Nicola Pearsall, WG3 Leader

Trained as a physicist, I have been involved in photovoltaics since the eighties. In the early nineties my group was involved in studies on the solar resource, among which was the first study on the potential solar output in the UK. This included an actual demonstration of retrofitting a building with solar panels. We did the monitoring and analysis on the system-side.

WORKING GROUP 3

Nicola Pearsall

‘Modelling is highly useful for predicting real-life situations’

Analysing, predicting and comparing performance
My expertise lies in *predicting* what the system will do in terms of performance, as well as *analysing* and *comparing* to the actual performance, looking at the effect of design, the operating conditions and faults in the system operation. This relates to the focus of Working Group 3 on *simulation* and *modelling* the performance of PV *modules and systems*. What we want is accurate prediction of their performance.

There is a great deal of modelling software available. One problem, however, is: they present predictions on the basis of *average* conditions. But this isn't always useful! For short term predictions, it can be more useful to use non-averaged data. This will tell you how low and high you may go, and how your design is functioning. If you base your predictions on averaged input data, however, you don't know what will happen in case of extremes. With lots of panels connected to the grid, on a very sunny day, this may have an effect on the grid, increasing the voltage. So the grid should be designed such that it can cope with such extremes. We need to be prepared and perhaps take measures such as *storage* in batteries or electric vehicles.

Real-life situations
The importance of simulating the performance lies in the

Prof. Nicola Pearsall holds a degree in physics. She has been working at the Department of Mathematics, Physics and Electrical Engineering at Northumbria University in renewable energy, specialising in photovoltaics. Her research experience includes simulation and modelling, and more specifically, analysis of PV system performance and assessment of environmental impact as well as the impact of renewable energy on the electricity grid and within the built environment.

prediction of *real-life situations.* You do the modelling and predicting, and then you look whether this fits the real data. Compare this with planning a journey. You select your flight and a hotel on the basis of assumptions. Then you see how your predictions have worked out in a real-life situation, so that next time, you can make choices on the basis of your earlier experiences. Did your hotel meet your expectations? Then you might consider going back. Did you have to wait for al long time at the check-in counter? Then you might consider taking an earlier train to the airport.

Now that we move forward to more PV as a major energy supplier along with other renewables, it becomes more and more important to know how to get the best results. How do we, for instance, design the grid so that it can deal with the surpluses of solar energy? This is also true for to the built environment. Most of our buildings were designed decades ago. And the buildings that we are designing now will still be in use in the following decades. Retrofitting is something that needs to be done every 20 to 30 years, so we need to be aware of this when designing our buildings.

Interrelation with other WGs
Which brings us to the interrelation of the other WGs in the network. With WG 4, there is the link in terms of city and building design, while with WG 1 we link with the data they are already collecting on existing situations and buildings. You need the existing data to validate and predict PV performance. With WG 2 the interrelation is in how the performance of modules will change, as this gives you long-term performance information. Finally, the link with WG 5: what is the effect of PV on the grid? This means analysing the current situation, but also how the infrastructure needs to change as we move forward.

Comparing existing and developing new software
What we as WG 3 have done is identify all kinds of software that have already been developed. There is a lot of software available for different purposes: commercial purposes, but

also for highly detailed research purposes, for instance, to predict the degradation of PV modules or systems, with all of the models having advantages and disadvantages. What we do not (yet), however, have is some specific software that deals with all the latest developments in system design. Therefore, we started by asking PEARL PV participants: which software do you actually use, which advantages and disadvantages do you encounter. And most of all: what kind of software are you looking for, that is not there yet?

'We make our choices on the basis of earlier experiences. With modelling, you basically do the same: you predict the performance and then compare with real system data.'

The next step will be doing our own tests, taking the same modules and methods, to be tested by different people within the network. For PEARL PV this means looking at modelling a specific system with different software. The question is: how do the different software models compare in modelling specific system characteristics? The idea is that in the end, we can give advice to the PV community on the performance of the *existing* software packages, as well as develop *new* software, based on the acquired knowledge. In order to do so, we'll need different rounds of testing, this being an ongoing development!

Mirjana Devetaković, WG4 Leader

Have studied to be an architect, my field of expertise is information technology in architecture as well as Building Information Modelling (BIM). Which also brings me to the PEARL PV network: how to combine solar BIM with big data?

WORKING GROUP 4

Mirjana Devetaković

‘I expect that in a few years solar PV also will gain ground in the South East European region’

Climate change and urban environment: adaptation and mitigation

The impact of Climate Change on the urban environment is a major concern that has been my subject of interest for years: how does the ongoing climate change influence the urban environment? Adaptation and flexibility to climate change need our thorough attention. In Serbia, for example, we had a recent period of huge floods. Now how are we going to solve this and make our cities more resilient? Careful planning and designing new buildings according to certain principles to resist demanding circumstances, such as appropriate foundations and specific ground floor design, can certainly help.

