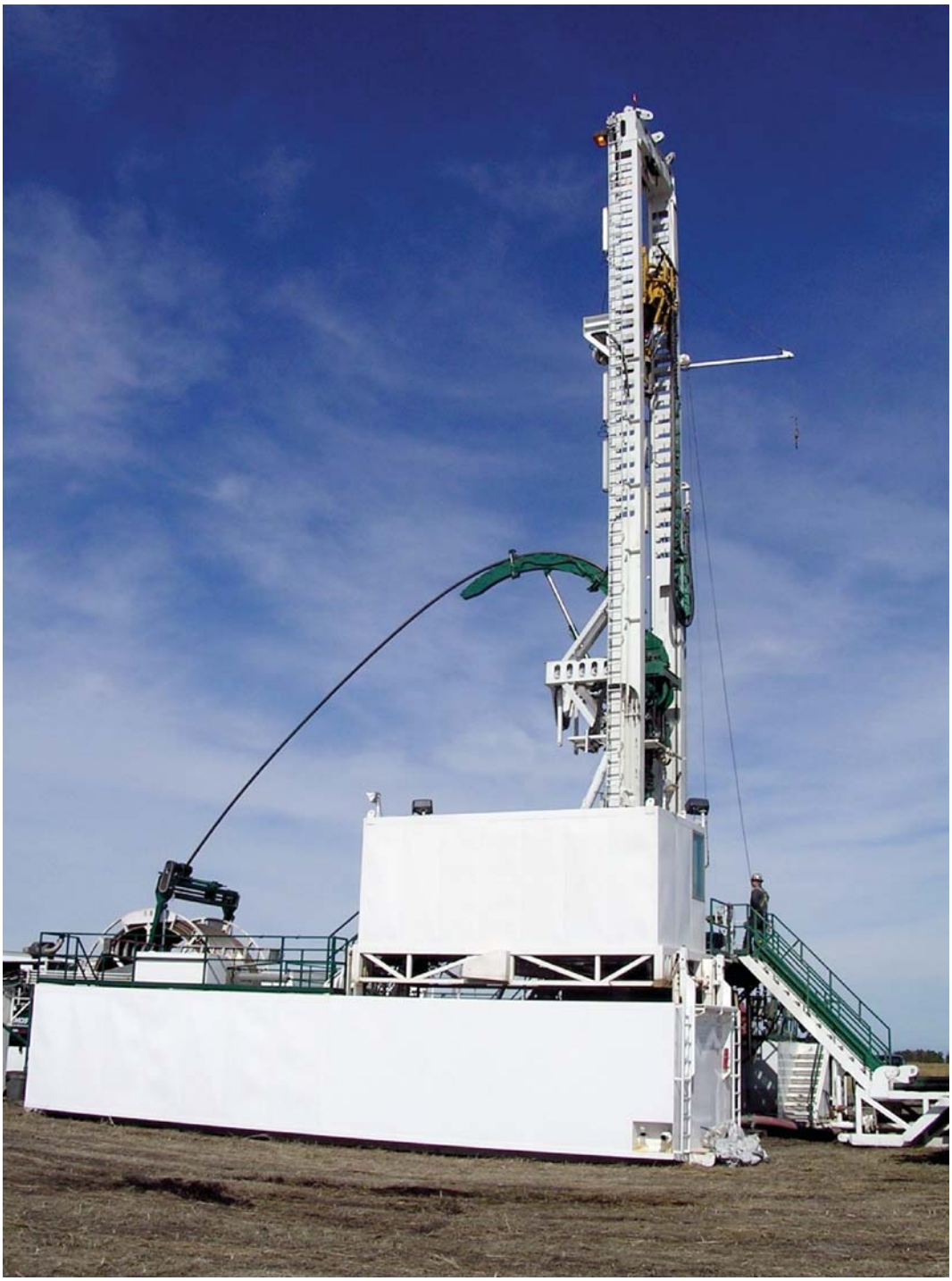
Coal Bed Methane Extraction in South Wales
Technical Briefing Note
Centrica Energy



Contents

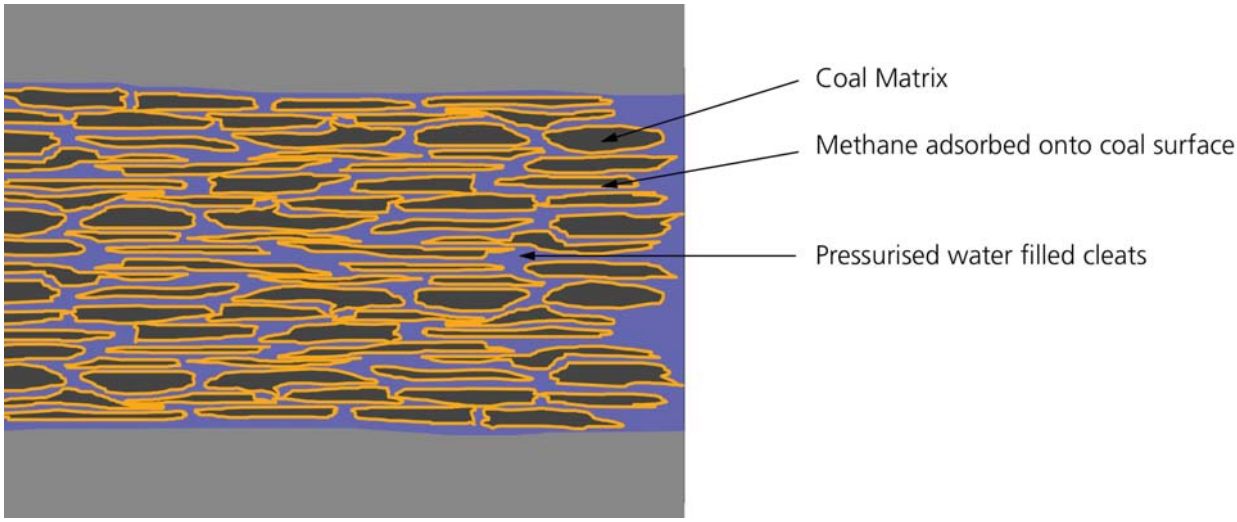
1. What is Coal Bed Methane?

