Mobile PV testing in India

Testing | With India going all out to achieve its target of 100GW of PV by the year 2022, the quality of equipment used in installations is becoming increasingly important. Satish Pandey and Abhishek Sharma of Mahindra Susten explore the role of on-site testing in quality control, based on the early results from India's first mobile PV lab

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India's Ministry of New and Renewable Energy (MNRE) is rolling out a new order seeking to improve the quality of solar components. From later this year, all PV modules, inverters and batteries manufactured in or imported into India must obtain a new Indian 'standard mark' certifying that they have satisfied certain quality requirements [1]. In the case of PV modules every module supplied/ used must qualify under IS14286/ IEC61215 or IS/IEC 16077/61646 and IS/ IEC 61730(PART 1, 2), IS/IEC 61701 and also IEC 61804 PID [1] {3.7.1 PV Modules}. The standard will be administered by the Bureau of Indian Standards and require equipment samples to be taken at least every two years to ensure compliance of products [2]. Non-compliant equipment will be subject to confiscation and disposal.

Meanwhile, degradation over time is an issue known to affect PV modules for a variety of reasons. Degradation studies have been made throughout the world indicating different values of degradation percentages and their impact on the PV plant performance. The difference generally occurs due to the weather conditions and the topography of that particular location; for example a soiling loss of 2-3% is generally assumed while performing analysis of solar power plants in the Indian sub-continent. The performance of a module is generally also affected by factors such as operating temperatures, shading, vegetation, humidity, presence of any abrasive chemicals and varying irradiance levels.

Mobile module testing will help India drive up quality standards

Quality checks and the need for mobile testing

As per the MNRE's order, it will become mandatory to do regular quality checks of PV modules which are either manufac-

Sr. No	Location	Installation year	Module type	Module country of origin	Sample Size	Nameplate power (Wp)	Measured PIV value in Mobile Lab (Wp)	Deviation from rated power (%)	Annual degradation rate (%)
1	Mumbai (MH)	2013	Polycrystalline	India	10	250	238.94	-4.42%	-1.1%
		2017	Polycrystalline	India	10	250	240.48	-3.81%	NA
2	Charanka (GJ)	2012	Polycrystalline	China	10	235	219.08	-6.77%	-1.4%
		2017	Polycrystalline	China	10	320	319.73	-0.08%	NA
3	Rawra (RJ)	2012	Polycrystalline	India	10	235	228.11	-2.93%	-0.6%
	Phalodi (RJ)	2014	Polycrystalline	China	10	250	227.35	-9.06%	-3.0%
	Bikaner (RJ)	2017	Polycrystalline	China	10	320	321.91	0.60%	NA

Table 1. Flash test results from Mahindra Susten mobile PV lab

tured in India or being imported from other countries, more so for the imported PV modules as they need to pertain to Indian climatic conditions for reliability and sustainability for a long lifetime performance. And with India's specific climatic conditions, modules will also need to be tested regularly to monitor degradation rates and performance losses over their typical 25-year design lifetimes.

A network of accredited laboratories with expert manpower adhering to IEC/ISO 17025 is in place in India to offer the necessary quality assurance infrastructure. But since the accredited labs present in the country are situated away from the active solar parks, it's not always feasible to transit large numbers of modules from sites to the labs. The sample size of PV modules shared for testing is thus frequently low, undermining its viability as an effective quality control on PV modules.

Mahindra Susten mobile PV lab has been developed for conducting qualification testing. It is a robust test lab which can move across various geographies and produce reports on the health status of modules in fewer than three days. The lab is the first of its kind in India, providing a range of electrical and visual tests of PV modules as per IS14286/ IEC61215. The mobile PV lab has applied for accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL), which is an autonomous body under the aegis of Department of Science & Technology, Government of India, and is registered under the Societies Act. It is the only one of its kind to assess laboratories in India for quality and consistency in the results.

The mobile PV lab can mitigate the problems associated with remote testing as it can travel to a plant or manufacturer location and thus the sampling rate of the PV modules to be tested can be increased significantly. This process is feasible techno-commercially as testing can be done in non-generation hours, thereby no generation loss occurs. Also, since handling and transit costs are mitigated, the process is more commercially feasible. We believe that the MNRE will enforce and promote testing processes to be more robust and quick. In the current scenario the turnaround time for testing PV modules is roughly about a week, which the same in the mobile PV lab can be completed in about one day with the test reports for 10 times the number of modules.

