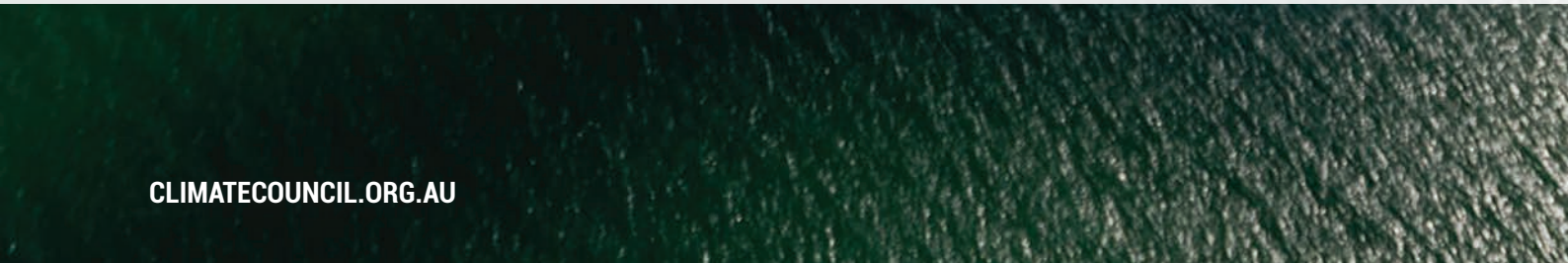
CLIMATE COUNCIL

RISKY BUSINESS: HEALTH, CLIMATE AND ECÓNOMIC RISKS OF THE CARMICHAEL COALMINE



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Preface

The Carmichael mine will be Australia's largest coalmine with a potential lifetime of up to 60 years. Australia has very large coal deposits, but for Australia to play its role in tackling climate change, over 90% of Australia's existing thermal coal reserves must be left in the ground unburned and no new thermal mines can be developed.

This report follows on from our previous reports in 2015 titled "Galilee Basin – Unburnable Coal" and "Unburnable Carbon: Why we need to leave fossil fuels in the ground". It outlines why – based on the "carbon budget" approach – opening up the Galilee Basin for coal mining is fundamentally at odds with global efforts to tackle climate change effectively and protect Australia from the dangerous impacts of climate change, such as more intense extreme weather events and destruction of our most iconic ecosystems including the Great Barrier Reef.

As the strong global trend away from coal to renewable energy and storage gathers even more momentum, Australia's thermal coal export industry future looks increasingly shaky. The Galilee Basin, if developed, could well become a stranded asset in a world rapidly moving away from coal. The need to move away from fossil fuels to renewable energy is extremely urgent. Furthermore, as climate impacts worsen, climate change litigation is becoming a significant risk for corporations. New coalmines, such as the Carmichael coalmine, potentially undermine the vibrancy of other major Australian industries that rely on water resources, land and healthy ecosystems, such as agriculture and reef tourism. The report also describes how coal and human health is deadly serious.

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Key Findings

1

Developing *any* new thermal coalmines, particularly of the scale of the Carmichael mine in the Galilee Basin, is fundamentally at odds with protecting Australians from the impacts of climate change.

- If the Galilee Basin were a country on its own, it would emit more than 1.3 times Australia's current annual emissions from all sources and rank in the top 15 emitting countries in the world.
- Climate change, driven by greenhouse gas pollution from burning coal and other fossil fuels, is increasing the severity and frequency of many extreme weather events in Australia, such as heatwaves, bushfires and intense rainfall.
- Developing the Carmichael mine fundamentally undermines any national or state action to tackle climate change.

2

Opening up the Galilee Basin undermines other industries, such as tourism and agriculture.

- Burning coal anywhere in the world, including India, increases the incidence and severity of many extreme weather events in Australia, with direct economic risks to the agriculture and tourism industries.
- Coal expansion will drive further warming of the oceans, which increases the risk of extreme bleaching to Australia's multi-billion dollar tourism asset, the Great Barrier Reef.
- Australia's agricultural industry is vulnerable to worsening extreme weather events, like extreme heat and more severe drought. Coal burning here, or abroad, further increases those risks.
- To protect Australia's tourism and agricultural industries from worsening extreme weather, coal burning must be rapidly and completely phased out; this includes coal burning in Australia, India and elsewhere in the world.

3

Coal is very harmful to human health.

- Particulate air pollution (fine particles that enter the lungs) caused 4.2 million deaths globally in 2015. Burning of coal is a major source of particulate air pollution.
- In India, to which the coal from Adani's Carmichael mine in Queensland will most likely be exported, an estimated 80,000-115,000 people die from coal pollution each year.
- It is estimated that the ash content from the planned Carmichael coalmine is about 26%, roughly double, the Australian benchmark.
- There has been a recent re-emergence of the life threatening 'black lung' (coal workers' pneumoconiosis) in Queensland, with 21 reported cases.
- Coal's health impacts cost Australian taxpayers an estimated $2.6 billion every year.

4

The Carmichael mine is a risky financial investment and promises of economic benefit are overblown.

- Plummeting costs of renewable energy and the reduced coal demand from China combined with India's aggressive move towards energy self-sufficiency all place new coalmines, and associated rail/port infrastructure investments, on shaky ground, increasing the risk of stranded assets.
- 17 major banks worldwide have stated they will not fund the Carmichael mine based on both its lack of economic viability and environmental impact.
- As the world moves towards a more sustainable, lower carbon economy, company directors who do not properly consider climate change related risks may be held legally liable for breaching their duty of care and due diligence.

Contents

Introduction

To protect Australia from the impacts of climate change, the vast bulk of fossil fuels must be left in the ground, unburned. This means that existing coalmines will need to be retired before they are fully exploited and new mines cannot be developed. This is particularly relevant for Australia as plans and approvals to open up the Galilee Basin for lower quality thermal coal mining operations, such as the Adani Carmichael coalmine, are advanced.

Existing coalmines will need to be retired before they are fully exploited and new mines cannot be built.

Climate change is driven by rising greenhouse gas emissions, particularly from the burning of coal, oil and gas. Since the 1970s, global average temperature has trended strongly upwards (e.g. Rahmstorf et al. 2017), with a global temperature now more than 1°C above pre-industrial levels. Furthermore, since 1970 global temperature has been increasing at a rate 170 times faster than the background rate over the past 7,000 years (Steffen et al. 2016).

Rising temperatures and the accelerating impacts of climate change are affecting all nations, including Australia. Heatwaves are now hotter, lasting longer and occurring more often in Australia (Perkins and Alexander 2013; Climate Council 2014). The ocean is also warming. Rising sea surface temperatures, driven by climate change, are increasing the prevalence of "marine heatwaves" (Perkins et al. 2016), which can trigger coral bleaching events, like those seen in 2016 and 2017 on the Great Barrier Reef. The reef is an environmental treasure, as well as a key tourism and fisheries asset. Ongoing damage to the reef driven by climate change puts marine life, livelihoods and the north Queensland economy at risk.

