

Joint Italian-Israeli Laboratory on Solar and Alternative Energies (ILSE-Joint Laboratory)

1. Introduction

The Memorandum of Understanding signed by the Italian Foreign Affair Ministry with ENEA and Ben Gurion University of the Negev drafts a first rationale for the establishment of the ENEA-BGU Joint Italian-Israeli Laboratory on Solar and Alternative Energies (ILSE-Joint Laboratory).

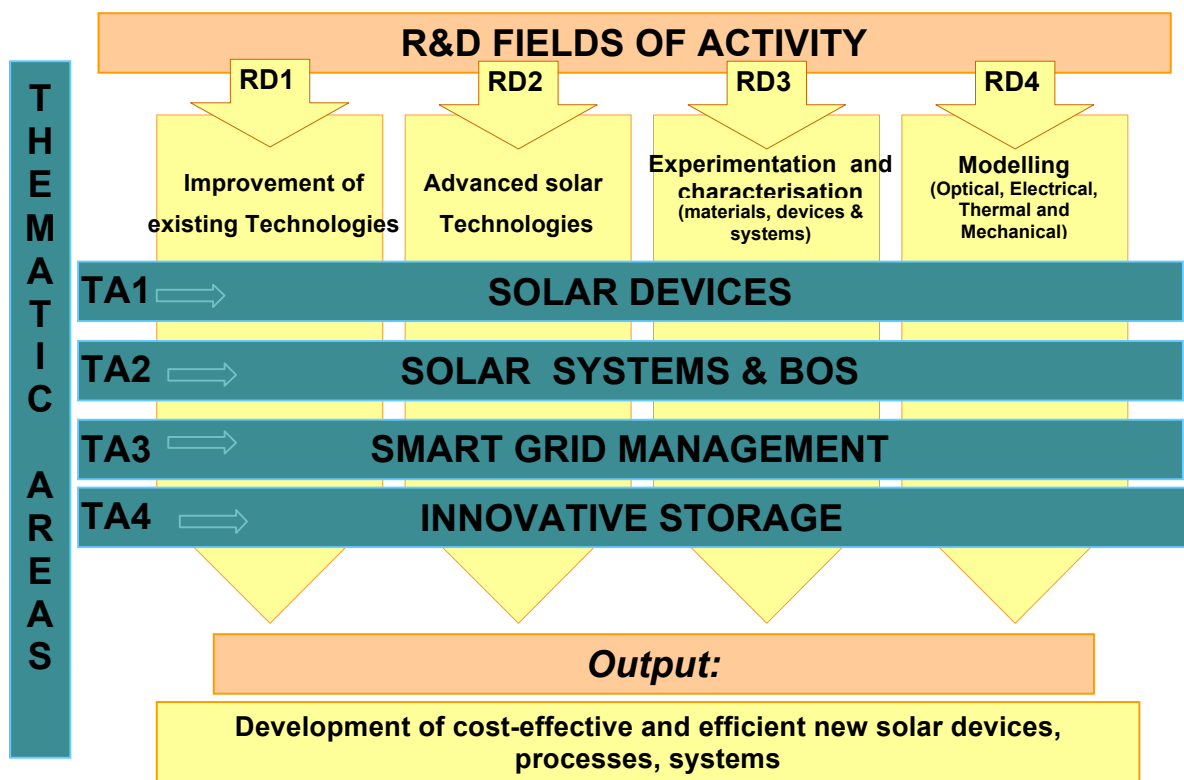
The present document outlines the areas of collaboration, with a first selection of topics for the joint R&D activities of the Laboratory.

2. Thematic areas

Current limits to the development and diffusion of solar technologies for energy production include:

- low efficiency/density power (W/m^2);
- high costs and availability of raw materials for PV applications;
- low production throughput unable to sustain an increasing market,
- energy production discontinuity.

The proposed ILSE-Joint Laboratory aims to carry out R&D activities to overcome some aspects of the limits mentioned above. The picture below illustrates the domain of activity of the JL as a grid connecting Thematic areas and R&D fields of activity.



- TA1. Solar Devices:* Development of cost effective and very efficient solar devices based on the existing technologies (cSi and thin silicon solar cells and modules and conventional solar panel) and approach to emerging and novel PV-technologies (cost effective organic materials, utilization of inorganic materials is SJ structure and MJ with efficiency >30%) and other advanced solar devices.
- TA2. Solar systems & BOS.* Reliable, long-term, stable and low-cost solutions for PV systems, development of flat and concave mirrors, lenses and Fresnel lenses and their combination with secondary concentrators. Innovative mirror and refractive optics with very high acceptance angle and for light splitting. Trackers design optimised with respect to size, load-capacity, stability, stiffness and material consumption.
- TA3. Smart grid Management.* Management of renewable energies integrated into electricity grid through advanced application of the Information and Communication Technology concepts. Development of advanced tools for grid management through the control of energy generators, automated local optimization, weather and consumption prognoses, as well the development of innovative control algorithms.
- TA4. Innovative storage.-* Advanced energy storage systems (ESS) related to battery utilization and development of complementary storage methodologies related to high-temperature heat storage, phase change materials, hydrogen production, seasonal storage and back-up by biomass cultivations, marine algae cultivations, steam explosion for biomass valorisation.

