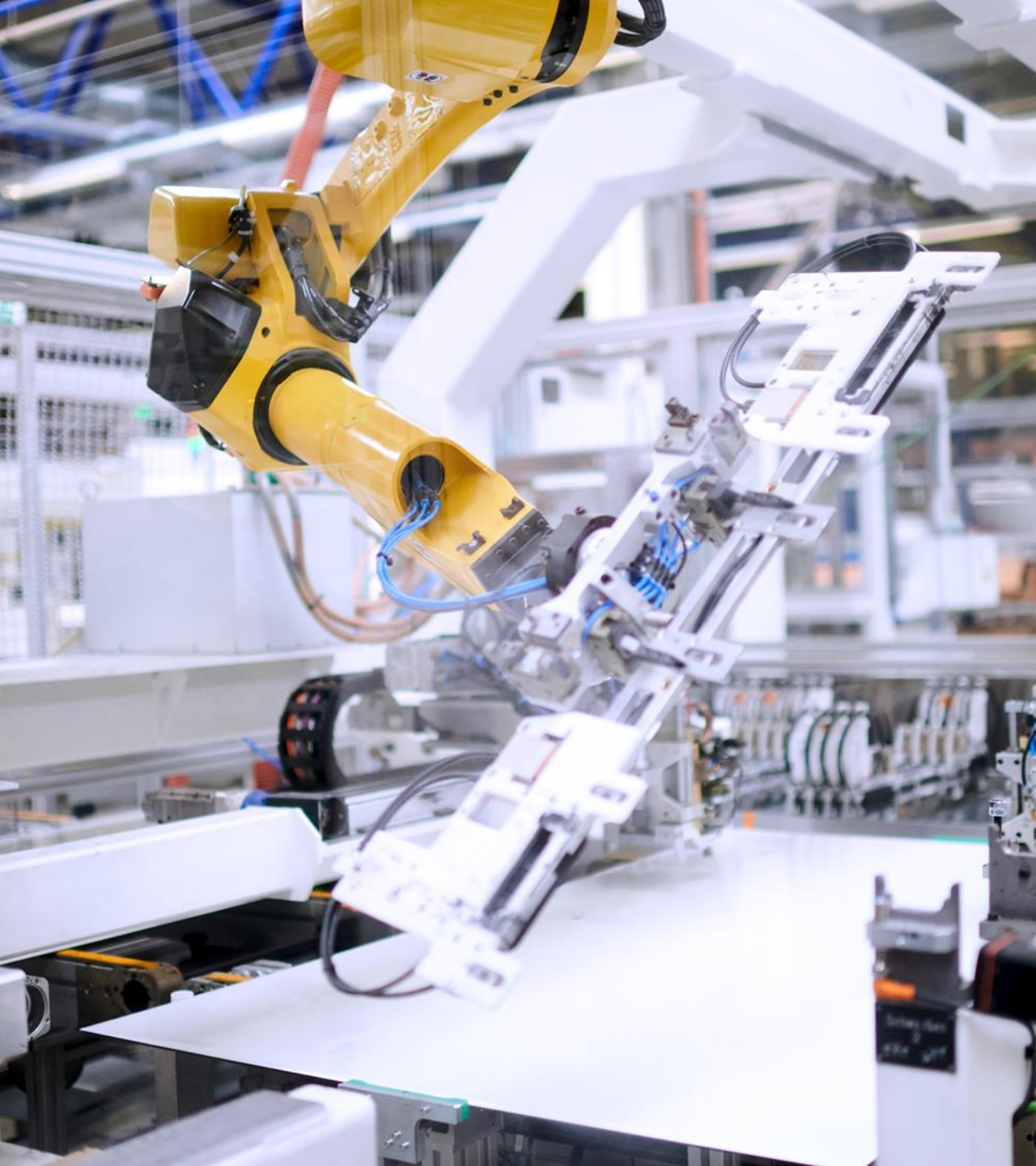


The Sirius project: Tunnel IBC solar cell and module upscaling at Meyer Burger Research

