29th European Photovoltaic Solar Energy Conference and Exhibition,
Amsterdam, the Netherlands, 22-26 September 2014

STRATEGIC VISION ON PV RESEARCH INFRASTRUCTURE IN EUROPE

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ABSTRACT: The European FP7 project "SOPHIA" has worked on a Strategic Research Infrastructure Agenda, presenting a listing of existing Research Infrastructure (RI) across the consortium of this project , current trends in access and use of PV RI as well as recommendations for future PV RI, upgrading the capability of EU PV RI. This agenda is targeted at those who make decisions on the allocation of research budgets. It might be taken up by ESFRI (European Strategy Forum on RI) in the next update of its roadmap, by presenting a view to set a whole range of multi-purpose RI, addressing the whole PV value chain form the lab to the fab all along the Technological Readiness Level (TRL) scale. It should further enable flexible cooperation and optimal use by European user communities.
Keywords: Research infrastructure, Strategy, Roadmap

1 INTRODUCTION

The European Energy Research Alliance (EERA) is helping to coordinate a massive public research effort to push renewable technologies forward, as part of the Strategic Energy Technology Plan (SET-Plan), launched by the European Commission and Member States in 2007. The EERA Joint Programme on Photovoltaic Solar Energy will contribute to these goals and to developments beyond 2020 through Europe-wide programming and aligning of R&D activities in member states. This includes the inventory of the research infrastructure (RI) available at the European R&D institutes as well as defining the future requirements for the R&D infrastructure in order to keep up to date with new PV developments. This has led to the Strategic Research Infrastructure Agenda (SRIA), which is developed in the framework of the FP7 'SOPHIA' project[1].

The SRIA will present the consensual view of the 20 partners of SOPHIA (European research centres and EPIA) on RI for photovoltaic energy. The document will discuss current trends in the access and use of photovoltaic RI from the entire PV field: silicon materials, organic PV, thin films, concentrator PV, module lifetime, module and system performance, modelling and building integrated PV.

The aim of this document is further to identify future needs by setting up a whole range of multi-purpose RI addressing all the PV value chain from lab to fab and the market.

2 APPROACH

The evidence base for the SRIA is written input from members of the SOPHIA consortium with expertise in certain specific fields of PV technologies, who have consulted, in a structured manner. Drafts of the SRIA have been presented to the whole consortium at project General Assemblies taking place in April 2013, November 2013 and March 2014. Suggestions for improvements have been taken on board in subsequent drafts.

3 SRIA OVERVIEW

3.1 What is Research Infrastructure?

RI as understood in this document is the scientific apparatus or cluster of different equipment with a common objective needed to carry out an experiment. The complex in which it is housed is the "research centre". In the context of the SOPHIA project, RI might be a climate chamber for accelerated ageing tests, test rigs to simulate faults on the grid and analyse the response of inverters or a synchrotron for probing the structure of materials. A pilot line and the equipment manufacturing devices comprising it may also be described as RI (these are crucial for developing and testing novel manufacturing processes ahead of their transfer to industry.). Also, a 1-2 MW plant with flexibility for testing different solutions to grid feed-in and to the provision of auxlliary services would be considered RI. The understanding of 'RI' is sometimes broader, including the resources, services and IT infrastructrure needed to support a research centre, as well as "soft" items such as collaboration platforms. We restrict our discussion to hardware because it is often the core of a research centre, with resources and services being there to support the hardware or the people who use it.

3.2 European PV Research Infrastructures in figures

As mentioned in the introduction, the EERA aims to strengthen, expand and optimise EU energy research capabilities through the sharing of world-class national facilities in Europe and the joint realisation of pan-European research programmes. SOPHIA follows EERA's structure of technical topics as listed below:

- Silicon materials
- Organic PV
- Thin film PV
- Concentrator PV
- Modelling
- Lifetime prediction
- Module and system performance
- BIPV

As a given facility could be used for different technological topics (for example an outdoor module testing bench), these different technical topics were merged into two RI clusters, named TNA01 and TNA02, where TNA stands for Trans-National Access. Within the SOPHIA project, the consortium members offered access to these facilities with the aim to provide European researchers the possibiity to execute research projects on state-of-the-art research facilities not available in their own organisations. Some of the RI have not been requested by users, but the very unique ones supported several research activities.

TNA 01: **Facilities for improved characterisation of materials and innovative technologies for PV**
(covering the topics on silicon materials, organic PV,thin film and cell modelling)
This TNA component makes available outstanding facilities for the testing and characterizing of new technologies/materials at lab scale. Staff at the host site also assist in the analysis of experiment results.

