Project SOPHIA

PhotoVoltaic European Research Infrastructure

GA N° 262533

Data Beneficiary

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NA03: Interoperability benchmarking, Definition of test procedures, Common database

D3.3 – Development of common reference databases

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1. Executive summary

1.1 Description of the deliverable content and purpose

The development of common databases should support the good use of the PV research infrastructure at the SOPHIA partner institutes. One purpose of the databases is to provide a common reference for a specific topic. Another purpose is to provide an overview and raise awareness of what's available, for example to facilitate collaborations and to avoid unnecessary duplication of resources. The databases have been mostly initiated within the JRAs and implemented with the data available within the different entities. The databases can be roughly divided in three categories, based on their contents:

- Sets of measurement data and test results
- Overviews of test- and analysis capabilities
- Overviews of modelling tools

1.2 Deviation from objectives, corrective action

The DoW states that databases should be established M24, and hence this deliverable report is due M24. At the same time, however, several databases are being developed as part of tasks that run until M48. So, in some cases, development of databases is ongoing. An update of D3.3 at the end of project (M48) seems appropriate. Examples of databases under development are:

- Task JRA3.1.3 "innovative solutions for data collection" was planned to start Fall 2012. This task includes: (1) a database of different available alternative silicon materials, and (2) the development of a common format for imaging results for data exchange, which is related to the database of most prominent imaging and scanning techniques for wafers and cells reported in section 2.7. This task runs until M48 so results will become available after the D3.3 deadline.
- The spectral (CPV) network database (described in Section 2.2) is connected to Subtask 3.4.4, which runs until M48. Currently, the equipment is available at several locations, collection has started and the database itself will be fed with data during the rest of the project.
- The database for Various photovoltaic measurement data is filling as a part of JRA02 activities, as is described in Section2.3.
- The database for Accelerated testing procedures and degradation phenomena (Section 2.6) will be completed when results of the currently running climate chamber tests become available (JRA1.2 & 1.3).
- The database of DER and Smart Grid research infrastructure (Section 2.10) is ready for content upload by the project partners, and will be publicly accessible thereafter.

Further, the DoW mentions examples of common databases that could be established within SOPHIA under Task 3.3. Realisation of one example mentioned there, environmental impact of PV, has been dropped. During the M18 project meeting in Brussels (October 2012), ECN pulsed the interest for organizing an LCA workshop in order to address questions related to LCA databases. In particular, the idea was to:

- Make an inventory of data gaps for processes and materials that are applied in PV manufacturing, but are not present in the common LCA databases, such as the Ecoinvent database for example. Examples are: range of vacuum deposition processes such as sputtering and chemical vapor deposition.
- Find best procedures to organize that the data gaps will be filled.
- Identify new "figures of merit" for the demonstration of the environmental value of PV products and to differentiate between different PV products in terms of their environmental profile. This is desirable, because the traditional "figures of merit", i.e., energy payback time and carbon footprint have reached by now such excellent values for most PV products (energy payback times of ≤ 1-2 years and carbon footprints of ≤ 20-40 g CO2/kWh), that further improvements will certainly continue to be achieved, but may be perceived as less crucial.

There was not enough interest among the project partners present during the meeting to proceed with the organization of a corresponding workshop though. The reason may be that LCA background expertise is underrepresented in the consortium such that the critical amount of expertise required for a successful workshop could not be reached. As a follow-up action, a short course or webinar on 'environmental aspects of PV' will be proposed in NA04, to broaden the basic expertise in the area.

1.3 Technical progress

N/A

1.4 Impact of the results

N/A

1.5 Dissemination activities carried out, planned

The *DER and Smart Grid Research Infrastructure* and *TNA Infrastructure* databases are primarily intended to increase the visibility of available PV research infrastructure, and will be actively promoted in SOPHIA external communication.
Public reporting of the *Database of most prominent imaging and scanning techniques for wafers and cells* is considered, to be decided in the JRA3.1 meeting (End of February 2013).

