Submission
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INQUIRY INTO COAL SEAM GAS

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Most people are brought up with the understanding that if something is dangerous, leave it alone, however monetary benefits will give people the incentive to engage in a variety of dangerous activities. Usually if someone wishes to be involved in dangerous activities, these are acceptable if it does not put anyone else at risk in the process however there are a great many ventures that are undertaken for the benefit of money that put a great many people at risk. Clearly there is no consideration for the consequences that rest upon oneself for causing harm to others, generally known as a state of ignorance.

As a part of an organization of living entities on this planet, I believe that all people are valuable and have a right to live a dignified life. I believe it is an unfounded fact that there is a "lack" as is implied by certain facets of society in light that the earth naturally provides and all of the technology readily available can produce all our energy needs without destroying important ecosystems, human health and livelihood.

Now is the time to give the value of all life our full consideration since through various means the earth as we know it is undergoing an unnecessary onslaught of wanton pollution by those who disregard its' true and most valuable resources. We need to have a clear head at this time of decision making or deeply regret that it is too late to realize that this need not have happened; that the water resource need not have been poisoned; that the production of food need not have been destroyed; that the health of so many people need not have been impacted; that the future generations may have been able to enjoy the pleasures of this earth

"and the potential energy of these reserves is massive" explains Chair of the Committee, the Hon. Robert Brown MLC. "Known reserves of coal seam gas in NSW could power all current NSW residential energy use for the next 181 years. If the potential energy is "massive", it is likely the potential damage is also "massive".

So this is debatable that the "massive" reserves can last for 181 years and when considered in the light of the known destruction the extraction of this resource can have on environs, what would be the benefit in 181 years. Has this really been considered? In any case the sun can power us all indefinitely and not create what is called "collateral damage" in the process of extraction. This expectation of "collateral damage" is unacceptable and is already a reality in light of all the evidence of change occurring in the environment as a result of fracking - from land to water and human health. What then is the purpose of extracting the gas if not for improving the quality of life. What use is gas in 181yrs?

In reality it is not necessary to exploit these reserves of gas as we can just as easily instate solar facilities to supply the demand. Spain is a great example with its Gemasolar power plant producing power 24/7 . If it is energy we need to power our lives, solar can do it.

"However, coal seam gas mining has the potential to affect the environment, particularly water supplies"

It is in fact no longer just a *potential* effect, but is *already* having a devastating impact on the environment and water supply. It is not some possible future event or occurrence; it is presently being allowed to take place now. What was once good clean bore water for stock and crops is now polluted with methane at the very least and other unnaturally found ingredients used in the extraction process

"economic and social benefits to communities"

These 'benefits' are largely exaggerated when considering as a consequence of these industries, the natural environment is severely disrupted and the toxic outflow is deposited all around, through dust and water as well as noise. The temporary fly-in labour have little commitment to the area and fail to understand the everlasting damaging effects of the impact of their 'job'.

"It can also raise issues of property rights"

Issues which are of major concern is the right of landholders to truly own their land that they purchased and present land prices but become unsalable once mining companies claim the resources. Also these companies are able to purchase the land at regular land value but are able to access and profit from the resources underground. Regulations have been put on landholders to prevent them from developing their land for agricultural purposes and removing natural rights of ownership. In order to put pipes, wells and processors on the property, more land has been claimed and disturbed by gas companies than originally envisaged by the landholder, carving up the property and obstructing its function. In this way property value is greatly reduced and that is aside from the toxic effect of gas fumes, water pollution, and the precarious threat of open holding ponds for produced water in the face of flooding. These things cannot just be written off as "collateral damage", they are serious flaws in the process of extracting coal seam gas and these effects are happening everywhere this industry goes.

There is no real way that the coal seam gas industry can co-exist with social and environmental issues since by their nature they oppose each other. Granted the economics are a great boon but not to the people that are being affected except by token gesture because the real money and economic benefit is going to the corporations and a few workers who have no lasting connection with the local community and environment.

The fact that policies have been made that have weakened our local economies in favour of foreign investment is destroying the value of the natural environment in favour of a fast grab for resources that we could better leave alone and produce an efficient and clean economy that thrives on all levels benefitting all local communities. However once this infrastructure is in

place and committed, it is very costly to turn around and provide the truly clean technology provided by solar and other renewables.

"This inquiry is an opportunity for all stakeholders and communities to provide input into how NSW can balance social, economic and environmental objectives of coal seam gas mining. I encourage all people interested in the inquiry to get involved and have their say in front of the Committee."

I was born and grew up in the Pilliga region and have seen many changes to the land that I believe have altered the health of the land irrevocably. I am a stakeholder in the well being of this planet and firmly believe there is more to life than making money at any cost. I am a part of the global community responsible for all other citizens and the preservation of the natural environment as the true supporter of our life. If we do not protect the natural state of the earth i.e. maintaining clean water and natural ecosystems, life will not continue as we know it and our economic and social future will not flourish.

"Coal seam gas is a naturally occurring gas"

There are a great many naturally occurring elements in existence on this planet that are not all desirable for the human existence. No matter how much these industries appear to be regulated, the use and extraction of dangerous elements are inevitably going to cause serious consequences of degradation of the environment and economics as well as the loss of human health and animal species. Not enough can be done to safeguard life from the untold mishaps that are occurring on a daily basis.

"used for the production of electricity"

As we all know there are alternatives that even Thomas Edison knew of.

"I'd put my money on the sun and solar energy. What a source of power!
I hope we don't have to wait until oil and coal run out before we tackle that..." Thomas Edison in conversation with Henry Ford

"Over the past five years interest in the industry has skyrocketed"

Monetary gain should not be considered as a reason on its own to be swayed by this industry.

