To the Legislative Council's Environment and Planning Committee

Submission to the UCG Inquiry from Sally Newell, 10th July 2015

Introduction

I would like to begin by presenting my interest. I have three children, one 24, one 14 and one nearly 12. I would like my children to have a happy, secure future, in our beautiful state of Victoria or elsewhere in Australia, and not face the horrifying prospect of a world damaged by fossil fuels beyond the capacity of humans to repair. What happens in the next decade will determine what world they will face, and indeed determine the fate of humanity. In only twenty years we are told that our world will have passed the point of no return, we will have consumed all of the currently conservatively calculated global carbon budget (Mann 2015). As a corollary, considering the average life cycle and locked in emissions of carbon emitting purchase decisions, the world should not undertake any new installations, purchases or extraction of any new fossil fuel based energy sources or devices that use fossil fuels in only three years if we are to avoid crossing over this threshold of increasing risk of a terrifying future (Leahy 2105).

If we fail in this task my children will face a frightening world fill of conflict, extreme climate events, and growing areas that are hostile to life as we know it, and my grandchildren (if my children choose to have any children) will be looking at possibility of a world, towards the end of their lives, that can only support one billion people, and possibly no structured civilisation. John Richardson weaves a compelling narrative of the very human reactions of front line climate scientists as they face ever mounting evidence that we are very close to, or perhaps even have passed the point of no return (Richardson 2015). Australia's preeminent climate scientist John Veron, working on the impacts of ocean acidity on coral reefs, says that we are one of the two worst countries in the world for climate denial. In a one hour interview with climate communication fellow John Cook he says "what we are doing to the oceans now, we are doing in an explosive rate that has never been seen on this planet before" (UQx 2014 at 27.20) As Obama said, we are the first generation to be impacted by climate change and the last generation that can do anything about it (Obama 2014).

Our family has laboured hard in a small photography business for over twenty five years, seeking to support our children in their dreams and future lives via leaving equity in trust. Around three years ago, having read Clive Hamilton's "Requiem for a Species", we made the decision to change course, to radically down size, sell two properties and become self funded climate activists - to work that our children and our world might have a future, rather than regret that in this what is left of this "critical decade" (Steffen & Hughes, 2013) we did not give our all before it was too late. I have devoted considerable energy to educating myself about climate change and the specifics of a transition to renewables. I am currently working through Chisholm's Post Graduate Certificate in Community Advocacy with a view to working at a local government level to reduce emissions, for instance to help found Stonnington Energy Foundation (after MEFL) in the next 2 years, as well as learning to lobby effectively on carbon at a Federal level.

I would like to address all the Inquiry Terms of Reference briefly with a stronger focus ToR Two, and also add a section on emissions and climate change which I believe is of central relevance to the Committee's decision on UCG in Victoria. I find it remarkable that the Terms of Reference do not include the health

impacts of UCG as a separate term, given the large number of studies citing severe impacts (for example referenced in the large report that lead to banning UCG in New York State recently (Zucker, H 2014)), when the health of Victorians (and future drains on the Treasury) would be considered by most of us as more important than the potential for UCG to provide a "competitive source of energy" for Victoria given UCG's unfortunate track record on health and the rapid and increasing competitiveness of the alternative of non health damaging renewables - 3.87 cents per kilowatt hour is Buffet's new low (Wallace &Shahan 2015; Martin 2105).

I would commend Dr McCarron's expert presentation on You Tube to the Committee, twenty minutes tightly packed with overseas and Australian evidence of the extensive health impacts of UCG (McCarron 2015). And also Zucker's 184 page report (condensed from 900 pages) that lead to New York State's recent ban on fracking (Zucker 2014). And what was New York State Commissioner Howard Zucker's response to this vast amount of evidence: "I asked myself, 'would I let my family live in a community with fracking? The answer is no" (St Fleur, 2014). This is in no way a complete literature review, I have worked primarily from these sources to present evidence of serious health impacts, particularly to children. In view of these documented impacts I would respectfully ask the Committee to consider requesting a formal expert review of the large amount of literature currently available on health impacts of UCG, and not to subject Victorian families to an industry that is clearly not safe. I have also included some short passages from the National Networks Network Submission to the SA UCG Inquiry (2015) in their entirety due to their concise presentation of the risks of toxic contamination from UCG extraction and subsequent impacts on health and agriculture in the Australian context.

Section One: Terms of Reference

Terms of Reference 1)
The first thing that comes to my mind in considering the "prospectivity" of Victoria for UCG is an unwelcome long term perspective: what is the point of discovering available commercial UCG resources if the mining and then burning of those resources would threaten all that we hold dear - the health of those in the gas fields, the integrity of our agriculture and our environment, and contribute to the grave threat of climate change (Howard 2015). McGlade and Ekins (2015) in a landmark paper in Nature, tell that 93% of Australia's coal reserves and 74% of our UCG reserves must stay in the ground to avoid breaking the two degree limit to the dangerous territory of escalating runaway climate feedback cycles (IPCC 2013, Summary for Policymakers p. 27) with catastrophic consequences for the future. Equally, what is the point of committing considerable private public money to an industry where demand is falling (Gaventa, Dufour & Jones 2015), and assets risk being stranded in a carbon bubble caused by the concerted action of most nations in trying to limit fossil fuel emissions to avoid dangerous climate change (Leaton J 2014).

