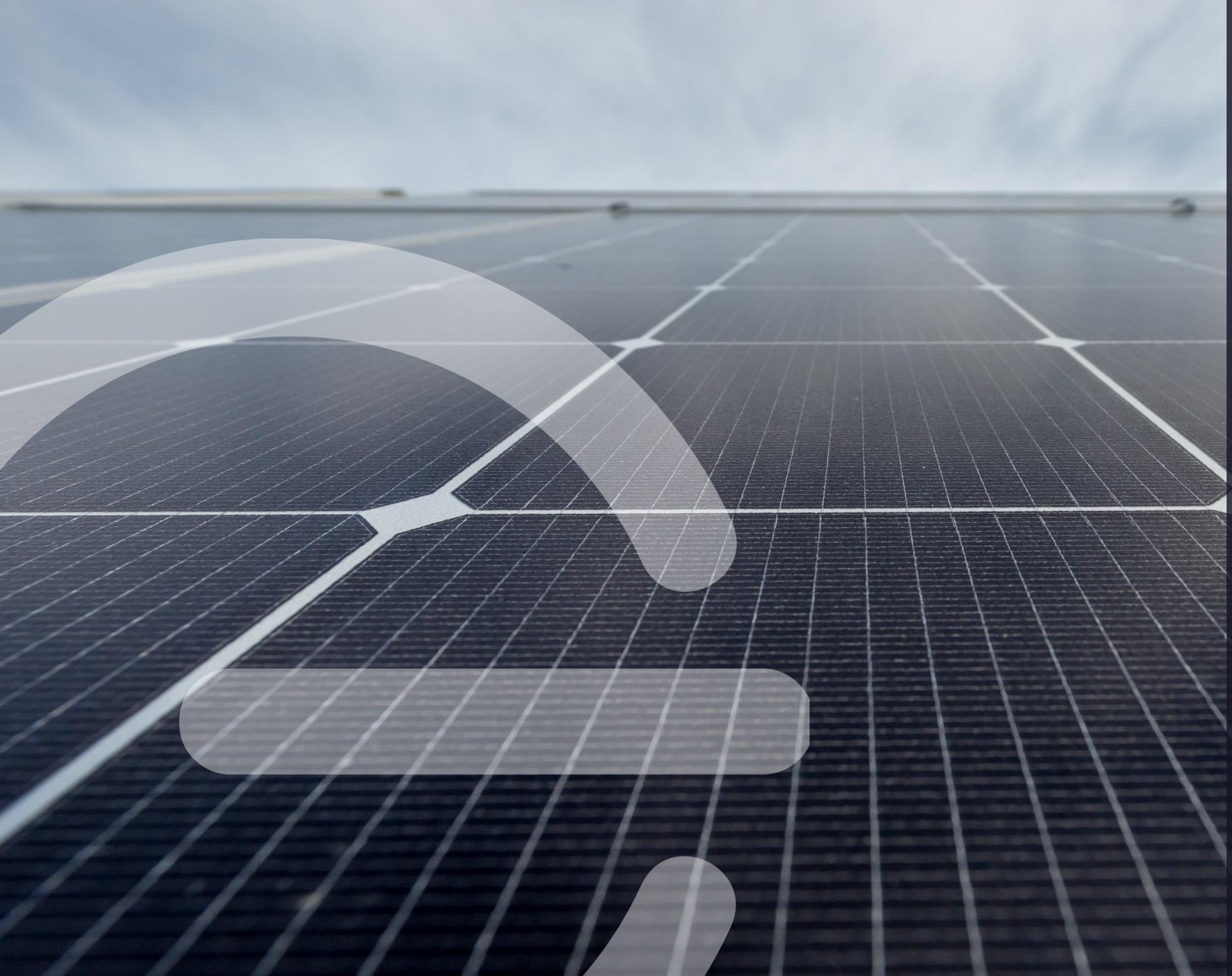


HEVEL
ENERGY GROUP

Solutions for marine applications

September 2019

Head for the sun: solar panels for sustainable present and future of marine

Yachts

Solar panels are becoming more and more ubiquitous on marine vessels of different types

