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# Trials and tribulations of market responses to climate change: Insight through the transformation of the Australian electricity market

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*Abstract*
*We analyse the energy transition from coal to renewable. Our research contributes to the literature on transitions and grand challenges. Mitigating the effects of dangerous human induced climate change requires Australia to adopt a 'carbon budget' of no more than 10 Gt between 2015 and 2050. To achieve this, the Australian electricity sector must reduce greenhouse gas emissions to at least net zero emissions by 2050. Australia's strategic response to climate change will have a significant influence on greenhouse gas emissions across Asia and the Pacific. The transition to renewables has proved difficult. The Liddell case study, involving closure of an aging coal-fired power station, shows how the transition was impeded by institutional decisions. While firm level actors recognised opportunities, regulators resisted the transition. Our research illustrates that transitions for grand challenges may require a relational stakeholder review, beyond the concept of short-term win-wins.*

*Keywords: Transition, climate change, climate change knowledge, decision-making, energy industry, grand challenge*

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## 1. Introduction

*Their [AGL's] obligations are to their shareholders', ours [the Australian Government] obligation is to the community* The Hon. Josh Frydenberg MP in The Project (2017 5:35m)
Trials and tribulations: *problems and suffering* (Cambridge Dictionary, 2018)

Human induced climate change is a quintessential grand challenge that represents a significant issue for the world (Bremer and Linnenluecke, 2017; George et al. 2016). Grand challenges are characterised as large scale socio-economic and environment problems, which present greater issues globally, across disciplines (Travis et al., 2018). Such challenges require action from a range of stakeholders thus rending them complex, with uncertain outcomes (Linnenluecke et al., 2018). Climate systems are predicted to alter, and therefore negatively impact biological and economic processes and systems (Intergovernmental Panel on Climate Change, 2013). In the past global policy responses to mitigating the effects of "dangerous anthropogenic interference with the climate system" [herein dangerous climate change] (United Nations Framework Convention on Climate Change, 1992: 4) have failed (The Economist, 2018). Scholars have long argued for global frameworks and approaches to grand challenges that circumvent the limitations of national markets and regulators (Finkbeiner et al., 2018; Lo, 2016; Helm 2010; Mackie, 2016). However, this call has yet to be met (Linnenluecke et al., 2018).

In response, this paper analyses Australia's transition to renewable energy, in response to the grand challenge of human induced climate change, to further understand why national regulatory responses may fail in the future. The paper examines tension that arose between a firm and national regulators in relation to the closure of a coal-fired power station. Given the interdisciplinary nature of grand challenges, the paper contrasts economic analysis with subjective stakeholder reviews. In doing this, the two perspectives can provide novel insight into how organisational strategy can be enhanced to facilitate market-based solutions to solving grand challenges.

This article is divided into six sections. First, the grand challenges are introduced. Second and third, we discuss the current state of knowledge regarding the grand challenge and method of our inquiry. Furthermore, we then present our findings from this discussion. Lastly, we discuss the implications for theory and practice, as well as opportunities for future research.

## 2. The grand challenge: reducing reliance on fossil fuel in response to human induced climate change

Australian regulators, like many countries, have made an international commitment (through the United Nations Framework Convention on Climate Change) to limit global warming to 2 degrees Celsius (Australian Government 2015). This commitment has been a driving force in interest in national transitions from fossil fuel based fuels to renewable energy (Dahlmann et al., 2017b; Haney and Pollitt, 2013). Substituting emissions intensive coal-fired energy with renewables to mitigate anthropogenic climate change requires consideration of not just greenhouse gas emissions, but impacts on energy pricing and inequality, and the economic transition of communities that have depended upon emissions intensive industries for their economic livelihoods (see Newell and Mulvaney, 2013).

The Climate Change Authority (2017) state that Australia should adopt a ‘carbon budget’ of no more than 10 gigatons (Gt) between 2015 and 2050 to meet Australia’s fair share of a global budget, aimed at avoiding dangerous climate change. Electricity generation is the highest source of carbon emission in Australia (Deloitte Access Economics, 2015). Achieving the above carbon budget requires the electricity sector to reduce greenhouse gas emissions to produce at least ‘net zero’ emissions by 2050 (Denis, 2017). This “production-based” view of emissions reflects national emission reduction targets and policies (Deloitte Access Economics, 2015: i).

Given the existing regional electricity supply mix is greenhouse gas emissions-intensive, Australia, and all nations across Asia and the Pacific, face the challenge of reducing greenhouse gas emissions (SDG 13) while also ensuring reasonable prices for energy (Sustainable Development Goal 7) (Pront-van Bommel, 2016). Maintaining the electricity system in a way ensures reliability and security adds to the complexity and creates an ‘energy trilemma’ of emissions, reliability and affordability (Haney and Pollitt, 2013).

