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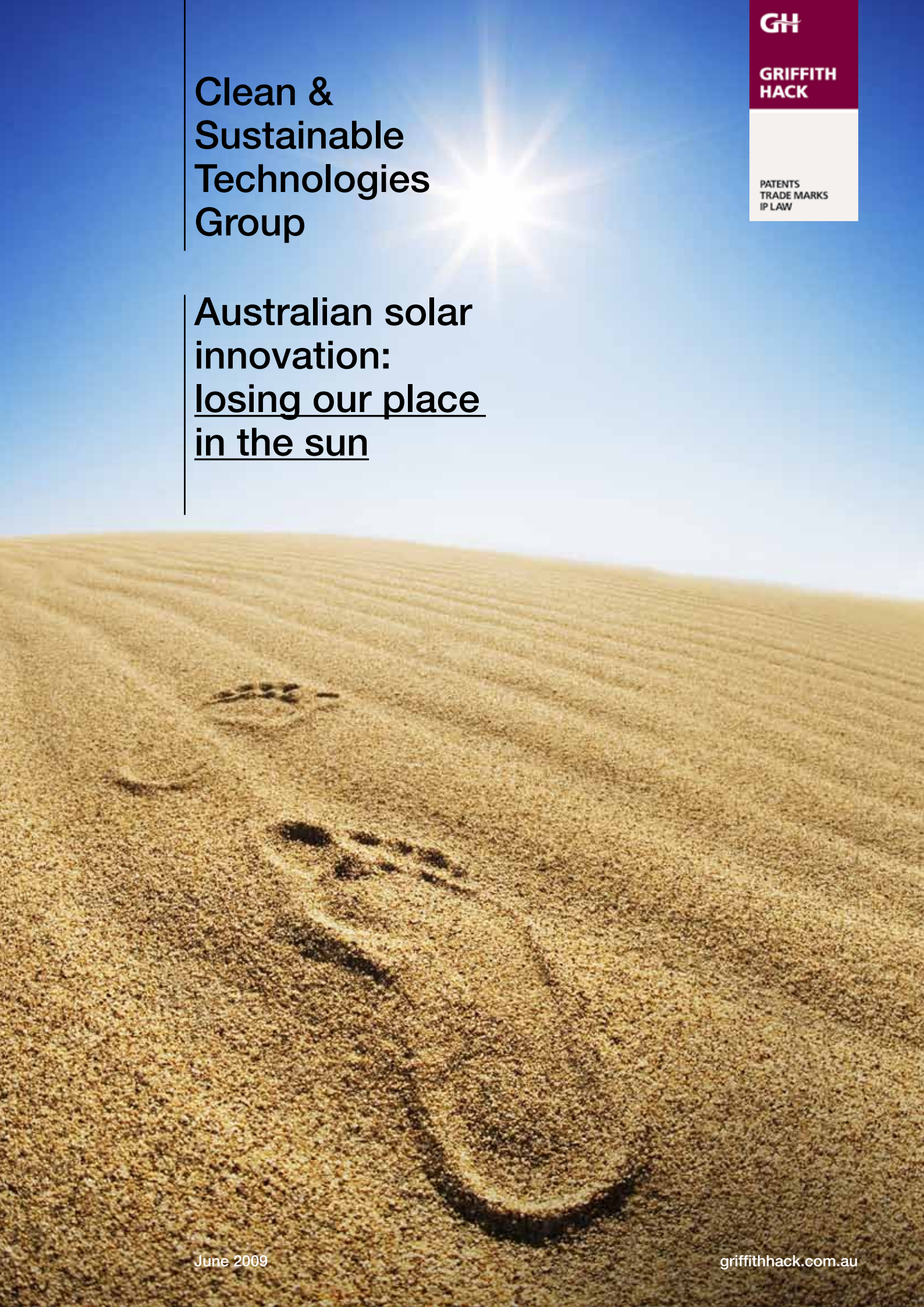
Australian solar innovation: losing our place in the sun



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The Opportunity

As one of the world's sunniest places, Australia should be well placed to both use and drive solar technology innovation. Unfortunately, our research shows this isn't the case.

