CLIMATE COUNCIL

KICKING THE GAS HABIT: HOW GAS IS HARMING OUR HEALTH

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Authors: Professor Hilary Bambrick, Dr Kate Charlesworth, Dr Simon Bradshaw and Tim Baxter.

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info@climatecouncil.org.au
climatecouncil.org.au

Professor Hilary Bambrick
Climate Councillor

Dr Kate Charlesworth
Climate Councillor

Dr Simon Bradshaw
Acting Head of Research

Tim Baxter
Senior Researcher
(Climate Solutions)

Contents

Key findings

1

Unconventional gas development, including fracking, is exposing Australian communities to unnecessary health risks.

- Gas extraction and processing involves many hazardous substances including those that cause cancer, interfere with hormones, trigger asthma and contaminate the local environment through airborne pollution and wastewater.
- Unconventional gas extraction, including coal seam gas and shale gas, with or without fracking, introduces further risks to human health.
- There is growing overseas evidence of health impacts on communities living close to gas wells, including on reproductive and respiratory health.
- Evidence of negative health impacts in Australia is emerging, and while independent research, free of any ties to the gas industry, from here is limited, this is consistent with overseas studies.
- Continued expansion of gas across the country puts more Australians at risk of adverse health impacts.

2

Burning gas at home can harm our children's health.

- Far from the "clean and natural" image that the gas industry markets, the use of gas for heating and cooking indoors carries many health risks.
- Cooking with gas is estimated to be responsible for up to 12% of the burden of childhood asthma in Australia. A child living with gas cooking in the home faces a comparable risk of asthma to a child living with household cigarette smoke.
- Better ventilation, including modern extraction fans over stoves, flues for gas heaters and other safety measures like ensuring appliances are properly serviced or opening windows can reduce – but not eliminate – these risks.

3

Children and poorer households are at highest risk from, and most likely to be harmed by, gas production and use.

- Gas production and use poses additional risks for babies and children. At the production phase there is mounting evidence of associations between living close to unconventional gas extraction and impacts upon early-life development. Within homes, the indoor air pollution from gas used for heating, cooking and hot water disproportionately risks children's health.
- In addition, poorer households are more exposed to the harmful effects of gas appliances: they are less able to afford proper maintenance, and more likely to be renting or living in public housing where they rely on old, poorly maintained gas appliances.

4

Gas is a polluting fossil fuel. Governments can prevent health issues, and reduce harm, by helping households, and the country, get off gas.

› While today's gas may have once been a welcome upgrade from still dirtier fuels such as town gas, wood, coal or kerosene, gas appliances have fast become a poor and polluting cousin to more efficient and healthier electric alternatives.

› Simple, practical policy steps from governments like ending mandatory gas connections for new residential developments – as has occurred in the ACT – and incentives that help people replace gas appliances with electrical alternatives, will speed up the switch already underway and promote better health outcomes.

5

Clean energy alternatives like solar and wind are the key to a prosperous, healthy future for all Australians.

› Australia does not need to rely on gas for domestic energy security or for export revenue. As the sunniest and windiest inhabited continent on Earth, Australia is blessed with some of the world's best renewable energy resources – enough to support both our own energy needs and a large renewable-powered export industry.

› Renewables, like solar and wind, backed by storage, like batteries and pumped hydro, now offer the cheapest sources of electricity for Australians.

› For households, shifting from as to efficient electric appliances can save money over time and be good for our health, while reducing burdens on the healthcare system.

Recommendations

1

Transitioning out of gas production.

Australia must rapidly move beyond fossil fuels, both for domestic use and exports, including gas. Renewable energy, backed by storage, offers the best path to affordable and reliable electricity for homes and industry. Over time, gas used in manufacturing processes can be replaced by renewable alternatives.

As first steps to a future beyond gas, the federal, state and territory governments should:

a) Rule-out public funding for new gas developments and associated infrastructure.

b) Ban further unconventional gas development.

c) Implement an economic recovery that maximises opportunities for jobs and prosperity in clean energy, energy efficiency, ecosystem restoration and other climate solutions.

d) Impose stringent monitoring for emissions, leaks, flaring and care of decommissioned wells.

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2

Helping families, schools and workplaces move off gas.

Governments also have an important role to play in helping homes, schools and businesses move progressively away from gas and on to healthier, cleaner alternatives, and in particular to support people on lower incomes. Existing technologies including heat pumps and induction cookstoves provide efficient electric alternatives to gas for heating and cooking respectively. Gas users should be strongly encouraged to switch to electric alternatives once existing appliances reach the end of their life, if not sooner.

Governments should also remove any policies that actively encourage use of gas.

State and territory governments should:

a) Provide incentives for homes, schools and businesses to switch to electric appliances, including subsidies for low-income households.

b) Phase out gas connections in new residential developments and remove any planning rules that require new residential developments to be connected to gas. This includes removing rules that restrict local governments from banning gas connections in new residential developments.

c) Introduce planning rules and building regulations that encourage installation of non-gas-powered heating and cooking – such as induction cooktops, reverse cycle air conditioning or electric heat pumps for water – in all new homes.

2 *(Continued)*

Helping families, schools and workplaces move off gas.

The New South Wales government should join other Australian Governments by:

a) Accelerating the replacement of unflued gas heaters in NSW public schools with zero emissions alternatives like reverse cycle air conditioning and heat pumps.

Local governments should:

a) Phase out gas connections in new residential developments via local planning regimes.

b) Lead the transition away from gas by switching council-owned buildings and facilities to renewable electricity.

3

Improving gas safety.

Recognising that it will take time for all households to transition away from gas, households using gas should be encouraged to take practical steps to improve safety and minimise the health risks.

Federal, state and territory governments, in consultation with health professionals, should:

a) Develop and implement effective public education campaigns to ensure all Australians are aware of the dangers of indoor gas burning, and the importance of safety checks, servicing, and adequate ventilation. Where these exist, significantly expand their reach.

b) Introduce mandatory servicing and safety checks on gas appliances in public housing and rental properties.

1. Introduction

Decades of aggressive marketing to Australians has led to several misconceptions about gas. The reality is that it is far from clean. Gas is a polluting fossil fuel that is already harming our health, well-being and, of course, the climate. With more gas in the mix, this risk of harm only increases.

The good news is, with new, cleaner and cheaper technology available now, this fossil fuel is simply no longer needed. Like coal and kerosene before it, gas no longer has a place in our homes, schools and communities.

Gas extraction and consumption is directly impacting the health of Australians today. Relying on gas for our energy needs poses multiple threats to human health, through exposure to known environmental contaminants. It is these health risks – associated with both the production and consumption of gas in Australia – that are the subject of this report.

The first part of this report considers gas production. The basic requirements of good health include enough clean air, food and water. For communities living close to gas wells, these essentials may be compromised as they are exposed to contaminated air, surface water and groundwater, chemical additives used during drilling and hydraulic fracturing, and compounds used in or generated through the extraction process.

Relying on gas for our energy needs poses multiple threats to human health.

Figure 1: The risks to health from gas are unfairly distributed and often fall on the most vulnerable groups.

The second part of this report looks at gas consumption, focusing specifically on the hazards of gas use in cooking and indoor heating. Household gas use is a major source of indoor air pollution and a significant contributor to disease burden among Australians, in particular young children. As is shown in the report, using gas at home can create a comparable risk of childhood asthma as from household smoking.

This report also highlights how these health risks of gas are unfairly distributed. Just like the other impacts of fossil fuel consumption and climate change, they are borne disproportionately by poorer households, young people and First Nations groups. Gas production and use has a greater impact on children and babies; low-income households may not be able to afford gas alternatives; and renters often have little choice over what sort of appliances are in their homes.

Given current proposals to massively expand the gas industry in Australia, it is vital that Australians understand the health consequences of these plans, as well as the healthier alternatives available. Among other things, the report recommends Australia rapidly transitions out of gas production, provides incentives for people to move off gas, stops automatic new gas connections in new home builds and embarks on an education campaign to minimize the health risks.

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The Climate Council acknowledges the Traditional Custodians of the lands on which we live, meet and work. We wish to pay our respects to Elders past and present and recognise the continuous connection of Aboriginal and Torres Strait Islander people to Country.

1.1. What role does gas play in climate change?

Gas is not clean. From floods to bushfires, Australia is in the grip of a climate crisis. Extracting and burning more gas creates greenhouse gases that escalates risk and puts more Australians in harm's way. That is because gas is a fossil fuel. In fact, even before it is burned, gas causes climate harm. The main component of gas, methane, is a greenhouse gas nearly 100 times more potent than carbon dioxide in the short term. Along the entire gas supply chain large quantities of methane are emitted.

Gas is keeping Australia's emissions high. Gas is the fastest growing fossil fuel in the world and is increasingly a contributor to climate change. The rapid growth of Australia's export gas industry is the main reason that Australia's total greenhouse gas emissions have remained stubbornly high over the past several years (Climate Council, 2020a). Right now, Australia is not counting the true contribution of gas towards climate change (Climate Council, 2020b). Once this is corrected for, the supposed climate benefit of gas often disappears.

The gas industry is driving up energy prices for everyday Australians. The growth of the gas industry has been driving up the price of energy for most Australians in recent years – and in some instances prices have tripled. Burning gas in power stations is often the most expensive form of electricity generation in use in Australia's large grids (Australian Energy Market Operator, 2021). When the price of gas increases, this drives up the price of gas-powered generation, and so drives up the price of electricity right across the grid even in instances where gas is not technically setting the wholesale price of power (McConnell and Sandiford, 2020). For those vulnerable Australians struggling to pay their energy bills, the role of gas in driving up the price of energy has very real public health consequences by further entrenching poverty.

