SINCLAIR KNIGHT MERZ

SKM

Proposed Economic Targets for Low Emission Investment in South Australia

REPORT

- 30 September 2013

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Sinclair Knight Merz
Level 5, 33 King William Street
Adelaide SA 5000 Australia
PO Box 8291
Station Arcade SA 5000 Australia
T +61 8 8424 3800
F +61 8 8424 3810
www.globalskm.com

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Executive Summary

The Department of Manufacturing, Innovation, Trade, Resources and Energy (DIMTRE) has commissioned SKM to examine potential economic based targets for low emission generation to complement the South Australian Government's existing targets on renewable energy generation and long-term greenhouse gas abatement. The objective is to highlight the potential economic impacts of achieving low emission generation targets. The targets are to be aspirational in nature rather than a mechanism with financial penalties or incentives. The existence of a target may provide confidence to investors that the South Australia Government is committed to supporting the delivery of low emission technologies.

SKM conducted an analysis of potential economic targets that comprised a qualitative analysis combined with some quantitative analysis. The qualitative analysis looked at the potential effectiveness of proposed measures as well as potential distributional and compliance impacts. The quantitative analysis provided insights into the levels of the targets for the economic impact.

Investment in low emission technology was identified as the most appropriate primary target. Low emission was defined as generation with emission intensity below 300 kg/MWh to 400 kg/MWh, which would include generation from the most efficient gas-fired technologies as well as renewable energy.

The target measures the level of investment invested in South Australia in low emission generation by a target date as a cumulative amount since investment in the sector began. The benefit of this target is that it links achievement of physical targets (e.g. renewable energy and abatement targets) with a key economic indicator with flow on benefits to the remainder of the South Australian economy. A number of policy and economic drivers are facilitating investment in low emission technologies and achievement of national and State targets of greenhouse gas abatement will require significant investments in low emission technologies.

Choosing investment levels as the primary target has several advantages:

- It is easy to measure in practice, relying on published information.
- Would be a leading indicator of how well broader (renewable target and greenhouse emission) targets are tracking.
- Achievement of the target would likely not adversely affect anyone.

The measure could also be broken down into domestic and international sources for the investment to get better information on the benefits to the domestic economy.

Other sub measures were also assessed. These sub measures included: wages and salaries earned from operating low emission technologies; the value added (a key component of national income); liabilities avoided (in terms of potential carbon liabilities in absence of the investment); and a composite measure that estimates the value of the benefits to the energy market of investment in low emission generation.

Quantitative analysis was also undertaken. The level of investment was tested under a range of economic scenarios covering the level of electricity demand, costs of renewable and fossil fuel generation, and potential carbon prices. There was also sensitivity analysis on the level of national Large-scale Renewable Energy Target, with sensitivities to a "true" 20% target and deferment of the 41 TWh target to 2030.

The results of the analysis for the expected scenario are summarised in the following table. For the key indicator of investment, the cumulative investment to 2020 is expected to reach around $10 billion. This result is robust to changes in electricity demand, carbon price and renewable energy cost since it is mainly driven by the need to meet the national Large-scale Renewable Energy Target, which sees South Australia as the preferred region for investment in wind generation. The level of investment is also partly due to the continuing good levels of uptake in roof-top PV generation.

Target / Sub-measures	Actual level to 2013	Projected level to 2020
Low emission generation		
Investment, $M	5,446	9,751
Wages and Salaries, $M	254	612
Value added, $M	5,389	10,125
Liability avoided, $M	760	760
Composite, $M	1,198	2,769
Renewable generation		
Investment, $M	5,439	9,738
Wages and Salaries, $M	189	380
Value added, $M	2,012	6,198
Liability avoided, $M	322	438
Composite, $M	757	1,630

Source: SKM analysis

For the primary target, the results of the scenario analysis indicated that around $10 billion in investment in low emission generation is achievable by 2020. However, this level of investment was affected by:

- The level of the national target for Large-scale Renewable Energy Target (LRET) currently set at 41 TWh by 2020. A reduction in the target to a true 20% (26.4 TWh) is likely to see investment in low emission technologies reach $8 billion by 2020. A deferment in the 41 TWh target is likely to result in investment reach $10 billion by 2025.
- The purported good wind resource in South Australia (relative to other States) and less stringent land planning regulations compared with other States means that South Australia is likely to be favoured for wind generation. However, either these comparative advantages not being realised in practise or potential constraints in land planning or transmission in South Australia could see a substantial reduction in investment.

For these reasons it is recommended that a prudent investment target should be set that is achievable under most circumstances. One possibility is a target of $10 billion by 2025.

1. Background

The Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) has commissioned SKM to develop and model economic based targets for investment in low emission energy in South Australia.

The potential investment targets are to complement existing South Australian Government renewable energy and greenhouse emission targets which were developed against the backdrop of a climate change policy agenda. The aim is to highlight the economic opportunity associated with investment in low emission generation technologies. This will be achieved by developing measures that more directly link to the economic benefits related to this uptake.

The targets are to be aspirational in nature rather than a mechanism with financial penalties or incentives. The existence of a target may also provide confidence to investors that South Australia, its government and agencies are seriously committed to supporting their delivery. The targets would have at least two key applications:

- Provide a signal or beacon to attract the attention of investors
- Provide a justification for activities within government against a broader strategy for low carbon economy currently being developed by the South Australian Government.

The initial consideration was for the scope of targets and what technologies would be included and excluded. Taking into account the ease for calculating and monitoring progress towards achieving the target, it was determined that any low carbon generation target should include the following technologies:

- Generation technologies where the emission levels were less than a specified threshold.
- Cogeneration and tri-generation
- Renewable technologies as defined by the Office of the Renewable Energy Regulator (PV, Solar thermal, wind power and so on).

Initiatives such as energy efficiency measures would be excluded as there are already a number of government policies, targets and incentives to support their development including government and residential energy efficiency initiatives, and because of the difficulty in monitoring and calculating investments in energy efficient appliances and equipment.

Several thresholds on emission intensity were examined. A threshold of 400 kg/MWh[1,2] would allow generation from combined cycle plant to be included as a low emission technology. A threshold of 300 kg/MWh would exclude combined cycle generation from being defined as low emission.

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[1] This would allow generation from gas-fired CCGT operating at an average efficiency of around 7.8 GJ/MWh (46% thermal efficiency)

[2] We assume the target only covers emissions from combustion of fuel in generation

While the target is specifically related to the electricity sector there will potentially be consequential effects on other fuels such as gas as the target may encourage fuel substitution from coal to gas, and displacement between fossil fuels and renewable energy technologies.

2. Approach to Evaluating the Target

2.1. Overview

The approach to assessing potential metrics as targets involved a screening process against evaluation criteria developed in consultation with DMITRE. The second stage was the assessment of the achievability of the pre-selected target with modelling of outcomes to 2020 and 2030.

The evaluation criteria for potential metrics as targets were:

- Value: does the target provide a meaningful metric the achievement of which provides net benefits to the South Australian economy
- Effectiveness: will the target likely lead to uptake of low emission technologies
- Equity: will the target unfairly disadvantage some group in the community
- Administrative simplicity: Will the target be simple to measure and monitor or will there be a high level of administrative costs.
- Institutional fit: will the outcomes of the target comply with the spirit of energy market reforms and be complementary to existing targets.

