

FP7-CHEETAH KNOWLEDGE EXCHANGE PLATFORM: RESULTS AND THEIR EXPLOITATION

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ABSTRACT: FP7-CHEETAH is a combination of a collaborative project (CP) and a coordination and support action (CSA), receiving funding from the European Union under grant agreement No 609788. The project aims at solving specific R&D issues to overcome fragmentation of European PV R&D and to accelerate the industrialization of innovations by intensifying the collaboration between R&D providers and industry. This proceeding reports on the strategy and key tools brought by the CHEETAH project to improve the state of the art in knowledge exchange on PV RTD. Its CHEETAH Knowledge Exchange Platform (KEP) features a dynamic database, a powerful build-in search engine, the dedicated e-learning platform for on-line meetings with internal and external stakeholders, webinars, on-line tests and experiments. The portal profits from the best practice in more efficient social and professional networks web portal by representing a significant step forward in knowledge exchange for the European photovoltaics community to support training, share knowledge and research infrastructures and foster collaboration opportunities at EU scale.

Keywords: e-Learning, Education and Training, Dissemination, Qualification and Testing, Stability, PV Technologies, Social and professional Networks

1 INTRODUCTION

FP7-CHEETAH “*Cost-reduction through material optimization and higher Energy output of Solar Photovoltaic Modules - joining Europe’s research and development efforts in support of its PV Industry*” coordinated by ECN, NL [1,2,3] is a combined collaborative project (CP) and coordination and support action (CSA) funded under the European Commission’s 7th Framework program with the aims to solve specific R&D issues and to overcome fragmentation of European PV R&D by intensifying the collaboration between R&D providers and industry to accelerate the industrialization of innovations. The project description and the Pert diagram are shown in Fig. 1. This project is also tightly linked to the EERA-PV Joint Program and for this reasons its outputs will also be continued under the EERA-PV Joint Program at the end of project in December 2017 [7].

The CHEETAH Knowledge Exchange Area Portal (KEP), in parallel to the project web site and other dissemination activities (newsletter, communication, etc.), constitutes the pillar of the project to bring information from different sources in a uniform and simple way to any interested CHEETAH partner and external organization on availability of infrastructures,

equipment, expertise, technical documents [4,5,6] (fig. 2).

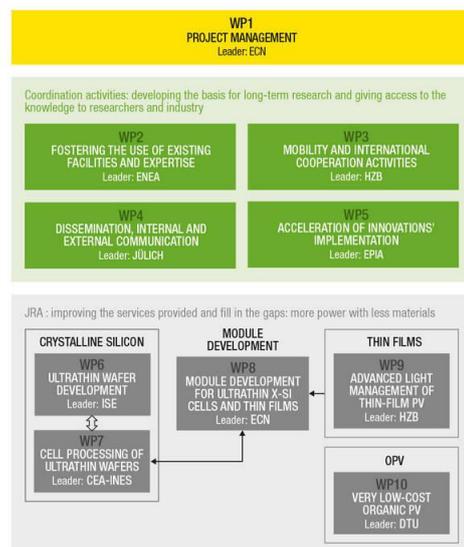


Figure 1: Description of CHEETAH Project and Pert diagram of the workpackage structure



Figure 2: CHEETAH Knowledge Exchange Platform (KEP) web site <https://www.cheetah-exchange.eu>

It operates from collection in its database of expertise/infrastructure (supply site), to its elaboration (management) and its final offer to project partners (demand site) by utilizing user-friendly dedicated tools having a very effective potential to share expertise (see fig. 3)

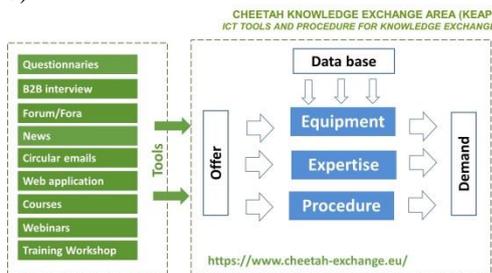


Figure 3: CHEETAH Knowledge Exchange Platform (KEP) ICT Tools and its rationale.

