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Disordering Fantasies of Coal and Technology: Carbon Capture and Storage in Australia

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Abstract

One of the main ways that continued use of coal is justified, and compensated for, is through fantasies of technology. This paper explores the politics of 'Carbon Capture and Storage' (CCS) technologies in Australia. These technologies involve capturing CO2 emissions, usually to store them 'safely' underground in a process called 'geo-sequestration'. In Australia the idea of 'clean coal' has been heavily promoted, and is a major part of CO2 emissions reduction plans, despite the technological difficulties, the lack of large scale working prototypes, the lack of coal company investment in such research, and the current difficulties in detecting leaks. This paper investigates the ways that the politics of 'clean coal' have functioned as psycho-social defence mechanisms, to prolong coal usage, assuage political

discomfort and anxiety, and increase the systemic disturbance produced by coal power.

[8428 words]

Keywords

[Carbon Capture and Storage; Social Defence Mechanisms; Climate Politics]

1) Introduction

Coal mining and burning increasingly contributes to climate change and other forms of ecological destruction. This will eventually undermine the social orders which depend upon coal. Mine sites can displace people or destroy environments and are rarely rehabilitated to their original forms, while coal-powered technology is a major source of directly harmful gas emissions (Lockwood et al, 2009). The IPCC 2014 Mitigation report states: "Increased use of coal relative to other energy sources has reversed the long-standing trend of gradual decarbonization of the world's energy supply" (IPCC, 2014: 8). "The energy supply sector is the largest contributor to global greenhouse gas emissions… GHG [greenhouse gas] emissions from the energy sector grew more rapidly between 2001 and 2010 than in the previous decade" (ibid: 516). The report recommends "the long-term phase-out of unabated fossil fuel conversion technologies and their substitution by low-GHG alternatives" (ibid: 69).

Some argue we cannot open new mines, or increase coal burning, and hope to prevent climate turmoil[1]. An article in the *New Scientist* summarises the initial 2013 release of the IPCC report as follows: "Here, in 10 words, is the bottom line: *we have to leave most fossil fuels in the ground*. It really is that simple" (Le Page, 2013). Likewise:

> To have just a 50:50 chance of preventing a 2°C rise in global temperature: 88% of global coal reserves, 52% of gas reserves and 35% of oil reserves are unburnable and must be left in the ground… For Australia to play its role in preventing a 2°C rise in temperature requires over 90% of Australia's coal reserves to be left in the ground" (Climate Council, 2015: iii-iv. Cf. McGlade & Ekins, 2015).

[1] I prefer 'climate turmoil' to 'climate change' because the latter term implies a degree of evenness or order. Climate turmoil indicates unexpected, marked and destructive weather patterns: floods, droughts, storms and sea level rises (Baer & Singer, 2014: 11ff.). This turmoil may eventually settle into a relatively stable system. How long this will take is uncertain, but will probably depend upon human action, and levels of emissions from fossil fuels.

As the ‘50:50’ implies, such restrictions may not be enough. Similarly, the International Energy Agency stated that climate stability “requires coal consumption to peak well before 2020 and then decline” (IEA, 2011: 43). The recent Paris agreement may necessitate not only reduction of emissions, but removal of greenhouse gases from the atmosphere with unready technology (Anderson 2015; Shepherd 2016).

Coal has become a locked-in technology (Unruh 2000), with social orders, modes of conception, regimes of problem solving and power relations built around it. The social orders around coal produce disorders of climate and ecology which threaten those orders. There is, in that sense, a coal paradox: coal leads to social stability and social destruction. However, coal is plentiful and profitable; the coal industry is not planning to phase itself out and gains political support easily. While these social orders contribute to climate turmoil, challenges to these habits of action and conception can produce social and psychological disturbance. Such challenges provoke group attempts to lessen existential crisis through psychological defence mechanisms which direct people into fantasy, produce a sense of accomplishment, distract from the paradox and hinder attempts to prevent increasing climate turmoil. One technologically based fantasy, of continuing import, is known as ‘carbon capture and storage’ (CCS) in which carbon dioxide emitted from coal burning is prevented from entering the atmosphere, captured, and stored. Storage usually involves putting the CO_2 underground (geo-sequestration), although burying bio-char, planting trees and developing algae which consume CO_2 can also be considered. It should be noted that while I argue CCS has functioned as a defensive fantasy in Australia, this does not mean it could never have been a viable technology, or that it is not recognised as potentially such by scientific authorities.

The IPCC first reported on CCS in 2005 (IPC, 2005), and more recently stated its social value, as CCS should "reduce the adverse effect of mitigation on the value of fossil fuel assets" (IPCC, 2014: 462). The International Energy Agency states: "If CCS is not widely deployed in the 2020s, an extraordinary burden would rest on other low-carbon technologies to deliver lower emissions" (IEA, 2011: 43). CCS theoretically could provide a smooth transition while reducing "the risk that capacity is idled before recovering its investment costs" (IEA, 2014: 3). Defence of established asset-values is vital. Many studies of CCS imply that CCS is hampered by technological, political or business difficulties (see section 2.2). These difficulties and delays stand out, given the claimed ability of CCS to solve emission problems, and the usual consensus that no major scientific or technological breakthroughs are required. Ongoing delays suggest that CCS primarily serves as a defensive fantasy preserving the current political and social order.

The paper argues this case through a history of CCS politics in Australia. Australia is a 'good example' for investigation because it is a large coal exporter, with one of the highest per capita CO_2 emissions in the world; 17.2 tonnes per person in 2014 (PBL, 2015: 31). Australia would appear to have an interest in developing CCS technology, both to reduce its share of emissions and to maintain coal sales, and CCS has been a pillar of its climate action. Given these conditions, the failure of CCS is marked. Its main policy value has been to defend coal burning and sales, and distract from other solutions.

