EC Grant Agreement n°609788

CHEETAH

Cost-reduction through material optimisation and Higher EnErgy outpuT of solAr pHotovoltaic modules - joining Europe's Research and Development efforts in support of its PV industry

Deliverable

D2.1 – Listing of existing research infrastructures within the entire CHEETAH consortium, including a user-friendly selection tool

WP2 – Fostering the use of existing facilities and expertise

Section 1 – Document Status

Document information

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Section 2 – Table of content

Section 3 – Publishable summary

The strategic goal of CHEETAH WP2 (aiming at fostering the use of existing facilities and expertise) consists in: on one hand, identifying currently running technical-scientific needs of European PV RTD sector; on the other hand, establishing the best way of taking profit from each CHEETAH partner's facilities and expertise, in order to avoid work duplication and to improve collaboration within and outside the consortium. CHEETAH Research Infrastructure represents a unique relevant scientific apparatus (ie. Synchrotron accelerator, solar furnace, etc) or a cluster of different equipment constituting a laboratory with a common objective (ie a laboratory for the growth and the characterization of materials) and with the need of carrying out experiments. The deliverable D2.1 focuses specifically on the relevant aspect of knowledge and infrastructure exchange, concerning the inventory of existing research infrastructures within the entire CHEETAH consortium. It serves to prevent duplication by stimulating access (CHEETAH task 2.2), and to promote future developments (CHEETAH task 2.3) in the circumstance of necessity of demand and lack of availability on the other side.

CHEETAH Infrastructure inventory operates from the collection of availability of expertise/infrastructure (supply site), to its elaboration (management) and its final offer on demand site to project partners by offering information through an extended database improved , in comparison with pre-existing initiatives.

The listing of existing research infrastructures is managed dynamically through Cheetah Knowledge Exchange Area Portal (KEAP) http://www.cheetah-exchange.eu/infrastructure.asp

Each segment of information is now dynamically interlinked to others (expertise, similar infrastructures, etc), in order to enable efficient comparative sorting criteria, and the researcher/scientist/expert/student can reach directly information that can be useful to him/her without waste of time.

The collection of information and its offer is now based on user-friendly selection tools having an improved graphic interface very similar to more diffused professional social network (linked-in, Research-gate, etc) already existing.

A periodic update will also realized by also including the description of the research facilities of new EERA members.

Section 4 – Executive summary

Description of the deliverable content and purpose

The strategic goal of CHEETAH WP2 (aiming at fostering the use of existing facilities and expertise) consists in: on one hand, identifying currently running technical-scientific needs of European PV RTD sector; on the other hand, establishing the best way of taking profit from each CHEETAH partner's facilities and expertise, in order to avoid work duplication and to improve collaboration within and outside the consortium.

In this document, the Research Infrastructure represents a unique relevant scientific apparatus (ie. Synchrotron accelerator, solar furnace, etc) or a cluster of different equipment constituting a laboratory with a common objective (ie a laboratory for the growth and the characterization of materials) and with the need of carrying out experiments. The deliverable D2.1 focuses specifically on the relevant aspect of knowledge and infrastructure exchange, concerning the inventory of existing research infrastructures within the entire CHEETAH consortium. It serves to prevent duplication by stimulating access (CHEETAH task 2.2), and to promote future developments (CHEETAH task 2.3) in the circumstance of necessity of demand and lack of availability on the other side.

The rationale of CHEETAH D2.1 Inventory is based on the review of already proposed SOPHIA Infrastucture (17 research centres 48 RI-Research Infrastructures), whose conclusion is scheduled in in January 2015. CHEETAH Inventory will extend the database with additional information coming from the 16 new partners and by covering additional topics, such as ultrathin crystalline silicon solar cells which is not covered in the SOPHIA project. This will also optimize the SOPHIA offer by modulating existing profiles.

CHEETAH Infrastructure inventory operates from the collection of availability of expertise/infrastructure (supply site), to its elaboration (management) and its final offer on demand site to project partners by offering information through an extended database improved , in comparison with pre-existing initiatives.

