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# Carbon Mitigation Strategies in the Electricity Distribution Sector in Australia

## An Analysis of Activities and Opportunities in the National Electricity Market

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In collaboration with AECOM

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# Abstract

This paper looks at strategic responses to climate change mitigation of electricity distribution companies in the National Electricity Market in Australia. The work uses institutional theory, resource dependence theory and aspects of stakeholder management theories and dynamic capabilities theory to describe and analyse current strategies of distribution companies in response to climate change mitigation. An analysis of the electricity market, policies in place and the external environment provides insights into barriers and drivers of climate change mitigation activities for the sector. This information in combination with stakeholder interviews reveals potential future business opportunities in relation to carbon mitigation and indicates actors already moving into this emerging market. It also highlights some constraints on their implementation. To analyse the actual responses to change a survey amongst distribution companies provides information on the current activities and strategic elements. Those findings are described and analysed through the lens of the theoretical framework developed for this research. The information from those different parts is finally used to provide insights into approaches and recommendations on how distribution companies could adapt their activities and business models to move towards a lower carbon electricity provision while at the same time maintain organisational efficiency and profitability.


**Keywords:** distribution companies, network service provision, strategic response to change, electricity market, low carbon electricity provision, carbon mitigation, NEM, Australia

# Executive Summary

With 27.3 tonnes $CO_2$-e emissions per person and year, Australia has one of the highest per capita emissions of $CO_2$-e worldwide. 35% of these emissions related to the country's electricity generation which mostly stems from brown and black coal. Australia has signed the Kyoto protocol and aims to reduce its overall emissions by 5% by 2020 compared to 2000 levels. In case an international agreement can be reached to keep carbon particles below 450 ppm or 550 pm, respectively, Australia's current government has committed to increase its emission reduction efforts to 15% - 25% within the same timeframe. At the same time, modelling of future electricity use indicates a steady increase of electricity use in the country. This is related to growth in the economic activities of industries such as aluminium smelting and increasing peak demand rooted in the domestic sector's additional installation of residential air conditioning, pool pumps and other appliances.

While electricity network provision companies may have an important role to play in facilitating the move towards lower carbon electricity provision, limited research has so far been conducted in this field. This work therefore aims to analyse the role of electricity distribution companies and their strategic responses to climate change mitigation. The role of these companies can be particularly interesting as they are in direct contact with end customers on the demand side and small to medium sized distributed generation companies on the supply side. The main research question asked is: *How can companies, active in distributing electricity in the National Electricity Market in Australia, efficiently, affordably and sustainably react to change related to carbon mitigation?* Two sub-questions guiding the research to this aim are: a) *What sustainable business opportunities appear to be emerging within the sector?* and b) *What carbon mitigation strategies and activities are being undertaken?*

The methodology chosen to answer those questions is a combination of literature research and the use of primary data. Literature research was used to describe the electric market, policies in place and to outline the external factors influencing strategies and activities. A survey amongst the thirteen distribution companies in the NEM was used to obtain data about current strategies and activities in the distribution sector. To triangulate data from the survey and expand on the literature review, semi-structured stakeholder interviews were conducted to provide in-depth market insights and information about external perceptions on activity levels and collaboration of distribution companies. Data obtained was analysed in a qualitative way, using primarily the framework of *strategic response to change* originally developed by Christine Oliver, a researcher based with the York University who first published her work in this area in 1991. This framework is based on the institutional theory in combination with resource dependence theory. Additionally, other frameworks have been drawn upon to reflect the complexity of strategy development in dynamic business environments: Stakeholder salience theory first introduced by Mitchell (Mitchell, Agle, & Wood, 1997) was incorporated to provide an insight into the importance of stakeholder management while the resource based view and dynamic capabilities as postulated by authors such as Teece (Teece, 2007; Teece, Pisano, & Shuen, 1997) provided insights into potentially successful future strategies.

The National Electricity Market in Australia is mostly liberalised with generators dispatching their electricity via a central wholesale spot market from which retailers buy electricity for their customers. Electricity prices in the market are highly volatile with both, retailers and generators engaging in hedging activities to protect themselves against market risks. Many generators engage in the retail business to internally manage those risks. While transmission companies are mostly governmentally owned (or controlled), eight of the thirteen distribution companies are privately owned with the remaining five under government ownership. Distribution businesses are regulated by the Australian Energy Regulator AER with the agency

approving five-year plans including revenue caps and approval of infrastructure upgrades. Network charges have increased in the last few years, mostly due to increasing demand, growing peak demand and necessary replacement of network assets due to an ageing infrastructure. Today, network charges account for 50% - 60% of an average electricity bill.

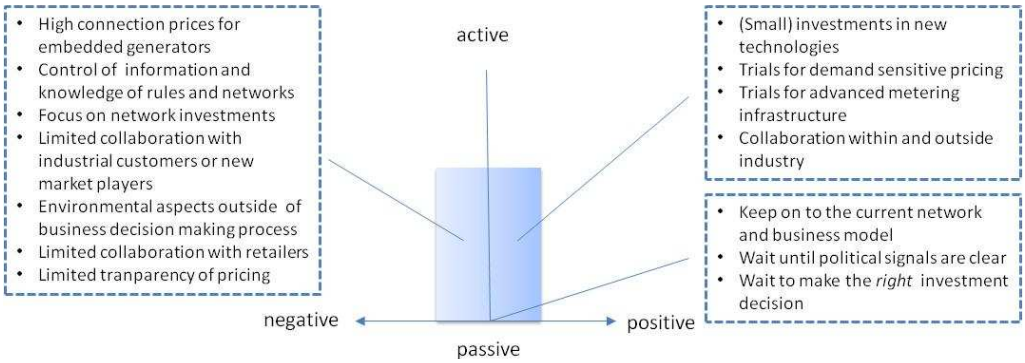
A major policy influence to the electricity market so far has been the Renewable Energy Target (RET) requiring the feed in of 20% renewable energy sources into the grid by 2020. Other policy-supported activities in the research sector have not (yet) affected the market. At a state level, feed-in tariffs primarily encouraging small scale photovoltaic power production have proven to be highly popular with end consumer. However, the total capacity of those very small scale generators is well below one percent of the total market capacity. Distribution companies in Victoria have been affected by a mandatory roll-out scheme of smart meters. Additionally, the current government plans to introduce a price on carbon of AUD 23 per tonne $CO_2$ by July 2012 to encourage emissions reductions.

Many dynamic external factors influence the development of the electricity market and its shift towards lower carbon electricity supply. Major uncertainties can be found in the political area with the Liberal party strongly opposing the recently announced carbon tax and threatening to remove it should they gain power in the 2013 elections. Customers generally have a positive view towards carbon reduction activities. However, opinion polls show that a majority opposes the carbon tax proposed. Public concerns about increasing electricity prices and potentially required life-style changes are being politicised by the opposition party and representatives of the extractive industries. Stagnating participation rates of the voluntary GreenPower scheme and opposition against market-based pricing indicate price sensitivity towards carbon mitigation activities. Industrial associations generally oppose carbon mitigation for economic reasons, claiming that Australian companies would be disadvantaged compared to companies in countries without carbon pricing. This is particularly relevant as the heavily electricity-depended mineral industry is considered to be the backbone of Australia's industry, accounting for 25% of the export economy. Technologies in the area of renewable energy sources are still emerging, with wind turbines being among the most mature technologies. While solar power is expensive today, studies indicate a high future potential. Other technologies such as biomass and geothermal have so far received limited attention.

Business options for distribution companies in the area of low carbon electricity provision include activities on the supply and demand side. A shift towards more sustainable energy sources including gas-fired power plants is likely to result in more distributed generators, feeding directly into the distribution network. This means that networks, currently set up for one-way, top-to-bottom energy flows will have to be adapted to accommodate two-ways flows and potentially intermittent electricity supply. On the demand side, options include the development of load shifts, flexible electricity pricing, home area networks and two-way communication First activities in the residential area are under way, however mostly in small scale trials. Demand management, including SME's and large-scale industrial companies, is another area with service and products opportunities. So far however, the focus has mostly been on financial gains from the wholesale market rather than on energy efficiency measures.

The survey of distribution companies indicates that companies undertake climate change mitigation activities to help address their direct environmental impacts. Examples include $SF_6$ reduction, fleet management, good housekeeping and employee education. However, a majority of distribution companies does not feel responsible for energy network losses; these accounting for 80% - 95% of their carbon emission impacts. Even more importantly, a majority of distribution companies considers supply chain aspects including the sourcing of electricity and the use of electricity as beyond their scope. Energy efficiency measures such as

demand side management are mostly implemented in response to reliability and security obligations required by the regulatory framework. Other activities e.g. in the area of smart meter installation provide business value to distribution companies, enabling them to increase network charges. At the same time, smart meters have the potential to improve the networks e.g. by increasing fault visibility and demand patterns. The illustration below provides an overview of activities through the lens of the theoretical framework applied in the work. Passive reactions refer to areas where companies perceive to gain most business value by adhering to institutional norms and rules. *Negative* and *positive* activities refer to active behaviour were companies perceive to gain most by either *negatively avoiding* and *defying* imminent change or by *positively compromising* and *manipulating* the change process.




Sustainability managers interviewed mostly consider the strategies of distribution companies to be *passive* or slightly *active*. The triangulation of information by external stakeholders and industry insiders shows however, that distribution companies are perceived to be *passive* to *negatively active*, trying to avoid change through strategies of *buffering* (e.g. small, highly advertised smart grid trials, high connection costs) or *concealment* of market information.

Given the potential business options, the current strategies in place and external factors, the answer to the main research question is complex. While opportunities are shown to be present, most of them do not currently provide business benefits to distribution companies. This is partly due to perverse incentives being in place that focus on asset expansion rather than energy efficiency. One exception is smart meter infrastructure, providing the potential for demand side management options and an increase in revenues from assets of distribution companies. However, customer protests in Victoria show that the fear of increasing electricity bills is currently a strong external barrier to change. Based on the academic framework of the resource based view and dynamic capabilities, the author postulates however that a continued pattern of *passive* or *negative* strategic approaches could mean that distribution companies miss out on future business opportunities including those feasible in electricity provision services and new products. Already now, other, generally new formed companies are moving into the market of energy services, clearly indicating the availability of new opportunities.

The research suggests that the rate of change will accelerate and its complexity increase. In turn, this suggests that more *active* organisational responses to climate change mitigation should be more successful. It may strongly depend on the level of preparedness if distribution companies will be able to cope with those changes in a *positive active* way. The author therefore suggests that distribution companies should prepare themselves for future changes even if most options are not (yet) profitable or offering tangible benefits. Possible starting points include adoption of a more active role in policy shaping, a review of the current business model (from infrastructure provision to electricity service provision), increased collaborative efforts e.g. with new market players and retailers and more generally, a broader engagement with various stakeholders. At a more fundamental level, diversification of the management, new skills, adaptation of processes and routines will very likely be necessary to gain the dynamic capabilities required to create a new, sustainable business model over time.

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# Abbreviations

| | |
|---|---|
| AC | Air conditioning |
| ACT | Australia Capital Territory |
| AECM | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| AMI | Advanced metering infrastructure |
| AUD | Australian Dollar; equivalent to 1.07 USD[1] |
| CCGT | Combined cycle gas turbine |
| CDM | Customer Demand Management |
| $CO_2$-e | Carbon dioxide equivalent |
| CPRS | Carbon Pollution Reduction Scheme |
| DCCEE | Department of Climate Change and Energy Efficiency |
| DSM | Demand Side Management |
| DSR | Demand Side Response |
| ETS | Emission Trading Scheme |
| GGAS | Greenhouse Gas Reduction Scheme (NSW) |
| GHG | Greenhouse gas |
| HAN | Home area network |
| IT | Institutional Theory |
| kV | kilo Volt |
| MCE | Ministerial Council on Energy |
| MWh | Mega Watt hour |
| Mt | Mega tonne |
| NEM | National Energy Market |
| NGER | National Greenhouse gas reporting act |
| NSW | New South Wales |
| OCGT | Open cycle gas turbine |
| O&M | Operation & Maintenance |
| QLD | Queensland |
| RBV | Resource-based view |
| RECT | Renewable Energy Certficiate |
| RES | Renewable energy source |
| RET | Renewable Energy Target |
| SREC | Small Scale Renewable Energy Certificate |
| SA | South Australia |
| T&D | Transmission and Distribution |
| TAS | Tasmania |
| TWh | Terra Watt hour |
| VIC | Victoria |
| WA | Western Australia |

[1] Rate on 10 July 2011 according to: http://www.xe.com/

# 1 Introduction

## 1.1 Background

Australia has one of the highest per capita emissions of $CO_2$ worldwide. This is largely due to its heavy reliance upon high carbon intensity fossil fuels (largely coal) for industry and the electricity sector. While total energy consumption and $CO_2$ emissions have been continuously increasing, the Australian government has signed the Kyoto protocol and committed to a 15% - 25% reduction of $CO_2$ by 2020 compared to the 2000 level. However, only if a global agreement on the stabilisation of $CO_2$-equivalents at 450 ppm can be reached. Without a global agreement, the minimum reduction target the government is committed to is set at a 5% reduction below the 2000 level until 2020 (Australian Government, 2011b).

For the production of its electricity, Australia is heavily dependent on fossil sources and particularly on coal. According to the Energy Supply Association of Australia ESAA, in 2007/8 coal alone accounted for 81% of the national electricity capacity while 13% was derived from natural gas, 5% from hydro and 1% from oil and other sources (International Electricity Partnership, 2009). Figure 1-1 below indicates the various sources of fuel in the different states. Electricity generation is responsible for 35% of GHG emissions in Australia and electricity consumption has been growing with an average annual growth rate of approximately 3% since 1990. In 2009 electricity use amounted to 231 TWh and is expected to increase to 245 TWh by 2020 (ClimateWorks Australia, 2010; Garnaut, 2008). While it is clear that Australia alone cannot lower worldwide $CO_2$ emissions, the country has the potential to serve as an important role as role model for economies in Asia, particularly China.

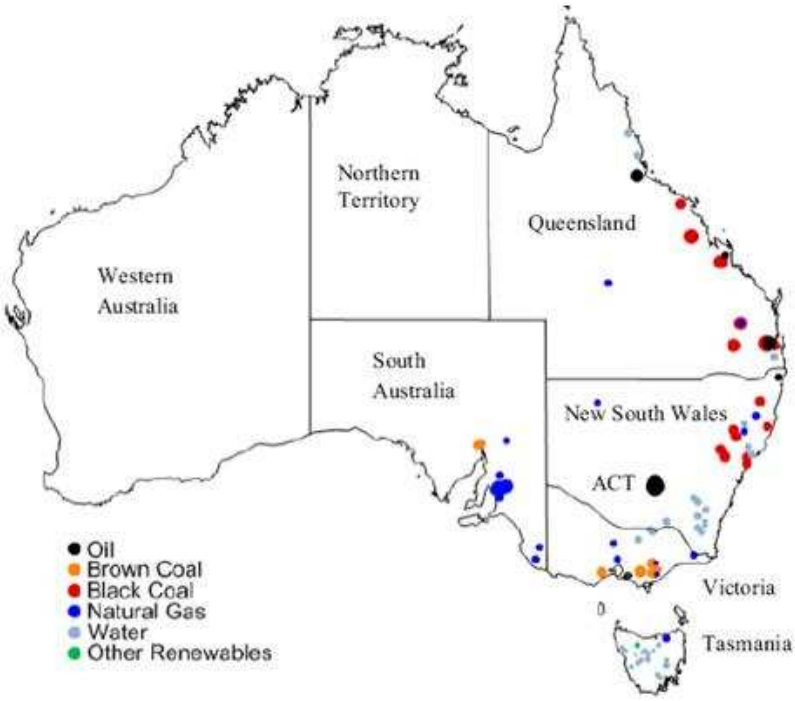


*Figure 1-1: Electricity generation in NEM according to fuels used*
*Source: (Wileya, Hoa, & Dondea, 2011, p. 1894)*

The national electricity market (NEM) in Australia is the most expansive interconnected power system on the global scene, covering the major part of Australia's electricity over distances of about 4 500 km with a total capacity of 48 GW and almost 10 million customers.

Besides this extensive system, two much smaller networks in Western Australia and the Northern Territory are in place (International Electricity Partnership, 2009). ESAA estimates that the total stationary electricity sector holds assets with a value of AUD[2] 120 billion from generation, transmission and distribution and is responsible for 1.6% of the annual GDP. According to the same organisation, investments in the sector have been modest in 2009 -10, mostly due to high uncertainty in the policy area (ESAA, 2010c). Australia's electricity sector is mostly deregulated and necessary investments related to the renewal, expansion and adaptation of it will have to come from market sources.

### 1.1.1 The Electricity Value Chain

The National Electricity Market (NEM) consists of 268 generators, five transmission companies, 13 distribution companies and 26 retailers (M. Davidson, 2010a). These companies are tightly linked to each other by regulations, electricity flow and financial interactions as shown in the graph below (AEMO, 2010b).

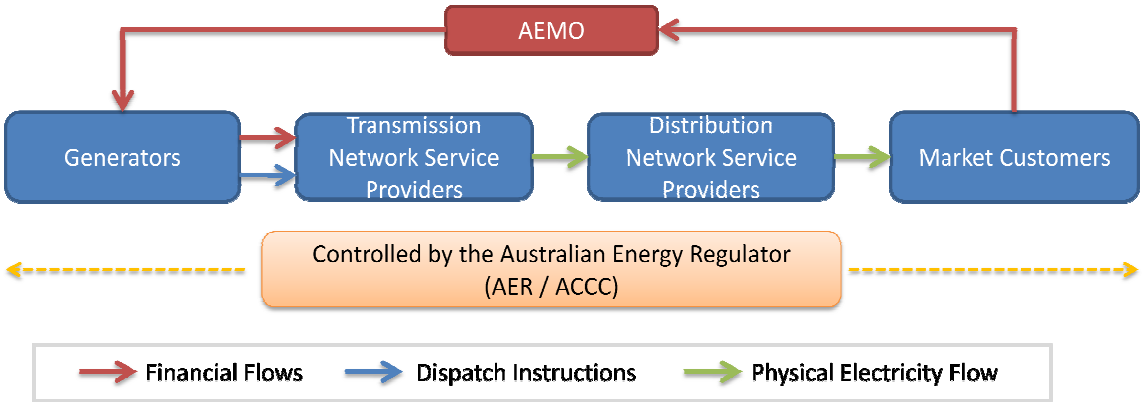


*Figure 1-2: The electricity value chain in Australia's NEM*
*Source: adapted from: (AEMO, 2010b, p. 7)*

According to authors such as Künneke (2008) and Hofman (2005), the structure of liberalised electricity markets does not readily accommodate technological innovation development as the "technology, infrastructure, regulation, industrial organisation and user preference have become mutually attuned" and are shaped to accommodate centralised, large scale fossil-fuel electricity generation (Hofman, 2005, p. 27).

The Transmission and Distribution (T&D) sector is thus of particular interest as it is – according to a study by Haigh (2008a) – equally responsible for climate change issues within the electricity market in Australia but much less aware of its responsibility than generators or retailers. According to a further study (Wong, 2010), most small and medium-sized companies in the distribution sector don't provide complete sustainability reporting so that their strategies and activities within this area are unclear. T&D companies with their regional monopolies are however a crucial part in the electricity system in Australia: major renewals of the networks need to be undertaken within the next ten years and those huge investments with a life-expectancy of 30 or more year will play a decisive role in accommodating renewable energy and demand management into the Australian grid (Shaw, Attree, & Jackson, 2010; Wolfs & Isalm, 2009). The role of distribution companies is particularly interesting as they are affected by both, new distributed generators that are added to the networks and measures required on the side of their end customers. It can be expected that upcoming changes will significantly affect the infrastructure and potentially the collaboration and business models of those companies.

[2] Australian dollars

### 1.1.2 Policies in Place

As of 2011, the Australian government bases its climate strategy on their so called three pillars of mitigation, adaptation and global solution (Australian Government. Department of Climate Change and Energy Efficiency). Programs in place include amongst others;:[3]

- National Greenhouse and Energy Reporting Act (NGER);
- Large and Small Scale Renewable Energy Target (LRET / SRES);
- Clean Energy Initiative;
- Greenhouse gas reduction scheme in NSW;

While some effort is reflected by such initiatives, Australia has not yet introduced a carbon pricing mechanism at a national level as implemented in other countries or regions such as the EU. The government plans to implement a carbon tax in 2012 and to introduce an emission trading scheme (ETS) in 2015. Political opposition against these projects is strong, supported by the (right-leaning) Liberal Party (Mercer, 2011). Research institutes seem to be in disagreement on the usefulness and economic viability of the carbon tax and ETS. Hunt (2011) states that a 5% GHG reduction is not achievable from a practical viewpoint and that targets need to be downsized The main reason given is the requirement for base-load electricity which according to Hunt can at the earliest be changed to more sustainable sources by 2040 (Hunt, 2011). Garnaut (Garnaut, 2008, 2011), who initially assessed the feasibility of a carbon pricing for the government, states in his reports that both, a carbon tax or a carbon cap-and-trade emission scheme are valid tools to achieve reduced $CO_2$ emissions aiming to stabilise $CO_2$-e levels at 450 ppm or – in the 2011 version of the report – 550 ppm[4] $CO_2$. ClimateWorks, a collaboration between Monash University in the State of Victoria and the philanthropic Myer Foundation finds in its 2010 report that Australia can achieve a 25% GHG reduction by 2020 if a carbon tax of AUD 43 per ton is introduced. With heavy polluters having to pay for their emissions, they estimate that investments in clean energy projects would triple. Investments that could become profitable are for example carbon capture and sequestration (CCS) or renewable energy projects such as wind or solar. According to the study, the power sector could reduce its emissions by 39% by 2020 compared to business as usual (ClimateWorks Australia, 2010). Other organisations such as Beyond ZERO Emissions, Greenpeace and Friends of Earth propose alternative scenarios leading to fast-track zero emissions from energy use through energy savings, wind and solar technologies as well as energy storage technologies (Beyond Zero Emissions, 2010; Vincent & Wakeham, 2009).

## 1.2 Problem Definition

Australia's energy supply for electricity focuses heavily on fossil resources, mostly coal. Given the environmental goals of the incumbent national government and the expected implementation of a carbon tax and cap-and-trade carbon emission scheme, the market conditions in the electricity market appear very likely to change notably in the near future. Changes however will not only stem from environmental arguments but shall also include the need to cater for increasing electricity demand, fast growing peak load, changing political environments and institutional conditions. Electricity prices between 2007 and 2010 clearly exemplify this situation: they have shown overall price increases and increasing volatility in electricity prices (Simshauser, Molyneux, & Shepherd, 2010). It is clear that climate change mitigation efforts in general, and the planned carbon tax and ETS in particular, will affect the

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[3] See chapter four for further information or go to: http://www.climatechange.gov.au/government/initiatives.aspx for a complete overview of initiatives.

[4] The change was introduced in the view that only strong international commitments from main polluting countries such as the US, China and India can lead to an overall stabilisation of CO2 at 450 ppm.

electricity market. As one of the main actors within the electricity market, distribution companies are particularly important because of the imminent needs for infrastructure renewal, the long lasting effects of investment decisions taken and as there are indications that their business models hinders moves towards new electricity sources. However, there is insufficient aggregated knowledge about the current climate change mitigation strategies in the distribution sector going beyond the handling of direct environmental impacts (Salahuddin, 2011). Depending on drivers from the external environment and the internal capacity of firms, companies in the distribution sector may apply environmental strategies ranging from proactive to defensive (Haigh, 2008b). It is not known what those strategies are, how they may influence the future development of low carbon electricity provision services, or how they may affect the interaction within the value chain.

## 1.3 Aim & Research Question

This work aims to show how companies in the distribution sector may engage in efficient and sustainable business activities related to current and future climate change mitigation. The work will be based on an examination of how existing companies are reacting to changes in the institutional and market environment. It will focus on activities that go beyond the management of direct environmental aspects. This study will base analysis on a theoretical framework that provides insights into the rational choices of strategies that organisations can take in response to factors both outside and inside the companies. As such, the work also seeks to deliver emerging strategic approaches that can be considered by distribution companies.

Work towards this aim will be guided by the following research question:

***How can companies, active in distributing electricity in the National Electricity Market in Australia, efficiently, affordably and sustainably react to change related to carbon mitigation?***

Work contributing to delivering answers to this focus question will be supported by two sub-questions:

a) *What sustainable business opportunities appear to be emerging within the sector?*
b) *What carbon mitigation strategies and activities are being undertaken?*

The specific objectives to be achieved in the work and thus contribute to work towards the aim are:

- describe and analyse the Australian electricity market and its recent development;
- delineate current and future policies affecting climate mitigation in the power sector;
- compare stakeholder positions and broader external factors affecting the future development;
- identify sustainable and business opportunities in the distribution sector;
- map and analyse current climate change mitigation strategies and activities in the distribution sector and explain them rationally through with a framework describing strategic responses to institutional and market conditions;
- provide advice on strategic approaches to prepare for change.

## 1.4 Research Methodology

The author utilises existing literature as well as primary data collected during the project. For the literature collection, the databases LibHub, ESCOS, Web of Knowledge and SciVerse were used. Further, information from online sources and web pages was included. Interviews

were conducted with distribution companies (survey), experts with in-depth market knowledge and proponents from stakeholder groups.

### 1.4.1 Finding an Analytical Framework

Frameworks were researched in the above mentioned databases using key words or phrases such as *market opportunities*, strategy, *response to change*, institutions, stakeholders, *environmental management*, change and sustainability, in various combinations. This yielded in items such as institutional theory, stakeholder theory, resource-based view, coalition advocacy framework and innovation frameworks. Analytical elements mentioned in several academic articles were followed up by using the snowballing system of looking up further references indicated in the bibliography section of the articles. In addition, ISI Web of Knowledge was utilised to provide insights into how influential or accepted supporting academic works were. This validation was done by finding out in how many academic papers articles have been cited.

The analytical framework chosen to analyse strategic responses to change is one initially developed by Christine Oliver, an academic based with York University, published in Academic Management Review in 1991. Her work combines aspects of both institutional and resource dependence theories. It has been expanded to include work of later scholars in the same area. The theory helps explain and rationalise the heterogeneous behaviour of companies (even when subject to forces within the same market or context) based on external factors and internal capabilities (see chapter two for further information). In addition, stakeholder salience theory, resource-based view and dynamic capabilities are used to identify potentially beneficial future approaches the distribution companies could apply.

The goal of this paper is not to identify a new sustainability framework for companies but rather to combine existing, well proven and applied frameworks into one structure which is adapted to the general context of Australian power companies and the research question. It is however important to keep in mind that theoretical frameworks always are a simplification of reality and that the actual development of business strategies includes more elements than those mentioned in this paper (Kolk & Pinkse, 2007).

### 1.4.2 Research on the Electricity Market and Distribution Companies

The electricity market was researched in the above mentioned databases with key words and phrases relating to: electricity, Australia, *power industry*, energy, ETS, $CO_2$, *climate mitigation*, ETS, carbon tax, RET, power generation, coal, transmission, retailer, distribution / distributers, generators, electricity, network, climate, policies, *green energy*. Findings were structured according to the PESTEL approach which helps to structure a coherent overview of an industry. The acronym stands for political, economic, social, technological, environmental and legal factors (Gillespie, 2007). The basis of this summary of market factors is provided by the literature reviewed and interviews conducted. Information has been triangulated by stakeholder interviews and literature, respectively. A list of interviews conducted can be found in Appendix A.

Information on current strategic business approaches and current business opportunities of distribution companies was primarily collected through semi-structured interviews with stakeholders in- and outside the electricity sector. For the distribution sector, all companies in the NEM were included in the survey. Of the thirteen companies in the market, eight replied to the survey and are represented through a total of eleven interviews in the analysis. Eight of the eleven interviews with distribution companies were conducted with sustainability managers of the companies and three interviews with managers in the area of Technology Development and/or Demand Management. Ten interviews were conducted by phone while

one company replied in writing to the questionnaire. In all cases, information available online was used to complement the information provided by interviewees. Questions posed to the distribution sector included information about current sustainability strategies and perceived future market environments; they were based on the analytical framework used in order to have a sound and consistent basis for the analysis of the information. The questionnaire is attached in Appendix B. For the analysis, different factors such as size, rural vs. urban network, state or private ownership were taken into consideration. As some of the distribution companies required unattributed interviews, the information regarding the companies is provided anonymously without information being attributed to specific managers or companies.

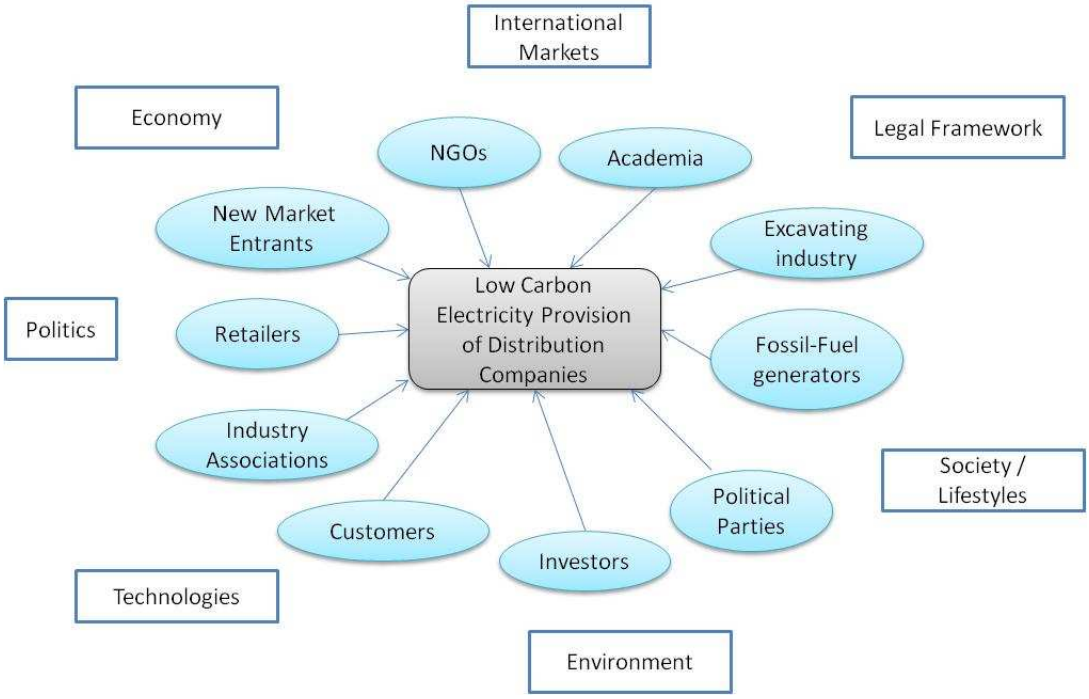


*Figure 1-3: Potential for support and opposition (actors) and drivers or barriers (factors)*
*Source: by the author; starting points included: (Magali Delmas & Toffel, 2004; Kolk & Pinkse, 2007; Mitchell et al., 1997)*

First interviews with stakeholders were conducted according to stakeholders groups identified as important ones by the stakeholder theory. Further interviews were conducted with persons who were indicated as valid contacts by interviewees, online sources or literature researched. Various different stakeholders were interviewed to shape a balanced picture not only of the market itself but to gain insights on possible current and future opportunities seen from different angles. Some of the interviewees, who requested unattributed interviews, are mentioned in an anonymous way. In order to allow for highest possible transparency, the interview date, form and industry is mentioned, however without specification of the actual company or name. Illustration 1-3 provides an overview of identified actors and factors acting as support or constraint to a more sustainable electricity network provision. Of the stakeholder indicated in illustration 1-3 above, a total of 19 semi-structured interviews were conducted including with representatives of the University of NSW, Greenpeace, industry associations, the Australian Energy Regulator, Beyond Zero Emissions, (business) retailers, several consultants and new market players such as Better Place and GreenBox. Additionally, information was retrieved from the Energy User Association's briefing on Climate Change and Energy Efficiency. Unfortunately, the author could not obtain first hand information from the industry association ENA (Energy Network Association) despite several attempts to obtain information via phone and email.

