



PV POWER

Newsletter of the IEA Photovoltaic Power Systems Programme



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2001

Contents

- P.2 PVPS SURVEY CONFIRMS STRONG MARKET GROWTH
- P.3 COMPARATIVE ANALYSIS OF PV SYSTEMS' OPERATION
- P.4 PV WITHIN THE CLEAN DEVELOPMENT MECHANISM
- P.4 PV ADDED VALUES – DOCUMENTED EVIDENCE
- P.5 PVPS ADVISES G8 RENEWABLE ENERGY TASK FORCE
- P.6 PVPS BRIEF
- P.7 PVPS NEWS
- P.8 THE SOLAR SKIN
- P.8 MANDATORY RENEWABLES TARGET FOR AUSTRALIA

The G8 countries have established a Task Force to identify key actions for increased use of renewable energy for sustainable development. Page 5 shows the IEA-PVPS recommendations to the Task Force.

PVPS SURVEY CONFIRMS STRONG MARKET GROWTH

The latest update of the PVPS Annual international Survey Report 'Trends in Photovoltaic Applications' covering the period 1992-1999 is now available.

The report gives an overview of installed generation capacity, application segmentation, manufacturing capabilities and the business and political environments for PV in the 20 countries participating in PVPS as at the end of 1999. Market development trends over the preceding 8 years are also analysed.

MARKET EXPANSION

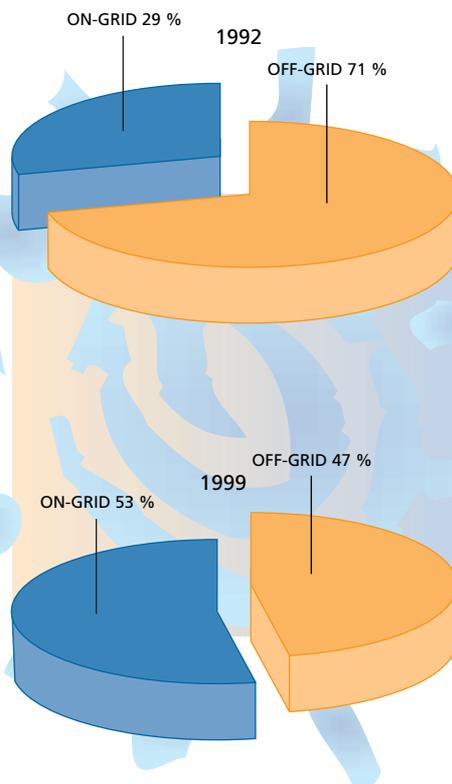
The market for PV power continues to grow rapidly: between 1998 and 1999 the total installed capacity grew by 31 %, to reach 516 MWp. Japan's New Sunshine Programme, which commenced in 1995 is now exerting a major influence on the trends in participating countries (see box). Of the 121 MWp installed during 1999, 60 % was installed in Japan alone. If Japan is excluded from the analysis, installed capacity grew by 19 % in the remaining countries – similar to the previous year. Collectively Japan, USA and Germany accounted for 87 % of the PV installed in 1999.

APPLICATIONS

In the most recent report the market is divided into three sectors (a change from previous reports): off-grid applications, distributed on-grid and centralised on-grid applications.

Overall the trend is for an increase in the proportion of grid connected systems. In 1992 only 29 % of the installed capacity was connected to the grid; this had increased to 53 % by the end of 1999. Again, this is largely due to significant government-subsidised programmes in Japan, the USA and Germany, which have a predominant on-grid focus.

Nevertheless, off-grid applications – for seasonal/recreational buildings, rural electrifi-



cation, pumping, agricultural uses, traffic signals and telecommunications for instance – are still very important in many countries. Indeed 90 % of the combined capacity in Australia, Canada, Finland, France, Israel, Mexico, Norway, Portugal and Sweden is off-grid.