Terms of Reference 2)
Here is a summary of some of the main areas of impact.

A) Health Impacts

I would like to introduce this health impacts section with a conundrum from Bamburger & Oswald (2012 p. 71) which also occurs in Australian gas fields: the "produced water", despite its toxicity, is still given an innocuous classification (due to the lack of definitive studies) which allows it to be distributed within the gas fields "to reduce dust", thus increasing environmental exposure: "The materials extracted from underground can be equally or more toxic than the hydraulic fracturing fluid, and include radioactive material (e.g., radium-226, radon-222, and uranium-238), arsenic, lead, strontium, barium, benzene, chromium and 4-nitroquinoline-1- oxide. However, despite the actual toxicity of this material, according to the EPA, "drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of . . . natural gas" are considered "solid wastes which are not hazardous wastes". This allows the substances to be spread on roads as deicing solutions and as solutions to minimize dust and sets up a potentially lethal threat, particularly to companion animals, wildlife, and children." Dr McCarron has

documented similar practices at Tara - the UCG company sold the produced water to a council, which has a further benefit to the company of leaving any legal or health consequences firmly in the local communities lap.

The National Toxics Network (2015 p.10) links UCG to volatile organic compounds (often shorthanded to BTEX) and describes their toxicity in some detail within the paper: “Many VOCs are toxic. Some are known to cause cancer in animals (eg methylene chloride), or in humans (eg formaldehyde) or are suspected human carcinogens (eg chloroform and bromodichloromethane). VOCs are also key ingredients in forming ozone (smog), which is linked to asthma attacks, and other serious health effects. VOCs help form fine particle pollution (PM2.5). VOC exposure may result in eye, nose, and throat irritation; headaches, visual disorders, memory impairment, loss of coordination, nausea, damage to liver, kidney, and central nervous system. BTEX are components of drilling fluids and are natural VOCs released from the coal seam.”

Their is a considerable body of evidence that proximity to UCG well heads, high points, pipe lines and mining industrialisation leads to increased prevalence of a variety of health problems, particularly affecting children.

• Skin irritations

Dr McCarron found that local children in Australian gas fields have near universal and severe skin irritations which worsens with proximity (McCarron 2015). Rabinowitz et al (2014 p. 3) found that “In a model that adjusted for age, gender, household education, smoking, awareness of environmental risk, work type, and animals in house, reported skin conditions were more common in households <1 km compared with >2 km from the nearest gas well (OR= 4.1; 95% CI: 1.4, 12.3; p=0.01)” The New York study also reported much higher than normal numbers of patients presenting with skin rashes (Zucker 2014 p. 22).

• Asthma and other respiratory impacts

Dr McCarron found that local children in Australian gas fields have high rates of asthma asthma which worsens with proximity and is relieved with travelling away from the gas fields (McCarron 2015). The New York report highlighted the dangers of methane “which have been linked to asthma” (St Fleur 2014); also “the hazard quotient for benzene from the SUMMA canister sampling summarized in the Table in Appendix B was high enough at the proposed setback distance at four of the drilling locations sampled to be of concern” (West Virginia Department of Environmental Protection 2013 p, 19). Rabinowitz et al (2014 p. 3) found that “Upper respiratory symptoms were also more frequently reported in persons living in households less than 1 km from gas wells (39%) compared to households 1-2 km or >2 km from the nearest well (31 and 18%, respectively)”

• Elevated levels of many toxic chemicals in the atmosphere

Dr McCarron presented a compelling range of atmospheric toxic chemicals associated with UCG extraction, some showing levels 10-100x above safe levels (McCarron 2015). The New York study found that UCG extraction correlated with significant methane emissions with asthma risk; dust and benzene from truck idling and movements; and “longer-term climate change impacts from methane accumulation in the atmosphere (Allen, 2013; Bunch, 2014; CDPHE, 2010; Macey, 2014; Miller, 2013; Petron, 2012; Weisel, 2010).” (Zucker 2014 p. 5).

I would like to present a passage from the National Toxics Network (2015 p. 10) detailing VOC’s in Tara, Queensland which clearly links these highly toxic chemicals to UCG:

“While there has been no comprehensive monitoring of air pollutants in the Tara community near gasfields, industry and government sampling of ambient air around homes detected a wide range of VOCs. These included many toxic VOCs, eg acetone, acrolein, alpha-pinene, benzene, benzothiazole, chloromemethane, cyclohexane, dichlorofluromethane, ethanol, ethyl acetate, ethylbenzene, 2-ethyl-1-hexanol, heptane, hexane, heptadecane, hexadecane, 2-methylbutane, methylcyclohexane, methylene chloride, methyl ethyl ketone, 3- methylhexane, 3 methylpentane, naphthalene, pentane, phenol, propene, tetradecane, tetrachlorethylene, 1,2,4,-trimethylbenzene, toluene, vinyl acetate, xylene, ethanol, phenylmaleic anhydride, methyl ethyl ketone.

