International Energy Agency

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task I
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Australia
1998

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i 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 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 overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (Tasks) is the responsibility of Operating Agents. Currently nine Tasks have been established.

The twenty members are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), European Commission, Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA).

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic and environmental aspects of photovoltaic power systems for utility applications and other users.

ii Introduction

The Australian survey report is intended to provide information on the local manufacture and use of PV, to identify trends and to report on policies and support programmes offered by utilities and Commonwealth, State and local governments. The information is used to compile an International Survey Report, published by the IEA PV Power Systems Programme.

iii Definitions, symbols and abbreviations

For the purposes of this report, the following definitions apply:

1. PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV capacity of 40 Wp or more.
2. PV system: Modules, inverters, batteries and all installation and control components for modules, inverters and batteries with a PV capacity of 40 Wp or more.

3. Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.
4. Off-grid domestic: PV systems installed in households and villages which are not connected to the utility grid.
5. Off-grid non-domestic: PV systems used for a variety of applications such as water pumping, remote communications, safety and protection devices, etc. which are not connected to the utility grid.
6. On-grid distributed: A PV system installed on consumers' premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers. etc.
7. On-grid centralised: PV systems used for support of the utility distribution grid performing the function of a centralised power station.
8. Turn-key price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid system, the prices associated with battery maintenance/replacement should be 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 the interior of Greenland should not be included.)
9. Field Test Programme: A programme to test the performance of PV systems/components in real conditions.
10. Demonstration Programme: A programme to demonstrate the operation of PV systems to the general public and potential users/owners.
11. 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. They may be implemented by government, the financing industry, utilities etc.
12. NC: National Currency
13. Final annual yield is defined as the total energy delivered to the load during the year per kWp installed.
14. Performance ratio is defined as the ratio of the final yield to the reference yield, where the reference yield is the theoretically available energy per year per kWp installed.

1 Executive summary

The manufacture and use of PV in Australia has continued to increase in 1998. PV production has been expanded to 10 MWp and is running at full capacity. PV also provides significant export earnings for Australia, with over 65% of PV production being exported.

The local market continued to grow at 20%. Off-grid applications are still the major Australian market, accounting for 75% of sales in1998. This market is widespread across Australia, is largely unsubsidized and comprises domestic, water pumping, telecommunications, cathodic protection, navigation aid and signaling systems.

Commonwealth government funding for PV R,D&D has been around AUD 1.35 M for the year, including R&D and education funding for PV through the Australian Co-operative Research Centre for Renewable Energy (ACRE). State government funding for the year was around AUD 4.85 M. Industry funded R,D&D focused on thin film PV, improvements in production processes, balance of system components and system design. Joint industry and research institution activities continue in standards development and associated component testing.

The electricity market has become more competitive and, combined with the current emphasis on greenhouse gas reduction, has significantly expanded its promotion and use of renewable energy, typically via Green Power schemes. Over 500 kWp of PV has now been installed under Green Power schemes around the country. The Federal government target of a 2% increase in new renewables on the grid by 2010 will also contribute to an increase in on-grid PV over the next decade.

Australia-wide there has been a steadying of the PV market for off-grid domestic systems. The Western Australian government offers remote area power supply (RAPS) assistance grants, specifically to encourage renewable energy use. This has resulted in 83 kWp of PV being installed to date in remote properties and communities in the north of the State. A new scheme beginning in Queensland in 1999 is expected to boost that market. The Aboriginal and Torres Strait Islander Council (ATSIC) has provided capital funding for PV systems to 19% of indigenous communities in the Northern Territory, resulting in the installation of 86 kWp of PV to date. Typical systems comprise 0.75 kWp of PV with 15 kWh of battery storage.

Several large PV systems (50-400 kWp) have been installed on central and diesel grids over the past two years. The 665 X 1 kWp systems being installed at the Newington Solar Village, near the Olympic site, dominate smaller scale growth, although Green Power schemes and net metering offers around the country are resulting in steady sales. Grants available in NSW for building integrated PV on residences and public buildings have so far resulted in the installation of 47 kWp. Grid connected PV now accounts for 6% of total installations in Australia.