2) Methods and previous literature

2.1 The general focus

After looking at recognised problems with CCS, this paper analyses the post-1996 politics and actions of CCS supporters in Australia. The legal aspects of CCS in Australia have been

detailed by Dwyer (2015).

This research was undertaken with a neutral attitude towards CCS. As we have seen, it is a recommended technology, and clearly would be of great benefit if it could be implemented. However, what became noticeable during the research, was the apparent lack of action and development in Australia and the disconnect between rhetoric and reality. This is not to denigrate those companies and individuals who have performed genuine and apparently groundbreaking research in Australia (see appendix), it is simply to say that it appears the opportunity has not been taken, and that the main impetus for policy around CCS was to protect coal and the ways of life associate with coal power.

Data came from political party and Ministerial websites, the Parliamentary e-library (http://parlinfo.aph.gov.au/), news media (primarily the *Sydney Morning Herald* and the *Guardian*). These texts led to industry websites, reports and press releases. The texts led to the construction of the historical narrative in section 3, and the account of CCS installations in Appendix A, which provide the basis for policy recommendations. The dynamics of policies and technical work are more easily perceived over time and the narrative provides contexts for the statements and events, giving them meaning and connection while lessening the risk of misreading them. The single country focus allows consideration of the dynamics in detail. Discovering whether the arguments can be generalised elsewhere requires further research, but repeated local themes gives force to the policy suggestions.

2.2 Previously identified problems with CCS

Assuming the technology can be developed, then among the foreseen (as opposed to unforeseen) problems of CCS are:

1) No examples exist of either carbon capture or storage working at anything like the volumes required. “CCS has not yet been applied at scale to a large, operational commercial fossil fuel

power plant" (IPCC, 2014: 517). Gibbins and Chalmers point out that given the short lead times necessary to contain climate turmoil, the technology deployed cannot be innovative, must have few problems of scale, and require only limited technological refinement (2008: 4317); this is unlikely.

2) Possible long-term leaks and difficulties monitoring those leaks, especially with offshore storage. If the storage site is an old oil or gas field then exit points are often plentiful. Leaks are also possible in transport. Identifying leaks can be a confusing process as with the Weyburn field in Canada where local farmers reported observations indicating CO_2 leaks and funded their own research, released in 2011, which prompted a priori refutations and calls for further research. It is unclear if this research occurred. The project closed in 2011-12. The MIT CCS site currently reports the leak "is still being investigated" (Nikiforuk, 2011; Orcutt, 2011; CCST, 2015c). Even small leaks may undo the whole venture.

3) CO_2 storage may increase the possibility of earthquakes, therefore increasing the possibility of leaks (Zoback & Gorelick, 2012; Verdon, 2014; National Research Council, 2013).

4) Sudden leaks may produce fatalities: "Natural escapes from volcanic lakes in Cameroon have killed thousands of people" (Kemp, 2013). Concentrations of CO_2 over 10%, even in the presence of oxygen, can be fatal (IPPC, 2005: 392).

5) Leaks and underground flow may introduce unpleasant tastes or poisons to underground water supplies (Folger, 2009: 11-12; Little & Jackson, 2010).

6) CCS requires extra energy to run, adding to operational costs and possibly increasing coal consumption.

7) CCS will significantly increase energy prices (IPCC, 2005: 27, 168-70; IRENA, 2015: 42). The director of the Callide Oxyfuel CCS project stated that CCS technology "would double the cost of wholesale electricity and add about 30 per cent to retail costs" (McCarthy, 2015). Using figures from the US Energy Information Administration, Ash (2015) argues that CCS

would cost almost 40% more per kilogram of avoided CO_2 emissions than photovoltaic energy, 125% more than wind and 260% more than geothermal.

8) As securities analyst Andrew Harrington warned: "Companies claiming credits for putting CO_2 in the ground need to be solvent forever. Very few companies are solvent forever" (q La Canna, 2009). Liability will usually end up with taxpayers. Consequently, private companies have little incentive to guarantee storage is stable as they will avoid long-term responsibility.

9) Difficulties retrofitting old power stations may produce demand for new coal fired power stations, locking in more investments in coal technologies rather than acting as a bridge to renewables.

10) It is a massive project. Vaclav Smil wrote in 2006:

> Sequestering a mere 1/10 of today's global CO2 emissions (<3 Gt CO2) would thus call for putting in place an industry that would have to [transport and] force underground every year the volume of compressed gas larger than or (with higher compression) equal to the volume of crude oil extracted globally by petroleum industry.

In 2009, the International Energy Agency (IEA, 2009), suggested that if CCS was to provide 20% of the world's abatement, 100 working projects were needed by 2020, and 3,400 by 2050. A later document significantly reduced the targets, proposing 30 successful capture projects by 2020, and 7,000 Megatonnes CO_2 (7 billion tonnes) stored annually by 2050 (IEA, 2013). In 2011 emissions reached "a record high of 31.2 gigatonnes" (31.2 billion tonnes) (ibid: 7) while the four then existing projects merely stored some millions of tonnes per year (ibid: 9) with a total of 50 million tonnes during trials (ibid: 10). The IEA aims for storing a quarter to a fifth of current emissions, while hoping emissions do not increase. Storing that much CO_2 requires massive (non-leaking) CO_2 transportation networks (ibid: 35). This represents a considerable scale-up in a fairly short period of time (see also Herzog, 2011;

Nykvist, 2013).

There are also sociological and economic problems. Bowen suggests that CCS opens opportunities for corporate lobbying for subsidies rather than deployment (2011: 2256). It is a risky investment, based on climate risks unlikely to affect investing companies more than others. Upfront costs are high with little return. There are dangers and liabilities in storage and transport, and possible local protests. There is little chance of gaining competitive advantage as developments could easily be imitated, and costs will be greater earlier than later when difficulties have been uncovered and solved (ibid: 2257-61). Consequently, it is financially sensible to postpone development, especially if CO_2 emissions are cheap or free. Davies, Uchitel & Ruple (2013) surveyed stakeholders who named cost (lack of financial benefit and increased prices of electricity) and liability, as far more significant problems than lack of demonstration projects or public resistance. In 2014 a representative of Shell declared that a carbon price of less than US$120.00 per tonne *could* make CCS viable, while people from Exxon thought a price of US$60.00 might be enough (Carr, 2014). At present, CO_2 is not priced anything like that anywhere, and such prices would probably arouse opposition, given reactions to, the now repealed, Australian prices of less than half that.

