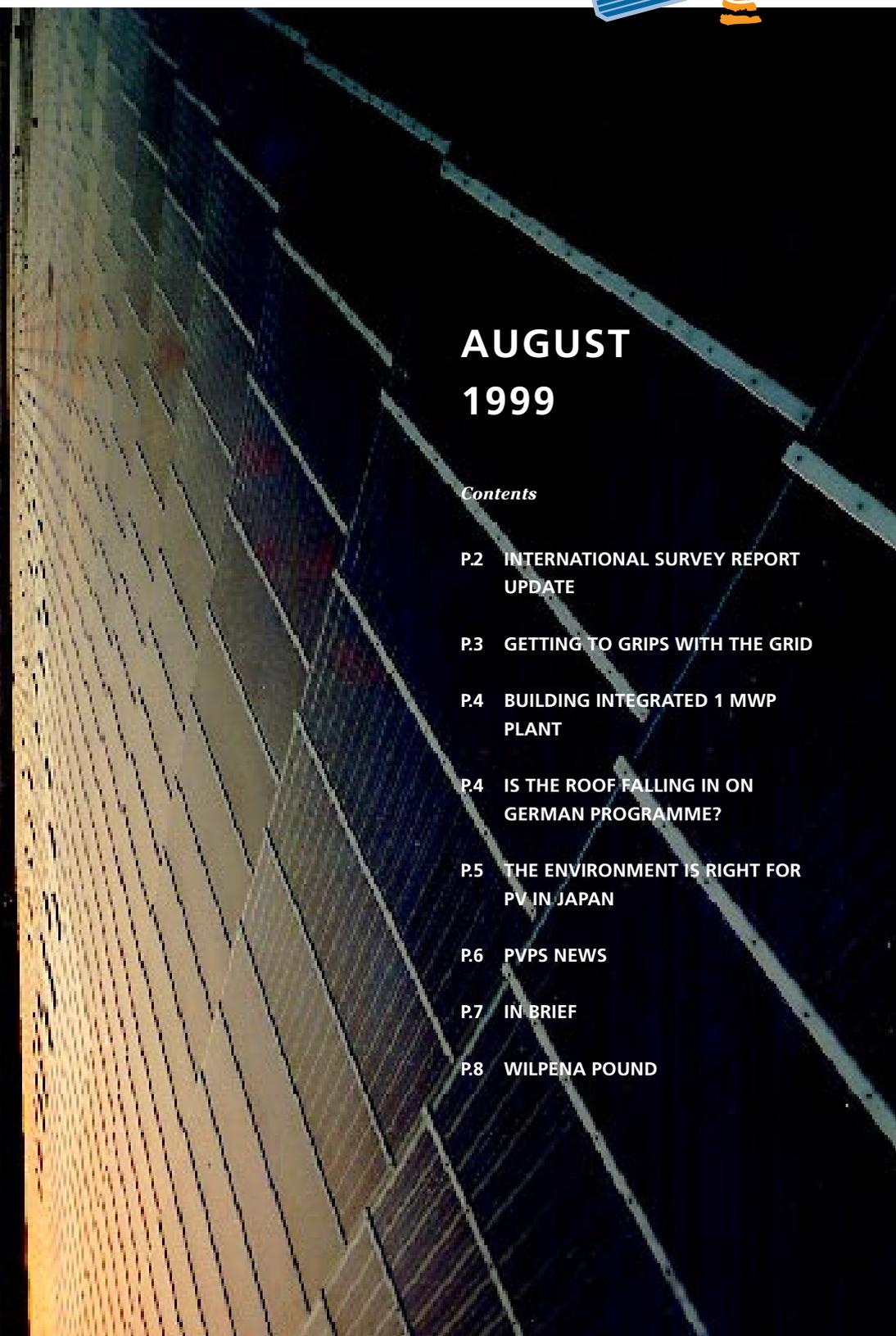




PV POWER

Newsletter of the IEA Photovoltaic Power Systems Programme



**AUGUST
1999**

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New horizons for photovoltaics: large-scale PV building integration concepts are breaking new ground in Herne, Germany. More on page 4.

INTERNATIONAL SURVEY REPORT UPDATE

As announced in PV Power #10, the third edition of the PV Power Systems International Survey Report (ISR) is now available.

