ARC Centre of Excellence for Solar Energy Systems
Report for the year 2004
CEO348198

Australian National University

Establishment and funding
The Centre was established late in 2003, and will operate until the end of 2007. Indicative funding from the ARC is $300,192 per year. Funding was first received from the ARC in November 2003.

Investigators
Prof AW Blakers (RD) (40%) Director

Dr VA Everett (CI) (40%) Deputy Director

Dr KJ Weber (CI) (20%)

Dr P Deenapanray (CI) (10%)

PhD Candidates

Mr Evan Franklin

Ms Wendy Jellett

Chief Operating Officer

Mr Ray Prowse

Other ANU technical and research personnel involved with or related to the Centre of Excellence

Dr Joe Coventry – Recent PhD whose thesis was based on CHAPS systems development

Dr Mike Dennis – Recent PhD who developed the tracking software for CHAPS systems

Mr John Smeltink – Managing Engineer for Bruce Hall project

Mr James Cotsell – Manager for receiver fabrication

Mr Chris Holly – Manager for concentrator cell production

Ms Nina De Caritat – Cell fabrication

Ms Josephine McKeon – Cell fabrication

Ms Sonita Singh – Cell fabrication

Dr Kidane Belay – Cell fabrication

Mr Bruce Condon – Electronics technician

Mr Neil Kaines – Laboratory manager

Mr David Barton – PhD candidate whose thesis is based on the social issues of sustainable technologies

Research Program

The focus for the *ARC Centre of Excellence for Solar Energy Systems* is the development of improved silicon concentrator solar cells for 10-50 sun linear concentrators. The development of integrated high-performance linear concentrating systems is underway with funding from the Centre of Excellence and a variety of other sources.

Solar concentration systems have the potential to provide more cost effective conversion of solar energy into a useful form of energy, such as electricity and hot water. Much of the cost associated with photovoltaic conversion is in the infrastructure associated with the mounting of photovoltaic modules into a ground or rooftop mounted array.

Bruce Hall CHAPS system

There is equivalent infrastructure involved with solar thermal conversion systems, so combining solar photovoltaic and thermal elements to form a hybrid system has the potential to improve the cost effectiveness of solar energy conversion. Combined electrical and thermal efficiencies of up to 70% have been achieved in Combined Heat and Power Solar (CHAPS) systems designed and built at ANU.

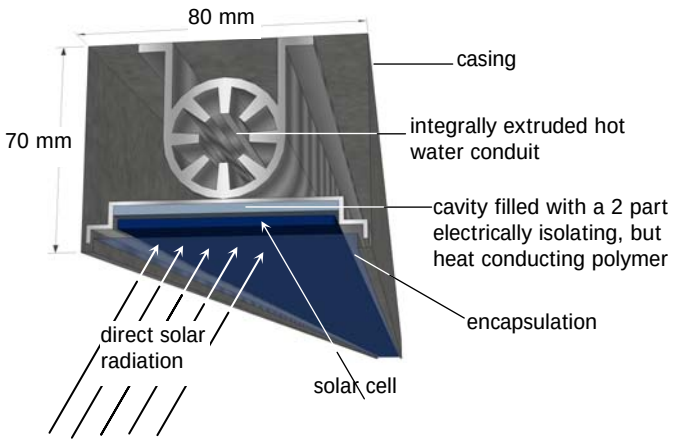
Solar radiation produces both heat and electricity in the photovoltaic array. The heat and electricity must be removed from the solar cells in a way that keeps the operating temperature low and the parasitic resistance losses small. This requirement impacts upon the design of the solar cells.

A variety of linear concentrators have been constructed by ANU to act as test-beds for linear concentration technology and components. A 160m^2 air-cooled two-axis tracking system was constructed in Perth, and a water-cooled single-axis tracking 300m^2 demonstration CHAPS system has been constructed at ANU on the roof of Bruce Hall (a college a residence).

