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

2008

Prepared by

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for the Australian PV Association

ACKNOWLEDGEMENTS

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 photovoltaic solar 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 the IEA-PVPS, including:
    - PV Information Exchange and Dissemination
    - PV Services for Developing Countries;
    - Urban Scale PV Applications
    - PV Hybrid Systems within Minigrids.

The Association receives funding from the Australian Government to assist with the costs of IEA PVPS membership and Task activities.

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TABLE OF CONTENTS

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 systems 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.

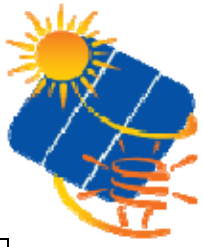
Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

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, Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey, the United Kingdom (GBR) and the United States of America (USA). The European Commission and the European Photovoltaic Industry 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 Government.

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.

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

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 2008. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

EXECUTIVE SUMMARY

Installed PV power

A total of 22,02 MW of PV were installed in Australia in 2008, an 80% increase on 2007 levels. Of this, nearly 69% was grid connected, taking the cumulative grid connected portion to nearly 30%, up from 19% in 2007. Total installed capacity in Australia is now 104,51 MW.

Costs & prices

Typical module and system prices remained steady in 2008, although there was a greater spread of prices, a noticeable drop in minimum prices and a move to bulk purchase arrangements. Module prices averaged AUD 8 / Wp and small grid systems AUD 12 / Wp.

PV production

42 MW of cells were produced in Australia in 2008, from imported wafers, and 8 MW of modules.

Budgets for PV

Government expenditure on PV research, development, demonstration and market incentives totalled AUD 117,91 Million in 2008. Australian Government market incentive programs, primarily the Solar Homes and Communities rebates and the Renewable Remote Power Generation Program, accounted for 88% of expenditure.

Figure 1: 48 V Bushlight system at New Bore, Northern Territory
Photo: Bushlight

1 THE IMPLEMENTATION OF PV SYSTEMS IN AUSTRALIA

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 2008 statistics if the PV modules were installed between 1 January and 31 December 2008, although commissioning may have taken place at a later date.

1.1 Applications for photovoltaics

The 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 is supported by government grants through the Renewable Remote Power Generation Program (RRPGP) which provides 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.

The market for PV installations connected to central grids continues to increase and represented the largest market for PV in 2008. The majority of installations took advantage of a government grant program (the Solar Homes and Communities Plan) which can contribute up to 80% of up front capital costs. The main applications are rooftop systems for private residences, schools and community buildings. Commercial and light industry sector interest is also growing, with support available to selected projects through the Solar Cities Program. All grid connected PV systems can create Renewable Energy Certificates for the Renewable Energy Target. This mechanism is to take over from grant based support from mid 2009.

1.2 Total photovoltaic power installed

The PV power installed in 5 sub-markets during 2008 is shown in Table 1. The most significant change is the high uptake of grid-connected distributed systems, with installations increasing from 6 MW in 2007 to 14,8 MW in 2008, due to the high capital grants available. This in turn meant that overall installations increased from 12 MW in 2007 to over 22 MW in 2008.

Table 1: Total PV power installed during 2008 in 5 sub-markets.

Sub-market/ application	off-grid domestic[1]	off-grid non-domestic	grid-connected distributed	grid-connected centralized	diesel grids	Total
PV power installed in 2008 (kW)	4 790	1930	14 815	305	180	22 020

Notes: 1) Includes 180 kW used in caravans, boats and similar applications.

The data in Table 1 was gathered directly from industry, government agencies and research groups via surveys, emails and phone calls. Other information is taken from annual reports and other publications. Inaccuracies in Table 1, and subsequent tables, arise because businesses are sometimes reluctant to disclose detailed information on sales breakdown, costs or prices. The accounting periods for different companies vary, with most using the Australian financial year (July to June) but others using the Japanese financial year (April to March) or the calendar year (January to December). This makes data collation for these companies more time consuming. Many companies are small 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 sales may be on a long term project basis, with installations actually occurring over a number of years.

For cost estimates, it is difficult to separate out component and system costs 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 1992-2008, broken down into five sub-markets is shown in Figure 2 and Table 2.

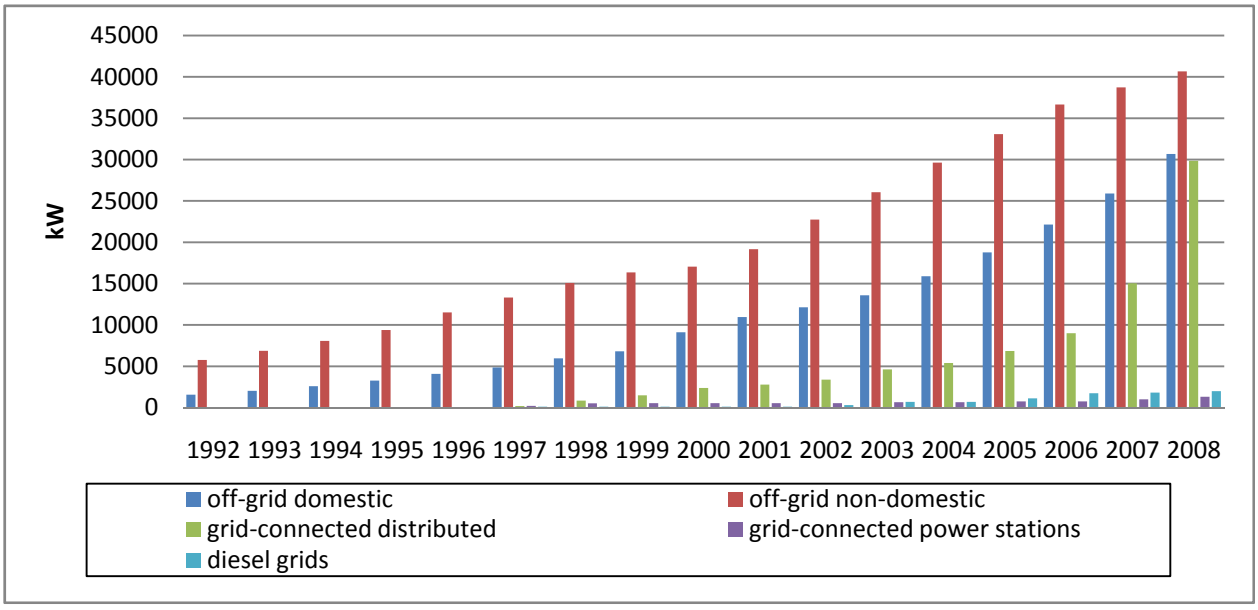


Figure 2: Cumulative PV Installations by End-Use Category. Australia 1992-2008.

