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Large-Scale (Utility-Scale) Photovoltaic Power Plants 1980-2015, Literature Survey

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Predgovor

Po uspešni uporabi fotonapetostnih sistemov v vesoljskih programih so bile bogate izkušnje uporabljene tudi pri načrtovanju in izvedbi fotonapetostnih sistemov na zemlji. Prvi primeri prizemnih fotonapetostnih sistemov so bili sistemi za uporabo v nerazvitih deželah: na podeželju za črpanje vode, sistemi za potrebe telekomunikacij in podobno.

Pomemben mejnik predstavlja konferenca "The Ninth IEEE Photovoltaic Specialists Conference", ki je potekala v Silver Springu, Maryland, maja leta 1972, kjer so bili prizemni fotonapetostni sistemi prvič obravnavani kot samostojna skupina fotonapetostnih sistemov.

Prvi veliki fotonapetostni sistemi so bili načrtovani in zgrajeni v okviru različnih razvojnih in raziskovalnih programov konec sedemdesetih let v ZDA in kasneje v osemdesetih letih tudi v Evropi. Po uspešni realizaciji in pridobljenih izkušnjah je sledil razvoj tržišča s pomočjo različnih spodbud, ki se je začel v devetdesetih letih z nemškim programom "1000 streh", ki mu je kasneje sledil program "100.000 streh", ki je predstavljal tudi osnovo za pripravo subvencij in ustrezne zakonodaje ne samo v Nemčiji, pač pa tudi v drugih evropskih državah. Prav ustrezna zakonodaja je omogočila, da so veliki fotonapetostni sistemi v zadnjih dvajsetih letih postali stalnica, nameščeni širom po svetu.

Pričujoča publikacija bralcu ponuja pregled znanstveno-strokovne literature s področja velikih fotonapetostnih sistemov. V zadnjih štiridesetih letih je bilo o velikih fotonapetostnih sistemih objavljenih veliko znanstvenih člankov in drugih publikacij. Glavni namen pregleda literature je bil ustvariti zbirko naslovov publikacij in drugih podatkov, povezanih z velikimi fotonapetostnimi sistemi, ki ne bi vključevala zgolj znanstvenih prispevkov, pač pa tudi druge pomembne tehniške publikacije.

Pregled literature zajema obdobje od sredine sedemdesetih let do leta 2015 in vključuje strokovne objave v angleškem in nemškem jeziku, o več kot 350 velikih fotonapetostnih sistemih po svetu.

Pregled literature zajema naslednje teme oziroma publikacije:
- temeljne študije,
- predloge pomembnih projektov,
- posebej pomembne projekte v posameznih državah,
- velike fotonapetostne sisteme z baterijami,
- velike fotonapetostne sisteme kot del zgradb,
- velike fotonapetostne sisteme na stanovanjskih naseljih.

Žal za pojem veliki fotonapetostni sistemi ni enotno veljavne definicije. Grobo pravilo, kakšne moči fotonapetostnih sistemov so bile v literaturi obravnavane kot veliki fotonapetostni sistemi, je naslednje:
- 1975–1989, obdobje razvoja in raziskav, 20 kW – 6 MW,
- 1990–1999, začetek finančnih spodbud, 200 kW – 6 MW,
- 2000–2010, zakonodaja s področja finančnih spodbud, 1 MW – 100 MW,
- 2011–2015, › 20 MW.

Pregled literature vsebuje naslednje podatke o posameznih objavah oziroma publikacijah:
- avtor(-ji), urednik(-i),
- leto izdaje,
- naslov,
- publikacija,
- letnik, številka, strani,
- založnik,
- spletna povezava,
- ISBN,
- DOI.

Pri vsaki objavi je tudi kratek seznam projektov, na katere se objava nanaša, dodan je še kratek seznam ključnih besed.

Poleg znanstvenih člankov pregled literature zajema tudi:
- pomembnejše objave v tehniških publikacijah,
- različna poročila.

Pri pripravi publikacije so bile zajete naslednje skupine dokumentov:
- konferenčni zborniki,
- objave člankov in plakatov na konferencah,
- znanstvene objave v tiskanih publikacijah,
- poročila in zborniki delovnih skupin,
- druga poročila,
- knjige,
- objave v tehniških publikacijah,
- baze podatkov GIS,
- druge baze podatkov,
- karte v knjigah in drugih publikacijah, stenske karte.

Te publikacije ne bi bilo brez nekaterih ustanov in posameznikov, ki so prispevali slikovno gradivo, vsi so navedeni v zahvali. Posebna zahvala gre knjižnicam, še posebej knjižnici TIB Hanover, brez katere te publikacije ne bi bilo, velika zahvala pa gre tudi oddelku za medknjižnično izposojo Centralne tehniške knjižnice Univerze v Ljubljani.

Denis Lenardič,
na Jesenicah, avgusta 2018

Introduction

FOREWORD

After the successful implementation of photovoltaic (PV) systems in space programmes, rich experiences were used for the realisation of terrestrial PV systems. The most common terrestrial PV applications in the beginning included small rural PV power plants, PV systems for telecommunication purposes, PV systems for water pumping and similar applications.

An important milestone, considering terrestrial photovoltaic systems, was the ninth IEEE photovoltaic specialists conference held in Silver Spring, MD, in May 1972 where terrestrial PV systems were discussed in a dedicated section for the first time.

Based on national and international photovoltaic R&D programmes, the first large-scale PV power plants were constructed at the end of the 1970s. After the first successfully realised large-scale photovoltaic power plants, based on R&D projects in the USA and later in Europe, the second phase of market development driven by feed-in tariffs and initiated by the German 1,000 roofs solar programme followed in the 1990s. The next important milestone in market development was the German 100,000 roofs programme, substituted later by the feed-in tarrif law and also used as a prime example for similar programmes and activities that followed later in Spain, Italy and in other countries.

Over the last forty years, many scientific papers and other publications related to large-scale PV power plants have been published. The main goal of the literature survey was the compilation of titles of publications and other important data related to large-scale photovoltaic power plants, which not only includes scientific papers but also other publications with scientific or significant technical relevance, thus targeting not only the scientific audience but also, at least to a minor extent, the broader technical community.

This literature survey, that covers the time period from the late 1970s to 2015, includes the publications and studies of more than 250 grid-connected PV projects worldwide, whereas the main idea was to compile an overview or list of publications that can serve research studies in the field of large-scale grid-connected PV systems as a time saving tool in case of searching for particular project related information.

Denis Lenardič, Jesenice, 15th August 2018

ACKNOWLEDGEMENTS

This survey did not receive any grants from funding agencies in the public, commercial, or not-for-profit sectors, but it would not be possible without the following libraries and organisations:

- **Technische Informationsbibliothek (TIB), Hannover** – for allowing me access to their library collection and for supporting me during my stay in Hannover in April 2016 and in March and November 2017. Without Library TIB Hannover, this survey would not have been possible.
- **Central Technological Library at the University of Ljubljana,** Interlibrary Loan Department (CTK IIL) - for providing an extensive amount of requested papers and other information while I was conducting the survey. The documents provided by CTK IIL, especially tables of contents of numerous proceedings represent the initial collection of data upon which this survey has been built.
- **Universitätsbibliothek der Technischen Universität München (TUM)**, for permission to access proceedings from their magazine and to study them in the library's reading hall for several weekends between December 2016 and November 2017.
- **International Solar Energy Society, ISES** - for allowing me access to the ISES archive and to conduct a survey at the ISES headquarters in Freiburg in November 2016.
- **Mary Brunisholz, IEA-PVPS**, for providing the Task 6 workshop report, which is only available in the IEA-PVPS Task 6 archive.
- **Library of Faculty for Electrical Engineering**, University of Ljubljana

DISCLAIMER

1980 and earlier

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **STRUB, A. S. Ed.** 1977. Photovoltaic Solar Energy Conference Proceedings, Luxembourg, 27–30 September 1977. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-0889-4.
- **VAN OVERSTRAETEN, Roger J. and Wolfgang PALZ. Eds.** 1979. 2nd E. C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1021-X.
- **PALZ, Wolfgang. Ed.** 1980. Third E. C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1230-1.

PROCEEDINGS – IEEE Photovoltaic Specialists Conferences

- **IEEE**. 1975. The Conference Record of the Eleventh IEEE PV Specialists Conference, Scottsdale, Arizona, 6–8 May 1975.
- **IEEE**. 1976. The Conference Record of the Twelfth IEEE Photovoltaic Specialists Conference, Baton Rouge, LA, 15–18 November 1976.
- **GOLDSMITH, John, V. Ed.** 1978. The Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978.
- **BACKUS, Charles Ed.** 1980. The Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980.

PROCEEDINGS – International Solar Energy Society, ISES

- **BÖER, Karl W. Ed.** 1976. Sharing the sun : solar technology in the seventies; Joint Conference of American Section, International Solar Energy Society and Solar Energy Society Society of Canada, Winnipeg, 15–20 August 1976.

  DOI: 10.1111/j.1751-1097.1976.tb06804.x
- **DE WINTER, Francis and Michael COX. Eds.** 1979. Sun: Mankind's future source of energy. Proceedings of the International Solar Energy Society Congress, New Delhi, 16–21 January 1978, 1–3. Oxford: Pergamon Press. ISBN 0080227252.

  URL: http://www.sciencedirect.com/science/book/9781483-284071 (30 May 2018)
- **BÖER, Karl W. and Barbara H. GLENN. Eds.** 1979. Sun II - ISES Silver Jubilee Congress; International Congress of the International Solar Energy Society; Annual Meeting of the American Section of the International Solar Energy Society (AS/ISES), Atlanta, GA, 1979, 1–3. New York: Pergamon Press. ISBN 0080250742.

PROCEEDINGS – American Solar Energy Society, ASES

- **BÖER, Karl W. and Alec F. JENKINS. Eds.** 1978. Solar Diversification, Solar Energy Symposia of the 1978 Annual Meeting, American Section of the International Solar Energy Society, Denver, CO, 28–31 August 1978. ISBN 0895530147.
- **FRANTA, Gregory E. and Barbara H. GLENN. Eds.** 1980. Solar Jubilee, 25 Years of the Sun at Work, Proceedings of the 1980 Annual Meeting American Section of the International Solar Energy Society, Phoenix, Arizona, 2–6 June 1980. ISBN 089553021X.

WORKSHOPS

- **DURAND, Henry L., Paul D. MAYCOCK and Wolfgang PALZ. Eds.** 1980. Medium-Size Photovoltaic Power Plants, Proceedings of an EEC/DOE Workshop, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1279-4.

PRELIMINARY STUDIES

- **BRADLEY, Jerry O. and Dennis R. COSTELLO**. 1977. Technoeconomic Aspects of Central Photovoltaic Power Plants. Solar Energy, 19, 6, 701–709.

  DOI: 10.1016/0038-092X(77)90032-9

  Abstract: This paper gives an analysis of the economic feasibility of central photovoltaic power plants from the perspective of an electric power utility company. Factors that would enhance the economic attractiveness of the system are analysed. Conventional fuel costs, decreases in photovoltaic system costs and subsidies are discussed in detail. One of the conclusions of the study is that a socially justified subsidy programme and a moderate research and development programme resulting in cost reduction can lead to the economic competitiveness of photovoltaic power plants with conventional energy sources.

1980 and earlier

- **DE MEO, Edgar A. and Piet B. BOS**. 1978. Perspectives on Utility Central Station Photovoltaic Applications. Solar Energy, 21, 3, 177–192.

  DOI: 10.1016/0038-092X(78)90020-8

  Abstract: In this paper, some proposals for estimating the nominal costs for photovoltaic power plants intended for large-scale electric utility applications are given. The main objective of the paper is to provide an improved basis for establishing research and development priorities for photovoltaic devices and conversion concepts. Different conceptual designs of photovoltaic power plants are also compared in the paper. One of the important conclusions is that thin film technologies seem to be promising in terms of long-term economic evaluation.

- **O'BRIEN, G., R. POHL and Nancy TURNER**. 1979. Requirement Definition and Preliminary Design of a Photovoltaic Central Power Station Experimental Test Facility. Volume 1: Final report. Philadelphia, PA: General Electric Space Division, Valley Forge Space Center, December 1979. NTIS #SAND-79-7022.

  URL: http://www.osti.gov/scitech/biblio/5516328-requirement-definition-preliminary-design-photovoltaic-central-power-station-experimental-test-facility-volum-final-report (21 November 2016)

- **O'BRIEN, G.** 1979. Requirement Definition and Preliminary Design of a Photovoltaic Central Power Station Experimental Test Facility. Volume 2: SOLMET site insolation and weather data. Philadelphia, PA: General Electric Space Division, Valley Forge Space Center, December 1979. NTIS #SAND-79-7022.

  URL: http://www.osti.gov/scitech/biblio/5516681-requirement-definition-preliminary-design-photovoltaic-central-power-station-experimental-test-facility-volume-solmet-site-insolation-weather-data (21 November 2016)

- **RUZEK, John B. and Walter J. STOLTE.** 1979. Requirements Definition and Preliminary Design of a Photovoltaic Central Station Test Facility. San Francisco, CA: Bechtel National Inc., Research and Engineering Operation, April 1979. NTIS #SAND-79-7012.

  URL: https://digital.library.unt.edu/ark:/67531/metadc304-031/ (1 March 2018)

REPORTS

- **BENOIT, Alfred E.** 1980. Construction of a photovoltaic power system at Natural Bridges National Monument, Technical Report, 1 December 1980. DOE/ET/20279-94. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  DOI: 10.2172/6727596

- **FORMAN, Steven E. and E. E. LANDSMAN.** 1978. Safety Procedures for the 25 kW Solar Photovoltaic Array at Mead, Nebraska, Technical Report, 7 April 1978. COO-4094-7. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  DOI: 10.2172/6652525

- **KIRPICH, Aaron S.** 1979. Photovoltaic Concentrator Application Experiment to be located at Sea World Park, Orlando, Florida. Phase I. System Design. Final Report. DOE/CS/05314-1. Philadelphia, PA: General Electric Co., Valley Forge Space Center.

  DOI: 10.2172/5718399

  Abstract: This report describes a photovoltaic concentrator system to be located at Sea World's Marine Park near Orlando, Florida. The planned system should consist of nine azimuth-tracking turntable arrays and each array should contain 24 elevation-tracking parabolic trough photovoltaic concentrators. The power capacity of the system should be 330 kW, with an annual electrical energy gain of 355 MWh. For grid interconnection, a 3-phase line-commutated inverter with maximum power point tracking should be used. Energy should be transferred to the 13 kV grid through a bidirectional transformer. The system should also produce cooled air for the air conditioning system.

- **MATLIN, Ronald W., William R. ROMAINE and Paul E. FISCHBACH.** 1978. The 25-kilowatt Photovoltaic Powered Agricultural Experiment at Mead, Nebraska. COO-4094-4. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  DOI: 10.2172/12136881

- **NICHOLS, Burt E.** 1980. A Solar Photovoltaic Power System for a Radio Station, Technical Report, 1 December 1980. COO--4094-85. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  DOI: 10.2172/6638466

MAPS PUBLISHED IN BOOKS, JOURNALS AND MAGAZINES

- **TREBLE, Fred C., Giuliano GRASSI and W. SCHNELL.** 1980. Photovoltaic Pilot Projects in the European Community. In: Third E. C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, map with proposed PV projects in Europe, 519.

  DOI: 10.1007/978-94-009-8423-3_75

  Abstract: Proposals received for the construction of photovoltaic pilot plants, as part of the Commission of the European Communities' second 4-year solar energy research and development programme, are presented. The main objectives are to prove feasibility, develop systems and critical components and compare different technological approaches in the field. The proposed plants, ranging from 30 kWp to 300 kWp, cover a variety of applications, such as rural electrification, water pumping, desalination, dairy farming, factories, hospitals, schools and vacation centres. A final choice of the plants to be built is expected to be made in November 1980. It is planned to accept about 15 projects with a total generating capacity of about 1 MWp and it is intended that each EC Member State should host at least one project. Construction of the proposed projects is scheduled to be complete by mid-1983.

- **BURGESS, Edward L.** 1978. Status of the Photovoltaic Concentrator Application Experiments. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 35–40.

  Abstract: In the paper, concentrator projects selected for design evaluation within the DoE Program Research and Development Announcement (PRDA) issued by the DoE Albuquerque Operations Office are presented. On page 40, the paper also includes a map of the proposed project locations in the USA.

JOURNAL AND CONFERENCE PAPERS

- **ADDISS, Richard R.** 1980. A 100 kilowatt Solar Photovoltaic Flat Panel Power System for the Combined Beverly High School/C. H. Patten Vocational High School. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings. Sophia-Antipolis, France, 23–24 October 1980, Commissariat a l'Energie Solaire, 34–36.

  Keywords: project description, case study

  Project: Beverly Hill School, Beverly, Massachussetts, USA

  Abstract: This paper describes the 100 kW photovoltaic system of Beverly Hill School, Beverly, MA, USA. The system is located on a southern facing hillside, close to the school buildings, north of the school, and it consists of 40 subarrays with 80 photovoltaic modules each. The arrays are further divided into two subfields with 20 subarrays each. The operating voltage is 250 V and 60 kW inverters transform voltage to 4,160 V. The system configuration is also described with attention to the safety measures during array maintenance. The system produces 116 MWh of power annually, which is 8 % of the school's energy demand. A brief description of the monitoring system and system performance is also given in the paper.

- **ANONYMOUS**. 1980. A 60 kW Photovoltaic Rural Electrification for the Island of La Reunion. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 75–78.

  Keywords: project proposal

  Project: Cirque de Mafate, Island of La Reunion, French overseas department

  Abstract: A proposal for a 60 kW photovoltaic system for Cirque de Mafate on the Island of La Reunion, French Overseas Department, is presented. The system should supply about 400 people that live in a 15 km long, 6 km wide rift valley surrounded by mountains. Two arrays with 30 kW, 330 V DC and 220 V AC voltage are proposed. Due to the remote location, the use of helicopters is proposed for system construction. The objective of the proposal is to demonstrate that a photovoltaic system is a suitable and reliable source of energy for remote and rural locations.

- **BLEVINS, B., R. HSIAO, A. MASUD, Harry ZWIBEL, J. BROWN, J. MORRISON, L. GOLUCKE and P. LOCKE.** 1979. A 20 kW photovoltaic flat panel power system in El Paso, Texas. In: Sun II - ISES Silver Jubilee Congress Proceedings; International Congress of the International Solar Energy Society; Annual Meeting of the American Section of the International Solar Energy Society (AS/ISES), Atlanta, GA, 1979, 3, 1749–1753.

  Keywords: project description

  Project: Newman Power Station, El Paso, Texas, USA

  Abstract: A photovoltaic system for powering the uninterruptible power supply at the Newman Station of the El Paso Newman Electric Company in El Paso, Texas, is presented in this paper. The module and array construction is presented, protection functions are described and simulation results are also given. The photovoltaic array consists of silicon and thin-film cadmium-sulphide/copper sulphide (CdS/CuS) solar modules. A detailed evaluation of the economic parameters such as capital cost, maintenance cost for a different array configuration and tilt angle is also given in the paper.

- **BOES, E. C., M. W. EDENBURN and Donald G. SCHUELER.** 1978. Overview of the DoE Photovoltaic Concentrator Project. In: Solar Energy Symposia of the 1978 Annual Meeting, Newark, DE: American Section of International Solar Energy Society, 25–28.

  Keywords: programme overview

  Abstract: Some economic and technical aspects of the DoE photovoltaic concentrator project are presented in this paper.

- **BOES, E., M. EDENBURN and Donald SCHUELER.** 1978. The Economics of Photovoltaic Concentrators. In: Solar Energy Symposia of the 1978 Annual Meeting, Newark, DE: American Section of International Solar Energy Society, 21–24.

  Keywords: preliminary study, economics, cost

1980 and earlier

Abstract: In this paper, some economic aspects of photovoltaic concentrators are discussed and presented. Current concentrator prices and projections for the future are given. Cost estimations for different concentrator technologies are also presented.

- **BRUNING, Gerhard, C. N. KOUROGENIS and Hartwig WILLMES.** 1980. Photovoltaic Power Pilot Plant in the Island of Kythnos - Greece. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 49–51.

  Keywords: project proposal

  Project: Kythnos Island, Cyclade Islands, Greece

  Abstract: A 100 kW photovoltaic system is proposed for the Island of Kythnos, Cyclade Islands, Greece, to operate in parallel with the existing diesel grid and a 60 kW wind energy system. The proposed photovoltaic system would produce 170 MWh and save about 60,000 litres of crude oil annually. The objective of the proposal is to prove the technical and economic feasibility of the parallel operation of photovoltaic systems in a hybrid system.

- **BUCCIARELLI, Louis L., John D. CREMIN, Harvey A. FENTON, Raymond F. HOPKINSON, Ervin F. LYON and William R. ROMAINE.** 1978. The Mead 25 Kilowatt Photovoltaic System. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 16–21.

  Keywords: project description

  Project: Mead, Nebraska, USA

  Abstract: A description of a 25 kW photovoltaic power plant for agricultural purposes located in Mead, Nebraska, is given in this paper. The power plant consists of two south facing arrays and two 6 V lead-acid battery banks each rated 375 Ah. Each battery bank with 120 V terminal voltage includes 20 batteries. The three-phase inverter consists of three separate single phase 27.5 kVA units. The inverter powers a three phase AC motor used for irrigation purposes. For irrigation purposes, an additional 7.5 kW DC motor is also used. Besides the technical description, operating experiences are also discussed and presented. For a specific day, different charts are available, such as array, battery and inverter power, utility energy balance, bus voltage and inverter efficiency, load balance and array energy balance, to name but a few.

- **BUCCIARELLI, Louis L. and Raymond F. HOPKINSON.** 1979. Performance of the Mead, Nebraska 25 kWp Photovoltaic Solar Energy System and Comparison with Simulation. In: Proceedings of 14th Intersociety Energy Conversion Engineering Conference, Boston, MA, 5–10 August 1979, 219–224.

  Keywords: project description

  Project: Mead, Nebraska, USA

  Abstract: A description of the system performance of a photovoltaic irrigation project in Mead, Nebraska after one year of operation is given. Array efficiency is between 6 and 8%, battery in-out efficiency is 83% and inverter efficiency is 87%. A comparison of system performance with simulated values is also presented in the form of plots.

- **BUCCIARELLI, Louis L., Barbara GROSSMAN, Ervin F. LYON and N. E. RASMUSSEN.** 1980. The Energy Balance Associated with the Use of a Maximum Power Tracer in a 100-kW-peak Power System. In: Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980, 523–527.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: In this paper, the hourly simulation results for the Natural Bridges National Monument photovoltaic system are presented. The main objective of the simulation was the use of maximum power point trackers and their advantage in the Natural Bridges National Monument photovoltaic system. Electrical schematics of the system, including the MPP trackers charger and inverter, are also presented in the paper. Some mathematical simulation expressions are also given. Simulation results include typical winter day array output with MPP, typical summer day with MPP and system auxiliary power requirements.

- **BULLO, P., S. CORSI, V. PIAZZA, G. EMANUELE, G. CELLI and M. GIUFFRIDA.** 1980. Considerations on the Feasibility of a 1 MW Central PV Plant to be Tied to the European Electrical Network. In: Third E.C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, 1076–1081.

  DOI: 10.1007/978-94-009-8423-3_181

  Keywords: preliminary study

  Abstract: This paper describes the basic items related to the practical construction of a large-scale 1 MW range ground-based photovoltaic system. The main criteria related to system design are yield estimation, optimisation of PV generator and module selection, inverter selection, lightning protection, system optimisation and cost estimation. Detailed cost estimations for different parts of the PV system are also presented. The schematics of the hierarchical system structure and interconnection with the utility grid are also given.

- **BURGESS, Edward L.** 1978. Status of the Photovoltaic Concentrator Application Experiments. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 35–40.

  Keywords: project overview

  Projects: Wilcox Memorial Hospital, Kauai, HI; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Batelle Columbus Laboratory, Columbus, OH; BDM Corporation, Albuquerque, NM; Dallas Forth Worth Airport, Dallas, TX; Sea World, Orlando, FL; Fanquier High School, Warrenton, VA; Kaman Sciences computing center and manufacturing plant, Colorado Springs, CO; Los Angeles Department of water and power, Sun Valley, CA; Roxborough State Park Visitors Center, Denver, CO; Research Triangle Park, NC; Solarex, Rockville, MD; Sun Trac Corporation, Racine, WI; Texas Tech University, Lubbock, TX; Varian Associates Incorporated, San Ramion, CA; Georgia Power Company, Fulton County, GA, USA; Univeristy of Porto Rico, San Juan, Porto Rico

  Abstract: In this paper, concentrator projects selected for design evaluation within the DoE Program Research and Development Announcement (PRDA) issued by the DoE Albuquerque Operations Office are presented. Systems ranging from 20 kW to 500 kW were selected from seventy seven proposals received. Phase one of the DoE project includes design evaluation, lasting from June 1, 1978 to February 28, 1979. In the paper, a brief description of the seventeen selected projects is given. The paper also includes an overview table of the projects and a map of the proposed projects' locations.

- **BURGESS, Edward L.** 1980. U.S. Grid-Connected Photovoltaic Application Experiments. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 11–12.

  Keywords: project overview

  Projects: Wilcox Memorial Hospital, Kauai, HI; Phoenix Sky Harbor International Airport, Phoenix, Arizona; BDM Technology Office Building, Albuquerque, NM; Dallas-Forth Worth Airport, Dallas, TX; Sea World Park, Orlando, FL; Lovington Square Shopping Center, Lovington, NM; Newman Power Station, El Paso, TX; Oklahoma Center for Science and Arts, Oklahoma City, OK; Beverly High School, Beverly, MA, USA

  Abstract: This paper briefly describes the objectives of a programme initiated by the U.S. Department of Energy in 1977, with the intention of designing, installing and operating several grid-connected photovoltaic application systems. The size range of these experiments was 20 to 500 kWp with either common flat modules or concentrating modules. The objective of this programme was to gain PV system level experience with intermediate sized PV systems connected to the grid. Nine photovoltaic systems scheduled for commissioning in 1980 and 1981 are presented in a table, including the system type and construction costs.

- **CASTLE, John A. and Kenneth RONNEY.** 1978. 10-kW Photovoltaic Concentrator System Design. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1131–1138.

  Keywords: preliminary study

  Abstract: In this paper, a brief description of a 10 kW concentrator system is given. Different parts of the proposed system are described including the concentrator unit, cell assembly, cell configuration and interconnection, structure, foundation structure, tracking drive system, control systems, etc.

- **CHADJIVASSILIADIS, John, J. L. CHENON and D. J. DENIS**. 1980. A 50 kW Photovoltaic Power Plant Coupled to the 15,000 V Electricity Grid. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 62–64.

  Keywords: project proposal

  Project: Cyclade Islands, Greece

  Abstract: A proposal for a 50 kW photovoltaic system connected to a 3-phase, 15 kV grid, with the grid as the proposed energy storage location, is given in the paper. The proposed location is the Cyclade Islands, Greece. A total of 1,500 photovoltaic modules with 33 Wp are required for a 50 kWp array, while the tilt angle of the photovoltaic modules should be seasonally adjusted. The voltage of the subarrays should be 160 V, while the expected system efficiency at nominal power should be 94% and 92% at 10% of the nominal power. Some similarities with the Kythnos project can be recognised from the presentation.

- **CHENON, J. L. and D. J. DENIS**. 1980. A 50 kW Photovoltaic Power Plant Coupled to the 15,000 V Electricity Grid. In: Third E.C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, 526–530.

  DOI: 10.1007/978-94-009-8423-3_77

  Keywords: project proposal

  Project: Cyclade Islands, Greece

  Abstract: A proposal for a 50 kW photovoltaic system connected to a 3-phase, 15 kV grid, with the grid as the proposed energy storage location, is given in the paper. The proposed location is the Cyclade Islands, Greece. A total of 1,500 photovoltaic modules with 33 Wp are required for a 50 kWp array, while the tilt angle of the photovoltaic modules should be seasonally adjusted. The voltage of the subarrays should be 160 V, while the expected system efficiency at nominal power should be 94% and 92% at 10% of the nominal power. Some data about the Kythnos project, such as the daily profile of power consumption on Kythnos Island, is also presented.

- **CORDES, V. and K. H. KORUPP**. 1980. 300 kW Photovoltaic Pilot Plant Pellworm/Germany. Medium-Size Photovoltaic Power Plants. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 55–58.

  Keywords: project proposal

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: Based on a particular load profile, a 300 kW photovoltaic system is proposed for Pellworm Island, Schleswig-Hollstein, Germany. On the Island, nine different generators have already been installed and tested. For a 300 kW array, 32,760 modules are required and lead acid battery storage of 8,000 Ah capacity is also proposed. The arrays should have a fixed tilt, optimised for northern latitudes. With the aim of studying the efficiency of tracking arrays, a small amount of arrays should also be mounted on tracking systems.

- **CULL, Ronald C. and Americo F. FORESTIERI.** 1978. The DOE/LeRC Photovoltaic Systems Test Facility. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 22–25.

  Keywords: project description

  Project: Lewis Research Center (LeRC), Cleveland, OH, USA

  Abstract: A description of the photovoltaic test facility located in the grounds of the Lewis Research Center, LeRC, Cleveland, OH is given in this paper. The installed power capacity of the

test facility is 10 kWp with proposals for an additional 30 kWp expansion. The system also consists of 48 kWh lead acid battery storage. A brief description of the power conditioning equipment, power distribution equipment, instrumentation and data acquisition system is also given in the paper. The test results are also presented and discussed.

- **DIETRICH, G., W. DÖNITZ and H.-J. HENSELER.** 1980. Photovoltaic Power Plant Zambelli (Verona). In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 111–113.

  Keywords: project proposal

  Project: Zambelli, Verona, Italy

  Abstract: A photovoltaic power plant with 140 kW is proposed for the Zambelli potable water station, north of Verona, Italy. The possibility of reduction to 70 kW power capacity is also considered. For the Zambelli water station, four pumps have been planned, one of them with 55 kW for continuous 24 h operation and the other three for operation on demand. The photovoltaic system should generate power for the pump operation. Attention is given to system efficiency, especially regarding inverter selection. To improve efficiency, single axis trackers are proposed.

- **DONOVAN, R. L., H. L. HUNTER, J. T. SMITH, R. L. JONES and S. BROADBENT.** 1978. Ten-Kilowatt Photovoltaic Concentrating Array. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1125–1135.

  Keywords: preliminary study

  Abstract: In this paper, a 10 kW concentrator photovoltaic array for use in large-scale photovoltaic systems is described.

- **FONZI, Fulvio.** 1980. Photovoltaic Pilot Plant for the Water Supply of the Tremiti Islands. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 85–87.

  Keywords: project proposal

  Project: Water desalination, San Nicola Island, Tremiti Islands, Adriatic Sea, Italy

  Abstract: A photovoltaic project to power a seawater desalination system for the drinking water self-sufficiency of the Tremiti Islands, Italy, is proposed. The system, located on San Nicola Island, would have a power capacity of 80 kWp and should produce 30 m^3 of drinking water daily. The annual energy delivered by a 710 m^2, 84,500 kWh solar array would result in about 8,500 m^3 of drinking water annually. For a supply of 60,000 m^3 of drinking water, which is the annual demand, energy storage of 1,000 Ah and 220 V DC voltage is planned.

- **FORMAN, Steven E.** 1978. Field Testing and Evaluation of PV Module Performance. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 41–46.

  Keywords: project description

  Projects: Mead, NE, USA

  Abstract: In this paper, the operating experiences of some photovoltaic power plants in the USA after six months of operation are summarised. Detailed field inspection results for the Mead power plant are given in the paper. Of 2,240 modules initially put into service, only six failed electrically within the first six months of operation. The main failures include the delamination and discoloration of modules/operating terminals. Other problems include dirt below encapsulant and cracked cells. Module degradation and soil accumulation results are also given.

- **GAUTIER DI CONFIENGO, E.** 1980. Photovoltaic Project for Giglio Island. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 65–67.

  Keywords: project proposal

  Project: Water desalination, Fosso di Valle, Ortona, Giglio Islands, Tyrrhenian Sea, Italy

  Abstract: A pilot photovoltaic system with 60 kWp for water desalination on Giglio Island in the Tyrrhenian Sea is proposed. The system with an output voltage of 220 V or 380 V AC, should supply a reverse osmosis system and pumps for water supply. Annually, an energy yield of about 100,000 kWh is expected. Interconnection with the diesel generator grid and a wind energy system is also being planned.

- **GOMIS, J. P. and C. GRENIER**. 1980. Power Supply of Electrical Energy Control System of an Airport. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 102–104.

  Keywords: project proposal

  Project: Nice Cote d'Azur Airport, Nice, France

  Abstract: A photovoltaic system for the Nice Cote d'Azur Airport in Nice, France, is proposed. A system with a 50 kWp power capacity should consist of 720 photovoltaic modules and should supply airport infrastructure like remote control and signalling, remote control of the emergency power station, the alarm network and display panels. The system should be installed on the roof of the technical building beside the runway. Energy storage should be realised by one 200 Ah battery bank with 48 V terminal voltage. The system should operate completely autonomously during the year and a monitoring system is also part of the proposed system. The main objective of the proposal is to study the reliability of photovoltaic systems in applications where high reliability is required.

- **GOMIS, J. P. and J. C. VIALART**. 1980. Power Supply for a Solar Water Heating Installation. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 81–84.

  Keywords: project proposal

  Project: Village "les Boucaniers", La Martinique

  Abstract: In this paper, a 30 kWp photovoltaic system for a holiday resort on Martinique, as support for a thermal water heating system, is proposed. The thermal water heating system

1980 and earlier

with a 950 m^2 collector area supplies 80 m^3 water daily. The electrical demand of the thermal system with three 1.5 kW pumps in the primary circuit and three 550 W pumps in the secondary circuit, should be covered by the proposed photovoltaic generator, supported by 300 kWh energy storage. The nominal string voltage should be 400 V and the module tilt angle should be 15°. The monitoring system, array and string structure and power conditioning are also described in the paper.

- **GREBY, Erik, Gerhard BRUNING and Hartwig WILLMES**. 1980. Photovoltaic Power Plant in Denmark. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 45–48.

  Keywords: project proposal

  Project: Village Vester Bøgebjerg, Denmark

  Abstract: In this paper, a 100 kW photovoltaic system in the village of Vester Bøgebjerg, Denmark, is proposed. The purpose of the project, located about 100 km south-west of Copenhagen, is to supply remote consumers. The required module array would be about 1,200 m^2. Battery storage of 1,000 kWh is also part of the project. Three phase 380 V inverters are proposed. The aim is to prove that a photovoltaic system can reliably supply small isolated consumers.

- **GRENIER, C. and J. C. VIALART**. 1980. Power Supply for FM and TV Emitter Station. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 105–107.

  Keywords: project proposal, telecommunication

  Project: Telediffusion de France, Mont Bouquet, Alès, France

  Abstract: This paper proposes a 50 kWp photovoltaic system for supplying Telediffusion de France, TDF emitters, located in the south of France. The power consumption of the equipment at the proposed location is about 102 kWh daily. Additionally, 180 kWh electrochemical energy storage is also proposed. An array with a tilt angle of 60° should consist of 35 Wp and 70 Wp modules and it should be divided into 60 strings with nominal voltage of 300 V.

- **GROSSMAN, Barbara L., B. L. BRENCH, Louis L. BUCCIARELLI and F. John SOLMAN.** 1980. Simulation of the Performance of a 100 kW peak Photovoltaic System. In: Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980, 266–272.

  URL: https://www.osti.gov/scitech/biblio/5625792-simulation-performance-kw-peak-photovoltaic-system (5 August 2017)

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: The Natural Bridges National Monument photovoltaic system in Utah was commissioned in May 1980. The system's components and characteristics are briefly presented in the paper. Electrical load is estimated to be 127 MWh/year. In the paper, mathematical simulation models and results, such as array output versus load power, are presented.

- **GUPTA, Y. P.** 1980. Design and Performance Characteristics of a Solar Photovoltaic Power System at the Oklahoma Center for Sciences and Arts. In: Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980, 109–114.

  Keywords: project description

  Project: Oklahoma Center for Science and Arts, Oklahoma City, OK, USA

  Abstract: A detailed technical description of the photovoltaic system proposed for the Oklahoma Center for Sciences and Arts, OCSA, is given in this paper. The proposed system consists of two arrays each with 10 strings and an inverter with an input voltage of 400 V DC. Detailed system criteria such as wind loads, peak loads, climatic data and available roof are presented and discussed. Simulated daily load and output profiles are also discussed. An artistic view of the system is also presented in the paper.

- **HENRY, E. Michael.** 1979. Mississippi County Community College Solar Photovoltaic Total Energy Project. In: American Society of Mechanical Engineers, Gas Turbine Conference and Exhibit and Solar Energy Conference, San Diego, CA, 12–15 March 1979, 6 pages.

  Keywords: project description

  Project: Mississippi County Community College, Blytheville, Arkansas, USA

  Abstract: In this paper, a solar photovoltaic project planned for installation at the Mississippi County Community College, Blytheville, Arkansas, is presented. A description and experiences with collector prototypes are discussed. The planned system includes a passive solar system, a photovoltaic system concentrating collectors and monitoring and control equipment. For power conditioning, 300 kW, 480 V three-phase inverters are proposed. Installation and checking of the system are scheduled for summer 1979.

- **HENRY, E. Michael and Harry V. SMITH.** 1979. Mississippi County Community College Solar Photovoltaic Total Energy Project. In: Sun II - ISES Silver Jubilee Congress Proceedings; International Congress of the International Solar Energy Society; Annual Meeting of the American Section of the International Solar Energy Society (AS/ISES), Atlanta, GA, 1979, 3, 1729–1731.

  Keywords: project description

  Project: Mississippi County Community College, Blytheville, Arkansas, USA

  Abstract: This paper describes the system proposed for the Mississippi County Community College, Blytheville, Arkansas, USA. The system should consist of a passive solar facility, concentrating collectors, photovoltaic system, power conditioning and energy storage and process control and energy management. Subsystems are described and the schedule for the completion of the project is given in the paper.

- **HESSE, John L**. 1980. Survey of Residential and Intermediate Photovoltaic Application. In: Third E.C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, 498–504.

  DOI: 10.1007/978-94-009-8423-3_73

  Keywords: project description, project overview

  Projects: Mead, NE; Mt. Laguna Air Force Station, CA; Natural Bridges National Monument, UT; AM radio station Bryan, OH; Dallas-Fort Worth Airport, Dallas, TX; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Wilcox Memorial Hospital, Kauai, HI; Oklahoma Center for Science and Arts, Oklahoma City, OK; Newman Power Station, El Paso, TX; Beverly High School, Beverly, MA, USA

  Abstract: This paper describes a photovoltaic system constructed on behalf of the United States Department of Energy (DOE) Photovoltaics programme. The power capacity range of the intermediate systems constructed for the mentioned programme is from 5 kWp to 225 kWp. The first roof-integrated photovoltaic array with 6.6 kWp was commissioned in Phoenix, Arizona in June 1980. Intermediate projects described in the paper are an agricultural project in Mead, Nebraska, Mt. Laguna Air Force Station, California, Natural Bridges National Monument, Utah and others. Project proposals for Dallas Fort Worth Airport, Orlando Sea World, BDM Building in Albuquerque, Wilcox Memorial Hospital, Kauai, Phoenix Sky Harbour International Airport, Oklahoma Center for Sciences and Arts, Beverly High School and Newman Power Station, El Paso, Texas, are also briefly described.

- **IMAMURA, Matthew S**. 1980. Terrestrial Photovoltaic Power System Project. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 25–27.

  Keywords: project description, project overview, concentrator, battery storage, hybrid, diesel generators

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: This paper describes the photovoltaic project for supplying villages in Saudi Arabia. The project, which is in the planning stage, includes a 470 kW concentrator photovoltaic array, 1 MW diesel-powered generator, 470 kWh lead acid battery storage, a 300 kVA inverter and a solar and weather data monitoring station. The system should be fully operational by mid 1981. The paper also includes an evaluation of the costs of the described system.

- **JARVINEN, Philip O. and Howard HAIGES**. 1978. Natural Bridges National Monument, Utah - Solar Photovoltaic Power System Design. In: Second National Conference on Technology for Energy Conservation Proceedings, Albuquerque, NM, 24–27 January 1978, 318–325.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: Natural Bridges National Monument photovoltaic systems in the planning stage is presented in this paper. The artist's concept and block diagrams are also included. Array location, array shading and computer simulation results including required fossil fuel backup are also given and discussed. Solar radiation data and energy conservation options are also presented.

- **KEAVENY, D**. 1980. Realization of a 5 kW Photovoltaic Generator. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 52–54.

  Keywords: project description, telecommunications

  Project: VHF transmitter power supply, Berlin, Germany

  Abstract: The paper describes a 5 kWp photovoltaic system commissioned in Berlin in 1979 for a broadcast transmitter, supported by the European Commission first Energy R+D programme and the German Ministry of Research and Technology. The photovoltaic array consists of 10.3 Wp modules composed of square solar cells. The array includes 486 AEG-Telefunken modules, 243 connected in parallel and 2 in series-connected modules. The array's nominal voltage is 24 V and the total solar cell area is about 44 m². The modules have a tilt of 60° and are mounted on frames that are able to withstand wind speeds of up to 200 km/h. Battery storage with 1,000 Ah capacity is also part of the system. Due to the test of a new inverter, the array was reconnected in 1980, so that the open circuit voltage was 400 V.

- **KEAVENY, D. and C. KRUSE**. 1979. Analysis, Design and Realisation of a 5 kW Photovoltaic Generator. In: 2nd E.C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979, 584–592.

  Keywords: project description, telecommunications

  Project: VHF transmitter power supply, Berlin, Germany

  Abstract: This paper describes a 5 kWp photovoltaic system for a broadcast transmitter, constructed in 1979 in Berlin, Germany. The photovoltaic array consists of 10.3 Wp modules composed of square solar cells. The array includes 486 AEG-Telefunken modules, 243 connected in parallel and 2 in series-connected modules. The array's nominal voltage is 24 V and the total solar cell area is about 44 m². The modules have a tilt of 60° and are mounted on frames that are able to withstand wind speeds of up to 200 km/h. Battery storage with 1,000 Ah capacity is also part of the system. The measurement results of the module parameters are also presented.

- **KERN, Edward C.** 1980. Lincoln Laboratory Experimental Photovoltaic Systems. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 22–24.

  Keywords: project overview

  Projects: Mead, NE; Bryan, OH; Blanding, UT, USA

  Abstract: This paper describes photovoltaic projects of the Massachusetts Institute of Technology, Lincoln Laboratory. Since 1976, the Laboratory has designed, built and operated four battery-equipped photovoltaic systems and two grid-connected systems with power capacities ranging from 1.5 kWp to 100 kWp. An overview of the parameters of the test systems, such as power capacity, array area, location, battery capacity and others is presented in the paper.

- **KIRSCH, N.** 1980. A 30 kW Photovoltaic Power Generating Plant for Industrial Application. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 132–140.

  Keywords: project proposal

  Project: Volaiville, province Luxembourg, Belgium

  Abstract: A photovoltaic system with a 30 kW array power capacity, for industrial purposes, located in the area of Volaiville, province of Luxembourg, Belgium, is proposed. The brief description includes a proposal for concentrator solar cell use.

- **KOUROGENIS, C. N., Bernard AUBERT, L. SELLES and John CHADJIVASSILIADIS**. 1980. Aghia Roumeli - Island of Crete, a 50 kW Autonomous Photovoltaic Power. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 121–123.

  Keywords: project proposal

  Project: Aghia Roumeli, Island of Crete, Greece

  Abstract: A project is proposed for the Aghia Roumeli village on the island of Crete. A photovoltaic array with a 50 kWp capacity should support energy demand in the village. 1,520 modules should be mounted on 63 frames, each frame including 24 modules. The use of DC/DC converters is proposed. The system should use two 20 kW inverters and battery storage with a 500 kWh capacity. The input voltage of the inverters should be 300 V and the output 220 V grid voltage. The aim of the project is to demonstrate that a photovoltaic system is able to supply power to a remote and stand-alone community.

- **LAMBARSKI, Timothy J., Karen E. BARDWELL, Robert M. TURFLER and Calvin B. ROGERS.** 1980. A Power Conditioning System for a Professional Services Office Building. In: Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980, 121–124.

  Keywords: project description

  Project: BDM Technology Office Building, Albuquerque, New Mexico, USA

  Abstract: In the paper, the power conditioning system for a system proposed for BDM Technology Applications Center in Albuquerque, NM is presented and described in detail. Among the inverter other aspects of power conditioning systems are described as well, like: array electrical layout, inverter, load distribution and switching, reverse power sensing in case of utility outage. The proposed inverter has 65 kVA of continuous load with five seconds of 100 kVA overload capability. The voltage range of the proposed three-phase inverter is 200 to 300 V DC.

- **LEONARD, Stanley L.** 1978. Central Station Power Plant Applications for Photovoltaic Energy Conversion. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1190–1195.

  Keywords: preliminary study

  Abstract: In this paper, some aspects of large-scale photovoltaic power plants are discussed. Three different photovoltaic power plant configurations are considered: a south facing system with flat-plate arrays with a tilt angle equal to the local latitude, a system with parabolic through concentrators with a concentrator ratio of 20 and a central receiver system with a concentrator ratio of 600. The levelised busbar cost of energy and a comparison with coal-fired power plants is given for all three types.

- **LUQUE, Antonio, G. SALA, A. ALONSO, J. M. RUÍZ, J. FRAILE, G. L. ARAÚJO, J. SANGRADOR, M. G. AGOST, J. EGUREN, J. SANZ and E. LORENZO.** 1978. Project of the "Ramon Areces" Concentrated Photovoltaic Power Station. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1139–1146.

  Keywords: project description, project proposal, concentrator

  Abstract: In this paper, a proposed two axis tracking concentrator system, funded by the Ramón Areces Foundation, for powering a Spanish rural village with 240 inhabitants is presented. The proposed system also includes battery storage.

- **LYON, Ervin F.** 1979. The Design and Construction of a 100 kW Photovoltaic Remote Stand-Alone Power System. In: 2nd E.C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979, 593–600.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: This paper describes the largest photovoltaic system under construction in a remote national park in south-eastern Utah, situated more than 2,000 m above sea level. The power capacity of the system is 100 kWp and the array consists of more than 266,000 silicon solar cells and covers 5,600 m² of area. Electrical storage consists of 224 lead-calcium batteries with a capacity of 750 kWh, charged by a 50 kW battery charger. Power is supplied by a 50 kW, 60 Hz inverter. Control and operating conditions are also described in the paper. Upon completion of the PV system in late 1979, the present diesel generator will be relegated to a backup role and is expected to supply less than 15% of the annual electrical demand.

- **LYON, Ervin F.** 1979. Peak Photovoltaic Power System for the Natural Bridges National Monument. In: Sun II - ISES Silver Jubilee Congress Proceedings; International Congress of the International Solar Energy Society; Annual Meeting of the American Section of the International Solar Energy Society (AS/ISES), Atlanta, GA, 1979, 3, 1732–1736.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

1980 and earlier

Abstract: A photovoltaic system that should replace the diesel generators used for the Natural Bridges National Monument site supply is described in this paper. Power for the site is produced by a single phase 240/120 V 60 Hz, 50 kVA/40 kV diesel generator in continuous operation. This should be replaced by a 100 kW solar array and energy storage. The system consists of a photovoltaic array and a control building in which energy storage and control equipment is located. The array and control building are connected through 335 m of underground cable. Parts of the system such as power conditioning, control equipment and the control building are also briefly described.

- **LYON, Ervin F., Louis L. BUCCIARELLI and Alfred E. BENOIT.** 1978. Design of the Natural Bridges National Monument 100 kW PV Power System. In: Conference Record of the 13th IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1268–1271.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: The MIT/Lincoln Laboratory will manage the design, fabrication, installation and testing of a 100 kW peak photovoltaic (PV) power system for the Natural Bridges National Monument in Utah. This system is scheduled to become operational in mid-1979. It should consist of a photovoltaic array, battery storage and will supply AC power to the NBNM site through the use of a main inverter. It is expected that the site demand will be in the range of 10 to 40 kW.

- **MACOMBER, Harold L.** 1980. Photovoltaic Systems Design Comparison Between Grid-Connected and Stand-Alone Systems. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 13–15.

  Keywords: project proposal, economics, LCoE

  Project: Monegon Corp., San Bernardino, California, USA

  Abstract: Among other things, this paper describes the photovoltaic system analysed by Solarex on behalf of Monegon, a light producer in San Bernardino, California, USA. The system should generate 35 kWp in June. Different system configurations were investigated: a flat-plate, fixed-tilt PV array with a maximum power point tracking (MPP) power conditioner and no battery storage; a two-axis tracking, flat-plate PV array with an MPP power conditioner and no battery storage; a two-axis tracking concentrating, linear focus PV array with an MPP power conditioner and no battery storage; and a fixed-plate, fixed-tilt PV array with a power conditioner without an MPP. The annual costs and life-cycle cost of energy (LCoE) are given for each configuration.

- **MAGID, Leonard M.** 1977. Current Status of the U.S. Terrestrial Photovoltaic Conversion Programme. In: Photovoltaic Solar Energy Conference Proceedings, Luxembourg, 27–30 September 1977, 453–461.

  Keywords: programme description

  Abstract: This paper describes the "U.S. Terrestrial Photovoltaic Conversion Programme". Part of the programme was the intermediate systems in a power capacity range from 20 kW to 500 kW. The four major task areas were to develop and establish a solar photovoltaic conversion system, subsystem, and component performance and lifetime criteria, to establish standards and procedures for testing the performance and lifetimes of conversion systems, subsystems and components, to support the identification and certification of testing laboratories qualified to conduct photovoltaic performance and lifetime tests and to assist in the establishment of building and power plant standards and codes.

- **MALAGUTI, C. and Achille TASCHINI**. 1980. Adrano Photovoltaic Project. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 94–95.

  Keywords: project proposal

  Project: Adrano, Sicily, Italy

  Abstract: Two photovoltaic projects close to the Eurelios 1 MW central receiver plant in Adrano, Sicily, are proposed. The proposed photovoltaic systems should have 20 kWp power capacity each. One system should utilise a flat-plate array and another a concentrator array. A system efficiency of about 85% is expected for a power capacity between 25 and 100% of the rated power.

- **MALAGUTI, C. and Achille TASCHINI**. 1980. Alicudi Project. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 96–98.

  Keywords: project proposal

  Project: Alicudi Island, Aeolian Archipelago, Messina, Italy

  Abstract: This paper describes a proposed 80 kWp photovoltaic system to be located on Alicudi Island near Sicily, for the local power supply of about 100 inhabitants. The proposed power capacity together with electrical storage would supply enough energy even in the winter months. Manual tilt adjustment of the photovoltaic array is proposed. The proposed system consists of a flat-panel photovoltaic array, maximum power tracker and a battery charger, electrochemical storage, a stand-by diesel engine for emergency battery charging, an inverter, a meteorological station and a data acquisition system. The purpose of the Alicudi Project is to test the possibility of supplying electricity to a small community living in a remote area using locally available renewable energy sources.

- **MANZONI, G. C., Achille TASCHINI and L. SALVADERI**. 1979. Integration of Photovoltaic Generation into a Large Generating System. In: 2nd E.C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979, 552–562.

  Keywords: preliminary study

  Abstract: This paper provides rough guides for the economic planning of large-scale photovoltaic power plant integration into an existing large generating system. Some application examples of the proposed approach to electric systems are also presented in the paper.

- **MATLIN, Ronald W., William R. ROMAINE and Paul E. FISCHBACH.** 1978. 25 kilowatt photovoltaic powered irrigation and grain drying experiment. In: Sun: Mankind's future source of energy; Proceedings of the International Solar Energy Society Congress, New Delhi, 16–21 January, 1978, 3, 1925–1928.

  Keywords: project description

  Project: Mead, Nebraska, USA

  Abstract: A photovoltaic power plant for irrigation purposes located in Mead, Nebraska is presented in this paper. Images of the system and block schematics are also part of the paper. In the introduction, a general overview about irrigation in the USA is presented and discussed. The photovoltaic system in Mead consists of a 25 kW photovoltaic array, and it also includes battery storage comprising thirty-eight 6 V batteries, three inverters and a data acquisition system.

- **MAYCOCK, Paul D.** 1980. Overview of U.S. DOE Large PV Systems. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 4–7.

  Keywords: project overview

  Projects: Mead, NE; Mt. Laguna Air Force Station, CA; Natural Bridges National Monument, UT; Newman Power Station, El Paso, TX; Oklahoma Center for Science and Arts, Oklahoma City, OK; Lovington Square Shopping Center, Lovington, NM; Beverly High School, Beverly, MA; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Dallas-Fort Worth Airport, Dallas, TX; BDM Office Building, Albuquerque, NM; Wilcox Memorial Hospital, Kauai, HI; Sea World Park, Orlando, FL; Mississippi County Community College, Blytheville, AR; Georgetown University Campus Building, Washington, DC, USA

  Abstract: In this paper, participants from the USA are introduced and the results of large U.S. system projects are presented. The dates of commissioning of the most notable residential and intermediate projects in the USA are also given.

- **McNELIS, B.** 1980. Solar Photovoltaic Cold Store. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 124–126.

  Keywords: project proposal

  Project: Cold store, Mazzara del Vallo, Sicily, Italy

  Abstract: The concept of a photovoltaic-supplied cold store with 750 m^3 space is presented in this paper. The array power should be 40 kWp and the array voltage 70 V.

- **O'NEILL, Mark J.** 1980. The 25 kW Fresnel Lens/Photovoltaic Concentrator Application Experiment at Dallas – Forth Worth Airport. In: Conference Record of the Fourteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 7–10 January 1980, 125–130.

  Keywords: project description

  Project: Forth Worth Airport, Dallas, Texas, USA

  Abstract: In this paper, a 25 kW photovoltaic concentrator and thermal system for Dallas/Fort Worth Airport, Texas, is presented. The solar concentrator array consists of 11 arrays with 10 collector modules each. A graphical concept of the collector receiver is presented. The estimated annual system performance of the photovoltaic and thermal parts is presented. A collector production cost estimate is also presented. Some other economic terms like levelised energy costs are also discussed. The results of prototype collector testing are also discussed.

- **POPE, Marwin D. and Ronald W. MATLIN.** 1978. Photovoltaic Power System Field Tests. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 27–34.

  Keywords: project description

  Projects: Mead, NE, Natural Bridges, UT, USA

  Abstract: In this paper, a brief description of the operating experiences and system description of some large-scale photovoltaic facilities is given. The paper also gives some cost estimations, and the efficiency, reliability and safety aspects are also discussed. Several photographs of the test systems are also presented.

- **RECHOU, Jacques and Dominique MERCIER**. 1980. Renewal of Rural Life by Photovoltaics - A Photovoltaic Pilot Plant for Rural Communities. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 72–74.

  Keywords: project proposal

  Project: Rondulinu, Corsica, France

  Abstract: This paper presents a proposal for a photovoltaic system with a 52 kW power capacity in Rondulinu, Corsica, France. The system should supply houses, street lighting, water pumping, a dairy with a milk refrigeration system, a mechanics repair shop and optionally a small solar powered telephone system. The system should consist of a flat-plate photovoltaic array, 50 kW three phase inverters with input voltage of 192 V DC and energy storage with a 250 kWh capacity. The energy storage should cover 3.5 days of energy demand. A cost estimation of the project is also given in the paper.

- **ROESLER, Dietrich J.** 1978. 60-kW Solar Cell Power System with Peak Power Tracking and Utility Interface. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 978–983.

  Keywords: project proposal, project description

  Project: Mt. Laguna Air Force Station, California, USA

  Abstract: This paper presents a photovoltaic power plant proposed to be built on the grounds of the Mt. Laguna Air Force Station. The proposed system should augment the existing diesel powered generators and generate about 10% of the power, saving an equal amount of fuel. The solar array should

consist of 1,610 modules with a 60 kWp power capacity and 169 strings. The design voltage of the array was selected to be 230 V DC. An inverter with 75 kW power and an input voltage ranging from 200 to 400 V DC is proposed. Some aspects of the assembly and electrical schematics are described and an artist's concept of the proposed power plant is presented.

- **ROESLER, Dietrich J., D. D. FAEHN and Larry R. SUELZLE.** 1980. Analysis of a 60 kW Photovoltaic Power Plant after the First Year of Operation. In: Third E. C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, 505–512.

  DOI: 10.1007/978-94-009-8423-3_74

  Keywords: project description, case study

  Project: Mt. Laguna Air Force Station, California, USA

  Abstract: The first year operating results of Mt. Laguna photovoltaic project are presented in this paper. The system has operated for 3,400 hours, generated about 111,000 kWh of electricity and fed into the grid more than 94,000 kWh of energy. Detailed measurement results including extreme measured values of ambient parameters are also presented and discussed. A technical description of the system is also given in the paper. During the first year of operation, no technical problems occurred.

- **ROSS, R. G.** 1978. Design Considerations of Solar Arrays for Terrestrial Applications. In: Sharing the Sun! Solar Technology in the Seventies. A Joint Conference of American Section, International Solar Energy Society and Solar Energy Society of Canada, Winnipeg, 15–20 August 1976, 6, 48–56.

  Keywords: preliminary study

  Abstract: This paper compares and discusses the situation and future requirements for large-scale photovoltaic arrays for terrestrial application. The main required improvements are described, such as modularity, prices and higher voltages, required for large-scale arrays in the future.

- **SALA, G., G. L. ARAÚJO, Antonio LUQUE, J. M. RUÍZ, A. COELLO, E. LORENZO, F. CHENLO, J. SANZ and A. ALONSO.** 1979. The Ramon Areces Concentration Photovoltaic Array. In: Sun II - ISES Silver Jubilee Congress Proceedings; International Congress of the International Solar Energy Society; Annual Meeting of the American Section of the International Solar Energy Society (AS/ISES), Atlanta, GA, 1979, 3, 1737–1741.

  Keywords: project description, project proposal, concentrator

  Abstract: A brief description of the 1.8 kW concentrator system funded by the Ramón Areces Foundation is given in this paper. Some economic and technical aspects of the project are also discussed.

- **SELLES, L. and A. EUVRARD.** 1979. Engineering Studies on the Optimization of the Collection Subsystem of a 1 MW Photovoltaic Facility. In: 2nd E. C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979, 1054–1064.

  Keywords: preliminary study

  Abstract: In this paper, various operating conditions of an intermediate size photovoltaic power plant of 500 kW to 1 MW power range are presented and evaluated. Topics like module inclination, ground cover ratio, copper wire cost, fixed and tracking systems are systematically evaluated for different system configurations and some proposals for optimisation are given.

- **SMEKENS, G. R.** 1980. North Europe Hydro Photovoltaic Peak Power Producing Plant. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 114–118.

  Keywords: project proposal

  Project: Hydroelectric power station Erpeldange, Suur River, Luxembourg

  Abstract: This paper presents a proposal for the photovoltaic power system of the hydroelectric power plant on Suur River in Luxemburg. Besides a 38 kW hydro electric generator, a 42 kW photovoltaic array should be constructed. The array should consist of 38 subarrays with 40 modules each. Brief requirements for the inverter and some cost estimations are also given in the paper.

- **SOLMAN, F. John.** 1980. Photovoltaic Power System at Natural Bridges National Monument. In: National Conference on Renewable Energy Technologies, Honolulu, HI, 7 December 1980, 5-48–5-50.

  URL: http://www.osti.gov/scitech/biblio/5084443/ (6 February 2016)

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: In this paper, the Natural Bridges National Monument photovoltaic system, which has been operating since May 1980, is briefly described. The system consists of 48 subarrays and includes battery storage to provide a 24 hour load supply. Simplified system schematics and load requirements compared to the available array power operation are presented and discussed in the paper as well.

- **SOLMAN, F. John, John H. HELFRICH, Ervin F. LYON and Alfred E. BENOIT.** 1980. The 100-kWp Photovoltaic Power System at Natural Bridges National Monument. In: Proceedings of 15th Intersociety Energy Conversion Engineering Conference, AIAA, Seattle, WA, 18–22 August 1980, 511–514.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: The standalone photovoltaic project located at the Natural Bridges National Monument in Utah is described in this paper. The array covers 1.3 acres and includes 1,100 subframes. Several smaller lightning rods are used for array protection. Battery storage consists of lead acid batteries with 600 kW of useful capacity. A block diagram of the system is also given in the paper. The system parameters are sampled every 10 minutes and stored in a data logger's memory. Images of the photovoltaic array, battery storage, control room, data logger and an aerial image of the photovoltaic system, are also included. Some operating and test experiences are also given in the paper.

- **SOLMAN, F. John and Burt E. NICHOLS.** 1980. Design, Construction and Evaluation of Two Large Photovoltaic Power Systems. In: Solar Jubilee, 25 Years of the Sun at Work, Proceedings of the 1980 Annual Meeting American Section of the International Solar Energy Society, Phoenix, Arizona, 2–6 June 1980, 1010–1016.

  Keywords: project description

  Project: Bryan, Ohio; Natural Bridges National Monument, Utah, USA

  Abstract: In this paper, photovoltaic power plants in Bryan, Ohio and the Natural Bridges National Monument photovoltaic system in Utah are described. Some construction details and experiences are presented and discussed. For the Bryan photovoltaic power plant, the first five month performance was evaluated and the results are presented in the paper. A mid-term cost prediction for different categories like solar modules, balance of system, batteries, etc. until 1986 and 2000 in 1975 U.S. dollars is also given. In the brief description of the Natural Bridges National Monument, a photovoltaic system performance simulation is also presented. In later papers, the performance simulation data is compared to real time data in more detail.

- **SONNEVILLE, R. P. M.** 1980. Self Supporting Photovoltaic Supply System for the School of Maritime Studies on the Island Terschelling, Holland. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 91–93.

  Keywords: project proposal

  Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

  Abstract: The proposed photovoltaic system for the School of Maritime Studies on Terschelling Island, the Netherlands, should cover about 95% of the 32 MWh power demand of the school and about 50% of the boarding school's 40 MWh. To assure a reliable power supply for the school and to increase utilisation, the photovoltaic array system is connected to the public grid. A wind generator and battery storage are also part of the system.

- **SPAZIANTE, P. M., G. SIOLI and D. G. PHILIPPIDES.** 1980. Photovoltaic Unit Integrated with an Active Chlorine Generator. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 130–131.

  Keywords: project proposal, water treatment

  Abstract: A photovoltaic system with a 30 kW array for industrial purposes that should supply an electrolyser generating active chlorine water sterilisation is presented and described. Active chlorine should be directly stored as chlorinated water for later distribution. The schematics of the system are also given in the paper.

- **SPAZIANTE, P. M., G. SIOLI and D. G. PHILIPPIDES.** 1980. Photovoltaic Unit Integrated with a Hydrogen Generator, Pressure Storage and Distribution System. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 127–129.

  Keywords: project proposal, solar hydrogen

  Project: Margherita di Savoia, Italy

  Abstract: A photovoltaic system with a 30 kW array for industrial purposes is presented in the paper. The system should supply an electrolyser, generating hydrogen in unsteady state conditions. Hydrogen should be stored on site under 30 Bar pressure and used for industrial HBr production and for supplying a fuel cell for producing electrical energy in periods without solar radiation, for the local supply of the industrial facility.

- **SUELZLE, Larry R. and Dietrich J. ROESLER.** 1979. Operational Characteristics of a 60 kW Photovoltaic System Integrated with a Utility Grid. In: 2nd E. C. Photovoltaic Solar Energy Conference Proceedings, Berlin (West), 23–26 April 1979, 1096–1104.

  Keywords: project description, case study

  Project: Mt. Laguna Air Force Station, California, USA

  Abstract: The operating parameters of the Mt. Laguna photovoltaic system are presented in this paper. The power plant with an output voltage of 480/277 V AC 60 Hz operates with low distortion to augment a remote utility grid. The system operates unattended and fully automatically. Detailed technical data for the system, system schematics and efficiency as a function of power are also presented.

- **TREBLE, Fred C., Giuliano GRASSI and W. SCHNELL.** 1980. Photovoltaic Pilot Projects in the European Community. In: Third E. C. Photovoltaic Solar Energy Conference Proceedings, Cannes, France, 27–31 October 1980, 513–520.

  DOI: 10.1007/978-94-009-8423-3_75

  Keywords: project proposal

  Projects: Pellworm Island, Germany; Nice Cote d'Azur Airport, France; Cosenza University, Italy; San Nicola Island, Tremiti Islands, Italy; Zambelli, Verona, Italy; Industrial Zone, Aix-en-Provence, France; Vester Bøgebjerg, Denmark; Kythnos Island, Greece; Marchwood, UK; Alicudi Island, Italy; Campese, Giglio Island, Italy; Reunion Island, Indian Ocean, France; Rondulinu, Corsica; Aghia Roumeli, Island of Crete, Greece; Montpellier, France; Nice, France; Fota Island, Cork, Ireland; Terschelling Island, The Netherlands; Margherita di Savoia, Italy; Alderney, Channel Islands, UK; Erpeldange, Luxembourg; Adrano, Sicily,

Italy; Mazzara del Vallo, Sicily, Italy; Martinique, Carribean Sea, France; London, UK; Olen, Belgium; Belgium, Province of Luxembourg

Abstract: This paper describes the objectives and projects as part of a four-year solar energy programme of the Commission of the European Communities, which is financially supporting a number of photovoltaic pilot projects ranging from 30 to 300 kWp. The proposed photovoltaic projects include various applications, such as rural electrification, water pumping, desalination, dairy farming, industrial use, schools and vacation centres. It is planned to accept about 15 projects with a total generating capacity of about 1 MWp and each EC Member State should host at least one. The construction of the selected projects is planned to be completed by mid-1983. The proposed projects are listed in a table and an overview map with the proposed project locations is also part of the paper.

- **TSOU, Peter and Walter STOLTE.** 1978. Effects of Design on Cost of Flat Plate Solar Photovoltaic Arrays for Terrestrial Central Station Power Applications. In: Conference Record of the Thirteenth IEEE Photovoltaic Specialists Conference, Washington, DC, 5–8 June 1978, 1196–1201.

  Keywords: preliminary study, cost, economics

  Abstract: In this paper, different aspects of the cost factors of large-scale photovoltaic power plants are discussed. Cost baselines are defined and based on these definitions, design parameter trade-offs are presented and discussed. Panel size, latitude sitting, panel loading, ambient temperature and array DC voltage are considered and discussed in terms of cost in the paper.

- **VAN GYSEL, Marc.** 1980. Photovoltaic Utility Connected to the Grid, Feeding the Auxiliaries of a Solar Thermal System. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 119–120.

  Keywords: project proposal

  Project: Domain Provincial de Chevetogne, Namur, Belgium

  Abstract: This paper describes a photovoltaic project with an array of 25 kWp for supplying a solar thermal system with 2,100 m² of solar collector area in Chevetogne, Belgium. The system should also include small additional battery storage. Alternatively, instead of battery storage, the system could be directly connected to the grid. The proposed system voltage is 200 V and four 10 kW inverters should be used for grid connection.

- **VISENTIN, R.** 1980. 80 kWp Solar Photovoltaic Plant for Isolated Areas and for Integration in Multisources Energetic Economies – designed by Cocsier Int. Consortium Italy (Progr. I7 I+D). In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 135–140.

  Keywords: project proposal

  Project: Cosenza University, Cosenza, Italy

  Abstract: This paper presents a proposal for an 80 kWp photovoltaic power plant with partially fixed and partially tracking arrays. The proposed photovoltaic project is part of a larger building and should be constructed as part of a larger project related to the Cosenza University. For the proposed photovoltaic project, autonomous and non-autonomous operation modes are considered.

- **WOLFE, P. R.** 1980. The Epsilon Project, European Photovoltaic System Installation in London. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 88–90.

  Keywords: project proposal

  Project: London, UK

  Abstract: This paper describes a proposal for a 30 kW photovoltaic system to be installed on the roof of a TV station. This roof-mounted system should be located in an urban environment. The array size has been calculated to provide sufficient power to meet the yearly average load of one studio in the complex. The system is also planned to include a storage capacity and could double as a standby power supply for the entire building.

- **WRIXON, Gerard T.** 1980. The Fotavoltaic Project: A 50 kWp Photovoltaic Pilot Plant Proposed for Fota Island, Cork, Ireland. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 108–110.

  Keywords: project proposal

  Project: Dairy Farm, Fota Island, Cork, Ireland

  Abstract: In this paper, a proposal for a 50 kW photovoltaic power plant on Fota Island near Cork, Ireland, is presented. The proposed photovoltaic system should supply the local dairy farm. The photovoltaic supply and dairy farm demand show similar profiles – for instance, in the summer much more milk is produced than in the winter. The system should also include battery storage with 220 V DC and 700 Ah capacity, which should assure one day's backup in case of emergency.

- **ZWIBEL, Harry S.** 1980. 20-kilowatt El Paso Photovoltaic Project. In: Medium-Size Photovoltaic Power Plants. EEC/DOE Workshop Proceedings, Commissariat a l'Energie Solaire, Sophia-Antipolis, France, 23–24 October 1980, 28–30.

  Keywords: project description

  Project: Newman Power Station, El Paso, Texas, USA

  Abstract: This paper describes the 20 kW Newman Power Station photovoltaic project in El Paso, Texas. The photovoltaic array is a fixed tilt, flat-panel array that supplies a DC bus of uninterruptible power supply (UPS) at Newman Power Station. Computers are used to control the combined cycle facility and a 25 kW uninterruptible power supply provides fail-safe power for the equipment and also for other DC loads.

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **BLOSS, Werner H. and Giuliano GRASSI. Eds.** 1982. Fourth E.C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1463-0.

  DOI: 10.1007/978-94-009-7898-0

- **PALZ, Wolfgang and E. FITTIPALDI. Eds.** 1983. Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1724-9.

PROCEEDINGS – IEEE Photovoltaic Specialists Conferences

- **BISHOP, Charles J. Ed.** 1981. The Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981.

- **BRANDHORST, Henry W. Ed.** 1982. The Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982.

- **RALPH, Eugene L. Ed.** 1984. The Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984. ISSN 0160-8371.

PROCEEDINGS – International Solar Energy Society, ISES

- **HALL, David O. and J. MORTON. Eds.** 1982. Solar World Forum: Proceedings of the International Solar Energy Society Congress, Brighton, UK, 1981. ISBN 0080267300.

- **SZOKOLAY, Steven Ed.** 1983. Solar World Congress: Proceedings of the 8th Biennial Congress of the International Solar Energy Society, Perth, Australia, 14–19 August 1983. ISBN 0080299474.

PROCEEDINGS – American Solar Energy Society, ASES

- **GLENN, Barbara H. and Gregory E. FRANTA. Eds.** 1981. Proceedings of the Annual Conference of the American Section of International Solar Energy Society, Philadelphia, PA, 26–30 May 1981. New York: American Solar Energy Society. Volume 1–2. ISBN 0-89553-030-9.

- **GLENN, Barbara H. Ed.** 1984. Proceedings of the American Solar Energy Society Annual Meeting 1984, Anaheim, CA, 5–7 June 1984. Boulder, CO: American Solar Energy Society.

PROCEEDINGS – Other

- **McDONALD, R. R. Ed.** 1982. Flat Plate Solar Array Project: Proceedings of the 20th Project Integration Meeting, Pasadena, CA, 21–22 April 1981, NASA-CR-169370.

  URL: http://ntrs.nasa.gov/search.jsp?R=19830002235 (10 June 2016)

  Abstract: In this report progress on the field of flat plate photovoltaic arrays project, during the period from November 1981 to April 1982 is presented. The report includes progress in research and applications from solar cells to large photovoltaic power plants and related engineering topics. Some large scale photovoltaic power plants' relevant entries are also briefly discussed.

WORKSHOPS

- **PALZ, Wolfgang Ed.** 1981. Photovoltaic Power Generation Proceedings of the Final Design Review Meeting on EC Photovoltaic Pilot Projects. Solar Energy R&D in the European Community Series C, Volume 1. Brussels, 30 November – 2 December 1981. Brussels: Commission of the European Communities, D. Reidel Publishing. ISBN 90-277-1386-3.

- **VAN OVERSTRAETEN, Roger and Wolfgang PALZ. Eds.** 1982. Photovoltaic Power Generation, Proceedings of the EC Contractors' Meeting. Solar Energy R&D in the European Community Series C, Volume 3. Brussels, 16–17 November 1982. Brussels: Commission of the European Communities, D. Reidel Publishing. ISBN 90-277-1585-8.

  DOI: 10.1007/978-94-009-7136-3

- **PALZ, Wolfgang Ed.** 1984. Photovoltaic Power Generation, Proceedings of the EC Contractors' Meeting. Solar Energy R&D in the European Community Series C, Volume 4. Hamburg/Pellworm, 12–13 July 1983. Brussels: Commission of the European Communities, D. Reidel Publishing. ISBN 90-277-1725-7.

  DOI: 10.1007/978-94-009-6342-9

PRELIMINARY STUDIES

- **CARMICHAEL, Donald C., G. ALEXANDER, G. T. NOEL and W. R. HUSS.** 1982. Development of a Standard Modular Design for Low-Cost Flat-Panel Photovoltaic Array Fields. SAND 81-7183. Columbus, OH: Battelle-Columbus Laboratories. NTIS #DE 83-005118.

  URL: http://www.osti.gov/scitech/biblio/6550999 (23 October 2016)

  Abstract: In this report detailed photovoltaic array design and construction concepts are presented. Array design studies of different module types including laminates and frame structures consisting of different materials, like steel and

wood, are given in the paper. Detailed maintenance effort and cost evaluation of large scale photovoltaic arrays are also discussed.

- **JONES, Gary, Matthew S. IMAMURA, Dave HUGHES, Lee MARSHALL, Pat HARDEE, Jerry STEPHENSON, Bruce HELLER, Eric R. WEBER, Thomas C. LEPLEY, William B. LANG, L. J. DUBBERLY, Don PARKER, Jim WALTON, Jerry HARRIS and Jack BROCK.** 1984. Design of a Photovoltaic Central Power Station. SAND 82-7149. Denver, CO: Martin Marietta Corp., February. NTIS #DE 84-009505.

  DOI: 10.2172/5265519

  Abstract: This report details and describes the design of large 100 MW photovoltaic power plants divided into 5 MW subsystems. Flat panel arrays and two-axis tracking arrays are discussed in the report. All parts of photovoltaic power plants are considered including power conditioning units and control systems. A detailed economic evaluation is also given. Proposals for further study are also discussed in the paper.

- **JONES, Gary, Matthew S. IMAMURA, Dave HUGHES, Lee MARSHALL, Armando SOLORZANO, Patrick HARDEE, Jerry STEPHENSON, Khaled SHARMIT, Bruce HELLER, Eric R. WEBER, Thomas C. LEPLEY, William B. LANG, L. J. DUBBERLY, Don PARKER, Jim WALTON, Jerry HARRIS and Jack BROCK.** 1984. Design of a Photovoltaic Central Power Station Concentrator Array. SAND 82-7148, Denver, CO: Martin Marietta Corp., February. NTIS #DE 84-008823.

  DOI: 10.2172/5148555

  Abstract: The design and construction of a 100 MW photovoltaic concentrator array is described in this report. A solar generator should be divided into 5 MW subarrays, each with their own inverter. A detailed description of the modules, two axis trackers, and protection functions is given in this report. A photovoltaic power plant should be connected to the 115 kV transmission line. Detailed cost estimation and structure are also discussed. The paper also includes detailed technical drawings and electrical schematics of the whole system.

- **JONES, Gary, Matthew S. IMAMURA, Dave HUGHES, Lee MARSHALL, Armando SOLORZANO, Patrick C. HARDEE, Jerry STEPHENSON, Khaled SHARMIT, Bruce HELLER, Eric R. WEBER, Thomas C. LEPLEY, William B. LANG, L. J. DUBBERLY, Don PARKER, Jim WALTON, Jerry HARRIS and Jack BROCK.** 1984. Design of a Photovoltaic Central Power Station Flat Plate Array. SAND 82-7147, Denver, CO: Martin Marietta Corp., February. NTIS #DE 84-008825.

  DOI: 10.2172/5148558

  Abstract: The main scope of this report is planning and construction recommendations for large scale 100 MW photovoltaic power plants. The report covers all parts of the power plant like mounting structure, photovoltaic array, balance of system, switch gear, protection elements, and power conditioning units. One chapter in the report also discusses topics like security services and utilities including system security and access and enclosures of the system. A solar generator should consist of five 20 MW subarrays connected to a 115 kV grid.

- **IMAMURA, Matthew S., D. J. HUGHES and R. P. SEMMA.** 1981. Photovoltaic Central Power Station Requirements Definition (Vols. I and II). MCR-81-1736, Denver, CO: Martin Marietta Corp., September.

- **LEVY, S. L. and L. E. STODDARD.** 1984. Integrated Photovoltaic Central Station Conceptual Design. EPRI AP-3264, Research Project 2197-1. Kansas City, Missouri: Black & Veatch Engineers Architects, June.

  URL: https://www.epri.com/#/pages/product/AP-3264/ (23 October 2016)

  Abstract: In the report conceptual designs of 100 MW photovoltaic power plants are presented. Different technologies are evaluated and presented in detail - fixed flat plate, one-axis tracking arrays, two-axis tracking arrays and two-axis tracking high concentration arrays. A detailed description, economic evaluation, drawings and estimated material consumption are discussed and presented in the report. Maintenance and replacement costs are also given including special topics like array washing costs estimation. Transportation to the site of the power plant and mounting techniques are also discussed.

- **POST, H. N., D. C. CARMICHAEL and J. A. CASTLE.** 1982. Low Cost Modular Designs for Photovoltaic Array Fields. SAND-81-2379C. Albuquerque, NM: Sandia National Laboratories, Columbus, OH: Battelle Columbus Laboratories, Los Angeles, CA: Hughes Aircraft Co.

  DOI: 10.2172/5251341

  Abstract: This paper describes the design and development of modular array fields for photovoltaic systems. Two different construction layouts of 100 MW power plants are presented and compared. The main criteria for the design are voltage of about 400 V DC, compliance with applicable codes and safety requirements, suitability for installation at favourable sites, module efficiency of 10% at NOCT, and suitability for near-term (1982–1983) use.

- **SIMBURGER, Edward J.** 1982. Central Station Photovoltaic Power Plant Design. Aerospace Report No. ATR-82-(9595)-01. El Segundo, CA: The Aerospace Corporation, Energy and Resource Division, September.

- **STOLTE, Walter J.** 1982. Photovoltaic Subsystem Organization and Design Tradeoff Study, Final Report. SAND 81-7013. San Francisco, CA: Bechtel Group Inc., March. NTIS #DE 84-008823.

  DOI: 10.2172/5249385

  Abstract: This study examines photovoltaic power plant design and installation. The study covers detailed array layout and array wiring, grounding and protection functions, array support optimisation, power conditioning units, and design trade-offs and optimisation.

1981 – 1984

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- **BAIRD, R. H. and F. John SOLMAN.** 1982. System design drawings for the PV power system at Natural Bridges National Monument, Technical Report, 1 May 1982. DOE/ET/20279-178. ON: DE82017130. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: https://www.osti.gov/scitech/biblio/6600351 (5 August 2017)

- **BRENCH, B. L.** 1981. Application, sizing, testing and performance of the photovoltaic battery subsystem at Natural Bridges National Monument, Utah, Technical Report, 1 November 1981. DOE/ET/20279-153, ON: DE82007040. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: https://www.osti.gov/scitech/biblio/5599473 (5 August 2017)

- **COLEMAN, S. D.** 1982. Natural Bridges National Monument photovoltaic power plant operations manual, Technical Report, 1 February 1982. DOE/ET/20279-142, ON: DE82015388. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: https://www.osti.gov/biblio/5353998-natural-bridges-national-monument-photovoltaic-power-plant-operations-manual (1 August 2018)

- **FLOYD, A. B.** 1982. ARCO Power Systems Second Generation Heliostat. US Department of Energy, Solar Central Receiver Annual Meeting, Sandia Report SAND 82-8002.

- **GROSSMAN, Barbara L.** 1981. Simulated performance of the stand-alone photovoltaic system at Natural Bridges National Monument, Technical Report, 1 March 1981. DOE/ET/20279-125, ON: DE81027274. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: https://www.osti.gov/scitech/biblio/6207302 (5 August 2017)

- **HOPKINSON, R. F.** 1981. Safety procedures for the 100-kW solar photovoltaic system at Natural Bridges National Monument, Technical Report, 1 September 1981. DOE/ET/20279-108, ON: DE82002840. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: http://www.osti.gov/scitech/biblio/5961920 (6 February 2016)

- **Jet Propulsion Laboratory.** 1983. SMUD PV Phase I Functional Requirements. JPL, No. 5250-18. Pasadena, CA, March.

- **KERN, Edward C. and Marwin D. POPE.** 1983. Development and Evaluation of Solar Photovoltaic Systems: Final Report. Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Massachusetts. DOE/ET/20279-240. Prepared for the U.S. Department of Energy under Contract No. DE-AC02-76ET20279.

  URL: https://www2.jpl.nasa.gov/adv_tech/photovol/2016CTR/MIT-LL PV Appl Exp Final Rpt_1983.pdf (23 October 2016)

- **KLEIN, D. N.** 1981. Safety Analysis Report, Natural Bridges National Monument 100 kW PV Power System, Technical Report, September 1981. DOE/ET/20279-116, ON: DE82004406. Lexington, MA: Massachusetts Institute of Technology, Lincoln Laboratory.

  URL: https://www.osti.gov/scitech/biblio/5900896 (5 August 2017)

- **NAFF, G. J.** 1983. Photovoltaic Array Field Optimization and Modularity Study. SAND 81-7193. Los Angeles, CA: Hughes Aircraft Corp., March. NTIS #DE 83-011337.

  URL: http://www.osti.gov/scitech/biblio/6403915 (23 October 2016)

- **RISSER, Vernon Vilas.** 1981. A 20-kW Solar Photovoltaic Flat-Panel Power System for an Uninterruptible Power-System Load in El Paso, Texas. Phase II - System Fabrication. Final Report. DoE/ET/20629-1. Albuquerque, NM: United States Department of Energy.

  DOI: 10.2172/5355264

  Project: Newman Power Station, El Paso, Texas, USA

  Abstract: In the report, the 20 kW photovoltaic power plant located at the Newman Power Station, El Paso, Texas, commissioned on 27th January 1981 is described in detail. The construction details and detailed system drawings, system integration, including yield simulation and economical details are presented in the paper.

- **SOLMAN, F. John and S. D. COLEMAN.** 1982. Power Processing Subsystems for the 100-kWp Solar-Photovoltaic-Power System at the Natural Bridges National Monument in Utah. Technical Report. DOE/ET/20279-180-Vol.5. Lexington (USA): Massachusetts Institute of Techology, Lincoln Laboratory.

