Renewable generation projections 2009 to 2028

Revised Final Report

Carbon Market Economics Pty Ltd

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Disclaimer

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1 Introduction

1.1 Terms of reference

This is a report to the Market Simulation Working Group (MSWG) of the Inter-regional Planning Committee. The terms of reference of this report is to produce projections of investment in wind generation for the period from 2009 to 2028. The assumptions used to produce these projections were provided by the MSWG. Carbon Market Economics (CME) has provided data on possible renewable generators and has provided the analytical tools and methods used in the creation of the projections in this report.

This report was finalised in November 2008. However since late December 2008, the Australian Government has presented exposure draft legislation on the revised Mandatory Renewable Energy Target scheme. This report has therefore been updated to take account of changes in the scheme set out in the exposure draft legislation. These changes include:

- The right to create RECs by non-deemed eligible plant for the life of the scheme to 2030, instead of for a maximum of 15 years;
- The creation of RECs from solar water heaters after 2020;
- A sizeable increase in the calculation of deemed RECs from small generating units (principally photovoltaics);
- Slight changes in the annual MRET demand profile to 2020; and
- The non-indexation of the REC penalty.

These changes have been reflected in the descriptions and in the modelling presented in this report. Other changes between the earlier report and this report include additional announcements on wind capacity in Western Australia that had not yet been included in our Renewable Energy Database (RED) model at the time of the previous report.

1.2 Structure of the report

Section Two sets out the methodology we have used. This describes the analytical approach, the data sources and assumptions.

Section Three presents results of the analysis. It also identifies the limitations that should be borne in mind when using these projections.

2 Methodology

2.1 Analytical approach

We developed two different forms of projection:

- **Approach 1: Expanded Renewable Energy Target (RET) achieved.** This assumes that the 20% renewable energy target by 2020 plus expected RET demand to 2020 will be met although not necessarily for every year from 2008 to 2020. It uses the input assumptions described in Section 2.2, but changes the Renewable Energy Certificate (REC) prices in order to provide revenues needed to attract investment in wind generation to meet the target.

- **Approach 2: REC penalty capped at $43.** This uses an unindexed $43/REC penalty cap (non-deductible) and all the other input assumptions described in Section 2.2. For retailers that are required to acquit RECs and that have taxable income, the non-deductibility translates into a REC price of $61 (assuming a marginal tax rate of 30%) in 2009. This declines in real terms at the rate of the inflation which we have assumed to be 2.5% per annum.

Of all the different renewable generation sources, wind is likely to be the most sensitive to the price of RECs. There are several reasons for this:

- Wind generation technologies are mature and there is a large volume of wind generation proposals that could be implemented from the start of the expanded RET scheme – where the investment incentive through RECs will be greatest;
- Most (but not all) other renewable generation technologies will have lower REC price supply elasticity. For example, solar water heaters or solar PV, will be influenced by capital subsidies and building standards. In many biomass plants, the decision to produce electricity will be affected by factors other than REC (or even electricity prices); hydro generation will be affected by water availability;

geothermal is only expected to become viable in significant scale towards the end of the RET period when the effect of REC income will diminish as the scheme is progressively phased-out.

The RGE model selects wind farms if the present value of expected revenues is greater than the expected cost of that wind farm. Revenues are based on expected electricity prices and REC prices.

The free variable in our Renewable Generation Expansion (RGE) model is the price of RECs. This is varied in order to provide the revenues to ensure that sufficient volume of wind generation is commissioned to meet the expected demand (in Approach 1). The RGE model tests if the present value of the expected revenues over the life of the wind farm is greater than the present value of the expected cost. If so, the wind-farm is included in the calculation using probabilistic or deterministic adjustments as described in Section 2.1.8 below.

Approach 1 assumes that the RET target will be met. To calculate the upper and lower bounds of the possible contribution of wind to the target, the approach relies on a calculation of the lower and upper bounds of non-wind REC creation (i.e. RECs created from non-wind renewable electricity generation and solar water heaters). The upper/lower bounds of investment in wind is therefore calculated as the total RET and GreenPower demand less the lower/upper bounds of REC creation from non-wind sources.

A "central estimate" is also provided. This is based on what we consider to be highest likelihood levels of REC creation from non-wind sources, plus the REC creation from wind sources as the balancing entry so that the total RET plus expected GreenPower demand is met.

