# Emissions Trading Scheme Effects on the Australian Electricity System - A Qualitative Study of Environment Society and Economy


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## Abstract

Australia is vulnerable to global warming and electricity generation is the single largest contributor to greenhouse gas emissions in Australia. An Australian Emissions Trading Scheme will affect stakeholders in the electricity system. This paper focuses on two design principles of an Emissions Trading Scheme, the cap on total number of permits allocated and the number of free permits allocated, and how this will impact on the pillars of sustainability: environmental, social and economic. To discuss these impacts, the pillars of sustainability are represented by key stakeholders in the electricity system, environmental by the atmosphere, social by electricity consumers predominantly households, and economic by the electricity generation industry. This paper discusses the interactions of these stakeholders based on a number of qualitative indicators and finds that by focussing on environmental objectives, emissions reduction is possible and trade-offs with social and economic sustainability occurs, though with government intervention, these trade-offs are manageable and on a whole the electricity system can become less unsustainable.

Keywords: Electricity System, Emissions Trading Scheme, Social Environmental Economic Sustainability

# Table of Contents

## List of Figures and Tables



## Abbreviations

A$: Australian Dollars
AETS: Australian Emissions Trading Scheme
$CO_2$: Carbon Dioxide
$CO_2$-e: Carbon Dioxide Equivalent
ETS: Emissions Trading Scheme
EU: European Union
GWh: Gigawatt hours
MRET: Mandatory Renewable Energy Target
Mt: Million Tonnes
NEM: National Electricity Market

# 1 Introduction

## 1.1 Problem Definition

From an environmental perspective, the electricity system in Australia is currently unsustainable. The electricity generation industry is the single largest contributor to greenhouse gas emissions[1], as it is dependent on burning fossil fuels, predominantly coal (DCC 2008a:22). Electricity is an integral part of the economy and society, and therefore a reliable and accessible electricity system is a necessity. However, given the seriousness of global warming and its likely impacts on the environment, society and economy, a change in the system must occur.

The cause and effects of climate change are becoming less and less disputed as new scientific evidence is produced linking anthropogenic activities with the rising levels of greenhouse gases (particularly carbon dioxide) in the atmosphere and global warming. The evidence also describes the potential disastrous impacts on the environment, society and economy across the globe. This has resulted with the acknowledgement that abatement and mitigation measures must be incorporated into economic structures to affect change (IPCC 2007ab, Stern Review 2006). A central part of integrating mitigation measures into the economy is through the use of Greenhouse Gas Emissions Trading Schemes in order to place a price on warming the globe (EC 2007, Stern Review 2006).

In Australia, with a change in Federal Government in December 2007, came a change in environmental policy and full acknowledgement of the climate change problem. The new Prime Minister, Kevin Rudd, has made the environment a key priority within this Government. This was signalled with the Prime Ministers first official act to ratify the United Nations Kyoto Protocol. With the previous Government's lack of commitment to strong environmental policies to combat climate change, development in abatement and mitigation measures, especially in the private sector has been limited given the uncertainty of future regulation (Kent and Mercer 2006). With strong environmental policies, business and industry can make long-term decisions with more certainty to move towards operations and activities that reduce greenhouse gas emissions. Australia is now looking to finalise the design of an Australian Emissions Trading Scheme for implementation in 2010 as a key component of moving towards a low carbon economy (MCCW 2008a).

[1] Greenhouse gas emissions, will simply be referred to as emissions from this point on. Greenhouse gases include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Though for the purposes of this research it predominantly refers to carbon dioxide, as it represents over 70 per cent of gas emissions in Australia (DCC 2008a:24).

Although on a global stage Australia's contribution to total emissions is relatively insignificant, at 1.4 per cent, on a per capita basis Australia ranks as one of the highest emitters with 17.9 tonnes per person, which is almost five times the world average (Earth Trends 2003). Australia is also vulnerable to climate change (CSRIO 2007, Garnaut 2008a, Hennessy 2007), therefore it must make every effort to lower its emissions, not to directly overcome the problem of global warming but as the principle of per capita emissions will play a significant role in limiting national emissions, Australia, in order to increase its influence, must aim to put an equity and fairness perspective into international negotiations (Garnaut 2008a). Australia cannot take the lead in negotiations and expect others, particularly developing countries, to limit their emissions and subsequently economic growth, without evidence of strong domestic action.

### 1.2 Aim and Objective of Research

The aim of this research is to explore potential impacts of an Emissions Trading Scheme (ETS) on environmental, social and economic factors. This field of research is relevant as ETSs are an important measure contributing to the mitigation of greenhouse gases across the globe and its application for trading of emissions is in its infancy. It is currently topical given the recent start of the Kyoto Protocol's first commitment period 2008-12, the second phase of the European Union (EU) ETS in 2008 and the new Australian Government's commitment to implement an Australian Emissions Trading Scheme (AETS) by 2010.

The objective of this research is to analyse potential impacts that an AETS may have on key stakeholders in the electricity system in Australia both in the short-term and longer-term. This includes its potential impact on the atmosphere, electricity consumers and the electricity generation industry. The outcome of this research can assist in further discussions of how ETS design principles can impact on an electricity system in the Australian context and to show how the electricity system can become less unsustainable.

### 1.3 Research Question

What are potential effects of an AETS on the Australian electricity system?

In order to answer the main research question a number of sub research questions are proposed, to achieve the aim and objective of the research:

- What is the electricity system, who are the main stakeholders and what interactions occur?
- What are the important design principles for an AETS?
- What are some likely effects of an AETS on stakeholders and their interactions for a short-term period (introduction phase of AETS) and longer-term period (to 2050 and beyond)?
- How can an AETS contribute to a less unsustainable electricity system?

## 1.4 Methodology

Bryman (2006) states that deductive studies take an initial theory and deduce a hypothesis to test and inductive studies draws generable inferences out of observations to develop theories. This paper adopts both a deductive and inductive form of study. A deductive approach is used initially in that sustainability theory suggests that within a system, a balance can be achieved in its pillars of environment, society and economy (Fiksel 2006, Marten 2006). From this, the hypothesis that, within a system trade-offs in the pillars must occur, as opposed to balancing them, is deduced to discuss the sustainability of the electricity system in Australia. This motivated the qualitative data collection, which is secondary data. A review of available literature, including government policies, research institute publications, published articles and databases containing economic and demographic information, was performed.

An inductive approach is then used during the data collection and an analytical tool from grounded theory is utilised. Bryman (2004:8) discusses that grounded theory is difficult to define, but it entails a number of procedures and analytical tools. The analytical tool used was coding of data during collection, where the existing field of knowledge on ETSs and their impacts and outcomes are interpreted into the category of the three pillars of sustainability and generates the concept of trade-offs between sustainability pillars as opposed to balancing them.

The initial theory and the pillars of sustainability led to a theoretical framework which is used to analyse the data through an integrated assessment approach wherein, through the framework, this paper describes and explains system changes between periods of dynamic trade-offs in the electricity system (Marten 2006:39). This has been achieved by discussing the AETS (as a driving force), the changes to key stakeholder interactions and the impacts on the electricity system.

The analysis progressed by categorising the data on key stakeholders into the three pillars of sustainability (environment, society and economy). The key stakeholders are: the atmosphere, the electricity consumers and the electricity generation industry. In order to gain a more in-depth discussion, the above key stakeholders were chosen, as they represented the underlying principles of each pillar (being economic efficiency, social fairness and equity, and environmental resilience and capacity to recover, Marten 2006) and as these stakeholders will likely experience the largest impacts based on changes to the system.

Indicators of sustainability are used as the basis to discuss, qualitatively, potential impacts of an AETS on key stakeholders and their interactions. The main indicators used in this research are: the reduction in greenhouse gases emitted into the atmosphere, the price of electricity, the social acceptance of alternative forms of electricity generation, the cost of producing electricity, and employment levels.

### 1.5 Limitations

Due to the broad scope and trans-disciplinary approach of this paper, it is necessary to clarify limitations. This research will not provide an in-depth examination into the appropriateness of using market-based mechanisms for mitigating environmental harm, nor will it discuss the appropriate mechanism, be it ETSs or carbon taxes. Though these are relevant studies, it is irrelevant to this paper, given that, the Government has already committed to implementing an AETS. Given length constraints the paper does not attempt to discuss all the potential design principles of an ETS. Furthermore the appropriate structure of the electricity system is not discussed, in terms of technical specifications of infrastructure to support a more sustainable system. In addition this paper does not discuss which alternative technologies are appropriate for emissions reductions, only that a switch to low intensive technologies in the short-term is needed and in the longer-term a system cannot be sustainable unless it is based on renewable resources.

### 1.6 Structure of Paper

This paper is structured as follows, chapter two introduces the theoretical framework adopted by this paper used to analyse and discuss the problem, chapter three discusses the problem of climate change and developments in Australian politics leading to an AETS, chapter four discusses the Australian electricity system and its stakeholders, and outlines the trend in emissions, chapter five discusses the relevant design principles of ETSs that impact environmental objectives, chapter six provides the analysis for trade-offs in the pillars of sustainability in terms of interactions of stakeholders in the electricity system, and discusses the role of government intervention and chapter seven provides concluding remarks.

# 2 Theoretical Framework

## 2.1 Concept of Sustainability

The development of sustainability was firmly established with the Brundtland report in 1987 which defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Although this definition was accepted by the UN and participating governments around the world, the practical implementation of sustainability and, indeed, its working definition remains a challenge.

Sustainability is a complex idea and its application even more so. The concept of sustainability has inspired the new thinking of sustainability science which must take into account complex integrated system thinking, where it must be able to encompass different magnitudes of scale, from time and space to function, dynamic system balances, multiple interests and multiple system failures (Marten 2006).

Marten (2006) states that given the complexity of sustainability that taking an unsustainable perspective can be advantageous. However, according to Fiksel (2006) a focus of reducing unsustainable practices is not enough as even though environmental harm and waste is reduced, little is known about the broader impacts of material and energy flows in a dynamic ecological system. According to Fiksel (2006) the key is to develop new industrial and societal systems that mirror dynamic attributes of ecological systems with resilience to disturbances.