The most common hydrocarbons are natural gas, oil and coal. Coal Bed Methane (CBM) is a source of natural gas. CBM is the primary source of natural gas in the North Sea.

Natural gas can be classed as conventional and unconventional gas. CBM is an unconventional gas because of how and where it is present underground. It is also known as Coal Seam Methane.

The extraction of methane gas from deep, unworked coal seams is well established in Australia, Canada and USA.

As CBM is a finite resource and commercial production is anticipated to be possible for approximately 25 years, none of the facilities associated with CBM extraction will be permanent and eventually all surface operations will be restored to the original land use.



Within coal seams, methane is present on the surface of the coal. The pressure of the surrounding water and rock holds the methane in place, adhering the gas to the coal surface (adsorption). It exists as free gas within the rock structure. This is not a pressurised reservoir environment as such.

When pressure is released, the methane desorbs off the coal surfaces and flows through a system of natural fractures (cleats) within the coal seam. By controlling the release of pressure in the coal seams, it is possible to capture the methane.

Once it is captured and brought to the surface, it is collected and treated. It can then be used in a variety of applications:

- supplied as a gas to a local network via low pressure pipeline;
- utilised for electricity generation;
- used by local high energy users;
- supplying gas or electricity to industry; or
- an injection of gas into high pressure national distribution pipelines.

UK Government figures indicate that the best Virgin Coal Bed Methane (VCBM) prospects lie in coal seams thicker than 0.4m at depths between 200m and 1,200m. Currently, low permeability and high drilling costs make deeper targets unattractive.

Extent of inland UK coalfields

CBM offers a method of extracting methane from the coal seams without detrimentally affecting the physical properties of the coal. This provides many benefits:

- It facilitates extraction of gas from deep coal seams in areas where it is unlikely to be worked by traditional mining methods;

- As the coal remains in the ground there is no surface subsidence;

The CBM process is beneficial if undertaken in advance of coal extraction should it ever be technically and economically viable to mine the coal at these target depths in the future.

In fact, extracting methane in advance of working the coal is worthwhile because it provides essential information about the coal resource, dewaters and degasses the coal seam, improving its potential for extraction.

Despite its name, the processes involved in the exploitation of CBM are not related to those of traditional minerals. In policy terms, it should be considered an energy resource. This relationship with energy and not minerals needs to guide any new policy framework in a development plan.

This is essential to differentiate CBM's relatively benign operational impacts at the surface from the disturbance and disruption normally associated with surface mineral extraction. CBM gas is a non-renewable energy resource, and should be considered a "Clean Coal Technology".

CBM can be utilised for electricity generation, use of gas by local high energy users, direct supply as a gas to a distribution network via low pressure pipeline, supplying gas or electricity to industry and injection of gas into high pressure national distribution pipelines.

2. CBM Extraction Strategy in the UK

CBM is important to the UK because it is a long-term source of indigenous natural gas. This untapped energy resource can provide an additional secure and diverse energy supply - an energy resource that would go untouched without CBM extraction activities.

It is estimated that the extraction of CBM could supply 10% of the UK's annual gas consumption, based on current requirements, for the next 20 years. Its potential as a source of clean energy is therefore significant.

The extraction of CBM is carried out under license from the UK Government. To date, thirteen licensing rounds have awarded licences for the extraction of hydrocarbons, including oil and gas.

The first CBM well in the UK was drilled in 1992 and there have been several drilling schemes across the country since. Around £65m has been invested in CBM exploration and appraisal to date.

There are no large scale operational developments as yet. However in the last three years, 17 core wells and 9 pilot production wells have been drilled in the UK.

In a handful of areas across the UK, operators appear close to achieving commercial-scale extraction.

Composite Energy is close to reaching commercial extraction at its Airth Development Area in Scotland.

Nine CBM companies formed the UK CBM Association in 2007 as a knowledge sharing forum, and to recognise the different focus which CBM has in comparison to UK oil and gas. Centrica Energy is one of the founding members.

Other members include

- Composite Energy,
- Reach Coal Seam Gas Ltd,
- Marathon,
- Greenpark Energy,
- UK Onshore Gas Group,
- Nexen Gas,
- Island Gas and
- Coastal Oil & Gas.

The nine companies represented have the bulk of the prospective acreage, and the main intention of the Association is as a knowledge sharing forum.

3. PEDLs in South Wales

The CBM within South Wales is substantial and is therefore an important energy resource for Wales and the UK, with some estimates suggesting that CBM could meet 10% of the UK's gas production by 2020.

Petroleum Exploration & Drilling Licences (PEDLs) are awarded by the Department of Environment and Climate Change (DECC).

In total, there are 14 PEDLs covering the South Wales coalfields which have been awarded to four companies:

- Centrica Energy;
- Composite Energy;
- UK Methane Ltd; and
- Coastal Oil and Gas.

These PEDLs primarily extend over seven Local Authority areas:

- Swansea;
- Neath & Port Talbot;
- Bridgend;
- Rhondda Cynon Taf;
- Merthyr Tydfil;
- Caerphilly; and
- Vale of Glamorgan.