It offers a comprehensive as well as à-la-carte testing solution for both plant developers and module manufacturers, thus its results can be inferred both for benchmarking and qualification testing as required for PV modules, thus catering towards the goal of MNRE, of seeking quality assurance in solar PV modules.

Experimental testing

To give a better understanding of the working of the mobile PV lab we have compiled results in which observations from various sites and of various tests are shared, stating the percentage of degradation of PV modules along with EL test and thermographic inspection which was observed during the testing in the Mobile PV Lab. The results include various tests conducted in Maharashtra, Gujarat and Rajasthan. The mobile lab consists of essentially three major pieces of equipment namely flash tester, electroluminescence (EL) tester and thermal imaging cameras. The flash test is achieved with the help of an AAA-class sun simulator, which comprises of a flash lamp, flash generator and an electronic unit. The flash test gives the IV characteristics of the PV module. Thermal imaging is done for finding hotspots using a thermal camera while the EL test helps us to identify micro cracks & PID-affected modules, both of which have a separate housing space in the lab.

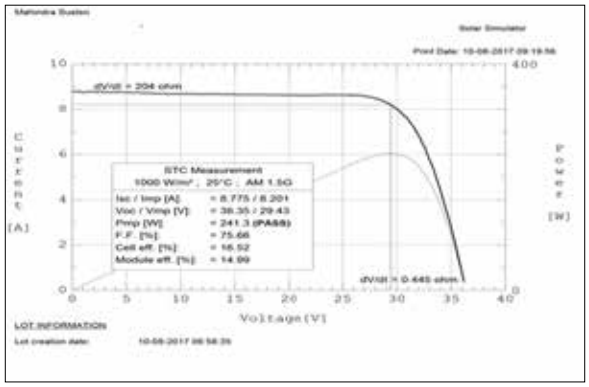
In our case studies, we have taken the mobile PV lab to sites in Gujarat, Rajasthan and Maharashtra covering 280MWp of installed capacity with projects ranging from 1MW-80MWp. Following visual inspection, 10 modules were selected from each site for flash testing, EL testing and thermography. The results compiled here show modules of

Sr. No	Location	Installation year	Module type	Module country of origin	Sample size	Nameplate power (Wp)	Cell crack observed	% of modules affected from cell crack (%)
1	Mumbai (MH)	2013	Polycrystalline	India	10	250	No	Nil
		2017	Polycrystalline	India	10	250	No	Nil
2	Charanka (GJ)	2012	Polycrystalline	China	10	235	No	Nil
		2017	Polycrystalline	China	10	320	No	Nil
3	Rawra (RJ)	2012	Polycrystalline	India	10	235	No	Nil
	Phalodi (RJ)	2014	Polycrystalline	China	10	250	Yes	10%
	Bikaner (RJ)	2017	Polycrystalline	China	10	320	No	Nil

Table 2. EL test results from mobile test lab

Sr. No	Location	Installation year	Module type	Module country of origin	Sample size	Nameplate Power (Wp)	Hotspot symptoms	% of modules affected from hotspot
1	Mumbai (MH)	2013	Polycrystalline	India	10	250	No	Nil
		2017	Polycrystalline	India	10	250	No	Nil
2	Charanka (GJ)	2012	Polycrystalline	China	10	235	No	Nil
		2017	Polycrystalline	China	10	320	No	Nil
3	Rawra (RJ)	2012	Polycrystalline	India	10	235	No	Nil
	Phalodi (RJ)	2014	Polycrystalline	China	10	250	Yes	10%
	Bikaner (RJ)	2017	Polycrystalline	China	10	320	No	Nil

Table 3. Thermography results from mobile PV lab



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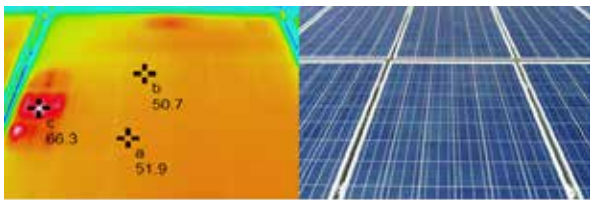
IV curve (flash test)