FISCAL SUPPORT

The total budget allocated by government bodies to support the PV industry increased by 4 % between 1998 and 1999, to USD 479 million. Over 50 % of the 1999 funding was allocated by Japan. Spending trends show an increasing proportion of the budget is for initiatives to encourage market deployment as opposed to research, development and demonstration.

The ISR summarises key initiatives in the reporting countries and shows that a range of fiscal instruments are being used to support and promote PV, including: reduced interest rates, tax credits, accelerated depreciation, grants, and preferential tariffs. Utilities are seen to be increasingly supportive of PV with initiatives such as net metering and investments in PV.

NURTURING THE MARKET

Many countries have set targets to increase PV deployment significantly in the near/medium term (Germany, Finland, France, Italy, Japan, the Netherlands and the USA) which can be attributed to the Kyoto Protocol. Another major influence is energy market deregulation.

Public opinion appears to be generally supportive of PV although lack of awareness and access to information remains a barrier in some countries.

Education is increasingly being recognised as a key aspect of national programmes. A number of countries, including Germany, Japan, Israel and the UK have programmes to install PV systems on schools and universities.

PRODUCTION AND PRICES

The report also summarises information on cell and module production, technology preferences and trends in system prices. Total module production increased by 34 % between 1998 and 1999 to 168 MWp a year, primarily in Japan and the USA. Japanese production alone increased by 67 %, and

BEHIND THE SCENES: JAPANESE PV PROGRAMME INFLUENCES WORLD WIDE TRENDS

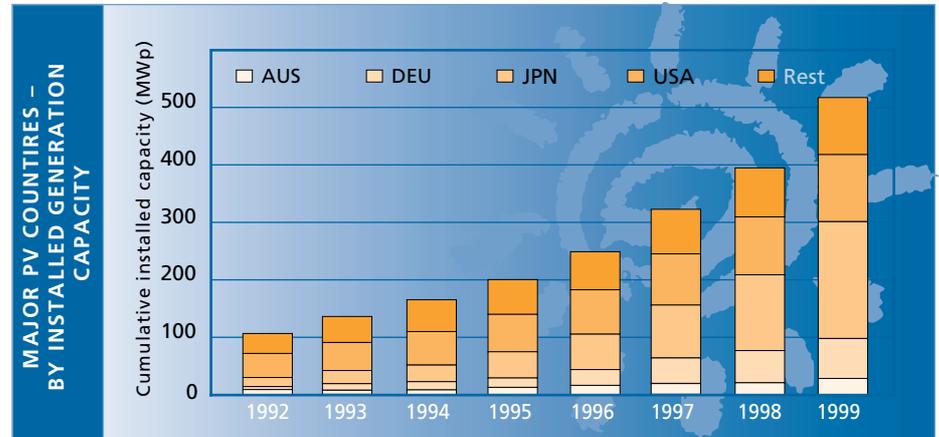
Japan has several large PV demonstration and field test programmes, which expanded dramatically in 1999, moving towards the target of 5 000 MWp of installed PV capacity by 2010. Residential PV systems, of typically 3-5 kWp, are subsidised on the condition that the individuals provide operational data on their system. Between 1994 and 1998 15 596 PV systems were installed on dwellings and a further 17 396 houses were accepted under this programme in 1999. Other programmes provide subsidies for local public organisations and private industrialists who are establishing new energy businesses. Net metering has been available in Japan since 1992.



largely to meet the increased demand in the home market. However overall production remains well below capacity (52 %) in all producing countries.

In terms of the technology used, 84 % of the modules produced in 1999 were crystalline silicon, of which 60 % was multicrystalline and 40 % was single crystalline. Amorphous crystalline is emerging as a viable alternative in the PV market, with production more than doubling between 1998 and 1999. In addition, CdTe and CIS manufacturing plants are planned or operational in Japan, Germany and the USA.

Generally the price of systems has not changed significantly since 1998, although reductions were seen in France, Italy and Japan. On-grid building integrated systems of 1-3 kWp are typically between 6-12 USD/Wp installed, though prices below 6 USD/



Wp were reported in Denmark and Germany. Off-grid systems remain competitive in many applications.