Climate change has also increased extreme fire weather in the south and east of Australia since the 1970s (Clark et al. 2013; CSIRO and BoM 2016; Figure 1), threatening people and property, while climate change is likely making drought conditions in southwest and southeast Australia worse (CSIRO and BoM 2015; Climate Council 2015c). At the same time, sea level has been rising rapidly, exposing coastal infrastructure and property to increasing coastal erosion and higher risk of inundation from storm surges (McInnes et al. 2015; Climate Council 2017).

Figure 1: Bushfire risk is increasing in Australia as a result of climate change (Clark et al. 2013).

Given that it has taken significant time to ramp up action on climate change globally, there is now only a relatively small "carbon budget" left. The carbon budget approach allows us to quantify the amount of fossil fuels that can be burned to have a good chance of remaining under a 2°C rise in global temperature, the upper warming limit agreed to in Paris in 2015. More than 140 governments around the world, including Australia, have already ratified the Paris Agreement. Anything more than 2°C warming is considered too dangerous for humanity, not only for unacceptably large increases in direct impacts such as extreme weather events, but also for crossing climate 'tipping points', where large, rapid and potentially irreversible changes occur in the climate system (Church et al. 2017). Examples of these tipping points are the loss of the Greenland and West Antarctic ice sheets, thawing of permafrost in Siberia and loss of the Amazon rainforest.

Consistent with the remaining global carbon budget, for Australia to play its role in tackling climate change, over 90% of Australia's coal reserves must be left in the ground unburned (McGlade and Ekins 2015) and no new mines can be developed. If all of the Galilee Basin mines are developed to their maximum potential, it is estimated that over 700 million tonnes (Mt) of carbon dioxide (CO_2) would be released to the atmosphere each year

Opening more Australian coalmines will directly worsen extreme weather.

(Greenpeace 2012). That's more than 1.3 times Australia's current annual emissions from *all* sources (2015 emissions were 527 Mt CO_2; Australian Government 2016). Put another way, if the Galilee Basin were a country on its own, it would rank in the top 15 emitting countries in the world (Olivier et al. 2016). Any new mine is fundamentally at odds with protecting Australia from the impacts of climate change, and runs contrary to good government policy to transition the Australian economy in a planned way, consistent with our Paris Climate Agreement commitments. It also poses serious and irreversible risks to tourism and agriculture, which are vital not only for the livelihoods of many Australians but also for the national economy.

In the last few years action on tackling climate change worldwide has been accelerating with the transition from fossil fuels to renewable energy. A global movement to decarbonise the world is underway and rapidly gaining momentum. Globally, carbon dioxide (CO_2) emissions were near flat for the third year in a row in 2016 (Le Quéré et al. 2016). Last year, 139GW of renewable capacity was built, an 8% increase on the previous year, largely driven by rapidly falling renewable energy costs (Frankfurt School-UNEP Centre/BNEF 2017). Much of the recent renewable energy growth has occurred in developing countries, with China, and more recently India, leading the way (IEA 2016). Meanwhile, in Australia new renewable power is now cheaper than new coal or gas power.

This report outlines why – based on the carbon budget approach – opening up the Galilee Basin for coal mining is fundamentally at odds with tackling climate change. Protecting Australia from worsening extreme weather and protecting the Great Barrier Reef from further damage requires a rapid transition away from coal. The report also tackles two of the key assertions proponents for the mine consistently make, that it is: (a) economically beneficial and (b) beneficial for those who are poverty stricken in India. The report also considers these assertions, finding that they are both false.

Coalmines are becoming an increasingly risky investment as carbon regulation is imposed, the world moves to renewables and coal increasingly loses its social licence. 17 major banks worldwide have stated they will not fund the Carmichael mine, with all of Australia's four major banks (ANZ, NAB, Westpac and Commonwealth Bank) now declaring they will not fund the project. With the global trend away from coal gathering momentum, any Galilee Basin coalmine could well become a stranded asset in a world rapidly moving away from coal towards clean energy systems.

Furthermore, coal mining and burning pose significant health risks which were brought into focus recently with 21 reported cases of black lung disease in Queensland. Human health risks from coal exploitation include lung cancer, bronchitis, heart disease and other conditions of ill health (Temple and Sykes 1992; García-Pérez et al. 2009; Hendryx and Zullig 2009). In India, approximately 100,000 people die from exposure to coal pollution each year (Guttikunda and Jawahar 2014). In addition, the impacts of climate change on people living in poorer and more vulnerable countries such as India are severe, with poorer people most at risk from climate-related hazards. An extreme heatwave in 2015 in India killed more than 2,000 people (ABC 2015c), many of whom were poorer people and the homeless, who had few resources to escape the extreme conditions (CNN 2015). People who are poor have the fewest resources to cope with the consequences of climate change and will suffer the most as extreme weather and sea-level rise intensify (IPCC 2014; The Guardian 2014a).

1. How Much Coal Can We Burn?

To tackle climate change, the Paris Agreement was signed by 197 countries around the world and has now been ratified by more than 140 countries, including Australia (UNFCCC 2017). The Agreement aims to limit global temperature rise to no more than 2°C above the pre-industrial level. It is very important for Australia that temperatures stay within this 2°C limit, to protect people in Australia from worsening climate impacts, which affect human health, livelihoods and the environment.

Australians are already feeling the impacts of climate change, with global average temperature about 1.1°C above the pre-industrial levels (UK Met Office 2017). This summer alone has seen more than 205 records broken across the nation, with heat and rainfall records broken widely in the east and west, respectively, in what has been termed the 2016/2017 "Angry Summer" (Climate Council 2017). For example, Brisbane, Sydney and Canberra had their hottest summers on record, while regional towns, such as Moree in New South Wales recorded 54 consecutive days of temperatures 35°C or above, a record for the state. To protect Australians from worsening climate impacts, Australia must rapidly reduce greenhouse gas emissions from the burning of fossil fuels to contribute its fair share to the global effort to limit temperature rise to less than 2°C.

To protect Australians from worsening climate impacts, Australia must contribute its fair share to eliminating global greenhouse gas pollution.

Figure 2: San Juan generating station and coalmine in New Mexico. The more CO_2 emitted into the atmosphere, the more the Earth warms.

There is a direct relationship between our emissions of CO_2, primarily from the burning of fossil fuels (Figure 2), and the rise in global average temperature (IPCC 2013). The more CO_2 we emit, the more the Earth warms. So, to limit warming to no more than 2°C, there is a limit to how much CO_2 we can emit. That is, there is a global carbon budget for the amount of fossil fuels we can burn. The global carbon budget provides a framework for understanding how much fossil fuels we can burn to have a good chance of staying below a 2°C rise in global temperature. While no amount of global warming is entirely 'safe', the budget approach can assist in planning the speed and scale of the transition away from fossil fuels.