  URL: http://www.osti.gov/scitech/biblio/6609142/ (6 February 2016)

- **SPENCER, R., R. HARPER, G. MABERRY, R. BEDARD and D. RAFINEJAD.** 1982. Design, Construction, and Startup of a Concentrating Photovoltaic Solar Energy System in Hawaii. Phase II. Acurex Final Report FR-82-28/AE. DoE/ET/20623--T4. Mountain View, CA: United States Department of Energy.

  Project: Wilcox Memorial Hospital, Kauai, Hawaii, USA

  Abstract: In the report, the design, construction and commissioning of the Wilcox Memorial Hospital photovoltaic concentrator system is presented in detail. The report includes details and images of the system design and performance modelling, construction activities and a detailed estimation of the predicted costs of the system. Problems and the commissioning procedure are also discussed in the report.

- **STARR, Michael R. and Wolfgang PALZ.** 1983. Photovoltaic Power for Europe, An Assessment Study. Solar Energy R&D in the European Community, Series C, Volume 2. Brussels: Commission of the European Communities, D. Reidel Publishing Company. ISBN 90-277-1556-4.

JOURNAL AND CONFERENCE PAPERS

- **ALBERGAMO, V. and P. BULLO.** 1981. The Delphos Project. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1208–1213.

  Keywords: project description

  Projects: Delphos 1, Delphos 2, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: A description of the Delphos project is given and the most important design criteria of the proposed project are discussed in this paper. The array configuration of the proposed power plant is given and the influence of the tilt angle is discussed. It is planned to construct a 1.12 MW photovoltaic power plant, consisting of 12 subfields of about 100 kW each. The balance of system of the proposed project is also described. For standalone mode of operation the use of MPP trackers has been planned and for grid connected operation the use of line commutated inverters is proposed.

- **Anonymous.** 1983. Kythnos Photovoltaic Power Plant. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 55–74.

  DOI: 10.1007/978-94-009-6342-9_5

  Keywords: project description, case study, battery storage, hybrid, diesel generators

  Project: Kythnos Island, Cyclades Islands, Greece

  Abstract: In the paper, the photovoltaic power plant on Kythnos Island, located about 60 km south of Athens, is detailed as technically described. Numerous details about the solar generator, batteries, DC/DC and DC/AC converters are given. Additional technical details presented in the paper include information about the array support structure, cabling, lightning protection, battery bus and control equipment. Technical drawings and images are also part of the paper. The Kythnos PV system is a hybrid system with 2 x 1,200 Ah battery capacity and a 100 kWp solar array. It feeds power into a three-phase island local grid.

- **ARCIDIACONO, V., S. CORSI, Alberto ILICETO, A. PREVI and Achille TASCHINI.** 1982. Alicudi Project. In: Fourth E.C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 115–119.

  DOI: 10.1007/978-94-009-7898-0_19

  Keywords: project proposal

  Project: Alicudi Island, Aeolian Archipelago, Messina, Italy

  Abstract: The project to be built on Alicudi Island in the Aeolian archipelago, Sicily is presented in the paper. Two 40 kWp arrays should deliver energy to be stored in 3,200 Ah batteries. A 220 V DC power supply should be realised by a three-phase inverter 40 kVA, 380 V AC. Construction of the proposed project is challenging due to the remote location and absence of roads on the island. The solar array should be located on terraced ground on the south slope of the island. An emergency supply should be assured by a 60 kW, 380 V AC diesel generator backup. Electrical schematics and island location related data are also part of the presentation.

- **ARNAULT, R. J., E. BERMAN, Charles F. GAY, R. E. L. TOLBERT and J. W. YERKES.** 1983. The ASi 1 MW Photovoltaic Power Plant. In: Solar World Congress: Proceedings of the 8th Biennial Congress of the International Solar Energy Society, Perth, Australia, 14–19 August 1983, 3, 1624–1628.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: In the paper, 1 MW Lugo photovoltaic power plant is described. The chronology of construction activities from April 1st 1982 when the agreement between ARCO Solar and Southern California Edison was signed until December 15th 1982 when the plant reached full operation is given. System performance evaluation and system losses are also given in the paper.

- **ARNETT, J. C., L. A. SCHAFFER, J. P. RUMBERG and R. E. L. TOLBERT.** 1983. Design, Installation and Performance of the ARCO Solar one-Megawatt Power Plant. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 314–320.

  Keywords: project description, case study

  Project: Lugo, Hesperia, California, USA

  Abstract: Photovoltaic power plant located in Lugo, Hesperia, California at an elevation of 1,134 m was put into service on December 15th, 1982. Design-, installation- and performance related data is presented in this paper. The PV system occupies 8 hectares of land and consists of 108 two-axis trackers, and each tracker includes 256 solar modules. The system is connected to a 12 kV utility by underground cables. More detailed tracker construction, a description of the data acquisition system and project construction time line are also given. The paper also includes performance data and an estimation of losses of different parts of the system.

- **AUBERT, Bernard.** 1981. Aghia Roumeli Electricity Supply to an Isolated Village. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 374–385.

  Keywords: project proposal

  Project: Aghia Roumeli, Crete, Greece

  Abstract: A photovoltaic system to be located in a remote village on Crete is proposed in this paper. Aghia Roumeli village with 105 inhabitants is only reachable by sea or by a 5 hour walk through the Samaria park protected area. Due to the protected area, the laying of power lines is prohibited from the island site. Submarine cable power line would require a length of 15 km, which is not economical, so a 50 kW PV array divided into two 25 kW subarrays is proposed. Energy should be stored in 300 V batteries with a capacity of 1,500 Ah and 70% discharge possibility. Consumers should be supplied with a 3 x 220 V, 40 kW inverter connected to a three phase 380 V transformer. The system should function fully automatically without an operator's presence on site. The expected system life-time should be 20 years. Cost estimation and estimated construction time are also given in the paper.

- **AUBERT, Bernard.** 1981. Rural Electrification in French Guyana. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 305–316.

  Keywords: project proposal

  Project: Kaw, French Guyana, French Overseas Department, South America

  Abstract: A photovoltaic system for the remote village Kaw in French Guyana is proposed. This village with 70 inhabitants can be accessed after a two hour drive, so due to the remote location power line construction is not economical. The proposed photovoltaic generator should replace two existing diesel generators that are used for power supply in the village. The proposed photovoltaic array should consist of 528 66 W modules and be divided into 44 strings with 12 modules in each string, connected in series. Energy should be stored in 1,500 Ah batteries. Loads should be supplied by a 40 kW inverter. Estimated cost, general layout, construction details and estimated losses are also presented.

- **AUBERT, Bernard.** 1983. Aghia Roumeli Electricity Supply to an Isolated Village. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 187–201.

  DOI: 10.1007/978-94-009-6342-9_13

  Keywords: project description, battery storage

  Project: Aghia Roumeli, Crete, Greece

  Abstract: Construction details and results after 9 months of operation of the Aghia Roumeli PV system located on Crete are described in this paper. The photovoltaic system supplies homes, shops and hotels, whereas lighting, water pumping, cold stores, refrigerators, and some other domestic appliances are main loads supplied. A technical description of the array support structure, batteries, monitoring, inverters, and protection measures is also presented. The paper includes a computer simulation of the PV system and an evaluation of the environmental impacts. After nine months of operation, the system has supplied 15 MWh of energy to the village, whereas in June 1983 the mean value of the maximum daily demand was 220 kWh.

- **BERTELS, G.** 1981. Photovoltaic Powerplant for Hydrogen Production and Waterpumping. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 418–423.

  Keywords: project proposal, solar hydrogen

  Project: Hoboken, Antwerp, Belgium

  Abstract: An industrial photovoltaic system with a 30 kW roof mounted array located at an industrial facility of a metallurgic plant is proposed in this paper. The system should consist of 912 modules divided into 19 subarrays. The system should supply electrolysers for industrial hydrogen production. Excess energy could also be used for 7.5 kW DC centrifugal pumps supply, which are also used at an industrial facility for 3-bar water pumping. Grid connection should be realised by three-phase 220/380 V AC inverters.

- **BOZZOLO D., O. DALDINI, R. PAMINI, G. SALVADÉ, F. SOLCÀ, C. SPINEDI, F. ZAMBONI, T. CELIO, C. GIOVANNINI and M. CAMANI.** 1982. TISO 15, 15 kW Experimental Photovoltaic Solar Power Plant. In: Fourth E.C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 97–100.

  DOI: 10.1007/978-94-009-7898-0_15

  Keywords: project description

  Project: Technical School Lugano-Trevano, Lugano, Switzerland

  Abstract: This paper describes the experimental line interactive photovoltaic system, TISO 15. The photovoltaic system consists of two parts. The 10 kW array is installed on the roof of the technical school, Scuola Tecnica Superiore in Lugano-Trevano. A smaller part with a 5 kW array with concentrator modules should be installed in 1982. The array of the technical school consists of 288 ARCO Solar 37 Wp modules. The grid is connected to a 10 kW inverter. Measured inverter efficiency was 92%. The main purpose of this research and development driven installation is to evaluate the operation data under different working conditions.

- **BULLWINKEL, Henry J. and Raymond F. HOPKINSON.** 1981. Three-Year Performance Study, of the Mead Nebraska 26-kWp Photovoltaic Power System. In: Proceedings of the Annual Conference of the American Section of International Solar Energy Society, Philadelphia, PA, 26–30 May 1981, 1239–1243.

  Keywords: project description, project evaluation, concentrator

  Project: Mead, Nebraska, USA

  Abstract: In this paper, three years' performance of a photovoltaic power plant in Mead, Nebraska is presented. The system was installed in summer 1977 and has provided 107 MWh in three years of operation with an annual average of about 35,000 kWh. The system consists of two south facing array rows and it also includes two battery banks. Three single phase 7.5 kW inverters are used in the system. Different operating parameters were monitored and the main results are presented and discussed in the paper. Presented are the array output versus time, total array output versus total incident solar radiation, in-service performance record for modules, module failures and factors affecting array output like snow, plants, array washing, etc. The system has provided power for the irrigation requirements of an 80 acre cornfield.

1981 – 1984

- **CEPPI, P., M. CAMANI, G. SALVADÉ and C. SPINEDI.** 1983. Analysis of the First Year of Operation of the Photovoltaic Utility Interactive Plant TISO. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 378–382.

  Keywords: project description, case study

  Project: Technical School Lugano-Trevano, Lugano, Switzerland

  Abstract: The paper gives an overview of the first operation results of the 10.6 kW array which is also known as the TISO1 experimental PV power plant located on the roof of a technical school in Lugano-Trevano. TISO1, the first part of the experimental photovoltaic plant has been operating since May 1982. The plant consists of three arrays of flat plate modules with a peak electrical power of 10.6 kW. To increase energy production in the winter months, the module tilt is 65°. The average daily inverter efficiency was 89%. The system has delivered 7,021 MWh of electricity in time from November 1982 to September 1983. It has operated automatically without any maintenance.

- **CHADJIVASSILIADIS, John.** 1983. Experience with CEC Pilot Plants in Greece and PPC's Perspectives. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 281–288.

  Keywords: project description, case study

  Projects: Aghia Roumeli village, Crete; Kythnos Island, Greece

  Abstract: A brief technical description of the operating photovoltaic systems in Greece, Aghia Roumeli on Crete and Kythnos Island are presented in this paper. More attention is placed on the project experiences and the preliminary results of operation. Some potential improvements for further projects are proposed. The plant operating data and daily load profiles are also part of the paper. The paper also includes a short part about the possibility of the realisation of island located PV systems together with wind generators.

- **COUREAU, Patrice.** 1981. Nice Airport Survey and Control System. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 331–342.

  Keywords: project proposal

  Project: Nice Cote d'Azur Airport, Nice, France

  Abstract: In this paper, a project proposal for a 50 kW roof mounted photovoltaic system on a freight building in Nice Cote d'Azur Airport is described. The system should supply equipment for traffic control in the air as well as equipment for monitoring the ways inside the airport. The solar array should consist of 76 strings with ten 66 W modules each. Energy should be stored in batteries with a capacity of 1,500 Ah. To assure a stable power supply, a 5 kW inverter is also part of the proposed system, which should supply on average about 88% of the annual demand for the navigational equipment power supply. Mounting structures, monitoring equipment, and detailed schematics are also given in the paper.

- **COUREAU, Patrice.** 1981. Power supply for TV and FM Emitters - Mont Bouquet. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 317–330.

  Keywords: project proposal, telecommunication

  Project: Telediffusion de France, Mont Bouquet, Alès, France

  Abstract: This paper describes the photovoltaic system installed on the roof of the freight building of Nice Cote d'Azur Airport to power navigational equipment for air traffic control. The solar array consists of 710 modules, connected into 72 strings. The array should supply about 48 MWh annually, and considering the system losses annually, the available net energy should be 38 MWh. Energy is stored in 106 battery cells with a cumulative capacity of 1500 Ah. The total average load of the equipment supplied by the photovoltaic system is 6kW. Other parts of the system like the batteries, inverters, charger, and lightning protection are also described. A single phase 5 kW inverter and a 7 kW 3-phase charger with 380 V input voltage are also part of the system. Civil works and related issues due to the roof-mounted system are also discussed in the paper.

- **COUREAU, Patrice.** 1983. Nice Airport Survey and Control. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/ Pellworm, 12–13 July 1983, 138–152.

  DOI: 10.1007/978-94-009-6342-9_10

  Keywords: project description, telecommunication

  Project: Nice Cote d'Azur Airport, NIce, France

  Abstract: Paper describes photovoltaic system installed on the roof of freight building of Nice Cote d'Azur Airport to power navigational equipment for air traffic control. Solar array consist of 710 modules, connected into 72 strings. Array should supply about 48 MWh annually, considering system losses annually available net energy should be 38 MWh. Energy is stored in 106 battery cells with cumulative capacity of 1500 Ah. Total average load of the equipment supplied by photovoltaic system is 6kW. Other parts of the system like batteries, inverters, charger, and lightning protection is described as well. Single phase 5 kW inverter and 7 kW 3-phase charger with 380 V input voltage are also part of the system. Civil works and related issues due to roof-mounted system are also discussed in the paper.

- **COUREAU, Patrice.** 1983. Power Supply for TV and FM Emitters. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/ Pellworm, 12–13 July 1983, 117–137.

  DOI: 10.1007/978-94-009-6342-9_9

  Keywords: project description, telecommunication

  Project: Telediffusion de France, Mont Bouquet, Alès, France

  Abstract: A detailed description of a 50 kW Mont Bouquet experimental photovoltaic project to power FM and TV emitters of Telediffusion de France (TDF), located on a remote mountain near Alès, France, is given in this paper. A detailed analysis of the load profile and power demand is also presented. The system also includes an 800 Ah battery bank and a 30 kW three-phase inverter. Other parts of the system like the charge regulator, system monitoring, data acquisition system and protection system are also described in the paper. Civil works and assembly are also described in detail. A summary of the economic terms is also part of the paper.

- **DANIELS, R. E., Daniel J. ROSEN and B. DILTS.** 1984. Unique Design Feature of the SMUDPV1 1 MWac Photovoltaic Central Station Powerplant. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Orlando, FL, 1–4 May 1984, 1276–1281.

  Keywords: project description

  Project: SMUDPV1, Rancho Seco 1, California, USA

  Abstract: In this paper, the photovoltaic system SMUDPV1 under construction and scheduled for grid connection in July 1984 is described. A detailed description of the arrays, tracking mechanisms, inverters, and balance of system is given. A wiring diagram of the array subfield is presented in detail. The system cost and cost structure is also presented and discussed. The predicted performance for different tracking arrays for the period from May to October are presented and discussed too.

- **FONZI, Fulvio.** 1981. Tremiti desalination plant. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 276–291.

  Keywords: project proposal, water treatment

  Project: San Nicola Island, Tremiti Islands, Italy

  Abstract: A proposal of a photovoltaic system to supply a sea water desalination facility to supply drinking water for San Nicola Island, Tremiti Islands, Italy is presented in this paper. A solar array with 65 kWp should supply a desalination plant using reverse osmosis processes with a capacity of 30 m^3 water daily in continuous 24 hour operation. The facility consists of three parts with a power range of 0 to 17 kW. Different pumps/motors operate on demand and are powered by power conditioners with single phase or three-phase output. Energy should be stored in batteries with 2,000 Ah at discharge within 10 hours or 2,700 Ah at discharge within 48 hours. A detailed evaluation of the support structure including costs is given in the paper.

- **FONZI, Fulvio, Mario CARLEVARO, Claudio PELINO and Antonio PONTICELLO.** 1983. Tremiti Desalination Plant. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/ Pellworm, 12–13 July 1983, 75–91.

  DOI: 10.1007/978-94-009-6342-9_6

  Keywords: project description, water treatment

  Project: San Nicola Island, Tremiti Islands, Italy

  Abstract: A photovoltaic system to supply a reverse osmosis sea water desalination plant on San Nicola Island, Tremiti Islands, Italy is described in this paper. At the time of presentation the system was in the planning and constructing stage. Two different module types are proposed. The modules should be connected into strings with 160 V DC voltage which is converted by power conditioners to 250 V DC bus voltage. The main loads are eight three-phase motors in power ranging from 1.5 to 5.5 kW, whereas the desalination facility consists of two parts that can operate independently. The array support structure, designed according to Italian seismic regulations, monitoring and data acquisition system are also described in detail.

- **FORRESTER, Donald L.** 1984. Qualification Testing for a Central Station. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1019–1024.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: In this paper, the qualification tests and test procedures performed at Lugo photovoltaic power plant are described. The qualification tests include individual trackers, DC switchgear, AC components, power conversion units, tracker control, data acquisition systems and system level operations/control. The qualification tests include control wiring, ground fault detection, tracking limit switches, voltage measurements, verification of proper phasing, etc. Simplified wiring diagrams and block diagrams of the power plants are also given.

- **FUENTES, M. K. and J. P. FERNANDEZ.** 1984. Performance Evaluation of Large-Scale Photovoltaic Systems. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1060–1065.

  Keywords: project evaluation

  Projects: Sky Harbor Airport, Phoenix, Arizona; Dallas Forth-Worth Airport, Dallas, TX; Oklahoma Center for Sciences and Arts, Oklahoma City, OK; Lovington Square Shopping Center, Lovington, NM; Beverly High School, Beverly, MA; Newman Power Station, El Paso, TX, USA

  Abstract: In this paper, the methodology for the performance evaluation of large scale photovoltaic systems is presented. Based on the array and power conditioning subsystem, the equations results are calculated using regression analysis. For six large-scale photovoltaic power plants, the results are presented in a table. The array power and power conditioning subsystem data have been analysed from the following power plants: Sky Harbor Airport, Dallas-Fort Worth Airport, Newman Power Station, Lovington Shopping Centre, Beverly High School, and the Oklahoma Centre for Science and Arts.

- **FUNK, Joachim.** 1981. Vester Bøgebjerg Photovoltaic Power Plant. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 202–215.

  Keywords: project proposal

  Project: Vester Bøgebjerg Village, Denmark

1981 – 1984

Abstract: A photovoltaic system for the Vester Bøgebjerg village in Denmark, about 100 km from Copenhagen is proposed in this paper. The main scope of the project is the possibility of island operation independent of other generators in the grid. The solar array should consist of 800 modules with a string voltage of 160 V. The system should include three 50 kW three-phase inverters and DC/DC converters for battery charging. Some other data like environmental protection and power demand is also discussed in this proposal.

- **GARNER, I. F.** 1983. Photovoltaic Application Activities in the Netherlands: National and International Projects. In: Fifth E. C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 393–397.

  Keywords: programme overview, project description

  Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

  Abstract: This paper presents the technical description and first operating experience of the photovoltaic system on Terschelling Island, the Netherlands. The system consists of 50 kWp flat-plate photovoltaic arrays with one 1.7 kWp and 29 2.6 kWp direct DC coupled subarrays. The system also includes a 40 kW wind generator, two 360 V battery banks with 500 Ah battery storage, an energy management system and 50 kVA, three-phase 380/220 V self-commutating inverters. The paper also describes the experiences of PV systems in Africa.

- **GAY, Charles F., J. W. YERKES and J. H. WILSON.** 1982. Performance Advantages of Two-Axis Tracking for Large Flat-Plate Photovoltaic Energy Systems. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 1368–1371.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: Plans for the Lugo photovoltaic power plant were announced in April 1982. In the paper, the performance estimation for Lugo power plant is given and the performance comparison for the fixed and tracking arrays is presented and discussed. The system size comparison for the fixed and tracking arrays is also presented. Field experiment data from West San Fernando Valley for the fixed and tracking arrays is also presented and discussed.

- **GERMANO, Giovanni.** 1981. Pump Station for Fresh Water Supply - Zambelli (Verona). In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 261–275.

  Keywords: project proposal, water treatment

  Project: Zambelli, Verona, Italy

  Abstract: A photovoltaic power plant for industrial purposes in Zambelli, close to Verona is proposed in this paper. The PV power plant with a 70 kWp array with 230 V DC rated voltage, should be used as a power supply for Zambelli drinking water station. The array consists of 1,104 modules and total array losses are estimated at < 6%. The main load should be three pumps with 35 kW asynchronous motors. The inverter is composed of five modules with 13.5 kW each. Battery storage of 90 Ah, 300 V is also part of the proposed system. Details about the module mounting, control and monitoring system and electrical schematics are also given in the paper.

- **GERMANO, Giovanni.** 1981. Water Disinfection System and Cold Store - Giglio Island. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 386–399.

  Keywords: project proposal, water treatment

  Project: Fosso di Valle, Ortona, Giglio Islands, Tyrrhenian Sea, Italy

  Abstract: A proposal for an industrial photovoltaic project for a water disinfection system and cold store power supply is presented in this paper. The proposed project should be located on Giglio Island in Italy. A 15 kW array should be used for the water disinfection system based on an ozoniser and the remaining 30 kW for powering the cold store loads like a condenser fan and field coil of the compressor motor. For the water disinfection system, an array voltage of 465 V and for the cold store 265 V are planned. Detailed electrical schematics of the water disinfection plant and cold store system are also presented.

- **GREEN, Martin A., M. R. WILLISON and Andrew W. BLAKERS.** 1983. Survey of Large Photovoltaic Systems in the Megawatt to Multi-Megawatt Range. In: Solar World Congress: Proceedings of the 8th Biennial Congress of the International Solar Energy Society, Perth, Australia, 14–19 August 1983, 3, 1629–1632.

  Keywords: project overview

  Projects: Lugo, Hesperia, California; Carissa Plains, California; Phoenix Sky Harbor International Airport, Phoenix, Arizona, USA; Saijo city, Japan; Pellworm Island, North Frisian Islands, Germany; villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: In this paper, a brief description of some MW ranged photovoltaic power plants worldwide is given.

- **GUPTA, Y.** 1981. Photovoltaic Power System for the Oklahoma Center for Science and Arts. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1464–1468.

  Keywords: project description

  Project: Oklahoma Center for Science and Arts, Oklahoma City, Oklahoma, USA

  Abstract: The main features of a 150 kWp photovoltaic system being installed at the Oklahoma Centre for Sciences and Arts in Oklahoma City are presented in this paper. The system should have a peak output power of 150 kWp at 480 V and a three-phase grid connection through inverter and transformer. The array's open circuit voltage should be slightly below 600 V. An artist's rendering of the system is also given in the paper. Some important construction related issues are also discussed in the paper, like roof penetrations, hail risk estimation, etc. The cost estimation of the system is also given. Relative shares of different cost impact factors are presented: solar array, array wiring, construction works, design and engineering, power conditioning and miscellaneous materials.

- **HESSE, John L.** 1981. Photovoltaic Systems Overview. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1139–1145.

  Keywords: project description, project overview

  Projects: Mead, NE; Mt. Laguna Air Force Station, CA; Natural Bridges National Monument, UT; Dallas-Fort Worth Airport, Dallas, TX; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Wilcox Memorial Hospital, Kauai, HI; Oklahoma Center for Science and Arts, Oklahoma City, OK; Beverly High School, Beverly, MA, USA

  Abstract: In this paper, an overview of residential and intermediate sized photovoltaic power plants is given. The system overview is presented as a table where important data like construction start, commissioning, array construction, inverter data, utility, etc. is given. Some important lessons learned are also given in the conclusion of the paper.

- **HUGHES, D. J., B. W. HELLER and J. E. STEPHENSON.** 1982. Detailed Conceptual Designs and Economic Analyses of a Reference Photovoltaic Central Power Station. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 1, 276–280.

  Keywords: preliminary study

  Abstract: The detailed conceptual design and economic analysis of a large-scale 100 MW Photovoltaic Central Power Station are presented in this paper. The paper discusses key design requirements, different power plant designs and related performance. The detailed electrical schematics and balance of system requirements are given. The area required for the power plant is estimated at 20.2 hectares for flat plate and 29.6 hectares for concentrator arrays. The rough cost and economic analysis is also given. The cost estimation for a flat plate array is in the range of USD 179 million to USD 483 million and from USD 201 million to USD 505 million for a concentrator PV CPS, both of which are given in 1982 U.S. dollars.

- **HURAIB, Fahad, Bakr KHOSAIM, Ahmed Al-SANI, Matthew S. IMAMURA and Abbas A. SALIM.** 1982. Design, Installation and Initial Performance of 350-kW Photovoltaic Power System for Saudi Arabian Villages. In: Fourth E. C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 57–66.

  DOI: 10.1007/978-94-009-7898-0_9

  Keywords: project description, case study, battery storage, hybrid, diesel generators

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: In this paper, a photovoltaic project located 45 km northwest of Riyadh, commissioned in August 1981 is described. The system consists of a 350 kW concentrator array, a 300 kW inverter, 480 battery cells with a capacity of 1,700 Ah, and four 250 kW diesel generators. The system also includes a 13.5 kV transformer and data acquisition system. The array is a point focusing concentrator array with an acrylic Fresnel lens with a geometric concentration ratio = 40. The design and construction details and system performance are also presented. The system performance is given and evaluated for some months in 1981 and 1982. The main purpose of the system is to evaluate the dispersed power generator in remote areas with no utility transmission system.

- **JONES, Gary J.** 1982. Central-Station Applications, System and Subsystem Research Activities. In: Flat Plate Solar Array Project: Proceedings of the 20th Project Integration Meeting, NASA-CR-169370, Pasadena, CA, 21–22 April 1981, 105–111.

  Keywords: preliminary study

  Abstract: This paper presents a brief summary of research activities related to large-scale photovoltaic systems. It includes an overview of reports related to array field engineering, design trade-offs, and detailed preparation, central station reference design and utility impact/value determination.

- **KAPLAN, S.** 1982. Startup experience with a concentrating photovoltaic power system. In: American Institute of Aeronautics and Astronautics, 20th Aerorpace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0068.

  DOI: 10.2514/6.1982-68

  Keywords: project description

  Project: Mississippi County Community College, Blytheville, Arkansas, USA

  Abstract: In this paper, the startup testing of the Mississippi County Community College photovoltaic system in Blytheville, Arkansas is described. A description of the system is given in the paper. Problems detected during the startup period and testing are described and measures for their solutions are proposed and discussed.

- **KAUFMANN, W. R.** 1983. Commercial Application of a Photovoltaic Concentrator System (CAPVC). In: Fifth E. C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 268–272.

  Keywords: project description

  Project: BDM Office Building, Albuquerque, NM, USA

  Abstract: The system on the roof of the BDM Corporation facilities building was commissioned in July 1982. The project, which is known as the Commercial Application of a Photovoltaic Concentrator (CAPVC) has a 50 kW solar concentrator array and a single axis linear parabolic trough with mono crystalline silicon photovoltaic cells with a concentration ratio of 60. The short system description including the inverters and data acquisition system including the operating data of the power plant for part of the year 1983 is also given in the paper.

- **KAUFMANN, W. R.** 1983. McClellan PV System Provides Key Lessons. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 373–377.

  Keywords: project description

  Project: McClellan Air Force Base, CA, USA

  Abstract: The photovoltaic system located in the grounds of McClellan Air Force Base in California is presented in this paper. The purpose of the line-interactive photovoltaic system is to power loads into the minimarket within the air base. Excess power is fed into the grid. A solar array with 40 kW power that consists of Arco solar modules with a fixed tilt is connected to a 45 kW inverter. The system also includes a monitoring and data acquisition system including a pyranometer for solar radiation measurements. The paper estimates an annual solar yield of about 57 MWh.

- **KAUFMANN, W. R., Timothy J. LAMBARSKI and Donald L. FORRESTER.** 1983. Design and Construction Experience from Photovoltaic Installation. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 309–313.

  Keywords: project description, project overview

  Projects: Lugo, Hesperia, CA; BDM Office Building, Albuquerque, NM; Mississippi County Community College, Blytheville, AR; McClellan Air Force Base, CA, USA

  Abstract: This paper presents the experiences and photovoltaic project portfolio of BDM Corporation. It includes short presentations, descriptions and images of photovoltaic systems realised by BDM. The paper includes brief descriptions of the ARCO two axis tracking 1 MW central power station in Lugo, California, the Mississippi County Community College, a 240 kW hybrid photovoltaic/thermal power system for the college campus, a 50 kW roof-mounted commercial application hybrid photovoltaic/thermal system installed on the BDM office building in Albuquerque, NM, McClellan Air Force Base Mini-Mart System, a 40 kW ground mounted flat plate system for a small market in the housing area, a 4.7 kW roof-mounted flat plate residential prototype power system and 1 kW roof-mounted flat plate testing system for the Taiwanese ERL, located in Taiwan.

- **KHOSHAIM, Bakr, Fahad HURAIB, Ahmed AL-SANI and Abbas A. SALIM.** 1983. Eighteen-Month Performance of 350 kW PVPS for Saudi Arabian Villages. In: Proceedings of 18th International Energy Conversion Engineering Conference, IECEC, Orlando FL, August 1278–1283.

  Keywords: project description, case study, project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: This paper summarises the operating experiences and problems of the 350 kW concentrator Solar Village project close to Riyadh in Saudi Arabia after 18 months of operation. In the paper, detailed operating data and the system performance are presented and discussed.

- **KHOSHAIM, Bakr, Fahad HURAIB, Ahmed AL-SANI and Abbas A. SALIM.** 1984. Performance of 350 kW concentrating photovoltaic power system after two years. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 207–214.

  Keywords: project description, case study, project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: This paper summarises the operating experiences and problems related to a 350 kW concentrator array in Saudi Arabia. Issues reported in this paper include performance degradation due to dust accumulation on the modules, shorts and open circuit within the modules, reason solder void due to overheating and array washing time evaluation.

- **KHOSHAIM, Bakr, Fahad HURAIB, Ahmed AL-SANI, Abbas A. SALIM and Matthew S. IMAMURA.** 1984. Performance of 350 kW Photovoltaic Power System for Saudi Arabian Villages After 30 Months. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1426–1432.

  Keywords: project description, case study, project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: In this paper, the operating experiences of the photovoltaic concentrator Solar Village project after two and a half years of operation are presented. A simplified block diagram of the power plant is presented. The photovoltaic array performance is also evaluated and discussed in the paper. The number of PV field component failures from January 1982 to April 1984 is presented in a table and includes the following categories: array tracking electronics, solar cell/module, azimuth drive assembly electrical/mechanical and field junction box. The main problems during operation were separations of the module solder bonds; otherwise the system operates reliably with few unexpected events.

- **LEONARD, Stanley L.** 1982. PV Large Systems Project. In: Flat Plate Solar Array Project: Proceedings of the 20th Project Integration Meeting, NASA-CR-169370, Pasadena, CA, 21–22 April 1981, 111–120.

  Keywords: economics, cost

  Project: Lugo, Hesperia and Rancho Seco, California, USA

  Abstract: A brief economic presentation of the photovoltaic power plants is given in this paper. The presentation also discusses the detailed investment evaluation.

1981 – 1984

- **LEPLEY, Thomas C. and W. J. McGUIRK.** 1984. First-Year Operation of the Phoenix Sky Harbor Solar Photovoltaic Concentrator Project. In: Proceedings of the American Solar Energy Society Annual Meeting 1984, Anaheim, CA, 5–7 June 1984, 877–880.

  Keywords: project description, case study, project evaluation, concentrator

  Project: Phoenix Sky Harbor International Airport, Phoenix Arizona, USA

  Abstract: The Phoenix Sky Harbour International Airport photovoltaic concentrator system, located in Phoenix Arizona was commissioned in April 1982. The system consists of 80 passively cooled tracking concentrator arrays with 225 kW array power capacity. The concentrator design is similar to that used for the 350 kW Saudi Arabian Village project. The system is connected to a 12.5 kV grid trough 250 kW inverter. In the paper, the first year operating experience is presented and discussed. The main problems in the first year of operation were failures of the array tracking mechanism, inverter problems, and problems related to the data acquisition system.

- **McGUIRK, W. J.** 1982. Solar Photovoltaic Concentrator Project at Sky Harbor Airport. In: Progress in Solar Energy, 1613–1618.

  Keywords: project description, concentrator

  Project: Phoenix Sky Harbor International Airport, Phoenix Arizona, USA

  Abstract: The Phoenix Sky Harbour International Airport photovoltaic concentrator system and its historical development is described in this paper. The start of the engineering activities was in June 1981 and the system was completed in May 1982. The system consists of 32 strings with 7.05 kW each which results in 225 kW overall power capacity. Photographs of the arrays are also included. The construction details of the photovoltaic concentrators and heat exchangers are also given in the paper. The investment cost for the system was USD 4 million.

- **LOWALT, Hans-Jürgen.** 1981. 300 kW Photovoltaic Pilot Plant Pellworm. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 179–201.

  Keywords: project proposal

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: The proposed photovoltaic pilot project Pellworm for the supply of a recreation centre on the island Pellworm, is described in this paper. The solar array mounted on difficult ground should have 300 kWp power capacity. The recreation centre should be connected by 20 kV/50 Hz underground cable 2.5 km in length. For array mounting structures hot galvanised steel and bongossi wood are proposed due to the harsh environment. The solar array should be divided into 20 subarrays of 15 kW each. The system should also include energy battery storage with two units, each with capacity of 4,000 Ah. Energy conversion will be done with a one line-commutated inverter, for the utility board supply and with two self-commutated inverters.

- **LOWALT, Hans-Jürgen, Hartmut GREEN, Bernd PROETEL and Peter THOEL.** 1983. 300 kW Photovoltaic Plant Pellworm - Power Supply for Recreation Centre. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 30–54.

  DOI: 10.1007/978-94-009-6342-9_4

  Keywords: project description

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: The photovoltaic project on Pellworm Island is described in this paper. The solar array consists of 7,568 modules with rated voltage of 348 V and 300 kW power capacity. For supply of the recreation centre two 75 kW inverters are used. A detailed description of the power conditioners, energy storage, monitoring and protection systems is also given in the paper.

- **MACOMBER, Harold L.** 1983. Status of U.S. Large PV Systems Applications. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 6–22.

  DOI: 10.1007/978-94-009-6342-9_2

  Keywords: project overview

  Projects: Mead, NE; Mt. Laguna Air Force Station, Mt. Laguna, CA; Newman Power Station, El Paso, TX; Bryan, OH; Natural Bridges National Monument, UT; Beverly High School, Beverly, MA; Lovington Square Shopping Center, Lovington, NM; Mississippi County Community College, Blytheville, AR; Wilcox Memorial Hospital, Kauai, HI; Light MFG Facility, San Bernardino, CA; Oklahoma Center for Science and Arts, Oklahoma City, OK; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Dallas-Fort Worth Airport, Dallas, TX; BDM Office Building, Albuquerque, NM; Solarex, Frederic, MD; Epcot Center, Walt Disney World, Orlando, FL; Lugo, Hesperia, CA, USA

  Abstract: This report presents intermediate size (15 kW – 1,000 kW) photovoltaic systems already installed or that have been planned for installation in the USA. The photovoltaic system for agricultural application in Mead, NE has been utilised for the irrigation system of 80 acres of cornfields, a natural-air grain drying system and an electric-arc process for producing nitrogen fertiliser. Mont Laguna radar station's PV system has a 60 kW array which supplies about 10% of the required energy, while the other required energy is generated by diesel generators. The system in Bryan, OH, commissioned in 1979 supplies Bryan, Ohio WBNO radio station. The 100 kW Natural Bridges photovoltaic system is located in Natural Bridges National Monument. The system in El Paso, TX supplies the UPS of Newman Utility Substation, the 100 kWp system provides power to the Beverly High School in Beverly, MA and the 100 kW system in Lovington, NM, provides about 8% of the annual energy requirements of the Lovington Square Shopping Centre, etc.

- **MACOMBER, Harold L. and W. F. HUFNAGEL.** 1983. A Stand-Alone Photovoltaic Powered Industrial Facility. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 362–366.

Keywords: project description, case study

Project: Solarex, Frederick, Maryland, USA

Abstract: The photovoltaic system on the site of the Solarex facility in Frederic, MD is presented in this paper. It consists of a 200 kWp array, a 300 kW DC/DC converter, two 20 kVA generators and one 10 kW inverter and 8 DC/DC converters. The modules are mounted on the south facing plane with a tilt of 40°. Battery storage with four strings, each including 120 battery cells with a capacity of 3,000 Ah, is also part of the system. A brief description and first experiences during the system construction and operation phase are also given.

- **MAGID, Leonard M.** 1983. U.S. Photovoltaic System Experience Prospects for Large Power Plants. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 437–444.

Keywords: project overview, economics, cost

Projects: Mead, NE; Mt. Laguna Air Force Station, Mt. Laguna, CA; Newman Power Station, El Paso, TX; Natural Bridges National Monument, UT; Beverly High School, Beverly, MA; Lovington Square Shopping Center, Lovington, NM; Mississippi County Community College, Blytheville, AR; Wilcox Memorial Hospital, Kauai, HI; Light MFG Facility, San Bernardino, CA; Oklahoma Center for Science and Arts, Oklahoma City, OK; Phoenix Sky Harbor International Airport, Phoenix, Arizona; Dallas-Fort Worth Airport, Dallas, TX; BDM Office Building, Albuquerque, NM; Solarex, Frederic, MD; Epcot Center, Walt Disney World, Orlando, FL; Lugo, Hesperia, CA, USA

Abstract: Different economic aspects of the USA terrestrial photovoltaic programme are described in this paper. Cost per Wp for the most important projects and cost per Wp for the solar array and balance of the system is also presented in the paper. The average cost of engineering, construction and management, civil work and related activities and power conditioning including monitoring systems is also presented.

- **MARCHESE, F. J. and Richard R. ADDISS Jr.** 1981. Design and Start-up Performance of a 100 kW Utility Interconnected Flat Panel Photovoltaic System for the Beverly High School, Beverly, MA. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1469–1471.

Keywords: project description, case study

Project: Beverly High School, Beverly, Massachusetts, USA

Abstract: In this paper, a description of the Beverly High School photovoltaic system in Beverly, MA is given. An array with a total of 3,200 modules consists of two subarrays, each of them connected to their own inverter. The system was officially commissioned on April 13th, 1981. The initial checkout test included the subarray switch test, bypass diode tests, etc. The main problems during the system's initial check include wrong fuses used, arcing at DC switch, etc. The inverter's initial check included maximum power point, ground fault detection, utility outage disconnect check, etc. The system's performance for one day in April 1981 is also presented in the paper.

- **MARCHESE, F. J. and Richard R. ADDISS Jr.** 1982. Module Interaction Losses in a 100 kW Utility Interactive Array. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 1350–1354.

Keywords: project description, project evaluation

Project: Beverly High School, Beverly, Massachusetts, USA

Abstract: The Beverly High School photovoltaic system in Beverly, MA was commissioned in April 1981. The power plant consists of two 50 kW arrays, each with its own inverter. Each array is composed of 20 subfields. Each subfield consists of 80 modules, connected 16 in series and 5 series wired in parallel. In the paper test, the methods and results of the estimation of the losses are presented and discussed. The test results include the total module mismatch loss, subarray mismatch loss and the effects of modules in parallel. Details of the electrical wiring and graphical test results are also presented.

- **MARSHALL, Neil.** 1984. Georgetown University Photovoltaic Higher Education National Exemplar Facility (PHENEF). JPL Proceedings of the 24th Project Integration Meeting (SEE N85-32394 21-44), 87–98.

URL: http://ntrs.nasa.gov/search.jsp?R=19850024087 (6 February 2016)

Keywords: project description

Project: Georgetown University, Washington DC, USA

Abstract: In this paper, the Georgetown University photovoltaic project is briefly described and many photos of the system under construction are presented.

- **MERCIER, Dominique.** 1981. Revitalisation d'un village Corse - Paomia - Rondulinu. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 400–417.

Keywords: project proposal

Project: Rondulinu, Paomia, Corsica, France

Abstract: A photovoltaic project for the hamlet Rondulinu in the Paomia area in Corsica, France is proposed. The main purpose of the project is to supply three-phase 380 V voltage to the local grid, to supply seven family houses in winter and sixteen family houses in summer, street lighting, a ewe dairy, a small cottage-industry workshop to be installed, and a community meeting room for the village. Energy should be generated by a 44 kWp solar array and converted by a 50 kW inverter. Energy should be stored in 3,000 Ah battery storage, which has enough capacity to store ten days' of winter energy production and four days' of summer energy production.

1981 – 1984

- **MERCIER, Dominique.** 1983. Solar Plant for a Remote Corsican Village. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 230–254.

DOI: 10.1007/978-94-009-6342-9_15

Keywords: project description

Project: Rondulinu, Paomia, Corsica, France

Abstract: This paper discusses a detailed description of the photovoltaic system realised in Rondulinu hamlet in the Paomia area of Corsica, France and put into service on June 30th, 1983. Different details of the construction, protection systems, power conditioners and loads are presented. The solar array consists of 36 Wp modules. Batteries with a capacity of 2,500 Ah are charged by charge regulators with a 350 A rated current and 168 V voltage. Energy is fed into the local grid by a 50 kVA three-phase inverter with efficiency ranging from 88% to 93%. The 25 kVA gas generator charges batteries in days with low solar radiation. Images of the site and electrical schematics are also part of the paper.

- **NAKATA, Y., T. KOBE, N. SHIBUYA, T. MACHIDA, T. TAKEMOTO and T. TSUJI.** 1982. A 30 kW Concentrating Photovoltaic/Thermal Hybrid System Application. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 993–998.

Keywords: project description, concentrator, hybrid, thermal

Project: Hiroshima, Japan

Abstract: In this paper, a technical description of the proposed 30 kW concentrator PV hybrid system under construction in Hiroshima, with commissioning scheduled for March 1983, is given. The proposed system should have 5 kWp of electrical power and 25 kW thermal power capacity. Estimated daily power consumption of the two axis tracking mechanism is about 250 Wh. A detailed technical description of the two axis tracking system, Fresnel lens and concentrator solar cell is given in the paper. The proposed system is the first photovoltaic concentrator thermal hybrid system for practical application in Japan.

- **NOEL, G. T., D. C. CARMICHAEL and G. ALEXANDER.** 1984. Installation, Cost and Performance Testing of a 30 kW Photovoltaic Array Field Based on a Low Cost Modular Design. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 865–871.

Keywords: project description

Project: Battelle's power plant, Columbus, OH, USA

Abstract: In this paper, Battelle's test facility located at Sandia National Test Facility in Columbus, Ohio is described. The power plant was commissioned in January 1985. A brief experience of the first year of operation is described in the paper. Several images about the construction and wiring details are also presented and some economic details and cost projections are also discussed.

- **O'NEILL, Mark J. and David B. MUZZY.** 1984. First-Year Operational Results for the Dallas-Fort Worth Airport Linear Fresnel Lens Photovoltaic/Photothermal System. In: Proceedings of the American Solar Energy Society Annual Meeting 1984, Anaheim, CA, 5–7 June 1984, 865–876.

Keywords: project description, case study, project evaluation, concentrator

Project: Dallas-Forth Worth Airport, Dallas Texas, USA

Abstract: The Dallas-Forth Worth Airport photovoltaic concentrator system was commissioned on 21st June 1982. In this paper, the operating experience in the first six months of operation is presented and discussed. The system performance for different parts of the system is presented for the time frame from September 1982 to March 1983. A detailed system daily performance is also given for each month. A comparison between the measured and predicted system total output performance is also presented in the paper.

- **PALZ, Wolfgang.** 1983. Overview of the European Community's Photovoltaic Pilot Programme. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 2–5.

DOI: 10.1007/978-94-009-6342-9_1

Keywords: programme overview

Abstract: In 1980, the European Commission launched a call for tenders for photovoltaic pilot projects in the range of 30 to 300 kW. A short description of the programme and a list of eleven projects completed by June 1983 is given in the form of a table.

- **POLGAR, S.** 1983. Solar Energy for Broadcasting Equipment. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 445–449.

Keywords: project description, telecommunication

Project: Telediffusion de France, Mont Bouquet, Alès, France

Abstract: A brief description of the photovoltaic project for the Mont Bouquet site owned by Telediffusion de France (TDF) is presented. Some technical details of the 50 kW PV system and system cost are also presented. Some other aspects and experiences of TDF with photovoltaics are discussed too.

- **POWELL, R. V.** 1982. Sacramento Municipal Utility District 100-MWe Photovoltaic Plant. In: Flat Plate Solar Array Project: Proceedings of the 20th Project Integration Meeting, NASA-CR-169370, Pasadena, CA, 21–22 April 1981, 123–124.

URL: https://ntrs.nasa.gov/search.jsp?R=19830002243&terms=powell+sacramento+municipal+utility+district&qs=N%3D0%26Ntk%3DAll%26Ntt%3Dpowell%2520sacramento%2520municipal%252outility%2520district%26Ntx%3Dmode%2520matchallpartial (16 April 2017)

Keywords: preliminary study, economics, cost

Abstract: A brief proposal for the 100 MW photovoltaic power plant located at Rancho Seco's site in California is presented in this paper. The project should be constructed in 10 phases with a 1 MW power plant in the initial phase of the project.

- **RAFINEJAD, D. and R. SPENCER.** 1982. Design and construction of a concentrating photovoltaic total energy system in Hawaii. In: American Institute of Aeronautics and Astronautics, 20th Aerospace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0069.

  DOI: 10.2514/6.1982-69

  Keywords: project description, case study

  Project: Wilcox Memorial Hospital, Kauai, Hawaii, USA

  Abstract: A description of the recently commissioned Wilcox Memorial Hospital photovoltaic system is given in this paper. This actively cooled photovoltaic array consists of parabolic linear focus concentrators with a total area of about 445 m². The system generates 35 kW DC power at 1000 W/m². The system also consists of a thermal subsystem. Images of the system are also presented in the paper.

- **REAL, Markus.** 1982. The Behaviour of Large Solar Power Station in the Swiss Alps. In: Fourth E.C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 51–56.

  DOI: 10.1007/978-94-009-7898-0_8

  Keywords: project evaluation

  Project: Davos, Switzerland

  Abstract: Experiences with a small photovoltaic system located at an altitude of 2,600 m above sea level in the Swiss Alps are discussed. The solar array consists of 18 modules with 34 W each, which are mounted with a tilt of 60° to improve solar yield. The solar array mounted in three rows with 4 m distance and 15 m width also includes dummy modules which are intended to study environmental impacts on the solar array in high altitudes. The PV system is monitored by a data acquisition system.

- **RESNIK, W. M. and Timothy J. LAMBARSKI.** 1983. Data Acquisition System for the ARCO 1 MW photovoltaic power facility. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 682–686.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: This paper discusses the data acquisition system (DAS) for Lugo 1 MW photovoltaic power plant in Hesperia, CA, USA, that has been in operation since January 1983. The main parts of the data acquisition system at the Lugo facility are the Hewlett-Packard HP-9826 desktop microcomputer which controls all system data acquisition and Burr-Brown MCS-100 which monitors and reports sensor data to the HP-9826. The data acquisition system collects and stores data from 186 different sensors. Complete weather station and remote reporting capability are also features of the discussed data acquisition system.

- **RHODES, George W. and M. R. REILLY.** 1983. The ARCO 1 Megawatt Photovoltaic Power Plant. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 321–324.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: A brief system description of the 1 MW Lugo photovoltaic power plant is presented and some images of the system are also part of this paper. The PV power plant occupies a 20 acre site adjacent to the Southern California Edison Lugo substation. The entire design and construction process took seven and a half months and was completed on schedule and also below the planned budget. The system consists of 180 two-axis trackers each containing 256 modules. Each tracker array produces about 10 kWp power capacity. Voltage is transformed from three-phase 480 V to 12 kV and fed into the grid.

- **RHODES, George W.** 1984. The ARCO 1 Megawatt Photovoltaic Power Plant. In: Proceedings of the American Solar Energy Society Annual Meeting 1984, Anaheim, CA, 5–7 June 1984, 815.

  Keywords: project description

  Project: Lugo, Hesperia, California, USA

  Abstract: A very short description of the Lugo Photovoltaic power plant is presented in this paper.

- **RISSER, Vernon Vilas and Steve DURAND.** 1982. The El Paso Electric 20-kilowatt Photovoltaic System. In: American Institute of Aeronautics and Astronautics, 20th Aerospace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0064.

  DOI: 10.2514/6.1982-64

  Keywords: project description, case study

  Project: Newman Power Station, El Paso, Texas, USA

  Abstract: In this paper, a description of the Newman Power Station in El Paso, Texas is given. The system is part of El Paso Electrics' Newman Power Station uninterruptible power supply system. It consists of 64 panels, and each panel includes 9 flat-plate modules. Modules with an area of 279 m² are tilted with a tilt of 26° off horizontal. The output of the power plant is supplied to the UPS DC grid with 134 V voltage. Operational results in the first year of operation are also given in this paper.

- **RISSER, Vernon Vilas and Paul HUTCHINSON.** 1982. The Lea County Electric 100-kilowatt Grid-connected Photovoltaic System. In: American Institute of Aeronautics and Astronautics, 20th Aerospace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0067.

  DOI: 10.2514/6.1982-67

  Keywords: project description, case study

  Project: Lovington Square Shopping Center, Lovington, New Mexico, USA

1981 – 1984

Abstract: The photovoltaic system located on the Lovington Square Shopping Center in Lovington, NM is described in this paper. The system includes two 50 kW arrays, each with 21 subsystems with 80 modules each. The tilt of the south-oriented arrays with an area of 1685 m² can be adjusted manually to 10, 30 or 40 degrees. The system was commissioned on 17th March 1981. In the paper, the operating results and experience to date are described and discussed.

- **RISSER, Vernon Vilas and Harry S. ZWIBEL.** 1983. Operational success - Flat-plate photovoltaic systems. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 368–372.

  Keywords: project description, case study

  Projects: Newman Power Station, El-Paso, Texas; Lovington Square Shopping Center, Lovington, New Mexico, USA

  Abstract: In this paper, the performance evaluation of two intermediate photovoltaic systems, evaluated by the New Mexico Solar Energy Institute, are discussed. The evaluated systems are the 20 kWp system at El Paso, Texas, commissioned on January 27th, 1981, which supplies DC power to an uninterruptible power supply at El Paso Electric's Newman Power Station and the 100 kWp system in Lovington, New Mexico, commissioned on 17th March, 1981, which supplies AC power to the Lea County Electric Cooperative's grid. The paper presents the energy yield, daily simulation results and TRNSYS simulation for the year 1982. Maintenance effort including a description of exceptional events, module replacements and similar actions are also presented and discussed for both systems.

- **RITTER, Horst.** 1981. Kythnos Photovoltaic Power Plant. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 216–227.

  Keywords: project proposal

  Project: Kythnos Island, Cyclades Islands, Greece

  Abstract: The proposed 100 kW photovoltaic power plant, located on the Greek island of Kythnos, and proposed to operate parallel to the existing diesel power station is presented in the paper. Operating together with diesel generators and wind turbines, the PV power plant should feed about 170,000 kWh annually into the island's 15 kV local grid. The system should include four 25 kW DC/DC converters for battery charging and 2x1,200 Ah battery storage. Energy should be fed into the grid by three 50 kW, three-phase inverters.

- **ROGERS, Calvin B., T. D. HARRISON, H. H. BAXTER and H. D. PRUETT.** 1982. Reporting of Operational Results from Intermediate-Sized Photovoltaic Systems. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 988–992.

  Keywords: project evaluation

  Projects: BDM Office Building, Albuquerque, NM; Beverly High School, Beverly, MA; Dallas Forth Worth Airport, Dallas, TX; Wilcox Memorial Hospital, Kauai, HI; Mississippi County Community College, Blytheville, AR; Lovington Square Shopping Center, Lovington, NM; Newman Power Station, El Paso, TX; Oklahoma Center for Sciences and Arts, Oklahoma City, OK; San Bernardino Community Development Center, San Bernardino, CA; Sky Harbor Airport, Phoenix, Arizona; Natural Bridges National Monument, UT; Mt. Laguna Air Force Station, Mt. Laguna, CA, USA

  Abstract: In this paper, an overview of the reporting of intermediate sized photovoltaic systems in the USA is presented. Reporting includes twelve projects in the range of 20 kW to 225 kW. Monthly summary reports include topics like general project information, operation and maintenance, photovoltaic array, power conditioning, thermal performance, battery storage, load, system performance, meteorological data, energy summary, efficiency summary, financial data and executive summary. For example, a project in Lovington, NM detailed the daily monitoring data for July 1982. The presented data include, among other things, daily PV array energy production, compared with solar radiation on site, daily PV array efficiency and PV array energy production versus array power level. The paper also includes a small map with locations of the evaluated photovoltaic systems.

- **ROSEN, Daniel, Edward J. SIMBURGER and Russell S. SUGIMURA.** 1984. An Overview of the DC Wiring System Design Issues in the SMUD Phase I Photovoltaic Power Plant. In: IEEE Transactions on Power Apparatus and Systems, Vol. PAS-103, 9, 2394–2398.

  DOI: 10.1109/TPAS.1984.318378

  Keywords: project description

  Project: SMUD1 PV, Rancho Seco, California, USA

  Abstract: The DC wiring system of a Rancho Seco 1 MW photovoltaic solar power plant is presented in this paper. The power plant was initially designed as part of the 100 MW project. The power plant utilises single-axis tracking arrays by rotating around a horizontal north-south axis. Different aspects of protection functions like grounding problems, hot spots, in-circuit arcs and overcurrent protection are also discussed. The planned initial costs of the power plant were USD 12,000/kW for the first phase and USD 2,000/kW for the last phase of the 100 MW system.

- **ROSEN, Daniel, Edward J. SIMBURGER and Russell S. SUGIMURA.** 1984. An Overview of the DC Wiring System Design Issues in the SMUD Phase I Photovoltaic Power Plant. In: IEEE Power Engineering Review, Vol. PER-4, 9, 31–32.

  DOI: 10.1109/MPER.1984.5525790

  Keywords: project description

  Project: SMUD1 PV, California, USA

  Abstract: A brief description of the SMUD1 PV project by Rosen et al. as published in PAS-103, 9, 2394–2398 is given. A summary of the project design and its features is presented and discussed in this paper.

- **SCOTT, R. D. W.** 1981. Solent project - 80 kilowatts - Marchwood Power Station Site. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 248–260.

  Keywords: project proposal

  Project: Marchwood Power Station, UK

  Abstract: A photovoltaic system with 80 kW power capacity to be located on the CEGB Marchwood Power Station site, near Southampton, UK, is proposed in this paper. The power plant should be integrated into the existing power system, either to feed electricity into the grid or to supply independent loads. Parallel to the solar array, battery storage with a capacity of 400 Ah and 220 V voltage should be connected. Energy should be fed into the grid by a 100 kW inverter.

- **SCOTT, R. D. W.** 1983. Marchwood Project - 30 kilowatts Marchwood Power Station Site. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 277–292.

  DOI: 10.1007/978-94-009-6342-9_17

  Keywords: project description

  Project: Marchwood Power Station, UK

  Abstract: A proposal for the 30 kW photovoltaic power plant on the site of the old coal yard at CEGB Marchwood Power Station is presented. The output from this power plant should be directly coupled into the existing Marchwood site distribution network at three-phase, 415 V or be arranged to supply independent loads. The planned system consists of a solar array constructed of 960 modules and a supporting structure, DC controls and 400 Ah, 240 V battery storage, a 40 kW inverter, a data monitoring system, site, housings and interfaces with them.

- **SHUMKA, Alex and Steve G. SOLLOCK.** 1981. A Comprehensive Analysis of the Performance Characteristics of the Mount Laguna Solar Photovoltaic Installation. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1237–1244.

  Keywords: project description, case study

  Project: Mt. Laguna Air Force Station, Mt. Laguna, California, USA

  Abstract: In this paper, the first operating experiences and reliability topics of the Mt. Laguna photovoltaic power plant are discussed. The main focus of the paper is on the module reliability issues. The system consists of 169 strings connected in parallel and each string includes 14 modules. The array consists of the modules of two suppliers. Module malfunctions are analysed and presented graphically in terms of distribution curves.

- **SIMBURGER, Edward J.** 1982. Engineering Design for a Photovoltaic Central Station Power Plant Using Tracking Concentrator Arrays. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 1, 164–169.

  Keywords: preliminary study

  Abstract: In this paper, a detailed engineering concept and plans for a large-scale photovoltaic power plant using concentrator arrays are presented. The system design of different stages of a large-scale photovoltaic power plant is presented: photovoltaic arrays, DC wiring subsystems, power conditioning equipment, AC station service power, AC power collection system and plant control system. The total service load for the plant operation with 2,160 trackers is 263.5 kW. The plant should be connected to the 34.5 kV grid. Detailed wiring diagrams and the array layout are also given in the paper.

- **SIMBURGER, Edward J. and Richard B. FLING.** 1983. Engineering Design for a Central Station Photovoltaic Power Plant. In: IEEE Transactions on Power Apparatus and Systems, Vol. PAS–102, 6, 1668–1677.

  Keywords: preliminary study

  Project: The proposed project location is Southwestern US. Solar radiation data for Barstow, California was used.

  Abstract: The paper presents the engineering concept of the 200 MW photovoltaic power plant. The power plant should be divided into subarrays with voltage transformed to 34.5 kV and the power plant should then be connected to the 200 kV grid. Subarrays in the range of 5 to 15 MW with a ±1000 V centre grounded are proposed. The string schematic is also given. Wiring and grounding are also discussed in detail. The equipment power rating and string control system and central control system are also presented. Detailed technical drawings of the proposed project are also presented.

- **SMITH, Harry V.** 1982. The Mississippi County Community College Large Scale Demonstration Project, a Success Story. In: Fourth E. C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 94–96.

  DOI: 10.1007/978-94-009-7898-0_14

  Keywords: project description, case study

  Project: Mississippi County Community College, Blytheville, Arkansas, USA

  Abstract: The world's first large-scale photovoltaic concentrating system was commissioned in October 1981. The project located at Mississippi County Community College in Blytheville, Arkansas, USA is briefly described in this paper. The single tracking solar array consists of 270 concentrator trackers with a 28 suns optical and about 42 suns geometric concentrator ratio. It is designed to deliver about 85% of the building energy needs. The control and monitoring system of the photovoltaic power plant are based on a Hewlett Packard desktop computer, Model 9845-B. This provides wake-up capabilities.

1981 – 1984

- **SOLMAN, F. John.** 1981. Photovoltaic Systems Performance Experience. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1146–1152.

  Keywords: project description

  Project: Natural Bridges National Monument, Utah; Bryan, OH, USA

  Abstract: In this paper, a detailed reliability analysis of photovoltaic power plants in Bryan Ohio and Natural Bridges National Monument in Utah is given. Sources of outages identified include modules, array, lighting protection, wiring and switchgear, storage, system control, array regulation, auxiliary power and inverters. Several images of parts of the system are described. Reliability aids are identified and discussed in the paper. The costs of outages are evaluated and described in detail. For the Bryan power plant, the operating time summary from September 1979 to April 1981 is also given.

- **SOLMAN, F. John and Barbara L. GROSSMAN.** 1981. Operating Experience with the Natural Bridge National Monument Photovoltaic Power System. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1231–1236.

  URL: https://www.osti.gov/scitech/biblio/6428011-operating-experience-natural-bridges-national-monument-photovoltaic-power-system (5 August 2017)

  Keywords: project description

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: The Natural Bridges National Monument photovoltaic system in Utah was commissioned in May 1980. In terms of the research project, the initial simulation results were compared to the actual performance and the results are presented in this paper. The simulation model includes topics like loads, battery state of charge and load management. Other simulation topics include array performance and battery system. Measured values from the period July 1980 to March 1981 are efficiencies like battery charger, main inverter, UPS inverter, battery array, and system efficiencies. A site AC energy summary was also evaluated and is presented in the paper. Operating experiences and cost data and cost projections are also given in the paper.

- **SOLMAN, F. John, Henry J. BULLWINKEL, J. D. DOUCET and B. L. BRENCH.** 1982. Photovoltaic system with energy storage - Natural Bridges National Monument 100-kW system. In: American Institute of Aeronautics and Astronautics, 20th Aerorpace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0066.

  DOI: 10.2514/6.1982-66

  Keywords: project description, case study

  Project: Natural Bridges National Monument, Utah, USA

  Abstract: The operating performance of the Natural Bridges National Monument photovoltaic system after 18 months of operation is given in this paper. The operating performance fit well with the predicted and simulated data before the system construction.

- **SONNEVILLE, R. P. M.** 1981. Solar-Wind Project Terschelling. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 354–373.

  Keywords: project proposal

  Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

  Abstract: The proposed photovoltaic system located on Terschelling Island that should provide about 95% of the electrical energy needed by the island's school for maritime studies, the "Hogere Zeevaartschool Willem Barentsz", is proposed in this paper. Instead of large battery storage, wind generators should be used parallel to the solar power plant. The system consists of a 50 kWp photovoltaic generator, 30 kW wind generator, 360 V, 500 Ah battery bank, energy management system, synchronisable self-commutating inverter 50 kVA, three-phase, 380 V. All subsystems including the protection and monitoring system are described in the paper in detail.

- **SONNEVILLE, R. P. M.** 1983. Solar-Wind Project Terschelling. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 170–186.

  DOI: 10.1007/978-94-009-6342-9_12

  Keywords: project description

  Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

  Abstract: The system on Terschelling Island provides about 95% of the electrical energy of a school for maritime studies. It consists of a 50 kWp solar array in combination with a battery bank as the energy storage and wind generator. The solar array is divided into 30 subarrays; 29 arrays consist of 3 parallel strings with 30 modules each and 1 array has 3 parallel strings with 46 modules each. The maximum power point tracking, inverters and parts of the system like the mounting structure, lightning protection and experiences from the construction phase are also presented.

- **SPENCER, R. M.** 1982. Operating Experience with a 35 kWp Concentrating Photovoltaic System. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 984–987.

  Keywords: project description, case study, concentrator

  Project: Wilcox Memorial Hospital, Kauai, Hawaii, USA

  Abstract: In this paper, the technical description and operating experiences of the first six months of operation of the Wilcox Memorial Hospital, Kauai, Hawaii, photovoltaic concentrator system are given. System performance was evaluated from 1st November 1982 to July 1982. The monthly performance data compared to the predicted values is summarised and presented

in a table. The main operating issues were overheating of solar cells, appearance of moisture within the encapsulated envelope, ground faults, mechanical failures and failures of the data acquisition system. Corrosion due to the salty environment was also observed in the initial period.

- **SPENCER, R. M.** 1982. Operational Experience with a 35-kW Concentrating Photovoltaic System. In: Fourth E.C. Photovoltaic Solar Energy Conference Proceedings, Stresa, Italy, 10–14 May 1982, 184–188.

  DOI: 10.1007/978-94-009-7898-0_30

  Keywords: project description, case study, concentrator

  Project: Wilcox Memorial Hospital, Kauai, Hawaii, USA

  Abstract: The photovoltaic energy system located at Wilcox Hospital, Kauai, Hawaii was commissioned in October 1981. The system consists of 445 m² of parabolic trough concentrators. Cooling water, circulated through the receivers to cool the solar cells, is heated to 80°C. The heat is stored in a 12,000 l water storage tank and used as hot water in the hospital. Electrical energy with 480 V voltage is fed into the island's grid. System performance was evaluated from November 1981 to March 1982. The results and problems in this time period are also discussed in the paper.

- **SPENCER, R. and M. ANDERSON.** 1984. SMUDPV1 Photovoltaic Powerplant Construction and Operation Experience. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 872-875.

  Keywords: project description, case study

  Project: SMUDPV1, Rancho Seco, California, USA

  Abstract: In this paper, details about the SMUDPV1 power plant under construction, located in Rancho Seco, California are presented. Commissioning of the power plant is scheduled for June 1984. Several construction details like array foundation and control room foundation are given in the paper. In the paper, the value/cost ratio for single axis tracking, flat plate and two axis tracking arrays is presented. A cost analysis is also given in the paper for SMUDPV1 cost estimation = USD 2.24/W DC.

- **STARR, M. R., Harold L. MACOMBER and D. INGRAM.** 1981. Power Conditioning and Control Systems. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 43–87.

  Keywords: project proposal

  Projects: Pellworm Island, North Frisian Islands, Germany; Vester Bøgebjerk, Denmark; Kythnos Island, Cyclade Islands, Greece; Alicudi Island, Italy; Marchwood, Southampton, UK; Zambelli, Verona, Italy; San Nicola Island, Tremiti Islands, Italy; Chevetogne, Belgium; Kaw, La Guyane, Overseas Department of France, South America; Mont Bouquet, Alès, France; Nice Cote d'Azur Airport, Nice, France; Fota Island, Cork, Ireland; Terschelling Island, the Netherlands; Aghia Roumeli, Crete, Greece; Giglio Island, Italy; Rondulinu, Paomia, Corsica, France; Hoboken, Antwerp, Belgium

  Abstract: The power conditioning and control systems proposed for the pilot plants in the EC are briefly described in this paper. Basic data are presented in a table, whereas the following data for each photovoltaic pilot power plant is included: solar array power capacity (kWp), battery size (Ah), type of backup system, efficiency of DC/DC converters, efficiency of DC/AC converters, size and type of inverter and cost of power conditioners for each system. Power conditioners including electrical schematics are described in detail for each system.

- **STARR, Michael and Wolfgang PALZ.** 1983. Photovoltaic Power for Europe, An Assessment Study. In: Solar Energy R&D in the European Community, Appendix B - CEC Photovoltaic Pilot Plants, 194–195.

  Keywords: project overview

  Projects: Pellworm Island, North Frisian Islands, Germany; Alicudi Island, Italy; San Nicola Island, Tremiti Islands, Italy; Marchwood, UK; Fota Island, Ireland; Terschelling Island, the Netherlands; Kythnos Island, Greece; Aghia Roumelli, Crete, Greece; Mont Boquet, Nice Airport, France; Rondulinu, Paomia, Corsica, France; Hoboken, Belgium.

  Abstract: In appendix B of the study CEC photovoltaic pilot power plants, contracts started in March 1981 to be completed by mid-1983, are presented in this paper.

- **STODDARD, L. E. and S. L. LEVY.** 1984. Integrated Photovoltaic Central Station Conceptual Design. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1282–1285.

  Keywords: preliminary study

  Abstract: In this paper, the design criteria and requirements for large-scale photovoltaic power plants are described and discussed. Different photovoltaic technologies are compared and evaluated: fixed flat plate arrays, single axis tracking arrays, double axis tracking arrays and concentrator arrays. A detailed cost estimation for different parts of power plants is given, including land and site preparation, array and supporting structures, power conditioning, balance of system, control system, and buildings, spare parts and taxes. In the study, two sites, one in Barstow, California and one in Bay Minnette, AL are considered, and the results/comparison are presented and compared graphically and in the form of tables.

- **STRANIX, A. J. and A. H. FIRRESTER.** 1983. Conceptual Design of a 50 MW Central Station Photovoltaic Power Plant. In: IEEE Transactions on Power Apparatus and Systems, Vol. PAS–102, 9, 3218–3225.

  DOI: 10.1109/TPAS.1983.318132

  Keywords: preliminary study

  Abstract: In this paper, the design proposal for a large-scale photovoltaic system is evaluated and presented. The paper presents a detailed description of the array design of the power plant including the mounting structure and array layout and the array support structure. The electrical design includes protection systems and installation procedures, and performance and cost estimation is also given in the paper. Operating and maintenance costs are also discussed.

- **SUELZLE, Larry R. and D. E. HASKINS.** 1982. The Mt. Laguna Photovoltaic Project. In: American Institute of Aeronautics and Astronautics, 20th Aerospace Sciences Meeting Proceedings, Orlando, FL, 11–14 January 1982, Paper 82-0065.

  DOI: 10.2514/6.1982-65

  Keywords: project description, case study

  Project: Mt. Laguna Air Force Station, Mt. Laguna, California, USA

  Abstract: The Mt. Laguna Air Force Station photovoltaic system in Mt. Laguna, CA, was commissioned in 1979. In the first two years of operation, the system performance of this 60 kW system exceeded expectations but the performance of the system has continuously declined in two years of operation. The operating performance of the system is described and discussed in this paper.

- **TAKAHASHI, M., H. HOSOKAWA, Y. TAKEDA and K. TAKIGAWA.** 1984. Development of 1 MW Centralized PV Power Plant. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1031–1035.

  Keywords: project description

  Project: Saijo City, Ehime Prefecture, Japan

  Abstract: In this paper, the Sunshine Project photovoltaic plant proposed for construction and currently under construction in Saijo City, Ehime prefecture Japan is presented. The power conditioning system consists of three self-commutated inverters, 200 kW, and two 400 kW units. For solar arrays, about 30,000 modules should be used. Several construction details are presented in the paper. Efficiency of more than 93% is expected after power plant completion.

- **TASCHINI, Achille.** 1981. Adrano Project. In: Photovoltaic Power Generation, Final Design Review Meeting on EC Photovoltaic Pilot Projects Proceedings, Brussels, 30 November – 2 December 1981, 424–430.

  Keywords: project proposal

  Project: Adrano, Sicily, Italy

  Abstract: A proposal for the Adrano test site for different photovoltaic technologies is presented. The test site should be located close to the 1 MW Eurelios central receiver power plant in Sicily. It should consist of six different 5 kW photovoltaic systems with the aim of testing different PV technologies for use in larger systems. The proposed configurations are: mono crystalline flat array with fixed tilt, two axis tracking polycrystalline flat array, two different configurations with a CdS/Cu_2S flat array with fixed tilt and a concentrator array with mono crystalline solar cells with parabolic concentrator.

- **TASCHINI, Achille.** 1981. Alicudi Project. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 228–247.

  Keywords: project proposal

  Project: Alicudi Island, Aeolian Archipelago, Messina, Italy

  Abstract: Pilot photovoltaic power plant, to be located on Alicudi Island, Italy is described in detail in this paper. This Mediterranean island with terraces on the slope has 150 inhabitants and an electricity supply with an additional 80 kW photovoltaic project should improve living conditions on the island. Particular attention is put on the construction site which is barely accessible due to the absence of roads on the island so materials and equipment for the project should be delivered on site by helicopter. The proposed project, including the solar array, power conditioners, backup diesel generators, mounting structures and control and monitoring system, is described in the paper.

- **TOLBERT, R. E. L. and J. C. ARNETT.** 1984. Design, Installation and Performance of ARCO Solar Photovoltaic Power Plants. In: Conference Record of the Seventeenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 1–4 May 1984, 1149–1152.

  Keywords: project description, project overview

  Projects: Lugo, Hesperia; Carrisa Plains, California, USA

  Abstract: Lugo power plant was commissioned on 18th November, 1982, Hesperia power plant followed on 14th November, 1983. In the paper, details about trackers are also given. Lugo is installed on a 20 acre site, and includes 108 double axis trackers. Carissa Plains is located on a 160 acre field and is divided into nine independent segments. Some electrical details and photographs of the trackers are also included in the paper. System performance for Lugo power plant is also presented and discussed in the paper.

- **TOLBERT, R. E. L., R. S. MEGERLE and E. N. HARMON.** 1982. One Megawatt Photovoltaic Power Plant. In: Conference Record of the Sixteenth IEEE Photovoltaic Specialists Conference, San Diego, CA, 27–30 September 1982, 2, 1459–1460.

  Keywords: project description

  Projects: Lugo, Hesperia, California, USA

  Abstract: A short description of Lugo photovoltaic power plant in Hesperia, California is given in this paper. The paper also includes an artist's graphical impression of the power plant.

- **TOMASSINI, Maurizio.** 1983. Water Desinfection System and Cold Store. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 202–229.

  DOI: 10.1007/978-94-009-6342-9_14

  Keywords: project description, water treatment

  Project: Fosso di Valle, Ortona, Giglio Islands, Tyrrhenian Sea, Italy

Abstract: This paper describes a photovoltaic plant in Fosso di Valle, Ortona, Giglio Island, Italy. The photovoltaic power plant is divided into two parts, 15 kWp is used for the power supply of an ozoniser for water disinfection and 30 kWp for a cold store for the conservation of food. Different parts of the system like the solar array, mounting storage, protection systems, etc. are presented in the paper. A detailed description of the commercial ozoniser and cold store is also given and environmental aspects of the project are presented as well.

- **TOMBAZIS, A. N., E. ZACHAROPOULOS, L. DAMIANIDES and D. KIRIMLIDES.** 1983. Kythnos Island and Aghia Roumeli Photovoltaic Pilot projects - an Architectural Approach. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 289–293.

Keywords: project description, case study, hybrid

Project: Kythnos Island, Cyclade Islands; Aghia Roumeli, Crete, Greece

Abstract: Some architectural aspects of the photovoltaic pilot systems on Kythnos Island and Aghia Roumeli, Crete, are presented in this paper. For Kythnos Island with an area of 135 km² and 1,700 inhabitants, key questions regarding the project planning were: the open Cycladic landscape with typical houses, sloped land broken into terraces, crop cultivating and cattle breeding, prevailing strong north winds and the fact that the site is visible from the village. For Aghia Roumeli, key aspects were: the fact that the village is built in the exit of Samaria Gorge, a preserved Natural Park, the possibility of flash flooding is a real threat in winter, shadows on the site eastwards and westwards during sunrise and sunset and that the only way to transport materials and equipment to the site is by sea.

- **VAN GYSEL, Marc.** 1981. Powering of a Solar Heated Swimming Pool - Chevetogne. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 292–304.

Keywords: project proposal

Project: Domain Provincial de Chevetogne, Namur, Belgium

Abstract: A proposal for a photovoltaic pilot system in Chevetogne, Belgium is presented in this paper. The site is a leisure centre which includes a camp site and swimming pool. The PV system should supply the pumps of a 2,100 m² solar thermal system for the swimming pool and by using battery storage; it should also light the site in the evening. The solar array should consist of two parts, 40 kW for powering 14 pumps of the solar thermal system and a 23 kW system together with 275 kWh battery storage for lighting purposes. A modular 10 kW three-phase inverter should also be part of the proposed system.

- **VAN GYSEL, Marc.** 1983. Powering a Solar Heated Swimming Pool. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 92–116.

DOI: 10.1007/978-94-009-6342-9_7

Keywords: project description

Projects: Domain Provincial de Chevetogne, Namur, Belgium

Abstract: A photovoltaic project realised in Domain Provincial de Chevetogne, Namur province, Belgium is presented in this paper. The Domain features a 500 hectares area including camping grounds, sports centres and an Olympic size outdoor swimming pool. The photovoltaic power plant has two parts - 40 kW for the power supply of water pumps and 23 kW for site lighting. The system has three 20 kW inverters, two of them are used in part for the water pump supply and one in part for lighting purposes. Energy storage used in the 40 kW part has 120 Ah capacity and battery storage used in the 23 kW part has 1,500 Ah capacity.

- **VAN HAL, P.** 1983. Photovoltaic Power Plant for Hydrogen Production and Water Pumping. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 255–276.

DOI: 10.1007/978-94-009-6342-9_16

Keywords: project description, solar hydrogen

Project: Hoboken, Antwerp, Belgium

Abstract: The purpose of the project proposed in this paper is the use of a photovoltaic power plant in an industrial environment for hydrogen gas-production and storage. The system should consist of a 30 kW photovoltaic array mounted on a galvanised steel mounting structure on the roof of the warehouse, directly coupled to a 10 kW water electrolyser and two 7.5 kW DC driven water pumps. The main unit of the load management system is achieved by a Texas Instruments PM 550 programmable controller. A detailed description of other parts of the system including hydrogen production is also given in the paper.

- **WABREK, Richard and Vernon RISSER.** 1984. The Lovington Square Shopping Center Photovoltaic System. In: Proceedings of the American Solar Energy Society Annual Meeting 1984, Anaheim, CA, 5–7 June 1984, 861–864.

Keywords: project description, case study

Project: Lovington Square Shopping Center, Lovington, New Mexico, USA

Abstract: The photovoltaic system located on Lovington Square Shopping Centre in Lovington, NM was commissioned in March 1981. The system consists of two 50 kW south facing arrays with a manually adjustable tilt angle. Each array is connected to a 60 kW three phase inverter and transformed to 12.5 kV utility voltage. Some performance data and operating experiences for the period March 1981 to March 1983 are also given in the paper.

- **WOOL, M. and R. SPENCER.** 1983. The Sacramento Municipal Utility District 100-MW AC Photovoltaic Project - Phase I Progress. In: Fifth E.C. Photovoltaic Solar Energy Conference Proceedings, Kavouri (Athens), Greece, 17–21 October 1983, 398–402.

Keywords: project description, preliminary study

Project: Rancho Seco, California, USA

1981 – 1984

Abstract: The Sacramento Municipal Utility District (SMUD) Photovoltaic Project is described in this paper. The first part of 100 MW planned photovoltaic system, the SMUDPV1 1 MW photovoltaic system Rancho Seco, is also briefly described in the paper. Rancho Seco with a 1.2 MW DC array should produce 2,65 MWh of electricity annually and it should be commissioned in 1984. The system costs are estimated to be USD 12 million, which is jointly funded by the Sacramento Municipal Utility District, the U.S. Department of Energy, and the California Energy Commission. A more detailed cost estimation is also presented.

- **WRIXON, Gerard T.** 1981. The Fotavoltaic project - a 50 kW Photovoltaic System to Power a Dairy Farm on Fota Island, Cork, Ireland. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Brussels, 30 November – 2 December 1981, 343–353.

Keywords: project proposal

Project: Dairy Farm, Fota Island, Cork, Ireland

Abstract: Fota Island in Cork Harbour is the property of University College Cork and is the site of the University Farm which is administered by the University's department of Agriculture. In this paper, the photovoltaic system to cover the island's energy demands is proposed. Proposed is a 50 kW photovoltaic system as the power source for the dairy farm, with a solar array consisting of 2,664 modules, mounted under a tilt of 45° and protected against wind loads by a concrete structure. The system should also include 300 Ah energy storage. Three 10 kW inverters are used to power the dairy farm loads (motors) and an additional 50 kW inverter is proposed to feed surplus energy into the grid. The back and sides of the array are enclosed by a concrete block structure to reduce wind loading.

- **WRIXON, Gerard T.** 1983. The Fotavoltaic Project - A 50 kW Photovoltaic system to Power a Dairy Farm on Fota Island, Cork, Ireland. In: Photovoltaic Power Generation Proceedings, Final Design Review Meeting on EC Photovoltaic Pilot Projects, Hamburg/Pellworm, 12–13 July 1983, 153–169.

DOI: 10.1007/978-94-009-6342-9_11

Keywords: project description

Project: Dairy Farm, Fota Island, Cork, Ireland

Abstract: The 50 kWp photovoltaic installation built on Fota Island is described. The solar array consists of 2,775 modules and is mounted on the roof of the building part of a dairy farm with a tilt angle of 45° with 25 rows each, including 111 modules. The array is divided into 13 subarrays, each with six parallel strings consisting of 36 modules. The control and monitoring system is based on the microcomputer with a Motorola 6800 microprocessor. Three 10 kW three-phase and one 50 kW three-phase inverters are used in the system. The system is described in detail, including schematics and a description of different parts of the system.

- **ZWIBEL, H., E. YAZDANI, Vernon RISSER, P. COULTER and J. BROWN.** 1981. A 20-Kilowatt Photovoltaic Flat-Panel Power System – an Overview. In: Conference Record of the Fifteenth IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 12–15 May 1981, 1447–1453.

Keywords: project description

Project: Newman Power Station, El Paso, Texas, USA

Abstract: Newman Power Station located in El Paso, TX, which commenced automatic operation on 27 January, 1981, and was fully completed in April 1981, is presented in this paper. An overview of the system design, construction and operating and system testing and performance results is also presented. The total system cost was USD 511,000, whereas single cost categories are also given in the paper.

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **PALZ, Wolfgang and Fred C. TREBLE. Eds.** 1985. Sixth E.C. Photovoltaic Solar Energy Conference, Proceedings of the International Conference, London, 15–19 April 1985. Brussels: Commission of the European Communities, D. Reidel Publishing Comp. ISBN 90-277-2104-1.
- **GOETZBERGER, Adolf, Wolfgang PALZ and Gerhard WILLEKE. Eds.** 1986. Seventh E.C. Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Sevilla, 27 September–1 October 1986. Brussels: Commission of the European Communities, D. Reidel Publishing Comp. ISBN 9027724490.

  DOI: 10.1007/978-94-009-3817-5
- **SOLOMON, I., B. EQUER and Peter HELM. Eds.** 1988. Eighth E.C. Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Firenze, 9–13 May 1988. Brussels: Commission of the European Communities, Kluwer Academic Publishers. ISBN 9027728151 (Vol. 1), ISBN 902772816X (Vol. 2), ISBN 9027728178 (Set).
- **PALZ, Wolfgang, Gerard T. WRIXON and Peter HELM. Eds.** 1989. Ninth E.C. Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Freiburg, 25–29 September 1989. Brussels: Commission of the European Communities, Kluwer Academic Publishers. ISBN 0-7923-0497-7.

PROCEEDINGS – IEEE Photovoltaic Specialists Conferences

- **BARNETT, Allen M. Ed.** 1985. Proceedings of the Eighteenth IEEE Photovoltaic Specialists Conference 1985. Las Vegas, 21–25 October 1985. ISSN 0160-8371.
- **IEEE.** 1987. Proceedings of the Nineteenth IEEE Photovoltaic Specialists Conference 1987. New Orleans, 4–8 May 1987. ISSN 0160-8371.
- **WISE, Joseph Ed.** 1988. Proceedings of the Twentieth IEEE Photovoltaic Specialists Conference 1988. Las Vegas, 26–30 September 1988, 1–2. ISSN 0160-8371.

PROCEEDINGS – International Solar Energy Society, ISES

- **BILGEN, E. Ed.** 1985. INTERSOL '85; Congress of the International Solar Energy Society, Montréal, Québec, 1985. ISBN 2550121023.
- **BLOSS, Werner H. and F. PFISTERER. Eds.** 1987. Advances In Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987. ISBN 978-0-08-034315-0.