Likewise, publication of the *TCO testing facilities* database on the EERA and SOPHIA websites is considered.

2. Technical sections

2.1 TNA Infrastructures database

The SOPHIA consortium offers free access for external parties to 48 facilities covering eight specific PV technologies or topics. The main goal of these Trans National Access (TNA) activities is to make available some of the existing top-class PV Research Infrastructures for the benefit of the whole European photovoltaic community. The use of the shared infrastructures within the SOPHIA project is supported by an online database which descibes the research infrastructures in detail. The TNA database is available on the SOPHIA project website : www.sophia-ri.eu and is frequently updated during the course of the project.

2.2 Irradiance and spectral data

The concentrator photovoltaic (CPV) group within SOPHIA consortium has a special interest in the collection of spectrally resolved irradiance data. The reason for that is the fact that most CPV systems apply multi-junction solar cells (at least systems aiming at concentration ratios >>100x). Multi-junction solar cells correspond to an internal series connection of several so called subcells. The subcells are internally connected in series with tunnel diodes. The current of the complete cell however is limited by the subcell with the lowest current. As the subcells have different bandgaps and thus absorption bands, the ratio of current generation between the subcells depends strongly on the spectral irradiance impinging the cell.

Ideally the solar spectrum is known as spectral irradiance on a wavelength resolution base. However, spectroradiometers capable of measuring the solar spectrum are rather cost-intensive and not necessarily well suited for outdoor applications. Thus an alternative approach within the CPV community is the use of so called component/isotype sensors. Component or isotypes correspond to single-junction solar cells with the same spectral response as the subcells within a multi-junction cell, however with only one active pn junction. In other words they allow for the direct measurement of the short circuit current of a solar cell that corresponds to one of the subcells of a multi-junction cell. Measuring the currents of such a component cell sensor thus does not correspond to a direct measurement of the solar spectrum but the determination of the effect of the solar spectrum on a multi-junction cell.

Some of the partners of the CPV group within the SOPHIA consortium already run measurements of solar spectra with spectroradiometers and/or component/isotype cell based sensors. The following Table 1 shows the different locations and measurements performed there. One goal of the SOPHIA project is to form a spectral recording network enabling the better understanding of the potential of the CPV technology at different locations.

Current status: the equipment is available at several locations, data collection has started and the database will be fed with data accordingly. It is foreseen that this database will be merged with the Database for photovoltaic measurement data described in Section 2.3.

Table 1 : Spectral irradiance measurement capabilities within the SOPHIA CPV group. (DNI = direct normal irradiance)

Partner	Location	DNI	Spectrum with spectroradiometer	Component / isotype cell sensor
FhG ISE	Freiburg, Germany 48.00N, 7.83E	yes	possible for special measurement activities	yes
RSE SpA	Piacenza, Italy 45°3'N 9°42'E	yes	yes	potentially in the future
JRC	Ispra, Italy 45°49'N 8°38'E	yes	possible for special measurement activities	no
Enel I&R	Catania, Italy 37.40N 15.00E	yes	possible for special measurement activities	yes
CEA-INES	Le Bourget du Lac, France 45.65N 5.87E	yes	no	yes
CEA-INES	Cadarache, France 43.68N 5.76E	yes	possible for special measurement activities	yes
IES-UPM	Madrid, Spain 40.45N 3.71W	yes	yes	yes
ENEA	Portici, Italy 49°11'N 14° 20'E 159 m a.s	yes	yes	yes

2.3 Database for the collection and management of various photovoltaic measurement data

A standardized database for the storage of various PV measurement data has been constructed in JRA02. Details have been reported in D10.3. Its purpose is to promote exchange of data between different European research institutes and to provide a common basis for performance modeling tools. The submitted data can only be used for R&D purposes within the SOPHIA-project, because almost all partners want their data to be treated confidential. The data is organised in the following series of tables:

- meteorological measurement data
- spectrum measurement data
- module outdoor measurement data
- BIPV outdoor measurement data
- CPV outdoor measurement data
- Indoor measurement data

The data upload should take place in February 2013. Before this, however, these should be examined with the plausibility tools from subtask JRA2.2. These tools should be available in January 2013.