## 1.5 Limitations and Scope

The production of this paper took place between 23 May 2011 and 9 September 2011. Eight weeks of this time were allocated to primary research activities and writing in Sydney, Australia. The focus of this research paper is on Australia and the electricity market analysed is limited to the National Electricity Market (NEM) which incorporates the electricity supply in the states of New South Wales, Queensland, Victoria, South Australia and Tasmania. The other two electricity systems in Western and Northern Australia are not included in this work as they operate independently and under different rules. It is therefore held that this omission does not affect the validity of the work. This report strictly analyses the electricity market without incorporating elements of the interlinked gas market. While the gas market faces many similar challenges such as an aging network, network losses and an uncertain policy future, the potential in renewable generation and demand management differ between the two markets. The author therefore suggests that the gas market can be excluded without significantly affecting the results.

Regarding the value chain of the electricity market, the main elements included range from the electricity generators to retail and end customers, while not explicitly including the fossil-fuels extraction and power plant manufacturing industries. While they are important players potentially influencing policies, pricing of electricity and future developments, their influence is reflected in a general way in the chapter of the electricity market and the PESTEL analysis without addressing the industry in detail. The general focus of this paper lies at the federal level. However, policies are discussed at federal and state-level. The reason is that initial research indicated state policies as important drivers or barriers for business opportunities.

The scope of the survey includes electricity distribution companies only. For the survey of the distribution companies, no interviews could be obtained from companies in Tasmania and ACT. The author judges however that the absence of results from those states has a limited impact due to their small market sized (ACT and Tasmania together account for under six percent of the customer base and just above four percent of the distribution network within the NEM). Results from the survey are analysed in a qualitative way without including statistical information. While most other authors who have applied the same framework used statistical analysis, the author of this report favoured a qualitative analysis, mostly because of the small sample.

The reason for the focus on distribution companies (e.g. not including transmission companies) is given by the project brief of AECOM. Aspects of the transmission sector will be included and taken into consideration as part of the value chain analysis and external aspect by which distribution companies are affected. Within the climate change model the focus lies on mitigation activities (how to reduce $CO_2$ emissions) not incorporating adaptation strategies (how to deal with climate change consequences).[5] This focus potentially limits the scope of the study as many distribution companies do engage in climate change adaptation projects. However as will be shown in the report, climate change adaptation and mitigation are often interlinked with each other.

Other elements only marginally discussed in this paper are the impacts an international agreement on carbon reduction would have on the business models of distribution companies and the specific effect of the carbon tax and future ETS planned for introduction in 2012. Another element not included in detail is the role of the wholesale spot market as driver for demand management solutions. The reason is that this work is mostly based on institutional

[5] According to the IPCC, climate change mitigation refers to the reduction of climate change e.g. through emission reduction while adaptation refers to strategies dealing with climate change which is happening. (IPCC, 2007).

rather than on economic models. As activities in the wholesale market mostly affect the financial results of companies rather than their actual energy efficiency activities, it is held that this omission does not significantly alter the result of this research. Additionally, the author mostly concentrates on distributed generation based on solar and wind, as most reports and research suggest them as major renewable energy sources. However, other options such as carbon capture and storage (CCS) or biomass may play a role in future market development even if they do not feature in most of the fuel-mix scenarios or if they do, only at small scale.

It is important to note that this work has been written in collaboration with AECOM. Some of the background interviews about the industry and electricity market were conducted with climate experts from the same company. AECOM requested a strong focus on the strategic aspects and less so on the electricity system as a whole. Theoretical aspects not included are therefore e.g. innovation systems, cultural and organisational factors and decision making processes within companies. Additionally, an important aspect to keep into consideration is that persons interviewed for the survey potentially provided different angles or information due to their different areas of work, their perspectives, work experience and knowledge levels.

## 1.6 Audience

The main audience for this report are consulting companies providing strategic advice to stakeholders in the electricity sector; particularly in Australia. The author hopes that primary research in a mostly unresearched area of the otherwise well explored power market in Australia may be of general use to them in their work to advising clients. This said, distribution companies in Australia are another target group of this report, with the hope that this report will provide an industry overview in the area of strategic response to climate change mitigation that the companies wouldn't gain otherwise. The report is particularly shaped to fit the needs of AECOM; a global consulting company active in business consulting in Australia. AECOM supported this thesis by hosting the researcher and providing privileged access to companies and market information. In addition, the report aims to provide value to a broader range of stakeholders within the power industry in Australia and the academic research community.

## 1.7 Disposition

In chapter two, the analytical framework is introduced to the reader. This framework provides the foundation for the analysis of strategic activities in chapter seven and the discussion and conclusions in chapter eight and nine, respectively. Chapter three provides information on the National Electricity Market (NEM) in Australia, providing the reader with background information in order to understand the market environment surrounding distribution companies. Chapter four describes institutional elements with a strong focus on policies and regulations in place. Chapter five provides a market overview based on stakeholder opinions, providing insights into institutional and resource dependence aspects not based on coercion but rather on societal norms and cultural aspects. Those insights are summarised through the use of the PESTEL analysis, indicating political, economic, social, technological, environmental and legal factors affecting lower carbon electricity provision strategies. Low(er) carbon electricity provision opportunities for distribution companies are introduced in chapter six with indications on barriers and drivers for those options to become economically viable for distribution companies. Chapter seven provides an overview of carbon mitigation activities currently in place and climate mitigation strategies pursued by the distribution companies surveyed. Besides the analysis of the current situation, this chapter includes starting points for more sustainable business strategies and recommendations on how to engage in sustainable business areas. Chapter eight takes a step back from the actual findings and critically looks at the framework used, the role of market liberalisation and societal norms. A summary of the findings and recommendations as well as conclusions are presented in chapter nine.

# 2 Analytical Framework

The main frameworks chosen for this paper are the institutional theory in combination with the resource dependency theory (RDT) and the resource-based view (RBV). As will be shown later, the institutional framework in combination with the RDT incorporates a very broad area of market elements, stakeholder issues, supply chain and technology-related aspects, which are, according to Kolk & Pinkse (2005), all important strategic aspects that help form business strategies. RBV and dynamic capabilities (DC) will be used to help explain how companies can – based on their individual capabilities and resources available – prepare for changes in the institutional environment. The RBV postulates that a company does not only react to external factors but that the accumulation of internal resources and capabilities lead to competitive positions within the market (Hart, 1995). Dynamic capabilities, an extension of the RBV, postulates the importance of capability adaptation over time in changing environments (Teece et al., 1997). RBV and DC are thereby important elements explaining why *soft* and intangible assets can be important towards successful company strategies (Helfat & Peteraf, 2003).

Due to its importance, and in order to describe and graphically depict stakeholder management, the stakeholder theory – and particularly the theory on stakeholder salience - is explained in more detail in a separate section to provide further insights into external factors of particular interest to management. Additionally, the meaning of the term *sustainable business options* is shortly analysed from a theoretical point of view.

## 2.1 Institutional and Resource Dependence Theory

Institutional theory suggests that companies not only operate according to economic optimisation but as well according to social norms, habits and obligations. By adhering to those norms and values, companies gain legitimacy, capabilities and resources (Oliver, 1997). Several authors indicate that institutional pressure particularly influences companies in periods of uncertainty when procedures are not institutionalised yet (M. A. Delmas & Toffel, 2008).

> *"The basic premise of institutional theory, then, is that firms' tendencies toward conformity with predominant norms, traditions, and social influences in their internal and external environments lead to homogeneity among firms in their structures and activities, and that successful firms are those that gain support and legitimacy by conforming to social pressures." (Oliver, 1997, p. 700)*

Various authors have applied institutional theory to explain business strategies and responses to (institutional) change. In a seminal article, DiMaggio & Powell (1983) argue that institutionalism leads companies to become homogeneous due to coercive, mimetic and normative institutional isomorphism (DiMaggio & Powell, 1983). Along those lines, Delmas & Toffel (2004) indicate that governments, regulators, customers, competitors, communities, environmental interest groups and industry association all apply informal and formal coercive and normative pressures to companies leading to institutional structures being taken for granted even if they do not provide the most efficient market solution. Reasons for this "non-choice" behaviour are habit, convention, convenience, or social obligation (Oliver, 1991).

In a development to the institutional theory and in order to explain heterogeneous behaviour of firms operating under the same market conditions, researches combined the institutional theory with resource dependence theory (RDT). RDT looks at how companies adapt their behaviour according to resources available outside of the organisations; e.g. by other companies or networks (B. L. Johnson, Jr., 1995). The RDT thereby takes the institutional theory one step further, proposing that companies are not only moulded according to institutional influences but can actively shape and react to their external environment (Hagan, 1996).

Several external and institutional aspects around electricity systems are indicated in a 2005 study on the Dutch electricity system and are shown below (Hofman, 2005). Hofman indicates, that those elements are interconnected and aligned to each other through institutionalised coordination (Hofman, 2005).

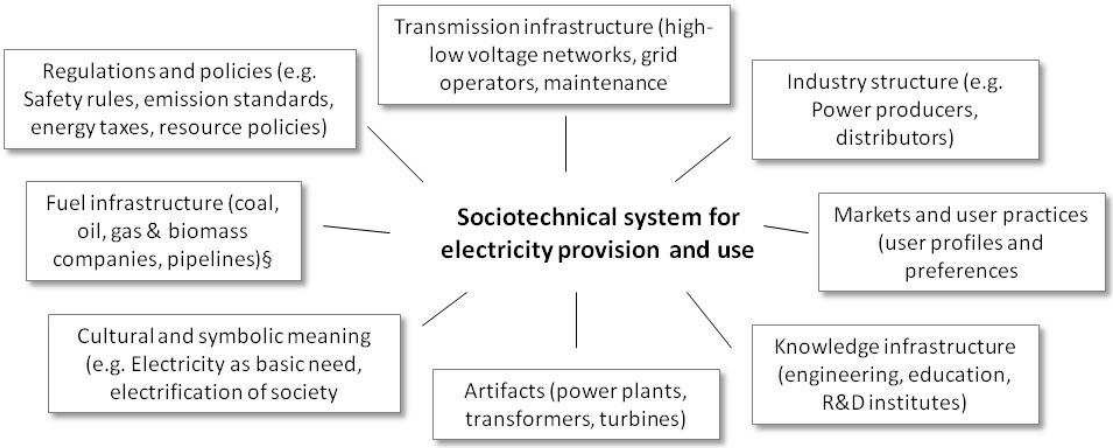


*Figure 2-1: Socio-technical system for electricity provision and use*
*Source: (Hofman, 2005, p. 74)*

Künneke, who looked at electric system liberalising in combination with current technological solutions argues that unequal development of institutional and technological aspects renders electricity systems unstable and potentially leads to lock-in to certain technologies. The reason is that the prevailing technological systems approach with centralised planning, control and operation does not fit the fragmentation of the market caused by liberalisation. According to Künneke, future changes incorporating small-scale or decentralised inputs are hampered by present regulatory regimes that help to maintain the status quo of network governance. New environmental business opportunities in the electricity market may therefore only be possible if technological change goes hand in hand with institutional change (Künneke, 2008).

### 2.1.1 Strategic Response to Institutional Change

According to Oliver (1991), institutional theory in combination with resource dependence theory can explain responses to institutional changes because elements such as resistance, awareness, proactivity, influence and self-interest are taken into consideration as well as the themes of acquiescence and legitimacy seeking in the face of institutional influences found in institutional theory. The framework allows provision of an overview and comparison within an industry sector regarding reactions towards institutional forces while at the same time explaining heterogeneous behaviour through the inclusion of resource dependence theory.

Looking at institutional pressure towards conformity and internal resources and capacities available, she identifies the following typologies companies can follow in the face of institutional change:

| Reactions | Strategy | Description |
|---|---|---|
| Acquiesce | habit, imitate, comply | Mimicking successful companies, align with institutional structures and norms with the aim of enhancing legitimacy and social support |
| Compromise | balance, pacify, bargain | In view of conflicting interests companies can put up some resistance to pressure, however with the main aim of finding a compromise; the goal of the company is to follow the rules while promoting its own interest |
| Avoid | conceal, buffer, escape | Companies attempt to conceal non-conformity, avoid scrutiny or exit a certain industry to avoid control |
| Defy | dismiss, challenge, attack | Resistance to institutional processes, may be used of organisations which have little to loose |
| Manipulate | co-opt, influence, control | Most active response to institutional processes |

*Table 2-1: Reactions to institutional change*
*Source: adapted from: (Oliver, 1991)*

The work by Oliver postulates that such possible courses of action become valid for specific organisations in specific contexts depending on different institutional factors potentially leading to different results in the same industry. Oliver further postulates that the weaker the institutional forces, which provide legitimacy to companies, the higher the chances that companies will show active behaviour not to acquiesce with it. Factors influencing strategic responses are:

| Institutional Factor | Elements |
|---|---|
| *Cause*; why the organisation is pressured | • Perceived legitimacy of cause<br>• Economic efficiency gain perceived by the company |
| *Constituents*; expressing demands | • Multiplicity of stakeholder views / demands<br>• Dependence towards the stakeholders |
| *Content*; describing which norms are under being changed | • Consistency of institutional pressure with company goals<br>• Constraints to the company given by the institutional change |
| *Control*; implementation of institutional changes | • Level of expected coercion for the institutional change<br>• Degree of voluntary diffusion of institutional norms |
| *Context*; business context are the changes to be implemented | • Uncertainty in what can be anticipated and accurately predicted<br>• Interconnectedness of organisations in the organisational field |

*Table 2-2: Factors influencing responses to institutional change*
*Source: adapted from: (Oliver, 1991)*

As shown in table 2-2, companies will according to this theory have a higher prosperity by choosing different strategic responses. Extensions made to Oliver's theory include the addition of activity/passivity[6] level of firms depending on uncertainty of state, size of the company, uncertainty of effect and perception of managerial influence. According to a later work and empirical study by Etherington & Richardson, the five strategies can be split up in three main categories of active negative and active positive reaction as well as passive neutral reaction as shown in figure 2-2 on the next page (Etherington & Richardson, 1994). Empirical studies to test Oliver's postulations and Etherington & Richardson's adaptation and predictions have been conducted across different industries or within industries. Their hypotheses have amongst others been supported by scholars such as Clemens & Douglas (2005). It is important to note that, contrary to Oliver's original framework and according to empirical findings, the manipulation strategy is thereby perceived as a proactive strategy executed within the system.

[6] Active behavior relates to behaviour not in line with the institutionalized processes in place while passive behavior refers to adherence to institutional settings

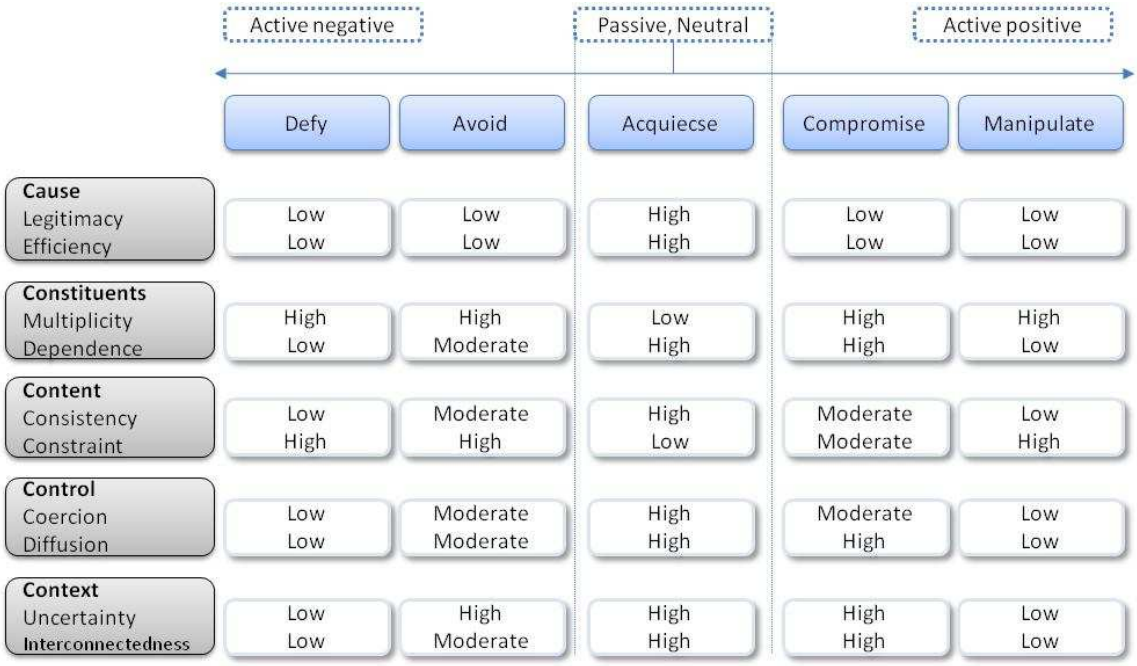


*Figure 2-2: Strategic responses to change*
*Source: adapted from: (Etherington & Richardson, 1994; Oliver, 1991, p. 152)*

Clemens, Bamford & Douglas (2008), who looked at the institutional alignment of activities in regards to emerging environmental policies, found a negative statistical correlation between the size of a company and the level of active behaviour, a higher level of activity for firms operating under high uncertainty, a negative relation between effect uncertainty and active behaviour as well as a positive correlation between perceived influence and more active behaviour (Clemens et al., 2008). In a later work on sustainable competitive advantage, Oliver (1997) writes that both, internal, resource-based capital as well as institutional legitimacy needs to be acquired for a company to be successful.

## 2.2 Resource-Based View and Dynamic Capabilities

The Resource-Based View (RBV) looks at internal resources and capabilities a company has (and needs to establish and nurture) in order to differentiate itself from its competitors and respond to external opportunities and threats. Whilst the differentiation from competitors may not play a big role in the quasi-monopolistic distribution sector, elements important to any industry are the identification of opportunities and threats, potentially affecting the long-term survival and profitability of companies.

Within RBV, resources are defined as including "all assets, capabilities, organisational processes, firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of an implement strategies that improve its efficiency and effectiveness" (Barney, 1991, p. 101). Resources can be divided into human, physical and organisational capital. For firm resources to become valuable and lead to a competitive advantage, they must be valuable, rare, not possible to imitate and without direct substitutes (Barney, 1991). RBV, in contrast to the institutional theory or the often applied five-forces theory provided by Michael Porter (Michael E. Porter, 1996) helps explain why different businesses in the same industry, operating under the same conditions choose to have different business strategies to gain market advantages.

The resource based view has been adapted and further developed by several scholars to incorporate the important element of development of strategies over time, given changes in

the external environment (e.g. technology) of companies. One limitation of the RBV identified by Teece et al. (1997) is its focus on existing company resources and capabilities but its failure to explain how new capabilities are built. The dynamic capability theory therefore proposes that companies can gain advantages in the market through high-performing internal processes and positions (i.e. dynamic capabilities) that allow to reconfiguring operational capabilities and resources. According to Helfat & Peteraf (2003), capabilities undergo lifecycles similar to products which a company needs to manage and develop. Additionally, several authors propose that not only adaption itself but the capability for learning is crucial in a changing environment (Ambrosini, Bowman, & Collier, 2009). Combining the institutional theory with the resource based view can therefore provide further valuable insights into strategic responses as e.g. postulated by Oliver herself in a 1997 article in the Strategic Management Journal (Oliver, 1997). This combined framework has been applied in the area of strategic response to climate change in the electric industry in Australia.by Haigh( 2008a). A visual overview of the various elements is provided in Appendix C.

## 2.3 Stakeholder Salience

In the broadest sense, stakeholders are actors- individual or groups - which affect the company in one way or the other or are affected by the actions of a company. It is often the managers of a company who need to decide which stakeholders need to be addressed in which way (Mitchell et al., 1997). Stakeholders can be community groups, financiers, environmentalists, customers, employees, competitors, suppliers, regulators or the natural environment and typically cannot be attended with the same strategy due to limited resources and management attentions. (Haigh & Griffi, 2009; Kolk & Pinkse, 2007). According to Mitchell et al. (1997), the two questions a company needs to be aware of therefore are who the stakeholders are and to whom a company needs to pay attention. According to Mitchell et al. various theoretical approaches including behavioural, ecological, institutional and resource dependence theories cannot explain how to best manage stakeholders as a firm. Instead, the authors suggest that the salience of stakeholders is defined according to their varying degree of power, legitimacy and urgency. The importance of stakeholder dependence on the combination of attributes and is highest if all three attributes are present as shown below:

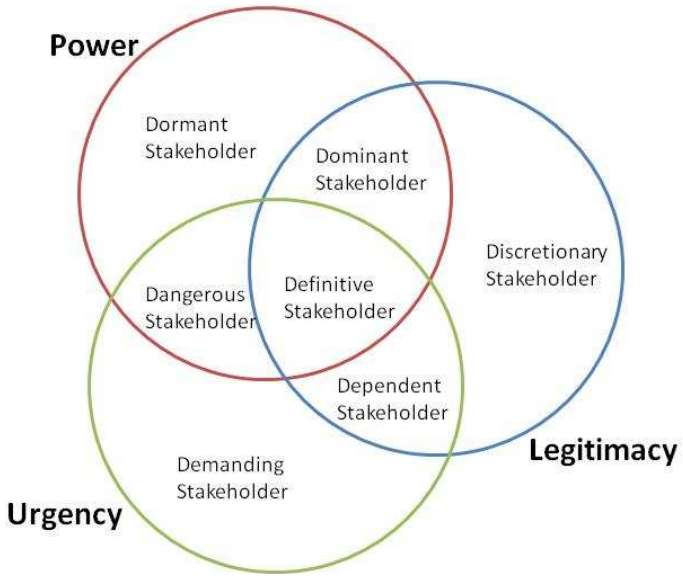


*Figure 2-3: Stakeholder salience;*
*Source: adapted from: (Mitchell et al., 1997, p. 874)*

Stakeholders can move towards becoming Definitive Stakeholders by building coalitions, being political active or by influencing society and thereby intent to influence the strategy of companies. The important lessons for companies in this theory and applied to this work are

that stakeholders are dynamic, can vary according to different issues and can change over time. Managers therefore need to map stakeholder positions and development and adapt strategies accordingly over time (Mitchell, et al., 1997). Stakeholders can be managed by companies according to their urgency, power and legitimacy and valence towards the company. In their analysis of the sustainability of the French nuclear industry, Banerjee & Bonnefous (2010) indicate that the industry can apply reinforcement strategies for supportive stakeholders, containment strategies for opposing stakeholders and stabilisation strategies for dormant stakeholders (Banerjee & Bonnefous, 2010). In regards to climate change impact, Kolk & Pinkse (2007) write that the government is the most important stakeholder for most companies; e.g. through emission reduction requirements, carbon tax, emission trading schemes or technology-oriented measures. Other salient stakeholders include NGOs, investors, customers and competitors (Kolk & Pinkse, 2007).

It is important to note that the framework introduced here is not undisputed particularly if applied to sustainability topics. While applied by some authors such as Esty & Winston in their book "Green to Gold**:** How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage" (Esty & Winston, 2006 as cited in Clifton & Amran, 2011) other authors point out its limitations in regards to identify crucial sustainability issues (Clifton & Amran, 2011). Authors such as Banerjee and Bonnefus (see previous paragraph) propose to adapt the framework accounting for their assumption that strategies are not only based on legitimacy, power and urgency but as well on positive, neutral or negative stakeholder perception of the management (Banerjee & Bonnefous, 2010).

## 2.4 Definition and Viability of Sustainable Business Scenarios

One of the broadest and most widely used definitions of sustainability is the one of the Brundtland Commission (officially the World Commission on Environment and Development) which defined sustainability in 1987 as "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. chapter 2). The concept of sustainability is used in many different ways and is depicted differently in various forms. The World Conservation Union suggests the use of three interconnected circles to indicate that the three spheres of environment, society and economy overlap and influence each other (W. M. Adams, 2006).

For the purpose of this work, the term sustainability will be used in a broad sense, in order not to omit potential pathways to a lower carbon intensive provision of electricity. According to Porter & Reinhardt (2007), sustainable business opportunities need to be in any case looked upon as vital strategic decisions. This approach reflects the opinion of many contemporary scholars, that it is absolutely crucial for companies to treat environmental management like any other business relevant opportunity or threat (Magali Delmas & Toffel, 2004; Escobar & Vredenburg, 2011; Haigh & Griffi, 2009; Oliver, 1997; M. E. Porter & Reinhardt, 2007).

Besides costs reductions and profit, drivers for climate change mitigation activities can be credibility enhancement, risk management, ethical considerations, positioning for or in response to market shifts, pressures from regulation and directives, investor pressure, and / or change in technologies (Okereke, 2008). Delmas, Hoffman & Kuss (2011) found in their work that drivers to the implementation of sustainable business opportunities are mostly external stakeholders such as regulators, customers and NGOs and much less internal organisational capabilities. Internal capabilities and resources are however needed to absorb the external knowledge and gain a competitive advantage e.g. through environmental reporting, operational improvements, organisational changes or a proactive stand towards regulations (M Delmas et al., 2011).

# 3 The National Electricity Market (NEM) in Australia

The NEM includes the States of NSW, VIC, ACT, TAS, SA and QLD. Western Australia and the Northern Territory have separate markets due to their remote location. The market in Western Australia, the Wholesales Electricity Market (WEM) operates in the South-West Interconnected System (SWIS). Electricity in the Northern Territory is supplied by a government-owned electricity utility. Total capacity installed amounts to almost 51 GW on-grid and five GW off-grid. The transmission and distribution networks comprise approximately 895 000 km (ESAA, 2010a). The electricity produced by generators within the NEM (as well as the one within the WEM) is sold on a wholesale market. A particular challenge in Australia's electricity market is the small demand of about 30 GW combined with a very wide geographic span of the system which spreads over 4000 km for the NEM alone. (AEMO, 2010b). The following sections will describe the largest market area, the NEM in more detail and give an overview of the market itself, institutional aspects, the value chain as well as stakeholders and technologies.

Historically, the electricity system started in the NEM consisted of local systems in the different states with many different electricity and gas providers. In the 1930s the states took over control of the electricity system with liberalisation and desegregation efforts starting under the Labor government in the 1990s (D. Adams, 2011). The process was mostly finalised by 2006 with a fully functioning wholesale spot market. Elements that were changed during liberalisation include the disaggregation and partial privatisation of the supply industry, the introduction of the National Electricity Market NEM in 1998, a new policy framework for the same market and the elimination of retail franchise (Outhred & MacGill, 2006).

Today, the market contains five regional pools: VIC12 (Victoria), NSW1 (NSW), QLD1 (QLD), SA1 (SA), SNOWY1 (Snowy Mountains Hydroelectric power generation) and TAS1 (TAS). Those areas are linked with each other through physical interconnectors linking QLD with NSW, NSW with VIC, VIC with SA and VIC with TAS. The system works in such a way that the cheapest bids are brought online first, while higher priced supply only receives dispatch orders with increasing demand. Dispatch periods are five minutes intervals and wholesale prices (the price generators receive) are calculated on a 30 minutes average. Prices can range from AUD -1000 to AUD 12500 per MWh (I1, 2011). Besides price, other factors influencing the dispatch order are congestion in transmission networks (particularly between states) and ramp-up times[7] for power plants. The most expensive generating plant determines the price of all electricity in the grid for the given trading period. The network operator AEMO matches demand and supply on a half-hourly basis (AEMO, 2010d; Skoufa & Tamaschke, 2011; Stuart, Ramiah, Mitchell, & Heaney, 2011). The majority of the electricity is sold to energy retailers which "bundle electricity with network services for sale to residential, commercial and industrial energy users" (Australian Energy Regulator, 2010, p. 19). The network consists of approximately 200 large generators, five transmission networks owned by the states and 13 large distribution networks, supplying end users with energy. Interconnectors between the states can be both, governmentally and privately owned. (Australian Energy Regulator, 2010). Figure 3-1 on the next page provides key data of the market.

NSW with 38% of production output and QLD with 25% of electricity supplied account for the majority of electricity production within the NEM mostly generated from black coal. Approximately 25% of electricity is produced by brown coal in VIC. SA provides approximately 6.5% and TAS 4% of the electricity used in the market. South Australia

[7] The time needed for a power plant to get on-grid

contributes to the electricity generation mostly with natural gas while electricity produced in Tasmania is predominantly supplied by hydroelectricity (Wileya et al., 2011).

| | |
|---|---|
| Participating jurisdictions | Qld, NSW, Vic, SA, Tas, ACT |
| Regions | Qld, NSW, Vic, SA, Tas |
| Registered capacity | 49 010 MW |
| Registered generators | 299 |
| Customers | 8.9 million |
| Turnover 2009–10 | $9.6 billion |
| Total energy generated 2009–10 | 206 TWh |
| Maximum winter demand 2009–10 | 32 274 MW |
| Maximum summer demand 2009–10 | 33 758 MW |

*Figure 3-1: The NEM at a glance*
*Source: (Australian Energy Regulator, 2010, p. 19)*

While Australian's power generation mostly stems from coal, "with around 81% of all output being produced by black and brown coal-fired generators, only 58% of Australian Power generation capacity is coal-fired" (Nelson, Kelley, Orton, & Simshauser, 2010, p. 450). The reason for this difference is that electricity cannot be stored, which means that some power plants are used for very short periods of time. The illustration below shows the outputs and capacities installed, respectively. Wind power, contributing to approximately 20% of the energy mix in SA is controlled by the AEMO who can reduce the output of wind turbines in case the network is rendered unstable by volatile wind energy (Australian Energy Regulator, 2010).

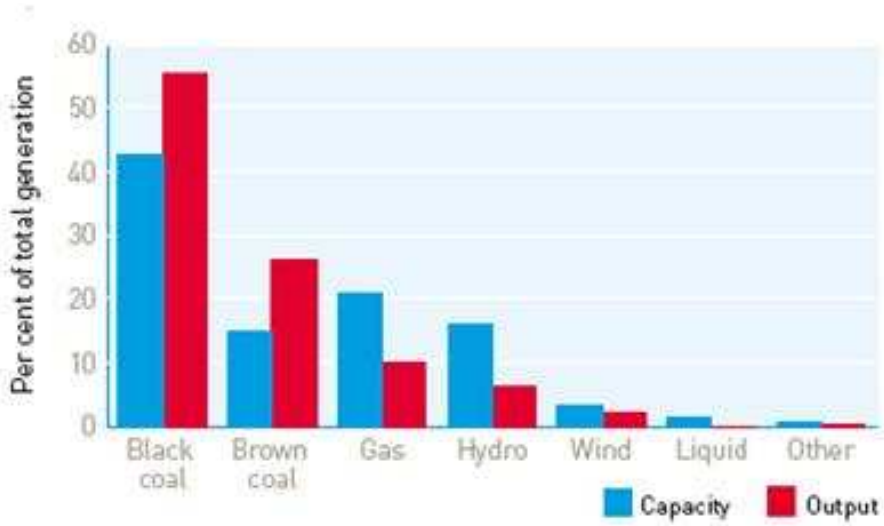


*Figure 3-2: Total installed generation capacity and electricity generation in 2010*
*Source: (Australian Energy Regulator, 2010, p. 21)*

Base-load requirements are mostly met through black and brown coal power plants that have a slow start-up and shut down time and low marginal costs per MWh produced. Those plants run at 75% - 90% of their capacities. Intermediate or daytime demand is met by adding plant with more flexible operating capacity to the grid such as combined cycle gas turbines (CCGT). Those plants operate at 40% - 60% of their capacity rates and have higher marginal

operational costs. Peak demand is mostly covered by plants with low capital costs but high operating costs such as open cycle gas turbines (OCGT) or hydro power. Their capacity utilisation rates are between 5% - 30% annually. (Nelson et al., 2010). Demand is estimated to increase significantly in the next few years, with peak demand currently increasing at a faster growth rate than base-load demand (Australian Energy Regulator, 2010; Nelson et al., 2010).

