Greenhouse-related licence conditions for electricity retailers

NSW Government Position Paper

December 2001

Table of contents

Section *Page*

Table of contents

Section ***Page***

Section ***Page***

EXECUTIVE SUMMARY

Introduction

The NSW Government has taken a leading role amongst Australian governments in the effort to reduce greenhouse gas emissions.

In 1997, the NSW Government introduced greenhouse gas emissions benchmarks, through which electricity retailers were asked to reduce per capita carbon dioxide equivalent (CO_2-e) emissions.[1] NSW is the only Australian jurisdiction to develop such a benchmarking scheme.

The scheme has created a solid policy base for reducing greenhouse gas emissions created through NSW electricity consumption. However, there is room for improvement. The NSW Government proposes to build upon this framework by introducing incentives for retailer compliance with greenhouse benchmarks.

The purpose of this paper is to set out the context for this proposal, provide some detail about the proposed changes to the benchmark scheme, and seek comment on the issues raised.

International efforts to combat climate change

Earlier this year, the Intergovernmental Panel on Climate Change released its third five-yearly assessment of the science of climate change. It found increasing evidence that human activity is already altering the global climate system and projected that the rate of warming over the next 100 years is "very likely to be without precedent during at least the last 10,000 years."

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in December 1997. It commits industrialised countries to reduce their net emissions over the 2008-12 period to five percent below 1990 levels, on average. Australia is limited to an emission increase of eight percent.

1 Because different amounts of individual greenhouse gases have different greenhouse intensities, they are weighted and emissions are expressed as carbon dioxide equivalent.

In November 2001, final agreement was reached on the rulebook for implementing the Kyoto Protocol. This agreement by 171 countries paves the way for industrialised countries to ratify the Protocol. The Protocol may now come into force as early as late 2002. Although the Bush Administration has ruled out joining the protocol, the United States is widely expected to develop its own parallel emissions reduction plan.

These commitments are widely recognised as just the first step towards achieving over coming decades the deep cuts in global emissions required to meet the UNFCCC's ultimate objective of avoiding dangerous anthropogenic interference with the climate system. International negotiations are due to commence by 2005 on further emission reductions beyond 2012.

The Australian National Greenhouse Strategy encompasses actions by all jurisdictions in Australia aimed at meeting these international commitments.

The NSW response to climate change

The NSW Government has been at the forefront of Australian efforts to reduce greenhouse emissions. At the same time, the Government recognises the need to implement policies that do not threaten the viability and competitiveness of NSW businesses, and the welfare of consumers.

Consistent with a balanced approach, the NSW Government has implemented a range of initiatives to encourage and assist the economy to progress towards a less carbon-intensive production base. These include:

- the introduction of a greenhouse electricity benchmark scheme for NSW electricity retailers;
- the establishment of the Sustainable Energy Development Authority (SEDA). SEDA invests in the commercialisation and use of sustainable energy technologies;
- the introduction of carbon rights legislation in 1988. As a result of this legislation the Tokyo Electricity Power Company has committed to 3,000 hectares of new plantations on the North Coast to offset emissions in Japan; and
- the promotion through State Forests of the carbon credits market.

In addition the Government has recently commissioned a major inquiry by the Independent Pricing and Regulatory Tribunal on electricity demand management. Reducing demand for electricity consumption is one way of reducing emissions produced by electricity production.

Complementing these strategies, in June 2001 the Premier of NSW sought Council of Australian Government support for the introduction of national greenhouse gas emissions benchmarks. Under the proposal, Australian electricity retailers would have been set a per capita emissions reduction target of 5% of 1989-90 levels by 2005-06. The NSW Government considered this target to be achievable without being overly onerous.

Electricity production and greenhouse emissions

Electricity generation is the largest source of Australia's greenhouse gas emissions, accounting for 38 percent of net emissions in 1999 (not including land-clearing emissions, the contribution of which remains uncertain). The sector's emissions are growing rapidly and in 1999 were at 133 percent of 1990 levels.[2]

The electricity industry faces particular challenges in tackling greenhouse because of its high emissions intensity and the long-lived nature of its assets. In addition, demand for electricity has risen sharply in recent years, driven by the increased use of air conditioning and strong economic growth.

New investments in generation plant commenced now will have economic lives that extend well beyond the near term commitment dates agreed to under the Kyoto Protocol. Investors will wish to take into account the likely price of emissions over the relatively long life of the investment.

Governments have a responsibility in this regard to provide clear signals about future policy directions. This will provide greater certainty to investors in future generating capacity, allowing them to make more informed commercial decisions. Governments can also assist by enabling the industry to gain early experience with the kinds of new mechanisms and rules that are being established under the Kyoto Protocol, such as caps on emissions and trading of entitlements to emit. These international rules and mechanisms are

2 Figures derived from *National Greenhouse Gas Inventory Analysis of Trends and Greenhouse Indicators 1990 to 1999* by the Australian Greenhouse Office.

likely to become a major factor shaping the energy industry worldwide and early experience can provide a competitive advantage for NSW business.

NSW retail licence benchmark scheme

In 1997, the NSW Government introduced greenhouse gas emissions benchmarks. The benchmarks were incorporated into electricity retailer licence conditions. Electricity retailers were required to reduce per capita CO_2-e emissions to a level 5% below 1989-1990 levels or 7.27 tonnes per capita[3] by 2001.

Electricity retailers must:

- develop and negotiate with the Minister for Energy strategies to reduce greenhouse gas emissions arising from electricity sales to NSW customers;
- develop one, three and five year plans for energy efficiency and demand management strategies, and strategies for purchasing energy from sustainable sources; and
- prepare and publish annual reports in relation to the implementation of their strategies, and greenhouse gas emissions arising from electricity supplied by them.

Electricity retailers can comply with their benchmark obligations by:

- reducing the greenhouse intensity of electricity consumed by, for example, assigning or exdusively counting 'greenhouse friendly' generation (such as wind powered generation) in the electricity they sell;

3 Licence conditions have previously stated 7.34 tonnes per capita. This figure has been adjusted because of data revisions. The framework for translating the benchmark of 7.27 tonnes per capita into individual retailer benchmarks can be found in *Further Environmental Guidelines and Requirements 1997* which is on the Ministry for Energy and Utilities web site (www.energy.nsw.gov.au).

- reducing electricity consumption by, for example, improving the energy-efficiency of their customers through the promotion of more efficient household appliances and solar water heating; and / or
- offsetting emissions through the purchase of carbon sequestration credits (the methodology of calculating these credits is currently under consideration).

Each electricity retailer is free to seek out the lowest cost options available which allow it to meet its benchmark obligations.

Extending the NSW greenhouse benchmarking scheme

The NSW Government is proposing to build upon the retail licence benchmark scheme by reinforcing electricity retailers' greenhouse targets under the current scheme and introducing incentives for compliance.

Changes to the current arrangements are proposed only if they will:

- increase the capacity for reliably reducing greenhouse gas emissions;
- lower compliance costs; and
- involve minimal change to the current regulatory and legislative framework.

It is proposed that the changes to the scheme will commence on 1 July 2002.

Greenhouse targets

Electricity retailers' obligations under the current scheme will be reinforced: electricity retailers will be required to gradually reduce their emissions so that by 2006-07 the benchmark of 7.27 tonnes of CO2-e per capita per annum is achieved. Targets in each year will be enforced.

A new compliance mechanism

Under this proposal electricity retailers will be penalised if they fail to meet their annual benchmarks. This means that electricity retailers will pay a dollar amount per excess tonne of CO_2-e emitted.

Penalties will be no lower than the marginal cost of compliance with the scheme. If the penalty is less than this, then the electricity retailer will be better off simply paying the fine than by reducing emissions.

Who will enforce the scheme?

It is proposed that the Independent Pricing and Regulatory Tribunal (IPART), which is currently responsible for licence monitoring and compliance, would be responsible for ensuring compliance with the scheme, including the imposition of penalties.

The system of penalties should provide a high degree of certainty for businesses and the regulator. To this end an arrangement that is largely, but not totally, mechanical is preferred. This will promote certainty, transparency and fairness for electricity retailers and NSW consumers.

Minimising compliance costs

The Government, in contributing to its responsibility to reduce greenhouse gas emissions, is committed to minimising the costs of abatement to NSW consumers and industry. Accordingly, the existing abatement framework has been reviewed to provide a fairer and more cost effective set of abatement rules.

The proposed changes involve:

- changing arrangements relating to the pool coefficient and total sales forecasts;
- allowing existing plants to assign energy produced above a certain baseline level;
- including interstate carbon sequestration;

- removing the pro-rating rules that previously limited the amount of energy that could be assigned by generators in other States;

- extending the scheme to large load customers who buy their electricity directly from the pool; and

- allowing trade in assigned generation, electricity sales foregone and sequestration credits.

Pool coefficient and total sales forecasts

Under the current arrangements, electricity retailers do not know the final pool coefficient (which measures the greenhouse intensity of energy sold through the pool, excluding energy that has been assigned to a particular electricity retailer) and their share of total sales (and hence their share of allowable emissions) until after the end of each financial year. To promote greater certainty, it is proposed to lag the pool coefficient to its value in the previous year. Also, a total sales forecast will be provided at the start of each financial year, which will be used to calculate individual electricity retailers' compliance at the end of the year, regardless of the level of actual total sales. Knowledge of these variables up front allows retailers to be certain about their level of compliance at any point in time.

Extending carbon sequestration and assignable generation

Electricity retailers will be able to purchase carbon sequestration credits from anywhere in Australia. The pro-rating rules, which previously restricted the value of assigned energy from generators interstate, will be removed. From an environmental perspective, abatement action in any jurisdiction is equally valuable.

Existing generators and assignable energy

Under the current rules, generally speaking, only 'new' generators are able to assign their output to electricity retailers. However, significant greenhouse gains could be achieved by running existing low-emissions generators more intensively. To create an incentive for this to occur, existing generators will be able to assign output above a baseline level. In determining the baseline of current capacity, an average of a number of years' output of each particular generator will be used to ensure that the baseline is reflective of general output and not output caused by a one-off event.

Large load customers

Large load customers who buy their electricity from the electricity market directly will be subject to the same benchmarking requirements as customers who buy through electricity retailers or resellers of any kind. The Government believes that all users should contribute to meeting the abatement task. This will lower the impact to individual customers.

Trading

The Government is committed to establishing an efficient framework that will allow electricity retailers to minimise their costs of compliance. Assigned generation, electricity sales foregone and carbon sequestration credits will all be tradeable.

How will this proposal affect the cost of electricity?

It is important that the costs imposed upon electricity retailers and ultimately users by this proposal are small enough not to affect the competitiveness of NSW business. NSW Treasury has undertaken an extensive modelling exercise on the effects of introducing incentives for electricity retailers to meet their benchmark obligations. The results of the economic modelling exercise indicate that implementing the scheme will have a minimal effect on the cost of electricity production.

The model simulates economically efficient investment in the electricity industry. It minimises the costs of meeting demand subject to electricity retailers fulfilling their benchmark obligations by utilising the cheapest abatement options available. It is important to note that whilst the approach is robust, like any modelling exercise, it simplifies commercial reality. The modelling results are also highly dependent on assumptions regarding the cost and availability of different abatement options.[4]

A number of scenarios were modelled:

- a base case where no benchmarks are in place;
- introduction of the NSW Government proposal on NSW electricity retailers; and
- introduction of the NSW Government proposal on all retailers in the National Electricity Market (NEM).

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4 The assumptions underlying the investment options in this report were provided by various NSW Government agencies, particularly the Sustainable Energy Development Authority and State Forests.

The costs associated with different scenarios are compared with the base case. The base case is a 'business as usual' scenario, in which the only greenhouse related constraint relates to the Commonwealth's Mandatory Renewable Energy Target (MRET). The costs associated with the other scenarios are presented as increments above the base case.

On the basis of current assumptions about the cost and availability of abatement options, the introduction of the NSW Government proposal on NSW electricity retailers is forecast to have a limited impact on the production cost of electricity. The average cost of electricity delivered to customers is forecast to increase by around $1-$2 / MWh.

The dollar cost of abatement per tonne is significantly lower than under other proposals such as the Commonwealth's MRET scheme.

The cost increases are forecast to be higher if the proposal is extended throughout the National Electricity Market. This is because the total abatement task is larger, and more customers are competing for available options, which pushes up the average cost of abatement.

Will the price of electricity change?

The price impacts of this proposal are more difficult to predict. Electricity retailers will pass on the cost increases to different customer groups in different ways. However, standard retail contracts will still be regulated by the Independent Pricing and Regulatory Tribunal.

In calculating the standard retail tariff, the Independent Pricing and Regulatory Tribunal has recently allowed electricity retailers to incorporate the costs of meeting their greenhouse obligations into their tariff structure. Because prices already reflect an allowance for benchmark compliance, the price impacts on standard retail contract consumers, which currently cover over 95% of all customers in NSW, should be minimal.

Energy intensive industry

Energy intensive consumers of electricity in NSW often negotiate with electricity generators and retailers over tariffs because of the extremely large volumes of electricity they consume. As such, many of the tariffs currently paid by energy intensive industrial users of electricity are lower than residential tariffs.

Since large users generally pay considerably less per megawatt hour than households, the increase in energy production costs due to benchmark compliance would represent a greater proportion of their energy bill. However, the pass-through of these cost increases to consumers is unpredictable and energy intensive users will still be able to negotiate contracts with generators and retailers.

Global competitiveness

The estimated cost increases are not expected to adversely affect the global competitiveness of NSW economy. The cost of electricity production will still compare extremely favourably with that of other nations.

Extent of the scheme

The NSW Government has been a strong advocate of creating a national benchmarking scheme, as highlighted by the Premier's approach to COAG in June 2001. Whilst the NSW Government is committed to a benchmarking scheme within its own jurisdiction, it would welcome wider adoption of the scheme.

Consultation

The NSW Government would appreciate comments from interested parties on this proposal. In particular comments are sought on the following specific matters:

The benchmark framework

- The form of penalty for non-compliance.
- The target benchmark levels for each year.
- The proposed changes to the rules on assigned generation.
- The clarification of retailers' obligations.
- Monitoring trade in compliance elements.

Modelling of the proposal

- Whether the estimated economic cost effects are realistic.
- The accuracy of the costs of different options, including generation, demand side management, generator efficiency and sequestration credits.
- The appropriateness of the amounts of each option that would be available for retailers to purchase during the forecast period.

Extension of the proposal beyond NSW

- Whether the proposal is best implemented within NSW only, within the National Electricity Market or Australia-wide.

The Ministry of Energy and Utilities will conduct forums in early February to allow more detailed discussion of issues raised in this paper. Please contact the Ministry of Energy and Utilities if you are interested in participating.

Written submissions should be made by 15 February 2002, preferably by email to the Ministry of Energy and Utilities at the following address:

Hemmingd@energy.nsw.gov.au

Alternatively submissions can be posted to:

The Director-General
Level 6, Minerals and Energy House
29 – 57 Christie Street
St Leonards NSW 1590

or sent by facsimile to (02) 9901 8403

REPORT

1 Introduction

As part of its commitment to addressing the greenhouse problem, the NSW Government was the first State Government in Australia to introduce greenhouse benchmark requirements into electricity retail licence conditions. This report presents the Government's position on the extension of this scheme from 1 July 2002.

Since 1997, all NSW electricity retailers were required to have a plan to reduce greenhouse gas emissions relating to electricity by 5 per cent per capita by 2000-01, compared with levels in 1989-90. However, the current enforcement mechanisms do not provide sufficient incentive to reduce emissions to the benchmark level.

Retailers' strategies did not extend beyond 1 July 2001. When the scheme was implemented, the Government foreshadowed that the benchmarks would be reviewed before determining arrangements to apply beyond this time. The Further Environmental Guidelines state:

> The guidelines emission benchmark for 1997-98 is the per capita emissions level in 1996-97. … The guidelines emission benchmarks for 1998-99 and 1999-2000 will reduce uniformly so that the 2000-01 benchmark is 5% below the 1989-90 per capita emissions level. For the purposes of the five-year plans the benchmark will remain constant at this per-capita level beyond 2000-2001. However the benchmarks beyond this date will be subject to review in light of changes to Australian commitments under the FCCC [Framework Convention on Climate Change].[5]

A review of the benchmark scheme has been conducted. This document presents the results of that review, and the Government's proposed way forward.

Section 2 of this report outlines the benchmark arrangements that operated until 30 June 2001. Section 3 presents the Government's proposed changes to these arrangements, to apply from 1 July 2002.

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5 Further Environmental Guidelines and Requirements for Electricity Retail Suppliers Licences, Greenhouse Gas Reduction Strategies, July 1997, pp.3-4.

The compliance costs associated with the revised arrangements have been modelled. The modelling framework and results are presented at Appendix A.

2 NSW retail licence requirements: 1996-97 to 2000-01

Prior to July 2001, electricity retailers in NSW were required to agree strategies with the Minister for Energy to meet certain benchmarks in relation to the greenhouse intensity of the electricity that they purchased. This was a retail licence condition. The first year of operation of the benchmark system was 1996-97.

The *Guidelines and Requirements Policy (1997)* states that the emissions benchmark is a five per cent reduction in per capita emissions compared with 1989-90 levels by 2000-01. This translates to a 2000-01 emissions target of 7.27 tonnes per capita.[6] At the time that it was announced, this benchmark was described as 'challenging but achievable.'

The benchmarks were phased in – the target level of per capita emissions fell gradually over the period to 2000-01. Retailers as a group never met their interim benchmark in any year. Note that the interim benchmarks did not have any particular status under the licensing regime – they were viewed simply as milestones measuring progress toward meeting the true benchmark in 2000-01.

The benchmark was not met in 2000-01. Instead of achieving per capita emissions of 7.27 tonnes, actual emissions were 8.42 tonnes per capita.

The following sections describe how individual retailer benchmarks are set under the current rules, how compliance is measured, and the enforcement arrangements that applied to the benchmark arrangements.

6 Note that the Guidelines state that the benchmark for 2000-01 is 7.34 tonnes per capita. However, subsequently the data on which this was based was revised, delivering the new benchmark of 7.27 tonnes per capita.

2.1. Translating the target into individual retailer benchmarks

The process for establishing individual retailer benchmarks is set out in the *Further Environmental Guidelines and Requirements 1997*. Individual benchmarks are determined by market share, the relevant benchmark emissions rate for the year, and the total population of NSW. The process is as follows:

- by 31 May each year, the Ministry of Energy and Utilities (MEU) must publish an 'emission benchmark forecast' (based on the projected population multiplied by the applicable per capita emissions rate for that year) and a 'notional electricity sales forecast' (including forecast sales foregone) for each of the next five financial years;

- each retailer makes a preliminary estimate of their apportioned benchmarks for the purposes of developing their 1-, 3- and 5- year plans. Retailers estimate their apportioned benchmarks on the basis of anticipated market share;

- as soon as possible after 31 August in each year, MEU nominates actual total sales to customers in NSW in the preceding financial year, and advises each retailer, the Environment Protection Authority (EPA) and the licence regulator of any revised apportioned benchmark to reflect assessed market share.

2.2. Current means of compliance

There are two means by which retailers can comply with their benchmark obligations currently:

- by reducing the greenhouse intensity of electricity consumed; and

- by encouraging reduced electricity consumption - 'sales foregone'.

The methodology by which greenhouse gas intensity of electricity consumed is calculated is described in the *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook (October 2000)*.[7]

The methodology for calculating sales foregone is set out in the *Framework for Calculation of Electricity Sales Foregone*.[8]

The legislation provides for a third means of compliance through sequestration credits. However, as discussed in Section 2.5, no methodology for incorporating such credits into the emissions calculation has yet been approved by the Minister.

2.3. Reducing greenhouse intensity of electricity consumed

The Workbook calculates the tonnes of CO_2-e that are attributed to each retailer, given their electricity sales.

Assigned and unassigned electricity

Calculations of each retailer's share of emissions resulting from energy use is based on a distinction between 'assigned' and 'unassigned' energy.

Some generator output can be assigned to individual retailers. This electricity is assumed to have either zero emissions, low emissions, or 'negative' emissions (eg burning gases that would otherwise have been vented). Generators can assign their output to retailers by providing them with Assigned Energy Declarations. The Workbook calculates the emissions attributable to each form of generator.

The remainder of energy used by a retailer is unassigned. This is energy purchased through the pool that is not assigned to any particular retailer. The

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7 The Workbook, in turn, relies on the methodology for calculating emissions from generating plant contained in the *National Greenhouse Gas Inventory (1996).*

8 DOE 1999, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Framework for Calculation of Electricity Sales Foregone – For Use in Reporting in 1998/99 and subsequent years, Attachment to Further Environmental Guidelines and Requirements, Retail Suppliers – Greenhouse Gas Reduction Strategies, July 1997.*

greenhouse intensity of unassigned energy purchased through the pool is calculated as the 'pool coefficient'.

Existing and new generation

Whether generators are allowed to assign output to a retailer depends on whether the generation is considered 'existing' or 'new'.

Existing generation was in place before the Guidelines were published – i.e. 1 July 1997. Except under certain circumstances (discussed below), electricity produced by existing generators cannot be assigned. New generation is classified as being commissioned after 1 July 1997, and can be assigned.

