Independent Review of Underground Coal Gasification – Report

Campbell Gemmell

Annex 2

A report to…The Scottish Government, Edinburgh 2016

Annex 2

2A Interviews and Materials Submitted

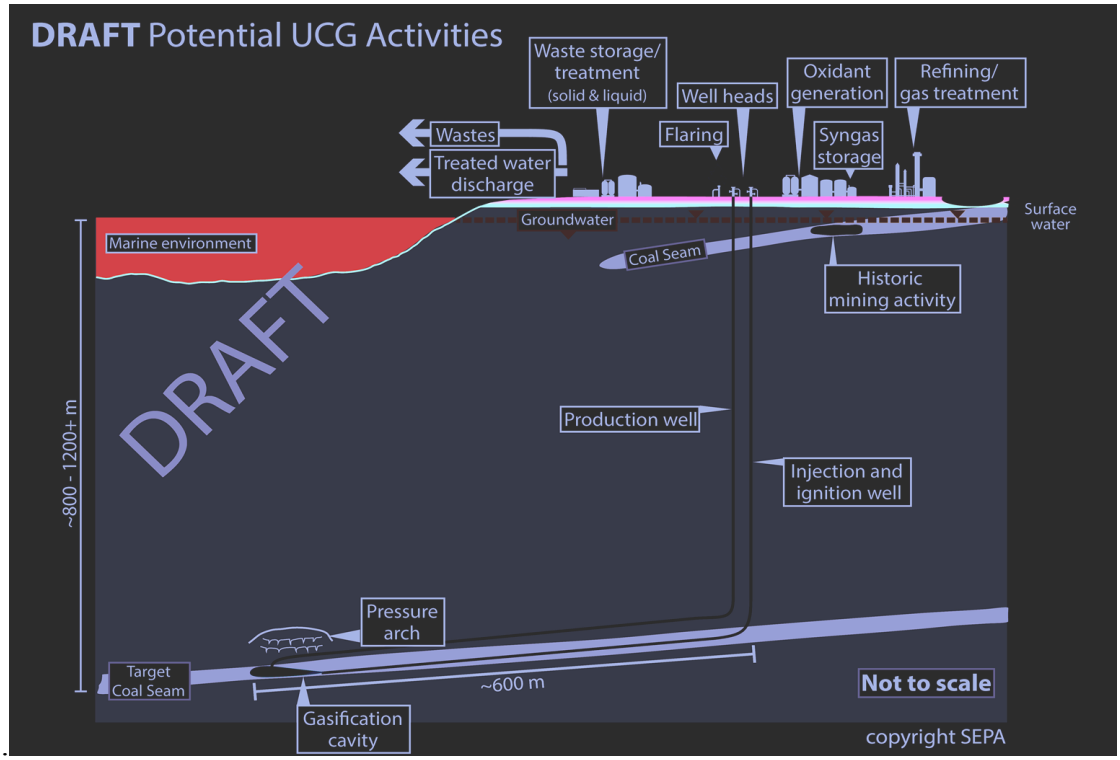
Interviews

1. Aedán Smith and Alexa Morrison, Royal Society for the Protection of Birds (RSPB)
2. Dr. Richard Dixon, Mary Church and Flick Monk, Friends of the Earth Scotland (FoE)
3. Simon Reed, Simon Cooke, Tim Marples and Nick Ethelstone, Coal Authority (CA)
4. Prof. Alex Russell, Robert Gordon"s University
5. Prof. Alex Kemp, University of Aberdeen
6. Lang Banks and Dr. Sam Gardner, WWF Scotland
7. Alison Monaghan, British Geological Survey (BGS)
8. Robert Nicol, CoSLA and John Milne, Falkirk Council/SSD/HP
9. Prof. Stuart Haszeldine, University of Edinburgh
10. Donald Campbell, Broad Alliance
11. Emily Bourne, Nick Shaw (James Clarke and Brendan Roth), Department for Energy and Climate Change (DECC, now DBEIS)
12. Dr. Colin Ramsay, Health Protection Scotland (HPS)
13. Prof. Jim Skea, Imperial College London
14. Andrew Nunn and Algy Cluff, Cluff Natural Resources
15. Tony Almond and Beverley Boyce, Health and Safety Executive (HSE)
16. Luca Demicheli, EuroGeoSurveys
17. Christian Wimmer, DG Env and Vladimir Zuberec, DG Energy, EU Commission
18. Prof. Andrew Watterson, University of Stirling
19. Ken Cronin, UK Onshore Oil and Gas
20. Prof. Zoe Shipton, University of Strathclyde
21. Mark Gifford, Chief Environmental Regulator of the NSW EPA
22. Ian Jardine, CEO of Scottish Natural Heritage (SNH)
23. Anna Donald, Marine Scotland

[Brief notes of interviews are available on request, subject to approval of the interviewees.]

Materials

SEPA



Cause	Details	Contributing factors	Example(s)/reference(s)
Site selection (FoF target seams are 800<1300 m deep)	**This is the primary risk mitigation strategy**. - Increased target coal seam depth corresponds to decreased risk. - Must be sufficient distance from environmental receptors - Higher hydrostatic pressure allows effective gasification and reduces risk of pollutant egress. - Impermeable cap rock and absence of faulting or natural rock pathways are key. - Site must be optimised for process design (e.g. industrial scale and potential for multiple panels) and effective monitoring.	- Lack of data - Inadequate modelling - Lack of expertise (industry, operator, consultant, regulator) - Costs (commercial viability) - Poor HRA and CSM	References: - Firth of Forth UCG overview - ISP report, Queensland pilot trials (summary). o Recommended that guidelines/standards are developed that then serve as go/no go gates for development decision. - IEA CCC report: o Emphasises that due to the highly unique nature of each site and low maturity of the technology, published site selection criteria should be viewed as preliminary screening criteria. Examples: - Queensland pilot trials (summary): shallow depth (<150m) - Hoe Creek
Risk management approach	**A risk-based framework should be integrated at every level.** It should include: - A Hazard and operability study (HAZOP) - Industry best-practice safety operating procedures - Levels of Protection Analysis - Fault/event tree analysis	- Inadequate regulatory framework - Inadequate modelling - Lack of expertise (industry, operator, consultant, regulator) - Costs (commercial viability) - Poor HRA and CSM	ISP

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

	- Process design that accounts for significant variability/deviations		
Monitoring		- Inaccessibility of monitoring points (e.g. in marine environments) - Inadequate regulatory framework - Lack of modelling and baseline data - Lack of expertise (operator, consultant, regulator) - Costs (commercial viability)	Examples: ISP report, Queensland pilot trials (summary): - "[Linc Energy and Cr b on Energy] have yet to fully demonstrate the capability to design and install a monitoring network suitable for multi-panel operations"
Process control	**The UCG process is exposed to some unknown and uncontrollable conditions**: comprehensive and real-time process control is crucial. - Process monitoring and control should include: - Pressure/temperature - Flow rates - Mass balances - Gas quality - Critical alarms - Safety instrument systems - Pressure relief systems - Pressure control is seen as most important	- Inadequate monitoring - Inadequate regulatory framework - Lack of industry 'best practice' guidelines - Lack of expertise (operator, consultant, regulator) - Low maturity of UCG technology - Costs (commercial viability)	Examples: - ISP report, Queensland pilot trials (summary): - There was a lack of critical alarms, safety instrument systems and appropriate decisions making procedures - Several incidents occurred from lack of sufficient process control. References: Atiken for DTI
Process modelling	Needed to understand: - Chemical reactions - Heat transfer - Mass transfer - Rock deformation/stress distribution	- Inadequate data - Lack of expertise (operator, consultant, regulator) - Low maturity of science (modelling and validation) - Cost (time and money)	References: - Cavity simulation presentation Examples: - ISP report, Queensland pilot trials (summary):

– draft sent to Campbell Gemmell 18/01/16

DRAFT INFORMATION

Created by FolderMill | www.foldermill.com

	- Cavity growth **Crucial for informing process design and risk management**. Must be validated by empirical data.		- Found process modelling and validation to be lacking.
Design, materials and construction	- Must be informed by HRA, CSM, process modelling and risk management strategy. - Must be able to cope with significant variations in thermal and mechanical stress. - Must include physical protection systems - Well integrity	- Inadequate regulatory framework	Examples: ISP report, Queensland pilot trials (summary): - Deviations in temperature and pressure resulted in weakening of the liners or lifting of the wells that subsequently failed. - Downstream po cessing couldn't cope with process variability/deviations. - Pollution incidents occurred. - Fault of poor design, materials and construction.
Decommissioning	**Aim is to extinguish the reaction, establish thermal equilibrium and prevent future environmental harm.** - Includes important changes of states in temperature and pressure, and rates of change are important. - Potentially contaminating chemicals have a high probability of forming during cooling. - There is reasonable evidence from small-scale trials ih se UA that a 'clean		ISP report, Queensland pilot trials (summary): - Insufficient evidence has been gathered or provided for the pilot trials regarding decommissioning. - There is no evidence of the capability to control the temperature and pressure gradients in large cavities. - Extrapolation from other small cavities is inadequate, as the

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

	cavity' ean b achieved,ub t there are significant potential scale-up issues. - The final integrity of the cavity and overlying cap-rock is critical for minimising risk to the environment and risks increase with increasing cavity size.	process is highly dependent on site geology and process design. - Access to cavities appears to be a very challenging design issue, limiting knowledge of the decommissioning process and its success. - While several pilot trial panels have been shut down, it is unclear if rehabilitation has taken place. - A formal process model, mass and energy balances and appropriate data support were all lacking. - **Available evidence is not sufficient to develop the best strategies.** -
Multi-panel activities	**Industry Scale-up presents a number of additional potential issues**, including: - establishment of above ground and underground buffer or active zones - a design that avoids connectivity between final cavities and active panels resulting in: - unacceptable surface subsidence; - groundwater transport of contaminant - loss of control of oxygen conditions - the need for external injection of water to maintain the hydrostatic pressure across the site;	

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

- a minimum distance from a UCG facility boundary and other activities (e.g. CBM) that require different hydrostatic operating conditions;
- acceptable and agreed decommissioning procedures

Main operational causes of increased risk

This table is based on information from:

ISP report, Queensland pilot trials (summary)

Atiken for DTI

SISTech report: Environmental impacts and legislation of UCG

DRAFT incomplete

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

SUMMARY OF POTENTIAL ENVIRONMENTAL HAZARDS ASSOCIATED WITH UNDERGROUND COAL GASIFICATION (UCG)

Introduction:

The main technical challenges with regards to UCG arise because the conditions under which the gasification reaction takes place are complex, naturally variable and difficult to monitor. This, combined with potential environmental hazards, which are summarised below, creates risk.

However, currently, there are several factors limiting a robust assessment of the risks associated with UCG:

Lack of evidence of environmental impact from similar situations

Data on the environmental impacts of UCG is limited, particularly from trials relevant to the proposed target coal seams under the Firth of Forth and fro the depths being proposed (~800-1300m).. The best available environmental data come from USA trials of the late 1970s and 1980s, but these were conducted on shallow coal seams (<200m depth). The most relevant examples are the deep (> 500 m) European trials (e.g. El Tremedal, Spain), however, environmental impact data from these are either absent or limited[11].

Lack of data on impact that commercial scale UCG will have on the environment

While major trials have taken place for more than fifty years and there are dozens of current trial projects around the world, no commercial UCG project has been demonstrated* and there remains significant technological and knowledge gaps[1,17].

Furthermore, a recent International Energy Agency report[17] emphasises that experience and expertise from closely related fields have limited applicability to UCG, and that the techniques and technologies proven in small-scale pilot trials do not necessarily transfer linearly to commercial-scale projects as new aspects such as the greater cavity size, multiple panels and increased length of operations likely present additional challenges.

Lack of clarity about degree of regulatory control over UCG Regulatory framework

Currently, we are considering our regulatory controls and it is likely that The Water Environment (Controlled Activities) (Scotland) Regulation and Pollution Prevention and Control (Scotland) Regulation 2012, amongst others, may apply. SEPA is working with Scottish Government and other regulators including the Coal Authority, Health and Safety Executive and planning authorities to ensure we have the appropriate controls and regulations to protect the environment and human health. However, because these controls and regulations are still being clarified, it is not possible at this stage to assess the level of protection they will provide.

* The Yerostigaz UCG facility in Angren, Uzbekistan, (majority-owned by Linc Energy) has been operating for over 50 years and could be considered commercial as it consistently produces 1 million m^3 of syngas per day (according to Linc Energy). However, it uses old, full depreciated equipment, the consistency and quality of syngas produced has not been a critical factor, it probably doesn't m et the environmental standards of OECD countries, and there have been no moves to scale-up the operation[17].

– draft sent to Campbell Gemmell 18/01/16

DRAFT

Created by FolderMill | www.foldermill.com

Below, the main hazards associated with UCG are outlined, with relevant examples given. In a separate table, the main operational causes of increased risk are given. Note that these tables are intended to cover the full range of risks associated with UCG and are neither site- nor technology-specific, but, where possible, the Scottish-specific context is considered

Potential hazard	Details and environmental concerns	Influencing factors	Example(s)	Relevance to Scottish context
Groundwater pollution	- Consistently identified as the primary environmental concern. - Pollutants include: - Organic compounds (e.g. Phenols, PAHs, BTEX) - Inorganic compounds (e.g. ammonia, nitrogen, cyanides) - Soluble gases (e.g. hydrogen sulphide, carbon monoxide, heavy metals) - Naturally Occurring Radioactive Material (NORM). - Changes in pH can also occur - Risk depends on the potential for pollutant migration and the presence of receptors. - Waste coal ash left in situ after decommissioning poses permanent risk of groundwater pollution. - There are uncertainties over	- Inadequate site selection - Inadequate decommissioning - Groundwater flow altered post-operation - Excess cavity/well pressure - Inadequate monitoring - Inadequate process control - Well blockage - Fire/explosion - Damage to monitoring or production boreholes/wells - New pathways created due to cavity collapse and thermal/mechanical alteration of surrounding rocks - Faults/natural pollutant pathways - Intersection of historical mines	**Hoe Creek I, II & III, USA** (late 1970s, 3 shallow depth (~50m) trials): - Significant long-term groundwater pollution due to over-pressured cavity[2,3]. **El Tremedal, Spain** (1997, ~550m deep): - Main environmental impact was to groundwater and was calculated to be similar to underground tungsten mining[9] **Former Soviet Union**[14,15,17] (various trials): - Groundwater contaminants, resulting from gasification during the late 1950's ad early 1960's, found to be widespread and persistent, even up to five years after production had ceased. - Phenols were found within an aquifer which extended over an area of 10 km^2 - There were significant gas	- Developments are likely to be at >800m depth, making examples from shallow (<500m) settings less informative. - The Coal Authority would not permit developments that have potential for intersecting historical mine-workings. - Groundwater at proposed sites is likely to be permanently unusable because it is naturally saline.

– draft sent to Campbell Gemmell 18/01/16

DRAFT

Created by FolderMill | www.foldermill.com

	contaminant: - generation - persistence - transport		losses due to leakage, and it was common for between 5% and 25% of the gas formed to be lost from the underground gasifier **Experimental Mine "Barbara", Poland** (2013, a 30m deep engineered reactor): - Heavy metals, ammonia and cyanides found in effluents and groundwater near the site[13].	
Surface water pollution	- Surface waste water can originate from: - process water - gas treatment - cavity flushing water - Pollutants include (same as above?) - The quality of waste water can vary significantly and rapidly This can be as a result of 1)migration from depth into surface ecosystems as row above or 2)inadequate control or disposal of waste water	- Inadequate site selection - Natural or anthropogenic features (e.g. faults, fissures, boreholes) may create hydraulic connections to the surface - Inadequate treatment/disposal of extracted waste water - Inadequate surface infrastructure, including materials, maintenance, procedures and protection systems - Excess well pressure due to: - Inadequate monitoring - Inadequate process control - Well blockage - Fire/explosion	Risk of surface incidents due to inadequate surface infrastructure and treatment/disposal of waste should be similar to conventional surface industries **El Tremedal, Spain** (1997, ~550m deep): - 240 tonnes of coal gasified -The influx of groundwater into the cavity was much larger than expected, resulting an excess of produced water with elevated contaminant levels. This was a major technical and economic problem, although no local surface water contamination was detected[11]. **Carbon Energy, Bloodwood**	- Developments are likely to at >800m depth, making uncontrolled hydraulic connections from the cavity to the surface highly unlikely, except in the case of damaged boreholes. - Discharge of waste water is likely to be into the marine environment because of its proximity to proposed sites. There will be huge dilution potential.

Created by FolderMill | www.foldermill.com

			Creek, Queensland, Australia (2008 to present, ~150m deep): - An injection well blockage caused pressure to spike well above hydrostatic pressure, resulting in the emission of process water through the flare[1].	

Air emissions	- Pollution of air with:
	  - Unburned hydrocarbons
	  - NOx
	  - H_2S and SO_2
	  - CO
	  - Fly ash
	  - Particulates and heavy metals
	  - Mist formation (from cooling)
	  - Dust deposition
	- Greenhouse gas (GHG) release:
	  - CO_2
	  - CH_4
		- Inadequate:
		  - Monitoring
		  - Site selection
		  - Process modelling
		- Construction emissions
		- Emissions imbedded in materials
		- Flaring
		- Refining/combustion of syngas
		- Venting during start-up
		- Fractures or old mine workings
		- Fugitive (escaped) gases due to:
		  - Leaking/damaged underground and surface infrastructure
		  - Excess well pressure
		  - Fire/explosion
		  - Well blockage
		- Combustion of syngas
			- **Linc Energy, Chinchilla plant, Queensland, Australia** (2007-2013, ~150m deep): workers suffered ill health due to "uncontrolled leaks" of syngas[4]. In 2007, a coal tar blockage caused a chamber fire, Linc Energy increased injection pressure causing well casings and overburden to crack and allow syngas to escape to the surface[5].
			
			- Lifecycle climate impacts are estimated (from few studies and limited evidence) to be less carbon intensive than electricity generation from coal but more than from natural gas[6,7,16]. Large uncertainties remain.
				- Regulation of emissions to air will depend on whether PPC 2012 applies to UCG and what other activities occur on site (e.g. gas processing or combustion for electricity generation).
				- CCS has been proposed for sites in Scotland, which would reduce lifecycle GHG emissions. However, CCS is still in its infancy, with only one commercial full-chain project in operation in the world today.

