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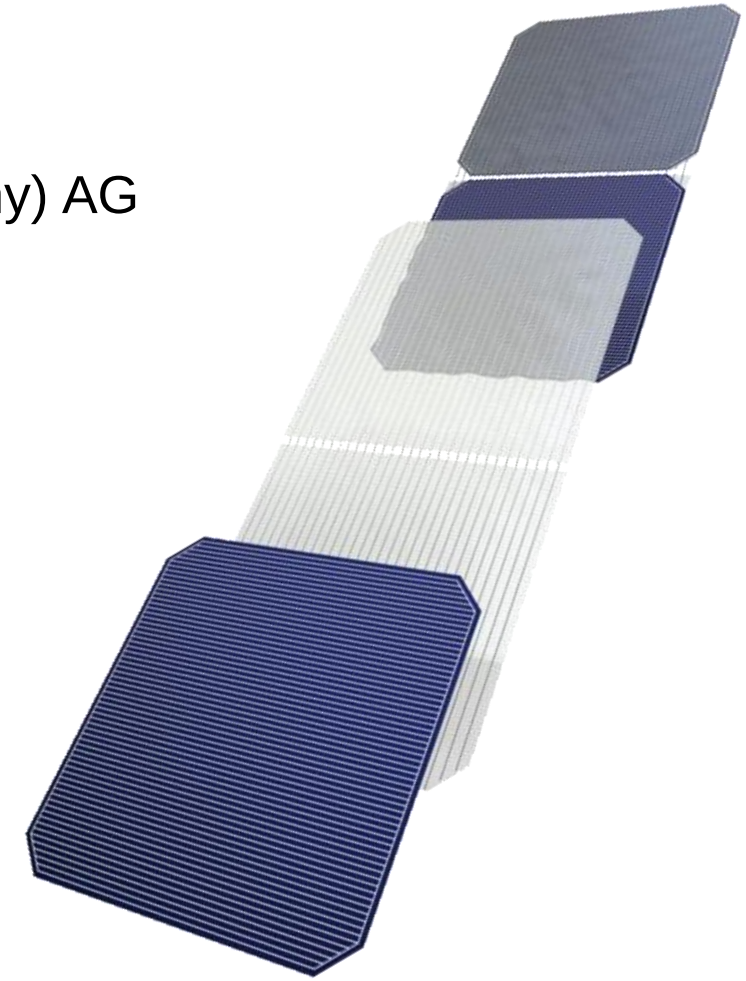
Heterojunction cells combined with smart wire bifacial modules

Andreas Waltinger, Benedicte Bonnet-Eymard, Heiko Mehlich, Jun Zhao

Overview

- New PV generation
- Pilot line of Meyer Burger (Germany) AG
- Busbarless Heterojunction cells
- Bifacial properties of HJT cells
- Module designs of MB
- Summary



The new PV generation

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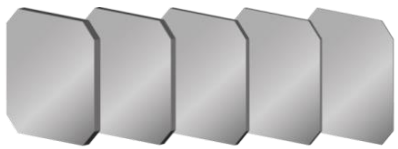
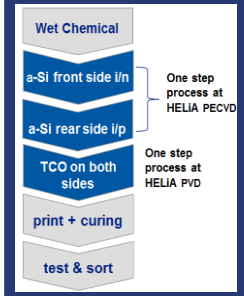
A Diamond Wire

Thinner wafer ➔ Lower costs

180 µm 160 µm 140 µm 120 µm 100 µm



Heterojunction (HJT)



High efficiency
- Lower system cost (BOS)
- Independent of wafer thickness

Only 6 process steps
- Low COO

Temperature coefficient
- Higher energy yield

Bifacial design
- Higher energy yield

C

D Adapted test metrology

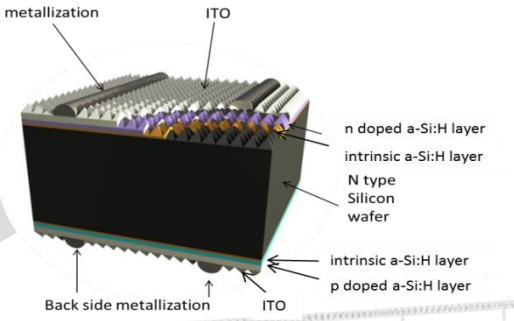
- High cap cells
- Busbarless cells
- DragonBack
- PED (Chipping)

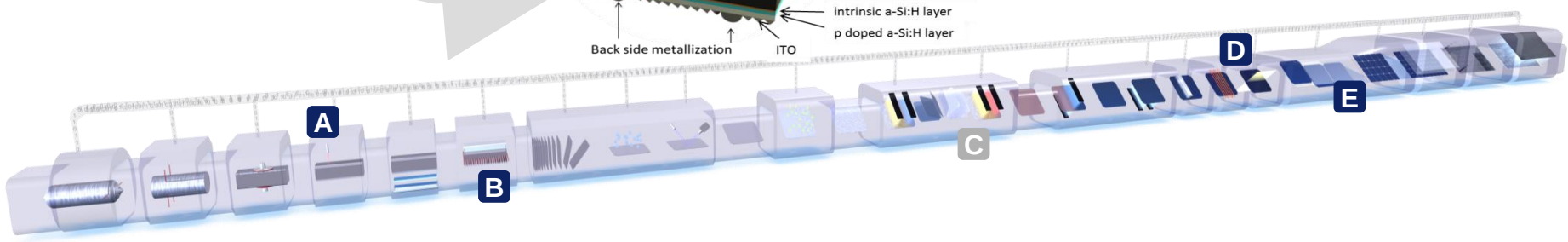
E SmartWire Connection (SWCT)

TCO layer and wafer thickness suitable for SmartWire
- 80% less silver
- Higher energy yield
- Higher efficiency
- Micro-crack resistant

