Webinar
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DSM Advanced Solar

24 September 2020

4 pm – 5 pm | CEST, Berlin
3 pm – 4 pm | BST, London
7 am – 8 am | PDT, Los Angeles
10 am – 11 am | EDT, New York

pv magazine webinars

Back-contact's move to the front

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Introduction to back-contact cell / module technology and DSM Conductive backsheets

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pv magazine webinar | Back-Contact's Move to the Front

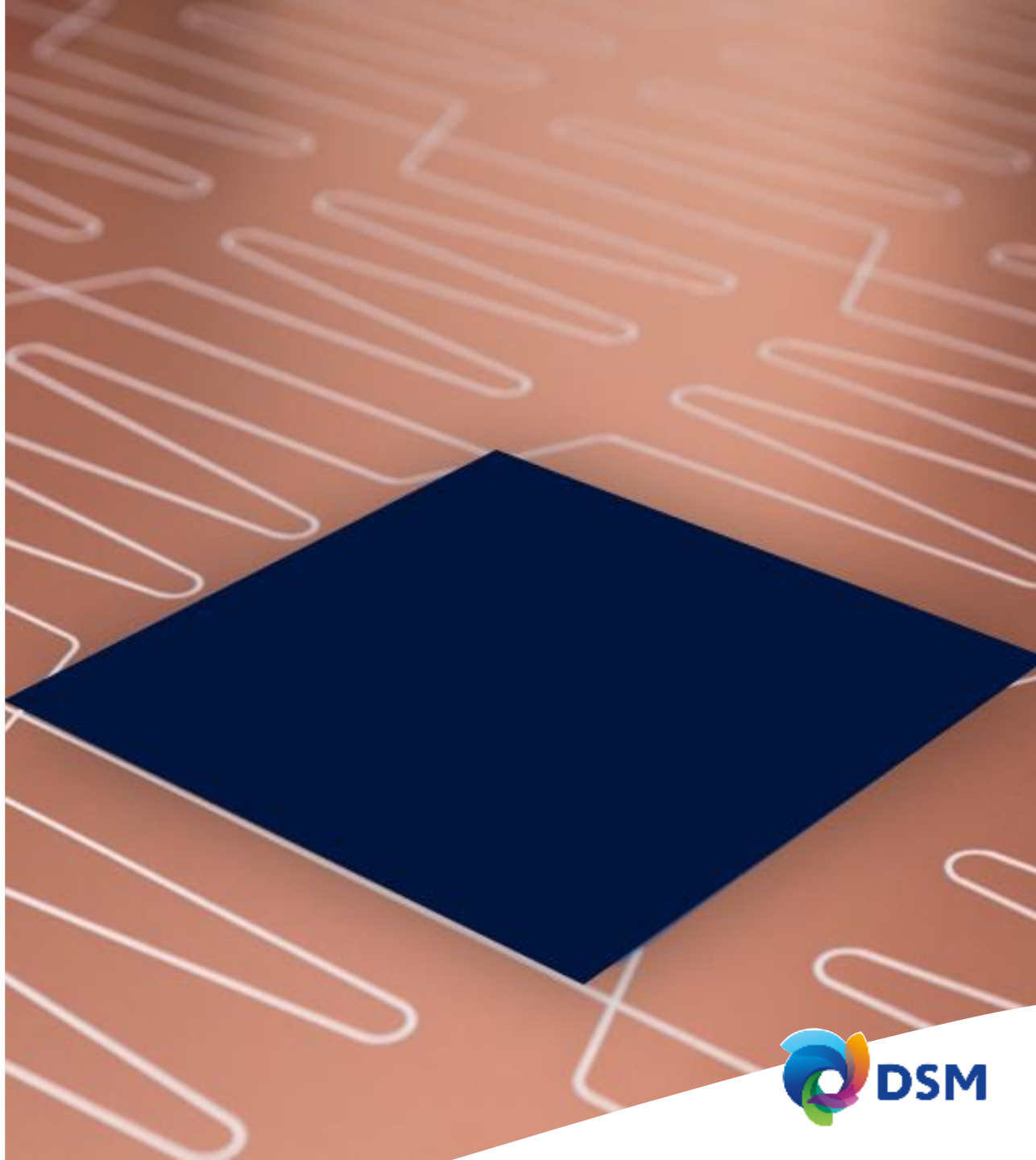
September 24, 2020

DSM

BRIGHT SCIENCE. BRIGHTER LIVING.

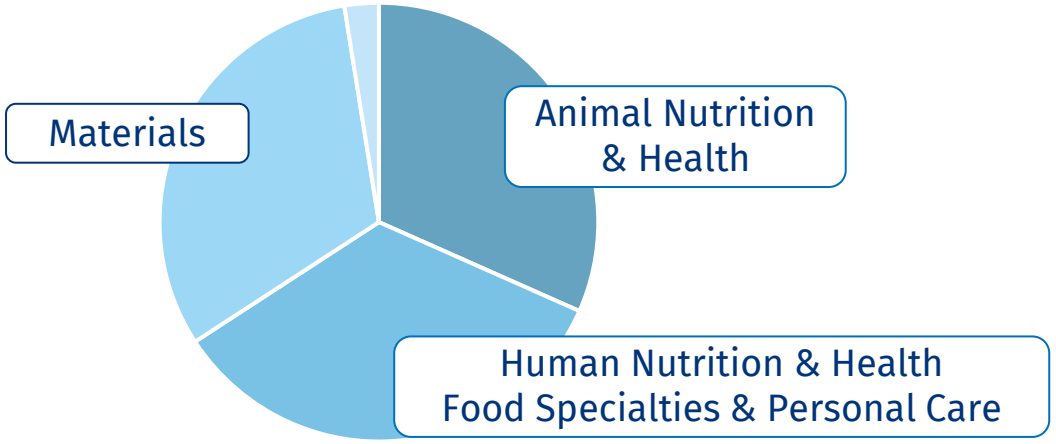
Outline

1. DSM in Solar
2. Introduction Back-contacted (BC) technologies
3. Market applications and trends
4. DSM Conductive backsheet (CBS) technology
5. Use case CBS vs other cell interconnection technologies