Mitigation is an important strategy for dealing with climate change, in which the installation of PV on a large scale plays an important role. The presence of PV systems in our region, not only in Serbia but also in the entire Western Balkan, however, is still at an early stage. In Hungary, especially in the southern part, solar is playing a much bigger role already, as I can see with my own eyes while traveling from Belgrade to Budapest. With Hungary being our neighbouring country, this sets an example for our region. I am hopeful that, with technology gaining ground from North to South, the situation will change in a few years.

Building Information Modelling (BIM) and the application of PV in buildings

Within Working Group 4 we are exploring the potential of Building Information Modelling in the application of PV in buildings. Contemporary BIM software tools are fully equipped to provide us with information on solar potential in any location. This is also where my expertise can be useful. Talking about PV in the built environment and teaching architects, we have to be aware of the possibilities of sunshine to produce electricity, as well as of the potential of the so called BIPV (Building Integrated PV) to contribute to overall functionality and aesthetics of buildings. My mission is to mediate between technical developments of PV technology on the one hand and architecture and urban design on the other hand, and to explore how to connect those two.

I had, at the University of Belgrade, already been involved in solar geometry studies. Which means how sunshine moves, which effect solar angle and tilts might have on any surface of the buildings, but also the orientation of the buildings themselves, in order to define how to produce electricity optimally. Achieving a full awareness of those aspects is very important.

With building information modelling we have to take into account not only the roof but also windows, facades, shades etcetera, as well as other urban furniture, such as benches and all kinds of infrastructure. While designing and including all those elements in information models you have to be aware that buildings produce energy. This can be observed over the entire lifecycle of buildings, that is throughout all the four different stages of design: not only the conceptualisation and the actual design, but also in the stage of construction and facility management.

Making use of big data

I am very excited that for our research in WG 4 we are going to have access to data from the existing built environment use of data from different regions and environments.

Mirjana Devetaković graduated from the Faculty of Architecture of the University of Belgrade, Serbia, where she is now working as a senior researcher. Her expertise includes information technology in architecture and Building Information Modelling (BIM). For PEARL PV network she is working on combining BIM with PV big data.

‘My mission is to mediate between developments in PV technology on the one hand, and architecture and urban design on the other, and to see how we can more efficiently connect those.’

The next step then will be to distinguish data that are relevant for the built environment, followed by visualising these data and making analyses. In the end, this will help us improve the design. How? By seeing how the built environment relates to PV production in terms of avoiding mistakes and technical obstacles, such as unnecessary shadows, inappropriate material choice, differences in urban density and additional technical requirements.

With PV systems being relatively new in buildings, the focus of our research is on ‘landmark objects’, such as public buildings, hospitals, big hotels and schools. Why? Because they are different from the surrounding built environment, while, in relation with photovoltaics, they set an example for local and wider community. For this we want, in cooperation with WG 1, to set up a study with a focus on university buildings all over Europe. For this purpose data will be collected from PEARL PV participants. University campuses are very useful to start with, as they usually consist of old and new buildings and contain a considerable density of buildings, and usually already have installed PV, while data are accessible through PEARL PV network partners. I am very enthusiastic about this project, in which we can connect those data with BIM modelling, visualising data and getting new information on the behaviour and design of buildings.

The PEARL PV network provides me with an excellent opportunity to get to know other researchers. We all benefit from this kind of exchange of knowledge. My contribution lies in relating big data to BIM modelling, while simulating and observing how buildings behave.

Jonathan Leloux, WG5 Leader

Born in Belgium, I studied mining and geology engineering. After spending two months in the copper-mines in Chile, however, I decided I rather wanted to do something with energy and recycling.

WORKING GROUP 5

Jonathan Leloux

‘To integrate the increasing amount of solar power, we either have to adapt the grid or the PV system. Or both.’

Learning in practice
I have been working in solar energy for 14 years now, starting with an internship at a solar company in Spain. At the same time, I enrolled at the University of Madrid, with a specialisation in energy. From there I moved on to working as a technology and engineering manager for a Spanish solar company, learning all kinds of PV related things in practice, such as infrastructure, solar irradiation and PV system designs in general.

In 2008, I was offered a PhD research appointment at the Solar Energy Institute of the Universidad Politécnica de Madrid, where I am still working as a researcher. Not much later I started my own company as a solar energy consultant, which I am running in parallel to my research activities.

Evaluating solar systems
My consulting activities involve the evaluation of the performance of solar systems. This relates to the PEARL PV’s other working groups, as solar integration in grids is interconnected with data analysis (WG 1) as well as simulation (WG 3).

