



Project SOPHIA
PhotoVoltaic European Research Infrastructure
 GA N° 262533

Data Beneficiary

Name Beneficiary	FhG
Contact person	Gerald Siefer
Postal address	Heidenhofstrasse 2, 79110 Freiburg, Germany
E-mail	gerald.siefer@ise.fraunhofer.de
Project Website	www.sophia-ri.eu

NA2: Expert groups on a PV infrastructure Strategic Vision

**D2.2 (M33)– Consolidated public yearly progress report on PV
 Infrastructure Networking Activities**

Proprietary rights statement

This document contains information, which is proprietary to the SOPHIA consortium. Neither this document, nor the information contained herein, shall be used, duplicated or communicated by any means to any third party, in whole or in parts, except prior written consent of the SOPHIA consortium.

Document Information

Document Name	SOPHIA_D2.2(M33).docx
Revision	Final Draft
Due date Annex I	M33
Author	Gerald Siefer, based on inputs from: Brigitte-Y Assoa, Ian Bennett, Jürgen Hüpkes, Iver Lauermann, Peter Sommer-Larsen, Nigel Taylor, Wilhelm Warta
Dissemination Level	Public Restricted Confidential

Document approval

Name	Position in the project	Beneficiary	Date	Visa
Philippe Malbranche	Coordinator	CEA	18/03/2014	PM

Document history

Revision	Date	Modification	Author
V1	28/05/13	Creation	Gerald Siefer
V2	8/7/13	Minor editing	Maarten de Bruijne
V3	22/7/13	Minor editing	Gerald Siefer
V4	9/09/13	Comments	Stéphanie Ruguet
V5	18/03/14	Final check	Philippe Malbranche

Table of contents

1	Executive summary	4
1.1	Description of the deliverable content and purpose	4
1.2	Deviation from objectives, corrective action	4
1.3	Technical progress.....	4
1.4	Impact of the results	4
1.5	Dissemination activities carried out, planned	4
2	Technical sections.....	5
2.1	Si-material	5
2.2	OPV	5
2.3	Thin films	6
2.4	CPV	6
2.5	Cell Modelling.....	7
2.6	Lifetime prediction	7
2.7	Module & system performance	8
2.8	BIPV	8
3	Conclusions.....	9
4	References.....	9

1 Executive summary

1.1 Description of the deliverable content and purpose

The objective of this deliverables is to summarize, in a public progress report, the work done by the experts groups regarding the eight technical topics addressed within the networking activities of the SOPHIA project:

- Si material (FhG ISE, ECN, CEA/INES, IMEC, SINTEF, ENEA)
- Organic material (Risoe DTU, ECN, CEA-INES, IMEC, TECNALIA, VTT, ENEA)
- Thin Film Technology (HZB, FZ Jülich, AIT, JRC, ENEA, SINTEF, EPIA, EUREC, ECN, CEA, FhG ISE)
- Concentrated PV (ENEA, RSE, ENEL, CEA-INES, UPM, Tecnalia, FhG ISE, JRC – external partner Soitec)
- Cell Modelling (FZ Jülich, ECN, CEA-INES, IMEC, HZB))
- Lifetime prediction (ECN, IMEC, CREST, CEA-INES, JRC, EPIA, AIT)
- Module and system performance (JRC, FhG, ECN, CEA-INES, ENEL, RSE, CREST, Tecnalia, EUREC, EPIA, AIT, DerLab, ENEA, external partner Phoenix Solar)
- BIPV (CEA-INES, AIT, Tecnalia, FhG, JRC, EPIA, ENEA, external partner HELIOTOP)

The deliverable covers the period from M13 to M24.

1.2 Deviation from objectives, corrective action

N/A

1.3 Technical progress

The work of the expert groups progresses well. Several round robin activities were planned and are supervised by the individual expert groups. The expert groups especially gave helpful input regarding the definition of the procedures to be applied within the intercomparison activities.

1.4 Impact of the results

It is intended to support the standardization activities within several subgroups of the IEC technical committee 82 (IEC TC82). As several SOPHIA partners are member of different working groups of TC82 a direct approach to the standardization bodies is guaranteed.

1.5 Dissemination activities carried out, planned

Several workshops and meetings of the different groups have already been held. See also D3.1 for an overview of organised workshops, and D5.4 for the planned dissemination and promotion activities.