2.2. Description of target and qualitative assessment

Assuming that the existing greenhouse emission targets and renewable energy targets remain, based on the screening process, a primary financial target has been preselected for further assessment. In addition, to give an added dimension to the target, a number of economic indicator measures highlighting the benefits to both the beneficiary industry and the South Australian economy through the more widespread adoption of low emission technologies, will be analysed

Investment in low emission technology was identified as the most appropriate primary target. This has the advantage of being a simple metric of capital investment in low emission technologies in dollars that highlights one of the benefits to the SA economy in its transformation to a low carbon emission economy. It also has the advantage of being able to be subdivided into domestic components to highlight the relative proportion of investment supplied by the local economy and overseas.

The sub-measures chosen would not necessarily have associated target values. Rather these would be used as indicators to track the efficacy of the primary target.

The primary target and sub measures plus a qualitative evaluation are shown in Table 1.

Table 1 – Primary target and sub-measures

Aspect	Evaluation Criteria	Commentary
Primary Target - Investment target (in $)	**Value**	Measures dollars invested in SA in low emission generation by 2020 as a cumulative amount since investment in the sector began. It can be broken down to domestic and overseas components. Highlights the level of investment in low emission (LE) technology, a key component of State and National income.
	Effectiveness	May not provide a direct incentive to invest in LE technologies but a target highlights the state government's commitment to the adoption of low carbon generation and should support investor confidence. The level of investment would be a leading indicator of how well broader (renewable target and greenhouse emission) targets are tracking – low levels of investment would indicate some difficulty in meeting broader targets in future years.
	Equity	Should have no equity issues.
	Administrative simplicity	Moderate difficulty in determining investment costs for some technologies. Also some averaging would be required to split into domestic and overseas components. Otherwise low cost, relying on published data from ASX announcements and other reputable sources.
	Fit	Should complement existing 33% by 2020 target.

Aspect	Evaluation Criteria	Commentary
Sub Measure - Wages and salary	**Value**	Measures the number of employees and the level of spend on wages and salaries in installing and operating low emission technologies. Provides a highlight of labour earnings from adoption of LE technologies. This may also be able to be measured on a regional basis if issues such as wages to workers covering many regions can be managed.
	Effectiveness	As a measure to be tracked, this would highlight a type of economic benefit accruing from investment. This information would serve to inform on-going community perceptions and support for low emission investment.
	Equity	May need to calculate net wage increase (after deducting for wages/salaries foregone in other generation sectors).
	Administrative simplicity	Difficult to separate data on wages into those directly attributable to LE technology (e.g.: head office functions may cover several technologies). Data on wages and salaries can be constructed by using data on people employed and wages/salary spend from dedicated low emission technology owners. Can also use average weekly earnings data published by ABS to measure wage spend.
	Fit	Directly attributable to existing targets.

Aspect	Evaluation Criteria	Commentary
Sub Measure - Value Add	**Value**	Measures the value of the economic contribution of low emission technologies. This will be measured by revenue less costs of material inputs (and perhaps imported capital input) to derive a measure that highlights the contribution to SA GSP. Measures contribution to SA economy and may provide supporting impetus.
	Effectiveness	May encourage adoption of technologies with greater contribution to SA economy.
	Equity	No equity issues.
	Administrative simplicity	Difficult to measure since we would need to deduct material (input) spend component from revenue estimates. Revenue estimates would be simple to derive (from market electricity and certificate price data), but input costs would be more difficult to derive.
	Fit	Complementary with prime target.
Sub-Measure – GSP/Emission intensity	**Value**	The target would monitor GSP and emissions to calculate GSP intensity (GSP/emissions) to track the reduction in reliance on high emission technologies for economic development. If target is correlated to national targets could provide an indication of what is required to achieve national or State target.
	Effectiveness	Could encourage investment in low emission technology. Notably a reduction to this sub-measure would indicate that the economy is less dependent on RE development for growth
	Equity	As national targets are binding there is no cost impost to SA.

Aspect	Evaluation Criteria	Commentary
	Administrative simplicity	Simple to measure using published data on emissions and GSP.
	Fit	Complementary
Sub-Measure - Liability avoided	Value	Measures the liability avoided in $ (from foregone purchases of carbon permits) of abatement engendered by low emission technology adoption. Provides a measure of the liability that would be paid by SA industry to meet carbon targets. Can be applied at the household level (using NATSEM and other data) to determine the reduction in exposure of household spend to carbon price.
	Effectiveness	Should act as a spur to invest in LE technology
	Equity	Equitable, although there is a risk that cost of meeting emission targets will be highlighted
	Administrative simplicity	Simple - only issue is determining the component of the reduction in emission intensity attributable to policy and that which would have occurred anyway (under business as usual)
	Fit	Complementary
Sub-Measure - Composite metric	Value	A composite measure that highlights the benefits of adoption of LE technologies through reduced network spend due to reduced peak demand, increases in net exports of energy to other States, and decreased emission liability. Provides indication of benefits of achieving low emission generation targets
	Effectiveness	Would provide encouragement to adoption of and solidify support for LE technologies

Aspect	Evaluation Criteria	Commentary
	Equity	No equity issues
	Administrative simplicity	Could be complex to measure and monitor
	Fit	Complementary

2.3. Analytical approach

The analytical approach to evaluating the proposed measures involved three steps:

- Evaluation of historical data on the measures. This basically collates published information to establish an historical time-series of the metrics correlated with installation and operation of low emission technologies.
- Modelling the uptake of renewable and low emission generation in South Australia in the future using SKM's suite of electricity market (STRATEGIST) and renewable energy market (REMMA) simulation models.
- Based on the simulated uptake calculate investment, labour and other measures based on simple ratios developed from historical data.

Renewable generation covered large-scale wind, mini-hydro and biomass generation, and small scale renewable energy systems such as roof-top PV and solar water heaters. Low emission generation included gas-fired combined cycle plant and embedded cogeneration plant.

2.3.1. Historical analysis

Historical data was assessed using the following process.

First, data on commissioning dates and the associated capital expenditures was sourced from reputable published sources. The process was as follows:

- Data on timing of commissioning of new low emission plant was sourced from AEMO. AEMO also provided data on installed capacity and generation levels. Historical spot price data for the South Australian regional reference node was also sourced from AEMO.
- Investment data was based on capital expenditure. Capital expenditure data was sourced from Australian Stock Exchange (ASX) announcements, which provide the most reliable source of data on capital expenditure. If ASX data was not available, estimates provided by project proponents in media releases was used.
- Data on employment was sourced from project proponents, and data contained in annual reports of the generation companies.

- Data on installations of roof-top PV and solar water heaters was sourced from the Clean Energy Regulator. The DCCEE also was the source of data on schools installing solar energy systems.
- Data on embedded low emission generation capacity was sourced from the Clean Energy Council, AEMO and from the office of the technical regulator in SA.

Second, data on value add, wages and salaries, liabilities avoided and other benefits was constructed.

