# ILUMEN PID SOLUTION

Independent party testing

Confirmation of regeneration

We believe trust in a relation is very important. This is why we let an independent party put our Ilumen PID Solution product to the test. Hereby we can provide you with objective evidence and facts of our products effectiveness. To do this Ilumen selected ELIOSYS engineering services as an independent party for testing our solution.

ELIOSYS is specialized in environmental and renewable energy testing. Their testing facilities correspond with IEC 61215, IEC 61646 and IEC 61730 standards. Also accredited with the BELAC ISO17025 ensures high quality professional and competent testing services recognized internationally. In the past they already had encounters with PID also.

To start ELIOSYS selected a demo project with sting configuration A: 3x19 and B: 1x20 from which the 4 worst modules would be tested before, during and after the regeneration process with the Ilumen PID Solution. Determining the PID infection in the PV installation was done on site (result shown by some pictures below). The modules have a 245Wp nominal datasheet value but to set the reference first the real power of the good modules was determined.
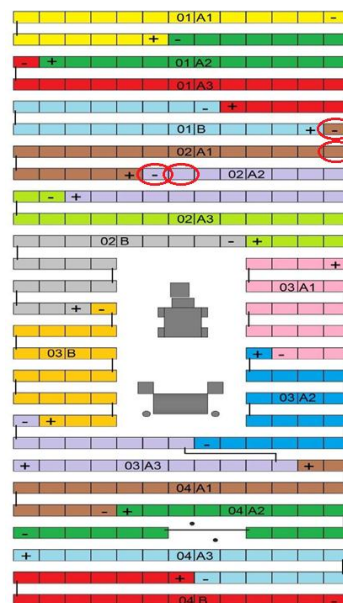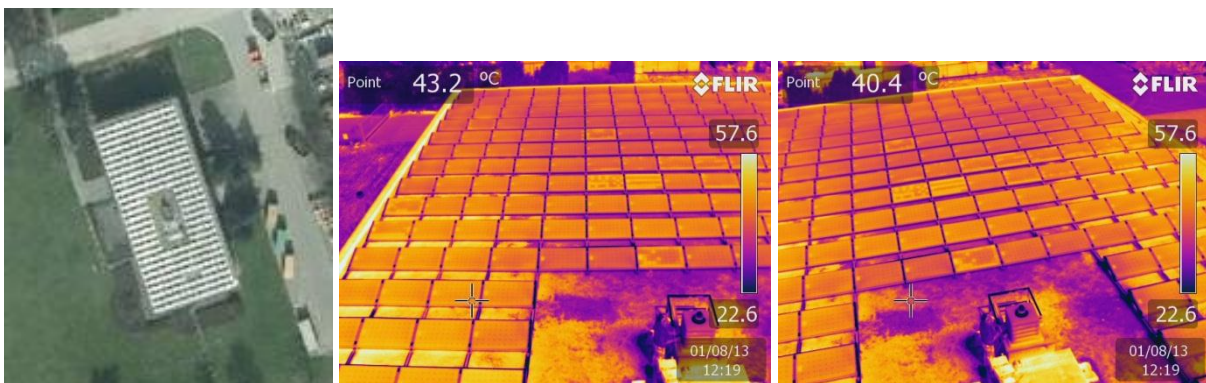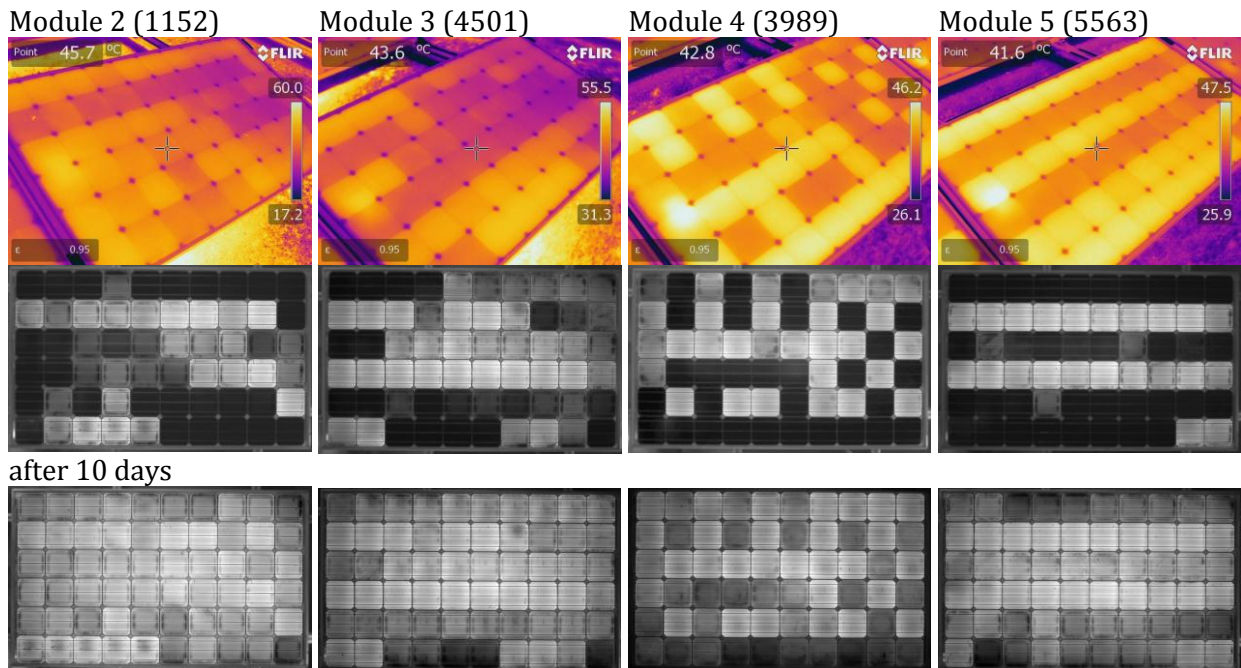
Module n° 1105M603S60100XXXX	1731	2065	2242	5365
P_{max} [W]	235.1	234.9	234.4	228.7
V_{Pmax} [V]	28.93	28.85	28.91	28.87
I_{Pmax} [A]	8.12	8.14	8.11	7.92
V_{oc} [V]	37.05	36.92	37.03	36.74
I_{cs} [A]	8.66	8.61	8.64	8.4
Fill Factor	0.73	0.74	0.73	0.74
Efficiency [%]	14.4	14.4	14.3	14.0