  URL: http://www.sciencedirect.com/science/book/9780080343150#ancpart2 (23 October 2016)
- **HORIGOME, T., K. KIMURA, T. TAKAKURA, T. NISHINO and I. FUJII. Eds.** 1989. Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989. Oxford: Pergamon Press. ISBN 0080371930.

  URL: http://www.sciencedirect.com/science/book/9780080371931 (23 October 2016)

PROCEEDINGS – American Solar Energy Society, ASES

- **HUNN, Bruce D. Ed.** 1986. Proceedings of the American Solar Energy Society Annual Meeting 1986. Boulder, CO: American Solar Energy Society. ISBN 0895531593.
- **HAYES, John and Dennis A. ANDREJKO. Eds.** 1987. Proceedings of the Solar '87 – the 1987 American Solar Energy Society and Solar Energy Society of Canada Annual Meeting, Portland, OR, 12–16 July 1988. ISBN 0895531607.
- **COLEMAN, M. J. Ed.** 1988. Proceedings of the Solar '88 – the 1988 American Solar Energy Society Annual Meeting, Cambridge, MA, 20–24 June 1988. ISBN 0895531615.
- **COLEMAN, M. J. Ed.** 1989. Proceedings of the Solar '89 – the 1989 American Solar Energy Society Annual Conference, Denver, CO, 19–23 June 1989. ISBN 0895531623.

PROCEEDINGS – Symposium Photovoltaische Solarenergie, Bad Staffelstein

- **OTTI.** 1986. Symposium Photovoltaische Solarenergie, Staffelstein, 21–22 April 1986. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **OTTI.** 1987. Symposium Photovoltaische Solarenergie, Staffelstein, 17–18 March 1987. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **OTTI.** 1988. Drittes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 9–11 March 1989. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **OTTI.** 1989. Viertes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 17–18 March 1989. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

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- **GILLET, W. B., J. E. BATES and W. KAUT Eds.** 1988. Photovoltaic Demonstration Projects. Brussels: Commission of the European Communities, Directorate-General for Energy, Elsevier. ISBN 1-85166-190-5.
- **NOEL, G. T., R. W. SMITH, J. H. BROEHL, Donald C. CARMICHAEL and G. ALEXANDER.** 1986. Optimization and Modularity Study for Large-Size Photovoltaic Flat-Panel Array Fields. SAND-84-7012, ON: DE87001626. Columbus, OH: Battelle-Columbus Laboratories.
- **NOEL, G. T. and R. W. SMITH.** 1987. Central station photovoltaic array-field designs and design practices. SAND-87-7003, ON: DE87007358. Columbus, OH: Battelle-Columbus Laboratories.

  URL: https://www.osti.gov/scitech/biblio/6745124..Legacy.ID..DE87007358 (24 March 2017)

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- **AL-BUSAIRI, H. and A. AL-KANDARI.** 1987. Design and Installation of a 24.2 kW Photovoltaic System in Kuwait. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 284–288.

  DOI: 10.1016/B978-0-08-034315-0.50062-8

  Keywords: project description, project evaluation

  Project: English school in Kuwait, Kuwait

  Abstract: The installation of the 24.2 kWp photovoltaic system for a private school in Kuwait is discussed in this paper. The system consists of a photovoltaic array, 200 kWh lead acid battery bank, 15 kVA inverter and charge and control unit. The main purpose of the system is to provide energy for lighting in the school. A brief description of the system, including the array, battery storage, wiring and control units is also given. System installation commenced in January 1985 and was completed in May 1985.
- **AL-GARNI, Y., M. AL-SAEDI and M. C. GUPTA.** 1989. A Solar-Powered 350 kW Photovoltaic-Electrolyzer System for Hydrogen Production. In: Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989, 1, 440–444.

  DOI: 10.1016/B978-0-08-037193-1.50092-6

  Keywords: project description, solar hydrogen

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: A photovoltaic project for hydrogen production located about 50 km northwest of Riyadh is presented in this paper. The system which consists of two-axis trackers was commissioned in 1981, includes 160 arrays and covers an area of 40,000 m². The system includes two sub units – a photovoltaic power plant and an electrolyser for hydrogen production. Installation of a new data acquisition system based on HP1000 mini computers that should be installed is also briefly discussed in the paper. The energy storage system is furnished with 1,100 kWh lead acid batteries, which provide electrical power during the night and inclement weather. The system operates fully automatically in three possible operating modes: stand-alone with battery storage, grid-connected in MPP mode and electrolyser-connected to produce hydrogen.
- **ALAMOUD, A. R. M., Fahad S. HURAIB and Abbas A. SALIM.** 1988. Reliability Prediction of the 350 kW Concentrating Photovoltaic Field. In: Eighth E.C. Photovoltaic Solar Energy Conference Proceedings, Firenze, 9–13 May 1988, 1, 299–303.

  Keywords: project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: This paper presents the results of field measurements of the 350 kW two-axis tracking concentrator photovoltaic system, which has been operating since September 1981 and is located about 50 km northwest from Riyadh, Saudi Arabia. The most common failures are module failures due to contact failures, e.g. bond breakage with an almost constant rate of failures of about nine modules per month. From the measurement results, reliability and degradation can be calculated. Mathematical expressions for the reliability of the PV system are given in the paper and a degradation rate of 1% annually is estimated.
- **ALBERGAMO, V., L. FABRIANI, L. GENTILIN, G. MESSINA, M. ROMANAZZO and A. SARNO.** 1988. Analysis of Delphos 300 kW Connected PV Plant after the First Year of Operation, In: Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference, Las Vegas, 26–30 September 1988, 2, 1267–1271.

  DOI: 10.1109/PVSC.1988.105908

  Keywords: project description, case study

  Project: Delphos 1, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: The operating experiences of Delphos photovoltaic power plant after the first year of operation are presented in this paper. The power plant was commissioned in August 1986. The solar array is mounted in one plane as a roof with a tilt angle of 20°. So, the space saving construction covers an area of 3,880 m². The power plant can function in stand-alone mode with a 660 V maximum array voltage or in grid connected mode with a maximum 800 V array voltage. Yield analysis in comparison with solar radiation models and power plant losses are also presented and discussed in the paper
- **ATMARAM, Gobind H., Bill MARION and Christy HERIG.** 1989. Design, Installation and Initial Operational Performance of a 15 kWp Amorphous Silicon Photovoltaic System. In: Proceedings of the Solar '89 – the 1989 American Solar Energy Society Annual Conference, Denver, CO, 19–23 June 1989, 309–317.

Keywords: project description, case study

Project: Orlando, Florida, USA

Abstract: In this paper, a 15 kW photovoltaic power plant installed in August 1988 near Orlando, Florida is described. The solar array consists of amorphous modules and the wiring layout is also given in the paper. Other parts and features of the power plant like fault tolerance, lightning/surge protection grounding and grid interconnection are also discussed. Array performance including mathematical performance evaluation and measured values are presented in graphical form as a chart.

- **BELLI, G., Alberto ILICETO and A. PREVI.** 1985. Design, Installation and Preliminary Operational Results of the Vulcano and Adrano Photovoltaic Projects. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 496–503.

Keywords: project description, case study

Projects: Adrano, Catania, Sicily; Vulcano Island, Italy

Abstract: In this paper, technical descriptions of Adrano and Vulcano photovoltaic systems commissioned in 1984 are presented. Adrano, the test site for different module and mounting configurations, is located in Catania, Sicily. The Adrano site was used to evaluate fixed and two axis tracking systems with modules of different producers, whereas the array power is from 2.7 kWp to 3.2 kWp. A detailed technical description and preliminary test results of measurements on the Adrano site are also given. The Vulcano photovoltaic system with 80 kWp can operate in grid-connected mode and alternatively also as a stand-alone system with battery storage. Energy is fed into the 20 kV grid by a 140 kVA inverter. The battery can be charged from the PV system or from the three-phase 380 V grid. Some technical details about the construction and system operation are also discussed and the measurement results of some parameters during a typical day of operation for each of the two installations are presented.

- **BETZIOS, G. and H. KADELLA.** 1989. Gavdos Photovoltaic Power Plant. In: Ninth E. C. Photovoltaic Solar Energy Conference Proceedings, Freiburg, 25–29 September 1989, 866–869.

Keywords: project description, case study

Project: Gavdos Island, Lybian Sea, Greece

Abstract: The photovoltaic system on Gavdos Island in the Libyan Sea, south of Crete is described in this paper. To improve the living conditions of inhabitants, a 20 kW photovoltaic system and some small dispersed systems were constructed. The plant itself was completed in 1986, whereas the villages Kastri and Vatsiana were connected in May 1987. At the same time, six small dispersed 24 V DC systems including small battery storage were also installed, supplying three houses in Ampelos, two houses in the Port of Karave and the school on the island. The array with 20 kWp consists of 160 modules mounted on structures with a manual adjustable tilt according to the season. The system also includes battery storage with a capacity of 936 Ah. A DC/DC converter and a 30 kVA 230 V/400 V single phase, three-phase inverter are used in the system. Installation experiences and system results are also discussed.

- **BEYER, Ulrich and Ralf POTTBROCK.** 1989. Design, Construction and Operation of a 340 kWp Photovoltaic Plant. In: Ninth E. C. Photovoltaic Solar Energy Conference Proceedings, Freiburg, 25–29 September 1989, 655–660.

Keywords: project description, case study

Project: Kobern-Gondorf, Germany

Abstract: The photovoltaic power plant Kobern-Gondorf is part of a 1 MW photovoltaic project of Rheinisch-Westfälisches Elektrizitätswerk (RWE). The system commissioned on 17th October 1988 is located on the River Moselle close to Koblenz, Germany. Ten different types of modules were used, connected into eight different arrays with a total 340 kWp power capacity. Two self-commutated 74 kW inverters and line-commutated 80 kW inverter are used for line-interconnection. Three-phase 400 V inverter output is connected by transformer to a 20 kV line. Different protection functions, operating results and ecological aspects are also discussed in this paper.

- **BRUNSTRÖM, C. and M. LARSSON.** 1985. Analysis of the Performance of a Grid-Connected Photovoltaic Plant. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 509–518.

Keywords: project evaluation

Project: Älvkarleby, Sweden

Abstract: The photovoltaic system at Älvkarleby Laboratory has been in operation since June 1983. It is an experimental system with 1.2 kWp and with the purpose of evaluating the results of photovoltaic systems in northern latitudes. Some test results and an efficiency evaluation are presented in this paper.

- **CAMANI, M., P. CEPPI, D. IACOBUCCI, D. BOZZOLO, O. DALDINI, R. PAMINI, G. SALVADÉ, F. SOLCÀ, C. SPINEDI and F. ZAMBONI.** 1985. Performances of the Grid Connected Photovoltaic Plant TISO 15. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 613–617.

Keywords: project description, case study

Project: Technical School Lugano-Trevano, Lugano, Switzerland

Abstract: The performance of the TISO power plant, 10 kW connected to the grid in May 1982 and monitored since November 1982 is discussed. The 10.6 kW array consists of 288 modules with an output voltage of 192 V. Different reliability related events are presented and discussed in the paper. Energy production and cost analysis are presented as well. The results of almost three years of operation of the PV plant TISO 15 are presented in this paper.

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- **CEPPI, P., M. CAMANI and D. IACOBUCCI.** 1986. Behaviour of the Modules of the Photovoltaic Plant TISO 15. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 177–181.

DOI: 10.1007/978-94-009-3817-5_32

Keywords: project description, case study

Project: Technical School Lugano-Trevano, Lugano, Switzerland

Abstract: The operating results of the experimental photovoltaic plant TISO 15 from May 1982 to November 1986 are presented in this paper. Technical problems and energy gain are discussed. There was no need for maintenance on the array-field during the four years it has been in operation. No evidence of electrical efficiency loss of the modules was found.

- **DURISCH, W., M. BÜHLMANN, P. KESSELRING and R. MORISOD.** 1987. Measurement and Operational Experience with a Photovoltaic Plant in the Swiss Alps. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 289–297.

DOI: 10.1016/B978-0-08-034315-0.50063-X

Keywords: project evaluation

Abstract: In this paper, the operating experience of a 1.2 kWp photovoltaic power plant commissioned in 1983 and located in the Swiss Alps is given. The main purpose of the study was power plant operation in a harsh environment, high altitudes and extreme weather conditions. At the alpine test site no damage of the panel array has been caused by wind speeds up to 135 km/h, low temperatures (down to minus 26°C) and high peak irradiations (up to 1,615 W/m², due to snow reflection and cloud/fog effects. Brief results of the power plant operation are discussed in the paper.

- **DURISCH, W., M. BRACK, W. BULGHERONI and E. GÄHWILER.** 1989. Albedo Measurements and System Performance of a Grid-Connected Photovoltaic Plant in the Swiss Alps. In: Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989, 1, 336–340.

DOI: 10.1016/B978-0-08-037193-1.50071-9

Keywords: project evaluation

Abstract: This paper discusses the measurement results, obtained in 1989, of a 2.5 kWp photovoltaic power plant located at a height of 2,450 m above sea level in the Swiss Alps put into service in 1988. The power plant equipment is presented and the first measurement results are briefly discussed.

- **EMSLIE, William A. and Carol J. DOLLARD.** 1988. Photovoltaic Pilot Plant. In: Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference, Las Vegas, 26–30 September 1988, 2, 1283–1288.

DOI: 10.1109/PVSC.1988.105911

Keywords: project description, case study, concentrator

Project: Platte River PV Pilot Plant, CO, USA

Abstract: The Platte River pilot photovoltaic power plant was commissioned in October 1987. This paper describes the technical features of the system and the installation experiences. The River Platte Pilot PV Plant consists of four stages: a concentrator two axis tracking array, flat plate array, flat plate array with passive one axis tracker and flat plate array on two axis tracker. The system cost overview for different parts of the system is also given. The total cost of the 10 kW pilot PV plant was USD 155,281.

- **FABRIANI, L. M., C. GARGIULO, L. GENTILIN, F. MUSELLA, Fabrizio BASEVI and C. MACCIÒ.** 1986. Present Situation of the Delphos Project - Design, Installation and Testing. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 108–112.

DOI: 10.1007/978-94-009-3817-5_19

Keywords: project description, case study

Project: Delphos 1, Manfredonia, Monte Aquilone, Foggia, Italy

Abstract: The technical details and operating results for the first 300 kW stage of the Delphos PV power plant are presented in this paper. The first part of the Delphos power plant was commissioned in August 1986. The array consists of 5,760 modules with maximal 800 V array voltage and a 20° tilt angle. The system can operate in stand-alone or grid connected mode. Parts of the system are a 300 kW line-commutated inverter and a 150 kW self-commutated inverter. In stand-alone mode battery storage with a 1,200 kWh capacity is also used. Some operating aspects and a brief description of the system parts are also given.

- **FONZI, Fulvio.** 1989. Tremiti Islands Desalination Plant. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 155–156.

Keywords: project evaluation, case study

Project: San Nicola Island, Tremiti Islands, Italy

Abstract: A brief description of a water treatment system for potable water sterilization and disinfection is given. Water treatment is done by anodic oxidation. An image of the water treatment system is also included.

- **FRANCIS, C. E. and Xu SHENG.** 1988. The 5,5 kW Line-interactive photovoltaic project at the Blackberry Farm Park Aurora, Illinois. In: Proceedings of the Solar '88 – the 1988 American Solar Energy Society Annual Meeting, Cambridge, MA, 20–24 June 1988, 433–436.

Keywords: project description

Project: Blackberry Farm, Park Aurora, Illinois, USA

Abstract: In this paper, the photovoltaic residential scale public demonstration project is described. The system is important for the public perception of photovoltaics and is also a sample case of large-scale distributed power systems.

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- **GRASSI, Giuliano.** 1985. Two-Year Experience of the EC Photovoltaic Pilot Projects. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 2, 871–875.

  Keywords: project overview

  Projects: Aghia Roumelli, Crete, Greece; Chevetogne, Belgium, Fota Island, Ireland; Giglio Island, Italy; Hoboken, Belgium; Kaw, French Guyana; Kythnos Island, Greece; Marchwood, UK; Mont Bouquet, Nice, France; Pellworm Island, Germany; Rondulinu, Corsica, France; Terschelling Island, the Netherlands; San Nicola Island, Tremiti Islands, Verona; Vulcano Island, Italy

  Abstract: In this paper, the two year experience of the European Community photovoltaic pilot projects is presented. A brief overview of the installation, operating and maintenance experiences for sixteen European systems is given. The main lessons learned presented in the paper are: large photovoltaic arrays must be aesthetically designed, modules with higher efficiencies should be used, the costs for site preparation have to be reduced, the system design should be as simple as possible and the reliability of electronic components and monitoring systems has to be increased. One of the important conclusions and recommendations was that the person with technical know-how in charge of a site is recommended.

- **HEIKKILÄ, Matti.** 1989. Photovoltaics in Northern Climate, a 30 kW Grid Connected Battery Backed PV-Plant in Finland. In: Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989, 1, 341–343.

  DOI: 10.1016/B978-0-08-037193-1.50072-0

  Keywords: project evaluation, northern latitudes

  Project: Inkoo, Koparnäs, Finland

  Abstract: The photovoltaic power plant located in Inkoo, Finland is presented in this paper. The grid-connected power plant, the most northern of its kind in the world, was constructed in 1988 and commissioned in August 1989. It consists of a 27 kW crystalline Si array and a 3 kW amorphous Si array. For the support structures galvanised steel was used. A brief project description and monitoring activities are also presented.

- **HELM, Peter.** 1986. Overview on CEC Photovoltaic Pilot Projects. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 96–102.

  DOI: 10.1007/978-94-009-3817-5_17

  Keywords: project overview

  Projects: Kythnos Island, Greece; Vulcano Island, Italy

  Abstract: A brief summary of the photovoltaic power plants constructed within the PV programme of the Commission of the European Communities is given in this paper. Projects constructed will not only act as showcases but also as objects where rich experience will be collected and used later for other projects. Images of the Kythnos and Vulcano projects are presented and some project specific topics are discussed as well.

- **HOFF, Tom and Gary SHUSHNAR.** 1987. Two Years of Performance Data for the World's Largest Photovoltaic Power Plant. IEEE Transactions on Energy Conversion, EC-2, 2, 232–235.

  DOI: 10.1109/TEC.1987.4765835

  Keywords: project evaluation

  Project: Carissa Plains, CA, USA

  Abstract: This paper presents the operating experiences of the Carissa Plains photovoltaic power plant from January 1984 to October 1985. The monthly values of the energy yield are given for a selected period. Particular attention in the analysis is put on the load match of utility in comparison to power plant electricity production. The results are also discussed and analysed in detail.

- **HOFF, Tom and Gary SHUSHNAR.** 1987. Two Years of Performance Data for the World's Largest Photovoltaic Power Plant. IEEE Power Engineering Review, PER-7, 6, 41.

  DOI: 10.1109/MPER.1987.5527124

  Keywords: project evaluation

  Project: Carissa Plains, CA, USA

  Abstract: A brief summary of the operating experiences of Carissa Plains from January 1984 to October 1985 is presented in this paper.

- **HOFFNER, John E.** 1989. Analysis of the 1988 Performance of Austin's 300-kilowatt Photovoltaic Plant. In: Proceedings of the Solar '89 – the 1989 American Solar Energy Society Annual Conference, Denver, CO, 19–23 June 1989, 48–55.

  Keywords: project description, project evaluation, case study, concentrator

  Project: PV300, 3M facility, Austin, Texas, USA

  Abstract: In this paper, the operating experiences and performance of a PV300 single axis tracking photovoltaic project in Austin, TX in 1988 are described. Monthly performance data in terms of generated power, availability and capacity factors is given in the table. Monthly peak outputs and energy cost savings are also discussed. Maintenance costs are also evaluated.

- **HOFFNER, John and David PANICO.** 1986. Centralized Photovoltaics for the Austin, Texas Electric Utility Department. In: Proceedings of the American Solar Energy Society Annual Meeting 1986. Boulder, CO: American Solar Energy Society, 438–445.

  Keywords: project description

  Project: PV300, Austin, Texas, USA

  Abstract: In this paper, a description of the proposed 300 kW photovoltaic power plant project PV300 in Austin, TX is given. The project background, system design consideration and cost and benefits of the project are discussed in the paper. The proposed power plant should generate 620,000 kWh annually. The total installation cost is estimated to be about USD 2.7 million or about USD 9,000/kW.

- **HOFFNER, John E. and Raju YENAMANDRA.** 1987. Construction Experience with a 300-Kilowatt Photovoltaic Plant in Austin, Texas. In: Proceedings of the Solar '87 – the 1987 American Solar Energy Society and Solar Energy Society of Canada Annual Meeting, Portland, OR, 12–16 July 1987, 121–124.

  Keywords: project description, project evaluation, concentrator

  Project: PV300 project, Austin, Texas, USA

  Abstract: Tracking photovoltaic power plants in Austin was commissioned on 5th December 1986, with the final tests completed in May 1987. The power plant with a 326 kWp array consists of single axis tracking flat plate arrays and is located close to the gas fired power plant and is connected to a 12.5 kV grid. The power plant technical details are presented. Cost and cost reducing measures are presented and discussed in the paper as well. The total PV300 power plant cost was USD 10.55/W AC.

- **HOHL, F. and P. KYAS.** 1987. Simulation and Optimization of Large Scale PV-Plants. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 368–373.

  DOI: 10.1016/B978-0-08-034315-0.50078-1

  Keywords: preliminary study

  Abstract: A brief description of the simulation programme for the simulation and optimisation of large photovoltaic power plants is presented. The simulation programme is capable of calculating different parameters of the photovoltaic power plant like the calculation of normal solar radiation, calculation of the angle of incidence, computation of the in plane radiation, shadowing effect, computation of MPP, ohmic loses, MPP mismatch loses, DC/DC converter efficiency, power delivered to battery and power used from battery and inverter efficiency. A comparison of the grid connected and stand-alone system with battery storage is also discussed in the paper.

- **HURAIB, Fahad S., Matthew S. IMAMURA, N. EUGENIO and N. R. RAO.** 1986. Status of 350-kW Concentrator PV System after Five Years. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 272–278.

  DOI: 10.1007/978-94-009-3817-5_51

  Keywords: project description, project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: The 350 kW photovoltaic system operated in stand-alone mode from being commissioned in September 1981 to December 1984. Subsequently, the regional grid network was connected to the village grid, and the photovoltaic system has been operating very well in a conventional utility-connected peak-power tracking mode. The system performance and operating results are presented in the paper. Lessons learned are also discussed in the form of a table.

- **JONES, Gary J., Harold N. POST, John W. STEVENS and Thomas S. KEY.** 1985. Design Considerations for Large PV Systems. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1307–1313.

  Keywords: preliminary study

  Abstract: This paper summarises the main design recommendations for the design of large-scale photovoltaic power plants. The main objectives of the paper are solar modules, power conditioning subsystem considerations, array field configuration, guidelines and other issues, utility interface, installation and checkout. For designing, the array paper gives some recommendations about module and string interconnections, ground fault detection, switchgear and grounding.

- **KAUT, W. and W. B. GILLETT.** 1986. Preliminary Experience from the CEC Photovoltaic Demonstration Programme and Future Prospects. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 103–107.

  DOI: 10.1007/978-94-009-3817-5_18

  Keywords: project overview, project evaluation

  Projects: Gavdos Island, Antikythira Island, Arki Island, Milos Island Greece; Bornholm Island, Denmark...

  Abstract: This paper presents a brief summary of the 38 photovoltaic systems of the CEC Demonstration Programme, with a total installed capacity of 507 kWp including a wide range of photovoltaic applications like residential houses, desalination plants, farms, mountain huts and refuges, lighthouses, street lights, water pumps, desalination plants, warning systems for fog, fire and floods, TV and radio transmitters and electrification of remote leisure centres.

- **KEY, Thomas S. and Fred G. TURNBULL.** 1985. Power Conditioning Options for Central Station Rated Photovoltaic Power Plants. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1320–1325.

  Keywords: preliminary study

  Abstract: Design recommendations and some basic schematics for power conditioning systems for large-scale photovoltaic power plants are presented in the paper. The paper includes trade-off studies and design requirements, high-power module configuration, low-power module configuration and future price projections.

- **KITA, Y., H. TAKAKURA, M. MUROZONO, M. KUBOTA, S. YAMAUCHI and Y. HAMAKAWA.** 1985. 100 kWp Photovoltaic Power Generation System for the Car Battery Manufacturing Plant. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 1, 263–268.

  Keywords: project description, case study

  Project: Matsushita Battery Industrial Company, Shizuoka Prefecture, Japan

Abstract: The Matsushita Battery Industrial Company photovoltaic system was constructed as a research project in March 1984. It is installed at Matsushita Battery Industrial Company's manufacturing facility near Lake Hamanako in Shizuoka prefecture Japan. The solar array consists of silicon and CdS/CdTe solar modules with a total power capacity of 101.63 Wp. The system operating data and several operating details for the period December 1984 to August 1985 are presented in this paper.

- **LEONARD, Stanley L.** 1986. Photovoltaic Power Generation for Utilities: The Implications of Some Recent Projects and Design Studies. IEEE Transactions on Energy Conversion, EC-1, 2, 61–67.

  DOI: 10.1109/TEC.1986.4765701

  Keywords: project description, project overview

  Projects: Lovington Square Shopping Center, Lovington, NM; Beverly High School, Beverly, MA; Sky Harbor Airport, Phoenix, Arizona; Lugo, Hesperia, CA; Carrisa Plain, CA; SMUDPV1, Rancho Seco, Sacramento, CA

  Abstract: This paper presents a comparison of six large-scale photovoltaic projects. The projects in Beverly and Lovington are almost identical, utilising fixed arrays. The Sky Harbour project is based on concentrating tracking arrays, and another three projects consist of single and two axis trackers partially also enhanced with V-shaped mirrors. Three projects were funded by the federal government, two by private investors and one by the federal and state government as well as by a utility grid operator. For each project key data like the time of commissioning, owner, utility, type of array and power capacity is given. Some recent design studies of very large-scale photovoltaic power plants are also presented

- **LEONARD, Stanley L.** 1986. Photovoltaic Power Generation for Utilities: The Implications of Some Recent Projects and Design Studies. IEEE Power Engineering Review, PER-6, 6, 41–42.

  DOI: 10.1109/MPER.1986.5528006

  Keywords: project description, project overview

  Projects: Lovington Square Shopping Center, Lovington, NM; Beverly High School, Beverly, MA; Sky Harbor Airport, Phoenix, Arizona; Lugo, Hesperia, CA; Carrisa Plains, CA; SMUDPV1, Rancho Seco, Sacramento, CA

  Abstract: A brief summary of the comparison of six large-scale photovoltaic projects is presented in the paper.

- **LI CAUSI, Saverio, Salvatore CASTELLO and G. MURZILLI.** 1989. Photovoltaics for a Cold Store in Giglio Island, Italy. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 153–154.

  Keywords: project evaluation, water treatment

  Project: Fosso di Valle, Ortona, Giglio Islands, Tyrrhenian Sea, Italy

  Abstract: A brief description of the Giglio Island photovoltaic project is presented. The presentation includes an image of the system, system cost and a brief description of the system. The Giglio project consists of a cold store system and an ozoniser for water purification. Because of chemical contamination of the well water to be sterilised and due to issues with the hydraulic and electronic components, the ozoniser system was disconnected and dismantled in May 1987. The related solar array and other components were used to power some other loads such as lamps, an air conditioner and the data acquisition system.

- **LOUCHE, A., G. SIMONNOT, G. NOTTON and G. PERI.** 1989. Global Analysis of the Rondulinu-Paomia PV Plant Behaviour. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 149–150.

  Keywords: project evaluation

  Project: Rondulinu, Paomia, Corsica, France

  Abstract: A brief description of Rondulinu photovoltaic system on Corsica, France is presented in this paper. The paper also includes an image of the system. The Rondulinu photovoltaic system consists of a 44.064 kWp solar array installed nearby the hamlet. A 50 kVA three-phase PWM inverter, a battery bank of 2,500 Ah rated capacity, charge regulator and control and a measurement system are also part of the system. In the case of very low solar radiation like in the winter months, the batteries are charged by a 25 kVA backup system.

- **LOWALT, Hans-Jürgen. and Bernd PROETEL.** 1985. The 300 kW Pellworm Solar Power Station: Performance and Experience. In: Sixth E.C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 486–490.

  Keywords: project description, project evaluation, case study

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: The 300 kW Solar Power Station on Pellworm Island was commissioned in July 1983, with the fully automatic mode started in March 1984. The total area of the Pellworm project is 28,000 m² and the solar array with a module tilt of 40° consists of 17,568 modules. The battery house on the estate contains the switchboard, converters and the control room. The connection cable for recreation centre power supply is 1.3 km long. Different issues and operating experiences are also described in this paper. Some environmental aspects are discussed briefly as well, and sheep that are using the area around the array as pasture can be observed.

- **LOWALT, Hans-Jürgen.** 1989. Follow-on-activities, 300 kW Pellworm Solar Plant. In: Photovoltaic power generation, European research and development, Participating contractors. Report EUR 12359, 141–142.

  Keywords: project description, project evaluation, case study

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: In this paper, some modifications of the Pellworm photovoltaic system after five year of operation are presented. The modifications and improvements are all software related. It is planned to install a separate data acquisition system to separate the current system control equipment and the data acquisition system. Improvements also include modification of energy management. A monitoring panel for the indication of important plant operation parameters with remote control switches is installed in the recreation centre. An additional modem connection is to be installed for remote monitoring of the plant from Wedel, 160 km away.

- **MATSUDA, K. M.** 1987. PVUSA: A Central Station R&D Project. In: Conference Record of the Nineteenth IEEE Photovoltaic Specialists Conference, New Orleans, 4–8 May 1987, 1363–1367.

  Keywords: project overview

  Projects: Davis, California; Carissa Plains, California, USA

  Abstract: In the paper, the PVUSA project is announced and described. The project goals and objectives, project concept plan and project management are presented and discussed. The proposed time schedule and proposed funding plan are also given in the paper. It is planned to complete the project by 1991 with a total budget of USD 39.5 million. The total power capacity of the project should be 3,500 kW with Davis and Carissa Plains, California as the main project sites. An artist's conceptual rendering of the photovoltaic power plants in Davis and Carissa Plains is presented as well.

- **McCARTHY, S., L. KEATING and Gerard T. WRIXON.** 1989. Computer Modelling and Simulation of PV Power Plants. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 134–136.

  Keywords: project simulation

  Projects: Aghia Roumelli, Crete, Greece; Delphos, Foggia, Italy; Fota Island, Ireland; Giglio Island, Italy; Kythnos Island, Greece; Marchwood, UK; Pellworm Island, Germany; Rappeneck, Germany; Terschelling Island, the Netherlands; San Nicola Island, Tremiti Islands, Italy; Vulcano Island, Italy; Zambelli, Verona, Italy

  Abstract: In this paper, the power conditioning equipment, inverters, for the systems Aghia Roumelli, Delphos, Fota Island, Giglio Island, Kythnos Island, Marchwood, Pellworm Island, Rappeneck, Terschelling Island, San Nicola Island, Tremiti Islands, Vulcano Island and Zambelli are listed. In the table, the parameters of the equipment like system power capacity, type of inverter, manufacturer, rated power, input voltage, output voltage, THC and efficiency at rated power, no load losses and MPPT, if used, are presented.

- **McCARTHY, S. and Gerard T. WRIXON.** 1989. Specific Action on the Fotavoltaic Project. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 145–146.

  Keywords: project description

  project:, Dairy Farm, Fota Island, Cork, Ireland

  Abstract: In this paper, some improvements of the Fota photovoltaic system after some years of operation are discussed. Particular improvements are the connection of two separate battery banks to form a single battery and improving the power management of the line-commutated inverter. By using a single battery, the photovoltaic system could supply up to 49% of the load against 29% when using a double battery. After power management of the inverter, 10% more energy could be delivered to the utility grid.

- **MENGA, P. and A. PREVI.** 1989. Photovoltaic Pilot Plant of Vulcano - Specific Action. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 143–144.

  Keywords: project description, case study

  Project: Vulcano Island, Italy

  Abstract: Some improvements and research of the operating results of the 80 kW Vulcano photovoltaic system, after four years of operation are presented in this paper. The power plant commissioned in 1984 can operate either in grid-connected or stand-alone mode. No interruption has been recorded in four years of operation. Brief results of the research on the deterioration, over a period of time, in the characteristics of the arrays and research on the plant's electrochemical storage system were performed and are also discussed in the paper.

- **MIERKE, Thomas, Bernhard VOIGT, Rolf HANITSCH, Klaus BÜRGEL and Roland HAUK.** 1988. 10 kWp PV Plant in Berlin. In: Eighth E.C. Photovoltaic Solar Energy Conference Proceedings, Firenze, 9–13 May 1988, 1, 229–233.

  Keywords: project description, battery storage

  Project: Residential project, Berlin, Germany

  Abstract: A photovoltaic system currently being installed in a residential district of Berlin is presented in this paper. The system consists of two arrays with 220 V output voltage. The energy will be stored in a battery with a capacity of about 100 kWh and will be used to cover the electric demands of a heat pump, household appliances and lighting a building. Additionally, the system is grid-connected to feed the surplus energy into the public grid. The plant should be put into operation in June 1988. Detailed descriptions of parts of the system, electrical schematics and photographs of the array are also included.

- **MIERKE, Thomas, Bernhard VOIGT, Klaus BÜRGEL and Elsayed HEMEAD.** 1989. 10 kWp-Photovoltaic Plant in Berlin - Energy Feed-back with High Efficiency DC/AC-converted Based on Sine Wave Synthesis. In: Ninth E.C. Photovoltaic Solar Energy Conference Proceedings, Freiburg, 25–29 September 1989, 874–877.

  Keywords: project description, battery storage

  Project: Residential project, Berlin, Germany

  Abstract: A residential photovoltaic system put into service at the start of 1989 is described in this paper. The array with 9.4 kWp has an output voltage of 220 V which is transformed to 280 V. Three inverters are part of the system: 2.2 kW three-phase for powering a heat pump, 10 kW three-phase for grid-connection and 2 kW for the supply of local loads. Energy is stored in batteries with a capacity of 100 kWh, whereas the battery can be charged either from a solar array or the public grid.

- **MORRIS, James A.** 1987. Power Quality Testing at John's "Solar 1". In: Proceedings of the Solar '87 – the 1987 American Solar Energy Society and Solar Energy Society of Canada Annual Meeting, Portland, OR, 12–16 July 1987, 125–129.

  Keywords: project description, project evaluation

  Project: Solar One, Phoenix, Arizona, USA

  Abstract: The 200 kW photovoltaic power plant was commissioned on 19 November 1985. In the paper, the power quality testing methodology and results are presented.

- **NOEL, G. T., D. C. CARMICHAEL, R. W. SMITH and J. H. BROEHL.** 1985. Optimization and Modularity Study for Large-size Photovoltaic Flat Panel Array Fields. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1438–1442.

  Keywords: preliminary study, design recommendations

  Abstract: In this paper, the design requirements for flat plate arrays for large-scale photovoltaic power plants are presented. The paper includes topics like array design, array fields' layout, mounting structure, foundation design and cost estimation.

- **NOEL, G. T., R. W. SMITH and J. G. AYRES.** 1985. Central Station PV Array Design Practices. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1314–1319.

  Keywords: design recommendations

  Project: Lugo, Hesperia, California, USA

  Abstract: Design practices for some large-scale photovoltaic power plants are presented in this paper. The study include the structural design, structural hardware and installation, electrical design, source circuit design practices, building block design practices, array field design practices, etc. The main array parameters and features are presented in tables, including grid voltage, area used, operating voltage, power rating, etc. Among other projects, the parameters of the Lugo power plant are presented in the paper.

- **NORDMANN, Thomas, Luzi CLAVADETSCHER and Raimund HÄCHLER.** 1989. Realisation of a 100 kW Grid Connected PV Installation Using the Sound Barriers along a Motorway in the Swiss Alps. In: Ninth E. C. Photovoltaic Solar Energy Conference Proceedings, Freiburg, 25–29 September 1989, 669–678.

  Keywords: project description, case study, noise barriers

  Project: PV noise barrier N13/A13 motorway, Domat-Ems, Switzerland

  Abstract: This paper presents the results of the evaluation study of the potential of a large grid connected PV-installation using the existing land resources including noise barriers along motorways and railway lines that was carried out in 1987/1988. Based on the results of the study pilot, a 100 kW installation along the N13 motorway should be constructed. Details about the project, including an economic evaluation are given in the paper. The power plant mounted on a noise barrier more than 800 m in length should include 2,208 modules and generate about 145 MWh energy annually. Grid connection should be realised by a 100 kW three-phase inverter. The cost of electricity produced was estimated to be in the range of CHF 0.82 to 1.16/kWh (USD 0.48 to USD 0.68/kWh).

- **O'NEILL, Mark J.** 1985. Measured Performance for the First Three years of Operation of the DFW Airport 27 kW (Electric)/120 kW (Thermal) Photovoltaic & Thermal (PVT) Concentrator System. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, 1985. Las Vegas, 21–25 October 1985, 2, 1249–1254.

  Keywords: project evaluation

  Project: Dallas-Forth Worth Airport, Dallas, Texas, USA

  Abstract: In this paper, the results of the performance measurements of Dallas Fort Worth Airport photovoltaic system after three years of operations are presented.

- **PANICO, Dave.** 1988. A Utility Perspective on PV Rating Criteria: Case Study of Performance Testing at the Austin PV300 Project. In: Proceedings of the Solar '88 – the 1988 American Solar Energy Society Annual Meeting, Cambridge, MA, 20–24 June 1988, 177–182.

  Keywords: project evaluation

  Project: PV300, Austin, Texas, USA

  Abstract: In this paper, the performance testing methods and results of the PV300 photovoltaic power plant located in Austin, Texas, USA are presented and discussed. The power plant was commissioned on 5 December 1986. Sensitivity analysis was performed and the actual values were compared to the design rating. The main conclusion of the paper is that commonly accepted test criteria for the power plant performance evaluation are needed.

- **PANTOJA-LÓPEZ, A. and J. GARCÍA MARTÍN.** 1986. Experimental Photovoltaic Solar Plant - 100 kWp. Poster. In: Seventh E. C. Photovoltaic Solar Energy Conference Proceedings, Sevilla, 27–31 October 1986, 137–141.

  DOI: 10.1007/978-94-009-3817-5_24

  Keywords: project description, project evaluation, case study

  Project: Emilio Usaola Training School, Hidroeléctrica Española, San Agustín de Guadalix, Madrid

  Abstract: A photovoltaic system on the grounds of the Training School "Emilio Usaola" of Hidroeléctrica Española, located in San Agustín de Guadalix, a village on the Madrid-Burgos highway is presented in this paper. The solar array mounted with a tilt of 30° consists of three parts: a 50 kWp array includes 1,149 monocrystaline Si modules, a 40 kWp array includes almost 500 modules of bifacial monocrystalline Si cells and a 10 kW array consists of 2 kW amorphous Si modules and 8 kW monocrystalline Si modules. The purpose of the project is the design, optimisation and evaluation of the operations of PV systems in order to gain experience, and to demonstrate the economic feasibility of such systems.

1985 – 1989

- **PATAPOFF, Nick W.** 1985. Two Years of Interconnection Experience with the 1 MW at Lugo. Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference. Las Vegas, 21–25 October 1985, 2, 866–870.

  Keywords: project description, case study

  Project: Lugo, Hesperia, California, USA

  Abstract: In this paper, the operating results of Lugo photovoltaic power plant after two years of operation are presented. The capacity factor of the power plant is discussed in detail. Monthly capacity factors for the period January 1983 to December 1985 are presented in a table.

- **PATAPOFF, Nick W. and D. R. MATTIJETZ.** 1985. Utility Interconnection Experience with an Operating Central Station MW-Sized Photovoltaic Plant. IEEE Power Engineering Review, PER-5, 8, 31.

  DOI: 10.1109/MPER.1985.5526375

  Keywords: project evaluation, case study

  Project: Lugo, Hesperia, California, USA

  Abstract: A brief description of the 1 MW photovoltaic plant at Lugo substation in Hesperia, California, commissioned in November 1982 is given in this paper.

- **PATAPOFF, Nick W. and D. R. MATTIJETZ.** 1985. Utility Interconnection Experience with an Operating Central Station MW-Sized Photovoltaic Plant. IEEE Transactions on Power Apparatus and Systems, PAS-104, 8, 2020–2024.

  DOI: 10.1109/TPAS.1985.318776

  Keywords: project evaluation, case study

  Project: Lugo, Hesperia, California, USA

  Abstract: The 1 MW photovoltaic plant at Lugo substation in Hesperia, California, was commissioned in November 1982 and monitored after that. The power plant is on 20 acres of land and uses two axis trackers with 108 pedestals, each with about a 9 kW solar array. The system can be interconnected to the grid either through a 1,000 kVA line commutated inverter or two 500 kVA self-commutated inverters. The photovoltaic station is near the end of a 13 mile 12 kV line. The power plant yield is analysed for the years 1983 and 1984 and results are presented in the paper. Distortion of the inverters is also discussed in this paper.

- **PLIGOROPOULOS, P.** 1989. Aghia Roumeli Photovoltaic Plant. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 147–148.

  Keywords: project description, case study, battery storage

  Project: Aghia Roumeli, Crete, Greece

  Abstract: Aghia Roumeli photovoltaic pilot power plant was commissioned in November 1982. The experiences and some improvements are briefly discussed in this presentation. The installed power capacity is 50 kWp, and the power plant also includes 1,500 Ah, 300 V battery storage. In the first year of operation 19 battery cells were replaced and a new battery charging system was installed. According to the JRC ISPRA guidelines, a new monitoring system made by Hewlett-Packard was installed. Measurements of module efficiency and some other maintenance tasks were performed as well.

- **POST, E. N. and M. G. THOMAS.** 1987. Photovoltac Systems for Current and Future Applications. In: Proceedings of the Solar '87 – the 1987 American Solar Energy Society and Solar Energy Society of Canada Annual Meeting, Portland, OR, 12–16 July 1987, 80–88.

  Keywords: project overview, project description

  Projects: Solar One, Phoenix, Arizona; Lugo, Hesperia, CA; Rancho Seco, CA, USA

  Abstract: A brief description of some large-scale photovoltaic power plants including some economic details is presented and discussed in this paper.

- **PRATT, Robert D. and Joseph BURDICK.** 1988. Performance of a 4 kW Amorphous-silicon Alloy Photovoltaic Array at Oakland Community College, Auburn Hills, Michigan. In: Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference, Las Vegas, 26–30 September 1988, 2, 1272–1277.

  DOI: 10.1109/PVSC.1988.105909

  Keywords: project description

  Project: Oakland Community College, Auburn Hills, Michigan

  Abstract: In this paper, the operating experiences of Oakland Community College photovoltaic system are described. The system that was commissioned in spring 1987 consists of thin film silicon modules. The system performance and data analysis results are presented in the paper. Twenty different parameters are assessed with a data acquisition system. Performance related data is also presented as plots, like DC array energy conversion efficiency, daily and monthly energy output, etc.

- **PROETEL, Bernd.** 1987. The Pellworm Solar Power Station. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 279–283.

  DOI: 10.1016/B978-0-08-034315-0.50061-6

  Keywords: project description

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: A description of the 300 kW Pellworm photovoltaic power plant commissioned in 1983 is given in this paper. Battery storage is also part of the system with a total battery capacity of 6,000 Ah, separated into two battery banks of 3,000 Ah each. Data monitoring and energy balance for the days between 30 April 1985 and 15 April 1985 is given in the paper. The results are presented graphically and in a table. An evaluation of system losses is also discussed.

- **REINOEHL, R., Gary SHUSHNAR, E. BERMAN, J. CALDWELL and J. ARNETT.** 1985. Large Scale Photovoltaic Energy Systems. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 519–523.

Keywords: project description, project overview

Project: Lugo, Hesperia, CA, Carrisa Plains, CA, USA

Abstract: The Lugo and Carissa Plains photovoltaic power plants are briefly presented, with the main attention on economic aspects of the project. The Lugo power plant was commissioned in November 1982, which includes 108 two-axis trackers, with each tracker including a 9 kWp array. The Carissa Plains consist of 756 two-axis trackers divided into nine fields with 84 two-axis trackers each. Seven out of nine fields were commissioned in November 1983, and the two remaining fields were completed in October 1984. In comparison to the Lugo system, the Carrisa power plant includes solar cells of square shape which results in higher module efficiency, different construction of panels and reduced module framing using glass reflectors and one inverter per each 700 kWp field.

- **SALIM, Abbas A., Fahad S. HURAIB, N. N. EUGENIO and Thomas C. LEPLEY.** 1987. Performance Comparison of Two Similar Concentrating PV Systems Operating in the U.S. and Saudi Arabia. In: Conference Record of the Nineteenth IEEE Photovoltaic Specialists Conference, New Orleans, 4–8 May 1987, 1351–1357.

Keywords: project evaluation, concentrator

Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia; Sky Harbor Airport, Phoenix, Arizona, USA

Abstract: In this paper, the performances of two similar concentrator projects, installed by the same supplier, commissioned in 1981 and 1982 are evaluated and compared. A detailed system description and comparison is given in the table. Performance comparison is discussed and the results are presented. Power conversion, energy conversion, array washing, subsystem hardware reliability, electronic control unit, module performance, azimuth feedback potentiometers, array drives, DC system wiring, array cables and power conditioning system performances are discussed in the paper. The array field component problems are also presented in a table. System degradation was estimated to be less than 1.5% annually.

- **SALIM, Abbas A., Fahad S. HURAIB, Bakr KHOSHAIM, N. N. EUGENIO and N. R. RAO.** 1985. Four Year Performance Summary of 350 kW Concentrating Photovoltaic Power System. In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1545–1552.

Keywords: project description, project evaluation, case study, concentrator

Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

Abstract: In this paper, the performance after four years of operation of Solar Village Projects near Riyadh, Saudi Arabia is given. Photovoltaic energy output, inverter energy efficiency, array output power and ambient parameters are presented. Lessons learned after four years of operation are also summarised.

- **SCHLUETER, Larry E.** 1987. Maintenance Requirements and Costs at the Carrisa Plains Photovoltaic Plant. In: Conference Record of the Nineteenth IEEE Photovoltaic Specialists Conference, New Orleans, 4–8 May 1987, 1358–1362.

Keywords: project description, project evaluation, economics, case study

Project: Carissa Plains, California, USA

Abstract: In this paper, the maintenance effort of the Carissa Plains photovoltaic power plant during the period from 1st January, 1985 to 30th June, 1986 is described and discussed. The power plant was designed for 24 hours daily and 365 days a year continuous operation. Tracking control is based on a computer algorithm and not on the actual position of the sun. A list of preventive maintenance tasks with a total of 724 man hours monthly is given in the paper. Unscheduled maintenance has reached 24.4% of the total maintenance effort over the 18 months monitoring period. Scheduling activities are described and an economic evaluation is also given. Operation and maintenance cost are estimated at about USD 112,000 and total energy production at 14,000,000 kWh annually, which results in operation and maintenance costs of USD 0.008/kWh.

- **SCHOEN, Richard.** 1987. The ARCO Solar 62 kW Solar Photovoltaic Powered Space Frame Automobile Shade Structure, King Abdulaziz International Airport, Jeddah, Saudi Arabia. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 333–337.

DOI: 10.1016/B978-0-08-034315-0.50071-9

Keywords: project description

Project: King Abdulaziz International Airport, Jeddah, Saudi Arabia

Abstract: The photovoltaic carport photovoltaic roof located at the King Abdulaziz International Airport in Jeddah, Saudi Arabia is described in this paper. The system consists of 1,760 modules and battery storage with two 1,440 Ah battery banks designed for 20% maximum daily discharge. Batteries feed two 10 kVA three-phase, 60 Hz inverters. The design of the system that should provide energy for the lighting of carports is also described from an architectural point of view. The architectural and structural characteristics of the system are discussed and presented as well.

- **SHUSHNAR, Gary J., J. H. CALDWELL and R. F. REINOEHL.** 1985. Balance of System Costs for a 5 MW Photovoltaic Generating Station. IEEE Power Engineering Review, PER-5, 8, 29.

DOI: 10.1109/MPER.1985.5526373

Keywords: project evaluation

Project: ARCO's projects in California, USA

Abstract: Brief results of the 5 MW photovoltaic power plant balance of system cost study are presented in this paper.

1985 – 1989

- **SMITH, Steve, Tim TOWNSEND, Chuck WHITAKER and Steve HESTER.** 1989. Photovoltaics for utility-scale applications: project overview and data analysis. In: Solar Cells, 27, 1–4, 259–266.

DOI: 10.1016/0379-6787(89)90034-3

Keywords: project description, PVUSA

Projects: Davis, California, USA

Abstract: In this paper, a short description of the PVUSA Davis project is given. The data acquisition system is also presented in the paper. System performance evaluation is discussed and presented with edge sealant degradation as one of the main problems. The performance rating modelling and methodology are also briefly described.

- **SOLERA, J. S.** 1985. 100 kWp Experimental PV Power Plant In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 504–508.

Keywords: project description, case study

Project: Emilio Usaola Training School, Hidroeléctrica Española, San Agustín de Guadalix, Madrid

Abstract: The photovoltaic system installed on the grounds of the Emilio Usaola Training School, the training site of Hidroeléctrica Española located in San Agustín de Guadalix, Madrid is presented in this paper. The power plant with a modular structure is composed of three subarrays. Two independent blocks of 40 and 50 kWp are connected to the 20 kV public grid. A 10 kWp array that consists of two small subarrays is used to charge the batteries and is also connected to the local 220/380 V grid by a 2kW inverter. The first 50 kW part of the system was connected to the grid on 29th March 1985.

- **SOMA, N., E. INADA, Y. EGUCHI, O. KURODA and K. NISHINOIRI.** 1989. Long Term Actual Operation of the Seawater Desalting by 25 kW Photovoltaic Cells on a Small Island. In: Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989, 1, 307–311.

DOI: 10.1016/B978-0-08-037193-1.50065-3

Keywords: project description, project evaluation, case study, water treatment

Project: Oshima Island, Fukue city, Nagasaki pref., Japan

Abstract: A seawater electro-dialysis, 25 kW photovoltaic desalination system, located on Oshima Island in Japan is described in this paper. The system was commissioned in June 1986. The system produces on average about 4 m^3 of fresh water daily with maximum values of up to 9 m^3 daily. A detailed system description, losses evaluation and performance evaluation for the time period from June 1986 to March 1989 are given in the paper. The system cost is also discussed.

- **SOROKIN, Alecsei and D. BRAGGION.** 1989. Zambelli PV Pumping Station (70 kWp) - Plant Improvements and Results. In: Ninth E. C. Photovoltaic Solar Energy Conference Proceedings, Freiburg, 25–29 September 1989, 885–888.

Keywords: project description, case study, water pumping

Project: Zambelli, Verona, Italy

Abstract: The Zambelli photovoltaic pumping system was commissioned in June 1985. This paper summarises four years of operating experiences of one of the largest PV pumping systems worldwide. The main parts and features of the system are the 70 kWp array, the direct coupled load without main battery storage, two variable frequency PWM inverters powering two AC driven piston pumps, each pump 35 kW, MPP operation, auxiliaries and control systems are fed by an UPS and the system works as a stand-alone system fully automatically. Some system improvements made after commissioning are also discussed in the paper, so a new control and monitoring system was added.

- **SOROKIN, Alecsei and D. BRAGGION.** 1989. Zambelli Photovoltaic Pumping Station (70 kWp) - Optimization and Monitoring. In: Photovoltaic Power Generation, European Research and Development, Participating Contractors. Report EUR 12359, 157–158.

Keywords: project evaluation, water pumping

Project: Zambelli, Verona, Italy

Abstract: The operating experiences of Zambelli photovoltaic pumping system that has been operating since June 1985 are presented in this paper. The power plant operates unattended and fully automatically with the main purpose of powering two 35 kW piston pumps for water pumping. Some control and monitoring aspects and their improvements are discussed. The main concern was often operating interruption which has required a manual restart of the system. It is proposed to install and optimise the local controller, and to install a remote monitoring system - to monitor the system 24 hours daily, including periodical checking of the PV array and battery performance.

- **STOLTE, Walter J., P. DE LAQUIL III and J. GOODMAN.** 1987. Sizing Utility-Scalable PV Power Segments. In: Advances in Solar Energy Technology, Proceedings of the Biennial Congress of the International Solar Energy Society, Hamburg, Germany, 13–18 September 1987, 1, 374–377.

DOI: 10.1016/B978-0-08-034315-0.50079-3

Keywords: preliminary study

Abstract: In this paper, the results of analyses about the photovoltaic power plant size required for failure rate prediction are presented. The conclusion of the study proposes that power plants in the range of 200 kW to 400 kW are required to demonstrate module failure rates of about 0.1% at 90% confidence.

- **SUMNER, D. D., Chuck M. WHITAKER and Larry E. SCHLUETER.** 1988. Carrisa Plains Photovoltaic Power Plant 1984-7 Performance. In: Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference, Las Vegas, 26–30 September 1988, 2, 1289–1292.

DOI: 10.1109/PVSC.1988.105912

Keywords: project description, project evaluation, case study

Project: Carissa Plains, California, USA

Abstract: In this paper, the four years of performance of the Carissa Plains photovoltaic power plant is evaluated. First, the 3.2 MW array was commissioned in January 1984, reaching a 5.2 MW array power plant that was fully operational in August 1985. The solar array consists of 113,968 modules mounted on 799 two-axis trackers. The trackers installed in 1983/84 also consist of V-shape mirrors mounted on trackers. The trackers installed in 1985 do not include mirrors. The array field is divided into ten 550 V DC subarrays. Each of the first nine segments is connected to a 700 kW inverter, while the tenth segment is connected to a 750 kW inverter. The inverters operate with 480 V output voltage which is transformed to 12 kV, and finally connected to a 115 kV transmission line. In the paper, operating experiences with attention on module degradation in arrays with trackers is given. Module degradation is caused by high temperatures, reaching up to 90° caused by mirrors and consequently damage of the EVA foil. Yield analysis and a description of maintenance effort are also given in the paper.

- **TAKANASHI, M., H. HOSOKAWA, Y. TAKEDA and K. TAKIGAWA.** 1985. Development of 1-MW PV Power System for Centralized Array Location (No. 2). In: Conference Record of the Eighteenth IEEE Photovoltaic Specialists Conference, Las Vegas, 21–25 October 1985, 3, 1468–1471.

Keywords: project description, case study

Project: Saijo City, Ehime Prefecture, Japan

Abstract: The design experience of a 600 kW stage of the Saijo photovoltaic power plant is presented in this paper. The already completed part of the Saijo power plant consists of two 200 kW arrays and two 100 kW arrays with a total of 1,400 kWh energy storage. The system is connected to the grid through two 100 kW and two 200 kW inverter stages. The system configuration, aerial view and several images of the system are presented in the paper. The operation results for particular days are also given.

- **TAKEDA, Y., K. TAKIGAWA, H. KOBAYASHI, K. NAHAKARA, T. MORISHITA, A. KITAMURA, A. MIYOSHI, H. MATSUDA and S. KOMATSU.** 1988. Test and Study of Utility Interface and Control Problems for Residential PV Systems in Rokko Island 200 kW Test Facility. In: Conference Record of the Twentieth IEEE Photovoltaic Specialists Conference, Las Vegas, 26–30 September 1988, 2, 1062–1067.

DOI: 10.1109/PVSC.1988.105868

Keywords: project description, case study

Project: Rokko Island, Kobe, Japan

Abstract: Rokko Island test photovoltaic facility, comprising 100 2 kW photovoltaic systems and commissioned in January 1988, is described. The main intention of this system was to test the impact of large amounts of distributed photovoltaic systems. The test results are presented in this paper. The test has included the investigation of several powerline related parameters like the investigation of harmonics, voltage variation, safety issues, characteristics in the case of the outage of a low voltage distribution system, islanding, etc.

- **TER HORST, Emil W., Jean H. BOUMANS and Kornelis BLOK.** 1988. The Terschelling PV/Wind after Five Years of Operation. In: Eighth E. C. Photovoltaic Solar Energy Conference Proceedings, Firenze, 9–13 May 1988, 1, 275–279.

Keywords: project description, project evaluation, case study

Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

Abstract: This paper discusses the optimisation of the Terschelling Island photovoltaic system carried out from November 1987 to May 1988. The PV array consists of 2,748 modules with 50 kW of rated power. The array is divided into 30 subarrays. The main issues in five years of system operation were cable cracks, earth leaks and glass cracks. Among the improvements, new software for battery monitoring was installed. The simulation results and electrical schematics of the system are also presented in the paper.

- **TER HORST, Emil W.** 1989. Power Supply to a Marine Training School, Terschelling Island, the Netherlands. In: Photovoltaic Power Generation. European Research and Development, Participating Contractors. Report EUR 12359, 151–152.

Keywords: project description

Project: School of Maritime Studies, Terschelling Island, Wadden Islands, the Netherlands

Abstract: In this paper, the results after the optimisation of the Terschelling photovoltaic system are presented. Optimisation was performed in the period 1987-1988 which resulted in significantly improved system performance after that. Additional optimisation and improvements are scheduled for the period from 1988 to 1990. The results should be presented at a workshop in 1990.

- **TREBLE, Fred C.** 1985. The CEC Photovoltaic Pilot Projects. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 474–480.

Keywords: project overview, project evaluation

Projects: Pellworm Island, Germany; Vulcano Island, Giglio Island, San Nicola Island, Tremiti Islands, Italy; Marchwood, UK; Fota Island, Ireland; Terschelling Island, the Netherlands; Kythnos Island, Aghia Roumelli, Crete, Greece; Chevetogne, Hoboken, Belgium; Mont Bouquet, Nice, Rondulinu, Paomia, Corsica, France; Kaw, French Guyana, South America

Abstract: The fifteen photovoltaic pilot plants financed by the Commission of the European Communities (DG XII) commissioned as part of its second four year Energy R&D Programme (1979-83) are briefly presented in this paper. The total costs were ECU 22 million, whereas the project size ranged from 30 to 300 kWp. A brief description of all 15 systems is given, including location, array features, and power conditioners. Some known quality and reliability issues are also discussed.

1985 – 1989

- **WATANABE, M., T. MARUYAMA, H. SAWAI, T. TSUJI, M. KANESHIMA and T. TANAKA.** 1989. A 10 kW Marine Photovoltaic System for Aquaculture. In: Clean and Safe Energy Forever, Proceedings of the 1989 Congress of the International Solar Energy Society, Kobe City, Japan, 4–8 September 1989, 1, 332–335.

DOI: 10.1016/B978-0-08-037193-1.50070-7

Keywords: project description

Abstract: A 10 kW marine photovoltaic system for aquaculture commissioned in August 1986 is presented in this paper. A solar array is mounted on the deck of the barge which also includes battery storage, inverters, control units and data acquisition equipment. The system is described and monthly operating results from October 1986 to March 1989 are presented. The project is important because it represents a preliminary study for MW ranged large-scale floating photovoltaic power plants constructed and commissioned after that worldwide.

- **WRIXON, Gerard T, and S. McCARTHY.** 1985. Field Experience of a 50 kWp Photovoltaic Array at Fota Island. In: Sixth E. C. Photovoltaic Solar Energy Conference Proceedings, London, 15–19 April 1985, 491–495.

Keywords: project description, project evaluation, case study

Project: Dairy Farm, Fota Island, Ireland

Abstract: The Fotavoltaic Project 50 kWp photovoltaic system supplies electrical energy to a 250 head dairy farm on Fota Island, Cork, Ireland. The system was commissioned in June 1983 and data recording began in January 1984. In this paper, the operating experiences, issues and improvements during operation are presented. Some improvements include reducing the large starting currents of induction motors using star/delta starting on all motors, power factor correction capacitors installed in all motors and the use of voltage/frequency control. The failures of the monitoring system were also caused by improper grounding. The monitoring data is recorded but also sent to a 20 km remote site with the VAX 11/780 system at the National Microelectronics Research Centre (NMRC), where the main parameters are presented on the screen.

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **LUQUE, Antonio, G. SALA, Wolfgang PALZ, G. DOS SANTOS and Peter HELM. Eds.** 1991. Tenth E. C. Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Lisbon, Portugal, 8–12 April 1991. Brussels: Commission of the European Communities, D. Kluwer Academic Publishers, ISBN 0-7923-1389-5.

  DOI: 10.1007/978-94-011-3622-8

- **GUIMARÃES, Leopoldo, Wolfgang PALZ, C. DE REYFF and Peter HELM. Eds.** 1992. Eleventh E. C. Photovoltaic Solar Energy Conference, Montreux, Switzerland, 12–16 October 1992. Brussels: Commission of the European Communities; Chur: Harwood Academic Publishers, ISBN 371865380X.

- **HILL, Robert, Wolfgang PALZ and Peter HELM. Eds.** 1994. Twelfth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Amsterdam, the Netherlands 11–15 April, 1994. Brussels: Commission of the European Communities, James & James, ISBN 978-0952145240.

PROCEEDINGS – IEEE Photovoltaic Specialists Conferences

- **IEEE.** 1990. The Conference Record of the Twenty First IEEE Photovoltaic Specialists Conference 1990. Volume 1–2. Kissimmee, FL, 21–25 May 1990. ISSN 0160-8371.

- **IEEE.** 1991. The Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference 1991. Volume 1–2. Las Vegas, NV, 7–11 October 1991. ISBN 0-87942-636-5.

- **IEEE.** 1992. The Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference 1992. Las Vegas, NV, 7–11 October 1991. ISBN 0-87942-636-5.

- **SCHWARTZ, Richard J. Ed.** 1993. The Conference Record of the Twenty Third IEEE Photovoltaic Specialists Conference 1993. Louisville, KY, 10–14 May 1993. ISBN 0-7803-1220-1.

PROCEEDINGS – World Conference on Photovoltaic Energy Conversion

- **IEEE.** 1994. IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, 1994. Waikoloa, HI, USA, 5–9 December 1994. Volumes 1-2, ISBN: 0-7803-1460-3.

PROCEEDINGS – International Solar Energy Society, ISES

- **ARDEN, M. E., Susan M. A. BURLEY and Martha COLEMAN. Eds.** 1992. Solar World Congress: Proceedings of the Biennial Congress of the International Solar Energy Society, Denver, Colorado, USA, 19–23 August 1991. Boulder, CO: American Solar Energy Society. ISBN 0-08-041690-x.

  URL: http://www.sciencedirect.com/science/book/9780080416908/1991-solar-world-congress (10 August 2018)

- **IMRE László and András BITAI. Eds.** 1994. Harmony with Nature. Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993. Volume 1, Energy Policy, Environment, Education. Budapest: Hungarian Solar Energy Society, 1994.

- **FARKAS István. Ed.** 1994. Harmony with Nature. Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993. Volume 2, Radiation, Meteorology, Fundamentals. Budapest: Hungarian Solar Energy Society, 1994.

- **PÁLFY Miklós. Ed.** 1994. Harmony with Nature. Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993. Volume 3, Photovoltaics. Budapest: Hungarian Solar Energy Society, 1994.

PROCEEDINGS – American Solar Energy Society, ASES

- **BURLEY, Susan M. and Martha J. COLEMAN. Eds.** 1990. Proceedings of Solar '90 - the 1990 American Solar Energy Society Annual Conference, Austin, TX, 19–22 March 1990. ISBN 0895531631.

- **BURLEY, Susan M. and M. E. ARDEN. Eds.** 1992. Proceedings of Solar '92 - the 1992 American Solar Energy Society Annual Conference, Cocoa Beach, FL, 15–18 June 1992. ISBN 089553164X.

- **BURLEY, Susan M. and M. E. ARDEN. Eds.** 1993. Proceedings of Solar '93 - the 1993 American Solar Energy Society Annual Conference, Washington, DC, 22–28 April 1993. ISBN 0895531658.

- **BURLEY, Susan M., M. E. ARDEN, Rebecca CAMPBELL-HOWE and B. WILKINS-CROWDER. Eds.** 1994. Proceedings of Solar '94 - the 1994 American Solar Energy Society Annual Conference, San Jose, CA, 25–30 June 1994 (On the Proceedings cover 27–30 June 1994 is given as event date). ISBN 0895531666.

1990 – 1994

PROCEEDINGS – Symposium Photovoltaische Solarenergie, Bad Staffelstein

- **OTTI.** 1990. Fünftes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 1990. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

- **ECKARDT, Günther and Adolf GOETZBERGER Eds.** 1991. Sechstes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 6–8 March 1991. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

- **GOETZBERGER, Adolf Ed.** 1992. Siebtes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 18–20 March 1992. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

- **GOETZBERGER, Adolf Ed.** 1993. Achtes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 17–19 March 1993. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

- **GOETZBERGER, Adolf Ed.** 1994. Neuntes Symposium Photovoltaische Solarenergie, Staffelstein, 16–18 March 1994. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

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- **CARATTI, G., W. SHOCK and M. REIS. Eds.** 1990. Photovoltaic Power Generation, European Research and Development; Participating Contractors in the R&D Programme of the Commission of the European Communities 1989. Brussels: Commission of the European Communities, Directorate-General XII Science, Research and Development, ISBN 92-826-1225-2.

- **GILLET, W. B., R. J. HACKER and W. KAUT. Eds.** 1991. Photovoltaic Demonstration Projects, Fourth Contractors' Meeting Proceedings, Brussels, Belgium, 21–22 November 1989. Brussels: Commission of the European Communities, Directorate-General for Energy, ISBN 92-826-1816-1.

- **GILLET, W. B., R. J. HACKER and W. KAUT. Eds.** 1991. Photovoltaic Demonstration Projects, Proceedings of the Fifth Contractors' Meeting, Ispra, Italy, 22–24 May 1991. Luxembourg: Office for Official Publications of the European Communities, ISBN 92-826-3429-9.

- **ZERVOS, A. Ed.** 1993. Photovoltaic Power Systems Technology; Proceedings of the First Contractors Meeting for PV Systems Projects, Munich, 11–12 February 1993, Solar R&D Programme, JOULE II, 1991–1994, Commission of the European Communities.

- **HACKER, R.J., D. K. MUNRO and W. KAUT. Eds.** 1994. Photovoltaic Demonstration Projects. Sixth Contractors' Meeting Proceedings, Ispra, Italy, 23–24 March 1993. Brussels: Commission of the European Communities, Directorate-General for Energy, ISBN 92-826-2569-9.

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- **Interatom GmbH, Hellenic Telecommunications Organization SA (OTE).** 1994. Photovoltaic Installation of the RF Station Antikythira. Final Report, Contract No SE/704/83/HE. Luxembourg: European Commission, Office for Official Publications of the European Communities. ISBN 92-826-7445-2.

- **PODBIELSKI, V. and D. SHAFF.** 1994. The Photovoltaic Higher Education National Exemplar Facility (PHENEF) at Georgetown University. Final Project Report. Prepared for US Department of Energy. Grant No. DE-FG05-80CS83014.

  URL: http://adsabs.harvard.edu/abs/1994STIN...9521409P (6 February 2016)

- **STEELE, R. Ed.** 1990. 1989–1990 PVUSA Progress Report. Mountain View, CA: Strategies Unlimited.

  URL: http://www.osti.gov/scitech/servlets/purl/10163193 (5 April 2016)

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- **BÖER, K. W. Ed.** 1990. Advances in Solar Energy, 6, 126-189. Boulder, CO: American Solar Energy Society, New York, London: Plenum Press. ISBN 978-1-4613-9950-6.

  DOI: 10.1007/978-1-4613-9948-3

JOURNAL AND CONFERENCE PAPERS

- **ADAMI, G., Giancarlo ZAMBONI, R. BISSOLI, Matthew IMAMURA and M. BÄCHLER.** 1992. Recent Results of Experimentations at Zambelli Pilot Plant Involving PV Array, Battery and Real-Time Monitoring. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1271–1275.

  Keywords: project evaluation, water pumping

  Project: Zambelli, Verona, Italy

  Abstract: In this paper, the operating performance of the Zambelli photovoltaic water pumping station after six years of operation is discussed. The Zambelli photovoltaic water pumping station is the largest of its kind. Operational results are given for the year 1991 and until August 1992. The analysed data includes plant availability, the photovoltaic array utilisation factor, the pumping utilisation factor, the total volume of water pumped and the number of key failures. Additionally, the produced energy, capability, utilisation factor, inverter energy output, inverter efficiency, UPS battery performance and pumping performance are presented in the table and discussed. The project also includes an array degradation assessment, which is still ongoing. The battery monitoring system, battery performance analysis and battery problems are also discussed in the paper.

1990 – 1994

- **ARCIDIACONO, V., S. CORSI and L. LAMBRI.** 1994. The Control System of Enel's 3.3 MWp PV Plant. In: IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, 1994. Waikoloa, HI, USA, 5–9 December 1994, 1, 1089–1093.

  DOI: 10.1109/WCPEC.1994.520151

  Keywords: project description

  Project: Serre, Salerno, Italy

  Abstract: The control system of ENEL's first photovoltaic power plant located at Serre, Salerno, Italy, is described in this paper. The power plant consists of ten subarrays of 330 kWp each. The control system consists of ten peripheral controllers, one for each 550 kVA inverter housed at the subfields' cabins, and one central monitoring and data acquisition system installed in the central control room. The peripheral controllers are connected to the central system in the control room by an Ethernet, fibre optic LAN connection. The control system is based on a MicroVax workstation, with 40 Mb RAM and a 95 MB hard disk drive. Some images and schematics of the control system and equipment are also given in the paper.

- **BARLOCCI, A., L. BARRA, Salvatore CASTELLO and C. MESSANA.** 1991. A Standard 100 kW Photovoltaic System for Grid Connected and Stand Alone Applications. In: Biennial Congress of the International Solar Energy Society, Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 149–154.

  DOI: 10.1016/B978-0-08-041696-0.50033-4

  Keywords: project description, ENEL

  Project: Delphos 2, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: This paper presents a design for a standardised 100 kW photovoltaic power plant known as the Photovoltaic Low-Cost Utility Generator (PLUG), developed for the Italian demonstration programme of medium size applications. Construction costs are minimised by the use of standardised and preassembled power plant subsystems. An overall efficiency of 96% is expected on the basis of the preliminary studies.

- **BARRA, L., Salvatore CASTELLO and C. MESSANA.** 1991. Design and Development of a Standard 100 kW Photovoltaic System. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1285–1288.

  DOI: 10.1007/978-94-011-3622-8_321

  Keywords: project description

  Project: Delphos 2, Manfredonia, Monte Aquilone, Foggia; Casaccia, Sicily, Italy

  Abstract: In this paper, a standardised concept of a 100 kW photovoltaic system is presented. Systems of this type were designed to be used in larger power plants like the later Delphos and Casaccia. A 100 kW array with 490 V output voltage consists of 26 strings. The power conditioning units are three-phase thyristor inverters. The scalable system consists of standardised components and subsystems and is also useful in larger systems.

- **BECKER, Karlheinz, Robert KRÖNI and Peter TOGGWEILER.** 1994. A 200 kW Building-Integrated Power Plant on a New UBS-Administration Building near Lugano, Switzerland. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 2, 1903–1906.

  Keywords: project description, case study

  Project: UBS Bank, Administration Building Lugano, Lugano, Switzerland

  Abstract: The new UBS office building, under construction in Suglio near Lugano, Switzerland, is described in this paper. The photovoltaic roof and façade mounted system with 200 kWp array is also part of the project. The expected energy yield is about 240 MWh annually. Modules without frames should be used for the roof array. The system should be connected to the grid through two 70 kW, three 15 kW and one 12 kW inverter.

- **BEYER, Ulrich, B. DIETRICH, Ralf POTTBROCK and A. LOTFI.** 1990. 340 kWp – Photovoltaikanlage im Netzgekoppelten Betrieb. Ergebnisse des Ersten Betriebjahres. In: Fünftes Nationales Symposium Photovoltaische Solarenergie. Staffelstein, 14–16 March, 1990, 57–62.

  Keywords: project description, case study

  Project: Kobern-Gondorf, Germany

  Abstract: The Kobern-Gondorf photovoltaic power plant was commissioned on 7th October 1988, with a test period until March 1989. The solar array consists of eight subarrays. Module efficiencies are presented in comparison to supplier data. In this paper, the operating experience of the inverters, mounting structures and the entire energy yield in comparison to the simulated values are also presented and discussed. A cost analysis is also given. For a 100 kWp part, the relative cost shares are: solar modules 36%, mounting structures 9%, module mounting 7%, wiring and electrical equipment 19%.

- **BEYER, Ulrich, B. DIETRICH, Rolf HOTOPP and Ralf POTTBROCK.** 1991. Operating Results of the 340 kWp Plant "Kobem-Gondorf". Design and Construction of the 330 kWp Plant "Neurather See". In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1281–1284.

  DOI: 10.1007/978-94-011-3622-8_320

  Keywords: project description, case study

  Project: Kobern-Gondorf, Neurather See, Germany

  Abstract: This paper presents the 340 kW Kobern-Gondorf photovoltaic power plant commissioned in 1988. The power plant is grid-connected without energy storage. The array consists of 7,704 solar modules and is divided into three 100 kW arrays with 380 V DC output voltage and five smaller arrays with varying output voltages. Different solar cell types are used in the arrays. Each array is connected to its own inverter, whereas in total nine inverters ranging in power from 1.3 kW to 80 kW are used in the system. Module performance and cost analysis are also given in the paper. The Neurather See power plant was commissioned in June 1991. The array consists of 3,850 solar modules and three subarrays with an 800 V nominal voltage. For the Neurather See power plant 360 kW, a central inverter was proposed. Some environmental aspects of the site are also discussed in the paper

- **BEYER, Ulrich and Ralf POTTBROCK.** 1991. RWE – Photovoltaikprojekt "Neurather See"; Planung und Bau eines 360 kWp-Photovoltaikkraftwerks. Sechstes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 6–8 March 1991, 364–370.

  Keywords: project description, case study

  Project: Neurather See, Germany

  Abstract: The Neurather See photovoltaic power plant in Germany, under construction, is described in this paper. The test operation is scheduled for June 1991. The photovoltaic array consists of 3,850 solar modules divided into six sub-arrays. The main purpose of this project was the demonstration of a possible cost reduction. Some data about the modules used in this project and sub-arrays are also given. Other data like a short description of inverters, ecological aspects and a description of the scientific programme in cooperation with Rheinisch-Westfälischen Technischen Hochschule in Aachen are also discussed.

- **BEYER, Ulrich, Ralf POTTBROCK and Rainer VOERMANS.** 1992. 1 MW Photovoltaic Project - Planning, Construction and Operation of Photovoltaic Power Plants. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1221–1224.

  Keywords: project description, case study

  Projects: Kobern-Gondorf, Neurather See, Germany

  Abstract: In this paper, the Kobern-Gondorf and Neurather See photovoltaic power plants in Germany are presented. Electrical block diagrams for both systems are given; the operating results and performances are also discussed. Issues related to the main module and the inverter are presented. The utilisation ratio of the solar generator is evaluated and the inverter efficiency estimation is given. Topics relevant to structural engineering are presented and a detailed cost evaluation is given. The power plant costs were DEM 16,300/kWh for a 350 kW system. A photo of the Kobern-Gondorf photovoltaic power plant is also presented in the paper.

- **BOGANI, M., L. LORI and P. REDI.** 1994. PV Systems for the Railway Lines around Siena. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 863–866.

  Keywords: project description

  Abstract: Photovoltaic systems for powering railway systems along the Pisa-Vada and Cecina-Saline di Volterra tracks are described in this paper. The main purpose of these systems with an approximate 7 kW power capacity is to supply various security-relevant railway systems.

- **BRACK, M., D. WUILLEMIN and W. DURISCH.** 1992. Experience and Albedo Measurement with a Grid-Connected PV-plant in the Swiss Alps. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1327–1330.

  Keywords: project evaluation

  Project: Titlis-Stand, Engelberg, Switzerland

  Abstract: The results of the Albedo measurement and the performance assessment of a grid-connected 2.4 kWp photovoltaic power plant located at a high altitude in the Swiss Alps is given in this paper.

- **BROCKE, W. A. and H. BARTHELS.** 1993. Simulation and Design of the Energy Management System for the Jülich Solar-Hydrogen Plant. In: Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993, 2, 431–436.

  Keywords: project evaluation, solar hydrogen

  Projects: Jülich Solar-Hydrogen Project, Germany

  Abstract: The Jülich solar hydrogen power plant should supply the Central Library building at the Jülich, Kernforschungsanlage Jülich des Landes Nordrhein-Westfalen - KFA site. The simulation results and the design of the energy management system are discussed and presented in detail in this paper.

- **CANDELARIO, Tammie R., Steve L. HESTER, Tim U. TOWNSEND and Dan J. SHIPMAN.** 1991. PVUSA-performance, experience, and cost (PV power systems). In: Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference, Las Vegas, NV, 7–11 October 1991, 1, 493–500.

  DOI: 10.1109/PVSC.1991.169264

  Keywords: project overview

  Project: Davis, California, USA

  Abstract: With the main focus on the photovoltaic power plants in Davis, California and Maui, Hawaii, all parts of the PVUSA projects, the operational performance is analysed and discussed. The capacity factor and array DC efficiencies are evaluated for the time period from January 1989 to July 1991. The generated output in comparison to solar irradiation is also presented. The cost per watt of the installed power capacity is also discussed and evaluated.

- **CANDELARIO, Tammie R. and Tim TOWNSEND.** 1993. PVUSA – Progress and Plans. In: Proceedings of Solar '93 - the 1993 American Solar Energy Society Annual Conference, Washington, DC, 22–28 April 1993, 135–140.

  Keywords: project overview

  Projects: Kerman City, California; Davis, California, USA

  Abstract: In this paper, the PVUSA project overview is given. A brief description of the Davis photovoltaic system under construction and the Kerman photovoltaic project are also given. An artist's rendering of the Kerman power plant is also presented in the paper.

- **CASTELLO, Salvatore, M. GUERRA, Saverio Li CAUSI, C. MESSANA, G. NOVIELLO and A. SARNO.** 1992. Preliminary Analysis of Plug Performance: Delphos and Casaccia Plant Operation Data. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1005–1008.

  Keywords: project description, case study

  Projects: Delphos 1, Delphos 2, Manfredonia, Monte Aquilone, Foggia; ENEA Casaccia Center, Casaccia, Italy

  Abstract: The Delphos and Casaccia photovoltaic power plants are briefly described in this paper. The operating electrical performance for both power plants is assessed and evaluated in the paper. The monthly values of the array efficiencies and system efficiencies for the time period from April to September 1992 are presented. A mathematical evaluation of power versus irradiance and an expression of curve fitting are also given. Power plant availability and monthly energy production are also presented.

- **CLAVADETSCHER, Luzi and Thomas NORDMANN.** 1992. Voraussage und Effektiver Ertrag der 100 kW Netz-Verbundanlage N13 nach 2 Jahren Betrieb. Poster. In: Siebtes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 18–20 March 1992, 411–418.

  Keywords: project evaluation, case study, noise barriers

  Project: Photovoltaic noise barrier, N13/A13 motorway, Domat-Ems, Chur, Switzerland

  Abstract: In this paper, the operating results of a photovoltaic noise barrier along the N13/A13 motorway in Switzerland are presented. Based on solar radiation modelling, the yield and yield loss were evaluated for the period from September 1990 to August 1991. System efficiency was also calculated. The monthly values for the yield, system losses and array losses are given for the period from January 1990 to December 1991. The whole system losses are estimated to be 21.8%. The relative shares of the losses are also presented - they include inverter losses, module temperature losses, string losses, diode losses, DC losses, standby inverter losses and AC losses.

- **CORVI, C., R. VIGOTTI, Alberto ILICETO and A. PREVI.** 1991. ENEL's 3-MW PV Power Station Preliminary Design. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1277–1280.

  DOI: 10.1007/978-94-011-3622-8_319

  Keywords: preliminary study

  Project: Serre, Salerno, Italy

  Abstract: In this paper, a technical description of the Serre photovoltaic power plant in Salerno is presented. The proposed project would consist of 330 kW subarrays each with a line commutated inverter. Modules with 90 Wp or 100 Wp power capacity are proposed. The power plant should be connected through a transformer to the 20 kV public grid. This paper presents the main technical characteristics of the proposed project in its preliminary design phase, and the available information on the principal components.

- **CORVI, C., R. VIGOTTI, Alberto ILICETO and A. PREVI.** 1991. ENEL's 3-MW PV Power Station Preliminary Design. In: Biennial Congress of the International Solar Energy Society, Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 337–342.

  DOI: 10.1016/B978-0-08-041696-0.50063-2

  Keywords: preliminary study

  Project: Serre, Salerno, Italy

  Abstract: The design of the proposed MW-ranged photovoltaic power plant to be located in Serre, Salerno, Italy is presented in this paper. The main design considerations in this study are the module tilt angle and converter efficiency. Based on these parameters, a small area and a power level as close to the specified peak power in winter conditions are desired. An electrical diagram of the subarrays is given in the paper – the proposed power plant should consist of ten 330 kWp subarrays. Two proposed alternative wirings are presented, one with a mid-point ground and another with two stages and a grounded lower side. The module array wiring is also presented. Each subarray should be connected to an inverter and then through a transformer to a 20 kV grid.

- **COTTIER, Jean-Marc.** 1992. 10 kW Photovoltaic Roof with Large Sized PV Shingles for a Commericial Building. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1455–1458.

  Keywords: project description, BIPV, roof integrated

  Project: Digital Equipment, Geneve, Switzerland

  Abstract: A roof-integrated photovoltaic array on a commercial building in Geneva, Switzerland is briefly presented in this paper.

- **DI NUZZO, M., A. GAETA and P. REDI.** 1991. Cecina-Saline di Volterra, Railway Line Demonstration PV Plant. In: Photovoltaic Demonstration Projects, Proceedings of the Fifth Contractors' Meeting, Ispra, Italy, 22–24 May 1991, 182–185.

  Keywords: project description

  Project: railway line, Cecina-Saline di Volterra, Italy

  Abstract: In this paper, a description of the 7.2 kWp photovoltaic power plant for the Cecina-Saline di Volterra railway line is given. The purpose of the system is to supply the automation systems of the railway infrastructure. The system also includes a battery bank for 12 days of autonomous operation.

- **DI NUZZO, M., A. GAETA and P. REDI.** 1991. Photovoltaic Power for the Railway System near Siena. In: Photovoltaic Demonstration Projects, Proceedings of the Fifth Contractors' Meeting, Ispra, Italy, 22–24 May 1991, 186–189.