The latest update of 'Trends in PV Power Applications in Selected IEA Countries' provides a snapshot of the status of PV Power systems applications and markets in the 20 PVPS participating countries as at the end of 1997. In combination with the historic information gathered during the course of preparing previous editions of the ISR, this represents a very reliable assessment of the latest trends in PV systems development around the world. The individual country data that comprises the full report were gathered through the PVPS national experts network.

In common with the previous ISR, the latest edition differentiates PV applications into four main categories: off-grid domestic, off-grid non-domestic, on-grid distributed and on-grid centralised systems. Only those applications with a single system installed capacity of 40 Wp or more are included in the survey.

Throughout the 20 participating countries, 65 MWp of new PV capacity was installed during 1997. This took the cumulative installed capacity in the reporting countries to 304 MWp by the end of 1997, representing an average annual growth rate (1990-1997) of 25 %.

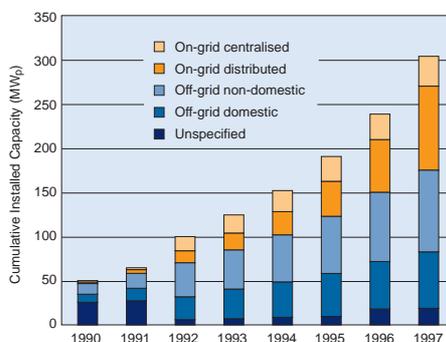
In terms of cumulative installed PV power to date, off-grid systems account for the majority (57 %) of the reporting countries capacity. Key markets for off-grid applications include Australia, France, Italy, Mexico and

PVPS REPORTING COUNTRIES

Australia, Austria, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States of America.

the USA, where off-grid systems account for between 59 % and 97 % of total installed PV power. In France and Mexico, the priority is for domestic applications, whereas the Australian market is dominated by non-domestic systems. Italy and USA each have similar proportions of domestic and non-domestic systems.

1997 was a significant year for grid-connected PV applications, as new on-grid capacity exceeded off-grid installation for the first time. Indeed two-thirds of newly



Cumulative installed PV Power by application in the reporting countries.

installed capacity was for on-grid use, and the large majority of this was in the form of distributed systems, mainly driven by strong national programmes in Germany and particularly Japan.

It is important to reiterate that the survey does not cover non-PVPS participating countries and as such does not include the large developing country markets, particularly for solar homes systems and other remote off-grid uses. The ISR supply-side analysis, which shows total production from PVPS countries to be 100 MWp (i.e. 50 % greater than what was actually installed within PVPS regions), serves to highlight this discrepancy. It is estimated that the cumulative installed capacity worldwide amounted to 600 to 700 MWp at the end of 1997. The USA and Japan both reported 1997 module production to be around 35 MWp, while Australia, Spain and Germany each

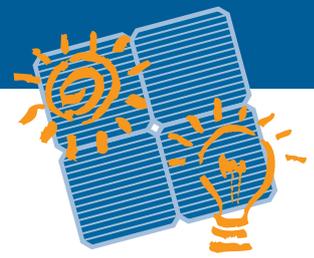


contributed between 6 and 8 MWp. It should be noted that this representation relates only to module encapsulation rather than cell production, in order to avoid double-counting; several manufacturers produce cells which are shipped to other countries for encapsulation.

It is estimated that 85 to 90 % of worldwide PV module production takes place in the PVPS reporting countries. In 1997 this provided some 9 140 full-time jobs, and generated revenues of 1 133 million USD. The majority of jobs were concentrated in Japan (1 900), Germany (1 800) and the USA (1 750), and these three countries respectively accounted for 21 %, 10 % and 36 % of the total industry revenue in the reporting countries.

Ex Works module price (weighted in line with module production in each country) varied considerably from one country to the next. For example, the price for large orders (over 100 kWp) in Australia averaged 2,9 USD/Wp, compared to 6,1 USD/Wp in Switzerland, though the latter price accounted for non-standard building integrated products.

Across the PVPS countries, the average price for large orders was 4,1 USD/Wp, representing a 16 % reduction since 1995. Small orders ranged from 4,5 USD/Wp in Germany to around 7 USD/Wp in Switzerland and Denmark, though again the higher price was for custom modules. The typical price for small orders was 5 USD/Wp.



Customers purchasing through dealers can typically expect to pay 20 % above these factory prices.