By **Mike Lloyd** and **Justin Blows**

Australian solar innovation

Australia is falling behind a number of other countries in its use of solar power. This study uses patent filing data to determine if this under-utilisation is due to a lack of local solar innovation.

Griffith Hack's report authors, Mike Lloyd, IP Portfolio Management Consultant, and Justin Blows, Patent Attorney, found that Australian solar innovation has been flat over the last five years, while the rest of the world has been surging ahead.

Australia has produced some world-leading solar innovators, and some of these innovators remain in Australia. However, Australia cannot afford to rest on its laurels, otherwise it will risk falling behind both in the use of solar energy as a power and heat source, and also in the worldwide export of solar technologies.

The recent announcement of significant federal and state government funding is encouraging, and we look forward to seeing this funding reflected in new innovations and patent filing data.

Solar power potential

It is believed Australia could supply its electricity with the sunlight falling on a square area about 50 kilometres by 50 kilometres[1]. Many Australian rural communities are situated long distances from major power generation plants, and locally based generators, such as solar power plants, are naturally suited to these areas. Solar power has a significant potential to reduce the consumption of fossil fuels, which is thought to be a major contributor to climate change.

Solar power production is growing rapidly around the world. Photovoltaic power production is expected to grow 40% in 2009[2], building on growth figures estimated in 2008 to be as high as 110%[3].

Germany, Japan, the US and Spain are the major contributors

Contents

Australia's weak performance in the utilisation of solar power is a poor reflection of the quality of its innovators

to this growth, with solar power already providing around 2.2% of Germany's and 0.5% of Japan's electricity production capacity[4]. The comparable figure for Australia is 0.15%[5], which is barely ahead of the global estimate of around 0.12% of total global electricity capacity.

A similar picture is seen with solar hot water. By 2006, there was an estimated 1.3GWth (gigawatt-thermal) of installed solar hot water capacity in Australia[6], which is equivalent to 2.8% of our electricity capacity, and ahead of the equivalent worldwide figure of around 2.4%. However, this compares poorly with Israel, which has around three times Australia's installed capacity of solar hot water with about one-third of our population.

Australia's performance

Australia's weak performance in the utilisation of solar power is a poor reflection of the quality of its innovators, who include some of the world's early pioneers in this field. For example, Dr Zhengrong Shi, formally from the University of New South Wales, became the world's first solar billionaire after founding the Nasdaq-listed Suntech. Also, Dr David Mills, formerly from the University of Sydney, developed and licensed solar water heater technology that is now used by 60% of the world's solar collectors[7]. Dr Mills later founded the Californian company Ausra, which is now building a 180MW (megawatt) solar thermal power plant in California.

More recently, Victorian company Solar Systems has partnered with the state of Victoria to build the world's largest photovoltaic power plant near Mildura.

Patents and innovation

Patent applications are filed by inventors or their employers to claim ownership of their innovations. Ownership in turn provides the underpinning for subsequent commercial innovation. For this reason, patents are a good predictor of commercial innovation.

As examples of this, the Australian patent database shows the aforementioned Dr Shi and Dr Mills are inventors of 12 and 20 Australian patents or patent applications respectively, while Solar Systems has filed 20 patent applications since 1993.

Waking up to Australia's potential

"Australia appears to be waking up to its enormous potential in both solar production and solar technology commercialisation. The world's highest capacity photovoltaic power plant is being built near Mildura, Victoria, using Australian technology, and the federal government has allocated significant funding for other solar power plants. However, recent patent data shows Australian solar innovators are falling behind some other countries. I hope this report encourages Australian innovators, and their supporters, to improve our competitive position." – *Mike Lloyd*.

Strong local innovation performance is a sign of a healthy local skills base

Innovation performance

In this study, we used recent patent data to investigate current solar innovation in Australia, and to help understand whether the recent underperformance in the take up of solar power in Australia is because of a corresponding underperformance in innovation.

While rich countries such as Australia are always free to benefit from imported technologies, a strong local innovation performance is a sign of a healthy local skills base and associated economic benefits.