10th BC workshop – Konstanz – 21./22. November 2022

Derk Bätzner, Meyer Burger Research



About Meyer Burger

Meyer Burger – almost 70 years of experience, including 40 years in PV

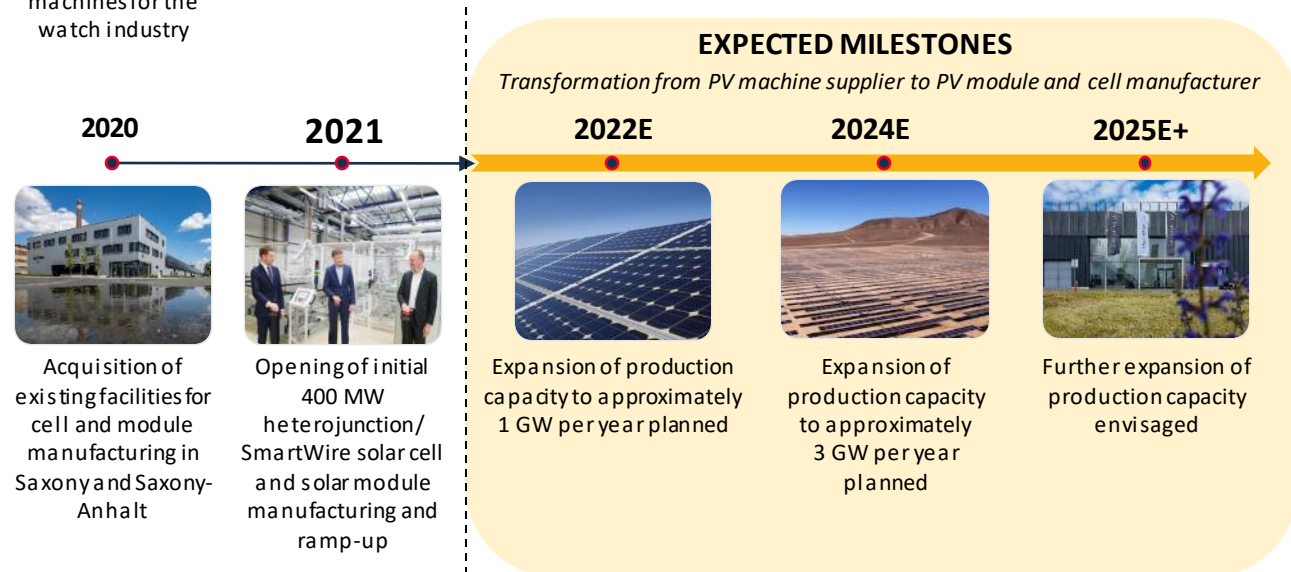
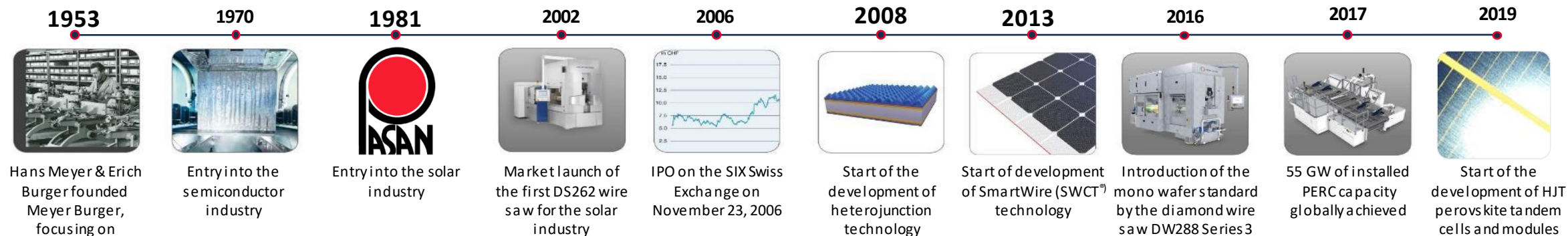


Photo: Grand opening ceremony solar cell factory Thalheim, May 18, 2021 with Saxony-Anhalt Prime Minister Dr. Haseloff (left), MBTN CEO Gunter Erfurt and Saxony-Anhalt Minister Prof. Armin Willingmann

Meyer Burger industrializes Swiss innovation in Germany's „Solar Valley“



Swiss innovation

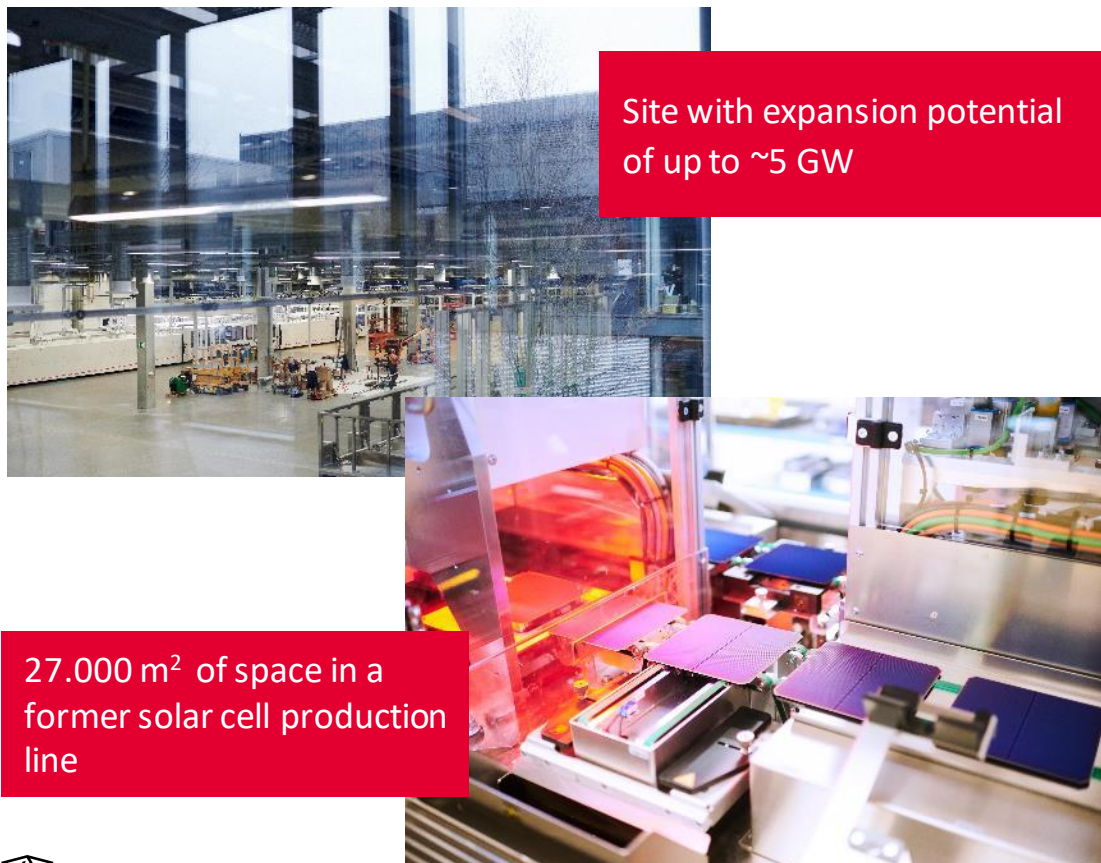
- Headquartered in **Thun**, listed on Swiss stock exchange
- Deep collaboration with leading Swiss research institutes and universities
- Financial support from Swiss Federal Office of Energy and InnoSwiss Institute.

