Final Report to

South Australian Department of Premier and Cabinet

Projected Carbon Intensity for South Australian Renewable Energy Target in 2020

February 2010

McLennan Magasanik Associates

Ref: J1869 Final Report

Project Team

Ross Gawler

Leah Tang

Melbourne Office
PO Box 825
South Melbourne Vic 3205

242 Ferrars Street
South Melbourne Vic 3205

Tel: +61 3 9699 3977
Fax: +61 3 9690 9881

Brisbane Office
GPO Box 2421
Brisbane Qld 4001

Level 2, 200 Mary Street
Brisbane Qld 4000

Tel: +61 7 3100 8064
Fax: +61 7 3100 8067

Canberra Office
GPO Box 443
Canberra City ACT 2601

Email: mma@mmassociates.com.au
Website: www.mmassociates.com.au

ACN: 004 765 235
ABN: 33 579 847 254

TABLE OF CONTENTS

LIST OF TABLES

1 INTRODUCTION

This report is prepared for the South Australian Department of Premier and Cabinet (SA DP&C) to determine the projected carbon intensity drawing upon renewable energy projections in South Australia in calendar year 2020. This report evaluates the credibility and achievability for South Australia to have 33% of its energy generation coming from renewable sources by 2020. For detailed analysis and modelling assumptions, please refer to report: J1822 Final 2009 Report v1.0.

Energy generation and carbon emission figures are developed for a medium economic growth scenario, with a 50% probability of exceedance (POE) as presented in the 2009 AEMO Electricity Statement of Opportunities (ESOO). Three scenarios of carbon price were examined based on the -5%, -15% and -25% target reductions by 2020.

The discussion focuses on the assumptions leading to market outcomes in South Australia including:

- The 33% renewable energy target is met
- The carbon intensity of non-renewable improves at the same rate as applies to the rest of Australia. In the reference modelling, it was assumed that the carbon intensity of existing thermal generation does not change over time. Improvements occur due to a change in the supply mix.

The energy generation and emission projections are developed for calendar year 2020. The underlying modelling has been conducted to 2040 in developing the expansion plan. The calendar year estimates were based on an average of the financial years 2019/20 and 2020/21 for which data were available.

2 BACKGROUND

The emission and generation data are evaluated for calendar year 2020 using MMA's National Electricity Market model based on the probabilistic model Strategist and insights gained from running the more sophisticated mathematical model, PLEXOS for Power Systems (PLEXOS), developed by Energy Exemplar.

The studies are based upon carbon prices according to the 5%, 15% and 25% reduction of carbon emissions by 2020, based on medium economic growth.

3 RESULTS

In this section, we provide:

- The level of renewable energy generation and the average emission intensity for South Australian generation under the CPRS -5, CPRS -15 and CPRS -25 policy scenarios.
- The emission intensity for South Australian generation when the level of renewable energy generation is fixed at 33.3%.

South Australian thermal and renewable energy generation have been extrapolated from previous strategist modelling work (please refer to report: J1822 Final 2009 Report v1.0) for -5%, -15% and -25% carbon scenarios. Carbon emission data is also extracted to calculate South Australia's emission intensity for each scenario.

Table 3-1 details total energy generation, renewable energy generation, the proportion of renewable generation, emission data and emission intensity in South Australia for calendar year 2020 based on the latest market simulations. Total generation includes energy generated from both thermal and renewable sources. The emission intensity is calculated by dividing the total carbon emission in tonnes by the total energy generation in GWh sent out. Under a CPRS, South Australia is primarily exporting into Victoria and New South Wales in 2020. Thus imported power becomes irrelevant for the purpose of this calculation.

Given the generation profile listed in Table 3-1, the proportion of renewable energy generation falls between 47% and 50% of South Australia's total energy generation. This is well in excess of South Australia's renewable energy target of 33.3% in 2020, and indicates that the 33.3% renewable energy target is credible and potentially achievable.

Table 3-1 Total generation, renewable generation and emission intensity for SA in 2020

Parameter	CPRS5	CPRS15	CPRS25
Total generation (GWh)	16,752	17,774	16,883
Renewable generation (GWh)	8,351	8,376	8,493
Proportion of renewable generation	49.85%	47.13%	50.31%
Total emission (tonnes)	6,797,560	7,454,698	6,285,232
Emission intensity (t CO_2e/MWh so)	0.41	0.42	0.37

Achievement of the levels of renewable generation in Table 3-1 would require the successful development of geothermal energy or an upgrade of the transmission network to support more wind generation. To represent the emission intensity for a renewable

energy target of 33.3% in 2020, the renewable energy generation was scaled back while keeping thermal generation constant. Table 3-2 outlines the impact on average emission intensity from the reduced level of renewable energy generation.