Value add data was set to be equivalent to the sum of profit earnt plus depreciation plus labour costs. Operating profits was calculated as revenue earnt form the electricity market minus operating costs. Revenue earnt was estimated from historical average spot prices for the typical generation profile for the low emission technologies. For large scale wind projects, the time weighted price with a discount of 7% (was the typical discount to time-weighted average price observed historically) was used to determine revenues. For biomass and gas-based low emission generation, the time weighted average price was used to calculate revenues. For solar-PV systems, the revenue earnt was calculated from peak period prices. For solar water heaters, off-peak prices were used to calculate revenue[3].

Operating cost data was estimated using data on operation costs sourced from annual reports for companies dealing exclusively with low emission generation. Published operating costs were averaged on a $/MWh generated basis and this was applied for generators for which operating cost data was not available. Fuel costs were also deducted were relevant.

Labour costs were calculated from wage and salary estimates (see below). Depreciation data was calculated from investment data using a straight line depreciation method calculated over the typical operating life of the technology (25 years for all technologies, except for a CCGT when 30 years was used).

Wages and salaries was calculated by taking data on labour employed on a full-time equivalent basis and multiplying this by data on average total weekly earnings for full time employees. Estimates of wages and salaries multiplied by an overhead rate was also used to calculate the value add estimates.

Liabilities foregone from carbon abatement were calculated using the emission intensity for gas-fired open cycle gas turbines or gas-fired boilers (the plant most likely to be displaced by low emission generation) multiplied by a shadow carbon price. The shadow price of carbon represents the unit value of carbon abatement from society's point of view – this was set equivalent to the fixed price for 1012/13 ($23/t CO_2e) discounted back in time by 4.5% per annum.

[3] Revenue for solar water heaters was set equivalent to the cost foregone from displacing an electric or gas water heater. Solar water heaters will typically displace off-peak electric water heaters or gas-based water heaters. The off-peak pool price was used as a proxy for calculating foregone costs. This approach is likely to underestimate the actual costs foregone because foregone costs for gas-based systems are likely to be higher.

The composite measure was constructed from the sum of reduced emission liability (as calculated above), increased export value[4], and network offsets. Export value was calculated from the product of hourly exports times the hourly spot price at the regional reference node for South Australia. Network offsets was calculated as follows:

- Peak demand reductions were calculated based on the firm level of installed capacity (installed since 2003). The firm level was assumed to be 100% for all technologies except for wind for which the firm level was assumed to be 5% and for solar rooftop PV for which the firm level was assumed to be 80% of firm capacity.
- Multiplying form capacity by unit cost of transmission, which was assumed to average $500/kW in 2012/13 declining by 5% per annum back to 2003/04.

The process used for estimating historical values of the measures was also used for estimating the measures in the projection period, although using projected values of the key assumptions. The approach adopted in this study is indicative of the approaches that could be used to calculate the measures. Once deployed, more rigorous approaches may be deployed in the future to calculate measure values.

2.3.2. Electricity market model

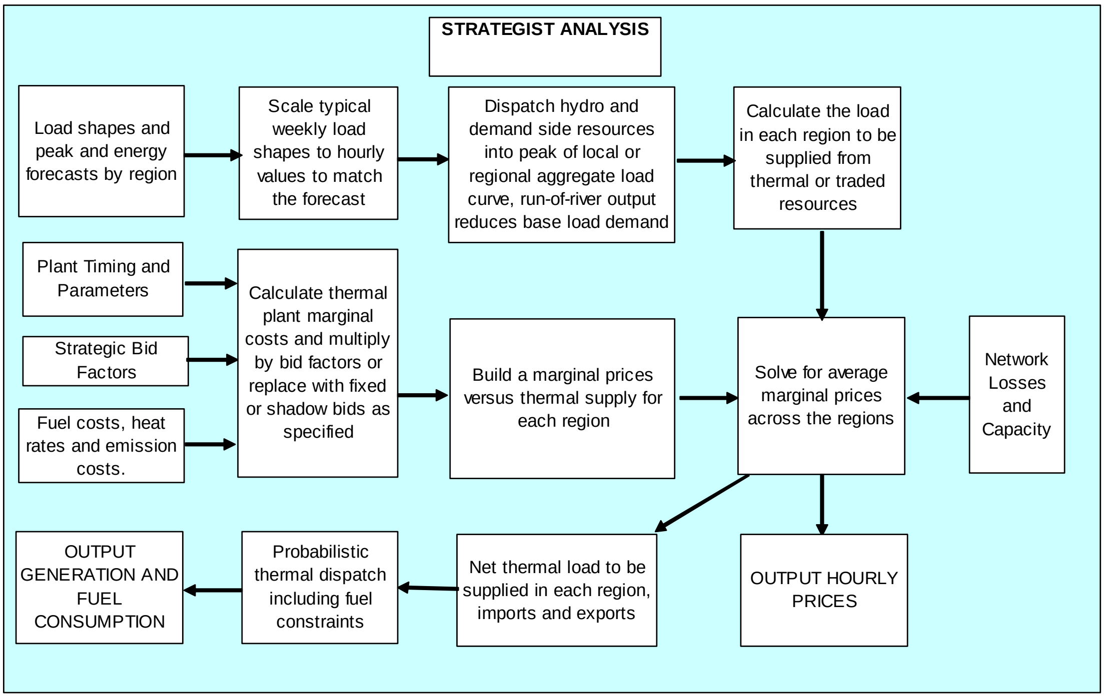
SKM MMA's market models are designed to create predictions of wholesale electricity price and generation driven by the supply and demand balance, with long-term prices capped near the cost of the cheapest new market entrant (based on the premise that prices above this level provide economic signals for new generation to enter the market). Price drivers include carbon prices, fuel costs, unit efficiencies and capital costs of new plant. These models have been developed over more than 20 years, and include an energy market database that is regularly populated with as much publicly available information as possible and a suite of market modelling tools covering the electricity and gas industries as well as renewable and emissions abatement markets. The primary tool used for modelling the wholesale electricity market is Strategist, proprietary software licensed from Ventyx that is used extensively internationally for electricity supply planning and analysis of market dynamics. Strategist simulates the most economically efficient unit dispatch in each market while accounting for physical constraints that apply to the running of each generating unit, the interconnection system and fuel sources. Strategist incorporates chronological hourly loads (including demand side programs such as interruptible loads and energy efficiency programs) and market reflective dispatch of electricity from thermal, renewable, hydro and pumped storage resources. As well as this, Strategist accounts for inter-regional trading, scheduled and forced outage characteristics of thermal plant (using a probabilistic mechanism), and the implementation of government policies such as the expanded Renewable Energy Target (RET) schemes.

[4] Increased export value was included on the assumption that increased generation from low cost emissions (particularly wind generation) was the principle source of exports to other States, as the cost of fossil fuel generation in South Australia is typically higher than for other States.