The electricity consumption is divided into residential use, commercial, industrial (metals, aluminium smelting, mining, manufacturing), transport & storage and agriculture. Figure 3-3 below indicates the percentage uses in 2009-10.

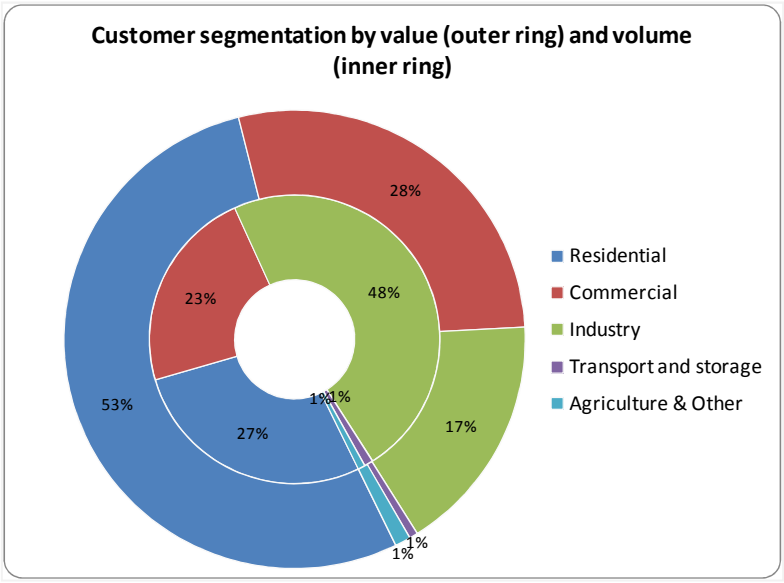


*Figure 3-3: End customers for electricity in 2009-10*
*Source: adapted from: (Datamonitor, 2009; ESAA, 2010c)*

## 3.1 The Networks: Transmission and Distribution

Transmission and Distribution (T&D) are regulated by the Australian Energy Regulator (AER). AER sets the maximum revenue that network service providers can earn during a regulatory period of five years. Currently, network revenues and prices are used to determine this revenue cap; however, the Australian Energy Market Commission (AEMC) proposed the use of a factor productivity approach in a 2010 draft report. This new approach would measure how network service providers use their resources to provide output, linking company revenues to industry performance, thereby increasing the competitiveness and efficiency in the industry. Investment forecasts of capital expenditure for the individual companies have to be approved by the AER at the beginning of regulatory periods. Drivers for such investments are increased licensing controls, obligation in regards to network security, safety and reliability, market growth and increased peak demand, new connections, replacement of old assets often stemming from 1950-1970, climate change policies and the move towards a smart grid (Australian Energy Regulator, 2010).

The NEM features five high-voltage transmission networks (normally voltage above 220kV, in some cases down to 66kV): Powerlink in QLD, TransGrid in NSW, SP AusNet in VIC, ElectraNET in SA and Transend in TAS. Those transmission networks are mostly owned by the respective state governments, with the exception of the SP AusNet where Singapore Power International owns 51% of the shares. This private ownership is possible through the separation of ownership from planning and investment decision making. ElectraNet in SA is

owned jointly by the Queensland government, YTL Power Investment and Hastings Utilities Trust. An overview is provided in table 3-1 on the next page.

| Network | State | Line length | Electricity transmitted 2008-9 | Owner |
|---|---|---|---|---|
| Powerlink | QLD | 13 106 | 49 104 | Qld Government |
| TransGrid | NSW | 12 445 | 75 744 | NSW Government |
| SP AusNet | VIC | 6 553 | 51 777 | Publicly listed (Singapore Power Int. 51%) |
| ElectraNet | SA | 5 589 | 13 327 | Powerlink (Qld Government), YTL Power Investment, Hastings Utilities Trust |
| Transend | TAS | 3 650 | 11 031 | TAS Government |

*Table 3-1: Overview of transmission companies*
*Sources: adapted from: (Australian Energy Regulator, 2010, p. 50)*

Those networks are connected to each other via interconnectors consisting of Directline linking QLD with NSW, MurrayLink, connecting VIC with SA and Basslink joining VIC and TAS. While those three interconnectors are privately owned, three further connectors are owned by the state-based network: Heywood (VIC – SA), QNI (QLD – NSW) and Snowy-VIC. The total length of the transmission network is approximately 44 000 km (Australian Energy Regulator, 2010). The capacities of those interconnectors are in the area of a few hundred MW each. While QLD and VIC both have extensive base-load capacities and are net exporter of electricity, NSW, TAS and SA are net importers. NSW particularly relies on imported electricity to cover peak demand while SA is increasing its capacity mostly with wind. TAS, heavily relying on hydro power, has been importing mainly due to drought in the state (Australian Energy Regulator, 2010).

| Distribution Network | State | Customer numbers | Line length / km | Owner |
|---|---|---|---|---|
| Energex | Qld | 1 256 574 | 52 361 | Qld Government |
| Ergon | Qld | 636 480 | 145 904 | Qld Government |
| Energy Australia | NSW | 1 591 372 | 49 546 | NSW Government |
| Endevour Energy (former Integral Energy) | NSW | 859 718 | 33 579 | NSW Government |
| Essential Energy (former Country Energy) | NSW | 786 241 | 189 823 | NSW Government |
| ActewAGL | ACT | 161 061 | 4 795 | ACTEW Corporation (50% ACT government, 50% Jemena) |
| Powercor | Vic | 698 509 | 83 468 | Cheung Kong Infrastructure 51%, Spark Infrastructure 49% |
| SP AusNet | Vic | 609 855 | 47 999 | SPAus Net, (Singapore Power Int. 51%) |
| United Energy | Vic | 620 300 | 12 707 | Jemena (Singapore Power Int. 34%, DUET Group 66%) |
| CitiPower | Vic | 304 957 | 6 478 | Cheung Kong Infrastructure 51%, Spark Infrastructure 49% |
| Jemena | Vic | 303 245 | 5 928 | Jemena (Singapore Power Int.) |
| ETSA Utilities | SA | 807 500 | 86 634 | Cheung Kong Infrastructure 51%, Spark Infrastructure 49% |
| Aurora | TAS | 269 554 | 25 050 | TAS Government |

*Table 3-2: Overview distribution companies*
*Source: adapted from: (Australian Energy Regulator, 2010, p. 49)*

The medium- and low-voltage distribution sector (normally up to 66kV, in some cases up to 220kV) includes 13 major networks, with QLD, NSW and VIC featuring several networks in the same state. However, for every given area, distribution service providers act as de-facto monopolies. The distribution networks have a total length of 750 000 km. The distribution

networks in VIC are privately owned by Cheung Kong Infrastructures (Powercor and CitiPower). The same company has leased the SA distribution network ETSA Utilities for a time period of 200 years. In Victoria, Singapore Power International owns Jemena distribution and has stakes in the United Energy distribution network. Additionally, the company owns 50% of the ACT network ActewAGL. All network infrastructures in NSW, QLD and TAS is owned by the respective government (Australian Energy Regulator, 2008, 2010). Appendix D provides a complete overview of the companies which are active in the distribution sector.

Distribution companies are expected to invest AUD 200 million per year and company in network augmentation. In order to incentivise efficient operation and maintenance, the AER has an incentive schemes that allows the network operators to retain revenues from efficiency gains (or contrary losses) for five years after the gain / loss has incurred (Australian Energy Regulator, 2010). Urgent network issues are indicated in the table below.

| State | Network issues |
|---|---|
| **Queensland** | Capital requirements due to<br>- Population growth<br>- New connections<br>- Industrial demand<br>- Rising energy use per customer<br>- Performance improvement required (reliability standards |
| **South Australia** | Significant investments required:<br>- Rising market<br>- Increasing peak demand (air conditioners during summer)<br>- Improve reliability risk (aging assets)<br>- New reliability standards for Adelaide |
| **Victoria** | Comparatively reliable<br>- Replace aging infrastructure<br>- Address new bushfire safety standards<br>- Maintain reliability under growing demand and with increasing costs |

*Table 3-3: Network issues in the different states*
*Source: (Australian Energy Regulator, 2010)*

While transmission companies won't be the focus of this topic, more detailed information of this part of the electricity supply chain is provided in Appendix E.

## 3.2 Generators

In 2009, approximately 1 800 MW new power generation capacity was commissioned; this in comparison to a capacity increase of 2 500 MW in 2008. Over 50% of the new investments were gas-fired plants built in Queensland.[8] One of the largest projects commissioned was the Darling Downs 605 MW power plant built by Origin. From a sustainability point of view, wind capacity has been increased significantly, particularly in SA where about 20% of the capacity stems from wind. New capacity that companies have committed to amounts to 1 200 MW with Origin Energy's Mortlake power plant, a 518 MW gas-fired facility in Victoria being the most significant project. A full overview of generator capacity, ownerships and planned projects is provided in Appendix F (Australian Energy Regulator, 2010).

Because of the volatile spot market prices, generators that are not integrated (including both retail and power generation), normally protect themselves against market risks through

[8] Australia has relatively large resources of natural gas, with the industry having experienced rapid growth in the last decades. Most of the gas is currently exploited in northwest Australia; however newer gas fields have been have been located offshore in southern Victoria. Additional coal seam gas is extracted from sources in Queensland and NSW (Roarty, 2008).

hedging. Financial hedging is used to establish a fixed price between buyer and seller; in case the market price is above or below the agreed price, the parties are obliged to pay the difference to the market price agreed (AEMO, 2010b; I1, 2011).

In Victoria and SA, generators are mostly privately owned and include e.g. AGL Energy, International Power, TRUenergy, Great Energy Alliance Corporate (belonging to 35% to AGL), Alinta Energy and Origin Energy. In the Snowy Mountain area, Snowy Hydro is the main generator with 20% belonging to the Victorian government. NSW privatised its generation in 2010 and sold its assets to TRUenergy. Queensland has a mixed of state owned and private generators including the Gladstone and Collinsville power station, Joint ventures such as Tarong North and Callide C power stations, Origin Energy, InterGen, AGL Energy, Alinta and Arrow Energy. Tasmania's generators Hydro Tasmania and Aurora Energy Tamar Valley are state owned (Australian Energy Regulator, 2010).

Generators connected to the NEM are required to pay the feed-in connection to the nearest grid connection (node). The disadvantage with this system is according to Betz & Owen that "this approach discourages a socially optimal level of investment in transmission, since initial capacity will be financed solely by the initial investor and would ignore future system expansion" (Betz & Owen, 2010, p. 4970). Another problem for remotely placed renewable generators is the 'first mover disadvantage' with the first generator having to cover the full costs for the transmission line (Diesendorf, 2011).

## 3.3 Retail

The retail market in NEM is very competitive, except for TAS where the prices are still regulated by the state.[9] Victoria with a customer switching rate of almost 25%, is one of the most active markets worldwide (I2, 2011). All states except Victoria apply retail price regulations to regulate market prices (Australian Energy Regulator, 2010; Switch Wise).

The leading retailers in Queensland are Origin Energy, AGL Energy and Integral Energy. Ergon Energy (providing network service as well) is owned by the government and retails electricity in rural areas at regulated prices. This company is not permitted to compete for new customers. In NWS, TRUenergy (former EnergyAustralia), Integral Energy and Country Energy have a joint market share of over 80% for small customers. Eight new (niche) suppliers have recently entered the market. Active retailers in Victoria include besides others AGL Energy, Origin Energy and TRUenergy as well as eleven newcomers to the market. In SA, AGL Energy's market share has dropped from 79% in 2005 to 53% in 2009. Aurora Energy supplies residential customers in TAS. In ACT ActewAGL had a market share of 93% in 2009. The three largest players together, AGL, Origin and TRUenergy supply around 80% of the electricity market (Australian Energy Regulator, 2010; Switch Wise). Appendix G gives a coherent overview of retailers in the NEM.

The retail market value has been growing with an average rate of 7.4% between 2005 and 2009. In the same time, the actual market volume increased with 1% (-7.8% in 2009 due to the global financial crisis). The most profitable area for retailers is residential electricity supply (Datamonitor, 2009). According to Chris Parrat from ERM Retail, low margins in the retailer market can partially be explained by very high competitive pressure at the beginning of the market liberalisation, when large customers used high level of competition to push down prices through contract agreements. As some retailers went out of business during the first few years after market liberalisation, competition is not as strong any more but still

[9] The system in TAS is currently changing, with customers using more than 150 MWh being contestable and with small businesses (> 50 MWh) becoming the same in 2011.

considerably high. Margins for small customers have increased while large customers still benefit from low margins. Attempts to focus more on services and thereby increase margins have failed with retailers perceiving low customer interest and a strong focus on low price (Parratt, 2011). In the NEM, many retailers focus therefore their business model on risk management by operating in the wholesale market. A limited focus is given to other customers services (O'Reilly, 2011).

## 3.4 Across the Supply Chain and States

The electricity market is strongly vertically integrated with AGL Energy, Origin Energy, TRUenergy and International Power all playing significant roles in electricity generation and retail. Not only private companies are integrated; this also extends to the public electricity sector e.g. with Snowy Hydro owning Red Energy or Hydro Tasmania owning Momentum Energy. Various companies also have stakes in the gas network or other business activities such as telecommunication, and these are sometimes bundled into customer offers. Illustration 3-4 below indicates how the costs of energy supply are distributed among the supply chain (Australian Energy Regulator, 2010).

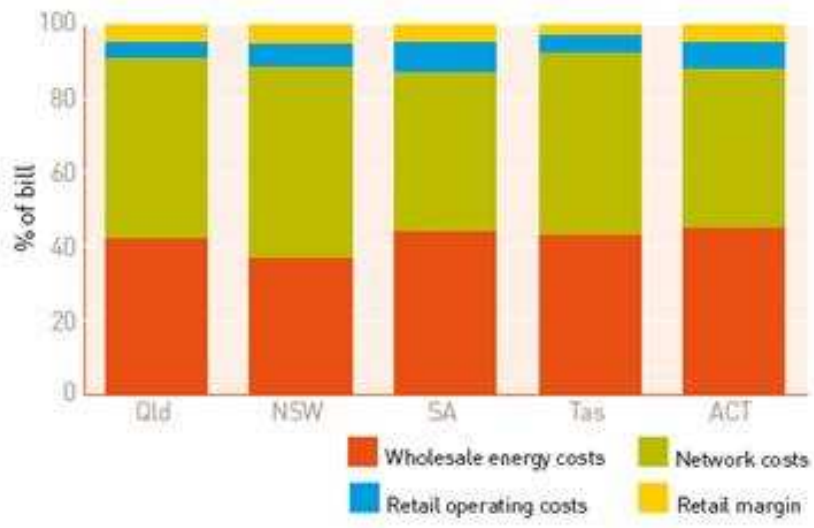


*Figure 3-4: Composition of residential electricity bills, 2010*
*Source: (Australian Energy Regulator, 2010, p. 13)*

Electricity prices in the different states vary depending on the different regulations in place and the competition given. Even under the same conditions, prices can differ as the inter-state electricity trade is limited by the physical limits of the interconnectors linking the different areas with each other (AEMO, 2010b). In 2008, the average cost of a kWh was around 13 cents AUD (ACIL Tasman, 2008).

Besides considerable differences in electricity wholesale prices, network charges can be different from state to state. One industry example provided by Phil Watts, the Group Procurement Manager of Boral,[10] at the Climate Change and Energy Efficiency Briefing of the Energy User Association of Australia is shown in graph 3-5 on the next page. According to Watts, the reasons for those differing prices are often not transparent for large customers such as Boral (P. Watts, 2011, p. 7).

[10] Boral is an international cement and lime production company and Australia's largest construction and building material provider

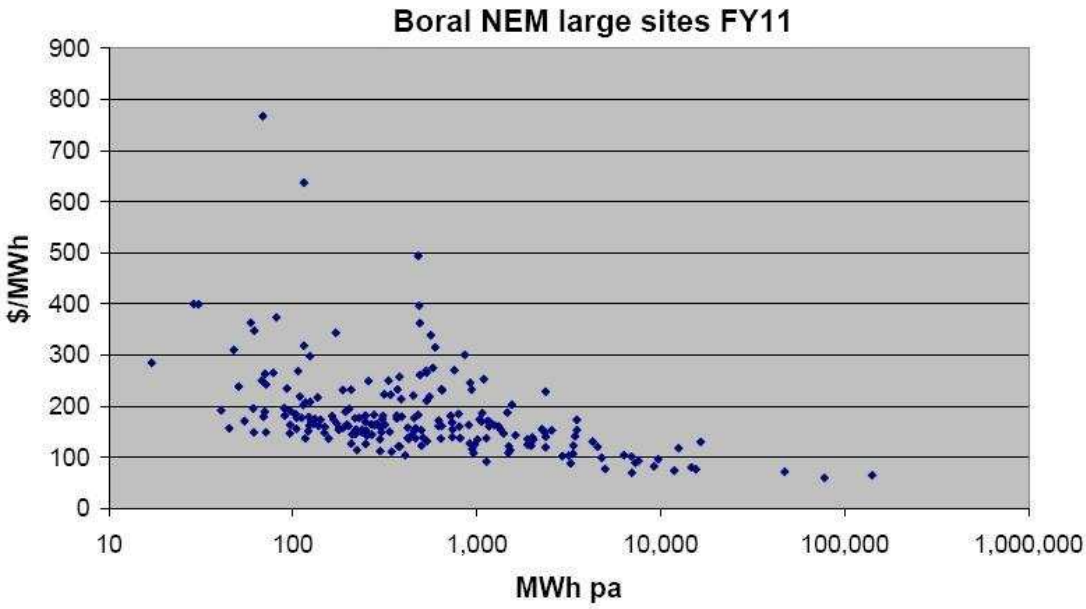


*Figure 3-5: Network charges for large industrial sites based on the example of Boral*
*Source: (P. Watts, 2011, p. 7)*

Distribution companies normally provide retailers with a bulk bill for network charges which are then broken down to an individual customer level. Retailers are normally the companies in closest contact to customers. According to the regulatory set-up, they have direct access to customer and *own* them (Barnes, 2011).

# 4 Market Regulations and Policies

Since 2009, the NEM has been regulated by the Australian Energy Market Organisation AEMO,[11] that overviews the wholesale market and dispatches supply orders to generators. The organisation oversees and balances the security, quality, price and reliability of electricity and the grid. Additionally, it is responsible for the transmission planning. AEMO is 60% governmentally owned while 40% belong to industry members (AEMO, 2010d). The Australian Energy Regulator, that is part of the Australian Competition and Consumer Commission ACCC, regulates the "terms and conditions on which competing businesses can gain access to transmission wires and pipelines, and constrains monopoly pricing" (ACCC, 2000).

The Australian Government has several policies in place affecting the electricity industry with a commitment to a 5% reduction until 2020 compared to 2000 level.

## 4.1 National GHG Emissions Reporting Act (NGER)

In 2007, the government introduced the NGER Act obliging companies to quantify their greenhouse gas emissions and report them to the Federal Government. The legislation aims at increasing the knowledge of the government on GHG emissions, informing the public and meeting Australia's international obligations for the Kyoto protocol. The NGER is seen as a first step and basis for the planned carbon tax and emission trading scheme (Australian Government, 2011a).

Reporting is divided in scope one; direct emissions from business activities, scope two; consumption of electricity that is not produced at the premises and scope three; indirect emissions outside the facility boundary such as air travel or waste. Scope three emissions are voluntary to report while scope one and two must be reported by companies. The first year of reporting was 2008/9 (Department of Climate Change and Energy Efficiency). All the distribution companies in the NEM are reporting their emissions according to NGER and many perceive this policy as the main regulatory framework in place affecting the companies' activities in the area of carbon mitigation.[12]

## 4.2 Renewable Energy Target RET

A Mandatory Renewable Energy Target (MRET) was introduced by the national government in 2001. In 2009, this program was followed by the Renewable Energy Target (RET) which was revised in 2010 to be split up in two components: the small scale renewable energy scheme (SRES) and the large scale renewable energy target (LRET). The goal of the policy is to achieve 20% sustainable energy supply by 2020 through the use of renewable energy certificates (REC) and by obliging electricity retailers to purchase a given amount of certificates each year. One REC is equivalent to 1 MWh. Certificates are provided either for the generation of renewable energy (built after 1997) or by displacing electricity by using solar water heaters or heat pumps. The SRES features fixed prices and unlimited quantities while the LRET has floating prices and is based on a structure with fixed quantities, available to large scale renewable power generation. The price of a Small-Scale Technology Certificate (STC) was AUD 26 at the end of August 2011 while the price of a Large-Scale Generation Certificate (LGC) was equivalent to AUD 37 at the same time (Green Energy Trading, 2011).

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[11] Previous separate entities included: NEMMCO; VENCorp, ESIPC, REMCO, GMX and GMRO

[12] The treshholds for reporting are 1) 50 kilotonnes or more of GHG emissions within one financial year; 2) 200 terrajoules or more energy production per financial year; 3) 200 terrajoules or more energy used for operations per financial year (Department of Climate Change and Energy Efficiency)

The requirement for sustainable energy sources increases annually by 13% until 2020 with an expected total of 45 TWh stemming from renewable energy. In 2010, 12 TWh electricity were supplied by renewable sources and renewable assets had a value of approximately AUD 9 billion (ORER, 2011). An overview of distribution of RET investments according to fuels is provided in figures 4-1 below. The compulsory additional capacity for 2011 amounts to just below 15 TWh. The Australian Energy Market Commission estimates that the RET will lead to around eight GW of new renewable capacity installed until 2020 with most of it wind powered generation. Those new resources are likely to be clustered in geographically favourable locations remote to the currently installed transmission and distribution network (AEMC, 2009).

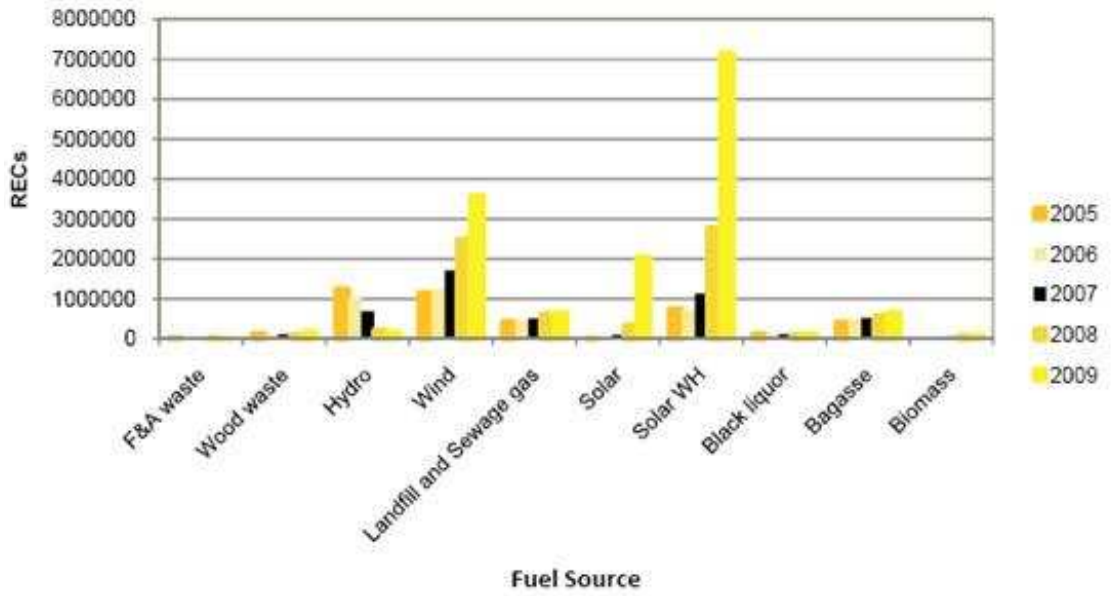


*Figure 4-1: Renewable energy certificates by fuel sources*
*RECs: renewable energy certificates traded; each equivalent to 1MWh*
*Source: (AEMO, 2010a, p. 12)*

According to AEMO, wind, solar, photovoltaic, geothermal and wave technologies have the highest potential in Australia due to available technologies and the vast availability of solar and wind. However, solar presently has high costs, particularly in comparison to wind power. Geothermal and wave technologies are both immature technologies with very high costs. Biomass technology is viewed to have limited potential by the AEMO due to its limited scale[13] (AEMO, 2010a, p. 12).

While the RET is seen as the main driver for the instalment of new renewable energy sources, the scheme has received criticism in different areas (D. Adams, 2011; Buckman & Diesendorf, 2010; Valentine, 2010):

- waste coal seam gas is included as eligible source as the government assumed that an ETS would be introduced in parallel with the RET;
- the duration of the program is only until 2020, in expectation of an ETS to be fully in place and stable enough to run by itself from 2020 onwards;

[13] The potential of sustainable biomass and its use is highly disputed in Australia with many environmental organisations fearing the loss of native forest; however some studies show that particularly second generation biomass has the potential to improve soil quality and provide cheap, fast growing biomass. A major limitation for biomass can be drought conditions (Diesendorf, 2011).

- small scale electricity generator inputs are counted according to a multiplier system which limits the total amount of projects;
- the cap of the system may limit investments;
- the inclusion of non-electrical solar and water heat pumps in the certification system;
- the RET does not promote a wide range of different renewable energy sources;
- it probably won't achieve the 20% renewable electricity supply targeted by 2020.

The RET scheme is complemented by other policies supporting the introduction of renewable energy. One of the largest programs introduced in the next section is the Clean Energy Initiative (CEI).

## 4.3 Clean Energy Initiative and Other Programs

The Australian Government has allocated AUD 5.1 billion to the Clean Energy Initiative (CEI) which includes the following elements (DCCEE, 2011):

| Initiative | Description |
|---|---|
| Smart Grid, Smart City | An AUD 100 million demonstration / trial project including a consortium of companies such as IBM, AGL, Transgrid, Newcastle City Council and the NSW state government (ENA, 2010a) |
| Carbon Capture and Storage (CCS) Flagship Program | An AUD 1.68 billion project; the program aims to accelerate CCS development and will support two to four test facilities with a power production of one GW each. |
| Solar Flagships Program | An AUD 1.5 billion project, the funding will be used to develop large-scale on-grid solar power stations with the aim to establish one GW of solar power. |
| Australian Solar Institute | A research Institute in the field of solar / photovoltaic energy production |
| Australian Centre for Renewable Energy | Investing over AUD 560 million towards renewable energy research including second generation biofuels, wind energy forecasting capabilities and advanced electricity storage |

*Table 4-1: Clean Energy Initiatives*
*Source: (DCCEE, 2011)*

Other programs the Australian Government is currently undertaking to reduce emissions are (DCCEE, 2011):

- Clean Business Australia, a fund mostly for small and medium sized companies to increase their actions on climate;
- Low Carbon Australia, including two innovation programs, one on energy efficiency and one on carbon neutral products;
- Renewable Energy Bonus supporting households to purchase solar panels and / or energy pumps.

## 4.4 GreenPower

The GreenPower government program is a voluntary purchase program for customers to buy electricity from renewable resources. The program has been jointly initiated by all Australian states except Tasmania (where electricity is government regulated and the grid predominantly consists of renewable hydro-electricity). The extra costs the consumers pay are used for investments in renewable energy sources. The government audits energy retailers to assure that investments into green energy are made. The purchases under the GreenPower scheme are separate from the ones required under the RET (Green Power). Illustration 4-2 indicates the growth and volume of GreenPower purchases between 1997 and 2010.

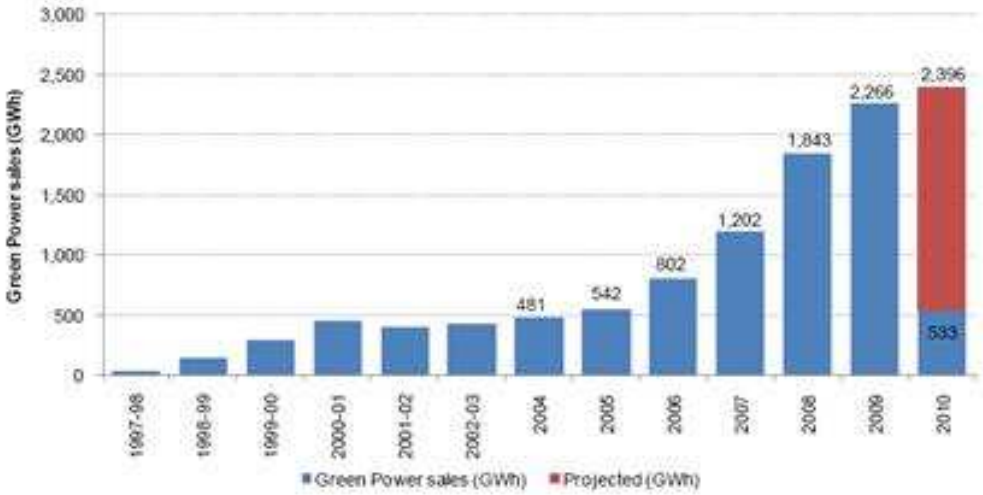


*Figure 4-2: Green Power Sales until 2010 (incl. estimates for 2010)*
*Source: (ACIL Tasman, 2010, p. 36)*

## 4.5 Major Policies at State Level

In 2003, a mandatory ETS based on baseline-and-credits[14] (in contrast to cap-and-trade) was introduced in NSW. The Greenhouse Gas Reduction Scheme (GGAS) requires electricity retailers to adhere to compulsory benchmarks, depending on the size of their market share in the electricity market. Those so called benchmark participants can reduce their emissions intensity (which is based on electricity consumption i.e. electricity sold) by supplying or buying abatement certificates. The system is regulated and controlled by the Independent Pricing and Regulatory Tribunal of NSW (IPART). The system is compatible with the national Renewable Energy Target RET. Abatement certificates can be gained by generating electricity with low emission intensity, by increasing energy efficiency on the consumption side or through carbon sequestration projects such as forest management (GGAS, 2011). Electricity generators have an incentive to participate through the possibility of selling abatement certificates to retailers (Nelson et al., 2010).

In 2005, ACT introduced a Greenhouse Gas Reduction Scheme which mirrors the GGAS in NSW. The system is – as in the case of NSW – administered by the IPART. Abatement certificates and projects are valid under the GGAS in NSW; however only NEM generation activities are eligible for accreditation by the GGAS (GGAS, 2011).

Queensland has introduced the Queensland Gas Electricity Generation Target in 2005 in order to encourage investment in other energy sources than coal. The scheme runs until 2020 and obligates electricity retailers to source at least 13% of their electricity from gas-fired power plants. A Gas Electricity Certificate (GEC) is provided for every MWh of gas-fired electricity and needs to be handed in to the state regulator (ACIL Tasman, 2010; MCLennan Magasanik Associates, 2008).

The State of Victoria mandates the roll-out of smart meters until the end of 2013 to all households. However, this legislation is currently under review by the new, Liberal government in place (State Government Victoria, 2011). In addition, In the Victorian Renewable Energy Target (VRET) was introduced in 2007. Its target is to achieve 10% of

[14] In the baseline-and-credit ETS, emission reductions compared to the baseline or target are tradable; credits are generated after certification and are often provided by parties not otherwise affected by the ETS; in comparison, only covered parties can create allowances under the cap-and-trade system (MacGill, 2005).

renewable energy by 2016 without including old hydro stations or solar hot water. Retailers and large wholesale purchasers are obliged to buy and hand in Victorian Renewable Energy Certificates (VREC) each worth one MWh of renewable electricity (MCLennan Magasanik Associates, 2008).