Experimental rooftop CHAPS system on Faculties Teaching Centre

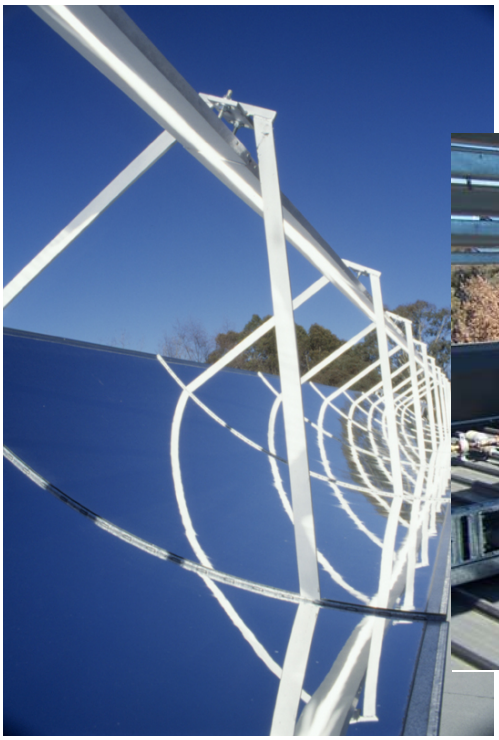
In a CHAPS system, the solar cells are mounted on an extruded aluminium receiver "looking down" at the mirrors. Water is circulated behind the solar cells in order to extract heat. With funding from other sources, receivers have been developed to maximise the transfer of energy from the incident solar radiation to the end products, heat and electricity. This has been done by:

1. Improving the optical performance of the front surface of the cells by experimenting with different glazing techniques and encapsulating materials
2. Improving the transfer of heat from the concentrator cell into the water in the integral conduit
3. Reducing the heat lost from the receiver through the use of improved insulation materials between the aluminium extrusion and the casing
4. Improving the electrical output of the receiver by investigating different combinations of bypass diodes connected between the 28 cells in each receiver



CHAPS receiver incorporating high efficiency concentrator cells

With other funding, advanced glass-on-metal-laminate mirrors have been developed that offer high reflectivity, shape accuracy, simplicity and long field life. Sophisticated tracking and control software and hardware has also been developed. A complete testbed is available for the linear concentrator solar cells being developed with funding from the ARC Centre of Excellence.



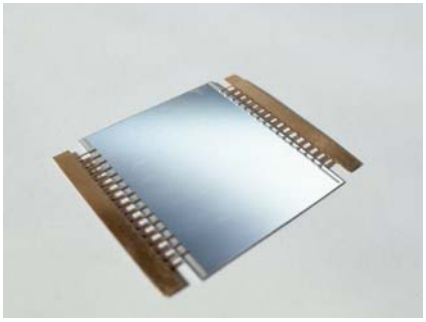
CHAPS receivers "on sun"

Roof top system on Bruce Hall showing mounting, plumbing, electrical and heat dumping infrastructure

ARC Centre of Excellence activities

Conventional concentrator solar cells

About 3000 monocrystalline concentrator cells (each with an area of 20cm^2) were fabricated to populate the receivers in the Bruce Hall CHAPS system. The cells were specifically designed for the system. The design is a compromise between cost, performance and yield. Typical cell performance is around 20% at 25C and 30 suns illumination. This exercise yielded valuable information with respect to statistical analysis of performance and yield. It was found that both performance and yield increased as the design was bedded down.

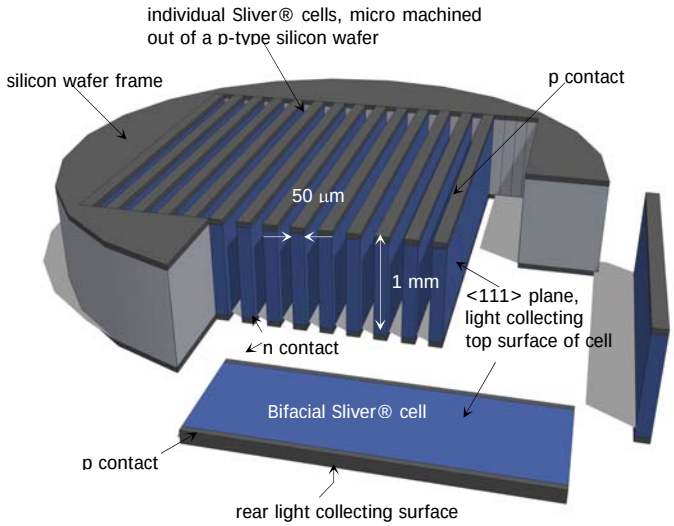


High efficiency concentrator cell with tabbed bus bars

The cell metallisation technique was refined, and a patent application was lodged.