Turnkey system prices are more difficult to assess on a comparative basis as size, location, technical specification and so on can vary considerably from one system to the next. The ISR presents a price breakdown by application for off-grid systems in the ranges 40-1000 Wp and 1-4 kWp, and for on grid applications in size ranges 1-4 kWp,

10-50 kWp and above 50 kWp. The range of system prices for 1997 and comparisons with 1995 figures are shown in the table below.

The 1997 ISR presents a great deal of text to complement the fundamental market information summarised here, including overviews of the various national demonstration and field-test programmes, budgets for R&D and promotion measures, a summary of the key module manufacturers in the reporting countries, and information on inverter, balance-of-systems and installation companies.

Key factors which are likely to have an impact on future deployment of PV technol-

ogy, such as policy initiatives, standards issues, public and utility perceptions of PV and new industry developments are also summarised.

PVPS Programme objective from now on is to provide even more timely updates of the ISR, though in a more streamlined format, to maximise the value of the data collected. The next issue of the ISR summarising the position up to the end of 1998 will be available later this year.

To order copies of the third ISR (Report IEA PVPS 1-06: 1998) or for more information about future editions contact your national newsletter representative (contact details are given on page 8).

	Off grid 40-1000 Wp	Off grid 1-4 kWp	On grid 1-4 kWp	On grid 10-50 kWp (Ground)	On grid 10-50 kWp (BIPV)	On grid >50 kWp
1997 Range	8,4-52,8	8-35,7	5-20	6-10,8	5,8-21,4	5,8-35,7
1995 Range	14-41	10-28	6,9-20	7,5-30		7-13,7

Range of Turnkey PV power system prices in USD for different applications in the reporting countries.

IEA

GETTING TO GRIPS WITH THE GRID

Task V, the PVPS working group responsible for Grid-Interconnection of Building Integrated and other Dispersed PV Power Systems has recently published a report on 'Utility Aspects of Grid-connected PV Power Systems'

The study, which is intended for readers familiar with technical concepts of PV systems and/or those with an electrotechnical background, presents the results of Task V's analysis of the current and near-future problems of network connection of PV systems. Recommended countermeasures to address

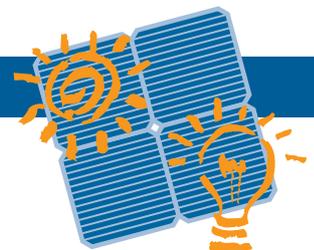
the majority of these issues are also presented.

Chapters of the report deal with harmonics, AC modules, multiple inverters, grounding and ground fault detection, over-voltage protection, islanding, electromagnetic compatibility of inverters, external disconnects, reclosing, isolation transformers and DC injection. Each chapter can serve as a stand-alone reference, to the respective utility connection issue, but as a whole the publication provides an invaluable insight into network interconnection of PV systems.

In addition, the report presents a useful annex summarising the various national re-

quirements related to installation of PV systems in each of the Task V participating countries (Australia, Austria, Germany, Italy, Japan, Netherlands, Switzerland, UK and USA). This covers grounding requirements, cabling and PV array wiring protocol, the use of batteries and stand-alone inverters as well as utility interactive inverters. Disconnection requirements, thresholds and protective devices and relevant standards are also described.

For further details, or to request copies of the report (IEA PVPS T5-01: 1998), visit the IEA website: www.iea.org



BUILDING INTEGRATED 1 MWP PLANT

The world's largest building integrated PV project began operation in March. The one megawatt PV system is integrated into roof and facade of the Academy Mont-Cenis Herne. It combines modern architecture with an innovative PV concept.

The opening ceremony of the spectacular building of the new Academy of Further Education of North-Rhine Westphalia will take place on August 20th. The building's enormous glass envelope measures 180 m by 72 m by 16 m and contains offices, a library, an hotel and other facilities such as

a restaurant. The envelope produces a micro-climate, transforming the former coal mining site into a 'Mediterranean area', enabling users to walk 'outside' under the glass roofing alongside plants and a pond. 3 184 Pilkington Solar OPTISOL® PV elements, which use a glass-glass encapsulation technique, are integrated into roof and facade elements, to provide shading, daylighting and electricity production. The total roof area is around 12 000 m² which presented a challenge to the roofing and PV system designers.