B Single Wafer Tracking

Quality & performance control





Pilot Line Cell Process Hohenstein-Ernstthal

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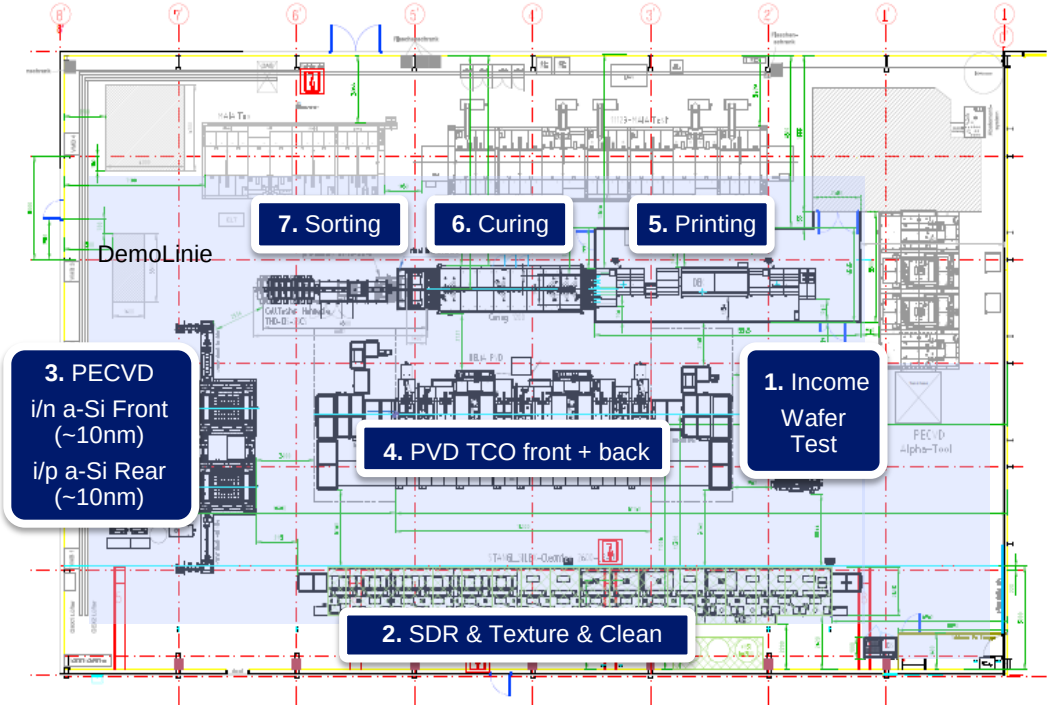
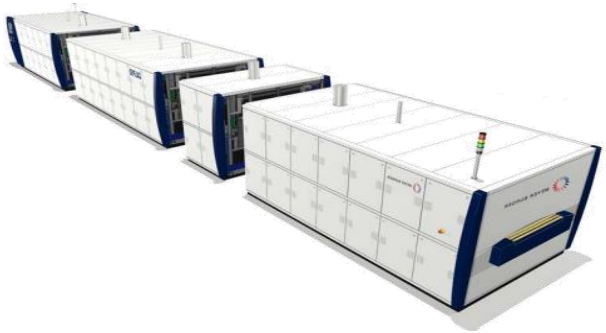


HELiA$_{PECVD}$

HELiA$_{PVD}$

- Pilot line with 15MW capacity was installed in Q1 2015
- Process Knowhow was transferred from the previous R&D line
- The key equipments HELiA PECVD and PVD as well as the Curing Furnace CALiPSO combined with Process Intelligence (Testing & MES) are from MB
- Other tools are from 3rd party vendors

Curing Furnace CALiPSO®



HJT Pilot Production Cell Line Performance

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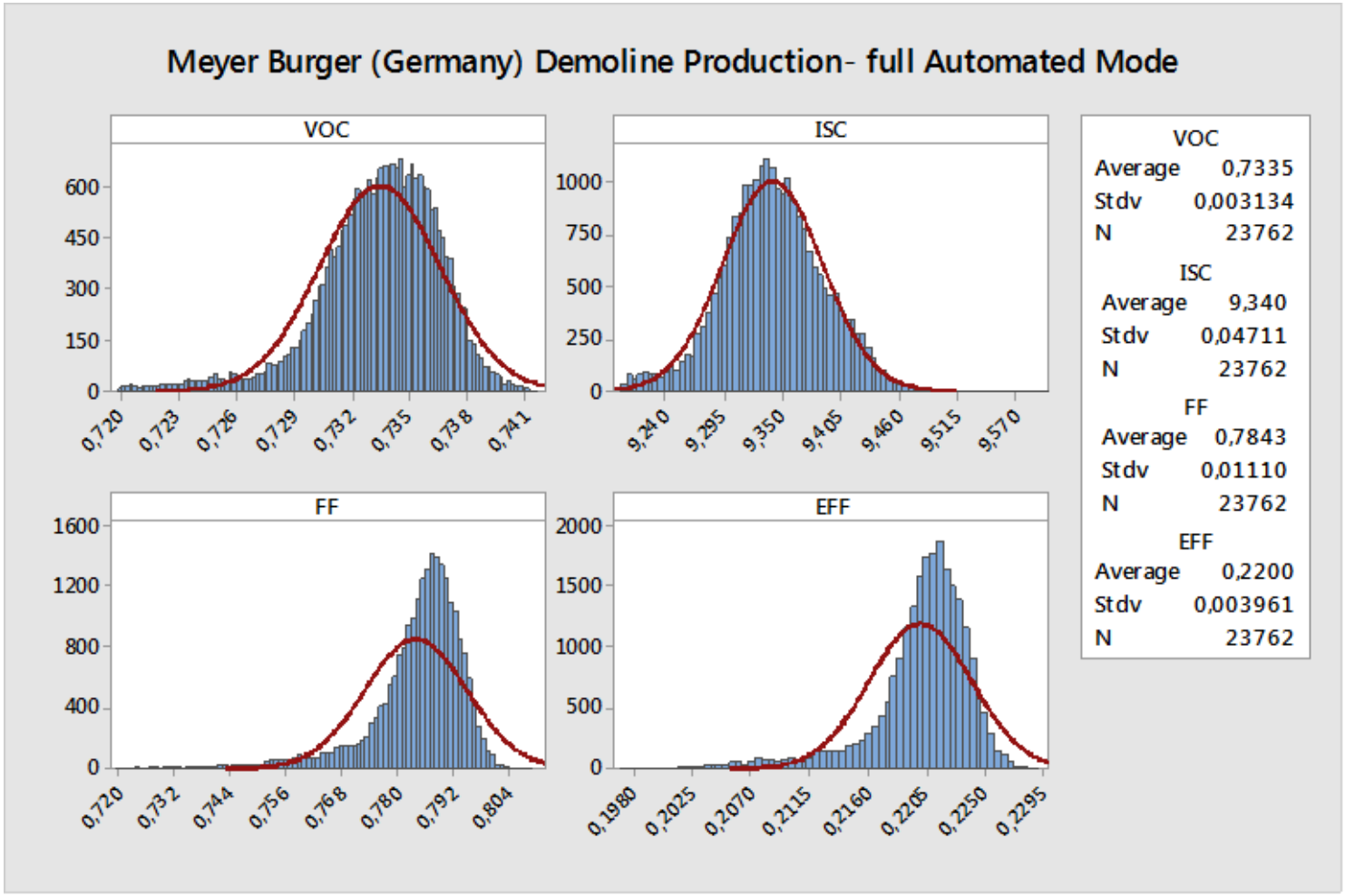
- Weekly production: ~25.000 cells, averaged efficiency 22%



