Have sun!

IBC SOLAR Modules

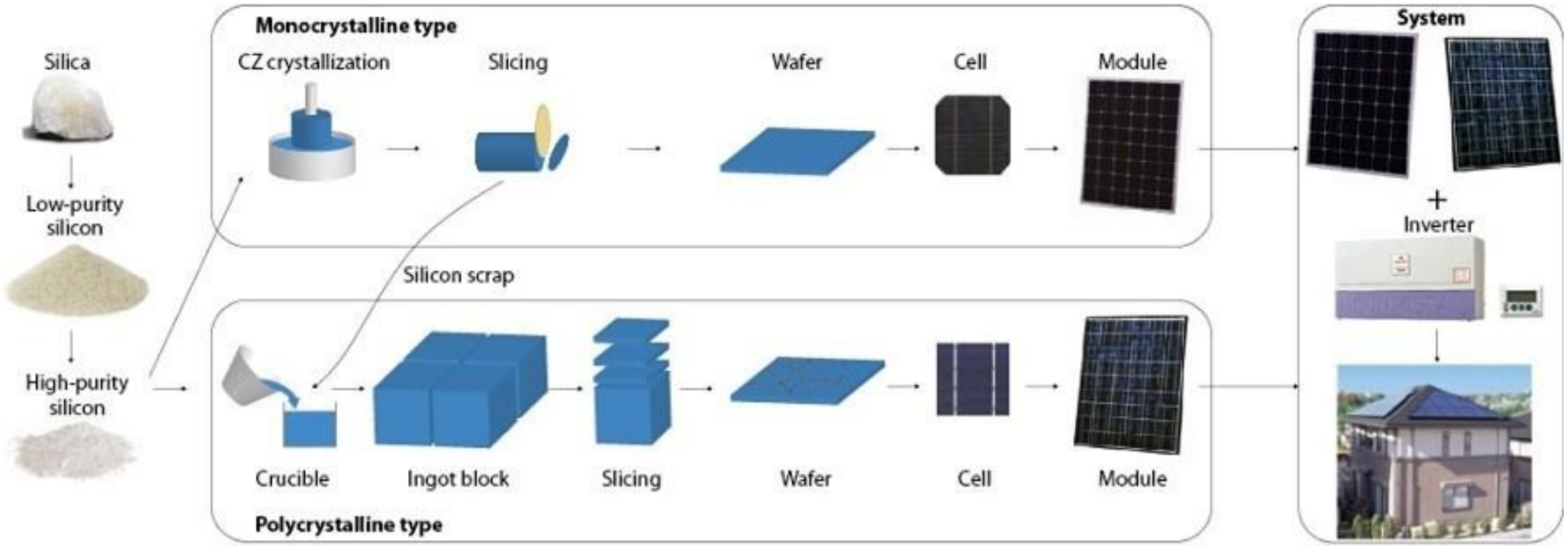
Presenter: Florian Mechler
27.09.2023

AGENDA

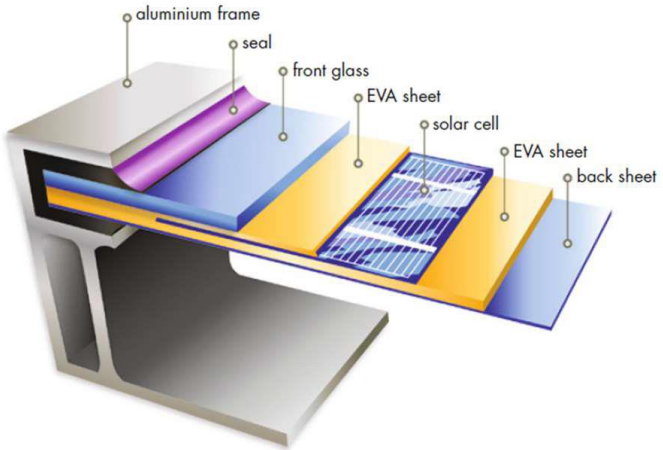
IBC SOLAR Modules

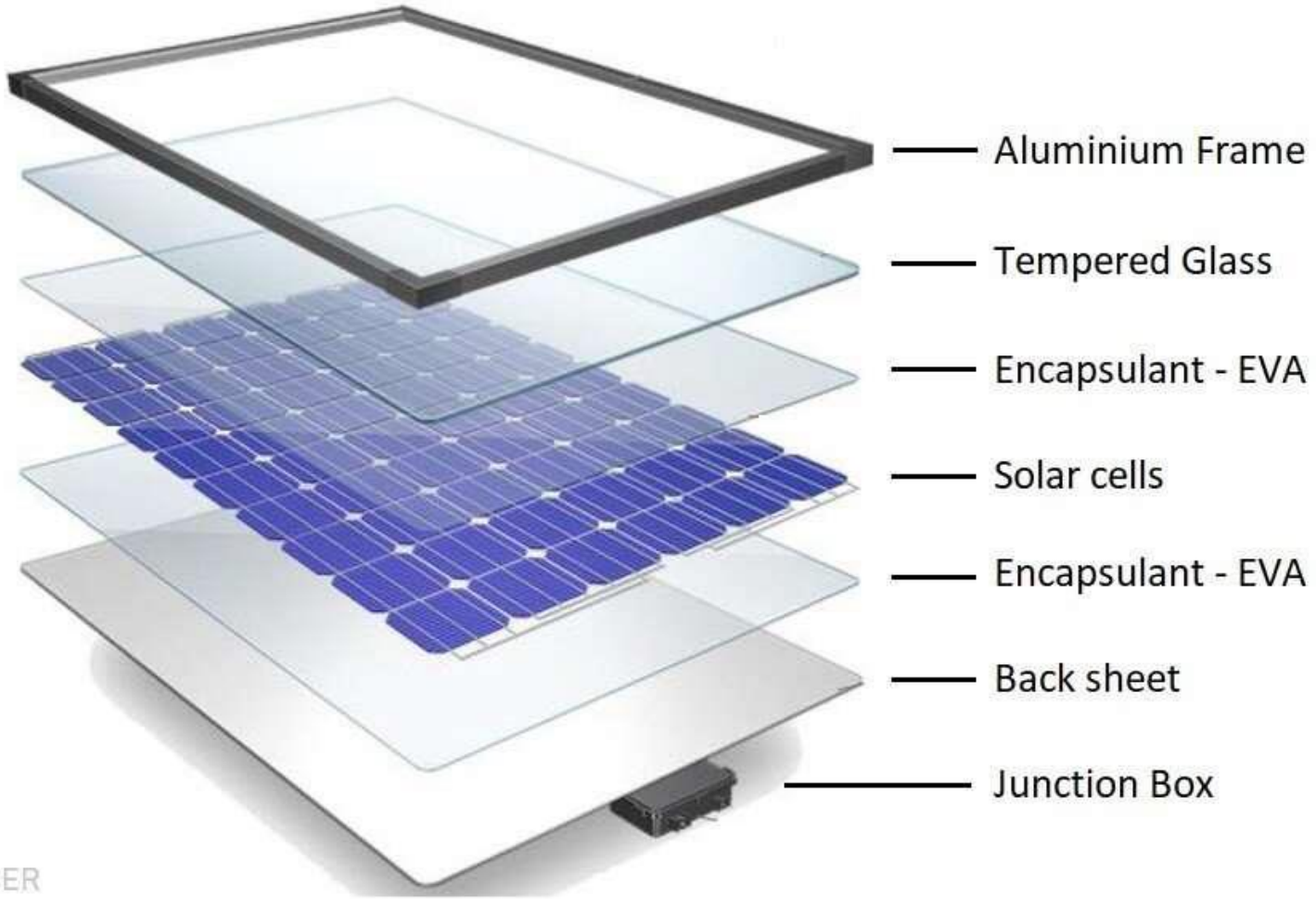
1. General: PV-Modules
2. Current market trends
3. Current technologies
4. Presentation of the bifacial module
5. Tests bificial module
6. How do we secure our quality promise?

From raw materials to the finished module



Structure of the IBC SOLAR modules



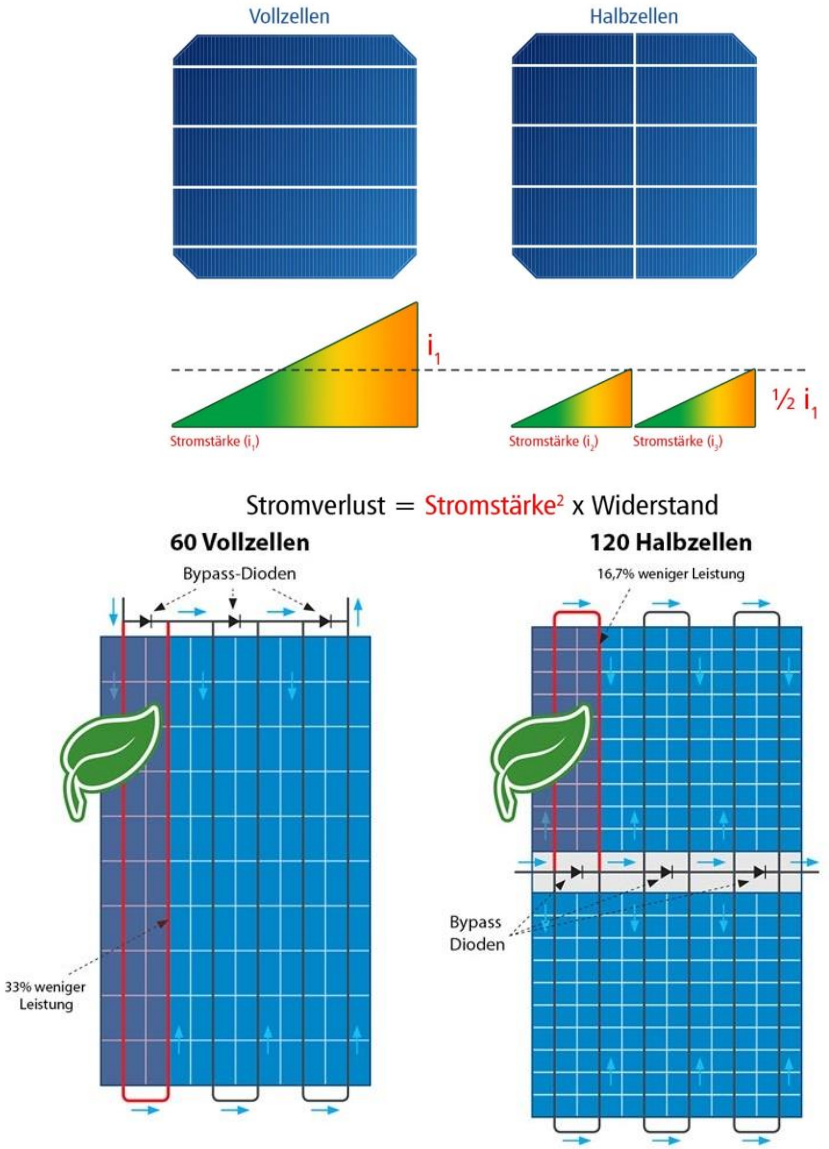


CER

Current market trends

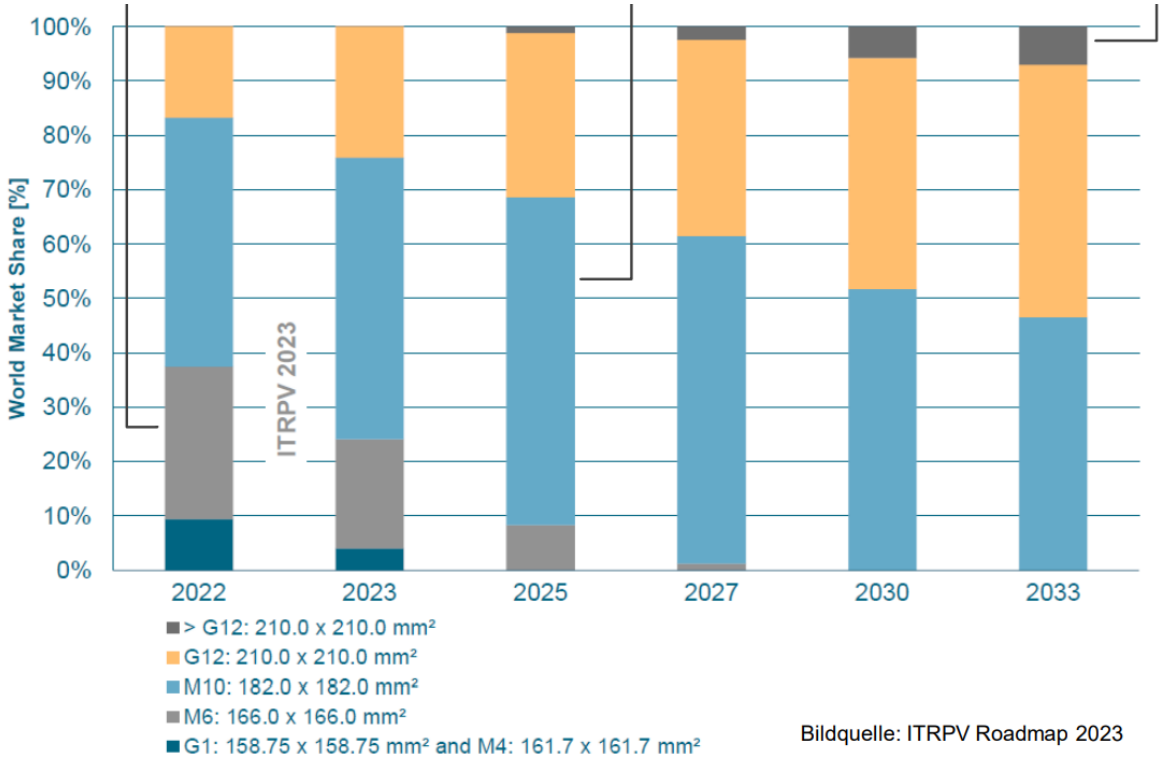
Full vs. Half vs. Triple Cell

- Half Cut:
  - Lower power loss
  - Better shading management
- Triple Cut:
  - More stress for the cell
  - Error-proneness
  - Higher production costs
  - Shading advantages, strongly depend on the interconnection (no standard design)

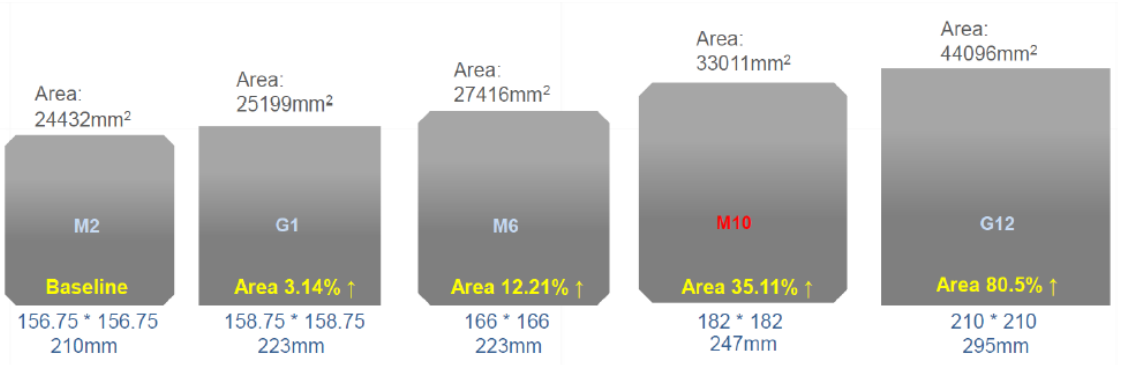


Wafer trends

- M10 + M12 wafers become the predominant sizes
- Change from square to rectangular wafers
- M6 wafers 2023 only for Meyer Burger and Jolywood modules in IBC Solar portfolio