The problems of CCS are severe and recognised. This reinforces the notion that continuing support of CCS serves other functions than reducing CO_2 emissions.

3) Analysis and Theory

3.1 Fantasy, Politics, Technology

Recently academics have been analysing the role of fantasy in energy technology systems and innovation, with studies of hydrogen energy (Eames et al., 2006; Sovacool and Brossman,

2010; Bakker et al. 2011), smart grids (Ballo, 2015; Engels and Münch, 2015; Vesnic-Alujevic et al., 2016), modular nuclear reactors (Sovacool and Ramana, 2015) and so on. These papers start from the position that the "capacity to imagine futures is an important part of social and political life" (Ballo, 2105: 9). Without imagination of the 'not-present' future, there can be little deliberate adaptation. Consequently, innovative technological projects are not only matters of design, but of fantasy and, in particular, fantasy which aids persuading others. The usual approach shows how these fantasies or 'imaginaries', align goals and actors, legitimise investments, define research priorities, transcend uncertainties, and give actors a sense of progression (Eames et al., 2006: 362; Ballo, 2015: 12; Engels et al., 2015). Sovacool and his colleagues warn that technological fantasy can also lead to misrepresentations of technological development, exaggerations of capacity, distort remembrance of past experiences (especially failure), and allow contradictory claims which help avoid criticism (Sovacool & Brossmann, 2010; Sovacool & Ramana, 2015). Bowen argues that competing or challenged incumbents may use claims about CCS investments to persuade others of their status and legitimacy, rather than produce working projects or knowledge (Bowen, 2014: 140-2, 164-5, 170). Imagining, while essential for envisioning the future and gaining support, is as likely to mislead as motivate.

These writings do not delineate any kind of theory of imagining, consequently they remain unanchored. This paper's theory is based in the psychological study of defence mechanisms which is well documented and applicable.

3.2 The theory of social defence

'Defence mechanisms' were first postulated in psychoanalytic theory. However the idea does not require acceptance of psychoanalysis. Baumeister et al. (1998) show plenty of social-

psychological evidence for defence mechanisms in groups. Defence mechanisms are usually seen as ways of nullifying ideas, drives, affects, anxiety or events which diminish a socially valued view of one's self, or group, or which provoke anxiety (ibid: 1082; Jaques, 1974). "People who lack... [a] defense mechanism are vulnerable to threats, and people who overuse it are vulnerable to its destructive side effects" (Baumeister et al, 1998: 1114). "[D]efences are both adaptive, enabling workers to cope, and, usually, simultaneously dysfunctional" (Hoggett, 2010: 203).

Recognition of climate turmoil challenges many fundamental socially valued conceptions, self-images and habits, because the normal order of life in Western society produces the problem without providing a 'normal' behaviour as a solution. Even if people reject the idea of climate turmoil, they face conflict with those who do, and this conflict challenges their normal order of life, producing anxiety. Climate turmoil is therefore likely to provoke socially organised defence mechanisms, where people co-operate to defend a valued state of being (Hoggett, 2010: 203-4). Group anxiety can lead to ways of conveying and collecting information which focuses on fantasies of continuance or invulnerability, and ignores challenges (ibid: 206-7), as seems structurally normal in 'information society' (Marshall et al, 2015: 77-112). Jaques (1974: 278) suggests that when the source of anxiety resists conscious control (as with climate turmoil) mutual defensive reinforcement of worldview may become a primary cohesive (and destructive) ordering element of social life. Identificatory objects are important here; even normally, an institution, group or an associated brand can become linked to a person's self-identity, leading to defences against challenges to that brand (Lisjak et al, 2012). With climate turmoil, coal, coal technology or the coal industry often seem to become identificatory objects symbolising 'modernity', 'progress' and a valued way of life. Defence of coal can become defence of self-identity, leading to exaggerations of coal's importance.

The main defence mechanism of interest in CCS policies seems to be 'isolation' in which the threatening impact of an idea/event is reduced by isolating it from other ideas or affects. Isolation fragments. With this mechanism, people or groups approach threatening ideas with minimal attention or in a rushed manner, returning to patterns of favourable, reassuring or self-affirming ideas as soon as possible. "Without associative connections, the threat will not be [frequently] remembered and cannot influence other spheres of mental activity" (Baumeister et al, 1998: 1099). Life can be resumed as if a solution existed. Isolation is related to dissociation and disconnection. It becomes a particularly problematic defence in a situation where the best knowledge we have asserts that climate (like ecology generally) involves 'complex systems', with multiple connections which may be difficult to perceive and which resist control. Isolation effectively separates coal, and its associated valued way of life, from its inherent dangers.

In summary: To lessen climate turmoil we have to lower greenhouse gas emissions. This can be achieved by reducing the coal being burnt, or by attempting to capture and store those emissions through CCS. CCS faces many known technical and social-economic difficulties. CCS is an imagined technological innovation and, like other such imaginings, may be used to provide persuasion and co-ordination for particular groups. Often imagining can be misleading, defend established modes of life and self-identity, or preserve power relations. This paper suggests that CCS acts as an 'isolating' defence mechanism, allowing the burning of coal, the maintenance of conceptions and habits, and postpones alternative action, thus preserving some established power relations and values. I now look at the history of CCS and CCS policy in Australia to observe the ways that CCS has worked under several different governments.