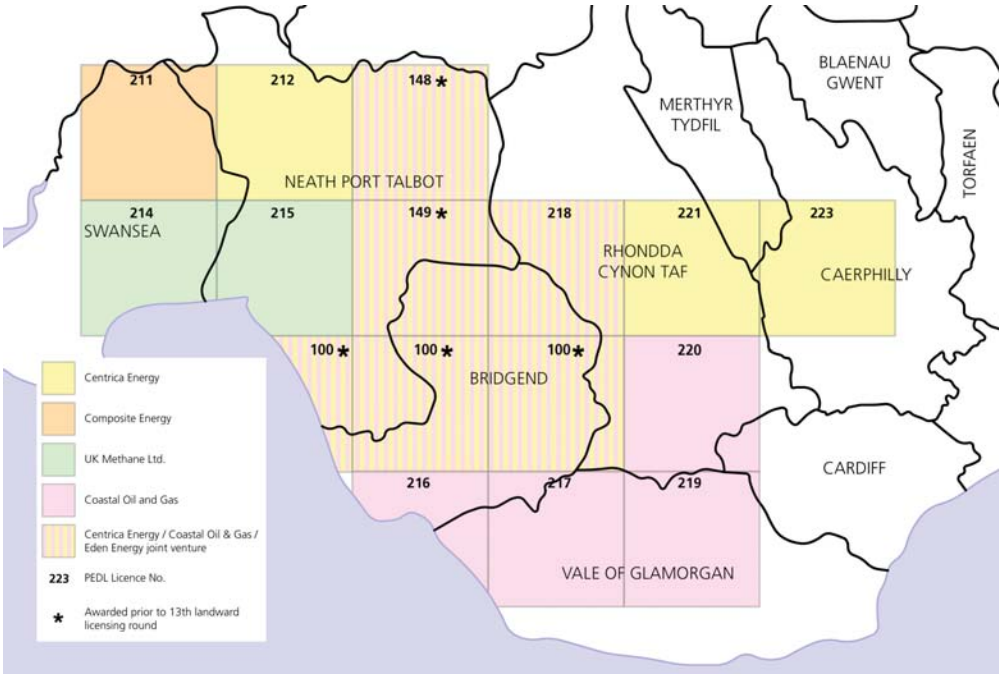
Centrica Energy were awarded their three PEDLs as part of the 13th Onshore Oil & Gas Licencing round.

These PEDLs (212, 221 and 223) are located over coals contained in the County Boroughs of Caerphilly, Merthyr Tydfil, Rhondda Cynon Taf and Neath Port Talbot and cover an area of 276km^2.

Centrica Energy has estimated the potential resource within two of these three PEDL areas. Between PEDLs 221 and 223, the Company estimates that there are approximately 760 10^6 tonnes of coal with an average gas contact of $10m^3$ per tonne. With a potential recovery factor of 25%, these two PEDLs have a potential resource of 62 billion cubic feet (bcf).

The potential resource over the three PEDLs is estimated at over 100 bcf. The life expectancy of this gas is restricted to a period of 20 to 25 years depending on the rates at which commercially viable extraction is possible.

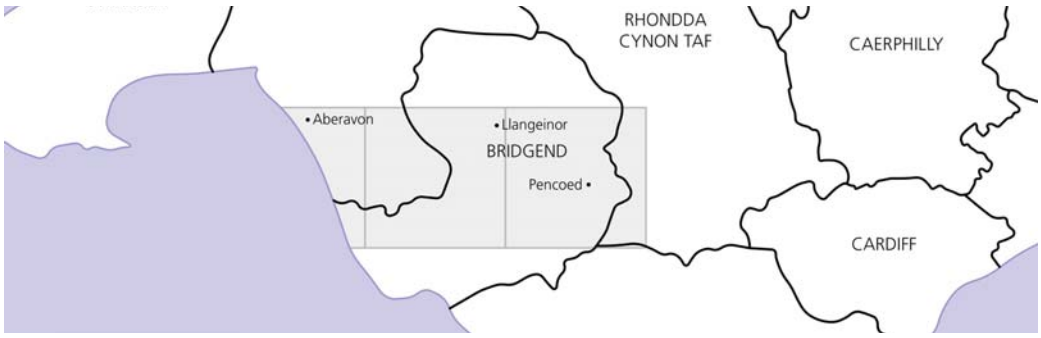
As well as the PEDLs awarded as part of the licensing rounds, Centrica Energy have recently entered into a joint venture with Coastal Oil and Gas, and now have an interest in an additional four PEDLs.
In order to exploit the full potential of CBM, it is essential for the Authorities to work in concert to facilitate



the inter connectivity of the extraction and distribution process.

The extraction and subsequent use of this gas has potentially significant economic benefits for the region if exploited on a co-ordinated basis.

Coastal Oil & Gas, run by Welsh businessman and ex-miner Gerwyn Williams is involved in a number of PEDL licences in South Wales, and some of these licences were awarded 16 years ago. Within PEDL 100, test drilling has taken place in 3 fields (Aberavon, Llangeinor, Pencoed), revealing substantial quantities of high-quality CBM.



4. Centrica Energy's Experience of CBM Extraction

CBM is well developed in North America, including at Centrica's North American subsidiary Direct Energy. Direct Energy has expertise in drilling over 160 coal bed methane wells since 2000. Direct Energy is North America's largest competitive energy solutions provider, serving residential and business customers in Canada and the US.

In Canada, there are three established CBM development areas within the province of Alberta:

- Bittern Lake,
- Corbett Creek and
- Horseshoe Canyon.

CBM is extracted in a gradual process from appraisal to full production in these development areas. Wells are drilled initially to establish commercial resources in the deep coal seams and then additional wells are drilled roughly 1km apart to increase the potential to achieve commercial production. Eventually, clusters of 8 or 9 wells are established to create a commercial development area with each wellhead linked to a central gathering station.

At this central gathering station, Centrica Either compresses the gas and introduces into the existing gas grid, or the gas can be used to generate electricity.

As a CBM cluster becomes exhausted, new appraisal wells are drilled by Centrica and once commercial feasibility is proven, the process is repeated and another cluster is created to exploit the CBM deep beneath the ground.

Direct Energy creates significant economic benefits in these development areas. The cost of well drilling is significant and estimated at around £700,000 per well.

Around a third of this cost can be spent in the local economy - local suppliers and local employment.

Direct Energy's environmental performance in Alberta is excellent. CBM is relatively benign in environmental terms. Direct Energy operates in internationally sensitive areas - without mishap. In these areas, it uses nitrogen fraccing as its preferred method to extract CBM.

