

PV Power Update

Newsletter of the
International Energy
Agency Photovoltaic
Power Systems
Programme
IEA PVPS

www.iea-pvps.org

PVPS Achievements

In this issue IEA PVPS looks back on the achievements of its fourth 5 year term from 2008-2012. By the end of the year PVPS will have marked up 20 years of successful global cooperation in the field of PV. With the recent impressive PV market growth and unprecedented cost reduction, the past term has been an exciting and challenging one.

The main achievements of IEA PVPS in this term have been:

- the establishment of three new PVPS tasks on key issues for PV (Task 12 - Environment, Health and Safety Issues, Task 13 - Quality and Reliability of PV systems and Task 14 - High PV Penetration in Electricity Grids)
- an increased interest from new countries and industry associations, resulting in five new members
- stronger cooperation with the IEA Secretariat and technology network, enhancing the strategic position of PV in recent IEA scenarios and roadmaps
- increased dialogue with industry and utility stakeholders.

With 27 members, the programme embraces the majority of countries active in PV production and deployment. The results of the collaborative work of the past years are documented in numerous reports, books and publications, making IEA PVPS a truly global reference for the PV sector.

Stefan Nowak - Chairman PVPS

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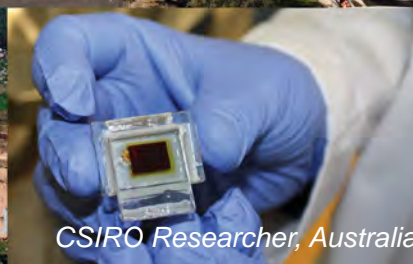
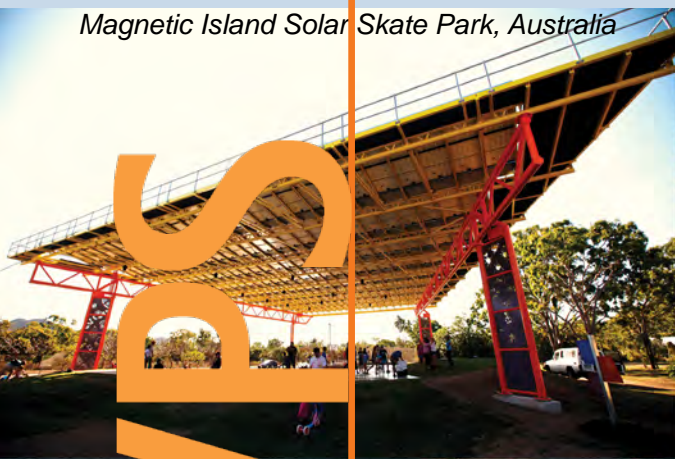
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Magnetic Island Solar Skate Park, Australia

University of Queensland, Australia



PV power plant, Pajam, Malaysia by Cypark Resources

CSIRO Researcher, Australia

PVPS Knowledge

The IEA PVPS Programme has produced a wealth of reliable market data and technical information. PV Power #25 reported on publications from the IEA PVPS Programme from 2003 through to 2006. Following is an update for late 2006 through to 2012. The reports are available to download from the IEA PVPS website www.iea-pvps.org.

IEA PVPS ANNUAL REPORTS AND ROADMAP

- Implementing Agreement on Photovoltaic Power Systems, Annual Reports
- Technology Roadmap - Solar Photovoltaic Energy, 2010.

MARKET AND TECHNOLOGY SURVEY REPORTS

- Trends in photovoltaic applications in selected IEA countries. Annual editions.
- National Survey Reports of PV Power Applications in all participating countries. Annual editions.

VERY LARGE SCALE PV POWER GENERATION SYSTEMS

- Energy from the Desert –Very Large Scale Photovoltaic Systems, Socio-Economic, Financial, Technical and Environmental Aspects, Sept 2009. This is the 3rd in a series of books available from www.routledge.com

DEPLOYING PV SERVICES FOR REGIONAL DEVELOPMENT

- Policy Recommendations to Improve the Sustainability of Rural Water Supply Systems, June 2012.
- 10 Years of Task 9 (Provides a series of case studies and summarizes all the lessons learnt in 10 years), Feb 2010.
- Renewable Energy Services for Developing Countries, Dec 2008.
- Flyer PV Injection, Oct 2007 (English and French versions available).
- Renewable Energy Powered Water Services, Aug 2007.

