INTERNATIONAL ENERGY AGENCY
CO-OPERATIVE PROGRAMME ON
PHOTOVOLTAIC POWER SYSTEMS

Task 1
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Australia 2009

Prepared by
Muriel Watt & Joe Wyder
IT Power Australia

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This report is prepared on behalf of and with considerable input from members of the Australian PV Association (APVA) and the wider Australian PV sector.

The objective of the APVA is to encourage participation of Australian organisations in PV industry development, policy analysis, standards and accreditation, advocacy and collaborative research and development projects concerning solar photovoltaic electricity.

APVA provides:

- Up to date information on PV developments around the world (research, product development, policy, marketing strategies) as well as issues arising.
- A network of PV industry, government and researchers which undertake local and international PV projects, with associated shared knowledge and understanding.
- Australian input to PV guidelines and standards development.
- Management of Australian participation in IEA-PVPS, including:

    PV Information Exchange and Dissemination;

    PV Hybrid Systems within Mini-grids

    High Penetration PV in Electricity Grids.

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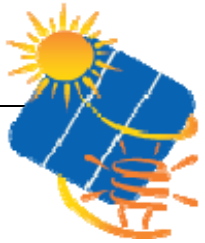

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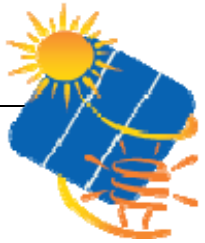

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Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

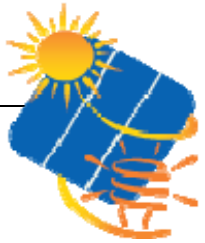
Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are



incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

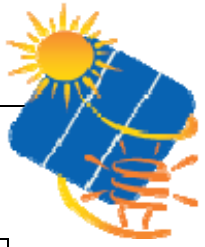
Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is Australian dollars (AUD).

PV support measures:

Enhanced feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favouring hydro, wind and biomass)
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often



	called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net metering	in effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Electricity utility activities	includes 'green power' schemes allowing customers to purchase green electricity, large-scale utility PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development

Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The 21 participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association and the US Solar Electric Power Association are also members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website: www.iea-pvps.org

Australia participates in the PVPS via the Australian PV Association (www.apva.org.au) with funding assistance from the Australian Solar Institute.

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

An important deliverable of Task 1 is the annual Trends in photovoltaic applications report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the Australian National Survey Report for the year 2009. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 EXECUTIVE SUMMARY

1.1 Installed PV power

A total of 79 MW of PV were installed in Australian in 2009, a 360% increase on 2008 levels. Of this, nearly 87% was grid-connected, taking the cumulative grid-connected portion to nearly 54%, up from 30% in 2008. Total installed capacity in Australia is now 184 MW.

1.2 Costs & prices

Typical module and system prices fell in 2009 compared to 2008, although there was still a wide spread of prices. Module prices averaged AUD 5,60 / Wp but ranged from 3 to 7,50, and small grid systems AUD 9,10 / Wp, ranging from 7 to 10,50 / Wp.

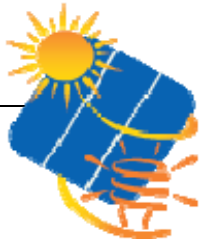
1.3 PV production

12 MW of cells and modules were produced in Australia in 2009, from imported wafers.

1.4 Budgets for PV

Government expenditure on PV research, development, demonstration and market incentives totalled AUD 526 million in 2009. The Australian Government market incentive programs: Solar Homes and Communities Plan and the Renewable Remote Power Generation Program ended pre-purchase approvals in June 2009, but still account for 96% of 2009 expenditure.

Figure 1: 48 kWp PV array on Sydney Town Hall (Photo: NSW Government Architect's Office)



2 THE IMPLEMENTATION OF PV SYSTEMS

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

For the purposes of this report, PV installations are included in the 2009 statistics if the PV modules were installed between 1 January and 31 December 2009, although commissioning may have taken place at a later date.

2.1 Applications for photovoltaics

The market for PV installations connected to central grids continues to increase and represented the largest market for PV in 2009. The majority of installations took advantage of a government grant program (the Solar Homes and Communities Plan) which ceased pre-purchase approvals in June 2009. The main applications are rooftop systems for private residences, and community buildings. Commercial and light industry sector interest is also growing, with support available to selected projects in certain areas through the Solar Cities program. All grid-connected PV systems can create Renewable Energy Certificates (RECs) for the Renewable Energy Target. This mechanism and the Solar Credits REC multiplier took over from the grant based support mechanisms in June 2009.

The second largest installed capacity of PV in Australia is for off-grid industrial and agricultural applications. These include power systems for telecommunications, signalling, cathodic protection, water pumping and lighting. Significant markets also exist for off-grid residential and commercial power supplies and increasingly for fuel saving and peak load reduction on community diesel grid systems. Some of this market was supported by government grants through the Renewable Remote Power Generation program (RRPGP) which provided 50% of system costs with the aim of reducing diesel fuel use. There is also a market for recreational PV applications for caravans, boats and off-road vehicles.

2.2 Total photovoltaic power installed

The PV power installed in 4 sub-markets during 2009 is shown in Table 1. The most significant change is the high uptake of grid-connected distributed systems, with installations increasing from 14,8 MW in 2008 to 67,4 MW in 2009, due to the generous grants available. This has led to overall installations increasing from 22 MW in 2008 to over 79 MW in 2009.

Table 1: PV power installed during calendar year 2009 in 4 sub-markets.

Sub-market/ application	off-grid domestic	off-grid non-domestic	grid-connected distributed	grid-connected centralized	Diesel grid	Total
PV power installed in 2009 (MW)	7.18	2.48	67.36	1.21	0.90	**79.13**

The data in Table 1 was gathered directly from industry and government agencies via surveys, emails and phone calls. Other information is taken from annual reports and government data bases. Inaccuracies in Table 1, and subsequent tables, may arise because:

- businesses are reluctant to disclose detailed information on sales breakdown, costs or prices;
- the major importing companies do not keep statistics on the end-uses of their modules;
- the accounting periods for different companies vary, with most using the Australian financial year (July to June) but others use the Japanese financial year (April to March) or the calendar year.
- PV companies are busy and unwilling to spend the time collating data.

For Table 1 particularly, it is difficult to separate out sales into end-use categories. In addition, some projects may be long term, with installations actually occurring over a number of years. Hence the overall accuracy of the 2009 installation rate is estimated to be ±10%, but the error bar may be higher within sub-categories.

For cost estimates, it is difficult to separate out component and system cost from overall project costs, since tenders may be on the latter basis and include provision for transport, installation and after sales service.

A summary of the cumulative installed PV Power, from 1992-2009, broken down into five sub-markets is shown in Figure 1 and Table 2.

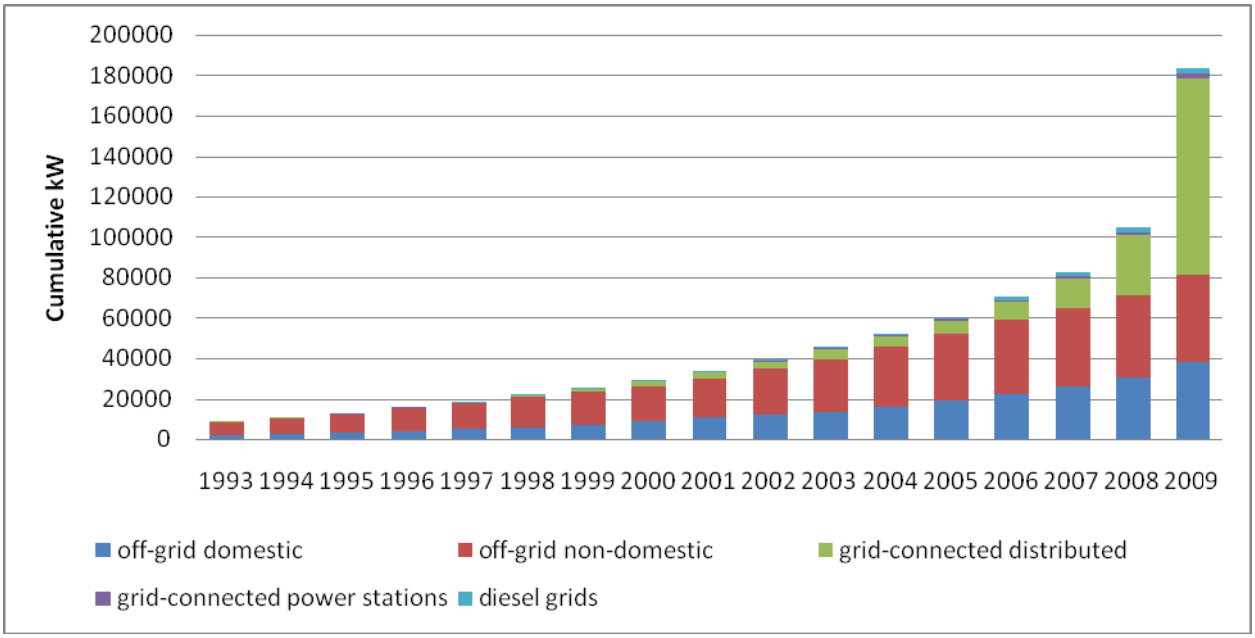


Figure 2: Cumulative PV Installations by End-Use Category. Australia 1992 – 2009.

