# THE AUSTRALIAN RENEWABLE ENERGY CLUSTER

---

## Microeconomics of Competitiveness

**Professor Michael E. Porter**
**Harvard Business School**

**2 May 2008**

**Ju-Hon Kwek**
**Clare O'Neil**
**Alex Satchcroft**
**Thomas Vogt**

## Executive Summary

Rich natural endowments, strong legal and political institutions and a highly educated population have provided the foundation for Australia's tremendous economic and social prosperity. However, challenges lie in the path of that prosperity continuing. Australia's future performance is constrained by a dependence on natural resources for exports, a weak manufacturing sector, a shortage of risk capital and declining investment in higher education.

The renewable energy cluster illustrates how Australia's natural potential interplays with the challenges the nation will face. Australia exhibits the world's best natural conditions for renewable energy production and has nurtured some of the strongest intellectual capital in the field. However, the cluster has failed to turn good ideas into successful businesses.

The opportunity remains to create the right policy and business context to support competitiveness and growth for the national economy and for the renewable energy cluster. Recommended reforms include:

*At a national level*

- Diversification of export clusters based on Australia's unique advantages;
- Improvements to physical infrastructure and review of competition policy;
- Enhanced linkages between innovation and commercialization, with clear paths from invention to funding to commercialization;
- Closer economic and trade linkages with Asia.

*At a cluster level*

- The establishment of a technology-neutral policy playing field to facilitate even competition between renewable energy and fossil fuels;
- Increased private and public sector financial support for the commercialization and deployment of Australian renewable energy;
- Streamlining the process for integration into the electricity grid, to facilitate equal access for renewable energy sources;
- Enhancing the ability of the Australian manufacturing sector to support the renewable energy cluster.

## 1. Australian Country Analysis

Australia is a prosperous country located between the Indian and South Pacific Oceans. Blessed with substantial national endowments, strong institutions and a highly educated population, Australia has exhibited strong economic performance and retains further potential. However, business and policy challenges remain impediments to Australia fulfilling that potential. This section considers Australia's history and economic performance. Barriers to Australia's continued growth are then explored through the national diamond.

### Australia's Economic Performance

Australia has a per capita GDP of US$35,453, compared with the OECD average of US$31,469 (OECD, 2008).[1] This prosperity is the result of a series of reformist governments which, over the last 25 years, instituted a program of macroeconomic and microeconomic reforms which transformed Australia from a protectionist, inwardly-focused country to one which embraces international integration and competition.

Australian economic policy in the post-WWII period reflected similar trends to those seen in the US and across Western Europe. During the 1950s and 1960s, successive Australian governments pursued an economic strategy characterized by high tariff and quota protection of Australian manufacturing and agriculture. Initially, this led to a period of sustained economic expansion during which the standard of living enjoyed by Australians increased dramatically. Between 1939 and 1974, GDP per capita doubled (Dyster and Meredith, 1999, p6-9). Exploitation of natural resources, supported by high commodity prices, allowed the Australian manufacturing sector to prosper behind high tariff barriers. However, during the 1970s global economic instability, inefficiencies in the manufacturing and agricultural sectors and a decline in global commodity prices led to a substantial trade deficit and persistent problems with inflation and unemployment (Charlton, 2007, p130). Growth stagnated, and during several years, the economy contracted in real terms.

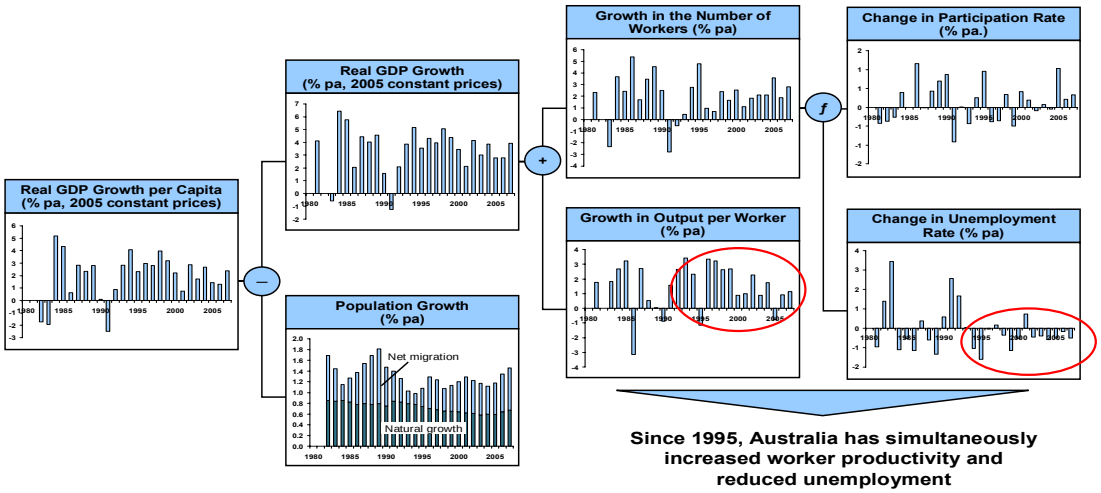
In 1983, the Hawke/Keating Government was elected and set about modernizing Australia's economy. Reforms included sweeping cuts to tariffs, the floating of the Australian dollar and microeconomic reforms including deregulation of the banking industry, privatisation and corporatisation of state owned enterprises and labour market reforms such as enterprise bargaining (Charlton, 2007, p125). The pace of reform led to a painful adjustment period during the recession of the early 1990s. Since then, economic performance has been consistent and, at times, outstanding. Australia's GDP growth has averaged 3.3% CAGR over

[1] 2006, based on current US dollars at PPP. References to dollars ($) refer to AUD unless indicated.

the last 15 years and Australia currently enjoys low unemployment at 4.9% and manageable – but rising – inflation at 2.5% (Australian Bureau of Statistics, 2008). The Howard government, which governed from 1996 to 2007, continued the program of economic reforms through such measures as granting formal independence to the Reserve Bank, introducing a Goods and Services Tax and deregulation of the labour market (Charlton, 2007, p125). A new government was elected in November 2007, with Prime Minister Kevin Rudd promising to continue the policy of fiscal responsibility that has been the consensus of the major governing parties in Australia since the 1980s.

The drivers of growth throughout the reform period are represented below in **Exhibit 1**, and illustrate that growth in real GDP per capita has been generated by a simultaneous increase in worker productivity and reduction in unemployment.

**Exhibit 1: Drivers of Australian Growth**




Source: EIU; Australian Bureau of Statistics

As the policy environment has changed over time, so too has the composition of the economy, as **Table 1** indicates. The contribution of manufacturing and agriculture to GDP has diminished as tariff support to those sectors has declined and since the 1970s the relative importance of services has increased.

**Table 1: The Australian Economy**, 1974-2004[2]
(Percentage shares of value-added, constant prices)

| | 1974 | 1984 | 1994 | 2002 |
|---|---|---|---|---|
| **Agriculture** | **4.4** | **4.3** | **3.0** | **2.7** |
| **Manufacturing** | **18.1** | **15.2** | **13.3** | **11.8** |
| **Other industry, inc. mining** | **14.2** | **14.0** | **14.6** | **14.4** |
| **Services** | **63.4** | **66.4** | **69.1** | **71.1** |

[2] The Economic History of Australia, at http://eh.net/encyclopedia/article/attard.australia

**Political, Legal and Social Context**

Australia is a constitutional monarchy, governed by an elected, bicameral Parliament. Voting is compulsory for all those aged over 18. Australia is a peaceful country, with negligible internal security threats. Australia ranks third on the UNDP Human Development Index, behind Iceland and Norway.[3] School is compulsory to the age of 16, and the literacy rate is 99%. Australia has a Gini distribution of 0.305, compared with the US distribution of 0.47.[4]

## 2. The Australian Business Environment

The strong performance of the Australian economy is underpinned by a solid national business environment and national diamond. Australia has excellent factor endowments, sophisticated demand conditions and relatively strong competition and firm rivalry. Since 2004, however, Australia has slipped from a ranking of 10 to 18 in the Global Competitiveness Report's Business Competitiveness Index (BCI).[5] This suggests underlying economic challenges Australia must address to continue its prosperity.

### *2.1 The National Business Environment*

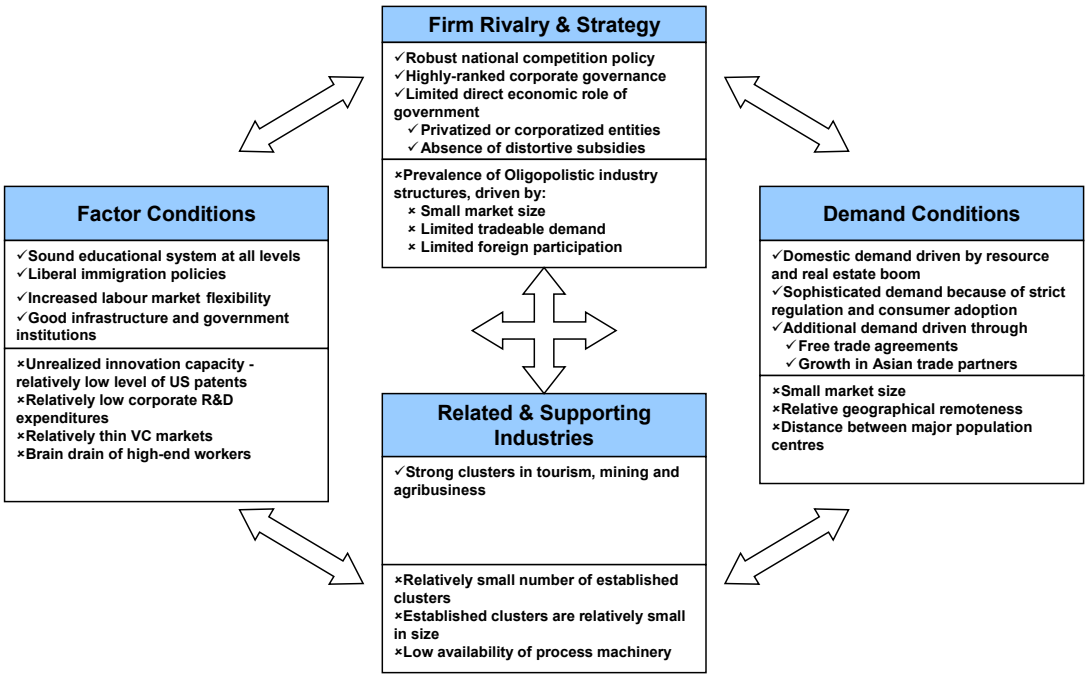
Australia's performance across National Business Environment metrics provides insight into underlying economic strengths and weaknesses. Institutional supports are strong. Australia has an independent judiciary and an excellent legal framework which facilitate good corporate governance and competition and firm rivalry. Weaknesses emerge in measures of related and supporting industries. Local supplier quality and quantity, as well as the local availability of process machinery are areas of comparative weakness. This illustrates Australia's lack of diversified and well-established clusters. While primary and secondary education is a strength, at a tertiary level education is a source of weakness. The inter-related metrics of science and math education, the quality of business/tertiary integration and the availability of engineers and scientists, highlights a critical policy challenge in the area of research, development and innovation. (Global Competitiveness Ranking Data, 2007)