Underground explosion	Concerns include:
	- Water environment/air pollution from
	  - Highly over-pressured cavity
		- Inadequate:
		  - Monitoring
		  - Site selection
		  - Process modelling
		- Inadequate process control
			- **Experimental Mine "Barbara", Poland** (2013, a 30m deep engineered reactor): cracks developed causing gases to leak and create explosive	

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

	- New pathways in rock fractures - Damaged boreholes - Damaged surface infrastructure - Subsidence - Induced seismicity	-Temperatures too high -Too much gasification agent -Too slow gas collection - Damaged wells (ignition and production) - Material defect/installation error - Induced seismicity	accumulations, igniting due to high temperatures[8]. - **El Tremedal, Spain** (1997, ~550m deep): malfunction of ignition system and failure of temperature measurement system resulted in accumulation of methane and a subsequent explosion. The injection well was damaged and the decision made to terminate the trial[7,12].	
Cavity collapse	Concern: - New pollutant/air pathways in rock fractures - Impacts to surface or groundwater hydrology - Surface subsidence - Damaged surface infrastructure - Damaged well casings Details: - Surface subsidence risk deemed to be low if mitigated through site selection, e.g. - Deeper target coal seam - High structural integrity of overburden - Subsidence expected to be ~1/3 of coal seam thickness, with 98% of height loss occurring within 7 months[16].	- Uncontrolled gasification - Poor structural integrity of overburden - Disturbance of historical coal mines - Inadequate: - Monitoring - Site selection - Process modelling	Experience may be drawn from longwall mining. **Hoe Creek III, USA**[2] (late 1970s, shallow depth (~50m) trial): cavity collapse caused serious groundwater pollution and subsidence could be seen at the surface.	- Developments are likely to at >800m depth, greatly reducing the likelihood and impact of surface subsidence - The Coal Authority has stated that licences will normally only be issued in offshore areas and onshore areas where it can be demonstrated that the surface is suitable for piloting UCG. Hence, it is unlikely that surface infrastructure will be at risk.
Seismicity	Concern:	- Stresses imposed by the cavity	No instances found in the	

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

	- Pollution to the water environment and air via:
	  - New pathways in rock fractures
	  - Damaged boreholes
	- Damaged surface infrastructure
	- Explosion from gas accumulation via new pathways
		remaining after combustion
		- Cavity collapse
		- Proximity to existing faults
		- Use of hydraulic or explosive fracturing to link wells
		- Inadequate:
		  - Monitoring
		  - Site selection
		  - Process modelling
			literature but this may be from lack of reporting or monitoring. It is expected that induced seismicity will be small compared to mining and dam construction, for example.	

Groundwater depletion	Concern: - Supply shortage for other water users - Impacts to ecology Details: - Due to use of water in reactor - Rate of water supply into the reactor affects the product gas composition - Impact is expected to be small but uncertainties remain.	- Size of operation - Local hydrogeological conditions	The Independent Scientific Panel report on UCG pilot trials in Australia found that in some instances there is a need for external injection of water into the cavity to maintain appropriate hydrostatic pressure. It also recommended that a minimum distance is set between UCG and other activities that require different hydrostatic operating conditions (e.g. Coal Bed Methane).	If Water Environment (Controlled Activities) Regulations (2011) apply, then groundwater depletion would be prohibited.

Uncontrollable fire	Concern:
	- Pollution to the water environment and air
	- Cavity collapse
	
	Details:
	Risk decreases with greater target coal seam depth.
		- Requires uncontrolled air/oxygen source to gasification cavity, via:
		  - Faults/fractures/subsidence
		  - Damaged borehole casings
		  - Shallow target coal depth
		- Inadequate:
		  - Monitoring
		  - Site selection
			No instances found in the literature but this could be from lack of reporting and the short duration of most projects. Analogous experience may be drawn from traditional mining activities.	- Developments are likely to at >800m depth, greatly reducing the likelihood of an uncontrolled air/oxygen source to the cavity occurring.
				- Developments will be occurring below the water

– draft sent to Campbell Gemmell 18/01/16

DRAFT

Created by FolderMill | www.foldermill.com

		- Process modelling		table, making both oxygen ingress and uncontrolled combustion unlikely.

1 Independent Scientific Panel report on Underground Coal Gasification in Queensland, Australia
2 Hill RW, Thorsness CB, Cena RJ, Aiman WR and Stephens DR, 1980. Results from the third LLL Underground Coal Gasification Experiment at Hoe Creek. Proceedings of the 6th Underground Coal Conversion Symposium, Shangri-La, OK.
3 US DoE, 1997. US Department of Energy, Environmental assessment, Hoe Creek Underground Coal Gasification Test Site Remediation, Campbell County Wyoming, October 1997, DOE/EA-1219.
4 ABC News: Linc Energy allegedly exposed miners to dangerous gases
5 ABC News: Linc Energy accused of failing to report series of dangerous leaks
6 Zeshan Hyder, 2012, Site Characterization, Sustainability Evaluation and Life Cycle Emissions Assessment of Underground Coal Gasification, PhD dissertation submitted to the Faculty of Virginia Polytechnic Institute and State University
7 Muhammad Imran, Dileep Kumar, Naresh Kumar, Abdul Qayyum, Ahmed Saeed, Muhammad Shamim Bhatti, Environmental concerns of underground coal gasification, Renewable and Sustainable Energy Reviews, Volume 31, March 2014, Pages 600-610,
8 Eugeniusz Krause, Alicja Krzemień, Adam Smoliński, Analysis and assessment of a critical event during an underground coal gasification experiment, Journal of Loss Prevention in the Process Industries, Volume 33, January 2015, Pages 173-182
9 Vidal Navarro Torres, Anthony Steven Atkins and Raghu Nath Singh, Assessment of an Environmental Sustainability Index for the Underground Coal Gasification Process by Using Numerical Analysis, 14th Coal Operators' Conference, University of Wollongong, The Australasian Institute of Mining and Metallurgy & Mine Managers Association of Australia, 2014, 309-323
10 Shu-qin, L and Jun-hua Y, 2002. Environmental Benefits of underground coal gasification. Journal of Environmental Sciences, vol. 12, no. 2, pp.284-288.
11 Atkins report for DTI – Review of Environmental Issues of Underground Coal Gasification, 2004
12 Shafirovich E, Varma A. Underground coal gasification: a brief review of current status. Industrial & Engineering Chemistry Research 2009;48(17): 7865e75.
13 Kapusta et al., 2013 - Environmental aspects of a field-scale underground coal gasification trial in a shallow coal seam at the Experimental Mine Barbara in Poland. Fuel, volume 113, pages 196–208
14 Liu Shu-qin, Li Jing-gang, Mei Mei and Dong Dong-lin, "Groundwater Pollution from Underground Coal Gasification," Journal of China University of Mining & Technology 17, 4 (2007).

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

15 Klimentov P P. Influence of groundwater on the process of underground coal gasification. Izv Vyssh Ucheb Zavendenii Geologiya Ixazvedka, 1964, 4: 106–119.
16 Pembina Institute report on Underground Coal Gasification Environmental Risks and Benefits, 2010
17 International Energy Agency Clean Coal Centre report on Underground Coal Gasification

DRAFT

– draft sent to Campbell Gemmell 18/01/16

Created by FolderMill | www.foldermill.com

The COAL AUTHORITY

Presentation to SEPA and Scottish Government

Underground Coal Gasification

Simon Reed
Director of Operations

The COAL AUTHORITY

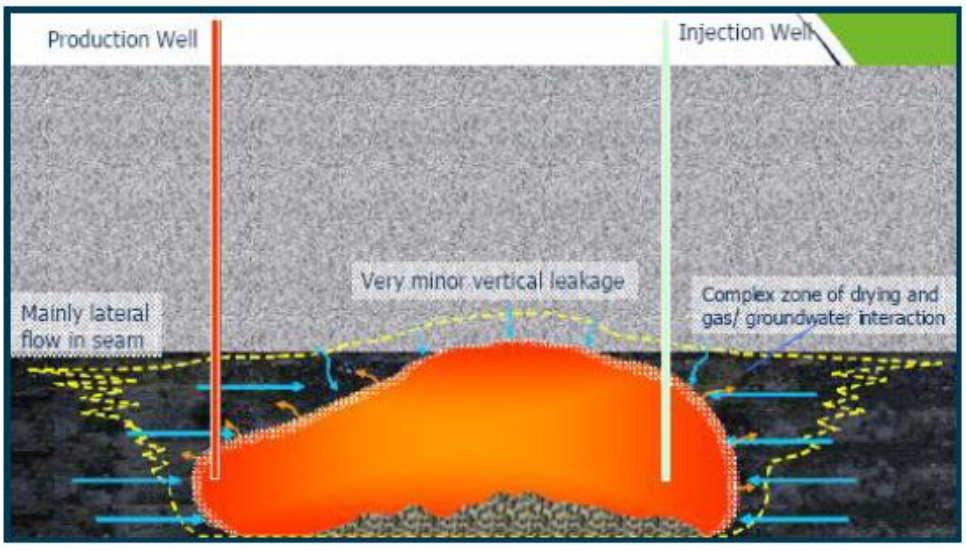
- Brief Overview of Process
- Some findings from Queensland ISP Review
- CA Licensing and UCG
- Questions as we go along

General Process – (diagram after Linc Energy)

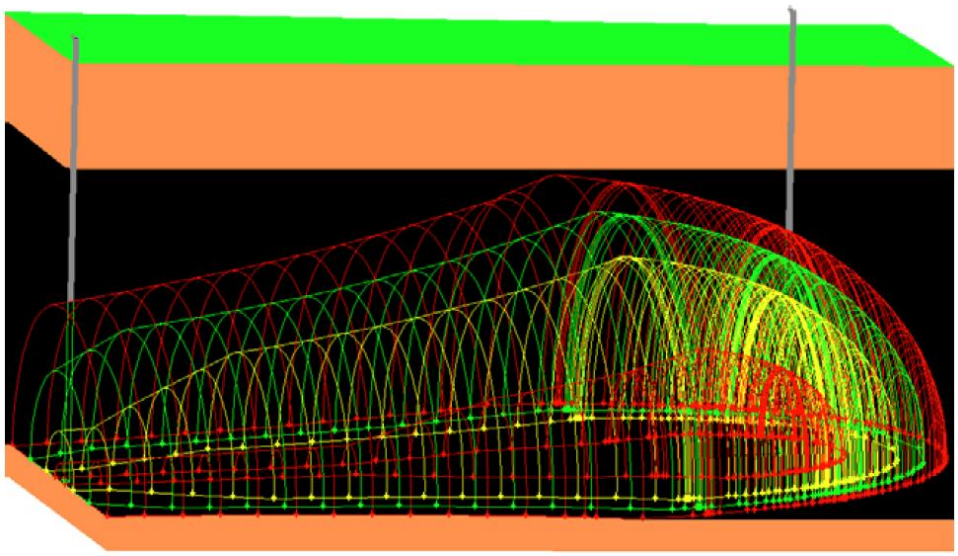
•The process generates Syngas , principally carbon dioxide, hydrogen, carbon monoxide, methane, nitrogen, steam and gaseous hydrocarbons.

•The proportion of these gases varies with the type of coal, the efficiency and control parameters of the gasification process.

Process - Linc Energy slide



Cavity Formation - Linc Energy slide



Stages of UCG

1. Well construction and linkage:

2. Ignition: The coal seam is dried and then ignited.

Gasification is typically conducted between 900C and 1200C.

.

3. Gas production:

Syngas is produced through combustion and gasification reactions.

Syngas flows from the gasification zone, through constructed or formed horizontal channels, to the gas production well.

Used for fuel for power generation, chemical feedstock, gas to liquids fuel conversion or fertiliser.

4. Decommissioning:

:

Some Pros

- Requires no manpower underground
- Enables access to coal seams that cannot be worked by conventional mining and can realise a high proportion of the energy in the coal
- Syngas is a multi-use product. Can be used for power generation or processed to extract hydrogen and manufacture other fuels (diesel, jet A1 etc), fertilisers and chemical feedstock
- Can be coupled with Carbon Capture and Storage technology

Some Cons

- "New Technology"
- Environmental Questions – potential sources of contamination
  - Loss of syngas into geological formations
  - Leaching of residual ash or tars remaining in a spent UCG cavity
  - The gasification produces chemicals that become serious contaminants if they escape the gasification cavity into the surrounding environment.
  - Issue particularly during cooling
- Will still cause coal-mining subsidence but depth and limited size of combustion chambers will mitigate the effects at the surface
- Still a fossil fuel

Site Selection – Main Technical Factors

The COAL AUTHORITY

- **Coal properties:**

  Chemical nature, structure, depth and thickness

- **Hydrogeology:**

  Groundwater supplies water for the gasification reactions
  Hydrostatic pressure serves to contain the process and drives gas towards the production well

- **Geology**:

  Good structure and low permeability of rock overlying the coal is favourable to limit subsidence and provide a seal between the coal and overlying strata.

The COAL AUTHORITY

INDEPENDENT SCIENTIFIC PANEL REPORT ON UNDERGROUND COAL GASIFICATION PILOT TRIALS

Published June 2013

Queensland Independent Scientific Panel for Underground Coal Gasification (ISP)

Examined issues relating to:

Site Selection
Commissioning
Operation
Decommissioning
Rehabilitation


© Linc Energy Pty Ltd

ISP Review

Pilots rather than demonstration

"Underground coal gasification could, in principle, be conducted in a manner that is acceptable socially and environmentally safe when compared to a wide range of other existing resource-using activities".

"...that for commercial UCG operations in Queensland *in practice first* decommissioning must be demonstrated and then acceptable design for commercial operations must be achieved within an integrated risk-based framework".

Specific Recommendation #4

No further panels should be ignited until the long term environmental safety provided by effective decommissioning is unambiguously demonstrated.

Selected ISP comments

a UCG site should operate under a rigorous risk-based approach which includes (selected comments):

•Coal seam to be at "sufficient" depth to ensure minimal environmental consequences.

•Coal seam sufficiently thick to sustain gasification with reasonable likelihood of economic viability

•Coal seam capped by impermeable rock.

•Target coal located so that there is "sufficient " distance to any valuable aquifer higher up the geological succession

•Sufficiently distant from rivers, lakes, springs and seeps to avoid contamination should chemical escape the cavity, sufficiently distanced from the nearest town and/or intensive surface infrastructure

Coal Authority Licensing

- A coal-mining operation requiring a licence from the Coal Authority
- The Coal Authority published its policy on UCG in 2009
  - Conditional Licences – no operations until operator has all other rights and permissions in place (land, planning, environmental, health & safety etc)
  - Offshore areas but only onshore where it can be demonstrated that the surface is suitable for piloting the technology
  - Not in existing petroleum licence areas or designated offshore windfarm areas
  - Conditional licences for 3-5 years and can only be extended if project is being developed
- UCG and CBM can legally co-exist but not practically

Underground Coal Gasification Licences

- 24 conditional UCG licences issued to Sep 2013
- 13 now expired but applications received to renew 11 of these
- Extension application refused in 5 of these cases
- 8 applications in process, only 1 onshore (Warwickshire)
- Some geological modelling but no exploratory or seismic work carried out at any site yet
- CA – potential liabilities as subsidence or residual hazards in its property,

UCG, Coal Bed Methane & Shale Gas comparison

The COAL AUTHORITY

UCG	Coal Bed Methane	Shale Gas
• Synthetic Gas (Syngas)	• Methane	• Methane
• No recent commercial exploitation worldwide	• Established worldwide but not in UK	•Established in USA but not in UK
• Drills boreholes into unmined coal seams	• Drills boreholes into unmined coal seams	• Drills boreholes into shales, not coal seams
• Directional drilling	• Directional drilling	• Directional drilling
• Does not utilise fracking to produce gas	• Fracking can be used but is not always needed	• Fracking essential to release gas
• Chemical reaction	• Physical process	• Physical process
• Retains groundwater to maintain hydrostatic pressure	• Requires the pumping out of groundwater to reduce hydrostatic pressure and release methane from the coal	• Requires large amounts of water to be injected in fracking process

2B Supplementary materials provided by interviewees

I-1 RSPB

Relevant policy links:

RSPB Energy Vision Project launched on 24 May.
https://www.rspb.org.uk/Images/energy_vision_summary_report_tcm9-419580.pdf

The Energy Futures project.
http://www.rspb.org.uk/whatwedo/projects/details.aspx?id=350939

Moore V, Beresford A, & Gove B (2014). Hydraulic fracturing for shale gas in the UK: Examining the evidence for potential environmental impacts. Sandy, Bedfordshire, UK: RSPB. http://www.rspb.org.uk/Images/shale_gas_report_evidence_tcm9-365779.pdf

Durham University‟s well study and ReFINE work.
https://www.dur.ac.uk/news/research/?itemno=26932
http://www.refine.org.uk/independenceethics/independentscienceboard/
http://www.sciencedirect.com/science/article/pii/S0048969715312535

I-2 Friends of the Earth Scotland (FoE)

Fuelling the Fire report.
http://www.foei.org/wp-content/uploads/2016/07/FoEI_Fuelling_the_Fire_July2016.pdf

FoEI/Stockholm Environment Institute work on Fair Shares.
https://www.foe.co.uk/sites/default/files/downloads/uks-fair-share-emissions-cuts-76425.pdf

With RSPB/WWF, FoE produced “Power of Scotland” 3 documents – Explained, Renewed, Secured - set the scene.
http://www.foe-scotland.org.uk/sites/www.foe-scotland.org.uk/files/Community_Briefing_web.pdf

http://www.foe-scotland.org.uk/sites/www.foe-scotland.org.uk/files/Power%20of%20Scotland%20full%20report.pdf

http://www.foe-scotland.org.uk/sites/www.foe-scotland.org.uk/files/possv6final.pdf

I-3 Coal Authority

The Coal Authority provided the following policy statement for licensing.

UNDERGROUND COAL GASIFICATION ("UCG")

POLICY STATEMENT FOR LICENSING BY THE COAL AUTHORITY (DECEMBER 2009)

Policy Objective

The Coal Authority ("The Authority") recognises the recent interest in UCG in Great Britain and its future potential for generating energy from its coal reserves. The Authority wishes to support its development and see UCG pilot operations established in order to assess the effectiveness and environmental impacts of this technology in Great Britain.

Statutory Duties

The Authority"s duties and obligations are set out in the Coal Industry Act 1994 under which it is given the power to grant licences for the carrying on of coal-mining operations including UCG.

This policy relates to applications for new UCG licences and variations to existing UCG licences but at this stage of development of UCG in Great Britain it is anticipated that applications will be for conditional licences.

Licence Areas

The Authority will normally only consider UCG conditional licence applications for:-

- Offshore areas. Offshore licence areas can also include an onshore access strip to facilitate the sinking of exploration boreholes during the conditional licence phase and for sinking directional access boreholes into the offshore UCG area during the operational phase. *(see note 2)*
- Onshore areas, but only where it can be demonstrated that the surface is suitable for piloting this technology. *(see note 3)*
- Areas where there are :-

    - no other Coal Authority Mining Licences & Agreements;
    - no existing Petroleum Licences;
    - no identifiable defence installations; and
    - no existing or proposed wind farm sites or other major structures on the seabed. *(see note 4)*

- A maximum initial application area of 10,000 hectares. *(see note 5)*
- Areas where the Department of Energy & Climate Change, The Crown Estate, The Ministry of Defence or other relevant bodies do not raise objections. Consultation will be undertaken by the Authority with these relevant bodies on receipt of a conditional licence application. *(see note 6)*

Licence Conditions

Licences will be subject to advertising by the Authority in order to stimulate competition.

The initial term of the Conditional Licence will normally be restricted to a maximum of three years.

The Authority will require Conditional Licence holders to undertake further discussions with the Department of Energy & Climate Change, The Crown Estate, The Ministry of Defence and other relevant bodies during the conditional period as they formulate the detail of their operations.

The conditions will include a requirement for the applicant to undertake an agreed programme of works during the term of the Conditional Licence. Failure to complete the agreed programme of works will result in the Licence being revoked unless the Authority can be satisfied that the Licensee is committed to the pilot project.