The benefits of patenting

The benefits of securing patents are also significant for individuals and businesses. These benefits include:

- A claim on ownership of the technology it covers, promoting investment in research, development, commercialisation, deployment and diffusion of the technology within the market.
- Increased likelihood of attracting funding for the technology through equity, loan or government grant.
- Clarity and legal certainty, which promotes technology transfer through licensing, joint ventures and sale of the technology.
- Leverage when engaging other commercial parties about an alleged infringement.
- Leverage during the negotiation of technology transfer and sale.
- Increased reputation and brand value.
- Confirmation that commercial technology is being developed, and not just research publications.
- Proof of publication.

References

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8 Unpublished analysis of Australian patent filing data, based on the UK's DTI/OST patent classification scheme
9 *China to offer subsidies to boost photovoltaic market*, Reuters, 21 May 2009, www.guardian.co.uk/business/feedarticle/8518779

Market dominance

"Economists believe a mass exploitation of clean and sustainable technologies, like solar energy technology, has the potential to create wealth on the same scale as the introduction of the railways, electricity, cars, and information technology. Some are realising the opportunity and are aggressively protecting new technology. For example, Toyota has crystallised its early mover advantage in hybrid vehicle technology, giving it overwhelming market dominance – which it is now executing. New and substantial government backing gives the Australian solar industry the potential to achieve similar dominance, provided that innovation is carefully and thoughtfully protected." – *Justin Blows*.

The Method

How this study was produced

Griffith Hack patent search specialists developed a broad search query for patents and patent applications related to devices capturing solar energy and the application of captured solar energy.

The analysis was limited to Australian patents registered between 2003 and 2008 to emphasise recent innovations. The patent data was obtained from the public electronic database of Australian patents – 656 patents or patent applications were found.

The patent was assigned the date it was registered with the Australian patent office, which in the case of international PCT (Patent Cooperation Treaty) applications was taken to be the national phase entry date. Provisional patent applications were not included in this data.

The term 'patent' is used in this report for both granted patents and patent applications.

What is solar technology?

Solar technology encompasses a wide range of technologies, including the conversion of solar energy into power or heat, the various technologies needed to support this conversion, and how the heat or power is used. The patents have been grouped according to the technological categories detailed in Table 1.

Table 1: Categorisation of solar patents found in this study

Photovoltaic cells	All technologies directly related to photovoltaic solar cells **Sub categories** • Photovoltaic (PV) modules (how PV cells are assembled and internally connected) • Conventional crystalline silicon PV cells • Dye sensitised PV cells • Thin film PV cells • Silicon thin film PV cells • Organic/polymer PV cells • Nano-crystalline PV cells • Copper indium selenide PV cells
Solar infrastructure	How photovoltaic cells or solar thermal systems are mounted or managed, including concentration of solar energy **Sub categories** • Solar concentration • Solar tracking • Solar panel mounting • Solar power control (how solar electrical energy was converted and controlled) • Combined solar heat and power • Solar panel cooling
Solar thermal	Technologies that use solar heat as a form of energy, either to convert this heat to electricity, or for other industrial purposes **Sub categories** • Solar thermal heat absorption (how solar heat is absorbed by the energy converter) • Solar thermal energy conversion (how solar heat is converted into electricity or other useful applications)
Solar applications	Innovations concerned with the application of solar energy to specific applications, such as solar power refrigerators
Solar hot air and water	Direct use of solar energy to create hot air or water, mainly for domestic purposes

The Results

Solar innovation trends

The number of Australian solar patents registered doubled from 67 to 135 patents between 2003 to 2008 (Graph 1). However, the increase in patents is entirely due to overseas applicants.

The overall trend in the number of Australian sourced patents was flat. Consequently, the proportion of Australian solar patents filed by Australian patent applicants fell from 36% in 2003 to 19% in 2008.

The majority of patents were related to solar cells (Graph 2), closely followed by solar infrastructure. Graph 2 also shows that solar infrastructure was the most popular area for Australian solar patents, followed by solar hot air and water (mostly water) and then photovoltaic cells.

In comparison, the rest of the world predominately filed patents in the area of solar cells, followed by solar infrastructure.