Table 3-2 Total generation, renewable generation and emission intensity for SA in 2020 when renewable energy level is at the 33.3 % target range

	CPRS5	CPRS15	CPRS25
Total generation (GWh)	12,830	14,374	12,633
Renewable generation (GWh)	4,429	4,976	4,243
Proportion of renewable generation	34.52%	34.62%	33.59%
Total emission (tonnes)	6,797,560	7,454,698	6,285,232
Emission intensity (t CO_2e/MWhso)	0.53	0.52	0.50

Since the demand forecast for SA for 2020 is estimated to be around 17,000GWh[1], the shortfall between local generation (listed in Table 3-2) and the forecast demand as a result of the reduced level of renewable generation would be made up from thermal energy generated both locally and interstate. As it is assumed no new coal fired generation is built under CPRS, South Australia's additional local thermal generation would mainly come from a mixture of open and combined cycle gas fired generation, at a weighted average emission intensity of about 0.50 t CO_2e/MWhso. The emission intensity of energy coming from imported electricity can be assumed to be between 0.45 t CO_2e /MWhso and 0.65 t CO_2e /MWhso, allowing for transmission losses to South Australia. NEM-wide average emission intensity cannot be used as a bench mark for the marginal emission intensity of imports because no new coal fired generation would be likely to be built under CPRS in the period to 2020.

In scaling up the thermal generation with renewable generation at 33%, the average emission intensity is around 0.52 t CO_2e/MWhso, which is higher than the emission intensity with the level of renewable generation recorded under the market simulations. The higher emission intensity reflects the near halving of the level of renewable energy generation in order to represent a renewable energy target of around 33.3%. The higher emission intensity arises from the need to replace the renewable energy generation with gas-fired electricity generation or from imported electricity from thermal generation in other States.

1 This is an estimate of the energy demand on a sent out basis for South Australia. It should not be confused with energy generated in South Australia, estimates for which are provided in Tables 3-1 and 3-2. Energy generated may be more or less than energy demand depending on the level of imports and exports of electricity from South Australia.

The emission intensity for Australia as a whole is illustrated in Table 3-3. It is calculated by dividing the total emission by all states in tonnes by the total energy generation. The analysis indicates that under the CPRS, the level of emission intensity is likely to be higher in other states than in South Australia. The lower emission intensity in South Australia reflects the higher proportion of renewable generation and the predominance of gas-fired generation especially under a CPRS when dispatch of coal plant (Northern and Playford) are curtailed.

Table 3-3 Emission intensity of Australia's electricity generation, t/MWh, 2020

	CPRS5	CPRS15	CPRS25
Australia emission intensity (t/MWh)	0.79	0.78	0.75

Source: market simulations performed by MMA.

Achieving the renewable energy target of 40% greatly depends on the timely commercialization of geothermal technology and the associated transmission infrastructure developments. In particular additional interregional transmission capacity is needed to deal with the additional renewable energy generation. Table 3-4 represents a 40% renewable target with demand ranging from 17,000 GWh to 24,500 GWh. Under these demand forecasts, a 40% target would require around 7,400 GWh to 9,800 GWh of renewable energy. Achievement of this level of generation would require the expansion of the interregional transmission capacity by at least 250 MW to 500 MW

Table 3-4 Analysis of export requirement to achieve a 40% renewable energy target

			2020 (Med)	2020 (High)
Load in South Australia				
	Energy	GWhso	17,000	24,500
	Min Load	MWso	1,086	2,164
	Max Load	MWso	3,529	4,741
Wind generation				
	Energy	GWhso	3,050	4,850
	Capacity(38% CF)	MWso	916	1457
Geothermal generation				
	Energy	GWhso	4,000	4,600
	Max (85% CF)	MWso	537	618
Other renewable				
	Energy	GWhso	350	350
	MAX (70% CF)	MWso	42	42
Total renewable				
	Energy	GWhso	7,400	9,800
	Proportion of demand	%	40.0%	40.0%
Export capacity				
	Required	MWso	896	639
	Available	MWso	400	400
Extra export capacity needed		MWso	496	239

Source: MMA analysis. Note assumptions on capacity factors for wind farms are based on historical levels of wind generation at operating wind farms. Some developers have recently claimed higher capacity factors for wind farms currently being developed.