My parallel jobs as a solar energy consultant and as a researcher are perfectly intertwined. My clients being consulting companies, banks, PV plant owners and administrative or public bodies, as a consultant, I am familiar not only with their problems and reality, but also with the

Jonathan Leloux holds a Mining and Geology Engineering Degree as well as a Master of Research in Solar Energy. He is currently working as a researcher at the Solar Energy Institute of the Universidad Politécnica de Madrid and in parallel as an independentsolar energy consultant.

data involved. I have analysed the data from thousands of PV systems. My company provides services, related to energy simulation, yield prognosis, financial profitability and risk, and monitoring data analysis. I analyse data, for instance, for IT companies involved in installing and monitoring the PV systems, but with little knowledge of them. That is also what makes my work really interesting: researchers usually have no access to large amounts of data on PV systems, while I can make use of those for my publications as a researcher.

Grids and data

A few years ago, while visiting the yearly European PV solar conference EU-PVSEC, I came in contact with people with a mutual interest, such as Wilfried van Sark, who is now leader of WG 1. He turned out to be working on similar topics, such as large-scale PV performance data analysis. It was him who contacted me as he was working with Angèle Reinders and some other people on the project proposal for PEARL PV. After some time, to my great surprise and honour I received another mail informing me that the project proposal had been accepted, as well as inviting me to join the network as the leader of Working Group 5.

Working Group 5 is mainly about the integration of the increasing power into the grid from solar but also other renewables, but also on data analysis. This is something we have to deal with, *either by adapting the grid or the PV system, or both*. The goal is to increase PV power, but the grid must be able to accommodate for this. To investigate how this can be realised, we are now working with datasets of more than 20,000 small PV systems, made accessible to us from companies or associations in the solar energy field that I collaborate with. This wouldn't otherwise have been possible for privacy issues and commercial interests. The companies involved, however, are in the end interested in the same thing: to improve their services! PEARL PV participants therefore now also have access to those data and have already started using them.

‘Thanks to my work as a solar energy consultant, I am familiar with the reality of my clients, as well as the data.’

Web service
What we want to accomplish is to develop web services that provide full performance analysis services for PV systems. The idea being that it communicates with the system and automatically detects failures. This correlates to the performance analysis on a global scale in Working Group 1. But it also has to do with an analysis in relation with increasing PV and the grid in relation to, for instance, the power fluctuation due to passing clouds in neighbourhoods, that is the correlation between the power intermittency of neighbouring PV systems. The worst thing for the grid is when all the neighbouring PV systems see their power output fluctuating at the same time, as the grid then would get overloaded. Fortunately, in reality, this is hardly to be expected as the variation in the cloud cover is not homogeneous nor simultaneous over a region. Therefore, we want to try to statistically evaluate what is both the worst case, being stale fluctuation, and the best case, which is a perfectly dispatchable power, and then determine what is in between: the typical fluctuation in reality.

This is important to be able to assess how much more PV we can integrate into the grid. From there we can come up with mitigation solutions, such as storing the surplus of energy in *batteries,* but also other new, innovative field as batteries in *vehicles*. Which is related to another object of study of ours: the correlation of energy from PV panels and *self-consumption*, including *collective* self-consumption*,* and ways to sell your surplus energy to your neighbours.

Markus Schubert, STSM Manager

With a background in electrical engineering and semiconductor physics, my research focus at the University of Stuttgart has shifted from silicon thin film semiconductors, solar cells and photodetectors to photovoltaic (PV) systems and, more currently, to PV systems' inspections by daylight luminescence and on bioanalytical sensors.

SHORT TERM SCIENTIFIC MISSION (STSM) COORDINATOR

Markus Schubert

'What makes the STSM exchange program really interesting is that its scope is very wide'

Wide range of opportunities
I was involved in the proposal of the PEARL PV project from the beginning and became its Short Term Scientific Mission (STSM) coordinator. My tasks as such are basically advertising the opportunities of STSM, guiding through the application procedure, checking and pre-approving the STSM applications.

What makes this STSM program then really interesting is that its scope is very wide. It is targeted at single researchers, leaving their home institutions for a certain period of scientific exchange with another research institute. The length of this stay can be anything from 5 to 180 days, targeted to experienced as well as early career investigators. Hosting research institutes can include universities, but also other research centres as well as companies with a strong focus on R&D. This is, by the way, not limited to PEARL PV member institutions only, but is open for institutions in *all* COST member countries involved in the PEARL PV project.

It is important that these opportunities are strongly emphasized on the STSM website, as well as in advertising mailings and at PEARL PV meetings. Our STSM website also presents offers by research institutions to individual

Being educated in electrical engineering, Markus Schubert's research focus covered silicon thin film semiconductors and photovoltaics. He is currently working as group leader and associate director at the Institute for Photovoltaics at the University of Stuttgart in Germany, where he is involved in research on PV systems inspections and bioanalytical sensors. For the PEARL PV project he acts as the Short Term Scientific Mission (STSM) coordinator.

researchers with a certain topic. Both individual researchers *and* institutions can propose such a topic for scientific exchange and cooperation. It is also important to communicate the procedures for acceptance of a STSM application, such as the PEARL PV catalogue of priorities and how everything should be embedded in the PEARL PV project.