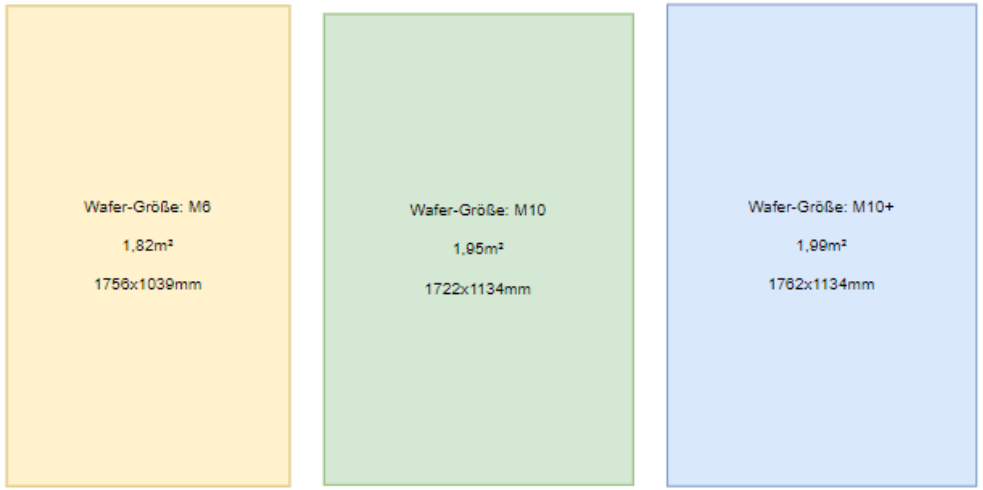


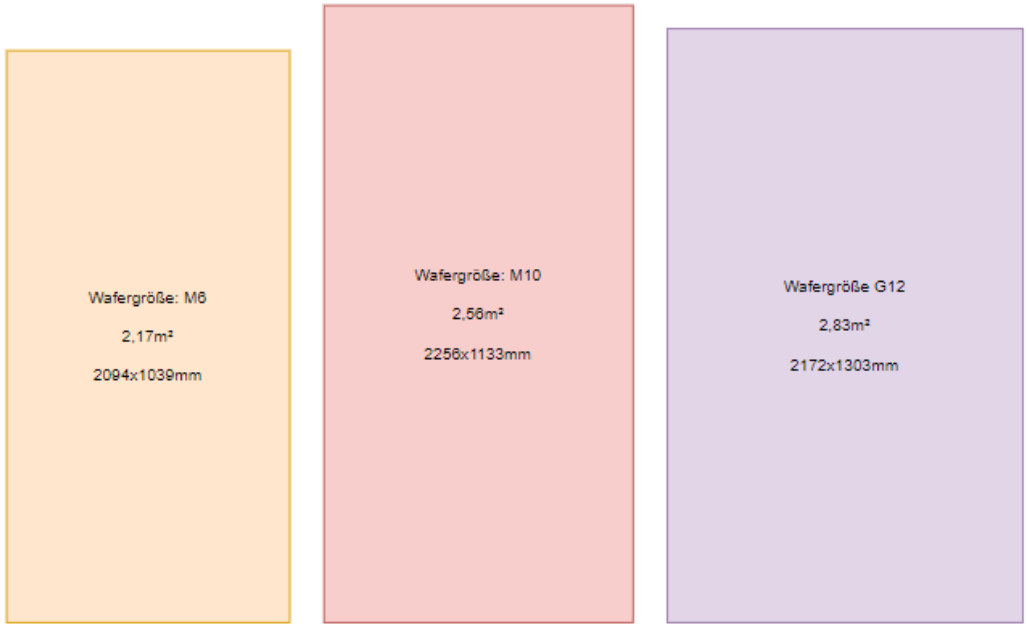
Bildquelle: ITRPV Roadmap 2023



Module sizes

- Significant increase of the size of residential modules within 2 years
- Significant increase in size of power plants modules
- Gradually decreasing frame height to 30mm (residential) or 35mm (power plants)



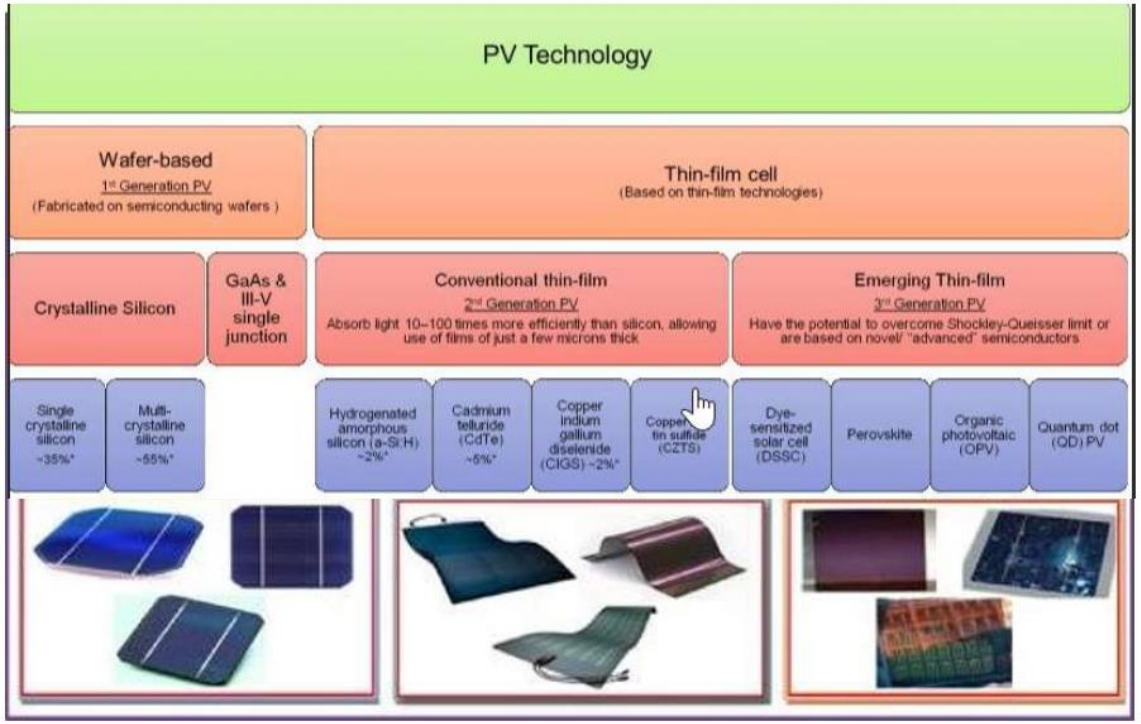


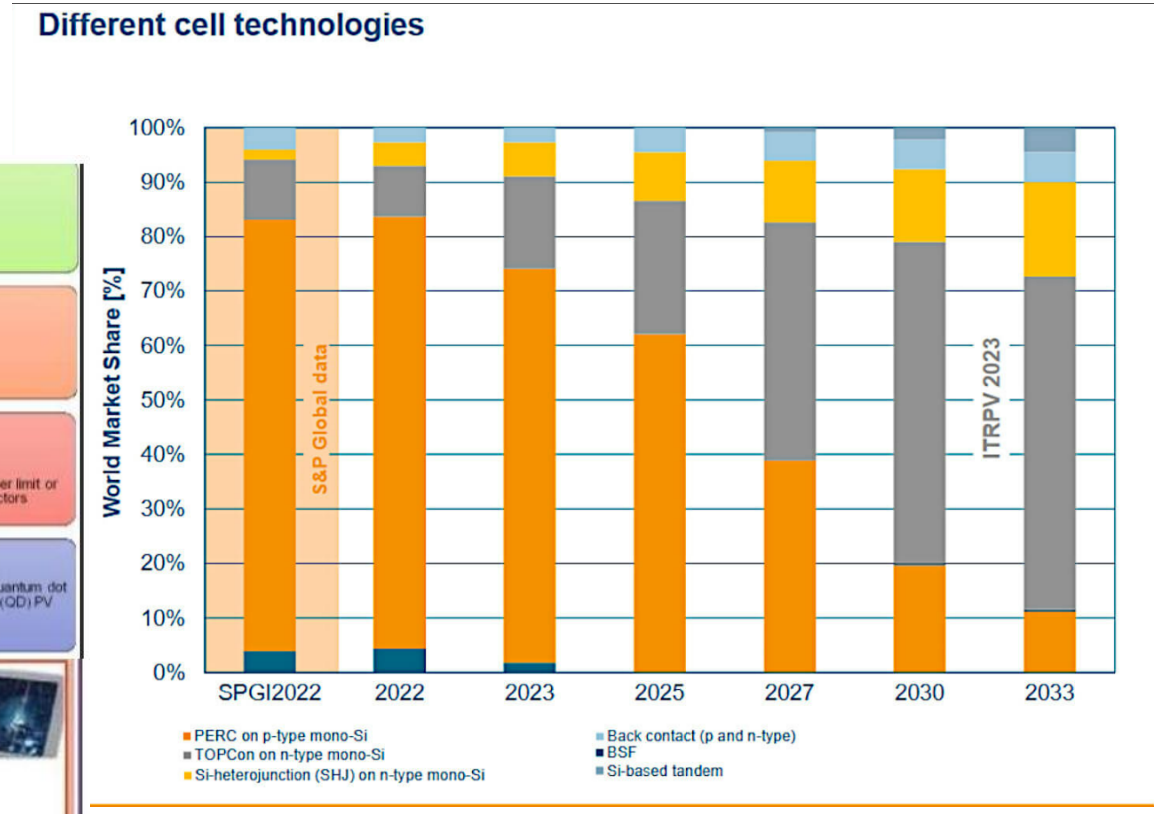
Effects of the frame height on the system

- Focus on the system
- Cell breakage is not considered in the standard
- Unique selling point IBC Solar
- Module manufacturer: test module only
- Mounting manufacturer: only mounting

