The Energy Story
Mining Institute of Scotland Presidential Address
Steve Bedford October 11th 2006
HSE Moment - Managing Energy
Surabaya Indonesia
Local exploration & production company drilling for gas 800 km east of Jakarta near Surabaya

- Last casing point, 13-3/8” @ 3850’
- Lost circulation at 8,500’
- Operator decided to drill ahead
- Whilst drilling at 9,297’ on 29th May steam, water and mud and a minor amount of gas broke surface 200m from the well
- Source of the mud is thought to be from 4000 - 6000 ft, Upper Kalibeng clay formation
- Snubbing and well kill failed
• Flowing c300,000 bbls/day of mud - water with suspended and dissolved solids, mainly silt sized

• >25 mmbbls flowed to end August

• No toxic gas

• 6 people arrested, including: drilling manager, project manager and geologist..... 12 -15 years in prison if convicted
450 hectares of paddy farm, 1810 homes, 10 schools, 20 factories, 2 offices and 15 mosques destroyed. Main road to Surabaya cut and 10,000 people are homeless.
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The Energy Story

Agenda

- Global Energy Demand and Supply
- UK Energy Demand and Current Supply
  - Overview of UK Oil and Gas
- The Operating Environment
- The Future and the Role of this Institute
Global Energy Demand and Supply

Global Demand by Fuel: 1970 to 2030

Source: IEA, 2005
Global Energy Demand and Supply
Reserves of Fossil Fuels

Proved energy reserves

Proved Oil Reserves

Bbbls

<table>
<thead>
<tr>
<th>Year</th>
<th>Non-OPEC</th>
<th>OPEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>800</td>
<td>1200</td>
</tr>
<tr>
<td>1996</td>
<td>850</td>
<td>1250</td>
</tr>
<tr>
<td>1998</td>
<td>900</td>
<td>1300</td>
</tr>
<tr>
<td>2000</td>
<td>950</td>
<td>1350</td>
</tr>
<tr>
<td>2002</td>
<td>1000</td>
<td>1400</td>
</tr>
<tr>
<td>2004</td>
<td>1050</td>
<td>1450</td>
</tr>
</tbody>
</table>

Reserves/Production Ratios 2004

- Oil: 40.5
- Gas: 66.7
- Coal: 164

Source: BP Statistical Review
Global Energy Demand and Supply
Resource Location

Location of resources

Oil, Gas and Coal Resources by Region (bnboe)

Source: BP Data

Key:
- conventional oil
- gas
- unconventional oil
- coal
The Energy Story
The Operating Environment

- Global Energy Demand and Supply
- UK Energy Demand and Current Supply
The UK Energy System

- Oil
  - Gasoline or Diesel
  - Transport

- Gas
  - Heat (homes and business)
  - 37%

- Coal
  - Electricity
  - 34%

- Renewables
  - Power services (homes and business)
  - 5%

- Nuclear
  - 20%

- High CO2
- Zero/Low CO2
- Depends on initial generation

Source: DTI, 2006
UK Energy Demand and Current Supply

UK Electricity Generation

Source: DTI, 2006
UK Energy Demand and Current Supply

Carbon Emissions

Table 5.1: Illustrative annual carbon emissions from 500MW electricity generation plant

<table>
<thead>
<tr>
<th>Plant type</th>
<th>Carbon emissions (millions tonnes / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional coal</td>
<td>0.90</td>
</tr>
<tr>
<td>Efficient coal</td>
<td>0.69-0.74</td>
</tr>
<tr>
<td>Efficient coal with biomass</td>
<td>0.60-0.65</td>
</tr>
<tr>
<td>Natural gas</td>
<td>0.36</td>
</tr>
<tr>
<td>Natural gas or efficient coal with</td>
<td></td>
</tr>
<tr>
<td>carbon capture and storage</td>
<td>&lt;0.10</td>
</tr>
</tbody>
</table>

Table 5.3: Total Lifetime Releases From Selected Technologies

<table>
<thead>
<tr>
<th>Technology (2005-2010)</th>
<th>GC/kWh*</th>
<th>Equivalent to GCO₂/kWh**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignite</td>
<td>228</td>
<td>836</td>
</tr>
<tr>
<td>Coal</td>
<td>206</td>
<td>755</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>105</td>
<td>385</td>
</tr>
<tr>
<td>Biomass</td>
<td>8-17</td>
<td>29-62</td>
</tr>
<tr>
<td>Wind</td>
<td>3-10</td>
<td>11-37</td>
</tr>
<tr>
<td>Nuclear</td>
<td>3-6</td>
<td>11-22</td>
</tr>
</tbody>
</table>

*Grams of Carbon per kilowatt hour of electricity produced.
** Grams of Carbon Dioxide per kilowatt hour of electricity produced.