## 3. Current state of knowledge regarding organisational strategy and transition to renewable energy

### *3.1 Relationship between this research and the grand challenge theme*

This research contributes to the transition literature (Grodal and Mahony, 2017). Expressly, transitions and grand challenges (Garaus et al., 2016; Wright and Nyberg, 2017). To contribute new knowledge that can be applied (McGahan, 2018), we adopted a “micro-level” approach, including “predictors of… behaviour” (Simsek et al., 2018, pp. 2022-2023). In this way dangerous climate change and energy transition are viewed as a grand challenge (George et al., 2016) rather that a wicked problem (Rittel and Webber, 1973). The perspective applied here focuses on pathways to solutions (George et al., 2016). This differs from wicked problems, which are characterised as being hard to define and thus provide “difficulties in knowing when [they have been] solved” (Jacobs and Cuganesan, 2014, p. 1252). Unlike wicked problems, we contribute to the grand challenge literature by analysing optimal solutions. Wicked problems are not conducive to such an approach (Rittel and Webber, 1973).

Antecedents of behaviour change in the context of grand challenges include institutional support (Pacheco et al., 2010; Pinkse and Groot, 2015; York et al., 2016). However, what if such support was absent? To extend the transitions literature to explore this facet, we analyse Australia’s transition to renewable energy (specifically electricity). In light of the criticality of stakeholders in transitions and grand challenges (Banks et al., 2016) we adopt a stakeholder perspective (Freeman, 2010).

### *3.2 Australia’s transition to renewable energy*

There has been profound change within the Australian electricity sector in recent years (Dahlmann et al., 2017b; Haney and Pollitt, 2013). In the 2000s, government policies drove much of this through subsidies for low-emissions electricity generation (Dahlmann et al., 2017b). This was despite significant policy uncertainty or discontinuity that occurred over a twenty-year period (Simshauser, 2018). Many scholars have analysed the various causes and effects of the uncertainty on the Australian energy sector (see Apergis and Lau, 2015; Byrnes et al., 2013; Freebairn, 2014; Molyneaux et al., 2013; Nelson et al., 2013). Political dynamics within a federal system of government have been a key factor in driving this policy discontinuity (see Jones, 2009; Jones, 2010; Jones, 14; and Simshauser and Tiernan, 2019) and policies were introduced and repealed at both the state and federal level as a result (Nelson, 2015). Among the body of work on emission reduction policies, production subsidies, emissions trading schemes and feed-in tariffs have been explored at length (see Garnaut, 2014; Nelson, 2015; Wagner et al., 2014). Importantly, climate change and energy policy have never been sufficiently integrated. This is despite the first consideration of climate change policy by the Australian Government in 1989 (see Simshauser, 2018). In many ways, the policy discontinuity could be due to disagreement about among practitioners and researchers about: (a) the source of climate change; and (2) whether additional costs should be imposed on electricity consumers to fund renewable energy technologies with a view to avoiding dangerous climate change (Nelson, 2015).

In recent years, technological evolution and market dynamics have shifted the focus of investors to new energy generation technologies despite the lack of any coherent national policy in relation to greenhouse gas emission reductions (Nelson, 2018). Nelson (2018: 49) summarises: “market dynamics in relation to demand and technology costs results in the most economic new investment option being renewables for energy and gas-fired generation for flexible, dispatchable capacity”. This is the case even without pricing externalities in relation to greenhouse gas emissions.

Of note, however, are conflicting views related to the closure of coal-fired power stations (Nelson et al., 2017). Currently, strategies to move toward lower greenhouse gas intensive sources of energy remain highly contested (BP, 2017; Linnenluecke et al., 2015a; Linnenluecke et al., 2015b). In some parts of the world the levelised cost of energy shows that renewables are already the cheapest form of energy (Marcacci, 2018). Despite predictions that renewable energy will be cheaper than coal by 2020 (International Renewable Energy Agency, 2017; World Economic Forum, 2018), leaders of many oil firms argue that their traditional businesses models do not face imminent threat (Scheyder and Bousso, 2017). The International Renewable Energy Agency (2017) forecasted a 10 per cent rise in oil demand through 2040. Renewable energy projects gain approximately three per cent of $US100 billion in combined annual spending by the five biggest oil firms (Scheyder and Bousso, 2017). Research argues that information deficits, including carbon and climate change mitigation disclosure, may hinder effective action and market-based responses (Cotter and Najah, 2012). Some Australian regulators support the ongoing use of coal, while firms such as AGL Energy (herein AGL) have announced moves to exit coal due to it being no longer economic as an electricity source in Australia (see Nelson, 2018). For AGL, this includes the closure of a 2000 MW power plant by 2022.

This tension highlights the gap in theory and management practice (Bansal et al., 2012; Simsek et al., 2018). According to stakeholder theory (Freeman, 2010) grand challenges, such as dangerous climate change, could motivate private industry to explore win-win strategies that protect the environment, as well as profits. However, as argued above this is not the case. Before we progress with empirical analysis to understand why, we first explore the foundations of stakeholder theory.

