Environment and Sustainability Committee

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Shale gas and gasification – Evidence from Clean Coal Limited

Underground Coal Gasification

Underground coal gasification (UCG) is essentially the same well known chemical processes used in surface gasification that converts solid coal into a mixture of gases known as synthesis gas (or syngas). Syngas is made up of mixtures of methane, carbon monoxide, carbon dioxide, hydrogen and water steam. Rather than taking place in an expensive, purpose built reactor vessel, however, UCG takes place in coal seams while they are still buried deep underground.

With a century of experimentation behind it, UCG is not a new technology. Relatively recent advancements in key enabling technologies, however, have allowed UCG to develop into a safe, economic energy technology that is now at the stage of becoming commercialised in many countries around the world.

All UCG processes are similar in that they require a minimum of two physically linked boreholes: (i) an Injection Well to inject the gasifying agents and start ignition; and (ii) a Production Well, to recover the syngas. A linked injection and production well is known as a UCG "module" (Figure 1).

During UCG, air and/or oxygen with steam is introduced to the coal by pumping it down an injection well, which is drilled into a very deep coal seam from the surface. The mixture of oxygen, steam and coal is then heated and gasification takes place. The process of gasification is self-sustaining, as long as oxygen is made available and as soon as the oxygen is withdrawn, gasification will stop. The syngas produced flows back to the surface under pressure via a production well, which is linked through the coal seam to the injection well. In modern UCG technologies, the linkage between the injection and production well is achieved using directional drilling, which eliminates the need for other techniques such as fraccing.

Syngas is a very versatile gas mixture that can be used to produce electricity or converted into a variety of useful products from fertilizers to ultra-clean aviation fuel.

Potential for UCG in Wales

Cardiff University has undertaken extensive assessments of the potential for UCG in Wales and continues research into UCG as part of its Seren project. Application of geographical information systems with detailed site selection criteria identified a number of areas in South Wales with good potential for UCG. These studies showed that the South Wales coalfield contains many areas of deep coal with good qualities for UCG located in areas of sufficient distance from populations or historical mines. The potential of UCG in Wales is further demonstrated by the existence of two UCG conditional licences in Swansea Bay and the Loughor Estuary, Carmarthenshire.

Benefits of UCG

UCG has a number of advantages over other conventional coal exploitation technologies:

1. UCG is Economic

A number of independent studies have shown UCG to be highly economic, producing syngas at a cost competitive with Shale Gas, for example.

2. UCG can exploit deep, otherwise unminable coal resources

Modern technologies allow coal seams over 1000 m deep to be accessed for UCG, greatly expanding the resource base for producing energy in the UK.

3. UCG has limited environmental impacts compared with other coal utilisation technologies

UCG offers the opportunity to exploit coal with greatly reduced environmental impacts, by avoiding the need to mine (which also removes the risks to miners), wash and transport the coal, and by ensuring the bulk of coal-ash and sulphur-compounds remain buried deep underground.

a. Reduced Surface Footprint Impacts

Compared with coal mining, UCG has a negligible surface footprint, largely because the coal extraction ("mining") and coal conversion (gasification) takes place in situ, at greater than 500m below ground level. The coal is accessed via relatively small diameter boreholes, which when removed leave very little evidence of them ever being there at all. Furthermore, the requirements for a coal mine, coal washing and storage facilities, coal transportation infrastructure and complex gasification plants, as well as fly ash storage collection and disposal facilities are completely obviated by UCG.

b. Minimal Groundwater Depletion

Groundwater plays a fundamental role in UCG as it seals and pressurises the underground reactor. For these reasons, UCG operators aim to cause minimal impact on groundwater levels i.e. cause minimal groundwater depletion.

c. Minimal Groundwater Impacts

There are known risks of groundwater contamination from UCG, but lessons learned from previous trials have enabled UCG operators to ensure groundwater resources are protected. Modern site selection techniques ensure that UCG is undertaken in very deep coal seams that are completely isolated from sensitive groundwater resources by thick, low permeability rock layers. With respect to reactor operation, it is possible to stop contaminants from entering the groundwater by ensuring that water only flows into the UCG cavity, because contaminants will not be transported against the direction of water flow. Groundwater will flow into the cavity when the pressure inside the cavity is less than the pressure of the groundwater outside. Modern UCG projects therefore ensure that the pressure in the reactor never exceeds the pressure of the surrounding groundwater.

The effectiveness of modern site selection and UCG operational techniques is demonstrated by the fact that that three pilot projects have been operating in heavily regulated regimes for years with no indications of causing groundwater impacts.

d. UCG is Safe

Coal mining is an intrinsically dangerous activity, where risks of mine collapse, fires and explosions have to be carefully managed on a regular basis. UCG is inherently safer because no people are required to mine the coal. Furthermore, there is no risk of uncontrolled coal seam fires, because UCG takes place beneath many hundreds of metres of rock, which isolates the seams from atmospheric oxygen. Once oxygen injection is turned off, gasification will stop and there will be no risk of uncontrolled fires.