Due to the stalling by government to take up the use of solar power decades ago to fulfill the needs of the community, it has left us in this position of seeking desperate measures and needing to make rash decisions. It is now time to make a courageous decision to set the future of this great country in a direction of independence and reliance on renewable energy and resources. Coal Seam Gas is not part of that future; in fact it does not provide a future at all.

I refer you to references below to support this case and thank you for this opportunity to share my opinion about this most serious issue.

What is Coal Seam Gas?

Coal Seam Gas (CSG) is methane gas found in coal seams. Often referred to as "unconventional Gas", CSG should not be confused with Liquid Natural Gas (LNG) which is also known as "conventional gas". CSG is a newer resource extracted from coal deposits that are too deep to mine economically. The methane lies in pores and 'cleats' in the coal seams and is trapped there by water.

When burnt, methane produces about 40% less greenhouse gas than coal. Un-burnt it is at least 20 times more polluting than carbon dioxide (CO2). The process of removing methane from a coal seam sees a large amount leaking into the atmosphere, adding significantly to greenhouse pollution.

How is Methane Gas extracted from a Coal Seam?

A mining company will first apply to the State Government for an exploration licence. (Petroleum Exploration Licence [PEL] in NSW or Exploration Permit Petroleum [ATP] in Queensland). They then conduct geological studies to determine which areas offer potential for coal seam gas extraction. This may involve drilling exploratory holes to take samples. They will also seek to identify land where they can get permission from the owner to drill.

Test wells are then drilled into the coal seam. These initial wells are unlikely to produce much gas until the coal seam has been stimulated by hydraulic fracturing (fracking). This is achieved by pumping a fracturing fluid into the coal seam at pressures sufficient to crack open the rock. This enables the gas to flow to the well more easily.

Gas companies are very reluctant to reveal what they use in the fracking process and imply they are quite safe. Fracturing fluids are primarily water but contain other chemicals, including acids, solvents, surfactants, biocides, and hydrocarbons. Sand is often added as a propping agent to hold the fractures open and allow the gas to flow freely to the well bore. Some of this toxic fracturing fluid, known as 'flowback water' resurfaces but much may remain underground.

The next stage in the development is to de-pressurise the coal seam by pumping out some of the water. This "produced" or "associated" water is generally saline and contains a range of carcinogens, heavy metals and radionuclides naturally present in coal seams, as well as the man-made chemicals used in the drilling and fracking processes. The produced water has to be transported from the site by road tanker for proper disposal. The volume of water produced can vary considerably. Initially, large volumes are produced but this declines as the rate of gas flow increases. When gas is flowing steadily, the test well will be left to run for several months. During this time the methane is flared at the well-head and the gas company tests the flow rate and quality of the gas produced.

If the tests are favourable, the next stage is to apply for a Petroleum Production Lease (PPL) in NSW or a Petroleum Licence (PL) in Queensland. In order for the gas-field to be economically viable, the company has to plan for a high density of well-heads. Drilling each production well involves the same process as a test well. In addition, the development will include the installation

of infrastructure and equipment at each well-head - gas and water pipelines and compressor stations - also huge associated water storage ponds, perhaps a water treatment plant and brine storage pond, project offices and potentially, workers' accommodation camps.

As the CSG industry expands, there will be further applications for processing facilities and major pipelines.

In NSW the principle legislation is the *NSW Petroleum (Onshore) Act 1991*, which does not even mention coal seam gas. In Queensland, the industry is partly regulated under the *Minerals Resources Act 1989* and partly under the *Petroleum and Gas (Safety) Act 2004*. Large CSG projects may be designated 'state significant' in which case a streamlined and very favourable assessment process will apply under the Queensland *State Development and Public Works Organisations Act 1971* or Part 3A of the *Environmental Planning and Assessment Act 1979* in NSW. In both states, despite being a large user of water, the industry is exempt from State Water Acts. The industry is self-regulated, with governments generally reliant on information supplied by the industry itself. Environmental regulation is ineffective and the responsible agencies lack the resources to undertake many compliance and enforcement responsibilities.

Hydraulic fracturing

- Hydraulic fracturing (fracking) is a technique used to speed up the flow of coal seam gas (CSG) from underground rock formations. It causes micro-seismic events or little earthquakes that open up pathways for fluids or gases to flow out of the rock and into a gas well or bore.[i]
- With fracking first used in the oil and gas industry in 1948, industry proponents claim that it is a well-tried and tested technique. But fracking methods developed in the last decade are not. They involve higher pressures, take several days and require large volumes of water.
- Not all wells are fracked - but some may be fracked multiple times.
- Typically, a mixture of water, proppants and chemicals is pumped at extremely high pressure into the gas-bearing formation, fracturing the rock. Proppants, usually sand or ceramic beads, hold the cracks open. Radioactive tracer beads may be used to monitor the process.[ii]
- An estimated 30% to 70% of the fracking fluid resurfaces, bringing with it toxic substances naturally present in underground oil and gas deposits. This is pumped into storage dams. Sometimes, nothing is recovered - all the chemicals stay underground.[iii]
- If the fractures intercept existing fissures or faults, fracking fluids, saline water or gas can move into other geologic layers, risking contamination of groundwater supplies. There have been cases in which fracking has split bore casings and even sheared through them.[iv]
- The CSG industry insists that the chemicals in fracking fluids are found in everyday, household items. **This does not mean they are safe.** Ingredients include acetic and boric acids, bleach, caustic soda, detergents, polish and hydrocarbon derivatives.[v] They should not be inhaled, ingested or even handled by sensitive people. Plus in combination chemicals respond differently.
- In the US, there are thousands of documented cases of drinking water supplies being contaminated by fracking fluids and gas,[vi] even though they are separated by tens or even hundreds of metres of rock.