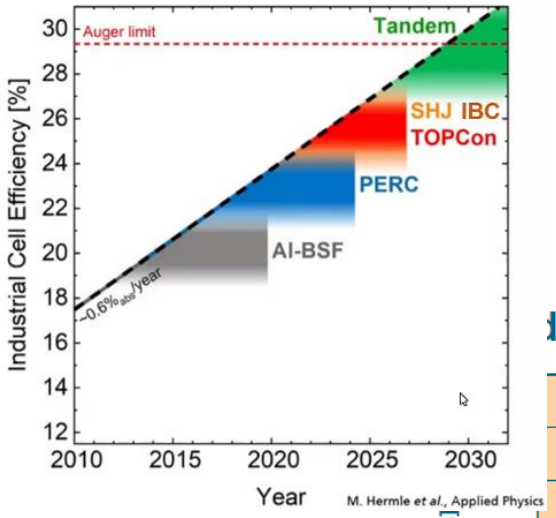
Current technologies

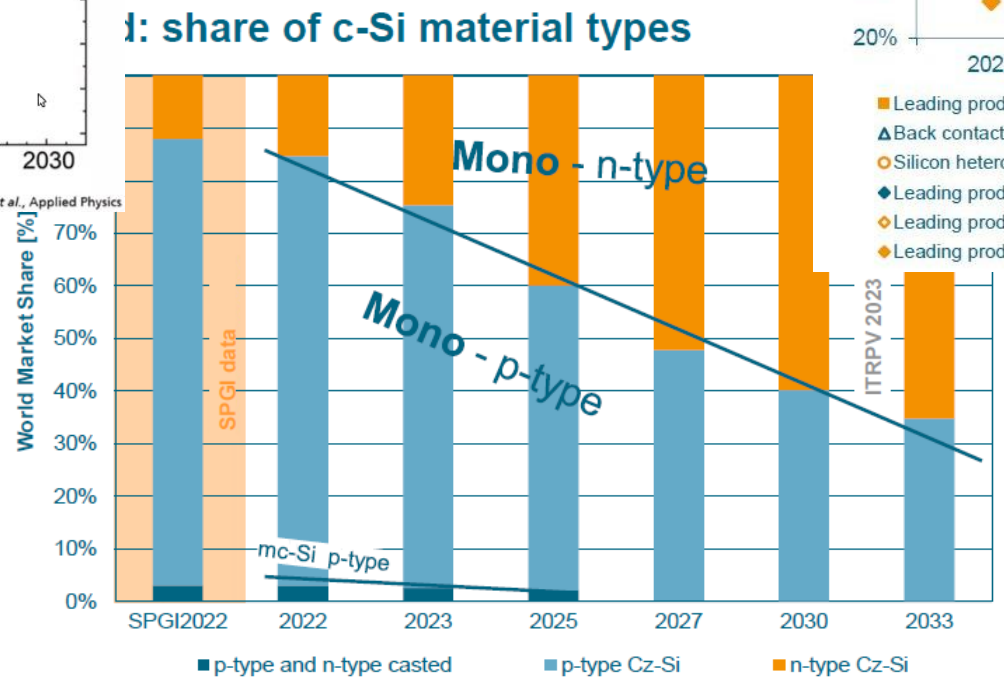
Classification of PV cells



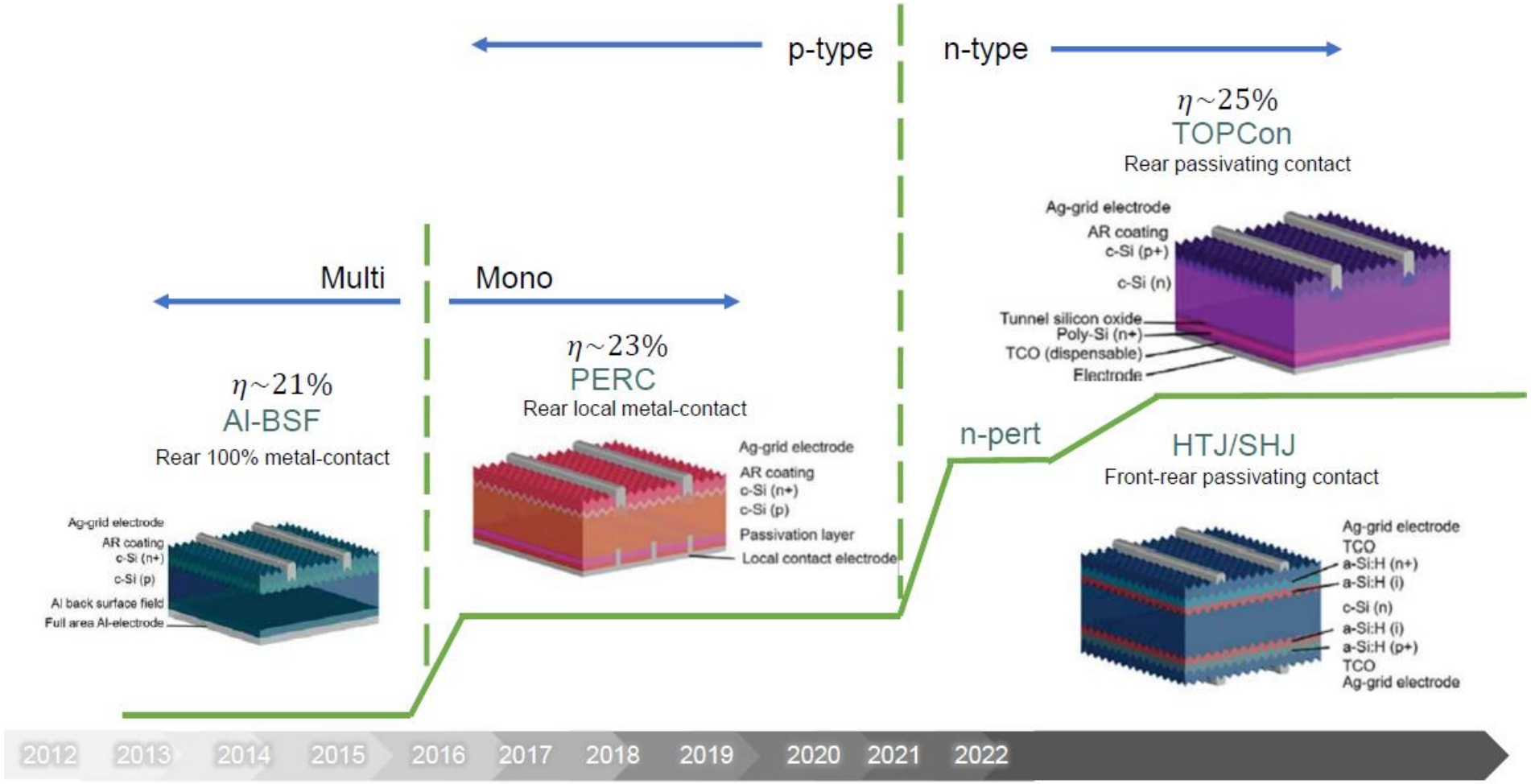


Current technologies

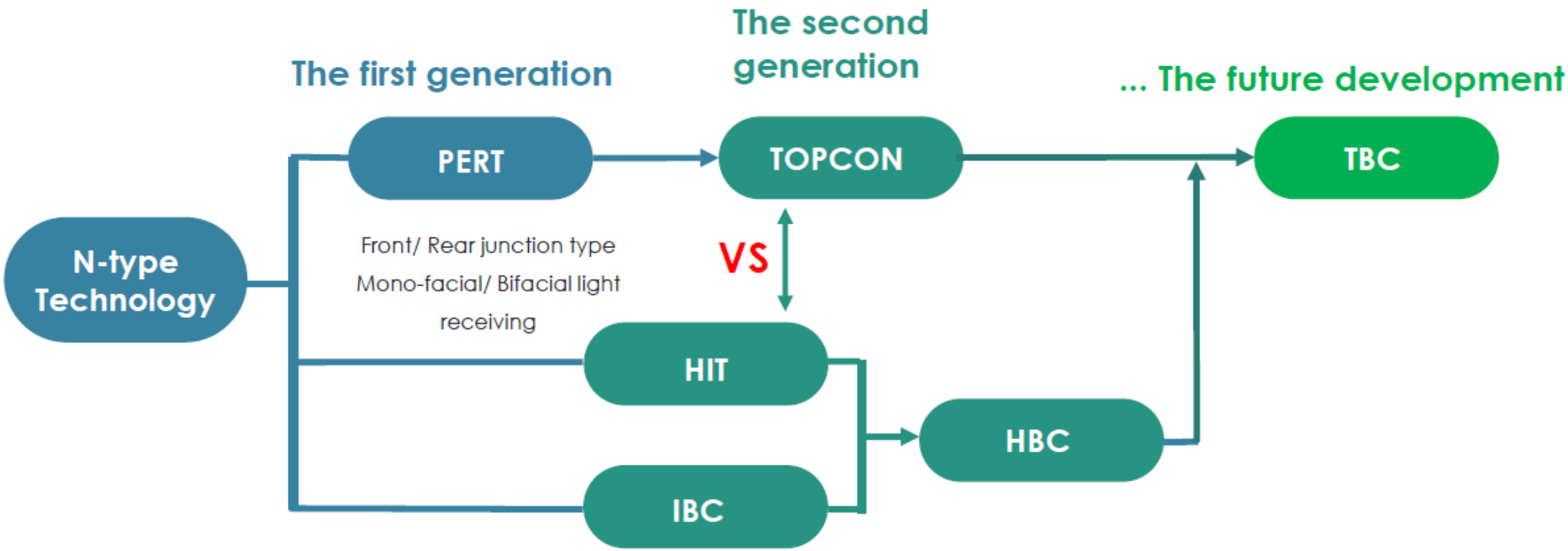




The path of efficiency



N-type cell technologies



Example:
IBC MonoSol ES10-HC-N BF

IBC SOLAR

Have sun!

Auf Modul & Halterung

15 Jahre Kombi-Garantie

Produktdatenblatt

IBC MonoSol 405 - 420 ES10-HC-N BF

Hochwertige Doppelglas-Solarmodule aus monokristallinen Half-Cut-Zellen.

Verlängerte Leistungsgarantie

Garantierte langfristig höhere Stromerträge dank der TOPCon-Technologie.

Höhere Schwachlichtausbeute

Bereits bei schwachem Licht, beispielsweise bei Dämmerung und an bewölkten Tagen, findet eine erhöhte Stromproduktion statt.

Bifaziale Stromerzeugung

Bis zu 25% ertragsstärker dank beidseitig aktivem Modul, welches sowohl über die Vorder- als auch über die Rückseite Sonnenlicht aufnimmt.

Besserer Zellschutz

Die Front- und Rückseiten-Glasschicht schützt die Zellen vor Beschädigungen und Umwelteinflüssen.

Zudem profitieren Sie von:

- einer positiven Leistungstoleranz (-0/+5W)
- erhöhter mechanischer Stabilität (5400 Pa)
- einem deutschen Garantiegeber
- 100% geprüfter Qualität
- einer 30-jährigen Leistungsgarantie
- einer 25-jährigen Produktgarantie

Online-Shop:
Hier finden Sie unsere Produkte und weitere Informationsmaterial.

IBC SOLAR ist Mitglied des Rücknahmesystems take-e-back. Weitere Informationen finden Sie unter www.take-e-back.de.

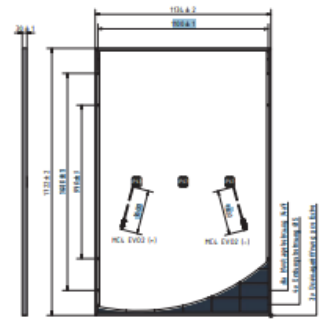
WEEE-Reg. Nr. für Deutschland: DE 55734541

ENGINEERED IN GERMANY

IBC SOLAR AG • Am Hochgericht 10, 96231 Bad Staffelstein • Tel. +49 (0)9573-92240 • info@ibc-solar.de • www.ibc-solar.de

IBC SOLAR

Have sun!



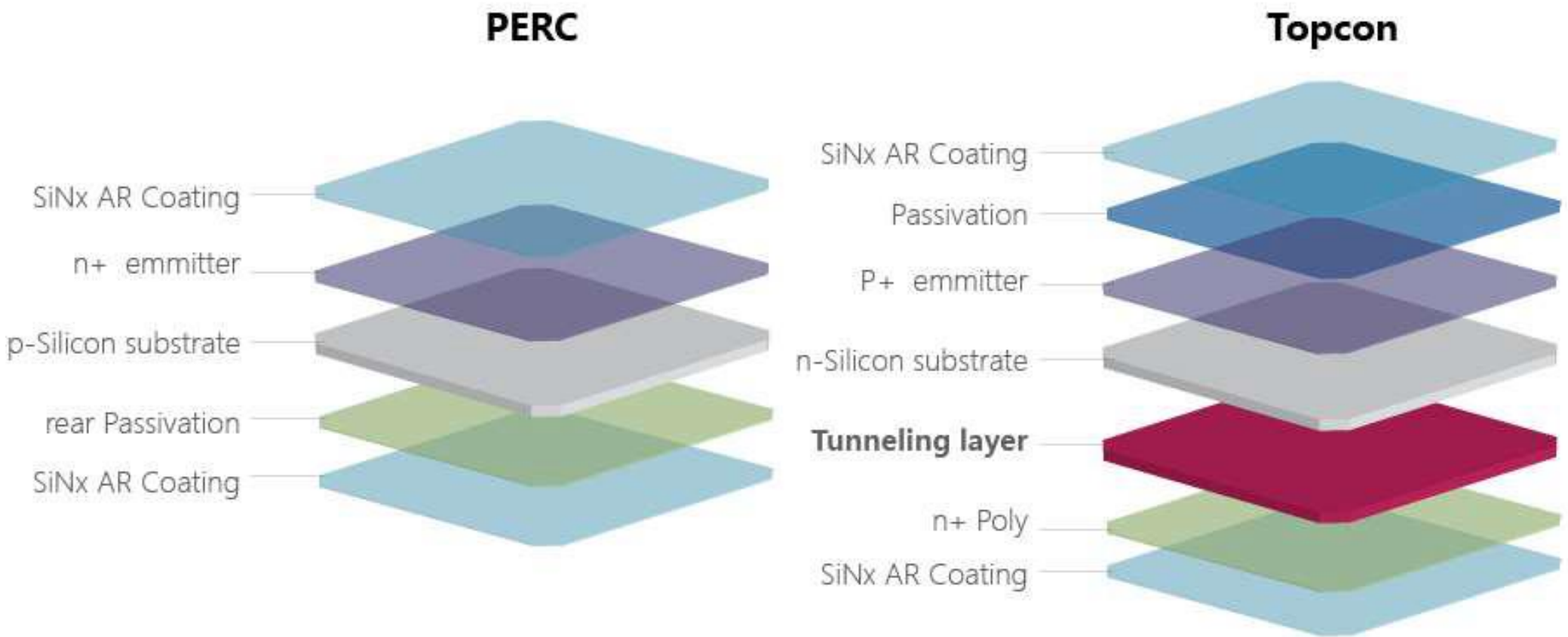
IBC MonoSol	405 ES10-HC-N BF	410 ES10-HC-N BF	415 ES10-HC-N BF	420 ES10-HC-N BF
Artikelnummer	2006200005	2006200003 2006200006	2006200007	2006200008
Elektrische Daten (STC)[2]				
STC Leistung Pmax (Wp)	405	410	415	420
STC Nennspannung Umpp (V)	31,3	31,5	31,7	31,9
STC Nennstrom Impp (A)	12,95	13,02	13,10	13,17
STC Leerlaufspannung Uoc (V)	37,3	37,5	37,7	37,9
STC Kurzschlussstrom Isc (A)	13,75	13,82	13,91	13,98
Modulwirkungsgrad (%)	20,67	20,92	21,25	21,51
Leistungstoleranz (W)	-0/+5	-0/+5	-0/+5	-0/+5
Elektrische Daten (NMOT)				
NMOT (°C)	42	42	42	42
800 W/m² NMOT AM 1.5 Leistung Pmax (Wp)	307	311	315	318
800 W/m² NMOT AM 1.5 Nennspannung Umpp (V)	29,4	29,6	29,8	30,0
800 W/m² NMOT AM 1.5 Leerlaufspannung Uoc (V)	35,7	35,8	36,0	36,2
800 W/m² NMOT AM 1.5 Kurzschlussstrom Isc (A)	11,09	11,14	11,22	11,27
Rel. Wirkungsgradreduzierung bei 200 W/m² (%)	≤ 5	≤ 5	≤ 5	≤ 5
Temperaturkoeffizient (linear)				
Tempkoeff Isc (%/°C)	0,046	0,046	0,046	0,046
Tempkoeff Uoc (mV/°C)	-96,98	-97,50	-98,02	-98,75
Tempkoeff Pmpp (%/°C)	-0,32	-0,32	-0,33	-0,33

Betriebsbedingungen	
Max. Systemspannung (V)	1500
Anwendungsklasse	A
Rückstrombelastbarkeit Ir (A)	25
Absicherung ab parallelen Strängen	2
Schutzklasse	II (DIN EN 61140)
Brandschutzklasse	C (IEC 61730-ANSI/UL790)
Mechanische Eigenschaften	
Abmessungen (L × B × H in mm)	1722 × 1134 × 30
Gewicht (kg)	24,5
Max. Testlast, Druck/Zug (Pa)	5400/2400
Max. zulässige Last[2], Druck/Zug (Pa)	3600/1600
Frontabdeckung (mm)	2,0 (eisenarmes Solarglas mit Antireflexionsbeschichtung)
Rahmen	eloxiertes Aluminium, Hohlkammerrahmenprofil
Zellen	12 × 9 monokristalline Siliziumzellen
Anschlusstyp	EVO2
Garantien und Zertifizierung	
Produktgarantie	25 Jahre[1]
Leistungsgarantie	30 Jahre[1]
Jährliche Degradation	Jahr 1 1,0% Jahr 2-30 0,4%
Zertifizierung	IEC 61215, IEC 61730-1/-2, ISO 9001, ISO 14001, OHSAS 18001
Verpackungsinformationen	
Anzahl Module pro Palette	36
Anzahl Paletten pro 40' Container	26
Größe inkl. Palette (L × B × H in mm)	1764 x 1140 x 1254
Bruttogewicht inkl. Doppelpalette (kg)	918
Stapelbarkeit pro Palette	2-fach