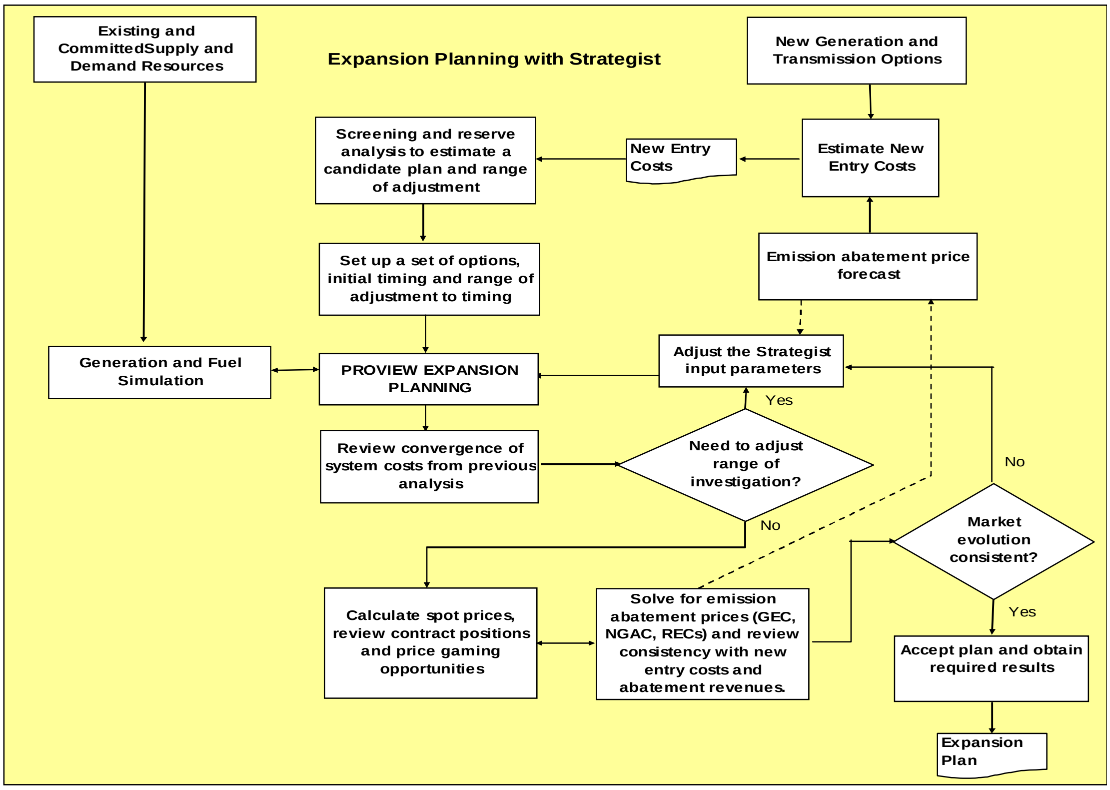
Timing of new generation is determined by a generation expansion plan that defines the additional generation capacity that is needed to meet future load or plant retirements. The expansion plan has a sustainable wholesale market price path, applying market power where it is evident, a consistent set of renewable and thermal new entry plant and must meet reserve constraints in each region. Selection of low emission plant in a regions occurs where this is a more economic (lower cost to the systems) compared to alternative new generation options.

Average hourly pool prices are determined within Strategist based on thermal plant bids derived from marginal costs or entered directly. The internal Strategist methodology is represented in Figure 1 and the SKM MMA modelling procedures for determining the timing of new generation and transmission resources, and bid gaming factors are presented in Figure 2.

- **Figure 1: Strategist Analysis Flowchart**



▪ **Figure 2: Modelling Procedures**



2.3.3. Renewable Energy Market Model Australia

The Renewable Energy Market Model of Australia (REMMA) is a tool that estimates a least cost renewable energy expansion plan, and solves the supply and demand for LGCs having regard to the underlying energy value of the production for each type of resource (base load, wind, solar, biomass with seasonality). REMMA is an Excel application based on a database of nearly 900 existing, committed, proposed and generic projects across Australia.

Strategist is iterated with the renewable energy market model to ensure that the wholesale market solution is consistent with the renewable energy model outcomes. Additional renewable generation has the effect of reducing wholesale prices while reduced wholesale prices typically have the effect of reducing investment in renewable generation. Iteration of these models typically allows the overall solution to converge to a stable model of consistent wholesale and renewable energy market outcomes.

The REMMA model allows SKM MMA to model the impact of policies affecting the LRET scheme, under various scenarios.

The REMMA uses linear programming to determine least cost uptake of renewable technologies to meet the target, subject to constraints in resource availability and limits on uptake. The optimisation requires that the interim targets are met in each year (by current generation and banked certificates) and generation covers the total number of certificates required over the period to 2030 when the program is scheduled to terminate. The certificate price path is set by the net cost of the marginal generators, which enable the above conditions to be met and result in positive returns to the investments in each of the projects.

SKM MMA has a detailed database of renewable energy projects (existing, committed and proposed) that supports our modelling of the LGC price path. The database includes estimation of capital costs, likely reductions in capital costs over time, operating and fuel costs, connection costs, and other variable costs for over 900 individual projects.

The focus of the modelling for this study was uptake of renewable energy generation in South Australia as a result of the incentives provided by the RET scheme and Greenpower schemes. South Australia competes with other states as a location of renewable generation to meet national targets. The capacity projected to be installed in South Australia depends on the net cost of renewable generation relative to other States and constrained by the impact on regional pool prices of increasing the level of renewable generation and any transmission limits to energy flows.

For South Australia, the data base contains the following details (see Table 2) on available renewable energy projects.

Table 2: Details of large-scale renewable energy projects in South Australia

Technology	Existing/committed			Announced		
	No.	MW	GWh	No.	MW	GWh
Agricultural Waste	0	0	0	0	0	0
Black Liquor	0	0	0	0	0	0
Landfill Gas	6	15	28	0	0	0
Municipal Solid Waste	0	0	0	0	0	0
Sewage Gas	3	7	13	0	0	0
Wood / Wood Waste	1	6	0	2	28	191
Geothermal	1	25	184	0	0	0
Hydro	2	4	15	0	0	0
Solar / PV	7	5	7	3	81	221
Wave	0	0	0	0	0	0
Wind	17	1,369	3,891	39	5,637	16,111
Wet waste	0	0	0	0	0	0
Wheat/ethanol plant	0	0	0	0	0	0
Total	**37**	**1,430**	**4,138**	**44**	**5,746**	**16,523**

Source: SKM MMA Renewable Energy Database. Note: data is on a generated basis.

The data base indicates that the renewable energy resource base is of sufficient size to meet higher targets for renewable generation. Less than one-fifth of the announced wind projects have to go ahead for South Australia to meet its long term renewable energy targets[5].

More resources are possible if technologies such as geothermal generation are developed and if the costs of some resources come down (e.g. solar thermal).

Other constraints may limit uptake:

- Interregional transmission constraints, which constrain the amount of energy that can be exported. The recently announced upgrade for SA/Vic interconnect will likely increase exports by around 200 MW. No further upgrade is assumed before 2020, but an upgrade post 2020 is assumed.
- Market constraints: the impact of wind on reducing spot prices constrains further uptake. This is considered in the modelling as a post entry pool price determines the timing of uptake of new renewable generation. However, we do not assumed any extension of the Eyre Peninsula to Adelaide grid, so there is a significant constrain on the wind resource development in this region.
- Land planning constrains. No land planning constraints are assumed to bind uptake of wind capacity

2.4. Assumptions

Three cases have been developed for the modelling for DMITRE. These are essentially based around the high, medium and low load forecasts produced by AEMO and incorporate the following additional assumptions.