It is time to get off gas. We do not need new gas when renewables are cheaper and cleaner. Seismic shifts in the economics of renewables over the past decade mean new gas infrastructure is not needed. The cost of the core components of lithium ion batteries, used for battery storage, have fallen by nearly 90% in the past decade, from $1,100 per kilowatt hour in 2010 to a mere $156/kWh in 2019 (BloombergNEF, 2019). The Australian Energy Market Operator sees a steadily shrinking role for gas over the next 20 years (Australian Energy Market Operator, 2020). Wind and solar powered generation, even after being backed by storage, are the cheapest forms of new electricity generating infrastructure (CSIRO, 2020).

Figure 2: The growth of Australia's export is a massive new source of greenhouse gas emissions and has been driving up energy bills.

BOX 1: WHAT DO WE MEAN BY HUMAN HEALTH 'RISK'?

Climate change has clear, negative impacts on Australians' health (IPCC, 2014). While these climate risks to health are pressing, the focus of this report is narrower and focuses on the risks to human health from direct and indirect exposure to contaminants produced by gas production and consumption.

Adverse health outcomes occur because of a series of complex interactions between exposure to the contaminants, pre-existing health conditions, and exposure to many other sources of environmental pollution and disease. As a result, on an individual level it is often difficult – and sometimes impossible – to demonstrate that bad health has been caused specifically by exposure to gas. For example, it is highly unlikely that any parent would be able to prove that their child's asthma was caused by the presence of a gas heater in their home.

However, as discussed elsewhere in the report, epidemiological studies looking at populations more broadly than the individual have found clear associations between the use of gas cooktops in the family home and the proportion of children with asthma. Looking at the larger trend allows health professionals to identify patterns that may not otherwise be evident.

In addition, as is also shown in the report, gas cooktops are known to produce contaminants that are known to increase the risk of childhood asthma: in particular, nitrogen dioxide and certain forms of particulate matter, such as PM2.5. As a result, it is possible to make connections between the presence of gas cooktops in the home and the burden of childhood asthma at the level of the overall population.

The process used to establish health risks from gas is the same as the process for identifying many other well-known risks to human health. For example, poor physical fitness and an unhealthy diet do not always lead to heart disease. However, it is very well-understood by the medical community that these greatly increase the risk of heart disease.

Figure 3: Illustrative exposure pathways between emissions source and health impact in gas fields.

HOW CONTAMINATION AFFECTS HUMAN HEALTH

The pathway from an emissions source can be complex and diffuse, but there are a few key elements.

SOURCE → EMISSIONS → EXPOSURE → DOSE → HEALTH EFFECTS

SOURCE: Emissions sources are those sites where contaminants are released. The released contaminants may affect air, water, or soil.

EMISSIONS: The emission is the specific chemical contaminants that has been released from the source, as well as its quantity and concentration.

EXPOSURE: The exposure is the specific pathway (or pathways) through which a person is affected by the contaminant.

DOSE: The dose is the amount of the contaminant which is absorbed by, or otherwise affects, the individual who is exposed.

HEALTH EFFECTS: The health outcome occurs as a result of the dose, and any specific vulnerabilities and pre-exisiting conditions in the individual.

2. Extraction and processing: impacts on local communities

Concerns over potential health risks of gas development – especially concerns over the impact of unconventional gas development – are not new. That said, unconventional gas extraction remains a relatively young industry, albeit one that has seen extraordinary and rapid growth. While much remains to be understood, recent analyses from the peer reviewed literature are painting an increasingly clear picture of the negative impacts of gas extraction on the health of people living nearby. As shown in this section, negative impacts include – most concerningly – impacts on foetal and infant health.

In Australia, commercial production of coal seam gas began in the Bowen Basin in Queensland in 1996 (Department of Agriculture, Water and the Environment, 2021), a decade or so after it began in the United States. Shale gas production is more recent, beginning in the United States in the 2000s. The shale gas industry is still in its infancy in Australia with major shale gas developments planned, including in the Beetaloo Basin in the Northern Territory and Canning Basin in Western Australia.

With diffuse exposure to industrial processes and contaminants of the kind used in the unconventional gas industry, there is an inevitable lag between any harmful exposures and the ability to see trends in adverse health outcomes in those communities living near the industry.

In Australia, the primary vehicle for researching the impact of the gas industry, including its health impacts, is a body that is funded and overseen by the gas industry itself (Ogge, 2020): the Gas Industry Social and Environment Research Alliance (GISERA). This is a particularly inappropriate vehicle to deliver impartial and robust research into the impact of the country's growing gas industry. Given the negative health impacts identified elsewhere in the peer-reviewed literature, small scale, studies performed under the auspices of the industry – and not subjected to full academic peer-review – like those released by GISERA in the past several years (GISERA, 2020) are not sufficient to assess the industry's safety.

WHAT IS GAS, AND HOW IS AUSTRALIA'S GAS EXTRACTED?

The vast majority of gas produced is of ancient origin, and burning this fossil fuel for energy is a major contributor to climate change. While small amounts of biomethane from landfills and agricultural wastes are produced and used, and 'town gas' – a manufactured energy source produced from coal – was historically piped into Australian homes instead, almost all of the gas used for energy today is methane sourced from deep, naturally-occurring underground reserves.

As well as being a fossil fuel – and releasing carbon dioxide when burned – this methane is a powerful greenhouse gas in its own right. Methane heats the atmosphere by around 100 times as much as carbon dioxide in the short term once all impacts are considered (Climate Council, 2020b). Around one quarter of the heating of the atmosphere seen since 1750 is attributable to the release of methane into the atmosphere (Etminan et al., 2016). Along the gas supply chain, large quantities of methane are released to the atmosphere, both intentionally – as part of routine operations – and inadvertently, along the full length of the supply chain (Climate Council, 2020b). Cumulatively, these releases add a significant additional burden to the climate impact of the industry.

Australia's gas reserves vary greatly in their quality and accessibility. The degree of risk to human health of any individual project can be approximated by dividing projects into two categories: 'conventional gas' and 'unconventional gas'.

Figure 4: Unconventional gas extraction, such as is occurring at this coal seam gas site in Queensland, brings new risks to human health.

'Conventional gas' is found in porous rock formations that are capped by another type of rock that does not allow the gas to escape naturally. Once the layer of rock that is holding the gas in place is penetrated, the high pressures found underground will push gas up to the surface toward the wellhead. Despite the name, conventional gas projects can pose extraordinary technical challenges. By definition, additional high-risk activities like dewatering and fracking (explained below) are not ordinarily needed to access conventional gas. However, conventional gas, particularly when extracted offshore, still comes with substantial risks to the local environment. On top of this, conventional gas extraction adds greenhouse gases to the atmosphere, driving climate change and adverse impacts to human health. Australia's existing offshore gas reservoirs, such as those found in Bass Strait or off the coast of Western Australia, are all conventional, as are several of the onshore resources in Western Australia, South Australia and Queensland.

'Unconventional gas' is found in more complex and difficult-to-access geologies. As a result, it requires considerably more complex processes to be accessed and may present additional risks. There are three main types of unconventional gas that are either under production in Australia today, or under active consideration: coal seam gas, shale gas, and tight gas. These are described in Box 2.

BOX 2: FORMS OF UNCONVENTIONAL GAS IN AUSTRALIA

Coal seam gas (CSG) holds methane adsorbed on underground coal seams. This gas is often held in place by rock and ancient groundwater ('fossil water'), and to extract the gas this water must be removed in a process known as 'de-watering'. As a result, CSG poses significant risks for local users of groundwater. This includes farmers and sensitive environments downstream, particularly if the water is extracted from the aquifers that farmers rely on or if produced water is not managed appropriately. CSG extraction often uses fracking (described below) to increase the supply of gas, but this is not always required for CSG. The large quantities of gas being extracted from Queensland's Surat Basin is CSG (as discussed in Case Study 1), as is the recently approved Narrabri Gas Project in New South Wales.

Shale gas holds methane in clay-rich, layered rock formations known as shales. Within these shales, the gas is contained in small pores that do not allow the gas to flow freely. Fracking is almost always required to access shale gas in economically viable quantities. The proposed Beetaloo Basin development in the Northern Territory is primarily shale gas and there are further potential sites for shale gas production right across the country, including in the Canning Basin inland from Broome in Western Australia.

Tight gas is like shale gas in most ways, but the methane is found in sandstone or limestone rather than shales. As with shale gas, tight gas extraction almost always requires fracking. There is very little tight gas production in Australia, but several potential sites for tight gas production have been identified, including in the Darling Basin in western New South Wales. The Cooper Basin, which extends across the border of South Australia and Queensland and currently produces significant quantities of conventional gas, also holds significant amounts of tight gas. Some of this tight gas is being extracted.

Figure 5: Unconventional gas development requires many individual wells to be drilled over a large area, as seen in this aerial photo of Queensland's Western Downs.

Like most other gas-producing countries, Australia has historically relied on accessing its conventional gas reserves. Many of the technical interventions required to conduct unconventional gas extraction have only been mastered in the past few decades. The majority of new gas developments proposed for Australia are unconventional gas projects, particularly coal seam gas and shale gas. As noted in the previous section, development of these harder-to-access unconventional reserves involves more complex and potentially hazardous techniques, such as fracking.

Some risks are common to both conventional and unconventional gas. For instance, the wastewater produced in gas extraction often contains naturally occurring chemicals that are harmful to human health. While naturally occurring underground, these chemicals can be hazardous when brought to the surface.

Gas extraction produces significant wastewater which contains many potentially harmful contaminants.

This includes naturally occurring radioactive materials (NORMs), polycyclic aromatic hydrocarbons (PAHs), heavy metals and volatile organic compounds (VOCs) such as benzene as well as residual lubricants and other chemicals used in the drilling process (Esswein et al., 2014; Price and Adams, 2016). The quantity of wastewater produced varies greatly across the forms of gas extraction, and across different well sites. Large quantities of water are being brought to the surface through the process of extracting gas. This water often contains high amounts of salt, which can harm the productivity of soils and agricultural lands.