The two major Australian manufacturers, BP Solar and Solarex, are impacted by the international merger of BP and Amoco-Enron. Their plans for future production or expansion are currently uncertain. BP Solar Australia has cancelled plans for a new 20

MW facility, although Solarex is proceeding with production upgrades and technology improvements. New thin film manufacturers are planning over 20 MWp of new production facilities over the next 5 years.

The increasing need for specialised PV training in all aspects of system design, installation and maintenance has led to the development of trade, undergraduate and professional courses in PV and renewable energy through a number of Technical and Further Education colleges, Universities and ACRE. The PV related courses include PV devices, RAPS systems and an internet based applied PV course. A new degree course in PV and Solar Engineering will begin at the University of NSW in 1999.

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 Wp or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Applications for photovoltaics

The main market for PV in Australia is in off-grid installations for domestic power supply, telecommunications and water pumping. However, over the past two years the grid connected market has increased rapidly, to cater for emerging Greenpower programmes as well as commitments by industry, utilities and governments to reduce greenhouse gas emissions.

2.2 Total photovoltaic power installed

The total cumulative installed PV power in Australia, for each sub-market on the 31 December of each year from 1992 onwards is shown in Table 1.

Table 1: The cumulative installed PV power in Australia in 4 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
off-grid domestic	1 560	2 030	2 600	3 270	4 080	4 860	5 960
off-grid non-domestic	5 740	6 865	8 080	9 380	11 520	13 320	15 080
on-grid distributed		5	20	30	80	200	850
on-grid centralised				20	20	320	630
TOTAL	**7 300**	**8 900**	**10 700**	**12 700**	**15 700**	**18 700**	**22 520**

2.3 Major projects, demonstration and field test programmes

Renewable Energy Remote Area Power Systems Scheme – Western Australian Office of Energy

a) reasons for, and goals of, embarking on the programme or project;

– To encourage the use of renewable energy in off-grid domestic power systems by improving cost effectiveness, performance and maintenance.

b) size (installed capacity to date and target installed capacity for the whole programme, kWp) and main technical and economic data;

– 137 systems have been installed to date, incorporating 83 kWp of PV.

c) funding sources and cost sharing;

– The WA government offers grants up to AUD 8 000 for single households and AUD 48 000 for communities. A total of AUD 1.038 million had been allocated in grants by end 1998.

d) problems encountered and lessons learned;

– Response to the scheme has been positive, with most problems being only small. However, due to the remote locations, even small problems can be difficult and costly to rectify. Hence one of the main outcomes of the scheme has been an identification of the need for trained local technicians.

e) planned continuation of the programme and plans for new activities.

– The scheme will provide AUD 2 million over the 4 years 1997 – 2000.

Photovoltaic Power Systems for Indigenous Communities – Australian and Torres Strait Islander Council (ATSIC)

f) reasons for, and goals of, embarking on the programme or project;

– To provide off-grid domestic power systems.

g) size (installed capacity to date and target installed capacity for the whole programme, kWp) and main technical and economic data;

– 115 systems have been installed to date, incorporating 86 kWp of PV.

h) funding sources and cost sharing;

– ATSIC provides capital grants.

i) problems encountered and lessons learned;

– System maintenance is often poor and must be funded by the community itself.

j) planned continuation of the programme and plans for new activities.

– Robust, reliable, standardised systems, scheduled maintenance and availability of spare parts are essential if PV is to continue to be specified for indigenous community power systems.

Rooftop PV Cashback Scheme – NSW Sustainable Energy Development Authority (SEDA)

a) reasons for, and goals of, embarking on the programme or project;

– To increase awareness of PV;

– To increase the experience of builders, electricians and the electricity industry in using PV;

– To identify remaining barriers to PV use.

b) size (installed capacity to date and target installed capacity for the whole programme, kWp) and main technical and economic data;

– Systems must be between 500 Wp and 5 kWp;

– 57 systems approved to date, approximately half grid connected and half RAPS;

– 35 systems installed, with 47kWp of PV.

c) funding sources and cost sharing;

– SEDA provided 20% towards the cost of residential systems, to a maximum of AUD 2 400/kWp and 40% towards community systems. To date SEDA has contributed AUD 220 000 towards a total investment of AUD 1.1M.

d) planned continuation of the programme and plans for new activities.