<table>
<tr><td colspan="15">Demand growth - from 2012 National Electricity Forecasting Report, with median peak demand</td></tr>
<tr><td colspan="5">Base Case</td><td colspan="5">High case</td><td colspan="5">Low case</td></tr>
<tr><td colspan="5">AEMO's MEDIUM economic growth scenario</td><td colspan="5">AEMO's HIGH economic growth scenario</td><td colspan="5">AEMO's LOW economic growth scenario</td></tr>
<tr><td colspan="15">Price Elasticity – demand has been adjusted for difference in carbon price underlying AEMO's forecast and carbon price used in SKM MMA's forecast using the following elasticities: i.e. 1% change in carbon price results in -0.37% less demand
AEMO's PV forecast has been replaced by SKM MMA's PV forecast[6]</td></tr>
<tr><td colspan="3">NSW</td><td colspan="3">VIC</td><td colspan="3">QLD</td><td colspan="3">SA</td><td colspan="3">TAS</td></tr>
<tr><td colspan="3">-0.37</td><td colspan="3">-0.38</td><td colspan="3">-0.29</td><td colspan="3">-0.25</td><td colspan="3">-0.23</td></tr>
</table>

[5] Only 1,400 MW of the announced wind projects is projected to be deployed in the market simulations reported in Section 4 of the report

[6] SKM MMA's forecast of PV uptake was used instead AEMO's forecast as the SKM estimates are able to provide regional breakdowns.

Carbon price		
Base Case	High case	Low case
Carbon price drops to about $12/t after 2014/15 after the CPM's fixed price period and escalates at 6.5% per annum reflecting future international agreement on carbon abatement	Carbon price is as per the Federal Treasury's core policy scenario, which rises to about $27/t CO2e in 2015/16 and grows at about 5.4% per annum thereafter	Carbon price drops to $10/t after the CPM's fixed price period and escalates at 4% per annum thereafter

Gas prices			
Aspect	Base case	High Case	Low Case
Price	SKM MMA's medium gas price scenario	SKM MMA's high gas price scenario	SKM MMA's low gas price scenario
LNG plant[7]	Two trains of Arrow LNG follow the current six trains, and then no further development	One additional LNG train is produced every two years after the Arrow Energy LNG trains come online	No further trains of LNG are developed, and the gas currently "reserved" for the two prospective Arrow trains are released
Production costs	increase in real terms	increase in real terms as per base case	flat in real terms
Export prices	assume oil price of $US120/bbl & 0.90US/$A exchange rate		
Domestic demand	projected to grow at 2% per annum at an upstream price of $6/GJ in $2012 terms	Domestic demand is projected to grow at 2% per annum at an upstream price of $6/GJ in $2012 terms	projected to grow at 2% per annum at an upstream price of $6/GJ in $2012 terms
Initial Contract prices	Initial new contract price rises are due to export value/gas shortage/market power		
LNG contracting	fully contracted for 20 years and therefore don't affect the contract market for 20 years		

Renewable technology capital cost trends growth per annum[8]			
Technology	Medium case	High case	Low case
Biomass	-0.3%	0.7%	-1.3%
Geothermal	-0.7%	0.3%	-1.7%
Hydro	-0.2%	0.8%	-1.2%

[7] A LNG processing plant is called a "train"

[8] Source: SKM projections based on projections of technology learning by doing rates published by the IEA and trend projections of fossil fuel based generation capital costs.

Solar / PV	-2.0%	-1.0%	-3.0%
Wind	-0.4%	0.6%	-1.4%
Thermal technology capital costs trends			
Technology	Medium case	High case	Low case
CCGT	0.0%	1.0%	-1.0%
CCGT with CCS	-0.5%	0.5%	-1.5%
OCGT	0.0%	1.0%	-1.0%
Coal	-0.5%	0.5%	-1.5%
Coal with CCS	-1.0%	0.0%	-2.0%

3. Historic Performance of the Primary Target and Sub-measures

This section provides data on the performance of the selected indicators in the period from 2003 to 2013.

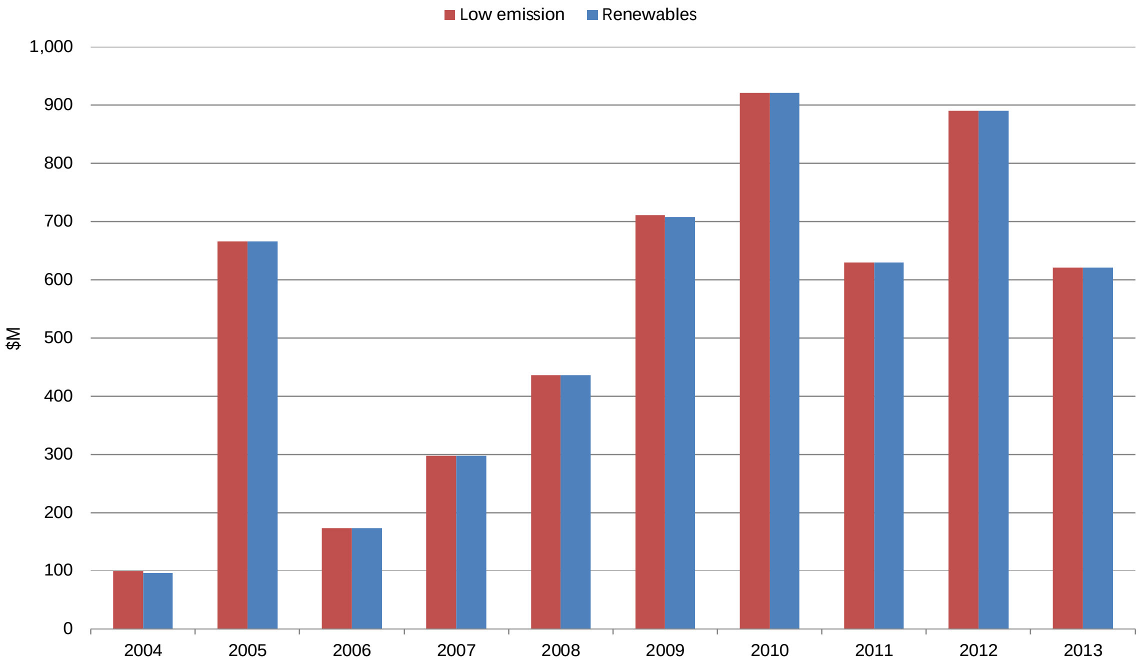
3.1. Capital Investment

Historical investments in South Australia and in renewable energy and low emission generation (including renewable energy) are shown in Figure 1. Investments occurred mainly in renewable energy technologies (including roof-top solar). There was no investment in low emission gas-fired technologies such as CCGT and cogeneration plants However, there has been a modest amount (around $10 million) of investment in small scale embedded gas-fired generation.

