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MC4 meeting – 24th February,
Utrecht, The Netherlands

<https://www.pearlpv-cost.eu/event/mc4-meeting-cost-action-pearl-pv/>

WG Workshops, 25 - 27 February,
Utrecht, The Netherlands

<https://www.pearlpv-cost.eu/event/workshops-cost-action-pearl-pv/>

IEEE PVSC-47, June 14-19,
Calgary, Canada

EU PVSEC, September 7-11,
Lisbon, Portugal

Welcome

Dear PEARL PV members,
In 2020, we look forward to continuing our networking and PV research activities with your knowledge as PV system experts. Thanks to your efforts and energy, PEARL PV received an excellent mid-term review from the COST Association on the basis of the PR2 report which covers the scientific progress of this Action during its first two years. Thank you all for this achievement!

Furthermore, the Action grew again, now at the start of 2020, PEARL PV represents 37 countries and has more than 250 participants.

Our Action was very active in 2019 by the organization of an MC meeting and Workshops in Lisbon, an ICT Workshop in Serbia, a Seminar and Training School in Malta and an LSC PV Workshop in Eindhoven, the Netherlands. Many thanks to the organizers of these events, the speakers, the trainers and the local hosts for making this possible.

An interesting Seminar and a subsequent 4-day Training School on “PV Reliability and Durability” took place from 14 to 18 October 2019 in Malta College of Arts, Science and Technology MCAST in Paola, Malta, and was excellently hosted by Dr. Brian Azzopardi. This Newsletter will report on both events as well as on the

workshop which was dedicated to LSC PV technologies and their applications. Also, we are excited that thanks to the efforts of Dr. Carolin Ulbrich of PVComB Helmholtz Centrum Berlin and the ICT team at University of Twente in realizing an interface and user manual, we can announce that the CKAN data server for sharing of big data and software, will soon be accessible for all our participants. Please expect communication about this topic in the next weeks.

We would like to sincerely thank you, all volunteering PV experts, for your energy, enthusiasm and efforts! PEARL PV’s success story will be based on your contributions to the Action as a whole and to the programs of the Working Groups. Therefore, we will be looking forward to meeting you all again in February 2020 in Utrecht!

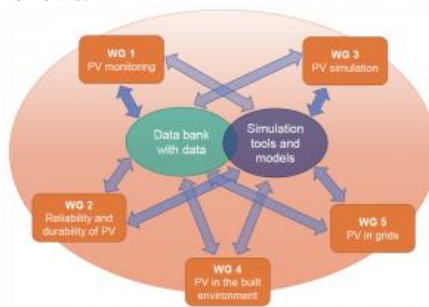
Sunny regards,
Chair Prof *Angèle Reinders* (University of Twente & Eindhoven University of Technology) & Vice Chair Dr David Moser (EURAC)

Introduction

The aim of PEARL is to improve energy performance and reliability of PV systems in Europe leading to lower costs of electricity produced by PV systems by a higher energy yield, a longer life time eventually beyond the guaranteed 20 years as

specified by manufacturers, and a reduction in the perceived risk in investments in PV projects. This Action entails the formation of an inclusive network of PV system researchers, data resources that will be analysed by researchers, forming a very large agglomeration of PV systems performance data for Europe, and experts that can include more-nuanced evidence-based reliability in PV system, evaluation methods and simulation and design tools.

Five Working Groups (WG) have been set up which will conduct research using a shared data bank and shared simulation tools and models. An update on each WG follows.

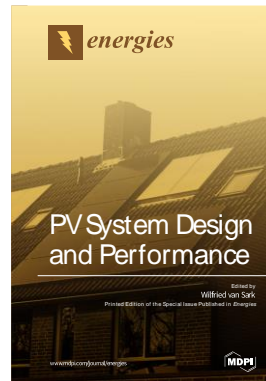


WG1: PV Monitoring

Focus of the work in the past months has been on the realisation of the fully functional data bank based on CKAN. A proof-of-concept version was realized in early 2019 by University of Twente ICT department with the help of many WG1 participants. Due to some personnel changes, we are very happy that now Dr. Carolin Ulbrich (HZB) took over responsibilities. She has developed the user interface of the CKAN data bank and wrote a user manual together with Judith Süveges (HZB) and Arian Olde Kalter (UT), which both will be available in February 2020. This will mark an important milestone: the start of the databank.

