#BePartOfTheChange

energetica
PHOTOVOLTAIC INDUSTRIES

e.ISP®

Intelligent
Shadow &Temperature Management

12 BB
halfcut

Engineered masterpiece of tomorrow.
Available today.
Only with Energetica.

EFFECTS OF SHADING EVENTS SOLAR PANELS

- When a solar cell is shaded, the current through the entire cell string is reduced, preventing the unshaded cells from operating at maximum power.
- The shaded cells absorb electric power generated by unshaded cells, leading to highly localized power dissipation (hot spot) that may bring irreversible damage to the module.
- Partial shading can be caused by many things, such **as snow, trees, leaves, accumulated dirt, remaining sand from sandstorms, buildings, chimneys, clouds, antennas, telephone or electricity poles, bird dung, etc.** covering PV module surface.
- If an entire cell is shadowed, the panel output will drop drastically - you may have covered small percentage of the panel, but see a 50% drop in output. Therefore, only a small amount of shading can have a dramatic effect on the power output of a solar panel.

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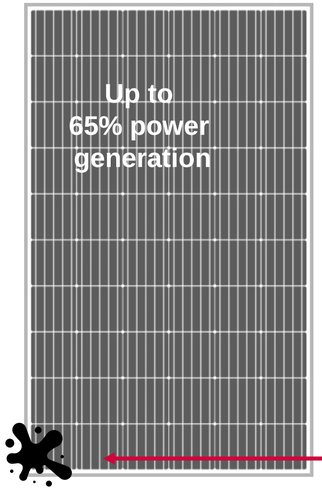
SHADING EVENT and its consequences: one cell shaded

MAINSTREAM MODULES versus ENERGETICA e.ISP MODULE

up to 65% power generation

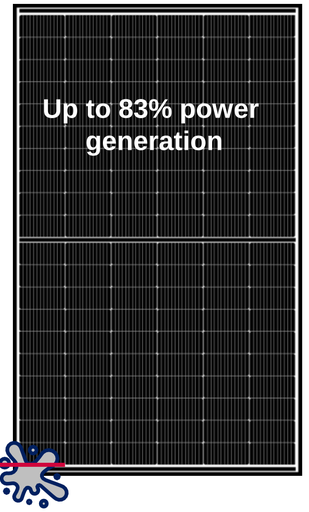
up to 83% power generation, no overheating

Less safety.
Shorter lifespan.
High Temperatures.
Reduced performance.



SHADOW event covering one cell

DIRT



More safety.
Longer lifespan.
Low Temperatures.
High performance.

Overheating of shadowed cells and junction box, leads to faster degradation, hotspots, power consumption from adjacent module in the string

No overheating of shadowed cells and junction box**, low module temperature, slower aging thus longer lifespan**

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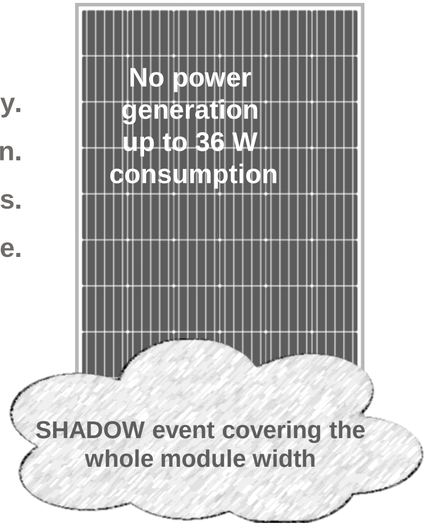
SHADING EVENT and its consequences: cell strings shaded

MAINSTREAM MODULES versus ENERGETICA e.ISP MODULE

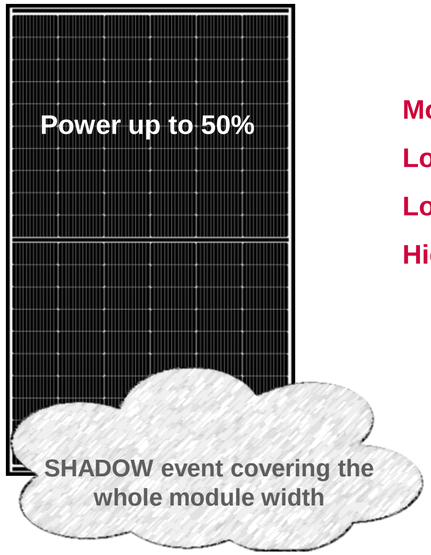
0% power generation
up to 36 W power consumption from adjacent modules in the string

Less safety.
Shorter lifespan.
High Temperatures.
Reduced performance.



Overheating of shadowed cells and junction box, leads to faster degradation, hotspots, power consumption from adjacent module in the string

up to 50% MORE POWER, no overheating



More safety.
Longer lifespan.
Low Temperatures.
High performance.

No overheating of shadowed cells and junction box**, low module temperature, slower aging thus longer lifespan**

EFFECT OF generated HEAT to DURABILITY of PV modules

What happens inside of a module in shading event?

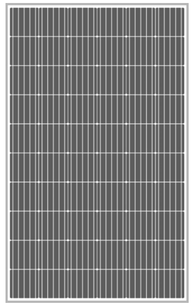
- The forward biased diode in the junction box can, during shading, reach 150 to 200 ºC, leading to the increase of the leakage current of up to 35 times under a reverse voltage of 15 V.