Table 2: The cumulative installed PV power in 5 sub-markets (MW).

Sub-market	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Off-Grid domestic	1,56	2,03	2,60	3,27	4,08	4,86	5,96	6,82	9,11	10,96	12,14	13,59	15,90	18,77	22,14	25,89	30,68	37,87
Off-Grid non-domestic	5,76	6,87	8,08	9,38	11,52	13,32	15,08	16,36	17,06	19,17	22,74	26,06	29,64	33,07	36,65	38,73	40,66	43,14
Diesel grids						0,11	0,11	0,11	0,11	0,11	0,31	0,69	0,69	1,12	1,75	1,82	2,00	2,90
Grid-connected distributed		0,01	0,02	0,03	0,08	0,20	0,85	1,49	2,39	2,80	3,40	4,63	5,41	6,86	9,01	15,04	29,85	97,21
Grid-connected centralised				0,02	0,20	0,21	0,52	0,54	0,54	0,54	0,54	0,66	0,66	0,76	0,76	1,01	1,32	2,53
TOTAL (MW)	**7,30**	**8,90**	**10,70**	**12,70**	**15,70**	**18,70**	**22,52**	**25,32**	**29,21**	**33,58**	**39,13**	**45,63**	**52,30**	**60,58**	**70,30**	**82,49**	**104,51**	**183,64**

2.3 PV implementation highlights, major projects, demonstration and field test programmes

Australian Government support programs impacted significantly on the PV market in 2009. Key programs are described below.

2.3.1 Solar Homes and Communities Plan (SHCP)

The SHCP provided rebates of up to AUD 8 000 for 1 kWp of PV installed on residential buildings and up to 50% of the cost of PV systems up to 2 kW installed on community buildings. Rebates up to AUD 5 000 were available for system upgrades, if no previous rebates had been received. To be eligible, a household's income had to be less than AUD 100 000 per year.

The SHCP operated on a two stage application process – a pre-purchase application which allowed for an eligibility check before purchase and installation, followed by a rebate application after installation. On 9 June 2009, the Minister for the Environment announced that:

> *'The Government will bring the application period for rebates under the SHCP to a conclusion today, with Solar Credits to be provided upon passage of the RET legislation for systems installed from today onwards'.*

This effectively meant that SHCP pre-purchase applications that were sent after midnight on 9 June 2009 were not eligible. Not surprisingly, a record number of applications were sent on 9 June 2009. The surge of applications at the end of the program led to reports that it was over budget by AUD 850 million. However, the actual expenditure will not be known until mid 2010 when the final pre-purchase approvals expire. There is some doubt that all the pre-purchase approved systems will be installed before their expiry date, (9 months from pre-purchase approval).

This program had the most impact on the PV market in Australia during 2009, with 56,8 MW of PV installed and grants of AUD 454,4 Million provided. The vast majority of this (56,7 MW) was for grid-connected installations. A total of 84 MW of PV had been installed under this program to end 2009.

2.3.2 Renewable Remote Power Generation Program (RRPGP)

RRPGP provided rebates of up to 50% of the capital cost of renewable energy and related components used for diesel displacement in stand-alone power systems. Typical applications included off-grid households, indigenous communities, community organisations, retail/roadhouses, tourism sites, pastoral stations and other off-grid business and government facilities.

Components eligible for the rebate included renewable generation equipment, inverters, battery banks, enclosures, other supporting equipment and installations costs. For water pumping, only the renewable energy components were eligible (not pumps, pipe, concrete footings etc). Stand-alone power systems varied from 100% renewable to less than 50% renewable, with the diesel generator providing the majority of the load. Some systems included both PV and wind. System upgrades were also funded.

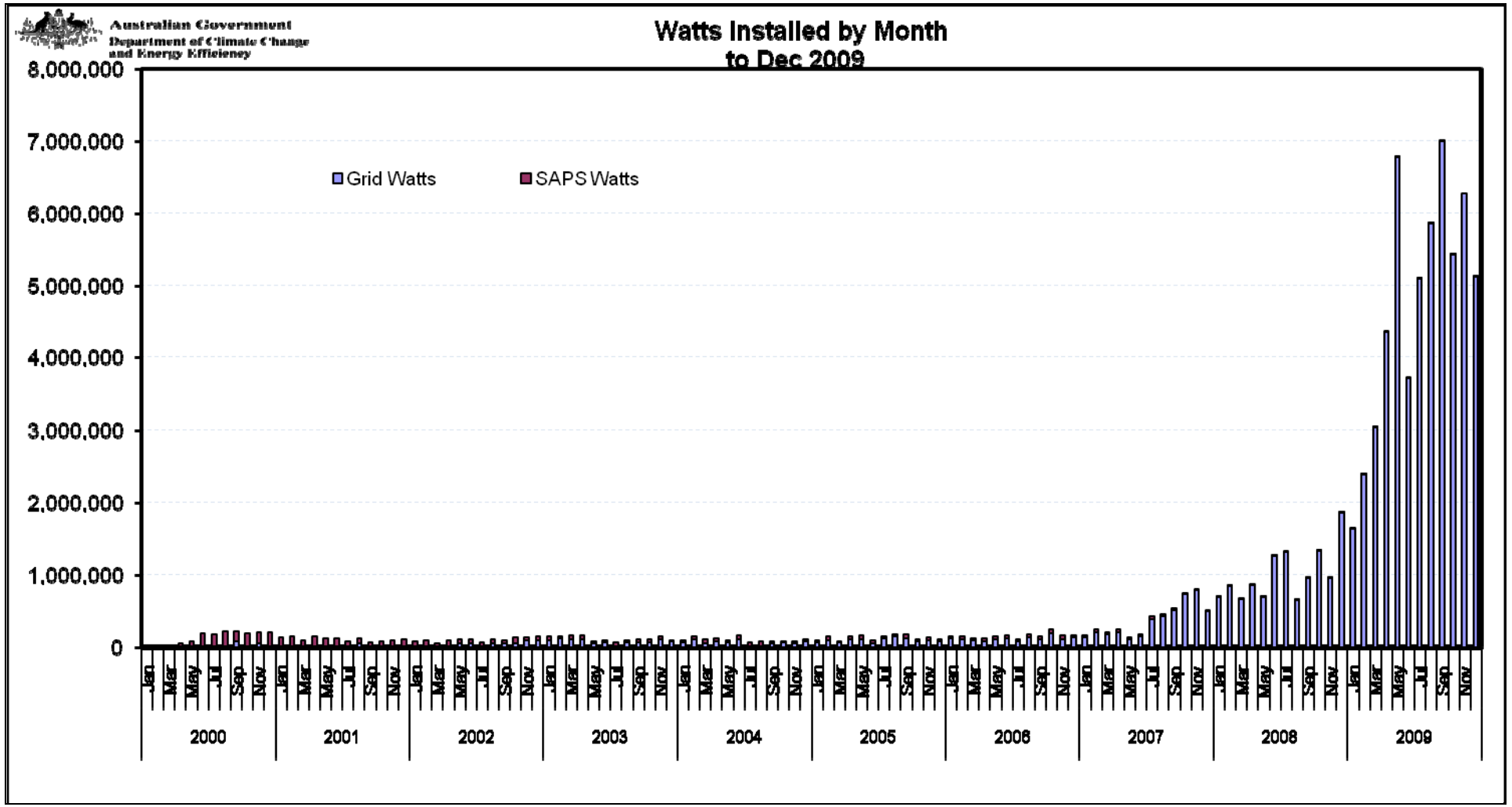


Figure 3: PV installations under the Solar Homes and Communities Plan 2000 to 2009 (www.environment.gov.au/settlements/renewable/pv/index.html)

In 2009 a total of 3180 kW of PV was installed in remote residences and 1537 kW in non-residential systems. Of these systems, 477 kW of PV were installed and connected to the Norfolk Island diesel mini-grid. A total of AUD 45,34 Million was provided in rebates, including 170 kW of wind power.

In total 4895 kilowatts were installed under RRPGP in 2009. This includes 175 kilowatts of concentrated PV at Windorah and 3,2 kilowatts of PV, integrated with two 20 kilowatt wind turbines, on Cape Barren Island.

The program operated under a number of sub-programs, including water pumping, industry support and major projects, some of which are administered by state government agencies.