Unconventional gas extraction amplifies the health risks associated with conventional gas and introduces a number of additional ones. Unconventional reserves are typically spread over a large area, requiring many wells to be drilled. Where water is scarce, as in many regions of Australia where unconventional gas development is underway or proposed, both de-watering and hydraulic fracking may reduce the volume of water available for local farmers and communities (Rosa et al., 2018). As a result, the extraction of gas exacerbates the water shortages associated with drought. This drought is itself exacerbated by climate change for much of the continent's most fertile land (Abram et al., 2020), and the heating of the climate is driven by the consumption of fossil fuels like gas (Friedlingstein et al., 2020).

Evidence is building that negative health impacts from unconventional gas are being felt today.

WHAT IS 'FRACKING'?

One commonly discussed intervention needed to access unconventional gas is hydraulic fracturing, also known as 'fracking'. Fracking is a process that poses significant risks to local communities. As discussed further below, many of the chemicals used in fracking are known environmental contaminants and this includes various cancer-causing agents, as well as substances that interfere with hormone production and development. Fracking is often, though not always, required to access unconventional gas. While these cause-effect pathways are complex and diverse, there is early evidence that the negative effects of fracking are being felt already by communities living nearby.

To access fossil fuel reserves in more difficult geologies, the process of fracking injects immense quantities of water, loaded with sand and potentially harmful chemicals underground to crack open otherwise inaccessible reservoirs. The precise mix of chemicals used in any particular instance is often confidential, even from landholders, and disclosed only to various state and territory regulators. However, broader industry and government disclosures, including through environmental impact statements, often include a range of chemicals that can be harmful to human health, given sufficient exposure (Ground Water Protection Council and Interstate Oil and Gas Compact Commission (US), 2021).

Contamination of land and water – whether as a result of an accident or negligence – is almost inevitable given the scale of extraction activity in Australia. Incidents have already occurred, including an instance where a groundwater aquifer was contaminated in New South Wales Pilliga region by coal seam gas operations in the area (Carey et al., 2014). This led to higher than normal levels of uranium and heavy metals in the groundwater. That said, given that much of the activity with fracking occurs underground, many incidents may not be detected, or even detectable, until after remediation becomes impossible.

Alongside more serious risks such as permanent groundwater contamination, there are also insidious and chronic risks to communities living near unconventional gas operations. Cumulatively, these insidious risks can have a larger impact than a single point-source incident because that they are diffuse throughout the community.

2.1 Risks to water

Many of the health concerns with the production phase of unconventional gas relate to the contamination or depletion of water resources (Haswell and Bethmont, 2016). Chemicals present in wastewater – both naturally occurring and introduced – include substances known to harm reproductive capabilities and/or interfere with fetal, infant and child development (Elliott et al., 2017a), carcinogens (Elliott et al., 2017b) as well as agents that interfere with the body's hormone systems and so may interfere with growth and development (Kassotis et al., 2016).

This wastewater may be dealt with in different ways, all of which are potentially harmful (Davies et al., 2015). The wastewater may be injected back into the ground or held in unlined pits, with the risk of it contaminating productive groundwater resources. It may also be evaporated from large holding ponds and in certain instances used for irrigation of agricultural lands or discharged into rivers (Sun et al., 2019).

There are a number of ways in which people may be exposed to potentially harmful waterborne chemicals in unconventional gas production. These are what epidemiologists call 'exposure pathways'. The fracturing process may, in some instances, lead to contamination of aquifers, with the contaminated groundwater then ingested by humans or livestock (DiGiulio and Jackson, 2016). Similarly, spills during the handling of hydraulic fracturing chemicals or wastewater, including leakage from wastewater ponds, may contaminate both surface and groundwater resources (US EPA, 2016).

Inadequately treated water may be discharged into rivers or used for irrigation. While the risk is more remote, there is also potential that over time humans may become indirectly exposed to these chemicals through the foods we eat (Navi et al., 2015). Another path for contamination of the local surroundings occurs when old or abandoned wells lose their integrity (Davies et al., 2014). Where this occurs, it creates additional opportunities for exposure, such as through leakage of contaminants into soils and groundwater.

2.2 Air pollution

People living near unconventional gas operations may be directly exposed to airborne pollutants including volatile organic compounds and poly-aromatic hydrocarbons evaporated from wastewater, diesel fumes from trucks and machinery, and sulfur dioxide and nitrogen dioxide from flaring. In addition, reactions between airborne pollutants from unconventional gas mining, including volatile organic compounds and nitrogen oxides, can produce significant quantities of ground-level ozone (Field et al., 2014).

Airborne pollution is emitted at most stages of gas production, including the operation of heavy machinery during well site preparation and drilling, the venting and flaring of gas, and evaporation of wastewater (Field et al., 2014). This means that there are a number of different pathways for human exposure to the contaminants.

These pollutants can have a diverse range of impacts on the human body. Along with the direct risks, many of the emissions sources from gas production can precipitate the development of ground level ozone or smog, leading to additional health risks (Coram et al., 2014). Excessive ground-level ozone can cause or exacerbate a variety of respiratory problems, including asthma and reduced lung function (Srebotnjak and Rotkin-Ellman, 2014). Ground-level ozone can spread out over a large distance, affecting people well beyond the immediate vicinity of unconventional gas operations (Field et al., 2014; Manisalidis et al., 2020). Other pollutants can affect the heart, lungs and nervous system as well as interfering with the proper development of the body, including through affecting the balance of hormones in the body (Colborn et al., 2011).

Air pollution from gas operations poses potentially serious health risks for workers (Coram et al., 2014). Although not well-assessed in Australia, there are many paths through which a worker might be exposed to toxic or otherwise harmful materials, including the diverse range of chemicals used operationally and through inhaling airborne silica from sand used during fracking.

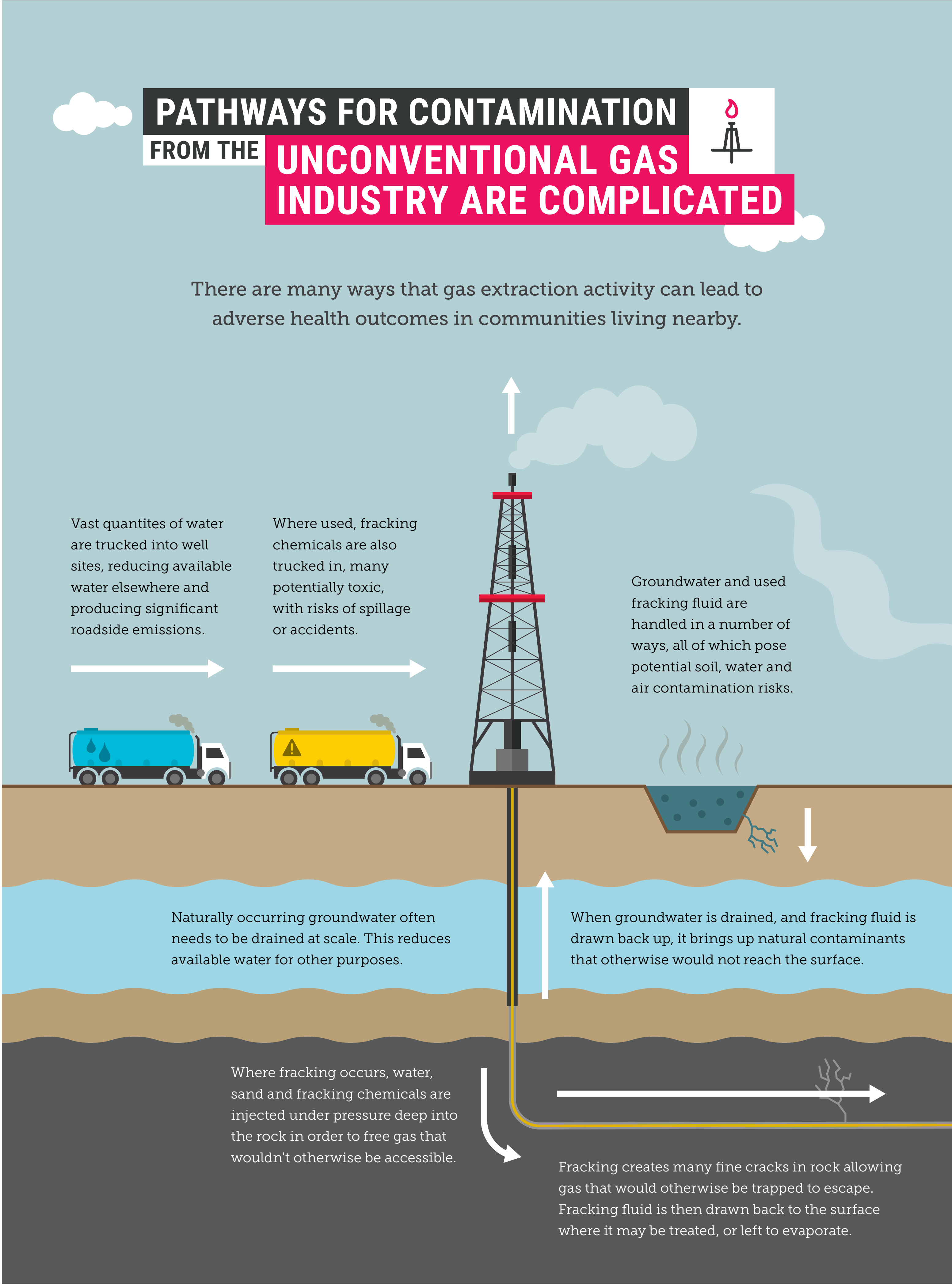
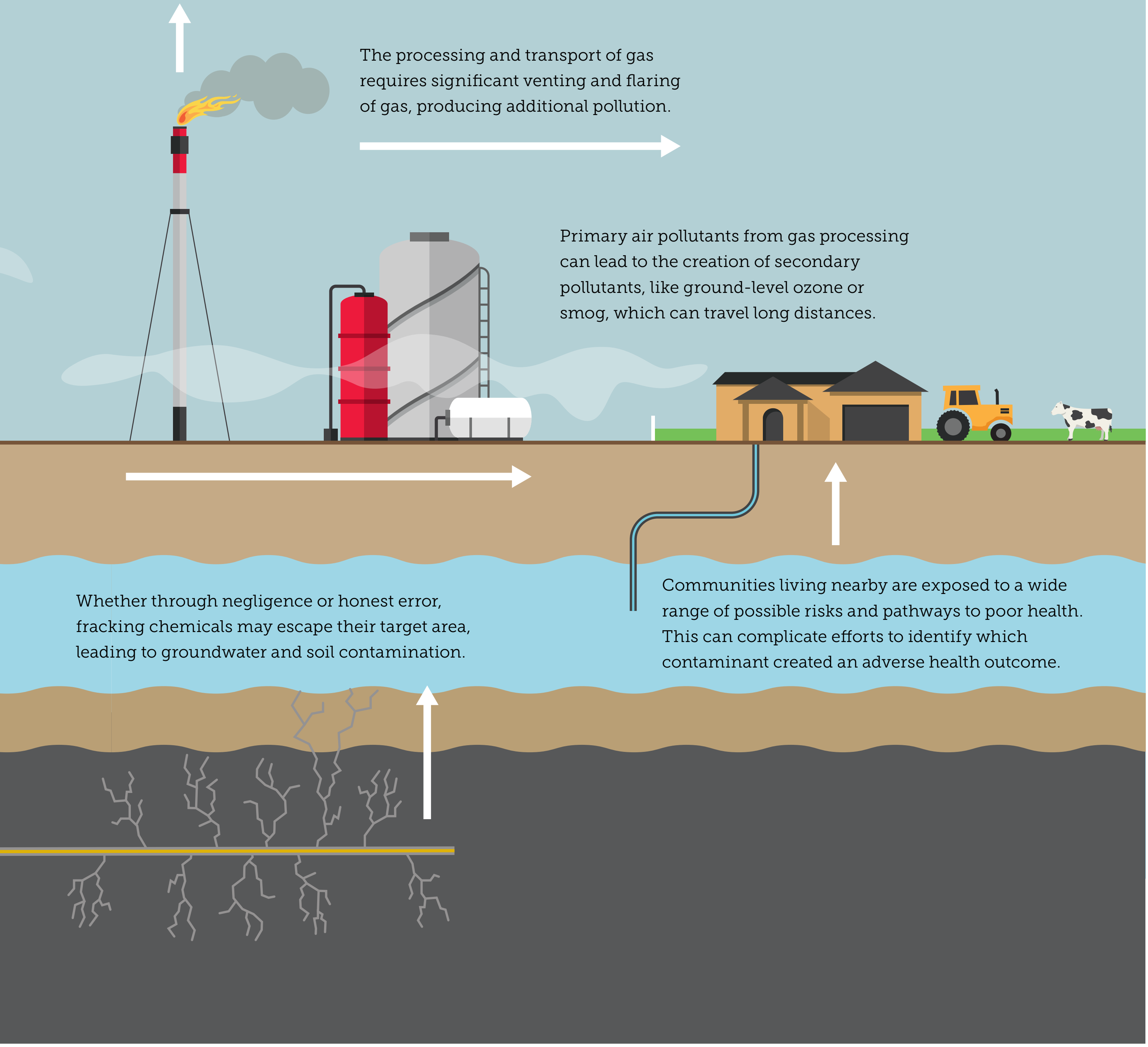