The approach adopted by this paper follows Marten's (2006) reasoning, to gain a better insight into sustainability through the investigation of unsustainable practices in the electricity system and contribute to making such practices less unsustainable. In terms of the necessity to create new industrial systems as Fiksel (2006) states, this research to a certain extent is an initial step for how the system may look in the longer-term, through discussing potential changes to the electricity system and its impacts.

Another concept of sustainability is weak versus strong sustainability. Strong sustainability originates from the principle of environmental conservation, and defines sustainability as activities that improve the productive capacity of the economy without degrading the overall quality of the environment. Whereas weak sustainability takes the perspective of maintaining a defined value of environmental assets, disregarding the quality of the assets or associated environmental harm (Hediger 1999).

## 2.2 Pillars of Sustainability

In order to achieve sustainability, it is integral to balance the objectives of the three pillars of sustainability: environment, social and economic. The difficulties of balancing these are clear, given the underlying principles are different, economics is efficiency, society is fairness and equity and environment is resilience and the capacity for recovery (Marten 2006).

Electricity or energy more generally is a necessity for societal advancement, however typically its production entails significant environmental harm and to limit this would create a barrier to competition, economic development, and in turn, access to energy and ultimately societal advancement (WEA 2004). Given these complexities it is difficult to find a balance and move from an unsustainable electricity system to a sustainable system. In fact, according to Hediger (1999), as a general rule, simultaneously achieving all three is not possible and trade-offs are inescapable.

The sustainability approach of this paper is to outline the progression from an unsustainable electricity system towards one that aims to balance concerns, with the acknowledgement that given its complexities a system where all environmental, social and economic concerns are balanced perfectly is not likely, but to move to a system with trade-offs at a more acceptable level or as defined by Giampietro (in Marten 2006:40) "…society to move itself…between satisfactory, adaptable, and viable states."

In this paper, satisfactory is defined as electricity generation that meets society's basic demands, while simultaneously reducing greenhouse gas emissions from current levels, yet still contributing to the economy without disadvantaging those in society that can least afford it. In order to achieve this, the paper asserts that government policy intervention is necessary to redistribute and smooth impacts across the three pillars of sustainability.

Given the inherent complexities of balancing, this paper is skewed towards environmental sustainability, or strong sustainability, in recognition of the necessity for immediate action to reduce emissions in order to lessen the ongoing environmental degradation. It is not to say that economic and social sustainability are to be ignored, in fact the opposite is true that a system approach must be cognisant of all dimensions, however the current trade-offs on environmental harm must be altered given the pending problem. If the impacts of climate change eventuate as Stern (2006) and the IPCC (2007ab) have elaborated, then the existing trade-offs that continues with destruction of the environment will ultimately greatly impact society and the economy sooner, rather than later.

This paper takes a relatively limited time perspective of the transition period of the coming few years to 2050, as this is the period that the Australian Government has set for its target to reduce emissions by at least 60 per cent. Beyond this time energy systems will need to be virtually climate neutral and may well mirror dynamic attributes of ecological systems, as asserted by Fiksel (2006).

Good governance is a key to achieving sustainability, and without appropriate institutions, measures to achieve objectives of the three pillars would not be possible (Spangenberg et al 2002). According to Jones (2003) institutional structures in Australia can create difficulties for regional policy integration as there is an overarching Federal Government and individual State and Territory Governments. For matters that extend beyond State boundaries, this structure can often lead to confusion over the lines of responsibility, and potential conflicts.

This would suggest that institutional structures may play a role in the effective implementation of an AETS. However, the Council of Australian Governments is the intergovernmental forum for governments to work together and has been utilised to develop proposals for an AETS. The previous Government had not been cooperating on the development of an AETS, however the Rudd Government has committed to working with the Council on this issue (MCCW 2008b). Therefore there is a mechanism in place to achieve good governance. Subsequently institutional aspects will not be considered further in this paper, as the assertion is that implementation of an AETS with consideration of the three pillars (environment, social and economic) is the crucial first step.

# 3 Climate Change and Australia

## 3.1 The Problem of Climate Change

The current understanding of the climate change problem is based on the IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report (IPCC 2007ab). The report builds upon earlier IPCC Assessment Reports with new research and significantly strengthens the science behind climate change with more comprehensive data, more sophisticated analyses, and improvements in the understanding of processes and their simulation in models. These improvements have lead to a general consensus, with less opposition in all fields, including sciences, politics and business, that anthropogenic activity is causing global warming through atmospheric concentrations of carbon dioxide due primarily to fossil fuel use and land use changes.

Australia is vulnerable to climate change due to the climate already being hot, dry and variable. Second, the sensitivity of our temperate agriculture assumes special importance because of the large role that agriculture plays in the Australian relative to other developed economies. Third, our terms of trade are highly sensitive to economic performance in Asian developing countries that are vulnerable to climate change (Garnaut 2008:a22)

The CSRIO (Commonwealth Scientific and Industrial Research Office) prepared a report of the likely effects of global warming for Australia (CSRIO 2007), based on conclusions from the IPCC Fourth Assessment Report, and various Australian research agencies. The report found that since 1950 the Australian average temperatures have increased by 0.9 ºC, with significant regional variations. The impacts of rising temperatures have seen an increase in the frequency of hot nights. Rainfall patterns, including extreme daily rainfall, have all altered across Australia, with some areas experiencing substantial rainfall declines, while other areas experiencing an increase. In addition, recent droughts have been hotter, with both the maximum and minimum temperatures higher than in the earlier dry periods. Also, substantial warming has occurred in the three oceans surrounding Australia.

The report provides likely projections of ongoing impacts to 2030. The best estimate of annual warming by 2030 relative to the climate of 1990 is approximately 1.0ºC, with warmings of around 0.7-0.9ºC in coastal areas and 1-1.2ºC inland. Beyond 2030, the warming estimate is dependent on emissions scenarios but could range from as little as 0.8ºC for lowered emissions to 5.0ºC for continued high emissions.

Estimates of precipitation patterns vary greatly, however continued changes and uncertainty in rainfall is expected, including an increase in daily precipitation intensity and in the number of dry days. Drought occurrence is projected to increase over most of Australia, along with a substantial increase in fire weather risk at most sites in south eastern Australia. Changes to wind speed affecting storm surges occurring in conditions of higher mean sea levels will enable inundation and damaging waves to penetrate further inland, increasing flooding, erosion and the subsequent impacts on infrastructure and natural ecosystems. Essentially Australia will be faced with more intense weather systems.

Australia is vulnerable to extreme weather events that in recent decades have increased in frequency, causing substantial damage and economic costs. According to Hennessy et al (2007) three periods of drought from the 1980's have caused in excess of US$ 13 billion, in addition hailstorms, flooding, cyclones and fire events in this century has caused economic damages upwards of US$2 billion.

### 3.2 The Economics of Climate Change

Climate change does not only impact on the environment but it also has associated economic and social effects. With the science behind climate change and its impacts becoming less disputed, the focus then turns towards the associated costs of appropriate abatement and mitigation actions. The Stern Review (2006) assessed the economics of moving to a low-carbon global economy and the potential of different approaches for adaptation to changes in the climate.

Based on aggregate monetary estimates, the Review concludes that a temperature rise of 5 to 6 ºC, and with the risk of abrupt and large-scale climate changes, could result in a 5 to 10 per cent loss of global Gross Domestic Product (GDP). The Review's findings that climate change inaction will cost the global society are also supported by the findings of the IPCC: that a 4 ºC rise in temperature could translate to losses of 1 to 5 per cent of global GDP (IPCC 2007a).

According to the Review if additional factors are included, direct impacts on the environment and human health, higher responsiveness of the climate system to greenhouse gases and weighted unequal distribution of burden from the poor, then potentially a 20 per cent reduction of global per capita consumption, as a proxy for GDP, can occur. There is always inaccuracy and differing interpretation when dealing with models, however at the core, there is the fact that inaction will increasingly cost our global society more and more. However, the Review continues to state that moving to a low carbon economy, to stabilise greenhouse gas levels at a significant, but manageable level, will cost an average of 1 per cent of global GDP to 2050.

The Stern Review's contribution of the modelling of costs of potential climate change outcomes represents an important step towards incorporating the problem of climate change into the current economic paradigm. It has also contributed by altering the economics of climate change discourse and, as Foucault believes, by creating a discourse it establishes what is meaningful (in Callinicos 2005:277) and according to Habermas' theory of communicative action the release of the Review can amount to "the intention of universal and unconstrained consensus" (in Callinicos 2005:283).

Therefore, in the Foucault context, the release of the Review in itself was an important step, as it caused much debate (changed the discourse) within all fields from the natural sciences, to economics, politics and non-governmental organisations, but perhaps more importantly the debate was ongoing in the media arena, and subsequently received wider coverage. It essentially brought the economic impact discourse into a mainstream arena, and gave it meaning, with the notion that, in the current paradigm, there are costs of action, but that there are also costs of inaction, which may even be greater. Although there are many criticisms regarding the accuracy of the economics, in a Habermas context the essential first step of communication (communicative action) and creating an audience, be it of critics, has led to the "unconstrained consensus" that action is needed. The implication for this paper is that it legitimises putting a price on carbon and the use of market mechanisms, such as ETSs to do so.

### 3.3 Australia and International Agreements

Australia ratified the United Nations Framework Convention on Climate Change in 1992 and since has, more or less, continued to participate in international negotiations and to meet its commitments under the Convention. Australia signed the Kyoto Protocol in 1997 and committed to limit its growth of emissions to 108 per cent of its 1990 baseline in the first commitment period 2008-12. Australia was granted an increase of its emission levels based on an argument on the concept of 'differentiated targets' based on a country's particular economic circumstance (Roarty 2002).

The road to an effective international agreement was made increasingly more difficult with the refusal of the USA to ratify and subsequently its withdrawal from the Kyoto process. Australia also refused to ratify the Protocol on the back of the USA withdrawal, citing that it would not be in Australia's economic interest. With Prime Minister Howard stating that "because the arrangements currently exclude, and are likely under present settings to continue to exclude, both developing countries and the United States, for us to ratify the protocol would cost us jobs and damage our industry" (in Roarty 2002). Australia subsequently ratified the Protocol ten years later in 2007.