*3.3 Stakeholder theory: A foundation for solutions to grand challenges*

Stakeholders are defined as “groups and individuals who affect, or are affected by, the achievement of an organisation’s mission” (Freeman, 2010: 52). Stakeholder theory predicts that organisational performance is positively related to maximising stakeholder value (Freeman, 2010). The stakeholder concept has a rich history. For example, Mainardes et al., (2011) and Preston and Sapienza (1990) suggested that the stakeholder concept dates back to Adam Smith's *The Theory of Moral Sentiments* and *An Inquiry into the Nature and Causes of the Wealth of Nations* (Evensky, 2005; Dodd, 1932; Dill, 1958). However, Freeman (2010) argued that the stakeholder concept was popularised in 1963 by the work of the Stanford Research Institute. Beyond stakeholder theory, the stakeholder concept is used in corporate social responsibility (CSR), corporate planning and systems theory literature. CSR literature explores business/society relationships (Cragg et al., 2009), while corporate planning and systems theory examines the role of stakeholders in planning (Freeman, 2010). CSR, corporate planning, and systems theory advocate the consideration of stakeholders in the design of strategy. Freeman (2010) was the first scholar to extend the stakeholder concept into a theory (Key, 1999).

Stakeholder theory has three fields of research that concern the management of salient stakeholders: instrumental; descriptive; and normative (Agle et al., 1999; Mitchell et al., 1997). Instrumental theory purports to describe what will happen if managers or firms behave in certain ways (Jones, 1995; Jones and Wicks, 1999). Descriptive formulations describe and/or explain how firms or their managers actually behave (Jones, 1995). Normative theory concerns the moral propriety of the behaviour of firms and/or their managers, and supports claims of why stakeholder management may be causally related to corporate performance (Donaldson and Preston, 1995). Donaldson and Preston (1995) argue that all three fields of stakeholder research are mutually supportive and can be applied in the study of salient stakeholder relationships (Agle et al., 1999). According to Mitchell et al., (1997) salient stakeholders possess one or more of three relationship attributes: power; legitimacy; and/or urgency.[1] Power is the probability that one actor within a social relationship would be able to carry out his or her own will despite resistance (Mitchell et al., 1997). Legitimacy includes attributes that can combine to create authority (Mitchell et al., 1997) and urgency concerns the dimension of time, i.e. does the stakeholder's concern require an immediate response? (Mitchell et al., 1997). These foundations of stakeholder theory have been applied in the literature to test the relationship between stakeholder management and organisational performance (Freeman et al., 2010).

Scholars have tested the central claim of stakeholder theory, that managing for stakeholders increases organisational performance, in a range of settings (Freeman et al., 2010; Xu et al., 2014). Based on 11 years of longitudinal data, Choi and Wang (2009) analysed the impact of stakeholder relations on firm financial performance and found a positive relationship between stakeholder relations and superior financial performance. Preston and Sapienza (1990) used Fortune Magazine survey data to establish a positive correlation between stakeholder relationship performance and corporate profitability and growth. Greenley and Foxall (1997) studied companies in the United Kingdom to support the proposition that orientation to multiple stakeholders is positively associated with performance. Berman et al., (1999) observed a positive relationship between employee relations, product safety/quality, and financial performance. While we recognise that not all studies support a positive relationship between high quality salient stakeholder relationships and corporate performance (see Agle et al., 1999; Berman et al., 1999), stakeholder theory is established on a strong foundation of knowledge that could enhance the building blocks of how organisational strategy could solve grand challenges (Freeman et al., 2010). Thus, this research will draw on stakeholder theory to further understand the following: "How stakeholder theory strengthens market-based solutions to grand

[1] With the rise of social media, explicit power is becoming more diffuse through the concept of 'devolved power'. This can broaden the set of relevant stakeholders for a business or industry.

challenges?". We draw on the instrumental stakeholder typology of "definitive stakeholders" offered by Mitchell et al (1997: 874). Definitive stakeholders possess power to influence the firm, including a legitimate relationship with the firm, as well as an urgent claim on the firm (Mitchell et al., 1997).

## 4. Research design

Our inquiry is abductive, seeking to extend existing theory (Edmondson and McManus, 2007). This differs from pure inductive approaches, which seek to build new theory and deductive approaches designed to test theory (Dubois and Gadde, 2002; Meyer and Lunnay, 2013; Timmermans and Tavory, 2014).

Because of the dearth of previous systematic research involving decision-making, and definitive stakeholders, we adopted a qualitative case study approach (Creswell, 2007, 2009). We analysed the dynamics of the Australia electricity generation market, as well as one critical firm level decision related to the closure of a coal-fired power station. The electricity market was selected because there is a profound change underway driven by the 'energy policy trilemma' grand challenge – reducing electricity sector greenhouse gas emissions in order to avert dangerous climate change, while maintaining a reliable and affordable electricity supply (see Haney and Pollitt, 2013). The firm level decision was selected because the New South Wales electricity system in Australia faces changing market dynamics in relation to electricity demand and technology costs. The firm in question, AGL, is also Australia's largest point-source emitter of greenhouse gas emissions and was somewhat pressured by some of the political actors to keep the relevant power station operating beyond its scheduled 2022 closing date.