German production

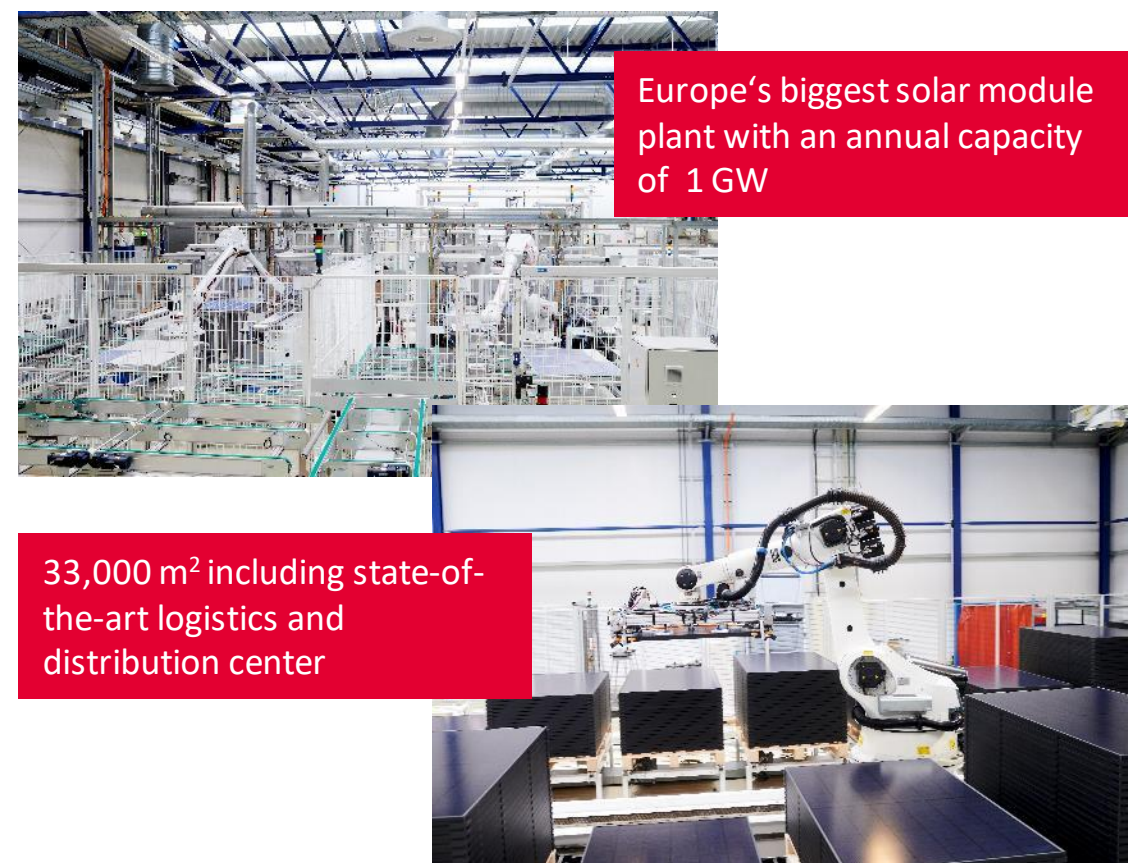
- Access to highly qualified employees
- Vacant factory buildings and brownfield sites with substantial multi-GW expansion potential
- Excellent logistics
- Political support by federal and state governments

Our two PV plants are highly modern and fully-automated production facilities in Saxony-Anhalt and Saxony

Cell production – Thalheim (Bitterfeld-Wolfen)



Module production – Freiberg

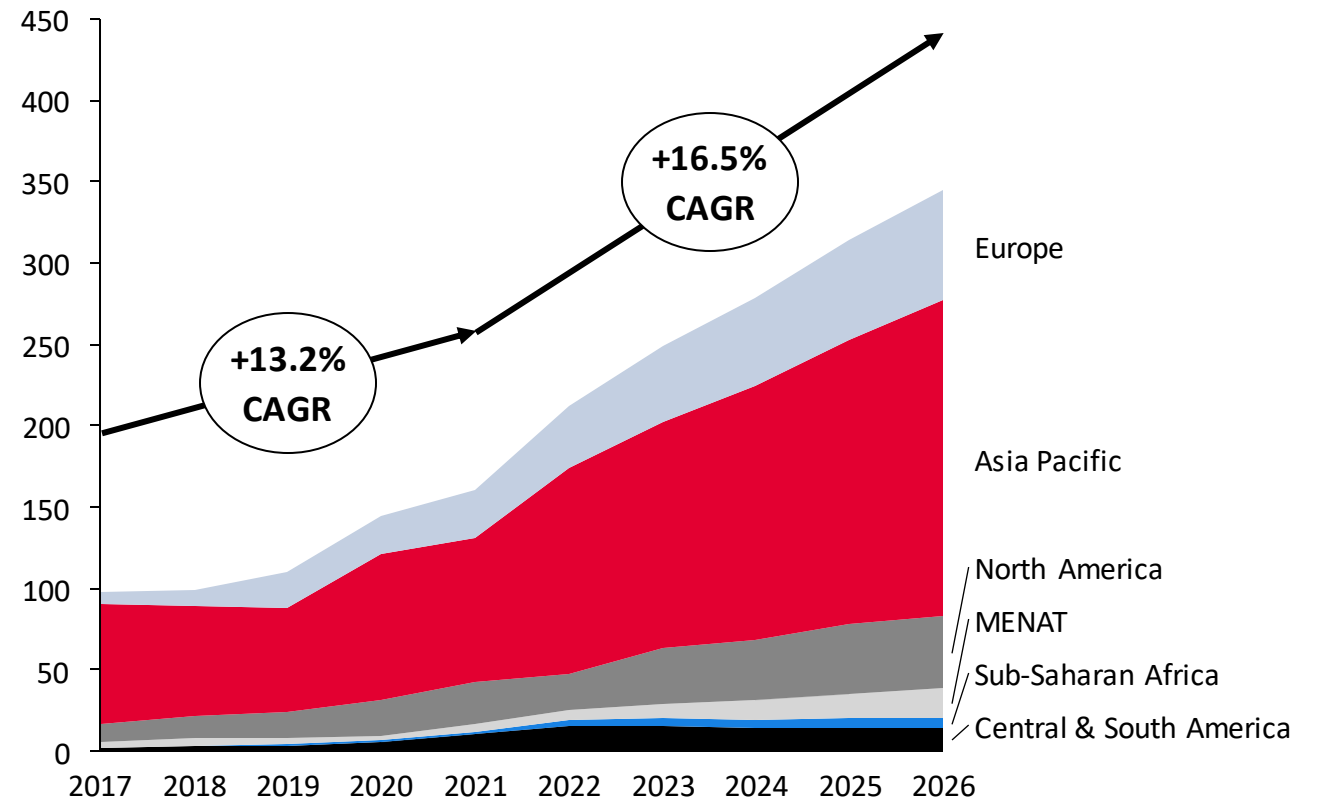


‘Global energy crisis’ drives growth in renewable energy further, especially in the PV sector