At the February Utrecht meeting we will organize, together with the other WGs, several cross fertilization

workshops to identify research questions that we will be able to answer with appropriate data. This will streamline and expedite the collection of data.



A special issue of the journal *Energies* has been published as an open access book, entitled “Photovoltaic System Design and Performance.” It is a collection of 21 papers on topics including data analysis for optimal performance and fault analysis of photovoltaic systems, causes for energy loss, and design and integration issues. Not surprising, some PEARL PV participants have contributed, and PEARL PV is therefore acknowledged. Freely downloadable from <https://doi.org/10.3390/books978-3-03921-623-9>.

Chair: Dr Wilfried van Sark (*Utrecht University*) & Vice Chair Dr Christian Braun (*FhG-ISE*)

WG2: PV Reliability & Durability

The main objectives of WG2 are to define reliability and durability metrics for PV modules, components and systems, to identify relevant data to be collected to measure reliability and durability, to develop/integrate comprehensive methods/models for autonomous monitoring using the potential of big data banks in order to detect the failures and analyze the degradation mechanisms systematically, predict the performance and service life, real-time study of reliability and durability for PV systems, and eventually to share knowledge via workshops, seminars and joint publications originating from WG2 with a wider community of PV experts and other

stakeholders namely insurers, investors, banks, manufacturers, researchers, and consumers. On the one hand, different views of PV stakeholders exist describing reliability and durability, while on the other hand different metrics for different PV technologies namely, c-Si, thin-film, organic are considered, so a common metric would be beneficial. Furthermore, identification of relevant data will include the description of big PV data analysis methods - output power over time and multi-faceted analysis to gauge output decrease, the identification of issue causing a decrease in power output (e.g. shading, physical degradation, etc.) and a correlation of failure modes with climatic conditions. Moreover, automating the monitoring procedure and real-time decision-making are very important tasks for the reliability and service life of PV systems. The research progress, publications planning, upcoming events will be discussed at the workshops in Utrecht.

Chair: Dr.Mohammadreza Aghaei, Eindhoven University of Technology, The Netherlands & Vice-chair: Dr.Jeffrey Kettle, Bangor University, UK

WG3: PV Simulation

WG3 is investigating the simulation models that are being used by the PV community to determine where development is required. In particular, we are interested in simulation issues that reflect new system configurations or complex simulation problems. Performance modelling of bifacial modules was selected as the first topic to be addressed by the comparison of several different models with the same input data in order to determine the effectiveness of those models for performance prediction. We have now identified data for different operating conditions and a preliminary analysis has been completed. A more extensive study will be carried out over the next few months. WG3 is also considering other topics for similar studies, including the simulation of complex shading, curved surfaces and floating PV systems. These topics will be discussed at the workshops in Utrecht.

Chair: Prof Nicola Pearsall (*Northumbria University*) & Vice Chair Prof João Serra (*Universidade de Lisboa*)

WG4: PV in the Built Environment

The activity of Working Group 4 is focused on identification of the required data and appropriate simulation models to be used in the framework of the application of PV systems in the built environment. It is structured in two main tasks: (1) Collection of data for the data server of this Action & (2) Identification of the required data and appropriate simulation models.

Following the research plan from the Lisbon Workshop, in 2019, the members of WG4 from various European countries (Greece, Romania, Norway, Serbia) have been working on papers; one example is the paper "Parametric approach to BIPV retrofitting office buildings", due to be completed during 2020 and another example is the paper "Solar PV Potential at Urban Scale: From Buildings to Cities". Members from ITC countries (Serbia, Montenegro, and Albania) also prepared a paper titled: "Modernization of built environment by integration of PV technology - the case of streetlight systems" in which was discussed PV implementation to street lighting in Cetinje, Tirana and Belgrade. The paper was published at the Conference IFAU2019 in Tirana, 3rd International Forum for Architecture and Urbanism, Modernization and Globalization, Challenges and Opportunities in Architecture, Urbanism, Cultural Heritage, in November 2019.