URBAN SCALE PHOTOVOLTAIC APPLICATIONS

- Overcoming PV Grid Issues in the Urban Areas, Oct 2009.
- Urban Photovoltaic Electricity Policies, Oct 2009.
- Promotional Drivers for Grid-Connected PV, Mar 2009.
- Community Scale Solar PV: Housing and Public Development, Apr 2008.
- Urban BIPV in the New Residential Construction Industry, Mar 2008.
- Analysis of PV System's Values beyond Energy, Feb 2008.
- Environmental Benefits of PV Systems in OECD Cities, Sept 2006.

PV HYBRID SYSTEMS WITHIN MINI-GRIDS

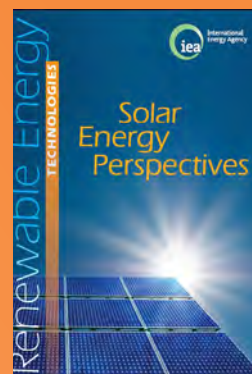
- Overview of Supervisory Control Strategies, June 2012.
- PV Hybrid Mini-Grids: Applicable Control Methods for Various Situations, June 2012.
- Design and Operational Recommendations on Grid Connection of PV Hybrid Mini-grids, Oct 2011.
- Communication between Components in Mini-Grids, Sept 2011.
- Social, Economic and Organisational Framework for Sustainable Operation of PV Hybrid Systems within Mini-Grids, Sept 2011.
- The Role of Energy Storage for Mini-Grid Stabilization, July 2011..
- Sustainability Conditions for PV Hybrid Systems, 2011.
- World-wide Overview of Design and Simulation Tools for Hybrid PV Systems, Jan 2011.

PV ENVIRONMENTAL HEALTH AND SAFETY

- Methodology Guidelines on Life Cycle Assessment of PV Electricity, Nov 2011.
- Life Cycle Inventories and Life Cycle Assessments of PV Systems, Oct 2011.
- Methodology Guidelines on Life Cycle Assessment of PV Electricity, Oct 2009.

PVPS Books

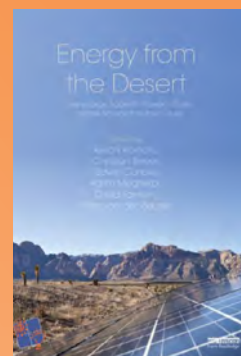
Solar Energy Perspectives



This book explores how best to use, combine and successfully promote solar heating and cooling, photovoltaic and solar thermal electricity, as well as solar fuels.

It is available from the IEA Online Bookshop - www.iea.org/books.

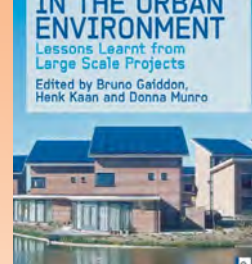
Energy from the Desert 4: Very Large Scale PV Power: State of the Art and Into the Future.



The 4th volume in the Energy from the Desert series gives an overview of the potential of very large scale PV, guidelines for these systems as well as technical and strategic

options for implementation. It will be published Oct 2012 by **Routledge**. ISBN 978-0-415-63982-8.

Photovoltaics in the Urban Environment - Lessons Learnt from Large Scale Projects



This book provides detailed case studies and examines the role of large scale PV in urban renewal and development. It includes

technical guidelines and regulations on planning, building and grid connection. Published in 2009 by **Routledge**. ISBN: 978-1-84407-771-7:



PVPS Looks Ahead

The PV market is rapidly changing:

Worldwide decreasing costs of PV generated electricity, increasing costs of electricity in general and a stronger differentiation of electricity prices depending on demand mean that PV is now entering into competitive situations in regions of high solar irradiation and/or high electricity prices.

In the near future, the most important PV applications in the IEA member countries are expected to be decentralized generators connected to the utility grid. Centralized large PV systems will also gain importance in many countries. The lower prices for PV mean that off-grid applications are becoming more affordable for rural applications in both developed and emerging economies. Over the next decade, PV will therefore make a transition from a technology which is subsidised or reliant on government policy, to a mainstream, cost effective alternative to established energy sources.

Different regulatory structures, deployment models and financing schemes will become important as the PV markets grow. Effective grid integration will require new management strategies for both grid and PV.