  Keywords: project description

  Abstract: This paper presents the photovoltaic system located near the railway lines of South Tuscany that connect small villages between Siena, Grosseto and Cecina. The system power is 3.6 kWp and the system also includes a battery bank. A description of the system including the solar array and monitoring system is also given in the paper.

1990 – 1994

- **DIEFENBACH, Günter.** 1993. Utilization of Land in Harmony with Nature at Centralized PV Plants - Ecological Results of Kobern-Gondorf 340 kW Plant. In: Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993, 1, 221–226.

  Keywords: project evaluation

  Project: Kobern-Gondorf, Germany

  Abstract: The Kobern-Gondorf photovoltaic power plant project was also combined with an environmental project. About 5.5 hectares of land were converted into a nature preserve. 303 different butterfly species were counted on the site, including 52 endangered species. The site was ready for colonisation in 1988. This paper gives a detailed description of the species including butterflies, grasshoppers, birds and snakes. The study has concluded that the soil has a significant impact on the species on site. Recommendations for environmental measures regarding land utilization for large-scale photovoltaic power plants are also summarised in this paper.

- **DOLLARD, Carol J. and William A. EMSLIE.** 1990. Photovoltaic Pilot Plant. In: Proceedings of Solar '90 - the 1990 American Solar Energy Society Annual Conference, Austin, TX, 19–22 March 1990, 235–239.

  Keywords: project description

  Project: Platte River Power Authority PV Project, Colorado, USA

  Abstract: The Platte River Power Authority PV Project was commissioned on 29th October 1987. It consists of four subsystems with 10 kW total power capacity. In this paper, the construction and start-up details are given, the system parts are described and the operating results from June 1988 to December 1989 are presented.

- **DREWES, Per.** 1992. The Hugh MacMillan Rehabilitation Centre Photovoltaic Project. In: 18th Annual Conference of the Solar Energy Society of Canada Proceedings, Edmonton, Alberta, 4–8 July 1992, 8–12.

  Keywords: project description

  Project: Hugh MacMillan Rehabilitation Centre Photovoltaic Project, Toronto, Ontario, Canada

  Abstract: The Hugh MacMillan Rehabilitation Centre Photovoltaic Project under construction in Toronto is described in this paper. It is installed on the roof of the children's hospital and was the largest photovoltaic system in Canada at the time of installation. It has a 100 kWp array and is divided into four 25 kWp subunits. Each subunit should use other module technology, mono- and polycrystalline modules and new technologies like thin film modules and modules with spherical solar cells. Module tilt is optimised for peak demand in the summer months. Power conditioners are required to interface with the hospital's three-phase grounded Y 600/346 V AC grid. It is planned to commission the first two systems by mid-1992 and to add another two in 1993.

- **GORDON, J. M. and Howard J. WENGER.** 1991. On Optimizing Central-Station Photovoltaic Solar Power Systems: The Role of Field Layout, Shading, Tracking and Array Geometry. In: Biennial Congress of the International Solar Energy Society, Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 125–130.

  DOI: 10.1016/B978-0-08-041696-0.50029-2

  Keywords: preliminary study

  Abstract: In this paper, the optimization methods of large-scale photovoltaic power plants are presented. Particular attention is paid to ground cover ratio, field geometry and array geometry. Losses are estimated and evaluated in comparison to the ground cover ratio, and the maximum rotating angle of the tracking systems is given in graphical form. The width to height ratio of the solar array, also known as the aspect ratio, and shading losses are also evaluated. The main conclusion of the paper is that sensitivity to the key design parameters can only be predicted accurately by calculating the energy generated.

- **HÄCHLER, Raimund and Thomas NORDMANN.** 1991. 100 kW Grid Connected PV-Installation Along Rail Infrastructure in Southern Switzerland - A Feasibility Study. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 738–741.

  DOI: 10.1007/978-94-011-3622-8_189

  Keywords: preliminary study

  Project: MBB Magadino project, Locarno, Switzerland

  Abstract: Based on the experience from the 100 kW photovoltaic system along the N13 motorway system, a proposal for a 100 kW system along the Belizona-Locarno railway track is given in this paper. Modules should be mounted along the railway track along with a heat pipeline for district heating. Technical details about the support structure, site details and costs are also given in the paper. The preliminary study of the electromagnetic interference between the DC PV-installation and the nearby high voltage electric railway line is also being carried out at a test site.

- **HÄCHLER, Raimund and Thomas NORDMANN.** 1992. 100 kW Grid Connected PV-Installation Along Rail Infrastructure in Southern Switzerland - Project and Realization. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1213–1216.

  Keywords: project description, case study

  Project: MBB Magadino project, Locarno, Switzerland

  Abstract: The project description and installation experience of the 100 kW photovoltaic power plant along the Belinzona-Locarno railway in Switzerland is given in this paper. After the feasibility study was finished in 1991, the project was realised in 1992 and commissioned in late autumn of the same year. Some details of the mechanical and electrical design of the power plant are presented in the paper and a cost estimation is given. The total construction cost of the system was SFR 1.95 million. A detailed description of the inverters and measuring equipment is also given in the paper.

1990 – 1994

- **HOFFNER, John E.** 1990. The First Two Years of Operations for Austin's 300-kilowatt Photovoltaic Plant. In: 25th Intersociety Energy Conversion Engineering Conference Proceedings, IECEC-90, Reno, NV, 12–17 August 1990, 5, 56–59.

  Keywords: project description, project evaluation, case study

  Project: 3M facility, Austin, Texas, USA

  Abstract: This paper presents an analysis of Austin's 300 kW photovoltaic power plant in the two-year period from January 1988 to December 1989. For this period, detailed data for each month is presented, including the energy yield, power plant reliability, power plant availability and capacity factor. Power plant operation was very reliable in the monitored period with availability greater than 99% and very little performance degradation. Maintenance efforts and events are also discussed. The maintenance costs were less than 0.5 cent/kWh.

- **HOFFNER, John E.** 1991. Description and Performance of Austin's Two, 300-Kilowatt Photovoltaic Plants. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1289–1292.

  DOI: 10.1007/978-94-011-3622-8_322

  Keywords: project description, project evaluation, case study

  Project: PV300, 3M facility, Austin, Texas, USA

  Abstract: Two photovoltaic plants located in Austin, TX are presented in this paper. The flat plate solar array PV300 with modules mounted on single-axis passive trackers is ground mounted and was commissioned in July 1986. The rated power capacity of the system is 250 kW AC. The concentrator system 3M facility Austin, with a rated power of 248 kW AC was put into service in June 1990. It uses fresnel-lens concentrators and dual-axis trackers. Some aspects of energy gain and energy production are also discussed. Both projects are part of the Research and Demonstration Programme of the City of Austin's Electric Utility Department, with the main purpose of examining applications of photovoltaics for electric generation.

- **HOFFNER, John E.** 1991. Performance of Austin's 300-Kilowatt Photovoltaic Power Plants. In: Biennial Congress of the International Solar Energy Society Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 119–124.

  DOI: 10.1016/B978-0-08-041696-0.50028-0

  Keywords: project description, project evaluation, case study

  Project: PV300, 3M facility, Austin, Texas, USA

  Abstract: The operating performances of two large-scale photovoltaic plants installed in Austin, Texas are presented and compared in this paper. The PV300 photovoltaic power plant is ground mounted and uses varying technologies and single axis trackers. The 3M concentrator photovoltaic power plant is installed on top of a four-level parking garage at the 3M Austin center and uses two-axis trackers. Solar radiation data is also analysed and peak energy production and demand are also discussed and presented. The performance of the flat plate array was better than that of the concentrator array, which could be a sign that the location in Austin is not the best for concentrator arrays.

- **HOFFNER, John E. and Carlos GARCIA-VELEZ.** 1990. Construction and Start-up of the 3M/Austin Concentrating Protovoltaic Plant. In: 25th Intersociety Energy Conversion Engineering Conference Proceedings, IECEC-90, Reno, NV, 12–17 August 1990, 5, 28–30.

  Keywords: project description, case study, project evaluation

  Project: PV300, 3M facility, Austin, Texas, USA

  Abstract: In this paper, some construction details of a 300 kW concentrating photovoltaic power plant are presented. The power plant, which is being constructed at the 3M Center in Austin, Texas through a unique public/private partnership, is located on the upper levels of a parking ramp that was completed in 1988. The concentrating lenses are installed on 720 individual modules, or collectors, assembled in 12 rows, each row including 60 modules. A particularly significant part of the project was that it is a private/public partnership, which was recognised as a suitable model for photovoltaic projects in the future.

- **HOTOPP, Rolf.** 1991. Housing Estate in Germany with 25 Photovoltaic Roofs. In: Proceedings of the ISES Solar World Congress, Budapest, 23–27 August 1993, 3, 123–130.

  Keywords: project description, case study, distributed, housing estate

  Project: Housing estate, Essen, Germany

  Abstract: A photovoltaic roof-mounted system proposed for 25 existing houses in Essen is described in this paper. Grid-connected systems with 2 kWp each should be installed in the spring of 1994. In the paper, a detailed electrical description of the proposed system is given. Particular attention is given to the requirements for the commission of blocking diodes; grid perturbations are also discussed.

- **ILICETO, Alberto, A. PREVI, S. CORSI, G. BELCASTRO and R. VIGOTTI.** 1992. Progress Report on the 3.3 MWp Photovoltaic Plant Being Set Up by ENEL at Serre (Southern Italy). In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1217–1220.

  Keywords: project description

  Project: Serre, Salerno, Italy

  Abstract: A description of the Serre photovoltaic power plant, under construction and scheduled to be completed in 1994, is presented in this paper. A graphical representation of the power plant under construction is also given. A general description, block diagrams and details of the supporting structure are described in the paper. Some details of the civil construction work are presented - 700 tons of steel and 2600 m^3 of forced concrete are required per subfield. The estimated cost is ECU 7,000/kWp, with a module cost of about 60% of the total cost – a detailed cost structure is also presented in the paper.

- **ILICETO, Alberto, A. PREVI, V. ARCIDIACONO and S. CORSI.** 1994. Progress Report on ENEL's 3.3 MWp PV Plant. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 2, 1167–1170.

  Keywords: project description

  Project: Serre, Salerno, Italy

  Abstract: The Serre photovoltaic power plant, constructed in 1991 at Serre, Salerno, Italy, is described in this paper. The power plant consists of ten 330 kWp subarrays. Different parts of the power plants are described and some photos of the system are also presented. The paper includes a description of the photovoltaic array, DC wiring, inverters, AC wiring, centralised monitoring and control and remote control. Some construction details and a cost analysis are also given.

- **JENNINGS, Christina, Tammie CANDELARIO, Samir BHATNAGAR, Brian FARMER, Antonio REYES, Dan SHIPMAN and Kerry O'BRIEN.** 1993. PV-USA Kerman Costs. In: Conference Record of the Twenty Third IEEE Photovoltaic Specialists Conference, Louisville, KY, 10–14 May, 1993, 1134–1139.

  DOI: 10.1109/PVSC.1993.346964

  Keywords: project description, economics, cost

  Project: Kerman City, California, USA

  Abstract: The Kerman photovoltaic power plant was commissioned in March 1993. In this paper, a detailed construction cost analysis from August 1991 to March 1993 is presented and discussed. Different cost categories are considered in the paper, such as: project management cost, site development cost, electrical infrastructure cost, data acquisition system cost, etc. Project milestones are presented and the monthly costs of project management, site development, electrical infrastructure and the data acquisition system are given. For these categories, relative cost shares are also given for labour, expenses, material and subcontracts.

- **JENNINGS, Christina, Antonio B. REYES and Kerry P. O'BRIEN.** 1994. PVUSA Utility-Scale System Capital and Maintenance Costs. In: Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, Waikoloa, HI, 5–9 December, 1994, 1, 754–758.

  DOI: 10.1109/WCPEC.1994.520069

  Keywords: project evaluation, economics, cost, PVUSA

  Projects: Kerman City, Davis, California, USA

  Abstract: In this paper, detailed capital and maintenance costs for the PVUSA projects are given. The actual costs for Davis were USD 10.41/W and for Kerman USD 10.19/W. Maintenance costs include preventive maintenance and failure-related maintenance costs. The main failures were related to power conditioning unit problems and passive tracker reliability. Module problems were rare. Monthly maintenance costs are given for the time period from October 1992 to October 1994 for the Davis power plants and for October 1993 to October 1994 for the Kerman photovoltaic power plant.

- **JIMENEZ, C., E. LORENZO and Beatriz YORDI.** 1994. 100 kWp Tracking PV Plant at the Toledo PV-Project. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 822–824.

  Keywords: project description

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: In this paper, a 100 kWp tracking array, part of the 1 MWp Toledo photovoltaic power plant, is described. The tracking array consists of four north-south oriented horizontal tracking rows with 1,120 modules. Each row includes 280 modules. The trackers are centrally controlled. The system has operated since January 1994. The rows between the trackers are 7.5 m wide so a ground cover ratio of 0.35 is achieved.

- **KÄLIN, Toni.** 1992. Photovoltaik Großprojekte der EWI in der Schweiz. In: Siebtes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 18–20 March 1992, 257–270.

  Keywords: project overview

  Projects: Mont-Soleil, Park+Ride Neufeld, Bern, Switzerland

  Abstract: In this paper, brief descriptions are given of large photovoltaic power plants in Switzerland. The Mont-Soleil power plant with a 560 kWp array is scheduled to be commissioned in the spring of 1992. It should deliver 720 MWh of energy annually. The proposed Moos solar power plant with a 520 kWp array is also briefly described. The Park+Ride photovoltaic power plant in Bern was commissioned in May 1992. The solar array peak power is 75 kWp and the power plant feeds power directly into the 650 V trolleybus DC grid. The solar array consists of 836 modules with 22 modules in each string. The predicted yield of the fully automatically operated Park+Ride power plant is about 76 MWh.

- **KÄLIN, Toni and Max KELLER.** 1992. Solar Photovoltaic Power Plant P+R Neufeld, Bern. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1203–1205.

  Keywords: project description

  Project: Park+Ride Neufeld, Bern, Switzerland

  Abstract: A brief description of the 75 kW photovoltaic power plant located on the roof of the Park & Ride facility in Neufeld, Bern, Switzerland is given in this paper. The system is directly connected to the DC trolleybus grid. The annual energy production should reach 76,000 kWh. The brief description includes an electrical schematic diagram of the power plant and a brief description of the monitoring system.

- **KNÖPFEL, H. and Thomas NORDMANN.** 1992. 24 kW Photovoltaic Interconnected Network Installation to Power the Marzili Funicular Railway, Berne. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1475–1478.

  Keywords: project description, case study

  Project: Marzili Funicular Railway, Berne, Switzerland

  Abstract: The Marzili funicular railway transports passengers from the terrace of the Swiss parliament to the holiday area on the bank of the Aare. In the autumn of 1992, a 24 kW photovoltaic power plant was commissioned that replaced

the previous gravity-driven funicular system. A detailed description of the mechanical and electrical part of the system including electrical block schematics is given in this paper. A yield estimation and site evaluation including a sun path diagram for the selected site is also given in the paper.

- **KOLTUN, M., V. SCHADRIN, A. CHERNYAVSKY and N. KOSHKIN.** 1994. Design of 1 MW Photovoltaic Power Station for Southern Regions of Russia. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 837–839.

  Keywords: preliminary study

  Project: Kislovodsk city, South Russia

  Abstract: This paper describes a 1 MW photovoltaic power plant proposed for the Kislovodsk city region in South Russia. It should be constructed in 1995. Solar parabolic concentrators with a concentration ratio of 20-25 are proposed.

- **KRUSE, C., Hans-Jürgen LOWALT and Karl MAAß.** 1991. Eight Years Experience with the 300 kWp Solar Power Plant on the Island Pellworm (FRG) and the Extension to a 1.25 MW Hybrid System. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 724–727.

  DOI: 10.1007/978-94-011-3622-8_186

  Keywords: project description, case study, project evaluation

  Project: Pellworm Island, North Frisian Islands, Germany

  Abstract: The Pellworm photovoltaic power plant was commissioned in 1983. In this paper, the operating experiences after eight years of operation are discussed and presented. For the purpose of monitoring, the 300 kWp solar array is divided into 21 groups. For grid connection, a 450 kVA line commutated inverter is used; two 75 kVA self-commutated thyristor inverters are also part of the system. Several improvements were made during the system operation, such as improvements to the monitoring software, as well as the installation of a remote monitoring panel in the recreation centre and a modem for remote data transfer. In 1988, three 33 kW wind generators were also installed, so Pellworm became a hybrid system. Plans for an additional expansion of the solar arrays and wind generators with a total power of 1.25 MW are also discussed in the paper.

- **LAUKAMP, Hermann, W. LEITHOLD and U. REHG.** 1994. "Solarzentrum Freiburg" - Europe's First Photovoltaic Structural Glazing Facade. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 928–934.

  Keywords: project description, case study, BIPV, façade

  Project: Solarzentrum Freiburg, Freiburg, Germany

  Abstract: In this paper, Europe's first structural glazing 9 kWp photovoltaic façade is described. It was built into the façade of Solarzentrum Freiburg's office building. Technical details of the system and the first operating results are also presented.

- **LEIDNER, Jean-René and Igor MISEREZ.** 1992. Measurement Infrastructure at the 500 kW Power Plant PHALK Mt.Soleil and Associated R&D Program, In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1298–1299.

  Keywords: project evaluation

  Project: Mont-Soleil, Switzerland

  Abstract: A brief description of the measurement equipment and data management concept for monitoring the Mont-Soleil photovoltaic power plant is given in this paper.

- **LI CAUSI, Saverio, Salvatore CASTELLO and G. MURZILLI.** 1991. Preliminary Operation Data of the Improved Pilot Plant "Isola del Giglio". In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 838–841.

  DOI: 10.1007/978-94-011-3622-8_214

  Keywords: project description, project evaluation, case study, water treatment

  Project: Fosso di Valle, Ortona, Giglio Islands, Tyrrhenian Sea, Italy

  Abstract: This paper briefly describes the operating experience of the 45 kW pilot photovoltaic plant "Isola del Giglio" commissioned in June 1985. The initial plan to use the power plant for the water disinfection system power supply was abandoned and the power plant was used for cold store power supply only. In 1990, configuration of the power plant was modified. The 45 kW array operates at 240 V DC and consists of 18 strings arranged in three subarrays. Two subarrays power the main compressor, while the third one charges the batteries. With the purpose of easier battery load matching, the number of strings in the third subarray is variable. In the case of low solar radiation or a low state of charge, each subfield can be switched to feed the main compressor or the batteries. Important exceptional events and operating data are also discussed in the paper.

- **LORENZO, E. and R. ZILLES.** 1994. PV Modules and Arrays Test at the 1 MW Toledo PV Plant. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 807–809.

  Keywords: project evaluation

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: This paper presents a simple test method for module and array testing, with the main scope being to use this method in a large-scale photovoltaic power plant in Toledo, Spain.

- **MAAß, Karl, Hans-Jürgen LOWALT and Gert NIMZ.** 1992. Energy Supply of the North Sea Island Pellworm by Submarine Cable as well as by Solar and Wind. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1191–1194.

  Keywords: project evaluation, case study, balance of system, energy supply

  Project: Pellworm Island, North Frisian Islands, Germany

1990 – 1994

  Abstract: The Pellworm photovoltaic power plant was commissioned in 1983 as part of a European research programme. The 300 kWp power plant, which operates under extreme climatic conditions, was enlarged with an additional 300 kWp array commissioned in August 1992. Wind generators were also installed so Pellworm became the largest hybrid photovoltaic power plant at the time. Three 33 kW wind generators were commissioned in 1988 and one 300 kW in 1992. Both photovoltaic parts are briefly described in this paper; the project goals are listed and the electrical block schematics of the system are also given. Some photographs of the system are presented and the layout of the submarine power cables is presented in the paper as well.

- **MATLIN, Ronald W. and Daniel S. SHUGAR.** 1994. Performance of a 400 kW_{AC} Thin-Film a:Si Photovoltaic Power Station. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 842–845.

  Keywords: project description, project evaluation, PVUSA

  Project: Davis, California, USA

  Abstract: The operational performance of the 400 kW photovoltaic system located in Davis, California within the Pacific Gas and Electric Company service territory, is given in this paper. Based on power plant monitoring data from 1993, including module performance, array performance, availability and capacity factor, the energy output as a percentage of the possible output and the inverter efficiency are discussed in detail.

- **MINDER, R.** 1992. The Swiss 500 kW Photovoltaic Power Plant PHALK Mont-Soleil. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1009–1013.

  Keywords: project description, case study

  Project: Mont-Soleil, Switzerland

  Abstract: In this paper, a detailed description of the Mont-Soleil photovoltaic power plant project is given. The power plant was commissioned in March 1992. Some images of the mounting structures and array wiring are also included in the paper. Other parts of the power plants are also described. A brief overview of the operating experience and economic evaluation including the cost of the project is also discussed in the paper.

- **MOSCHELLA, U. and U. ROCCA.** 1994. Technical Characteristics and Initial Field Testing of the 1 MW "ELIO 1" Photovoltaic Plant. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 2, 1171–1175.

  Keywords: project description, case study

  Project: ELIO 1, Vasto, Italy

  Abstract: In this paper, the technical characteristics of the ELIO1 photovoltaic power plant located in Vasto on the Adriatic coast of central Italy are presented. The power plant was commissioned in the spring of 1993. It consists of two 500 kW arrays of 381 and 372 parallel strings. Each unit is equipped with a line commutated thyristor inverter. Both units are connected to the 20 kV grid through a 500 V/20 kV transformer. The preliminary test results and cost structure are also discussed. The price of 1 kWh is ECU 0.45, considering 8% annuity. In the paper, some other large-scale demonstration projects in Europe are also listed.

- **MUKADAM, K. and F. CHENLO.** 1994. The Data Acquisition System for the 1 MW PV Plant in Toledo, Spain. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 818–821.

  Keywords: project description, case study, balance of system

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: In this paper, the data acquisition system for the 1 MW Toledo photovoltaic power plant is described. The system is based on the Windows NT operating system and it monitors 128 measured and 14 calculated channels. The following parameters are monitored with the data logged and analysed: DC currents of the subarrays, inverter input DC currents and DC voltages, inverter output AC currents and AC voltages, AC parameters of the high voltage power line, meteorological data, event recording digital signals, status and alarms.

- **NARAYANAN, Brig M. R., D. V. GUPTA, R. C. GUPTA and R. S. GUPTA.** 1994. Design, Development and Installation of 100 kW Utility and Grid-Connected, Solar PV Power Plants for Rural Applications – an Indian Experience. In: IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference,1994. Waikoloa, HI, USA, 5–9 December 1994, 1, 1073–1076.

  DOI: 10.1109/WCPEC.1994.520147

  Keywords: project description

  Projects: village Kalyanpur, district Aligarh; village Sarai Sadi, district Mau, Uttar Pradesh, India

  Abstract: Two 100 kW solar photovoltaic power plants have been installed in the State of Uttar Pradesh to provide energy for a cluster of villages spread some km from the power plants. Each power plant operates in two modes: 75 kW stand-alone mode and 25 kW grid-connected mode. Stand-alone mode is used to provide electricity for domestic use, street lights and water pumps. The stand-alone array consists of 72 strings 1.05 kW each with 480 V DC voltage. For stand-alone mode, a 2,000 Ah battery bank with 360 V DC voltage is used. A brief system description and some images of the system are also part of the paper.

- **NENTWICH, Alfred, Michael SCHNEEBERGER, Andreas SZELESS and Heinrich WILK.** 1991. 30 kW Photovoltaic Plant in the Alps of Austria. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 766–770.

  DOI: 10.1007/978-94-011-3622-8_197

  Keywords: project description, case study

  Project: Loser, Styria, Austria

  Abstract: The photovoltaic project on Loser Mountain, 1550 m above sea level in Styria, Austria, was commissioned in 1989. The

solar array with a 30 kW power capacity has a rated voltage of 265 V. The system is grid-connected with three subarrays and three 10 kW inverters, one for each phase. Operational results and issues, causes of outages of the system, are also discussed in the paper.

- **NORDMANN, Thomas, Luzi CLAVADETSCHER and Raimund HÄCHLER.** 1991. 100 kW Grid-Connected PV Installation along Motorway and Railway. In: Photovoltaic Demonstration Projects, Proceedings of the Fifth Contractors' Meeting, Ispra, Italy, 22–24 May 1991, 133–141.

  Keywords: project description, project evaluation, case study, noise barriers

  Project: PV noise barrier N13/A13 motorway, Domat-Ems, Chur, Switzerland

  Abstract: The photovoltaic power plant on the noise barrier along the N13 motorway in Switzerland is presented in this paper. This 100 kW array, with 2,208 modules assembled in frames with 12 modules, is 830 m long and 1.3 m wide. The system is grid-connected and the line-commutated inverter is controlled by a Simatic processor unit. It is planned that the system will produce about 120 MWh of electricity annually. Energy from the array is fed into the grid through a 200 kVA transformer and is used to supply local consumers. System monitoring is also presented in the paper, and a more detailed cost estimation is given as well.

- **NORDMANN, Thomas and Adolf GOETZBERGER.** 1994. Motorway Sound Barriers: Recent Results and New Concepts for Advancement of Technology. In: IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, 1994. Waikoloa, HI, USA, 5–9 December 1994, 1, 766–769.

  Keywords: project description, noise barriers

  Project: Photovoltaic noise barrier, N13/A13 motorway, Domat-Ems, Chur, Switzerland

  Abstract: A brief description of new concepts based on the experience of existing photovoltaic noise barriers located along motorways and railways in Switzerland is given in this paper. Photographs of the N13/A13 motorway noise barriers are also presented.

- **NORDMANN, Thomas, Raimund HÄCHLER and Luzi CLAVADETSCHER.** 1991. 100 kW Grid-Connected PV-Installation along Motorway and Railway. In: Biennial Congress of the International Solar Energy Society, Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 131–136.

  DOI: 10.1016/B978-0-08-041696-0.50030-9

  Keywords: project description, project evaluation, case study, noise barriers

  Project: Photovoltaic noise barrier N13/A13 motorway, Domat-Ems, Chur, Switzerland

  Abstract: This paper presents an 830 m long photovoltaic noise barrier along the N13 motorway, constructed within 8 weeks in 1989. The power plant is located between Felsberg and Domat-Ems and is built on an existing noise barrier. The system with a predicted annual yield of 120 MWh was commissioned in the autumn of 1989. Details about the mechanical and electrical construction of the system are given in the paper. The system consists of 2,208 modules connected into 92 strings with 24 modules in series. The system is connected to the grid through a three-phase 100 kW inverter with a maximal 152 A current per phase. The operating experience and performance of the system are also discussed in the paper. Monthly data for the year 1990 is presented and inverter efficiency is evaluated.

- **NYMAN, Christer.** 1991. Gridconnected 30 kWp Photovoltaic Power Plant in Finland. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 712–715.

  DOI: 10.1007/978-94-011-3622-8_183

  Keywords: project description, case study

  Project: Helsinki University of Technology, University of Turku experimental project, northern latitudes

  Abstract: In this paper, a 30 kWp grid-connected photovoltaic power plant at the latitude of 60°N is described. The array consists of two parts, 27 kW with monocrystalline modules and 3 kW with amorphous modules. The modules are mounted on a two-axis tracking system. The solar array and system performance are evaluated.

- **O'NEILL, Mark J., R. R. WALTERS, J. L. PERRY, A. J. McDANAL, M. C. JACKSON, D. H. SPEARS and W. J. HESSE.** 1990. Development, Deployment, and Startup of the 2,000 sq.m. Linear Fresnel Lens Photovoltaic Concentrator System at 3M/Austin (Texas). In: Proceedings of Solar '90 - the 1990 American Solar Energy Society Annual Conference, Austin, TX, 19–22 April 1990, 241–245.

  Keywords: project description, project overview, concentrator

  Project: 3M facility, Austin, Texas, USA

  Abstract: In this paper, the photovoltaic concentrator for the 3M/Austin photovoltaic facility is presented, as well as the manufacturing, installation and operating details. This paper also includes some drawings of the photovoltaic concentrators and array.

- **O'NEILL, Mark J., A. J. McDANAL, R. R. WALTERS and J. L. PERRY.** 1991. Recent Developments in Linear Fresnel Lens Concentrator Technology, including the 300 kW 3M/Austin System, the 20 kW PVUSA System, and the Concentrator Initiative. In: Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference, Las Vegas, NV, 7–11 October 1991, 1, 523–528.

  DOI: 10.1109/PVSC.1991.169269

  Keywords: project description, project overview, concentrator, PVUSA

  Projects: 3M facility, Austin, Texas; Davis, California, USA

  Abstract: Photovoltaic concentrator power plants were commissioned in Austin, Texas and Davis, California, USA. The 300 kW power plant in Austin was commissioned in March 1990 and the 20 kW system in Davis was put into operation in March 1991. Improvements of the concentrator technology related to these projects are discussed in this paper. Fresnel lenses are used in both systems and array images are also presented. Electrical performance is also discussed, including lens optical efficiency, cell efficiency, module efficiency, wiring mismatch loss factor, array efficiency and array power rating.

- **OSSENBRINK, Heinz A., Luigi RIGOLINI, Oussama CHEHAB and Olaf VAN DER VENNE.** 1994. Building Integration of an Amorphous Silicon Photovoltaic Façade. In: IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, 1994. Waikoloa, HI, USA, 5–9 December 1994, 1, 770–773.

  Keywords: project description

  Projects: ELSA building, JRC, Ispra, Italy

  Abstract: A brief description of the photovoltaic façade system of the ELSA building, located in JRC Ispra, Italy is described in this paper. The solar array consists of amorphous solar modules. Realisation challenges and experiences are discussed. Electrical performance and measurement results are also presented. The performance ratio for the time period from July to October 1994 is also given.

- **PIETRUCCIOU, S.** 1991. Photovoltaic Desalination Plant – Lipari Island. In: Photovoltaic Demonstration Projects, Proceedings of the Fifth Contractors' Meeting, Ispra, Italy, 22–24 May 1991, 169–171.

  URL: http://cordis.europa.eu/project/rcn/15030_en.html (10 June 2016)

  Keywords: project description, case study, water treatment

  Project: Lipari Island, Aeolian Islands, Tyrrhenian Sea, Italy

  Abstract: The demonstration PV desalination plant of Lipari Island with a 63 kWp solar array is presented in this paper. The array consists of 1,440 modules arranged into 180 strings with 8 modules. The system also includes battery storage with a capacity of 1,800 Ah. The system should increase the production of fresh water to 400 m^3/h. Solar energy drives three pumps in a reverse osmosis system. The electrical schematics of the system are also part of the presentation.

- **PREVI, A.** 1993. Comparative Review of Design Criteria for Multi-megawatt PV Plants. In: Report of the Commission of the European Communities - EUR; 15263, 65–69, Photovoltaic Power System Technology, Contractors Meeting for PV System Projects, 1.

  Keywords: preliminary study

  Abstract: A study for the review of the design criteria of MW ranged photovoltaic power plants is proposed in this paper. The coordinator will be responsible for the planning and implementation of various tasks conducted by the project partners. The main tasks proposed for the study are: site selection, grid features, PV plant layout, module and panel design, DC circuit design, support structure design and materials, array field assembly, earth grounding, DC circuit fault detection and protection, power conditioning, utility interface design, quality assurance, etc.

- **PREVI, A., Alberto ILICETO, G. BELLI, V. ARCIDIACONO, S. CORSI and L. LAMBRI.** 1994. The 3.3 MW-peak Photovoltaic Power Station at Serre. In: IEEE First World Conference on Photovoltaic Energy Conversion, Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, 1994. Waikoloa, HI, USA, 5–9 December 1994, 1, 750–753.

  DOI: 10.1109/WCPEC.1994.520068

  Keywords: project description

  Project: Serre, Salerno, Italy

  Abstract: The photovoltaic power plant at Serre, Salerno, Italy is presented in this paper. The power plant is under construction with commissioning scheduled for December 1994. The preliminary planning was carried out in 1990, the procurement of materials started in 1992 and the main building was completed in December 1994. The power plant consists of ten subarrays with 330 kWp each. It is fully automated and operates as an unmanned facility. This paper presents some constructional details and a cost analysis of the project. Brief annual yield expectation and efficiency data are also given in the paper and some images are presented as well.

- **REAL, Markus G.** 1991. Project Megawatt: 333 Residental Grid-Connected PV-Houses Spread Over Switzerland. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1305–1307.

  DOI: 10.1007/978-94-011-3622-8_325

  Keywords: project overview, distributed systems

  Abstract: Phase zero of Project Megawatt was initiated in 1987. Project Megawatt was designed to stimulate the distributed high-volume installation of small-scale, residential, grid-connected photovoltaic systems. A brief description of some installation experiences is also given.

- **REAL, Markus and Hans LÜDI.** 1991. Project Megawatt: Experience with Photovoltaics in Switzerland. In: Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference, Las Vegas, NV, 7–11 October 1991, 1, 574–575.

  DOI: 10.1109/PVSC.1991.169278

  Keywords: project overview, distributed systems

  Abstract: This paper presents a brief description of Project Megawatt, which was initiated in 1987 to develop a standardized, roof-mounted 3 kW photovoltaic system. This project is important because it has shown the path to large-scale distributed photovoltaic systems on residential buildings. In 1990, 100 such systems were installed throughout Switzerland as part of this programme.

- **ROSENTHAL, Andrew L. and Gary C. LANE.** 1991. Field Test Results for the 6 MW Carrizo Solar Photovoltaic Power Plant. Solar Cells, 30, 1–4, 563–571.

  DOI: 10.1016/0379-6787(91)90088-7

  Keywords: project description, project evaluation, case study

  Project: Carissa Plains, CA, USA

1990 – 1994

Abstract: In this paper, the performance evaluation of trackers in the Carissa Plains photovoltaic power plant, commissioned in 1983, is discussed. The performance evaluation included testing subgroups, trackers and laminates. The main reason for the low performance was the degradation of the EVA foil used for module lamination. In this paper, detailed data on the groups of trackers is presented and discussed. For each group of trackers, with or without mirrors, typical parameters are presented in the table: module temperature, irradiance, open circuit voltage, short circuit current, maximal power and fill factor.

- **RUFER, A. C., R. MINDER and T.-E. MOEN.** 1993. Operating Experience at the 500 kW Photovoltaic Plant PHALK Mont-Soleil. In: Fifth European Conference on Power Electronics and Applications. Brighton, 13–16 September 1993, 18–23.

  Keywords: project description, project evaluation, case study

  Project: Mont-Soleil, Switzerland

  Abstract: In this paper, the technical concept of the Mont-Soleil photovoltaic power plant in Switzerland is presented. The paper also includes block diagrams and the presentation of control circuits. This solar array consists of 10,560 solar modules connected into 220 strings with 840 V DC nominal voltage. The power plant also includes two voltage source inverters connected to the output of the solar array and two transformers for connection to the 16 kV public grid. The control unit is based on a programmable high-speed controller which controls, monitors and serves as a protection unit for the power plant. Daily production during the first year of operation is also part of the paper.

- **SARNO, A., Saverio LI CAUSI, F. APICELLA and M. GUERRA.** 1990. A Simple Method to Analyze and Present Performance Data of the 300 kW Delphos PV Plant. In: Conference Record of the Twenty First IEEE Photovoltaic Specialists Conference. Kissimmee, FL, 21–25 May 1990, 2, 1089–1094.

  DOI: 10.1109/PVSC.1990.111785

  Keywords: project evaluation

  Project: Delphos 1, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: This paper presents a simple method for the evaluation of grid-connected photovoltaic power plant performance. The method is based on normalized parameters referring to system efficiency, incident solar radiation and operation and maintenance data. Some terms like available hours, unavailable hours, service hours, night time hours and outage hours are also defined and used in the presented model. The method was applied in the case of the Delphos power plant and the performance results are discussed and presented in the paper.

- **SARNO, A., S. CORDISCO and M. GUERRA.** 1991. The Influence of the Maintenance on the Operation: Lesson Learned by Two Years Management of the Delphos Plant. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1312–1315.

  DOI: 10.1007/978-94-011-3622-8_327

  Keywords: project evaluation, case study

  Project: Delphos 1, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: The Delphos power plant has been in operation since August 1986. Maintenance tasks and activities in the last five years are presented in this paper. The paper presents scheduled maintenance tasks and unscheduled maintenance tasks for the period from January 1989 to December 1990. A mathematical approach to maintenance is also presented in the paper. For terms like "service hours", "weight of preventive maintenance, Wpm" and "weight of corrective maintenance, Wcm", background mathematical explanations are given and the mathematical expressions are defined.

- **SCHAEFER, John, Andy ROSENTHAL, Larry SCHLUETER and Howard WENGER.** 1991. Electrical Degradation of the Carrisa Plains Power Plant. In: Tenth E. C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 1248–1253.

  DOI: 10.1007/978-94-011-3622-8_315

  Keywords: project evaluation, case study

  Project: Carrisa Plains, CA, USA

  Abstract: The Carrisa Plains power plant was built between 1983 and 1985 as a demonstration project of photovoltaics' potential for commercial power production. The power plant is located about 100 km east of San Luis Obispo in Central California and has shown a steady degradation in electrical performance since 1986. The rated power of the plant was 5.2 MW AC but the power plant produced less than 3 MW in 1990. The reason for the decrease in performance is investigated in this paper. The paper also gives some proposals for the construction of further large-scale PV power plants.

- **SCHLANGEN, J. and R. C. VAN PUFFELEN.** 1994. Integration of PV in a Dutch Soundbarrier. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 885–886.

  Keywords: project description, noise barriers

  Project: PV noise barrier, A27 motorway, Utrecht, the Netherlands

  Abstract: The photovoltaic noise barrier concept is described in this paper. Modules should be mounted with a 50° tilt angle, while anti-vandalism measures were also considered during project planning. A project with 55 kWp array power capacity should be realised along the A27 motorway, near Utrecht, the Netherlands.

- **SHUGAR, Daniel S. and Ronald W. MATLIN.** 1994. The Design, Construction and One-year Performance of the World's Largest (400 kW) Thin-film Photovoltaic System. In: Proceedings of Solar '94 - the 1994 American Solar Energy Society Annual Conference, San Jose, CA, 25–30 June 1994, 49–54.

  Keywords: project description, project evaluation, case study, PVUSA

  Project: Davis, California, USA

  Abstract: The Davis photovoltaic power plant, constructed as part of the PVUSA projects, was commissioned in August 1992. The optimisation of the mounting structure weight was one of the tasks during the design and installation phase of the photovoltaic system. The system is divided into subarrays mounted on separate mounting structures with the intention of wind load minimisation. The operating performance of the Davis power plant is described in this paper in detail. Availability and capacity factor and output as a percentage of the possible output are given for each month between January 1993 and February 1994.

- **SHUGAR, Daniel S., Markus G. REAL and Peter ASCHENBRENNER.** 1992. Comparison of Selected Economic Factors for Large Ground-Mounted Photovoltaic Systems with Roof-Mounted Photovoltaic Systems in Switzerland and the USA. In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1001–1004.

  Keywords: project evaluation, economics

  Projects: Solar One, Phoenix, Arizona; PV300, Austin, Texas; PVUSA, Davis, California; Carissa Plains, California, USA; SMUD PV2, Rancho Seco, Sacramento, California; Mont-Soleil, Switzerland

  Abstract: In this paper, criteria for the systematic cost comparison of different photovoltaic power plants are presented. The study was done based on historical costs collected for eight photovoltaic systems located in the USA and Switzerland.

- **SHUGAR, Daniel S., Howard J. WENGER, Tom HOFF and Brian FARMER.** 1994. PVUSA 500 kW Grid-Support Photovoltaic Project: Interim Results on Value. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 2, 1176–1182.

  Keywords: project evaluation

  Project: Kerman City, California, USA

  Abstract: This paper presents the operating experience of the Kerman photovoltaic power plant, in particular in terms of grid support operation. Based on monitoring and measurements in 1993, the following parameters are presented: energy generation value, generation capacity value, sub-station transformer analysis, PV's effect on voltage and current, the value of grid-support PV to transform the load tap changer and grid support value in reducing real power losses. A comparison with the case study from 1992 is also given.

- **SMIAI, M. S. and S. AL-AWAJI.** 1992. Performance of a 350 kW Photovoltaic Concentrator Field (in Operation Since 1981). In: Eleventh E. C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1340–1343.

  Keywords: project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: In this paper, the 350 kW system close to Riyadh, Saudi Arabia is described. A brief evaluation of the operating performance and some operation issues are discussed in this paper.

- **SMIAI, M. S. and Majed AL-SALEM.** 1992. Improvement in the Power Output of a 350 kW Photovoltaic Field, (in operation since 1981). In: Proceedings of Solar '92 - the 1992 American Solar Energy Society Annual Conference, Cocoa Beach, FL, 15–18 June 1992, 71–75.

  Keywords: project evaluation, concentrator

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: After eleven years of operation, significant degradation was observed in the concentrator photovoltaic system in the Solar village project close to Riyadh, Saudi Arabia. A description of the power plant is given in the paper; along with a proposal for yield improvement. Proposals include new module wiring and the arrangement of the modules in the array. Drawings of the wiring before and after proposal implementation are also given in the paper.

- **SOROKIN, Alecsei and Giancarlo ZAMBONI.** 1991. Zambelli, Photovoltaic Pumping Station (70 kWp) Operating Experiences. In: Tenth E.C. Photovoltaic Solar Energy Conference Proceedings, Lisbon, 8–12 April 1991, 822–825.

  DOI: 10.1007/978-94-011-3622-8_210

  Keywords: project evaluation, water pumping

  Project: Zambelli, Verona, Italy

  Abstract: The Zambelli water pumping system close to Verona, Italy was commissioned in 1985 and, with a 70 kWp array, represents the world's largest pumping system. In 1989, an improved controller and remote data monitoring were installed. This paper presents its technical features and operating results for the year 1990.

- **SZELESS, Andreas and Heinrich WILK.** 1991. 30 kW netzgekoppelte alpine Photovoltaikanlage am Loser - Analyse des ersten Betriebsjahres. In: Sechstes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 6–8 March 1991, 342–349.

  Keywords: project description, case study

  Project: Loser, Styria, Austria

  Abstract: The Loser photovoltaic power plant near Altaussee in Austria was commissioned on 4th January 1989. The total cost of the power plant was ATS 200,000. In this paper, the operating experiences after the first operating year are presented. Different performance parameters and data, such as the monthly AC energy output and system efficiency, are given in the paper for the time period of August 1989 until July 1990.

- **TOWNSEND, Tim U. and Steve L. HESTER.** 1991. PVUSA: Two Years of Operating Experience. In: Biennial Congress of the International Solar Energy Society, Proceedings, Denver, Colorado, USA, 19–23 August 1991, 1, 309–314.

  DOI: 10.1016/B978-0-08-041696-0.50058-9

  Keywords: project evaluation, project overview

  Projects: Davis, California, Maui, Hawaii, USA

  Abstract: This paper evaluates five 20 kW photovoltaic power plants, four located in Davis, California and one in Maui, Hawaii. Electrical performance is analysed in detail and discussed. PV capacity factors and DC efficiencies for the year 1989 are also given in the paper.

- **VISIERS GUIXOT, M. and Beatriz YORDI.** 1994. Static Converter Design for the 1 MW "Toledo PV Project". In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 1, 846–849.

1990 – 1994

Keywords: project description, case study

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: A detailed description of the inverters used for the 1 MW Toledo photovoltaic power plant is given in this paper. The fixed arrays are connected to two 450 kW line commutated thyristor inverters, and the tracking array is connected to a 100 kW self-commutated IGBT inverter. A short comparison of the two inverter technologies in terms of efficiency and cost is also discussed.

- **VOERMANS, Rainer, Ulrich BEYER and Ralf POTTBROCK.** 1994. 1 MW Photovoltaik-Anlage Toledo/Spanien. Anlagenbeschreibung und Erfahrungsbericht der Bauphase. In: Neuntes Symposium Photovoltaische Solarenergie, Staffelstein, 16–18 March 1994, 93–98.

Keywords: project description, case study

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: A description of the 1 MW photovoltaic power plant under construction in Toledo is given in this paper. Preliminary investigations were done in 1992 and planning in 1993. Commissioning of the power plant is scheduled for spring 1994. Simplified electrical schematics, as well as the predicted energy yield, are also presented. The first experiences from the construction phase are also described. Module mounting was done with a silicone sealant to save time and cost. Wiring cost reduction should be achieved by high DC voltage. Part of the power plant will also be a single axis tracker. A short description of the system is given as well.

- **WENGER, Howard J., Thomas E. HOFF and Brian K. FARMER.** 1994. Measuring the Value of Distributed Photovoltaic Generation: Final Results of the Kerman Grid-Support Project. In: Conference Record of the Twenty Fourth IEEE Photovoltaic Specialists Conference, IEEE First World Conference on Photovoltaic Energy Conversion. Waikoloa, HI, 5–9 December 1994, 1, 792–796.

DOI: 10.1109/WCPEC.1994.520079

Keywords: project evaluation, case study

Project: Kerman City, California, USA

Abstract: The Kerman photovoltaic power plant was commissioned in June, 1993 as one of the first projects designed to measure the benefits of photovoltaics as grid-support technology. It is located in California's Central Valley outside the city of Kerman, which is about 15 miles west of Fresno, California. A data acquisition system monitors over 130 different parameters on a real-time basis, including solar resource, power plant performance and utility distribution system operation. Detailed results are presented in this paper and an economic evaluation is also given. The main conclusions of the monitoring are that data analysis and testing confirm that both traditional and non-traditional benefits are measurable, predictable and significant for photovoltaics as grid support technology.

- **WENGER, Howard J., Christina JENNINGS and Joseph J. IANNUCCI.** 1990. Carrisa Plains PV Power Plant Performance. In: Conference Record of the Twenty First IEEE Photovoltaic Specialists Conference, Kissimmee, FL, 21–25 May 1990, 2, 844–849.

DOI: 10.1109/PVSC.1990.111740

Keywords: project evaluation

Project: Carissa Plains, CA, USA

Abstract: This paper gives an overview of the Carissa Plains power plant performance in the time period from 1984 to 1989. One of the important findings is that power plant efficiency has declined at the rate of 8–12% per year since 1986. Detailed power plant performance is discussed in the paper, including energy output and efficiency, capacity factor, power profile and annual performance summary. The performance of the mirrored and non-mirrored arrays and a comparison of both types are also given. The paper also gives an operation and maintenance effort analysis, with a 40% increase in 1988 in comparison to 1987, including scheduled and unscheduled activities.

- **WENGER, Howard J., John SCHAEFER, Andrew ROSENTHAL, Bob HAMMOND and Larry SCHLUETER.** 1991. Decline of the Carrisa Plains PV Power Plant: the Impact of Concentrating Sunlight on Flat Plates. In: Conference Record of the Twenty Second IEEE Photovoltaic Specialists Conference, Las Vegas, NV, 7–11 October 1991, 1, 586–592.

DOI: 10.1109/PVSC.1991.169280

Keywords: project evaluation

Project: Carissa Plains, CA, USA

Abstract: In this paper, the decline in the performance of the Carrisa Plains photovoltaic power plant is discussed. The power plant, located about 100 km east of San Luis Obispo, California, was constructed between 1983 and 1985 as a photovoltaic demonstration project. A steadily degraded performance at a rate of approximately 10% per year has been observed. The power plant was rated at 5.2 MW after commissioning, but has produced less than 3 MW as of 1990. The main reason for the performance decline is the trackers with V-trough mirrors, which cause high module temperatures and consequent browning of the EVA foil used in the modules. Acetic acid, caused by ultraviolet radiation and high temperatures, was detected during module disassembly. This was recognised as an important concern for the PV industry.

- **WILK, Heinrich.** 1992. 40 kW Photovoltaik auf der Autobahn – Schallschutzwand Seewalchen/Österreich. Poster. In: Siebtes Nationales Symposium Photovoltaische Solarenergie, Staffelstein, 18–20 March 1992, 531–540.

Keywords: project description, case study, noise barriers

Project: Photovoltaic noise barrier, A1 motorway, Seewalchen, Upper-Austria, Austria

Abstract: The construction and operating experience of a 40 kW photovoltaic noise barrier along the A1 motorway in Austria are presented in this paper. The 40 kW photovoltaic power plant delivers about 38 MWh annually. The construction cost was ATS 6,500,000. The cost shares are also given: solar modules 42%, inverter 13%, mounting structures, wiring 13%, transport 15%, measurement equipment 6%, other 12%. This is the first Austrian photovoltaic power plant with frameless modules and 792 modules were used in total. Simplified electrical schematics and a drawing of the data acquisition system are also given in the paper.

- **WILK, Heinrich.** 1992. 40 kW Photovoltaic System with IGBT Inverter on the Soundbarriers of Motorway A1, Seewalchen-Austria. In: Eleventh E.C. Photovoltaic Solar Energy Conference Proceedings, Montreux, 12–16 October 1992, 1038–1041.

Keywords: project description, case study, noise barriers

Project: Photovoltaic noise barrier, A1 motorway, Seewalchen, Upper-Austria, Austria

Abstract: The photovoltaic noise barrier along the A1 near Seewalchen, Austria was commissioned in February 1992. The total length of the solar array is 264 m. In a small part of it, laminates were used as well as modules. A three-phase 40 kW inverter is placed in a container. Grounding and ground fault protection is also described. The system's monthly operating performance for the time period from February to September 1992 is presented in the paper. Energy loss, including the reasons for it, is also discussed in the paper.

- **YORDI, Beatriz, J. J. VILLA, M. ALFONSO, Ralf POTTBROCK and Rainer VOERMANS.** 1994. 1 MW Photovoltaic Power Station Toledo/Spain - Plant Description and Gained Experience During Construction - Toledo PV. In: Twelfth European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, 11–15 April 1994, 2, 1163–1166.

Keywords: project description, case study

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: In this paper, some construction details of the Toledo 1 MW photovoltaic power plant are presented. The power plant is divided into three parts – 456 kWp and 423 kWp fixed arrays, each with its own 450 kVA line commutated thyristor inverter and a 100 kWp tracking array with a self-commutated 100 kVA IGBT inverter. Details of the solar generators are also given. The installation details are presented, including the difference between screwing or gluing the modules. The manpower installation time is also discussed and the man hours for particular construction activities are also presented

MAGAZINE PAPERS

- **BEYER, Ulrich and Ralf POTTBROCK.** 1991. Solar power in the brown coal area: Biggest photovoltaic plant of Europe grid connected. In: Energie, 43, 11, 25–28.

Keywords: project description

Project: Neurather See, Germany

- **BEYER, Ulrich and Ralf POTTBROCK.** 1991. Planung und Bau einer 360-kWp-Photovoltaikkraftwerks. In: Elektrowärme International, Edition A (Elektrowärme im Technischen Ausbau), 49, A2, A86–A88. ISSN 0174-6189.

Keywords: project description

Project: Neurather See, Germany

- **BEYER, Ulrich, B. DIETRICH, Ralf POTTBROCK and A. LOTFI.** 1990. Solar modules tested at Kobern-Gondorf (solar power stations). In: Modern Power Systems, 10, 11, 81–85. ISSN 0260-7840.

Keywords: project description

Project: Kobern-Gondorf, Germany

- **BEYER, Ulrich, B. DIETRICH, Ralf POTTBROCK and A. LOTFI.** 1990. Ergebnisse des erstes Betriebsjahres der Photovoltaikanlage Kobern-Gondorf. In: Elektrowaerme Int. 48, 2, 64–69. ISSN 0020-9147.

Keywords: project description

Project: Kobern-Gondorf, Germany

- **BEYER, Ulrich, B. DIETRICH, Ralf POTTBROCK and A. LOTFI.** 1991. Ergebnisse des erstes Betriebsjahres der Photovoltaikanlage Kobern-Gondorf. In: Technische Mitteilungen, Haus der Technik e.V., 84, 1, 30–35. ISSN 0040-1439.

Keywords: project description

Project: Kobern-Gondorf, Germany

- **BEYER, Ulrich, Ralf POTTBROCK and Rainer VOERMANS.** 1993. 1 MW photovoltaic program of the 'RWE Energie AG: planning, construction, and operation of photovoltaic power plants'. In: Elektrizitaetswirtschaft, 92, 24, 1537–1540. ISSN 0174-6189.

Keywords: project description

Project: Neurather See, Germany

- **BEYER, Ulrich, Ralf POTTBROCK and Rainer VOERMANS.** 1994. 1 MW-Photovoltaik-Anlage Toledo/Spanien - Anlagenbeschreibung und Erfahrungsbericht der Bauphase. In: 9. Internationales sonnenforum, Energie Energie für die Zukunft, 355–362.

Keywords: project description

Project: La Puebla de Montalbán, Toledo, Spain

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- **FREIESLEBEN, W., Wolfgang PALZ, Heinz A. OSSENBRINK and Peter HELM. Eds.** 1995. Thirteenth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Nice, France, 23–27 October 1995. Brussels: Commission of the European Communities, H. S. Stephens & Associates, ISBN 0952145278.
- **OSSENBRINK, Heinz A., Peter HELM and Heinz EHMANN. Eds.** 1997. Fourteenth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Barcelona, Spain, 30 June – 4 July 1997. H. S. Stephens & Associates, ISBN 978-1901675035 (2 volumes).

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- **BASORE, Paul Ed.** 1997. The Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference 1997, Anaheim, CA, USA, 29 September – 3 October 1997. ISBN 0-7803-3767-0.

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- **SCHMID, J., Heinz A. OSSENBRINK, Peter HELM, Heinz EHMANN and Ewan D. DUNLOP. Eds.** 1998. 2nd World Conference on Photovoltaic Solar Energy Conversion, 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference. Proceedings of the International Conference, Vienna, Austria, 6–10 July 1998. Brussels: European Commission, Directorate General Joint Research Centre, Environment Institute Renewable Energies Unit, Ispra (VA), I–III, ISBN 92-828-5179-6, ISBN 92-828-5419-1, ISBN 92-828-5420-5.

PROCEEDINGS – International Solar Energy Society, ISES

- **ISES.** 1995. ISES Solar World Congress 1995 Proceedings, Harare, Zimbabwe, 9–16 September 1995, International Solar Energy Society. Oxford: Pergamon Press.
- **ISES.** 1997. ISES Solar World Congress 1997 Proceedings, Taejon, South Korea, 24–29 August 1997, International Solar Energy Society.
- **GROSSMAN, Gershon Ed.** 1999. ISES Solar World Congress 1999 Proceedings. Jerusalem, Israel, 4–6 August 1999, International Solar Energy Society. Oxford: Pergamon Press.

PROCEEDINGS – EuroSun, ISES

- **GOETZBERGER, Adolf and Joachim LUTHER. Eds.** 1996. 10. Internationales Sonnenforum (EuroSun) Proceedings, Freiburg, Germany, October 1996. München: Deutsche Gesellschaft für Sonnenenergie, DGS-Sonnenenergie-Verlag.
- **GOETZBERGER, Adolf and Aleš KRAINER. Eds.** 1999. Eurosun 98, International ISES Europe Solar Congress, Portorož, Slovenia, 1998. Birmingham: Franklin Company Consultants. ISBN 0952415038.

PROCEEDINGS – American Solar Energy Society, ASES

- **CAMPBELL-HOWE, Rebecca and B. WILKINS-CROWDER. Eds.** 1995. Proceedings of Solar '95 - the 1995 American Solar Energy Society Annual Conference, Minneapolis, Minnesota, 15–20 July 1995. ISBN 0895531674.
- **CAMPBELL-HOWE, Rebecca and B. WILKINS-CROWDER. Eds.** 1996. Proceedings of Solar '96 - the 1996 American Solar Energy Society Annual Conference, Asheville, NC, 13–18 April 1996. ISBN 0895531682.
- **CAMPBELL-HOWE, Rebecca Ed.** 1997. Proceedings of the 1997 Annual Conference American Solar Energy Society, Washington, DC, 25–30 April 1997. ISBN 0895531690.
- **CAMPBELL-HOWE, Rebecca, T. CORTEZ and B. WILKINS-CROWDER. Eds.** 1998. Proceedings of the 1998 Annual Conference American Solar Energy Society, Albuquerque, NM, 14–17 June 1998. ISBN 0895531704.
- **CAMPBELL-HOWE, Rebecca Ed.** 1999. Proceedings of the Solar 99 Conference, ASES Annual Conference, 24th National Passive Solar Conference, Portland, Maine, 12–16 June 1999. ISBN 0895531712.

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- **LUTHER, Joachim Ed.** 1995. 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **LUTHER, Joachim Ed.** 1996. 11. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 1996. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **KLEINKAUF, Werner Ed.** 1997. 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **HEZEL, Rudolf Ed.** 1998. 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).
- **SCHOTT, Thomas Ed.** 1999. 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI).

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- **IEA.** 1997. Review of Medium to Large Scale Modular PV Plants Worldwide. International Energy Agency PVPS, Task VI, ENEL Research.

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- **POTTBROCK, Ralf.** 1995. Toledo PV. Planung, Bau und Betrieb eines 1-MW-Photovoltaikkraftwerkes in Spanien. Schlussbericht. (Toledo PV. Design, construction and operation of a 1 MW photovoltaic power station in Spain). RWE Energie AG, Essen, Germany.
- **TNC.** 1999. EU PVNB POT: Evaluation of the Potential of PV Noise Barrier Technology for Electricity Production and Market Share. Thermie B Project. Project Number: SME 1479-97, Final Report Volume 1 & 2, TNC GmbH, Freiburg, 29 June 1999.

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- **AGUILERA, J., E. CAAMAÑO and E. LORENZO.** 1995. PV Grid-Connected Systems in Petrol Stations. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1997, 1, 1026–1029.

  Keywords: project description

  Projects: petrol stations in Maracena, Granada; Riotinto, Huelva; Estepona, Málaga; Sevilla, Spain

  Abstract: This paper describes four photovoltaic systems constructed, on the locations of petrol stations in the south of Spain, within the EU THERMIE programme. Photovoltaic systems are installed on the locations of Maracena (Granada), Riotinto (Huelva), Estepona (Málaga) and Sevilla. Solar arrays with power capacities of 13.2 kWp and 12.67 kWp were installed. All four systems are grid connected with 12.5 kVA IGBT self-commutated inverters. Because they are petrol stations, particular attention was put on the safety operations of the photovoltaic systems. The first operating experiences are also given in the paper.

- **ALMONACID, G., J. AGUILERA, P. J. PÉREZ and P. G. VIDAL.** 1998. UNIVER Project: A 200 kWp Photovoltaic Generator Integrated at Jaén University Campus. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2833–2836.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: The Univer Project, with a total power capacity of 200 kWp, located at Jaén University Campus, currently under construction is described in this paper. Annual planned electricity production is 280 MWh, whereas the total University Campus current consumption is 1,400 MWh annually, so the system should cover 10 to 15% of campus demand. The system consists of several subsystems located on buildings and used as carport roofs. A car port roof should consist of two identical systems, each with 640 modules, array power of 68 kWp and a three-phase 60 kW inverter. An additional 64 kWp system with 608 modules and a 60 kW three-phase inverter is integrated into the University building.

- **APICELLA, F., M. GUERRA, F. IANNONE, Saverio Li CAUSI, C. MESSANA, G. NOVIELLO and A. SARNO.** 1995. ENEA Experience on Large Grid Connected PV Plants: the Delphos Project. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 973–975.

  Keywords: project description, project evaluation

  Project: Delphos 1, Delphos 2, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: Delphos 1 and Delphos 2 photovoltaic power plants are described in this paper. Delphos 1 was commissioned in August 1986 and Delphos 2 in January 1992. Delphos 1 consists of a 308 kW array with a 20° module tilt and Delphos 2 of 3 x 100 kW arrays with a 30° module tilt. Both power plants are technically independent and are connected to a 20 kV grid. A detailed performance analysis, including an analysis of different sections of the power plant and an economical evaluation including the investment cost are also given in the paper.

- **ARBOIRO, J. C., G. SALA, J. I. MOLINA, L. HERNANDO and E. CAMBLOR.** 1998. The EUCLIDES™ Concentrator: A Lightweight 84 m Long Structure for Subdegree Tracking. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 2, 2229–2232.

  Keywords: project description, concentrator

  Project: EUCLIDES, Canary Islands, Spain

  Abstract: In this paper, the EUCLIDES tracker project is described. A tracking photovoltaic power plant with a capacity of 480 kW is planned with trackers that should rotate through the N-S axis. Some theoretical aspects are also discussed. Estimated construction costs are USD 1.71/Wp. Wind load test results are described as well and the system can withstand a wind load of up to 200 km/h.

- **ASHRAF, Imtiaz, Atif IQBAL and M. S. Jamil ASGHAR.** 1996. Performance evaluation of an experimental 100 kW Kalyanpur solar photovoltaic power plant-a case study. In: Proceedings of the International Conference on Power Electronics, Drives and Energy Systems for Industrial Growth, New Delhi, 8–11 January 1996, 1, 107–113.

  DOI: 10.1109/PEDES.1996.537290

  Keywords: project description, case study

  Project: Kalyanpur, India

  Abstract: An experimental photovoltaic power plant located in the village of Kalyanpur, Tahsil Atrauli, Aligarh district, is described in this paper. The power plant supplies an irrigation system, households, street lighting and is also connected to

the public grid. It consists of 2,880 modules oriented east-west at a tilt angle of 45°. System performance is discussed in the paper and some proposals for performance improvement are also given.

- **BALL, Timothy J.** 1997. Design and construction of a 115 KW photovoltaic/hybrid system for Dangling Rope Marina Glen Canyon National Recreation Area. In: Proceedings of the 1997 Annual Conference of the American Solar Energy Society, Washington, DC, 25–30 April 1997, 125–129.

  Keywords: project description, battery storage

  Project: Dangling Rope Marina, Lake Powell, Glen Canyon National Recreation Area, Utah, USA

  Abstract: The purpose of the Dangling Rope Marina photovoltaic power plant is to replace diesel generators as the main source of power. It is the largest national park photovoltaic facility. Due to the specific national park location, several challenges need to be considered during the system planning stage, like mounting structures with as few possible interactions with the ground, high quality and reliability due to the high number of visitors, the large number of loads like gas pumps, water pumps, sewage pumps, etc. Due to the remote location, significant logistic and transport efforts were required. For the array mounting structure a unique solution with helical soil anchors was used. Battery storage of 2,400 kWh with nominal voltage of 396 V was designed for an 8 hour rate. The construction start was in April 1996 and the system was officially commissioned on 29th August 1996.

- **BALL, Timothy J. and Douglas DE NIO.** 1997. A 10 kW Photovoltaic/Hybrid System for Pinnacles National Monument. In: Proceedings of the 1997 Annual Conference of the American Solar Energy Society, Washington, DC, 25–30 April 1997, 115–119.

  Keywords: project description

  Project: Pinnacles National Monument, California, USA

  Abstract: The roof-mounted Pinnacle National Monument photovoltaic hybrid system was installed in December 1996. The photovoltaic system supplies the maintenance facility, visitor's centre, and ranger's residency. It includes a 10 kW photovoltaic array, a 200 kWh battery bank, and 24 kW inverters. Additionally, new 20 kW propane generator was also installed. Due to the many visitors, the system also serves for information purposes. A brief description of the system components is also given in the paper. The installation and operating experiences during the initial phase of operation are also discussed in the paper.

- **BALZER, Bernd and Edwin CUNOW.** 1998. Siemens Solar's Approach on Photovoltaic Electricity. New Milestone: One Megawatt Photovoltaic Plant at the New Munich Trade Fair Centre. In: World Renewable Energy Congress, Florence, Italy, 20–25 September 1998; Renewable Energy, 15 , 1–4, 506–511.

  DOI: 10.1016/S0960-1481(98)00214-6

  Keywords: project description, roof mounted, case study

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The 1 MW roof-mounted photovoltaic power plant located on the roofs of the Munich trade fair halls was commissioned on 19th November 1997. The power plant is located on six B-halls of the trade fair facility. In this paper, a description of the system is presented. The power plant should feed about 1 GWh of electricity annually into the 20 kV public grid. The investment cost of the system was DEM 14 million. The project objectives are also presented and a description of the different parts of the system, including the supporting structure and metal roof, are also given in the paper.

- **BAUMANN, A. E., R. A. D. FERGUSSON and R. HILL.** 1997. External Costs of the Toledo 1 MW PV Plant and the Newcastle 40 kW BIPV Facade. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 408–411.

  Keywords: project evaluation, case study, economics, BIPV, façade

  Projects: La Puebla de Montalbán, Toledo, Spain; Northumberland Building, University of Northumbria, Newcastle, UK

  Abstract: In this paper, the 1 MWp Toledo photovoltaic power plant and the 40 kWp building integrated system in Newcastle are described and compared. Both systems are grid-connected and are based on crystalline silicon solar cells. The Toledo system covers an area of 30,000 m² and it consists of three subarrays; two of them are fixed mounted arrays and one is a single-axis tracking array. The system in Newcastle consists of laminates integrated into a rain screen over the cladding system of the façade. The energy requirements for the manufacturing of both systems are given, and the environmental impacts and costs due to atmospheric emissions are discussed as well. The environmental impacts of both systems (kg/kWp and g/kWh) are compared.

- **BÄCHLER, Manfred, A. MASCH, T. KRAUS, Peter SPRAU, Herbert REINER and Gerhard PFEIFFER.** 1997. PV-Anlage Brunnenbach: 6 Jahre Batteriebetrieb – Ergebnisse, Erfahrungen und Schlußfolgerungen. In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 184–188.

  Keywords: project evaluation, battery storage

  Project: Brunnenbach, Bavaria, Germany

  Abstract: The Brunnenbach experimental photovoltaic power plant was commissioned in 1989. The operating results and experiences after 7 years of operation are presented in this paper. A detailed evaluation of the battery failure modes and degradation is given. Topics like deep discharge, corrosion, and electrochemical equalisation of battery cells are discussed. The operating conditions like I-V characteristics, battery capacity and load are also presented graphically.

- **BEGOVIĆ, Miroslav, M. E. ROPP, Ajeet ROHATGI and R. LONG.** 1997. Performance Evaluation on the Georgia Tech Aquatic Center Photovoltaic Array. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 374–379.

  Keywords: project description, project evaluation, case study

1995 – 1999

  Project: Georgia Tech Aquatic Center, Atlanta, Georgia, USA

  Abstract: A performance evaluation assessment of Georgia Tech Aquatic Centre roof-mounted photovoltaic system is given in this paper. With a 342 kW rated power capacity and an area of 3,175 m², this was the world's largest roof-mounted array at the time of construction. A model for the system efficiency calculation is also given in the paper. Four main criteria were used for system evaluation: monthly energy production in comparison with the computer models, monthly power production in comparison to the calculated value, the sunlight to AC power efficiency compared to the calculated values, and the total number of system operational hours in comparison to the number of daylight hours.

- **BERMAN, D., D. FAIMAN, B. FARHI and Howard WENGER.** 1997. Preliminary Studies for a 250 kW Photovoltaic Power Plant at Kibuzz Samar in the Negev Desert. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1528–1532.

  Keywords: preliminary study

  Project: Kibbutz Samar, Negev Desert, Israel

  Abstract: A preliminary study of the 250 kW grid-connected photovoltaic system in Negev Desert is given in this paper. The influence of module characteristics, incidence angle and changes of spectral conditions were studied and are discussed in the paper.

- **BING, James, Miles C. RUSSELL, Philip BOLDUC and Ruel LITTLE.** 1998. Restoration of a 17-Year Old 100 Kilowatt Photovoltaic System in Beverly, Massachusetts. In: Proceedings of the 1998 American Solar Energy Society Annual Conference, Albuquerque, NM, 14–17 June 1998, 137–141.

  Keywords: project description, project evaluation

  Project: Beverly Hill School, Beverly, MA, USA

  Abstract: The Beverly Hill School photovoltaic project was constructed in 1981. It is a ground mounted array in Beverly, north of Boston. In 1997, the power plant was refurbished including module reorganisation and replacement of damaged modules. One of the biggest problems was vandalism with 139 damaged modules. During the refurbishment process all modules were tested and failed modules were removed from the array. The work was completed on 2nd October 1997 when the repowered power plant restored to its original capacity was put into operation. Simulated versus measured AC power for the period 10th August 1997 to 2nd November 1997 is also presented in this paper.

- **BITTEROLF, Ulrich, Karl ROTH, Wolfgang OHNEBERG and Peter SCHMIDBERGER.** 1998. Die erste PV-Fassade mit "farbigen" Solarzellen beim Betriebshof der Stadtwerke Ulm/Neu-Ulm. In: 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998, 170–174.

  Keywords: project description, case study, BIPV, façade, coloured solar cells

  Project: Stadtwerke Ulm/Neu-Ulm, Germany

  Abstract: A brief description of the photovoltaic power plant located on the building of Stadtwerke Ulm/Neu-Ulm is given in this paper. Parking garage for 80 buses and 15 trams commissioned in 1997 hosts one of the first European photovoltaic power plants with coloured solar cells/modules. The power plant consists of two different module types that graphically represent the Stadtwerke Ulm/Neu-Ulm logo. Power is fed directly into the 600 V DC grid of the Ulm tram supply.

- **BLAKERS, Andrew and John SMELTINK.** 1998. The ANU PV/Trough Concentrator System. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 2, 2193–2195.

  Keywords: project description, concentrator

  Project: ANU 20 kW PV/Trough Concentrator, Perth, Australia

  Abstract: In this paper, a description of a 20 kW photovoltaic concentrator is given. The concentrator system in Perth under construction consists of a two axis tracking system and parabolic troughs. The system can be either water or air cooled. Estimated electricity costs for serial production of such systems are USD 0.15/kWh.

- **BLEIL, Andreas, Christoph BINDER, Dirk SCHEKULIN and Ingo VOIGTLÄNDER.** 1996. 10 kW PV-Fassade mit 100 W Wechselstrom-Solarmodulen. In: 11. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 1996, 95–99.

  Keywords: project description, project evaluation, BIPV, façade

  Project: Parking garage in Chemnitz, Germany

  Abstract: The parking garage photovoltaic project in Chemnitz is presented in this paper. The system was commissioned in October 1995 and was the largest PV power plant in the city of Chemnitz at the time of construction. It was financed by private investors. Simplified schematics of the system are given and details about the system are described in the paper. Operating experiences like shading impact, inverter related issues and data analysis are also discussed. Small inverters with a power of 200 W and 400 W are used in this system.

- **BOETI, B., L. LORI, P. REDI, V. RIZZO, M. RUŽINSKÝ and V. ŠÁLY.** 1998. Photovoltaic System for the Pratomagno Control Centre of RAI-Radiotelevisione Italiana. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 3055–3057.

  Keywords: project description, telecommunications

  Project: RAI, Pratomagno, Italy

  Abstract: This paper describes the photovoltaic system installed on the Pratomagno Mountain in central Italy, constructed as part of the Thermie Programme of the European Community. The standalone system with a power capacity of 11.7 kWp and voltage of 48 V DC supplies the RAI control

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centre. The array consists of 254 modules mounted with a 58° tilt angle. The battery storage allows for storage of 115 kWh of energy and its capacity is 2,500 Ah/C10. During construction particular attention was put onto wind loads, so the system can withstand winds up to a wind velocity of 150 km/h. Other parts of the system like the control cabinet, cabling and brief system experiences are described as well.

- **BONVIN, J., P. AFFOLTER, J.-B. GAY, A. N. MULLER, C. ROECKER and R. EGLOFF.** 1995. Photovoltaic Integration into Railway Canopies. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 500–502.

  Keywords: project description, application description, roof integrated, BIPV, train station

  Project: Morges Train Station, Lake Geneva, Switzerland

  Abstract: In this paper, the 22 kWp photovoltaic system installed onto two platform canopies of the Morges railway station in Morges near Lake Geneva, Switzerland is described. The first part was commissioned in June 1995 and the second one in June 1996. The architectural integration of transparent modules into the canopies was well received by the public as well as by professionals.

- **BOUMANS, Jean H., A. J. N. SCHOEN, C. W. A. BALTUS, R. J. C. VAN ZOLINGEN and Theo C. J. VAN DER WEIDEN.** 1995. Overview and Performances of Gridconnected PV Systems in the Netherlands. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 2, 2437–2439.

  Keywords: project overview, project evaluation, BIPV, housing estate

  Projects: Nieuwland, Amersfoort, Nieuw Sloten, Amsterdam, the Netherlands

  Abstract: Some technical details about the inverters and inverter sizing in large-scale photovoltaic power plants are given in this paper. The paper also includes some information about the inverters used in the Nieuw Sloten photovoltaic system.

- **BURGESS, K., Theo C. J. VAN DER WEIDEN, K. J. HOEKSTRA, M. WOLLNY and B. WILLER.** 1995. Hybrid PV-Wind-Diesel-Battery System - Innovative System and Battery Management and Operational Experiences after One Year of Autonomous Operation. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 759–764.

  Keywords: project description, project evaluation, case study, hybrid

  Project: School of Maritime Studies, Terschelling Island, Waden Islands, the Netherlands

  Abstract: Terschelling photovoltaic system was optimised in the period from 1990 to 1994. In 1994 it was disconnected from the grid and it operated in stand-alone autonomous mode after that. New computer equipment was also supplied during the optimisation period. The operating experiences in the autonomous mode of operation are presented in this paper.

- **CAAMAÑO, E. and E. LORENZO.** 1998. The Instituto de Energía Solar PV Grid Connected Building: Three Years of Operation Experience. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2710–2713.

  Keywords: project description, project evaluation, BIPV, façade

  Project: IES, Instituto de Energía Solar Building, Madrid, Spain

  Abstract: In this paper, the building integrated photovoltaic system located on the building of the Instituto de Energía Solar in Madrid, commissioned in December 1994, is presented. The array with 13.5 kWp power capacity consists of three parts: a façade with 5.7 kWp, a terrace with 7.3 kWp and a tower with 0.5 kWp, in total including 596 modules. The system is grid-connected with a 12 kW three-phase inverter. Operational results for the period from 1995 to 1997 including the performance ratio and annual yield are presented in the paper. The system losses are also evaluated and discussed. One of the challenges during the grid-connection phase was the very bad quality of the grid voltage.

- **CAMANI, M., N. CEREGHETTI, D. CHIANESE and S. REZZONICO.** 1997. 15 Years of Experience: Long Term Behaviour of Plants with m-Si & a-Si Modules. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 709–712.

  Keywords: project description, project evaluation

  Project: Technical School Lugano-Trevano, Lugano, Switzerland

  Abstract: The operating experiences after 15 years of operation for the TISO photovoltaic power plants commissioned on 13th May 1982 are presented in this paper. The results of monitoring, like thermographic analysis, visual analysis, module degradation, etc. are also discussed.

- **CANDELARIA, Gary J.** 1997. A Photovoltaic Case Study: Pinnacles National Monument – West District. In: Proceedings of the 1997 American Solar Energy Society Annual Conference, Washington, DC, 25–30 April 1997, 109–113.

  Keywords: project description

  Project: Pinnacles National Monument, California, USA

  Abstract: In this paper, a brief description of the Pinnacles National Monument project development is given. A short summary of the system performance and benefits of the system are also discussed.

- **CARRARA, E., L. LORI, P. REDI, M. RUŽINSKÝ and V. ŠÁLY.** 1998. Elba Airport Photovoltaic System. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 3058–3060.

  Keywords: project description

  Project: Elba Airport, Elba, Italy

  Abstract: This paper describes the PV system located on Elba Airport and installed as part of the Thermie Programme of the European Community. The system was commissioned in June 1996. The solar array consists of 260 modules and has power capacity of 11.7 kWp with nominal array voltage of 120 V DC. Battery capacity is 960 Ah/C10 with 115 kWh of energy storage. Particular attention was required due to the location of the system - because the system is located 1 km away from the sea, the salty atmosphere and wind loads have had to be considered in the planning phase. The solar array can withstand winds with velocities up to 150 km/h. The system supplies energy to the visual landing aid and to the runway border light system. Further energy is used by the parking area and the control tower of the airport.

- **CUNOW, Edwin, Bodo GIESLER, Peter HOPF and Georg MAIER.** 1998. One Megawatt Photovoltaic Plant at The New Munich Trade Fair Centre The World's Largest PV Rooftop Plant. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2472–2475.

  Keywords: project description, case study

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The roof-mounted system on the roofs of the Munich Trade Fair is presented in this paper. The 1 MW system was commissioned in February 1998. The solar generator consists of 7,812 modules with 1,016 MWp array power capacity. The power plant feeds electricity into a 20 kV internal trade fair grid by three 330 kVA centralised inverters. The power plant is remotely monitored via an ISDN line. The total whole installation cost, including the viewing platform and information terminal, was DEM 14 million. The power plant has an expected 30 years of service life time and 3.2 years energy pay-back time (EPBT).

- **CUNOW, Edwin, Bodo GIESLER and Georg MAIER.** 1999. Megawatt-Solardach Neue Messe München - Erste Betriebserfahrungen und -ergebnisse - Systemtechnische Optimierung. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 106–113.

  Keywords: project description, project evaluation, case study

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The operating results of the Munich Trade Fair photovoltaic roof-mounted power plant are presented in this paper. The power plant was constructed and commissioned in 1997 followed by an optimisation period in 1998. The detailed operation results are presented and discussed. The highest efficiency of the master slave central inverters was >96% and the performance ratio was about 80%. A comparison of the centralised and decentralised inverter concepts is also discussed.

- **CHOWDHURY, B. H., S. MUKNAHALLIPATNA, J. J. CUPAL, J. C. HAMANN, T. DINWOODIE and Daniel SHUGAR.** 1997. A 50 Kilowatt Distributed Grid-Connected Photovoltaic Generation System for the University of Wyoming. In: Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference, Anaheim, CA, USA, 29 September – 3 October 1997, 1369–1372.

  DOI: 10.1109/PVSC.1997.654345

  Keywords: project description, project evaluation, case study

  Project: University of Wyoming, Laramie, WY, USA

  Abstract: The University of Wyoming campus hosts a 50 kWp photovoltaic solar power plant. The power plant consists of three systems, 10 kW on the roof of the engineering building, 5 kW on the walkway roof of the engineering building and a 35 kW shade structure system. A brief description of all three parts is given in this paper. The technical details are also presented. System performance is evaluated and maintenance and reliability issues are described in the paper.

- **ČAČE, Jadranka, Adriaan KIL and Theo VAN DER WEIDEN.** 1997. 250 kWp Fully Integrated PV Systems in New Sloten, Amsterdam - First Operational Results. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 698–700.

  Keywords: project description, case study, BIPV, housing estate

  Project: Nieuw Sloten, Amsterdam, the Netherlands

  Abstract: The first operational results of Nieuw Sloten photovoltaic system are presented in this paper. The system which can supply 100 households in Amsterdam is divided into different subsystems: 213 kWp connected to a single 150 kW inverter and a 21 kWp façade mounted system, connected to three 5 kW inverters in master-slave mode, whereas both systems operate with 300 V DC voltage. Penthouses with 16 kWp are connected to eight 1.5 kW inverters with 60 V DC voltage. The system was connected to the grid in March 1997. The operating results in April and May 1997 were monitored and are discussed in this paper.

- **DE PALERO, Julián Alfonso, Jesús GARCIA and Estefanía REOLID.** 1998. First Year of Daily Running of the School PV System. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2563–2566.

  Keywords: project descripton, project evaluation, BIPV, roof integrated

  Project: Nuevo Horizonte Association's centre for autistic children, Las Rozas, Madrid

  Abstract: This paper describes the operating experiences of a 54 kWp photovoltaic system at a location of a special educational centre for autistic children owned by the Nuevo Horizonte Association, located in Las Rozas, Madrid. The solar array has been installed on a sloped roof with a height of between 4 and 5 meters, which is used as the roof for a game court inside the school complex. The system was put into service in October 1995. The operating results for the period October 1995 to October 1997 are evaluated and presented. The system has shown a reliable operation in this time frame with some data loss in 1997 due to heavy storms in this period.

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- **DECKER, Burchard, Dieter HUSEMANN, Eduard KINDEREIT, Frank WERWITZKI, Peter ZICKEL, Bodo GRIMMIG and Detlef MENCKE.** 1997. 73-kWp-Photovoltaik-Anlage an den Fassaden und auf dem Dach der ADAC-Zentrale in Hannover/Laatzen. In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 71–75.

  Keywords: project description, BIPV

  Project: ADAC Office Building, Hannover-Laatzen, Hannover, Germany

  Abstract: The description of a planned photovoltaic power plant on the ADAC site in Hannover, Germany is given in this paper. A cross section of the façade from an architectural point of view is also presented. Several different module sizes should be used, including bifacial solar modules. Due to the specific power plant layout, decentralised inverters with 24 arrays are proposed. The power capacity of the arrays should be 73 kW with annual energy production of about 58 MWh. The estimated investment costs are DEM 23,750/kWp with energy production cost of about DEM 2.40/kWh.

- **DECKER, Burchard, Detlef MENCKE, Steffen KÄHLER and Oliver WESTPHAL.** 1999. 250-kWp-Anlage HELIOTRAM in Hannover-Leinhausen - Modul- und systemtechnische Auslegung der PV-Anlage. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 221–228.

  Keywords: project description, roof mounted

  Project: HELIOTRAM, Hannover-Leinhausen, Hannover, Germany

  Abstract: In this paper, the photovoltaic system proposed for üstra Hannoversche Verkehrsbetriebe in Hannover, Germany is described. Commissioning of a 250 kWp photovoltaic power plant was expected in September 1999. The module description and interconnection are also given in the paper. The system should feed power directly into a 600 V DC grid, and in the future voltage should be increased to 750 V DC. The system simulation and performance ratio results are also presented.

- **DI FILIPPO P., M. PARONCINI and B. CALCAGNI.** 1998. Optimisation of a Roof-Integrated Photovoltaic System applied to a University Centre with a Direct Supply of the Load and Production of Hydrogen, V.2.7. In: Eurosun 98, ISES Solar Europe Congress Proceedings, Portorož, Slovenia, 14–17 September 1998, 2, V.2.7-1.

  Keywords: project description, project evaluaton, case study, BIPV, solar hydrogen

  Abstract: In this paper, the simulation of a photovoltaic system for the University Centre of Monte Dago in Ancona is given. The system covers an area of 40,000 m² and it supplies the university loads. Surplus energy supplies the electrolyser for hydrogen production. The simulation was done for different tilt angles and array orientation. The results of the simulation are discussed in the paper.

- **DIETSCH, Thomas.** 1995. Solar-Wasserstoff-Anlage in Neunburg vorm Wald: Auch Testzentrum für Photovottaikanlagen. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 345–350.

