Business opportunities in a low carbon economy

Final report
Industry and Investment NSW

17 September 2010

Ernst & Young

Contents

1. Executive summary

1.1 Project overview

Climate change, and the policy action directed at responding to climate change, is creating opportunities and challenges for NSW industry over the next decade. It is shifting incentives towards renewable and lower emission electricity generation technologies, with the largest consequence being the implementation of commercially proven technologies. Climate change is also expanding market demand for carbon-reducing technology, product and services for use across a variety of industries.

The NSW Government has recognised that there are significant opportunities for companies and economies that are positioned to invest in, and deliver solutions to support this transition to a low carbon economy. Industry and Investment New South Wales (I&I NSW), on behalf of the NSW Innovation Council, commissioned Ernst & Young to deliver this 'Business opportunities in a low carbon economy' (LCE) report to provide a greater understanding of specific growth opportunities and barriers in a low carbon economy across a number of industries.

Prior to Ernst & Young being engaged to deliver the LCE report, I&I NSW, in concert with government stakeholders, identified eight industries to be included in the LCE project:

- Grid solutions
- Green buildings
- Waste conversion
- Low emissions vehicles
- Solar energy
- Wind energy
- Geothermal energy
- Business services

The eight target industries were selected based on several criteria, including the degree to which NSW companies are already active in the industry, the natural resource potential of NSW and the presence of policy drivers or a dominant technology that might provide a level of certainty. Importantly, each selected industry would align with and enhance, not duplicate, other government projects.

The key trends, supply chain, market value and potential opportunities within each of the eight industries were analysed, and over 90 discrete business opportunities were identified. Five specific opportunities were selected for detailed analysis:

- Developing software and applications for the integration, networking and management of grid-connected electricity
- Retrofitting of commercial buildings with energy efficient products
- Use of mid-scale solar installations in commercial, industrial and public facilities
- Increased generation capacity from wind farms
- Use of geothermal heat pumps in heating, ventilation and air conditioning (HVAC) systems in commercial, industrial and residential buildings

The opportunities were investigated as case studies to show drivers of supply and demand in NSW, estimates of market size and economic benefits and detailed analysis of any barriers to realise the opportunity.

Table 1: Project approach

Supply chain and market analysis of target Industries	Business opportunity identification and shortlisting	Detailed analysis of business opportunity case studies
1. Grid solutions 2. Green buildings 3. Waste conversion 4. Low emissions vehicles 5. Solar energy 6. Wind energy 7. Geothermal energy 8. Business services	► 92 business opportunities identified ► Shortlisted to five case studies, selected from across the eight sectors ► The five case studies include near and long term opportunities, and may deliver moderate to large economic gains for NSW	► Developing software and applications for the integration, networking and management of grid-connected electricity ► Retrofitting commercial buildings with energy efficient products ► Using mid-scale solar installations in commercial, industrial and public facilities. ► Increasing generation capacity from wind farms ► Using geothermal heat pumps in heating, ventilation and air conditioning systems in commercial, industrial and residential buildings

1.2 Drivers and barriers in a low carbon economy

The case studies investigated in this report highlight a number of key factors driving the transition to a low carbon economy. These include:

- **Increasing electricity prices:** Australia's relatively low electricity prices are expected to increase significantly as future network costs are passed through and infrastructure upgrade costs are added on.
- **Increasing electricity consumption:** As electricity consumption increases, particularly at peak times, spikes in demand are addressed through the use of extra power plants which may only be required for a fraction of the entire year. In this context, renewable energy sources, and distributed generation sites become increasingly attractive.
- **An implied price on carbon:** The establishment of an explicit price on carbon in Europe, and the expectation of pricing in other jurisdictions is driving investment decisions to support lower emission products and processes. Current action, although voluntary, is also taken as a hedge against future liabilities due to high emissions and/or high energy costs.
- **Policy action:** Federal and State policy drivers stimulating a low carbon economy include Australia's emissions reduction targets, the proposed development of a national carbon pricing mechanism, the Renewable Energy Target (RET), government investment in cleantech research and industry, energy efficiency incentives, government regulation and levies (e.g. on waste disposal).
- **Increasing global action on climate change:** Although strong global action on climate change was not achieved at Copenhagen, it is expected that countries will increasingly take on stringent national targets, and globally agreed targets may be set.
- **Changing market structure in the electricity industry:** The partial privatisation of the NSW electricity industry is likely to influence incentives and costs. It may also help to build smart grid momentum as private actors see the value in a smart grid future.
- **Decreasing technology costs:** The cost of clean technology solutions, most notably Solar Photovoltaic (Solar PV) and energy efficient products, are falling as a result of significant R&D investment, and due to growing global markets.
- **Consumer and business sentiment shift:** As climate change action gains momentum globally and in Australia, a continued shift in consumer and business sentiment is expected, driving 'green' purchases such as low emissions vehicles, green building products and renewable energy options.

The case studies also highlight a number of common barriers that need to be overcome in order to ensure the growth of low carbon industries between now and 2020.

- **Regulatory uncertainty:** Investment decisions relating to clean technologies will be postponed or avoided as long as there is uncertainty regarding the nation's approach and ambition towards climate change. The ongoing uncertainty damages the business case for investment, and financial viability of early stage firms.

- **Lack of a price on carbon:** Until an explicit price on carbon is introduced, electricity prices remain lower than if the true price of carbon were reflected in costs of fossil fuels. As a result, investments in low carbon economy opportunities are deterred in three areas:

  - **Renewable energy:** The price of electricity depends on the relative cost of competing sources of generation. Although the costs of renewable energy are reducing, they are still not cost competitive relative to fossil fuel-fired electricity generation.

  - **Other Cleantech Industries:** Clean technology costs are expected to decrease, in some cases significantly between now and 2020 but the current relatively high costs will deter investment in these technologies in the absence of ample subsidies.

  - **Traditional energy sources:** In the face of increasing uncertainty regarding carbon pricing, efficient investments in coal generation will also be delayed, thereby further constraining supply at a time of rising demand.

- **Low electricity prices:** Compared to many major economies, where energy costs represent a significant cost to business, historically low electricity prices in Australia have provided a weak incentive to reduce energy consumption.

- **High capital costs and long payback periods:** Many clean technologies require significant upfront investment and result in long pay back periods. This is compounded by the lack of a price on carbon and continued relatively low electricity prices, meaning that anticipated energy savings are undervalued. Long payback periods tend to discourage investors who place a higher value on the upfront cost outlay. Policies that provide subsidies for the uptake of certain renewable technologies go part of the way to rectify this issue.

- **Lack of knowledge/understanding:** Despite significant evidence of expected rises to energy prices over time, the majority of energy consumers appear not to be fully appreciative of the impact on their overall costs, nor modifying behaviour in preparation for higher costs. As a result, there is low knowledge and/or interest in some low carbon options by potential consumers. In addition to low consumer demand for certain solutions, a lack of understanding regarding clean technologies on behalf of money lenders can reduce access to finance for early-stage, low carbon-related firms.

1.3 Estimated market size of target industries

Ernst & Young has estimated the total market value of the target industries in 2020 to be between **$6.8B and $10.9B** annually, delivering around **23% year on year growth** over the next 10 years. All potential market values shown in Table 2 are on a per annum basis. Forecast capital expenditure between 2010 and 2020 has been annualised for reporting purposes. The growth numbers have been based on a variety of assumptions outlined in Section 2.6 including the introduction of an explicit price on carbon in 2014.

Table 2: Summary of market value estimates[1]

Sector	Description[2]	Market value ($M) – NSW 2020		Employment prospect (Full Time Equivalent) – NSW 2020	Employment Allocation (Full Time Equivalent) – NSW 2020
		Low	High		
Grid Solutions[3]	Infrastructure, products and services that support energy transmission and distribution, upgrade the electricity grid, expand capacity, improve efficiency and allow connectivity with intermittent sources of energy such as renewables.	90	120	360-680	Construction: 175-335 Operation: 185-345
Green Buildings	Technologies and designs that reduce the consumption of energy in the construction and ongoing life cycle of buildings	3,280	3,930	17,110-20,530	Construction: 7,697 -9,236 Operation: 9,413-11,294
Waste Conversion[4]	The removal of substances, materials or energy out of discarded materials or waste	860	1,030	1,250-1,620	Construction: 438-564 Operation: 812-1,056
Low Emissions Vehicles[5]	Low carbon fuels, technologies and infrastructure requirements for the introduction of low emissions vehicles (LEVs). Including alternative power vehicles, alternative fuel vehicles, and more efficient internal combustion engine (ICE) vehicles	1,440	1,730	3,780-4,540	Construction: 340-412 Operation: 3,440-4,128
Solar Energy[6]	The generation of energy using Solar PV or concentrating solar thermal technologies to convert solar radiation into electricity	210	320	1,350-2,030	Construction: 980-1,470 Operation: 370-560
Wind Energy	The conversion of wind energy to a useful form of energy, such as electricity through the set up and operation of on-shore wind turbines and farms	230	490	2,740-5,990	Construction: 2,400-5,101 Operation: 340-889
Geothermal Energy[7]	Convert geothermal reserves of heat in the ground to energy via conventional or enhanced geothermal systems	0	760	0-2,500	Construction: 0-1,883 Operation: 0-617
Business Services[8]	Legal, accounting, finance, project management sectors and other technical and consultancy business services that have grown from a carbon constrained economy	650	2,540	2,950-12,150	Construction: Operation: 2,950-12,150
TOTAL		**6,760**	**10,920**	**29,540-50,040**	Construction: 12,030-19,001 Operation: 17,510-31,039

Source: Ernst & Young estimates

The market values shown in Table 1 above are in 2010 dollar values. The market values are based on the value of capital expenditure within the industry segment and the value of sales of the final product within the industry segment in the year being assessed. For example, within the wind energy market segment the market value of the final product within the industry segment is the value of the electricity supplied to the grid and purchased by consumers. The market value of capital expenditure is the value of expenditure on wind farm components and materials.

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[1] Based on a variety of assumptions listed in each of the respective chapters
[2] The description of each sector is as analysed in each chapter, however market estimates may be based on a more narrow subset of each sector
[3] Market and employment numbers are based on the roll out of smart-meters in households NSW only, a portion of the total smart grid market.
[4] Includes waste to energy and waste to fuel generation
[5] Market estimates based on hybrid electric vehicles only. Sales persons who might be employed in car sales in any case comprise a large proportion of the operations employment numbers.
[6] Includes large and small scale solar PV installation only.
[7] Large scale generation only. Stakeholders suggest that the market will either thrive or die, and there is unlikely to be a moderate growth scenario given the high capital expenditure involved and depending on whether the technology will be commercialised by 2020.
[8] Market size has only been established for accounting, finance, legal and project management sectors

It should be noted that this analysis does not account for the substitution effect that will be prevalent within the clean energy industry due to the finite supply of capital and aggregate level of energy demanded. Total figures should therefore be interpreted with caution as there is likely to be some overlap between industries and some substitution of renewable solutions.

1.4 Key features of opportunities investigated in case studies

The case studies provide detail on five business opportunities, selected from a broad range of opportunities identified across the eight sectors considered. The five case studies show drivers of supply and demand in NSW, estimates of market size, employment and economic benefits and current barriers to realising opportunities. Consistent underlying price, investment and information barriers are evident across the diverse opportunities. Importantly the case studies show not only the influence of a price on carbon but also the influence of a variety of policy and market drivers.

Table 3: Market value of five case studies

Sector	Market value ($M) – NSW 2020		Economic benefit ($M) – NSW 2020		Employment prospect FTE– NSW 2020
	Low	High	Low	High	
Smart grid software[9]	69	127	27	50	611-1,145
Commercial retrofits	108	433	25	99	807-3,229
Mid-scale solar[10]	17	89	7	39	228-1,206
Wind energy	226	494	97	212	2,738-5,990
Direct use geothermal	6	140	1	28	33-811

Source: Ernst & Young estimates

The market values shown in the table above are shown in 2010 dollars at current costs. The market values have been calculated based on the value of the final good produced within the industry segment and the capital expenditure forecast to be undertaken within the industry. The economic benefits have been calculated for NSW using an input –output methodology to determine the contribution to the industry segments to the NSW economy.

[9] Estimates based on the global value of smart grid IT hardware and software
[10] Does not include installations on industrial buildings due to data limitations.

1.4.1 Software and applications for the integration, networking and management of grid-connected electricity

Market size and economic impact in 2020	► **Market size**: \$69M - \$127M, resulting in \$27M to \$50M of economic benefits for NSW per annum ► **Employment**: 600 -1,100 people ► **Impact on energy usage**: The rollout of smart meters alone will reduce total electricity usage by 4% to 10%[11]
Key drivers	► **Growing energy demand**: An increasing population and growing energy demand are placing additional pressures on the ageing grid. In particular, the increased use of air-conditioning units and other cooling devices add to peak demand. ► **Ageing grid**: Smart grid applications could allow electricity to be used more efficiently, facilitate integration of distributed energy generation sources to provide local power and reduce reliance on the grid. Consequently, upgrades to the ageing grid could be deferred. ► **Policies to address climate change**: Meeting Australia's Renewable Energy Target (RET) requirement for 20% renewable energy by 2020 will require a smarter grid as dispersed sources of electricity are increasingly installed. The introduction of a carbon price will further incentivise its development as electricity becomes increasingly more expensive. ► **ICT expertise**: NSW is well-positioned to lead development of software and applications due to the strength of the ICT sector in NSW, including a strong export base.
Key barriers	► **Lack of knowledge/understanding:** Developing successful software solutions will require a deep understanding of the smart grid which is very complex. ► **Consistent standards:** Australian and international authorities have yet to agree on common standards for many applications and areas of the smart grid. This is crucial for the software market's efficient development and access to export opportunities. ► **Lack of customer engagement**: The majority of customers are not yet engaged with the concept of smart grids, caused by a lack of information and understanding of smart grid technologies, and also unrealistic expectations of cost and energy savings. ► **Absence of regulatory framework:** A smart grid vision, implementation plan and associated targets would help to provide greater certainty for businesses.

1.4.2 Retrofitting of commercial buildings with energy efficient products

Market size and employment impact in 2020	► **Market size**: \$108M to \$433M, resulting in \$25M - \$99M of economic benefits for NSW per annum ► **Employment**: 800 – 3,200 people ► **Impact on energy usage**: Up to 25% energy savings
Key drivers	► **Energy savings:** Energy efficient products and processes will reduce energy consumption and costs. These savings will be particularly evident to organisations that have the ability to monitor and adjust energy consumption. ► **Reputational benefits:** Organisations can use energy efficiency to build a profile of Corporate Social Responsibility. ► **Financial management**: Current investments in energy efficiency can reduce susceptibility to volatile energy prices and carbon price increases in the future. ► **Policy drivers**: Regulation, incentives and rebates, primarily from the NSW Government, are supporting company action to reduce energy usage.
Key barriers	► **Low rate of return on investment:** Electricity prices are a less significant business cost in Australia compared to major economies such as Japan, UK, and Germany[12]. Even if carbon prices increase in Australia, energy may still represent only a small proportion of overall business costs, providing a weak incentive for action. ► **Split incentives:** Investment by building owners to improve energy efficiency leads to economic benefits for the tenant. On the other hand, a tenant is reliant on the owner to implement cost saving measures, yet the owner has little incentive due to no personal rewards from investment. ► **Lack of information:** There is a lack of accurate, detailed and timely data on energy use which could be used to establish a definitive case for investment.

[11] Total Environment Centre, Advanced Metering for Energy Supply in Australia
[12] IMD World Competitiveness Yearbook 2009

1.4.3 Use of mid-scale solar installations in commercial, industrial and public facilities

Market size and economic impact in 2020	► **Market size**: $17M to $89M, resulting in $7M - $39M of economic benefits for NSW per annum ► **Employment**: 200 -1,200 people ► **Impact on energy generation**: 60 - 250 MW, excluding the potential from industrial buildings
Key drivers	► **Government policies**: As mid-scale solar is currently not price-competitive, demand is currently driven by electricity feed-in tariffs (where available) and the price of Renewable Energy Certificate (RECs). Requirements for meeting National Australian Built Environment Rating System (NABERS) 4.5 star rating in all Government buildings could also drive investment in solar installation in public buildings. ► **Reputational benefits:** Mid-scale solar is appealing for corporate social responsibility reasons ► **Appropriateness of building:** Large retail centres, suburban offices and industrial buildings suit solar installations, since roof space is abundant and energy usage is high. The aspect of the building also determines thermal quality. ► **Ageing grid:** As appropriate buildings for mid-scale solar installation are dispersed across the State, rollout of solar generation on buildings provides an opportunity to increase distributed generation and relieve pressure on the grid.
Key barriers	► **Payback periods:** Ernst & Young estimates suggest that payback periods for mid-scale solar are over 16 years, which deters investment in this technology. ► **Regulatory and cost uncertainty:** Investors in mid-scale solar PV await certainty on policy in Australia and future anticipated cost reductions. Without these, investments will be deferred. ► **Structural building issues:** Large PV installations may require significant load-bearing capabilities. ► **Knowledge gap:** Building asset owners and managers have not typically been involved in energy generation and retailing, which causes reluctance to enter into costly capital expenditure with limited expertise. In particular, stakeholders express discomfort with the logistics of installing renewable energy and its actual costs.

1.4.4 Increased generation capacity from wind farms

Market size and economic impact	► **Market size**: $226M - $494M, resulting in $97M to $212M of economic benefits for NSW per annum ► **Employment**: 2,700 – 6,000 people ► **Impact on energy generation**: An additional 2,000MW - 3,500 MW capacity between now and 2020
Key drivers	► **Government policies:** The demand for wind-generated power by retailers is primarily determined by the RET - a legislative requirement for energy retailers to source an increasing percentage of their energy from renewable sources. ► **Relative price competitiveness compared to other renewables:** Wind energy is currently the most economically viable amongst renewable energy sources and is providing a large portion of the RET requirement. ► **Natural resource:** Investment in wind generation in NSW is driven by knowledge of the available high quality wind resource. ► **Infrastructure**: With transmission lines nearing capacity in the wind-rich States of South Australia and Western Australia, there is an opportunity for NSW, which has sound grid infrastructure, to provide the remaining capacity required to meet the RET.
Key barriers	► **Relative price competitiveness of coal and gas generated energy:** Additional demand for wind power beyond the RET is considered unlikely between now and 2020, despite forecast increases in the carbon and electricity price. ► **Lack of pre-agreed purchasers:** Stakeholders report difficulties in obtaining long-term Power Purchase Agreements which provide a guaranteed future stream of income from the RECs generated. ► **Planning processes:** Stakeholders seek a faster planning approval process, and perceive the process to be under-resourced, despite improvements. ► **Grid connections:** Stakeholders voice concern over the complexity of connection processes with the National Energy Market (NEM) and difficulties in negotiations with network service providers.

1.4.5 Use of geothermal heat pumps (GHPs) in heating, ventilation and air conditioning (HVAC) systems in commercial, industrial and residential buildings

Market size and economic impact	► **Market size**: \$6M - \$140M, resulting in \$1M to \$28M of economic benefits for NSW per annum ► **Employment**: 30-800 people ► **Impact on energy generation**: 29MW to 645MW
Key drivers	► **Increasing demand for air-conditioning systems:** Market penetration for HVAC has increased from 35% to 65% over the past decade and industry revenue is expected to continue to grow at 6% per annum in the near term. ► **Relative cost-effectiveness of GHPs:** Evidence shows that efficiency savings are greater for GHPs, compared to alternative HVAC systems. The payback period is estimated to be between 6 and 16 years depending on the assumptions and application scale. Government subsidies would further truncate the payback period. ► **Appropriateness of buildings:** GHPs are most suitable in high occupancy or high energy use buildings but have a wide applicability to different scales and uses. They also tend to be more cost competitive for off-grid buildings whose alternative power source is high cost fuels such as LPG. ► **Maturity of technology:** GHP has seen significant take-up over North America and Europe and is gaining increasing prominence in these areas due to carbon pricing and government incentives.
Key barriers	► **Lack of knowledge/understanding:** There is a general lack of awareness of GHP technology in Australia because the market is very much in its infancy, both from the point of view of customers and government. This lack of awareness leads to a reluctance to invest and also hinders availability of finance. ► **Technology-biased policies:** Several State and Federal policies to incentivise uptake of renewables are not always technology-neutral in their specification, leading to the exclusion of GHPs in some cases. ► **Long payback periods:** Despite significant energy savings, the 6 to 16 years payback period discourages some investors. This problem is exacerbated by the current lack of a carbon price which means the technology competes against a very low electricity price, making it even less cost effective.

1.5 Report structure

Section 2 explains the approach and methodology underlying this work and provides a contextual overview of the drivers and barriers to a low carbon economy including existing Federal and NSW policies.

Section 3 provides a high level overview of the eight target industries highlighting sector trends, NSW strengths and barriers and market analysis. Published data and stakeholder feedback were used to identify a number of specific opportunities for growth within each industry in NSW.

Section 4 presents the detailed case studies of five business opportunities, showing drivers of supply and demand in NSW, market analysis, estimates of economic benefits, and a detailed analysis of current barriers.

The appendixes show the list of stakeholders consulted, related government policies, and underlying assumptions used in market size calculations.

2. Project background

2.1 Limitations of this work

The nature and content of any analysis that we have provided necessarily reflect the specific scope and limitations of our engagement, the accuracy and quality of the information that was provided to us (both from published sources and industry provided) and the timescale within which the advice was required. The services provided in this engagement were advisory in nature and thus did not constitute an audit or review in accordance with Australian Auditing Standards or an engagement to perform Agreed-Upon-Procedures.

The information contained in this document is provided on the basis that it neither represents nor is intended to be legal, tax, investment or other professional advice. Interested parties must take steps to verify the information contained in this publication, as well as any additional or supporting information supplied, prior to acting or relying on such information. If expert advice is required, competent professional advice should be obtained. Ernst & Young gives no representations or warranties as to the accuracy or completeness of the data, views, conclusions, comparisons or insights contained in this publication. Ernst & Young expressly disclaim all responsibility and all liability to any third parties that rely upon the information contained within this report.

A considerable element of the report comprises the views of stakeholders. Ernst & Young engaged over 40 stakeholders including Australian businesses, industry associations, and academic institutions. In addition, we engaged with personnel across NSW Government to understand current and developing policies. The views contained in this report do therefore not represent those of Ernst & Young. It was not within the scope of this project to verify any of these statements. However, where possible, these are reported as a consensus view across the stakeholder group. Ernst & Young has endeavoured to reflect accurate and up-to-date information about relevant Federal and NSW Government policies, but this may not be exhaustive and should therefore not be taken as accurate statements of government policy. In documenting the current state of policy it should be noted that the report accounts for policies announced before September 17^{th} 2010.

2.2 Low carbon economy definition

A low carbon economy can be defined as an economy that:

- Uses clean, secure and affordable sources of energy
- Procures and manages resource-efficient, zero- or low carbon infrastructure, buildings, products and services
- Adopts accessible, efficient, low-carbon transport
- Influences consumer decisions based on resource impacts
- Incorporates high waste recycling and re-use of materials, and has the necessary local infrastructure for this
- Has strengths in innovation and diverse employment to respond quickly to economic drivers, such as a price on carbon
- Has high skills-development infrastructure to equip the current and future workforce for changing demands
- Has established sustainable public and private procurement practices

2.3 Drivers and barriers of a low carbon economy

The imperative to transition to a low carbon economy within the next decade is clear – estimates from the International Energy Agency (IEA) suggest that each year the world delays taking action on climate change, it will add an extra $500 billion onto the total cost of tackling the problem. This estimate is representative of the emerging consensus that early, strong action on climate change is much less costly than inaction – a view confirmed by influential publications such as *The Garnaut Climate Change Review*, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* and *The Stern Review*.

In addition to government policies, there are market trends that are driving growth, as well as a range of barriers that are impeding the transition to a low carbon economy.

2.3.1 Drivers of a low carbon economy

- **Policy action:** Governments worldwide are putting in place targets and policies to reduce emissions which will enable the world to avoid the threat of dangerous climate change by limiting the increase in global temperature to below 2 degrees. There is an international push to reduce carbon emissions and reliance on carbon intensive industries, as seen through the Kyoto and Copenhagen processes. Federal and State policy drivers stimulating a low carbon economy include Australia's emissions reduction target levels, development of a national carbon pricing mechanism, the RET, government investment in cleantech research and industry, government regulation and levies (e.g. on waste disposal). Federal policy actions are outlined in more detail in Appendix A.

- **Increasing electricity prices:** Current electricity prices in Australia are low relative to other countries, with Australia ranked as having the 10th lowest energy costs out of 57 countries[13]. This is expected to increase significantly as costs for improvement of the network and infrastructure upgrades are passed through to consumers.

- **An implied price on carbon:** Between now and 2020, a carbon price is expected to be introduced through an emissions trading scheme or equivalent market mechanism. This will mean that the opportunity cost of carbon permits will be added onto production costs and passed onto the end-user who will be increasingly incentivised to move away from carbon intensive goods to those which are low-carbon. In the case of electricity prices, the carbon price will serve to elevate the electricity price increase for carbon intensive fuel, strengthening the incentive to produce energy from renewable sources.

- **Technology costs decreasing:** As clean technology R&D progresses worldwide, costs will fall, making them more competitive against fossil fuel generation once a carbon price is imposed. In the face of increasing uncertainty regarding carbon pricing, efficient investments in coal generation will also be delayed.

- **Changing market structure in the electricity industry**: The NSW Government announced the Energy Reform Strategy on 1 November 2008. The Strategy includes the sale of retail arms of the three State-owned energy corporations. The Government received binding bids from potential acquirers on November 15 with the transactions to be executed by the end of 2010.

- **Increasing global action on climate change:** Although strong global action on climate change was not achieved at Copenhagen, it is expected that countries will increasingly take on stringent national targets and globally agreed targets may be set. This will increase the global momentum towards tackling climate change and may incentivise Australia to move from its 5% target towards its 25% goal should there be a global agreement commensurate with a scenario of stabilising CO2 emissions at 450 parts per million (ppm). Such an agreement would spur action in all sectors.

- **Consumer and business sentiment shift:** Currently there is some consumer appreciation of issues surrounding climate change in Australia, however this has not yet translated into a strong shift towards the purchase of low-carbon goods. This shift is starting to be seen in the corporate sector although a current lack of certainty surrounding medium-term climate change targets and policies is limiting this. As climate change action gains momentum globally and in Australia, a gradual shift in consumer and business sentiment is expected, which will drive 'green' purchases such as low emissions vehicles, green building products and others.

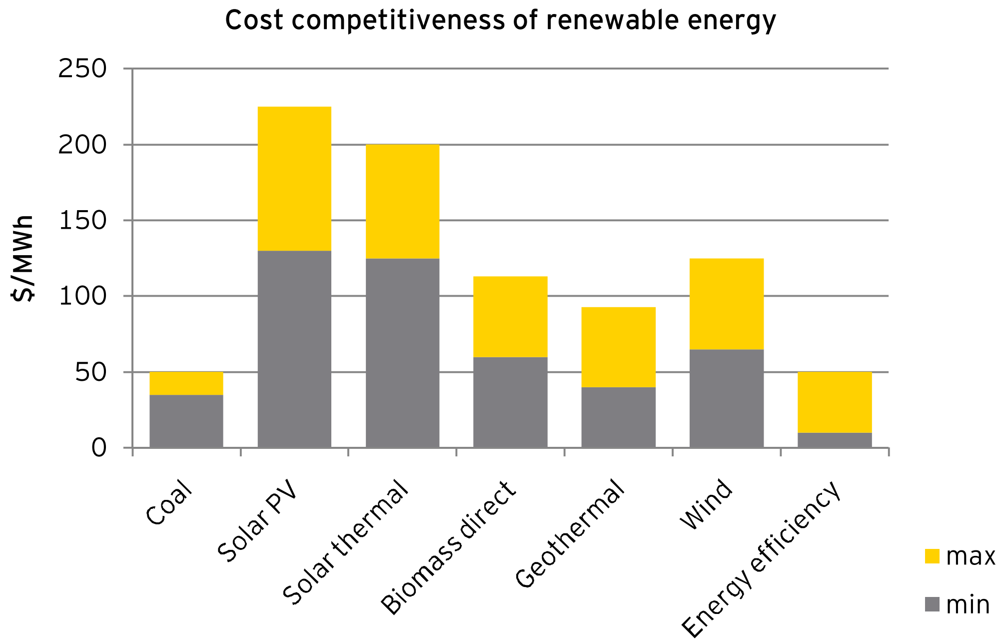
- **Increasing electricity consumption and an aging grid:** As electricity consumption increases, particularly at peak times, smoothing peak demand is becoming an increasing priority. Extra power plants are required to produce electricity for these peak periods which may only be required for a fraction of the year, thus making the capital cost outlay potentially cost ineffective. Additionally, the NSW grid requires upgrading in order to service growing demand and this is extremely costly. Renewable energy sources, and distributed generation sites offer potential solutions to both issues, although significant investment will be required to transition to a smarter, more efficient grid.

[13] IMD World Competitiveness Yearbook 2009

2.3.2 Overarching barriers

- **Cost competitiveness of cleantech industries:** Although the costs of renewable energy are reducing, they are still not cost competitive relative to fossil fuel-fired electricity generation. Technology costs are expected to decrease, in some cases significantly between now and 2020 but the current relatively high cost will deter investment in these technologies in the absence of ample subsidies. An illustration of the current cost differentials is provided in Figure 1: Cost competitiveness of renewable energy Figure 1.

Figure 1: Cost competitiveness of renewable energy



Source: Ernst & Young – Clean Technology 20/20 report, www.Unenergy.org,National associated of forest Industries. Scientific America. www.geodynamics.com.au (large scale geothermal extraction not direct use). Green Econometrics. World Nuclear Organisation. (These sources all have $/MWh estimates for a number of technologies and ranges have been constructed on the basis of these varying estimates.)

- **Lack of carbon price:** There is a substantial differential in the cost of energy between the traditional fossil fuel dependant energy generators and energy generated from renewable sources. This is primarily due to the fact that carbon is not currently factored into the cost of electricity, meaning that carbon intensive forms of generation are cheaper than they should be and are therefore over consumed relative to a world where the cost of the carbon emitted is factored into the electricity price.

- **High capital costs and long payback periods:** Many of these technologies require significant upfront investment and long payback periods. This will tend to discourage investors as they place a higher value on the upfront cost outlay. The purpose of policy induced subsidies currently available for the uptake of certain renewable technologies (i.e. solar) is to rectify this issue.

- **Lack of knowledge/understanding:** Despite significant evidence of expected rises to energy prices over time, the majority of energy consumers appear not to be fully appreciative of the impact on their overall costs, nor modifying behaviour in preparation for higher costs. As a result, there is low knowledge and/or interest in some low carbon options by potential consumers. In addition to low consumer demand for certain solutions, a lack of understanding regarding clean technologies on behalf of money lenders can reduce access to finance for early-stage, low carbon-related firms.

- **Regulatory uncertainty:** Whilst there is uncertainty regarding the nation's approach and ambition towards climate change, investors will face uncertainty about their investment decisions in clean technologies. This will defer and deter investment as the increased risk resulting from the ongoing uncertainty damages the business case for investment.

2.4 Policy context

Government has a vital role to play to ensure that businesses can realise their comparative advantage in a low carbon economy by unlocking the barriers and market failures that are inherent to the climate change policy area. National and State targets, together with existing and proposed policies, provide some impetus for firms to factor the carbon price into their behaviour and investment decisions. Government policies will guide the transition to a global low carbon economy in the coming decade and present both opportunities and challenges for businesses across all areas of the economy.

This section provides an overview of key Federal and NSW policies, but is not an exhaustive list. The key initiatives of relevance to this report include:

- Australian emissions targets
- Emissions trading scheme (ETS)
- Support for renewable energy
- Support for lower emissions energy
- Green buildings / Energy efficiency measures
- Other Federal initiatives

Further detail on relevant policies is provided in Appendix A.

2.4.1 Australian emission targets

In December 2007, Australia ratified the Kyoto Protocol to the United Nation's Framework Convention on Climate Change (UNFCCC), agreeing to limit Australia's annual carbon pollution to an average of 108% of 1990 levels during the Kyoto period (2008-2012).

The Australian Government has committed to reducing Australia's carbon pollution to 25% below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of greenhouse gases in the atmosphere at 450 parts per million CO2 equivalent or lower. If the world is unable to reach agreement on a 450 parts per million target, Australia will still reduce its emissions by between 5 -15% below 2000 levels by 2020.

The Australian Government has also committed to a long-term emissions reduction target of at least 60% below 2000 levels by 2050. If the world achieves the ambitious agreement required for the minus 25% target, the Government will seek a new election mandate for an increased target for 2050. NSW similarly aims to achieve a 60% cut in greenhouse gas emissions by 2050 in line with the Federal Government targets.

2.4.2 Emissions trading scheme

The proposed Carbon Pollution Reduction Scheme (CPRS) is an emissions trading scheme which uses a cap and trade mechanism to achieve the desired environmental outcome for Australia. Under the CPRS, the Government will set an annual limit (or cap) on the total amount of carbon pollution that can be emitted within Australia. Businesses are able to trade carbon permits, which will ensure that pollution reduction opportunities throughout the economy are harnessed, therefore reducing the economic cost of meeting Australia's carbon pollution reduction targets.

On 27 April 2010, the Prime Minister announced that the Government will delay the implementation of the CPRS until after the end of the current commitment period of the Kyoto Protocol and only when there is greater clarity on the action of other major economies including the US, China and India.

The NSW Government has been operating one of the world's oldest emissions trading scheme, the Greenhouse Gas Reduction Scheme (GGAS). Commencing in 2003, GGAS aims to reduce greenhouse gas emissions associated with the production and use of electricity, by using project-based activities to offset the production of greenhouse gas emissions. GGAS sets annual state-wide greenhouse gas reduction targets, and then requires individual electricity retailers to meet mandatory benchmarks. Monitoring the performance of participants is undertaken by the Independent Pricing and Regulatory Tribunal of NSW (IPART) and those who fail to meet their benchmarks are penalised. IPART is also the administrator of the scheme, and is responsible for assessing abatement projects, accrediting parties to undertake eligible projects, creating certificates, and managing the registration and transfer of certificates created from abatement projects.[14] GGAS will continue to 2020 or until a national emissions trading scheme commences.

2.4.3 Support for renewable energy

2.4.3.1 Renewable Energy Target

The Renewable Energy Target (RET) is an initiative of the Australian Government intended to deliver on the Government's commitment to ensure that 20% of Australia's electricity supply comes from renewable sources by 2020. This is estimated to represent 45,000 gigawatt-hours (GWh) in 2020. The RET encourages the deployment of both large and small-scale renewable energy technologies such as wind farms, solar, geothermal or hydroelectric power as well as household solar panels and solar water heaters. The RET creates a guaranteed market for additional renewable energy deployment using a mechanism of tradeable Renewable Energy Certificates (RECs).

In February 2010 the Government announced changes to the existing RET Scheme. From January 2011, the existing scheme includes two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). Entities such as electricity retailers currently liable under the RET will be obligated to purchase RECs from both the LRET and the SRES.

- The SRES has been designed to deliver households, small business and community groups $40 for each Renewable Energy Certificate (REC) created by small-scale technologies like solar panels and solar water heaters.

- The LRET's 41,000 GWh target for 2020 has been set to achieve a level of large-scale renewable electricity generation above what was expected under the existing RET. The new LRET annual targets (to commence in 2011) show a four-fold increase in large-scale renewable electricity generation over the next nine years.

2.4.3.2 Other incentives

- The NSW Solar Bonus Scheme provides financial incentives to people who produce renewable energy through eligible roof-top solar panels and micro-wind installations. The Scheme provides a gross feed-in-tariff of 60 cents a kilowatt/hour (kWh) for systems purchased prior to October 28th 2010, and 20 cents per kWh for the electricity generated from systems purchased after this date.

2.4.3.3 Government direct investment in research and industry support

There are a number of Australian and NSW Government programs to encourage innovation in clean energy and to attract expertise from overseas. These include:

- The Solar Flagships program worth $1.5 billion to support the construction of up to four large scale, grid-connected solar power stations in Australia, using solar thermal and photovoltaic technologies.

- Funding of $100 million for the Australian Solar Institute to undertake solar photovoltaic and solar thermal research.

- Six renewable energy precincts have been established across NSW in areas with the best-known wind resources in order to streamline the planning and approval process for wind developers. These include: New England Tablelands, Upper Hunter, Central Tablelands, NSW/ACT Border Region, South Coast and Cooma-Monaro.

- The $652.5 million Renewable Energy Fund to accelerate the development, commercialisation and deployment of renewable energy technologies in Australia, with funding earmarked for R&D into Gen2 biofuels and geothermal drilling as part of the Australian Government's 2010-11 budget.

- In the area of bioenergy, the NSW Government has supported significant research of second generation biofuels, biochar, carbon storage in forestry, and utilisation of excess biomass from forestry operations.

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[14] www.greenhousegas.nsw.gov.au

- NSW provides support for renewable energy investments including NSW-based applicants for the Federal Solar Flagships Program, wind developers seeking to establish in NSW, the Delta Mallee biomass trial, and the solar manufacturer, Silex Solar.

2.4.4 Support for lower emissions energy sources

A number of Australian and NSW Government programs encourage research to lower emissions of existing energy sources as well as adopt lower emissions energy sources. These include:

- The federally-funded Carbon Capture and Storage Flagships program worth $2 billion to support construction and demonstration of large-scale integrated carbon capture and storage projects in Australia, including gasification, post-combustion capture, oxy-firing, transport and storage technologies.
- The Australian Clean Coal Fund worth $500 million to support R&D, commercialisation and deployment of technologies to cut emissions from coal power generation in Australia and abroad.
- The NSW Clean Coal Fund worth $100 million over four years to provide funding for clean coal technologies.
- The NSW Government is also supporting natural gas supply and pipeline projects across NSW.

2.4.5 Green buildings/energy efficiency measures

The Federal and NSW Governments have established a number of programs to improve the energy efficiency of buildings and to reduce overall energy consumption. Actions include:

- The Federal Green Building Fund provides $90 million in grants across five years for projects which reduce the energy consumed in commercial office buildings. Projects include retrofitting, and the training of those who operate commercial office buildings in specific disciplines, such as HVAC systems, lighting controls, energy monitoring and smart metering.
- The NSW Government provides an administrative role for the National Australian Built Environment Rating System (NABERS), which is a national initiative for rating the environmental performance of existing buildings.
- The NSW Government's Energy Savings Scheme is designed to increase opportunities to improve energy efficiency by rewarding companies who undertake eligible projects that either reduce electricity consumption or improve the efficiency of energy use.
- The $137 million NSW Energy Efficiency Strategy contains a range of measures to assist families and businesses save money and help the environment by reducing the growth in energy use and the State's greenhouse gas emissions.
- Sustainability Advantage is a modular and member-based NSW program which assists organisations to use resources more efficiently and develop appropriate environmental strategies.
- The NSW Government Sustainability Policy sets targets and strategies for the NSW Government to lead by example in sustainable water use, reducing greenhouse gas emissions from energy, waste reduction, fleet management and sustainable purchasing. Among its targets, NSW Government owned or tenanted office buildings over 1000m^2 must, where cost effective, achieve and maintain a NABERS rating of 4.5 stars for energy and water by 1 July 2011.
- The Public Facilities Program provides $30 million to assist water and energy savings in public and community facilities in NSW. As well as delivering water, energy and greenhouse gas savings, the program aims to showcase technologies in action to encourage uptake by the wider community.