CBM production is monitored informally by the Fort Assiniboine and Area Multi-stakeholder Alliance (FAAMA) which is a community based, non-profit association in Alberta. The FAAMA's primary goals are to allow the public to communicate effectively with the CBM industry, and to ensure that development is conducted in a responsible manner.

5. Centrica Energy's Commitment to CBM Extraction in South Wales

Centrica Energy's financial commitment in South Wales in its three PEDLs from the initial assessment phase, through to developing a pilot project will be in the region of £26m. This will be spent over a 10 year period.

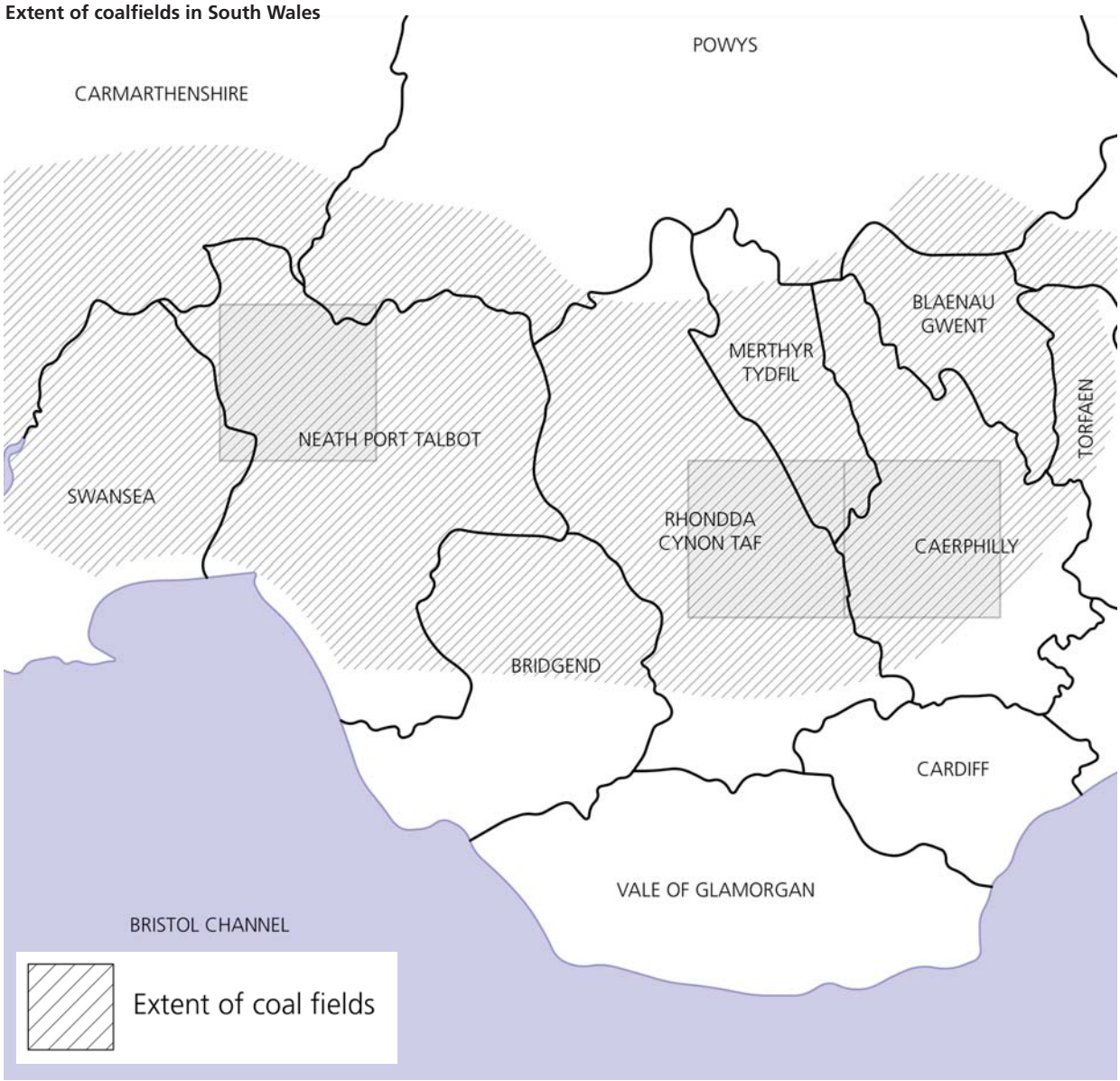
Centrica Energy has committed to drilling 2 appraisal wells within each licence area to approximately 800 metres below surface.

The Farewell Rock (Lowest Westphalian A) marks the base of the productive coal measures. There is a presumed permeability floor at around 1200 metres below the surface. It is not planned to drill deeper than the base of the Westphalian A coals.

Thereafter, it is anticipated that full scale development will cost Centrica around £20m per annum over an estimated 8 year period with wells being drilled at a rate of 20 per annum as the Company seeks to extract CBM from its production or development area.

All of this expenditure will provide an opportunity for the local businesses to supply and service this new business sector.