- The temperature of the diode cools down, when the bypass diode returns to its normal reverse-biased condition. But this cooling process is not immediate. During the transition from high to low temperature, the diode leakage will be very high due to the residual forward-biased self-heating. If the leakage current is high, it can maintain **self-heating (Thermal Runaway Effect**).

- Testing of the reverse biased standard bypass diodes at **105 ºC, revealed 20 % of diodes failure at 500 hours**. If the temperature is increased to **155ºC** the **20 % failure happens after 31hours** (by Arrhenius's equation)!

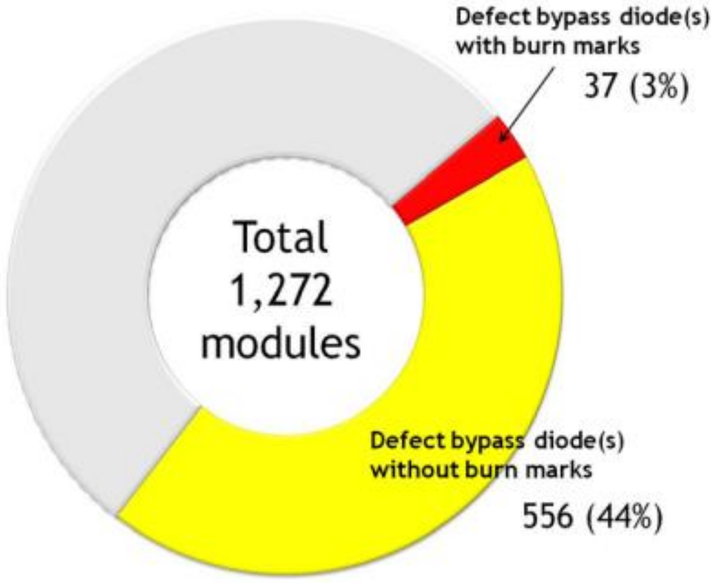
How safe and reliable is CURRENT TECHNOLOGY?

Modules already installed worldwide.



620 GW installed == 8 billion diodes

Most common failures are with opened, shorted or partially damaged
Bypass-Diodes due to repeated overheating



Test on modules after **ONLY 4 years** in the field!

Source : Fraunhofer ISE, Heribert Schmidt, Vortrag auf dem 31 Symposium Photovoltaische Solarenergie 2016, Aktive Bypass-Dioden Aktuelle Technik, Anwendungsgebiete und Markt

Source : [Hermann09] W. Herrmann, W. Wiesner, W. Vaaßen, Hot Spot Investigations on PV Modules - new Concepts for a Test Standard and Consequences for Module Design with Respect to Bypass Diodes, Proc. 26th PVSC (IEEE, Anaheim, CA, USA, 1997), pp. 1129-1132 88 [Kato02] K. Kato, “PVRessQ!”: A Research Activity on Reliability of PV System from an user’s viewpoint in Japan, Proc. Optics + Photonics 8112 (SPIE, San Diego, California, USA, 2011), 811219

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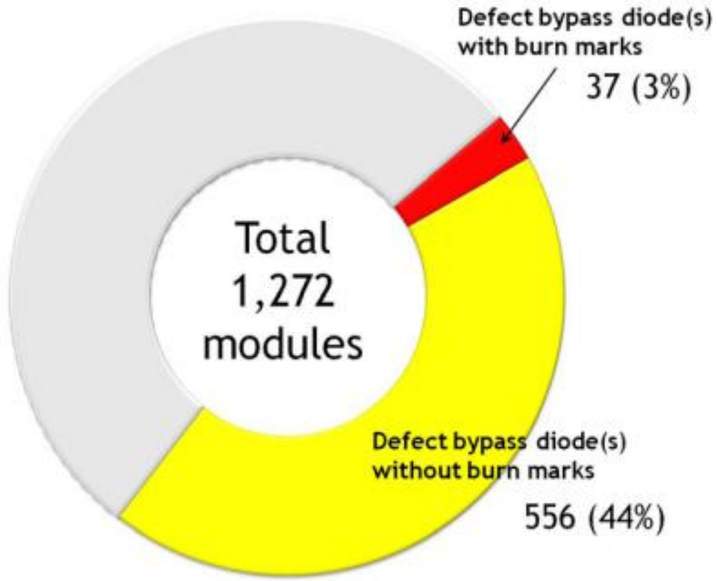
FAILURE RATE: Current technology versus e.ISP.

Get more safety for your PV installation today.

47% FAILURE RATE and only 3% immediately detectible!

0,00005% FAILURE RATE (1 piece out of 2 million pieces)



Source : [Hermann09] W. Herrmann, W. Wiesner, W. Vaaßen, Hot Spot Investigations on PV Modules - new Concepts for a Test Standard and Consequences for Module Design with Respect to Bypass Diodes, Proc. 26th PVSC (IEEE, Anaheim, CA, USA, 1997), pp. 1129-1132 88 [Kato02] K. Kato, "PVRessQ!": A Research Activity on Reliability of PV System from an user's viewpoint in Japan, Proc. Optics + Photonics 8112 (SPIE, San Diego, California, USA, 2011), 811219

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EFFECTS OF SHADOWS and high TEMPERATURE.