Because the world is only now beginning to take substantial action on climate change, our remaining carbon budget is small. For a 75% chance of staying below the 2°C warming limit, the budget from 2012 is 672 billion tonnes (Gt) of CO_2 globally (Meinshausen et al. 2009; IPCC 2013). While this looks like a very big number, current annual global emissions are around 36 Gt CO_2 (Le Quéré et al. 2016) so the budget will be exhausted in less than two decades at current rates of emissions. The bottom line is that the need to move away from fossil fuels is extremely urgent.

A further analysis based on the economically optimal use of the three main fossil fuels – coal, oil and gas – highlights the need to eliminate coal usage as soon as possible (McGlade and Ekins 2015). Even for the most generous assumptions – just a 50% chance of staying below 2°C warming– only 38% of the world's fossil fuels can be burned (Figure 3). This drops to only 23% for the more prudent approach of a 75% of chance of staying below 2°C (Table 1).

Table 1: The carbon budget for three probabilities of meeting the 2°C warming limit, and the fraction of fossil fuel reserves and resources that can be burned within the budget.

Probability of meeting 2°C policy target	Budget from 2000 Gt CO_2	Budget from 2012 Gt CO_2	% of fossil fuel reserves that can be burned from 2012	% of fossil fuel resources that can be burned from 2012
50%	1440	1112	38	10
66%	1338	1010	35	9.2
75%	1000	672	23	6.1

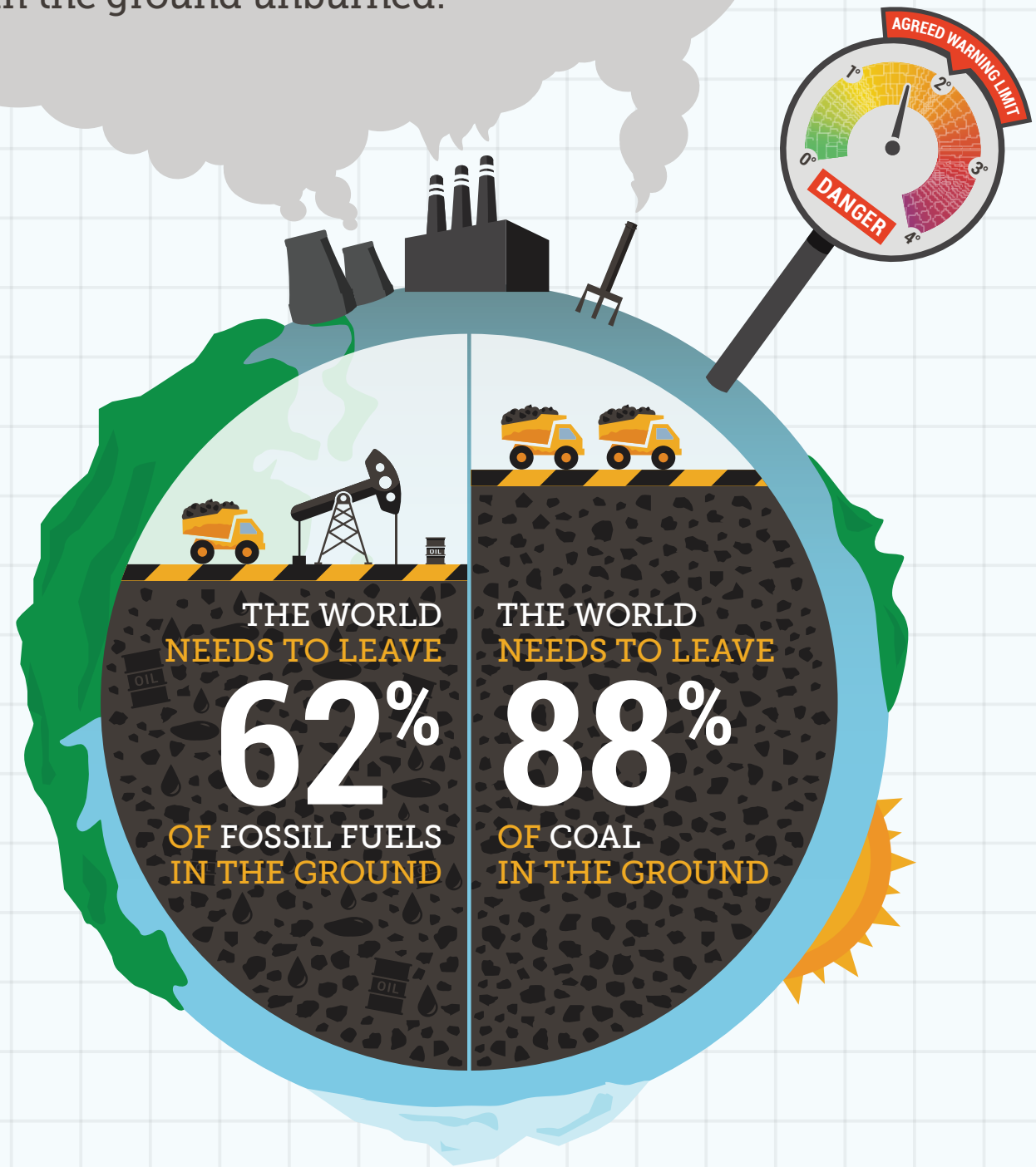
Sources: Meinshausen et al. 2009; IPCC 2013; McGlade and Ekins 2015.
Note: "resources" are all of the fossil fuels that we know exist, and "reserves" are the subset of resources that are economically and technologically viable to exploit now.

The news for coal is clear. Based on the economic optimisation of McGlade and Ekins (2015), the bulk of the allowable fossil usage comes from oil and gas, leaving very little of the carbon budget left for coal. In fact, for the most generous budget, only 12% of the world's coal reserves – deposits that are economically and technologically viable to exploit today – can be burned.

When the economic analysis is extended to geographical regions, it is clear that there is little room for coal burning and none at all for new coal mining in Australia's budget. Well over 90% of our coal reserves are unburnable (Table 2), even under generous assumptions and allowing for uncertainties in the analysis (see Climate Council 2015d for more details). This includes all types of coal, regardless of its quality. There is no such thing as "clean coal" (see Box 1).

WHAT IS OUR CARBON BUDGET?

To stay **below a catastrophic 2°C** rise in global temperature most of the world's fossil fuel reserves must be kept in the ground unburned.



AT THE CURRENT RATE

We will blow our carbon budget within the next **two decades** or even sooner.

Figure 3: The amount of coal and fossil fuels (coal, oil and gas) available for a 50% chance to keep global warming below 2°C. For a 75% change of staying within the 2°C limit, more than 90% of the world's coal reserves must stay in the ground, and 97% of Australia's coal reserves must stay in the ground, unburned (see Table 2).

Over 90% of Australia's existing coal reserves must remain in the ground, unburned.

Table 2: Percentage of existing fossil fuel reserves that can be burned, based on a carbon budget approach for the OECD Pacific group (largely Australian reserves) for emissions from 2011 through 2050.

Fossil fuel	Percentage of reserves that can be burned
Oil	32
Gas	29
Coal	**3**

Source: Meinhausen et al. 2009; IPCC 2013; McGlade and Ekins 2015.