Royal DSM: A company with a purpose

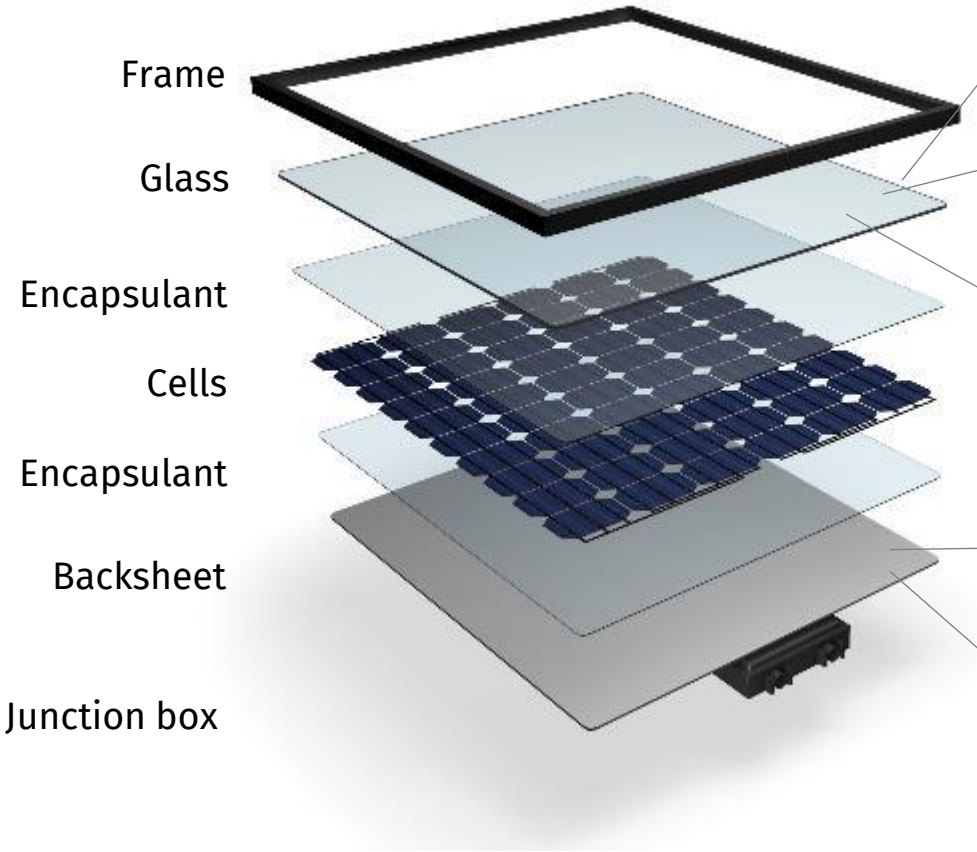
- Global workforce ~22,000 employees
- Sales ~€9.0bn
- EBITDA ~€1,7bn
- 50% purchased electricity from renewable sources
- Global company with 66% of sales outside Europe



Sales

Workforce

DSM solutions are lowering the cost of solar power



DSM Anti-Reflective coating
Crystal-clear light transmission for a 3% performance boost

DSM Retrofit Anti-Reflective coating
Retrofit your PV plant and get a power boost of up to 3%

DSM Anti-Soiling coating
Boost the IRR of your solar projects

DSM Endurance backsheets
Reliable solar performance in extreme environments

DSM Conductive backsheets
For back-contact high power modules

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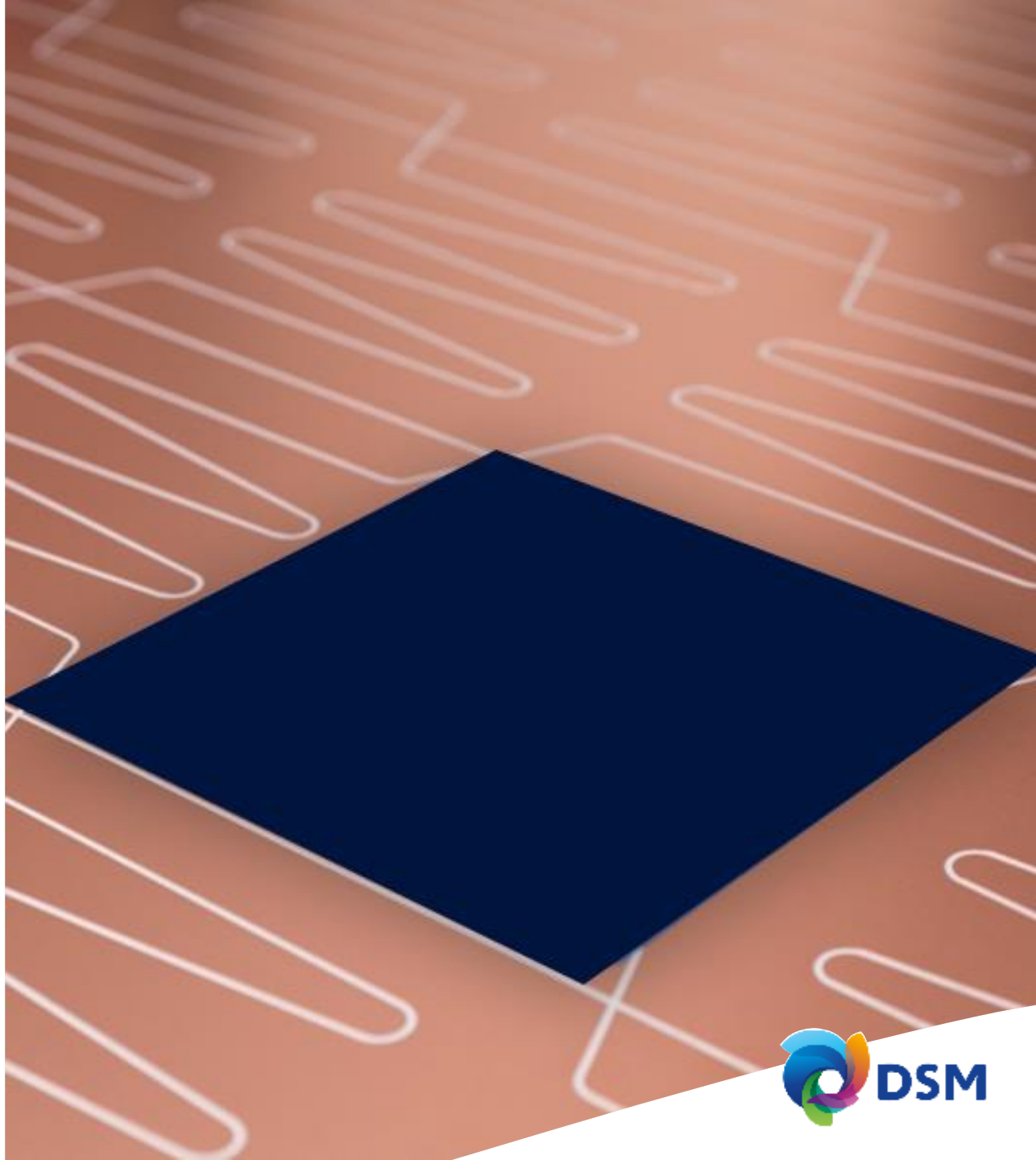
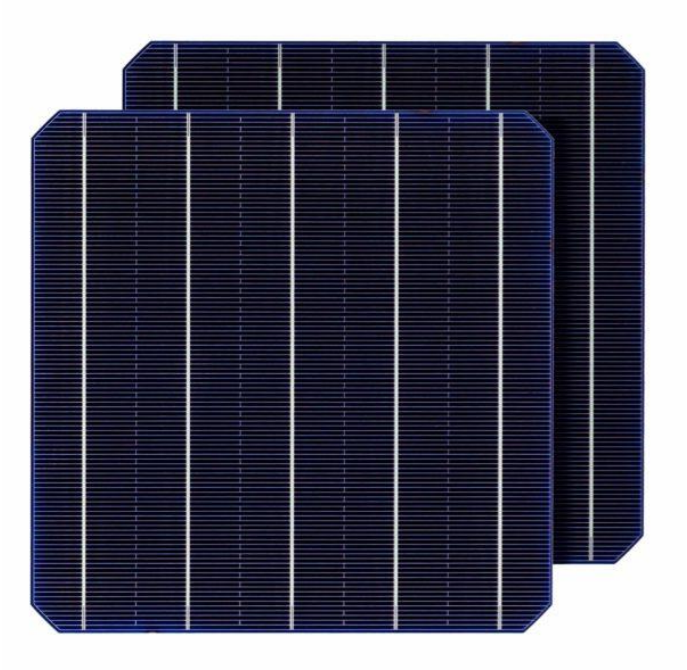