As the PV market grows the PVPS Programme also needs to grow. The end of the current 5 year programme and the start of the 2013-2017 programme provides an opportunity for a major review of PVPS strategy. A PVPS strategy workshop was therefore held at the IEA PVPS Executive Committee meeting held in Sweden in April 2012. A key output from the workshop was the need for a broader range of involved stakeholders from industry, utilities, governmental authorities and finance. The interfaces with other energy and related technologies as well as increasingly with the non-IEA countries with growing renewable energy markets were also identified as important.

A new PVPS strategy has been prepared which aims to:

- ensure sustainable PV deployment
- improve PV performance and reliability
- assist in designing new market structures and regulations which will be suitable for the widespread adoption of unsubsidised PV.

At the same time the international cooperation within PVPS must remain forward looking and in the precompetitive domain, in order not to interfere with issues such as competition between individual technologies and/or stakeholders, or intellectual property rights.

The overall mission of the IEA PVPS programme for 2013-2017 is: **To enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems.**

Swedish Utilities Talk Solar

Opportunities within solar electricity generation for utility companies

were discussed at a joint IEA-PVPS Task 1 and Swedish Energy Agency workshop, held in Stockholm on 19th of April 2012. The workshop gathered together stakeholders from the Swedish PV community and senior utility representatives. Although the Swedish PV market is very small, several utilities have identified private micro-production of electricity as a growing movement that will eventually take off in Sweden. The main question that the utilities are struggling with is how they can make money out of PV since their traditional business models don't suit small-scale production by their customers.

Some utilities have, in collaboration with installation companies, started to sell small (1-5 kW) PV-systems for private householders. Others are buying excess electricity from private PV owners at a higher price than the spot prices and selling the electricity to consumers that are willing to pay a little extra for "green" electricity. Some grid owners have started to offer net-metering. While these are all positive developments, it can be confusing for PV system owners as what they get for their excess electricity depends on where in the country they live, the local grid-owner and their awareness of what kind of deals are available.

The presentations from the workshop are available at:

www.iea-pvps.org.

On-line Reports

The international Trends report is released annually and provides information on PV systems installed, PV industry, R & D and national programmes in the participating countries. The report is based on a set of National Survey Reports which go into greater depth on individual countries. All of the reports are available on the PVPS website www.iea-pvps.org and are well worth looking at, giving great insight into developments in individual countries.

The photos on the front cover come from the Australian and Malaysian reports and illustrate the range of topics covered.

Sustainability of Rural Water Supply Systems

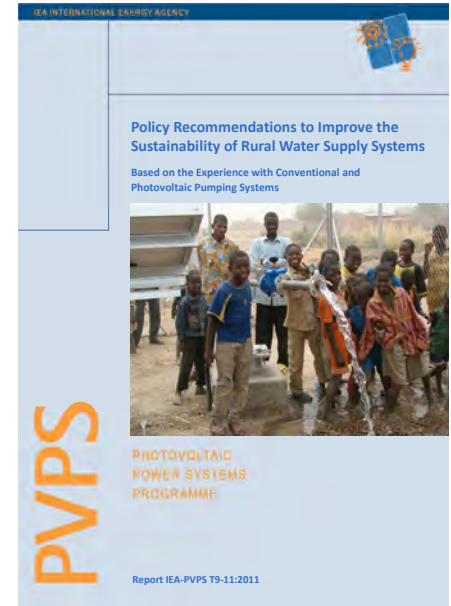
Policy Recommendations to Improve the Sustainability of Rural Water Supply Systems

is the subject of the latest report from Task 9. Experiences with conventional and PV rural water supply systems over the past thirty years are reviewed. The International Drinking Water Supply and Sanitation Decade started in 1981. The failure to achieve 'safe water for all' by the end of the decade was mainly considered a consequence of the ineffectiveness of water utilities in many developing countries. Following this the international donor community sidestepped utilities and governments and began to place increased emphasis on the operation and maintenance of single water points or systems such as public taps and hand-pumps. Village Level Operation and Maintenance became the leading concept. Each

community was meant to manage the operation, maintenance, repair, and eventual replacement of its own water supply independent from government services. International funding and assistance was focused on installing new systems rather than ensuring the successful long term operation of systems. Evidence is mounting that this approach is not sustainable in the long run.