The bottom line is simple. If we are to tackle climate change:

- The vast majority of the world's, and especially Australia's, coal must stay in the ground unburned.
- Existing mines can only be partially exploited and will need to be retired before they are exploited fully.
- New mines, such as those in the Galilee Basin, cannot be built.
- New energy sources, such as solar and wind, must come online rapidly to replace coal to help transition the Australian economy towards clean industries of the future.

BOX 1: THE FALLACY OF "CLEAN COAL"

Coal is always polluting (Climate Council 2017a; Figure 4). When dug up and burned, coal pollutes the environment and damages our health in several ways. Burning coal for electricity emits toxic and carcinogenic substances into our air, water and land, directly and severely damaging the health of miners, other workers and communities. The Australian Academy of Technological Sciences and Engineering (2009) estimated coal's health impacts cost taxpayers $2.6 billion every year (see Section 4).

More efficient coal plants labeled "ultra supercritical" (called "clean coal" by the Federal Government) still emit a significant amount of greenhouse gases, which drive climate change with its many impacts on our health, livelihoods and ecosystems. A new high-efficiency coal plant run on black coal would still produce about 80% of the emissions of an equivalent old plant, while renewables (e.g. wind and solar) have zero emissions. So-called "clean coal" does not help Australia meet its (very inadequate) obligations to reduce its emissions 26-28% by 2030 below 2005 levels.

Building new coal plants would be a very expensive option for replacing Australia's ageing, inefficient coal fleet. New wind and solar plants both in Australia and overseas are beating new coal, gas and nuclear plants on price. AGL's Silverton Wind Farm will deliver power to the grid at a price of $65 per MWh (megawatt-hour) compared to new coal power, which could have costs of up to $160 per MWh (BNEF 2017).

For very clear and commercial reasons, major Australian energy companies have ruled out building new coal plants. The Australian Energy Council sees them as "uninvestable". Consistent with APRA's February 2017 Climate Risk position, banks and investment funds are not interested (APRA 2017). Any new coal plants would be much more expensive than renewables and carry a huge liability through the carbon emissions they produce (see Section 3).

Figure 4: Coal is never "clean"; it pollutes the environment and damages our health.

2. World Rapidly Moving Away From Coal to Renewables

After a slow start over the past two decades, the world is beginning to take action on climate change, and the primary emphasis is on the switch from coal to renewables for electricity generation. The speed and magnitude of the movement away from coal as an energy source in Europe and countries like China, the United States, India and Japan is striking, and it is gaining even more momentum in new markets like Mexico and Chile (Ernst & Young 2016; REN21 2016; Frankfurt School-UNEP Centre/BNEF 2017).

The world's economy grew in 2016 by 3.1%, meanwhile growth in emissions stalled for a third straight year, meaning energy-related CO_2 emissions are no longer rising. This is due to rapid renewable energy growth, energy efficiency improvements, and gas replacing coal in some areas (IEA 2016b; 2017). In the United States, emissions fell 3% in 2016, while the economy grew by 1.6%. China's emissions also fell by 1%, while their economy grew by 6.7% (IEA 2017). Both these countries are achieving reductions in emissions while still experiencing strong economic growth.

The stall in global emissions is largely due to China's concerted and sustained policy drive to reduce coal usage and invest in renewables. China is both the world's biggest emitter of CO_2 and the world's largest producer and consumer of coal, and is now accelerating its transition away from a coal-based electricity generation system. In fact, China has most likely already passed peak coal use in 2013 (IEA 2017). In its 13th Five-Year Plan for the period 2016-2020, China scaled up plans for transitioning away from coal, introducing a cap on the country's total energy consumption and expanded renewable energy targets for 2020 (Carbon Tracker 2016; IEA 2016a). The country's coal use has declined for three consecutive years, with reductions in coal volume consumption of 2.9%, 3.7% and 4.7% reported in 2014, 2015 and 2016, respectively (National Bureau of Statistics 2015; 2016; 2017). Cities such as

The US and Chinese economies have prospered while renewable energy has taken off.

Global CO_2 emissions stalled for the third consecutive year in 2016.

the capital Beijing, which has been plagued by severe air pollution from its coal-fired power stations, closed its last coal-fired plant in 2017 as the push for clean air and clean energy progresses rapidly (Sydney Morning Herald 2017; Figure 5).

Growth in renewable energy is booming across the globe as costs continue to fall rapidly.

- Since 2009, investment in new renewable capacity has passed investment in new capacity for all fossil fuels combined, including coal (REN21 2015).
- In 2016, 139GW of renewable capacity was built worldwide – an 8% increase on the previous year, largely driven by rapidly falling costs (Frankfurt School-UNEP Centre/BNEF 2017).
- 2016 was a record year for the solar photovoltaic (PV) industry, with 75GW of new capacity added, eclipsing the 2015 record of 50GW (Frankfurt School-UNEP Centre/BNEF 2017; Climate Council 2017d; Figure 6).
- The trend of rapidly growing solar PV and wind capacity in 2016 continued a decade of growth. For example, in the last ten years to 2016, wind capacity has grown around the world from 94GW to 467GW, while solar PV capacity grew from 9GW to 291GW (IRENA 2017).

Figure 5: Dense air pollution in China. The country is rapidly transitioning away from a coal-based electricity generation system.

In many parts of the world, renewables are now providing similar- or lower-cost power than fossil fuels. The costs are even lower when health, environmental and climate benefits of renewables, as well as the US$550 billion to $5.5 trillion in subsidies to fossil fuels are considered (IRENA 2015). When comparing new power plants on a cost per kilowatt-hour basis, many renewable energy technologies (biomass, hydropower, geothermal, onshore wind and industrial scale solar PV) are already cost-competitive with fossil fuelled power generation (IRENA 2015), particularly when compared to higher cost, imported thermal power alternatives. Since 2009, wind turbine costs have fallen 30-40%, and solar PV module costs have fallen 80% (IRENA 2016). The cost of power from solar and wind is expected to fall by a further 59% and 26% (respectively) by 2025 (IRENA 2016).

Between 2009 and 2015, the prices of wind turbines fell 30-40% and solar PV modules fell by 80%.

Figure 6: A large-scale solar farm (43MW) in southeastern Europe. More solar PV was added globally in 2016 than in any other year.

Most of the renewable energy growth has occurred in developing countries such as Brazil, South Africa, Mexico and Chile, with China leading the way (IEA 2016b; REN 21 2016). China is undertaking 30-40% of the world's total new investment in clean energy, which employs nearly 3.4 million people, with plans to install about 600GW of renewable power by 2020 (REN21 2015; Figure 7). It is set to invest close to $500 billion into renewable power generation (Deutsche Welle 2017).

India invested US$10 billion in renewable energy in 2015 and again in 2016, a direct result of the Indian government's increased focus on renewable energy, particularly solar power (REN 21 2016). In December 2016 the government of India announced a target for the cumulative installation of 275GW of renewable capacity by 2027, signalling a strong, clear policy shift towards renewables. This is leading to uncertainty concerning India's future use of coal as it aims to become a "renewables superpower" (The Guardian 2014b).