Where the proposed UCG operation and its ancillary activities have a potential to interact with or damage third party property interests then a condition will be included requiring the Licensee to provide evidence of the existence of a Commercial Agreement between the parties outlining the manner in which any interaction or damage so caused is managed, remediated and funded. *(see notes 8 & 9)*

Further requirements for de-conditionalising a licence in whole or in part will be incorporated into the licence conditions and are set out in more detail in the Authority"s Model Underground Coal Gasification Licensing Documents.

Fees and Payments

The licence application and grant fees will be the same as for underground and surface mining licence applications as published by the Authority.

The annual fee whilst the licence is conditional will be a fixed amount, currently £500 (reviewed and published from time to time) plus an agreed payment for holding an Option for a Lease of the property interest in the coal.

Policy Review

This policy shall be reviewed from time to time to ensure licence and lease terms are appropriate for developing technology.

NOTES ON POLICY

Licence Areas

1. The assumptions that the Authority has made are :-
    1. 1.1 The development of UCG will initially require pilot projects to evaluate the process in Great Britain. Once the process is proved in these conditions then larger scale projects may be established.
    2. 1.2 At this stage of the development of UCG in Great Britain, it will be easier for operators to get all the necessary permissions and consents for offshore UCG operations than onshore, hence the emphasis on offshore.
    3. 1.3 In addition to a licence from the Authority, consent for offshore UCG will be required from the Crown Estate for withdrawal of support from the seabed.
    4. 1.4 A pilot project will require an environmental impact assessment prepared by the operator rather than a strategic environmental assessment.
    5. 1.5 The syngas produced will be used for generating electricity or conversion to other petro-chemical products and the UCG operation itself will not require consent under Section 36 of the Electricity Act 1989.
    6. 1.6 The process is outside the remit for carbon capture and storage.
    7. 1.7 DECC do not require the applicant for a UCG Licence to hold a Petroleum Licence for the area applied for but at the operational phase will issue a simplified licence akin to an underground mine‟s methane drainage licence to facilitate the lawful removal of any native methane in the strata in conjunction with the UCG operations.
2. The grant of an onshore access strip will be non-exclusive so as not to prevent conventional surface mining operations, exploration or coal methane operations in that area.
3. Onshore applications will only be accepted where the Authority considers that the applicant has a reasonable chance of bringing the project to fruition. By way of an example, an application for onshore UCG by, or with the agreement of, a surface landowner with ownership of all the surface land likely to be affected by the proposed UCG operation could be said to stand a reasonable chance of getting planning consent etc.
4. Limiting UCG licences to areas outwith existing Petroleum Licences, large or proposed seabed structures such as wind farms or Ministry of Defence installations will remove some of the potential objections to licence applications.
5. Introducing a size limit of 10,000 hectares for applications (unless there are site specific issues that dictate otherwise) limits UCG applications to areas comparable to existing or proposed underground mining operations.
6. Consulting with relevant bodies (DECC, Crown Estates and MOD etc) will minimise the risk of the Authority granting a licence for an operation that may turn out to be unworkable.
7. It should be noted that a licence can always be varied to include a previously excluded area after grant if, for example, a proposed surface installation isn‟t built or an existing one ceases to operate.
8. The Authority has taken legal advice and it is still uncertain whether the provisions of the Coal Mining Subsidence Act 1991 (“the 1991 Act”) apply to offshore installations. The Authority intends to adopt a comprehensive approach and incorporate provisions in the licence to ensure that no one suffers a loss from subsidence damage arising from the actions or failures of a UCG Operator, whether or not the 1991 Act applies.

9. The requirement of the Authority to have a Commercial Agreement in place where UCG and ancillary activities have a potential to interact with or damage third party property interests is intended to be similar to the approach adopted in the Petroleum Industry.

Licence Conditions

1. Limiting the normal initial conditional licence period to three years will enable licensees to evaluate a project without sterilising the coal for an unacceptable length of time. This period can be extended by agreement if the licensee demonstrates that the agreed work programme has been carried out and further works are proposed.
2. Agreeing a work programme mirrors the current arrangements with Petroleum Licences and ensures that coal is not acquired as an asset with no intention of progressing with the operation.

Fees & Payments

1. The Licence will attract a normal annual licensing fee whether conditional and/or unconditional, as is the case with Underground and Surface coal mining licences.
2. There will be an agreed annual payment for the Option rights whilst the Licence is conditional.
3. Once the Licence is made un-conditional and a Lease is granted then rental payments under the Lease will commence. At present it is intended that these rental payments are the equivalent of the Coal Authority"s standard Production Related Rent paid for the amount of coal gasified.
4. The method of assessing the amount of coal worked will be agreed with the Licensee prior to the Lease being granted. The options could include :-
    1. 4.1 a calculation from an agreed plan based on an accurate survey of the void(s) submitted to the Authority by the Licensee at an agreed interval; or
    2. 4.2 a calculation based on an agreed formula relating the amount of syngas generated to the amount of coal worked; the syngas measurements to be supplied to the Authority at an agreed (monthly) period.

L:\Word Documents\Model Documents\2012\Underground Coal Gasification Policy.docx

I-4 British Geological Survey (BGS)

Available report which gives a map of the offshore extent of Brora coalfield here: http://www.bgs.ac.uk/downloads/browse.cfm?sec=1&cat=195 „Jurassic of the central and northern North Sea" page 79 of the document (or page 91 of the PDF).

Groundwater chemistry reports are available here: http://www.bgs.ac.uk/research/groundwater/quality/BaselineScotland/baselineScotlandReports.html and at the bottom of the page is the link to the groundwater bodies report http://www.bgs.ac.uk/research/groundwater/waterresources/ScotlandsAquifers.html

I-5 Robert Nicol, CoSLA and John Milne, Falkirk Council/SSD/HP

The following two submissions were provided.

1
Background note to meeting with Professor Gemmell
13.30 – 15.00 Tuesday 7 June 2016
COSLA Offices, Verity House, Edinburgh

Professor Gemmell is conducting an independent review of Coal Gasification. Heads of Planning Scotland will be represented by Donald Campbell (Falkirk Council) and John Milne (Falkirk Council).

Falkirk Council has experience of planning applications relating to Unconventional Gas Extraction of Coal Gas Methane through a dewatering process. Although not directly related to Coal Gasification, it is hoped that there are sufficient similarities in the proposals to offer Professor Gemmell some insight to potential issues arising from a planning authority and legislative perspective to such applications.

Planning application background

A planning application – P/12/0521/FUL – Development for Coal Bed Methane Production, including Drilling, Well Site Establishment at 14 Locations, Inter-site Connection Services, site access tracks, a gas delivery and water treatment facility, ancillary facilities, infrastructure and associated water outfall point at Letham Moss, Falkirk for Dart Energy was lodged with Falkirk Council on 29 August 2012.

As a small proportion of the site area extended into another planning authority, Stirling Council, a similar application was submitted to that authority.

The application was considered a „Major" proposal in terms of Hierarchy of Development, was preceded by a Proposal of Application Notice and procedure and accompanied by an Environmental Statement.

On the failure of Falkirk Council and Stirling Council to issue a decision [within the statutory timescales], both applications were referred to the Directorate for Planning and Environmental Appeals and a Public Inquiry concluded. On 10 October 2014, Scottish Ministers decided that the appeals should be recalled for their own determination, given the high level of public interest in the proposals.

A case update was received from the Directorate of Planning and Environmental Appeals on 12 October 2015:-

"This is one of two conjoined appeals the other being PPA-390-2029. The papers connected with both appeals can be found under this case reference. An announcement was made in the Scottish Parliament on 28 January 2015 by Mr Fergus Ewing, Minister for Business, Energy and Tourism, that there is to be a moratorium on granting consents for unconventional oil and gas developments in Scotland while further research and a public consultation is carried out. Having regard to the announcement and to the fact that it is likely that further procedure will be required in these appeals in order to consider the outcome of the assessment and review and any other relevant matters that may arise before the moratorium comes to an end, the reporters have suspended work on their

report to Ministers and the appeals have been sisted to await the outcome of that process".

Application impact on Falkirk Council

Without prejudice to any decision on the applications, the submission of the proposals had significant impact on resources and procedures within the planning authority, as well as raising issue with regard to monitoring regimes and inter-relationship with other stakeholders (Scottish Environment Protection Agency).

1) The minimum level of submitted information required to accompany the application to validate the proposals was criticised.

2) On receipt of the planning application, the application was advertised as per current regulations and advice. Many contributors considered current Neighbour Notification procedures insufficient. Similarly, criticism was received that the Proposal of Application procedures were deficient for the purpose intended.

3) As the interest in the application grew, so did the number of interested parties and contributors. Over 2,400 representations were received. This had both a cost implication and a resource implication:-

a) Each written representation had to be acknowledged in writing.
b) I.T. protocols had to be established to ensure acknowledgement of electronically submitted information.
c) Staff resources to conduct information exchanges with contributors.
d) Staff attendance at Community Council and Interest Group meetings.
e) The potential of a pre-decision „hearing" event before recommendation was made to elected members.

4) The technical issues raised through contribution to the application could not be addressed by suitably qualified internal staff. A procurement process was undertaken to employ qualified consultants. This incurred time delay in the processing of information, criticism of „bias" from members of the public and considerable expense to the planning authority.

5) The resultant technical analysis produced an increased number of documents, all having to be placed in the public domain and formal consultation procedures refreshed. Criticism was made that the document increase was substantial when referring back to the original submission list – that seen fit for validation. Accusations were made of „moving the goalposts" and „drip feeding information".

6) Some technical data submitted by the applicant was subject to confidentiality limitations or could not be verified by third parties due to copyright or licensing restrictions.

7) The magnitude of interests generated by the proposal, exchanges of correspondence and response to information requests (including Freedom of Information Requests) dictated that a number of staff were allocated to the application – all to the detriment of other work commitments during that period.

8) Clarity was sought as to what – and what could not – be placed in the public domain was raised. Indexing and redacting of documents had a significant cost in terms of time

and expense.

9) The „Precautionary Approach" advocated through Environmental Impact Regulations required technical assessment of the proposals and questioning whether it was the role of the planning authority to review matters which it seemed more appropriate to be within the remit of another stakeholder. As an example, the Regulatory duty of the Scottish Environment Protection Agency (SEPA) was examined and some criticism made that the planning authority was deferring monitoring and enforcement both above and below ground to that authority, rather than tackling these matters through application of the Environmental Impact Regulations.

10) In both the case of Falkirk Council and Stirling Council, external legal representation at Public Inquiry was sought. This presented an additional cost implication dictated by limited internal resources.

11) Questions were raised as to what issues are „material" when considering such planning applications, not least the issue of Public Health.

These anecdotal examples are not intended to be an exhaustive examination of the general approach to all Unconventional Gas planning applications but should reflect the potential impact of such proposals on a planning authority in an environment where transparency, communication and community engagement are promoted. Not least, it should also provide an example of where the planning application fee associated with proposals is far outweighed by the expenditure required by the planning authority to secure robust analysis and determination.

2

FEEDBACK ON THE PROCESSING OF A MAJOR APPLICATION - DART ENERGY - P/12/0521/FUL (Development For Coal Bed Methane Production, Including Drilling, Well Site Establishment at 14 Locations, Inter-Site Connection Services, Site Access Tracks, a Gas Delivery and Water Treatment Facility, Ancillary Facilities, Infrastructure and Associated Water Outfall Point AT Letham Moss, Falkirk, FK2 8RT)

FALKIRK COUNCIL APPEAL REF : AP/13/006/PPA

RECAP/LESSONS LEARNED

[Prologue by Head of Planning & Transportation, Falkirk Council
As background to this document, two points should be noted. It is a draft which will not be completed until the planning application has been determined by Ministers and all the Council‟s relevant officers and consultants have been able to contribute to it. More lessons may emerge by then.

References to “lessons learned” variously include confirmation of the approach actually taken by the Council as well as issues which might be handled differently in future.]

1. General Comments

1.1 Very unusual case/circumstances, so lessons learned may have limited (less) relevance to future cases.

1.2 Committee decision [that it would have refused planning permission because of the lack of some relevant information] was defended, and threatened claim for expenses was not submitted. Members of public who attended thanked Dr Salmon for his evidence, and Neil Collar for his Closing Submission.

1.3 AMEC Technical Notes provided a sound audit trail.

1.4 Importance of tailoring approach to personalities involved - e.g. DPEA warning to Messrs X & Y.

2. Pre-Application Stage

Issue

- Participation by Falkirk Council in Proposal of Application Notice Procedure

Concern

- No concern. The planning case officer participated in detailed pre-application discussion with the applicant. Attended a scheduled public exhibition and participated in a joint site visit with the applicant.

- As the proposal also involved Stirling Council, an early liaison meeting was conducted with representatives from the neighbouring planning authority.

Lessons Learned

- Early dialogue with the applicant essential.

- Close liaison with representatives of neighbouring planning authority established.

- Could have considered the use of a processing agreement?

3. Application Stage

Issue

- Document management.

Concern

- The large volume of individual representations received required careful recording.

- As is normal practice, hard copy representations were destroyed after scanning to file.

- Summary totals on-screen did not match up.

- Large volume of "community mandate" electronic documents required a new IT protocol to be established.

- Public access to documents.

- IT capacity on individual PCs.

Lessons Learned

- It is acknowledged that individuals may make multiple representations - online and in writing - which make the same comment. These submissions contribute to the total representations received and may give a slightly skewed impression.

- If possible, thought should be given to retaining hard copies of representations. In this instance, 2,486 letters of representation had to be printed out for submission to the DPEA. These documents had to be accompanied by an index of individuals and addresses. It may not, however, be practical to predict which future application this would apply to.

- In addition to individual representations, a "community mandate" document was available to submit. Electronic and paper copies were submitted. A separate classification was added to the Uniform system for "Community Mandate", and allowed these documents to be distinguished from representations received.

- With the helpful assistance of a third party - a community mandate co-ordinator - the co-ordinator collected a large volume of mandates, collated them and - in co-ordination with Falkirk Council - directed these to a separate "dropbox" which was uniquely and solely for that purpose. This was extremely beneficial in terms of document handling by the planning case officer.

- Public access to documents was a high priority for 3rd parties. Taking into

account the high public profile of the application, it was considered prudent to allow public access to more than the documents submitted by the applicant. External consultation responses were published, as were all 3rd party representations. The publication of 3rd party representations required writing to contributors, advising them of the publication of the documents and seeking their acceptance or otherwise in relation to this change in procedure. Acknowledgment letters issued on receipt of representation on all planning applications could be adapted to accommodate this procedure if considered appropriate in other applications.

- Public representation of 3rd party representations dictated that each representation was read and suitably redacted prior to publication.

- The volume of large documents received by the case officer substantially reduced the operating speed of the receiving PC. In addition, Falkirk Council's threshold for document size also created difficulties in communication. Common practice in placing large documents in "dropboxes" for access is not a practice shared or adopted by Falkirk Council. The receipt of multiple large documents remains problematic.

- Physical storage space to store hard copy documents remains an issue.

Issue

- Allocation of case to officer.

Concern

- The major application generated daily workloads of a significant volume, which required prompt response and co-ordination. The demands of the application pushed other workloads to a lesser priority.

Lessons Learned

- Planning Co-ordinator recognised [the case officer"s] workload pressure and limited allocation of additional workload accordingly. The reduced workload allocation allowed time to focus on this planning application.

- The introduction of several other colleagues within "Team Dart" with regular meetings allowed issues to be fully discussed, views shared, feedback given and positions agreed in relation to progressing matters.

- The information sharing within "Team Dart" allowed access to other officers in the absence of the case officer. This facilitated early response to 3rd parties.

Issue

- Keeping elected members and the public informed.

Concern

- Misinformation to elected members.

- Political polarisation on any decision.

- Confrontation with contributors to the application.

Lessons Learned

- Need to be and be seen to be neutral on the application important and ensuring that this was reinforced at meetings, in conversation and in correspondence.

- Regular published updates on Falkirk Council website is productive.

- Case officer cannot be confrontational to 3rd parties and should emphasise transparency in the processing of the planning application.

- Advise/seek view of elected members in relation to the need for a public hearing, prior to any recommendation on the application.

- Allowing flexibility in "material considerations" and, if necessary, introduce new consultees (e.g. consulting Public Health Division on concerns over health issues).

Issue

- Review of EIA.

Concern

- Council did not issue request for further information per Regulation 23.

Lessons Learned

- While request for further information was made, the approach was not formally made quoting Regulation 23. Regulation 23 should be quoted on future approaches on EIA information requests.

Issue

- Complex technical nature of application.

Concern

- Lack of "in-house" experts to address technical concerns.

- Clarification of roles and responsibilities (i.e. Environmental Health and methane monitoring).

Lessons Learned

- Early commissioning of external consultants essential.

- Clarification of roles and responsibilities enabled by facilitating meeting of relevant parties (i.e. Environmental Health and SEPA).

Issue

- Adhering to timeline for determination.

Concern

- Managing expectations of applicant, objectors and elected members.

Lessons Learned

- Essential that thorough analysis of technical concerns is undertaken. Where there is doubt, revisit the topic until there is satisfactory resolve.

- Objectors and applicant may have access to technical "experts", therefore it is critical that Falkirk Council was - and seen to be - reasonable and thorough in technical evaluation.

- Scrutiny takes time. Applicant formally approached through extension of time letters. Update papers provided at Planning Committee prior to formal recommendation.

- Communication with Stirling Council maintained and "common views" identified.

4. Appeal Stage

Issue

- Instruction from elected members as to Falkirk Council's position in the appeal process.

- Legal advice.

- Submission of documents to DPEA.

- Potential costs.

Concern

- Gaining consensus of opinion on the proposal, where no recommendation had yet been made.

- Likely to be complex and time consuming appeal process.

- Impact on staff time.

- Impact on budget.

Lessons Learned

- Case officer has to be afforded the time to concentrate on the application, additional workload reviewed and monitored.

- Budget has to be available to allow external consultees to be involved in the appeal process, including external legal advice.

- Early meeting with DPEA to agree submission details (i.e. electronic/paper submissions and formats) proved useful.

- Administration demands to generate paper copies of over 2,000 letters of objection.

- Conforming to deadlines set by DPEA essential.

- Report to Planning Committee timeous and non-committed to single course of action - explain the options and let Committee decide.

Issue

- Consequences of Pre-Examination Meeting.

Concern

- Allocation of appropriate personnel to individual topics set by DPEA.
- Establishing communication protocols with DPEA, applicant and other parties.
- Adhering to timescales set by DPEA.
- Document exchange protocols.

Lessons Learned

- Inform internal consultees about their likely participation in the process. Not all consultees are aware of the appeal process.
- Establish which consultees need to prepare hearing statement or precognitions and set the timescale. Many consultees not aware of this process and needed previous examples provided.
- Close working with legal team advised and review of statements/precognitions undertaken. Ensure there is sufficient time for revision.
- The DPEA allowed further documents to be submitted between parties. This required co-ordination and recording by the case officer, ensuring consultees were appraised of new information and were allowed to respond appropriately.

Issue

- Instruct DPEA to participate in a Joint Statement of Common Understanding, including schedule of potential planning conditions.