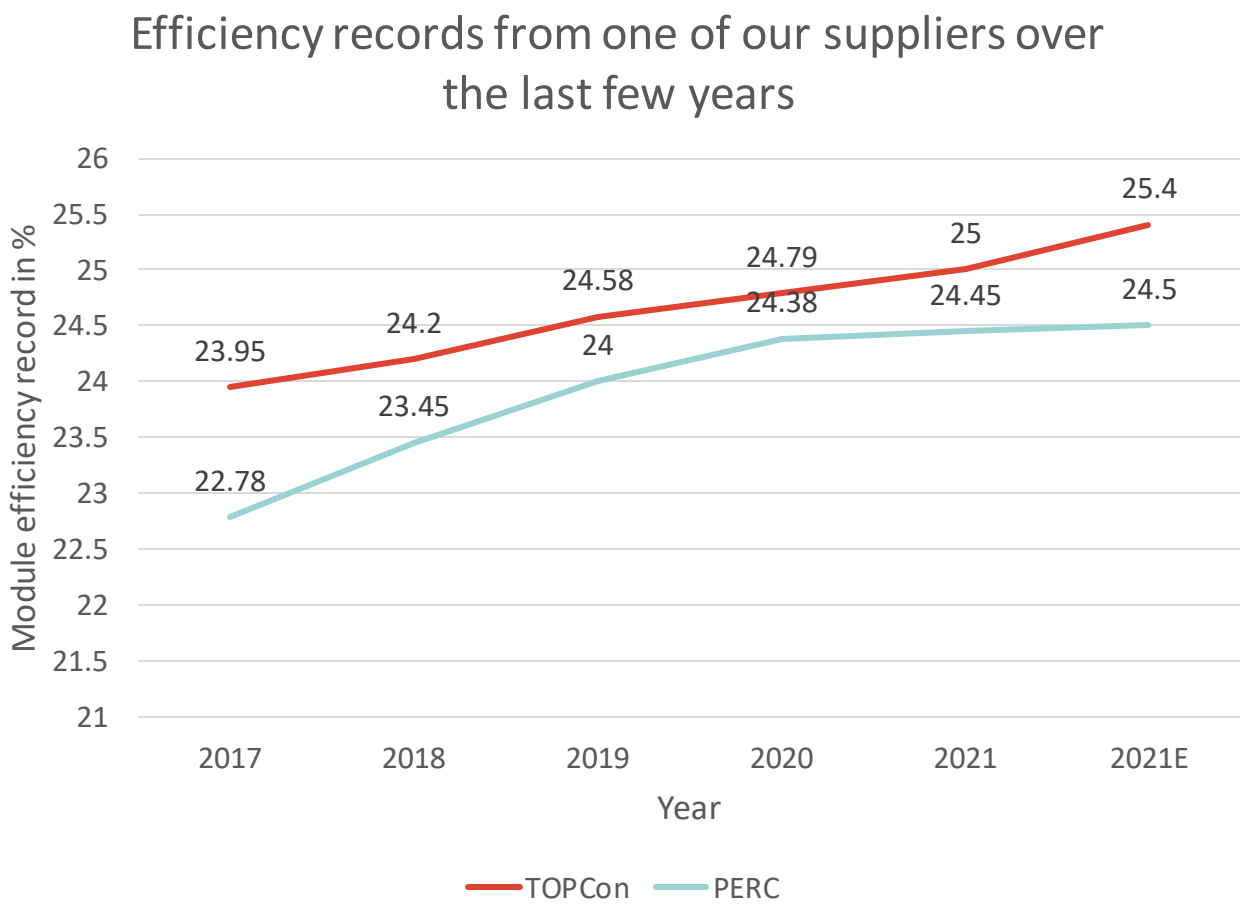
9001500128 • Stand 01.02.2023

10, 96231 Bad Staffelstein • Tel. +49 (0)9573-92240 • info@ibc-solar.de • www.ibc-solar.de

Cell structure TOPCon



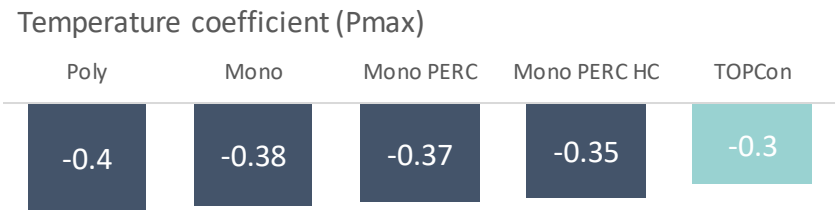
Advantage 1: more efficient cells

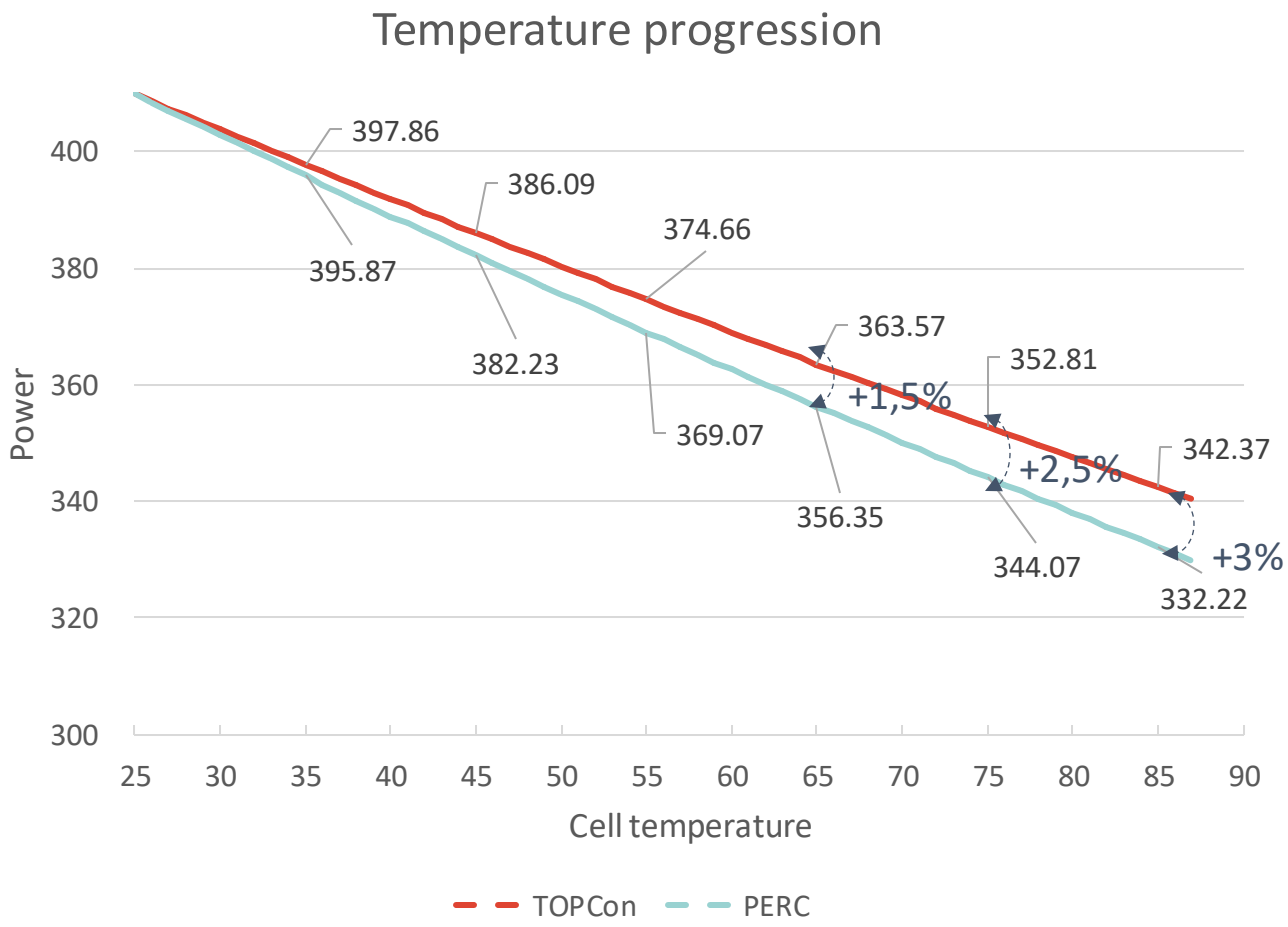


- Higher limit of efficiency
  - PERC cells: 24,5%
  - TOPCon cells: 28,2 – 28,7%
- More energy production
  - Lower electrical losses
  - Higher currents/voltage
  - Negligible LID/LeTID degradation
  - Lower temperature coefficients

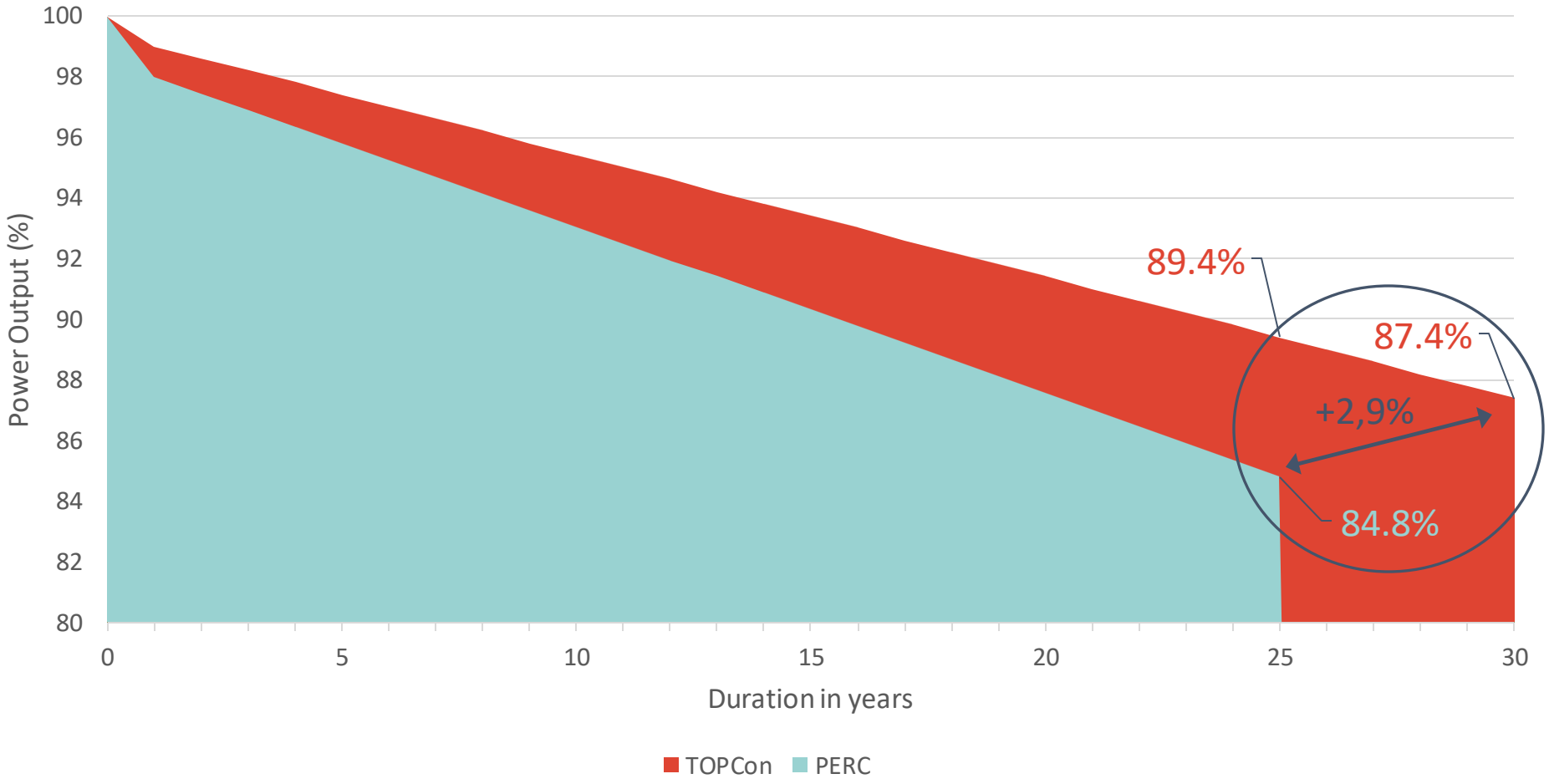
Advantage 2: Temperature coefficiency

- Efficiency increase of 16.5% (PERC → TOPCon)
- Improve real-world performance with TOPCon: **2 – 3% Surplus**





Advantage 3/4: degradation + perfomance guarantee



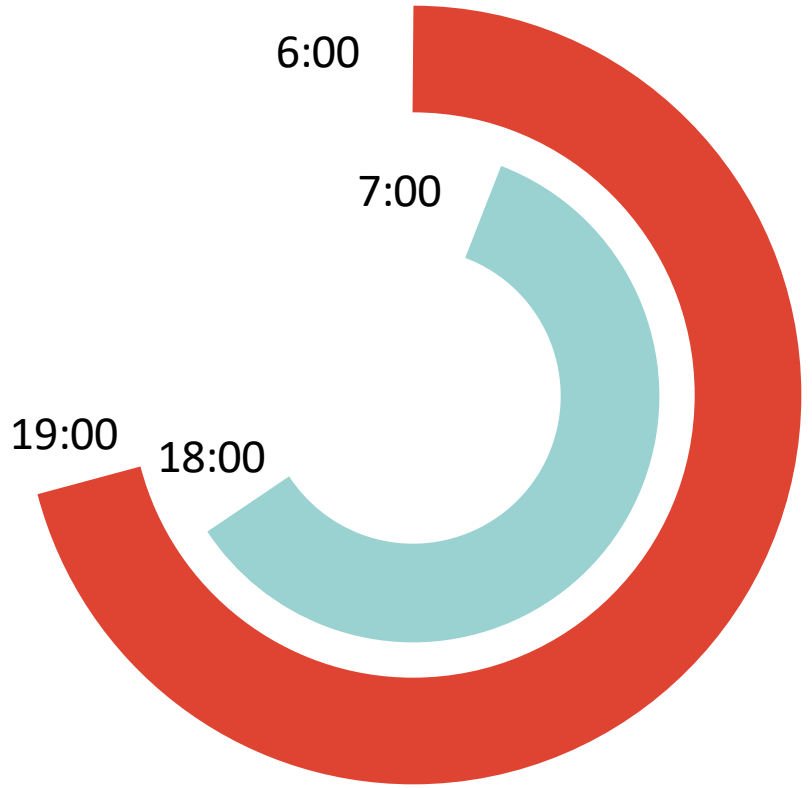
Advantage 5: Low light behavior

- N-type cells have lower resistances
- Longer carrier life

➔ Better low light behavior

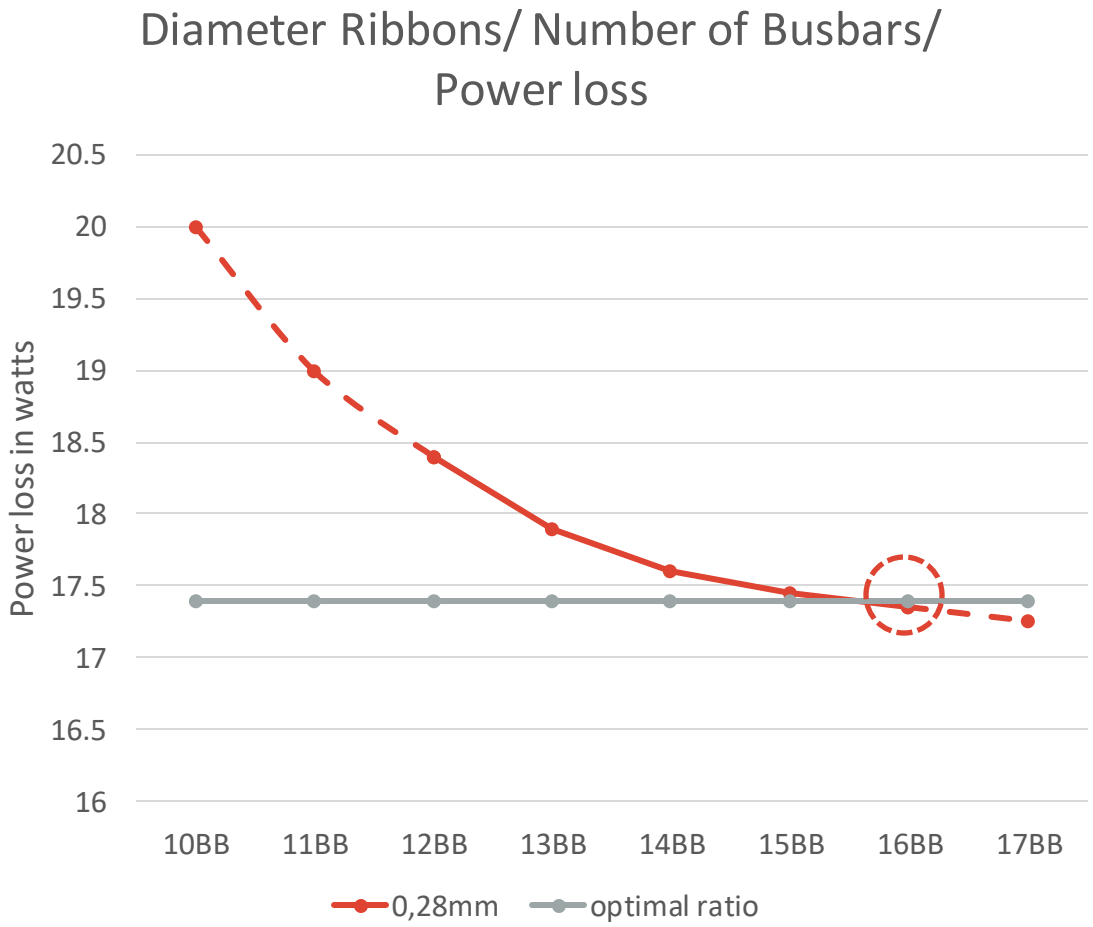
- Customer benefits:

➔ storage can be charged approx. 2h per day longer

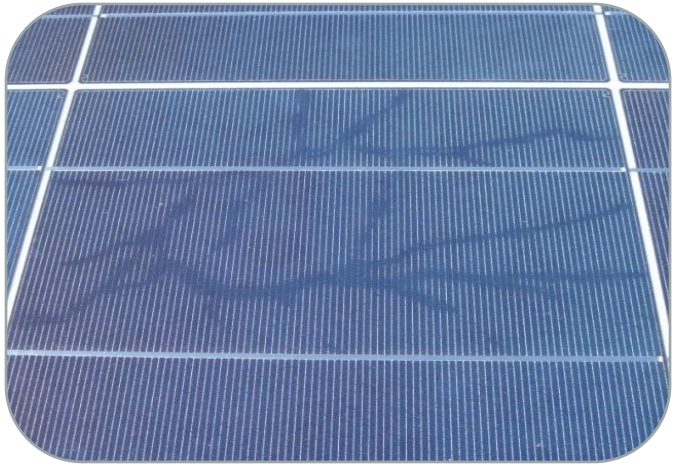


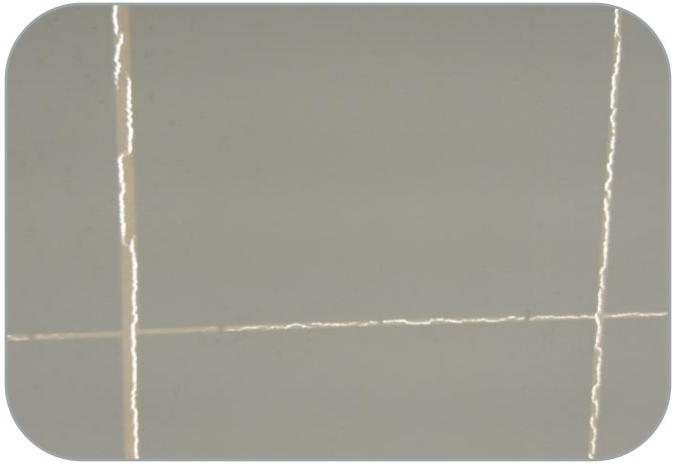
Advantage 6: Multi busbars

- Per additional busbar
  - 4% less internal resistance
  - 0.18% more power output
- Per additional busbar
  - Shading area increases by 0.18%
  - Means 0.11% power loss
- Reduces the effects of micro cracks
- Improves current transport
- Reduces power losses