Cumulative investment over the period to 2013 reached $5.5 billion dollars. The cumulative investment by generation category is as:

- Large scale renewable energy: $3.3 billion.
- Solar water heaters: $0.2 billion.
- Rooftop PV: $1.9 billion
- Gas-fired generation :< $0.1 billion

Figure 3: Capital Investment in renewable and low emission generation, mid 2013 dollars



Source: SKM analysis using data on installed capacity provided by AEMO, CEC and technical regulator in SA

3.2. Other measures

Summary statistics of the historical performance of the primary target and sub measures are shown in Table 3. For the period from 2003 to 2013, around $0.4 billion was expended in wages and salaries. Value-added was around $5.4 billion. The composite value of the direct energy market benefits amounted to around $0.8 billion.

- **Table 3: Summary statistic for historical performance of the measures (2003 to 2013)**

Target / Sub-measures	Average annual	Cumulative (State wide)	Cumulative (regions)
Low emission generation			
Investment, $M	545	5,446	2,026
Wages and Salaries, $M	23	254	214
Value added, $M	490	5,389	3,153
Liability avoided, $M	69	760	-
Composite, $M	109	1,198	-
Renewable generation			
Investment, $M	544	5,439	2,000
Wages and Salaries, $M	17	189	186
Value added, $M	183	2,012	1,690
Liability avoided, $M	29	322	-
Composite, $M	69	757	-

Around 40 per cent ($2.0 billion) of the investment value was incurred in regional areas. The regions also captured around $0.2 billion in wages and $1.7 billion (renewable energy) to $3.1 billion (low emission generation) in value add.

4. Primary Target Forecast to 2020 and 2030

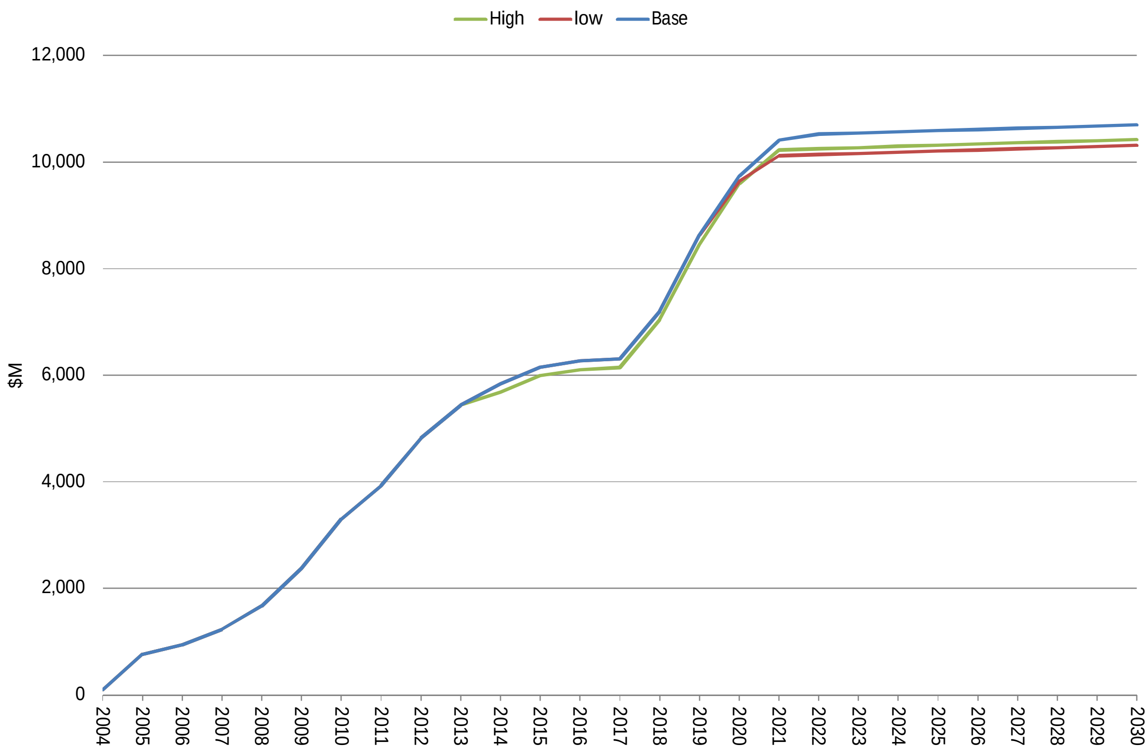
This section discusses the results of the 5 main indicators chosen including the main indicator on cumulative investments and 4 sub-measures for the base case.

4.1. Investment

4.1.1. Main results

Projected cumulative investments in South Australia are shown in Figure 2. Investments in renewables (and low emission) technologies are projected to be about $9.8 billion in 2020, up from $5.5 billion up to the end of 2013. Investments are expected to peak to around $10.5 billion in the mid-2020's. Most of the investment is in renewable energy technologies, mostly wind generation capacity and roof-top PV capacity, with around $0.1 billion of the investments in low emission gas-fired embedded generation.

Figure 4: Cumulative investments, renewable energy generation



Investments can be lower in the both the high and low cases due mainly to lower levels of renewable investments in South Australia. In the low case, lower demand growth drives lower wholesale prices in South Australia which encourages more renewable generation in other regions, leading to a reduction in renewable investments. In the high case, the higher cost of renewable generation causes combined with relatively higher increases in wholesale prices in other regions (driven by higher fossil fuel based generation costs) leads to lower level of investment in wind generation in South Australia.

However, the differences between the three scenarios are relatively minor. In all scenarios, the level of investment reaches around $10 billion. The high and low cases lead to marginal differences and these differences are not significant enough to alter the general conclusion that the level of renewable energy in South Australia should exhibit strong growth as a result of the LRET scheme.

4.1.2. Sensitivities

Sensitivities were undertaken to lower large-scale generation targets as follows:

- True 20% target in 2020 to be 26,400 GWh. This target to remain the same until 2030.
- Target of 41,000 GWh is delayed to 2030 (with the end period of the scheme extended to 2035).

The impact on investment in renewable energy generation is shown in Figure 5. A reduced target is likely to lower investment in renewable energy generation (principally wind farms) in South Australia. With a true 20% target, cumulative investment peaks at $8 billion in 2020. With a deferred target of 41 TWh in 2030, investment peaks at $10 billion but not until much later estimated to be around 2025.