Certified busbarless cells

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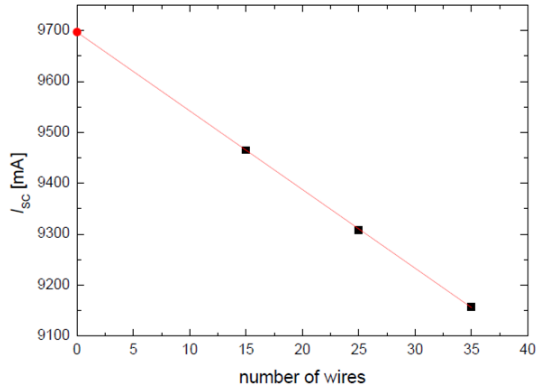
- GridTOUCH was establish at ISE Callab in 2016 in strong collaboration with the Meyer Burger Group
- Shading-free Isc extrapolation by different wire configurations → 15, 25, 35 wire



- Calibration reports for busbarless cells available now
- Bifacial contacting by black contact foil or bottom wires

22,9% confirmed for industrial HJT cell

Certificate from Fraunhofer ISE

4. Messergebnis

Measurement results

CalLab PV Cells

Mismatch-Faktor / *Mismatch factor* :	=	1.0089			
(Spektral-Korrektur / *spectral correction*)					
Fläche / Area (t)[1]:	=	(244.25	±	0.24	) cm²

[1] : *(t) = total area, (ap) = aperture area, (da) = designated illumination area /7/*

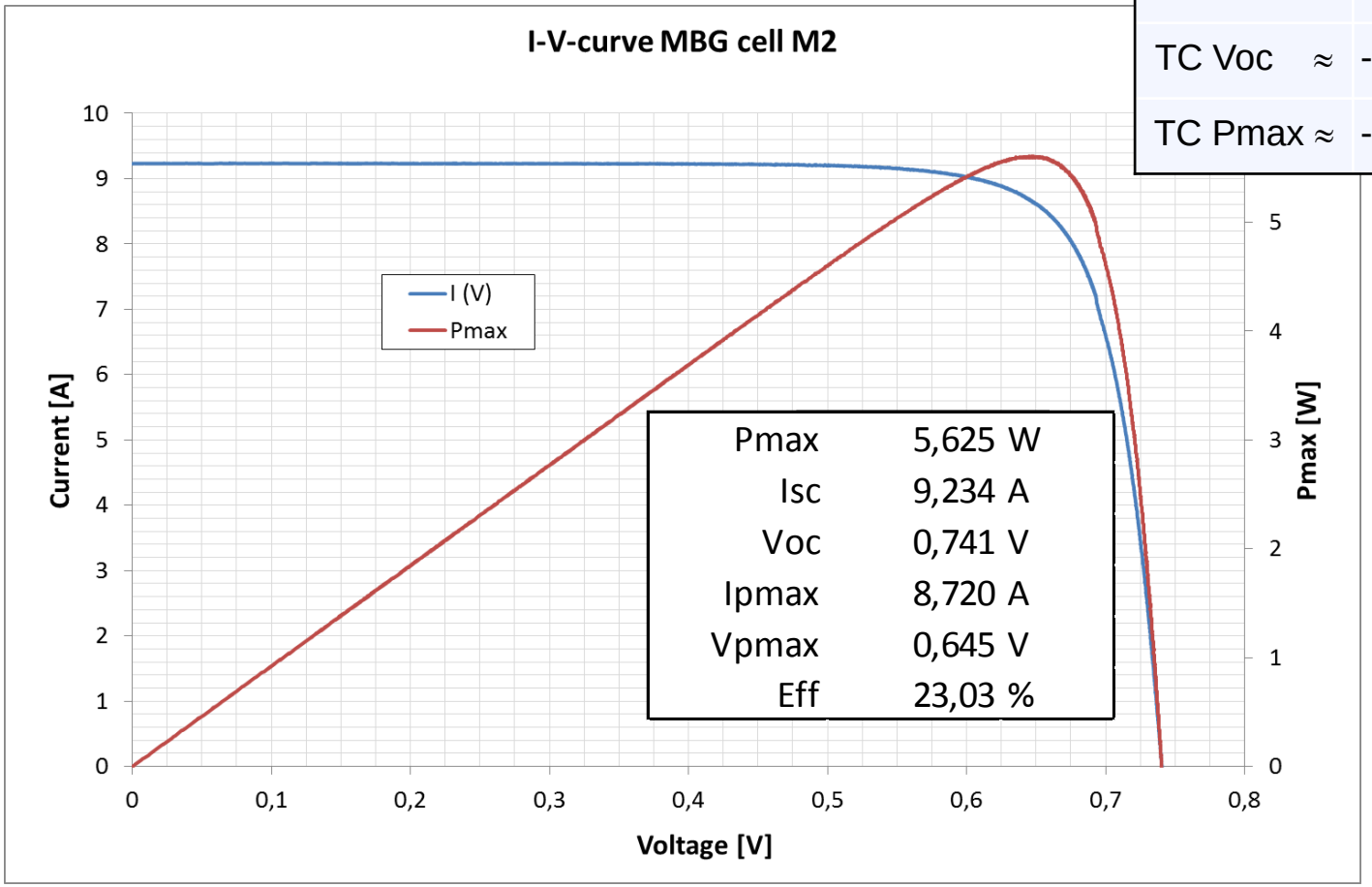
Kennlinienparameter des Messobjektes unter Standardtestbedingungen (STC) / *IV-curve parameter under Standard Testing Conditions (STC)* :

V_{OC}	=	(741.2	±	2.5	) mV
I_{SC} (Ed.2 - 2008)/3/	=	(9.24	±	0.18	) A
J_{SC}	=	(37.82	±	0.72	) mA/cm²
I_{MPP}	=	8.71			A
V_{MPP}	=	641.8			mV
P_{MPP}	=	(5.59	±	0.11	) W
FF	=	(81.62	±	0.53	) %
η	=	(22.88	±	0.46	) %

Cell properties

- Internal measurement shows 23,0% efficiency (22,9% confirmed independently)
- Excellent temperature coefficients