PV growth propelled by energy crisis, but global supply chains need to become more resilient

- Solar demand has shown to be robust despite significant uptick in cost of all system components, including modules, and despite supply chain disruptions
- Cost increase is driven by high materials prices. Polysilicon as key driver remains around ten-year high
- War in Ukraine, natural gas shortage and high energy prices are even further fueling demand for solar
- Almost exclusive regional concentration of PV supply chain in Asia and the resulting high degree of dependency is becoming a concern for many customers

Expected global solar market size by region [GW]

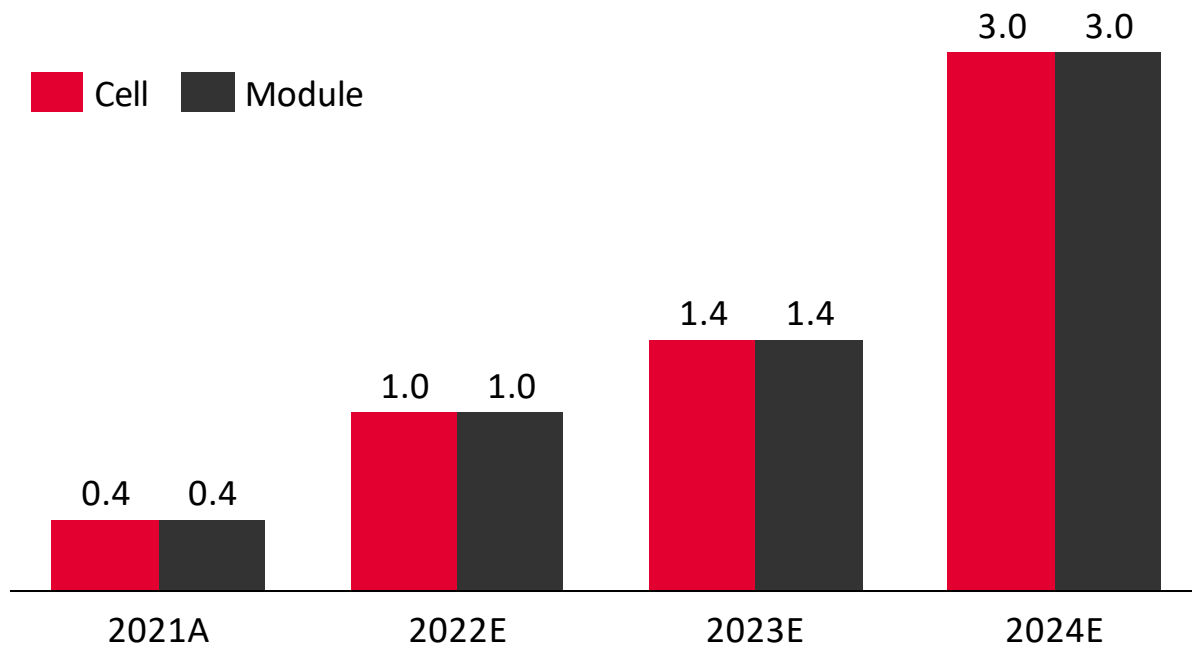


Source: Apricum – The Cleantech Advisory, Q1 2022, center scenario

Following the successful build-up of our 0.4 GW capacity, we are continuing our international capacity growth

Cell and module production

Meyer Burger planned installed nameplate production capacity, year-end [GW]



Roadmap:

- Approximately 1 GW cell and module nameplate capacity expected to become available in Thalheim and Freiberg, Germany, respectively, in 2022
- A further ~0.4 GW cell and module capacity expected to become available at the same German sites in 2023
- Expansion by another ~1.5 GW of cell production in Thalheim by 2024, Germany and module production in Goodyear, Arizona planned (thereof up to 1 GW for long-term offtake with DESRI)

Current products: 3 variants of MB 120 half-cell modules

Meyer Burger Black

“The elegant one”



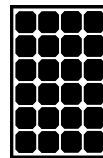
120 GBb



- Black water-barrier backsheet
- **375–395 Wp**
- 20.4%–21.5%

Meyer Burger White

“The high-performer”