## 3.4 The Changing Australian Political Climate

### 3.4.1 The Howard Government

Prime Minister John Howard held office for four terms and over 11 years, from 1996 to 2007. The general perception of the Howard Government's stance on environmental policy was unimpressive and essentially a climate change sceptic. This was evident in Howard's refusal to ratify the Protocol, his ambivalence towards climate change and the lack of a coherent policy framework. Overall, climate change policy in Australia has been described as disjointed and fragmented measures, across sectors and jurisdictions (PC 2007). The Howard Government's energy policy "Securing Australia's Energy Future" has been described as a "business-as-usual" statement that continues to promote fossil fuel based industries and therefore does not secure Australia's energy future beyond fossil fuels (Kent and Mercer 2006).

Since the creation of the Mandatory Renewable Energy Target (MRET) investment has stalled due to the low target, State Governments proposed that the MRET be expanded but the Howard Government rejected this idea. Australia's economy also has low energy efficiency levels in comparison with many other OECD countries, due to an unstructured national approach. However, the most significant inadequacy is that there is no consistent price on greenhouse gas emissions. Without a carbon price signal, electricity prices remain very low by world standards. Consequently, the electricity industry's decision-making does not take into consideration its large and rapidly rising emissions (Outhred and MacGill 2006).

This lack of strong environmental policy has been a driving factor of low levels of industry innovation as businesses cannot make long-term investment decisions without some certainty of future environmental policies. The Energy Supply Association of Australia[2] (ESAA) stated that "uncertain greenhouse gas emission policy is adversely affecting new energy supply decisions and that a national policy approach incorporating a greenhouse gas emissions price signal is needed to promote investor confidence, deliver greenhouse gas abatement and reward the uptake of new low-emission technologies" (ESAA 2007).

Towards the end of the 2007 election campaign, Howard proposed stronger environmental policies, as it was clear that the environment was a key election issue. The Howard Government promised to raise the MRET: though it would not lead to real increases, it merely matched what State Governments had implemented, above the Federal target (Kent and Mercer 2006). Howard then also announced that an AETS would be implemented, after years of non-cooperation with the State Government based taskforce that was looking into its design. However, these commitments were too little too late with the Howard Government losing the 2007 elections, as voters wanted a stronger commitment to the environment (The Economist 2008).

### 3.4.2 The Rudd Government

With a change in Government, came a change in environmental policy and full acknowledgement of the climate change problem. The new Prime Minister, Kevin Rudd, has made the environment a key priority within the new Government. This was signalled with the Prime Minister's first official act to ratify the Kyoto Protocol at the COP13 in Bali. The Rudd Government has made a number of key Environmental commitments including an emissions reduction target of 60 per cent by 2050 of 2000 levels, setting a medium term target, increasing the MRET to 20 per cent and the creation and implementation of an AETS by 2010 as its main mechanism (MCCW 2008a).

## 3.5 Chapter Conclusion

This chapter has depicted the changes in Australian politics that lead to an AETS. In addition, it has outlined research establishing the problem of climate change, that action is needed now and that measures are available to enact change.

[2] ESAA represents more than 40 electricity and downstream natural gas companies.

# 4 The Australian Electricity System

## 4.1 Key Stakeholders and Interactions

In this paper the electricity system is defined as the utility for the provision of electricity, from mining of raw materials, predominantly coal as is the case in Australia, electricity generation from renewable and non renewable resources, electricity transmission and distribution, and the wholesale and retail markets. In addition to technical aspects it includes a number of key stakeholders, electricity consumers, the atmosphere, and the Government's relevant policies. As the overall mechanism to affect change within the system it also includes the proposed AETS.

For the purposes of this research and to gain a more in depth discussion, the system boundary has been limited to key stakeholders, as these will likely experience the largest impacts based on changes to the system. The focus will be on the interactions between stakeholders that are driven by the necessity for the electricity generation industry to reduce its emissions as a result of an AETS. In order to depict flow on and feedback effects of stakeholder interactions within the electricity system a Causal Loop Diagram (CLD) is provided:

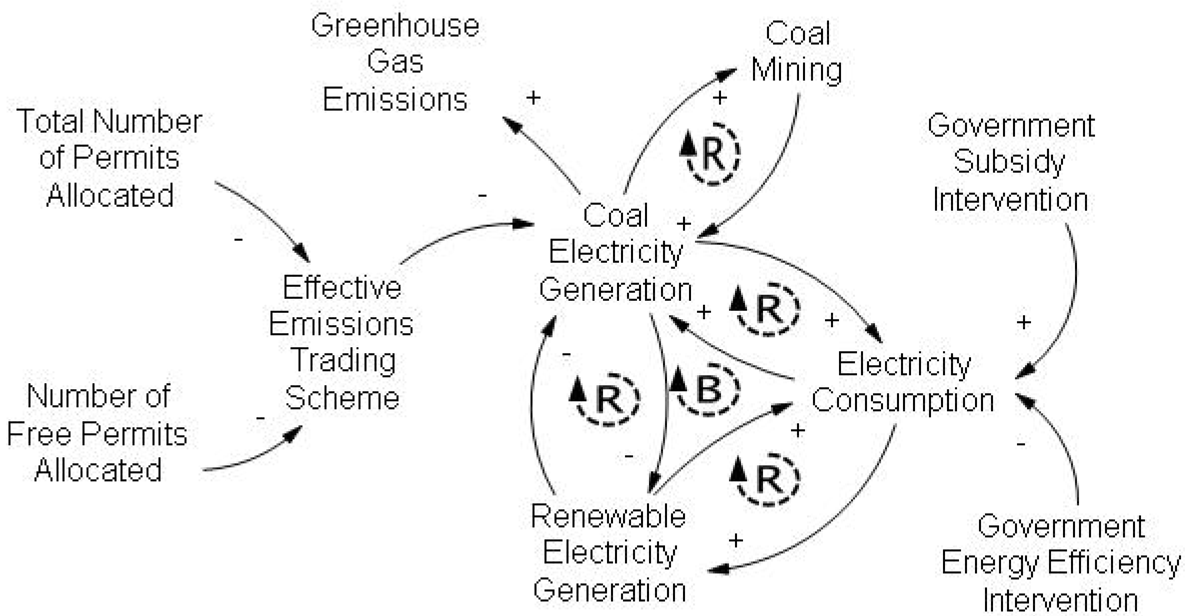


Figure 1: Causal Loop Diagram depicting potential effects of an Emissions Trading Scheme on the electricity system in Australia

With the introduction of an effective ETS, as determined by a tight cap on number of total allocated permits or allowances[3] and a limit to the number of free permits, the coal electricity generation industry will have to take measures to reduce its emissions. These measures will likely translate to a decrease in coal electricity generation and in the short-term will be an increase in the cost of electricity production as new investments will have to be made or the additional cost of internalising environmental harm through the purchase of permits.

These investment decisions in the industry can either lead to less intensive or carbon neutral technologies or a shift in fuel mix of electricity generation, which will subsequently reduce total emissions. Investment in alternative technologies can include less intensive coal fired generators, carbon capture and storage technology or nuclear energy. However in this paper it assumed that in the short-term a shift in fuel mix will occur to generation from renewable resources that are already operational and have a market share. Therefore, as the proportion of electricity generated from coal decreases, more electricity will be generated from renewable sources, for example from wind farms.

This shift in fuel mix will have a number of impacts, including on the economy. As coal generation decreases, potentially some coal-fired generators will have to close down leading to a loss of employment. In addition this will lead to a reduction in raw materials mining, predominantly coal, and its localised effects on communities that are dependent on such activities, and also its impact on the wider economy, as coal is a significant contributor to Australia's export trade.

Furthermore, the increased cost of electricity will flow through the economic chain and will likely transfer to higher electricity prices for consumers at all levels: from industry, business and households. This paper will predominantly focus on the subsequent impact on households. As the price of electricity increases this will lead to a decrease in consumption and subsequently lead to decrease in generation. This feedback is true for electricity generation from coal and renewable resources. An additional impact for industry will be that with higher electricity prices it will lead to increased production costs, especially for energy intensive industries.

Government intervention will then be required to smooth the impacts of introducing an AETS by redistributing the wealth generated through emissions trading. Intervention can take a number of

[3] A permit or allowances provides the ability or right to emit one tonne of carbon dioxide equivalent. This concept will be elaborated on in further sections.

policy approaches, including subsidies to ensure that those most vulnerable in society will not be disproportionately affected by higher prices, and coal communities are supported for transition to another income source. This subsidy will therefore lead to increase in consumption again and subsequently increased electricity generation, but predominantly from the more competitive renewable sources. An alternative government measure could be through energy efficiency programs for low socio-economic households to reduce consumption and subsequently electricity bills while maintaining the same utility, this however will feedback to decreased electricity generation.

As mentioned above the electricity system also includes electricity distributors, wholesalers and retailers. The interactions and effects of these stakeholders are not discussed as they have been defined as outside of the system boundary. However, in general terms the impacts on these stakeholders will somewhat mirror those of key stakeholders, in terms of price and volume fluctuations through increases or decreases in generation will be felt on distribution and markets, as will changing consumption patterns.

## 4.2 Electricity Generation in Australia

With around A$100 billion in assets, the electricity industry ranks as one of Australia's largest, making a direct contribution of 1.5 per cent to Australia's GDP (ABARE 2008:38) and the generation industry is the single largest contributor to emissions in the country. Therefore appropriate emissions reduction measures must take into account the structure of the industry in order to achieve effective outcomes, in terms of environmental harm, social equity and economic costs. According to Dubash (2003) the electricity industry should not only aim to achieve economic efficiencies but should incorporate larger agenda of environmental and social objectives.