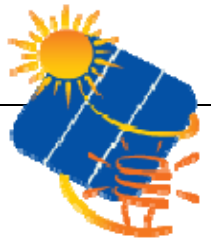


Table 2: The cumulative installed PV power in Australia in 5 sub-markets.

Sub-market/ application	31 Dec 1992 kWp	31 Dec 1993 kWp	31 Dec 1994 kWp	31 Dec 1995 kWp	31 Dec 1996 kWp	31 Dec 1997 kWp	31 Dec 1998 kWp	31 Dec 1999 kWp	31 Dec 2000 kWp	31 Dec 2001 kWp	31 Dec 2002 kWp	31 Dec 2003 kWp	31 Dec 2004 kWp	31 Dec 2005 kWp	31 Dec 2006 kWp	31 Dec 2007 kWp	31 Dec 2008 kWp
off-grid domestic	1 560	2 030	2 600	3 270	4 080	4 860	5 960	6 820	9 110	10 960	12 140	13 590	15 900	18 768	22 138	25 893	30 683
off-grid non-domestic	5 760	6 865	8 080	9 380	11 520	13 320	15 080	16 360	17 060	19 170	22 740	26 060	29 640	33 073	36 653	38 733	40 662
grid-connected distributed		5	20	30	80	200	850	1 490	2 390	2 800	3 400	4 630	5 410	6 860	9 005	15 035	29 850
grid-connected power stations				20	20	210	520	540	540	540	540	660	660	760	760	1 010	1 315
diesel grids						110	110	110	110	110	310	690	690	1 120	1 745	1 820	2 000
TOTAL	**7 300**	**8 900**	**10 700**	**12 700**	**15 700**	**18 700**	**22 520**	**25 320**	**29 210**	**33 580**	**39 130**	**45 630**	**52 300**	**60 580**	**70 300**	**82 490**	**104 510**

1.3 PV implementation highlights, major projects, demonstration and field test programs

1.3.1 Key PV deployment activities in 2008

Australian Government support programs impacted significantly on the 2008 PV market, contributing funding towards 74% of PV capacity installed over the year. Key programs are described below.

Demonstration and field test programs

Desert Knowledge Australia Solar Centre

The Desert Knowledge Australia Solar Centre (www.dkasolarcentre.com.au) is an AUD 3.1 Million initiative of Desert Knowledge Australia that showcases and demonstrates a range of solar power technologies in commercial-scale installations. These installations provide meaningful and accurate comparisons of the performance of the technologies' in the arid environment of Central Australia, improving the knowledge base for solar initiatives globally.

A range of different manufacturers and suppliers have chosen to demonstrate their technologies at the site. While some of the technologies have been widely used within Australia, many of the installations use technologies that are new to Australia. Different mounting technologies are also demonstrated. An example is shown in Figure 3.

The Desert Knowledge Australia Solar Centre is located within the Desert Knowledge Precinct, on the outskirts of Alice Springs - a hub for the transfer of knowledge and expertise across the arid regions of Australia. It provides a place for the Centre for Appropriate Technology, as part of the Desert Peoples Centre, to train students in the use and maintenance of solar installations. The Desert Knowledge Australia Solar Centre complements the community education and 'iconic solar projects' of Alice Solar City. It reinforces the position of Alice Springs, which has one of the highest levels of solar insolation in Australia, as a leader in solar power design, development and implementation. Power production from the Desert Knowledge Australia Solar Centre levels out the peak-load demands from the precinct, particularly during the summer months when high solar resource coincides with higher power demands.

Figure 3: CdTe array at Desert Knowledge Australia Solar Centre. Photo: S. Troman.

Funding for this project has been provided by the Australian Government's Renewable Remote Power Generation Rebate Program. CAT Projects, a subsidiary of the Centre for Appropriate Technology, is responsible for design and project management, using technical capabilities and learning's generated through the successful Bushlight program (see below).

Market stimulation programs

Solar Homes and Communities Plan (SHCP)

The SHCP provides rebates 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 are available for system upgrades, if no previous grants have been made. A household means test of AUD 100 000 per annum applies. Imposition of the means test caused significant public debate and high exposure for the program. Uptake rates therefore remained high overall, despite the means test, even though some installers, particularly those in urban areas, saw installation rates fall.

This program has had the most impact on the PV market in Australia during 2008, with 12,2 MW of PV installed and grants of AUD 68,4 Million provided. The majority of this (12,1 MW) was for grid-connected installations. A total of 27 MW of PV had been installed under this program to end 2008.

The high grant, which was doubled in 2007, had a dramatic impact on uptake levels, as shown in Figure 4 below. As a result, the initial budget allocation was expended earlier than planned, but the Government continued to fund the program. From mid 2009, the rebate is expected to be replaced by extra Renewable Energy Certificates from the Renewable Energy Target (see Section 5).