Sailboats

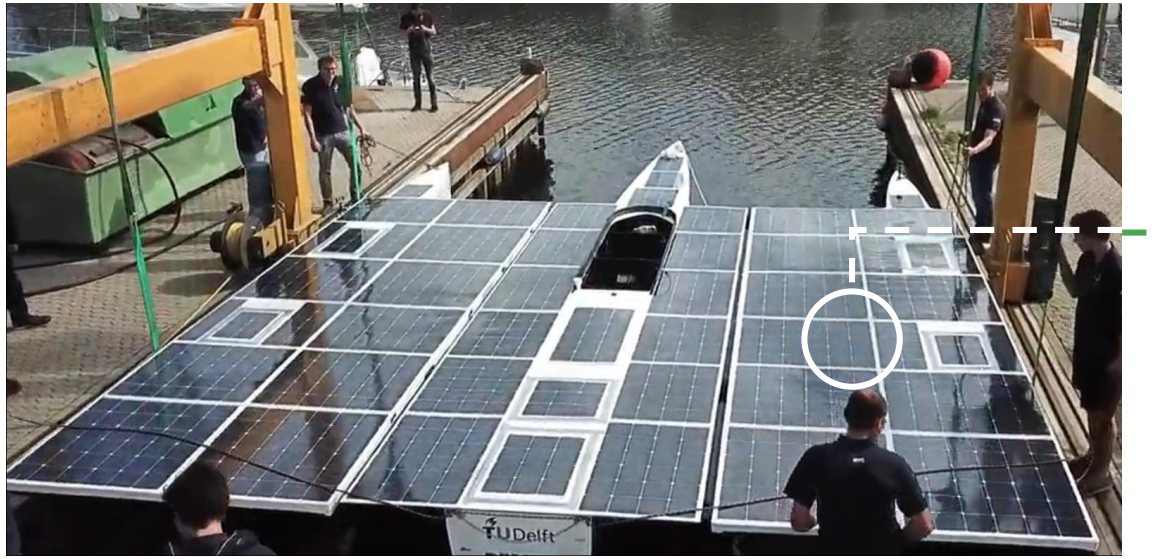
Houseboats

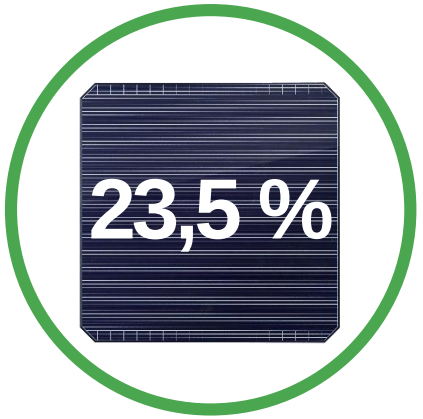
Cooperation of Hevel and TU Delft Solar Boat Team

the official HJT cells supplier for

World Champion Solar Boat racing Team – winner of Monaco Solar & Energy Boat Challenge

Cooperation of Hevel and TU Delft Solar Boat Team





Hevel Busbarless
Heterojunction Solar Cell

PV array characteristics	
PV array area	28,4 m²
No. of cells	1097
Total nominal power	~6 kW

Hevel flexible modules have proven themselves in harsh conditions

Electric twin-hull boat «Ecowave»

PV array characteristics	
PV array area	57 m^2
PV array nominal power	11 kW (193 W/m^2)
Motor power	2x4 kW
Dimensions	11,6 m x 6,4 m
Weight	~ 5 tonnes

Rowing boat «AKROS»

Boat is specifically designed for solo circumnavigation of famous Russian survivalist and traveller Fedor Konyukhov.

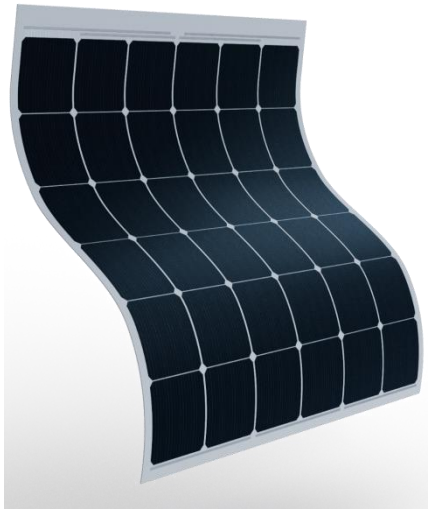
Boat's PV power supply system contains 11 Hevel flexible panels with total capacity of 500 W

Hevel supports innovative projects of leading Russian Universities

Multipurpose self-driving powerboat developed at Peter the Great St. Petersburg Polytechnic University

Hydrofoil self-driving solar boat “Storm-600” developed at Peter the Great St. Petersburg Polytechnic University

Hevel flexible module: efficiency and reliability



Hevel flexible modules are based on **heterojunction cells** of own production **without the use of glass** or **aluminum frame**.