Concern

- Busy exchange of e-mail traffic, including liaison with legal advisers, consultees, appellant and Stirling Council.

Lessons Learned

- Division of workload beneficial, with Development Management colleague isolating planning conditions as a separate task.
- Resolving opinions not always easy. Legal advisers, consultees and Falkirk Council all having opinions which had to be met and concluded.
- Tight deadlines led to some frantic evening working.
- Capacity issues of PC hampered e-mail exchanges.
- All parties had to be informed through an ongoing process as to changes in approach/working within draft agreement.

Issue

- Document production and receipt prior to Inquiry.

Concern

- Ensuring all documents, when received, sent on to consultants for review and potential impacts on precognitions and hearing statements identified.

- Ensuring all productions distributed and made available as required.

Lessons Learned

- Electronic document exchange a huge undertaking, requiring careful administration.

- PC capacity issues hampered exchanges.

- Having documents couriered quickly was problematic. Administration process failed.

- Reviews of hard copy submitted documents from appellant raised significant issues (documents indexed but not lodged), resulting in extensive e-mail exchange with DPEA and appellant.

- Physical storage and handling of a large volume of documents required to be addressed.

- Falkirk Council productions lodged and circulated timeously. No reminders from DPEA.

Issue

- The Public Local Inquiry and Hearing Sessions.

Concern

- Was Falkirk Council input considered (including by others) as being sufficient and robust?

- Hard copy document access during appeal sessions.

- Appropriate management of Falkirk Council participants.

Lessons Learned

- The DPEA session list approved at the Pre-Examination Meeting determined the appropriate people at the appropriate session. This was largely achieved.

- Development Management representatives attended every relevant appeal session, even when not actively taking part.

- The physical transfer of 17boxes of documents was problematic, especially when venues were changed.

- No IT support during appeal sessions (iPads, laptops, etc.).

- Instructions by the DPEA during the appeal sessions dictated swift response (e.g. site history session with appellant/objectors).

- Late night working by consultees and legal team dictated early morning workload for case officer, i.e. printing out documents, retrieving specific information, etc., prior to start of appeal sessions.

- Availability of case officer had to be assured.

Summary - Lessons Learned

- Team approach beneficial on major applications.
- Recognition given to case officer in terms of other workload.
- Good communication between stakeholders essential.
- Recording of information exchanges laborious but essential.
- IT capacity issues can hamper flow of information.
- Public domain issues require to be resolved early, i.e. advising 3rd party representatives that comments may be available to review.
- Document management requires careful attention.
- Stakeholders require to be periodically informed of progress, i.e. bulletins on web page, Planning Committee update papers, etc.
- Early decision making on commissioning of consultants is beneficial, while commissioning process could be streamlined.

Action Points

- IT capacity issue needs explored, along with potential dropbox option for very large documents.
- Uniform system needs reviewed to allow public access to specific documents.
- Standard acknowledgement letter/e-mail to contributors to an application should make them aware that their representation will be made publicly available.
- Commissioning of external consultant process requires clarification.
- IT handling of large volumes of representations needs reviewed.

I-6 Broad Alliance
The Broad Alliance provided the following submission.

Why
Underground Coal Gasification
Should Be Banned

Submission of Evidence Against the Planned Underground Coal Gasification Trial in Kincardine

and

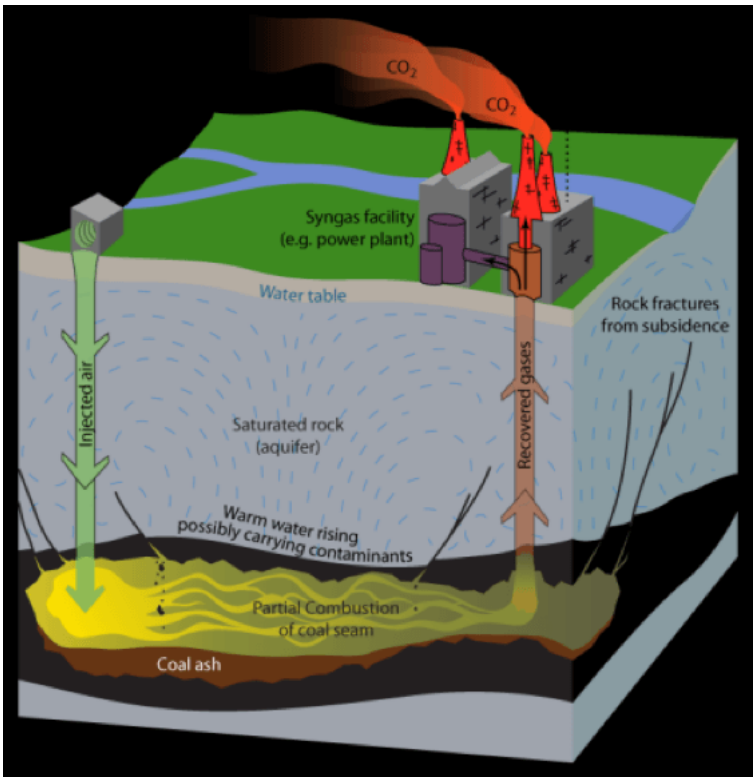
Other Conditional UCG Licenced Operations Across Scotland

08 July 2016

Contents

Introduction

Underground coal gasification is a process to burn coal underground, where it lies, to produce synthetic gas (syngas), instead of burning coal safely in power stations, i.e. creating underground gasworks (Pearce 2014)[1].



Slide 28 of a presentation on the "Status of Underground Coal Gasification (UCG) as a Commercial Technology" **(**Dryburgh,2005**)**[2] states

> "Despite 50 years of trials no commercial UCG project has been demonstrated. There has been a great deal of recent progress with pilot projects showing considerable promise and the current pilots could result in commercial operations within five to seven years, providing greatly increased confidence in the technology."

It had been hoped new horizontal drilling techniques could prove to be the breakthrough that would prove UCG could finally be undertaken safely.

The Queensland government decided no industrial scale UCG operations could go ahead until three trials, by private companies, to be monitored by the Queensland government, were undertaken first, to assess if UCG could finally be undertaken safely using the latest

horizontal drilling techniques, after other recent trials around the world reported issues with groundwater contamination with cancer causing chemicals and an uncontrolled explosion that resulted in the EU trial being abandoned.

The Westminster Government has issued conditional Underground Coal Gasification (UCG) licenses across Scotland, England and Wales, to brand new companies, set up to apply for the conditional UCG licenses, companies with absolutely no UCG experience, with Cluff Natural Resources Kincardine UCG license chosen to be the one used to conduct the pilot of UCG in the UK using new horizontal drilling technology.

Julie Lauder, CEO of the Underground Coal Gasification Association (UCGA), based in London (which has now gone into administration), claimed the Linc Energy UCG trial in Chinchilla, Queensland has proved to be the "eureka moment" for UCG. (Pearce 2014)[1]

This statement proved to be premature as in April 2016 the Queensland Government's Natural resources minister Dr Anthony Lynham declared all commercial UCG was completely banned immediately **(**Associated Press 2016**)** [3], with laws to follow, all remaining trial sites would be decommissioned, with the state environment minister, Steven Miles, saying

> "What we have in Hopeland, near Chinchilla, is the biggest pollution event probably in Queensland's history," Miles said. "Certainly the biggest pollution investigation and prosecution in Queensland's history."

This submission is intended to present the evidence, which we believe proves conclusively, based on the results of latest trials around the world, using world leading horizontal drilling techniques and other evidence widely available, including two reports commissioned by Cluff Natural Resources, that underground coal gasification (UCG) still cannot be undertaken safely, which is why, like the Queensland Government, the Scottish Government should enforce a complete ban on underground coal gasification immediately, with laws to follow too, the Kincardine UCG trial proposed by Cluff Natural Resources stopped from going ahead and all UCG licenses revoked.

The Broad Alliance : Who We Are

We are an alliance of groups from Scottish communities directly or indirectly at risk from the unconventional gas extraction industry, within Scotland.

Broad Alliance Community Group Members include :

Canonbie and District Residents Association	Canonbie
Clacks Against Unconventional Gas	Clackmannan
Concerned Communities of Falkirk	Falkirk
Don't Frack The Brigg	Bishopbriggs
Dunbar Anti Fracking Team	Dunbar
East Lothian Against Fracking	Pencaitlan
Halt Unconventional Gas Extraction	Cumbernauld
Highlands and Islands Against Fracking	Highland districts
Iona Community Mull and Iona Family Group	Iona
No Fracking North Berwick	North Berwick
Our Forth	Portobello
Kincardine CC	Kincardine, Fife
Coastal Regeneration Alliance	
PEDAL (Transition Grp)	Portobello
Transition Stirling	Stirling
Markinch Environmental Action Group	
A Greener Melrose	Merose
Transition Town Linlithgow	Linlithgow
South Lanarkshire Against Unconventional Gas	
Frack off Fife	Fife
Coal Industry Social Welfare Organisation	
Denny & Dunipace Against Unconventional Gas	Denny & Dunipace
Midlothian Against Fracking	Midlothian
Stirling Against Unconventional Gas Extraction	Stirling
Greens (Dumfries & Galloway)	Dumfries & Galloway
Scotland Against Fracking	Central Belt
Friends of the Earth Stirling	Stirling
Friends of the Earth Falkirk	Falkirk
Glasgow Frack Watch	Glasgow
Torrance Against Fracking	Torrance
Forth Under Fire	
Scottish Pagans Against Fracking	
Frack Off West Lothian (FOWL);	West Lothian
Shotts Say Frack Off	Shotts
Frack Free Forth Valley	Forth Valley
Milton Community Garden Group	Milton

Supporters of the Broad Alliance include:

Friends of the Earth (Scotland)
Unison Scotland
Radical Independence Campaign (National Forum)
Women"s Environmental Network Scotland
Radical Independence Campaign East Kilbride
Environmental Justice Network
Scottish Education and Action for Development
Frack off Scotland
Transition Scotland
Coal Action Scotland
BioFuels Watch
Educational Institute of Education, Further Education Lecturers Association
Scottish Hazards Campaign
Reclaim the Power Scotland
Assemblies for Democracy

The Queensland UCG Pilot Experience which has resulted in a ban on UCG in Queensland

UCG trials in Wyoming America (Burton, Friedmann, Upadhye, 1993)[4], leached into groundwater with "Elevated levels of coal tars, residual organic carbon, BTEX (benzene, toluene, ethyl benzene, xylene) found in coal seam and overlying aquifers.

As a result the Queensland Government in Australia decided no industrial scale UCG could go ahead unless three small scale trials were undertaken, by private companies Carbon Energy, Cougar Energy and Linc Energy, while being closely monitored by the government to prove UCG could finally be carried out safely.

Within a year, Carbon Energy"s small UCG trial in Bloodwood Creek contaminated water and land with cancer causing chemicals, which the company failed to report **(**Nancarrow 2011**)**[5], forcing the Queensland government to shut down the trial for seven months and also resulting in Carbon Energy being fined $62,000 (plus costs) in court for the environmental damage caused and breaching environmental protection laws **(**Powell, 2012**)**[6]**.**

Within weeks of Cougar Energy"s UCG trial in Kingaroy commencing in 2010, the trial contaminated groundwater with cancer causing chemicals, with directors failing to notify the authorities as quickly as they could have done, **(**Wall 2011**)**[7] which resulted in the trial being permanently shut down by the government, with Cougar Energy fined $75,000 in September 2013 **(**Powell, 2013**)**[8].

Cougar Energy abandoned UCG operations and announced they were changing their name to Moreton Resources declaring "its current name is strongly linked to UCG and may be disadvantageous for attracting and retaining the support of investors in the future **(**Yeo, 2013**)**[9].

Julie Lauder, the CEO of the UCG (trial) Association in London (which is now in administration) claimed Linc Energy"s Chinchilla UCG trial in Hopeland Queensland was to be the "Eureka Moment" for UCG **(**Pearce 2014**)**[1].

In June 2013 the Independent Scientific Panel Report On Underground Coal Gasification Pilot Trials **(**Moran, de Costa, Cuff, 2013**)**[10] recommended a continued the ban on commercial scale UCG in Queensland as the two remaining trials had "still not proven they could demonstrate safe decommissioning, by extinguishing the fires, shutting off reactions and preventing groundwater contamination."

In November 2013, unhappy with this decision by the independent panel of Scientists, Peter Bond, CEO of Linc Energy said they were shutting down their Chinchilla UCG trial and transferring operations to Asia, Peter Bond claiming this was "Due to the regulatory uncertainty" **(**Validakis, 2013**)**[11].

The Queensland government announced five months later, as a result of a nine month ongoing investigation, they were taking Linc Energy to court on four counts of causing serious environmental harm **(**Willacy, 2014**)**[12].

But later news reports revealed, just weeks before Peter Bond‟s announcement his company‟s offices were raided after search warrants **(**Frost, 2015**)**[13] were issued on the basis of tip offs from former workers regarding alleged toxic gas leaks and other serious problems at the Linc Energy plant (Solomons, Willacy, 2015**)**[14].

As investigations continued, by 1st March 2015, the Queensland government issued a warning deadly gases carbon monoxide, hydrogen and hydrogen sulphide had been found just below the surface in two private properties in the Hopeland area, near the Linc Energy UCG trial, with farmers told not to excavate below two meters unless they contact the government first (Willacy, 2015)[15].

Yet the next day, on the 2nd March 2015, Fife Today (Trimble, 2015)[16], in an article headlined "Cluff claims UCG plans for Forth pose „negligible risk‟" the Chief Operating Officer of Cluff Natural Resources, Andrew Nunn, declared their planned UCG trial in Kindardine posed "negligible risk", making no

reference to events unfolding in Australia claiming

> "The only way to further the evidence base is to proceed in a cautious manner with a small pilot operation with rigorous oversight from all the various regulators and members of the local community."

This despite the fact it is well documented all three UCG pilots in Queensland had resulted in major environmental damage, with what could be the biggest environmental disaster in Queensland‟s history reported the previous day, due to the Linc Energy UCG trial – despite close government monitoring with rigorous oversight from all the various regulators and members of the local community.

Andrew Nunn went on to say, as opponents of called for it not only to be included in the moratorium but completely banned

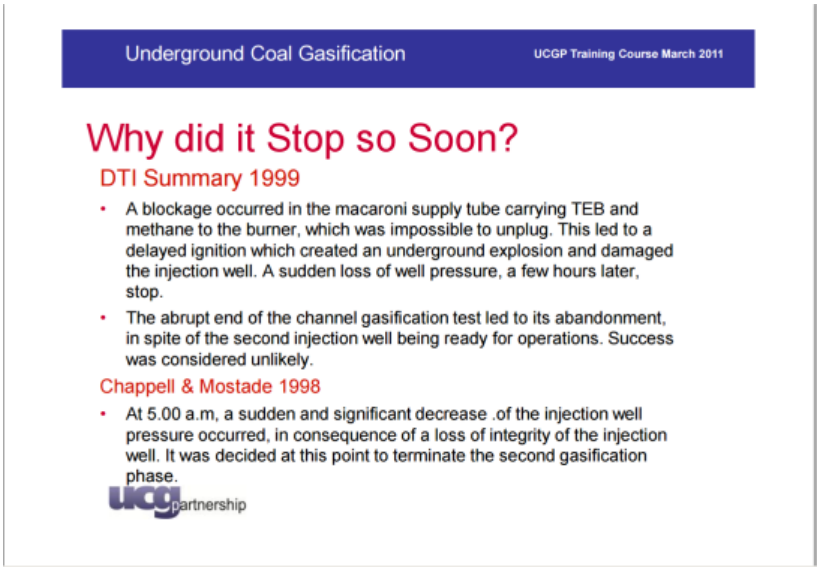
> ""This scientific study was carried out between 1999 and 2009 and culminated in a feasibility report for a UCG demonstration project in the Firth of Forth. The Scottish Government has always been committed to an evidence-based approach to energy Policy and the deliberate exclusion of UCG from the moratorium is acknowledgement the evidence base for UCG already exists.""

The UCGEngineering.com[17] website reveals, the study Andrew Nunn refers to was

> The trial was undertaken by the Spain, the UK and Belgium, and was supported by the European Commission.
>
> The Spanish trial was completed successfully (although operating hours were low) and it demonstrated the feasibility of gasification at depth, the viability of directional drilling for well construction and intersection and the benefits of a controllable injection and ignition point (CRIP- controlled retractable injection point)."

But what Andrew Nunn, the UCG Engineering website and Westminster's DECC website[18] also do not reveal was this UCG trial had to be completely abandoned after the pipe feeding the combustion products got blocked, resulting in an explosion, which could not be controlled, covering the surface site in contaminants and the entire UCG trial had to be abandoned, with DECC only stating

> "the trial demonstrated that UCG wells in deep seams could be successfully constructed. The encouraging results of the European trial led the DTI to reevaluate UCG as a longer-term option for clean coal exploitation in the UK, as described below."



So with no mention of the fact the part funded DTI EU trial was forcibly abandoned after it was impossible to unplug a blockage in the tube carrying the TEB and methane to the burner resulted in an explosion that could not be controlled , as revealed by the European UCG Case Study (Green 2011)[19] revealed why the UCG trail had to stop so soon.

While Andrews Nunn goes on to claim

> "The only objection to this sort of scientific approach can be that it will expose the extremists' anti-UCG rhetoric for what it is and leave communities wondering what all the fuss was about."

and

> "Unfortunately for those opposed to UCG, you cannot randomly pick which scientific evidence you choose to believe in. If you accept unequivocal evidence for climate change you also have to accept similarly strong evidence that a well-executed UCG project will have a negligible risk of adverse environmental outcomes."

With Andrew Nunn failing to mention the EU trial was forcibly abandoned after an underground explosion it appears it is Andrew Nunn being picky with the scientific evidence, along with DECC and the UCG Engineering website.

On 12th March 2015 "a court ruled Linc Energy will stand trial on five counts of wilfully and unlawfully causing serious environmental harm" between 2007 and 2013 **(**Frost, 2015**)**[20].

Meanwhile in Britain, on the same day, academic expert Harry Bradbury, the boss of Five Quarter, who held UCG licenses in the Firth of Forth, at the time, claimed those protesting against the UCG proposals who had signed a petition against his company"s UCG plans for the North East coastline where being "alarmist" and were "misinformed" (McCusker, 2015)[21], with the report going on to say

> "About its technology Mr Bradbury was unequivocal."

> "Five-Quarter is not running experiments – the initial technology roll out uses technology tested over 15 years with five years of Australian Government monitored trials using expert witnesses, the results of which have been that the follow-on commercial programme has full Government approval."

With Harry Bradbury making absolutely no mention of the disaster unfolding in Australia as a result of the Linc Energy flagship UCG trial – after Linc Energy had fled the country months earlier with the Queensland government suspecting the coal fire may still possibly be burning underground from that Linc Energy trial, the Cougar Energy trial being closed down within weeks of

starting and the Carbon Energy trial also resulting in a court case- 100% of the UCG trials in Australia resulting in 100% of the companies being taken to court for causing serious environmental damage.

By 17th March 2015, further reports stated Linc Energy were facing further allegations, (Solomons, Willacy, 2015)[22]. with the ABC News report revealing staff complained to the company of nose bleeds, dizziness, nausea, vomiting, headaches, blurred vision and respiratory ailments, which the company is alleged to have failed to report , with another news report claiming it had been confirmed, the workers had been exposed to toxic gases (Hagemann, 2015)[23].