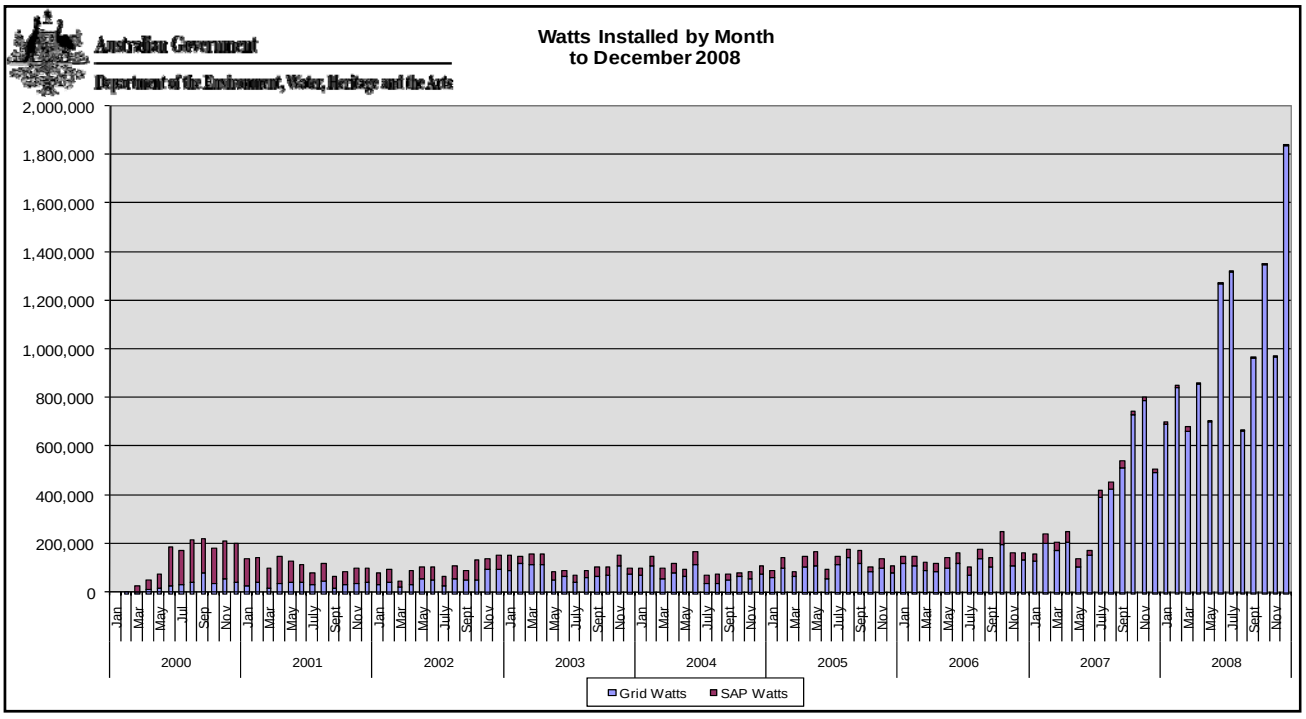


Figure 4: PV installations under the Solar Homes and Communities Plan 2000-2008 (http://www.environment.gov.au/settlements/renewable/pv/index.html)

The high capital rebates, and the subsequent high PV uptake levels, saw a number of market innovations in 2008. One was the emergence of bulk purchase and install schemes, whereby households signed up for a low cost system, on the basis of sufficient local interest (typically 50 homes) being shown. Bulk purchase of lower-cost Chinese modules, combined with streamlined installations in a local area allowed prices to fall considerably, (around AUD 9/Wp) compared with standard purchase models (around AUD 12/Wp).

The high PV uptake rates in 2008, and the relatively slow government rebate processing times caused cash flow problems for many installers. One solution was to have systems financed through a bank, which paid for the system on installation and then received the rebate when it came through some months later.

Renewable Remote Power Generation Program (RRPGP)

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

In 2008, AUD 980 000 was provided from the Industry Support component of the RRPGP for 64,9 kW of PV in the new Alice Springs Desert Knowledge Australia Solar Centre (see above) where a range of different systems and configurations are being monitored and tested.

In 2008 a total of 2 472 kW of PV was installed in remote residences and 1080 kW in non-residential systems. A total of AUD 36,7 Million was provided in rebates. In total 11,92 MW of PV have been installed under RRPGP to end 2008.

The program operates under a number of sub-programs, including water pumping, industry support and major projects, some of which are administered via State Government agencies.

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 2008, Bushlight installed 17 new renewable energy systems, with a combined total of 171 kW's of PV. Bushlight also coordinates a maintenance program that serviced more than 150 renewable energy systems by the end of 2008.

During the year, Bushlight completed working with 100 homelands. To celebrate this achievement, and to showcase the projects' work, special events were held in three separate homelands. These events provided a broad range of stakeholders with an opportunity to hear more about Bushlight and to experience first-hand homeland-life with a Bushlight system.

The events were held in Kapalga, located within the iconic Kakadu National Park in the Top End of the Northern Territory, Kulpa in the Cape York region of Queensland and Chile Creek on the Dampier Peninsula in the west Kimberley region of Western Australia. Each event was attended by local community residents and traditional owners plus a range of Bushlight stakeholders.

In late November 2008, Bushlight and CAT Projects hosted 15 guests from the IEA-PVPS on a technical tour of a number of PV and mini-grid sites in Central Australia. The tour visited the 225 kWp Power & Water Corporation operated solar power system connected to the min-grid at Kings Canyon resort (480kms south-west of Alice Springs). The system designer/project manager, Wolfgang Meike, conducted the tour and provided insights into its design and operation. The group also visited Ulpanyali, a small Indigenous homeland community near Kings Canyon resort that recently had a Bushlight system installed. The tour of the Bushlight system and homeland allowed guests to gain first-hand experience of some of the unique design and installation challenges of working in remote contexts. IEA guests heard details about the community engagement process and innovative user interfaces to support demand side management that are included in Bushlight systems.

Figure 5: Bushlight system at Glen Garland. Photo: Ergon Energy

Solar Schools

The AUD 480 Million National Solar Schools Program (NSSP) commenced on 1 July 2008 and finishes on 30 June 2015. It replaces the Green Vouchers for Schools Program, the schools component of the Solar Homes and Communities Plan and supplements State Government schools programs. An example is shown in Figure 6.