2 Technical sections

2.1 *Si-material*

Several Si(licon)-material related round robins that are performed in Work Package 11 (JRA 03) are supervised by the expert group. Some of the round robin activities were completed in part within the reporting period. These dedicated round robin efforts were run aiming at elaborating differences between the participating infrastructures concerning characterisation of material and cell properties.

It has been agreed within the material expert group that there is the need to have a common basis for the determination of the most central performance parameters of a solar cell, i.e. the parameters determined from the illuminated current to voltage curve and the spectral response.

As a first step, an initial measurement round robin was performed with standard type industrial cells. Within the round robin the cell's spectral response and current voltage characteristic was measured.

Additionally the expert group pointed out that the long wavelength internal quantum efficiency gives good access to the material quality of a solar cell. For the determination of the internal quantum efficiency the spectral response and the reflection is required. Thus, a further intercomparison on reflection measurements has been successfully conducted.

2.2 *OPV*

The organic photovoltaic (OPV) expert group has successfully initiated a characterisation intercomparison that is still on-going. The goal is to improve and harmonize test procedures, parameters and equipment in order to increase the interoperability of cell and module tests between European partners in EERA and SOPHIA. The status of this activity is reported under JRA 3.2.

An additional study has been initiated in September 2012 with the goal to improve characterisation and prediction methods as well as procedures for OPV materials, performance and lifetime studies. A further aim of this study is to clarify the relations between materials properties and performance of OPV devices.

It is planned to initiate a further round robin study for studying inter-operability and inter-comparability of testing OPV stability. The performance round robin study finalized in the present reporting period can be viewed as a pre-study for the demanding life-time tests planned for the next study. Protocols will be prepared with the aim to support the on-going ISOS (International Summit on Organic Photovoltaic Stability) work on OPV stability. Also the study will run in parallel with a non-SOPHIA initiated international outdoor inter-laboratory test presently being arranged.

Two further round robin studies are under consideration at the moment. This involves a material round robin as well as an OPV encapsulation round robin. However, the feasibility of the latter one still needs to be verified.

2.3 Thin films

Currently the thin film expert group has started work on a strategic vision for PV research infrastructure (RI) with respect to thin film devices and transparent conductive Oxides (TCOs). This work has been initiated during the meeting in Freiburg during the 2012 SOPHIA general assembly.

A questionnaire about the PV research infrastructure was prepared following discussions during the SOPHIA meeting in Brussels in October 2012. The questionnaire has been circulated among the members of the expert group. The outcome of this activity is now used to write a first draft for the strategic vision on PV research infrastructure. During the SOPHIA GA in April 2013 the thin film PV expert group will meet for a working session to add to the current draft and discuss the future of thin film PV research in the light of the current situation in the thin film PV industry.

A training course organised by HZB in October/November 2012 was held to increase awareness on the available research infrastructures at HZB. Additionally training for two specific research infrastructures was offered. The discussion during this workshop has emphasized the need for specialized characterisation infrastructures in the field of thin film PV like EPR (electron paramagnetic resonance) and x-ray based spectroscopy. However such equipment requires large investments and/or special know how and experience, so that they will always be available only at a small number of research centres.

2.4 CPV

The concentrator photovoltaic (CPV) expert group advises and supervises the CPV activities in JRA2. One major success of these activities was the successful combination of SOPHIA partners with an intercomparison activity for spectrally sensitive sensors originating from the EC project APOLLON. Bringing together the two projects in this activity is of benefit for all partners and both projects. A first intercomparison was held in Catania (Italy) in 2012. The success of this activity led to the agreement to repeat this activity again in 2013 in Puertollano in Spain. Additionally a spectral recording network has been initiated successfully and data recording is on the way since beginning of 2013.

A CPV module round robin has been initiated. Here the involvement of external experts from Soitec was beneficial. CPV modules provided by Soitec are under initial characterisation at Fraunhofer ISE at the moment of the writing of this report. The modules will be distributed to the partners after finalizing initial characterisation. Additionally to the full size modules also so called mono modules, comprised of one lens and one cell will be shipped. These mono modules have been manufactured in the frame of the project and will serve as irradiance sensors. The partners are in close contact to the International Electrotechnical Commission, technical committee 82, working group 7 (IEC TC82 WG7) which is responsible for the development of international standards for CPV. Some partners are also

official members of the WG7. The CPV module round robin will be used as practical test for the power rating procedures under discussion for implementation in IEC 62670-3 (power rating of CPV modules and systems). Partners and experts are involved in the WG7 telephone conferences in order to assure that the round robin results will be useful for the standardization activities.