Effect on durability. Performance. Life.

There is a mainstream HC conventional module and there is ENERGETICA HC e.ISP module

Why are Energetica modules so UNIQUE?

Standard halfcut module with bypass diode

- Switches the cell string off, but only after considerable **heat** has been generated in the part of the cell where the shadow event occurs and the junction box, leading to:
- **Hot spots** after many re-occurring shadowing events
- **Overheating** of the junction box to up to **200 degrees Celsius** / over time leading to damages not only because the material suffers due to the high heat, but also because the cooling process is not instant! With raising temperature, the leakage current is higher and the module is exposed to heat **for longer time period** that the actual shading event.
- All these occurrences during and for a longer period after shading event lead to **INCREASED THERMAL STRESS** on the module resulting in**: fast aging of modules, significant drops in module performance over time and damage to material**.

e.ISP PATENTED NR. 2517265

Energetica module with e.ISP Technology

e.ISP intelligent internal control system can understand differences in various shadowing events and find the right time to react fast:

PRIOR to the creation of heat ► safeguarding the cell, junction box surrounding material and thus the entire module

e.ISP switches **PRECIZE, QUICK** and **ON-TIME** the affected cell string off

The module doesn’t suffer any damage**, the life of components goes beyond expected.**

More safety.
Longer lifespan.
More output. Higher performance.

GAIN FOR THE CUSTOMER by using e.ISP modules

Reach for more. Reach for the future. Today.

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Standard module with bypass diode

- Higher panel temperature leads to damaged material and premature aging of the panel
- Reduced efficiency of the solar panel leads to overall Increased System Loss
- Cell overheating leads to the creation of hot spots
- Shaded panels reduce the performance of the entire module string by consuming a part of the produced energy within the string

Less safety.
Shorter lifespan.
Reduced performance.

Energetica module with e.ISP Technology

e.ISP switches precisely the affected cell string off without generating any heat, resulting in the prevention of cell and junction box overheating, occurrence of hot spots, damages to material and premature aging of the module.

More safety.
Longer lifespan.
More output.
Higher performance.

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Reach for the SMART PHOTOVOLTAIC FUTURE.

Be part of **Energetica**.

What makes **Energetica** modules so **INTELLIGENT**?

What do you gain **DAILY** with **e.ISP**?

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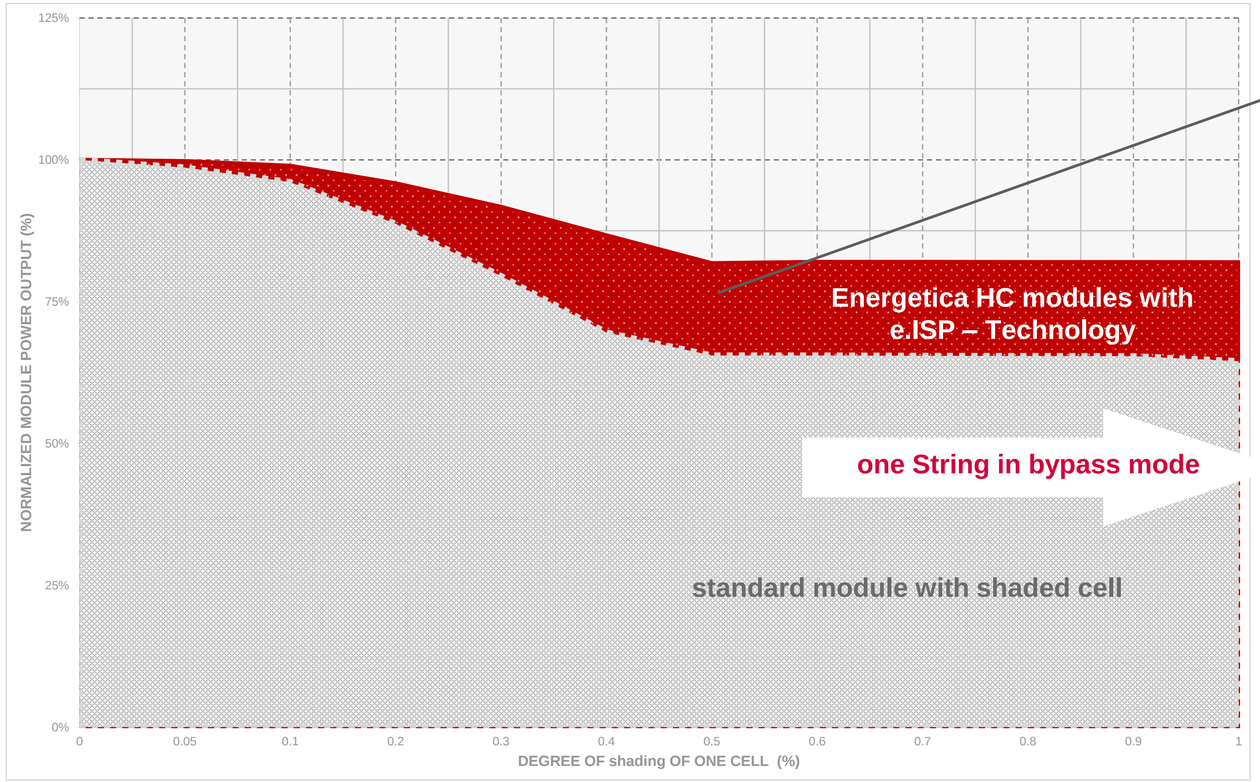
DAILY MORE PERFORMANCE in every shading event.