NSSP offers primary and secondary schools grants of up to AUD 50 000 to install solar and other renewable power systems, solar hot water systems, rainwater tanks and a range of energy efficiency measures including insulation, energy efficient lighting and ceiling fans.

In addition to the Federal Government funding, the Victorian Solar Schools program provides AUD 5 Million to June 2011 to support the installation of PV systems. The AUD 5,1 Million

WA Solar Schools Program supports the installation of PV systems in 350 metropolitan and regional State schools by 2010.

Figure 6: PV System at Edge Hill State School, Cairns. Photo: Ergon Energy

The National Solar Schools Program will leverage learning outcomes for students and school communities, raising awareness and understanding of renewable energy and efficiency. It involves the whole community in a process of social learning as we move towards a cleaner energy future. The Australian Government is working with state and territory governments and non-government education agencies to identify opportunities to deliver the program in a cooperative and phased approach over the seven years of the program. A phased approach will assist industry to match installation capacity with demands across all of Australia's schools. Installations are expected to commence in early 2009.

Solar Cities

In 2008 the Solar Cities program saw two new Cities announced, Moreland (previously announced as Coburg) and Perth, expanding the Program to 7 Solar Cities. Four Solar Cities were operational in 2008: Adelaide, Blacktown, Alice Springs and Townsville. Central Victoria and Moreland Solar Cities finalised their funding agreements in 2008 and will begin to roll out projects to their communities in 2009.

The four operational Cities installed a total of 550,5 kW of household PV in both private and public houses of which 508 kW was co-funded by SHCP. They also installed a total of 166 kW of PV on commercial and iconic buildings.

Solar Cities also administered AUD 30 545 of RRPGP funding that assisted (along with SHCP) to install 49 kW of private housing PV in Alice Springs. RRPGP funds totalling AUD 1,54 Million also paid for the Solar Cities administered iconic installation of 305 kW on the Crowne Plaza Hotel in Alice Springs (see case study box).

In total there was 716,5 kW of PV installed in 2008 funded through AUD 2,7 Million from the Solar Cities Program.

1.3.2 Electricity utility and public stakeholder developments

Electricity utility, State government and local government involvement in PV has increased through the Solar Cities program and, for systems off the main grid, the RRPGP.

Alice Springs

Alice Solar city (alicesolarcity.com.au) provides a capital subsidy of up to 50% for eligible householders to install a PV system. Householders are also able to sell all electricity generated to the Power and Water Corporation and benefit from a gross feed-in tariff. With funding support from Alice Solar City, the Power and Water Corporation purchases all the electricity generated by Solar PV systems from residents at an increased buy-back tariff for the life of the program. Currently the elevated buy-back tariff is AUD 45.76 c/kWh, capped at AUD 5 per day.

Townsville Solar City

Ergon Energy is installing up to 1 MWp of PV on premises around Magnetic Island, as part of the Townsville Solar City (townsvillesolarcity.com.au) project. 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 inland.

Horizon Power

WA electricity company Horizon Power has commissioned SunPower to install 500 kWp of tracking PV on its diesel grids at Marble Bar and Nullagine, 1500 km from Perth. Flywheel storage systems will also be installed by Powercorp to optimise use of the PV output. The systems are expected to generate over 1 GWh of electricity each year and save 35-40% of the diesel fuel used in the power stations.

Crowne Plaza Alice Springs

Crowne Plaza and Alice Solar City have installed Australia's largest rooftop PV system, a 305 kWp system using 1326 X 18.5% efficient SunPower modules which generate 40 to 80% of the hotel's peak power requirements, depending on the time of year.

- Annual electricity savings 504 MWh
- Annual CO_2 reduction: 420 tonnes.

The project is a joint initiative between the owner of Crowne Plaza Alice Springs, Investnorth Pty Ltd, and the Australian Government, and is part of the Alice Solar City Project – one of the seven cities selected for funding under the Australian Government's AUD 94 Million Solar Cities Program. The project feasibility studies, design and project management were undertaken by CAT Projects, a subsidiary of the Centre for Appropriate Technology. SunPower Corporation Australia won the tender for the supply and installation of the PV System.

The PV system includes online real time monitoring of all inverters and the development of a "Sustainability Corner" that provides information to Guests on the performance and operation of the PV system, as well as on other Energy Efficiency measures within the hotel. There is also a dedicated "Solar Channel" in guest rooms that shows the instantaneous and historical performance of the PV system as well as general information on solar energy.

Figure 7: Photo: Courtesy SunPower Corporation

1.4 Highlights of R&D

1.4.1 R&D at Universities and Research Centres

Australian National University

The Centre for Sustainable Energy Systems (CSES) at the Australian National University hosts the ARC Centre for Solar Energy Systems. CSES undertakes research into solar photovoltaic, thermal and hybrid technologies, including advanced characterisation, high performance silicon solar cells, high efficiency thin and flexible solar cells, linear solar concentrator systems, PV-thermal hybrid concentrator systems and solar cooling. ANU researchers are establishing a world-class process and characterisation solar research facility with funding from the new Australian Solar Institute.

In 2008 CSES researchers won the DuPont Innovation Award for second generation Sliver solar cell technology. An ANU led international consortium including Silicon Valley company Chromasun Inc, Tianjin University in China and Anna University in India, commenced an AUD 2,5 Million research project to create novel cost-effective hybrid micro concentrator systems. CSES successfully completed the first milestone of an AUD 2.2 Million Australian Defence Force funded project to develop highly efficient, lightweight and flexible silicon solar modules. A prototype is shown in Figure 8: Prototype of ANU lightweight flexible solar module based on ultrathin crystalline Si solar cells.