Source: DTI 2006

Source: OECD Nuclear Energy Agency.
### UK Energy Demand and Current Supply

#### Coal Reserves

<table>
<thead>
<tr>
<th></th>
<th>Million tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Mines</td>
<td>540</td>
</tr>
<tr>
<td>Surface Mines</td>
<td>325+</td>
</tr>
<tr>
<td>TOTAL</td>
<td>865+</td>
</tr>
</tbody>
</table>

Source: DTI 2006 adjusted to reflect mine closures
UK Energy Demand and Current Supply

**Agenda**

History – Wood Mackenzie; Future - BP Estimates

Production (mboed)

- **Oil**
- **Gas**

Giant Fields

90’s Growth: CRINE & Gas Market Liberalisation

Increasing Basin Maturity
UK Energy Demand and Current Supply
Gas Supply: Pipelines / Storage / LNG

Table 4.3: Planned gas storage projects

<table>
<thead>
<tr>
<th>Projects</th>
<th>Date of commissioning</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldbrough storage</td>
<td>Q3 2007</td>
<td>420 mcm</td>
</tr>
<tr>
<td>Holford storage</td>
<td>2006 (proposed)</td>
<td>170 mcm</td>
</tr>
<tr>
<td>Welton storage</td>
<td>2006</td>
<td>435 mcm</td>
</tr>
<tr>
<td>Freesall storage</td>
<td>2009 (proposed)</td>
<td>1,700 mcm</td>
</tr>
<tr>
<td>Aldbury (Phase 1)</td>
<td>2007/08 (proposed)</td>
<td>160 mcm</td>
</tr>
<tr>
<td>Aldbury (Phase 2)</td>
<td>2010 (proposed)</td>
<td>715 mcm</td>
</tr>
<tr>
<td>Bletchingley</td>
<td>2009 (proposed)</td>
<td>900 mcm</td>
</tr>
<tr>
<td>Saltfleetby</td>
<td>2008</td>
<td>600 mcm</td>
</tr>
<tr>
<td>Caythorpe</td>
<td>2007</td>
<td>210 mcm</td>
</tr>
</tbody>
</table>

Source: JESS, 2006

Table 4.2: Planned gas imports infrastructure

<table>
<thead>
<tr>
<th>Projects</th>
<th>Date</th>
<th>Max capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langeled South</td>
<td>2006/07</td>
<td>70 mcm/day</td>
</tr>
<tr>
<td>Statfjord Late Life</td>
<td>2007/08</td>
<td>17 mcm/day</td>
</tr>
<tr>
<td>Expansion Interconnector</td>
<td>2006 (December)</td>
<td>from 44 to 66 mcm/day</td>
</tr>
<tr>
<td>BBL</td>
<td>2006 (December)</td>
<td>44 mcm/day</td>
</tr>
<tr>
<td>Expansion Isle of Grain</td>
<td>2008 (Q4)</td>
<td>25 mcm/day</td>
</tr>
<tr>
<td>South Hook LNG</td>
<td>2007 (2009)</td>
<td>33 mcm/day (26 mcm/day)</td>
</tr>
<tr>
<td>Dragon LNG</td>
<td>2007 (Q4)</td>
<td>27 mcm/day</td>
</tr>
<tr>
<td>Teesside LNG</td>
<td>under consideration</td>
<td>under consideration</td>
</tr>
<tr>
<td>Canvey Island LNG</td>
<td>under consideration</td>
<td>under consideration</td>
</tr>
</tbody>
</table>

Source: JESS, 2008
The Energy Story

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Overview of UK Oil and Gas

Onshore Oilfield: Kimmeridge Bay, Dorset

- First Dorset exploration well drilled in 1934
- Field on stream in 1959
- Producing from the naturally fractured Cornbrash Limestone following an acid treatment
- Production rate declined from 500 to current 80 bbl/day
- Beam pumped
- Sweet, light crude with very little gas
Overview of UK Oil and Gas

**Onshore Oilfield: Wytch Farm, Dorset**

- On stream in 1974 – offshore size field
- Production zones: Frome Limestone, Bridport Sands and Sherwood Sands
- Extensive use of new technology: electric pumps, multi lateral wells, intelligent completions, downhole fibre, extended reach drilling – world leader
Overview of UK Oil and Gas
Southern North Sea Gas

- Typically sandstone reservoirs, often hydraulically fractured to stimulate rates
- First fields on stream in the mid 1960’s.
- As the larger fields were developed, smaller fields have been developed with subsea wells and unmanned small platforms. Move towards multi lateral wells, under balanced drilling and de-liquification technologies.
Overview of UK Oil and Gas
Large Integrated North Sea Oil Platforms