  Keywords: project description, project evaluaton, case study, solar hydrogen

  Project: Neunburg vorm Wald, Germany

  Abstract: Two stages of the Solar-Hydrogen project in Neunburg vorm Wald, commissioned in 1990, are described in this paper. Phase one consists of Siemens and AEG solar modules. Both subarrays were commissioned in January 1990. Stage two consists of different subarrays, commissioned between November 1993 and June 1994. The power capacity of both stages is 371.4 kWp. In the paper, operating experiences including the performance ratios and efficiencies of subarrays are presented. The performance ratio of stage 1 arrays was between 84% and 87%. Energy yield for the period January 1990 – December 1993 is also evaluated and presented.

- **DIETSCH, Thomas.** 1996. Monokristalline 135 kWp PV-Anlage liefert seit über 6 Jahren sehr gute Ergebnisse - Solar-Wasserstoff-Bayern(SWB)-Anlage, Neuburg vorm Wald. In: 11. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 1996, 611–615.

  Keywords: project description, project evaluation, case study, solar hydrogen

  Project: Neunburg vorm Wald, Bavaria, Germany

  Abstract: In this paper, a technical description of both stages of the Neunburg vorm Wald Solar-Hydrogen project is presented. The power capacity of both stages of the project was 373 kWp. For phase one of the project commissioned in January 1990, with 276.6 kWp power capacity, generator efficiency for the period 1991 to 1994 is given. The performance ratio for the dependency of full load operating hours is also presented. The mean annually measured performance ratio values were between 78.8% for poly Si modules and 85.9% for mono Si modules. Phase two of the project, consisting of solar arrays of six different module suppliers, is also described in the paper. Phase two was commissioned in parts between November 1993 and June 1994. Part of one solar array was, due to lower module efficiency as expected, repowered in April 1995.

- **DREWES, Per.** 1996. The Hugh MacMillan Rehabilitation Centre Photovoltaic Project. In: A Sustainable Energy Future: How do we get there from here? Proceedings of Solar Energy Society of Canada Inc., SESCI'96 Conference, Orillia, Ontario, 9 -12 June 1996, 71–78.

  Keywords: project description

  Project: Hugh MacMillan Rehabilitation Centre Photovoltaic Project, Toronto, Ontario, Canada

  Abstract: In this paper, a detailed overview about the system design and performance of the 80 kWp Hugh MacMillan Rehabilitation Centre photovoltaic project in Toronto, Canada is given. The system consists of three 25 kWp subsystems, the first installed in August 1992, the second in May 1993 and the third in March 1994 and of one 5 kWp system installed on the canopy over the entrance. Detailed availability data including capacity factor are also presented in the paper.

- **DUCEY, Roch, Richard CHAPMAN and Samuel EDWARDS.** 1997. The US Army Yuma Proving Ground 900-kVA Photovoltaic Power Station. In: Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference, Anaheim, CA, USA, 29 September–3 October 1997, 1261–1264.

  DOI: 10.1109/PVSC.1997.654317

  Keywords: project description, case study

  Project: US Army Yuma Proving Ground, Arizona, USA

  Abstract: A general description of the Yuma Proving Ground in Yuma, Arizona, USA, photovoltaic system is given in this paper. The system was commissioned on 25th March 1997. It consists of two 450 kVA stages, with each stage connected to two 225 kVA inverters operating in master slave mode. The system operates in three different modes - daytime utility-tied, night time utility-tied and stand-alone mode. The system also includes a battery with a capacity of 5,600 kWh. Images and schematics of the system are also presented in the paper.

- **DYMOND, Michael S.** 1997. Practical Results from Islanding Tests on the 20 kW Kalbarri PV System. In: Proceedings of the 35th Annual Conference of the Australian and New Zealand Solar Energy Society, Canberra, Australian Capital Territory, Australia, 1–3 December 1997, paper 128.

  Keywords: project description, project evaluation, concentrator

  Project: Kalbarri, Western Australia, Australia

  Abstract: In this paper, the methodology and results of islanding tests of Kalbarri photovoltaic system, located in Western Australia, are presented. Some of the tests were also tested under fully operational conditions, whereas the islanding test procedure has included 35 tests that were performed on the inverter.

- **ECKEL, Theodor.** 1999. Solar-Wasserstoff-Projekt Neunburg vorm Wald. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 70–73.

  Keywords: project description, case study, solar hydrogen

  Project: Neunburg vorm Wald, Germany

  Abstract: The operating experiences of the Solar-Wasserstoff Projekt, Neuburg test facility after ten years of operation are given in this paper. The highest efficiencies were reached by an array of crystalline solar modules. Different issues related to cables, DC/DC converters and inverters are discussed as well. Practical experiences with module and array mounting are also presented.

- **EDWARDS, Sam, Roch DUCEY and Richard CHAPMAN.** 1998. The U.S. Army Yuma Proving Ground 900-kVA Photovoltaic Power Station. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2887–2890.

  Keywords: project description, case study, water treatment

  Project: US Army Yuma Proving Ground, Arizona, USA

  Abstract: This paper presents the photovoltaic system commissioned in the early spring of 1997 located at the U.S. Army Yuma Proving Ground (YPG) in southwest of Arizona. The system with a 900 kVA power capacity consists of two identical 450 kVA subsystems. Each 450 kVA subsystem further consists of two 225 kVA MPP inverter/rectifiers, a master and a slave unit. One of the system's features is also the use of a bidirectional DC/DC converter function for the battery charging. The system should be used to offset peak demand and will serve as an emergency power system for YPG's water treatment plant. Besides, the 450 kWp solar array system also includes 5,600 kWh battery storage and a 900 kVA power processing and control system. The system operates in three operating modes - daytime utility-tied, night time utility-tied, and stand-alone mode of operation.

- **ERGE, Thomas, V. U. HOFFMANN, Klaus KIEFER, E. RÖSSLER, Udo RINDELHARDT, G. TEICHMANN, B. DECKER, J. GROCHOWSKI, Gerd HEILSCHER, M. SCHNEIDER, G. BLÄSSER, Heinz OSSENBRINK, H. BECKER, W. VAAßEN, B. GENENNIG, H. RIEß and Peter SPRAU.** 1998. The German 1000-Roofs-PV Programme - a Résumé of the 5 Years Pioneer Project for Small Grid-Connected PV Systems. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2648–2651.

  Keywords: programme overview

  Abstract: This paper gives an overview of the results of the German 1000-Roofs-PV Programme with a total of 2,056 grid-connected PV systems with a total output of 5.3 MWp installed on the roofs of private houses. The programme was important because it has shown that even small residential photovoltaic systems can contribute to distributed large-scale photovoltaic systems as was proven in the years that followed.

- **FARMER, Brian K., Walter J. STOLTE and Antonio B. REYES.** 1995. PVUSA Experience with Power Conditioning Units. In: Proceedings of Solar '95 - the 1995 American Solar Energy Society Annual Conference, Minneapolis, Minnesota, 15–20 July 1995, 254–259.

  Keywords: project overview, PVUSA

  Project: Davis, California; Kerman City, California, USA

  Abstract: In this paper, the operating experience including start-up tests, operation and maintenance of power conditioning units used in the PVUSA projects are presented. Many technical details about the inverters operating at Davis and Kerman photovoltaic power plants are given. The failures and component damages are also described and discussed.

- **FOSTER, Robert E., Ronald C. OROZCO, Arturo ROMERO and Paredes RUBIO.** 1999. Lessons Learned from the Xcalak Village Hybrid System: A Seven Years Retrospective. Evaluation and First Results. In: ISES Solar World Congress 1999 Proceedings, Jerusalem, Israel, 4–6 August 1999, 1, 319–328.

Keywords: project description, project evaluation, case study

Project: Xcalak, Quintana Roo, Mexico

Abstract: The wind-photovoltaic hybrid system in Xcalak village was commissioned in August 1992. Xcalak is located on the coast of southeast Mexico in the State of Quintana Roo. The photovoltaic part of the hybrid system consists of 11.2 kWp Siemens modules. Battery storage has a capacity of 1,738 Ah. In the paper, operation and maintenance related problems are discussed in detail. The biggest problem is that the location is near the sea and the salt has a significant negative impact on the electrical and electronic equipment. The main problem was the lack of maintenance and trained personnel in charge of the system.

- **GREEN, Martin A.** 1997. Photovoltaics in the Sydney 2000 Olympics: The World's Largest Solar Village. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1953–1955.

Keywords: project description

Project: Olympic Solar Village, Sydney, Australia

Abstract: A brief description of the Sydney Olympic Village, at the time of planning and commissioning the largest solar powered residential housing development, is given in this paper. Some aspects from the tender point of view are also presented.

- **GROEHN, H.-G. and H. BARTHELS.** 1998. 43 kW PV at Facades and Roofs of a Public Building Peculiarities in Design and Operation, Thermohydraulic Description of the Modules. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 2, 2096–2099.

Keywords: project description, PHOEBUS project

Project: Research Centre Jülich, Central Library

Abstract: This paper describes a photovoltaic system constructed as a courtain wall on a library building of the Research Centre Jülich in Germany. The solar array with a power capacity of 43 kWp is mounted on a façade with a height of 4.6 m and that covers an area of 312 m². The modules in the façade cover walls and windows as 'curtain wall façades'. One of the façades is also part of a courtyard. The main objective of this project was to gain experiences by using the photovoltaic façades and to analyse their thermal performance.

- **HAUSER, T., B. SANG and K. BYSTRON.** 1997. The Solar Power Station of Constance: The Citizen Shareholding Scheme. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1665–1670.

Keywords: project description

Project: Bürgerbeteiligungsanlage Konstanz, Germany

Abstract: This paper describes a system commissioned in November 1996 and built on behalf of the community council of Constance, Germany. The solar array covers 900 m² of roof area. The system is connected to the grid by three inverters. The project was financed by the citizens and business community of Constance, with the citizen shareholding.

- **HÄBERLIN, Heinrich and Christian RENKEN.** 1999. Hoher Energieertrag auf Jungfraujoch: Die ersten fünf Betriebsjahre der netzgekoppelten 1,1 kWp-Photovoltaikanlage der HTA Burgdorf. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 February 1999, 301–305.

Keywords: project description, project evaluation, case study, alpine region

Project: Jungfraujoch, Switzerland

Abstract: In this paper, the operating experiences after 5 years of operation of the 1.1 kWp photovoltaic power plant located on Jungfraujoch at an altitude of 3,454 m above sea level are presented. The power plant was commissioned in October 1993. The inverter was exchanged with a better model in 1996. In the paper, the monthly energy yield for the period 1994 to 1998 is presented. A comparison with other photovoltaic power plants in Bern Cantone is also given.

- **HÄBERLIN, Heinrich and Chr. BEUTLER.** 1995. Die netzgekoppelte 1,1 kWp-Fotovoltaik-Testanlage der ISB auf dem Jungfraujoch. Poster. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 449–454.

Keywords: project description, project evaluation, case study, alpine region

Project: Jungfraujoch, Switzerland

Abstract: In this paper, the operating experiences and yield evaluation for the year 1994 are presented and discussed. The performance ratio of the power plant was 81.8%. A comparison with Mont-Soleil power plant and the power plant in Burgdorf are also given in the paper.

- **HÄBERLIN, Heinrich and Chr. BEUTLER.** 1995. Highest Grid-Connected PV Plant in the World at Jungfraujoch (3454 m): Excellent Performance in the First Two Years of Operation. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 969–972.

Keywords: project description, project evaluation, case study, alpine region

Project: Jungfraujoch, Switzerland

Abstract: In this paper, the operating details and experiences of the Jungfraujoch photovoltaic system located at an altitude of 3,453 m in the Swiss Alps are given. Detailed monthly data is presented for the period from October 1994 to September 1995. Energy production including the normalised yield analysis and performance ratio is given. A comparison with the 560 kWp Mont-Soleil power plant located at 1,270 m is also presented in the paper.

- **HÄBERLIN, Heinrich and Christian RENKEN.** 1998. Grid Connected PV Plant Jungfraujoch (3454 m) in the Swiss Alps: Results of More than Four Years of Trouble Free Operation. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2768–2771.

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Keywords: project description, project evaluation, case study, alpine region

Project: Jungfraujoch, Switzerland

Abstract: The highest located grid connected photovoltaic power plant in the world, at Jungfraujoch at 3,454 meters above sea level, was put into service and its operation has been monitored since 27th October 1993. The power plant has an array of 1,152 Wp consisting of 24 modules. The project also represents an important example of the feasibility of photovoltaic systems in harsh climate conditions. The plant has been operating reliably without any major events since it was put into service. Annual energy production varied between 1,272 kWh/kWp in 1994 and 1,504 kWh/kWp in 1997, whereas the energy contribution in winter was between 44.6% and 48%.

- **HAM, M., A. BALTUS, P. KIESKAMP, A. J. G., KOLEN, Peter VAN DER VLEUTEN and F. VAN DER VLEUTEN.** 1998. A 1.2 MWp PV Powerplant in Holland. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2793–2794.

Keywords: project proposal

Project: upgrade of waste disposal site, project proposal

Abstract: In this paper, a 1.2 MWp photovoltaic power plant for the upgrade of a waste disposal site is proposed. A four hectare waste disposal site would be required to realise the proposed project. Some other aspects of the proposed project are discussed in the paper as well.

- **HELMKE, Claas, E. HAVERKAMP, W. ZAAIMAN and Heinz A. OSSENBRINK.** 1998. The ELSA Façade: Four Years of Operation of the Largest Amorphous Silicon Photovoltaic Façade. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2752–2755.

Keywords: project description, project evaluation, case study, BIPV, façade, thin-film

Project: ELSA building, JRC, Ispra, Italy

Abstract: The largest amorphous silicon façade in the world, located at the Joint Research Centre in Ispra, Italy is described in this paper. The system with 21 kWp was commissioned on 12th July 1994. The façade area is 770 m², with an active module area of 539 m². The system is grid connected and energy is fed into the grid by four 5 kW inverters that operate in master-slave operating mode. Two acceptance tests were performed on the system, first at the beginning of operation in August 1994 and the second in winter 1997/98.

- **HELMKE, Claas, E. HAVERKAMP, W. ZAAIMAN and Heinz OSSENBRINK.** 1999. Die ELSA Fassade: Die größte Fassade der Welt aus amorphem Silizium ist vier Jahre im Betrieb. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 380–385.

Keywords: project description, project evaluation, case study, BIPV, façade, thin-film

Project: ELSA building, JRC, Ispra, Italy

Abstract: In this paper, four years of operating experiences of Europe's largest amorphous silicon photovoltaic façade in Ispra, Italy are presented. The power plant was commissioned on 12th July 1994. The solar generator consists of seven subarrays, whereas six subarrays include seven strings and one subarray includes ten strings. The results of monitoring with the data acquisition system are presented in the paper. The results include efficiency in comparison to ambient temperature and irradiance and power generated in comparison to irradiance and ambient temperature.

- **HEILSCHER, Gerd, Robert PFATISCHER and Ivan KATIĆ.** 1998. Integration of Photovoltaics in Renovating Big Residential Buildings 100 kWp Plant Solgården Kolding. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2714–2716.

Keywords: project description, distributed, roof mounted

Project: Solgården, Kolding, Denmark

Abstract: Complete renovation, including use of a photovoltaic system, was chosen for the residential building Solgården in Kolding, Denmark, built in the 1940s. Some aspects of the added photovoltaic system are presented in this paper. The system consists of a roof mounted system with custom made modules on a steel structure with an area of 757 m² and façade modules integrated in the balcony enclosures with an area of 175 m². The total power capacity is 89.5 kWp for the roof mounted part and 16.5 kWp for the façade's array. The power plant is divided into 16 subsections. It produces about 100,000 kWh of energy annually, most of it consumed in the Solgården building itself. The system is grid connected and surplus energy is fed into the grid by 94 string inverters.

- **HELMKE, C., M. JANTSCH and Heinz A. OSSENBRINK.** 1995. The Large Amorphous Silicon PV Façade in Ispra, Experience and Results after One Year of Operation. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 695–698.

Keywords: project description, project evaluation, case study, BIPV, façade, thin-film

Project: ELSA building, JRC, Ispra, Italy

Abstract: In this paper, a detailed evaluation of the façade integrated system located on the ELSA building, JRC Ispra, Italy, is given. The system has been monitored since July 1994. It consists of an array divided into 52 strings with a 544 m² module area. The monitoring system consists of a pyranometer, wind sensor and Pt100 temperature sensors. Component reliability is also estimated based on measured and evaluated monitoring results.

- **HIELSCHER, Thomas and Gudrun SCHMIDT.** 1998. Die 48 kW peak-Photovoltaik-Fassade für die Sanierung eines Wohnhauses der Wohnungsbaugesellschaft Marzahn GmbH. In: 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998, 456–459.

  Keywords: project description, distributed, housing estate, BIPV, roof mounted

  Project: Marzahn housing estate, Berlin, Germany

  Abstract: A double apartment building in Berlin with 22 and 25 floors, originally constructed in 1986, was refurbished in 1998. Part of the refurbishment was also an added façade integrated photovoltaic power plant. The construction of the apartment building and façade cross section from an architectural point of view are presented in this paper. The construction details and experiences are also presented.

- **HOELSCHER, James F., Garyl D. SMITH, Roch DUCEY and Larry W. STROTHER.** 1996. Photovoltaics in the United States Department of Defense. In: Proceedings of Solar '96 - the 1996 American Solar Energy Society Annual Conference, Asheville, NC, 13–18 April 1996, 383–388.

  Keywords: project overview

  Projects: Superior Valley, China Lake, California; Yuma Proving Ground, Yuma, Arizona; Twentynine Palms, California, USA

  Abstract: In this paper, a brief description of some large-scale photovoltaic power plants in operation or under construction on the grounds of the US army is given. The China Lake photovoltaic power plant was commissioned in January 1996. It has a 350 kW array and the installation cost was USD 3,570,850. Yuma Proving Ground should consist of a 450 kW array and battery storage with a construction cost of about USD 7 million. The preliminary design was completed and the construction start was scheduled for March 1996. Contractor selection for the Twentynine Palms power plant was scheduled for March 1996.

- **HOELSCHER, James F., Garyl D. SMITH, Roch DUCEY and Larry W. STROTHER.** 1997. Recent Photovoltaic Systems Activity in the United States Department of Defense. In: Proceedings of the 1997 American Solar Energy Society Annual Conference, Washington, DC, 25–30 April 1997, 97–101.

  Keywords: project overview

  Projects: Yuma Proving Ground, Yuma, Arizona; Twentynine Palms, California, USA

  Abstract: In this paper, a brief description of some large-scale photovoltaic power plants operating or to be constructed on the grounds of the US army is given.

- **HOELSCHER, James F., Garyl D. SMITH, Larry W. STROTHER, Richard R. WALSH and Roch DUCEY.** 1999. Summary of Department of Defense Renewable Energy Activities. In: Proceedings of the Solar 99 Conference, ASES Annual Conference, 24th National Passive Solar Conference, Portland, Maine, 12–16 June 1999, 349–353.

  Keywords: project overview

  Project: Yuma Proving Ground, Yuma, Arizona; Superior Valley, China Lake; Twentynine Palms, California, USA

  Abstract: A brief description of the status of some large-scale photovoltaic and hybrid power plants operating or to be constructed on the grounds of the US army is given in this paper.

- **HOPF, Peter, Georg MAIER and Gottfried LAMPL.** 1997. Die 1 MW-Photovoltaikanlage "Neue Messe München". In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 49–54.

  Keywords: project description, roof mounted

  Project: Munich Trade Fair, Munich, Germany

  Abstract: In this paper, the photovoltaic power plant located on the roofs of Munich Trade Fair is presented. Detailed project goals, the structure and the proposed time frame for project realisation are presented. Commissioning is scheduled for November 1997, whereas the new trade fair facility should be commissioned in March 1998. Investment costs are estimated at DEM 15 million. The use of master slave inverters is proposed in the paper and electrical schematics are also presented. The proposed roof layout and module frames are also described in the paper.

- **HOPPE, Wolfgang.** 1995. Photovoltaikanlage "Neurather See" - Erfahrungen der ersten Betriebsjahre. Poster. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 373–378.

  Keywords: project description, project evaluation

  Project: Neurather See, Germany

  Abstract: Neurather See PV power plant was put into test operation in September 1991. The operating experiences of the power plant are presented and discussed in this paper. Large area modules were used, and their comparison with standard modules of the same supplier is presented in the paper. The performance ratios for 1992 and 1993 are also given. Different operating issues like delamination, bypass diode malfunction and inverter malfunction are also briefly discussed in the paper.

- **HOPPE, Wolfgang and Andreas SCHULZ.** 1999. 10 Jahre Betriebserfahrung in der Photovoltaikanlage Kobern-Gondorf. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 306–310.

  Keywords: project description, project evaluation, case study

  Project: Kobern-Gondorf, Germany

  Abstract: The operating experiences of Kobern-Gondorf 340 kWp photovoltaic power plant are presented in this paper. The power plant was commissioned in October 1988. Experiences with crystalline and amorphous solar modules and inverters are described. The importance of scientific work in connection with the diploma thesis is also highlighted.

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- **ILICETO, Alberto and Fabrizio PALETTA.** 1998. Modular Photovoltaic Plants for Large Scale Power Generation. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2496–2500.

  Keywords: project overview, project evaluation

  Projects: Alta Nurra, Casaccia, Vulcano Island, Mandatoriccio, Delphos 1, Delphos 2, Carloforte, Lamezia, Vasto, Serre, Italy; Miyako City, Saijo City, Japan; Ho Island, South Korea; Kg Marak Parak, Malaysia; St. Agustin, Toledo, Spain; Chur, Disentís, Giebenach, Magadino, Mont-Soleil, Switzerland

  Abstract: An international IEA programme established in 1993 is described in this paper. In the frame of the Implementing Agreement on Photovoltaic Power Systems, Task VI was dedicated to modular PV plants for large-scale power generation (LSPVPS) connected to the medium voltage electric grid. A short description and activities of the Task and a brief overview of the projects realised is given. Different Subtasks were also established for subtopics related to the Task VI activities. Several power plants were also monitored, whereas monitoring data are also available.

- **ILICETO, Alberto and Luigi SARDI.** 1996. Electricity from the sun: The largest photovoltaic plants in operation in Italy. In: Renewable Energy, 8, 1–4, 77–84.

  DOI: 10.1016/0960-1481(96)88824-0

  Keywords: project description

  Projects: Serre, Salerno; Lamezia, Catanzaro; Leonori, Rome; Mandatoriccio, Cosenza; Salve, Lecce; Vasto, Chieti; Carloforte, Sardinia, Italy

  Abstract: In this paper, a detailed description of the largest photovoltaic power plants constructed to date or under construction is given. The detailed description includes a description of the plant as a whole, DC wiring, power conditioning units, AC wiring data, acquisition systems, civil works and assembly. A detailed cost structure is also given. A civil works details comparison is given in a table for the Vasto, Carloforte and Lamezia solar power plants. A brief description of other large-scale photovoltaic power plants in Italy is also given in the paper - Vasto in the Abruzzo region, Carloforte on Sardegna with a 2x300 kW solar array and 2x320 kW wind generator, and Lamezia in the Calabria region with a 2x300 kW solar array and 2x300 kW wind generators; Salve in the Puglia region with the same characteristics as Lamezia; Mandatoriccio with 216 kW and Leonori with 86 kW located on the Citroën cars concessionary in Rome; Vulcano with 80 kW commissioned in 1984 and Alta Nurra, Sardegna. The 100 kW standardized unit developed by ENREA was used for the carport at Casaccia Laboratories. Delphos 2 also consisted of standardized 100 kW units.

- **ILICETO, Alberto and R. VIGOTTI.** 1998. The Largest PV Installation in Europe: Perspectives of Multi-megawatt PV. In: Renewable Energy, 15, 1–4, 48–53.

  DOI: 10.1016/S0960-1481(98)00135-9

  Keywords: project description

  Project: Serre, Salerno, Italy

  Abstract: This paper presents the operation results since the commissioning of the Serre photovoltaic power plant with particular attention to the 1996/96 period. Technical data for nine subarrays is given in the table. The system is connected to the grid through a 550 kVA thyristor type inverter. System losses are presented and discussed in detail – the analysis includes low radiation losses, mismatching losses, temperature losses in solar modules, losses in the DC switchboard and wiring circuits, converter losses, and losses in auxiliary services. Losses are also presented in a table. During 1996 and 1997, the power plant's operation was stable with only one converter section failure. The plant met the design requirements. In the conclusion, a summary of multi-megawatt power plants is given and open questions for further work are also presented.

- **ISHIKAWA, Naoki, A. KANNO, H. YAMASHITA, Y. HATANAKA and I. HIDE.** 1998. Installation Cases with Design Oriented PV Systems in Japan. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2501–2506.

  Keywords: project overview, project evaluation

  Project: Hooh High School, Kagoshima, Japan

  Abstract: Several cases of design oriented photovoltaic systems are presented in this paper. Among the presented cases is also the 150 kW roof mounted photovoltaic system on the roof of Kagoshima High School gymnasium for martial arts. Problems related to the installation of such systems are briefly discussed and a path for using photovoltaic modules as construction materials is also shown.

- **JENNINGS, Christina, Brian FARMER, Tim TOWNSEND, Paul HUTCHINSON, Antonio REYES, Chuck WHITAKER, Jim GOUGH, Dan SHIPMAN, Walter STOLTE, Howard WENGER and Tom HOFF.** 1996. PVUSA - the First Decade of Experience. In: Conference Record of the Twenty Fifth IEEE Photovoltaic Specialists Conference, Washington, DC, USA, 13–17 May 1996, 1513–1516.

  DOI: 10.1109/PVSC.1996.564424

  Keywords: project evaluation

  Projects: Kerman City, California; Davis, California, USA

  Abstract: In this paper, the operating experiences of PVUSA projects are given. For Kerman and Davis, the site cost and maintenance related data is given. The system efficiencies from January 1989 to January 1996 are presented. The cumulative module replacement trough 1995 is also given. The PCU efficiencies and power factors are given as well. Failure related maintenance costs for the Kerman and Davis sites are also presented.

- **JENNINGS, Stephanie U. and Adele M. MILNE.** 1997. A Review of the Kalbarri Photovoltaic System. In: Proceedings of the 35th Annual Conference of the Australian and New Zealand Solar Energy Society, Canberra, Australian Capital Territory, Australia, 1–3 December 1997, paper 131.

  Keywords: project description, project evaluation, concentrator

  Project: Kalbarri, Western Australia, Australia

  Abstract: In this paper, the operating experiences of the 20 kW Kalbarri photovoltaic power plant in Western Australia are given. The system has been monitored since April 1996. Monthly energy production from June 1996 to July 1997 is presented in the paper. The monthly values of performance indicators like performance ratio, system AC efficiency and capacity factor are presented for the same period as well. The system is connected to the grid by a 35 kVA inverter and a 440 V/6.6 kV transformer. Operating experiences include some inverter and tracking system malfunctions. Required routine and non-routine maintenance is also briefly described. The positive public acceptance of the photovoltaic system is also highlighted in the paper.

- **KALAGIA, H., P. BALTAS and J. NIKOLETAOS.** 1998. New Photovoltaic System in the Greek Island of Sifnos. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2829–2832.

  Keywords: project description

  Project: Sifnos Island, Greece

  Abstract: This paper presents some aspects of electricity supply on Greek islands. A brief analysis of the economic terms and electricity costs on the Greek islands is also given. On Sifnos Island, one of the Cyclades Islands located in the Aegean Sea, powered by diesel generators, a 60 kWp photovoltaic system was installed. The system should provide about 1.3% of the electricity demand on the island. It consists of 33 identical PV units, connected to three local 220 V grids. The system is connected to the medium voltage island grid by a transformer. Each unit includes a transformerless 1.5 kW string inverter and two parallel connected strings, with 13 modules each. The array is south oriented and mounted with a tilt angle of 20°.

- **KIEFER, W., Th. KÖRKEL, E. RÖSSLER, Edo WIEMKEN and A. REINDERS.** 1995. 2250 PV-Roofs in Germany - Operating Results from Intensive Monitoring and Analysis through Numerical Modelling. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 575–579.

  Keywords: programme overview, project evaluation, distributed, Germany

  Abstract: In this paper, the monitoring results of 2,250 roof mounted systems constructed within the 1,000 Roofs Programme are presented. A detailed analysis of the performance ratio is also given.

- **KNAUPP, Werner, Dirk SCHEKULIN, Ingo VOIGTLÄNDER, Andreas BLEIL and Christoph BINDER.** 1996. 10 kW PV Facade with 100 W AC Modules. In: Internationales Sonnenforum (EuroSun) Proceedings, Freiburg, October 1996, 755–759.

  Keywords: project description, project evaluation, BIPV, façade

  Project: Parking garage in Chemnitz, Germany

  Abstract: In this paper, a detailed description of the multi storey car park in Chemnitz, Germany is presented. In the system, in total 102 AC modules with module inverters are used. The power plant configuration and some construction details of façade integrated photovoltaic modules are given. The operating experiences and power plant performance are also discussed.

- **KOÏTA, Z. and A. M. DAHOUENON.** 1997. Diaoulé and Ndiébel Photovoltaic Plants: 6 Years of Experiences. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1665–1670.

  Keywords: project description, project evaluation

  Projects: villages Diaoulé, Ndiébel, Senegal

  Abstract: The photovoltaic systems in Senegal's villages Diaoulé and Ndiébel were put into service in 1989 and 1990 respectively. After 5 years of operation, degradation was observed and both systems were repowered - Diaoulé with 24.64 kWp and Ndiébel with 20 kWp. The systems are connected to the local 220 V, 50 Hz grid. A detailed description and operating experiences evaluation for both systems is given in this paper. Yield as performance criteria is also mathematically evaluated and discussed.

- **KOÏTA, Z. and A. M. DAHOUENON.** 1997. Diaoulé and Ndiébel Photovoltaic Plants: 6 Years Operating Experiences. In: ISES Solar World Congress 1997 Proceedings. Taejon, South Korea 24–29 August 1997, 3, 270–277.

  Keywords: project description, project evaluation

  Projects: villages Diaoulé, Ndiébel, Senegal

  Abstract: The photovoltaic power plants in the villages Ndiébel and Diaoulé in Senegal were put into service in May 1989 and September 1990. The systems use self-commutated inverters operating in master-slave mode, and the grid length for each village is about 7 km. System efficiency is defined in detail and monthly yield performance is also given. Reference yield, array yield, final yield, performance ratio, mean array efficiency and overall power plant efficiency are mathematically evaluated and presented in the paper. The systems were repowered - Diaoulé, 24.64 kWp in December 1995, and Ndiébel, 20 kWp in May 1996.

- **KUROKAWA, Kosuke, Kazuhiko KATO, Fabrizio PALETTA and Alberto ILICETO.** 1998. Very Large Scale Photovoltaic Power Generation System (VLS-PV) Project. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2853–2856.

  Keywords: preliminary study

  Abstract: IIn this paper, the content of a pre-feasibility study of the "Very Large Scale Photovoltaic Power Generation System (VLS-PV)" project initiated within IEA/PVPS Task VI is presented. Based on the results of the study, further Task VI activities should be defined.

- **LAUKAMP, Hermann.** 1995. Eine "Structural-Glazing" Photovoltaik Fassade: Das "Solarzentrum Freiburg". In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 151–160.

  Keywords: project description, BIPV, façade

  Project: Solarzentrum Freiburg, Freiburg, Germany

  Abstract: Astructural-glazing façade in Solarzentrum Freiburg with a power capacity 18.5 kWp is presented in this paper. The project consists of four façade and roof integrated subarrays. The array details and operating experiences are presented in the paper. The results of the module temperature measurements are given and mathematically analysed.

- **LEPLEY, Thomas and P. NATH.** 1997. Photovoltaic Covered-Parking Systems Using Lightweight, Thin-Film PV. In: Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference, Anaheim, CA, USA, 29 September – 3 October 1997, 1305–1308.

  DOI: 10.1109/PVSC.1997.654328

  Keywords: project description, car ports

  Project: Yuma, Arizona, USA

  Abstract: In this paper, a car port photovoltaic roof installed near Yuma, Arizona is presented. Some images, operating results and economic evaluation are also given in the paper.

- **LLORET, A., O. ACEVES, J. P. BERRY, A. MARTINEZ and L. SABATA.** 1998. Large Grid Connected PV System Integrated in Two Buildings of the Barcelona Municipality. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2659–2662.

  Keywords: project description, case study, BIPV, façade, coloured solar cells

  Project: Barcelona City Hall, Barcelona, Spain

  Abstract: This paper presents a proposal for a 98.3 kW photovoltaic system to be constructed on two of three buildings of Barcelona City Hall which needs to be reconstructed. The useful surface area on two roofs for the PV modules installation is close to 1,000 m². For module cooling a ventilation system using the venturi effect is proposed. The module tilt angle should be 5° and 1.5 kW string inverters should be used. System simulation using the SPICE models has shown a predictable annual yield of 122 MWh.

- **LLORET, A., O. ACEVES, J. P. BERRY, A. MARTINEZ, L. SABATA and R. D. W. SCOTT.** 1998. The Construction of a Grid-Connected Coloured PV Façade. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2663–2665.

  Keywords: project description, case study, BIPV, façade, coloured solar cells

  Project: Pompeu Fabra, Library of Mataró, Barcelona, Spain

  Abstract: A large 30 kWp PV façade under construction on a four storey building beside the "Museu Nacional de la Ciencia i Tècnica de Catalunya" located in Terrassa, Catalonia, Spain is described in this paper. Four large façade coloured solar cells will be used, whereas blue, gold and magenta colours were chosen. Distributed string inverters are proposed for the grid connection. To evaluate the system's features in advance SPICE simulations were performed. Early architectural plans of the PV façade are also included in the presentation.

- **LLORET, A., O. ACEVES, J. ANDREU, J. MERTEN, J. PUIGDOLLERS, M. CHANTANT, Ursula EICKER and L. SABATA.** 1997. Lessons Learned in the Electrical System Design, Installation and Operation of the Matáro Public Library. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1659–1664.

  Keywords: project description, case study, BIPV, façade, coloured solar cells

  Project: Pompeu Fabra, Library of Mataró, Barcelona, Spain

  Abstract: The Pompeu Fabra Libraries photovoltaic system was one of the first completely integrated into a building using semi-transparent and opaque photovoltaic thermal hybrid modules. The system is described and evaluated in this paper. The building's thermal energy performance, loss analysis and cost and benefits are presented and discussed.

- **LLORET, A., J. ANDREU, J. MERTEN, O. ACEVES, L. SABATA, F. SEN, J. PUIGDOLLERS, C. PERSON, M. CHANTANT, J. M. SERVANT and Ursula EICKER.** 1995. The Matáro Public Library: A 53 kWp Grid Connected Building with Integrated PV-Thermal Multifunctional Modules. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 490–493.

  Keywords: project description, BIPV, façade, coloured solar cells

  Project: Pompeu Fabra, Library of Mataró, Barcelona, Spain

  Abstract: In this paper, the photovoltaic system of the Mataró Public Library is described. The functionality of the multifunctional photovoltaic solar thermal modules is described and some construction experiences are presented and discussed. The multifunctional modules deliver not only electricity but also heat without affecting the requirements for a public library.

- **LLORET, A., J. ANDREU, J. MERTEN, J. PUIGDOLLERS, O. ACEVES, L. SABATA, M. CHANTANT and Ursula EICKER.** 1998. Large Grid-Connected Hybrid PV System Integrated in a Public Building. In: Progress in Photovoltaics: Research and Applications, 6, 6, 453–464.

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DOI: 10.1002/(SICI)1099-159X(199811/12)6:6‹453::AID-PIP234›3.0.CO;2-P

Keywords: project description, case study, BIPV, façade, coloured solar cells

Project: Pompeu Fabra, Library of Mataró, Barcelona, Spain

Abstract: In this paper, the photovoltaic hybrid system at the public library 'Pompeu Fabra' in Mataró, close to Barcelona, Spain is presented. A general view of the building and details of the photovoltaic hybrid façade elements are presented in the paper. An outside view of the façade and an interior view are presented as well. The paper also includes some construction details of the system. Details of the 53 kWp solar array consisting of eight subarrays are given in the paper. Each subarray is connected to the grid by its own inverter. The system includes seven 5 kW inverters and a 2 kW one. System performance for one day is presented graphically and discussed.

- **LONG, R., Ajeet ROHATGI and Miroslav BEGOVIĆ.** 1995. Photovoltaics in Architecture - The Design, Construction and Monitoring of a Photovoltaic Power System on the Georgia Institute of Technology Aquatic Center. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 675–678.

Keywords: project description, case study, roof mounted

Project: Georgia Tech Aquatic Center, Atlanta, Georgia, USA

Abstract: In this paper, the project proposal and description of a 340 kW roof mounted photovoltaic system to be constructed on the roof of the Aquatic Center in Atlanta, a sports complex which will host the Olympic Games in 1996, is given. A brief description of the planned system, its expected performance and costs is presented. It is expected that the system will produce 514 MWh annually and it will cover 42% of the unenclosed facility load and 30% after the facility is enclosed after the Olympic Games in 1996.

- **LORENZO, E., C. MAQUEDANO and P. VALERA.** 1995. Operational results of the 100 kWp Tracking PV Plant at Toledo-PV Project. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 2, 2433–2436.

Keywords: project description, project evaluation, tracker

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: In this paper, the operating results of a 100 kWp tracking array of the 1 MWp Toledo photovoltaic project are presented. Energy cost reduction in the range of 10 to 15% was observed in comparison to the fixed arrays. A detailed cost estimation for the whole system and for parts of it is also given in the paper. The average monthly values for expected daily energy output considering reflection and dust losses are also given. Photographs of the tracker's proximity detectors are also available.

- **LUQUE, Antonio, G. SALA, J. C. ARBOIRO, T. BRUTON, D. CUNNINGHAM and N. MASON.** 1997. Some Results of the EUCLIDES Photovoltaic Concentrator Prototype. In: Progress in Photovoltaics: Research and Applications, 5, 3, 195–212.

DOI: 10.1002/(SICI)1099-159X(199705/06)5:3‹195::AID-PIP166›3.0.CO;2-J

Keywords: project description, project evaluation, concentrator

Project: EUCLIDES, Canary Islands, Spain

Abstract: In this paper, a detailed description of the EUCLIDES photovoltaic concentrator array is given. The concentrator is based on modified laser-grooved buried grid types of solar cells. The mirrors consist of silver-covered acrylic auto-adhesive film on aluminium sheets. A detailed mathematical evaluation of the concentrator module is given in the paper, including optical efficiency determination, temperature and efficiency determination. Module performance is also discussed in detail. The results of continuous monitoring of the array performed in August 1996 are also presented and discussed. The predicted performances and cost analysis are also presented in the paper.

- **MAIER, Georg.** 1999. Die 1 MW-Photovoltaikanlage Neue Messe München. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 77–78.

Keywords: project description, case study, roof mounted

Project: Munich Trade Fair, Munich, Germany

Abstract: In this paper, a brief description of the project of the photovoltaic power plant of the Munich Trade Fair is presented. The power plant with an investment cost of DEM 14 million was commissioned on 19th November 1997 and it fed energy into the 20 kV grid. An aerial photograph of the roofs with photovoltaic arrays is also part of the paper.

- **MENCKE, Detlef, Burchard DECKER, Frank WERWITZKI, Dieter HUSEMANN, M. HINTZ, U. HUSEMANN, Eduard KINDEREIT and Peter ZICKEL.** 1998. 55 kWp PV Façade and 23 kWp Roof PV Generator at the ADAC Administration Building. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2678–2681.

Keywords: project description, case study, BIPV

Project: ADAC Office Building, Laatzen, Hannover, Germany

Abstract: The four storey ADAC building in Laatzen near Hannover, close to the EXPO2000 exhibition grounds, was finished in December 1997 and the photovoltaic systems, described in this paper, in June 1998. The solar array consists of a 55 kWp part at the east, south and west façade and a 23 kWp part located on the roof. Due to the façade construction elements only two thirds of each module is covered with solar cells, and the modules also substitute the façade shading elements.

- **MOSCHELLA, U. and W. BERGNA.** 1995. 1560 kW Hybrid (PV+ Wind) Power Plant at Carloforte. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 1045–1048.

Keywords: project description, case study, hybrid

Project: Carloforte, Sardinia, Italy

Abstract: This paper describes the largest European hybrid photovoltaic power plant located in Carloforte, Sardegna. The power plant was connected to the grid in April 1994 to start the test phase. The array has a 600 kW power capacity and is divided into two 300 kW subarrays, each with their own 300 kW inverter and connected to a 15 kV grid. Energy yield and performance of the power plant are presented for the period from May 1994 to September 1995.

- **MUKADAM, K., F. CHENLO, M. C. ALONSO, M. A. ALONSO-ABELLA, A. MATAS and P. VALERA.** 1995. Analytical Monitoring Results of the 1 MWp Toledo PV Plant. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 755–758.

Keywords: project evaluation

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: The monitoring results of the photovoltaic power plant in Toledo, for the time period July 1994 to September 1995 are presented in this paper. The I-V curves of each string were measured. The results are presented for each subfield of the power plant. Reference yield, array yield, final yield and performance ratio are also given. The system losses are also estimated.

- **MUKADAM, K., F. CHENLO, L. REBOLLO, A. MATAS, L. ZARAUZA, P. VALERA and P. GARCIA.** 1997. Three Years of Operation and Experience of the 1 MW Photovoltaic Plant; Toledo PV Spain. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 705–708.

Keywords: project description, project evaluation, case study

Project: La Puebla de Montalbán, Toledo, Spain

Abstract: The operating experiences after three years of the Toledo photovoltaic system are given in this paper. The system consists of two subarrays with ±400 V DC, center grounded, voltage and one subarray with ±200 V DC, center grounded, voltage. The system is connected to a 15 kV medium voltage grid. Performance ratio and yield are evaluated and low grid quality is discussed as one of the major problems in the first years of operation.

- **NORDMANN, Thomas, Thomas BÄHLER and Adolf GOETZBERGER.** 1995. Photovoltaik-Schallschutz-Integration: Neue Konzepte und erste Messresultate. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 173–177.

Keywords: project evaluation, noise barriers

Project: PV noise barrier N13/A13 motorway, Domat-Ems, Chur, Switzerland

Abstract: The photovoltaic noise barrier along the A13 in Switzerland is briefly presented in this paper. Some operating experiences are presented and discussed.

- **NORDMANN, Thomas and Adolf GOETZBERGER.** 1995. Motorway Sound Barriers: The Bifacial North/South Concept and the Potential in Germany. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 707–709.

Keywords: preliminary study, noise barriers

Project: PV noise barrier N13/A13 motorway, Domat-Ems, Chur, Switzerland

Abstract: A brief description of the photovoltaic noise barrier experiences and the potential of photovoltaic noise barriers in Germany is presented in this paper. The potential for Germany is estimated to be about 200 MWp.

- **NORDMANN, Thomas, A. FRÖLICH and Luzi CLAVADETSCHER.** 1997. Eight Years of Operation Experience with Two 100 kWp PV Soundbarriers. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 1124–1127.

Keywords: project evaluation, case study, noise barriers

Project: PV noise barriers, N13/A13 motorway, Domat-Ems, Chur, Graubünden; N2 motorway, Giebenach, Switzerland

Abstract: Two photovoltaic noise barriers along a motorway in Switzerland are presented in this paper. The construction details, including the balance of system cost, are compared for both systems. For the Giebenach system, the costs are significantly lower because of the larger modules used. Module efficiency for the time period January 1990 – January 1996 for the system in Domat-Ems and for the time period April 1996 to December 1996 for the system in Giebenach are given in the paper as well.

- **NORDMANN, Thomas, Kilian REICHE, G. KLEISS, A. FRÖLICH and Adolf GOETZBERGER.** 1998. Integrated PV Noise Barriers: Six Innovative 10 kWp Testing Facilities - A German/Swiss Technological and Economical Success Story! In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2486–2491.

Keywords: project overview, case study, noise barriers

Project: PV noise barriers, A1 motorway, Wallisellen, Switzerland, A96 motorway, Munich Germany

Abstract: In this paper, the construction and operating experiences of the three different 10 kW noise barriers along the A96 motorway near Munich and one on the bridge of the A1 motorway in Wallisellen in Switzerland are presented. The systems along the A96 at Ammersee, near Munich, Germany, have been in operation since June 1997. The modules of three different producers were chosen, whereas module appearance and mounting is fundamentally different from case to case. One system has modules in the form of module cassettes, the second has modules mounted as shingles and the third one has modules mounted as a zigzag construction. In their first year, all of the systems produced about 800 kWh/kWp, with slight performance variation. The Wallisellen project on the A1 bridge in Switzerland is the world's first noise barrier with bifacial solar cells. It is part of a south-north oriented transparent fence at a length of 120 m.

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- **NORDMANN, Thomas, A. FRÖLICH, Kilian REICHE, G. KLEISS and Adolf GOETZBERGER.** 1998. Sechs 10 kWp Testanlagen für integrierten PV-Schallschutz. Erste Betriebserfahrungen und Meßresultate aus Deutschland und der Schweiz. In: 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998, 175–180.

  Keywords: project description, project overview, case study, noise barriers

  Project: PV noise barriers, A96 motorway, Walchstadt am Ammersee, Germany, Aubrugg, Zürich, Switzerland

  Abstract: In this paper, the technical details and operating experiences of different photovoltaic noise barrier types are presented. The presented noise barriers are located along the A96 in Germany, commissioned on 13th June 1997 and in Aubrugg, Switzerland, consisting of bifacial solar cells and commissioned at the end of 1997. Along the A96 three module types were used - zigzag, cassettes and shingles.

- **O'NEILL, Mark J. and A. J. McDANAL.** 1996. The 25 kilowatt Solar-Row: a Building Block for Utility-Scale Concentrator Systems. In: Conference Record of the Twenty Fifth IEEE Photovoltaic Specialists Conference, Anaheim, CA, USA, 13–17 May 1996, 1529–1532.

  DOI: 10.1109/PVSC.1996.564428

  Keywords: project description, concentrator

  Project: Ft. Davis, Texas, USA

  Abstract: In this paper, a brief description of a 25 kW concentrator photovoltaic array is presented. An example of the array use is the 100 kW field at Ft. Davis Texas, photovoltaic power plant. At the time of construction it was the largest two axis tracking photovoltaic array. One 25 kW unit of the Ft. Davis solar power plant includes 72 concentrators and delivers 63 A and 400 V DC to the inverter. Photographs of the Ft. Davis photovoltaic system are also presented in the paper.

- **OSBORN, Donald E. and David E. COLLIER.** 1996. Utility grid-Connected Photovoltaic Distributed Power Systems. In: Proceedings of Solar '96 - the 1996 American Solar Energy Society Annual Conference, Asheville, NC, 13–18 April 1996, 338–346.

  Keywords: project overview, SMUD

  Projects: Rancho Seco; SMUD Hedge substation, Sacramento International Airport, California, USA

  Abstract: Projects constructed under the Sacramento Municipal Utility District, SMUD PV programme between 1984 and 1996 are presented in this paper. The paper includes some technical details of the SMUD's photovoltaic projects. Cost details and commercialisation cost curve are also presented and discussed.

- **OSBORN, Donald.** 1997. Commercialization of Utility PV Distributed PV Power Systems. In: Proceedings of the 1997 American Solar Energy Society Annual Conference, Washington, DC, 25–30 April 1997, 153–159.

  Keywords: project overview, SMUD, PVUSA

  Project: Rancho Seco; SMUD Hedge substation, Sacramento International Airport, California, USA

  Abstract: Projects constructed under the Sacramento Municipal Utility District, SMUD PV programme are presented in this paper. The SMUD programme includes several large-scale photovoltaic power plants like Rancho Seco with sub-systems commissioned in 1984, 1986 and 1996, hedge sub-station power plants with 210 kW and an additional 317 kW, the 160 kW carport of Sacramento's international airport, etc. The cost details and commercialisation cost curve are also given in the paper.

- **PEARSALL, N. M., A. R. WILSHAW, M. SHAW, A. PARR, F. CRICK and R. HILL.** 1995. Installation and Operation of the Northumberland Building Photovoltaic Facade. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1997, 2, 1800–1803.

  Keywords: project description, BIPV, façade

  Projects: University of Northumbria, Newcastle, UK

  Abstract: In this paper, the photovoltaic façade on the Northumberland Building is described. The system with a power capacity of 39.5 kW was commissioned in January 1995. 15 laminates are connected in series with 270 V string voltage at the maximal power point. The system is connected to the grid through a three-phase 415 V inverter. The system was monitored between January and August 1996. Average inverter efficiency was >90% for the whole period. A yield analysis is also given in the paper.

- **PFEIFFER, Gerhard, Herbert REINER, Andreas JOSSEN, Wolfgang HÖHE, M. WOLLNY, Bernd WILLER, Dirk Uwe SAUER, Georg BOPP, Peter SPRAU and Manfred BÄCHLER.** 1999. Photovoltaikanlage Brunnenbach - 10 Jahre Betrieb. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 356–360.

  Keywords: project evaluation, case study

  Project: Brunnenbach, Bavaria, Germany

  Abstract: In this paper, the operating experiences of Brunnenbach stand-alone photovoltaic power plant after 10 years of operation are presented. The power plant was commissioned in 1989 and the project cost was DEM 750,000. After 8 years of operation, the batteries were exchanged and battery capacity was from 500 Ah/2V enlarged to 600 Ah/2V. Problems related to solar modules included too low insulation resistance caused by moisture and some signs of delamination.

- **PLIGOROPOULOS, P. G., A. I. ANDROUTSOS and E. K. BAKIS.** 1998. A Photovoltaic Plant Integrated in the Advanced Autonomous Power Supply System of the Greek Island of Kythnos. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2825–2828.

  Keywords: project description, project evaluation, case study, battery storage, hybrid, diesel generators

  Project: Kythnos Island, Cyclade Islands, Greece

  Abstract: The photovoltaic power plant on Kythnos operating since 1984 is described in this paper. A new inverter was installed in 1993 and a new battery storage unit should also be installed. On Kythnos new wind generators should also be commissioned soon. Together with the diesel and wind energy systems, different operating modes should be possible, like parallel operation of wind, photovoltaic, diesel and storage, parallel operation of diesel, photovoltaic and storage, parallel operation of wind, photovoltaic and storage, parallel operation of photovoltaic and storage and parallel operation of wind and photovoltaic systems.

- **POGGI, P., G. NOTTON, J. L. CANALETTI and A. LOUCHE.** 1997. Integration of Large Scale PV Plants in an Islander Electrical Grid Case Study of Corsica. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 1128–1131.

  Keywords: preliminary study, islands

  Project: Corsica, France

  Abstract: In this paper, some aspects of the integration of large-scale photovoltaic power plants into the island's grids are briefly presented.

- **REICHE, Kilian, Adolf GOETZBERGER, A. FRÖLICH and Thomas NORDMANN.** 1996. Integrated Photovoltaic Sound Barriers (PVS) – Results of the International Competition. In: Internationales Sonnenforum (EuroSun) Proceedings, Freiburg, October 1996, 839–847.

  Keywords: project overview, case study, noise barriers

  Projects: N13/A13 motorway, Domat-Ems; N2 Motorway Giebenach, Basel, Switzerland

  Abstract: In this paper, some background information about the photovoltaic noise barriers in Switzerland is given. Technical feasibilities and potentials are presented and discussed in the paper.

- **REICHE, Kilian, Adolf GOETZBERGER, A. FRÖLICH and Thomas NORDMANN.** 1997. Integrated PV Sound Barriers: Results from the International Competition and Realisation of Six 10 kWp Testing Facilities. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1604–1607.

  Keywords: project overview, case study, noise barriers

  Project: Ammersee, A96, Bavaria, Germany

  Abstract: A brief description of different noise barrier construction is given in this paper. Some cost reduction aspects and some details from the test site in Ammersee along the A96 motorway are given.

- **REIF, Ralf.** 1997. Photovoltaiksiedlung Hettstadt. In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 65–70.

  Keywords: project description, distributed, housing estate, roof mounted

  Project: Solarsiedlung Hettstadt, Würzburg, Germany

  Abstract: The construction of the housing estate Solarsiedlung Hettstadt, near Würzburg, Germany, was initiated in favour of young families with low budgets. On 22 houses a photovoltaic roof integrated power plant with 3.12 kWp is located. One system is also located on the roof of the kindergarten which is also part of the housing estate. In the paper, project details like module type, module mounting and system monitoring are discussed.

- **REIJENGA, Tjerk and W. O. J. BÖTTGER.** 1997. Glass Roof Integrated Photovoltaic System de Kleine Aarde, Boxtel (NL) Thermie SE 104/93 NL. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June–4 July 1997, 2, 1887–1890.

  Keywords: project description, case study, roof integrated, BIPV, transparent

  Project: De Kleine Aarde, Boxtel, the Netherlands

  Abstract: A brief description of the roof integrated transparent system De Kleine Aarde, the National Environmental Education Centre, in Boxtel, the Netherlands is given in this paper. The operation results have been evaluated since October 1996. The results are presented and discussed in the paper. One of the problems was a low dimensioned DC switch which has caused operational brakeage several times. The performance ratio varied between 0.59 and 0.72.

- **REIJENGA, Tjerk and W. O. J. BÖTTGER.** 1998. Glass Roof Integrated Photovoltaic System De Kleine Aarde Boxtel (NL) Final Report Thermie SE 104/93 NL. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2748–2751.

  Keywords: project description, case study, roof integrated, BIPV, transparent

  Project: De Kleine Aarde, Boxtel, the Netherlands

  Abstract: The National Environmental Education Centre De Kleine Aarde in Boxtel (Noord-Brabant) is the oldest environmental education centre in the Netherlands. In the Kleine Aarde, transparent roof integrated solar modules are used. The purpose of the project is to demonstrate the feasibility of a roof integrated PV system in glass covered parts of the building. The photovoltaic system consists of 68 modules and is divided into three parts: 2 x 2,808 Wp and 2,308 Wp. The performance ratio is between 0.59 and 0.72. System operation was monitored in detail from October 1995 to November 1997.

- **REIJENGA, Tjerk and Henk F. KAAN.** 1998. PV Integration in Solar Shading: A Retrofit Case Study Petten (NL). In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2740–2743.

  Keywords: project description, case study, shading

  Project: ECN Building 42, Petten, the Netherlands

  Abstract: A proposal for the integration of a photovoltaic system on the site of ECN in Petten, the Netherlands is given in this paper. A building of the General Laboratory of the Netherlands Energy Research Foundation ECN, built in

1963, should be renovated to improve the energy efficiency of the whole building. The renovation should also include the construction of a building integrated photovoltaic system. In this paper, the results of developing and designing the PV-integrated sun shading system are also discussed.

- **REIJENGA, Tjerk and Tony SCHOEN.** 1998. IEA Task VII Project Evaluation of Existing PV Integrated Projects Architectural Criteria. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2744–2747.

  Keywords: programme overview, project overview, BIPV

  Abstract: This paper describes IEA PVPS Task VII, activity 1.1 with the purpose of collecting projects, to define the selection criteria and to evaluate about 20 BIPV projects. About 200 projects are collected. More projects and data are requested. It is expected that the preliminary results will be available in summer 1998 and the final results in spring 1999. The database should also be published on the Internet.

- **REINDERS, A. H. M. E., A. E. ALSEMA, E. A. SJERPS-KOOMEN and V. A. P. VAN DIJK.** 1997. A 52 kWp PV Sound Barrier System - Performance during the First Year. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1842–1846.

  Keywords: project description, noise barriers

  Project: PV noise barrier, A27 motorway, Utrecht the Netherlands

  Abstract: This paper describes a photovoltaic noise barrier system along the A27 motorway in Utrecht, the Netherlands, commissioned in spring 1995. Monitoring of the system started in July 1995, whereas different parameters like irradiance on the reference cell, temperature of the subarray, ambient temperature, array voltage, array current, array voltage and DC power from the subarray and AC power from the inverter were monitored and evaluated. Detailed performance results are given in the paper as well.

- **RINDELHARDT, Udo, R. BROCKMANN and R. HENKEL.** 1996. 40-kWp-Photovoltaikanlage Kirnitzschtalbahn. Poster. In: 11. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 1996, 289–293.

  Keywords: project description, project evaluation, case study, transportation

  Project: Kirnitzschtalbahn, Bad Schandau, Saxony, Germany

  Abstract: The Kirnitzschtalbahn railway was put into service in 1898. Until 1926 it was supplied by its own power plant and after 1926 the required power was delivered from the public grid. In May 1994 a photovoltaic power plant for the railway was commissioned. The power plant delivers 30% of the power required by the railway. The photovoltaic power plant is divided into two 20 kWp subarrays with 21 strings; each string consists of 18 modules. The power plant is connected to the grid by four master-slave inverters. The investment cost was DEM 18,700/kWp. For the year 1995, seasonal variation of the performance ratio is presented and discussed in the paper. The efficiency of the solar generators and inverters is presented and discussed as well.

- **ROPP, M., Miroslav BEGOVIĆ, Ajeet ROHATGI and R. LONG.** 1995. Roof-Installed PV System on the Olympic Swimming Pool at Georgia Tech. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 965–968.

  Keywords: project description, roof mounted

  Project: Georgia Tech Aquatic Center, Atlanta, Georgia, USA

  Abstract: The monitoring results of the Georgia Olympic Swimming Pool photovoltaic system are given in this paper. A brief description of the monitoring system is presented and the monitoring results are discussed and compared with the simulation results.

- **ROSENTHAL, Andrew, Steven DURAND, Michael THOMAS and Harold POST.** 1997. Economic Analysis of PV Hybrid Power System: Pinnacles National Monument. In: Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference, Anaheim, CA, USA, 29 September–3 October 1997, 1269–1272.

  Keywords: project description, case study

  Project: Pinnacles National Monument, California, USA

  Abstract: In this paper, the economic analysis including the load analysis and energy generation of the Pinnacles National Monument photovoltaic power plant is presented. An emissions estimation of the power plant is also discussed in the paper.

- **ROUJOLLE, Eric, Tadao KASAHARA and O. ISHIKAWA.** 1998. Residential Roof Integrated PV System. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2463–2465.

  Keywords: project description, BIPV, roof integrated, distributed, Japan

  Abstract: A roof integrated photovoltaic system for a residential building in Japan is presented in this paper. Polycrystalline modules 910 x 910 mm in dimension were used in this case. Similar systems were later used in large distributed photovoltaic systems on residential housing, even in the MW scale range.

- **RÜTHER, Ricardo.** 1998. Experiences and Operational Results of the First Grid-Connected, Building-Integrated. Thin Film Photovoltaic Installation in Brazil. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2655–2658.

  Keywords: project description, project evaluation

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Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

Abstract: The first grid connected, building integrated, thin film PV system in Brazil is described in this paper. The system is located on the façade of the Universidade Federal de Santa Catarina in Santa Catarina, Brazil. In the façade, which has an area of 40 m², 2 kWp aSi modules were integrated, whereas 54 opaque and 14 semi-transparent 60 x 100 cm² modules were used.

- **SALA, G., J. C. ARBOIRO, Antonio LUQUE, I. ANTÓN, M. P. GASSON, N. B. MASON, K. C. HEASMAN, T. M. BRUTON, E. MERA, E. CAMBLOR, P. DATTA, M. CENDAGORTA, M. P. FRIEND, P. VALERA, S. GONZÁLEZ, F. DÓBON and F. PÉREZ.** 1998. 480 kW Peak EUCLIDES™ Concentrator Power Plant Using the Parabolic Troughs. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 2, 1963–1968.

  Keywords: project description, case study, concentrator

  Project: EUCLIDES, Canary Islands, Spain

  Abstract: The EUCLIDES concentrator system under construction on the Canary Islands, scheduled to be completed in October 1998, is presented in this paper. The power plant consists of 14 parallel arrays, each 84 m in length, with 480 kW total power capacity. Two modules are connected in parallel to one 60 kW inverter input. The mirrors consist of reflective films glued onto aluminium plates. The total investment cost of the system was ESP 525 million.

- **SALA, G., J. C. ARBOIRO, Antonio LUQUE, J. C. ZAMORANO, J. C. MIÑANO, C. DRAMSCH, T. BRUTON and D. CUNNINGHAM.** 1996. The EUCLIDES Prototype: An Efficient Parabolic Trough for PV Concentration. In: Conference Record of the Twenty Fifth IEEE Photovoltaic Specialists Conference, Washington, DC, USA, 13–17 May 1996, 1207–1210.

  DOI: 10.1109/PVSC.1996.564348

  Keywords: project description, project evaluation, concentrator

  Project: EUCLIDES, Canary Islands, Spain

  Abstract: In this paper, a brief description of the EUCLIDES photovoltaic trough concentrator is given. The concentrator is a 24 m long one axis tracking structure, which tracks the sun around a north-south oriented, horizontal axis. The geometric concentration ratio is 32. Such concentrators were later used for the construction of the EUCLIDES photovoltaic power plant on the Canary Islands.

- **SAMAK, I., R. LOZA, R. SCHELB, C. SCHWEIZER and M. MUNZERT.** 1997. The World's Largest Photovoltaic System to be incorporated into One Building. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1864–1867.

  Keywords: project description

  Project: Daimler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

  Abstract: Brief technical data of the system components, installed on the roof of the Daimler Benz facility in Bad Canstatt is given in this paper. The system consists of five parts, four with fixed arrays and one with a V-trough tracking array, with total 435 kWp power capacity and a 350 MWh annual energy yield. The system is connected to the grid by 76 5.8 kW inverters.

- **SARDI, Luigi, Fabrizio BASEVI and Alecsei SOROKIN.** 1997. Solar PV Parking Roofs and Their Evolution in Italy. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 2, 1951–1952.

  Keywords: project overview, transportation, car ports

  Project: Leonori, Rome; ENEA Casaccia Center, Casaccia; Reggio Emilia, driving school carport, Notabartolo, Italy

  Abstract: A brief description of the photovoltaic carport roof projects in Italy is given in this paper. Described are the carport projects in ENEA Casaccia research facility in Rome, 100 kWp; Leonori, Rome, 85 kWp; the driving school carport roof in Reggio Emilia, 94 kWp; a car exchange parking roof, Notabartolo, Palermo, Sicily, 24 kWp. The main conclusion of the paper is the necessity of standardisation. The paper also highlights the functional and architectural integration of the power plants into the shelter structure.

- **SAYIGH, A. A. M.** 1997. Photovoltaic Applications in the Arab World. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 452–456.

  Keywords: project overview

  Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

  Abstract: A brief description of solar energy use in the Arab world including a brief programme description and some images is given in this paper.

- **SCHAUER, Gerd, Michael FRIESS, Peter KORCZAK and Andreas SZELESS.** 1998. 10 Years Operational Experience of Joint Utility Siemens PV Projects in Austria. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2837–2840.

  Keywords: project description, project overview, noise barriers, alpine region

  Projects: Loser, Styria; PV noise barrier, A1 motorway, Seewalchen, Upper-Austria; BIPV façade, Kelag Office Building, Klagenfurt, Carinthia, Austria

  Abstract: In this paper, some photovoltaic projects realised by Austrian electric utilities are presented. A brief technical description and operation experiences of the 30 kW Loser photovoltaic power plant, the 40 kW photovoltaic noise barrier along the A1 motorway in Seewalchen and the 10 kW photovoltaic façade on the Kelags building in Klagenfurt are given in the paper.

- **SCHLEMPER, Klaus and Reinhard NOWAK.** 1995. 35 kWp PV Installation on a Train Station in Berlin. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1995, 1, 507–509.

Keywords: project proposal

Project: Train station Berlin Charlottenburg, Berlin, Germany

Abstract: A proposal for a 35 kWp photovoltaic system located at Charlottenburg train station in Berlin is presented. The train station situated in the centre of Berlin has two platforms, which should be covered by a photovoltaic roof. Some proposed construction details and the outlook for project realisation are discussed in the paper.

- **SCHMIDT, Rupert, Wolfgang WALLE and Franz HEINRICH.** 1996. Integration einer netzgekoppelten Photovoltaikanlage in eine schallreflektierende und -absorbierende Lärmschutzwand. In: 11. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 1996, 201–205.

Keywords: project description, case study, noise barriers

Project: PV noise barrier, A6 and A620 motorways, Saarbrücken-Güdingen, Saarland, Germany

Abstract: Two photovoltaic noise barriers along the A6 and A620, located close to each other in Saarbrücken-Güdingen, on the merge of two motorways commissioned in June 1995, are described in this paper. Both noise barriers are east-west oriented; one is 332 m long with a 40 kW solar array at a length of 293 m. Another 20 kWp array is mounted on a 217 m long noise barrier with an array length of 197 m. With the intention of better noise reduction, the solar modules are inclined at both power plants. The cost of the power plants was about DEM 15,000/kWp. The paper also includes some images and construction details about the power plants.

- **SCHMIDT, Rupert, Wolfgang WALLE, P. WÜNSCH and Franz HEINRICH.** 1995. Integration of a Grid-Integrated Photovoltaic System into a Sound-Reflecting and a Sound-Absorbing Noise Protection Barrier. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1997, 1, 550–553.

Keywords: project description, case study, noise barriers

Project: PV noise barrier, A6 and A620 motorways, Saarbrücken-Güdingen, Saarland, Germany

Abstract: In this paper, two photovoltaic noise barriers along the A6 and A620 in Saarbrücken-Güdingen, on the merge of two motorways commissioned in June 1995, are described. Power plant section 9062 is 332 m long with a 40 kW solar array that is 293 m in length. Another power plant, section 9065 with a 20 kWp array is mounted on a 217 m long noise barrier with an array length of 197 m. With the intention of better noise reduction, the solar modules are inclined at both power plants. A more detailed study of noise protection is also discussed in the paper. A short description of other parts of the power plants is also given.

- **SCHNAPPER, Christoph, Herwig GÜNTNER, Rudolf LINDNER and Peter WIEGNER.** 1999. Die PV-Anlage der Fachhochschule Nürnberg. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 February 1999, 65–69.

Keywords: project description

Project: Fachhochschule Nürnberg , Nürnberg, Germany

Abstract: In this paper, the photovoltaic power plant located on the building of Fachhochschule Nürnberg in Nürnberg Germany is described. The photovoltaic power plant, with the primary goal of serving students for education purposes, was commissioned in 1997 and it was enlarged at the end of 1998. It includes façade mounted arrays and roof mounted shed arrays. The profile of generated power and some operating issues, like the impact of shading, are also presented and discussed in the paper.

- **SCHOEN, Tony, Emil TER HORST, Jadranka ČAČE and Frans VLEK.** 1997. Large-scale Distributed PV Projects in the Netherlands. In: Progress in Photovoltaics: Research and Applications, 5, 3, 187–194.

DOI: 10.1002/(SICI)1099-159X(199705/06)5:3<187::AID-PIP172>3.0.CO;2-P

Keywords: project overview, project description, distributed, housing estate, BIPV, the Netherlands

Projects: Nieuw Sloten, Amsterdam, Nieuwland, Amersfoort, the Netherlands

Abstract: The large-scale photovoltaic project Nieuw Sloten in the Netherlands consists of distributed systems on 71 houses with a total power capacity of 250 kWp. Several photographs of the Nieuw Sloten project are presented in the paper. The most important lessons learned include the fact that full acceptance of photovoltaics as a building material is needed, that cooperation between the architect and project developer is needed, and that the public perception of the system was positive. Some details of the project development and large-scale distributed photovoltaic projects are also given. The 50 houses involved in the photovoltaic project in Amersfoort were connected to the grid on 26th June 1996 and others are under construction, with a 1 MW power capacity to be reached in 1998.

- **SCHOEN, Tony, Frank WOUTERS and Frans VLEK.** 1999. 1,3 MW dezentrale und gebäudeintegrierte PV-Anlage in einem neuen Stadtviertel in Amersfoort, den Niederlanden. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 February 1999, 234–238.

Keywords: project description, distributed, housing estate, BIPV

Project: Nieuwland, Amersfoort, the Netherlands

Abstract: In this paper, some details about the Amersfoort housing estate are presented. The housing estate includes about 500 individual photovoltaic systems located on houses, a sports hall, school, church and one skyscraper. The first systems were commissioned in 1998 followed by others in 1999. A monitoring time frame of two years was planned. The monitoring plan was partially based on experiences gained at the Serre project in Italy. The following data should be monitored and inspected: material and components test, control of the planning stage, monitoring of construction works and civil engineering and monitoring of expected yield.

- **SCHUMM, Gerhard and Fritz-Harald KLOTZ.** 1995. Das 40 kW Photovoltaik V-Trog Kraftwerk in Widderstall. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 99–104.

1995 – 1999

Keywords: project description, project evaluation, concentrator

Project: V-trough project Widderstall, Widderstall, Germany

Abstract: The V-trough project in Widderstall, Germany was commissioned in 1994. The thermo-hydraulic driven V-trough project consists of nine subarrays with 2.72 kW for each array, mounted on nine mounting structures 28 m in length and 2.5 m in width. The project cost was DEM 613,000. Energy yield and economic cost analysis are presented and discussed in this paper.

- **SHUGAR, Daniel S. and Krishna A. SHAH.** 1998. Status and Early Performance Results of Western Area Power Administration's Building-Integrated Roofing Assembly Projects. In: Proceedings of the 1998 American Solar Energy Society Annual Conference, Albuquerque, NM, 14–17 June 1998, 127–130.

Keywords: project description, project evaluation

Project: Western Area Power Administration, Elverta, California, USA

Abstract: A brief description of the roof integrated photovoltaic systems on the Western Area Power Administration's maintenance building in Elverta, California, is given in this paper. The performance of the power plant for the period November 1996 to October 1997 is presented and some images of the system are presented. An additional 32 kWp array is also under construction.

- **SMELTINK, John, Andrew W. BLAKERS and S. HIRON.** 1999. The ANU 20 kW PV/Trough Concentrator. In: Solar 99 - plug in : Proceedings of the 37th Annual Conference, Geelong, Victoria, Australia, 1–3 December 1999.

Keywords: project description, concentrator

Project: ANU 20 kW PV/Trough Concentrator, later used at Rockingham, Perth, Australia

Abstract: The installation of the ANU 20 kW PV/through concentrator two-axis tracking system planned in Rockingham, Perth is described. Concentrator mirrors are parabolic shaped laminated glass structures with dimensions of 1.6 x 1.2 m. The design of the planned 20 kW system is based on the Spring Valley demonstration facility. In case of mass production, an estimated cost of USD 0.20/kWh can be expected.

- **SMELTINK, John, A. J. CARR, A. CUEVAS, U. THEDEN, W. KEOGH, M. F. STUCKINGS and Andrew W. BLAKERS.** 1997. The ANU/PV Trough Concentrator System. In: Proceedings of the 35th Annual Conference of the Australian and New Zealand Solar Energy Society, Canberra, Australian Capital Territory, Australia, 1–3 December 1997, paper 115.

Keywords: project description, project evaluation, concentrator

Project: Spring Valley Demonstration System, Australia

Abstract: A brief description of the Spring Valley Demonstration System with an ANU photovoltaic trough concentrator is given in this paper. The site was used as a demonstration facility for further development of ANU PV/through a concentrator used in larger systems, located in Rockingham, Perth Australia.

- **SMELTINK, John, G. MATLAKOWSKI, A. CARR, A. CUEVAS, U. THEDEN, W. KEOGH, M. F. STUCKINGS, S. ARMAND and Andrew W. BLAKERS.** 1996. The ANU/PV Trough Concentrator System. In: Solar '96 - Energy for life. Proceedings of the 34th Annual Conference of the Australian and New Zealand Solar Energy Society, Darwin, Northern Territory, Australia, 22–25 October 1996, 195–202.

Keywords: project description, concentrator

Project: ANU PV/trough concentrator later used at Rockingham, Perth, Australia

Abstract: In this paper, a technical description of the ANU photovoltaic through concentrator is presented. Some technical drawings are also part of the paper.

- **SPOONER, E. D., Peter ZACHARIAS, P. MORPHET, G. GRUNWALD and J. MACKAY.** 1998. Solar Olympic Village, Design and Testing Experience. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2466–2471.

Keywords: project description

Project: Olympic Solar Village, Sydney, Australia

Abstract: The Sydney 2000 Olympic Games solar village, under construction, located adjacent to the main Olympic venues at Hombush Bay will also host a roof mounted distributed large-scale photovoltaic power plant. A detailed description of the system which consists of 665 homes, each equipped with a 1 kW roof mounted photovoltaic system is given in this paper. Particular attention was put on the protection measures and operating conditions, like islanding, impact on fault levels, harmonics and voltage regulation.

- **STACHORRA, Elmar, M. SCHROEDER, T. STEPHANBLOME and T. PIERSCHKE.** 1999. Wirtschaftliche Bereitstellung von Spitzenlastenergie durch Kombination einer 1-MW-Photovoltaikanlage und eines multifunktionalem 1,2-MW-Batteriespeichersystems. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 311–315.

Keywords: project description, battery storage

Project: Akademie-du-Mont-Cenis, Herne, Germany

Abstract: In this paper, 1.2 MWh batteries, part of the Mont-Cenis project in Herne, Germany, are described. The main purpose of the project was to use the energy to compensate for the energy requirements in case of a peak load. Battery storage was put into service in December 1997. It is divided into three parts, each with 400 kWh energy storage. The anticipated life time of the batteries is 12 to 15 years, with 100 charge-discharge cycles annually. Similar battery storage was also constructed in Bocholt, where energy is produced by a wind power plant.

- **STEINHARDT, Frank, Gerd HEILSCHER and Robert PFATISCHER.** 1998. 200 kWp Roof Integrated PV Power Station 'Auf dem Kruge', Bremen. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2534–2537.

Keywords: project description, distributed, housing estate

Project: Solarsiedlung, Auf dem Kruge, Bremen, Germany

Abstract: The 200 kWp photovoltaic power plant "Auf dem Kruge" in Bremen, Germany, consists of roof mounted photovoltaic systems installed on 80 terraced houses and residential housing with 72 apartments. The array consists of 960 modules, 12 modules per house and is connected to a centralised inverter, which is located in the transformer station. The inverter is a 190 kW line-commutated thyristor inverter, with 380 V input voltage and it feeds power into a 10 kV grid. During the monitoring period a performance ratio of 76.2% was calculated. Experience gained with this system should be used for similar projects in the future.

- **STEINHARDT, Frank, Thomas ERGE and Edo WIEMKEN.** 1999. Analyse der Photovoltaikanlage "Auf dem Kruge". Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 341–345.

Keywords: project description, case study, distributed, housing estate

Project: Solarsiedlung, Auf dem Kruge, Bremen, Germany

Abstract: A technical description of the photovoltaic power plant on the housing estate "Auf dem Kruge" in Bremen is presented in this paper. A detailed analysis of the monitored data and yield assessment are given in the paper. Measured as well as simulated results are discussed in the paper. Energy yield and performance ratio are presented as well.

- **STEINHARDT, Frank and Gabriele RANKE.** 1997. 200 kW-Photovoltaik-Kraftwerk "Auf dem Kruge". In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 60–64.

Keywords: project description, distributed, housing estate

Project: Solarsiedlung, Auf dem Kruge, Bremen, Germany

Abstract: In this paper, technical data and some constructional and architectural details of the photovoltaic systems of the housing estate "Auf dem Kruge", Bremen are presented. The solar generator located on 80 houses consists of 80 subarrays. It is connected to a 10 kV grid trough three-phase transformer. The project time line from the initial planning in January 1994 to the test commissioning in October 1996 is also presented in the paper.

- **STELLBOGEN, Dirk and Axel EICHHORN.** 1998. Comparing Five PV System Configurations in a 435 kWp Industrial Rooftop Installation. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2507–2512.

Keywords: project overview, project evaluation

Project: Daimler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

Abstract: On the roof of the new engine production facility, with a roof area of 5,000 m² in Stuttgart-Bad Cannstatt, Germany, a photovoltaic power plant with a rated power of 435 kWp has been installed. Technically, this project is very similar to the photovoltaic power of the Olympic Natatorium in Atlanta, Georgia, USA. Five different subarrays are mounted on shed roofs, the roofs of ventilation units, a cafeteria and gate house. Additionally, PV-V troughs with one-axis tracking are also used. The module size and mounting system varies depending on the location. The monitoring system is also described in the paper in detail.

- **STELLBOGEN, Dirk and Andreas BLEIL.** 1998. Integriertes Datensystem für die 435 kWp Photovoltaikanlage des Motorenwerks Bad Cannstatt. In: 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998, 247–251.

Keywords: project description

Project: Daimler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

Abstract: Some technical data and the monitoring system of the 435 kWp photovoltaic power plant located on the Mercedes-Benz facility are presented in this paper. The power plant consists of 5 different subsystems located on the production facility, engineering facility, cafeteria and entrance building. It also includes a small single axis tracking array with mirrors. The monitoring system also includes a visualising pane for visitors where all the important data of the power plant are presented.

- **STELLBOGEN, Dirk, Axel EICHHORN and I. SAMAK.** 1997. 435 kWp-Photovoltaikanlage für das Motorenwerk Bad Canstatt. In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 55–59.

Keywords: project description

Project: Daimler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

Abstract: A short description of the photovoltaic power plant located on the Mercedes-Benz facility in Bad Cannstatt Stuttgart is given in this paper. Each of the five subsystems has some innovative purpose, either for optimal building integration, like the arrays located on the production facility, good orientation and integration into the roof on the engineering facility, thermo-hydraulic tracking function, solar shading of the cafeteria and minimizing of fixation points due to large modules used at the entrance building. Construction started in June 1996 and the power plant was commissioned in autumn the same year. For the system a two year monitoring period was planned.

- **STREY, Ulf.** 1999. Heliotram - Integration von Photovoltaik in Dach und Fassade am Beispiel einer Wartungshalle für Stadtbahnen in Hannover-Leinhausen - Projekt für die EXPO 2000. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 205–212.

Keywords: project description, case study

Project: HELIOTRAM, Hannover-Leinhausen, Hannover, Germany

Abstract: In this paper, the Heliotram photovoltaic project, located on the facility of üstra, Hannover is described. A detailed description of the system in terms of light condition at the building, from an architectural point of view is given in the paper. The requirements and features of modules for building integration, like thermal coefficient, module structure and glass type are also presented and discussed. Shading is also exposed.

1995 – 1999

- **STRONG, Steven J.** 1996. World Overview of Building-Integrated Photovoltaics. In: Conference Record of the Twenty Fifth IEEE Photovoltaic Specialists Conference, Washington, DC, USA, 13–17 May 1996, 1197–1202.

DOI: 10.1109/PVSC.1996.564346

Keywords: project overview, BIPV

Projects: Mataro Library, Olympic Natatorium Atlanta, Aerni Fenster, Switzerland, Tsukasa Electric Industry Company building, Japan, Bavarian Ministry for Environment, Munich, Solarzentrum Freiburg

Abstract: An overview of large-scale building-integrated photovoltaic projects worldwide is given in this paper. The paper also includes several photographs of the discussed projects.

- **STRONG, Steven.** 1998. An Overview of Building-Integrated Photovoltaic Applications in the United States. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2481–2485.

Keywords: project overview, BIPV

Projects: Georgetown University Intercultural Center, Washington, DC; Atlanta Olympic Naratorium, Atlanta, GA; Mauna Lani, HI, USA,

Abstract: This paper presents some of the most notable building-integrated photovoltaic systems in the USA. Some historical background of the BIPV development in the region is also given. The conclusion put attention on the significant potential for building-integrated photovoltaic systems in the future.

- **SZYSZKA, Axel.** 1996. Review of the Neunburg vorm Wald Solar Hydrogen Demonstration Project. In: Power Engineering Journal, 10, 5, 226–232.

DOI: 10.1049/pe:19960507

Keywords: project description, solar hydrogen

Project: Neunburg vorm Wald, Germany

Abstract: The Neunburg vorm Wald solar hydrogen project consists of two parts. A detailed technical description of phases 1 and 2 of the project is given in this paper. Phase 1 consists of a 135 kWp solar array, DC/DC equipment, two advanced low-pressure electrolysers rated at 111 kW and 100 kW, hydrogen and oxygen gas systems for the compression, purification, drying and storage of the electrolytically generated gases, two gas-fired heating boilers, two fuel cell plants and a liquid hydrogen filling station for testing car fuelling systems. Phase 2 consists of solar generators, a 100 kW alkaline pressure-type electrolyser, a catalytic heater, a catalytically heated absorption-type refrigeration unit, and a 10 kW fuel cell plant with a proton-exchange membrane for mobile application in an electric forklift truck with hydrogen supply from metal hydride storage. A block diagram and some images of the system are also part of the paper.

- **TEGTMEYER, Dirk and Bernd ADELMANN.** 1998. Integration of Photovoltaic Elements within the Redeveloped Railway Station in Uelzen. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2723–2725.

Keywords: project description

Project: Railway Station, Uelzen, Germany

Abstract: An example of the reconstruction of an old monumental protected train station, also using a photovoltaic system, is presented in this paper. At the train station in Uelzen, a small town in Northern Germany, between Hannover and Hamburg, a 73 kWp photovoltaic system has been integrated into the roof of the station that is over 100 years old. The array, which consists of 264 photovoltaic laminates, is connected to a 50 kW central inverter which feeds energy into the grid. The system was monitored between June 1997 and May 1998. Based on the monitoring results, an average energy gain of about 820 kWh/kWp was calculated.

- **TER HORST, Emil, J. T. N. KIMMAN and E. LYSEN.** 1995. Large-Scale Urban PV Projects in the Netherlands, four pilot projects in urban areas. In: Thirteenth European Photovoltaic Solar Energy Conference Proceedings, Nice, France, 23–27 October 1997, 2, 1796–1799.

Keywords: project overview, noise barriers, distributed, housing estate, BIPV

Projects: PV noise barrier A27 motorway, Utrecht; Nieuwland, Amersfoort, the Netherlands

Abstract: In this paper, the large-scale photovoltaic projects in urban areas in the Netherlands are described. Noteworthy projects described in the paper are the A27 Utrecht noise barrier and the Nieuwland residential housing photovoltaic project in Amersfoort. Some background of the projects is also given and some photographs of photovoltaic projects in the Netherlands are presented.

- **TOWNSEND, Timothy U., Antonio B. REYES, Jeffrey D. NEWMILLER, Paul A. HUTCHINSON, Art SEKI and Daniel D. WHITNEY.** 1998. PVUSA's Maui Host Site PV System: A Revamping Case Study. In: Proceedings of the 1998 American Solar Energy Society Annual Conference, Albuquerque, NM, 14–17 June 1998, 143–148.

Keywords: project description, project evaluation

Project: Kihei, Maui, Hawaii, USA

Abstract: At the time of installation in October 1989, Kihei photovoltaic power plant was the largest of its kind in Hawaii with 18.5 kWp. In November 1997 due to malfunctioning power conditioning units, it was forced out of service and was repowered and restarted in December 1997. Even after seven years the modules remain in good condition. The three phase power conditioning unit was replaced by three 6 kW single-phase inverters. In the paper, the performance data before and after repowering for January/February 1995, January 1996 and January/February 1998 is also given.