The following arrangements have been put in place for the upload:

- Each participant/organisation to upload datasets for 15 months. Three months (preferably April-May-June) should be used for tuning the models. The remaining 12 months are intended to be used for the checking the simulations. For this part of the dataset, only the model input values will be visible in the database during the phase of simulation.
- The data will be uploaded in an encrypted format.
- For the subtask on CPV and BIPV some additional tables are available in the database. On the one hand there is a general table for the measurement data for all different modules type (standard, BIPV, CPV) containing the basic measurement e.g. MPP values and so on. CPV or BIPV specific measurements (such as additional temperature data) can be provided in these extended tables.

2.4 Database of module power- and energy prediction models

An inventory of power and energy prediction models together with its applications, data input and data output has been made within JRA02. Model descriptions from IWES, ECN, INES, ENEL, ISE, JRC and CREST have been included. The listing has been reported in D10.9, together with criteria for evaluation of errors.

The next steps are as follows:

- JRA2 have organised the 1st European Workshop on PV performance modelling to be held 21-22 February at INES, Chambery, France. The various models will be presented there.

- The models will be applied to the data sets uploaded to the outdoor performance database in February 2013 (see Section 2.3 above).

2.5 Database of module test and analysis equipment at the major PV institutes in Europe.

An inventory of the available module level test and analysis equipment has made in JRA01, and reported in D9.1. The listing provides an overview of the available standardised test equipment related to executing IEC61215 or IEC61646 design qualification tests at ISE, JRC, CREST, INES, ENEA, ENEL, RSE, ECN, AIT and Tecnalia. Details of all the test equipment and the availability at the PV institutes are given.

In addition to the test capabilities, the wide variety of analysis equipment that is available at various institutes is listed. Most of this equipment is used to detect – in a non-destructive way - forms of degradation inside modules. In addition, destructive – mainly chemical analysis' – tools can be used to get insight in interface and bulk properties of module materials.

2.6 Accelerated testing procedures and degradation phenomena

A database on accelerated testing procedures and degradation phenomena has been set up to support the JRA01 activities. It uses the existing MyndSphere platform, where a section has been set up to collect test descriptions and test data, eg. Excel tables and photos of test samples (EL, IR, visual characterisation). All data is accessible for all partners, because the interpretation of data is a joint effort within JRA01. This approach, partners (re)viewing each other's test results, has been chosen as it triggers questions and lively discussion. Of course, the dataset is also the basis for calculation of activation energy for degradation mechanisms and further analysis. This analysis is intended to give input for a new test sequence to be proposed for inclusion in the standard.

Status : the structure has been defined and first datasets have been entered. More data will be added during the course of climate chamber tests. The database will be on line as long as the MyndSPHERE platform for SOPHIA is maintained.

2.7 Silicon properties, material characteristics / Database of most prominent imaging and scanning techniques for wafers and cells

Within JRA03 an overview has been compiled of the most prominent imaging techniques of each partner for the characterization of silicon wafers and solar cells. These include camera-based techniques as well as scanning techniques. The listing has been reported in D11.1. It contains descriptions of the techniques, typical measurement results, accessible material parameters, assessments on attainable spatial resolution, sensitivity, and speed, requirements for sample preparation as well as a discussion about strengths and weaknesses of the techniques. Public reporting of the overview will be decided in the next JRA3.1 meeting (end of February 2013). This would enable research institutes as well as solar companies to assess potential future collaboration areas in the field of silicon material and solar cell characterization.

2.8 Database of modeling tools

A database has been set up within JRA04 which lists software tools for simulation in PV. Its purpose is to provide a toolbox covering all simulation aspects ranging from materials via cells and modules to real system modelling and energy output prediction via modelling. The list contains already inputs on 36 different software tools used by 22 persons from 12 institutes inside and outside SOPHIA. It specifies the purpose of the model, its strengths and weaknesses, the inputs and outputs, and contact and licence information. This list is available on the SOPHIA internal website.