Linc Energy"s Chairman is quoted as saying in response to the allegations "We have not received direct complaints from former employees (Solomons, Willacy, 2015)[22].

Further allegations claim "unreported incidents at Chinchilla allegedly include a fire caused by a clogged pipe" and Linc Energy knew in 2013 all the gasifiers were fractured, with fractures also occurring on site, which also happened in the EU trial causing an explosion that could not be controlled which resulted in the the entire UCG trial having to be abandoned (Solomons, Willacy, 2015)[22].

The blockage in the Linc Energy trial, "which the company tried to clear by increasing the pressure so much that the rock above it cracked, allowing the gas to escape"

It was also alleged that groundwater was contaminated with benzene, at levels 60 times higher than allowed and attempts were made to hide gas leaks by covering them with crusher dust and that carbon monoxide was penetrating the surface as well as syngas from Gasifier 4, with the management of Linc energy aware of this and ordering staff to reduce the pressure during a site inspection by Government staff to conceal the leakage (Solomons, Willacy, 2015)[22].

The news report also states the Environment Department also alleges “extremely high levels of contaminants were recorded at monitoring wells on the site, with levels of contaminants so high a third party laboratory, which tested samples, rejected them on the basis they could damage laboratory equipment” **(**Solomons, Willacy, 2015**)**[22].

So both Cluff Natural Resources and Five Quarter, both holders of UCG licenses in the Firth of Forth, make statements at the same time this UCG trial disaster in Queensland was unfolding, which combined claimed those against their UCG trials are being “alarmist” and “extremists” and being picky with evidence.

Harry Bradbury also stated his plans to go into full industrial scale production in the UK, without any trials, justifying this statement by saying there is no need, referring to a similar facility in Australia **(**The Journal, 2014**)**[24] - one of the Australian UCG trials which has resulted in a total ban on UCG as of April this year), attempting to use a technology for the first time - in an environment UCG has never been tried before – under water

The Broad Alliance, whose members were fully aware - and following this unfolding disaster in Queensland - assert it is Cluff Natural Resources and Five Quarter, to protect their own investments, who were being picky with the scientific evidence, when neither made reference to the on-going ban in Australia, put in force by an independent panel of scientists, with no vested interest, as the trials had still not proven the latest UCG techniques, proposed for Scotland, using that very technology, could be carried out safely from start to finish, neither made reference to the previous environmental damage that resulted in one UCG trial being shut down within weeks of starting a second UCG trial also ending up in court for causing serious environmental harm.

But most importantly both companies making these statements when it had already been reported just weeks earlier the Queensland government had imposed a 320sq km excavation exclusion zone near the Linc Energy trial

warning “property owners should seek advice from The Department of Environment and Heritage Protection (EHP) if they plan to excavate to the dept of 2 metres or deeper within this zone.” **(**EPA 2015**)**[25] as toxic combustion gases were present just below the surface at explosive levels.

When the three private companies involved in the Australian trials failed to report in a timely fashion, at best, covering up serious problems from a UCG trial and breaches of UCG pilot regulation and fleeing the country while the investigation into major problems at the Linc Energy UCG trial at worst, these statements made by these companies prove a level of recklessness that begs the question are either of these companies fit to hold a UCG license, especially as Algy Cluff had already misled the people of Fife when he stated categorically water is not used in UCG operations – yet he told prospective investors “oxygen and steam” are used in the UCG process, not once but twice

Despite these statements the Broad Alliance were following events closely in Queensland and by 10th August 2015 an ABC news report, revealed (Solomons, Willacy, 2015)[26]

> “A study commissioned by Queensland's environment department says an experimental plant operated by mining company Linc Energy at Chinchilla, west of Brisbane, is to blame and has already caused "irreversible" damage to strategic cropping land.
>
> The department, which has launched a $6.5 million criminal prosecution of the company, alleges Linc is responsible for "gross interference" to the health and wellbeing of former workers at the plant as well as "serious environmental harm".

On the same day a report revealed **(**Brisbane Times, 2015**)**[27]

> “Four Queensland government workers were hospitalised while investigating an underground coal gasification plant at the centre of serious pollution allegations.
>
> Documents obtained by the ABC reveal the environment departmental investigators suffered suspected gas poisoning while testing soil at the site of the Linc Energy operation at Hopeland, west of Brisbane.
>
> One of the workers said he was nauseous for several hours and his blood tests showed elevated levels of carbon monoxide.
>
> An expert study commissioned by Queensland's environment department, also obtained by the ABC, says gases released at the plant have caused the permanent acidification of nearby soil”

By October 2015, **(**Robertson, 2015**)**[28] farmer George Bender, who was said to be “proud of his "clean and green" produce, and had won many awards for his wheat” committed suicide, unable to take any more of life due to the effects on his farm and his life by the Coal Seam Gas and UCG operations, with his daughter Helen saying to a government panel

> “On Saturday we buried my father [who was] struggling for 10 years against the CSG industry and Linc Energy.”

With the Guardian report going on to say

> “A Chinchilla local, Karen Auty, told the panel credible medical studies had identified problems with exposure to gas, which had led to children in her area for the past two and a half years suffering from nose bleeds, rashes and insomnia from headaches.”

When Federal Assistant Health Minister Fiona Nash was asked what she "would do in response to lingering health concerns among residents near Queensland's gasfields." she said studies were on going

> "But there's no doubt we need to do more," Nash said. "Where there are health impacts, we need the work to be done to show us. I know there is existing work already but we need to build on that to get a clear and proper picture exactly of what these health impacts are.
>
> "And from my view in all of this, we should take the precautionary principle, we should be conservative and things should be on hold until they can be proven not to have an impact, in my view."

UCG Banned In Queensland April 2016

As a result of the Cougar Energy, Carbon Energy and Linc Energy UCG pilots and the resulting environmental disaster in Hopeland as a result of the Linc Energy UCG trial, on April 18, 2016 in a joint statement, Government Ministers, the Honourable Anthony Lynham, and The Honourable Steven Miles revealed, The Palaszczuk Government has moved to ban underground coal gasification because of its environmental impact stating **(**Lynham, Miles, 2016**)**[29]

> "We have looked at the evidence from the pilot-operation of UCG and we've considered the compatibility of the current technologies with Queensland's environment and our economic needs.
>
> "The potential risks to Queensland's environment and our valuable agricultural industries far outweigh any potential economic benefits," he said.
>
> "The ban applies immediately as government policy, and I will introduce legislation to the Parliament by the end of the year to make it law."

> “As a government, we support our resources sector for the jobs and economic growth it generates, but UCG activity simply doesn‟t stack up for further use in Queensland.”
>
> “In addition, our new chain of responsibility laws will provide new powers to require that contaminated sites must be cleaned up.”

Two days later it was reported in the Ilawarra Mercury, (Phelps 2016)[30] farmers affected by the UCG disasters are collectively suing Linc Energy‟s insurers and from the Queensland government stating

> “The State Government is the ultimate owner of mineral resources in this state and they are responsible for the granting of licenses to exploit those resources,” Mr Marland said.
>
> “They owe a duty of care to the community that those licenses are appropriately granted, regulated and monitored.”

Why UCG Should Be Banned In Scotland Too

With the Queensland government having now banned UCG completely, based on the evidence from all three pilots, which all resulted in severe environmental damage, one trial forcibly shut down within weeks and the other two trials being decommissioned, with all three private operators charged in court with causing serious environmental damage and breaching environmental safety regulations, this is not the only evidence available which proves conclusively UCG should also be banned in Scotland.

Sepa has admitted it has no way to monitor UCG operations in Scotland

All UCG trials around the world to date have been conducted and monitored onshore. The results of these trials were varied with some of the problems reported being:

- Groundwater contamination with BTEX chemicals
- Land contaminated with BTEX chemicals
- Livestock contaminated with BTEX chemicals
- Underground explosions, which could not be stopped, due to pipes feeding the combustion material into the UCG cavity becoming blocked
    - With the pipes becoming blocked in both the part DTI funded EU trial and the Linc Energy Chinchilla trial
- Subsidence underground and at ground level
- Workers exposed to toxic gases
- UCG cavities fractured by too much pressure leaking toxic gases hydrogen, hydrogen sulphide and carbon monoxide underground, rising to just below the surface to gather at explosive levels across a 320sq km radius in Queensland and toxic gas leaks from the cavity in the Polish trial too.

With one Queensland resident reported as saying (The Australian, Weekend Australian Magazine)[31]

> ""Anyone who has a bit of common sense would wonder about it," …
>
> "You"re lighting a fire down there, pumping all that air pressure in – something"s got to give. I don"t know how anyone could dream they could contain it."

With the Weekend Australian Magazine[31] going on to report

> "In the 16 months since then, they"ve become a lot more enlightened. They"ve learnt that Linc Energy stands accused of fracturing the rock beneath their land and releasing toxic chemicals into the soil, air and groundwater over a six-year period. They"ve read that Linc"s workers were told to cover up the contamination and drink milk to protect themselves. They"ve been told that digging a hole in a paddock might release "potentially explosive and/or toxic and/or asphyxiating mixtures

> of gases". They've heard the Queensland environment minister, Steven Miles, describe it as "the biggest pollution event probably in Queensland's history"."

With the two of the three UCG trials in Australia, both running for several years, still managing to cause severe environmental harm, despite being carefully monitored by the Queensland government – how on earth do Sepa propose to monitor a pilot UCG trial, by a company with absolutely no commercial UCG experience under the Firth of Forth?

In response to a freedom of information request[32], on 28th September 2015 to FOI FOI85781 Sepa officials state

- Point 3.2 "at this time, no monitoring plans or processes specifically related to UGC have been developed.

The Ferret, online investigative reporting news website reported in December 2015 in an article headed "Mining for coal gas could cause blasts, fires and quakes, says Sepa" **(**Edwards, 2015**)**[33]

> "Plans to gasify coal under the sea around Scotland could cause pollution, earthquakes, underground explosions and "uncontrollable" fires, according to confidential draft reports from the Scottish Environment Protection Agency (Sepa).
>
> The Scottish Government's green watchdog admits that it doesn't know what level of protection its safety regulation can provide against the hazards of underground coal gasification (UCG). The risks were "sometimes unknowable", it says in one report.
>
> The revelations have prompted anger from politicians, community groups and environmental campaigners. They are demanding that the government's temporary moratorium on UCG be turned into a permanent ban."

The news report went on to say FOI requests had revealed

> “In preparation for regulating the technology, Sepa scientists have drafted reports outlining the potential hazards. A first draft from early this year and a second, marked “confidential” and dated July 2015, have been released under freedom of information law.
>
> Drawing on evidence from UCG facilities in Europe, the US and Australia, the reports list eight things that can go wrong. Groundwater can be polluted by toxins such as phenols, cyanides and radioactivity, they say.
>
> Air can be polluted by highly toxic particles, ash, heavy metals and a series of hazardous gases, says the latest draft. Emissions of the greenhouse gases that disrupt the climate are estimated to be lower than from coal but higher than from natural gas though “large uncertainties remain”, it warns.
>
> There is a risk that “induced seismicity” could damage boreholes and surface installations, as well as spread pollution. Underground explosions, which have been recorded abroad, could inflict similar damage, Sepa says.
>
> Igniting the coal underground could lead to “uncontrollable fire”, which would worsen water and air pollution. The danger of underground “cavity collapse” could cause subsidence on the surface.
>
> “The fundamental cause for concern with regards to UCG is that the conditions under which the reaction takes place are naturally variable and difficult to know (sometimes unknowable), placing an inherent limitation on process control,” says Sepa’s first draft. “This, combined with a number of significant environmental and human health hazards, creates risk.”

The more recent draft points out that some of these risks could be reduced if developers drill down to more than 800 metres below the sea, as they plan to do. But it doesn‟t say the risks could be eliminated.

There are “significant technological and knowledge gaps”, it warns. Because controls and regulations are still being clarified ”it is not possible at this stage to assess the level of protection they will provide.”

Emails released in response to a freedom of information request also reveal that Sepa was anxious to alter the minute of a meeting with the UK government officials discussing UCG in February 2015. Sepa sought to remove a sentence questioning whether there was “a robust regulatory environment in place”.

The Ferret Report listed the eight hazards of underground coal gasification:

Groundwater pollution	toxic gases and metals could contaminate the ground and possibly find their way into drinking water
Surface water pollution	toxic gases and metals could contaminate the sea and other surface waters
Air emissions	ash, particles, metals and gases could pollute the atmosphere, risking health and worsening climate change
Underground explosion	inflammable gases could be ignited by a spark and explode, damaging boreholes and buildings
Cavity collapse	underground cavities could collapse and cause subsidence on the surface
Seismicity	earthquakes that would damage boreholes and surface installations, as well as spread pollution
Groundwater depletion	other users could be deprived of water, and environmental damage could be caused
Uncontrollable fire	underground coal could burn out of control, causing air and water pollution and risking cavity collapse

With Sepa admitting “The assessment of potential risk requires significant additional work”

With explosions in the UCG trials in Spain and Poland – with the UCG cavity cracking and releasing toxic gases in the Polish trial – just as happened in the Linc Energy trial in Queensland, this proves conclusively this technology is not controllable at levels closer to the surface onshore than that proposed by the Cluff Natural Resources trial under water– and even with government monitoring of the onshore trials major environmental damage could not be prevented.

As onshore trials have been so disastrous it is impossible to go ahead with a UCG trial in Scotland under water as Sepa admit they have no idea how to monitor this trial under water, as this has never been tried anywhere in the world, and are not aware of any country in Europe having developed any safety policies in relation to UCG based on EU directives.

With none of the UCG license holders in the UK having any commercial UCG experience, Sepa and the EA having no experience monitoring UCG onshore, never mind under water, Sepa and the EU unable to figure out what regulations should be in place and no one able to say how this should be regulated in line with EU directives, the Underground Coal Gasification Association in London going into administration and the Queensland government declaring a complete ban on UCG, based on the evidence from their trials over many years - even investors have walked away from UCG in the UK, resulting in Five Quarters, one of the UCG license holders in Scotland going into administration in April this year, despite being given £15million of taxpayers money and a £1billion taxpayer guarantee by the Westminster Parliament, to cover investor losses should it all go wrong.

Even the Westminster UCG group ask the question, given the risks involved and the fact the technology is relatively unproven, should the UK be the first country in the world to roll out UCG **(**UCG Working Group, 2014**)**[34].

The Broad Alliance believes the Queensland government answered that question conclusively in April 2016– UCG cannot be undertaken safely – so much so an immediate ban across Scotland (and the rest of the UK) should also be put in place, with laws to follow– as UCG is so dangerous has even small pilots of UCG, using world leading horizontal drilling techniques can cause irreversible environmental damage and pollute and put endanger the economy, business and those living within hundreds of square kilometres when things go wrong.

It is vital this ban is put in place across the whole of Scotland ass the Kincardine and other UCG licenses in Scotland are issued near densely populated areas, with the real possibility each UCG licenses could leak toxic combustion gases hydrogen sulphide, carbon dioxide and hydrogen from underground up to densely populated areas via honeycombs of old mine workings and fault lines, affecting even our capital City of Edinburgh.

Why Kincardine & the Firth Of Forth Are Not A Suitable Area for UCG licenses

The "UNDERGROUND COAL GASIFICATION ("UCG") POLICY STATEMENT FOR LICENSING BY THE COAL AUTHORITY" **(**UK Government December 2009**)** [35] states

> "The Authority will normally only consider UCG conditional licence applications for :-
>
> Offshore areas. Offshore licence areas can also include an onshore access strip to facilitate the sinking of exploration boreholes during the conditional licence phase and for sinking directional access boreholes into the offshore UCG area during the operational phase. *(see note 2)*
>
> Onshore areas, but only where it can be demonstrated that the surface is suitable for piloting this technology. *(see note 3)*
>
> Areas where there are :-
>
> o no other Coal Authority Mining Licences & Agreements;

- no existing Petroleum Licences;
- no identifiable defence installations; and
- no existing or proposed wind farm sites or other major structures on the seabed.*(see note 4)*

A maximum initial application area of 10,000 hectares. *(see note 5)*

Areas where the Department of Energy & Climate Change, The Crown Estate, The Ministry of Defence or other relevant bodies do not raise objections. Consultation will be undertaken by the Authority with these relevant bodies on receipt of a conditional licence application. *(see note 6)"*

The license conditions state

"Licences will be subject to advertising by the Authority in order to stimulate competition.

The initial term of the Conditional Licence will normally be restricted to a maximum of three years. The Authority will require Conditional Licence holders to undertake further discussions with the Department of Energy & Climate Change, The Crown Estate, The Ministry of Defence and other relevant bodies during the conditional period as they formulate the detail of their operations.

The conditions will include a requirement for the applicant to undertake an agreed programme of works during the term of the Conditional Licence. Failure to complete the agreed programme of works will result in the Licence being revoked unless the Authority can be satisfied that the Licensee is committed to the pilot project.

Where the proposed UCG operation and its ancillary activities have a potential to interact with or damage third party property interests then a condition will be included requiring the Licensee to provide evidence of the existence of a Commercial Agreement between the parties outlining the manner in which any interaction or damage so caused is managed, remediated and funded. *(see notes 8 & 9)*

Further requirements for de-conditionalising a licence in whole or in part will be incorporated into the licence conditions and are set out in

more detail in the Authority"s Model Underground Coal Gasification Licensing Documents."

The September 2004 DTI Report "Review of the Feasibility Of Underground Coal Gasification In the UK" (DTI, 2004)[36] stated

> "Firth of Forth UCG Study : A study, entitled "The Coalmine of the 21st Century" has been initiated by Heriot-Watt University with support from DTI, Scottish Enterprise and Scottish and Southern Energy Ltd. Its aim is to undertake a feasibility of UCG in the substantial coal resources of the Firth of Forth This study builds on work already undertaken as part of the initial search for a test site, and will establish whether this area offers prospects for large-scale UCG and power generation. If the one-year study is successful, a prospectus will be produced to attract investment funds in the development of the project."