Toluene, a neurotoxin was detected in the air around at least eight Tara homes and in the air over a private bore. In the latter it was well above the 'Chronic Reference Exposure Limits' used by many states in the USA (eg California, Massachusetts, Michigan) for assessing the impacts of long term exposure.

Community sampling in the vicinity of gas activities over an eight hour period also detected ethanol and chlorofluorocarbons (CFCs). Dichlorodifluoromethane, a potent CFCs, was detected in all samples.

In July 2014, State government sampling outside a family residence adjacent to the gasfields identified Acrolein at 9.6ppb, more than 100 times higher than acceptable chronic exposure standard. The Texas annual criterion is 0.066ppb. Acrolein is an acute irritant of the eyes, nose, throat, lungs and skin and is reported to be used by the oil and gas industry as a biocide in drilling waters, as well as a scavenger for hydrogen sulphide and mercaptans. Flares are also a possible source of acrolein. Formaldehyde, as well as acetaldehyde was also detected."

• Severe and recurrent nosebleeds
This is one of the most distressing impacts of UCG and is well documented through images and anecdotes. The New York study reported many patients presenting with nosebleeds (Zucker 2014 p. 22).

• Neurological effects
McCarron found that one third of children at Tara had parasthesia (abnormal sensations and numbness) and some had "abnormal movements" (central nervous damage) (McCarron 2015).

• Increase incidence of severe congenital abnormalities
US studies have shown 100% increase in neural tube defects and 30% increase in congenital hear defects (St Fleur 2014). This Colarado study examined rate of neonatal damage in 124,000 births and showed that "Prevalence of CHDs increased with exposure tertile, with an odds ratio (OR) of 1.3 for the highest tertile (95% CI: 1.2, 1.5); NTD prevalence was associated with the highest tertile of exposure (OR = 2.0; 95% CI: 1.0, 3.9, based on 59 cases)" (McKenzie et al 2014). The New York review found evidence that low birth weight and other adverse neonatal health indicators were correlated with close proximity to existing well heads (Zucker 2014 p. 19).

• Increases in particulates which are class one carcinogens and other cancer risk including from radioactive compounds
Zucker found evidence of higher levels of carcinogens and particulates "NIOSH has also reported that the occupational fatality rate among oil and gas industry workers is seven times higher than the average rate for all US industries" (Retzer, 2011 cited in Zucker 2014 p. 27). The National Toxics Network (2015 p. 9, 12) also links UCG with cancer causing particulates and notes the health risks of silicates. Benzene is also implicated in an elevated cancer risk and was found around the well pads.

The National Toxics Network (2015 p. p. 13-14) clearly links UCG extraction with much higher levels of naturally occurring radioactive materials (NORMs) and subsequent cancer risk:

"NORMs are often present in high concentrations in gas-bearing shale, and may be brought to the surface via drill cuttings and other waste from the well. NORMs can be concentrated by human actions (i.e., drilling and processing ores) and this concentrated, technologically (human) enhanced naturally occurring radioactive material is called TENORM.

Uranium, thorium, radium-228 and radium-226 are found in both coal seams and shale.48 The radioactive material can be released to the environment through disposal of drill cuttings/muds, flowback water and through air emissions. Radon-222 is the immediate decay product of Radium-226 and preferentially follows gas lines. It decays (through several rapid steps) to Pb-210, which can build up as a thin film in gas extraction equipment. The level of reported radioactivity varies significantly, depending on the radioactivity of the reservoir rock and the salinity of the water co-produced from the well. The higher the salinity the more NORM is likely to be mobilized. Since salinity often increase with the age of a well, old wells tend to exhibit higher NORM levels than younger ones.49

Both radon and radium emit alpha particles, which are most dangerous when inhaled or ingested. Radium is a known carcinogen50 and exposure can result in increased incidence of bone, liver and breast cancer. When inhaled, radon can cause lung cancer, and there is some evidence it may cause other cancers such as leukemia.51 Consuming radium in drinking water can cause lymphoma, bone cancer, and leukemias.52 Radium-226 and radium-228 have half-lives of 1,600 years and 5.75 years, respectively. Radium is known to bioaccumulate in invertebrates, mollusks, and freshwater fish,53 where it can substitute for calcium in bones."

• Poor studies partly due to conflicts of interest, lack of testing and poor methodology

Existing health reports have suffered from poor methodology such as being based on affected people volunteering information only or intermittent testing which was discontinued (McCarron 2015, p.p. 28-25), genuine difficulties and ethical conflicts involved in doing longitudinal prospective cohort studies (Zucker 2014 p.18). Studies are also hampered by confidentiality agreements with affected persons (Bamberger and Oswald 2014 p. 67), lack of skilled researchers or Government or industry funding due to conflicts of interest (personal phone conversation with Doctors for the Environment researcher in late January 2015 while preparing material related to the Queensland election). Bamberger and Oswald (p. 69) cautioned that disclosure of particular chemicals "is not required if a component can be justified as a "trade secret"" and "Complete evidence regarding health impacts of gas drilling cannot be obtained due to incomplete testing and disclosure of chemicals, and nondisclosure agreements. Without rigorous scientific studies, the gas drilling boom sweeping the world will remain an uncontrolled health experiment on an enormous scale." (p.69).