Figure 5: Sensitivity of investment levels to changes in LRET

4.2. Sub-measures

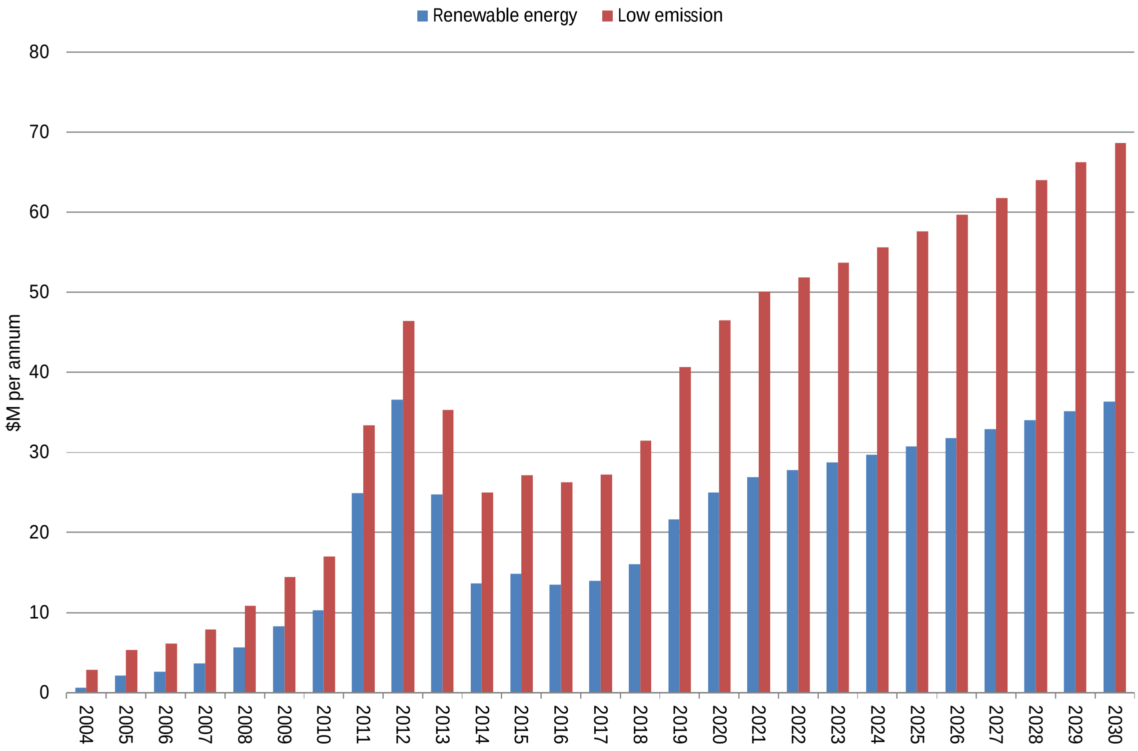
4.2.1. Wages and salaries

Wages and salaries for direct employment[9] in renewable energy generation (including installers of roof-top PV and solar water heaters) is expected to drop from $25 million in 2013 to $14 million in 2014 and 2015 due to the fall in the number of installations of PV systems. Wages and salaries are then expected to rise to reach $25 million in 2020 in line with a projected increase in capacity in large-scale wind generation. Wages and salaries for direct employment in large scale renewable generation increases from $10 million in 2013 to around $23 million in 2020, indicating that employment in this sector overtakes employment in small scale renewable energy sector.

Wages and salaries for all low emission generation is expected to grow from $35 million in 2013 to around $47 million in 2020.

Wages for construction workers is expected to be around $100 million in the period to 2020.

- **Figure 6: Wages and salaries for direct employment, $m per annum**



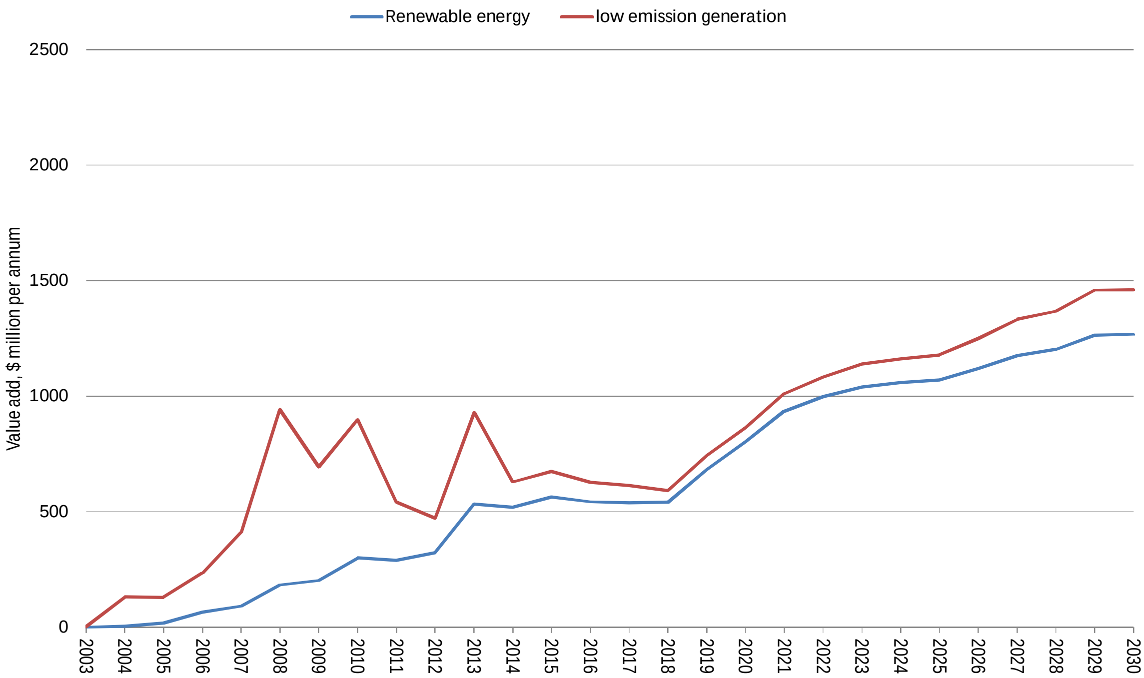
[9] Direct employment covers operating and maintenance staff and installers of PV systems. Wages and salaries is volatile from year to year depending on the number of PV systems installed from year to year.

4.3. Value added

Value-add includes profits from generation plus wages plus capital depreciation. It represents the contribution to national income from renewable or low emission generation.

Value added projections are shown in the Figure 4. Value-add are projected to stabilise for the next five years due to falling wholesale prices. Value-add from renewable generation reaches around $0.8 billion per annum by 2020. Value add from low emission generation (including renewable generation) is projected to be $0.9 billion by 2020. Estimates of the value-add in 2020 for low emission generation varies from $0.7 billion to $1.0 billion mainly due to variations in electricity prices received.