The duration of the study was 13 months, from March 2004 to March 2005 and the report of study stated **(**Heriot-Watt University, 2006**)**[37]

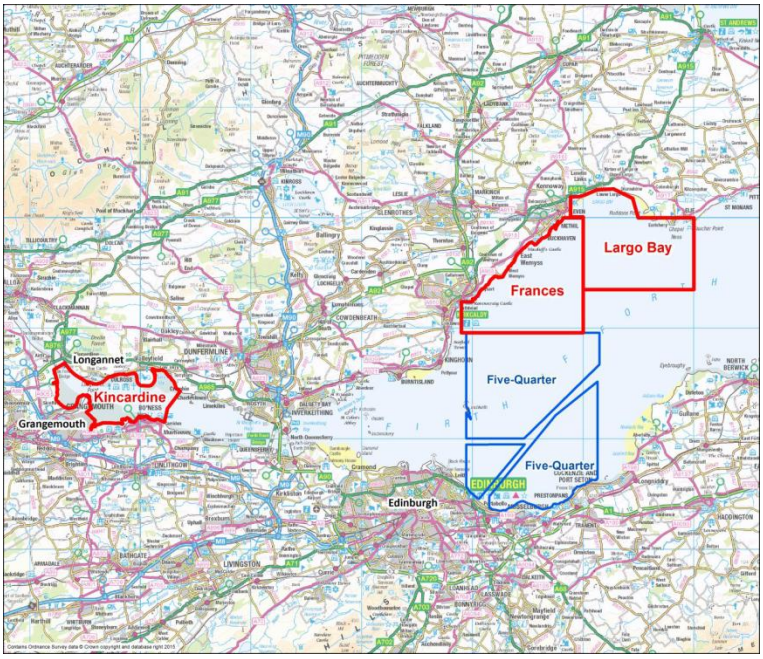
> "The search for a site became a greater challenge than initially expected. Kincardine was soon ruled out because the river narrows to the west of Kincardine Bridge and any UCG operation beyond the initial trial would require the inclusion of onshore resources, parts of which are licensed for CBM extraction.
>
> Grangemouth was more promising as the river is unusually wide and the surface banks already have significant industrial activity. However, the previous work had found that the Longannet-Grangemouth area had an unacceptable geological risk, and this was largely supported by the present study.
>
> Some structurally benign areas can be found within the prospect for trial purposes, but large areas are likely to be affected by structural and igneous features which would probably eliminate a commercial scale

operation.

As the study progressed, the coal seam area of Musselburgh to the west of Edinburgh was found to be superior on geological and hydrogeological grounds and the best geological option for large-scale UCG production. However, the parallel environmental impact study showed that surface constraints at the shoreline would make access and shore facilities difficult to locate, and any UCG operation would need to be based entirely on offshore platforms. For the other sites, there were more options for the location of shore-based plant, but the geology was less certain, and more data were required to prove whether any of the sites would be suitable for a UCG trial."

The feasibility study concluded

"Four potential regions of the FoF, Kincardine, Grangemouth, Musselburgh and East Fife, were examined as potential areas for commercial UCG. All had commercial quantities of coal potentially suitable for UCG (>20M tonnes), but the first three regions identified above had either data deficiencies, limitations on coal geology or surface constraints."



In a report commissioned by Cluff Natural Resources, (Beltree Limited, 2015)[38] the study looked at an area of interest 2km around the Kincardine license area

On page 5 of the report it says

> "CNR"s Kincardine licence lies in the Midland Valley of Scotland (MVS) – a southwest-northeast trending basin cutting the central belt of Scotland (Figure 1.1). The MVS is around 80km wide, extends roughly 150km onshore across Scotland and is a major population centre with five of Scotland"s seven cities lying within it. (Beltree Limited, 2015)[38]

On page 26 of the report it says

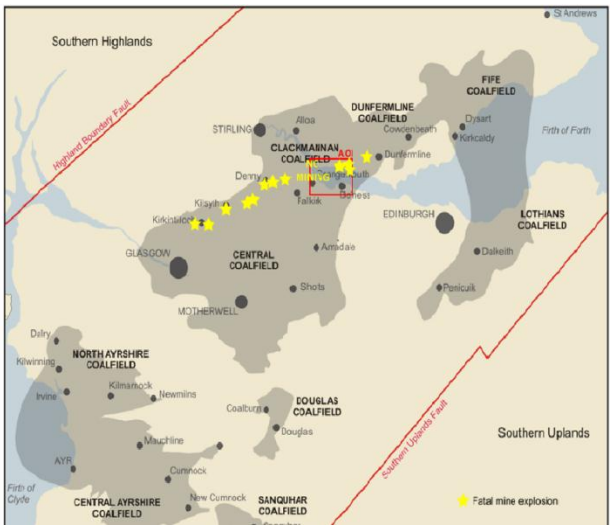
> "Uncharted mine entries and abandoned workings in multiple seams of coal and associated minerals within the Coal Measures should be anticipated wherever they outcrop in the Kincardine UCG license area of interest. Shallow voids, loosely compacted mine waste, and weak roof-supporting pillars within abandoned workings pose a high risk of

rockhead and surface instability and loss of fluid circulation at drilling locations(Beltree Limited, 2015)[38]

Page 26 of the report also reveals

> “The Bowhousebog Coal, in the upper part of the Passage Formation locally attains a thickness of 1.3m between Larbert and Dunmore and several old pits are believed to have worked it at both locations and in the intervening ground.
>
> Abandoned mine workings therefore pose a risk to surface stability and loss of circulation at drilling locations wherever the lower part of the Passage Formation subcrops beneath superficials, and close to the outcrop of the Bowhousebog Coal.” (Beltree Limited, 2015)[38]

Page 34 of the report gives a map showing “location of a lineament of fatal mine explosions in workings within Limestone Coal Formation seams in the Central and Clackmannan Coalfields. Data from UK Government statistics summarised by scottishmining.co.uk. Note that a break in the lineament occurs in the axis of the Clackmannan Coalfield where the seams were too deep to be mined but where high gas contents and saturations have reported to have been measured by Composite Energy in exploratory CBM drilling at Airth. (Beltree Limited, 2015)[38]



Page 36 of the report reveals

> "All of the target coals have been worked by traditional mining methods within the project AOI. All except the Upper Hirst have been worked in the east of the licence area where they are at shallower depths. The Upper Hirst seam conversely has been worked in the west – extensively onshore and to a lesser degree under the Firth of Forth" (Beltree Limited, 2015)[38]

Page 41 reveals

> "However, despite the reasonable quality, the seismic lines are widely-spaced in relation to the structural complexity, so borehole tops, fault analyses and mine abandonment plans of Old Coal Workings (OWS) have been key to understanding the structure and filling some of the gaps between seismic lines. Without this supplementary data, seismic faults and the target continuous reflection event segments would almost certainly be mis-correlated. Even with the supplementary drilling and mining data, some areas are of the licence have too poor data coverage to make an unambiguous interpretation" (Beltree Limited, 2015)[38]

Page 44 goes on to say

> "with faults progressively migrating out of the licence to the north and to the south with increasing depth" and "The Midland Valley sill, known from drilling, does not image well in the legacy seismic. Line TOC86M112 tentatively images a flat zone at the appropriate depth predicted by its penetration in the Inch of Ferryton 1 well. It is hoped that reprocessing might strengthen the confidence in this pick and its extrapolation away from well control." (Beltree Limited, 2015)[38]

Page 48 says of possible coal panels for the UCG operations

> “It is important to point out that the identification of these panels is largely based on legacy 2D seismic of insufficient density and resolution to image faulting that can be observed in the mine abandonment plans. It should therefore not be assumed that the panels identified in Figure 4.15 are completely free of faulting or folding of a complexity that might have a negative impact on successful execution of a horizontal UCG well.” (Beltree Limited, 2015)[38]

Page 49 says

> “In fact, most of the small faults displayed on the interpretation have throws smaller than 20 m and, if encountered during drilling of a horizontal production lateral, could result in premature termination of the wellbore if the seam could not be found on the other side of the fault. “(Beltree Limited, 2015)[38]

While the people of Scotland are told not to worry this UCG trial will operate at depths much deeper than previous failed UCG trials, this report reveals on page 53, this trial in fact is specifying a minimum depth of 300m up to a maximum of 2000 metres – so Cluff proposes burning coal just 300m below the surface – not as deep as we have been led to believe. (Beltree Limited, 2015)[38]

The Belltree Ltd report conclusions are

> “After collating, reviewing and interpreting the public domain data that is available for the Kincardine licence and adjacent areas, it is concluded that current data density (from boreholes, mine abandonment plans and particularly seismic) may be insufficient to:
>
> - Detect the presence of some barriers to UCG burn progression such as minor faulting which may also compartmentalise the resource;
> - Accurately plan the trajectory of a horizontal well (especially the in-seam land-out coordinates at the end of the build

section, and provide early warning of steering requirements imposed by structural undulations or discontinuities); and

- Characterise faulting in terms of its ability to transmit water and gases without further modelling. (Beltree Limited, 2015)[38]

The academic paper, "The groundwater hydrology of underground coal gasification coupled to carbon capture and storage" states subsidence of the UCG cavity "could" provide the benefit of making the rock in the roof above the cavity "more permeable" up to 60 times higher than the cavity itself P.L. (Younger, G. González 2010)[39]

With the Belltree Ltd report revealing the minimum depth of the coal being considered for the Kincardine trial being just 300m below the surface, once the UCG cavity inevitably collapses, as Professor Paul Younger who used to be on the board of UCG company Five Quarter states, how close to the surface this rock will become more permeable.

Professor Younger"s paper is an academic paper and if those calculations are incorrect – and that cavity collapse causes the rock above the cavity to become permeable all the way to the surface then this could allow the waters of the Firth of Forth to access not only the UCG cavity but the honeycomb of interlinked mine workings, charted and uncharted, surrounding the cavity made accessible when the cavity collapses too.

There is no way to support a UCG cavity, as one can in a traditional coal mine, which makes undertaking a UCG project in an area honeycombed with old mine workings and fault lines an unsuitable area for any UCG project – a conclusion the Heriot Watt university feasibility study has already concluded.

While the Westminster government can draw a line on the shoreline for each UCG license – fires and gases escaping from UCG trials do not respect the lines drawn on a map but follow fault lines and permeable rock and gaps caused by old mine workings which would allow the gases from a process that

cannot be controlled underground to rise to the surface in a densely populated area.

Cluff Natural Resources stated in January 2016 their UCG plans for Scotland are not "dead in the water" **(**Lammey 2016**)**[40] with the Energy Voice report stating

> "CNR said in a statement it felt there was more support for investment in energy and industry in England, where there is no moratorium on UCG."

This statement was proven wrong after Five Quarter went into administration just three months later, after investors could not be found, despite the £1billion Westminster government taxpayer guarantee.

The Midland valley faces a UCG-CBM-Fracking perfect storm, with fracking and UCG both known to cause earthquakes in an area with known fault lines and seismic activity before any of these UGE proposals are moved forward – fault lines on which both Scotland"s ailing nuclear power plants also sit on.

Should millions of tons of coal be set on fire, underground, using a process where operators have proven time and again they have no control over once things go wrong, in an area where fracking operations are taking place to fracture rocks deep underground to release methane gas.

Imagine a combined UCG/fracking/CBM methane underground explosion from the underground coal fires of the UCG trial meeting methane from fracking operations that has seeped through underground fractures and fault lines, the explosion ripping through a honeycomb of coal mines, many not documented, in a densely populated area with two major road bridges, a chemical plant, Rosyth Naval Base, with decommissioned nuclear submarines and the biggest methane tanker in Europe in a densely populated area – a disaster which would make the recent chemical plant explosion in China

appear like a small fire work exploding should this very realistic scenario happen.

But the risks do not end there.

The Impact of UCG On The Climate

In the academic paper **"Underground coal gasification with CCS: a pathway to decarbonising industry** (**Younger, G. González 2010**)[39] the former directors of Five Quarter stated

> "Underground coal gasification (UCG) opens up the prospect of accessing trillions of tonnes of otherwise unmineable coal. When combined with carbon capture and storage (CCS), UCG offers some attractive new low-carbon solutions on a vast scale. This paper has several aims: to review key developments in technologies for UCG, CCS and CO2 storage in coal seam voids; to quantify the scale of the opportunity that these technologies open up; .. and to propose a basis on which UCG-CCS can sit at the heart of plans to decarbonise present day industry in a way that dove-tails with longer-term ambitions for an economy based on renewable energy."

They report states in the introduction

> "If UCG can be successfully linked to CCS, then the combined UCG–CCS offering provides a way of harnessing the energy contained within huge untapped coal resource whilst remaining within the ever-tightening targets for reducing CO2 emissions. The requirements for achieving long-term storage of CO2 and the CO2 trapping mechanisms for deep saline aquifers and depleted hydrocarbon fields are well documented"

In section 2 of the UCG technology it states

> "The basic idea is that energy can be recovered from deeply buried coal seams by gasification of the coal in situ. This is readily achieved by introducing hot steam and oxygen or air to the coal via injection boreholes. In a sense, the uncontrolled combustion of coal underground is well known as a result of the many coal fires that have occurred around the world. However, the controlled gasification of underground coal is a different matter."

Over 50 years ago the town of Centralia in Washington State had to be abandoned after a fire at a landfill spread to an abandoned coal mine (BBC 2012)[41].

And Queensland has discovered UCG is not a different matter and a UCG trial has resulted in toxic combustion gases hydrogen sulphide, carbon dioxide and hydrogen leaking across a 320 sq km radius to gather at the surface at explosive levels, resulting in permanent damage to prime farmland and farmers being instructed not to excavate below 2m – something no traditional coal mine has caused.

Section 2.1 of the report goes on to say

> "The target coal seam can be on-shore, near-shore or off-shore. In all three cases, a fundamental requirement is the ability to accurately and remotely direct drilling equipment to create the network of gasification channels, injection wells and production wells for a UCG operation"

This requirement cannot be met in the Midland Valley as the Belltree report conclusions state clearly

> "After collating, reviewing and interpreting the public domain data that is available for the Kincardine licence and adjacent areas, it is

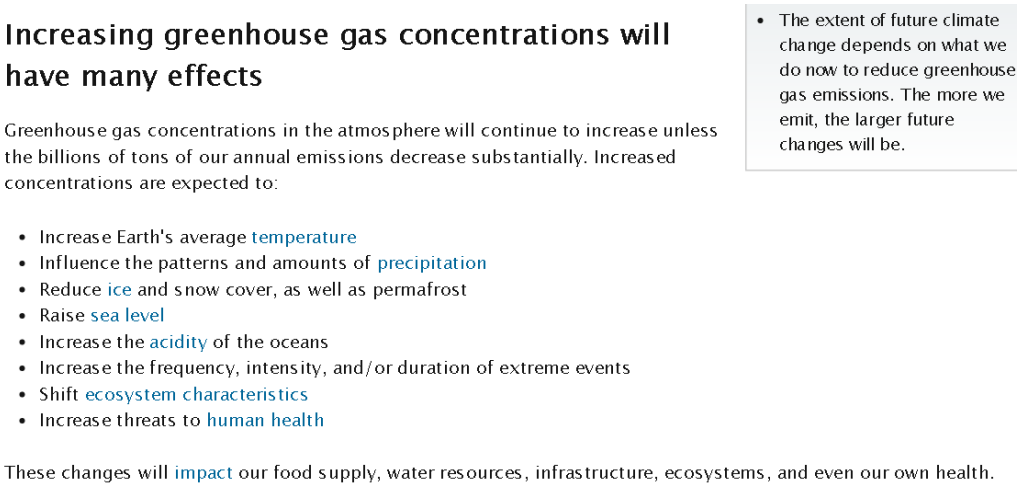
concluded that current data density (from boreholes, mine abandonment plans and particularly seismic) may be insufficient to:

- Detect the presence of some barriers to UCG burn progression such as minor faulting which may also compartmentalise the resource;
- Accurately plan the trajectory of a horizontal well (especially the in-seam land-out coordinates at the end of the build section, and provide early warning of steering requirements imposed by structural undulations or discontinuities); and
- Characterise faulting in terms of its ability to transmit water and gases without further modelling.

In section 3.2 of the report “Storage Potential” (for CO2) the report states

> “For the reasons given in Section 2.3 above there is still a question over the precise volume of CO2 that can be stored in the UCG coal void. Suppose, for the sake of argument, that 50% of the CO2 arising can be stored back in the void space. If the aspiration is to target (say) 4 trillion tonnes of coal for UCG operations, that would translate into 12 trillion tonnes of CO2 arisings, with (say) 10 trillion tonnes of CO2 being captured (if CCS is deployed universally), and 5 trillion tonnes being stored in UCG void space. Compared with current levels of CO2 emissions world-wide of around 27 billion tonnes per year, we are therefore looking at around 200 years of CO2 storage capacity at current emission levels, which is getting close to the figures usually quoted for CO2 storage capacity in saline aquifers. From a global perspective, therefore, the UCG–CCS concept deserves more serious consideration alongside some of the other more prominent carbon management proposals.”

The Environmental Protection Agency in America states on their website



Increasing greenhouse gas concentrations will have many effects

Greenhouse gas concentrations in the atmosphere will continue to increase unless the billions of tons of our annual emissions decrease substantially. Increased concentrations are expected to:

- Increase Earth's average temperature
- Influence the patterns and amounts of precipitation
- Reduce ice and snow cover, as well as permafrost
- Raise sea level
- Increase the acidity of the oceans
- Increase the frequency, intensity, and/or duration of extreme events
- Shift ecosystem characteristics
- Increase threats to human health

These changes will impact our food supply, water resources, infrastructure, ecosystems, and even our own health.

- The extent of future climate change depends on what we do now to reduce greenhouse gas emissions. The more we emit, the larger future changes will be.

In an article in The Bulletin of Atomic Scientists it states (House 2010)

> It's been estimated that around 4 trillion tonnes of otherwise unusable coal might be suitable for underground gasification. If true, then the economic development of this process would expand coal reserves by a factor of about five. Such an expansion would be both good and bad. From the perspective of maintaining a prodigious and affordable energy supply, gasification would be a boon. But from a climate change perspective it could be a nightmare. If just current conventional coal reserves were fully combusted, the concentration of atmospheric carbon dioxide would approximately double. But if an additional 4 trillion tonnes were extracted without the use of carbon capture or other mitigation technologies, atmospheric carbon-dioxide levels could quadruple--resulting in a global mean temperature increase of between 5 and 10 degrees Celsius.

The DTI report on proposals for UCG in the UK states that carbon capture would be required for any UCG operations in the UK.

Yet the "**UNDERGROUND COAL GASIFICATION ("UCG") POLICY STATEMENT FOR LICENSING BY THE COAL AUTHORITY (**UK Government December 2009**)** states clearly in Notes on Policy License Area where one of the assumptions the Authority has made in note 1.6

> "The process is outside the remit for carbon capture and storage."

Yet in the article New Scientist Journal “Fire in the hole: After fracking comes coal” (Pearce 2014)[1]
Pearce states

> “The Intergovernmental Panel on Climate Change recently reckoned that the world needs to limit total emissions of carbon, from now on, to less than half a trillion tonnes just to keep global warming below 2 C. Most climate analysts agree even burning a large fraction of conventional fossil fuel reserves would produce unacceptable warming, let alone what could be released by UCG.”

In the Biggar Ecomonics Report, commissioned by Cluff Natural Resources, in section 3.2 Drilling it states

> “The drilling of panels will be a continuous operation to supply the oxygen required for the gasification process and to extract the products of this process. Throughout the thirty-year life span of this project, it is anticipated that 108 panels would be drilled. Each panel would have a life span of approximately three to five years before it is decommissioned.”

Cluff Natural Resources stated in 2013, just five of their UCG license areas hold **1.75 billion tons of coal**.

This is the equivalent of 680 miners taking 538 years to mine 1.75 billion tons of coal, based on the UK record of 3.25 million tons of coal mined in a single year at the Daw Mill coal mine – which ironically shut in 2013 because of an underground coal fire.

Former Academic Dr Harry Bradbury, and former CEO of Five Quarter, in an article entitled “FIVE-QUARTER: “WIN-WINNING” SOLUTION FROM COAL on the Natural Gas Europe website states there are **three trillion tons** of coal in the North Sea and he says “getting progressively smarter about how we can access those assets is **a real prize for us.**

The DTI estimates there are a further 300 years worth of UCG coal onshore.