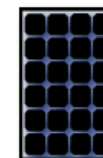
120 GBw



- White water-barrier backsheet
- **380–400 Wp**
- 20.7%–21.7%

Meyer Burger Glass

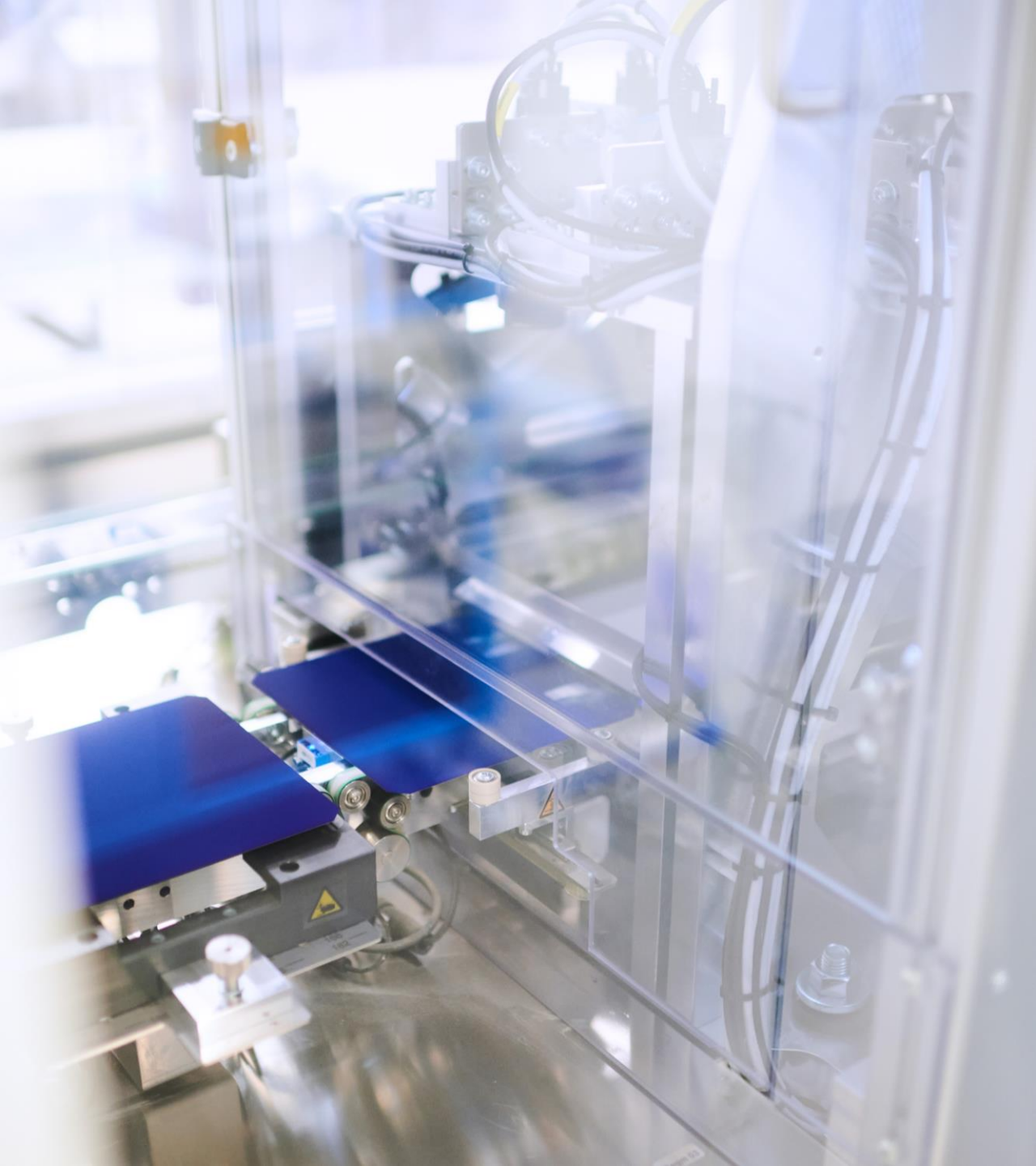
“The special one”



120 GGb



- Transparent solar glass back cover
- **370–390 Wp**
- 20.6%–21.8%
- Bifacial



What's next?

Tomorrow: utility modules & Meyer Burger's solar roof tiles



Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

aufgrund eines Beschlusses
des Deutschen Bundestages

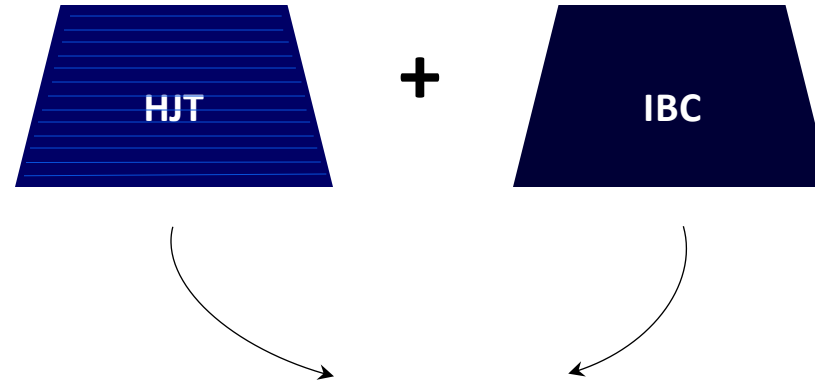
*Parts of this work are funded by
German Federal Ministry for
Economic Affairs and Climate Action
within the research project:
"Utility4Indium" 03EE1127A*



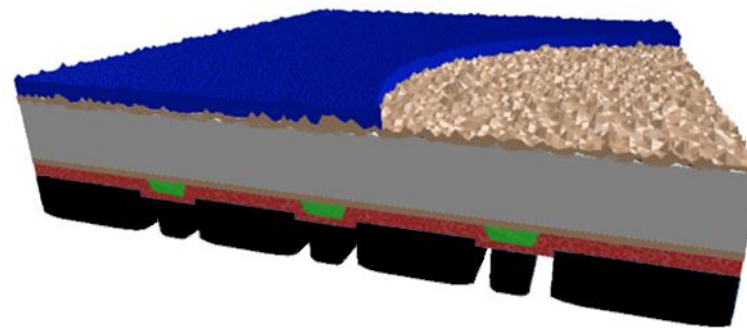
After tomorrow: BC Heterojunction

3 objectives:

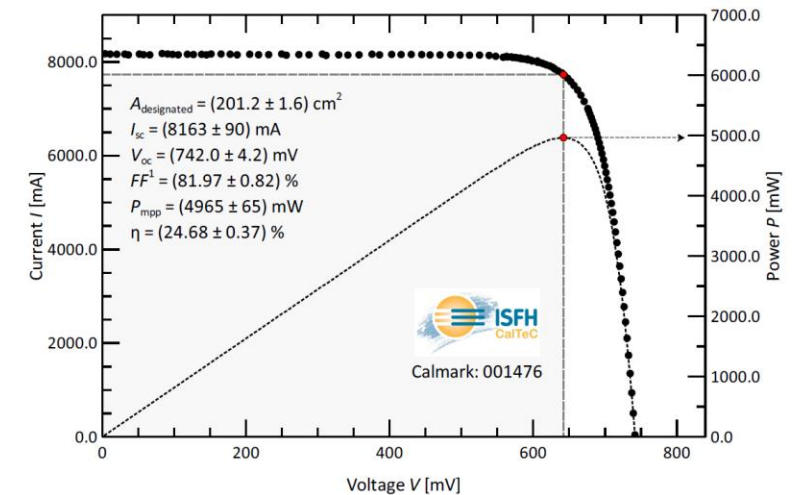
1. increase efficiency
2. use less critical resources
3. superior reliability



Gen2 Tunnel-IBC solar cell



Novel patented rear architecture



IBC projects from R&D to production

50-100 cells /week

TRL6 Halbion R&D



TRL7

SIRIUS



EU project PILATUS

TRL 8-9 IBC Demoline MegaWatts scale



2020

2021

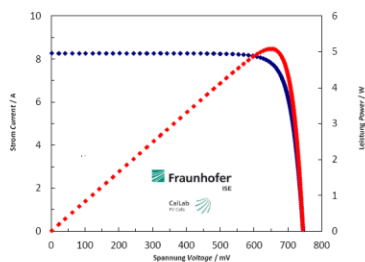
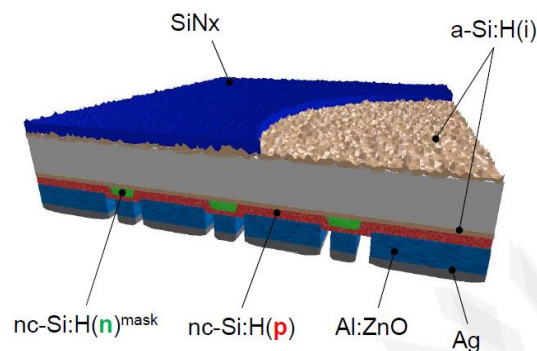
2022

2023

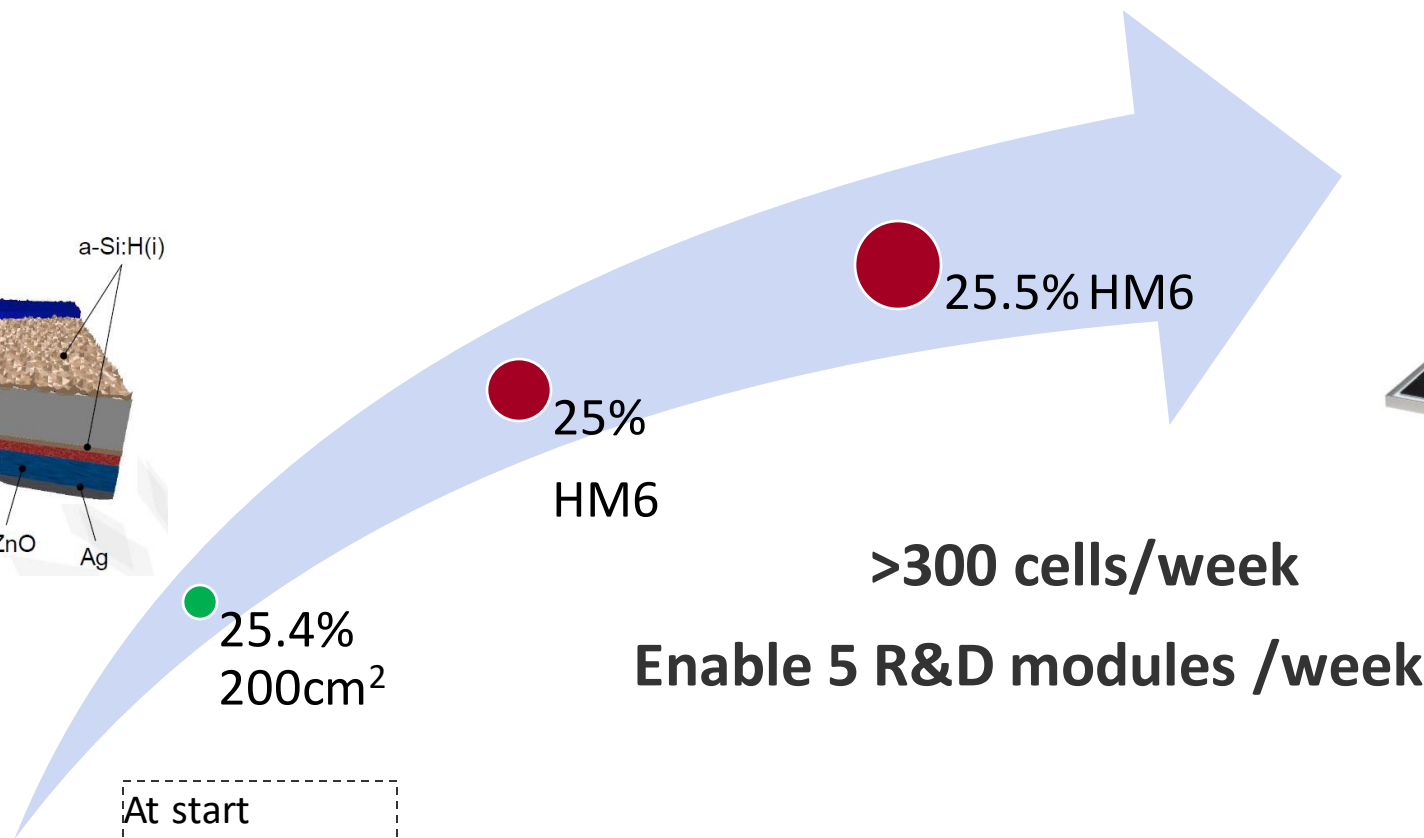
2024

SIRIUS project & objectives

The SIRIUS project is a Swiss Federal Office for Energy funded collaboration of MBR, CSEM and MBT within the SFOE's the pilot and demonstration programme