- The NSW Sustainable Government Investment Program (SGIP), formally known as Government Energy and Water Efficiency Investment Program, was established under the NSW Treasury Loan Fund to help agencies finance water and/or energy and related greenhouse gas emissions saving projects. Through SGIP, budget-dependent NSW Government agencies can access between $10,000 and $500,000 per project (or $1 million for NSW Health).

2.4.6 Grid solutions

The NSW Government actively supported the successful bid of Energy Australia for the Commonwealth Government's $100 million Smart Grid, Smart City scheme to be rolled out in the Hunter and parts of Sydney.

The Smart Village test bed established by Energy Australia and Sydney Water is being trialled in Newington and Silverwater. The trial is supported by $1.5 million from NSW Government's Climate Change Fund. The trial will be used to test world leading energy and water management products and services.

2.4.7 Other Government initiatives

The NSW Government established the **Electric Vehicles** Taskforce to explore the opportunities for and barriers to the uptake of electric vehicles in NSW. The Taskforce is reviewing the technology, infrastructure, policy and legislation needed to support electric vehicle use by NSW motorists.

The NSW Government is investing in green skills to ensure the NSW workforce is well placed to tackle climate change. This is initially a three tiered approach, comprised of the $20 million NSW **Green Skills** Strategy (a component of the NSW Energy Efficiency Strategy), the Green Skills Business Incentives Scheme, and the work of the Green Skills Taskforce, which provides input to the implementation of the NSW Government's Green Skills agenda.

The NSW Government has also established the Sydney **Carbon Market** Taskforce to assist in the development and implementation of a strategic action plan to establish Sydney as a carbon trading and finance hub for the Asia Pacific region.

2.5 Project description and scope

Industry and Investment NSW (I&I NSW), on behalf of the NSW Innovation Council, commissioned Ernst & Young to provide an understanding of specific growth opportunities in a low carbon economy across a number of industries; including inhibitors to growth and initiatives to enable industry growth.

This 'Business Opportunities in a Low Carbon Economy' (LCE) report was developed in parallel with two I&I NSW projects that were foreshadowed in the 2009 State Plan: namely, the NSW Business Sector Growth Plan, and the NSW Economy in 2020 Foresighting Study. The development of the LCE Report was overseen by a Steering Group consisting of members from I&I NSW, the Department of Environment, Climate Change and Water (DECCW), and Department of Premier and Cabinet (DPC).

Within this framework, the LCE project supports longer term activities underway in I&I NSW and DECCW, including:

- Investment attraction in renewable energy, grid development and green buildings
- Export promotion in renewable energy and green buildings
- Regional support for installation of renewables
- Innovation support through the Innovation Pathways Program
- Actions to strengthen the manufacturing sector
- Support for energy efficiency and reduced energy consumption by residential, commercial and government users

2.5.1 Identification of the eight target industries for the LCE Project

Prior to Ernst & Young being engaged to deliver the LCE report, I&I NSW undertook research and consulted with key experts in the Office of the NSW Chief Scientist and Scientific Engineer and the NSW DECCW, which culminated in the identification of eight target industries to be considered in the LCE project:

- Grid solutions
- Green buildings
- Waste conversion
- Low emissions vehicles
- Solar energy
- Wind energy
- Geothermal energy
- Business services

The eight target industries were selected, based on several criteria, for investigation from a longer list of industries with the potential to grow in NSW in a low carbon economy. These criteria included:

- the degree to which NSW companies are already active in the industry
- the presence of related industries with the critical mass and stability in NSW to diversify into the specified industries
- a level of certainty provided by the presence of policy drivers and/or a dominant technology that can be commercialised within the next five to ten years
- the natural resource potential of NSW
- growing demand for the industry domestically, and international demand, particularly in the key trading partners where I&I NSW has offices
- the status of NSW-based private or public R&D in the industry

Importantly, work on each selected industry would align with, and enhance, not duplicate, other government projects. This criteria eliminated key sectors such as Clean Coal and Carbon Capture and Storage (CCS), as significant government funded research and development opportunities are already underway at both Federal and State levels. For example, the NSW Government has committed $100 million over four years to the Clean Coal Fund, supported by the NSW Clean Coal Council. Further, the Australian Government's Global Carbon Capture and Storage Institute receives federal funding of $100 million per annum to facilitate the development and deployment of safe, economic and environmentally sustainable commercial-scale CCS projects.

2.6 Methodology

This report was undertaken in two phases over a three month period. The first phase delivered a broad overview of the eight sectors and the second phase, where the majority of the work and analysis was undertaken, looked in depth at five specific opportunities, which are presented as case studies in section 4.

2.6.1 Phase I: methodology

The broad overview of the eight industry sectors comprised of the following outputs:

- Identification of the key trends that are influencing the development and future of the eight identified growth industries
- Development of a supply chain for each of the growth industries, with high-level market value estimates
- A list of potential business opportunities in a low carbon economy

2.6.1.1 Key trends and supply chain analysis

Desktop based research and a literature review were carried out to understand the market segments, value chains and sub-sectors of each of the eight sectors. Based on this review and discussions with stakeholders, supply chains were identified for each sector which broadly cover raw materials, products, services, and infrastructure requirements.

For each supply chain component or sector segment, high level analysis was carried out on the following:

- Potential market size
- Emerging trends
- Market drivers and enablers
- NSW strengths and capabilities
- Key players in NSW and globally
- Issues, barriers and risks

For the larger sectors, including waste, low emissions vehicles, green buildings and grid solutions, specific segments of each sector were identified rather than complete supply chains. Accordingly, the analysis was undertaken more broadly for these segments in comparison to the other supply chains.

2.6.1.2 Estimation of potential market values of industry supply chains

Demand for renewable and cleantech industries is a derived demand. There is not demand for wind generated electricity, for instance, but a demand for electricity. Based on this, Ernst & Young approached the market value calculation by valuing the demand for the end product, be it motor vehicles or electricity. Using estimates based on industry benchmarks and stakeholder consultation, a market value for the end product was allocated across the supply chain. When calculating the potential size of the market, the high scenario assumes that some barriers to market growth have been addressed.

The market value was calculated using a series of industry sources and based on Ernst & Young's experience in industry valuation. The sources used include:

- The Australian Bureau of Statistics (ABS)
- IBIS World
- Australian Energy Market Operator (AEMO) (formally National Electricity Market Management Company, NEMMCO)
- Australian Bureau of Agricultural and Resource Economics (ABARE)

In addition, industry specific information was garnered from internal Ernst & Young reports and stakeholder consultations.

The market values across industry sectors were conducted at two time periods, being 2010 and 2020. A high and low market value is presented in this analysis which recognises the uncertainty within the renewable space, including a price for carbon. The outputs of the potential market value analysis are presented on a per annum basis. As such, capital expenditure between 2010 and 2020 was annualised over the assessment period.

The outputs of the analysis were two-fold:

- Sector based market values
- High level employment assessments based on the market value outcomes across each sector

In the specific sector analysis, outputs are presented on a supply chain basis. Given the interrelationship between the components of the supply chain, there are elements of potential market value which appear in multiple segments. Therefore, the components of the supply chain may contain elements of double counting, however, the overall potential market value for the sector does not.

2.6.1.3 Opportunity identification

From the supply chain analysis a process of opportunity identification was carried out. In identifying opportunities, a range of selection criteria were used, including but not limited to:

- Global trends and case studies toward growth areas
- Market drivers and enablers
- Potential greenhouse gas abatement or energy savings
- Demonstrated NSW capacity or potential
- Potential market value
- Potential opportunities and barriers identified through discussion with stakeholders
- Market barriers
- Linkages with other sectors and potential to stimulate other growth opportunities

As a result of this process Ernst & Young identified a non-exhaustive range of potential opportunities in each sector - over 90 opportunities in total, listed at the end of each of sector analyses in section 3. It is important to note that some opportunities are viable without a carbon price, such as certain energy efficiency measures including energy saving light bulbs and commercial retrofit of HVAC systems, while others, such as renewable energy, require a carbon price.

2.6.2 Opportunity short-listing process

In order to identify a selected number of opportunities to take forward to the next phase of the project, a collaborative short-listing process was undertaken.

As set out in the terms of reference, Ernst & Young worked with I&I NSW (and the cross-government Steering Group, more broadly) to agree the criteria for the short-listing of opportunities. The process led to a broad range of criteria being considered, that ultimately resulted in a matrix of opportunities being mapped against both likelihood of success, and size of opportunity. Ernst & Young and the Steering Group then worked together to select a balanced portfolio of the potential opportunities. This portfolio approach aimed to provide coverage across a range of the eight sectors, and to further investigate opportunities that represented both larger but longer-term or more complex opportunities, as well as those more likely, but with lower or nearer-term impact.

The Steering Group ultimately selected five opportunities for detailed investigation in Phase II of the project which were approved by the NSW Innovation Council in June 2010. Selection of opportunities was based on best available information at the time, in an evolving political and policy environment. Explicitly, opportunities that are largely contingent on the introduction of a price on carbon were not selected for analysis, due to current uncertainty in such areas.

These five opportunities, detailed as case studies in section 4, are:

- Developing software and applications for the integration, networking and management of grid-connected electricity
- Retrofitting of commercial buildings with energy efficient products
- Use of mid-scale solar installations in commercial, industrial and public facilities
- Increased generation capacity from wind farms
- Use of geothermal heat pumps in HVAC systems in commercial, industrial and residential buildings

2.6.3 Phase II: methodology

This phase constituted the main focus of this project. The investigation of the selected opportunities in the second phase produced the following outputs:

- A more detailed investigation into the opportunity to determine an opportunity-specific supply chain, employment profile, market overview and international comparison
- Identification of the key drivers from a supply and demand perspective in order to determine the potential market size of the opportunity as well as the economic benefits and employment impacts
- Identification of the key barriers to each opportunity, established through detailed stakeholder consultation

The selected opportunities differ significantly in terms of their scope and correlation with work performed over Phase I of the report. As a result the exact depth and focus of the analysis varies accordingly.

2.6.3.1 Market size methodology and assumptions

The methodology used to calculate the market size is consistent with that used in Phase I of the report. There are some key differences associated with the analyses which are detailed below.

- The first phase of the report attempted to identify the total market size and associated employment opportunities within a number of low carbon economy sectors. These estimates should be viewed at a very high level.

- The initial market size calculations were constrained by a number of factors including available public information and time.

- Within the second phase of the project Ernst & Young undertook a more detailed analysis and estimate of the potential market size and associated employment levels within five key specific opportunities within the low carbon market.

- The market value and expenditure was classified as being capital or operational.

- When calculating the potential size of the market, it has been assumed that only barriers that have a realistic chance of being overcome are removed.

Analysis undertaken within the second phase provided a greater level of understanding around these potential opportunities and their true impact, and therefore provided more information on which to base market projections.

Within the study, assumptions have been made regarding a carbon price and the effect on market size:

- A price on carbon, representing the true social cost of producing and consuming fossil fuel powered energy, is one of the largest drivers of the renewable energy industry. A carbon price – in addition to increases in the cost of coal, decreases in the cost of renewable energy generation, together with ongoing government support – will make renewable energy a more attractive investment. It is therefore assumed that a higher carbon price will result in a greater level of investment in renewable technologies (assuming that all other things remain constant).

- The high estimate of the market size assumed that a material market price (above $20 per tonne of CO_2 or its equivalent) on carbon was in place from 2014, whereas the base case estimate market size assumed a carbon price below $20 per CO_2 in place from 2014.

However, it must also be realised that over the next 10 years and beyond, the Commonwealth Government had proposed that high carbon industries will be compensated for the introduction of a carbon price. By compensating industries over this period, it means the pricing signals may not be of the scale to change behaviour as estimated in this study.

2.6.3.2 *Economic impact methodology and assumptions*

An economic impact study measures the contribution that a project, event or facility has on a regional/local, state or national economy. Economic impacts are usually measured in terms of contribution to four key economic indicators:

- Output
- Employment
- Value added (i.e. GDP)
- Household income

The modern economy is complex. It involves the use and hence provision of infrastructure, a variety of administrative and regulatory functions of government and a variety of services provided by operators that are supported by a vast array of specialist support services.

For this study we have used an input-output methodology to determine the economic impact of the specific opportunities in NSW. Input-output models are static multiplier models which attempt to capture economic impacts at a point in time. When an input-output model is used prices and capacity remain steady and outcomes tend to be higher than the alternative General Equilibrium method.

The Input-Output multipliers used for this study have been developed by the Centre of Policy Studies (CoPS), Monash University, and are derived from their general equilibrium model. Given that the input-output multipliers are derived from a general equilibrium model, the resulting outcomes of the analysis should not be overstated and will be more defensible than the standard input-output modelling outputs. The Input-Output multipliers are developed with price and labour constraints inbuilt and provide a realistic output when calculating economic contribution. However, as with all Input-Output modelling it is possible to overestimate the indirect impacts due to the limitations on restrictions to pricing and capacity. This is particularly the case with employment outcomes where it is possible that growth will result in more hours worked by existing employees rather than additional jobs being made available.

There are two components to an economic impact study – a direct component and a flow-on (or indirect) component.

- **Direct Economic Impacts:** Direct impacts are the obvious or linked effects associated with project, event or facility and consider the actual or estimated costs and revenues, employment, wages and salary outputs associated with the project.

- **Indirect Economic Impacts:** Indirect (flow-on) impacts are associated with the “multiplier effect”, that is the construction and operation of an infrastructure asset that will have downstream impacts associated with the increase in expenditure through the economy.

Economic contribution can be measured using a range of variables. The measures calculated in this analysis are:

- **Value added** – this is a measure that excludes the use of intermediate inputs in the supply chain and approximates the measurement of Gross National Product, or as in the case of a State based analysis GSP, used by the ABS to measure the value of output;

- **Employment** – this is a socio-economic measure used as an indicator of performance. Employment may be measured in terms of the number of jobs or in terms of jobs adjusted to FTEs. The employment analysis can be separated between construction and operational employment. The construction employment is more of a short term employment opportunity (within the time frame which is being analysed in this study) while the operational employment analysis is continuous and ongoing.

It is important to note that when calculating and presenting employment numbers, that the outputs of this study will show the upper limit of FTEs that result from the investment and operation of the low carbon economy industries. This is the case because the level of employment can be diminished by individuals working longer hours or undertaking differential work practices which will result in a reduction in the number of FTEs in practical terms.

Additionally, market values and economic contribution values differ when estimating the impact of an industry on the NSW economy. The market value presents an estimate and forecast of the expenditure within the industry. It includes estimates of the size of the sales within an industry and estimates of the capital expenditure across all links within the supply chain. Meanwhile, the economic contribution shows the actual growth in the economy as a result of the operation of the industry. It is a representation of the profitability of the industry (at a NSW economy level) and hence represents the net impact on the overall economy.

2.6.4 Stakeholder engagement

As part of both phases of work, Ernst & Young engaged with over 40 stakeholders across a wide range of industries and interests. (See Appendix B) These included technology developers and distributers, property and energy companies, as well as a range of international and local organisations. It should be noted that each stakeholder was not consulted on every sector under consideration and consultations were not exhaustive.

3. Sectoral analysis

3.1 Grid solutions

3.1.1 Sector description

This sector, also known as smart grids, is defined as the infrastructure, products and services that support energy transmission and distribution, upgrade the electricity grid, expand capacity, improve efficiency and allow connectivity with intermittent sources of energy such as renewables. Defined in the simplest terms, a smart grid is the application of information and communications technology to the generation, delivery and use of electricity. The concept of smart grids provides an opportunity for energy distributors to transform their networks to deliver energy more efficiently by improving network reliability, delivering energy savings to customers, minimising transmission and distribution losses and enabling networks to deliver increasing amounts of renewable energy.

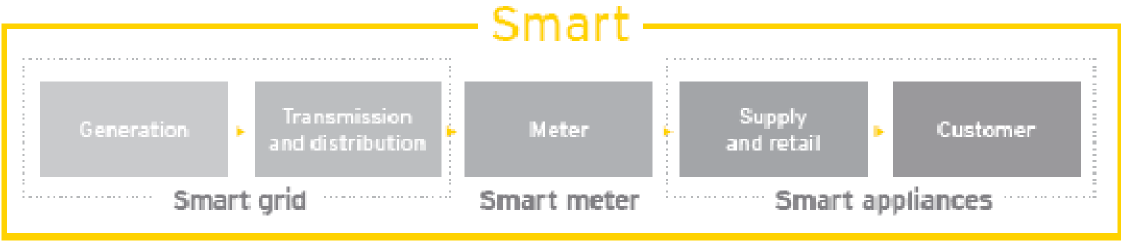
By making better use of IT and new communication structures, and actively involving energy customers, smart grids will change the way we:

- **Produce energy** — generation is currently heavily reliant on fossil fuels. In addition to traditional energy sources, smart grids can accommodate renewables (such as solar and wind) and other energy sources (such as micro-generation) more easily — which means they can play a much greater role in generation than they have in the past.
- **Deliver energy to customers** — traditional electricity grids send energy one way, from the power plant to the customer. Smart grids send both energy and information two-ways. They use automated tools and sensors to improve network performance, as well as to measure energy flows between consumer and power sources — giving utilities more flexibility in the management of supply and demand.
- **Energy Use** — smart homes and smart meters communicate with the smart grid — providing detailed information on energy consumption. For example, consumers can see how much energy their appliances are using in real time, and through "demand response," they can take a more active role in how and when they use power. The objective of demand response is to expose customers to real time electricity prices so that their preference for peak load power can be extracted, and they can make decisions on whether to consume, or switch off their consumption at these prevailing peak load prices. This provides the appropriate price signals for efficient capital investments in peaking capacity.

"Smart" has three key components as shown in Figure 2.

1. The smart grid balances actual energy demand with energy generation. Smart grid activities — generation, transmission and distribution — are the domain of power and utilities companies.
2. The smart meter is a device that can be read remotely. It measures actual energy consumption in real time for homes and businesses and relays that information to the grid. Meters are also required at intermediate points along the grid to perform tasks such as monitoring usage, detect faults and even to make local load control decisions.
3. The smart home responds to remote signals from the utility through devices such as smart thermostats, which can be used to automatically reduce demand during peak times. Activities in the smart home are typically managed by supply and retail companies as well as energy service companies.

Figure 2: Smart grid schematic



Source: Ernst & Young

There have been various assessments of the benefits of a smart grid to the Australian economy, some of which are highlighted below.

- In the report *Smart Grid, Smart City: A new direction for a new energy era*, the Australian Government stated that preliminary analysis indicated that implementing smart grid technologies across Australia could deliver at least $5 billion of gross annual benefit to Australian society, reducing annual emissions of 3.5 million tonnes of CO_2. This is considered a preliminary and conservative estimate, which does not consider the cost of each application, including economies of scale resulting from commercial deployment of technologies.

- Analysis undertaken by Access Economics also uses conservative assumptions to model the potential benefit of investing $3.2 billion in the smart grid over seven years, and estimates gains to GDP of $7.1-$16.4 billion – with significant improvement in productivity and employment.

- CSIRO's Intelligent Grid report estimates that between 2006 and 2050, the combination of energy efficiency, demand management, distributed generation and structural change could produce savings of $130 billion. Under this scenario, the combined abatement from these sources is estimated at over 32 million tonnes per annum in 2020, and represents almost 75% of cumulative abatement between 2010 and 2020.

- At an individual utility level, a recent indicative desktop study by NSW-based energy provider, Integral Energy, suggested that investing $680 million in the Smart Grid over 15 years could deliver operational benefits to Integral Energy of $580 million, and total benefits, including for consumers, of $1.7 billion in present value terms.

3.1.2 NSW strengths in this sector

NSW has a strong information and communication technologies (ICT) presence – a key industry required for the smart grid transformation. It also has existing software development, data storage and analytics capability. Product development and R&D tends to be undertaken by large multinational corporations such as IBM which have presence in NSW.

Australia's first commercial-scale smart grid will be based in NSW, in the city of Newcastle, plus other locations including Sydney CBD. The Federal Government has committed $100 million to this demonstration project which will be undertaken in partnership with Energy Australia and will leverage significant additional private sector spending on the smart grid. This project is expected to promote Australia among the leading countries in this area. Its objectives are to gather information about costs and benefits of smart grids. It will also demonstrate a range of smart grid technologies and applications such as in-home displays. Stakeholders report that the Government funding has been significantly leveraged and has stimulated complementary investment in smart grid solutions.

3.1.3 Australian/NSW trends and international comparisons

3.1.3.1 Australia

Progress in Australia varies across states. So far, Victoria, followed by NSW have led the rollout of smart meters, which is driving Australia's leading position in the market with regards to implementation, relative to other countries.

Many Australian utilities are also taking a broad integrated approach to the smart grids that includes advanced metering infrastructure (AMI) and looks at an end-to-end solution. Stakeholders report that this approach is far more developed in Australia relative to other countries.

3.1.3.2 Smart meter rollout

In 2006, the Council of Australian Government (COAG) committed to a nationally mandated rollout of smart meters in areas where benefits could be proven to outweigh costs. These smart meters support time-of-use (TOU) pricing, which offers lower prices for off-peak energy use. This enables the consumer to better understand pricing for the use of electricity at certain points of the day (particularly at periods of high demand) and for the utility to better manage demand for peak power.

- **Victoria**, which represents 27% of the Australian market by customer numbers, is currently leading roll-out for smart meters and expects to have installed 25% of meters by 2011 in the first stage of the roll out with installation complete by 2013. Over 250,000 have already been installed. However, in March 2010, the Victorian Government called for a temporary halt to the introduction of TOU tariffs following concerns about the impact of new energy prices on pensioners and the financially disadvantaged. The Energy and Resources Minister said a moratorium was needed to consider pricing options for vulnerable groups and that a consumer education campaign was needed.

- **New South Wales** has an aspiration to install smart meters in every home by 2017. Energy Australia has completed the rollout of 400,000 first generation smart meters, smart sensors and communications technologies in a $170 million project — excluding all back-office related infrastructure. Country Energy is conducting a pilot with 10,000 meters to be rolled out by 2011. Integral Energy is a key partner in Blacktown Solar City which has deployed 4,000 smart meters.

- In **Queensland**, the state's largest distribution companies, Energex and Ergon Energy, are active in the smart metering market. Both have launched trials which focus on cost-benefit assessments specific to their jurisdictions.

- **South Australia** has focused its smart metering efforts on the Adelaide Solar City Project, a deployment of 5,000 smart meters in homes. Roughly 1,000 installed devices have contributed to a reported 19% to 35% reduction in peak demand for those users.

- **In Western Australia**, which due to its geography operates in isolation from the National Electricity Market (NEM), there were initial concerns over commitment to smart meters. However, Western Power has announced an AMI trial incorporating 10,500 smart meters over four years.

- Across the **Northern Territory**, the Power and Water Corp. will be deploying 400 smart meters under the Alice Springs Solar City project.

3.1.3.3 International comparison

The global transformation towards smart grids is driven by a variety of factors, which influence the relative state of development across nations.

- Canada is more advanced in smart grid technology than most other nations, spurred on by the need to connect hydroelectric resources to electricity consumers more efficiently. Leading provinces include Ontario, British Columbia and Alberta.

- North America's aging transmission grid has been described as "inadequate and congested," and significant funding has been allocated to smart grid projects. But smart projects are still in their early stages, and no standards have been agreed. The real challenge for power and utility companies is how to leverage this early funding to generate innovative and successful smart grid programs.

- The 2009 European Union (EU) directive mandated the installation of smart meters by 2020. Leading installers are Sweden (all installed meters are smart) and Italy (90%). However, differing national regulations mean there are substantial differences between meter functionalities and specifications across Europe.

- Smart meter development in China has not progressed as far as in other countries. However, the Chinese Government has made smart grid development a strategic priority and a growing number of projects are underway.

- India's transmission grid is in urgent need of expansion and improvement. However, investors are deterred by the sector's financial weakness, public ownership of utilities and bureaucratic delays. Delhi, Bangalore and Mumbai are taking the lead in smart projects, primarily smart meter installations.

- The Korean Government has launched a $65 million pilot program on Jeju Island for a fully integrated smart grid system for 6,000 households. It includes distributed generation and electric cars. It is part of a deal with the State of Illinois, USA, to develop and test smart grid technology for commercialisation and export.

Relative to these other countries, Australia appears to be fairly advanced in terms of implementation of specific smart technologies and the integrated approach being taken by utilities to find an end-to-end solution. However, Australia lacks an overarching, decisive and comprehensive vision at a national level which is likely to drive continued progress and benefit those countries with this in place.

3.1.4 Market size

Ernst & Young estimates suggest that the market value in 2020 could be between $90-$120 million in NSW. This is based on the roll out of smart-meters in NSW which is only a portion of the total smart grid market, and was limited to households, with no focus on commercial or industrial buildings.

Table 4: Grid solutions market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE-NSW 2020
	Low	High	Low	high	
Grid Solutions	0	0	90	120	360-680

Source: Ernst & Young estimates

A report by Total Environment Centre, *Advanced Metering for Energy Supply in Australia*, suggests that smart meter roll out will deliver a reduction in total electricity usage by 4-10%.

3.1.5 Identified specific opportunities

Grid solutions - the conversion to a smart grid - offer significant broader opportunities for NSW in transitioning to a low carbon economy. Indeed, improving the 'intelligence' of the NSW grid will enable advances to be made in energy efficiency through greater transparency of energy use to customers, increased ability to integrate in small and large scale renewable energy technologies and distributed energy sources. It will also provide an important component for low emissions vehicles. These opportunities are discussed in the green buildings, wind, solar, microgeneration and low emission vehicles sectors.

Specific opportunities relating to the smart grid sector are identified in the table below. These do not include opportunities relating to 'smart home and business' as these are covered under the energy efficiency sector. The fifth opportunity "developing software/applications for the integration, networking and management of grid-connected electricity" was investigated as a detailed case study, summarised in the section 4 of this report.

	Grid solutions
1	Develop a smart grid in NSW.
2	Expand sales and distribution of smart meters and other energy efficiency appliances.
3	Expand support services (installation and maintenance of hardware such as meters, sensors and load control technology).
4	Provide platforms for off the shelf smart grid applications by information technology hardware suppliers, and specialise in installation of communications hardware.
5	Develop software/applications for the integration, networking and management of grid-connected electricity,
6	Tailor and optimise imported software solutions to Australian requirements.

3.1.6 Identified issues/barriers

The detailed smart grids case study identified a number of issues and barriers, including:

- Lack of company knowledge/understanding
- Lack of interoperability standards
- Lack of customer engagement
- Need for a longer-term regulatory framework

These barriers are outlined in detail in section 4.1.10 of this report.

3.2 Green buildings

3.2.1 Sector description

This sector comprises building development initiatives, technologies, and designs that reduce the consumption of energy in the construction and ongoing life cycle of buildings. Green buildings includes two sub-sectors, which are used to define this analysis:

- **Energy efficient buildings:** Covering materials and products that improve energy efficiency in homes.
- **Microgeneration:** The generation of zero or low-carbon electrical power or heat on a small scale, at the point of use. Microgeneration options include solar hot water heating and heat pumps, cogeneration and trigeneration, small scale wind turbines, and small-scale solar photovoltaic (PV) systems.

3.2.1.1 Energy efficient buildings

The built environment has the propensity to deliver considerable savings in energy consumption and embodied carbon[15]. 'Green Buildings' is a term that describes the advancement of technologies and practices that lead to lower-ecological impact buildings in both the domestic and commercial environment. Broadly, this sector is classified as initiatives, technologies, and design that reduce the consumption of energy in the construction and ongoing life cycle of buildings. This sector encompasses subsectors:

- **Architectural design:** The role of modern architectural design is critical in delivering optimal results for comfort and efficiency; indeed, good design is instrumental in limiting the impact buildings have on greenhouse gas emissions. Energy consumption can be reduced by optimising the orientation of the building and selecting efficient building materials and products.
- **Energy efficient products:** Commercial buildings and residential homes comprise various building materials which combine together to create a comfortable environment to work and live in. The building envelope is a constituent of its parts, and there are many opportunities for improving efficiency through the utilisation of higher-performance systems.
- **Enabling and optimising technologies and products:** Enabling and optimising technologies reduce energy usage by either alleviating demand side pressures by activating when in use or changing consumer behaviour through the provision of information. The key challenge to this sector is to overcome the outdated grid infrastructure.

3.2.1.2 Microgeneration

Microgeneration is the generation of zero or low-carbon electrical power or heat on a small scale, at the point of use. The sector primarily includes five systems for energy generation:

- **Solar Water Heaters (SWH):** Thermodynamic solar technologies used to capture the sun's energy for heating purposes. Solar heating systems are generally composed of solar thermal collectors, a water storage tank, interconnecting pipes and a fluid system to move the heat from the collector to the tank. A solar water heating system may use electricity for pumping the fluid, and have a reservoir or tank for heat storage.
- **Heat pump systems:** A solar heat pump system is a form of solar water heating system. It does not rely on direct or diffuse solar radiation instead it uses the vapour compression, refrigeration cycle to transfer heat from the ambient air, generally outside the house, into the water in the storage tank. Heat pump water heaters have become more popular because they reduce energy consumption to about one-third of a conventional electric water heater, hence reducing running costs and CO_2 emission. Geothermal Heat Pump (GHP) systems are similar but draw the heat from the ground rather than the ambient air. Because of the relatively more constant temperature of the ground versus the air, GHPs are typically more efficient than air-sourced heat pumps.

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[15] Embodied carbon is the total Greenhouse Gas (GHG) emissions caused from resource extraction, transportation, manufacturing and fabrication of a product or system. It is an important measure of CO2 emitted in the life cycle of building products. Source: *Development of an Embodied CO2 Emissions Module for AccuRate*, Forest & Wood Products Australia, August 2010.

- **Cogeneration and trigeneration:** Cogeneration involves the efficient production and use of two forms of energy (heat and electricity) from a single fuel source. Also known as 'combined heat and power', the efficiency arises from the capture of waste heat from the electricity generation process, which in turn can be applied to heating processes such as hot water or space heating. Trigeneration furthers the cogeneration application of waste heat by extending the concept to both heating and cooling applications. Trigeneration involves the addition of absorption chillers to generate cool air that can be used for air-conditioning or cold-manufacturing processes.

- **Micro-wind:** A micro wind turbine is a very small turbine commonly used in remote locations isolated from the grid to provide electricity for a variety of industrial, commercial and household needs.

- **Small scale solar PV:** These devices capture the energy of sunlight and convert it to low-voltage, direct electric current. A converter is required to change this to a high-voltage alternating current suitable for supplying electricity to the grid.

More detail on solar PV, wind, and GHPs is outlined in sections 3.5, 3.6, and 3.8 respectively. Accordingly, these microgeneration options are not analysed further in this chapter.

3.2.2 NSW strengths in the sector

NSW has a significant concentration of key players across the supply chain in both energy efficient buildings and products, and microgeneration.

3.2.2.1 Energy efficient buildings and products

- NSW has capabilities for **manufacturing** glass, insulation, cement, aggregates, sandstone, limestone, plasterboard, bricks, cement fibreboard, roof tiles, masonry, timber, metal fabrication/roofing and fibre cement. NSW also has the largest metal manufacturing industry in Australia. CSR has glass manufacturing capability in NSW – they also have an insulated glass unit (IGU) manufacturing operation that has yet to be operationalised (up to 40 extra jobs). There are also large window manufacturers in NSW, such as Stegbar, and regionalised assemblers. Global companies in the manufacture of energy efficient products such as Schneider Electric and Siemens have their domestic headquarters in NSW.

- Large **design, construction and property management** companies such as Bovis Lend Lease, St Hilliers, Mirvac, Dexus Property Group, GPT, Westfield, Balderstone, Leighton Construction, Thakral, Multiplex, Investa, Stockland, Australand, Build Corp, Meriton, and AMP Capital are headquartered in Sydney.

- **Engineering consulting** organisations such as Sinclair Knight Merz, Arup and GHD have capabilities in energy efficiency consulting. These companies are headquartered in NSW.

- NSW has **energy retailers** such as Energy Australia which are investing in smart grid technologies. The Newington Smart Village initiative by Energy Australia to trial smart meter technology is an example of home area networks and advance metering infrastructure in practise.

- **Universities** in NSW such as the University of Sydney, University of New South Wales and the University of Technology Sydney offer courses around building design and architecture to supply additional professionals to the market. The University of Wollongong has substantial laboratories to test new construction technologies and to research the incorporation of sustainability principles in building design[16].

3.2.2.2 Microgeneration

- NSW has a strong solar water heater **manufacturing** industry, being home to two major Australian SWH manufacturers – Rheem (incorporating Solarhart and Edwards) and Dux. Rheem products have approximately 80% of market share of the solar water heating market.

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[16] As reported by Green Jobs Illawarra report

- NSW is home to key **research and development** players in Australia including: National Solar Energy Centre, University of Sydney, University of New South Wales, Dyesol and Solahart. Solarhart's centre of excellence includes industry leading specialists in material science, performance testing and enamelling technology. Research and development activities include improvements to aesthetics and installation of roof-mounted models; development of sophisticated materials technology, such as anti-reflection coatings; and research of large scale commercial applications.

- State and Local government authorities have stimulated the development and trial of cogeneration through initiatives such as the City of Sydney and the Department of Planning pilots detailed in section 3.2.3.2.

3.2.3 Australian/NSW Trends and international comparisons

3.2.3.1 Energy efficient buildings and products

Australia

The building sector currently accounts for a significant share of energy use, with commercial buildings estimated to account for 10% of Australia's GHG emissions[17]. While emissions are expected to grow on average by 2.1% per annum, there is significant abatement potential in the commercial buildings sector. The Australian Sustainable Built Environment Council summarises a range of reported estimates for energy efficiency, which indicate that potential reductions are between 10-39%[18]. Many savings can be made at 'negative cost', or as net saving to businesses. Climate Works estimate that approximately 12Mt CO2e can be reduced from the commercial buildings sector at 'negative costs'. Climate Works also report that implementing energy efficiency measures could save the economy $5 billion per year.

The Australian Government has accelerated efforts in the energy efficiency sector in the past few years and awareness of the potential of the commercial buildings sector to produce energy savings is growing. The Climate Trust Australia was recently awarded funding specifically to incentivise commercial building retrofit activity. There are a range of different government initiatives in place to encourage energy efficiency uptake in the commercial building sector. However, Australian policies are less aggressive, decisive and targeted than policies of many international counterparts.

In NSW, the Energy Savings Scheme is a mandatory energy efficiency scheme for electricity retailers which commenced on 1 July 2009 with an energy efficiency target of 0.4% of total electricity sales, which will increase to 4% in 2014. Liable parties meet the target by undertaking energy efficiency activities or contracting specialist companies to undertake them. The NSW State Plan 2010 sets out a target to "implement 4,000 GWh of annual electricity savings through NSW energy efficiency programs by 2014".

Since 2004, NSW has implemented its Building Sustainability Index (BASIX) to ensure homes are designed and built to be more energy and water efficient. BASIX sets energy and water reduction targets for houses and units, against which the design of new residential properties are assessed in order to obtain the mandatory BASIX certificate. BASIX is a sustainable planning measure administered via an online tool.

In July 2010, the Victorian Government set out a number of actions and commitments to spur the market in Victoria. These actions include a new target for government buildings to improve energy efficiency by a further 20% by 2018, on top of existing targets. For the residential market, a plan was released to raise the energy efficiency of existing Victorian homes to an average of 5 Stars by 2020.

International comparisons

Countries around the world are recognising the energy and CO2 savings that can be made by improving energy efficiency in existing commercial buildings. Ambitious energy efficiency targets have been introduced in various locations:

- European Union: Target to reduce primary energy use by 20% below business-as-usual (BAU) by 2020
- The USA has announced its intention to reduce energy demand by 15% below BAU by 2020
- China has a goal to reduce the greenhouse intensity of the economy by 40-45% by 2020

[17] http://www.asbec.asn.au/files/ASBEC%20CCTG%20Second%20Plank%20Report%202.0_0.pdf
[18] With one outlier of 70%. See http://www.asbec.asn.au/files/ASBEC%20CCTG%20Second%20Plank%20Report%202.0_0.pdf It does not state by what year this was achievable.

The European Union (EU) has put in place a number of directives relating to energy efficiency standards in commercial buildings that have been implemented by member states in a number of ways including information dissemination, financial incentives and trading schemes.

One example is the UK's Carbon Reduction Commitment Scheme which is a **permit-based trading scheme**, aimed at commercial buildings. Participants must buy a carbon allowance from the Government for each tonne of CO_2 that is emitted. Allowances are purchased in April each year, after which time the Government benchmarks participants against each other and positions participants in a league table. In October each year, the Government returns ('recycles') all allowance payments. Participants receive payments back with a bonus or a penalty, depending on how they are benchmarked against peer companies. The Tokyo Metropolitan Government and the Seoul Metropolitan Government have recently put in place similar trading schemes.

An **information based scheme** rolled out across the EU is Energy Performance Certificates (EPCs). These are designed to provide information about a building's energy performance, for both new and existing buildings. EPCs are generally required for all commercial, retail and industrial buildings, as well as warehousing units and storage premises whenever built, rented or sold. The requirement is on the building owner or agent to obtain a certificate to ensure compliance with the legislation.

In Canada, **substantial financial incentives** have been provided to encourage the uptake of commercial retrofit. Called the ecoENERGY Retrofit Incentive for Buildings, it is aimed at commercial and institutional buildings, and provides substantial incentives based on the lowest of the following three amounts - $10/gigajoule of estimated energy savings, 25% of project costs or $50,000 per project.

3.2.3.2 Microgeneration

Distributed generation in NSW

There are several established co-generation facilities in NSW, and additional projects approved for future implementation. Under the Demand Management and Planning Project, the Department of Planning provided funding for two cogeneration pilot programs in multi-residential units in Chatswood and Rouse Hill. Large co-generation projects operate in commercial buildings such as 101 Miller Street in North Sydney, 133 Castlereagh Street in Sydney, and at Macquarie University. The University of Newcastle implemented Australia's first commercial application of a gas-powered micro turbine in the University's Medical Sciences building cogeneration unit. Australia's largest renewable baseload energy project involves two 30 MW cogeneration facilities at the sugar mills in Condong and in Broadwater in northern NSW.

The City of Sydney Council plans to implement at least 330MW of combined cooling heat and power or "trigeneration" in Sydney. The trigeneration plants will initially be fuelled by natural gas but designed to ensure that natural gas can be replaced by a renewable gas or fuel in the future, such as biogas or syngas or even methanol/hydrogen. The city project will establish trigeneration plants in seven locations around the CBD at Town Hall, Customs House and its five aquatic centres. The plan is to create a network of plants providing up to 325MW over a 15-year period, which may also connect to neighbouring buildings and the entire CBD. The City of Sydney is currently working with Energy Australia to obtain exemption to transfer surplus power to other Council buildings across the electricity network. The City of Sydney's trigeneration project was included in Energy Australia's smart grid project which has been awarded Federal Government funding.

Two power plants will also be constructed by energy company GridX to serve Qantas' Sydney Jet Base, catering centre and domestic terminal. This represents the largest commercial trigeneration – cooling, heating and electricity – project so far undertaken in Australia.

Distributed generation internationally

Globally, energy policies often discourage suppliers and grid operators from bringing energy generation to market. There is an increasing acceptance that smaller-scale distributed generation (both renewable and conventional) has benefits in terms of delaying expensive and capital intensive transmission and distribution infrastructure required for peak load times.

European countries generally have a greater proportion of distributed energy than other countries, primarily due to the relatively colder climates and highly urbanised regions. The EU Cogeneration Directive attempts to promote high efficiency cogeneration, through recognition of its potential, creating a common definition and removing barriers.