CME's renewable energy database (RED) model has 639 operating and proposed renewable electricity generation plants listed in its register. This high supply scenario includes 402 non-wind renewable (Hydro, Biomass, Solar, Wave, Tidal) electricity generation plants.

Each registered renewable electricity plant has data fields that specify the name of the plant, MW capacity, capacity utilisation, GWh output, annual REC creation, location and start date. All plants on the RED model are ranked on the basis of our expectation of the plant operating during the MRET period. Operating plants are given a rank of 10, and plants that have a very low probability of success are given a ranking of 1. These rankings are based on our judgement based on our assessment of various sources of information on each plant. We continuously monitor information on operating and proposed renewable electricity generation plant.

The low supply scenario includes all non-wind, non-hydro renewable energy plants with a ranking greater than six. The high supply scenario includes all plants with a ranking greater than zero.

2.1.1 Hydro

The production of RECs from hydro electricity generation depends on rainfall in Tasmania and in the Snowy Hydro catchments. There is limited ability to expand hydro generation capacity through investment. For this reason, the capital base of hydro-based REC production is essentially a sunk cost. Therefore REC production from hydro facilities will occur as long as water is available, and will be affected by the price of RECs. Notwithstanding this, through water release decisions from various locations it is possible to maximise REC production from one year to the next.

To produce projections of REC production from baseline hydro plants we have produced high and low forecasts on the basis of the assumption that REC production over the 20 year period will be 125% or 75% respectively of the 2002 to 2007 average.

There are 28 proposed hydro plants included in the RE database. Most of these plants are micro hydro plants. There are a small number of larger plants in the database including Bogong hydro which is expected to be generating electricity in 2009.

2.1.2 Solar PV

The starting point for the projections of RECs created from solar PV is the number of RECs created from Solar PV in 2008. The introduction of generous rebates to households in 2007 for installation of Solar PV led to a surge in the volume of PV cells in 2007 and 2008. As at January 1st 2008 the number of RECs created from Solar PV in electricity generation year was 315,400. In 2006 only 32,600 RECs were created from Solar PV.

In December 2008 the Federal Government announced the rebate for the installation would be abolished and that the installation of solar PV would be able to create multiple RECs for a limited period, although the multiplied is restricted to the first 1.5 KW of installed capacity. This policy change means that RECs created from solar PV break the existing nexus under MRET between the number of RECs created and the MWh of electricity generated. This is a significant shift in policy.

Three different supply scenarios for Solar PV for the period 2009 to 2030 are included in the report. The reference case assumes that the estimated additional MW capacity for solar PV for each year of the years from 2009 to 2030 will be equal to estimated solar PV capacity for each state and territory in 2008. The low supply scenario assumes that the new installed MW capacity for each year from 2009 to 2030 will be half of the new MW capacity in 2008. The high supply scenario assumes that the new MW capacity for each year from 2009 to 2030 will be double that of the MW capacity installed in 2008.

It is important to note that a number of simplifying assumptions were made to estimate the MW capacity of additional solar PV in 2008 based on the REC data from the ORER database. The most important assumptions for each state and territory related to solar zone in each state and territory. The assumed Solar Zone factors for each state are set out in the table below. Although a number of the states have different solar zones it was necessary to decide on a single zone for each state because more detailed data is not availabile.

ACT	1.382
NSW	1.382
NT	1.622
QLD	1.536
SA	1.382
TAS	1.185
VIC	1.185
WA	1.536

On the basis of our analysis we have projected additional MW capacity in solar PV of 7.5 MW per year in the low case, 15 MW in the medium case and 30 MWs per year in the high case. In the high case, solar PV becomes one of the most significant sources of additional non-wind capacity in the period to 2020.

Finally we note that there has been significant change in the cost of conventional silicon PV technology, with very considerable cost declines in the recent past, attributable in part to the global economic slow down. These cost declines do not yet appear to be reflected in the price of installed PV systems. It is possible that if these cost declines are reflected in price decreases, the demand for residential PV systems will continue at the high rate of the last two years, despite a decline in the expected level of the subsidy.