Figure 8: Prototype of ANU lightweight flexible solar module based on ultrathin crystalline Si solar cells. Photo: ANU

University of NSW

The University of NSW hosts the Australian Research Council Centre of Excellence for Advanced Silicon Photovoltaics and Photonics. It undertakes research into 1st generation advanced silicon cells, 2nd generation thin film silicon cells and 3rd generation quantum engineering of solar cells. Recent outputs include:

- 25% silicon solar 1 sun conversion efficiency (world record)
- Suntech Pluto technology, >19% efficiency (c-Si), > 17% efficiency (mc-Si)
- Sunrise Global Energy, Laser Doped Selective Emitter volume production licensee
- CSG Solar, thin film silicon
- BT Imaging, photoluminescence spin-out.

The University expects to receive funding through the new Australian Solar Institute and is establishing a solar industrial research facility, incorporating a Roth & Rau pilot line to test new technologies, as well as a new Energy Technology showcase building.

Organic PV

Australian research in organic photovoltaics (OPV) is strong and well organised, with over a hundred PhD students and researchers engaged across six universities and two divisions of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and a record of achievement that is highly competitive by global standards.

Figure 9: Dr Chris Fell with a sample OPV cell. Photo: CSIRO

The International Consortium for Organic Solar (ICOS) was established in 2006 with Australian government support. It brings together significant OPV research capabilities at the Universities of Melbourne, Monash, Newcastle, Queensland, Sydney and Wollongong, along with a large CSIRO project that involves teams in both Melbourne and at the National Solar Energy Centre in Newcastle. The ICOS consortium coordinates the activities of the Australian groups across a common set of milestones and also provides Australia with access to the experience of major international research groups in the US, UK and Singapore.

The consortium has demonstrated the ability of geographically distributed research teams to focus on a common goal. Each partner in the consortium brings complementary strengths to the group across activities such as synthesis of new organic molecules, the physics of photovoltaics and the characterisation of OPV systems.

Murdoch University

Murdoch University hosts the Research Institute for Sustainable Energy (RISE) which develops and tests renewable energy systems, has NATA accreditation for inverter testing and assists with Standards development.

1.4.2 Industry R&D

Dye Solar Cells

Australian company Dyesol manufactures and supplies a range of Dye Solar Cell products comprising equipment, chemicals, materials, components and related services to researchers and manufacturers of DSC. Dyesol's Dye Solar Cell (DSC) technology is sometimes called artificial photosynthesis because it uses a dye analogous to chlorophyll to capture the energy from light, releasing electrons which are captured and conducted as electricity in a nanoparticulate titanium dioxide layer. The Company is playing a key role in taking this third generation solar technology out of the laboratory and into the community.

In 2008 Dyesol opened a new manufacturing facility in Queanbeyan, New South Wales. to fast track its commercialisation strategy. Dyesol has also established a facility in North Wales, UK, in conjunction with Corus, the world's fifth largest steel producer, to accelerate the commercialisation of DSC technology onto steel sheeting. These facilities will enable Dyesol to effectively service its collaboration partners and subsidiary companies operating in UK, Italy, Switzerland, Korea, and Singapore. Dyesol Italia recently announced it will partner with Italian utility ERG Renew and the world's leading façade company, Permasteelisa, to develop and commercialise next generation solar panels for buildings. Similarly, Dyesol has established a joint venture company with Timo Technology in Korea (Dyesol-Timo) to commercialise DSC products.

Figure 10: DSC modules are under test for the Australian defence force. Photo: Dyesol

1.5 Public budgets for market stimulation, demonstration / field test programs and R&D

Table 3 gives figures for the year on budgets from the public authorities for R&D, demonstration/field test programs and market incentives (public subsidies, fiscal incentives) on the national/federal level, and on the state/regional level. The proportions are illustrated in Figure 11.

Table 3: Public budgets for R&D, demonstration/field test programs and market incentives in Australia in 2008 (AUD million)

	R & D	Demo/Field test	Market incentives	Total
National/federal	6,98	3,92	104,08	114,98
State/regional	0,43	2,50		2,93
Total	**7,41**	**6,42**	**104,08**	**117,91**

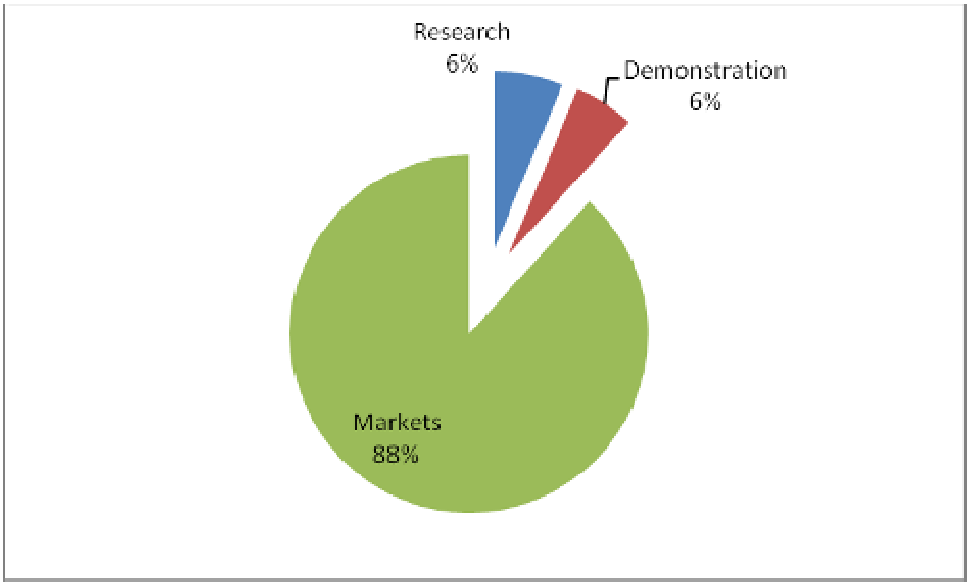


Figure 11: Proportion of public funding for PV research, demonstration (including Solar Schools) and market incentives, Australia 2008.