On 22 June 2009, the Department of the Environment, Water, Heritage and Arts emailed the Clean Energy Council requesting they email all accredited industry designers and installers informing them that the program closed to new pre-purchase applications as of 8:30am. This sudden closure meant many applicants missed out on a rebate, even though they had gone through the rigorous application process. The only support for renewable off-grid systems in Australia is now provided through the Renewable Energy Target and its Solar Credit mechanism (see below).

2.3.3 Bushlight

Bushlight (www.bushlight.org.au) is an Australian Government-funded national, non-profit project that installs renewable energy systems in remote Indigenous communities (known as homelands) throughout central and northern Australia. Each system installation is preceded by, and carried out in conjunction with, a comprehensive program of community engagement, education and training. The project is partially funded by RRPGP. In 2009, Bushlight installed 5 new renewable energy systems, with a combined total of 66 kilowatts of PV. Bushlight also coordinates a maintenance program that serviced more than 180 renewable energy systems, located in 150 communities during 2009.

2.3.4 The Renewable Energy Target

The Australian Government has expanded the Renewable Energy Target (RET) to 45 000 GWh by 2020, as shown in Figure 4. This is expected to increase the amount of renewable generation from current levels of around 8% of total generation to 20% by 2020. The RET will continue to use the Renewable Energy Certificate (REC) mechanism, with each MWh of renewable energy generation eligible for one REC. REC multipliers, or Solar Credits, are available to PV systems, wind turbines and micro-hydro systems for the first 1,5 kWp of capacity, as shown in Table 3.

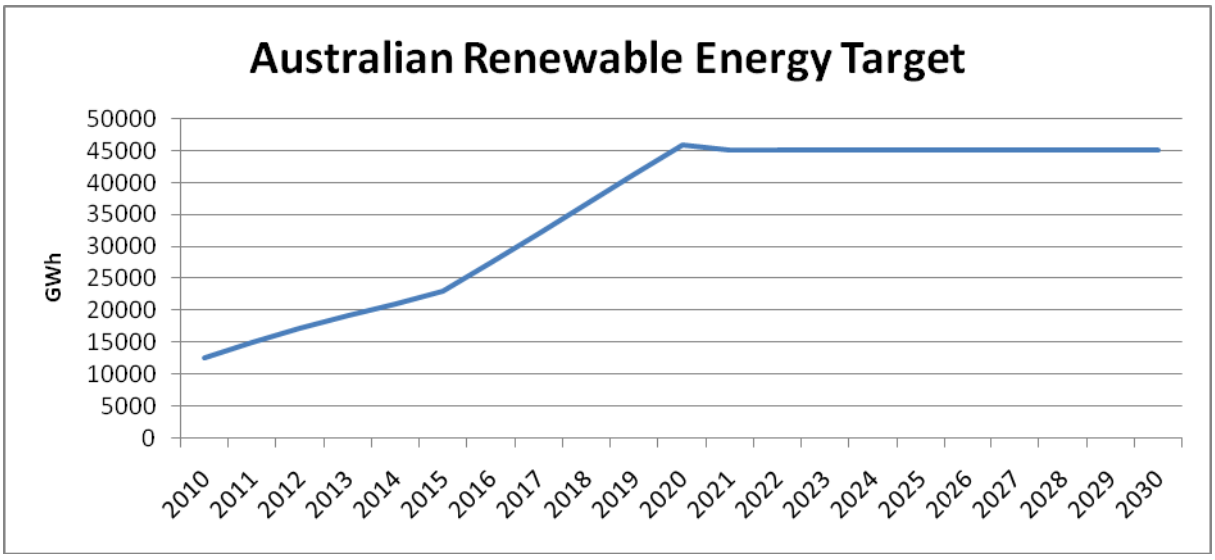


Figure 4: Australian Renewable Energy Target 2010-2030.

Output from capacity above 1,5kWp is eligible for 1 REC per MWh. As well as homeowners, other organisations such as schools, community groups, businesses and developers are eligible for Solar Credits, and no means test will be applied. For PV systems up to 100 kWp, 15 years' worth of RECs can be claimed up front, according to a set deemed output, depending on the site. RECs typically trade around AUD 30 to 40. Thus the RET can provide valuable capital cost reductions for small PV systems and will be one of the main market drivers in States with no gross feed-in tariffs. PV modules and inverters must meet Australian standards or specifications. This program, which follows on from grant based support schemes, has seen a rapid increase in the number of PV businesses, training and accreditation.

Table 3: Solar Credit Schedule

Year	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	From 2015-16 onwards
Multiplier	5	5	5	4	3	2	No multiplier

2.3.5 Solar Schools

The Australian Government's National Solar School Program (NSSP) assists schools to take practical action in the fight against climate change. It offers eligible primary and secondary schools grants of up to AUD 50 000 (up to AUD 100 000 for multi-campus schools) to install solar and other renewable power systems, solar hot water systems, rainwater tanks and a range of energy efficiency measures.

Schools across Australia have responded with great enthusiasm to the NSSP. Since the program commenced on 1 July 2008, more than 5600 schools have registered their interest to participate. To May 2010, funding totalling more than AUD 114 million had been paid or approved to more than 2500 schools. In addition, over 1000 schools have reported their installations complete.

Over 90 per cent of schools whose claims have been approved have chosen to install a PV system with their National Solar Schools funding. In 2009, NSSP funding of approximately AUD 35 million assisted schools to install around 4,5 MW of PV.

The NSSP was temporarily suspended on 15 October 2009 due to the very high demand for program funding from the 2009-10 budget allocation. The program will re-open to new claims early in the 2010-11 financial year.

In addition to the Australian Government funding, the 5 year Victorian Solar Schools program provides AUD 5 million to June 2011 to support the installation of PV systems. The 5 year AUD 5,1 million WA Solar Schools Program similarly supports the installation of PV systems in 350 metropolitan and regional State schools by 2010.

2.3.6 Solar Cities

In 2009, the Central Victoria, Moreland and Perth Solar Cities were launched and began offering energy saving products and programs to their communities. All seven Solar Cities are now operational: Adelaide, Alice Springs, Blacktown, Central Victoria, Townsville, Perth and Moreland.

Three solar Cities installed a total of 735 kW of household PV systems in 2009. In addition, a total of 938 kW of PV systems was installed on commercial and iconic buildings.

Alice Solar City

In late 2009, Alice Solar City (www.alicesolarcity.com.au) led a highly successful marketing campaign to support 100 rooftops to go solar in 100 days. This target was exceeded in the first 50 days of the campaign, demonstrating the willingness of households to embrace the use of renewable energy.

As a result of this campaign, the Alice Solar City financial incentives for PV were fully committed and approximately 300 households will receive a residential PV incentive through the Alice Solar City project. The majority of residents have installed 2 kW PV systems, while commercial premises have received assistance for PV systems in the range of 3 to 20 kW, as appropriate to their operations and energy use.

The NT Power and Water Corporation purchase solar power generated from households at their standard retail rate, with Alice Solar City providing a supplementary gross feed-in tariff. The combined residential buy-back tariff is currently AUD 0,499 per kWh, capped at AUD 5 per day per system.

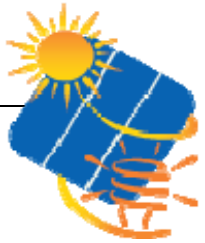
Townsville Solar City

The electricity utility, Ergon Energy continues to install PV systems on premises on Magnetic Island as part of the Townsville Solar City, (www.townsvillesolarcity.com.au). The goal for this project is 1 MW of PV systems.

Magnetic Island residents can volunteer their roof space and Ergon will fully manage installation and maintenance of the PV systems, as well as using the electricity generated to reduce daytime peak load on the island. In 2009, 187 kW of PV systems were installed on the island, bringing the total installed capacity to 288 kW.

Central Victoria Solar City

In November 2009, the Central Victoria Solar City (www.centralvictoriasolarcity.com.au) was launched with the opening of both the Bendigo and Ballarat solar parks. These PV systems have a combined capacity of over 600 kW. These two solar parks are unique elements of the Central Victoria Solar City in that they are two of Australia's largest ground-mounted, flat-plate,



grid-connected PV systems that are providing locally generated renewable energy to the region. Almost 900 people attended the official events and took tours of the two sites.

Central Victorian residents can support the solar parks by subscribing to the Solar Park Package, which includes a Participation Plan for their share of the local Solar Park, equivalent to a 2 kW PV system. The cost of this plan has been reduced due to the generous financial incentives provided by the project during the period of the trial including:

- The Central Victoria Solar City feed-in tariff – a gross tariff of AUD 0,60 per kWh which is a credit based on the electricity generated by a participant's share of the park; and
- the Central Victoria Solar City Investment Allowance – a capital allowance component.

Figure 5: The Ballarat Solar Park

2.3.7 Australian Capital Territory Solar PV Installations

The ACT's *Electricity Feed-in (Renewable Energy Premium) Act 2008* (the 'Act') commenced on 1 March 2009. The Act established the ACT Electricity Feed-in Tariff Scheme which supports residential and small commercial renewable generators (solar or wind) with a generating capacity of up to 30 kilowatts (http://www.environment.act.gov.au/energy/fit).