References

[i] Hydraulic fracturing 101 http://www.earthworksaction.org/FracingDetails.cfm

[ii] Qld Gas Corporation's Environmental Authority Amendment Application PEN 100020207

[iii] Tory Shenstone, "Learning to Lead" seminar, Brisbane EKKA, 2009

[iv] "Chemicals that may be used in Australian CSG fraccing fluid" http://www.appea.com.au/images/stories/mb_files/APPEA_fraccing_chemicals.pdf

[v] The Endocrine Disruptor Exchange http://www.endocrinedisruption.com/chemicals.introduction.php

[vi] Scientific American, 17 Nov 2008 http://www.scientificamerican.com/article.cfm?id=drill-for-natural-gas-pollute-water

Greenhouse gas emissions

The production, burning and export of CSG for energy may be little or no better for our climate future than coal.

- Coal seam gas (CSG) is a fossil fuel - a dirty energy source that adds to greenhouse pollution.
- The gas industry claims gas-fired power stations produce 70% less CO2 than existing coal-fired power stations.[i] This figure only refers to the emissions released when the gas is burnt. It does **not** include the emissions involved in producing the gas - the drilling, fracking, compressing, pumping, liquefying and transporting the gas; nor the loss of carbon-storing forests and woodlands cleared to make way for gas wells and pipes.
- Liquefying natural gas consumes at least 20% of its energy value and cancels almost 30% of its "clean" character.[ii]
- Queensland is the largest producer of greenhouse gases in the country[iii] and by far the highest per capita emitter.[iv]
- The CSG industry will increase Queensland's emissions by 21% over the next 3-5 years. The Queensland Curtis Island LNG project alone will generate 95 million tonnes of CO2-e during its construction and 20 year operational life.[v]
- The total emissions per year from 3 LNG projects approved in Queensland amounts to 24.14 million tonnes of CO2 equivalent (CO2-e)[vi] - excluding the emissions from burning the exported gas.
- The Queensland government wants to export 50 million tonnes of LNG per annum.[vii] When burnt, this will generate 140 million tonnes of CO2 equivalent a year[viii]
- Total greenhouse gas emissions due to hydraulic fracturing have been estimated at 33.6 tonnes of CO2 equivalent per gigawatt hour (t CO2-e/GW.h) or about 62% **more** than for diesel and petroleum (approximately 20.3t CO2-e/GW.h)[ix]

- The substantial leaks of gas to atmosphere before combustion are not included in the 70% figure. Methane is the major component of natural gas. It is a much more potent greenhouse gas than CO2, 72 times more effective at trapping heat in the atmosphere over a period of 20 years, or 25 times more effective over 100 years. [x]
- Monitoring of methane leakage in the oil and gas industry is limited, but conservative estimates[xi] suggest that during the life cycle of an average coal seam gas well, 3.6 - 7.9% of total production is emitted to the atmosphere as methane. This is at least 30% and perhaps more than twice as great as the life cycle methane emissions for conventional (natural) gas which range from 1.7 - 6%.

CSG may be cleaner than coal, but it is not *clean*, nor *green*.

References

[i] APPEA CSG Factsheet #4, Environment

[ii] http://www.peakoil.org.au/Heede.lng.greenhouse-intensity.pdf

[iii] http://www.couriermail.com.au/news/features/states-gas-emissions-surge/story-e6freowx-1111116723526

[iv] http://www.climatechange.qld.gov.au/pdf/climateqreport/climateqreport-chapter3.pdf

[v] Queensland Curtis LNG Environmental Impact Statement. http://qclng.com.au/uploads/docs/Queensland_Curtis_LNG_Project_IAS.pdf

[vi] Figures from Santos, http://www.glng.com.au/library/EIS/0c%20Executive%20Summary%20(Section%20ES)%20FINAL%20PUBLIC.pdf

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Origin http://www.dip.qld.gov.au/resources/project/aplng/eis-executive-summary.pdf

Environmental Impact Statements.

[vii] Premier Anna Bligh, media release 28/8/09. "Multi-billion dollar Gladstone LNG projects a step closer."

[viii] Energy Strategies Ltd calculate 1 tonne LNG generates 2.8 tonnes CO2.

[ix] Howarth, R.W., & Atkinson, D.R., *Preliminary Assessment of the Greenhouse Gas Emissions from Natural Gas obtained by Hydraulic Fracturing.* Cornell University, 2011.

[x] IPCC 4th assessment report www.ipc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf

[xi] Howarth, R.W., & Atkinson, D.R., *Preliminary Assessment of the Greenhouse Gas Emissions from Natural Gas obtained by Hydraulic Fracturing.* Cornell University, 2011.

Further reading

Valuing the greenhouse gas emissions from nuclear power: A critical survey

Carbon Dioxide Emission Factors for Stationary Combustion

Comparative Life Cycle Air Emissions of Coal, Domestic Natural Gas, LNG, and SNG for Electricity Generation

Life-Cycle Energy Balance and Greenhouse Gas Emissions of Nuclear Energy in Australia

Noise and infrastructure - Lots of heavy machinery is needed to drill gas wells. The costs of hiring drilling rigs means they must operate around the clock. Scores of heavy trucks will come and go each day carrying equipment and supplies and carting away toxic "flowback" water. A cement pad covering approximately 1 hectare will be laid and a security fence installed at each well-head. Pumps will operate and lights will be on continuously. Pipelines will be laid connecting each well-head to a main gas pipeline which will flow to very large and noisy compressor stations that maintain pressure in the gas pipeline and also separates out unwanted hydrocarbons from the gas which are then vented into the atmosphere. Many hydrocarbons are carcinogenic.