2 INDUSTRY AND GROWTH

2.1 Production of photovoltaic cells and modules

Total PV cell and module manufacture, together with production capacity information for Australia in 2008 is summarised in Table 4 below.

Table 4: Australian PV Production and production capacity in 2008

Cell / Module manufacturer	Technology	Total Production (MW)		Maximum production capacity (MW / yr)	
		Cell	Module	Cell	Module
Wafer-based PV manufacture					
BP Solar	c-Si	31	7	32	8
BP Solar	mc-Si	11	1	12	2
Total		***42***	***8***	***44***	***10***

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) Amount of production (cells, modules, other components, systems) exported from the country.

80% of cells produced in Australia were exported. An additional 1600 kWp of modules (Australian made and other) and systems were exported.

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

BP Solar has installed over 3 MW of PV in its Solar Energiser grid connect integrated kits. Many other companies also supply standard grid systems. Bushlight has developed standardised, modular systems for off-grid installation.

d) New developments and new products that arrived on the market during 2008.

In-house meter displays of PV output and electricity use for homes installing PV.

2.2 Module prices

Table 5 shows 2008 module prices for typical sales and lowest price achieved. Australian prices were impacted by the strong market in Australia and internationally, and by a significant drop in the Australian dollar against other currencies.

Table 5: PV Module prices (AUD excluding GST) –Australia 1993-2008

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Typical module price	9	7	8	8	7	8	8	8	8	7	7	8	8	8.5	8	8
Minimum price														7.5	7	5

2.3 Manufacturers and suppliers of other components

Balance of system (BOS) component manufacture and supply is an important part of the PV system value chain. Australian company involvement in BOS manufacture and supply is as follows:

- PV inverters (for grid-connection and stand-alone systems) and their typical prices

Selectronic Australia manufactures a range of inverters and has just released its SP PRO grid inverter, which can also be used in back-up mode or as an inverter charger for stand-alone applications.

The Latronics' PV Edge inverter is designed and built in Australia. It offers a PV only, a PV-wind or micro-hydro option, or an uninterruptible power supply option, which can be used with multiple energy sources and a battery bank.

- Storage batteries

Exide Technologies "Energystore" battery for remote area applications has been designed in Australia to suit local conditions.

2.4 System prices

Table 6 provides typical turnkey prices per W for the various categories of installation. Prices do not include recurring charges after installation, such as battery replacement or operation and maintenance. Additional costs incurred due to the remoteness of the site or special installation requirements are not be included.

Tables 6a and 6b show the trends in the turnkey prices of selected applications over the past 16 years.

Table 6: Turnkey Prices of Typical Applications – Australia 2008

Category / Size	Typical applications and brief details	Current AUD per W
OFF-GRID Up to 1 kW	Remote homes, water pumps, lights	18-30
OFF-GRID >1 kW	Telecommunications, pastoral/mining power systems	15-22
ON-GRID Specific case	1-3 kW roof-mounted systems	12-13
ON-GRID up to 10 kW	Larger roof mounted systems on homes, public buildings	9-12
ON-GRID >10 kW	Larger roof mounted systems on public and commercial buildings	9-10
GRID – CONNECTED (centralized)	Larger roof mounted systems on commercial buildings.	7-10

Table 6a: 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
AUD/ Wp:	**24**		**22**		**30**	**30**	**30**	**22**	**22**	**20**	**20**	**20**	**20**	**22**	**22**	**22**

Table 6b: 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
AUD/Wp:	**11**	**12**	**12**	**14**	**14**	**13**	**10**	**12**	**12**	**12,5**	**12**	**12**

2.5 Labour places

Full-time equivalent employment in different areas of the PV sector are shown in Table 7. Note the significant increase in distribution and installation jobs due to the high PV uptake rates through the Solar Homes and Communities Plan. Because the systems are small, typically 1-1,5 kW in size, the labour content per kW is significantly higher than international averages.

Table 7: Estimated PV-related labour places (full-time equivalent) in Australia in 2008

Research and development (not including companies)	200
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	500
Design, sales, distribution and installation of PV products and systems	2900
Utilities, government agencies, education, other	200
Total	3800

2.6 Business value

Table 8 provides an estimate of the value of PV business in Australia.

Table 8: Value of PV business

Sub-market	Capacity installed in 2008 (MW)	AUD per W	Value AUD million	Totals AUD million
Off-grid domestic	4,79	20	95,8	
Off-grid non-domestic	1,93	24	46,32	
Grid-connected distributed	14,815	12	177,78	
Grid-connected central power stations	0,305	10	3,05	
Diesel grids	0,18	20	3,6	
	22.02		**TOTAL**	*326,55*
Export of PV products				*97,8*
Import of PV products				*184,37*
Value of PV business				***239,98***

2.6.1 Discussion of the industry value chain in Australia.

The value of the PV market in Australia grew by 26% in 2008. Nevertheless, with a large import component, including wafers, modules and inverters, the overall increase in business value is lower than the 80% increase in installations.

The need to import wafers and to export 80% of cells produced locally is one of the reasons given for BP Solar's decision to close its Australian manufacturing facilities in 2009.

3 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

Table 9 lists the main support measures for PV during 2008, using the definitions provided earlier. Further details on new initiatives are provided below.

Table 9: PV support measures operating in 2008

	On-going measures	Measures that commenced during 2008
Enhanced feed-in tariffs	SA: AUD 0,44c/kWh net export	Alice Springs Solar City: AUD 0,45 c/kWh gross QLD: AUD 0,44c/kWh net export
Capital subsidies for equipment or total cost	Solar Homes & Communities: AUD8/Wp RRPGP: 50%	Solar Schools: Up to AUD 50 000
Green electricity schemes	GreenPower	
PV-specific green electricity schemes	GreenEarth Solar (Origin Energy)	
Renewable portfolio standards (RPS)	Mandatory Renewable Energy Target: 9 500 GWh/year by 2010 from post 1997 generators	
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, MRET Energy Australia: net export feed-in tariff of AUD 0,28 c/kWh between 2-8pm for small residential PV systems.	Via Solar Cities
Sustainable building requirements	NSW BASIX NABERS GreenStar ratings	

3.1 Description of new support measures introduced in 2008

3.1.1 Enhanced feed-in tariffs

Several State governments and the Alice Springs Solar City have introduced feed-in tariffs for small PV systems. The rates, system sizes and length of time vary but all State schemes to date are net export. The Alice Springs scheme is gross, as is the planned ACT scheme, to be introduced in 2009. See section 4.2.4 for further details.

