PV ENLARGEMENT - DEVELOPING A NUCLEUS FOR PV EXPERTISE IN ACCESSION COUNTRIES AND FOCUSING ON NEW PV TECHNOLOGIES IN EU15

M. Grottke [(1)], P. Helm [(1)], T. Suker [(1)], K. Gehrlicher [(2)], A. Toth [(2)], G. Becker [(3)], T. Becker [(3)], J. Rehak [(4)], S. Jakubovic [(4)], C. Protogeropoulos [(5)] L. Ceccherini Nelli [(6)], F. Cariello [(7)], G. Tondi [(7)] and G. Friesen [(8)]
[(1)] WIP, Sylvensteinstrasse 2, 81369 Munich, Germany, Tel. 00498972012-737, Fax. -791, matthias.grottke@wip-munich.de;
[(2)] Gehrlicher Umweltschonende Energiesysteme GmbH, Guerickestraße 35, 80805 Munich, Germany;
[(3)] ATB, Dörferstraße 16, 6067 Absam, Austria;
[(4)] SOLARTEC s.r.o., Televizni 2618, 756 61 Roznov pod Radhostem, Czech Republic;
[(5)] Centre for Renewable Energy Sources, 19th km Marathonos Av., 190 09 Pikermi, Athens, Greece;
[(6)]) Università degli Studi di Firenze, Divisione servizi patrimoniali, via Cavour 82, 50129 Firenze, Italia;
[(7)] ETA - Renewable Energies, Piazza Savonarola, 10, 50132 Firenze, Italy;
[(8)] Scuola Universitaria Professionale della Svizzera Italiana, LEEE-TISO, 6952 Canobbio-Lugano, Switzerland

ABSTRACT: The EC funded project "PV Enlargement" aims at developing a nucleus for PV expertise in accession countries and is focusing on new PV technologies in the EU-15. It boldly demonstrates Europe's commitment for improved energy efficiency and cost-effectiveness of PV systems, enhancing the development of large European PV markets. This paper presents the results obtained during the first phase of this ambitious demonstration project which involves partners from 11 countries of Europe, among them five CCE countries. It discusses the first PV systems realised and gives an outlook on the scientific tasks to be elaborated during the second phase of the project. www.pvenlargement.com.
Keywords: grid-connected, thin film, monitoring, performance, qualification and testing

1 INTRODUCTION

The "PV Enlargement" project can be subdivided into three major fields of activities:

1. Demonstration (> 1,2 MWp) of highly cost-effective or very innovative PV technologies in 10 European countries for increasing public awareness about and visibility of PV solar electricity
2. Transfer of PV Technology know-how among EU-15 and CEE countries
3. Inter-European scientific exchange for improving performance and efficiency of innovative PV technologies through interconnected monitoring of performance data, which will be made publicly accessible.

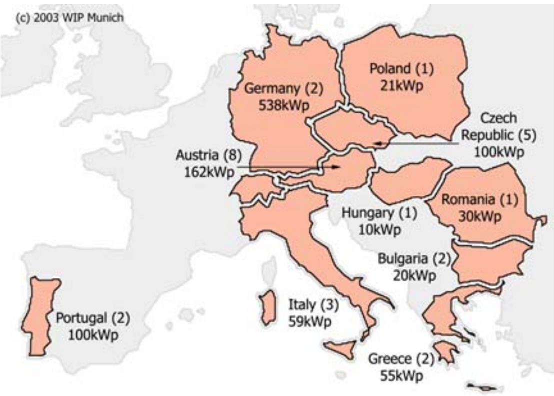

Figure 1: Map of PV Enlargement partner countries. The number of installations per country is indicated in brackets.

WIP initiated this project, developed the project concept, joined the partners and coordinates this project. 32 grid-connected PV demonstration systems with an overall generation capacity of more than 1,2 MWp will be installed and will be operated by 22 technical universities or academies and one municipality.

The PV systems (each > 10 kWp / 70m²) are being set up at visible places, often being the first grid-connected and / or largest installation of the country, which will result in increased public attention.

After one of four project years over 55% of the foreseen PV capacity is installed. This paper presents six outstanding installations realised within the first phase of this project.