A triangulation perspective was applied, comparing economic forecasts from the Australian Energy Market Operator [AEMO] and economic modelling of decision to close a coal fired power station. Our analysis uses an 'optimal plant mix', which is an economic model that is used to determine the incremental investment required in an electricity system. We applied this model to assess the economics of different technologies that a firm may invest in to replace the Liddell power station. Our optimal plant mix model is based upon Berrie (1967) and Nelson (2018). Input assumptions are derived from AEMO (for electricity demand) and Simshauser (2018) for energy technology costs. We establish two scenarios to demonstrate why AGL's decision may have generated such significant stakeholder reaction. The first scenario is based upon current technology and market assumptions, while the second scenario is based upon technology and market assumptions from a decade ago. Our subsequent results are instructive for demonstrating how the economics of new technologies, rather than just climate change considerations, are changing firm decision-making.

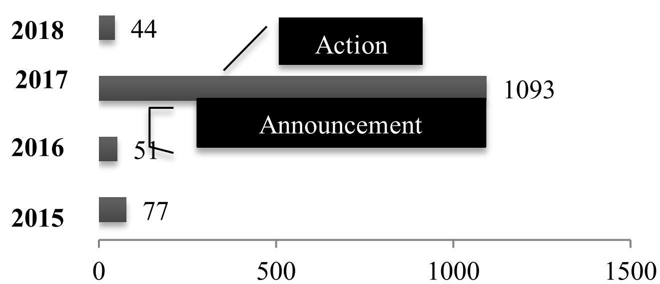
The model is based upon deploying technologies to meet three key types of electricity demand:

1. 'Baseload demand' is demand that occurs all the time. Historically, coal-fired generation has been used to meet baseload demand as increased operation of a set amount of capacity decreases the unit cost of operation.
2. 'Intermediate demand' is demand that occurs during the day. Historically, combined cycle gas units have been used to meet this type of demand.
3. Peak demand occurs only when air conditioners and heaters are switched on the hottest and coldest days of the year. Hydro-electric generation and quick-start gas generation has historically been used to meet peak demand.

Economic analysis in isolation does not sufficiently explain the action of the firm. The case study present here was highly contentious. The firm received significant media coverage in relation to the closure of the power station. This subjective view may have contributed to the outcome observed. We therefore analysed qualitative stakeholder comments in the media in response to a perceived shock to the Australian electricity market from closure of the coal-fired power station by AGL Energy. While groups of stakeholders' commenting in the media included: consumer groups, businesses, and governments we focused on the salient group of government. This is because the government (both at federal and state level) had powerful, urgent, and legitimate claims that influenced the firm's actions. For instance, pressure by the Australian Government ultimately resulted in the firm significantly amending its original plan. The focus on one salient stakeholder was selected to facilitate deeper understanding of the claims that may have influenced the firm's decisions.

Salient stakeholder comments were gathered, stored, and coded using NVivo 9.0. In total, 1,262 news articles were identified via ProQuest Australia & New Zealand Newsstream (2018), using the key word search "Liddell coal". The search was bounded by the dates: 1 January 2015 - the year of the announcement of the coal-fired power station closure, and 28 February 2018 - a year after the first stage implementation of the closure (see Figure 1). First and second order coding and theoretical aggregated dimensions (Gioia, 2014; Gioia et al., 2013) were identified.

Figure 1: Documents number by year 2015 to 2018




All articles were reviewed once and repeat occurrences of the same article (i.e. those that appeared in more than one publication) were only used once in the analysis. Similarly, articles that did not directly relate to the closure of the power station were removed from the data set.

## 5. Analysis and interpretation of the results

### *5.1 Economic analysis*

Our modelling (Table 1 and 2) demonstrates that it is more economic for firms to replace ageing coal-fired power stations with variable renewable sources of energy, supported by firming generation technologies.

**Table 1: 'Optimal' and 'actual' plant mix in 2022 using 2018 market assumptions**

| Category | Optimal | Actual (2022)[2] | Imbalance | Weighting |
|---|---|---|---|---|
| Baseload | 7,295 | 8,160 | 865 | overweight |
| Intermediate | 1,669 | 567 | -1,102 | underweight |
| Peaking | 5,022 | 4,236 | -786 | underweight |
| | 13,986 | 12,963 | -1,023 | |

Table 1 shows the results of our 'optimal plant mix' model and contrasts these with the actual installed capacity in 2022 following the closure of the Liddell power station. The imbalance between the three categories of generation is effectively the surplus or deficit of generation that is installed to meet that type of electricity demand most efficiently. The results show that there is a surplus (i.e. overweighting) of baseload demand – the type of demand most suited to being supplied by a coal-fired electricity generator. Declining electricity demand and the increased adoption of economic renewable technologies are the primary reasons for this result.