Extent of coalfields in South Wales



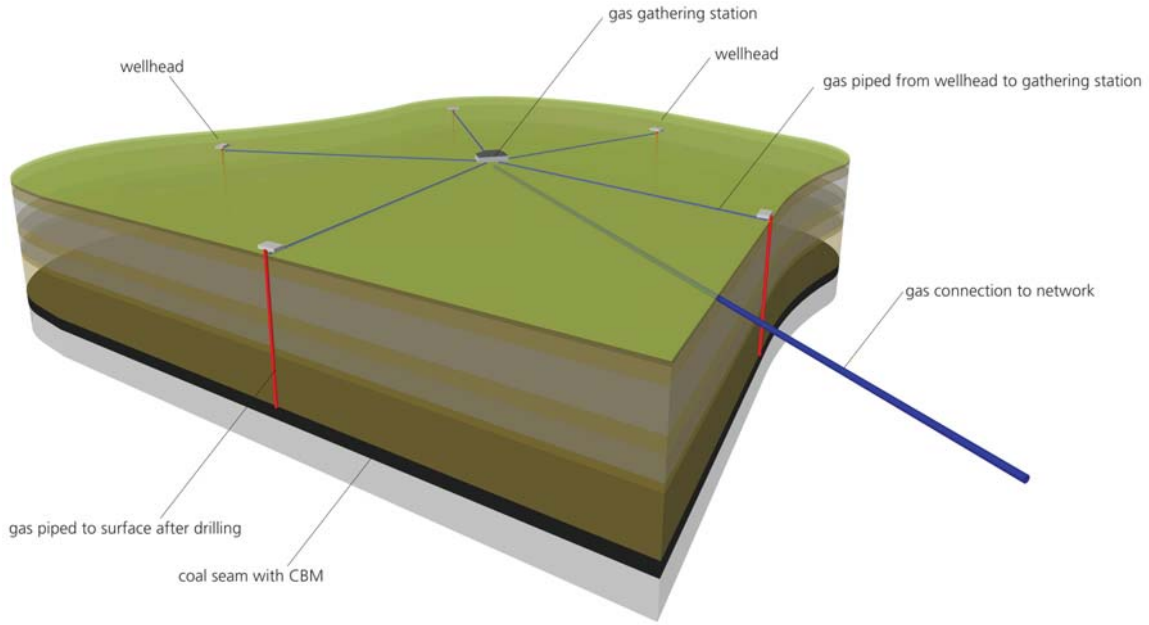
6. Appraisal and Extraction Process Explained

The way of determining whether or not methane is present in the coal, and can be produced commercially, varies across coalfields. Indeed, studies have found that every coal seam has different characteristics.

After the surface site is formed and the drilling rig is in place, the process of investigating the gas resource begins. The wellbore is formed by drilling down to the virgin coal seam. The width of this vertical wellbore is 0.5m down to 0.15m at coring point. For well stability, steel pipe casing is inserted and cemented in place to form an impregnable barrier.

Essentially, the detailed appraisal process involves pumping water away from the coal seam, with the water saturation of the seam being a key factor in determining viability.

When the drilling is complete, tubing and a pump is inserted in the wellbore and the pumping of water held in the coal matrix is started (dewatering). This is turn releases the pressure holding the gas in place and the gas begins to travel up the annulus of the well. The pumped water is treated on site or taken from site and disposed off under licence.



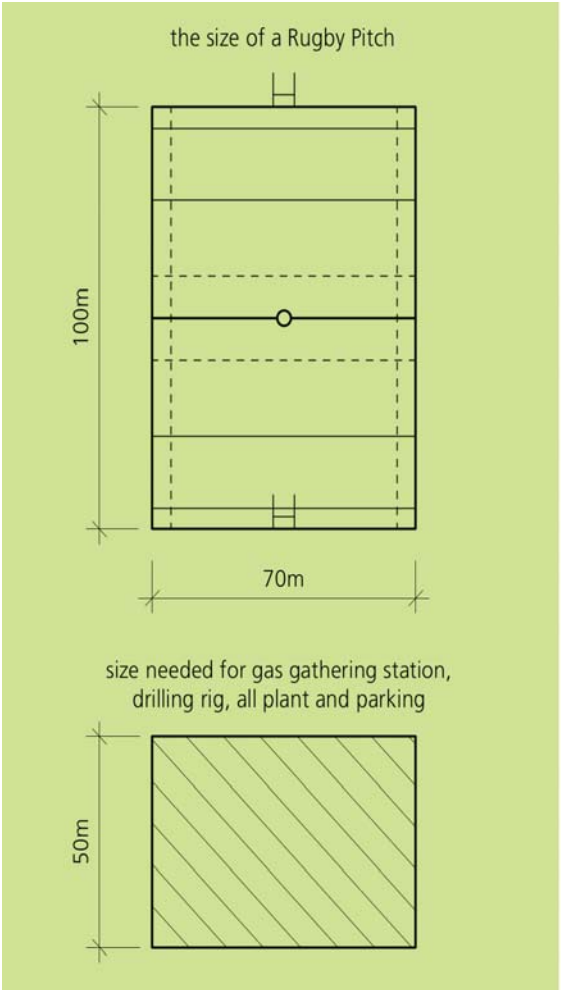
CBM is extracted in a gradual process from appraisal to full production in a development area. The appraisal wells, drilled initially to establish commercial resources in the deep coal seams, are added to with wells drilled roughly 1km apart. After dewatering is completed, the potential to achieve commercial production is proven. Eventually, clusters of 8 or 9 wells are established in a single area to create a commercial development area with each wellhead linked to a central gathering station.

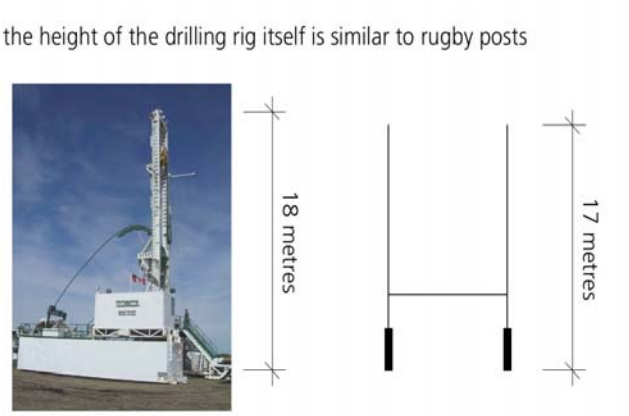
At this central gathering station, water is treated at the surface or tankered away to a treatment facility. The gas can then be compressed and introduced into the existing gas grid, or the gas can be used to generate electricity using a conventional gas generating engine.

As this CBM cluster gradually becomes exhausted, new appraisal wells are drilled a distance away and once commercial feasibility is proven, the process is repeated and another cluster is created to exploit the CBM deep beneath the ground.

There is potential to use the CBM process in carbon capture. Carbon Dioxide has a tendency to be adsorbed onto carbon, displacing the methane. It is possible therefore to pump flue exhaust gases from power stations down existing wells to expel methane from the coal seams, aiding the productivity of recovery. The potential of carbon capture is still under investigation.