B) Environmental Impacts

UCG severely impacts Australia's scarcest resource, water, and also impacts the atmosphere, both in terms of toxicity, but also in terms of climate change. Please consider the case of the WorleyParsons Study where the UCG industry was asking the public to trust the bare outline of a report (from a service provider) that suggested that GHG potential of UCG was a bare 30% of coal, but refused to release the report citing "confidentiality". Making quite the opposite point was a study by Howarth published in the peer reviewed journal *Climate Change Letters* attempting to measure fugitive emissions from shale gas, practically for the first time, which reached a very different conclusion (Manning 2011).

Since then Santoro from Cornell has concluded that "assuming a 20-year timeframe and using the most up-to-date figures for the global warming potential of methane, natural gas potentially contributes more to climate change than coal does." (cited in BZE)

• release of very potent green house gases including methane, that nullify any GHG saving associated with the transition from coal to gas

The Cornell study concludes "Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years" (Howarth, Santoro and Ingraffea 2011).

BZE interviewed Patrick Hearps, a researcher from the Melbourne Energy Institute on the the carbon intensity of UCG:

"Fugitive emissions from coal seam gas are significant. Even if only a few percentage points of fugitive emissions across the whole process are released then the supposed benefits of gas will be eroded. Methane is 25-times worse than CO_2 over a 100-year period. But when its impact is considered over a 20-year period — which is a reasonable timeframe given our proximity to climate change tipping points – the climate change forcing is 72-times greater than carbon dioxide.Taking into consideration the total life cycle emissions of coal seam gas, particularly methane, its emissions intensity is likely to be a lot closer to coal fired power. Increasing the use of coal seam gas will increase the difficulty of achieving mid- to long-term emissions reduction goals. Coal also produces fugitive emissions that are sometimes vented and sometimes flared. Such emissions would also need to be considered by national greenhouse accounting.There hasn't been enough research. In Australia, it's standard practice to estimate fugitive emissions based on general factors from the American Petroleum Institute's Compendium. It could be

argued that using these figures is not as impartial or independent as it could be, or that they do not accurately reflect the Australian industry." (BZE)

The National Toxics Network (2015 p. 9) also links the "2,500-square-mile cloud of methane over the region, where the borders of Arizona, Colorado, New Mexico, and Utah intersect" to UCG activity, and cites a Queensland Government study that "found 26 of 58 gas wells tested leaked methane; one above the lower explosive limit (LEL), 4 at or above 10% of the LEL and 21 with levels between 10- 3000ppm. Similar figures were found in surrounding gas fields"

• release of naturally occurring BTEX compounds and other contaminates into the atmosphere and into groundwater.
Noted expert Prof Anthony Ingraffea, Cornell, discusses the risks of UCG production: "It is physically impossible to ensure that a well will not leak", and that leak rates at 5-7% for new well which increases with age. He notes that the well will still exist after production, and that regulations only apply during the productive life of the well, and that afterwards the community "will have to bear the costs of monitoring and maintaining that well for ever." (Land Water Future 2014 at 3.55m). Also of concern is the large number of wells in close proximity in an UCG gas field "approximately 8-10 per square mile" increasing the likelyhood of failure and then exposure (Ingraffea 2013).

I would be grateful if the Committee would consider the following extract of the expert National Toxics Network (2015) which lists an enormous number of industrial and hazardous chemicals commonly used in UCG/HF:

"At a minimum, HF usually requires:

- biocide to prevent bacterial action underground (eg glutaraldehyde, THPS, DBNPA);
- clay stabiliser to prevent clay expanding on contact with water and plugging the reservoir (eg tetramethyl ammonium chloride);
- gelling agent to hold the proppant in suspension (eg mixtures of guar gum, diesel);
- gel stabiliser (eg sodium thiosulphate) and gel breaker (eg sodium persulfate);
- friction reducer to ease pumping and evacuation of fluid (eg polyacrylamide, mixtures of methanol, ethylene glycol, surfactants); and
- buffer fluids and crosslinking agents.
  HF may also utilise corrosion inhibitors (eg formamide, methanol, naphthalene, naptha, nonyl phenol); scale inhibitors (eg ethylene glycols); iron control (eg citric acid, thioglycolic acid); pH adjusting agents (sodium or potassium carbonate) and various surfactants to affect fluid viscosity (eg isopropanol, 2-BE.) Large quantities of proppant are used for each fracturing, consisting of sand or manufactured sol-gel ceramic spheres based on alumino- silicates.
  More than 750 chemical products containing 650 hazardous substances plus 279 products with trade secrets were identified by the US House of Representatives Committee on Energy and Commerce. These include carcinogens (eg naphthalene), neurotoxins (eg isopropanol), irritants/sensitisers (eg sodium persulfate), reproductive toxins (eg ethylene glycol) and endocrine disruptors (eg nonylphenol). Some of the chemicals were found to be dangerous at concentrations near or below chemical detection limits (eg glutaraldehyde, brominated biocides (DBNPA, DBAN), propargyl alcohol, 2-butoxyethanol (2-BE), heavy naphtha.)
- A number of chemicals used in hydraulic fracturing have recently been identified as endocrine disrupters. These include ethylene glycol monobutyl ether, 2-ethylhexanol, ethylene glycol, diethanolamine, diethylene glycol methyl ether, sodium tetraborate decahydrate, 1,2-bromo-2-nitropropane-1,3-diol, n,n-dimethyl formamide, cumene, and styrene.