The report also includes the latest news on standards and codes in the reporting countries and a PV technology note on balance

of system components, prices manufacturers and suppliers.

To order copies of the report (IEA-PVPS T1-08:2000) contact your national newsletter representative (contact details on page 7) or visit the PVPS website: www.iea-pvps.org.

IEA

COMPARATIVE ANALYSIS OF PV SYSTEMS' OPERATION

Data from over 260 PV systems have been analysed and compiled onto an IEA-PVPS database.

A new report 'Analysis of Photovoltaic Systems' has been produced under PVPS Task 2. The study summarises the operational performance, reliability and costs of 266 PV systems installed in the 7 participating IEA member countries (Austria, France, Germany, Israel, Italy, Japan and The Netherlands, plus EU) as contained in the Task 2 database (see PV Power #12).

Based on the experiences and lessons learnt from the sampled systems, the report sets out to identify how the performance of PV systems in general may be optimised. Detailed operational results for each of the systems are included, illustrated with

graphical representations of key data. A normalisation methodology has been adopted to allow performance analysis comparisons to be made between typical PV systems in different countries under different climatic conditions and different load patterns.

The results include; an analysis of the annual yields, which show only slight fluctuation from one year to the next; annual performance ratios, which differ from plant to plant, but range between 0.25 and 0.9 with an average of 0.66; and analysis of loss factors.

Potential optimisation measures identified in the report include: avoiding diode, wiring and mismatch losses; improving efficiencies of components through the selection of high efficiency modules and inverters; and

avoiding high module temperatures by integrating modules into the building during installation.

The report also describes the project background data sources and the use of the database, and gives an overview of the evaluation procedures developed to enable system comparisons.

Copies of the report IEA-PVPS T2-01:2000, priced at USD 75, are available from the Task 2 Operating Agent, or can be downloaded from the PVPS website: www.iea-pvps.org.

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PV WITHIN THE CLEAN DEVELOPMENT MECHANISM

The Clean Development Mechanism (CDM) is an instrument established under the Kyoto Protocol aimed at achieving sustainable development while contributing to the cost-effective mitigation of climate change.

It allows Parties to the Protocol to meet part of their reduction commitments abroad – notably in developing countries – where specific greenhouse gas (GHG) abatement costs are lower. Simultaneously, this can allow developing countries to attract investments in clean energy technology and assist them in reaching a sustainable development path. Under the CDM, the GHG emissions that are avoided through the use of clean energy technologies (in comparison to what would have been emitted had polluting energy technologies been adopted) will generate 'certified emission reduction units' (CERs) for the investor. These CERs can then be offset against the investing Party's emission allowance, effectively reducing the emissions reduction measures that need to be implemented domestically. The CDM should therefore be a suitable vehicle for the implementation of PV projects in developing countries. However,



CERs, as the name suggests, require that the amount of avoided emissions needs to be certified. This represents a potential problem for small, distributed energy technologies such as PV solar home systems (SHS), as monitoring of all such systems would be impractical.

To address this problem, the Dutch PV Export Group, with funding from Novem, has commissioned a study to assess the eligibility of SHS under the CDM and determine a simple reference CER calculation procedure. Details of eight solar home system projects and field studies in Africa, Asia, and Latin America were evaluated. The case studies show that savings of kerosene for lighting provide the largest contribution to CO₂ displacement. In some cases, savings of candles and battery charging also contribute.

In order to pave the way for PV SHSs in the current CDM negotiations, the study proposes that a simple standardised emission value appears to be the most appropriate approach to use. Based on information from the existing case studies and factors such as upstream emissions, the study concludes that an abatement potential of 200 kg CO₂ per 50 Wp SHS per year is a conservative but safe standard emission reduction value.