Your health and safety - There are many hazards involved with CSG extraction. CSG wells and pipelines are fire and explosion hazards. Over 50% of wells tested in Queensland leak methane. Many landholders have reported instances of methane in their stock watering bores and even household taps.

Investigations in USA have revealed serious effects from volatile organic compounds (VOCs), poly-aromatic hydrocarbons (PAHs), heavy metals (eg uranium, lead, mercury) and other compounds naturally present in coal seams. These may be brought to the surface via leaks or in the associated water. Of the compounds typically released, 25% are carcinogenic; 37% affect the endocrine system; 52% affect the nervous system; 40% affect the immune system; and 100% affect the respiratory system. Many compounds affect several systems whether drunk in contaminated water or inhaled.

Water tables - CSG extraction poses serious risks to fresh water aquifers. The huge volumes extracted from coal seams can lead to major depletions in adjoining aquifers used for drinking water, agriculture, other industries and fire fighting. Aquifers may also be connected to surface

water systems; fracturing and the chemical residues from fracking may cause potentially irreversible contamination to both ground and surface water sources.

Environment - The water taken from the coal seam is toxic and must be handled with extreme care. The dissolved salts permanently ruin good farming land the water contacts, making it useless for agriculture or pastoral production. It is toxic to aquatic life if spilled into creeks or rivers. There is no reasonable or practical method of dealing with the vast amounts of saline water that will be brought to the surface.

Clearing of native vegetation for well sites destroys wildlife habitats and constant industrial noise scares away much of what remains. Weeds are introduced and spread by hundreds of vehicle movements.

A methane leakage rate of 3% of total well production cancels out any emissions advantage gas has over coal. The latest research conservatively estimates a methane leakage rate of 3.6% - 7.9% of total well production. Over 20 years, this gives CSG a greenhouse gas footprint at least 20% greater than coal.

Coal seam gas threatens some of our most precious habitats, unique plants and animals and endangered species. Some examples are:

The Pilliga forest in NSW is the largest temperate woodland in eastern Australia. It covers more than 500,000 hectares and is home to threatened species such as the Regent Honeyeater and the Pilliga Mouse. It also helps recharge the Great Artesian Basin.

Eastern Star Gas plans to drill 1,100 gas-wells in the Pilliga. With each well requiring clearing for a 1 hectare pad, an all-weather access road and a corridor for gas and water pipelines plus waste water storage ponds and other infrastructure such as condensers and compressors, the forest will be fragmented. A nationally significant bush icon will become an industrial wasteland.

Gas pipelines will run from the Pilliga along environmentally sensitive Traveling Stock Routes to a liquid natural gas (LNG) export terminal in the Hunter estuary. The Hunter estuary's Ramsar-listed wetland is also at risk.

The Great Artesian Basin (GAB) is a resource of national importance. It lies under 22% of Australia and is the only reliable source of water in arid and many semi-arid areas.

GAB springs support rare plants and animals found nowhere else. Some are found only in a single spring. These springs rely on flows from GAB aquifers.

Extracting large amounts of water to allow coal seam gas to flow will reduce the pressure in adjoining aquifers and flows to some streams will be affected. There is likely to be "a significant impact" on threatened species that live only in GAB springs.[i]

Scientists recently discovered life deep underground. There are thousands of species of *stygofauna* in artesian water. The task of identifying these tiny organisms has barely begun. No one knows whether they play important roles in protecting groundwater resources.

Groundwater

- Extracting coal seam gas (CSG) requires the removal of large volumes of generally saline "associated water" from the coal seam.
- The extraction of associated water can lower water levels in adjoining aquifers[ii] or in shallower, alluvial systems. [iii]
- In many areas, we do not fully understand the degree of connectivity between different aquifers, nor the extent to which groundwater sources are connected to surface waters. In some places groundwater provides the base-flow to creeks and rivers; in others, creeks recharge groundwater aquifers.
- Hydraulic fracturing (fracking) causes micro-seismic events or little earthquakes intended to open up pathways for fluids or gases to flow. If these fractures intercept fissures or faults, the fracking fluids, contaminated water or gas can move into other geologic layers, contaminating the groundwater.
- Fracking has been known to split bore casings and even completely shear them.[iii]
- Bores and gas wells pierce all geologic layers between the surface and bottom of the shaft, including the aquifers people rely on for drinking water and stock or irrigation supplies. If bore casings or cement seals fail, contamination can occur. Steel casings corrode rapidly in saline water while cement seals deteriorate over time and under pressure.[iv]
- The risk of any one bore hole corroding or leaking is low, but is greatly magnified by the vast number of wells proposed and the timescale over which gas and water extraction will occur.
- CSG projects are planned in areas that provide drinking water to millions of people, as well as irrigation supplies to some of our most important food-producing areas. The quantity and quality of these water supplies may be at risk.