Members of the group also initiated research on the integration of PV systems in so-called landmark buildings, i.e. buildings that could be distinguished by their importance, function, size, architectural appearance, etc. The landmark buildings equipped with PV systems will be the topic for the knowledge exchange in the Utrecht Workshop.

New members have joined the group: Florian Nepravishhta (Albania), Nikolina Shutinovska (Macedonia), Cihan Gercek (Netherlands), Goran Radović (Montenegro), and Anna Svensson (Sweden). WG4 welcomes new members and looks forward to knowledge sharing with them.

Chair: Dr Mirjana Devetaković (University of Belgrade) and Vice-Chair Dr Bogdan Burduhos (Transilvania University of Brasov).

WG5: PV in Grids

There has been a change in the Vice-Leader position at WG5. Marios Theristis is now working at SANDI Labs in the USA. He will still be involved in Pearl PV but cannot endorse a management role anymore. Sonia Pinto from University of Lisbon will replace him in this role.

WG5 has started to produce significant outputs and these have now translated into 3 articles published in high-level scientific journals. More information is available from the website of WG5 from:

<https://www.pearl-pv-cost.eu/wg/wg5/>

WG5 is promoting a Special Issue in the journal *Energies* "Impact of Interconnected PV Systems on Power Quality of

Distribution Networks". The deadline for the submission of articles is 31 October 2020. We welcome your contributions. Here is the link:

https://www.mdpi.com/journal/energies/special_issues/PV_PQ

If you are willing to join a task or create a new one? Ready to meet with the required high level of collaboration? Send an email with your proposal to Jonathan at

jonathan.leloux@upm.es

Chair: Jonathan Leloux (*Polytechnic University of Madrid*) & Vice Chair Sonia Pinto (*University of Lisbon*)

Meeting Updates

PEARL PV Seminar and Training School in Malta, October 2019

EU COST Action PEARL PV has completed a Seminar focusing on the topic of "PV Reliability and Durability", which took place in Malta, on the 14th of October 2019 in collaboration with the MCAST Malta College of Arts, Science and Technology. Throughout the Seminar which was chaired by Dr. David Moser, the importance of performance, reliability and durability of solar PV power systems for the growth and competitiveness of the market was demonstrated. World leading experts in the field presented first-hand experiences





coming from monitoring, field inspections, characterization techniques, related economic impact in order to provide extremely valuable knowledge on the topic of quality and reliability of PV modules and systems.

This weblink shows the full program and the presentations of this event:

<https://www.pearlpv-cost.eu/event/seminar/>, which was well attended by 40 participants.

The Seminar was followed by a four-day Training School between the 15th and 18th October 2019, on the topic of “Evaluation of the performance degradation of PV systems influence factors, failure modes and their detectability and effect on economic viability”. The 2019 Training School of PEARL PV was organized by Dr. Gabriele Eder and Prof. Alexandra Krstic-Furundzic. More than 50 researchers, students and other trainees had the opportunity to learn about key topics of reliability, failures in the field and economic impact for state-of-the-art and emerging technologies from PEARL PV Working Group members and external experts through multiple expert lectures, interactive seminars, and practical courses including team action work and study tours. The program was dense and interesting, while being

decorated by sight-seeing and a great social dinner. As such the Training School was positively evaluated by its Trainees. Therefore, compliments to the organizers.

LSC PV Workshop, Eindhoven, November 2019

On 14 November 2019 a workshop was held at Eindhoven University of Technology on the interesting topic of Luminescent Solar Concentrator PV. See here for the complete program and the speakers of this workshop:

<https://www.pearlpv-cost.eu/event/workshop-on-luminescent-solar-concentrator-photovoltaics/>

The workshop was chaired by Prof. Angèle Reinders and Dr. Michael Debije and was a very inspiring event with approximately 30 participants.