### 4.2.1 Restructure of the Australian Electricity Industry

Since the early 1990's, the Australian electricity industry has gone through a restructuring, moving from vertically integrated public sector monopolies, to the National Electricity Market (NEM) which is opening the state-owned utilities to competition. Public electricity utilities were structurally separated and corporatised or privatised. The industry is now divided into separate competing businesses comprising generation through power stations, transmission through the high-voltage grid and distribution through poles and wires (Rann 1998). Previously each state focused on supplying its own needs and based capacity decisions in isolation, which led to over capacity being developed in different regions. Now through interconnectors, electricity generators sell through the NEM and distributors operate transmission infrastructure in their region (Roarty 1998).

Due to the restructure, the Australian electricity industry in economic efficiency terms has been improving with average electricity prices falling by 19 per cent since the early 1990s (Outhred and MacGill 2006). In addition since this time substantial improvements in rates of return on investments in the industry have occurred (Abbott 2006).

This model has occurred in all states except in Western Australia and the Northern Territory, which are the only two regions that are not connected to the NEM and where vertically integrated government ownership has been maintained (Abbott 2006). This paper will continue refer to the electricity system as the NEM to the exclusion of Western Australia and Northern Territory, as the electricity generation and consumption is small. The NEM accounts for 93 per cent of Australia's generation (IEA 2005:97) and services over 90 per cent of the population (MacGill et al 2006).

A positive of the restructure is that the industry is now one the most transparent and competitive markets in the world. Given the transparency and responsiveness of the industry it is well suited for the adoption and implementation of market-based mechanisms such as an ETS (IEA 2005:116-17).

### 4.2.2 The National Electricity Market

In Australia, as is the case with all electric power systems, the supply of electricity must be constant, due to the inability to store electric energy in a cost effective manner. This continuity of electrical energy flow, from generation to equipment end use, must be maintained in order to avoid local and widespread blackouts. The role of the NEM is therefore to assure the appropriate management of electricity system operation by balancing supply and demand, and ensuring that sufficient reserve capacity is available to handle peaks in electricity usage and emergencies (Outhred 2007).

The NEM is a wholesale spot market for electricity supply to the Australian Capital Territory (ACT) and the States of Victoria, New South Wales (NSW), Queensland, Tasmania and South Australia (SA). The NEM is an interconnected power system that stretches more than 4000 km from the North to the South, and includes a sea-bed cable between Victoria and Tasmania. It comprises six regions that are based on the State boundaries, with the Snowy Hydro Scheme being classified as a region in its own right (NEMMCO 2007). The NEM regions are characterised by a small number of very large generators, either comprising of a single large power station or a few generators controlling large portfolios of power plants. The limited number of players in the market for generation means that there is limited competition in generation within regional boundaries (OECD 2003:156).

The NEM involves the generation of electricity and its transport through the interconnected power system. It operates through a wholesale electricity pool and a spot market operating through a centrally-coordinated dispatch process that continuously balances supply with demand to satisfy the electricity requirements of almost eight million end-use customers (NEMMCO 2007). The dispatch process achieves this balance by scheduling generators to produce sufficient electricity to meet customer demand. Within the dispatch process, generators compete by providing prices for different levels of generation and market customers (retailers and end use customers who are wholesale market participants) submit bids, specifying quantities of electricity demanded. Based on the offer and bid process a clearing price for wholesale electricity is calculated for each half-hour period and the transaction between generators, and retailers and wholesale end-use customers occurs in the spot market (OECD 2003).

### 4.2.3 Electricity Supply and Demand

In 2006/07, 196,668 GWh of electricity valued at more than A$11.4 billion, were traded in the NEM, compared with 150,748 GWh at a value of $5.6 billion in 1999/00. The significant growth in value of electricity was most visible from 2005/06 where 194,781 GWh was traded at a value of only $7.1 billion (NEMMCO 2007).

The following table shows the generation of the industry by fuel and clearly identifies that Australia is largely dependent on the burning of fossil fuels for its electricity generation, with 61 per cent generated from black coal, 25 per cent from brown coal, 6 per cent from gas and oil and only 8 per cent from hydro (ACIL Tasman 2007).

| | Black Coal | Brown Coal | Gas | Oil | Hydro | Regional Total |
|---|---|---|---|---|---|---|
| QLD | 53,722 | | 3,395 | 34 | 539 | 57,690 |
| NSW | 66,761 | | 1,020 | | 460 | 68,241 |
| ACT | | | | | | |
| Snowy | | | | | 5,180 | 5,180 |
| SA | 4,535 | | 5,802 | 3 | | 10,340 |
| VIC | | 51,029 | 578 | | 416 | 52,023 |
| TAS | | | 610 | | 9,254 | 9864 |
| Fuel Total | 125,019 | 51,029 | 11,404 | 38 | 15,849 | 203,339 |

Table 1: NEM energy generated in GWh by region and fuel in 2005/06 (ACIL Tasman 2007)

This heavy reliance on coal is the driver of Australia's large greenhouse gas emissions on a per capita basis. Therefore it is clear that from an environmental sustainability point of view the current electricity generation is unsustainable. In order to reduce emissions and move towards a path of sustainable electricity system Australia must alter its fuel mix. This task is made more difficult given that electricity generation is expected to increase by two per cent per annum to 415,000 GWh by 2029/30 (ABARE 2007).

## 4.3 Australian Greenhouse Gas Emissions

### 4.3.1 Baseline, Current and Projected Emissions

Australia's baseline emissions from 1990 are 554 million tonnes (Mt) of carbon dioxide equivalent[4] ($CO_2$-e) and in 2005 total emissions were 555 Mt. The current analysis projects Australia to meet its Kyoto Protocol target of limiting its emissions to 108 per cent of 1990 levels, this equates to 599 Mt $CO_2$-e emitted annually in the Kyoto commitment period of 2008-12  (DCC 2008a:21, b:1,4,).

Although there has been significant growth in Australia's emissions since 1990, this is not reflected either in actual emissions in 2005 or Kyoto projections, due to changes in land clearing legislation, reduced forest cover removal, the regrowth of previously cleared land and increased sequestration of carbon from commercial forestry, environmental planting and national forest management. These accounting differences are measured in accordance with the Kyoto guidelines. Emissions for land use changes and forestry were recorded as 136 Mt in the baseline total, however in 2005 was only recorded as 25 Mt and in the commitment period projected to be 24 Mt per annum (DCC 2008a:22,b:4,13,14).

[4] Carbon dioxide equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

Decreases in projected emissions take into consideration current greenhouse gas abatement measures, of which the most significant is the new Government's 20 per cent Mandatory Renewable Energy Target (MRET). Projections indicate that by 2020 emissions will reach 120 per cent of 1990 levels, without these measures the business as usual projections were projected to reach 124 per cent of 1990 levels (DCC2008b:1,4).

Beyond the Kyoto Protocol it can be assumed that further reductions will be required of Australia, therefore new mechanisms will be needed in order to achieve emissions reductions beyond 2012, and one such measure which the Government has highlighted is an AETS. Currently, projections do not include the effect of an AETS, as many of the policy design elements remain under consideration (DCC 2008b:3). The implication is then that an effective ETS will have to be designed and implemented in order to set Australia on an appropriate path towards the Government's target of 60 per cent emissions reduction by 2050.

### 4.3.2 Stationary Energy Industry Emissions

The stationary energy industry[5] is by far the largest contributor to emissions in Australia. In the baseline year, 196 Mt $CO_2$-e came from the industry and in 2005 it increased to 283 Mt, which is equal to 51 per cent of net national emissions. The diagram below shows the percentage contribution of sectoral emissions to total $CO_2$-e emissions in 2005 (DCC 2008a:21):

[5] Stationary energy industry comprises fossil fuel combustion in electricity and heat production and manufacturing and construction industries (DCC 2008a:26).

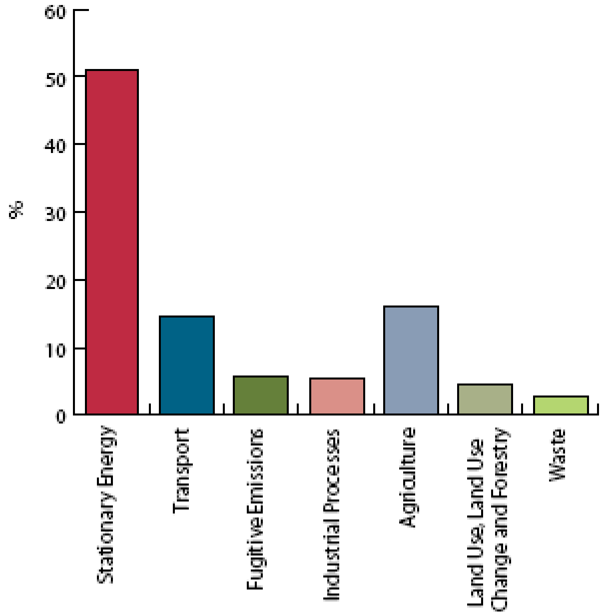


Figure 2: Contribution of sectoral emissions to total Australian $CO_2$-e emissions in 2005 (DCC 2008a:21)

The industry's emissions for the Kyoto commitment period are projected to increase by 56 per cent of the baseline to reach 304 Mt $CO_2$-e per annum (DCC 2008a:21).

Electricity generation accounts for 69 per cent of the stationary energy industry's emissions which makes it the single largest contributor to emissions. However, projected emissions in electricity generation are expected to decline by 0.2 per cent per annum from 2010 to 2020 due predominantly to the MRET (DCC 2008a:26,b:4,7). This reduction, however, is insufficient for Australia to meet the Government's 60 per cent emissions reduction target.

### 4.4 Chapter Conclusion

This chapter has answered the first research sub question of defining the electricity system and its stakeholders and their interactions, and shown that measures to reduce emissions in the electricity industry are a valid approach given its significant contribution to the problem in Australia.

# 5 Greenhouse Gas Emissions Trading Schemes

A key element of early action to combat global warming is carbon pricing as an effective and economically efficient means to achieve emissions reductions. A mechanism to achieve such reductions is through ETSs, currently in its infancy, though clarity and predictability about future rules and structure will instil confidence in carbon pricing and ensure that it develops over the coming decades to become universally and automatically factored into all decision making (Stern Review 2006).