The Great Artesian Basin

- The Great Artesian Basin (GAB) is a resource of national importance. It lies under 22% of Australia and is the only reliable source of water in arid and many semi-arid areas.
- Springs fed by GAB waters support rare plants and animals found nowhere else.
- In Queensland CSG is mostly extracted from the Walloon Coal Measures, an aquifer of GAB. In NSW, CSG companies are targeting the Pilliga Sandstones in the southern recharge area of the GAB near Narrabri.
- Current total extraction of water from the GAB is estimated to be 616,166 megalitres per annum (ML/ann). [v] The total amount of associated water extracted will depend on the size of the industry.
- Pressure in adjoining aquifers could fall by up to 6,000 KPa (equivalent to 600 metres of water "head"),[viii] and cause some artesian bores to become sub-artesian, requiring expensive pumps to obtain water. Flows to some streams could be affected.
- The Springbok and Precipice sandstones will not have recovered after 200 years. In the case of the Hutton Sandstones, recovery could take a thousand years.[ix]

- There is likely to be "a significant impact" on threatened species dependent on GAB springs.[ix]

There is much about groundwater and the GAB that we do not know. It is not possible to wholly mitigate against human errors and shortcuts taken due to economic pressures. It may not be possible to ever fix pollution of aquifers, or damage to recharge areas or springs.

Self-regulation lacks transparency and is not good enough when so much is at stake. Independent monitoring and investigation are essential to ensure that problems will not be hidden.

Farmers fear it may be impossible to prove that gas extraction caused any decline in groundwater levels, pollution of their water, or other damage to their bores or water supplies.

The companies responsible for the damage may no longer exist.

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[ii] Hillier, J.R. Groundwater connections between the Walloon Coal Measures and the Alluvium of the Condamine River, August 2010

[iii] Tory Shenstone, "Learning to Lead" seminar, Brisbane EKKA, 2009

[iv] Mavroudis, D. Downhole Environmental Risks Associated with Drilling and Well Completion Practices in the Cooper/Eromanga Basins, PIRSA 2001

[v] GAB Updated Resource Study sourced at http://gabcc.org.au/tools/getFile.aspx?tbl=tblContentItem&id=412

[vi] DERM presentation to Qld GAB Advisory Council, 1 Dec 2009

[vii] Water Group Advice (to Minister Burke) on EPBC Act Referrals, QGC referral - 2008/4399;

Santos-Petronas referral - 2008/4059 and AP LNG referral - 2009/4974

[viii] Groundwater (Deep Aquifer Modelling) for Santos GLNG Project - Environmental Impact Statement 31/3/2009, http://www.glng.com.au/library/EIS/Section%206/06%2006%20Groundwater%20(Section%206.6)%20FINAL%20PUBLIC.pdf section 6.6.2.5

[ix] Groundwater (Deep Aquifer Modelling) for Santos GLNG Project Environmental Impact Statement

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[x] Water Group Advice (to Minister Burke) on EPBC Act Referrals, QGC referral - 2008/4399; Santos-Petronas referral - 2008/4059 and AP LNG referral - 2009/4974

Salt and other contaminants

- Coal seam gas (CSG) water (also known as 'associated', 'produced' or 'formation' water) is regarded as a waste by-product. Large volumes must be removed from coal seams to allow gas to flow.
- CSG water is generally high in sodium and contains many other contaminants. Each megalitre (one million litres) of associated water brings up 5 - 8 tonnes of salt [i] previously stored safely underground.
- The Queensland government estimates that 126,000 - 216,000 megalitres of associated water will be extracted per year - along with 630,000 - 1,728,000 tonnes of salt. Detailed plans for use or disposal of these huge quantities of salt are lacking. Burial is proposed as a last resort.
- CSG water may also contain heavy metals, carcinogens such as benzene, toluene, ethylbenzene and xylene, and radioactive chemicals that are naturally present in coal seams. [ii] Some of these highly toxic substances bio-accumulate - that is, they are concentrated as they move up the food chain.
- In 2010 the Queensland Government decided to ban the evaporation of this water from large earth dams. The preference is to find economically beneficial uses for it. The water must now be stored until it can be treated, used or re-injected into an aquifer holding poor quality water. Re-injection is energy-intensive and expensive, and over the life of a gas field, risks the contamination of aquifers.
- If untreated CSG water comes into contact with good quality, high clay-content soils, such as those on the Darling Downs, Central Queensland grain belt and NSW Liverpool Plains, the soil becomes impervious to water. Plant roots cannot penetrate. **The soil becomes useless for agriculture.** [iii]
- If CSG water is accidentally released - through the failure of a dam wall or a spill - it could damage aquatic life in rivers and wetlands that depends on freshwater.
- Treatment by reverse osmosis removes salt and can make CSG water fit for purposes including stock watering, irrigation and town water supply. But it is expensive and energy intensive. There is also the problem of how to dispose of the concentrated brine that remains.
- Reverse osmosis does not remove some of the other contaminants. The Queensland DERM authorises CSG companies to dispose of certain amounts and concentrations of these toxic substances by discharging them into creeks and rivers.[iv]
- While individual releases may not cause serious damage, the total cumulative impact of discharges from all sites is unknown because Environmental Impact Studies only assess individual projects.