### *2.2 National Diamond analysis*

Analysis of the National Diamond reveals substantial strengths and weaknesses across each indicator. A summary of the national diamond is shown in **Exhibit 2**, with analysis below.

[3] Human Development Report, United Nations Development Program, http://hdr.undp.org/en/statistics/
[4] Human Development Report, United Nations Development Program, http://hdr.undp.org/en/statistics/. A lower Gini co-efficient reflects lower inequality.
[5] Global Business Competitiveness Report 2007-2008, http://www.gcr.weforum.org/

**Exhibit 2: National Business Diamond**




*2.3 Factor Conditions*

Australia benefits from strong factor conditions, reflected by natural endowments, strong institutions and high quality, free and compulsory primary and secondary education. However, Australia is one of the only OCED countries where expenditure on tertiary education has declined in real terms over the last five years (OECD, 2006, p3). Corporate R&D expenditure is low at 1.04% of GDP compared with an average of 1.53% in OECD countries.[6] Venture capital markets are relatively thin.

Natural endowments

Australia is one of the most resource-rich countries on earth, with significant reserves of iron ore, uranium, base metals (copper, lead, zinc), coal, gold, bauxite and a range of other ores. The World Bank estimates that Australia has approximately US$11,500 per capita of subsoil assets, amongst the highest in the world (World Bank, 2006). The country has a total land mass of 7.6 million square kilometres (3.0 million square miles), making it the seventh largest country in the world (CIA World Factbook, 2008). However, it is geographically isolated from many countries, including key trade partners such as Japan and China. Although Australia's warm climate would be suitable for many forms of agriculture, only six percent of the total land mass is arable, primarily due to the relative scarcity of water. Water-

[6] Booz Allen Hamilton, Global Innovation Report, www.boozallen.com.au/media/image/Global_Innovation_1000_17Oct07.pdf

related environmental issues have become increasingly prominent as Australia has suffered the effects of recurring long-term droughts.

Labour

Australia has a strong education system. Education is free and compulsory at primary and secondary school levels, leading to adult literacy levels of 99%.[7] Australia has over 50 universities, mostly public, several of which belong to international bodies such as Universitas 21 (a global network of leading research-intensive universities). However, many universities have suffered from cuts in Federal government funding over the past 10 years.

The microeconomic reforms of the past 30 years have led to considerable labour market flexibility and reduced industrial unrest. A major concern, however, is the "brain drain" that is witnessed amongst skilled workers. Combined with relatively thin VC markets, low levels of innovation output and low corporate R&D spending, this may explain why Australia struggles to develop and commercialize innovations at home.

Capital and infrastructure

Australia's physical infrastructure is in good condition. However, the recent boom in minerals exports has exposed significant bottlenecks in key parts of the distribution chain (Batchelor, 2007).

The Australian Stock Exchange (ASX) is the 15th largest public exchange in the world, with a market capitalization of over US$1,200 billion in February 2008 (World Federation of Exchanges, 2008).[8] This places Australia on similar footing to the United States in terms of market capitalization per capita.[9] Sophisticated fixed income and derivatives markets also exist.

One clear deficiency, however, is the lack of risk capital in the Australian economy. Private equity remains a relatively less important source of capital than in the US, and venture capital is extremely limited. The Australian Private Equity & Venture Capital Association Limited lists 33 members that classify themselves as early stage investors (AVCAL, 2008), only a handful of which have over $10m to invest. This limits the ability of Australian start-ups to successfully expand within Australia, and likely contributes to such firms moving to more attractive investment locations.

[7] Human Development Index, UNDP, http://hdrstats.undp.org/indicators/3.html
[8] The ASX is approximately half the size of the Hong Kong Exchanges and the Shanghai Exchange, approximately equal in size to the Bombay Stock Exchange and the National Stock Exchange of India, and significantly larger than the Korean, Taiwanese and Singaporean exchanges.
[9] Market capitalization is approximately US$50,000 per capita in Australia, compared to approximately US$60,000 per capita in the United States.

*2.4 Firm Rivalry and Strategy*

Australia has strong formal rules establishing competition between firms. The microeconomic reform and privatisation policies carried out by the Keating government in the 1990s contributed to increased competition in key areas such as banking, telecommunications and electricity generation and distribution. Between 1990 and 1997, the value of Australia privatizations exceeded any other OECD country except the United Kingdom (Reserve Bank of Australia, 1997). Australian competition policy is supported by a powerful institutional and legislative framework, including the Australian Competition and Consumer Commission, the National Competition Council and the Australian Competition Council.

Australian companies are well governed, with Australia ranking fourth worldwide in the efficacy of corporate boards (Global Competitiveness Report, 2007). However, a key concern in this area relates to the relatively concentrated nature of local markets. An oligopolistic market structure exists in several industries, including grocery retailing, air transportation and retail banking. Recent company consolidations have contributed to a worsening of Australia's ranking with respect to the intensity of local competition.

Many Australian firms also suffer from a lack of export orientation. This is partly driven by the services-based nature of the economy, as well as Australia's relative remoteness with respect to our trade partners. As a result, exports account for just 21% of GDP compared to an OECD average of approximately 28% (EIU, 2008).

*2.5 Demand Conditions*

While the overall size of the domestic market is small and Australia is relatively isolated, Australians are sophisticated consumers with a high affinity for the early adoption of technology. Two clear examples of this are cellular phone subscriptions and internet usage, where Australia ranks significantly ahead of several other developed nations like the United States, Japan and France (United Nations, 2007). In fact, Australia had the fifth highest number of internet users per capita in 2005. This performance is supported by the existence of strict regulatory standards and stringent environmental regulations (ranked $10^{th}$ and $15^{th}$ respectively in the 2007 Global Competitiveness Report).

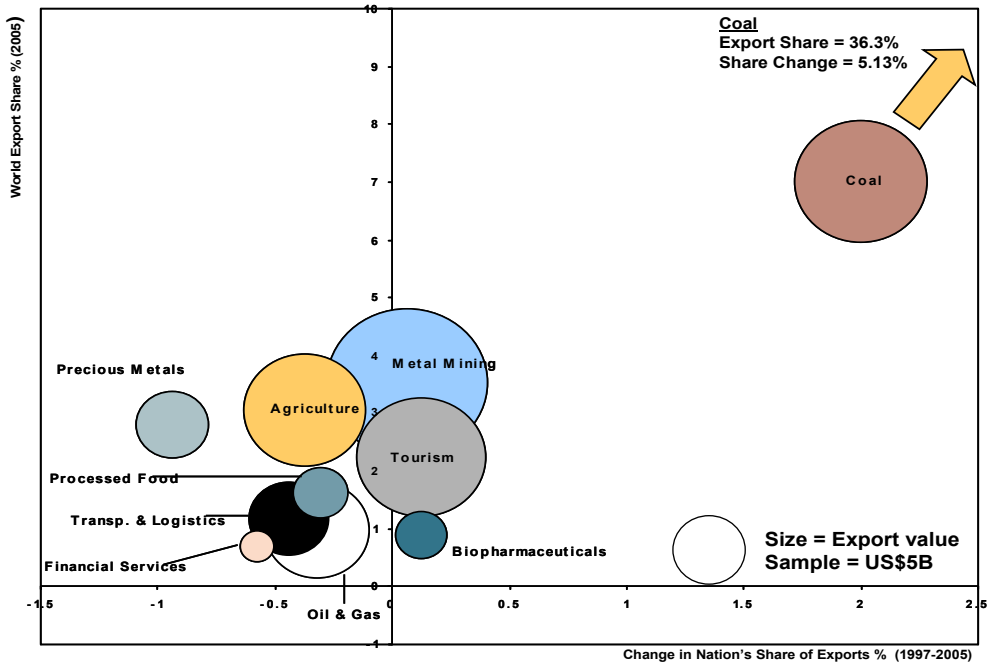
However, Australia has continually suffered from a lack of government procurement of advanced technology, which may be reflective of a relatively greater emphasis on the provision of basic services such as universal health care. In addition, Australia's low population density has necessitated greater spend on basic infrastructure such as roads. For

example, due to Australia's low population density, it has the fourth highest amount of roadway per capita (39.7 metres) of any country, double that of the United States (CIA, 2007; team analysis). The maintenance of such extensive infrastructure therefore typically attracts more attention than purchases of advanced technology, with little regard to the potential such purchases might have to stimulate domestic innovation. More worrisome, however, is the reduction in buyer sophistication noted in the Global Competitiveness Report. Since 2004, Australia has slipped from fourth place to 17th.