Categories of generation

There are seven categories of generation, which are all-inclusive. These categories define whether or not electricity can be assigned, and whether or not the interstate 'pro rata' rules apply. If there is a dispute, the Minister can decide how generation can be categorised.

Categories A, B and C relate to existing plant. Categories D and E relate to new plant. Category F relates to both new and existing plant that sells power to retailers as part of Green Power schemes.

Category A: Energy output deemed to be assigned (existing plant)

Where a retailer takes direct physical supply from a generator that existed before 1 July 1997, all of this electricity is assigned to that retailer. It may not be assigned to another retailer for as long as the direct supply contract exists. If the direct supply arrangement terminates and is not replaced by another, the generator's output is considered 'non-assignable' (Category C).

Direct physical supply from existing generators outside NSW

The rules are:

- the capacity of the generator must be less than 30 MW;

- the amount of electricity deemed to be supplied is the lesser of the amount actually sent out that year, or the actual electricity sent out in 1996-97; and

- the amount of electricity that can be assigned is subject to the pro-rata rules (see Section 2.3.2).

Category B: Part of energy output assignable (existing plant – new measure)

If a 'distinct measure' is introduced on or after 1 July 1997 that has the effect of increasing the efficiency of generation and/or results in reductions in greenhouse gas emissions, then the effect of that reduction (the 'notional energy') can be assigned to a retailer. The balance of the energy is assigned to the pool (either NSW or VIC/SA, depending on the location of the generator).

Category B generation that is generated outside NSW is subject to the pro-rata rules.

The rules dictating whether some part of an existing generator's output can be assigned are as follows:

- a distinct measure is implemented on or after 1 July 1997 which results in a reduction in greenhouse gas intensity per kWh sent out, or (in the case of a zero-emissions generator) increase the energy sent out for the same renewable energy flux;
- the effects are measurable and auditable
- the measure is not associated with increases in gas emissions away from the power station (eg if fugitive methane is used, it should be collected in a way which reduces pre-existing emissions: such emissions should not be increased in order to then gain a credit for using them in power generation); and
- the retailer provides an Assigned Generation Declaration.[9]

All of the effects of the measure accrue to the assigned portion of the generation. The adjustment to be made for the measure can be decided on a case by case basis. The default assumption is that the unassigned generation is assumed to be produced with the same greenhouse intensity as in the 'baseline', which is the average for the years 1995-96, 1996-97, 1997-98.

The Workbook defines how the effects of the 'distinct measure' are to be calculated for various types of plant.

Category C: Energy output non-assignable or unassigned (existing plant)

All output from existing generators that is not Category A, B or F is automatically category C. To date, Category C has accounted for the majority of electrical output. Together with Category E, this amount is used to calculate the pool coefficient.

Category C includes output that could have been assigned under Category B, but was not.

9 MEU 2000, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook*, p. 25.

Pool coefficients are also calculated for interstate pools. These are calculated excluding any electricity assigned to NSW retailers under either Category B or Category F (Green Power).

Category D: Assigned output (new plant)

Category D comprises all output from 'new' generators that has been validly assigned. (Note that all new generation can be assigned, but need not actually be assigned. If output from a new generator is unassigned, it is included in Category E.)

If the new generator is located outside NSW, the assigned output is subject to the pro rata rules.

Category E: Unassigned output (new plant)

Category E comprises all output from new plant that is not assigned (Category D) or categorised as Green Power (Category F).

Category E is in the calculation of pool coefficients for NSW or other States.

Category F: Assigned output via Green Power (existing or new plant)

Output from eligible generators that is used to supply an accredited Green Power scheme is categorised as Category F. Category F generation includes both 'new' and 'existing' green generators.

Before a retailer can count any sales as Category F, it must have purchased sufficient eligible power from green generators to fulfil all of its Green Power sales:

> All of a retailer's sales and purchases under accredited Green Power programs are pooled, irrespective of where on the interconnected grid they may be located, so all of that retailer's Green Power sales have the same greenhouse gas intensity. In addition, all of a retailer's Green Power sales (wherever they occur) must be met by energy generated by accredited Green Power Generation before any balance of that energy can be assigned towards meeting NSW greenhouse obligations.[10]

The pro rata rules do not apply to Category F sales. However, they do apply to output from Green Generators that is over and above what retailers require to fulfil their Green Power retail contracts (see below).

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10 MEU 2000, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook*, p.19.

Electricity produced by a Green Generator that is in excess of a retailer's Green Power requirements can be treated in a number of different ways:

- the generator could assign the additional electricity to a second generator making Green Power sales. This second generator would therefore be able to count this as Category F generation;

- if the generator is 'new', the output would be assignable to any retailer, and then classified as Category D;

Any excess generation that is counted in a category other than F is subject to the pro rata rules.

2.3.1. Treatment of transmission and distribution losses

Assigned generation is grossed up by 'scaling factors' that take account of losses that occur on transmission and distribution networks. The scaling factors differ according to whether the generator feeds into the transmission network, the distribution network, or supplies users directly.

2.3.2. Pro-rating rules

The legislation states that retailers' strategies must be related to reducing greenhouse emissions associated with 'electricity supplied to customers in NSW'.[11] In an interconnected electricity network, it is impossible to state precisely whether emissions related to sales in NSW, or sales in other jurisdictions. However, to give effect to this legislative requirement, the emissions methodology proxies the amount of interstate generation that related to sales in NSW through the pro-rating rules.

The pro-rating rules reduce the amount of assigned energy produced interstate that can be counted in a retailer's total emissions calculation.

Categories A, B and D are subject to the pro-rating rules.

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11 *Electricity Supply Act 1995*, Schedule 2, cl. 6(6)(a).

The amount of energy that can be used in the calculation is the lesser of:

- the ratio of that retailer's sales in NSW to its total retail sales in the interconnected system; or
- the ratio of the maximum nominal flow capacity (into NSW) through the interconnector/s to energy sent out in the source pool area.[12]

The smaller ratio is multiplied by the amount of energy assigned to the retailer, to get the maximum amount that can be included in the calculation. This amount might be reduced again by either a distribution or transmission scaling factor, if the generator is not directly connected to a user.

2.4. Electricity sales foregone

As discussed above, besides reducing the greenhouse intensity of electricity actually consumed, retailers can meet their benchmarks by *discouraging* electricity consumption. The *Further Environmental Guidelines* include a concept of *electricity sales foregone*, i.e. potential sales lost due to actions taken by a retailer that reduces electricity consumption. The purpose of including electricity sales foregone is to avoid discouraging retailers from promoting energy efficiency among customers.

The amount of electricity foregone is added to the retailer's amount of electricity actually sold. This has the effect of increasing the amount of CO_2-e that the retailer is allowed to emit – that is, it raises the retailer's benchmark. Naturally, no emissions are associated with electricity sales foregone, so increasing the benchmark in this way makes compliance easier.

12 MEU 2000, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook*, p.24.

2.4.1. Principles to be applied in calculating electricity sales foregone

Detailed guidelines on how electricity sales foregone are to be calculated are included in the *Framework for Calculation of Electricity Sales Foregone*. This Framework sets out the principles that guide the methodology:

- **Additionality**: Sales foregone can only be claimed in relation to measures that would not have happened in the absence of action by the retailer claiming the sales foregone;

- **Responsibility**: Sales foregone can only be claimed by the retailer or retailers that have taken the action that led to the foregone sales;

- **Proportionality**: sales foregone can only be claimed by the retailer or retailers in proportion to the extent that the retailer/s have taken the action that led to the foregone sales.

- **Accuracy**: The lower the accuracy in estimating the sales foregone the lower the share of estimated sales foregone that the retailer can claim.

- **Simplicity**: Given that there is a cost involved in estimating sales foregone, a balance must be struck between accuracy and simplicity in the methodology for estimating sales foregone.

- **Consistency**: The methodology will be applied consistently to all retailers and as far as possible, consistently across types of measures and over time.[13]

2.4.2. Qualifying activities

The sorts of actions that can qualify under the Framework include, but are not limited to:

- customer energy audits fully funded by the retailer or its associates;

- energy audits carried out for customers on a fee for service basis by the retailer or its associates;

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13 DOE 1999, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Framework for Calculation of Electricity Sales Foregone – For Use in Reporting in 1998/99 and subsequent years, Attachment to Further Environmental Guidelines and Requirements, Retail Suppliers – Greenhouse Gas Reduction Strategies, July 1997, p. 4.*

- financing programs (i.e. where the retailer facilitates investment by the customer but the customer repays the funding);
- 'cashback' type programs where payments to customers (eg towards purchase of low-energy products) are non-repayable;
- general energy efficiency information and promotion activities funded by the retailer (subject to the content of the programs being clearly related to efficient use of electricity. Expenditure on general electricity marketing or advisory services is not eligible).[14]

For energy efficiency activities, retailers can use the 'deeming formula' developed by SEDA to estimate the current impact of programs undertaken in previous years.

Sponsoring generation or cogeneration at the customer site

Where a retailer has sponsored generation or co-generation at the customer's site, this can be included in the benchmark calculations as *either* 'assigned energy' or as electricity sales foregone. The Framework sets out how the effective electricity sales foregone are to be calculated.

Fuel substitution

Retailers can claim effective sales foregone where their efforts have caused customers to substitute lower emission fuels, eg converting to gas water or space heating.

Details of how the sales foregone are to be calculated are included in the Framework.

Off-grid electricity supply

Where a retailer's actions have led to a customer installing a remote area power supply (RAPS) package, the retailer can claim the sales foregone as a

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14 DOE 1999, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Framework for Calculation of Electricity Sales Foregone – For Use in Reporting in 1998/99 and subsequent years, Attachment to Further Environmental Guidelines and Requirements, Retail Suppliers – Greenhouse Gas Reduction Strategies, July 1997,* p.5.

result of this. Often, at least some of the reduction in emissions associated with the RAPS will be related to transmission losses avoided.

If the retailer actually owns the RAPS, the retailer will count this as assigned energy, rather than calculating sales foregone.

The methodology for calculating sales foregone due to off-grid electricity supplies is outlined in the Framework.

2.4.3. What happens when the customer switches retailer?

The Framework recognises that consumers can readily switch retailers, and that this needs to be taken into account when attributing electricity sales foregone.

The Framework states:

> Where a retailer implements a specific ESF [electricity sales foregone] activity with a customer who subsequently changes to a different retailer, the realised impacts of that activity continue to be claimable by the implementing retailer, provided that the retailer can document them.[15]

However, fuel substitution is an exception – a retailer can only claim sales foregone for its own customers.

2.5. Sequestration

The *Electricity Supply Act* 1995 was amended in 1999 to allow retailers to take into account net reductions in greenhouse gases resulting from sources such as carbon sequestration by planted forests in accordance with a methodology approved by the Minister for Energy. Such a methodology is currently under development.

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15 DOE 1999, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Framework for Calculation of Electricity Sales Foregone – For Use in Reporting in 1998/99 and subsequent years, Attachment to Further Environmental Guidelines and Requirements, Retail Suppliers – Greenhouse Gas Reduction Strategies, July 1997,* p.10.

2.6. Enforcement

Currently, licence conditions are monitored by IPART. If licence conditions are not met, then the Minister can impose fines of up to $100,000, or revoke the retailer's licence. IPART is able to impose fines of up to $10,000 for the first day of the offence, and $1,000 for each subsequent day (not exceeding 30 days). So far, no enforcement action has been taken.

Retailers' performance against their benchmarks is publicly acknowledged, which provides the only incentive to comply currently.

3 A revised retail licence benchmark system

While the current system has led to some abatement activity that was unlikely to have occurred in the absence of the scheme, on the whole emissions performance could be better. Interim targets have not been achieved, and instead of achieving per capita emissions of 7.27 tonnes in 2000-01, actual emissions were 8.42 tonnes per capita.

There appear to be several reasons why the current system has not delivered the desired level of greenhouse gas reduction. The most significant reasons are that:

- a retailer is judged to comply with the scheme if it has negotiated a plan with the Minister and reports on progress against this plan; and
- there are not strong incentives to achieve the greenhouse targets.

Retaining the current benchmark system in some form has a number of advantages:

- it minimises the costs to the industry of learning to comply with a completely different system;
- it takes advantage of the existing regulatory framework, and minimises the extent of new legislation required;
- depending on how it is implemented, it appears capable of reliably delivering reductions in greenhouse emissions in the electricity sector in a least-cost manner, provided it was accompanied by an effective enforcement mechanism.

Nonetheless, a number of modifications to the existing arrangements could be made to improve the schemes performance. These relate to:

- changing the nature of the retailers' obligation to be focussed on achieving an emissions outcome;
- enforcing this target;

- changing some aspects of the scheme to make retailers' obligations at any point in time more certain; and

- minimising compliance costs associated with meeting the emissions objective.

These changes are discussed below.

3.1. Changing the nature of the obligation

Currently, retailers are required to prepare strategies to meet the greenhouse benchmark, agree these strategies with the Minister, and report on progress. There is no obligation on the retailer to actually meet the benchmark.

If penalties were to be based on emissions performance, the legal obligation on retailers would need to be amended to refer to an obligation to meet an emissions benchmark. Both the benchmark and performance against the benchmark would need to be specified not as actual rates of emissions – which cannot accurately be attributed to any particular retailer – but emissions as calculated according to the methodology approved by the Minister.

There appears to be no need for retailers to prepare, negotiate and report on plans if the penalty regime applies to emissions performance. Therefore, obligations relating to strategies to achieve the benchmark will be removed.

Retailers' obligations will relate to emissions performance against a benchmark, calculated according to a methodology approved by the Minister.

Obligations relating to preparing, negotiating and reporting on strategies relating to the benchmark will be removed.

3.2. Enforcement

One of the main reasons why the current system has not delivered the gains expected is the lack of effective incentives to comply. As discussed in Section 2.6, existing penalties include enforcement by the Minister through either a $100,000 fine, or the cancellation of a licence. The former is too small a penalty to have any effect, while the latter is too drastic a penalty to be credible. IPART is able to impose fines of up to $10,000 for the first day of the offence, and $1,000 for each subsequent day (not exceeding 30 days). A system of effective penalties should be introduced, which would increase the likelihood that the benchmark regime will achieve the desired greenhouse emission reductions.

The role of IPART and the system of penalties will need to be thoroughly reviewed and tested to ensure the arrangements are effective, to ensure compliance.

3.2.1. Structure of penalties

Penalties could be based on either:

- the degree of non-compliance in relation to emissions, i.e. the number of tonnes of CO_2-e by which the retailer exceeded its benchmark; or
- the degree of non-compliance with a plan for reducing greenhouse emissions, as negotiated with the Minister.

The first of these options appears to be the simplest and most logical penalty structure. This most accurately reflects the objective of actually reducing greenhouse emissions. As discussed below, basing penalties on actual performance removes the need for the Minister to agree to plans at all. This is similar to the approach adopted under the Commonwealth's MRET program – penalties are calculated on the basis of certificate shortfalls alone, and there is no need for the Government to inquire into how each liable party intends to fulfil its obligation.

Basing penalties on adherence with a plan is more complicated. It essentially treats the emissions benchmark as a 'soft' target – potentially, retailers could comply with their approved plans, but actual emissions could exceed the benchmark by a considerable margin. It increases compliance and administration costs, since it requires plans to be negotiated and approved. Reporting on compliance against a plan is more administratively onerous than simply reporting on emissions performance.

Penalties will be structured as a dollar amount per tonne of CO_2-e by which the retailer has exceeded its benchmark.

3.2.2. Size of penalties

Penalties should be at least as high as the marginal cost of compliance. Estimates of these costs are discussed in Appendix A for different benchmark scenarios.

Any penalty will cap the amount that retailers are willing to spend on abatement activities. If the cost of abatement exceeds the penalty, the retailer will be better off paying the penalty.

A penalty that exceeds the marginal cost of compliance will not lead to 'over-compliance', as the retailer would receive no extra benefit from this. If there is some doubt about the marginal cost of compliance and actually meeting the benchmarks is highly valued by Government, then the safest option is to over-estimate penalties.

On the other hand, if the benchmark is set too stringently, and sufficient abatement options are simply not available at any price, then high penalties could have the effect of significantly reducing retailers' profits for no extra greenhouse benefit. So long as the benchmark is set at a realistic level, however, this should not occur.

Penalties should be at least as high as the marginal cost of abatement. Estimated marginal costs of compliance are discussed in Appendix A.

3.2.3. Administering the penalty system

The *Electricity Supply Act* currently allows for two forms of enforcement action – either by the Minister, or by the Tribunal.

In line with its existing role of administering the licensing regime, it is suggested that the Tribunal take prime responsibility for administering the penalty system. The penalty system should provide a high degree of certainty for both the businesses and regulator. The calculation of emissions and the penalty payable if emissions exceed the retailer's benchmark should be formulaic and certain. This approach offers greatest certainty to retailers, minimises incentives to lobby the regulator, and is most likely to deliver the Government's emissions objective.

The penalty system will be administered by IPART. Consideration will need to be given to the method for administering the penalties to provide a high degree of certainty for both the businesses and the regulator.

3.3. Increasing retailers' certainty

The current formulation of the legislation is that retailers must 'knowingly' fail to comply with licence conditions before either the Minister or the Tribunal can undertake enforcement activities.[16]

[16] Schedule 2 of the *Electricity Supply Act 1995*, cl. 8(3) regarding enforcement by the Minister, and cl. 8A(5) regarding enforcement by the Tribunal.

One reason why it would be difficult to prove that a retailer knowingly breached its benchmark obligation is because timing issues prevent a retailer from knowing the key elements of compliance until after the end of the relevant year. These elements are:

- its exact emissions benchmark, which is based on its share of total electricity sales; and
- the final pool coefficient.

It will be important that the penalty regime can be effectively enforced to ensure the policy objectives are achieved. The method for ensuring compliance and IPART's role as the regulator will have to be carefully reviewed to ensure there is an effective regime in place.

3.3.1. Creating certainty regarding the retailer's benchmark

Currently, a retailer can only estimate its share of total allowable emissions (i.e. its benchmark), which is based on market share. The exact share cannot be known in advance because it depends on (a) total actual sales in the year, including sales foregone and (b) the retailer's share of those total sales.

A retailer can estimate its market share at any point in time fairly precisely – publicly available information on the NEMMCO website contains figures for total electricity purchased through the NEM in the NSW region on a weekly basis. This does not include embedded generation, however. Although retailers can assess their market shares to date, it may be unreasonable to expect them to be able to accurately predict total sales in the future. Some certainty regarding market share would be desirable to encourage forward-contracting with low-emissions generators. Greater certainty is also highly desirable if penalties apply to non-compliance.

As a solution, the regulator could provide an estimate of total sales at the start of each year. This estimate would not be revised, regardless of what happens to actual total sales. As a retailer makes sales throughout the year, it could assess its market share against this fixed estimate, and calculate its allowable emissions on that basis.

If actual sales are higher than estimated sales, then the total emissions benchmark is likely to exceed the overall benchmark for that year. This is because each retailer's share of total allowable emissions would add up to more than the total allowable emissions. On the other hand, the reverse would occur if actual total sales were below estimated total sales. This is because the sum of each retailer's share of allowable emissions would be less than the total allowable emissions. Thus, providing an estimate of total sales provides retailers with certainty regarding their benchmark, but it reduces certainty for the Government regarding total emissions. However, forecasts of electricity sales one year in advance are usually reasonably accurate, which reduces this risk.

An alternative could be to base each retailer's market share on their market share in the previous year. However, retailers' market shares can be unstable from year to year, and are likely to become less stable as the level of retail contestability increases. It would be extremely difficult for a retailer whose market share rose rapidly from the previous year (for example, if the retailer signed up a major industrial user) to meet its emissions target. Also, it would be necessary to assume a market share for a new retailer entering the market. For these reasons, this option is not suggested.

The regulator will nominate a total sales forecast at the start of each period. This forecast will be used to calculate each retailer's market share, and hence share of total allowable emissions, at the end of the period.

3.3.2. Pool coefficient

Currently, retailers use an estimate of the pool coefficient to prepare their strategies for reducing greenhouse emissions. The final pool coefficient – which can vary due to a number of causes, including rainfall-affected hydroelectric production, or surplus low-emissions generation being added back to the pool – is not known until after the relevant year has ended.

To address this problem, the pool coefficient could be lagged. That is, the pool coefficient used for calculating emissions in 2002-03 could be the final pool coefficient in 2001-02. This would remove a significant element of uncertainty for retailers.

The disadvantage in using a lagged pool coefficient is that the measurement of emissions in any year would be less accurate than it would be if that year's pool coefficient were used. On balance, this appears less important than the loss of certainty associated with the current arrangements.

The pool coefficient used to calculate emissions will be the pool coefficient of the previous year. Retailers will be informed of the pool coefficient to be used in calculating emissions at the start of each year.