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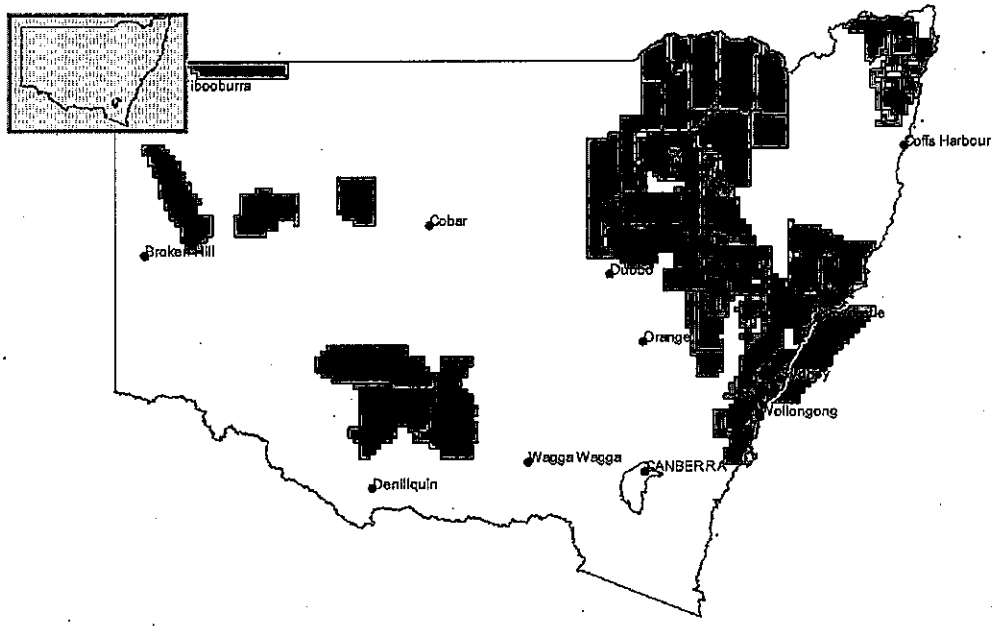
Coal Seam Gas in Context

- Approximately 25% of NSW is currently covered by coal seam gas exploration licenses.[i]
- These licenses cover major metropolitan areas, cities and towns including Sydney, Wollongong, Newcastle, Kangaroo Valley, Gunnedah, Taree, Casino and others.
- The coal seam gas is a large scale industry. In Qld today there are approximately 4000 wells already in production with 40,000 planned over the next two decades.
- In NSW 6% of the state's domestic gas supply is provided by coal seam gas currently being produced in the Camden area of Sydney. Most of the gas deposits being targeted are planned for export with proposals for an export terminal in Newcastle, an offshore gas processing facility off the coast of Ballina and a pipeline to Queensland to access export terminals being built in Gladstone.



A Map of Petroleum Licenses already issued in NSW

The environmental and health impact of CSG activities

Water Impacts: Quantity

Coal Seam Gas is trapped within the coal seam by water pressure. In order to access the gas water must be extracted from the coal seam to allow the gas to flow. This can be a large amount of water.

- In Gloucester where AGL are approved to drill 110 gas wells, the company expects the equivalent of one Olympic swimming pool per day of this wastewater to be extracted across the field[i].
- The National Water Commissioner raised concerns about the volume of water that would be extracted by CSG development in a position paper in December 2010 stating that *"Current projections indicate the Australian CSG industry could extract in the order of 7,500 gigalitres of co-produced water from groundwater systems over the next 25 years, equivalent to ~300 gigalitres per year."*[ii] This volume is more than half of existing total extraction from the Great Artesian Basin.
- In media statements in July 2011 the National Water Commissioner reaffirmed the concerns of the authority publically stating that the coal seam gas industry presents *"significant potential risks to water and our water management as a result of the scale of the development of the sector."[iii]*

Water Impacts: Quality

The water that comes up from the coal seam is often saline and contains naturally occurring chemicals from within the coal seam.

- The National Toxics Network released a report in June 2011 indicating that the BTEX chemicals (Benzene, benzene, Toluene, Ethylbenzene and Xylene) are found naturally in the coal gas seams and that the fracking process can release BTEX from the natural-gas reservoirs, which may allow them to disperse into the groundwater aquifers or to volatilise into air.[iv]
- The National Water Commissioner released a position paper in December 2010 in relation to the developing coal seam gas industry which warned that *"The production of large volumes of treated waste water, if released to surface water systems, could alter natural flow patterns and have significant impacts on water quality, and river and wetland health."*[v]
- On 4 August 2011 the NSW Environment Minister issued a formal warning to AGL in relation to an uncontrolled gas and water release at a CSG well near Campbelltown. AGL was found to have been in breach of its environmental protection license.[vi]

Health Impacts

- Doctors for the Environment Australia made a detailed submission to the Federal Parliamentary Inquiry relating to coal seam gas impacts in the Murray Darling Basin. The submission covers a range of health concerns relating to coal seam gas development.[vii]

Fracking Impacts

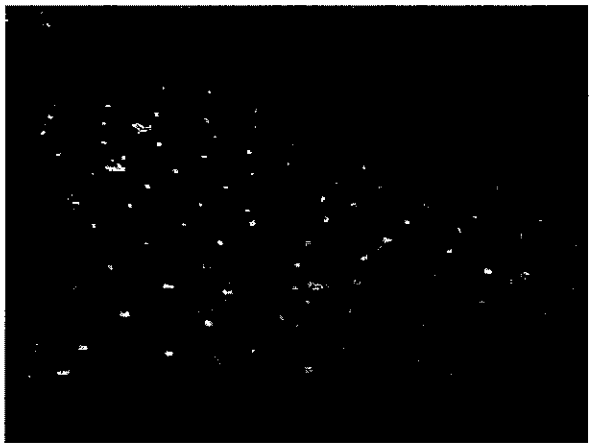
Hydraulic fracturing or 'fracking' risks contamination of fresh water aquifers. Fracking forces a mix of water, sand and chemical into the CSG well at high pressure to fracture the surrounding coal in order to improve gas flow rates. It also has the potential to create fractures outside of the seam and can link the well with fresh water aquifers. This potentially exposes fresh water aquifers to fracking chemicals and other contamination existing within the coal seam.

