

# ASSESSMENT OF STATUS OF DEVELOPMENT OF STANDARDS AND TRAINING FOR RENEWABLE ENERGY IN AUSTRALIA

A Consultancy Report by ACRE  
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## Executive Summary

### Standards

Standards in Australia are the responsibility of an independent Sydney based company Standards Australia International Limited. Standards Australia was originally formed in 1922 and now has annual revenue of A\$74 million. It currently maintains over 6,000 Standards using around 9,000 voluntary experts serving on around 1,700 technical committees and supported by a full-time staff of 280. Standards Australia represents Australia on the two major international standardizing bodies, the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC). Standards for renewable energy systems are a small part of its total business.

The number and extent of Australian Standards for renewable energy systems, which currently exist, reflect the maturity of the target sector and the maturity of the specific industry. Table 1 lists all standards relating to renewable energy that were identified for this report.

### Solar hot water systems

For solar hot water systems (SHW), where there is a mature Australian industry, the standards in place cover the industry and protect the consumer relatively well, although there is a need for standardising consumer information labelling of all water heaters. A total of eleven Australian standards<sup>1</sup> are in place relating to domestic solar hot water systems and to solar pool water heating systems. International standardisation is underway with Australia playing a leading role in the development of those standards in order to minimise the non-tariff barriers to Australian exports, additional support for these activities will expedite developments and assist Australian export businesses. Existing industry is relatively happy with the national standards situation as it relates to them. The exception being some new industry players that are developing novel plastic collector and storage systems, as the existing standards do not apply easily to them. One aspect that is of some concern with regards to SHW standards is that existing testing facilities are not adequately funded to test to the necessarily stringent demands required by the standards.

### Electricity Production

For the RE sectors relating to electricity production utilising photovoltaic (PV), micro-hydro and wind generators there are fewer Australian Standards. Only one standard is in place relating to PV panels and this may be out of date. Two Australian standards exist for storage batteries but these do not relate to the design of the storage component of systems. Three Australian standards (one in draft form) exist for stand-alone power systems but these don't cover the full range of hybrid systems that are being developed. The reliability issues associated with RAPS systems suggest that

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<sup>1</sup> Here we are counting Standards as including Parts of Standards as separate Standards: this is how they are issued by Standards Australia.

standards in this area are urgently required. No Australian standards exist for small wind turbine systems although four exist for the towers and associated structures. A number of international standards and certification arrangements exist for large (> 100kW) wind turbines reflecting the state of play in this sector of the industry.

No Australian standards exist for water pumping systems, control systems, charge controllers, maximum power point trackers, PV arrays – DC side, RAPS or grid linked inverters, solar home systems (SHS), micro-hydro systems, demand side systems including DC supplied fluorescent lamps, or industry contracting. An Australian Guideline, however, exists for grid-linked inverters. A single Australian standard exists for the installation of small stand-alone generating sets.

### **International**

Internationally there is considerable interest in developing standards for electricity generating RE systems and here the situation is a bit further advanced. The International Electro-technical Commission (IEC) has a number of existing standards some of which are pertinent to this report. There is an IEC standard for small wind turbines but opinion is that this standard is currently inadequate. The IEC also has various Technical Committees writing standards for components including TC82 PV panels and balance of systems, TC 21:- storage batteries, TC 88:- wind energy systems and a new TC, TC105 for fuel cells.

For RAPS systems the first meeting of the IEC Joint Coordination Group (JCG) TC82/TC21/TC88, *Decentralized Renewable Energy Systems* was held early this year. In attendance were delegates from USA, UK, Australia, Canada, France, Germany, Japan and Denmark. This group will oversee development of a French document that covers an extensive range of RAPS, into a series of IEC standards. Other initiatives are underway including: various International Energy Agency (IEA) task forces on RE, a joint laboratory initiative under the European Commission under their Fifth Framework Convention, and the PV-GAP initiative.