2.5 Cell Modelling

The expert group on cell modelling has identified the problem of lack of awareness of available modelling resources in the research community: many software tools are developed to a high level - however, the modelling activities are typically isolated, do not interact with other software tools and often are not available for user access. Thus a questionnaire with the aim of gathering a collection of available modelling activities and contact persons at various institutions has been initiated. Regularly the questionnaire is being sent out to scientists worldwide. The result of the questionnaire will be published on the SOPHIA website, thus enabling the dissemination of the available expertise.

One highlight of the work of the expert group was the organization of the “1st European Workshop on PV performance modelling” at CEA Ines in Chambéry in February 2013. This has been realized in close co-operation with the activities within JRA 2 and JRA4. The interaction between work packages and partners especially in the JRAs could be successfully strengthened.

2.6 Lifetime prediction

Most effort of the lifetime prediction expert group has been focused on the coordination of the activities in JRA01, whose goal is the development of new module tests and the investigation of their relation to the expected lifetime of the modules. This activity should lead to an adaptation or update of the international standard IEC61215 to become more relevant to lifetime. Meetings were organized at the GA in Freiburg February 2012 and regular conference calls were held.

An overview of test and characterisation facilities at the partners’ institutions has been collected and reported. The document will be updated regularly. New, harsher test methodologies outside IEC61215 have been defined. The tests have been carried out on a set of three different types of module including a reference module with crystalline cells and EVA as encapsulant. The aim is to compare the degradation rate of three different types of modules under different conditions to identify any possible variation in degradation mechanisms.

The expert group will develop recommendations for the development of the research infrastructures. The lack of capacity for testing outside the current IEC61215 and 61730 testing has been identified as main current drawback. This situation limits the capability of the partners to investigate the effect of conditions outside the standard. These conditions will become more and more relevant as the industry grows and modules are installed at different location with different

climatic conditions. The introduction of new module concepts, new cell technologies and new module materials is also predicted to require testing under other conditions than currently used.

2.7 Module & system performance

In late 2011 the module and system performance expert group performed a survey on R&D issues for module and system qualification and qualification of balance of system components. The resulting recommendations were presented to the General Assembly in February 2012. Based on that main topics to be worked on within the JRAs have been identified as developing guidelines for long-term outdoor testing, as well as potential degradation by reverse current and PID (Potential Induced Degradation). In general, it has been concluded that the activities within SOPHIA should focus on R&D infrastructure issues up to module level but not beyond to system level.

The input for SOPHIA's Strategic Research Infrastructure Agenda questionnaire at the end of 2012 highlighted several technical issues including durability, ageing and system lifetime management, energy and power prediction for different applications and innovative devices as well as an increased cooperation on standards and associated pre-normative R&D. These issues are also discussed at the 1st European workshop on PV Performance Modelling workshop in February 2013 and at the General Assembly in April 2013. One outcome of the discussions should be a prioritization of the further activities within the JRAs. Consideration also needs to be given to supporting initiatives for the NA3 (databases, standards) and NA4 (education/training) work packages.

2.8 BIPV

The expert group on building integrated PV (BIPV) has described the state of the art on BIPV performance in the M18 deliverable (D10.14). It is related to the electrical and thermal behaviour and the performance of BIPV systems (non ventilated PV systems). The report comprises an optical analysis part, a thermal behaviour part and an electrical behaviour part.

A questionnaire has circulated in order to provide an overview of JRA2.6 partners' infrastructures, numerical models and measured data on BIPV. In order to realize the benchmark between the partners' models, two or three cases could be selected in the questionnaire answers.

Closely upcoming activities will consist in attending the JRA2 workshop on PV module modelling in February in Chambéry. It will comprise 3 sessions including one BIPV session. During the Brussels meeting in October 2012, additional workshops and training sessions related to BIPV were proposed as activities for years 3 and 4. First discussions were realized between the partners in order to decide about the number, the topics and the participants of these workshops and training sessions. A first workshop could be organized in August 2013 during IBPSA World conference in Chambéry. Further discussions will permit to validate this proposal.