Overseas patents

Between 2003 and 2008, the number of Australian solar patents filed by non-Australian applicants more than doubled. The number of solar patents registered by US applicants quadrupled, and the number of patents filed by German applicants tripled, if from a low base (Table 2). The number of patents filed by Japanese applicants fell, however, reducing their annual share from 27% in 2003 to 10% in 2008.

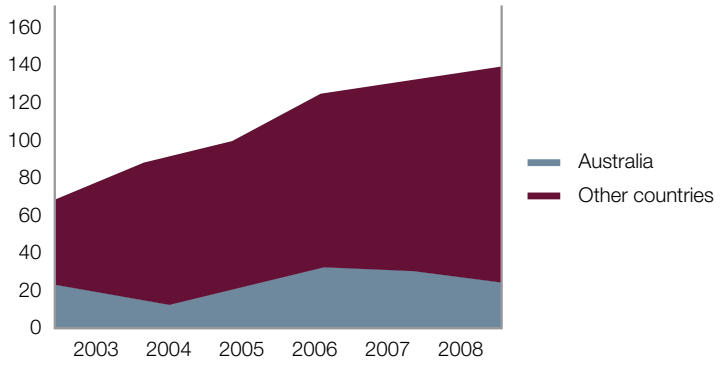
Given the strong increase in US originating applications, the US is likely to be the source of most Australian patents in the future.

How Australia fared

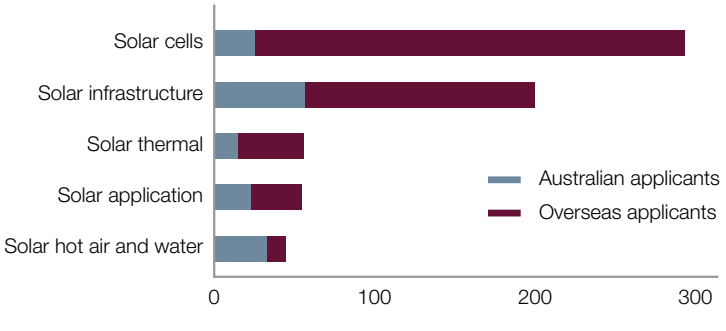
We can use the relative proportion of Australian originating patents registered as an indication of the relative strength of Australia's industry. Table 2 shows that 19% of solar patents were filed by Australian applicants in 2008, which compares well to the 13% of patents filed by Australian applicants across all technology areas.

Other areas of national interest, however, achieve a greater fraction of domestic filings. For example, 31% of Australian civil

Graph 1: Australian solar patents filed 2003-2008



Graph 2: Types of Australian solar patents 2003-2008



Australia is not innovating sufficiently to capitalise on its abundant solar resources

engineering and mining patents and 30% of agricultural patents were registered by Australians during the same period.

These figures demonstrate what Australian innovators can achieve when backed by large reserves of natural resources, such as minerals and land. In this context, it appears that Australia is not innovating sufficiently to capitalise on its abundant solar resources.

On the other hand, the 19% proportion of Australian solar patents filed is ahead of the equivalent figures for the related fields of electrical engineering and electrical devices (10%), optics (10%) and semiconductors (5%)[8].

We expect there will be large numbers of Australian solar patents filed in the next decade. For example, Toyota filed more than 800 patent families between 2003 and 2008 to protect its hybrid engine technologies. When the global solar industry matures to the point at which the hybrid vehicle industry is now, the current 20 or 30 Australian original solar patents registered per year may not have any significant commercial impact.

