Photovoltaics lasts: you can depend on it!

Photovoltaics is one the most promising renewable technologies capable of producing electricity on a large scale. The endurance of photovoltaic modules is a crucial factor for the competitiveness of solar installations. As part of the Fifth EU Framework Programme, the SOLAREC project studies the durability and long-term efficiency of photovoltaic cells. Developed at the Laboratory for Energy, Ecology, and Economics (LEEE), SUPSI, and headed by Angelo Bernasconi, the project is run in association with the Centro comune di ricerca, Ispra.

Photovoltaic technology helps us convert solar energy into electricity by exploiting the properties of some materials that generate electricity when struck by sunlight. Today, research on photovoltaics focuses on two fundamental aspects: energetic yield and competitiveness of photovoltaic cells. To become competitive, photovoltaic energy requires essentially a combination of factors: the components of a photovoltaic cell must be durable and efficient in the long term. Working closely with Centro Comune di Ricerca (CCR), Ispra, SUPSI's Laboratory for Energy, Ecology, and Economics (LEEE) has embarked on a programme named SOLAREC-MTBF, to investigate the long-term durability of photovoltaic cells. The TISO 10kW plant in Canobbio (Ticino) enabled the realisation of the project. Active since 1982, this has been the first system in Europe to produce solar power in connection with the electricity grid. Relying on a twenty-year experience, and constantly monitored, the plant has proved ideal for this sort of research.

LEEE-TISO: serving clean energy for over 20 years

The Laboratory for Energy, Ecology, and Economics (LEEE) was created in 1998 as an offshoot of the Department of the Environment, Building and Design, SUPSI. Its research activities cover mainly two areas: renewable energies, in particular solar and geothermic energy, and secondly the rational use of energy in housing in compliance with environmental and economic criteria. The two concerns run through the Laboratory's two main research streams. With regard to photovoltaics, the TISO team (TISO is an acronym for Ticino solare) was set up in 1982, hence it antedates LEEE. It was then that the mainstay of the SOLAREC-MTBF project saw the light of day. Therefore, and also owing to its long experience, TISO is a national centre of excellence reputed for its testing facilities on photovoltaic modules. Its activities aim to ensure quality control, reliability, and efficient photovoltaic modules; additionally the centre is also working out a method to standardise energy output.

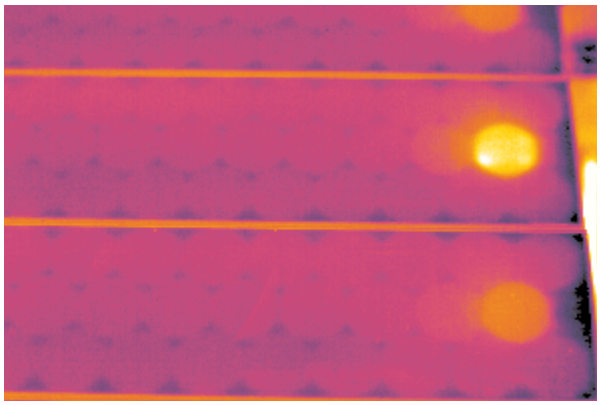
Aerial view of TISO 10 kW SUPSI-LEEE.

Toward a competitive photovoltaic

The project has drawn up a full record of the main features of the system's modules at the end of a twenty-year activity, and carefully observed the nature and causes of the faults that prevent it from functioning properly. All the breakdowns of the system have been recorded, and so have all replacements and repairs. One particularly relevant task has been the calculation of the energy output of the modules and its possible correlation with any wear-and-tear elements. Finally, the project has identified the causes of the obsolescence of the modules and has estimated their life expectancy, relating it to ups and downs in energy output. Quite apart from their scientific interest, the findings may provide food for thought for manufacturers as well as for potential buyers/customers. Manufacturers, in fact, will make use of these results to identify any flaws in their products and improve materials as well as future performance. The findings of SOLAREC will also contribute to refining forecasts as well as to calculate prices and the yield of investments in photovoltaic systems.

Clean energy from one generation to the next

The LEEE Laboratory has played a leading role in this project, which relies on the historic installation, TISO 10kW, but equally on the expertise of SUPSI's researchers. Indeed, the plant has always been maintained in good working order, and constantly monitored. In addition to placing both the plant and historic data at the disposal of the public, LEEE researchers have provided testing and monitoring facilities, thermographic searches, and energy output checks. Likewise, all the modules of the installation have been measured for electricity yield by applying the LEEE Laboratory's sunlight simulator. The consequences of the deterioration of other components of the plant have also been duly taken into account, for example the lifetime and functioning of the inverter, a device that converts the energy generated by the sunlight system into power usable by the grid. By simulating obsolescence, the ESTI Laboratory of CCR, Ispra, has been able to draw more general conclusions on the behaviour of photovoltaic modules. By means of in-lab tests, researchers have managed to estimate the lifetime of PV cells over an even longer period. In fact, the ESTI Laboratory's simulations enable researchers to determine in one year the degree of ageing of solar panels over the next 20-25 years. On the other hand, the longevity of the LEEE installation makes it possible for Ispra to check the accuracy of the senescence tests, by comparison with modules that have grown old 'naturally'. Senescence tests, carried out in accordance with international regulations (International Standard IEC 61215), pinpoint the various decay factors: UV rays; temperatures (high, low, and cyclical); water (damp, seepage); electrical resistance; mechanical stress (torsion, hail). As indicated in the European Union White Book on Energy for the future, the long-term strategies for the development of photovoltaic technology may lead to an output quota of 1m. KWp installed in Europe. SOLAREC's contribution fits into this context by building up PV technology into a viable method of electric power output on a large scale.



Thermographic picture of a module. The hotspots that have a negative impact on output have been highlighted (softer tone).

Life expectancy of PV modules: twice as long as they were given credit for

Mean Time Before Failure of Photovoltaic Modules is part of SOLAREC - Photovoltaic Solar and Thermal Electricity Project, run by the Fifth EU Framework Programme, under 'environment and sustainable development'. Two partners are involved: ESTI,

a laboratory of Centro Comune di Ricerca, Ispra (Italy), and SUPSI's LEEE Laboratory, Lugano (Switzerland). The project has identified several faults likely to impair the output of module in the long run; these faults include delaminating of the encapsulant, damp penetration, hotspots, manufacturing and assembling defects, breakages, cracks and decay in other components. These problems notwithstanding, the project has shown that TISO 10kW is still a perfectly sound system. The annual average loss of power has been 0.2%, an indicator of good endurance. In other words, installations of this kind might, according to estimates, enjoy a lifetime of approximately 40 years with a steadily efficient output. The installation thus turns out to last twice as long as it was originally calculated and guaranteed by the manufacturers of the modules (20 to 25 years).

For further details:

Antonella Realini - Laboratorio LEEE
Dipartimento Ambiente, Costruzioni e Design
Scuola Universitaria Professionale della Svizzera Italiana
CH-6952 Canobbio - Tel. +41 91 58 666 63 55
E-mail: leee@supsi.ch

Web addresses:

Laboratorio Energia Ecologia, Economia:
www.leee.supsi.ch
Dipartimento Ambiente, Costruzioni e Design:
www.dacd.supsi.ch
Scuola Universitaria Professionale della Svizzera Italiana:
www.supsi.ch

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Servizio ricerca USI - SUPSI
via Lambertenghi 10a, CH-6904 Lugano
Tel. +41 58 666 46 17; e-mail: sr@ticinoricerca.ch