### **Wood-heaters**

While wood-heaters<sup>2</sup> are certainly a mature industry in general terms Australian standards relating to them have only been developed relatively recently: as the safety problems developing from installing them in relatively large numbers in modern houses became apparent. A total of nine Australian Standards have been prepared over the past 15 years dealing with safe installation of solid-fuel burning appliances, appliance quality, appliance performance (efficiency, heat output rate), and emission of particulates.

### **Testing Facilities**

In addition to the writing of standards it is considered essential for Australia to develop the capacity to test to any standards developed. The testing has to be available to industry at a cost commensurate with the cost and volume of the product line being tested for. If this is not done it will only frustrate industry and make the standards development work irrelevant to that industry. Australia had been very tardy compared to many comparable countries internationally, which mostly have their own national renewable energy laboratories. In Australia the testing facility

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<sup>2</sup> The brief for the study refers to 'wood stoves'. This is a term used in North America, but in Australia and Europe the term for controlled-combustion wood-burning heaters is 'wood-heater'. Wood-stove is used in relation to cooking stoves.

situation has been very fragmented. There is already a problem with testing of SHW systems in that the facilities at the only QAS registered test laboratory at the UNSW needs an urgent injection of funding to enable it to continue offering services. Testing of wood-heaters has fared somewhat better due to a transfer of the testing from the University of Tasmania (which offered the original test service) to two private test companies. For electricity producing RE systems the situation will improve as the new ACRELab facility comes on line. It is anticipated that this facility, which is presently operational, will be accredited by the National Association of Testing Authorities (NATA) by the end of 2001.

### **Short term goals**

The report identifies a list of short and long-term goals for standards development. The short-term goals include:

- Converting the present grid linked inverter guideline into an Australian standard
- Converting the existing IEC international standard for small wind turbines into an Australian standard.
- Developing a standard for DC PV arrays
- Developing a standard for RAPS inverters
- Developing a standard for industry contracts for RAPS supply
- Developing a standard for micro-hydro systems

It is thought that all these short-term goals are achievable provided sufficient resources are available to allow technical drafting and survey work to be carried out.

### **Long term goals**

In addition more extensive list of longer-term goals is given to cover the remaining gaps. These goals include developing Australian standards, or adopting international standards, for the following:

- RAPS systems
- Charge controllers
- Systems controllers
- Rating scheme for PV modules
- DC loads including fluorescent lamps
- RAPS batteries (classification/testing procedures)
- RAPS batteries (installation, voltages > 115 Vdc)
- Solar home systems (SHS)
- Maximum power point trackers (MPPT)
- Water pumping systems
- Redox / flow batteries
- Metering of grid connect and RAPS systems
- Fuel cell generators (further down the track as these systems are still at the research stage)

In many cases it may be best for Australia to keep a close watch on international developments and participate in international programs before entering specific standard development. In all cases substantial laboratory and industry liaison is needed before embarking upon the actual writing stage.

**Table 1: summary table of Australian Standards relating to RE systems**

<b>Sector</b>	<b>Standard #</b>	<b>Short Title</b>
SHW	AS 3500.4.2-1997	<i>National Plumbing and Drainage Part 4.2: Hot water supply systems – Acceptable Solutions</i>
SHW	AS 2535-1986	<i>Solar Collectors with Liquid as the Heat-Transfer Fluid</i>
SHW	AS 2535.1:1999	<i>Thermal performance of glazed liquid heating collectors including pressure drop</i>
SHW	AS 2813-1985	<i>Method of Test for Thermal Performance – Simulator Method</i>
SHW	AS 2984-1987	<i>Method of Test for Thermal Performance – Outdoor Test Method</i>
SHW	AS/NZS 4445.1:1997	<i>Domestic water heating systems- performance rating procedure using indoor test methods.</i>
SHW	AS 4234-1994	<i>Domestic and heat pump water heaters – Calculation of energy consumption</i>
SHW	AS 2712-1993	<i>Solar Water Heaters Design and Construction</i>
SHW	AS 3634-1989	<i>Solar heating systems for swimming pools</i>
SHW	AS 2369.1-1990	<i>Materials for solar collectors for swimming pool heating - Rubber materials</i>
SHW	AS 2369.2-1993	<i>Materials for solar collectors for swimming pool heating - Flexible or plasticized polyvinyl chloride</i>
PV	AS 2915-1987:	<i>Solar photovoltaic modules - Performance requirements</i>