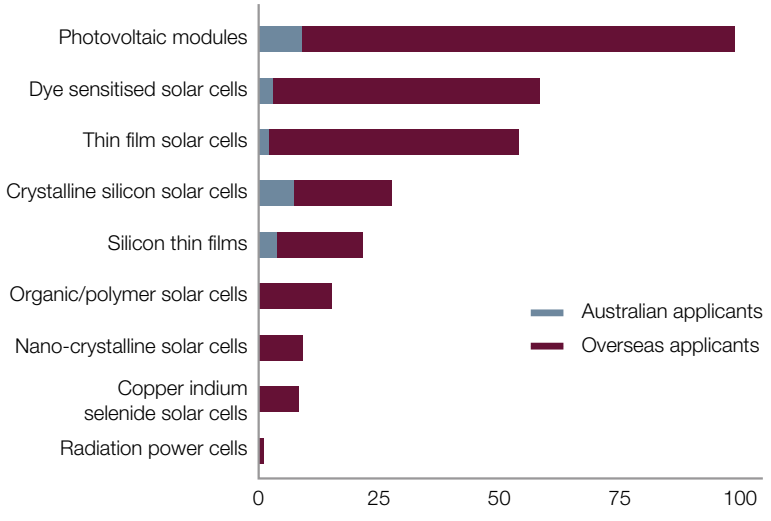
Solar photovoltaic patents

The most popular area for photovoltaic cell patents was related to the design of the photovoltaic modules (Graph 3). Dye sensitised and other thin film photovoltaic cells were also popular areas. Australian applicants

Table 2: Leading countries of origin for Australian solar patents

	2003	2008	2003-2008	% change 2003-2008
Australia	24 (36% of all patents)	25 (19%)	150 (24%)	+4%
All overseas	43	110	485	+155%
Key overseas countries				
US	10 (15%)	44 (33%)	147 (23%)	+340%
Japan	18 (27%)	14 (10%)	121 (19%)	-20%
Germany	4 (6%)	13 (10%)	55 (9%)	+220%
Total patents – (All countries)	67	135	635	+100%

Graph 3: Types of Australian photovoltaic cell patents 2003-2008



A truly significant technology is likely to be protected by a number of different patents

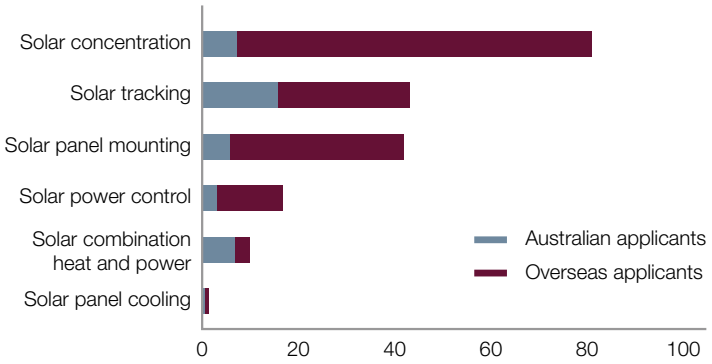
appeared to file a low proportion of these patents, except in the area of crystalline silicon solar cells.

Solar infrastructure patents

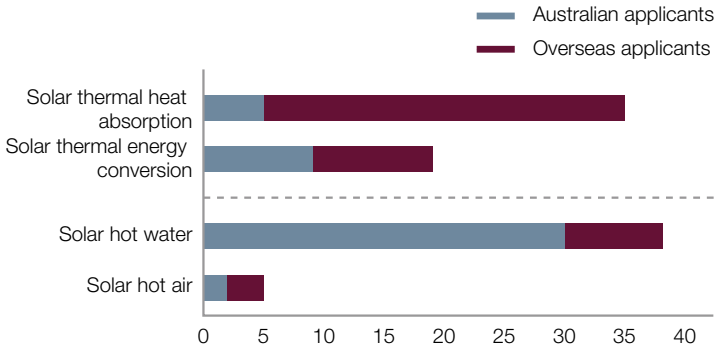
Patents related to the concentration of sunlight dominated this category (Graph 4). There were also many innovations relating to solar tracking, with many of these patents disclosing elements related to the concentration of solar energy.

Australian applicants filed a reasonable proportion of the patents in all sub-categories.

Graph 4: Australian solar infrastructure patents registered by sub category 2003-2008



Graph 5: Australian solar thermal and solar hot air and water patents registered by sub category 2003-2008



It should be noted that many of the technologies covered by this group potentially cover both photovoltaic cell and solar thermal technologies, which is why they are in separate groups.

Solar thermal patents

About two-thirds of solar thermal patents were related to heat absorption technologies, such as fluid-based heat exchangers and the selection of ceramic materials. Australian applicants filed a greater proportion of solar thermal conversion patents, which refer to how heat is converted into useful energy (Graph 5).