- information is now managed according to a wide number of effective sorting criteria (research organization, technical topic, category of infrastructure, available expertise, available equipment, etc), offering more efficient searching criteria/catalogue than in the past. Furthermore, the listing of existing research infrastructures is now managed dynamically through Cheetah Knowledge Exchange Area Portal (KEAP)
- each segment of information is now dynamically interlinked to others (expertise, similar infrastructures, etc), in order to enable efficient comparative sorting criteria, and the researcher/scientist/expert/student can reach directly information that can be useful to him/her without waste of time.

- The collection of information and its offer is now based on user-friendly selection tools having an improved graphic interface very similar to more diffused professional social network (linked-in, Research-gate, etc) already existing.

The database will serve to prevent duplication by stimulating access (CHEETAH task 2.2), and to ensure that the EU infrastructures will be ready for future developments (CHEETAH task 2.3) to make available some of the existing top-class PV Research Infrastructures for the benefit of the whole European photovoltaic community. For that reason a periodic update will be realized by including the description of the research facilities of new EERA members.

Concerning the management of access to CHEETAH Research Infrastructure (herein named short RI), research activity will not be funded in Coordination Workpackages and CHEETAH access to Research Infrastructure doesn't have much in common with SOPHIA Trans-national Access Procedure (TNA) having special budget assigned to host any interested researcher/scientist.

So CHEETAH should mainly focus on promoting access to RI based on:

- Technical/scientific interest among partners on the basis of the establishment of reciprocal collaboration framework within funded projects or in perspective of them;
- Advantages among organizations in guaranteeing mutual access to their own infrastructures

23 SOPHIA Infrastructures were confirmed and other ones will be very soon confirmed and initiatives are in progress to further improve the offer of new infrastructures. To date, thefollowing new infrastructures were already proposed:

- CIEMAT- PV Unit,
- IKZ-FVB Infrastructure for the preparation of Silicon and CIGS precursors,
- KAPE-CRES Photovoltaic Systems and Distributed Generation Department (PSDGD)
- LNEG-PV technologies lab METU-Center for Solar Energy research and Applications
- NPL Photovoltaics and Organic Electronics Infrastructure
- TUT- Electrical, structural and optical characterization of PV materials
- UNIMIB-Milano-Bicocca Solar Energy Research Center
- UPM-Semi-industrial plant for silicon purification, synthesis, crystal growth and characterization

Brief description of the state of the art and the innovation brought

See technical session. The content will be further described in CHEETAH WP4 documents

Section 5 – Deliverable technical report

1. CHEETAH INFRASTUCTURES INVENTORY: ITS MOTIVATION

Research Infrastructure, in this document is a single very relevant scientific apparatus or cluster of different equipment with a common objective, needed to carry out experiments.

The deliverable D2.1 focuses specifically on the inventory of existing research infrastructures within the entire CHEETAH consortium, based on the review of proposed SOPHIA Infrastructure (17 research centers + 48 Research infrastructures). SOPHIA Project will end in January 2015 and CHEETAH extends the database with additional information coming from the 16 new partners and by covering additional topics such as ultrathin crystalline silicon solar cells which are not covered in the SOPHIA project.

This initiative of inventory serves to prevent duplication but also to stimulate access to existing infrastructures (CHEETAH task 2.2), and to promote future developments and acquisition in the circumstance of necessity of demand and lack of availability (CHEETAH task 2.3), In fact CHEETAH will complete the list of existing research infrastructures by encouraging research teams to use available equipment without waiting for purchasing and installing new one.