3.4. Increasing flexibility: changing the definition of 'new' generation

The modelling described in Appendix A shows that a key element in meeting a greenhouse target in a cost-effective manner is to run *existing* gas plant more often. Generally, gas plant in the NEM tends to run only when available coal-fired capacity is insufficient to meet demand. This leaves gas plant with significant excess capacity. Since gas plant is significantly less greenhouse-intensive than coal-fired plant, using up some of this excess capacity to displace coal has a significant effect on total emissions.

The current licensing rules do not encourage existing gas generators to increase their output. Only new generation can be assigned – existing generation merely affects the pool coefficient.[17] This benefits all retailers, so any individual retailer has no incentive to contract with an existing gas generator to increase their output. This is a feature of the current system that is likely to significantly increase the costs of compliance for no greenhouse benefit.

To encourage existing gas generators to run more often, the following changes could be made to the Workbook:

- the distinction between new and existing generation could be abandoned altogether. While this would reduce compliance and monitoring costs, it would provide a windfall gain to existing greenhouse-friendly emissions generators; or

- allow increases in output over a baseline (calculated as the average output for the years 1996-97 to 1999-00) to be assigned. This would encourage additional output from existing plant.

All increases in output from existing generators beyond a baseline calculated as the average output for the years 1996-97 to 1999-00 will be assignable. This will not depend on whether a 'distinct measure' has been implemented to increase thermal efficiency, for example.

17 As discussed above, the exception to this rule is where an existing generator has implemented a 'direct measure' that improves its greenhouse performance.

3.5. Increasing flexibility: trading compliance elements

Currently, the benchmark arrangements do not allow retailers to trade in either assigned generation or electricity sales foregone. This imposes an unnecessary constraint on the system, and has the potential to increase the risk of contracting in advance (eg contracting in advance with low-emissions generators in the expectation of high retail sales that subsequently fail to eventuate).

3.5.1. Assigned generation

Currently, retailers cannot trade their assigned generation. If a retailer accrues a surplus (i.e. it 'over-complies'), this surplus cannot be sold. Surpluses are actually added back to the pool, which reduces the pool coefficient, and makes it easier for all retailers to achieve their benchmarks. This creates incentives to 'free ride' on retailers that over-achieve against their benchmarks.

There is some flexibility in the current arrangements, since Assigned Generation Declarations need only be produced at the end of the year. Therefore, generators could enter into a variety of side-arrangements with retailers that governed the final assignment of generation. However, this is more cumbersome than simply being able to trade either assigned generation or surpluses.

An ability to trade assignments appears desirable. This would increase flexibility in the arrangements and reduce the risk of purchasing too much assigned electricity.

Should retailers be able to sell any assigned generation, or only surpluses?

There are three options on what could be traded:

- surpluses only;
- all assigned generation and energy sales foregone (and, when applicable, Carbon Assignment Declarations); or
- a combination of both.

The first option raises significant timing issues - when would the retailer feel sure it was in surplus? When could its surplus be traded? Given the administrative complications associated with this option, it is not recommended.

The second option creates all of the flexibility that the first option seeks to deliver, yet avoids these timing issues. It is therefore preferred.

The third option does not appear to offer any advantages over the first or second, and would introduce several complications. It would be administratively difficult to avoid double counting in surpluses and the underlying assigned generation certificates.

How easily can the rule against on-selling assignments be changed?

The restriction on on-selling assigned generation is only located in the Workbook, not in legislation or regulations. Therefore, changing this requirement appears to be technically straightforward.

Assigned energy will be tradable. This will not be dependent on whether the retailer has surplus assigned energy.

3.5.2. Trading electricity sales foregone and sequestration credits

Similar to the logic applying to assigned generation, credit for electricity sales foregone will also be able to be traded.

Once a methodology has been approved by the Minister, sequestration credits will be counted against electricity sales. As with assigned generation and credits for electricity sales foregone, any sequestration credits that have not yet been acquitted will also be able to be traded.

Credit for electricity sales foregone and non-acquitted sequestration credits (when available) will also be able to be traded.

3.5.3. Administration requirements

Allowing retailers to trade in compliance elements would require keeping track of ownership of these elements. This is to avoid the same compliance elements being counted by different retailers. A central registry could track this trade. This is the approach taken by the Commonwealth regarding the MRET measure – the generation of 'certificates' and all trades of these certificates is registered with the Renewable Energy Regulator. The NSW Government will adopt a similar approach.

To create an incentive for participants to inform the registry when a compliance element changes hands, a retailer will not be able to count a compliance element in its emissions calculation unless its ownership of that element had been registered.

This role could be undertaken either by IPART or MEU.

A central body will track trade in compliance elements. For the purposes of calculating emissions, only compliance elements that have been registered as belonging to that retailer will be counted. The registry role could be undertaken either by IPART or MEU.

3.6. Treatment of surpluses

Currently, if a retailer purchases 'too much' low emissions electricity, the balance is added back to the pool. This reduces the pool coefficient, making it easier for all other retailers to comply.

There are two factors that would be likely to reduce the chance of a retailer being in surplus:

- allowing assignments, credits for electricity sales foregone, and eventually, sequestration credits, to be traded; and

- changing timing arrangements to provide greater certainty regarding benchmarks and pool coefficients.

These issues are discussed in Section 3.4 of this paper.

However, in the event that a retailer does find itself in surplus at the end of the period, there are several options for the treatment of this surplus.

- First, the current arrangements could apply – the surplus is added back to the pool, thus reducing the pool coefficient for all other participants. This seems undesirable for two reasons – it allows other retailers to free-ride, and reduces their own incentives to actively seek greenhouse emission reductions, and it introduces difficult timing issues. The revision of the pool coefficient is one of the main reasons why compliance cannot be determined until some time after the end of the period.

- Second, the surplus could simply be lost – that is, it cannot be carried forward to the next period, and it does not affect the pool coefficient. This appears to be the simplest option. So long as retailers can trade in compliance elements, the risk of losing a benefit that was paid for appears low.

- Third, retailers could carry forward surpluses into future years. This should not be overly complicated to implement. However, it would be inconsistent with the reporting of greenhouse gases emitted during a single year.

Surpluses at the end of the year will be 'lost', rather than added back to reduce the pool coefficient, or carried forward to future years.

3.7. Treatment of interstate generation

There are two key restrictions on the amount of energy generated interstate that may be counted when calculating a retailer's emissions performance:

- the pro-rata rules; and

- the requirement that only energy assigned from generators 'electrically connected with the interconnected grid covering south-east Australia' can be counted.

Both of these rules stem from the legislative formulation of the benchmark. The Minister can require retailers to develop strategies 'based on the principle of achieving the reduction of greenhouse gas emissions, *from electricity supplied to customers in New South Wales*, as the electricity sector's contribution to achieving the target of reducing greenhouse gas emissions, as agreed in any national greenhouse policies approved by the Council of Australian Governments' (emphasis added).[18] Both of the key interstate restrictions

18 *Electricity Supply Act 1995*, Schedule 2, cl. 6(6)(a).

reflect an abstract concept developed to estimate the amount of electricity generated interstate that was actually sold in NSW. (The actual amount cannot be calculated – this is a physical impossibility on an interconnected grid.)

While these provisions accord with the current legislative framework, they do not necessarily promote efficiency in achieving reductions in per capita greenhouse gas emissions, as discussed below.

The pro-rata rules

Apart from electricity generated by Green Power generators and sold through Green Power contracts to NSW customers, all assignments of interstate generation are subject to pro-rata arrangements.

As discussed in Section 2.3.2, the pro-rata rules are as follows:

> For generation located outside NSW that meets the criteria for assignment under Categories A, B or D, the proportion of output and emissions that can be used to offset (or 'assigned against') the retailer's sales in NSW is the lesser of:
>
> - the ratio of that retailer's sales in NSW to its total retail sales in the interconnected system; and
>
> - the ratio of the maximum nominal flow capacity (into NSW) through the interconnector(s) to energy sent out in the source pool area ... .[19]

The pro-rata rules significantly reduce the amount of interstate generation that can be assigned against a NSW generator's sales in NSW. In an environment in which the licence conditions are enforced through a penalty regime, this is likely to have the following effects:

- it would discourage NSW retailers from entering arrangements with new and existing non-Green generators (eg new gas plants) relative to those in NSW; and

- if Green Power sales lag behind the amount of power produced by Green Generators, the excess created in NSW is treated more favourably than excess created interstate. This would discourage retailer support of Green Power generators interstate.

From a greenhouse gas abatement perspective, there is no difference between a NSW retailer subsidising low-emissions generation in NSW or in another State.[20] To the extent that they limit flexibility, the current arrangements would also raise the cost of compliance.

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19 Ministry of Energy and Utilities, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook*, October 2000, p. 24.

20 This logic extends beyond other States to other countries. However, the logistical difficulties associated with monitoring overseas activities means that including compliance elements from overseas is unlikely to be a practicable option.

The current arrangements could perhaps be defended on State-based industry development or regional employment grounds. However, it should be noted that:

- a number of other Commonwealth and State programs target industry and regional development directly. This includes programs specifically designed to encourage the development of greenhouse-friendly generation;
- retail licence conditions may prove to be relatively short-lived compared with the economic life of a new low-emissions generator. If the location of new generation capacity is influenced unduly by licence conditions, this could result in uneconomic generation capacity lobbying for government assistance in the future; and
- the NSW Government has criticised the Commonwealth's MRET measure on the basis that it did not appear to be a cost effective means of achieving either industry development or greenhouse abatement.

It is suggested that the pro-rata rules be removed. Total assigned energy from interstate generators will be counted when calculating a retailer's emissions.

The pro-rata rules relating to interstate generation will be removed.

Requirement of electrical connection to the interconnected grid covering south-eastern Australia

Another restriction contained in the Workbook is that no generation can be assigned at all unless it is physically connected to the NSW grid. This means that no energy can be assigned from greenhouse-friendly generators in Western Australia, the Northern Territory, or, currently, Tasmania.

From a greenhouse perspective, promoting greenhouse abatement in, say, Western Australia, is equally as valuable as abatement activity in NSW. Solely from a greenhouse standpoint, the requirement for electrical interconnection is not necessary.

From a practical perspective, however, there are several advantages to this rule. It is easier to track the output of generators that participate in the NEM. NEMMCO maintains data on when generators ran, and how much power was produced. This makes it significantly easier to monitor and audit retailers' assigned generation. For these reasons, it is suggested that this rule be maintained.

The requirement that assigned generation must be supplied by generators electrically connected to the grid servicing NSW will be maintained.

3.8. Treatment of interstate sequestration credits

The Workbook foreshadows a number of requirements that are likely to form a part of the carbon sequestration credits methodology, when such a methodology is developed and approved by the Minister. One of these requirements is as follows:

> Location – physical carbon stores may be sited in other States or Territories as long as those States or Territories are physically connected to the NSW grid (the same condition as for out-of-state generation).[21]

Even within the current legislative framework, this requirement appears unnecessary. It is suggested that it not be reflected in the methodology applying to sequestration credits ultimately approved by the Minister.

There will be no requirement that the source of sequestration credits be located in States physically connected to the NSW grid included in any methodology to be approved by the Minister for recognising sequestration credits.

3.9. Timeframe

The current benchmark scheme involved gradually reducing greenhouse emissions per capita over a period of five years. If a revised benchmark system is to be put in place, the Government will need to decide the timeframe over which it will apply.

Meeting a greenhouse benchmark will require new investments in either low emissions generation, demand side management/fuel switching activities or carbon sequestration. Such investments are likely to be long lived. A licence benchmark requirement that was only to last for a short period of time, say

21 Ministry of Energy and Utilities, *Greenhouse Gas Emissions from Electricity Supplied in NSW: Emissions Workbook*, October 2000, p. 46.

one or two years, is highly unlikely to encourage any investment in these areas that would not otherwise have occurred.

On the other hand, international and national greenhouse policies are highly uncertain. It is not beyond the realms of possibility that other mechanisms might be implemented within a few years' time, such as an emissions trading scheme, that would negate the need for the retail licence benchmark scheme. Locking retailers into arrangements for a very long period of time is not desirable.

To balance these conflicting concerns, it is suggested that new retail licence greenhouse benchmarks relate to a further five year period, i.e. from 2002-03 to 2006-07. From a simple cost perspective it is better to defer the abatement task for as long as possible. However, this would not allow the community to see whether there is any gain being made in the initial period of the scheme. Consideration should be given to form of phased abatement timetable. To balance the economic interests of the wider economy and the community's desire to see progress towards the target this phasing can begin with a low abatement task in the early years, with an increasingly stringent target towards the end of the timetable.

Note that effects of a revised benchmark scheme have been modelled over a 10 year timeframe with the benchmark being achieved by the end of the 5th year of the scheme, as discussed in Appendix A.

Retail licence benchmark conditions will relate to the period 2002-03 to 2006-07.

3.10. The target

The current licence requirement is to reduce per capita greenhouse gas emissions by 5 per cent by 2000-01 compared with 1989-90 levels. In 1989-90, per capita emissions were 7.65 tCO_2-e. This translates into a target of 7.27 tonnes of CO_2-e per capita by 2000-01.

The original target was to be phased in over a five-year period. Instead of achieving the benchmark of 7.27 tonnes per capita, by the end of the compliance period actual emissions were 8.42 tonnes per capita.

Target for 2001-02

For the purposes of preparing 1-, 3- and 5-year plans, retailers were to assume that the emissions benchmark would remain constant after 2000-01 – i.e., the target for 2001-02 would again be 7.27 tonnes per capita. However, the Guidelines noted that this benchmark would be reviewed.

This target represents a 14 per cent reduction in emissions from actual levels in 2000-01, as reported by IPART. This appears to be a large reduction in emissions to occur in a short space of time.

An alternative is to phase in compliance with the benchmark over a period of five years. This will be more easily achievable. This is the preferred option.

In 2006-07, the benchmark target will be 7.27 tonnes per capita (i.e. a five per cent reduction compared with emission levels in 1989-90). Interim targets will step down in a linear fashion from 2001-02 (in which the target will be set at 8.42 tonnes per capita, which is the actual level of emissions in 2000-01) to the final benchmark of 7.27 tonnes per capita in 2006-07.

3.11. Will liability be extended to Market Customers?

Imposing an obligation on retailers would create an incentive for electricity users to by-pass retailers and purchase electricity directly through the pool. Note that this would not be a realistic option for most consumers – trading through the pool entails considerable risk, and a major component of the retailer's service function is to manage this risk. However, for some large customers, purchasing directly through the pool could be cost-effective.

Customers that purchase directly from the pool will be included in the greenhouse benchmark scheme for two reasons. Firstly, there is no reason why customers that purchase electricity from retailers should bear the cost of greenhouse abatement while other consumers do not. This is unfair. Secondly, retailers would be disadvantaged as they are by-passed by large customers in favour of the pool. This represents an artificial distortion in the market structure.

The National Electricity Code requires that all customers making purchases from the pool be registered as a Market Participant, under the category of Market Customer. Market Participants are required to comply with the Code, are subject to prudential requirements, and must meet any relevant requirements set out by the Jurisdictional Regulator (i.e. IPART).[22]

IPART's current powers do not allow it to impose conditions on Market Customers generally – its powers relate to the licensing regime. To create a 'requirement set out by the Jurisdictional Regulator', the *Electricity Supply Act* could be amended either:

- to require all Market Customers in NSW to hold a retail licence (administered by IPART). However, note that retail licences entail numerous obligations that do not relate to greenhouse benchmarks. For this reason, this option is not recommended; or

22 Clause 2.4.2, *National Electricity Code*.

- to create a new type of licence for Market Customers that do not hold retail licences, which could also be administered by IPART. The conditions of this special type of licence could be solely related to greenhouse benchmarks, and could be subject to the same arrangements as the retailer benchmark system. Fees relating to these licences should not be prohibitive. This is the preferred option.

Customers that purchase electricity directly from the pool will be covered by the benchmark arrangements.

A new category of licence will be created under the Electricity Supply Act, to be administered by IPART. These licence conditions will be solely relate to greenhouse requirements. Licence fees will not be prohibitive.

3.12. Treatment of generator direct sales

NSW generators have direct supply contracts with large users. Some of these do not allow pass-through the cost of licence compliance to their customers. This reflects earlier policies of exempting State-owned bodies from a number of taxes and regulatory requirements.

Rather than consider whether direct sales ought to be covered by retail licence conditions under current arrangements, which is a legal question, this report considers the policy question of whether these sales ought to be counted as direct sales under any revised benchmark arrangements.

3.12.1. Options for dealing with generator direct sales

There are three broad options for dealing with direct generator sales:

1. exempt generators' direct sales entirely, regardless of whether they hold a retail licence;

2. impose liability on generators holding a retail licence; or

3. legislative options to stage a negotiated transfer of liability from generator to the direct supply customer.

3.12.2. Option 1: Exempting direct generation sales

Policy issues

Generator direct sales are significant. They include sales to some of the largest consumers of energy in the State. Exempting these sales means that the firms that supply their electricity escape the financial burden of complying with the retail licence conditions. From a greenhouse perspective, this does not appear defensible.

On the other hand, exempting generator direct sales will protect State-owned generators from the need to incur costs that their contracts do not allow them to pass on to their customers. These costs are significant. Exemption would protect shareholder value in these generators.

On balance, the exemption option is not preferred. This would damage the credibility of the benchmark arrangements, and unfairly increase the abatement burden to be borne by retailers and their customers.

3.12.3. Option 2: Including direct sales as retail sales

Policy issues

As noted above, it is possible that some existing generator direct sale contracts do not contain pass-through provisions relating to new compliance costs. Therefore, enforcing greenhouse benchmarks on generators that hold retail licences would reduce the profitability of the Government owned generator.

Options for dealing with the inability to pass through compliance costs include:

- doing nothing, and allowing generators' profitability (and ability to pay dividends) to fall. This would create strong incentives for the generator to minimise its compliance costs;

- compensating generators for their compliance-related losses. This would be a more transparent option, and more commercially desirable option from the perspective of the generators. On the other hand, it may weaken generators' incentives to minimise compliance costs;

- enacting legislation to stage implementation to allow cost pass-through if the parties have not reached a negotiated commercial arrangement during a statutory time period (the third option noted above). This option does not appear desirable as it raises significant sovereign risk issues.

Requiring direct sales to be counted as retail sales could create incentives that distort the market. In particular, this option could create two incentives:

- generators would be encouraged to give up their retail licences, to avoid greenhouse benchmark requirements; or

- customers would seek direct sale contracts with generators that did not hold retail licences.

However, both of these effects could be addressed in the legislative framework.

3.13. Minor scheme design changes

The suggested changes to the current retail scheme discussed above constitute the most important changes that could be made to the retail licence benchmark scheme. A number of other relatively minor design changes are canvassed below.

3.13.1. Measures involving an increase in output from existing zero-emissions generation

Increments in output from existing zero-emissions generators that are not the result of changes in operating efficiency can potentially be counted. However, the Workbook states:

> It is open to operators of such plant to make a case to the Minister that any increase in generation is due to their active management efforts, rather than to normal variations in rainfall or other renewable energy flow. The Minister may then choose to declare the additional output so created as Category B generation, and therefore assignable (Workbook, p. 28)

This requirement that the increment in supplied energy needs to be somehow 'worthy' is perhaps unnecessarily onerous. From a greenhouse perspective, it does not matter whether a good outcome is the result of good luck rather than good management. Arguing the case raises administrative costs, and adds an element of uncertainty to scheme operations. Therefore, consistent with the Commonwealth's MRET scheme, any increment in output over the 1997 baseline will be capable of assignment.

Increases in output from existing zero-emissions generators will be capable of being assigned, regardless of the cause of the increase.

3.13.2. Treatment of fuel substitution when a customer switches retailer

As discussed above, fuel substitution activities that result in electricity sales foregone are only claimable while the electricity retailer supplies that customer. If the customer switches retailer, the benefit is lost.

This is likely to mean that retailers are unlikely to encourage the uptake of, say, ga s water or space heaters, unless the customer is willing to enter into a long term supply contract. To the extent that consumers are unwilling to enter into contracts that are as long as the expected life of the appliance, this reduces the incentive for retailers to promote the uptake of more greenhouse friendly appliances.

An alternative mechanism could be to allow the retailer to continue to claim this credit for the expected life of the appliance. This credit, in turn, could be traded.

Credit for fuel substitution will not be lost when a customer switches retailer. This credit will be capable of being traded.

3.13.3. Assignment of property rights

There are two instances in which it would be desirable to clarify who holds the right to generation: energy currently classified under Category A, and energy generated from coal mine methane.

Category A generation

Category A generation covers electricity that is supplied by an existing generator to a retailer via a direct supply agreement. This electricity is *deemed* to be assigned to the retailer, and no Assigned Generation Declaration is required.

This is an exception to the normal rule that output from existing generators cannot be assigned except under special circumstances, for example, where some deliberate action has been taken to reduce the greenhouse intensity of production at that plant.

If assignments are to be tradable, at a minimum, these arrangements would need to be formalised, and an Assigned Generation Declaration issued. Since assigned generation would become valuable, who owns the property right – the generator or the retailer – would need to be decided.

For existing direct supply arrangements, ownership and allocation of property rights would either be governed by existing contract terms or would need to be negotiated between the parties.