2.1.3 Wave and tidal

Wave and tidal power are at the pre-commercial stage in Australia. There is one operating plant at Port Kembla and a small number of ocean wave projects under development in Australia and these are included in our projections. Wave and tidal power is not expected to make a significant contribution.

2.1.4 Non-PV solar

Solar power plants do not generate a significant quantity of electricity in Australia in 2008. All known proposed non-PV solar are included in CME's register of renewable electricity plants. Non-PV solar may be a significant generator of renewable electricity generation in the future. The details of proposed non-PV solar are included in the renewable electricity generation register. The information on the register includes start year, plant size, capacity factor, electricity generation, development status and ordinal ranking of proposed plants.

There are 6 proposed non-PV solar plants included in CME's register of renewable electricity generators. Solar Systems' proposed non-PV solar plant in the Wimmera is accorded the highest probability of success during the expanded RET period.

2.1.5 Biomass

Biomass is a significant source of electricity generation in Australia. There are 126 electricity generation plants that use biomass as an energy source. The projections of RECs created from existing biomass plants is based on past generation performance and knowledge of proposed expansion of existing plants.

As of the end of October 2008, the RE database of renewable electricity generating plants included 89 proposed biomass electricity generators. The sources of proposed biomass are very diverse, ranging from large-scale wood waste plants and bagasse plants to small-scale food waste plants. The timing of proposed biomass plants, the MW capacity of plants and capacity factors of plants is based on information gathered from industry sources and research over the past decade.

The low supply scenario includes 146 operating and proposed biomass sourced electricity generation plants. The high biomass scenario includes 168 biomass plants. A number of proposed biomass plants have run into difficulties over the past 12 months. We have excluded proposed biomass plants where the owners have gone into liquidation.

It is important to note that fossil fuel plants co-firing with biomass are included in the register of renewable electricity generators as biomass plants. There are three coal-fired plants using various forms of biomass waste as a co-firing source. Such co-firing may increase in future.

2.1.6 Geothermal

Geothermal energy may become a major source of electricity generation in Australia in the future. There is great potential to generate electricity from "hot dry rocks" in Australia. However electricity generation from geothermal sources is at the pre-commercial stage. There is only a small amount of electricity generation in Australia from geothermal sources in 2008.

The projections from proposed geothermal electricity generators are based on assessment of all known geothermal plants under development. CME has evaluated proposed geothermal electricity generation plants and set start up dates, plant capacity, plant capacity utilisation and prospective ranking of proposed geothermal plants. Upper and lower possibilities for the rate of geothermal expansion are included in the high and low scenarios.

The low supply scenario for geothermal plants includes Geodynamics Innamincka pilot and demonstration plant. The low supply scenario also includes Petratherm's proposed Paralana pilot plant. The high supply scenario includes the proposed geothermal plants that we know of. We have modified the output and timing of these plants from the levels claimed by proponents, after reviewing papers available from the Geothermal Association of Australia, and research documents on generating electricity from hot dry rocks in Australia in internationally.

2.1.7 Solar Water Heaters

Solar water heaters make a significant contribution to the creation of RECs in Australia and strong growth in the installation of solar water heaters is anticipated in the future. Federal and State government rebates, State and Territory government regulations, REC prices, energy prices and environmental preferences are important drivers of solar water installation. Victoria's 5 star housing policy for new homes has had a major impact on the volume of solar water heaters installed in Victoria. The projection of solar water heaters is based on estimates of the number of solar water heaters projected to be installed in each state and territory. Account is also taken of variations between the number of solar water heaters installed in each region and the number of solar water heaters registered for REC creation.

Solar water heaters are expected to continue to make a significant contribution to REC creation in the future. The quantity of RECs created from solar water heaters grew rapidly in 2007 and 2008. Both low and high supply scenarios assume that existing government rebates and regulations remain in place. The high supply scenario assumes that new government policies will be introduced to stimulate an increase in the installation of solar water heaters. Future regulatory policies relating to solar water heaters in new homes are likely to be an important focus of policy makers.

