Mines Gas – Hazards & Opportunities
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Brownfield Land Wales
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Presentation Content

1. Introduction and the mines gas hazard

2. Coal mining legacy within the UK & Wales

3. The Gorebridge incident

4. Mines gas resource opportunities
Sept 2013 - Gorebridge

Council tenants overcome by mines gas and taken to hospital
By Sept 2014 - Gorebridge

22 people had attended A&E or sought medical help – estate evacuated

In March 2017, whole estate (64 homes) was demolished
Coal and Gas Formation

Plant material buried and subjected to:
- Time,
- Pressure
- Heat

Coal formed with natural gas:
- 80-95% methane
- some higher chain alkanes
- Some nitrogen
- Some carbon dioxide

© Steve Greb, Kentucky Geological Survey
Increasing Depth, Pressure and Temperature

Peat
Lignite
Sub-bituminous
Bituminous
Semi-Anthracite
Anthracite
Meta-Anthracite

Methane Content (per tonne of coal worked)
50 to 100 m$^3$/tonne
Hazardous Mine Gases

Both Chronic & Acute Risks

Firedamp
Blackdamp or Stythe gas
Afterdamp

Methane
Carbon Dioxide & Nitrogen
Carbon Monoxide

CH₄  CO₂  N₂  CO
UK Mines Gas Incidents

• Between **1851 and 1980** - 186 coal mine explosions causing 10,000 fatalities (*CIRIA 152*)

• **1980** – Evacuation of homes in Rotherham (*Guardian, 31.1.2001*)


• **1988** – Demolition and relocation of entire village of Arkwright (*DoE 1996*)

• **1995** – Fatal asphyxiation in stable in Widdrington (*DoE 1996*)

• **1998** – Fatal asphyxiation in service trench in Barnsley (*NCE, 1999*)

• **2000’s** – Explosion in home in Workington (*Allerdale BC, 2006*)

• **2000’s** – Demolition and rebuild of school in Workington (*Allerdale BC, 2006*)

• **2013** – Hospitalisation of council tenants in Gorebridge (*IMT, 2017*)
Senghenydd Colliery Disaster 1913

14 October 1913 major explosion:
439 miners and a rescuer died from:
  • Explosion
  • Fire
  • Afterdamp

Inquest established the colliery had:
High quantities of firedamp
  • High levels of airborne coal dust
  • Ignition was probably caused by electric signalling bell
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Coal Mining Legacy

- 11% of the UK is occupied by the UK coalfield
- 172,000 recorded mine entries
- 7 million properties lie within Britain's coalfield
- 130,000 properties lie within 20 metres of at least one mine entry
- 360,000 abandoned mine plan

Coal Authority Data
Coal Mines Regulation Act, 1887

Progression from:
• workings at coal outcrop
• single shaft ‘bell pits’

to:
• ‘pillar and stall’ workings

and finally
• ‘long wall’ mining

172,000 recorded mine entries
Probably same number of unrecorded pre-1887 entries
Early Coal Mining

- Initially worked from outcrop
- Then via ‘Bell Pits’
- No records
Pillar and Stall Workings

- Typically 30% coal extraction
- If shallow can lead to crown-hole surface collapse
- If pillars ‘robbed’ through retreat mining surface subsidence occurred

Photos © British Geological Survey
GeoScience Ref P001520 - Blindwells Opencast Site, Tranent, East Lothian
Long wall mining

Total extraction with progressive subsidence at the surface
Mines Gas Issues

- Open voids in abandoned mine workings
- Mines gas accumulating in voids
- Gas migration pathways to the surface
- Pressure driven migration along pathway

Additional factors:

- Mines drainage failing
- Mine pumps turned off
- Rising ground-water in mine workings
Coal Mining Reporting Areas

North Wales and South Wales Coalfields

- 1800 – 1,500 workers
- 1913 - 250,000 workers

By 1913 Welsh collieries produced 63.6 million tons of coal per annum.

South Wales Coalfield was the largest in the world.
South Wales Coalfield

Coal outcrops
Opencast mining
Shallow and deep mining
South Wales Coalfield

Red Mine Shafts
Brown Mine Adits
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Council tenants overcome by mines gas and taken to hospital
Chronology

- 2006 Desk Study identifies possible mines gas
- 2006 SI & Risk Assessment doesn’t find ground-gas
- Consultants conclude ‘low ground-gas risk’ – no gas protection measures required
- 2009 sixty four homes built
- Sept 2013 first residents taken to A&E
- April 2014 IMT set up
- by Sept 2014, 22 people had attended A&E or local GP
Gorebridge - Area of Probable Shallow Mine-workings

The Coal Authority
Coal Working Drilling & Grouting Stabilisation

- <1 Tonne
- 1-5 Tonnes
- >10 Tonnes
- 5-10 Tonnes
- Pressure Test Borehole
2013/14 Coal Authority Investigations

87 Newbyres Crescent found to have:

- 8% CO₂ in downstairs toilet
- 12% CO₂ in Lounge (where son had been sleeping)
- 19% CO₂ beneath kitchen flooring
- 21% CO₂ measured in hole drilled through raft
- 23% CO₂ in wall cavity

Borehole drilled to the shallowest coal seam at 13m bgl:

- 25.1 % CO₂ & 4.6% O₂
- No grout was found in the coal seam
Continuous gas monitoring
2017 IMT Report Conclusions

- Source confirmed as worked coal seam
- Workings not fully grouted
- Grout holes beneath houses possibly not sealed
  - SI boreholes beneath houses possible not sealed
  - Vibro stone column foundations
  - Service entries through raft not sealed
  - No gas protection measures installed
  - Highest CO2 associated with falling atmospheric pressure

"Was this was an entirely preventable incident?"
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Mines Gas as a Resource

Former mine workings which:
• are actively degassing,
• have open voids, and
• have surface space for a production pad.

Can be potential commercial sources of methane.

Alkane Energy

Is a UK onshore petroleum operator that utilises methane from abandoned mine workings for power generation for more than 20 years - Gas to Power.

• 30 sites across the UK.
• Total installed generating capacity - 160MW.
Coal Mine Methane (CMM):
Askern, Bevercotes, Bilsthorpe, Cadeby, Florence, Gedling, Kings Mill Hospital, Maltby, Newmarket, Sherwood, Prince of Wales, Edenthorp

Flexible Peak Generation:
Grimethorpe, Houghton Main, Hickleton, Manvers, Markham, Cardiff, Redditch, Shirebrook, Haydock, Telford, Kirkby, Leopold, Star Lane

CMM and Flexible Peak Generation:
Hem Heath, Mansfield (Toray), Wheldale, Warsop, Whitwell, Calverton

Sites Under Construction
Ince, Staveley
Prince of Wales, Yorkshire
Coal Mine Methane Site

©Alkane Energy
Future Opportunities - Unworked Coal
Coal Bed Methane

UNECE, Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines, 2nd Ed., Dec. 2016:
References:


The Coal Authority – Online Maps:  
http://mapapps2.bgs.ac.uk/coalauthority/home.html

UNECE, Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines, 2nd Ed., Dec. 2016:  

Alkane Energy Website:  
https://www.alkane.co.uk/
Thank you

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