2.9 Database on TCO testing facilities

A list of TCO activities within Europe has been collected within the Thin Film expert group. This provides an overview on possible partners for collaboration. The overview, formatted as an Excel sheet, includes: deposition systems and processed, TCO-characterization tools, and available materials. This activity was originally driven by EERA and has now been extended to Sophia partners. It is intended to publish the information on the EERA and Sophia web sites (for internal or public access). The datasource will be maintained within the EERA Thin Film activity; the last update was 15/8/2012.

2.10 Database of DER and Smart Grid Research Infrastructure

DERLab plans to set up another new infrastructure database where the Smart Grid testing capabilities of laboratories (including the capabilities of SOPHIA partner institutes) can be searched according to various categories and features. The database should be online spring 2013. Each SOPHIA project partner will be kindly asked to update their own laboratory profile to increase their visibility and to inform about their research infrastructure related to PV and others DER related topics. Next step would be to interlink it with the SOPHIA website.

The database offers systematic information on research infrastructure and related assets, testing capabilities and services of 34 institutes from Europe and US which focus their work in the field of Photovoltaics, general Distributed Energy Resources and Smart Grids.

Additional information on accreditations, grid codes and standard compliance testing as well as mobile and static equipment is described in the database.

The database allows filling up information via an interactive user backend while the result is shown immediately on the website (see Figure 1). New infrastructure and testing equipment can be added individually by the partner institutes, feature allowing keeping related information up to date. Therefore the institutes' visibility is increased allowing interested academics, companies and applicants for the Trans National Activities to access updated information on the participating laboratories.

The Database will be publicly accessible via: http://www.der-lab.net/derlabsearch after all content has been uploaded. Currently, the access to the database can be done password-secured only by the project partners who have to update their institute-related content.

The database is hosted and maintained by DERlab.

