Coal seam gas in a Nutshell

A guide for journalists prepared by the AusSMC

This is part of the *Science in a Nutshell* series produced by the AusSMC and verified by independent experts. This document provides simple explanations of coal seam gas extraction and some of its controversial aspects.

If you need help finding an expert on coal seam gas, please contact the AusSMC by email (info@smc.org.au) or call us on 08 7120 8666.

Please note: there is an accompanying infographic on coal seam gas available here.

What is coal seam gas?

Coal seam gas (CSG) is a naturally occurring gas, predominantly methane, found in underground coal seams. It is produced as coal forms and is found in different amounts in all coal types. It is held within the coal seam by adsorption to the coal (forming a thin film of molecules on the surface) and pressure from water in the seam. Coal seams are typically 300-1000m beneath the surface. This is below aquifers, which are on average 100 to 200m beneath the ground.

CSG is also known as coal seam methane (CSM) or coal bed methane (CBM).

Why is coal seam gas controversial?

The main issues revolve around:

- Potential impacts on the environment and water resources, including groundwater
- Community concern about rapid expansion and exploitation of this resource
- Conflicts over land use and water use, particularly between gas extraction, agriculture and the environment

How is coal seam gas used?

CSG is either used directly in a gas-fired electricity generator or compressed and transported in a natural gas pipeline for export or retail as natural gas.

How is coal seam gas extracted?

CSG is extracted by drilling a vertical well down to the coal seam which can be anywhere from 300m to a kilometre below the surface. Horizontal wells are also employed to enhance production rate. For comparison, aquifers, which contain water used for agriculture and other uses, are typically 100 to 200m beneath the surface. The coal seam is then depressurised by pumping out the water. Reducing pressure in the coal seam allows the gas adsorbed into the coal to be released. While wells typically take two weeks to drill, water may need to be pumped out for days or even months before gas flows. The extracted water is called ‘seam water’ or ‘produced water’.

The well consists of a steel pipe extending through the layers underground to the layer beneath the coal seam. Cement encases the steel pipe. The steel and cement casings prevent water, gas and other materials flowing between the coal seam and other layers, including aquifers. Coal seams can consist of multiple layers. The cemented casing is perforated at the coal seams to allow gas and seam water to enter.

What is fracking (hydraulic fracturing)?

Hydraulic fracturing (fracking or fraccing) involves pumping fracturing fluid into the well at high pressure, which causes the coal seam to fracture for distances over 100m. Hydraulic fracturing increases the conducting path in the coal, allowing the gas to flow more freely. It is used when the flow of gas is not sufficient to make the coal seam economically viable. Hydraulic fracturing typically takes place during the week after the well has been drilled.

Fracturing fluid consists of water (approximately 97-99 per cent), sand and chemicals. The mixture of chemicals is added to help the fracturing process. The fracturing fluid mixes with seam water in the induced hydraulic fractures. Due to depressurisation of the coal seams, the fracturing fluid and seam water flow back out of the well over a period of several days. Sand from the fracturing fluid remains in the fractures and holds them open, which stimulates gas flow. At this point a well that has been hydraulically fractured (a "fracked" well) acts like a well that hasn't required hydraulic fracturing (an "unfracked" well) and can produce gas along with seam water for years.

What is the difference between coal seam gas and conventional natural gas?

There is no functional difference between conventional natural gas and unconventional natural gases, such as CSG, which both mainly consist of naturally occurring methane. The main differences are where they are found and how they're extracted.

	Coal seam gas	**Conventional natural gas**
Composition	Mainly methane	Mainly methane
Geologic location	Coal seam. Coal is relatively impermeable – gas cannot move easily through it	Underground reservoir in sandstone or siltstone – easier to extract
Depth	300-1000m	Up to 5km
Extraction	Need to depressurise coal seam by removing water	Simpler technology used to extract it. Gas comes out under its own pressure once a well is drilled
Hydraulic fracturing	In most cases	Possible for fracking to be needed
Location of resources	QLD, NSW	WA, Vic, Tas
Location of production	QLD, NSW	WA, Vic, Tas

What's the difference between coal seam gas and shale gas?

CSG and shale gas are both unconventional natural gases. While coal is relatively impermeable, shale is even more impermeable than coal.