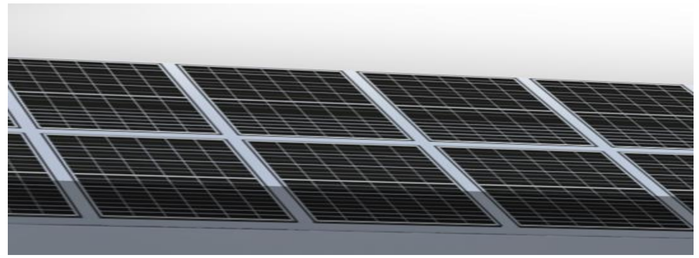
Added value for the owner of the PV plant.

Better performance on a daily basis



Up to 17 % more

Shading event

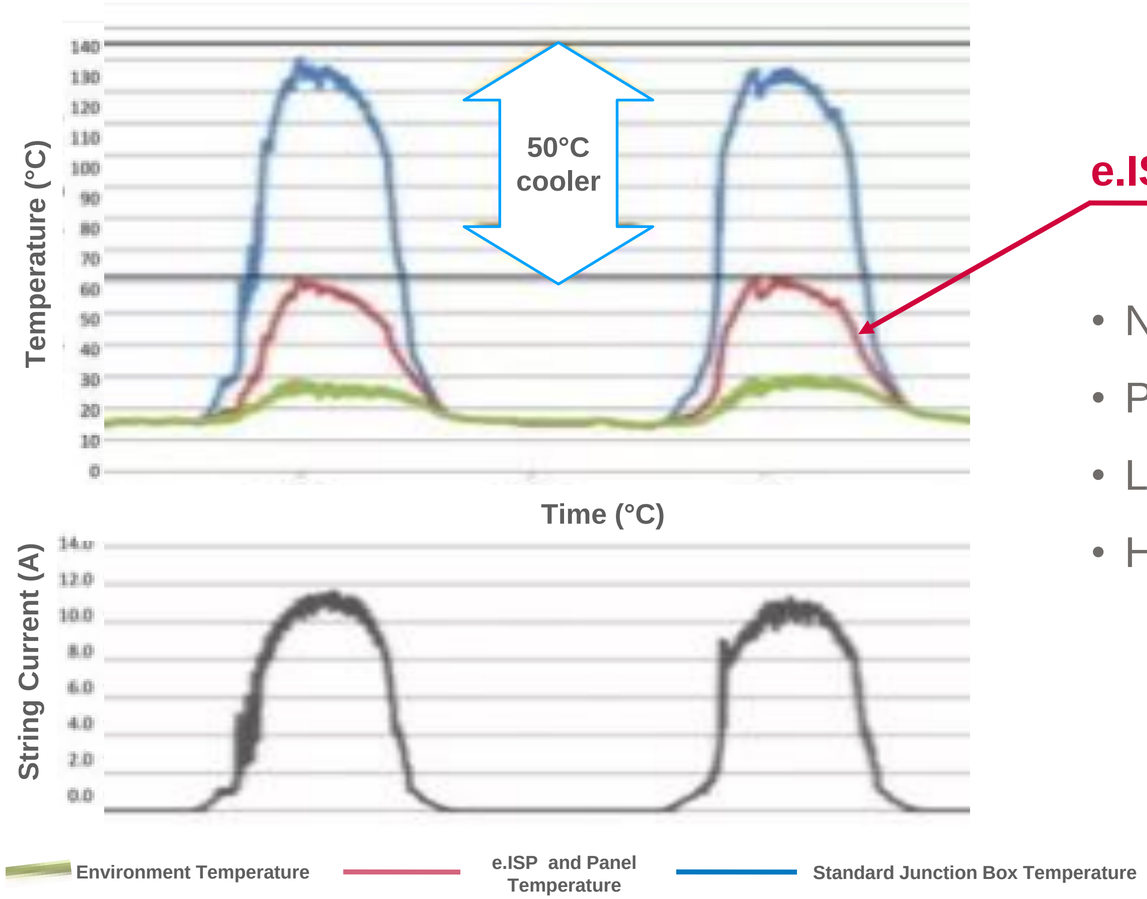


Standard PV Module

ENERGETICA e.ISP - Technology

Up to 50 degrees COOLER.

e.ISP Technology controls the temperature management on the module level

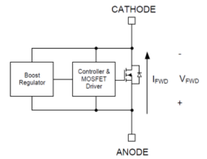


e.ISP Integrated Temperature Management

- No increase on panel temperature.
- Premature aging of materials is prevented.
- Longer lifespan.
- Higher Performance.

Conventional external bypass diodes versus e.ISP integrated solution.