*2.6 Related & Supporting Industries*

Australia has strong export performance in a relatively small number of clusters, primarily based around natural resources. See **Exhibit 3** below for details.

**Exhibit 3: Australia's Export Portfolio by Cluster**




Mining makes up the majority of Australian exports, constituting around $100 billion out of total exports of $216 billion in 2006-07 (Australian Department of Foreign Affairs and Trade, 2007). Australia maintains leadership positions in coal, iron & steel, copper, gold and other metals (Institute for Competitiveness Cluster Project, 2005). The mining industry employs around 141,000 people directly, paying $12 billion in wages annually (Australian Bureau of Statistics, 2007).

Agriculture contributes $22 billion to total exports (including processed foods), with export leadership positions in grains, wine, meat, and fruit and vegetables. The sector employs over

360,000 people, paying $6 billion in direct wages and $15 billion in farm profits and mixed income.

Tourism is Australia's largest service export at between $16 – 32b (depending on definition), again relying heavily upon the natural resource endowments, including oceans, reefs and natural rock formations. Over 500,000 people are employed in hotels and restaurants in Australia, earning $12 billion in wages. In addition, a further 300,000 are employed in cultural and recreational services.[10]

Other significant export clusters include the provision of higher education to international students ($5.0 billion p.a.), biopharmaceuticals such as blood products and technologies ($2.7 billion p.a.) and medical devices such as hearing implants ($1.0 billion p.a.).

Beyond these industries, metrics for related and supporting industries are low, and most other clusters are organised around serving the local economy. Many of these industries are in the non-traded sector, which is reflected in the relatively high contribution of services to GDP (EIU, 2007).

Of particular note is the decline in Australian manufacturing following the lifting of protective import tariffs during the 1980s and 1990s. The contribution of manufacturing to GDP has fallen from almost 19% in 1980 to just under 11% in 2007 (EIU, 2007). This reduction can be primarily traced to heavy tariff protections in the 1960s and 1970s, which reduced incentives for productivity and competitiveness improvements.

This poor performance is also reflected in the Global Competitiveness Report. Australia ranks very poorly with respect to the local availability of process machinery (ranked 35), and has suffered from declines in the both the quality and quantity of local suppliers. While these latter metrics cannot be tied entirely to the decline in manufacturing, it is certainly a contributing factor.

*2.7 Strategic Issues facing the Australian economy*

Australia faces two major areas of strategic challenge: those relating to long-term structure, and the issues driving Australia's more recent decline on the BCI.

Longer term structural issues

Microeconomic challenges remain in the path of realizing Australia's full economic potential. The major structural issues are:

[10] These figures include people working for establishments that service the domestic population as well as international tourists.

- Australia has few developed clusters, and exports are low compared to OECD peers. Most export clusters are dependent upon natural endowments rather than created wealth.
- Innovation output remains low, with companies facing considerable difficulty in commercializing and growing technologies within Australia.
- Australia's small population and isolation impose additional constraints, such as limited market potential for new ideas, increased transportation costs and a lack of export focus.

Issues driving the decline in Australia's rankings since 2004

The quality of both business environment and company operations have diminished since 2004. The major drivers behind this decline include the following:

- Increasing concentration of export markets and products, particularly in mineral commodities to Asia
- The growing inadequacy of existing physical infrastructure
- Industry consolidation and the resulting reduction in competition, which has also led to stagnating buyer sophistication. This may also be linked to reduced supplier quantity and quality.

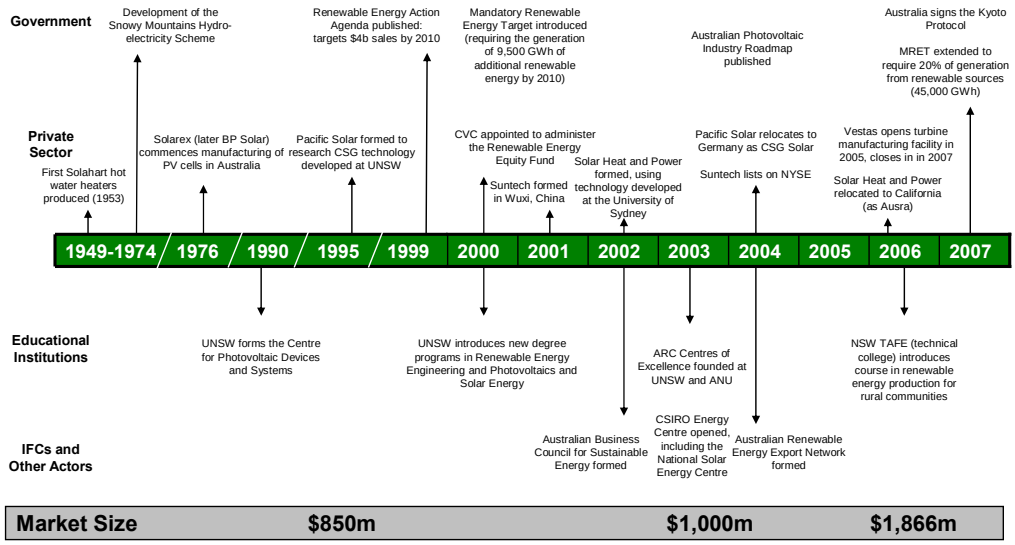
## 3. The Australian Renewable Energy Cluster

Australia has a mix of demand and factor conditions that could support a thriving renewable energy cluster. While the sector has grown over the last decade to a market size of $1.9 billion, the cluster has failed to develop a core of world-class renewable energy companies. Today, Australia's renewable energy cluster lags behind corresponding clusters in leading countries. This section considers the history and performance of the cluster in Australia. It then uses the diamond framework to analyse why this cluster has failed to realise its potential.

### *3.1 History of the renewable energy industry in Australia*

The genesis of the Australian renewable energy industry can be traced to the Snowy Mountains Hydro-electricity scheme and is summarised in Exhibit 4:

**Exhibit 4: Development of the Australian Renewable Energy Cluster**




Source: Press searches, MMA (2006).

*3.2 Overview of the renewable energy cluster: activities and participants*

The Australian renewable energy industry consists of three distinct activities (MMA, 2006, pp16-22):[11]

*1. Generation ($1,105m revenues in 2005)* refers to the production of electricity from renewable sources, including both on-grid and off-grid (standalone) production. This portion of the cluster is geared towards serving the domestic market, since the nature of electricity production means that it cannot be exported directly. This portion of the cluster is dominated by large-scale hydro, which accounts for $883 million in revenues, which is in turn dominated by three large producers with 94% of capacity.

*2. Manufacturing ($320m)* refers to the manufacture of components for renewable energy generation, for example the manufacture of solar photovoltaic cells or wind turbines. This portion of the cluster serves both the domestic and export markets, and in 2004 generated $185m in export earnings (MMA, 2006, p19). Technologies manufactured include wind turbines and components (dominated by three foreign firms with a manufacturing presence in Australia), solar PV cells (two major firms, one foreign and one domestic) and solar water heaters, where Australia has 10 major competitors exporting their products to 70 countries.

*3. Services ($440m)* refers to a broad range of ancillary services related to the renewable energy industry, including installation, fuel collection, R&D, distribution, sales and consulting. This portion of the cluster had export earnings of around $55 million with the

[11] The bulk of activity relating to the renewable energy cluster is focused on electricity production (rather than other forms of energy such as transportation fuels).

balance of revenues from the domestic market (ABCSE, 2004, p2).[12] Typically, exports involve services performed by overseas by Australian companies or overseas site development.[13]

A breakdown of the revenues of the industry by technology is given in **Table 2**.

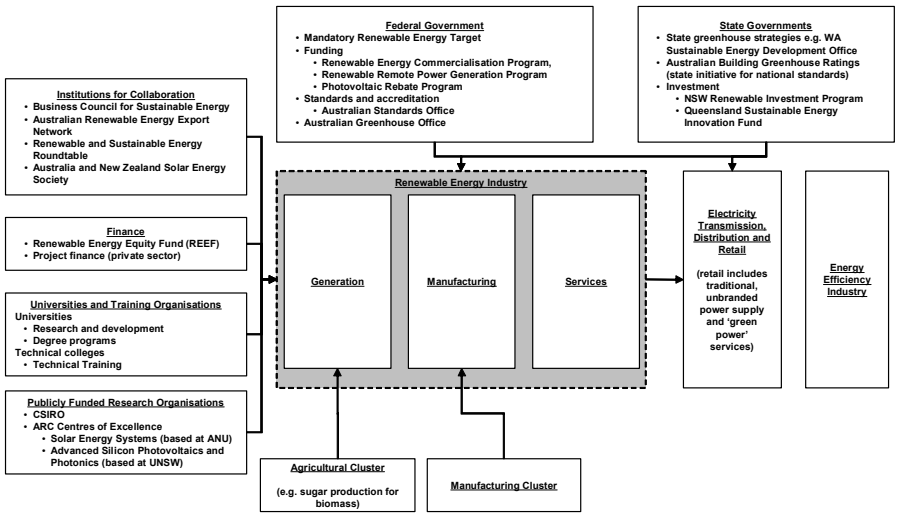
**Table 2: Australian Renewable Energy Industry Revenues, 2005**

| | Generation | Manufacture | Services |
|---|---|---|---|
| **Wind** | **$97m** | **$126m** | **$28m** |
| **Hydro (large-scale)** | **883** | **-** | **-** |
| **Hydro (small-scale)** | **18** | **22** | **62** |
| **Biomass** | **90** | **18** | **196** |
| **Solar PV** | **16** | **102** | **102** |
| **Solar Water Heater** | **-** | **53** | **53** |
| **Wave** | **<1** | **<1** | **-** |
| **Total Revenues** | **$1,105m** | **$320m** | **$440m** |
| **Employment** | **1,450** | **1,500** | **3,300** |

Source: MMA (2006).