TNA 02: Facilities to develop common approach to evaluating the performance and lifetime of PV modules (covering the topics on concentrated photovoltaics (CPV), module lifetime and module & system performance)
This TNA makes available testing facilities for characterising and qualifying existing or prototype commercial devices at a range of geographical locations around Europe. As part of SOPHIA research activities, these facilities have benchmarked their proprietary methodologies and procedures in order to understand the strengths and weaknesses of each and how to map test results between them.

The detailed facilities that SOPHIA offered per technical topic are presented in Figure 1, while the geographical spread of SOPHIA partners is shown in figure 2

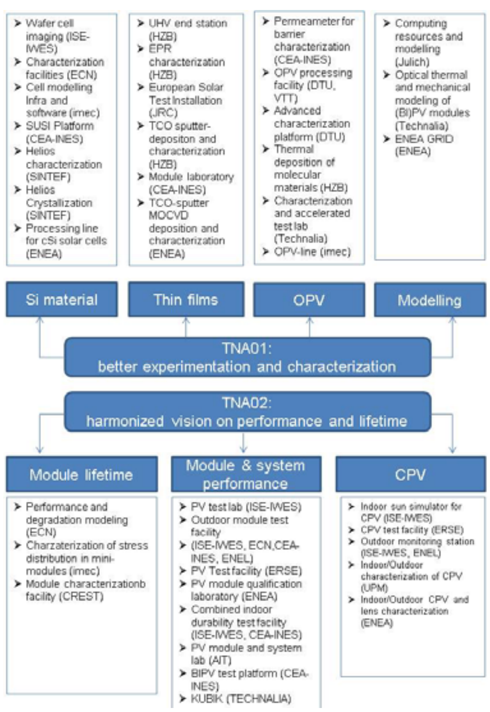

Figure 1: List of TNA PV Research Infrastructure facilities offered by the Sophia project

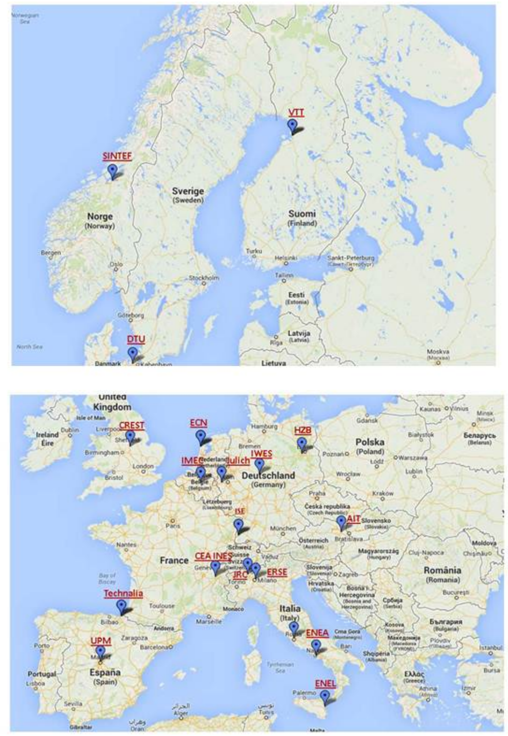

Figure 2: Maps pinpointing SOPHIA partners. There is good geographical coverage of the EU

3.3 Trends in PV Research Infrastructure

After consulting the SOPHIA consortium the following issues have been identified:

- Effects of manufacturing decline: many research centres have relied on contracts with industry for a large and (until recently) increasing share of their income. They have allowed industry to access their apparatus, most often with their staff on-hand to guide them or to perform the experiments on their behalf. Their collaborations have been paid for entirely by industry or subsidised in the framework of national or European projects. In any case, regardless of the form or detail of a particular collaboration, a weaker PV industry could result in job losses in research centres or a downscaling of its capacity to perform the highest quality research.
- The current ‘growth’ area is mainly for downstream work, in particular related to module testing, module performance assessment and system grid integration. The PV community appears relatively less interested in cost per Wp than in the past, and relatively more interested in the amount of kWh that may be fed into the grid for a given investment cost, which implies a concern for the productivity of PV devices. This also is resulting in a expansion and/or reorientation of the activities of R&D centres to cater for the needs of the downsream end of business.
- Interest in unique single-site research infrastructure like for instance BESSY[3] (HZB, Berlin) or high performing supercomputing facilities (FZ Julich, Enea-Grid) remains strong.
- The range of services offered by research centres is increasing. They are more dependent on public money than they were a few years ago when the European market was booming. Industry funding of

research apparatus is declining. Research centres have embraced a variety of survival strategies:

- “go niche”: market RI for unique market applications
- “go extensive”: establish a vertically integrated service, including complete maufacturing lines, capable of assessing the overall value of new or improved concepts
- “go international”: Increase visibility and and attractiveness to companies overseas
- “be complementary”: Harder times promote cooperation over competition
- “get exposure to other industries”by utilizing opportunites for cross-fertilization and exploitation of developed expertise in other business areas/markets than PV
- “market yourself as a cost-saving option”: offering of “affiliates” or “shared research” programmes.
- “clustering”: aggregation of RI-owning entities, could profit from increased interactions between the entitities strengthening their position in the cluster collectively.