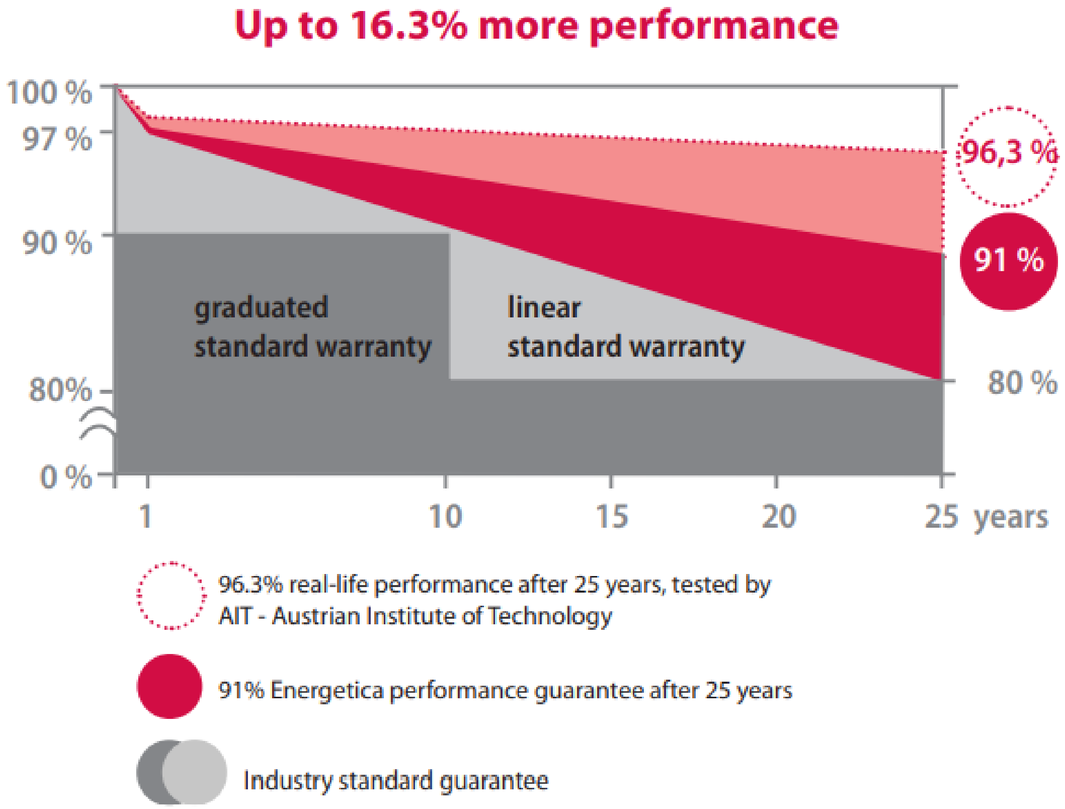
Reach for more.

	p-n-Diode	Schottky-Diode	e.ISP - Technology
Principle			
Maximum Reverse Voltage	200 – 1000 V	40 – 70 V	30 – 40 V
Max. average forward on - voltage @ T_J = 125 °C, I_D = 10 A	0,5 - > 1,25 V	0,3 - 0,7 V	< 0,05 V
Reverse current @ T_J = 125 °C, U_R = 15 V	µA	mA - A	nA - µA
Surge- und ESD-robustness	uni-directional	uni-directional	bi-directional
power loss / module @ 10A	15 – 36 Watt	15 - 21 Watt	**1,5 Watt**

10 times better than conventional Bypass Diodes

LEADING PERFORMANCE WARRANTY globally.

Long-term quality matters. Less degradation = long life-time.