Ultimately, if assignments are tradable, the rights should ultimately be purchased by the party that values them most highly. However, clearly each party would prefer that the rights were allocated to themselves.

The general principle for new arrangements under the benchmark system is that the right to assign energy belongs to the generator. Consistent with these arrangements, it is suggested that the property rights relating to direct supply agreements by generators lie with the generators.

Category A generation will be assignable and tradable. The right to assign new energy will lie with the generator.

Coal mine methane

Electricity that is generated from coal mine methane that would otherwise have been vented as part of normal mining operations actually counts as negative emissions under the current arrangements.

Given rights to assign electricity generated from coal bed methane will become valuable if penalties for licence non-compliance are introduced, it will be clear to whom the right of assignment belongs – either the mine or the electricity generator.

Property rights relating to assignable electricity generated from coal mine methane will be clarified if necessary.

3.14. Conclusions regarding a revised benchmark scheme

The analysis presented in this report has assumed that potential changes are desirable if they:

- increase the capacity to reliably reduce greenhouse gas emissions;
- reduce compliance costs; and
- involve minimal changes to the regulatory and legislative framework.

The changes suggested above further these objectives, as discussed below.

3.14.1. Capacity to reliably reduce greenhouse gas emissions

The changes to the benchmark scheme would greatly increase its capacity to reliably reduce greenhouse gas emissions. In particular, the following suggested changes would lead to this result:

- changing the nature of the obligation from a duty to prepare, negotiate and report on a strategy to meet the benchmark to an obligation to actually meet the benchmark; and
- enforcing compliance with the benchmark through a robust system of penalties.

3.14.2. Reducing compliance costs

Since the proposed amendments would encourage retailers to comply with their benchmarks, total compliance costs must inevitably rise. The extent of compliance costs are estimated in Appendix A.

That said, a number of the suggested changes seek to minimise the costs of compliance in other ways. These changes include:

- providing greater certainty through nominating a total sales forecast and lagging the pool coefficient;

- changing the definition of new generation to output that exceeds a baseline (say, an average of output from the years 1997-98 to 1999-2000);

- eliminating the need to negotiate strategies with the Minister, or to report on those plans. Retailers will still be required to report on their emissions performance, however;

- allowing compliance elements to be traded; and

- reducing restrictions on the types of interstate generation that can be included in the retailer's emissions calculation.

3.14.3. Utilising the current regulatory framework

A number of the suggested revisions to the benchmark scheme do require legislative amendment. In particular, amendments will be required to give effect to changes in the nature of the retailers' obligation, creating a power to impose meaningful penalties, and allowing the full amount of increases in low-emissions generation in other States to be counted in a retailer's emissions calculation.

However, without such amendment, the other objectives could not be achieved.

Anticipated legislative changes

At this stage of the development of the framework, the following amendments are anticipated. Changes to the legislation would need to include:

- the design of a robust penalty regime;

- inserting a requirement for retailers to comply with an emissions benchmark, rather than simply being required to negotiate and report on strategies;

- inserting a power to impose penalties according to the number of tonnes of CO_2-e by which a retailer exceeded its benchmark, as calculated according to the methodology approved by the Minister;

- inserting a penalty per tonne of CO_2-e, and amending the monetary limit on the Tribunal's (and possibly the Minister's) powers to impose penalties;

- creating a new category of licence to include customers that purchase electricity directly from the pool, rather than through a retailer.

Other changes suggested in this paper can be implemented through changes to the Guidelines and associated documents.

3.15. Including other jurisdictions

There is no reason, in principle, why other jurisdictions could not be involved in this scheme. The likely costs of other NEM jurisdictions have been modelled, and the results are presented in Appendix A.

The scheme outlined above could be implemented with different jurisdictions adopting different greenhouse targets.

Including other jurisdictions raises some policy and logistical issues, which include:

- developing a system of approving and changing rules that is common to all jurisdictions. Mirror legislation may be required, together with agreed processes for changing this legislation;

- establishing a common dispute resolution mechanism. This ensures consistency, as well as containing administration costs;

- possibly establishing a common centre for assessing and reporting on compliance, to ensure consistency and minimise administration costs; and

- ensuring that credits towards the scheme are not double-counted (i.e. if a generator sells an assigned generation certificate to a retailer in NSW, it cannot assign the same energy to a retailer in Victoria).

None of these issues seems to present insurmountable difficulties.

APPENDIX A: MODELLING

A Conceptual framework

This Appendix presents the results of modelling work undertaken by the Market Implementation Group (MIG) within NSW Treasury.

As in any modelling exercise, the results are sensitive to the assumptions used. In this case, assumptions regarding generation, demand-side management, generator efficiency and sequestration credits were provided by a range of NSW Government agencies, particularly the Sustainable Energy Development Authority (SEDA) and State Forests. The assumptions are presented at Appendix B.

The purpose of the modelling exercise is to assess:

- the *economic costs* associated with different target scenarios. Costs are defined as the *extra* costs associated with generation, demand side management, generator efficiency or carbon sequestration associated with achieving the benchmark and meeting forecast demand, compared with a business-as-usual (no benchmark) Base Case. This means that to the extent that a particular option makes more use of an existing asset (say a gas fired unit) the extra costs do not include the capacity costs since these costs have already been incurred. In reality owners of this capacity would want to charge for the use of their plant. This commercial cost is not taken into account in this economic modelling exercise. Note also that this does not estimate the full costs to society of any particular benchmark scenario, which would also include the environmental costs associated with different levels of emissions. While emissions output has been calculated, no attempt has been made to place a dollar value on the environmental costs associated with these emissions; and

- the size of *penalties* required to induce compliance.

The extent of economic *distributional effects* associated with achieving the benchmark are also discussed. These relate to the *effects on electricity pool prices, and retail prices*. These impacts are not the same as economic costs as defined above, since they include transfers of wealth between consumers, retailers and different classes of generators, rather than net costs to society.

However, these distributional effects are of interest to the groups affected, and to Government.

A.1. Benchmark scenarios

The current emissions benchmark in NSW is 7.27 tonnes of CO_2-e per capita by 2000-01. This benchmark was to have been achieved in gradual steps over the previous five years. The Guidelines state that retailers were to assume that this benchmark was to remain constant for following years, but that the licence condition arrangements would be reviewed before the end of 2000-01.

The following scenarios have been modelled:

- a **Base Case Scenario**, which assumes that no emissions benchmark is in place for the years 2002-03 to 2011-12. The Commonwealth' MRET program is assumed to be in place in all three scenarios. The costs associated with the other scenarios are measured as incremental costs over this Base Case;

- **NSW-Only Benchmark Scenario**, which assumes that NSW alone implements the benchmark policy. Emissions are reduced in even steps from their levels in 2000-2001 to meet the 7.27 tonnes benchmark in 2006-07. Thereafter, the benchmark remains constant; and

- **NEM-wide Benchmark Scenario**, which assumes that all jurisdictions in the NEM adopt the emissions benchmark policy. Total per-capita emissions in the NEM are reduced below their levels in 1989-90 by 2006-07, and remain constant thereafter;

The assumed population (as at the start of the financial year) and per capita emission target scenarios are shown in Figure 1 below.

Figure 2 below translates the per capita targets into total emission targets, including the effects of population growth.

To determine the economic *costs* and size of *penalties* required for each target scenario, the model solves for the *least-cost* way of achieving greenhouse targets in each year.

Figure 1: Population and greenhouse emission targets

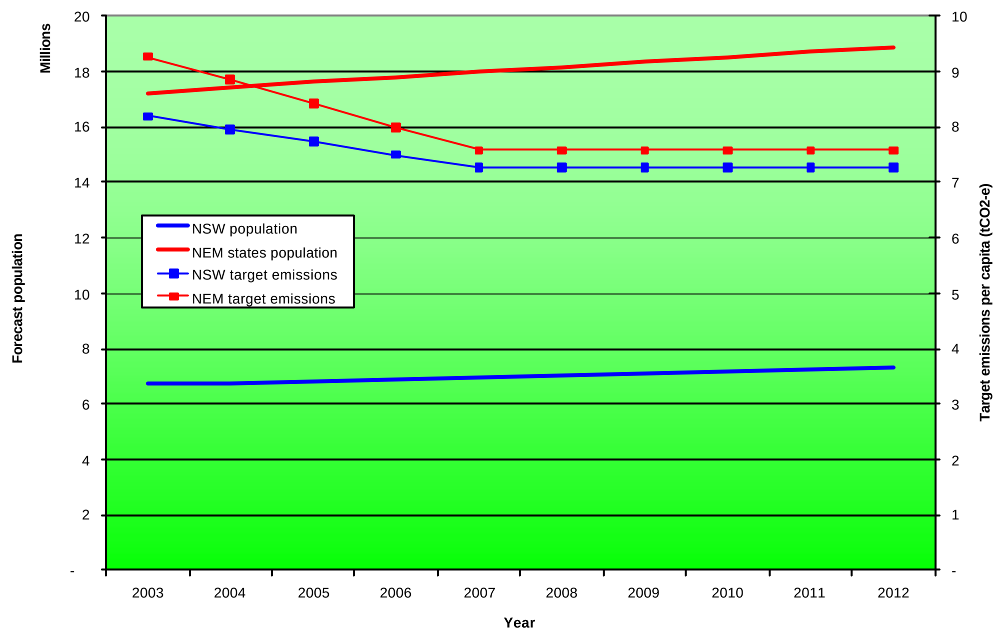
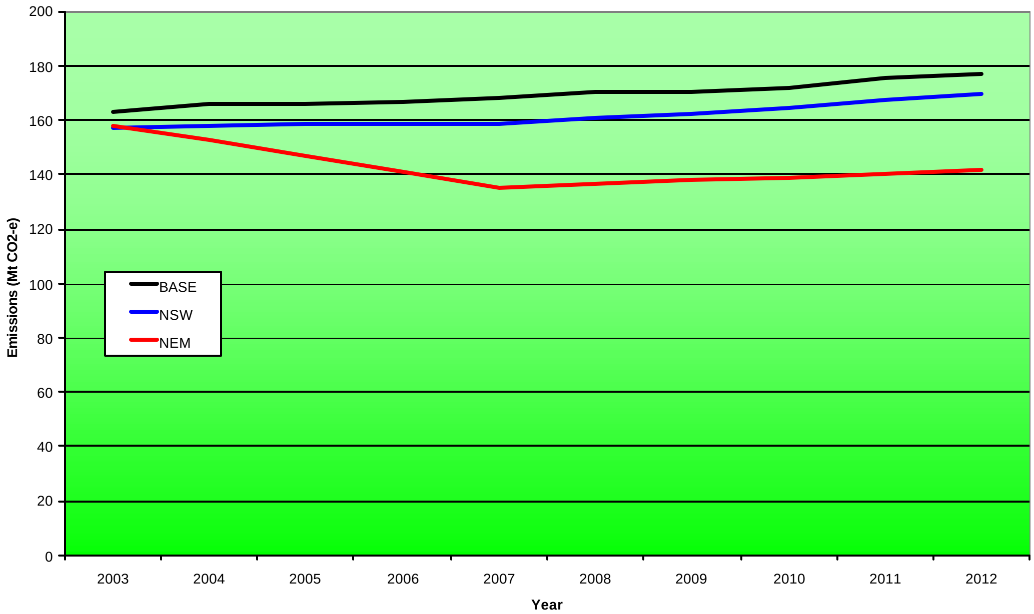


Figure 2: Total emissions under target scenarios


200
180
160
140
120
100
80
60
40
20
0
Emissions (Mt CO2-e)
BASE
NSW
NEM
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

A.2. Analytical framework: the Investment Model

The first step in the modelling approach involves identifying the range of abatement measures (e.g. greenhouse-friendly generation, generator efficiency measures, demand side management, take-up of sequestration credits) that needs to come on-stream in various years to meet the greenhouse targets. These assumptions are included in the Investment Model.

The optimal (least-cost) mix of greenhouse abatement investments is determined using a total cost optimisation model of the NEM system. This model finds the least-cost mix of greenhouse abatement investments subject to meeting a given greenhouse emission target (and reliability target as determined by NEMMCO).

This modelling stage is used to estimate changes compared with the Base Case in:

- total emissions;
- investment patterns;
- generation costs; and
- generator output.

A.2.1. The Investment Model – methodology

The model is formulated as a mixed-integer programming (MIP) problem - a specialised linear programming problem where some/all of the decision variables are constrained to integer values.

The objective of the problem is to minimise the total cost of meeting demand for electricity, subject to meeting a given greenhouse emission target and available greenhouse abatement options.

The investment options are categorised into three groups:

- Interconnection options, denoted by *i*,
- Generation plant, denoted by *j*;

- Non-generation greenhouse emission abatement options, denoted by k.

A.2.2. Data required

The model requires general system data for:

- the regional demand levels over a representative set of dispatch periods;
- the frequency of occurrence (hours per year) of each representative period;
- the interconnection capacities between regions; and
- the reserve capacity requirements for each region.

General data requirements are given in Table 1 below.

The model requires the following data for existing generation plant and potential greenhouse abatement options:

- fixed and variable costs of production;
- greenhouse emissions intensity coefficients;
- capacities and annual energy output potential; and
- commissioning timeframes.

The data required for generation plant and greenhouse emission abatement options are given in Table 3 and Table 4 below.

Table 1: General input variables		
Variable	**Units**	*Description*
$D_{r,p}$	MW	Demand in region r, period p
$PD_r^{10\%POE}$	MW	Peak demand in region r (10% probability of exceedence)
H_p	Hours	Frequency of period p in year in hours
IRF_i	Region	Notional 'from' region for interconnect I
IRT_i	Region	Notional 'to' region for interconnect I
ICX_i	MW	Capacity of interconnect i from IRF_i to IRT_i
ICM_i	MW	Capacity of interconnect i from IRT_i to IRF_i
RES_r	MW	Reserve capacity requirement in region r
RATE	%	Discount rate
GT	TCO_2-e	Greenhouse emission target
GC	$/$tCO_2$-e	Excess greenhouse emission penalty
RT	GWh	Renewable energy target
RC	$/MWh	Deficit renewable energy penalty
VoLL	$/MWh	Surplus/deficit generation penalty

Table 2: Input variables for interconnection options		
Variable	**Units**	*Description*
IRF_i	Region	Notional 'from' region for interconnect I
IRT_i	Region	Notional 'to' region for interconnect I
ICX_i	MW	Capacity of interconnect i from IRF_i to IRT_i
ICM_i	MW	Capacity of interconnect i from IRT_i to IRF_i
F_i	$/ yr	Fixed cost of interconnect i per year amortised over the life of the interconnect

Table 3: Input variables for generation plant

Variable	**Units**	*Description*
FT_j	Fuel Type	Fuel type of plant j
F_j	$/MW/yr	Fixed cost of plant j per MW of capacity per year amortised over the life of the plant
C_j	MW	Maximum potential capacity of plant type j
BS_j	MW	Block size of plant j, for new investment
CF_j	%	Maximum capacity factor of plant j
V_j	$/MWh	Variable cost of plant j per MWh produced
G_j	TCO_2-e/MWh	Tonnes of CO_2 equivalent emitted by plant j per MWh of electricity produced
R_j	Region	NEM region where plant j is located

Table 4: Input variables for greenhouse emission abatement options

Variable	**Units**	*Description*
F_k	$/t$CO_2$-e/yr	Fixed cost of option k per tonne of CO_2 equivalent abated per year amortised over the life of the option
C_k	tCO_2-e	Maximum potential capacity of option k per annum
V_k	$/t$CO_2$-e	Variable cost of option k, per tonne of CO_2 equivalent abated

All data and assumptions used in this modelling task are given in Appendix B.

A.2.3. Model formulation

The model will optimise (minimise) the total fixed and variable costs of meeting demand for electricity in the NEM while meeting a given greenhouse emission target. For clarity, the model formulation in this report is presented for a single year, multiple year optimisation is performed by discounting the costs of future years by an assumed discount rate of 7% per annum (from a base year of 2002).

Decision variables

The decision variables used in the problem relate to the decisions to invest in the various options (fixed costs) plus the output levels of these options over time to meet demand and the greenhouse target (variable costs).

These decision variables are given in Table 5 below.

Table 5: Decision variables

Variable	**Type (bounds)**	*Description*
I_i	Binary {0,1}	Represents the decision to invest in interconnect i, (1=yes, 0=no)
$I_{j,k}$	Integer $\{0,C_{j,k}/BS_{j,k}\}$	Represents the number blocks of type j/k to invest in
O_k	Real $[0,C_k.I_k]$	Represents the total output of option k in tCO_2-e abated
$O_{j,p}$	Real $[0,BS_j.I_j]$	Represents the output of plant j in MW in period p
$X_{i,p}$	Real $[-ICM_i,ICX_i]$	Represents the flow on interconnect i in period p
GX	Real [0,infinity)	Represents excess greenhouse emissions
RX	Real [0,infinity)	Represents the deficit renewables energy
$RD_{r,p}$	Real [0,infinity)	Represents the deficit supply in region r, period p
$RS_{r,p}$	Real [0,infinity)	Represents the surplus supply in region r, period p

Calculated variables

Using the input variables and the decision variables a number of key calculated variables can be determined. These variables are given in Table 6.

Table 6: Calculated variables

Variable	Formula	*Description*
O_j	$\sum_p H_p.O_{j,p}$	Total output of plant j in MWh
$NM_{r,p}$	$\sum_{i \forall IRT_i = r} X_{i,p} - \sum_{i \forall IRF_i = r} X_{i,p}$	Net imports into region r, period p
$S_{r,p}$	$NM_{r,p} + \sum_{j \forall R_j = r} O_{j,p}$	Total supply in region r, in period p
TC_j	$I_j.F_j.BS_j + O_j.V_j$	Total cost of plant j
TC_k	$I_k.F_k.BS_k + O_k.V_k$	Total cost of option k
TCSD	$VoLL.\sum_p \left(\sum_r \left(RD_{r,p} + RS_{r,p} \right) \right)$	Total cost of surplus / deficit supply
TC	$\sum_j TC_j + \sum_k TC_k + TCSD + GC.GX + RC.RX$	Total system cost (to be minimised)
TR	$\sum_{j \forall FT_j = \text{"Renewable"}} O_j$	Total renewable energy output (MWh)
TG_j	$O_j.G_j$	Total greenhouse emissions from plant j
TG_k	O_k	Total greenhouse emission abatement from option k
TG	$\sum_j TG_j - \sum_k TG_k$	Total greenhouse emissions

Constraints

Certain constraints need to be applied to the decision variables in order to take account of:

- capacity limits of plant and interconnects;
- greenhouse emission target limits;
- supply / demand balancing; and

- regional reserve requirements.

These constraints can be placed directly on the allowable values of the decision variables, or indirectly on the allowable values of any of the calculated variables.

The constraints placed directly on the decision variables are given in Table 5 above as the bounds on the variables and relate mainly to capacity constraints on the plant and interconnects. Indirect constraints, placed on the calculated variables, are given in Table 7 below, relating to the supply/demand balance, reserve level and greenhouse target constraints.

Table 7: Constraints

Constraint	**Formula**	*Description*
Plant capacity factor constraint	$O_j \leq I_j.BS_j.CF_j.\sum_p H_p$	Ensures that the plant does not run at a capacity factor higher than is practicable for the technology
Regional energy balance	$S_{r,p} + RD_{r,p} - RS_{r,p} = D_{r,p}$	Supply (including deficit/surplus) equals demand in each region r, and in each period p
Regional reserve requirement	$\sum_{j \forall R_j = r} I_j.BS_j + \sum_{i \forall IRF_i = r} I_i.IM_i + \sum_{i \forall IRT_i = r} I_i.IX_i \geq PD_r^{10\%POE} + RES_r$	Available capacity (including import capacity) exceeds demand by at least the reserve level in each period
Renewable energy target	$TR + RX \geq RT$	Renewable energy output (including any penalised deficit) is at least at the target level
Greenhouse target	$TG - GX \leq GT$	Greenhouse emissions (less any penalised surplus) are capped at the target level

The regional energy balance constraint ensures that supply meets demand in each NEM region. The model allows for a deficit/surplus of supply, the quantity of which is priced at the value of lost load (VoLL), soon to increase from $5,000/MWh to $10,000/MWh in the NEM.

The regional reserve requirement constraint allows for a single plant/interconnect outage contingency by ensuring that, at all times, each region has a minimum level (RES_r) of spare capacity available relative to the 10% probability of exceedence peak demand forecast. RES_r is generally set to the size of the largest generating unit or interconnector transmission line capacity in the respective region, and is published by NEMMCO for each region. The assumed reserve levels for each region are given in Table 8 in the Appendices.

The renewable energy target constraint ensures that the renewable energy target is met, taking into account any deficit that incurs a penalty cost of RC $/MWh to the system.

The renewable energy target constraint operates differently depending on the level of the associated penalty factor, RC. The constraint can be:

- *turned off* by setting the penalty, RC, to zero effectively turns the constraint off as there is no penalty cost to the system of not meeting the renewable energy target;

- a *hard target* by setting the penalty, RC, high enough to ensure that the target will always be fully met. In this case, the *shadow price* of this constraint gives the optimal penalty to induce compliance to the target; or

- a *soft target* by setting the penalty, RC, at some level that may or may not ensure that the target is fully met, the system will meet the target unless doing so imposes costs to the system greater than the penalty cost.