– SEDA plans to continue the program for at least 2 more financial years; to promote the systems that have been installed, to promote training in building integrated PV concepts and installation; perhaps to offer awards; and to help utilities standardise metering and billing requirements.

Newington Solar Village – Mirvac Lend Lease and Pacific Power

a) reasons for, and goals of, embarking on the programme or project;

– To contribute towards a "Green Olympics" in 2000;

– To promote the use of PV;

– To develop easy to install, standard systems;

– To investigate the use of a high density of distributed PV systems.

b) size (installed capacity to date and target installed capacity for the whole programme, kWp) and main technical and economic data;

– 100 of planned 665 X 1 kW systems installed by end 1998.

c) funding sources and cost sharing;

– Jointly funded by property developer Mirvac Lend Lease, utility Pacific Power and SEDA using systems designed by BP Solar. Houses will be sold to private buyers.

d) problems encountered and lessons learned;

– Need for training of engineers, architects, planners, builders, electricians and others involved.

e) planned continuation of the programme and plans for new activities.

– All systems will be installed before September 2000. All participants hope for future BIPV market development.

Table 2: Summary of major projects, demonstration and field test programmes

Project Date plant start up	Technical & Economic data	Objectives	Main accomplishments to end 1998 Problems & lessons learned	Funding	Project management	Remarks
Singleton PV power station 1997 & 1998	Grid-connected Power: 400 kW_p 200 kWp each of multicrystalline and amorphous PV cells	To obtain experience with centralised grid-connected PV system and evaluate components and system	Installation of the largest central PV power station in Australia.	EnergyAustralia, through its Pure Energy scheme, SEDA	Energy Australia	Performance monitoring of modules and BOS components is being undertaken
WA Renewable Energy RAPS Scheme 1997 - 2000	Grants for renewable components in off-grid domestic systems $1.038 M in 1998	To increase the reliability and usage of renewables in RAPS systems	137 systems installed 83 kWp PV Most problems small, but difficult & costly to rectify in remote locations Need local trained technicians	System owners & WA government	WA Office of Energy	Detailed monitoring to be undertaken of 3 systems Checklists to be prepared for installers Training courses for installation and maintenance to be established
Dubbo Zoo 1998	Grid Connected Power: 50 kW_p multicrystalline PV cells	To demonstrate PV technology in a high visibility tourist site To gain installation & operational experience with PV systems	Site compromises needed to accommodate trees and PV	Advance Energy, through its Green power scheme, SEDA	Advance Energy	Good tourist site, which is expected to generate interest in PV
Rooftop PV Cashback Scheme 1998 - 2000	Rebates of 20% for domestic and 40% for community BIPV systems $220,000 in grants 1998	To increase awareness & use of BIPV systems and the experience of trades involved To overcome barriers to PV use	32 systems installed	SEDA, system owners	SEDA	Slow take-up, with PV still high cost. SEDA to promote standard metering & billing.
SolarSense 3 in 1 rooftop solar system Demonstration	PV, solar thermal collector and skylight for energy & water efficient houses	To facilitate installation, reduce costs and overcome aesthetic concerns	Demonstration system installed in new housing development in Adelaide	ERDC, SA Housing Trust, ETSA, Solahart, Land	ETSA, SA Housing Trust	Included with other innovative energy and water systems, along with new urban planning concepts and “green