Advantage 7: Glass/Glass surface



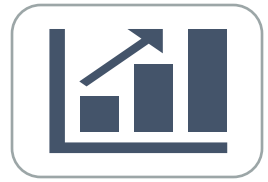


Advantage 7: Glass/Glass surface

Higher protection against environmental influences

Better stability properties under snow and wind loads

Better protection against animal damage



Advantage 7: Glass/Glass surface

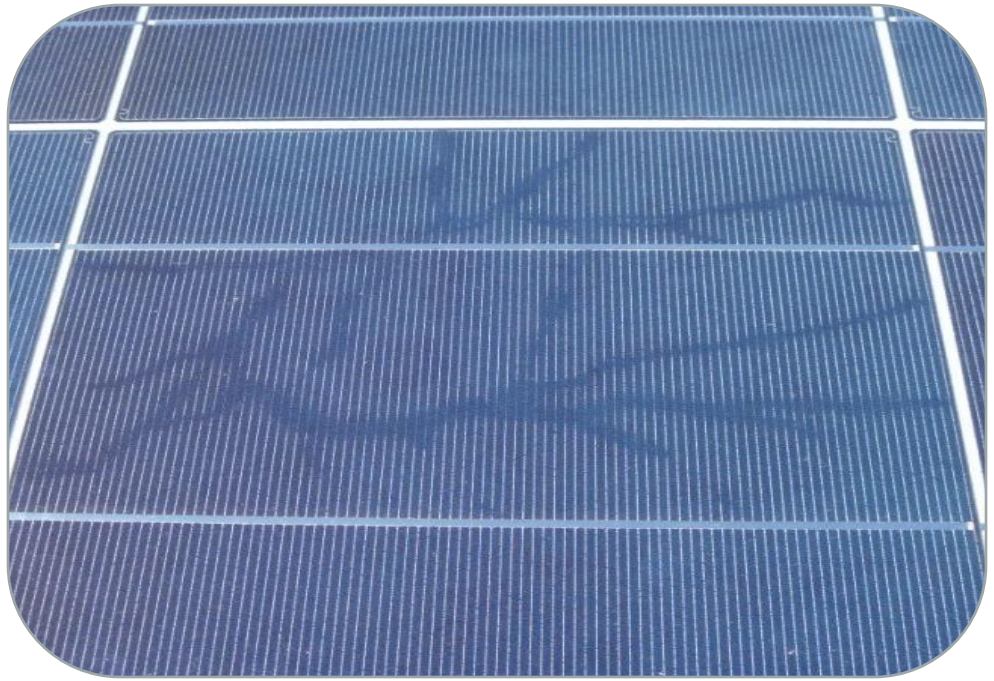
Longer warranty periods

Higher return

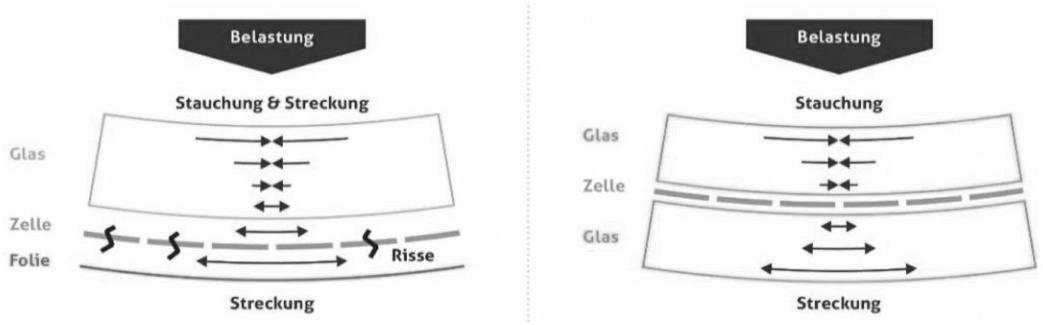
Revenue protection



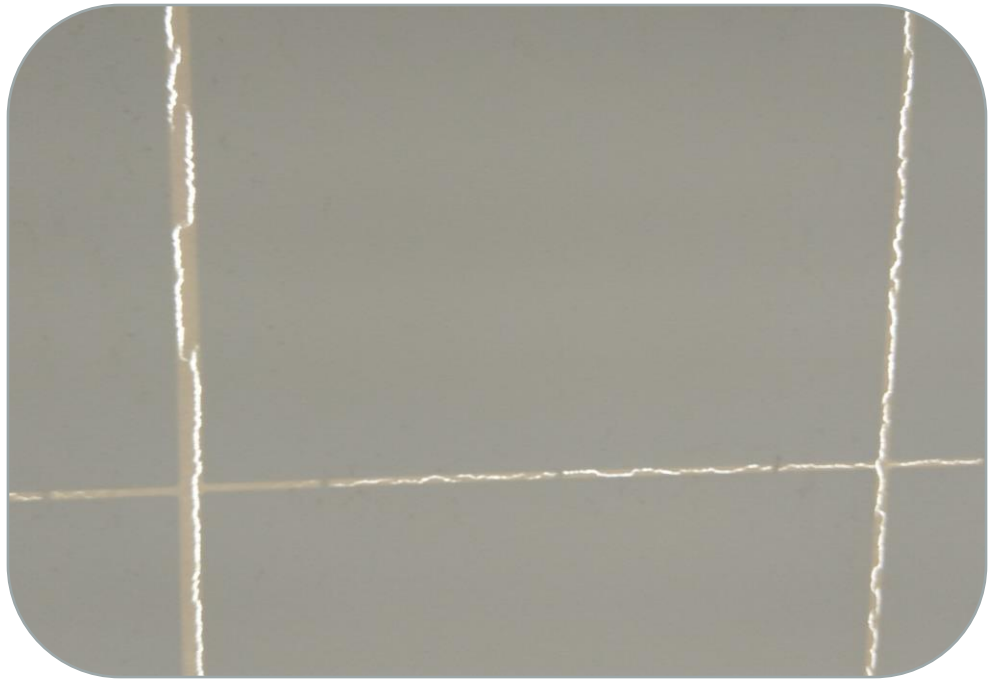

Advantage 7: Glass/Glass surface



Increased cell protection against microcracks



Advantage 7: Glass/Glass surface



No degradation of the back side

No water vapor, oxygen or other gases are allowed through

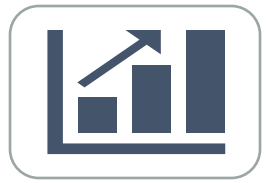
Advantage 7: Glass/Glass surface

Higher safety

Higher protection in case of fire

Can often be built closer to the fire wall

ATTENTION: always observe present building regulations



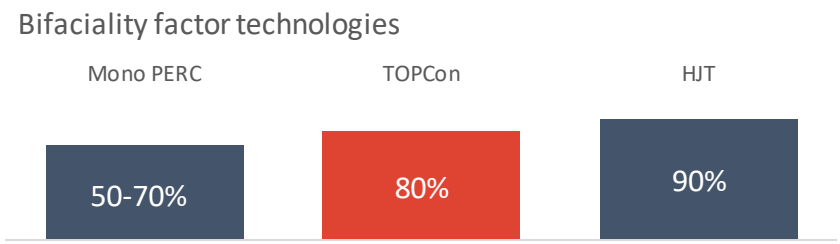
Advantage 7: Glass/Glass surface

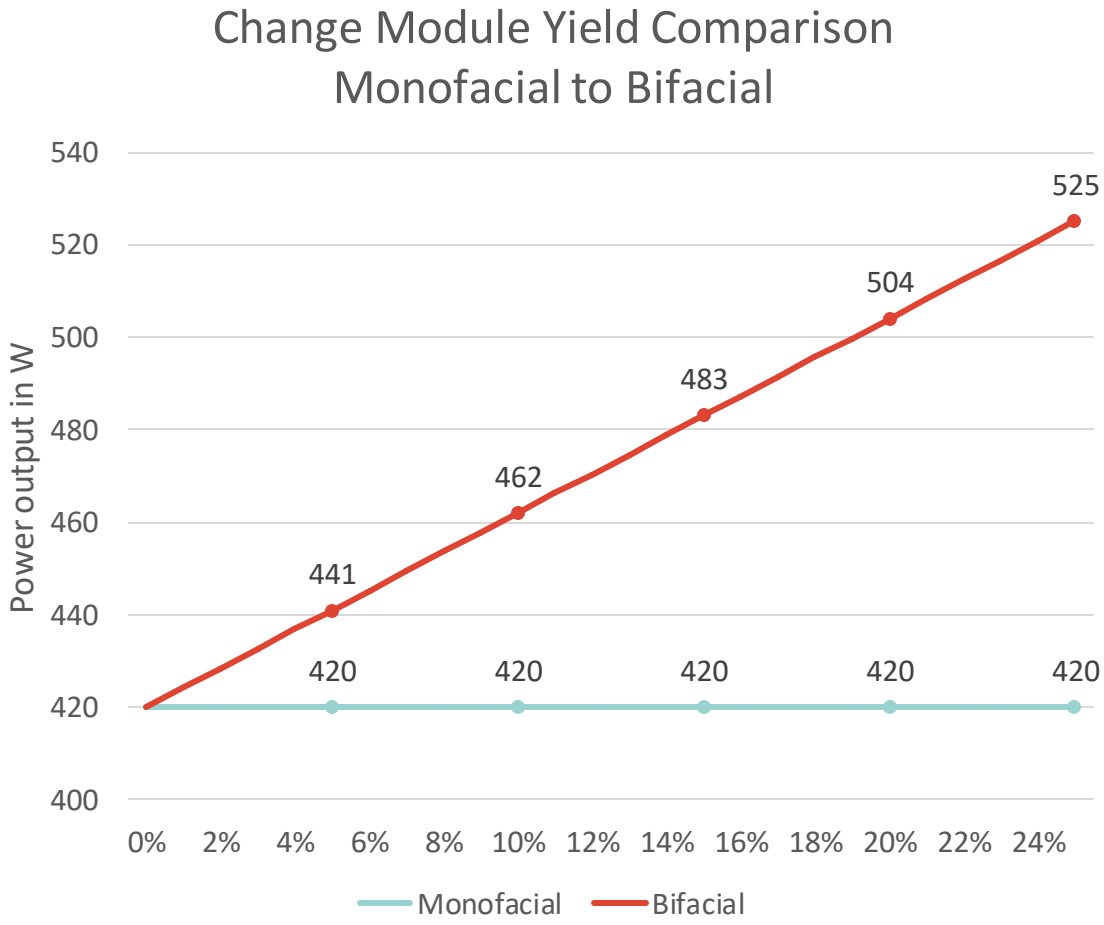
Additional income

Longer product lifetime

Advantage 8: Bifaciality

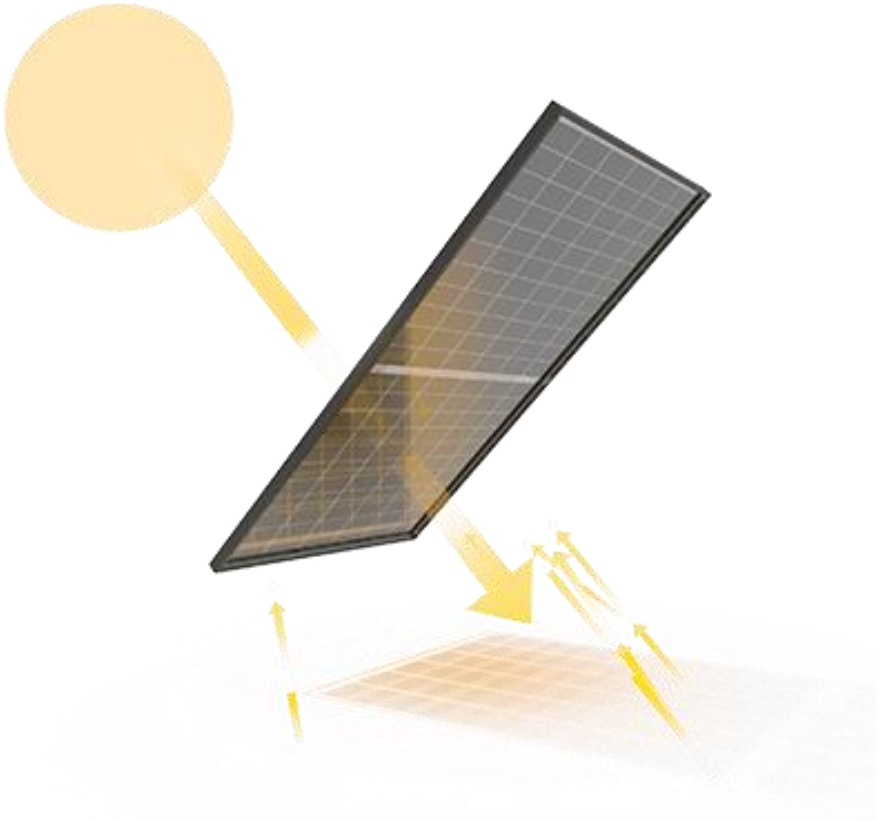
- Additional income due to double-sided power generation
- Vertical elevation possible and useful
- More efficient use of space

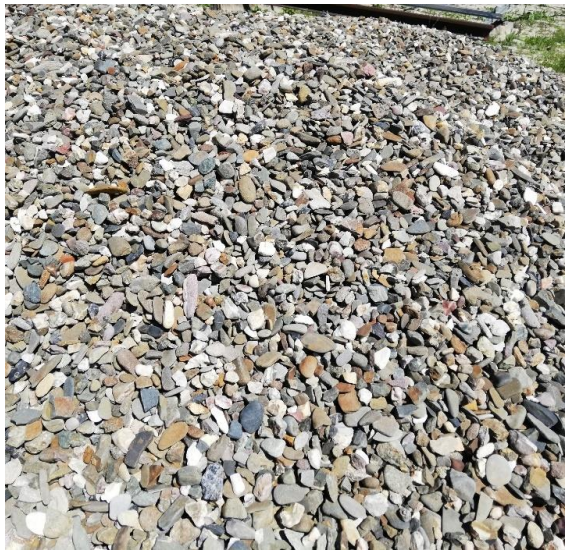




Testing of bifacial modules

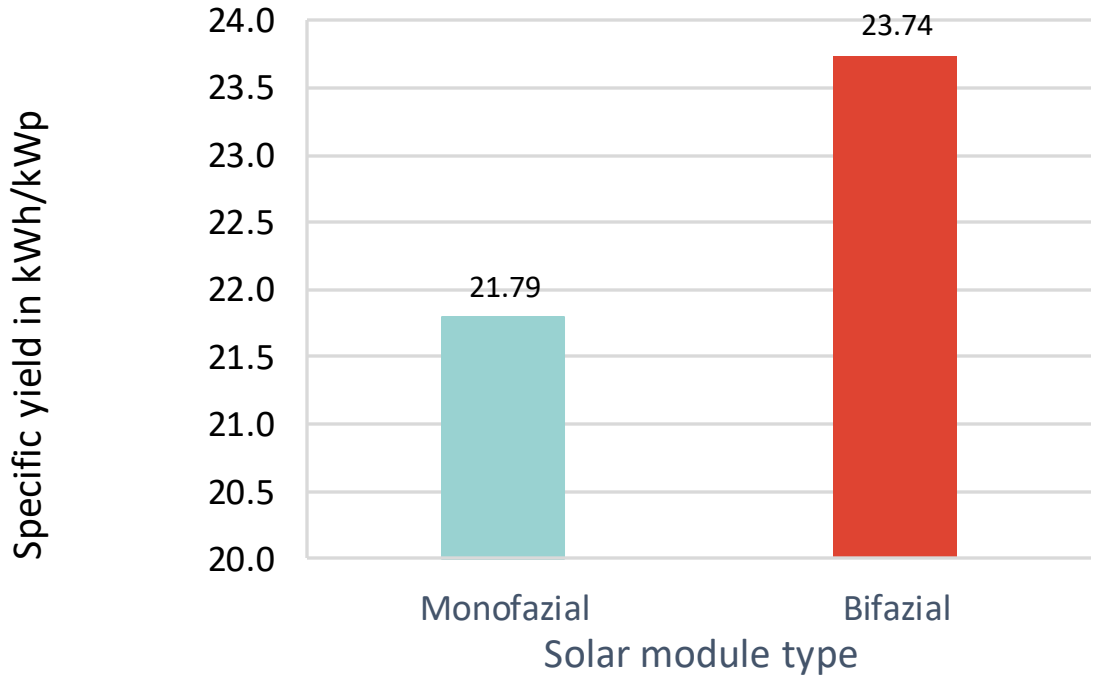
Example of Bifacial



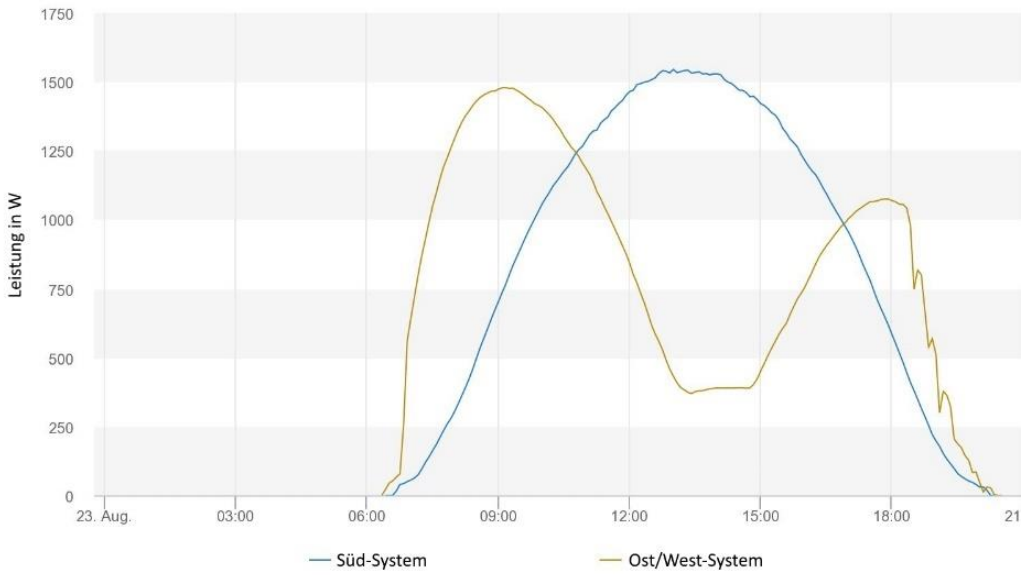


Example of bifacial - open area plant

- Existing soil
- Same land use
- Additional yield increased: 8.97%
- Increasing the excess yield with other cell technologies



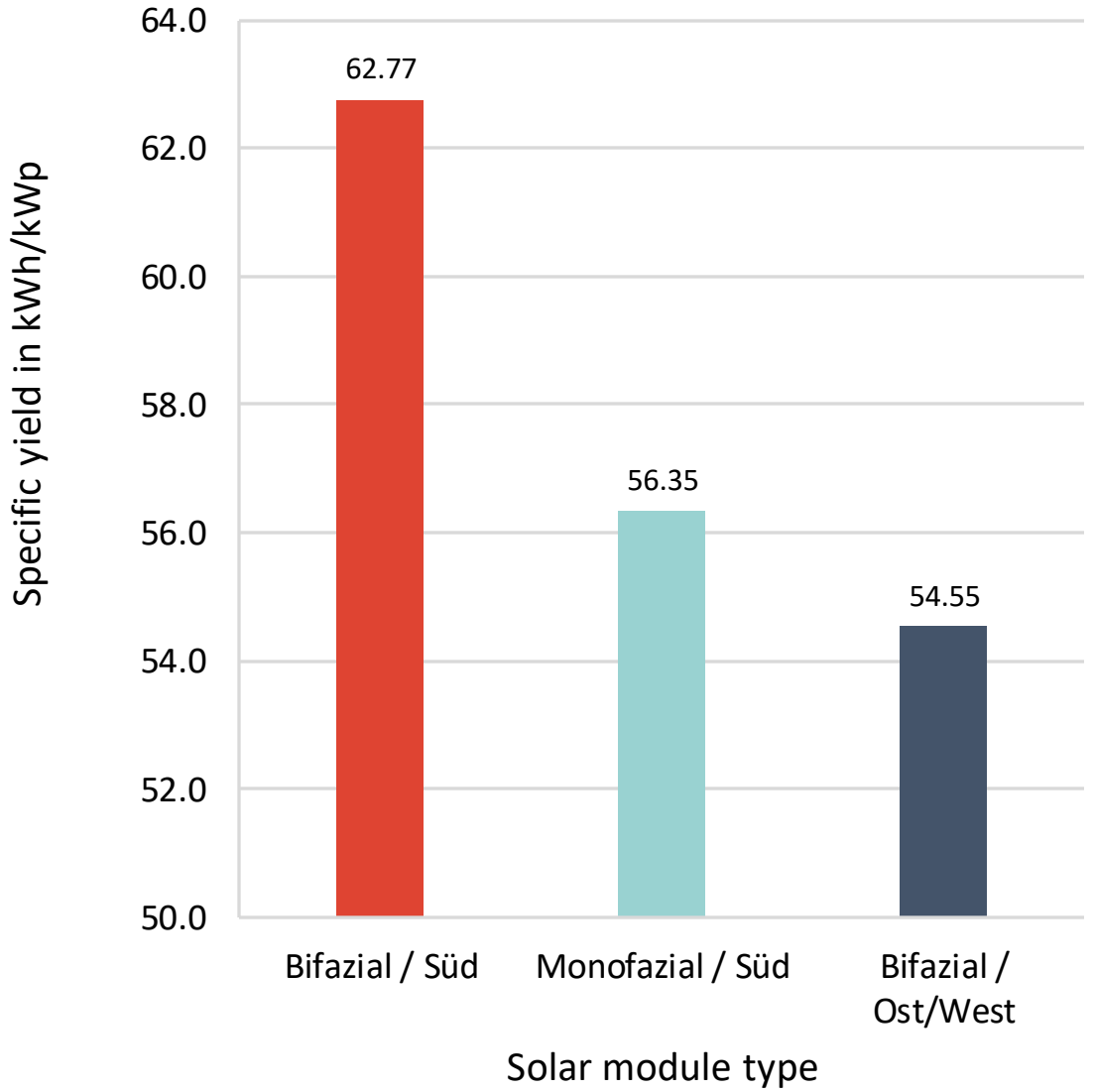
Example of Bifacial - Vertical Alignment



Example of Bifacial - Vertical Alignment

- 11.4% higher yield with elevation + south orienation
- -3.2% less yield with elevation + east/west orientation

→ Yield maximization with south orientation



Example of Bifacial - AeroFix system east/west

- Test system:

comparison of silver⇔ black roofing foil

- Additional yield Ø (silver): 3.57%
- Sunny days: 4.24%

Why do we test our products so rigorously?

Our quality promise

WHAT?

PV systems are only as good as the installed components. We want to provide systems which work perfectly together.

We ensure system integration, internal controls and independent certifications and audits for more than 20 years.

How do we secure our quality promise?

TOUGHER THAN EVERYDAY LIFE.