The first grid connected PV system was installed in the ACT in mid-2000. Community uptake of the technology was initially slow with only 136 further installations occurring between 2000 and late 2007. The concept of a Feed-in Tariff for the ACT was first raised in November 2007. After that announcement community interest rose sharply with 383 new installations being put in place between November 2007 and February 2009.

Since the Scheme's formal commencement on 1 March 2009 this growth continued with 163 new installations being added in the four months up until 30 June 2009 (a growth of 31% over that period). The 1000th connection was celebrated in early November 2009. By the end of that month, electricity distributor ActewAGL advised that the figure had grown to 1126 installations (an increase of 116% over the first 9 months). On current figures an estimated total of 1460 connections will be in place by 1 March 2010, a growth rate of about 180% over 12 months.

As at 30 November 2009, a generating capacity of 2.5 MW had been installed. Based on current trends, it is estimated that by the end of the first five year period, 27 MWp of distributed PV will be connected to the ACT electricity grid. All installations to date have been

solar photovoltaic generators. Though allowed for under the legislation, no wind generators have yet been proposed.

The ACT Department of the Environment, Climate Change, Energy and Water undertook a public and industry consultation in early 2010 on the possible expansion of the ACT Electricity Feed-in Tariff Scheme and published a Discussion Paper as the basis for community input (See: http://www.environment.act.gov.au/__data/assets/pdf_file/0006/174795/Electricity_Feed-in_tariff_WEB.pdf#Discussion%20Paper). The report and recommendations from that consultation process will be considered by the ACT Government by mid-year.

2.3.8 Demonstration and field test programs

A further eight systems will be installed at the Alice Springs Desert Knowledge Solar Centre by early 2010. The Centre monitors many different and innovative technologies, including refractive concentrators which use Fresnel lenses to concentrate the sunlight on the solar cells, hybrid solar cells which combine and crystalline and amorphous silicon layers and large scale tracking systems suitable for commercial power generation.

The facilities allow residents and visitors, educators and professionals alike to learn about the benefits of using the abundant solar resource available. At the associated Desert Peoples Centre the Certificate IV of the Remote Area Power Supply Maintenance course is on now on offer and participating Indigenous trainees can take advantage of the facility directly by working with the wide variety of technology installed; improving their capacity to maintain solar installations in Central Australia and benefit their communities.

Funding for the project was provided by the Australian Government's Renewable Remote Power Generation Program and is facilitated by the Northern Territory Department of Regional Development, Primary Industry, Fisheries and Resources.

More information is available at www.dkasolarcentre.com.au

2.3.9 Electricity utility and public stakeholder developments

The 1 MW Adelaide Showground Solar Power Station is the largest PV system in Australia to date. Funded by the State Government of South Australia, the AUD 8 million installation has the capacity to generate in excess of 1400 MWh of solar electricity each year – the equivalent of powering 250 South Australian homes – and provide 40% of the entire Showground's power needs. It will also save around 1400 tonnes of greenhouse gas emission annually.

The project is the first MW-scale industrial rooftop solar plant in Australia, and the first commercial installation of First Solar Cadmium Telluride thin film technology.

The installation, which comprises 12,720 panels, took three months to complete. All work was conducted while the Showground remained open to the public. The project introduced a number of construction innovations:

- A special rack-loading system was devised, with the solar panels stacked on pallets, lifted onto the roof by crane and then distributed via trolleys on framing rails.
- A clip-on extrusion framing system minimised the number of holes that needed to be drilled in the roof.
- To install the panels, drilling rigs were custom-made for each of the major roofs, while cloth and mesh screens prevented drilling waste from entering the stormwater collection system.

Figure 6: 1 MW PV array on Adelaide Showgrounds (Photo: Solarshop)

2.4 Highlights of R&D

University R&D

2.4.1 Australian National University

PV research at ANU involves a group of 60 research staff, research students and support staff undertaking work in the areas of photovoltaic solar cells and solar thermal energy (PV/thermal hybrids in particular). The Centre for Sustainable Energy Systems (CSES) was founded in 1991, and is one of the largest and longest established solar energy research groups in Australia. ANU is a core member of the Australian Solar Institute. In 2009 the Centre benefited from an AUD 5 million foundation grant from the Australian Solar Institute to extend and enhance its research facilities.

Work in CSES spans the range from basic R&D through to technology commercialisation. Current grants and contracts from Government and private companies total AUD 20 million, with several substantial commercialisations in progress.

Activities include defect detection and surface passivation in silicon wafers; high performance silicon solar cells, including SLIVER solar cells; modelling; plasmons and nano PV technology; PV modules, hybrid PV/thermal parabolic trough concentrator systems; and solar cooling. The research is supported by a state-of-the-art fabrication and characterisation laboratory, and spans the spectrum from the fundamental to the applied. The CSES collaborates extensively with industry and research institutes, and conducts a vigorous outreach program.

In 2009 a new agreement was reached between ANU and Transfom, a new joint venture of Origin Energy and Micron Inc. The new JV opens doors for Sliver photovoltaic technology, invented at the ANU and being commercialised by Transform.

Substantial progress was made towards the development of combined heat and power micro concentrator systems based on elongate solar cells. This project is conducted in collaboration with a US company called Chromasun and universities in China and India.

Funding support for CSES comes from the Australian Research Council, the Australian Solar Institute, the Defence Department, the Asia Pacific Partnership program, DIISR, private companies and several other sources.

Figure 7: A prototype solar heat and power micro concentrator developed by Chromasun, utilizing advanced PV/thermal receiver technology developed at ANU, http://cses.anu.edu.au.

2.4.2 Murdoch University

Devices

During the eighties and nineties Murdoch researchers worked on amorphous silicon, in particular the bonding and the degradation problems and attempted to make new device designs with improved performance. Since 2000, Murdoch researchers have worked mainly on nanocrystalline silicon, in combination with amorphous silicon, seeking to make devices with low cost and improved performance. Current work is mostly on solar cells composed of silicon nanowires and amorphous silicon. Fundamental work on silicon nanowires and quantum dots for possible PV applications is also being undertaken.

Systems

Research in the area of PV system technology at Murdoch University encompasses work on BOS components (e.g. fuses and circuit breakers for overcurrent protection in PV systems) and issues associated with transformerless PV inverters in grid connected PV systems. Outdoor PV performance monitoring is undertaken and the University is also putting together a small renewable power system training facility (wind, batteries and PV, SMA Sunny Island technology) with funding from the Australian Power Institute. The system will expose renewable and electrical power engineering students to a “mini electricity grid”. It will have a fully monitored renewable energy display system, accessible to the public, and will allow for further research projects on distributed energy generation.

Figure 8: Dr. Martina Calais and Andrew Ruscoe use the NATA accredited PV inverter testing facilities at Murdoch University (including a 25kWp PV array simulator) for PV standards development

2.4.3 University of NSW

Australian Research Council Photovoltaics Centre of Excellence

The University of NSW (UNSW) hosts the Australian Research Council Photovoltaics Centre of Excellence. The Centre undertakes research into improving efficiencies and reducing costs of 'first generation' crystalline silicon cells and modules; development of 'second generation' thin silicon layers on glass; 'third generation' high efficiency thin film cells; and silicon photonics. It also hosts the University's School of Photovoltaic and Renewable Energy Engineering which offers undergraduate and post-graduate degree programs.

In 2009 the Centre provided the key contribution to a multi-cell combination that set a new outright record of 43% efficiency for converting sunlight into electricity by any means, irrespective of complexity or cost. To produce this result, the Centre's silicon cell was assigned its own specific colour band to convert. The four other cells involved in the new result were likewise assigned their own optimal colour bands ranging from the ultraviolet to the far infrared. These other four cells had been fabricated earlier by two separate US-based groups at the National Renewable Energy Laboratory and Emcore Corporation.

Sunswift

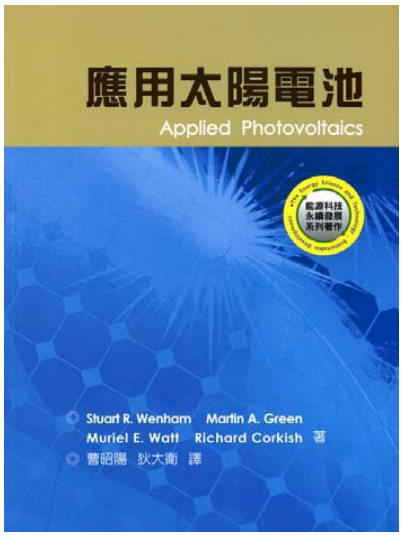
UNSW's solar racing team won a major victory in the Global Green Challenge from Darwin to Adelaide. Sunswift IV was the first Australian car to cross the finish line and the top-placed silicon cell car, a double win for the elated members of the student-led team. This was the debut race for Sunswift IV, a three-wheeled, hand-built carbon fibre solar vehicle. The car cruises at 90km/h and can reach a top speed of 115km/h using just 1,300 watts. Team Leader Clara Mazzone, who is a student in the Centre's Renewable Energy Engineering program, said the Sunswift team had put in an extraordinary effort to prepare the new car and raise the $280,000 needed to fund the project and race campaign.