The risk of subsidence from UCG is reduced greatly by ensuring UCG takes place at great depth beneath strong, competent rocks. Furthermore, the “cavities” left after UCG are partially filled with ash, so are not truly open volumes in the same way as the voids left over from mining. The risk of subsidence from UCG is therefore reduced, compared with coal mining for example.

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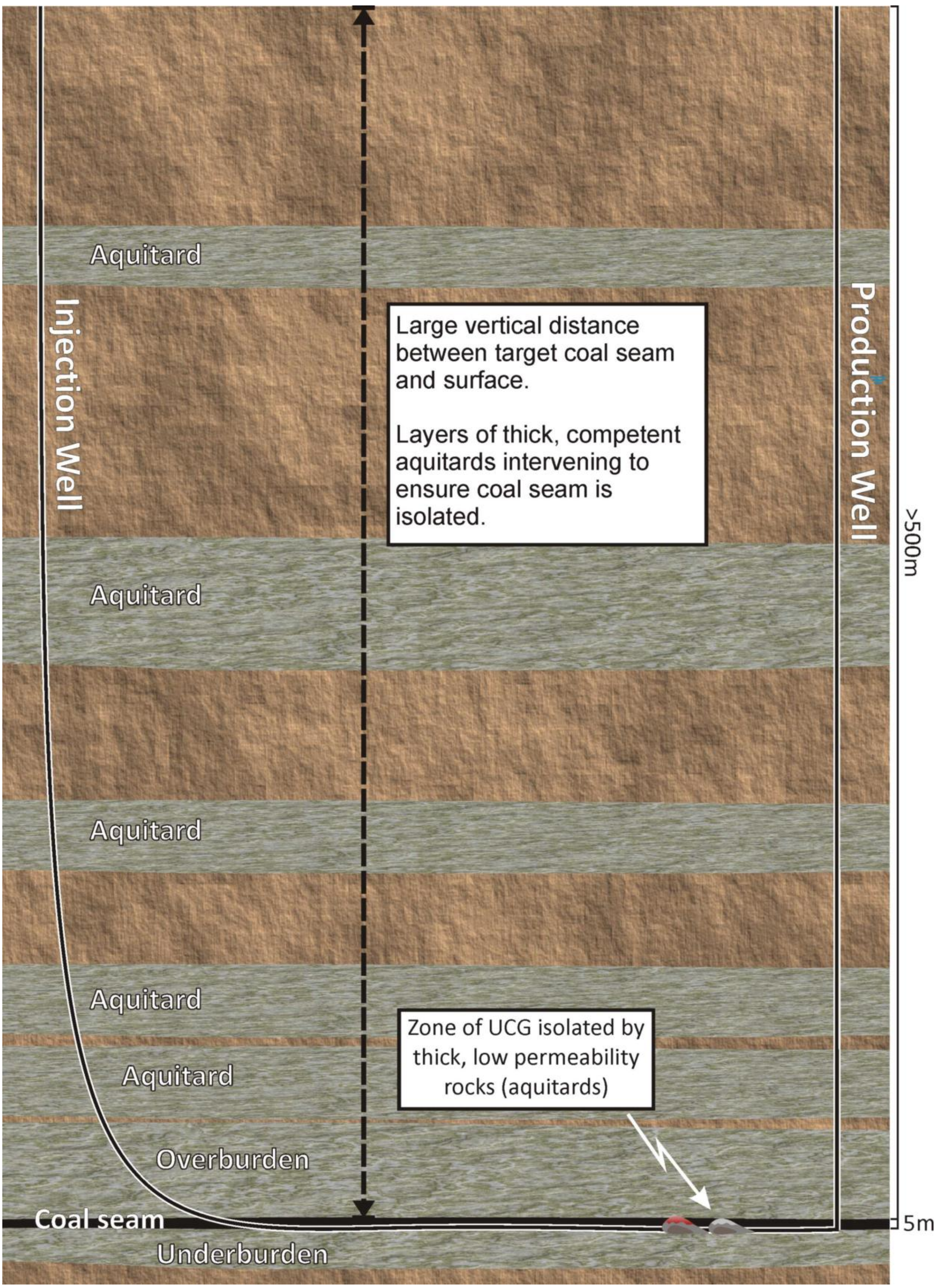

Figure 1. Setting for UCG "module" showing a linked injection well and production well. The aim of UCG site selection is to choose areas that are physically isolated from groundwater resources and coal seams that are very deep to minimise subsidence.