SUN LAB

1

TEST:

DETERMINING THE HIGHEST PERFORMANCE

2

TEST:

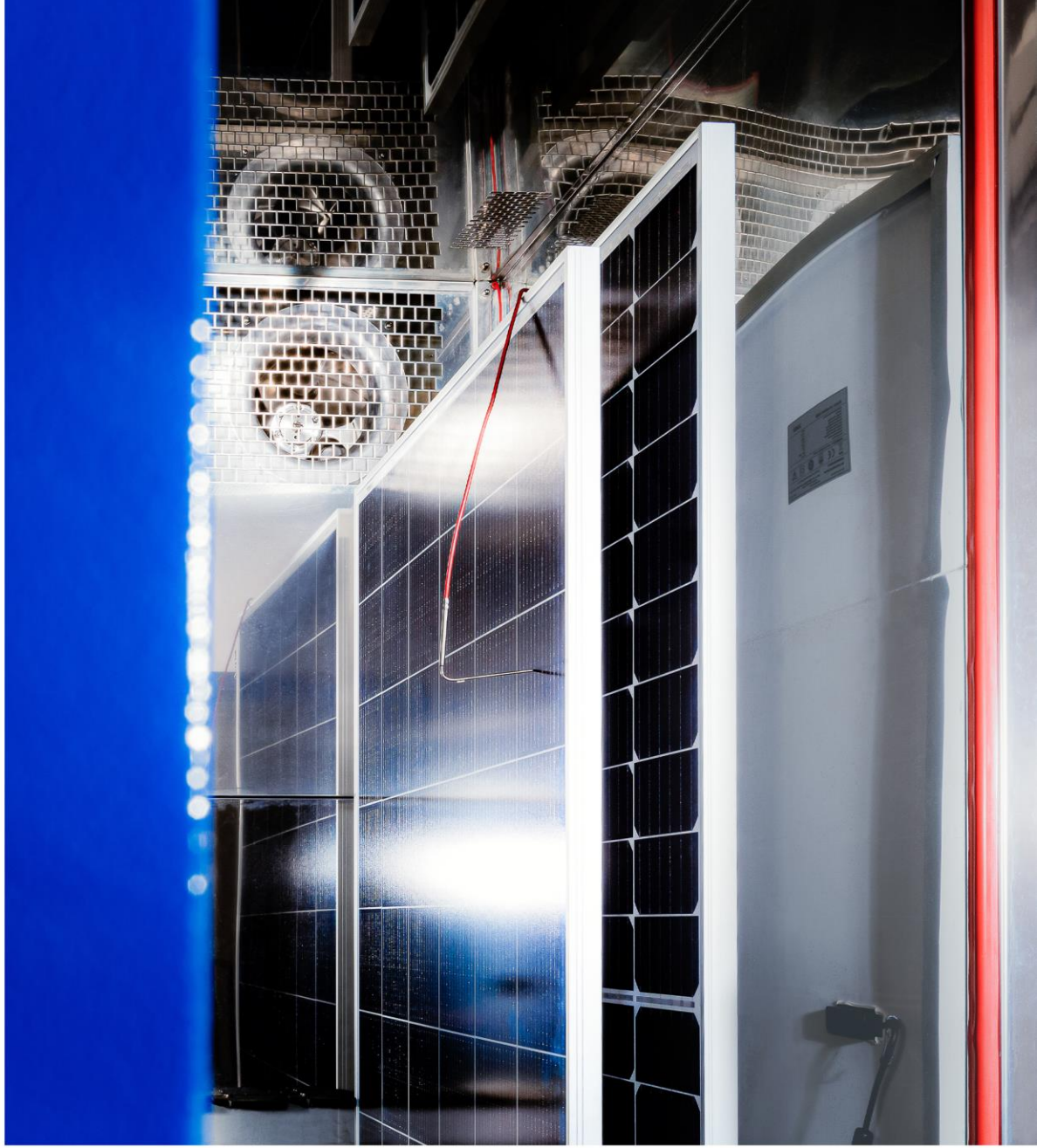
ELECTROLUMINESCENCE MEASUREMENT OF PV MODULES

3 | TEST:

STATIC MECHANICAL LOAD TEST

4 TEST:

TEMPERATURE CYCLING TEST



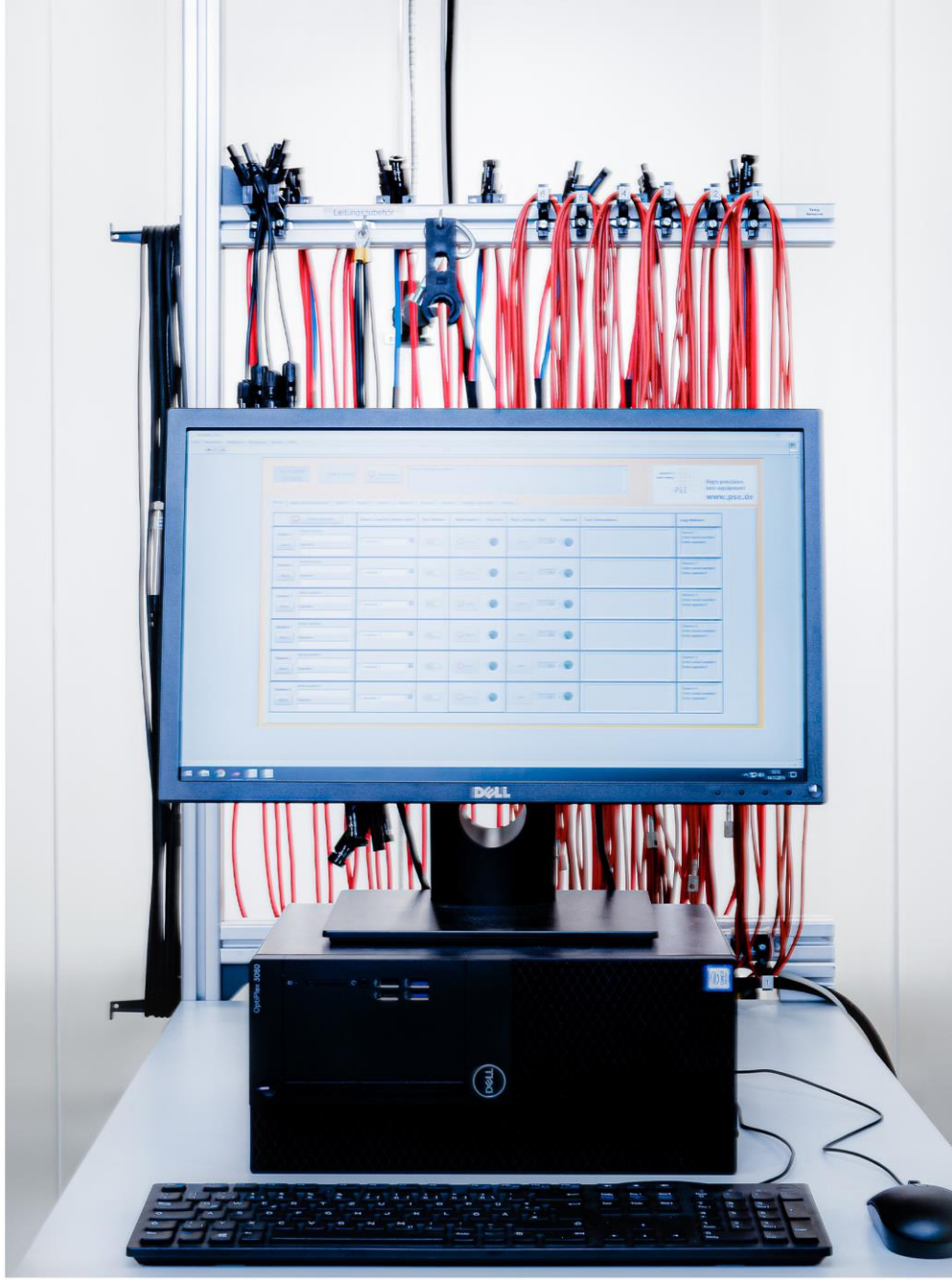
5 | TEST:

MOIST HEAT TEST

6

TEST:

DETECTION OF VOLTAGE-INDUCED DEGRADATION



7

TEST:

MEASUREMENT OF INSULATION RESISTANCE UNDER WET CONDITIONS

How does the test on the load table work?

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

Temperature control

- **Temperature control of the module**

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Setup

D

IE

Testing

- Determination of a minimum satic load for a PV module
- **Holding time:**
  1 hour per cylce
- **Repetition:**
  push cycles /
  3 pull cycles

EL and Performance Measurement

- **Performance**
  Radiant intensity:
  1000 W/m²
  Test temperature:
  +25 °C
  Measure time:
  10 ms
  Standard:
  IN EN IEC
  61215-2:2021
- **EL**
  Camera:
  Model Great Eyes
  GE 2048 2048 FI
  Test temperature:
  +25 °C (+/-5)
  Test duration:
  2 minutes
  Standard:
  C 82/1062/CD:2016

Report

- Test procedure **with photo and video documentation**
- Test Setup
- Performance measurement before and after
- **Movement of the module**
- **Test result**

D

IE

What do we do more than others?

Quality newly defined

Tests under real conditions

Test setup including mounting identical to roof installation.

Not required by IEC standard.

EL Measurement

EL measurement allows us to guarantee the performance of the module.

Not required by IEC standard.

Three tests

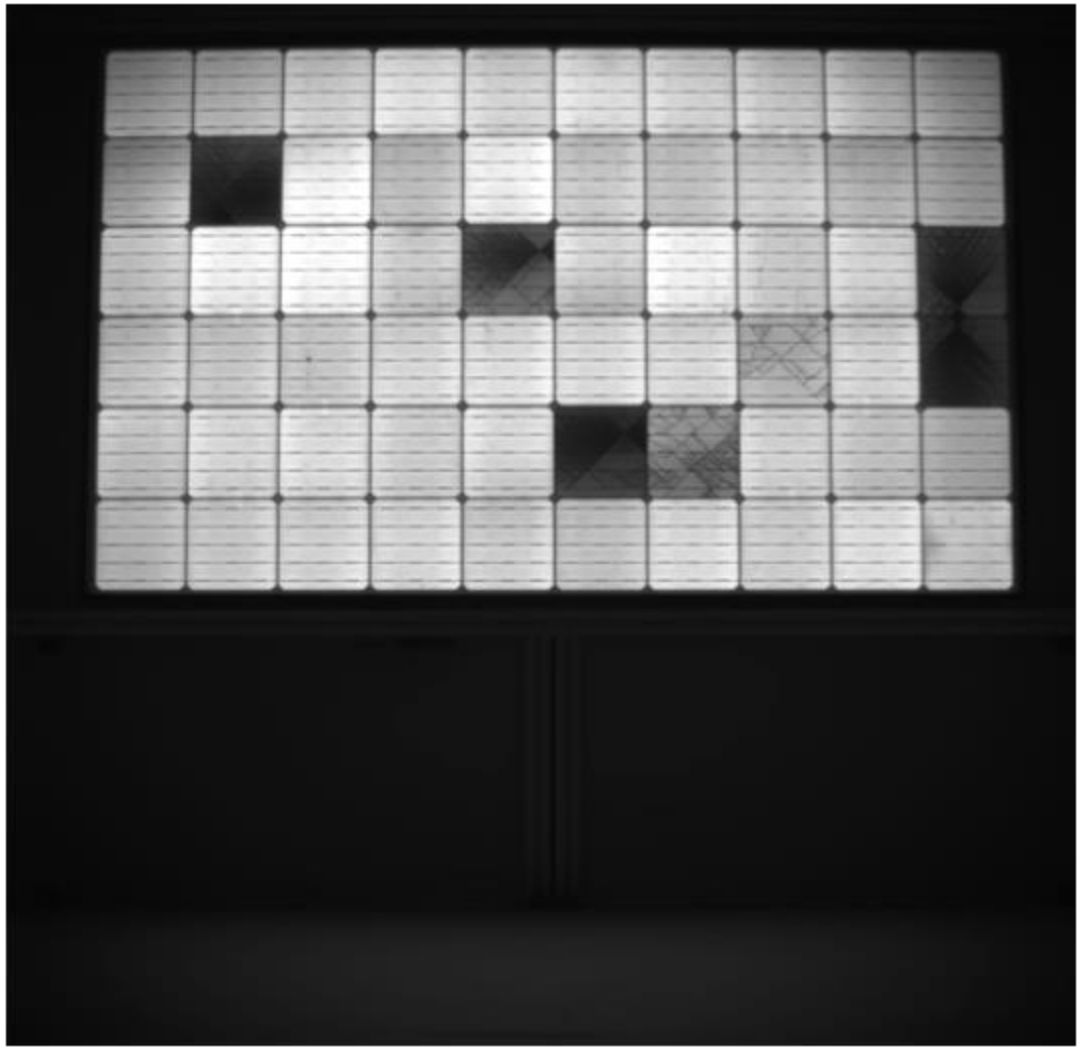
This means we exclude fluctuations or "one hit wonders".

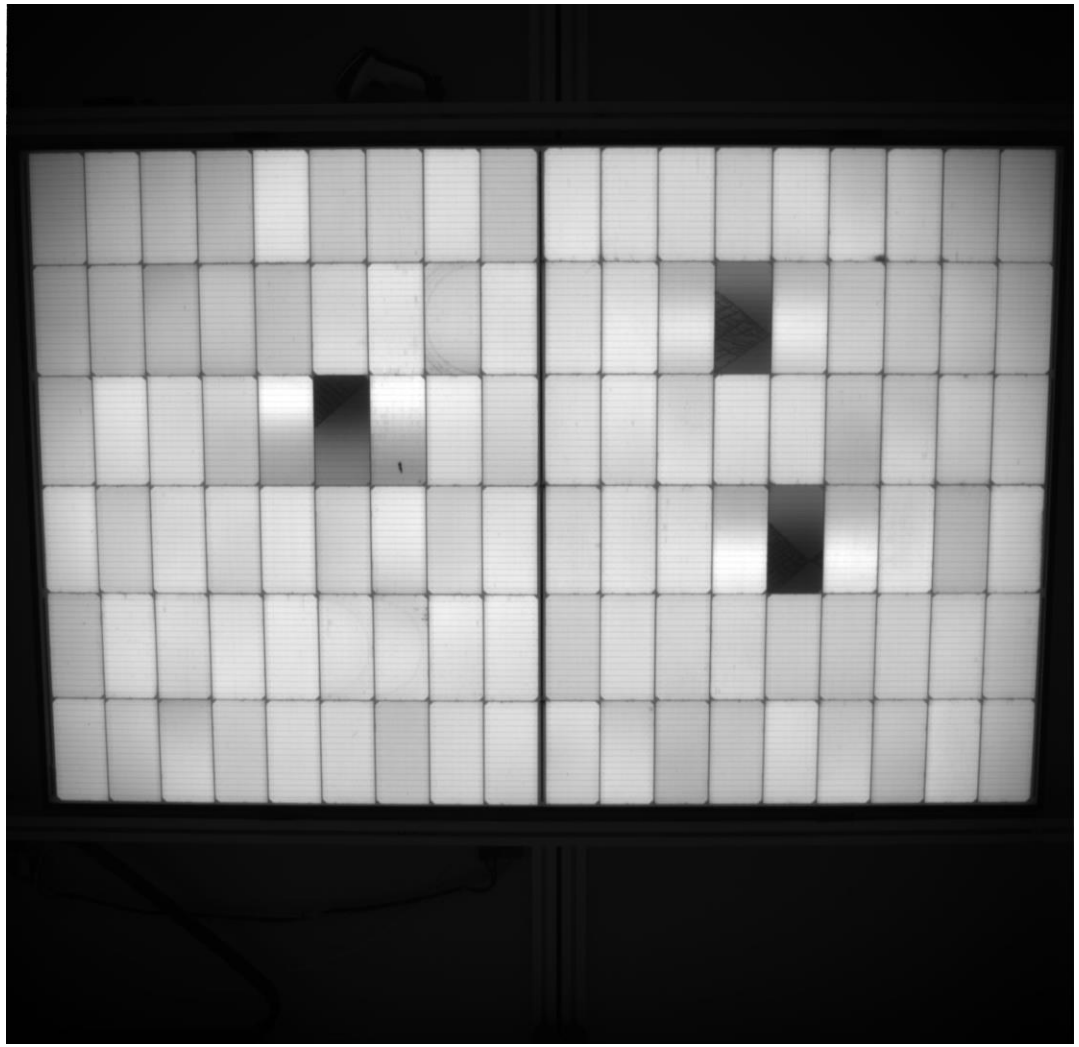
According to the IEC standard, only one test is required.

Our quality standards are unique!