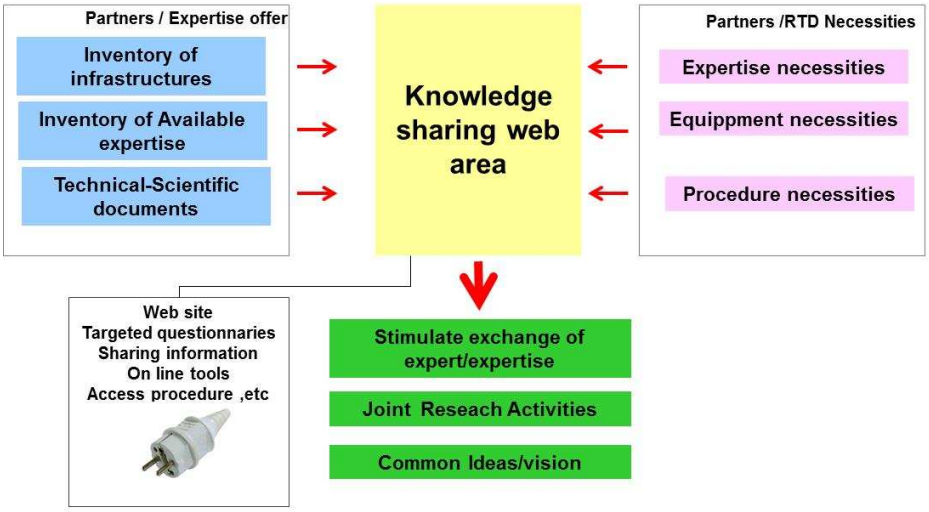

Fig. 1 CHEETAH Knowledge Exchange Area Portal (KEAP) rationale

Furthermore some equipment could require a limited use and their acquisition could not be adequately motivated, but their utilization in specific experiments could speed up the achievement of the objectives of interested laboratory without loss of time and resources in acquiring useless or unmotivated equipment because of its limited use.

2. CHEETAH INFRASTUCTURES: ORGANZIATION OF DATA BASE

The supply/demand of Cheetah Infrastructures is based on the utilization of CHEETAH Knowledge Exchange Area Portal (KEAP) , the web site is operating in parallel to the project website and other dissemination activities (newsletter, communication, etc) to bring information from different sources in a uniform and simple way both inside than outside CHEETAH consortium (see fig 1).

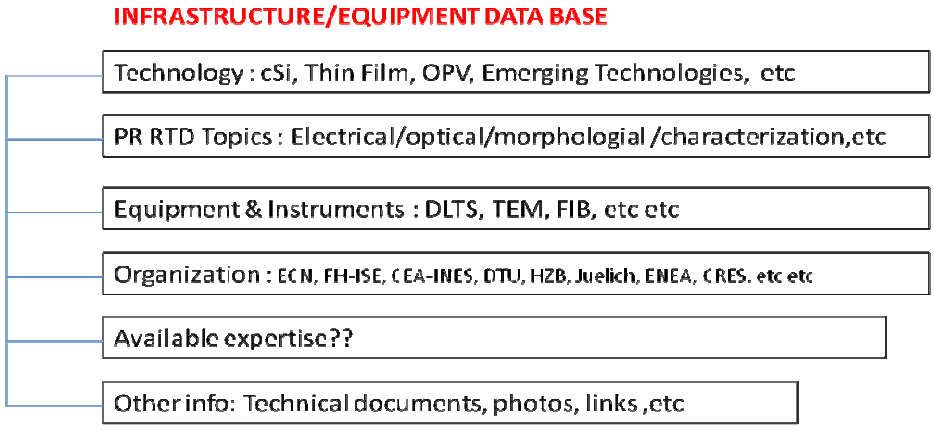

Fig. 2 Structures collected information for each Infrastructure

Fig. 3 Template utilized to collect information on CHEETAH infrastructure

The first step of the process has been the definition of sorting criteria of cataloguing (fig.2) based on research organisation, technical topic, category of infrastructure, available expertise etc and the definition of specific excel template to collect information (fig.3)

Information has been uploaded on CHEETAH KEAP (fig.4)