The final solution, which looks like a cloud-patterned sky, uses six different types of



modules with differing densities of solar cells and glass of various degrees of transparency. The number of cells per module ranges between 260 and 128 (with corresponding power outputs of between 419 and 250 Wp) from the roof areas above the inner buildings to the middle and edges of

IS THE ROOF FALLING IN ON GERMAN PROGRAMME?

Within weeks of the Social Democrat / Green Party coalition coming to power in Germany last year, plans for a massive new PV programme using long-term interest free loans were announced. But can the government live up to its promises?

January 1999 began with a big bang for PV power in Germany: Federal Economics Minister, Werner Müller, announced a six year, DEM 1 billion (about 600 million USD) initiative to help install 100 000 PV systems (300 MWp) throughout the country. A ten-year, 0 % finance scheme is proposed, administered by the state reconstruction bank KfW, under which the customer will have a two-year 'holiday', before starting repayments.

If the system is still running after nine years, the final year's repayment will be waived. This translates to 40 % of the cost of a system being met by the government.

If it can be achieved, such large-scale instal-

lation would help drive down module prices, which would be positive for PV worldwide, not just in Germany. The government itself sees the initiative as a bridge to a new solar age.

Nevertheless, there appear to be a number of problems with the proposed structure of the programme which need to be resolved before bridge-building begins.

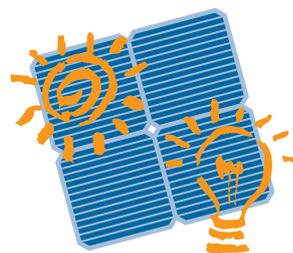
Not least is the conflict between the 100 000 rooftop loan scheme, and the application of rate-based incentives which have been introduced as a means of funding renewable energy installation in a number of cities around Germany with good effect. Rate-based incentives pay a premium to buy-back energy from producers who feed renewable energy into the grid. In several places, home-owners can earn as much as 2 DEM/kWh for their PV-generated energy.

Obviously if the rate-based incentive and interest free loan schemes are applied together users can theoretically obtain a sub-

sidy of more than 100 % for their system. The government has placed a blanket ban to prohibit disbursement of the national loan in cities where rate-based incentives apply, but this move has been heavily criticised by many organisations involved in the implementation of solar projects.

The various parties are working to resolve the difficulties, but in the interim subscription to the 100 000 rooftop programme is slow.

Let's hope the big bang doesn't end as a small sizzle.





the roof where more daylight is needed. The inverter concept is innovative for a project of this size. 569 String inverters are used in order to reach the highest system efficiency for the complicated module distribution on the roof. Installation of the inverters only took about three months in to-

tal; two weeks each to install the frames and fix the inverters into position, and a further two months for cabling. The advantage of this arrangement is that every string has its own MPP-tracking and is connected to a central computer, which shows not only the total power of the PV generator but also the working condition and power of every string. It is possible to check the whole PV system with one glance at the computer screen.

Energy production is expected to reach 750 000 kWh per annum, which is approximately three times more than the building will consume each year. The results of the

first few weeks operation have been very encouraging, with production reaching 49 000 kWh in March and peak system power exceeding 500 kWp.

The overall installed cost of the system was DEM 14,7 million. A cost of about 8,5 USD/Wp for a system that is roofing, facade, shading and solar generator in one. It was financed 49 % by the state of North-Rhine Westphalia and the EU, with Stadtwerke Herne, the local utility company, investing the remaining 51 %.

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IEA

THE ENVIRONMENT IS RIGHT FOR PV IN JAPAN

For modern Japanese consumers, eco-friendliness is one of the most important factors in many purchasing decisions. Companies are beginning to seize upon photovoltaics as a means of highlighting their environmental credentials to their customers.

This has already resulted in PV systems being used to create 'environmentally friendly' convenience stores, with family restaurants



PV Power for your convenience; a grocery store incorporating roof-mounted PV modules.

and manufacturing industries next on the list for a green image make-over. If this is good for the companies involved, it is equally valuable for PV-increasing familiarity and understanding of the technology, which will eventually help trigger a widespread chain-reaction of PV systems deployments throughout industry and across all local government.

Residential systems are now quite well-catered for, with commercial banks and several local governments offering low-interest loans for the introduction of PV on new houses, extensions, or refurbishment of old buildings. The national government is also actively promoting the technology through the inclusion of PV in both the 'Green Government Office Building' and the New Tokyo International Airport, as well as the Prime Minister's official residence.