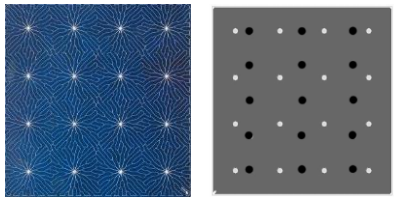
Back-contact (BC) cell technologies: Metal Wrap Through (MWT) and Interdigitated Back Contact (IBC)

Standard cell

CELL FRONT-SIDE CELL BACK-SIDE

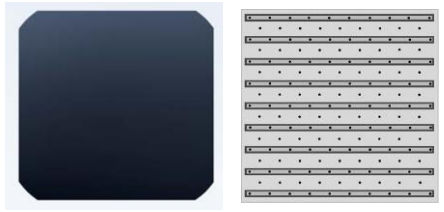


MWT cell

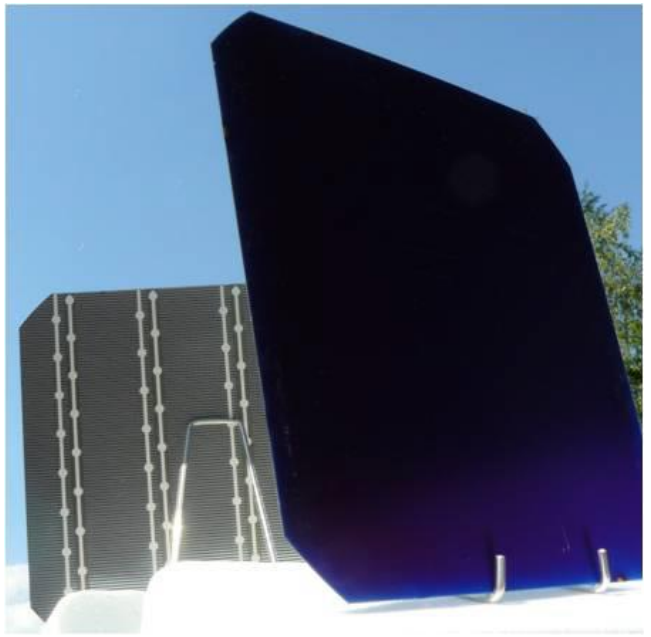


CELL FRONT-SIDE CELL BACK-SIDE

IBC cell

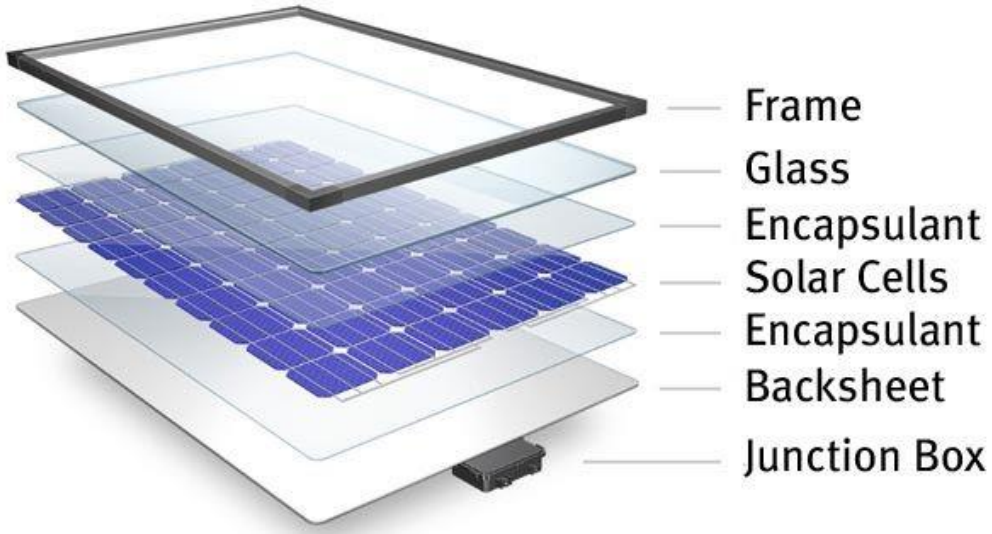


CELL FRONT-SIDE CELL BACK-SIDE

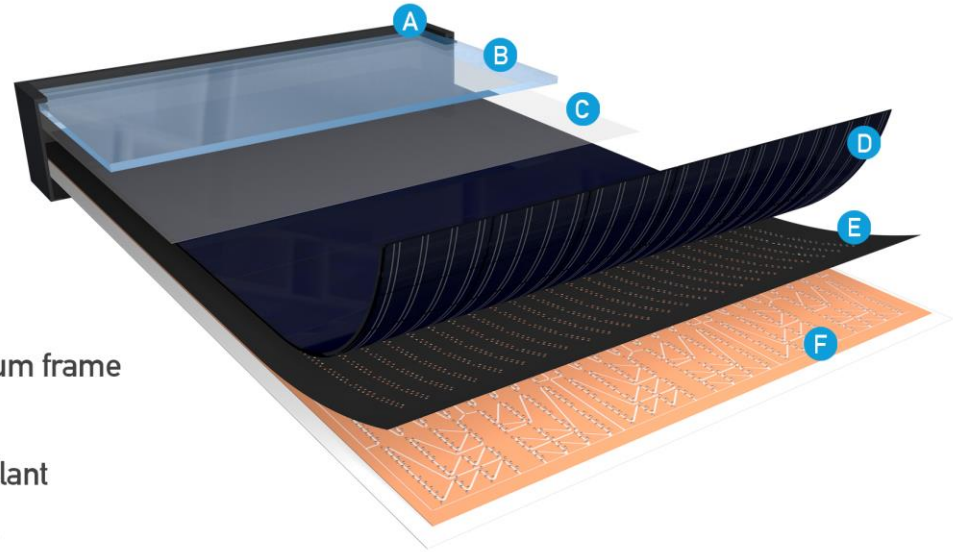


Back-contact module technology: BC cells combined with conductive backsheets (CBS)