- Typically sandstone reservoirs with highly prolific wells and water flood
- Platforms typically accommodate 150 to 250 people with facilities for: drilling, primary processing, export and life support
- As fields age upgrades typically required to reduce discharges, artificially lift wells and access adjacent smaller fields e.g. subsea wells
Overview of UK Oil and Gas

CRINE (Cost Reduction In the New Era)

- Novel designs to reduce development costs and thereby access smaller Reservoirs
- Example is the Harding Field where a jack up on a concrete storage base is used for drilling, production, storage and export. Once the Field is exhausted the facility will be moved to the next field
Overview of UK Oil and Gas

Post Piper Alpha Facilities

- Move to separate living accommodation from process and drilling facilities

- Example is the Bruce Platform with three bridge linked structures:
  Quarters/Utilities: Drilling/Process and Export. Subsea wells tied back to the Drilling/Process platform
Overview of UK Oil and Gas

Subsea Developments

- Increasing subsea well count in the North Sea
- Use of floating production systems and mobile drilling rigs, particularly in deep water areas e.g. Foinaven and Scheihallion Fields in 550m of water in the North East Atlantic.
The Energy Story

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The Operating Environment

Earnings

Record earnings for oil and gas producers after 20 years

Average Spot Price of Brent Crude ($/bbl)

Record earnings for oil and gas producers after 20 years
The Operating Environment

Petroleum Industry Capital Spending ($US bn)

Source: 2004 Worldwide Petroleum Industry Outlook, IEA
The Operating Environment

Costs

- Industry not sized for current demands
- Offshore costs up 68% on 2000
- BTC pipeline $1bn over budget
- Shell oil sands costs up 50% on 2005
- Production sharing agreements and windfall taxes

Average P/E ratio of oil companies on S&P 500 9.8 – half historic average
The Operating Environment

The Natural Environment: Increasing Concern

Power, politics and pollution
The dirty fuel that’s burning us

Measurement of environmental articles in the media
Source: Factiva

Biodiesel puts on a suit
Fuel heavy industries are turning to an alternative
UK Energy Demand and Current Supply
Safety: DAFWCF 12 Month Rolling Average
The Operating Environment
Current Petroleum Workforce

Initial age distribution

No people

22 25 28 31 34 37 40 43 46 49 52 55 58 61 64

E F G H I J Kbelow
The Operating Environment
New Entrants to the Petroleum Industry

U.S. Petroleum Engineering Enrollment
Thousands

Source: 2004 Worldwide Petroleum Industry Outlook, IEA; AAPG membership; EIA, BLS
The Operating Environment

New Technology: Downhole Scale Removal

Event:
Barium Sulphate scale bridges in two offshore gas producing wells.

Action:
Used new technology - wireline tractor deployed mill instead of coiled tubing deployment

Result:
- 4mmscf/day extra production
- Cost £0.33m vs. £0.87m for Coiled Tubing
- Job 12 days vs 35 for Coiled Tubing
- Crew reduced from 23 people to 12
- Eliminated heavy lift requirements
- Technology transferable to other areas
UK Energy Demand and Current Supply

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Global energy demand is forecast to continue rising over the long term.

Current balance between supply and demand with security of supply issues is driving high prices leading to:

- Large investment and resulting shortages of supply causing high inflation
- Increasing taxation and nationalisation

Much of the energy demand in the UK will continue to be met by fossil fuels, with a focus on oil and gas.

Oil and Gas prices have fallen recently – expectation is that prices will rise over the long term but in the short/medium term will continue to be volatile and will likely fall to say c$25/bbl.
The Future and the Role of this Institute

UK Challenges and Role of this Institute

- Domestic oil and gas production is well established in the UK but production rates are declining rapidly and intervention is required to:
  - Maintain and increase utilisation of the aging existing infrastructure and develop new infrastructure e.g. LNG facilities, gas storage, new pipeline systems
  - Increase recovery factors
  - Develop smaller more complex fields against a backdrop of increasing cost
  - Address increasingly demanding environmental targets e.g. carbon emissions
  - Develop alternative fossil fuel resources e.g. coal bed methane
  - Continue improvements in health and safety
  - Renew the workforce

- What role can this Institute play in addressing these challenges?
  - Provide a diverse forum for sharing knowledge pertinent to current and future issues to promote continuing professional development
  - Provide assurance on the competency of individuals and programmes
  - Act as an advisory body
The Mining Institute of Scotland

Founded in 1878 to help improve health, safety and efficiency in the winning of the fuels of our economic prosperity