At start
50-100
cells/week



MBR's R&D Cell Line conversion to M6



Helia PECVD
loading/unloading automation



M6 screen printer with
loading/unloading automation



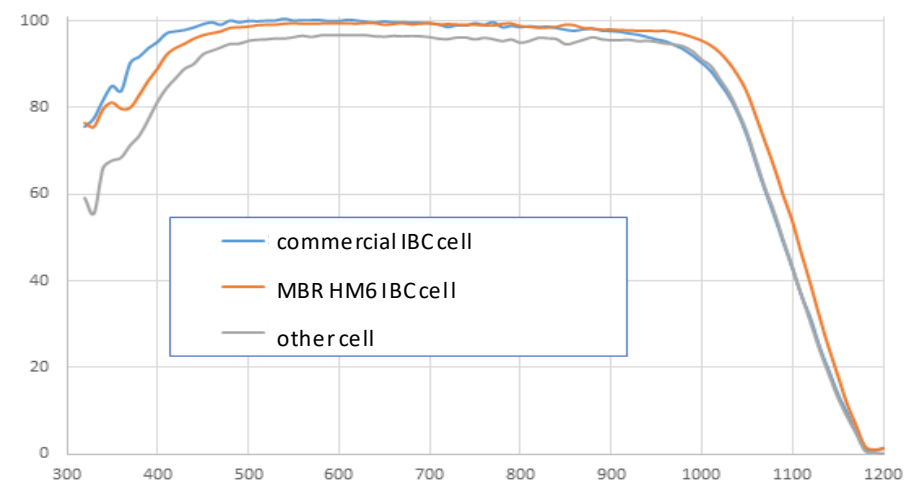
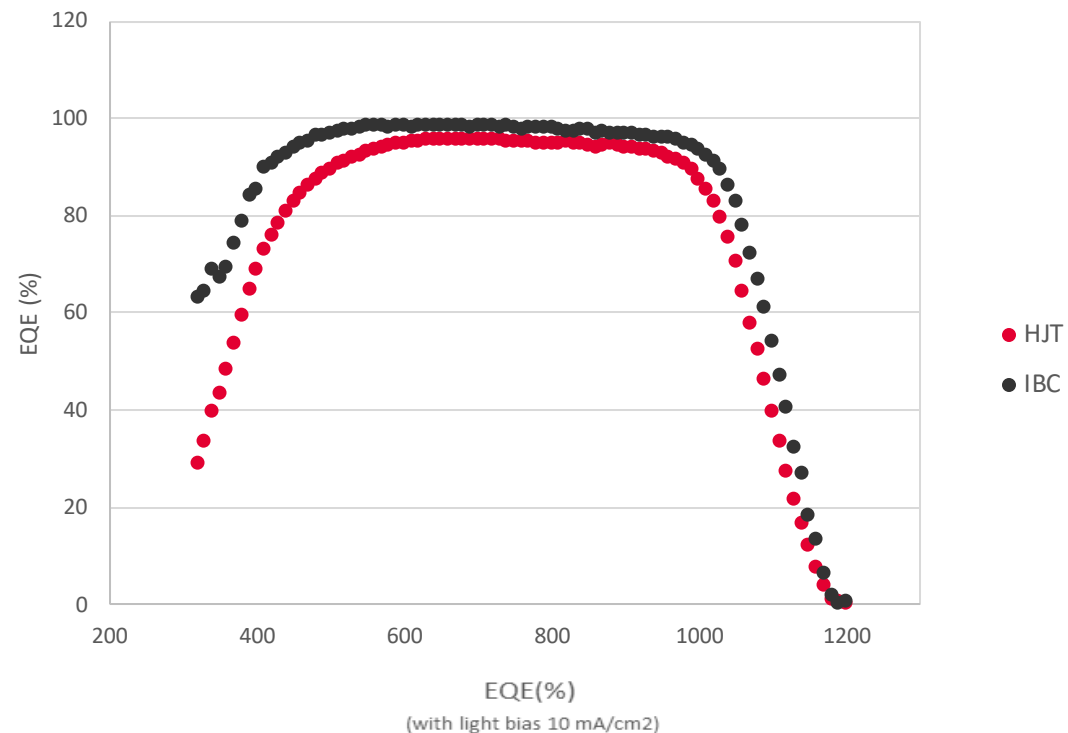
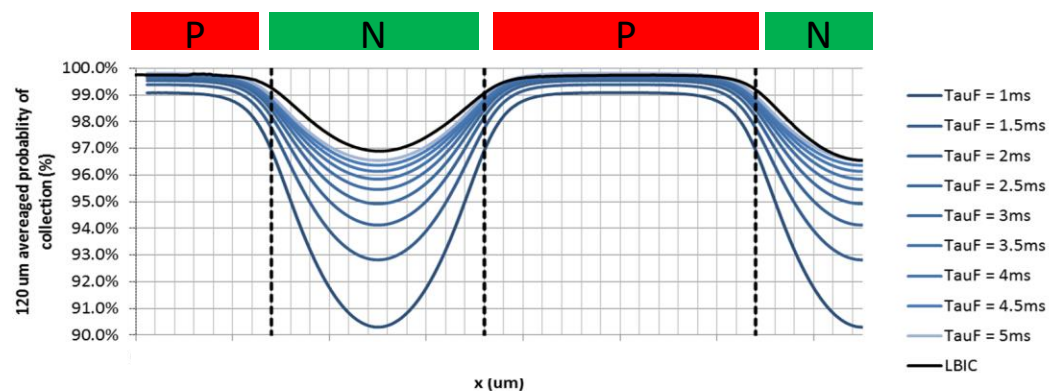
SpotLight and 6-axis robot
loading/unloading &
wafer / cell
handling automation

MBT (Thun) built a 2 tool stringing prototype line for HM6 IBC Smart Wire cell interconnection

IBC characteristics

Better response over the whole spectrum

- Optimized front layers for better transparency
- Optimized back layers for better reflectance
- Electrical shading effect still exists but can be limited by the excellent a-Si:H passivation / pitch optimization.