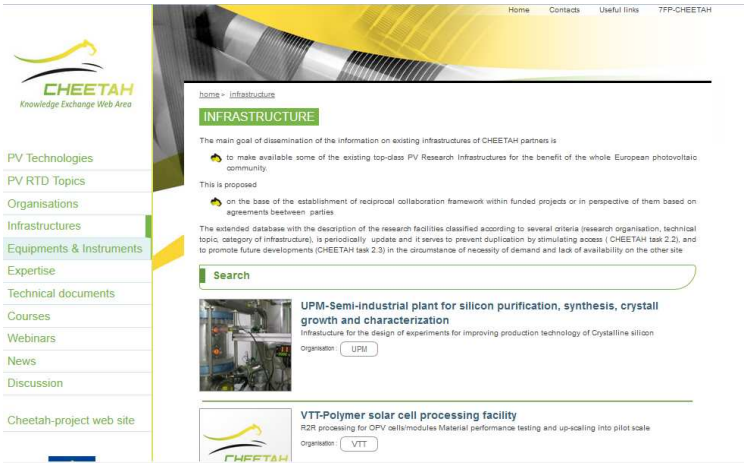

Fig. 4: Infrastructure profiles uploaded on the CHEETAH KEAP

For each infrastructure, the following information is displayed on CHEETAH KEAP (fig5) "infrastructure" web pages : http://www.cheetah-exchange.eu/infrastructure.asp

- the main technical information (equipment, their performances, etc)
- the main limitation or constrain to access
- typical service or results
- participation to Research Projects
-

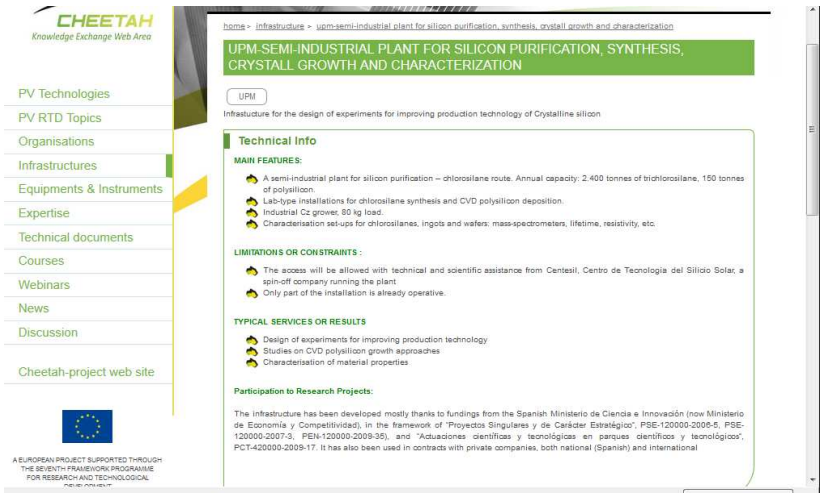

Fig. 5 Typical collected information describing the infrastructure

Extra information can be uploaded concerning:

- Which PV Technologies are investigated by the Research Infrastructure??(cSi, thin film, CdTe, PV module characterization, etc)
- Which PV RTD Topics? (ie interface investigation, photoelectric properties characterization, etc)

- Which Equipment and Instruments? (PECVD, sputtering, distillation column, XPS, AFM, etc)
- Technical document of interest
- Photos