But demonstration and public support alone will not necessarily stimulate the desired chain reaction. Cost is still the major obstacle to be overcome, and providing at-

tractive products at acceptable prices is the issue which the New Energy and Industrial Technology Development Organisation (NEDO) is now addressing through its PV Field Test Project for Industrial Use.

The five-year joint research project which will be 50 % funded by NEDO initially has two main aims: the first is to accelerate price reductions through standardisation; small and medium-sized generators (up to 100 kWp) will be constructed from multiples of standard 50 kWp units. The second aim is to assess new products including thin-film materials and other novel technologies.

In total, 81 systems totalling 2,1 MWp of capacity will be installed across 34 of Japan's 47 prefectures under the Field Test Project. The joint partners include 58 private companies, 17 public service corporations (hospitals, schools and welfare facilities) and 6 local governments.

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PVPS NEWS

BUILDING INTEGRATION CONCEPTS WORKSHOP

PVPS Task VII held a workshop at the EPFL (the Swiss Federal Institute of Technology) in Lausanne during February to discuss building integration concepts and products.

More than 70 delegates took part in the meeting, the main goal of which was to assess the 'state of the art' of building integrated PV systems with respect to mounting technology. Further aims were to identify opportunities for the development of existing or new PV products and systems for building integration.

The proceedings, which will be available in August 1999, will incorporate all the workshop presentations, as well as a brief description of most of the mounting systems currently available. The document will be a practical tool for architects, building designers and system suppliers. It costs 20 USD and is available through PVPS national representatives and Task VII delegates.

The workshop also incorporated a visit to the PVPS-Task VII Demosite which is operated by LESO-EPFL (the Solar Energy Laboratory of EPFL). Demosite comprises a site for facade and roofing systems, recently extended to 16 stands, and a separate area for flat-roof specific systems. In total, over twenty systems are installed at the demonstration facility. Contact: Pascale Affolter, EPFL
Fax: +41 21 693 2722



'Demosite' at EPFL has over 20 methods for PV mounting on display.

IEA EXECUTIVE CONFERENCE ON PV POWER SYSTEMS

Following on from the IEA-PVPS Executive Conferences in Taormina, 1990, and Idaho, 1995, the IEA will hold its third Executive conference on PV Power Systems in Venice on November 3-5, 1999.

Participation in the meeting 'Photovoltaics: Il valore del sole; Business Opportunities from Utility Restructuring, Customer Choice & Building Sector Transformation' will be by invitation only. The 150 pre-selected delegates will comprise senior electric utility, energy service company and PV industry executives, as well as high-level representatives from the building community, financial institutions and government.

The meeting aims to allow better understanding of the problems and business opportunities associated with the deployment of PV power systems in evolving electricity markets. Using a combination of invited presentations and focused discussion groups, the conference will draw on lessons already learned, and will provide information and guidance as to suitable instruments for promoting, financing and implementing PV projects – both in the rapidly growing market for grid-connected PV applications in the built environment, and other promising market areas.

A review of the key conclusions of the meeting will appear in a dedicated *PV Power* #12.

GO-AHEAD FOR NEW TASKS

PVPS Exco approved two new Annexes to the Programme (Tasks VIII & IX) in May.

Task VIII is a three year programme to examine and evaluate the potential of Very Large Scale Photovoltaic Power Generation Systems (VLS-PV) – i.e. up to GW capacity. The first of three Subtasks will be a

PV DESIGN COMPETITION

PVPS Task VII launches 'Photovoltaic Products for the Built Environment'

The competition which is open to individuals and organisations worldwide, aims to encourage PV-integration concepts that enhance the built environment. The contest is organised by Halcrow Gilbert, and sponsored by Shell International Renewables. An international jury consisting of technical PV experts, designers and architects will short-list entries for exhibition at the European PV Conference in Glasgow 1-5 May 2000. Final judging will take place during the conference and awards will be made for the best entry in each of the six categories.

Registration closes on 30th November 1999, with the deadline for submissions being 29th February 2000.

Further information is available on the web: www.***7.org

conceptual study to identify the key parameters under which such systems can be technically and economically feasible. This will result in the development of the total system concept, and the selection of appropriate regions for case studies.

The VLS-PV concept and evaluation criteria identified will feed into a second Subtask, under which full case studies will be undertaken to evaluate the effects, including environmental impact, of VLS-PV systems in the selected regions.