A target of 40% could also be achieved with the successful deployment of geothermal energy expansion. Market simulations indicate that geothermal energy could contribute around 4,000 GWh of renewable energy generation in South Australia or around half of the required amount of renewable energy for a 40% target. Assuming renewable generation reaches 40%, the emission intensity of generation drops to 0.45 to 0.49, depending on the carbon price assumed.

Table 3-5 Emission intensity of generation when renewable energy generation is 40% of total generation, 2020

	CPRS5	CPRS15	CPRS25
Total SA Generation (GWh)	13,990	15,674	13,983
Renewable Generation (GWh)	5,589	6,276	5,593
% Renewable Generation	39.95%	40.04%	40.00%
Total Emission (TONS)	6,797,560	7,454,698	6,285,232
Emission Intensity (tons CO2e/MWh)	0.49	0.48	0.45

4 RECOMMENDATIONS

Achieving a renewable energy target of 33% will have an impact upon the greenhouse gas intensity of South Australia's electricity as a whole. Our estimate is that this intensity will fall to about 0.52 t/MWh of sent-out generation by 2020. The MMA estimate for Australia as a whole is about 0.78t/MWh by 2020.

The South Australian projection assumes:

- The 33% renewable energy target is met.
- The carbon intensity of existing non-renewable generation remains unchanged over the period to2020.
- Any shortfall between projected local generation from existing generators and the demand forecast is met by either local or external generation, with an average emission intensity of around 0.50 t/MWh so locally and 0.55 t/MWh from imports.

While it has been demonstrated that 33% is a robust estimate of the renewable energy target in 2020, a target of around 40% is also considered attainable if:

- There is a supporting planning and approval environment to ensure the transmission infrastructure is developed in a timely manner to avoid energy delivery constraints.
- The timely commercialization of geothermal technology in the lead up to 2020

These finding are similar to a similar review conducted for the South Australian Government in 2009. The previous study found levels of renewable generation of the order to 40% to 50%, but recommended that a 33% target be set since the higher target range required to successful development of geothermal energy and/or a substantial upgrade of the local transmission network[2]. The recommended 33% was a cautious level of target reflecting the uncertainties not captured in the modelling. In the current study, we find slightly higher levels of renewable generation, with this higher level mainly due to slightly lower energy demand. AEMO recent outlook forecasts a lower growth rate in electricity demand compared to previous forecasts because of the recent global financial crisis[3]. Because of this, a reduction in demand while keeping renewable energy generation constant will increase the renewable energy target ratio.

---

2 The upgrade is beyond the normal connection upgrades required for new renewable energy generation, the cost for which were included as part of project costs in MMA's analysis. Connection costs to the transmission network are included in the analysis MMA typically perform on a project by project basis. The key issue is to upgrade the system beyond the immediate connection point. MMA understands, for example, that this issue is holding up (deferring) the expansion of Wattle Point.

3 The demand reduction is something in the order of 5% (assuming CPRS is implemented) reflecting lower growth rates than has occurred historically, reflecting the perception that economic growth rates will not match those recorded in the period to 2009. Looking out into the future, that level of demand growth may be lower still since there is an implicit assumption over the probability of Olympic Dam expansion proceeding.

Achievement of the 40% target in South Australia is also dependent on development of renewable energy in other States. The distribution amongst states of renewable energy generation encouraged under the expanded RET scheme is uncertain and depends on a number of factors. Small changes in the relative costs of renewable energy generation (brought about say by changes in the MLF) can cause large swings in the profile across the states. Further, other factors (such as social acceptance or otherwise for more wind farms in a region) can also cause the state profiles to diverge. And the response by other State governments also matter. Both the West Australia and Northern Territory governments want to achieve their share of the 20% target and are trying to find ways to do this. The Queensland government has recently provided Mackay Sugar Coop with $9 million funding to support a Bagasse cogeneration project.

The achievement of the 40% target also depends in a small part on what is included as renewable energy generation. For example, should the energy generation from solar water heaters and roof top PV systems be included[4]?

In summary, a 40% target for renewable energy is achievable, but to ensure that it is achieved either geothermal has to be developed successfully or that the interregional transmission network (as well as some parts of the intraregional network) needs to be developed. Achievement of the 40% target would be more credible if backed up by some concrete action such as facilitation measures to support renewable energy generation in South Australia.

4 They are not included in the MMA calculations for this report.