Many governments across the globe are utilising ETSs within a policy framework to reduce greenhouse gas emissions. This trend can be seen through the implementation of predominantly cap-and-trade emissions schemes, such as the European Union, the Californian and North East US states, New Zeeland and a framework through the Kyoto Protocol to link these schemes. Evidence of ETS's growing importance, was the establishment in 2007 of the International Carbon Action Partnership (ICAP) by many authorities (currently 25 members) across the globe that are implementing ETSs (ICAP 2007). The Australian Government has committed to implement such a scheme and is a member of ICAP.

As mentioned, the appropriateness of ETSs as a measure to achieve environmental objectives is not discussed, as the Australian Government has already committed to implementing an AETS by 2010. Therefore what is needed is an analysis of what design principles are important to ensure that an AETS can achieve environmental objectives more effectively.

The following section provides a review of the EU ETS. This is necessary as it is the largest ETS market in operation, it will provide lessons, and in all likelihood the AETS will be largely based on similar design principles.

### 5.1 Kyoto Protocol Provision

Amongst its mechanisms for member countries to fulfil emissions reduction commitments, the Kyoto Protocol includes the provision for trading emissions with member countries. In addition a provision allows interaction with domestic and regional ETSs, if the scheme's rules are compatible. Under such schemes, governments set emissions obligations to be reached by participating entities. The rules of the scheme can allow these obligations to be fulfilled through holding any of the approved Kyoto units[6] or other units established specifically for those trading schemes which equate to the Protocol units on a one to one basis (UNFCCC accessed Feb 2008).

[6] Each single unit is equal to one tonne of carbon dioxide equivalent of emissions. For details of the Kyoto units refer to the UNFCCC web page (UNFCCC accessed Feb 2008).

## 5.2 The European Union Emissions Trading Scheme

The European Union Emissions Trading Scheme (EU ETS) was established by Directive 2003/87/EC. The Directive states that the EU ETS is compatible with the UNFCCC and the Kyoto Protocol and in order to increase compatibility with other ETSs, agreements should be concluded with countries that have ratified the Kyoto Protocol to provide for the mutual recognition of allowances. The Directive's intention is to contribute to fulfilling the Kyoto Protocol commitments of the 27 Member States of the European Community (Member States) through an efficient European market in greenhouse gas emission allowances[7], with the least possible burden on the economy (Directive 2003).

The EU ETS is the world's largest company level cap-and-trade scheme which focussed initially on large industrial emitters. The EU has identified the use of an ETS as the most cost effective way to reduce emissions (EC 2007). European Commission studies have concluded that the targets can be achieved at an annual cost of €2.9 to €3.7 billion, which is less than 0.1 per cent of the EU GDP and that without the ETS costs could reach € 6.8 billion (EC 2006:7).

In the first three-year trading period, from 2005 to 2007, the EU ETS covered only $CO_2$ emissions[8] from large emitters (based on a size threshold) in the power and heat generation industry and in selected energy-intensive industrial sectors: combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp and paper.[9] Approximately 10,500 installations in the Member States are covered and account for around 50 per cent of the EU's total carbon dioxide emissions and about 40 per cent of overall greenhouse gas emissions (EC 2007).

### 5.2.1 Allocation of Permits

The Member States must develop a national allocation plan stating the total quantity of allowances that it intends to allocate for a trading period and how it proposes to allocate them. For the first trading period the States allocated at least 95 % of the allowances free of charge. For the second trading period (five years) from 1 January 2008, the States allocated at least 90 % of the allowances

[7] Allowance means an allowance to emit one tonne of carbon dioxide equivalent during the specified period.
[8] The Directive can also be applied to the following greenhouse gases: Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons, and Sulphur Hexafluoride. But was limited to $CO_2$ emissions due to availability of emissions data for other gases (Directive 2003).
[9] A table detailing installations covered under the EU ETS can be found in Directive 2003 Annex I, however from 2008 Member States may expand the allowance to other activities, installations and greenhouse gases (Directive 2003).

free of charge. The Member States must ensure that the allocation of allowances will ensure it meets its obligations to limit its emissions pursuant to the Kyoto Protocol and other European Commission directives (Directive 2003).

### 5.2.2 The Third Trading Period and Beyond

For the period after 2012, the EU has committed to reduce its emissions to a minimum of 20 per cent and up to 30 per cent below 1990 levels by 2020 provided that other developed countries commit to do likewise under a new international climate agreement. These targets will form the basis for setting the cap on emissions allowances in the third phase of the EU ETS starting in 2013 to 2020 (EC 2007).

Proposed amendments to the EU ETS for the third trading period are currently being considered, devised based on the lessons learnt from the first period. The main changes relevant to this paper are:

- A single EU-wide cap (which will decrease along a linear trend line each year) on the number of emission allowances instead of 27 national caps;
- A much larger share of allowances will be auctioned instead of allocated free of charge, estimates are that 60 per cent of total allowances will be auctioned in 2013, and this will increase on a yearly basis. In addition allowances for the power sector will fully auctioned;
- Harmonised rules governing free allocation will be introduced, which will take into consideration sectors with significant risk of international competition (EC 2008a).

## 5.3 Operation of the EU ETS

Given the infancy of the EU ETS and the time lag for data to become available there are a limited number of researches that have been published evaluating the actual outcome of the EU ETS. However the findings of those available and studies modelling likely impacts have been used as the basis for the following section.

### 5.3.1 Impact of EU ETS Outcomes

Phase one of the EU ETS successfully established trade in greenhouse gas emissions, however, the EU reviewed the outcomes of the ETS operations (which subsequently led to the proposed amendments above) and the relevant finding for this paper was that environmental outcomes could have been more significant but was limited due to excessive allocation of allowances (EC 2008b).

In terms of trade in global $CO_2$ allowances and credits, the EU ETS constitutes over 80 per cent of the turnover. In the first year of operation, 2005, at least 270 million allowances were traded, with a value of around €5 billion. In 2006, trading volume rose to more than 800 million allowances, valued at €14.6 billion (EC 2007). This growth continued in 2007 with more than two billion allowances traded, valued at €37 billion (Capoor and Ambrosi 2008).

Many studies highlight the difficulties in evaluating the EU ETS considering its infancy, though generally it is agreed that the overall position of the market was long, as for a majority of installations covered, more allowances were allocated then verified emissions. Consequently, emissions reductions were not as high as could have been. These studies also highlight the effect on price, as in 2006 following the announcement of 2005 actual verified emissions data, the price of permits fell drastically as many countries' actual emissions were below the total amount of allocated permits (Anger and Orberndorfer 2008, Ellerman and Buchner 2007, Kettner et al 2007).

Some authors however, also state that to a certain extent environmental objectives were met and that the extent to which they were not met could be the result of many other variables. Ellerman and Buchner (2006) state that the level of emissions was below the allocated permits, though the authors suggest that this can be due to a number of reasons including uncertainty in prediction of emissions. They also argue that in fact abatement did occur and this can be attributed to an under estimation of abatement as facilities already incorporated the price of carbon into production processes regardless of the actual market price. Therefore they argue that to a certain extent the EU ETS achieved its environmental objective, though they do qualify the statement with uncertainty due to potential bias in baseline data.

Kettner et al (2007) also state that large variations with allowances and verified emissions occurred, however qualify that both long and short positions may occur due to other factors than cap level, for example, long or short positions can reflect an unexpected rise or fall in production, abnormal weather conditions, specific situations in the availability of raw materials and fuels, or changes in production processes.

Although there will always be uncertainty in measuring and verifying actual impacts and outcomes, it is generally agreed that an over-allocation of permits occurred and that this reduced the environmental effectiveness of the EU ETS. This acceptance is seen in the EU's proposed amendments for future trading periods of setting an EU-wide cap to ensure over-allocation does not occur and emissions reduction objectives are achieved (EC 2008b).

#### 5.3.2 Allocation of Permits

The introduction of an ETS will cause distortions in some form, and the initial allocation of allowances has impacts on efficiency and overall cost of emissions abatement. The allocation of free permits essentially compensates companies for the additional cost of emissions, and potentially can lead to substantial profits, as the marginal cost of production will be included in prices, even though companies received free permits (Grubb and Neuhoff 2006). If free updated allocations are given, based on past emissions, this leads to inefficiencies, as it provides perverse incentive for intensive emitting installations to remain in operation and produce excessive output and emissions to receive free allocations (Neuhoff et al 2006).

The alternative to free allocation is the auctioning of permits, which is supported almost unanimously amongst economists (Hepburn et al 2006). Auctioning of permits will lead to a more cost efficient scheme, with reduced administrative costs but also secondary trading as initial allocation is more efficient (Betz, date unknown). It will also provide assurance and potentially help to stabilize the system through minimum price auctions (Grubb and Neuhoff 2006). With more transparency in allocation, robust price signals and scarcity in the market would occur, it adheres to polluter pays principle and addresses windfall profits from free allocations (Rogge et al 2006).

Given that distortions will occur from free allocation, an additional benefit of auctions would also be to improve the macroeconomic efficiency of an ETS, as auctioning benefits from revenue raising (Hepburn et al 2006). This revenue can be can be redistributed to address distortions in the economy (Rogge et al 2006) and to help the development of low carbon technology (Grubb and Neuhoff 2006).

According to Betz (2006) volatility in the EU ETS market and ineffectiveness in phase one was due to inefficient price discovery driven by the allocation process. In order to reduce this volatility more auctioning of permits is required. The price crash and volatility of the EU ETS also contributed to not fully achieving environmental objectives as with the low price of permits, emissions intensive installations could still continue operations.

Once again it seems that auctioning is becoming accepted, as can be seen with the EU's own review, stating that auctioning best ensures efficiency of the ETS, transparency and simplicity of the system and avoids undesirable distributional effects. It has been proposed that full auctioning should be the rule from 2013 onwards for the power sector and for installations in other sectors, a gradual transition starting with free allocation at a level of 80 per cent, decreasing by equal amounts each year, and arriving at zero free allocation by 2020 (EC 2008b).