The UK's combined heat and power strategy document sets out a framework to support the growth of cogeneration capacity in the UK. The Government announced, in 2000, a target of achieving at least 10,000 MW of combined heat and power plant (CHP) capacity by 2010, however by 2009, only 5,569MW was installed[19].

Solar hot water heaters

With respect to total cumulative installed capacity of solar hot water heaters, China ranks first, followed by the United States, and then Turkey, Germany, Japan, Australia, Israel, Brazil, Austria and Greece. The global solar thermal market enjoyed a growth rate of about 15% in 2007 (down from 20% in 2006) largely contributable to a sustained growth in China. Subsequent years have witnessed further growth rates of 40-50% in the Chinese market. In Europe, growth rates in 2008 were similarly around 45-50%. These large initial growth rates are reflective of responses to policy from a relatively low base starting point.

3.2.4 Market size

Ernst & Young estimate the potential market value of this sector to be between $3,280 million and $3,920 million. This estimate assumes a proportion of the building construction industry could potentially move to green products. From a materials perspective, the analysis concentrated on optimising technology and energy efficient products.

Table 5: Green Buildings market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE- NSW 2020
	Low	High	Low	High	
Green buildings	770	930	3280	3930	17,110-20,530

Source: Ernst & Young estimates

3.2.5 Identified specific opportunities

The opportunities in Table 6 were identified as a result of the initial phase of work undertaken by Ernst & Young:

A hybrid of these opportunities was taken for further investigation in Phase II of the project which became the opportunity 'to retrofit commercial buildings with energy efficient products'. This has been investigated as a detailed case study, summarised in section 4 of this report.

Table 6 : Opportunities in the green building sector

	Green buildings: Energy efficient buildings
1	Develop building materials with lower embedded carbon content (e.g. increased fly-ash content in cement)
2	Improve integrated manufacturing of building products
3	Development of the energy audit/assessor services
4	Improve relevance of information on home energy statements
5	Retrofit with energy efficient products, including those that improve the thermal envelope
6	Increase energy efficiency of old building stock through air sealing
7	Improve building energy efficiency from government buildings where owned
8	Increase uptake of more energy efficient building products, including those that improve the thermal envelope
9	Improve building energy efficiency from government buildings where leased
10	Develop net carbon zero or high-performance residential homes
11	Develop building designs that can be exported to comparable climates overseas
12	Simplify the roll-out of Home Area Networks
13	Develop software for management systems and smart networks
14	Establish leading training programs

[19] UK Department of Energy and Climate Change - http://www.decc.gov.uk/en/content/cms/statistics/source/chp/chp.aspx

	Green buildings: Microgeneration
1	Increased manufacture of solar water heaters
2	Develop thermal heating and cooling technologies
3	Expand cogeneration and trigeneration project development in residential/commercial sector, particularly for businesses that cannot get enough power from the grid and for areas that have an aging/insufficient grid capacity
4	Expand rollout of solar hot water heaters and heat pumps
5	Develop specific training solutions and demonstration sites in the distributed generation sector, including power system analysis, installation of solar PV and solar hot water systems and cogeneration installation and maintenance

3.2.6 Identified issues/barriers

The detailed energy efficiency case study identified a number of issues and barriers, including:

- Length of payback period
- Issue of split incentives for tenants and building owners
- Availability of capital for improvements
- Low investment in new technologies
- Contradictory regulatory impacts
- Insufficient data to measure benefits
- Insufficient customer knowledge of energy usage

These barriers are outlined in detail in section 4.2.8 of this report.

3.3 Waste conversion

3.3.1 Sector description

This sector is defined as the capture or removal of substances, materials or energy out of discarded materials or waste. This is a large and complex sector for analysis. The sector has been broken down into two main subsectors:

- **Household and business waste:** This subsector refers to waste collected from the municipal, commercial and industrial (C&I) and construction and demolition (C&D) waste streams. It considers the supply chain of waste from collection and sorting to recycling, recovery and disposal.

- **Other bioenergy:** This subsector refers to any organic material, other than urban waste, which can be used as a source of energy for power generation, direct source heat applications and/or for the production of biofuels. The main sources of biomass include crops, wood waste, agricultural waste (manure) and waste oils. Typically biomass is combusted to produce electricity and/or heat, or it is fermented to make biofuels.

3.3.1.1 Household and business waste

The different elements of the supply chain for household and business waste are considered below.

- **Collection of waste from households, commerce and industry:** The collection of municipal waste is the responsibility of local government. A large number of these services are contracted out by local government to a wide range of private operators and existing collection service contracts can be established for up to seven to ten years. C&D and C&I waste is normally collected on-site by private operators.

- **Sorting of waste into material streams for recycling and residual for disposal:** There has been a progressive increase in source segregation of waste streams at the household level but there are more opportunities for better segregation. There is limited source segregation in the commercial and industrial sector, particularly at the small to medium enterprise level.

- **Recycling and recovery of material waste streams:** Recycling occurs at material recovery facilities (MRFs) where waste is sorted and processed. There are MRFs for municipal and for C&I waste. Existing facilities for municipal waste often have long term contracts to receive waste from surrounding areas, particularly where these facilities are associated with high capital costs, such as Alternative Waste Technology (AWT) facilities which treat waste using mechanical and biological processes.

- **Creation of energy from waste:** There are multiple ways to create energy from waste, including biological, thermal and physical methods. Biological technologies include anaerobic (without oxygen in a closed system) options for biodegradable wastes[20]; aerobic digestion; composting; biofuel production; and electricity generation using bioreactors at landfills. Thermal treatment options – such as pyrolysis, thermal gasification, plasma arc gasification and incineration – is not widely used in Australia for waste destruction or the recovery of energy in wastes. Physical treatment options include autoclaving (treatment with high-pressure steam) and the production of pellets or bricks of Refuse Derived Fuel (RDF).

- **Disposal of residual waste to landfill:** The disposal of municipal waste is the responsibility of local government. A large number of these services are contracted out by local government to private operators for lengthy periods, a trend which is likely to continue. Most modern landfills are required to manage their landfill gas as part of their licence conditions. Flaring or gas capture is the common method of landfill gas management in larger landfills. Landfill gas is generated for at least 15-30 years after the organic waste is deposited in landfill.

[20] Solid waste that contains organic matter capable of being composted by microorganisms

3.3.1.2 Other bioenergy

Bioenergy is a complex field due to the variety of possible materials or 'feedstocks', and the diversity of current and emerging processes that can be used to convert the feedstocks into energy. The supply chain also includes a range of distribution options.

- **Feedstock:** Biomass is any biological material which can be used as a source of energy for power generation, direct source heat applications and/or for the production of biofuels. In some cases, biomass is produced directly for the purpose of energy generation, however more often, it is a waste product or residual biomass from other production processes. The main sources of first generation biomass include crops, wood waste, agriculture waste (manure), urban waste and waste oils. Second generation biofuels are currently being developed from different feedstocks, such as algae and offer a more efficient way of generating electricity or fuels. For the purposes of this report, organic waste from the municipal waste stream, which is another source of organic feedstock, is covered in the household and business waste subsector.

Table 7 : Feedstocks considered in this analysis

Feedstock	Description
Agriculture Crops: Sugars and starches from grains	Companies who produce waste products from sugar cane, molasses, grain such as wheat, corn or sorghum have commercialised their by-products into ethanol for transport use. Manufacture and supply of ethanol is usually a by-product, and the profitability of the whole company is driven by the amount of primary product produced (e.g. sugar, flour, sorghum) rather than from the ethanol production.
Agriculture livestock: Manure	Mainly cow and pig manure, other organic materials such as chicken manure are also an option
Wood waste	Includes forest residues, whose production can be increased with optimal forest management. Waste wood from sawmill for example is a concentrated source of wood waste. An interesting biomass source in this category is mallee eucalypt which is grown for its desalination abilities. It also has the potential to generate significant energy as well as valuable co-benefits such as and mallee-oil, together with being a high energy, quick rotating crop.
Waste Oils	Tallow, waste cooking oil, oil seeds and soy are used to produce biodiesel. Plants tend to be small/medium scale and economics rely on the feedstock being low-cost due to their lack of alternative higher value uses or their generation as a by-product of the primary product, such as soy meal or meat.
Cellulose	Cellulose is the main component of woody and agricultural biomass such as wood, straw and much of the structure of plants. It is emerging as a key second generation of biofuel once conversion processes have been fully commercialised.
Other second generation feedstocks	One of the most promising is microalgae which are grown in a closed reactor under controlled conditions. Others include pongamia and mustard seeds.

- **Conversion methods:** Biomass can be directly converted into energy or can be transformed into biogas or bio-liquids. The four possible outputs include 1) generated electricity 2) direct source heat applications 3) production of liquid fuels (biofuels) for transport and 4) biogas for combustion to produce electricity and/or heat. Almost all feedstocks are able to produce any of these four outputs. Australia transforms significant amount of its biomass to transport fuel, wood is used for heating and there is significant biomass energy production along the Queensland and NSW coastline with bagasse cofiring and secondary residues from wood processing. The specific conversion process and technologies used will depend on the type of feedstock used and the output required.

Table 8 : Conversion methods considered in this analysis

Energy output	Typical conversion process

Transport fuels (liquid)	► Ethanol production: Sugar and starches from grains are fermented into ethanol which is then distilled to produce fuel grade.
	► Biodiesel production: Trans-esterification of vegetable oils and fats through the addition of methanol (or other alcohols) and a catalyst.
	► Cellulose: Two main ways that are emerging to produce ethanol from cellulose:
	  ► Enzymatic Process: Pre-treatment, cellulose hydrolysis, separation of sugar solution, microbial fermentation and distillation.
	  ► Gasification Process: Instead of breaking down the cellulose into sugar molecules, the carbon in the raw material is converted into synthetic gas, followed by fermentation and distillation
	► A portion of the microbe is transferred daily to a large open pond where it is subject to nutrient deprivation, stimulating oil production. Oil is extracted and processed into biodiesel.

Electricity and heat generation through production of biogas, syngas, biomethane or heat or transport fuels (gaseous)	► Direct biomass combustion either in dedicated plant or co-firing in fossil fuel plant. Main benefit is GHG emissions saved (IEA estimate 10% less with bioenergy, on average) rather than increased energy generation. ► Pelletisation – wood to pellets: compared to wood, relatively high energy content and easy to transport ► Pyrolysis – produces biochar which can be sequestered and used as a fertiliser, syngas and bio-oils ► Gasification - converts biomass into a gas and anaerobic digestion (produces biomethane). ► Anaerobic digestion: Organic waste is anaerobically digested by enzymes that produce bio-methane and produces valuable products such as fertiliser.

Anaerobic digestion is a particularly topical conversion method. It is an alternative and readily available technology that produces methane which can be used as a biogas for combustion to produce electricity and/or heat. This technology is currently used in the urban waste and waste water treatment sectors, and also has applications in dealing with agricultural waste. Due to the relatively simplistic concept of anaerobic digestion, the process can be encouraged through various applications including covered lagoons, contact digesters, plug flow reactors, completely missed digesters, fixed-film/packed-bed sludge blanket, hybrid fixed-film/sludge blanket and landfills[21].

- **Energy Distribution:** The infrastructure and other requirements to distribute the energy product to its end use include connection to the electricity or gas grid, off-grid energy use (i.e. local or on-site use of energy produced) and transportation of ethanol or biodiesel or wood chips (roads, train, pipelines)

[21] *Waste to Energy: A Guide to Local Authorities, Australian Business Council for Sustainable Energy (2005)*

Table 9 : Distribution methods

Distribution method	Description
Biofuels distribution	Biodiesel is distributed from the point of production via truck, train, or barge. Pipeline distribution of biodiesel, which would be the most economical option, is still in the experimental phase. Biodiesel is distributed to retail fuelling stations and directly to end users such as large vehicle fleets. Most biodiesel distributors will deliver pure or preblended (with petroleum diesel) biodiesel depending on the customer's preference.
Ethanol distribution	The main property of ethanol that affects its distribution is its affinity for water (unlike petroleum products), which means ethanol blends are more likely to absorb moisture and carry it into the fuel system than diesel or 100% petroleum fuels. As a result of ethanol's hygroscopic properties, the recommended best practice is to blend the ethanol and petrol as close to the end use as possible.
Biogas distribution	Biogas is typically consumed at the point of production, such as with household-sized cooking and lighting systems, or distributed via pipeline. Different end uses require different levels of gas quality. Boilers, for example, can use relatively low-quality biogas, whereas biogas must be upgraded to a high standard for vehicle fuel and injection into the natural gas grid. Once biogas has been upgraded to the required quality standard, it could be distributed via the same routes as conventional natural gas. Because the required technologies are not yet fully developed and tested, distributing upgraded biogas via the pipeline grid is not a common practise today.
Connection to electricity grid	This can be prohibitively costly if there are no existing transmission and distribution lines in close proximity to the conversion location.

3.3.2 NSW strengths in the sector

3.3.2.1 Household and business waste

NSW has strong targets and levies for waste disposal and recycling and has made progress in increasing recycling rates and avoiding landfill. NSW produces the largest volume of waste relative to other states, thus enhancing commercial opportunities for these technologies and facilities.

NSW has a major green waste composting sector and the majority of larger AWT plants are currently located in NSW and WA. Their construction has grown over the past five years and the uptake has remained limited to NSW, WA and Queensland.

NSW has the largest number of landfill sites that are covered relative to other states and capabilities in advanced landfill gas capture techniques such as bioreactors. However, there is no landfill gas collection at over a third of the NSW sites, including 6 out of 16 landfill sites greater than 100,000 tonnes, and a further 5 out of 9 between 50,000-100,000 tonne capacity. Such sites without landfill gas capture are generally non-putrescible landfills or older regional landfills located away from populated residential areas.

NSW has a regulatory framework that supports the bona fide recovery of energy from waste where there is minimal risk of harm to the environment and human health. In 2005, the NSW Government published the *Guidance Note: Assessment of Non-Standard Fuels* which outlines the criteria used by the Department of Environment, Climate and Water (DECCW) to assess proposals for the use of waste-derived fuels. Where assessed as appropriate, waste-derived fuels may be granted an exemption from the normal waste regulatory requirements that would otherwise apply to the receipt and use of waste at a facility. This exemption mechanism provides a point of distinction between wastes that are combusted for disposal from those that present genuine energy recovery opportunities. In 2008, DECCW also introduced the new scheduled activity of Energy Recovery into the Protection of the Environment Operations Act 1997 which sets the regulatory platform for dedicated, purpose built energy from waste facilities in NSW.

NSW headquarters several of the leading national and international waste companies including SITA and Veolia. Experience in landfill means industry skills could be transferable to other countries and states with rising waste management standards.

3.3.2.2 *Other bioenergy*

Feedstock

NSW has significant biomass resource including agricultural wastes such as crop residues and livestock manure, bagasse, wood wastes, bioenergy crops and urban wastes. NSW has strengths in both first and second generation biofuels:

- First generation biofuels: NSW accounts for less than 10% of total sugar production, although Manildra has recently established Australia's largest ethanol plant in NSW. NSW generates grain based ethanol and stakeholders indicate that expansion would be possible (into Sorghum feedstock for example) if demand for ethanol were to be maintained or increased.

- Second generation biofuels: NSW produces significant crop and forest residues which could be a major feedstock when conversion technologies are commercialised. In the interim their use could be expanded to produce heat and electricity through co-firing and gasification. Co-firing biomass could be a strong mitigation strategy for coal-fired electricity generation plants as a mechanism to retain their position in the merit order if a carbon price is introduced.

The low rainfall wheat belt may be suitable for the production of trees or woody crops. There is potential for Mallee crops, for example, to be further exploited in the form of narrow belts on the contours of farmland designed to intercept surplus agricultural water. NSW has significant potential to expand its production of fast-growing plants like eucalyptus that can be grown on marginal land[22].

NSW has large biological research facilities and large areas of land to test on, giving NSW a potential comparative advantage for research. It is also home to a number of universities looking to accelerate their abilities in these climate change issues to assist in the solution of reasonably minor technical issues that could yield great economic benefits (including exports). The NSW Government supports the Farm Futures Cooperative Research Centre, located in Western Australia, which is investigating the suitability and productive capacity of native woody species for bioenergy production.

Although NSW has some of the capabilities needed to grow algae, it is unlikely to be commercially available before 2020, therefore is not considered in this analysis.

Conversion

NSW Government announced on 15 April 2010 that proposals for biofuel manufacturing facilities will be given a guaranteed 3 month assessment time in order to create additional biofuel capacity over the following 15 months. This should help to accelerate investment in the region. NSW has a number of other strengths:

- NSW is home to world leading cellulosic technology development at Harwood Sugar Mill

- NSW Government has supported the Cooperative Research Centre (CRC) for Biofuels (located in Lismore) which researches and develops high biomass and matched conversion technologies

- NSW has abundant biomass resources

[22] See Bartle, J., Olsen, G., Cooper, D. & Hobbs, T. 2007. Scale of biomass production from new woody crops for salinity control in dryland agriculture in Australia. (Special issue: Liquid fuels from woody biomass.). *International Journal of Global Energy Issues,* **27**, 115-137.

Distribution

E10 is most readily available in NSW and Queensland. Accordingly, these States also have the highest usage of E10 as a total percentage of gasoline. As of August 2009, there are 1,575 retail outlets offering E10. The availability of retail infrastructure is key to encouraging consumer uptake of ethanol blends. In NSW, usage is most likely attributable to mandates in place since 2007 which have encouraged retailers to install extensive E10 distribution networks[23].

NSW Government is supporting the biofuel industry through the Green Fleet policy requirement that vehicles use E10 where possible. In addition, several new electric and alternative fuel cars are being developed, for example Holden's E85 Commodore.

3.3.3 Australian/NSW trends and international comparisons

3.3.3.1 Household and business waste

Australia/NSW

Australia generates approximately 40 million tonnes in solid waste, which is currently generating an estimated $8.8 billion in revenue through collection, disposal and treatment of this waste. Waste generation is expected to reach 45 million tonnes by 2013-14. Over the five years to the end of 2014-15, industry revenue is expected to grow at an average rate of 6.4% a year to reach $12.11 billion in 2020. Revenue growth is expected to come from the increasing level of collection and treatment of recyclable material.

The *2008 Blue Book*[24] has estimated that at least 150 new recycling facilities will be required across Australia by 2015 at a cost of $2.6 billion, based on the recovery and processing of an extra 16 million tonnes of waste and domestic recycling of an extra 2 million tonnes of materials. This is estimated to generate significant growth in economic activity and at least 2,000 direct and 4,000 indirect jobs. Modelling from Equilibrium OMG, a sustainable strategies and management company which projects resource infrastructure needs in 2020, estimates that compost, consolidate, shred and mulch organics will require around half of this infrastructure investment – between 49-98 facilities. These figures have been reaffirmed by stakeholders who are ready to install significant numbers of AWT plants in NSW should household collection increase.

The C&I waste stream accounts for over half of Sydney's landfill and there are still significant amounts of landfill being disposed of and, in particular, large amounts of food waste being thrown away by manufacturers, hospitality businesses and supermarkets. Pallets and cardboard also require further landfill avoidance. A typical supermarket produces 46% packaged food waste, 27% food waste, 22% other waste and 3% paper/cardboard. Action on food waste is not as far advanced although Woolworths and Coles have taken some action to divert food waste to composting and AWT facilities. It should be noted that commercial and industrial waste can be problematic for recovery as it can be highly contaminated.

Historically, landfills have been the predominant method of waste disposal in Australia, and continue to be so. Australia's geography has aided the establishment of landfills due to the large amount of uninhabited land, as well as the large number of old mine sites and quarries available, which have made landfills an economically attractive avenue for waste disposal. Furthermore, the relative simplicity of old landfills has aided the establishment of many such sites by small businesses, creating a vast supply of landfills and low disposal costs.

[23] The Biofuel(Ethanol Content) Amendment Act 2009 (an update to the original 2007 Biofuel (Ethanol Content) Act) mandates that from 1 January 2011, a minimum of 6% ethanol content of the total volume of petrol sales by major retailers (more than 20 service stations) and primary wholesalers.
[24] *The Blue Book, Australian Waste Industry, 2007/8* Industry and Market Report, WCS Market Intelligence (2008)

There are five key trends in waste disposal:

1) Improved landfill performance, including emissions reduction

2) Diversion of waste from landfills

3) Introduction of AWT facilities,

4) More sophisticated source segregation collection and recycling methods

5) Greater emphasis on material recovery

- Major urban and regional landfills have changed greatly since 1990, and have developed sophisticated environmental management systems. Landfills are continuing to improve their performance including making a worthwhile reduction to greenhouse gas emissions by capturing landfill gas (LFG) and generating renewable electricity. Research into improved landfill performance is an active field in Australia and overseas.

- In the last five years, the establishment and introduction of AWT facilities in Australia has had a major impact on the waste industry. However AWTs are capital intensive and require access to a high, constant and guaranteed volume of waste. The only viable participants are large operators that have access to capital but are unable to attract large volumes of waste. Hence, they have joined forces or have taken over smaller participants in order to guarantee optimal waste input. Councils are increasingly tendering for disposal services that offer higher levels of waste recycling and recovery, consolidating this trend. This movement towards large scale AWT, landfill and material recovery facilities has also encouraged the trend over the current period for local governments to band together in planning and purchasing such services.

- Kerbside recycling has been a successful initiative that has widespread social support. The level of service required, particularly for collection for recycling, is increasing. Despite good progress, there are still significant amounts of recyclable material disposed of to landfill by households. Estimates from the *Waste Avoidance and Resource Recovery Report 2008* estimate that over 820,000 tonnes of recycled material in Sydney were disposed of to landfill in 2006 of which 400,000 tonnes were from compostable food organics and 150,000 or other compostable organics.

- There is increasing uptake of existing technologies and more sophisticated collection and recycling methods are being adopted. Alternate disposal methods such as bioremediation, organic composting, and waste to energy techniques are growing in popularity. It is expected that state based waste recovery targets, the use of waste to provide alternate energy sources, and targets to reduce carbon emissions will provide increasing opportunities for growth in this industry.

- Out to 2020, some significant changes are expected in this industry. Generation of energy from waste will attract investment into NSW from leading-edge companies in this field, through the expansion of the existing waste companies based in NSW. This is a significantly underutilised resource in Australia that is likely to become increasingly targeted as we transition to a low carbon economy. NSW is in a fairly strong position to capture some of this market, given the delay in the CPRS.

With greater resource recovery, residual waste streams are expected to become more concentrated and more difficult to treat, leading to opportunities for innovative waste management organisations to provide specific solutions, such as capacity for sorting glass or cost-effective sorting technology for mixed plastics. It has been estimated that up to 80% of the material currently landfilled could be recovered with improved resource recovery application.

With expanding waste diversion targets, increasing waste levies and an increasing focus on low carbon energy generation, there is likely to be a stronger demand for recycling and recovery of waste, increasing revenue from the adoption of waste-to-electricity/gas technologies, and growing economies of scale and scope available to industry players. It is likely that the trend to produce energy and other products from waste will continue, and will provide an increased revenue stream to offset the cost of recycling. Companies that can produce new markets for waste materials and that develop end-use applications such as compost stand to benefit from the opportunities of moving to a low carbon economy.

International comparison

Hyder Consulting's report, *Waste and Recycling in Australia*[25] compared Australia's waste and recycling performance against four countries with similar geographical and/or socio-economic features. The findings, on a per capita basis, are shown below:

Table 10: Comparison of waste and recycling across nations

Country	Generated (kg)	Disposed (kg)	Recycled (kg)	Diversion rate (%)
Germany	555	215	341	61
Australia	566	349	217	38
United States	927	625	302	33
England	574	398	176	31
Canada	411	292	118	29

Source: Hyder Consulting

These results show that Australia has a slightly above average recycling rate, but also that there is the potential to improve this rate and reduce our overall volume of waste sent to landfill. Other countries have the following characteristics and initiatives regarding household and business waste:

- ***China***: China's economy promotes reduction, re-use and recycling of waste as central to production and it seeks to curb the generation of all types of waste by fostering a high quality, low material intensity, and economic growth model. A progress report published in 2008 showed strong improvements in household waste reduction, reduced landfill disposal and some increased household recycling.

- ***New Zealand:*** In 2008, NZ set 30 aspirational targets for improved waste management, waste minimisation and resource efficiency. NZ has enacted legislation which moves NZ towards a zero waste objective through improved public recycling, dedicated funding to support waste minimisation and management and regulations to support industry led product stewardship scheme.

- ***EU:*** The EU waste strategy focuses on waste prevention, recycling and improving the final disposal and monitoring processes. The main waste streams targeted in the strategy include packaging waste, end-of-life vehicles, batteries, and electronic waste. The strategy reinforces recycling as preferable to incineration and landfill a last resort.

- ***UK:*** The UK Waste Strategy targets waste reduction and re-use, with recycling and energy recovered wherever possible. The strategy specifically mentions green waste, plastics and aluminium as high re-use and recovery products. The majority of emissions from the waste sector in the UK come from landfill and there is a strong policy framework that acts to incentivise a significant reduction of waste to landfill and consequently a reduction in the associated emissions. This is underpinned by the EU Landfill Directive and implemented through measures such as the landfill tax and the landfill allowance trading scheme which targets biodegradable waste specifically.

3.3.3.2 Other bioenergy

Australia/NSW

Bioenergy resources are difficult to estimate due to their multiple and competing uses. However, Australia's potential bioenergy resources are large and under-utilised, particularly in agriculture and forest wastes. Agricultural related wastes in total are a very large resource but currently not widely collected as a bioenergy feedstock. They are often widely dispersed and can have a range of alternative uses including composting for garden product manufacture and stockfeed for animals. Residues from forests and wood processing are large untapped resources, and effective and sustainable use of these resources can contribute to energy generation.

[25] http://www.environment.gov.au/settlements/publications/waste/waste-recycling.html

Feedstock

First generation biofuels will continue to provide capacity where they are produced as by-products and NSW should be well placed to take a greater share of this. However, supply is not expected to grow significantly between now and 2020 due to a limited market for the primary product. Of the two main biofuels (ethanol and biodiesel) ethanol has become the largest contributor as a substitute for gasoline. Biodiesel has made only a small contribution to the diesel supply chain in Australia, despite large investments in new biodiesel capacity since 2005.

First generation biofuels will be superseded by second generation biofuels as soon as these become commercially viable. Although still in the development phase, commercialisation could be expected before 2020 in certain technologies. This will require significant R&D investment. They are expected to focus on less productive or underutilised land that has few competing uses. As second generation crops become viable, there is expected to be more research into crop improvement biotechnologies and crop harvesting technologies.

Conversion

There is some co-firing and combustion of woody and crop residues and some development in gasification and pyrolysis, but not on a large scale. The recent award of grants and international research suggests the ongoing development of pyrolysis. Industrial scale development (200 tonne per day) is underway but is yet to be commercialised. Biochar is a strong driver for pyrolysis technology. The current disadvantage is that it creates less energy than burning biomass in the conventional way.

Distribution

Ethanol is gaining wider community acceptance, and there is support at national and state levels for a greater role for biofuels in transport. However, Australian Government regulations limit the proportion of ethanol in petrol to 10% due to vehicle warranties. A number of car manufacturers are planning to introduce E85 flexible vehicles which can run on blends from E10 to E85. Biodiesel blends – usually B5 or B20 – are available at an increasing number of service stations in all states. Distribution of biogas via the gas grid is not practised in Australia, however is being developed in countries like the UK.

International comparison

Currently around 10% of the world's primary energy consumption comes from bioenergy. However, a significant proportion comes from the burning of fuel wood to produce heat, primarily in developing countries, which is inefficient and causes significant air pollution. Currently only around 4% is used for electricity generation and another 2.5% is used for biofuels in the transport sector.

At present, agricultural waste and municipal waste are the key feedstocks used to generate heat and electricity. This is a growing market which has the potential to compete with other sources of renewable generation as technology costs come down between now and 2020.

Leading locations in the production of biofuels include Europe, Brazil, North America, Japan, China and India. Sugar, grain and vegetable oil crops are used for the production of biofuels. There is a mature and commercial market for these first generation biofuels, however sustainability issues such as competing land uses and life-cycle emissions mean that these will be displaced by more efficient and sustainable second generation biofuels. The IEA predicts that biofuels have the capacity to displace 5.4% of the world's gasoline by 2013. In the major markets of Brazil and the United States, where ethanol is an important part of the fuel mix, consumption is growing by 10–20% per year. Asian countries are also setting targets in this area – for example China has a target for 15% renewable fuels by 2020 and India is considering a 10% ethanol mandate.

Biodiesel has been produced commercially in Europe since 1992, which accounts for more than 80% of global biodiesel consumption. Since 2006, biodiesel capacity has more than doubled. The current target for the EU is a 5% share of renewables in fuel used for transportation by 2015 and 10% by 2020. Biodiesel markets are experiencing double digit growth in the US and Asia, in particular India and China. However, the competitiveness of the biodiesel industry is being challenged by higher priced feedstocks.

The key growth markets for power generation are the EU, North America, Central and Eastern Europe and Southeast Asia. Countries in the EU are leaders in the field of anaerobic digestion (AD) for managing farm waste. Throughout Europe centralised anaerobic digester systems have been installed. Manure and other organic industry waste products are shipped to these central processing units where electricity is produced for domestic as well as commercial applications. Of particular note:

- Denmark has a number of farm cooperative AD plants which produce electricity and heating for local villages. Plants have been built in Sweden to produce vehicle fuel for fleets of town buses. In Germany, a range of policies have been introduced in recent years which have led to widespread investment in AD technology, resulting in over 3,700 biogas facilities treating municipal and agricultural wastes (mostly in regional areas). Regional economic investment is approximately €650 million per annum. The UK has recognised the potential of using AD for good waste and agricultural waste, and set a target of having 1000 AD systems in place by 2020. There is currently a GBP 10 million demonstration fund in the UK to encourage take up of this technology.

- Outside the EU, India and Thailand have several thousand small scale AD facilities. In many other developing countries, simple home and farm based AD systems offer the potential for cheap, low cost energy from biogas. AD facilities are currently being incentivised in Europe.

- Anaerobic facilities are operating successfully within Australia and overseas, particularly throughout Europe and the US. The main global players are ArrowBio, Biogen (in the UK this company runs an AD plant at Milton Ernest in Bedfordshire which processes pig slurry and food manufacturers' waste), Cambi, Dranco, Entec Biogas, Environmental Power Corporation, Farmatic AG, Haase, HiRAD, Kompogas, Kruger AS, Linde, Monsal, Passavant, Paques, Schmack Biogas, Schwarting, UTS Biogas, Valorga and Xergi.

The market for biofuels is mostly driven by renewable fuel mandates established by a number of countries. These are mandated generally for reasons of energy security and emissions reduction, and will increase the demand for food-based biofuels in 2009 and beyond. Food crop-based ethanol demand is projected to grow by about 12% per year through to 2012. Demand for biodiesel produced from food crops is expected to grow by 16% per year through to 2012.[26]

Specific action taken by different countries includes:

- Tax incentives and subsidies: Various US states offer subsidies which are strongly benefiting the US biofuels sector. Biodiesel receives US$1/gallon tax incentive. There is US$0.51/gallon tax incentive to fuel marketers who blend ethanol into gasoline. This incentive expires in 2010, but is expected to be extended at a lower level.

- Total direct and indirect subsidies for ethanol are estimated to range from US$1.05-US$1.40 per gallon sold in the US, or about 45-60% of the current market price. Subsidies and tax incentives have been, or currently are, being provided in Canada, China, the EU, Indonesia, Malaysia, Switzerland and Thailand.

- Subsidies in the EU reached €3.7 billion in 2007. France exempts 1.2 million tonnes per year of biofuels from excise taxes and offers a progressive tax rate linked to the amount of biofuel blended into transportation fuel. Sweden also exempts biofuels from excise duties.

- Usage mandates: Three US states (Oregon, Minnesota and Washington) have mandated 2% or more biodiesel in vehicle fuels and Pennsylvania and Massachusetts plan to follow. European countries have also adopted mandates for biofuel use.

- Support for biofuels research and commercialisation: In May 2009, President Barack Obama signed a Presidential Directive establishing a Biofuels Interagency Working Group. He also announced a proposed rulemaking to establish a national renewable fuels standard (RFS) and US$786.5 million in additional Recovery Act funds for renewable fuel projects.

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[26] United Nations' Food and Agriculture Organisation (FAO)

- The experience of Brazil demonstrates significant market stimulation through government policy. Brazil initially offered tax rebates to consumers and incentives to producers. Ethanol is no longer subsidised and is competitive at 60-70% of the price of E10 gasoline. Ethanol storage benefits from lower excise taxes and domestic production is protected by a 20% tariff on imported product.

3.3.4 Market size

Ernst & Young estimate the market value of this sector to between $860 million and $1,030 million in 2020. This estimate does not exhaustively cover all the complex sub categories of this sector. For the initial phase of the study, the sub sectors considered were waste to energy and waste to fuel generation. Forms of waste to energy generation analysed included: sugarcane, wood, landfill gas, sewage gas, agricultural waste, urban waste and energy crops, and were sourced exclusively from the Clean Energy Council[27]. The waste to fuel generation industry looked at the biofuels market as a substitute for petrol.

Table 11: Waste market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE- NSW 2020
	Low	High	Low	High	
Waste conversion	150	180	860	1,030	1,250-1,620

Source: Ernst & Young estimates

The Australian Bioenergy Roadmap identified that Australia has sufficient biomass resources to supply 11,000GWh or 2,000 MW per annum of electricity generation from biomass by 2020 (dominated by bagasse, wood-waste and landfill gas). NSW has potential to supply about 2,000GWh or 300MW of this according to Ernst & Young estimates. This calculation assumes conservative use of emerging second generation technologies which could offer further opportunities.

3.3.5 Identified specific opportunities

	Waste conversion: Household and business waste
1	Increase levels of separated household waste collection.
2	Increase levels of commercial and industrial collection, particularly for paper and cardboard, organic wastes and pallets and associated technologies to recover these products.
3	Harmonise waste collection systems across geographic areas and across waste streams.
4	Expand energy generation from organic waste, in particular focussing on distributed generation opportunities through the production of biogas to fuel combined heat and power (CHP) plants or as co-firing feedstock.
5	Increase generation of compost from source segregated organics.
6	Increase number of AWT plants in NSW that utilise mechanical biological treatment methods.
7	Expand number of smaller scale alternative waste treatment (AWT) plants in more centralised locations such as transfer sites.
8	Provide innovative waste treatment solutions as more waste is recovered.
9	Co-fire clean plastic in black coal power stations.
10	Sell/install landfill gas collection systems to 14 remaining large landfills that do not have this technology.
11	Export landfill gas collection technologies to countries with less well developed waste management systems in close proximity.
12	Expand use of biogas in waste collection vehicles.

[27] http://www.cleanenergycouncil.org.au/cec/resourcecentre/reports/bioenergyroadmap.html

	Waste conversion: Other bioenergy
1	Expand planting of Eucalypt Mallee
2	Optimise/improve/expand forest management practices
3	Focus research facilities on exportable technologies/crops
4	Expand feedstock suitable for ethanol production as a by-product and associated production facilities
5	Expand use wood and crop waste to produce heat and electricity through increased co-firing, particularly in coal-fired plants
6	Expand use of biomass for distributed generation
7	Extend application of renewable energy precincts to include bioenergy where near to biofuel resources.
8	Expand use of anaerobic digestion on large scale farms and those situated closely to other organic waste sources
9	Develop mobile processing plant solutions
10	Expand use of E85
11	Government purchasing of biofuels for public transport fleet

3.3.6 Identified issues/barriers

There are a number of issues limiting greater activity in this sector. These are explored briefly below, however have not been the focus of thorough investigation.

3.3.6.1 Household and business waste

Industry consultation has identified the following:

- **Localised systems**: Localised distribution and collection networks and localised policy context mean that is it difficult to gain sufficient economies of scale for collection and sorting companies.

- **Barriers to market entry**: Long-term supply and sales contracts upon which most operations rely puts smaller and more innovative firms at a disadvantage. In addition, a lack of understanding of new and unproven technologies inhibits their take up and can also hinder financing being obtained. The planning process and community concerns often place constraints upon larger or centrally located facilities. Where grid connection is needed, significant additional costs are added to the initial investment.

- **Information standards**: Measuring waste emissions is notoriously difficult and there are large variations in emissions estimates, making it difficult to identify areas for improvement and quantify investment benefits. In addition, there is an absence of scientifically sound, product quality standards for outputs from waste technologies which help to develop new markets for products and increase market acceptance.

- **Lack of price signals**: There is a lack of consistent signals on regulation and a need for forward visibility for renewable energy generation. Two issues further compounding this situation are:

    - Alternative sources of energy are currently cheaper than energy generation from waste but wider benefits of waste recovery are not factored into the uptake decisions.

    - Costs of landfill are low compared with energy and resource recovery options, in particular, capital costs of alternative solutions to landfill can be expensive with large upfront cost and onerous financing requirements. (Note: increasing waste disposal levies help address the imbalance between cheap landfill and higher resource recovery costs).

3.3.6.2 Other bioenergy

Industry consultation has identified the following:

Feedstock

- There are **sustainability issues** with first generation biofuels. Some of these crops do not produce emissions savings over the lifecycle of their production given the emissions released from disturbance of the soil and the fertiliser used in the growth process.

- There is a small risk that growing crops for fuel **competes with food production** and leads to increases in food prices, although this can be minimised where waste and low-value products are used as feedstocks. Alternative view points, such as those of the World Bank, conclude that concerns over increased food prices are not correct. There is also a risk that bioenergy production diverts valuable water resources.

- **Production costs** for Australian producers are substantially comprised of items whose prices and availability are difficult to control, for example fuel costs and fertiliser costs.

- **Fuel source is not consistent** and can vary by season, site and climate. For example, bagasse is available for about half a year during the harvesting and crushing season (June to November). To make this an efficient capital outlay, other waste material would have to be available for the remainder of the year to generate energy or the conversion plant used for other uses.

- Stakeholders have reported that **export potential may be limited** because technologies tend to be very specific to the particular crop and environment they are developed for. Overseas crop varieties may be slightly different or they may not grow in the same conditions due to, for example, soil and climate differences. Therefore a business model that works in Australia may not work overseas.

- **Uncertainty** about future changes in oil and feedstock prices continues to restrict investment in new capacity.

Conversion

- **Emerging industry:** Australia's biofuel industry has only existed since 2004, trailing behind countries such as Brazil and the US from a technology, usage and cost standpoint. The technology associated with conversion is not well understood, making finance difficult to secure. Clear and transparent information, technical information, and mapping of low cost reliable feedstocks is also not readily available.

- **Planning challenges:** Stakeholders report that there can be issues with inconsistent application of local and environmental planning rules to potential production sites, and slow response to applications for planning permits.

- **Regulatory uncertainty:** There is also regulatory uncertainty and complexity. Certainty around future government policy is key to securing future supply by Australian producers. Ongoing ethanol plant investment risks are considerable given the uncertainties around the following policy aspects:

    - Mandates for ethanol use
    - Producers' rebate phase out
    - Import tariffs

- **Logistical issues:** The geographical distribution of feedstocks can sometimes be sparse leading to logistical issues associated with handling, transport and storage. This is not always the case with hardwood and softwood plantation residues that have several good locations.

- **Market links:** Stakeholders report difficulty in establishing the necessary grid connections and securing a Power Purchase Agreement (PPA) to guarantee demand.