Supporting the renewable energy industry, a diverse range of cluster participants has developed, as shown in **Exhibit 5**:

**Exhibit 5: Australian Renewable Energy Cluster Map**




*3.3 Performance*

The performance of the Australian renewable energy industry can be measured across two dimensions: the level of production of electricity from renewable sources and the commercial vitality of the industry.

[12] Export earnings based on team calculations using data sourced from ABCSE, 2004, p2 and MMA, 2006, p19.
[13] Examples include SMEC, an engineering consultancy with offices in Australia, Asia, Africa and the Middle East; Roaring 40s, a partnership between Snowy Hydro and China Light & Power formed in 2005 and currently developing renewable energy generation facilities in Australia, New Zealand, India, Hong Kong and Mainland China, and Hydro Tasmania Consulting, which operates in 25 countries. See further MMA, 2006, p24.

*1. Generation:* The installed capacity of renewable generation has increased from 7.4GW in 1996 to 7.9GW in 2004; at a CAGR of 0.7%, this growth rate has lagged non-renewable sources and the share of electricity generated from renewable sources has declined from 9.6% to 7.6% over the same period (MMA, 2006, p3; OECD, 2007, p85). Further, after excluding large hydro, Australia's share of electricity generated from renewable sources is 1.2%, below the OECD average of 2.8% and considerably below leading OECD countries such as Denmark (28.1%) and neighbours such as New Zealand (9.7%) (OECD, 2007, p18).[14] However, there has been a strong growth in the 'new renewables' technologies of wind (83% CAGR from 1996 to 2004) and solar (32% CAGR), albeit from a low base.

*2. Industry development:* The renewable energy industry has grown from revenues of $850 million in 1995 to $1,866 million in 2005. Whilst this growth (and the export performance discussed above) is positive, Australia has failed to develop world-class companies and the cluster lags the vitality of competitor locations such as Germany and Denmark (a more detailed analysis of the performance of these two countries is provided in **Appendix B**). Australia has developed only a limited number of large renewable energy companies[15] and is absent from the top performers in both wind (the largest component of renewables generation excluding large hydro) and solar PV (the fastest growing segment) (REN21, 2007, p6).[16]

One trend which has undermined the development of the industry has been that companies incubated in Australia have chosen to relocate overseas.[17] An illustrative example of this is that three quarters of the world's solar collector mills are manufactured in China, and 80% of those use technology developed at the University of Sydney (SMH, 2008). In the recent past, there have been numerous examples of promising technologies developed in Australia finding commercial success elsewhere. Examples include: Pacific Solar (a spin-off from UNSW to commercialise crystalline silicon on glass technology), which subsequently became Suntech (China) and CSG Solar (Germany);[18] Solar Heat and Power (a company

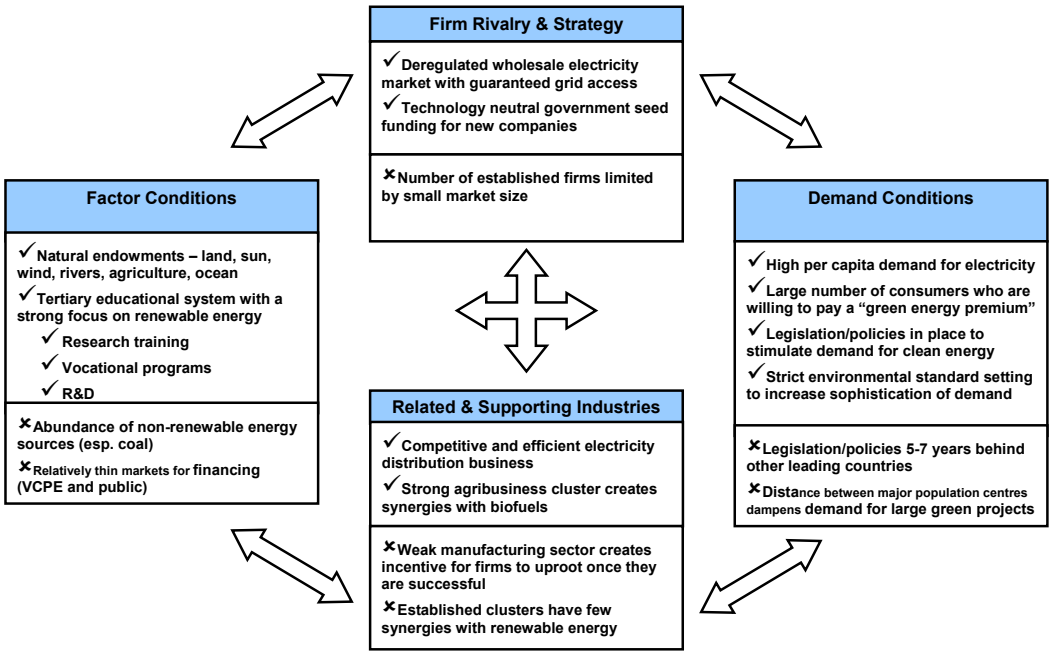
[14] Data excluding generation from large scale hydro-electricity has been used for the purposes of comparison, since generation from this source has largely reached its technical potential and has exhibited little growth in recent times for most OECD countries, growing at 0.6% per year from 1990-2005 (OECD, 2007, p13).
[15] As calculated by the Renewable Energy Policy Network. Australia has four publicly-held companies of which >US$40m market capitalisation can be attributed to renewable energy, out of the world-wide total of 140, sixth behind Germany (19), USA (17), Japan (12), Canada (8) and UK (8). See further REN21, 2006, pp25-26.
[16] The top 5 manufacturers accounted for 80% of wind turbine production in 2007 and 50% of solar PV production in 2005 and did not include any Australian companies: see European Commission, 2006, p10 and BTM Consult, 2008, p2.
[17] This section has been sourced from company websites and press searches. See Sydney Morning Herald, 2007; The Age, 2007, The Independent, 2008, www.csgsolar.com and www.ausra.com (accessed March 2008).
[18] Pacific Solar was headed by Dr Zhengrong Shi from 1995-2001. In 2001 Dr Shi formed Suntech in Wuxi province, China, to manufacture PV cells. In 2004 Suntech listed on the NYSE and currently has a market capitalisation of US$7.5 billion. In June 2004, the 20 remaining employees of Pacific Solar announced the formation of a new company, CSG Solar, to be based in Germany. CSG Solar constructed a manufacturing

using compact linear fresnel technology developed at the University of Sydney), which relocated to Silicon Valley under the name Ausra;[19] and Origin Energy (an Australian utility active in commercialising sliver cell technology developed at ANU), which is considering relocating to Germany or the USA. Companies relocating cite four key reasons for their decision to relocate: an insufficient market size in Australia, a more supportive policy environment in other locations, a lack of investment capital and cheaper manufacturing costs.

Despite this trend, there have been a number of niches where Australian firms have been successful, for example the manufacture of solar PV cells, where Australia was the world's fourth largest producer as of 2003 (ABCSE, 2004, p19);[20] solar water heaters, where Australian companies export 30-40% of their production to over 70 countries (MMA, 2006, p56); and off-grid photovoltaics, where demanding conditions in rural locations have led to the development of the world's most robust and reliable products (ABCSE, 2004, p49).

*3.4 Cluster diamond*

**Exhibit 6: Australian Renewable Energy Cluster Diamond**




facility in Germany with financial assistance from the local and national governments and the European Union. Source: company websites, press searches.

[19] Solar Heat and Power was formed with $3.2 million in federal government funding to commercialise CLFR technology. In 2006, Solar Heat and Power received a US$50 million 'A' round financing from Kleiner Perkins and Khosla Ventures and corporate headquarters and key personnel relocated to Silicon Valley.

[20] However, since 2003 China has emerged as a significant producer of solar cells, for example through companies such as Suntech.

Australia's renewable energy cluster is a story of strong fundamentals but unrealized potential. Within the framework of the diamond model, "factor conditions" is the most significant driver of the Australian renewable energy cluster's current predicament. Australia has some of the world's best natural conditions for renewable energy production, but at the same time possesses rich coal endowments which create a strong disincentive for investments in the renewable energy sector. There is a similar tension at work with Australia's man-made factors. Australia has world-class intellectual capital in the field of renewable energy; but lacks the risk capital necessary to turn ideas into successful businesses.

In the other corners of the cluster diamond, strong levels of demand and a competitive national electricity market are evident. However, two key limitations emerge: first, the small size of the Australian market tends to sustain a limited number of large firms (with a negative impact on firm rivalry). Second, weaknesses in Australian manufacturing create a gap in the renewable energy sector's value chain, pushing successful local companies outside of Australia.

Factor Conditions

Australia has some of the world's best natural endowments for alternative energy production. Australia's varied geography endows it with natural conditions that support every form of renewable energy generation (rivers for hydro power, coastlines for wave power, fault activity for geothermal power and agriculture for biofuels). Australia thus has the unique potential to serve as a testing ground for renewable energy solutions.

As the world's sixth largest country (area of 7.6 million square kilometers) and with one of the world's lowest population densities, Australia can accommodate land-intensive alternative energy generation facilities (up to 20 square kilometers per facility for solar and wind farms) far more easily than almost any other developed country.[21] Meteorological conditions in Australia are also among the world's best for solar and wind power generation, two of the fastest growing areas of renewable energy technology.