The Commonwealth MRET scheme has been modelled using a soft target with a penalty of $57.50/MWh (recognising the post-tax nature of the penalty).

The greenhouse target constraint ensures that the greenhouse emission target is not exceeded, taking into account excess greenhouse emissions. Excess emissions incur a cost to the system of GC $/t$CO_2$e.

As with the renewable energy target constraint, the greenhouse emission constraint can be either *turned off*, a *hard target*, or a *soft target* by altering the penalty factor for excess emissions, GC.

A.3. Modelling results

The Stage 1 Modelling results show changes compared with a Base Case in:

- total emissions;
- investment patterns;
- generator output; and
- generation costs.

A.3.1. Total emissions

Total target emissions under each scenario are shown at Figure 2. This shows that total emissions in the NEM with no greenhouse constraints in place other than the MRET program would rise by around 9 per cent to 177 Mt of CO_2-e by 2011-12.

If NSW alone adopts the benchmark policy, total emissions at the end of the period are predicted to be 170 Mt, or around 4 per cent lower than they would otherwise be. If all NEM jurisdictions participate in the program, emissions at the end of the period are predicted to be around 20 per cent lower than they would otherwise have been.

A.3.2. Investment

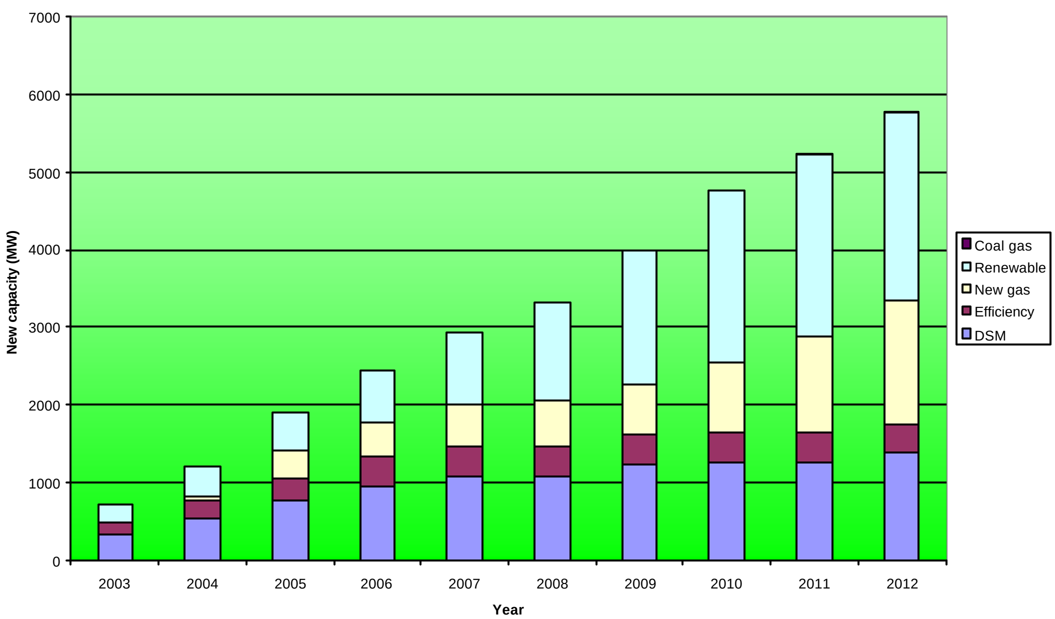
In all scenarios, meeting the greenhouse targets requires a pattern of investment that differs from what would have occurred under the Base Case. The timing and pattern of this investment differs according to the target scenario

Base Case

The Base Case models the minimised cost of investments required to meet forecast system demand from 2002-03 to 2011-12 assuming no emissions constraints other than the MRET program.

Figure 3 below shows new generation capacity and demand side management (DSM) options that the model chooses to install to meet forecast demand at least cost. (As discussed above, in all scenarios, the choices made by the model depend on the cost and availability assumptions chosen for each investment possibility.)

Figure 3: New capacity: Base Case (MW)



The major changes in capacity over time under the Base Case scenario are:

- an increase in the take-up of DSM options;
- the adoption of some generator efficiency measures (i.e. the efficiency of existing thermal generators is increased);
- increasing amounts of gas generation capacity are installed from 2003-04 on; and
- an increasing amount of renewable generation is added, largely in response to the MRET program.

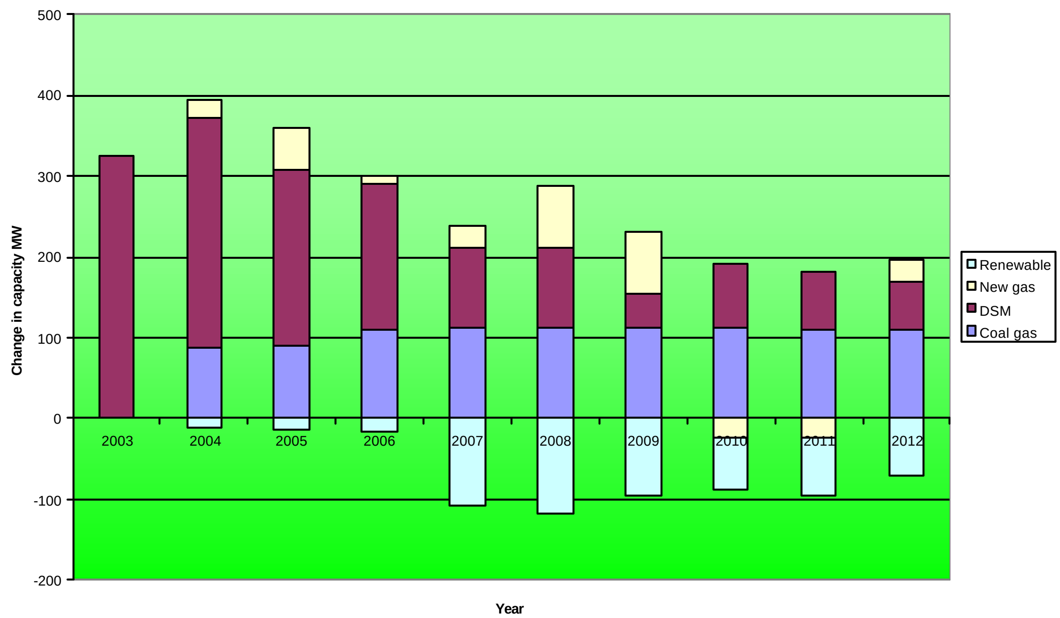
No sequestration credits are purchased under the Base Case.

NSW-Only Benchmark Scenario

The NSW-Only Benchmark Scenario requires the 7.27 tCO_2-e benchmark to be met via gradual per capita emission reductions until 2006-07. Per capita emissions remain stable after this date, resulting in total NSW emissions increasing in line with NSW population growth.

Figure 4 below shows the differences in investment patterns between this scenario and the Base Case. The results suggest that more DSM options become viable, coal mine methane projects are included, and there would be less renewable capacity included than under the Base Case. Sufficient renewable capacity to meet the MRET targets would still be included: renewable generators with higher capacity factors are installed in the locations that give the greatest emission abatement, and less renewable capacity is required over all. In the presence of emissions targets, the amount of greenhouse emissions abated by the renewable option becomes important. The emission abatement depends on the type of generation that is displaced by the renewable generation, so the location of the renewable plant becomes increasingly important. The other significant change from the Base Case is the increase in gas generation capacity included.

Figure 4: New Capacity – NSW linear reduction, differences from Base Case (MW)

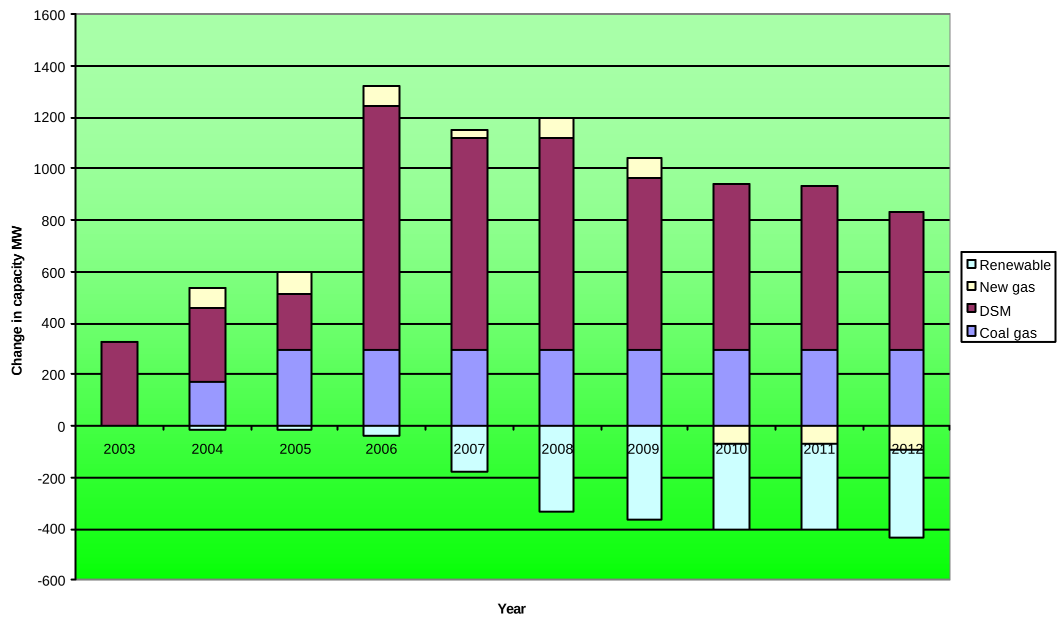


At the assumed price of $10 per tonne, no sequestration credits are chosen by the model in this scenario.

NEM-wide Benchmark Scenario

The NEM-wide Benchmark Scenario assumes that all NEM jurisdictions adopt the benchmark regime, and per-capita emissions in the NEM as a whole are reduced by 5 per cent compared with 1989-90 levels.

Figure 5: New Capacity – NEM-wide Benchmark Scenario, differences from Base Case (MW)



The main differences between investment in this scenario and the Base Case are:

- substantially more DSM options become viable;
- more coal gas options become viable;
- less renewable capacity is installed (again, this reflects the fact that renewable generators with higher capacity factors become viable because they would provide greater emission abatement, which means less renewable capacity is required overall); and
- in some years, there is slightly less gas capacity than under the Base Case, and more in others.

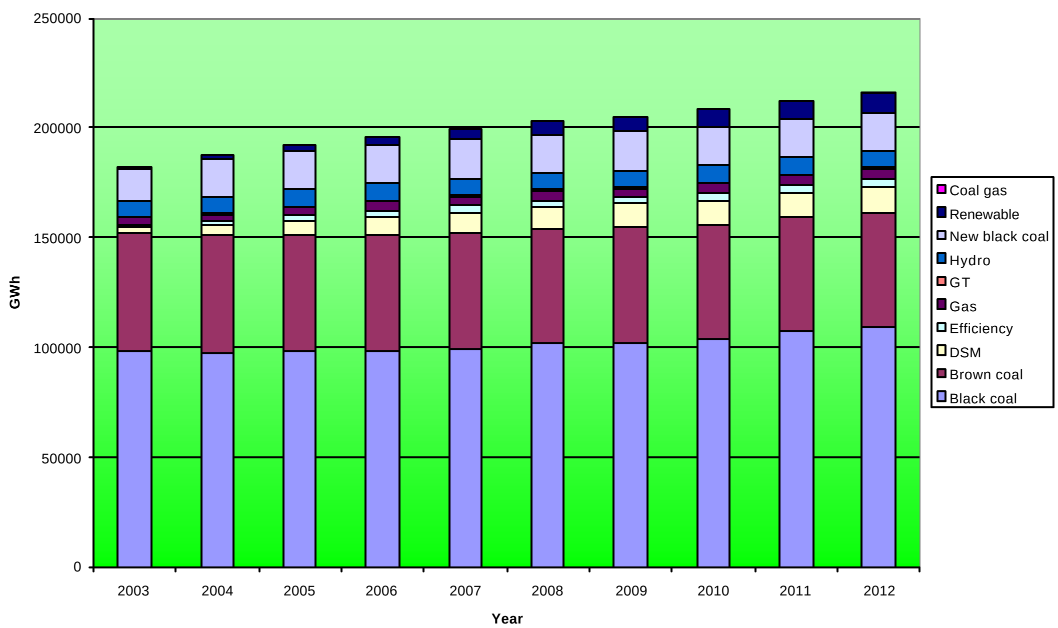
A.3.3. Generator output

The mix of generator output has been estimated in each year between 2002-03 to 2011-12. The changes in output mix over time reflect the changes in installed capacity discussed above, and also reflect the intensity with which all installed capacity is utilised.

Base Case

As shown in Figure 6 below, output for the entire forecast period is dominated by coal: black coal (existing and new), and brown coal. Despite a significant increase in gas generation capacity in the Base Case, gas earns only a relatively small market share. (These generators would generally only be dispatched in peak periods, which amount to a small proportion of total demand over a year.)

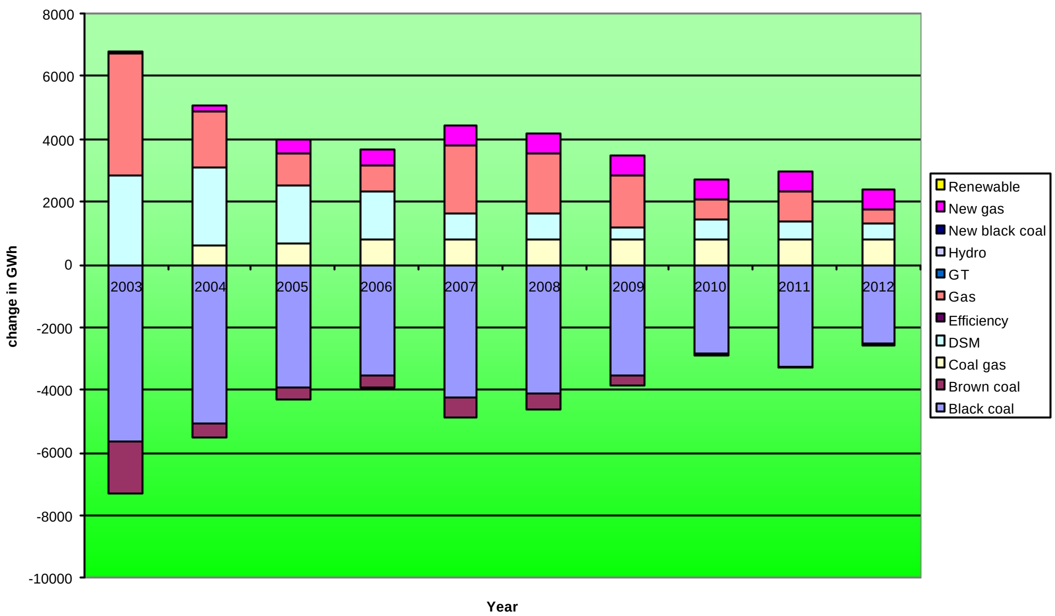
Figure 6: Output by generator class – Base Case



NSW-Only Benchmark Scenario

Figure 7 below shows the difference in output of different options (generation, DSM and generator efficiency measures) compared with the Base Case. The most notable factor in this scenario is the reduced output of coal-fired generators – despite the fact that there is no difference in installed coal capacity in this scenario compared with the Base Case. Other significant changes include a substantial increase in the uptake of DSM options, as well as a rise in the output of existing gas, coal gas and new gas generators.

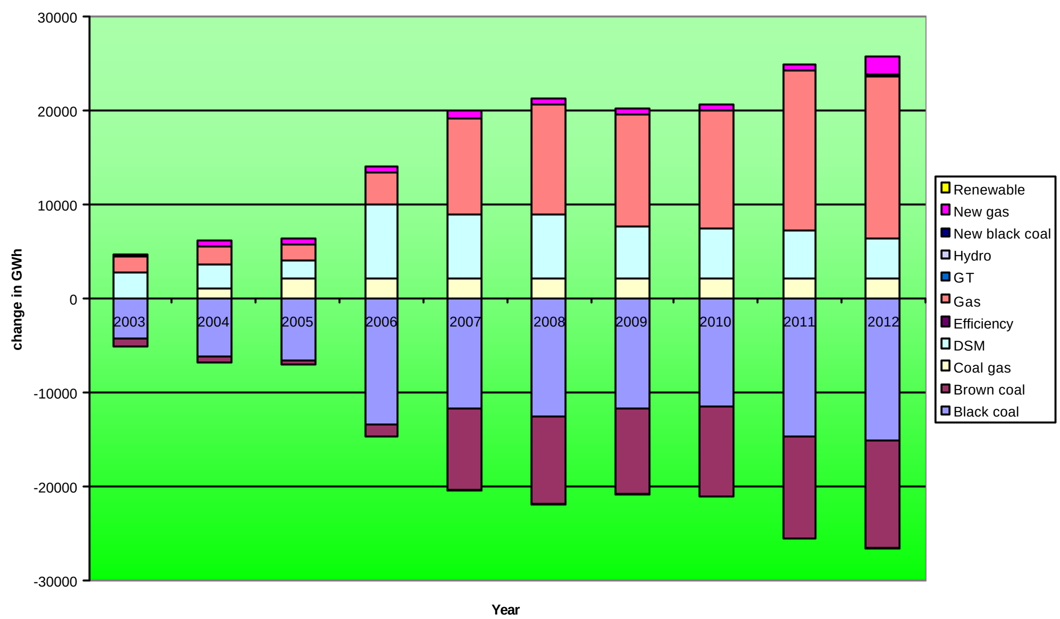
Figure 7: Output by generator class – NSW-Only Benchmark Scenario compared with Base Case



Changes in output – NEM-wide Benchmark Scenario

The changes in utilisation of different options under the NEM-wide Benchmark Scenario is shown in Figure 8 below. As in the NSW only scenario, the biggest impact relates to the utilisation of existing and new coal-fired plant. The biggest reductions in output are in black coal plants: the proportionally smaller reductions in output of brown coal plant reflect the fact that they represent a smaller proportion of NEM generation capacity. These effects are much more marked under this scenario than in the NSW-only case. The increased utilisation of gas-fired generation is another substantial change. Again, significantly more demand is reduced through the uptake of DSM options.

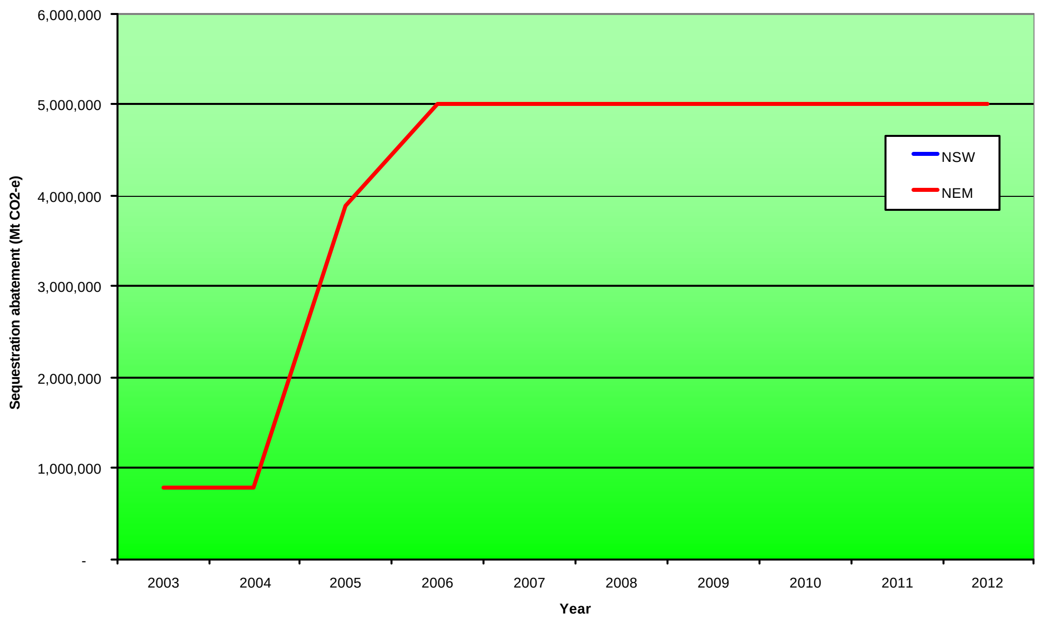
Figure 8: Output by generator class – NEM Benchmark Scenario compared with Base Case



A.3.4. Sequestration

As shown in Figure 9, at the assumed price of $10 per tonne, no sequestration credits are purchased under the NSW-only Benchmark Scenario. However, under the NEM-wide Benchmark Scenario, the overall abatement task is larger. The supply of other, cheaper abatement options are insufficient to meet the targets (at least for the costs and availabilities assumed), and more expensive options must be used in addition. Accordingly, under this Scenario the maximum number of credits that is assumed to be available is taken up from 2005-06 onwards, with a lesser amount taken in the preceding years.