- **Undervalued benefits:** The price paid for distributed energy does not fully reflect all the benefits gained from having power generation distributed. There is a need to incentivise high capital start up costs by accounting for these market failures.

Distribution (specifically for Biofuels)

- **Preference for petrol:** Due to the low price of petrol, ethanol is not a significantly cheaper fuel source. It is negatively impacted by the complexity /uncertainty of the fuel excise regime and the absence of fuel standards for biodiesel/ethanol blends. There are also negative consumer attitudes and general public distrust of biofuels, including the belief that it will harm engines.

- **Market transition:** As with any new technology associated with vehicles, time is required for the phase-out of incompatible vehicles. Most vehicle models from 2004 can run on ethanol blends. As older vehicles are phased out, the market for ethanol blends will grow.

- **Government support:** As demonstrated in Brazil, the market for biofuels requires considerable government support before the market can become self-sustaining. Government subsidies in NSW need to be continued to create market demand.

- **Infrastructure requirements:** Although biogas is cheaper than traditional fuels and often subject to lower taxes, biogas requires expensive infrastructure such as a network of filling stations. In addition, the costs of converting vehicles to run on gas, and higher maintenance costs, represent further barriers to roll-out.

3.4 Low emissions vehicles

3.4.1 Sector description

This sector encompasses low carbon fuels, technologies and infrastructure requirements for the introduction of Low Emissions Vehicles (LEVs). LEVs have been classified as follows:

- Alternative power vehicles
- Alternative fuel vehicles
- More efficient internal combustion engine (ICE) vehicles

3.4.1.1 Alternative power vehicles

There are several categories of alternative power vehicles. These include:

- **Hybrid Electric Vehicles (HEV):** HEVs combine both an internal combustion engine with an electric engine, with electrical energy stored in batteries. Vehicle propulsion is a mix of the internal combustion engine (ICE) and electric drive trains typically dependent on vehicle speed (urban/non-urban use). HEVs are more fuel efficient than regular ICE vehicles as they take advantage of the complementary power generating characteristics of the two technologies.

- **Plug-in Hybrid Electric Vehicles (PHEV):** Plug-in Hybrid Electric Vehicles (PHEVs) are similar to regular hybrids in that they combine the use of combustion and electric motors. However, PHEVs are capable of being recharged by plugging in to the electricity grid. Charging can be achieved through a conventional household wall socket and at charging stations similar to existing petrol stations. The batteries in a PHEV are typically larger than those in a HEV leading to a greater all-electric range that is sufficient for average metropolitan use. The trade off for larger batteries and greater range is increased battery cost, size and weight.

- **Full Electric Vehicles (EV):** Full Electric Vehicles are powered only by electricity stored in batteries. EVs face similar limitations as other alternate power vehicles due to the need for batteries. In EVs, battery shortcomings are highlighted as there is no ICE to boost range and acceleration, for example. To increase range, more or larger batteries are required with costs and weight also increasing. Improvements in battery technology will gradually address these issues.

3.4.1.2 Alternative fuel vehicles

Alternative fuel vehicles can operate on a range of fuels including:

- **Ethanol:** Ethanol can be used in light-duty, medium and heavy-duty trucks and buses – flexible fuel vehicles that can be fuelled with E85 (15% petroleum and 85% ethanol), gasoline, or any combination of the two fuels. In Australia, 10% ethanol is the maximum permitted ethanol content in petrol, but there is no fuel standard for ethanol currently under consideration. Ethanol has less energy by volume than petrol and acts as a solvent, sometimes requiring modifications to the engine to ensure optimum fuel flow and compression ratings.

- **Biodiesel:** Small quantities of biodiesel are produced in Australia. Biodiesel typically costs two to three times more to produce than petroleum fuels but can be mixed with regular diesel without requiring substantial engine modifications.

- **Biogas:** Biogas is derived from the breakdown of organic matter in the absence of oxygen to produce methane and carbon dioxide from the conversion of manure or sewerage and municipal waste. These can be combusted with oxygen in air as a fuel and then compressed to replace natural gas for use in vehicles. For use as an engine fuel, the methane content has to be boosted to around 97% (by chemically removing most of the carbon dioxide). Various biogas powered cars have been produced over the years in Britain, India and China. Applications tend to be small scale and are often used for fleet cars whose company produce the gas directly e.g. waste treatment plants.

- **Other fuels:** There are many other types of alternative fuels that could provide lower emissions alternatives to current petrol/diesel cars including LPG, CNG, hydrogen, methanol, biomethanol and biobutonal. However, various issues associated with these alternative fuels indicate they are unlikely to be the source of large market growth between now and 2020.

- More detail on alternative fuels is provided in the Bioenergy subsections of the Waste Conversion Section (3.3), as the production of these fuels is an important part of the alternative fuel vehicle supply chain.

3.4.1.3 Efficiency improvements to ICE vehicles

This category includes improvements in engine efficiencies, transmission technologies, fuel efficient tyres, and accelerated vehicle retirement (whereby owners of old vehicles are offered a bounty to scrap their vehicles) and energy efficient auxiliary equipment. This has not been considered in the scope of this sector given that the large majority of manufacture is abroad and manufacture that does occur in Australia is not located in NSW.

3.4.2 NSW strengths in the sector

- There are regulatory drivers supporting LEVs in NSW, as well as favourable mineral resources, an appropriate skills and training base, driving patterns suited to LEVs, and the presence of possible future market players. NSW policy drivers include:

    - The NSW Government has agreed to participate in an Australian trial of the i-MiEV (Mitsubishi Innovative Electric Vehicle). The i-MiEV will be used as a fleet car to help Mitsubishi gather data about the car's performance under Australian driving conditions. The trial will be run by the Department of Services, Technology and Administration. This fully electric, zero-emissions vehicle was commercially released in Japan in 2009 and trials are planned for Europe, New Zealand and the US in late 2010.
    - The NSW Electric Vehicles Taskforce, established to review the technology, infrastructure, policy and legislation needed to support electric vehicle use by NSW motorists.
    - SWITCH, Australia's first plug-in hybrid electric vehicle which is being trialled by the DECCW vehicle fleet to test fuel efficiency, electricity use, greenhouse gas emissions and air pollution savings.
- The Federal Government has committed up to $100 million to develop a single Smart Grid, Smart City demonstration project in NSW in partnership with the energy sector. This will provide a strong pilot of LEVs in NSW.

- NSW's mineral resources include some of the key materials used in car production, including aluminium, iron and steel. Magnesium and cobalt resources are also present in NSW.

- NSW has the capacity to train workers to be highly skilled in the area of electric and hybrid vehicle maintenance. Capital and labour employed in petrol vehicle industries could move across to electric vehicle industries with little industry restructuring costs. For example, service stations could become recharge stations and mechanics could progressively re-skill to service LEVs. The strong base of labour specialising in engineering, science and technology, together with research and development infrastructure, further position NSW well to support the LEV market. At the University of Technology (Sydney) Institute for Sustainable Futures, a team of researchers has converted three Toyota Prius cars into PHEVs which can be charged directly from the domestic power grid.

- In Sydney 85% of vehicle owners drive less than 100km per trip (Dr Peter Pudney, University of South Australia) making the use of shorter range vehicles viable.

- NSW is home to several players in the LEV supply chain. Chargepoint Pty Ltd, an infrastructure company, is headquartered in Sydney. Toyota Industries have been developing solar charging points, their headquarters situated in Sydney.

3.4.3 Australian/NSW trends and international comparisons

3.4.3.1 Australia

The supply of alternative fuel or powered vehicles to the Australian market is expected to be quite limited in the short term. Not only is production expected to be limited over the next few years, those that are produced are likely to be allocated to markets other than Australia. Furthermore, pricing in Australia is likely to be relatively high - $40,000-$70,000 - although growth in production is likely to bring this down quickly.

Motor vehicle production is forecast to grow over the next five years, driven by government assistance programs such as the Green Car Innovation Fund (GCIF) and the shift towards the production of smaller and hybrid cars. Limited volumes will grow in the next 3-5 years as the industry plans to launch more than 30 EV and PHEV models with global production targets set to reach around 1 million units. For example, Toyota has started manufacturing the hybrid Camry in Australia in 2010 after obtaining government grants.

The shift towards environmentally friendly cars will have a significant impact on this industry as it will need to alter the type of products manufactured to accommodate green trends. In componentry, for example, many hybrid vehicles use regenerative braking. Regenerative braking stores energy in the battery of electric and hybrid electric vehicles for later use, making it consistent with the energy efficient aim of hybrid electric vehicles.

It is unlikely that domestic motor vehicle manufacturers will be able to increase their value added on new vehicles in the short term, especially as they will be competing with foreign manufacturers that have been making fuel efficient vehicles for years. However, over the medium term to long term, the following changes are expected to take place:

- **Battery development:** Lithium-ion PVs are on the verge of mass production and commercial viability, with plug in hybrids following close behind. They are produced by companies in Japan, Korea and China, who are often vertically integrated into automakers limiting the supply into the open market and creating high barriers to entry. This also limits the scalability of aftermarket retrofit plug-in vehicle solutions. The US has recognised this concern and has been increasingly funding domestic battery manufacture, although similar moves are not evident yet in Australia.

- **Network development:** There are a number of companies that are beginning to set up electric charging stations operations in Australia. This is likely to grow as production increases. Similarly, a number of businesses are looking to establish battery switching stations in Australia. Upgrades to the underlying network infrastructure will not be required as long as the numbers of vehicles are limited.

- **Vehicle to grid capabilities**: Smart grids are being established worldwide, with significant roll-out of smart meters to monitor and modulate household use. In Australia, Victoria, followed by NSW, have led the roll-out of smart meters. The Smart Grid, Smart City demonstration project, which has $100 million in funding from the Commonwealth, is further increasing the potential for vehicle to grid capabilities.

- **Materials:** Increased use of magnesium to replace aluminium, in a bid to improve fuel economy, is a competitive strategy that manufacturers could use in the future. Magnesium is lighter and stronger than aluminium and has better die-casting characteristics. The use of magnesium is expected to increase from the current average of three kilograms per vehicle to more than 100 kilograms in the next 15 to 20 years.

- **Aggregators:** Have started to emerge where the market is further developed, such as in the US.

The move from conventional vehicles to LEVs may change employment needs in the petrol vehicle industry (including service stations and mechanics) in terms of number of jobs and skills required.

3.4.3.2 International comparisons

Governments in the US, China and much of Europe are becoming significantly more involved in their respective automobile industries. New government incentive programs have been introduced in Asia and Europe to persuade customers to purchase all electric vehicles, vehicles with combined electricity and fuel engines, plug-in hybrids as well as vehicles with fuel cells.

Electric vehicles have received over US$1 billion globally in venture capital investment since 2004[28]. Other alternatives, such as biofuels, will remain viable and in all cases internal combustion engines will continue to dominate the near-term landscape. The hybrid vehicle market is expected to grow to nearly 2 million vehicles in 2013, from 550,000 units sold in 2008. Market share is expected to grow to 25% by 2020, with over 5 million PHEVs sold per year by 2030. Nissan estimates full electric vehicles could account for 10% of global vehicle sales in 2020.

Credit Suisse (2009) estimate that global automotive sales of electric vehicles are expected to rise to over $400 billion by 2030. Sales of batteries are expected to rise to over $100 billion and incremental charging infrastructure spending to be at least $170 billion through 2030. It is estimated that 1.1% of global vehicle sales will be electric by 2015, driven by more than $15 billion in subsidies. That number could climb to nearly 7.9% by 2030. Hybrid electric vehicles could reach 5.9% by 2030 from 0.6% today. Nearly every auto manufacturer has plans to develop electric vehicles, with many models targeted to launch in 2010 and 2011, including by Chevrolet, Nissan and Toyota.

3.4.4 Market size

Ernst & Young estimate the potential market for this sector to be between $1,440 million and $1,730 million in 2020. The value estimates are based on sales in NSW of hybrid vehicles which are assumed to be direct substitutes for other low emissions vehicles, but more likely to be commercialised in the time period under consideration. Estimates suggest that employment potential could reach 3,780 – 4,540 people by 2020.

Table 12: Low emissions vehicles market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE- NSW 2020
	Low	High	Low	High	
Low Emissions Vehicles	100	120	1,440	1,730	3,780-4,540

Source: Ernst & Young estimates

3.4.5 Identified specific opportunities

	Low Emissions Vehicles: Alternative power
1	Lead the aggregator market in Australia for vehicle to grid ancillary services
2	Make Sydney a pilot or demonstration hub for alternative power vehicles
3	Incorporate charging infrastructure into new urban developments and renewable energy precincts
4	Establish businesses in NSW that can design new and innovative business models for LEVs, for example, leasing strategies for batteries and membership to charging networks
5	Use of NSW primary resources, including magnesium and cobalt for the manufacture of alternative power vehicles within Australia
6	Integrate LEVs into the smart grid including software development requirements

[28] EY Cleantech Insights, November 2009

3.4.6 Identified issues / barriers

The following barriers to the growth of the low emissions vehicle market in Australia have been identified:

- **Cost:** The difference in purchase price between an electric and a conventional car remains substantial. This is primarily due to the disparity in production cost. It is estimated that production costs (at present rates of production) for a full hybrid car are US$7,000 higher than a similar non-hybrid. The purchase price is a significant factor for consumers when deciding which car to buy, even though the costs incurred over the life of the LEV are considerably lower. It is clear that this will impact negatively on the sales of LEVs. This is likely to continue until electric vehicle prices converge with conventional vehicles.

- **Market size:** The dominance and cost competitiveness of overseas manufacturing in countries like China makes Australia less attractive as a potential manufacturing hub for LEVs. Also, the size of the Australian market, relative to other countries, is relatively small, resulting in exacerbated supply problems in the Australian market. Automotive companies seem reluctant to commit to increased production until there is more certainty about the future of the industry.

- **Technology issues:** There is considerable uncertainty about battery technology improvements. The lack of standardisation and regulation in the battery industry may hinder the development of charging infrastructure. New business models are emerging, however these are not proven yet. There is the risk that Australia may not choose the business model that emerges as the winner.

- **Distance and infrastructure issues:** Given the geography of Australia, there is a need to ensure that the performance of LEVs is comparable to traditional vehicles, particularly in relation to issues of speed and distance. Negative factors include the lack of a smart grid in NSW and associated capacity, as well the high projected cost of infrastructure investment. This is compounded by uncertainty around the type of infrastructure that will be needed (i.e. charging points vs. battery switching).

- **Regulation/standards and knowledge issues:** There is presently an absence of standards and regulations for LEVs, which may be creating uncertainty among consumers. There may also be a lack of knowledge among consumers about the performance and safety of LEVs compared to conventional vehicles. It may be too time consuming and costly for individual purchasers to commit resources to researching and assessing the performance of electric vehicles.

- **Barriers to entry:** Battery companies are often vertically integrated into automakers limiting the supply onto the open market and creating high barriers to entry. This may limit the scalability of aftermarket retrofit plug-in vehicle solutions.

3.5 Solar energy

3.5.1 Sector description

This sector encompasses the generation of energy using technologies able to convert solar radiation into electricity. The use of solar radiation as a mechanism for energy generation is categorised as:

- Solar photovoltaic (PV) electricity generation: These devices capture the energy of sunlight and convert it to a low-voltage, direct electric current. A converter is required to change this to a high-voltage alternating current suitable for supplying electricity to the grid.
- Concentrating solar thermal (CST) electricity generation: This technology focuses sunlight using mirrors to concentrate it onto photovoltaic surfaces for improved power production.
- Solar thermal heating and/or cooling (which is covered under Green Buildings in Section 3.2).

3.5.1.1 Solar PV

These devices capture the energy of sunlight and convert it to a low-voltage, direct electric current. A converter is required to change this to a high-voltage alternating current suitable for supplying electricity to the grid. There are many competing technologies with varied stages of development and market share:

- **Crystalline silicon** (c-Si) – divided into two categories i) single, or mono-crystalline and ii) multi, or poly-crystalline. These account for the majority of the global market (85 – 90%).
- **Thin films** – divided into three main categories i) amorphous and micromorph silicon, ii) cadmium telluride, and iii) copper-indium-diselenide and copper-indium-gallium-diselenide. In total these account for 10 – 15% of the global market.
- **Emerging technologies** – including organic cells, dyes, and advanced thin-films.
- **Other novel PV concepts** – technologies principally at basic research level globally that aim for ultra-high efficiency solar cells using advanced materials and photo-chemical processes (e.g. single crystal cells).
- **Concentrated photovoltaic** – technology that focuses sunlight using mirrors to concentrate it onto photovoltaic surfaces for improved power production. Solar concentrators of all varieties may be used, and these are often mounted on a solar tracker in order to keep the focal point upon the cell as the sun moves across the sky. Various types of concentrating /focussing systems are described in the solar thermal section below. These (PV) systems require cooling water to protect the system and cells from damage due to high temperatures.

3.5.1.2 Solar thermal

This technology harnesses the heat from solar radiation and concentrates it using focusing devices (mirrored surfaces) to drive conventional steam turbines. With the incorporation of heat storage (such as molten salts) and fuel back-up (such as gas) large-scale solar thermal can act as a baseload replacement with greater consistency than many other renewable generation systems. There are four main technologies:

- **Parabolic trough** – the most mature technology, representing the majority of commercial developments. The system consists of a linear parabolic reflector that concentrates rays onto a receiver positioned along the reflector's focal line. The receiver is a tube positioned right above the middle of the parabolic mirror and is filled with synthetic oil as a heat transfer fluid which is used to create steam. Alternative approaches also use direct steam generation or molten salts as the heat transfer material. The reflectors usually move to track the sun during the daylight hours.
- **Towers and central receivers** – use of an array of reflectors to concentrate light on a raised central receiver tower. Towers generate saturated or super-heated steam directly, or use molten salts, air or other media as heat transfer fluids. These are cost effective systems (although have higher manufacturing and construction costs due to the use of curved mirrors), offer high efficiency and good energy storage capability.

- **Linear Fresnel Reflectors (LFRs)** – the use of many thin mirror strips to concentrate rays onto an elevated fixed receiver. LFR has a lower efficiency than other concentrating solar technologies, but has low manufacturing and construction costs due to the use of flat, instead of curved, mirrors.
- **Parabolic (or stirling) dish** – stand-alone parabolic reflectors that concentrate light onto a receiver positioned at the reflector's focal point. The reflector tracks the sun along two axes. Parabolic dish systems give the highest optical efficiency among concentrating solar technologies but usually on much smaller capacities (tens of KW).

3.5.2 NSW strengths in the sector

NSW is supported by a number of characteristics for solar energy including:

- NSW has excellent solar resources, with average solar exposure exceeding 15MJ/m2 per day and increasing to 21 MJ/m2 per day in the north-west of the state.
- NSW has a well-developed **mineral** mining industry and a large silica mine in Cowra, with significant deposits elsewhere throughout the State that have export potential. NSW also has strong capability in steel, copper and cement production.
- Silex Solar is the only commercial **manufacturer** in Australia of single crystal silicon PV cells and modules although there are various companies that import overseas made PVs (for domestic installations). Tyco Electronics (international electrical components company) has a presence in NSW (previously partnered with PV Solar Energy to develop PV roof tiles). Tyco manufactures products such as cable accessories, connectors, insulation and street lighting.
- NSW has leading **research and development** capacity in both solar thermal and photovoltaic technologies. Key research centres include The Photovoltaic Centre of Excellence at the University of New South Wales which is leading research on first, second and third generation solar cells; and the CSIRO's National Solar Energy Centre in Newcastle which is developing solar thermal technologies and is home to the largest high concentration solar array in the southern hemisphere.
- There are currently 352 accredited **designers and installers** of PV systems in NSW and the ACT combined (second only to Victoria)[29].
- Off-grid development has been strong, and there is potential to further develop this and replace diesel generation in regional areas. NSW invested in a huge upgrade of **energy infrastructure** in 2009 including replacing cables and substations. Much of the work will be taken on by State-owned infrastructure company, TransGrid.

3.5.3 Australian/NSW trends and international comparisons

3.5.3.1 Australia

In Australia, PV has experienced rapid growth in the residential sector. Table 13 below indicates the IEA's predictions for electricity generation by application. Residential (distributed) application remains the largest single contributor to PV generation.

Table 13: Cumulative PV potential in Australia (in GW)

PV capacity (GW)	2010	2020	2030	2040	2050
Residential	17	118	447	957	1380
Commercial	3	22	99	243	404
Utility	5	49	223	551	908
Off-grid	2	21	103	267	463
Total	**27**	**210**	**872**	**2019**	**3155**

Source: IEA – IEA Vision for PV deployment, 2009

[29] http://cleanenergyaustraliareport.com.au/technologies/solar/

Off-grid applications have been bolstered by increasing fuel prices so renewable technologies meet price parity more readily. Meanwhile, utility scale production is expected to increase significantly out to 2020 due to investment under the Solar Flagships Program.

There are limited examples of installations of mid-scale commercial installations in NSW. Queensland has examples of academic institutions and retail centres installing 200 kW to 1.2MW systems, but most are sporadic and often have financial support in some manner. Despite this, there has been market interest in the potential for utilising roof space for distributed energy generation, particularly from property owners with large property portfolios in locations that could utilise space and maximise the impact of generation during peak hours. IEA forecasts considerable growth in this sector, up to 22 GW nationally by 2020, or an annual growth rate of 22%.

The significant growth in residential small scale (<10KW) and planned expansion of utility scale (>50 MW) solar PV market has been driven by government incentives, none more-so than in NSW which has the most generous feed-in tariff. The Victorian Government's move to generate 5% of its electricity from solar energy by 2020 will spur market developments, underpinned by the first feed-in tariff for large-scale solar generation in Australia.[30]

Global

The global PV market has grown significantly since the late 1990s, with an annual growth rate of around 40%. The IEA predicts that by 2050 solar PV will account for 11% of global generation (up from earlier predictions of 6%). This large contribution recognises the reduction in costs for production and large uptake. It also recognises that distributed generation and off-grid applications will be integral in emerging economies. In total, this would represent growth to around 3,000 GW installed capacity – up from 14 GW in 2008.

The exponential growth of PV is expected to come after 2020, since costs of production are likely to mean that grid parity is not possible until technology costs are significantly reduced. China and India, in particular, are investing heavily in solar module manufacture that has already seen prices reduce by over 40%. This was as a consequence of increased supply, market forces, and a reduced silicon price.

More recent forecasts of growth by sector indicate that large commercial systems will grow at a greater rate than domestic installations[31]. Approaching 150% growth year on year would see significant investment in a sector that has historically received less attention in countries outside of Germany (including the US). Historically, Germany, the US, and Spain have accounted for the highest installed capacity from solar PV, with Italy and Czech Republic also becoming major players.

- **Germany** has long been the market leader in solar power generation despite having non-ideal weather conditions. This is primarily due to Germany's national renewable energy policies. It has a subsidy program for small, domestic systems and a generous, national feed-in-tariff (FiT) requiring utility companies to subsidise solar power generators by buying electricity at a marked-up rate. The FiT will undergo a revision in the near future which will lead to a more constrained PV market in Germany. The German Government has also invested heavily in scientific research in this area. Germany is likely to remain a frontrunner in research and development, however is expected to fall behind in installed capacity of photovoltaic power.

- **China** is accelerating its renewable energies effort and making rapid gains in the solar sector. The Government has targets of 10GW of solar power by 2020 and to meet 15% of its energy demand through renewable energy methods by 2050. PV components such as silicon ingots, wafers, cells and modules manufactured in China account for 50% of the world's production capacity. Its lead in PV manufacturing comes from low manufacturing costs, low silicon prices and a solar subsidy program for rooftop installations and building integration.

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[30] Victorian Climate Change White Paper – *The Action Plan*, July 2010
[31] Pike research - *The New Solar Market: Implications of the Shift to a Demand-Driven Market: Key Differentiators to Watch in 2010 and Beyond Published 2Q 2010*

- **Japan** is a leader in PV cell manufacture and research. Some of the largest PV cell manufacturers such as Sanyo, Sharp, Kyocera, Nikkei and Mitsubishi are based in Japan. Japan is likely to stay a strong player due to its exceptional research and development capabilities.

Key trends in providers

A key trend in the growth of the solar market is the ownership of systems by Independent Power Producers (IPP). An IPP owns and operates a solar power system and bears all the risks of construction, ownership and maintenance. The IPP sells the electricity to the customer under a long-term fixed price contract called a Power Purchase Agreement (PPA).

Vertical integration in companies is widespread, and allows greater cost control of supply chain elements. For example, processing of solar-grade silicon to mono-crystalline ingots, production of wafer and cell/modules, and installation may all be handled by one company. Large scale solar PV manufacturers have entered the market as installers, leveraging finance at scale and driving the market in well-supported countries such as those in Europe and the US.

3.5.4 Market size

Ernst & Young estimate the market size for this sector to be between $210 million - $320 million in 2020, which is based on large and small scale PV installation only. Employment could reach 1,350 – 2,030 people in this market by 2020.

Table 14: Solar market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE- NSW 2020
	Low	High	Low	High	
Solar Energy	10	20	210	320	1,350-2,030

Source: Ernst & Young estimates

These estimates assume that large scale capacity will increase to a maximum of 250MW by 2020 and that the small scale market will grow at 10% per annum between now and 2020.

3.5.5 Identified specific opportunities

A number of opportunities were identified. These are detailed below.

The fourteenth opportunity ‘increase uptake of mid-scale solar PV on commercial, industrial and public buildings’ was investigated as a detailed case study, summarised in the section 4 of this report.

	Solar: Solar PV
1	Smelt silicon for poly-silicon or solar-grade silicon production for integrated component manufacture.
2	Expand current framing system design and manufacture in NSW.
3	Integrate PV with building/roofing materials.
4	Expand current inverter design and manufacture business in NSW.
5	Develop concentrating PV from current mono-crystalline cells with manufacture of cylindrical troughs.
6	Manage pre-commercial trials of novel technologies and organic PV.
7	Install utility scale solar PV or concentrating PV on buildings/schools/ hospitals.
8	Develop regionalised solar hybrid systems that can deliver baseload potential. Could replace current smaller-scale diesel generation facilities with a solar/CCGT gas or solar/diesel system.
9	Invest in solar energy as demonstration of technologies based on UNSW’s PV research success.
10	Build grid infrastructure (high voltage direct current lines) to allow for large-scale baseload solar in far west/central Australia locations where solar resource is greatest.
11	Construct local infrastructure for large-scale PV electricity generation.
12	Increase skill-base in installers through training.
13	Increase servicing and maintenance contractors, including inverter replacement services.
14	Increase uptake of mid-scale solar PV on commercial, industrial and public buildings.

	Solar: Solar Thermal
1	Generate electricity from thermal solar inputs through high-efficiency organic rankine cycle technology-specifically for regional and smaller- scale off-grid. Could utilise lower-temperature inputs from solar in sites of less radiation (e.g. NSW). Or increase the efficiency of current technologies.
2	Use locally sourced aluminium for manufacture of parabolic troughs and/or cylindrical troughs.
3	Add value to current glass manufacture to create mirrors for solar thermal plants.
4	Develop concentrating technology and/or components, building upon the research of University of Sydney, CSIRO and University of Newcastle.
5	Manufacture cylindrical and/or parabolic troughs.
6	Build/construct solar towers, and necessary infrastructure (steam turbines, towers, mirror infrastructure).
7	Convert a utility-scale CST plant to be a combined hybrid (either gas or coal) such as the Liddell plant.
8	Invest in development of a solar park or attract investors based on University of Sydney's research success (Fresnel reflectors) to the Australian CST market.
9	Develop regionalised solar hybrid systems that can deliver baseload potential. Could replace current smaller-scale diesel generation facilities with a solar/CCGT gas or solar/diesel system.
10	Develop a NSW-based equivalent of the WA Advanced Solar Thermal Initiative.
11	Build substantial grid infrastructure (high voltage direct current lines) to allow for large-scale baseload solar in far west NSW/central Australia locations.
12	Provide appropriate training to support the diversification of engineering firms into renewable projects.

3.5.6 Identified issues/barriers

When the detailed mid-scale solar PV for commercial and industrial buildings case study was examined, a number of issues and barriers were identified, including:

- Context with multiple competing renewable technologies
- Length of payback period
- Uncertainty over the future costs for solar PV
- Structural building issues
- Availability of capital
- Knowledge gap regarding installing renewable energy generally
- Supply chain bottlenecks around the availability of inverters
- Moderate solar resource in NSW

These barriers are outlined in detail in section 4.3.10 of this report.

3.6 Wind energy

3.6.1 Sector description

Wind power is the conversion of wind energy to a useful form of energy, such as electricity through the set up and operation of on-shore wind turbines and farms[32]. To capture this energy, the modern wind industry uses wind turbines. Wind energy is primarily used for electricity generation, both onsite and for transport to the grid. Wind energy is also used to pump bore water, particularly in rural areas. A typical wind turbine consists of a tower and foundation, supporting a nacelle (housing for a gearbox and generator) and a rotor with three specially shaped blades. When the wind passes over the blades, their shape creates pressure differences and causes the rotor to turn. The rotor is attached to the generator, which creates electricity.

The greatest technological advance to wind farms is the growing size of the wind turbine. Blades have increased in size from 5-10 metres to 30-45 metres, which increases the electricity output from each turbine. Tower height has also increased which allows the blades to capture higher wind speeds. This trend is expected to lead to incremental cost decreases between now and 2020. Larger turbines make slower wind speeds more productive, pushing previously uneconomic wind speeds towards cost efficiency. These technological advances potentially benefit NSW sites of lower 'wind yield'. Currently, individual wind turbines have a capacity of between 1.5MW and 3.5MW with the most common being between 2-3MW for the onshore market.

The RET requires 20% renewable energy generation by 2020, the majority of which is likely to be from wind due to its cost competitiveness relative to other renewable technologies. To date, the majority of wind farms have been constructed in states other than NSW (principally SA and Victoria).

3.6.2 NSW strengths in the sector

Wind energy in NSW is supported by strong drivers of demand, favourable wind resource and capabilities for manufacturing and government efforts.

- NSW has good capacity for grid connection and plenty of baseload power to offset intermittent supplies.

- NSW has marginally higher spot electricity prices compared with neighbouring states, which provides another driver of demand for wind energy.

- Stakeholders report that NSW has localised areas of very good wind speeds not reflected in current wind maps.

- NSW has strong capability in steel, copper and cement production, required for wind tower manufacture. The large majority of wind turbine parts, such as towers, blades, can be manufactured without a large investment in technology or training. Most non turbine components and infrastructure built in Australia could be built in NSW.

- NSW Government initiatives to support wind energy utilise multiple policy levers, including planning, facilitation, procurement, and funding. For example:

  - Planning reforms have started to streamline the planning processes by classifying large scale renewable energy generation as critical infrastructure and waived the additional fees associated with such a classification until mid 2011.

    - This has involved commitment to assess all major wind energy projects within four months and appointment of a renewable energy project manager to help proponents negotiate the planning approval process. According to the Department of Planning, major wind energy projects approved following this commitment have been approved in under four months, which is faster than average approval timeframes for major wind energy projects in Victoria, NSW's key competitor in attracting wind energy investment.

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[32] Offshore wind farms were not considered in the analysis due to scope restrictions on the project

- The establishment of six Renewable Energy Precincts in areas with the best wind resource should provide a focal point for wind power development and greater community engagement.

- NSW Government agencies are required to purchase a minimum of 6% GreenPower, which will drive some demand for electricity sourced from renewable energy.

- Over $2 million of the NSW Renewable Energy Development Program funding has been directed to two wind projects in small scale wind farm technology and battery storage for wind applications.

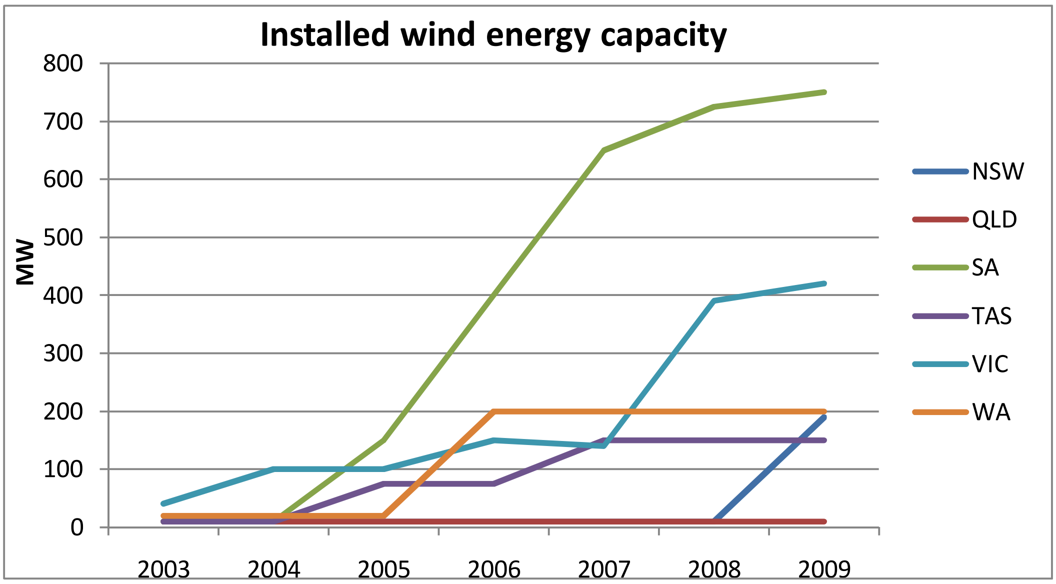
3.6.3 Australian/NSW trends and international comparisons

3.6.3.1 Australia/NSW

Energy generation from wind is playing an ever increasingly important role in Australia meeting its future sustainable energy generation needs. As at the end of 2009, Australia had 1,703MW of installed wind energy capacity which accounts for 16% of the nation's renewable energy generation and the second largest form of generation behind hydro energy.

Currently, South Australia has the largest wind energy generation capacity representing 44% of the nation's capacity, followed by Victoria at 25% of the nation's capacity. New South Wales is playing a small role currently with only 187MW of wind capacity in operation, but has a significant pipeline of projects which will facilitate increased generation capacity between now and 2020 as shown in Figure 3and Table 15. NSW has around 3,700MW of wind energy in the planning pipeline (including the largest wind farm in the southern hemisphere), which is more than four times the total installed capacity in South Australia.

Figure 3:Installed wind energy capacity



Source: ABRE and Department of Resources

Table 15: Current wind project pipeline

Status	Capacity	Details
Constructed/operational	187 MW	Crookwell 1, Blaney, Kooragang, Cullerin, Capital
Approved (received development approval from either planning or local councils)	2,103 MW*	Includes Silverton[33] - 1,000MW
Proposed or in intermediate stages of planning process (NB this is not comprehensive)	1,420 MW	Including Ben Lomond, Flyers Creek, Paling Yards, Sapphire and Crookwell 3
Total Capacity	**3,710 MW**	

** Source: Industry and Investment NSW, Energy Division (www.industry.nsw.gov.au/energy/electricity/generation), November 2010*
Note: This table does not necessarily assume that the approved projects have secured finance.

[33] Silverton Wind Farm in far west NSW is the largest wind energy project with a planned capacity of 1,000 megawatts. If developed, the wind farm will be the largest in the Southern hemisphere.

While the NSW Government has introduced various policies to support wind generation, other States have also introduced incentives to attract wind developers. For example, Victorian agencies are mandated to a 10% minimum purchase of GreenPower, compared to 6% in NSW; South Australia has mandated a 38 week grid connection time, compared to an average estimate of 18 months in NSW. While each State presents its own advantages, NSW faces significant competition from comparable policy drivers in other jurisdictions.

3.6.3.2 International comparison

The IEA has estimated that there was 121,188MW capacity of wind energy globally, as at December 2008 The largest producer of wind energy is the US representing 21% of global capacity with Australia contributing 1.2% of global wind capacity as at December 2008.

Based on an assumed productive utilisation of a nation's wind capacity of between 20% and 40% (industry average) it is possible to compare a nation's wind energy generation with its total energy consumption. Out of the 15 largest wind energy generating countries, Denmark's wind energy generation represented the greatest proportion of the country's energy needs, accounting for between 15% and 30% of total generation. Spain and Portugal are the next highest producing countries of wind energy as a proportion of overall energy needs.

Wind energy growth is led by Germany, Denmark, Spain, China, India, the US, Canada and a number of other European nations. The global wind power market increased capacity by 29% in 2008, or around 27GW, bringing in total installed capacity to 121GW. In 2007, worldwide annual wind power growth was 27%. In recent years, there has been a consistent trend of increasing growth in worldwide cumulative installed capacity.

Table 16:Global installed wind capacity

Ranking	Country	Installed wind capacity (MW) 2009
1	USA	35,159
2	China	26,010
3	Germany	25,777
4	Spain	19,149
14	Australia	1,877

Source: Global installed wind capacity by country (2009) WWEA (2009)

In Germany, Spain and Denmark, where wind power supplies a significant proportion of total electricity generation, the following conditions are in place:

- Higher electricity prices (particularly for fossil fuels)
- The availability of low-interest loans to wind farm developers
- Challenging renewable electricity targets
- Guaranteed access to the electricity network for wind farms
- Guaranteed payment of a premium price for wind power fed into the grid

For example, in Germany and Spain, there is a set and agreed price paid for renewable power via a feed-in tariff system that guarantees sale of all renewable power generated. The US offers production tax credits for renewable energy generation. China also introduced in 2009 a feed-in tariff which guarantees a fixed remuneration over the lifetime of a project.

Notably, the countries with the greatest installed capacity and investment in the industry are also leaders in wind energy technology. Advances in technology in the industry's short history have seen significant increases in turbine size and capacity, and reductions in costs. Over the last 10 years, for example, production costs per kilowatt hour have dropped by 20%. Continuation of this trend will add significantly to the industry's competitiveness.

3.6.4 Market size

The potential market size for wind was investigated as part of the detailed case studies and found that NSW could obtain between 2,000MW to 3,500MW of wind generation capacity by 2020. Details of the market size can be found in section 4.4.6.

3.6.5 Identified specific opportunities

A number of opportunities relating to this sector were identified. The first opportunity, 'increase power generation from wind farms in NSW' was taken forward as a detailed case study in section 4 of the report.

	Wind
1	Increase power generation from wind farms in NSW
2	Manufacture towers in regional areas of NSW
3	Design and manufacture small-turbines for micro-wind generation
4	Manufacture blades in regional areas of NSW
5	Establish expertise in wind modelling and energy assessments through investment in skills and research

3.6.6 Identified issues/barriers

The challenge for NSW is to ensure that the existing pipeline of projects are not hindered in their development and that any barriers to additional applicants are reduced to ensure its efficient share of wind generation capacity by 2020.

The detailed wind case study identified a number of issues and barriers through stakeholder consultation, which are summarised below. These can be found in more detail in section 4.3.10 of this report.

- **Lack of carbon price** resulting in relatively low electricity prices.
- **Bottlenecks in the supply chain**, with some stakeholder concern that necessary construction equipment, specifically cranes, may be in short supply when wind farms suddenly emerge from the planning and development processes in 2013.
- **Difficulties in obtaining long-term Power Purchase Agreements**, which provide a guaranteed future stream of income from the RECs generated.
- **Stakeholder concerns that the planning approval process** could be faster and is under-resourced, despite improvements.
- **Stakeholder concerns about grid connection issues,** such as the complexity of connection processes regulated by the National Energy Rules and difficulties in negotiations with network service providers.