Figure 6: There are many possible pathways for contamination from gas extraction.

Where there is early evidence of poor health outcomes in an area exposed to these risks, it is essential that well-resourced, substantial research with full site access is conducted to uncover their cause.

This research must be completely independent of the gas industry.



2.3 Health impacts

Plausible biological pathways exist between pollution from unconventional gas development and several observed health problems. Studies often observe a rise in health problems soon after the time at which unconventional gas development began. The incidence or severity of problems often increases the closer people are to gas wells (indicating a 'dose-response' relationship). Taken together, these realities give strong grounds to conclude that gas developments may be harmful to health. This creates an urgent imperative for fully independent research into the impact of the industry, free from the influence of the gas industry. To date, funding for this research – and site access to extraction infrastructure in order to conduct it – has been limited. The main exception to this is those studies conducted by research bodies with clear links to the gas industry (Ogge, 2018).

The tremendous growth in unconventional gas extraction in Australia over the last five years has occurred against the growing body of evidence from the United States that such practices increase risks to the health of local populations. While the evidence from Australia has many gaps, there are concerning indications that many of the problems documented overseas are beginning to be seen here. This is discussed in Case Study 1.

Some of the documented associations between unconventional gas development and detrimental health impacts are summarised in the next section.

There are now many studies finding significant and concerning links between oil and gas development and adverse health outcomes in communities living nearby, both in Australia (McCarron, 2018; Werner et al., 2018) and in the USA (Deziel et al., 2020). However, there is a critical need for further research into the specific pathways, including for impacts on infant and prenatal health. As noted above and in Box 1, there are many possible exposure pathways for environmental contaminants present as a result of gas extraction. Understanding which of these is leading to the specific adverse health outcomes will allow for more targeted treatment, mitigation and – where necessary – remediation. However, as discussed in Case Study 1, substantial, well-funded, and truly independent research into the health impacts of the gas industry has been limited in Australia.

Substantial, well-funded, and truly independent research on the health impacts of unconventional gas is essential and urgent.

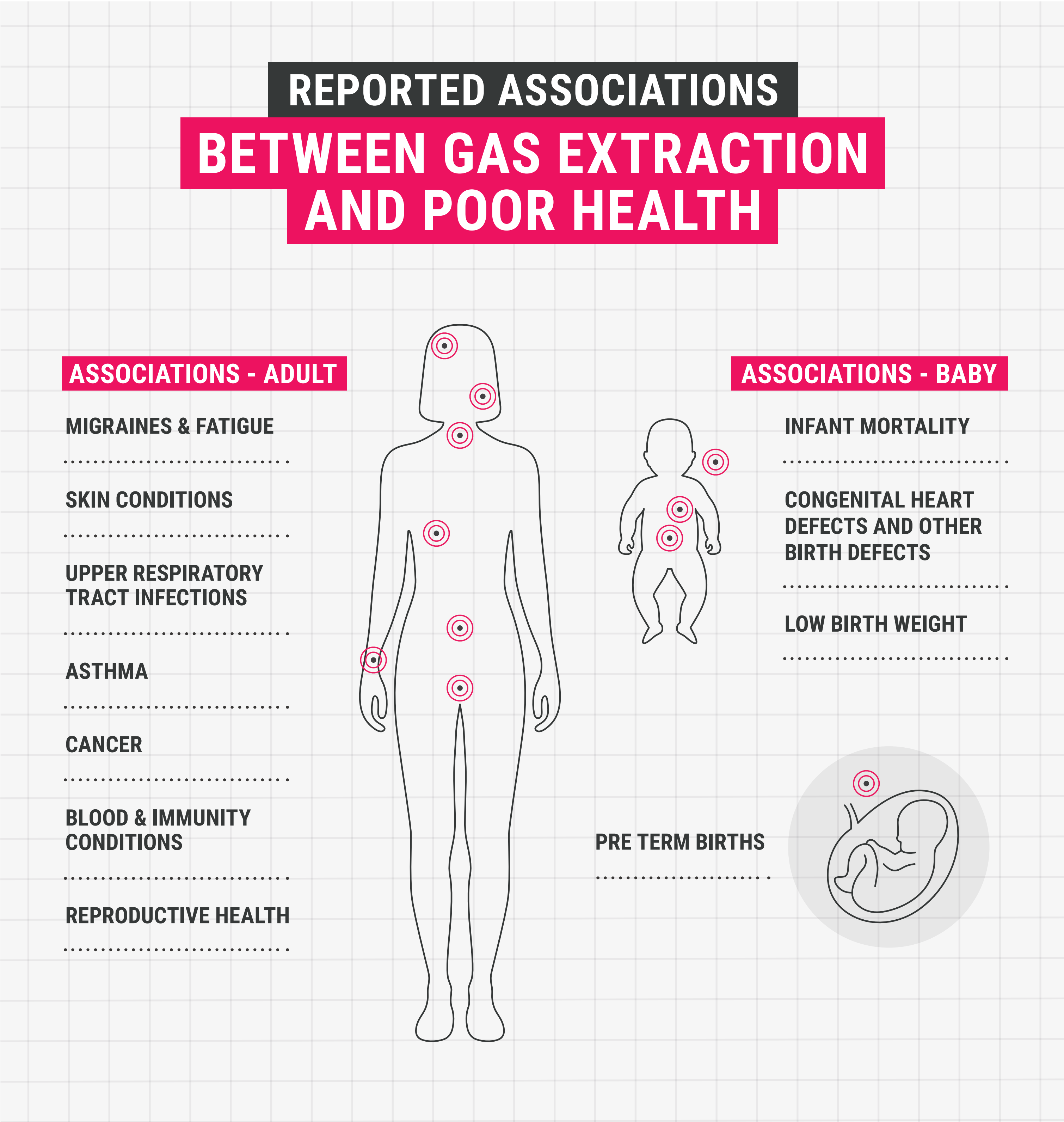


Figure 7: Illustrative exposure pathways between emissions source and health impact in gas fields.

