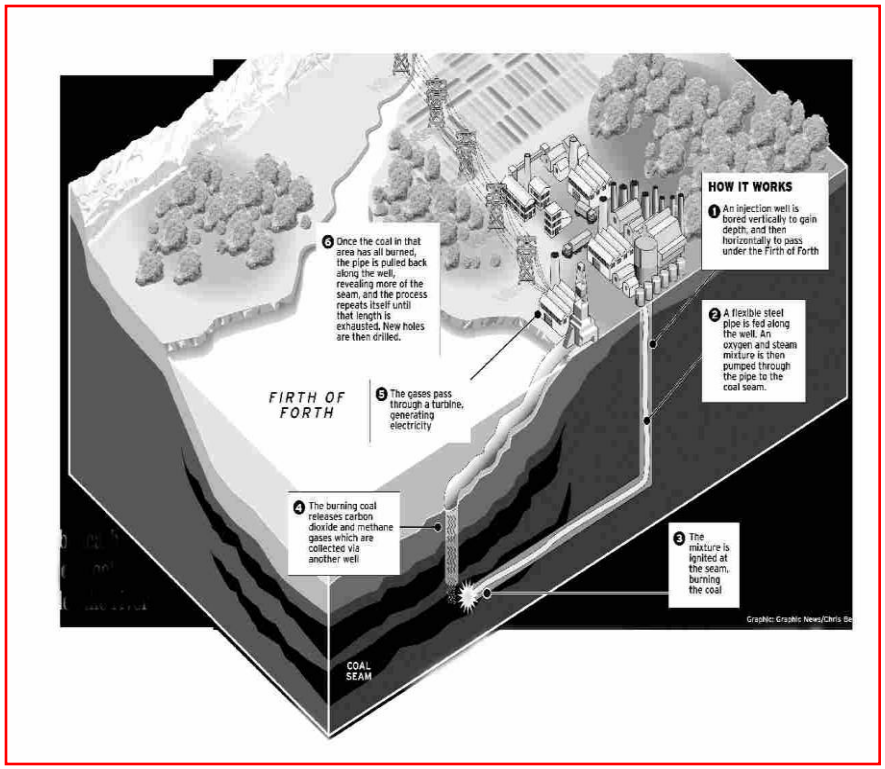
Area of UK	"Good" UCG Resource M-tonnes	Power Output over 40 years MW	UCG as Nat Gas BCM
Eastern/NE England	6,824	11,900	681
Lancs/Dee	4,770	14,100	476
Wales	220	730	22
Scotland	171		17
TOTAL	16,784	26,730	1,676