The PVPS experts therefore recommend in this report that international efforts focus on providing support to governments to shape policies that create enabling environments for rural water supply. Measures should be taken to attract private investors to leverage available funds. Larger scale projects are required, with a critical mass of similar systems, to lower investment costs and to make rural maintenance services feasible. When PV systems are chosen,

the whole water chain should be considered to guarantee system reliability. Where possible, the setting up of larger, integrated renewable electricity and water supply systems should be encouraged.



The full report is available on the PVPS website www.iea-pvps.org.

Israel's Largest PV Trackers

The largest PV tracking system installed in Israel was recently completed by Ormash Holdings Ltd., in collaboration with Sun-Add Ltd.

The 44 kWp two-axis tracking PV

system is part of a larger 110 kWp system. A total of four two-axis trackers were installed, with each tracker carrying 11 kWp of PV modules. High efficiency panels from Solar Enertech with 15.7 % rated

efficiency were used.

The tracking systems are expected to deliver an additional 35 % energy output compared to static systems and provide a fast return on the extra expenses. However the

use of tracking systems significantly increases the complexity of installation of a PV system. Excellent engineering design and installation are required in order to ensure a long life span of the system and deliver the expected benefits. Ormash Holdings decided to use its broad experience in design and installation of roof-top PV systems to expand into tracking PV systems. The company aims to take a large share of the Israeli market for equipment, design and construction for PV systems.

Israel is an ideal location for installing solar tracking systems. With an average annual global radiation of 2200 kWh/m², most of the radiation is direct radiation, rather than scattered by clouds, and so the benefits of tracking systems are maximized.



The tracking systems are installed on top of 8 m high poles in order to prevent shading. They are installed in a plant yard at Kibbutz Ein Zurim. Photo by: Ormash

New FiT Promotes Large-scale PV in Japan

A new Feed-in Tariff (FiT) programme launched in July 2012 is expected to significantly accelerate the Japanese PV market.

Previously the market was led by a subsidy programme for residential PV systems. The FiT programme will add non-residential sectors such as public, industrial, commercial and power generation to the market. As the commercial and industrial PV markets expand on top of the residential PV market, Japan's industrial structure surrounding PV power generation is expected to be expanded and enhanced.

Against the backdrop of: power outages following the suspension of nuclear power plants across the nation; increasing electric bills; heightening demand for clean energy and accelerating price reductions of PV systems, individuals, private entities, local

governments and municipalities are becoming more eager to install PV systems.

The new tariffs are as follows:

- 40 JPY/kWh (0.501 USD/kWh) for all electricity from PV systems of 10 kW or more for a period of 20 years.
- 42 JPY/kWh (0.526 USD/kWh) for surplus electricity from PV systems with a capacity below 10 kW for a period of 10 years.

In expectation of the FiT programme starting, some local authorities and electric utilities constructed MW-scale PV power plants ahead of schedule. A great number of such plants were completed in 2011.

The Japanese National Status Report 2011, available on the [PVPS website](#), has a wealth of information on the Japanese PV industry and market trends.



The 2.1 MW "SoftBank Kyoto Solar Park", commissioned in July 2012, is one of the first MW-scale PV plants qualifying for the new FiT programme. Photo by RTS Corporation.

PV Hybrid Systems and Mini-grids

The work of PVPS Task 11 on PV Hybrid Systems within Mini-grids came to an end in 2012 with the publication of two reports:

- Control Methods for PV Hybrid Mini-grids: Applicable Control Methods for Various Situations, April, 2012.
- Overview of Supervisory Control Strategies including a MATLAB Simulink Simulation Tool, May, 2012.

Both reports are available on the [IEA-PVPS website](#) and at www.iea-pvps-task11.org.

Although the task has been officially completed there are still issues to

work on and discussions are ongoing as to how follow-on work should be organized. Two routes for further work were identified at a workshop held in April 2012 in Chambéry, France. Approximately 50 experts attended the workshop and decided to investigate two options:

a) Dissemination work and the further development of specific topics relevant to PVPS Task 9: Deployment of PV Services for Regional Development may be pursued within Task 9. Experts interested in participating in this effort should contact Silvia Puddu (s.puddu@ied-sa.fr), who will coordinate the development of these new topics. Task 9 has a

meeting on 28 Sept. in Frankfurt (after EU PVSEC) where this will be discussed.

b) A new Task focused on technical issues associated with PV hybrid mini-grids is also being explored. Experts interested in participating in the development of the work plan should contact Thilo Bocklich (thilo.bocklich@etit.tu-chemnitz.de).