3.7 Geothermal energy

3.7.1 Sector description

Geothermal power comes from heat extracted from the ground and can be used directly to generate electricity. Typically, direct geothermal energy is extracted at much shallower depths than geothermal used for electricity generation and is much less capital intensive. Furthermore, the key applications, such as geothermal heat pumps (GHPs) are established mature technologies as opposed to large-scale geothermal electricity generation which is still at the proof-of-concept stage. Electricity generation is much more complex and technologies are still developing and not expected to be commercially available until beyond 2020. Due to this uncertainty, geothermal power for electricity generation has only been considered at a high level.

3.7.1.1 Geothermal for electricity generation

There are two main categories of systems used to convert geothermal reserves to energy.

- Global development in the geothermal sector has primarily been in conventional geothermal systems (CGS). Conventional geothermal energy is based on magmatic heat sources and naturally convective fluid systems, and is geographically limited to hot volcanic regions such as New Zealand and Iceland.

- Engineered geothermal systems (EGS), also known as enhanced geothermal systems, utilise a man-made enhanced reservoir deep below the surface, and are suitable for non-volcanic locations, such as Australia. EGS technologies include the use of hot fractured rock and hot dry rock reserves, which are at an early stage of commercialisation. Such hot rock (HR) developments extract heat energy by injecting water down a well that has been drilled into the dry hot rock body, and returning the heated water to the surface. Hot sedimentary aquifers (HSA) are hydrothermal reservoir systems that occur outside volcanic regions. HSA systems contain heated water deep beneath the surface. HSA resources tend to be shallower and cooler than the HR systems, but will yield large volumes of hot water without stimulation.

3.7.1.2 Direct use geothermal

Direct use applications exist on a scale ranging from households (GHPs and hot water supply) to large industrial and institutional buildings (such as hospitals, factories and universities) and district applications (such as housing estates and CBD applications). GHPs achieve high level of energy efficiency by using the ground rather than ambient air as a heat source and sink.

Circulating hot water (CHW) systems are used for industrial heating and drying, space and district heating and aquiculture. Geothermal energy is sourced from the upper few hundred metres of the earth. Closed-loop, water-based geothermal heat pump systems are generally more viable in larger commercial and institutional buildings because of the larger capacity of a single unit.

3.7.2 NSW strengths in the sector

3.7.2.1 Geothermal for electricity generation

Mapping based on data from petroleum wells and water bores indicates the existence of at least five major thermal centres in NSW. However, these are not close to existing population or grid connections. Sydney-Gunnedah Basin and the Hunter Valley are two basins in NSW with active geothermal tenements and are currently being explored for geothermal potential. Researchers from the University of Newcastle have developed a 100kW geothermal pilot plant could bring commercial geothermal energy generation in NSW a step closer. NSW Government has provided $10 million in funding from the Renewable Energy Development Program to fund the Geodynamics Limited Hunter Valley Geothermal Power Project.

3.7.2.2 Direct use geothermal

There are many potential applications for direct-use geothermal across NSW including in hospitals, schools, residential and commercial facilities. There are currently several direct use applications which are proving their efficiency in NSW, although the rate of take-up has been lower than Victoria, where support was provided from 2007 to 2009 under the Four Seasons Pilot Program[34].

3.7.3 Australian/NSW trends and international comparisons

3.7.3.1 Geothermal for electricity generation

Australia

Australian industry is working towards demonstrating technical proof of concept of sustainable commercial hot rock (HR) and hot sedimentary aquifer (HSA) power generation. In 2009, Geodynamics demonstrated proof of concept for its HR development in South Australia's Cooper Basin.[35]. The majority of the current and forecast investment for future exploration and demonstration of geothermal energy in Australia is focussed on HR prospects. There is one existing geothermal power plant in Australia based in Birdsville, Queensland using HSA geothermal resource. HSA is being pursued in Great Artesian, Otway and Gippsland Basins.

The trend in Australia is towards joint venture partnerships to manage difficulties associated with high risk capital requirements of pilot and demonstration phases. Small companies are required to develop strategic relationships with large retailers or generators to manage risks associated with selling electricity on the NEM (spot market).

International

The majority of electrical generation undertaken globally is at high temperature resources (220-340°C) at shallow depths (<3.5km)[36]. Global development in geothermal sector has been characterised by conventional geothermal energy systems (CGS) (based on magmatic heat sources and naturally convective fluid systems). Leading countries in CGS are the US, Philippines, Italy, Indonesia, Mexico, Iceland, Japan and New Zealand.

Globally there is HR development in Europe, the US and Japan, however systems are yet to be brought into large scale commercial production and Australia is close to leading the world in developing and commercialising this technology. HSA systems are being produced in Germany.

3.7.3.2 Direct use geothermal

Australia

Australia contributes 110MW thermal installed capacity of direct use geothermal to the global installed capacity of 28,266 MW thermal.[37] Direct use geothermal has also been explored for drying coal, prior to its combustion during electricity generation, and for the desalination of water. Given the increasing demand for potable water this could be an area of focus going forward.[38]

Geothermal space heating is most applicable to large industrial and office sites, such as factories, university campuses, and hospitals and could have very wide application, especially in Greenfield construction sites. The city of Portland in Victoria has operated a district heating system since 1983. The city water supply is drawn from a number of bores between 1,200 and 1,500 metres deep, which deliver water to the well heads at between 55°C and 60°C. One bore services approximately 19,000m^2 of (mainly public) building floor space. The annual energy savings were estimated in 1995 to be about 8,900 GJ per year, or $570,000 worth of natural gas, at the prices prevailing then.

A new trend in circulating hot water direct use geothermal is for the still-hot 'effluent' water from a geothermal power station to be 'cascaded' down for several direct use applications, to improve efficiency and economics. For instance, fluids may enter a geothermal power station at 200°C and exit at 120°C.

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[34] The Victorian program included contribution towards the design and construction cost (up to 50% for commercial and up to 100% for public projects) of Ground Heat Exchanger (GHE) design and installation. www.business.vic.gov.au/busvicwr/_assets/main/lib60076/four-seasons-program.pdf

[35] *Australian Journal of Mining*, May 01, 2009 - www.theajmonline.com.au

[36] Australian Government Department of Resources, Energy and Tourism, *Technology Roadmap*, p. 5

[37] Australian Geothermal Energy Association, Position Paper: *Direct Use Geothermal Applications* (2008), p. 1

[38] Australian Government Department of Resources, Energy and Tourism, *Technology Roadmap*, p. 37

Before being re-injected, the ‘waste’ fluids might be used in food processing (120°C - 100°C), then for space heating (100°C - 50°C) and finally for fish farming (50°C - 20°C).

There is no comprehensive database on the use of geothermal heat pumps in Australia because their use is not regulated or comprehensively monitored. According to the latest IEA Geothermal Implementing Agreement[39], ground source heat pumps constitute 24MW thermal of total installed capacity (approximately 44GWh). This data is gathered from a verbal survey of GHP installations and includes over 300 residences and several commercial sites. The total number of installations in Australia is thought to be around 500, with over 100 projects being installed annually. Around 80-90% of these GHPs are used for HVAC systems according to stakeholders.

GHPs have been in Australia since the late 1980’s but have only experienced notable growth over the past five years. Increasing interest and green awareness, as well as growing electricity and LPG prices and uncertainty over future prices have helped to grow this market. Historically, the market established in Adelaide, Canberra and Tasmania. Victoria has recently experienced growth because of the Four Seasons Pilot Program offering support for residential, industrial and commercial GHP projects since 2007. NSW has experienced relatively poor growth in comparison and stakeholders cite lack of government incentives or a lack of knowledge as the major factors.

GHPs make up only a negligible proportion of the total Australian HVAC market compared to around 2% in the US, where over 50,000 systems are installed annually. Non-residential HVAC services consume an estimated 9% of all electricity generation in Australia. Accordingly, there is significant potential for GHPs to reduce the associated carbon footprint in commercial contexts.

International

Relative to the rest of the world where approximately 3.5 million GHPs have been installed[40], Australia is lagging in the take up of this technology. Globally, there is strong interest in the scale application of this technology and it is quoted as being one of the fastest growing applications of renewable energy. The majority of growth has taken place in the US and Europe, although there is growing interest in Asian markets.

- The US has the greatest number of installed GHPs – around 600,000 units in 2005[41]. It is reported that there is a roughly equal split between residential and commercial applications[42]. From a 3% total market penetration in 2008, which was largely driven by electricity cost increases and grid failures, the market is now growing at 40% annually as a result of US Federal Government subsidies from 1 January 2009, providing 30% rebates on installations[43].

- Canadian grants are spurring rapid growth in GHPs and an estimated 10,000 GHP units are being installed annually from a base of around 36,000 in 2005[44], with considerable government subsidies to promote use of this technology across a broad sphere (commercial/residential).

- Sweden is leading the European market with 95% penetration in new housing developments and the largest number of installations.[45] Germany and France have the second and third highest installed capacity, with strong GHP growth in Eastern Europe over recent years.

- Stakeholders report that demand for GHPs in Asia, particularly in China and South Korea is expanding rapidly as a result of supportive government policies.

[39] http://www.iea-gia.org/publications.asp
[40] Lund et al. 2000-2008
[41] Lund, Sanner, Rybach, Curtis, Hellstrom **Geothermal (Ground-Source) Heat Pumps A World Overview** 2004
[42] Earth-to-Air publication **Ground source heat pump: international overview**
[43] Payne, Wearing-Smith **Direct Geo-Exchange Heat Pump Industry – Overview**
[44] Lund, Sanner, Rybach, Curtis, Hellstrom **Geothermal (Ground-Source) Heat Pumps A World Overview** 2004
[45] EurObserv’ER, Heat Pump Barometer, October 2009, http://www.eurobserver.org/pdf/baro193.pdf.

3.7.4 Market size

Ernst & Young estimate that the market value of large scale geothermal electricity generation to NSW could be between zero and $760 million in 2020, with employment of up to 2,500 people.

Table 17:Geothermal market value estimates in 2020

Sector	Market value ($M) - NSW 2010		Market value ($M) - NSW 2020		Employment prospect FTE- NSW 2020
	Low	High	Low	High	
Geothermal energy	0	10	0	760	0-2,500

Source: Ernst & Young estimates

The estimate is based on an Ernst & Young report *A Preliminary assessment of NSW renewable energy investment environment* which estimated that generation through geothermal technology could increase to a maximum of 5,000GWh by 2020. The wide range reflects the uncertainty regarding whether or not the technology will be commercialised by 2020. Furthermore, advice received by Ernst & Young from stakeholders suggests that the market will either thrive or die, and there is unlikely to be a moderate growth scenario given the high capital expenditure involved and depending on whether the technology will be commercialised by 2020.

3.7.5 Identified specific opportunities

No opportunities were identified for NSW in geothermal electricity generation because this project focused on opportunities with realisable benefits by 2020. There remains considerable uncertainty and risk associated with geothermal exploration, and costs associated with its extraction are high relative to other renewable technologies. Also, NSW is geographically disadvantaged compared to other states because existing geothermal resources are not located near grid connections.

There are a number of opportunities that were identified for direct-use geothermal.

	Geothermal: Direct use
1	Use Geothermal Heat Pumps (GHPs) in HVAC systems
2	Expand manufacture of GHPs in NSW
3	Install direct use geo-thermal applications in new commercial and industrial developments

The first opportunity was taken forward as a detailed case study in section 4 of the report.

3.7.6 Identified issues / barriers

The detailed direct-use GHP case study identified a number of issues and barriers through stakeholder consultation, which are summarised below. These can be found in more detail in section 4.5.10 of this report.

- Lack of knowledge and understanding of GHP systems by consumers and government
- High capital costs and long payback periods
- Technology-biased State and Federal policies that exclude GHPs
- Lack of carbon price reducing competitiveness of GHP options
- Classification of GHP as capital expenditure, rather than ‘infrastructure’
- Lack of industry standards and potential risks to industry credibility
- Lack of skilled workers if demand increases rapidly
- Administrative requirements of existing rebates

3.8 Business services

3.8.1 Sector description

This sector encompasses the emerging business services and additional business services from a low carbon economy. This sector analysis focuses on two main areas:

- The legal, accounting, finance, and project management sectors
- Broad analysis on other technical and consultancy business services that have grown from a carbon constrained economy

This sector is closely aligned with other specialist advisory and ancillary services, such as sustainability and corporate social responsibility. It is also aligned to broader service offerings, such as legal, accounting and engineering. As such, the majority of this analysis will focus on qualitative assessments.

3.8.2 NSW strengths in the sector

As Australia's predominant player in the professional services industry, NSW is well-placed to capitalise on its leadership position to address growing demand for a range of business services. NSW also has the largest greenhouse gas emissions of any of the States or territories (164.7 million tonnes CO2e, or 28.6% of national emissions in 2008). As such, it is most likely to benefit from, and drive, growth in related business services.

Business service providers may locate close to clients, or may serve clients from a national base. Either way, NSW is likely to gain a disproportionate share of the low carbon economy business service providers due to strong energy demand in NSW, and the preference for Sydney as the base for professional services providers.

Based on existing supply and demand drivers in NSW, the NSW Government is actively pursuing strategies to position Sydney as the carbon trading and finance hub for the Asia-Pacific region. These include the continued operation of the world's first mandatory emissions trading schemes – the Greenhouse Gas Reduction Scheme (GGAS). GGAS will continue to operate until a national scheme is established. In addition, the NSW Government continues to support the activities of the Sydney Carbon Market Taskforce whose aim is to develop strategic actions to establish Sydney as a centre of emissions trading, finance and reporting.

3.8.2.1 Financial services

NSW houses the majority of financial institutions in Australia. It is therefore expected to play a leading role in the development of financial tools to assist businesses. These range from green loans, to new financial products, carbon trading and associated services.

A number of service offerings that develop from a low carbon economy will require a technical understanding of the issues, drawing predominantly on the current skills-base. For example, trading in national and international carbon credits, permits and offsets will require additional capacity in the trading sector. Ernst and Young's report, "*The Economics of a Carbon Hub in Sydney*" 2009 found that the introduction of a Carbon Emissions Trading Scheme would potentially bring an additional $200 million in revenue to the NSW economy with an expected 610 increase in full time employment by 2020, including:

- 100 new jobs in banking and finance
- 220 new jobs in business services industry
- 250 jobs in emissions trading industry

3.8.2.2 Emissions intensive industries

Whilst all sectors of the economy will need to transition to a low carbon economy, those most fundamentally impacted will be the emissions-intensive industries, which will be both liable and heavily impacted under a carbon trading regime. In NSW these industries include mining (particularly coal), paper and pulp manufacture, aluminium, steel, cement, thermal energy, other industrial products, and manufacturing.

These sectors are represented by some of Australia's largest businesses, many of which have already invested in developing carbon management strategies in advance of expected legislation on emissions trading. Under an emissions constrained economy, these businesses need deeper assessment of carbon abatement options including sourcing emissions permits from regulated markets. They will seek out advice on technological improvements for emissions reductions, and will embed systems for consistent monitoring and reporting that will allow assurance on data that will ultimately flow into their financial statements. Such businesses may require specialist engineering and business strategy assistance to achieve emissions reductions at least cost.

3.8.2.3 Other sectors likely to benefit

In contrast to the emissions intensive industries, those sectors most able to capitalise on cheaper carbon abatement will look for new opportunities in a carbon constrained environment – regardless of a cap and trade regime. Such sectors will include **property and manufacturing** where comparative cost of abatement is likely to be lower than some other sectors due to the low cost nature of the abatement opportunities. There is expected to be an increase in the assessment of current performance, driven in the property sector by mandatory reporting. This will require up-skilling of professionals to meet the market demand. **Engineering firms** and **environmental consultancies** that are most responsive to these trends will benefit most. With a growing requirement for renewable energy and public and private investment in alternative fuels, clean coal, and carbon capture and storage; it is expected that **engineering organisations** will build capacity to provide a range of business services.

Some **legal and accounting organisations** have developed expertise to focus on developing cleantech opportunities. These have focussed on combining expertise in the technologies with usual professional services. As demand grows for greenhouse gas and energy reporting, it will generate further need for **advisory services** including legal advice, (non-financial) accounting advice, IT infrastructure engineering support, and financial services. It is expected that small businesses will be high users of advisory services. Similarly, there are relatively low barriers to entry for **small businesses** seeking to provide advisory services.

IT service providers have created a market for tools to monitor and report on emissions. Larger international players that already produce financial reporting tools (SAP, IBM) have developed 'bolt-on' applications for greenhouse gas and other non-financial metrics in a way that will allow carbon permit liabilities to flow to the balance sheet. Smaller IT firms have also established a market for more bespoke applications that enable monitoring and reporting (such as CarbonSystems and CarbonView). As a way of market differentiation, a number of these firms have sought to establish complimentary services, such as energy billing management, or supply chain carbon monitoring. Expanding the pool of firms that are required to report their emissions has provided a wider market to small and larger **consultancy providers**.

Development of services industries is likely to place demand **on education and training providers** to up-skill both current and future professionals, with specific emphasis on low-carbon markets and solutions. **Research institutions** will also benefit from an increased need for sophisticated technical and advisory expertise.

3.8.3 Australian/NSW trends and international comparisons

Ernst & Young commissioned a survey in early 2010 of 300 global executives representing companies with revenues of more than US$1 billion. It found that nearly half were likely to spend between 0.5 – 5 % of their revenue on climate change initiatives, which would represent between US$5 million to US$50 million annually for each business. Moreover, 70% of those surveyed planned to increase their spending between 2010 and 2012.

Businesses offering consulting and related business services to organisations for a low carbon economy are at varying degrees of maturity globally, with key global players emerging in both voluntary and regulated markets for carbon.

3.8.3.1 *Developing nations*

Significant growth has occurred since 2005 in the Asian and Indian and, to a lesser degree, African markets for climate change advisory services on carbon abatement as prescribed under UN-sanctioned schemes such as the Clean Development Mechanism (CDM). This has seen companies investing in project development, design, and consultancy for the generation of carbon permits (Certified Emissions Reductions [CER], and Removal Units [RMU]). Significant growth in the finance sector related to these transactions has predominantly been driven by liable trading parties under the European Emissions Trading Scheme (EU ETS).

3.8.3.2 *Europe*

The greatest drivers for growth in business services from a low carbon economy have been in Europe – particularly those member countries of the EU ETS. In particular, the UK, France, and Germany have led the finance, accounting and consulting fields to establish a number of market-leading services. Growth in carbon monitoring, reporting and verification has seen investment from the 'Big 4' accounting firms as well as international IT providers. In the majority of EU and accession states, this has been driven by compliance requirements under the European ETS. These professional services companies have now built strong teams that include interdisciplinary financial and non-financial skills.

The legal sector, with higher incidence of test-cases, has seen development of specialist practices within large organisations and more specialist 'boutique' providers. The finance sector saw growth from the late 1990's to establish market hubs for trading exchanges, brokerage services, and project finance. Around five trading exchanges account for the majority of all carbon permits traded, which has primarily been led by BlueNext (Paris, France). Consulting services have been provided by a combination of technical specialist 'boutique' organisations and larger international strategic and management consultancies. International environmental consulting service providers have also established a market presence in the past ten years. Consulting services provided by other professional services organisations, such as accounting and engineering firms, have also taken a considerable market share.

3.8.3.3 *United States of America*

The *Climate Change Business Journal* estimates that the US climate change consulting industry grew by over 30% annually in recent years to reach $670 million in 2008. While growth slowed to 15-20% in 2009, annual growth is expected to be in the 20-30% range through to 2012. Traditionally the reserve of smaller (up to 10 staff) technical consultancies and environmental consultancy groups, the most significant growth in the last two years has been seen in the 'big 4' accountancy and professional services organisations (Ernst & Young, PricewaterhouseCoopers, KPMG and Deloitte) and larger legal firms.

Key drivers in the US have been regulated national greenhouse gas reporting, State-level environmental regulation, and regulated and voluntary carbon markets (such as the Chicago Climate Exchange). Speculative up-skilling of staff to meet a potential market-demand from regulation to cap emissions of greenhouse gases is widely reported.

3.8.3.4 *Australian trends*

With a large resource industry, Australia has developed a strong environmental business services sector. The legal, accounting, finance and banking sectors have also built considerable sector expertise from close working relationships with the resource industry. A large number of consultancies with between 1 and 15 staff have been established to meet a growing requirement from corporate Australia for technical and specialist skills to monitor and report on their emissions, and their corporate and social responsibility (CSR) commitments related to climate change. These small consultancies usually build on the capabilities of their staff that have experience in management consulting, engineering, or public policy. The mid-sized firms servicing this market comprise energy management, environmental and engineering groups.

The remaining market players are the large listed corporations, private companies and partnerships that have developed new service lines to meet the market needs. These are a combination of up-skilling *in-situ* staff, and recruiting specialists. For the accounting and legal firms, this represents less than 1% of staff in 2010. Stakeholders in professional services firms indicate that at least 1% of all accounting and legal staff will be devoted to low carbon related services by 2020. These services will be important for any expansion in the low carbon economy. It is anticipated that the increased level of business activity as a result will ultimately increase the aggregate level of demand for these professional services to meet legislative and regulatory requirements.

Internationally, companies have also been benchmarking their preparedness for a carbon constrained economy against peers, however recent market research conducted on behalf of Ernst & Young indicated that Australian companies have not benchmarked their performance to the same degree as international corporate peers. More recently, legislated reporting requirements (the National Greenhouse and Energy Reporting System, NGERS) have driven larger businesses to establish a baseline for measuring and monitoring greenhouse gas emissions and energy consumption and production. This has provided growth in related legal and accounting services, and increased advisory services. The initiation of NGER audits on behalf of the Department of Climate Change and Energy Efficiency is also expected to stimulate growth in IT service providers with tools to monitor and report on emissions.

The Mandatory Renewable Energy Target, and now the enhanced Renewable Energy Target, have seen the development of large-scale projects that demand project management, financing, transactions, legal, and other business services. Stakeholders indicated that development of key skills in the renewable and clean energy sectors (including CCS) may provide potential for export of skills to Asian and other international markets.

3.8.3.5 NSW trends

NSW has had an early market advantage from localised business services that met the requirements of those companies included within the mandatory NSW Greenhouse Gas Reduction Scheme (GGAS). As the first mandatory carbon trading scheme globally it provided invaluable opportunity for the legal, accounting, finance and related business services to gain market experience. With financial penalties and incentives, a monitoring, reporting and verification service market inevitably established itself. Local voluntary and regulated schemes to minimise emissions have also provided further opportunity for growth in the sector. Specifically, schemes like the Energy Saving Scheme, and the National Australian Built Environment Rating System (NABERS) assessment have led to growth in energy assessors and efficiency businesses.

However, despite NSW's early market advantage since 2003, stalled national policy has seen the market grow less quickly than internationally, particularly Europe. When the Federal Government announced in 2007 its intention to establish the Carbon Pollution Reduction Scheme (CPRS), many NSW industry players rallied to gain market-leader advantage. Initial offerings for futures of the as-yet unestablished Australian Emissions Units (AEUs) were made[46]. From discussions with stakeholders, many of the financial sector players that made an investment in this area have since seen staffing plateau, or scaled back, awaiting regulatory certainty. Likewise, those business service providers that established teams able to provide the strategic and management consultancy services on emissions trading (such as marginal abatement analysis, establishing trading desks, carbon risk assessment and options) have seen little growth, and in some cases, significant decline. Some businesses, particularly those smaller businesses unable to maintain continued high staffing costs, have retrenched staff or changed their roles for more generalist purposes.

By 2020, with an emissions trading regime established, it is expected that business services will mimic those from more developed carbon economies, such as Europe.

3.8.3.6 Market drivers

The market in Australia, like overseas, is driven by a number of key factors:

- **Carbon price** – establishing a price on carbon provides incentives for efficiencies and growth in low-carbon sectors.
- **Energy price** – with increasing energy prices, businesses seeking new ways to manage their costs will look toward energy efficiencies and new renewable sources of energy.
- **Social drivers** – businesses are increasingly taking account of their impact from a social and environmental perspective. Financial analysts are factoring this into their valuations and investment decisions are increasingly being impacted. Almost 70% of the ASX200 report on their sustainability performance, including climate change.

[46] AGL, 2008

- **Policy** – environmental regulation and policy aims are driving investment globally. Compliance as a minimum has required considerable business service assistance. However, strong policy objectives, such as emissions reductions targets or policies for reduced, or zero emissions, are driving innovation.

3.8.3.7 Services offered in a low carbon economy

Legal - increased business activity within the legal profession will predominantly be driven by the requirement of local regulation and compliance, transactions, policy and international growth in carbon mechanisms.

Specialist services may include legal advice on a range of climate-change related topics including:

- International and national climate change law and policy
- Climate change litigation
- Clean Development Mechanism (CDM) and Joint Implementation (JI) projects
- Carbon financing
- Cap and trade schemes
- Structured and secondary carbon market transactions
- Carbon exchanges, auctions and market infrastructure
- Regulatory counselling and advocacy
- Carbon tax and transfer pricing
- Carbon disputes
- International carbon credit transactions
- National Greenhouse and Energy Reporting System
- Carbon offsets
- Planning and environmental assessment
- Government climate change policies
- Electricity contracting

Accounting - increased business activity within the accounting (and professional services) sectors will predominantly be driven by the requirement of compliance measurement and business management services.

Specialist services may include:

- National Greenhouse and Energy Reporting System advisory and assurance
- Greenhouse gas and energy inventory advisory and assurance
- Offset advisory and assurance
- Transactions advisory
- Mergers and acquisitions
- Tax implications from trading schemes and regulated carbon markets
- Assurance over sustainability reports, and other published non-financial data/metrics
- Carbon scenario planning
- Abatement options analysis
- Environmental, Occupational Health and Safety due diligence
- Carbon due diligence
- Carbon market transacting and strategy
- Accounting for carbon assets and liabilities

Finance - increased business activity within the finance and banking profession will predominantly be driven by core banking and corporate finance services, as well as the trading and dealing of carbon related financial instruments. Some specific financial services may also be developed to benefit/capitalise from a low carbon economy.

Specialty services within the finance industry may include:

- Financing and advisory services for emissions-intensive businesses looking to reduce emissions
- Development of financial products for energy efficiency, waste management, new technology innovation and renewable energy
- Carbon market analyst services
- Carbon trading, brokerage and exchange

- Financing and structuring related business opportunities
- Insurance and risk management services for new business opportunities, including indentifying risk factors
- New opportunities for banking/financing services for customers that reward low-carbon behaviours

Project management - increased business activity within the project management profession will predominantly be driven by the requirement to meet additional environmental standards within general engineering, asset management and construction practices, and increases in the number of renewable and low-carbon projects. This can be at both the development and operational scale.

Specialist services may include:

- Environmental consultancies and project management
- Efficiency management services
- Project management within infrastructure capital and operationally intensive sectors, including the development of utility-scale wind and solar projects, carbon capture and storage and geothermal energy project development, and thermal power retrofit projects for improved efficiencies

3.8.3.8 Opportunity for export of skills from NSW

The quick growth in specialist skills for business services in NSW has seen a number of professionals being recruited from overseas, in particular from Europe, South Africa, India and, to a lesser degree, China and the US. The import of key skills will continue to be required to meet the speed of policy development expected, particularly with regard to the CPRS. It is expected that once Australia moves toward greater regulatory certainty, and begins to establish technologies and solutions for clean energy and technology, businesses will utilise their skills in developing markets in Asia.

Despite delays in policy, considerable experience has already been gained in the Oceania market. This experience is starting to be leveraged in Asia, and is expected to continue out to 2020. The key driver for this growth is regulation. Evidence has shown that those economies with the greatest policy and regulation have established market-leadership of professionals in this field. Stakeholders inform us that protracted delays could lead to professionals leaving the Australian market for growing policy markets currently with lower levels of specialist knowledge, such as the US.

3.8.4 Market size

Market size has only been established for accounting, finance, legal and project management sectors as at 2020.

Table 18: Business services market value estimates in 2020

	Total market value		Total employment	
Sector	Low	High	Low	High
Accountants	116	472	728	2,950
Legal	129	522	805	3,265
Finance and banking	335	1,133	986	3,333
Project management	68	417	428	2,603
TOTAL	648	2,544	2,947	12,151

Source: *Ernst & Young estimates*

3.8.5 Identified specific opportunities

	Business services
1	Improve professional development from carbon-related business service education
2	Export re-training expertise and systems to other countries developing low carbon markets
3	Establishment of related vocational training programs
4	Lead the development of carbon related business services in Australia
5	Become a leader in carbon related services within the Asia Pacific region
6	Establish LCE related accreditation programs
7	Increase service offerings to deliver carbon footprinting tools and analysis

3.8.6 Identified issues/barriers

The following risks have been identified as potential barriers to the professional services actively participating, growing and facilitating the development of a low carbon economy:

- **Regulatory uncertainty** – without certainty on the direction that Australia will take for a low carbon economy, businesses will not invest in the training or recruitment of new staff that may not meet the specific market needs. Indeed, a potential barrier to establishing a growing market may be a lack of policy decisions at a time when global economies are moving forward. This could lead to skilled, trained professionals leaving Australia for overseas markets to maintain expertise and align to progressive policy environments. An additional barrier from this is a reduction in the capacity for NSW-based businesses to export skilled teams to developing Asian markets.

- **Knowledge development and skills shortages** – given the development of international and national policies, there is potential for insufficient numbers of appropriately educated/skilled individuals in NSW. Expansion of low carbon industries, for example in renewable energy and financial markets, in other States and internationally may lead to relocation of skilled workers.

- **Investment risk** – businesses may limit their investment in their own development or the development of other businesses because of the uncertainty of the size and profitability of the low carbon market within Australia, particularly given uncertainties with regulation.

4. Case studies

These case studies provide detail on five business opportunities, selected from a broad range of opportunities identified across the eight sectors considered. The case studies show drivers of supply and demand in NSW; market analysis and estimates of economic benefits; and a detailed analysis of any barriers to realise the opportunity. The case studies demonstrate the presence of consistent underlying price, investment and information barriers across diverse opportunities.

The process for selecting these five opportunities is outlined in section 2.6.2.

4.1 Case study 1 - Developing software for the integration, networking and management of grid-connected electricity

4.1.1 Description of opportunity

There is an opportunity for NSW to develop software/applications for the integration, networking and management of grid-connected electricity. This opportunity encompasses a range of software/applications across the whole of the smart grid and includes utility business software, demand response software and meter data, grid and energy management software.

4.1.2 Rationale

Smart grids have enormous potential to improve the efficiency of the electricity sector and transform the way we use energy in our homes and businesses. The growth of smart grids will lead firms to integrate and it will spur the development of new business models. Globally, major countries are embracing smart grids through investments, demonstration projects and smart meter roll outs. Sophisticated software will be a fundamental component of the smart grid, required to automate, monitor, verify, analyse and communicate data. NSW has a strong IT presence, world class R&D facilities and is home to Australia's Smart Grid Smart City Pilot. It is therefore well placed to benefit from the development of the smart grid. There may also be export opportunities to countries in Asia given Australia's relatively advanced position in this market.

4.1.3 Limitations of scope

This opportunity does not discuss individual software applications but instead focuses on the software market more generally. Opportunities within the software side of the market will be driven by the growth of the smart grid more generally, which is reflected by this case study. Given the infancy of this market there is very limited data available and most information provided is qualitative in nature.

4.1.4 Software applications across the smart grid

Software applications will be required across all areas and applications of the smart grid to enable it to function, to facilitate communications, to interpret data and to automate systems. Some of these software requirements will be updates of legacy systems, others will be completely new. Certain pieces of software will be part of a more integrated service offering, others will be standalone applications. Progressively, software is being integrated into hardware components and the previously distinct boundaries are becoming increasingly blurred.

Examples of the broad spectrum of software requirements are given below:

- **Utility business software** including customer information systems, billing requirements, and enterprise asset management.
- **Meter data management** - storage and management of the vast quantities of usage and activity data that are now being delivered by different meter data collection sources (on transformers, assets and in the home) egg remote meter reading, connect/disconnect, tamper and theft detection, fault detection and mobile data management. Software functions include validation, editing and estimation, use calculation and aggregation to support billing, load profiling, forecasting and asset use functions. It is a critical component of an advanced metering infrastructure and is also crucial to demand response programs and for the better use of asset utilisation and reliability which requires data for network analysis.

- **Distribution management software** – this includes functions such as charging and discharging, grid stability, outage management systems, geographic information systems, self healing networks, distributed energy and optimisation. This area requires sophisticated data analytics companies to manage the huge amount of data that will be inherent in a smart grid.

- **Integration and communication:** software required for the integration of communications, applications and networked grid sensors including voltage monitors, customer smart meters, HAN and enterprise networks. Software for smart grid application platforms is also part of this category.

- **Energy management software:** used to reduce consumer's energy consumption and costs by collecting data from a variety of sources and appliances for reporting, verification, monitoring and engagement with the end-user to promote further energy conservation through understanding of energy consumption.

4.1.5 Software opportunities

The key component of a smart grid is energy data which is where many of the software related opportunities will lie. Research providers and stakeholders identify a number of trends and specific opportunities in smart grid software.

4.1.5.1 Software development trends

A report from Gartner published at the end of 2009 looks at software trends in the utilities market with a focus on smart grids[47]. They identify some interesting trends relating to the software market that point to opportunities in certain areas of smart grid development.

1. Utilities are likely to spend more on software technology in 2010 in two specific areas:
    - Infrastructure software which includes operating systems, storage, business intelligence, IT operations management, application development, middleware, security and virtualisation software.
    - Vertically integrated enterprise applications which include meter data management (MDM), geographic information systems (GIS), enterprise asset management (EAM), and distribution management systems.
2. Growing use of open-source and hosted software.
    - Budgets previously spent on propriety software are being redirected towards internal development of open-source applications. Applications include application development, infrastructure and middleware, database management systems, storage management, IT operations, security systems, and operating systems.
3. Security, storage and business intelligence are likely to see increased spending from utilities in 2010.
    - Business Intelligence allows transactional and operational data to be analysed and is used for performance tracking and is expected to be used increasingly for advanced asset management analytics.
    - Cyber or information security is increasingly important with the increased use of IT throughout the electricity grid. It includes software requirements such as the monitoring of systems, access control, perimeter security and other security features. Given the integrated nature of smart grids, the remit for cyber and information security issues is expanding.
    - There will be new opportunities in the storage market such as online backup, remote data protection, archiving software, compliance and data reduction.

New Energy Finance, a Bloomberg information service, also identifies several software specific opportunities including advanced resource forecasting; asset, element and fault management; smart billing; energy management and optimisation.

[47] Gartner: *Market Trends: Software Technology for the Utilities Industry, Worldwide, 2009*

4.1.5.2 Stakeholder identified opportunities

A number of specific opportunities were identified by stakeholders.

1. Software for monitoring/controlling electricity past substation level, for example at low-voltage electricity transformer level

   - To ensure grid optimisation and to enable efficient distributed generation, there is a need to optimise capacity at a more granular level. This may be done at a centralised level where a 'dumb' sensor sends all data back for processing – currently firms like Oracle, BBE, Arriva and GE offer software solutions in this area. Increasing interest is being given to a decentralised solution where local software performs optimisation tasks itself. This niche could be well suited to smaller niche companies.

2. Software to enable meter to appliance communication

   - In the short to medium term there is a requirement for communications software to facilitate communications between appliances and meters before this software becomes directly integrated. Standards are emerging with respect to these plug in modules and, if these are embraced, there could be a well defined market for software developers.

3. The automation of energy management system software - in home and remotely

   - There could be a standalone opportunity for programs which allow customers to directly manage and control their energy use through a home computer or other remote interfaces (such as the smart phone). Some solutions in this space are emerging but it is in its infancy. There would be large export potential for such a program. Currently, consumer demand is not there and the space is not yet well defined.

4. Data analytic software for specific end-users

   - Currently data analytics packages are fairly generic and focus on a broad range of business applications. With the huge amount of data that will become available from smart grids and meters, there will be a need to develop analytics programs that can tailor data mining and analysis to specific needs of different end users, for example electrical engineers, maintenance, planning, operations.

5. Demand response software

   - Currently not a well defined market but will require software to analyse customer consumption patterns and send real time signals to customers around energy savings opportunities.

6. Australian-specific tailoring requirements

   - Australia has a few characteristics not shared with the global market which means specific software/applications will be required. These include: two element metering (hot water and mains electricity), air conditioning usage standards (to allow cycling) and air conditioning controlled by a remote control in Australia vs. programmable thermostats in the USA.

7. Australia also has an advantage in areas where smart-grid roll out is most advanced, namely:

   - Roll out of smart meters

   - Development of end-to-end integrated solution from utilities.

4.1.6 Demand drivers

The move toward smart grids is occurring due to a number of reasons — and at different speeds — around the globe. The demand for software will be driven directly by the development of the smart grid itself. The fundamental drivers of the Australian smart grid are explained below.

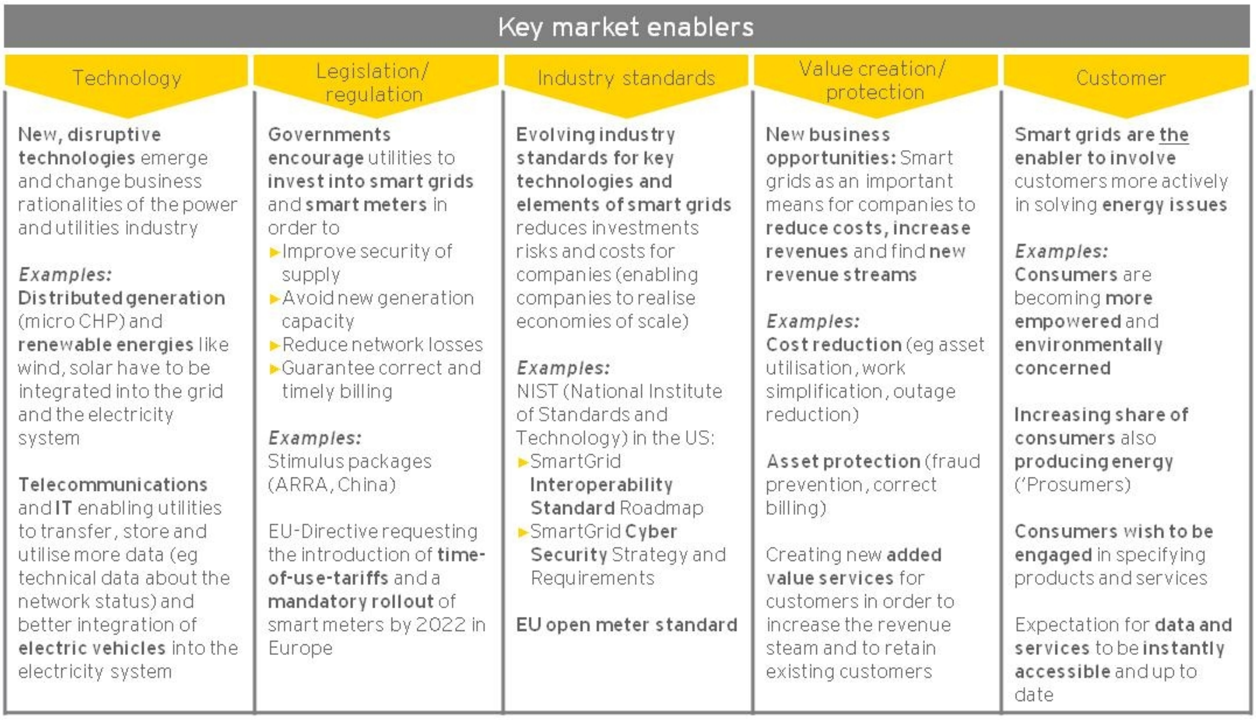
- **Reliability:** Like many countries, Australia has an ageing grid infrastructure which is struggling to cope with increased periods of peak demand, population growth and the continuing warm Australian climate. Australia's ageing infrastructure risks power outages which can be costly. For example, the power outage of August 2003 in North America, which left 50 million US and Canadian citizens in the dark and accounted for billions in financial losses, highlighted the vulnerabilities of the ageing North American transmission grid. A smart grid will defer the need for this grid infrastructure investment as it will allow electricity to be used more efficiently and will allow integration of distributed energy generation sources to provide local power, reducing reliance on the grid.