4. CCS in Australia

4.1 Government Policy 1997-2013

Efforts to promote CCS in Australia began in the 1990s and were phrased in terms of defending the economy and keeping business stable. The then Coalition Government under John Howard emphasised they were dealing with climate change by promoting "Australia's national interests… we are not prepared to see Australian jobs sacrificed and efficient Australian industries, particularly in the resources sector, robbed of their hard-earned, competitive advantage… Fossil fuels currently provide 94 per cent of our energy needs". As CO_2 is absorbed by vegetation growth there was "$22 million for farm forestry and [a] massive $328 million revegetation programme" (Howard, 1997). The first geo-sequestration project, the Otway project in Victoria, was proposed in 1998. In 2003 David Kemp Minister for Environment and Heritage lauded fossil fuels: "fossil fuels will continue for some time to provide the main sources of energy for power and transport… it is on these cheap fossil fuels that Australia has built significant elements of its industrial base" and stated that "in the last round of grants to Co-operative Research Centres $21.8 million was provided for a new Co-operative Research Centre on CO_2…. Australia is at the leading edge of geological sequestration efforts and we are continuing to advance this work" (Kemp, 2003a). In another speech Kemp said this expenditure safeguarded the use of Australia's "vast reserves of low cost brown coal" (Kemp 2003b). Similarly, Ian MacFarlane Minister for Industry, Tourism and Resources at the Launch of Coal21, a government and industry partnership for 'clean coal', said:

> Coal is a key industry within the Australian economy. It is our single largest export commodity – accounting for 10% of our export trade. That in turn

> represents one third of the world's coal trade. We rely on coal as a low cost and secure energy source – it provides 85% of our electricity (MacFarlane, 2003).

Nick Minchin, Minister for Finance and Administration, pointed to the Government's financial assistance to the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) and participation in the "Carbon Sequestration Leadership Forum, being initiated by the United States" (Minchin, 2003). Macfarlane (2004) clearly expected "geo-sequestration projects to take advantage of the $500 million [Low Emission Technology Development Fund] announced this week by the Prime Minister". Macfarlane (2005a) later elaborated that this "must be an industry-defined fund, not an exercise in academic detail"; control was to reside with established players. Money for CCS was simultaneous with cutbacks to funding for renewables (Brown, 2004). It could be seen as defending the coal industry from that challenge.

The government joined the Asia Pacific Partnership on Clean Development and Climate, involving India, China, South Korea and the U.S. This was a non-binding alternative to the Kyoto Protocol with no targets. The Industry minister Macfarlane stated it "should turn the spotlight on Australian projects that are already developing new clean energy technologies, like carbon capture and clean coal" (Macfarlane, 2005b). Announcing the agreement, Prime Minister John Howard said "Australia is the largest coal exporter in the world and it is in Australia's interests that we try and find a way of coal being consumed in a manner that does not add as much as it does now to greenhouse gas emissions" (Howard, 2005). Coal is being associated with a particular and apparently successful way of life and its institutions. Consequently, defending coal defends that way of life. The partnership was disbanded in April 2011, with the Government having contributed over $27 million to CCS research between 2006 and 2010 through it (Carr, 2010).

Since 2005 coal has not declined in perceived value. According to the Minerals Council of Australia: "Over the last five years, coal has accounted, on average, for more than 15 per cent of Australia's total exports – with export earnings either on par or greater than Australia's total agricultural exports." In 2102-13 exports reached $22.4 billion worth of metallurgical coal and $16.2 billion of thermal coal (MCA, 2014). Whether coal exports are particularly beneficial given government subsidies, tax breaks, taxpayer funded infrastructure, foreign ownership, small workforce, purchase of technology overseas, transfer pricing, transfer of earnings to tax havens, overpriced loans from overseas branches, loss of manufacturing or tourism and so on, is a subject of dispute (ACF, 2011; Grundoff, 2013; Peel et al., 2014). Coal may not be as important as is claimed; yet if it is an identificatory object, associated with the self-identity and life patterns of members of important groups we might expect a tendency to exaggerate coal's importance to magnify that self-identity, its wealth and social place. Distortions are to be expected.

The industry group Coal21 received hefty government funding, especially after Labor assumed Government in December 2007; both main political parties support coal. In 2012 Coal21 claimed:

> In 2006 we established the $1 billion COAL21 Fund as part of a world-first whole-of-industry funding approach to support greenhouse gas abatement. The COAL21 Fund will raise $1 billion over 10 years from a voluntary levy on coal production to support the… demonstration of low emissions coal technologies, including carbon capture and storage (Coal21, 2012).

In 2009, reports claimed the spending since 2006 totalled $36.4 million, "less than 0.1 per

cent of the year's black coal export revenue of $52 billion" (Manning, 2009). The 2012 website claimed that $289.3 million in funding had been committed to projects, but it is unclear what Coal21 actually spent on CCS research. There are no obvious annual reports and requests to the organisation were not responded to. In December 2012 it was revealed Coal21 had changed its constitution so research funds could be spent on: "[p]romoting the use of coal both within Australia and overseas and promoting the economic and social benefits of the coal industry." The CEO of the Australian Coal Association commented that this was because "apart from obviously investments in R and D and the scientific and technological part… we would necessarily need to talk about the role of coal" (Brewster, 2013). The vagueness of the expenditure reports suggests that persuasion by CCS was more important than spending on CCS.

Following the recommendations of the Strategic Review of Australian Government Climate Change Programs, the Labor Government enacted what three ministers called "the world's most comprehensive carbon capture and storage legislation – the Offshore Petroleum and Greenhouse Gas Storage Act" (Tanner et al., 2009: 9) and:

> On 16 April 2009 the Government launched the Global Carbon Capture and Storage Institute (GCCSI) to drive the rapid international deployment of commercial scale carbon capture and storage projects. The Carbon Capture and Storage Flagships Program under the Clean Energy Initiative will invest $2 billion in industrial scale carbon capture and storage projects. This will complement the Government's National Low Emissions Coal Initiative and the GCCSI by supporting the demonstration of two to four large industrial scale projects in Australia (ibid: 9).