2.1.8 Wind

The challenge in predicting investment in wind generation is to decide which of the 14,400 MW of proposed and existing plant in the RED model will be developed. We have developed two approaches and the results we have derived are based on the average of the outcome for these approaches. The two approaches are:

- **Probabilistic:** We assigned a probability ranking (a number from one to ten) to each of the 200 existing and prospective future wind farms in our database. A score of 10 is for plant operating or under-constuction. A score of 1 applies to plant that will only be developed far into the future, if at all, and which we think is less likely to proceed. The probabilistic approach weights the capacity to be developed based on the ranking. So, a wind farm that is ranked 10 will have 100% of its capacity included, while a project ranked 1 will only have 10% of its capacity included. For each of the wind farms, we have then run all prospective wind-farms through the RGE model. This model uses an investment decision analysis: if the present value of the expected revenues over the life of the plant is greater than the present value of the expected cost, it is assumed to be built and hence included in the probabilistic assessment. If this investment criterion is not met, then the wind farm is not eligible to be included in the probabilistic assessment.

- **Deterministic:** The deterministic assessment is based on excluding all wind-farms ranked three or lower in the RE database. The remaining windfarms are then subject to the investment criterion in the RGE economic model. Wind farms that satisfy the investment test are then included in the calculation of investment and REC creation.

The RGE model assumes that wind farms will be commissioned halfway through the year.

The MSWG asked us to produce projections of wind investment to 2028. There are currently no wind farms in the RED model expected to be commissioned after 2020. To develop projections of wind generation entry for the period 2020 to 2028 we set an annual investment test based on whether or not the Long Run Average Cost (LRAC) of wind-farms in each state is less than the expected price of electricity in that state plus the expected REC prices. If this criterion is satisfied, an additional amount of wind capacity (based on the average annual additional capacity for that state for the period 2009 to 2020) is assumed to be commissioned.

A particular difficulty is how projected REC prices will change after 2020 once the MRET scheme is progressively phased-out. The current Government policy is that the MRET scheme is to be phased out as emission prices increase. The MRET target is kept constant at 45 million RECs per year from 2020 to 2024, but then rapidly declines after that. If the MRET target is met by 2020, then it is highly likely that the REC price will drop significantly immediately after that – because by then supply will exceed demand (by defintion, since the target is met). However, our modelling shows that in likely scenarios, on the basis of the electricity price assumptions provided by the MSWG, the target will not be met with REC prices of $43/REC unindexed from 2010. If the target is not met, then REC prices will not decline after 2020 and probably not until after 2024 when the MRET target begins to fall away. To take account of this we have included functionality in the RGE model, for the REC price to remain at the maximum penalty level up to 2024, after which it will drop to zero.

Even assuming that REC prices will continue at the price of the penalty for non-compliance for four years from 2020 to 2024 is still not sufficient to attract new wind entry after this date.

2.1.9 MRET demand

The MRET demand assumption is based on the information provided in the exploratory draft legislation.

2.1.10 Green Power Demand

GreenPower demand is based on the expected actual demand in 2008. For the high and low scenarios the rate of growth of demand is expected to decline over the next five years, but at different rates. For the low scenario, total GreenPower demand for the period 2008 to 2020 is expected to be 13% of the total MRET REC demand for this period. For the high scenario, it is expected to be 18%. In both cases, GreenPower is expected to decline relative to the demand from the MRET: in 2008 GreenPower demand is expected to be around 26% of the MRET demand.

2.2 Wind-farm specific input assumptions

The common assumptions in the RGE model are summarised in Figure 1 below. In the updated modelling in this report, we have assumed a slightly lower capital cost of wind turbines of $2,800/kW (we had assumed $3000/MW previously) to take account of the very considerable decline in steel prices over the last six months.

Figure 1. Common assumptions

				%	rate	
Life of generator	25	years	**debt**	65%	8%	pre-tax
Capital cost in 2008	$ 2,800	$/kW	**equity**	35%	15%	post tax
Annual operating cost	$ 30	$/kW/year	**tax rate**		30%	
Annual escalation in per unit capital costs from 2008	-0.5%	percentage	**inflation rate**		2.50%	
Average commissioning delay (after 2008)	0	years	**Pre-tax real wacc**		8.8%	

Wind farm specific assumptions on the expected capacity factor and commissioning date of all wind farms have been made. These assumptions are based as far as possible from publicly information on the various wind farms. In some cases, we have needed to make our own assumptions, particularly on commissioning date.

The MSWG electricity price assumptions per state as summarised in Table 2 below.