TC Isc	≈	+ 0.035 %/K
TC Voc	≈	- 0.241 %/K
TC Pmax	≈	- 0.239 %/K



Bifacial properties

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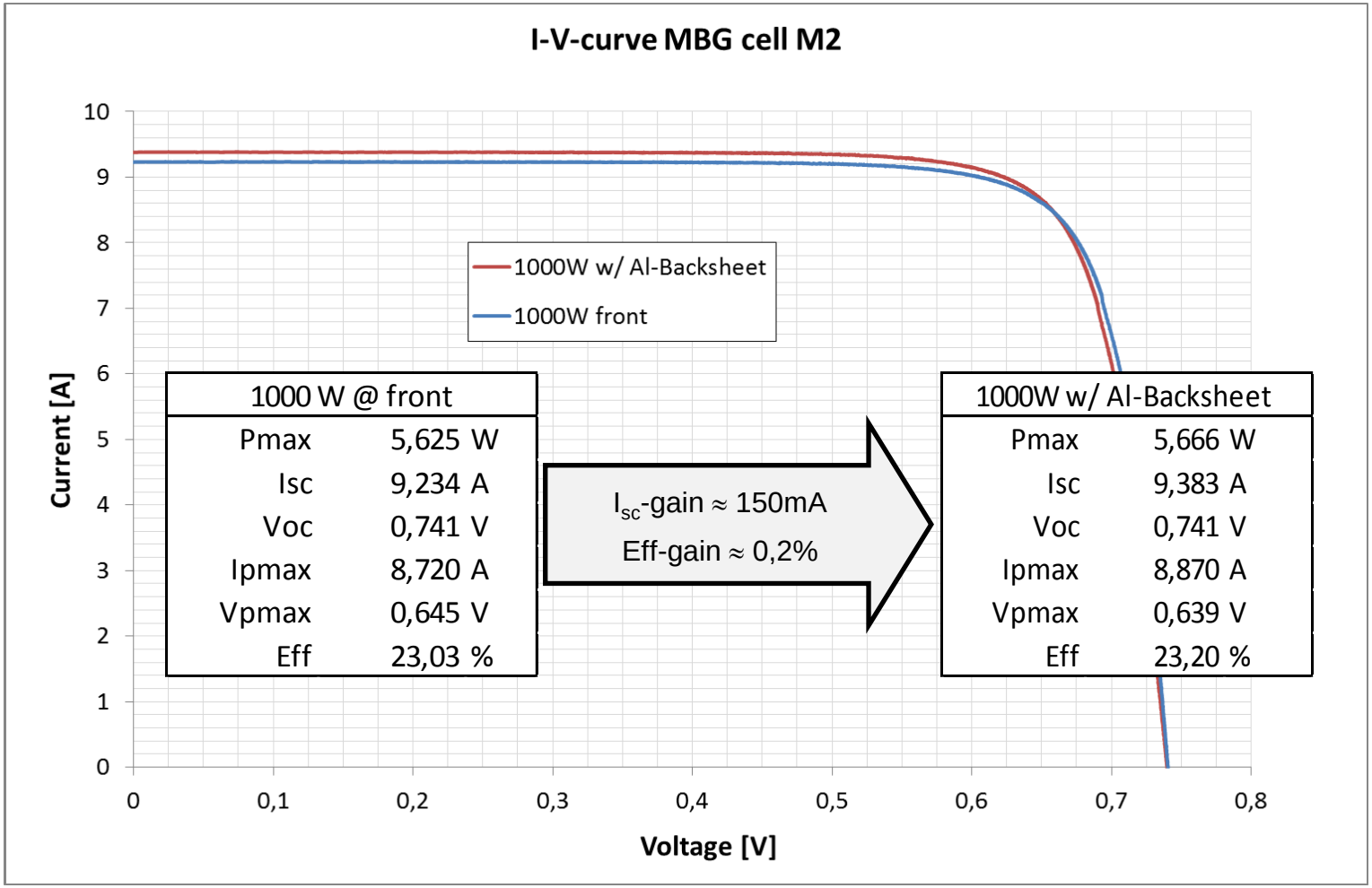
- What happens in a backsheet module?