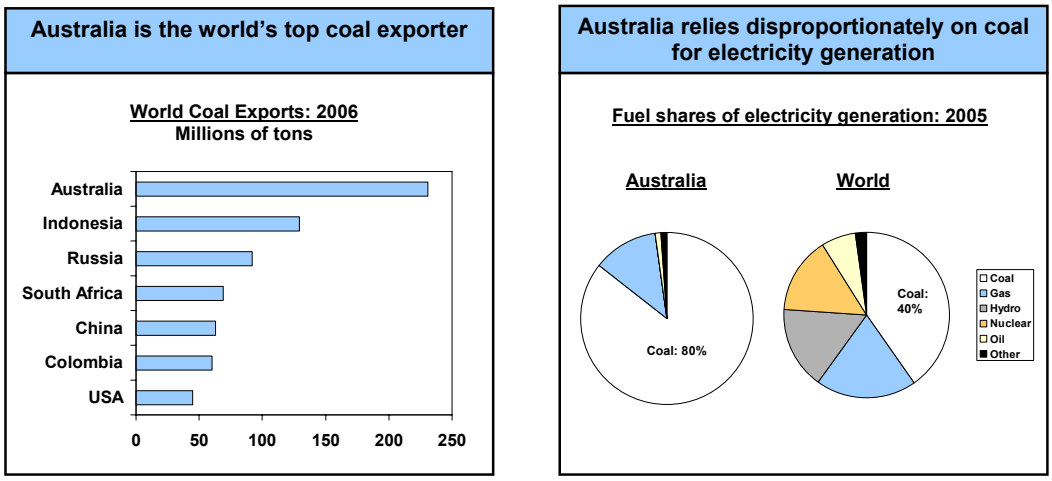
However Australia's sizeable reserves of fossil fuels dampen both economic and strategic incentives for investments in renewable energy generation. Australia's current electricity generation system is built around the country's plentiful (180 years worth of) coal reserves (Australian Coal Institute, 2008). 80% of electricity in Australia is generated by coal fired plants, in contrast to a global average of 40% (International Energy Agency, 2008). The bulk

[21] In densely populated countries in Europe, the land intensity of renewable energy generation facilities occasionally leads to political opposition within local communities. Such opposition emerges despite very high levels of support for renewable energy at the national level.

of the costs of Australia's coal-based power infrastructure are sunk costs, so the marginal costs of coal-fired generation are extremely low.

In addition, coal creates a difficult political obstacle for the renewable energy sector. With Australian mining companies as a powerful political lobby and with the coal industry as one of the major employers in southern Australia, there are significant domestic constituencies that view renewable energy as a threat. In fact, the coal lobby has been cited by some as the key reason why the Howard government refused to ratify the Kyoto Protocol even though the instrument had widespread support in Australia (Pearce, 2008).

**Exhibit 7: Australia's Coal Exports**




Source: Australia Coal Association, International Energy Agency

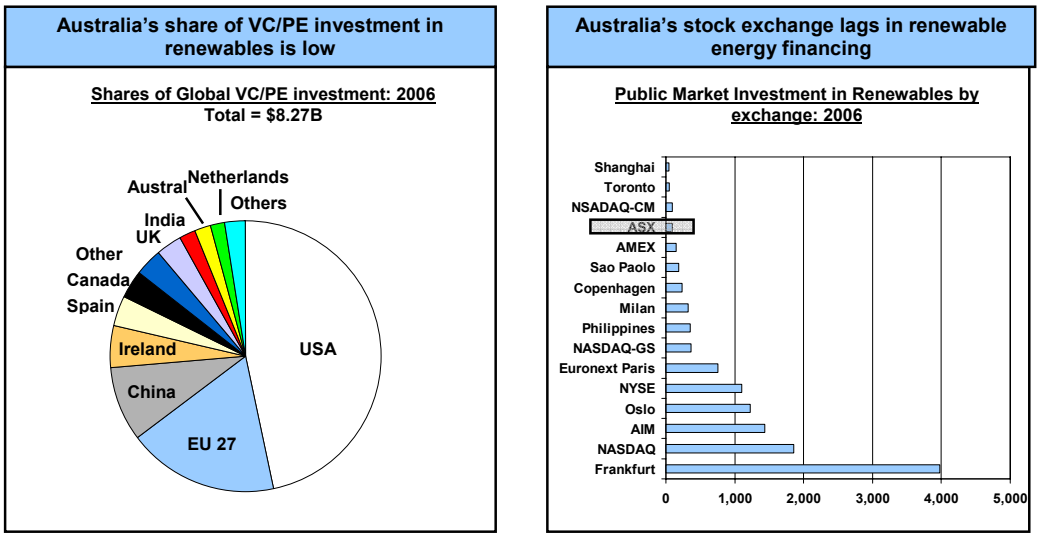
In terms of man-made endowments, Australia has some notable strengths in its intellectual capital and human resources. Australian tertiary institutions like the University of New South Wales and the Australian National University are among the world leaders in alternative energy research. These institutions have also developed a broad range of training programs which address the full range of skills (basic science, engineering, and even business and policy analysis) needed across the entire value chain of the alternative energy sector. In addition, Australia's technical college system offers specialized programs that provide trade qualifications and common accreditation in the manufacturing, installation, and maintenance of renewable energy systems.[22]

However the potential of Australia's human resources is hampered by the lack of a developed market for risk capital. As is clear from **Exhibit 8** below, Australia's venture capital market is fairly undeveloped and investments in the renewable energy sector lag significantly behind

[22] For a discussion of the strengths of Australia's human resources in renewable energy technology see ABCSE (2004). For comprehensive details on the range of training programs offered in Australia, see ACRE (2001).

the US and Europe. The shortage of risk capital also extends to Australia's public markets. Despite the depth and sophistication of the ASX, it lacks the critical mass of renewable energy listings that is necessary to attract sustained analyst coverage and investor interest. The difficulty of raising financing is a reason often cited by promising home-grown alternative energy companies that leave Australia.

**Exhibit 8: Capital Markets and Renewable Energy**




Source: *Global Trends in Energy Sustainable Energy Investment 2007: Dataset*, report commissioned by UNEP Division of Science, Technology and Economics

Demand

Demand conditions in Australia are favorable for the renewable energy cluster. Australians consume significant amounts of electricity on a per capital basis, yet at the same time they appear to be willing to pay a premium for green energy. Despite its small size, Australia accounts for 15% of "Green Power Consumers" (users who have signed up for retail schemes to purchase green energy) around the world (REN 21, 2007, pp28-29). This trend is consistent with domestic survey data which indicates a high level of environmental awareness across the country.[23]

In recent years, the Australian Government has made significant moves to increase the level of national demand for renewable energy. It has imposed high environmental standards (e.g. binding commitments to reduce greenhouse gas emissions under the Kyoto Protocol), specific targets for renewable generation (a target of 20% of all generation by 2020), and a slew of targeted incentives including the $75 million Solar Cities project to encourage the use of solar technologies in urban areas.

[23] For detailed polling data on Australians' attitudes to the environment see Dee (2007).

**Exhibit 9: The Renewable Energy Policy Context**

| Government policies in place to stimulate demand for renewable energy | Government policies also increase sophistication of demand |
|---|---|
| **Adoption of Kyoto Protocol**<br>• Commitment to reduce greenhouse gas emissions by 60% of 2000 levels by 2050<br>**National Greenhouse Accounts**<br>• System for tracking emissions reductions<br>• Self-imposed target of 108% of 1990 levels over the period 2008-2012<br>**Mandatory Renewable Energy Target**<br>• Target of 20% of all consumption by 2020<br>— 9500 GwH by 2010, 45,000 GwH by 2020<br>• Establishment of Office of Renewable Energy Regulator to ensure compliance<br>**Photovoltaic Rebate Program**<br>• Grants of $4 per watt installed<br>• 5.7MW installed since 2000<br>**Solar Cities**<br>• $75M public-private pilot project to demonstrate effectiveness of solar-based energy solutions in urban areas | **Standard setting**<br>• Standards Australia Int'l Ltd – independent company to establish and monitor standards<br>• Active role in renewables industry: long and short term plan for standards development along entire value chain (generation, grid connection, storage, controllers, home systems)<br>• Collaboration with foreign/international organizations (e.g. ISO) to ensure out-of-country compatibility)<br>**Renewable Remote Power Generation Program**<br>• To increase renewable generation in remote off-grid areas<br>• Funded from diesel fuel excise tax<br>• Grants for training, information provision, equipment testing, standards development and feasibility studies |

Source: Australian Government, Department of Climate Change, International Energy Agency – Global Renewable Energy Policy and Measures Database.

These demand-building policies are extremely sound, and in line with policies implemented by governments in leading renewable energy countries like the US and Germany. However, leading countries have had their policies in place 5-10 years before Australia, which has allowed renewable energy clusters in Germany and the US to gain critical mass, leaving Australia in a game of catch-up.

Firm Rivalry and Strategy

The Australian electricity market is highly competitive. The market was fully deregulated in 1992 with the result that generation, transmission, distribution and retail functions are performed by separate companies. Australia's rigorously enforced National Competition Policy assures independent generators access to the electricity grid on fair and reasonable terms.[24] A number of Australian states are currently considering the implementation of Feed-in Tariffs (guaranteed payments for producers that sell green energy to the grid), a move that should encourage additional producers to enter the market.

The Australian Government has attempted to increase the dynamism of the renewable energy cluster by providing seed and growth funding for promising young companies through a unique mechanism called the Renewable Energy Equity Fund (REEF). Under this program, a $26.6m pool of funds has been outsourced to global private equity firm CVC Capital

[24] See IEA (2005) for a detailed discussion of the success of Australia's electricity market reforms.

Partners, who are charged with tapping private sector investment expertise to allocate public sector capital.[25]

Despite these positives, the extent of competition within the renewable energy sector is limited by the relatively small size of the Australian market (the national electricity market is half the size of California's). The limitations of the home market are felt more significantly as firms grow. Australia is currently home to only four renewable energy companies with a market capitalization above US$40 million. In contrast, Germany supports 19 such companies (REN 21, 2006, pp25-26).