2 SAME MPP TRACKING FOR ALL SYSTEMS REALISED / STANDARDISED DAS

To allow for a standardised and competitive comparison of PV module and system performance the project coordinator WIP together with key partners such as ATB, Gehrlicher and SOLARTEC agreed-upon to use one common inverter type and one common data acquisition system, wherever applicable within this project. It was decided that one manufacturer should supply the inverters for all project partners. All inverters shall use the same mpp tracking logic and should have equivalent energy conversion efficiencies. Based on past experience in central European countries transformer-based inverters were selected.

The data acquisition system satisfies high level requirements which allow for a full scientific monitoring of every PV module technology applied within the project. It is configured, purchased and programmed for the partners by the project coordinator WIP. The partners have the task to operate the DAS and to check their data in respect to data plausibility. Data acquired cover meteorological data, dc and ac level PV system parameters. The data collected are available for scientific evaluation to the operator of the PV system and, in addition, they will be centrally evaluated and used for PV system comparison by WIP.

3 QUALITY CONTROL

Quality control is considered from the beginning. After receiving the PV modules most of the installers are requested by TISO and WIP to randomly select a minimum of six PV modules from every technology used which are then sent to the partner LEEE-TISO in Switzerland for indoor module power tests according to IEC 60904-1. In addition on-site I-V curve tests are performed by WIP at relevant installations to verify the PV array output. The results are discussed with the relevant partners and the manufacturers before being published.

4 FEATURES OF OUTSTANDING PV SYSTEMS REALISED WITHIN THE FIRST PROJECT PHASE

4.1 Germany / Munich: the worlds largest PV field for thin-film and crystalline PV technology comparison

The project partner Gehrlicher realised the worlds largest field for thin-film and crystalline PV technology comparison in Munich with a total capacity exceeding 600 kWp. This PV field covers an area of 17.185 m² on the roof of the parking garage of the Munich fair centre. Today over nine different PV technologies are installed. Each PV module technology is represented with capacities between 14 and 85 kWp.

PV modules used are depicted in table 1.

Table 1: PV modules installed on the roof of the parking garage of the Munich fair center by Gehrlicher.

PV Module Manufacturer	Module Type	Technology
RWE Shott Solar	ASI-F 32/12	aSi
Antech Solar	ATF 43	CdTe
First Solar	FS-55	CdTe
Shell Solar	ST40	CIS
Würth Solar	WS 11007	CIS
Shell Solar	PowerMax Ultra 175	Monocryst. Si
SOLON	M210 / 6	Monocryst. Si
SANYO	HIP-J54BE2	Monocryst. Si / aSi
RWE Shott Solar	ASE 275 DG FT	Multicryst. Si
Shell Solar	PowerMax Plus 160	Multicryst. Si

Figure 2: Over 9 different PV module technologies are installed and operated with same orientation and in combination with the same inverter technology on the roof of the parking garage of the Munich fair center by Gehrlicher / DE (Photo: WIP).

A direct output comparison is possible since all PV arrays are connected to the same inverter type and are installed at the same site. PV array capacities are large enough to avoid that the manufacturers simply select the best modules of their production for this project. Therefore results are expected to be representative for the respective technology.

Tests are not limited to the comparison of PV module technologies but do also extend to a comparison of different inverter technologies in a relevant number. Here the idea is to operate inverters of a similar power class with PV arrays using the same PV module type and capacity. This part of the project is a joint cooperation of Gehrlicher, WIP and selected inverter manufacturers and is not co-funded by the EC.

4.2 Austria / Oberlech: an outstanding co-operation between architects and PV experts

In an altitude of 2.200 m the PV Enlargement partner ATB realised an outstanding show case for PV module integration into a building.

The lift station on top of the Kriegerhorn and close to Oberlech was realised with transparent glass-glass façade elements. Part of these glass elements are PV modules and use semi-transparent PV cells from Sunways with a total generating capacity of 8,5 kWp. A high energy output is expected due to the exposed position of this system. All PV modules are custom designed and were manufactured by Fischer. Fischer developed and patented a special system to fix such glass elements to a metal structure. This installation is an excellent solution and show case for PV integration in the building envelope and guarantees highest dissemination effects.

Figure 3: Façade integration of semi-transparent PV cell and PV module technology at the Kriegerhorn / AT (Photo: Sunways).

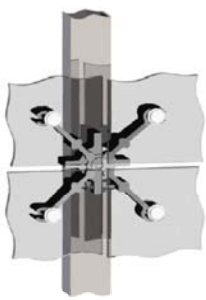

Figure 4: Construction system to fix glass elements to a metal structure developed by Fischer.