Bifacial properties

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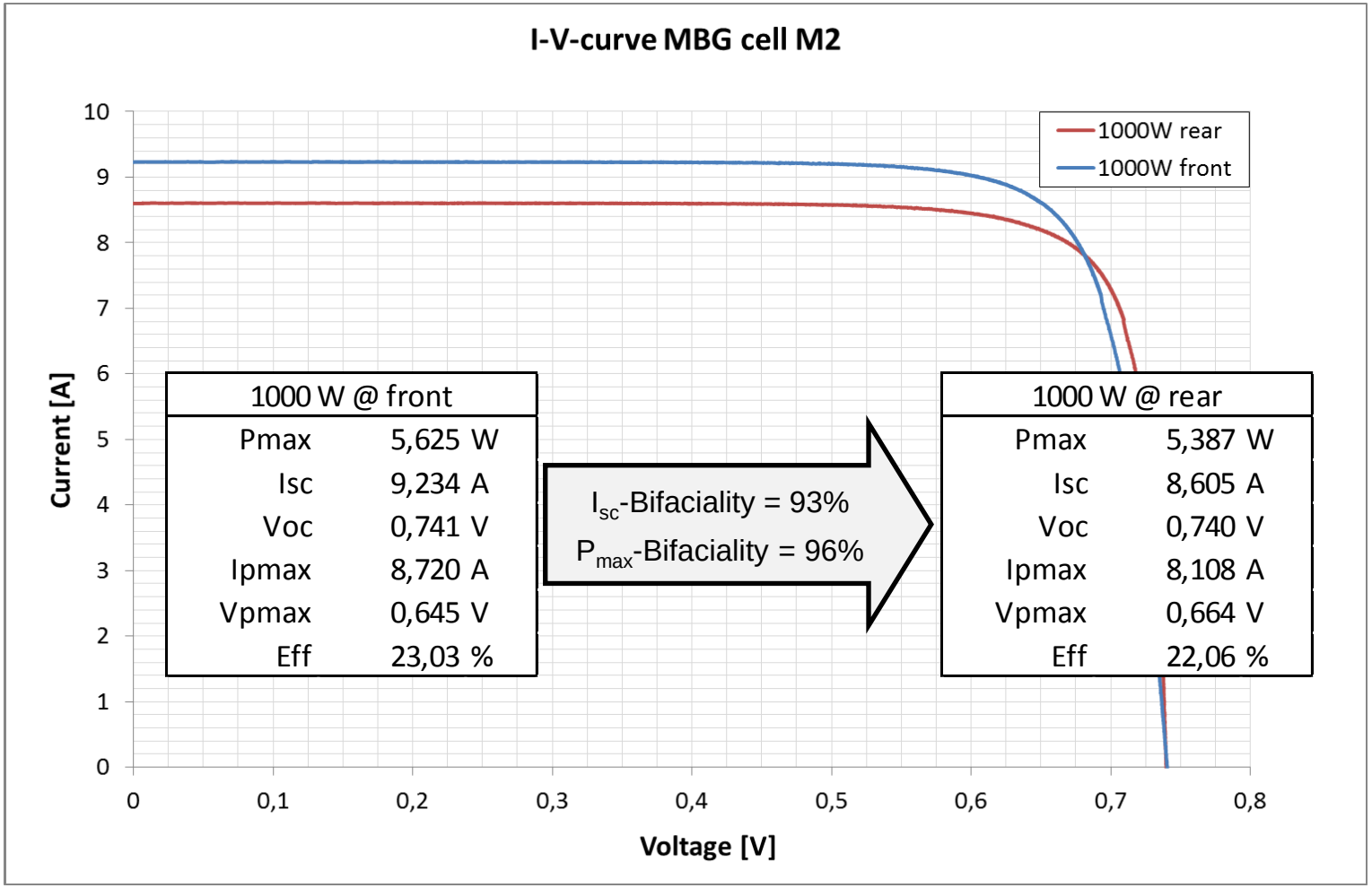
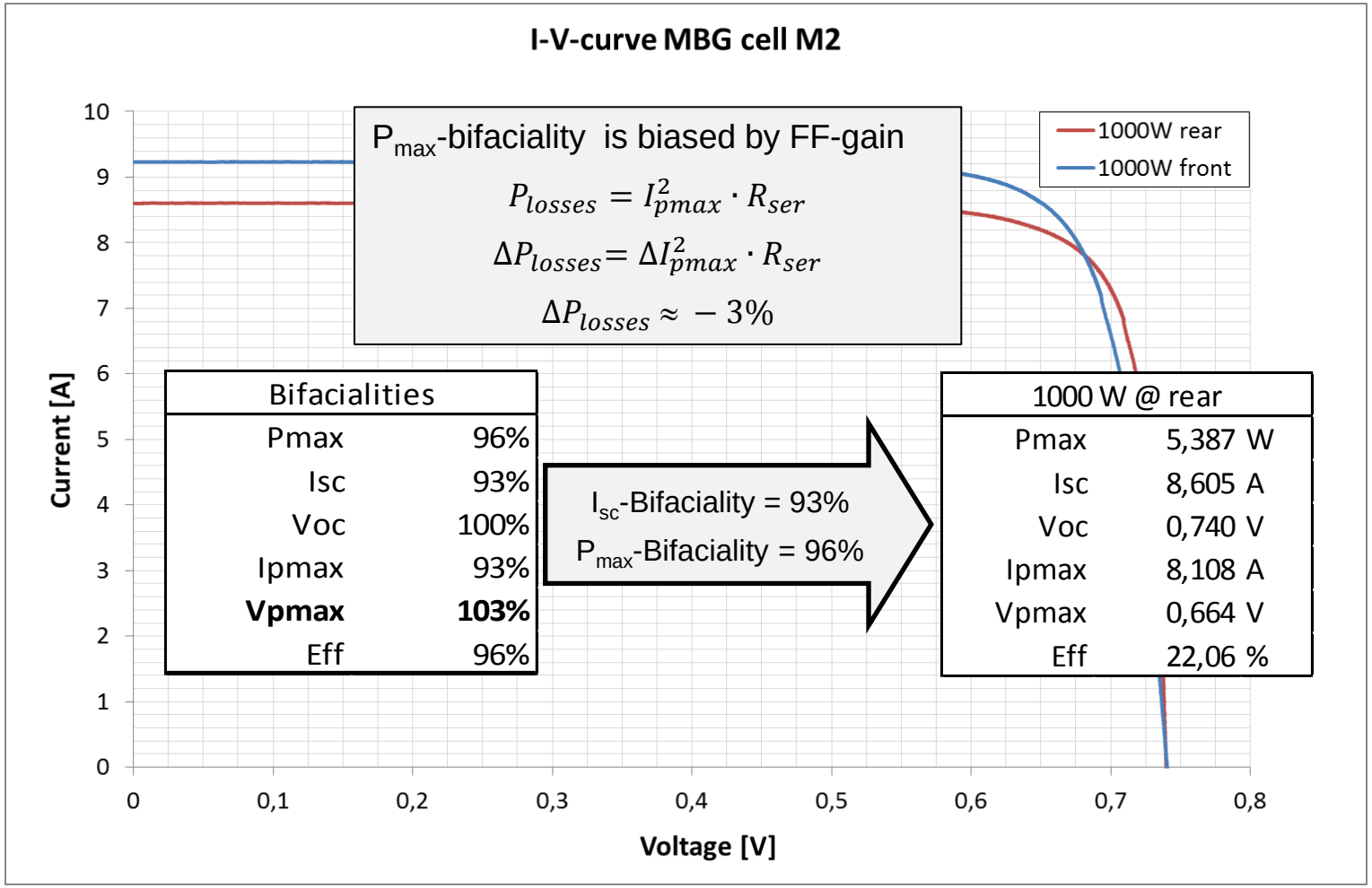
- What‘s about bifaciality factors?