The Government also promised the GCCSI approximately $100 million a year in

organisational funding. This over $2 billion promised funding shows considerable State enthusiasm, being larger than $1 billion the coal industry was promising and far more than the industry had apparently spent.

In December 2009 the Federal government's carbon storage task force claimed that eastern Australia *probably* had a greenhouse gas storage capacity of "70 to 450 years" in aquifers (CST, 2009: 1, 45). This wide margin of estimation suggests vagueness is important. CO_2 from NSW might have to be transported (at a cost of up to $60 per tonne) more than 1000 kilometres to Queensland and Victoria for storage (ibid: 36-7), while about 5000 kilometres of large-diameter pipeline would need building before 2035 (ibid: 76). This elaborate infrastructure would enable capture of only 20% of the country's 2009 CO_2 emissions.

In May 2010 the Australian initiated Global Carbon Capture and Storage Institute held a CCS conference in Pittsburgh. A *Sydney Morning Herald* journalist attended and asked:

> why [should] the public... invest billions in CCS when the fossil fuel industry has not done so and alternatives like renewable energy are increasingly cost-competitive and carry none of the risks associated with storing CO2 underground? (Manning, 2010).

The answer given at the conference was that stopping coal use was inconceivable. According to the journalist, the group thought storage was the easy part, despite little knowledge of how CO_2 actually migrates underground, which is a major constraint. Projections were based on computer models which could use mistaken assumptions. However, they acknowledged that movement through rocks could cause earthquakes, and that when "CO_2 meets mineral-rich groundwater the result often is cyanide and heavy metals contamination" (Manning, 2010).

Finally the journalist remarked “while there were plenty of oil and gas types about, the coal companies were notable absentees,” implying a lack of coal industry interest.

This possible lack of interest together with the overriding of ignorance and the vagueness of corporate funding suggests some confusion or ‘isolation’ in coal industry approaches to CCS, and this confusion permeates coal’s defenders. This is apparent in 2010 as the Liberal National Party Coalition formulated its climate policy and attacked that of the Government. Their main focus was supporting coal rather than climate, promising that they would “get the exploration industry back on its feet following the devastating loss of confidence for investment in mineral exploration in Australia”, apparently brought about by suggestions of a carbon tax and a mining super-profits tax (Abbott & MacFarlane, 2010). They would redirect $158.3 million from the Carbon Capture and Storage Flagships (CCSF) programme “towards clean coal technologies including carbon geo-sequestration projects associated with coal-fired electricity generation” which the money was already intended for. They added “No viable solution in Australia for clean energy sources can work without the clean coal component. Rather than ignore our enormous natural advantage in coal, the Coalition will ensure it is an integral part of the future clean energy mix.” They would also transfer money from the CCSF towards “the development and implementation of soil carbon technologies” (ibid).

Ambiguity reappears a month later when the Coalition complained the “Global Carbon Capture and Storage Institute was to give a $5 million grant to a coal-fired power station in Canada”. This, they said, was an obvious waste of taxpayers’ money and showed “the clear reluctance of other countries to invest their own cash in the project” (MacFarlane, 2010). MacFarlane emphasised this lack of interest by remarking that the government had committed $100 million to this supposedly global institute, while the United States was the only other

contributor, "and that contribution was limited to just $500,000" (ibid). When the Government established the Clean Energy Finance Corporation to encourage renewables, the Liberals protested that the body could not give money to CCS (Ferguson, 2011), despite the amounts already available through the CCS Flagships Program, the GCCSI and (supposedly) the coal industry. The attack appears contradictory (CCS should be supported and not supported), but coal must be defended irrespective. Attacking the Government's carbon price, Tony Abbott reinforced the vital importance of coal, declaring that:

> The whole purpose of the carbon tax is to phase out the coal industry….
> Now, I think that the coal industry is the foundation of a modern economy. I think that affordable power is essential to Australia's economic future. I don't want to close down the coal industry… the Government's own figures they say that coal will go from 80 per cent of our power generation to 10 per cent or 25 per cent, *if you include clean coal using various forms of sequestration*. So, the Government's own figures involve a radical downsizing and ultimate demise of the coal industry (emphasis added Abbott, 2011a).

He would repeat these figures over the next couple of years, avoiding direct questions about CCS, or responding with statements such as the Government is "perfectly happy for coal to be burnt to provide power in China but it seems to think that burning coal here in Australia is somehow wrong" (Abbott, 2011b). He would continue to complain that the Clean Energy Finance Corporation did not fund CCS (Abbott, 2012). The Coalition appeared to support CCS to attack renewables, without committing to it as a solution. This conflicting process continued when they attained Government in 2013, indicating an inherently 'isolated' attitude.

According to the CO2CRC annual report for 2012-13, corporate members withdrew support

and funding for research. The report draws attention to incoherence as a problem around CCS and climate.

> The lack of coherence on climate change action has seen public and political attention moving away from major climate mitigation activities. Some recent withdrawals from CO2CRC have reflected this trend. There is clearly a risk that, with CRC funding concluding in December 2014 and with little or no commercial incentives to further develop and maintain a technical capability in CCS, the scientific and engineering base that has been built up over the last 10 years will dissipate (CO2CRC, 2013: 8).

Judging by the financial data in the 2013-14 report (CO2CRC, 2014a: 53-3) most funding for the CO2CRC over six years came from government agencies or departments, and from universities. Funding from coal companies was a small part of the total, displaying lack of interest yet again. As shown in Appendix A, the level of success of actual projects was far less than required. However, government policy fantasised that CCS was the way of the future. The Energy White Paper of 2012 stated that:

> Treasury modelling assumes power plants fitted with CCS will provide one-third of Australia's power by 2050 (Taylor, 2012b, See EWP, 2012: 33, 88).