1995 – 1999

- **TÖNGES, Karl-Heinz and Günter CRAMER.** 1998. Anlagenkonzept der 1 MWp-PV-Anlage Herne. In: 13. Symposium Photovoltaische Solarenergie, Staffelstein, 11–13 March 1998, 156–162.

  Keywords: project description, BIPV, roof integrated, façade integrated

  Project: Akademie-du-Mont-Cenis, Herne, Germany

  Abstract: In this paper, a technical description of the building integrated photovoltaic power plant Akademie-du-Mont-Cenis in Herne, Germany is described. It includes a 1 MW photovoltaic power plant integrated into a transparent building envelope. It is integrated into a transparent façade as well as into a transparent roof. The system includes 572 string inverters. The monitoring concept is also described and the technical schematics of the monitoring system are given.

- **VAN MIERLO, B. C., B. C. OUDSHOFF and M. J. UITZINGER.** 1997. Social Acceptance of an Integrated PV-Sound Barrier in the Netherlands. In: Fourteenth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 30 June – 4 July 1997, 1, 908–911.

  Keywords: project evaluation, noise barriers

  Project: PV noise barrier, A27 motorway, Utrecht, the Netherlands

  Abstract: The results of a questionnaire about the photovoltaic noise barrier system along the A27 motorway in the Netherlands are presented in this paper. People living in the vicinity of the sound barrier and 600 drivers were questioned. The results were evaluated and are discussed in the paper. Some topics from the questionnaire include opinion on aesthetics, opinion on traffic safety and social acceptance of photovoltaics as well as renewable energy. One conclusion of the questionnaire is that more publicity on such projects is needed.

- **VÁZQUEZ, Manuel.** 1999. Cies Islands Stand-Alone Photovoltaic Plant: Evaluation and First Results. In: ISES Solar World Congress 1999 Proceedings. Jerusalem, Israel 4–6 August 1999, 1, 234–238.

  Keywords: project description, case study

  Project: Cies Islands, Galicia, Spain

  Abstract: On Cies Island, Natural Park in Vigo, Galicia, a 12 kW photovoltaic power plant was constructed and commissioned in December 1997. The solar array consists of 162 75 Wp modules, connected into six subarrays with a 30° module tilt angle and a 162° azimuth angle from north. Battery storage has a capacity of 2,522 Ah, with 10 hours discharge time. Energy performance and yield evaluation for the period from March 1998 to February 1999 are given in the paper. The efficiencies are also discussed - unassembled array efficiency, hardware efficiency and maximum overall power plant efficiency are mathematically evaluated and presented on a monthly basis.

- **VÁZQUEZ, Manuel, E. LORENZO and J. MORAN.** 1997. A Stand-Alone 12 kWp Photovoltaic System for an Island Natural Park in Spain. In: ISES Solar World Congress 1997 Proceedings. Taejon, South Korea 24–29 August 1997, 3, 253–256.

  Keywords: project description, case study

  Project: Cies Islands, Galicia, Spain

  Abstract: Cies Island, Natural Park in Vigo, photovoltaic system is described in this paper. The system consists of 162 75 Wp modules, battery storage with 2,700 Ah capacity, charge regulators and a one-phase modular inverter. The main loads on the island are the forest guard family house, police house, residence for workers, residence for university researchers, museum and information centre. The monthly values of the estimated energy yield and available solar radiation are presented in the paper.

- **VIGOTTI, R. and N. CARIDI.** 1996. Large Scale Deployment of PV Power Systems – Prospects and Role of Utilities. In: Internationales Sonnenforum (EuroSun) Proceedings, Freiburg, October 1996, 918–924.

  Keywords: preliminary study

  Project: Serre, Salerno, Italy

  Abstract: Some general outlines about the large-scale PV deployment and realisation of the Serre photovoltaic power plant are discussed in this paper.

- **VLEK, Frans, Tony SCHOEN and Alberto ILICETO.** 1998, 1 MW Decentralized and Building Integrated PV System in a New Housing Area of the City of Amersfoort, The Netherlands. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2492–2495.

  Keywords: project description, distributed, housing estate, BIPV

  Project: Nieuwland, Amersfoort, the Netherlands

  Abstract: In this paper, the project proposal for a 1 MW photovoltaic project on the housing estate Amersfoort in the Netherlands is described. The Nieuwland system should be realised on the roofs of approximately 500 houses in Amersfoort. Some important topics in the field of architecture and quality are highlighted in the paper too. Among others, the paper also addresses the quality control and commissioning procedures developed for large-scale PV systems, including a protocol for "Guaranteed Results of PV Systems" (GRSPV).

- **VOERMANS, Rainer and Ralf POTTBROCK.** 1995. 1-MW Photovoltaikanlage Toledo/Spanien. Erste Betriebsergebnisse und kumulierter Energieaufwand. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 93–98.

  Keywords: project description, project evaluation, case study,

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: La Puebla photovoltaic power plant was commissioned in 1994. It consists of two 450 kWp fixed mounted arrays and one 100kW tracking array. Since October 1994, the power plant has been operating fully automatically. The power plant is connected to a 15 kW grid. The energy required for the manufacturing of parts of the power plant was analysed and evaluated. The energy payback period is estimated and discussed in the paper. For different solar arrays, the energy payback period was between 3.8 years and 4.6 years. The investment cost of the power plant was DEM 15,950,000, which would be DEM 0.82/kWh for Spain – an equal analysis for Germany would result in about DEM 1.35/kWh.

- **VON BECHTOLSHEIM, Christof and Roland BURKHARDT.** 1997. Betriebserfahrungen der 58 kWp Bürgerbeteiligungsanlage in Konstanz. Poster. In: 12. Symposium Photovoltaische Solarenergie, Staffelstein, 26–28 February 1997, 263–267.

  Keywords: project description, project evaluation, case study

  Project: Bürgerbeteiligungsanlage Konstanz, Germany

  Abstract: In this paper, the system realised in Konstanz, Germany is described. Some architectural and technical features of the system are described. Energy yield and inverter EU efficiency are presented in the paper as well.

- **WATT, Muriel.** 1996. PV Applications in Australia. In: Conference Record of the Twenty Fifth IEEE Photovoltaic Specialists Conference, Washington, DC, USA, 13–17 May 1996, 19–24.

  DOI: 10.1109/PVSC.1996.563938

  Keywords: project overview, project description, Australia

  Project: Kalbarri, Australia

  Abstract: This paper presents an overview of the development of off grid and grid connected photovoltaic systems in Australia. It also includes a brief description of the Kalbarri photovoltaic tracking power plant, located at the end of a 136 km transmission line. One of the purposes of Kalbarri's project was also to evaluate the effects of photovoltaic projects, connected at the end of a grid. The array consists of 256 modules, mounted on 16 single-axis tracking rings. The power plant also includes an inverter with 75 kVA rated power.

- **WIRTZ, Guido.** 1995. Die Solarfassade am Bayerischen Umweltministerium. Ein Beispiel für die Integration von PV-Anlagen in Bürogebäude. In: 10. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 1995, 167–172.

  Keywords: project description, BIPV, façade

  Project: Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen, Bavarian Ministry for Environment, Munich, Germany

  Abstract: The photovoltaic façade on the building of the Bavarian Ministry for Environment was commissioned in August 1993. It consists of two crystalline and one amorphous Si arrays. Different operating experiences of the solar modules/arrays and inverters are discussed in the paper. Electrical yield and shading impact are presented and discussed in the paper as well.

- **WOLFF, Dieter, Oliver WESTPHAL, Steffen KÄHLER, Matthias VICTOR and Detlef MENCKE.** 1999. 250-kWp-Anlage HELIOTRAM in Hannover-Leinhausen - Direkteinspeisung der PV-Anlage in das Stadtbahnnetz der Üstra. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 213–220.

  Keywords: project description, case study, transportation, tram

  Project: HELIOTRAM, Hannover-Leinhausen, Hannover, Germany

  Abstract: In this paper, a short description of the tram grid in Hannover is given. The new facility for trams also includes a 250 kW photovoltaic power plant directly connected to the tram DC grid. Total project costs were estimated at DEM 3.6 million. The calculations for a direct power injection into the DC grid are presented and discussed in the paper. Energy flow of the DC grid is evaluated and discussed as well.

- **YORDI, Beatriz, W. GILLETT and V. GERHOLD.** 1998, Four Years of Experience of the Multi MWp Thermie Programme. In: 15th European PV Solar Energy Conference, 27th US IEEE Photovoltaics Specialists Conference, 10th Asia/Pacific PV Science and Engineering Conference Proceedings, Vienna, Austria, 6–10 July 1998, 3, 2457–2462.

  URL: Architecturally Integrated, Grid-connected Photovoltaic Roof Lights for the Jaguar/Escort Engine Plant of Ford UK, http://cordis.europa.eu/project/rcn/37875_en.html (10 June 2016)

  Keywords: project overview, Thermie Programme

  Project: PHEBUS project, France; Solarsiedlung Auf dem Kruge, Bremen, Germany; Karlsruhe Art Centre, Karlsruhe, Germany; Berlin Bank, Germany; Greenpeace Headquarters, Hamburg; EUCLIDES, Cannary Islands, Spain, Ford Motor Company, Bridgend (South Wales)

  Abstract: This paper presents a summary of the EU Thermie Programme. A general overview of the programme is given and some of the most notable photovoltaic projects constructed within this programme are briefly mentioned.

- **ZACHARIAS, Peter and E. SPOONER.** 1999. Netzrückwirkungen von Photovoltaikinvertern am Beispiel des Olympischen Dorfes in Sydney. Poster. In: 14. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 1999, 336–340.

  Keywords: project evaluation

  Project: Olympic Solar Village, Sydney, Australia

  Abstract: A detailed technical discussion about inverter grid interconnection, based on the case of the Solar Olympic village in Sydney is given in this paper. The Olympic village system consists of 675 grid-connected 1 kWp photovoltaic systems. The system also includes a 2 kWp thermal solar system.

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- **BATH, D.** 1997. The Essene Way Renewable Energy System. In: Solar Today, May–June, 16–19. Boulder, CO: American Solar Energy Society, ISSN 1042-0630.

  Keywords: project description, case study

  Project: Ambergris Caye Island, Essene Way, Belize

- **BING, J.** 1998. PV in Paradise, Photovoltaic systems bring clean, renewable energy to Mona Island, a remote natural wildlife refuge in the Caribbean. Solar Today, Nov–Dec 1998. American Solar Energy Society. ISSN 1042-0630.

  Keywords: project description, case study

  Project: Mona Island, Caribbean

- **KREUTZMANN, A.** 1999. Size Matters. Die dachintegrierte Solarstromanlage in Herne ist am Netz. Photon das Solarstrom Magazin. Mai–Juni, 42–46.

  Keywords: project description, BIPV, roof integrated, façade integrated

  Project: Akademie-du-Mont-Cenis, Herne, Germany

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- **LANG, J. Ed.** 1999. Photovoltaik in Siedlungen. BINE Informationsdienst, projektinfo 7/99. Fachinformationszentrum Karlsruhe, Gesellschaft für wissenschaftlich-technische Information mbH.

  URL: http://www.bine.info/themen/erneuerbare-energien/photovoltaik/publikation/photovoltaik-in-siedlungen/ (26 March 2016)

  Keywords: project description, distributed, BIPV, roof integrated

  Projects: Solarsiedlung Hettstadt, Germany; Solarsiedlung Auf dem Kruge, Bremen, Germany; Amersfoort, the Netherlands; Solarsiedlung Gelsenkirchen, Germany

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **SCHEER, Hermann, B. McNELIS, Wolfgang PALZ, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2000. Sixteenth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Glasgow, United Kingdom, 1–5 May 2000. Volume 1–3. James & James, ISBN 9781902916187.

- **McNELIS, B., Wolfgang PALZ, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2001. Seventeenth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Munich, Germany, 22–26 October 2001. Volume 1–3. ETA Florence, WIP München, ISBN 3-936338-08-6, ISBN 3-936338-07-8 (CD ROM).

- **HOFFMAN, W., J.-L. BAL, Heinz A. OSSENBRINK, Wolfgang PALZ and Peter HELM. Eds.** 2004. Nineteenth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Paris, France, 7–11 June 2004. ETA Florence, WIP München, ISBN 3-936-338-14-0, ISBN 88-89407-02-6, ISBN 3-936338-15-9 (CD ROM).

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- **ROHATGI, Ajeet Ed.** 2000. The Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference 2000, Anchorage, AK, USA, 15–22 September 2000. ISBN 0-7803-5772-8.

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PROCEEDINGS – World Conference on Photovoltaic Energy Conversion

- **KUROKAWA, Kosuke, Larry. L. KAZMERSKI, B. McNELIS, M. YAMAGUCHI, C. WRONSKI and Wim SINKE Eds.** 2003. 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar. Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003. ISBN 4-9901816-0-3 (Vol. A), ISBN 4-9901816-1-1 (Vol. B), ISBN 4-9901816-2-X (Vol. C).

PROCEEDINGS – International Solar Energy Society, ISES

- **SAMAN W. Y. and W. W. S. CHARTERS. Eds.** 2001. ISES Solar World Congress 2001, 39th Annual Conference of the Australian and New Zealand Solar Energy Society Proceedings, Adelaide, Australia, 25–30 November 2001, International Solar Energy Society. Oxford: Elsevier. ISBN 095861928X.

- **ISES.** 2003. ISES Solar World Congress 2003 Proceedings, Göteborg, Sweden, 14–19 June 2003, International Solar Energy Society.

PROCEEDINGS – EuroSun, ISES

- **FURBO, S. Ed.** 2001. Selected Proceedings of the 3rd ISES Europe Congress, Copenhagen, 19–22 June 2000. Oxford: Pergamon Press. ISBN 8777566254.

- **ISES.** 2002. EuroSun 2002, the 4th ISES Europe Solar Congress, Proceedings, Renewable energy for local communities of Europe, Bologna, 23–26 June 2002. ISBN 889008930X.

- **ISES.** 2004. EuroSun 2004, the 5th ISES Europe Solar Congress, 14th Internationales Sonnenforum Proceedings, Freiburg. ISBN 3980965635, 3980965600.

PROCEEDINGS – American Solar Energy Society, ASES

- **CAMPBELL-HOWE, Rebecca Ed.** 2000. Proceedings of the Solar 2000 Conference, ASES Annual Conference, 25th National Passive Solar Conference, Madison, Wisconsin, 16–21 June 2000. ISBN 0895531720.

- **CAMPBELL-HOWE, Rebecca Ed.** 2001. Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001. ISBN 0895531739.

- **CAMPBELL-HOWE, Rebecca Ed.** 2002. Proceedings of the Solar 2002 Conference, 31st ASES Annual Conference, 27th National Passive Solar Conference, Reno, NV, 15–20 June 2001. ISBN 0895531747.

- **CAMPBELL-HOWE, Rebecca Ed.** 2003. Proceedings of the Solar 2003 Conference, 32nd ASES Annual Conference, 28th National Passive Solar Conference, Austin, TX, 21–26 June 2003. ISBN 0895531755.

- **CAMPBELL-HOWE, Rebecca Ed.** 2004. Proceedings of the Solar 2004 Conference, 33rd ASES Annual Conference, 29th National Passive Solar Conference, Portland, OR, 9–14 July 2004. ISBN 0895531763.

PROCEEDINGS – Symposium Photovoltaische Solarenergie, Bad Staffelstein

- **LUTHER, Joachim Ed.** 2000. 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17. March 2000. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-04-2.
- **SCHMID, Jürgen Ed.** 2001. 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16. March 2001. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-13-1.
- **GABLER, Hansjörg Ed.** 2002. 17. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15. March 2002. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-19-0.
- **HEZEL, Rudolf Ed.** 2003. 18. Symposium Photovoltaische Solarenergie, Staffelstein, 12–14. March 2003. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-25-5.
- **MEYER, Tim Ed.** 2004. 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12. March 2004. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-32-8.

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- **KUROKAWA, Kosuke Ed.** 2003. Summary, Energy from the Desert; Feasibility of Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems. London: James & James (Science Publishers).

URL: http://www.iea-pvps.org/index.php?id=95&eID=dam_frontend_push&docID=200 (10 June 2016)

- **VAN DER BORG, N. J. C. M. and M. J. JANSEN.** 2001. Photovoltaic noise barrier at the A9-highway in the Netherlands. Results of the monitoring programme. Report, ECN-C--01-021, February 2001.

URL: https://www.ecn.nl/publications/E/2001/ECN-C--01-021 (23 October 2016)

Abstract: In the report, the operating results of the photovoltaic noise barrier located along the A9 motorway near Ouderkerk aan de Amstel in the Netherlands are analysed and discussed. The system was commissioned on 1 December 1998. The total length of the photovoltaic system is 1650 m and it consists of two different module types with a 50° module tilt and integrated module inverters. Inverter efficiency was analysed in detail and some other impacts on overall efficiency were studied as well. One of the conclusions is that accumulated traffic dust on the modules can cause significant energy losses. Annual cleaning of the photovoltaic arrays after the winter season was proposed. Photovoltaic monitoring was proven to be effective and further monitoring in the future was proposed as well.

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- **OSBORN, Donald E.** 2001. Sustained Orderly Development and Commercialization of Grid-Connected Photovoltaics: SMUD as a Case Example. In: Advances in Solar Energy, Volume 14, 167–228. Boulder, CO: American Solar Energy Society. ISBN 0-89553-257-3.

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- **AGUILERA, J., G. ALMONACID, P. J. PÉREZ and P. G. VIDAL.** 2000. Universidad Verde-200 kWp grid connected PV system. In: Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference. Anchorage, AK, USA, 15–22 September 2000, 1668–1670.

DOI: 10.1109/PVSC.2000.916222

Keywords: project description, case study

Project: UNIVER Project, Jaén University Campus, Jaén, Spain

Abstract: In this paper, a brief description of the Jaén University Campus, photovoltaic system is given. The UNIVER Project with a power capacity of 200 kWp was financed through the EU Thermie Programme. The system consists of four different photovoltaic subsystems located on the university building's roof and façade and on the carport roof. Some safety and protection aspects are also discussed. Operating experiences and monthly performance including the yield and performance ratio for the period from November to July is also given in the paper.

- **AL-AMOUDI, A. and S. AL-ZAHRANI.** 2001. Degradation Analysis of 350 kW Photovoltaic Plant After 20 Years of Operation. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 1, 533–536.

Keywords: project evaluation, concentrator

Project: Solar Village Project, villages Al-Jubaylah, Al-Oyaynah, Al-Hijrah, Riyadh, Saudi Arabia

Abstract: The reasons for the degradation of the 350 kW photovoltaic concentrator system installed close to Riyadh after 20 years of operation are discussed. A brief description of the system is given and the main reasons for the degradation are presented and discussed. Due to degradation caused by heat and dry air, the 350 kW rated system has, after 20 years, delivered only 45 kW of power capacity. A short historical maintenance overview is also given.

- **ASHRAF, Imtiaz and A. CHANDRA.** 2004. Energy pay-back time and air pollution mitigation of a 100-kWp grid connected SPV power plant for Lakshadweep Island. In: Proceedings of the 39th International Universities Power Engineering Conference, 2004. UPEC 2004. Bristol, UK, 6–8 September 2004, 1, 639–643.

Keywords: project description, case study

Project: Kiltan, Minicoy, Agatti, Kavaratti, Andrott, Kadmat, Lakshadweep Islands, India

Abstract: The Lahshadweep group of islands are 36 Indian islands in the Arabian Sea, ten of which are inhabited. On six islands, 100 kW range photovoltaic power plants were commissioned in 2000 and 2002. This paper presents the theoretical background for economic evaluation and energy payback time for the photovoltaic systems on the Lakshadweep islands. The system lifetime is estimated at 30 years and the EPBT about 9.9 years with actual and interpolated values and 7.5 years with expected values for the lifetime.

- **BAHAJ, A. S., P. A. B. JAMES and J. BRIGHTWELL.** 2004. Photovoltaic Atrium on a New Administration and Student Services Building - University of Southampton. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 3066–3068.

Keywords: project description

Project: University of Southampton, Southampton, UK

Abstract: A brief description of the atrium with roof-integrated photovoltaic modules of the new administration and student services building at the University of Southampton, UK, is presented. The system is located at the Highfield Campus, Southampton, and it has a power capacity of 14 kWp. Some construction and architectural details are discussed and a yield estimation is also given.

- **BAKKER, Cees Th. R., Robert CLARK, Robert PFATISCHER and Esther ROTH.** 2004. SUNCITIES: Large-Scale Integration of PV in the Urban Planning Process. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2760–2763.

Keywords: project description

Projects: SunCities photovoltaic project, Heerhugowaard, the Netherlands; Ravensthorpe, Titanic Mill, Primrose Hill, Fernside, UK and Dorsten, Erlangen, Germany

Abstract: In this paper, some technical and architectural details of the SunCities photovoltaic project are presented. The SunCities project, with a total of 3 MW photovoltaic roof-mounted systems, consists of 2.45 MW in Heergouwaard, the Netherlands, 400 kW in Ravensthorpe, Titanic Mill, Primrose Hill and Fernside Housing at different sites in the UK and 200 kW in Dorsten and Erlangen, Germany. The purpose of the project was to evaluate large-scale urban photovoltaic systems located on dwellings in urban environments.

- **BECKER, Gerd, Bodo GIESLER, Gerald KUMERLE, Wolfgang REHM, Bruno SCHIEBELSBERGER and Walter WEBER.** 2004. More Than 6 Years of Operation Experience with a 1 MW Photovoltaic Power Plant - Highlights and Weak Points. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2861–2864.

Keywords: project description, project evaluation

Project: Munich Trade Fair, Munich, Germany

Abstract: This paper presents the operating experiences and performance data of a 1 MW roof-mounted photovoltaic system located on the roofs of Munich Trade Fair halls commissioned in November 1997, after six years of service. After six years of operation, the performance ratio was in the range of 77% and 79%. The influence of temperature and the efficiency of the photovoltaic generator and inverters are also discussed. Among the weak points, shading effects and some storm damage and malfunctions of the equipment were evaluated in the paper.

2000 – 2004

- **BECKER, Gerd, Georg MAIER and Mike ZEHNER.** 2000. Line Side Behaviour of a 1 MW-Photovoltaic Plant. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2647–2650.

  Keywords: project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The Munich Trade Fair 1 MW photovoltaic power plant was commissioned in February 1998. The system is connected to the grid by three 330 kVA master-slave central inverters. In this paper, the results of the line side behaviour of the photovoltaic power plant are presented. The total harmonic distortion, THD and power produced were measured during one week of low load and one week of high load. The measured values were within the limits specified by the EN 50160 norm.

- **BEGOVIĆ, Miroslav, Aleksandar PREGELJ and Ajeet ROHATGI.** 2000. Four-Year Performance Assessment of the 342 kW PV System at Georgia Tech. In: Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference, Anchorage, AK, USA, 15–22 September 2000, 1575–1578.

  DOI: 10.1109/PVSC.2000.916198

  Keywords: project evaluation, case study

  Project: Georgia Tech Aquatic Center, Atlanta, Georgia, USA

  Abstract: The Georgia Tech Aquatic Center photovoltaic power plant has being operating since June 1996. In this paper, the performance of the system during the first four years of operation is presented. The system consists of 2,856 modules wired in 238 strings with 12 modules in each string. The system is connected to the grid by a 315 kW (DC) inverter. A comparison between the predicted and measured system performance and a detailed analysis of the reliability and failures are also given in the paper. The main failures were lightning strikes, plumbing failures, fan malfunction and IGBT failure. Mathematical statistical analysis of the system performance is also discussed, including the mean time between failures (MTBF), which is calculated and presented as a plot. The reliability function and expectation for a 10 year period is also presented.

- **BENEMANN, Joachim, Oussama CHEHAB, Erhard KRAUSEN and Eric SCHAAR-GABRIEL.** 2000. 1 Megawatt Building-Integration of Photovoltaics: Mont Cenis Academy Herne. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1787–1789.

  Keywords: project description, BIPV

  Project: Akademie-du-Mont-Cenis, Herne, Germany

  Abstract: The Akademie-du-Mont-Cenis 1 MW building-integrated photovoltaic system was connected to the grid in March 1999. Transparent photovoltaic modules are integrated into the façade and roof of the glass envelope, which serves as a microclimatic envelope for the building's interior. The photovoltaic system supplies about 150 homes with solar power, whereas a string inverter concept with 569 inverters is used for grid connection. In this paper, a brief description of the system is given and several photographs of the roof and façade integrated modules are presented.

- **BETCKE, J. W. H. and V. A. P. VAN DIJK.** 2000. An Analysis of the Design of PV Systems in the Built Environment in the Netherlands in 1997–2000. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2691–2694.

  Keywords: project overview, distributed, housing estate

  Projects: Nieuw Sloten, Amsterdam, The Netherlands

  Abstract: In this paper, a brief description of the efficiency measurement, including an estimation of losses in photovoltaic systems in a built environment in the Netherlands is given. Part of the measurements was also conducted on the Niew Sloten photovoltaic projects. For this project, a detailed analysis of losses is given, whereas total losses are estimated to be about 26.2%.

- **BING, James.** 2001. Suitland Federal Center's 100 kW Amorphous PV Installation: Thin Film Technology in a Utility Scale Application. In: Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001, 117–120.

  Keywords: project description

  Projects: Federal Center, Suitland, Maryland, USA

  Abstract: In the summer of 2000, a 100 kW photovoltaic system was installed in Suitland, Maryland as a large-scale demonstration project. It comprises 2,800 thin film 43 W modules with a fixed tilt angle of 30°. The system is located at the Federal Center, which houses the National Records Center, the Headquarters of the Census Bureau, the offices of the National Oceanic and Atmospheric Administration (NOAA) and Naval Intelligence. The system design and lessons learned are presented and discussed in more detail.

- **BLEIJS, J. A. M., A. D. SIMMONS and Ian WALKER.** 2004. A Demonstration and Research PV System for the Department of Engineering at the University of Leicester. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2927–2930.

  Keywords: project description

  Project: University of Leicester, United Kingdom

  Abstract: In this paper, the 40 kWp building-integrated photovoltaic system proposed for the Main Campus of the University in Leicester, UK, is presented. The proposed system is part of the UnivERsol project founded by the European Commission. The electrical diagram of the proposed system is given and some architectural and technical details such as the predicted yield and performance ratio are discussed.

- **CLAVADETSCHER, Luzi and Thomas NORDMANN.** 2000. 100 kWp Gridconnected PV Plant A13 in Switzerland - 10 Years and 1,000,000 kWh Later. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2249–2253.

  Keywords: project evaluation, noise barriers

  Project: Photovoltaic noise barrier N13/A13 motorway, Domat-Ems, Chur, Switzerland

  Abstract: The photovoltaic noise barrier along the N13/A13 motorway in Switzerland was constructed in 1989, with a total investment cost of CHF 2,130,000. Until 31 March 1999, the power plant fed 1,000 MWh into the grid. Operating experiences after 10 years of operating are presented in this paper. The monthly values of the yield for the ten year period and yield losses are presented; performance data including the performance ratio is also given. Detailed maintenance effort is also presented in the paper.

- **CORSI, M., P. REDI, M. RUŽINSKÝ and V. ŠÁLY.** 2000. Photovoltaic System for the Funicular of Leghorn, Italy. In: Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference, Anchorage, AK, USA, 15–22 September 2000, 1560–1562.

  DOI: 10.1109/PVSC.2000.916194

  Keywords: project description, transportation

  Project: Funicular of Leghorn, Italy

  Abstract: The Leghorn funicular railway photovoltaic system was commissioned in early 2000. The Leghorn funicular railway runs from the town to Montenero Sanctuary at the top of the hill. The system produces about 45 MWh annually. The solar array has a 36,5 kWp power capacity at 384 V DC. It is connected to the grid by one 36 kW three-phase inverter. In the case of a grid outage, the system backup is 400 Ah, 380 V battery storage connected to DC/DC converter. In this paper, a brief description of the power plant is given and some plans for future improvements are also discussed.

- **CUNOW, Edwin and Bodo GIESLER.** 2001. The megawatt solar roof at the new Munich Trade Fair Centre – an advanced and successful new concept for PV plants in the megawatt range. In: Solar Energy Materials and Solar Cells, 67, 1–4, 459–467.

  DOI: 10.1016/S0927-0248(00)00315-9

  Keywords: project description, project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: In this paper, the 1 MW power plant located on the Munich Trade Fair halls is presented and described. A block diagram of the power plant is given and photos of the system are presented. The paper includes a brief description of the module mounting structures, lightning and overvoltage protection and the inverter unit. The inverters are operating in master-slave mode with daily rotation of the master and slaves. Brief operating experiences from the first year are presented and the data monitoring system is also briefly described.

- **CUNOW, Edwin, Bodo GIESLER and Wolfgang REHM.** 2001. One MW PV Roof at the Munich Trade Fair Centre - Results and Experiences of Three Years of Operation. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2407–2409.

  Keywords: project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The first operating results of the 1 MW photovoltaic roof-mounted system, located on the roofs of Munich Trade Fair, commissioned in 1998 are presented in this paper. Power plant operating data was analysed for the first three years of operation - for the period from December 1997 to June 2001. The performance ratio of the power plant was 70% in 1998 and reached 80% in 2000.

- **DE LILLO, Anna, Saverio LI CAUSI and Salvatore CASTELLO.** 2003. Longterm Performance of Casaccia Plant. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, Volume C, 2231–2234.

  Keywords: project description, project evaluation, car port

  Project: ENEA Casaccia Center, Casaccia, Italy

  Abstract: In this paper, long-term operational data collected in the period from 1992 to 2002 on the 100 kW photovoltaic power plant on the ENEA carport in Casaccia, Italy is presented. The power plant was constructed in 1991, with an investment cost of EUR 930,000. The system has a performance ratio 0.65 and is connected to the public grid by one custom-made 160 kVA inverter. For each year, the plant performance, including energy yield, availability and performance ratio, is given. Maintenance experiences with the main incidents and outages listed are also presented.

- **DECKER, Burchard, Jürgen SCHULT, Dieter WOLFF and Clemens TRIEBEL.** 2001. 253-kWp-PV-Anlage auf dem Betriebshof Hannover-Leinhausen zur Direkteinspeisung in das Stadtbahnnetz. Poster. In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 540–546.

  Keywords: project description, case study, transportation, tram

  Project: HELIOTRAM, Hannover-Leinhausen, Hannover, Germany

  Abstract: The photovoltaic power plant in Hannover-Leinhausen was commissioned in May 2000. The arrays are located on the southwest oriented roofs of the maintenance hall of the tram facilities. The power plant is connected to the 600 V DC grid. It consists of a 129.3 kWp array with a 10° tilt on the flat roof, a 93.5 kWp array of solar modules with thermal insulation and a 30.6 kWp façade-integrated array. Block schematics of the power plant are given in the paper and mounting experiences are also briefly described. The investment cost of DEM 3.7 million was partially financed by the EU Thermie programme.

2000 – 2004

- **DECKER, Burchard, Markus BRAND, Peter KRABBE, Günter SCHLEIFF, Christoph KOEPPEN and Stefan MÜLLER.** 2001. Gebäudeintegrierte 61-kWp-PV-Anlage im Rahmen der EXPO 2000 an der Halle 7 Hannover-Messegelände. Poster. In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 547–552.

  Keywords: project description, case study

  Project: EXPO 2000, Hannover, Germany

  Abstract: The building integrated photovoltaic system of Hall 7 on the Hannover Trade Fair grounds was commissioned at the beginning of the EXPO 2000 fair. Photovoltaic arrays with a 30° tilt angle and a 32 kWp power capacity were integrated into the southern part of the roof of Hall 7. An additional 29 kWp were mounted on an aluminium and steel construction about 160 cm from the south façade. An annual gain of 40,000 kWh is expected. Energy is fed directly into the low voltage grid of the trade fair facility by 14 inverters used for the roof part and by 11 inverters used for the façade array. The qualification procedures of the modules are also briefly described. The total cost of the photovoltaic system was DEM 3 million.

- **DE LA CASA, J., P. J. PÉREZ, J. AGUILERA, G. ALMONACID and J. M. ANGUITA.** 2003. Lessons Learning During Evaluation and Maintanance of a Building Integrated Grid Connected Photovoltaic Plant (UNIVER Project). In: ISES Solar World Congress 2003 Proceedings, P 2 66. Göteborg, 14–19 June.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: The photovoltaic system located on the Jaén University Campus, Jaén, Spain, is briefly described in this paper. It consist of three subsystems, two 70 kWp systems on the carport roof, a 20 kWp system on the roof of the University building and a 40 kWp system on the façade of the University building. Maintenance experiences are presented and discussed in detail. Some proposals relevant to the inverter control strategy regarding system operation are: the system should be connected when the radiation conditions are above self-consumption, solar arrays should operate at the maximal power point, the phase of current/voltage fed to the grid by an inverter should be precisely controlled, the system should be disconnected when operating conditions are outside of the range, such as temperature overload, malfunction of the inverter, etc.

- **ENZ, Carole.** 2002. 10 Jahre Mont-Soleil. Jubiläum des Solarkraftwerks Mont-Soleil: eine Zwischenbilanz. Tec, 21, 4, 13–14.

  DOI: 10.5169/seals-80509

  Keywords: project evaluation

  Project: Mont-Soleil, Switzerland

  Abstract: A brief description of the Mont-Soleil photovoltaic power plant in Switzerland after 10 years of operation is presented in this paper. The technical details are listed and an aerial image of the power plant is also given.

- **ERGE, Thomas, A. BEUSCHEL, Klaus KIEFER, E. RÖSSLER, and W. SCHMITZ.** 2001. Operation Experience of the 120 kWp PV System "Butzweilerhof". In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2375–2378.

  Keywords: project description, project evaluation

  Project: Bildungszentrum des Handwerkskammers, Butzweilerhof, Köln, Germany

  Abstract: The photovoltaic system consisting of different arrays installed at “Butzweilerhof”, the education building of the Chamber of Skilled Crafts and Small Industries “Handwerkskammer zu Köln (HWK)”, is described in this paper. The system consists of façade- and flat-roof-mounted arrays and it also includes a small training system with battery storage. The monitoring concept is also presented and the operating results for different parts of the photovoltaic power plant are discussed. The performance ratio and related problems are also presented; some images of the system are also included.

- **FARHANGI, Shahrokh, Behzad VAFAKHAH, Babak FARHANGI, Peyman KANAAN and Samira MANESHIPOOR.** 2004. A 5 kW Grid-Connected System with Totally Home-Made Components in Iran. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2988–2991.

  Keywords: project description

  Project: Deputy of Energy Affairs, Ministry of Energy, Tehran, Iran

  Abstract: In this paper, technical details of the 5 kW roof-mounted photovoltaic system in Tehran commissioned in June 2003 are presented. The system configuration, inverter details and performance results are given in this paper.

- **FIORAVANTI, E., E. BRICCA, A. CONTI and A. PRAMPOLINI.** 2001. An 80 kW Grid Connected System in the "Guglielmo Marconi" Airport in Bologna, Italy. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2636–2637.

  Keywords: project description

  Project: Guglielmo Marconi Airport, Bologna, Italy

  Abstract: A brief description of the 80 kWp photovoltaic system that has been integrated into the coverage structure of the new area of the airport in Bologna, Italy, is described in this paper. Some basic operating data is also briefly discussed.

- **GABLER, Hansjörg and H.-D. MOHRING.** 2002. Photovoltaische Großanlagen – Technologie und Realisierung. FVS Themen, 2002, 56–60.

  Keywords: project description

  Project: Munich Trade Fair, Munich; Akademie-du-Mont-Cenis, Herne; Markstetten, Germany

  Abstract: In this paper, some technical and economic details of the large-scale photovoltaic power plants located on the roof of the Munich Trade Fair, the building-integrated system of Akademie-du-Mont Cenis in Herne, Germany, and in Markstetten are given. Electrical schematics with the central inverters of the Munich Trade Fair and the decentralised system with 569 1.5 kW inverters of the Akademie-du-Mont Cenis PV power plants are presented.

- **GIESLER, Bodo, Edwin CUNOW, M. ERMER.** 2002. 2,3 MWp PV-Dach der FLORIADE - weltgrößte und innovative PV-Dachintegration. In: 17. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 2002, 203–208.

  Keywords: project description, BIPV

  Project: Floriade, Harlemeermeer, the Netherlands

  Abstract: A technical description of what was, at the time of construction, the world’s largest roof-integrated transparent photovoltaic system in Harlemeermeer, the Netherlands, is given in this paper. The photovoltaic system was constructed on the grounds of the Floriade flower exhibition. For the transparent roof, special glass-foil 118 Wp modules with 17% transparency were used. The roof consists of a total of 19,380 modules. The investment cost of the system was EUR 17.5 million, with EUR 5.2 million state subsidies. Block schematics of the system are given. The expected annual gain was 1.23 GWh. The system is connected to the grid through four 300 kVA and four 200 kVA master-slave inverters and transformers.

- **GIESLER, Bodo, Peter HOUZER and Edwin CUNOW.** 2000. Exzellente Performance des Solardachs Neue Messe München - detaillierte Betriebsergebnisse. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 70–77.

  Keywords: project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The operating results of the Munich Trade Fair 1 MW power plant are presented for a two-year period, from December 1997 to December 1999. The energy yield is presented for a 12 month period starting from December 1997 to January 1999. The highest values of the performance ratio of the power plant were more than 84% in the first half of 1999 and 86% in October 1998. The module temperature in comparison to solar irradiance is also evaluated and presented. The inverter efficiency of the large master-slave inverters is also given.

- **GILLETT, W., R. GAMBI, C. OBLED, Heinz OSSENBRINK, A. PERUJO and H. SCHOLZ.** 2001. Results from PV Demonstration Projects in Europe. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2426–2429.

  Keywords: project evaluation

  Projects: Photocampa, Car Port, Tarragona, Spain; Lehrter Bahnhof, Berlin, Germany; Amersfoort, Sun Cities, the Netherlands

  Abstract: The key lessons learned from different EU demonstration photovoltaic projects are presented and discussed in this paper. Brief descriptions of the projects are given and some economic data like investment cost reduction are also presented.

- **GOETZBERGER, Adolf, Thomas NORDMANN and G. HILLE.** 2000. Das Potential von Photovoltaik auf Lärmschutzwänden in Europa. Poster. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 455–460.

  Keywords: preliminary study

  Projects: Domat-Ems A13, Gordola Railway, Giebenach A2, Zürich Nord, Switzerland; Seewalchen A1, Austria; Rellingen A23, Saarbrücken, Ammersee A96, Bavaria, Germany; Utrecht A27, Ouderkerk aan de Amstel A9, the Netherlands.

  Abstract: In this paper, the results of the European photovoltaic noise barrier potential estimation are presented. In one table, a brief overview of the PV noise barriers in the EU is also given.

- **GROTTKE, M., Peter HELM, A. HOFER, N. OLARIU, I. ALEXANDRU, S. PIETRUSZKO and D. MAVROTAS.** 2001. First Grid-Connected PV System in Romania. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2613–2616.

  Keywords: project description

  Project: University Valahia Târgoviste, Romania

  Abstract: In April 2001, the 10 kW photovoltaic system located at University Valahia Târgoviste, Romania, was commissioned. The system consists of two subarrays, one with transparent solar modules mounted into the sloped glass façade of the classroom and another consisting of thin film solar modules. The monitoring and operating results of the system are presented and photovoltaic array efficiencies are also discussed in detail. Images of the system are also part of the paper.

- **GROTTKE, M., T. SUKER, R. EYRAS, J. GOBERNA, O. PERPIÑÁN, A. VOIGT, A. THIEL, M. SPENDEL, K. GEHRLICHER, G. FRISEN, R. GAMBI and K. KELLNER.** 2004. PV Soundless - World Record "Along the Highway" - A PV Sound Barrier with 500 kWp and ceramic Based PV Modules. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 2, 2102–2104.

  Keywords: project description, noise barriers

  Project: Photovoltaic noise barrier, A92 motorway, Freising, Germany

  Abstract: In this paper, the operating experience of a 338 kWp array, part of the 500 kWp photovoltaic noise barrier along the A92 motorway in Freising, Germany, is presented. The array consists of ceramic-based solar modules. The technical features and performance results of different module/array types are presented and discussed. The ceramic-based solar array has a performance ratio between 0.7 and 0.76, whereas the other array's performance ratio is between 0.70 and 0.75.

2000 – 2004

- **GUELBENZU, E., A. B. CUELI and A. R. LAGUNAS.** 2004. 1.2 MW Photovoltaic Plant with Sun Tracking on all Generation Systems. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 2, 2258–2261.

  Keywords: project description, project evaluation, trackers

  Project: Tudela, Navarra, Spain

  Abstract: In this paper, details of the 1.2 MWp Monte de Cierzo photovoltaic power plant, located in Tudela, Navarra, Spain, are presented. This was the first 100% sun tracking photovoltaic power plant in Europe. The power plant consists of a central area with 856.8 kWp arrays consisting of 40 trackers, divided into two subarrays with 20 trackers each. The distributed area consists of six subarrays with 321.2 kWp in total. The yield and operating results for May 2004 are presented in the paper.

- **GUNNING, Rebecca, Jonathan BATES, Francesco CONESA, Andrew PARR, Paolo REDI, Michel COURTOIS, Luis GORDO and Anibal LAMY.** 2004. Mediterraneo: The Large Scale Deployment of PV in the Urban Environment in Europe. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2768–2771.

  Keywords: programme description

  Projects: Testimoni di Geova, Vibo Valentia, Italy; Universidad La Salle, Barcelona; Universidad de Empressa, Madrid; Sports hall Cordoba, car port, Cordoba, Spain; Almareleja school; Moura secondary school, Portugal.

  Abstract: In this paper, brief results of the Mediterraneo photovoltaic project – a large-scale deployment of PV in an urban environment - are presented. The project should include 862 kW of photovoltaic systems. Installation started in March 2002 and by May 2004 about 750 kW had been installed in different countries. Participating countries include Italy, France, Spain and Portugal. The project size ranges from 2 kWp to more than 80 kWp. The largest systems are the Universidad la Salle Barcelona with 80 kWp and the Cordoba sports hall carport with 84 kWp.

- **HÄBERLIN, Heinrich.** 2004. Grid Connected PV Plant Jungfraujoch (3454m) in the Swiss Alps: 10 Years of Trouble-Free Operation with Record Energy Yields. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2846–2849.

  Keywords: project evaluation, case study, alpine region

  Project: Jungfraujoch, Switzerland

  Abstract: Operating experiences after 10 years of operation of the Jungfraujoch photovoltaic power plant, located 3,453 meters above sea level, are presented in this paper. The normalised monthly energy production for the period from 1994 to 2003 is presented and discussed in detail. Power plant operation experiences and reliability issues include heavy storms, thunderstorms, large temperature differences, irradiation peaks and snow and ice coverage.

- **HAYDEN, Herb, Peter JOHNSTON, Vahan GARBOUSHIAN and David ROUBIDEAUX.** 2002. APS installation and operation of 300 kW of Amonix High Concentration PV systems. In: Conference Record of the Twenty Ninth IEEE Photovoltaic Specialists Conference. New Orleans, LA, USA, 19–24 May 2002, 1362–1365.

  DOI: 10.1109/PVSC.2002.1190862

  Keywords: project overview, concentrator

  Project: Glendale Airport, Glendale, Arizona, USA

  Abstract: The Glendale Airport 100 kW concentrator photovoltaic system was commissioned in spring 2001. Each tracking unit with a 24 kW AC output power tracks the sun with 0.25° accuracy. The passively cooled trackers consist of 10 strings with 360 V DC voltage. The maximum tracking height is 47 feet and the width is 50 feet. The system is monitored in real-time. Operating and maintenance experiences are given in this paper. Plans for further concentrator projects, including the APS Prescott Airport Solar Project, are presented in the paper as well.

- **HENNIG, Carsten, Reiner BLUMENSCHEIT, Carsten HETTWER, Carola DIESTELMEIER, Ansgar WIEGMANN, Burchard DECKER and Michael MACK.** 2004. 60-kWp-PV-Anlage Schulzentrum Spalterhals Barsinghausen - Synergien bei der energetischen Sanierung eines Schulgebäudes. In: 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 2004, 488–494.

  Keywords: project description

  Project: Schulzentrum Spalterhals Barsinghausen, Barsinghausen, Germany

  Abstract: The photovoltaic system on the new GE Wind Energy's office building was commissioned in May 2003. The system consists of three subsystems with a power capacity of 115.10 kWp. Polycrystalline and thin-film silicon modules are used and one thin-film array is integrated into the transparent roof. The total investment cost of the power plant was EUR 1,022,584 or about EUR 8.88/Wp. For the time period from June 2003 to December 2003, the monthly performance ratio and energy yield are given.

- **HENNIG, Carsten, Torsten FLEMMING, Andreas WAGNER, Stanley BLACK, Christoph KOEPPEN and Burchard DECKER.** 2004. 115-kWp-PV-Anlage GE Wind Energy Salzbergen - Nutzung eines neuen Produktions- und Verwaltungsgebäudes. In: 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 2004, 495–503.

  Keywords: project description

  Project: GE Wind Energy, Salzbergen, Germany

  Abstract: The photovoltaic system on the new GE Wind Energy's office building was commissioned in May 2003. The system consists of three subsystems with a power capacity of 115.10 kWp. Polycrystalline and thin-film silicon modules are used and one thin-film array is integrated into the transparent roof. The total investment cost of the power plant were EUR 1,022,584 or about EUR 8.88/Wp. For time period from June 2003 to December 2003, the monthly performance ratio and energy yield are given.

- **HICKS, Warren, Jim THORNYCROFT, Hugh FALKNER and Paul REED.** 2004. UK Large Scale Field Trial - Building Integration and Performance. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 3024–3027.

  Keywords: project overview

  Projects: North Devon District Council Civil Centre, Birmingham Athletics Centre, Cotswold Water Park, University of Gloucestershire, The Optic Centre, Cavehill Primary School, UK

  Abstract: A brief project overview of the UK Large-Scale Fields Trial project, with the purpose of installing projects >20 kW, is given in this paper. Barriers, public perception and technology are presented in the paper as well.

- **HWANG, I. H., K. S. AHN, H. C. LIM and S. S. KIM.** 2000. Design, Development and Performance of a 50 kW Grid Connected PV System with Three Phase Current-Controlled Inverter. In: Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference, Anchorage, AK, USA, 15–22 September 2000, 1664–1667.

  DOI: 10.1109/PVSC.2000.916221

  Keywords: project evaluation, case study, roof mounted

  Project: KEPRI, Taeon, South Korea

  Abstract: The photovoltaic power plant in Taeon, Korea, commissioned in 1999 is described in this paper. A mathematical analysis of the three-phase inverters and generated power from May 1999 to April 2000 is given. The monthly system performance, capacity factor and efficiency, from May 1999 to April 2000 are presented in the paper. The total cost of the 50.88 kWp power plant was USD 460,000 or USD 9,200/kWp.

- **ITO, Masakazu, Kazuhiko KATO, Keichii KOMOTO, Tetsuo KICHIMI, Hiroyuki SUGIHARA and Kusoke KUROKAWA.** 2003. An Analysis of Variation of Very Large-Scale PV (VLS-PV) Systems in the World Deserts. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2809–2814.

  Keywords: preliminary study

  Abstract: The potential for very large photovoltaic projects in deserts is presented. In the study, parameters such as life-cycle assessment, installation area, transport, operation and maintenance are considered. Based on the case of the Gobi Desert, the following results are obtained for tracking systems: a cost of 5.4 cent/kWh, an energy payback time of 1.6 years, and a 12 g-C/kWh CO_2 emission rate.

- **ITO, Masakazu, Kazuhiko KATO, Keichii KOMOTO, Tetsuo KICHIMI, Hiroyuki SUGIHARA and Kusoke KUROKAWA.** 2004. Comparative Study of Fixed and Tracking System of Very Large-scale PV (VLS-PV) Systems in the World Deserts. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 2, 2113–2116.

  Keywords: preliminary study

  Abstract: In the preliminary study, very large photovoltaic power plants in world deserts are evaluated. Detailed evaluation results of the projects planned for the Sahara, Negev, Thar, Sonoran and Great Sandy deserts are presented.

- **ITO, Masakazu, Kazuhiko KATO, Hiroyuki SUGIHARA, Tetsuo KICHIMI, Jinsoo SONG and Kusoke KUROKAWA.** 2001. A Preliminary Study on Potential for Very Large-scale PV (VLS-PV) System in the World Deserts. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2430–2433.

  Keywords: preliminary study

  Abstract: A study of the very large 100 MW photovoltaic power plant to be located in the Gobi Desert is presented in this paper. Energy payback time, life-cycle CO_2 emission rate and generation cost of the system are estimated. The results of the study are an expected 1.7 year energy payback time and 12 g-C/kWh of CO_2 emissions. Assuming a module price of USD 1/W, a system lifetime of 30 years and an interest rate of 3%, the generation cost of such a system would be 6.1 cent/kWh.

- **JIMÉNEZ, D., L. M. CARRASCO, R. EYRAS, O. PERPIÑÁN and A. G. MARSINACH.** 2003. Architectural Integration of Grid Connected Photovoltaic Systems for Schools in Coslada. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2370–2374.

  Keywords: project description

  Project: Coslada, Spain

  Abstract: The installation of photovoltaic systems for schools in Coslada, Spain, is briefly described. The systems were realized in the frame of the Coslada's Town Hall's public tender from 2001. Images and renderings of the realized systems are also presented in this paper.

- **KAMPSCHULTE, Timon and Klaus NEUMAYER.** 2002. 1,6 MWp: Planung, Bau und Betrieb von Deutschlands größter PV Anlage. Poster. In: 17. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 2002, 247–250.

  Keywords: project description, case study

  Project: Solarpark Hohenfells-Markstetten, Germany

  Abstract: Solarpark Hohenfells-Markstetten located near Regensburg was commissioned in December 2001 after 5 months of construction activities. At that time, it was Germany's largest photovoltaic power plant. It consists of 16 separated 99 kWp units mounted on 5 hectares. The power plant includes about 12,000 modules and is connected to the medium voltage grid by 16 inverters and its own transformer. In the paper, remote monitoring, mounting construction and logistical topics are also described.

2000 – 2004

- **KAMPSCHULTE, Timon and Frank WOLFF.** 2003. Solarpark Hemau: Planung, Bau und Betrieb des weltweit größten Solarparks mit einer Gesamt-Spitzenleistung von rund vier MWp. In: 18. Symposium Photovoltaische Solarenergie, Staffelstein, 12–14 March 2003, 249–254.

  Keywords: project description, case study

  Project: Solarpark Hemau, Regensburg, Germany

  Abstract: Solarpark Hemau, near Regensburg, Germany, was commissioned at the beginning of 2003. At the time of construction, it was the largest operating photovoltaic power plant in the world. It was built on an abandoned military area and covers 18 hectares. The construction of the 40 separated 99 kWp subunits was finished in 12 weeks. The solar arrays consist of 32,740 modules. The system is connected to the medium voltage grid by central master-slave inverters. Some logistical, environmental and financial aspects of the projects are also presented. The total project cost was EUR 18.4 million.

- **KETJOY, Nipon, Wattanapong RAKWICHIAN, Vitsarut WONGCHUPAN and Theerapon SANKARAT.** 2004. Large Scale Rooftop Photovoltaics Grid Connected System at Charoenphol-Rama I Green Building. In: EuroSun 2004, 14. Internationales Sonnenforum Proceedings, Freiburg, 3, 219–223.

  Keywords: project description

  Project: Tesco, Bangkok, Thailand

  Abstract: This paper presents a feasibility study for a 350 kW roof-mounted photovoltaic system to be located on the roof of the Charoenphol-Rama I superstore green building. The yield with different module orientations/tilts was simulated. The simulation results are presented and discussed in this paper.

- **KIL, Adriaan J., Theo C. J. VAN DER WEIDEN and Jadranka ČAČE.** 2000. Operational Results of the 250 kWp PV System in Amsterdam. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2707–2710.

  Keywords: project evaluation, case study, distributed, housing estate, BIPV

  Project: Nieuw Sloten, Amsterdam, the Netherlands

  Abstract: In this paper, operational data based on the monitoring period from August 1997 to July 1998 of the Nieuw Sloten distributed photovoltaic system in Amsterdam is presented. The performance ratio of four subsystems was estimated to be 76.5 %. The monthly yield and monthly inverter efficiency are given in the paper as well.

- **KREMER, Peter.** 2003. Betriebserfahrungen Floriade 2002 mit 2,3 MWp-PV-Generator, das größte Solardach der Welt. Poster. In: 18. Symposium Photovoltaische Solarenergie, Staffelstein, 12–14 March 2003, 270–274.

  Keywords: project description, BIPV

  Project: Floriade, Harlemeermeer, the Netherlands

  Abstract: In this paper, the operating results after the first year of the Floriade photovoltaic system are presented and discussed. The Floriade roof size of 96 x 272 m with about 26,000 m2 total area includes 19,380 custom modules. The system is connected to a 10 kW grid by 8 inverters operating in master-slave mode and two 1 MW transformers. The project description, including block schematics of the system, is given in this paper. The expected energy gain was between 1.3 and 1.4 GWh annually and it was exceeded in the first year of operation, whereas annual gain was 1.56 GWh in the first year of operation. The operating results have confirmed the good matching of array and inverter size.

- **KREMER, Peter.** 2002. Netzfreundliche PV-IGBT-Wechserichtereinheiten für das größte Solardach der Welt. Poster. In: 17. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 2002, 257–262.

  Keywords: project description, BIPV

  Project: Floriade, Harlemeermeer, the Netherlands

  Abstract: The Floriade photovoltaic system is described in this paper with a particular focus on the inverters. A brief description of the system is given and a more detailed description of the inverter visualising system is also included. Inverter block schematics and block schematics of the visualising system are presented in the paper. Images of the Floriade roof are also included.

- **KREMER, Peter and C. MAINKA.** 2004. Operation Experiences of the Largest Solar Roof Top of the World - Floriade 2002 (2,3 MWp). In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 3048–3051.

  Keywords: project description, BIPV

  Project: Floriade, Harlemeermeer, the Netherlands

  Abstract: In this paper, technical details of the 2.3 MWp Floriade photovoltaic project are presented. A transparent roof with solar modules covering 25,000 m² is part of the international flower exhibition Floriade 2002, close to Amsterdam, the Netherlands. The transparent roof consists of 19,380 solar modules. Inverters are arranged into four groups; each group consists of two inverters in a master-slave configuration. The solar array comprises two subarrays, each connected to the 10 kV medium voltage grid through a 1 MW transformer. The operating results of the system are also presented and discussed. The paper also includes the electrical schematics of the system and an aerial image of the Floriade exhibition complex.

- **KREMER, Peter and Sebastian SCHMITT.** 2004. PV-UPS System at TPM in Malaysia. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2753–2755.

  Keywords: project description

  Project: Technology Park, Kuala Lumpur, Malaysia

  Abstract: In this paper, the 362 kWp photovoltaic system located at Technology Park Malaysia in Kuala Lumpur, Malaysia, is described. The existing photovoltaic system was enlarged by two 200 kW UPS units connected in parallel and two battery banks with a total of 662 kW. Images of the system are also presented.

- **KUROKAWA, Kusoke, Kazuhiko KATO, Masakazu ITO, Keichii KOMOTO, Tetsuo KICHIMI and Hiroyuki SUGIHARA.** 2002. A cost analysis of very large scale PV (VLS-PV) systems on the world deserts. In: Conference Record of the Twenty Ninth IEEE Photovoltaic Specialists Conference. New Orleans, LA, USA, 19–24 May 2002, 1672–1675.

  DOI: 10.1109/PVSC.2002.1190939

  Keywords: preliminary study

  Abstract: The methodology for the cost estimation of very large-scale photovoltaic systems in deserts is presented. The results of the cost estimation are given for different tilt angles under the assumptions presented in this paper. For a 20° array tilt, the estimated costs are 5.3 cent/kWh for the Sahara, 6.4 cent/kWh for the Gobi, 7.2 cent/kWh for the Negev, 6.6 cent/kWh for the Thar, 6.6 cent/kWh for the Sonora and 8.3 cent/kWh for the Great Sandy Desert.

- **LANDEN, Robert.** 2001. 8,8 kWp Photovoltaik-Demonstrationsanlage auf dem Dach der Stadtwerke Bonn. Poster. In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 623–627.

  Keywords: project description

  Project: Stadtwerke Bonn, Bonn, Germany

  Abstract: A demonstration photovoltaic project located on the facility of Stadtwerke Bonn is briefly described. The photovoltaic system consists of 10 different arrays - one two-axis tracker, seven free-standing arrays, one roof-integrated array and one array mounted on the roof.

- **MACKAMUL, Kevin and Robert WIETING.** 2004. The Shell Solar 245 kW Grid-Connected CIS Thin Film PV Rooftop Array: System Design and First Year Performance. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 3084–3086.

  Keywords: project description

  Project: Shell Solar, Camarillo, CA, USA

  Abstract: In this paper, a thin-film photovoltaic system located on the Shell facility in Camarillo, CA, USA, is described. The system consists of 6,144 CIS modules and a 225 kW inverter. The inverter is connected to the power line through a 208/480 V three-phase transformer. The solar array consists of 256 module strings of 24 modules each. Performance data for the time period from November 2003 to May 2004 are also given in this paper.

- **MARANDA, Witold, Grzegorz JABLONSKI and Dariusz MAKOWSKI.** 2004. 1 kWp PV System at Technical University of Lodz in Poland. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2915–2918.

  Keywords: project description

  Project: Technical University of Lodz, Poland

  Abstract: A brief description of the small demonstrating system located on the roof of the Technical University of Lodz, Poland, is given in this paper.

- **MAURUS, H., M. SCHMID, B. BLERSCH, P. LECHNER and H. SCHADE.** 2003. BIPV Installations Worldwide in ASP Technology. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2375–2378.

  Keywords: project overview

  Projects: Stillwell Avenue Terminal, New York, USA, Paul-Löbe Haus, Berlin, Germany

  Abstract: A brief description of some a-Si transparent building-integrated projects worldwide is given in this paper. The most notable projects are Stillwell Avenue Terminal in New York, USA, and Paul-Löbe Haus in Berlin, Germany.

- **MENCKE, Detlef, Dirk TEGTMEYER and Nikolai MARIS.** 2000. Feldbusorientierte Meßdatenerfassung in Kombination mit einer SPS-Anlagenüberwachung bei der 250 kWp PV-Anlage der üstra in Hannover. Poster. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 341–344.

  Keywords: project evaluation

  Project: HELIOTRAM, Hannover-Leinhausen, Hannover, Germany

  Abstract: In this paper, data acquisition concerning the HELIOTRAM photovoltaic project in Hannover is presented. Data acquisition schematics and the measurement environment on site are also given. Measurements were performed based on the LabView software. The parameters measured were environment temperature, three radiation values, four module temperatures, different currents and voltages.

- **MOLENBROEK, E. C., Adriaan J. KIL, A. J. N. SCHOEN and Frans VLEK.** 2000. Quality control and performance monitoring in the 1 MW PV project in Amersfoort, the Netherlands. In: Conference Record of the Twenty Eighth IEEE Photovoltaic Specialists Conference. Anchorage, AK, USA, 15–22 September 2000, 1756–1759.

  DOI: 10.1109/PVSC.2000.916245

  Keywords: project description, distributed, housing estate, BIPV

  Project: Nieuwland, Amersfoort, the Netherlands

  Abstract: The Nieuwland 1 MW PV project consists of more than 500 building-integrated photovoltaic systems. To assure the reliable maintenance and operation of the system, quality control and performance monitoring guidelines were defined. The quality control programme consists of design review, building inspections and commissioning procedures. Monitoring assures data acquisition at several points of the low voltage grid: line voltage at the transformer station and at five points varying distances from the transformer. Active and reactive power data are measured and stored.

- **NASSE, Wolfgang, Kai KSINSIK, Günter DEHMEL, Rudi KLÖCKNER and Burchard DECKER.** 2004. Lärmschutz und Solarstrom - die innovative PV-Lärmschutzwand an der A31 in Emden. In: 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 2004, 312–319.

  Keywords: project description, noise barriers

  Project: Photovoltaic noise barrier, A31 motorway, Emden-Bottrop, Germany

  Abstract: A 53.5 kWp photovoltaic noise barrier was commissioned in March 2003. The noise barrier is located along the A31 motorway close to the Emden Nord motorway connection. The photovoltaic array consists of thin film glass-glass modules mounted in 4x2.5 m aluminium panels. The system also includes foil-steel modules. In total, 1,055 modules were used. The system is divided into 54 subsystems, each with its own inverter. The energy yield and performance ratio for the period from June to December 2003 are presented. The investment cost for the noise barrier was EUR 315,000 or EUR 5.90/Wp.

- **NEYENS, J., J. NIJS, W. COPPYE, L. DE GHESELLE, P. OUT, A. J. N. SCHOEN, Johan COOLEN, Guido CLAES and Thierry BOECKX.** 2001. PV Demonstration Project on Social Houses in Flanders Using an Innovative Roof Integration Concept. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2638–2641.

  Keywords: project description, distributed, housing estate

  Project: Social housing project “Het Hofken”, Genk, Belgium

  Abstract: A roof-integrated distributed photovoltaic project on a social housing estate in Genk, Belgium realised in the years 1997-2000 is described in this paper. The system consists of two arrays with 13.68 kWp power capacity. Mounting and roof integration details are also given.

- **NORDMANN, Thomas, Andreas FRÖLICH, Martin DÜRR and Adolf GOETZBERGER.** 2000. First Experience with the Bifacial PV-Noise Barrier. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1777–1783.

  Keywords: project description, project evaluation, noise barriers

  Abstract: In this paper, the first experiences with a bifacial noise barrier are given. The bifacial noise barrier was installed near Zurich Airport in Switzerland. Detailed operating data including inverter efficiency, inverter capacity utilisation, array efficiency etc. are presented and discussed.

- **NORDMANN, Thomas and Luzi CLAVADETSCHER.** 2004. PV on noise barriers. In: Progress in Photovoltaics: Research and Applications, 12, 6, 485–495.

  DOI: 10.1002/pip.566

  Keywords: project overview, noise barriers

  Project: Domat-Ems A13, Giebenach A2, Magadino, Seewalchen, Austria; Alpha 1 Switzerland; Utrecht A27, Ouderkerk aan de Amstel A9, the Netherlands; Ammersee A96, Rellingen A23, Saarbrucken A6, Germany.

  Abstract: An overview is given of photovoltaic noise barriers in Europe after more than a decade of development. Brief technical descriptions of the Domat-Ems, Giebeach, A9 Netherlands, Alpha 1 PV (Switzerland), Ammersee A96, Wallisellen and Brüttisellen and Aubrugg PV power plants, including noise barrier function, are given in this paper. The paper also includes some images of the described projects. The most important system parameters, including costs, are presented in a table.

- **OLDENGARM, Hans, Wouter BORSHOOM and Willem KOPPEN.** 2004. Development and Application of a New PV-Roof Concept for the 5 MW Project in the "City of the Sun". In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2868–2871.

  Keywords: project description, distributed, housing estate, BIPV

  Project: SunCities, Heerhugowaard, Alkmaar, Langedijk, the Netherlands

  Abstract: Technical details of the roof-integrated photovoltaic systems of the SunCities projects are presented in this paper. Images of the construction works are also included. The roofing system presented in this paper was first used on 152 houses in Alkmaar with a 3.4 kWp photovoltaic array on each house, commissioned in 2002.

- **OSBORN, Donald E.** 2001. Sustained Orderly Development and Commercialization of Grid-Connected Photovoltaics: SMUD as a Case Example. In: Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001, 123–129.

  Keywords: project overview, SMUD

  Projects: Rancho Seco 1, Cal Expo, Sacramento Municipal Airport, Rancho Seco 2, SMUD Hedge Substation, Rancho Seco 3, Rancho Seco 4, California, USA

  Abstract: The Sacramento Municipal Utility District's (SMUD) photovoltaic programme is described. The paper also includes a brief description and images of some large projects realized on behalf of SMUD, such as the Hedge Substation and the Rancho Seco photovoltaic facility.

- **PALOMINO, Ernie and John KIRBY.** 2001. Performance of Salt River Project’s Solar ChoiceTM Program’s Photovoltaic Power Systems. In: Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001, 31–35.

  Keywords: project evaluation

  Project: Salt River Project's (SRP) Santan Generating Station, Gilbert, Arizona, USA

  Abstract: The Salt River Project has installed two 97.4 kW arrays at the Santan Generating Station in Arizona. Both arrays were commissioned in the third quarter of 1998 and the first quarter of 1999 respectively. The installation cost was USD 945,000 for the first array and USD 900,000 for phase 2 of the project. The system design and performance are discussed and the monthly energy production for the year 2000 is given in the form of a table. Operating performance and experience are given as well.

- **PARETTA, A., M. PELLEGRINO, A. SARNO, M. GUERRA and R. SCHIOPPO.** 2001. Analysis of Delphos PV Generators Degradation. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 1, 500–503.

  Keywords: project evaluation

  Projects: Delphos 1, Delphos 2, Manfredonia, Monte Aquilone, Foggia, Italy

  Abstract: In this paper, the operating experiences of the Delphos photovoltaic power plant are discussed. The Delphos 1 3x100 kWp photovoltaic power plant was commissioned in August 1986, followed in January 1992 by another 300 kWp stage, Delphos 2. Detailed array characteristics and a description are given. The generator degradation effect after 15 years and 8 years of operation respectively is also discussed.

- **PARONCINI, M., B. CALCAGNI and A. PISTOIA.** 2004. Technoeconomic Assesment of a 20 kWp Building Integrated Photovoltaic System at the Energetic Department of Ancona. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2961–2964.

  Keywords: project evaluation

  Project: Università Politecnica delle Marche, Ancona, Dipartimento di Energetica

  Abstract: In this paper, a brief technical description of the 21.6 kWp photovoltaic system mounted on the roof of the Universita politecnica delle Marche in Ancona, Italy, is presented. Detailed operating experiences such as the energy production for April and July 2003 and January and March 2004 are given. Economical parameters are also discussed and the cumulative cash flow for the power plant with an estimated 30 years lifetime is given.

- **PATTERSON, S. and D. E. OSBORN.** 2002. Large-scale Deployment of Distributed Generation Through Photovoltaics. In: Power Systems 2002 Conference, Impact of Distributed Generation, Clemson, SC, 13–15 March 2002.

  Keywords: project description, project overview, SMUD

- **PEARSALL, Nicola M. and Kathleen M. HYNES.** 2001. Performance Analysis of 68 kWp PV System at the University of Jaen. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2649–2652.

  Keywords: project description, case study, car port

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: In this paper, the operating results of a 68 kWp photovoltaic system, part of the UNIVER project, monitored between November 1999 and October 2000 is presented. The photovoltaic array is mounted on the carport roof of the Jaén University Campus. System losses are discussed in detail and the analysis includes shading losses, inverter losses, temperature losses and electrical losses. A comparison of the measured and predicted generated energy is also presented.

- **PÉREZ, P. J., J. AGUILERA, G. ALMONACID, P. G. VIDAL, J. DE LA CASA and J. E. MUÑOZ.** 2001. Project UNIVER (UNIversidad VERde) 200 kWp Grid Connected PV System at Jaén University Campus. Results from Two Operation Years. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2732–2735.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: A system description and operating experience of the UNIVER project is given in this paper. The system was commissioned in the period from July 1999 to March 2001. A technical description and the construction cost are given in the paper. The detailed monthly performance ratio for each of the four subsystems is given and the system losses are also presented. Array losses, losses due to a decrease in the insulation system, losses due to the disconnection of the system, losses due to the starting up threshold of the inverter and other losses are discussed.

- **PÉREZ, P. J., J. AQUILERA, G. ALMONACID and P. G. VIDAL.** 2000. UNIVER Project: A 200 kWp Photovoltaic Generator Integrated at Jaen University Campus. First Experience and Operational Results. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2695–2698.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: The operating experiences of the UNIVER Project located at the Jaén University Campus, Jaén, Spain, are presented in this paper. Brief technical details of the four subsystems are given. The energy gain of a 200 kWp photovoltaic system is estimated at about 280 MWh/year. For a 70 kWp subsystem located on the parking area and commissioned in August 1999, the monthly values of the energy yield and performance ratio from August 1999 to March 2000 are given and discussed. The completion of other subsystems is also planned.

- **PÉREZ, P. J., J. AGUILERA, G. ALMONACID, P. G. VIDAL, J. DE LA CASA and J. E. MUÑOZ.** 2003. Project UNIVER (Universidad Verde) 200 kWp Grid Connected System at Jáen University Campus. Final Conclusion after four Operation Years. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2310–2313.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: The Jaén University Campus photovoltaic system consists of four subsystems that generate 240 MWh electricity annually. The system is divided into two subsystems with 60 kW inverters and 24 subsystems with 2 kW inverters. The operating experiences from August 1999 to April 2003 are

presented in this paper. System losses are evaluated and discussed as well. The total investment cost of the system was EUR 1,513,158.

- **PEREZ, P. J., J. AGUILERA, G. ALMONACID, P. G. VIDAL, J. DE LA CASA and J. E. MUÑOZ.** 2003. Project UNIVER (Universidad Verde). 200 kWp Grid Connected PV System at Jaén University Campus. Final Conclusion after Four Operation Years. In: ISES Solar World Congress 2003 Proceedings, O545. Göteborg, 14–19 June.

  Keywords: project description, case study

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: The detailed cost structure of the photovoltaic power plant installed at the Jaén University Campus in Jaén, Spain, is given in this paper. The total investment cost was EUR 1,513,158. Photographs of the different solar arrays and parts of the system are presented. The operating experience, particularly system losses, are presented in detail - losses due to temperature, losses in the generator, losses due to a decrease in the insulation system, losses due to the disconnection of the system, losses due to the starting up threshold of the inverter, losses in the inverter and other losses.

- **PERPIÑÁN, O., A. GONZÁLEZ, J. VEGA, I. EYRAS and R. EYRAS** 2004. FORUM SOLAR: A Large PV Pergola for FORUM 2004. In: EuroSun 2004 Proceedings, Freiburg, 3, 259–263.

  Keywords: project description

  Project: FORUM 2004, Barcelona, Spain

  Abstract: In this paper, the construction experiences of a photovoltaic pergola construction in Barcelona are described. The photovoltaic power plant was designed and constructed for Forum Barcelona 2004, an event that took place from May to September 2004 in Barcelona, Spain. The construction with an array area of 3,410 m² and a height of 50 m consisted of 2,686 modules with a 443 kW array power capacity and a 600 V DC array voltage. The modules are connected into 79 strings with 34 modules each. The system is connected to the grid through three 125 kW inverters. A yield of 1,250 kWh/kWp is expected.

- **PERPIÑÁN, O., L. MÉNDEZ, R. EYRAS, N. PEARSALL, W. ERNST and M. SCHNEIDER.** 2003. PHOTOCAMPA: PV System Integrated into a Large Car Park. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2302–2305.

  Keywords: project description, case study, car port

  Project: Photocampa, Car Port, Tarragona, Catalonia, Spain

  Abstract: The Photocampa project, photovoltaic arrays integrated into carports located in the Port of Tarragona, Catalonia, with a 318 kWp power capacity, consist of 3,000 modules with an area of 2,600 m². It is located on a 200,000 m² parking area for car distribution. The technical characteristics, safety measures, monitoring system and data analysis are presented and discussed in more detail.

- **PERPIÑÁN, O., J. VEGA, I. EYRAS, R. EYRAS, A. IVANCIC, M. GARATE, S. ESCRIBANO, J. A. PÉREZ and D. GONZÁLEZ.** 2004. Forum Solar: a Large PV Pergola for Forum 2004. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 2, 2337–2339.

  Keywords: project description

  Project: FORUM 2004, Barcelona, Spain

  Abstract: In this paper, the FORUM 2004 photovoltaic system in Barcelona is described. This 443.2 kWp photovoltaic generator consists of 2,686 modules mounted on a special construction supported by four legs and with a maximal height of 54 m. The support structure is able to withstand wind loads of up to 200 km/h wind speed. The system is connected to the grid through three 125 kW inverters in a master-slave configuration and a transformer. An aerial image of the FORUM PV Pergola is also presented in this paper.

- **PIASKOSKI, Roman, Moneer AZZAM, Ron GONSORIAWSKI and Sysavanh SOUTHIMATH.** 2001. 2001: A Solar Odyssey. In: Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001, 75–79.

  Keywords: project description

  Projects: GSA New England, Boston, USA

  Abstract: On February 29th, 2000, a 30 kW array was commissioned for the J.F. Williams Federal building located in downtown Boston. The array consists of 372 panels, some of which failed shortly after installation. This paper presents the maintenance effort and problem solving. Many detailed images of the array and the investigation are also included.

- **PIETRUSZKO, S. M. and M. GRADZKI.** 2001. First PV System Connected to Electrical Grid on School in Poland. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2629–2632.

  Keywords: project description

  Project: Public Grammar School No. 76, Warsaw-Wawer, Poland

  Abstract: In this paper, the demonstration photovoltaic system located on a school in Poland and connected to the grid in December 2000 is briefly described.

- **PLYMPTON, Patricia, Patty KAPPAZ, Benjamin KROPOSKI, Byron STANFORD and John THORNTON.** 2001. Four Federal Grid-Connected Photovoltaic Systems: Powering our Nation's Capital With Solar. In: Proceedings of Forum 2001 - Solar energy: the power to choose, ASES Annual Conference, 26th National Passive Solar Conference, Washington, DC, 21–25 April 2001, 25–30.

  Keywords: project description, project evaluation

  Projects: Pentagon, Arlington, VA, USA

2000 – 2004

Abstract: In this paper, grid-connected photovoltaic systems located on federal leased facilities are presented. The most notable is a project commissioned on 28th June 1999 on behalf of the U.S. Department of Defence on land adjacent to the Pentagon in Arlington, VA. A brief description of the presented systems is given; images of the projects are included in the paper as well.

- **PROTOGEROPOULOS, C., D. SCHMITT and M. GROTTKE.** 2004. Building Integration of Total 40 kWp PV Systems at CRES. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2931–2934.

  Keywords: project description

  Project: CRES, Pikermi, Athens, Greece

  Abstract: The photovoltaic system at the Centre for Renewable Energy Sources, CRES in Pikermi, Greece, is described in this paper. The system consists of six separated grid-connected photovoltaic subsystems mounted as a pergola and entrance roof over a parking area and on the roof of the building. The largest subsystem has a power capacity of 10.35 kWp. The module types and array configuration are also given. A description of the data acquisition system and the first operating results are also presented and discussed.

- **RAETZ, Matthias and Clemens TRIEBEL.** 2001. Photovoltaikanlage Paul-Löbe-Haus in Berlin - Die weltgrößte gebäudeintegrierte Anlage aus amorphem Silizium geht ans Netz. In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 197–202.

  Keywords: project description

  Project: Paul-Löbe-Haus, Berlin, Germany

  Abstract: The photovoltaic power plant located on the Paul-Löbe-Haus, Berlin, Germany, was commissioned in early 2000. The photovoltaic system consists of a thin-film array with a shading function. At the time of commissioning, this 123 kWp system with a 5,500 m² area was the largest thin-film building-integrated photovoltaic system worldwide. In total, 6,048 modules were used for the whole system. The shading arrays are mounted on one axis trackers. The module's 10 % optical transparency was achieved by laser treatment of the thin-film modules.

- **RAETZ, Matthias, Clemens TRIEBEL and Michael ZEUNER.** 2000. Photovoltaikanlage Paul-Löbe-Haus in Berlin - Die weltgrößte gebäudeintegrierte Anlage aus amorphem Silizium. Poster. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 449–454.

  Keywords: project description

  Project: Paul-Löbe-Haus, Berlin, Germany

  Abstract: At the time of construction, the Paul-Löbe-Haus in Berlin had the largest amorphous silicon-based building-integrated photovoltaic system. It was commissioned in the year 2000. The 123 kWp solar array consists of 6,048 solar modules. Some architectural and construction details are presented in this paper. One of the main objectives was the merging of electricity production and sun protection of the building interior using semi-transparent amorphous silicon modules.

- **REALINI, A., E. BURÀ, N. CEREGHETTI, D. CHIANESE, S. REZZONICO, T. SAMPLE and Heinz OSSENBRINK.** 2001. Study of a 20-Years Old PV Plant (MTBF Project). In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 1, 447–450.

  Keywords: project evaluation

  Project: Technical School Lugano-Trevano, Lugano, Switzerland

  Abstract: In this paper, the degradation experience and operating results of the oldest European grid-connected photovoltaic power plant are presented in this paper. The 10 kWp power plant was commissioned in 1982. Visual inspection, IR analysis and indoor performance measurement results are discussed. The daily energy production is also presented in this paper. The performance ratio from June 2000 to September 2001 is also presented.

- **REIJENGA, Tjerk.** 2000. PV Integration in WWF Houses in Harderwijk and Zoetermeer. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1793–1796.

  Keywords: project description, distributed, housing estate

  Projects: WWF Houses, Harderwijk, Zoetermeer, the Netherlands

  Abstract: The Harderwijk and Zoetermeer WWF Houses were constructed in 1999 and 2000. The Harderwijk project includes 31 senior houses, each with a 0.4 kWp photovoltaic system. The Zoetermeer project includes 35 houses, each with a 0.85 kWp photovoltaic array. In this paper, some architectural details, renderings and photographs of municipal housing and photovoltaic arrays are presented.

- **REIJENGA, Tjerk.** 2000. PV Integration in WWF Houses in Harderwijk and Zoetermeer. In: Proceedings of the Solar 2000 Conference, ASES Annual Conference, 25th National Passive Solar Conference, Madison, Wisconsin, 16–21 June 2000, 51–54.

  Keywords: project description, distributed, housing estate

  Projects: WWF Houses, Harderwijk, Zoetermeer, the Netherlands

  Abstract: The residential project in the city of Harderwijk, constructed in 1999, includes 31 houses. Family houses and senior houses are part of the project. The Harderwijk project includes small PV systems of about 400 Wp each. The houses in Zoetermeer, which also include a distributed PV system, were constructed in 2000. The power capacity of each system in the Zoetermeer project is about 850 Wp. In this paper, both systems are presented from an architectural point of view. Images and drawings/renderings of both systems are presented.

- **REIJENGA, Tjerk and Henk KAAN.** 2000. Building Integration of Photovoltaics ECN – Building 42 Petten (NL). In: Proceedings of the Solar 2000 Conference, ASES Annual Conference, 25th National Passive Solar Conference, Madison, Wisconsin, 16–21 June 2000, 35–37.

2000 – 2004

Keywords: project description, BIPV

Projects: Netherlands Energy Research Foundation, ECN Building 42, Petten, the Netherlands

Abstract: The Netherlands Energy Research Foundation (ECN) Building 42, with construction starting in 1999, is presented in this paper from an architectural point of view. The completion of the building is scheduled for the year 2001. Transparent photovoltaic modules with a 400 m² area and 21 kWp are integrated into the building's roof - the total power capacity of the building's PV system including the transparent roof is 40 kWp. Images of the interior details of the ECN building including the transparent PV roof are also presented in the paper.

- **REIJENGA, Tjerk and Henk KAAN.** 2000. Roof- and Façade Integration of PV Systems in a Laboratory Building - An Example of PV Integration in Buildings (Renovation) Thermie SE/115/97/NL/DK. In: Proceedings of the Solar 2000 Conference, ASES Annual Conference, 25th National Passive Solar Conference, Madison, Wisconsin, 16–21 June 2000, 39–43.

Keywords: project description, BIPV

Projects: Netherlands Energy Research Foundation, ECN, Petten, the Netherlands

Abstract: The photovoltaic system that is part of the refurbishment process of the ECN building constructed in 1963 is presented in this paper. About 700 m² of photovoltaic modules should be installed. For the south facing façade, a PV shading system with an area of 340 m² is proposed. An additional photovoltaic shading system with a 330 m² area should be integrated into the roof construction. The estimated energy yield of the PV system is 56.440 kWh annually. The building is presented from an architectural point of view and several images/renderings are also part of the paper.

- **REIJENGA, Tjerk** 2001. The Sustainable and Solar Building (5 MW Project) - Langedijk (NL). In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2462–2465.

Keywords: project description, distributed, housing estate

Project: Langedijk, the Netherlands

Abstract: The roof-integrated photovoltaic system in Langedijk, the Netherlands, commissioned in September 2000 is described in this paper. The system has a power capacity of 131.8 kWp and consists of subsystems with 8 kWp, 5 kWp and 3 kWp on the roofs of a housing estate. Architectural and construction experiences are described. The photovoltaic arrays on the roof are roof-mounted and the waterproofed roofs are covered with foil below the modules. Images of the system are also presented.

- **REIJENGA, Tjerk.** 2001. PV-Integration in Solar Shading (Renovation) and PV-Integration in Atrium Glazing (New Building), ECN 31 and 42 - Petten (NL). In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2466–2469.

Keywords: project description, BIPV

Project: Netherlands Energy Research Foundation, ECN Building 42, Petten, the Netherlands

Abstract: In this paper, the photovoltaic system installed at the Netherlands Energy Research Foundation (ECN) in Petten, the Netherlands is described. The system consists of a 72 kW array located on building 31 with façade mounted, solar shading and roof-mounted subsystems and a 43 kW array located on building 43, integrated into the glazing. Some technical details of the system are also given in this paper.

- **REIJENGA, Tjerk.** 2004. 21 Zero Energy Houses - Etten-Leur (NL). In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2865–2867.

Keywords: project description, case study, housing estate

Project: Etten-Leur, the Netherlands

Abstract: A brief description of zero energy houses with photovoltaic systems located in district de Keen in Etten-Leur, the Netherlands, from an architectural point of view is given in this paper. The houses were constructed in 2002/2003.

- **REIJENGA, Tjerk.** 2004. 21 Zero Energy Houses - Etten-Leur (NL). In: Proceedings of the Solar 2004 Conference, 33rd ASES Annual Conference, 29th National Passive Solar Conference, Portland, OR, 11–14 July 2004, 1131–1134.

Keywords: project description, case study, housing estate

Project: Etten-Leur, the Netherlands

Abstract: In this paper, a brief description of the zero energy residential housing with photovoltaic systems located in district de Keen in Etten-Leur, the Netherlands is presented. The residential housing was constructed in 2002/2003 and is presented in this paper from an architectural point of view. The paper also includes several drawings and images with construction details.

- **REIJENGA, Tjerk.** 2004. 282 kWp BIPV, Bioclimatic Sports Centre, Wageningen (NL). In: Proceedings of the Solar 2004 Conference, 33rd ASES Annual Conference, 29th National Passive Solar Conference, Portland, OR, 11–14 July 2004, 993–998.

