

ESAPRO

**SOLAREBUG:**  
**MEASURES**  
**PROCESSES**  
**BOOSTS**

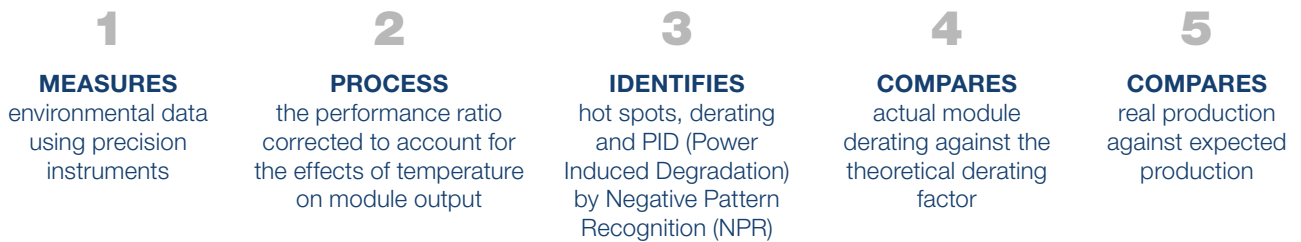
# SolarBug

## Tells the truth about your system

The decline in performance of photovoltaic systems below their effective potential means a significant reduction in cost-effectiveness for investors.

Traditional monitoring systems simply signal faults on individual components in the power station or generate system productivity reports, without providing information useful in identifying the causes of such inefficiencies.

To respond to the needs of investors for immediate information on system power output, real performance and the technical causes of inefficiencies, Esapro has developed SolarBug, an analysis tool based on a proprietary algorithm.



## CPR determination (Corrected Performance Ratio)

The performance of a photovoltaic system decreases as working temperature increases. SolarBug returns performance ratio values that are corrected to account for the effects that ambient temperature has on system components, defining a corrected performance ratio – CPR.

## Negative Pattern Recognition (NPR)\*

When using a traditional monitoring system, it is impossible to determine whether a reduction in performance is due to environmental factors (high ambient temperature) or faults in the main system components.

By continuously sampling CPR, SolarBug can formulate trend analyses and consequently perform Negative Pattern Recognition (NPR) so as to highlight any problem relating to hot spots, PID, derating or dirty modules.

\* Patent pending

## IDENTIFICATION OF: HOT SPOT · PID · DERATING



Figure 1. Negative Pattern Recognition  
The first box shows the normal trend in hourly corrected performance ratio (CPRh); the following boxes, in clockwise order, show patterns that identify problems relating to hot spots, PID and excessive derating.

## Real production vs potential production

Complete mapping of the main elements making up the system and measurement of radiation data allow SolarBug to determine theoretical system daily production data. This parameter allows the operator to check that expected production is being reached or to quantify any shortfalls in production on a daily basis, and consequently to promptly implement appropriate corrective actions.

REAL PRODUCTION VS OPTIMUM PRODUCTION

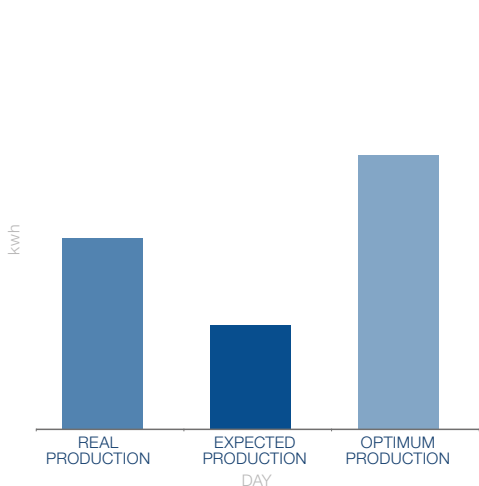


Figure 2. Real production vs optimum production. SolarBug compares real production against expected production based on the specifications provided by the manufacturer of the main system components, and against optimum production according to actual derating.

DERATING FROM DATASHEET VS DERATING ESTIMATED BY CPRh

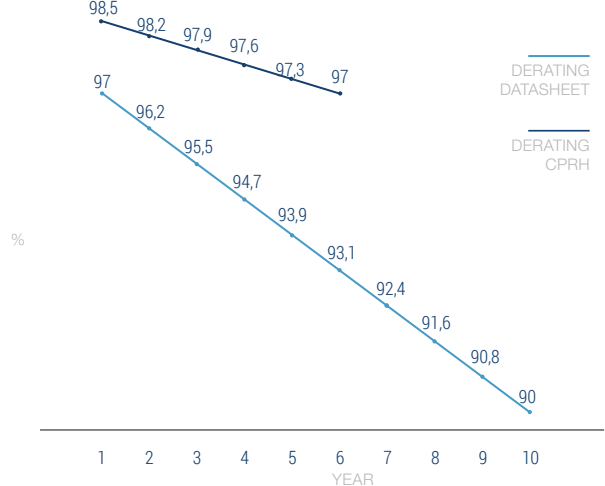


Figure 3. Actual derating of the photovoltaic modules. The trend in CPRh is used to estimate effective annual decline in photovoltaic module output and provide a true indication of performance.

## SolarBug and SolarBug Plus

Both versions provide access to the SolarBug portal for displaying system performance indicators.

### SOLARBUG

#### Monthly performance check

This involves installation of a precision monitoring station for calculating actual solar radiation. SolarBug, thanks to the possibility to send photovoltaic system production counter data over a remote connection, can provide monthly performance indicators to monitor system performance and identify any inefficiencies and their possible causes.

### SOLARBUG PLUS

#### Daily performance check

This involves installation of a precision monitoring station for calculating actual solar radiation, and Rogowski probes to measure instant system power output. SolarBug Plus can display all the performance indicators on a daily basis, and instantly receive any performance alarms.

SolarBug Plus also offers access to the optional supervision service and management of O&M activities.

Using this service, Esapro can monitor trends in system performance on behalf of the customer, ensure service providers are performing correctly, and coordinate appropriate O&M activities.

## COMPARISON BETWEEN SOLARBUG AND SOLARBUG PLUS

SolarBug	WEB PORTAL BASED K.P.I.	SolarBug Plus
YES		YES
Month	CORRECTED PR PRODUCTION	Day
Month	THEORETICAL PRODUCTION	Day
YES	NPR	YES
Static	ACTUAL RADIATION	Dynamic
YES	<b>FUNCTIONS</b>	YES
Month	ALARMS	Instant
Month	DATA UPDATE	Instant
Month	MONITORING KPI	Instant
NO	<b>HARDWARE</b>	YES
YES	ROGOWSKI PROBE	YES
	WEATHER STATION	
	<b>OPTIONAL</b>	
YES	QUALITATIVE ANALYSIS	YES
YES	HISTORICAL TRENDS	YES
YES	BENCHMARK	YES
NO	O&M MANAGEMENT	YES

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