If these values are combined and all this coal was burned underground without capturing any of the CO2 this would result in UCG operations in Britain alone could cause a global mean temperature increase of between 5 and 10 degrees Celsius.

Section 6.2 of the report " Potential Contribution to the Scottish Chemicals Sector" it states

> "CNR has an interest in several UCG licence areas around the UK but has chosen to develop the Kincardine project first. One of the main reasons for this is because the Kincardine site is located very close to Grangemouth, which is a potential end user of syngas."

Section 7 SYNGAS USE – POWER GENERATION states

> Should UCG be widely adopted across the UK it is considered likely that the majority of syngas produced would be used in new build, high efficiency gas turbines for the production of primary electricity. There is a legal presumption that any new build generation capacity built to consume UCG derived syngas would have to include CCS or at least be CCS ready.

Section 7.1 The UK Energy Market states

> The introduction of the 2008 Climate Change Act means that the UK Government is now under a legally binding obligation to reduce the UK‟s greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050

Section 7.3 Kincardine Power Generation states

> “The economic impact of the construction phase would depend on the amount of capital expenditure required to develop a new power station. It is understood that this could amount to around £250 million excluding the cost of any associated CCS infrastructure which would be required to transport CO2 from the UCG production site to the proposed Feeder 10 pipeline which is planned to take CO2 from the central belt of Scotland to the Goldeneye CCS project off Peterhead

Section 7.4 UK Opportunity for Syngas Power Generation”

> “The development of a 300MW power plant in the vicinity of the Kincardine project would represent a small proportion of the opportunity presented if the full UK UCG resources were utilised.”

> “The Kincardine UCG project is based on a site with an estimated coal consumption of 1 million tonnes per annum. This production is expected to be sufficient to produce enough syngas to power a 300MW power plant.”

So the Kincardine UCG trial, the Biggar Economics report states will

> “transport CO2 from the UCG production site to the proposed Feeder 10 pipeline which is planned to take CO2 from the central belt of Scotland to the Goldeneye CCS project off Peterhead”

On the Peterhead CCS Project factsheet it states on November 25 the Westminster government cancelled funding to develop the Goldeneye CCS project of Peterhead.

This means the Kinardine UCG project has no CCS solution, with the Biggar Economics report completely ignoring all costs associated with CCS in the economic case.

In response to the Committee on Climate Change report, published just three days ago, the government response states

> “Moreover, the Government welcomes the CCC‟s primary conclusion that shale gas development at scale – i.e. at production stage - is compatible with carbon budgets if certain conditions, set out as three “tests”, are met,”

The government does not state it is not just fracking that will contribute to CO2 emissions in the UK as it has also issued over 20 UCG licenses with plans to initially burn billions of tons of coal underground across the UK without capturing any of the CO2 as there is no CCS solution and the government have put in place a loophole which allows none of the CO2 to be captured from UCG production if the syngas is used for anything other than power production e.g. chemical feedstock, fertilizer production.

Environmental Consultant, Paul Mobbs, in an email stated in response to the report and the governments‟ response

> “the CCC have completely ducked the issue of fugitive methane emissions.
>
> Yes, they refer to some recent research studies on the issue, but as part of their calculations they're still using the data from "reduced emissions completion" studies in the USA.
>
> Recent peer-reviewed studies on this data has shown that it is flawed because the methane sensor used doesn't work under all test conditions -- and the data from the Allen study, the standard data source used, demonstrates that it was not sensing high methane releases for some of the time.
>
> The problem with the sensor has been known publicly for about 12 months, and within the industry for much longer. In fact the failure of

the measuring equipment goes some was to explaining the difference between "inventory analysis" studies used by the industry, and the recent studies of actual gas concentrations which discovered high methane emissions.

All-in-all then, the report is a move on from the blinkered approach of DECC's 2013 Mackay-Stone report. It does have some interesting conclusions -- such as the fact that current oil and gas regulation standard in Britain can't meet the emissions ceiling necessary to meet the UK's carbon budget.

However, due to its failure to reflect the most recent studies on fugitive emissions form the US, its analysis is deeply flawed. It relies upon data which is know to be significantly in error from actual emissions in order to arrive at its conclusions.

Therefore the CCC's report fails to adequately identify the hazards to the climate from unconventional oil and gas exploitation in Britain.

And that is before we factor in billions of tons of coal burned underground without capturing any of the CO2 at the same time.

Conclusions

The Broad Alliance concludes the evidence of the disastrous damage to the environment by UCG trials around the world prove conclusively UCG should be banned in the UK, based on the long term pilots in Australia, which used the same technologies proposed for the Kincardine pilot which have likely caused the biggest environmental disaster in Queensland‟s history, resulting in an outright ban on all UCG earlier this year.

The Heriot Watt feasibility study stated Kindardine and most of the UCG sites considered in Fife are unsuitable, Kincardine definitely being unsuitable for UCG and even the report commissioned by Cluff Natural Resources, published in November 2015 by Beltree Limited concluding there is insufficient data available for the Kincardine pilot this alone proves the UCG plans for Scotland are not viable.

The report reveals the Kincardine pilot is based on coal reserves starting from just 300m below the surface and as academic experts state it is inevitable the UCG cavity will collapse and the rock above the cavity, up to 60 times the height of the cavity will become more permeable, this could result in the Waters of the Firth Of Forth seeping into the UCG cavity causing an underground explosion, in an area honeycombed with coalmines and with known and unknown fractures meeting methane from surrounding fracking and coal bed methane operations underneath two road bridges and around a chemical plant, Rosyth naval dockyard, which holds decommissioned Nuclear Subs and the biggest methane tanker in Europe in a densely populated area.

And with no CCS solution for any UCG plans for the Kincardine project – when the DTI report stated all UCG plans for the UK must have a CCS solution again this proves UCG should not go ahead, especially as the UCG plans for the UK, with a convenient loophole stating none of the CO2 need be captured if the syngas is not used for power production, this will definitely result in the UK UCG energy strategy breaching climate change targets not only for the UK but for much of the world – and definitely proves the CCC report published this week, which made no mention of the UCG contribution to UK CO2 emissions and climate change targets does not provide the full unconventional gas CO2 emissions and the impact on global climate and UK climate emissions.

The Broad Alliance believes the evidence from Australia and the information provided in this report alone proves conclusively that UCG should be completely banned by the Scottish Government, especially as the Biggar Economics report, commissioned by Cluff Natural Resources, putting the

economic case for UCG completely ignored the colossal cost of CCS and any risks and associated costs to the environment, local people and industries surrounding the proposed Kinardine UCG project and all the other UCG areas licensed in Scotland.

This is just part of the story and as the Broad Alliance reserves the right to submit further evidence as and when it becomes available to ensure the Government investigation to decide if UCG should be allowed to go ahead in Scotland has the fullest information available before making any decision on this matter to ensure the Scottish Government makes the right decisions on behalf of Scottish Communities.

Bibliography

1 New Scientist Journal "Fire in the hole: After fracking comes coal" 13 Feb 2014 by Fred Pearce https://www.newscientist.com/article/mg22129560.400-fire-in-the-hole-after-fracking-comes-coal?full=true#.Uv1tBLSGPFI

2 Presentation "Status of Underground Coal Gasification (UCG) as a Commercial Technology Peter Dryburgh – Wardell Armstrong International" http://globalenergysystemsconference.com/wp-content/uploads/presentations/GES2013_day1_session2_Peter_Dryburgh.pdf

3 Guardian "Queensland bans underground coal gasification over environmental risk" (Associated Press, 2016) https://www.theguardian.com/australia-news/2016/apr/18/queensland-bans-underground-coal-gasification-over-environmental-risk

4 Presentation "Environmental Issues in Underground Coal Gasification (with Hoe Creek example) (Burton, Friedmann, Upadhye) https://fossil.energy.gov/international/Publications/ucg_1106_llnl_burton.pdf

5 Brisbane Times Charges laid over UCG Spill, Dan Nancarrow July 12th 2011 http://www.brisbanetimes.com.au/queensland/charges-laid-over-ucg-spill-20110712-1hbvu.html

6 Queensland Government Website Carbon Energy fined for releasing contaminated water, Minister for Environment and Heritage Protection, The Honourable Andrew Powell 6th Dec 2012 http://statements.qld.gov.au/Statement/2012/12/6/carbon-energy-fined-for-releasing-contaminated-water

7 Queensland Government Archive, Cougar Energy faces environmental charges, Wall 1 Jul 2011 http://web.archive.org/web/20120119220916/http:/www.derm.qld.gov.au/media-room/2011/07/01-cougar-energy-charged.html

8 Queensland Government Website, Cougar Energy fined $75,000 for breaching Environmental Protection Act, Powell, 24 Sep 2013 http://statements.qld.gov.au/Statement/2013/9/24/cougar-energy-fined-75000-for-breaching-environmental-protection-act

9 Proactive Investors Website, Cougar Energy shareholders to decide on name change to Moreton Resources, Bevis Yeo, Aug 19 2013 http://www.proactiveinvestors.com.au/companies/news/46891/cougar-energy-shareholders-to-decide-on-name-change-to-moreton-resources-46891.html

10 Independent Scientific Panel Report On Underground Coal Gasification Pilot Trials, Moran, de Costa, Cuff, June2013 https://www.dnrm.qld.gov.au/__data/assets/pdf_file/0006/291633/isp-final-report-cs-review.pdf

11 Australian Mining website, Linc Energy dumps coal gasification project, Validakis 7 Nov 2013
https://www.australianmining.com.au/news/linc-energy-dumps-coal-gasification-project/

12 ABC News Website, Linc Energy facing criminal charges over alleged environmental harm, Willacy 2014
http://www.abc.net.au/pm/content/2014/s3987161.htm

13 The Morning Bulletin, Environment department forced to return files to Linc, Frost, 20 Mar 2015
http://www.themorningbulletin.com.au/news/department-forced-return-files-to-linc/2580259/

14 ABC News website, Linc Energy allegedly failed to report series of dangerous gas leaks at Chinchilla plant, court documents reveal, Solomons, Willacy 17 Mar 2015
http://www.abc.net.au/news/2015-03-17/linc-energy-accuse-failing-report-series-of-dangerous-leaks/6323850

15 ABC News Website, Queensland's Department of Environment not ruling out underground fire as cause of gases near Chinchilla, Willacy 1 Mar 2015
http://www.abc.net.au/news/2015-03-01/environment-dept-not-ruling-out-underground-fire-chinchilla/6272450

16 Fife Today, Trimble Cluff claims UCG plans for Forth pose „negligible risk"
http://www.fifetoday.co.uk/news/local-headlines/cluff-claims-ucg-plans-for-forth-pose-negligible-risk-1-3702657

17 UCG Engineering website Underground Coal Gasification Current Developments (1990 to date) - Spanish trial completed successfully
http://ucgengineering.com/currentdevelopments2.html

18 DECC website UNDERGROUND COAL GASIFICATION IN THE UK page - UCG Spanish trial
http://webarchive.nationalarchives.gov.uk/20140721140515/http://coal.decc.gov.uk/en/coal/cms/publications/mining/gasification/gasification.aspx

19 European UCG Case Study Green 2011 -
http://repository.icse.utah.edu/dspace/bitstream/123456789/11029/1/European%20UCG%20Case%20Study%20MBGreen2011.pdf

20 The Morning Bulletin Environment department forced to return files to Linc, Frost, 20th Mar 2015
http://www.themorningbulletin.com.au/news/department-forced-return-files-to-linc/2580259/

21 The Journal, North East energy firm Five-Quarter hits out at 'alarmist' petition against its activities, McCusker, 11 Mar 2015
http://www.thejournal.co.uk/business/north-east-energy-firm-five-quarter-

8810542

22 ABC News website, Linc Energy allegedly failed to report series of dangerous gas leaks at Chinchilla plant, court documents reveal, Solomons, Willacy, 17 Mar 2015
http://www.abc.net.au/news/2015-03-17/linc-energy-accuse-failing-report-series-of-dangerous-leaks/6323850

23 Australian **Mining website, Linc Energy workers gas exposure confirmed, Hagemann 17 Mar 2015**
https://www.australianmining.com.au/news/linc-energy-workers-gas-exposure-confirmed/

24 The Journal headlined "New coal industry in North East will create hundreds of jobs and create greener energy 3 Sep 2014
http://www.thejournal.co.uk/business/business-news/new-coal-industry-north-east-7708191

25 Queensland Government website, EPA 2015 Hopeland area testing Update https://www.ehp.qld.gov.au/management/hopeland.html

26 ABC News website, Linc Energy: Secret report reveals toxic legacy of coal gasification trials near SE Queensland town of Chinchilla , Solomons, Willacy, 10 Aug 2015
http://www.abc.net.au/news/2015-08-10/linc-energy-secret-report-reveals-toxic-chemical-risk/6681740

27 Brisbane Times 10th August 2015 Government inspectors hospitalised after gasfield visit
http://www.brisbanetimes.com.au/queensland/government-inspectors-hospitalised-after-gasfield-visit-20150810-giw0hy.html

28 Guardian website Q&A: George Bender's daughter accuses politicians of neglecting farmers, Robertson, 26 Oct 2015
https://www.theguardian.com/australia-news/2015/oct/27/qa-george-benders-daughter-accuses-politicians-of-neglecting-farmers

29 Queensland Government : Underground coal gasification banned in Queensland, Lynham, Miles, 18 Apr 2016
http://statements.qld.gov.au/Statement/2016/4/18/underground-coal-gasification-banned-in-queensland

30 Ilawarra Mercury Farmers set to sue Linc Energy, Qld Government over UCG contamination (Phelps 20 April 2016)
http://www.illawarramercury.com.au/story/3859501/farmers-set-to-sue-qld-gov/?cs=2452

31 The Australian website, Weekend Australian Magazine http://www.theaustralian.com.au/life/weekend-australian-magazine/linc-energys-ucg-plant-at-chinchilla-a-smart-state-disaster/news-story/89096454ced60874c5d8e2e967fb9c1c

32 Sepa responded on 28th September 2015 to FOI85781 https://www.whatdotheyknow.com/request/285798/response/712764/attach/2/F0185781%20Review%20Response%20EIR%20final.pdf

33 The Ferret website, Mining for coal gas could cause blasts, fires and quakes, says Sepa. Edwards, 2015 https://theferret.scot/new-coal-gas-could-cause-polution-says-watchdog/

34 DECC Minutes of the third meeting of the Underground Coal Gasification (UCG) Working Group held on Friday 17th October at 10:00am in Room L.G.01, 3 Whitehall Place (Oct 2014) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/402569/FOI_2015-00868_Minutes_of_the_Third_Meeting_of_the_Underground_Coal_Gasification.pdf

35 The "UNDERGROUND COAL GASIFICATION ("UCG") POLICY STATEMENT FOR LICENSING BY THE COAL AUTHORITY (UK Government December 2009) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/361590/Underground_Coal_Gasification_Policy_-_model_document.pdf

36 DTI Report "Review of the Feasibility Of Underground Coal Gasification In the UK" DTI, September 2004 http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file19143.pdf

37 Heriot-Watt University report CREATING THE COALMINE OF THE 21ST CENTURY COAL MINE, The feasibility of UCG under the Firth of Forth, PROJECT SUMMARY 382, March 2006 http://webarchive.nationalarchives.gov.uk/20090609003228/http:/www.berr.gov.uk/files/file30689.pdf

38 Beltree Report Kincardine UCG Potential (November 2014) http://www.cluffnaturalresources.com/wp-content/uploads/2016/01/Kincardine-Coal-Resource-Report.pdf

39 Underground coal gasification with CCS: a pathway to decarbonising industry (Younger, Roddy, 2010) http://www.rsc.org/delivery/_ArticleLinking/DisplayHTMLArticleforfree.cfm?JournalCode=EE&Year=2010&ManuscriptID=b921197g&Iss=Advance_Article

40 Energy Voice "Cluff insists Scottish UCG plans not dead in water" Mark Lammey - 08/01/2016

https://www.energyvoice.com/otherenergy/97863/cluff-insists-scottish-ucg-plans-not-dead-in-water/

41 BBC website Fifty years of fire in the abandoned US town of Centralia, 8 Aug 2012
http://www.bbc.co.uk/news/world-us-canada-19169021

Q&A: George Bender's daughter accuses politicians of neglecting farmers 26 Oct 2015 https://www.theguardian.com/australia-news/2015/oct/27/qa-george-benders-daughter-accuses-politicians-of-neglecting-farmers

Sepa response to Freedom of Information Request regarding UCG plans for Scotland -
https://www.whatdotheyknow.com/request/285798/response/696345/attach/html/2/F0185741%20EIR%20Response.pdf.html

EPA Impact of Greenhouse Gas Emissions
https://www3.epa.gov/climatechange/science/future.html

The Bulletin of Atomic Scientists Is underground coal gasification a sensible option? (House 2010) http://thebulletin.org/underground-coal-gasification-sensible-option

Five Quarter Winning Solution from Coal
http://www.naturalgaseurope.com/unconventional-gas-aberdeen-2014-five-quarter-harry-bradbury

Peterhead CCS Factsheet
https://sequestration.mit.edu/tools/projects/peterhead.html

I-7 Cluff Natural Resources

In advance of interview, Andrew Nunn provided the following (brackets() are CG edits used to enhance comprehension):

Meeting with Andrew Nunn, Chief Operating Officer, Cluff Natural Resources Plc

Scottish Government Underground Coal Gasification Study

Thank you for agreeing to meet with me on Thursday, 30th June at 1.30. From previous interviews, I estimate that this will take around 90 minutes, subject to the time you have available.