The 2012 Energy White Paper also implied that *more* fossil fuels would be exported from Australia and burnt (EWP, 2012: x, 5, 16, 29). Encouraging new coal mines, and providing subsidies for dirty coal power stations were Labor strategies (Chubb 2014). There was little demand that coal should be exported to countries with CCS. Greg Combet, Minister for Climate Change and Energy Efficiency, commented:

> I would hope companies in the fossil fuel sector see the commercial desirability of it [CCS] [if not] then you are not being a very sensible business person (Taylor,

2012a).

But coal miners did not have the impetus. “The industry blames the influence of the Greens for blocking crucial subsidies for CCS” (Taylor, 2012b), despite the billions already available for it.

4.2 The Coalition Government 2103 to present

In September 2013 the Liberal-National Coalition regained power after relentless attack on the Labor government’s carbon price, an attack supported by the mining industry and most of the media. The new Environment Minister, Greg Hunt, said coal will remain the main energy source for “decades and decades” and that:

> we will be able to use coal and gas in a dramatically more efficient way, with dramatically lower emissions… That will happen, I think, over the coming decade…. We can make real progress… on cleaning up our brown coal power stations, with drying gasification then capture, not so much for storage, because at this stage that appears to be expensive without real prospect, but capture for reuse through things such as algal energy (Hunt, 2014).

The first budget of the Coalition Government attempted to defund the Australian Renewable Energy Agency (ARENA) altogether (ARENA, 2014), succeeded in reducing renewable energy targets, cut funding for Australia’s main science organisation the CSIRO, and cut $459m from Carbon Capture and Storage Flagships Programme leaving a total of $192m (Massola, 2014; Burton, 2014). Environment Minister Hunt suggested that a coal-slurry powered engine developed by the CSIRO would solve the problem of emissions (Cox, 2014). However the principal scientist working on the direct injection carbon engine told reporters

"we are struggling to get the funding from the coal industry" (ABC, 2014). Again the official solution to CO_2 emissions could not gain industry support.

At the UNFCCC Conference in Lima 2014, the Foreign Minister Julie Bishop praised ARENA and the Renewable Energy Target, both of which the government had tried to abolish, and said "Australia is committed to supporting low emissions technologies through carbon capture and storage (CCS)…. The Australian Government has committed more than $300 million to low emissions coal technology research and development", and instanced the Otway and Gorgon projects as "world class" (Bishop, 2014). This defensive dis-association before a UN audience was played out domestically in the Government's 2015 Energy White Paper, which did not discuss climate change while proposing a "technology-neutral approach". It discussed CCS, in passing: "Australia has worked closely with other countries which rely heavily on fossil fuels to investigate opportunities to utilise CO_2 in products such as carbonated drinks and plastics or to enhance the growth of oil-rich algae in solar bioreactors to produce biofuel" (EWP, 2015: 56). How making carbonated drinks significantly lowers CO_2 emissions is not elaborated. The paper remarks "there is no commercial CO_2 re-use in Australia, largely reflecting the high cost of capturing the CO_2 from a flue gas stream". It continues: "We have invested significantly in driving global approaches to lowering the cost of capture through the Global Carbon Capture and Storage Institute and the IEA" (ibid: 57). CCS would "open up the opportunity to create a new export market for Australian brown coal" (ibid: 57). Imaginings of clean coal justified encouraging investment in coal-fired plants to support emission reduction technologies. Pending CCS, coal exports are to be encouraged. CCS is used to defend the value of coal.

In 2014 the Australian coal industry formed another Roundtable for the development of low

emissions technologies for fossil fuels with no announced budget or projects other than "to support ongoing innovation, cooperation, knowledge sharing, debate and collaboration to further enhance low emissions technologies, including CCS" and build on current achievements (CO2CRC, 2014c). It instanced the world's first large scale CCS coal power project in Canada opening that week, which might capture a million tonnes a year (Pearson, 2104). The managing director of Whitehaven coal stated that given the promise of CCS, "coal may well be the only form of energy that can materially address the man-made contributions to climate change" (Kurzoil, 2014).

The Prime Minister declared coal was "good for humanity" and "is essential for the prosperity of the world." (Massola et al., 2014). He tried to prevent formal discussion of climate change at the G20 meeting in Brisbane. Asked about the final IPCC report in November 2014 and comments that coal should be phased out by the end of the century (86 years away), Mr. Abbott said:

> for the foreseeable future, coal is the foundation of our prosperity. Coal is the foundation of the way we live because you can't have a modern lifestyle without energy. You can't have a modern economy without energy and for now and for the foreseeable future, the foundation of Australia's energy needs will be coal. The foundation of the world's energy needs will be coal (Abbott, 2014).

The Government repeatedly argued that coal exports must increase as coal relieves poverty, a line promoted by the coal industry (Goldenberg, 2015). However, as World Bank President Jim Yong Kim states: "If we don't confront climate change, we won't end poverty". Climate change could roll back decades of development, and force tens of millions into poverty (Kim, 2013). For the Australian government, coal equals modern life, and CCS is only embraced

insofar as it hypothetically answers concerns about emissions and directs attention away from coal's role in producing climate turmoil. Coal burning is isolated from its consequences.

Prime Minister Tony Abbott was displaced by his own party, and replaced by Malcolm Turnbull, who is believed by many to be concerned about climate change. If anything, the government's climate policies have become vaguer, even although they signed the Paris Agreement. Further cuts were made to the CSIRO both in staff and research especially in climate change, and the Budget Strategy and Outlook Budget Paper No. 1 2016-17, states that the Government continues to support its:

> 2014-15 Budget decisions to reduce funding for the Carbon Capture and Storage Flagships program as well as the closure of the Low Emissions Technology Demonstration Fund and the Low Carbon Communities program in 2015-16 and Coal Mining Technology Abatement Support Package in 2016-17 (Morrison and Corman 2016: 5-34).

There is no real sign of them facing the dangers of coal or climate change.