BAT	AS 4086.1-1993	<i>Secondary batteries for use with stand-alone power systems - General requirements</i>
BAT	AS 4086.2-1997	<i>Secondary batteries for use with stand-alone power systems - Installation and maintenance</i>
<b>Sector</b>	<b>Standard #</b>	<b>Short Title</b>
SYS	AS 4509.1-1999	<i>Stand-alone power systems - Safety requirements</i>
SYS	AS 4509.2- 2001?	<i>Draft Stand-alone power systems - Part 2 System Design Guidelines</i>
SYS	AS 4509.3-1999	<i>Stand-alone power systems - Installation and maintenance</i>
WIND	AS 1170.1-1989	<i>Minimum design loads on structures (known as the SAA Loading Code) - Dead and live loads and load combinations</i>
WIND	AS 1170.2-1989:	<i>Minimum design loads on structures (known as the SAA Loading Code). Part 2: Wind loads</i>
WIND	AS 1170.3-1990	<i>Minimum design loads on structures (known as the SAA Loading Code) - Snow loads</i>
WIND	AS 3995-1994:	<i>Design of steel lattice towers and masts</i>
GEN	AS 3010.1-1987	<i>Electrical installations - Supply by generating set - Internal combustion engine driven sets</i>
WOOD	AS 2918-1990	<i>Domestic solid fuel burning appliances – Installation</i>
WOOD	AS/NZS 3869:1999	<i>Domestic solid fuel burning appliances – Design and construction</i>
WOOD	AS/NZS 4012:1999	<i>Domestic solid fuel burning appliances – Method for determination of power output and efficiency.</i>

WOOD	AS/NZS 4013:1999	<i>Domestic solid fuel burning appliances – Method for determination of flue gas emission</i>
WOOD	AS/NZS 4014:1999	<i>Domestic solid fuel burning appliances – Test Fuels Parts 1 to 5 for different fuels</i>

**Abbreviations:** SHW- solar hot water systems, PV- Photovoltaic Panels, BAT – storage batteries, SYS- Renewable Energy Systems, WIND- Wind Energy Systems, WOOD – Wood-heaters

### **Training**

Australia is a recognised world leader in renewable energy education with well-developed courses available at all levels including university research training, undergraduate and postgraduate coursework, TAFE and short courses for industry and Government. The report is the result of an extensive national survey of RE courses but it does not claim to be all-inclusive. In particular the report does not include once-off courses, courses run at secondary level including secondary level vocational courses and specialist courses run by Government departments or Government agencies.

### **University**

Ten universities (see table3) were identified as offering research training in various aspects of renewable energy installation and design. In general there is good coverage of photovoltaics and renewable energy systems but several other areas, including micro-hydro, wind and biomass are poorly represented. Coursework Masters level courses with a major emphasis on Renewable Energy are available at four institutions at present (see Table 2) although several others are considering entering this field. Units or courses in renewable energy are available at undergraduate and postgraduate level at most Universities but only two currently offer full undergraduate degree programs in this area. Formal research into renewable energy topics was identified at 10 universities but could obviously be carried out (with regard to some aspect) at many more.

### **TAFE**

There are 8 TAFE colleges (see table 4), which offer the Certificate IV in Renewable Energy. Four of these are in Victoria and two in Queensland. TAFE colleges in WA and NT also offer this qualification but no offerings are available in NSW, SA, Tasmania or the ACT. This is a serious issue, which affects the ability of the industry to recruit well-trained trades people for the design, installation and maintenance of renewable energy systems. The Australian National Training Authority (ANTA) is now addressing this issue with a view to developing a national curriculum that will be available in all States. There are also some gaps in the offerings. Although PV, wind and diesel hybrid power supply systems are adequately covered in the existing TAFE syllabus, there is a lack of training packages available on wood heaters and microhydro systems.