The web portal operates by an Operational database management systems (also referred to as OLTP On Line Transaction Processing databases). Any data is updated in real-time and KEP allows us to do more than simply view archived data: any uploaded information is dynamically linked to all others by logic connections that allow access to any individual information as well as to information already uploaded by improving the informative content (available equipment? expertise? where are they located? who could I contact? Etc.).

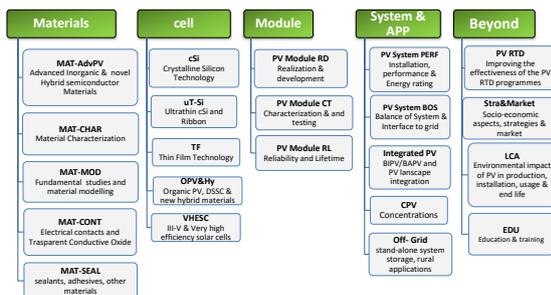


Figure 4: CHEETAH Knowledge Exchange Platform (KEP) cataloguing criteria

It is also based on the utilization of structured cataloguing criteria applied to PV technologies/PV RTD topics and organizations involved in CHEETAH (see fig. 4).

From this point of view, the procedure to collect and offer information to CHEETAH partners and other project consortia represents a major breakthrough in the field with highly innovative content and a substantial improvement in comparison with the state of the art of knowledge exchange on PV RTD and it makes CHEETAH KEP unique in its approach.

CHEETAH KEP offers the following opportunities:

- All interested browsers/readers can have efficient access to stored data thanks to the utilization of search engine/query keywords used in connection with the more diffuse and efficient ICT procedures and user friendly graphic interfaces.
- Offer/demand and needs of infrastructures, equipment, expertise, technical documents, test procedures
- Open access on-line lectures, courses , workshop by widely using webinars based on the implementation of the fruitful results and experiences of SOPHi@Webinar, the internal e-learning platform of FP7-SOPHIA project
- Public access in reserved web-area (documents, data, reports, etc.)
- Restricted area for specific technical documents (for user-partners only)
- On-line forum/fora for internal, external and technical/scientific discussions on specific themes
- On-line questionnaires & ICT tools to optimize submissions and collection of specific information
- For the first time the platform is also moving to propose live experiments followed remotely by other scientists.

CHEETAH KEP is highly secure and user-friendly. It is the portal for the European photovoltaics community to support training, share knowledge and research infrastructures and foster collaboration opportunities at EU scale.

2 CHEETAH KEP Rationale and organization

The strategic goal of CHEETAH is on the one hand, to identify currently running technical-scientific needs of the European PV RTD sector and, on the other hand, to establish the best way of taking profit from the strength owned by each CHEETAH partner in terms of facilities and expertise, in order to improve collaboration inside the European PV Research and Industrial community. This goal is also a practical translation of an objective of EERA.

CHEETAH KEP defines the facilities and expertise needed to achieve those goals based on a multistep process

2.1 Collection of information

Information on partners knowledge needs is realized by circulating questionnaires, business-to-business interviews, discussion among partners by fora/circular emails, and news. It is further elaborated in connection with other parallel initiatives launched by the European

and international photovoltaic community such as PV road maps [3,4,5,6]

2.2 Knowledge necessities: demand side

The CHEETAH knowledge exchange necessities inventory is based on assuming that for each of the indicated topics (PV Technologies, PV RTD topics, Equipment) the interest shown by each respondent is strongly influenced by his/her role, typology and level of expertise, and clearly involvement in the project. This imposes that the category to which the respondent corresponds needs to be identified at least for statistic motivations to know better and more efficiently about the knowledge needs.

The following categories of respondent are defined

- i. *Organization Contact points*: they are the respondents for their own organization and they assign the relevance showed by each organization in the specific topic.
- ii. *WP/task leaders*: they offer evaluation specific for their own field of expertise within the CHEETAH project.
- iii. *Group leader*: they offer an evaluation of relevance of their own laboratory/group of activities, and the elaboration will be based on the coherence of the group they belong to. Just as example it could be the relevance assigned to a specific equipment by a group of laboratories having the same objective.
- iv. *Student/younger researcher*: they express the interest of researchers, on specific topic mainly at an initial stage of their career.

The elaboration of received questionnaires offered different points of view on the relevance assigned to each topic depending on the role of respondents and it will be also a very useful tool to be shared towards a global European strategic vision of different categories.