- Fracking has been banned in France[viii], is currently suspended in areas of the UK[ix], is suspended pending review in Quebec, Canada[x] and has strict conditions in the New York state in the US including a ban within primary aquifers and within the drinking water catchment[xi].
- A recent report showed fracking near water bores increased methane levels in those bores to potentially explosive levels.[xii]

Surface Impacts

The surface impact from CSG relate primarily to the quantity of infrastructure required to connect wells with pipelines and roads, water management facilities, processing facilities, compressor stations, and transmission pipelines to power stations and export terminals. Depending on the environment, the impact on the surface can undermine the agricultural potential of an area or significantly disrupt the environmental values of bushland.

- A report in June 2011 led to the exploration activities of Eastern Star Gas being investigated by the Federal Environment Minister for potential breaches of Federal Environment laws due to the extent of clearing within the Pilliga Forest.[xiii]



Gas Wells and Pipeline Corridors near Chinchilla in Queensland

Greenhouse Gas Emissions

Claims by industry of CSG being a clean, low emission technology are not supported by science. Very little research has been done, but what has points to CSG as having little if any greenhouse gas benefit over coal fired power.

- A Cornell University study suggests that the fugitive emissions (methane that escapes into the atmosphere during the production of gas) created in Shale Gas production in the US was so significant as to potentially make the carbon footprint of shale gas larger than coal when used for electricity generation. The processes for Shale Gas extraction are similar to those used for coal seam gas[xiv]
- Methane is 20 times more greenhouse potent than Co2 over a 100 year timescale[xv] which pushes up its carbon equivalent footprint. It is even worse if it is turned to LNG for export because a significant portion, estimated at around 10% of the gas is used in the refrigeration process to liquefy the gas.[xvi]

The economic and social implications of CSG activities

Royalties

- The coal seam gas industry currently enjoy a 5 year royalty holiday. The royalty arrangement in NSW are 0% for the first five years, 6% in year 6, 7% in year 7, 8% in year 8, 9% in year 9 and 10% in year 10 and for remaining years.
- In 2010 royalties from coal seam gas was only $462,000[xvii]
- Industry experience in NSW has shown that peak production of wells often occurs in the first few years of the life of a well with production dropping off significantly after that. This means that NSW under the current arrangements will miss out on the bulk of royalties that would be payable if a fixed 10% rate was in place.
- Coal Seam Gas royalties in Qld are a flat 10%.

Social Implications

Under NSW law the Government owns and controls mineral and gas resources under the ground. There are laws pertaining to the granting of rights to explore for and exploit those resources that give mining companies the right to force access to private land. These rights are creating tremendous anxiety and frustration in many communities, particularly in agricultural land. The issues include:

- Creating division within communities with individual landholders being able to grant access without reference to the neighbors or communities wishes. This has created some conflict between members of communities
- Impacting on land values
- Creating uncertainty where land is covered by exploration licenses which can remain under licence for years without any idea of what the plans are for exploration or development.

Food Security

Large areas of productive agricultural land in NSW are covered by existing petroleum exploration licence. There are growing arguments that these areas should be protected for growing food and because of the water and surface impacts of coal seam gas development it is a risk to the future agricultural potential of these areas to allow CSG.

The areas at risk include more than just the most productive agricultural land like the Liverpool and Moree Plains. The Sydney Basin and Hawkesbury areas also produce large amounts of food for local consumption and there are important horticultural areas in the Southern Highlands, Central West and Mid North Coast and North Coast of NSW. This all need to be protected to ensure future food security

The role of CSG in meeting the future energy needs of NSW

There are a number of future energy options for NSW including existing coal fired, potential future gas and also renewable energy and any mix in between. How these options are managed is a political question. What is known however is the intention of companies currently engaged in CSG development.

Some of the projects flagged at the moment will provide gas for domestic power generation such as at Wellington Power Station (660 MW no yet under construction and able to be supplied by existing conventional gas[xviii]), Wilga Park Power Station (16MW currently in operation)[xix] and a new power station planned at Casino (Metgasco – 30MW not yet under construction[xx]). These are relatively small power plants compared to current NSW electricity supply.

While 6% of Sydney's domestic gas is supplied by coal seam gas from AGL Camden Gas field[xxi], the bulk of projects currently being developed in Australia and NSW are targeted to the export market. Options include export from a Liquefied Natural Gas plant at Newcastle as being proposed by Eastern Star Gas[xxii]. Metgasco in Queensland are proposing an offshore processing and export facility off the coast of Ballina[xxiii] and a pipeline to Queensland would see the major deposits currently under exploration in the Gunnedah Basin and north to the Queensland border transported to Gladstone in Queensland where four major export terminals are planned[xxiv].

The argument made by government and industry is that coal seam gas is a cleaner burning fuel that should be used in a transition to renewable energy. The fact that the greenhouse gas emissions profile for CSG is subject to significant uncertainty undermines this argument. Further to this, the focus on export and the lack of discussion by the industry about retiring coal power stations to be replaced by gas suggests that this is not a serious consideration by industry.

It also needs to be noted that there is growing evidence that renewable technologies have matured to the point that there is no need for a transition fuel to fill any gap in energy demands. NSW currently has over 2,200 MW of wind energy installed, approved or proposed[xxv]. Recently in Spain a solar thermal power station with molten salt storage was commissioned demonstrating the ability for 24hour electricity from solar power[xxvi].

Beyond Zero Emission have provided a roadmap for Australia to move rapidly to zero emission energy generation within a decade with a focus on solar thermal, wind and biomass power generation.[xxvii] This could be done within a time frame as to not require a gas transition fuel.

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[i] Taken from a snap shot of petroleum titles as shown on the NSW Government's Minview site as at 1 August 2011.