The main topics which I would like to cover include:

- **Your opinion, overall view and any concerns of UCG.**

  - *Deep UCG has been demonstrated at pilot scale to be a potentially viable method for producing SYNGAS from coals for electricity or petro-chemical feedstocks with environmental impacts which can be significantly lower than conventional coal mining and approaching the footprint of conventional natural gas production.*

  - *The UK is particularly attractive for UCG as much of the suitable coal is at significant depth and located offshore – allowing potential offshore developments in the longer term.*

  - *Demonstration of scale up to commercially attractive production rates has not been achieved in recent times (regulatory, technological, fiscal and energy price regime have all moved on since Angren and other large scale Soviet UCG projects which were operational in the 1950/60's) and is a key risk to any future development.*

  - *Public and Government/Regulator knowledge of UCG is extremely limited and not helped by stated positions on absolutes with respect to risk – ie **"Unless it can be proven beyond doubt that there is no risk to health, communities or the environment, there will be no fracking or UCG extraction in Scotland".** We view this as a an ill judged approach to policy making and suggest it would preclude everything from farming to petrol stations if applied consistently across the board.*

  - *In the end UCG is a tool – when applied properly in the correct geological setting the achieved results are entirely acceptable and the overall risk profile is not significantly different to conventional oil and gas production (ie see Carbon Energy / Alberta Synfuels / Solid Energy). Where geological understanding is limited or corners are cut on engineering or operational oversight then UCG has the potential to*

produce undesirable outcomes (ie alleged incidents around Linc Energy and some early US R&D trials)

- **The conditions under which you consider UCG could be viable and operated successfully**

  - *The DECC/DTi studies clearly set-out the conditions under which UCG should be conducted in the UK – this includes some specifics around depth of operations and interaction with historical mine workings. The DTi/DECC reports also set out a comprehensive risk assessment methodology for UCG projects.*

    - *A copy of all reports produced by the decade long DTi/DECC study into UCG are included on the provided USB stick.*

  - *Recent examples in Australia would not have progressed if similar criteria were applied (all shallower than the recommended 600m depth restriction) and many UCG trial projects with less conservative parameters than those proposed for the UK have proceeded with limited or non-measurable impacts.*

  - *It is likely that any commercial scale UCG project will require CCS to meet certain climate change objectives. The carbon capture part is not considered to be a significant technical challenge however any future UCG industry may be reliant on access to 3rd party CO_2 storage facilities, or CO_2 based EOR projects, such as those currently being proposed in the North Sea. However given the long lead times for developing a UCG project it is likely that the development of suitable storage facilities would need to occur in parallel with the UCG projects.*

Your views on:

Global/(climate) context

- *UCG is a coal based fossil fuel and produces CO_2 at both the point of production and potentially at the point of consumption, with an unabated footprint somewhere between natural gas and coal when used for generating electricity.*

- *However it is recognised that UCG derived SYNGAS is particularly suitable for pre-combustion CO_2 separation, using commercially available scrubbing technologies, due to high CO_2 concentrations and operational temperatures and pressures at the point of production.*

- *A recent DECC report concluded that when SYNGAS produced by UCG was used for electricity generation in a gas turbine fitted with post-combustion CCS technology then the overall footprint could be close to half of that achievable with abated natural gas. A draft copy of this report is included on the provided USB stick.*

- *A key enabler supporting an emerging UCG industry is the development of viable CO_2 storage facilities in the UK which seems more distant following withdrawal of the CCS competition by the Westminster Government – although certain projects such as Summit Power's surface coal gasifier fitted with CCS is receiving significant financial support from the Scottish Government and the Teesside Industrial CCS project still seems to be progressing.*

The energy policy context

- *While UCG could play a significant role in electricity generation, assessing it entirely within the context of energy policy is short sighted and doesn't take into account the potential of UCG to provide feedstocks for the petrochemicals sector, clean burning liquid fuels, fertilizers for agriculture or to become a significant source of hydrogen for fuel cells etc.*

- *While it is recognised that renewables have an important and increasing role to play in the energy mix, the need for renewable generation to be supported by fossil fuels, preferably gas, for balancing fluctuations in supply and demand have not been adequately communicated or conveniently ignored in the debate over our energy future.*

- *A UK based UCG industry has the potential to provide both surety of supply and further diversifies the UK's energy mix which would aid in wider issues around security of supply.*

- *Along the same lines, our increasing reliance on imported gas to heat our homes, cook our food and support Scottish industry is also overlooked and there is little written about how much extra renewable capacity would be required to completely replace gas as the primary energy source for domestic and industrial heating.*

- *UCG has the potential to provide a locally produced feedstock or industrial fuel gas for Scottish businesses local to our proposed UCG projects – this would displace grid quality natural gas produced from the North Sea and freeing it up for domestic heating and cooking.*

The geological context – specifically Kincardine licence area

- *The Kincardine area is particularly suitable for early stage R&D and modest scale commercial UCG production for a number of reasons:*

    - *Geology is well understood by comparison to many other areas – history of coal exploration & mining + oil and gas exploration provides significant datasets including drilling, geotechnical, geochemical, groundwater and seismic data.*

- *Coal quality is appropriate for UCG, coals are relatively thin and generally separated from each other and the surface by a very low permeability sequence.*

- *Coal located offshore can be accessed from drilling locations onshore.*

- *Groundwaters within, and overlying, the coal bearing strata levels are highly saline and naturally contaminated with a range of organic and inorganic contaminants due to long residences times in contact with coal bearing strata:*

    - *Both the above low permeability formations and water quality issues mean(s) any potential impact on deep groundwater is (not) likely to be insignificant. () CG edits*

- *Historical mining and associated degradation of near surface water quality restricts potential abstraction of near-surface waters for agricultural or potable use.*

- *Composite/Dart Energy has already locally demonstrated the ability to steer long horizontals in coal seams at depths of around 1,000m – this is a key factor in the construction of commercial sized UCG panels.*

- *If any potential residual subsidence associated with the gasification panel is realised (models suggest 10-25mm in an extreme worst case) it will be restricted to offshore and not impact on established infrastructure.*

- *Access to major brownfield sites adjacent to the coast including Longannet & Grangemouth which have established HGV infrastructure, industrial baselines for noise and light impacts and extensive monitoring baselines for groundwater and air quality.*

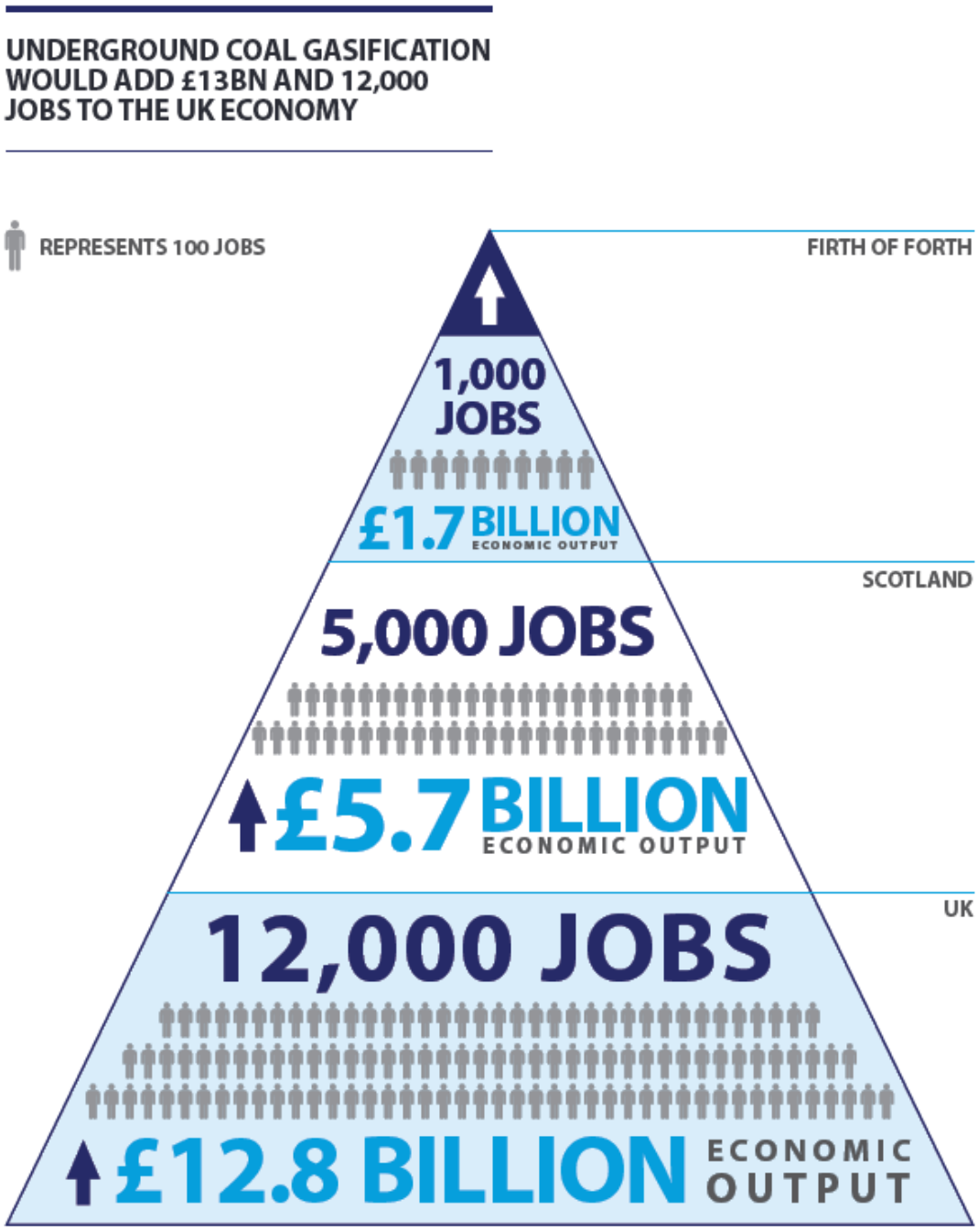
- *Ready-made customer base for SYNGAS products*

- *Potential access to proposed future CCS infrastructure – Feeder 10 pipeline and Goldeneye/Captain CCS projects*

Economic/employment context

- *Cluff commissioned a report from respected Scottish based Biggar Economics outlining the potential economic and employment impacts of Scotland achieving first mover status for a UK based UCG industry including the potential for exporting skills & knowledge to support a global UCG industry – summarised below:*

    - *A copy of this report is included on the provided USB stick.*



Community context

- *While community concerns about new projects are perfectly understandable, it is our view that the general public have been poorly served by Scottish Government communications around its energy policy and significantly misle(a)d by anti-fracking /anti-UCG campaigners over both the very real requirements for fossil fuels to support the expected quality of life (ie surety of energy supply and access to hydrocarbon based products) and the potential risks / benefits and impacts which are likely to be associated with properly designed, operated and regulated UCG project.*

Environment and h&s (general & regulatory) context

- *The current goal setting regulatory system with respect to most HS&E issues is inherently suitable for regulating UCG projects – what appears to be lacking is a suitably qualified and experienced technical resource within the various regulators available to assess and monitor innovative projects leading to an overly conservative, rather than pragmatic, approach.*

- *The Health and Safety Executive has taken a pro-active approach to date and has updated its guidance around borehole construction and other issues to ensure UCG is captured.*

Planning system/process context

- *The current local authority led planning system is not fit for purpose when it comes to determining projects of potentially national significance, especially those deemed 'controversial'*

- *Insufficient technical ability at the local authority level to assess potential impacts, risks and benefits of complex and/or innovative projects which fall outwith the usual traffic / visual / noise / dust aspects*

- *Lack of clarity over primacy in terms of regulatory roles – ie should SEPA (who should have greater technical ability and resources) have the final say on issues relating to groundwater through the existing permitting system rather than it being part of the local authority planning system?*

- *Political interference in the planning system is deterring potential investment into energy projects.*

Technological/Operational context/capabilities to exploit the resource?

- *The vast majority of both the technology and the skills required to operate a UCG project exist within the UK and especially Scotland:*

    - *Drilling is a standard onshore oil and gas operation – existing support and supply chain within the UK and Aberdeen in particular*

    - *Casing design and metallurgy, cement, coil tubing operations and instrumentation from offshore HPHT, sour gas and high temperature geothermal projects are all directly applicable to UCG*

    - *Surface infrastructure required to clean-up and process the gas and any produced water at the surface is again similar to many processes already operated within the Grangemouth facility.*

- *All appropriate required skills to develop and operate a UCG project are available within the UK and particularly Scotland. The experience resides within our globally recognised oil and gas industry and within our*

petrochemical sector and their associated supply chains and consultancy support networks.

Other aspects of significance?

Given the above (context), what for you is the most compelling aspect determining the way forward…and why?

- *Producing energy locally, whether by UCG or other forms, and taking responsibility for our own consumption rather than displacing our environmental liabilities to geographies where we have no control over HSE, employment or human rights standards at the point of production has to be an inherently better option than continued over-reliance on imports.*

- *The Kincardine project is the ultimate expression of localism where SYNGAS (could be) produced and consumed locally by a highly skilled local workforce and could prove to be a sustainable model for a circular industrial economy which could be rolled out to other UK industrial hubs such as Teesside and Port Talbot.*

What conclusions do you draw about UCG?

- *UCG could be a potentially significant UK based supplier of clean fuel gas for electricity supply and industrial heat or as a valuable feedstock (to) support a significant UK based petrochemical industry.*

- *Scotland was ideally placed to become a leader in the UCG industry, drawing on extensive local highly skilled workforce, cutting edge engineering and technology and established supply chain which currently supports the offshore oil and gas sector and the local petrochemicals industry.*

- *Public, political and regulator perception are key risks which need to be addressed prior to the establishment of a UCG industry and until these issues are resolved and developed into a coherent supportive policy regime the required financial support from the investment community will not be realised.*

What would you recommend that Government do?

- *Establishing a UCG project is a capital intensive process and without clear supportive policy from government that investment will not be made available.*

- *This supportive policy should be grounded on sound scientific evidence (which is already available from previous DTi/DECC studies which are included on the provided USB stick), covering both the requirements for the project in a national context and a clear assessment of the potential and perceived risks and how they are controlled through the existing*

regulatory regime, which can then be widely communicated to the various stakeholder groups – unfortunately the current Scottish Government has a poor reputation within the investment sector for producing sound evidence based policy given it has ignored its own expert panel on Shale Gas and a global scientific consensus on GM Crops.

- *The path to a commercial UCG project is a series of steps including a small scale demonstrator project, similar to that being proposed by CLNR, and commercial projects are scaled up over a number of years. However no company is going to invest in a demonstrator if there is not a clear commitment to support a commercial project should all the pre-agreed KPI's be met at each stage of the process.*

- *Therefore it is our view that the Scottish Government should:*

    1) *Abandon the completely inappropriate and unworkable 'proven beyond doubt' stance and take a more pragmatic and realistic risk based approach to new projects including UCG.*

    2) *Set out a clearly defined scope and timetable for the studies to be completed under the UCG moratorium along with a firm commitment to lift the moratorium when the studies indicate a risk profile in-line with other accepted land based industrial processes such as petrochemicals and oil and gas production.*

    3) *In conjunction with industry, agree a staged UCG development process with various KPI's at each decision gate along with a commitment that a policy supportive of UCG development will be maintained as long as the KPI's are achieved.*

    4) *The Scottish Government should take responsibility for approval of nationally significant infrastructure projects at Scottish Government level to ensure a cohesive approach to energy and industrial policy delivery.*

An approach similar to that taken in South Australia when producing their Roadmap for Unconventional Gas Projects (included on the memory stick provided) and building on the existing research into UCG would be warmly welcomed by industry, investors and go a long way to ensuring that other stakeholder groups are better informed on many aspects of the industry, it's potential contribution to society and the legislative and regulatory regime.

Campbell Gemmell
27 June 2016
Canopus Scotland

Andrew Nunn
28 June 2016
COO – Cluff Natural Resources

Andrew Nunn also provided a number of useful documents:

1. The Australian UCG pilot experience: A review of Carbon Energy‟s UCG Pilot facility at Bloodwood Creek, Queensland, Australia. Cliff Mallett and Anne Ernst, 26th Nov 2014

2. Cluff Natural Resources Deep Offshore Coal Gasification presentation Stockton November 2015

3. Draft Environmental Impact Report for the Proposed Underground Coal Gasification Pilot Project, Secunda, Mpumalanga Province. For public review. A project of SASOL Synfuels and SASOL Mining, February 2009, by Bohlweki SSI Environmental

4. Application for Rectification i.t.o. Section 24G of the National Environmental Management Act of 1998 (as amended) for the Unlawful Commencement of Listed Activities for Underground Coal Gasification: Pilot Plant Phase 1, near Amersfoort, Mpumalanga. Draft
   Eskom Holdings SOC Ltd, DEA ref 14/12/16/3/3/1/54 October 2013

5. Environmental Scoping Report for the Underground Coal Gasification Project and Associated Infrastructure in support of co-firing of gas at the Majuba Power Station, Amersfoort, Mpumalanga. Draft
   Eskom Holdings SOC Ltd, DEA Ref 14/12/16/3/3/3/61 DMR Ref: MP 30/5/1/1/2/10031 MR, October 2012

6. AFRICAN CARBON ENERGY (PTY) LIMITED
   Air Quality Specialist Assessment for Underground Coal Gasification and Gas-Fired Power Generation Project. REPORT
   Report Number: 13615077-12437-6, Submitted to: Etienne Roux, Golder Associates Africa (Pty) Ltd, January 2014

7. Environmental Management Programme February 2014 AFRICARY (PTY) LTD, UCG DRAFT EIA REPORT APPENDIX J
   Environmental Management Programme for Underground Coal Gasification and Power Generation Project near Theunissen. REPORT
   Report Number: 13615077 -12329 -5., February 2014

8. AFRICARY HOLDINGS (PTY) LTD
   Underground Coal Gasification and Power Generation Project Near Theunissen, Free State Province.
   Africary and Golder Associates, July 2013

9. AFRICAN CARBON ENERGY (PTY) LTD
   Final Scoping Report: Underground Coal Gasification and Power Generation Project near Theunissen.
   Due date for public comment: 26 September 2013

10. Need and Economics of UCG in Alaska.
    Estimated economics of the CIRI Underground Coal Gasification

Facility, Beluga Alaska, January 29, 2010, Jeremy Fisher, PhD, Synapse Energy Economics.

11. Viability of Underground Coal Gasification in the "Deep Coals" of the Powder River Basin, Wyoming.
Prepared for the Wyoming Business Council Business and Industry Division, State Energy Office, GasTech, Inc., Casper, Wyoming, June 2007

12. Groundwater Pollution from Underground Coal Gasification, Lui Shu-qin, Li Jing-gang, Mei Mei, Dong Dong-lin. School of Chemistry and Environmental Engineering, China University of Mining & Technology, Beijing 100083, China, 2007.

I-8 Health and Safety Executive (HSE)

Onshore/unconventional guidance from HSE in conjunction, for England, with EA‟s environmental regulatory role is set out in (HSE 2012): http://www.hse.gov.uk/aboutus/howwework/framework/aa/hse-ea-oil-gas-nov12.pdf

I-9 UK Onshore Oil and Gas
Ken Cronin

The following information was provided after the interview.

The Industry‟s community benefit scheme is enshrined in UKOOG‟s community engagement charter, which can be found at: http://www.ukoog.org.uk/images/ukoog/pdfs/communityengagementcharterversion6.pdf

An explanation of how the pilot schemes work is given in the UK Government consultation on the shale wealth fund paras 3.4 to 3.8. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/544241/shale_wealth_fund_final_pdf-a.pdf

Annex 2C
Other contributors

State environment staff in Queensland, NSW, Victoria and South Australia. I am especially grateful to Mark Gifford, Chief Environmental Regulator for the NSW EPA for his various inputs and initial lessons learned/community outrage webinar produced in 2015.

Legal representatives in Australia, including prosecutor Professor Christine Trenorden and other environmental lawyers in Adelaide, Melbourne, Newcastle, Brisbane and the Environment Agency of England.

Staff at the Newcastle Institute for Energy and Resources, Newcastle, NSW and CRC CARE colleagues there.

Charles Godfray, University of Oxford.

Profs. Paul Younger and Susan Waldron, University of Glasgow.

Prof. Sir Jim McDonald and Prof. Mark Poustie, University of Strathclyde.

Dr. Miroslav Angelov, EU Commission, DG Env.

Dr. Andrea Strachinescu, DG Energy.

Dr. Andrzej Jagusiewicz, former Chief Inspector of Polish State Inspectorate of Pollution.

Prof. Piotr Czaja, AGH University, Krakow.

Chair of the SEA, Colin McNaught.

Prof. Louise Heathwaite, SG CSA.

I also spoke informally with and received inputs from members of a number of community groups from Leith, Musselburgh, Airth and Stirling.