• aquifer contamination with toxic chemicals and leakage from ponds

Both McCarron and Zucker are very concerned about the impact on UCG on aquifer levels and about the health impacts of water contamination; "produced water" is left in ponds that will inevitably leak or spill or is sprayed on local roads.

Zucker concludes: "Studies have found evidence for underground migration of methane associated with faulty well construction (Darrah, 2014; US EPA, 2011). For example, a recent study identified groundwater contamination clusters that the authors determined were due to gas leakage from intermediate-depth strata through failures of annulus cement, faulty production casings, and underground gas well failure (Darrah, 2014). Shallow methane- migration has the potential to impact private drinking water wells, creating safety concerns due to explosions" (Zucker 2014 p. 5)

• **multiple earthquakes** are associated with fracking and csg globally (Zucker 2014 p. 6).

• Dr McCarron documented reports of **toxic acid rain** which strips paint off cars at Ph 4.36 associated with the use of produced water for dust control activities (McCarron 2015).

C) Agricultural Impacts

• increase in groundwater and soil salinity and contamination of groundwater and aquifers

UCG has a high risk of contamination of water with toxic chemicals (Ingraffea 2013), leading to poisoning of livestock and contamination of our high quality agricultural industry products "BTEX chemicals have been found in 5/14 monitoring wells in Queensland gas fields; benzene at levels 6 and 15 times Australian drinking water standard. Toluene and methane were also found in private drinking water bore adjacent to gasfields (National Toxics Network 2015 p.15).

This extract from the National Toxics Network (2015 p. 15) describes the difficulties in adequately treating produced water in Queensland leading to UCG chemical contamination of the environment:

- Produced water tends to be of high salinity and large quantities of salts are a by-product of CSG production.
  Produced water is either reinjected into aquifer formations, used for dust suppression on roads, reused for brick making, sent to holding ponds or partially 'treated' and released into waterways. The treatments to remove contaminants from produced water are limited by the chemicals they can remove, the energy needed and their economic costs. Reverse osmosis filtration has significant limitations and cannot remove many of the organic chemicals used in UG activities. Low molecular weight, non polar, water-soluble solutes such as the methanol and ethylene glycol are poorly rejected.
  In Queensland, the UG company, Santos claimed in their original environmental impact statement that they would treat the produced water to Australian standards before disposing of it in local waterways (Dawson Creek). However, Santos found that they were unable to treat the water to Australian standards. (Ammonia was 45 times guidelines, sulphate was 80 times guidelines, boron was 8 times guidelines and total suspended solids were twice guidelines). In late 2012, they requested permission to dump this contaminated water and they were given permission by the Queensland government to pump 12-18 million litres per day of contaminated water into the Dawson Creek.

• depletion of groundwater

UCG extraction uses up very large quantities of water, leaving less of human and agricultural use, particularly draining aquifers. This leads to conflict between agricultural and mining usages of water. National Toxics Network (2015 p. 17) "Depending on the depth and permeability of the formation, shale gas requires between 7.7 - 38 megalitres / ML (2-10 million gallons) of water each time the well is hydraulically fractured. UNEP reports a single fracking operation on a shale gas well may use between 11 and 34 million litres of water. As wells may be fracked up to 10 times and large amounts of water are also used in drilling processes (approx 1 million litres per well), the combined impacts of the shale gas industry

may lead to significant pressure on water resources particularly in areas already experiencing drought or drier than normal conditions."

D) Community Impacts

• immediate community impacts of UCG include division and mistrust, then falling property values as the industrial process occurs and health impacts start to bite, agriculture being impacted, followed by families being bought out under confidentiality agreements, and communities being closed or relocated.

• unconventional gas extraction has near universal local disapproval, is strongly resisted, and proceeding is against communities self determination.

Terms of Reference 3)
I would request the Committee to consider the real situation with coexistence with agriculture and tourism in the medium and long term, and not just be blinded by attractive UCG industry propositions on short term export revenue and jobs.