$$P_{ref} = \frac{235{,}1 + 234{,}9 + 234{,}4 + 228{,}7}{4} = 233{,}275W$$

The maximum power determination test was done according to IEC 61215 10.2: Temperature 25 °C, Irradiation power 1000W/m², AM 1.5.

Infra-red (IR) and electroluminescence (EL) photos of the selected infected panels:

Module 2 (1152) Module 3 (4501) Module 4 (3989) Module 5 (5563)

after 10 days

Module n° 1105M603S60100XXXX	1152			4501			3989			5563		
Regeneration days	0	10	35	0	10	35	0	10	35	0	10	35
P_{max} [W]	97.67	206.04	219.5	131.79	216	227.6	102.27	198.8	218.2	90.51	208.7	221
V_{Pmax} [V]	17.33	28.7	28.87	20.93	28.29	28.88	15.49	28.34	28.36	14.91	27.88	28.37
I_{Pmax} [A]	5.63	7.18	7.6	6.3	7.63	7.88	6.6	7.01	7.69	6.07	7.49	7.79
V_{oc} [V]	28.4	36.42	36.28	32.05	36.7	36.64	24.99	36.23	36.27	25.67	36.45	36.35
I_{cs} [A]	8.39	8.49	8.65	8.52	8.52	8.79	8.46	8.51	8.66	8.53	8.49	8.72
Fill Factor	0.41	0.67	0.70	0.48	0.69	0.71	0.48	0.64	0.69	0.41	0.67	0.70
Efficiency [%]	6.0	12.6	13.4	8.1	13.2	13.9	6.3	12.2	13.3	5.5	12.8	13.5