Conventional module technology: cell interconnection via tabbing and stringing



BC module technology: IBC cell interconnection with a conductive backsheet



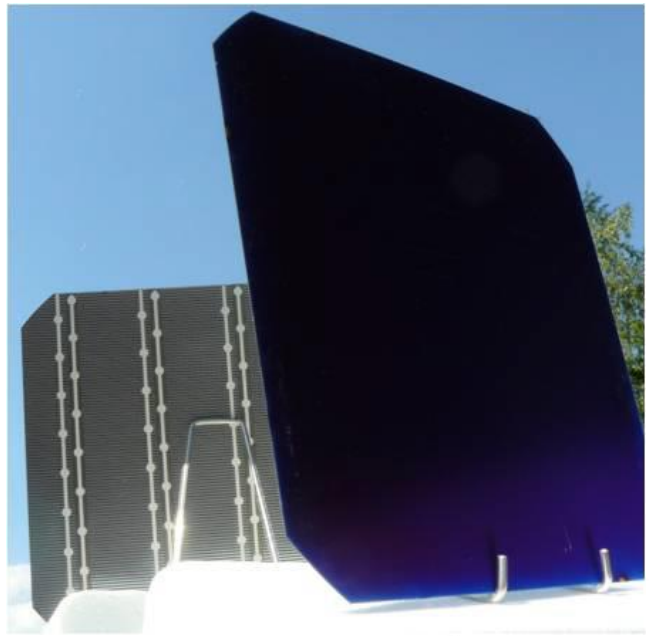
- A Aluminium frame
- B Glass
- C Encapsulant
- D IBC cells
- E Rear perforated insulator sheet
- F Conductive backsheet

Back-contact cells combined with CBS maximize module power density

Key features of back-contact cell and module technology:

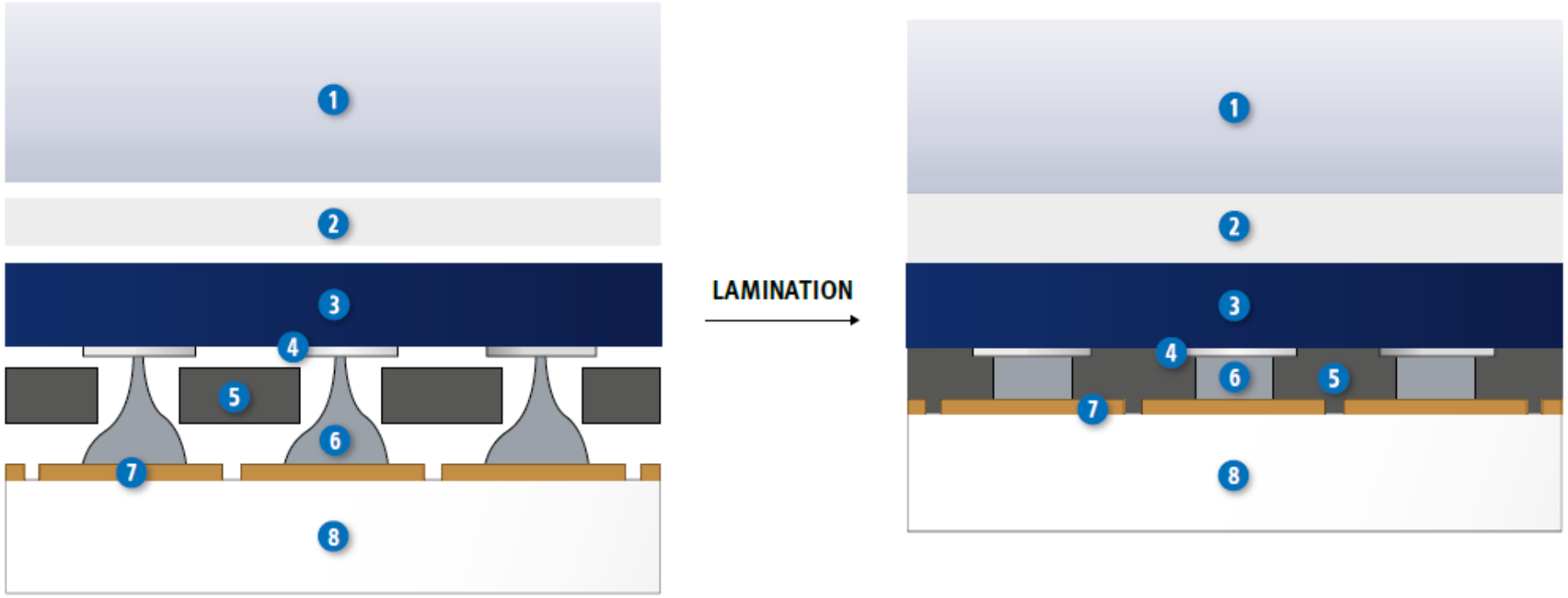
- Minimized (MWT) / no (IBC) front side metallization, so more cell surface available to capture the sun
- No busbars and tabbing/stringing, so less shading
- No soldering step, so very low stress and relatively low temperature during module manufacturing securing highest reliability during the module lifetime
- Cells are interconnected at the rear side using a conductive backsheet which minimizes cell-to-module (CTM) losses, resulting in a higher module efficiency
- Aesthetically pleasing module appearance (less / no visible metallization), 'all-black' appearance possible

MWT cell



IBC cell

The IBC cell interconnection is obtained during the lamination process



1. GLASS
2. ENCAPSULANT
3. CELL
4. REARSIDE METALLIZATION
5. REAR PERFORATED INSULATOR
6. CONDUCTIVE ADHESIVE / SOLDER PASTE
7. PATTERNED COPPER FOIL
8. BACKSHEET