**Table 2: 'Optimal' and 'actual' plant mix in 2022 results using 2007 market assumptions**

| Category | Optimal (MW) | Actual in 2022 (MW)[3] | Imbalance (MW) | Weighting |
|---|---|---|---|---|
| Baseload | 9,583 | 8,160 | -1,423 | underweight |
| Intermediate | 245 | 567 | 322 | overweight |
| Peaking | 6,385 | 4,236 | -2,149 | underweight |
| | 16,385 | 12,963 | -3,250 | |

Table 2 shows the results of our 'optimal plant mix' model and contrasts these with the actual installed capacity in 2022 following the closure of the Liddell power station but with 2007 demand and technology cost assumptions. The results show that there is a shortfall (i.e. underweighting) of baseload demand. There is therefore an economic case for the construction of a coal-fired electricity generator.

Our conclusions are that the electricity system is not suited to the ongoing operation of the Liddell power station after 2022 as there is an overweighting of baseload capacity (i.e. coal-fired power) (see expanded argument in Nelson, 2018). The most economic form of energy production in Australia is no longer coal but renewable wind generation with a long-run marginal cost of around $60 per MWh. However, by conducting the same analysis utilising 2007 assumptions, Table 2 demonstrates that, absent climate change considerations, the most economic replacement option for a coal-fired power station would have been a new coal-fired power station. As such, changing market dynamics and conditions have changed the investment response of Australian firms (irrespective of climate change considerations) to new renewable energy.

Further, our analysis supports AGL's conclusion that investment in alternative capacity is a preferable solution (see AGL Energy, 2018). As excess baseload capacity is approximately equal to the shortage of intermediate and peaking capacity, the appropriate

[2] This assumes no new investment apart from plant under construction. It also assumes Liddell power station is closed.

[3] This assumes no new investment apart from plant under construction. It also assumes Liddell power station is closed.

technology to deploy is 'firm' generation suited to operating at low capacity factors. This is precisely the type of generation AGL has announced it intends to deploy (i.e. gas-fired engines, batteries and synchronous condensers). AGL's own analysis shows that the levelised cost of meeting electricity demand with new technologies is $83 per megawatt-hour (MWh), compared with $106 per MWh to keep Liddell operating. Australia's electricity sector has experienced a 'disorderly' transition as existing ageing coal-fired power stations are decommissioned (see Nelson et al, 2017). The economic pressure of relatively low wholesale electricity prices, driven by increased supply of renewable energy and flat electricity demand, led to the disorderly withdrawal of significant quantities of capacity (see Table 3).

**Table 3: Power station closures in National Electricity Market since 2012**

| State | Power station | Coal type | Commissioned | Closed | Capacity (MW) |
|---|---|---|---|---|---|
| NSW | Munmorah | Black | 1969 | 2012 | 600 |
| NSW | Redbank | Black | 2001 | 2014 | 143 |
| NSW | Wallerawang C | Black | 1976 | 2014 | 1,000 |
| VIC | Morwell | Brown | 1958 | 2014 | 189 |
| VIC | Angelsea | Brown | 1969 | 2015 | 160 |
| QLD | Collinsville | Black | 1968 | 2012 | 180 |
| QLD | Swanbank B | Black | 1970 | 2012 | 500 |
| SA | Northern | Brown | 1985 | 2016 | 546 |
| SA | Playford | Brown | 1960 | 2016 | 240 |
| VIC | Hazelwood | Brown | 1964 | 2017 | 1,600 |
| Total | | | | | 5,158 |

Source: AEMO (2018)

Table 4 shows that investment in new 'firm' capacity has not been sufficient to replace the withdrawals of ageing coal-fired power station capacity.

**Table 4: New capacity and coal-fired capacity withdrawals in Australia**

| Year of Exit/Entry | Coal Retirements | | Gas Plant Entry | | | Renewables Entry | |
|---|---|---|---|---|---|---|---|
| | No. of plant | Capacity (MW) | No. of plant | Total (MW) | CCGT[4] (MW) | No. of plant | Capacity (MW) |
| 2005-2012 | 2 | 740 | 31 | 8,674 | 2,546 | 112 | 2,640 |
| 2013+ | 9 | 4,656 | 4 | 218 | 52 | 49 | 2,422 |
| Total | 11 | 5,396 | 35 | 8,892 | 2,598 | 161 | 5,062 |
| Av. Age | | 42 years | | | | | |
| Coal-fired generation closure – 18% of fleet | | | | | | | |

Source: Simshauser (2018)