Figure 9: Uptake of sequestration credits – all scenarios



A.3.5. Total costs

Total costs are measured as increases in expenditure on generation, DSM, and generator efficiency compared with the Base Case. These costs are measured as the amortised fixed costs of generation plant or one-off investments required for DSM, as well as variable costs associated with operation. The costs of acquiring sequestration credits (where they are taken up) are also included in this measure.

Excluding environmental costs, which are not measured in this exercise, these costs represent the closest match to the costs borne by society associated with meeting different greenhouse targets.

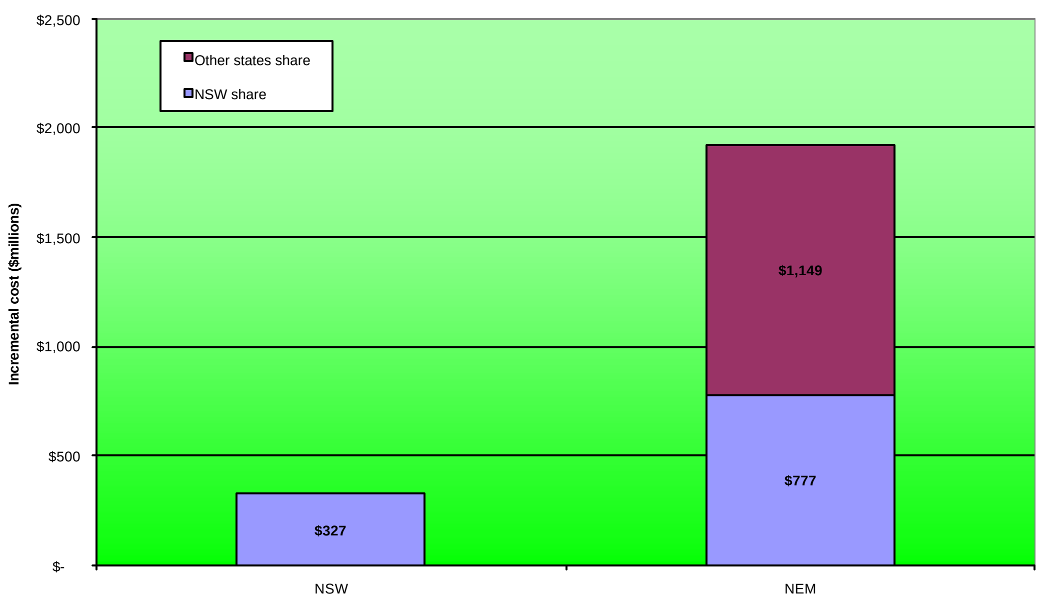
Cost results are reported according to:

- net present value (NPV) of total costs (fixed and variable) over the 10 years from 2002-03 through 2011-12 inclusive; and
- average real increases in costs per MWh.

A.3.6. NPV of total costs, 2002-03 to 2011-12

The differences between the costs associated with the Base Case and the target scenarios are shown in Figure 10 below (costs are discounted to real 2001-02 dollars).

Figure 10: Increase in total costs (NPV, 10 years), target scenarios



Reflecting the smaller deviations from the Base Case in both investment and output patterns, the NSW-only benchmark option imposes the lowest costs: $327 million in NPV terms.

Given greater deviations from the Base Case are required to fulfil the target under the NEM-wide Benchmark Scenario, this involves much higher costs overall: $1,925 million in the case of the former. The NSW share of these

NEM-wide costs is shown in the lower, blue bar as $777 million for the NEM Benchmark Scenario.

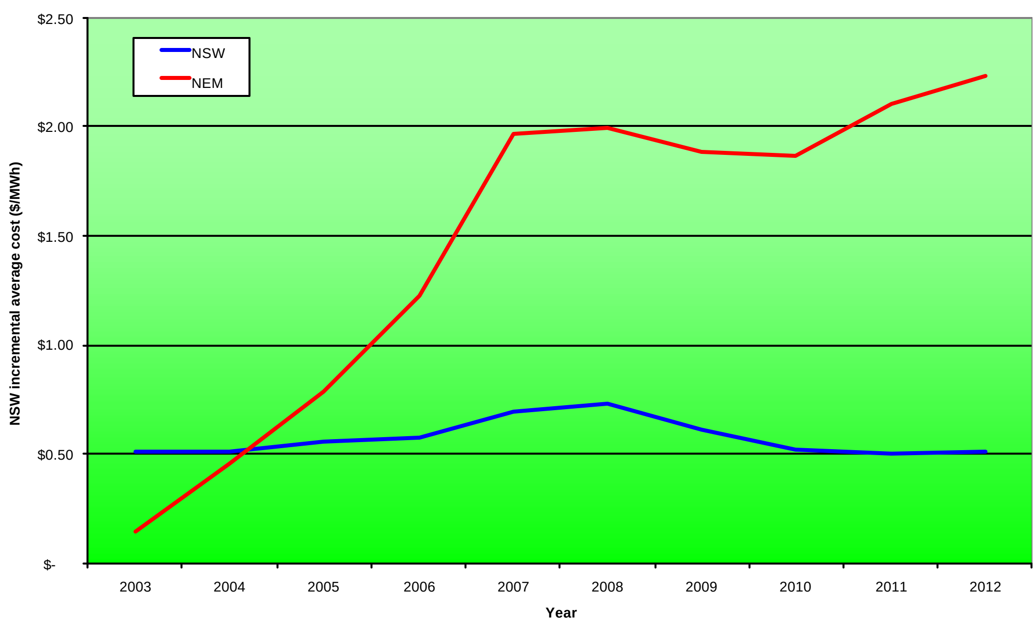
The share of costs allocated to NSW was calculated according to NSW's share of total demand. Participants in all NEM jurisdictions would be competing to find low cost abatement options. It has been assumed that NSW's chances of securing low cost options are the same as for other jurisdictions.

A.3.7. Increased energy costs in each year

Figure 11 below shows the difference in generation costs per MWh compared with the Base Case. Note these costs are the actual real forecast costs in every year – they are in constant dollars (i.e. no inflation has been assumed), but no discounting over time is included.

Note that these costs represent the *average* cost per MWh to comply with the target in that year– they do not represent the *marginal* cost of compliance, which is the relevant figure when calculating penalties required to induce compliance.

Figure 11: Increases in energy costs compared with Base Case, 2002-03 to 2011-12 ($/MWh)



For both the NSW-only Benchmark Scenarios, the average cost increase per megawatt hour never exceeds $0.73/MWh in all years. To put this into perspective, the average delivered electricity price paid by NSW customers is in the order of $100/MWh. Thus, under these scenarios, mandating the benchmarks would result in a maximum increase in price of about 1% using the assumptions outlined in this report and Appendix B.

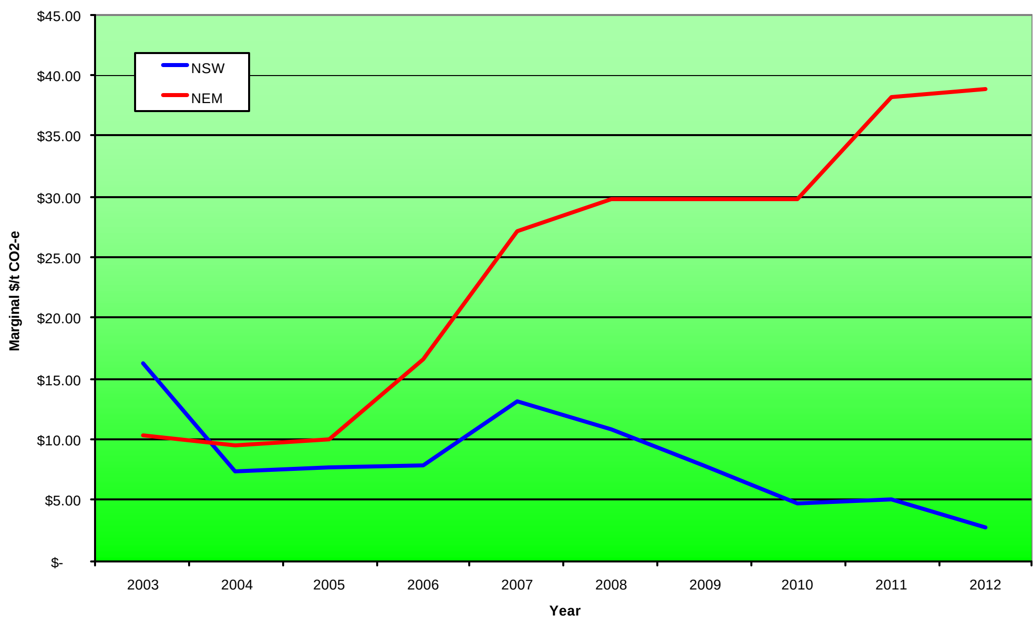
The average costs for the NEM-wide scenarios are higher, reflecting the greater abatement task being undertaken, and the uptake of progressively more expensive abatement options. Even so, the average increase in costs per megawatt hour only exceeds $1.00 from 2005-06 onwards. After this time, the targets become significantly more difficult to meet. Under the NEM benchmark scenario, average costs per megawatt hour peak at $2.23 at the end of the forecast period.

A.3.8. Marginal cost of compliance

Figure 12 below shows the difference in *marginal cost of compliance* per tonne of CO_2-e abated for each of the target scenarios. Note these costs are the actual real forecast costs in every year – they are in constant dollars (i.e. no inflation has been assumed), but no discounting is included.

The *marginal cost of compliance* is derived from the *shadow price* of the greenhouse emission constraint in the model formulation and can be thought of as the additional cost borne by society due to increasing the greenhouse emission abatement target by 1 tonne CO_2-e in a particular year. As previously described, the *marginal cost of compliance* can be used as a guide for setting appropriate excess emission penalties in order to induce compliance with the emission targets.

Figure 12: Penalties based on marginal cost of compliance 2001-02 to 2010-11 ($/t$CO_2$-e)



Under the NSW-only Scenario, the penalty required to induce compliance never exceeds $16 per tonne in the forecast period. The marginal cost of compliance for the NSW-only Scenario falls after 2007 because after this time the target has been achieved and the emissions levels only need to be maintained at the target level.

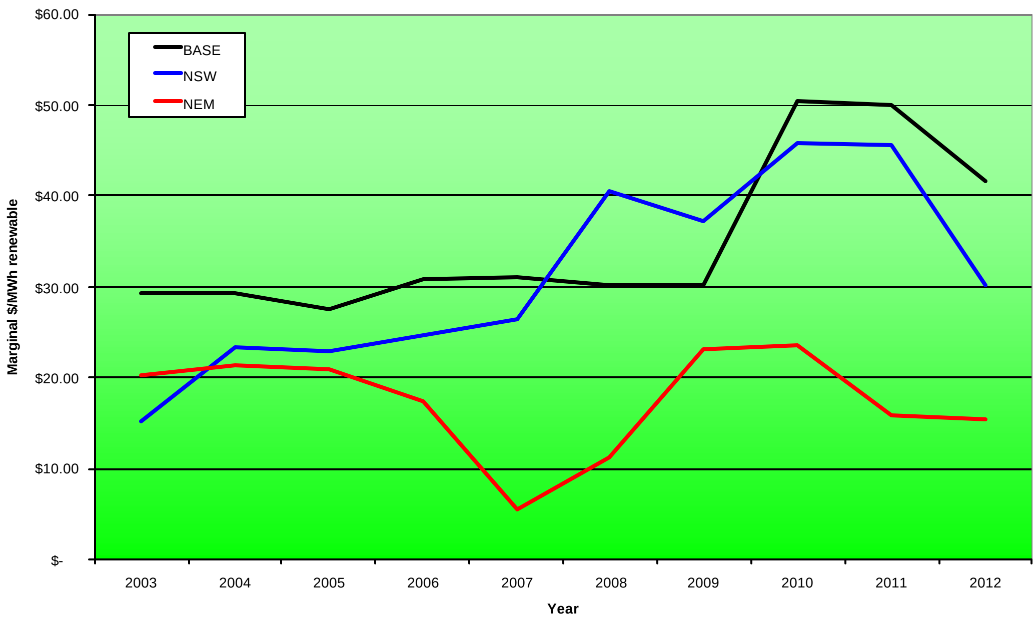
Under the NEM-wide Benchmark Scenario, higher penalties would be required to induce compliance. This reflects the fact that the cheaper abatement options are exhausted, and more expensive options must be used. The marginal cost of abatement stays under $40 for the entire forecast period.

A.3.9. Marginal cost of compliance: MRET

The costs of meeting an incremental increase in the MRET target has been estimated using the same assumptions for the costs and availability of different renewable options as used in the scenarios above. This is the cost ($/MWh) of increasing the renewable target by an additional MWh. *Note that this does not measure the cost of introducing the MRET scheme, just the incremental cost of tightening the existing 2% target*.

Penalties under the MRET scheme have been set at $40 per megawatt hour. Given the tax treatment of these penalties, this translates into an incentive to purchase renewable power so long as it costs less than $57.50. At all times in the forecast period, the marginal cost of abatement is lower than $57.50, which implies that the Commonwealth target, theoretically at least, ought to be met.

Figure 13: Marginal cost of abatement – MRET ($ per MWh)

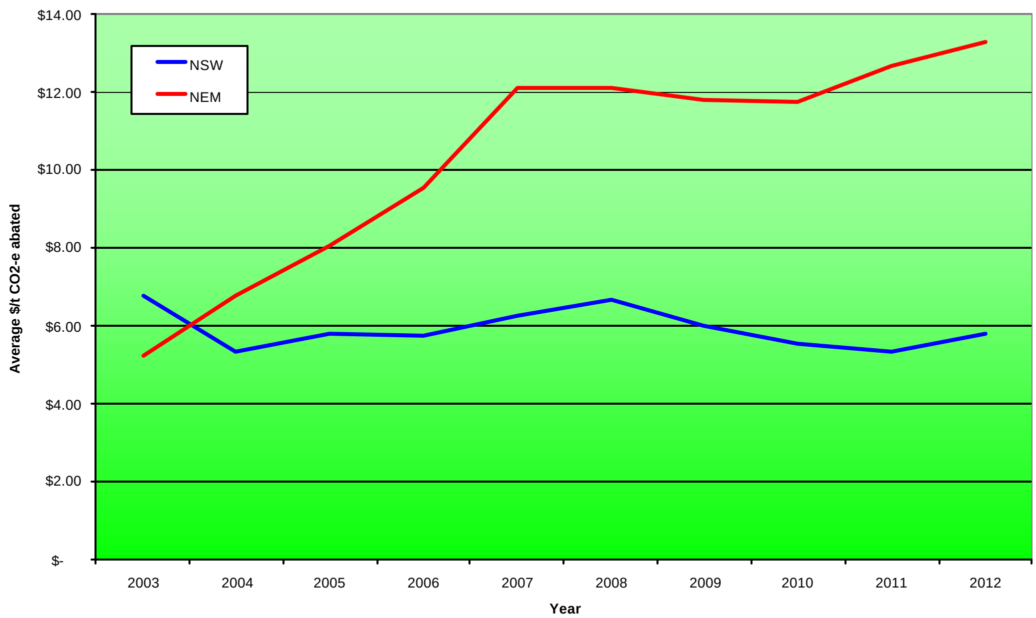


A.3.10. Average abatement cost per tonne

The average costs per tonne of abatement are shown in Figure 14 below. Under the NSW-only scenario, the average cost per tonne abated is less than $7 per tonne in all forecast years.

Reflecting the greater abatement task and the necessary uptake of more expensive abatement options, the NEM-wide scenarios involve higher average abatement costs. Average abatement costs per tonne peak at $13.29 at the end of the forecast period under the NEM-wide Benchmark Scenario.

Figure 14: Average abatement cost per tonne ($/tCO2-e)



A.3.11.Impact of MRET

The modelling results presented so far have included the MRET program in the base case assumptions. For informational purposes, this section presents the impact of the MRET program compared to an alternative "do nothing" scenario (No MRET) that excludes the MRET targets, and all other greenhouse related targets from the assumptions. For the purposes of this review it is assumed that the MRET arrangements are in place until 2012, however it should be noted that currently the scheme is expected to last until 2010.

The effect of the MRET program on NEM emissions (compared with a "do nothing" scenario) is shown in Figure 15 below. The NEM wide emission abatement solely due to the MRET program ranges from about 2.5 $MtCO_2$-e in 2002/03 to about 5.7 $MtCO_2$-e in 2009/10. (This is shown by the difference between the No MRET scenario and the Base, which includes MRET.) In total, the NEM emission abatement due to the MRET program is about 37.3 $MtCO_2$-e over the 10 year modelling period.

Figure 16 and Figure 17 show the impact of the MRET program on investment and generation respectively. The MRET program results in renewable generation investment replacing investment in DSM and Gas options, and renewable generation displacing Black Coal, DSM and Gas generation.