IBC CELL

CONDUCTIVE BACKSHEET

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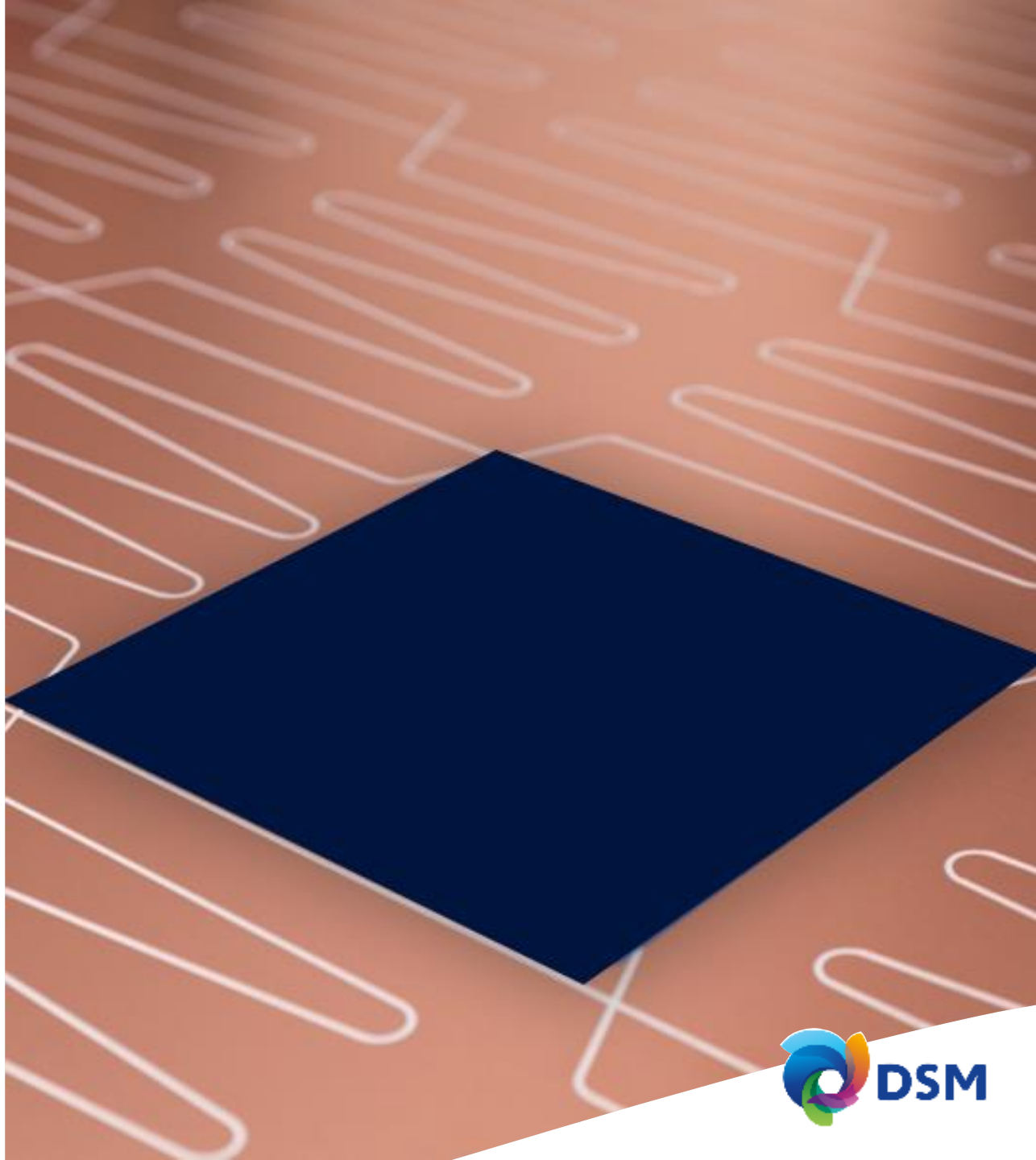


Back-contact modules meet the growing demand for high efficiency PV modules in residential / commercial segments

Segments with highest premia

Key requirements for the target residential / small commercial rooftop segment:

- High power density – maximum kWp/m² / kWh/m² for space constraint areas
- High aesthetics – all black modules
- Weight restrictions

Traditional PV modules don't meet these requirements:

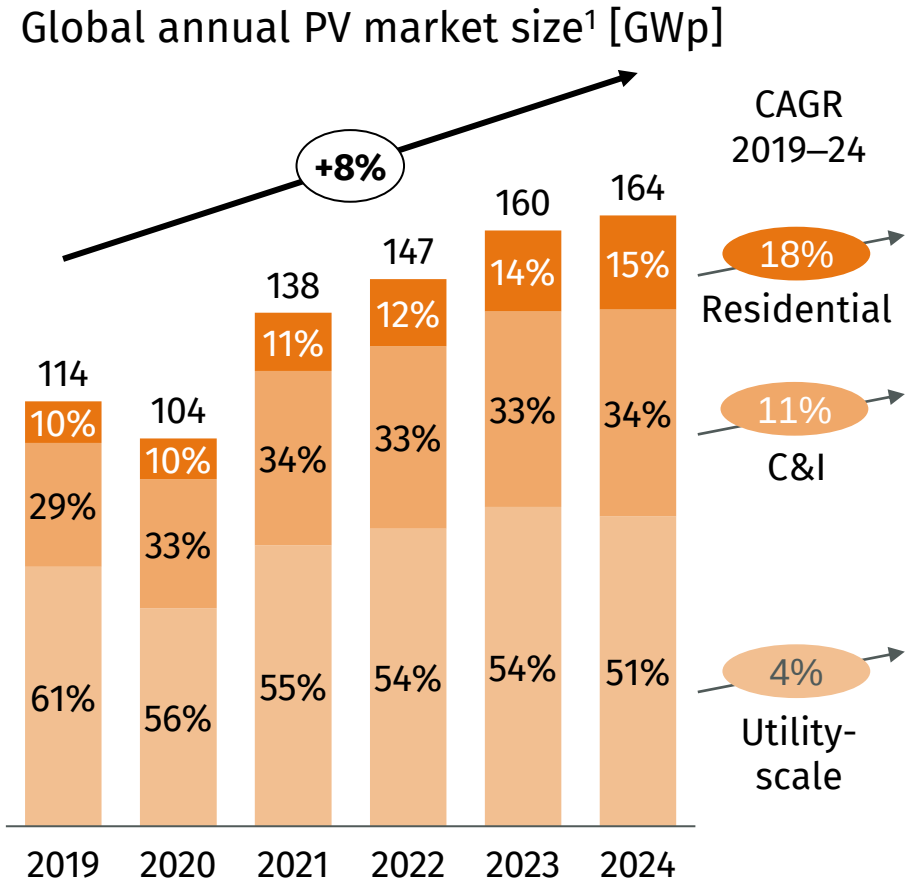
- The power of conventional 60 cell modules is too low
- New high-power modules (72+ cells / very large cells) are too heavy
- 'All-black' appearance is not possible with traditional cell metallization

Back contacted module technology is well suited to address the increasing customer requirements for high efficiency and area constraints, coupled with aesthetics, quality and brand

1 Residential

2 Small commercial

Growth in the global PV market is highest in the high premium residential / commercial rooftop segments



Source: IHS Markit, IEA
1) Adjusted for corona virus impact in 2020, excl. off-grid