A second phase of work and further consultation with stakeholders is now under way aimed at refinement of the streamlined processes for SHSs in the CDM. Recommendations arising from this work will be presented at the next round of climate talks.

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PV ADDED VALUES – DOCUMENTED EVIDENCE

The conclusions of a PVPS special information activity to assess PV 'added values' are to be published as a new report.

Following on from the focus workshops held in Sapporo, Japan in 1999, and Glasgow, UK last year, a summary report documenting the 'Added Values of Photovoltaic Power Systems' has been prepared under

PVPS Task 1 (Information Dissemination), with support from Task 7 (PV in the Built Environment).

PV is increasingly accepted as an economically viable energy supply technology for a wide variety of – mostly off-grid – applications. Photovoltaics can provide high-value service or amenity wherever low-maintenance, reliability, easy of deployment or relatively small power demand are impor-

tant factors. For grid-connected applications in particular, though, viability assessments continue to be made largely on the basis of electricity cost, which despite consistent reductions over the past three decades, typically remain higher than those available from centralised fossil fuel or nuclear plants, or even retail electricity prices. As the report details, however, even in grid supplied areas, values other than kWh en-

PVPS ADVISES G8 RENEWABLE ENERGY TASK FORCE

At the Okinawa Summit in July 2000, G8 leaders announced the formation of a Renewable Energy Task Force (RETF). The Task Force's primary mission is to identify the main barriers preventing significantly increased use of renewable energy for sustainable development worldwide, and to recommend key actions which G8 governments can take to remove these barriers.

The work of the RETF is complementary to that of PVPS Task 9, whose primary objective is to increase the overall rate of successful deployment of PV systems in developing countries. Following the 3rd Experts Meeting of Task 9 in Marrakech in September 2000, a formal submission presenting PVPS recommendations for G8 action was delivered to the RETF. The document was also submitted to the IEA's Renewable Energy Unit whose personnel are drafting the RETF's report that will be presented to the G8 ministers when they next meet in Genoa in June.

Although Task 9 is mandated to focus on photovoltaic technologies, the submission recognises that other renewable energy

RECOMMENDATIONS TO THE G8 RENEWABLE ENERGY TASK FORCE

- 1 G8/OECD development aid organisations should set a target of electrifying 1 billion people within the next 10 years. In order to achieve this, aid budget allocation to renewable energy should be immediately doubled then increased progressively. A renewable energy component should be included in conventional energy projects. Investments should be targeted at the development of sustainable infrastructures rather than purely at product subsidies.
- 2 Renewable energy expertise should be incorporated into all G8 development aid organisations and capacity built in the country offices and sector teams.
- 3 Energy supply options should be chosen on the basis of a least cost analysis in multilateral and bilateral development projects. The least cost analysis should be based on a life cycle cost analysis and, where possible, include externalities.
- 4 The OECD should allocate funds to South-South exchanges in order to accelerate the adoption of renewables.
- 5 The G8 should ensure that the electrification of those without access to electricity services is addressed explicitly in G8/OECD funded bilateral or multilateral programmes for restructuring or privatising power sector utilities in developing countries, which implies that resources must be specifically earmarked to this effect.
- 6 The G8 should encourage high level planning for rural development and rural electrification through the development, and implementation of appropriate Rural Electrification/Energy Plans.

technologies can also satisfy energy needs of rural communities in developing countries. Many of the recommendations proposed by Task 9 are also applicable to these other technologies.

The six key recommendations proposed are summarised in the box above. The full text of the submission can be downloaded by visiting task 9 via the PVPS website, www.iea-pvps.org.