Figure 15: NEM emissions with/without MRET

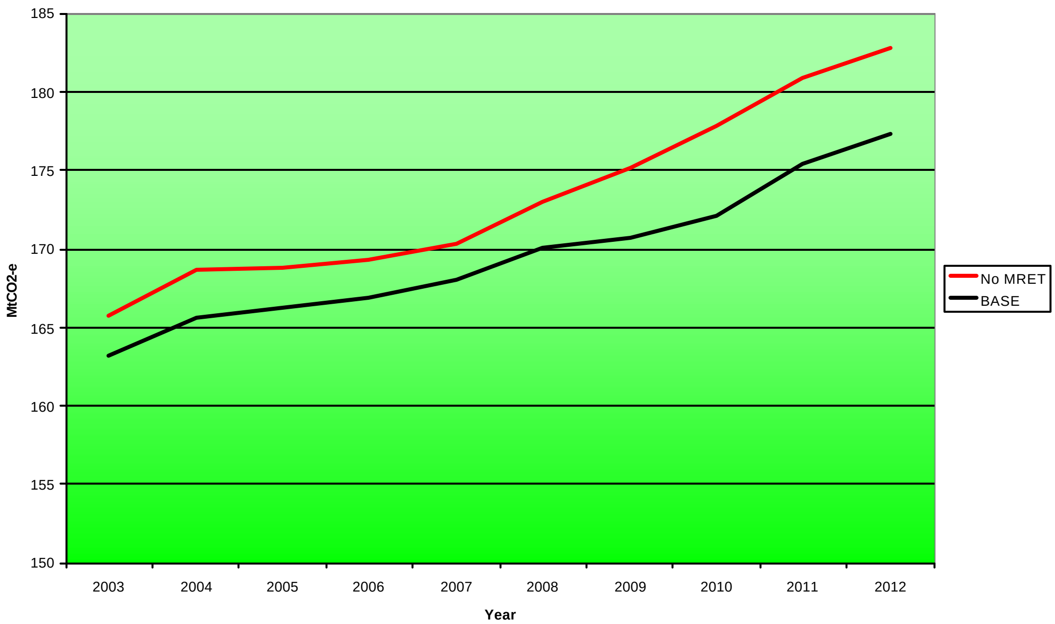


Figure 16: Change in investment with/without MRET

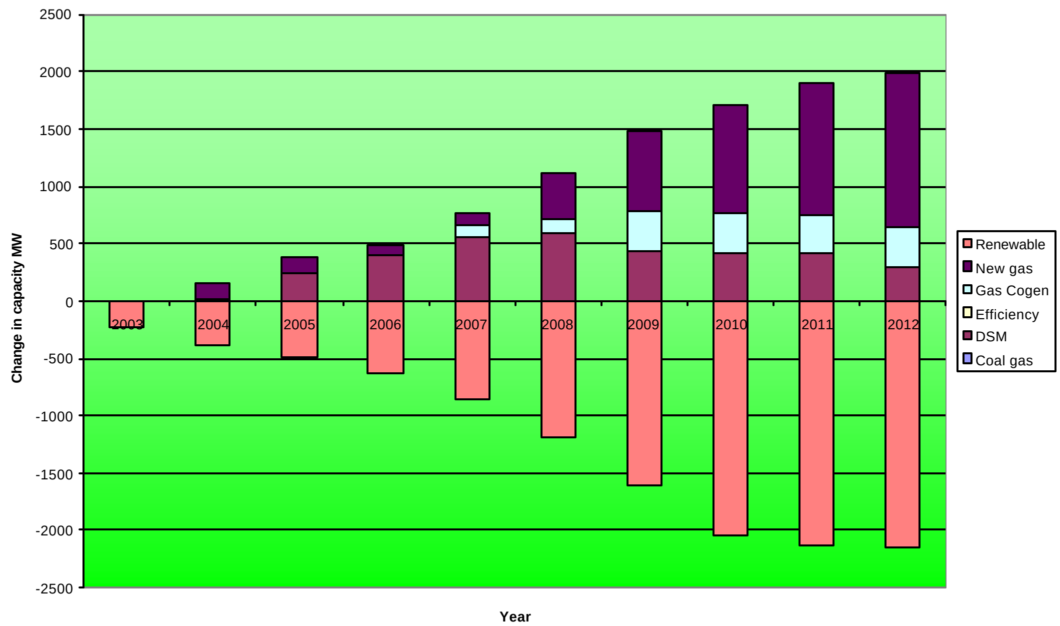


Figure 17: Change in generation with/without MRET

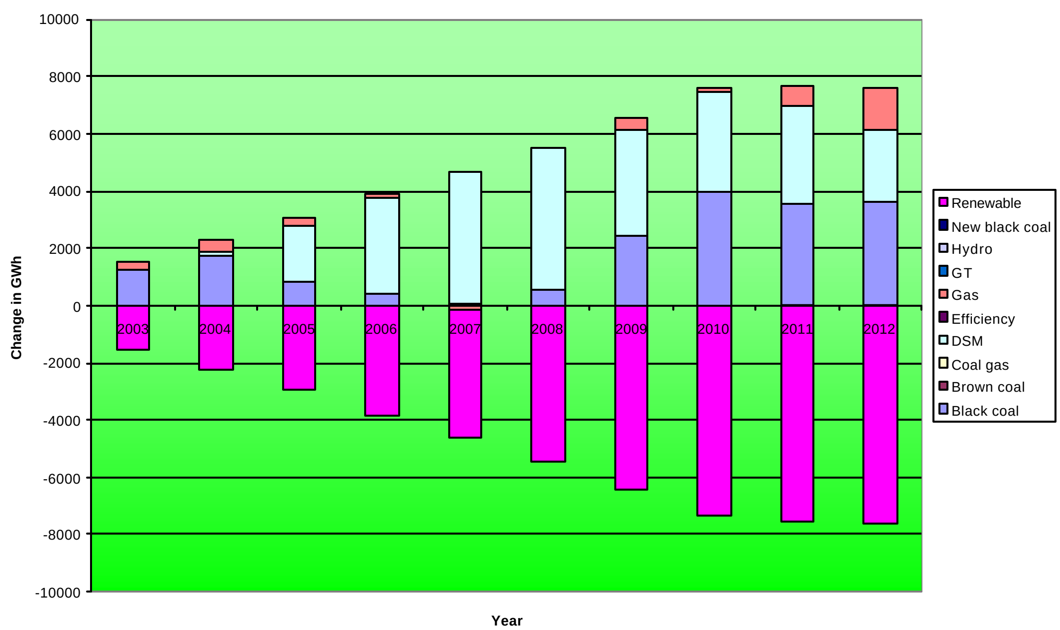
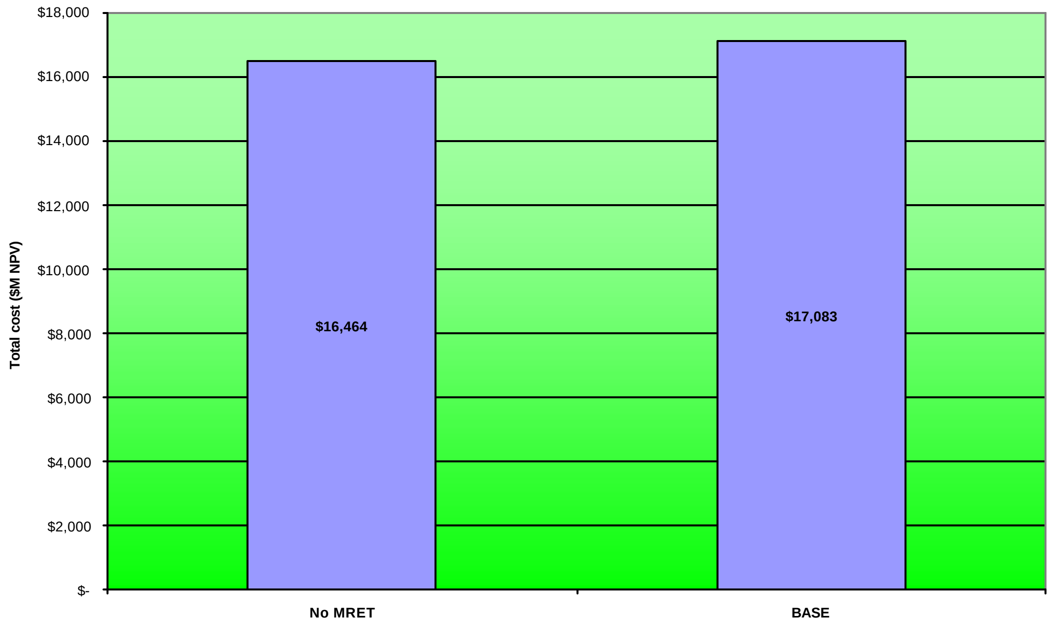


Figure 18: Total cost of meeting forecast demand with/without MRET



The costs of the MRET program compared to the "do nothing" (No MRET) scenario are shown in Figure 18 above. The MRET program imposes additional costs of about $620 million NEM wide (in NPV terms) and total emission abatement of 37.3 $MtCO_2$-e over the 10 year modelling period, equating to an average abatement cost of $16.6/$tCO_2$-e.

A.4. Some matters not taken into account in the model

Like all models, the Investment Model abstracts from reality. In order to be useful, models are always more simplified than the real economy.

Some of the more important matters that are not taken into account in the model include:

- any impediments to the market identifying and implementing least cost options;

- Government subsidies offered under other greenhouse programs, such as the Commonwealth's GGAP funding program;
- the potential for some options (DSM and embedded generation) to postpone the need for network augmentations;
- the potential for the costs of different options (in both absolute terms, and relative to other options) to change over time.

Well informed, rational markets

Like most economic models, the Investment Model assumes that market participants are well informed and rational.

In practice, there may be impediments to markets seeking out and acting on least cost investment options. Such impediments might include poor information about such options being available, or long-term contracts locking participants into a particular technology.

Governments already play a role in disseminating information about investment opportunities. For example, SEDA and similar bodies in other jurisdictions play an active role in encouraging greenhouse-friendly generation and DSM options. At a Commonwealth level, the Australian Greenhouse Office plays a large role in this regard, and also publishes the Australian Renewable Energy Website.

The role of the private sector should not be underestimated. There are numerous industry bodies that actively promote the technologies that they represent. Individual firms also have an incentive to market their product to potential users. As enforceable greenhouse targets increases the financial incentives to adopt different technologies, the role of 'middle men', or technology advisers and brokers, would be expected to increase.

However, adapting to new incentives is unlikely to occur instantaneously: some adjustment period might be expected.

Effects of other greenhouse programs

Only the effects of the MRET program have been included in the model. However, a number of other Government programs aimed at reducing greenhouse gas emissions in the electricity sector exist. These have the potential to alter the pattern of investments that would otherwise have occurred, changing the overall costs to society (inclusive of subsidies).

Potential to postpone the need for network augmentation

There is scope for some options, such as embedded generation and DSM, to postpone the need for network augmentations. These potential savings are not included in the model.

The size of any network augmentation savings are highly sensitive to the location of embedded generators, the timing and size of the augmentations that would otherwise have occurred, and the length of time for which they have been postponed.

The effects on the need for new investment in the network are not easily predicted. The characteristics of electricity networks mean that changes in the system at one point change the pattern of flows throughout the system. These effects cannot be easily approximated. These effects can only be modelled accurately using a highly complex load flow model, such as that used by TransGrid. Such modelling is outside the scope of this report.

To the extent that network augmentations could be avoided by the use of DSM and embedded generation, the model overestimates the true costs to society of these options.

Changing technology costs

The option cost assumptions provided by NSW Government agencies do not assume any increases or decreases in the real costs of technology over time. This may not be realistic.

There are two main sources of potential cost reductions associated with some options over time:

- advances in technology, that lower the cost of producing and using different options; and

- realisation of economies of scale by producers of some technologies, which they are currently unable to achieve.

On the other hand, there is potential for the costs of some technologies to rise over time in real terms, because there might be bottlenecks in the supply of suitable sites, skilled engineers familiar with the technology, or other inputs.

A.5. Impact on retail prices

The impact of achieving greenhouse targets on retail prices depends on the interaction between two factors:

- the extra costs incurred by retailers in complying with the regime, in purchasing credits from greenhouse-friendly generators, undertaking or funding DSM measures, buying sequestration credits or purchasing credits for generator efficiency measures; and

- the effects that changes in the electricity wholesale market that occur as a result of greenhouse policies.

It is important to recognise the difference between costs retailers incur in compliance and the cost of electricity they buy from the pool. This can be illustrated through a simplified example. Say a retailer sells 1000 GWh in a given period, and this translates into an emissions limit of 840,000 tCO_2-e. The retailer could meet this target through a mix of compliance options, as shown in the table below.

Item		**Emissions**	**Cost to retailer**
Sequestration credits		(100,000 t)	$1 million
Credit for 100 GWh from gas generator (0.40 tCO_2-e/MWh)		40,000t	$0.5 million
Purchases from the pool (1.0 tCO_2-e/MWh) (pool price = $40/MWh)	Actual = 1000 GWh	n.a.	$40 million
	Assumed for emissions calculation (1000 – 100 (assigned) = 900 GWh)	900,000t	n.a.
Total		**840,000 t**	**$41.5 million**

In practice, this retailer purchases all of the electricity it on-sells from the pool. This costs $40 million, at an average pool price of $40/MWh. However, the retailer also has to purchase compliance options. In this case, the retailer spends $1 million on sequestration credits. It also spends $0.5 million on the credit for 100 GWh of output from a gas generator, with an emission coefficient of 0.4. This adds 40,000 tonnes of emissions to its tally, but allows it to avoid the emissions associated with 100 GWh of its purchases from the pool. As discussed in Section 2 of the report, for any individual retailer, calculated pool emissions are not necessarily the total amount of energy actually purchased from the pool. Rather, they reflect total electricity sales minus any 'assigned' generation. In this case, this is 1000 GWh of total sales minus 100 GWh of energy assigned from the gas generator. Therefore, the emissions associated with only 900 GWh of electricity purchased from the pool enter the retailer's tally. Assuming a pool coefficient of 1.0, this amounts to 900,000 tonnes of emissions.

To calculate the retailer's total emissions, this is the sum of 900,000 tonnes of pool emissions, plus 40,000 tonnes of emissions from the gas generator, minus 100,000 tonnes from sequestration credits. The retailer has complied with its emissions limit of 840,000 tonnes.

The total cost to the retailer is made up of two parts:

- $40 million in purchases it actually made from the pool; plus
- $1.5 million it spent on buying compliance options.

A.5.1. Compliance costs

The average increase in costs per megawatt hour associated with complying with the greenhouse targets are shown in Figure 11. For the NSW-only scenarios, the effects of achieving greenhouse targets is estimated to be below $1 per megawatt hour for the entire forecast period. For the NEM benchmark scenario, the increase in costs is estimated at under $2.30 per megawatt hour for the entire forecast period.

A.5.2. Effects on pool prices

The measures taken to comply with greenhouse targets can have an effect on pool prices. In general, if greenhouse targets have any effect on pool prices, this is likely to be negative, as discussed below, as compared to an increase, which is commonly assumed.

As discussed in Section A.3.2, compliance tends to (prematurely – in respect of the minimum quantity needed to maintain the reliability of supply) add capacity to the interconnected system. All other things being equal, extra capacity would be assumed to have a negative effect on pool prices.

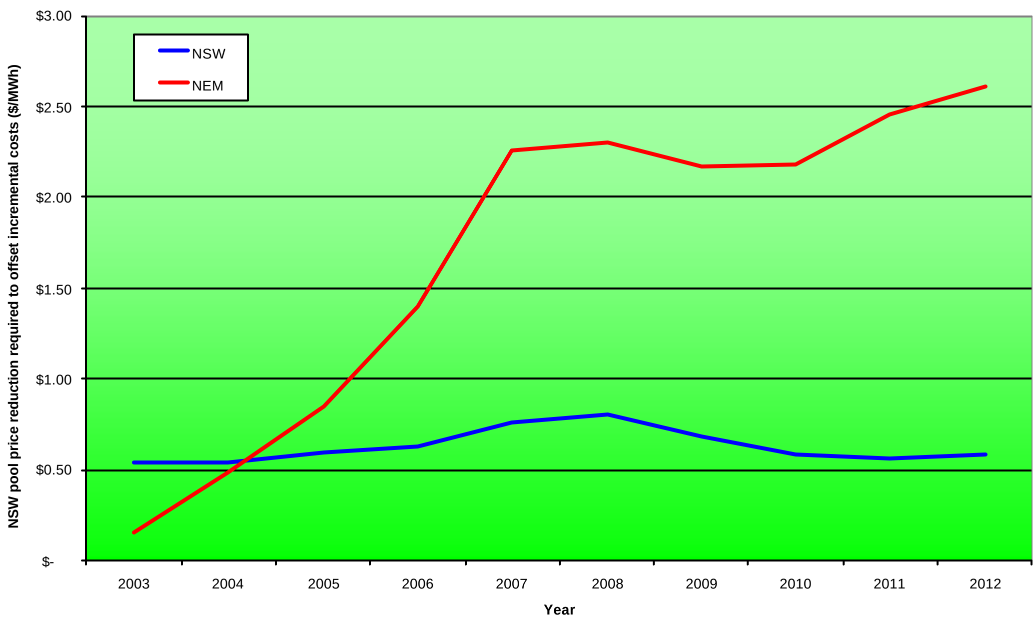
The nature of contracts with greenhouse friendly generators is also important. Say a gas generator has agreed to assign its output to a retailer. It is only likely to get paid under this contract if it actually runs in accordance with the credits purchased. In order to make sure this greenhouse friendly capacity is dispatched, the ga s generator is likely to put in lower bids than it would have otherwise have done – knowing that the difference between its true marginal cost and its bid price will be made up via the greenhouse contract. Combined with the effect of introducing additional capacity to the system, this bidding behaviour would reinforce the dampening effect on pool prices.

The type of investment options chosen to meet the greenhouse targets is also important. DSM options reduce demand, which would have a negative effect on pool prices, all other things being equal, particularly when this is targeted at reducing short-term price spikes. Embedded generation options, by reducing the demand for electricity purchased through the pool, would have a similar effect.

On the other hand, incumbent (fossil fuel) generators are likely to resist a reduction in pool prices. To the extent that any existing generators have market power, they may be able to constrain their own output, and thereby keep pool prices from falling significantly, if it is profitable to do so.

The size of pool price reductions that would be required to offset the costs of compliance have been estimated. These are presented in Figure 19 below. These required reductions in the average pool price reflect the average cost per megawatt hour to comply with the greenhouse targets. However, they are slightly higher, reflecting the fact that not all energy sold is purchased from the pool (i.e. they are averaged over a smaller number).

Figure 19: Pool price reductions required to offset greenhouse compliance costs



A.5.3. Effects on different user groups

The effects on different user groups depends on the degree to which retailers can effectively price discriminate. This, in turn, depends on the competitiveness of each level of the electricity retailing market.

Household demand for electricity is generally considered less price sensitive than some classes of industrial demand. At the extreme a monopoly retailer could pass on all of the costs of greenhouse compliance onto households, without significantly affecting current patterns of consumption. The retailer is then able to avoid increasing prices to price-sensitive industrial customers, thereby avoiding the possibility of affecting their power demand, production and employment. The monopoly retailer can recover all of its costs, and also maximise sales.

Such price discrimination generally does not withstand the rigours of competition. Say a retailer served two market segments: industrial customers and retail customers. Before competition was allowed, it passed its total compliance costs for both sides of its business onto households. Then assume that competitive entry is permitted to sell electricity to households. Assuming there are no other barriers to entry, a new retailer could enter the market and sell electricity only to households. It would only have to pass on to households the compliance costs associated with sales to households. It has no need to include in household prices the compliance costs associated with selling electricity to industrial customers. Therefore, it could offer households lower prices than the incumbent, and therefore win market share.

If all households are won by the new entrant retailer, the incumbent is left with only one class of customers – industrial customers. It cannot pass on the costs of compliance associated with these sales to anyone else – they must be borne by the industrial customers. Since these customers are assumed to be price sensitive, this will be associated with some reduction in their demand.

In summary, the more competitive the retailing market becomes, particularly at the small customer end of the market, the less likely cross subsidisation is to occur. This means that the costs of compliance are likely to be spread evenly over customer groups, based on each customer's energy usage.

The NSW Government, together with other jurisdictions, is endeavouring to ensure that the retail market for small customers is highly competitive. This involves minimising barriers to entry, and ensuring that small customers face no unreasonable barriers to switching retailers. If these efforts prove successful, the most likely outcome is that the costs of compliance will be spread evenly across customer classes.

APPENDIX B: MODELLING ASSUMPTIONS

o Regional reserve levels

Table 8: Assumed regional reserve levels

Region	Reserve (MW)
NSW	660
QLD	350
SA	260
VIC	500

Source: NEMMCO 2001 Statement of Opportunities.

o Interconnection

The following assumptions relating to existing and new interconnection were assumed.

Table 9: Existing interconnection

Interconnect	From	To	Export MW	Import MW
V_SA	VIC	SA	500 / 750[1]	250 / 500[1]
V_SN	VIC	SNOWY	1050 / 1200[1]	1500 / 1750[1]
SN_N	SNOWY	NSW	2500	1000
QNI	NSW	QLD	520	570
Directlink	NSW	QLD	180	180

1. Pre / post SNI capacity (SNI assumed commissioned in 2004)

Note: Dynamic losses according to the Loss Factor equations published by NEMMCO were assumed on each interconnect in the stage 1 modelling.

o Existing and committed generation plant

Existing and committed generation plant assumptions are given in Table 10 below. Note that the marginal costs of production of these plant have not been included due to the confidential nature of this data.

Table 10: Existing and committed generation plant

Region[23]	Station	Cap [24]	Year In	Year Out	Fuel Type	tCO_2-e/MWh	Max CF[25]
VIC	Anglesea	160			VIC old coal	1.20	81%
VIC	Bairnsdale	37			Gas	0.40	93%
QLD	Barcaldine GT	56			GT	0.60	94%
QLD	Barron Gorge	60			Hydro	0.00	50%
NSW	Bayswater	2640			NSW coal	0.86	91%
NSW	Blowering	80			Hydro	0.00	25%
QLD	Callide A	120			QLD&SA coal	0.90	91%
QLD	Callide B	700			QLD&SA coal	0.91	91%
QLD	Callide Power Plant	840			New coal	0.85	94%
QLD	Collinsville	186			QLD&SA coal	0.90	91%
SA	Dry Creek GT	145.5			GT	0.52	94%
VIC	Energy Brix Complex	170			VIC old coal	1.20	81%
NSW	Eraring	2640			NSW coal	0.88	80%
QLD	Gladstone	1680			QLD&SA coal	0.91	91%
VIC	Hazelwood	1620			VIC old coal	1.23	81%
NSW	Hume (NSW)	25			Hydro	0.00	50%
VIC	Hume (Vic)	25			Hydro	0.00	50%
NSW	Hunter Valley GT	47.5			GT	0.89	94%
VIC	Jeeralang A	215			Gas	0.72	93%
VIC	Jeeralang B	235			Gas	0.72	93%
QLD	Kareeya	72			Hydro	0.00	35%
SA	Ladbroke Grove	79			GT	0.77	94%
NSW	Liddell	2000			NSW coal	1.03	91%
VIC	Loy Yang A	2000			VIC coal	1.12	89%

[23] NEM region.

[24] Generator terminal capacity.

[25] Maximum annual capacity factor for the plant (includes planned and forced outages, and available energy for hydro plant).