INFANT AND PRENATAL HEALTH

Reproductive health and risks to infants and fetuses

A 2016 review of 45 studies from around the world into the impact of oil and gas mining upon workers and nearby residents concluded there was ample evidence for the disruption of female and male reproductive hormones, as well as moderate evidence for increased risk of miscarriage, preterm birth, birth defects, prostate cancer, and decreased semen quality (Balise et al., 2016). The review looked only at conventional gas extraction, due to the lack of similar studies dealing with unconventional extraction available at that time. The review authors concluded that unconventional gas extraction is likely to have an impact upon reproductive health and birth outcomes due to the large number of substances that interfere with hormone production and development present in hydraulic fracturing.

Infant mortality

A 2017 study from Pennsylvania found that while the number of early infant deaths across the State had declined over the period of the study, there had been a significant increase in the number of early infant deaths among communities living in the most heavily fracked counties in the State. Further analysis of the results suggests that these early infant deaths may have been linked to elevated concentrations of naturally occurring radioactive materials (NORMs) in drinking water, resulting from the dispersion of wastewater from gas wells (Busby and Mangano, 2017). An association between unconventional gas developments and early infant deaths was also found in a 2017 study from Texas (Whitworth et al., 2017).

Pre term births

Babies born pre-term have a higher risk of early death, cerebral palsy, impaired learning, vision and hearing problems, and chronic health issues (Saigal and Doyle, 2008; Vogel et al., 2018).

Studies from Pennsylvania and Texas published in 2016 and 2017 respectively found a small but statistically significant association between a mother's proximity to unconventional gas developments and the likelihood of a pre term birth (Casey et al., 2016; Whitworth et al., 2017). A follow-up study from Texas suggests that there is a particularly strong association between extremely pre term birth – births at less than 28 weeks' gestational age – and proximity to unconventional gas extraction (Whitworth et al., 2018).

It is worth noting that other cohort studies elsewhere in the United States – that have found associations between gas, or oil and gas development and either congenital heart defects (McKenzie et al., 2014) or low birth weight and small for gestational age infants (Tran et al., 2020) – have not been able to find associations between proximity to oil and gas extraction and pre term birth. However, pre term birth is not a single phenomenon, and has many separate causes that present in different ways (Moutquin, 2003; Vogel et al., 2018). These studies did not differentiate between degrees of prematurity.

Recently, a study from Texas looked at birth outcomes among women living within 5 kilometres of flaring from unconventional oil and gas development (Cushing et al., 2020). The study found that exposure to a high number of flares was associated with a 50% higher odds of preterm birth.

Figure 8: Many of the most confronting associations between gas extraction and human health involve the health of infants and babies at birth.

Low birth weight

A large study from Pennsylvania, where there has been prolific use of hydraulic fracturing to tap into the state's rich shale gas reserves, based on more than a million birth records from 2004 to 2013 and published in 2019 found a "decrease in the health of infants born to mothers living up to 3 kilometres from a hydraulic fracturing site", with the impacts most severe for those whose mother lived within one kilometre of a site. Babies whose mother lived within that one-kilometre radius were 25% more likely to have a low birth weight (Currie et al., 2019). Two earlier studies from Pennsylvania in 2015 and 2018 respectively also found an association between low birth weight and proximity to unconventional gas developments (Hill, 2018; Stacy et al., 2015). An earlier study investigated this issue in Colorado and struggled to find an association there (McKenzie et al., 2014).

Congenital heart defects and other birth defects

Observing over 120,000 mothers and infants, a 2014 study from Colorado – a region with a large shale gas extraction industry close to residential areas – found a higher incidence of congenital heart defects among infants whose mothers lived close to gas wells (McKenzie et al., 2014). A subsequent study performed in Pennsylvania in regions with and without unconventional gas developments concluded that rates of congenital birth defects were higher in areas with unconventional gas development. That said, this latter study struggled to find causation once long-term trends – unconnected to unconventional gas development – were taken into account (Ma et al., 2016).

CHILD HEALTH

Childhood asthma

The relationship between childhood asthma and unconventional gas development is highly plausible given the pollution that is known to be created by these developments. Several airborne pollutants associated with unconventional gas development, including formaldehyde, ozone and particulate matter, are known asthma triggers.

Another study from Pennsylvania published in 2018, showed that children exposed to unconventional gas developments bore a consistently higher risk of being hospitalised for asthma compared with children who were not exposed. The study, which covered the period 2003-2014, showed children faced a 25% greater risk of being hospitalised for asthma during the 3-month period when a well was drilled. Significantly, the results also demonstrated increased odds of hospitalisation from asthma could be associated with increased emissions of some known asthma triggers (Willis et al., 2018). A more recent study from the same research team – this time in Texas – also found increased odds of asthma in unconventional and conventional gas extraction regions (Willis et al., 2020).

These effects aren't limited to children. A large study from 2016 in Pennsylvania, showed people with asthma living closer to gas wells had substantially higher risk of suffering asthma attacks (Rasmussen et al., 2016). The pattern was present during all stages of the development: from preparing the site, to drilling and fracking, to producing the gas, and was strongest during the production stage.

Cancer in children and young people

Many chemicals used in gas extraction are known carcinogens, particularly those used in fracking. While more research is needed to identify the specific pathways for exposure and the chemicals responsible, overseas studies have shown associations between living near gas extraction activity and elevated risk of cancer in early life.

A 2017 exploratory study from Colorado found an association between the rate of acute lymphocytic leukemia among people aged 5-24 years and their proximity to gas wells (McKenzie et al., 2012). Children and young people aged 5–24 years diagnosed with this type of blood cancer were more likely than those diagnosed with a non-hematologic cancer to live within 16.1-kilometers of an active oil and gas well.

Gas developments produce several known carcinogens, including benzene – a volatile organic compound that is associated with increased risks of leukemia. The presence of these carcinogens in the operations of the industry, and the elevated rates of cancer in the local community, demonstrates a clear need for further inquiry.

OTHER HEALTH IMPACTS

In addition to the studies described above, a number of other health conditions have been reported among people living close to unconventional gas developments, including: upper respiratory tract infections, migraines and fatigue (Tustin et al., 2017), urinary tract problems (Denham et al., 2019), blood and immune conditions (Werner et al., 2018, 2017), skin conditions (Denham et al., 2019), and a host of other respiratory, circulatory and neurological conditions (Alahmad and Khraishah, 2020; Jemielita et al., 2015; McAlexander et al., 2020; McCarron, 2018).

The results of a household survey in Washington County, Pennsylvania showed that reported skin conditions were more than four times as common in households located less than a kilometre from a gas well compared to those more than 2 kilometres from a gas well (Denham et al., 2019; Rabinowitz et al., 2015). As some of these conditions are relatively common, and not all the studies ideally designed, these reports are not conclusive but raise the need for further investigation (Adgate et al., 2014).

CASE STUDY 1: EARLY EVIDENCE FROM QUEENSLAND'S DARLING DOWNS

The Darling Downs, west of Brisbane, is known for its prime agricultural land, beautiful landscapes, historic towns, and wineries. It is also ground zero for the extraordinary expansion of Australia's unconventional gas industry.

The Surat Basin, which spans central southern Queensland including the Darling Downs and central northern New South Wales, is home to a substantial share of known coal seam gas reserves in Australia. Production began in 2004/5 and between 2013/14 and 2015/16 alone, production increased almost fivefold, primarily to meet the demand of Curtis Island's three large gas export terminals (Department of Natural Resources and Mines, 2017). In February 2019 the Queensland Government gave the green light to a massive further exploitation of the Surat Basin, approving the $10 billion Surat Gas Project (Ludlow, 2019).

Health impacts from coal seam gas developments have been a major concern in the local community since the industry arrived in the early 2000s (Hutchinson, 2013). The industry's growth coincided with complaints from residents about health issues they believed they were suffering because of coal seam gas developments. A 2013 investigation by the Queensland Government's Department of Health concluded that a clear link could not be drawn between these health complaints and coal seam gas activities (Queensland Health, 2013).

A series of studies based on hospitalisation rates in that region from 1995-2011 found that people living in areas with coal seam gas developments were more likely to be hospitalised for neoplasms (tumours) and blood/immune diseases than areas of regional Australia without coal seam gas (Werner et al., 2016), and that there was a significant increase in hospitalisations for respiratory diseases among children (Werner et al., 2018).

CASE STUDY 1: *CONTINUED*

A separate study in 2018, based on hospitalisation rates from 2007-2014, observed that the growth in gas production, and the accompanying surge in local emissions of nitrogen oxides, carbon monoxide, particulate matter (PM10), volatile organic compounds and formaldehyde, was accompanied by a marked increase in hospitalisations for acute respiratory and circulatory conditions (McCarron, 2018). It concluded that the "the burden of air pollution from the gas industry on the wellbeing of the Darling Downs population is a significant public health concern".

Such observations are more than sufficient to trigger a need for truly independent, whole-of basin studies to get to the bottom of the impacts being felt by those living in proximity to a massive expansion of unconventional gas extraction.

It is important to note that studies of this kind – looking at hospitalisation rates only – will mostly cover the more severe forms of illness. This approach will invariably underestimate the actual burden of ill-health in the community. Many who have been exposed to unconventional gas production contaminants will not – or will not yet – be unwell enough to require hospitalisation.

As in other parts of Australia, there was very little investigation into the possible human health impacts of the coal seam gas industry in the Darling Downs before the industry was approved, and there has been little resourcing provided to fully independent research since.

As noted above, the small-scale research overseen by the gas industry – such as the kind released last year (GISERA, 2020) – are unconvincing attestations of the industry's safety given observed trends. Truly independent, well-resourced and peer-reviewed studies –conducted with full access to extraction sites and infrastructure – is required.

Figure 9: The scale of unconventional gas development through Darling Downs is immense, as are the opportunities for environmental contamination.

3. Burning gas in our homes and schools

Far from the healthy, natural image that is promoted, the use of gas for heating and cooking has many well-known health risks in our homes and schools. As with other burdens posed by the consumption of coal, oil and gas, these health risks – including asthma and carbon monoxide poisoning – fall first, and hardest on young people, poorer households, and the most vulnerable.