IEA

ergy cost are important. For utilities these include ancillary services, such as power quality and reliability, and capacity values. For customers and society in general reliability, environmental impact, convenience, supply security and associated employment are important issues. In the built environment, there are other non-energy values to consider, such as avoided land and structure costs, architectural interest and multifunctionality. Present arrangements for ancillary services and network augmentation or extension continue to focus on the larger

participants in the electricity market and distributed options like PV do not yet receive equal consideration. Additionally, electricity industry regulation with respect to climate change is still in its infancy, so that little value is placed on emission-free generation. The study summarises the key barriers which are currently hampering increased PV power system utilisation, and proposes measures to overcome these. Although the report does not attempt to quantify all the values in a form which could be used for cost/benefit analysis, docu-

menting the various added-values is an important first step towards this. Copies of the report, IEA-PVPS T1-09:2001, are available from Task 1 National contacts (see page 7) and from the PVPS website, www.iea-pvps.org, form April 2001.





IN BRIEF

EUREC AGENCY PV OUTLOOK & ROADMAP 2000

The European Renewable Energy Centres Agency (EUREC) has prepared a position paper on 'Future Research & Development in Photovoltaics'.

The document provides an introduction and status review of PV technology and applications, and presents short (to 2005) and medium (to 2010) term goals for PV components and system efficiency improvements and cost reductions. The Agency identifies six main barriers that must be overcome if uptake of PV technology worldwide is to be increased. Key amongst these are the need for System price reductions, resolution of silicon feedstock issues, continued development of thin film technology to improve public image and efficiency, and alleviation of energy storage problems.

EUREC outlines an R&D roadmap to address the problem areas and achieve the cost and efficiency goals. Various fiscal initiatives and im-

proved product marketing measures are also identified to complement the R&D focus. The PV position paper forms part of the Agency's update of its publication, *The Future for Renewable Energy: prospects and directions*. Contact: EUREC
Fax: +32 (0)2 502 92 84

LOW-COST SOLAR-GRADE SILICON CLAIMS

Venture Aims to Accelerate Industry Growth by Removing Raw Material Constraints

US PV manufacturer, Astropower and Elkem of Norway, the world's largest silicon processor, signed a technical cooperation agreement in December 2000 aimed at finalising a low-cost process for manufacturing large-volumes of solar-grade silicon. Both companies have been researching feedstock issues for several years, and have been cooperating since 1998 to develop a solar-grade silicon manufacturing process. The agreement calls for the future establish-

ment of a jointly-owned manufacturing venture, based in Norway and managed by Elkem, that will supply low-cost silicon feedstock to the global solar power industry.

The limited availability and high price of solar-grade silicon feedstock have hampered solar industry growth, noticeably in recent years as electronics industry 'scrap' has become a more valued commodity.

Contact: Astropower
Fax: +1 302 368 6087

GREEN ENERGY CERTIFICATE TEST TRADING

Six European countries are piloting an initiative which enables cross-border trading of the environmental benefits of electricity from renewable energy (RE) sources.

Renewable Energy Certificates (RECs) are issued to electricity producers according to the amount of RE power they generate. The RECs can be bought by energy supply companies to confirm that a proportion of their

purchases are made up of green electricity. The certification helps ensure that suppliers' green power schemes comply with their claims. They can also serve as an indicator of power companies compliance to national renewables obligations (which exist in Australia, and will be introduced in the UK in October, for instance.)

National RE certificate trading systems are already in operation in the participating countries – Denmark, Greece, Italy, The Netherlands, Norway and Sweden – but their certificate issuing rules have now been harmonised to facilitate international trading.

Contact: RECS Secretariat
Fax: +31 (0)10 280 56 54

NAME-CHANGE FOR UPVG

The US Utility Photovoltaic Group is now known as the Solar Electric Power Association, SEPA.

Contact details are unchanged.
Fax: +1 202 223 5537

INTERNET RESOURCES

US NATIONAL CENTER FOR PHOTOVOLTAICS (NCPV)

The NCPV, which was established by the US Dept. of Energy in 1996, serves to mobilise US resources in photovoltaics by performing world-class research and development, promoting partnering and growth opportunities, and serving as a forum and information source for the photovoltaics community.