In the past decade, there have been great advances in not only the performance, but also the potential application range of Luminescent Solar Concentrator Photovoltaic (LSC PV) devices. New inorganic luminophores promise the elimination of reabsorption losses and extended lifetimes and complex organic dyes with large Stokes shifts have been developed in labs. Photonic coatings could significantly decrease surface losses, plasmonic enhancements can generate more emission and dye alignment can improve light focusing. New applications are being developed, such as switchable ‘smart’ windows, building integrated PV modules, daylighting elements, greenhouses and even hydrogen production with LSCs. With silicon cell efficiencies reaching values close to the theoretical maximum, LSC PV devices can reach a mature state, while new solar cell materials also can contribute to improvements in performance and commercialization of LSC PVs. Given this context, this workshop sought to bring together the world’s experts in LSC PV research and development for a focused conversation on the performance enhancement of this intriguing device. Through a series of lectures ranging from fundamental science to device design and from applications to industrial opportunities, the workshop enlivened the debate, fostered new collaborations and tackled barriers that should be lowered or



eliminated to create commercially available LSC PV applications with improved performance.

For the first time ever, PEARL PV offered the opportunity to publish research results in a Special Issue of Applied Sciences (IF: 2.217) about Luminescent Solar Concentrator Photovoltaics. Speakers and attendees of this workshop were cordially invited to submit their manuscript about LSC PV research to this Special Issue for peer review and, eventually, publication. For all information see the website of the journal at https://www.mdpi.com/journal/applsci/special_issues/lsc_pv The deadline of submission of manuscripts will be the end of March 2020.

It is the intention to define diverse PV research topics for future Special Issues of Applied Sciences and hence create a series of Special Issues for this Cost Action.

Country Reports

For those of you that have yet to respond to the request for country information – please do so. We look forward to getting your valuable contributions and working together on these Country Reports!

Prof Istvan Farkas, (*Szent Istvan University*) Dr Ayda Esfandyari (*Technical University Dublin*), Prof Angèle Reinders (*University of Twente*) Dr David Moser (*EURAC*)

STSM Updates

STSMs are Short Term Scientific Missions which are institutional visits aimed at supporting individual mobility, fostering collaboration between individuals. They are primarily intended for PhD students and early career investigators (ECI) to visit other research groups, to acquire new expertise, contribute their expertise to projects and

exchange ideas between participating institutions. STSM topics are linked with ongoing work in the PEARL PV Working Groups. We strongly encourage researchers and institutions from Inclusiveness Target Countries (ITC) to participate in STSMs.

For detailed information on STSMs, please visit <https://www.pearl-pv-cost.eu/activities/stsm> or contact STSM Manager Dr Markus Schubert (University of Stuttgart) markus.schubert@ipv.uni-stuttgart.de

ITC Conference Grants

ITC Conference grants allow us to support conference visits of PhD students and Early Career Investigators (ECIs) from ITC countries. ECIs include post-doc researchers up to 8 years after receiving their PhD. We are looking forward to your applications! For details, requirements and applications, please visit <https://www.pearl-pv-cost.eu/activities/itc-conference-grants> or contact STSM Manager Dr Markus Schubert (University of Stuttgart) markus.schubert@ipv.uni-stuttgart.de

STSM Interview



Emilio Muñoz Cerón

Last July 2019, I had the opportunity to hold an STSM at the Eurac Research Center under the warm welcome of David Moser. The centre is located in a beautiful location, in Bolzano, in the Trentino-Alto Adige region, which includes a large part of the Dolomites and the southern Alps. In this centre as well as wonderful scenery, I found the technical quality to be of the highest level, especially the quality of

personnel and scientific level of the team in the Institute for Renewable Energies, specifically the group of the Photovoltaic Energy Systems.