- **Figure 7: Value added projections, $ million per annum**



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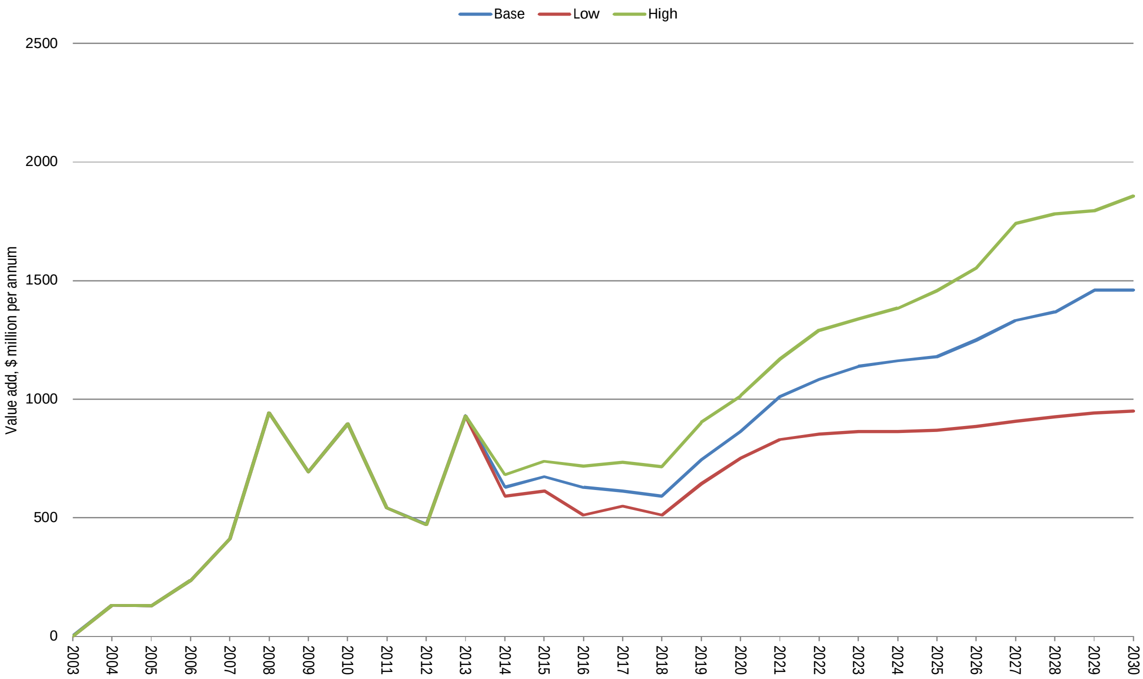
- **Figure 8: Variations in value-add projections for low emission generation, $million per annum**



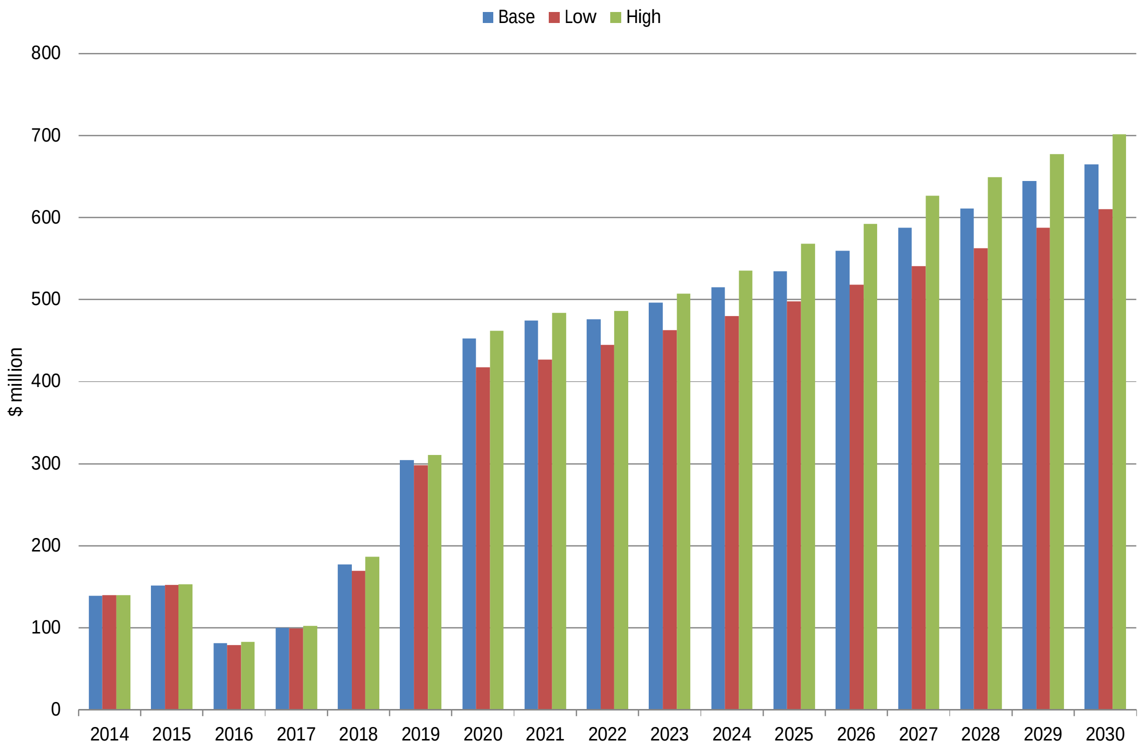
Value-add continues to grow steadily after 2020, mainly on the back of rising wholesale electricity prices (due to rising gas prices and rising carbon prices)

4.4. Composite index

The composite index reflects the economic value that renewable energy or low emission generations bring to South Australian energy sector. It comprises the contribution of reduced emission liability, avoided network costs and the value of additional exports of electricity to other markets in the NEM.

The value is projected to be around $0.4 billion per annum by 2020, with a cumulative value to 2020 of about $2.2 billion to around $2.4 billion

Figure 9: Value to the economy of low emission generation, $ million per annum



4.5. Regional impacts

Regional impacts from renewable energy generation are shown in Table 4. Investment spend (on local goods and services) in regional areas is expected to average around $200 million per annum. Wages and salaries for operating and construction staff are expected to average around $28 million per annum. Value–add to the regional areas are expected to add around $550 million per annum. Outcomes for low emission generation are a little higher.

Investment is expected to drop off after 2020 due to the fact that any target under the LRET scheme will have largely been met by then.

■ **Table 4: Regional impacts, $M per annum**

Technology	2014	2015	2016	2017	2018	2019	2020	2025	2030
Renewable energy									
Investment	153	119	44	13	358	570	443	46	8
Wages & salaries	18	16	15	28	35	38	35	32	36
Value added	393	423	391	396	415	541	616	810	1004
Low emission									
Investment	157	123	48	18	363	576	448	15	8
Wages & salaries	23	22	21	34	43	46	45	44	51
Value added	440	470	428	427	437	568	642	857	1087

4.6. Uncertainties

There are a range of uncertainties that should be considered before interpreting the results of this analysis for setting of targets:

- The level of new capacity in renewable generation is difficult to predict as it can be affected by a range of factors not considered in the modelling. The current renewable energy target requires a significant increase in the level of new capacity required to be built over the next 7 years (approximately 1,500 MW per annum from 2015 to 2020). There may be limits on the ability to construct this level of capacity. The increase in capacity constrains may also impact on the cost of renewable energy projects, and this may significantly reduce the level of uptake of renewable energy in South Australia

- If land planning rules are tightened, then the level of new wind capacity may be affected.

- It is difficult to predict the level of uptake of roof-top PV systems. Only a modest increase is predicted, far less than recent growth rates, on the back of reduced subsidies for this form of generation. However, uptake has continued even though there are lower subsidies. In addition, the new Federal Coalition government intends to subsidise some additional uptake of solar generation.

- Whether the RET target will be met in a scenario where there was no carbon pricing. With current low demand growth combined with a surplus of generation capacity, there is a chance that wholesale prices will be at depressed levels and that the LGC certificate price will move towards the cap determined by the penalty price. The combination of a depressed wholesale price and the certificate price at its cap may not be sufficient to cover the long-run marginal costs of new wind generation.