Performance deviations

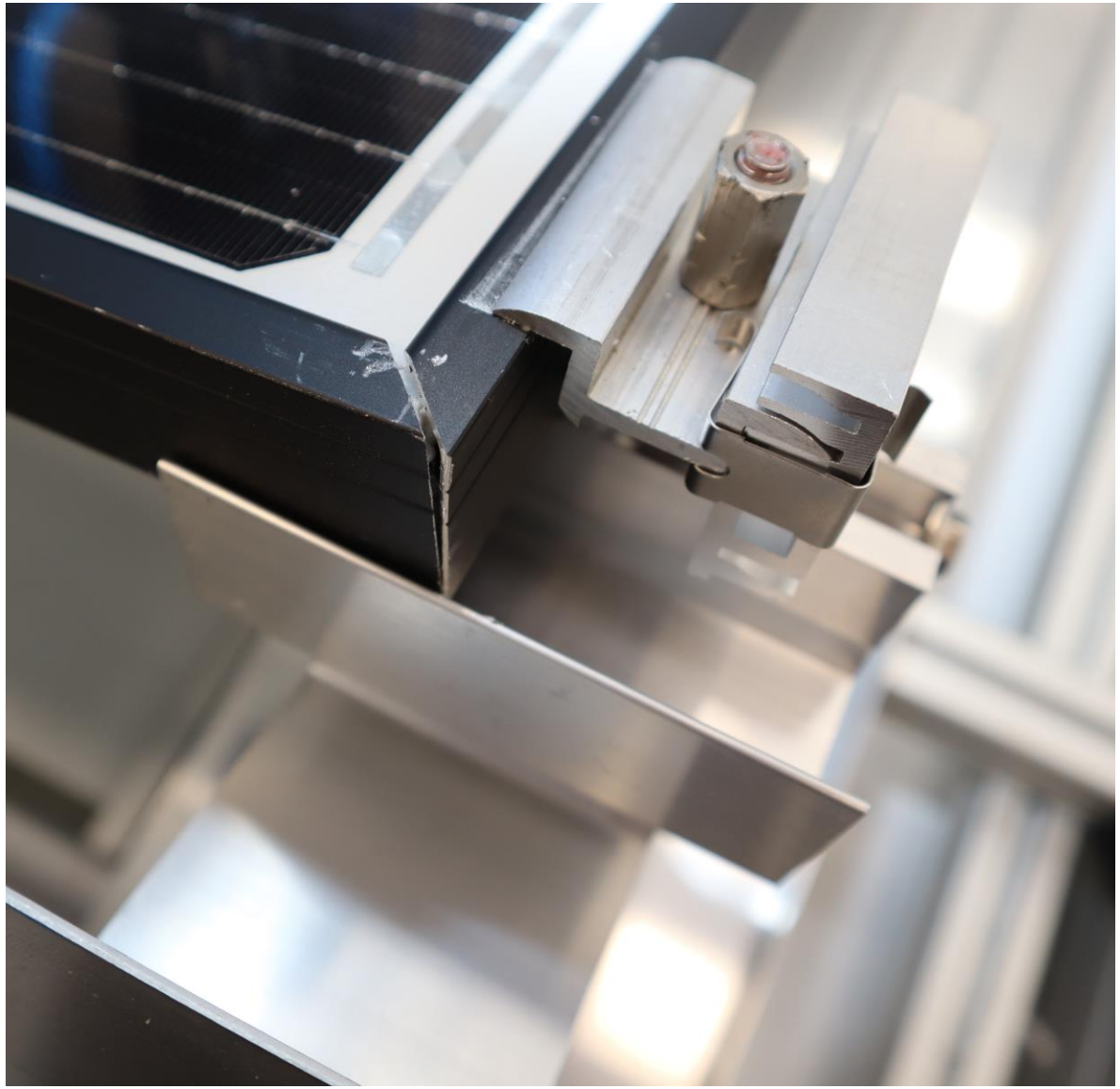
- Not acceptable for IBC SOLAR :
  - Inactive cells
  - Cell fractures and critical micro cracks which can lead to reduced performance or damage of the module
  - ≤ 3 % Maximum power loss
- IEC permitted up to 5 %

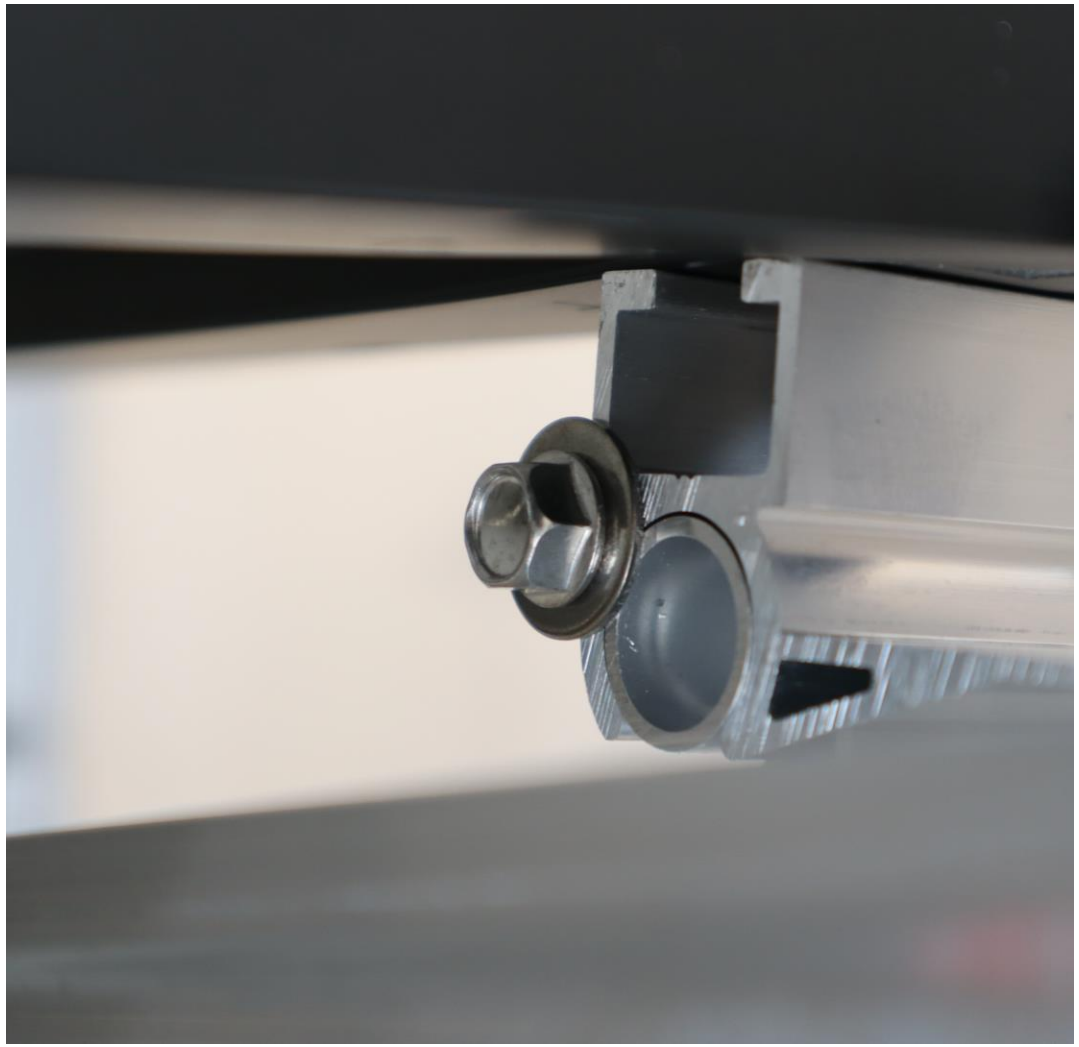


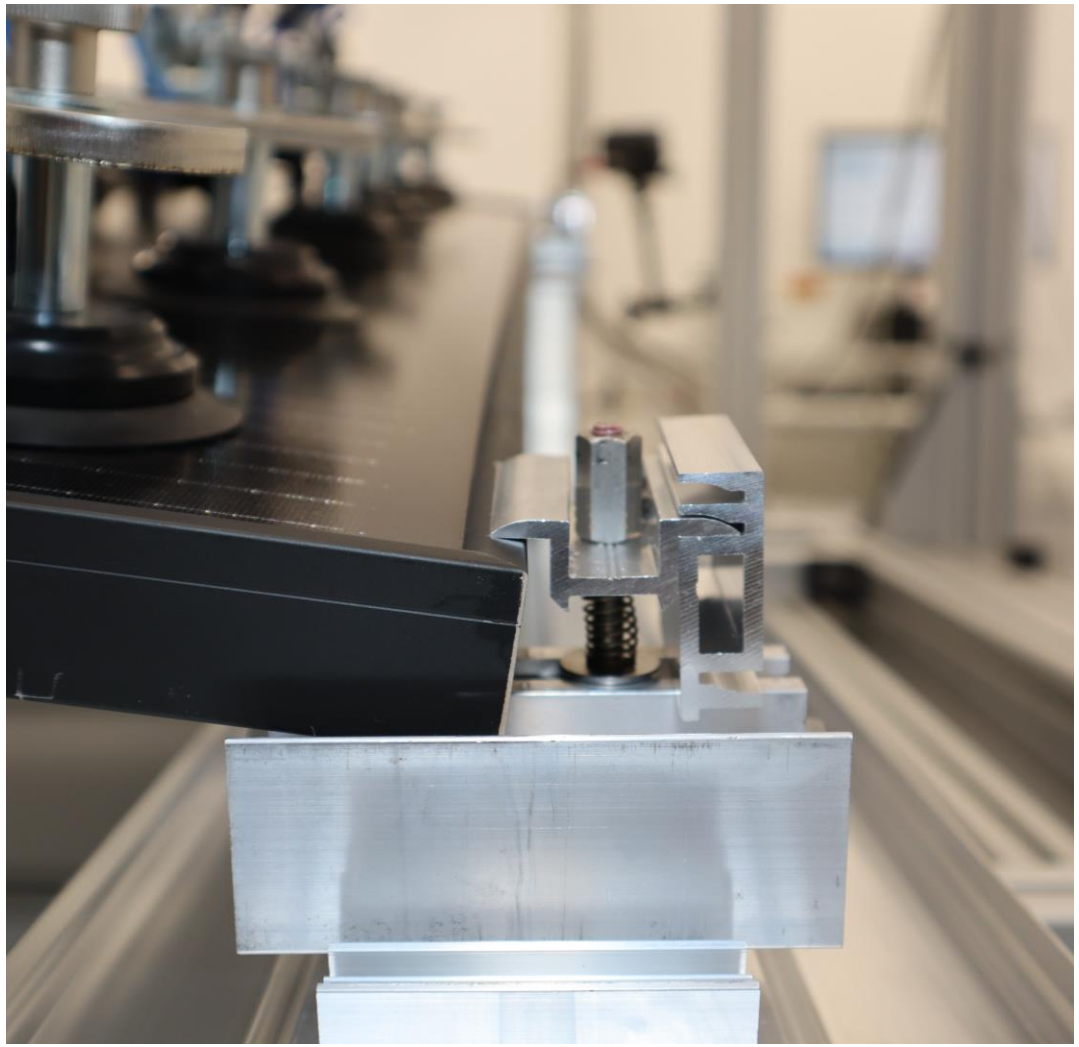


Optical deviations

- Not acceptable for IBC SOLAR :
  - Glass breakage
  - Mitre gap on the frame > 0,5 mm
  - Frame deformation
  - Damaged junction boxes
  - Failing the isolation tests
  - Residual clamping < 50 %
  - ≤ 69 mm max. deflection/movement



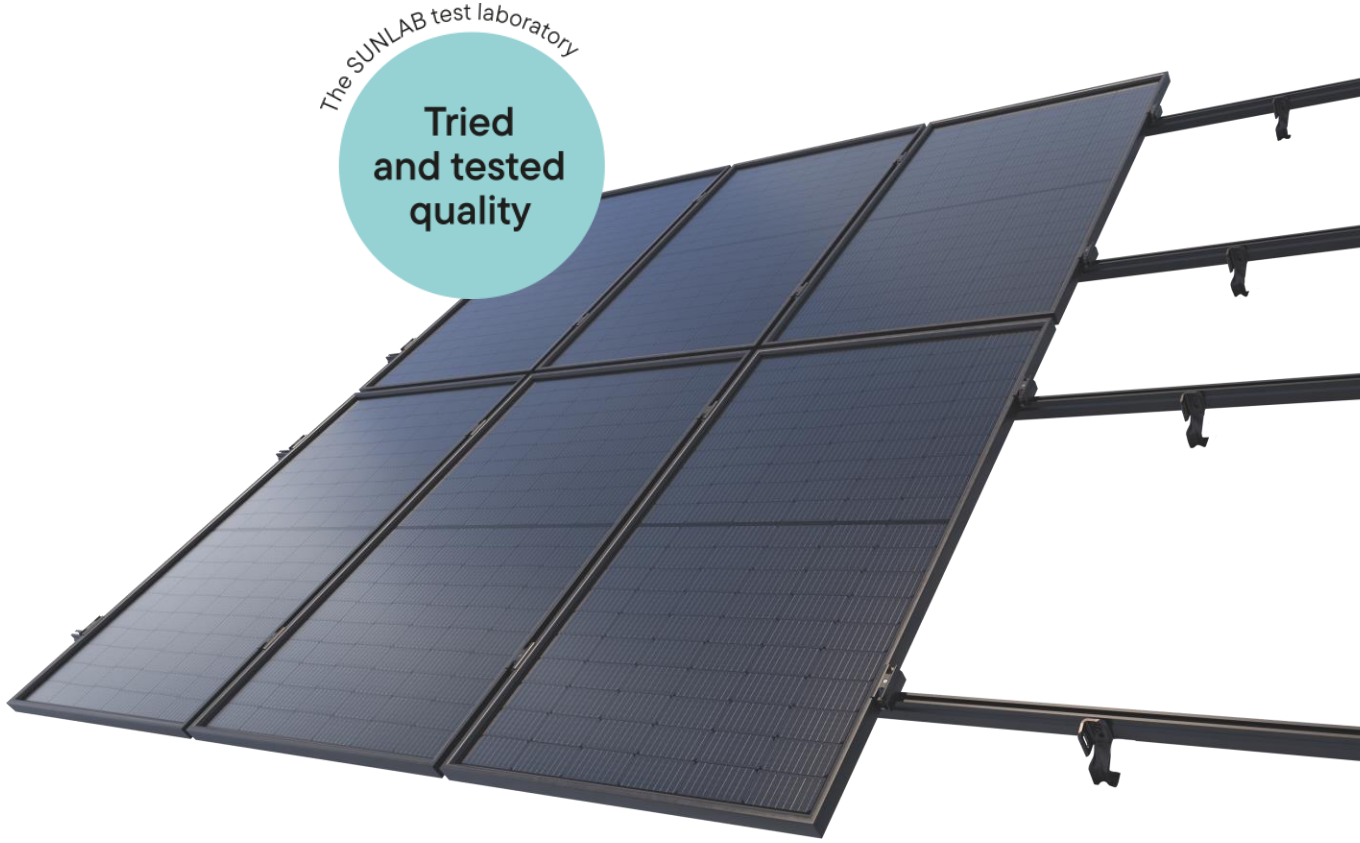




What we can guarantee!

No stress if things go that far.

- No loss of system performance due to permanent wind and snow load on the roof
- No premature ageing due to environmental influences
- No material fatigue



Do you have any questions?