	Coal seam gas	**Shale gas**
Composition	Mainly methane	Mainly methane
Geologic location	Coal seam	Layers of shale. Shale is much more impermeable than coal
Depth	300-1000m	Shale usually deeper than coal seams.
Extraction	Need to depressurise coal seam by removing water	Extensive fracking needed to allow gas to flow because shale is much more impermeable. Almost no water present within shale so doesn't need depressurisation
Hydraulic fracturing	In most cases	Always
Location of resources	QLD, NSW	Large shale gas reserves in SA, NT, WA
Location of production	QLD, NSW	Moomba, SA

What is seam water?

Seam water is water pumped out of coal seams to decrease pressure in the coal seam, allowing gas to flow. Seam water contains salt and chemicals, either those naturally present in coal seams, or from drilling or hydraulic fracturing processes. Seam water can vary greatly in salt content, with seam water in Queensland varying from less than 200mg/L to over 10,000mg/L. To give context, drinking water has up to 500mg/L and sea water about 37,000mg/L.

There are two main management options for seam water: it can be treated and then reinjected underground, or treated and used for activities such as irrigation. Water treatment is likely to produce waste brine or salt, which require safe disposal.

What are the potential impacts on the environment?

CSG extraction will have different impacts depending on the characteristics of the coal seam, the geology of the surrounding rock, the proximity and connectivity to aquifers and the specific techniques, including hydraulic fracturing, and precautions used to extract the gas.

The main issues are likely to revolve around the impact of coal seam gas on water, including:

- Aquifers potentially becoming contaminated from seam water, fracturing fluids or drilling chemicals during the drilling or hydraulic fracturing process
- Hydraulic fracturing extends beyond the coal seams which has the potential for water and or coal seam gas to migrate towards the surface
- Spills of seam water or water that has flowed back after hydraulic fracturing
- Seam water and drilling muds need to be disposed of or treated, and this may impact on surface water
- Waste products from treated seam water, including waste brine or salt, which, if not properly disposed of, can lead to increased salinity
- Cumulative water use may also be significant, as a typical hydraulic fracturing operation could use 1.5-6 mega litres (ML, 1ML is equivalent to one million litres) of water, where 2.5ML fills an Olympic-size pool. This could result in resource conflict between agriculture, CSG and the environment
- Lowering of water levels (subsidence) from depressurising the coal seam, including the depletion of aquifers

Other potential issues include:

- Direct greenhouse gas emissions, known as fugitive emissions, of methane and CO_2
- Impacts of the mining operation on the surface environment, including noise, odour, dust and traffic
- Air pollution from the drilling operation or from some water treatment options

Is coal seam gas greener than coal?

Gas has generally been considered to offer significantly lower greenhouse gas emissions compared with coal. However, there has been controversy over comparisons between gas and coal emissions. While methane doesn't remain in the atmosphere for as long as CO_2, it is a more potent pollutant over the short term. Considering that the next few decades are crucial for climate change, there is contention over which timeframe to use when comparing the global warming potential of methane and CO_2.

There is also concern over whether fugitive emissions have been adequately accounted for in the life cycle of emissions from CSG.

Most studies stress that methane emissions from gas production can be significantly reduced by industry best practice. A carbon price and regulation requiring monitoring and reporting will also motivate further emission reductions. However, no studies have focused on Australian CSG for domestic consumption. Direct measurement of life cycle emissions from CSG are needed in Australia to reach conclusions on the scale of benefits from CSG compared with coal.

Is coal seam gas a suitable transition fuel to renewable energy?

Gas has been considered a suitable transition fuel to renewable energy for three main reasons:

1. Next cheapest electricity source after coal
2. Lower emissions profile than coal
3. More flexible, as gas generation can start and stop much more quickly than coal. This is particularly important in electricity systems with intermittent renewable sources such as solar and wind.

While they have an emissions benefit compared with coal, CSG and other gases are not sufficient to reach the emissions targets necessary to keep climate change within 2°C. Thus, experts maintain that investment in lower emission energy options, such as renewable energy, and increasing energy efficiency remain crucial.

Acknowledgments

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Further resources

CSIRO. Coal seam gas fact sheets http://www.csiro.au/news/coal-seam-gas#FactSheets

Gas Industry Social & Environmental Research Alliance, GISERA. Coal seam gas fact sheets http://www.gisera.org.au/publications/factsheets.html

Queensland Department of Environment and Resource Management, DERM. Coal seam gas information and fact sheets http://www.derm.qld.gov.au/environmental_management/coal-seam-gas/index.html

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