The third Subtask will be a comparative analysis of the case studies, in order to identify the best route for future implementation of VLS-PV. The conclusions of the study will be presented at one or more international workshops in 2002.

Task IX's role is to further increase the overall rate of successful deployment of PV systems in developing countries. The Task will provide tech-

nical assistance and cooperation that will address the needs and potential of developing countries, multilateral and bilateral donor agencies and development banks.

Three Subtasks will address Deployment Infrastructure, Support and Co-operation, and Technical and Economic Aspects of PV in Developing Countries. Task IX will also maintain a watching brief on international negotiations related to clean development mechanisms, activities implemented jointly and the implications for the three Subtasks.

Both new Tasks will commence in the second half of 1999.

Contact: Irene de Jong, PVPS ExCo
Fax: +31 40 24 64 133

STAND-ALONE PV SYSTEMS

An extension to PVPS Task III, which covers the use of PV systems in stand-alone and island applications, was approved by the PVPS ExCo in May.

The new five-year workplan will focus mainly on technical work, and in particular is dedicated to two main Subtasks: Quality Assurance of SAPVS, and Technical Issues on Hybrid Systems, Storage and Management of Appliances.

Task III will cover stand-alone systems in general, without limitation to developing countries whose interests will be strongly supported under the newly approved Task IX.

There will be close cooperation between Tasks II and III on the identification of key quality assurance issues that need to be addressed, and between Tasks III and IX both with a view to reducing global life cycle cost of systems, and to producing common recommendations on certification and accreditation of systems, and training of installers and users.

Contact: Philippe Jacquin, PHK
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IN BRIEF

BP SOLAREX

BP Amoco announced in April that it had purchased Enron's 50% stake in Solarex.

The move gives BP Amoco total ownership of Solarex and has resulted in the formation of the world's largest PV business through the merger of UK based BP Solar and Solarex of Maryland, USA.

BP Solarex now has capabilities to produce advanced single crystal and polycrystalline silicon, multi-junction amorphous silicon, thin-film cadmium telluride and concentrating devices, and is expected to produce around 30 MWp of PV products this year with a turnover exceeding 150 million USD. The company has manufacturing operations in USA, Spain, Australia and India, and currently employs around 1 500 staff worldwide, though some rationalisation of staff is inevitable. Harry Shimp has been appointed President of BP Solarex, which will be headquartered in Maryland.

Contact: Sarah Howell, BP Solarex
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TWIN AWARDS FOR ISOFOTON

Spanish cell and module manufacturer, Isofoton, announced in April that it has signed a collaborative agreement with the Industry and Energy Ministry of Senegal.

The firm will supply equipment and expertise to assist the Senegalese government's ongoing rural electrification programme.

Isofoton have already supplied three centralised AC Power systems totalling 190 kWp to Senegal, providing power to 19 500 inhabitants in Dionewar and Niodior, Bassoul and Bassar and Djirnda. At the end of the two year, 2,5 million USD project, which included supply and installation of the complete generation systems as well as a training component for six local technicians, operation

was transferred to the Project Senegalo Nipon de Energie Solaire. Isofoton also recently announced that it has been awarded ISO 9001 certification by SGS IGS Iberian related to its PV and solar thermal manufacturing, design and installation activities at its facilities in Madrid and Malaga.

Contact: Ramón Eyras, Isofoton
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ASE & KOBE STEEL COOPERATIVE AGREEMENT

ASE GmbH, Germany's biggest in-country manufacturer of PV modules in 1998, has entered into a strategic alliance with the Japanese technology and equipment supplier, Kobe Steel Ltd.

Kobe Steel, which has good contacts with the housing industry in Japan, will market ASE's crystalline and amorphous silicon modules following the signing of a Distributorship Agreement in April this year. The alliance is seen as the first step towards a 'long-term and expandable cooperation', and is a shrewd move for both parties, given that Japan is currently the major market for grid-connected PV systems in the world.

The Japanese government has set aside a budget of around 120 million USD for fiscal year 1999, to assist the deployment of 48 MWp of PV under its '70 000 rooftop' PV programme. Contact: ASE GmbH, Alzenau
Fax: +49 60 23 91 1188

KYOCERA DEMONSTRATES THE WAY FORWARD

Japanese electronics giant, Kyocera now leads the world in terms of PV module production.