Solar hot air and water patents

Solar hot water patents greatly outnumbered solar hot air patents (Graph 5), with the majority filed by Australian innovators. The data suggests that Australian companies are competitive in solar hot water, at least within Australia.

Who filed these patents?

The leading patent applicant was BP, followed by Japanese companies Canon and Fujikura (Graph 6). However, Australia's Solar Systems and the University of New South Wales are both in the top 10.

The top Australian enterprises include Solar Systems (with 11 applications), the University of New South Wales (seven), Rheem (six), the Australian National

University (six), the University of Sydney (five), Dyesol (four), and Solar Heat and Power (four).

It should be noted that the 150 Australian sourced solar patents we identified came from 80 different applicants. A truly significant new technology is likely to be protected by a number of different patents. An average of only 1.9 patents per applicant suggests the majority of the Australian solar patent applicants may struggle to make a major commercial impact.

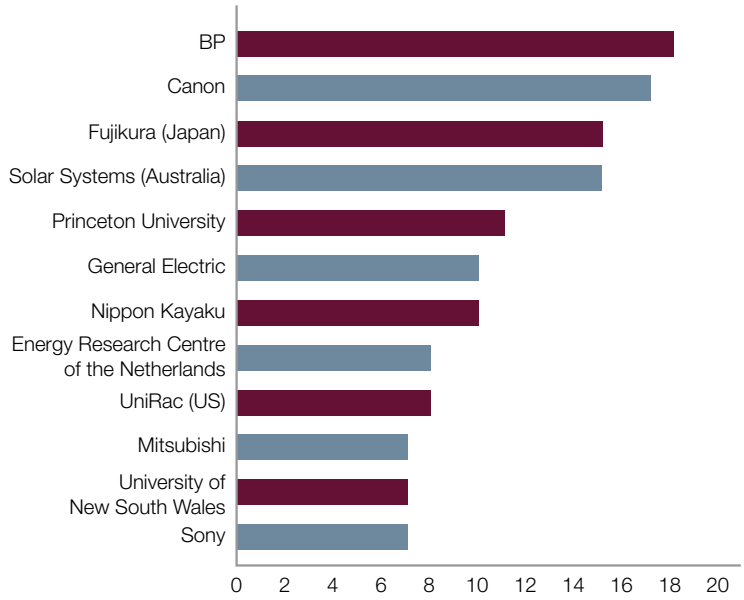
How the states performed

New South Wales is leading Australia in terms of solar innovation, filing a little less than half of the Australian patents filed (Graph 7). These patents are being filed by a range of leading applicants, including the University of New South Wales, Rheem Australia, the University of Sydney, Solar Heat and Power, Dyesol and Origin Energy.

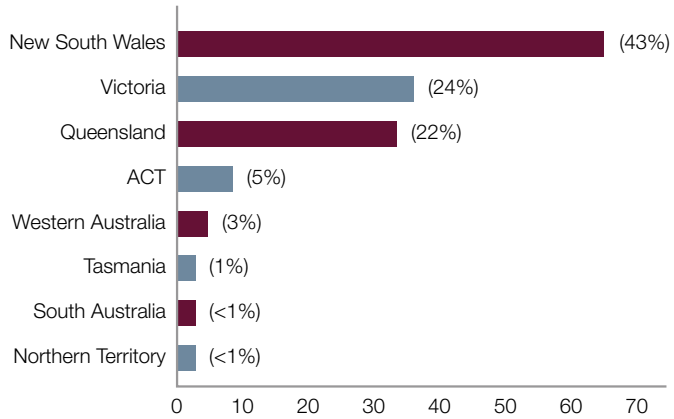
Victoria and Queensland each filed a little less than one-quarter of the remaining patents. Leading Victorian applicants were Solar Systems and Universal Biosensors, while Solar Power Limited was the leading Queensland applicant.

The low numbers of patents filed by Western Australian and South Australian applicants is perhaps surprising, considering their hot climates and established technical and scientific resources.