3.4 Upgrading the capability of EU PV Research Infrastructures

Ideas for future PV RI needs were collected from the consortium members. The needs were consistent with existing roadmaps like the SEII Implementation Plan[2]. A more detailed description per technical topic will be available in the final SRIA document which is scheduled for publication in January 2015. Table I shows an overview of recommended RI related to electrical performance characterisation. The affected technologies are listed alongside.

Table I: Needs for electical performance characterisaiton RI as identified by the SOPHIA experts, together with the relevant technologies affected by the RI

Modules	
Recommended RI	***Technologies***
Solar simulators with flexibiity for non-STC conditions (wide rang of intensities, tunable spectral content, temperature control, extended measurement duration etc.)	Thin films, OPV, advanced Silicon concepts
Very large area (10 m^2) continuous sun simulator, with collimated light as a further option	CPV, BIPV, thin films
Tools for preconditioning (temperature, spectrum, intensity, duration)	Thin films, OPV
Solar simulatorswith collimated light and tunable spectrum for “power matching”	CPV
Advanced analytical and imaging techniques for module failure analysis	All
Climate chambers for multiple stress testing (DH+UV/VIS)	All
Systems	
Recommended RI	***Technologies***
Sites for field testing of grid-connected PV systems with flexibility to explore new configurations, operational modes and different climate condition (central Europe, mediterranean area, apline, marine, etc)	All
Smart home and buiding systems	All
BIPV test demos and facades, addressing electrical and thermal performance	All, BIPV
General	
Recommended RI	***Technologies***
Development of new and improved testing protocols, supported by appropriate benchmarking and quality control	All
Modelling tools for performance assessment (electrical, thermal), simulation of degradation behavior,	All
Performance databases (e-infrastructures)	All

Most of the recommendations, as listed in Table 1, are related to the extension of existing, facilities for testing, characterisation, analysis and modelling for more upstream (i.e. concepts low-to-mid TRL) research.

3.5 Advanced Manufacturing Research Infrastructure

The consortium have also noted the need for RI dedicated to establishing advanced manfacturing processes and for bringing these to a commercially viable level. Indeed EERA-PV wishes to support the creation of several large scale technology R&D platforms to accelerate the transfer of promising high efficiency concepts from “lab” to “fab”. This will also impose new approaches to performance characterization and reliability by defining new test standards and revision of already existing ones The upcoming SRIA will further elaborate on these ideas.

4 CLOSING REMARKS

The SOPHIA project has developed a Strategic Research Infrastructure Agenda for photovoltaics in Europe, with an analysis of existing RIs, current trends in their access and use as well as recommendations for future, upgrading. It is hoped that these will be addressed by public and private funding. Where appropriate these should be taken up by ESFRI (European Strategy Forum on Research Infrastructure) in the next update of its roadmap), with a view to set up a whole range of multi-purpose RI, addressing the whole PV value chain form the lab to the fab all along the TRL scale. It should further enable flexible cooperation and optimal use by European user communities.

The lessons learned from TNAs and work on the SRIA document has led to the following provisional recommendations, which will be refined after stakeholder feedback for publication in January 2015:

- Continuation of public access to outstanding and unique equipment for characterisation and analysis as well as larger facilities for supercomputing.
- Continued actions to coordinate and stimulate exchange and use of RI dedicated to accelerated life time testing and life time predictions.
- More in-depth focus is required on specific research topics such as quality assurance, reliability and standardisation, which are considered as important drivers for a competitive European industry offering premium products to investors and consumers.
- The establishment of a number of large-scale pilot production lines which are crucial for co-developing and testing novel manufacturing processes for different PV technologies (x-Si, CIGS, TF-Si and OPV) and manufacturing concepts (HIT, MWT, IBC, other) ahead of their transfer to industry.

5 ACKNOWLEDGEMENTS

This work is supported by the EU-FP7 project "SOPHIA", Grant Agreement number: 262533

6 REFERENCES

[1] 'PhotoVoltaic European Research Infrastructure'; http://www.sophia-ri.eu/about/partners
[2] The SEII IP 2013-2015 can be found on: http://www.eupvplatform.org/publications.html
[3] BESSY stands for a synchroton source and is a large facility for materials research, belonging to helmholtz Zentrum Berlin (HZB)