Bifacial properties

- P_{max}-bifaciality is a function of I_{Pmax}-bifaciality and R_{ser}



Bifacial properties

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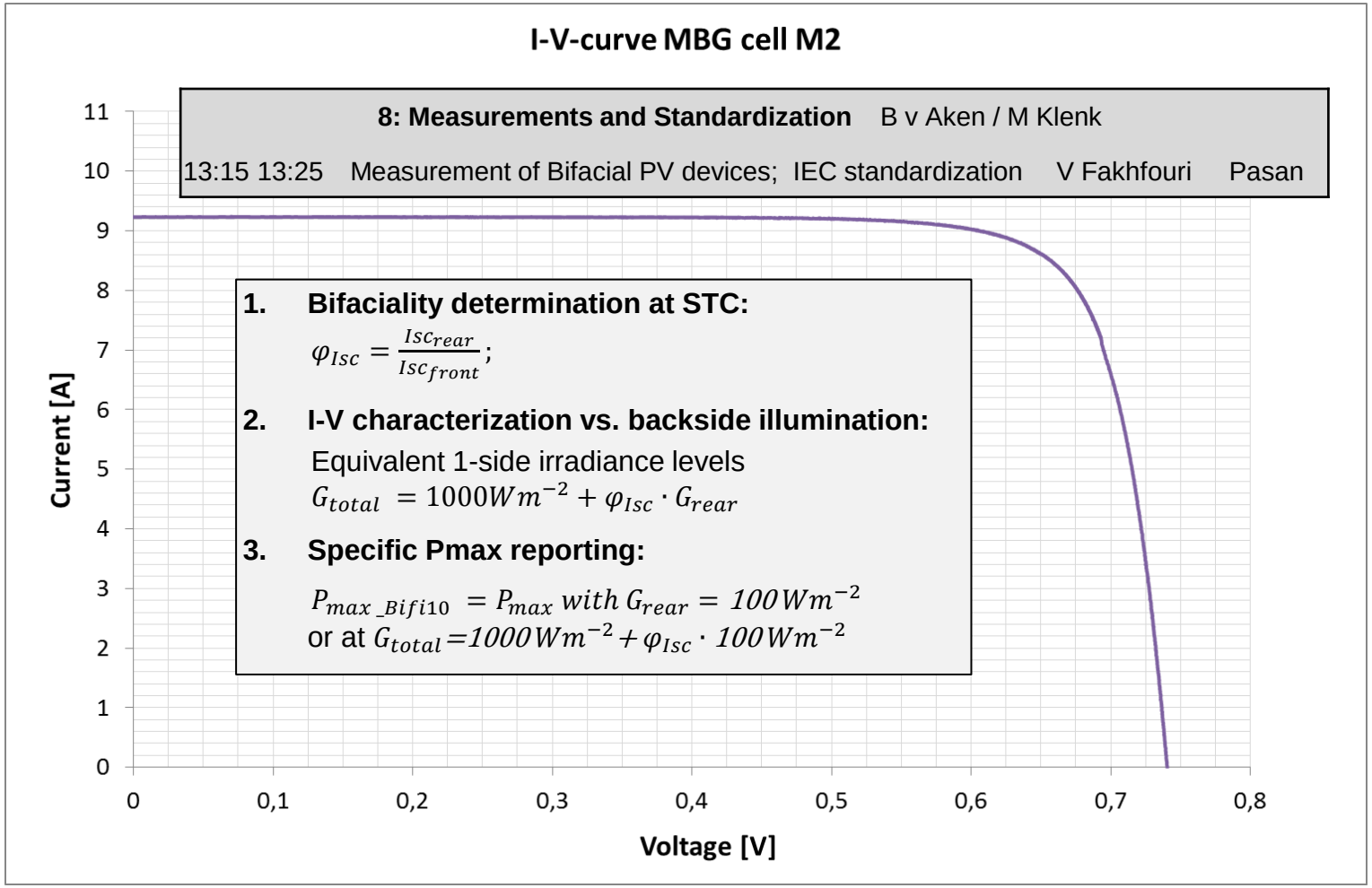
- Equivalent irradiance method according Pasan for Albedo factors of 10% and 20%



Bifacial properties

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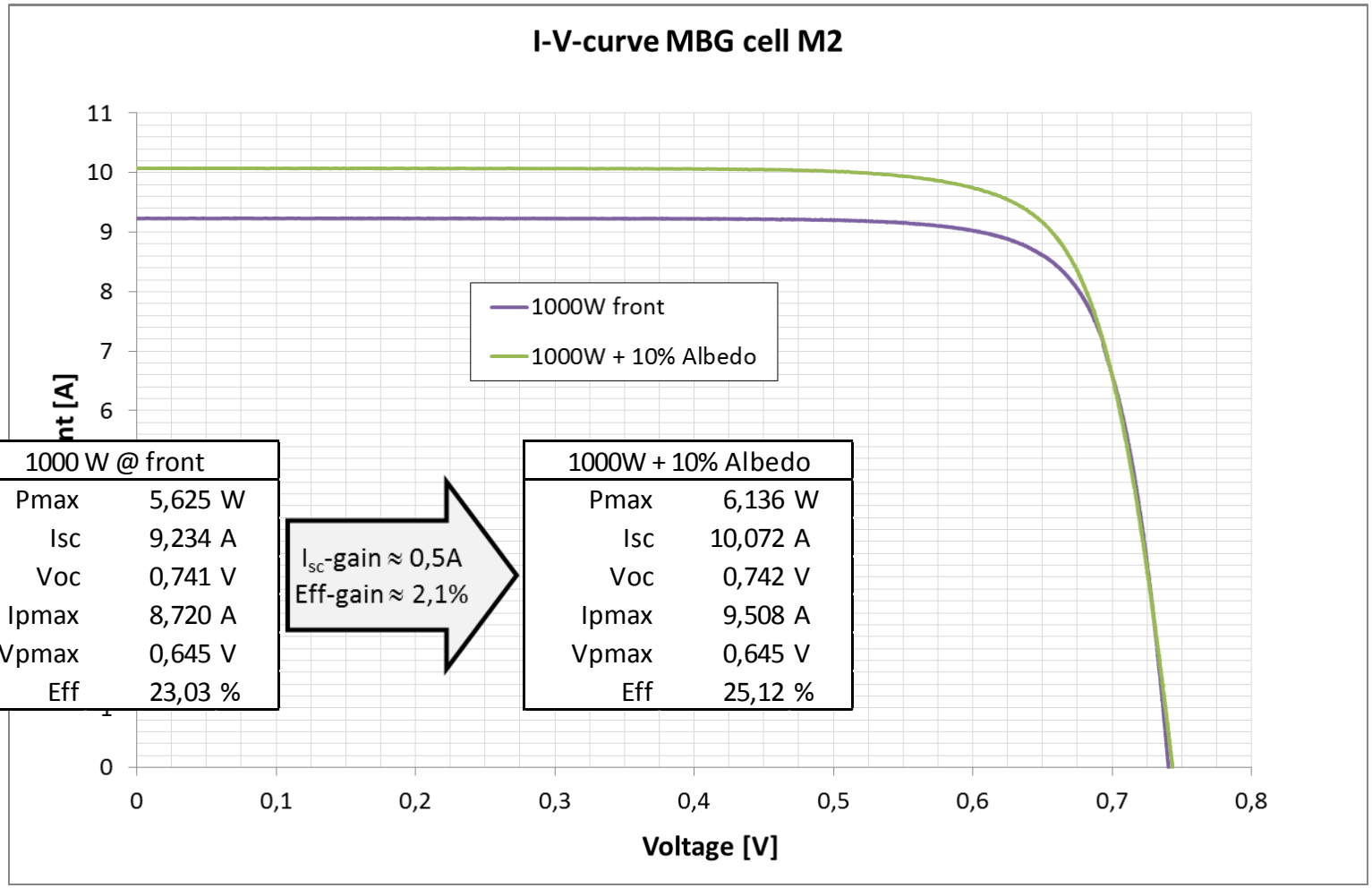