India is investing heavily in renewable energy.

Figure 7: Mulan Wind Farm near Harbin City. China accounts for over a third of global investment in clean energy (REN21 2015).

3. Coal is a Risky Business

Climate change, driven largely by greenhouse gas emissions from fossil fuels, presents a serious challenge to business and industry. As the world transitions to renewables, coal is becoming a risky business, with the possibility of stranded assets and liability for company boards that fail to account for the risks.

As nations worldwide strive towards limiting global temperature rise to less than 2°C, companies face increasing emissions regulation. Furthermore, when making investment decisions in a carbon constrained world, boards will need to consider if the climate risks and damage of those investments will mean assets have a liability and investment is risky. New fossil fuel projects will release more greenhouse emissions, worsening climate impacts, such as heatwaves, droughts and storms, with consequences for economies around the world.

Figure 8: In a carbon constrained world companies face increasing emissions regulation. Investing in new coalmines is a risky business.

3.1. Stranded Assets

Limiting global temperature increase to no more than 2°C above pre-industrial levels requires a drastic and rapid reduction in our economies' dependence on fossil fuels, with their associated greenhouse gas emissions (OECD 2015; University of Oxford 2016). Energy intensive economic activities will have to be retired quickly to make way for renewable energy, battery storage technologies, smart grids and improvements in energy efficiency. As climate policies drive this transition, some assets will become 'stranded' (OECD 2015; e.g. Figure 9). A 'stranded asset' is defined as an "asset that has suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities, and it can be caused by a range of environment-related risks" (Caldecott et al. 2013, p. 7). For example, air pollution and water scarcity in China may strand coal-fired power generation assets, as coal demand declines and affects global coal prices. Lower coal prices can increase the risk that coalmines, reserves and coal-related infrastructure could become stranded assets (Caldecott et al. 2013).

Coal is becoming a risky business, with the possibility of stranded assets and board liability.

Figure 9: Stranded asset. Anglesea coalmine in Victoria closed in 2016 after the coal plant owner Alcoa was unable to find a buyer for the power station (RenewEconomy 2015).

Recognising the risk of stranded assets as the world transitions to a low carbon economy, investors are moving away from putting money in fossil fuel assets, that is, they are 'divesting' (OECD 2015). It is estimated that investors engaged in divestment managed a total of US$50 billion in assets in 2014 and by early 2015 this figure grew to US$2.6 trillion (Arabella Advisors 2015). By December 2016, it is estimated that the value of assets of institutions and individuals committing to divestment from fossil fuel companies was US$5 trillion (Figure 10). One year on from the Paris climate agreement, 688 institutions and 58,399 individuals across 76 countries have committed to divest from fossil fuel companies, doubling the value of divested assets represented in just over a year (September 2015 – December 2016; Figure 10). Pension funds and insurance companies now represent the largest sectors committing to divestment, indicative of the growing financial risks of having fossil fuel investments in a world committed to staying below 2°C global temperature rise (Arabella Advisors 2016).

The significant economic and technological adjustments required to meet the 2°C target is already having a significant impact on fossil fuel companies, energy-intensive activities and asset values (IEA 2014; OECD 2015). This is because the majority of the world's – including Australia's – fossil fuel reserves must remain in the ground, unburned (McGlade and Ekins 2015).

Financial institutions around the world are moving away from fossil fuels. A number of large global banks including JP Morgan Chase, BNP Paribas, Crédit Argricole, HSBC, ING, Natixis, Société Générale have agreed to not directly finance new coalmines around the world (BankTrack 2016). The latter four banks listed have also ended direct financing of new coal power plants. In Australia, the 'Big Four' banks (ANZ, NAB, Commonwealth Bank and Westpac) have withdrawn the possibility of funding Adani's Carmichael coalmine (Holmes 2017).

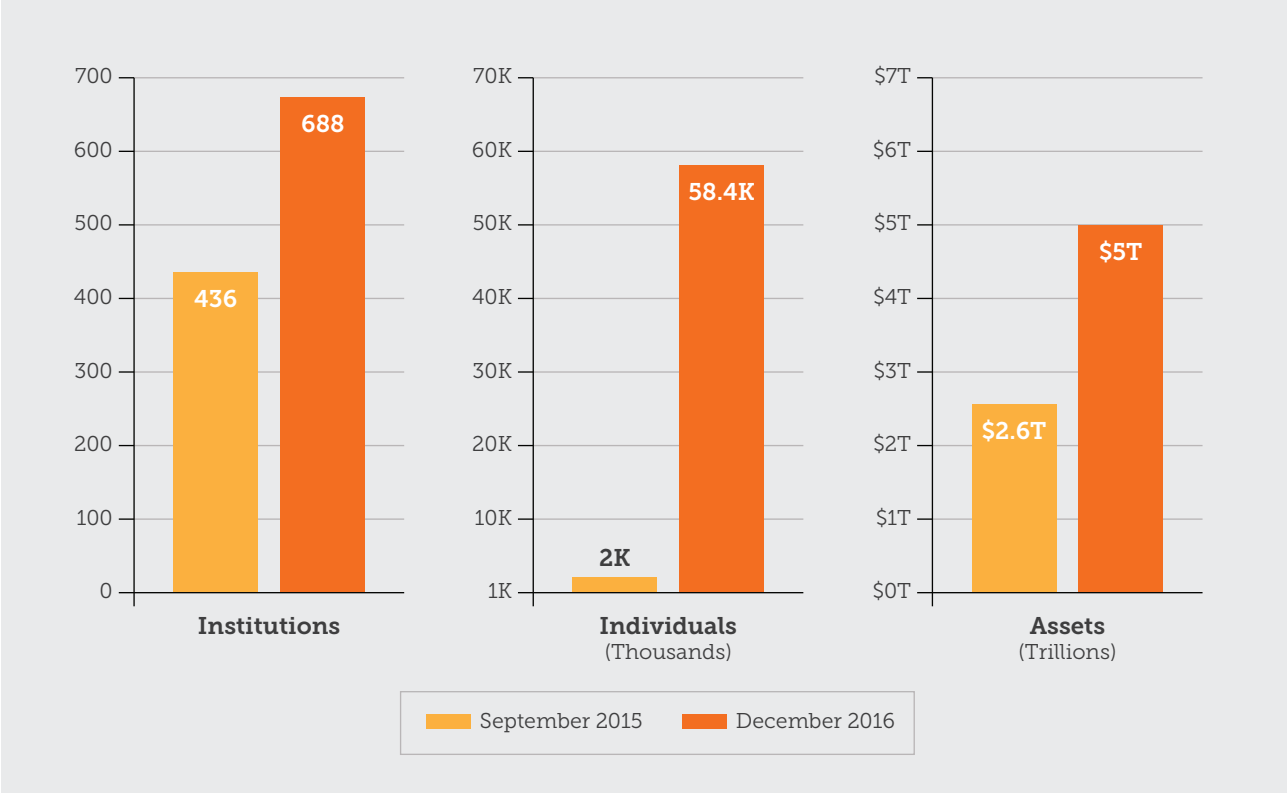


Figure 10: Fossil fuel divestment doubled between September 2015 and December 2016, with an asset value of over US$5 trillion. **Source:** Arabella Advisors 2016.