3 Conclusions

During the second year of the SOPHIA project the work of the expert groups focused mainly on:

- Finalizing the gathering of information about the partners capabilities and the research infrastructures available at the partners institutions and elsewhere in Europe. Several questionnaires have been circulated.
- Further recommendations for, as well as steering and planning of the activities within the joint research activities (JRAs)
- Initiating and performing several round robin activities in different tasks
- Initiating meetings and workshops related to the individual tasks.

Thus the expert groups are working on their anticipated tasks as planned. It is expected that the fruitful work of the expert groups will continue in the third year of the SOPHIA project.

4 References

N/A



Project SOPHIA
PhotoVoltaic European Research Infrastructure
GA N° 262533

Data Beneficiary

Name Beneficiary	ISE-IWES
Contact person	Siwanand Misara
Postal address	Koenigstor 59, 34119 Kassel, Germany
E-mail	Siwanand.Misara@iwes.fraunhofer.de
Project Website	www.sophia-ri.eu

NA2: Expert groups on a PV infrastructure Strategic Vision

D2.2 – Consolidated public yearly progress report

Proprietary rights statement

This document contains information, which is proprietary to the SOPHIA consortium. Neither this document, nor the information contained herein, shall be used, duplicated or communicated by any means to any third party, in whole or in parts, except prior written consent of the SOPHIA consortium.

Document Information

Document Name	SOPHIA_D2.2.docx
Revision	Final Draft
Due date Annex I	M12
Author	Wilhem Warta, Peter Sommer-Larsen, Iver Lauermand, Bart Pieters, Gerald Siefer, Maarten de Bruijne, Nigel Taylor, Ya-Briggite Assoa, Siwanand Misara
Dissemination Level	Public Restricted Confidential

Document approval

Name	Position in the project	Beneficiary	Date	Visa
Philippe Malbranche	Coordinator	CEA	27/02/2013	PM

Document history

Revision	Date	Modification	Author
V0	09/02/12	Creation	Wilhelm Warta
V1	06/02/2012	Content filled in	Wilhelm Warta
V2	22/02/2012	Content filled in	Peter Sommer-Larsen
V3	22/02/2012	Content filled in	Iver Lauermand
V4	22/02/2012	Content filled in	Gerald Siefer
V5	22/02/2012	Content filled in	Maarten de Bruijne
V6	22/02/2012	Content filled in	Nigel Taylor
V7	22/02/2012	Content filled in	Ya-Briggite Assoa
V8	28/02/2012	Content filled in	Bart Pieters
V9	28/02/2012	Final version	Siwanand Misara

Table of contents

1	Executive summary	4
1.1	Description of the deliverable content and purpose	4
1.2	Deviation from objectives, corrective action	4
1.3	Technical progress.....	4
1.4	Impact of the results	4
1.5	Dissemination activities carried out, planned.....	4
2	Technical sections.....	5
2.1	Si-material	5
2.2	OPV.....	5
2.3	Thin films	5
2.4	CPV	5
2.5	Cell Modelling.....	6
2.6	Lifetime prediction	6
2.7	Module & system performance	6
2.8	BIPV	6
3	Conclusions.....	7
4	References.....	7

1 Executive summary

1.1 Description of the deliverable content and purpose

The objective of this deliverables is to summarize in a public progress report the work done by the experts groups regarding the eight technical topics addressed within the networking activities of the SOPHIA project:

- Si material
- Organic material
- Thin Film Technology
- Concentrated PV
- Cell Modelling
- Lifetime prediction
- Module and system performance
- BIPV

1.2 Deviation from objectives, corrective action

N/A

1.3 Technical progress

N/A

1.4 Impact of the results

N/A

1.5 Dissemination activities carried out, planned

N/A

2 Technical sections

2.1 *Si-material*

A Si-material expert group was formed with members from CEA-INES, ECN, ENEA, IMEC, ISE and SINTEF and Elkem. In a workshop at ISE, coordination concerning upcoming specialist workshops in the field, possible reporting formats, planning for a Si-material characterization intercomparison and a special ICP-MS analysis intercomparison was discussed. The wide material scope reflects the attempt to address silicon sources of medium as well as long-term importance. The different infrastructure and expertise available at the partner shall be used in order to generate the information about the material, which is seen as being decisive for further cell efficiency. The intercomparison is running and evaluated in detail within the supporting action JRA3.1, results then utilized by the expert group.

2.2 *OPV*

An ongoing characterization inter comparison with support of WP 11 (JRA 3.2) aims at improving and harmonizing the test procedures, parameters and equipment in order to increase the interoperability of cell and module tests between European partners in EERA and SOPHIA.