There is also much literature on the appropriate method of auctioning, however it is beyond the scope of this paper, the important concept that has been highlighted here is that a more efficient and therefore more effective ETS, in terms of environmental objectives, is achieved through the auctioning of permits as opposed to allocating the permits for free.

### 5.3.3 Impact on the Economy

There are also a limited number of empirical studies that have modelled the impacts of the EU ETS on competitiveness and employment within different economies in the EU. Generally, these studies conclude that competition and employment have not been and would not be effected.

The impact of the EU ETS on competitiveness and employment is modest and only slightly negative, given commitment to emissions reduction, ETS is the least-cost method to achieve targets compared with other forms of regulation. Improvements can me made to ensure distributional effects are limited by expanding the ETS to all emitting sectors. Research suggests that the power sector will benefit from the current setting and that energy intensive industries will suffer even if they are not included in the scheme (Orberndorfer et al 2006).

A number of studies have looked into country and sector specific cases. According to Anger and Orberndorfer (2008) at a firm level for Germany, the EU ETS did not have a significant impact on competitiveness and employment, though this is largely related to the long position. Research modelled the competitiveness of the EU ETS across five energy intensive industries in the UK, given free allocation of permits, and found that companies increased prices but cut back on output in response to increased costs. The outcome being that profits increased with costs passed onto consumers and modest loss of market share and minimal employment would occur due to decrease in output (Smale et al 2006).

According to Lund (2007), the implementation of the EU ETS had both direct (through the emissions reduction) and indirect (through higher electricity prices) costs for energy intensive manufacturing industries. For the Kyoto period, the costs for most industries will remain below 2 per cent of the production value. Sjim et al (2006) found that in Germany and the Netherlands, free allocation will lead to power companies passing on costs to consumers through higher electricity prices and subsequently realising substantial profits.

Sato et al (2007) supports the findings of the above studies, but qualifies that results vary on individual firm and sectoral level, dependent on sensitivity to indirect electricity impacts. Lund (2007) supports that if reductions of 30 per cent are required post Kyoto, the indirect costs could potentially outweigh direct costs raising total cost to 8 per cent of the production value for energy intensive manufacturing industries and could jeopardise profitability. Sato et al (2007) also state that with 100 per cent free allocation perverse incentives occur across all sectors. Although according to Orberndorfer et al (2006), higher job losses occur from auctioning as compared to free allocations, this will be offset by optimising innovation potentials including new opportunities in other job markets.

In addition to competitiveness and employment, Hoffman (2007) found that in the electricity sector in Germany the EU ETS has not lead to radical changes in development and use of power generation technologies. Companies seem to have similar considerations for their investment decisions as before the introduction of the EU ETS. This can be traced to two aspects that are particular to the electricity industry, emission reduction efforts are driven by the objective to reduce fuel costs or by other legislative measures such as renewable energy targets.

Given the analysis above, regarding the outcomes of the EU ETS, the two design principles that have a significant impact, on the effectiveness of an ETS, and subsequently environmental outcomes, is a tight cap limiting the total number of permits allocated and a greater proportion of permits being auctioned as opposed to allocated for free.

### 5.4 An Australian Emissions Trading Scheme

Draft proposals for the creation of an AETS have been created, and largely follow the characteristics and structure of the EU ETS. The Government has committed to finalising an AETS by the end of 2008, with implementation by 2010, as part of a policy framework for meeting the climate change challenge (MCCW 2008b).

While the specific AETS design has not been released, the Government has outlined design principles that will guide the development of an ETS:

- It will be a cap-and-trade scheme to ensure international consistency;
- The cap's quantitative limits, that define its effectiveness and environmental contribution, will be designed to place Australia on a low emission path in a way that best manages the economic impacts of transition, while assuring our ongoing economic prosperity;
- The scheme will have maximal coverage of greenhouse gases and sectors, to the extent that this is practical;
- The system will be designed to enable international linkages, while ensuring it suits Australian economic conditions; and
- The design will address the competitive challenges facing emission-intensive trade exposed industries in Australia (MCCW 2008a).

The intention of this paper was not to suggest a complete design of an AETS. As can be seen by the guiding principles above, the Government will implement an ETS with an appropriate structure to ensure international linkages and has considered principles that the EU ETS followed. This paper's contribution was to analyse and discuss design principles that have been debated in the wider literature, and owing to political sensitivity and intense lobbying have been difficult to determine (Grubb and Neuhoff 2006). Given this difficulty, as was evident in the EU ETS first and second phase, the concern for national economic competitiveness led to a cap that was not sufficiently tight and virtually no auctioning of credits (Hepburn et al 2006).

### 5.4.1 Setting the AETS Cap and Auction Level

This paper will not suggest a quantitative level for the cap, but in setting the cap, the Government should take into consideration a number of issues. Obviously the most important is the level of total Australian emissions that it wishes to achieve, given that an AETS will not cover 100 per cent of emissions. In the longer-term the Government has committed to a 60 per cent reduction by 2050 and for the medium-term the Government has announced that it will set an interim target for 2020, however, this has yet to be announced. According to Garnaut (2008a), the setting of an interim target is crucial as it will provide certainty and will instigate immediate action. The EU has announced that it would commit to a 30 per cent reduction by 2020. At a minimum Australia should support this by setting a similar interim target and actively negotiating on an international level. The AETS cap must be sufficiently tight to ensure that it sets an ambitious level, to set Australia on the path towards these targets.

Another consideration is the principle of per capita emissions, as mentioned, to ensure an equity perspective, but also to ensure that rapidly growing developing countries will be convinced to adopt reduction measures (Garnaut, 2008a). Given that Australia is currently almost five times above the global average on a per capita basis, it suggests (obligates) that, a tight cap must be set.

In order to determine the appropriate level of auctioning (100 per cent versus 10 per cent) is a complex process to model the likely economic impacts given the large sets of variables, that is clearly not the intention of this paper, but to draw out the discussion that currently the EU ETS has set no minimum auction level and consequently for future trading periods it is likely to auction approximately 60 per cent of permits. This increase is also supported by the available literature, and the implication for Australia, is therefore, in order to have a more effective ETS from the beginning, with immediate impacts on its ultimate objective of reducing environmental harm, it should look to auction permits. The greater proportion auctioned will lead to greater efficiency. This would also give the Government access to revenues that can be redistributed.

Coal generation in Australia represents over 80 per cent of production and the majority of base load[10] electricity. Given coal-fired generator dominance in the system, it would not be appropriate to auction 100 per cent of permits from the beginning, a minimum level of free allocations will still be needed to the electricity generator industry to ensure that electricity supply is not jeopardised and base load operations will still be competitive in the market. However, given the experience of the EU, a percentage of permits should be auctioned from the beginning to ensure a more efficient ETS and avoid a situation where companies are receiving windfall profits.

### 5.5 Chapter Conclusion

This chapter has shown, that from an environmental perspective, two design principles that can alter the effectiveness of an ETS are the limit to the cap and the amount of free permits allocated. Therefore, it has answered the second research question of important design principles for an

[10] Base load refers to the minimum level of demand over a 24 hour period.

AETS, the overall cap should be tight and a greater number of permits should be auctioned, in order to achieve an effective ETS and reach environmental objectives.

The Government has highlighted the important principles identified in this paper, however it is strongly recommended that in order for an AETS to be effective and achieve strong environmental objectives the AETS design principles should focus on the environment, as a priority.

# 6 Sustainability and the Electricity System

The following chapter discusses the interactions between key stakeholders and potential impacts of an AETS on the electricity system in relation to the pillars of sustainability. Given the conclusion of the previous chapter, the following will discuss impacts on the environment, society and economy, based on an effective AETS, which is defined henceforth as an ETS that has a tight cap on total number of permits and auctions a greater number of its permits.

## 6.1 Electricity System and Environment

The electricity system in Australia, from an environmental perspective, is unsustainable. It is the single largest contributor to emissions in Australia and it has significant projected emissions growth (DCC 2008a,b). The introduction of an AETS is the main mechanism to increase the environmental sustainability of the system and reduce greenhouse gas emissions in order to avoid “dangerous” levels of concentration in the atmosphere.

With the introduction of an AETS that has a tight cap and a greater number of permits auctioned, it will lead the electricity generation sector to internalise the costs of environmental harm more effectively. This internalisation will lead to a decrease in electricity generation from coal and subsequently a reduction in emissions released into the atmosphere. These outcomes will result in immediate effects and thereby improving the [environmental] sustainability of the electricity system, as measured by the indicator used for this paper, through reducing the amount of emissions released into the atmosphere.

The tight cap will ensure that the price of emitting is more costly than to find alternative sources of generation with lower emissions intensity. In the short-term, generators will look to exhaust internal energy and operational efficiency measures, but also alternative sources of electricity generation that are already operational, particularly renewable sources, such as wind, hydro and solar, but also gas plants, will increase their market share as with the increased cost of electricity, these sources will become more price competitive (Garnaut 2008b:50), as it will not incur the additional expense of having to purchase emissions permits through the market. Given the NEM operation as previously described, it allows for the more competitive renewable energy generators to bid the price of electricity in the wholesale market, and as mentioned will become more competitive as coal generators will have to include the additional cost of emissions.

An issue, however, of shifting to a greater proportion of renewable resources, is that there must be a continuous supply of electricity in the system, with reserves to handle peaks. Given the dominance of coal and subsequent infrastructure that is most suitable to such technology (Sonneborn 2004), in the short-term renewable energy will not be able to supply the majority of the necessary base load of the system, until significant infrastructure investment and development is achieved. A shift to natural gas plants as base load generators will likely occur in the shorter-term (Garnaut 2008b:49)

This development will have to occur in the medium to longer-term. The price of emissions will have immediate impact on investment decisions within the generation industry. Emissions will have to be internalised into the cost of generation and this will alter investment payoffs and make alternative sources of generation from renewable sources more attractive. However, the changes to the system, in terms of infrastructure that is more suitable for renewable energy, will take time to develop. Pricing of emissions will also stimulate research and development in other technologies that are currently not operational on a commercial scale, such as some cleaner coal production and carbon capture and storage (Garnaut 2008b:53). As investments in alternative less emissions intensive sources comes to fruition this will further strengthen the [environmental] sustainability of the electricity system as less and less emissions will be released into the atmosphere.