The Thematic areas mentioned above can be covered through four main R&D fields of activity:

- RD1. Improvement of existing technologies:* crystalline and multicrystalline Solar cells, amorphous-crystalline SHJ, development and optimization of thin silicon solar cells and micromorph solar cells including application of intermediate reflectors and optimized light trapping, very high efficiency small area solar cells ($\sim 1\text{-}2\text{ cm}^2$) suitable for concentration, low cost transparent conductive oxides.
- RD2. Advanced Solar Technologies:* Development of new ideas, materials, processes, devices and solar systems, development of innovative growth techniques and process reactors for the realization of new and advanced materials and process for photovoltaic devices, optical coating, transparent conductive oxide, antireflective and protective coatings for solar cells, lens and mirrors. New concepts for solar energy conversion, energy storage and grid management.
- RD3. Experimentation and Characterization:* Set-up and use of different characterization equipment to evaluate electrical, optical, mechanical, morphological, compositional properties, corrosion and ageing of conventional and advanced materials for solar applications. Use of a wide range of advanced characterization methods and models to analyze films, crystals, interfaces mechanical tests, functional properties, definition of fabrication process. Development of indoor-outdoor characterization tests and participation to round robin indoor-outdoor tests procedures.
- RD4. Modelling (Optical, Electrical, Thermal and Mechanical)* Computational approaches for ab-initio modelling of the interaction of solar radiation with organic-inorganic materials, thermal exchanges and chemical-physical properties. This R&D field of activity can be carried out through the use of a virtual environment where researchers, from both ENEA and BGU can work together sharing computing resources, software, specialized services, skills and best practices.

3. Proposal for 2010-2011 ILSE-JL Activity

The preliminary exchange of information between the two partners suggests the following list of topics for R&D activities to be carried out in the first 2 years of collaboration.

RD1 - Improvement of existing technologies

- a. Training of selected young Italian scientists in order to conduct experiments and research protocols of common ENEA-BGU interest.

RD2.- Advanced Solar Technologies

- b. Development and utilization of enhanced materials for III generation PV based on innovative concepts (Si quantum dot and array of metallic nanoparticles, nano-wires, nano-rods).
- c. Polymer solar cells and direct synthesis of hybrid inorganic-organic PV dispersed in conjugated polymer matrices and nanocrystalline titania (realization, characterization and study of the degradation and stability).
- d. Development and utilization of antireflective coatings for photovoltaic and solar thermal application and protection of lenses and mirrors.

RD3.- Experimentation and characterization on materials and devices

- a. Implementation of personnel skills on several scientific and technological fields and utilization of different characterization equipment available in laboratories of both ENEA and BGU to evaluate the electrical, optical, mechanical, morphological, compositional properties, corrosion and ageing of conventional and advanced materials for solar applications and to analyze films, crystals, interfaces, mechanical tests, functional properties.
- b. Development of indoor-outdoor characterization tests and participation to round robin indoor-outdoor tests on single-junction and multi-junction solar cells and PV flat and concentration modules.
- c. Generation of standards and measurement tools and procedures and development of specific algorithm for performance energy rating of PV system based on different technologies. Comparison between measurements carried out at BGU and ENEA.
- d. Development of qualification/certification procedures.

RD4.- Optical, electrical, thermal and mechanical modelling based on computational approach

- a. Set-up of a common virtual computational environment through the use of GRID solutions, to share computing resources, software, services, skills. Numerical modelling of characteristics and behaviour of crystalline and amorphous silicon, carbon and other semiconductors for application in the field of solar cells, quantum dots, etc.

4. ILSE-JL organization

The Scientific board will define a detailed programme for R&D activities to be carried out in the first 2 years of collaboration highlighting:

- Objectives and expected results in short-medium and long term;
- Specific activities to be carried out;
- Resources (human, equipment, materials) to be committed;

- Duration and management of the activity;
- Procedures for reporting and external dissemination.

Given also the limited amount of financial resources currently available for the JL, one of the main purposes of the Joint Laboratory will be to generate and stimulate new R&D project proposals among Italian and Israeli scientific and industrial partners, to be submitted for financial support to the bi-national scientific and technological cooperation agreement, or to other international financing schemes such as the EU Framework Programme.

The Scientific Board will periodically meet (in person or through VDC) to review the progress of the R&D activities and to integrate/modify the programme.

5. Visits at BGU of young Italian scientists

ENEA will identify a first group of young Italian scientists that will benefit of the grants offered by BGU. This personnel will take part in the above mentioned R&D projects. The duration of individual visits will be defined taking into account project workprogrammes and availability of personnel.

6. Feasibility study on the introduction of renewable energy systems in selected buildings of the Italian Public Administration

A complete diagnosis of the energetic balance will be jointly performed by the two partners on one or several selected buildings of the Italian Public Administration. Possible actions will be identified and general plans will be outlined to use the best available innovative technologies, and particularly those addressed by the R&D activities of the Joint Laboratory, to achieve significant results in terms of energy efficiency.

7. Workshop

A bi-national Workshop will be organized in the second half of year 2010, to draw together a certain number of scientists from Italy and Israel to discuss the scientific topics of the JL. The title of the workshop and the composition of the attendance will be defined at a later date. Participation of young researchers and students from both countries will be encouraged.