5) Discussion and Results

Coal, as former Prime Minister Abbott repeatedly assured us, has been (and is) the mainstay of modern Western life. This position implies that without burning coal, only chaos and decline can be expected. Coal (in the abstract) seems to be a valued symbolic object, representing modern orders. It functions as an identificatory object for social groups who strongly stand for those orders. Ironically, if the effects of burning coal are recognised, they promise chaos and decline. The position is paradoxical. Normal and virtuous modes of life are threatened by continuing them, and normal ways of problem solving become problematic. One possible reaction to both the paradox, and the apparent attack on virtue, is to encourage

defences of isolation by proposing solutions that avoid threatening coal, and allow ‘normality’ and prosperity to be resumed by assuming problems are solved. This removes the paradox and the solution plays its primary role in fantasy.

The coal industry, as important and foundational, is also socially powerful and persuasive. In many of the comments presented above, CCS, is promoted as preserving the profits and capital investments of coal and coal based energy companies. CCS defends an unstable establishment through fantasies which do not require physical fulfilment, because they are fulfilled by distracting attention away from dangers of the coal paradox. Hence, there is remarkably little indignation when these fantasies are not carried out; they have served their purpose. CCS in Australia is primarily funded by governments, looking to continue coal exports, rather than by the coal industry who, given apparently guaranteed exports, have little commercial incentive to engage in CCS research. Coal companies do, however, have an interest in promoting CCS, as it gives them a defence which supports technological lock-in.

As well as risking leaks, CCS risks boosting coal usage, and allows cutbacks in help for renewable technologies which might challenge coal. CCS also renders policies incoherent. Captured CO_2 can be used to help extract oil or produce biofuel, thus potentially increasing CO_2 emissions. It seems possible to postpone and defend CCS initiatives at the same time. Risks of leakage are not perceived as serious problems, when in reality they are fundamental. Long-term taxpayer responsibility is not a serious problem, even when cuts in government spending have priority everywhere else. CCS allows people to argue they are in favour of action against climate change without action. It seems easy not to put the pieces together, or gaze at the paradox, as could be expected if the defence mechanism of isolation is in play. People act within a disconnected confusion, but remain committed to coal as a mark of

modernity and progress.

The coal industry and its supporters seem to expect that others will pay for the resolution of its problems. They complain when a green energy body does not give money for CCS, even when the industry has its own special funds (private and government) which it appears not to use. Rather than feeling in control, supporters of the fossil fuel industries seem to see themselves as victims: 'why cannot we do what China does?' while ignoring any Chinese attempts to reduce pollution. They cannot avoid knowing that some people think coal usage should be curtailed, but information that contradicts their stability can be denied. It appears that information is not judged by accuracy but by its effects and politics (Marshall et al, 2015). In this context, CCS, despite having no success at the levels required, and despite the overt prospect it may fail, becomes a fantasy stabilising an industry and its social power.

6) Conclusions and Policy Implications

Focusing on Australia, a country with a tradition of coal exports, and hence a likely interest in diminishing the effects of coal burning to lessen climate turmoil, shows that policy aimed at making CCS a major factor in mitigation has not achieved much, despite the amounts of talk, money and effort devoted to it. CCS primarily seems to function as a defence mechanism encouraging inaction. It also defends powerful, and symbolic, interests and allows them to continue generating the problem. In these circumstances, policy tends to be confused and contradictory. There are few immediate financial, market or operative incentives for the industry to embrace CCS. Monitoring is difficult. CCS may allow society to become more dependent on coal, and locked into using coal, as it is hard to imagine that capital invested in new mines and plant would be easily discarded, especially if CCS is phrased as a defence of

assets and investments. While it is possible that CCS could once have made a difference, the possibility that it can be applied in the time available is lessening. Deadlines pass, even if they are extended. At the best, CCS represents a massive and expensive project, adding significant costs to electricity, with no guarantee of the continuing absence of leaks.

If the aim is to have a policy directed at dealing with greenhouse gas emissions, then efforts based on fantasies of CCS being both implemented and wholly successful, are misleading at best. They could be a dangerous waste of time and money. If the problems we face come from burning fossil fuels, then we need to replace those fuels, and to finance that replacement without distraction. Policy makers could emphasise that CCS has severe problems in cost, monitoring and potential harm. It exists to defend the coal industry, and the coal industry has been uninterested in pursuing the option, despite large amounts of taxpayers' money being made available. Existing research projects have not been particularly successful. Overall the project has failed. Consequently, to reduce GHG emissions, coal must be kept in the ground. This may require a timetable, and a refusal to allow new coal mines, and imports from new coal mines. However, running such a policy will generate conflict, intense resistance from vested interests, and psychosocial upset as modern life and its virtues appears at stake. All we can hope for is that abandoning policies in favour of CCS will allow politicians and policy makers to clarify those issues for the electorate, and overcome well-funded opposition.

On the other hand, alternate and renewable energy sources seem quick to take up government subsidies and support, and provide employment. Aid has been appreciated and used. Costs have come down. Usage has flourished. New research has been successful (IEA, 2015; IRENA, 2015; Katz, 2014; Ren21, 2015). The contrast is so great, as to make the reluctance of the coal industry to save itself even more marked. It is probable that the money granted for

CCS, clean coal and the necessary infrastructure for further mines, could be much more effectively deployed elsewhere. If so, there will eventually come a time when alternate energy industries may be effectively able to help policy makers stand against coal and move in a different direction with greater ease.

Appendix A: CCS installations

The current GCCSI website reports "Globally, there are 15 large-scale CCS projects in operation, with a further seven under construction" (GCCSI, 2016a). 'Large scale' can be less than one million tonnes of CO_2 (GCCSI 2016b). For comparison human emissions are probably over 35,000 million tonnes per year (PBL, 2015: 11). Current projects have no impact on emissions.