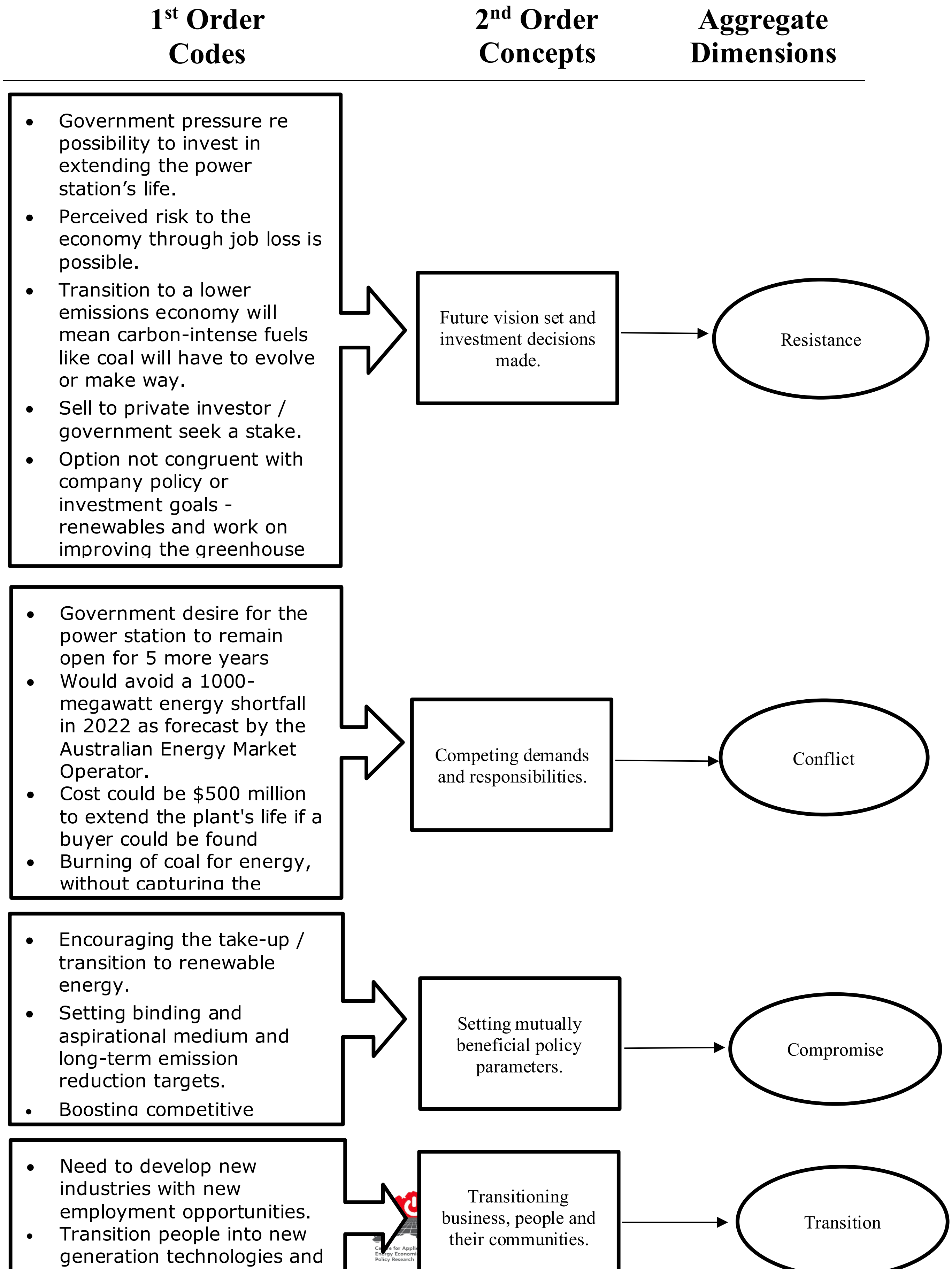
The result of this 'disorderly' transition to new renewable energy has been a significant increase in electricity prices. This has created sustained public commentary about the industry and intensified the debate about the closure of the Liddell power station.

*5.2 Document analysis*

It is unclear if definitive stakeholders understand the analysis presented in Section 4.2. Figure 2 shows themes that emerged through the document analysis. Of the 1,262 news articles analysed, 19% were featured in The Australian (n=244), followed by local newspapers, the Newcastle Herald (15%, n=194), and The Daily Telegraph (7%, n=87). The then Federal Energy Minister, the Hon. Josh Frydenberg MP, in The Project (2017) claimed that the firm was acting in its own interest, asserting that "Their obligations are to their shareholders', ours [the Australian Government] obligation is to the community". This sentiment was reflected in the documents analysed. Using the Gioia et al., (2013) method for interpreting qualitative data, it was noted that four key aggregated dimensions emerged: (1) resistance; (2) conflict; (3) compromise and (4) transition (Figure 2).

[4] CCGT column is a subset of the total gas capacity column.