A paper reviewing Task 11 activities and results is available for download at www.iea-pvps-task11.org (under Public Downloads). This was presented at the 6th European PV Hybrid and Mini-grid Conference held in Chambéry, France, April 2012.

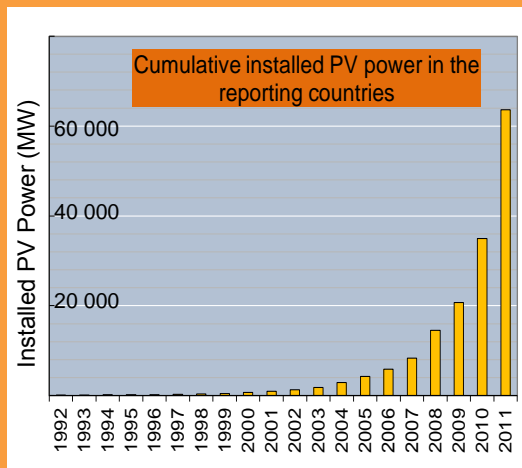
Key Market Trends

Tomorrow's technology - here today

With almost 28 GW of PV installed during an economically challenging 2011, global capacity exceeding 63 GW and an increasing number of countries demonstrating strong annual growth in their PV markets, **PV technology can now be regarded as mainstream.** Significant employment has been created across R&D, manufacturing and deployment; business value is returning healthy numbers for many countries. Still PV is often thought

of as tomorrow's technology. Some recent statistics belie that belief. If we look at the proportion of newly installed electricity power generation capacity that was PV (not nuclear, not coal or gas, not other renewables) during 2011, the numbers are impressive. In Australia 36%, France 57%, Italy over 60%, Korea almost 6%, the US approaching 10% and so on. PV is now on the agenda as a serious source of power generation, worldwide, today.

PV public support measures (particularly feed-in tariffs) have significantly boosted the quantity of PV installed in many markets. Nearly all countries now offer, or are about to implement, some kind of feed-in tariffs for PV electricity. FiT approaches have successfully driven investments in large-scale PV plants, smaller-scale building-integrated applications and combinations of both.



The rise and rise.. and fall of the FiT

The FiT - an explicit monetary reward provided for producing PV kWh's - has clearly been the prime mechanism for promoting growth in grid-connected PV applications. However, FiTs have also been associated with explosive markets, profiteering, political interference, over-reliance on imports, market collapses and business closures.

In today's environment **a well-functioning FiT scheme usually has the ability to adjust** for changes in PV system prices and other factors. In Germany the FiT is adjusted in response to market conditions and encourages self-consumption of the PV electricity. Other countries have also demonstrated a hands-on approach to their FiT schemes

- France, Switzerland, Austria, for example.

The political course of action in response to an explosive market is often highly reactionary. In Australia for example, FiTs are organized at the state level and 2011 saw the end or significant scaling back of FiTs in almost all states. However, the Australian PV market remains healthy. This has also been seen elsewhere. In the Netherlands, for example, many new PV initiatives, independent of governmental subsidies, have been set up. In many countries, the debate is now shifting, from if or how to implement a FiT, to how to move to a self-sustaining market post FiT.

The next big thing?

As parity of PV generation costs with retail electricity prices occurs over the coming years a sustainable PV market will eventuate in different markets and market segments.

For governments this may mean moving support policies away from handouts of public money to focus more on enabling strategies, appropriate regulation and the development of innovative business models for PV.

Renewable portfolio standards, sustainable building regulations, municipal and local government activities promoting PV and third-party financing schemes are all becoming more widespread. It is also likely that the electricity utilities will play a more significant role in the future PV market. The 'new' electricity network businesses in particular (encouraging customers to be more than simply loads, using smart grids with advanced metering and communications and where storage and electric vehicle charging will play an increasing role in system operations).

Worldwide, electricity utilities are investing in large-scale PV plants or investigating how they can benefit from meeting their customers' interest in PV, often leading to the development of new business opportunities.

On the technical side, concerns have been raised about high levels of penetration of PV in networks. On the business side, what will be the approach taken by utilities and their industry regulators to the growing interest in PV? An outline of current electricity utility PV activities can be found in the National Survey Reports, with a summary in the soon to be published Trends report, all available on www.iea-pvps.org.