Region[23]	**Station**	**Cap** [24]	**Year In**	**Year Out**	**Fuel Type**	**tCO_2-e/MWh**	**Max CF**[25]
VIC	Loy Yang B	1000			VIC coal	1.10	89%
QLD	Mackay GT	32			GT	1.15	94%
QLD	Middle Ridge GT	48			GT	1.35	94%
QLD	Millmerran	858	2003		New coal	0.85	94%
NSW	Minor NSW Hydro	12.5			Hydro	0.00	100%
SA	Mintaro GT	83			GT	0.52	94%
NSW	Mt Piper	1320			NSW coal	0.91	91%
QLD	Mt Stuart GT	296			GT	0.75	94%
NSW	Munmorah	600			NSW coal	1.02	91%
SA	New SA Gas	150	2002		Gas	0.70	93%
VIC	New VIC Gas	400	2002		Gas	0.70	93%
VIC	Newport	505			Gas	0.52	93%
SA	Northern	520			QLD&SA coal	0.96	91%
NSW	Northern GT	47			GT	1.05	94%
QLD	Oakey GT	332			GT	0.75	94%
SA	Osborne	182.5			Gas	0.26	93%
SA	Pelican Point	468.5			Gas	0.40	93%
SA	Port Lincoln	45			GT	0.77	94%
NSW	Redbank	130			NSW coal	0.50	85%
QLD	Roma GT	67			GT	0.60	94%
NSW	Shoalhaven	240			Hydro	0.00	6%
SNOWY	SMHEA	3676			Hydro	0.00	15%
NSW	Smithfield	172.5			Gas	0.50	93%
SA	Snuggery	54			GT	0.57	94%
VIC	Southern Hydro	451			Hydro	0.00	26%
QLD	Stanwell	1400			QLD&SA coal	0.90	91%
QLD	Swanbank A	408			QLD&SA coal	0.96	91%
QLD	Swanbank B	500			QLD&SA coal	0.96	91%
QLD	Swanbank C GT	26.5			GT	1.93	94%
QLD	Swanbank D GT	34.5			GT	0.75	94%
QLD	Swanbank E	370	2003		Gas	0.40	93%
QLD	Tarong	1400			QLD&SA coal	0.82	91%

Region[23]	Station	Cap [24]	Year In	Year Out	Fuel Type	tCO_2-e/MWh	Max CF[25]
QLD	Tarong North	450	2004		New coal	0.82	94%
SA	Thomas Playford	195		2005	QLD&SA coal	0.96	91%
SA	Torrens Island B	800			Gas	0.53	93%
SA	Torrens Island A	480			Gas	0.53	93%
QLD	Townsville GT	169.5			GT	0.75	94%
NSW	Vales Pt B	1210			NSW coal	0.88	91%
NSW	Wallerawang C	1000			NSW coal	0.94	91%
QLD	Wivenhoe	500			Hydro	0.00	10%
VIC	Yallourn W	1450			VIC coal	1.20	89%

Sources: NEMMCO Statement of Opportunities 2001; NEMMCO Addendum to Statement of Opportunities 2001; Frontier Economics

o Investment options

Table 11: New generation plant options

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
NSW	Mine waste gas - dedicated engine	50	1	2004	-3.50	$230.00	$15.00	80%	Coal gas
QLD	Mine waste gas - dedicated engine	20	1	2004	-3.50	$230.00	$15.00	80%	Coal gas
SA	Mine waste gas - dedicated engine	5	1	2004	-3.50	$230.00	$15.00	80%	Coal gas
VIC	Mine waste gas - dedicated engine	25	1	2004	-3.50	$230.00	$15.00	80%	Coal gas
NSW	Mine waste gas - vent air	100	1	2004	-3.50	$300.00	$15.00	80%	Coal gas

26 The minimum incremental block size (MW) for "lumpy" plant.

27 Fixed cost of plant, in dollars per kW per annum amortised over the expected life of the plant using a discount rate of 7%/annum.

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
QLD	Mine waste gas - vent air	40	1	2004	-3.50	$300.00	$15.00	80%	Coal gas
SA	Mine waste gas - vent air	10	1	2004	-3.50	$300.00	$15.00	80%	Coal gas
VIC	Mine waste gas - vent air	50	1	2004	-3.50	$300.00	$15.00	80%	Coal gas
NSW	Com-Ind - Energy Efficiency	100	1	2003-2006	0.00	$80.00	$0.00	100%	DSM
QLD	Com-Ind - Energy Efficiency	40	1	2003-2006	0.00	$80.00	$0.00	100%	DSM
SA	Com-Ind - Energy Efficiency	10	1	2003-2006	0.00	$80.00	$0.00	100%	DSM
VIC	Com-Ind - Energy Efficiency	50	1	2003-2006	0.00	$80.00	$0.00	100%	DSM
NSW	Comm – Natural Gas cooling	200	1	2003	0.20	$250.00	$10.00	47%	DSM
QLD	Comm – Natural Gas cooling	80	1	2003	0.20	$250.00	$10.00	47%	DSM
SA	Comm – Natural Gas cooling	20	1	2003	0.20	$250.00	$10.00	47%	DSM
VIC	Comm – Natural Gas cooling	100	1	2003	0.20	$250.00	$10.00	47%	DSM
NSW	Comm – Standby	100	1	2003	0.60	$0.00	$500.00	5%	DSM
QLD	Comm – Standby	40	1	2003	0.60	$0.00	$500.00	5%	DSM
SA	Comm - Standby	10	1	2003	0.60	$0.00	$500.00	5%	DSM
VIC	Comm - Standby	50	1	2003	0.60	$0.00	$500.00	5%	DSM
NSW	Ind - Sm Cogen	400	1	2003	0.30	$190.00	$0.00	95%	DSM
QLD	Ind - Sm Cogen	160	1	2003	0.30	$190.00	$0.00	95%	DSM
SA	Ind - Sm Cogen	40	1	2003	0.30	$190.00	$0.00	95%	DSM

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
VIC	Ind - Sm Cogen	200	1	2003	0.30	$190.00	$0.00	95%	DSM
NSW	Res - Demand displacement	300	1	2003-2006	0.30	$70.00	$0.00	100%	DSM
QLD	Res - Demand displacement	120	1	2003-2006	0.30	$70.00	$0.00	100%	DSM
SA	Res - Demand displacement	30	1	2003-2006	0.30	$70.00	$0.00	100%	DSM
VIC	Res - Demand displacement	150	1	2003-2006	0.30	$70.00	$0.00	100%	DSM
NSW	Res - Energy Efficiency	150	1	2003	0.00	$170.00	$0.00	100%	DSM
QLD	Res - Energy Efficiency	60	1	2003	0.00	$170.00	$0.00	100%	DSM
SA	Res - Energy Efficiency	15	1	2003	0.00	$170.00	$0.00	100%	DSM
VIC	Res - Energy Efficiency	75	1	2003	0.00	$170.00	$0.00	100%	DSM
NSW	Improved PS Efficiency	250	25	2003-2006	0.00	$60.00	$0.00	93%	Efficiency
QLD	Improved PS Efficiency	100	25	2003-2006	0.00	$60.00	$0.00	93%	Efficiency
SA	Improved PS Efficiency	25	25	2003-2006	0.00	$60.00	$0.00	93%	Efficiency
VIC	Improved PS Efficiency	125	25	2003-2006	0.00	$60.00	$0.00	93%	Efficiency
NSW	Alise (Botany) Cogen	350	115	2004	0.40	$70.00	$40.00	90%	Gas Cogen
NSW	Illawarra Cogen	350	350	2004	0.40	$90.00	$45.00	90%	Gas Cogen
NSW	Pt Kembla Cogen	225	225	2003	0.40	$160.00	$30.00	68%	Gas Cogen
NSW	Sithe (Kurnell) Cogen	430	430	2003	0.40	$90.00	$40.00	90%	Gas Cogen
NSW	Tomago CCGT	500	500	2003	0.40	$160.00	$40.00	90%	Gas Cogen

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
NSW	Wagga Cogen	100	100	2004	0.40	$90.00	$50.00	90%	Gas Cogen
NSW	New coal	2000	400	2006	0.85	$190.00	$14.50	85%	New black coal
QLD	New coal	2000	400	2006	0.85	$190.00	$13.00	85%	New black coal
NSW	Mine waste gas in PS	40	1	2004	-3.50	$190.00	$25.00	93%	New gas
QLD	Mine waste gas in PS	16	1	2004	-3.50	$190.00	$25.00	93%	New gas
SA	Mine waste gas in PS	4	1	2004	-3.50	$190.00	$25.00	93%	New gas
VIC	Mine waste gas in PS	20	1	2004	-3.50	$190.00	$25.00	93%	New gas
NSW	New CCGT	1800	180	2003	0.40	$170.00	$25.00	93%	New gas
QLD	New CCGT	1800	180	2003	0.40	$170.00	$25.00	93%	New gas
SA	New CCGT	1800	180	2003	0.40	$170.00	$22.00	93%	New gas
VIC	New CCGT	1800	180	2003	0.40	$170.00	$22.00	93%	New gas
NSW	New OCGT	2000	50	2003	0.70	$80.00	$45.00	93%	New gas
QLD	New OCGT	2000	50	2003	0.70	$80.00	$45.00	93%	New gas
SA	New OCGT	2000	50	2003	0.70	$80.00	$40.00	93%	New gas
VIC	New OCGT	2000	50	2003	0.70	$80.00	$40.00	93%	New gas
NSW	Bagasse Cogen	100	1	2003	0.00	$170.00	$15.00	50%	Renewable
QLD	Bagasse Cogen	40	1	2003	0.00	$170.00	$15.00	50%	Renewable
SA	Bagasse Cogen	10	1	2003	0.00	$170.00	$15.00	50%	Renewable
VIC	Bagasse Cogen	50	1	2003	0.00	$170.00	$15.00	50%	Renewable
NSW	Crop waste	150	1	2003	0.00	$270.00	$8.00	20%	Renewable

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
QLD	Crop waste	60	1	2003	0.00	$270.00	$8.00	20%	Renewable
SA	Crop waste	15	1	2003	0.00	$270.00	$8.00	20%	Renewable
VIC	Crop waste	75	1	2003	0.00	$270.00	$8.00	20%	Renewable
NSW	Energy crops	0	1	2003	0.00	$280.00	$15.00	85%	Renewable
QLD	Energy crops	0	1	2003	0.00	$280.00	$15.00	85%	Renewable
SA	Energy crops	0	1	2003	0.00	$280.00	$15.00	85%	Renewable
VIC	Energy crops	0	1	2003	0.00	$280.00	$15.00	85%	Renewable
NSW	Food & Ag Wet Waste	20	1	2003	-3.50	$850.00	$8.00	95%	Renewable
QLD	Food & Ag Wet Waste	8	1	2003	-3.50	$850.00	$8.00	95%	Renewable
SA	Food & Ag Wet Waste	2	1	2003	-3.50	$850.00	$8.00	95%	Renewable
VIC	Food & Ag Wet Waste	10	1	2003	-3.50	$850.00	$8.00	95%	Renewable
NSW	Geothermal – Aquifer	2.5	1	2004	0.00	$380.00	$1.00	30%	Renewable
QLD	Geothermal – Aquifer	1	1	2004	0.00	$380.00	$1.00	30%	Renewable
SA	Geothermal – Aquifer	0.25	1	2004	0.00	$380.00	$1.00	30%	Renewable
VIC	Geothermal – Aquifer	1.25	1	2004	0.00	$380.00	$1.00	30%	Renewable
NSW	Geothermal - Hot Dry Rock	20	1	2006	0.00	$160.00	$1.00	67%	Renewable
QLD	Geothermal - Hot Dry Rock	8	1	2006	0.00	$160.00	$1.00	67%	Renewable
SA	Geothermal - Hot Dry Rock	2	1	2006	0.00	$160.00	$1.00	67%	Renewable
VIC	Geothermal - Hot Dry Rock	10	1	2006	0.00	$160.00	$1.00	67%	Renewable
NSW	Hydro (large)	20	1	2003	0.00	$360.00	$2.00	35%	Renewable

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
QLD	Hydro (large)	5	1	2003	0.00	$360.00	$2.00	35%	Renewable
SA	Hydro (large)	0	1	2003	0.00	$360.00	$2.00	35%	Renewable
VIC	Hydro (large)	5	1	2003	0.00	$360.00	$2.00	35%	Renewable
NSW	Hydro (small)	60	1	2003	0.00	$150.00	$2.00	70%	Renewable
QLD	Hydro (small)	30	1	2003	0.00	$150.00	$2.00	70%	Renewable
SA	Hydro (small)	6	1	2003	0.00	$150.00	$2.00	70%	Renewable
VIC	Hydro (small)	24	1	2003	0.00	$150.00	$2.00	70%	Renewable
NSW	Landfill gas	10	1	2003	-3.50	$230.00	$1.00	90%	Renewable
QLD	Landfill gas	8	1	2003	-3.50	$230.00	$1.00	90%	Renewable
SA	Landfill gas	2	1	2003	-3.50	$230.00	$1.00	90%	Renewable
VIC	Landfill gas	10	1	2003	-3.50	$230.00	$1.00	90%	Renewable
NSW	Micro Hydro RAPS	0.5	1	2003	0.00	$340.00	$1.00	70%	Renewable
QLD	Micro Hydro RAPS	0.2	1	2003	0.00	$340.00	$1.00	70%	Renewable
SA	Micro Hydro RAPS	0.1	1	2003	0.00	$340.00	$1.00	70%	Renewable
VIC	Micro Hydro RAPS	0.25	1	2003	0.00	$340.00	$1.00	70%	Renewable
NSW	Municipal Solid Waste Combustion	60	1	2003	-2.00	$590.00	$1.00	85%	Renewable
QLD	Municipal Solid Waste Combustion	24	1	2003	-2.00	$590.00	$1.00	85%	Renewable
SA	Municipal Solid Waste Combustion	6	1	2003	-2.00	$590.00	$1.00	85%	Renewable
VIC	Municipal Solid Waste Combustion	30	1	2003	-2.00	$590.00	$1.00	85%	Renewable
NSW	PV & PV-hybrid RAPS	15	1	2003	0.00	$880.00	$1.00	20%	Renewable

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
QLD	PV & PV-hybrid RAPS	6	1	2003	0.00	$880.00	$1.00	20%	Renewable
SA	PV & PV-hybrid RAPS	1.5	1	2003	0.00	$880.00	$1.00	20%	Renewable
VIC	PV & PV-hybrid RAPS	7.5	1	2003	0.00	$880.00	$1.00	20%	Renewable
NSW	Sewage gas (Municipal water water)	10	1	2003	-3.50	$230.00	$1.00	85%	Renewable
QLD	Sewage gas (Municipal water water)	4	1	2003	-3.50	$230.00	$1.00	85%	Renewable
SA	Sewage gas (Municipal water water)	1	1	2003	-3.50	$230.00	$1.00	85%	Renewable
VIC	Sewage gas (Municipal water water)	5	1	2003	-3.50	$230.00	$1.00	85%	Renewable
NSW	Solar Hot Water	200	1	2003	0.00	$130.00	$1.00	15%	Renewable
QLD	Solar Hot Water	80	1	2003	0.00	$130.00	$1.00	15%	Renewable
SA	Solar Hot Water	20	1	2003	0.00	$130.00	$1.00	15%	Renewable
VIC	Solar Hot Water	100	1	2003	0.00	$130.00	$1.00	15%	Renewable
NSW	Solar PV (Grid connected)	390	1	2003	0.00	$730.00	$1.00	18%	Renewable
QLD	Solar PV (Grid connected)	234	1	2003	0.00	$730.00	$1.00	18%	Renewable
SA	Solar PV (Grid connected)	39	1	2003	0.00	$730.00	$1.00	18%	Renewable
VIC	Solar PV (Grid connected)	117	1	2003	0.00	$730.00	$1.00	18%	Renewable
NSW	Solar Thermal	10	1	2003	0.00	$260.00	$1.00	25%	Renewable
QLD	Solar Thermal	12	1	2003	0.00	$260.00	$1.00	25%	Renewable

Region	Plant	Cap	Block size[26]	Year available	TCO_2-e/MWh	$/kW/yr[27]	$/MWh	Max CF	Fuel Type
SA	Solar Thermal	3	1	2003	0.00	$260.00	$1.00	25%	Renewable
VIC	Solar Thermal	15	1	2003	0.00	$260.00	$1.00	25%	Renewable
NSW	Tidal	2	1	2006	0.00	$370.00	$1.00	50%	Renewable
QLD	Tidal	18.4	1	2006	0.00	$370.00	$1.00	50%	Renewable
SA	Tidal	4.6	1	2006	0.00	$370.00	$1.00	50%	Renewable
VIC	Tidal	23	1	2006	0.00	$370.00	$1.00	50%	Renewable
NSW	Wind	1000	1	2003	0.00	$160.00	$1.00	28%	Renewable
QLD	Wind	500	1	2003	0.00	$160.00	$1.00	28%	Renewable
SA	Wind	100	1	2003	0.00	$160.00	$1.00	28%	Renewable
VIC	Wind	400	1	2003	0.00	$160.00	$1.00	28%	Renewable
NSW	Wind & wind-hybrid RAPS	1	1	2003	0.00	$680.00	$1.00	25%	Renewable
QLD	Wind & wind-hybrid RAPS	0.4	1	2003	0.00	$680.00	$1.00	25%	Renewable
SA	Wind & wind-hybrid RAPS	0.1	1	2003	0.00	$680.00	$1.00	25%	Renewable
VIC	Wind & wind-hybrid RAPS	0.5	1	2003	0.00	$680.00	$1.00	25%	Renewable
NSW	Wood waste	170	1	2003	0.00	$280.00	$8.00	85%	Renewable
QLD	Wood waste	68	1	2003	0.00	$280.00	$8.00	85%	Renewable
SA	Wood waste	17	1	2003	0.00	$280.00	$8.00	85%	Renewable
VIC	Wood waste	85	1	2003	0.00	$280.00	$8.00	85%	Renewable

Sources: AGO *2% Renewables Target in Power Supplies: Potential for Australian Capacity to Expand to Meet the Target (Redding Energy Management)*; SEDA.

o Sequestration options

Advice from NSW State Forests suggested that NSW has the potential for about 600,000 tCO_2-e abatement per annum (over the modelling period) from sequestration at a cost of \$10/tCO_2-e abated. Similarly, NSW State Forests conservatively estimate that 5 Mt CO_2-e abatement is available NEM wide per annum at the same cost of \$10/tCO_2-e abated.

o Demand forecasts

The model has been run over 100 different demand points in each year. These points have been chosen and weighted (hours per year) to form a statistically representative set of demand levels for each year that match the demand forecasts as set out below.

Sent out energy is converted to generator terminal energy by assuming auxiliary power station loads of 4.5% as advised by TransGrid. This gives the following relationship:

Energy at generator terminal = Energy sent out / 0.955

Energy at the generator terminal, combined with the peak demand forecast (also at the generator terminal) is used to shape an historic demand profile into a forecast demand series for future years.

It is assumed that intra-regional transmission losses are accounted for in the energy and peak demand forecasts provided by TransGrid. Inter-regional losses are modelled explicitly in this analysis using dynamic piecewise-linear loss equations for each interconnect.

Table 12: NEM sent out energy forecasts (GWh)

Year ending	NSW	QLD	SA	VIC
30/06/02	66,175	41,236	12,600	43,715
30/06/03	68,611	42,555	12,959	44,536
30/06/04	71,216	44,099	13,365	45,525
30/06/05	72,803	45,741	13,710	46,564
30/06/06	74,233	47,208	14,019	47,464
30/06/07	75,361	48,798	14,314	48,312
30/06/08	76,516	50,401	14,518	49,033
30/06/09	77,629	51,419	14,707	49,645
30/06/10	78,828	53,016	14,959	50,327
30/06/11	80,079	54,882	15,387	51,028
30/06/12	81,330	56,748	15,815	51,729

Source: TransGrid 2001, medium economic growth

Table 13: 50% POE Peak demand forecasts (MW at generator terminal)

Year ending	NSW	QLD	SA	VIC
30/06/02	12,215	6,944	2,786	8,261
30/06/03	12,548	7,165	2,874	8,482
30/06/04	12,783	7,439	2,970	8,737
30/06/05	12,991	7,729	3,064	9,014
30/06/06	13,141	7,983	3,153	9,263
30/06/07	13,283	8,259	3,237	9,500
30/06/08	13,429	8,542	3,314	9,723
30/06/09	13,651	8,724	3,389	9,953
30/06/10	13,914	9,010	3,482	10,201
30/06/11	14,188	9,329	3,585	10,437
30/06/12	14,462	9,648	3,688	10,673

Source: TransGrid 2001, medium economic growth 50% probability of exceedence

Table 14: 10% POE Peak demand forecasts (MW at generator terminal)

Year ending	NSW	QLD	SA	VIC
30/06/02	12,581	7,135	2,984	8,809
30/06/03	12,988	7,362	3,079	9,052
30/06/04	13,312	7,644	3,183	9,331
30/06/05	13,613	7,944	3,285	9,634
30/06/06	13,858	8,207	3,382	9,905
30/06/07	14,099	8,492	3,473	10,164
30/06/08	14,346	8,785	3,557	10,409
30/06/09	14,650	8,974	3,641	10,666
30/06/10	14,942	9,271	3,742	10,943
30/06/11	15,245	9,601	3,853	11,201
30/06/12	15,548	9,931	3,964	11,459

Source: TransGrid 2001, medium economic growth 10% probability of exceedence

Note: The 10% POE forecasts are only used within the model for the regional reserve requirement constraint.

o Commonwealth MRET program

The national renewable targets have been converted to a NEM share using the historical ratio of NEM electricity production to national electricity production in 1999. The ratio used is about 87% and we assume that this ratio remains constant over the ten year modelling period.

Table 15: Federal 2% renewable targets (GWh)

Year ending	National	NEM share
30/06/02	1,100	960
30/06/03	1,800	1,571
30/06/04	2,600	2,269
30/06/05	3,400	2,967
30/06/06	4,500	3,927
30/06/07	5,600	4,887
30/06/08	6,800	5,934
30/06/09	8,100	7,069
30/06/10	9,500	8,291
30/06/11	9,747	8,506
30/06/12	10,024	8,721

Sources: AGO for targets; ESAA for 1999 national and NEM electricity production

o Population projections

The population projections were used to convert the per capita greenhouse emission targets to tCO2-e emission targets.

Table 16: NSW population projections

Year ending	NSW Population (millions)	NEM Population (millions)
30/06/02	6.64	17.04
30/06/03	6.70	17.24
30/06/04	6.77	17.42
30/06/05	6.84	17.61
30/06/06	6.91	17.80
30/06/07	6.97	17.98
30/06/08	7.04	18.16
30/06/09	7.10	18.35
30/06/10	7.17	18.53
30/06/11	7.23	18.71

Sources: ABS