Module design is based on **several layers of polymers**.

Heterojunction Solar Cell

Eff. 23,5%

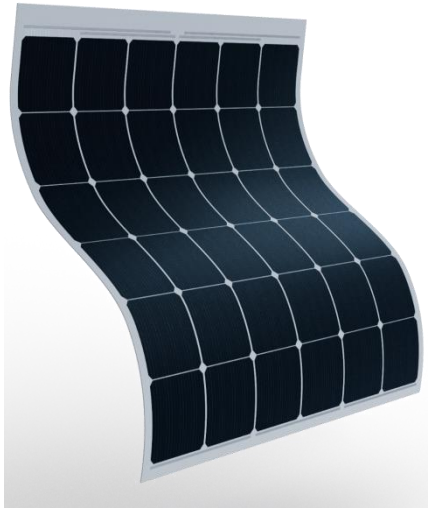
High efficiency is achieved thanks to the use of Hevel **heterojunction cells** (cell efficiency of **up to 23,5%**).

Production system is fully **automated** and **ISO certified** (ISO 9001:2015 and ISO 14001:2015).

Reliability and **resistance** to **water** and **salt impact** throughout the whole operation period is achieved through the use of **special polymer composition**, developed by Hevel R&D center (R&D Center TFTE).

R&D Center TFTE

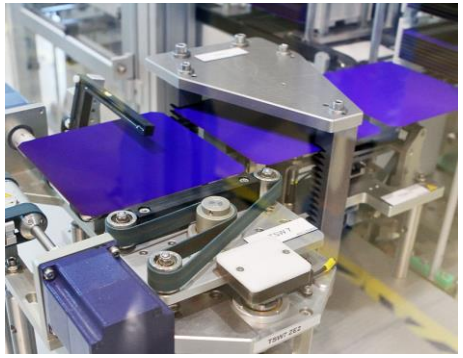
Hevel flexible module: key characteristics

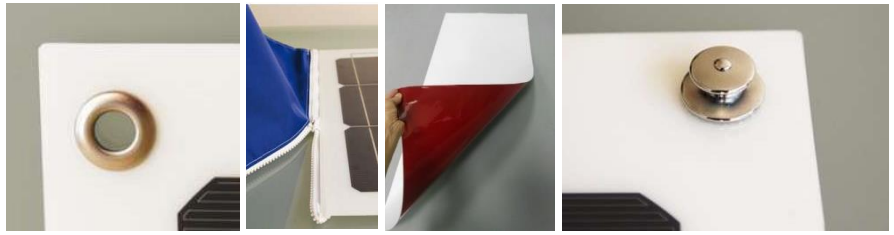


KEY FEATURES:

- High efficiency (**~ 190 - 195 W/m²**)
- Light weight **(~0,6 – 1,8 kg/m²**)
- Aesthetic design and optimized thickness of just **~0,5 - 3 mm**.
- **IP65/ IP68** certified junction boxes.
- **No corrosion** thanks to **SmartWire technology**.
- **Full compatibility** with leading manufacturers equipment
- **Your product can be fully customized**: dimensions, shape, fastening system, junction box location, material (depending on operating conditons).
- **Wide range of applicable fastening systems**: adhesive, eyelets, LOXX fasteners or zip.