PV Recycling Work Expanding

PV recycling is a critical part of the work of PVPS Task 12, and an increasingly important component of the growth of the solar industry. As a part of the updated Task 12 workplan, the Task 12 experts plan to develop and release information regarding potential recycling infrastructures, corresponding financing, and

policies. Additionally, Task 12 continues to research implementation of recycling throughout the lifecycle of solar products, through design for recycling, recycling of decommissioned modules, and re-use or recycling of reclaimed materials.

Preliminary information is expected to be released in early 2013.



End of Life PV modules Photo by: PV CYCLE

Energy Return on Investment

A new study from IEA Task 12 members M Raugei and V Fthenakis calculated the **Energy Return on Energy Investment ratio (EROI) for PV** compared to oil, gas and coal. The EROI of PV systems has previously been considered too low for the technology to be a serious alternative to conventional power plants. This study however showed the EROI of modern PV technologies to be in the range 19-60. The EROI of oil and gas used to be over 100, however depletion of reserves has led to significant declines in the EROI which now ranges from around 10-30. The EROI for coal is better at around 40-80. However coal is more polluting than PV, gas and oil.

Previous calculations of the EROI of PV were based on outdated lifecycle energy data and a lack of consistency

in calculations and assumptions and had led to a belief that the EROI of PV was poor. These results suggest that today it is much more efficient to use fossil fuels to develop PV power plants than to combust fossil fuels in conventional thermal power plants. The full paper is available from the journal *Energy Policy* (Raugei, M., Fullana-i-Palmer, P., Fthenakis, V. (2012) *The energy return on energy investment (EROI) of photovoltaics: Methodology and comparisons with fossil fuel life cycles. Energy Policy 45: 576–582. DOI:10.1016/j.enpol.2012.03.008*) A summary is available on <http://ec.europa.eu/environment/integration/research/newsalert/pdf/293na1.pdf>.

Contact marco.raugei@esci.upf.edu or Vasilis Fthenakis, vmf@bnl.gov for further information.

Industry Commitment to Environmental & Social Responsibility

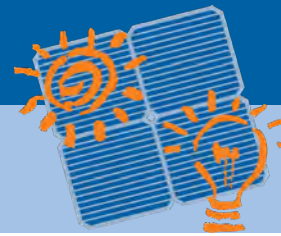
In March 2012, the U.S.-based Solar Energy Industries Association, Co-Operating Agent of PVPS Task 12, released the Solar Industry Commitment to Environmental & Social Responsibility, **the first corporate social responsibility guide developed for and by the solar industry.**

The Solar Commitment is based upon the Electronic Industry Citizenship Coalition's Code of Conduct, but also includes additional solar-specific provisions. SEIA is urging companies throughout the solar supply chain to adopt the sustainability provisions on a voluntary basis. The Solar Commitment is designed to evolve with the needs of the industry, and covers company and supplier requirements in the areas of labor, ethics, health and safety, environmental responsibility, human rights, and management systems.

"Solar is the cleanest, safest source of energy and the solar industry is committed to ensuring social and environmental responsibility for our supply chain," said Rhone Resch, president of the Solar Energy Industries Association. "The release of SEIA's Solar Commitment marks an important, proactive step toward a sustainable future for solar."

SEIA is dedicated to expanding the reach of the Solar Commitment, by increasing the discussion within the Task 12 platform, and through collaboration with other solar industry associations. Coordination through Task 12 provides a unique opportunity to increase the global discourse on sustainability and corporate social responsibility in the solar industry, and to expand upon the standards embodied by the Solar Commitment.

www.seia.org.



EVENTS

Solar Power International 2012,
Orlando, USA, 10-13 Sept 2012.
www.solarpowerinternational.com

27th European Photovoltaic Solar Energy Conference and Exhibition
- 27th EU PVSEC, Frankfurt, Germany.
Conference 24-28 Sept 2012, Exhibition 25-28 Sept 2012. Switzerland's Stefan Nowak, Chair of the PVPS Programme, has been invited to be the 27th EU PVSEC's General Chairman.
www.photovoltaic-conference.com



PVSEC-22, Hangzhou, China 5-9 November 2012. www.pvsec22.com.
The conference will also host a one day workshop on the IEA-PVPS programme on 6 Nov 2012. The workshop is open to all registered conference participants and will be held in English with simultaneous translation in Chinese.