The process of drilling and the equipment used is very discrete and flexible. The actual size of the area needed for the gas gathering station and all necessary plant, including parking equates to an area roughly half the size of a rugby pitch. Generally this has a very small impact on a wider landscape.

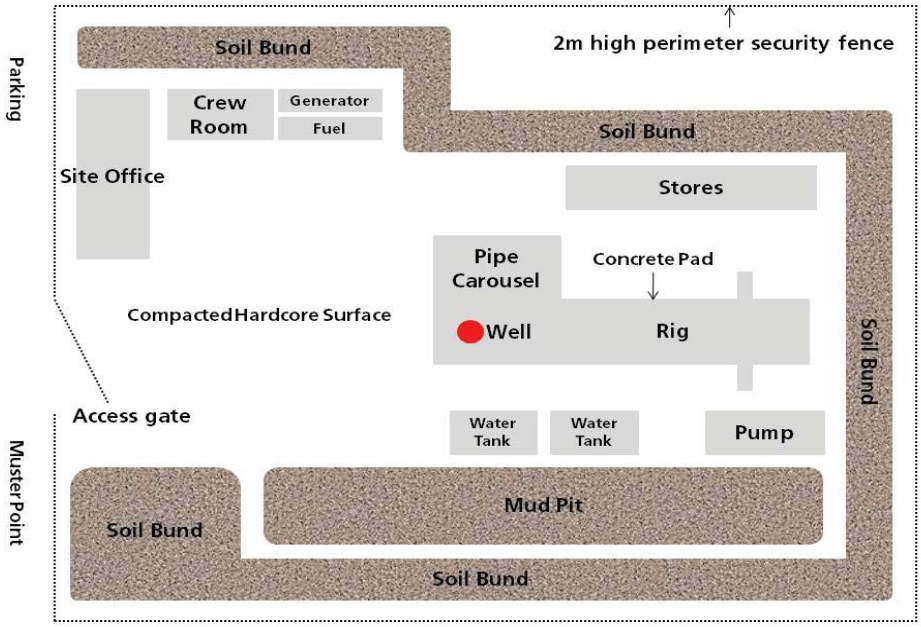




The drilling rig is small and light enough to be transported on the back of a lorry, and has a very compact form when installed on the ground. This means it can be transported over relatively rough ground to reach the most appropriate drilling locations.

The diagram below shows a typical site layout during drilling operations. The layout may vary depending on site location and site orientation.

Work carried out preparing the site usually comprises the stripping of topsoil to form soil bunds around the compound. The soil bunds act as both a visual and an acoustic screen. The bunds can be grassed to avoid windblow and erosion, and limit visual intrusion.



A concrete pad of limited size is then formed over the ground to support the rig when it returns to site for workover operations.

Security fence can be erected around the entire site.

7. Process of Evaluation to Production of Gas Explained

The development of a Coal Bed Methane resource is incremental in nature. The boundaries between appraisal and the move to commerciality in extraction are less distinct than in the case of the development of conventional oil and gas fields.

The process will follow a typical four stage approach.

1. Desktop analysis, comprising data gathering, geo and engineering assessment;
2. Exploration and appraisal stage - temporary vertical coring boreholes;
3. Pilot Test stage – establishing commercial extraction from a cluster of wells through dewatering; and
4. Production stage – establishing the commercial cluster of wells, pipeline interconnections and producing the gas.

Wells drilled at each stage will be utilised throughout the life of the development area.

A CBM development area is developed progressively as the gas supply from deep underground is exhausted. New well sites are needed to be established to enable the coals to be uniformly dewatered to access further supplies of gas. The network of wells on the surface is therefore dynamic and not static. Wells sites required for CBM development need planning permission and this maybe sought individually or in clusters with interconnecting pipelines corridors.

Further planning consents will be required during the operation of the development area to drill new wells to continue CBM gas production.

1. Data Gathering, Geo and Engineering Assessment

This is the initial stage which seeks to establish the feasibility of the exploratory stage. The initial geoscience involves reviewing existing geological data for a particular PEDL. This may be interpreted from historic mining records and British Geological Survey materials. It comprises the following steps:

- Examine existing borehole data to identify prospective coal seams.
- Determine local stratigraphy and structure to define larger continuous coal blocks through existing boreholes and testholes.
- Quantify coal quality based on existing core data (ash, sulphur and gas content and coal rank).
- Identify active and abandoned coal mines and other subsurface activity.
- Seismic structural assessment.
- Evaluate surface land access and restricted areas.
- Obtain water disposal licence.
- Assess water content of coals and salinity.

This initial phase will identify 4 to 5 blocks or development areas within deep virgin seams with the highest potential for CBM development.

At the end of this stage or Stage 2, there will be need to establish development plan policy support for the CBM extraction process and to brief local authorities about its technical requirements and economic benefits.

2. Exploration and Appraisal stage

This stage runs concurrently with the above stage, and also takes around 6 months. The tasks associated with this stage are:

- Identifying location for potential appraisal well
- Checking electric power availability to operate the equipment at the well head
- Resources for industry services.

- Drilling Rigs for coring and production wells.
- Completion equipment i.e. pumps.
- Infrastructure and major equipment fabrication.
- Shipping and transportation of major equipment.

Once an appraisal well location is agreed and to aid the organisation of the drilling programme, a Licence Agreement to drill is agreed with the landowner.

The site area for an appraisal well is around 50m by 70m. This equates to approximately half a rugby pitch.

Drilling is normally within a thirty day period but it is normal to allow up to 60 days. The actual drilling activity will operate 24/7 until complete. A typical drilling rig will be between 18m and 22m in height.

The actual area of the well head once the drilling operation is completed is much smaller at 5m by 5m. The well head needs to be accessible by track from the nearby local road.