1000 W @ front	
Pmax	5,625 W
Isc	9,234 A
Voc	0,741 V
Ipmax	8,720 A
Vpmax	0,645 V
Eff	23,03 %

I_{sc}-gain ≈ 0,5A
Eff-gain ≈ 2,1%

1000W + 10% Albedo	
Pmax	6,136 W
Isc	10,072 A
Voc	0,742 V
Ipmax	9,508 A
Vpmax	0,645 V
Eff	25,12 %

Bifacial properties

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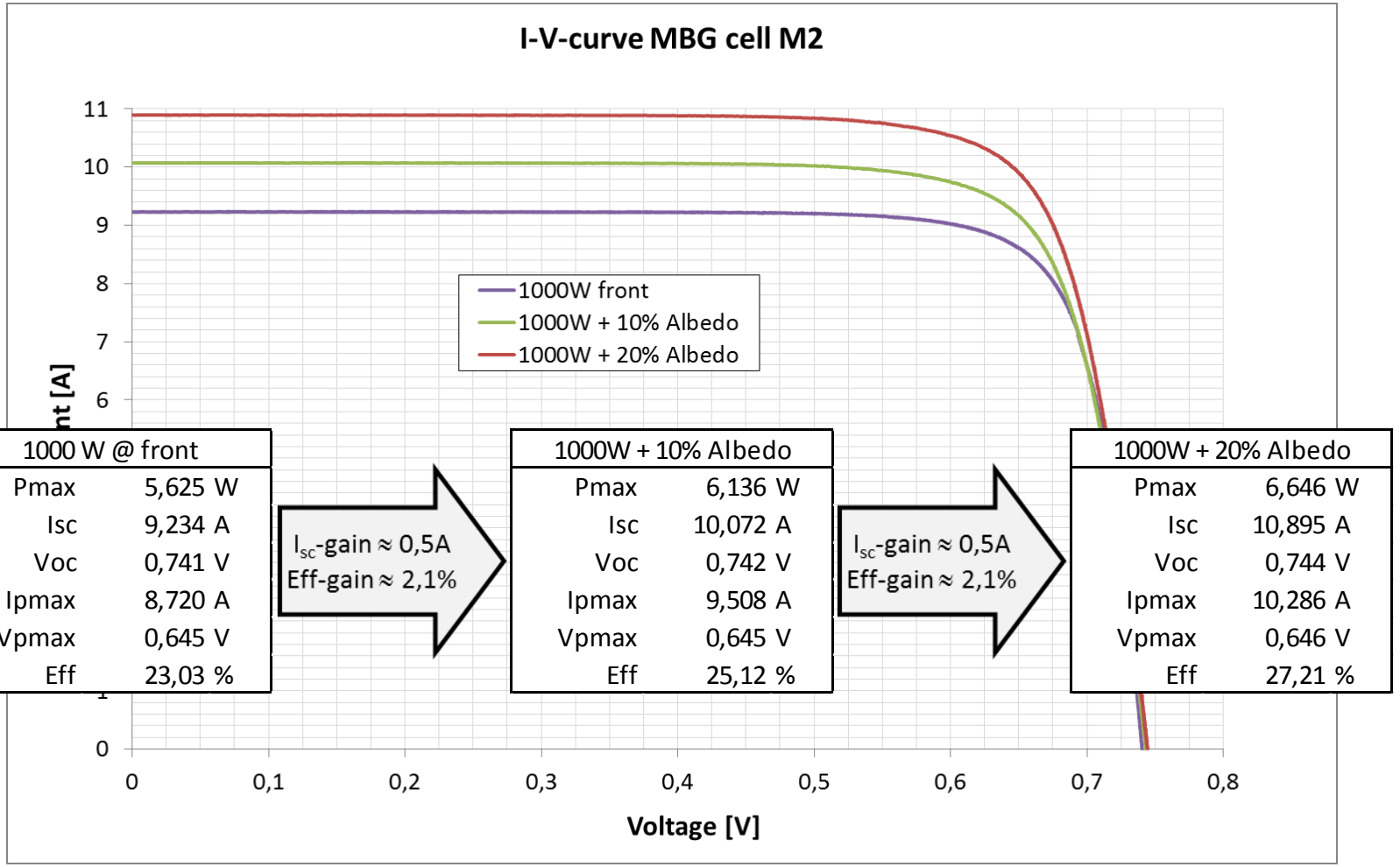
- $Pmax_{Bifi10}$ = 6,136W and $Pmax_{Bifi20}$ = 6,646W (illuminated with 1093W &1186W)



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I_{sc}-gain ≈ 0,5A
Eff-gain ≈ 2,1%

1000W + 20% Albedo	
Pmax	6,646 W
Isc	10,895 A
Voc	0,744 V
Ipmax	10,286 A
Vpmax	0,646 V
Eff	27,21 %

Module designs of MB

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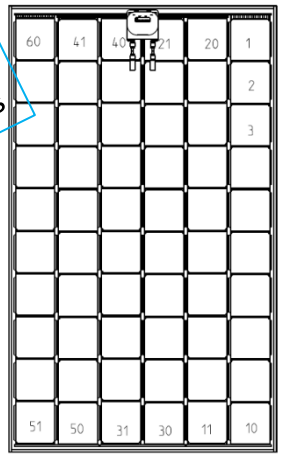
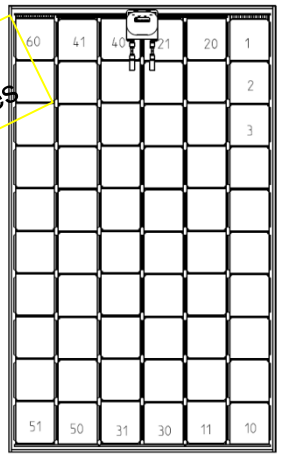
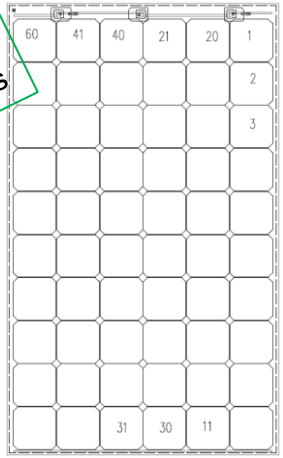
Glass-Glass modules with bifacial HJT cells and SWCT