### **Industry**

More than 50 companies and agencies run short training courses on various aspects of renewable energy systems. These are mostly offered on an occasional basis in response to demand or the opportunity to piggyback on a conference. Most of these courses are not offered by Recognised

Training Organisations (RTOs) or accredited. There is no coordination in these offerings and some are not available to the public.

There is a shortage of supply of trained personnel for the renewable energy industry at present. This is a result of the rapid growth of demand for systems and personnel in response to Government policy initiatives. Current training programs have largely been driven by company needs and Government policy initiatives (such as ACRE, SEIA and the Key Centre for Photovoltaic Engineering).

Education providers are aware of the need for greater training capacity and steps are being taken to increase the range of courses available. However there are still serious deficiencies in coverage in all sectors. Additional ongoing Government support is particularly needed to increase research training capacity. TAFE coverage is lacking in several States and some areas such as wood-heaters and micro-hydro are not covered at all. Training for indigenous communities is lacking at present. The area of short courses for in-service training is growing rapidly but needs better coordination and there is a need to look more closely at training standards and accreditation in this area. There is an important role here for Governments and professional bodies.

Standards and accreditation need to be more closely linked to education and training to ensure that trades people are fully aware of the standards for renewable energy systems. There is an important role here for Governments to facilitate this process.

**Table 2: University Level Courses in Renewable Energy**

<b>Institution</b>	<b>Award Level</b>
Curtin University of Technology	Master of Engineering Science in Renewable Energy Engineering - higher degree by coursework
University of Melbourne	Graduate Certificate of Engineering (Energy Studies) - higher degree by coursework
University of Melbourne	Graduate Diploma of Engineering (Energy Studies) - higher degree by coursework
University of Melbourne	Master of Energy Studies - higher degree by coursework
University of Melbourne	Master of Engineering (Energy Studies) - higher degree by coursework
Murdoch University	Postgraduate Certificate in Energy Studies - higher degree by coursework
Murdoch University	Postgraduate Diploma in Energy Studies and Bachelor of Applied Science (Energy Studies)- higher degree by coursework
Murdoch University	Master of Science in Renewable Energy - higher degree by coursework
Murdoch University	Bachelor of Engineering (Renewable Energy Engineering) – undergraduate degree
Murdoch University	Bachelor of Science (Energy Studies) – undergraduate degree

University of New South Wales	Bachelor of Engineering (Photovoltaics and Solar Energy) – undergraduate degree
University of New South Wales	Graduate Diploma in Electrical Engineering (major in Photovoltaics) – higher degree by coursework
University of New South Wales	Master of Engineering Science in Electrical Engineering (major in Photovoltaics) – higher degree by coursework

**TABLE 3: University Research Training in Renewable Energy**

University	Research Awards Offered	Major Areas Available
Curtin University of Technology	MPhil, PhD	Power conditioning, hybrid systems
Royal Melbourne Institute of Technology	MEng, PhD	Solar Thermal, Cogeneration
University of Melbourne	MPhil, PhD	Solar thermal, biomass
Murdoch University	MPhil, PhD	Hybrid systems, photovoltaics, energy storage
University of NSW	MPhil, PhD	Photovoltaics, hybrid systems, grid-connected systems, solar thermal, energy storage
Australian National University	MPhil, PhD	Photovoltaics, solar thermal
Northern Territory University	MEng, PhD	Hybrid systems
University of Newcastle	MPhil, PhD	Wind and hybrid systems
University of Tasmania	MPhil, PhD	Solar cooking, Wood heaters
University of Sydney	MPhil, PhD	Solar thermal power systems