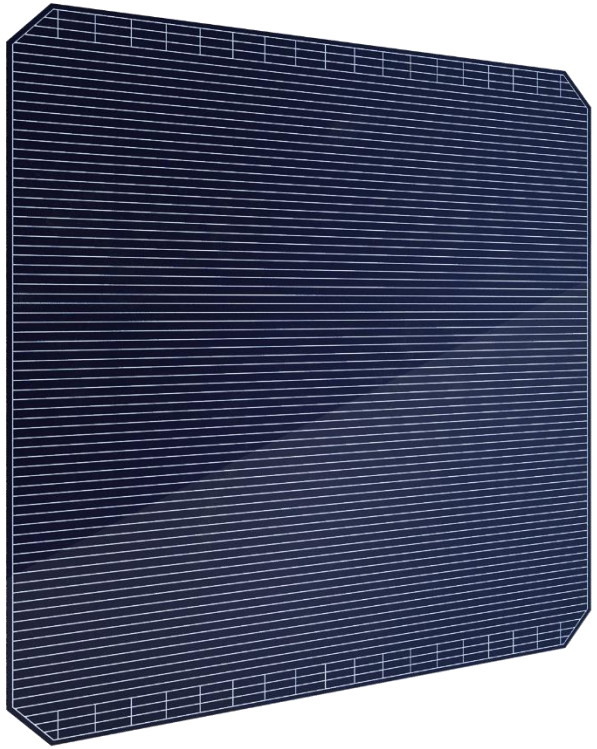
R&D Center TFTE





Hevel Heterojunction Cells: core of high-efficiency

Bifacial N-type HJT solar cell



Produced in Russia

ISO 9001:2015ISO 14001:2015 certified

OUTSTANDING CELL EFFICIENCY RATE

23.5%

vs. ~ 17-21 % for mass market solar cells

LOW TEMPERATURE COEFFICIENT

-0.31%/ºC

vs. from -0,37 to - 0,45 % / ºC for mass market solar cells

BIFACIALITY FACTOR

93%

vs .~ 75 % for mass market solar cells

MINIMIZED DEGRADATION

NO LID

n-type cells lacks light induced degradation (LID), which affects p-type cells

Front side ▶ ◀ Back side

23.5 % 21.9 %

5.73 Wp 5.33 Wp

Measured with GRID^{TOUCH} contacting system. Measurement uncertainty ±3%.

- Standard dimensions: 156,75 x 156,75 mm
- Busbarless design: current collecting grid optimized for 18 wires
- High open-circuit voltages due to superior a-Si passivation

HJT 60 cell PV module: maximum performance with minimum area

PEAK POWER
up to 325 Wp

MODULE EFFICIENCY
19,4 %

CELLS INTERCONNECTION
SmartWire

TEMPERATURE RATIO
– 0,31 %/ºC

DIMENSIONS
1671 x 1002 x 35 mm
with frame*

PRODUCT / PERFORMANCE WARRANTY
10 years / 25 years

IEC 61215
IEC 61730
Regular Production Surveillance
TÜVRheinland CERTIFIED
www.tuv.com
ID 1111213944

OPERATING TEMPERATURES
from -40ºC to +85ºC
thermocycling test (TC200)
passed at -60ºC

**frameless configuration available on demand*

HIGHER OUTPUT IN HOT CLIMATE AND LOW LIGHT CONDITIONS

+10%

Specific yield (kWh/kWp) due to low temperature coefficient

MORE EFFICIENT SPACE UTILIZATION

-13%

Space required for 1 KWp of HJT modules

HIGHER LIFETIME GENERATION

+21%

Yield / sq.m. over 25 year period due to low degradation

in comparison with mass market PV modules

72 cell bifacial HJT PV module: providing the highest output possible

PEAK POWER

up to 380 Wp +
70 Wp bifacial gain*

MODULE EFFICIENCY

19 – 22,5* %

CELLS INTERCONNECTION

5BB ECA

TEMPERATURE RATIO

– 0,31 %/ºC

DIMENSIONS

1996 x 1002 x 30 mm
with anodized aluminum frame**

OPERATING TEMPERATURES

from -40ºC to +85ºC

**additional BiFi output*

***also available in frameless configuration*

Bifacial HJT modules **show energy gain** over monofacial modules **at all weather** and **seasonal conditions**

up to 25%

additional output from back side depending on the season and weather conditions

YIELD OF BIFACIAL HJT MODULES IS ESPECIALLY HIGH IN SUCH ENVIRONMENT CONDITIONS AS:

SNOW **WATER** **SAND**

Energy gain of **up to 25%** is observed with water or ground covered by snow or sand

GUARANTEED POWER

80,6 %

by the end of 30-year life cycle:
2% in first year, 0,6% per year thereafter

30 years

+ 5 years to the life cycle of glass-backsheet PV modules due to highly reliable double glass encapsulation

HEVEL
ENERGY GROUP

Thank you for your attention!

overseas@hevelsolar.com