The Sliver Process

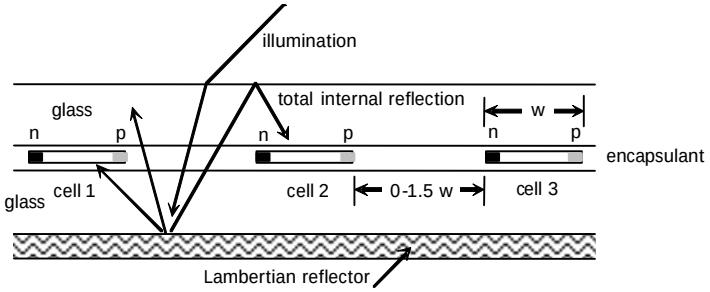
Sliver cells were developed because they promised inherent advantages over conventional mono and poly crystalline cells. The largest component of the cost of solar cells (50%) is the expensive high-grade silicon used in the construction of the cells. Sliver cells address this issue by reducing the amount of silicon used for a given output by a factor of 10.



The Sliver cell process

A silicon wafer, typically 1mm thick, is etched clear through the wafer to form slivers approximately 50microns thick, 80mm long and 1mm wide. The Slivers are held in place by a narrow annulus of unetched silicon. Conversion of the Slivers to solar cells by suitable diffusions, oxidations, depositions and metallisation follows. Finally the Slivers a broken out from the host wafer, rotated through 90°, mounted on a suitable heat sink and electrically interconnected.

The Slivers can be mounted into a module as per the diagram at left. In this process the Slivers are encapsulated between two sheets of glass with a diffuse reflector at the back. Light that passes between the Slivers is reflected back to be absorbed by another Sliver through the rear surface or the front surface after total internal reflection. Because the Slivers are perfectly bifacial (accept light from either side), only a small fraction of the solar radiation is lost, further reducing the amount of silicon needed due to the spacing of the Slivers. The extension of this process is that the rear reflector can be dispensed with and the module becomes transparent.



Mounting Slivers in modules.

The rotation of each Sliver through 90° provides large area multiplication and is the most important advantage of Sliver cells over conventional solar cells. The cumulative surface area of the Slivers cells is about 20 times larger than the surface area of the wafer. When arranged in modular form we find that the Sliver cells from two wafers cover the same area is about 60 conventional solar cells.

Sliver concentrator solar cells

The development of Sliver concentrator solar cells is the main focus of work in the Centre of Excellence. Andrew Blakers and Klaus Weber invented sliver solar cells in 2000. The technology is the subject of a $40 million commercialisation by Origin Energy. A factory has been built in Adelaide and production is due to commence this year. Sliver technology was originally conceived for non-concentrator applications. However, Sliver solar cells also perform well under 10-50 suns concentration.

Large progress was made in understanding the performance and limitations of Sliver concentrating solar cells. This has allowed considerable simplification of the cell fabrication process. The main improvements have been in understanding the role of defects in causing shunts; understanding the causes of the various types of defects, which allowed a drastic reduction in their number; reduction in the number of process steps by 40%; and improved understanding of surface passivation requirements.

Four patent applications were filed pertaining to ideas that have arisen under this program of work in 2004.

Sliver cells in concentration systems enjoyed several advantages over conventional concentrator solar cells:

- Reduced cost because of the area multiplication
- Reduced cost because Sliver cells suitable for concentration can be obtained from large production runs for one sun modules with relatively modest technical change
- Increased ability to tolerate non-uniform illumination by designing the Sliver cells in such a way that they have a small reverse breakdown voltage. This eliminates the need for bypass diodes.
- The ability to build voltage very quickly (up to 10 volts per linear centimetre) with a correspondingly small current, which reduces resistance losses. Resistance losses are difficult to manage in concentration solar cells.
- The ability to double the effective concentration ratio for a given concentrator design due to the fact that the Sliver cell is perfectly bifacial.