Table 2 MSWG electricity price assumptions ($/MWh)

MSWG Electricity Price assumptions	2008	2009	2010	2011	2012	2013	2014	2015	2016
NSW	59.37	60.12	66.33	64.35	65.38	66.62	66.94	67.34	67.84
VIC	63.06	63.91	70.41	70.25	70.30	70.60	70.96	71.35	71.75
QLD	56.88	57.57	64.96	65.25	65.55	66.34	66.74	69.12	69.66
SA	60.74	61.52	68.78	68.92	69.23	71.32	71.69	74.03	74.54
TAS	60.11	60.88	68.17	68.35	68.63	68.98	69.39	71.76	72.30
WA	63.40	64.24	71.14	70.81	71.22	72.24	72.63	74.31	74.82

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NSW	69.25	69.80	70.45	71.01	71.76	72.40	73.03	73.77	74.66	75.47	77.08	77.88
VIC	72.56	73.54	74.62	75.08	76.01	76.95	77.95	79.87	80.85	82.28	84.24	86.37
QLD	70.73	72.54	73.58	74.06	74.58	76.41	77.09	79.09	80.20	81.79	84.61	86.52
SA	75.57	77.35	78.35	78.79	79.28	81.08	81.72	83.69	84.77	86.32	88.92	90.08
TAS	73.37	75.18	76.22	76.70	77.22	79.05	79.73	81.73	82.84	84.43	87.32	89.17
WA	75.96	77.43	78.44	78.92	79.57	81.05	81.79	83.62	84.69	86.14	88.66	90.30

3 Results: wind-farm capacity additions (MW) by state 2009 to 2028

3.1 Approach 1: RET target achieved

Table 3. Upper bound of additional generation capacity in wind (MW) using Approach 1.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cumulative Australia total	580	1,416	2,586	4,135	5,358	8,426	9,318	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832	10,832
Australia total	580	836	1,170	1,550	1,223	3,067	892	1,514	-	-	-	-	-	-	-	-	-	-	-	-
NSW	-	142	128	856	560	226	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VIC	486	492	556	393	288	1,763	432	252	-	-	-	-	-	-	-	-	-	-	-	-
QLD	-	-	124	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SA	95	71	195	191	105	609	300	1,182	-	-	-	-	-	-	-	-	-	-	-	-
TAS	-	130	160	-	-	160	30	-	-	-	-	-	-	-	-	-	-	-	-	-
WA	-	1	7	110	270	309	130	80	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 Lower bound of additional generation capacity in wind (MW) using Approach 1.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cumulative Australia total	282	793	1,101	1,367	2,023	2,443	2,554	2,673	2,701	2,701	2,701	2,701	2,701	2,701	2,701	2,701	2,701	2,701	2,701	2,701
Australia total	282	512	307	266	657	420	111	119	28	-	-	-	-	-	-	-	-	-	-	-
NSW	-	135	80	202	426	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
VIC	182	227	60	-	-	114	15	-	-	-	-	-	-	-	-	-	-	-	-	-
QLD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SA	100	32	32	-	15	173	78	104	28	-	-	-	-	-	-	-	-	-	-	-
TAS	-	117	120	-	-	104	18	-	-	-	-	-	-	-	-	-	-	-	-	-
WA	-	1	15	64	216	28	-	12	-	-	-	-	-	-	-	-	-	-	-	-

Table 5 Central estimate of additional generation capacity in wind (MW) using Approach 1.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cumulative Australia total	520	1,319	2,178	3,066	4,006	5,425	5,883	6,590	6,649	6,649	6,649	6,649	6,649	6,649	6,649	6,649	6,649	6,649	6,649	6,649
Australia total	520	799	859	888	941	1,418	458	708	59	-	-	-	-	-	-	-	-	-	-	-
NSW	-	170	88	513	474	45	32	29	-	-	-	-	-	-	-	-	-	-	-	-
VIC	420	444	431	158	216	739	139	29	1	-	-	-	-	-	-	-	-	-	-	-
QLD	-	-	37	-	-	18	131	5	-	-	-	-	-	-	-	-	-	-	-	-
SA	100	67	167	144	35	432	105	592	58	-	-	-	-	-	-	-	-	-	-	-
TAS	-	117	120	-	-	104	18	-	-	-	-	-	-	-	-	-	-	-	-	-
WA	-	1	15	73	216	81	33	52	-	-	-	-	-	-	-	-	-	-	-	-