system 1998				Management Corporation, Menzel Plastics		mortgages"
Queanbeyan Energy Depot 1998	Grid Connected Power: 50 kWp Multicrystalline PV cells	To gain installation and operational experience with PV systems	Difficult site design due to sloping land in a NW direction	Great Southern Energy – through its Earthsaver scheme, SEDA	Great Southern Energy	
Wilpena Solar Power Station 1997/98	100 kWp ground mounted array in hybrid RAPS configuration with 440kW diesels, 400 kWh battery bank & 125 kVa inverter/charger. Multicrystalline PV cells	To gain experience with & demonstrate a community sized PV based power system, as an environmentally sensitive option to long distance grid extension.	The PV/battery component typically supplies all daytime loads. Site usage has increased 40% since the system was designed, but diesel usage has increased only 14%.	SA government, ETSA	ETSA Power	Remote monitoring and control via modem link.
White Cliffs PV concentrator test system 1998	Grid Connected Power: 20 kWp concentrator	To test concentrating PV systems for use on rural grids	Different configurations and materials tested	Solar Systems, Australian Inland Energy	Solar Systems	2 MW plant planned for Broken Hill in 1999/2000.
Newington Solar Village 1998 - 2000	Grid Connected Power: 665 X 1 kWp roof integrated Laser grooved single crystal PV cells	To develop easy to install roof integration systems To demonstrate a high density of individual PV systems	Training of tradespeople is critical to cost effective installation	Pacific Power, Mirvac Lend Lease, SEDA, Energy Australia	Pacific Power	Monitoring will be undertaken of selected systems across the Village

2.4 Budgets for market stimulation, demonstration and R&D

Table 3: 1998 budgets (in AUD millions) for R&D, demonstration programmes and market incentives.

	R & D	Demo	Market
National/federal	1.2	0.1	0.05
State/regional	0.45	3.1	1.3
Total	1.65	3.2	1.35

3 Industry and growth

3.1 Production of photovoltaic cells and modules

Table 4: Production and production capacity information for 1998 for each module manufacturer

Module manufacturer	Technology	Total Production (MWp)		Maximum production capacity (MWp)
		Cell	Module	
BP Solar Australia	sc-Si		5.1	5.1
Solarex	mc-Si		4.7	4.7
TOTALS			9.8	9.8

a) General description of the main steps of the production process employed for each manufacturer (feedstock, ingot crystallization, wafer cutting, cell fabrication, module fabrication and other appropriate steps).

For both manufacturers: Cell fabrication from imported wafers, through to module fabrication as well as total system production.

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

For both manufacturers: majority in-house from imported wafers. Laser grooved cells for the Newington Solar Village were fabricated in BP Solar's Spanish facility.

c) The quantity of PV cell production sold as cells on the international market to other module manufacturers.

Some cell sales to overseas subsidiaries.

d) Technical characteristics of standard commercial modules, cell material, typical module output power range, type of encapsulation, length of typical warranty, certification).

Modules range in size from 2 - 90 Wp, the most common being around 70 Wp. Almost all have front glass and EVA rear encapsulation. Warranties range from 10-20 years, depending on the application, as well as on the level of manufacturer involvement in system design.

e) Certification of modules to IEC 1215 or IEC 1646 or equivalent. Certification to ISO 9000, ISO 14000.

Australian standards, plus international standards via ISPRA testing.

f) Availability of modules specially designed for utility applications (large size modules, high insulation modules, facade and roof top modules, etc.) and their characteristics. If such modules are available, it should be specified whether or not module specifications have been issued (or approved) by utilities.

The array frames used for the Newington Solar Village were especially designed.

g) New developments and new products.

Continual development of crystalline cell products, to cater for market changes.

New thin film products are under development by:

- Pacific Solar – multi-layer thin film c-Si;
- Australian National University – thin film c-Si using the Epilift process;
- Sustainable Technologies of Australia - TiO_2;
- Murdoch University – a-Si:H.

New concentrator systems, initially to be based on Si cells, are under development by Solar Systems.

The South Australian government has funded the development of an integrated PV, solar thermal and skylighting system, aimed at facilitating ready installation and increasing the aesthetics of all three technologies when used on residential rooftops. Demonstration systems have been installed.

h) Details of module production capacity under construction at end of 1998 but not yet in production.

Solarex will complete current expansion by mid 1999, taking its capacity to 5 MW, and will begin a technology upgrade to increase cell efficiencies from 12 to 17%. Pacific Solar and STA are currently in pilot production, with full scale plants of 20 MWp and 0.5 MWp planned respectively by 2000.

3.2 Manufacturers and suppliers of other components

Table 5: Retail price of inverters for grid-connected PV applications.