Designs	Abalone SmartWire (BOM: 10127096)	Abalone SmartWire white (BOM: 10127097)	Abalone SmartWire optimal (BOM: 10127098)
	~400 modules 	~50 modules 	~50 modules 
Specificity	- Centralized jbox (Tyco) - Transparent back glass	- Centralized jbox (Tyco) - **White** back glass	- **Decentralized** jbox (Renhe) - Transparent back glass
Advantages	- Easy to produce on the wave line - Bifacial module	- Easy to produce on the wave line - No jbox shading - Not dependant on rear side illumination	- Low jbox shadowing (6 cells covered by less than 1%) - Jbox half the price than Tyco's - 3 holes (instead of 4) - Bifacial module
Disadvantages	- Jbox shadowing (2 cells over 20% covered) - Mounting stage shadowing	- Rear illumination not collected	- Manual mounting of the jboxes - Mounting stage shadowing

* All glass size: 1656 x 991

Bifacial glass-glass modules

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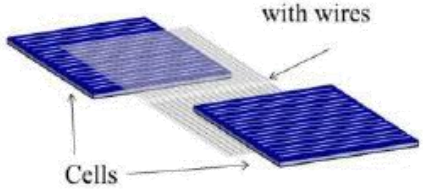
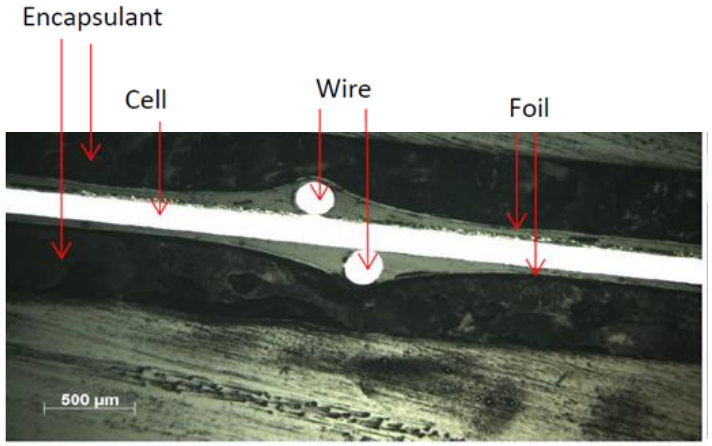
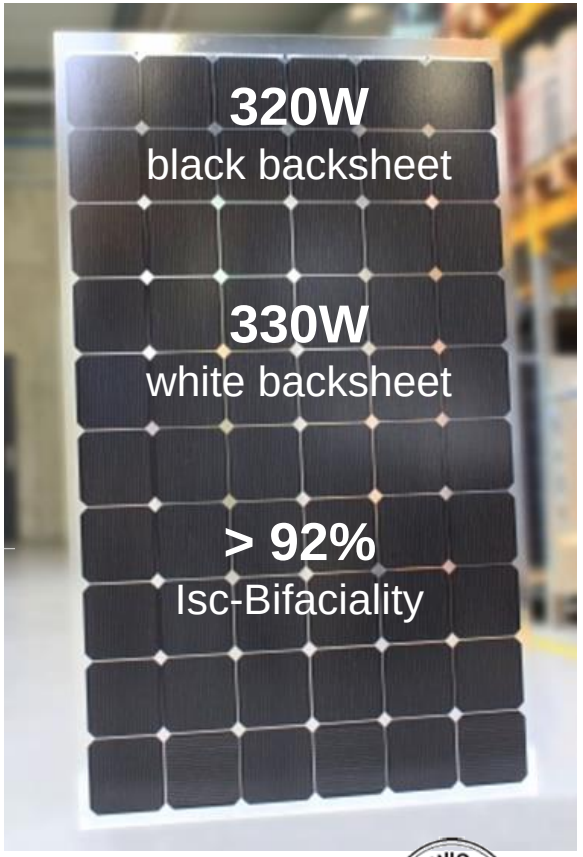
SmartWire



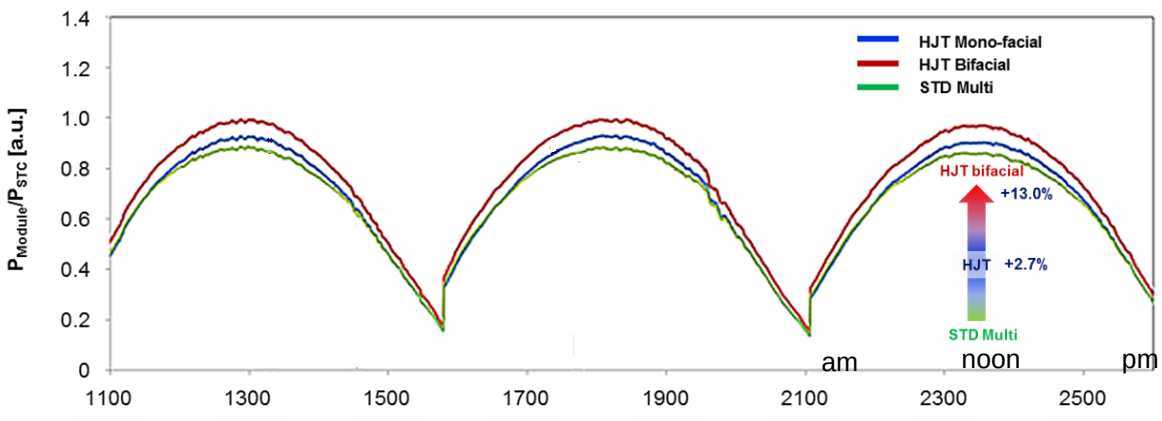


Record modules



Outdoor data

Example: Outdoor data from SUPSI (Switzerland) for March 2014 (max. module temp. 40°C)



SUPSI

SWISS TESTING
STS 531

Summary

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- Meyer Burger enforces the **New PV generation** by optimizing modules across the entire value chain **on mass production level**. Machine and technology developments go hand in hand (Wafering – Cell – Module).
- Almost **500.000 HJT bifacial cells** were produced since 2015. Mean **efficiency** is **higher than 22%**.
- **Busbarless** cells are **measurable correctly** by calibrated reference cells (calibraion measurements are available for 15, 25 and 35 wires).
- Heterojunction cells are very applicable for bifacial designs due to their symmetric architecture. A **J_{sc}-bifaciality of 93%** has been achieved.
- Equivalent irradiance method shows potential of **27% cell efficiency for 20% Albedo.**
- SWCT-glass-glass modules can be optimized for several application:
  → **white back** glass or **transparent back glass with decentralized J-box**
- **Outdoor** tests show **higher energy yield** (+13%) than other cell technologies

MEYER BURGER

Meyer Burger Germany
An der Baumschule 6-8
09337 Hohenstein-Ernstthal
Germany

Phone: +49 (0) 3723 671 - 2959
Fax: +49 (0) 3723 671 – 1000
Email:
jun.zhao@meyerburger.com

Thank you!