Appropriate ventilation can reduce the impact of harmful indoor air pollution, but not eliminate it.

Gas stoves and heaters were long ago established as a major source of indoor air pollution, in particular nitrogen dioxide (Chauhan, 1999). Young children suffer high exposure to household air pollution as they ordinarily spend a larger part of their day at home than older children and most adults (Vrijheid, 2013). When added to the higher vulnerability of young children's developing bodies, this means that the impacts are felt first and hardest by young children (Royal College of Physicians, 2016). Lower-income households are also at greater risk due to a number of factors including smaller homes, more people sharing a home, and inadequate ventilation (Adamkiewicz et al., 2011).

Harmful indoor air pollution from gas appliances – space and water heating, as well as cooking – can be reduced, though not eliminated, through proper ventilation. This includes exhaust fans over stoves – especially modern rangehoods – and ducts to remove waste gases from water and space heaters, which are known as flues (Knibbs et al., 2018). Their effectiveness depends greatly on the type of exhaust fan or flue and of course on their proper use and maintenance (Parrott et al., 2003). Even where present, flues (see Figure 11) can become blocked or otherwise rendered ineffective. As well, even where modern rangehoods are installed above cooktops, they are often not used due to the noise they create.

Nearly all gas burned in Australia today is fossil methane; a fossil fuel that drives climate change. In addition to producing carbon dioxide when burned, and driving the heating of the planet, burning fossil gas produces several other pollutants including nitrogen oxides (including nitrogen dioxide, and known collectively as NOx), carbon monoxide, formaldehyde, fine particulate matter (PM2.5) and ultrafine particles (UFPs) – all of which are known to be harmful to health if present in sufficient concentrations.

Today's gas appliances are a poor cousin to more efficient and healthier electric alternatives. Like kerosene, coal and wood, household gas is a technology that belongs in the past: a health risk that we no longer need nor can afford to be taking and a shift away will provide clear benefits.

Around half of all Australians have gas delivered to their home via a gas network (Australian Bureau of Statistics, 2014). In addition, an often overlapping 14% of Australian homes used bottled gas, most often in the form of liquefied petroleum gas (LPG), either as a primary source of gas or just for free-standing appliances such as barbeques. Household gas use varies considerably by state. Victoria has the highest rate of household gas use of gas. There, more than four-in-five homes use mains gas and one-in-seven use bottled gas. However, in Tasmania, less than one-in-twenty homes are connected to mains gas and one-in-six use bottled gas.

A 2014 study on homes in Southern California suggested that when gas cooking appliances were used without rangehoods, more than half of occupants were routinely exposed to harmful levels of NO_2 and formaldehyde (Logue et al., 2014). Another US-based study found that not only did homes with gas stoves have around 50% to over 400% higher concentrations of NO_2 than homes with electric stoves, but that indoor NO_2 pollution from gas stoves often reaches levels that would be illegal outside (Luben, 2008; Seals and Krasner, 2020).

Figure 10: While half of Australian homes rely on gas delivered via a local gas network, many rely on bottled gas instead. This varies significantly from state-to-state.

3.1 Health impacts

ASTHMA

Indoor pollution from gas appliances has been strongly linked with respiratory problems, most notably asthma. The impact of gas in the home on childhood asthma is very significant. Using a gas stove indoors without proper ventilation can have a comparable impact on childhood asthma to the impact of living in a household with a smoker. This is discussed further in Box 3.

This finding is especially concerning because a little less than half of all energy for cooking in Australian homes is provided by gas, either through connection to the gas mains or via bottled gas deliveries (EnergyConsult, 2015). While ovens – whether standalone or in combined oven and cooktop units – are most commonly electric, gas cooktops are particularly prevalent in Australia. Around two-out-of-three standalone cooktops are fuelled by either mains-supplied or bottled gas, with the remainder being either old-style coil electric or the more superior electric induction stoves.

A 2018 study estimated that cooking with gas is responsible for up to 12% of the burden of childhood asthma in Australia (Knibbs et al., 2018). A 2013 meta-analysis (i.e. a study that combines the results from multiple previous studies) found that children living in a home with gas stoves have a 42% increased risk of experiencing asthma symptoms, and a 24% greater chance of being diagnosed with asthma at some point in life (Lin et al., 2013). In the same year, a US study found that even low levels of NO_2 pollution in the home – well below US Environmental Protection Agency's standards for outdoors – exacerbate symptoms among asthmatic children, and that symptoms grow progressively more severe as NO_2 concentrations rise (Belanger et al., 2013). These results are consistent with those from an influential meta-analysis conducted two decades earlier on the risk of NO_2 pollution for asthma and other respiratory illnesses in children, which formed the basis for World Health Organisation guidelines on NO_2 (Hasselblad et al., 1992).

With properly functioning modern rangehoods that vent outdoors – as opposed to conventional ceiling exhaust fans – the asthma burden may be reduced for those who use them, but not eliminated (Knibbs et al., 2018). Efficient range hoods with flues that vent outdoors are very often either not present or not used (Parrott et al., 2003).

While most states and territories in the country have banned gas heaters that do not vent contaminants to the outdoors from schools, in New South Wales most schools still use gas heaters indoors that release the products of combustion directly into the classroom. As well, older estimates show that around one million Australian households have unflued gas heaters installed (Environmental Health Standing Committee, 2007). In a systematic review of the literature, a 2007 study funded by the Australian Government found evidence that unflued gas heaters were associated with both the prevalence of asthma in children and increased symptoms among children with asthma (Environmental Health Standing Committee, 2007). These findings have been confirmed in later studies. This issue is revisited in Case Study 2.

BOX 3: IMPACT OF GAS COOKING ON CHILDHOOD ASTHMA COMPARABLE TO HOUSEHOLD SMOKING

A recent analysis of data from over 12,000 Australian households found that up to 12% of the burden of childhood asthma is attributable to the presence of gas cooking in the home (Knibbs et al., 2018). There is strong and growing evidence that the presence of gas-powered cooking appliances in the home is linked to the burden of childhood asthma.

Where modern, efficient rangehoods that vent outdoors are present and used, this will reduce, but not eliminate, the risk (Knibbs, 2018). Such rangehoods are often either not present or not used (Parrott, 2003).

Asthma places a significant burden on the Australian community, both in terms of economic costs and quality of life. A 2015 study by Deloitte Access Economics put the cost of Asthma in Australia at $28 billion a year through the cost of healthcare, loss of productivity, loss of healthy life years and other factors (Deloitte Access Economics, 2015). Asthma is the leading cause of disease burden for children aged 4-15 (Australian Institute of Health and Welfare, 2019), and the prevalence of asthma in Australia is among the highest in the world (Australian Centre for Asthma Monitoring, 2011). An Australian Bureau of Statistics survey conducted in 2018 found that 11.2% of Australians – or one-in-nine – live with asthma (Australian Bureau of Statistics, 2018). In children, asthma can mean expensive treatments, missing days of school, and being excluded from many activities as well as the risk of more serious consequences.

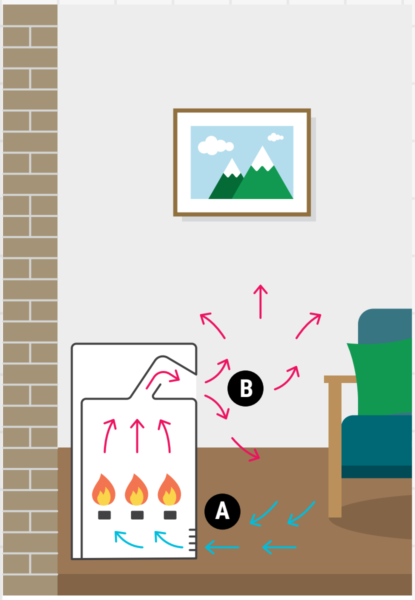
An earlier report in the peer-reviewed literature, which synthesised the findings of 41 other studies from around the world, found that asthma is 32% more likely among children living with gas cooking appliances than it is among those children living without (Lin et al., 2013).

Many parents today wouldn't dare to expose their children to second hand cigarette smoke, particularly inside their home. However, many parents wouldn't be aware the effect of gas cooktops on the burden of childhood asthma is comparable to the impact of passive smoking in the household. Jayes et al (2016) found that children exposed to household smoking were 1.14 to 1.30 times (14%-30%) more likely to develop asthma. Vork et al (2007) found that children exposed to household secondhand smoke were 1.33 times more likely to develop asthma during childhood. This is a similar range to the 32% increase in likelihood found by Lin et al (2013), above.

GAS HEATING
RISK FACTORS

UNFLUED HEATERS

Cold air is drawn from the room, and fumes are released directly into the living area.

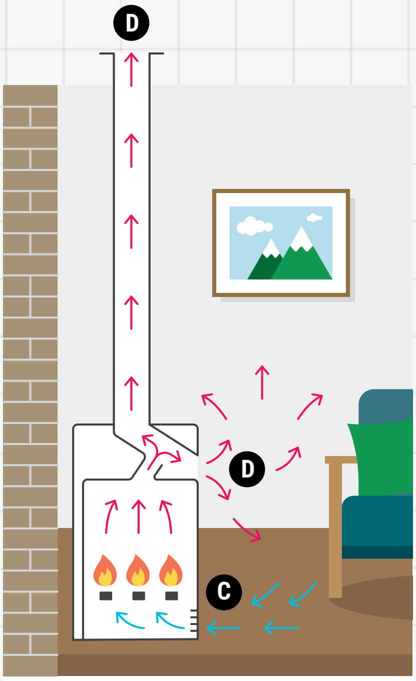


A Flames are fed with cold air from inside the room.

B All exhaust from the fire goes back into the living space. While the air is filtered, this can nonetheless lead to serious consequences.