Keywords: project description, case study

Project: Bioclimatic Sport Centre, Wageningen, the Netherlands

Abstract: The Wageningen Bioclimatic Sports Centre with a roof-integrated photovoltaic system is described. Attention is mainly focussed on the architectural aspects of the presented system. Several images, construction details and drawings are also presented in this paper.

- **REIJENGA, Tjerk and Henkjan MARSMAN.** 2004. 282 kWp BIPV, Bioclimatic Sports Centre, Wageningen (NL). In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2749–2752.

Keywords: project description, case study

Project: Bioclimatic Sport Centre, Wageningen, the Netherlands

Abstract: The Wageningen Bioclimatic Sports Centre with a roof-integrated photovoltaic system is presented and described in this paper. The photovoltaic array has a 281.8 kWp power capacity and covers 2,448 m² of roof area. The 25.6 kWp solar array is part of the solar chimney – the sports centre's ventilation system. The architectural concept of the system is discussed and presented in detail.

- **RIBEIRO, Lori Colombo and Jon ABE.** 2004. Brownfield to Brightfield: Developing a Utility-Scale Solar Generating Facility in Brockton, MA. In: Proceedings of the Solar 2004 Conference, 33rd ASES Annual Conference, 29th National Passive Solar Conference, Portland, OR, 11–14 July 2004, 557–582.

Keywords: project proposal

Project: Brockton, Massachussetts, USA

Abstract: A description of the proposed project for Brockton, MA, is given in this paper. A 1 MW power plant should be located on an unusable brownfield site. The conceptual study and financial details are presented. Project expansion possibilities are also discussed.

- **RIEDEL, Stephan.** 2003. Design and Construction of a Large Photovoltaic Plant on a Building under Monumental Protection. In: ISES Solar World Congress 2003 Proceedings, P 5 101. Göteborg, 14–19 June.

Keywords: project description

Project: Atelierhäuser of the Deutschen Werkstätten Hellerau, Dresden, Germany

Abstract: In this paper, a 29 kWp photovoltaic system for a building under monumental protection belonging to the old furniture factory Atelierhäuser of the Deutschen Werkstätten Hellerau is described. The roof-integrated photovoltaic system was commissioned in November 2002. It consists of 264 solar modules mounted with a 60° tilt angle, including some dummy modules required due to the architectural layout. The system produces 22,000 kWh annually and saves 13 tonnes of CO_2 emissions annually.

- **RÜTHER, Ricardo.** 2000. The First Grid-Connected, Building Integrated, Thin Film Photovoltaic Installation in Brazil. Output Performance after Two Years. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1816–1819.

Keywords: project description

Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

Abstract: In this paper, the operating experiences of a 2 kWp demonstration photovoltaic power plant, located on a building of the solar energy laboratory LABSOLAR, Universidade Federal de Santa Catarina in Florianópolis, Brazil, after two years of operation is presented.

- **RÜTHER, Ricardo, M. M. DACOREGIO and A. A. MONTENEGRO.** 2001. Four Year and Counting: The Continuous Operation of the First Grid-Connected, Building Integrated Thin-Film Photovoltaic Installation in Brazil. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2697–2700.

Keywords: project description

Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

Abstract: In this paper, the 2 kWp demonstration photovoltaic power plant, commissioned in September 1997 located on the building of the solar energy laboratory LABSOLAR, Universidade Federal de Santa Catarina in Florianópolis, Brazil, is described. The operating data and performance ratio for the period from September 1997 to September 2001 are also presented and discussed.

- **RÜTHER, Ricardo, A. J. G. DA SILVA, A. A. MONTENEGRO, I. T. SALAMONI and R. G. ARAÚJO.** 2002. The PETROBRAS 45.5 kWp, grid-connected PV system: a comparative study of six thin-film module types operating in Brazil. In: Conference Record of the Twenty Ninth IEEE Photovoltaic Specialists Conference. New Orleans, LA, USA, 19–24 May 2002, 1440–1443.

DOI: 10.1109/PVSC.2002.1190880

Keywords: project description

Project: PETROBRAS Research Center Headquarters (CENPES), Rio de Janeiro, Brazil

Abstract: A photovoltaic system with six different module technologies and a 45.5 kWp array power is planned for the PETROBRAS Research Center Headquarters building in Rio de Janeiro, Brazil. In this paper, the array layout and electrical schematics are presented. The different module technologies and module/inverter manufacturers are given in the table. The simulation results with the predicted AC energy output are also presented.

- **RÜTHER, Ricardo, A. J. G. DA SILVA, A. A. MONTENEGRO, I. T. SALAMONI, M. KRATZENBERG and R. G. ARAÚJO.** 2003. Assessment of Thin-Film Technologies most Suited for BIPV Applications in Brazil: The Petrobras 45 kWp Project. In: 3rd World Conference on Photovoltaic Energy Conversion, Joint Conference of 13th PV Science & Engineering Conference, 30th IEEE PV Specialists Conference, 18th European PV Solar Energy Conference Proceedings, Osaka, Japan, 11–18 May 2003, volume C, 2294–2297.

Keywords: project description, project evaluation

Project: PETROBRAS, Rio de Janeiro, Brazil

Abstract: The main characteristics of the Petrobras photovoltaic system located at the Petrobras Research Centre (CENPES) in Rio de Janeiro are given in this paper. For a 44.4 kWp grid-connected PV system, six different thin film technologies were used. An electrical schematic of the system is given as well. Design considerations such as the array and inverter sizing are also discussed.

- **SALA, G., I. ANTÓN, J. C. ARBOIRO, Antonio LUQUE, E. CAMBLOR, E. MERA, M. GASSON, M. CENDAGORTA, P. VALERA, M. P. FRIEND, J. MONEDERO, S. GONZÁLEZ, F. DOBÓN and I. LUQUE.** 2000. The 480 kW(p) EUCLIDESTM-THERMIE Power Plant: Installation, Set-Up and First Results. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2072–2077.

Keywords: project description, concentrator

Project: EUCLIDES, Canary Islands, Spain

Abstract: The EUCLIDES 480 kWp concentrator photovoltaic project located on the Island of Tenerife, currently in the commission phase, is described in this paper. It consists of 14 arrays, each 84 m long, and includes 140 parabolic mirrors and 138 modules oriented north-south and with one axis tracking. The power plant has seven 68 kW modular inverters for grid connection.

- **SCHAAR-GABRIEL, Eric, Joachim BENEMANN, Oussama CHEHAB and Erhard KRAUSEN.** 2000. 1 Megawatt Photovoltaikanlage - Akademie Mont-Cenis in Herne. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 201–206.

Keywords: project description, BIPV, roof integrated, façade integrated

Project: Akademie-du-Mont-Cenis, Herne, Germany

Abstract: The Akademie-du-Mont-Cenis photovoltaic system was commissioned in 1999. Transparent modules are integrated into the building's envelope, which results in microclimatic conditions comparable to those in Nice , France. The building houses a library, a hotel and part of Herne's public utility services. The size of the building is 180 x 75 x 16 m. Solar modules are integrated into 10,000 m² of the roof. Additional modules are also integrated into the façade. 569 transformerless inverters are used for grid connection. Many images of the system are also presented in the paper.

- **SCHUMACHER, Jürgen and Ursula EICKER.** 2004. Durchgängiges Auslegen, Betreiben, Visualisieren und Simulieren mit INSEL am Beispiel Lehrter Bahnhof Berlin. In: 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 2004, 120–127.

Keywords: project description, transportation, BIPV

Project: Lehrter Bahnhof, Berlin, Germany

Abstract: A simulation of the electrical performance of the Lehrter Bahnhof, Berlin, photovoltaic system using INSEL simulation software is presented in this paper. Transparent modules are integrated into the 320 m long transparent roof of Berlin's Lehrter Bahnhof railway station. The photovoltaic array has 780 modules reaching 189 kWp and is integrated into the 1,890 m² large roof. Six or seven modules are connected into a string with a DC voltage of 320 and 380 V respectively. The tilt angle of modules is between 7 and 19°.

- **SCOFIELD, John H. and David KAUFMAN.** 2002. First year performance for the roof-mounted, 45-kW PV-array on Oberlin College's Adam Joseph Lewis Center. In: Conference Record of the Twenty Ninth IEEE Photovoltaic Specialists Conference. New Orleans, LA, USA, 19–24 May 2002, 1691–1694.

DOI: 10.1109/PVSC.2002.1190945

Keywords: project description, project evaluation

Project: Oberlin College's Adam Joseph Lewis Center, Oberlin, Ohio, USA

Abstract: The roof-mounted photovoltaic system on the curved roof of the Adam Joseph Lewis Center, put into service in November 2000, is described in this paper. This 45 kW system consists of three 15 kW subarrays, each connected to the grid through a 15 kW inverter and a 15 kVA transformer. In the first year of operation, the system produced 59 MWh of electricity. Based on the predicted data, this is 12% less than expected. The array consists of 690 modules and covers 434 m². The projected and measured performance of the system is given. Reasons and possible explanations for the lower performance are discussed. The estimated system installation cost is USD 420,000. The energy payback time was estimated at 6 years.

- **SCONAMIGLIO, A., M. CITTERIO, MCA MARIO CUCINELLA Architects and C. PRIVATO.** 2003. A Project for an Energy Museum at the foot of Delphos PV Plant. In: ISES Solar World Congress 2003 Proceedings, P 2 21. Göteborg, 14–19 June.

Keywords: project description

Projects: Delphos 1, Delphos 2, Manfredonia, Monte Aquilone, Foggia, Italy

Abstract: In this paper, a proposal for a museum located on the site of the Delphos photovoltaic power plant is presented. Architectural aspects of the proposed project are discussed and some simulation results of the proposed building are presented.

- **SMELTINK, J., Andrew W. BLAKERS and S. HIRON.** 2000. The Anu 20kW PV/through Concentrator. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2390–2393.

Keywords: project description, concentrator

Project: Anu 20 kW PV/through Concentrator, Rockingham, Perth, Australia

Abstract: A brief description of the ANU 20 kW photovoltaic trough concentrator installed at Rockingham near Perth is given in this paper. The concentrator consists of 80 trough-shaped modules each with a parabolic mirror with an area of 1.92 m². The estimated electricity production costs are estimated at about USD 0.20/kWh if an appropriate manufacturing volume (economies of scale) is achieved, e.g. in the case of commercial fabrication.

- **SNOW, Mark and Deo PRASAD.** 2002. Architectural and Aesthetic experiences for Photovoltaics (PV) in the Built Environment. In: PLEA 2002 - International Conference on Passive and Low Energy Architecture - Designing with the Environment, Proceedings, Toulouse, France, 22–24 July 2002, 969–974.

Keywords: project overview

Projects: National Environmental Education Centre De Kleine Aarde, Boxtel, the Netherlands; Olympic Solar Village, Sydney; Kogarah, Sydney, Australia; SBIC Building, Japan

Abstract: An overview of some building-integrated photovoltaic systems worldwide is given in this paper. Some activities regarding the building-integrated photovoltaics of IEA PVPS Task 7 and evaluation criteria for BIPV systems are also presented.

2000 – 2004

- **STACHORRA, Elmar., T. STEPHANBLOME and T. PIERSCHKE.** 2000. Erste Betriebserfahrungen mit der dachintegrierten 1-MWp-Photovoltaik-Anlage des Energieparks Mont-Cenis in Herne Sodingen. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 64–69.

Keywords: project description, BIPV

Project: Akademie-du-Mont-Cenis, Herne, Germany

Abstract: In this paper, the first operating experiences and data acquisition of the Akademie-du-Mont-Cenis photovoltaic power plant commissioned in April 1999 are presented. The investment cost was DEM 14.7 million. The measured values are also visualized and presented on the Internet. The energy yield from January 1999 to December 1999 is also presented. The photovoltaic power plant is part of an energy park, which also includes two 235 kW gas-powered cogeneration power plants and 1.2 MW energy storage.

- **STELLBOGEN, Dirk and Axel EICHHORN.** 2001. Betriebsergebnisse der 435 kWp - Photovoltaikanlage des Motorenwerks Bad Cannstatt. Poster. In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 356–361.

Keywords: project description, project evaluation

Project: Daimler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

Abstract: The operating results of photovoltaic power plants located on the roofs of the Daimler-Chrysler facilities in Bad Canstatt, Germany, are presented in this paper. The whole system consists of 76 fixed subsystems located on the roofs of the production halls and the main building, a single axis tracking V-trough, a subsystem located on the cafeteria as a shading system and an array on the main entrance building. In this paper, the results of a two year monitoring period are presented, the monthly energy gain and total energy gain are given and the reasons for the low energy gain are described.

- **STICH, Christian, Gerd BECKER, Mike ZEHNER, Bodo GIESLER, Walter WEBER and Fabian FLADE.** 2003. OnToPV - eine virtuelle Führung durch die PV-Anlage "Solardach Neue Messe München". In: 18. Symposium Photovoltaische Solarenergie, Staffelstein, 12–14 March 2003, 168–173.

URL: http://www.sev-bayern.de (20 October 2017)

Keywords: project description, education

Project: Munich Trade Fair, Munich, Germany

Abstract: In this paper, an online virtual tour through the Munich Trade Fair roof-mounted photovoltaic system is briefly described. The online virtual tour is hosted on the website of Solarnergieförderverein Bayern.

- **STRAßMÜLLER, Michael, Gerd BECKER, Axel EICHHORN, Dirk STELLBOGEN, Georg MAIER and Peter HOUZER.** 2000. Untersuchung verschiedener Systemkonzepte netzgekoppelter Photovoltaikanlagen großer Leistung. Poster. In: 15. Symposium Photovoltaische Solarenergie, Staffelstein, 15–17 March 2000, 272–277.

Keywords: project evaluation, BIPV

Project: Akademie-du-Mont-Cenis, Herne; Munich Trade Fair, Munich; Dainler-Benz, Mercedes, Bad Canstatt, Stuttgart, Germany

Abstract: In this paper, large-scale operating photovoltaic power plants in Herne, Munich and Stuttgart are described and compared. Some economic terms are briefly described and discussed. A comparison of the monthly yield from the period September 1998 to November 1999 is also given.

- **TEGTMEYER, Dirk, Dirk RABENECK and Dieter FRIEDE.** 2001. Integration von Photovoltaik in die Architektur zweier dezentraler EXPO2000-Projekte. Poster: In: 16. Symposium Photovoltaische Solarenergie, Staffelstein, 14–16 March 2001, 528–533.

Keywords: project description

Project: EXPO 2000, Hannover, Germany

Abstract: Two photovoltaic projects located in Hannover, Germany are briefly described in this paper. Both projects are building-integrated, the first has 15 kWp and is located on the island of Steinhude and the second with 13.2 kWp is on the Hundertwasser railway station. Photos of the projects are also presented. Both systems also include visualising panels to attract the attention of visitors and to boost public perception.

- **THIESBRUMMEL, Bernhard and Timon KAMPSCHULTE.** 2003. Solare Fassaden für ästhetische Gebäudeansichten - Planung und Bau einer PV-Anlage mit einer Spitzenleistung von 300 kWp auf einem Bogendach in dachparalleler Ausführung. Poster. In: 18. Symposium Photovoltaische Solarenergie, Staffelstein, 12–14 March 2003, 299.

Keywords: project description, roof mounted

Project: Bad Oeynhausen, Germany

Abstract: A brief description of the 302 kWp system on the roof of Fenel Co. in Bad Oeynhausen is given in this paper. The system is located on 2,500 m² of roof area and was commissioned in August 2002. It consists of crystalline modules and several inverters.

- **VALERA, P., J. ENRILE, R. OSUNA, M. ALONSO, M. SÁNCHEZ and F. CHENLO.** 2004. Sevilla PV 1.2 MW - The World Largest Double Concentration PV System. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 2, 2656–2659.

Keywords: project description, case study

Project: Sanlúcar la Mayor, Sevilla, Spain

Abstract: In this paper, a photovoltaic concentrator system located in Sanlúcar la Mayor, Sevilla, Spain, is described in detail. The paper includes a detailed technical description, including trackers, heliostats, tracking control and an electrical scheme.

- **VAN DER BORG, N. J. C. M., E. RÖSSLER and E. B. M. VISSER.** 2000. A Traffic Noise Barrier Equipped with 2160 AC-Modules. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 3, 2651–2653.

2000 – 2004

Keywords: project description, case study, noise barriers

Project: PV noise barrier, A9 motorway, Ouderkerk aan de Amstel, Amsterdam, the Netherlands

Abstract: A PV noise barrier along the A9 motorway near Amsterdam, with a total length of 1650 m, was put into service on 1st December 1998. In this paper, the monitoring results from April 1999 to April 2000 are presented. The monthly operating data such as the performance ratio, module efficiencies and conversion efficiencies are presented. The number of malfunctions is also documented.

- **VEYAN, P., G. MOINE, J. C. MARCEL, L. ROWE and E. PEIRANO.** 2004. Implementation of an Integrated DSM/Photovoltaic Scheme and Emergency Battery Backup on The Island of Hoedic (Brittany, France). In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2854–2856.

Keywords: preliminary study, project proposal

Project: Hoedic Island, Brittany, France

Abstract: A brief description of the proposed 98 kWp photovoltaic system for Hoedic Island, Brittany, France, is given in this paper. The island has 117 inhabitants and is connected to the mainland by a 20 kV sea cable. The proposed photovoltaic power plant would cover 10% of the annual energy consumption; additionally, a 275 kW wind turbine was also under discussion.

- **VLEK, Frans, Tony SCHOEN and Alberto ILICETO.** 2000. 1 MW Decentralized and Building Integrated PV System in a New Housing Area of the City of Amersfoort. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1783–1787.

Keywords: project description

Projects: Nieuwland, Amersfoort, the Netherlands

Abstract: The Amersfoort municipal housing project, close to completion and with 60% of operating photovoltaic systems, is described in this paper. Lessons learned during the installation phase include learning about the materials below photovoltaic arrays, which is important for construction works, as well as an analysis of shading, which is important from an architectural point of view. A successful project requires close cooperation between the PV industry and house construction companies. Careful commissioning is also very important. Several photographs of different houses and photovoltaic arrays are also presented.

- **VLEK, Frans, A. J. KIL, E. C. MOLENBROEK and G. DE ANGELIS.** 2001. Results of the 1 MW PV project in Amersfoort, The Netherlands. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2367–2370.

Keywords: project description, distributed, housing estate, BIPV

Project: Nieuwland, Amersfoort, the Netherlands

Abstract: In this paper, realisation experiences and a brief project description of a photovoltaic roof-mounted distributed system in Nieuwland, Amersfoort, the Netherlands, is presented. The system was constructed on the roofs of 500 houses, a sports hall, a school and a childcare centre in Amersfoort. The system power capacity is 1.3 MWp, with the first subsystems commissioned in January 1999 and the last in November 2000.

- **VLEK, Frans and Tjerk REIJENGA.** 2000. 1 MW of Solar Power in a Singe Residental District. In: Proceedings of the Solar 2000 Conference, ASES Annual Conference, 25th National Passive Solar Conference, Madison, Wisconsin, 16–21 June 2000, 45–50.

Keywords: project description, distributed, housing estate, BIPV

Projects: Nieuwland, Amersfoort, the Netherlands

Abstract: The 1 MW photovoltaic project involving Amersfoort residential housing covers 500 buildings and is divided into eight parts in total, including solar modules with an area of more than 12,000 m². The start of construction of the residential housing was in November 1997 and the last part should be finished before 2000. The project includes residential houses and public utilities buildings. Several images that highlight the described system from an architectural point of view are also included in this paper. An overview table presents data such as the constructor/developer, architect, number of houses and PV area for eight parts of the Amersfoort residential housing.

- **WILK, Heinrich, Johann PICHLER and Walter WIMMER.** 2004. 50kW Photovoltaik auf dem Kirchendach der Pfarre St. Konrad in Linz. In: 19. Symposium Photovoltaische Solarenergie, Staffelstein, 10–12 March 2004, 390–394.

Keywords: project description

Project: Church St.Konrad, Linz, Upper-Austria, Austria

Abstract: The photovoltaic system on the roof of the St. Konrad Church in Linz, Austria, was commissioned in August 2003. The photovoltaic system was built as part of the church's roof renovation activities. Particular attention was paid to monumental protection in the planning stage. The operating results in the period from October to December 2003 show an 11% greater yield than expected. The total cost was EUR 340,000, partially financed by the church, partially by the State of Upper Austria and partly by some other contributors.

- **WOUTERS, Frank and Sascha GAJEWSKI.** 2002. CIS Anlage mit 45 kWp auf dem Museum für bildende Künste Leipzig, eine Pilotanlage im Bau. In: 17. Symposium Photovoltaische Solarenergie, Staffelstein, 13–15 March 2002, 185–190.

Keywords: project description, BIPV

Project: Museum of Fine Arts, Leipzig, Germany

Abstract: The Museum of Fine Arts in Leipzig, currently under construction, will also host a unique 45 kWp photovoltaic system consisting of 1,200 modules based on CIS technology with an estimated energy gain of about 34,000 kWh annually. About 490m2 of area should be used for solar array mounting. The new building should be completed in December 2003. Images of the museum and its construction are also included in this paper.

- **XIAO, Sun and Kong LI.** 2001. The Project of Andou 100 kW PV Power Station in Tibet, China. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2450–2453.

Keywords: project description

Project: Anduo, Tibet, China

Abstract: In this paper, a technical description and brief operating experiences of the 100 kW photovoltaic power plant located in Anduo, Tibet, is given. The power plant was commissioned in September 1998 and is located at an altitude of 4,800 m above sea level. The system also includes a battery bank of 4,000 Ah/400 V capacity.

- **YAGI, Yasuhiro, Ryuzo HAGIHARA, Takeo ISHIDA and Makoto TANAKA.** 2004. Analysis and Evaluation of the "SOLAR ARK" Large Photovoltaic System. In: Nineteenth European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 7–11 June 2004, 3, 2745–2748.

Keywords: project description

Project: Solar Ark, Sanyo, Gifu, Japan

Abstract: The Sanyo Solar Ark was commissioned in April 2002. A description of the system and operating experiences are discussed in this paper. The Solar Ark, a 300 m long building, was constructed in front of the Sanyo facility in Gifu, Japan. A photovoltaic array with 630 kW is connected to the grid by two 300 kW inverters. It generates about 530 MWh of energy annually. Operating experiences and results such as inverter conversion efficiency, system performance ratio, temperature differences and irradiation differences in the Solar Ark are also presented and discussed.

- **ZACHARIOU, A. and A. MEDRANO.** 2000. Building Integrated Photovoltaics: 50kW(p) on Two Buildings in the Province of Navarra, Spain. In: Sixteenth European Photovoltaic Solar Energy Conference Proceedings, Glasgow, United Kingdom, 1–5 May 2000, 2, 1858–1861.

Keywords: project description, BIPV

Projects: Tafalla, Gerinda, Navarra, Spain

Abstract: In this paper, a description of two building-integrated photovoltaic systems on control buildings owned by EHN in Tafalla and Gerinda, Navarra, Spain, is described. The system in Tafalla has 21.6 kWp and the system in Gerinda has 28.8 kWp. A brief technical description is given and a short summary of the operating data is given as well.

- **ZILLES, Roberto and Sérgio Henrique FERREIRA DE OLIVEIRA.** 2001. 6.3 kWp Photovoltaic Building Integration at Sao Paulo University. In: Seventeenth European Photovoltaic Solar Energy Conference Proceedings, Munich, Germany, 22–26 October 2001, 3, 2751–2753.

Keywords: project description, BIPV

Project: Eletrotechnics and Energy Institute of São Paulo University, Brazil

Abstract: In this paper, the installation and operating experiences of a 6.3 kWp photovoltaic system located on the grounds of the Electrotechnic's and Energy Institute of São Paulo University, Brazil, is briefly presented.

MAGAZINE PAPERS

- **Anonymous.** 2001. A 100 Kilowatt Photovoltaic Array Still Producing After Twenty Years. Renewable Energy World, May–June 2001. James&James. ISSN 1042-0630.

Keywords: project description

Project: Beverly Hill School, Beverly, Massachusetts, USA

- **BING, James.** 2000. PV at the Pentagon. Solar Today, Jan–Feb 2000. American Solar Energy Society. ISSN 1042-0630.

Keywords: project description

Project: Pentagon Headquarters, USA

- **BING, James.** 2001. Solar Power Inside the Beltway. Solar Today, Mar–Apr 2001. American Solar Energy Society. ISSN 1042-0630.

PROCEEDINGS – EU Photovoltaic Solar Energy Conferences

- **PALZ, Wolfgang, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2005. Twentieth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Barcelona, Spain, 6–10 June 2005. WIP-Renewable Energies, München, ISBN 3-936338-19-1.
- **POORTMANS, Jozef, Heinz A. OSSENBRINK, Ewan DUNLOP and Peter HELM. Eds.** 2006. Twenty-first European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Dresden, Germany, 4–8 September 2006. WIP-Renewable Energies, München, ISBN 3-936338-20-5.
- **WILLEKE, Gerhard, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2007. Twenty-second European Photovoltaic Solar. Energy Conference, Proceedings of the International Conference, Milan, Italy, 3–7 September 2007. WIP-Renewable Energies, München, ISBN 3-936338-22-1.
- **LINCOT, Daniel, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2008. Twenty-third European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Valencia, Spain, 1–5 September 2008. WIP-Renewable Energies, München, ISBN 3–936338–24-8.
- **SINKE, Wim, Heinz A. OSSENBRINK and Peter HELM. Eds.** 2009. Twenty-fourth European Photovoltaic Solar Energy Conference, Proceedings of the International Conference, Hamburg, Germany, 21–25 September 2009. ETA Florence, WIP-Renewable Energies, München, ISBN 978-8889407028.

PROCEEDINGS – IEEE Photovoltaic Specialists Conferences

- **IEEE.** 2005. The Conference Record of the Thirty First IEEE Photovoltaic Specialists Conference, 2005, Disney's Coronada Springs Resort, Lake Buena Vista, FL, USA, 3–7 January 2005. ISBN 0-7803-8707-4.
- **IEEE.** 2008. The Conference Record of the Thirty Third IEEE Photovoltaic Specialists Conference 2008. San Diego, CA, USA, 11–16 May 2008. E-ISBN 978-1-4244-1641-7, ISBN 978-1-4244-1640-0.
- **IEEE.** 2009. The Conference Record of the Thirty Fourth IEEE Photovoltaic Specialists Conference 2009. Philadelphia, PA, USA, 7–12 June 2009. E-ISBN 978-1-4244-2950-9, ISBN 978-1-4244-2949-3.

PROCEEDINGS – World Conference on Photovoltaic Energy Conversion

- **IEEE.** 2006. 4th World Conference on Photovoltaic Energy Conversion – WCPEC Proceedings (A Joint Conference of PVSC, PVSEC & PSEC), Waikoloa, HI, USA, 7–12 May 2006. ISBN 1-4244-0017-1.

PROCEEDINGS – International Solar Energy Society, ISES

- **GOSWAMI, Yogi, Sanjay VIJAYARAGHAVAN and Rebecca CAMPBELL-HOWE. Eds.** 2005. Proceedings of the 2005 Solar World Congress, 34th ASES Annual Conference, 30th National Passive Solar Conference, Orlando, FL, 6–12 August 2005. ISBN 0895531771.
- **GOSWAMI Yogi and Yuwen ZHAO. Eds.** 2007. ISES Solar World Congress 2007 Proceedings. Beijing, China, 18–21 September 2007. International Solar Energy Society.
- **ISES.** 2009. ISES Solar World Congress 2009 Proceedings. Johannesburg, South Africa, 11–14 October 2009. International Solar Energy Society. ISBN 1920017429, 9781920017422.

PROCEEDINGS – EuroSun, ISES

- **BUREK, S. Ed.** 2006. EuroSun 2006 Proceedings. Glasgow, 27–30 June 2006. Abingdon: Solar Energy Society. ISBN 0904963731.
- **ISES.** 2008. EuroSun Congress, 1st International Conference on Solar Heating, Cooling and Buildings Proceedings. Lisbon, 7–10 October 2008. Freiburg: ISES Europe, Solar Energy Society of Portugal.
- **ISES.** 2010. EuroSun 2010, International Conference on Solar Heating, Cooling and Buildings Proceedings. Graz, 28 September – 1 October 2010. Freiburg: ISES Europe.

2005 – 2009

PROCEEDINGS – American Solar Energy Society, ASES

- **ASES.** 2006. Proceedings of the ASME International Solar Energy Conference, Proceedings of the Solar 2006 Conference, Denver, CO, 8–13 July 2006. ISBN 0791847454.
- **CAMPBELL-HOWE, Rebecca Ed.** 2007. Proceedings of the Solar 2007 Conference, Proceedings of the 36th ASES Annual Conference, Proceedings of the 32nd National Passive Solar Conference, Proceedings of the 2nd Renewable Energy Policy and Marketing Conference, Cleveland, OH, 8–12 July 2007. ISBN 9781604233087.
- **CAMPBELL-HOWE, Rebecca Ed.** 2008. Proceedings of the Solar 2008 Conference, Proceedings of the 37th ASES Annual Conference, 33rd National Passive Solar Conference, 3rd Renewable Energy Policy and Marketing Conference, San Diego, CA, 3–8 May 2008. ISBN 9781605604787.
- **CAMPBELL-HOWE, Rebecca Ed.** 2009. Proceedings of the Solar 2009 Conference, Proceedings of the 38th ASES Annual Conference, Proceedings of the 34th National Passive Solar Conference, Proceedings of the 4th Renewable Energy Policy and Marketing Conference, Buffalo, NY, 11–16 May 2009. ISBN 9781615673636.

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- **SCHMID, Jürgen Ed.** 2005. 20. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2005. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI), Regensburg. ISBN 3-934681-38-7.
- **GABLER, Hansjörg Ed.** 2006. 21. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2006. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 3-934681-44-1.
- **SCHMID, Jürgen Ed.** 2007. 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 978-3-934681-53-8.
- **NORDMANN, Thomas Ed.** 2008. 23. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2008. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 978-3-934681-67-5.
- **EBERT, Günther Ed.** 2009. 24. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2009. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 978-3-934681-93-4.

PRELIMINARY STUDIES

- **ITO, Masakazu, Kazuhiko KATO, Keiichi KOMOTO, Tetsuo KICHIMI and Kosuke KUROKAWA.** 2005. Analysis of transmission losses of very large-scale photovoltaic power generation systems (VLS-PV) in world desert. In: Conference Record of the Thirty First IEEE Photovoltaic Specialists Conference, Buena Vista, FL, USA, 3–7 January 2005, 1706–1709.

  DOI: 10.1109/PVSC.2005.1488477

  Keywords: preliminary study

  Abstract: In this paper, a detailed analysis of the transmission losses of very large-scale photovoltaic power plants situated in remote desert areas is given. Losses are calculated for different power plant configurations and six deserts, which are the Sahara, Negev, Thar, Sonoran, Great Sandy and Gobi. 100 km transmission loss is 8.2% in the Sahara and 5.8% in the Gobi, for instance.

- **ITO, Masakazu, Kazuhiko KATO, Keiichi KOMOTO, Tetsuo KICHIMI and Kosuke KUROKAWA.** 2006. A Sensitivity Analysis of Very Large-Scale Photovoltaic Power Generation (VLS-PV) Systems in Deserts. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2387–2390.

  DOI: 10.1109/WCPEC.2006.279672

  Keywords: preliminary study

  Abstract: A sensitivity analysis on the potential of very large-scale photovoltaic power generation systems (VLS-PV) in deserts from an economic viewpoint has been performed. The results include the impact of module efficiency on electricity cost, energy payback time and the amount of material for support structures. Additional module efficiency vs. labour force required is presented. Annual operating cost and GHG emissions were studied as well. Additional results also include the ratio of degradation rate to GHG emissions and interest rate to electricity cost.

- **KOMOTO, Keiichi, Kosuke KUROKAWA, T. NISHIMURA, Kazuhiko KATO, K. OTANI, Masakazu ITO, M. ERMER, Claus BENEKING, G. KALENBACH, Karsten WELTZIEN, D. OTTO, C. SCHNEIDER, C. NOWICKI, A. BENEKING, Peter VAN DER VLEUTEN, L. A. VERHOEF, B. BESSAIS, M. ARRARAS, C. ITOIZ, M. OLITE, J. P. GANIGUER, David FAIMAN, D. RAVIV, R. ROSENSTREICH, N. ENEBISH, J. SONG, S. WANG, S. MA, D. SINGH, J. S. MACDONALD, T. HANSEN, H. HAYDEN, Fabrizio PALETTA and A. SARNO.** 2006. IEA PVPS Task 8: Project Proposals on Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems in Deserts. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2359–2362.

  DOI: 10.1109/WCPEC.2006.279665

Keywords: preliminary study

Abstract: Based on the work of IEA PVPS Task 8, some proposals for the locations of very large-scale photovoltaic power plants are given. Regions/locations proposed include the Mediterranean region in North Africa, the Gobi Desert in Mongolia, Dunhuang, China and Perenjori, Australia. Installation cost and electricity generation cost for the proposed locations are estimated in the paper as well.

- **KOMOTO, Keiichi, Kosuke KUROKAWA, Masakazu ITO, J. S. MACDONALD, C. BENEKING, M. ERMER, David FAIMAN, Fabrizio PALETTA, A. SARNO, J. SONG, Peter VAN DER VLEUTEN, T. HANSEN, H. HAYDEN and N. ENEBISH.** 2006. 3rd-Phase Activity of IEA-PVPS Task 8 (2006-2008) Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems in the Desert. Poster. IEA-PVPS Task 8 International Symposium, Makuhari Messe, Chiba, Japan, 9 October 2006.

  Keywords: preliminary study

  URL: http://www.iea-pvps.org/index.php?id=95&eID=dam_frontend_push&docID=355 (10 June 2016)

- **KUROKAWA, Kusoke, Keichii KOMOTO, Peter VAN DER VLEUTEN and David FAIMAN.** 2006. A New Knowledge of How to Make the Very Large Scale PVs Happen in the Desert. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2590–2596.

  Keywords: preliminary study

  Abstract: In the paper, sites for large-scale photovoltaic power plants are proposed. Some case studies for sites in the Gobi Desert, Mongolia, China, Australia and the Middle East and the Mediterranean region in Morocco, Tunisia, Portugal and Spain are presented.

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- **REN21.** 2008. Renewables 2007 Global Status Report (Paris: REN21 Secretariat and Washington, DC: Worldwatch Institute Copyright © 2008 Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, 11–12, 47 endnote 9.

  URL: http://www.ren21.net/status-of-renewables/global-status-report/

- **REN21.** 2009. Renewables Global Status Report: 2009 Update (Paris: REN21 Secretariat Copyright © 2009 Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, 12, 29 endnote 5.

  URL: http://www.ren21.net/status-of-renewables/global-status-report/

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- **KUROKAWA, Kusoke, Keichii KOMOTO, Peter VAN DER VLEUTEN and David FAIMAN.** 2006. Summary, Energy from the Desert: Practical Proposals for Very Large Scale Photovoltaic Systems. London, Sterling, VA: earthscan.

  URL: http://www.iea-pvps.org/index.php?id=95&eID=dam_frontend_push&docID=199 (10 June 2016)

- **KOMOTO, Keichii, Masakazu ITO, Peter VAN DER VLEUTEN, David FAIMAN and Keichii KUROKAWA.** 2009. Energy from the Desert Executive Summary: Socio-economics, Financial, Technical and Environmental Aspects. London, Sterling, VA: earthscan.

  URL: http://www.iea-pvps.org/index.php?id=95&eID=dam_frontend_push&docID=2580 (10 June 2016)

- **MOLLER, L.** 2005. Kogarah Town Square Photovoltaic Power System, Demand Power Analysis. Report prepared by Lianne Moller for the Demand Management Group.

  URL: https://www.ausgrid.com.au/~/media/Files/Network/Demand%20Management/Generation%20resources/KTS_DM_Analysis.pdf (10 June 2016)

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- **GAIDDON, Bruno, Henk KAAN and Donna MUNRO. Eds.** 2009. Photovoltaics in the Urban Environment, Lessons Learnt from Large-Scale Projects. Earthscan ISBN 978-1-84407-771-7.

- **KOMOTO, Keichii and Masakazu ITO. Eds.** 2007. Energy from the Desert: Very Large Scale Photovoltaic Systems: Socio-economic, Financial, Technical and Environmental Aspects, Volume Three Edition. Routledge. ISBN 978-1844077946.

- **KUROKAWA, Kusoke. Ed.** 2006. Energy from the Desert: Feasibility of Very Large Scale Power Generation (VLS-PV), Volume One Edition. Routledge. ISBN 978-1902916415.

- **PRASAD, Deo and Mark SNOW. Eds.** 2005. Designing with Solar Power, A Source Book for Building Integrated Photovoltaics (BIPV). The Images Publishing Group & earthscan. ISBN 1 876907 17 7 (The Images Publishing Group). ISBN 1 844071 47 2 (earthscan).

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- **National Geographic.** 2005. Collegiate Atlas of the World. ISBN 0-7922-3662-9.

  Map: Utility-scale PV Power Plants worldwide, operating in 2004, p.62.

- **LENARDIČ, Denis, Sibylle PETRAK and Ulrich DEWALD.** 2008. Large-Scale PV Power Plants. Annual Review 2008. ISBN 978-961-245-739-6.

  Maps: PV Power Plants in the years 2007/2008 in Spain (detailed for the regions of Andalusia and Castille-La Mancha), Italy, Germany and the Czech Republic. Map contributors: Dewald, U. and H.-J. Ehrig, RWTH Aachen.

- **LENARDIČ, Denis.** 2008. Installations of PV Power Plants in 2008, Photovoltaics International, 3rd Edition. Semiconductor Media Publ., 148–153.

  Maps: PV Power Plants in the years 2007/2008 for the Spanish regions of Andalusia and Castille-La Mancha. Map contributors: Dewald, U. and H.-J. Ehrig, RWTH Aachen.

- **RUTSCHMANN, Ines.** 2009. Land der Megawattparks. Photon, 9, 40–45.

  Map: Utility-scale PV Power Plants in Spain in the summer of 2009.

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- **ALAMI, Amine and Robert BATISTA.** 2009. 2008 performance analysis of a large scale grid connected solar system. In: Conference Record of the Thirty Fourth IEEE Photovoltaic Specialists Conference. Philadelphia, PA, USA, 7–12 June 2009, 550–553.

  DOI: 10.1109/PVSC.2009.5411625

  Keywords: project evaluation

  Project: Nellis Air Force Base, Las Vegas, Nevada, USA

  Abstract: In December 2007, a 14 MW photovoltaic power plant located on the grounds of Nellis Air Force Base in Nevada, USA, was commissioned. At the time of commissioning, it was the largest PV power plant in North America. It covers 140 acres of land and consists of nine subsystems. For the solar arrays, four different solar cell types were used - based on polycrystalline string ribbon, monocrystalline and high efficiency bifacial solar cells. The arrays are mounted on two different tracker types. System availability, performance and performance ratio are presented and discussed.

- **ALAMI, Amine, Robert BATISTA and David WILLIAMS.** 2009. 2008 performance analysis of a large scale grid connected solar system. In: SPIE, Reliability of Photovoltaic Cells, Modules, Components, and Systems II, 74120F, Conference Proceedings. Philadelphia, PA, USA, 20 August 2009, 7412 0F.

  DOI: 10.1117/12.824844

  Keywords: project evaluation

  Project: Nellis Air Force Base, Las Vegas, Nevada, USA

  Abstract: Operating performance of the largest North American photovoltaic power plant was analysed and the results for the year 2008 are discussed in this paper. Four different module technologies were used in the power plant: string ribbon poly-Si mounted on horizontal one-axis trackers, front contact and back contact mono-Si solar cells and bifacial hybrid solar cells all mounted on one-axis trackers with a 20° tilt angle. Solar radiation, system availability and energy yield, module yields and temperature performance and tracker power profiles were analysed and the results are presented and discussed in the paper.

- **ALMONACID, G., P. J. PÉREZ, P. G. VIDAL, J. AGUILERA, G. NOFUENTES, I. LUQUE-HEREDIA, P. H. MAGALHÃES, J. M. MORENO, G. QUÉMÉRÉ, R. CERVANTES and M. DOMÉNECH.** 2006. Lorca PV Solar Park. A Large (7MW) PV Plant in the Southeast of Spain. Towards the 2000kWh/kWp. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2777–2781.

  Keywords: project description, trackers

  Project: Huerta Solar Lorca, Lorca, Murcia, Spain

  Abstract: The Lorca Solar Park is planned in Lorca, Murcia, Spain. The power plant should consist of 64 subunits with 12 two-axis trackers each. The power capacity of each tracker should be 9 kWp. Each subunit should be connected to the grid through its own 100 kVA inverter. Inverters will be connected

to a 20 kV transformer. It is expected that the power plant will generate 211 MWh of electricity annually and will save more than 150,000 tonnes of CO_2 in its lifetime. System losses are estimated for three different scenarios and are given in a table.

- **ALONSO-ABELLA, Miguel, F. CHENLO, N. VELA, J. CHAMBERLAIN, R. ARROYO and F. J. ALONSO MARTÍNEZ.** 2005. Toledo PV Plant 1 MWp - 10 Years of Operation. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2454–2457.

  Keywords: project description, project evaluation

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: The photovoltaic power plant located close to the village of La Puebla de Montalbán in Toledo, Spain, was commissioned in July 1994. The arrays of the 1 MWp power plant consist of 7,936 modules installed in 25 strings. Two subarrays have a fixed tilt of 30° and ±400 V array voltage with midpoint grounded . The third subarray is a single-axis north-south tracker with floating ±400 V array voltage with midpoint grounded. The power plant is connected to a 15 kV medium-voltage grid. The operating experiences in the period from 1994 (six months) to 2004 are presented and discussed in this paper. Peak power, annual energy production, estimated losses, performance ratio and final yield are presented in tables and plots. The presented estimated losses also include angular and spectral losses, cable losses, MPP, shading, temperature and tracking-related losses. Maintenance efforts and experiences, like improved security measures and thermography array investigations are also presented and discussed. Images of the system and array investigations are also included.

- **ALONSO-ABELLA, Miguel, F. CHENLO, V. FERNÁNDEZ, J. ENRILE, R. OSUNA and P. VALERA.** 2005. Sevilla PV 1,2 MW - Double Concentrator PV Grid Connected Plant. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2709–2712.

  Keywords: project description, concentrator

  Project: Sanlúcar la Mayor, Sevilla, Spain

  Abstract: The project description of a planned 1.2 MW (700 kWp) concentrator power plant to be constructed in Sanlúcar la Mayor, Sevilla, Spain is presented in this paper. The system should consist of 170 heliostats, each with a 2.2 concentrator ratio and 100 m² array area. Eight 115 kVA inverters and three transformers should be used for grid connection. The concentrator modules and solar cells are described in detail, and the expected behaviour of the system including fill factor, efficiency and power estimation is also presented. It is planned that after the large-scale operation is established, the electricity cost of the system should reach EUR 0.22/kWh.

- **ALONSO-ABELLA, Miguel, F. CHENLO, C. RODRÍGUEZ, J. SÁNCHEZ and J. FERNÁNDEZ.** 2009. Operation and Energy Production of Two 1 MW Low Concentration PV Plants in Toledo (Spain). In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4033–4037.

  DOI: 10.4229/24thEUPVSEC2009-5BV.2.3

  Keywords: project description, concentrator, trackers

  Projects: Alcolea del Tajo; Talavera de la Reina, Toledo, Spain

  Abstract: This paper describes two 1 MW V-trough 2X low-concentration grid-connected PV plants located in Toledo province, Spain, that have been in full operation since May 2009. A detailed technical description of both power plants, located in Alcolea del Tajo and Talavera de la Reina is given. A mathematical description of the V-trough concentrators is also given in the paper. The results of the yield evaluation show a yield up to 30% higher than expected.

- **BÄCHLER, Manfred, Gerd BECKER, Bodo GIESLER, Gerald KUMERLE, Wolfgang REHM, Udo RINDELHARDT and Sylvia SCHMIDBERGER.** 2007. Comparing Long Term Operation Experience of Large PV-Systems. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 2956–2959.

  Keywords: project description

  Projects: Munich Trade Fair I, Munich Trade Fair II, Solarpark Meerane, Germany

  Abstract: The operating experiences and a comparison of three MW-ranged photovoltaic power plants are presented in this paper. Munich Trade Fair I and II, commissioned in November 1997 and 2002 respectively and Solarpark Meerane, commissioned in April 2004 are described. Experiences with the inverter configurations are presented and the performance ratio of the power plants is analysed. Operating problems and experiences include the exchange of the DC circuit breakers of the Munich Trade Fair I system and later also the retrofit of inverters. The system also showed a performance decrease due to module degradation. Forced ventilation of the inverters used in the Munich Trade Fair II system, was integrated in 2003. Grid fluctuation has also caused inverter shut-down. Some modules were damaged by roof maintenance personnel. Solarpark Meerane has shown an insulation resistance decrease under particular weather conditions due to the moisture and wooden construction, so insulation monitoring of the inverters needs to be adapted.

- **BEGOVIĆ, Miroslav, Seema R. GHOSH and Ajeet ROHATGI.** 2006. Decade Performance of a Roof-Mounted Photovoltaic Array. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2383–2386.

  DOI: 10.1109/WCPEC.2006.279671

  Keywords: project evaluation

  Project: Georgia Tech Aquatic Center, Atlanta, Georgia, USA

  Abstract: The Georgia Tech Aquatic Center photovoltaic system, located in Atlanta, Georgia, USA was commissioned in 1996. In 2006, after a decade of operation, a detailed analysis of the operating parameters was performed. The rooftop system is continuously monitored at 10-second intervals. The analysed and presented data for the period July 1996 to April 2006 includes: cumulative AC energy fed into the grid, system efficiency, inverter efficiency, module temperature, etc. The system has performed well with virtually no O&M cost. The only problem was with the power electronics that resulted in a long repair time, a problem that is human-related. The system efficiency was steady in the analysed time period.

- **BRANDHORST, Henry W., Steve R. BEST and Julie A. RODIEK.** 2009. Overview of solar power installation project for Lee County's TK Davis Justice Center. In: Conference Record of the Thirty Fourth IEEE Photovoltaic Specialists Conference, Philadelphia, PA, USA, 7–12 June 2009, 380–384.

  DOI: 10.1109/PVSC.2009.5411658

  Keywords: project description

  Project: T.K. Davis Justice Center, Lee County, Alabama, USA

  Abstract: The installation of the photovoltaic systems of the Lee County's T.K. Davis Justice Center (LCJC) in Lee County, Alabama, in the city of Opelika is presented in this paper. The simulation results, shading simulation and some constructional details of the 16.6 kW systems are presented. The results of the load profile analysis and financial analysis are presented and discussed as well.

- **CENDAGORTA, M., M. P. FRIEND, A. LINARES, E. LLARENA and C. MONTES.** 2007. Installation, Set-Up and First Results of the 20 MW Grid-Connected PV Solar Project in Tenerife. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3226–3229.

  Keywords: project evaluation

  Projects: Solten I, Granadilla de Abona, Teneriffe, Canary Islands, Spain

  Abstract: The SOLTEN Project, located in the south of the island of Tenerife, is described in the paper. The 20 MW power plant consist of two parts, one 13 MW completed in April 2007 and another 7 MW. The whole power plant is divided into 200 systems with a 100 kWp power capacity each. For each subsystem, separate investment was possible. Construction was done by ITER who is also responsible for power plant maintenance. The solar generators, inverters and monitoring system are also described. The performance ratio and energy production are also presented for summer 2007.

- **CENDAGORTA, M., C. MONTES, A. LINARES, E. LLARENA, P. GONZÁLEZ, E. FRIEND and M. FRIEND.** 2008. Bottlenecks in the Canary Island Multi-MW PV Development. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3668–3670.

  DOI: 10.4229/23rdEUPVSEC2008-6BO.7.7

  Keywords: project description, project evaluation

  Projects: Solten I, Granadilla de Abona, Teneriffe, Canary Islands, Spain

  Abstract: In the paper, some aspects of the legislation on constructing large-scale photovoltaic power plants on the Canary Islands are discussed. The main obstacles are the protected area, the non-unique grid quality on the island, and land occupation. The paper also addresses some economic issues and evaluates the necessity of subsidies until grid parity is reached.

- **CENDAGORTA, M., C. MONTES, A. LINARES, E. LLARENA, S. SALATA, M. DELGADO and M. P. FRIEND.** 2006. The 15 MW PV Solar Project in Teneriffe - Practical Issues in the Context of the Spanish Feed in Law Whilst Realising the Multi Megawatt Plant. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 3002–3004.

  Keywords: project evaluation

  Projects: Solten I, Granadilla de Abona, Tenerife, Canary Islands, Spain

  Abstract: The Solten I photovoltaic project, located in Granadilla de Abona, Canary Islands, should consist of 130 power plants. The first power plants are already completed. Further enlargement of the Solten project to 20 MW is also planned. Completed power plants use 100 kVA inverters. The first 10 power plants are connected to a 1000 kVA transformer, and the remaining power plants should, in sets of 20, be connected to a 2,000 kVA transformer. The cost of a 100 kW power plant is estimated at EUR 530,000.

- **CORRETGER, Josep M., Josep ARNAU, Alexandre DELTELL and Antonio MARQUEZ.** 2005. UnivERsol Project in the University of Girona. A Year of Monitoring. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2696–2697.

  Keywords: project description, project evaluation

  Project: University of Girona, Girona, Spain

  Abstract: The University of Girona's photovoltaic project was connected to the grid in November 2003. The array, with 15.36 kWp power from 160 modules, covers an area of 120 m². Module orientation is south with a 30° tilt angle. The system is connected to the grid by six inverters. Monthly operating experiences for the year 2004 like energy production, final yield, system losses and performance ratio are presented and discussed in the paper as well.

- **CRACIUNESCU, A., M. O. POPESCU, C. L. POPESCU, G. S. CIUMBULEA, M. PREDESCU, O. MITROI, A. BEJINARIU and M. GROTTKE.** 2007. Lessons Learnt During Installation of a 30 kWp Grid-Connected Photovoltaic Power Plant at University "Politehnica" of Bucharest, Romania. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3292–3295.

  Keywords: project description

  Project: University Politehnica Bucharest, Romania

  Abstract: A roof-mounted 30 kWp photovoltaic system located on the roof of the University Politehnica of Bucharest, Romania, is described in the paper. The system, commissioned

in May 2006, was financed by the EU and Romanian investors in the framework of the PVEnlargement and PV-Grid projects. The main idea was to use a system which would have as little interaction with the building as possible - no drilling holes, etc. The solar generators consist of two subarrays, each containing 24 strings. For the array structure, galvanised steel with support slabs is used. Monitoring and protection functions are described and yield estimation is also given in the paper.

- **DÄUKER, Eva.** 2008. 20 MW-Solarkraftwerk SinAn: In Südkorea entsteht eines der weltweit größten Vorzeigeprojekte nachgeführten Anlagenbaus. Poster. In: 23. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 5–7 March 2008, 264.

  Keywords: project description

  Project: SinAn, South Korea

  Abstract: Listed in the table of contents, but not available as a paper.

- **DE KEIZER, A. C., Emil TER HORST, E. C. MOLENBROEK and Wilfried G. J. H. M. VAN SARK.** 2007. Evaluating 5-Years Performance Monitoring of 1 MW Building Integrated PV Project in Nieuwland, Amersfoort, the Netherlands. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 2960–2965.

  Keywords: project evaluation

  Project: Nieuwland, Amersfoort, the Netherlands

  Abstract: The Nieuwland photovoltaic residential housing project was completed in 2001. It consists of 486 distributed photovoltaic systems with a total 1.3 MWp power capacity. The systems are situated in the urban area of Nieuwland in the town of Amersfoort in the Netherlands and are part of one of the largest distributed photovoltaic systems. The systems are mounted on the roofs of residential housing, the school and sports hall. The performance of the systems has been evaluated for a period of five years (2001–2006). The main conclusion of the monitoring is that the performance ratio of the systems is lower than expected. Some operating experiences, like hidden and unrecognised string errors, and some other issues, are also discussed in the paper.

- **DEN HERTOG, J., W. EDRICH, Robert PFATISCHER, R. CLARK, L. A. VERHOEF, R. WESTERHUIS, T. OOMEN and W. KOPPEN.** 2008. SUNCITIES: Final Results of a 3,05 MWp European Project and the Merits of Urban Planning. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings. Valencia, Spain, 1–5 September 2008, 3292–3295.

  DOI: 10.4229/23rdEUPVSEC2008-5AO.9.1

  Keywords: project evaluation

  Project: SunCities project, the Netherlands

  Abstract: This paper presents the results of the SunCities project in the Netherlands, which consists of three local projects of new housing developments with integrated photovoltaic systems. The power capacity of SunCities' photovoltaic projects is 3.05 MWp. The main part of the project is located in Heerhugowaard and includes 1410 zero-energy houses with 2.45 MWp photovoltaic systems, two satellite projects in the UK with 250 zero-energy houses and Germany with 50 zero-energy houses. The average project cost that was partially even below the target is also presented in the paper. Based on system monitoring, the yield and performance ratio are evaluated and presented as well. The importance of subsidies for large-scale photovoltaic systems is also discussed.

- **DUTTA, V., Deepak VERMA and O. S. SASTRY.** 2005. Performance Analysis of a 100 kW Grid Connected Photovoltaic System. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2458–2461.

  Keywords: project description

  Projects: village Jaitpurakalan, Rajgarh District, Madhya Pradesh, India

  Abstract: A photovoltaic power plant with a 99,864 kWp (100 kWp) power capacity was installed in the village of Jaitpurakalan, Rajgarh District, Madhya Pradesh, India. The array, with a 24° fixed tilt consists of 1,368 modules and is divided into 38 subunits. A 100 kVA inverter and 100 kVA transformer are used for connection to an 11 kV grid. Operating experiences for 12 months of operation, such as output power, monthly generated energy and array efficiency are presented and discussed in the paper.

- **FAZARI, L.** 2005. Application of 150 kWp Grid-Connected PV System in the "Arquata District". In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2682–2683.

  Keywords: project proposal, distributed

  Project: Arquata District, Turin, Italy

  Abstract: A brief description of a proposed 150 kW distributed photovoltaic system in Arquata District in Turin, Italy is given in this paper. The project proposal comprises 30 residential council houses and an office building. A visual simulation of the appearance of the photovoltaic system constructed in the office building is also part of the paper. It is estimated that energy demand will reduce by 33% for the residential buildings and 40% for the office building. Energy payback of 10 years is estimated. CO_2 emissions should reduce from 243 to 100 tonnes for the residential buildings and from 364 to 296 tonnes for the office building.

- **GARCÍA, Miguel, Jose A. VERA, Luis MARROYO, Eduardo LORENZO and Miguel PÉREZ.** 2009. Solar-tracking PV plants in Navarra: A 10 MW Assessment. In: Progress in Photovoltaics: Research and Applications, 17, 5, 337–346.

  DOI: 10.1002/pip.893

  Keywords: project description, project evaluation

  Projects: Arguedas I, II, Sesma, Cintruénigo, Rada, Castejón, Navarra, Spain

2005 – 2009

Abstract: A detailed analysis of the operating results for six solar tracking power plants located in Navarra, Spain, constructed in 2005, is presented. Some installation and technical details for the power plants in Arguedas, Sesma, Cintruénigo, Rada and Castejón are given. The power range spans from 940 kWp for Arguedas I to 2,643 kWp for the Castejón PV power plant. Energy performance is analysed and the reasons for energy losses like inverter efficiency, module temperature losses, dust, shadowing, etc. are discussed. Operating experiences, including a brief analysis of unscheduled events, is also given. Installation costs span from EUR 8.6/Wp for the first power plant to EUR 7.5/Wp for the last completed. The mean availability rates for the analysed power plants were >99·7% in 2006.

- **GIESLER, Bodo, Mike ZEHNER and Toni WEIGL.** 2009. Auslegungs- und Betriebserfahrungen bei Megawattanlagen. In: 24. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 4–6 March 2009, 220–225.

  Keywords: project overview

  Projects: Munich Trade Fair, Munich; Höslwang, Bavaria; Leipziger Land, Leipzig, Germany

  Abstract: In the paper, the operating experiences of three German MW ranged photovoltaic power plants are discussed. Evaluated are 1,016 MWp roof-mounted systems located on the roofs of the Munich Trade Fair, 1.8 MWp Solarpark Höslwang near Rosenheim, Bavaria and 5 MWp Solarpark Leipziger Land in Saxony. The main issues and operating experiences are presented. In 2008, all three power plants had a stable performance ratio; the Munich Trade Fair power plant was about 80%, Höslwang was about 82% and Leipziger Land was about 83%. Recommendations for further design improvements of the MW ranged photovoltaic power plants are also discussed in the paper. Recommendations include reliable lightning and overvoltage protection, mounting structures should withstand high snow and wind loads, high insulating resistance of modules and high capability of reverse currents in strings/arrays.

- **GRADITI, G., C. CANCRO, A. MEROLA and C. PRIVATO.** 2009. One or Two Axis PV Tracking? The Case Study of a 10kWp Tracking PV System Installed in Southern Italy. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4052–4056.

  DOI: 10.4229/24thEUPVSEC2009-5BV.2.8

  Keywords: project evaluation, trackers, solar hydrogen

  Abstract: A photovoltaic two-axis tracking concentrator system launched by Regione Campania ENEA, Italian National Agency for New Technologies, is described in the paper. The photovoltaic power plant supplies an electrolyser for hydrogen production, whereas the 10 kW alkaline electrolyser for hydrogen production, operating at atmospheric pressure, has been used. The facility is located in the Research Centre of Portici, Naples, Italy. The solar array consists of 4 subarrays with 2.4 kWp each with a total power capacity of 9.6 kWp. The system operating data in the period from July 2006 to June 2008 was evaluated and is presented in this paper. Cost evaluation in comparison with one-axis trackers is also evaluated and discussed.

- **GREGG, Alan, Richard BLIEDEN, Alen CHANG and Herman NG.** 2005. Performance analysis of large scale, amorphous silicon, photovoltaic power systems. In: Conference Record of the Thirty First IEEE Photovoltaic Specialists Conference, Buena Vista, FL, USA, 3–7 January 2005, 1615–1618.

  DOI: 10.1109/PVSC.2005.1488454

  Keywords: project evaluation

  Project: Solarmine, Bakersfield, California, USA

  Abstract: A photovoltaic system near Bakersfield, California, based on triple-junction amorphous solar cells was commissioned in December 2002. In the paper, performance evaluation with attention on the amorphous Si technology used is presented. The system consists of a 614 kW array and is connected to the grid by 225 kW and 300 kW inverters and three-phase transformers. Solar yield and losses are evaluated and presented.

- **GROTTKE, Matthias, Oliver BECK, Peter HELM, Javier GUERRERO, Joaquin MARTINEZ, Francisco ESPIN and Klaus GEHRLICHER.** 2009. Performance of a 230 kWp Solar Park in Spain with Two-Axis Trackers from a European Market Leader. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4080–4082.

  DOI: 10.4229/24thEUPVSEC2009-5BV.2.15

  Keywords: project evaluation, trackers

  Projects: Murcia, Spain

  Abstract: Solarpark Murcia, commissioned in 2006, consisting of 28 two-axis trackers and financed by the EC DG-TREN PV-Enlargement project, is described in this paper. The tracking facility in Murcia comprises 195 kWp of the 230 kWp capacity installed on the site. Individual trackers have a power capacity of between 6.78 kWp and 7.22 kWp. System operating data and monitoring results are discussed. Monitoring data also includes inverter monitoring and solar cell temperature. Yield, performance ratio and inverter efficiency are also evaluated.

- **GUASTELLA, Salvatore.** 2006. Vulcano 80 kW Photovoltaic Plant Technology Assesment: More Than 20 Years of Performance Evaluation and Experience. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2798–2801.

  Keywords: project description, project evaluation

  Projects: Vulcano Islands, Italy

  Abstract: As one of the pilot PV power plants of the EC research & development programme, Vulcano power plant was commissioned in 1984. Vulcano power plant was designed to operate either in stand-alone mode or in grid-connected mode, connected to a 20 kV grid. Vulcano power plant has two subarrays, 44 kWp polycrystalline and 36 kWp monocrystalline, both south-oriented with a 35° module tilt angle. After twenty years of operation, an analysis of module performance, an

analysis of system performance and an evaluation of overall power plant performance in some periods of operation were performed. Power plant performance after 20 years of operation is still good, and an average decrease of module power of 6% was estimated based on the measurement results. The result is significantly lower than the values declared by manufacturers - 20% decreased power after 20 years.

- **HEMMERLE, Claudia and Tobias FISCHER.** 2005. Erfahrungen mit garantierten Ertragen und dem DGS-Solar-Siegel: Betriebsergebnisse einer 345 kWp PV-Anlage. Poster. In: 20. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2005, 362–366.

  Keywords: project evaluation

  Project: Eissportzentrum, Westfalenhallen Dortmund, Germany

  Abstract: The photovoltaic system built on a centre for ice skating in Westfallenhallen, Dortmund was commissioned at the end of 2002. The 344.7 kWp system consists of 4,596 modules and is connected to the 10 kV grid of Westfalenhallen, Dortmund. The system has fulfilled requirements for the DGS Solar Siegel quality mark. Detailed monthly operating results of the power plant for 2003 are presented. The influence of solar radiation, temperature, shading effects and measurement effects were studied in detail and the results are presented and discussed in this paper.

- **HULD, Thomas, Ewan DUNLOP, Heinz OSSENBRINK and Willem ZAAIMAN.** 2006. Analysis of the Performance of the Large Amorphous Silicon PV Facade in Ispra after 11 Years of Operation. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2304–2307.

  DOI: 10.1109/WCPEC.2006.279633

  Keywords: project evaluation, case study, BIPV, thin film

  Project: ELSA building, JRC, Ispra, Italy

  Abstract: The operating results and experiences after 11 years of operation of the thin film façade system in Ispra are presented. Electrical parameters like DC voltage and current, AC energy output, irradiance, wind speed, ambient temperature, module temperatures, continuously monitored in minute intervals since 2003, are analysed and the results are discussed in the paper with particular attention put on conversion efficiency, DC conversion efficiency and seasonal variation of performance. Failure of the battery in the master inverter has occurred twice - as solution inverters were reconfigured, because the master inverter is operating most of the time, but inverters operating in slave mode are not.

- **JAEHNE HUNT, Cynthia** 2009. The Empower India Pilot 1 MW Grid-Connected PV Power Plant Project. In: Proceedings of the Solar 2009 Conference, Proceedings of the 38th ASES Annual Conference, Proceedings of 34th National Passive Solar Conference, Proceedings of the 4th Renewable Energy Policy and Marketing Conference, Buffalo, NY, 11–16 May 2009, 2, 742–746.

  Keywords: project proposal

  Abstract: A short proposal for the MW ranged project in an unspecified location in India is presented in this paper. The paper includes some details about site assessment, data acquisition, system design, operation and maintenance training and assessment of finance options.

- **KIM, Seok Ki, Jinsoo S. SONG, Soo Uk PARK, Young Roc KIM and Xu HONGHUA.** 2007. Performance Evaluation of 100 kWp PV System in Tibet. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3170–3173.

  Keywords: project description

  Project: Yangbajing, Damxung, Lhasa, Tibet

  Abstract: A 100 kWp grid-connected photovoltaic system was installed at the Tibet field test site in China and monitored from September 2005 to September 2006. In this paper, system monitoring under real operating conditions and data analysis are presented. Due to very high altitude and extreme environmental conditions, this analysis is of particular importance. The solar generator consists of 616 modules. The system is connected to a 10 kV three-phase grid. Array performance and performance ratio for the monitored period are also given in this paper.

- **KIMBER, A., L. MITCHELL and H. WENGER.** 2006. First Year Performace of a 10 MWp Tracking PV Plant in Bavaria Germany. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2695–2699.

  Keywords: project description, project evaluation

  Projects: Bavaria Solar I, Mühlhausen, Günching, Minihof (Pfarrkirchen), Germany

  Abstract: The Bavaria Solar I solar park is located on three sites with 10.08 MWp total power capacity. All three systems located in Mühlhausen, Günching and Minihof near Pfarrkirchen use single-axis N-S tracking systems. Total system losses are estimated at 21.4% and are given in a table. Estimated yield and performance ratios are also presented. Based on measurement results from 2005, system performance was evaluated and compared to predicted values.

- **KLIEFOTH, Stephan, Burchard DECKER, Karen KEDZIORA, Andreas HAHN, Matthias STEEGE and Reinhard BROY.** 2007. Solar Park at the Former Nuclear Power Plant Near Greifswald. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3217–3219.

  Keywords: project description, project evaluation

  Projects: Solarpark Lubmin, Greifswald, Germany

  Abstract: A solar park under construction on the site of the former nuclear power plant of Lubmin near Greifswald on the Baltic Sea, is presented in this paper. The solar array consists of 11,040 modules with 23 modules in one string. Modules are mounted with a tilt angle of 30°. For grid connection, three 500 kW inverter stations were used, each comprising two 250 kW inverters. Inverter output is three-phase, 400 V and is connected to the transformer and to a medium-voltage 20 kV grid. The installation experiences and operating results are also presented in the paper.

- **KNAUPP, Werner.** 2005. Gebäudeorientierte und Freiflächen-Photovoltaikanlagen - technische und ökonomische Analyse. In: 20. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2005, 30–36.

  Keywords: project evaluation, economics

  Projects: Bavaria Solar I, Solarparks Mühlhausen, Günching, Minihof (Pfarrkirchen), Solarpark Hemau, Solarpark Sonnen, Solarpark Fürth-Atzenhof, Munich Trade Fair, Bavaria; Solarpark Leipziger Land, Saxony; Bürstadt, Hesse; Merseburg, Saxony-Anhalt; Göttelborn, Saarbrücken, Saarland; Solarpark Neustadt an der Weinstraße, Rhineland-Palatinate.

  Abstract: In the paper, economic data for several MW-ranged ground and roof-mounted photovoltaic systems is presented, including an estimation of investment cost per MW power capacity installed.

- **KONISHI, Hiroo, Takeshi IWATO, Mitsuru KUDOU and Ryo TANAKA.** 2009. Outlines and Some Results in the First Stage of the Hokuto Mega-Solar Project. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 3914–3918.

  DOI: 10.4229/24thEUPVSEC2009-5AO.8.6

  Keywords: project description

  Projects: Hokuto Mega-Solar Project, Yamanashi Prefecture, Japan

  Abstract: The paper describes the Hokuto Mega-Solar Project located in Yamanashi Prefecture, Japan. The first stage, with a 600 kW array, was constructed in 2006-2007. Different module technologies mounted with a fixed-tilt on a steel mounting structure are used in this part. The system is connected to a 6.6 kV grid. The second 1.2 MW part is currently under construction. A detailed technical description of the power conditioning units is also given in the paper - in the first part, 10 kW inverters are used but in the second part, centralised 400 kW inverters are used. System monitoring and results are also discussed. The results include a harmonics analysis and a detailed evaluation of inverter performance.

- **KUWAYAMA, A., S. MIWA, N. MATSUNO, T. ITO, R. HARA, H. KITA, N. MATSUOKA and K. TAIRA.** 2009. Mega-Solar Demonstration Project at Wakkanai. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4116–4118.

  DOI: 10.4229/24thEUPVSEC2009-5BV.2.28

  Keywords: project evaluation

  Projects: Wakkanai, Mega-Solar Demonstration Project, Wakkanai, Japan

  Abstract: The paper describes the Mega-Solar demonstration project, partially completed and located at Wakkanai, the northernmost city of Japan. The demonstration project, with project duration of five years, until March 2011, is planned. About 4 MW of solar array and 1.5 MW of NaS battery system have already been commissioned. The system is connected to a 33 kV grid. Evaluations of the monitoring data and yield results are also discussed in the paper.

- **LANDAU, Markus and Hubert DEUBLER.** 2008. 10 Jahre Hybridsystem "Starkenburger Hütte" – Betriebserfahrungen mit einem innovativen Systemkonzept. In: 23. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 5–7 March 2008, 92–97.

  Keywords: project evaluation, hybrid

  Project: Starkenburger Hütte, Stubaital, Tyrol, Austria

  Abstract: The small hybrid photovoltaic power plant "Starkenburger Hütte" was commissioned in July 1997. In the paper, the operating experiences after 10 years of operation are presented. The energy produced by a photovoltaic power plant and diesel generator is compared for the period from 1997 to 2006. Solar power has covered up to 29% of electricity demand. Operating experiences and problems are also presented and discussed. The batteries were exchanged in the year 2006 after 10 years of operation.

- **LASICH, J. B., P. J. VERLINDEN, A. LEWANDOWSKI, D. EDWARDS, H. KENDALL, S. CARTER, I. THOMAS, P. WAKEMAN, M. WRIGHT, W. HERTAEG, R. METZKE, M. DALY, M. SANTIN, A. NEUMANN, A. WILSON, A. CAPRIHAN and M. STEDWELL.** 2009. World's first demonstration of a 140kWp Heliostat Concentrator PV (HCPV) system. In: Conference Record of the Thirty Fourth IEEE Photovoltaic Specialists Conference, Philadelphia, PA, USA, 7–12 June 2009, 2275–2280.

  DOI: 10.1109/PVSC.2009.5411354

  Keywords: project description

  Projects: Hermannsburg, Bridgewater, Australia

  Abstract: In the paper, some experiences and project descriptions of high-concentration photovoltaic (HCPV) systems are given. Concentrator arrays are dish-formed and mounted on two-axis trackers. Examples of the presented systems include a 240 kWp system in Hermannsburg, commissioned in March 2006 and a 140 kWp test facility at Bridgewater, close to Melbourne, commissioned in November 2008. The technical data and features of dish-formed HCPV systems are also presented and discussed in the paper.

- **LECOUFLE, David, Richard LAWLESS and Matthias HAMPEL.** 2009. Large Scale PV Plants in North Africa and the Middle East - Are Large Scale PV Plants in the Sun-Belt Countries Overshadowed by CSP's Recent Boom? A Technical and Economical Comparison. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4481–4484.

  DOI: 10.4229/24thEUPVSEC2009-6DV.2.29

  Keywords: preliminary study

Abstract: In the paper, a comparison of different solar and photovoltaic technologies for regions with high solar radiation, such as Northern Africa and the Middle East, are discussed and presented. The main attention was put on very large-scale power plants with 50 MW or more power capacity. Concentrated Solar Thermal Power (CSP) with solar-trough technology, photovoltaic crystalline Si solar cells and thin film CdTe, are compared. Yield, life cycle cost of energy, maintenance costs and investment costs are compared and discussed in the paper. Long-term prediction is also presented.

- **LINARES, A., E. LLARENA, C. MONTES, M. FRIEND and M. CENDAGORTA.** 2009. Lessons Learned while Installing Multi-MW PV Grid-Connected Facilities in Canary Islands (Spain). In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 3893–3895.

  DOI: 10.4229/24thEUPVSEC2009-5AO.8.2

  Keywords: project evaluation

  Projects: Solten I, Solten II, Granadilla de Abona; Finca Roja, Finca Verde, Arico; Canary Islands, Spain

  Abstract: In the paper, the practical non-technical experiences and lessons learned during the construction of photovoltaic solar power plants on the Canary Islands are discussed. Different general topics like budget availability, workforce skills, installation procedures, materials used and communications based on years of practical experience of realising MW ranged photovoltaic power plants on the Canary Islands, are presented.

- **LINARES, A., E. LLARENA, C. MONTES, B. GONZÁLEZ-DÍAZ, M. FRIEND and M. CENDAGORTA.** 2009. Three Years Operating 24 MW PV Grid-Connected Facilities in Tenerife (Canary Islands, Spain). In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4087–4089.

  DOI: 10.4229/24thEUPVSEC2009-5BV.2.20

  Keywords: project description, project evaluation

  Projects: Solten I, Solten II, Granadilla de Abona; Finca Roja, Finca Verde, Arico; Santa Cruz, La Laguna, La Cuesta, Canary Islands, Spain

  Abstract: In the paper, the MW-ranged photovoltaic solar power plants on the Canary Islands are briefly described. Two power plants with a total of 20 MW, SOLTEN I and II are located in Granadilla de Abona, where 2 MW are installed on the roofs of industrial warehouses, and another two in Finca Verde, 9 MW and Finca Roja, 3.6 MW are located in Arico. Some investment details and simulation results are also presented in the paper.

- **MAJDANDŽIĆ, Ljubomir, Zdeslav MATIĆ and Luka ČARAPOVIĆ.** 2006. Results of Two-Year Operation of 7,14 kW PV Grid-Connected System in Croatia. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2812–2813.

  Keywords: project description

  Project: Solar Roof Špansko, Zagreb, Croatia

  Abstract: The operating performance after two years of operation of a first grid-connected photovoltaic system in Croatia, Solar Roof Špansko, Zagreb is briefly presented in this paper.

- **MAJDANDŽIĆ, Ljubomir, Zdeslav MATIĆ and Mario PERIĆ.** 2005. Solar Roof Spansko - Croatia's First Grid-Connected PV Installation. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2606–2608.

  Keywords: project description

  Project: Solar Roof Špansko, Zagreb, Croatia

  Abstract: This paper presents the "Solar Roof Špansko-Zagreb" solar project. The project consists of a 7.14 kW photovoltaic system and a solar thermal system with a 10m2 collector area. The photovoltaic array comprises forty-two 170 W modules connected into three subarrays. The PV system is connected to the grid by three 3 kVA inverters. The solar thermal system for water heating also includes a 750 litre storage water tank. Both systems are monitored by a monitoring system – the operating results of the PV and thermal systems from January to December 2004 are presented in the paper. Natural gas is used as a backup energy source and estimated system CO2 savings are 6,500 kg annually.

- **MITCHELL, Lori, Paul BONITZ and John DOYLE.** 2008. Performance Assessment of 2 MW of Photovoltaic Projects Operating in the City and County of San Francisco. In: Proceedings of the Solar 2008 Conference, Proceedings of the 37th ASES Annual Conference, 33rd National Passive Solar Conference, 3rd Renewable Energy Policy and Marketing Conference, San Diego, CA, 3–8 May 2008, 2, 942–967.

  Keywords: project evaluation, waste water treatment

  Projects: Moscone Convention Center, Southeast Water Pollution Control Plant, Norcal Recycle Central - Pier 96, North Point Facility, City Distribution Divison (CDD) Yard, San Francisco, California, USA

  Abstract: About 2 MW of municipal photovoltaic projects was installed in San Francisco up to 2008. The power plants are under the operation of San Francisco Public Utilities Commission (SFPUC). The sites where the systems are located include, among others: Moscone Convention Center and several waste water and waste treatment facilities. Moscone Convention Center includes a 676 kWp photovoltaic system, commissioned in October 2003. The Moscone Convention Center solar system consists of three subsystems located on two buildings within the Convention Center complex - Esplanade Ballroom and South Lobby. Waste water and waste treatment facilities with solar systems include Southeast Water Pollution Control Plant, North Point Facility, City Distribution Division (CDD) Yard, etc. In the paper, a performance assessment of the different power plants is given. The average performance ratio of the analysed systems is 71%. Energy gain and efficiency are presented for the time frame from January to October 2007.

2005 – 2009

- **MIWA, S., N. MATSUNO, T. ITO, R. HARA, H. KITA, N. MATSUOKA and K. TAIRA.** 2008. Wakkanai Mega-Solar Project 1-Year Result. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3234–3235.

  DOI: 10.4229/23rdEUPVSEC2008-5AO.7.1

  Keywords: project description, project evaluation

  Project: Wakkanai, Mega-Solar project, Wakkanai, Japan

  Abstract: This paper presents the results of more than one year of monitoring of the first 80 kW stage of the Wakkanai Mega-Solar Project. An additional 2 MW photovoltaic array and 500 kW NaS battery storage were commissioned in March 2008. Different system parameters were evaluated, like performance ratio, output energy fluctuation ratio, system harmonics, etc.

- **MOORE, Larry M., Hal N. POST, Tom HANSEN and Terry MYSAK.** 2005. Photovoltaic Power Plant Experience at Tucson Electric Power. In: Proceedings of ASME 2005 International Mechanical Engineering Congress and Exposition, Orlando, Florida, USA, 5–11 November 2005, 387–394.

  DOI: 10.1115/IMECE2005-82328

  Keywords: project description, project evaluation

  Projects: Springerville Solar Generating Station, SSGS, Springerville, Arizona, USA

  Abstract: In this paper, a detailed description of the Springerville Solar Generating Station is given. The system is connected to a 34.5 kV grid and consists of twenty-six 135 kWp subsystems, reaching a total of 5 MWp power capacity. The date of commissioning was between 13 June 2001 for the first 135 kW system and 23 June 2004 for the last 135 kW system completed. System performance, including final yield vs. reference yield and performance ratio is also discussed in the paper. Operating experiences with a detailed analysis of unscheduled events and maintenance effort including costs by category and inverter repairs by events and category are also presented. The energy cost and capacity factor are given as well.

- **MOORE, Larry M. and Hal N. POST.** 2007. Five years of operating experience at a large, utility-scale photovoltaic generating plant. In: Progress in Photovoltaics: Research and Applications, 16, 3, 249–259.

  DOI: 10.1002/pip.800

  Keywords: project description, project evaluation

  Projects: Springerville Solar Generating Station, SSGS, Springerville, Arizona, USA

  Abstract: In this paper, a detailed description of the Springerville Solar Generating Station is given. The system consists of twenty-six 135 kWp subsystems, reaching a total of 5 MWp power capacity. The system also includes Xantrex inverters. The subsystems were installed between July 2001 and July 2004. The power plant operates without personnel and is remotely monitored. The performance of the power plant, based on the IEC 61724 standard, including final yield, reference yield and performance ratio is presented. System maintenance experiences are presented and discussed in detail as well. Maintenance effort is given as a detailed analysis of unscheduled maintenance events by component, unscheduled maintenance costs by category and inverter repairs by events and category. The energy cost and capacity factor are also given in the paper.

- **MUÑOZ, J. A., D. SILVA, A. PAYÁN, O. PERELES, R. OSUNA, M. ALONSO and F. CHENLO.** 2008. 2 Years of Operation of the Sevilla PV 1.2 MW Grid Connected Plant. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3199–3202.

  DOI: 10.4229/23rdEUPVSEC2008-5BP.1.1

  Keywords: project description, project evaluation, concentrator, trackers

  Project: Sanlúcar la Mayor, Sevilla, Spain

  Abstract: In the paper, the operating results of the 1.2 MW Seville photovoltaic concentrator power plant are presented. The project was subsidized by the EU DGTREN-Fifth Framework Programme and connected to the grid in April 2006 and was fully operational from December 2006. The power plant consists of three subsystems, and the arrays are installed on 154 two-axis solar trackers with 36 modules each. With the intention of increased energy production, one or two mirrors are mounted beside each module. The modules in the first subsystem are connected in two parallel strings of 18 modules, whereas all 36 modules in the second and third subsystems are connected in series. Monthly yield is analysed and also presented in the paper.

- **NEGRÃO-MACÊDO, Wilson, Gilberto Figueiredo PINTO FILHO, Marcos André BARROS GALHARDO, João TAVARES PINHO and Roberto ZILLES.** 2008. The First Grid-Connected PV Application in the Amazon Region. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3468–3471.

  DOI: 10.4229/23rdEUPVSEC2008-5BV.2.37

  Keywords: project description

  Project: Belém, Pará, Brazil

  Abstract: The first grid-connected photovoltaic system installed in the Brazilian Amazon Region is described. The system consists of a 2.5 kW inverter and a 1,575 kWp photovoltaic array. The paper presents the results of system monitoring and a yield evaluation is also given.

- **NELSON, Grant and Andrew ROSENTHAL.** 2005. One Megawatt Photovoltaic Plant Completes Twenty One Years of Successful Operation. In: Proceedings of the 2005 Solar World Congress, 34th ASES Annual Conference, 30th National Passive Solar Conference, Orlando, FL, 6–12 August 2005, 1285–1288.

  Keywords: project evaluation

  Project: SMUDPV1, Rancho Seco 1, Rancho Seco, California, USA

2005 – 2009

Abstract: The operating experiences and history of the Rancho Seco 1 photovoltaic power plant after 21 years of operation are discussed and presented in this paper. The power plant covers an area of 4.05 hectares and is divided into four subunits, each including 28 trackers. Each tracker consists of 8 panels of 32 modules. The subarray produces a nominal voltage of ±300 V DC and 492 A per subfield. The original investment cost was USD 12.14 million or USD 12.1/Wp. Over time, a 1% performance degradation annually was observed. The long-term effects of soiling, maintenance efforts and emissions reduction are also discussed in this paper. In 21 years, the power plant has generated about 31.3 GWh of electrical energy and has saved emissions of approximately 720,000 tonnes of CO_2, 2.3 tonnes of SO_x, and 6.3 tonnes of NO_x.

- **NISHIKAWA, Warren.** 2008. Energy Production of CPV Power Plants: 0.5 MW Demonstration in Central Spain. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3240–3244.

DOI: 10.4229/23rdEUPVSEC2008-5AO.7.3

Keywords: project description, project evaluation, concentrator

Projects: Puertollano, Almoguera, Spain

Abstract: Two demonstration photovoltaic concentrator power plants located in Almoguera and Puertollano are presented in this paper. Technical details of the concentrator systems, yield evaluation and cost calculation are presented and discussed.

- **NOIROT, Stéphane, Roel DE CONINCK, Werner COPPYE and Kristof VAN RATTINGE.** 2007. The Belgian Antarctic Station with Hybrid System: The Coolest BIPV Project So Far. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3434–3439.

Keywords: project description

Project: Research base, Antarctica

Abstract: The concept of a new Belgian research base located in Antarctica is presented in this paper. The building will accommodate up to 20 people in the summer and will operate as an unmanned scientific research data acquisition station during the winter months. The system also includes a 49 kW photovoltaic system. Other energy sources in hybrid systems are wind generators and diesel generators for backup power. The system also includes battery storage. A simulation of the proposed system is also presented in the paper.

- **ODAGAKI, K.** 2007. Practical Study on 5.2 MW PV System in Sharp's Kameyama Plant. In: Power Conversion Conference, PCC, Nagoya 2007 Conference Proceedings, Nagoya, Japan, 2–5 April 2007, 2012–2016.

DOI: 10.1109/PCCON.2007.373120

Keywords: project description

Project: Sharp, Kameyama, Japan

Abstract: The paper describes building an integrated photovoltaic system on the site of Sharp's LCD TV production facility. The building-integrated photovoltaic system is mounted on the roof of the facility and also as a curtain wall. Total power capacity of the arrays is 5.21 MW, enough to supply 1300 households. Transparent solar cells and the MPP algorithm of the system are described in more detail. The system schematics are also shown and discussed.