Priorities and objectives

Such a priority is the involvement of so-called Inclusiveness Target Countries (ITC): candidates to the EU but also countries such as Portugal, Poland, Hungary or Bulgaria, which are already EU-members but are not as far as other EU countries when it comes to solar research. The idea is to foster exchange between countries with strong and less strong infrastructures for PV research. Another priority is the involvement of early career investigators (ECI), up to eight years after receiving their PhD degree. PEARL PV wants to support young researchers in their scientific career. By bringing them in contact with other, more experienced researchers, they can learn a great deal. Moreover, such cooperations are important to proceed in reaching the climate targets in different regions in Europe. That is what the whole COST action program is all about: networking! Finally, gender-balance is an important priority for STSM exchanges.

Up till now we had 4 to 6 successful STSM applications within each one-year Grant Period. In the future we want to extend this to 6 to 8 applications per year with more short-term exchanges in order to enhance the knowledge transfer within the PEARL PV network. As we are already covering most countries in Europe, the two main objectives of STSMs are fostering the individual networking of researchers and, on the project level, supporting the objectives of PEARL PV, as a means to achieve more reliable, long-term stable PV contributions to the electricity supply all over Europe.

During the first Grant Period of the PEARL PV project, most STSM initiatives came from individual researchers, while

‘The two main objectives of STSMs are: fostering the individual networking of researchers and, on the project level, supporting the objectives of PEARL PV, that is to have more reliable photovoltaics in the EU with superior long-term performance.’

the STSMs of the second Grant Period were more closely linked with topics covered by the PEARL PV Working Groups. This is exactly what the PEARL PV project intends to further stimulate. STSM tasks and topics will be identified and offered by the members and leaders of the various Working Groups and will link more directly to the PEARL PV project goals and to ongoing work in the Working Groups. Suppose, for instance, that you have a specialist in the field of data evaluation, and another specialist in PV performance, linked to different Working Groups of PEARL PV. Now in one group you have the tools, while in the other you have the data. The question is: how to bring their expertise together? This is possible by using STSMs. This is especially rewarding for PhD students. But also for more senior researchers short-term STSMs enhance the mutual knowledge and fruitful interaction between research groups in the different member countries.

Benefits of networking exchanges

To illustrate the practical benefits of such STSMs: researchers from Spain and Cyprus are now cooperating on implementing performance monitoring tools for PV systems to assess their ‘health’: do they perform well or not? This involved a STSM, hosted by the University of Cyprus, which resulted in improved algorithms and first steps towards a user-friendly visualisation of PV system performance for everybody’s use. Consequently, other STSM exchanges addressed the fault detection in large PV plants by unmanned aerial vehicles, updating the knowledge on potential induced degradation of PV modules, as well as joint investigations on various PV performance data.

For more information on the STSM opportunities and application procedure please check the website: https://www.pearlpv-cost.eu/activities/short-term-scientific-missions-stsms/

Eliza Loucaidou, Science Communication Manager

How to join PEARL PV?

Are you interested in contributing to the research that is executed by the PEARL PV research network, do you want to contribute with data or are you working for a company, bank or consumer association with specific questions about PV systems? You may visit our website at: https://www.pearlpv-cost.eu/ for more information and follow us on Twitter @CostPearl

You are also welcome to contact the Chair of this Action, the Vice Chair or one of the 5 Working Group Leaders by email.Addresses are shown below.

You can express your interest to be registered as a participant of PEARL PV through this registration form: https://www.pearlpv-cost.eu/about/registration/. However, please note that participating also means contributing to the ongoing research and other activities. You will be asked to become a member of one of the working groups and to attend meetings. We would be happy to learn from your photovoltaic experiences.

We are looking forward to collaborating with you!

Warm regards from the Pearl PV Core Team,

Angèle Reinders, Chair, a.h.m.e.reinders@utwente.nl

David Moser, Vice Chair, david.moser@eurac.edu

Wilfried van Sark, WG1 Leader, w.g.j.h.m.vansark@uu.nl

Bettina Ottersböck, WG2 Leader, bettina.ottersboeck@pccl.at

Nicola Pearsall, WG3 Leader, nicola.pearsall@northumbria.ac.uk

Mirjana Devetaković, WG4 Leader, mirjana.devetakovic@gmail.com

Jonathan Leloux, WG5 Leader, jonathan.leloux@gmail.com

Markus Schubert, STSM Manager, markus.schubert@ipv.uni-stuttgart.de

Eliza Loucaidou, Science Communication Manager, eloucaidou@deloitte.com

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