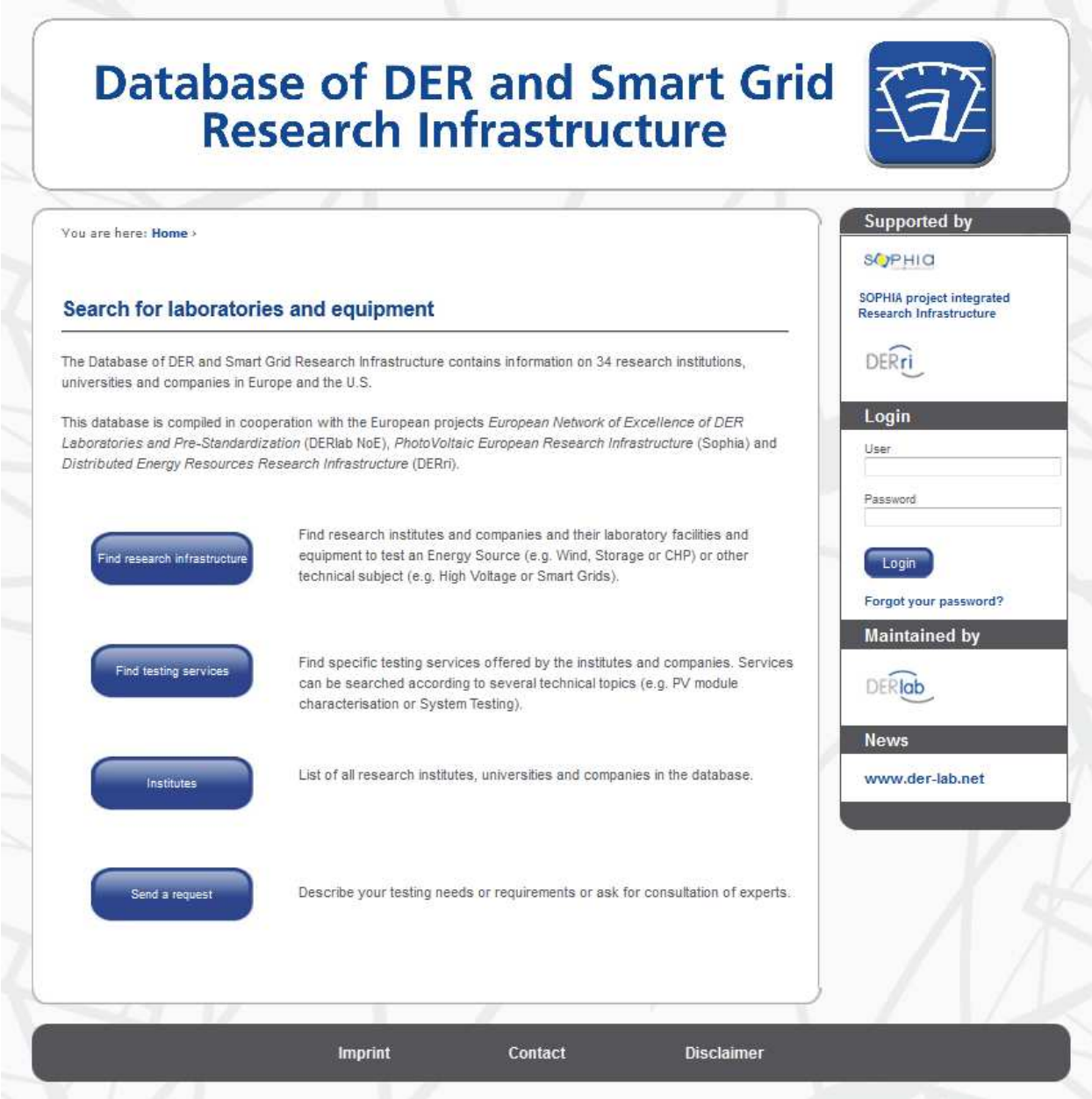

Figure 1 Screenshot of the frontpage of the Database of DER and Smart Grid Research Infrastructure

3. Conclusions

Common databases have been set up within SOPHIA for various topics, including: measurement and test data; overviews of modelling tools, and overviews of test- and analysis capabilities. Table 2 provides a comprehensive overview of the databases and their connection to the Technical Topics and Joint Research Activities. Some of these databases, mainly those containing measurement- and test data, are currently being filled with content.

					Connected to Technical Topic								Connected to Joint Research					
	Database topic	Category	Format	URL	Si Materials	OPV	TF	CPV	Modelling	Lifetime prediction	Module/system performance	BIPV	JRA01	JRA02	JRA03	JRA04	External parties involved	Status
1	TNA Infrastructure	test/analysis capabilities	website	www.sophia-ri.eu	x	x	x	x	x	x	x	x					no	released
2	Irradiance and spectral data	measurement/test data	mySQL	SSH tunnel to server				x						x			no	filling
3	Photovoltaic measurement data	measurement/test data	mySQL	SSH tunnel to server				x			x	x		x			no	filling
4	Power- and energy prediction models	modelling tools	D10.9	-					x		x			x			no	released
5	Module test and analysis equipment	test/analysis capabilities	D9.1	-						x			x				no	released
6	Accelerated testing procedures	measurement/test data	fileset	www.myndsphere.com						x			x				no	filling
7	Imaging and scanning techniques	test/analysis capabilities	D11.1	-	x										x		no	released
8	Modelling tools	modelling tools	.xls	www.myndsphere.com					x							x	yes	released
9	TCO testing facilities	test/analysis capabilities	.xls	www.myndsphere.com			x										yes	released
10	Smart grid research infrastructure	test/analysis capabilities	web interface	www.der-lab.net/derlabsearch							x						yes	filling

Table 2 : Overview of the common databases that have been set up in the SOPHIA project.

4. References

N/A