Furthermore, the respondents express actually the intensity of his/her personal interest or on behalf of his/her organization on the specific PV RTD technology/topic/ and/or on the equipment utilization by indicating a score ranging from no-interest (=0), moderately involved (=1), normally involved (=2), widely involved (=3); to strongly involved (=4).

The collected information takes also in consideration the evolution in time of the specific interest of each researcher/scientist. In fact, the respondents assign also a score expressing interest on today, but also in perspective for the short, medium and long term. This offers opportunities to also draw some road map on the evolution of the interest in each specific PV RTD technology/topic.

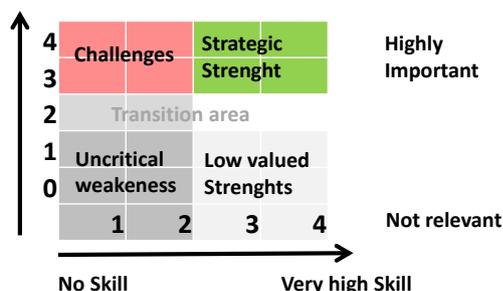


Figure 5 Skill assigned by each interviewee to any PV RTD technology/PV RTD Topic/PV RTD Equipment Level of importance assigned by each Interviewee to any

PV RTD technology/PV RTD Topic/PV RTD Equipment

Four areas of different needs are determined in this way;

Uncritical weakness:

an area where for each specific PV technology / PV RTD topic and equipment a both not prepared / not-relevant condition is verified for the specific organization;

Low-valued strength:

an area where for each specific PV technology / PV RTD topic and equipment a well prepared / not-relevant condition is verified for the specific organization;

Challenge area:

where needs should be satisfied with targeted actions (both not-prepared / highly important verified)

Strategic Strength:

an area where for each specific PV technology / PV RTD topic and equipment both well prepared / and relevant conditions are verified for the specific respondent organization

The opportunity to extend the questionnaires outside of the CHEETAH consortium, mainly to improve the population for statistic evaluation and to serve the PV RTD community with useful tools for evaluation of knowledge exchange needs has also been evaluated.

2.2 Knowledge necessities: offer side

Based on the FP7-SOPHIA experience, this step focuses on the available inventory of infrastructures and expertise and technical/scientific documentation (papers, reports, strategic position documents, etc.). It also concerns the development of tools and procedures to optimize the exchange process in order to adequately sustain demand/supply of expertise and infrastructures.

The large number of outstanding research organizations working together via the CHEETAH project can avoid the useless replication of a large number of small efforts by sharing information on the availability of knowledge. The CHEETAH Knowledge Exchange Portal (KEP) aims at widely distributing information among partners on available expertise, infrastructures, equipment and technical documents, to provide the scientific community with a common data base/catalogue. A list of useful information is associated to each CHEETAH organization (expertise, infrastructures, technical documents, courses, webinars, discussion, news, etc.) and currently uploaded on the CHEETAH KEP web site.

2.3 Data elaboration

The detailed and statistic elaboration of information on the main interest in PV technologies, PV RTD topics and equipment of CHEETAH partners is fundamental for several reasons:

- I. In this way the expertise and the experimental facility needs can be evaluated to be shared with the full services available
- II. It can be offered at the European level and the indication of different facilities/equipment could be used for different technological topics
- III. Experts, students stages and courses/webinar can focus on the field of main interest to optimize depending on constraints on financial budgets and time availability of the experts and participants

2.2 Data Management

The core of data management is represented by the CHEETAH KEP web site. It uses the same graphic frame as the main project web site, but it is based on a different ICT organization. In fact the content is periodically revised and implemented on a daily/weekly/monthly basis to adapt the web portal to new necessities of information on PV RTD fields/topic cataloguing/search criteria.

The updating process isn't just an updating of the information content but it deeply involves the development of new procedures and new and advanced ICT tools. For that reason CHEETAH KEP cannot be managed by utilizing the main project web site, but it needs to exploit a dynamic ICT environment that is totally different from any conventional html web site approach for the following motivations:

- All key participants are directly involved in the process and in real time, as it usually happens in exchange web sites like Linked-in, Research-gate, Google-Scholar, etc.
- It offers a more user-friendly shorthand approach . The technical/scientific content among WP/task leaders, webmaster and end-users and the scientists/researchers/experts/students interested in accessing the information are defined by focusing mainly on technical aspects and their needs, more than formal procedures to approve amendments in web site content, as it is typically requested by any "official" project Web Site,

The utilization of a different area also reduces any technical ICT difficulty which could be caused to the main project web site by the very frequent revision/maintenance/implementation requested by very frequent periodical updating.