The Australia Institute's submission to the SA UCG Inquiry mentions that the state's entire oil and gas industry employs only 2/3 of as many people as Bunnings and states "The gas industry is, however, relentless in its claims about job creation. It commissions modelling, creates dedicated websites and runs national multi-million dollar advertising campaigns that focus on the potential for the industry to create huge numbers of jobs" (Grudnoff, Campbell & Ogge 2015). TAI concludes that UCG is a "small employer", making "only a small contribution to the state budget" and has "serious impacts on local communities and other industries." TAI cites the Sustainable Minerals Institute Darling Down study and states that even an industry study was forced to note that "local businesses, farmers, the community and the advocacy sector consistently believed CSG and mining had led to a deterioration of.. financial capital .. built capital …. human capital .. [and] social capital" through poaching of skilled labour, increased costs and particularly a boom and bust cycle where "The flow on benefits to businesses servicing the mining construction is fleeting and disruptive to those businesses that do not service the mining industry (most businesses)."

Sharon Kelly (2015), in the very respected De Smog Blog, reports the IEA's blunt message on climate impacts on energy companies, and cites Potsdam Institute's founder Prof Schellnhuber, advisor to the Pope, on disruptive changes: "In order to stay below 2 degrees C (36F), or even 3 degrees C, we need to have something really disruptive, which I would call an induced implosion of the carbon economy". The take home message is fossil fuel investments look really risky, with a new wave of bankruptcies surfacing, "In late March, Moody's Investment Services added 25 oil and gas-companies to its watch list of most financially stressed firms, double the usual number". Other reports reinforcing this news include one in May by Standard and Poors: "fully one third of the world's three dozen corporate debt defaults this year were by oil and gas companies" (Loder 2015). Chatham House, a major advisory group, also highlights the risk of stranded assets in a recent report, stating that oil and gas prices are unlikely to recover and advising that the Paris talks will determine that the core viability of the oil and gas industry is in doubt (Mitchell, Marcel & Mitchell 2015). "Investment in gas infrastructure will become more risky…. traditional infrastructure financing based on long-term contracts with stable tariffs and volumes will not be not sufficient to deal with those risks".

This expansion in the consequences of growing debt which has been secured via future demand and reserves which about to be deemed unable to be extracted will have major implications for local and regional development, investment and jobs, as contractors are "cutting their costs to the bone" or "offering their services at cash break-even costs" (Ryder Scott 2015). "Landowners who leased their acreage for drilling have seen their royalties plummet as smaller companies go bankrupt — leaving them also on the hook for any pollution or damage since insolvent companies have no budget to pay for their liabilities" (Kelly 2015).

Worldwide resistance and opposition to UCG is mounting rapidly, from towns and councils, to regions, States and now whole countries. Movements such as Lock the Gate have mobilised resistance in Australia,

forming a platform for communities to assert their rights, organise, educate and substantially impede the advance of UCG which is universally unpopular except for some local town business people, and those hoping to profit, including politicians. Please listen to the energy and conviction of Leo Sayer's song *No Fracking Way:* "Did you think we'd stand by and let you do it?.. No Fracking Way No Fracking Way No No NO No Fracking Way….Get your dirty mitts off…." (Sayer 2013, first chorus)

The overall picture for UCG expansion into Victoria is one of unacceptable risk to individuals, local business, communities and State finances, where UCG companies become mired in debt, and leave a trail of wreckage which they can no longer fix pushing the burden back on individuals, local business, communities and the State. UCG causes serious disruption to agricultural practice through the close proximity of 24/7 industrial process, roads and truck movements; poses unacceptable short and long term impacts to the quality and quantity of water; and reduces property values, leaving families stuck, unable to move out despite severe health impacts.

Terms of Reference 4)

It is likely that domestic consumers will not benefit from UCG as an "affordable" "competitive source of energy" due to having to compete with export prices. One of the most competitive sources of energy is using less through energy efficiency programs or retrofit programs which can also be a source of jobs, and reduce, not create green house gas emissions.

I am curious why the Inquiry specifies only carbon dioxide emissions when the methane released from UCG wells, high points and nearby water sources is a most potent source of greenhouse gases.

I wish to address climate change separately below, presenting an argument against the emissions from coal seam gas from the perspective of the urgency of our global climate change mitigation task, and our responsibility to future generations.

Terms of Reference 5) and 6)

Dr McCarron describes many instances of ongoing safety issues with regular admissions of spills, lax or ceased monitoring, reports with poor methodology, and ingenious solutions to "produced water" that include selling it to local councils to spray on roads for "dust suppression", giving rise to acid rain that is potent enough to strip paint off cars.