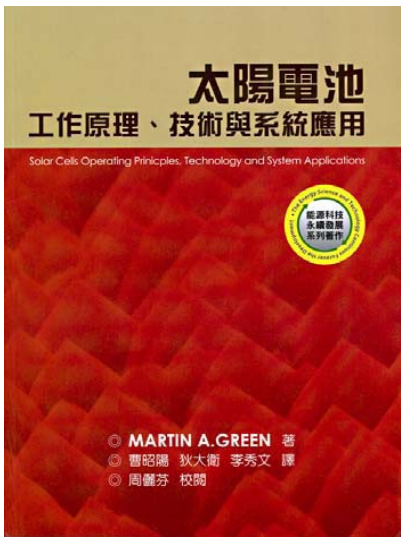
Figure 9: UNSW SUNSWIFT Solar Racing Car crosses finish line.

Books in Traditional Chinese

Following the publication of the University of NSW's first book in simplified Chinese in 2008, in 2009, the Centre published for the first time in the Traditional Chinese language, targeting photovoltaics growth in Taiwan, Hong Kong and Macau. Two books were published:

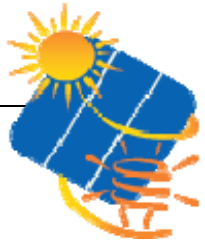
- Martin A. Green, *Solar Cells Operating Principles, Technology and System Applications*, Traditional Chinese translation, ISBN: 978-957-11-5756-6, Wu-Nan Book Company, Taipei. (20 August, 2009), (www.wunan.com.tw/english.asp).
- Stuart R. Wenham, Martin A. Green, Muriel E. Watt, Richard P. Corkish, *Applied Photovoltaics*, Traditional Chinese translation, ISBN: 978-957-11-5790-0, Wu-Nan Book Company, Taipei. (2009)





New Energy Technologies Building

In December 2009, Australia's Deputy Prime Minister, Julia Gillard opened the site for the new Tyree Energy Technologies Building at UNSW. This new AUD 155 million building will be the



new home for School of Photovoltaics and Renewable Energy Engineering's educational and research activities.

The project has received $75 million from the Australian Government's Education Investment Fund (EIF) and will be a carbon neutral design, due to be completed by early 2012. As well as housing the ARC Photovoltaics Centre of Excellence, the building will also be the focal point of the University's new Centre for Energy Research and Policy Analysis (CERPA), bringing together the capabilities of nine UNSW organisations to develop solutions to future energy challenges. As well as research in photovoltaics, other work under the umbrella of CERPA includes research into carbon capture and storage, oil and gas reservoir characterisation, nanomaterials and policy and market analysis.

2.4.4 The University of Queensland

Specific areas of solar energy research undertaken at the University of Queensland (UQ) include:

- *Next generation solar photovoltaics*: Significant activity within the Centre for Organic Photonics and Electronics (organic and hybrid solar cells funded by the Australian Solar Institute, Australian Research Council and QLD State Government) and the Australian Research Centre of Excellence for Nanomaterials (nano-structured photoanodes funded by the Australian Research Council and QLD State Government).
- *Power systems and network engineering:* with particular emphasis on embedded and distributed solar energy, adaptive and smart grids, frequency and voltage stability and new inverter technologies. This work is funded by the Australian Research Council and national and international energy companies and utilities.
- *Energy economics and solar energy value modelling:* Modelling the effect of distributed and utility-scale solar energy deployment on the National Electricity Market and future prediction of energy value in the context of carbon pricing.
- *Smart / Intelligent grids:* Several of the research efforts outlined above coalesce in a major CSIRO Flagship funded program (The i-Grid) investigating various hardware, software, control systems and economic aspects of developing and integrating smart grid systems into existing energy infrastructure.

In addition to the above strategic research programs UQ has implanted a new "Micro-Grid" strategy which seeks to deploy major renewable energy infrastructure across multiple campuses. The objective of this strategy is not only to reduce the University's carbon footprint, but also to provide state-of-the-art research and education infrastructure. Two significant solar-focused projects have just been initiated:

- The construction of Australia's largest flat panel PV array – 1.2MW of c-Si PV panels to be installed in a single array on roof tops at the St Lucia campus (due for completion end 2010).
- The development of a research PV array (50-100kW) to test and qualify new 2nd and 3rd generation PV technology with state-of-the-art monitoring and data acquisition.

Both these pieces of new infrastructure will provide a valuable resource not only for the University but external stakeholders, such as technology suppliers, local industry and government. The 1.2MW array in particular provides a real and relevant commercial-industrial scale test bed for PV technology in the Queensland context.

2.4.5 Queensland University of Technology

PV Technology Development research

- Development of improved components for transparent solar cells, based on titanium dioxide sensitised with a dye to increase light absorption. The project, funded by the Australian Council of Research, is focused on improving the counter-electrode in these solar cells, which is critical for high performance.
- Development of new complementary catalyst and electrolyte materials to reduce efficiency losses, improve performance and lead to new applications for dye-sensitised solar cells.
- Field testing the performance of DSC modules.
- Materials science underpinning the development of new polymer solar cells.

PV Applications research

Two key research projects explore the direct application of PV technologies for specific applications outside of the usual grid connect or stand-alone power systems applications:

- Direct utilisation in industrial process: the utilisation and matching of PV in direct coupled applications such as for the production of chemicals and electrolytic process.
- Wireless technology: solar powered nanosensors that can be used to operate wireless technology for deployment and monitoring in remote areas.

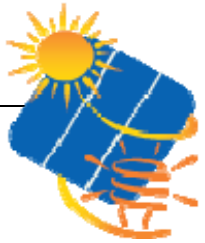
PV Performance Testing research projects

- Analysis and comparative performance of five types of commercially available PV modules across different technologies under Brisbane (latitude 27.5; sub-tropical) conditions, including technical, economic and environmental analysis.
- Performance evaluation of a grid-connect PV systems to establish MWh/kWp installed, on an annual basis, including the effects of degradation.
- Economic analysis of residential and commercial PV systems in Australia under existing feed-in-tariffs and other government incentives.

PV Integration

QUT undertakes a broad range of research projects aimed at enabling the seamless integration of solar energy into the electricity grid, building designs and industrial processes, including:

- Distributed Generation / Electricity distribution network analyses.
- Social and economic analyses to increase the uptake of solar energy.
- Building Integration: to improve the cost, functionality and aesthetics.
- Integrated systems modeling:
  - Towards Queensland's Future Energy Supply: Integration of Solar Energy (A Smart Futures Fellowship project).
  - Planning Future Electricity Grids: A comprehensive model of the electricity grid to support high penetration renewable generation.
  - Network technology modeling.
  - Business process modeling (electricity network businesses).
  - Decision Support Model for a Low Carbon Future.



Industry R&D

2.4.6 BT Imaging

BT Imaging continued the successful commercialisation of its luminescence imaging technology. The first product, the LIS-R1^{TM} is a flexible offline R&D tool that allows fast and highly spatially resolved characterisation of silicon bricks prior to wafering, silicon wafers at any processing stage or fully processed silicon solar cells.

Figure 10: The LIS-W1TM is an inline PL imaging system that can be integrated at any point of a solar cell production line.

Significant progress has also been made with the development of a range of inline characterisation tools. Hardware improvements made at BT Imaging allow full resolution (Megapixel) luminescence inspection of as-cut wafers at in-line speed with measurement times below one second in both the LIS-W1^{TM} and the sorter. BT Imaging received an Australian Government Climate Ready Grant of AUD3.4m over 2 years.

2.4.7 Dyesol

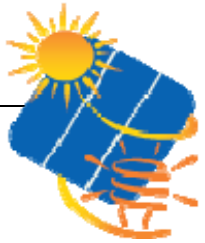
The Dyesol group is a world leader in development and commercialisation of dye solar cells (DSC). The main objectives of Dyesol R&D are:

- Higher performance with single cells and with tandems.
- Long term stability over 20+ years in the field.
- Development of lower cost materials and processes to achieve grid parity.

Most of the work is done in close collaboration between R&D in Australia, covering more fundamental aspects of materials and technology, and teams around the world focusing on specific applications such as smaller flexible DC panels or DSC integrated into steel roofs, facades or windows.

Specifically, the Dyesol R&D teams work on:

- Novel dyes which absorb more light and better match the solar spectrum.
- Novel electrolyte systems for improved long term and high temperature stability.
- Improved TiO_2 colloids and pastes.
- More reliable sealing materials and techniques.
- Alternative electrocatalysts to Pt.