≤3%

1st year degradation

-0.25%

Linear annual degradation
after the 1st year

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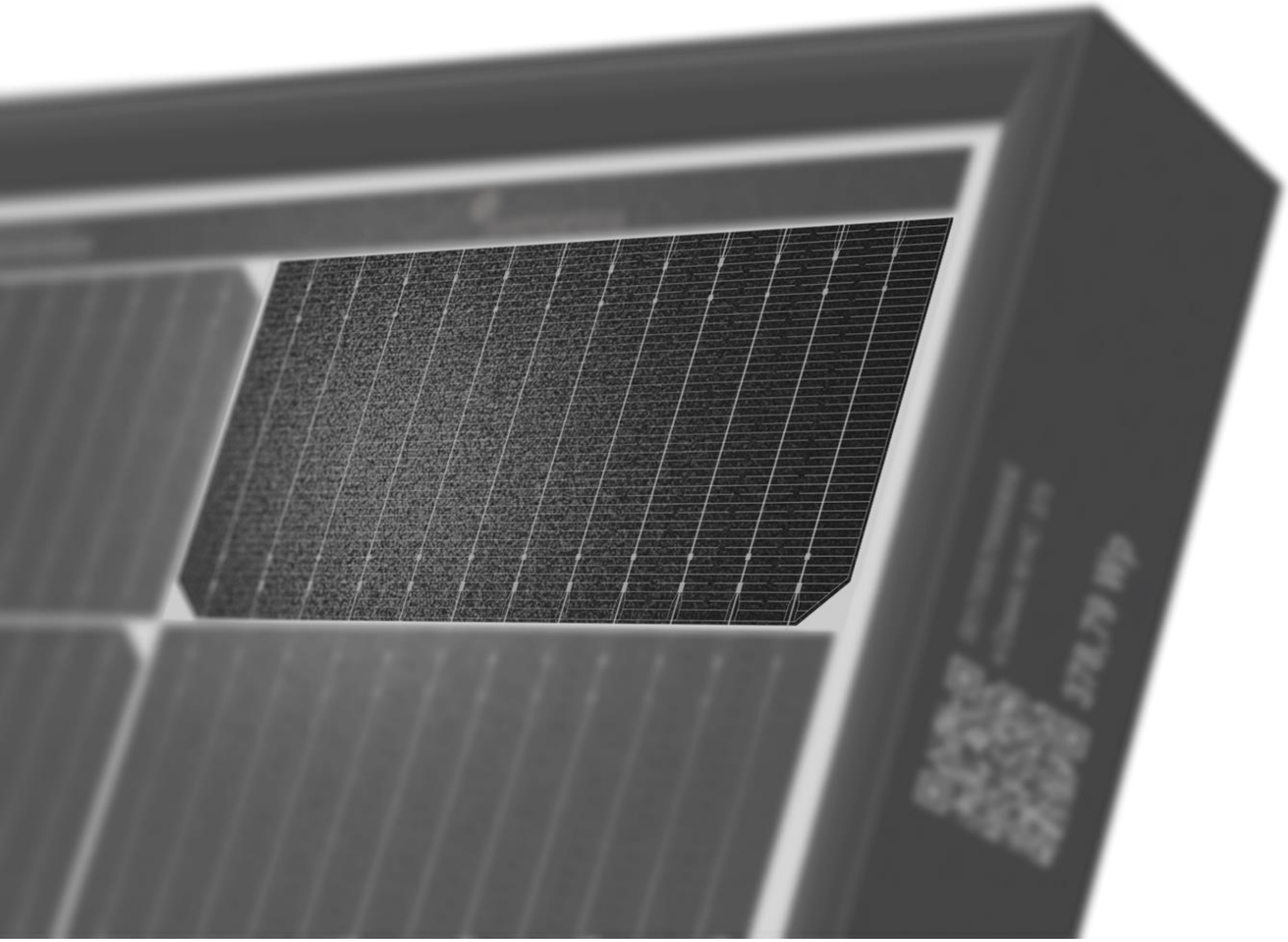
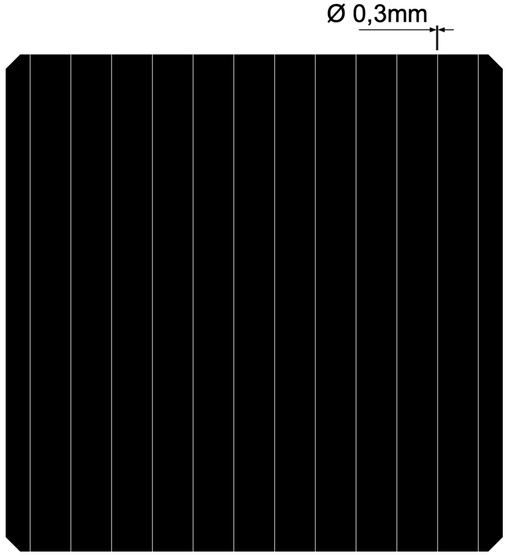


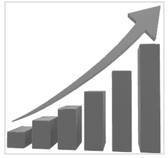
12 BB halfcut technology.

More efficiency. More power.

12 BB – Energetica versus

- Short transmission distance for electrons = lower cell resistance - power increase
- Wires with circular cross-sections **- increased light absorption in the cell from different angles**
- **Improved aesthetics**

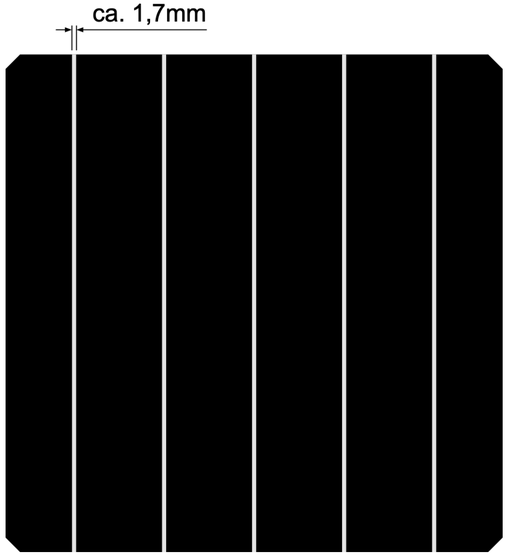




4,5 %
more power

5 BB – mainstream modules

- Large distance for electrons - increased resistance and increased electrical losses
- Ribbons, that have rectangular cross-sections, light absorption from one angle



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FINANCIAL GAIN FOR THE INVESTOR.

FAST return on investment. **MORE GAIN** year by year.

LET’S DO THE MATH!

FINANCIAL and PERFORMANCE GAIN*

*** example: Energetica versus conventional high quality EU made panel**

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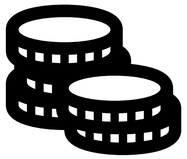
Energetica modules bring more output year by year.

Long-term quality matters = faster return on investment = higher financial gain.