3 CHEETAH KEP WEB SITE DESCRIPTION

In the following paragraph we summarize information on the main facilities offered by the CHEETAH Exchange Area web portal by leaving to the browser/reader the opportunities to directly access them by browsing on the web site

3.1 CHEETAH KEP PV Technologies

Photovoltaic (PV) technology steadily progresses thanks to both research and development at the laboratory level and the technological deployment and experience from the market place. Research and Development – "R&D" – is crucial to sustain in mid and long-terms the further development of PV technology. Performing joint research addressing well-chosen issues plays an important role in achieving the critical mass and effectiveness required to meet the sector's ambitions for definitive technology implementation and industry competitiveness,

Following indications of the "Strategic Research Agenda for Photovoltaic Solar Energy Technology" EU PV Technology Platform and indications of CHEETAH experts, a range of technologies and topics has been determined the development of which is expected to significantly contribute to reach the overall targets and can be the objective of knowledge exchange:

- cSi Wafer Based Technology
- Si Ultrathin Wafer development & ribbon
- TFSi-Thin Film Silicon

- CIGSS- Copper indium gallium diselenide
- CdTe-Cadmium telluride
- Emerging/Novel Inorganic, Hybrid PV Materials & Nanotechnologies (Perovskite, Kesterite, quantum dot/quantum wire SC, Intermediate band SC, etc)
- Organic Photovoltaics
- DSSC- Dye Sensitized Solar Cells
- Material and Device Characterisation
- Materials, devices, system modelling
- PV Module realization & Development
- PV Module qualification & testing
- PV Components, Systems & Interface to grid
- CPV Concentration Photovoltaics
- BIPV Building Integration Photovoltaics
- Education & training
- Socio-economic aspects & market
- Environmental impact, waste reduction and recycling
- PV RTD Networks, coordination of research efforts, strategy and PV RTD projects management

The CHEETAH Knowledge Exchange portal uses them as the base to catalogue the offer/demand among consortium partners of requested expertise, infrastructures, equipment, courses, technical documents, by promoting further development of knowledge in the same field of interest also outside of the consortium.



Figure 6 - PV RTD TECHNOLOGIES web page http://www.cheetah-exchange.eu/pv_technologies.asp

3.2 PV RTD TOPICS

Based on the CHEETAH catalogue of main PV RTD Technologies, a list of relevant R&D topics is proposed for the main existing technologies. The main R&D topics per technology area are summarized in the CHEETAH web site and consist of around 120 topics ranging from basic science to applications.

It is a tentative list that is dynamically updated following the indication of CHEETAH experts, and that we would deeply optimize in the final release of CHEETAH KEP. The PV RTD Topic can be sorted by utilizing different criteria. To each specific PV RTD topic is associated, when applicable, the list of available CHEETAH experts, infrastructures, equipment, courses, technical documents with the aim of intensifying the collaboration and the knowledge sharing among CHEETAH R&D providers.

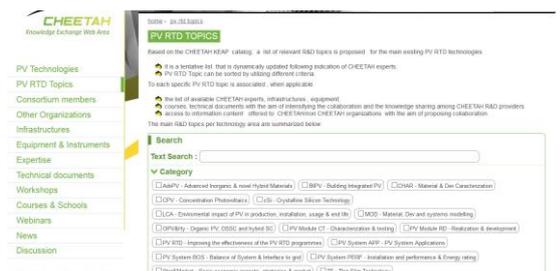


Figure 7: PV RTD TOPICS web page <http://www.cheetah-exchange.eu/tags.asp>

3.3 CHEETAH KEP: Expertise and infrastructures

The main goal of dissemination of the information on existing infrastructures of the CHEETAH partners is to make available some of the existing top-class PV Research Infrastructures and scientists for the benefit of the whole European photovoltaic community.