Facilities within the Centre of Excellence for Solar Energy Systems

The Centre of Excellence for Solar Energy Systems has full access to the resources of the Centre for Sustainable Energy Systems. The Centre for Sustainable Energy Systems is part of the Department of Engineering within the Faculty of Engineering and Information Technology. The resources include:

Centre of Excellence Building in the Department of Engineering

Photovoltaic Laboratories

E125 Gingera Laboratory – clean room used for production of high efficiency cells

E126 Gudgenby Laboratory – used for metal deposition under high vacuum conditions

E127 Ginini Laboratory – used for characterisation activities

E124 Bimberi Laboratory

Furnaces, fume cupboards, laminar flow workstation, etching station

- used for cell fabrication under less stringent conditions than the Gingara laboratory

E123 Tidbinbilla Laboratory

Fume cupboards, dicing saw, spin coating station

- used to process cells and addition of collection grids

E122 Piccadilly Laboratory

Fume cupboards, laser dicing workstation, furnaces , LPCVD, microscopes, rapid thermal annealing furnace

- used for general research

Bimberi Laboratory

Tidbinbilla Laboratory

E131 Franklin Laboratory

Dicing saw, soldering jigs, characterisation workstation, workbenches, glass cutting table, vacuum chambers

- used for module and receiver assembly

E114 Mechanical Workshop

Full workshop facilities with metal fabrication facilities shared with Department of Engineering

E138 Characterisation Laboratory

E129 Electronics Workshop

- used for fabrication of electronic components and as a maintenance resource for all other equipment

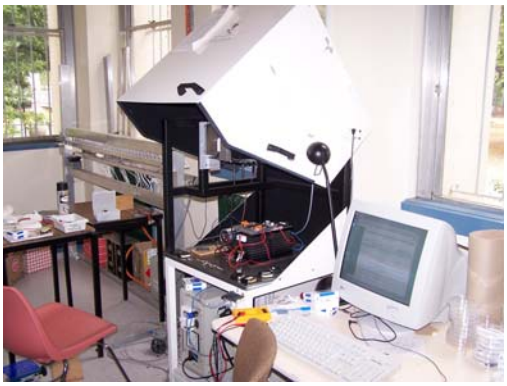
E128 Maintenance Office

- used for workbench maintenance of equipment

Faculties Teaching Centre – building 42 (separate from PV Laboratories)

- rooftop used for installation of prototype and demonstration systems – clear sky access from large flat roof area

Franklin Laboratory



Franklin Laboratory

Management and Visibility

The Centre Director is Professor Andrew Blakers.

The Deputy Director is Dr Vernie Everett, who replaced Dr Klaus Weber in March 2004. Dr Weber remains closely associated with the Centre.

Mr Ray Prowse has been appointed as the Chief Operating Officer.

Centre activities are located exclusively at ANU.

Further information about the Centre of Excellence can be obtained from:
http://solararc.anu.edu.au

Advisory Board

An Advisory Board has been established and met on Friday 15th April 2005. The Advisory Board will meet twice per year. Brief Biographies of members of the Board are attached. The role of the Advisory Board is to provide strategic advice on the research focus of the Centre, to provide an independent perspective on Centre structure and operating principles, to provide advice on intellectual property and commercialisation management and to assist with external contacts, linkages and relationships as the opportunity arises.

Education and training

Centre staff delivered lectures and tutorials in undergraduate courses ENGN 2224 and ENGN 4507. Several final year Engineering Project students undertook projects during 2004.

Two PhD students, Mr Evan Franklin and Ms Wendy Jellett, are attached to the Centre.

Industrial interactions

Centre activities have close links two commercial projects underway at ANU:

- The commercialisation of the Sliver® cell technology that was developed by Blakers and Weber at ANU. Origin Energy is currently investing $35 million in a factory in Adelaide for the production of non-concentrator solar modules, with first commercial sales expected in 2005. Sliver® solar cells as concentrator solar cells are an important focus for the Centre of Excellence.
- Success in the development of high-performance concentrator solar cells will assist the commercialisation of tracking concentrator systems developed at ANU. A 300m^2 demonstration system has been constructed on the roof of Bruce Hall College of Residence at ANU. Commercial partners for the system are now being sought.

Activity plan for the next twelve months

Activities planned for 2005 include the following:

- Further characterisation of Sliver solar cells, particularly for concentration where series rather than shunt resistance is the main parasitic loss.
- Incorporation of several new ideas for streamlining cell fabrication.
- If possible, implementation of some of the work performed during 2004 in the Origin Energy factory.
- Incorporation of concentrator Sliver cells into experimental modules to allow measurement outdoors and accelerated life testing.
- Improved public and government awareness of the Centre of Excellence for Solar Energy Systems through a strategic publicity and communication campaign.