- **Growing energy demand:** An increasing population and growing energy requirements due to economic growth are placing pressures on the ageing grid. In particular, the increased use of air-conditioning units and other cooling devices adds to demand, especially in peak times. This increased demand leads to increased energy system infrastructure costs. In parts of NSW, stakeholders report that housing developments are not being constructed because grid connection limitations do not allow air conditioning units to be installed. In other locations in Sydney, stakeholders report that businesses cannot locate in certain business parks because they cannot get a grid connection to power their building. A smart grid facilitates lower peak demand, distributed generation, energy efficiency and greater storage capacity.

- **Climate change:** The Council of Australian Governments (COAG) considers smart meters integral to consumers managing their energy consumption and reducing their greenhouse impact. Broader energy concerns permeate the economy, notably the continued use of coal-fired generation to supply base-load energy demand. The need to address climate change is now firmly on the political agenda. While policy measures are geared toward more efficient use of energy, the current focus is on smart meter implementation rather than smart grids. Meeting Australia's Renewable Energy Requirement will also require a smarter grid, as dispersed sources of electricity are increasingly required. For utilities, carbon reductions will be facilitated, where demand-response mechanisms shift flexible energy demand to off-peak hours — this will enable utilities to meet higher energy demands with the same amount of generation capacity. The introduction of a carbon price will further incentivise the development of a smart grid as electricity becomes increasingly more expensive.

- **Co-benefits:** There are wider applications of smart grid technologies that could include water and gas supply networks, emergency service networks for early fire detection (house or bush fires) or social welfare and aged care applications through in home monitoring.

- **Demand enablers:** There are a number of mechanisms within these drivers which will drive the growth of the smart grid. These are described below.



More recently, Australian Standards have been developed to standardise key technologies for smart meters. For example, AS4755 establishes a standard for demand response enabled appliances.

4.1.7 Supply of software from NSW

There are a number of factors influencing NSW suitability for local software development. These are primarily:

- The state of the ICT industry in NSW: This is well developed and leaves NSW well placed to take up opportunities.
- The ICT industry's understanding of the smart grid: This is less well developed and could be encouraged.
- Diversity of players: Larger opportunities are likely to be dominated by large international corporations who may need to expand their NSW presence. There is a view from stakeholders that NSW should focus on smaller opportunities to match the types of companies that originate from NSW.
- Major Government initiatives: The Federal rollout of broadband through the National Broadband Network (NBN) will improve coverage across NSW, and present synergies with the smart grid rollout. Synergies may occur in joint use of the backbone network lines and overlapping installation schedules for the NBN and smart metering infrastructure. Also, smart metering applications may rely on NBN infrastructure for communications between smart meters and distributors.[48] NSW Government initiatives are also investigating grid-related opportunities, such as the Electric Vehicles Taskforce investigating infrastructure requirements, whilst trials of Australia's first plug-in hybrid electric vehicle in the DECCW vehicle fleet is building capabilities in vehicles that charge from and feedback into a household power supply.

[48] *Smart Grid, Smart City - A new direction for a new energy era*, Australian Department of Environment, Heritage, Water and the Arts, 2009.

4.1.7.1 Information and Communications Technology (ICT) in NSW

NSW is a leading centre for ICT in Australia, accounting for 39% of ICT businesses and 38% of industry value-added output in Australia. NSW exports of telecommunications, computer and information services account for over 50% of total Australian exports in these sectors, and are valued around $1.1 billion. The NSW ICT sector currently employs around 155,000 people, representing 5% of total NSW employment and 37% of Australian ICT employment.

NSW leads Australian ICT research capabilities. It is home to the National ICT Centre of Excellence as well as five national centres of excellence in ICT-related research fields, two cooperative research centres, four R&D facilities under the National Collaborative Research Infrastructure Strategy and the Australian Centre for Advanced Computing and Communications.

Leading ICT infrastructure and service providers based in Sydney include IBM, Alcatel-Lucent, AAPT, CSC, Hewlett Packard, Fujitsu, Global Switch, SingTel-Optus, Sprint International, Novell, Huawei and Telstra. International companies with significant R&D centres in Sydney include Avaya, Canon Information Systems Research Australia (CISRA), Citrix Systems, Honeywell, Alcatel-Lucent, IBM and Andrew Network Solutions.

Australian companies undertaking significant R&D in Sydney include Altium, Atlassian, Audinate, Open Kernel Labs, CargoWise, iSoft, Macquarie Telecom, Opticomm, Google and Sapphicon.

NSW also offers a number of higher education and vocational training institutions allowing the development of a highly skilled workforce. In 2008 there were over 13,000 students studying IT courses in 11 universities in NSW. A further 22,000 students were studying IT via vocational education and training providers.

NSW has a history of innovation in this area: Google's Sydney office developed Google maps, a team in Sydney produced technology at the heart of WiFi and a spinoff from National ICT Australia produced software that is deployed in over half a billion mobile phones worldwide. NSW has a specific niche for developing real-time software to control pieces of equipment such as machinery control and sensing equipment, for example, Cochlear.

4.1.7.2 ICT industry understanding of the smart grid

Even though the necessary IT skills and support appear to be present in NSW to take advantage of some of the opportunities, these will be of limited value without a detailed understanding of the smart grid itself. It will be software companies' ability to frame the opportunity and visualise a solution that will spur 'winners' in this area, rather than just the presence of IT skills. In this respect, it will be important that demonstration programs like the Smart Grid Smart City project involve local software developers to improve their understanding. It will also be important to involve software companies in any R&D projects that occur, such as collaborations between industry and universities.

Given that sophisticated analytical software takes time and understanding to develop, it will be companies that are already in similar fields involving smart grids or engaging with utility companies that have the advantage in this market. NSW has several global companies headquartered in Sydney which could choose to develop their software in NSW if the right testing platforms and R&D facilities were present.

To be successful in developing software and applications for the integration, networking and management of energy, expertise across all of the key industries (Energy, Telecommunications and IT) is required, and across each layer of the utility value chain (transmission and distribution, communications and applications and services). One approach smaller companies could take to overcome this barrier is to identify the vendors around communication, meter manufacturer, MDM- software provider, grid optimization solution provider, demand response system and consumer energy management systems and partner with them to provide integrated solutions that meet the needs from end-to-end.

4.1.7.3 Key players

Different opportunities will naturally fall to different sized players. Large players will lean towards the high value opportunities and smaller companies are likely to be well suited to smaller opportunities. For example, distribution management software is immensely complicated and in reality only a handful of large, resourced, international companies will be able to compete in that area. Small companies are likely to prosper by building particular optimisation products or applications that sit on top of the larger integrated systems handled by the larger companies. For example, Opal Software, a Canberra based company partners with larger organisations to deliver mission critical information systems used to monitor and control the operation of the networks and provide first line response to fault and emergency conditions within those networks. Another example of this is the Australian company Yambay, who deliver mission critical mobile solutions for larger companies like General Electric in order to mobilise their offerings.

Larger companies are actively engaging with smaller start-up companies to try to encourage them to develop new and innovative technologies and solutions. For example GE have launched a $200 million open innovation challenge that seeks breakthrough ideas from around the globe to facilitate a smart grid with the aim of establishing a commercial relationship with the winners[49].

4.1.7.4 Export potential

There are opportunities for export of software products from Australia, particularly with increasing standardisation and interoperability. There is however likely to be stiff competition from overseas markets, for example South Korea is building a large demonstration project with the aim of commercialising smart grid technologies, focusing principally on the export market. Additionally, the US and China are putting a great deal of funding behind smart grids (see section 4.1.8) which will encourage innovation in those countries.

Stakeholders report that countries in Asia and in particular Singapore, are looking to Australia for smart grid expertise given the early smart meter roll out. Because of the relatively early stage of development of this market, the likely winners are difficult to pick. If a software company in Australia happens across a winning application or software package there could be large global export potential. However, this is subject to many uncertainties and risks.

4.1.8 Market size

Ernst & Young estimate the potential market value of smart grid software to be between $69 million - $127 million in 2020. This estimate is based on a global forecast of the smart grid IT hardware and software market by ZPryme Research and Consulting, who value it at $39 billion in 2014. This has been extrapolated to 2020 and apportioned to NSW based on the information and communications technology (ICT) industry value-add and employment levels.

Table 19: Smart grid market value estimates in 2020

Sector	Market value ($M) - NSW 2020		Economic benefit ($M) - NSW 2020		Employment prospect FTE- NSW 2020	
	Low	High	Low	High	Low	High
Smart Grid software opportunities	69	127	27	50	611	1,145

Source: Ernst & Young estimates

Further details of assumptions underpinning this calculation can be found in appendix C.

In 2020 it is forecast that between 483 and 905 jobs will be supported through the one off development and installation costs. It is estimated that a further 128 to 240 jobs will be directly supported through operating and maintaining the cumulative installed capacity as at 2020. The greatest number of jobs along the supply chain is anticipated to be realised within the R&D phase of development.

[49] www.ecomagination.com

4.1.9 Economic benefits

The economic benefit calculation provides an estimate of the benefit realised in NSW through this additional economic activity based on the market size calculations above. The economic benefit does not include the direct benefits that NSW gains from having a smart grid, just the benefit from software being produced here. The total economic benefit includes the direct benefit realised through the development and operation of smart grid products, as well as the flow on indirect benefit realised across all industries. The indirect benefit includes all the associated businesses that provide the goods and services to support those individuals and businesses in this industry.

NSW is estimated to realise between $27 million and $50 million in total economic activity in the year 2020 with smart grid software market. The greatest economic benefit to be realised in NSW as a result of the increased market presence of smart grid software development is within the R&D and technical support phases.

4.1.10 Identified issues/barriers

A number of barriers to the uptake of smart grid software have been identified. These correspond fairly closely with barriers to uptake of smart grid opportunities more generally.

4.1.10.1 Lack of company knowledge/understanding

The smart grid is a very complex area to understand and industry developers will need a deep understanding of every aspect of the smart grid in order to develop successful solutions as well as an integrated approach to the three main disciplines that will be crucial: energy, IT and telecommunications.

There is currently a lack of global reference cases which demonstrate clearly the costs and benefits of the smart grid and prove them on a commercial scale. This lack of knowledge relating to costs/benefits makes it difficult to justify a business case. Pilot projects will therefore be crucial in promoting this understanding and knowledge sharing. Similarly, there is no precedent guiding businesses towards best practice or away from common mistakes.

Coupled with this barrier, utilities show a bias towards engaging with larger companies with international experience, disadvantaging smaller companies. From this point of view, pilot programs that engage smaller start ups could be important.

4.1.10.2 Requirement for interoperability standards

Australian and international authorities have yet to agree on common standards for many applications and areas of the smart grid. Although this is still a barrier, there are moves towards creating international standards.

In May 2010, Standards Australia formed an Australian Reference Group on Smart Grid which includes a number of industry associations and government representatives. The Australian Reference Group will provide inputs into two other initiatives: a) The International Electrotechnical Commission's Strategy Group on Smart Grid, which aims to update international standards and improve interoperability across smart grid systems; and b) the Commonwealth Government's Smart Grid Initiative and Standards Working Group.

There are a number of other international initiatives aimed at reaching agreement on standards for smart grids.

- In the US, the National Institute for Standards and Technology (NIST) has received US$10 million to define critical standards that relate to different layers of the smart grid including communications security, metering data interface, home area network communications, grid-side application communication, demand response and communication standards for dynamic pricing.

- The European Committee for Standardization, European Committee for Electrotechnical Standardization, and European Telecommunications Standards Institute are in the process of creating a Joint Working Group on smart grid. It is expected to outline a roadmap for European standardisation needs in 2010.

Finally, some industry-owned initiatives have sprung up including the Intelligent Utility Network (IUN) Coalition convened by IBM, a group of international companies working together to accelerate the development of common standards, technology solutions and processes for intelligent networks. Country Energy is reported to be the only Australian utility to join this.

4.1.10.3 Lack of customer engagement

One of the major challenges for a successful smart grid is that the majority of customers are not engaged with the concept of smart grids. This is caused by a lack of information and understanding of smart grid technologies and also unrealistic expectations of cost and energy savings. There may also be concerns about data security and privacy.

According to Oracle's 2009 survey, only 20% of Americans say that they would be willing to pay an upfront cost for the ability to see detailed and/or real-time data. Costly education will be required to help consumers understand the different offerings that are available, the benefits and incentives..

4.1.10.4 Regulatory framework

A longer term regulatory framework setting out the smart grid vision and its implementation and associated targets would help to provide greater certainty to businesses. Diverse state legislation/regulation may also hinder companies from realising economies of scale. Additionally, regulators need to reflect the full potential benefits of smart grid applications and provide industry with critical guidance on cost recovery or risk.

The Australian Energy Market Commission (AEMC), which makes rules for the NEM, has commenced a detailed review of the issue in the context of its ongoing work on ensuring the rules do not work against efficient levels of demand-side participation in the NEM.

Larger stakeholders report that a country's attitude and policies towards climate change also have an effect on their willingness to invest in Australia. For example, the lack of a carbon price in Australia does not signal a long term commitment to tackling climate change which may make companies more reluctant to invest in Australia relative to other countries that are more progressively addressing climate change.

4.2 Case study 2 - Retrofitting energy efficient products in commercial buildings

4.2.1 Description of opportunity

The opportunity for NSW to retrofit energy efficient products in commercial buildings focuses on two types of product, those which improve current operating efficiencies and those which improve the thermal performance of buildings.

4.2.2 Rationale

Numerous studies have identified substantial low cost mitigation potential in the commercial retrofit market but historically this has not been the specific focus of policy. For example, the Energy Efficiency Council report that a 'major retrofit' of Australia's existing commercial buildings over the next decade could save $1.4 billion a year, reducing emissions by 30% and creating 27,000 jobs. Energy efficiency is also one of the cheapest ways to reduce emissions. Climate Works Australia report that energy efficiency could actually *save* the economy $5 billion per year. Examples from one property group noted that recent improvements to one of their properties (raising the standard from 2 to 4.5 NABERS stars) cut energy use by 50% at almost a 50% rate of return.

4.2.3 Scope limitations

This opportunity does not include the consideration of small-scale renewable energy installation in commercial buildings, nor does it consider smart metering specifically. It focuses on retrofit of commercial buildings rather than their refurbishment[50]. Total refurbishment has the potential to deliver twice the number of energy savings according to existing studies (50% savings rather than 25%)[51]. This opportunity does not discuss individual products in detail nor does it look in detail at the potential market size of specific products. Instead, it focuses on the general benefits to a commercial building associated with installing a suite of energy efficient products, and explores the barriers to retrofitting.

This report relies on public data coupled with stakeholder engagement, which is neither comprehensive nor exhaustive. We have used best-available data, and made some broad assumptions in estimating future costs and benefits. Data availability for analysis of the building sectors across Australia, and NSW specifically, is an inherent limitation of this study. Insufficient data exists at present to carry out detailed assessments that take into consideration the myriad differences between properties. Though not a specific requirement from this study, we highlight this as a barrier to effective forecasting and therefore policy development.

4.2.4 Demand drivers

There are a number of underlying drivers that are inducing some customers to switch to energy efficient products: the value of energy saved, the co-benefits gained and regulatory drivers.

- **Energy savings:** Energy efficient products and processes will reduce energy consumption and costs. These savings will be particularly evident to organisations that have the ability to monitor and adjust energy consumption. But in reality there are a number of financial and non-financial barriers that prevent much of these opportunities in energy efficiency from being taken up, as discussed in section 3.2, even though they are cost-effective. Between now and 2020, an increasing carbon price and electricity price may increase consumer willingness to invest in energy efficient measures. However the impact is likely to be marginal because electricity costs only account for a small percentage of consumer spending and because the cost of using more or less electricity is not transparent.

- **Co-benefits**: Other benefits to investing in energy efficiency products may outweigh the value of cost savings.

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[50] Refurbishment is the remodelling, refashioning and general renovation of a building, site, product or infrastructure. Retrofitting is a subset of refurbishment and covers the replacement of inefficient products.
[51] http://www.climatechange.gov.au/government/submissions/pm-task-group/~/media/submissions/pm-taskforce/papers/155-lend-lease-wsp-lincolne-scott-built-ecology.ashx

  - Corporate Social Responsibility (CSR) is an increasingly important marketing tool for commercial organisations and to be seen as 'green' is perceived as a benefit by customers and employees alike and a way to differentiate an organisation from its competitors. Being energy efficient is a significant part of CSR, and this is probably one of the key non-regulatory drivers of energy efficient uptake. For example, some of Australia's 'A' grade commercial property developers, owners and managers have set commitments to ensure higher energy efficiency ratings using NABERS. For example, Dexus Property Group, GPT, and Lend Lease have each committed to 4.5 Star NABERS average across their office portfolios.

  - Given the uncertainty regarding future energy prices, companies have an incentive to reduce their exposure to future energy price volatility. Investing in energy efficiency measures enables this by minimising their dependence on energy. Furthermore, given uncertainties surrounding the future price of carbon, putting in place energy efficiency measures is a way to 'future-proof' a company's exposure to this future liability by, again, minimising dependence on energy.

- **Government action:** NSW programs and other funding support, such as the Energy Savings Scheme, the Climate Change Fund, Energy Efficiency for Small Business program, Sustainability Advantage Energy Saver and Energy Savings Action Plans, stimulate awareness and action to reduce energy consumption.

4.2.5 Supply of retrofit in NSW

Commercial buildings include office blocks, retail outlets and hotels. Comprehensive data availability on the stock of commercial buildings in NSW is not available however some localised estimates have been made.

Data from the Property Council of Australia estimates the following commercial building stock covering the following areas: Sydney CBD, North Sydney, Crows Nest/St Leonards, Chatswood, Parramatta, Newcastle, North Ryde and Wollongong.

- Office stock of 8,133,161sqm which includes 1,298 office buildings

- Retail space of 5,794,700sqm, which includes 417 shopping centres

A significant proportion of this total number of buildings is below a 4.5 NABERS star rating, and therefore could benefit from retrofitting for energy efficiency.

- **Manufacturing capabilities:** NSW has some manufacturing capability for energy efficient products including lighting, HVAC, windows and insulation.[52] Many products are likely to face stiff competition from overseas manufacturers due to a lower cost-base. Accordingly, the proportion of NSW manufacture is likely to remain fairly low.

- **Installation and assessment capabilities:** These services will all be provided locally.

- **Export potential:** Stakeholders believe that there is an opportunity for Australian businesses to grow through exporting services and through the developing of innovative technologies, practices and products.

[52] Section 3.2.2.1 lists businesses that manufacture in NSW

4.2.6 Market size

Ernst & Young estimates that the market value of this opportunity to NSW could be between $108 million and $433 million in 2020. This is based on the cost of commercial buildings moving up one NABERS star rating grade, and does not account for the benefit that accrues to the companies in terms of the energy savings.

Table 20: Commercial retrofit market value estimates in 2020

Sector	Market value ($M) - NSW 2020		Economic benefits - NSW 2020		Employment prospects FTEs - NSW 2020	
	Low	High	Low	High	Low	High
Commercial retrofits	108	433	25	99	807	3,229

Source: Ernst & Young estimates

In 2020, it is forecasted that between 634 and 2,537 jobs will be supported through one off installation costs which include setting up data management systems, energy assessment and the production and installation of the efficiency measure. It is estimated that a further 173 to 692 jobs will be directly supported through operating and maintaining the cumulative installed capacity as at 2020. The greatest number of jobs along the supply chain is anticipated to be realised within the installation of the product and its ongoing maintenance.

Retrofitting energy efficient products in commercial buildings is estimated by stakeholders to produce average energy savings of 25%. The estimate of 25% energy savings was developed from NABERS building data which showed the highest energy reduction from a single building to be 74%. 50% of NABERS rated buildings have reduced their energy consumption by more than 10%, 15% of buildings by more than 30%, and 5% by more than 40%. This suggests that the average savings opportunity for buildings making a reasonable investment could be higher than 25% and that the 10-39% quoted by the Australian Sustainable Built Environment Council is reasonable[53].

It should be noted that this analysis does not consider that buildings that are currently performing poorly could be improved at a very low or zero cost. On average, NSW buildings that have obtained a NABERS rating have already improved their performance by about 0.5 stars, an average energy use reduction of 10% between their first rating and their latest rating. It is likely that most buildings have achieved these improvements within normal capital or maintenance budget limits – i.e. small amounts with a very short payback period. Increased investment would significantly improve the savings opportunity.

Several years ago DECCW ran a study into the cost of improving NABERS ratings in average buildings. This study, which provided energy audits to 10 buildings in Parramatta, determined that most buildings could improve their performance by a half to one star with very low investment, through improved maintenance and re-commissioning.

Further details of assumptions underpinning these calculations can be found in appendix C.

4.2.7 Economic benefits

Ernst & Young have estimated that NSW could realise between $25 million and $99 million in total economic activity by the year 2020 within the building energy efficiency market based on the market size calculations above. These figures represent additional economic activity and include the direct benefits realised through the construction and operation of energy efficient products, as well as the flow on of indirect benefits realised across all industries. The indirect benefits include all the associated businesses that provide the goods and services to support those individuals and businesses in this industry.

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[53] With one outlier of 70%. See http://www.asbec.asn.au/files/ASBEC%20CCTG%20Second%20Plank%20Report%202.0_0.pdf It does not state by what year this was achievable.

4.2.8 Identified issues/barriers

Despite it being widely acknowledged that energy efficiency in commercial buildings could deliver considerable greenhouse gas and energy savings, there remain a number of barriers to extensive uptake. A number of issues specific to commercial retrofitting can be applied to the rest of the sector, and are limiting investment in energy efficiency more broadly.

4.2.8.1 Payback period

One of the barriers to significant increases in investment in energy efficiency out to 2020 is the payback of investments. That is, the time taken for efficiencies to provide financial returns on the initial capital outlay. While there are lower-cost measures that will contribute to the reduction in energy consumption, and therefore greenhouse gas emissions, substantial investment will be required to achieve significant gains across the diverse range of buildings.

Clearly, building owners will assess the relative merits of capital expenditure and will factor in the potential financial savings that can be achieved from more energy efficient products. However, historically, low electricity prices have meant that payback periods have been considerably longer in Australia than in many other major economies where energy is a greater cost to business. In the years to 2020 it is expected that increases in retail electricity prices will improve the payback on products that reduce energy consumption or improve thermal performance. Despite this, energy may still represent only a small proportion of overall costs to a business (versus, for example, labour costs), and may therefore not lead to all opportunities being taken up.

Barriers often differ between the 'class' of building, as tenant requirements for performance from A-grade properties has been shown to lead to investment in energy efficiency. Evidence from the Property Council of Australia indicates that the cost of improving energy efficiency in poorer performing buildings can also be greater (up to 10% of the asset value for a 0.5 star NABERS improvement).

4.2.8.2 Split incentives

A well established barrier to investment in efficiency measures is the concept of 'split incentives'. The classic example of this is the tenant-landlord relationship, where investment made by the landlord to improve the performance of the space leads to benefits (such as the resulting financial savings) to the tenant. This is a barrier on both parties, since the tenant has little ability to implement significant energy efficiency and thermal performance measures, and the landlord does not (usually) receive the benefits from investment.

The wider split incentive from energy efficiency is that the investment made by the building owner leads to societal benefits related to reduced carbon emissions and easing of peak demand. Classic cost-curve analysis has demonstrated that the societal cost of investment in building energy efficiency can be negative (an 'opportunity cost') in the scale of -$100 to -$200 per tonne of carbon dioxide equivalent (CO2e). This greenhouse gas saving is ultimately delivered by the (reduced requirement for) energy generators, and hence there is not a mechanism for the building owner to realise this financial incentive.

4.2.8.3 Availability of capital

It is expected that the property industry in Australia will be recovering from the impacts of the Global Financial Crisis (GFC) over the next few years. The impacts have, most notably, been on the valuations of overseas property assets and, to a lesser extent, those in Australia. Since many of the large property owners and businesses in Australia have been exposed to the impacts of the global markets on their overseas properties, this has inevitably limited borrowing capabilities (against securities). More importantly, post-GFC regulatory uncertainty around financing has led to a reduction in liquidity that has limited borrowing more widely. Whilst it is expected that liquidity will return to the market in the next decade, this early phase of uncertainty will delay the availability of capital for expenditure on energy efficiency. Limited availability of financial incentives that would limit exposure to longer-term loans, such as access to accelerated depreciation (or tax incentives), means that investment may be delayed or not made at all by those businesses with greater financial fragility.

4.2.8.4 Investment in new technologies

Behavioural patterns commonly exhibited by individuals mean that they are often less likely to invest in new or unfamiliar technologies when making large capital investment decisions. The reasons for this include a lack of trust in the capability of unfamiliar products to achieve claimed energy savings, and a lack of sophisticated metering technology to monitor the performance over time.

Stakeholder feedback indicates that there is a gap between the research and development of new technologies and commercial uptake. This gap leads to first-movers absorbing the cost for field-testing of technologies, gaining at most the additional reputational benefits from market-leadership. Since the default scenario is to await the early investment by others, this can often lead to an underinvestment in innovative approaches. Related to this barrier is the cost of new technologies that are produced in limited numbers, and are therefore not exposed to usual economies of scale. An example of this is the energy efficient windows market, where manufacture is in its infancy in Australia, despite adequate capability and enthusiasm in the industry. As a market contrast, in Europe, the price of less energy efficient glazing often exceeds that of more energy efficient, and readily available, products.

Another barrier to investment in new technologies is the potential impact on associated equipment which can increase the initial cost and time for installation. Incompatibility with current systems may mean a less energy efficient product is selected on a cost basis.

4.2.8.5 Regulatory impacts

Regulation, or policy goals, can lead to technological advances in the building sector. For example, the UK policy objective for commercial buildings to be net carbon zero by 2019 is being achieved through a variety of policy levers (outlined in 3.2.3.1) including a trading scheme and financial incentives. Progressive regulation and policy overseas may lead to overseas firms gaining a competitive advantage in the production of exportable products, relative to Australia.

There are also two policy options that may result in negative outcomes for the building sector. First, mechanisms established to ensure the overall thermal performance of buildings may lead to perverse outcomes of increased energy use. For example, the requirement for whole-of-building thermal performance could lead to a reduction in glazed area (as a least-cost mechanism of achieving this aim), and therefore reduce natural light penetration. This in turn can mean a greater reliance on artificial lighting throughout the day, thereby increasing electricity consumption. Second, incentive schemes that target specific technologies and products can exclude alternative measures that may be better suited to a specific building design. Technology-agnostic approaches, such as white certificate energy saving schemes, are better at removing these barriers but still require assessment and approval of products/technologies prior to uptake. Such an approval process can be seen as too costly or time consuming leading, again, to less efficient alternatives being selected.

4.2.8.6 Measuring the benefits

Stakeholders inform us that one of the initial barriers to investment in energy efficiency is a lack of accurate and detailed data on energy use. We know from a number of examples that an improved understanding of energy use leads to behavioural changes and reduction in consumption. However, investment in sub-metering is expensive and the financial incentives for this investment are impossible to quantify. This provides a challenge to establishing a business case that requires a rate of return within a fixed period. Obtaining accurate data does, however, provide the underlying basis for understanding where investment should be focused.

NABERS ratings cannot be provided using estimated data. Stakeholders inform us that utility providers often bill quarterly using estimated readings. This can lead to significant delays in achieving NABERS ratings, and inhibit businesses from achieving market-leading objectives.

4.2.8.7 Information provision

Recent attention around a lack of information has led to the establishment of mechanisms such as the mandatory disclosure of energy performance when selling or leasing commercial property. However, other information barriers remain. Because billing is often in arrears and on an estimated rather than actual basis, companies do not have a way of understanding even on a high level what their energy usage is. This information barrier is a fundamental one: were more regular and detailed energy usage statistics available, this would start to build a link for the consumer between energy use and costs. Real time energy use displays achieve this whereby the customer can see how much energy use is at any point in the day.

4.3 Case study 3 - Mid scale solar PV on commercial, public and industrial buildings

4.3.1 Description of opportunity

This case study considers the opportunity for NSW to install solar PV on commercial, public and industrial buildings over 100kW in size.

4.3.2 Current situation

The significant majority of Solar PV installed in Australia has been for small (<10Kw) modules onto residential premises. These installations occurred in response to generous feed-in tariff policies in most jurisdictions. Some jurisdictions are considering rolling out these feed-in tariffs to larger installations in order to diversify away from Wind as the sole contributor to the RET.

There has been State and Federal support for small (usually below 10KW) and large (50 – 250MW) systems through feed-in tariffs, rebates and grants, and the Solar Flagships program. Mid-scale systems have not received additional support above the RET (except for one-off demonstration purposes).

Solar PV has been eligible for the generation of Renewable Energy Certificates (RECs) under the RET. Revisions in February 2010 led to the creation of the 'enhanced' RET, whereby generation of RECs from January 2011 falls under either the Small Renewable Energy Scheme (sRES), or Large Renewable Energy Target (LRET). This will be dependent on the size of installation (whether above or below 100Kw).

4.3.3 Rationale

Australia receives abundant solar exposure, which is significantly greater in NSW than in many other economies where solar PV has developed strongly (e.g. Germany).

Non-residential electricity use accounts for a significant proportion of NSW's total demand. The considerable majority of this energy is consumed at peak times, during which times the solar resources are at their greatest. Further, as identified in the Australian Sustainable Built Environment Council's second plank report (June 2010), energy use in the commercial sector is expected to grow faster than in the residential segment, is made up of fewer energy users than households, and bigger savings could be obtained per action or intervention.

Improved distributed generation may lead to a reduction in the risk of 'brown-outs' and are more likely to be actively employed in a low carbon economy alongside an improved Smart Grid infrastructure.

4.3.4 Limitations of scope

This report has not considered the application of less commercially-available technologies, such as organic dyes. Solar organic dyes are currently being trialled for use on building materials (through application on glass and metal), and are therefore expected to have future applications on commercial, industrial, and public buildings (especially on high-rise buildings where roof availability may limit application of solar PV). These technologies typically have lower solar conversion efficiencies (<5%), but may prove economically attractive in the future.

Off-grid applications have not been considered in the scope of this work.

This report uses published data as a basis for the economic assessments. In doing so, the myriad variances in availability and quality of light have not been considered. Moreover, accurate and comprehensive data was not available for commercial, industrial, and public buildings (particularly with reference to available roof, or usable, space for PV). We have therefore used best-available data, and made some broad assumptions. Assumptions have not been made for industrial buildings where severe limitations on data made analysis unworkable.

4.3.5 Specific opportunities

Solar energy offers a mechanism for reducing peak demand in commercial, industrial and public facilities. Aside from the benefits of reducing peak pricing (and thereby increasing the return on investment), it acts to reduce load on the infrastructure at critical times. In sufficient scale, this could reduce the need for expensive infrastructure revisions to the network[54].

Commercial

Large retail centres offer a good opportunity for solar PV since roof space is often large, alongside its energy consumption. The disperse nature of centres across NSW also provides an opportunity around distributed generation. CBD offices are not strong candidates for roof-mounted solar PV in the mid-scale, and are likely to benefit in future from more sophisticated glass-based or organic dye systems. Suburban offices offer a considerably stronger potential for distributed generation since they are often co-located, use large amounts of energy, and provide the opportunity for large-scale investment across a number of properties in a single project. This maximises economies from bulk purchase and return on investment. Large property managers often own 'blocks' of buildings within a location.

Industrial

Industrial buildings appear, from stakeholder engagement, to offer sufficient potential for further investigation. Buildings are generally in less well developed locations, and therefore utilise (cheaper) single-story construction with greater roof area.

Public

Aside from Federal grants for schools, there has been limited investment in public buildings. Stakeholder evidence suggests that requirements for meeting NABERS 4.5 Star in all leased or owned buildings may drive investment in solar PV. For example, where tenants remain in place over subsequent lease renewals, there is limited opportunity for the building owner to undertake significant retrofit projects due to continued tenant occupancy. Solar PV, in this case, becomes an attractive means of meeting increasing NABERS requirements as it can be installed without disturbing the tenants. The Treasury Loan Fund supports investment in public building solar PV.

4.3.6 Demand for mid scale solar PV

The demand for mid-scale solar PV will depend primarily on its ability to deliver a price-competitive wholesale cost of electricity relative to other forms of energy generation.

Currently, due to low energy prices and the lack of a carbon price, solar is not competitive when compared to fossil fuel generation. The REC price therefore plays a crucial role in improving solar's cost competitiveness in the near term before grid-parity is achieved. This is in addition to the significant electricity feed-in tariff premiums. As fossil-fuel electricity prices increase due to the imposition of a carbon price and the rolling of coal contracts, and costs of solar decrease with scale and technology improvements, solar will become increasingly price-competitive between now and 2020. This has been used as the rationale for fostering the industry at this early stage. According to the Technology Roadmap produced by the IEA, PV has already achieved competitiveness for a selected number of off-grid products, services and applications. However, the on-gird market is the major market segment of the future, and the opportunity that is focussed on in this analysis.

The IEA [55] report states that with PV prices reducing as a result of falling production costs, and with electricity prices expected to rise over the coming decade, PV grid parity is expected to be reached in many regions by 2020.

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[54] Mid-scale solar installations could reduce the need for redundant generation sources to provide backup at times of peak demand. Mid-scale solar installations could provide additional capacity to the grid when needed, and provide a constant supply to the building user. In some cases, this would delay the need to upgrade grid infrastructure.

[55] http://www.iea.org/papers/2010/pv_roadmap.pdf

Consumer demand in the residential sector drove Australia's PV market in 2009, growing 222% year on year to 74 MW (albeit from a small base). Specifically 80% of all capacity installed was for on-grid residential use. The PV market growth in recent years in Australia has remained steady, rather than continuing the escalated uptake.

Other factors come into play with these investment decisions. These include but are not limited to:

- Willingness or ability to pay upfront costs – high capital costs may deter some businesses/households from investing up front because they place a lower value on future financial benefits.
- Acceptable payback period – companies often require that the investment pays back within a short timescale, typically around three years.
- A small portion of demand will be driven by social preferences or corporate responsibility priorities, which will favour PV regardless of its cost competitiveness.
- Co-benefits: Businesses could foresee commercial benefit, outside the direct financial benefit, in making business operations more sustainable. As part of their role in corporate responsibility, most large organisations today have sustainability policies and spend considerable amounts of money to ensure their operations have the least impact possible on the environment. This would add to the perceived benefit of purchasing and applying energy efficient products that may not otherwise provide a sufficient financial benefit to entice the purchase of the products.
- Resource constraint: A material constraint to the installation of solar PV on a mass scale in the commercial sector is the availability of space. For example, solar PV would not be appropriate to be installed in a majority of buildings in the CBD as a result of their limited impact (multi-story buildings), other uses of roves (ventilation) and shadowing as a result of larger buildings.

The IEA Technology Roadmap forecasts an average annual market growth rate of 17% over the next decade from 6GW to 34GW, leading to a cumulative global installed capacity of 200GW by 2020. This is expected to be driven by PV reaching grid parity in an increasing number of countries over the decade, driven by policy incentives and measures increasing the costs of carbon intensive technologies, along with further cost reductions due to economies of scale. To support this growth PV will need sustained and consistent policy frameworks and support incentives. Of this, the commercial PV market is expected to grow from 3GW to 22GW. By 2020, PV generation costs are expected to range from US 13 – 25 cents/KWh for commercial systems, depending on the site specific irradiation level. This would compare favourably with retail energy prices that are expected to rise dramatically in the same period, and are currently in the range of 20c/KWh.

4.3.7 Supply of solar PV

Supply of solar PV components in NSW will be driven by cost competitiveness of manufacture in NSW relative to other States and other countries.

4.3.7.1 Current supply of solar PV in Australia

In 2008, 42MW of cells and 8MW of modules were produced in Australia, mostly from imported wafers. BP Solar in NSW was the sole manufacturer of PV in Australia, and 80% of cells produced were exported[56]. BP Solar sold its PV manufacturing plant in 2009 to pursue manufacturing facilities in China due to the lower labour and raw material costs. Silex Solar, who bought the BP Solar plant and began operating in January 2010, is now the only PV manufacturer in Australia (at a commercial scale), and are based in Sydney. Current production of 13MW/year is expected to rise shortly to 35MW/year, with future targets set on over 200MW cell manufacture and 500MW modules.

A number of local companies have indicated an interest in manufacturing Solar PV in Australia including; Spark Solar, Tindoz, Regency and PMC Solar.

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[56] 2008 Australian Photovoltaics Status Report for the Australian PV Association, May 2009.,www.iea-pvps.org/countries/download/nsr08/PV%20in%20Australia%202008%20Final.pdf

Selectronics Australia manufactures a range of inverters and released its SP PRO grid inverter in 2009, which can also be used in back-up mode or as an inverter charger for stand-alone applications. The Latronics' PV Edge inverter is also designed and built in Australia. It offers a PV only option, a PV- wind or micro-hydro option, or an uninterruptible power supply option, which can be used with multiple energy sources and a battery bank.

4.3.7.2 Current level of imports of solar PV into Australia

The NSW PV industry's reliance on imported products, such as wafers, modules and inverters, affects Australia's module and cell manufacturing capabilities, increasing the price on the end product relative to exchange rates and lowering market value.

Large and successful players in the PV supply chain are, by necessity, becoming increasingly multinational in their operations. A prime example is Norway's Renewable Energy Corporation which produces PV cells and wafers in Norway, silicon feedstock in the US, PV modules in Sweden, operates an integrated solar manufacturing complex in Singapore and has long-term supply agreements in place with markets such as Taiwan. With time it would be expected that the smallest businesses may disappear altogether, the small to medium players get absorbed by large multinationals or specialize in PV niche markets and vertical integration of the industry is the norm. The global financial downturn and tighter access to investment capital will only serve to accelerate this trend.

4.3.7.3 Propensity for increased manufacture in NSW

There is sufficient evidence to suggest that manufacture in NSW will continue, and grow over the years to 2020. With scale, it is expected that operations may locate to regional locations to maintain a lower cost-base. Manufacture will increasingly utilise robotics to provide high throughput and lower the cost per cell to compete with GW-scale manufacture in China that leverages lower labour costs. With sufficient market drivers, competitors may also look to base themselves in Australia.

4.3.7.4 Export potential from NSW

There is demand for export of Australian PV cells that have a strong reputation for quality and longevity in the market. Currently, the local manufacturer's entire production capacity is being met with demand in local markets, but with significant increases in scale expected over coming years, this may lead to significant export potential.

4.3.7.5 Potential for increased turn-key companies

Given one of the identified barriers for mid-scale manufacture is a lack of understanding, and/or a reluctance to enter into energy markets, there is significant potential for solar PV businesses to offer 'turnkey' solutions. New entrants into the PV market are leveraging their business strengths in the construction market and partnering with module suppliers and financial institutions to become a 'one-stop-shop' for commercial buyers. Significant investments from new market entrants like Bovis Lend Lease in such ventures will provide new avenues for turnkey systems or potentially even PPAs.