Related and Supporting Industries

Weaknesses in the Australian manufacturing sector pose a barrier to realization of the full potential of the renewable energy cluster. Manufacturing in the renewable energy industry links idea generation with the creation of marketable products. Our survey of the global renewable energy industry has indicated a close correlation between strong (advanced and/or cheap) manufacturing capabilities and a successful renewable energy cluster.[26] As Australia's resource and service based industries have boomed, manufacturing has shrunk in importance as a component of the Australian economy as was outlined in **Table 1** above. Manufacturing wages remain high by international standards while productivity has lagged significantly behind other sectors of the Australian economy (NOIE, 2005, p7 and p25). Suntech, one of the world's leading producers of photovoltaic cells, was incubated at the University of New South Wales. However its founder chose to launch the company in China because of the availability of a cheap but advanced pool of manufacturing labor.

A further disadvantage faced by Australia is the fact that the clusters where it has established strengths (e.g. mining and tourism) have few, if any, synergies with the renewable energy sector. The sole exception is the Agribusiness cluster, where Australia's highly competitive production of cereals, oilseed, sugar cane and its expertise in specialized areas like viticulture can help support the development of a biofuels subcluster.

*3.6 Strategic Issues Facing the Renewable Energy Cluster*

The future of the Australian Renewable Energy Cluster will be determined by how its key players address the following issues:

[25] A detailed description of REEF can be found on the AusIndustry website http://www.ausindustry.gov.au/

[26] For example, the high-end manufacturing capability sustained by California's semiconductor and advanced electronics industries creates a natural technical base for the R&D and manufacture of silicon based photovoltaics, while Germany's strengths in precision industrial engineering translate into a source of advantage to the wind power industry.

- *Implicit subsidies for fossil fuels*: Fossil fuel-based generators enjoy a significant implicit subsidy via the Australian government's investments in their distribution infrastructure. Producers are also not charged for the negative externalities (carbon emissions) that they generate. These implicit subsidies set up an uneven playing field for renewable energy generators.
- *Opposition from coal-linked constituencies*: Coal will continue to be an important source of employment and export earnings for Australia for the foreseeable future. The coal lobby is likely to throw up considerable political barriers to the development of the renewable energy cluster so long as it perceives the cluster as a direct threat.
- *A small and immature market*: The small size of the electricity generation market in Australia places limitations on the number and size of firms that can be sustained, with negative implications on the level of competition within the industry. The leading renewable energy countries (e.g. the US and Germany) have also had a 5-10 year head start over Australia in establishing and implementing a policy framework that enhances the demand for renewable energy.
- *Weaknesses in launching and sustaining new companies*: Australia's private and public capital markets do not provide sufficient amounts of risk capital for the launch and growth of companies built around Australian technology. The Australian manufacturing sector is also currently in a weak position against both high-end and low cost competitors. Specialized manufacturing capabilities are a key enabler for the commercialization of technology and the growth of businesses.

## 4. Recommendations

### *4.1 The Australian Economy*

*1. The Australian Government should streamline its approach to innovation, and increase efforts to link to foreign providers of venture capital.*

- The newly created Department of Innovation, Industry, Science and Research currently offer a broad array of programs to encourage new enterprises. *There is room to clarify the role and purpose of each program.*
- The Government has previously funded several venture capital co-investment funds that invest alongside several private venture capitalists. Some, such as the Pre-Seed Fund, have explicit aims to develop nascent technologies resident in Australian universities. While generally very successful, Cummings and Johan (2007) note that some of these funds compete with each other and crowd each other out. *The Government should review*

*existing funding programs, distil best practices, and then consolidate all funding under a single program.*

- *Activities related to venture capital and the commercialization of innovation should be housed in a standalone department.* This department would form a "one-stop shop" for start-up ventures at each stage of development, as well as for investors in such ventures. A greater emphasis should be placed on marketing to and creating links with overseas venture capital hubs such as California and Boston. This should include encouraging VC's in these locations to develop offices in Australia.

*2. The Australian Government should encourage the diversification of existing export clusters, based on advantages unique to Australia.*

- Australia has overcome considerable hardships in its development from a penal colony to a modern society, leading to the development of certain unique capabilities. Opportunity exists to develop these capabilities from being traditionally domestic and/or non-tradable into viable export clusters. Examples include: soil salinity management (due to arid climate), corrugated iron technology (for use in construction) and road construction skills.
- Opportunities exist to further the export of financial services to Asia. Through history and experience, Australia has gained considerable strengths in areas such as defined contribution pension plans, Public-Private Partnerships, and prudential regulation of banking and insurance.
- *To pursue such opportunities, the Australian government should form a multi-representative taskforce* of government bodies, industry representatives and academics to identify latent competencies and key opportunities, and to propose a strategy for their development into viable export clusters. This should also *consider the role that the Australian diaspora could play* in such furthering such efforts.

*3. To help overcome geographic isolation, Australia should actively pursue closer trade and economic linkages with neighbouring Asian countries.*

- As a significant trade partner, Australia can benefit from *greater cooperation with the Asian region*. Existing Institutes for Collaboration (such as the APEC Business Advisory Council) are a useful starting point, however Australia should also consider localized efforts to develop geographically proximate areas (such as Java, Perth and north-eastern Australia).

- State Governments should make it *mandatory that school students learn one Asian language* during their primary and secondary schooling. While long-term in nature, this will increase the ease with which the next generation of Australian workers will be able to integrate into the Asian region. Student exchange programs with Asian countries should receive greater emphasis.

- As Australia is already a large exporter of tertiary education to Asia, the Federal Government should develop an explicit cluster strategy for the tertiary education sector. This must focus on improving productivity by inducing competition and specialization amongst universities.

*4. The Australian Productivity Commission, in conjunction with a broad range of stakeholders, should conduct a comprehensive review of the state of Australia's physical infrastructure.*

- Emphasis should be placed on the most critical bottlenecks to sustained economic development, as well as seeking efficient funding models to address these problems.

*5. To combat decreased competition due to industry consolidations, the bodies responsible for competition policy in Australia should review their methods.*

- Bodies such as the Australian Competition and Consumer Commission constantly attempt to balance the benefits of consolidation against the costs of reduced competition. Such bodies should undertake a review of the methods and approaches they use to ensure these are still relevant to the current structure of the economy. Some degree of international benchmarking would be worthwhile in this regard.

*4.2 The Renewable Energy Cluster*

*1. Australian governments – federal and state – should establish a co-ordinated set of technology neutral policies to create competition within the renewable energy sector.*

- The Australian federal government should review its *choice of policy instrument* used to support the renewable industry, and *move from the use of a mandatory renewable energy target to a feed-in tariff system*. The feed-in tariff system should incorporate best practice from Germany's successful experience including the principles of *degression, no disadvantage* and *priority access*. Further details on the advantages of feed-in tariffs over the current MRET approach from a competitiveness and industry development standpoint are presented in **Appendix A,** and further details on the experience of Germany and other competitor locations is contained in **Appendix B**.

- Currently, there is a perception that Australian governments have engaged in 'stop-start' policies (ABCSE, 2004, p40). Australian governments *should increase the transparency and certainty* surrounding the policy environment through:
  - Including a *no-disadvantage test* in legislation. Such a clause would provide investors with the certainty that, should governments change or remove the policy instruments used to support the renewable energy industry (for example, the move from a MRET to a feed-in tariff system or eventually a carbon tax), existing investments will not be financially disadvantaged.[27]
  - *Extending the policy support to the lifetime of investments*. The MRET begins to be phased out in 2020, which discourages new investments since most projects require a payback period of at least 15 years (AGO, 2003, pxxi).
  - *Co-ordinating policy support between the federal and state governments*. The electricity industry is based on a national market, yet policies for renewable standards often differ at the state level.[28] The failure to co-ordinate policies increases uncertainty and compliance costs.
- The Australian government should *encourage the growth of a "clean coal" technology sub-cluster*. Such a move would help co-opt the Australian coal lobby into the development of the overall renewable energy sector, and would generate a potentially lucrative set of technology and service exports (to coal-fired plants in developing countries). "Clean coal" companies and research institutions should thus be included within all renewable energy IFCs and should be eligible for the same pools as funding as the more "pure" renewable technologies.
- The federal and state governments should *phase out subsidies fossil fuel technologies* to promote even competition between fossil fuel and renewables. For example, off-grid PV is disadvantaged by subsidised pricing for traditional fuel sources in rural areas (ABCSE, 2004, p7). Further, fossil fuel generation has enjoyed an implicit subsidy from the government in the form of public investment in transmission and distribution (AGO, 2003, p109) and renewable energy should be accorded equal treatment.
- The federal and state government should *phase out technology specific funding for renewables* (e.g. the solar PV rebate program) in favour of broad based, technology

[27] Such a provision has been included in Germany's feed-in tariff law, described in Appendix A.
[28] States have developed their own rebate schemes, demand targets and funding programs (for an overview, see ABCSE, 2004, p38) and at least one state has introduced a state based feed-in tariff program (see www.climatechange.sa.gov.au).

neutral funding and support. The governments' role should be confined to levelling the playing field between renewable and fossil fuel technologies and the private sector should be the principal actor to determine which renewable technologies in which to invest.

*2. Increase the financial resources available for commercialisation and deployment of renewable energy in Australia.*

- The Australian government should increase public sector *R&D spending* and provide incentives for private sector co-contribution (e.g. through matching). In the recent past, both public and private sector R&D spending has declined (AGO, 2003, p111) and the overall level of R&D spending significantly lags leading countries (OECD, 2004, p56). Increases in R&D should extend not to basic research (where Australia already enjoys considerable success) but instead to:
  - Commercialisation through funding *demonstration and deployment*,[29] for example through increasing funding for programs such as the Renewable Energy Commercialisation Program and the Renewable Energy Development Initiative.
  - Using R&D spending to encourage *public-private partnerships*, through increasing funding to the Co-operative Research Centres.[30]
- Public sector funding should be geared towards ensuring that the commercial success of publicly funded ventures benefits Australia. For example, particularly when technology is close to commercial deployment, funding should *take the form of equity stakes rather than grants*.
- The Australian federal government should *increase the public funding of venture capital through CVC REEF*. This model of funding – whereby public funding is 'outsourced' to a commercial venture capital company, and public funding is co-invested with private funds – is to be lauded. However, the scale of funding, at a total of $26.6m (of which $18m is provided by the Australian federal government) is insufficient.