Constraints

Legal/commercial constraints in the area of Sliver solar cell technology restricted publications. However, 4 patent applications were lodged covering some of this work.

Expenditure for the year

An annual certified statement is attached incorporating details of income and expenditure for the year covered by the Centre's report.

Drew Clarke

Drew Clarke commenced as Head of the Energy and Environment Division in the Australian Government Department of Industry, Tourism and Resources in April 2003. His previous position was Executive General Manager of AusIndustry, the Department's business assistance agency. Drew has worked in Australian Government science and business agencies for 25 years, including national and international representative roles. His professional background is in the spatial sciences.

The Energy and Environment Division comprises four Branches:

- Energy Futures: focussing on economic and policy research, energy data and forecasts, technology RD&D, fuel mix, and energy efficiency.
- National Energy Market: focussing on the policy, development and regulation of the wholesale, network and retail elements of the national electricity and gas market.
- International: focussing on Australia's interest in the International Energy Agency, APEC Energy Working Group, bilateral energy cooperation arrangements, energy security policy and energy security risk assessments.
- Environment: focussing on greenhouse policy, sustainable development, and development of the environment and renewable energy industries.

The Division provides the Secretariat for the Australian Ministerial Council on Energy, comprising Energy Ministers from the Commonwealth, State and Territory governments.

Lawrence Cram

Professor Lawrence Cram is Deputy Vice-Chancellor (Research) at the Australian National University. His career spans more than 30 years of research in engineering, mathematics, astronomy, physics and computing. He has a track record of involvement in successful commercialization of research, through experience at CSIRO and the University of Sydney as well as the ANU. Professor Cram also has extensive experience in research management and public sector research funding, having worked for three years as Executive Director in the Australian Research Council. He is currently a non-executive Director on four companies involved in the commercialization of research.

He is a Fellow of the Australian Institute of Physics, and the Royal Astronomical Society, as well as a member of the American Astronomical Society, the International Astronomical Union and the Astronomical Society of Australia.

Merv Johnston

Merv Johnston (**B.Eng (Syd), FIEAust)** has more than thirty years experience in industry, including, multinational private sector organisations; management consulting; as founder and principal shareholder of a small computer sales and service company; and in the public sector. He is currently Managing Director of CVC REEF Limited, which specialises in providing Venture Capital to businesses which are commercialising innovative Renewable Energy technologies, Managing Director of Magma Pty Limited, a management consultancy, specialising in the innovation and commercialisation processes, and early stage businesses, and a Director of Windcorp Australia Limited.

Susan Neill

Susan Neill has a tertiary background in mathematics and modern languages.

Susan commenced working in the renewable energy industry at a wholesale level in 1986, obtained PV System Design Accreditation and completed postgraduate Applied PV certificate from UNSW. She became involved in the development of the Solar Energy Industry Association of Australia (SEIAA) in 1990 through to its present status as part of the Business Council for Sustainable Energy, fulfilling the role as national president of SEIAA through the mid 1990s. Susan is currently a member of the PV Directorate for BCSE.

Susan is currently Managing Director of Quirk's Victory Light Co. Pty. Ltd. - Energy Today. This company specialises in stand-alone and grid-connected wind and solar systems for which Quirk's is a major wholesaler of system components. Susan's company also works on the development and manufacture of power efficient low voltage refrigeration.

Susan has broad experience in industry development issues and a wide network of contacts at industry level.

Peter Ottesen

Peter Ottesen is Executive Director of the Office of Sustainability within the Chief Minister's Department of the Australian Capital Territory government. The Office is responsible for driving implementation of the Government's sustainability agenda and has whole-of-government policy responsibility for water, energy and greenhouse.

He has more than 20 years senior level policy and management experience in the public and private sectors within the environment, protected areas, commercial fisheries, tourism, agricultural, transport, waste management, sport and event management industries, within Australia and Canada.

A personal career highlight was his five years with the Sydney Organising Committee for the Olympic Games (SOCOG) where he established and led its Environment Program. In 2001 the United Nations Environment Program elected SOCOG to its Global 500 Roll of Honour. He was subsequently an adviser to the successful Beijing 2008 Olympic Games Bid team on environmental matters and the London 2012 Bid.