Size of Inverter	<1 KVA	1-10 KVA	10-100 KVA	>100 KVA

Average Price per kVA (AUD)	2 - 3	1.5 - 2	1 - 2	na

Business activities, trends and strategies concerning other component products:-

- PV inverters

Development continues of inverters for grid connected applications, including development of a 1.5 kWp single phase, transformer-less inverter by Curtin University and Powersearch Ltd. However, the main market in Australia continues to be inverters for off-grid applications.

- Storage

Continued R,D&D on vanadium redox batteries, Zinc/Bromine batteries and ceramic fuel cells should see commercial products within 5 years. Current vanadium battery development is aimed at the RAPS and PV market. A 50 kWh Zinc/Bromine battery for use in renewable energy systems is under development.

- System controllers

Improved control systems for PV-diesel hybrid systems are being developed as part of an ACRE project at Curtin University. Systems for both remote area power systems and uninterruptible power supplies are being examined.

- Maximum power point trackers

New devices and different control methods are being used by the Northern Territory Centre for Energy Research to improve the performance of maximum power point trackers. Efforts are also being made to reduce weight.

- Electric machines

Work is underway at the University of Technology, Sydney, and the Commonwealth Science and Industry Research Organisation on the use of a new generation of rare-earth magnets for efficient and compact electric machines, which are particularly suitable for use in renewable energy systems. The production of low cost, high performance motors using soft magnetic composite materials is also being studied.

- Supporting structures

Frames have been developed for the 1 kW building integrated PV systems used in the Newington Solar village as well as for integration of PV, solar thermal and daylighting panels.

3.3 System prices

Table 6: Prices of typical applications

Category/Size	Typical applications and brief details	Price per Wp in AUD
OFF-GRID 40-1 000Wp	Lights, telemetry, dc supply for remote houses.	20-40 for complete systems
OFF-GRID >1 000Wp	Remote households, remote communities, telecommunications, cathodic protection, water pumping.	25-40 for complete systems
ON-GRID 40-10 000Wp	Rooftop systems	10-15
ON-GRID >10 000Wp	Ground and roof mounted systems	8-12

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

- **Promotional initiatives**

– An increasing number of electricity retailers are now offering net metering for domestic PV installations.

– The NSW State government offers a 20% "cashback" (up to AUD 2 400/kWp) for residential rooftop PV and 40% for installations on public buildings.

– The WA State government offers 75% grants (up to AUD 8 000) for renewables used in remote area power systems.

- **Utility perception of PV**

– There is an increasing interest in PV from utilities, which relates both to greenhouse gas reduction targets, as well as advancements in power conditioning and control system technologies, which have made the use of PV in hybrid systems with other generation sources feasible.

– Increasing utility acceptance of grid connected PV, particularly with availability of Australian guidelines for connection.

– As the electricity market is re-structured, there has been a general increase in private generation. However, for PV the emphasis has been on utility owned systems, although this may be attributable to the high capital cost.

– Few, if any installations to date have focussed on grid support or other distributed system benefits. However, the concentrator technology being developed at White Cliffs, and to be used in a 2 MW system at Broken Hill, plans to target markets where these benefits could be exploited.

- **Changes in public perceptions of PV**

– The public continues to support the development and use of renewable energy. However, with electricity prices falling during the recent re-structuring, and with taxes on diesel fuel due to fall, renewables continue to find it difficult to compete.

- **Major new projects or initiatives**

In addition to the impact of the promotional initiatives mentioned above, the main drivers to PV installation in the short term are:

- Newington Solar Village - continued installation of 1 kWp rooftop systems near the Olympic site, with another 465 systems to be installed in 1999/2000.

- Utility Green Power schemes, with new programs being developed in Victoria, Western Australia and South Australia.

- The Commonwealth Government's target of 2% new renewables for grid electricity by 2010. Although a portfolio approach does not appear to be favoured, technology availability and ease of installation may still see PV taking up some of the estimated 9 000 GWh of new capacity needed. It seems likely that a renewable energy credit scheme will operate to facilitate implementation of the 2% target.