OPEN FLUE HEATERS

Cold air is drawn from the living area, and fumes are mostly released outside. However, fumes may be released into the living space, with potentially fatal consequences.

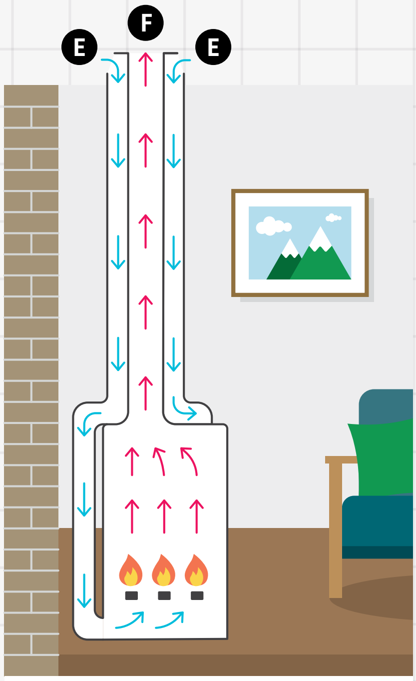


C Flames are fed with cold air from inside the room.

D Potentially deadly exhaust should go up the flue to the outdoors, but under many circumstances, can feed into the room instead.

ROOM SEALED HEATERS

Cold air is drawn from outside, and fumes are released outside. When in good working order, these are less likely to lead to elevated indoor air pollution.



E Flames are fed with cold air from outside.

F When properly maintained with clean flues and intact seals, these heaters pose the lowest level of risk, though continual maintenance is key.

No matter what kind of gas heater is present, regular qualified maintenance and proper operation is central to reducing the risk of harm, but it cannot eliminate the risk.

Figure 11: The risk from gas heaters depends significantly on whether flues are used and the kind of flue that is present.

CASE STUDY 2: UNFLUED GAS HEATERS IN NSW SCHOOLS

During the 1980s and 1990s, mounting concern over the health impacts of high levels of nitrogen oxides in NSW classrooms led to a tightening of the standard for nitrogen oxide (NOx) emissions and the development of "low-NOx" heaters (Environmental Health Standing Committee, 2007).

However, even low-NOx heaters present health risks, especially if they do not have a flue. A 2004 study funded by the National Health and Medical Research Council revealed clear links between NO_2 exposure and asthma symptoms, and showed that asthma symptoms could be reduced by replacing unflued gas heaters with electric heaters or flued gas heaters (Pilotto et al., 2004). In 2009, tests carried out by CSIRO at Blackheath Public School showed that one in three classrooms with unflued gas heaters had levels of indoor air pollution that exceeded World Health Organisation guidelines (Sydney Morning Herald, 2009a).

A 2010 study commissioned by the New South Wales Government and conducted by the Woolcock Institute of Medical Research compared the respiratory health effects of low-NOx unflued gas heaters with flued gas heaters. The study found that exposure to the unflued heaters was associated with increased respiratory symptoms (cough and wheeze) in atopic children (that is, those with a predisposition to allergic reactions, including asthma), and concluded that "it is important to seek alternative sources of heating that do not have adverse effects on health" (Marks et al., 2010). Around 50,000 unflued gas heaters were in use in schools across NSW at the time of this study.

Figure 12: Household gas use, especially from gas stoves, contributes significantly to the burden of childhood asthma in Australia.

CASE STUDY 2: *CONTINUED*

The study prompted the State's Education Minister to announce that the Government would immediately start replacing unflued gas heaters in schools in the coldest parts of the State (ABC News, 2010). As a result of this, 102 of the State's more than 2,200 government schools had their unflued gas heaters replaced (Firth, 2010; NSW Parliament, 2014).

However, in 2011 a State Government-commissioned review of the costs and benefits of replacing the unflued heaters, supposedly based on the findings of the Woolcock Report, recommended against their replacement. The review claimed that the health benefits to students did not justify the cost of replacement, and suggested alternative solutions including that students wear warmer clothing (Sydney Morning Herald, 2011a). This finding was criticised at the time, including by one of the authors of the Woolcock report (Sydney Morning Herald, 2011b).

The Government determined that it would only replace unflued gas heaters when the majority of heaters in a school had reached the end of their life, and that only flued gas heaters would be fitted in new school buildings from 2012. It also advised that when unflued heaters are in use, windows be opened to help with ventilation (NSW Government, 2018a).

The only current program to remove the unflued gas heaters from NSW schools is the Government's "Cooler Classrooms Program", which intends to install reverse cycle air conditioning in 900 government schools, with priority given to 600 of the State's hottest schools. As air conditioning units are installed, unflued gas heaters are removed under the program. While this program has its own merits, it is worth noting that it does not target colder schools that are likely to be more reliant on classroom heaters. To date, around 200 schools have had reverse cycle air conditioners installed under the program. Any unflued gas heaters will have been removed at the same time.

Unflued gas heaters are not used in schools in other states and territories, partly because of the risk that they pose. Consistent with advice from NSW Health (NSW Government, 2018b), unflued gas heaters are also generally not used in NSW private schools (Sydney Morning Herald, 2009b).

In July 2020, it was reported to the State Parliament that unflued gas heaters were still in use in the majority of NSW public schools (NSW Parliament, 2020). At the time, the NSW Education Department would not reveal which schools were still using them. A significant investment from the New South Wales Government could eliminate this issue once-and-for-all.

Most New South Wales schools have unflued gas heaters in the classroom.

Other respiratory problems

In addition to asthma, there is also evidence linking gas cooking to small reductions in lung function in children (Moshammer et al., 2010) and to rhinitis (inflammation of the nose) (Piekarska et al., 2018). A 2018 study from New Zealand revealed children faced a greater risk of acute respiratory infections in homes heated by gas, whether flued or unflued, compared to homes heated with electricity (Tin Tin et al., 2016).

Impacts on neuropsychological development

A 2009 study involving children in Spain found that pre-schoolers who had grown up with gas appliances in the home were at higher risk of developing symptoms of attention deficit hyperactivity disorder (ADHD) and had a lower level of general cognitive functioning, in particular verbal and executive functioning (Morales et al., 2009).

More recently, evidence has been growing significantly about the risk of combustion-related air pollution to a child's neurological development, including the many pollutants associated with household gas use (Payne-Sturges et al., 2019). Being exposed in early childhood to unhealthy air – whether indoor or outdoor – may have a profound impact on an individual's life prospects, with cognitive impairment going on to affect school performance and other opportunities.

CARBON MONOXIDE POISONING

Exposure to high concentrations of carbon monoxide can lead to headaches, nausea, confusion, tiredness, shortness of breath, chest pain, loss of consciousness and sometimes death. Carbon monoxide is colourless, odourless and tasteless, meaning that victims are unaware they are being exposed. Carbon monoxide prevents the blood from carrying oxygen, leading to the tissues and organs being starved of oxygen.

Short-term exposure to high concentrations of carbon monoxide from gas appliances, as well as long-term exposure to lower concentrations can have lasting adverse effects, including trouble with memory and concentration, and other neurological problems (Watt et al., 2018).

Carbon monoxide poisoning in the home can cause nausea, confusion, loss of consciousness and even death.

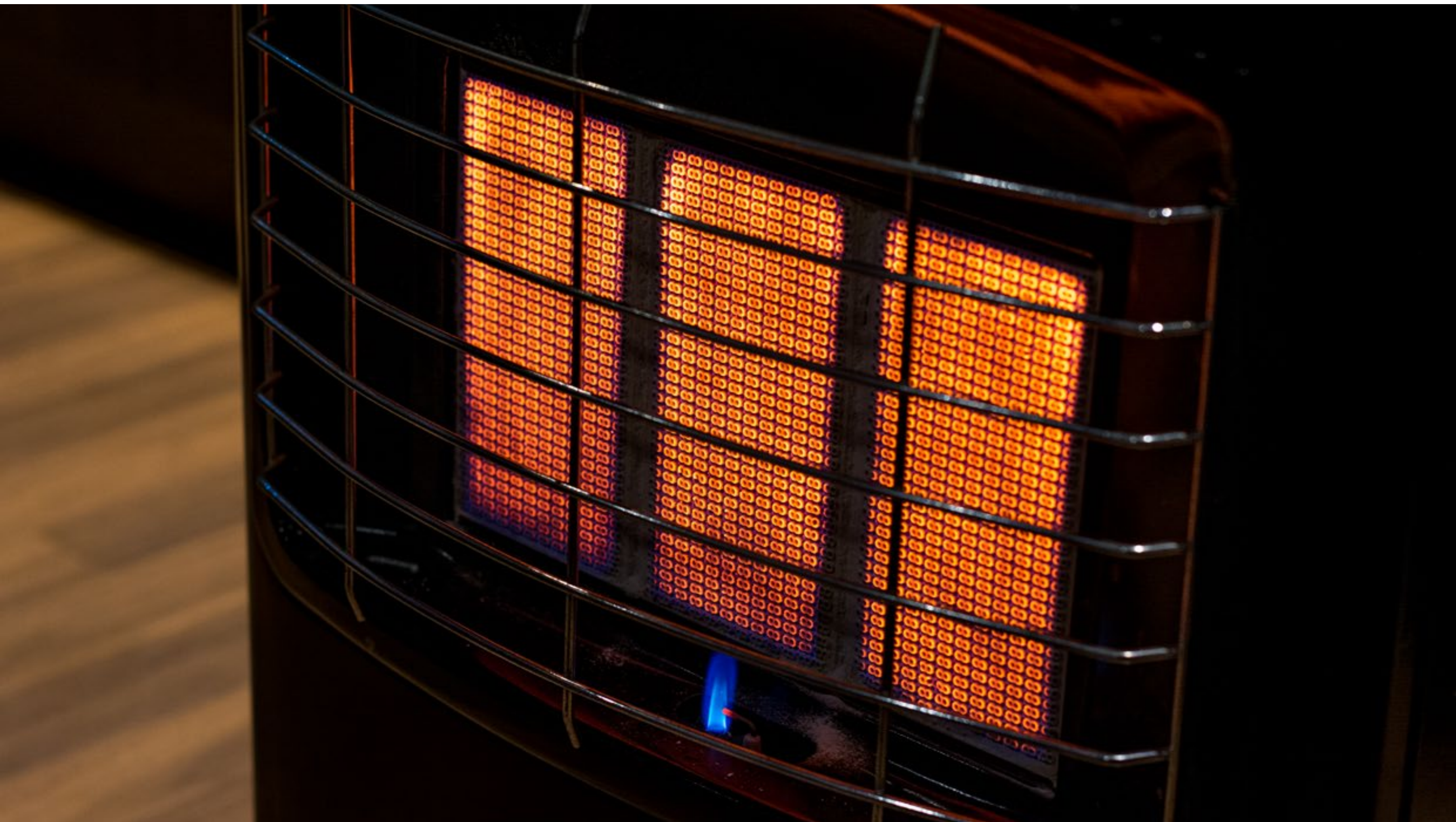
Acute carbon monoxide poisoning is a fatal, though rare, risk of indoor gas use. Carbon monoxide poisoning is the leading cause of accidental poisoning worldwide (Watt et al., 2018). Furthermore, the range, variability and non-specific nature of symptoms associated with carbon monoxide poisoning means the true number of cases may be much higher (Kar-Purkayastha et al., 2012). It is likely that many deaths from carbon monoxide poisoning go undetected as they are attributed to other causes.