526.861 kWh
MORE
per year for 25 years!

If the electricity price is, for example, 0,29 EUR/kWh total GAIN translates to

152.789,87 EUR x 25 =

3.819.746,82 EUR

MORE IN 25 YEARS!

Year	Conventional module in %	Warranty	kWh/kWp	Energetica in %	Warranty	kWh/kWp
1	94.50	5,306,491.58	1,075.44	97.00	5,638,664.32	1,127.66
2	93.93	5,274,652.63	1,068.99	96.75	5,624,131.68	1,124.76
3	93.37	5,243,004.71	1,062.57	96.50	5,609,599.04	1,121.85
4	92.81	5,211,546.68	1,056.20	96.25	5,595,066.40	1,118.94
5	92.25	5,180,277.40	1,049.86	96.00	5,580,533.76	1,116.04
6	91.70	5,149,195.74	1,043.56	95.75	5,566,001.12	1,113.13
7	91.15	5,118,300.56	1,037.30	95.50	5,551,468.48	1,110.23
8	90.60	5,087,590.76	1,031.07	95.25	5,536,935.84	1,107.32
9	90.06	5,057,065.21	1,024.89	95.00	5,522,403.20	1,104.41
10	89.52	5,026,722.82	1,018.74	94.75	5,507,870.56	1,101.51
11	88.98	4,996,562.49	1,012.63	94.50	5,493,337.92	1,098.60
12	88.45	4,966,583.11	1,006.55	94.25	5,478,805.28	1,095.69
13	87.92	4,936,783.61	1,000.51	94.00	5,464,272.64	1,092.79
14	87.39	4,907,162.91	994.51	93.75	5,449,740.00	1,089.88
15	86.86	4,877,719.93	988.54	93.50	5,435,207.36	1,086.97
16	86.34	4,848,453.61	982.61	93.25	5,420,674.72	1,084.07
17	85.83	4,819,362.89	976.71	93.00	5,406,142.08	1,081.16
18	85.31	4,790,446.72	970.85	92.75	5,391,609.44	1,078.26
19	84.80	4,761,704.03	965.03	92.50	5,377,076.80	1,075.35
20	84.29	4,733,133.81	959.24	92.25	5,362,544.16	1,072.44
21	83.78	4,704,735.01	953.48	92.00	5,348,011.52	1,069.54
22	83.28	4,676,506.60	947.76	91.75	5,333,478.88	1,066.63
23	82.78	4,648,447.56	942.08	91.50	5,318,946.24	1,063.72
24	82.28	4,620,556.87	936.42	91.25	5,304,413.60	1,060.82
25	80.00	4,492,268.00	910.42	91.00	5,289,880.96	1,057.91
		4,937,411.01	1,000.64		5,464,272.64	1,092.79
		ENERGETICA more yield	526,861.63			

5 MW example

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Give you solar installation a brain.

Ask for more.

Why Energetica as a reliable and important partner in the long-run?

The answer is simple.

You deserve a PIECE of mind. You deserve to earn more money.
Over 25 years and beyond.

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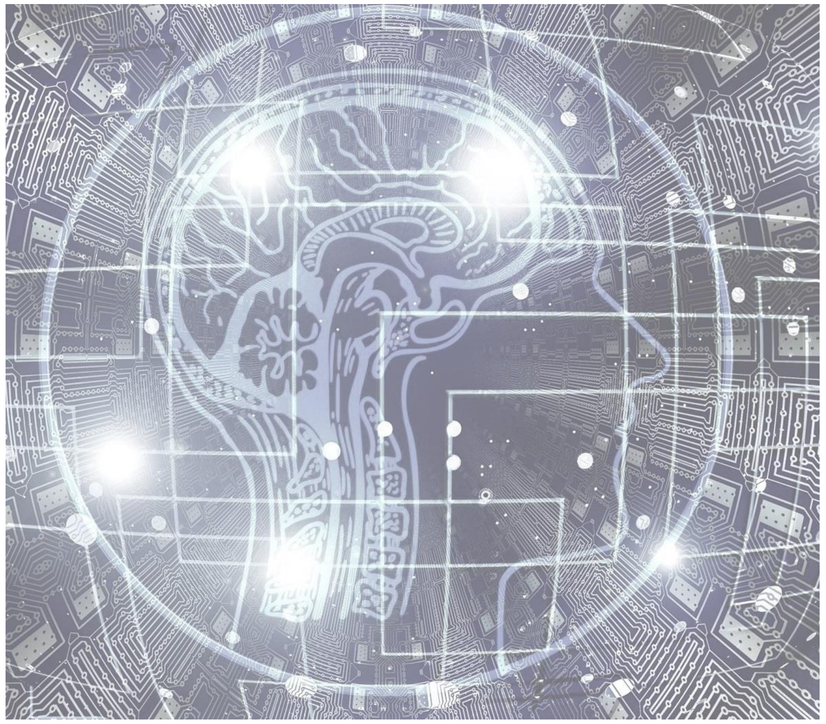
P-roduce. E-nsure. A-dvance. C-ontrol. E-arn.

P.e.a.c.e of mind.