PVPower Update is the newsletter of the IEA PVPS Programme:
www.iea-pvps.org.

The editor is Donna Munro.

Comments, queries or suggestions for articles should be sent the editor:
[munro.donna\(a\)virgin.net](mailto:munro.donna(a)virgin.net)

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WORKSHOPS AT THE 27th EU PVSEC

Three PVPS workshops will be held at the 27th EU PVSEC. Jointly organised by IEA - PVPS and EU PVSEC, these workshops are open to all participants of the 27th EU PVSEC, see www.iea-pvps.org for further details.

CHARACTERISING AND CLASSIFYING FAILURES OF PV MODULES

Monday, 24 September 2012 from 14:00 – 18:00

This workshop will look at issues ranging from testing and certification of PV modules, cracking of crystalline silicon modules, the results of field investigations into module failures such as snail tracks and PV module failures in the field. The workshop will be of interest to both researchers in the field and PV module manufacturers.

ASSIGNING A FAIR PRICE TO PHOTOVOLTAIC ELECTRICITY

Thursday, 27 September 2012 from 08:30 – 12:30

This workshop will discuss the policy, regulatory and business approaches that are likely to be on the table in the near future. As PV becomes more widely affordable and retail electricity prices rise PV public support measures such as FITs may cease. What then will be the approach to deployment of PV taken by the electricity network businesses and their industry regulators?

VERY LARGE SCALE PV SYSTEMS FOR SUSTAINABILITY

Thursday, 27 September 2012 from 13:30 – 16:30

Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems and their potential contribution to a sustainable solar energy world will be discussed in this symposium organized by Task 8. 100 MW-scale PV systems are already realized and may be the preliminary stage for implementing TW-scale PV electricity in remote regions of the world. The symposium will also see the launch of a new book, entitled 'Energy from the Desert: Very Large Scale PV Power – State-of-the-art and into the future'.

The International Energy Agency (IEA) was formed in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement a program of international energy cooperation among its member countries, including collaborative research, development and demonstration projects in new energy technologies.

The IEA Photovoltaic Power Systems Programme (PVPS) conducts joint projects in the application of photovoltaic conversion of solar energy into electricity. Currently, seven research projects, so-called Tasks, are established within the IEA PVPS Programme, each managed by an Operating Agent, contact details are given below.

Task 1: Exchange and Dissemination of Information on Photovoltaic Power Systems, Mr Greg Watt, [tallowood\(a\)westnet.com.au](mailto:tallowood(a)westnet.com.au)

Task 8: Very Large Scale PV Power Generation Systems in Remote Areas Mr Keiichi Komoto, [keiichi.komoto\(a\)mizuho-ir.co.jp](mailto:keiichi.komoto(a)mizuho-ir.co.jp)

Task 9: Deploying PV Services for Regional Development, Ms Anjali Shanker, [a.shanker\(a\)jed-sa.fr](mailto:a.shanker(a)jed-sa.fr)

Task 11: PV Hybrid Systems within Mini-grids, www.iea-pvps-task11.org, Mr Konrad Mauch, [konrad.mauch\(a\)ieee.org](mailto:konrad.mauch(a)ieee.org)

Task 12: PV Environmental Health and Safety, www.iea-pvps-task12.org, Ms Christine Covington, [info\(a\)seia.org](mailto:info(a)seia.org) and Prof Vasilis Fthenakis, [vmf\(a\)bnl.gov](mailto:vmf(a)bnl.gov)

Task 13: Performance and Reliability of Photovoltaic Systems, Ms Ulrike Jahn, [ulrike.jahn\(a\)de.tuv.com](mailto:ulrike.jahn(a)de.tuv.com) and Mr Christian Reise, [christian.reise\(a\)ise.fraunhofer.de](mailto:christian.reise(a)ise.fraunhofer.de)

Task 14: High Penetration of PV Systems in Electricity Grids, Mr Roland Bründlinger, [roland.bruendlinger\(a\)ait.ac.at](mailto:roland.bruendlinger(a)ait.ac.at) and Mr Christoph Mayr, [christoph.mayr\(a\)ait.ac.at](mailto:christoph.mayr(a)ait.ac.at)