Current Coal Power Capacity ~ 28,8550MW

UK Current Nat Gas Reserves 530BCM

BGS study of coal resources for UCG, supported by DTI

Feasibility Study of UCG-CCS in the Firth of Forth



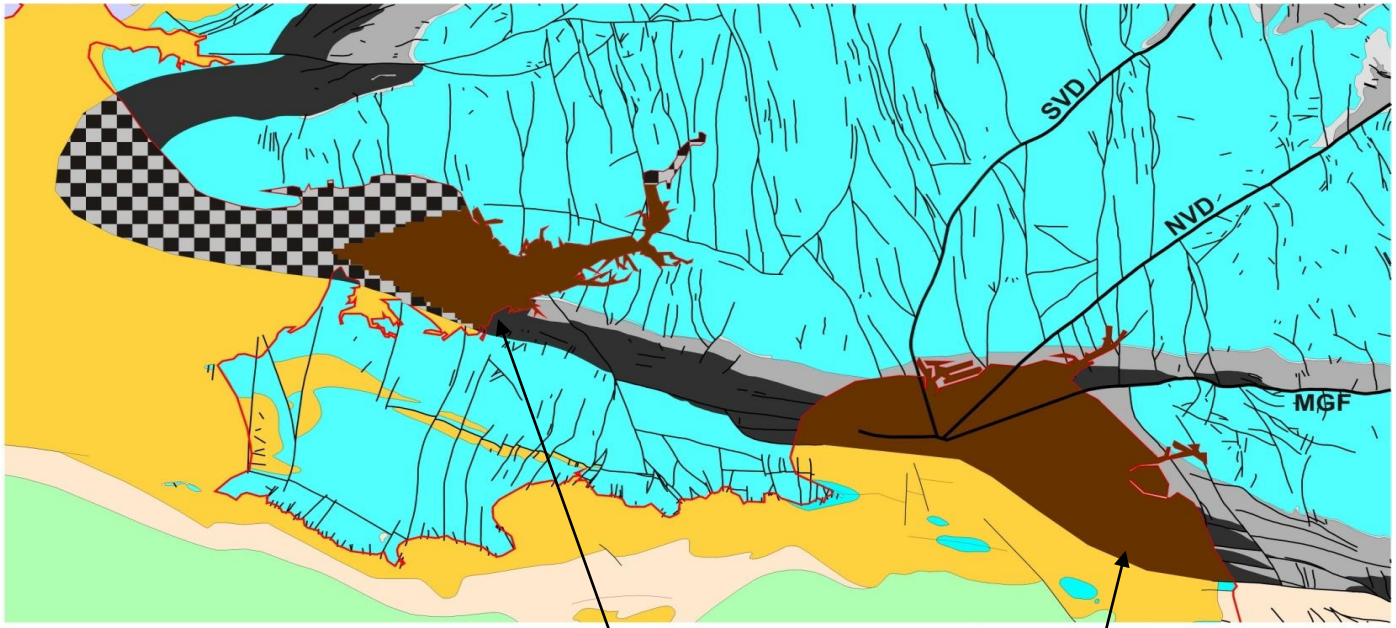
Project Objectives

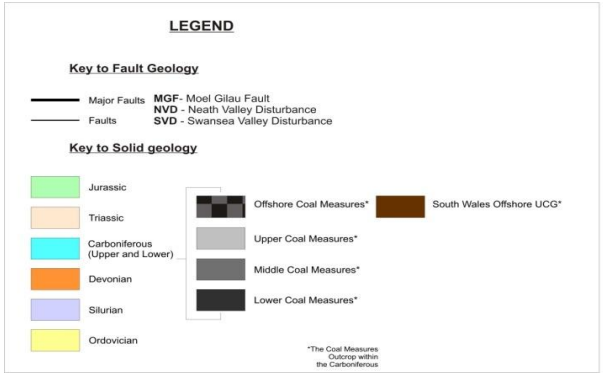
- Characterisation of the basin and coal reserves
- Site Selection for gasification and sequestration,
- Well design & plant specification
- Environmental impact assessment.
- Modelling of the mine operations and subsurface.
- Specification of regulatory and licensing requirements and risk assessment
- Preliminary economic evaluation and analysis of strategic and business opportunities presented

UCG in the North East Region

- The North East, after centuries of coal exploitation, still has large coal resources,
  in deeper seams, which are unlikely to be mined in the near future. The largest
  reserves are on the coast and just offshore.
  • Indigenous coal provides a secure supply of energy in the face of world
  uncertainties about all fossil fuels.
  • Power stations and industry are in place to receive the syngas from coal
  gasification (surface or UCG)
  • NE is well placed for the disposal of captured CO2 in North Sea storage sites
- One North East has initiated a scoping study of UCG & UCG-CCS (Dec 2007) covering economics, sites and H2 production