Governments are also opting for renewables rather than coal. For example, India's draft electricity plan released in December 2016, proposes no new coal-fired power stations in the next decade, while India ramps up renewable energy uptake, with 275GW of new solar and wind power planned by 2027 (Government of India 2016). This means the potential export markets for coal are rapidly dwindling as the world moves away from fossil fuels toward renewable energy. Coal mined at Carmichael in the Galilee Basin is primarily intended for export to India. However, India is experiencing extremely rapid growth in renewables, and is reducing coal imports overall, raising doubts about the projected, long-term market for coal (Climate Action Tracker 2016).

India's extremely rapid growth in renewables is raising doubts about the long-term market for coal.

3.2. Corporate Liability

Major institutions understand the need to tackle climate change. As the impacts of climate change from the burning of fossil fuels become more evident and as we work towards limiting global temperature rise, corporations could face severe liability challenges (The Australian 2017).

Global institutions such as the International Monetary Fund, World Bank, World Economic Forum, Organisation for Economic Co-operation and Development and Carbon Disclosure Project (representing 767 institutional investors with over US$92 trillion of assets under management) recognise the significant economic costs of climate change (Barker 2015). Climate change risks are now a major responsibility of the boardroom (Barker 2015; Horrigan 2016). For example, in 2015, France introduced a change in its Energy Transition Law requiring corporations to disclose climate-related vulnerability and counter-measures adopted. Furthermore, it mandated institutional investors to disclose the carbon exposure of their assets (Assemblée Nationale 2015). Boards in making investments need to consider if the climate risks and damage to those investments will mean assets have liability.

In Australia, the Centre for Policy Development (CPD) describes how companies and their directors now have a legal duty to consider foreseeable climate risks to their business (CPD 2016). Company directors who do not properly consider climate change related risks may be held legally liable for breaching their duty of due care and diligence (McLeod and Wiseman 2016). There is now more law applying to climate change responsibilities of Directors (The Australian 2017). For example, both the ASX Listing Rules and the ASX Corporate Governance Council standards recommend addressing climate change as part of a company's exposure to economic, environmental and social sustainability risks.

Financing the Carmichael could be risky business because:

- Assets risk becoming stranded as the world moves away from coal;
- Building new mines are not compatible with limiting temperature rise to less than 2°C; and
- Burning of coal will release more greenhouse gas emissions into the atmosphere, increasing temperature and worsening climate impacts such as coral bleaching on the Great Barrier Reef and increasing the severity of extreme weather events.

Climate change risks are now a major responsibility of corporations.

3.3. Carmichael Coalmine and Major Australian Industries

Not only is fossil fuel expansion a risky business for corporate boardrooms, proposed new projects, opening new coalmines and increasing coal burning will contribute to further climate change. Australia's agriculture and tourism industries are highly dependent on a stable climate and are at direct risk of further climate change. In addition, the Carmichael mine has been criticised for competing with agricultural interests for water.

AGRICULTURE

Australia's agricultural output as a proportion of the economy remains among the highest in the OECD (ABS 2012). The value of farm production in 2013-14 was worth $51 billion (ABARES 2014) and underpinned Australia's largest manufacturing sector – the food and beverage processing industry, worth $25 billion (ABS 2015). Yet Australia's agriculture industry is vulnerable to a wide range of impacts from the changing climate. Direct impacts of climate change on things like crop productivity (e.g. grains, grapes (Figure 11), fruit, sugar, vegetables) are relatively straightforward to quantify – such as the increased losses from more intense rainfall and storms, reduction in seasonal rainfall and a greater frequency and severity of extreme heat (Climate Council 2015a). Indirect climate impacts include changes to the distribution and incidence of pests and diseases, interruptions to supply chains and transportation networks, as well as altered seasonality and work schedules.

In addition to climate impacts, in recent years, prime agricultural land in some regions has become increasingly subject to competition from mining. In Queensland, local residents are concerned that the New Acland coalmine will affect the economic sustainability of the Darling Downs region by removing prime agricultural land for mining development (Miller et al. 2012; ABC 2015a). Further north, the proposed opening of the Galilee Basin, for example the Carmichael coalmine, has been opposed by landholders concerned about the loss of rangelands for cattle and sheep grazing (Duus 2013; The Sydney Morning Herald 2017).

Figure 11: Australia's wine industry contributes significantly to the Australia economy, but viticulture is highly sensitive to changes in the climate.

Because 90% of groundwater extraction is used in agriculture (Tan et al. 2015), one of the major areas of contention between farming and mining is the impact on aquifers (Lawrence et al. 2013; Tan et al. 2015). Community concerns have resulted in Federal and State governments agreeing to tighten regulations that protect aquifers and limit pollution (Lawrence et al. 2013).

In March 2017, Queensland's Department of Natural Resources and Mines granted an unlimited 60-year water licence to the Carmichael mine (Queensland Government 2017; Moon 2017). With North Queensland (e.g. Townsville area) currently experiencing water restrictions and with variable future rainfall projections (Queensland Government 2016), the provision of unlimited water for one of the largest mining operations in the Southern Hemisphere will no doubt compete with the water needs of the agriculture sector (Moon 2017). According to an environmental impact statement, the mine will draw 26 million litres of water a day from its pits by 2029 as annual production could reach as much as 60 million tonnes (The Sydney Morning Herald 2017). The decision has led to a range of questions about the coal mining industry's water use. For example, in Queensland, mining and industry possess around 1% (by number) of the water licences associated with the Great Artesian Basin but account for 10% of the water extracted.

Carmichael coalmine's unlimited water licence will likely affect agriculture water needs.

Figure 12: Bleached coral (white) and dead coral covered in algae (brown) at Port Douglas, on the Great Barrier Reef in March 2017.

TOURISM

Rapidly warming oceans, driven by the burning of coal, oil and gas, has led to the world's longest global bleaching event on record, beginning in 2014 and ongoing in 2017, with repeated bleaching of the Great Barrier Reef and other reefs worldwide with no reprieve (Figure 12; Climate Council 2017b). The rate of surface ocean warming in the 21st century is seven times faster than during the 20th century and the frequency of extreme sea surface temperature events has increased (Evans et al. 2017). Extreme coral bleaching and the death of reefs will become the new normal unless serious and rapid reductions in greenhouse gas emissions are achieved (Hughes 2016; ABC 2017; Climate Council 2017b).

Conservative estimates show that the observed warm conditions in the Coral Sea that caused the devastating bleaching on the north sector of the Great Barrier Reef in 2016 were at least 175 times more likely to occur because of climate change (King et al. 2016). Climate change is the greatest threat to the Great Barrier Reef.