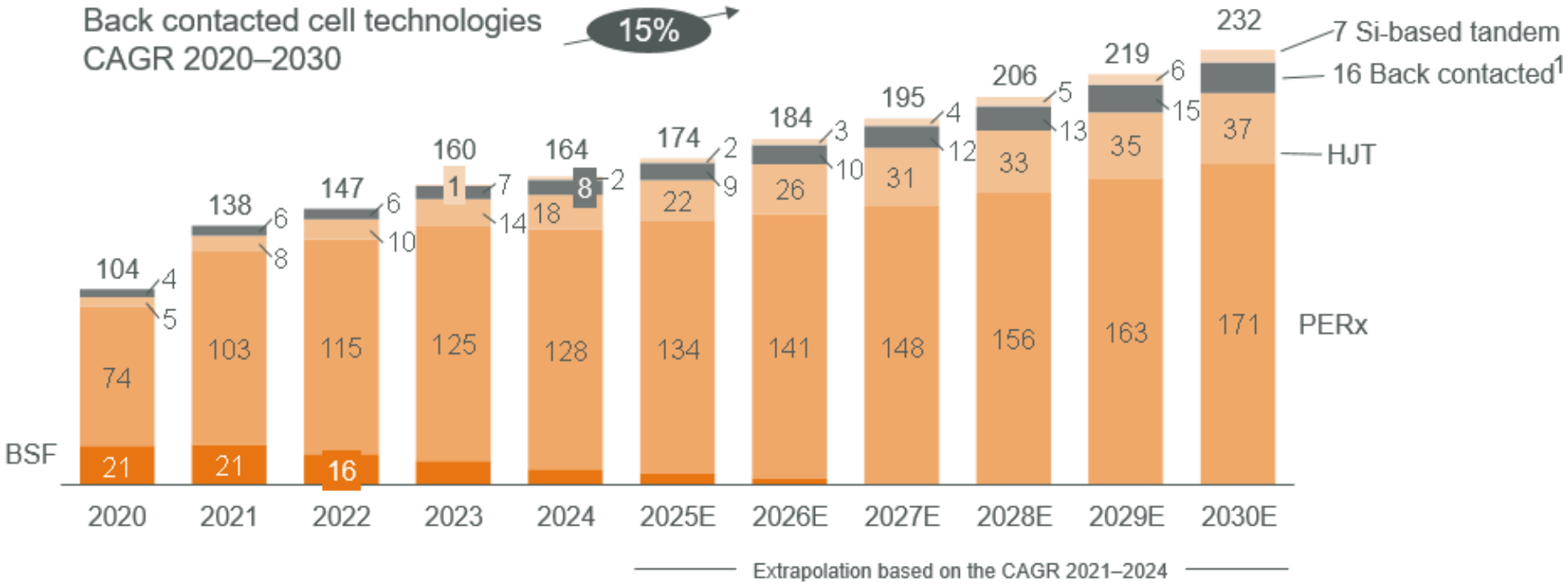
Main drivers for growth of the residential and C&I segments:

- Supporting policies (e.g., net-metering, near zero energy buildings)
- High electricity prices
- Increasing need for energy security (grid unreliability)

Source: Apricum

The market for back-contacted modules is forecasted to grow above average - from 4 to 7% of the global PV market

Global PV market by cell technology forecast, 2020–2030 [GWp]



Back contacted cell technology will grow significantly from current ~4 GW to ~16 GW by 2030.
CAGR for BC is ~15% between 2020–2030, almost two times higher than total PV installations (8%).

Source: IHS Markit, ITRPV 2020; 1) Including: IBC, MWT-PERC and MWT-HJT cell technologies

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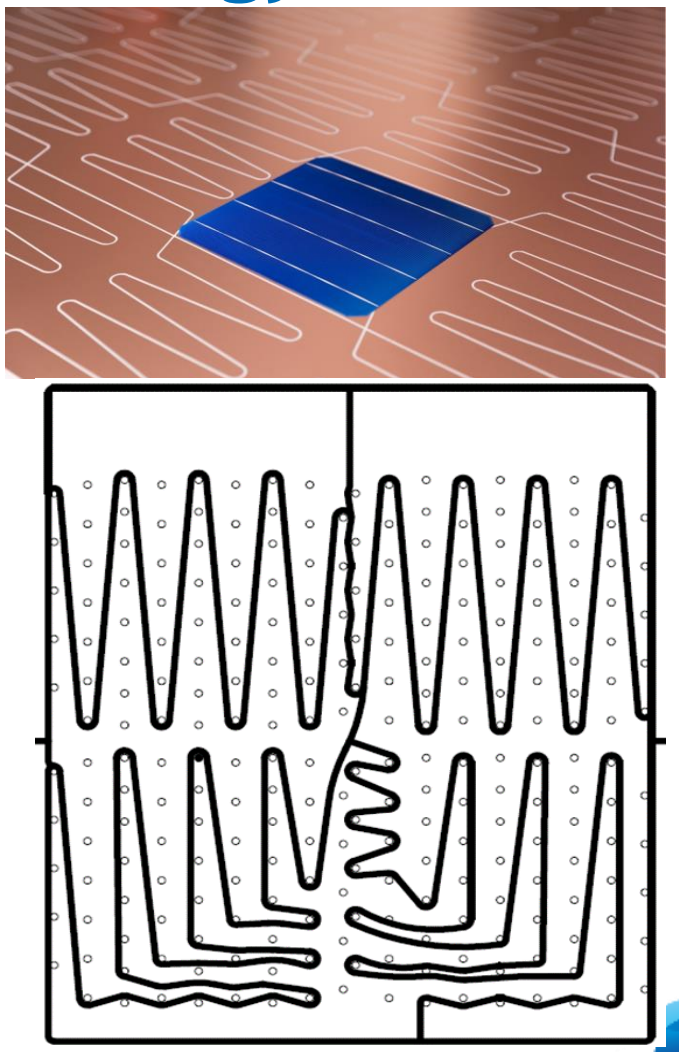
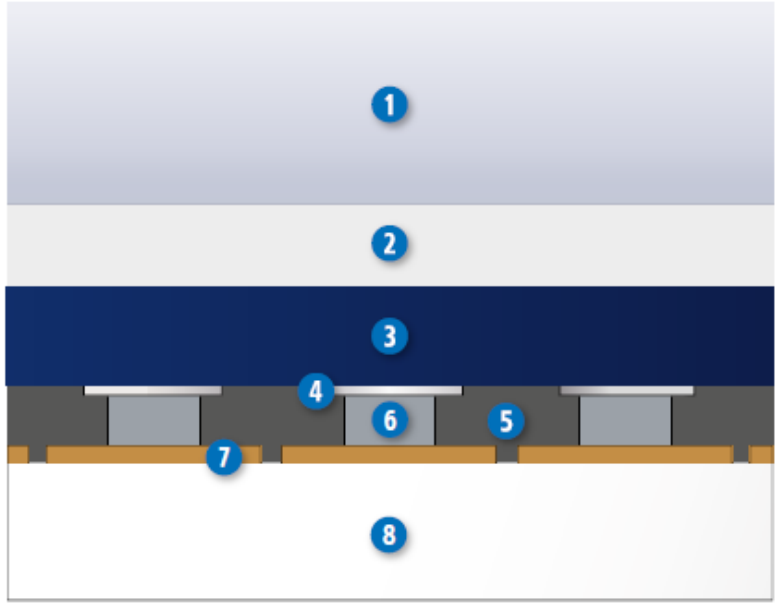
DSM Conductive backsheets
Enabling high power back-contact technology

- Innovative cell interconnection concept integrated in the backsheet
- The backsheet has a patterned metallization to separate the p- and n-contacts on the back of the cells
- The metal is separated from the cells by a perforated insulating film
- Contact between the cells and CBS is made by filling the holes in the insulating film with an electroconductive adhesive or a low temperature solder paste
- High flexibility in design, compatible with different cell configurations
- Fully compatible with automated, low stress pick & place cell lay-up equipment with a high freedom of module design