- Transparent conductive substrates as alternatives to FTO or ITO.
- Assistance in scaling up materials and processes towards large scale manufacture of DSC panels.
- Modeling and optimised design of DSC modules and panels.

A large number of novel materials are continually tested in standardised test cells, either based on glass substrates or on a metal base in combination with a flexible transparent conductor. Long term light soaking tests are done routinely with a large number of cells and modules. In addition, cells are stored at elevated temperature (85^{o}C) and are submitted to thermal cycling tests according to international standards. Such tests are crucial for the development of more reliable seal materials and processes. Finally, Dyesol R&D is focused on the development of scalable processes such as dye manufacture in 10kg lots, TiO_2 sintering and dyeing within minutes, rather than hours.

2.4.8 XeroCoat Pty Ltd

XeroCoat is a start-up company commercialising a new solar anti-reflection coating technology developed at the University of QLD (School of Mathematics and Physics). The company is now based in Silicon Valley, CA and maintains its research and development in Brisbane. The XeroCoat technology is based upon a novel liquid sol gel coating process which produces nanoporous silica thin films of the correct refractive index for anti-reflection coating glass and plastics in the visible solar window. XeroCoat's technology can increase the power output from a solar PV panel by 3%.

XeroCoat's first plant is in factory acceptance testing in China currently and the Brisbane R&D group are developing the next generation of coatings with anti-soiling as well as anti-reflection properties. Xerocoat research is supported by funding from the US Department of Energy and by an AusIndustry Climate Ready grant.

2.4.9 Commonwealth Scientific and Industrial Research Organisation

National Solar Energy Centre

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Energy Centre in Newcastle is home to the National Solar Energy Centre, a suite of research capability in both solar thermal and photovoltaics technology that includes a team of 30 specialist scientists and engineers. CSIRO conducts projects aligned with Australia's national research priorities and engages with government, universities and industry in both co-investment and fee-for-service arrangements.

Major projects

For major projects CSIRO draws on expertise across the organisation. As part of the Victorian Organic Solar Cell Consortium, CSIRO's Flexible Electronics Team are working to develop new materials and processes to enable high throughput, low cost, reel-to-reel printable solar cells. Other major engagements in photovoltaics include Dyesol and the University of Newcastle.

Performance evaluation

Development is also underway for an integrated photovoltaics performance facility. The facility will provide an ISO17025-accredited measurement laboratory for qualified measurement of the efficiency of research-scale photovoltaic devices to international standards. It will also include infrastructure for long-term outdoor evaluation of photovoltaic technologies, including independent assessment of the durability and annual energy yield, critical factors for determining the true value of any new development in photovoltaics.

Figure 11: Organic solar cell developed at CSIRO. This technology is compatible with a low cost, high speed printing process that could significantly reduce the cost to the consumer.

2.5 Public budgets for market stimulation, demonstration / field test programmes and R&D

Public funding for PV R,D&D in 2009 was dominated by the market support provided through the Solar Homes and Communities Plan, which ceased mid-way through the year. Funding from the Australian Solar Institute and from a range of demonstration programmes will begin to increase from 2010.

Table 4: Public budgets for R&D, demonstration/field test programmes and market incentives (AUD million).

	R & D	Demo/Field test	Market incentives
National/federal	8,6	3,9	499,5
State/regional	3,9	10,3	
Total	526,3		

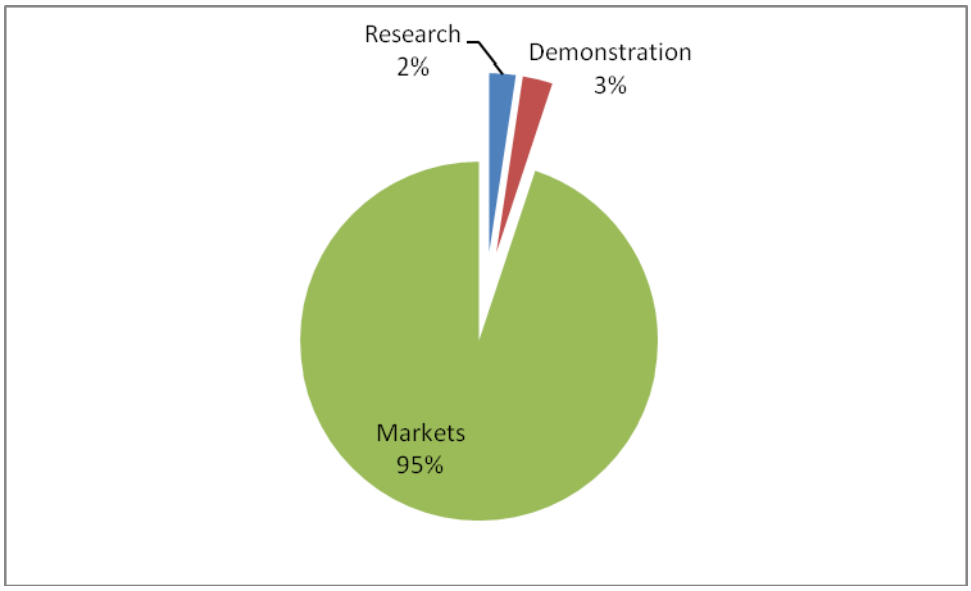
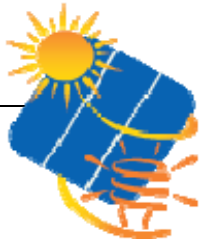


Figure 12: Proportion of public funding for PV research, demonstration (including Solar Schools) and market incentives, Australia 2009.



3 INDUSTRY AND GROWTH

3.1 Production of photovoltaic cells and modules

Total PV cell and module manufacture, together with production capacity information is summarised in Table 5 below. In March 2009, Australia's only PV manufacturer, BP Solar, closed its Homebush Bay factory. Hence the production figures are for 3 months only. The Factory has been purchased by Silex Solar and will begin production again in early 2010.

Table 5: Production and production capacity information for Australia 2009

Cell / Module manufacturer	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production (MW)**		**Maximum production capacity (MW / yr)**	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
1	mc-Si	12	12	50	12
Total		*12*	*12*	*50*	*12*
Thin film manufacturers					
Cells for concentration					
TOTALS		**12**	**12**	**50**	**12**

a) Whether the manufacturer produces their own cells in-house or whether they are purchased on the international market, or both.

BP Solar produced cells and modules made on imported wafers.

b) Availability of specially designed products (large size modules, modules with thermal benefits, facade and roof top modules, home system kits etc.).

Combined solar hot water and PV systems have been developed for the Blacktown Solar City.

3.2 Module prices

The trend in PV module prices in current Australian $ is shown in Table 6. Prices have remained relatively high, in line with rebate support, but have reduced somewhat in 2009, due to a strong exchange rate, global price reductions and a significant increase in market competition in Australia. The latter has included a range of bulk purchase options from PV and installation companies, local Councils and Solar Cities, as well as an increase in installers purchasing modules directly from the manufacturers.

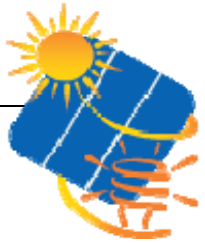


Table 6: Typical and best module prices Australia 1993-2009 (AUD/Wp)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Typical module price	9	7	8	8	7	8	8	8	8	7	7	8	8	8.5	8	8	6
Best price														7.5	7	5	3
Concentrator Cell price																	

3.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain, especially for the significant off-grid market in Australia.

3.3.1 PV inverters

PV inverters for both grid and off-grid applications are manufactured in Australia, especially to suit Australian conditions, particularly heat, dust, humidity and vermin.

3.3.2 Storage batteries

50 X 10 kWh Zinc Bromine flow batteries were manufactured in Australia for trial applications with PV systems and for demand management.

3.3.3 Battery charge controllers and DC switchgear

Battery charge controllers and both AC and DC switchgear are manufactured in Australia.

3.3.4 Supporting structures

A range of support structures are manufactured in Australia, especially for off-grid stand-alone applications, including water pumping, but also for grid systems.

3.4 System prices

A summary of typical system prices is provided in the following tables. System prices have fallen slightly, in line with module prices.