4.3.8 Market size

From the current position of very few mid-scale solar installations in NSW, Ernst & Young estimate that the potential installed capacity in 2020 of mid-scale solar to be between 60 and 250 MW, excluding the potential from industrial buildings.

Table 21: Mid-scale solar market value estimates in 2020

Sector	Market value ($M) - NSW 2020		Economic benefits ($m)- NSW 2020		Employment prospects FTEs - NSW 2020	
	Low	High	Low	High	Low	High
Mid-scale solar	17	89	7	39	228	1,206

Source: Ernst & Young estimates

The capacity forecast has been estimated using both a 'top down' and 'bottom up' approach. The top down approach bases estimates on the *Australian Business Council for Sustainable Energy PV Industry Roadmap 2004*. The bottom up approach takes the number of commercial and public buildings in NSW, their electricity use and ability and willingness to install solar PV.

This estimate does not include an estimate for the potential that could be installed on industrial buildings due to data limitations. Similarly the quality of the data for commercial and public buildings has meant that this market size is an indicative estimate only.

Further details of assumptions underpinning this calculation can be found in Appendix C.

4.3.9 Economic benefits

The economic benefit calculation provides an estimate of the benefit realised in NSW through this additional economic activity based on the market size calculations above. In 2020, it is forecast that between 156 and 824 jobs will be supported through the one off installation costs. It is estimated that a further 72 to 382 jobs will be directly supported by operating and maintaining the cumulative installed capacity as at 2020. The greatest number of jobs along the supply chain is anticipated to be realised within the installation of the product and its ongoing maintenance.

4.3.10 Identified issues/barriers

A number of barriers were identified for the mid-scale solar PV market. These are described below, and many will be applicable to the wider PV market.

4.3.10.1 Context

There is considerable global investment in a range of renewable technologies. At present, the merit order for investment is linked to the availability of the natural resource and the propensity to deliver a return on investment (whether with or without financial assistance mechanisms). Solar PV modules have considerably reduced in price over the past few years, and Australian properties provide a suitable location to minimise peak energy demand and increase distributed renewable generation. Despite this, Australia's contribution to the global PV market is minimal, so it follows that the current market barriers are sufficiently prohibitive as to stifle investment.

4.3.10.2 Payback periods

The overarching barrier to significant increases in investment in mid-scale solar PV, out to 2020, will be the 'rate of return' of those investments. That is, the time taken for savings on energy expenditure and revenue from energy delivered to the grid to provide financial returns on the initial capital outlay. In overseas markets where significant installed capacity from commercial systems is demonstrated, return on investment is supported by tax incentives, feed-in tariffs (and other scheme payments), and accelerated depreciation of the assets.

The most significant financial enabler for mid-scale solar PV over the next ten years will be financial support mechanisms to achieve price parity with retail electricity. Support for larger systems on commercial, industrial and public buildings is currently limited, and therefore the rate of return is dictated by the energy savings achieved and any revenue from sale of RECs. By contrast, meaningful incentives are available for small-scale (<30KWw) systems and grant-based support is available for utility-scale projects through the Solar Flagships Program.

A view widely shared with stakeholders is that clarity on assistance under the enhanced Renewable Energy Target (RET) will be needed to reduce investor risk; specifically, the future price for large scale RECs and the existence of targets beyond 2030. Like other investments in renewable energy, mid-scale solar will require a sufficient REC price to help meet retail price parity. Solar PV systems have a generating life of over 20 years, with (at best) payback periods greater than10 years, support from a REC price may be key to providing sufficient certainty for investors.

Roof-mounted and free-standing systems that are associated with commercial, industrial and public buildings are generally limited in their capacity to generate large volumes of electricity (> 1 MW). They are therefore not able to access the economies of scale for purchases when considered alongside free-standing and more remote utility-scale installations.

For property managers, the structure of their contracts with tenants may provide a barrier to investment in measures that will reduce overall energy costs. Contracts where the savings achieved are passed onto tenants and not shared with the landlord do not provide the additional rate of return required to make the capital investment.

4.3.10.3 Uncertainty

Investors in mid-scale solar PV await certainty on policy in Australia, and significant investment has lagged in the interim. Uncertainty over the future costs for solar PV means that institutional investment will be made in alternative renewable energy sources to meet the RET. This market-led investment may not provide sufficient scale to solar investment needed to bring down the overall cost and establish competitive market players.

High initial investment costs are an important barrier for small commercial customers. There are a number of companies that offer a mechanism to avoid the upfront cost of purchase and installation of solar PV by providing an energy service to the end-user using power purchase agreements (PPA). In these agreements these companies front the costs, own and manage the systems, and the commercial user is only responsible for purchasing the generated renewable energy (in effect ‘renting' the roof space). There are companies that currently offer PPAs in Australia, but for commercial-scale systems they require off-take pricing[57] of around 45–60c/kWh, and a requirement to buy all of the energy generated for a period of up to 20 years. Uptake has been limited because pricing is two to three times that of the brown energy retail price, and there is insufficient certainty on the increases expected in the retail energy price over the coming decade to demonstrate value in future-proofing supply.

4.3.10.4 Structural building issues

Larger commercial solar PV often requires additional time and materials for what are more complicated installations than for small, residential systems. As such the balance of system costs can be proportionally greater. Commercial installations often also require greater ancillary services, such as scaffolding and safety equipment.

Large solar PV installations on buildings can require significant load-bearing capabilities, and feedback from stakeholders has provided examples where the companies that manufactured and supplied the roofing material have sought to limit or even void current warranties. Such an issue may provide a level of insurance risk that property owners and managers are unwilling to take.

Building Integrated Photovoltaics (BIPV), where the panels themselves are the roofing material, are not as common in Australia as mounted systems, and their current costs likely outweigh any advantage attained from reduced building material and construction expenditure.

4.3.10.5 Availability of capital

It is expected that the property industry in Australia will continue to recover from the impacts of the GFC over the next few years. More importantly, post-GFC regulatory uncertainty around financing has led to a reduction in liquidity that has limited borrowing more widely. Whilst it is expected that liquidity will return to the market in the next decade, this early phase of uncertainty will delay the availability of capital for expenditure on solar PV.

[57] Off-take pricing refers to the price paid by the electricity retailer to purchase output from the installation

4.3.10.6 Knowledge gap

A recent survey of US executives carried out by Ernst & Young found that less than 5% of responding companies had installed on-site renewable energy in some form, expressing discomfort with their understanding of the logistics of installing renewable energy and its actual costs. This reaction was also held up during interviews with some property owners and managers in Australia. With the skills and time required to generate and retail energy outside the core focus of building asset owners and managers, some stakeholders expressed a reluctance to enter into costly capital expenditure with limited expertise.

The potential for solar PV differs for each building and location, and, until property managers seek to assess this, it remains a knowledge gap. This lack of knowledge on the potential for solar energy generation may be an initial barrier for investment, alongside access to information on financial and other incentives.

Connection to the grid network has been well established for small, residential solar PV applications. However, there are further requirements for system installers to meet with increases in load that are less well understood in the solar market. Considerations are needed around thermal limits, protection of the network and system harmonics. A potential barrier to deployment of mid-scale solar PV could be a lack of understanding of specific network requirements.

4.3.10.7 Supply chain

Continuity of supply of solar PV systems was initially limited by the availability of modules. However, significant investment in 1GW+ manufacturing facilities overseas (principally China) has ensured sufficient supply to meet global demand. The lack of availability of inverters has been the 'bottleneck' of the supply chain since 2009. Stakeholders confirmed that lead times are long for inverters, and many have changed their suppliers to maintain greater consistency in stock.

4.3.10.8 Solar resource in NSW

Many of the mid-scale investments on commercial and industrial solar PV have been outside of NSW, as the quality of light has generally given better returns from output. The Clean Energy Council provides broad estimates of returns per KW installed of around 3.9KWh in Sydney, 4.2kWh in Brisbane and 4.4kWh in Perth. All other costs being equal, such trends may provide a barrier to investment in NSW where national (or international) property companies seek to make the greatest return on investment.

4.4 Case study 4 - Increased power generation from wind farms

4.4.1 Current situation

The RET requires 20% renewable energy generation by 2020, the majority of which is likely to be from wind due to its cost competitiveness relative to other renewable technologies. Currently, the majority of wind farms are being constructed in States other than NSW, who are taking the bulk of the investment in this renewable energy source. There is a significant pipeline of NSW wind farms proposals in planning but stakeholders report that many have stalled due to barriers to their development.

4.4.2 Rationale

There are a number of reasons to suggest NSW will gain an increasing share of wind farms between now and 2020. To date, wind farms have clustered in South Australia and West Australia because of their better wind resource. However several States are now at the point where the transmission lines are nearing capacity and further projects would require major transmission line upgrades, which would be costly. This leaves an opportunity for NSW and Victoria to provide a substantial component of the remaining additional capacity required to meet the RET target. The fixed drivers behind the relative rate of return between NSW and Victoria appear to be comparable. Whilst Victoria has slightly higher wind speeds, NSW has slightly higher electricity prices, which go some way to compensating for this differential. Furthermore, stakeholders report that NSW has localised areas of very good wind speeds not reflected by the wind maps that currently exist. Grid infrastructure exists in both States. NSW could gain a significant proportion of the investment between now and 2020 if investors are presented with the appropriate financial, regulatory and policy settings.

4.4.3 Limitations

This work has relied on publicly available data and stakeholder consultations. It focuses on the barriers and opportunities from the *installation* of wind farms. Therefore, it does not thoroughly analyse the economic or job-related impacts on the domestic manufacture of the components within wind farms.

4.4.4 Demand drivers

The demand for wind-generated power by retailers will be primarily determined by the enhanced Renewable Energy Target (RET) - a legislative requirement for electricity retailers to source an increasing percentage of their energy from renewable sources. The NSW State Plan includes a target that NSW achieves 20% renewable energy consumption by 2020 in light of the Federal Government's expanded RET. Any additional demand for wind power beyond the RET target would be driven by a price-competitive wholesale cost of energy generated relative to other forms of energy generation. This is considered an unlikely scenario between now and 2020 given current forecasts[58]. The demand for NSW-specific wind generation will depend on the return for investing in NSW versus other States.

4.4.4.1 The Enhanced RET

The enhanced RET, announced in February 2010, requires large energy producers to produce 410,00GWh of renewable electricity by 2020. This does not include existing electricity from hydro generation but does include the RECs that have been banked already, of which there is a significant surplus. This new legislation requires approximately 10,000MW of additional renewable energy capacity between now and 2020, equating to around 1,000MW per annum[59]. Given that wind is a well established technology and currently is the largest and cheapest form of renewable energy generation, it is anticipated that a large proportion of this additional capacity will be met by the wind industry.

Given that NSW accounts for 30-40% of total energy demand, NSW will ultimately absorb a substantial proportion of this required wind capacity. While this rationale is quite simplistic, it illustrates that the wind abundant states of WA, SA and Tasmania will struggle to absorb the 1,000MW per annum that is needed unless large amounts of electricity are exported. The key implication from this is that even though NSW and Victoria do not have as good a wind resource, their higher electricity demand levels mean that they will ultimately share a substantial proportion of new wind capacity.

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[58] For example see ROAM's analysis

[59] Stakeholder consultation, previous Ernst & Young estimates

4.4.4.2 The wholesale cost of energy

The demand for any form of energy generation in an open market will be dependent upon the relative cost of different generation types. Currently there is a substantial differential in the price of energy between the traditional fossil fuel dependent energy generators and energy generated from renewable sources.

This differential is partly due to the low price of electricity in Australia, which is amongst the lowest in the world, driven by the high proportion of low-cost coal-fired generation which meets approximately 85% of the nation's energy requirements. A number of existing coal contracts have also kept prices low for generators, while the market coal price has been rising.

A number of factors are likely to push the price of coal-fired generation up between now and 2020 relative to wind power, which will decrease the price differential between the two forms of generation, which could, if the differential was reversed, incentivise demand in addition to the RET requirements. These factors are discussed briefly below.

4.4.4.3 Increasing global coal prices

Coal prices have increased markedly over the past few years, driven by growing energy consumption requirements, particularly from emerging economies such as China, coupled with limited increase in export growth from major suppliers such as Australia, South Africa and China. For example, contract negotiations for the Japanese fiscal year (JFY) 2008 resulted in prices for metallurgical coal (hard) and thermal coal increasing by 206% and 125% respectively. Compared with four years ago, metallurgical coal and thermal coal contract prices have increased by 426% and 178% respectively[60].

4.4.4.4 The rolling of subsidised long-term contracts

A number of thermal energy producers have long term (20 plus years) contracts with coal producers that are now significantly below the market rate and are on the point of expiry. New contracts will need to factor in the historical coal increase that has happened over this period.

4.4.4.5 Carbon price increase

Although the Carbon Pollution Reduction Scheme (CPRS) has been delayed, it is expected that a carbon price, in some form, will be implemented in Australia before 2020, which will serve to increase the cost of intensive forms of energy generation so that they more accurately reflect the environmental damage caused by their emissions. It is estimated that a $20 price on carbon will increase the price of producing 1MWh of energy from a coal generator by approximately $18. Therefore the price differential between coal energy generation and wind energy generation will decrease approximately to $22 (taking the mid-point between the high and low generation cost estimates), all other things remaining constant.

Recent modelling completed for the Clean Energy Council asserts that a higher carbon price will not materially affect wind generation. It shows that a $38 carbon price between now and 2020 does prevent the entry of new coal fired generation, but is insufficient to change the dispatch merit order (i.e. the ordering of generation to meet peak demand), which sees coal fired generation providing the base load, and gas fired generation playing an intermediate and peaking role.[61]

Overall, whilst these factors will increase the cost of coal-fired energy relative to wind, this anticipated increase is unlikely to be great enough to induce generation over and above the demand created by the RET.

4.4.5 Supply of wind farms in NSW

4.4.5.1 Investment criteria

The number of investments in wind energy generation will depend on the rate of return that can be realised by investors relative to other forms of generation. The number of wind farms in NSW will depend on how the rate of return compares between states (i.e. 'wind yield' and capacity factors). The rate of return will be affected by cost factors including direct costs, availability and quality of resources, rate of technological improvement, total time to construct and other perceived risks.

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[60] Source: International Energy Agency: Coal Information OECD
[61] ROAM 2010

On the benefits side, the rate of return will be driven by the total power price (including expected RET price, electricity price and carbon price), any additional subsidies offered and, crucially, the ability to lock in those benefits in advance and secure the investment through mechanisms such as off-take agreements which would reduce uncertainty and risk.

Wind-rich states are nearing their capacity given the current infrastructure which leaves an opportunity for NSW to provide a large share of the remaining capacity. The speed at which projects can come on line between now and 2020 will depend on the current pipeline, given the long lead times between project inception and operation.

4.4.5.2 Grid infrastructure capacity and connection agreements

Connecting wind to the grid will involve substantial costs if additional transmission is required. This is the one area where costs differ markedly between States because sites that are proximate to sufficient grid capacity gain a cost advantage.

The most prospective areas for wind farm development in NSW are well served by grid infrastructure compared to other states and there is significant capacity remaining. This will increasingly provide an advantage to NSW compared to WA, SA and TAS who already have a level of wind farm development that significantly exceeds their available grid capacity in a number of regions. Victoria, like NSW, is well served by grid connections.

4.4.5.3 Quality of wind

Wind speed and consistency improves the productivity of the generator and thus increases the profitability of the project. Wind mapping exercises show that NSW, with average wind speeds approaching 8 metres per second, is at a slight disadvantage to Victoria with wind speeds of over 8 metres per second on average, while Tasmania, South Australia and Western Australia have average wind speeds of 8.5 metres per second or greater.

However, stakeholder consultations suggest that wind resources in specific ridged areas are better than the broad geographical surveys on which this data is based and that there are a significant number of locations for which this is the case. Two recently constructed NSW wind farms demonstrate the efficiencies that can be achieved by NSW wind farms. Their published net capacity factors are 47% for Cullerin and 36% for Capital. Cullerin is one of Australia's largest wind farms based on capacity factor (output divided by installed capacity times number of hours in the year).

4.4.5.4 Planning process and costs

Typically a project will take around five years from conception to completion. The time is factored roughly as follows:

Table 22: Lead time for wind farm construction in NSW

Proof of wind resource	6 - 12 months
Permitting	1 - 2yrs, longer if legal challenges
Grid connection	18 months (minimum)
Procurement	4 - 12 months
Construction	2 Years
Total	**4 – 6 Years**

Source: Stakeholder consultation

In August 2009, the NSW Government amended the planning process for wind farms, by considering wind farms of 30MW or greater as critical infrastructure (and therefore subject to fast-tracking) and waiving critical infrastructure charges until June 2011. Under 'best case' conditions the planning process should take less than 6 months – broken down as follows:

- Environmental Impact Assessment: 3 months
- Exhibition: 1 month
- Assessment: 1 month
- Determination: 1 day

Department of Planning reports that, although it is currently meeting its performance targets for timeframes for parts of the planning approval process over which it has control, planning applications often take significantly longer than the quoted 6 months. For example, the process can be delayed if the Environmental Assessment prepared by the proponent is not adequate. The Department of Planning has no control over the time it takes for a proponent to consider public submissions received during the statutory public exhibition period. Such delays increase the cost of this process and decreases the rate of return. This is expanded in section 4.4.8.

4.4.5.5 Financing costs

Financing costs are heavily dependent on the degree of market risk that is exposed. For example, market risk will be considerably reduced if the wind farm operator has in place a long term power purchase agreement with an electricity retailer which locks in the prices they receive for their electricity and RECs. Current debt market liquidity issues have made it difficult to fund a wind farm on a merchant basis. In the current market, electricity and RECs need to be fully contracted.

4.4.5.6 Power price

The higher the total power price, the closer wind will come to grid-parity. This will be influenced by the REC price, electricity prices and any carbon price. Additional State subsidies could also favour investments in particular jurisdictions. Currently there is little differentiation on this point between States, although historically, NSW electricity prices have tended to be on average slightly above those of Victoria.

4.4.5.7 Propensity for local manufacture/employment

There is significant propensity for local manufacture/employment as a result of a growing wind industry in NSW. Many of the secondary components will be manufactured locally as well as the majority of service and construction based jobs being sourced locally. Most primary components of the wind turbine are likely to be imported rather than produced locally. Possible exceptions include the tower and other castings, but only if significant scale were to be reached. One example of a NSW based company that has the capacity to produce wind turbine gearboxes and nacelles is David Bown Gears (DBG) which currently manufactures gears and competes for wind turbine service and repair contracts in Australia.

4.4.5.8 Export potential

NSW does not have significant export potential given that it is one of the least well developed states in terms of its existing wind generation capacity. Internationally, there are well established manufacturers servicing the market already. At least two assembly plants have attempted to set up in other states but have not been successful due to uncertain supply. Were this situation to change, for example, if a further extension to the RET were to be announced, this may make Australia an attractive option for this investment once again. NSW will be well placed for selection given that the wind-rich states are, at present, reaching capacity given their current infrastructure. If this were to happen, NSW could become an exporter to other states.

4.4.6 Market size

Ernst & Young estimate that NSW could gain between 2,000MW and 3,500 MW wind capacity between now and 2020. This assumes that the market size will be limited to generation induced by the RET. This translates into a market value of between $226 million and $494 million in 2020. Although outside the scope of this analysis, some stakeholders report that there is the potential for NSW to generate up to 6,000MW of wind power by 2020 if sufficient incentives are put in place, for example, an extension of the RET.

Table 23: Wind energy market value estimates in 2020

Sector	Market value ($M) - NSW 2020		Economic benefits ($m) NSW 2020		Employment prospect FTE- NSW 2020	
	Low	High	Low	High	Low	High
Wind Energy	226	494	97	212	2,738	5,990

Source: Ernst & Young estimates

Further details of assumptions underpinning this calculation can be found in Appendix C.

In 2020 it is forecasted that between 2,058 and 4,502 jobs will be supported through the construction and installation of wind turbines in NSW. By 2020 it is forecast that a further 680 to 1,488 jobs will be required to operate and maintain the cumulative installed capacity as at that date. It is forecast that between 625 and 1,368 jobs will be realised in metropolitan NSW, compared with between 2,113 and 4,622 jobs realised in regional NSW. It is estimated that between 10.3 and 12.9 jobs in NSW will be created per megawatt of capacity constructed. The majority (75%) of these jobs will be realised through the construction and installation of the turbine as well as associated civil works and flow on.

4.4.7 Economic benefits

The economic benefit calculation provides an estimate of the benefit (profit) realised in the State through this additional economic activity based on the market size calculations above. The total economic benefit includes the direct benefit realised through the construction and operation of wind farms, as well as the flow on indirect benefit realised. The indirect benefit includes all the associated businesses that provide the goods and services to support those individuals and businesses that work and operate the wind farms and their further downstream benefits across the economy.

NSW is estimated to realise between $97 million and $212 million in total economic activity within the year 2020 as a result of wind farm developments. The greatest economic benefit is realised within the State as a result of the increased market presence of wind electricity through the wind turbine construction, associated civil works and ultimately its ongoing operation.

4.4.8 Identified issues / barriers

Stakeholders identified a number of important barriers in NSW that will prevent the State from reaching the potential market size. There are two 'tiers' of barriers in the market:

- Those that are delaying the most efficient wind projects from being taken up
- Those that are preventing the second tranche of efficient wind projects from being financially viable[62]

These barriers are addressed in the following section.

4.4.8.1 Barriers applicable to all states and territories

Lack of carbon price and uncertainty over the value of Renewable Energy Certificates

The current lack of a carbon price means that the electricity price is far lower than it should be if the true price of carbon and coal were reflected in costs. This will act to make wind farms relatively less competitive than they otherwise should be.

While reform of the RET was widely applauded by stakeholders, many felt that the current oversupply of RECs in the market has led to uncertainty over forecast values for RECs from large-scale projects. This is expected to lead to delays in the coming years as project financiers look to maximise returns on investment.

[62] Incentivising growth in NSW-specific wind generation at less viable sites may have a perverse outcome of diminishing investment elsewhere, leading to overall Australia-wide market inefficiencies.

Bottlenecks in the supply chain

There is a concern that crane availability will become an issue when developments suddenly starts getting built in 2013 when it is expected that the REC price will increase.

Other

Stakeholders were asked specifically about whether building consortia with project partners or a lack of skilled workers were barriers and neither were deemed to be.

4.4.8.2 NSW specific barriers

Shortage of companies willing to enter into long-term Power Purchase Agreements (PPAs)

Stakeholders report that it is difficult to find retailers willing to enter into agreements to purchase the future stream of RECs that a wind farm would provide. This is cited as a large barrier to project viability for independent wind developers as it is essential to reduce the financial risk to levels deemed acceptable by financiers to secure the investment. The importance of a relationship with retailers is demonstrated by the fact that two of the wind farms that have proceeded to construction in NSW have either been by an electricity retailer (Origin Energy) or through a long-term purchase agreement with Sydney Water (Capital Wind Farm).

Stakeholders believe difficulties in obtaining PPAs are partly due to uncertainty with regards to the future carbon price and the RET, and also due to the uncertainty created by upcoming privatisation of NSW retailers. Also, because wind is an intermittent source of generation, it requires support ('firming') by predominantly gas-fired generation which can be started quickly. Given these preconditions, PPAs require complicated arrangement of both the off-take agreement and the strategies to level out the intermittent generation.

Industry concerns regarding the NSW planning approval process

There was a consensus among industry stakeholders that Part 3A (Major Project Assessment Process) of the *NSW Environmental Planning and Assessment Act* was an integrated process for which there was wide support. However, despite Government efforts since August 2009 to streamline the planning process for wind farms, stakeholders perceive its implementation to be under-resourced. Although the planning process is expected to take six months, stakeholders indicate that average approval time in NSW is around twelve months, and often longer due to Court appeals. It is worth noting that the scope for Court appeals is now curtailed following the declaration of renewable energy projects over 30MW as critical infrastructure. Stakeholders also regard planning approval costs in NSW as being higher than other States largely as a result of their basis being on the capital value of the project.

Stakeholder concerns relating to grid connection delays

The time that it takes to negotiate grid connection can significantly affect costs. Stakeholder consultation suggests that NSW network service providers are slower in their response time compared to State counterparts. Not only is the indicative timetable provided by Transgrid to get a draft connection agreement[63] almost twice as long as its counterpart timetable in South Australia[64], stakeholder consultation suggests that this longer timetable is not always adhered to and any unplanned delays will increase costs to developers. It should be noted however that these timetables incorporate timelines for developers to respond to information requests and so the exact source of delay cannot be definitively pinpointed without further investigation.

There are initiatives in place to implement a commercial risk management policy for more prompt connection of renewable assets to the grid. Stakeholders also perceived the technical requirements in NSW to be more onerous and costly than most other states by, for example, including the requirement to update the communications network.

[63] Approximately 72 weeks. Source: Stakeholder correspondence with Transgrid
[64] 'Approximately 38 weeks. Source: *Options for progressing connections to electranet's transmission network' Electranet publication*

4.5 Case study 5 - Increased use of GHP in HVAC systems

The opportunity for NSW to increase use of Geothermal Heat Pumps (GHP) for heating ventilation and cooling (HVAC) in residential, commercial, industrial and public buildings

4.5.1 Current situation

Globally, GHPs are the fastest-growing means of exploiting geothermal energy, with most of the new pumps being installed for home heating. GHP growth has been particularly prominent in North America and Europe. There are over 3 million geo-exchange installations worldwide. The US manufactured 115,000 units in 2009, down 2% from 2008, with approximately 17% exported mostly to Canada[65]. Australia is behind the global trend of installing GHPs.

It is considered that a broad range of premises could benefit from GHP technology, however a lack of awareness and high upfront costs have limited activity to date. In Australia, GHP for HVAC applications are minimal, whereas in the US they make up around 2% of the market. Depending on the building type and use, HVAC can be responsible for between 40% and 60% of all energy used in non-residential buildings and creates, on average, more than 55% of electricity demand in a typical CBD during peak demand periods[66].

4.5.2 Rationale

GHP technology is a mature technology that has experienced significant take-up over North America and Europe and gained prominence in these areas due to a range of factors including increased awareness, the introduction of carbon pricing and government incentives. It is anticipated that technologies like GHP will gain popularity in Australia as increasing electricity prices, better understanding among consumers and the introduction of a carbon price encourage greater energy efficiency.

The expanding HVAC market holds opportunities for GHPs as they produce significant energy savings relative to conventional HVAC systems. Therefore, they are likely to be part of a suite of measures that will be required for Australia to transition to a low carbon economy, and will make economic sense for a range of specific applications such as high-occupancy buildings (such as schools and hospitals as well as off-grid semi-rural residential buildings).

The concept has been tested in Australia and is operating in a number of buildings such as Geoscience Australia's office building in Canberra. These projects are showing significant energy savings per year (even when compared to alternative systems such as air-source heat pumps) which more than offset their greater upfront costs over their usable life. Other benefits include peak load reduction due to the reduced energy demand of GHPs and also their potential to provide thermal storage.

4.5.3 Limitations of the case study

This study only examines GHPs that are defined as operating in the upper few tens of metres of the earth[67]. It does not include the other primary source of direct energy use of circulating hot water, which is sourced from the upper few hundred metres of the earth and used in larger applications such as industrial heating and drying and aquiculture. It should also be noted that the study focuses on the barriers and opportunities from the *installation* of GHPs. Therefore, it does not thoroughly analyse the economic or job-related impacts on the domestic production of GHP.

The market analysis relies on public data, which is very limited for this sector. Accurate and comprehensive data was not available for commercial, industrial, and public buildings. We have therefore used best-available data, and made some broad assumptions. The market size assumptions are technology agnostic, assuming an even share of all geothermal technologies. As both a challenge to this analysis, and identified as a barrier to increased uptake, there is limited data available regarding the applicability and efficiency savings of GHP systems to Australian buildings.

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[65] Geothermal Heat Pump Manufacturing Activities 2008, DOE Report, October 2009. http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html

[66] Australian Institute of Refrigeration, Air-conditioning and Heating (AIRAH), "*Retrofitting Pre-Loved Buildings*", 2009

[67] AGEA Direct Use Geothermal Submission

4.5.4 Description of GHP technology

GHPs extract heat from the ground which can be used for space and water heating and cooling. The ground is heated by solar radiation in the near surface layers of the earth and maintains a constant temperature of around 17 – 18 degrees in NSW. This heat can be extracted from the ground through a set of loops which are dug or bored into the ground to transfer heat to the building. In hybrid systems, an extra heating source increases this temperature further before use. Heat pumps can also be operated in reverse mode to provide cooling requirements by dumping heat into the ground.

The core of the heat pump is a loop of refrigerant pumped through a vapour-compression refrigeration cycle that moves and upgrades the heat. This is housed in a central unit that becomes the heating and cooling plant for the building.

There are two main ways in which to transfer heat from the ground into the pipe. Direct exchange systems circulate refrigerant underground whereas water source systems use water.

- Direct exchange GHPs have a single refrigeration circuit entailing a number of copper ground loops. Refrigerant is circulated by the heat pump through the copper ground loops that are continuous with the rest of the heat pump. The configuration of the buried part of the pipe system – ground heat exchanger – can be vertical or horizontal. Direct exchange GHPs require shorter and smaller pipes to be placed in the ground per unit heating or cooling capacity and can be used both in small and large applications.

- Water sourced GHPs have two circuits: a refrigerant loop which is contained in the appliance cabinet where it exchanges heat with a secondary water loop, made out of plastic that is buried underground. Loops can be closed, where the water circulates internally or open, where the waster is drawn from the ground.

- In closed loop systems, after leaving the internal heat exchanger, the water flows through the secondary loop outside the building to exchange heat with the ground before returning. A heat exchanger is required between the refrigerant loop and the water loop and pumps in both loops. Closed loops can be installed horizontally or vertically.

- In an open loop system, which are less common, the secondary loop pumps natural water from a well or body of water into a heat exchanger inside the heat pump.

- More recently, 'thermo-piles' have been successfully used in Europe, whereby the ground heat exchange coils are installed inside the foundation piles at the time of construction. This technology is only available in new-build properties, and has been used in a limited number of locations in the UK, including the main offices of the Greater London Authority. There is an active research program within Australian Universities that is exploring this application of geoexchange.

The overall efficiency of a GHP is measured using the coefficient of performance (COP) which is the ratio of heat output to electrical power input. For an effectively operating heat pump, the COP should always be greater than one and is typically in the order of 2.5 to 5, meaning that for every unit of electricity used the equivalent of 2.5 to 5 times that of energy is returned.

The greater the difference between the ground and air temperature, the greater the relative efficiency of the heat pumps. This is why GHPs have been more widely taken up in the harsher climates of Europe and the US. GHPs are generally more efficient than air-source systems due to the relatively constant temperatures of the ground source compared to the variability of the air temperature. GHPs can therefore reduce peak-load power and hence the grid power requirements.

4.5.4.1 *Advantages of GHPs*

GHPs present a number of benefits compared to conventional HVAC systems and other renewable options.

- **Energy efficiency:** By using GHPs, energy use is typically reduced by 30% to 70% relative to conventional HVAC systems. In 2006 the HVAC and refrigeration industry consumed up to 45,000GW hours of electricity, amounting to 22% of the country's production. The industry was also responsible for 7% of the national total of carbon emissions.[68]

- **Carbon emissions reductions:** Reduced energy use translates into carbon savings. The US EPA and Department of Energy have determined that GHPs have the lowest environmental impact of all heating systems and they reduce energy consumption and corresponding emissions up to 72% when compared to electric heat strips and standard air conditioning. The EPA verified up to 75% reduction in electrical consumption as compared with electric resistance water heating by a GHP commercial water heating system and a concomitant reduction in emissions up to 937 kg-CO_2 per KW of thermal capacity per year.[69]

- **Cost effectiveness:** Although capital costs of GHPs are higher than conventional HVAC systems, the resulting decreased energy use translates into annual cost savings, which over the lifetime of the system, makes them cost effective. The larger the scale, the cheaper the capital costs because of economies of scale in the drilling and installation prices.

- **Durability:** GHP systems, because of favourable operating conditions (namely, nearly constant ground temperature) and underground shelter, last far longer than conventional HVAC systems with typical warrantees on piping often at 25 years or more. Given the annual cost savings, this makes their lifetime cost even lower. Maintenance costs are also minimal.

- **Other benefits:** Larger scale application of GHPs, which reduce peak load electricity demand , help avoid expensive power generation and grid upgrade cost. Along with reliable and quiet operation, GHPs provide better humidity control and zone-level temperature control than conventional systems.

4.5.4.2 *Limitations of GHP systems*

There are two key limitations for GHP systems:

- **Land requirements:** Some configurations of GHP systems – horizontal loop ground heat exchangers, water loop systems – may be less suitable in urban areas where land is limited and existing infrastructure (cables, pipes etc) limit their applicability unless they can be installed directly in the foundations of the building.

- **Climatic conditions:** GHPs have the greatest efficiencies in climates which experience extreme weather conditions and in those with both heating and cooling requirements. NSW does not experience such extreme temperature variations as parts of Europe, however current installations show that significant efficiency savings are still possible.

4.5.5 Specific opportunities

Stakeholders indicate a number of particular applications for which GHPs would be most suitable.

- High occupancy buildings (in particular schools, hospitals, university campuses)
- Phone towers and exchanges that require cooling (approximately 5,000 in Australia)
- Property developments
- Military housing, resorts
- Abattoirs, Dairies, Piggeries, Wineries
- Other energy intensive commercial buildings
- Retail chain outlets
- Remote/off grid buildings, especially those that currently run on LPG

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[68] Klaus Regenauer-Lieb, Hui Tong Chua, Xiaolin Wang & Donald Payne "*Geothermal heating and cooling in Australia*"
[69] *Environmental Technology Verification Report*, US EPA & Greenhouse Gas Technology Centre, SRI/USEPA-GHG-VR34, September 2006, http://www.earthlinked.com/files/downloads/documents/Reports/EPA_report.pdf)

► Semi rural residential properties that have small plots of land to install cheaper horizontal systems
► Alpine areas

Stakeholders also discussed the concept of GHPs being installed by land owning companies prior to the land being sold for development. The price of the GHP system could then be incorporated into the price of the land and would only represent a marginal increase on the land price. However, there are currently no incentives for this to occur.

4.5.6 Demand drivers

The potential demand base that is considered in this analysis is GHP HVAC systems for residential, commercial, industrial and public buildings. The demand for GHPs for HVAC will be determined by three key factors:

1. Underlying demand for HVAC systems

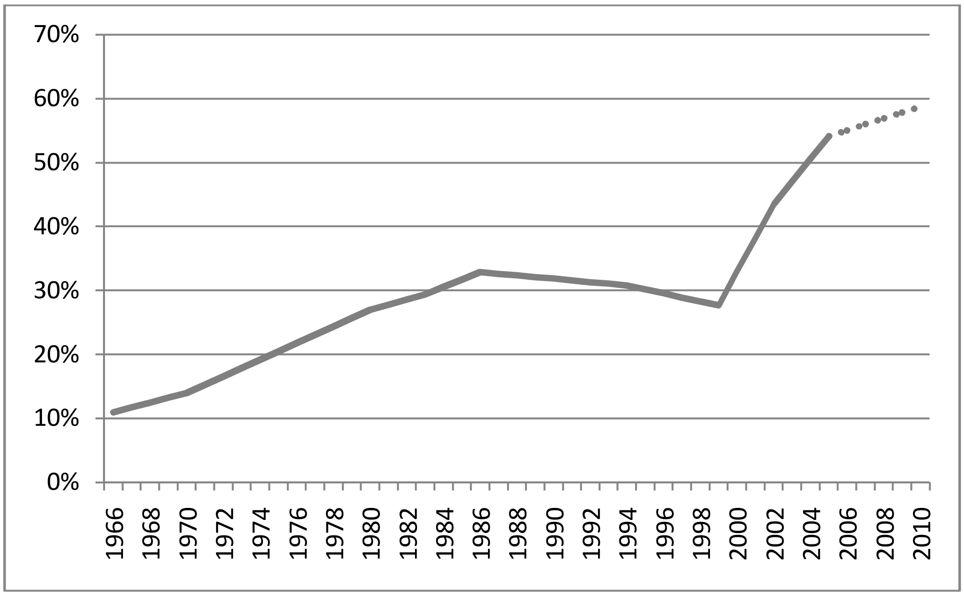
2. Cost effectiveness of GHP systems relative to alternatives

3. Market failures such as lack of access to capital and consumer myopia

4.5.6.1 Underlying demand for HVAC systems

The future level of demand for GHP HVAC systems, customer-type and market structure trends are likely to follow the general trends of the wider air conditioning market. The HVAC industry has experienced consistent long-term growth since the mid-late 80s, interspersed with cyclical demand fluctuations. This has been driven primarily by a distinct increase in the underlying demand for HVAC services.

Figure 4: National penetration of air conditioners by year



Source: Donald Payne, University of Melbourne, Direct Geo-Exchange Heat Pump (DGHP) Industry – Overview

Market penetration of HVAC systems in Australia has grown from 35% to 65% over the last decade as a result of higher living standards and natural economic expansion (Figure 4). Industry revenue has been growing at an average 6% per annum and IBIS project that this average growth rate will continue to 2015. The market for the air conditioning and heating service industry is now worth over $4 billion with value added of over $1.6 billion or 0.2% of Australia's GDP[70]. Of this value, 25% is in the residential market, with around 50% in commercial, 15% in public buildings and the remainder in industrial facilities.

[70] IBIS World

4.5.6.2 Cost effectiveness of GHP systems relative to alternatives

The overall size and breadth of the GHP market will be primarily derived by the discounted future net benefit of a GHP system relative to alternatives. In other words, if the use of GHPs reduced the energy use of the entity sufficiently so that the financial benefit (reduced energy bills) in the future was greater than the upfront cost of the good, and that net benefit was greater than alternatives, then a rational entity would purchase a GHP system.

A number of objective factors influence this decision, including:

- Amount of energy use
- Profile of energy use
- Land constraints
- Cost of alternate energy sources
- Potential impact on the standard of living

In addition, a number of subjective factors also influence the investment decision:

- Willingness or ability to pay upfront costs – because of the high capital costs, this may deter some businesses/households from investing up front because they value the financial benefit in the future less.

- Acceptable payback period – companies often require that the investment pays back within a short timescale typically below three years.

- Understanding and level of confidence in GHP technology – GHPs are not a well understood technology in Australia and therefore entities are likely to be wary of capital spend. Lack of understanding on behalf of money lenders may also prevent companies from obtaining loans to finance this investment.

- Availability of grants/subsidies/rebates for substitute systems.

Payback period

The time it takes to recoup the additional upfront cost to install a GHP from the ongoing reduced cost of heating/cooling will impact on the decision by individuals and businesses to invest in such a system. We have undertaken a simplistic payback period calculation for a number of system sizes and the projected output of the system. This payback period calculation is for replacing an air source heat pump with a GHP of the same capacity. The payback period in a new building may be different. All assumptions underlying the analysis can be found in Appendix C. The results of the analysis can be seen in Table 24 which shows that discounted paybacks are around 12-13 years for larger applications and 16+ years for residential size applications.

Table 24: Payback period base case

Base case kW capacity	NPV 15 yrs	Pay-back period	
		Undiscounted	Discounted (5%)
21	-$825	11 - 12 years	16+
140	$14,500	10 -11 years	12 - 13 years
210	$21,750	10 -11 years	12 - 13 years

Source: Ernst & Young estimates

Government subsidies/programs

Although there are many schemes that incentivise the take up of alternatives to GHP systems such as air-source heat pumps, GHPs are typically not included in these scheme definitions. The only scheme aimed at incentivising GHP uptake focussed on the public sector and was based in Victoria.