DSM Conductive backsheets
Enabling low-stress cell interconnection

- Minimal cell handling, low stress and low temperature during module manufacturing enabling cell thickness reduction to <100 microns
- Flat and dimensionally stable backsheet
- Lead-free electroconductive adhesive or low temperate solder paste
- Very low resistive losses for an improved CTM
- Lower Nominal Operating Cell Temperature (NOCT) due to heat dissipation



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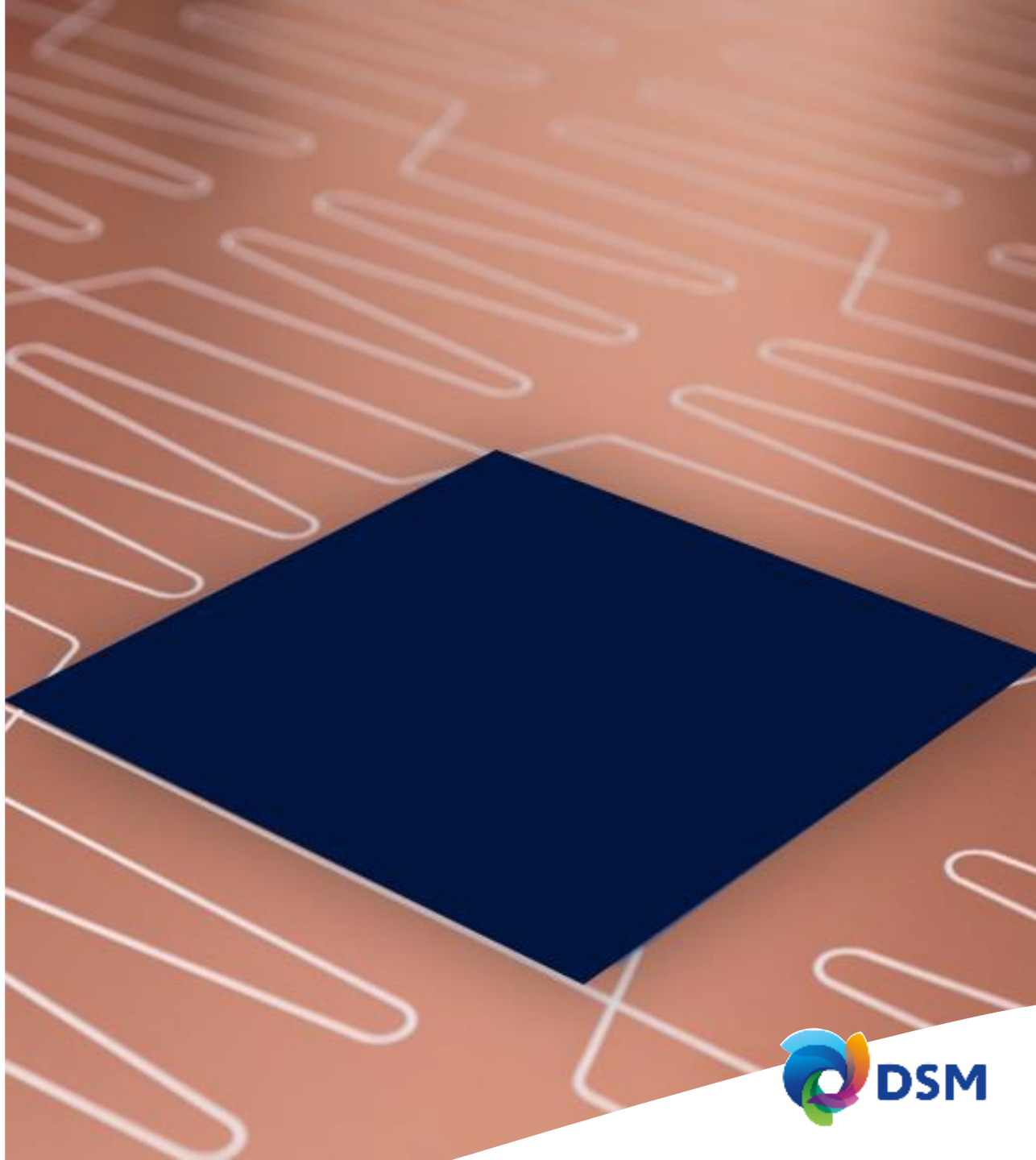
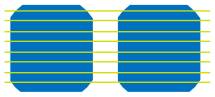
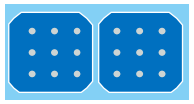
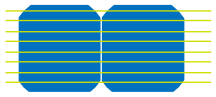


Cost and value creation comparison of various cell and cell interconnection technologies for high-efficiency modules

Cell level

Cell technologies	p-PERC[1]	n-PERT/TOPcon	n-SHJ	n-IBC
Schematic view of cell technologies				
Short description	Passivated emitter with rear contact	Passivated emitter /Passivated contacts	Silicon hetero-junction with higher absorption	Interdigitated back contacted with no shading at the front
Cell efficiencies	18%–23%	19%–23.5%	21%–24%	23–25%

Module level[3]

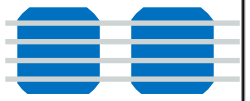
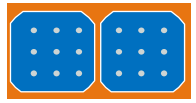
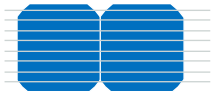
Interconnection technologies	Ribbons	Multiwire	Conductive backsheet	Shingling[2]	Paving/tiling
Schematic view of cell technologies (full cell)					

Analysis is made for modules with 120 half cells, similar cell technology and wafer size in a residential rooftop system in Germany.

Source: Apricum

CBS based modules display a higher power output per module than any other interconnection technology.