**Table 4: TAFE Courses in Renewable Energy**

Institution	Award Level
Brisbane Institute of TAFE, ITHACA Campus	Certificate IV in Ren. Energy Tech, Short Courses in Specific Tech Areas, Starting Certificate II in Electrotechnology Servicing (Renewable Energy Specialisation) - July 2002
Central TAFE, Perth	Certificate IV in Ren. Energy Tech, Short Courses and SEIA accreditation
NTU/TAFE	Certificate IV in Renewable Energy Technology
Swinburne Uni/TAFE	Certificate IV in Renewable Energy Technology
NMIT Victoria	Certificate IV in Renewable Energy Technology
Gordon TAFE, Victoria	Certificate IV in Renewable Energy Technology

CSIT TAFE Queensland	Certificate IV in Renewable Energy Technology
Chisholm TAFE Victoria	Certificate IV in Renewable Energy Technology

### Authors of the report

The report, compiled by ACRE, has had a number of contributors, each expert in his or her respective field. Some are ACRE staff and others worked as consultants, accessed via ACRE's extensive matrix network. ACRE staff have been involved in Australian and international standards committees since 1997. Important IEA survey documents on renewable energy systems have also been reviewed.

Solar hot water systems have been covered by a number of people including Graham Morrison (UNSW), Ken Guthrie (SEA-Victoria), Bob Lloyd (ACRE) and Trevor Pryor (ACRE). The electricity producing RE section was largely written by Ted Spooner (ACRE) with contributions on wind from David Wood (University of Newcastle) and micro-hydro from John Todd (University of Tasmania). John Todd also wrote the wood-heater section. Phil Jennings contributed to and coordinated the training section with assistance from Chris Lund, John Todd and Prakash Dubey. The report has been edited and assembled by Bob Lloyd (ACRE).

**Graham Morrison** is director of the Solar Thermal Energy Laboratory at the University of NSW. He has worked on the Standards Australia CS28 Solar Thermal Committee since 1980 and has been one of the Australian representatives to ISO TC180 committee. He has been involved in drafting many of the Australian and international solar thermal standards and developed the computer software used for rating solar water heaters (AS42324 and the Solar Certification and Rating Corporation in the USA).

**Ken Guthrie** is Group Manager Government and Renewables at SEA Victoria. He has 20 years experience in energy efficiency and renewables. He has carried out consulting on solar water heating for the United Nations in India and Syria and for the Pacific Forum, as well as working on EEC funded projects in the UK. He chairs both the Australian and the International Solar water heating standards committees.

**Trevor Pryor** is the Director of the Murdoch University Energy Research Institute (MUERI) and has been involved in the testing and monitoring of RE systems for over twenty years. This work has included the testing of solar thermal collectors, the monitoring of solar thermal systems and, more recently, the testing and monitoring of diesel hybrid and standalone diesel RAPS systems.

**Ted Spooner** is chairman of EL42/3 subcommittee on Grid Connection and a member of the International Electrotechnical Commission's (IEC) technical committee TC82 that covers photovoltaics. He has been involved in testing of RAPS inverters for the NSW RAPAS scheme since the early days of its implementation. He has also been involved since 1997 in testing grid connected inverters for PV systems.

**David Wood** is the only Australian member of IEC committee MT2, a committee, which is charged with revising the small wind turbine standard IEC 61400-2. He has been researching wind turbine aerodynamics for nearly 20 years and has designed blades from 600 W to 20 kW (1m to 5 m) for three Australian manufacturers.

**Bob Lloyd** is the ACRE Product Executive for RAPS and is a founding member of the IEC- JWG of TC21/TC82/TC88 for the production of RAPS standards from PAS 62111. He has worked on a survey of hot water systems in remote areas of Australia.

**John Todd** is a member of the Australian Standards Committee CS/62 that has prepared the Residential Solid Fuel Burning Appliance Standards. He was Chairman of the Committee from its inception in 1981 to 1998 and has represented Australia on the International Organization for Standardization Technical Committee ISO/TC 116 SC3.

**Philip Jennings** is the ACRE Product Executive for Education and Training and Professor of Physics at Murdoch University. He has been involved with education and training in the field of renewable energy for more than a decade.

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**Prakash Dubey** has a PhD in renewable energy and is ACRE's Education Product Development Officer.