Power Evolution
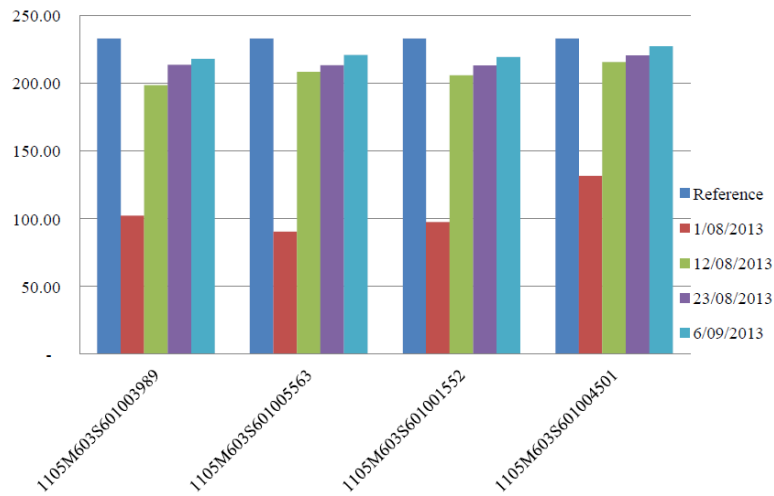
Latest results, after 35 days of regeneration, showed effective curing of the modules back to 95% of reference power on average with even one panel to 98%.
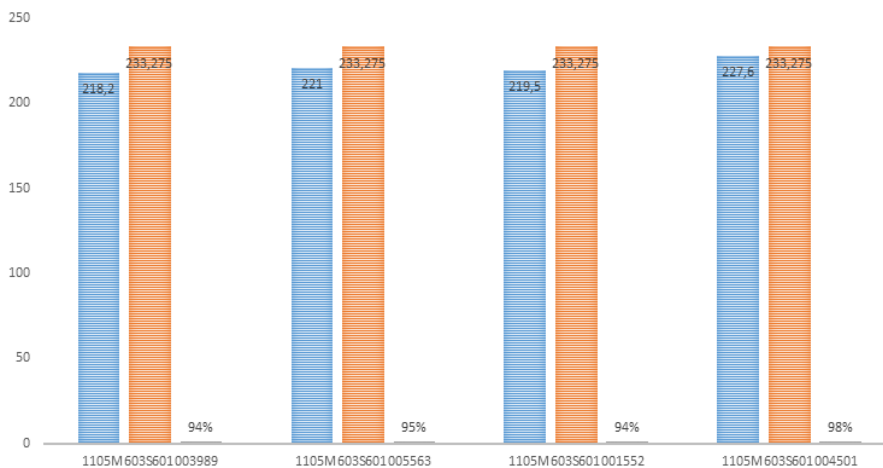
Open circuit voltage turned out to be the easiest and most effective first indicator for finding PID. EL measurement is used to confirm the first prediction. Infrared imaging would only be possible on high radiation days (<30 days per year in Belgium) and only during the noon time (10-16h).

ELIOSYS congratulated us with our results. They thought it was impossible to cure PID till this stage. They advised to stop the tests now and continue after 9 months because we noticed micro cracks because of the mounting and demounting.

Extensive field testing on various locations keeps returning very good results.

Facts:

- Almost all projects are infected by PID.
- In tested projects with PID in general 30% of the modules are infected.
- PID is mostly present in systems with transformerless inverters with higher voltage, but even grounded systems.
- Most infected modules are always on the negative pole of the string.
- Open circuit voltage is the easiest and most effective first indicator for finding PID.
- The yield of the infected projects goes down very rapidly.