South Wales Offshore

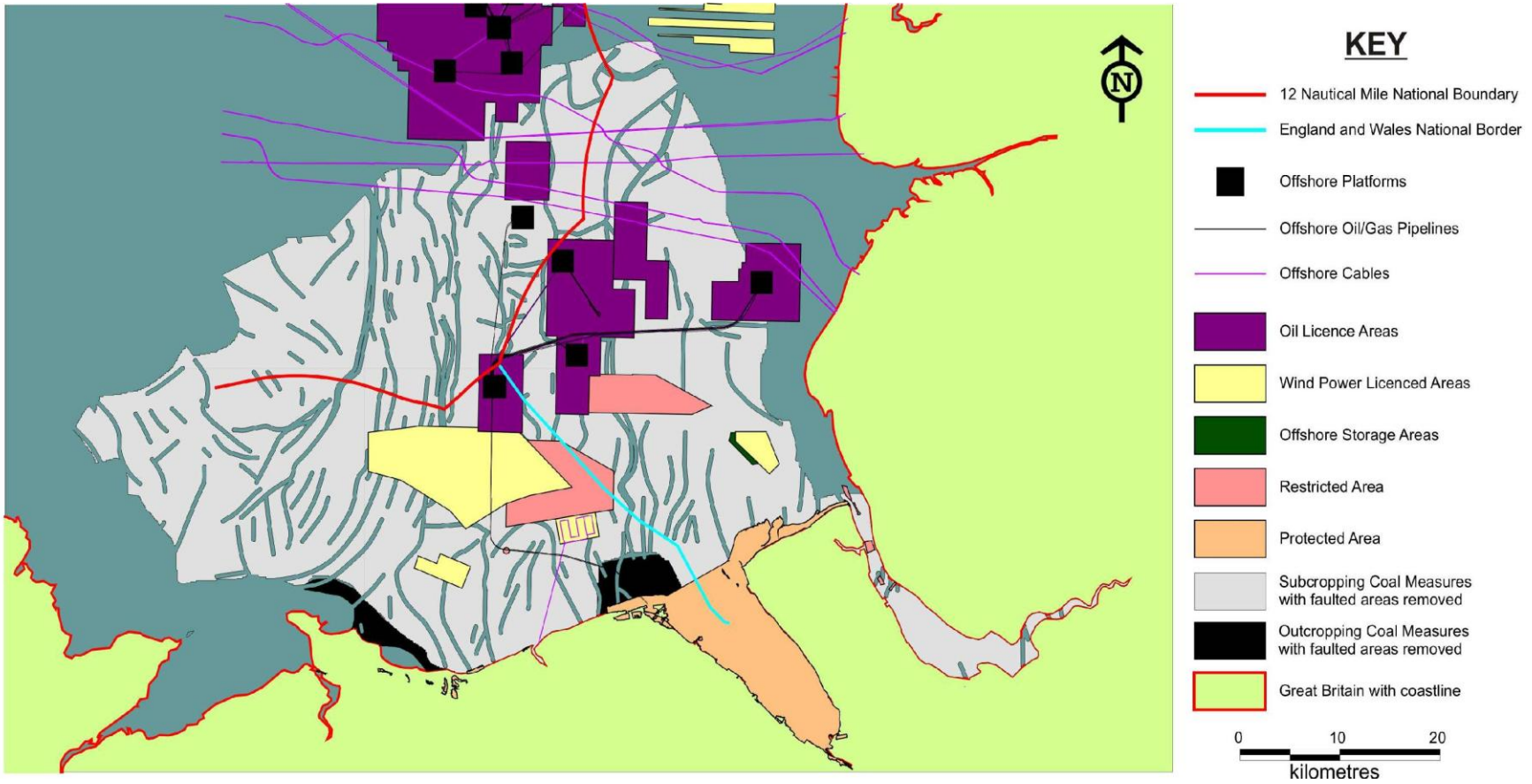




28km^2

66km^2

North Wales Offshore



UCG Licensing in the UK

- **UCG is 'coal working'under the 1994 Coal Industry act**
- **Within DECC, the licensing organisation is:**

200 Lichfield Lane

Mansfield, Notts NG 18 4RG

www.coalauthority.co.uk

UCG Licensing Procedure

- **Licence applications can be made at any time for any location**

  (i.e. not in blocks or rounds as for Oil & Gas)
- **Applications are publicised (to promote competition)**
- **The CA and Oil & Gas division liaise to co-ordinate UCG and CBM sites**
- **Licensing procedures on shore are akin to coal mining**
- **Offshore other factors are considered – shipping, windfarms, protected areas, military exclusion zones**

Status of UCG Licensing in the UK

- **First UCG licence application by :**

  Thornton New Energy

  - for an area in the Firth of Forth

  - publicised in October 2008

  - conditional licence granted February 2009

- **Second UCG licence application**

  Clean Coal Limited

  - for five coastal areas of England and Wales

  - publicised December 2008

Concluding Remarks

UCG is an exploitation technology for indigenous coal, which is ready for use, has significant advantages in terms of cost, security of supply and CO2 capture and storage.

It is being evaluated commercially in coal countries around the world, mostly in the private sector.

First movers are in place to exploit UCG as a profitable commercial clean coal opportunity

A global alliance of knowledge, expertise, training, networking & information for Underground Coal Gasification

www.ucgp.com