Thereafter, it will be necessary to secure planning consent for the appropriate appraisal well. Prior to drilling compliance with all permissions and licenses required to meet operational requirements is necessary. This phase would identify any major impediments to constructing and operating a pilot project and subsequently full scale development.

Planning permission will be sought for each of the individual appraisal wells. Each consent will need to endure for the duration of the CBM extraction period, potentially around 25 years.

3. Pilot Production Cluster for Test Purposes

This stage can last between 2 and 4 years with the aim to establish the feasibility of commercial exploitation.

- Drill, core and test initial evaluation well(s) to accurately determine coal permeability, gas content, reservoir pressure and deliverability in prospective coal seams.
- If initial test wells are successful or encouraging then proceed with pilot project with 4 to 10 additional wells to create a possible production cluster.
- Complete the pilot project assessment to determine commercially viable resources.

Coring boreholes is distinct in that a Company may wish to core the target coal seams and perform analysis of the gas content of the coal to satisfy themselves that sufficient gas is present to warrant investing in a Pilot Production Test. Coring boreholes will usually be designed to provide information about the characteristics of the coal i.e. gas content, coal structure, quality and permeability.

The activity will also allow further mapping of an area in terms of geological structure and sequence particular to the area in which the borehole is drilled. At the appraisal stage, the objective is to recover core samples and establish potential commercial viability. No gas will be produced.

The Appraisal Wells are temporary in nature and once the temporary site is established Centrica Energy typically require a period of up to 60 days to complete the drilling. Following the cessation of the drilling period, the site is restored in line with that agreed by the DECC as defined by the borehole regulations, the landowner and the Planning Authority.

Testing the ability of a coal seam to produce commercial volumes of gas cannot be achieved with the use of one borehole. Typically a number of boreholes will be drilled across a known isolated slab of coal. These wells will then be pumped as a collective, the intention to have a uniform drainage affect on the coal.

Commercial production will be determined by the volume of gas being produced when the volume of water that is being produced has reached a plateau. On average, it takes one year of dewatering before gas extraction can commence.

It may be necessary to secure further planning consent for additional works as the operation expands such as installing pipelines to convey the gas to the designated gas gathering station and then onto the national gas distribution network.

4. Full Scale Development

If the initial Pilot Test cluster is successful then the addition of wells to the initial appraisal cluster is required in order to scale up the production and only then the commerciality of an area will occur.

Each wellbore is expected to have a useful production life of up to 20 years.

Planning permission will also be required for additional operational needs such as electricity generation, if not already secured.

Additional wells maybe added to the production field to aid the commerciality of exploration.

At the end of the production process including any abandoned appraisal wells, each well head will restored and the site returned to its previous use.

Thereafter another appraisal cluster will need to be established to extract the CBM from the coal slab, and the process continues.

8. Environmental Impacts

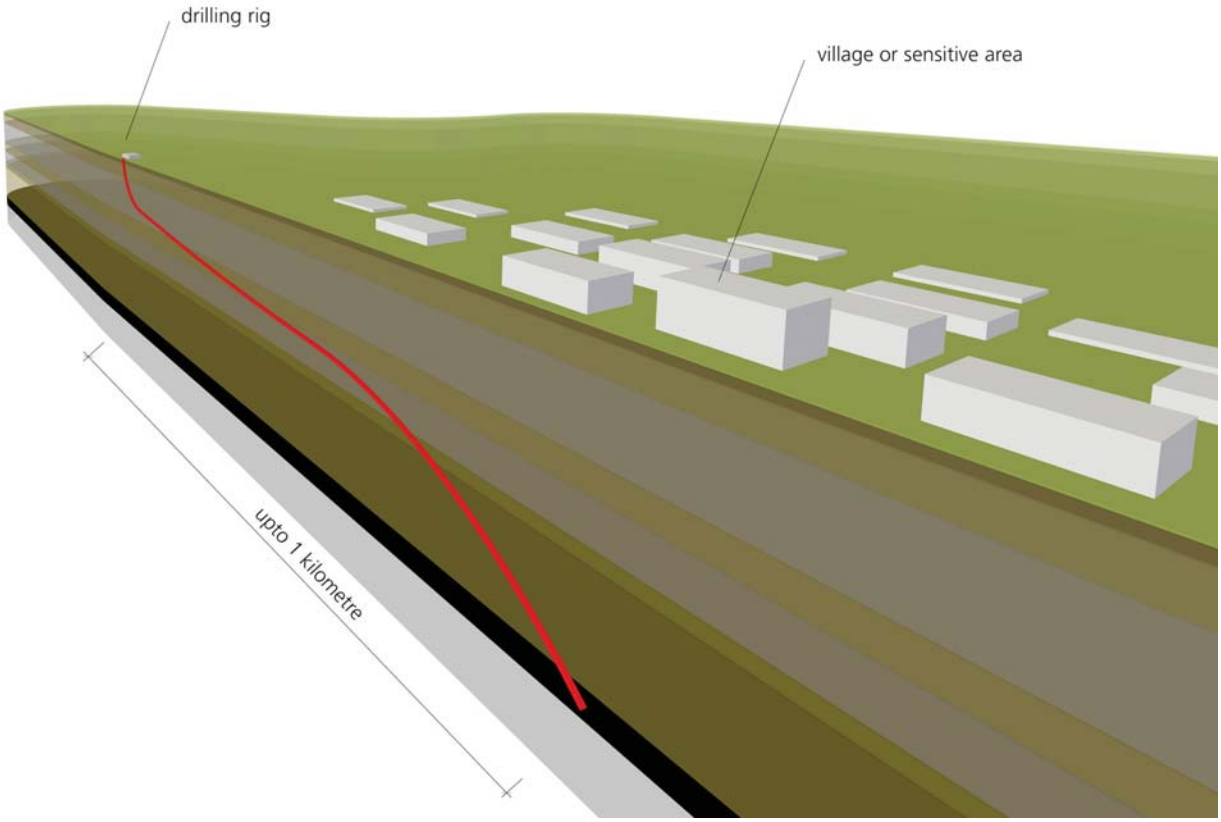
CBM extraction is relatively benign in environmental terms. Any likely impacts arising will be insignificant if properly managed or temporary in nature because of the operations.

