valid data of energy yields, installed capacity and energy cost. Thus it is crucial to understand long-term behaviour.

Effects on ageing of PV modules

Ageing is driven by a number of different effects, which has been summarised in above figure. STAPP is developing tests and equipment for accelerated ageing as well as models that allow linking of the operational environment determined for the different sites to the ageing and thus predicts ageing of materials in-service as well as the effects on module efficiency and failure.

Grid Issues and Balance of System

Photovoltaics are normally integrated into systems that are connected to the grid. Both steps involve additional loss mechanisms and thus affect the costs. The STAPP project will address issues such as mismatch and related issues, that can seriously distort the power characteristics of system.
These distortions and the intermittency of the solar resource affect the grid stability and reliability. Also, appropriate BOS components are required, including MPPT algorithms suited for non-ideal I-V characteristics and improved inverter topologies for improved system performance.

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STABILITY AND PERFORMANCE OF PHOTOVOLTAIC (STAPP)

UK-India Research Initiative in Solar Energy

Sponsored by

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Project Overview

STAPP delivers and upgrades the fundamental understanding required to reduce the levelised costs of energy from photovoltaic systems through a multidisciplinary collaboration of leading research teams in two countries, involving 23 investigators of 9 institutes/universities and more than 15 companies, for the benefit of both nations. Research Council UK and Department of Science & Technology, India provided funding of £ 4 Million, while considering the importance of the project.

Photovoltaics is a green technology with an undeniable potential for energy delivery. The key issue is the cost of the generated energy which is dominated by the long term performance of the PV system and its stability

The success of a PV system is defined in terms of the investment having an appropriate return. Understanding of the stability and performance enables the increase of life-time energy yield and thus reduces the levelised cost of energy. A lack of understanding will result in high risk investments with relatively high probability of failure rates. Emphasis of projects is on the topics related to stability and long-term performance of PV module and systems.

The environments in the UK and India are very different, but both countries have about the same capacity installed at present. The UK is lower on indigenous production of PV modules. However, installations and the related costs are 70% of the value and are generated nationally. STAPP will help in increasing the profitability of systems and thus enhance national industries as well as reducing the cost of green energy obtained from PV.

Energy Yield of PV Systems

The key technical indicator is the *specific energy yield* of a PV system over its life-time. The major unknowns are the influence of the environment and the degradation due to defect formation in the module.

STAPP will assess the PV resource by improving the understanding of the environment seen by the devices and its influence both in terms of performance as well as ageing of the materials.

Test beds currently operated by the STAPP team

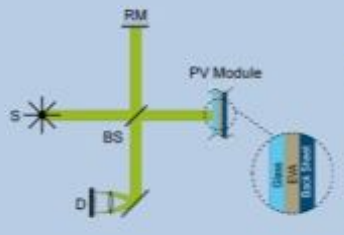
The project will deliver specially developed outdoor monitoring stations that will provide the high quality data required for modelling of the energy yield as well as giving good indications of the generation potential of PV technologies in both nations while uniquely considering system and durability issues.

Module Characterisation and Simulations

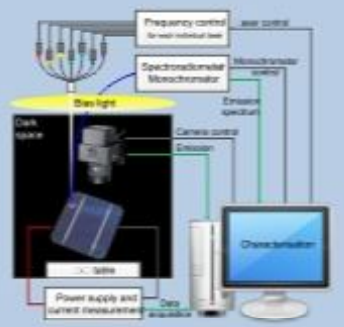
One of the focuses of STAPP is on improved characterisation of PV modules to understand the defects in module which affects its performance. This involves improving standard characterisation techniques as well as setting up novel systems that allow the identification of production faults and durability issues, by which problems can be solved in shorter time. This is linked to detailed modelling and simulation approaches that allow the identification of the earliest indicators of the various ageing mechanisms, and effect of defects on module and system performance.

Standard measurements are improved by cross-calibrating modules in form of an inter-laboratory round robin inter-comparison. This typically improves agreement between laboratories, e.g. the EU project 'PV-Performance' brought the comparability from ~4% to 1.5%. This links directly to the value of the installed PV and would be equivalent to an uncertainty in the value of installed PV larger than £ 100 Million for the two countries.

Novel measurement and characterization approaches involve identification of shunts, delamination, inactive regions, non-uniformity effects and humidity ingress into the PV-module laminate and detailed non-destructive probing of material properties.



Spectral optical coherence tomography



Multi-purpose scanner

The role of these techniques are same as of the X-Rays in the field of medicine.

Durability and Reliability

There are significant differences in the durability of PV modules. Devices typically age 0.3-3%/year, which is equal to a cost difference of PV energy of 30% over the life-time of the devices. This equates to a divergence of around 4.5 $x10^9$ kWh, which is equivalent to £ 625 Million while considering