Module characteristics for p-PERC cell case-study for 2020

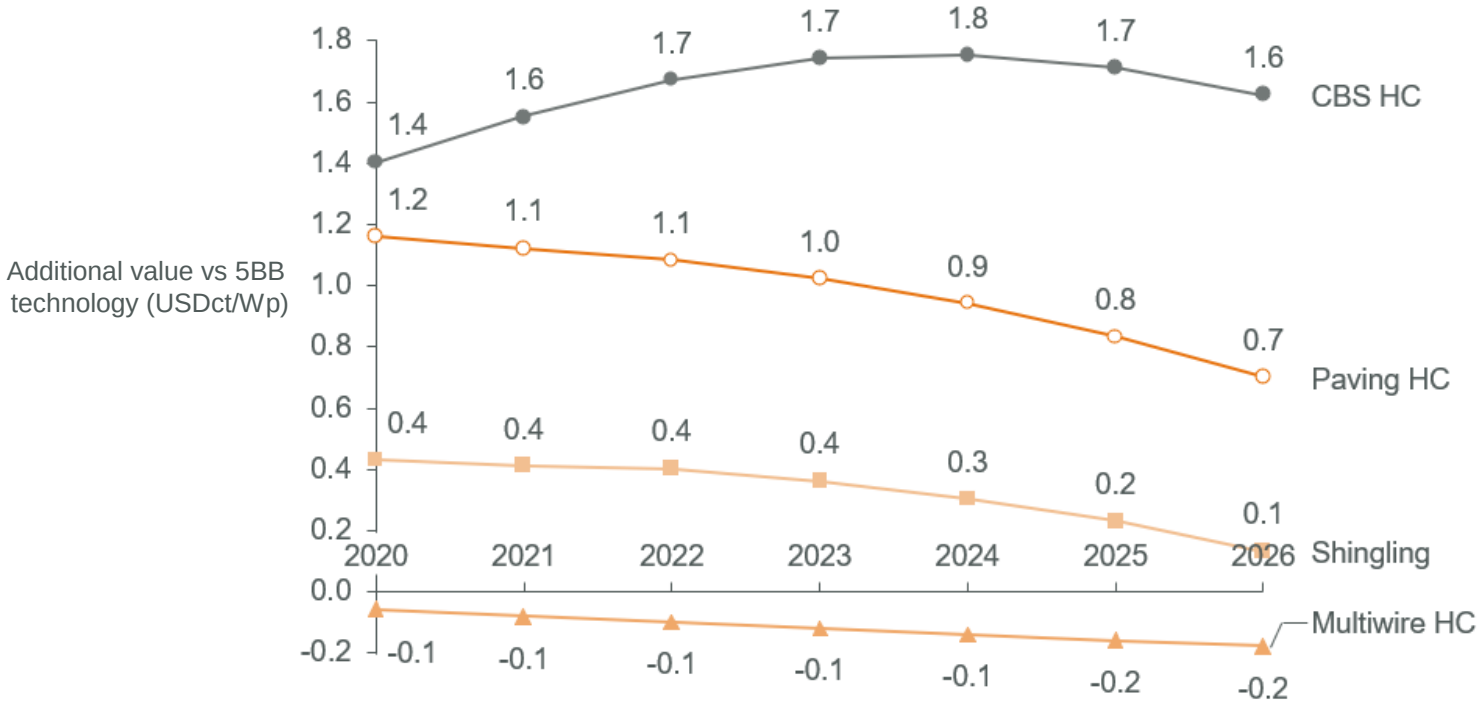
Cell inter-connection technologies	Ribbons	Multiwire	Conductive backsheet (CBS)	Shingling	Paving/tiling
Schematic view of cell technologies (full cell)					
Cell-to-module loss (CTM)	3.8%	3.8%	2.4%	2.2%	3.6%
Power density	189 W/m^2	189 W/m^2	202 W/m^2	195 W/m^2	199 W/m^2
Power output[1]	314 Wp	314 Wp	334 Wp	297 Wp[2]	314 Wp

Note: It is assumed all module technologies have similar starting cells with similar efficiency, except for shingling 1% cell efficiency drop due to laser cutting losses

Source: Apricum value model analysis; 1) For half cell modules with 120 cells (60 full cells); 2) Smaller module, 60 full cells cut in 5 sections

CBS Back-contacted modules deliver the highest value to module manufacturers

Total additional value created for module manufacturers by technology vs 5 BB standard tabbing/stringing for p-PERC cells, case-study 2020–2026 [USDct./Wp]

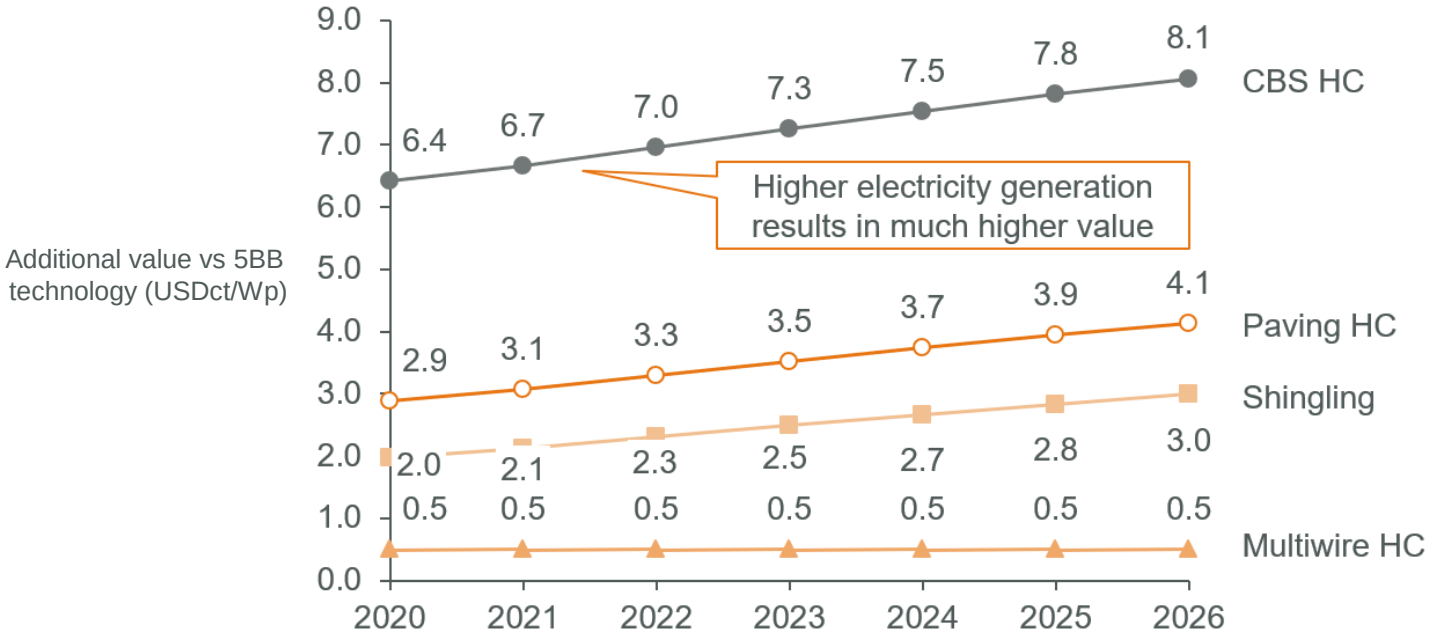


- CBS technology results in the highest value created for module manufacturers based on high value creation for end-customers
- Switching cost from standard to CBS and higher material cost is offset by higher premia
- Value created for the module manufacturer is the difference between value created and the sum of all values captured by end-customer and the downstream player (distributor, wholesaler) and the manufacturing cost increase/decrease

Source: Apricum value model analysis

Value creation for end-customers in the residential segment is highest with back-contacted modules with a CBS

Total additional value created for end customers by technology vs standard tabbing/stringing for p-PERC cells, case-study 2020–2026 [USDct./Wp]



- Calculation based on an area constraint methodology (constant rooftop area for all module types)
- The value created increases with time as higher cell efficiencies and increasing cost of electricity (residential and commercial applications) impacting the revenue in such PV systems
- Higher electricity generation due to heat dissipation impact of DSM's conductive backsheet

Source: Apricum value model analysis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