Social and environmental benefit

Besides the direct financial benefit of investing in GHP, individuals and businesses may undertake an investment in this technology due to other considerations including social considerations and indirect financial implications. Businesses could foresee indirect commercial benefit, outside the direct financial benefit, resulting from making its business operations more sustainable. Most large organisations today have sustainability policies and spend considerable amount of money to ensure that their operations have the least impact possible on the environment as part of a commitment to corporate social responsibility.

Marketing and public perception

GHPs are currently not a widely understood technology in Australia. This lack of understanding will limit demand. Improving knowledge of the potential benefits entities can receive through purchasing and implementing energy efficiency products can increase the industry's market size.

Marketing can:

- Improve the knowledge of what is offered and the benefit
- Improve the ease of access to information (suppliers)

Stakeholders have commented that media publicity has led to an increase in inquiries about the products.

Industry participants comment that they spend a substantial proportion of their time educating Australians about the benefits of GHPs and tend to take a targeted marketing approach to those companies and individuals that have the most to gain from installing a GHP system.

Products such as an internet energy use calculator can be employed so that individuals and businesses looking to invest in GHP products can get an initial indication of the potential financial benefit received in the form of reduced energy bills based on their particular information. However GHP efficiencies do vary on a case by case basis so would only provide an indicative estimate.

The role of standards and regulations

Regulation and standards are important within any market to ensure that customers are protected and can be assured of the quality of both the product and service that is provided to them.

Because of the lack of understanding of GHP systems currently, it is crucial that the industry maintains high and consistent standards as bad installations could damage the credibility of the entire market. Therefore any expansion of the market should be done in conjunction with some specific industry guidelines or standards.

Currently, there are no regulations or standards governing the installation or production of GHP in Australia. However, international standards exist, and some countries, such as the UK, have introduced their own specific standards. Australian, NZ and ISO standards are currently being developed in conjunction with the Canadian GeoExchange Coalition.

Standards for direct geoexchange systems are just as important as those for water-loop geoexchange - it is important that commercial refrigeration principles are followed in the design of any refrigeration system. The Canadian Geoexchange Coalition is working with the Australian geoexchange industry to implement appropriate standards for both types of GHP.

4.5.7 Supply of GHPs in NSW

Companies that sell GHP systems have typically located in states with government policies conducive to their growth. Whether or not GHP systems are likely to be assembled or manufactured in NSW will be driven by cost competitiveness of manufacture in NSW relative to other states and other countries. Part of this cost element will be related to where system demand is centred. There are currently few incentives for GHP manufacturers or assemblers to be located in NSW. Installation and maintenance will typically be performed by local contractors who have been trained by GHP companies.

4.5.7.1 NSW HVAC supply dynamics

The distribution of HVAC industry establishments generally corresponds with the national distribution of construction activity and population. However, the wide variations in climates across the population generate varying demands for industry services. For example, air conditioning units are more commonly fitted in new houses built in the hotter northern States while ducted central heating is in greater demand for buildings in Victoria, New South Wales, Tasmania and South Australia.

New South Wales accounts for around 34% to 35% of total industry establishments which matches the State's share of national population and economic activity. However, NSW has a disproportionately higher share of industry employer establishments (36.7% in June 2006).[71]

4.5.7.2 Propensity for manufacture in NSW

The majority of GHP systems currently used in Australia originate from the USA, with the exception of Geothermal Dynamics, a local NSW company that designs and manufactures niche GHP applications. The three key market players – Geoexchange, Direct Energy and Earth to Air - all use USA-based systems.

Water-based systems use generic pipes that are widely available on the market and will therefore be sourced locally. Direct exchange systems use specially designed copper pipes. As the industry matures, there is no reason why these cannot be produced locally. The difference is likely to be down to the scale of production of the associated companies.

GHPs are typically imported. Stakeholders report that one Australian GHP company does have a manufacture plant outside of NSW. Stakeholders that currently import report that scale would have to increase significantly to consider assembly plants. Typically non-GHP related heat pumps are often imported or manufactured in Asia by Australian companies. Typically, other fittings are bought locally.

Some of the benefits to manufacturing locally include avoiding risk associated with foreign exchange movements and freight unpredictability, but scale is required to make this economic. Stakeholders report that there have been incentives offered by other states to locate manufacturing or assembly plants in their jurisdiction, which are currently under consideration.

4.5.7.3 Propensity for GHP companies to locate in NSW

Due to the infancy of the market and the untapped market potential across the whole of Australia, companies that sell GHPs have been able to locate in a wide range of locations and grow their own market. However jurisdictions that have put in place incentives for GHP installation or have procured these systems for their own use have driven firms to locate nearby. For example, the Victorian Four Seasons Pilot Program spurred a number of GHP companies to establish in Victoria.

4.5.7.4 Export potential

IBIS reports that in the existing HVAC market, there is some scope for improved export performance which stems from neighbouring construction markets opting for a 'total solutions' approach to climate control and building automation systems. However, exports currently make up less than 1% of annual revenue from air conditioning and heating contractor services (around $30 million per annum), principally from work in neighbouring New Zealand and South-East Asia. Given that in GHP penetrated markets, GHP systems make up around 2% of all HVAC systems, this would imply export potential would be negligible: around $0.6m. Furthermore, NZ is far more advanced in its GHP application than Australia so this market would probably not be a worthwhile pursuit.

Separately, selected stakeholders saw Australia as a good location to prove the concept of GHPs in foreign countries with a similar profile for ground temperature, given Europe and parts of North America tend to have colder climates, which could then be exported to countries such as the Middle East or India. This idea would need to be explored further given the level of advancement in the US already over Australia.

[71] IBIS World

4.5.8 Market size

The potential size of the GHP market is difficult to estimate given the infancy of the existing market in Australia and should be regarded as an indicative estimate only. There is also limited data available regarding the applicability and efficiency savings of GHP systems to Australian buildings. The methodology for calculating the potential market size of the GHP industry incorporates the specific demand markets for the industry, their heating requirement, and a potential level of uptake of GHP by 2020. Overall, our estimate for potential market size in 2020 is in the range of $6m to $140m, corresponding to 29MW to 645MW.

Table 25:GHP market value estimates in 2020

Sector	Market size ($m) - NSW 2020		Market size (MW) - NSW 2020		Economic benefits ($m) NSW 2020		Employment prospect FTE- NSW 2020	
	Low	High	Low	High	Low	High	Low	High
GHPs	6	140	29	645	1	28	33	811

Source: Ernst & Young estimates

The sectors that were included in this analysis are residential housing, public/community buildings (schools, hospitals and council buildings only) and commercial buildings (office blocks and retail outlets only). Because of the lack of data, it was not possible to estimate potential market size for industrial buildings. This is also the reason why the commercial and public buildings sectors have been limited to certain types of buildings.

Further details of assumptions underpinning this calculation can be found in Appendix C.

4.5.9 Economic benefits

The economic benefit calculation provides an estimate of the benefit realised in NSW through additional economic activity associated with the production and installation of GHP units based on the market size calculations above. The total economic benefit includes the direct benefit realised through the construction and operation of GHP, as well as the flow on indirect benefit realised. The indirect benefit includes all the associated businesses that provide the goods and services to support those individuals and businesses that work and operate those businesses that work in this industry.

NSW is estimated to realise between $1 million and $28 million in total economic activity within the years to 2020 with the building and installation of GHPs. The greatest economic benefit as a result of the increased market presence of GHP will be derived from the production and installation phases.

It is forecasted that in 2020, between 28 and 677 jobs will be supported through the one off installation costs which include; setting up data management systems, energy assessment and the production, and installation of the efficiency measure. It is estimated that a further 5 to 134 jobs will be directly supported through operating and maintaining the cumulative installed capacity as at 2020.

4.5.10 Identified issues/barriers

The following are some of the barriers to growth in the industry that have been determined in the process of stakeholder consultation.

4.5.10.1 Lack of knowledge/understanding of GHP systems

There is a general lack of awareness of GHP technology in Australia because the market is very much in its infancy. This is both from the point of view of customers and government itself. This lack of awareness leads to a general reluctance and wariness of the technology which prevents further take up.

There is also a genuine lack of information and understanding regarding the efficiency of the technology and the payback that it can offer. Were customers and government to understand that the net benefit over the lifetime is greater than some other technologies, it may have a much higher rate of take up. Although there are a number of advocates in Australia who are helping to uncover the economics underpinning this technology, more work needs to be done in order to obtain reliable estimates of the benefits that these systems provide. Because the economics in Australia may be significantly different from the economics in the US, this understanding needs to be built from Australian-specific experience.

This lack of real understanding underpinning GHP technology also has a negative impact on access to finance. Were financiers to understand the technology and the project payback, they would be far more willing to finance these up-front costs at competitive rates as the actual risk may be far lower than perceived. The Treasury Loan Fund may be one currently available avenue for up front financing of GHP systems for public buildings, where the capital cost is paid off at the rate of cost saved by the system.

4.5.10.2 High capital costs and long payback periods

High capital costs and long payback periods are likely to deter investment in this technology. Consumers tend to take a short term approach to purchases, giving more weight to their cash-flow in the short term than the savings generated over the long term. This means that regardless of any other barriers, consumers are likely to be less receptive to a high initial capital spend even thought the lifetime benefits more than compensate for this.

4.5.10.3 Technology-biased policies

Currently, State and Federal policies that aim to encourage the uptake of energy efficient products or renewable energy, specify the eligible technologies that qualify for consideration. If GHPs were covered in the various subsidies and grants, some of the high up-front cost of the system could be offset, making them more attractive on a whole-of-life basis. These subsidies could be used to support the industry until it has the economies of scale needed to become self-sustaining.

4.5.10.4 Lack of carbon price

The current lack of a carbon price mean that the electricity price is lower than it should be if the true price of carbon and coal were reflected in costs. This acts to make GHP systems and other systems based on renewable energy relatively less competitive than they would otherwise be.

4.5.10.5 Classification of GHP 'infrastructure'

One viewpoint often expressed in literature regarding GHPs is that the ground loop portion of the GHP should be considered as underpinning infrastructure rather than part of the capital cost – a bit like the poles and wires and underground gas piping that is used to supply our other energy needs. This is often justified on the grounds that the GHP infrastructure will, if properly installed, outlive the building and many heat pumps.

If this argument is accepted, this provides a rationale for government to support the cost of ground loops and associated drilling (approximately 50% of total costs) or at least the consideration of different contracting models, for example loop leasing.

4.5.10.6 Industry standards

High quality installations are required in order to build industry credibility which is in a crucial stage of growth. The current lack of industry standards and accreditation in Australia would result in sub-quality installations that will damage industry credibility.

The industry would be aided by details on the parameters and conditions for performance assessment, and if design engineers produced certificates to confirm that a certain performance can be achieved from a GHP system according to the standard. In NSW, certificates issued by design engineers would be important for building inspectors (who are not experts of GHPs) to ensure that the GHP system complies with the relevant BASIX commitments.

There are also particular environmental concerns that need to be guarded against and drilling must be done by certified companies to mitigate issues such as groundwater pollution. Consumers need a way of identifying reputable market players which would be provided by the appropriate standards.

4.5.10.7 Lack of skilled workers

Currently there are enough skilled installers to meet market demand in NSW, however this is a barrier that could impact negatively on the future growth of the sector should demand start to increase rapidly. Having access to appropriately trained workers with both certification and experience is particularly crucial given the importance of high standards and correct installation in the early stages of the sector's growth. Lack of skilled workers is a key barrier to the growth of the UK industry at present and aggressive training policies are being put in place to overcome this barrier. As well as trained installers, an increased number or borehole drillers, excavation companies and GHP design engineers will be needed.

The Plumbing Industry Climate Action Centre (PICAC) is currently working with CGC, AGEG and the geoexchange industry to develop the appropriate skills to deliver geoexchange to Australia.

4.5.10.8 Administrative requirements of existing rebates

Stakeholders report that although they may be eligible for the NSW ESS, some perceive the documentation required as too onerous, which discourages them from making applications.

Appendix A Federal policy context

Australian carbon emission targets

The Australian Government has committed to reducing Australia's carbon pollution to 25% below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of greenhouse gases in the atmosphere at 450 parts per million CO2 equivalent or lower. If the world is unable to reach agreement on a 450 parts per million target, Australia will still reduce its emissions by between 5% -15% below 2000 levels by 2020.

The Australian Government has also committed to achieve a 60% cut in greenhouse gas emissions by 2050. If the world achieves the ambitious agreement required for the minus 25% target, the Government will seek a new election mandate for an increased target for 2050.

Ratification of the Kyoto Protocol

In December 2007, Australia ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), agreeing to limit Australia's annual carbon pollution to an average of 108% of 1990 levels during the Kyoto period (2008-2012).

Copenhagen Accord

On 27 January 2010, Australia formally submitted its existing 2020 target range for reducing emissions to the Copenhagen Accord. Consistent with the Government's commitment to do no more and no less than the rest of the world, Australia submitted its existing target range. The decision to maintain the Government's target range is consistent with the approach expected to be taken by other countries.

The Government has stated that it will not increase Australia's emissions reduction target above 5% below 2000 levels until:

- The level of global ambition becomes sufficiently clear, including both the specific targets of advanced economies and the verifiable emissions reduction actions of China and India
- The credibility of those commitments and actions is established, for example, by way of a robust global agreement, or commitment to verifiable domestic action on the part of major emitters including the US, India and China; and there is clarity on the assumptions for emissions accounting and access to markets.

Carbon Pollution Reduction Scheme

The proposed Carbon Pollution Reduction Scheme (CPRS) is an emissions trading scheme which uses a cap and trade mechanism to achieve the desired environmental outcome for Australia. Under the CPRS, the Government will set an annual limit (or cap) on the total amount of carbon pollution that can be emitted under the scheme, within Australia. The cap will be gradually lowered over time to reduce the level of carbon pollution produced each year. The CPRS will allow businesses to trade carbon permits, which will ensure that pollution reduction opportunities throughout the economy are harnessed, therefore reducing the economic cost of meeting Australia's carbon pollution reduction targets. To achieve this, the CPRS will introduce a price on carbon pollution which will directly affect around 1,000 businesses in Australia. The obligations for businesses directly affected by the CPRS will include reporting emissions-related information and a liability to surrender emissions units. The majority of businesses within Australia will not have CPRS regulatory obligations, however all businesses will need to take the CPRS into account when making business decisions.

On 27 April 2010, the Prime Minister announced that the Government will delay the implementation of the CPRS until after the end of the current commitment period of the Kyoto Protocol and only when there is greater clarity on the action of other major economies including the US, China and India.

Renewable Energy Target

The Renewable Energy Target (RET) is an initiative of the Australian Government intended to deliver on the Government's commitment to ensure that 20% of Australia's electricity supply comes from renewable sources by 2020. The RET encourages the deployment of both large and small-scale renewable energy technologies such as wind farms, solar, geothermal or hydroelectric power as well as household solar panels and solar water heaters. The RET creates a guaranteed market for additional renewable energy deployment using a mechanism of tradeable Renewable Energy Certificates (RECs). Demand for RECs is created by a legal obligation placed on parties who buy wholesale electricity, namely retailers and large users of electricity. Liable entities are required to source an increasing percentage of their electricity purchases from renewable energy to meet annual targets which are legislated in gigawatt-hours (GWh) of renewable energy. One REC is generally equivalent to one megawatt-hour (MWh) of renewable energy. Liable entities can acquire and surrender RECs to demonstrate compliance. Alternatively, they are required to pay a shortfall charge of $65/MWh with effect from the 2010 compliance year. The supply of RECs is created by renewable energy power stations using eligible sources including wind, large-scale solar, hydro-electric and in the future geothermal power, as well as small generation units including small-scale solar panels, small wind turbines and micro hydro systems, and solar and heat pump water heaters.

In February 2010, the Government announced changes to the existing RET Scheme. From January 2011, the existing scheme will include two parts – the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET).

It is estimated that combined, the new LRET and SRES will deliver more renewable energy than the existing 45,000 gigawatt-hour target in 2020. The degree to which the 20% target is exceeded will depend on the uptake of small-scale technologies by households, small business and community groups. The LRET portion of the target will be increased to ensure the 20% by 2020 target is still met if the uptake of small scale technologies is lower than anticipated.

Small-scale Renewable Energy Scheme (SRES)

The new SRES has been designed to deliver households, small business and community groups $40 for each Renewable Energy Certificate (REC) created by small-scale technologies like solar panels and solar water heaters.

Under the existing Solar Credits initiative, the new fixed price of $40 per REC will see a Sydney household that installs a 1.5 kilowatt solar panel system in 2011 benefit from an upfront subsidy of $6,200 through RECs. If the same household also installs a typical solar water heater, they will receive RECs worth $1,200.

The number of systems receiving support under the SRES will be uncapped to ensure small-scale installers have certainty. The Government will review the operation of the SRES in the context of the planned 2014 statutory review of the RET to ensure the fixed price for RECs remains relevant.

Entities such as electricity retailers currently liable under the RET will be obligated to purchase RECs from both the LRET and the SRES. The details of the new mechanism for obliging liable parties to purchase RECs created through the SRES will be finalised in consultation with stakeholders.

Large-scale Renewable Energy Target (LRET)

Recent changes to the RET scheme will assist the market for critical large-scale projects like wind farms, solar and geothermal to develop and grow free from any uncertainty that may have been caused by strong demand for small-scale renewable technologies.

The LRET's 41,000 GWh target for 2020 has been set to achieve a level of large-scale renewable electricity generation above what was expected under the existing RET. The new LRET annual targets (to commence in 2011) for large-scale renewable electricity generation are listed in the table below.

Table 26: RET 2011-2030

Year	Revised targets (GWh)
2011	10,400
2012	12,300
2013	14,200
2014	16,100
2015	18,000
2016	22,600
2017	27,200
2018	31,800
2019	36,400
2020 - 2030	41,000

Source: NSW DECCW

Government investment in Cleantech research and industry

A number of government programs to encourage innovation in clean energy and to attract expertise from overseas are available. These include:

- The $652.5 million Renewable Energy Fund to accelerate the development, commercialisation and deployment of renewable energy technologies in Australia, with funding earmarked for R&D into Gen2 biofuels and geothermal drilling as part of the 2010-11 budget.
- Funding of $100 million for the Australian Solar Institute to undertake solar photovoltaic and solar thermal research.
- The Clean Coal Fund worth $500 million to support R&D, commercialisation and deployment of technologies to cut emissions from coal power generation in Australia and abroad.
- The Solar Flagships Program worth $1.5 billion to support the construction of up to four large scale, grid-connected solar power stations in Australia using solar thermal and photovoltaic technologies.
- The Carbon Capture and Storage Flagships program worth $2 billion to support construction and demonstration of large-scale integrated carbon capture and storage projects in Australia including gasification, post-combustion capture, oxy-firing, transport and storage technologies.

Appendix B Stakeholder consultations

The following stakeholders were consulted with during the course of this project. It should be noted that not every stakeholder was consulted on each aspect of the project. Therefore, views throughout this report should not be taken as representative of every stakeholder consulted.

AGL	Granite Power
Alcanet	Green Building Council
AMP Limited	Housing Industry Association
CSR Building Products	IBM
Chargepoint	Ingenero
CISCO	Integral Energy
Citrix Systems	IPS - Ferrostaal
Dexus Property Group	Landis GYR
Direct Energy	Lend Lease Solar
Downer Edi	Lend Lease Ventures
Dyesol	Manildra Milling
Earth to Air	Mirvac Property Group
Eckermann & Associates	NBN Co
Energy Australia	Pidcock Architecture + Sustainability
Energy Response	Property Council of Australia
Epuron	Schneider Electric
Ethtec	Silex Solar
General Electric	SITA
Geoexchange	St Hilliers
Geothermal Dynamics	Sucrogen
Goodman Group	SunTech
GPT	Sustainable Windows Alliance

Appendix C Case study market size assumptions

Smart grid software market size assumptions

Ernst & Young estimate the potential market value of smart grid software to be between $69 million - $127 million in 2020. This estimate is based on a global forecast of the smart grid IT hardware and software market by ZPryme Research and Consulting, who forecast a global value of $39 billion in 2014, of which software represents $19.5 billion. This has been extrapolated using the average annual growth rate of 21% (based on industry trends between 2009 and forecast 2014) to derive a world market 2020 figure of $61.9 billion. The growth in the world market size is shown in the table below.

Table 27: Market size forecasts

Year	2014	2015	2016	2017	2018	2019	2020
Market size ($'b)	19.5	23.6	28.7	34.7	42.1	51.0	61.9

The Australian proportion of the international market was forecasted based on the OECD share of ICT value add by country statistics. The NSW proportion of Australia's smart grid software market was estimated based on the relative state wide employment levels within the Information technology industry.

It was assumed in the base case that Australia produces 3% of software that is developed globally and that the component of software development related to smart grid functionality is 9.6%. In the high case it is assumed that Australia's market share of the international software market will increase by 50% and the country will produce 4.5% of all software. It is assumed that NSW makes up 38.5% of the Australian software industry. In the high case it is assumed that NSW proportion of the Australian market will increase to 48%.

The outcomes of this analysis and assumptions used to derive these values are shown in the table below for 2020.

Table 28: Grid software market outcomes 2020

Scenario	World Market Size ($b)	Australian Proportion of World Market	NSW Proportion of Australian Market	Smart Grid Component of Software Market	Forecast Market Size ($m)
Low	61.9	3%	38.5%	9.6%	69
High	61.9	4.5%	48%	9.6%	127

A large proportion of the total smart grid software market was estimated to be realised within the economic cost of the software component – primarily due to the large R&D component and intellectual value associated to the technology.

Commercial retrofit market size assumptions

This bottom up estimate of the potential market size is based on the data set available which only includes selected commercial buildings in NSW. Under this assumption a premium grade building is unable to improve its energy efficiency rating (i.e. is assumed to have a NABERS star rating of 5).

Table 29: Commercial retrofit market size potential

SYDNEY CBD		Capitalised market value per metre square ($)	% (of market value) cost to improve 1 NABERS star rating	Market size ($m)	
NABERS Star rating	Office space in Sydney square metres (Source: PCA)			Low	High
5	31,461	10,000	0%	0	0
4	1,544,390	8,000	5%	154	618
3	1,587,565	6,000	10%	238	953
2	744,684	4,000	14%	104	417
1	440,855	2,000	20%	44	176
TOTAL value of installs over next ten years (Sydney CBD)				$541	$2,164
TOTAL value of installs over next ten years (NSW)				$1,082	$4,327
Average value of installs per year				$108	$433

Source: Ernst & Young estimates

The potential market size and the costs and associated economic benefit realised from the industry have been calculated under two scenarios:

- Low case – only 25% of buildings improve their property grade and energy efficiency
- High case – all buildings that are rated less than premium improve their property grade and energy efficiency by one star

The Sydney CBD information has been extrapolated by a factor of two to represent the total office space in NSW. Therefore we presume that the office space in Sydney represents 50% of the total office space in NSW. As this market size is based on the retrofitting of existing buildings to improve their energy efficiency, in the high case it is assumed that all new buildings/office space built from now to 2020 should be of a standard that does not require any improvements over the coming 10 years. The base case assumes that only 25% of the existing building stock is retrofitted with energy efficient products. The electricity use per square metre for different NABERS Star rating has been sourced from the Property Council of Australia (PCA). The cost to install energy efficient products has been estimated as a percentage of the average capital value for the different types of building grade (sourced from Colliers International Research 2010). These projections are based on average values and do not consider that individual building may be able to improve their ratings at lower costs.

Mid scale solar PV market size assumptions

The current market size of the industry has been calculated from information provided by stakeholder consultation, which have indicated that there are few (no more than 10) installations of medium scale solar PV in NSW currently.

The future market size of the commercial mid scale solar industry has been estimated using both a 'top-down' and 'bottom up' approach. The methodologies used to undertake this analysis are briefly described below.

Top-down approach

The top down approached was based on the analysis undertaken within the Australian Business Council for Sustainable Energy – *Photovoltaic Industry Roadmap 2004*. Within this report a market size for the whole of the solar PV industry was modelled under two scenarios; base case where the market did not receive any significant government assistance and a project sunrise case where the industry received assistance as seen within other countries (e.g.: Germany and Japan) and the potential exponential increase in the number of installations.

This report finds that the potential market size of the Commercial solar PV market in Australia is between 3.8 to 11.5GW with a potential average installation of 200MW per annum. The report also targets a 50% market penetration within the next 25 years. We have assumed that half of this market penetration will be realised within the coming decade. We have also assumed that only 25% of all commercial solar PV installations will be mid scale range (between 100kw and 1MW) with the remaining 75% installing small scale solar PV (up to 100kw systems). In addition, the NSW share of the commercial market, based on NSW commercial building share, has been assumed to range between 20% and 35%.

Table 30:Top down capacity assumptions

Scenario	Industry roadmap Australian potential market Size (MW)	NSW potential commercial capacity estimates	Potential capacity (MW)	Potential for mid scale solar	Market penetration by 2020	Capacity over 10 year period (MW)
Low	3,800	20%	760	25%	25%	48
High	11,500	35%	4,025	25%	25%	252

Bottom-up approach

The bottom up approach for calculating the market size was based on the number of commercial buildings in NSW, their electricity use, and their ability and willingness to install mid scale solar PV. Our analysis has found the greatest potential application of solar PV within the commercial sector is in shopping centres and large scale office blocks. With regard to public buildings the number of schools, hospitals and local government offices were included.

The Property Council of Australia provided an estimate of the number of shopping centres and office blocks in the greater Sydney CBD area. This estimate was extrapolated to take into account the whole of NSW.

The number of buildings that have the potential to take-up solar PV is only a subset of the total number of these buildings to take into account the lack of usable ceiling space and/or available sunlight. An average Solar PV system was applied to the number of buildings that were estimated to have the potential to install a system, which was provided through stakeholder consultation.

The number of public and commercial buildings and the potential capacity and output of Solar PV, as calculated using the bottom up methodology can be seen in the table below.

Table 31: Potential capacity for mid scale solar

Building type	Subset of appropriate buildings	Number of buildings in 2020		Total capacity in 2020 (mw)		Total energy output in 2020 (GWh)	
		low	high	low	high	low	high
Shopping centres	730	46	91	22.8	91.2	26.1	104.5
Office blocks	2,272	142	284	14.2	56.8	16.3	65.1
Schools	3,178	199	397	19.9	79.5	22.8	91.1
Hospitals	114	7	14	3.6	14.3	4.1	16.3
Council buildings	152	10	19	1.0	3.8	1.1	4.4

Comparison of 'top-down' and 'bottom-up calculations

A comparison of the 'top-down' and 'bottom-up' calculations of the market size of the commercial solar PV market can be seen in the table below.

Table 32:Comparison of top down and bottom up calculations for solar PV

Approach	Scenario	2020 capacity MW
Top down		
	Base	48
	High	252
Bottom up		
	Base	61
	High	246

As highlighted in the table above, both methodologies have provided a range of potential market size that is consistent. The high and low estimates within these methodologies (both being from the top down approach) are used within the calculation of the supply chain and economic and employment outcomes associated with this industry.

The capital cost forecast has been estimated based on the average annual increase in the provision of energy efficient products and services capacity over the next ten years. The average total installation cost of commercial solar PV is estimated to be $7,500 per kw of installed capacity over the coming decade representing a decrease in upfront costs by approximately 25%, which is a conservative industry target (IEA). In addition to the capital values included in the analysis, an operational market value of 1.5% was applied to the capacity market value on an annual basis. Again through consultation process, it was determined that in 2020, 41.1% of the market value could be realised in NSW.

The assumptions and derivations used in this analysis are shown in the table below.

Table 33: Solar market outcomes 2020

Scenario	Capacity (MW)	Market value per MW ($'m)	Market value over 10 years ($'m)	Market value p.a. ($m)	Additional operational market value proportion	Additional operational market value ($'m)	NSW market realisation	Market size estimate ($'m)
Low	48	7.5	356	36	1.5%	5	41.1%	17
High	252	7.5	1,881	188	1.5%	28	41.1%	89

The NSW market value realisation is derived from the supply chain assumptions presented below.

Table 34: NSW market value supply chain assumptions

	Components and manufacturing	System design	Installation	Operational costs
Total market value ($'m)	151	9	28	28
Realisation of market value (%)	20%	100%	100%	75%

The current and potential market size of the commercial solar PV market in NSW is presented in the table below.

Table 35: Estimated market size

Year	Scenario	Market size ($'m)
2010	Base	-
	High	0.02
2020	Base	17
	High	89

Wind generation market size assumptions

Ernst & Young estimate that NSW could gain up to an additional 3,500MW wind capacity between now and 2020, with an upper and lower bound of 6,000MW and 2,000MW respectively. This assumes that the market size will be limited to generation induced by the RET. Approximately 10,000MW of additional renewable capacity is required between now and 2020 and the majority of that is likely to be from wind generation.

Lower bound estimate

Analysis conducted by ROAM Consulting for the Clean Energy Council[72] to determine the market size of the renewable energy market in 2020 has been used to determine the lower bound estimate for the potential market size of NSW wind market. Crucially, the analysis does not appear to make any assumptions about whether or not the RET is met, rather the focus on the share of renewable energy growth given overall growing system demand requirements and REC price projections, based on its relative cost competitiveness.

The Clean Energy Council projects total electricity generation capacity will increase by between 13,200MW and 14,700MW by 2020, of which 8,200MW is made up of renewable energy. This is mostly wind capacity (7,000MW, which would be added to 1,557MW of existing capacity) with some biomass (700MW) and geothermal (500MW).

NSW is estimated to absorb 2,000MW of this additional capacity, with Victoria, South Australia and Tasmania forecasted to increase their wind energy generation capacity by approximately 2,000MW, 2,000MW and 1,000MW respectively The ROAM model calculates the distribution of wind farms upon a tiered approach; wind farms are grouped into blocks with the highest capacity factor wind farms in the first tier (installed first), and lower capacity factor wind farms in each state installed sequentially in later blocks. The model selects the lowest cost order in which to install each block, based upon the operation of individual wind farms in each block.

[72] ROAM modelling: The true costs benefits of the enhanced RET

This estimate appears conservative given the existing project pipeline and it is not clear how they have factored in grid constraints in South Australia. Therefore, it is highly likely that ROAMs forecast will be met, especially given that the analysis has been performed on a relative cost-competitiveness basis.

High estimate

A high estimate of around 3,500MW is based on a number of rationale:

- There are around 3,700MW worth of projects in the pipeline at various stages of development. The economic rationale for these projects will have already undergone some scrutiny and so have a preliminary business case. If existing market failures are removed, there must be potential to get these projects up and running.
- NSW Wind farm developers have indicated that this figure would be a reasonable expectation from NSW if off-take contracts could be secured and other barriers relating to the planning process could be removed.
- Assuming that an additional 10,000MW capacity is required between now and 2020, and 1,200MW is taken up by other forms of renewables (as per Roam's estimates) that leaves 8,800MW to be distributed among the states in Australia. Assuming that SA, WA and TAS take up 2,000MW of this, based on their limited remaining capacity, that leaves 6,800 for NSW and VIC. Given their similar natures, an even split would give NSW around 3,400MW.
- A separate Ernst & Young modelling exercise projected NSW potential at around 3,000MW.

Maximum estimate

Wind developers have indicated that they believe NSW could reach market size of 6,000MW by 2020 were sufficient incentives to be in place in NSW. This is a valid scenario but is not considered further in this analysis because it is likely to require some degree of subsidisation to make these wind farm investments preferable to those in other states if the RET remains the only incentive to generation or would require an extension of the RET and/or a carbon price above levels considered in this analysis to induce.

Each megawatt of capacity has a market value of $2 million in the low scenario and $2.5 million in the high scenario over a 10 year period based on industry consultation on the value of output. In addition, an operational market value of 1% was applied to the capacity market value on an annual basis. Again through consultation process, it was determined that in 2020, 51.4% of the market value could be realised in NSW.

The assumptions and derivations used in this analysis are shown in the table below.

Table 36: Wind market outcomes 2020

Scenario	Capacity	Market value per MW ($'m)	Market value over 10 years ($'m)	Market value p.a. ($m)	Additional operational market value proportion	Additional operational market value ($'m)	NSW market realisation	Market size estimate ($'m)
Low	2,000	2	4,000	400	1%	40	51.4%	226
High	3,500	2.5	8,750	875	1%	88	51.4%	494

The NSW market value realisation is derived from the supply chain assumptions presented below.

Table 37: Market value supply chain assumptions

	Wind turbine	Installation	Civil works	Electrical infrastructure	Grid connection	Other functions	Development costs	Operational cost
Total market value ($'m)	575	17	92	75	58	17	42	88
Realisation of market value (%)	25%	100%	100%	50%	100%	100%	100%	100%

GHP for use with HVAC market size assumptions

The current and potential market size of the GHP industry has been derived from a micro "bottom up" analysis approach. The lack of publically available information regarding the industry has prevented a top down analysis from being undertaken. The current market size of the industry has been calculated from information provided by stakeholder consultation. The three main industry players have confidentially provided an indication of the estimated number of GHP units they are currently installing (rounded terms). We have estimated that these companies make up 80% of the market and thus factored up the estimate of total market supply in 2010.

Given the infancy of the current market, the potential future market cannot be accurately calculated taking into account potential market growth, because of the sensitivity of the market to structural change. In other words because of the currently low installation levels of the industry, a series of large contracts could potentially double or triple the market size within a year.

The methodology for calculating the potential market size of the GHP industry has therefore been undertaken by looking at the specific demand markets for the industry, heating requirement and a potential level of uptake of GHP by 2020.

The overall size of the GHP market was based on the market growth within the following industries:

- Residential housing
- Public/community building industry (schools, hospitals)
- Commercial buildings

It was assumed that there are three types of installations of GHPs:

1. Installation in new buildings
2. Installation in existing buildings when AHP are required to be replaced
3. Installation in existing buildings when an individual/business is moving from general electrical systems to a form of HVAC

The methodology for calculating the potential size of these sectors of the market for each industry followed the same broad approach, which included:

1. Determining the number of buildings within the sector, current and future
2. Determining the proportion of these buildings that currently use HVAC and forecast the future uptake of HVAC in the coming ten years
3. Eliminating those buildings that cannot install GHP due to recourse limitations, including discretionary income and available land
4. Estimating the feasible market take-up during the next 10 years due to such factors as limited market knowledge, people's unwillingness to pay installation cost

Based on the methodology set out above, the number of buildings, the average size of a system (provided by stakeholders) the potential capacity by 2020 has been forecast and is presented below.

The assumptions underpinning the derivation of the market size of the GHP market in NSW is presented below.

Table 38: Installation estimates by building type

Building type	Sub category	Scenario	Total properties	Potential market for HVAC	Properties with available land for HVAC	GHP Application Assumption	Number of installations over 10 years	Average installation per year	Average size of installation (KW)	Capacity as at 2020 (MW)
Residential		Base	2,162,555	40%	38%	1%	3,329	333	14	46.6
		High	2,436,387	60%	59%	5%	42,843	4284	21	899.7
Community	Schools	Base	3,178	30%	44%	10%	42	4	140	5.9
		High	3,178	75%	82%	50%	983	98	210	206.5
	Hospitals	Base	114	40%	40%	10%	2	0	310	0.7
		High	114	75%	80%	50%	34	3	620	21.1
	Council buildings	Base	152	40%	40%	10%	2	0	140	0.3
		High	152	75%	63%	50%	36	4	210	7.6
Commercial	Shopping centres	Base	730	40%	34%	10%	10	1	140	1.3
		High	730	90%	85%	50%	280	28	210	58.9
	Office blocks	Base	2,272	35%	35%	10%	25	2	140	3.5
		High	2,272	65%	63%	50%	462	46	210	97.0

This analysis has found that the greatest application, both in terms of the number of buildings and the total aggregate capacity of GHPs are in the residential sector. However, the community and commercial sectors have the higher potential take up of GHP technologies, comparatively. The assumptions regarding the potential take up of GHP have been sourced from industry discussion and some high level analysis of the property market.

Currently little production in the GHP sector is being undertaken in Australia. Stakeholders have informed us of the possibility of creating production assemblies in the case of increased sustainable sales and installation within the Australian market, however, this will not necessarily take place in NSW.

The capital cost forecast has been estimated based on the average increase in the provision of GHP capacity over the next ten years on a per annum basis. The operating cost estimate is based on the forecast of the total cumulative generation capacity as at 2020 and the percentage of cost, on a per annum basis to maintain the asset. Stakeholder consultations have estimated that approximately 1% of the installation cost is realised on a per annum basis to maintain and operate these products/systems.

Table 39: Capital cost forecast

Property Type		Number of installs by 2020	Cost per Unit	Capital and Installation ($m)	Operational ($'m)	Total 2020 ($'m)
Residential	Base	3,329	15,000	5	0	5
	High	42,843	20,000	86	9	94
Community	Base	46	22,990	1	0	1
	High	1,054	45,692	48	5	53
Commercial	Base	34	22,500	1	0	1
	High	742	45,000	33	3	37
Total Market GHP	Base			7	1	8
	High			167	17	184

We have assumed that in the base case in 2020 that the market in Australia would reach a size that it is likely to be sourcing and producing a proportion of its own GHP, although only a small proportion of this economic activity would be realised in NSW. We have estimated that 76% of the market value produced in Australia would be realised in NSW and 59% of the market value would be installation value.

The breakdown of market value realised in NSW is presented in the table below.

Table 40: NSW market value realisation

	Total market value ($'m)	Realisation of market value
Materials	25	25%
Production	33	25%
Installation	109	100%
Operation/Maintenance	17	100%

Based on the assumptions made above, an estimate of the market value of the GHP market in NSW was constructed. The current and potential market size ($ million) is shown in the table below.

Table 41: GHP market value estimates

Year	Scenario	Total
2010	Base	1
	High	4
2020	Base	6
	High	140

Based on the number of installations, the potential energy savings in terms of GWh and millions of dollars has been estimated through the use of GHP, above the more traditional AHP.

Table 42: Energy savings estimation

Scenario	Number of buildings	Energy saved by use of GHP in the year 2020 (GWh)	Value of energy foregone in 2020 ($M)
Residential			
Base	3,329	1.7	$0.03
High	42,843	45.0	$1.80
Community			
Base	46	0.0	$0.00
high	1054	1.1	$0.04
Commercial			
Base	34	0.0	$0.00
High	742	0.8	$0.03

Note: value of energy saving in 2020 using 2010 energy values. To calculate the energy saved by using the GHP, an energy use coefficient of 5 was applied to GHP compared to an energy coefficient of 2 for AHP, and that use of system is 15% and 30% in the base and high case scenarios respectively. The value of energy is $20 and $40 per MWh in the base and high case scenarios respectively.

Payback period analysis - GHP energy efficiency assumptions (relating to section 4.5.6.2)

The payback period assumptions undertaken on the GHP using an NPV cash flow analysis are shown in the table below.

Table 43: Payback period assumptions

Parameter	Assumption
System size	21kw
Economies of scale factor	20%
Geothermal heat pump	
Upfront cost	-714 per kw
Production per day	1.37 kWh per day for 1kW capacity
For system size	28.77
Use of energy for output (coeff)	5
Days in year	365
Proportion used	100%
Standard heat pump	
Production per day	1.37 kWh per day for 1kW capacity
For system size	28.77
Use of energy for output (coeff)	2
Days in year	365
Proportion used	100%
Difference in running cost	0.3 $ per kW used
Increase in electricity prices	5% p.a.

The cash flow analysis was conducted over a 15 year evaluation period.

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