By mid-2012 little was happening in Australian despite its pledges to "lead the world", the "almost $2.5 billion" in public subsidy, and the aim of having at least one working large-scale CCS plant by 2015 (Taylor, 2012a). Looking at the larger projects gives some idea of what arose from the enthusiasm. Public information about CCS projects in Australia largely comes from its advocates, and is often vague despite the government money involved. This summary of work since 2011 is a caricature, as the research needed for CCS involves a multitude of topics, such as understanding saline aquifers, geomechanics, fluid flow in rock formations, monitoring processes, risk assessment, economics, methods of capture and so on. Research varies from small-scale laboratory installations, or simulations, to large-scale commercial ventures. Here the focus is on specific larger scale 'real world' projects.

The Gorgon project, off the north western coast of Western Australia, is run by the US company Chevron working with Shell and Exxon. Construction began in November 2009. It

is “the world’s largest sequestration project” estimated to cost $2 billion to set up ($60 million directly contributed by the Australian Government), and aiming to store between 3.4 to 4 Megatonnes per year. It was expected to start functioning in mid-2015 or 2016 (CCST, 2015a; Chevron nd). The CO_2 comes from gas mining not from power generation. The extracted gas has quite a high CO_2 content, possibly because it is driven to the surface by injections of CO_2. Normally this CO_2 is released to the atmosphere. Here, the chemically extracted CO_2 is to be injected into a saline aquifer beneath Barrow Island, a Class A nature reserve, with the storage pumps and wells situated on the island (Kemp, 2013). Chevron acknowledges that Barrow Island “supports 24 terrestrial species and subspecies not known to occur elsewhere and another five with restricted distribution” (Chevron, 2015b). Chevron has taken responsibility for the CO_2 for the project lifetime and 15 years afterwards, after which the taxpayers take indemnity. Being within a minor earthquake zone increases long-term risk (Scott & Sethuraman, 2009).

The SouthWest hub is an integrated CCS project for the industrial centres of Kwinana and Collie in Western Australia. It was awarded $52 million by the federal government in 2011 with further contributions from the West Australian government. In November 2015 it remained in the research phase (SWHub, 2015).

The ZeroGen project ceased as it “required significantly heavier and more ongoing government financial support than had previously been thought likely” (Garnett, Greig & Oettinger, 2015: xxii). The money’s expenditure resulted in some scandal (Lion, 2011).

CarbonNet is a project aiming to link largely non-existent capture projects on brown coal power stations in Victoria’s LaTrobe Valley, and store the CO_2 hundreds of kilometres away in

Bass Straight. Various governments awarded the project over $100m (Victorian Energy and Resources, 2012, 2015). It will not operate until the 2020s and it is unclear whether it has any industry partners (GCCSI, 2014: 163).

The Mulgrave Capture Project was another attempt to reduce the massive greenhouse emissions in Victoria's La Trobe Valley. The aim was to gasify coal at high temperature and pressure, and explore features of next-generation 'Integrated Gassification Combined Cycle' coal plants which allow precombustion capture, to ensure the "viability" of brown coal. "The key objective of this project was to reduce the technical risk and cost of pre-combustion" and identify the most cost effective of three methods of CO_2 capture (CO2CRC nd). The Victorian government supplied about half of the funding, with further money coming from the Federal Government. The technology seems to have been transferred to a project at Hazelwood Power Station, but initially (at least) had difficulties attracting commercial partners (CO2CRC, 2013: 7, 41).

In July 2013 Algae.Tec signed an agreement with Macquarie Generation to capture and use CO_2 emissions from the Bayswater power station in the NSW Hunter Valley and feed them "into sealed tanks packed with algae, which will then be harvested and turned into biofuels" (Cubby, 2013; Algae.Tec, 2013). Such biofuel does little to curtail emissions unless accompanied by a reduction of oil fuel usage, as emissions are re-released when the biofuel is burnt. Bayswater emits about 19 million tonnes of CO2 a year; the project was expected to capture about 270,000 tonnes of that (less than 2%), while growing to capture about 1.3 million tonnes (less than 10%) in a few years (ibid.). Despite a ministerial opening Algae.Tec still needed to raise funds (ibid). Algae.Tec later seemed to move into India and algal foods. Questions to the companies about the success of the project received no response.

Australia's only currently operational CO_2 storage site is the Otway Project. In March 2015 CO2CRC announced that the Otway Project had received "funding from the Australian ($25m) and Victorian ($5m) governments" to begin researching the movement of stored CO2 (CO2CRC, 2015b). They also stated that: "During the past 10 years, the Otway Project has injected and stored more than 60,000 tonnes of CO_2 in a depleted gas reservoir deep underground" (CO2CRC, 2014b), which makes it a very small scale project. The coal industry promised to contribute $10m, about a third of government input (CO2CRC, 2015a).

The Callide Oxyfuel project is a joint Australian Japanese venture near Biloela, Queensland, at the Callide coal-fired power plant. It involved a retrofit of the Callide A power station and burns coal in a mixture of oxygen and recycled exhaust gasses, producing concentrated CO_2. It began in December 2012 and appears to have finished in March 2015. It was the world's first demonstration of oxyfuel carbon capture and was to capture 70T/day for 2 years or 25-26,000 tonnes per year (CCST, 2015b; CS Energy, nd). It reached "the targets of 10,000 hours of oxyfuel combustion and 5,500 hours of CO2 liquefaction and capture" (Mitsui, 2015) and is "one of a handful of low emission coal projects in the world to move beyond concept stage to construction and… demonstration" (COP, nd1). The CO_2 "was transported by road to Victoria in late 2014 and injected underground at the… Otway Project site" (COP, nd2). It is therefore not an integrated CCS project, and the transport adds to emissions. The project cost $245 million, was awarded $63 million from the Australian Government under the Low Emissions Technology Demonstration Fund and received financial support from the Japanese and Queensland governments and technical support from JCOAL. Again the scale is relatively small, and the engine itself does not appear to reduce emissions.

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