He has been an adviser to a senior cabinet minister in the Australian Government and held positions in the Australian Government's Department of Primary Industry and the Great Barrier Reef Marine Park Authority, and Environment Canada.

Peter is Chair of the Banksia Environmental Foundation, a leading Australian NGO that identifies and rewards environmental excellence, an Executive Member of the ACT Division of the Environment Institute of Australia and New Zealand and an "Honorary Ambassador" to the ACT for his contribution to the Canberra-Beijing sister-city relationship.

Peter has a BSc, with Honours (Marine Ecology) from the James Cook University and a MSc (Natural Resource Management) from the University of Western Australia.

John Richards

Professor John Richards is the director of the ANU Institute for Information Sciences and Engineering.

He is also Master of University House, and Graduate House

Professor Richards was formerly Deputy Vice-Chancellor and Vice-President of the Australian National University from October 1998 to October 2003.

From 1987 to 1998 he was at the University College, Australian Defence Force Academy, where he served as Head of School of Electrical Engineering, Deputy Rector and Rector.

He graduated from the University of New South Wales with the degrees of Bachelor of Engineering (Hons1) and Doctor of Philosophy, both in Electrical Engineering, in 1968 and 1972 respectively. He is a Fellow of the Australian Academy of Technological Sciences and Engineering, and a Fellow of the Institute of Electrical and Electronics Engineers, NY.

Denis Smedley

Denis Smedley, MIE Aust

Manager Renewable Energy Technologies

Department of Environment and Heritage

Australian Greenhouse Office

Denis Smedley joined the Australian Greenhouse Office in 2001 and is responsible for the Australian Government's renewable energy commercialisation, deployment and industry development programs that are administered through the Office. Prior to this, Denis worked for the Western Australian Government's Office of Energy, looking after energy efficiency and renewable energy programs for the State. This followed a 24 year engineering career in the Royal Australian Air Force. Denis is an electrical engineer.

SCHEDULE E

Key Result Areas and Performance Measures for 2004

ARC Centre for Solar Energy Systems, CE0348198

(The Australian National University)

Key result area	Performance measure	Target	Outcome in 2004
Research findings			
	Publications	2/yr in general journals such as Applied Physics Letters, Journal of Applied Physics, Electron Device Letters 2/yr in solar energy journals such as Progress in Photovoltaics and Solar Energy Materials and Solar Cells 2/yr in international conferences 2/yr in local conferences	1. A. Blakers, "Sustainable Energy", invited chapter in "In Search of Sustainability", Ed. J. Goldie, B. Douglas & B. Furnass, CSIRO Publishing, ISBN0643090622, 2004 2. K.J. Weber, A.W. Blakers, M.J. Stocks, J. H. Babaei, V.A. Everett, A.J Neuendorf, and P.J. Verlinden, "A Novel Low Cost, High Efficiency Micromachined Silicon Solar Cell", Electron Device Letters 25, 37 (2004) 3. Keogh, W., Blakers, A., Cuevas, A, "Constant-voltage I-V curve flash tester for solar cells", (2004), Solar Energy Materials and Solar Cells, 81(2) pp183-196 (2004) 4. Keogh, W.M. and Blakers, A.W., "Accurate Measurement, using Natural Sunlight, of Silicon Solar Cells" (2004), Progress in Photovoltaics, 12(1) pp. 1-19. (2004) 5. A. Blakers, K. Weber, V. Everett, S. Deenapanray, J. Babaei and M. Stocks, Sliver modules - a crystalline Si technology of the future, 19th European Photovoltaic Solar Energy Conference, Paris, June 2004 6. Evan Franklin and Andrew Blakers, sliver cells for concentrator systems, 19th European Photovoltaic Solar Energy Conference, Paris, June 2004 7. Andrew Blakers, Klaus Weber, Vernie Everett, Sanju Deenapanray and Evan Franklin, Sliver solar cells and modules, Solar 2004, Perth, December 2004