The NCPV website provides information about the Centre and the United States' PV programme, as well as a good resource area containing PV-related background information, educational material and news.

www.nrel.gov/ncpv

ISES WIRE

WIRE is the International Solar Energy Society's World-wide Information System for Renewable Energy. The site is a global information exchange tool, giving visitors access to a vast, searchable database of RE-related news, opinion, papers, reports and images. The purpose of this service is to facilitate and accelerate the flow of knowledge among renewable energy professionals worldwide.

Visitors can enter as guests to view the available resources, or can register as a contributor, to enable them to upload text and other data for review and subsequent on-line presentation.

The WIRE system has been designed and optimised specifically for use by standard web browsers operating at low bandwidth to ensure maximum user accessibility.

www.wire.ises.org

RENEWABLE ENERGY CERTIFICATE SYSTEMS

The RECS Central Information Exchange contains public information about the pilot RECS scheme operating in Europe, and provides an information exchange for the organisations that are currently working to implement it.

www.recs.org

SOLARINFO

The German Solarinfo site provides a number of useful resources for visitors interested in PV and solar heating. Amongst the tools are product and service locators, information on finance support schemes, exhibition and job listings and a large database of solar projects, including many PV examples.

An English language version is available, though some content is not fully translated.

www.solarinfo.de

PVPS NEWS

STANDARDS, GUIDELINES & QA PROCEDURES FOR STAND-ALONE PV SYSTEMS

Quality Assurance (QA) of stand-alone PV systems and components is one of the priority focus areas for PVPS Task 3. A review of existing programmes of standardisation and QA for PV has been undertaken by Task 3 to identify ways in which the group



can best contribute to work in this area. The results of the review are now available as an on-line report, *Survey of National and International Standards, Guidelines & QA Procedures for Stand-alone PV Systems*.

The document in itself provides a useful resource which describes the current status of existing standards and QA programmes, as well as describing the role of international and national standardisation and QA organisations, and the work which they are conducting to provide guidelines for the application of quality stand-alone PV (SAPV) systems.

The survey identifies areas where there are insufficient, or no guidelines, and suggests a Task 3 plan of action to address some of these shortcomings.

This report, available for download via the PVPS website, will be regularly updated for the duration of the current Task 3 programme.

www.iea-pvps.org

COOPERATION FOR DEVELOPMENT

The fourth Task 9 meeting will be held in Jakarta, Indonesia in March. Two associated events are planned: a renewable energy promotion seminar with the ASEAN Centre for Energy and the Swiss State Secretariat for Economic Affairs, and a seminar on Financing SHS in developing countries.

Contact: Jonathan Bates
Fax: +44 (0)118 973 0820

WORKSHOP ANNOUNCEMENT

Building with PV – New Product Opportunities

*Wednesday May 9, 2001
at Amsterdam RAI*

The rapidly increasing number of photovoltaic projects around the world demonstrate that PV is becoming a serious market. PV technology is being used in building applications for its energy-efficiency and ecological benefits and its aesthetically-pleasing appearance. Users are purchasing systems to power their homes with independently generated, 'clean' electricity. Large PV plants are installed in ground-mounted arrays, on roofs of large, industrial buildings and along noise barriers to produce green electricity for utilities. To keep up with the demands of these rapidly developing markets, new and innovative building products are required.

The objective of this Task 7 workshop, is to consider opportunities for new products suited to the various emerging markets for PV in the built environment. The workshop will be closely linked to Sustain 2001, providing excellent opportunities to meet industry at the exhibition and join other events at the main conference.

Contact: Frederik Leenders at Ecofys, Fax: +31 (0)30 2808 301

DIARY DATES...