In addition as the system adapts, the cap will be gradually tightened overtime, thereby accelerating and intensifying achievement of environmental objectives. This trend over the longer-term will enable changes within the system to achieve the Government’s target of 60 per cent reduction by 2050 and entrench the intention of moving to a carbon neutral economy.

Additional considerations of the Australian context will be discussed in regards to the electricity system’s ability to adapt to changes.

### 6.1.1 Shift to Renewable Resources

According to Saddler et al (2007) Australia is in a unique position where it has the resources to move to a more sustainable energy system, given its access to renewable resources. According to Garnaut (2008a) amongst the rich natural resources are natural gas, uranium and renewable energy, and has good sites for carbon capture and storage. In addition, Australia has the resource capacity to evolve, and it also has the human resource in engineering, management and finance, which allows for competitive participation in innovation in the emerging low emissions industries.

According to Sonneborn (2004), historical fossil fuel subsidies will continue to inhibit the successful uptake of renewable energy even with the implementation of an effective ETS. In Australia it is estimated that since the second half of last century the fossil fuel industry received over A$3 billion in direct subsidies and consumers of fossil fuels received about A$37 billion. To over come this, auctioning of permits as opposed to free allocation would be needed. This would allow the renewable resources industry to be more competitive if coal-fired generators would not receive free allocations, and the market can then find the least-cost options and foster innovation and development in the appropriate technology, be it hydro, wind, solar, biomass or natural gas.

### 6.1.2 Barriers to Change

Australia has the renewable resources and the mechanism for change, however, the structure of the NEM itself is a barrier. MacGill et al (2006) states that historically in the electricity industry investment decisions have been made without taking environmental impacts and emissions into consideration and, therefore, environmental objectives have not been met. According to Outhred (2004) the NEM does not have any environmental objectives, and with an absence of any reference to environmental sustainability, there has been little success in achieving reduced environmental impacts in the past.

Furthermore, in general terms, the NEM structure provides a poor interface for end-users, distributed and renewable energy resources and is thus biased towards the large coal-fired generation (Outhred 2007). This historical bias has developed over time as an extensive infrastructure of fuel supply, maintenance and other ancillary services provide competitive advantage for the technology to maintain its dominance (Sonneborn 2004). These structural inefficiencies must be overcome through investment in infrastructure that can accommodate renewable resources, but as mentioned above, this will take time.

### 6.2 Electricity System and the Economy

It is well known that energy consumption and GDP growth are linked, the intensity of this interaction depends on the stage of development of a country (WEA 2004:37). The energy intensity of the Australian economy[11] has been decreasing since the 1990s and is projected to continue to decrease by one per cent per year to 2030 (ABARE 2007:24). Regardless of this decrease, the increased cost and price of electricity will impact on the economy in various ways.

As the discussion on the impact of the EU ETS has shown, competitiveness and employment in the EU will not be greatly affected, however, that is due predominantly to a somewhat ineffective scheme in terms of environmental objectives. However, an effective ETS will lead to costs, but given that binding Kyoto commitments have been made by the EU (and now also Australia) an ETS will lead to the most efficient achievement of emissions reduction (EC 2006, Oberndorfer et al 2006), in terms of least impact on competitiveness and employment.

As stated above, this paper recommends that an AETS which prioritises the environment should be implemented, therefore the effects on competition and employment, which did not eventuate in the EU, will have a greater effect on the Australian economy. With a more effective ETS, increased costs of generation will occur and can potentially force "dirty" coal-fired generation stations to close down operations or at the very least reduce its output, if the price of permits are sufficiently high. Closure or decrease in output, will cause loss of jobs in coal generation plants but also lead to a reduction in raw materials mining, in particular coal mining. This will have localised effects on single industry isolated mining communities that are dependent on such activities. These communities are established only for economic reasons and a marked increase of these communities was seen in the second half of last century, especially in Australia (Nadkarni and Stening 1989). Such communities are an important part of the Australian economy, the mining industry contributed 7 per cent to GDP in 2005-06 (ABS 2008:523).

Even though potential job losses will occur in coal generation, according to Sonneborn (2004) the renewable electricity industry (with the exception of photovoltaic cells) creates more jobs than

[11] Energy intensity of the economy is measured as total primary energy consumption per dollar of GDP.

conventional energy industries because their capital requirements are much more modest and their labour needs greater. Generating 1000 GWh of electricity per year requires 100 workers in a nuclear plant, 116 in a coal-fired plant, but 248 in a solar thermal facility and 542 on a wind farm.

Another important consideration for Australia is the export trade industry, Australia is the fourth largest coal producing country, but is the biggest coal exporter, as in 2003 it exported 73 per cent of coal it produced, representing over 30 per cent of world trade. Given its size it is also important to the economy as it accounted for over ten per cent of export revenue valued at over A$16 billion (IEA 2005:121). The costs of mining coal may be affected by the decrease in domestic demand due economies of scale, and subsequently would mean that cost of exports would need to increase to cover this loss in order to maintain export levels. This, however, raises an important question that if Australia must become a leader in emissions reduction measures for effective influence in international negotiations, as recommend by Garnaut (2008a), then it seems hypocritical to only reduce its (relatively insignificant) domestic emissions while still supporting and promoting the continuation of emissions intensive industries across the world.

Although an AETS will lead to increased costs for electricity generators, given the dominance of large generators in the NEM, it allowed market power to be exercised, resulting in higher-than-normal pool prices and subsequently higher profit margins (OECD 2003). This suggests that within industry operations efficiency gains are still available or at the very least that generators have a margin in their profits to accommodate the costs inherent in establishing an ETS. This could potentially ease the transition, to allow more time while base load demand is met, for the necessary infrastructure to be developed for renewable resources to take a much larger market share.

Another impact on the economy will be that as the cost of generation increases, this will likely lead to generators passing on the costs to consumers (Garnaut 2008b:51, Sjim et al 2006), resulting in higher electricity prices for consumers. This will affect all levels of consumers, and for industry and business will lead to increased production costs. The affect on small to medium sized business will likely be minimal, however, for electricity intensive industries, where electricity represents a significant proportion of production costs, it will be an issue. Lund (2007) noted that for energy intensive industries in the EU, over the Kyoto period, increased costs will remain below 2 per cent, which is a manageable increase.

Although there will be negative impacts, the economy will also be stimulated by increased investment in alternative technologies. Technologies include, less intensive coal-fired generators, carbon capture and storage technology, gas plants and renewable energy. This will, as mentioned above, also lead to additional jobs in these sectors. This paper assumes that a shift in fuel mix will occur to larger proportion of generation from gas plants and renewable sources. Therefore as the proportion of electricity generated from coal decreases, more electricity will be generated from renewable and gas resources and subsequently more investment in these industries.

### 6.2.1 Economic Feasibility of Implementing Emissions Reduction Measures

A study by a consulting firm (McKinsey & Company 2008) assessed the costs of abatement measures for emissions reductions in Australia. The results indicated that with changes to operation in key sectors, utilisation of existing approaches and deployment of mature technologies, emissions reductions of 30 per cent by 2020 and 60 per cent by 2030 of 1990 levels is possible. These reductions are achievable without major changes to consumption patterns, lifestyle or quality of life. The study noted that emissions could be reduced by 20 per cent to 2020 of 1990 levels with no net cost to the economy by predominantly by implementing energy efficiency measures in the building sector and households.

Another study found that early action to achieve a 60 per cent emissions reduction in Australia, by 2050, through the pricing of carbon will significantly reduce the cost burden to a loss of 0.1 per cent of annual GDP growth as compared, to waiting nine years which would lead to a loss of 0.3 per cent of annual GDP growth (The Allen Consulting Group 2006).

Though it is understood that such modelling takes into account variables that may or may not come to realisation, the importance is to note that on a basic level opportunities exist, and in particular in relation to the electricity system, growing share of generation from renewable energy have been modelled and shows that economically it is viable. The introduction of an AETS will therefore open to the market these opportunities. Saddler et al (2007) concluded that it was technically feasible to reduce the electricity generations emissions by using existing technologies with small improvements.

## 6.3 Electricity System and Social Context

### 6.3.1 Accessibility of Electricity

Access to electricity and increased consumption improves the health of a nation and societal advancement with data supporting a correlation with use and life expectancy, general health, education and prosperity opportunities (Dubash 2003, Ferguson et al 1997). In developed countries it is a mechanism to ensure equitable access to opportunities within society. Disproportionate access to electricity would mean that lower end socio-economic households would not have the ability to provide light and heat for basic needs, and this can affect health and educational and economic opportunities (WEA 2004).

Given the importance of electricity to society, a sustainable electricity system must have the necessary infrastructure to deliver electricity to all its population. In the Australian context, technical access to electricity is not an issue, as infrastructure and coverage essentially provides connectivity to everyone that can afford it. Therefore, accessibility to electricity is dependent on affordability and this is the key component for the [social] sustainability of an electricity system in Australia.

### 6.3.2 Price of Electricity

Given the increase in the cost of generating electricity described above, it will likely lead to increased electricity prices for Australian consumers. In the case of the EU increased electricity prices have eventuated and can be linked to the EU ETS (Hepburn et al 2006, Kettner et al, 2007, Lund 2007, Sjim et al 2006, Rathmann 2006).

According to Byrne and Mun (2003) electricity is seen as an essential public good, however access can also create inequity. There are cases in electricity systems where even though electricity costs are lowered, benefits are not distributed equitably as large consumers pay low prices with competitive providers, and residential and small business consumers experience price discrimination and pay higher unit prices. This certain extent can also be seen in Australia as the business sector benefiting greatly from falling electricity prices compared to households (Outhred and MacGill 2006). Therefore there is a possibility that households will disproportionately bear the burden of higher prices as a result of the AETS and generally according to Dubash (2003) higher electricity prices disproportionately affect the poorer among society as they pay a higher proportion of income on electricity.