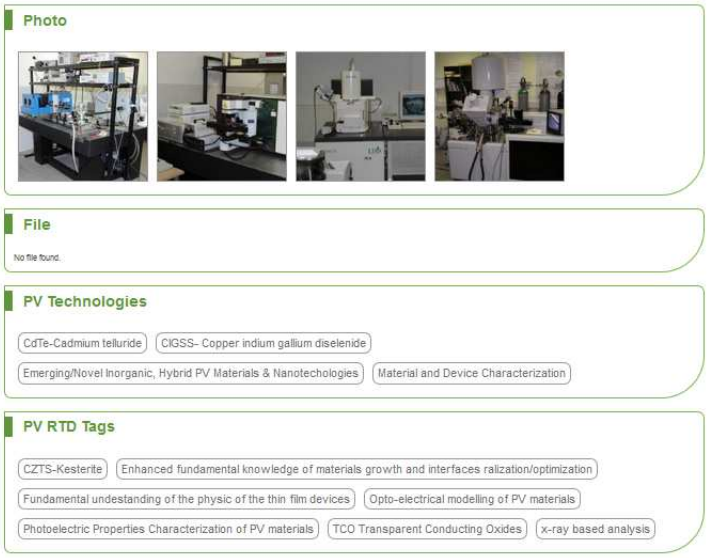

Fig. 6 Extra information available on infrastructure

The search engine allows access to uploaded information by utilization of different sorting criteria (free text, by organization, by PV technology, by Equipment, etc)