Graph 6: Leading applicants for Australian solar patents 2003-2008



Graph 7: Distribution of Australian sourced solar patents, by the applicant's home state or territory



The Lessons

Economic potential of solar

The overseas companies founded by Dr Shi and Dr Mills, and the listed Australian solar related companies Dyesol, CBD Energy and Skydome Holdings, show the economic potential of Australian solar innovation. There is also significant export potential, with China recently announcing plans to spend more than 3 trillion yuan ($AUD560 billion) on renewable energy by 2020[9].

However, patent filing data suggests Australia's solar innovation capacity has been static over the last five years. Meanwhile, solar innovation has greatly increased in the rest of the world.

> A larger number of new solar patents being filed by Australians should lead to a stronger local solar industry

Australia has produced two of the world's leading solar innovators, but these innovators have since moved to other countries. And while Australia still retains some strong local solar innovation capacity, such as that of Solar Systems and the scientific capabilities of the University of New South Wales, the Australian National University and the CSIRO, this may not be enough to achieve the full potential of solar power for Australia.

This produces two major risks for Australia:

1. Australia starts to lose the critical mass of know-how needed to understand and apply solar innovations, whether these innovations are generated in Australia or elsewhere. Solar technologies can be complex, and economies often need local expertise to properly benefit from technology advances.
2. Australia has a reduced capacity to export solar technologies. The ownership of key innovations by Australian companies or individuals is more likely to lead to the supply of these innovations or complementary technologies by Australian businesses, leading to growth in green collar jobs and associated tax revenues.

We have seen this complementary technology effect in Australia's mining industry, which built on Australia's mineral reserves to create a world leading industry in international mine ownership and related services. There is little reason why Australia could not repeat this achievement with solar power generation, especially considering that production of solar power technology has a high added value, and is therefore at lower risk of being transferred to low labour cost countries.

Strengths and opportunities

Australian patent applicants were over-represented compared to the rest of the world in solar infrastructure patents, while under-represented in photovoltaic patents. It may be that photovoltaic technologies are starting to mature, and the sophisticated manufacturing techniques needed to produce solar cells at commercial volumes are more likely to reside in overseas countries with significant electronics industries.

Many of the technologies claimed by the solar infrastructure patents fall within the realm of mechanical engineering, and Australia is well placed to compete in this area.

Recent developments

Recent Australian federal government announcements may help both solar power production

and innovation in Australia. These include the Australian federal budget allocation of around $AUD1.4 billion to build flagship solar plants, $AUD100 million for research and development, to be managed by the Australian Solar Institute, and $AUD465 million to support the development, commercialisation and deployment of renewable technologies.

There have also been some recent commercial announcements, such as the 154MW Solar Systems plant near Mildura in Victoria, hybrid solar/diesel power plants in the Pilbara regions in Western Australia, and a 30MWe (megawatt equivalent) solar thermal system to preheat boiler water at Liddell power station in New South Wales.

How to improve innovation

Innovation, to some extent, is a probability exercise – the more new innovations are tried, the greater the likelihood that one or more of these innovations will prove a large commercial success. Not all patents will lead to commercial successes and the range of complementary benefits, but over time some should.

In general, a larger number of new solar patents being filed by Australians should lead to a stronger solar industry, both in terms of production of solar power and sale and export of solar technologies.

However, there is a risk that some of the leading solar innovators, whether in Australia or elsewhere, may achieve such a strong patent position that competition is significantly reduced. It would be great if an Australian patent owner was to achieve this position, but might be problematic if the owner was based outside of Australia.

A common defence against this sort of situation is to build up a strong patent position of your own, which both defends your position and can be used against your competitors.

For this reason, it is essential that Australian solar innovators continue to safeguard their commercial positions with strong patent portfolios. Additionally, the funding partners for these innovators need to ensure that their interests are also secured by patent protection. GH

Australia's solar innovation capacity has been static over the last five years

Need to know more?

Griffith Hack is pleased to discuss the details of this study and other exciting work it is doing to promote the benefits of clean and sustainable technology IP.