[29] The President's Committee of Advisors on Science and Technology introduced the term research, development, demonstration and deployment ($RD^3$) to describe the process by which technology moves from basic research to commercial viability (PCAST, 1999, pp3-4 to 3-8). *Demonstration* refers to the building of energy production/use facilities to prove technical and potential commercial viability. In the case of *deployment*, one barrier for commercial adoption is that new technologies may be initially more costly than alternatives but exhibit declining costs as firms gain experience along the "learning curve". In those cases PCAST argues that there is a role for government, in conjunction with the private sector, to engage in "buy-down" to spur commercial deployment (PCAST, 1999, p3-6).

[30] The Co-operative Research Centres program was started in 1991 and includes programs relating to energy and other fields. Jointly funded by the public and private sector, CRCs foster collaboration between public research bodies (universities and the CSIRO) and the private sector in order to commercialise research and development. See further: www.crc.gov.au.

*3. Streamline the process for the integration into the grid of electricity generated from renewable sources.*

- For small scale producers to sell electricity generated into the grid, existing net meters must be replaced with interval meters. Currently, this responsibility rests with incumbent utilities and there are some examples of potential producers finding this a time consuming and bureaucratic process (ABCSE, 2004, p39). This activity should be opened to competition: IFCs should establish a *certification system* and *certified electricians should be permitted to access the grid* for this purpose, which should spur the development of a cadre of SMEs competing in this area.

*4. Enhance the competitiveness of the Australian manufacturing sector*

- The Australian federal government should support *the creation of a new IFC to support Australian manufacturing*. This IFC should bring together economic policy makers, manufacturers and educational institutions to review the steps that need to be taken by all participants to achieve the ideal positioning for the sector. The IFC should have a full time staff to measure and monitor manufacturing competitiveness, to monitor and disseminate information on best practices and new technologies, and to promote Australian manufacturing abroad.
- Clusters of Australian universities should *establish a series of regional incubators to commercialize the scientific ideas* that they generate in their laboratories. These incubators should make a special effort to expand their collaborations to include Australian SMEs so that innovations are proliferated to smaller firms.
- The Australian federal government should *increase incentives for R&D that is targeted at the manufacturing sector*. Beyond increases in funding for research at the university level, the government should increase R&D tax concessions to encourage SMEs to invest in potential process improvements.
- Australia's 15 technical colleges should *roll out a standard national curriculum and accreditation system for vocational training* in the renewable energy sector. The colleges should place a special emphasis on *developing programs in continuing education* to ensure that the workforce is up to date on latest developments in renewable energy technology.

**Appendix A: Relative Merits of Feed-in Tariffs and Renewable Portfolio Standards**

The main justification for government intervention to promote renewable energy is to promote even competition between renewable energy and fossil fuels through internalising the carbon externality from fossil fuels. To promote the generation of electricity from renewable sources, governments have used two main policy tools:

*1. Feed-in tariffs:* under a feed-in tariff system, producers of electricity are guaranteed a minimum payment for energy supplied to the grid. This payment per kilowatt hour supplied can be expressed either as a percentage of the market rate (typically a percentage of the retail rate, which is considerably higher than the wholesale rate) or as an absolute dollar amount. Feed-in tariffs may differ by technology.

*2. Renewable portfolio standard*s: under a renewable portfolio standard approach, of which Australia's mandatory renewable energy target (MRET) is an example, wholesale purchasers of electricity are required to purchase a given amount (typically in GWh) or a given proportion of their electricity from renewable sources.[31]

There is an emerging debate over the relative merits of the two policy approaches. This debate is far from settled, however, from an industry development and competitiveness perspective, a feed-in tariff offers a number of advantages:

- *Increased certainty and lower cost of capital:* under an RPS approach, the price of renewable electricity certificates can fluctuate widely in response to supply and demand.[32] In contrast, a feed-in tariff provides a certain payment over the lifetime of the investment, which in turn lowers the capital cost for investments (BMU, 2007, p21; EPIA, 2005, p5).
- *Lower transaction costs and greater accessibility to SMEs:* a further benefit of the transparency of a feed-in tariff is that it leads to low transaction costs, providing greater accessibility for small scale investors and entrepreneurs (EPIA, 2005, p9p9), which in turn leads to more innovation and competitive pressure (BMU, 2007, p21).[33] For example, it is argued that Germany's EEG has created enormous public interest in

[31] In the case of Australia's MRET, each megawatt hour of energy produced from renewable sources is awarded a Renewable Energy Certificate (REC). Producers could sell these RECs (at the market price) and wholesale purchasers of electricity are required to surrender sufficient RECs to the government to meet their MRET targets: see further AGO, 2003, pp2-4.

[32] For example, in Australia RECs have been priced between $16 and $80, with an average price of $37 or $38 (AGO, 2003, p93).

[33] In contrast, understanding pricing of RECs requires a greater level of specialised knowledge. As the Australian Greenhouse Office argues: "Calculating the renewable energy certificate price is a complex matter, because RECs are not traded on a market floor, and prices are not transparent, although for those actively involved in the market there seems to be a reasonable understanding of the spot and future prices prevailing. In addition, many sales of RECs are actually bundled with sales of energy, so that it is difficult to definitively assess the REC price component" (AGO, 2003, p93).

investing in renewable generation, spurring investments from "legions of homeowners, farmers and small businesses" (Reuters, 2007).

- *Technological improvement and cost reduction:* a feed-in tariff can be used to encourage technological improvement and cost reduction. For example, through lowering its feed-in tariff for PV by 5% each year, Germany's feed-in tariff encouraged manufacturers to seek cost reductions to maintain demand for their output of solar cells (EPIA, 2005, p9). In contrast, under a RPS approach, utilities are required to purchase a minimum percentage of their electricity from renewable sources regardless of its cost competitiveness.

Empirically, although comparisons across countries are difficult, countries that have adopted a feed-in tariff have generally seen larger increases in installed capacity for renewable energy and greater development of domestic industry (EPIA, 2005, p10).

The potential drawbacks of a feed-in tariff approach are two-fold:

- *Technological neutrality:* by allowing the government to set different tariff rates for different technologies, a feed-in tariff may encourage the government to pick winners amongst competing technologies.
- *The quantity of production is not known in advance:* thus, the cost impact is not knowable and a feed-in tariff that is set too high may encourage more investment than is socially optimal (however, in the case of a MRET, the government must still decide what the socially optimal level of production is).

Thus, on balance a feed-in tariff approach appears to be the best instrument to foster competition and the emergence of a viable renewable energy cluster. In implementing a feed-in tariff, however, governments should consider using a single tariff across technologies and monitor the level of the tariff so as to ensure a socially optimal quantity of production.

## Appendix B: Profile of Competitor Locations

### *B.1 Summary of Policy Support in Competitor Locations*

**Exhibit 10: Summary of Policy Support Mechanisms Used in Competitor Locations**

| Country | Feed-in tariff | Renewable portfolio standard | Capital subsidies, grants, or rebates | Investment or other tax credits | Sales tax, energy tax, excise tax, or VAT reduction | Tradable renewable energy certificates | Energy production payments or tax credits | Net metering | Public investment, loans, or financing | Public competitive bidding |
|---|---|---|---|---|---|---|---|---|---|---|
| **Developed and transition countries** | | | | | | | | | | |
| Australia | | ✓ | ✓ | | | ✓ | | | ✓ | |
| Austria | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | |
| Belgium | | ✓ | ✓ | | ✓ | ✓ | | ✓ | | |
| Canada | (*) | (*) | ✓ | ✓ | ✓ | | | (*) | ✓ | (*) |
| Croatia | ✓ | | | ✓ | | | | | ✓ | |
| Cyprus | ✓ | | ✓ | | | | | | | |
| Czech Republic | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | |
| Denmark | ✓ | | | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Estonia | ✓ | | | | ✓ | | | | | |
| Finland | | | ✓ | | ✓ | ✓ | ✓ | | | |
| France | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Germany | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | |
| Greece | ✓ | | ✓ | ✓ | | | | | | |
| Hungary | ✓ | | | | ✓ | ✓ | | | ✓ | |
| Ireland | ✓ | | ✓ | ✓ | | ✓ | | | | ✓ |
| Italy | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | | |
| Israel | ✓ | | | | | | | | | |
| Japan | (*) | ✓ | ✓ | | | ✓ | | ✓ | ✓ | |
| Korea | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | |
| Latvia | ✓ | | | | | | | | ✓ | ✓ |
| Lithuania | ✓ | | ✓ | ✓ | | | | | ✓ | |
| Luxembourg | ✓ | | ✓ | ✓ | | | | | | |
| Malta | ✓ | | | | ✓ | | | | | |
| Netherlands | ✓ | | ✓ | ✓ | | ✓ | ✓ | | | |
| New Zealand | | | ✓ | | | | | | ✓ | |
| Norway | | | ✓ | ✓ | | ✓ | | | | ✓ |
| Poland | | ✓ | ✓ | | ✓ | | | | ✓ | ✓ |
| Portugal | ✓ | | ✓ | ✓ | ✓ | | | | | |
| Romania | | | | | ✓ | | | | | |
| Russia | | | ✓ | | | ✓ | | | | |
| Slovak Republic | ✓ | | | ✓ | | | | | ✓ | |
| Slovenia | ✓ | | | | | | | | ✓ | |
| Spain | ✓ | | ✓ | ✓ | | | | | ✓ | |
| Sweden | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | |
| Switzerland | ✓ | | | | | | | | | |
| United Kingdom | | ✓ | ✓ | | ✓ | ✓ | | | | |
| United States | (*) | (*) | ✓ | ✓ | (*) | (*) | ✓ | (*) | (*) | (*) |

Note: an asterix indicates that there are policies enacted at the sub-national (e.g. state) level.
Source: REN21 (2007), p23.