- A renewable energy rebate scheme for RAPS systems in Queensland, for which AUD 8.75 M has been allocated over the next 4 years. Eligible applicants must not be grid connected, however, no grid connection cost is specified. Systems must have a minimum of 30% renewables, with maximum grants of AUD 7 500.

- **Planned developments**

- New production facilities for thin film silicon (Pacific Solar) and titanium dioxide (Sustainable Technologies Australia) cells and products planned by 2000.
- 70 kWp roof mounted system at the Sydney Superdome, by utility Energy Australia, with SEDA providing an interest bearing loan.
- 2 MWp concentrating PV system at Broken Hill by Solar Systems Pty Ltd, with contracts to sell electricity to Australian Inland Energy.

- 20 kWp trough concentrator PV system, with 2 axis tracking, part funded by the AGO and to be built in Rockingham, Western Australia, by the Australian National University, Solahart and Western Power. This will be based on a 320 Wp demonstration system which has been on display at Western Power's "World of Energy", Fremantle, WA.

- **Other new issues**

- A new Sustainable Energy Innovation Fund in Queensland, with a budget of AUD 850 000 per year, to support renewable energy and energy efficiency R,D,D & commercialisation.

4.2 Indirect policy issues

Policy initiatives that may influence the implementation of PV power systems in Australia:

a) international policies affecting the use of PV Power Systems;

- Greenhouse gas reduction policies resulting from the Kyoto Protocol.

b) the introduction of any favourable environmental regulations;

– NSW electricity license conditions encourage examination of grid supply options and greenhouse gas reduction. Other States may introduce similar regulations.

– Local government greenhouse gas reduction initiatives are increasing and may see supportive regulations introduced.

c) studies relating to externalities and hidden costs of conventional energy generation when compared to renewable energy;

– Climate change strategies at national, state and local level reflect the relative greenhouse gas intensity of different energy supply technologies.

d) taxes on pollution (e.g. carbon tax).

– No pollution taxes are proposed. However, an emissions trading scheme, to promote greenhouse gas reduction, is being discussed, while trading in renewable energy credits may result from implementation of the 2% renewables target.

4.3 Standards and codes

- **Technical regulations for PV plant construction and operation (d.c. working voltage, safety and control devices, supporting structures, etc.);**

– Standard building and electrical codes apply. Specific standards exist for RAPS systems and RAPS batteries.

- **Availability of standards and grid interconnection rules for PV systems (protection; islanding; harmonic distortion, power factor, safety, etc.)**

– Australian guidelines for grid connection using inverters have been developed (http://ee.unsw.edu.au/~std_mon/html-pages/inverter_guidelines.html) and standards are being discussed.

– The Australian Standards committee EL42 (Renewables) is to liaise with EL1 (Wiring) to work on a wiring standard for PV. It is yet to be decided if this will be placed in the AS3000 wiring rules or be a separate standard.

- **Specific rule problems to be solved in order to facilitate PV system diffusion;**

– Protection measures for high DC voltages, particularly in building integrated PV systems.

– Familiarity as well as professional (engineering, architecture) and trade (builders, electricians) training needed.

– Standardization of collection and reporting of system performance is desirable, to ensure appropriate data is collected, as well as to allow system comparisons and data sharing. ACRE has developed guidelines for system monitoring, which will facilitate this.

- **Building and wiring codes**

– Normal building codes and requirements apply. Some of these vary by local government area and by State. There are moves to encourage standardization across the country. It is not usually feasible to use standards developed overseas, since Australian building types are often very different.

Annex A Exchange rate

1AUD = 0.6 USD (av 1998)

Annex B Method and accuracy of data

a) A summary of the methods used to gather, process and analyse the data given in the NSR.

Production and proportional usage data was sourced from major manufacturers. Data on specific installations and programs was sourced from the responsible organisations, either from employees or from published information.

b) An estimate of the accuracy of the data if this is worse than 10 %. The accuracy can be given as a tolerance (either 20kWp ± 20% or 20kWp ± 4 kWp) or as a range (e.g. 16kWp to 24kWp).

The accuracy of data is generally within 10%.