Cornell UCG export Professor Ingraffea, drawing on a huge data base from millions of wells drilled world wide, with hundreds of thousands leaking says that consistently one in twenty wells will leak first up (Land Water Future 2014 at 4.31). Commenting on the NSW regulations from his vast knowledge of such regulations he notes the word "should" as being distinct from "must" and defined as "recommended" "from among options". Hence wording such as "title holders should ensure that cement design should avoid cement shrinkage" is not legally required, and in fact is a loophole, compared to comparable US requirements. In a TED talk prior to the New York consideration of UCG safety that lead to its permanent banning, Ingraffea shows an industry graph showing single digit figures for leaks almost immediately, followed by figures of around 30% of wells leaking after ten years (Ingraffea 2013 at 7.15). He also notes that similar rates of "sustained casing gas venting" occur over all mining sectors and that most wells fail by maturity. Shale or deviated wells also had much much higher rates of leakage over 60%. Ingraffea's Cornell University study in Pennsylvania (Ingraffea et al 2014) examined 75,000 inspection records for over 41,000 wells for "zonal isolation" (industry term for leaking) and found that the shale wells leaked at a higher rate of around 13% however the earlier wells failure rate had escalated to 50%. It didn't matter that Pennsylvania having "the toughest regulation in the world", mechanically the wells continued to fail, until they were no longer inspected. Ingraffea concluded that cement failure is ubiquitous, chronic and worse in "modern wells", and not amenable to regulation, and that from an annual 25-30,000 wells drilled annually in Pennsylvania, that very many water wells (thousands) will be contaminated and methane emitted.

It is clear that industry self regulation is not going to work. It is in not in an UCG extraction firm's interest for air or water toxicity testing to be carried out, or for there to be clear records of breaches of environmental regulations, and official reports have been found to be made with flawed methodology or are based on limited terms of reference that would decrease the attention paid to environmental and health concerns. For example Dr McCarron notes that industry environmental air testing carried out by QGC was "extremely limited" consisting of "only 13 air samples being collected" (McCarron 2013 p. 35). It also is instructive to look at Dr McCarron's criticism of the methodology of the Queensland Government official health report into the CSG industry, where despite reported symptomology, Minister Springborg concluded that there "was no evidence of health effects related to CSG". McCarron notes that the report is based only on 3 sources of data: calls to a 13 Health number, presentation to Doctors in clinics and hospitals with only 2 clinics attended by an the Government expert. She had previously noted incidents of local patients being passed over in favour of CSG workers; one worker's severe symptoms being totally ignored; and exclusion of data from November December time frame which coincided with a major peak in reports of illness, including extremely high levels of the neurotoxin toluene metabolite in at the urine of a gas fields 3 year old.(McCarron 2015 p.p. 28-31). In contrast McCarron's survey found hard neurological symptoms in one third of all 48 children at Tara.

Consistently, on a world wide basis, the industry cannot as well as will not abide by regulations, and the US experience has been that when the gas is exhausted the local community is left with much land and water that is toxic, unable to be farmed, and a community where many have had to flee due to health and environmental impacts with no tourist industry to speak of.

Section Two: Climate Change

Climate change (AGW) is humanity's and our planet's biggest threat (Howard 2015). We are the "last generation that can do something about it" (Obama 2014). This "critical decade" (Steffen & Hughes, 2013) is half gone, and the carbon budget allocated by international consensus is predicated on only a 66% success of crashing through the 2°C (450ppm CO2) barrier (IPCC 2013, Summary for Policymakers p. 27). This accounting is inherently out of date (McKibben 2014); some authors believe we are at 2°C already due to inherent lags in the climate system (Spratt 2013) or that a focus on 2°C limit and associated carbon budget is misleading (Anderson & Bows 2008, p. 3880). Four of the identified 6-7 major climate tipping points appear close to irreversible positive runaway feedback: Greenland Ice Sheet loss (Csatho 2014; Hsu 2014) at 1.6°C warming; Arctic Permafrost loss at 1.5°C (Spratt 2014). Many of these longer feedback process have not been accounted for in current climate modelling - for instance a loss of one month of summer Arctic sea ice equals 0.2 degree warmth (Spratt 2014). New modelling suggests that permafrost melt will contribute between 0.25-1°C by 2100, regardless of any improvement of emissions, and will cancel carbon sinks for the next two centuries (World Resources Institute; Skuce, 2012). Part of the West Antarctic Ice Sheet has been confirmed to be irreversibly moving into the sea (Rignot et al. 2014; Goldenburg 2014), and now we learn that the major Atlantic ocean currents are slowing due to the Greenland melt (Rahmstorf et al. 2014; Rahmstorf 2015); and that the Amazon can no longer be relied on to be a carbon sink due to warming and deforestation "contrary to expectations based on models" (Brienen et al 2015). Micheal Mann (2015) puts crossover (the end of a conservatively calculated global carbon rate) to dangerous climate change as early as 2036, and a New Scientist special report says that a 5m sea level rise is locked in already and that we have to act rapidly to avoid 20m (New Scientist 2015).

Despite the urgency and paramount importance of transitioning away from fossil fuels and towards renewables, public discourse and national policy in Australia overwhelmingly reflect the corporate profit oriented realities of Business As Usual. Current rates of emissions (RCP 8.5) would see us move past 4°C of warming well before 2100 (World Resources Institute); costing us "the ecosystem services upon which human livelihoods depend" (Warren cited in Spratt 2014). A 4°C future is incompatible with an organised global community; is likely to be beyond 'adaptation'; is devastating to the majority of ecosystems and has a high probability of not being stable" (Anderson cited in Spratt

2014). Population, agricultural practices and emissions are pushing our planetary boundaries; some already at "high risk of dangerous impacts" (Stockholm Resilience Centre, Research Fig 1, Fig 3) The world's known fossil fuel reserves contain five times the IPCC carbon budget (Johnson 2012 p. 5), that if burnt, would bring us to the edge of extinction (Cribb 2014).