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Research findings (cont)			
	Number of patents	Two over 5 years	1. A.W. Blakers and V. Everett, "A submodule and method of assembly", 2004904478 (filed August 2004) 2. V. Everett, "A Fabricated Article II", 2004904476 (filed August 2004) 3. A.W. Blakers and K.J. Weber, "A semiconductor processing method", 2004906003 (filed October 2004) 4. A.W. Blakers and E.T. Franklin, "A Fabricated Device", Complete patent, 2004224959 (filed October 2004)
	Invitations to address and participate in national and international conferences	Five per 5 years	1. A. Blakers, P. Verlinden, K. Weber, J. Babaei, V. Everett, M. Kerr and M. Stocks, "Sliver® Solar Cells: A New Thin Crystalline Silicon Photovoltaic Technology", PVSEC14, Bangkok, Jan 2004 (invitation to Blakers) 2. Andrew Blakers and Keith Lovegrove, Combined Heat and Power and Other Solar Thermal Developments, Enviro 04, 2004 (invited) 3. A.W. Blakers, Australian Optical Society conference (invited keynote), ANU, July 2004 4. A.W. Blakers, Solar Power, Towards Zero Emissions Conference (invited), Brisbane, 2004
	Number and nature of commentaries about the Centre's achievements	1/year in quality lay publications 1/year in electronic media	1. Jan-Feb 2004 issue of Renewable Energy World: 0.5p article including picture on Sliver cells 2. March 2004 issue of Photon International Magazine (the premier trade magazine): 3 page article including pictures on Sliver solar cells. 3. March 2004 issue of Solar Progress, the magazine of the ANZ Solar Energy Society: 1 page article including pictures on Sliver solar cells. 4. 17th June 2004: 500 word item in Canberra Times; Australian energy policy 5. 20th June 2004: ABC, "The National Interest" with Terry Lane, Australian energy policy 6. 14th July 2004: Delivered a seminar at the ACT Environment Institute monthly meeting 7. 25th September 2004: half page article in New Scientist on energy policy and Sliver cells. 8. 29th September 2004: Sustainability press release from PM mentions Sliver cells 9. A.W. Blakers and K.J. Weber, Sliver Solar Cells, 2200 word article for the November 2004 issue of Power Engineering International magazine (invited)

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Research training and professional education			
	Number of postgraduates recruited	Three per 5 years. Note: Restrictions on PhD recruitment are expected in commercial aspects of Centre activities	Evan Franklin (PhD) Recruited 2002 Wendy Jellett (PhD) Recruited 2005
	Number of postgraduates completions	Three per 5 years	Joe Coventry (PhD) Completed 2004 (recruited 2000)
	Number of Honours students or Summer Scholars	Two per year	Chris Bloomfield Olaf Theden
	Number and level of undergraduate and high school courses in the priority area of solar energy	At least two relevant undergraduate courses delivered per year	Engn 2224 Engn 4507

International, national and regional links & networks			
	Number of international visitors	Two per year	Dr Li Ming, Kunming, China (Dec03 to Dec04) Dr Rolf Brendel, ZAE Erlangen, Germany, (Jan-Feb 2004)
	Number of national and international workshops and conferences attended	Two per year	19th European Photovoltaic Solar Energy Conference, Paris, June 2004 Towards Zero Emissions Conference, Brisbane, 2004 Australian Optical Society conference, ANU, July 2004 Solar 2004, Perth, December 2004 ATRAA Conference of the Business Council for Sustainable Energy, Darwin, August 2004
	Number of visits to overseas laboratories	Two per year	nil
	Examples of relevant social science and humanities research supported by the Centre	At least one significant program supported most of the time	David Barton, PhD scholar, investigating the technical and social issues curtailing application of renewable energy on Norfolk Is. Board member of ANU's National Institute for the Environment Active in promoting solarization
	Number and nature of commercialisation activities	Per 5 years: One substantial; 2 minor commercial interactions	Nil major. Minor interaction with Origin Energy
	Number of Centre associates trained/ing in technology transfer and commercialisation	3 (either formally or by experience)	Ray Prowse – Concept to Commercialisation course conducted by Pyksis, July / August 2004

International, national and regional links & networks (cont)			
	Number and nature of public awareness programs	One substantial media program on a particular theme per year	**Australian Energy Policy** 1. 8th May 2004: ABC Earthbeat 2. 8th May 2004: Courier Mail 3. 19th May 2004: ABC radio news interview 4. 20th May 2004: WIN TV news 5. 1st June 2004: Laboratory tour with secondary school students 6. 15th June 2004: interview on ABC AM program 7. 15th June 2004: interview on ABC morning; Louise Marr 8. 15th June 2004: interview on ABC news; Julie Doyle 9. 16th June 2004: interview on radio 4EB 10. 17th June 2004: 500 word item in Canberra Times 11. 20th June 2004: ABC, "The National Interest" with Terry Lane 12. 22nd June 2004: State Line (Ch 10) interview 13. 11th August 2004: Public lecture for U3A Community Group 14. 11th October 2004: Radio interview with Ralf Krauter, freelance radio journalist from Germany