### 4.5.1 State Level Feed in Tariffs

Feed-in tariffs in Australia are used to encourage home owners and small business owners to install renewable energy sources. There are different feed-in tariffs in the various states belonging to the NEM. Most of the feed-in tariffs are so called net models, which are based on the excess electricity fed into the grid by the owner of the renewable energy. The only exceptions to this were the feed-in tariff in ACT and NSW, where the gross production of renewable energy was looked at; providing higher pay back to the owner of the renewable energy source. However, both schemes are closed to new entrants (Zahedi, 2010).

| State | Current status | Max Size | Rate Paid | Program Duration | Model |
|---|---|---|---|---|---|
| VIC | Started in 2009 | 5 kW for premium feed in; overall cap of 100 MW applies; | 60c (credit / cash) | 15 years | Net |
| SA | Started in 2008 | 30 kW (10 kW per phase) | 44c/22c /kWh | 20 years | Net |
| ACT | Closed | 200 kW per facility; total 30 MW | 30.16c / kWh | 20 years | Gross |
| TAS | Being set up | Tbc | 20c | Tbc | Net |
| QLD | Started 2009 'Solar Bonus Scheme' | 30 KW (10 KW per phase); less than 100 MWh consumption / customer / year | 44c + | 20 years | Net |
| NSW | Closed | 10 kW | 60c/kWh & 20c/kWh | 7 years | Gross |

*Table 4-2: Feed-in tariffs in the different states*
*Sources: (Department of Primary Industries, 2011; Energy Matters Pty Ltd, 2011; Zahedi, 2010)*

According to the 2010 study by Zahedi, average production costs of the renewable energy was between AUD 0.59 – 0.74 in the time analysed (Zahedi, 2010).

## 4.6 Regulatory Framework

Distribution companies are heavily regulated by the Australian Energy Regulator AER based on the National Electricity rules (compare chapter 5.6 describing legal aspects).

Guidelines and regulations related to carbon mitigation include demand management incentive schemes in SA, QLD, NSW and ACT and an efficiency benefit sharing scheme in ACT / NSW (AEMC, 2009; Australian Energy Regulator, 2008). Those schemes should compensate distribution companies for forgone revenue not earned due to capacity reductions and non-network measures and thereby encourage activities in the area of capacity reduction, efficiency increase and demand management. Different connection and costing guidelines affect the integration costs of distributed generators.

## 4.7 Carbon Pricing Mechanism

On 10 July 2011, the Prime Minister July Gillard confirmed that a carbon tax will be introduced on 1 July 2012 with a starting pricing of AUD 23 per tonne $CO_2$-e, increasing with 2.5% annually until the scheme is planned to be switched to an ETS scheme in 2015 (Australian Government, 2011b). According to several sources, the suggested carbon price of AUD 23/MWh will mostly make decentralised gas fired power plants more attractive to investors. The price will not be high enough to render coal unviable as source for electricity or to significantly push the use of renewable energy sources (D. Adams, 2011; Jeffries, 2011; Tomar, 2011). One important aspect of the carbon tax is, according to Greenpeace, that

energy market operators will be obliged to present their vision on how to integrate a scenario with 100% renewable energy sources into the power provision system (Vincent, 2011).

According to Betz & Owen (2010), an ETS will transform the NEM towards more renewable energy sources. The transformation will however be slowed down by free allocation of permits to existing coal fired power plants. The role of carbon capture and sequestration (CCS) is highly debated due to its unclear economic viability. According to the same report, renewable energy sources with the exception of hydro power are not yet economically viable without additional policies coming into place (Betz & Owen, 2010). Electricity delivery will play a crucial role within the change process as renewable energy such as wind and solar will have to overcome their inherent oscillation to become fully acceptable as base-load electricity. More information about the historic development and political issues behind the carbon pricing is provided in Appendix H.

### 4.7.1 Market Development Scenarios

Various business scenarios with the assumption of differing policy instruments and $CO_2$-e reduction goals mostly assume emission reductions in the range between -25% and -10% by 2020 compared to 2000 levels (ACIL Tasman, 2008; Garnaut, 2008; MCLennan Magasanik Associates, 2008). Figure 4-3 provides an overview of models for potential future generation mix and expected consumption levels under the *three highest profile models* as indicated by Betz & Owen (2010). Scenarios all assume an emission trading scheme in place, starting in 2010 (MMA, ACILTasman, CRA) or 2013 (Garnaut), respectively. In all scenarios prices would increase considerably and demand thereby be reduced. Price increases modelled range between +24 % to +55% compared to a baseline scenario depending on the model and the target of $CO_2$-e reduction. The use of black and brown coal would be reduced, the use of gas[15] and renewable energy increased (Betz & Owen, 2010).


*Figure 4-3: Comparison of scenarios and their impact on consumption and fuel*
*Source: (Betz & Owen, 2010, p. 4973 & 4974)*

[15] Average emissions per MWh from gas-fired electricity amount to 50% of $CO_2$, one third of NOx and 1% of sulphur compared to average emissions from coal fired power plant (U.S Environmental Protection Agency, 2007). Together with the fact that Australia has one of the largest gas reserves worldwide (Denning, 2009), this makes it *the next best option* after coal-fired power plants.

Depending on the future carbon pricing scheme and growth rates of the markets, additional network infrastructure and technology will have to be introduced to cater for renewable energy sources, distributed small-scale inputs into the grid and energy storage systems. Challenges are an increased complexity of the system including load flow power oscillations and voltage quality. The new challenges will require new information and control systems, technologies and management systems (Betz & Owen, 2010).

Environmental groups such as Greenpeace, WWF and national environmental organisations are critical of the carbon tax proposed by the government as it has in their views too many flaws and is compromised through agreements with the heavy-pollution industries. As alternatives, the environmental groups propose much higher $CO_2$-e reduction schemes leading to zero emissions (Beyond Zero Emissions, 2010; Greenpeace, 2008; Vincent & Wakeham, 2009). Julien Vincent from Greenpeace hopes however that measures included in the carbon price package will support new investments in renewable energy and allow for a gap to grow between the government and the decision-making bodies distributing financial support (Vincent, 2011).

Beyond Zero Emissions, an alliance of various environmental groups within Australia, is strictly against the use of any gas or other fossil-fuel and aims for an introduction of 100% renewable energy sources by 2020 (Beyond Zero Emissions, 2010). The model deliberately does not indicate approaches how zero emissions can be reached from a policy / economy point of view. Instead, and according to one of its proponents, it was set up as a feasible vision for the future, appealing to stakeholders from different parties and with different views on policies and economic solutions (Lucas, 2011). In the view of Beyond Zero Emissions, gas fired power plant should not be considered as intermediary solutions because other renewable technologies are available and sufficient to cover energy demand in Australia. According to Lucas, gas would lock in investments in fossil fuels, hinder the development of renewable and potentially cause higher than expected environmental damage due to the use of coal seam gas instead of natural gas[16] (Lucas, 2011). Julien Vincent from Greenpeace is aware that a rapid change in the energy provision system looks "politically almost impossible to achieve". In his view, the transition scenario 'Plan B' by Greenpeace is not blind to the fact that goals are currently not achievable from a social and political point of view. According to him, those models intent to reflect what can be achieved technically if the political and social will is there to do so (Vincent, 2011).

[16] Coal seam gas is extracted from coal mines; according to Lucas; in approximately 20% of the cases so called *fracking* would be used for extraction; including the use of chemicals such a benzene, potentially affecting land and ground water.

# 5 External Factors

Information in this chapter is structured according to the PESTEL structure looking at *p*olitical, *e*conomic, *s*ocial, *e*nvironmental and *l*egal aspects. The structure is used to provide an overview of barriers and drives for lower carbon electricity provision. Different stakeholder views based on literature review, online sources and interviews have been used to cover the aspects from different angles and to show potential areas of support or constraints for a move towards a lower carbon electricity provision.

## 5.1 Political Aspects

In the Australian political system, the major two parties are the (socialist) Australian Labor Party (ALP) and the (conservative) Liberal Party. The current Prime Minister, Julia Gillard belongs to the ALP. The Liberal party which is currently in opposition governed Australia from 1996 until 2007 in coalition with the National Party. The National Party (also known as the National Country Party) has its roots in the rural area of Australia and has progressively lost importance over the last years. In contrast, the Australian Greens emerged in the 1980s and have been able to continuously increase their share of voters. There are some further parties playing only marginal roles on the federal level but with some more influence on state level (D. Adams, 2011; Australianpolitics.com, 2011). Currently, the governments in NSW and Victoria are led by Liberal Premiers while Queensland, ACT, Tasmania and South Australia are led by Labor Premiers. Both major parties aim for a 5% $CO_2$-e reduction target until 2020 (compared to the 2000 level). This will not suffice to reduce climate change as envisioned by the Kyoto protocol.

To achieve its carbon reduction targets the national government mostly relies on economic, market based measures and reports produced by economists such as Professor Garnaut (who produced a very influential report promoting carbon pricing) and the Productivity Commission[17] (D. Adams, 2011; Diesendorf, 2011). The ALP with Julia Gillard as Prime Minister is committed to implement a carbon tax in 2012 (Australian Labor, 2011). The party has however received widespread criticism for this decision with the opposition calling the carbon tax inefficient and expensive (Benson, 2011). Opposition leader Tony Abbott strongly opposes carbon pricing and points to heavily increased prices for households and businesses and a loss of economic competitiveness. The Liberals propose instead an abatement scheme compensating companies for emission reductions (Liberal Party of Australia, 2011). The Greens, who hold the balance of power in the Parliament due to their power of creating a majority (see figure 5-1), agree with the current carbon tax suggestion but wish to achieve a 40% $CO_2$-e reduction by 2020 (Australian Greens, 2011).

Climate politics is a highly sensitive area in the Australian political environment. This is exemplified by the fact that the former Prime Minister, Kevin Rudd (ALP) was forced to resign in 2010 with one of the major reasons being his position and perceived weakness in regards to climate change policies (Suter, 2010; The Daily Telegraph, 2010). The strong opposition to a carbon tax by the Liberal party makes future policy developments unpredictable. The next elections are to be held already in 2013 with the opposition leader Tony Abbott determined to remove the carbon tax should he come into power. The Greens on the other hand will aim to push policies further towards more sustainability. Graph 5-1 on the next page illustrates how the voting intentions have changed over the last year, potentially shifting the balance of power for the election in 2013. While other factors besides the carbon

[17] According to Mark Diesendorf from the Institute of Environmental Science at the UNSW, the Productivity Commission consists of a group of economists who believe that the market economy can handle climate change mitigation once the market imperfection of pollution as a free good is taken care of (Diesendorf, 2011).

tax played a role for the decrease in popularity of the ALP (e.g. immigration policy, economic situation); it surely plays an important role explaining the change.

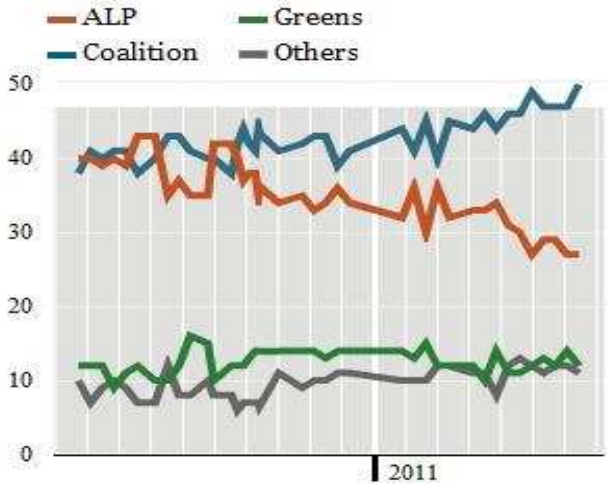


*Figure 5-1: Development of federal voting intentions January 2010 – August 2011*
*Source: (The Australian, 2011)*

## 5.2 Economic Aspects

A survey amongst the stationary electricity sector[18] conducted by the ESAA in 2010 indicates that network investments (refinancing and capex[19]) expected in the years immediately after the introduction of an ETS will include AUD 33.6 billon for refinancing of network infrastructure and AUD 45 billion for capex and new network assets. The overview in illustration 5-2 indicates estimated network investments by Chris Dunstan from the University of Technology in Sydney estimating investments to be around AUD 45 billion by 2015.

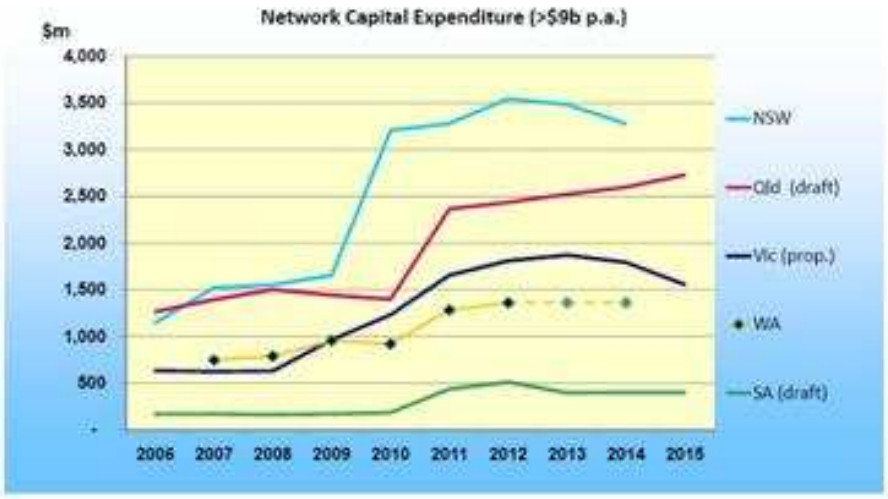


*Figure 5-2: Estimated network investment costs*
*Source: (Dunstan, 2010, p. 11)*

The energy market is highly dependent upon the financing market, with the industry being the third largest borrower in Australia after the government and banks (Simshauser et al., 2010). Additional capital expenditures (capex) are expected to arise through the rapid growth of peak load compared to average load (ESAA, 2010b).

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[18] Including generators, network providers and retailers

[19] A capital expenditure or capex is an expenditure which „results in the acquisition of permanent asset which is intended to be permanently used in the business for the purpose of earning revenue" (Accounting Explanation).

Scenario modelling for higher levels of renewable energy sources (RES) all show that this development comes at the price of higher electricity prices (ACIL Tasman, 2008; MCLennan Magasanik Associates, 2008). This finding is confirmed by a look at other countries with ETS in place: In Germany and the UK, which both have GHG emission reduction measures in place, electricity costs increased by 12% - 17% and 3% - 19%, respectively. The most expensive ways to reduce $CO_2$-e in Australia were found to be solar power systems and biomass (McKinsey & Company, 2008). This finding is however not undisputed. Australia is currently paying between USD 44 – 99 for one tonne of abated $CO_2$ while Germany is spending USD 137-175, the UK USD 75 -198, the US USD 43-50 and China USD 35-57 (Packham & Massola, 2011). With network charges having increased in the past due to network renewal and expansions, network prices can be expected to raise further in the future due to increased required capacity, replacement of old network elements, the roll-out of metering infrastructure and addition of renewable electricity sources (AEMC, 2009).

With the Australian industry including energy intensive industries[20] such as aluminium smelting, steel and mining, major influential industry stakeholders are concerned about the competitiveness of Australia in the international context should carbon mitigation measures be introduced. The Australian Coal Association points out that other economies based on mineral use such as the US, China, Russia, Indonesia, South Africa, Poland or India don't have a carbon price in place. The Association claims that Australia would be the only country with a carbon pricing scheme amongst the top four competitors for 13 key export commodities (Poland, belonging to the European ETS exempts emissions from coalmining) (Maher, 2011a).[21] The Australian government states that it supports a *vibrant coal industry* and has negotiated an extensive compensation package with the industry for the carbon tax. Those packages can be attributed to strong lobbying influences from the industries (Pezzey, Mazouz, & Jotzo, 2010; Radio Australia News, 2011).

Retail companies are closest to the customers and can provide information on how to reduce electricity bills. However, as many (of the large) retailers also have stakes in the electricity generation sector where margins are higher than in the retail sector, the incentives for retailers to reduce electricity consumption are relatively small[22] (Barnes, 2011). Distribution companies have a two-fold interest: while they gain revenue from increased network assets i.e. increased capacity, network charges have already increased significantly during the last years due to the replacement of old assets. This development has triggered pressure from customers and may force them to consider demand management in order to avoid network charges skyrocketing.

## 5.3 Social Aspects

There are strong concerns from residential customers that increased electricity prices will affect living standards.[23] Many stakeholders believe that energy and peak demand reduction will be very difficult to achieve as customers will not want or be able to change the timing of electricity use. In a study conducted by CSIRO in 2008, high electricity prices were perceived as more concerning by customers than apprehension for other topics such as security or the environment. This said, in this study, 38% of the participants still agreed or strongly agreed to putting a price on emissions (Ashworth, Jeanneret, Gardner, & Shaw, 2011). The same survey showed that knowledge about climate change is moderate to low with a high level of perceived uncertainty around the topic. According to a recent poll conducted by the Daily Telegraph,

[20] The mineral industry accounts for ca. 14% of the Australian GDP and 25% of the export economy (Lucas, 2011)

[21] In contrast, the Australian government compares the current situation in Australia moslty with countries being ahead of Australia in terms of CO2-e pricing such as Germany or the UK (Australian Government, 2011b).

[22] Those companies are called ‚gentailers'

[23] The argument of decreasing life-style has been strongly fuelled by carbon tax critics such as opposition leader Tony Abott. See e.g. an article in The Australian by Maher (Maher, 2011b).

less than one third of Australian voters support the proposed carbon tax and 73% fear that they will be worse off once the carbon tax is introduced. 75% of the voters believe that the tax would have little or no impact on the environment (Benson, 2011).

An important factor influencing the social acceptance of carbon mitigation measures is the media. The newspaper market in Australia resembles an oligopoly, controlled by just a few large media enterprises controlling the national and major urban market. In 2002, only two owners controlled 69% of the newspapers in the major cities. On a national basis, News Limited – to which amongst others The Australian belongs - is the largest owner of newspapers (Lewis, 2004). News Limited is owned by media tycoon Rupert Murdoch. The Australian has been pointed out as one newspaper strongly lobbying against the Greens, the current Labor government and strongly supporting climate change scepticism (Keane, 2010; Media Watch, 2010). According to an article in The Australian, the newspaper writes that it has been heavily criticised by Ross Garnaut, the author of the Climate Change Review for disinformation and biased reporting against the carbon tax and ETS (Kelly, 2011). This information is supported by John Merson and Mark Diesendorf, Director and Deputy Director of the Institute of Environmental Science at the UNSW (Diesendorf, 2011). According to Adam Lucas, advocator of the Beyond Zero Emissions solution, other media such as ABC, Fairfax Media and the Sydney Morning Herald have however been supportive of climate change topics including positive coverage on the topic (2011).

## 5.4 Technological Aspects

The technologies in place in the transmission and distribution sector are similar to the technologies used, when the first electricity networks were set up. This technological inertia is in sharp contrast to other industries such as telecommunications where major technological change has been happening during the last decades (Wolfs & Isalm, 2009). The power lines as they are today, most often stem from the 1950-70 and are in need for update or replacement (Picker, 2011). While transmission companies have a high degree of automation and control in their networks, the network of the distribution companies lack control technology in many instances. They are therefore often *blind* on levels below substations and companies cannot exactly locate outages in their network (Eckermann, 2011). Advanced Metering Infrastructure (AMI) as currently mandated and rolled-out in Victoria helps distribution companies not only to introduce tariff based pricing but allows for a better control of the network (Eckermann, 2011).

The electricity system in Australia is based on centralised fossil-fuel sources and is characterised by one-way flows to customers who often have limited information about the electricity they consume, shortages of electricity or outages (Energy Networks Association, 2009). Betz & Owen indicate that distribution companies may have to consider "integrated distributed and small-scale generation sources, grid- connected intermittent renewable energy sources and energy storage technologies" due to market changes caused by carbon pricing (Betz & Owen, 2010, p. 4978).

Many technologies on the side of RES as well as on the demand management side are still being developed with different technologies for smart meters, communication networks and other elements being tested by companies and research institutes in trial projects. As indicated in chapter four, research is financially supported by governmental initiatives and complemented by industry initiatives. One important aspect for the implementation will be appropriate standards that will be enforced by the authorities. This will be especially true for the introduction of electric vehicles produced by various manufacturers but using the same infrastructure (e.g. batteries, plugs) (Diesendorf, 2011). The use of highly energy intensive appliances is an area where there is a lack of standards (and enforcement of standards) causes

problems already today. One example is cheap, imported air conditioning being imported from Asia and leading to significantly increasing peak demand during hot summer days (Diesendorf, 2011). Another aspect that may cause problems at a later stage is the smart meters already introduced on broad scale in Victoria. Four of the five distribution companies introduced smart meters with low technical capabilities that will not be able to cope with advanced tasks of two-way communications and home network appliances (Eckermann, 2011).

While it is unclear in what direction the distribution network and technology applied will develop in the Australian market, many actors expect major changes within the next five to ten years reflecting developments similar to the ones that happened in the internet / telecommunications industry in the past 15-20 years.

## 5.5 Environmental Aspects

Pietsch & McAllister find in their recent report that "Australia's recent history can be characterised as political and sectoral resistance to Ecologic Management and structural reform" (2010, p. 219). According to the same authors, the main concerns are job losses, lower international competitive advantage, and increased costs of living (Pietsch & McAllister, 2010). The government is aware that its goals of a five percent $CO_2$-e reduction by 2020 (compared to 2000) are inconsistent with the overall ambition of keeping the $CO_2$ level below 450ppm to avoid an increase in temperature of more than two degrees Celsius However, the Australian government makes it clear that only a binding international agreement including amongst others the US, China and India can lead to an increased reduction target of 15% - 25% (Australian Government. Department of Climate Change and Energy Efficiency).

Given the current market and policy conditions, the electricity market in Australia is expected to grow further, with Queensland requiring new major investments already in 2013-14 (AEMO, 2010a). Growth in this area will be due to demand increase in the Surat Basin (coal seam gas developments), gas compressor loads and coal mining. NSW requires new capacity due to growth and reassignments of semi-scheduled and non-scheduled generation capacity (e.g. wind power is considered to be semi-scheduled). Victoria will need further capacities with economic growth while SA has low projected population growth rates delaying the need for further investments.

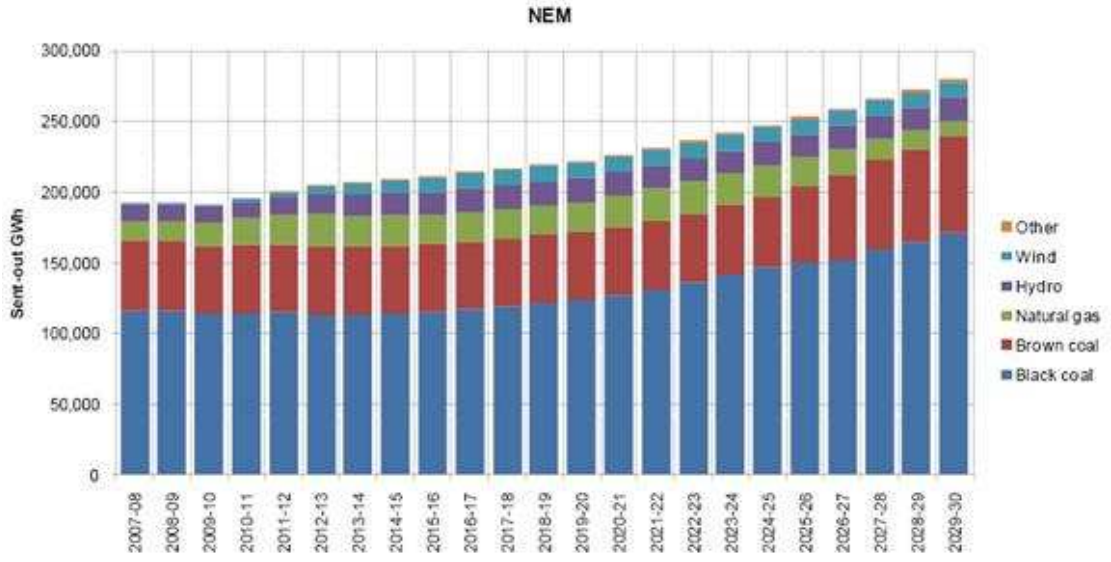


*Figure 5-3: Fuel scenario based on the current policies in place*
*Source: (ACIL Tasman, 2010, p. 49)*

Given the governmental policies in place,[24] the forecast for the use of various fuels has been modelled by ACIL Tasman and is depicted in figure 5-3 on the previous page. This scenario indicates an emissions increase of approximately 33% by 2020 compared to 2000 levels equivalent to an increase of 38 Mt $CO_2$-e. Compared to the government goal of a five percent reduction by 2020, the expected development falls short of 56 Mt $CO_2$-e (DCCEE, 2010).

Experience in Europe suggests that the introduction of smart meters and the increased visibility of electricity use and costs can lead to electricity decreases of around six to ten percent (Guardian, 2001). These figures indicate that progress on the demand management side will not be able to balance out indicated growth and peak demand. This view is supported by several stakeholders and distribution companies. If Australia wants to achieve high rates of $CO_2$-e reduction it will be required to strongly increase the level of renewable energy sources.

## 5.6 Legal Aspects

The Australian Electricity Regulator AER states that it has no role in energy policy development and is fully guided by the National Electricity Law. The role of the AER is to "achieve efficient prices for the provision of energy supply services" but "does not have a role in developing a strategy to reduce carbon emission with respect to these [transmission and distribution] businesses" (AER, 2011). The regulatory framework aims to compensate for a lack of competitive pressure in the industry. According to a report conducted by AEMC, the current regulatory frameworks is adequate to react to climate change issues, with adaptation recommendations made in the area of further liberating retail prices, encouraging the connection of generation clusters (avoiding first-mover cost disadvantage) and improved network utilisation.

Of the policies in place, the National Reporting Act and the Renewable Energy Target are regarded as the most effective policies in place to a shift toward a lower carbon electricity provision. The carbon pricing is viewed to have a limited impact as long as prices are too low to render renewable energy sources cheaper than fossil fuels. Some of the regulatory procedures in place are seen by the distribution companies as obstacles to more sustainable electricity provision; in essence encouraging the traditional way of doing things

The Energy Network Association ENA advocates a move towards a Smart Grid in order to ensure "secure, affordable and environmentally friendly supply of energy in a carbon constrained world" (Energy Networks Association, 2009). The five main goals of the ENA are to stimulate demand-side response, to accommodate renewable energy sources in the network, provide customer access to products and services based on price and environmental concerns, accommodate energy storage technologies and improve the performance of the network (Energy Networks Association, 2009). Other associations supporting the electricity industry include the Energy Supply Association of Australia (ESAA) and the Energy Retail Association of Australia (ERAA).

[24] without the inclusion of a carbon price

# 6 Options for Low(er) Carbon Electricity Provision

According to information provided through the various stakeholder and industry interviews and obtained from review of literature and web pages, future low carbon business opportunities within the transmission and distribution sector fall in three key areas:

1) demand side management, focusing on large, medium and small scale customers;
2) the development of a residential smart grid beyond trial phase;
3) integration of renewable energy sources into the grid.

On the supply side, the Renewable Energy Target is perceived to be the single most important driver for a significant increase in shares of renewable electricity in Australia. Networks therefore need to be able to accommodate an increase in volatility in supply and adapt to more distributed power sources (often called embedded generators) in the future. Additionally, state-level premium feed in tariffs for renewable energy sources, the upcoming carbon pricing and an aging infrastructure are further strong signals for required change in the industry, moving towards smaller-scale, more distributed and more renewable electricity inputs on the supply side.

On the demand side, peak demand grows twice as fast as overall base-load demand which increases the need for a better energy efficiency management amongst customers in order to avoid the creation of massive new capacity that will only be used during a few days or hours a year. Drivers for peak demand are – according to most stakeholders - mostly residential customers with the two single main contributors air-conditioning (and heating) and pool pumps. Future developments such as the introduction of electrical vehicles (being charged when people get home from work) may accentuate peak demand. Those developments point to the fact that distribution companies face a large impact in their business activities within the next few years. Reduction of peak demand may not necessarily reduce overall demand but only shift it to off-peak times. This means it may be possible to defer generation capacity and networks upgrades leading to lower resource use and emissions (most peak demand is currently covered by gas fired power plants in Australia). In addition, the sole installation of smart meters making the electricity use visible has been found to reduce overall consumption in other countries (Guardian, 2001).

Figure 6-1 below visualises some the main elements of supply and demand management the companies may face going forward.

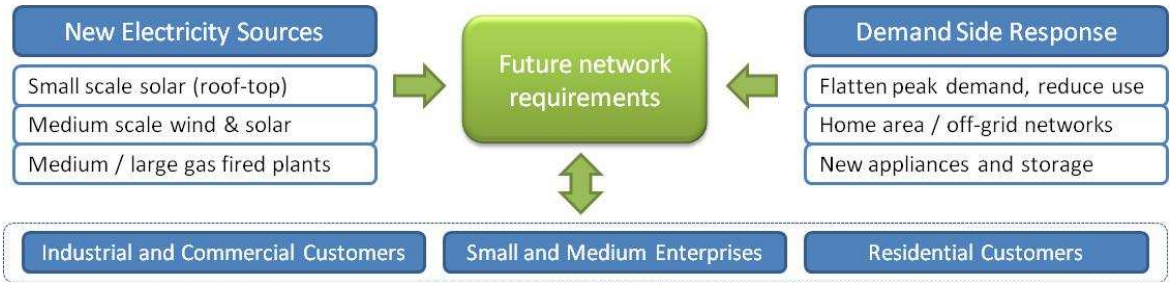


*Figure 6-1: Network challenges from supply and demand side in Australia*
*Source: compiled by the author*

Table 6-1 on the next page summarises constraints and drivers for the provision of lower carbon electricity identified through interviews and literature reviews. Those elements should be kept in consideration for the business solutions proposed in the next sections of this chapter and the viability of them from a business, efficiency and sustainability point of view.

| Drivers | Barriers |
|---|---|
| • RET, carbon pricing, premium renewable feed-in tariffs increasing the level of volatile renewable energy sources<br>• Increasing peak demand<br>• Aging infrastructure / need for network-upgrades<br>• Climate change adaptation measures leading to more resilient networks (response to increased flooding, land flips etc.) and higher automation<br>• Perception of need to justify increasing network prices (through the integration of renewable and the renewal of infrastructure)<br>• New market entrants such as electric vehicle infrastructure providers requiring changes in infrastructure<br>• Customer concerns regarding increasing network charges<br>• Increasing electricity prices | • Unclear, sometimes contradictory and weak regulatory requirements<br>• Regulatory framework that makes transmission and distribution companies responsible for failures in (volatile, renewable) power generation, leading to preference of network measures over non-network upgrades<br>• The revenue of distribution companies is obtained predominantly from their assets installed leading to a disincentive for capacity reduction and non-network measures<br>• Network losses are under the responsibility of power generating companies, not distribution companies<br>• Shareholder expectations of economic profitability leading to strong cost focus<br>• Monopolistic positions of companies leading to strong market power and non-competitive behaviour<br>• Key technologies such as storage (e.g. via electric cars) are not sufficiently developed with many other technologies (e.g. smart meters) being in trial phase<br>• High connection costs for new (embedded) generators; first mover disadvantage, and not clearly regulated framework on connection costs<br>• Low levels of customers trust in government and utilities regarding implementation of new distributed generations solutions |

*Table 6-1: Industry barriers and drivers*
*Source: compiled by the author from interviews and literature*

The options discussed in the following sections all refer to smart grids in the broader sense. Information about smart grids, different understandings and standards e.g. in the US and the EU are described in Appendix I.

## 6.1 Demand Side Management

According to a report prepared by Energy Futures for IPART (the NSW regulatory body in the electricity market), demand management incorporates energy efficiency, load management[25] and distributed generation including medium and small power generators feeding into the distribution network rather than the transmission network (Energy Futures Australia Pty Ltd, 2002). As an example, the Queensland government is currently running trials on demand management and energy conservation in collaboration with Ergon and Energex, expecting savings of around AUD 4 billion in infrastructure if peak demand can be reduced by 1 100 MW. In comparison, total capacity installed in Queensland is just over 13 000 MW. This also translates to estimated electricity savings of 22 000 GWh and overall emissions reductions of 23 200 kilo tonnes $CO_2$-e (Australian Energy Regulator, 2010; Queensland Government, 2009).