- **PRODUCE** up to up to **17 % MORE POWER** daily during shadow events
- **ENSURE** more safety of your installation: failure rate of Energetica electronic solution is 0,00005% in comparison to mainstream modules of 47% due to bypass diode failure
- **ADVANCE** invest in advanced Energetica technology that guarantees products with high durability even after 25 years
- **CONTROL** what happens: let your module decide when and what to do to prevent own malfunctioning
- **EARN** more money by achieving constantly more yield and shortening years for return on investment

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YOU DESERVE ONLY THE BEST.

Why settle for a cheap choice in solar module, if Energetica intelligent solution brings you more money in the long-run?

Stable growth over 25 years. **Committed** management with immense expertise, knowledge of the industry and creative minds to bring innovative **revolutionary** solutions.

Orientation towards ONLY **high-end technology**. Always working on new patents. Providing solutions **beyond** the market standard. Always **ahead of time**.

Providing customers added value. **More** gain. **More** performance. **Unique** solutions. Top quality **tested beyond** market **standards**, e.ISP tested acc.to standards for aerospace equipment.

Always there for the customer. 24/7. To help him make the best choice. To create for him a **tailor-made** solution.

Accompanying the customer throughout the project and beyond. Finding solutions for **all his needs**.

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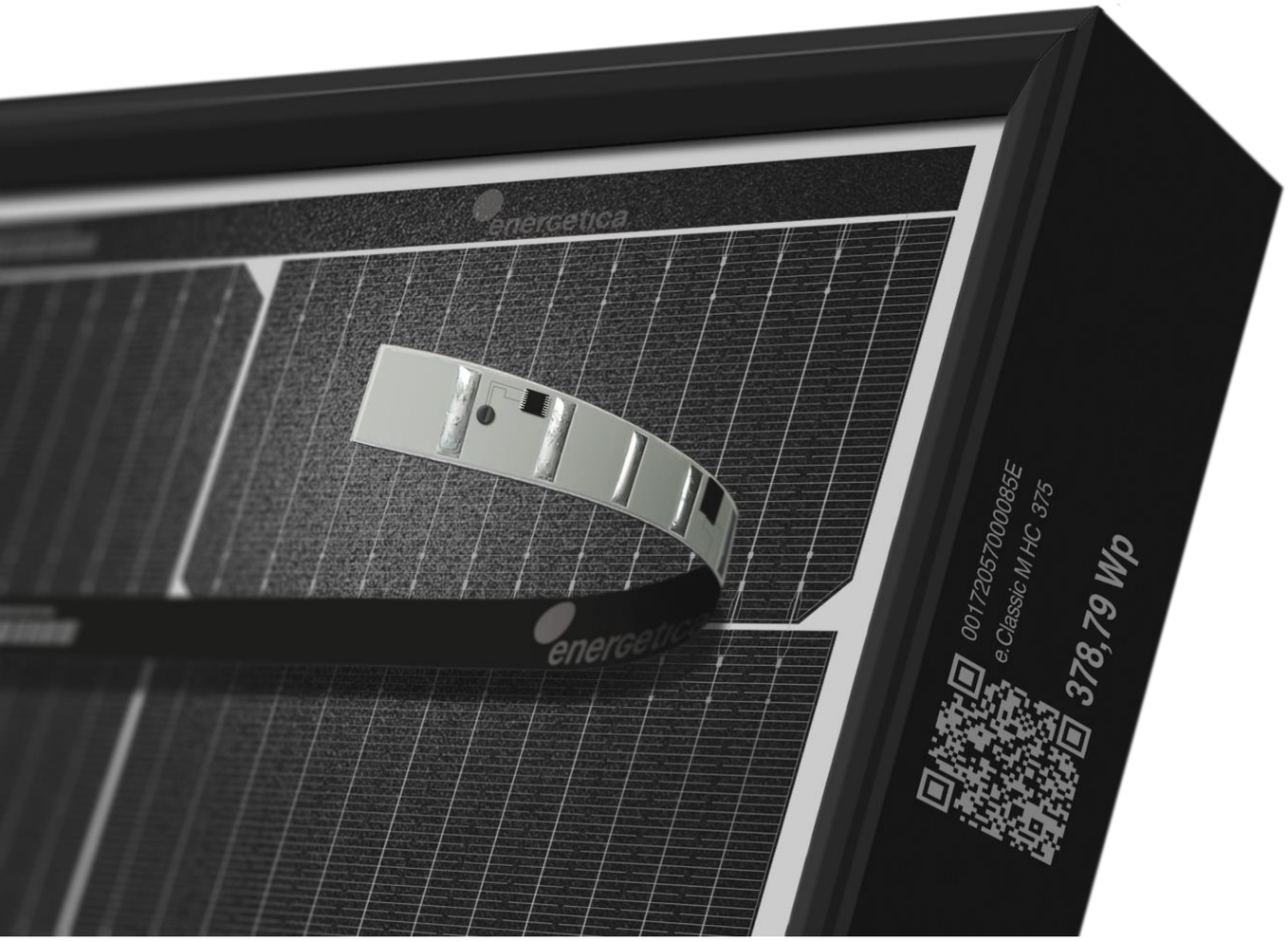

Join us.

Step into the future **TODAY**.

With **Energetica** patented solutions.

Send us an email today to:

sales@solsol.cz

orsag@solsol.cz