3.2 Approach 2: REC penalty capped at $43/REC

Table 6. Additional wind generation capacity (MW) using Approach 2

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cumulative Australia total	508	1,272	2,081	2,801	3,673	4,767	4,918	5,529	5,556	5,556	5,556	5,556	5,556	5,556	5,556	5,556	5,556	5,556	5,556	5,556
Australia total	508	764	809	720	873	1,094	151	611	28	-	-	-	-	-	-	-	-	-	-	-
NSW	-	135	80	452	426	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
VIC	409	444	426	64	216	530	55	-	-	-	-	-	-	-	-	-	-	-	-	-
QLD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SA	100	67	167	140	15	432	78	555	28	-	-	-	-	-	-	-	-	-	-	-
TAS	-	117	120	-	-	104	18	-	-	-	-	-	-	-	-	-	-	-	-	-
WA	-	1	15	64	216	28	-	52	-	-	-	-	-	-	-	-	-	-	-	-

It should be noted that the same low level of wind generation entry in Approach 2 arises under both the upper and lower bound assumptions. This is because the assumed REC price and electricity prices are not sufficiently high to attract large amounts of investment in wind generation.

4 Investment in non-wind capacity

The investment in non-wind REC eligible renewable capacity (other than solar water heaters) is shown in Tables 7,8 and 9.

Table 7 Lower bound estimate of investment in non-wind capacity (MW)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Biomass	43	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	8	1	-	-	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydro	257	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ocean Wave	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar	6	1	19	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar PV	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5								
Tidal	0	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8 Central estimate of investment in non-wind capacity (MW)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Biomass	200	76	9	-	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	8	1	-	-	47	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydro	295	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ocean Wave	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar	6	1	19	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar PV	15	15	15	15	15	15	15	15	15	15	15	15								
Tidal	0	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 9 Upper bound estimate of investment in non-wind capacity (MW)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Biomass	200	78	21	96	36	-	51	14	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	8	1	47	53	47	28	-	29	634	544	32	29	-	-	-	-	-	-	-	-
Hydro	385	-	301	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-
Ocean Wave	-	25	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar	6	35	19	42	-	-	-	75	-	-	-	-	-	-	-	-	-	-	-	-
Solar PV	30	30	30	30	30	30	30	30	30	30	30	30								
Tidal	0	5	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

5 Limitations of this analysis

This report has produced projections, rather than forecasts. The following limitations should be borne in mind when interpreting these projections:

- We have assumed that the penalty to be paid for not surrendering a REC by those with compliance obligations will be $43 non-deductible and unindexed. The Government's decision on this has yet to be announced.
- We have assumed that there are no barriers to entry in the form of transmission constraints or similar factors. In other words we have not specifically excluded some prospective wind farms on the basis of transmission limitations, easement problems of local planning consents.
- Approach 1 assumes the revised RET and expected GreenPower demand will be met. This is simply an assumption of this approach, and does not reflect our expectation of what will necessarily occur.
- The price of wind turbines is volatile and over the past few years has been rising. At the time of writing two significant counter-acting factors (the collapse of the spot price of steel and the devaluation of the Australia dollar relative to the Euro and US Dollar) may give rise to significant differences in the actual future price of wind turbines relative to the prices assumed in this study. We have attempted to account for this in the updated draft by reducing the estimated capital cost from $3000/kW to $2,800 per kW.
- Local factors affecting wind farm economics have not been taken into account. Some wind farms may have much higher Marginal Loss Factors compared to others, and the capital cost of some plants may differ significantly from others due to transmission connection charges, the choice of turbine or other factors.
- Plant capacity factors are generally based on information provided by project proponents. In some cases we have varied this if the proposed factors were implausible.
- In many cases we needed to estimate the expected commissioning date of possible future wind farms, because developers of prospective wind farms have

not always made this information available. This is mainly the case for wind farms that may be developed after 2013.

- Much less reliance should be placed on projections of investment after 2020. Such investment is projected based upon a simple formulation rather than an analysis of actual proposed wind farms, and the analysis makes assumptions that REC prices will be negligible after 2024.