There are various energy service companies (ESCOs) offering their services in Australia. According to GreenBox, an energy service company including a retail business division, it is however difficult to offer profitable solutions to small scale users. This is due to the cost of infrastructure and technology involved. GreenBox's business model therefore aims at connecting demand management of various small consumers virtually to leverage demand management and gain revenues by adapting demand to wholesale market prices. According to the company, options are however limited for companies without retailing rights as only

[25] Network load management including peak demand reduction in the network and generation load management including activities to avoid peak demand in the generation market

retailers can *own* customers (Barnes, 2011). Most retailers however appear to be disinterested in new service options with Origin as first retailer that just started to engage in smart grid trials (T. Watts, 2011).

### 6.1.1 Smart Meters

Smart meters are the first necessary step towards demand side management and demand price response (Eckermann, 2011). Currently, only Victoria is mandating the roll out of this new infrastructure with trials and smart meter supplier evaluations being conducted by distribution companies in other states. According to Eckermann, the legislation in Victoria may have come too early at a time where the requirements for efficient smart grid technologies were not yet specified. In his opinion, advanced metering infrastructure rolled out by four of the five distribution companies will not be sufficient to allow a full two-way communications include electric vehicles, smart appliances etc. (home area network). In Victoria, only SP AusNet has implemented smart meters which fulfil those future requirements (Eckermann, 2011).

On a national level, the National Framework for Energy Efficiency (NFEE) is responsible for demand side energy efficiency and the future national roll out of smart meters. Cost benefit analysis conducted by the Ministerial Council on Energy (MCE) show, that smart meters have greater benefits than costs to the network and should therefore be rolled out on a national level. It is expected that NSW will be the next state with compulsory smart metering.[26] The inclusion of smart infrastructure and demand side management will have to be reflected in an adapted National Electric Action Plan currently not including reference to energy efficiency or greenhouse gas reduction measures (Lyster, 2010). A 2007 study by Energy Futures Australia indicates that a nation-wide role out of smart meters will lead to a four to ten percent reduction in overall electricity use due to behavioural changes. The resulting annual emission reduction in $CO_2$-e is between 7.8 – 19.4 Mt. equivalent to 1.4% - 3.5% reduction in overall emissions. Those numbers are based on experiences in other countries where smart meters have been widely rolled-out out (Energy Futures Australia Pty Ltd, 2007). Costs of smart meters and their installation are approximately AUD 200 per household depending on the provider and technology chosen; those costs are currently covered by the electricity users through inclusion in the network charges. In comparison, Iberdrola a leading utility in Spain aims at introducing smart meters (based on the PRIME standard) at AUD 50 per installation This is amongst others achieved by a higher degree of standardisation (Eckermann, 2011).

### 6.1.2 Industrial Demand Management

According to ERM Retail and the consulting company Energy Response, demand management for large scale customers could significantly help to level out peak demand and lower network capacity demands. If actions were taken to ensure that demand management for large customers coordinated within the market and incentivised, the network could account for a large(r) share of oscillating renewable resources and peak demand. Figure 6-2 on the next page indicates the reason for the potential. Many companies have high capacities available but don't use their maximum capacity most of the time. By actively engaging them, the need for new additions to the network or network upgrades could be deferred (Tomar, 2011).

[26] As mentioned in the stakeholder section of this paper, the smart-meter roll-out is being questioned by the new Liberal government in Victoria; in NSW the government has changed as well from Labor to Liberal and compulsory roll-out may be more questionable now than when the report of Lyster was written in 2010.

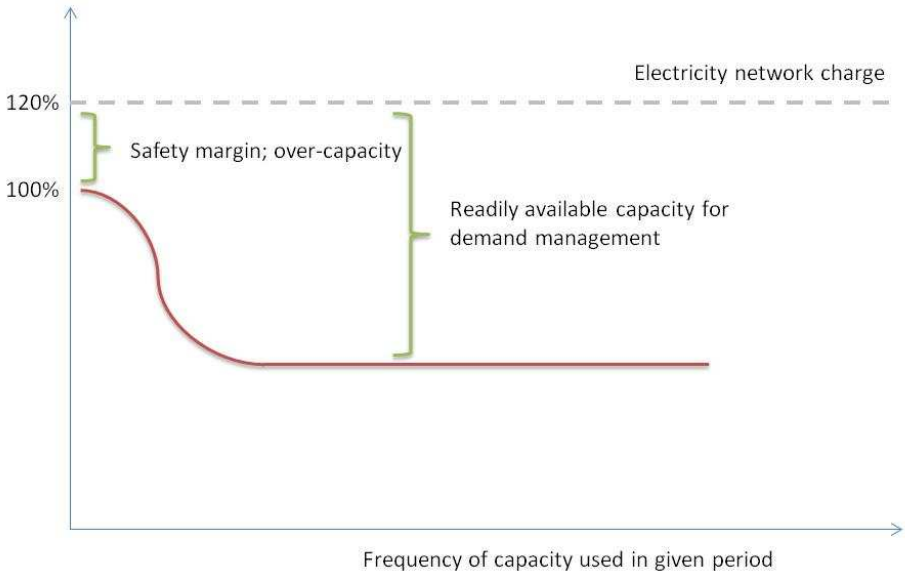


*Figure 6-2: Electricity capacity required over a given period; large customers*
*Source: adapted from (Tomar, 2011)*

A Demand Side Response (DSR) trial conducted by the Energy User Association Australia indicates that there are significant gains to be achieved in the area of large customers with potential gains of up to AUD two billion per year, equivalent to ten percent of retail turnover. Those gains could be achieved through demand reduction at price peaks, deferral of growth related capital investments and the improved utilisation of (economically) sunk network assets (Pareto Associates Pty Ltd, 2004). The main barriers that this report identified in 2004 included the knowledge and awareness level of end customers, low incentives for end-users to engage in DSR and the lack of a commercial DSR facility. A visual depiction of how a DSR Facility could look like is provided in Appendix J.

According to the findings; industrial demand side management has a high potential to reduce capacity installed and offers thereby an interesting option to shift towards lower carbon electricity provision.[27] Consulting companies and retailers specialised in large customers optimise the load management of large companies and actively approach distribution companies with suggestions for packages and load pricing. Retailers use the financial aspect of the wholesale market and their hedging experience to gain revenues from price spikes e.g. by asking their industrial customers to decrease demand in times of high price spikes. Those gains are shared between the retailers and the industrial companies. However, so called *gentailers*; retailers with stakes in the generation business (i.e. the largest three retailers Origin, AGL and TRUenergy) don't have an incentive themselves to lower demand as their profit mostly stems from the generation business with retail margins being very small (see chapter 3.4). Generally, the focus of large industrial companies and retailers has so far mostly been on load shifting to obtain financial gains from the wholesale market with a limited focus on actual energy efficiency measures. This may however change with increasing electricity prices according to some participants of the EUAA Climate Change and Energy Efficiency Conference the author spoke to.

In the Western Australian electricity market, the bidding process for higher capacity does not only involve the bidding of generation companies but also allows large industrial players be part of the process. Instead of bidding for new capacity, industrial customers put in their bids for demand reduction in case of capacity shortage for which they get remunerated as if they

[27] Again assuming that most electricity is produced from fossil fuel in the near future

were providing electricity. Such a process is lacking in the NEM (Tomar, 2011). One sector that has been neglected this far are small and medium enterprises (SMEs); it is however unclear how large the potential in this area is for efficiency gains and what would be the best way forward to tap into this market.

## 6.2 Home Area Networks Including Electric Vehicles

Home area networks (HANs) describe local area networks that enable home appliances such as ventilation, heating, AC and other electric machines to communicate amongst each other. So far, attempts to make HANs work have had limited success due to the absent or fast disappearing interest of consumers once they have smart appliances installed (Gilbert, 2010). HANs can however not only be managed by consumers themselves but can be monitored and controlled directly by electricity utilities. A HAN has the potential to shift load to off-peak times, to react to live price changes in the market and reduce electricity use. Additional energy sources such as photovoltaic cells or batteries (e.g. from an electric car) can be added to the system to complement or replace grid electricity all controlled by advanced metering infrastructure (AMI). An additional monitoring device can provide information to the customer on electricity use and prices. Currently, appliances can be controlled by external automatic switch off/on devices; a function potentially integrated into future electric devices. Communications can be wired (phone /TV or power lines) or wireless (Wi-Fi or broadband) depending on the infrastructure available (Frenzel, 2010). In the future, HANs have the potential to new electricity services to the market.

One option currently receiving particular attention in Australia is the introduction of electric passenger vehicles. Such vehicles are seen as a potential key to energy storage solutions and smart home network areas. Once broadly rolled-out; they could serve as electricity input; handling residential peak demand and feeding electricity back into the grid if required. While potentially adding a heavy additional load to peak demand with people charging their cars when they get home, smart plugs would allow for off-peak charging. First commercial electric plug-in cars could be sold already in 2012 with the infrastructure currently being set up by various companies. A study by AECOM shows that hybrid electric vehicle can become economically and financially viable for the use in the metropolitan NSW area. However, the transition from hybrid and hybrid plug-in electric cars to full electric cars is estimated to only become economically viable within a twenty years timeframe. Barriers currently in place include the absence of infrastructure for charging and battery exchange, high vehicle costs, the actual costs of electricity vs. petrol / diesel and the small scale of the Australian market. Other elements that will play important roles are life-style considerations, the development of adequate policies, new business models in the car manufacturing and service industry and the development of battery capacity, disposal and re-load issues (AECOM, 2009).

## 6.3 Integration of Distributed (Renewable) Energy Sources

Distributed generation has the potential to reduce GHG at lower costs than centralised renewable electricity sources e.g. used in the calculation of Garnaut's report. The reason is that distributed generators require lower network capital expenditure for connection lines to the network as they are closer to the grid and feed in directly to the distribution network instead of the transmission network. Additionally, distributed generation directly reduces GHG emissions through reduced lines losses due to the shorter power line. However, knowledge about the best deployment of distributed generators and the best distribution within the network is very limited (Wagner, 2010). Barriers to distributed generation are technology costs, institutional aspects including regulatory failure (e.g. not decoupling sales from network profits), split incentives, inefficient pricing, payback gaps, lack of information and cultural barriers.

In a 2009 review of the National Framework for Electricity Distribution Network Planning and Expansion, the MCE and AEMC recognise the barriers for distributed generation and demand side response and suggest the following activities to be introduced in the planning process (Ministerial Council on Energy, 2011):

- obligation for distribution companies to actively develop and adapt demand side engagement strategies and incorporate non-network solutions;
    - set up and maintenance of non-network case studies and proposals;
    - set up of a Demand Side Engagement Register;
- requirement for the description and identification of forecasting systems;
- increased transparency on the limitation of sub transmission and zone substations in order to identify investment opportunities in distributed generation and demand side response;
- transparent reporting of activities promoting non-network activities in the annual reports of distribution companies;
- introduction of a Regulatory Investment Test for Distribution to measure market benefits incl. energy losses of network and non-network alternatives.

Those rules – adapted by the addition of some more flexibility and exceptions – have been passed from the MCE top the AECM for implementation in March 2011 (Ministerial Council on Energy, 2011). According to a study conducted by CSIRO, distributed generators could reduce GHG emissions by 60% by 2050 compared to 1990 levels (CSIRO, 2009).

# 7 Strategic Responses to Climate Change Mitigation

This chapter presents and analyses current activities of the distribution companies within the NEM in the field of climate change mitigation. It then goes on to identify strategic changes required in order to tap into upcoming business options (as presented in chapter six). The analysis is conducted utilising the theories of institutionalism, resource dependency and a theoretical model addressing Strategic Response to Institutional Change as proposed by Christine Oliver and further developed by other scholars (see chapter two for details about the theory).

## 7.1 Current Activities

There is a base of environmental action in al organisations addressed by this study. All companies use ISO 14001 as their basis for their Environmental Management System and all are required to report their direct emissions to the government. These include emissions from their fleet or the use of $SF_6$[28] for electric insulation purposes or waste (scope one), electricity emissions such as internal use of electricity and network losses (scope two) and their indirect emissions generated in the wider scope such as e.g. from employees air travels (scope three) according to the National GHG Reporting Act from 2007 (Department of Climate Change and Energy Efficiency). The largest impact included in those reporting systems is the energy loss of power lines, which accounts for 80% - 95% of the environmental impact reported. However, there are significant differences between the distribution companies on where they draw the line of responsibility and action. While all companies in question have the ISO 14001 EMS in place, most companies only feel accountable for direct impacts such as fleet management, the use of $SF_6$, operative electricity use, waste and water management while others additionally commit to the use of green energy, $CO_2$ neutral fleets and reduction of losses from network losses. Table 7-1 below provides a summarised overview of significant emissions relating scope one to three defined under the NGER framework.[29]

| | Scope 1 – direct impacts | Scope 2 – energy use | Scope 3 – indirect impact |
|---|---|---|---|
| **Significant emissions** | • GHG emission from the use of SF 6<br>• Emissions from the fleet (used for network maintenance) | • Network losses (85% - 95% of environmental impact)<br>• Internal electricity use | • Air travel<br>• Waste management, particularly hazardous substance such as oil and the recycling of metals |
| **Main Activities** | • Introduction of new equipment / gear to reduce $SF_6$<br>• Initiatives to phase out $SF_6$<br>• Purchasing of low-fuel vehicles,<br>• Use of E10 / LNG for fuel<br>• Trials with electric vehicles<br>• Eco-driving | • Reduction of network losses (without indication on how this was achieved)<br>• Use of green electricity for internal use<br>• Staff education | • Reduction of air travel<br>• Reduction of waste<br>• Recycling of unavoidable waste<br>• Staff education |

*Table 7-1: Overview of main emissions and activities undertaken*
*Source: compiled by the author*

Few companies state that they are actively seeking to minimise energy losses, indeed most companies indicate that they consider that it is outside their area of responsibility. Currently, transmission and distribution companies have no regulatory obligation to try to minimise losses, with generators being held responsible for those losses. According to Colebourn,

[28] Sulfur hexafluoride (SF6) is used to insulate transmission and substations; it's a non-toxic non-flammable greenhouse gas

[29] Direct and indirect impacts are differently defined under ISO 14001 and the NGER reporting process; as NGER only includes emissions, it is used here for the categorization

(2010) a changed regulatory framework – or the allocation of electricity production costs to network losses and in turn allocation of those costs to distribution companies – could both be ways forward to provide incentives for the reduction of losses. However, reductions within the current infrastructure are costly and a report commissioned by the ENA shows that a ten percent reduction of the current losses would require investments of AUD 1.2 billion. Average T&D losses amounted to 5.6% in 2005/6; however in remote areas (e.g. rural Queensland and Broken Hill, NSW) losses can amount to 10% - 25% of the total electricity produced (Parsons Brinkerhoff, 2009).

According to Colebourn, network losses need to be better recognised in future decision making processes regarding the validation of various network and non-network alternatives. His suggestion is to incentivise the reduction of losses for distribution companies; however in Colebourn's view, regulatory incentives would be more effective than putting a price on energy losses for network companies (Colebourn, 2010). Drastic network losses in remote areas could become future drivers for distributed generators, should the reduction of energy losses become compulsory or incentivised[30] at the level of transmission and distribution companies. At the moment however, the responsibility for those losses lies fully with power generating companies as scope one emissions under the NGER framework (Department of Climate Change and Energy Efficiency).

### 7.1.1 Activities Outside Environmental Management Systems

In the following sections, the focus is not so much on scope one to three aspects; but rather on activities focusing on two main areas identified in chapter six that will play a crucial role if distribution companies (or more generally network companies) are to engage in a low carbon electricity system. The aspects are the integration of renewable energy sources and the management and reduction of demand, including the levelling out of peak demand and the decrease of overall demand.

The table below provides an overview of main activities currently conducted by the various companies in the area of climate change (mitigation) as indicated on their websites and in their annual reports. A complete overview is provided in Appendix K. Clearly, the main activities undertaken are in the area of residential demand management, to reduce peak demand. Many companies regard the reduction of peak demand as business improvement activities rather than carbon mitigation measures. Goals are increased customer service, increased network efficiency and the avoidance of network upgrades. As one major area of peak demand is residential electricity use, many activities in the area of demand management focus on residential customers. According to information retrieved, all distribution companies engage in some activities regarding energy efficiency measures for large customers such as off-peak electricity use agreements (demand responsive pricing), agreements for shut-down of non-critical assets in case of extreme electricity demand peaks etc. However, the extent to which those activities are conducted differs from company to company. According to interviews conducted with EMR (retailer) and Energy Response (consulting), distribution companies do not use the potential that commercial and industrial customers provide in regulating demand (Parratt, 2011; Tomar, 2011).

[30] By putting a price on the lost electricity

| Distribution Service Provider | Main business activities | Environmental activities (according to webpage and where available interviews) |
|---|---|---|
| ActewAGL | Distribution and generation | Sustainability strategy and five year action plan; focus on continuous improvement |
| Aurora Energy | Generation, retail, distribution | Environmental plan for internal improvements; focus on monitoring and reducing direct emissions |
| Citi Power PowerCor | Distribution networks | Focus on internal emission reduction, research in the area of smarter networks; very limited information regarding future strategy available online |
| Endeavour Energy (former Integral Energy) | Distribution | Commitment to be carbon neutral by in 2020 for operational emissions, smart grid trials incl. evaluation of different technologies |
| Energex | Distribution | Vision to achieve a smarter network by 2030 (in collaboration with Ergon) |
| Ergon Energy | Distribution | Recognition of importance of renewed networks, trials for demand management under way; collaboration with Energex in smart grid area |
| Essential Energy (Country Energy) | Distribution | IN programme, development of a smart grid; energy efficiency advice to customers (26% reduction rates), investments of AUD 6 billion until 2014 planned, participation in NSW GGAS scheme |
| ETSA Utilities | Main distributor in SA; includes maintenance and construction services | Focus on the technological upgrade of network (SCADA / DMS); currently no active roll-out of smart meters |
| United Energy | Distribution | Limited information on strategy available; company recognises potential of smart networks |
| Jemena | Builds, owns and services electricity assets; transmission and distribution | Almost no environmental information available on the webpage, integration of renewable energy sources seems to be a focus |
| SP AusNet | Transmission and distribution | Company takes part in zero emission houses and electric vehicle trial; only company in Victoria that rolled-out smart meters suitable for advanced two-way communications |
| AusGrid (Energy Australia) | Distribution | Winner of the AUD 100 million Smart Grid Smart City project, demand management program, target to be below the industry benchmark |

*Table 7-2: Overview of sustainability strategies in the distribution sector*
*Source: (ActewAGL; Aurora Energy, 2010; AusGrid, 2011; CitiPower & PowerCor, 2011; Endeavour Energy; Energex; Ergon Energy; Essential Energy (formerly County Energy), 2010; ETSA Utilities, 2010; Jemena Energy; SP AusNet; United Energy)*

Some of the companies surveyed are actively educating their customers on peak demand and offer price schemes based on peak and off-peak use. However, other companies do not offer active customer education on demand responsive pricing schemes or energy efficiency. Generally it is viewed that retailers should play the main role in this area. Responsibilities between retailers and distributions companies are perceived differently, with some distribution companies considering educational aspects and customer interaction to be beyond their scope. The role of retailers and distributors seems to be unclear in many way with the role of retailers not being explored to its full potential (O'Reilly, 2011; Parratt, 2011). According to the business retailer ERM, retailers are often left with business models based on efficient billing and public relations activities with small profit margins (see also chapter 3.3) (Parratt, 2011).

## 7.2 Factors Determining Response to Institutional Change

Before going into the analysis of the survey, the indicative elements are again briefly listed as a reminder from the theoretical chapter: *Cause* refers to the perceived social or economic benefit of institutional change to companies. If the change leads to increased legitimacy, companies are more likely to align with it. Conversely, if institutional change offers limited legitimacy gains or economic losses, companies are expected to actively compromise, avoid, defy or manipulate the changes.

*Constituents* refer to various stakeholder demands pressuring the company taking into consideration the power relationships and the multiplicity of demands. The company is more likely to align its behaviour with demands if its dependency upon constituents is higher, and if the multiplicities of stakeholder demands are low. *Content* refers to norms being changed due to changes in the institutional environment. If the institutional change is in alignment with company goals and does not constrain the company, an organisation is more likely to (passively) align its behaviour to it. *Control* indicates the level of coercion and voluntary action applied. Companies are more likely to actively resist change if enforcement and voluntary industry activities are weak. As a last point, *context* refers to the company's environment with companies likely to comply with institutional change in situations with high uncertainty and a high level of interconnectedness between the institutional change and other business areas.

### 7.2.1 Cause

Responses from distribution companies indicate that they feel their social legitimacy is only modestly affected by environmental activities or strategies in place related to climate change mitigation and lower carbon electricity provision. All but two companies rate climate change as medium to low management priority. This finding is supported by Scott Jeffries, AECOM. From his experience, environmental elements are often only included at the end of business processes (Jeffries, 2011).

However, companies seem to perceive an increasing pressure. This is indicated by the fact that almost all companies now provide sustainability reports and overviews of activities on how to handle climate change adaptation and mitigation on the internet, something which was not the case two years back (Wong, 2010). A major reason for more transparent reporting on environmental management issues is the NGER Act from 2007, requiring the companies to report on scope one (direct emissions), two (electricity use) and three (indirect emissions). The NGER is rated by many companies as the climate change regulation affecting the business most. Other reasons for gained perception of importance of climate change mitigation are the view of companies that climate change has already led to more extreme weather conditions incl. higher temperatures, storms and bushfires. Bushfires and extreme weather effects requiring more resilient networks are thus two main reasons indicated for why companies automate and strengthen their asset base. All companies interviewed indicate that they expect more extreme weather conditions and have started to investigate them in order to protect themselves against damage. Some companies have included climate change adaptation procedures in their standard planning processes. Adaptation strategies indicated include increasing the resilience of network and increasing the level of automation to react faster to outages. Such measures may also influence the preparedness of companies for carbon mitigation (e.g. level of automation). However, it could not be established to which extent this link between climate adaptation and mitigation plays a role. Carbon mitigation measures based upon the pursuit of reduction of energy losses are perceived as costly with little economic incentives for activities in the current regulatory environment.

Overall, companies quite uniformly perceive that climate change as such is happening, and that they have a role to play in mitigating carbon emissions from direct emissions. They also

indicate that such activities are looked at to be *good business practice*. Companies anticipate that such work will help to maintain and extend their legitimacy in the institutional field. Possible economic gains for the companies in regards to climate change mitigation policies is regarded as low because activities will necessarily be related to increasing costs for the companies that they may not be able to fully recover from the customers. Additionally, increasing electricity prices (mostly due to the required renewal of network infrastructure and partially due to the RET and feed-in tariffs) put a limit on further price increases from network upgrades.

To summarise, institutional changes required by the government and the regulator in the area of climate change mitigation are generally perceived as within reason by the companies surveyed. However, the companies expect limited to negative economic gains from those changes, making investments difficult to justify to owners and shareholders. As such their strategic position is deemed to fall within slightly active or passive. The most likely strategies are avoidance, compliance and compromising. Examples of compliances related activities are the NGER reporting, increased public reporting according to ISO 14001 and the strengthening of networks to maintain reliability. Avoidance strategies can be found in the areas where climate change mitigation is related to costs and a higher level of network insecurity, namely in the field of renewable energy source integration and new services such as electric vehicle infrastructure and more generally *non-network* upgrades. Distribution companies have established a barrier by charging high connection prices for interested investors (non-discriminatory, for both fossil and renewable energy sources). Many external stakeholders within and outside the value chain perceive investments (in the range of several millions AUD) into the area of smart grid, collaboration and new technologies as being symbolic and too small to change the current system set up. Depending on the point of view, those investments can be looked upon as either positive *compromising* strategies or as *negative avoidance* (*buffering*) strategies.

### 7.2.2 Constituents

According to the survey, the major stakeholders that can influence carbon mitigation are the regulator, the government, political parties, investors and consumers (or consumer groups). Of these, the regulator and customers are perceived to have the major influences. Companies indicate a very high dependency on the regulator in this heavily regulated industry. While many companies prefer not to rate the level of adequacy of climate change mitigation measures (e.g. energy efficiency, integration of renewable energy sources), several surveyed companies state that the signals they get from the regulator are confusing with some regulations being unclear and contradictory. It is perceived that consumers as a group will strengthen their position in the future, particularly if they are represented by communities or consumer groups. The main reason for their activities is increasing levels of network charges. In Victoria, where advanced metering was introduced in order to allow for price responsive demand, customer groups successfully influenced the political decision to review the scheme. This was driven by concerns among the public that electricity prices would increase. Currently, smart meters are still being rolled-out but demand responsive pricing is voluntary (State Government Victoria, 2011).

The analysis of external factors in chapter five showed that opinions regarding climate change mitigation within stakeholder groups differ substantially. Distribution companies perceive however a limited accentuated multiplicity of constituents, mostly due to the overall heavy focus on the regulator and customers as key stakeholders. While almost all companies perceive the regulator as being the stakeholder they are most dependent on, the regulator does not seem to imply a great sense of urgency on structural changes on the companies interviewed. Shareholders play an important role in the sense that they don't appear to attribute value to environmental sustainability of their investments but strongly focus on high returns.

The indicated overall multiplicity of constituents can still be viewed as moderate; due to the fact that parties within the parliament follow different carbon mitigation strategies and that consumers have different priorities than the current government.[31] The dependency is rated as high because companies strongly depend on governmental and regulator's influences.[32] This combination is according to the framework likely to lead to *passive (acquiescing)* or *compromising* strategies (*active positive*). Scott Jeffries and Greg Picker from AECOM both support the view that they find distribution companies to be waiting with their investment decisions given the uncertain future developments.

As investment in infrastructure is often very high, companies fear that they may *get it wrong* with only one chance to take the best possible decision. According to market insiders, the carbon pricing as well as evolving technologies will help to guide companies to make their choices in the near future, when it becomes imperative to replace infrastructure (Jeffries, 2011; Picker, 2011). An example of active behaviour that was mentioned in the survey was the use of working groups including internal and external stakeholders to discuss the future development of network services. In addition, an active dialog between most of the distribution companies and the regulator seems to be going on, mostly in the framework of the five-year network development planning. None of the distribution companies surveyed stated that active lobbying with one or more stakeholder groups is being undertaken. However, distribution companies are organised through the Energy Network Association ENA acting on a political level for the benefit of its member organisations.

### 7.2.3 Content

The norms the institutional change aims to shift are towards a less carbon dependent society and more efficient energy use. The goals are based on the Kyoto protocol and international agreements on the damaging impact of climate change. The government's target – in line with international agreements – is a 60% reduction of $CO_2$ by 2050 compared to 2000 levels. However, the current government values short term economic concerns higher than climate change mitigation and aims at an initial reduction of a mere five percent by 2020. Even with the policies in place now, and taking the future carbon pricing scheme into account, coal as fuel for electricity production will still be an economic viable option.[33] This means that it may remain interesting for investors to maintain or extend coal-fired power plants in Australia. In addition, gas will become more viable, which can lead to smaller scale, more decentralised gas-fired power plants, directly feeding into distribution networks instead of transmission networks.[34] There are however very few surveyed companies that expect the carbon tax / ETS to have a significant impact on their business. Only one company has according to the survey put a price tag on this new regulatory instrument.

At the same time, higher electricity prices may lead to reduced demand for electricity, potentially cutting down on some of the overall demand.[35] Future price responsive tariffs should help to cut down on peak demand caused by residential customers. However, as the majority of electricity is used for industrial purposes, the overall market is still expected to grow. According to stakeholders interviewed, it is unlikely that customer life-styles and demand based on extensive electricity use will change in the next few years (I1, 2011; Tomar,

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[31] See chapter four on external barriers and drivers for more information

[32] E.g. the revenue cap, approval of investments within 5-year periods and regulations on network reliability and security

[33] Reasons explaining the very cheap production costs of coal-generated electricity include that coal is readily available in Australia with 65% opencast mining, low building and operating costs of large-scale coal fired power plant and subsidies provided by the government to the coal industry (Lucas, 2011; World Coal Association, 2011)

[34] As described earlier, gas is a cleaner, more efficient option than coal. However, particularly the use of coal seam gas as intermediary fuel is heavily debated by NGOs and some academics.

[35] See the fuel modeling scenarios in chapter four

2011). The renewable energy target, aiming at 20% renewable energy sources by 2020 will most probably lead to further small and medium scale energy sources, mostly gas, wind and solar that the distributors will have to accommodate in their networks. However, as the target is on a national and not state level, it can be expected, that the distribution of renewable electricity will vary significantly from state to state (Lucas, 2011). Only one of the distribution companies interviewed stated that the carbon tax coming into force in 2012 will significantly affect their business.

New electricity sources and higher electricity prices may strongly affect the networks and require new investments. All distribution companies treat residential demand management, demand sensitive pricing and other elements of smart grids as business opportunities rather than policy imposed burdens or environmental good-will projects. The main driver indicated is to reduce peak demand thereby avoiding or delaying network investments. However, activities seem to focus quite heavily on residential customers. While those customers have a market share of only 27% they have a high(er) business value of 53% of the market (see illustration 3-3). Several external stakeholders state that distribution companies have a high self-interest in installing new assets at customer level to gain revenue from asset installation. Installation of smart meters and a push for a smart grid provides distribution companies with what Parratt and Tomar call *an excuse* to install new assets and increase higher network charges to their customers. This information contrasts with a strong majority of distribution companies indicating that they feel customer pressure not to increase network charges and to find solutions to cope with peak demand without increasing network assets. As an additional factor, by including telecommunications and high-end technologies in the network, it is projected that the industry will become more attractive for a young, highly-educated work force, adding new technical skills to it.

Contextual constraints can be found in reliability issues of the network and financial investments required for the integration of medium and large scale renewable energy sources. According to David Adams, Technical Director Economics at AECOM, distribution (and transmission) companies generally have a negative attitude towards the inclusion of distributed (renewable) energy sources into their network as they can decrease the network of and incur extra costs, some of which cannot be rolled-over to generators or end-customers. One major problem is that current distribution networks are built to include decreasing voltages charges[36] in their networks and cannot handle (significant amounts of) voltages from small or medium scale generators flowing in the opposite direction satisfactorily (Eckermann, 2011; Tomar, 2011). Additionally, distribution companies generate revenue by adding network assets and not by including new generators into the system. They have therefore limited incentives to lower high connection costs to encourage the integration of medium and small scale renewable energy sources (D. Adams, 2011). So far, small scale photovoltaic roof-top generators, supported by state-level feed in tariffs and bonus schemes have proven to be popular amongst residential customers. Those very small scale renewable energy sources have had a huge success in all states with feed-in tariffs and / or additional measures such as solar bonus schemes. With an overall capacity of well below one percent of the total electricity input, they currently provide no threat to the current system.

Taken together, the survey indicates that companies will apply *positive active* measures in the context of climate change mitigation. Strategic approaches undertaken at the moment are to inform customers about energy efficiency and undertake trials and research to find out how responsive customers are towards behavioural change. About half of the companies interviewed feel however, that customer information should mostly be the task of retailers. In

[36] From 220kV – 66kV at main hubs down to 230 V at residential consumer level

addition, distribution companies engage in investments for new technologies and innovation programs to development new customer relationships and business models. However, the self-perception of a proactive and innovative approach with significant investments is questioned by external stakeholders. Actors such as business consultants and academic proponents indicate that distribution companies follow *avoidance* strategies in the field of non-network upgrades including generator integration. Negative activities mentioned in that area are limited transparency in decision making, high connection pricing,[37] use of their market knowledge and power to indicate their preferred solution to the regulator.

### 7.2.4 Control

So far, the distribution companies have mostly been affected by the federal GHG Reporting Act, a law requiring the companies to list and report their GHG emissions on a yearly basis. According to findings from the survey, companies comply with the Act and have been reporting their emissions for the last three years since the legislation came into place. In particular, companies owned by the government would seem to have a strong incentive to comply. All of the companies report their results according to ISO 14001 standards. Other voluntary activities are in the area of customer information, the development of smart grids and demand management. However, those activities are most often on a small scale, in trial phase, and with unclear outcome for actual future business activities. No trends between the size of the company, the operating area (rural/ urban) or the ownership in relations to compliance could be established through the survey. According to Tomar from Energy Response, governmentally owned companies generally put more effort into residential demand side management and smart grids than publicly owned distribution companies (Tomar, 2011). This view is supported by the results from the survey.