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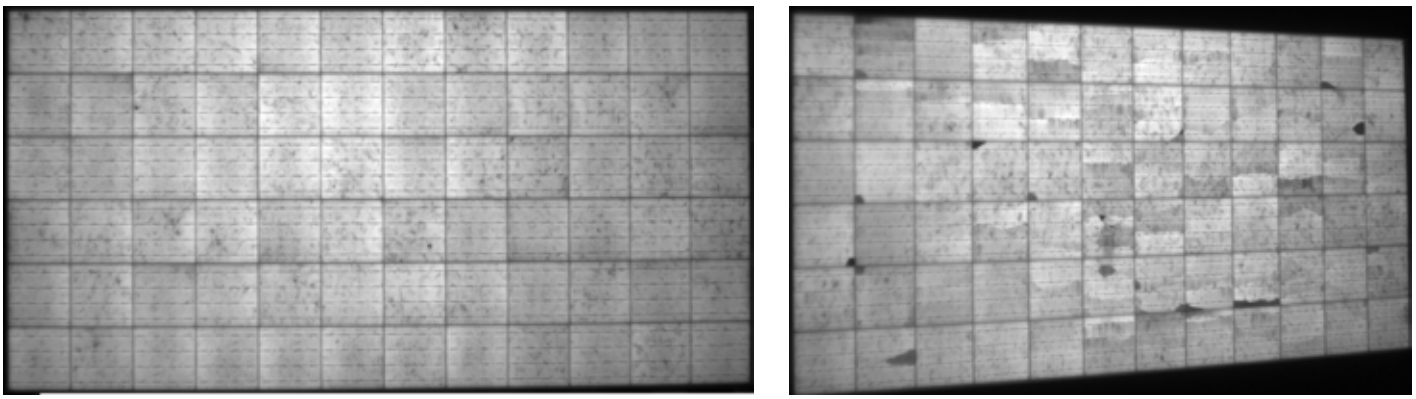
Sample image of thermography inspection



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EL image of healthy module (left) and unhealthy module

different makes at diverse locations of the sites. The module age at the various installations varied from one to six years, with the earliest installation from 2012.

Results

The results have been compiled in a series of comparative tables, which give us an overview of how degradation varies with respect to the year of installation and location. Table 1 shows the comparative analysis of all the flash test results as obtained by the mobile PV lab, Table 2 the results from EL testing and Table 3 from thermography.

Summary of test results of samples

1. The maximum deviation was found to be 10.59% in first six years of operation for the modules installed in the year 2012. Out of total 100 modules sampled 15% had degradation higher than warranty expectation.
2. Cell crack was evident on one of the modules installed in 2012, EL image of the same has been attached.
3. Sample thermography image of the module in which hotspot was found is attached; the rest of the modules were found OK during testing.

Conclusions

The mobile PV lab can help the testing domain of the Indian solar industry with its quick results and preciseness. Once it gets accredited from NABL, and its empanelment with MNRE is done it will change the PV module testing domain in the market. Precise and quick results are its forte, and reports can be submitted in two to three days. Since the testing can be done in non-generation hours, no generation losses occur. The testing cost of PV modules will be reduced as transportation and handling cost is minimised.

So far we have tested only polycrystalline modules; moving ahead we will include thin-film module technology covering all the regions of India. The commercial analysis shows, that for sample sizes exceeding 10 modules the mobile lab testing is commercially more viable than transportation to a laboratory. The preventive analysis of the module performance based on the test reports of the lab can be done and same can be shared with module supplier for corrective action under warranty terms. ■

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References

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[2] Solar Photovoltaics, Systems, Devices and Components Goods (Requirements for Compulsory Registration) Order, 2017. Ministry of New and Renewable Energy, India, 2016. http://mnre.gov.in/file-manager/UserFiles/Draft-Quality-Control-SPV-Systems_%20Devices_&_Components-goods-order.pdf

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Lead author Satish Pandey is the head of solar plant performance analysis and PV testing at Mahindra Susten, the clean-tech arm of the Mahindra group and a leading player in the Indian solar energy sector, with over 1,090MWp commissioned to date and over 502MWp under execution. He holds both an M.Tech and MSc in physics and has over 10 years' experience working in the solar industry. He worked with PV manufacturer Moser Baer Solar from 2008-2013 before joining Mahindra Susten in 2013.