**Figure 2: Document coding**



In examining the news articles several stakeholders were identified (Federal, State and Local Government, members of the Opposition, community advocates, political and media commentators). However, the key stakeholder identified was the Australian Government, particularly through the commentary of the Prime Minister and the Minister for the Environment and Energy. As the focal energy firm sought to move forward with the first stage of its plan in 2017, closing the coal-fired power station, it faced increased attention and agitation from some stakeholders. In September 2017 there was significant criticism and uproar from some parts of the Australian Government (Leyonhjelm, 2017), which initiated a spike in the number of news articles and media attention. For example, from the beginning of January to 31 August 2017, some 141 articles were attributable to the closing the coal-fired power station. Yet in September 2017 alone over 670 articles related to the closure were identified. The data show stakeholder concern and misunderstanding. AGL responded with a spokesperson stating: "planning for power station closure, rehabilitation or future site use will be done in consultation with all relevant levels of government, our local communities and employees" (McCarthy, 2017: 4). AGL is also said to be “committed to encouraging new business and employment opportunities in the Upper Hunter, and assisting to diversify the local economy" (McCarthy, 2017: 4).

The results of the document analysis show that economic decisions regarding energy investment options are influenced by rational and subjective considerations. The novel impact of this paper is the balance of rational and subjective perspectives. Below we argue for the connection (or nexus) between investment decisions and narratives in the media that may shed light on why AGL altered its original position, despite it having the highest economic return.

## 6. Discussion and implications

Understanding of antecedents of behaviour change to solve grand challenges is lacking in the transition literature (Grodal and Mahony, 2017). This research shows that to fully understand transitions in this context rational and subjective perspectives should be taken into consideration. Our analysis shows a discord between the rational and subjective perspectives of the case study. Definitive stakeholders opposed the course of action that would return the highest social, economic, and environmental value. Initially, definitive stakeholder resistance did not account for technological breakthroughs and resulted in a comprised position that reduced the potential positive impact of market-based solutions ($2^{nd}$ order code: Future vision set and investment decisions made). In this case conflict and compromise resulted in an outcome that lowered positive social, economic, and/or environmental outcomes in firm level decisions resulting in changing marketing dynamics. This shift was noted through the document analysis. Second order code “competing demands and responsibilities” shows the conflict that arose in the media before the $2^{nd}$ order code of “setting of mutually beneficial policy parameters” that resulted in a comprise. The value of time in this case study shows how salient stakeholder perceptions changes over time, as well as the issues and concerns which resulted in the conflict and required compromise. In response to our central question of “How stakeholder theory strengthens market-based solutions to grand challenges?” our results have implications for theory and practice, as now discussed.

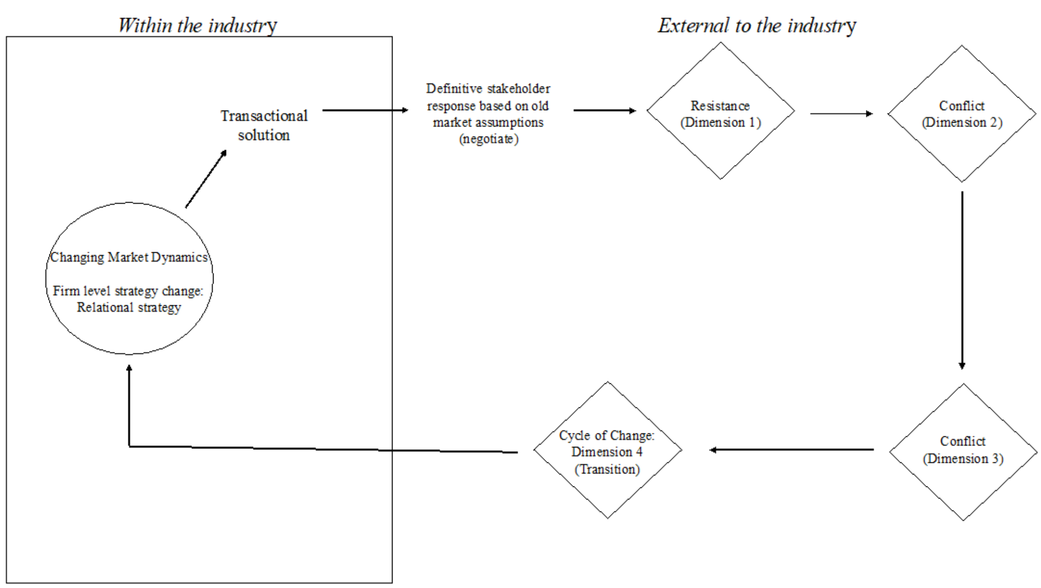
### *6.1 Opportunities for further research and conceptual development*

By examining trends in the Australian electricity generation market, we find an important dimension of flexibility in decision-making models for market-based solutions based on definitive stakeholder perceptions. This recognises the mutually dependence of stakeholders. In the context of sociology, the study of human societies (Abercrombie et al., 1984), and more specifically management, the term mutually dependent refers to a relationship between interdependent persons or groups for mutual benefit. The free market is argued to be a source of solutions to social and environmental problems, rather than the cause (Hart, 1995; Porter and Kramer, 2011). However, this imposes an artificial division between two concepts (social value and economic value) in which one actor (the firm) has the power to create value independent of stakeholders.