Overall, coercion is rated as high and diffusion of voluntary activities supporting climate change mitigation within the industry from low to moderate. The strategic response is thereby expected to range in the area between *passive neutral (acquiesce)* and *active negative (avoidance)*. The survey indicates that companies do comply with rules and regulations. Tomar indicates that companies do not lobby for different rules or breach rules in place. They have however the necessary insider knowledge and the market power to apply the rules in economic favour for the companies (2011). This includes for example the avoidance of non-network upgrades.

### 7.2.5 Context

There are many aspects to the external environment as indicated in the PESTEL summary in chapter four. Responses to this research indicate that major uncertainties exist in the area of future market development, future policies (depending on the next government), the international carbon price development, customer influence and future collaboration models. Despite these apparently unstable elements, companies feel a certain degree of stability due to the strong role of the regulator that is seen to be slow-moving and thus stable. An additional factor that may play an important role is that distribution companies are perceived to be very powerful with a monopoly not only on their network but as well on the knowledge of what needs to be done to maintain a reliable and stable network. They can therefore use the existing rules in the economically most efficient way to gain high profitability.

Given the huge investments and the long life-span of the infrastructure, five year periods still don't provide full risk coverage for companies. It could however provide a barrier to follow faster market developments in the near future with network charges being bound for the five-year periods. Illustration 7-1 below indicates the current and future planning periods for

[37] It is important to note that connection costs are non-discriminatory, applying to fossil and renewable energy sources

distribution companies. The timings of the transmission companies investment planning include a five years period as well but differ –except for the case of NSW – from the distribution network planning periods(Australian Energy Regulator, 2010)

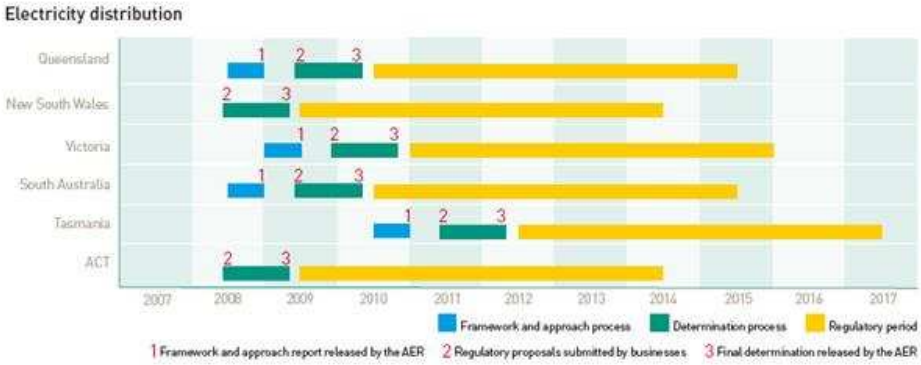


*Figure 7-1: Planning periods for distribution companies*
*Source: (Australian Energy Regulator, 2010, p. 53)*

Almost all distribution companies perceive increasing uncertainty and accelerated change coming in the next five to ten years due to new players and technologies. Some companies undertake scenario planning to be ready for incremental and/or more radical change. While distribution companies are in a traditional supplier relationship with transmission companies, it is perceived that further collaboration between medium and small-scale power generators as well as retailers may be required. Companies are interconnected in a way as there are industry wide organisations such as ESAA, ENA and cross-industrial project forums. Some of those forums include new actors such as IBM and GE (IT / telecommunications solutions).

Given this situation, the uncertainty in the external environment is rated high and interconnectedness, which describes the level of inter-organisational relations between companies in one organisational field, is perceived to be moderate. This suggests that *active negative* (avoidance) strategies will be pursued. The surveys indicate the distribution companies don't undertake strong lobbying activities but use their market and knowledge power to influence rules and regulations according to their best (economic) business interests. The main point of influence and interaction to do so is through the consultative process for the five-years planning between the regulator and distribution companies. While many distribution companies generally perceive themselves as active in developing demand side response and smart grids, external stakeholders perceive the companies to be inert without significant ongoing change happening. It appears that distribution companies have the technologies and technological knowledge available but don't heavily engage in new services such as demand management because of limited economic gains, perverse regulatory incentives and low levels of management attention. Retailers such as ERM and new companies such as GreenBox, an energy service provider with retailing rights are moving into the market to use business opportunities in the area of demand management and new services, indicating that financial gains can be achieved (Barnes, 2011; Parratt, 2011).

## 7.3 Overview of Findings from the Survey

Based on the indicative factors described and analysed in the previous sections, strategies of distribution companies in regards to climate mitigation are expected to range between slightly *positive* or *negative activity* levels to *passive* levels. It is important to note, that Oliver's framework assumes that companies can take on different strategies for different kind of change. This is reflected by more *positive* activities towards smart meters and higher reluctance to change in

the area of demand management. The main strategies that companies can be expected to follow are provided in figure 7-3 below. This illustration is based on the survey results and external stakeholder views. As indicated at several points in the previous section, external stakeholders generally perceive the strategies to be a lot more passive or *negative active* than the companies themselves.

| Strategy | Cause | Constituents | Content | Control | Context |
|---|---|---|---|---|---|
| Active positive (p++) | | | | | |
| Active positive (p+) | Balance | Pacify (customers) | Balance / Bargain | Pacify | |
| Passive, neutral | | Comply | | Comply | |
| Active negative (n-) | Buffer | Conceal (information) | | Buffer | Buffer |
| Active negative (n--) | | | | | |

*Table 7-3: Strategies based on Oliver's framework and the survey results*
*Colour code: the darker the colour of the indicative factor / strategy, the more often this outcome would be expected from the companies surveyed according to the responses they provided*
*Source: compiled by the author and adapted from (Etherington & Richardson, 1994; Oliver, 1991)*

Based on the information provided by the companies; many of them are actively tackling challenges in the area of residential demand management and the changing future use of electricity. However, companies appear to be hedging their current activities, not fully engaging in full-fledged projects bur rather small scale trials; potentially reflecting avoidance and compromising strategies of pacifying or buffering. Some of the companies are actively trying to influence institutional change by submitting information to the regulator and the government. Additionally, a majority of the companies surveyed work together with other companies both within and outside the industry and with customer groups to achieve a better use of the network capacity, thereby mitigating carbon. This study indicates that the business case and not the environmental thinking is the main driver for those activities.

Graph 7-2 below summarises information provided by distribution companies, stakeholders and information from online sources.

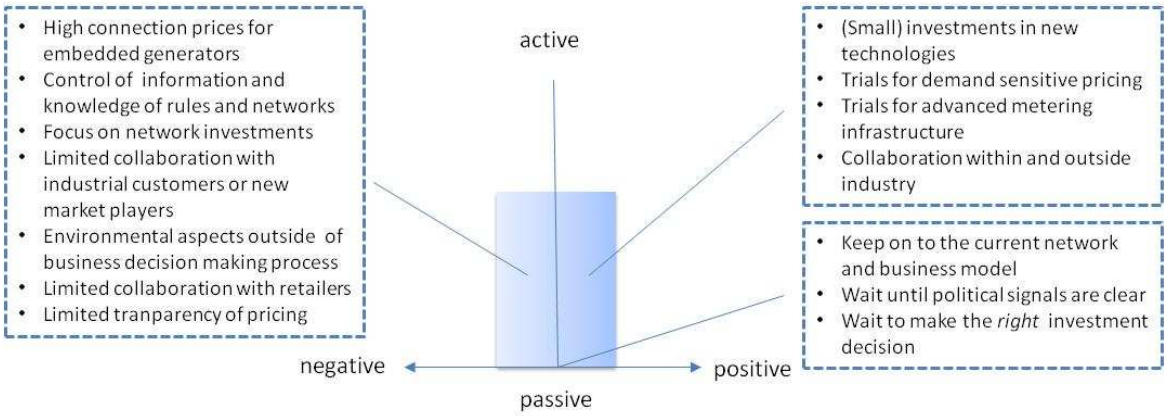


*Figure 7-2: Overview of strategic response to climate change mitigation issues*
*Source: compiled by the author*

Companies perceive themselves as generally positive towards climate change mitigation on the demand side. However, the levels of activity differ to a certain extent within the industry. Besides a regulatory-driven roll-out of smart meters in Victoria, no general activity differences could be established between companies operating in different states. While both governmentally owned and privately owned companies are among those perceived as

particularly active, the survey and stakeholder feedback indicate that governmentally owned companies appear to be more proactively engaged than some privately owned companies. It is however difficult to estimate, how much of the difference needs to be attributed to the level of communications effort vs. actual activities undertaken. The interview with Jitendra Tomar from Energy Response supports the finding that governmentally owned companies generally have a higher level of activities in the field of carbon mitigation. The correlation between *passive* behaviour in situations with high effect uncertainty, as proposed by Clemens et al. (2008), is supported by the survey. Concrete examples are the tendency to wait with new major investments until the policy situation becomes clearer and the cautious, risk avoiding approach in the smart grid area. Another hypothesis indicating active behaviour in correlation with high uncertainty was not supported by this survey. An interesting finding is that medium to large scale companies appear to be more active than small scale companies, contradicting another of Clemens hypotheses. This finding may point to the fact that larger companies have more resources available to influence their environment and to create dynamic capabilities.

The distribution sector has been inert for many years with few initiatives or new technologies being introduced. This inertia may in turn be an indication of limited capacity for proactive change and collaboration with new stakeholder groups. Distribution (as well as transmission) companies are perceived as quite powerful market player that normally prefer not to step outside their normal business areas. This information is supported by interviewees with long standing experience within the industry and the field of carbon economy. Some external stakeholder indicate that distribution companies mostly use the area of smart grids as public relations exercises rather than backing it up with actual business cases. This view is however only partially supported by other stakeholders. Glenn Patt from the research institute CSIRO indicates that some companies including AusGrid, Energex and ETSA are doing interesting work in the smart grid area and states that "some [companies] may support it [change] while many more will not" (Platt, 2011).

## 7.4 Strategic Outlook

With climate change issues accelerating on many different levels e.g. within the policy area (carbon tax, feed-in tariffs, RET), the technology sphere (telecommunications, smart meters, electric cars, renewable energy sources), the social area (higher demand, more active behaviour, price pressure) and the environment (perceived extreme weather conditions, international focus on carbon reduction), distribution companies may have to find ways to accelerate their level of change and actively start to manage environmental issues beyond their direct impacts if they are to sustain their important task of efficient electricity provision.

Table 7-4 summarises the status of the institutional environment according to the analytical framework, the development expected by stakeholders and the industry together with the direction and speed of change. It indicates that change is likely to accelerate and is likely to lead to more active responses. However, some areas are more likely to provoke a positive reaction while other developments may lead to companies avoiding change and defying their traditional strategies. An additional important factor is the level of uncertainty in the external environment making it difficult to predict the reliability of the information indicated above.

Current literature suggests that changes in the external environment may not only require changes in strategic approaches but rather changes in the whole business or industry model.[38]

[38] Depending on the definition used, business models can include all activities in the value chain or can be limited to reflect only the monetary value flows leading to profitability of organisations. Elements often included reflect the value proposition towards the customers, processes, resources and profit. What successful business models have in common is that successful companies often transform their models before they are forced to do so by

Fox-Penner (2009) stipulates that the "logical next business model for the industry" will be selling services instead of outputs. This view is supported by a US study postulating that the business model will shift away from the traditional seller-buyer relationship towards re-defined infrastructure, rules, standards and transactions between electricity providers and consumers The role of consumers is depicted to change, requiring more services but at the same time providing offerings beyond monetary compensation in return, leading to what the authors call a *multisided* platform with multiple buyers and sellers (Valocchi, Juliano, & Schurr, 2010). By charging money for the use of appliances, heat, AC and not the electricity itself energy-efficiency would be the logical consequence with distribution (or other companies) advising customers on electricity reduction schemes (Fox-Penner, 2009).

| Indicative Factor | Current Status | Likely development | Predicted change |
|---|---|---|---|
| Cause | Perceived legitimacy of climate change mitigation; the industry views itself mostly as 'transportation' industry without carbon responsibility from production or use | Higher focus on climate change mitigation; companies will probably try to resist carbon mitigation measures negatively affecting their profitability | Accelerating; can lead to active positive or negative response depending on the level of legitimacy vs. economic constraints |
| Constituents | The main stakeholders are the regulator, government, customer (communities) and shareholders; the main two stakeholders perceived are the regulator and customers; conflicting signals are sent by various stakeholders | Price sensitivity and activity level for customers likely to escalate, new market entrants are likely to start exerting pressure, possibly via politics / regulator | Accelerating ; likely to lead to active positive responses given the high dependency on the regulator and the customers |
| Content | Companies don't feel that they are heavily affected by carbon mitigation but rather by adaptation measures; some business goals in conflict with environmental goals | Policy impacts, distributed generation; peak demand and increasing costs may stipulate further polices affecting climate change mitigation indirectly | Accelerating; can lead to active positive or negative response, depending on the level of constraints added |
| Control | Control is high; however as the distribution companies have monopolistic functions and strong market power and knowledge; they are well positioned to use the rules to their best benefit | Distributed electricity, new technology and new actors coming into the business will require new rules potentially affecting the business models of distribution companies | Accelerating; acquiescing or compromising strategies are likely |
| Context | Highly uncertain situation at the political level (national and international) | The development will become clearer after the introduction of the carbon tax and re-elections | Unstable; likely to lead to a passive strategy |

*Table 7-4: Expected development of indicative factors*
*Source: Derived from interview responses and Oliver's framework (Oliver, 1991); compiled by the author*

Distribution companies may have to consciously decide on business models concentrating on pure network infrastructure, outsourced services such as the installation and maintenance of smart meters or the provision of full in-house service for new technologies and new market players. The management of those activities could be in the hands of distribution companies, retailers or third party consulting / engineering companies (Treadway, 2001; Trygg, Toivonen, & Järventausta, 2007). Along the same lines Grijalva & Tariq propose that changing the control of the infrastructure architecture rather than the architecture itself may be the best way to deal with changes in the electricity value chain (2011). The role of producers and consumers

external factors. This means, that companies need to constantly evaluate opportunities and threats in combination with their own, internal capabilities to match them (M. W. Johnson, 2010).

is expected to become more blurred with formerly passive consumers now having the possibility to actively shift, produce and store energy themselves. Grijalva & Tariq therefore postulate the introduction of the term *prosumers* to reflect the coming change in the electricity system where active consumers regulate their electricity demand based on economic decision making.

## 7.5 Shifting Towards Lower Carbon Electricity Provision

While bound by institutional factors and path dependence (e.g. the infrastructure installed, long established institutional structures and practice), companies that can influence the external environment or use the changing environment for business innovation may gain significant market advantage in the future. In situations of change the concept of *resources* and *capacity* within organisations can become particularly important; Teece (1997) holds that elements such as acquisition of skills, knowledge management and learning may become fundamental to successful business strategies (Teece et al., 1997). According to Teece, difficulties are that change often requires the change of routines and the integration of new tasks. This in turn requires surveillance of the external environment and the willingness of companies to adopt (or establish) best practice. Access to knowledge is thereby a key point. (Teece et al., 1997). It this is so, then particular pressure will be placed on managers leading change as they are the ones who need to build and implement capabilities into the company that allow change – so called dynamic capabilities. An important aspect of such capabilities is that they are intentionally and purposefully managed, thereby drawing the attention on the importance of managers within companies (Augier & Teece, 2009).

Table 7-5 on the next page summarises sustainable business opportunities for distribution companies, barriers, drivers in place and the potential for improved sustainability. As shown in chapter six, all of the activities mentioned can in the broadest sense be labelled under the umbrella term of *smart grids*. It is important to note that this list is not exclusive; future opportunities in other fields may arise with new social behaviour, technological or regulatory development. As shown in table 7-5, besides the installation of smart meters, there are few *obvious* business options at the present that fulfil the requirements of being environmentally sustainable and affordable at the same time besides the installation of smart meters. This is particularly relevant, taking into consideration the price sensitivity of investors and customers, two of the main stakeholders identified. Not surprisingly, a main focus of distribution companies therefore appears to lie on balancing financial gains against price concerns of customers.

Many of the possible activities will therefore require *active positive* responses of distribution companies in areas where current strategies are *passive* or leaning towards *negative active* approaches. As postulated by Delmas et al. (2011) (see chapter 2.4), external triggers in the regulatory, technological, political or social sphere may be necessary to bring about major change. However, as also indicated by Delmas et al. and other authors describing resource based view and dynamic capabilities, companies will have to be internally prepared to absorb such upcoming change (Teece, 2007). Possible approaches on how to improve preparedness to change are mentioned in the next section.

| Business option | Viability /Economics | Constraints/ Drivers | Sustainability |
|---|---|---|---|
| Smart Meters | Increase of automation, control and resilience of network, opportunity for real price tariffs and revenue increases through new assets installed | • Necessary foundation for further smart grid measures<br>• Concerns about higher costs leads to customer resistance (e.g. VIC)<br>• Voluntary introduction under way; however broad coverage and price-sensitive tariffs may require regulatory support | Smart meters themselves don't change electricity use; peak demand shift may lower capacity required; transparency in pricing likely to lead to lower demand |
| Residential Demand Management | Additional service can be provided, opportunity to lower peak demand/ overall capacity | • Low customer awareness<br>• Life-style changes required<br>• Raising electricity and fuel prices (due to e.g. network upgrades, new infrastructure)<br>• New appliances and services required | Potentially high effect to lower peak demand; limited reduction of overall capacity due to large industrial sector |
| Home Network Areas | Focus is mostly on specific items such as ACs / pool pumps; no economic reason for engagement at the moment | • Benefits in additional services, lower costs and higher convenience for users<br>• Appliance producers, IT companies and electric cars drive the process<br>• Questionable social acceptance / need<br>• Complex technological solutions | Similar to demand management; higher potential; potential for virtual power plants |
| Management of Industrial customers | Some interest, not (yet) profitable, focus on industrial customers has a high potential as non-network measure | • Regulatory framework in place is a barrier<br>• Power of distribution companies: asymmetric knowledge<br>• Increasing electricity prices may act as driver for businesses to take actions<br>• Financial gains from the wholesale market as driver for businesses to manage demand | Very high potential; win-win situation for industry and environment; can be offset by strong growth of demand |
| Demand management of SMEs | Currently not interesting to manage from economic point of view | • Raising electricity prices may render demand management viable for SMEs<br>• Technical difficult to create 'virtual' large customers levering the individual savings<br>• Limited awareness; out of the spotlight | Unclear how large the sector is; potentially significant efficiency gains |
| Encourage and integrate RES / distributed generation | Potential increases in reliability-risk and technical problems as well as preference of network solutions appear to outweigh potential gains from connection charges | • RET, feed-in tariffs, solar schemes etc.<br>• Regulatory framework is a barrier<br>• New market players entering<br>• Market power of distribution companies<br>• Requirement for plants with fast ramp up time due to peak demand (gas) | Very high potential, however more expensive option than energy efficiency; potential to reduce network losses |

*Table 7-5: Overview of business options*
*Source: compiled by the author*

### 7.5.1 Changing to *Positive Active* Responses

There is very limited literature and online information available on best practice activities and examples from distribution companies in other countries on the form that such approaches to change could take. Given characteristics of current electricity system where the product itself cannot (yet) be efficiently stored and needs to be consumed immediately, it is difficult to find benchmarking examples in other industries.

Examples that have however been mentioned by several stakeholders are Sydney Water and Melbourne Water, water provider in the area of Sydney and Melbourne, respectively. While water provision infrastructure and electricity provision infrastructure are not fully comparable to electricity utilities, the requirements of sufficient and reliable provision even in time of peak demand and restricted supply i.e. increasingly expensive sourcing of capacity are factors indicating potentially interesting parallels in those two sectors. The cases are shortly described in text box 7-1 below.

**Best Practice**

*Sydney Water*

Sydney Water was forced to act on reducing the use of water due to the lack of possibility to affordably increase water production. According to information provided on the company's webpage, Sydney Water attempts to reduce 24% of water use due to water efficiency initiatives. Sydney water thereby uses school education programs, information material for teachers and excursions. As a whole company, Sydney Water has embraced the carbon mitigation topic with its goal to become carbon neutral by 2020 with a 60% reduction goal by 2012. To achieve this, the company has built own renewable energy sources powering its pumps and stations.

*Melbourne Water*

Since 1997, Melbourne Water has to deal with water scarcity due to drought. Regulations on the use of water (mostly for gardening and car washing) have lead to a reduction from 500 litres per household and day in 1981 to 333 litres in 2005-06 and 277 litres in 2007. This example shows, that behavioural change of people is possible if the urgency of a problem is perceived to be strong enough. Additionally, in the case of Melbourne, water scarcity has had effects on increased collaboration between Melbourne Water and the city planning in order to ensure that urban planning takes sustainable water management into consideration.

*Textbox 7-1: Best Practice: Sydney Water & Melbourne Water*
*Source: (Melbourne Water; Sydney Water, 2011)*

Results from the survey and the stakeholder interviews as analysed through the framework in table 7-3 indicate some areas where preparative adaptation towards carbon mitigation could provide business advantages to the businesses. The author thereby postulates that the *acquisition strategy* is not the preferred alternative, given the weak regulatory framework towards climate change mitigation. The desired strategies from a sustainability point of view needs to be *active*, going beyond the regulatory requirements if a $CO_2$ reduction of 25% is to be achieved by 2020 (in comparison to 2000).

- *Cause*: As shown previously, the efficiency of carbon mitigation for distribution companies is low due to the regulatory framework providing revenues from assets. By anticipating changes in the institutional environment, distribution companies could actively seek to influence the regulatory framework to move towards providing financial incentives for energy-efficiency measures.
- *Content*: Distribution companies understand their business to be the provision of electricity infrastructure, this leading to *avoidance* strategies as institutional change is perceived to threaten the importance of the physical network. However, as shown in chapter 7.5, many future opportunities may lie in service provision. Defining exactly in

what business the company wants to be in (pure infrastructure vs. service provision) may support further managerial decisions making processes on investment. The text-box on distributed generation indicates how future business could look like:

**Distributed Generation as Future Opportunity**

A study by Werven & Scheepers (2005) focusing on the EU indicates that distributed generation provide opportunities as well as threats to distribution companies. The authors state that distribution companies benefit from adapting their strategies from passive towards active entrepreneurial network management with gains in innovation management and diversified business opportunities. However, similar to Australia, the EU regulatory framework is in many cases does not encourage active network management. By overcoming resistance to change companies can seek to proactively influence the development on the regulatory level and broaden their business opportunities – a proactive strategy called *manipulation* in the model of Oliver's adapted framework. Active strategies for the inclusion of distributed generation can include:

- role as market facilitator;
- provision of network and ancillary services through intelligent network management;
    - advanced information exchange between generation and consumption;
    - provision of network reliability and controllability;
    - improve customer benefit and cost-effectiveness.

*Textbox 7-2: Distributed generation as future opportunity*
*Source: (Werven & Scheepers, 2005)*

- *Control*: Many distribution companies participate in smart grid trials. However, those activities don't appear to be part of the broader business strategy indicating that distribution companies don't perceive environmental strategies as being included in the business process. Broader liaison, particularly with new market entrants could provide valuable insights for distribution companies into coming business opportunities

- *Context*: The collaboration with retailers with regards to customer education and offerings appears to be weak. Retailers themselves are perceived by many stakeholders as passive or disinterested in energy-efficiency measures (particularly *gentailers*). With increased demand management potentially undertaken in close collaboration of those two sectors, companies could benefit from selling new services, decrease the need for network upgrades and improve reliability and resilience. Anticipating future change in the regulatory framework, it may pay off for distribution and retail companies to start establishing more in-depth collaboration paths, engaging in knowledge sharing and joint educational activities.

By drawing on the technological knowledge available, the monopolistic (and thereby unique) infrastructure in place and the strong market power, distribution companies have assets and resources enabling them to actively shape their strategies despite the existence of strong regulations. However, due to this market power, an inherent inertia in the industry is observed (reducing their capacity to react to change). Rather, other market players are racing ahead in finding new markets and services. The author therefore suggests that – given the current market situation and regulatory framework – the most efficient and affordable way of reaction to climate change mitigation is to engage in a process of active preparation for significant changes in the next few years. Distribution companies not being able to cope with change may otherwise prove to be a massive barrier for new sustainability initiatives such as distributed generation, electric vehicles or home area network, potentially leaving to all parts of society, the environment and the companies themselves worse off.

### 7.5.2 Active Management of (New) Stakeholders

The multiplicity of stakeholders, their different needs and demands is a particularly challenging area to respond to. Surveys show that customers are open towards new services and products in the electricity system but that they have low levels of trust in both the government and the network utilities to provide them with adequate services (Chisholm, 2010). Other stakeholders such as industrial customers seem to be dissatisfied with both the reaction time and pricing of distribution companies with some new market entrants stating that they feel limited interest from distribution companies. Increasing the transparency and communication on planning and pricing may open up new collaboration channels with established and new customers, leading to opportunities.

As shown in chapter 7.2.2, distribution companies have a relatively narrow view on their main stakeholders with the regulator and the customers being mentioned as the most important ones. Additionally, there appears to be a gap between the internal perception and the external perception of environmental strategies of distribution companies: While distribution companies project perceptions of themselves that emphasise *acquiescing* and *compromising* strategies, in contrast, a number of external stakeholders expressed that they perceived avoidance strategies including *buffering* or *concealment* (limited transparency).

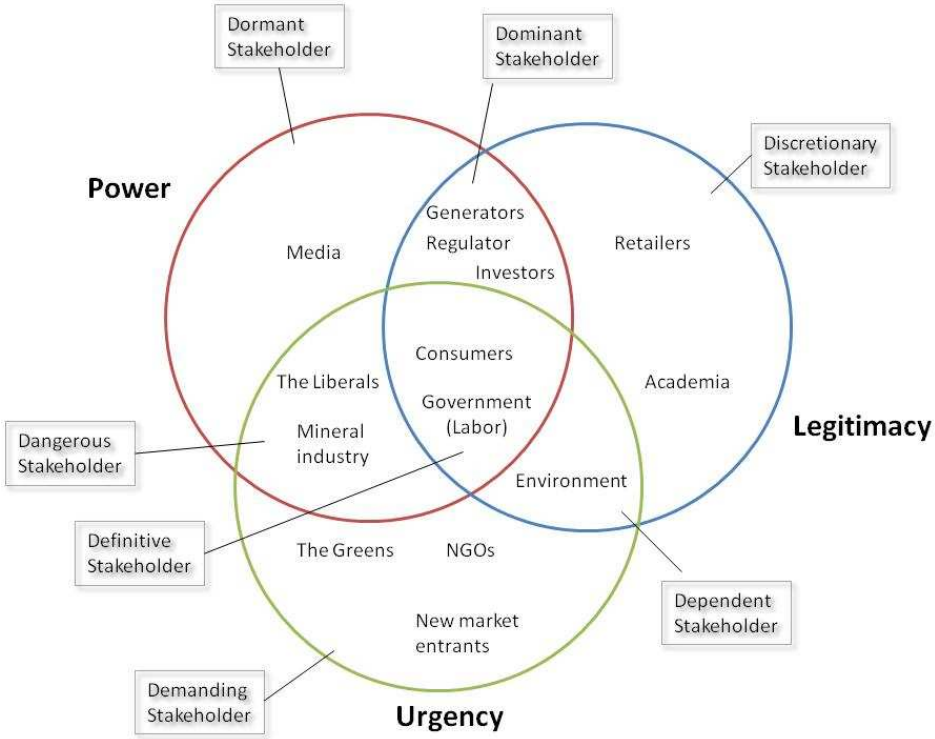


*Figure 7-3: Stakeholder salience – consolidated view (internal & external)*
*Source: compiled by the author, scheme adapted from: (Mitchell et al., 1997)*

Figure 7-3 provides a comprehensive overview of the stakeholder positions as indicated by the survey of distributers and expanded with information from stakeholder interviews. The framework used has been introduced in chapter two and postulates that companies' strategies are most successful if they listen to the stakeholders depending on their power, legitimacy and urgency. According to this framework, consumers and government have been identified as definite stakeholders at the moment while the regulator and investors are in a dominant position. Customers have the potential to become more powerful if they act via associations such as the Energy User Association or Community actions. Generators or combined *gentailers* potentially have the market power to require changes and affect distribution companies,

particularly if they expanded their business models more towards distributed generation. However, as most of them operate large scale coal and/or gas power plants, no urgency of action could be detected. Retailers (not being *gentailers*) on the other hand, are often small businesses, pressured by customers and small margins, thereby in a weak position to negotiate with distribution companies. However, their pressure on distribution companies could increase if new business models based on services allowed them to gain higher margins, increase market size, engage in collective actions and increase profitability. Stakeholders such as the mining industry, NGOs or new market entrants may not directly affect distribution companies but rather lobby pro or contra environmental policies, indirectly affecting the business model of distribution companies.

While distribution companies have contact channels to some stakeholders such as generators, retailers and other distribution companies established via industry associations (e.g. the Energy Supply Association of Australia or the Energy Network Association), the survey indicates that collaboration and knowledge exchange with new market entrants is be limited.

In order to narrow the gap between external and internal perception of the sector's strategy and in order not to miss potential new opportunities or threats, the author suggests that distribution companies set up new channels with various new actors to discuss potential future development and business opportunities. Additionally, an increased level of transparency and communication may be necessary to become an actively integrated actor in a new market shifted towards service provision. In order to reach those goals, the employment of employees with new skills may be necessary. Skills not only in the technical area but as well in the socio-economic field may thereby be of particular importance as they currently appear to be absent.

# 8 Discussion

While the study indicates that there are a number of drivers that are outside of the immediate reach and scope of the distribution companies; the author believes that the results of this study still provide room for valuable insights and recommendations highlighting that more proactive strategies in the area of carbon mitigation are already feasible today. Given the limited availability of literature sources and the limited information available regarding the question on *how network companies can shift* toward lower carbon electricity provision this research appears to be meaningful. Thus far, it appears that many researchers have concentrate on *how the future could look like* with limited focus on the roles of the distribution companies themselves or how businesses can bring about necessary change.

## 8.1 Validity of the Theoretical Framework

The analysis of research results through the lens of the main theoretical framework appeared to be well aligned with empirical evidence from previous studies with regards to the indicative factors and the related strategies chosen. However, in contrast to the initial hypothesis by Oliver (1991) but similar to Clemens & Douglas findings (2005), the study found that organisational size appeared positively linked to the level of activeness. As indicated in chapter two, the author departed from the original framework and, included Etherington & Richardson's proposition (1994) to separate strategic responses into positive and negative activities rather than seek to present strategic approaches along a continuous axis increasing from passive to more and more active. The author found this adaptation useful, indicating that many similar external factors can both lead to *positive* or *negative* strategic responses, depending on the underlying resources and capabilities available. One limitation of the use of the framework is that the data has only been evaluated qualitatively while most other scholars have presented analyses based upon statistical analysis of quantitative data. The author perceives however that the method was adequate for the scope of the study with only eight different companies surveyed and oral interviews conducted. Due to different experience and knowledge levels of the managers spoken to, it may have been more difficult to express differences in perceptions and allow for uncertain results if a statistical approach had been chosen; particularly in the view of limited resources available for this study.

The author perceives that the results based on the stakeholder salience theory according to Mitchell et al. reveal potentially important information for distribution companies by indicating a narrow view of sustainability managers regarding their the salient stakeholders. As indicated in chapter 2.3, the conceptual framework and its related postulations is however not undisputed. It is therefore important to note that the addition of other stakeholder management theories or a stronger focus on the attitude of stakeholders towards the focal companies may have revealed different management priorities.