3.1.2 Capital subsidies

All schools in Australia will have access to funding over the next 8 years towards PV systems up to 2 kW, as well as other sustainable energy installations. See section 1.3.1 for details.

3.1.3 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, since the emphasis of the Mandatory Renewable Target has been focussed on wind, hydro and solar water heater installations.

3.2 Indirect policy issues

The following policy initiatives have influenced the implementation of PV power systems in Australia during 2008:

3.2.1 International policies affecting the use of PV Power Systems

Increased international climate change activities continue to set the benchmark for Australian policies, while the outcomes of international PV programs are closely monitored.

3.2.2 Studies relating to externalities and hidden costs of conventional energy generation when compared to renewable energy

The Australian Academy of Technological Sciences and Engineering has undertaken a study of energy sector externalities, titled “The Hidden Costs of Electricity”. It concludes that PV has a total externality cost of AUD 5 /MWh, compared to AUD 42/MWh for black coal and AUD 1,50/ MWh for wind, as illustrated in Figure 12. It notes that the majority of PV externalities stem from manufacturing emissions and that these vary by site of manufacture. However, it does note the need for major balance of system requirements and perhaps network upgrades and storage if PV is to play a major role in Australia’s future electricity supply.

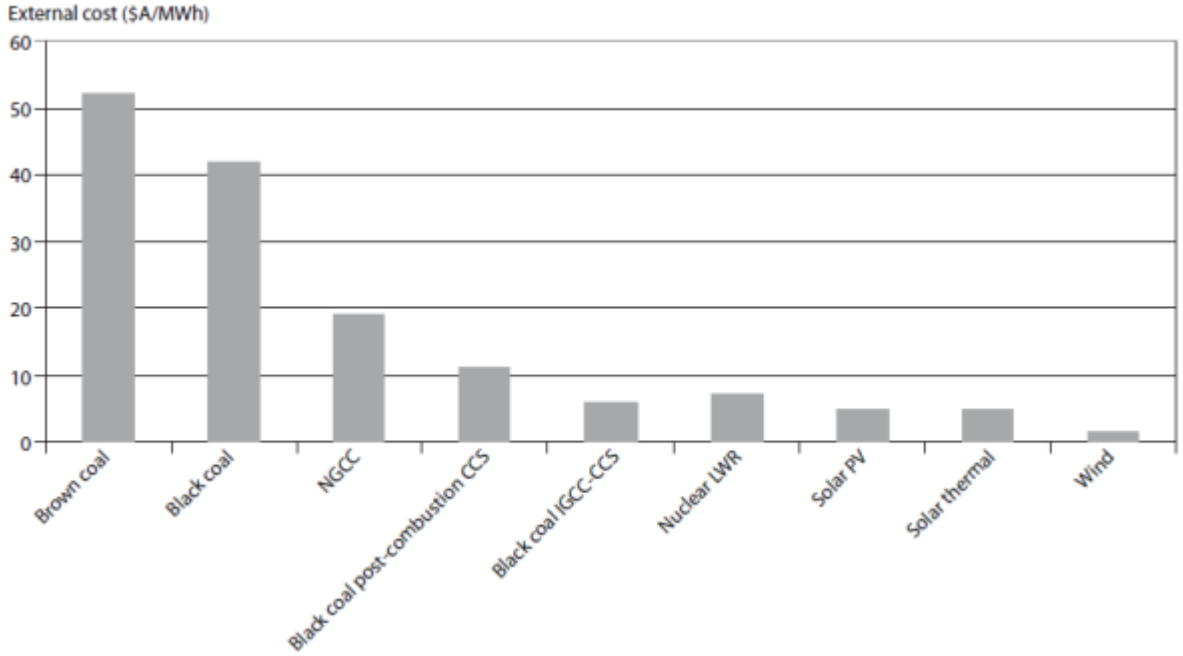


Figure 12: External costs of electricity generation technologies in Australia (www.atse.org.au)

3.2.3 Taxes on pollution

The Australian government has released a discussion paper on a proposed Carbon Pollution Reduction Scheme, based on a cap and trade emissions trading model. Details of the Scheme continue to be debated and no consensus has yet been reached. At present, a start date of 2011 is proposed.

3.2.4 Australian policies and programs 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.

3.3 Standards and codes

3.3.1 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.

- A new PV array installation standard which is a derivative of Australia's AS/NZS 5033 is currently under development as a full international standard. It has been extensively commented on internationally and has been the subject of two international working group meetings during 2008. The document will be sent to IEC TC 64 as input into the maintenance of IEC 60364-7-712 "Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems". This document is in the second stage of development but because of a need for strong interaction with TC 64 will take a

considerable time to get agreement between all parties. Many of the interim safety decisions may be brought back to Australia for updating of AS/NZS 5033 later in 2009.

- 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 is expected to be a final draft international standard for voting in 2009 and part 2 will soon be a committee draft ready for voting (CDV) also in 2009.
- Underwriters Limited is in the process of developing an arc detector and test methodology for dc arcs in photovoltaic systems and Eaton Corporation is also reported to be developing an arc detector for dc systems.
- IEC 62253 Ed. 1.0, on photovoltaic (PV) pumping systems has been sent out for comment by member countries as a CD.
- 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 was ratified by TC82 early in 2008 and circulated as a committee draft (CD). Comments on this document were received and addressed. The document was circulated in January 2009 as a committee draft for voting (CDV).
- IEC 62509 Ed.1: "Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection" was voted on in late 2007 and ratified to become a final draft international standard (FDIS), circulated in January 2009. The final voting for this document to be published is due in March 2009.