The tasks carried out were focused on knowing in more detail everything related to bifacial photovoltaic modules. There I had the opportunity to simulate by means of commercial software tools the expected performance of this bifacial technology under the climatic conditions of the area based on a real integration project.



Additionally, we made a comparison of the results obtained with this software with the PV simulation tool developed by the EURAC team which was modified specifically for this STSM. Moreover, several experiments were proposed and developed at the University of Jaen in relation to bifacial modules to compare real outdoor data with the output obtained with their in-house software. I am currently processing the experimental measurement data and they will be the subject of a joint paper.

I am deeply grateful to the Cost Action Pearl PV and Eurac Research for the opportunity provided, which allows a scientific positioning and progress in the field of bifacial modules.

Publication Policy

With several deadlines for international PV conferences and many journal manuscripts of the 5 Working Groups in the pipeline, it is useful to be informed about the publication policy of PEARL PV. Authors of papers are allowed to acknowledge PEARL PV only if at least 2 PEARL PV countries are represented. Please make sure that you circulate the author list and

an abstract of the manuscript to the relevant WG leader(s), chair and vice chair:

- 2 weeks before submission in case of submission to a peer-reviewed journal, and
- 1 week before submission in case of submission to a conference.

Once published please upload information about your publication in the excel file in Publications folder of the Dropbox of PEARL PV:

<https://www.dropbox.com/home/COST%20CA16235%20-%20PEARL%20PV/Publications>

This will enable the Action's Science Communication Manager to further disseminate your work through the PEARL PV publication list

<https://www.pearlpv-cost.eu/dissemination/publications>

Please follow the dissemination guidelines and COST corporate identity which can be found here <http://www.cost.eu/media/dissemination-corporate-identity>

Also please include the following standard acknowledgment in any publication (poster, paper, book)

"This article/publication is based upon work from COST Action CA16235 PEARL PV supported by COST (European Cooperation in Science and Technology)"

This text is compulsory for any PEARL PV publication!

Further texts are shown on page 55 of the Action's Workplan which you can access on the PEARL PV website

<https://www.pearlpv-cost.eu/dissemination/reports/>

Please also include the COST website, PEARL PV website, COST logo and EU logo in any publication. If space is limited then only the COST logo should be shown.

Join Us

For all the latest news check out PEARL PV's website at <https://www.pearlpv-cost.eu>

You can register for participation by this registration form <https://www.pearlpv-cost.eu/about/registration>. Please feel welcome to share this registration form with interested colleagues.

PEARL PV is also visible in social media, namely you can follow PEARL PV by Twitter account

<https://twitter.com/CostPearl> and by our LinkedIn group

<https://www.linkedin.com/groups/8655031>



Contact Us

For further info, please contact Action Chair: Prof Angèle Reinders (University of Twente & Eindhoven University of Technology), a.h.m.e.reinders@utwente.nl
Vice Chair: Dr David Moser (EURAC), David.moser@eurac.edu

WG1 Leader: Dr Wilfried van Sark (Utrecht University), w.g.j.h.m.vansark@uu.nl

WG2 Leader: Dr. Mohammadreza Aghaei, Eindhoven University of Technology, The Netherlands (m.aghaei@tue.nl)

WG3 Leader: Prof Nicola Pearsall (Northumbria University), nicola.pearsall@northumbria.ac.uk

WG4 Leader: Chair: Dr Miriana Devetakovic (Uni of Belgrade), mirjana.devetakovic@gmail.com

WG5 Leader: Dr Jonathan Leloux (Polytechnic University of Madrid), jonathan.leloux@upm.es

Science Communication Manager: Dr Eliza Loucaidou (Deloitte Cyprus), eloucaidou@deloitte.com

Training School Managers: Dr Gabriele Eder (OFI), Gabriele.Eder@ofi.at and

Dr Aleksandra Krstic-Furdzic (University of Belgrade), akrstic@arh.bg.ac.rs

STSM Manager: Dr Markus Schubert (University of Stuttgart), markus.schubert@ipv.uni-stuttgart.de

Newsletter Editor: Dr Sarah McCormack (Trinity College Dublin), mccorms1@tcd.ie

Vacancies

The following vacancies are available in PEARL PV COST Action
PEARL PV is seeking a **Training School Manager**, a **Science Communication Manager** and an **STSM Manager**. If you feel interested, then please contact Prof. Angèle Reinders (a.h.m.e.reinders@utwente.nl) and/or Dr. David Moser (david.moser@eurac.edu) for more information.