Resource-based view and dynamic capabilities were chosen to provide insights into potential approaches to change. The author believes that those frameworks provide useful insights for distribution companies as they focus on internal capabilities and have a point of departure that external barriers can be overcome by internal innovation. Ideally, the conduct of one or two in-depth case studies would provide more detailed insights into potential strategic approaches as those are likely to differ between companies given different capabilities and resources. This said, it is questionable if the author could have gained access to top level management members and sufficiently deep insight to apply those frameworks and via such work, advise companies on concrete activities that can be undertaken. An interesting comparison would be, to compare the results of this study analysed through resource-based view with the results

from an analysis using the competing academic framework of Michael Porter, focusing more on positioning and external factors.[39] While the frameworks are complementary rather than contradictory, some different angels and starting points may be discovered by applying Porter's model.

Other theoretical elements worth discussing are the definition of sustainability, affordability and efficiency. There is no clear indication where sustainable solutions within the electricity system begin and what should be discarded as insufficient or out of scope. One area where this situation becomes particularly apparent is in regards to demand management and load shift, here the primary goal is not energy reduction but the reduction of peak demand. Similarly, it is difficult to estimate if smart grid trials, educational activities or more general sustainable positioning are *affordable and efficient* options with tangible business impacts at a later stage. However, the author believes that sustainable and efficient business options are not only the ones providing highest emission reduction or highest rates of return but the ones providing long term value creation and maintenance as e.g. postulated by Okereke (2008). Therefore, those solutions are included in the recommendations.

## 8.2 The Influence of Market Liberalisation on Sustainability

In a broader sense, it is interesting to reflect upon the liberalisation of the electricity market and its consequences for distribution companies and their role in lower carbon electricity provision. While market liberalisation has led to Australia having some of the world's most competitive retail markets, business risks from wholesale market meant that generators and retailers moved closely together and in many cases integrated into *gentailers*. This situation created a principal agent problem, with *gentailers* mostly being interested in increased electricity production rather than energy efficiency. One of the main reasons revealed for this is that profits available from power generation are held to be considerably higher than profits available from the highly competitive retail market. Additionally, due to low profitability, the focus in the retail market has remained on risk management rather than on additional customer services. Similarly, distribution companies consider themselves mostly as electricity transportation companies, delivering electricity from the source (i.e. traditionally the transmission grid) to the end customers. Through the breaking up of the electricity market, they lost their direct contact with end customers, now handled by retailers. This situation appear to be one factor why many distribution companies don't feel responsible for customer information even though they have become direct point of access for customers e.g. through the installation of smart meters.

Given that other future services such as small distributed generation or electric vehicles will require an increased interaction between customers, distribution companies and retailers this situation potentially creates a major constraint for the further development of a sustainable electricity market. While the author does not intend to elaborate on potential other industry models better enabling the integration of energy services or energy service companies (ESCOs), it is certainly an intriguing question if the network would have developed more towards energy reduction rather than asset extension in case the market liberalisation – and/or different regulations - hadn't forced the retail business towards bundling with generation companies and apart from the distribution part.

[39] The original framework of Michael Porter postulates that market advanatages can be reached mostly by product positioning (low cost or differentiiation); competitive advantage thereby depends on five forces: rivalry within the industry; barriers to entry, power of buyers, power of suppliers and threat of substitutes. The model has been adapted by Porter and his scholar to include ‚factors' refering to processes and other elements, bringing the two different models closer to each other (Michael E. Porter, 1988, 2008; M. E. Porter & Reinhardt, 2007)

## 8.3 Changing Institutional Norms and Rules

Institutional theory as e.g. applied by Aldrich & Fiol (1994) suggests that collective intra and intercompany action may be necessary to support emerging industries and provide them with legitimacy necessary to survive and prosper in new areas of business. Additional factors to establish a new industry include socio-political acceptance. Indeed, collaboration appears to be a largely underdeveloped area in the case of smart grid activities within the NEM with new market entrants struggling to gain legitimacy. While the distribution companies have potential advantages, already having access to physical and knowledge resources and the required legitimacy, they have so far shown very limited interest in collaborating and setting up a more sustainable electricity industry. In this context, the author doubts that the industry associations ESAA, ERA and ENA will be able to play a crucial role in developing and supporting new, sustainable yet affordable and efficient solutions. From experience[40] the author had with the various industry associations, she questions if they are open and forward-looking enough, or if they have adequate levels of resources and capabilities to seize the new opportunities given or introduce new skills and capabilities outside of the traditional business model.

Two areas where collaborative activities may play a particularly important role are customer interaction and the establishment of new skills within the established industry. At the moment, customers appear to be sceptical of whether the current market players will be able to shift to more sustainable business options. Overcoming this distrust and establishing sound, long-term relationships may be a first step towards offering new services and changed business models. However, path-dependency and what seems to be the *path of lowest resistance* are currently dominating the market without companies doubting or challenging the industry model as a whole. However, if those industry associations cannot lead the way and increase the legitimacy of new service and product options the question is who can break up obsolete, institutionalised norms and rules to open up new potential for distribution companies?

One other factor that may help to explain a slow change in norms in this area in Australia at least, is a certain reluctance among some academia to work in close collaboration with market actors that the author has perceived during her research. Due to the polemic surrounding the topic, there appears to be a substantial fear that academic reports may be used by politicians or industry players to oppose the development of more sustainable electricity provision in the country. However, research collaboration barriers do not only appear to be in place from the side of universities but as well from the side of distribution companies. A case in point is the statement of one sustainability manager, indicating that collaboration with universities was only being conducted to *oil a squeaky wheel.*

[40] From the contact with ENA it appears, that the organisation did not have the resources to answer a few questions posed by the author within a timeframe of approximately six weeks. Information provided by distribution companies indicates that the ESAA is heavily dominated by the concerns of generators rather than network companies

# 9 Conclusion

This report set out to find out what kinds of sustainable, yet affordable and efficient business options distribution companies in the National Electricity Market may have open to them. In order to answer this question, the report aimed to describe business options and analyse strategies and business activities currently under way to then being able to answer the question on *How can companies, active in distributing electricity in the National Electricity Market, efficiently, affordably and sustainably react to change related to climate change mitigation?*

Addressing the first sub-question on *What sustainable business opportunities appear to be emerging within the sector?* leads to the two main areas of supply-side and demand-side management, now often referred to under the umbrella term of smart grids. Business opportunities on the supply side are provided by new, small to medium sized power generators being added directly to the distribution grid. Connection agreements and charges can provide revenue to distribution companies while an increase in electricity input can increase the reliability and electricity security demanded by the regulator. However, oscillating renewable energy sources, bottom-to-top energy flows in the network as well as the task of managing an increasing amount of distributed generators can pose threats to the distribution companies. On the demand side, elements such as smart meters, home area networks including electric vehicles as well as large scale demand management can provide opportunities to lower peak demand that is currently a prime concern for distribution companies. In addition to the potential load shift, demand side measures provide the opportunity for new services in the area of energy-efficiency leading to higher customer convenience and lower electricity costs. The installation of smart meters provides revenue to distribution companies while other services and energy-efficiency measures are not currently providing distribution companies with a business case. Many of the new opportunities experience institutional barriers such as inadequate regulatory framework, energy-intensive life-styles, immature technologies, and more generally the overall paradigm of the forms or appearance that stakeholders expect of electricity systems.

The second question *What carbon mitigation strategies and activities are being undertaken?* was addressed by conducting a survey amongst distribution companies and questioning external stakeholders. Results were analysed using an adapted version of Oliver's theoretical framework on strategic response to change. The survey showed that most of the companies actively mitigate carbon emissions from direct business activities. However, those mitigation efforts are marginal and most distribution companies do not actively seek to address the key areas of their carbon footprint, which are network losses. Even more importantly they are only undertaking a few activities related to energy-efficiency and the integration of renewable energy sources. Strategies within the distribution sectors were found to be quite homogeneous with activities mostly found on the residential demand side management, driven by peak demand concerns. *Passive* behaviour was indicated quite homogeneously in the area of distributed generation, large customer demand management and the handling of new services and collaboration with new market entrants. The homogeneity can be partially explained by the similarity of resources and assets available, a current heavy focus on engineering, technology-based solutions and infrastructure improvements. The high value of the infrastructure itself is another indicator that path-dependency will lead established companies to protect those traditional business assets.

From an external point of view, a majority of stakeholders perceive distribution companies to be hesitant at best; in general they are seen as largely *inactive* or even defensive towards carbon mitigation. While distribution companies are not openly *defying* certain emerging changes, high connection costs for distributors, limited transparency in planning and charging, strong market power and limited knowledge sharing activities are perceived by many as evidence of the

adoption of avoidance strategies; trying to defend the old business model based on revenue from infrastructure assets. Those aspects were then taken into consideration to answer the main question on *How can companies, active in distributing electricity in the National Electricity Market, efficiently, affordably and sustainably react to change related to carbon mitigation?*. As shown previously, business opportunities are available; however their present economic viability appears to be limited by a combination of social, technological, political and legal factors. The installation of smart meters in residential areas currently being the most viable option, provides both, business value and sustainable advantages. In line with what has been suggested by Delmas, the author believes that actual major change may have to be triggered by external factors such as an adapted legal and political environment and shifts in the social sphere. However, this finding is not intended to indicate that distribution companies should remain inert.

This research indicates that institutional change can be expected to accelerate in more areas than just climate change mitigation. This will place more pressure on distribution companies going forward to adapt their resources and capabilities. In this situation, those companies can decide if they prefer to *react* to changes pushed upon them or work to *proactively* shape their options and be prepared for new business alternatives to come. While few information sources could be found on best practice examples and empirical research in the area of applying dynamic capabilities to electric utilities or distribution companies, the author strongly suggests that preparedness for change will be a critical success factor for distribution companies in the Australian market. Even though major change may take another five to ten years, the author perceives that she has identified certain areas where adaptation would be feasible, affordable, efficient and leading to more sustainable solutions in the long run. Key areas identified range from more active participation in policy shaping to increased transparency and openness towards stakeholders, the active search for a new, future business models, active shaping of the public view, broader liaison across industry borders and a potential change in collaboration with retail companies. It is however important to note that those recommendations are rather generic and theory based, are based upon evidence collected in a small sample of interviews and reflect the opinion and experience of the author.

More generally, this analysis suggests that the creation of new capabilities and resources demanded by the changes or approaches suggested above will require changes in organisations. They will need to build management diversity, the acquisition of new employee skills, processes and routines. The reason is that fundamental changes to the business model are likely to require not only currently available knowledge on how to conduct business but new ways of acquiring skills and implementing them into the company's strategy. The development of dynamic capabilities not only focusing on technical and engineering aspects but taking societal and institutional factors into consideration are likely to be crucial. Importantly, companies may have to learn how to change such elements, which is a dynamic capability in itself. One possible starting point to obtain learning capabilities is the sourcing of new personnel from different fields, not only related to engineering tasks but as well to socio-technical aspects and new business innovation areas.

If distribution companies manage to move away from their current focus on physical infrastructure more towards customer values and electricity service they may be able play an important role in encouraging and facilitating new electricity industry models. Such models are likely to be based on multisided inputs from residential, industrial and commercial customers as well as new market entrants such as distributed generators, electricity vehicle infrastructure providers and other, maybe yet unknown actors.

As an established industry with institutional legitimacy, knowledge and established processes in place, distribution companies may potentially be better positioned to attract new, highly qualified employees and build trust than new companies moving into the market. It will be up

to the individual companies and their collective, coordinated activities within and across the industry to decide if they want to use this unique opportunity ahead of them or let it pass and let others benefit from it.

## 9.1 Further Areas for Research and Transferability of the Study

This study only looked at a small part of an area that seems to be unexplored in many ways. Further areas for research that are identified include the following:

- business models of distribution companies including a focus on collaborative aspects within the supply chain and new market entrants;
- roles of branch organisations and collective actions related to above;
- an analysis of the electricity market taking new market entrants as focal area; the study could include barriers and drivers within the established industry and policy support required;
- a study similar to this one focusing on retailers indicating their strategies, activities and business opportunities;
- a study providing insights into the benefits / shortfalls of the market liberalisation including the development of *gentailers*;
- identification and review of new skills and capacities required in the workforce;
- including research to find out if there is a sufficient pool of skills in the professional land vocational area;
- educational programmes related to above and the role of industry in promoting skill availability.

Findings from this study indicate that network service providers in other countries or regions may be affected by similar changes in the external environment including changing demand patterns; smart grid developments and the inclusion of more decentralised, renewable energy sources (see Appendix J for smart grid developments in the EU and the US). The author therefore suggests that it could be interesting to apply the theoretical framework developed for this paper to other geographic areas where centralised electricity systems are in place. Other interesting fields of application for the framework may be relating to companies active in the field of infrastructure provision such as water provision or transportation services.

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Distribution company G (2011, 01 August 2011). [Phone interview with Manager Strategic Planning and Communications].

Distribution Company H (2011, 01 August 2011). [Phone interview with Sustainability Manager ].

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Parratt, C. (2011, 25 July 2011). [Personal interview with Chris Parratt, National Business Development Manager, ERM Power Limited].

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## Conferences

*National Climate Change & Energy Efficiency Briefing, Energy User Association; 18 August 2011, Sydney*

- Anthea Harris, Chief Adviser, Department Climate Change & Energy Efficiency, presentation on *The Clean Energy Future Plan and Energy Users*
- Phil Watts, Group Procurement Manager Energy, Boral Ltd on Energy Users' Assessments; presentation on *Fhe Carbon Tax*
- Robert Poole, General Manager Industry & Government Affairs, Murray Goulburn Co-Op Ltd, presentation on *Energy Users' Assessment of the Carbon Tax*
- Peter Hawkes, Special Counsel, Herbert Geer, presentation on *Clean Energy Legislative Package – the detail explained*
- Chris McPherson, Senior Consultant Energetics, presentation on *The Carbon Price – Expected Price Trends for the Major Energy Sources*
- Roman Domanski, Director, Energy User Association of Australia, presentation on *EUAA's assessment of the Clean Energy Future Plan and its Impact on Energy Users*
- Cameron O'Reilly, Executive Director, Energy Retailers Association, presentation on *A Carbon Tax: What the Energy Retailers Think*
- Bruce Mountain, Director; Carbon Market Economics, presentation on *Renewable Energy Subsidies and What They Cost Energy Users*
- Brian Morris, Managing Director M&C Energy, presentation on *Outlook for Renewable Energy Prices & Strategies to Manage the Increasing Cost of Renewable Energy*
- Basil Carlo-Stella, General Manager Professional Services, Schneider Electric s, presentation on *Avoiding Energy Price Increases – the Challenge for Energy Users Through Action on Demand, Tariff & Cost Reduction*
- Ross Fraser, Chairman & Executive Director, Energy Response, presentation on *Energy Reduction through Demand Management*
- Graham Bryant, Project Manager, Simplot, presentation on *Energy Efficiency & Optimisation*

# Appendix A: Interviews

| Name and title of interviewee | Company | Topic of interview | Type of interview and date |
|---|---|---|---|
| David Adams, Technical Director Economics | AECOM | Insight into the electricity market value chain, experience of working with customers within the electricity sector | Phone interview, 11 July 2011 |
| AER (written feedback) | AER | AER's position and influence towards sustainable energy production | Email interview, 28 July 2011 |
| Simon Barnes, CEO & Executive Director | GreenBox Group | Information on how new market entrants perceive the development within the electricity market | Phone interview, 2 August 2011 |
| Mark Diesendorf, Deputy Director | Institute for Environmental Science, UNSW | General information on electricity market, Australian renewable energy modelling, Australian politics | Personal interview, 4 July 2011 |
| Robin Eckermann, Vice President | SmartGrid Australia | Information on SmartGrid developments in Australia, regulation, politics and technical aspects | Phone interview, 14 July 2011 |
| Manager DSM Technology and Strategy | Distribution company A | Information on technical aspects and new business areas, company activities and market development | Phone interview, 15 July 2011 |
| Director Smart Networks | Distribution company C | Information on business activities in new areas such as smart grid, integration of renewable energy etc. | Phone interview, 28 July 2011 |
| Protection and Control Engineer | Distribution company F | Information on technical aspects, development of new market areas | Phone interview, 22 July 2011 |
| Policy Manager | Industry Association | Information on wholesale market, actors along the value chain and policies | Phone interview, 9 June 2011 |
| Policy Manager | Industry Association | Information on market players, policies, perceived market shortcomings | Phone interview, 15 June 2011 |
| Sustainability Expert | Distribution company A | Survey, general questions on electricity market development | Phone interview, 6 July 2011 |
| Manager Climate Change | Distribution company B | Survey | Phone interview, 8 July 2011 |
| Sustainability Expert | Distribution company C | Survey | Phone interview, 15 July 2011 |
| Group Manager Sustainability | Distribution company D | Survey, general information on the electricity market | Phone interview, 18 July 2011 |
| Sustainability Manager | Distribution company E | Survey | Phone interview, 1 August 2011 |
| Environment and Sustainability Manager | Distribution company F | Survey | Phone interview, 22 July 2011 |
| Manager Strategic Planning and Communications | Distribution company G | Survey | Phone interview, 1 August 2011 |

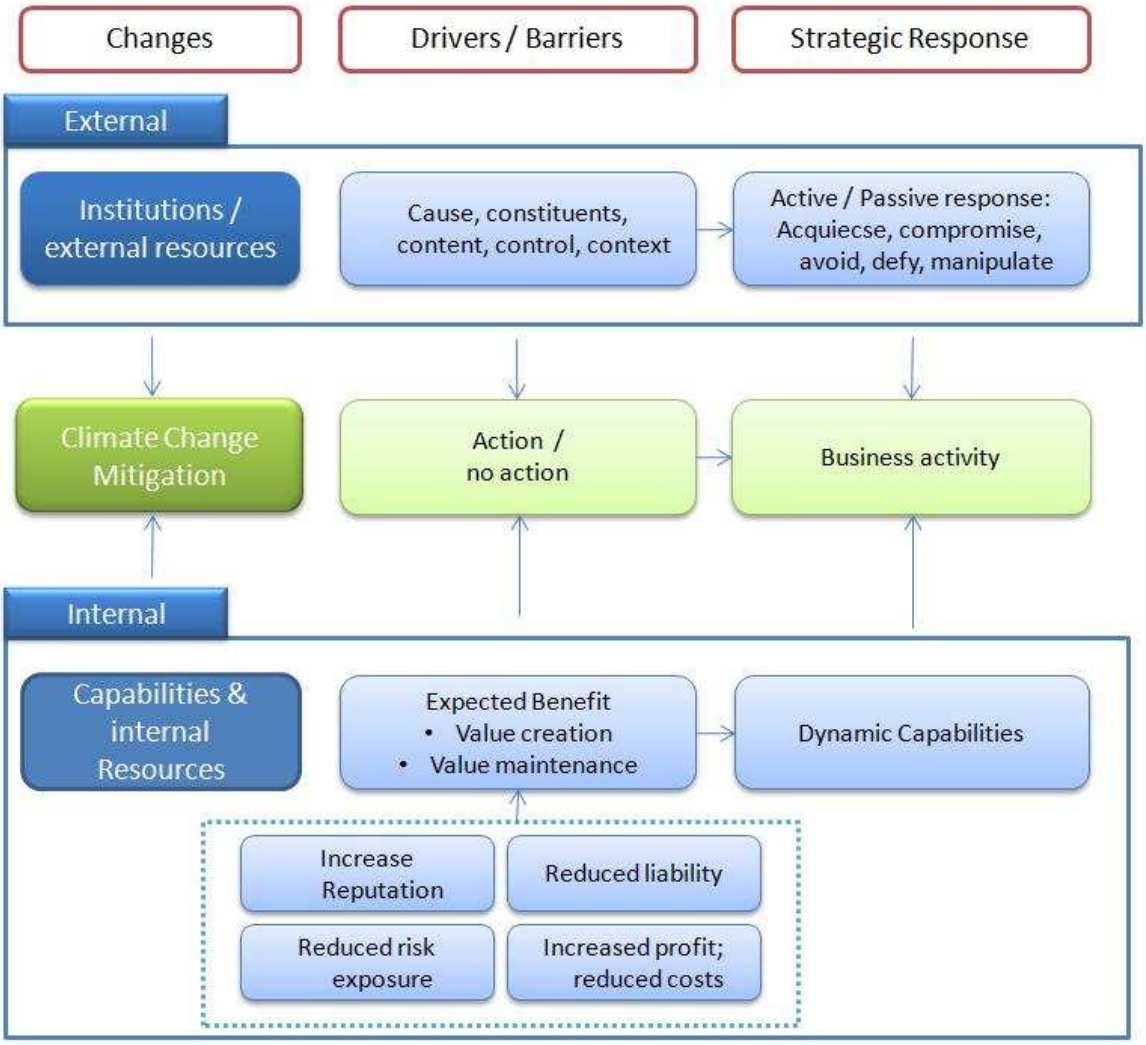
| | | | |
|---|---|---|---|
| Sustainability Manager | Distribution company H | Survey | Phone interview, 1 August 2011 |
| Scott Jeffries, Associate Director Power | AECOM | General market information, perceived positioning and strategies of distribution companies, information on future market development | Personal interview, 6 July 2011 |
| Adam Luca, Lecturer | University of Wollongong / Beyond Zero Emissions | Information on historic background of electricity industry, regulations, Australian politics, modelling of future energy supply, media and other actors | Personal interview, 22 July 2011 |
| Chris Parratt, National Business Development Manager | ERM Power Limited | Information on role of retailers, perception of distribution companies, strategies in place, policy, wholesale market | Personal interview, 25 July 2011 |
| Greg Picker, Associate Director Sustainability and Climate Change | AECOM | General information on the electricity market and information on policies / regulations and their development | Phone interview, 3 July 2011 |
| James Pirie, Manager Structured Transactions | Hydro Tasmania | General market information, perception on distribution companies from the generator's point of view | Phone interview, 8 August 2011 |
| Glenn Platt | CSIRO | Information on smart grid and DSM development in Australia, role of the different actors within the market chain, information on distribution companies | Phone interview, 28 July 2011 |
| Sharmin Salahuddin, Director Sustainability & Climate Change | AECOM | Information on AECOM's expectations of this thesis work, general information of the electricity market | Personal interview, 30 June 2011 |
| Martin Stephen | Powerlink | Information on transmission companies, regulations and policies and collaboration between transmission and distribution | Phone interview, 18 July 2011 |
| Jitendra Tomar, Network Specialist | Energy Response | Information on the electricity market, the role of distribution companies, the value chain, policies, demand side management | Personal interview, 25 July 2011 |
| Julien Vincent, Climate & Energy Campaigner | Greenpeace | Information on new carbon policy, the view of NGOs in Australia (Plan B), the current structures, policies and regulations in place | Email interview, 29 July 2011 |
| Tim Watts | Better Place | Information on electric vehicles, the collaboration with distribution companies, market developments and the role of policies | Phone interview, 3 August 2011 |

*List of interviews conducted for this thesis*
*Source: compiled by the author*

# Appendix B: Questionnaire

1. What is the size of your company (employees, turnover)
2. What is your role in this company and how long have you been having this position?
3. What does climate change mitigation mean to you?
   a. Does climate change mitigation have a high priority within the company?
   b. What kind of uncertainties is your company facing in regards to climate change
4. Which institutional changes related to climate change mitigation have affected the company so far?
   a. On state or federal level?
   b. Which climate change mitigation issues will affect the company in the future?
   c. How legitimate to you think are those issues / demands?
   d. How efficient would you rate the current regulations / institutional procedures in place?
5. What specific actions has the company taken so far to reply to climate change issues?
   a. What is the reasoning for the undertaking of those specific actions?
   b. Which further actions are planned?
6. What is the company's strategy in regards to climate change issues?
   a. Does the company agree with climate change policies (and the resulting obligations for the company)
   b. Do climate change issues interfere with other company goals?
7. How do you think will the T&D market develop generally, over the next 10 years (e.g. growth, peaks, investments given the current policies?
   a. What is in your view the most likely policies that will be in place in 2020?
8. What are the most important stakeholders within your industry?
9. Who is pushing climate change issues which will affect your company (e.g. government, international pressure, customers, environmental groups, political parties, value chain, industry)?
   a. How high is the external pressure regarding climate change mitigation issues?
   b. How dependent are you from those stakeholders?
10. Does your company play an active role in the policy shaping process?
    a. How?
    b. What is the expected outcome?

# Appendix C: Strategic Decision Making and Response to Change




*Combining institutional theory and RDT with RBV and dynamic capabilities*
*Source: compiled by the author*

# Appendix D: Overview of Distributors in the NEM

| NETWORK | CUSTOMER NUMBERS | LINE LENGTH (KM) | MAXIMUM DEMAND (MW) (2008–09) | ASSET BASE (2009 $ MILLION)[1] | INVESTMENT — CURRENT PERIOD (2009 $ MILLION)[2] | CURRENT REGULATORY PERIOD | OWNER |
|---|---|---|---|---|---|---|---|
| **QUEENSLAND** | | | | | | | |
| ENERGEX | 1 256 574 | 52 361 | 4 593 | 7 867 | 5 602 | 1 Jul 2010–30 Jun 2015 | Queensland Government |
| Ergon Energy | 636 480 | 145 904 | 2 498 | 7 149 | 4 866 | 1 Jul 2010–30 Jun 2015 | Queensland Government |
| **NEW SOUTH WALES AND ACT** | | | | | | | |
| EnergyAustralia[3] | 1 591 372 | 49 546 | 5 918 | 8 431 | 7 837 | 1 Jul 2009–30 Jun 2014 | New South Wales Government |
| Integral Energy | 859 718 | 33 579 | 3 798 | 3 744 | 2 721 | 1 Jul 2009–30 Jun 2014 | New South Wales Government |
| Country Energy | 786 241 | 189 823 | 2 332 | 4 382 | 3 826 | 1 Jul 2009–30 Jun 2014 | New South Wales Government |
| ActewAGL | 161 061 | 4 795 | ... | 607 | 275 | 1 Jul 2009–30 Jun 2014 | ACTEW Corporation (ACT Government) 50%, Jemena (Singapore Power International (Australia)) 50% |
| **VICTORIA** | | | | | | | |
| Powercor | 698 589 | 83 468 | 2 380 | 2 132 | 1 276 | 1 Jan 2011–31 Dec 2015 | Cheung Kong Infrastructure/ Hongkong Electric Holdings 51%, Spark Infrastructure 49% |
| SP AusNet | 609 855 | 47 999 | 1 682 | 2 043 | 1 365 | 1 Jan 2011–31 Dec 2015 | SP AusNet (listed company, Singapore Power International 51%) |
| United Energy | 620 300 | 12 707 | 2 070 | 1 330 | 725 | 1 Jan 2011–31 Dec 2015 | Jemena (Singapore Power International (Australia)) 34%, DUET Group 66% |
| CitiPower | 304 957 | 6 478 | 1 463 | 1 240 | 740 | 1 Jan 2011–31 Dec 2015 | Cheung Kong Infrastructure/ Hongkong Electric Holdings 51%, Spark Infrastructure 49% |
| Jemena | 303 245 | 5 928 | 1 011 | 729 | 418 | 1 Jan 2011–31 Dec 2015 | Jemena (Singapore Power International (Australia)) |
| **SOUTH AUSTRALIA** | | | | | | | |
| ETSA Utilities | 807 500 | 86 634 | 3 086 | 2 772 | 1 549 | 1 Jan 2011–31 Dec 2015 | Cheung Kong Infrastructure/ Hongkong Electric Holdings 51%, Spark Infrastructure 49% |
| **TASMANIA** | | | | | | | |
| Aurora Energy | 269 554 | 25 050 | 1 073 | 1 072 | 631 | 1 Jan 2008–20 Jun 2013 | Tasmanian Government |
| **NEM TOTALS** | 8 905 366 | 744 272 | | 43 498 | 31 832 | | |

*Source: (Australian Energy Regulator, 2010, pp. 48-50)*

# Appendix E: Transmission Companies

With a large industrial customer base and high-energy intensive aluminium smelters and mineral businesses projected to increase in growth, Australian will require large scale low carbon energy power sources in the future if the carbon reduction goals are to be met (ACIL Tasman, 2010). This means that a fully decentralised system only based on small scale generators would be difficult to operate in Australia and that efficient transmission lines across states are vital for the development for a more sustainable energy future (Diesendorf, 2011). The extension of interconnectors, together with a highly efficient north-south transmission backbone should allow the incorporation of new, remotely located large scale renewable energy sources in the long run (Diesendorf, 2011). However, large customers may consider installing off-grid capacity instead or as a supplement to electricity provided from the grid; given that approximately 60% of the industrial electricity bill is currently made up of network connection costs[41] (Parratt, 2011).

One area where transmission companies are *ahead* of their lower-voltage counterparts is the visibility of what is going on in the network. Martin Stephen from the QLD transmission company Powerlink estimates that Australian transmission companies are world class in their monitoring and automation of transmission lines. However, transmission companies face challenges in regards to strengthening the backbone of the energy system and extending the interconnectors, the inter-state connection points where energy is exchange across state-borders (Stephen, 2011). Stephen mentions, that transmission companies may be better positioned for a close collaboration within the industries as they have never operated in a competitive environment.