Table 7: Australian trends in typical system prices (current AUD excluding GST) for off-grid applications up to 5 kWp

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AUD /Wp:	24		22		30	30	30	22	22	20	20	20	20	22	22	22	20

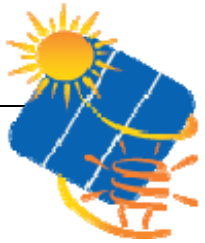


Table 8: Australian trends in typical system prices (current AUD, excluding GST) for grid applications up to 5 kWp

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
AUD /Wp:	11	12	12	14	14	13	10	12	12	12,5	12	12	9

Table 9: Turnkey Prices of Typical Applications in Australia 2009

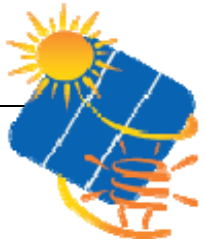
Category/Size	Typical applications and brief details	Current prices AUD per W (excl GST)
OFF-GRID Up to 1 kW	Remote homes, water pumps, lights	15-25
OFF-GRID >1 kW	Telecommunications, pastoral/mining power systems	15-20
ON-GRID Specific case	1-3 kW roof-mounted systems	9-10
ON-GRID up to 10 kW	Larger roof mounted systems on homes, public buildings	7-9
ON-GRID >10 kW	Larger roof mounted systems on public and commercial buildings	6-7
GRID – CONNECTED (centralized, if relevant)	Larger roof mounted systems on commercial buildings.	7-10

3.5 Labour places

Much of the PV related labour force in Australia is in installation companies, with the number of accredited installers continuing to increase strongly, mainly through accreditation of existing electricians. Since the major PV market in Australia remains small-scale (<2 kWp) systems, the labour intensity remains high relative to countries which have a more significant commercial or utility-scale market.

Table 10: Estimated PV-related labour places in 2009

Research and development (not including companies)	300
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	200
Distributors of PV products	1400
System and installation companies	3100
Utilities and government	200
Other (market analysts, financiers etc)	100
Total	**5300**



3.6 Business value

The values in Table 11 are estimates only because of the wide price range in grid systems and the difficulty in estimating market share amongst the higher cost versus the lower cost systems. For off-grid systems, prices are location, size and system dependent.

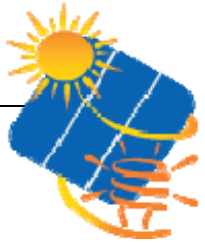
Table 11: Estimated Value of PV business in Australia 2009

Sub-market	Capacity installed *in 2009* (MW)	Price per Wp	Value AUD Million	Totals AUD Million
Off-grid domestic	*7,18*	*18*	*129,28*	
Off-grid non-domestic	*2,48*	*20*	*49,54*	
Grid-connected distributed	*67,36*	*9*	*606,26*	
Grid-connected centralized	*1,21*	*6,5*	*7,89*	
Diesel Grids (PV only)	*0,90*	*7,5*	*6,73*	
				799,69
Export of PV products				
Change in stocks held				
Import of PV products *(wafers, modules, inverters)*				*294,92*
Value of PV business				***504,77***

Notes on Table 11:

i. Local manufacture will influence figures from 2010.

ii. Exchange rates can have a significant impact on the price of imported components. The AUD was very high against the USD during much of 2009.

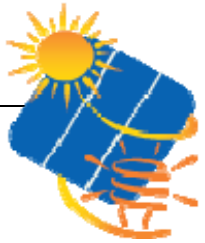


4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

Table 12 lists the main support measures for PV during 2009. Further details on new initiatives are provided below.

Table 12: PV support measures

	On-going measures	Measures that commenced during 2009
Enhanced feed-in tariffs	SA: AUD 0,44 c / kWh net Qld; AUD 0,44 c / kWh net Alice Springs Solar City AUD 0,45c / kWh gross	ACT: AUD 0,50 c / kWh gross Vic: AUD 0,60 c / kWh net
Capital subsidies for equipment or total cost	Solar Homes & Communities: AUD 8/W ended June 2009 RRPGP: 50% ended June 2009	
Green electricity schemes	GreenPower	
PV-specific green electricity schemes	GreenEarth Solar (Origin Energy)	
Renewable portfolio standards (RPS)	Renewable Energy Target: 45 000 GWh / year by 2020 from post 1997 generators	Solar Credits: 5 times multiplier for REC creation for small generation units started July 2009
PV requirement in RPS		
Investment funds for PV		
Income tax credits		
Net metering	Available to the majority of residential customers	
Net billing		
Commercial bank activities e.g. green mortgages promoting PV	Bendigo Bank: 0.5% reduction in mortgage rate for sustainable energy inclusions	
Electricity utility activities	Via GreenPower, RET, Solar Cities Energy Australia: net export feed-in tariff of AUD 0,28 c / kWh between 2-8pm for small residential PV systems	
Sustainable building requirements	NSW BASIX NABERS GreenStar ratings	



4.1 Description of new support measures introduced in 2009

4.1.1 Enhanced feed-in tariffs

A range of State based feed-in tariffs apply across Australia, as shown in Table 13. Revisions have been announced for the ACT tariffs from 2010, with a reduction in residential tariffs and an increase in tariffs for larger systems. Consideration is being given to tariffs for systems above 30 kW. A gross feed-in tariff commenced in NSW from 2010.

Table 13: Australian State and Territory Feed-in Tariffs

State	Commencement Date	Size Limits	Rate c/kWh	Duration Years	Type	CAP
Victoria	2009	5 kW	60	15	Net	
South Australia	2008	10 kW	44	20	Net	
Australian Capital Territory	2009	< 10 kW	50.05	20	Gross	
	2009	10 - 30 kW	40.04			
Northern Territory (Alice Springs Solar City)	2008	AUD 5 per day cap	45.76	20	Gross	
Queensland	2008	10 kW	44	20	Net	
New South Wales	*2010*	*10 kW*	*60*	*7*	*Gross*	*Review at 50 MW*

4.1.2 Capital subsidies

The two main rebate programs supporting small PV systems in Australia ended abruptly in June 2009. They have been replaced by the less generous Solar Credits mechanism which has its costs recovered from electricity retailers rather than the Federal government's budget.

Solar Schools continues to provide AUD 50 000 for schools to invest in PV systems up to 2 kW and other eligible activities. However, it was suspended in before the end of the year, due to the demand for funding being greater than the budget allocation for the 2009-10 financial year. It is expected to recommence in July 2010.

4.1.3 Electricity utility activities

All Solar Cities include electricity utilities in the consortia. Trials of new technologies, new tariffs and new deployment methods are being held, with accompanying education and awareness raising. These programs are increasing utility involvement with PV for the first time since GreenPower programs were introduced in 1997.

4.1.4 Smart grid, Smart City Program

The Australian Government has committed up to AUD 100 million to develop the *Smart Grid, Smart City* demonstration project in partnership with the energy sector.

The initiative will support the installation of Australia's first commercial-scale smart grid, combining advanced communication, sensing and metering infrastructure with existing energy networks. This enables a combination of applications that can deliver a more efficient, robust and consumer-friendly electricity network. A pre-deployment study was conducted during July and August 2009 and included a preliminary economic analysis of the benefits of smart grids, as well as consultation with industry, government, academic and regulatory stakeholders.

Applications were called from Australian electricity distribution companies, on behalf of interested industry consortia, to deliver the *Smart Grid, Smart City* demonstration project. The successful consortium will be announced in early 2010, while delivery of the project will commence in July 2010 and continue until June 2013.

4.2 Indirect policy issues

The following policy initiatives have influenced the implementation of PV power systems in Australia during 2009.

4.2.1 International policies affecting the use of PV power systems

Increased international climate change and PV development activities continue to set the benchmark for Australian policies. In addition, Australian PV prices are impacted by the large support programs for PV internationally.

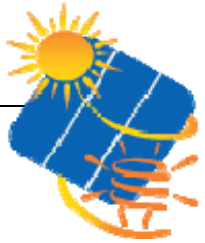
4.2.2 Taxes on pollution

Legislation to introduce a Carbon Pollution Reduction Scheme (CPRS), based on a cap and trade model passed the lower house of Parliament in 2009, but was unable to attract sufficient support in the Australian Senate to pass into law. The proposed legislation aimed at a 5% greenhouse gas reduction by 2020, based on 2000 levels, with a higher target to be negotiated should the rest of the world agree to post-Kyoto targets. The Australian Government has now postponed decisions on the introduction of an emissions trading scheme until 2013.

4.2.3 Australian policies and programmes to promote the use of PV in foreign non-IEA countries

The Climate Change and Energy section of Australia's international development agency, AusAID, includes PV in its portfolio of energy solutions. Much of its work is focussed in the Asia-Pacific region. It funds both PV installations and capacity building activities.

Australia has also joined the International Renewable Energy Agency (IRENA), with an initial budget allocation of AUD 5,6 million over 4 years.



4.3 Standards and codes

4.3.1 Technical regulations for PV plant construction and operation

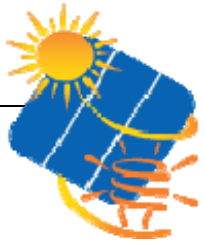
International standards development relevant to Australia

IEC TC 82 WG 3 – "Systems" and WG 6 –" Balance of Systems Components" are currently working on significant international standards for safety and installation.