In 2010, two young brothers Tyler and Chase Robinson were killed by carbon monoxide from a gas heater while sleeping in their home near Shepparton, Victoria. Their mother, Vanessa, tells her story in Box 4.

In 2017, Victorian mother and public housing resident Sonia Sofianopolous died in similar circumstances. Poor ventilation, a fault with the flue, and exhaust fans that were inadvertently drawing fumes inside the house, were the causes of the death (Victorian Government, 2018). The inquest into Ms Sofianopolous's death prompted the Energy Safe Victoria to ban the sale of the type of open-flue heater used in Sonia's apartment and many others (ABC News, 2018).

These tragedies highlight the disproportionate impact of fossil gas upon poorer households, who are less likely to be able to afford to have their appliances regularly serviced and to take other safety precautions. Unlike those who are able to own their home and install modern safe electrical appliances, renters and people living in public housing may be stuck with gas appliances.

Figure 13: Gas heaters pose a significant risk to human health.



BOX 4: VANESSA'S STORY

In late May, 2010, I did something I'd done many times before – I turned on the gas heater in my rental property. It was a chilly night in regional Victoria, and I wanted to keep myself and my two boys, eight-year-old Chase and six-year-old Tyler, warm.

Instead, I woke up to find they had died of carbon monoxide poisoning.

One moment I had two healthy kids, the next moment I was arranging their funerals. I lost my entire family in one fell swoop to an insidious, invisible killer – a gas that is colourless, odorless and tasteless.

The cause was an unserviced, faulty open-flued gas heater which was emitting carbon monoxide into my home 500 times above the safe level.

Carbon monoxide is produced when the carbon in fuels, such as gas, doesn't completely burn. It can be generated by vehicles, and can also be formed during bushfires. In my case, the faulty gas-powered heater in my rental property was to blame.

Carbon monoxide poisoning interferes with our red blood cells' ability to carry oxygen around our body. 'Minor' poisoning brings on flu-like symptoms such as headaches, dizziness, nausea and breathlessness. Severe poisoning can cause

Figure 14: Six-year-old Tyler Robinson (L) and his older brother Chase (R) passed away in 2010 after succumbing to carbon monoxide poisoning from a faulty gas heater.

BOX 4: *CONTINUED*

breathlessness, confusion, drowsiness, loss of consciousness, collapse, brain damage and death through oxygen starvation.

Ironically, when we feel fluey we're told to keep warm. But what if it's the heater itself that's making us sick? At the Chase & Tyler Foundation we suspect hundreds of thousands of people have been affected by low level carbon monoxide poisoning and don't even know it.

I spent nearly two months in hospital recovering from my poisoning, with the first few days in an induced coma. I suffered from renal failure, shoulder injuries and nerve damage to my left arm and hand due to the substantial time I was unconscious and laying on my side, as well as some mild cognitive issues due to oxygen starvation.

At the time I was in deep shock and disbelief. I'd never heard that gas heaters could be deadly. If I had, my kids would still be alive today, as I would never have used gas as a heating option knowing now of the risks.

Gas heaters can spill carbon monoxide if they haven't been regularly serviced, if they have a blocked flue, or if there's a lack of adequate ventilation. Gas spillage can also happen when there's a build up of 'negative pressure', which can occur when a gas appliance is on and an exhaust fan is also operating.

Australians living in rented or public housing are particularly vulnerable to carbon monoxide poisoning because they have no control over the method used to heat their home, and whether it's maintained well. In addition, they sometimes bring outdoor heaters like BBQs, briquettes and patio heaters indoors, because they can't afford gas and electricity prices, and that's really dangerous.

While we have public awareness programs now, we're yet to legislate mandatory gas appliance servicing in homes. I look at gas heaters as ticking time bombs and until mandatory servicing happens there will be more poisonings and deaths in Australia – this is a fact.

As for me and my ex-husband, we don't have a life. Every day is Groundhog Day, a day we live without our children. The day my children died, the old me died too. It's like a life sentence of torture, not having Chase and Tyler here.

"Every day is Groundhog Day, a day we live without our children."

4. Conclusion

The contribution of gas to the escalating global climate crisis is alone enough to render a gas-fired economic recovery incompatible with a healthy future for Australians and communities everywhere. The direct health impacts of mining and burning gas increases the imperative to move beyond the technologies of the past and ensure access to clean, modern energy for all.

Unconventional gas development, through its impact on water resources, clean air and other environmental determinants of health, is associated with significant health problems among those exposed. The unconventional gas industry was established in Australia without providing independently verifiable evidence of its safety and recent studies are finding evidence of its harm. It is imperative that such studies – which should have occurred before the industry was able to establish itself in the first place – be conducted today. Evidence has steadily accumulated in support of longstanding concerns from health professionals and affected communities.

The impact of each proposed new gas development is unique, and the degree of health risk will vary depending on proximity to homes, the local geology, the extraction methods to be used, the strength of any safeguards put in place, and many other factors. However, the early evidence available today provides a compelling case for further, independent research into the cause of adverse health outcomes being seen, and for halting further development of unconventional gas in Australia, investing in zero emissions alternatives instead.

To push ahead with new unconventional gas developments means taking unacceptable risks with the health and wellbeing of Australians.

Concern over the impacts of indoor air pollution from burning gas indoors is not new. However, growing evidence to support these concerns, and the availability of clean and healthy alternatives, now make it clear that gas is not a safe or appropriate energy source in these settings.

The risks of harm from indoor air pollution from gas appliances are greater among lower income households, who may also face greater barriers in transitioning away from gas. Appropriate support is therefore necessary to enable lower income households to make the transition. The eventual phase-out of gas for cooking and heating is a win-win for climate and for health, especially among the more vulnerable in our community.

Australia has some of the world's best renewable energy potential – enough to support both our own energy needs and a large export industry that can replace the inevitable permanent decline in revenue from fossil fuel exports. At the same time, modern, efficient electrical appliances mean we no longer need to burn gas in our homes, schools and businesses.

With the right policies and support, we can leave all fossil fuels including gas in the past where they belong, and build a cleaner, healthier future for Australians and communities everywhere. The urgency of the climate crisis requires swift action, and as this report shows, moving away from gas brings significant benefits for all.

With the right support, we can leave fossil fuels like gas in the ground, and press on with a cleaner, healthier future.

CASE STUDY 3: POWERING PAST GAS IN THE AUSTRALIAN CAPITAL TERRITORY

The Australian Capital Territory (ACT), under the *ACT Climate Change Strategy 2019-2025* (ACT Government, 2019), is working actively to remove gas from its energy mix.

Having reached its goal of 100% renewable electricity, burning gas is now the second biggest source of emissions in the ACT after transport. Transitioning out of gas is essential to achieve the ACT's goals of reducing its greenhouse gas emissions by 65-75% by 2030 and to net zero by 2045.

The ACT has already taken practical steps to begin weaning itself off gas. In 2020 it removed the requirement for new suburbs to be connected to gas – one of a series of commitments in its 2019-2025 strategy, thereby discouraging gas from being installed in new homes (Rattenbury, 2020). From 2020 the Government will begin a public education campaign highlighting options for switching from gas to electric appliances, along with potential cost savings.

The strategy notes that switching from gas heating to efficient reverse cycle air conditioning can save a household $500 a year on energy costs, and that switching from a gas hot water system to a heat pump can save $150 a year. By 2024, the Government will set timelines for phasing out existing gas connections (ACT Government, 2019).

Importantly, the strategy is also designed around the principle of a just transition, with support in place to assist low-income households. Under an extended Energy Efficiency Improvement Scheme (EEIS), some households are eligible for a rebate of up to $5,000 when replacing gas heating with efficient electric heating (Canberra Times, 2019). Further options, including interest-free loans or other innovative financing, are also set to be trialled. A similar measure, focused on low-income and vulnerable households, has been announced by the Victorian government, with a goal of upgrading heaters for 250,000 homes (Victorian government, 2020).

The strategy also commits the ACT government to phasing out gas in government facilities, including hospitals and schools. In September 2020 the Government announced that a new $500 million hospital in Canberra would be all electric (RenewEconomy, 2020).

The message is simple: The solutions to move away from gas permanently are here for Australian homes, schools and office buildings. We need to just get on with it.

The solutions are here.
Let's get on with it.

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