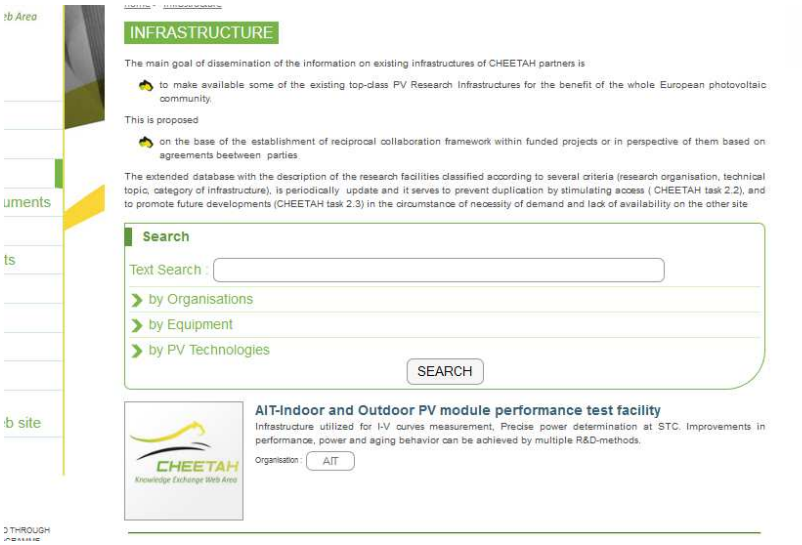

Fig. 7 Search engine: free text, by organization, by equipment, by PV Technology

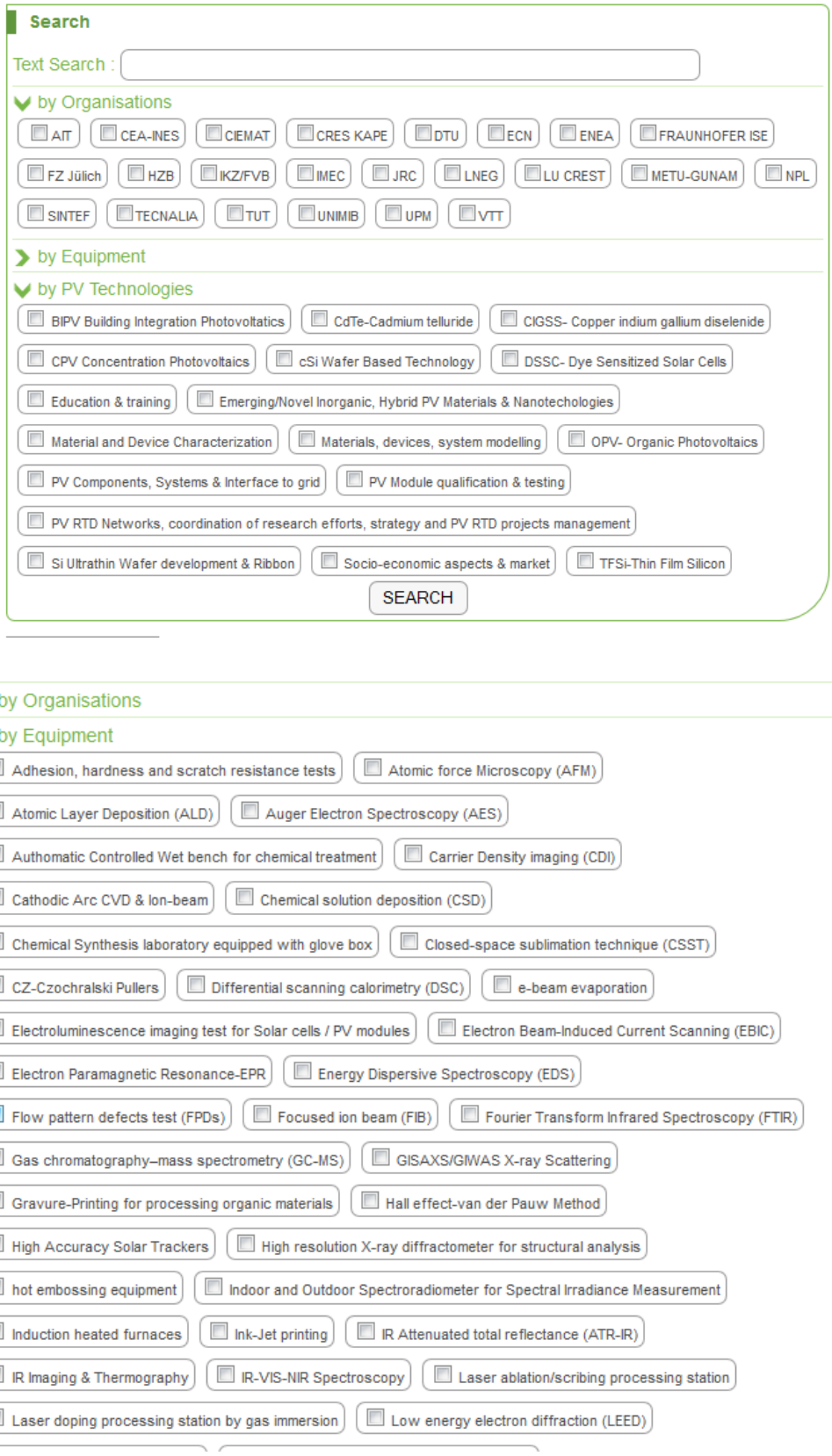

Fig. 8 Search engine: detail by organization, by PV Technology, and by equipment

3. NEW PROPOSED CHEETAH INFRASTUCTURES:

The user-friendly tools, utilized for the management of CHEETAH Research Infrastructure database, offer very efficient opportunities to acquire information on "Who is doing? What? and where?" in PV RTD but, it is very important that new information will be uploaded. In fact, the data base will regularly be updated during the duration of the project. The profile of 23 SOPHIA Researcher infrastructures were revised and updated and the following new infrastructures were uploaded in July 2014:

3.1. CIEMAT- PV Unit

Infrastructure for the:

- Calibration and characterization of PV Cells and Modules.
- Reliability of PV modules. Damp-heat degradation studies of several PV devices
- Preparation and characterization of thin-film TCOs (ITO, ZnO:Al, SnO2:Sb), TF-Si (a-Si, µ-Si) and chalcogenides (CIGS, ZnS, SnSx).

3.2. IKZ-FVB Infrastructure for the preparation of Silicon and CIGS precursors

Infrastructure for the Preparation of Silicon and CIGS precursors by Liquid Phase Epitaxy and Physical Vapor Deposition

3.2.1. Silicon on glass

- Low-temperature growth of silicon layers from metallic solutions
- Application of amorphous substrates (glass) as precondition for cost-saving solar cells
- Well-defined production of silicon seed layers by amorphous-crystalline phase transition (ALC) catalyzed by liquid metallic droplets
- Structural and electrical characterization both of seed and crystallite layers

3.2.2. Si/Ge nanocrystals

- Vapor-liquid-solid (VLS) growth of nanowires under UVH conditions
- Thermodynamics of liquid solid phase transition and investigation of the growth kinetics of nanowires
- Predefined localization of growth sites of nanostructures by local anodic oxidation (LAO) or focused ion beams (FIB)
- Embedding of nanostructures within hydrogen silsesquioxane (HSQ) and epitaxial overgrowth starting from uncovered parts of such nanocrystals