*Sustain 2001
Amsterdam, Netherlands*

08-10 May 2001
☛ Sustain 2001
Fax: +31(0)20 549 1843
www.sustain2001.com

*IEA Future Building Forum Think
Tank Oslo, Norway*

09-11 May 2001
☛ Helen Shawcross, ESSU
E-mail: exco.support@ecbcs.org

*12th International Photovoltaic
Science and Engineering Conf.*

*Cheju Island, Korea
11-15 June 2001*
☛ PVSEC-12 Secretariat KIER
Fax: +82 (0)42 860 3739
www.solarpv.or.kr/pvsec-12

*UPEX'01 - PV Experience Conf.
Sacramento, Ca, USA*

30 September - 5 October 2001
☛ Julia Judd, SEPA
Fax: +1 202 223 5537
www.upvg.org/upvg/upex2001

*17th EPSEC, European PV Conf.
Munich, Germany*

22-26 October 2001
☛ Bettina Kaisa, WIP-Munich
Fax: +49 (0)89 720 1291
www.wip-munich.de

*ISES 2001 Congress - Bringing
Solar Down to Earth*

*Adelaide, Australia
25 November - 02 December 2001*
☛ Hartley Management Group
Fax: +61 (0)8 8363 4577
www.unisa.edu.au/ises2001congress

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PV POWER

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THE SOLAR SKIN

CASE STUDY

PROJECT SUMMARY

- Location: Trondheim, Norway
- Installed: June 2000
- Retro-fitted secondary façade
- Total façade area: 455 m²
- BP Solar glass-glass encapsulated cells
- Total array generation capacity: 16 kWp
- PV module area: 192 m²
- PV cell net area: 102 m²
- Cavity width: 0,8 m

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BP Solar asked the solar energy research unit at the Norwegian University of Science & Technology (NTNU) to devise a challenging R&D problem project that would also demonstrate the company's activities in PV. NTNU proposed a BIPV double-façade – the 'Solar Skin'.



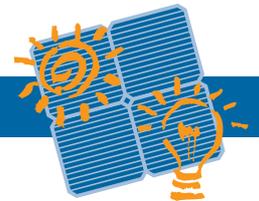
The solar skin combines two contemporary building concepts; the use of double façades in renovation projects, and building integrated photovoltaics (BIPV).

The double façade is effectively a glass wall attached to the outside of the existing building envelope, separated by an air gap of 0,8 m. Thermal performance is similar to a glazed atrium; the cavity creates a buffer zone which reduces heat loss from the main façade, while harnessing winter solar gains to reduce the building heating load. The cavity can be cooled during summer through ports at the top and bottom of the

secondary skin which induce stack-effect ventilation.

The PV cells are encapsulated in clear glass modules, which in turn are installed in the outer wall. The semi-transparent modules enable natural lighting to be taken advantage of, while the air gap between the two skins ensures that the modules are well ventilated to maximise their efficiency.

The façade will be monitored for at least one year to evaluate electrical and thermal performance. The data will be used to optimise simulation models for future double-skin PV systems.



MANDATORY RENEWABLES TARGET FOR AUSTRALIA

From April 1st, 2001, wholesale electricity purchasers in Australia will be legally bound into contributing towards the generation of an additional 9500 GWh of electricity from renewable energy sources in 2010.

A gradual scale-up of production to meet the 2010 target will be achieved by establishing mandatory renewable energy purchase requirements on electricity retailers and wholesale electricity buyers. Purchasers will be 'proportionately liable

for the measure'. In other words, if a party purchases 1 % of the country's total electricity production in a given year, they must purchase 1 % from the renewable energy target for that year.

The measure will be implemented through the creation of tradeable renewable energy certificates. Each 1 MWh of electricity generated from eligible renewable energy sources will earn 1 certificate for the generator. This can then be sold to a third party for surrender to the Renewable Energy Regulator as evidence of purchase of eligi-

ble power. Any shortfall in the obligatory purchase requirement will be penalised at the rate of 40 AUD/MWh.

In July last year, the Australian government introduced a 4 year, AUD 31 million, PV-specific support scheme, the Photovoltaic Rebate Programme. Rebates of up to 50 % of system capital costs are available for rooftop and integrated systems on homes and community use buildings. Details of both schemes are available from the Australian Greenhouse Office, fax: +61(0) 2 6274 1884