Despite this alarming news Australia's power brokers are entrenched in structural denial, controlling Australia's public policy on energy mix and resource extraction, seeking to resist the deep decarbonisation process that is required if we are to avoid dangerous climate change. Australia's proposed fossil fuel expansion would, if set against the rest of the world acting to limit warming to 2°C, see our emissions climb to an untenable 16% of global by 2050 (Drew 2014, p. 12). New research (McGlade and Ekins 2015, p 190), concludes "that a stark transformation in our understanding of fossil fuel availability is necessary" and suggests that 93% of Australian coal reserves must stay in the ground (Table 1 p.197), and that 74% of OECD Pacific unconventional gas reserves must stay in the ground (Extended Data Table 3). The expected Australian coal reserves (150GtCO2) are 75% of the lower limit of the total global carbon budget of 200GtCO2 for an 80% chance of meeting the 2°C limit (Sussams et al. 2013 p. 5) - new modelling on permafrost contributions reduces global carbon budget by around 30% (Skuse 2012). Although McGlade and Ekins acknowledges UCG as a transition fuel, principally in the US, this key paper states that development of UCG reserves would be contingent on reducing current levels of coal production (p 190); the Australian Government is determined to fast track as much coal expansion as possible. In this context, further expansion of total Australian UCG in doubly irresponsible.

Heads of prominent global organisations have called for coal to stay in the ground, and for us to decarbonise (Milman 2015; UN News Centre 2014). The key driver for CO2 emissions is "the continued flow of capital investment into fossil fuel extractive industries, primarily due to the lack of certainty, leadership and authority in climate change policy from national governments" (Johnson 2012 p. 39). In Australia we pay lip service to climate mitigation, bailing on our fair share and fudging our commitments (Hamilton 2014: Williams 2014), and setting in train institutional change and reviews that impede progress on combatting climate change (Parkinson 2015).

How can we possibly act to rob our children and their children of their birthright; health, a safe place to call home, a future filled with hope not fear and death. In the face of the global urgency to transition to renewables given the overwhelming scientific evidence, and global concern about climate change as our "top threat" (Pew Research Centre 2015); proposing new carbon extraction and burning is tantamount to intergenerational theft, a crime against the future, against those for whom we strive with all our hearts, as parents against those whose hopes fill the deepest places of our hearts.

The costs of many forms of renewable energy continue to plummet, and have achieved parity with extractive based generation. If the Committee recommends the expansion of UCG into Victoria, this recommendation will result in significant locked in emissions, when the energy could come from renewables for the same price, with the added benefit of much lower costs later. The small number of jobs from UCG and a temporary increase in expected State revenue has to be set against the price of severe environmental and health impacts and their deferred financial burdens.

I would respectfully ask the Committee if they would consider taking a bold step to secure the future of our State and families and join a growing number of regions and countries who recognise the grave dangers of UCG mining and institute a permanent ban.

Conclusion

Unconventional gas extraction presents a severe risk to the health of the families in the surrounding region, particularly to children.

Unconventional gas extraction risks Australia's most precious and scarce environmental and agricultural resource - water - through draining aquifers, and polluting groundwater.

Unconventional gas extraction has been hailed as a reasonable bridging fuel on the way to renewables but when fugitive emissions are counted, unconventional gas is just as green house gas emissions intensive as coal in the long term and worse in the short term (Howarth, Santoro & Ingraffea 2011). UCG also locks in new fossil fuel sources when we must rapidly transition to renewables or risk devastating damage to future generations. Exhaustive modelling has shown that renewables could handle base load in Australia (Diesendorf 2014; Elliston, MacGill & Diesendorf, 2014) - why risk this expensive detour to an industry that brings only temporary jobs, divided communities, ruin and disease in its wake for a mere decade of mostly exported corporate profit.

Unconventional gas extraction risks being part of the global carbon bubble, a new stranded industry mired in unpayable debt, fiscally and environmentally irresponsible: "if investors continue to pour money into pursuing assets that will wind up stranded, they stand to lose enormous sums of money" (Mitchell, Marcel & Mitchell 2015). Communities and States will then be left to bear the costs of wrecked agriculture and ruined environments.

Unconventional gas extraction damages local communities and families. There is good evidence that unconventional gas extraction is not safe, which is why many communities bitterly oppose it and a growing number of states and nations have banned the practice.

I wish to state that I believe UCG is a hit and run assault on communities, and do not support any form of unconventional gas extraction in Victoria including coal seam gas, tight gas, shale gas and underground coal gasification.

I would respectfully ask the Committee not to risk the health of present and future generations and recommend a permanent ban on unconventional gas mining. Such a ban (and in the first instance banning exploring and drilling permits) will assist in creating a secure future for our agriculture and tourism industries and will speed progress in Victoria's transition to renewables, necessary in creating a safe and just future for Victoria and protect the world of our children and our grandchildren.

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