Australia's reefs are incredibly valuable economic and environmental assets. For example, an estimated 69,000 jobs in the 2011-12 period were reliant on the Great Barrier Reef (Deloitte Access Economics 2013). The Great Barrier Reef contributes around $7 billion to the national economy annually, mainly via tourism (Jacobs 2016). A recent study by The Australia Institute (2016) showed that if coral bleaching persists, tourism areas adjacent to the Great Barrier Reef risk declines in visitors from 2.8 million visitors (2015 figures) to around 1.7 million per year. This is the equivalent of more than $1 billion in tourism expenditure, which supports around 10,000 tourism jobs in regional Queensland (The Australia Institute 2016).

The development of the Carmichael coalmine and the Galilee Basin, is fundamentally at odds with tackling climate change and protecting the Great Barrier Reef. To protect the Great Barrier Reef and Queensland's tourism industry, rather than opening new coalmines, Australia's focus should be to phase out existing coalmines well before their reserves are exhausted.

Climate change is the greatest threat to the Great Barrier Reef.

4. Coal's Impact on Human Health

Particulate air pollution (extremely small particles that can be inhaled into human lungs) caused 4.2 million deaths globally in 2015 (SoGA 2017). The burning of coal is a major source of particulate air pollution (Cohen et al. 2017). For example, in China alone, 366,000 deaths from air pollution in 2013 have been attributed to coal, while in India about 100,000 deaths per year can be attributed pollutants from coal-fired power plants (Guttikunda and Jawahar 2014; HEI 2016).

Every aspect of coal's lifecycle – mining, transportation, combustion and the disposal of waste – produces pollutants that affect human health (Epstein et al. 2011). Health impacts from coal emissions on miners, workers and local communities can be severe (Kizil and Donoghue 2002; Castleden et al. 2011; Armstrong et al. 2013). For example, the risk of premature death for people living within 50 kilometres of coal-burning power plants can be as much as three to four times that of people living at a greater distance (Epstein et al. 2010).

Health risks from coal include lung cancer, bronchitis, heart disease and other health conditions (Temple and Sykes 1992; García-Pérez et al. 2009; Hendryx and Zullig 2009). In Australia, there has been a re-emergence of 'black lung' (coal workers' pneumoconiosis) (ABC 2017b). Black lung disease is caused by long-term exposure to coal dust. As at 27 April 2017, there have been 21 confirmed cases of coal workers' pneumoconiosis in Queensland (Queensland Government 2017).

Coal combustion causes death and a range of human health issues including lung cancer, heart and respiratory diseases.

4.1. Examples of how Coal Affects Health

UNITED STATES

In the United States, coal contributes to four of the five leading causes of mortality: heart disease, cancer, stroke and chronic respiratory diseases (Lockwood et al. 2009). 50,000 deaths each year have been attributed to air pollution from coal fired power generation (Lockwood et al. 2009).

CHINA

Coal combustion is the largest source of air pollution in China, accounting for about 40% of the deadly fine particulate matter (PM2.5) in the atmosphere (HEI 2016). PM2.5 is especially dangerous for health because it is inhaled deeply into the lungs (e.g. Figure 13). In 2013, there were 916,000 premature deaths from air pollution, with 366,000 of these

Coal combustion is the largest source of air pollution in China.

Figure 13: A young coalminer in China. Miners, workers and local communities can suffer serious health consequences from coalmining (e.g. Castleden et al 2011).

deaths attributed to coal (HEI 2016). Observed health effects from coal use in China include respiratory illness and lung cancer (Zhang and Smith 2007). In 2010, approximately 1.9 million people suffered from skeletal fluorosis due to toxic coal based pollutants (Chen et al. 2014). Skeletal fluorosis is a bone disease caused by excessive accumulation of fluoride in the bones (Krishnamachari 1986).

INDIA

In India, to which the coal from Adani's Carmichael mine in Queensland will most likely be exported, there are considerable human health issues associated with air pollution from coal. A recent study of 2010-11 emissions from coal-fired power plants attributes 80,000 to 115,000 deaths to coal-fired power station pollutants and 20 million new cases of asthma (Guttikunda and Jawahar 2014). It is estimated that up to 10,000 children in India under the age of five died because of coal pollution in 2012 alone (Friedman 2013), while in townships close to coalmines, incidence of respiratory illness was found to be higher than in sites not near coalmines (Hota and Behera 2015). Coal from the Galilee Basin is poorer quality than coal from other regions in Australia. It is estimated that the ash content from the planned Carmichael coalmine is about 26%, roughly double the Australian benchmark. This raises health concerns for importing country populations (e.g. India), particularly respiratory illness, heart disease, lung cancer and other health conditions associated with high-ash coal (ABC 2017c).

EUROPE

An estimated 24.5 people die for every terawatt hour of coal electricity produced (Markandya and Wilkinson 2007). Pollutants produced from coal power stations in the European Union caused about 22,900 premature deaths, about 11,800 new cases of chronic bronchitis, and 6.6 million lost working days in 2013 due mainly to respiratory and cardiovascular disease (Jones et al. 2016). Coal plants in the Western Balkans were associated with approximately 7,200 premature deaths (Holland 2016) while Turkish coal plants are attributed a burden of 2,900 premature deaths (Gümüsel and Stauffer 2014). Ecological studies point to elevated prevalence of lung and laryngeal cancer as well as bladder cancer close to coal power stations in Spain (Garcia-Perez 2009), skin cancers and hearing loss in children due to arsenic emitted by one coal plant in Slovakia (Ranft 2003; Pesch 2002; Bencko 2009), as well as elevated lung cancer mortality in women in one location in Italy (Parodi 2004). Atmospheric modelling also shows large trans-boundary transport and health impacts in Europe (Preiss et al. 2013; Jones et al. 2016). In April 2017 EU Member States introduced a new technical regulation called LCP BREF which aims to reduce coal emissions and the associated burden of disease by up to 85% compared to 2013 levels (Schaible et al. 2016).

High ash content of coal from planned Carmichael coalmine poses serious health risks for communities in India.

AUSTRALIA

Despite Australia's dependence on coal for electricity generation – it provides 63% of our electricity supply (Commonwealth of Australia 2016) – there has been limited research into the health impacts of coal mining and power generation in this country compared with Europe and the US (Armstrong and Tait 2014; Selvey 2014). Yet emissions from coalmine fires, like the recent Hazelwood mine fire in Victoria, and the release of heavy metal and organic compounds pose health risks for surrounding populations, such as respiratory and heart disease, cancers and other conditions of ill health. At least 11 and most likely 23 people died directly from the health effects of the Hazelwood mine fire (ABC 2015b) but longer term health consequences from that exposure are hard to estimate. A review of air pollution and cardiopulmonary disease in Australia by Howie et al. (2005) concluded that air pollutants were associated with an increase in cardiovascular and respiratory mortality and hospital admissions, consistent with the international evidence (Colagiuri et al. 2012).

Australia has seen a re-emergence of the deadly 'black lung' disease in Queensland coalminers.