### *B.2 The German Renewable Energy Industry*

The main policy instrument used to promote the development of the renewable energy industry is the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG), introduced in 2000, which created a system of feed-in tariffs. Under this scheme, plant operators who supply the grid with electricity generated from renewable sources are provided a fixed tariff for a period of 20 years. The Act specified a payment schedule (in cents per

kWH) for each technology type. The EEG Act established three important principles (BMU, 2007, p7):

- *Degression:* under the principle of degression, the fee paid under the feed-in tariff steps down depending on the year in which the generating capacity is installed. For example, equipment installed in 2008 will receive a set tariff each year for 20 years; equipment installed in 2009 will receive a set tariff which is 5% lower than the 2008 fee, but again will receive a constant tariff (at the new, lower level) for the lifetime of the project.
- *Protection of legitimate interests ('no disadvantage'):* under this principle, generators are protected against adverse changes in the law, effectively guaranteeing the level of fees paid, the 20 year payment period and the principle of priority access.
- *Priority connection:* under this principle, generation from renewable sources is given priority access to the grid.

The Act increases the costs of electricity (since the feed-in tariffs are set above the market wholesale price) and these costs are shared across all electricity users in the form of a surcharge. This surcharge has increased costs by approximately €0.01 per kWH, which for a typical household with power consumption of 3,500kWH translates to an additional cost of €2.95 per month (BMU, 2008, p7).

The German renewable energy industry has demonstrated success across many dimensions. First, Germany has become a world leader in renewable energy electricity generation: for example, in 2006 Germany accounted for over half the world's PV market by installed capacity (850MW out of 1600MW) (EPIA, 2007, p5). Furthermore, the renewable energy industry has developed strongly. Turnover in the industry increased from €7 billion in year 2000 when the EEG was introduced to €24.6 billion in 2007 (BMU, 2008, p7), of which €10.7 billion related to the construction of new plants and €14.0 billion related to their operation (BMU, 2008, p3). The number of people employed in the industry is 230,000, of which 130,000 can be attributed to the EEG (BMU, 2007, p4).

Germany has also developed world class firms that have achieved significant export earnings. For example, in the case of solar photovoltaics, 37% of German solar PV production is exported (Solar Daily, 2008) and in 2007 the German Q-Cells became the world's largest producer of PV cells (Economist, 2008).

*B.3 The Danish Renewable Energy Industry*

The Danish renewable energy industry can trace its development to Denmark's energy plan published in 1976, whose objective was to make Denmark less dependent on imported

energy, particularly oil (Moore and Ihle, 1999). The Danish policy approach consisted of a number of elements:

- *Energy taxes*, first passed in 1974 and later replaced with a general carbon tax on all forms of energy.
- A *feed-in tariff* requiring utilities to buy power from renewable energy technologies for between 70% and 85% of the retail price of electricity. This was supported by open and guaranteed access to the grid.
- *Environmentally friendly zoning* that encouraged cogeneration units and prohibited the use of fossil fuels for many generators, and streamlined permitting to create a "one stop shop" for tendering bids for construction, approval of sites, environmental impact assessments and licensing.
- *Capital subsidies* equal to 30% of the investment costs of wind turbines were introduced in 1979, however, as the cost of wind turbines decreased this subsidy was repealed in 1989 for wind turbines (it was retained for other forms of electricity generation that were not yet cost competitive) (Moore and Ihle, 1999).

In 2005, Denmark sourced 28.1% of its electricity from renewable sources, the highest proportion of any OECD country and an increase from 3.1% in 1990 (OECD, 2007, p18). Further, Danish companies have achieved world leading positions, for example Vestas is the largest wind turbine manufacturer in the world with a market share of 23% in 2007 (BTM Consult, 2008, p2). Danish firms exported US$7.45 billion in energy technology and equipment in 2005 (Scitizen, 2008).

## Bibliography

ACRE (2001), *Assessment of Status of Development of Standards and Training for Renewable Energy in Australia*.

The Age (2007), "It's the stupid country", 16 October 2007. Available at: www.theage.com.au, accessed March 2008.

Australian Business Council for Sustainable Energy (ABCSE) (2004), *The Australian Photovoltaic Industry Roadmap*.

Australian Bureau of Statistics (2007), *5204.0 Australian System of National Accounts*, Canberra.

Australian Coal Institute website (2008): http://www.australiancoal.com.au/, accessed April 2008.

Australian Department of Foreign Affairs and Trade (2007), *Composition of Trade Australia 2006-07*, Canberra

Australian Greenhouse Office (2003), *Renewable Opportunities*.

Australian Private Equity & Venture Capital Association Limited (2008), www.avcal.com.au, accessed April 2008.

Australian Securities Exchange (2008), *History of ASX*. Available at: www.asx.com.au, accessed March 2008.

Batchelor, M. (2007), *Australia wants to ease delays at ports*, published in the *International Herald Tribune*, 12 April 2007.

BTM Consult ApS (2008), "International Wind Energy Development: World Market Update 2007 Press Release", March 28 2008. Available at: www.btm.dk, accessed April 2008.

Charlton, A (2007), *Ozonomics* (Random House, Australia).

CIA World Factbook (2008), https://www.cia.gov/library/publications/the-world-factbook/, accessed March 2008.

Cummings, D. and Johan, S., (2007), *Pre-Seed Government Venture Capital Funds*. Available at: http://papers.ssrn.com/, accessed April 2008.

Dee, Jon/GMI (2007) "Top 50 Australian Climate Change Findings", in *World Environment Review* published by World Market Insite, Inc.

The Economist (2008), "German Lessons", April 3 2008. Available at: www.economist.com, accessed April 2008.

Economist Intelligence Unit (2008), *CountryData* online database, accessed March 2008.

European Commission (2006), Directorate General Joint Research Centre, *PV Status Report 2006*.

European Pholtovoltaics Industry Assocation (EPIA) (2005), "Position Paper on a Feed-In Tariff for Pholtovoltaic Solar Electricity". Available at: http://www.epia.org, accessed April 2008.

European Pholtovoltaic Industry Assocation (EPIA) (2007), "Global Market Outlook for Photovoltaics until 2012". Available at: www.epia.org, accessed April 2008.

German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2007), *EEG – The Renewable Energy Sources Act*.

German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (2008), *Development of Renewable Energies in Germany in 2007*.

International Energy Agency (2005), *Energy Policies of IEA Countries – Australia 2005 Review*.

International Energy Agency (2008), website: http://www.iea.org/Textbase/stats/index.asp.

The Independent (2008), "Here Comes the Sun", January 23 2008. Via Factiva, accessed March 2008.

Institute for Competitiveness Cluster Project (2005). Available at: http://data.isc.hbs.edu/, accessed February 2008.

McLennan Magasanik Associates (MMA) (2006), *Renewable Energy – A Contribution to Australia's Environmental and Economic Sustainability*.

Meredith, David, and Dyster, Barrie, *Australia in the Global Economy: Continuity and Change* (Cambridge University Press, Cambridge, 1999)

Moore, C. and Ihle, J. (1999), "Renewable Energy Policy Outside the US", 1999. Available at: www.crest.org, accessed April 2008.

National Office for the Information Economy, Australia (NOIE) (2005) "Productivity Growth in Australian Manufacturing", *NIOE Occasional Paper*.

OECD (2004), *Renewable Energy Market and Policy Trends*.

OECD (2006), *Education at a Glance*.

OECD (2007) *Renewables Information 2007*.

OECD (2008), *OECD Factbook 2008: Economic, Environmental and Social Statistics.*

Pearce F. (2002), "Coal Rich Australia Rejects Kyoto Protocol", in *NewScientist*, June 4, 2002, accessed via Factiva in April 2008.

President's Committee of Advisors on Science and Technology (PCAST) (1999), "Powerful Partnerships: The Federal Role In International Cooperation on Energy Innovation". Available at: http://belfercenter.ksg.harvard.edu, accessed April 2008.

Porter, M., E. (2007), *Global Competitiveness Report* .

Renewable Energy Policy Network for the 21st Century (REN21) (2007), *Renewables 2007 Global Status Report*.

Reserve Bank of Australia (1997), *Bulletin – Privatisation in Australia*. Available at www.rba.gov.au, accessed April 2008.

Reuters (2007), "Cloudy Germany unlikely hotspot for solar power", 30 July 2007. Available at: www.wind-works.org, accessed April 2008.

Scitizen (2008), "Is the Danish Renewable Energy Model Replicable?", 20 March 2008. Available at: http://scitizen.com, accessed April 2008.

Solar Daily (2008), "Germany's PV Industry Securing Its Position As World Leader", April 2 2008. Available at: www.solardaily.com, accessed April 2008.

Sydney Morning Herald (2008), "Exodus for a place in the sun", September 19 2007. Available at: www.smh.com.au, accessed March 2008.

United Nations (2007), *2007/2008 Human Development Index rankings*. Available at: http://hdr.undp.org/en/statistics/, accessed March 2008.

UNDP, *Human Development Report* (2007-2008) accessed online at http://hdrstats.undp.org/indicators/

The World Bank (2006), *Where Is The Wealth Of Nations? Measuring Capital for the 21st Century*, Washington DC.

World Federation of Exchanges (2008), Domestic Market Capitalization data. Available at: http://www.world-exchanges.org/, accessed March 2008.

**Required disclosure:** Clare O'Neil, Alex Satchcroft and Thomas Vogt are Australian citizens.