This is proposed on the basis of the establishment of a reciprocal collaboration framework within funded European Community collaborative projects or in perspective of some projects based on agreements between parties by business-to-business approach or bilateral/multilateral public/private funded project.

The extended database with the description of CHEETAH experts is available to comment/interact on a wide range of PV RTD topics.



Figure 8 - CHEETAH Infrastructures web pages <http://www.cheetah-exchange.eu/infrastructure.asp>

A list is offered in alphabetical order and searching criteria can be utilized by typing names or keywords, such as PV Technology/ PV RTD/Topic/ Involved Organization/,

The research facilities are classified according to several criteria (research organisation, technical topic, category of infrastructure) and they are periodically updated. It serves to prevent duplication by stimulating access and to promote future developments in the circumstance of necessity of demand and lack of availability on the other side.

215 experts and 45 infrastructure profiles were uploaded as Sept. 2017 and they are growing day-by-day

4 CHEETAH WEBINARS

Based on the success and the fruitful results and experiences of the SOPHi@Webinar, the internal e-learning platform of FP7-SOPHIA, CHEETAH KEP is also proposing a set of interactive training courses and webinars planned in collaboration with all Joint Research Activity leaders, mobility and international cooperation activities and dissemination, internal-external communication responsables.

Electronic conferencing is very powerful for knowledge exchange. It requires no more than a set of interconnected computers with suitable software and hardware. Participants can connect with conferences and workshops at their convenience, regardless of their time zone and geographical location [4,5]-

Web conferencing is time saving, it reduces travel costs, video conferences enhance the possibilities for all to interactively review a subject, allowing them to share efficiently ideas, documents, conclusions and concerns.

There are no limitations on event location and it can be realized by laptops, tablets and mobile phones and can be followed from everywhere.

The involvement of participants can focus on the topic issues of direct interest, saving time from topics in which they are not involved or interested. Storage and streaming of produced output is very useful also to review the informative content. In fact the acquired material (i.e. slides and video presentations) can be easily distributed by webcasting them even after the event

The targeted audience ranges from 5-10 to a maximum of 20 participants, for short on-line courses, in order to enable a large number of them to effectively interact with experts, up 100-200 participants for lectures.

Very soon the platform will also offer on-line live experiments: scientists/researchers operating in a test site or by remote equipment can interact live with other researchers interested in the characterization/measurements.

CHEETAH is proposing different categories of webinars:

- Lectures and short on-line courses focused on best practice in the utilization of infrastructures, equipment, realization of experiments and test procedures (WP2);
- Lectures on specific technical-scientific aspects and dissemination of CHEETAH results/output (WP3 and WP4);
- Webinars concerning strategy in PV RTD, market and interaction with industries (WP4 and WP5)

The full list of material is available @ <https://www.cheetah-exchange.eu/webinars.asp>

- 46 webinars have been organized since January 2014 by the platform
- With more than, 930 “different” users
- They registered to participate 1450 times, and several hundred are accessing via streaming.

A modular series of web-courses targeted to researchers and PhD students will be very soon proposed.

This new MOOC-Massive Open Online Courses “learning PV at CHEETAH speed” lead by UPM will be organized as courses. Each one will ask for a student dedication of 5-20 hours and will provide tools for the students to address specific PV-related topics that may help in their work.

Trainers will try to go one step beyond “Fundamentals of PV” and tackle specific PV-related topics and tools that may be of help in their research work: for example,:

- introduction to solar cell simulation,
- extracting information from I-V and QE measurements,
- calculating limiting efficiencies of solar cells.

UPM will be responsible to launch the first series to serve as an example, by leading its organization and by also involving other CHEETAH partners.

Furthermore CHEETAH partners are invited to organize focused on line/onsite training courses on the utilization of infrastructures by also including practice sessions. The webinar platform will be provided with tools assuring opportunity to follow live experiments/tests

5 WEB AREA ACCESS TO NON-CHEETAH EXTERNAL PARTNERS

The CHEETAH Knowledge Exchange web area Portal is an open source portal open on request to any interested non-CHEETAH organization. Any public, private research centres and universities actively involved in PV energy research and located in the European Union or associated countries can propose its access to CHEETAH KEP but the elective members are EERA-PV and EU-PV platform partners. Non-CHEETAH partners could be also interested to participate in project activities .