3.3. KAPE-CRES Photovoltaic Systems and Distributed Generation

Infrastructure for the:

- Indoor Qualification and Testing Investigation Objectives: Investigation of the efficiency of the PV modules and PV cells at STC conditions according to IEC 60891.
- Outdoor Qualification and Testing Objectives: Investigation of the performance of PV Cells, Modules and Strings, by using natural light (the Sun) for measuring the characteristic I-V curves of PV Cells, Modules and Strings and calculating their critical performance parameters.
- Outdoor PV Module Long Term Testing Objectives: Investigation of the PV Module annual energy yield, in Athens (under real conditions), as well as the temperature coefficients calculation
- PV module degradation, Lifetime & Reliability Objectives: Investigation of the lifetime of the PV-modules exposed to UV and extreme environmental conditions.
- I-V characterization Objectives: Investigation of the efficiency of the PV cells at STC conditions according to IEC 60891
- IR Imaging & Thermography Objectives: Thermographic characterization of PV modules and cells.

3.4. LNEG-PV technologies lab

Infrastructure involved in technological development of photovoltaic systems, such as: Organic solar cells (OPV) and Inorganic solar (CZTS-based) cells for new generation solar units, new multifunction modules (hybrid PV/T modules), modelling and monitoring of photovoltaic systems and their components and evaluation of power plants performance with and without concentrated photovoltaic (CPV)

3.5. METU-Center for Solar Energy research and Applications

Research center dedicated to solar energy conversion systems in Turkey. GUNAM has 12 academicians and 70+ graduate students working on photovoltaic and solar thermal electricity technologies.

- c- Si group is the largest group and capable of production of industrial cells. Group focuses on material optimisation, light trapping, device applications and characterization
- Thin film solar cell groups of works on, a-Si and CIGS based solar cells. Recently thin film group as focused on hetero junction devices, Organic PV and, DSSC

3.6. NPL Photovoltaics and Organic Electronics Infrastructure

Laboratory for handling, realization and characterization of Organic Devices in controlled environmentally.

- Investigating low-cost production methods for large-area electronics and mechanical stability testing.
- Developing improved metrology for characterisation of thin-film energy materials.
- Developing and promoting an energy-based metric for characterisation of PV products.
- Developing new metrology to reduce uncertainty in PV energy yield assessments.

3.7. TUT- Electrical, structural and optical characterization of PV materials

Infrastructure currently utilized for electrical, structural and optical characterization of materials and devices based on kesterite (CZTS), chalcopyrite (CIGS) and cadmium-telluride (CdTe)

3.8. UNIMIB-Milano-Bicocca Solar Energy Research Center

Infrastructure with:

- fully equipped laboratories for synthesis (including glove-box reactions, microwave, etc.) and characterization (including multinuclear NMR, absorption and emission spectroscopy, ATR-IR, TGA, DSC, GC-MS, etc.) of organic, inorganic, and polymeric materials;
- fully equipped laboratories for electrochemical synthesis and investigation;
- study of chemical, thermal, and photochemical short- and long-term stability;
- fabrication of thin film CIGS solar cells by a technique hybrid between sputtering and evaporation
- fabrication of DSCs and organic/polymeric cells (glove-boxes);
- solar simulators for small cells (2×2”) and modules (6×6”) and Keithley digital source meters for current/voltage measurements
- fully integrated system for EQE and IQE measurements;
- Scanning Electron Microscopy (SEM) equipped with EDX and EBIC; 77-300 K;
- large variety of spectroscopic techniques for characterization of materials in solution, solid-state and in devices;
- Light Beam Induced Current (LBIC);
- sputter, evaporator, plasma and ozone cleaning;
- resistivity and Hall measurements
- Quasi Steady-State Photo conductance Decay (QSSPC) for lifetime testing;
- ageing of solar cells under thermal stress and light soaking