- The project for a new PV array installation standard which is derivative of Australia's AS/NZS 5033 is still under development as a full international standard. It is in the second round of committee drafts and has been extensively commented on internationally. It is unfortunately delayed because of political issues with the international wiring committee TC64. Discussions are ongoing to resolve these issues. Many of the interim safety decisions may be brought back to Australia for updating AS/NZS 5033.
- IEC 62109-1, -2 "Safety of power converters for use in photovoltaic power systems" part 1 is general safety and part 2 is specific to inverters. Both these documents are extremely important for Australia as they define safety requirements and marking requirements for inverters and classify the inverters for electrical separation between input and output. Part 1 has been voted on as a final draft international standard and has been approved for publication in 2010. Part 2 has passed voting as a CDV and will now progress to a final draft international standard in 2010.
- Underwriters Limited is continuing the process of developing an arc detector and test methodology for dc arcs in photovoltaic systems and Eaton Corporation and some inverter manufacturers are also reported to be developing an arc detector for dc systems.
- IEC 62253 Ed. 1.0, on photovoltaic (PV) pumping systems has been revised and commented on in a second round of committee drafts and will hopefully progress to a CDV stage in 2010.
- IEC 62509 Ed.1: "Performance and functioning of photovoltaic battery charge controllers" specifies minimum performance requirements. Australia is the project leader in the development of this standard. The project is expected to be completed in 2010 and sent out as a final draft international standard.
- IEC 62509 ED.1: "Grid connected photovoltaic systems – minimum requirements for system documentation, commissioning tests and inspection" was published early in 2009.
- A new subcommittee has been created to work on Building Integrated PV (BIPV) issues and is in the early stages of developing a new work item proposal.

4.3.2 Standards, wiring codes and grid interconnection rules for PV systems

- AS/NZS 6805 "Stand-alone inverter performance requirements" was published in 2009.
- AS 4509 for Stand-alone systems has been significantly revised and updated. Part 1 is in the final stages of publication and part 2 will be sent for publication early in 2010.
- AS/NZS 5033 was amended in 2009 to ensure that PV modules meet the requirements and tests of the IEC 61730 series for safety. A new project proposal will be submitted to Standards Australia in April 2010 for a major revision and update of this standard.
- AS4777 "Grid connection of energy systems via inverters" - a new project proposal will be submitted to Standards Australia in April 2010 for a major revision and update of this standard.



5 HIGHLIGHTS AND PROSPECTS

5.1 Key aspects of PV deployment and production in Australia during 2009

The Australian grid-connected PV market grew significantly in 2009, due to the AUD 8/Wp rebates available through the Solar Homes and Communities Plan, and then through the Solar Credits Renewable Energy Certificate multiplier, operating as part of the Renewable Energy Target. Further support from State based feed-in tariffs, schools programs and other activities has ensured a strong market, which continues through 2010.

The off-grid market, previously Australia's main PV market, no longer has any specific program support, with the ending of the Renewable Remote Power Generation Program during 2009. However, if PV prices continue to fall in line with international trends, both markets will become increasingly attractive for PV, with or without government subsidies.

5.2 Prospects for the future

5.2.1 Details from industry of planned increases in PV module production capacity

BP solar closed in March 2009, leaving Australia with no local manufacture. The factory was purchased by Australian company SilexSolar, which plans to recommence production, using its own technology, in 2010.

Australian Government plans to encourage large-scale PV systems has increased international interest in the Australian market, as well as the potential for other companies to begin cell or module manufacture in future.

5.2.2 Any significant developments in technologies

Australian research institutions continue to undertake world-leading research on Silicon cell and module manufacture, with a 43% cell developed by the University of NSW in 2009. An increased focus on thin film and organic solar cells is likely to see new developments in coming years.

The Australian Solar Institute (see section 5.2.4) was established in 2009 to support PV and Solar Thermal electric research, with results of its research program likely to begin to appear from 2010.

5.2.3 Renewable Energy Fund (REF)

The Government will launch an AUD 652 Renewable Energy Future Fund in 2010 to promote the commercialisation of renewable technologies. The Fund will provide additional support:

- for the development and deployment of large and small scale renewable energy projects, for example further investments in geothermal, solar and wave energy; and
- to enhance take-up of industrial, commercial and residential energy efficiency, helping Australian businesses and households reduce their energy consumption.

The Fund will include partnerships between the Government and the private sector to make critical early stage investments to leverage private funds to support the commercialisation of renewable technologies.

5.2.4 Australian Solar Institute

In 2008/9, the Australian Solar Institute was established with funding of AUD 100 million over 4 years to foster Concentrating Solar Thermal and PV Research and Development and to accelerate commercial deployment. A first round call for R&D projects was made in 2009, with successful projects commencing in 2010. 40% of funding has been committed to core projects undertaken at the Commonwealth Scientific and Industrial Research Organisation, the University of NSW and the Australian National University. Contestable funding is available for other basic and applied R&D projects.

At May 2010 13 projects had been funded by the ASI, including the three foundation projects being undertaken by ANU, CSIRO and UNSW, at a total funding cost of AUD 44,5 million. These projects comprise PV, CST and Organic PV projects. Detail of the projects funded can be found on the ASI website – www.australiansolarinstitute.com.au

A second funding round closed on 21 May 2010 with 72 expressions of interest received.

5.2.5 Solar Flagships

In May 2009 the Australian Government announced a call for 1 GW of solar generation via 4 solar power stations (including solar thermal and PV). A total of AUD 1,5 Billion has been allocated towards the Solar Flagships program (this includes AUD 200 million from the Education Investment Fund (EIF)). The Australian Government has indicated that it expects to contribute one dollar of Commonwealth funding for every two dollars of private and state/territory government funding.

The Solar Flagships program is split over two funding rounds with the first round to target 400MW of electricity generation. Proposals for the first stage of Round 1 closed on 15 February 2010 and included a wide range of applicants, including PV companies as well as electricity generators and retailers. Proposals also had a wide range of support from state and local governments, financial institutions and research partners. The Minister for Resources and Energy announced the eight shortlisted projects on 11 May 2010, which included four PV proposals. The shortlisted proposals will be invited to submit a full proposal as part of the Stage 2 process. Announcement of the successful PV and solar thermal projects for Round 1 is expected to be made in the first half of 2011. The call for Round 2 applications, targeting the remaining 600MW of solar generation is expected in 2013-14. All projects must include a research infrastructure component which satisfies the EIF merit criteria and this component will be assessed by the EIF Advisory Board.

5.2.6 Proposed Changes to the Renewable Energy Target legislation

With small-scale solar installations taking up an increasing portion of the Renewable Energy Target, a proposal is before Parliament to separate the scheme into two parts: a Large-scale Renewable Energy Target (LRET), with a target of 41 000 GWh by 2020 and a Small-scale Renewable Energy Scheme (SRES) for small-scale generators (for PV systems, this is up to 100 kW). The SRES will have a fixed REC price of AUD 40 and no specific capacity target. Liable parties will be required to purchase RECs from both markets. The Solar Credits mechanism would still apply. If passed, this change would effectively provide a fixed price subsidy for small-scale generators, which will reduce in line with reductions in the Solar Credits multiplier (see Table 3).

ANNEX A: COUNTRY INFORMATION

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

1) retail electricity prices vary between retailers and also have different fixed supply charges and step rates. Typical flat tariffs range from AUD 0,13 to 0,20 per kWh for households, with summer tariffs of AUD 0,23 or more in some jurisdictions and off-peak hot water tariffs or around AUD 0,05 per kWh also available. For commercial customers, time of use tariffs are more common and range from around AUD 0,05 to 0.10 to 0,20 per kWh for off-peak, shoulder and peak times respectively. However, various standing and peak power charges also apply and increasing numbers of customers are on private contracts. The latter may include packages with electricity, gas and other services provided.

2) typical household electricity consumption ~ 8 000 kWh per year. This can be higher in areas where gas is not available and may be twice this level in households with air-conditioning.

3) typical metering arrangements and tariff structures for electricity customers – most residential consumers in Australia do not have interval meters, although they are being introduced progressively. Time-of-Use tariffs are available, but most households have a flat tariff. Net metering for PV systems is available from most retailers, with some offering higher buyback rates for excess generation, although this is usually capped.

4) average household income – AUD 42 200 per year

5) typical mortgage interest rate – 6%

6) voltage – 240 volts

7) The electricity sector has separate retail, distribution, transmission and generation businesses. Some States have privatised sections of their electricity industry, but most remain publicly owned. The Australian Energy Market Commission (AEMC) is responsible for energy market rule-making and market development at the national level. The Australian Energy Regulator (AER) performs economic regulation of the wholesale electricity market and electricity transmission networks in the National Electricity Market (NEM). It is also responsible for the enforcement of the National Electricity Law and National Electricity Rules.

8) price of diesel fuel: AUD 1,1 to 1,5 per litre in capital cities, retail prices in rural and remote areas are higher. Price includes the Diesel Fuel Excise of AUD 0,38143 and a 10% GST which some consumers are eligible for rebates on.

9) typical values of kWh / kW for PV systems in Australia: 1200 to 1800 kWh/kW per year depending on location.