Although by world standards, Australia has some of the lowest electricity prices (IEA 2005), there are still those in the society that are vulnerable. In Australia household expenditure on domestic fuel and power in 2003-04, relative to total expenditure, for households whose gross income was in the bottom 20 per cent of all households was on average 4 per cent, while households in the top 20 per cent was 2 per cent. Although relative to total expenditure energy cost is low, for a small group of households energy is a significant expense. Approximately five per cent of all Australian households are unable to pay their utility bills on time due to a shortage of money (PC 2005). Although it is only a small percentage of the population, further increases in the price of electricity would exacerbate this problem and jeopardise the health, and educational and economic opportunities of a proportion of the Australian society by limiting access to electricity.

Therefore, to ensure that the indicator is met and the social sustainability of the electricity system is improved, the electricity price increase that will likely follow the implementation of an AETS must not disproportionately effect the lower income and most vulnerable in Australian society. This can be achieved by ensuring that these groups are effectively supported through redistribution mechanisms.

### 6.3.3 Social Acceptance

Another indicator of social sustainability used in this paper is social acceptance. According to Assefa and Frostell (2007) a basic component of social sustainability is social acceptance, of how society views and understands technologies in an energy system. The expressed level of fear in public opinion has an influence on decision making processes, and this public perception is based on knowledge. Social acceptance shortens the time between discussions and system implementations.

In Australia a number of recent surveys have been conducted to test perception and public awareness regarding various issues of climate change. A survey of over 1,000 Australians found that 89 per cent are concerned with climate change, and 78 per cent believe that urgent action is required to reduce greenhouse gas emissions, furthermore 70 per cent agree that strong emissions reduction targets should be implemented. New forms of electricity generation were also strongly supported with 74 per cent believing that clean energy technology must be used and 86 per cent supporting legislation for increased energy efficiency (CI 2008).

Another survey of over 1,000 Australians found that 74 per cent of Australians would prefer a greenhouse gas strategy to be based on energy efficiency and renewable energy as opposed to nuclear or clean coal technology. In addition 77 per cent would prefer to source electricity from renewable energy (Macintosh and Hamilton 2007).

An additional survey of Australian households was seeking to discern people's attitudes towards electricity alternatives, and more specifically household electricity consumption and demand management[12] and distributed energy technologies. The survey had over 2,000 respondents and found that 76 per cent of respondents had intentions to reduce consumption, 57 per cent and 55 per cent were open to utilising demand management technology and distributed energy technology respectively (Gardner and Ashworth 2007).

These survey results indicate that generally there is a high level of acceptance to alternative electricity technologies in Australia, which would be driven by the implementation of an ETS. Therefore an indicator of social sustainability would be achieved or at the very least not be undermined with the introduction of an AETS that would drive changes in the electricity system.

However, Wustenhagena et al (2007) stated that public opinion on acceptance of renewable energy, particularly wind, does not necessarily translate into implementation, as localised landscape issues are often not sufficiently considered.

There is a certain amount of not-in-my-backyard mentality, however it seems that in Australia with the continued growing number of wind farm projects being approved and built (Auswind date unknown), that social acceptance even in a localised setting is also increasing. There is a large body of research particularly on acceptance of wind energy, but little is known about acceptance of an ETS. However research on wind energy can be taken as a proxy for alternative energy systems as a sustainable system is based on renewable resources, and currently wind is a growing industry world wide and in Australia it has a large potential (IEA 2006:9,77).

[12] Demand management technology in this survey referred to a computerised device that would control energy consumption by regulating major household appliances, i.e. turning them on and off automatically, based on periods of peak electricity demand.

### 6.4 Chapter Conclusion

This chapter has discussed some potential impacts of an AETS on electricity system stakeholders. With the use of qualitative indicators in the pillars of sustainability it has shown that with an effective AETS, emissions reduction will occur, consequently effect the economy due to a higher cost of electricity and a need for shift in fuel mix and investments, and subsequently higher electricity prices for all consumers. Therefore this chapter has answered the third sub research question.

## 7 Trade-offs within the Pillars of Sustainability

The above discussion on indicators of sustainability and effects on key stakeholders in the electricity system has shown that government intervention in the form of implementing an AETS is needed in order to improve environmental sustainability. Furthermore this action has resulted in trade-offs in social and economic sustainability. Further government intervention, is required to assist in achieving satisfactory trade-offs within the pillars of sustainability, though redistribution. It has been mentioned that with an AETS that auctions a large number of permits, the Government will gain revenues, and these gains can be used as the basis to redistribute and smooth trade-offs in society and economy to bring the Australian electricity system into a satisfactory level.

### 7.1 Government Intervention in Economy

As mentioned previously, the impact on the economy will likely be job losses and competitiveness of coal-fired generators, coal communities and emissions intensive industries. Once the AETS is implemented, market forces will dictate what the most cost effective alternative technologies are and where the most potential for growth in innovation and development is. With this signal from the market the Government can redirect revenues raised, to the industries, and coal communities, to ensure a transition to alternative sources of income. For those that have experienced job losses the Government can provide services to support job search.

A less unsustainable electricity system must be based on renewable resources with low to no emissions, and even though the market will motivate a shift in fuel mix to more renewable resources, according to Saddler et al (2007), government assistance for a more renewable energy industry, is required to ensure that a renewable industry can be competitive. This is due to the need for the creation of adequate infrastructure for renewable resources and that given the current system of fossil fuel based industry has enjoyed and continues to enjoy much subsidy, government support for renewable industries is fair and equitable to ensure its growth. Although capital investment will be directed by the market, Government can ensure successful transition by assisting the development of infrastructure and potentially reduce the time it takes for this transition.

## 7.2 Government Intervention in Society

According to Dubash (2003) public subsidies are required to meet social policy goals. From a social sustainability perspective government intervention can be in the form of policy instruments to redistribute gains from implementation of an ETS and the subsequent higher energy prices could include adjustments to the social security and income tax systems, adjustment programs to coal regions and, assistance through information or capital subsidies for increasing energy efficiency of households (Garnaut 2008a).

### 7.2.1 Subsidies

Given that data is available on those low income and vulnerable households, and there are mechanisms to redistribute revenues through social security and income tax systems, the Government could directly subside those in society that are disproportionately impacted by higher electricity prices. In the short-term this will likely be the most immediate way to ensure that these households can afford to pay their electricity bills and maintain the same utility in order to meet basic needs and access health, education and economic opportunities. However according to MacGill et al (2006) decreased costs of electricity in the past had the opposite effect for environmental objectives as it has encouraged growth in electricity consumption intensifying environmental impacts. This can be extended to the implementation of an AETS, if subsidies are provided then electricity consumption will either be maintained or grow, depending on the amount and extent of the subsidy.

### 7.2.2 Energy Efficiency

Therefore, given the feedback of direct subsidies on electricity consumption, Byrne (2008) states that the main focus of government support should be in energy efficiency measures, and suggests that in order to effectively support low income households government funding should be made available for free installation of ceiling insulation, energy efficient lighting and solar or gas hot water storage systems. According to Dubash (2003), programs to encourage better end-use energy efficiency serve a valuable social purpose as well as an environmental one. Greater efficiency would decrease the burden of price increases on households, reduce the requirements for direct subsidies to low-income consumers and simultaneously contribute to the achievement of the initial objective of emissions reduction.

### 7.3 The Australian Electricity System in the Medium to Longer-Term

Implications for the medium to longer-term, are that the un-sustainability of the electricity system, can continue to decrease, if the AETS continues to drive stronger environmental objectives. This is achieved by continuing to tighten the cap on total number of permits allocated and auctioning 100 per cent of all permits. The continual movement towards a less unsustainable electricity system, means dynamic trade-offs within the three pillars will continue to occur. Though, as mentioned, the perspective of this paper takes a strong sustainability view and prioritises the environment above other objectives. Therefore, first and foremost the system must be continuing to achieve emissions reduction.

This increasing effectiveness in emissions reduction, will motivate the system to continue to invest in the necessary infrastructure until such time that renewable resources dominate generation, as opposed to coal, and build an economy that is based on low carbon technologies. Therefore, as environmental sustainability is improving, so to is economic sustainability, as the energy that it uses to drive growth will be less and less reliant on emissions intensive technology. As renewable resources become more competitive and the technology improves, it will eventually lead to lower electricity prices and as these alternative technologies become the norm the social acceptance will also increase. Continuing down the path towards an electricity system that is less unsustainable will mean that emissions reductions are achieved, the economy shifts towards low carbon economy and electricity that is affordable for society.

Therefore this chapter has answered the fourth and final sub research question of how an AETS can contribute to a less unsustainable electricity system.

## 8 Conclusion

This paper has shown evidence that the current electricity system is unsustainable, as electricity generation is the single largest contributor to greenhouse gas emissions. Although Australia is a small emitter relative to other countries, it is particularly vulnerable to climate change and on a per capita basis is one of the highest emitters in the world. Therefore it must show strong domestic action in order to gain influence in international negotiations and achieve stringent global commitments.

Emissions Trading Schemes can be an effective tool to achieve emissions reductions, the degree to which is determined by the design principles used, particularly the cap on total number of permits allocated and the proportion of permits auctioned. If environmental objectives are prioritised then immediate emissions reductions are achievable, however, in doing so, social and economic consideration must be taken into account. In the short-term the electricity system can become less unsustainable as environmental sustainability is prioritised and trade-offs occur in the other pillars, of society and economy.

Though it is difficult to define what sustainability in the electricity system is, however what can be achieved is a system that is less unsustainable both in the short and longer-term, with electricity generation that produces far less greenhouse gas emissions, an economy that is based on less carbon intensive technologies, and a society that is able to afford electricity services and accepts shifting technologies. Inevitably there will always be those affected negatively by change and it is therefore the role of the government to support those, whether it is low income households through subsidies to either increase energy efficiency or to meet rising electricity bills, or the transition period for the economy where certain sectors may be affected by higher prices and lose competitiveness and employment.

What this paper has achieved and argued is that given the increasing environmental harm driven by greenhouse gas emissions, it is possible to have a less unsustainable electricity system that prioritises the environment, while providing support for the negative consequences on society and the economy.

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