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

- AS 4509 for Stand-alone systems is in the final stages of significant revision.
- AS/NZS 5033 has now been amended to ensure that PV modules meet the requirements and tests of the IEC 61730 series for safety.
- A new stand-alone inverter performance standard AS/NZS 6805 is now in the final stages of publication.

4 HIGHLIGHTS AND PROSPECTS

4.1 Key aspects of PV deployment and production in Australia during 2008

The Australian PV market grew substantially in 2008, largely due to the increased grants of up to AUD 8 000 for 1 kWp of PV through the Solar Homes and Communities Program. Nevertheless, a large portion of this market was served by imported PV products and BP Solar has decided to close its Sydney manufacturing plant in 2009. The rapid increase in the grid connect market was accompanied by an increase in accreditation of electricians and other installers and the introduction of many new players in the market. Of particular interest is the growth in bulk purchase models of deployment where low cost installations are offered if sufficient households order PV systems within a small geographical area. Economies are gained by bulk purchase and rapid installation. This rebate program will finish in 2009, with a proposed transfer to a renewable energy certificate based model (see section 5.2.3).

PV production was limited to BP Solar, which produced 31 MW of single crystal silicon cells and 7 MW of modules and 11 MW of multi-crystal cells and 1 MW of modules. Cells were produced from imported wafers and 80% were exported.

4.2 Prospects for the future

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

BP Solar has announced it will close its Australian PV cell and module lines in 2009, thus leaving Australia with no local manufacture. Nevertheless, a number of companies, including Spark Solar, Tindoz, Regency and PMC Solar, have indicated interest in local manufacture. The current tight finance markets may delay plans, but it is hoped that at least one of these companies will be in a position to commence production by 2010.

4.2.2 Any significant developments in technologies

The University of NSW has announced a 25% efficient PERL (passivated emitter, rear locally diffused) silicon cell. Aspects of the technology have been licensed to several international manufacturers.

The CSIRO has announced advances in its organic solar cell developments, with the aim of producing low cost flexible and semi-transparent PV which can be used in a wide range of applications.

4.2.3 Target of 20% Renewable Electricity by 2020

The Australian Government has committed to increasing the Mandatory Renewable Energy Target (MRET) from the current 9 500 GWh by 2010, to an expanded Renewable Energy Target (RET) of 45 000 GWh by 2020. 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. The projected price of RECs is unlikely to be sufficient to drive deployment of small generation units and so, under the exposure draft legislation, Solar Credits will be made available to PV systems, small wind turbines and micro-hydro systems for the first 1.5 kWp of capacity. The total Solar Credits available to a PV system will be equal to the number of RECs created by 15 years of operation, for systems up to 100 kW, increased by a multiplier (see Table 10

below), deemed at the time of installation.[1] Any capacity greater than 1.5kWp will be eligible for 1 REC per MWh for that additional capacity. As well as homeowners, other organisations such as schools, community groups, businesses and developers, that were previously ineligible under the Solar Homes and Communities rebate program, will be eligible, and no means test will be applied.

Table 10: Proposed Solar Credit Multiplier

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

4.2.4 State Feed-in Tariffs

Prior to the introduction of feed-in tariffs, most electricity retailers in Australia offered net metering for small renewable energy generators connected to electricity distribution feeders, although this was often restricted to residential systems. Victoria, South Australia, Queensland have now implemented net export FiTs, while the ACT has planned a gross FiT for introduction from 2009.

The WA government has announced its intention to introduce a FiT. Although it is still in the design stages, it is expected to be a gross FiT of AUD 0,60/kWh for residential systems, which will be paid to system owners for long enough to pay off a system after all other subsidies are taken into account. They are examining options for extending the scheme to small businesses and commercial operations.

The NSW government established a NSW Solar FiT Taskforce which is considering the design of a NSW FiT. They have stated a preference for a FiT that is consistent with other jurisdictions.

There have been no significant steps towards a FiT in either Tasmania or the Northern Territory. However, the Alice Springs (NT) Solar City is offering a gross FiT (capped at AUD 5/day) of AUD 0,45/kWh (household) and 0,32/kWh (commercial).

4.2.5 Renewable Energy Fund (REF)

AUD 500 million has been allocated to the REF, which aims to accelerate commercialisation and deployment of renewable energy technologies in Australia, by assisting with demonstration. Funds are available on a 1:2 basis, with the aim of leveraging over AUD 1,5 billion in renewable energy investment to assist Australia to achieve its 20% renewable electricity target by 2020. Projects will be funded over the next 2 years.

4.2.6 Australian Solar Institute

AUD 100 million over 4 years has been allocated to the establishment of an Australian Solar Institute, which is to cover PV and Solar Thermal electric research. The final details of the structure and operation of the Institute have yet to be announced, however, existing solar research groups at the Australian National University, the Commonwealth Scientific and Industrial Research Organisation, and the University of NSW are expected to comprise the core research hubs. International collaborative research, including the IEA PVPS, is expected to be supported.

[1] Systems may also deem RECs for 1 or 5 year periods, and continue re-deeming until the end of the scheme.

ANNEX A: COUNTRY INFORMATION

This information is simply to give the reader some background about the Australian 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 charges and step rates. Typical flat tariffs range from AUD 0,12-0,17 per kWh for households, with summer tariffs of AUD 0,20 or more in some jurisdictions and off-peak hot water tariffs of 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 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 - 7500 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. TOU 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 33 500 per year
5) typical mortgage interest rate – 8.4 %
6) voltage – 240 volts
7) The electricity sector has separate retail, distribution, transmission and generation businesses. Some States have privatized sections of their industry, but most remain publicly owned. The Australian Energy Market Commission (AEMC) is the body 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 1,4-1,9 per litre (this 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: 1200-1800 kWh/kW per year depending on location.