Please note that the Science Communication Management position and the STSM Management position are both Core Group positions. Therefore applicants for these positions, should be either an MC Member or Substitute, or be in the situation that they can become an MC Member in the future. This condition doesn't apply to the vacancy of the Training School Manager which is open for any interested COST-registered PEARL PV participant. Below you will find short descriptions of the positions.

Training School Manager

This position entails various responsibilities, such as:

- Define the 4-day program of future TSS
 - Invite Trainers
 - Define and communicate the Call for Trainees (usually in Spring)
 - Select Trainees
 - Invite selected Trainees
 - Keep short communication lines with the local organizer / host of the TS
 - Brief all involved before the TS
 - Share educational materials and software which is relevant for the TS
 - Be present during the TS
 - Conduct and report about evaluations
- TSMs collaborate in a team of two and have regular contact with the WG leaders, Chair and Vice-Chair of this Action.

Science Communication Manager

The position of Science Communication Manager is offered to a member of the Management Committee, in the context of the communication & dissemination of the Pearl PV activities and outputs/results. This

challenging role is associated with the following duties:

- Publicly disclose of Pearl PV COST Action's activities by any appropriate means.
- Disseminate results and outputs generated by Working Groups (WGs).
- Revise communication strategy and implement tools to communicate outputs & activities of the action, namely:
Prepare announcements in specialized journals.
Prepare material for project website for purpose of information, communication & promotion.
Use social media (e.g LinkedIn, Twitter) for promotion of the Action, results of the WGs etc.
Prepare press releases for events as well as advertisements whenever useful.

- Follow the Guidelines for the communication, dissemination and exploitation of COST Action results and outcomes.
- Remind participants to disseminate the Action when attending international conferences.
- Remind participants to acknowledge the Action in research articles.
- Keep track of publications from participants during the lifetime of the Action.
- Design dissemination material when necessary and within available budget.

We have a vacancy at **WG1** for a volunteer leading task 1.3 "Development of generally accepted approaches and guidelines for analysis" and task 1.4 "Development of access strategy to data-bank". Note that regarding task 1.3 we can draw upon the reports published by IEA-PVPS Task 13. Some of the data bank access strategy already has been implemented in the data bank itself. If you are interested, please contact the Working Group leader Prof. Wilfried van Sark (W.G.J.H.M.vanSark@uu.nl).

We have a **vacancy at WG2** for a volunteer who would **lead sub-task**

2.2 on "Identification of relevant data to be collected to measure reliability and durability".

Task 2 aims to identify the required data and appropriate simulation models to be used in the framework of understanding reliability and durability given the challenges of (i) the often long elapsed duration before occurrence of both defects and degradation of PV modules in the field (ii) the climate dependency of these effects and (iii) relationships between the manufactured quality of PV module and observed reliability and durability in practice.

If you are interested please contact Dr.Mohammadreza Aghaei (m.ghaei@tue.nl)

Contribute

Thanks for reading, and if you would like to contribute to the next Newsletter please contact Sarah McCormack at mccorms1@tcd.ie before 1 Nov 2019. Next issue will be published in Dec 2019.

Acknowledgement

This Newsletter is based upon work from COST Action CA16235 - Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data – also called PEARL PV, supported by COST (European Cooperation in Science and Technology): www.cost.eu

PEARL PV Partners



Deloitte.



COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. COST Actions help connect research initiatives across Europe and enable scientists to grow their ideas by

sharing them with their peers. This boosts their research, career and innovation.

COST Description