- **OKTIK, Sener, Rustu EKE and Cemil SUDA.** 2007. The Three Years Performance Analysis of Building Integrated PV System at Muğla University Campus in Turkey. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3167–3169.

Keywords: project evaluation

Project: Muğla University Campus, Muğla, Turkey

Abstract: The first BIPV 25.6 kWp photovoltaic system in Turkey was connected to the grid in May 2003. It is located on the roof of the student cafeteria on Muğla University Campus, Muğla, Turkey. System performance and detailed operating data are presented in the paper.

- **OKTIK, Sener and C. TOZLU.** 2005. The First Building-Integrated Photovoltaic System (BIPV) in Turkey at Muğla University Campus. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2702–2704.

Keywords: project evaluation

Project: Muğla University Campus, Muğla, Turkey

Abstract: The Photovoltaic System located on the cafeteria of Muğla University Campus in Muğla, Turkey, was commissioned in May 2003. In the paper, a system description and operating performance in the first year of operation are given. The 25.6 kWp array consists of 120 PV modules and is connected to the grid by inverters operating in master-slave mode. There are eleven subarrays consisting of 14 modules and four subarrays consisting of 15 modules. Electrical and environmental data are monitored and collected by a data acquisition system. During the first year of operation, the system fed 37 MWh of energy into the grid. The monthly final yield and performance ratio for the first year of operation, from May 2003 to April 2004, are presented and discussed.

- **OTANI, Kenji, Takumi TAKASHIMA and Kosuke KUROKAWA.** 2006. Performance and Reliability of 1 MW Photovoltaic Power Facilities in AIST. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 4, 2046–2049.

DOI: 10.1109/WCPEC.2006.279904

Keywords: project evaluation

Project: AIST Tsukuba, Japan

Abstract: The AIST photovoltaic test facility in Tsukuba consists of 211 4 kW inverters designed for residential use and 14 10 kW inverters designed for industrial use. The inverters are connected to a 200 V low-voltage grid. Different module technologies, in total 5,600 modules, are used. In the paper, a detailed map with array locations and corresponding module technologies is presented. Operational performance for the time period from April 2004 to April 2006 is discussed in this paper. Monthly energy yield is given in plot form. The system, in operation since April 2004, produces 1,000 MWh of electricity and saves 300 tonnes of CO_2 annually. The total investment cost was JPY 800 million (in the year 2003). Reliability parameters like MTBF and MTTR are also given in the paper.

- **PANOSYAN, Zhozef, Artak HAMBARYAN, Kenell TOURYAN, Armen TUMANYAN, Yeremia YENGIBARYAN, Mikael PIRADYAN, Arsen DARBASYAN and Wilhelm AKUNYAN.** 2006. Design, Construction and Monitoring of a Solar Photovoltaic Station of AUA. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2285–2288.

Keywords: project description

Project: American University of Armenia, Yerevan, Armenia

Abstract: The photovoltaic system constructed at the location of the American University of Armenia (AUA) is briefly described in this paper. It was performed by the Engineering Research Center of AUA with the purpose of powering the air conditioning of the American University of Armenia. Based on power consumption and economic evaluation, 5 kWp was found as the optimal power capacity.

- **PERPIÑÁN, O., R. EYRAS, M. A. CASTRO and E. LORENZO.** 2005. Analysis and Comparison of Performance of Large Plants: Photocampa and Forum. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2470–2473.

Keywords: project description

Projects: Photocampa, Car Port, Tarragona; Forum Barcelona, Catalonia, Spain

Abstract: The Photocampa, Car Port, photovoltaic system in Tarragona consists of 3,000 modules resulting in 318 kWp array power capacity. The array consists of three subarrays with 27 strings. The system is connected to the grid by three 100 kVA inverters. The Forum of Barcelona is designed as a monument based on four legs with a maximal height of 54 meters. Its array has an area of 3,410 m^2, power capacity of 443.2 kWp and it consists of 2,686 modules and is connected to the grid by three 125 kVA inverters. The numerical model for DC energy yield estimation is given in the paper and theoretical calculations in comparison to the measurement results for both systems are also presented and discussed.

- **PORTER, Douglas B. and Otto VAN GEET.** 2008. Renewable Energy Standards and the Story behind the Project Delivery and Performance of a One Megawatt PV Array at the Denver Federal Center. In: Proceedings of the Solar 2008 Conference, Proceedings of the 37th ASES Annual Conference, 33rd National Passive Solar Conference, 3rd Renewable Energy Policy and Marketing Conference, San Diego, CA, 3–8 May 2008, 1, 556–562.

Keywords: project description

Project: Denver Federal Center, Denver, Colorado, USA

Abstract: The Denver Federal Center photovoltaic system was constructed in the period from October 2007 to January 2008. The photovoltaic array is comprised of two parts of about 1176 kWp in total. Each part is connected to the grid by its own 500 kW inverter. Investment cost was USD 6,899,992. Photos of the photovoltaic system under construction and after completion are also part of the paper. Inverter efficiency, electricity production and weather impact (snow) for the month of January are also presented and discussed.

- **PREISER, Klaus.** 2005. Regiosonne- 1MW Photovoltaik auf Dächern des Sportclub Freiburg und der badenova. In: 20. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 9–11 March 2005, 144–149.

Keywords: project description

Project: Sportclub Freiburg, Germany

Abstract: A brief description of the photovoltaic system located on "Badenova-Stadium" in Freiburg, Germany is given in this paper. Some background information about financing and investment is given and the operating results for November 2004 are also presented.

- **PROTOGEROPOULOS, C., N. STASINOPOULOS, M. GROTTKE and D. SCHMITT.** 2005. Initial Results and Experiences Encountered from the Operation of Total 40 kWp Grid-Connected PV Systems at Cres. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2678–2681.

Keywords: project evaluation

Project: Center for Renewable Energy Sources (CRES), Pikermi, Athens, Greece

Abstract: The photovoltaic systems at CRES were constructed between August and October 2003 and connected to the grid by November in the same year. The six subsystems include the main entrance PV system, parking area PV system, PV pergola at the main building, rooftop system, solar curtain façade and PV system mounted on a metal structure. A schematic view of the data acquisition system, including a detailed overview of the sensors/converters used is presented in the paper. The electrical yield and performance ratio for the period from April 2004 to March 2005 for each of the six subsystems are given and discussed as well.

- **REDI, P. and M. CORSI.** 2006. 1 MWp PV Power Station in Calabria, Italy, on an Artificial Bank. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2750–2752.

Keywords: project description

Project: 1 MW project Calabria, Italy

Abstract: The photovoltaic power plant under construction in the Calabria region to be commissioned in 2007, located on a waste, cinders landfill of a biomass power station, is

described in this paper. The power plant should consist of 5,888 modules with a fixed tilt and central inverter. The total area available for the power plant is 8,000 m2. Expected energy production is 1,310 MWh per year and GHG savings are estimated at 695 tonnes CO_2 annually.

- **REDI, P. and G. PAOLI.** 2007. 400 kWp Power Station in Sicily, Italy; Design, Installation and Related Problems. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 2936–2939.

  Keywords: project description

  Project: Belpasso, Catania, Sicily, Italy

  Abstract: The photovoltaic system in Belpasso, Sicily consists of 2,346 modules with 102 strings with 23 modules in each string. The system is connected to the medium-voltage grid by two 250 kW inverters and it should produce about 680 MWh of electricity annually. Commissioning of the system was scheduled for spring 2007. Some aspects of legislation relating to the photovoltaic power plants are also discussed in the paper.

- **REIJENGA, Tjerk.** 2005. 282 kWp BIPV, Bioclimatic Sports Centre, Wageningen (NL). In: The 2005 World Sustainable Building Conference (SB05Tokyo), Tokyo, Japan, 27–29 September 2005, 170–177.

  Keywords: project description, case study

  Project: Bioclimatic Sport Centre, Wageningen, the Netherlands

  Abstract: The Bioclimatic Sports Centre in Wageningen, the Netherlands, with a building-integrated photovoltaic system, is presented and analysed from an architectural point of view. The sports centre consists of two sports halls, an office tower, a canteen and an indoor climbing wall, situated around a Plaza as a central area. The transparent modules are integrated into the roof of the plaza and solar chimney, and two additional solar arrays are located on the flat roofs of both sports halls. Many images and BIPV architectural details are presented. The complex also includes several other innovative and sustainable solutions such as a conservatory concept, natural ventilation as a hybrid system, high-efficiency heat recovery, high insulation value, indirect daylight, thermal solar collectors, a heat pump, water-saving toilets, taps and showerheads, etc.

- **REHM, Wolfgang, Gerd BECKER, Bodo GIESLER, Peter KREMER and Gerald KUMERLE.** 2007. Kostenoptimales Retrofitting der 1 MW PV-Anlage NEUE MESSE MÜNCHEN RIEM I. Poster. In: 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007, 304–306.

  Keywords: project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: The electronic parts of the 1 MW Munich Trade Fair photovoltaic power plant have exceeded their lifetime after more than nine years of operation, so for cost reasons, partial repowering of the power plant was suggested. At the time before repowering, solar yield was about 950 kWh/kWp. In July 2006, 12 array switches were exchanged. Communication equipment repowering followed after that. To improve the efficiency of the inverters, the bipolar power switches on the inverters were exchanged for IGBT modules.

- **RINDELHARDT, Udo, Andreas SCHRÖDER and Walter LANZKE.** 2006. Betriebserfahrungen mit der ersten sächsischen Megawattanlage in Meerane. Poster. In: 21. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2006, 275–280.

  Keywords: project description, project evaluation

  Project: Solarpark Meerane, Saxony, Germany

  Abstract: Solarpark Meerane was the first MW-ranged photovoltaic power plant in Saxony, commissioned in April 2004. The operating results and experiences in the period from April 2004 to December 2005 are presented in this paper. The power plant is located behind a noise barrier alongside the A4 motorway. It occupies 2.5 hectares of land and consists of 406 mounting structures for frameless laminates with a tilt angle of 30°. Array power under STC conditions is 1066.85 kWp. For grid connection, three master-slave inverters are used. Total investment cost was EUR 4.6 million or about EUR 4,300/kW. Since August 2004, the operating results have been measured every 15 minutes. The performance ratio of the power plant in the initial period was 76%, with a yield up to 950 kWh/kW.

- **RINDELHARDT, Udo and Mirko BODACH.** 2007. Operational Experiences With Megawatt PV Plants in Central Germany. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 2952–2955.

  Keywords: project description, project evaluation

  Projects: Solarpark Nentzelsrode, Solarpark Geiseltalsee, Solarpark Leipziger Land, Solarpark Borna, Solarpark Meerane I, Solaranlage Wilkau-Haßlau, Solarpark Chemnitz, Germany

  Abstract: The paper describes the design and operating results of seven MW-ranged photovoltaic power plants, commissioned in the federal German states of Saxony and Thuringia in 2004 and 2005. Six power plants have fixed arrays and one has two-axis trackers. One power plant is roof-mounted, while the others are ground-mounted. Different inverter concepts are used - some power plants have string inverters and some have central inverters. A detailed yield analysis is given for all discussed power plants. Losses are also analysed and root causes for yield losses are identified.

- **RINDELHARDT, Udo, Andreas DIETRICH, Karen KEDZIORA and Andreas HAHN.** 2008. Megawatt PV Plants in Germany: A South-North Performance Comparison. In: Twenty-third European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 1–5 September 2008, 3236–3239.

  DOI: 10.4229/23rdEUPVSEC2008-5AO.7.2

  Keywords: project description, project evaluation

  Projects: Solarpark Lubmin, Solarpark Nentzelsrode, Solarpark Rote Jahne, Solarpark Leipziger Land, Solarpark Borna, Solarpark Meerane I, Solarpark Kappel-Grafenhausen, Solarpark Waltenhofen II, Solarpark Bad Grönenbach, Germany

  Abstract: In the paper, the description and operating results in 2007 for nine MW-ranged photovoltaic power plants in Germany are presented. The power plants are located between the Baltic Sea and the Alps. One power plant has two-axis trackers and others have fixed mounted arrays. Different module technologies are used - one power plant is comprised of CdTe modules. Different inverter concepts, including central and string inverters, are used as well. The yield estimation and measurement results are also presented in the paper. As one of the most important topics, the correct measurement of the module in-plane irradiation was exposed.

- **RINDELHARDT, Udo, Andreas DIETRICH and Christian RÖSNER.** 2009. Tracked Megawatt PV Plants: Operation Results 2008 in Germany and Spain. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 3910–3913.

  DOI: 10.4229/24thEUPVSEC2009-5AO.8.5

  Keywords: project evaluation, trackers

  Projects: Solarpark Borna, Solarpark Penig, Germany; Huerta Solar Alqueria, Huerta Solar Ventanas, Huerta Solar Guadix, Spain

  Abstract: The paper presents the operation results of 5 two-axis tracking MW-ranged photovoltaic power plants located in Germany and Spain for the year 2008. Different tracking principles are implemented, like following the astronomical sun path for systems in Spain and an algorithm for finding the maximum irradiance also in cloudy conditions. A detailed yield and performance ratio evaluation is given. A brief description of the systems, including the land area occupied and module area, is also presented in the paper. The final yields of the Spanish PV power plants exceed those of the German plants by nearly 78% which is in agreement with the higher solar irradiance and other environmental conditions, such as temperature.

- **RUBIO, F., M. MARTINEZ, R. CORONADO, J. L. PACHÓN and P. BANDA.** 2008. Deploying CPV power plants - ISFOC experiences. In: Conference Record of the Thirty Third IEEE Photovoltaic Specialists Conference, San Diego, CA, USA, 11–16 May 2008, 3, 1548–1558.

  DOI: 10.1109/PVSC.2008.4922733

  Keywords: project evaluation, concentrator

  Project: Puertollano, Spain

  Abstract: The paper describes experiences with photovoltaic concentrator testing and characterisation. Basic mathematical expressions are also given. A photovoltaic power plant with concentrators in Puertollano, Spain, currently being installed, is also briefly described. Puertollano photovoltaic concentrator power plant with 800 kW should be commissioned in June 2008.

- **RÜTHER, Ricardo, M. DACOREGIO, I. SALAMONI, P. J. KNOB and U. BUSSEMAS.** 2006. Performance of the First Grid-Connected, BIPV Installation in Brazil over Eight Years of Continuous Operation. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2761–2764.

  Keywords: project evaluation

  Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

  Abstract: The operating experiences of the system located on the buildings of Universidade Federal de Santa Catarina, Florianopolis, Brazil, are described in this paper. The photovoltaic system was commissioned in 1997 and operating data until September 2005 is presented and discussed. The DC and AC performance ratios after eight years of operation are 86.3% and 81.6%.

- **SCHMITT, Sebastian and Peter KREMER.** 2007. Power Quality der netzgekoppelten Wechselrichter SINVERT solar – Betriebsergebnisse 2005 des 5 MWp PV-Kraftwerkes Espenhain-Leipzig. Poster. In: 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007, 237–239.

  Keywords: project evaluation

  Projects: Solarpark Leipziger Land, Leipzig, Germany

  Abstract: Solarpark Leipziger Land is connected to a 20 kW medium-voltage grid by 12 master-slave inverters and two 2 MVA transformers. The paper describes the reduction of THD during operation of the power plant.

- **SCHROCK, Clifford B. and Kris J. NELSON.** 2007. A Plan to Develop a Megawatt Solar Farm and Co-located Solar Manufacturing Facility for Oregon. In: Proceedings of the Solar 2007 Conference, Proceedings of the 36th ASES Annual Conference, 32nd National Passive Solar Conference, 2nd Renewable Energy Policy and Marketing Conference, Cleveland, OH, 8–12 July 2007, 2, 877–883.

  Keywords: project proposal

  Project: Bed Redmond, Oregon, USA

  Abstract: A co-located thin-film manufacturing facility and photovoltaic power plant are proposed in this paper. Land-related aspects of the environmental evaluation and a detailed budget plan are presented and discussed in this proposal. The investment cost for the thin-film manufacturing facility and 1 MW photovoltaic power plant is estimated to be USD 20,993,750.

- **SCHULZ, Carsten and Jan-Hindrik SENS.** 2007. Solarpark Mering: Planung und Bau eines der weltweit größten Dünnschichtprojekte mit 1,7 MWp Gesamtleistung. Poster. In: 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007, 234–236.

  Keywords: project description

  Projects: Solarpark Mering, Germany

  Abstract: After three months of construction, Solarpark Mering, with 1781.25 kWp, was commissioned in July 2006. It is located on a 5.6 hectare area and it is assumed that it will

save 29,000 tons of CO2 in 20 years of operation. The solar array consists of 62,000 modules with a 25° tilt angle. Six 250 kW inverters and a central transformer station are used for connection to a 20 kV grid. The operating results for the three months from September 2006 to November 2006 are presented. The operating results have exceeded the expected values, and the solar yield was higher than expected by about 13% in September, 27% in October and 15% in November.

- **SMELTINK, John F. H., Andrew BLAKERS and Joe COVENTRY.** 2005. A 40kW roof-mounted PV thermal concentrator system. In: Twentieth European Photovoltaic Solar Energy Conference Proceedings, Barcelona, Spain, 6–10 June 2005, 2015–2018.

Keywords: project description, concentrator

Project: ANU 40 kW PV/Trough Concentrator, Bruce Hall Packard Wing, Canberra, Australia

Abstract: In the paper, a detailed technical description of an ANU roof-mounted 40 kW concentrator system, including a description of mirrors, collectors, collector structures and a system for hot water production is given. The system is located on top of Bruce Hall Packard Wing building for accommodation of 90 students, constructed in the years 2003/04. Waste heat from the photovoltaic concentrator is used for hot water production. The control system is also described in detail. The system is connected to the grid through a 40 kW inverter with a 525 V nominal input voltage of 76 A. The actuator motors and tracking control are powered by a 24 V battery pack. The system provides energy for hot water and 25% of the energy for space heating of the building. The paper also includes images of different parts of the system.

- **SMELTINK, John F. H. and Andrew W. BLAKERS.** 2006. 40 kW PV Thermal Roof Mounted Concentrator System. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 2, 636–639.

DOI: 10.1109/WCPEC.2006.279535

Keywords: project description, concentrator

Project: ANU 40 kW PV/Trough Concentrator, Bruce Hall Packard Wing, Canberra, Australia

Abstract: A photovoltaic thermal (PV-T) concentrator system was installed in 2003/2004 on Bruce Hall Packard Wing building. The system comprises eight 24 m-long one-axis tracking PV concentrators. The concentrators are liquid-cooled and cooling fluid passes a heat exchanger to provide heat to the circuit. The system includes 6000-litre hot water storage. Each collector incorporates 17 mirror panels. Some electrical and thermal performance-related data is given in the paper.

- **SMELTINK, John and Andrew BLAKERS.** 2006. The ANU Roof Mounted PV-Thermal Concentrator System. In: Clean Energy? - Can Do: Proceedings of the 44th Annual ANZSES Conference 2006, Canberra, Australia, 13–15 September 2006, 1–6.

Keywords: project description, concentrator

Project: ANU 40 kW PV/Trough Concentrator, Bruce Hall Packard Wing, Canberra, Australia

Abstract: Bruce Hall, Packard Wing's photovoltaic/thermal concentrator system is described in this paper. A technical description of the system, including operating performance, is given. Some faults rectified during commissioning include pivot-mount interference, cable durability, guide sheave seizure, refit temperature sensors, sundry leaks, actuator noise and building management system calibration.

- **SO, Jung Hun, Young Seok JUNG, Byung Gyu YU, Hye Mi HWANG, Gwon Jong YU and Ju Yeop CHOI.** 2006. Performance Results and Analysis of Large Scale PV System. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2375–2378.

DOI: 10.1109/WCPEC.2006.279669

Keywords: project evaluation

Project: Sincheon Sewage Disposal Plant (SSDP), Daegu City, Korea

Abstract: This paper presents the performance results of the photovoltaic system installed at Sincheon sewage disposal plant (SSDP) in Daegu City, Korea. The power capacity of the system is 479 kW. For analysis, the results of one 80 kW subsystem were used. PV array performance and PCU performance are presented and discussed. Array conversion efficiency, PCU efficiency, PCU power factor and whole system efficiency are presented and evaluated for a six-month period - from September 2005 to March 2006.

- **SO, Jung Hun, Young Seok JUNG, Byung Gyu YU, Hye Mi HWANG, Gi Hwan KANG, Gwon Jong YU and Ju Yeop CHOI.** 2006. Performance Monitoring Results of 50 kW Grid Connected PV System. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2746–2749.

Keywords: project description, project evaluation

Project: Daegu City, Korea

Abstract: The photovoltaic system in Daegu City, Korea, was commissioned in August 2005. Since then, the commissioning system has been monitored and the operating results and experiences are presented in this paper. The modules in the array are mounted with a fixed 18° tilt angle, with –5° azimuth. Annual energy gain is 52.9 MWh. The design predicted performance ratio is 76%, but the performance ratio measured was 72%. Array and PCU performance are also presented in graphical form, as plots.

- **SO, Jung Hun, Byung Gyu YU, Gi Hwan KANG, Hye Mi HWANG, Gwon Jong YU and Ju Yeop CHOI.** 2007. Performance Evaluation and Analysis of 80 kW Grid-Connected PV System. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3008–3010.

Keywords: project evaluation

2005 – 2009

Project: Sincheon Sewage Disposal Plant (SSDP), Daegu City, Korea

Abstract: A ground mounted 80 kW photovoltaic system was monitored in the time period from September 2005 to August 2006. The results, that include a performance analysis, the performance ratio of the power plants and an analysis, are analysed and presented.

- **STAHF, Dirk.** 2007. 8,4 MW installierte Kraftwerksleistung mit über 1000 kWh/kWp Jahresertrag am Standort Leipzig. Poster. In: 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007, 259–261.

Keywords: project description

Projects: Solarpark Leipziger Land, Solarpark Borna, Saxony, Germany

Abstract: Solarpark Leipziger Land was commissioned in September 2004. It is located on 22 hectares of an abandoned coal dust waste facility. The mounting structure, with 33,000 modules, consists of wood. The power plant is connected to the grid by 12 master-slave inverters. The solar yield of the Leipziger Land facility, as measured in 2006, was 1,058 kWh/kWp and it was 12% higher than the average expected values given in the planning documentation. Solarpark Borna, located close to Leipziger Land, consists of 438 tracking systems, each with 7.85 kW with its own inverter. Solarpark Borna occupies 21 hectares of land and its total power capacity is 3.44 MWp. Solar yield, as measured in the period from the 2nd to the 4th quarter of 2006, was 1260 kWh/kWp and has exceeded the planned values by about 2%.

- **STONE, Keneth W., Vahan GARBOUSHIAN, Kevork MARKARIAN, Robert BOEHM, Rick HURT, Allison GRAY, Gary WOOD, Herb HAYDEN and Thomas FLETCHER.** 2006. Installation and Operation of the Amonix High Concentration PV System At Nevada Power Company in Las Vegas, Nevada. In: the 4th World Conference on Photovoltaic Energy Conversion, Joint Conference of the 16th International PV Science & Engineering Conference, the 32nd IEEE PV Specialists Conference and the 21st European PV Solar Energy Conference Proceedings, Waikoloa, HI, USA, 7–12 May 2006, 5, 2446–2449.

DOI: 10.1109/WCPEC.2006.279704

Keywords: project description, concentrator

Project: Clark Generation Station, Las Vegas, Nevada, USA

Abstract: The installation experiences of a high-concentration photovoltaic system, installed on the site of the Clark Generating Station in Las Vegas, are presented. The 75 kW system consists of three 25 kW units, each comprising five modules. Several images with production and construction details are included in the paper. Installation of the system is described in more detail and a plot with generated electricity for March/April 2006 is given. System lifetime is estimated at 20 years.

- **TECHASIRIWAN, Riangsorn and Thawatchai PHAEFUEN.** 2009. Thailand's First BIPV System for 20-Story Office Building. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4265–4267.

DOI: 10.4229/24thEUPVSEC2009-5BV.2.76

Keywords: project description, BIPV, façade

Project: EGAT's headquarters, Nonthaburi province, Thailand

Abstract: This paper presents the design, installation and operating experiences of a 27 kWp BIPV system, commissioned in December 2007 and located on the east-facing façade of the 20-story EGAT's headquarters office building in Thailand. BIPV thin-film a-Si modules, embedded within the structural glazing comprise the first BIPV façade in Thailand. The solar array consists of 428 modules, divided into nine parallel subarrays connected to eight inverters. The system is connected to the public grid. Construction and testing experiences and issues are presented in this paper. This paper also presents the experiences which can be used, as a guideline, for the similar new commercial buildings in Thailand.

- **TYUTYUNDZIEV, N., P. VITANOV, R. RADKOV and M. GROTTKE.** 2006. First kW-Range Grid-Connected PV Demonstration System in Bulgaria. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 2753–2755.

Keywords: project description

Project: acadPV, Sofia, Bulgaria

Abstract: A photovoltaic system acadPV, located in front of the CL SENES building in Sofia, Bulgaria, built as a carport shading structure, was the first grid-connected PV power plant in Bulgaria. The array is oriented south with a 30° fixed-tilt angle. The system was put into service in May 2005 and has been monitored since commissioning. Software simulation results and experiences for the first months of operation are presented in the paper.

- **UEDA, Yuzuru, Mitsuru KUDOU, Hiroo KONISHI and Kosuke KUROKAWA.** 2009. Evaluation of Various PV Technologies in HOKUTO Mega-Solar Project. In: Twenty-fourth European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 21–25 September 2009, 4119–4122.

DOI: 10.4229/24thEUPVSEC2009-5BV.2.29

Keywords: project evaluation

Project: Hokuto Mega-Solar Project, Yamanashi Prefecture, Japan

Abstract: In the paper, an evaluation of various photovoltaic technologies in HOKUTO Mega-Solar Project is discussed. Modules from more than 20 different producers and different technologies were used in this system. Typical array power capacity is 10 kWp. Modules are mounted with a tilt angle of 30° for some arrays, and tilt angles between 15° and 40° were also used. A mathematical analysis of the performance ratio and losses and their detailed analysis are also given.

- **VAN SARK, Wilfried G.J.H.M., E. H. LYSEN, D. COCARD, P. BEUTIN, G. F. MERLO, B. MOHANTY, J. VAN DEN AKKER, A. RAZZAK IDRIS, A. FIRAG, A. WAHEED, A. SHAHEED, M. LATHEEF and A. WAJEEH.** 2006. The First PV-Diesel Hybrid System in the Maldives Installed at Mandhoo Island. In: Twenty-first European Photovoltaic Solar Energy Conference Proceedings, Dresden, Germany, 4–8 September 2006, 3039–3043.

URL: https://www.researchgate.net/publication/46691530_The_First_PV-Diesel_Hybrid_System_in_the_Maldives_Installed_at_Mandhoo_Island (22 October 2016)

Keywords: project description, hybrid

Project: Mandhoo Island, Maldives

Abstract: The first grid-connected 12 kWp photovoltaic hybrid system on the Maldives is described in this paper. The system is located on Mandhoo Island, which is inhabited by 40 families, all connected to the local grid. The system also includes a 108 kWh battery backup - 50 batteries 360 Ah, 6 V and 12 kW converter. Experiences during the evaluation period in 2005 are also described and discussed.

- **VANICEK, Phillip.** 2007. Eignung und Einsatz von Nachführsystemen in Photovoltaik-Großanlagen in Spanien. In: 22. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 8–10 March 2007, 72–74.

Keywords: project overview

Project: Solarpark Granada, Spain

Abstract: A brief overview of different trackers with particular attention given to applications in Spain is given. A photo of Solarpark Granada under construction is presented.

- **VERLINDEN, P. J., A. LEWANDOWSKI, H. KENDALL, S. CARTER, S. CHEAH, I. VARFOLOMEEV, D. WATTS, M. VOLK, I. THOMAS, P. WAKEMAN, A. NEUMANN, P. GIZINSKI, D. MODRA, D. TURNER and J. B. LASICH.** 2008. Update on two-year performance of 120 kWp concentrator PV systems using multi-junction III–V solar cells and parabolic dish reflective optics. In: Conference Record of the Thirty Third IEEE Photovoltaic Specialists Conference, San Diego, CA, USA, 11–16 May 2008, 3, 1552–1557.

DOI: 10.1109/PVSC.2008.4922734

Keywords: project evaluation, concentrator

Project: Hermannsburg, Australia

Abstract: The Hermannsburg power station photovoltaic concentrator system was constructed in the period 2006 to 2007. It consists of four dish receivers with multi-junction solar cells with a 120 kWp total power capacity. The first dish receiver was installed in March 2006, followed by the other three, with the last installed in 2007. In April 2008, one of the dishes was upgraded with new optics, as the benefits of upgrading were clearly recognized. Operating performance, system efficiency, performance and reliability are also presented and discussed in the paper.

- **VISA, I., A. DUTA, R. VELICU, D. TEODOREANU and I. BADARAU.** 2007. A 10 kWp PV Array in the Transylvania University of Brasov, Romania. In: Twenty-second European Photovoltaic Solar Energy Conference Proceedings, Milan, Italy, 3–7 September 2007, 3534–3537.

Keywords: project description

Project: Transylvania University, Brasov, Romania

Abstract: A proposal for a 10 kWp photovoltaic roof-mounted system on the site of the Transylvania University of Brasov, Romania, is given in this paper.

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- **SIEMER, Jochen.** 2005. Wachstum in Zehnerpotenzen, die größten Solaranlagen der Welt. Photon, 6, 114–129.
- **REFOCUS.** 2005. Multi-megawatt solar power plants commissioned. Refocus, 6, 4, July–August 2005, 7.

DOI: 10.1016/S1471-0846(05)70416-9

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- **OSSENBRINK, Heinz, Arnulf JÄGER-WALDAU and Peter HELM. Eds.** 2011. 26th European Photovoltaic Solar Energy Conference. Proceedings of the International Conference, Hamburg, Germany. 5–9 September 2011. München: WIP Renewable-Energies. ISBN 3-936338-27-2.
- **NOWAK, Stefan, Arnulf JÄGER-WALDAU and Peter HELM. Eds.** 2012. 27th European Photovoltaic Solar Energy Conference and Exhibition. Proceedings of the International Conference, Frankfurt, Germany, 24–28 September 2012. München: WIP Renewable Energies. ISBN 3-936338-28-0.
- **MINE, Arnaud, Arnulf JÄGER-WALDAU and Peter HELM. Eds.** 2013. 28th European Photovoltaic Solar Energy Conference and Exhibition. Proceedings of the International Conference, Paris, France, 30 September–4 October 2013. Paris: WIP. ISBN 3-936338-33-7.
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DOI: 10.1109/PVSC.2013.6744079

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DOI: 10.1109/PVSC.2014.6925694

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- **ISES.** 2010. EuroSun 2010, International Conference on Solar Heating, Cooling and Buildings Proceedings, Graz, Austria, 28 September–1 October 2010. Freiburg: ISES Europe.
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- **EBERT, Günther Ed.** 2014. 29. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 12–14 March 2014. Regensburg: Ostbayerisches Technologie-Transfer-Institut e.V. (OTTI). ISBN 978-3-943891-09-6.
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- **LE JANNIC, N. and A. GUILLIER.** 2012. L'Atlas des Grandes Centrales Photovoltaïques. Le Journal du Photovoltaïque, Novembre 2012, 44–83. Maps with locations of large scale PV power plants in French regions in 2012.
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- **La Tene Maps.** 2015. Ireland – Solar PV, Installations and Resource – 1st PDF Edition, October 2015.

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- **ALONSO-ABELLA, M., F. CHENLO, A. ALONSO and D. GONZÁLEZ.** 2014. Toledo PV Plant 1 MWp – 20 Years of Operation. In: 29th European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, the Netherlands, 22–26 September 2014, 2728–2733.

  DOI: 10.4229/EUPVSEC20142014-5BV.1.44

  Keywords: project evaluation

  Project: La Puebla de Montalbán, Toledo, Spain

  Abstract: The paper presents the performance data for 20 years of operation of the 1 MWp Toledo photovoltaic power plant. The power plant is located close to the village of La Puebla de Montalbán in the province of Toledo, Spain. It was inaugurated in July 1994 and has operated satisfactorily for 20 years. The electrical yield for all three subfields of the power plant is given for each year for the period from 1994 to 2004. The performance ratio for each subunit is also calculated. Some operating and maintenance events and issues are also presented.
- **BECKER, Gerd, Georg SCHIEßL and Helmut BAUER.** 2015. 20 Jahre erfolgreicher Betrieb der Photovoltaikanlage "Bürger für Solarstrom". Poster. In: 30. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 4–6 March 2015, 132–133.

  Keywords: project evaluation

  Project: Bürger für Solarstrom, Unterföhring, Munich

  Abstract: The Bürger für Solarstrom photovoltaic power plant, located in Unterföhring, Munich, was commissioned on 14th September 1994. It was built on behalf of 114 owners, who were local residents. The power plant comprises frameless modules with a south orientation and a fixed 35° tilt angle. Operating experiences after 20 years of operation are presented in this paper. Failures include problems with DC switches,

cables, inverters, module edge protection problems, module theft and a dead mouse found in an inverter. No module or cell failures were found by thermographic analysis. Three randomly selected modules were sent for analysis where an average power loss of about 0.5% annually was detected. The centralised inverter was replaced with string inverters in 2007.

- **BELMONT, J., K. OLAKUNU, J. KUITCHE and G. TAMIZHMANI.** 2014. Degradation rate evaluation of 26-year-old 200 kW power plant in a hot-dry desert climate. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 5, 3162–3166.

  DOI: 10.1109/PVSC.2014.6925606

  Keywords: project evaluation

  Project: Solar One, Phoenix, Arizona, USA

  Abstract: The Solar One photovoltaic power plant was designed by solar pioneer John F. Long and commissioned in 1985. Its purpose was to supply 20 houses in the neighbourhood. The Solar One facility consists of two arrays and both consist of 4000 50 W Arco modules. The operational performance of the power plant was investigated after 26 years of operation. Based on historical values, the I-V curves from 1985 were compared with the curves measured in 2011. The power degradation is between 1.6% and 2.3% per year. After 26 years of operation, the system was producing 40% of the rated power. The main failure modes are encapsulant browning, which results in an short-circuit current decrease and thermal fatigue of cell-interconnects, which results in an increase of series resistance.

- **CANCRO, C., S. FERLITO, G. GRADITI, R. NUÑEZ, I. ANTÓN, G. SALA, M. CASTRO and K. ARAKI.** 2014. Energetic Performances of the 50kW CPV Plant Realized within the NGCPV Project. In: 6th World Conference on Photovoltaic Energy Conversion, Proceedings of the International Conference, Kyoto, Japan, 23–27 November 2014, 783–784.

  URL: http://cordis.europa.eu/result/rcn/165591_en.html (10 June 2016)

  Keywords: project description

  Project: Villa de Don Fadrique, Spain

  Abstract: The concentrator photovoltaic project located in Villa de Don Fadrique, Spain was monitored in the period from October 2012 to April 2014. The operating results were evaluated and are discussed in this paper. The presented results include the monthly daily mean yield, DC efficiency, performance ratio and system losses. The power plant is based on new generation concentrator photovoltaics. Five subarrays, with each a tracker including one subarray, are connected to a 60 kW inverter input. The average value of DC efficiency is 80% and the average performance ratio is 75%.

- **CHANG, Maoyi, C. H. HSUEH, Chienyu CHEN and Haomin CHEN.** 2014. Premium Performance and Reliability of Back Contact Cell PV Module in 10 MW Field. In: 29th European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, the Netherlands, 22–26 September 2014, 2511–2514.

  DOI: 10.4229/EUPVSEC20142014-5DO.12.1

  Keywords: project evaluation

  Project: Optronics (AUO) TFT-LCD clean room factory buildings, Taichung, Taiwan

  Abstract: The whole year performance ratio of the AU Optronics 10 MW roof-mounted photovoltaic power plant is presented and discussed in this paper. The influence of irradiance and module temperature variation on the performance ratio is investigated and analysed.

- **DECKER, Burchard.** 2010. Bauwerksintegrierte Photovoltaik am Weserstadion Bremen - eine wirtschaftliche, eine ästhetische und eine innovative Lösung. In: 25. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 3–5 March 2010, 388–389.

  Keywords: project description, BIPV, roof mounted

  Project: Weserstadion Bremen, Bremen, Germany

  Abstract: Listed in the table of contents, but the paper is not available in printed proceedings.

- **DO NASCIMENTO, Lucas Rafael and Ricardo RÜTHER.** 2014. Fifteen years and counting: The reliable long-term performance of the first grid-connected, building-integrated, thin-film photovoltaic installation in Brazil. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 5, 3372–3377.

  DOI: 10.1109/PVSC.2014.6925657

  Keywords: project evaluation

  Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

  Abstract: The first grid-connected, building-integrated, thin-film solar photovoltaic power plant in Brazil was commissioned in 1997. In this paper, the operating performance for the time period from 1998 to 2012 is presented. The performance ratio, annual energy yield, annual PV system degradation and some operating issues are presented and discussed. The current generator performance ratio is 76%, with an average annual yield of 1160 kWh/kWp. The average annual degradation of the PV modules is 0.55%/year over the 15 year period.

- **FORESI, James, Alaric BABEJ, Rick HAN, Tingdi LIAO, Charlie WANG and David KING.** 2014. Suncore's CPV power plant deployment in western China. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 5, 3282–3286.

  DOI: 10.1109/PVSC.2014.6925636

  Keywords: project description, concentrator

  Project: Golmud, Anhui, China

  Abstract: In October 2013, the 50 MW concentrator photovoltaic power plant located in Golmud, Anhui, China was commissioned. At the time of commissioning it was the largest concentrator photovoltaic (CPV) power plant worldwide. It includes 100 500 kW inverters and double axis tracking concentrator arrays with a total of 128,000 modules resulting in a 58 MWp array power capacity. In the paper, the operating performance in comparison to the predicted value is analysed and discussed.

- **FRITZE, Peter, Fabian FLADE and Gerd BECKER.** 2013. 15 Years of Degradation: Modules of the 1 MW PV-System at Munich Trade Fair Centre under Review. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 3940–3943.

  DOI: 10.4229/28thEUPVSEC2013-5BV.4.30

  Keywords: project evaluation

  Project: Munich Trade Fair, Munich, Germany

  Abstract: In this paper, the module performance after 15 years of operation of the roof-mounted photovoltaic system on the Munich Trade Fair halls is discussed. The results of the degradation investigation and analysis are: the initial degradation of these modules is estimated to be 3.5%; with newer modules, lower values are probable. A decrease in current is the primary result of degradation-current continuing to fall over time, even if the module is kept in the dark after removal from the power plant. Changes to the resistances of the module only occur if the modules are exposed to the weather. The annual linear degradation is estimated to be about 0.2%.

- **FTHENAKIS, Vasilis, Julie BLUNDEN, Tim GREEN, Lisa KRUEGER and Damon TURNEY.** 2011. Large photovoltaic power plants: Wildlife impacts and benefits. In: Conference Record of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, USA, 19–24 June 2011, 3, 2011–2016.

  DOI: 10.1109/PVSC.2011.6186348

  Keywords: preliminary study

  Project: Topaz Solar Farm, California Valley Solar Ranch, California USA

  Abstract: A brief description of some construction details regarding wildlife protection for large photovoltaic solar power plants is given in this paper.

- **GHOSH, Biswait and Swapna ROY.** 2013. Performance of a 10 MWp Grid-Integrated PV System in Salty Warm and Humid Ambience in India. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 3678–3681.

  DOI: 10.4229/28thEUPVSEC2013-5CO.5.5

  Keywords: project evaluation

  Project: Gujarat Solar Park, India

  Abstract: The 10 MWp photovoltaic power plant located around Little Rann of Kutch in Gujarat, western India is presented and discussed in this paper. The power plant was commissioned in 2011 with commercial operation starting at the beginning of 2012. It consists of 43,560 24 V, 230 Wp modules with a variable tilt between 0° and 40°. The power plant is divided into ten subarrays with 1 MWp each. It is connected to the grid by 20 500 kW inverters installed in three control rooms. The monthly yield data for one year of operation is also presented in the paper.

- **GIESLER, Bodo, Moritz CZAKALLA, Mike ZEHNER, Ken MALETZ, Martin BOTHNER, Georg WIRTH, Gerd BECKER, Thomas VOLLWEITER, Thomas BÄUML, Gerald KUMERLE and Jakob GLEICHENSTEIN.** 2011. Analyse der Betriebsgrößen der unterschiedlichen Teilsysteme des 20 MW PV Großkraftwerks Rothenburg. Poster. In: 26. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 2–4 March 2011, 107–112.

  Keywords: project evaluation

  Project: Rothenburg/Oberlausitz, Germany

  Abstract: The Rothenburg 20,493 MW photovoltaic power plant was constructed in 2009. It is located on 70 hectares of abandoned military airport land and it consists of three subsystems. The solar arrays comprise CdTe modules and the power plant is connected to the grid by central inverters. The results of the analysis of the operating data are presented and losses in terms of inverter sizing are analysed. The situation plan and an image of the power plant are also included.

- **GOLNAS, Anastasios and Joseph M. BRYAN.** 2011. Output Variability in Europe's Largest PV Power Plant. In: 26th European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 5–9 September 2011, 4356–4359.

  DOI: 10.4229/26thEUPVSEC2011-5BV.2.50

  Keywords: project description, project evaluation

  Project: Rovigo, Italy

  Abstract: In this paper, the photovoltaic power plant in Rovigo, Italy is described. At the time of commissioning in December 2010 it had a 70 MWp power capacity and was the largest of its kind in Europe. The system covers an area of 850,000 m². The system consists of 60 arrays with 1.1 to 1.3 MWp power capacity. In the study, values measured by pyranometers were compared to the output power values. The results were evaluated and are presented in this study.

- **GROTTKE, Matthias, Andreas VOIGT and Franz HARTL.** 2010. PV Soundless – Keeping the World Record "Along the Highway" – Performance Gain by Repowering Part of a 718 kW PV Sound Barrier After 6 Years of Operation. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 5028–5031.

  DOI: 10.4229/25thEUPVSEC2010-5BV.4.25

  Keywords: project description, noise barriers

  Projects: PV noise barrier, A92 motorway, Freising, Germany

  Abstract: This paper presents the construction details and operation experiences of the 718 kWp photovoltaic noise barrier along the A92 motorway in Freising, Germany. The first array with a 123 kWp power capacity was installed in 2002. In 2003, another 338 kWp array with ceramic modules with a noise protection function was commissioned. In the same year, an additional 163 kWp array was added. Due to the discoloration of the ceramic modules, this part of the system was repowered in 2009 with a 432 kWp array so the total power capacity of the system has reached 718 kWp. The system is connected to the grid through several inverters with

a rated power of 8 kW, 30 kW and 40 kW respectively. This paper presents the lessons learned during the installation and performance results in the first year of operation.

- **HERFURTH, Dirk.** 2011. Project phases for large solar installations – Planning stages of Germany 5th largest PV power plant. In: Conference Record of the 37th IEEE Photovoltaic Specialists Conference. Seattle, WA, USA, 19–24 June 2011, 3, 1807–1810.

DOI: 10.1109/PVSC.2011.6186304

Keywords: project description

Project: Finow Tower, Eberswalde, Germany

Abstract: With 24.24 MW, Finow Tower was one of the largest German photovoltaic power plants at the time of construction. It is located in an abandoned military area. The planning stages of the power plant are described in detail with particular attention on the construction works and mounting structure. The arrays of the power plant consist of 90,000 modules, with 22.4 MWh generated electricity annually. The power plant should save 450,000 tonnes of CO_2 during its 20 years of operating time. As in all abandoned military areas, particular attention was paid to the disposal of bomb scrap, ammunition and toxic waste, which is a necessary precondition for surface revitalization.

- **HERRERO ALONSO, Rafael, Emerson MELO, Sergio SHIMURA, Cesar BIASI, Thiago COSTA, Roberto SILVA SIMPLICIO, José Aquiles BAESO GRIMONNI and Marcelo KNORICH ZUFFO.** 2014. Comparing Energy Yield Simulation in Grid-connected 450 kWp Parking-integrated Photovoltaics - Case Study: Villa Lobos Project in Sao Paulo, Brazil. In: 29th European Photovoltaic Solar Energy Conference Proceedings, Amsterdam, the Netherlands, 22–26 September 2014, 2612–2619.

DOI: 10.4229/EUPVSEC20142014-5BV.1.14

Keywords: project evaluation

Project: Villa Lobos Project, Sao Paulo, Brazil

Abstract: The photovoltaic carport roof currently under construction in São Paulo city, Brazil, is presented in this paper. The photovoltaic carport roof is part of a larger project, which also includes a meteorological station and five PV subsystems composed of a 450 kWp carport roof with 50 kWp arranged in nine solar trackers, 40 autonomous photovoltaic light poles and 2 building-mounted photovoltaic systems with 40 kWp and 10 kWp power capacity. Simulation results including shading analysis are also discussed in the paper.

- **HIRANVARODOM, S. and O. SADMAI.** 2010. 10 kWp Photovoltaic System Installed in a Thai University of Technology: First Year in Experience of System Operating. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 4537–4540.

DOI: 10.4229/25thEUPVSEC2010-4BV.1.47

Keywords: project description, project evaluation

Project: Rajamangala University of Technology, Thanyaburi, Thailand

Abstract: This paper describes the three-phase 10 kWp photovoltaic system installed in the central area of Rajamangala University of Technology Thanyaburi - RMUTT, Thanyaburi district, Pathumthani province, Thailand.

- **HOFER, A., J. KÖHLE and G. WIRTH.** 2010. Large-Scale Generation of Electricity in Desert Regions – Opportunities and Risks of an EU-MENA Cooperation. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 5379–5384.

DOI: 10.4229/25thEUPVSEC2010-6CV.5.21

Keywords: preliminary study

Abstract: In this paper, some opportunities and challenges about large-scale photovoltaic projects in the MENA region are discussed. The aim of this paper is to provide an overview of the opportunities and potential risks that are related to large-scale solar energy projects in the MENA region.

- **ITO, Masakazu, Sylvain LESPINATS, Jens MERTEN, Philippe MALBRANCHE and Kosuke KUROKAWA.** 2013. A Methodology to Identify the Most Strategic Locations for Large Solar Power Plants Using Satellite Images. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 3594–3596.

DOI: 10.4229/28thEUPVSEC2013-5AO.7.1

Keywords: preliminary study

Abstract: In this paper, the methodology for large-scale photovoltaic power plant location evaluation, using satellite images, is presented and discussed. The proposed method was applied to the Sahara Desert and a land suitability index map has been computed.

- **IQBAL, Zaki, Gorkem SOYUMER and Waqarullah KAZIM.** 2014. Design and implementation of 59 kWp solar hybrid mini-grid in SOLAB, Ras Al Khaimah. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 4, 2743–2747.

DOI: 10.1109/PVSC.2014.6925496

Keywords: project description, hybrid

Projects: SOLAB, Ras Al Khaimah, UAE

Abstract: A 59 kWp photovoltaic hybrid mini-grid power plant was commissioned at the Solar Open Air Laboratory (SOLAB) in Ras Al Khaimah, UAE. A load analysis and system description are given in this paper. The payback time, based on installation costs is estimated to be about 2.7 years, under a load assumption of 94,500 kWh/year. The designed system is estimated to reduce diesel consumption by 95%, thus saving 144 tons of CO_2 emission annually.

- **KAGILIK, Ahmed S. and Abduraouf M. TAWEL.** 2013. Performance Analysis of 14 MW Grid-Connected Photovoltaic System. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 4109–4113.

DOI: 10.4229/28thEUPVSEC2013-5BV.7.15

Keywords: project proposal

Abstract: In this paper, the first Libyan grid-connected 14 MWp photovoltaic plant, planned for construction in Hoon city, Libya is presented. Power plant efficiency and performance were calculated. The average performance ratio is expected to be 76.9% and the power plant should supply 24,964 MWh to the grid during the first year of operation. This results in an overall yield factor of 1,783 kWh/kWp.

- **KANDT, Alicen and Rachel ROMERO.** 2014. Siting Solar Photovoltaics at Airports. In: Proceedings of the 43rd ASES National Solar Conference, 39th National Passive Solar Conference and the 2nd Meeting of Young & Emerging Professionals in Renewable Energy, San Francisco, CA, 6–10 July 2014, 1, 487–494.

URL: www.nrel.gov/docs/fy14osti/62304.pdf (10 June 2016)

Keywords: project overview

Projects: Denver International Airport, Denver, Colorado; Indianapolis, Indiana; Fresno Yosemite Airport, Fresno, California; Manchester-Boston regional Airport, Manchester, New Hampshire, USA; Gatwick Airport, London; Birmingham Airport, Birmingham, UK; Athens International Airport, Athens, Greece; Ancona Falconara Airport, Falconara Marittima, Italy.

Abstract: In this paper, some large-scale photovoltaic power plants located at airports worldwide are listed, with the case study of the Manchester-Boston Regional Airport. Brief guidance on installing PV power plants at airports is also given in the paper, including system location recommendations, wildlife impact estimation and minimizing glare and glint.

- **KING, C.** 2010. Site data analysis of CPV plants. In: Conference Record of the 35th IEEE Photovoltaic Specialists Conference, Honolulu, HI, USA, 20–25 June 2010, 5, 3043–3047.

DOI: 10.1109/PVSC.2010.5614236

Keywords: project evaluation, concentrator, CPV

Projects: ISFOC1, Puertollano, Spain; Palo Alto Water, Palo Alto, California; APS Star Center, Arizona, USA; EDF, Alto Monte, Italy

Abstract: The operating results of concentrator photovoltaic systems on four different sites are presented. Power output, energy production and performance ratio are described for the sites in Puertollano, Spain; Palo Alto, California; APS Star Center, Arizona, USA and Alto Monte, Italy. The performance ratio is in the range from 87% to 91%. Notable sites with concentrator trackers of the same type include ISFOC1, Puertollano; ISFOC2 Almoguera, Spain; Allice Springs, Australia and Victor Valley College, Victorville, California, USA.

- **KITTISONTIRAK, Songkiate, Perawut CHINNAVORNRUNGSEE, Sasiwimon SONGTRAI, Kamonpan CHUMPOLRAT, Aswin HONGSINGTHONG, Jaran SRITHARATHIKHUN, Kobsak SRIPRAPHA, Pairash THAJCHAYAPONG and Wisut TITIROONGRUANG.** 2014. A 126 kWp PV-Diesel Generator Hybrid System in Kampong Chheuteal High School, Kampong Thom Province, Kingdom of Cambodia. In: 6th World Conference on Photovoltaic Energy Conversion, Proceedings of the International Conference, Kyoto, Japan, 23–27 November 2014, 1249–1250.

Keywords: project description, project evaluation

Project: Kampong Chheuteal High School, Kampong Thom, Kingdom of Cambodia

Abstract: The Kampong Chheuteal high school is located in Kampong Thom province, the kingdom of Cambodia. The school was established in the year 2001 in a rural area and also owns a photovoltaic hybrid system with battery storage. The system comprises a 126 kWp photovoltaic generator, a 100 kW diesel generator and 120 batteries, each with a capacity of 1,500 Ah. The system is briefly described and the load profile analysis is presented. To save fuel, the main energy source is the photovoltaic system and the diesel generators are designed as a backup power source.

- **KJÆR, Søren Bækhøj, Jörg DANNEHL, Frederik MECKING and Jens GODBERSEN.** 2011. A 12 Megawatt Power Plant with Fully Implemented Ancillary Services According to the German Grid Codes – The First Results. In: 26th European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 5–9 September 2011, 3869–3873.

DOI: 10.4229/26thEUPVSEC2011-5AO.4.3

Keywords: project description, project evaluation

Project: Solarpark Busenwurth, Germany

Abstract: In this paper, the Solarpark Busenwurth photovoltaic power plant is described. The power plant is divided into seven subsections, each of them including about 120 15 kVA string inverters connected to an LV/MV transformer. Subsections are connected through the main transformer located 5 km away to the HV grid. In the paper, the measurement results of power quality, reactive and active power provision are presented and discussed.

- **KOHAKE, Dieter and Thomas NIERHOFF.** 2011. Ertragsanalyse für eine 245 kWp Photovoltaik-Anlage mit unterschiedlichen Modultechnologien. Poster. 26. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 2–4 March 2011, 113–118.

Keywords: project description, project evaluation

Project: Fachhochschule Gelsenkirchen; Gelsenkirchen, Recklinghausen, Bocholt, Germany

Abstract: In 2010/2011, Fachhochschule Gelsenkirchen installed a 245 kWp rooftop photovoltaic power plant located on three sites - Gelsenkirchen, Recklinghausen and Bocholt. The power plants comprise polycrystalline solar modules, thin film modules and HiT modules. The operating data and the yield of the power plants for the time period from July 2010 to November 2010 are presented in this paper.

- **KOHAKE, Dieter and Thomas NIERHOFF.** 2012. Monitoring-Analyse einer 245 kWp Photovoltaik-Anlage nach dem ersten Betriebsjahr. Poster. In: 27. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 29 February–2 March 2012, 149–154.

Keywords: project evaluation

Project: Fachhochschule Gelsenkirchen; Gelsenkirchen, Recklinghausen, Bocholt, Germany

Abstract: The yield analysis of the Fachhochschule Gelsenkirchen photovoltaic system, constructed in 2010 and 2011 is given in this paper. For the time period from December 2010 to November 2011, the monthly values of the array yield and final yield are presented and analysed.

- **KOMOTO, Keichi, Edwin CUNOW, Christian BREYER, David FAIMAN, Karim MEGHERBI and Peter VAN DER VLEUTEN.** 2012. IEA PVPS Task8: Study on Very Large Scale Photovoltaic (VLS-PV) Systems. In: Conference Record of the 37th IEEE Photovoltaic Specialists Conference, Austin, TX, USA, 3–8 June 2012, 3, 1778–1782.

  DOI: 10.1109/PVSC.2012.6317938

  Keywords: preliminary study

  Abstract: A brief overview of the IEA PVPS Task 8 purpose and scope is given in this paper. The purpose, socio-economic and environmental benefits, technical potential and engineering including the financial approach of very large scale photovoltaic power plants are presented and briefly discussed in the paper.

- **KOMOTO, Keichii, Namjil ENEBISH and Jinsoo SONG.** 2013. Very large scale PV systems for North-East Asia: Preliminary project proposals for VLS-PV in the Mongolian Gobi Desert. In: Conference Record of the 39th IEEE Photovoltaic Specialists Conference, Tampa, FL, USA, 16–21 June 2013, 3, 2376–2379.

  DOI: 10.1109/PVSC.2013.6744952

  Keywords: preliminary study

  Abstract: Proposals for a very large scale plant in the Gobi Desert, Mongolia are presented in this study. Locations proposed for large-scale PV power plants in this region are Shainsand city, Zumiin-Uud, Choir and Borundur for 10 MW power plants, for a 100 MW power plant, a location in Mandalgobi is proposed and a 500 MW system should be installed between Oyu Tolgoi and Tsagaansuvraga. The demonstration phase with 10 MW power plants is scheduled for 2020.

- **KOMOTO, Keichii, Jinsoo S. SONG, Namjil ENEBISH and Xu HONGHUA.** 2013. Very Large Scale PV Systems for North-East Asia: Potential of VLS-PV Super-Grid in the Mongolian Gobi Desert. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 4655–4657.

  DOI: 10.4229/28thEUPVSEC2013-6BV.8.12

  Keywords: preliminary study

  Abstract: In this paper, suitable sites for very large photovoltaic power plants in the Gobi Desert, Mongolia are analysed. The idea about very large scale photovoltaic power plants in the Gobi Desert regions connected to high-voltage transmission lines to power populated areas in the northeast Asian countries has been discussed.

- **KONISHI, Hiroo.** 2013. Comparison of Current-Controlled and Voltage-Controlled MPPT for Large-Scale Power Conditioning System in Hokuto Mega-Solar System. In: 28th European Photovoltaic Solar Energy Conference Proceedings, Paris, France, 30 September–4 October 2013, 4196–4200.

  DOI: 10.4229/28thEUPVSEC2013-5BV.7.40

  Keywords: project evaluation

  Projects: Hokuto Mega-Solar Project, Yamanashi Prefecture, Japan

  Abstract: With the intention of verifying grid stabilisation with a large-scale photovoltaic system photovoltaic demonstration, a 2 MW photovoltaic system was constructed and tested in Hokuto city to verify grid stabilization with a large-scale PV system. In this paper, MPP control strategies are compared and discussed. The verification test results of the grid stabilization systems and PV modules and systems in the Hokuto Mega-Solar system are also presented.

- **KONISHI, Hiroo, Takeshi IWATO and Mitsuru KUDOU.** 2010. Development of Large-Scale Power Conditioner in Hokuto Mega-Solar System. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 4823–4827.

  DOI: 10.4229/25thEUPVSEC2010-5AO.7.2

  Keywords: project description

  Projects: Hokuto Mega-Solar Project, Yamanashi Prefecture, Japan

  Abstract: This paper describes a 2 MW photovoltaic system that has been constructed in Hokuto, Japan with the intention of verifying grid stabilization with a large-scale photovoltaic system. The system consists of several stages and is connected to a 6.6 kV grid. Power conditioning units and control and protection systems are also described. The simulation of string currents and a detailed analysis of array behaviour under shading conditions are discussed and presented. From the operating data, important results of harmonic current suppression and voltage fluctuation suppression analysis are presented.

- **KONISHI, Hiroo, Takeshi IWATO and Mitsuru KUDOU.** 2011. Evaluation of Large-Scale Power Conditioner in Hokuto Mega-Solar System. In: 26th European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 5–9 September 2011, 3908–3912.

  DOI: 10.4229/26thEUPVSEC2011-5AO.5.5

  Keywords: project evaluation

  Projects: Wakkanai, Mega-Solar Demonstration Project, Wakkanai, Japan

  Abstract: In this paper, the 2 MW photovoltaic power plant constructed in Hokuto is described. The main purpose of the Hokuto power plant is to verify grid stabilization in the case of a large-scale PV system. The power plant consists of three stages – the 1.2 MW stage includes 400 kW power conditioning units and 200 kW choppers, which perform the MPP function. The functions of the inverters include voltage fluctuation suppression, harmonic current suppression, and fault ride-through. The measured results are presented and discussed.

- **KUWAYAMA, A., Y. SAITO, N. MATSUNO, T. ITO, R. HARA, H. KITA, N. MATSUOKA and K. TAIRA.** 2010. Grid Connected 5MW PV Plant with Battery Storage System: Results from Four Years of Operation of the Wakkanai Mega Solar Project. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 5038–5042.

  DOI: 10.4229/25thEUPVSEC2010-5BV.4.27

  Keywords: project evaluation

  Projects: Wakkanai, Mega-Solar Demonstration Project, Wakkanai, Japan

  Abstract: The photovoltaic demonstration project named "Verification of Grid Stabilization with Large-scale PV Power Generation systems" located in Wakkanai is described in this paper. The project, which consists of a 5 MW solar array and 1.5 MWh NaS batteries, is connected to the 33 kV grid. Voltage fluctuation and harmonics were analysed in detail. The results are discussed and presented in the form of diagrams. Some influences on system efficiency, such as module tilt or tracking function, were studied and evaluated as well.

- **MALLINENI, J., K. YEDIDI, S. SHRESTHA, B. KNISELY, S. TATAPUDI, J. KUITCHE and G. TAMIZHMANI.** 2014. Soiling losses of utility-scale PV systems in hot-dry desert climates: Results from four 4–16 year old power plants. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 5, 3197–3200.

  DOI: 10.1109/PVSC.2014.6925615

  Keywords: project evaluation

  Projects: Glendale, Arizona; Mesa, California, USA

  Abstract: In this paper, soiling losses for some photovoltaic power plants are presented. Among others, the 243 kW PV power plant in Glendale, Arizona and the 113 kW power plant in Mesa, California are part of the study.

- **MANMALAI, Porn-In.** 2014. A Success Story of the First 90 MW Solar Power Plant in Thailand for EA Solar Nakornsawan Company Limited. In: Renewable Energy World, Conference and Expo, Asia, Kuala Lumpur, Malaysia, 10–12 September 2014.

  Keywords: project description

  Project: Tambol Huawai, Amphur Takli, Nakornsawan, Thailand

  Abstract: At the time of commissioning, the 126 MWp PV power plant located in Tambol Huawai, Amphur Takli, Nakornsawan province, approximately 250 km north of Bangkok, Thailand was the country's largest PV power plant. It was commissioned on 23 December 2013. Together with the PV facility, a 115 kV substation was constructed. The project, located close to Highway No. 3329, occupies 296 hectares of land. For the chosen site, a flood study was done and a drainage system was constructed to protect the arrays in case of flooding. The system consists of 1 MW subarrays based on a concrete foundation and steel support structure. Each array is connected to two 500 kW inverters. The inverters are connected to three 50 MW transformers, which are connected to the 115 kV high voltage power grid. Many images including the power plant control room are presented in the paper. The power plant security system consists of approximately 550 cameras, an electric fence and security lighting fixtures. The results of the initial testing and operating results for part of the year 2014 are also presented and discussed.

- **MATSUMOTO, Yasuhiro, José Antonio URBANO, Oscar Iván GÓMEZ, René ASOMOZA and Ramón PEÑA.** 2014. Evaluation of 60 kWp PV System Performance in Mexico City. In: 6th World Conference on Photovoltaic Energy Conversion, Proceedings of the International Conference, Kyoto, Japan, 23–27 November 2014, 1269–1270.

  Keywords: project description, project evaluation

  Project: Research Center CINVESTAV-IPN, Mexico City, Mexico

  Abstract: A research centre close to Mexico City installed a photovoltaic system on the roofs of the facility buildings. The array consists of 260 modules that are inclined 30° towards the east and have a fixed tilt of 20°. In the period from June 2012 to May 2014, in total 24 months, the system was monitored and the results were evaluated. The average performance ratio based on the monitoring results is 88%.

- **MONTES, C., B. GONZÁLEZ-DIAZ, A. LINARES, E. LLARENA, O. GONZÁLEZ, D. MOLINA, A. PIO, M. FRIEND, M. CENDAGORTA, J. P. DIAZ and F. J. EXPÓSITO.** 2010. Effects of the Saharan Dust Hazes in the Performance of Multi-MW PV Grid-Connected Facilities in the Canary Islands (Spain). In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 5046–5049.

  DOI: 10.4229/25thEUPVSEC2010-5BV.4.29

  Keywords: project evaluation

  Projects: Finca Roja, Arico, Canary Islands, Spain

  Abstract: In this paper, the influence of Saharan dust on photovoltaic power plants located on the Canary Islands is studied. Saharan dust affects the Canary Islands about twice a month and lasts for several days. Dust invasion was modelled using mathematical models: the results of the modelling shows a decrease in energy production of between 5 and 7% daily, which is more than the recorded decrease in the radiation, which was in the range of 2% and 3%. So, additional influences on yield are also present. Humidity also seems to be one of the important factors.

- **NORDMANN, Thomas, Thomas VONTOBEL and Luzi CLAVADETSCHER.** 2012. 15 Years of Practical Experience in Development and Improvement of Bifacial Photovoltaic Noise Barriers along Highways and Railway Lines in Switzerland. In: 27th European Photovoltaic Solar Energy Conference Proceedings, Frankfurt, Germany, 24–28 September 2012, 3843–3847.

  DOI: 10.4229/27thEUPVSEC2012-5DO.7.2

  Keywords: project evaluation, noise barriers

  Projects: photovoltaic noise barriers, Aubrugg, Münsingen, Switzerland

Abstract: In this paper, some operating experiences and an efficiency evaluation for bifacial noise barriers in Switzerland is given. Bifacial noise barriers along a motorway in Aubrugg and along a railway in Münsingen near Bern are presented.

- **OLAKUNU, K., J. BELMONT, S. TATAPUDI, J. KUITCHE and G. TAMIZHMANI.** 2014. Degradation and failure modes of a 26-year-old 200 kW power plant in a hot-dry desert climate. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 5, 3207–3210.

  DOI: 10.1109/PVSC.2014.6925618

  Keywords: project evaluation

  Project: Solar One, Phoenix, Arizona, USA

  Abstract: The object of this study is the photovoltaic power plant in Phoenix, Arizona, which was commissioned in 1985. The power plant comprises 4,000 frameless modules with a rated capacity of 175 kW. The modules have a fixed south orientation with a 17° tilt angle. The main attention of the study was focused on mechanical damage such as electrical connections, IR images of modules, problems with the supporting structure, etc. Degradation and failure modes were analysed and are discussed in the paper. The main problem is encapsulation browning, followed by grid-line blossoming, cell cracks, etc.

- **PANCHULA, Alex F.** 2011. Practical calculation of lost energy for large PV power plants. In: Conference Record of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, USA, 19–24 June 2011, 4, 2412–2414.

  DOI: 10.1109/PVSC.2011.6186435

  Keywords: project evaluation

  Project: Blythe, California, USA

  Abstract: The Blythe photovoltaic power plant in California was commissioned in 2009. It consists of 351,000 thin film CdTe modules mounted on south-oriented fixed arrays with a 25° tilt angle. Each of the 21 arrays are connected to the grid by two 500 kW inverters. Since 2010, minute operating data has been data logged and stored. The data was analysed using multi-linear regression and the results are presented and discussed in this paper.

- **PANCHULA, Alex F., William HAYES, John BILASH, Adrianne KIMBER and Cindy GRAHAM.** 2011. First year performance of a 20 MW_{AC} PV power plant. In: Conference Record of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, USA, 19–24 June 2011, 3, 1993.

  DOI: 10.1109/PVSC.2011.6186344

  Keywords: project description, project evaluation

  Project: Sarnia, Ontario, Canada

  Abstract: Abstract of a paper published in the IEEE Journal on Photovoltaics.

- **PANCHULA, Alex F., William HAYES and Adrianne KIMBER.** 2011. First year performance of a 20 MW_{AC} PV power plant. In: IEEE Journal of Photovoltaics. Abstract available in: Conference Record of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, USA, 19–24 June 2011, 3, 1993.

  DOI: 10.1109/JPHOTOV.2012.2185783

  Keywords: project description, project evaluation

  Project: Sarnia, Ontario, Canada

  Abstract: The large-scale photovoltaic power plant Sarnia consists of 20 1 MWac arrays mounted at a fixed tilt of 25°. The plant was constructed and put into service in late 2009. Operating performance after one year of operation is presented in this paper. The monthly performance ratio is evaluated and compared to the predicted values. Different measured operating data are presented and discussed including module temperature, inverter input power, inverter output power and incident solar radiation. Measured values are within 2.1% of the predicted long-term range.

- **PÉREZ-HIGUERAS, P., G. ALMONACID, E. FERNÁNDEZ, E. MUÑOZ, F. ALMONACID and C. RUS.** 2010. Operating Experience of Photovoltaic Systems Installed at the University of Jaen. International Journal of Energy and Environment, 4, 4, 189–196.

  URL: http://www.naun.org/main/NAUN/energyenvironment/19-559.pdf (27 March 2016)

  Keywords: project evaluation

  Project: UNIVER Project, Jaén University Campus, Jaén, Spain

  Abstract: Operating experiences of a photovoltaic system located in the Jaén University Campus, Jaén, Spain are described in this paper. The system consists of two subsystems with 60 kW inverters and twenty-four subsystems with 2 kW inverters. The photovoltaic system includes two 70 kWp systems on a carport roof, a 20 kWp system on the roof of the University building and a 40 kWp system on the façade of the University building. A small dual-axis tracking system is also included. The annual yield, efficiency and performance ratio were analysed in detail and the results are discussed in the paper. A detailed analysis of losses is also included - including losses due to temperature, array losses, inverter losses and other system losses. Several images and an electrical diagram are also part of the paper.

- **PERSSON, Hanna, Øystein KLEVEN, Michael NORTON and Tobias BOSTRÖM.** 2012. Initial Results from a Grid-Connected 2-Axis Solar Tracking PV System at 65°N in Piteå, Sweden. In: 27th European Photovoltaic Solar Energy Conference Proceedings, Frankfurt, Germany, 24–28 September 2012, 4020–4024.

  DOI: 10.4229/27thEUPVSEC2012-5AV.1.50

  Keywords: project evaluation

  Abstract: This paper presents the initial results and experiences from a small grid-connected 19.8 kWp two-axis tracking PV system that has been installed in Piteå at 65° N latitude on the Swedish coast of the Gulf of Bothnia. It is located in one of the sunniest areas of Northern Europe. The simulation results show that the electrical yield achieved with the two-axis tracking is comparable to those in central Europe.

2010 – 2015

- **PHAM, Thi Thu Ha, Jean-Paul FRETTI, Jean-Marc ROLLET, David GOULIELMAKIS and Thierry MUSSET.** 2010. Design of Large PV Power Plants: Details which Make the Difference over 25 Years Lifetime. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 4983–4987.

  DOI: 10.4229/25thEUPVSEC2010-5BV.4.13

  Keywords: preliminary study

  Abstract: In this paper, some aspects that impact the lifetime and reliable operation of large-scale photovoltaic power plants are discussed. Based on the FMEA analysis, results such as performance ratio and availability are evaluated and presented. To maintain the desired availability and performance of the photovoltaic power plant, the following actions are proposed - adequate maintenance plan, optimal sizing of spare parts and the consistent organization of corrective operation.

- **RINDELHARDT, Udo and Dominik FRÖHLER.** 2010. Betriebserfahrungen mit der 40-MW-Photovoltaik-Anlage Waldpolenz. Poster. In: 25. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 3–5 March 2010, 152–157.

  Keywords: project evaluation

  Project: Solarpark Waldpolenz, Brandis, Germany

  Abstract: Solarpark Waldpolenz was constructed during 2007 and 2008 in an abandoned military area close to Leipzig, Germany. The power plant covers an area of 120 hectares and includes 559,800 frame-less thin film modules. It is divided into 35 subunits, each with two central inverters. The operating results for the years 2008 and 2009 were analysed and evaluated. A performance ratio of 89% was calculated for 2009. The operating results are compared with data from the Rote Jahne, Leipziger Land and Königsbruck power plants. Plots of the monthly values of the performance ratio and solar yield are given for 2008 and 2009.

- **RODIEK, Julie A., Steve R. BEST and Henry W. BRANDHORST.** 2010. Data analysis of solar power installation project for Lee County's T.K. Davis Justice Center. In: Conference Record of the 35th IEEE Photovoltaic Specialists Conference, Honolulu, HI, USA, 20–25 June 2010, 4, 2279–2282.

  DOI: 10.1109/PVSC.2010.5617015

  Keywords: project evaluation

  Project: T.K. Davis Justice Center, Lee County, Alabama, USA

  Abstract: Lee County's T.K. Davis Justice Center (LCJC) 16.6 kW grid-connected photovoltaic system was installed in the spring of 2009. The roof-mounted photovoltaic array consists of 64 modules. A few modules are also pole-mounted. The system is connected to a 480 V three-phase grid by one inverter and an additional connection to the 208V grid is realised by another single-phase inverter. Software modelling results, compared to the operating data, are presented in the paper. The daily produced energy for July and August 2009 is given in the paper as well.

- **RUIZ, Mireya, Jaime AGREDANO and Humberto JIMÉNEZ.** 2011. Effect of Dust Accumulation on the Performance of the Grid Connected 60 kWp Photovoltaic System at the University Autonomous Metropolitan in Mexico City. In: ISES Solar World Congress 2011 Proceedings, Kassel, Germany, 28 August–2 September 2011, 2838–2849.

  Keywords: project evaluation

  Project: University Autonomous Metropolitan, Mexico City, Mexico

  Abstract: In this paper, the operating results of the 60 kWp photovoltaic system located in the University Autonomous Metropolitan, Mexico City, Mexico are presented and discussed. The main attention was focussed on the effect of dust on the performance of the power plant. The system consists of 286 210 Wp modules organized into 19 subarrays, each connected to a single phase inverter. Detailed pollution-related efficiency loss for the 2009-2011 period is presented and discussed. In comparison with a clean array, a dirty array showed a significant performance decrease - during analysis, up to a 40% reduction in the performance of the dirty array was observed.

- **RÜTHER, Ricardo, Lucas Rafael DO NASCIMENTO, J. URBANETZ, P. PFITSCHER and T. VIANA.** 2010. Long-term performance of the first grid-connected, building-integrated amorphous silicon PV installation in Brazil. In: Conference Record of the 35th IEEE Photovoltaic Specialists Conference, Honolulu, HI, USA, 20–25 June 2010, 4, 2283–2286.

  DOI: 10.1109/PVSC.2010.5617021

  Keywords: project evaluation

  Project: Universidade Federal de Santa Catarina, Florianopolis, Brazil

  Abstract: A 2 kW BIPV thin film system with an area of 40 m^2 was installed in Brazil in 1997. After inverter failures, four 650 W inverters were replaced with a single 2,500 W inverter. The array was rewired to a higher array voltage (390 V). The operating results including yield analysis and performance ratio, after 10 years of operation, are presented in this paper.

- **SIRISAMPHANWONG, Chatchai, Nipon KETJOY, Kongrit MANSIRI and Rattaporn NGOENMEESRI.** 2014. Techno-economics of Commercial PV Power Plant: Case Study 3 MWp CIS PV Power Plant in Thailand. In: 6th World Conference on Photovoltaic Energy Conversion, Proceedings of the International Conference, Kyoto, Japan, 23–27 November 2014, 1217–1218.

  Keywords: project description, project evaluation

  Project: PV power plant in northern Thailand

  Abstract: In this paper, a 3 MW photovoltaic power plant located in northern Thailand is briefly described. System parts, monitoring and financial analysis are presented and briefly discussed.

- **VELDHUIS, A. J., and Angèle H. M. E. REINDERS.** 2014. Performance of a 34 kWp grid-connected PV system in Indonesia - A comparison of tropical and European PV systems. In: Conference Record of the 40th IEEE Photovoltaic Specialists Conference, Denver, CO, USA, 8–13 June 2014, 3, 1978–1981.

DOI: 10.1109/PVSC.2014.6925313

Keywords: project description, project evaluation

Project: Jayapura, Papua, Indonesia

Abstract: The operating data and performance for one year of operation of the 34 kW photovoltaic system installed on the roof of the district office in Jayapura, Indonesia, close to the equator are presented and discussed in this paper. Modules are mounted north oriented with a fixed tilt angle of 10°. The main objectives of the study were a comparison of the evaluated and expected performance, a comparison of the performance with other similar photovoltaic systems located in tropical regions and in Europe, temperature losses in tropical climates, evaluation of different module technologies and evaluation of central inverters in comparison to micro inverters. Monthly results for the time period from May 2013 to April 2014 are presented and discussed in the paper.

- **VELDHUIS, Hans, Angèle H. M. E. REINDERS and Fred J. A. M. VAN HOUTEN.** 2012. Comparison of BIPV Simulation with Monitored Data: The Case of a 35 kWp PV System in Jayapura, Papua, Indonesia. In: 27th European Photovoltaic Solar Energy Conference Proceedings, Frankfurt, Germany, 24–28 September 2012, 3971–3973.

DOI: 10.4229/27thEUPVSEC2012-5AV.1.30

Keywords: project description, project evaluation

Project: Jayapura, Papua, Indonesia

Abstract: In 2010, a 35 kWp grid-connected photovoltaic system on the roof of the district office was commissioned in Jayapura, Papua, Indonesia. Modules are mounted with a 10° fixed tilt oriented to the north. The system consists of four arrays and two different module types - crystalline and amorphous silicon. For the period from May 2013 to April 2014, the operating results are presented. The performance ratio, energy loss and percentage of faults are discussed in the paper. The calculated performance ratio was about 80% for one array and 54% for the second array.

- **VERVAART, Mark, Jens MERTEN, R. COOL and Tanguy CADIN.** 2010. Performance Analysis of the First Medium Size PV-Plant in Burkina Faso on the City Grid of Ouagadougou. In: 25th European Photovoltaic Solar Energy Conference Proceedings, Valencia, Spain, 6–10 September 2010, 3947–3951.

DOI: 10.4229/25thEUPVSEC2010-4DO.11.6

Keywords: project description, project evaluation

Project: Ouagadougou, Burkina Faso

Abstract: In this paper, the 80 kWp grid-connected system installed on the roof of the bank "Société Générale de Banques au Burkina" (SGBB) is presented. The system was commissioned in April 2010. It consists of 14 subsystems with their own inverters. A brief system description is given in the paper and the monitoring results are also presented and analysed. Due to a special regulation, no energy feed is allowed into the grid, so special solutions with phase equilibration were developed for this system. In the case of grid failure, the building is switched to a generator set. The main PCs and servers are provided with an individual UPS system.

- **VIVIAN, Maurizio, Mirko GIRO and Nicola BAGGIO.** 2011. Integration of the Largest Rooftop System: 12.3 MW in Different Industrial Buildings of "Interporto Di Padova". In: 26th European Photovoltaic Solar Energy Conference Proceedings, Hamburg, Germany, 5–9 September 2011, 3987–3990.

DOI: 10.4229/26thEUPVSEC2011-5CO.11.4

Keywords: project description

Project: Interporto Padua, Italy

Abstract: This paper presents the construction experience of the largest photovoltaic rooftop system worldwide. The 12.3 MWp power plant was constructed on 18 different buildings of Interporto di Padova, one of the main logistic areas in Italy. Before installation, the old roof cover with asbestos was removed and disposed of and a new metal roof cover was installed. The system includes different types of roofs, such as north-south tilted roofs on three buildings, east-west tilted roofs on eight buildings, small domes on four buildings, a flat roof on one building, a shed and canopies. Additionally, 1 MW was installed near the buildings as a carport-roof.

- **WILK, Heinrich and Stefan POINTNER.** 2010. 1 MW Sonnenkraftwerk Oberösterreich. Poster. In: 25. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 3–5 March 2010, 68–73.

Keywords: project description

Project: Eberstalzell, Wels-Land, Upper-Austria, Austria

Abstract: The Eberstalzell photovoltaic power plant, close to Wels, Austria, was commissioned in the summer of 2010. Modules are mounted with a 30° tilt angle. Some solar array assembly details are presented and a brief description of lightning protection is given in the paper. For the 1 MW power plant, a solar yield of 1,000 MWh was predicted. The total investment cost of the power plant was EUR 6 million.

- **WILK, Heinrich.** 2010. 66 kW Photovoltaikfassade des Power Tower, dem Aktiv-Bürohochhaus der Energie AG Oberösterreich. In: 25. Symposium Photovoltaische Solarenergie, Bad Staffelstein, 3–5 March 2010, 376–381.

Keywords: project description

Project: Power Tower Energie AG, Linz, Austria

Abstract: In 2008, a new facility of Energy AG, Power Tower, was commissioned in Linz, Austria. The building also includes a 66 kW façade-integrated photovoltaic power plant. Construction details of the façade glazing are given, including the photovoltaic modules. The power plant includes five inverters located in the air conditioning room. Operating results for the period from August 2008 to December 2009 are presented in the paper.

GIS Databases

- **Institut für Technikfolgenabschätzung und Systemanalyse (ITAS)**, Karlsruher Institut für Technologie (KIT). Database includes MW-ranged PV power plants worldwide up to 2008 with a focus on European countries. Database established by Ulrich Dewald, PhD, during his PhD study on RWTH Aachen. Karlsruhe: ITAS, contact person Ulrich Dewald, PhD.

  URL: https://www.itas.kit.edu/

- **LaTene.** 2014. Commercial database includes large scale PV power plants in EU. Dublin: LaTene.

  URL: http://latenemaps.com/

- **Solargis.** 2016. Database includes large scale PV power plants in Slovak Republic. Bratislava: Solargis.

  URL: http://www.solargis.com/

Other Databases

- **IEA PVPS Task 13.** Performance database web application.

  URL: http://77.245.18.90/ (10 June 2016)

- **PVdatabase.** Building integrated and urban photovoltaic solar energy projects and products. Includes many details about some projects described in this survey.

  URL: http://www.pvdatabase.org/

IEA PVPS - Working Tasks

- **IEA PVPS Task 6** - Design and operation of modular photovoltaic plants for large scale power generation.

  URL: http://www.iea-pvps.org

- **IEA PVPS Task 8** - Study on very large scale photovoltaic power generation systems.

  URL: http://www.iea-pvps.org

- **IEA PVPS Task 13** - Performance and Reliability of Photovoltaic Systems.

  URL: http://www.iea-pvps.org

Links and Information about Large-Scale PV Power Plants

- **Akademie-du-Mont-Cenis** - 1 MW photovoltaic power plant with transparent modules integrated into building's envelope (roof and façade) in Herne, Germany.

  URL: http://www.stadtwerke-herne.de/index/unternehmen/umwelt/energiepark_mont_cenis.html (15 March 2018)

- **Puebla de Montalbán** - 1 MW ground mounted photovoltaic power plant in Toledo, Spain.

  URL: https://www.cordis.europa.eu/project/rcn/33896_en.html (26 March 2018)

- **Solardach München-Riem** - 1 MW roof-mounted photovoltaic system located on roofs of Munich Trade Fair facilities in Munich, Germany.

  URL: http://www.sev-bayern.de/index.php?entryid=14 (26 March 2018)

Other Links/Information

- **PV UP-Scale.** PV UP-Scale is a dissemination project about Urban Scale Photovoltaic Systems.

  URL: http://www.pvupscale.org/ (02 January 2017)

- **Joint Research Centre.** 2016. An assessment of the regional potential for solar power generation in EU-28.

  DOI: 10.1016/j.enpol.2015.10.004 (26 March 2016)

- **CELENTANO, R.** 2003. Solar Audit Assistance Tool. In: Proceedings of the Solar 2003 Conference, 32nd ASES Annual Conference, 28th National Passive Solar Conference, Austin, TX, 21–26 June 2003, 243–248.

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  DOI: 10.1007/978-1-4613-9948-3

- **MACHOVEC, George.** 1980. Solar Energy Index, The Arizona State University Solar Energy Collection. New York, Oxford, Toronto, Sydney, Paris, Frankfurt: Pergamon Press. ISBN 978-0-08-023888-3.

  URL: http://www.sciencedirect.com/science/book/9780080238883 (20 November 2016)

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- **NASA.** 1982. Energy, a Continuing Bibliography with Indexes. NASA SP-7043(35), 35. Washington, DC: National Aeronautics and Space Administration.

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- **Solarpraxis AG/Sunbeam Communications.** 2013. Industry guide PV Power Plants 2013 now also available as iPad app. Press Release, Berlin 15 October 2013.

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  DOI: 10.1109/MPER.1987.5526829

- **SUGIMURA, Russell S. and Joan M. WOOD.** 1987. Utility Application of Photovoltaic Power Generation: A Survey of Recent Literature. IEEE Transactions on Energy Conversion, EC-2, 4, 563–569.

  DOI: 10.1109/TEC.1987.4765893