To learn more about this study, please contact Mike Lloyd, Griffith Hack's IP Portfolio Management Consultant, on +61 3 9243 8315 or mike.lloyd@griffithhack.com.au

To use patent data to determine technology trends in your industry, please contact George Mokdsi, Griffith Hack's Information Services Manager, on +61 2 9925 5975 or george.mokdsi@griffithhack.com.au

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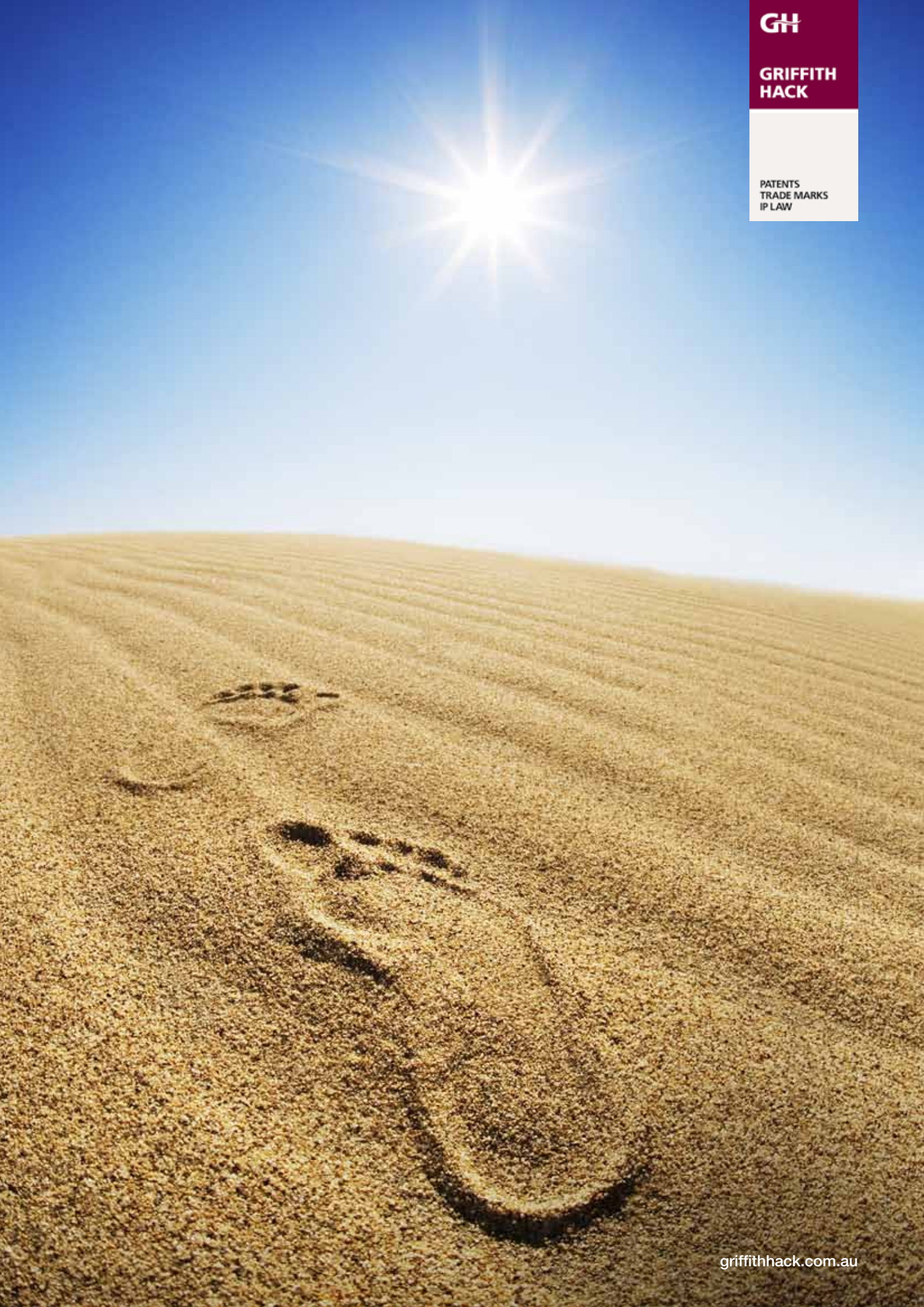

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