If organisational strategy aligns to such as view of the firm, also known as the natural-resource-based view (Hart, 1995), new opportunities may arise in the pursuit of needs through the reduced use of natural resources. While there are many examples of business based on this concept (see Ruskin et al., 2016; Waldron et al., 2016) the theoretical explanation of the decision-making models that underpin them remains nascent (Stephan et al., 2015; York et al., 2016).

We propose a framework to help organisations understand how to engage with definitive stakeholder to avoid strategic responses that require a shift from transactional to relational stakeholder engagement (Figure 3).

**Figure 3: Emerging theoretical model**




After months of discussion, the energy firm developed a revised strategy (released December 2017) for how the closure of the coal-fired power station would be managed, moving from theorised solution to actual strategy. Thus, this research highlights that transitions (in the context of grand challenges) may require a relational stakeholder review, beyond the concept of short-term win-wins. For the transition literature this support future research endeavours that seek to understand how market based solutions to grand challenges can be facilitated.

*6.2 Implications for practice*

The use of 2007 assumptions in the second scenario presented in Section 4.1 fundamentally changes the results. In 2007, energy demand was forecast to grow strongly, and coal-fired generation was the lowest-cost form of producing a unit of energy. By applying these assumptions to the capital stock of 2018, a distinctly different investment proposition is implied. The market requires new capacity to meet 'baseload' demand of approximately 1,500 MW. The most cost-effective way of meeting this demand is through investment in a new coal-fired power station.

By presenting both scenarios, we demonstrate a potential reason for the significant stakeholder reaction to AGL's decision to close the Liddell power station presented in Section 4.2. We replace the proposed solution with a mix of renewable and low capacity factor firming technologies. Stakeholders may have incorrectly concluded that AGL's primary (and most publicly stated) reason for the decision related to its consistency with achieving Australia's climate change objectives. This is reflected in the opening quote on page 1 in which the Australia Government perceived a transitional rather than relational view. In reality, the decision (supported by our analysis) was as much based upon evolving generation technology economics and changing market conditions. The decision rested on the assumption that social and economic value is inter-wound and mutually dependant.

Key learnings for this case, from theorised solution to actual strategy, involve communication. A critical improvement opportunity for participants in this market decision may rest with the notice of closure. In most instances, less than a year of notice is given. With such little notice of closure, new generation could not be built to replace the retiring capacity. Such capacity is required to complement the new variable wind and solar generation entering the system. It also demonstrates the relational review, which implies care and a presumption that the relationship will continue.

As noted earlier, AGL's analysis showed that the levelised cost of meeting electricity demand with new technologies is $83 per megawatt-hour (MWh), compared with $106 per MWh to keep Liddell operating. AGL (through Nelson, 2018) has also stated that there are three drivers for why this conclusion has been reached: climate change, declining energy demand, and a significant reduction in energy production costs of solar and wind technologies. Stakeholders such as the Australian Conservation Foundation (2017) and Australian Industry Group (Tennant Reed, Head of Climate, Energy and Environment Policy in Potter, 2018) publically supported AGL's analysis. The Australian Conservation Foundation (2017) commissioned modelling work by the University of Technology, Sydney, to examine the least cost way of replacing Liddell. Their analysis confirmed AGL's decision. The Australian Industry Group (2019) is one of Australia's leading business associations. In addition to commenting on Liddell, it has also stated that "The rise of renewables looks unstoppable; even without supportive public policies" Australian Industry Group (2019, third para).

## 7. Conclusion and avenues for future research

We analyse these underlying limitations of market-based solutions to solving grand challenges through the lens of stakeholder theory. Our research suggests the importance of shifting strategy from transactional stakeholder approaches (win-win) to relational approaches that seek to build stronger stakeholder relationships and understanding. In our case, AGL's position is that replacing Liddell with a mix of new technologies is a more reliable and cost-effective way of meeting electricity demand. Our economic modelling supports this. Stakeholders, however, did not agree, resulting in conflict and comprise. For market-based solutions to grand challenges this highlights the need for further conceptual development. Social and economic value do not exist in independence with value attributed to each. The transactional firm driven approach of market-based solutions to grand challenges can be enhanced through the view of a relational stakeholder approach. By mapping the trials and tribulations of Australia's transition to renewable electricity we highlight that organisational strategy should involve strong engagement with stakeholders, often requiring flexibility and compromise in proposed approaches.

Research avenues emerging from our analysis include further demonstration of the need to study patterns in the energy market. Specifically, implications from stakeholder responses to the changing nature of electricity supply. Opportunity also exists to advance stakeholder theory. This may include examining micro trends, such as increasing community interest, as well as understanding, of the environmental implications of fundamental economic inputs, such as energy. In addition, future research could explore implications if the other stakeholders, who supported AGL, were included in the analysis. Exploring implications beyond the salient stakeholder analysed in this case may uncover opportunity to expand the emerging theoretical model. This may be pertinent to emerging aggregated dimension 2 "Conflict". Last, further research is required to understand the inter-generational implications of our findings. How electricity supply addresses the triad of energy security, affordability, and eco-efficiency and how will changing social perceptions influence this and future policy responses.

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