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[xxv] http://en.wikipedia.org/wiki/List_of_wind_farms_in_New_South_Wales

[xxvi] http://en.wikipedia.org/wiki/Solar_Tres_Power_Tower

[xxvii] http://beyondzeroemissions.org/

Chemical, fracking use.	Common use example	Hazards, safety notes
1-Propanol. Complexor.	Used as a solvent in the pharmaceutical industry.	Hazardous chemical class 3 [1]. Highly flammable. Harmful by inhalation and if swallowed. Irritating to eyes and skin.
2-Butoxyethanol. Surfactant (used to reduce surface tension).	Used in whiteboard cleaners, liquid soaps, cosmetics and lacquers.	Poison. Causes hemoglobinuria as well as histopathologic changes in the liver and kidney. [2]

Chemical, fracking use.	Common use example	Hazards, safety notes
Acetic Acid. pH buffer (used to adjust pH).	Gives vinegar its taste.	Extremely corrosive and flammable. It requires special storage and handling considerations. Glacial acetic acid causes severe chemical burns to eyes and skin. [3]
Acrylic copolymer. Lubricant.	Used as a soil-repellent coating by the building industry.	Includes methyl methacrylate, methacrylic acid, butyl acrilate and buthyl methacrylate, all toxic chemicals used in solvents. [4]
Ammonium persulfate. Breaker. Used to reduce viscosity (turns a gel into water)	Used in hair bleach, blot gels and glass cleaning products.	Oxidizer with moderate oral toxicity. Airborne dust may be irritating to eyes, nose, lungs, throat and skin upon contact. [5]
Boric Acid. Crosslinker to increase viscosity.	Used in anticeptics to treat cuts and fungal infections (athlete's foot).	Poison. Chronic poisoning occurs in those who are repeatedly exposed to boric acid. Once used to disinfect and treat wounds, patients who received such treatment repeatedly got sick, and some died. [6]
Boric Oxide. Crosslinker to increase viscosity.	Used to produce high strength alloys, glasses and ceramics.	Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May cause kidney injury. [7]
Disodium Octaborate Tetrahydrate. Gelling agent/Crosslinker to increase viscosity.	Used as a fertilizer.	Affects the gastrointestinal tract, skin, vascular system and brain. [8]
Hydrochloric Acid. Cleaning of the wellbore prior to fracking.	Used to clean swimming pool filters.	Extremely corrosive. Inhalation of vapour can cause serious injury. Ingestion may be fatal. Liquid can cause severe damage to skin and eyes. Threshold Limit Value - 5 ppm. Lethal to fish from 25 mg/l or more. Toxic for aquatic organisms due to pH shift [9]
Methanol. Surfactant. Used to aid gas flow.	A type of alcohol, can be used in wastewater treatment and as an alternative fuel	Swallowing even small amounts has potential to cause blindness or death. Effects of sub lethal doses may be nausea, headache, abdominal pain, vomiting and visual disturbances ranging from blurred vision to light sensitivity. Repeated exposure by inhalation or absorption may cause systemic

Chemical, fracking use.	Common use example	Hazards, safety notes
		poisoning, brain disorders, impaired vision and blindness and worsen conditions such as emphysema or bronchitis. [10]
Ethylene Glycol Monobutyl Ether. Mutual solvent.	Used in household cleaners, fire fighting foam, and to degrease bowling pins and lanes.	Liquid and vapour are combustible. Harmful if inhaled, when in contact with skin and if swallowed. It is irritating to respiratory system. Causes eye irritation, affects central nervous system, blood and blood forming organs, kidneys, liver and lymphoid system. [11]
Muriatic Acid. Used for cleaning the well bore.	Leather tanning and for cleaning.	Irritating and corrosive to living tissue. Brief exposure in low levels produces irritation. Exposure to higher levels can cause breathing difficulties, narrowing of the bronchioles, blue colour of the skin, accumulation of fluid in the lungs and death. [12]
Potassium Chloride. Clay inhinbitor.	Used in making fertilizer, gas-welding flux, in medicines and for lethal injections.	Large doses cause gastro-intestinal irritation, purging, weakness and circulatory problems. [13]
Polydimethyldiallylammonium chloride. Clay control.	Flocculant in waste water treatment. Wetting agent, shampoo ingredient.	Avoid runoff into storm sewers and ditches. [14]
Quaternary Polyamines. Clay control.	Used in waste water treatment	Corrosive, dangerous for the environment. Risk of serious damage to eyes. Very toxic to aquatic organisms. Vapours may cause drowsiness and dizziness. [15]
Sodium Borate. pH buffer.	A component in glass, pottery, and detergents.	Eye irritation, blurred vision, eye damage. [16]
Sodium Hydroxide. pH buffer.	Used in paper-making, food processing, soap, detergents, drain cleaners.	Causes severe skin and eye burns. May cause blindness; severe and permanent damage to gastro-intestinal tract including burns, perforations [17]. Inhalation may lead to chemical pneumonitis, pulmonary edema. Causes severe irritation of, and possible chemical burns to upper respiratory tract

Chemical, fracking use.	Common use example	Hazards, safety notes
		– coughing, burns, breathing difficulty. Possible coma.
Tetrakis (hydroxymethyl) Phosphonium Sulfate. Antiseptic.	Used to elimate bacteria in water, petroleum.	Prolonged or repeated skin contact may cause dermatitis, liver and kidney damage. [18]
Tetramethyl ammonium chloride. Clay control.	A salt of ammonia. Few common applications.	May be fatal if swallowed. Causes dizziness, nausea, shortness of breath, severe hypotension, shock. A known ganglionic blocking agent, causing vasodilation, and curare-like actions, peripheral nerve damage, cardiac paralysis, dyspnea, effects, hypotension. [19]

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