4.3 Austria / St. Johann: largest façade integrated PV system in Austria

The owner of the furniture house TROP in St. Johann / Tirol is commited to clean energy and to the reduction of the energy consumption of his furniture house. In a consequence he decided to get Austrias largest PV façade installed at his furniture house by ATB. This façade with glass-glass PV modules from RWE Schott Solar has a high efficiency of 130 Wp/m² and a total capacity of 52,8 kWp. ATB designed and installed the PV system. The unframed PV laminates of the type ASE-275-DG-UT/MC are fixed to the metallic structure of the building via a metallic clamp especially developed for this project, which exhibits a minimum visibility. This installation demonstrates a highly attractive solution for clean energy generation at the opaque façade of industry buildings.

Figure 5: Façade integration of opaque PV laminates at the furniture house TROP / AT (Photo: ATB).

4.4 Italy / Florence: PV as aesthetical shadowing element in the building envelope

Suspended PV structures bring shadow for the central court yard of a rectangular university building. The university building hosts the classrooms and the library of the "Polo Scientifico" and is part of the new Florence University Campus in Sesto Fiorentino. This attractive design was developed by the Universitá degli Studi di Firenze. It covers an area of 560m², has a total generation capacity of 20 kWp and uses semi-transparent PV modules of the type PW1250 from Photowatt. These are framed modules with glass/tedlar technology. The building is highly frequented by young university students and thus guarantees a maximum dissemination value.

4.5 Greece / Athens: six PV technology integration examples from the façade to the aesthetically appealing PV module integrations in a wooden pergola

The Greek national centre for the promotion of RES in Pikermi - Athens, CRES, realised a series of six PV technology integration examples. The "PV park" comprises built examples for vertical, façade-type PV curtins, aesthetically appealing PV module integrations in a wooden pergola shedding the veranda, and roof-top arrangements. Thus it covers a unique variety of PV integration technologies for the high number of interested visitors of this RES centre.

In total 40,0 kWp are installed. The PV arrays use mono-crystalline silicon PV modules from two manufacturers, namely Solar Fabrik type SF 115 and Conergy type 105L.

Figure 6: PV as shadowing element in the building envelope. University Florence - Sesto Fiorentino / IT (Photo: WIP).

Figure 7: PV as sheding element in the form of a solar pergola at CRES – Pikermi / GR (Photo: CRES).

4.6 Czech Republic: the five largest PV systems in CZ with 20 kWp installed at renown universities

The PV Enlargement partner SOLARTEC managed to install five 20 kWp systems on the campus of the renown Czech universities in Prague, Brno, Ostrava, Plzen and Liberec. These are the largest and one of the first grid-connected PV systems ever installed in the Czech Republic and these systems are in the focus of the students, the decision makers of tomorrow. All installations had to be realized taking into account specific Czech construction regulations which request very solid PV array structures. The grid-connection issues are still under discussion with Czechs national utility and will have a model character for future PV system feed-in contracts of electricity into the public grid.

From the architectural point of view the most outstanding Czech installation is a PV façade with modules using light blue custom designed PV cells from SOLARTEC in Liberec. The design of the system was elaborated in a close cooperation between SOLARTEC and the university Liberec staff.

Figure 8: PV Façade with light blue solar cells manufactured by SOLARTEC for the University Liberec / CZ (Photo: SOLARTEC).

5 PROSPECTS

The majority of the PV systems to be realised in the framework of the "PV Enlargement" project shall be operational within 2004. These operational systems shall all comprise the aforementioned standardised data acquisition system and it is expected that first evaluation results with a broad comparison of the different PV technologies will be available in the beginning of 2005.
In parallel it is planned to have minimum one relevant inaugural event by country which shall attract politicians and decision makers in general and create awareness for the potential of PV in Europe.
In cooperation with the coordinator WIP the partners shall set-up national web pages for result dissemination and for the general information on PV and PV demonstration systems in national language.

6 CONCLUSIONS

The project started very well and the vast majority of the project partners is highly motivated to contribute with a best-practice installation and with major dissemination events. This positive development is certainly boosted by the level of expertise of the individual project partners.

In cooperation with the PV industry the "PV Enlargement" network expects to contribute to more transparency about the different technologies offered on the PV market and thus to a growing confidence in PV and a broader political support of the PV technology on the European level.

7 ACKNOWLEDGEMENT

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