**Planning Scenarios for the Network Transmission**

AEMO provides a 2010 study, which indicates the consequences for the transmission development given different scenarios as indicated in the table below. Those scenarios have been developed in collaboration with various, not further defined *key stakeholders* and are based looking at the supply side and demand side (AEMO, 2010c). Depending on the rate of change and other variables major differences are exemplified by the following three scenarios:

| Scenario | Economic growth | Population growth | Global carbon policy | Cent. supply-side response | Decent. supply - side response | Demand side response | Emission targets* |
|---|---|---|---|---|---|---|---|
| Fast rate of change | High | High | Strong | Strong | Strong | Strong | -25% |
| Decentralised world | Medium | Medium | Strong | Weak | Strong | Strong | -15% |
| Slow rate of change | Low (mixed) | Low | Weak | Moderate | Weak | Weak | -5% |

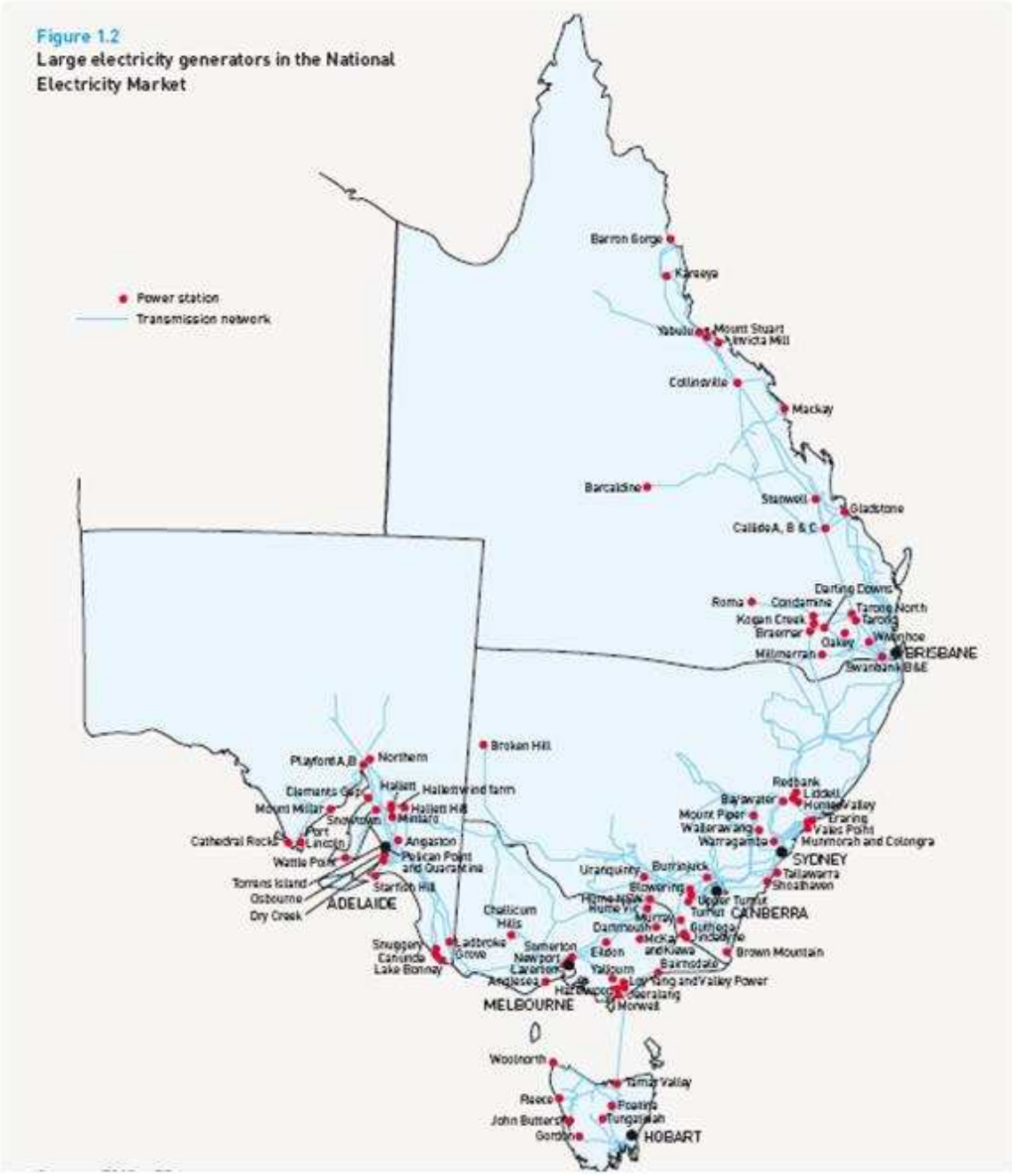
*Simplified scenarios for the transnational energy network*
** below 2000 levels*
*Source: adapted from (AEMO, 2010c, p. 8)*

[41] costs included are charges for the Renewable Energy Target, market operating charges (AEMO), charges for auxiliary services (AER), GGAS charges (only in NSW) and electricity (generation) costs

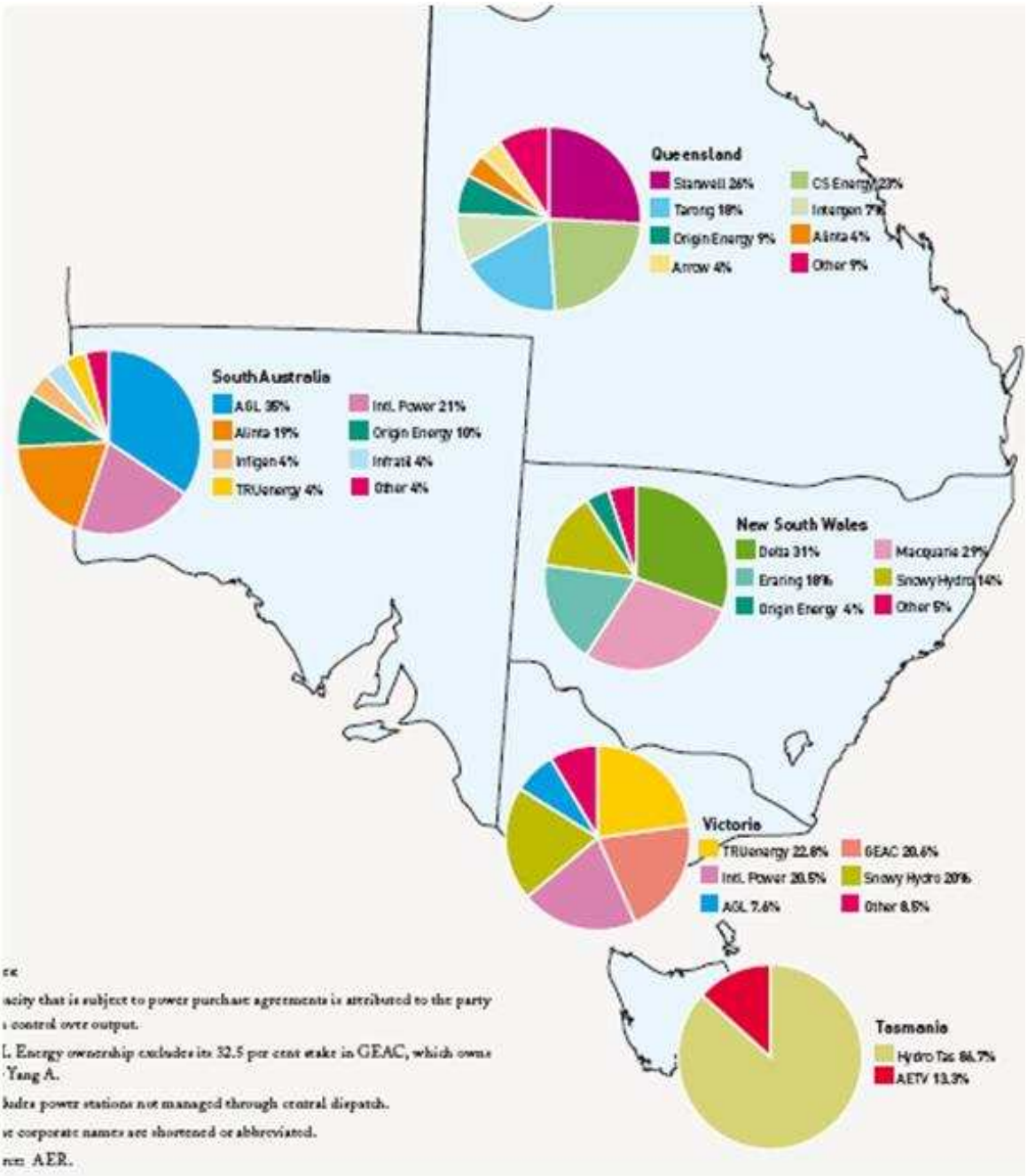
- slow Rate of Change: moderate investments in new generation, mostly wind and geothermal; moderate generation retirements; changes in the transmission network focus mostly on the reinforcement of the existing network from NSW to the urban areas of Sydney, Wollongong and Newcastle;
- decentralised World: assumes high investments in gas and wind and a moderate addition of geothermal; high generation retirement of brown and black coal; those developments require a strong reinforcements of the existing transmission network; mostly to provide new gas-power to centres;
- fast rate of change: new investments gas and coal base load (using carbon capture and sequestration and generation from renewable resources; moderate generation retirement; new transmission lines are required to deliver extended gas and coal-fired generation and renewable generation;

Based on those assumptions, the transmission sector will need to undertake investments in the range between AUD 4 and 9 billion. New generation could be installed in the area of North Queensland, South West Queensland, Country Victoria, South East South Australia, Northern South Australia and Tasmania (AEMO, 2010c).

# Appendix F: Overview of Generators in the NEM




*Source: (Australian Energy Regulator, 2010, p. 20)*




*Source: (Australian Energy Regulator, 2010, p. 26)*

# Appendix G: Retailers in NEM

| RETAILER | OWNERSHIP | QLD | NSW | VIC | SA | TAS | ACT |
|---|---|---|---|---|---|---|---|
| ActewAGL Retail | ACT Government and AGL Energy | | | | | | • |
| | | | • | | | | • |
| AGL Energy | AGL Energy | | | • | • | | |
| | | • | • | • | | | |
| Aurora Energy | Tasmanian Government | | | | | • | |
| | | | | | | | |
| Australian Power & Gas | Australian Power & Gas | | | | | | |
| | | | | | | | |
| Click Energy | Click Energy | | | | | | |
| | | | | | | | |
| Country Energy | New South Wales Government[1] | | • | | | | |
| | | | • | | | | |
| Dodo Power & Gas | Dodo Power & Gas | | | | | | |
| | | | | | | | |
| Energy Australia | New South Wales Government[1] | | • | | | | |
| | | | | | | | |
| Ergon Energy | Queensland Government | | | | | | |
| | | | | | | | |
| Integral Energy | New South Wales Government[1] | | • | | | | |
| | | | | | | | |
| Lumo Energy | Infratil | | | | | | |
| | | | | | | | |
| Momentum Energy | Hydro Tasmania (Tasmanian Government) | | | | | | |
| | | | | | | | |
| Neighbourhood Energy | Neighbourhood Energy[2] | | | | | | |
| | | | | | | | |
| Origin Energy | Origin Energy | • | | • | | | |
| | | • | • | • | • | | |
| Powerdirect[3] | AGL Energy | • | | | | | |
| | | | | | | | |
| Qenergy | Qenergy | | | | | | |
| | | | | | | | |
| Red Energy | Snowy Hydro[3] | | | | | | |
| | | | | | | | |
| Sanctuary Energy | Sanctuary Energy[4] | | | | | | |
| | | | | | | | |
| Simply Energy | International Power | | | | | | |
| | | | | | | | |
| Tas Gas Retail (formerly Option One) | Prime Infrastructure[5] | | | | | | |
| | | | | | | | |
| TRUenergy | CLP Group | | | • | | | |
| | | | | • | | | |

Electricity retailer
Gas retailer
Local area retailer •

1. The New South Wales Government was in 2010 progressing plans to privatise this entity.
2. Alinta Energy (formerly Babcock & Brown Power) became a major shareholder of Neighbourhood Energy in March 2010.
3. Snowy Hydro is owned by the New South Wales Government (58 per cent), the Victorian Government (29 per cent) and the Australian Government (13 per cent).
4. Sanctuary Energy is owned by Living Choice Australia (50 per cent) and Sanctuary Life (50 per cent).
5. Prime Infrastructure was formerly named Babcock & Brown Infrastructure.

# Appendix H: Historical Policy Development

In 2003, NSW implemented as first state in Australia a compulsory ETS, mostly holding the electricity retailers liable for emissions reductions. As the government did not undertake any policy changes on a national level, the World Wildlife Fund (WWF) together with the Australian Gas Light Company (AGL[42]) set up a task-force to investigate the possible implementation of a nation-wide ETS scheme. The Taskforce under the name National Emissions Trading Taskforce (NETT) found that emission reductions of 40% in the electricity sector by 2030 compared to 2000 levels could be achieved with a cost of AUD 250 per capita. The Australian Business Roundtable on Climate Change, as well as a study conducted by ClimateWorks similarly found, that delaying actions to reduce GHG emissions could become very costly for Australia while immediate actions would be affordable for the Australian population (ClimateWorks Australia, 2010; Nelson et al., 2010).

In 2006, the national government finally set-up a task-force inquiring the possibilities to reduce GHG emissions. In their 2007 report, this task-force recommended the introduction of a cap-and-trade ETS which gained support from both, the Labour and Liberal party. In the same year, the National Greenhouse and Energy Reporting Act 2007 came into force, requiring large emitters to report their emissions. In the same year, Labour – who committed to the introduction a national ETS by 2010 - won the national elections and ratified the Kyoto protocol by the end of 2007 (Nelson et al., 2010). A 2008 study by Ross Garnaut (Garnaut, 2008), which was committed by the Labour party, reinforced the importance of a fast introduction of a national ETS to end insecurity for businesses and reduce GHG emissions. In mid 2008, the so called Carbon Pollution Reduction Scheme (CPRS) was introduced in a Green Paper[43], followed by a White Paper in 2010. The goal indicated was a 5% - 15% decrease in GHG emissions by 2020 compared with 2000 emissions levels. Legislation supporting the CPRS was introduced in 2009 and industry, particularly generators started preparing for the introduction of the new legislation (Nelson et al., 2010). Introduction was planned for 2011. However, the legislation was turned down by the Upper House[44] a first time in August 2009 and a second time despite intensive negotiations and considerable changes in December the same year. In February 2010, the legislation was introduced again to the Parliament with the Government however announcing a delay of implementation until 2013 to gain domestic consensus and international clarity of what happens after the Kyoto protocol seizes to exist (Nelson et al., 2010). However, the latest developments now indicate that a carbon tax will be introduced in July 2012 (compare chapter 4.7).

From the literature reviewed, there is overall agreement in the academia that the position of renewable energies needs to be further strengthened if they are to become fully cost competitive with calls for much more stringent governmental policies (Betz & Owen, 2010; Buckman & Diesendorf, 2010; MacGill, Outhred, & Nolles, 2006; Nelson et al., 2010; Outhred & MacGill, 2006). Questions raised in those journal articles resolves around the proposed carbon tax / ETS scheme and an ongoing discussion of the related costs incurred and on which solution is most efficient while at the same time internationally compatible. Questions considered are for example administrative costs and the potential for an

[42] One of the three largest vertically integrated retailers in Australia (I1, 2011)

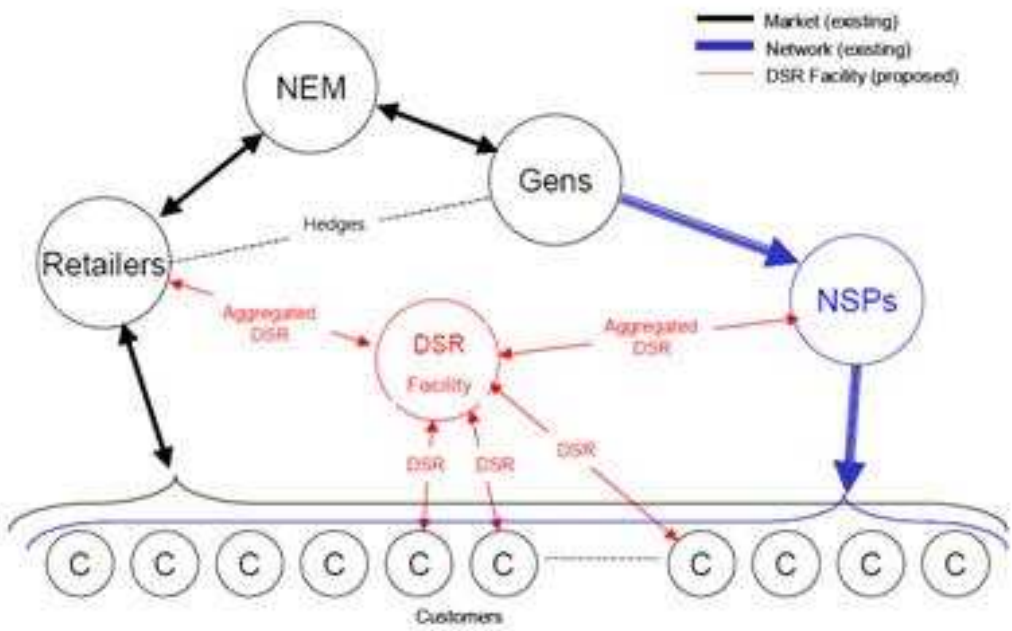
[43] Green papers are tentative government reports proposing new laws; however without a commitment for action. They can turn in White Papers, which outline and explain policies or proposed laws. Both, Green and White Papers allow for public participation to subjects to which the government is committed.

[44] The Senate in the Australian Parliamentary System

international market, which is only provided through an ETS (Maraseni, Maroulis, & Cockfields, 2009; Pope & Owen, 2009; Sheehan, 2009). Other arguments and questions raised include the transparency of an ETS, its international alignment, the level of compromise included in an ETS and the volatility of carbon prices possibly affecting companies negatively in comparison with a stable carbon tax. There is disagreement in how far a ETS affects the economy through cost increases (P. D. Adams, 2007; Zeller, 2010). An argument against the carbon tax is that it only increases the carbon prices but doesn't guarantee GHG reductions (Sullivan, 2010). Several reports warn that delaying carbon initiatives will become much more costly in the long run (ClimateWorks Australia, 2010; Diesendorf, 2010; Garnaut, 2008). One of the academic concerns is that the carbon tax could become part of the normal budget and thereby provide perverted incentives for the government to keep a certain level of carbon emissions in order to receive revenue (S. Davidson, 2011).

# Appendix I: Potential Demand Side Response Model

**Figure 1: How the DSR facility would relate to the NEM**




*Source: (Pareto Associates Pty Ltd, 2004, p. 22)*

# Appendix J: What is a Smart Grid?

Both, telecommunications and electricity systems have had major impact on our way of living since they were invented by Alexander Graham Bell and Thomas Elva Edison, respectively. The development of those to major inventions has however taken different paths: while telecommunications has fundamentally changed over the last decades, electricity systems still feature the same recognisable elements as they did at the beginning of development of electric systems (Wolfs & Isalm, 2009). However, the development of intelligent networks, so called smart grids is expected to change electric systems in a similar radical way as telecommunications systems were changed. According to a Technology and Strategy Manager at one of distribution companies (2011), the electric industry will see a parallel development with a delay of approximately 15 years. According to the manager, this means that major exponentially growing developments can be expected within the next 10-15 years within the electricity industry. At the moment, the industrial development of smart grids is in its very early stages.

Smart grids don't have one single accepted definition and concepts are perceived differently in different studies and countries (e.g. the US and the EU). The smart grid is however in any case a "broad collection of technologies that delivers an electricity network that is flexible, accessible, reliable and economic" (Wolfs & Isalm, 2009, p. 1). Smart grids can provide solution approaches on how to integrate more volatile and smaller renewable energy sources such as wind or solar. In Australia, the Ministerial Council on Energy defines priority within the area of Smart Grids to be energy efficiency including demand management, energy market reform including investments in transmission and smart meters, energy security and renewable as well as distributed power generation (Wolfs & Isalm, 2009). According to Flick & Justin (2011), the dynamic concept of smart grids currently involved two-way communication (e.g. via broadband), advanced components (e.g. storage, fault and diagnostic devices), advanced control methods (e.g. data collection), sensing and measurement technologies (smart meters), improved interface and decision support and application of smart grid technology (smart appliances).

Tröster et al (2011) differentiate in their report (commissioned for Greenpeace) the follow three grids:

- micro grids which refers to smart infrastructure within distribution networks and uses local energy generators; they include various energy sources as well as energy efficiency and communications measures for load management;
- smart grids which operate in a whole region including decentralised power generation linked to highly efficient distribution. Advanced types of monitoring and controlling technology make the grid run efficiently and avoid e.g. peak demand through smart pricing and customer information;
- super grids connect large (renewable) energy sources from various regions or countries with each other;

While most electric networks worldwide only include certain elements of smart grids, the case of Spain and Germany should be mentioned, where wind power contributes with approximately 16% of the total electricity used to the smart grid. However, those networks will have to be upgraded in order to further increase the share of oscillation energy inputs. According to Greenpeace, inflexible base-load such as nuclear and coal are in both countries limiting the future potential of wind, solar and even gas which cannot be fed into the grid

because of the capacity being used by fossil / nuclear power plants that don't vary their output capacity (Tröster et al., 2011).

In a first step, electric systems can become price sensitive through the introduction of advanced metering infrastructure (AMI) which allows for distribution companies or retailers to introduce dynamic pricing e.g. including peak pricing or peak rebates (for staying below a certain level of electricity use at peak times) as well as real-time pricing (Centolella, 2010). Such pricing has the potential to defer new investments towards an increased system capacity and better use of available assets. It can as well reduce transmission and distribution losses, which are higher when lines are at operated at full capacity. An additional benefit of transparent electricity use is increased customer awareness of electricity use and costs which can lead to reduce demand through change, more energy efficient behavior. In case of real-time pricing, outages can be compensated by immediate demand reductions and AMI can be used to disconnect certain non-vital areas of the network, limiting the scope of outages. Flexible demand means that less reserve capacity needs to be calculated into the forecasting which additional lowers the total load capacity required[45] (Centolella, 2010).

## The Smart Grid Initiative in the US

The Waxman-Markey Bill which is currently discussed in the US parliament, proposes that the US reduced $CO_2$-e from major sources by 17% in 2020 and 80% by 2050 compared to 2005 levels. Energy efficiency and renewable energy sources are both elements included in the Bill (Lyster, 2010). The smart grid initiative in the US aims to increase the:

> *"digital control and information technology with realtime availability; dynamic optimisation and cyber-security relating to grid operability, inclusion of demand side response (DSR) and demand side management (DSM) technologies; integration of distributed energy resources (DER) including renewable and energy storage and deployment of smart metering, automated metering infrastructure, distribution automation, smart appliances and customer devices" (Brown, Suryanarayanan, & Heydt, 2010, pp. 64-65).*

The goal is to develop self-healing capacities in the network and actively involve the customers to take actions. Another aspect in the US smart grid initative is to increase resilience against disruptions, caused by extreme weather events or humans. A particular emphasis is given to distribution networks, where new technologies such as smart meters, sensors and communications software needs to be introduced in order to run smart appliances, make full use of renewable energy sources and meshed[46] structures.

## The Smart Grid in the EU

The EU wants to reduce GHG emissions by 20% in 2020 compared to 1990 levels. At the same time, the EU aims to increase the level of renewable energy sources to 20% until 2020. The long term goal is to reduce $CO_2$-e by 80% compared to 1990 levels by 2050. The Strategic Energy Technology Plan (SET-Plan) and a roadmap for the implementation of it include wind energy, solar, biomass, CCS, the grid, sustainable nuclear energy and smart cities with investments of €2 billion over the next ten years (Lyster, 2010).

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[45] With forecasting being based on the quantity requested as a function of the price (for residential customers only)

[46] Meshed networks refer to a networked structure where nodes are connected to each other and can redirect, disconnect (or connect) electricity flows as needed

In order to accelerate the development of smart grids, demonstration projects are under way with elements including automation, smart meters, electricity storage, dynamic pricing and different communication technologies.

## Smart Grid in Australia

According to Wolfs & Isalm, the Smart Grid development is behind the development in the EU and the US; however developing at a fast pace. Future priorities in Australia should according to those authors shift the focus away from decentralised generation to a more holistic Smart Grid view, including all activities from generation, transmission, distribution through to customers' home area networks. The system should be based on a solid communications system underlying it and interoperability including open standards and the emergence of new business models. Wolfs and Isalm additionally propose to increase attention towards international collaboration and interaction between universities and industry (Wolfs & Isalm, 2009).

The Energy Network Association Australia (ENA) stipulates that the key drivers to the smart grid development in Australia are to reduce climate change through a decrease in carbon emissions, and to "maintain and enhance energy security" (Energy Networks Association, 2009). According to the same organisations, the five identified goals are to accommodate for:

1) active demand-side response;
2) renewable energy sources, including small scale generators at customer premises;
3) service offering based on price and environmental considerations;
4) new energy storage technologies;
5) improved network performance through automation, telecommunications, optimised investments and strengthened interconnectors;

According to Hendricks (Hendricks, 2009 as cited in Lyster, 2010), two different smart grids are needed in Australia: an interstate transmission grid for high-voltage, long distances and a smart, digital distribution network on the local level. The need for a strengthen north-south transmission backbone and the extension of interconnectors is emphasised by Mark Diesendorf from the UNSW (Diesendorf, 2011). Industrial customers are likely to play a significant role in shaping future electricity network as they are the main user of on-grid electricity. Aluminium production alone accounts for 13% of electricity consumption in Australia today. Many current models indicate that those large and increasing demands can be best catered for by large scale renewable energy sources rather than decentralised ones (Diesendorf, 2011; Lyster, 2010). Those large scale projects are however expected to mainly affect the transmission companies that are not the central part of this research. It should be noted however that several actors in the industry believe that this part of the network will need regulatory intervention to develop on a fast pace. The main reason is the very high connection costs of remotely based generators (or generation clusters) to the grid that may prove to make investments unattractive for potential new market entrants e.g. engaging in wind and solar energy production[47]. The illustration on the next page provides an overview of smart grid functionalities amongst the value chain.

[47] While distribution companies price connection on a project-to-project bases; average costs have been estimated at approximately AUD 1 million / km by stakeholders. Given that the ideal locations for large scale wind and solar power plants have been identified to be remotely located, connection costs are a significant barrier.

| Generation | Network | Load |
|---|---|---|
| | Information | |
| Metering<br>Generation<br>• Dispatch<br>• Power quality<br>• Fault management<br>Energy Storage<br>• Dispatch<br>Electric Vehicles<br>• Dispatch | System Operation<br>• Protection<br>• Remote switching<br>• Voltage regulation<br>Monitoring<br>• Outage detection<br>• Load forecasting<br>• Preventative maintenance<br>• Quality of Supply<br>• Losses<br>Customer service<br>• Remote meter reading<br>• Remote connection / disconnection | Price signalling<br>• Retail<br>• Distribution<br>Information<br>• kWh & kW<br>• $CO_2$<br>• AUD<br>Demand side response<br>• Direct load control<br>• Capacity limitation<br>• Energy storage<br>Customer services<br>• Messaging<br>• Change of tenancy<br>Electric vehicles |

*National smart electricity networks*
*Source: (M. Davidson, 2010b, p. 5)*

The goal of a smart distribution network is to reduce load on the grid and to reduce distribution losses e.g. through shortened electricity lines. Additionally, peak demand can be reduced and remote communities better served (Lyster, 2010). ENA, the industry association of network providers states that its priorities are the facilitation of customer education and the enhancement of network capabilities achieved by customer support mechanism and commercial and regulatory frameworks, respectively. Besides the facilitation of carbon emission reductions, other objectives stated in ENAs strategy paper are improved cost effectiveness, the creation of a customer platform and improved reliability, quality and security (ENA, 2010b).

Communication would be enabled on three levels, the home are networks operating within residences, wide area networks communicating between residences and distributor substations and backhaul networks linking distributors substations to the utility (Lyster, 2010). A trial in collaboration with the National Broadband Network (NBN) is under way to find out if synergies for communication means can be used (Essential Energy (formerly County Energy), 2010).

According to Lyster (2010), major reasons for the implementation of a smart grid relate to climate change adaptation. Threats include increasing bushfires, cyclones, flooding, which increase the risk of infrastructure being destroyed or damaged. This means increased risk insurance premiums, increased manual work required and raising maintenance costs potentially leading to shortage of skilled workers and increasing maintenance and end-user electricity prices. The single main factor which will require investments in electricity grids in Australia are increasing temperatures leading to an increased use of air conditioners (ACs). Increased use of ACs are mentioned as the main source of an expected AUD 2.5 billion network expenses due to climate change adaptation (Lyster, 2010).

# Appendix K: Overview of Activities in the Distribution Sector

| Company | Environmental Report / Plan available online | Direct significant aspects handled | Indirect aspects handled | Smart grid / demand side management | Climate change mitigation priority | Reason for activities | Future activities |
|---|---|---|---|---|---|---|---|
| Energex | Yes | ISO 14001, carbon management plan to reduce emissions, offset of fleet emissions; reduction of $SF_6$, sustainable procurement, waste management | Electricity use and network losses are considered as indirect losses, so are employee air travel, waste and taxi travel; energy losses are not handled actively | Cool Change program to increase efficiency of AC and pool pumps in Brisbane; provision of off-peak tariffs | 41% of electricity purchased from renewable sources on 2009; reduce $CO_2$-e emissions by 20% in 2015 compared o 2008 | Reduce peak demand, reduce energy use, install more sustainable power stations | N/A |
| Ergon | Yes (Environmental Policy, Climate Change Response Plan) | ISO 14001, reduce air travel, reduce emission form vehicle fleet (emission standards), property electricity, | Energy saving programs for customers, reduce internal use of electricity, | Tariff trials, commercial demand management trail, strong focus on the cost aspect; smart grid trial in collaboration with Energex | Development of isolated renewable power grids (reduce diesel) | Avoid network investments, keep prices for customers down – leverage customer price response to the benefit of the environment | Some innovation in hydrogen fuel cells; climate change adaptation plan in place, use of renewable energy sources, empower customers |
| Endevaour Energy (former Integral Energy) | Yes (on the old Integral Energy) | ISO 14001; renewal of vehicle fleet, energy consumption, $SF_6$, waste management, managing of hazardous substances | Energy saving programs for customers, internal energy reduction e.g. computer shut-down programs | home energy consultations; trials with incentives for reduced peak consumption, customer education | Carbon neutral by 2020 for direct emissions | Alignment to NSW governmental goals | Different views within the company; impressions from nothing happening to quite significant |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | moves within the next 5-10 years |
| Essential Energy (former Country Energy) | Yes, environmental policy, environmental section in annual report | ISO 14001, waste management, employee education, | Energy saving programs for customers, purchasing of green power, internal energy reduction programs | Focus on intelligent engineering solutions in rural areas, trial communities reg. smart grids under way | Platinum ranking in CRI index | Intelligent network as key to operational excellence | Collaboration with the national broadband network; integration of distributed generation and renewable – IN initiative |
| ActewAGL | Yes, separate sustainability report | ISO 14001, staff awareness, waste management, hazardous substances, use of E10 / LPG for the vehicle fleet, replacement of $SF_6$ switch gear to reduced $SF_6$ emissions | Energy saving programs for customers, Greenchoice electricity promotion; use of green electricity for internal use, reduction of energy losses, encourage customers to connect renewable to the grid | No specific information on the webpage regarding smart grid; however information on the intention of including renewable in the network, electric cars etc. | Environmental Committee attended by the board, Environmental Leader in the field in ACT | Recognition of impact the electricity industry has on the carbon footprint, prepare for the future | Planned solar power plant; activities in deployment of electric vehicles (A Better Place), investigation in smart meters |
| CitiPower / Powercor | Yes, joint sustainability report since 2003 | ISO 14001, change in purchasing process – green purchasing policy, waste management | Climate change issues factored into project assessment and infrastructure upgrade | N/A | Climate change is viewed as key issue for the business | Business case | Innovation program, influence regulator |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SP AusNet | Yes, sustainability report (sent by email) | ISO 14001, $SF_6$ reductions, reductions of fleet emissions, recycling of waste (metals) | Generators are responsible for network losses, otherwise little info on webpage | Research into smart grid / demand management activities | Compliance, minimise impact, acknowledge climate change | Increase resilience of system ( climate change adaptation), efficiency gains | Supportive of renewable sources |
| AusGrid (former Energy Australia) | Yes, sustainability report, GRI reporting | ISO 14001, reduction of $SF_6$, eco-driving, waste management, reduced impact on operations, | 100% green electricity use in buildings, help customers to reduced their carbon emissions; GHG savings under the GGAS scheme (NSW) | Has won the governmental Smart Grid, smart city project, demand management of webpage; learning center, other projects and university collaboration; use of fiberglass cables | Minimise environmental impact, culture of innovation and sustainability; | Maximising opportunities, keep emissions below industry norm; CRI platinum star | Further roll-out of smart meters, |
| United Energy | Little information available on the webpage; no particular env. Section in the annual report | ISO 14001, waste recycling, staff training, green office program, dealing with hazardous substances, | aware of impacts beyond direct impacts, reduction of voltage losses (power faction correction), energy saving info | N/A | Wants to be recognised as an environmental leader | Reflect community attitudes in environmental management | Implementing wind and renewable embedded generators into the grid |
| Aurora Energy | Yes, sustainability policy; Sustainable Aurora program | ISO 14001, minimise own impacts, control waste, replace fleet with low-fuel vehicles, eco-driving, considerations to phase out $SF_6$, reduction of power use, waste management, sustainable | Energy efficiency, support renewable sources (webpage: warm.com.au); customer training center | Net metering to allow small scale feed in of renewable | Sustainably responsible company | Leader in responsible management | N/A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | purchasing | | | | | |
| Jemena | No, only a very short summary on the webpage | ISO 14001, employee education, improve infrastructure, environmental purchasing principles, | Follow the guidelines, reduce, reuse, recycle, educational programs for staff | No information on the internet | Comply with regulations / laws | Reputation, new customer connections, economic reasons | Planning to build a wind-farm; promotion of gas as cleanest fossil fuel |
| ETSA Utilities | Yes, environmental management plan | ISO 14001, direct impacts; 90% of waste recycled; reduce electricity consumption internally (building management, AC), offset vehicle emissions, employee eduction | Demand side management, trial-use of electric cars | Focus on technology infrastructure (SCADA) and distribution management system (DMS), some trials | Lower peak demand | Prudent environmental management practices | |

*Overview of activities*
*Source: (ActewAGL; Aurora Energy, 2010; AusGrid, 2011; CitiPower & PowerCor, 2011; Endeavour Energy; Energex; Ergon Energy; Essential Energy (formerly County Energy), 2010; ETSA Utilities, 2010; Jemena Energy; SP AusNet; United Energy)*