Locations for wells are relatively flexible and therefore the siting of a well can take account of any sensitivities arising from local circumstances.

The following is a listing on the likely factors which need to be taken into consideration.

- Cultural heritage
- Ecology
- Landscape and visual - temporary during the drilling process
- Water resources
- Acoustics - compressor shed works 24/7
- Light pollution, temporary during the drilling process

With horizontal drilling, the well head can be some distance away so deep coal resources under known sensitive areas can still be extracted. The drilling rig can be situated up to one kilometre away from the target coal bed. This is useful if an area is scenically very sensitive, or the land above a coal bed is not suitable for installing a drill rig or gas gathering station.



A planning application submitted for appraisal or extraction purposes would be accompanied by an environmental appraisal which addresses the impacts of the proposed operations.

9. Future Economic Benefits

The various options available for CBM use include electrical power generation, use by local high energy users, supply to low pressure pipeline as gas, supplying to industry or domestic consumers and injection into high pressure national distribution pipelines.

Some of the benefits it can bring to South Wales are:

- Local economic benefits through the purchase of supplies and resources. This is significant and has the potential to include the creation of an important supply sector to meet the demands of drilling and production and then pipeline maintenance;
- Supply of local gas to high energy users within the LDP area at potentially competitive rates; and
- Generation of electricity and potential distribution of heat through District Heating Systems (DHSs) as well as Combined Heat & Power generation.

In addition to this activity, Centrica Energy will also look to joint venture with other opportunities involving the generation of gas. For example, if a CBM development area is near to a landfill site which is capable of sustaining methane production then there is the possibility of networking to jointly generate electricity, sharing costs.

10. Requirements from Planning System

CBM is an energy source and its extraction process is entirely different from that associated with minerals.

In a plan led system, activities associated with CBM exploration and development needs to be represented by a policy framework provided in the LDP.

A standardised policy framework in all LDPs would ensure a consistent approach the appraisal of planning application for CBM exploration and development.

A model policy framework has been proposed and is set out in *"Policy Framework for Coal Bed Methane Extraction - Rationale for Policy Proposals",* available from Geddes Consulting.

The proposed policies should not have any other policy implications for any of the LDPs within PEDL areas.

There is an obvious danger that an identified reserve of CBM can only become commercially viable if planning permissions for its extraction are granted across several local authority areas.

Whilst this is the nature of the democratic process, given the huge investment that is needed to promote CBM exploration and development, that it would far better for all concerned, if the principle of the development, as well as its potential impacts, were acknowledged and understood by each of the local planning authorities with an interest in the proposed area of search.

The inclusion of an explanation within the Local Development Plan of both how the CBM technology works and the benign nature of the extraction process, also assists members of the public understand its implications. These may be neighbours in properties subject to a neighbour notification requirement. By being in the LDP, the public has prior opportunity to understand the process and thereby alleviate what might otherwise be unfounded fears and unnecessary objection.

A reasonable degree of certainty in the planning process is also important to Centrica Energy in attracting ongoing investment.

The proposed policy framework aims to create a presumption in favour of CBM exploration and development across the area of search identified in the Proposals Map.

The presumption in favour of development would be capable of being rebutted if, in the view of the relevant local authority any one or more of the bespoke development management criteria as part of this policy framework, was not properly satisfied. This could be as a consequence of an identified impact not being deemed to be capable of being satisfactorily mitigated through the application of a planning condition.

There are no significant cumulative impacts to consider from the incremental development of the number of wells over time. For example, there is no meaningful increase in traffic (traffic would be reduced by the centralisation of activities) or disturbance to wildlife as the site is approx 0.35 ha and are dispersed.

The objective for Centrica Energy is to have a standard policy framework in the LDP. This framework would be applied by each of the local planning authorities when applications for the exploration, assessment and/or commercial extraction of CBM are submitted.

The model polices and supporting text have been prepared in accord with Local Development Plans Wales 2005 and Local Development Plan Manual 2006.

Both these documents direct the Council to consider the structure and the elements that the LDP should include.

With this in mind, the policy framework structure is:

- Strategic/Core Policy - Sustainable Energy Policy
- Area Wide Policy - Onshore Gas Extraction, including areas of search
- Specific Policy - Coal Bed Methane Extraction, with development management criteria

As Local Development Plans Wales 2005 also states:

> *LDPs should have particular regard to the prudent use and conservation of finite or non-renewable resources such as water and energy, and the need for sustainable development. Assumptions should be in broad terms and should not attempt an unrealistic degree of precision.*

The model policy framework is in accord with this sentiment, providing the structure that those Councils within PEDL areas will assess future CBM exploration and development planning applications.

11. Regulation in the Industry

Onshore gas extraction is comprehensively regulated. Each PEDL is defined and regulated by the DECC.

The regulation of the extraction of CBM within PEDLs is comprehensive and involves approval from a number of organisations at different stages in the process. It is a well regulated industry by DECC, the Coal Authority, the Health & Safety Executive, The Environment Agency and the Local Authority.

Any discharge of water is also controlled by The Environment Agency.

A comprehensive range of legislation and regulation therefore controls operations as well as any planning conditions.

The following organisations have responsibilities in the approval process for the exploration and extraction of CBM:

- Local authority
- Welsh Water
- HSE
- DECC
- Environmental Agency
- Coal Authority

Relevant legislation to be complied with includes the following:

- Town and Country Planning Act 1990 (as amended)
- Petroleum Act 1998
- Borehole Regulations 1995
- Pipelines Act 1962
- Water Resources Act 1991 (as amended)
- Energy Act 1976
- Control of Pollution Act 1974
- Environmental Protection Act 1990
- Pollution Prevention and Control Act 1999
- Coal Industry Act 1994
- Health and Safety at Work Act 1994

CBM extraction, processing and distribution is extremely well regulated as the legislation testifies.

12. Further Information

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