The following network meeting were organized:

- | | |
|--------------------|---|
| 10. August 2011: | Online – work plan and workshop preparation |
| 23 August 2011: | Online – follow up on previous meeting |
| 6. September 2011: | During EU PVSEC, Hamburg – Round Robin preparation |
| 8-9 November 2011: | Workshop at ENEA, Portici, Italy – Round Robin definition |

2.3 *Thin films*

Currently the core thin film expert group consists of members from HZB, AIT, FZJ and ECN. This group has started work on a strategic vision for PV research infrastructure with a first meeting in Freiburg during the SOPHIA GA. A much larger group met in Berlin in October 2011 for a 2-day workshop on innovative thin film devices, discussing future research priorities. The outcome of that meeting was five proposals from different fields of thin film PV (encapsulants, light management, low cost processes, multifunctional materials, and new materials) for the WP2013 within the FP7 of the European Commission. A round robin for thin film tandem devices is in preparation (JRA 3.3.2.) and a second round robin for thin film modules is planned in the near future (JRA 2.3).

2.4 *CPV*

A CPV expert group was formed with members from ENEA, RSE, ENEL, CEA-INES, UPM, TecNALIA, FhG ISE and JRC. The involvement of additional experts from outside the project consortium is also an important part of the activities. Main objective of NA 2.4 is the surveillance and guidance of the activities within JRA 2.5 in order to create substantial input to the standardization processes that are under way in the IEC TC82 WG7. The main activities being planned and supervised are the organization and performance of a CPV module round robin test, the formation of a spectral network as well as the assessment of the influence of the tracker on the output of CPV systems.

2.5 Cell Modelling

A cell modeling expert group was formed with members from Jülich, ECN, CEA-INES, IMEC, HZB. A questionnaire was sent to collect the available software tools, their applications, users, providers, and contact persons at the respective institutes. Furthermore, we are working on developing databases for sharing in input data and simulation results for comparison and validation of the various modeling tools.

2.6 Lifetime prediction

A lifetime prediction expert group was formed with members from ECN, CREST, CEA-INES, JRC and AIT. In several meetings an overview of test and characterization facilities at the partner institutes was made. Test methodologies outside IEC61215 were defined and a test plan for three different types of modules was made. The large experiment matrix and testing outside standard conditions clearly showed a need for expanding test capacity and flexibility at the institutes. It also showed that joint research of institutes independent of industry is needed to extend the current standards. The test plan is running within the supporting action JRA01 and first preliminary results are expected Q4/2012. These will be used as input for the expert group and ultimately the TC82, WG2.

2.7 Module & system performance

The PV Module and System Performance Expert Group has focused its efforts on the identification of issues relating to module and system qualification and to qualification of BOS components. A questionnaire was circulated on the group to determine priorities and timescales. This has led to a series of recommendations, including:

- Further development of outdoor energy testing guidelines with DERlab
- Priorities for energy performance evaluation tools and methods
- Need for a platform for addressing a range of system-level issues identified in the questionnaire.

In the second year the expert groups will follow-up the implementation of these recommendations via SOPHIA networking and joint research activities, as well as contributing to the strategic roadmap for related R&D infrastructure.

2.8 BIPV

A NA2.8 Expert group was formed and comprises members from CEA-INES, TECNALIA, FRAUNHOFER IWES, FRAUNHOFER ISE, AIT, HELIOTOP, EPIA and JRC. In the meeting at CEA INES on May 18th, an action plan was defined with five main steps. The first action is to make a document for the state of the art on BIPV products and technologies and BIPV R&D activities and project. Secondly, each country has to give the definition and the vision of “BIPV” (Italia, Spain, Germany, France, Austria, others). Thirdly, partners have to make a list of functions that could be done by BIPV products. Fourthly, the description of the BIPV test facilities has to be updated. The fifth action consists in making a list of existing practices in order to characterize BIPV taking into account the energy production and the global energy balance of BIPV and building. This action plan was validated at the General meeting in Freiburg at Fraunhofer ISE. Some of these actions, especially the state of art are realized in the JRA2.6 subtask.

3 Conclusions

During the first year, the expert groups per topic were set-up and the first recommendations were given.

In the second year the expert groups will follow-up the implementation of these recommendations via SOPHIA networking and joint research activities, as well as contributing to the strategic roadmap for related R&D infrastructure.

4 References

N/A