A set of useful information can be uploaded on the web site which is also associated to each external organization (expertise, infrastructures, technical documents, courses, webinars, discussion, news).

Access of the portal to external non-CHEETAH partners has imposed that some special areas of CHEETAH KEP can be reserved to project partners only. For instance, information concerning maintenance, or some relevant results or information related to the project management.

Access to CHEETAH KEP is offered by a registration procedure by user name (email) /password. Three different access right levels are arranged depending on the project necessities to access to the information content. The registration procedure offers also the opportunity to collect statistical data (role, gender, nationality, etc.) on registered users and the procedure includes also the opportunity to recover forgotten passwords.



Figure 9. CHEETAH External partners web Log-in area

6 CHEETAH KEP: ACHIEVED RESULTS

We warmly invite interested readers to directly browse within the platform web pages to learn more about the potential of the platform.,

The main achieved results (as Sept 2017) are the following:

- a collaborative spirit has been created within the project partners and external organization as demonstrated by the numerous actions in Knowledge Exchange.

- A more efficient "ranking list" of the most demanded technologies / Topics / Equipment extended also to EERA-PV Members has been produced and it will be objective of another upcoming report.
- More than 60.000 accesses by its dynamic links moved interested users to 33 CHEETAH and 13 non CHEETAH corporate descriptions
- 215 experts and 45 infrastructure profiles uploaded are growing day-by-day
- 46 webinars with 930 "different users" registered to participate 1450 times, and many hundreds accessing via streaming.

7 CHEETAH RESULTS in PERSONNEL AND TEST PROCEDURE EXCHANGE

During the first 3 years of the project, there were 49 visits of researchers to project partner laboratories ranging from 1 day to months. A total of 13 summer universities and workshops was associated with the project. An international coordination board was formed with high-ranking experts from 5 countries.

As an additional activity within WP3 supported by WP2 and joint Research Work packages the following round robin test procedure were launched:

- RR Thin Si Tandem Solar Cells
Organizer JRC-ESTI & Jülich
Participants: DTU; CREST; TÜBİTAK; AIT; UNIMIB; IFE; ECN; CEA-INES; ENEA; ISE; HZB
- RR & common test procedures on determining the accurate composition in CIGS absorber layers
Participants: EMPA, ZSW, HZB
- RR on OPV Solar Cells (ISOS-L-3)
Participants: DTU, FhG-ISE, ECN, ENEA,
- RR Perovskites Interlaboratory Studies (ISOS-D3 life testing) in collaboration with EERA

CONCLUSION

The CHEETAH Knowledge Exchange Portal constitutes a very useful tool to bring information from different sources in a uniform and simple way to all CHEETAH and non-CHEETAH partners, as permanent channel fostering the use of existing facilities and Expertise.

The CHEETAH Knowledge Exchange Platform (KEP) represents a significant step forward in the PV RTD knowledge exchange taking profit from the best practice in more diffused social, scientific and professional networks.

It is very useful to identify the current European PV RTD Community's technical-scientific needs and efficiently establish and promote channels and procedures to transfer information among each partner in order to enforce potential and effectiveness of RTD activities held by each organization.

The portal is also accessible to non CHEETAH partners offering them information on the availability of infrastructures, equipment, expertise, technical documents to widely foster the interaction and collaboration among organizations involved.

In addition, the web area provides dedicated tools to share expertise by organizing also on-line meetings, webinars and on-line tests. Such tools have been realized

with the aim of promoting individual and collective knowledge exchange actions among experts and trainees from beneficiary organizations. CHEETAH KEP represents a major breakthrough in the field with highly innovative contents and a substantial improvement in comparison with the state of the art of knowledge exchange on PV RTD.

Acknowledgement

We would like to thank all CHEETAH members for their continuous support and their contribution in helping to enrich the web site of information and technical – scientific content to make the CHEETAH KEP initiative possible and successful.

We also thank as of September 2017 all CHEETAH KEP browsers who for more than 60.000 times have accessed to our web pages and several of them have reacted with enthusiasm and interest by supporting us with comments and amendments, they are essential for the development of the portal.

We acknowledge the technical staff of ENEA, which has consistently supported both the development and the use of applications and David Casaburi, ENEA and Francesco Beone for Web site development and the Adobe Connect Corporate e-learning platform, respectively and their technical help.

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