Assisted by a buoyant home market – a direct reflection of strong government commitment to, and support for, PV technology – Kyocera's production rocketed from just over



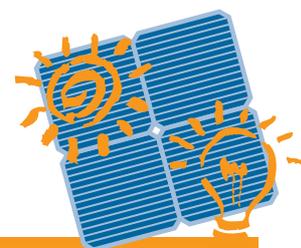
Kyocera's new headquarters.

15 MWp in 1997 to almost 25 MWp in 1998. Output from the company's Yokkaichi manufacturing facility could exceed 35 MWp this year.

The firm is demonstrating its confidence in its own products by offering long-term warranties on its latest generation 'KC' power modules. This guarantees performance at or above 80 % of rated power for a period of up to 25 years, otherwise the unit will be repaired or replaced.

The company recently moved into a brand new 'environmentally friendly' headquarters in Southern Kyoto: the building incorporates many energy-efficient concepts, but the most striking feature is the PV-facade which extends almost the full 95 m height of the south wall. The 1 392 facade integrated modules, which are tilted at 75° (15° off vertical) to maximise energy capture, together with a further 504 roof-mounted panels have a peak power output of 214 kWp. This is equivalent to 12,5 % of the building demand. The system is expected to generate nearly 183 000 kWh/year, avoiding almost 100 tonnes of CO₂ emissions (when compared to petrol fuelled generators). This facility is one of the participants in the PV Field Test Programme for Industrial Use (see page 5).

Contact: Kyocera Solar Energy Div.
Fax: +81 75 604 3475



DIARY DATES...

PVSEC-11

*Sapporo, Hokkaido, Japan
20-24 September 1999*

11th International Photovoltaic Science & Engineering Conference 'Photovoltaic Energy for the Coming Century'

☛ Prof. T. Sameshima
Fax: +81 423 88 9055

UPEx '99

*Tucson, Arizona, USA
4-6 October 1999*

Utility Photovoltaic Experience Conference & Exhibition 'Opening Doors in the Solar Marketplace'

☛ Tina Schneider, UPVG
Fax: +1 202 223 5537

*Energy for the New Millennium
Sydney, Australia
8-10 March 2000*

Combined conferences of the Electricity Supply Association of Australia, ANZSES, the IEA SolarPACES Programme and IEA PVPS Tasks V & VII

☛ The Meetings Manager
Fax: +61 2 9241 5354

16th EPSEC

*Glasgow, Scotland, UK
1-5 May 2000*

16th European PV Solar Energy Conference and Exhibition

☛ WIP
Fax: +49 89 7201 291

*Solar Millennium Congress
Toulouse, France*

25-28 October 2000

Organised by the European Solar Council

☛ European Solar Council
Fax: +33 1 44 18 00 36

WILPENNA POUND

CASE STUDY

PROJECT SUMMARY

- Location: Wilpena Pound, South Australia
- 100 kWp ground mounted array
- 1 260 x 80 Wp Solarex multi-crystalline Si modules
- Off-grid, AC, hybrid system (combined with 3 diesel generators totalling 440 kWp)
- 400 kWh Sonnenschein Gel battery storage capacity
- Single AES 125 kVa inverter
- PV offsets approximately 200 l (40 %) of the Resort's daily diesel fuel need

Contact Monica Oliphant, ETSA
Tel. +61 8 8404 4391

The Wilpena Pound Resort in Flinders Ranges is powered by the largest off-grid PV system in Australia.

The 1,5 million USD hybrid system delivers reliable, high quality power 24 hours a day, while offering a quiet, efficient and environmentally-sound power supply that is sensitive to the natural surroundings. The site was chosen to optimise the collection of solar energy, whilst minimising visual impact from the area's highest landmark, reducing the risk of excavating aboriginal remains during construction and minimising noise intrusion.

The power station combines 100 kWp PV, 400 kWh of battery storage, an inverter and 440 kWp of diesel generators.

At night a computerised smart controller



automatically switches between the battery storage and the most-efficient diesel generator combination to match the load. A modem-link provides remote monitoring and control facilities. The plant was designed and built by Prime Power Systems, and is owned by ETSA Power, which is required to supply the resort with electricity at the same cost and reliability as the grid. The system is giving ETSA valuable hands-on experience to help evaluate similar instances where grid-extension or replacement is not economic.

IEA-PVPS

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