International, national and regional links & networks (cont)			
	Number of government, industry and business briefings	3 per year	1. 19th March 2004: Hosted a visit from Greg Evans, Chief of Staff for the Minister for Science Senator McGauren to discuss renewable energy policy 2. 21st May 2004: Tour and briefing with Robert Holgate, program manager Business ACT 3. 28th April 2004: 40 min meeting with ACT Chief Minister (Solarization) 4. 11th May 2004: 40 min meeting with Senator Lyn Allison 5. 2nd July 2004: Tour and briefing with Dave Williamson, program manager at the Australian Greenhouse Office 6. 5th July 2004: 1 hr meeting with Jocelyn Plovits from the ACT Chief Ministers Department 7. 15th July 2004: 1hr meeting with Katyn Chittick (Business ACT) and Gordon McAllister (Environment ACT) 8. 31st August 2004: hosted visit by senior members of the Department of Industry, Tourism and Resources to discuss the design of the new Renewable Energy Development Initiative. 9. 3rd September 2004: visit by Labour Minister Kelvin Thomson 10. 15th October 2004: Conducted site tours and briefing for Korean delegation 11. 17th October 2004: 1 hr meeting with Senator Lynne Alison at Parliament House 12. 25th November: half day meeting and tour with Jan Decker, Centre for Energy and Greenhouse Technologies 13. 14th December 2004: Tour and briefing with Darryn Burlang et al from ActewAGL
	Networking contributions to the solar energy industry	Substantial non-technical contributions to solar energy industry development	Blakers successfully applied for funding of $147,000 to conduct a PV Road Mapping exercise. The exercise was conducted under the auspices of the Business Council for Sustainable Energy. Virtually the entire PV industry participated. Blakers organised and wrote a bid for an ARC Renewable Energy Research Network. Virtually the entire Australian R&D community was included. Seed funding of $20,000 was awarded but the full application was unsuccessful. Blakers organised and led a bid for a Solar Energy CRC, which, unfortunately, was unsuccessful. Prowse supported industry development though chairmanship of the ACT branch of the Australian and New Zealand Solar Energy Society Prowse represented the CoE on the International Energy Agency Photovoltaic Power Systems consortium Prowse continued advisory role with the Business Council for Sustainable Energy's Standards, Training and Accreditation committee

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Organisational support			
	Annual cash contribution from collaborating organisations	ANU: at least $90,000 per year cash	Received.
	Annual in-kind contributions from collaborating organisations	ANU: provision of the salary of the Research Director and Deputy Research Director	Director's salary received
	Level and quality of infrastructure provided to the Centre	ANU: Full access to ANU research facilities, including CSES laboratories	Achieved
	Acquisition of additional support for Centre activities	Additional grants or commercial investment at ANU that make use of Centre IP directly or indirectly.	Nil
Governance			
	Breadth and experience of the members of the advisory board	Membership by senior academic and commercial people	Senior academic, Government and commercial people have accepted positions on the Advisory Board. Brief Biographies attached to the Annual Report.
	Frequency and effectiveness of advisory board meetings	Two per year; effective Board briefings; effective interaction between the Board and Centre	The first meeting 15th April 2005 was rather valuable, particularly in the area of funding and commercial advice.
	Quality of the Centre strategic plan	Effectively guides Centre activities; reviewed and updated regularly	Reviewed
	The adequacy of the Centre's key performance measures	Reflect Centre focus; are challenging but achievable with available resources; are updated as required.	Reviewed

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National benefit			
	Measures of expansion of Australia's capability in the priority area of solar energy	Good research outcomes; good research training outcomes	Too early
	Contributions to economic, social, cultural and environmental benefits of solar energy	Good commercial outcomes; good outcomes from outreach activities	Too early

Report prepared by Professor Andrew Blakers (Director) and Mr Ray Prowse (COO), April 2005