There is a is a lack of consistent monitoring of air, water and soil quality at and around Australian coalmines (e.g. Figure 14). Furthermore, there is a deficiency in research into the effects of coal on Australian communities. Given the extensive work done overseas to quantify the risks and the impacts of coal burning and mining, Australia is well behind similar countries worldwide in understanding the human health impacts on our population (Climate Council 2014).

Following a re-emergence of 'black lung' in Queensland and 21 reported cases (Queensland Government 2016), recent Coal Workers' Pneumoconiosis (CWP) committee interim findings suggest "a massive systemic failure across the entirety of the regulatory and health systems intended to protect coal industry workers" (ABC 2017). A recent survey conducted by Environmental Justice Australia found that about half of 1,507 survey respondents said that the state and federal governments were not adequately responding to the harmful impacts of coal pollution on human health (Clean Air Action Network 2016).

Figure 14: Uncovered coal train wagons in the Hunter Valley, New South Wales.

4.2. The Hidden Costs of Coal

A global study of health indicators spanning 40 years and 41 countries found that there are large, hidden health costs associated with coal consumption (Gohlke et al. 2011). Estimated costs of health damages associated with coal combustion for electricity in Australia amount to $2.6 billion per annum (Beigler 2009). The associated costs of coal and health in Australia relate to, for example, time off work, health care costs for pollution-related chronic disease and early mortality. The annual costs associated with health damages from coal-fired power stations in Hunter Valley, NSW are estimated at $600 million per annum (Armstrong 2015). The global health costs (social cost of carbon) associated with coal from the Hunter region has been estimated at $16-66 billion per annum (Armstrong 2015). In Europe, the health cost of air pollution from coal-fired power stations is €43 billion (A$61 billion) a year. US economists have estimated the health impacts of coal-fired power stations in the US to be between one and six times its value added (Muller et al. 2011). In India, it is estimated that the health costs associated with pollution from coal-fired powered stations costs the Indian government US$3.2-4.6 billion (Guttikunda and Jawahar 2014).

Recognising the adverse effects of air pollution on human health from the combustion of fossil fuels for electricity, transport, agriculture and other human activities, the World Health Organization recommends a reduction in energy sector-related emissions and a greater uptake of renewable technologies (e.g. solar and wind) and improved energy efficiency. Air pollution is a major environmental health problem affecting everyone in both developed and developing countries (Lelieveld et al. 2015). By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma (WHO 2016; Cohen et al. 2017), thereby reducing the significant economic costs associated with the health burden of fossil fuels, including coal.

Coal's impact on Australian's health is an astounding $2.6 billion per year.

5. So Where Does This Leave Galilee Basin Coal?

Once completed, the Carmichael mine will be Australia's largest coalmine and would have a potential lifetime of 25 to 60 years (ABC 2016). Opening up the Galilee Basin for coal mining is completely at odds with protecting Australians, infrastructure, industry and ecosystems (Figure 15).

More emissions from new fossil fuel projects will expose Australia to more intense extreme weather events including bushfires, heatwaves and storms. The Great Barrier Reef and the millions of tourists it attracts each year is at even greater risk if mining goes ahead. Competition for water from within the mining industry places pressure on the agriculture sector. Furthermore, exploiting the Galilee Basin coal deposits could also drive major local and regional impacts, ranging from groundwater contamination, biodiversity loss, social impacts on local communities, and damages to human health (Duus 2012).

One argument pushed by proponents of opening up the Galilee Basin is that the world is better off using Galilee coal rather than lower energy content coal from India, and that opening the Galilee is therefore doing a service to the poor of India. Both are fact-free assertions that ignore the fact the cost of imported thermal coal is 2-3 times that of domestic Indian coal even after adjusting for energy content differentials (India wholesales thermal coal for an average US$20/tonne in 2016 vs the Newcastle export benchmark at US$80/tonne) (RenewEconomy 2014; Australian Financial Review 2016; IEEFA 2016). Further, it is not the access to electricity that is preventing India's poor from solving energy poverty, it is that the cost of the product is prohibitive and/or the electricity grid does not extend to many

Coal has no future if we are to protect our way of life.

Figure 15: Abbot Point Coal Terminal in Gladstone, surrounded by wetlands and coral reef. This may become one of the world's largest coal ports if the coal terminal expansion goes ahead.

regions in the poorest areas of India. Coal also causes early death and reduces work productivity, therefore contributing to the maintenance of poverty. Death and ill health from air pollution can be substantially lowered with emission reductions of major sources of pollution.

For effective action on climate change, under any set of assumptions or uncertainties, Galilee Basin coal is unburnable. Over 90% of coal in Australia's existing reserves must stay in ground (McGlade and Ekins 2015). Thus, the most pressing challenge we face is to phase out existing coalmines, well before their deposits are exhausted. There is no basis for developing any potential new coalmines, no matter where they are or what size they are. If all of the Galilee Basin mines are developed to their maximum potential, it is estimated that over 700 million tonnes of CO_2 would be released to the atmosphere each year (Greenpeace 2012), which is more than 1.3 times Australia's current annual emissions (Australian Government 2016). If the Galilee Basin were a country on its own, it would rank in the top 15 emitting countries in the world.

Australia has an important choice to make. We can advance our economy while protecting our population from climate impacts without losing ground to trading allies, partners and competitors who are transitioning rapidly to renewables.... or we can fall behind the rest of the world and continue to back polluting and expensive energy. Both China and the US have demonstrated that the economy can grow while ramping up investment in renewable energy. As the world transitions to renewables, coal is becoming a risky business, with the possibility of stranded assets and board liability. Recognising this risk of stranded assets as the world transitions to a low carbon economy, investors have already begun divesting from fossil fuel assets (OECD 2015).

Fortunately, Australia is a country of huge potential for renewable energy. Australia has the potential to generate 100% of our electricity from renewables (CSIRO and Energy Networks Australia 2017). Our renewable energy resources are among the best in the world, potentially capable of providing 500 times the amount of electricity we currently use (Commonwealth of Australia 2014; AEMO 2013). However, compared to similar countries, Australia has one of the lowest levels of renewable electricity generation (ESAA 2015), accounting for just 15% of Australia's electricity in 2015 (Clean Energy Council 2016). Nevertheless, there are a number of exciting large-scale renewable energy projects under construction or starting in 2017, totalling more than 3.5GW, worth $7.4 billion and providing 4100 jobs (Clean Energy Council 2017), including projects in North Queensland near the proposed Carmichael coalmine.

The exploitation of Galilee Basin coal would be bucking a global trend of transitioning away from fossil fuels to renewable energy. There are two undeniable trends – an accelerating uptake of renewable energy and coal plant closures. For Australia to fight these trends is economically, socially and environmentally unwise and counterproductive. Rather, we need to be preparing for – and indeed joining, facilitating and accelerating – this transition to a clean energy world. The future is in renewable energy, storage, smart grids and energy efficiency. Now is the time for action.

Australia's renewable energy resources could provide 500 times the amount of energy we currently use.

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