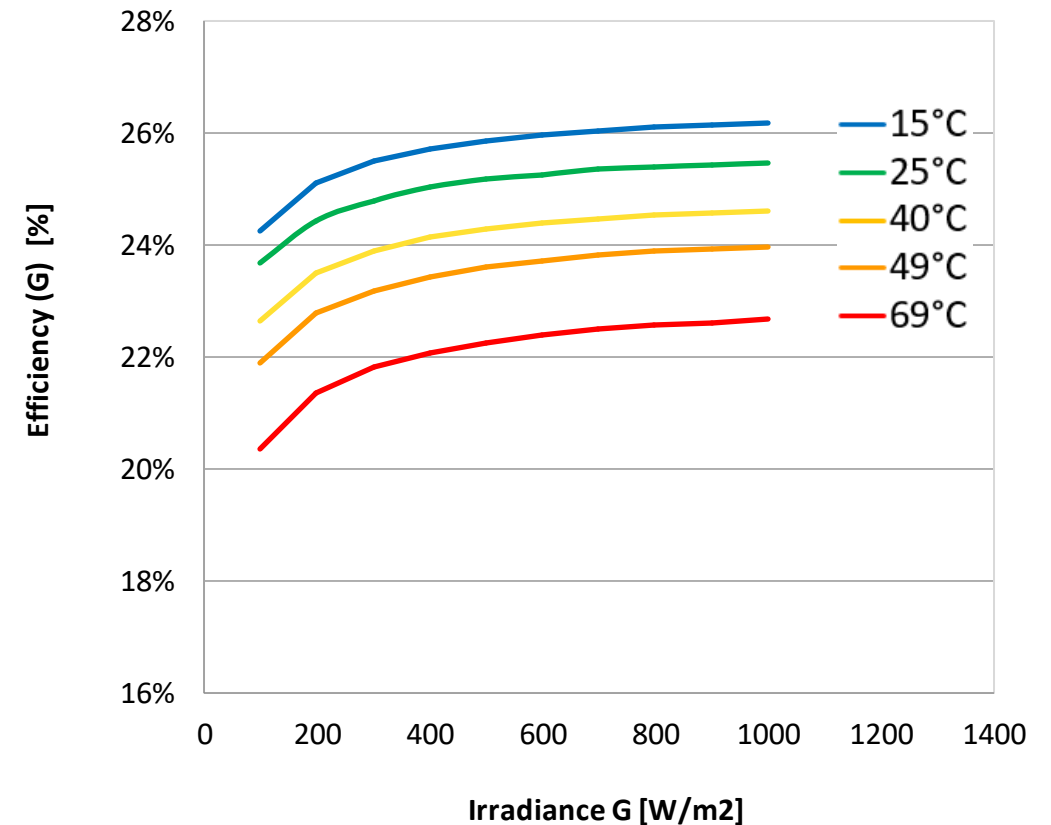


IBC characteristics

Better irradiance dependent performance

- limited efficiency loss (-0.6% abs) down to $\sim 300\text{W/m}^2$
- consequence of lower R_s and higher R_{sh}
- same TC as HJT thanks to a-Si:H passivation
- Highest energy yield expected

Voc	-0.178 mV/ °C
Isc	+0.05 % /°C
P	-0.254 % /°C

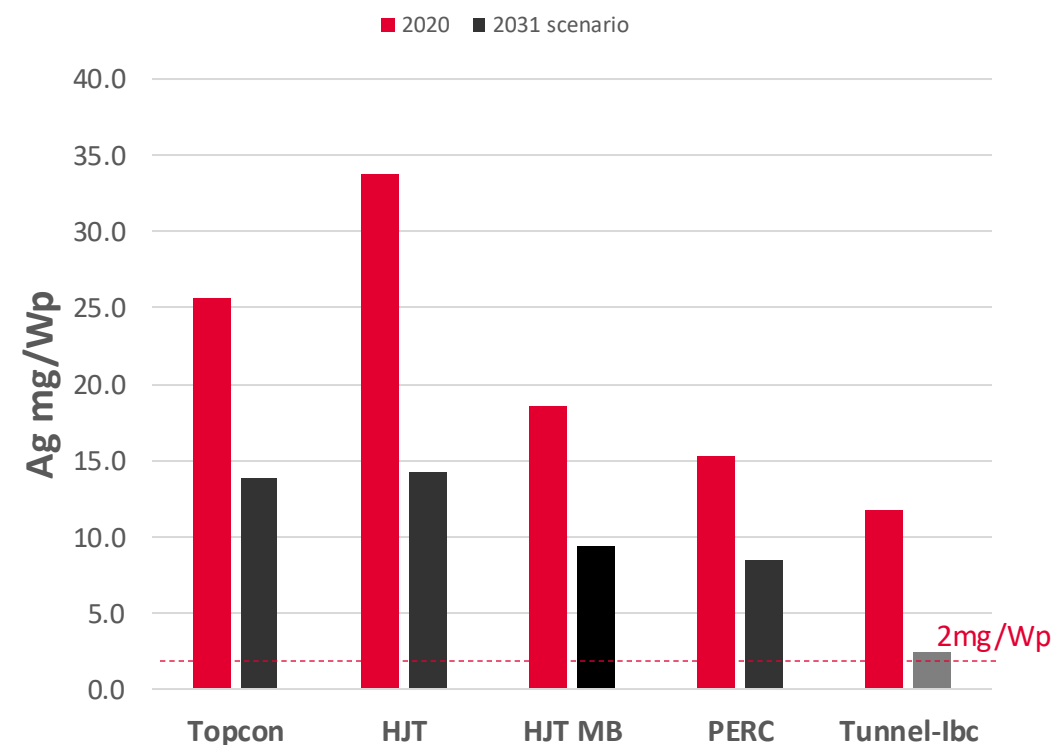


Ag reduction on track

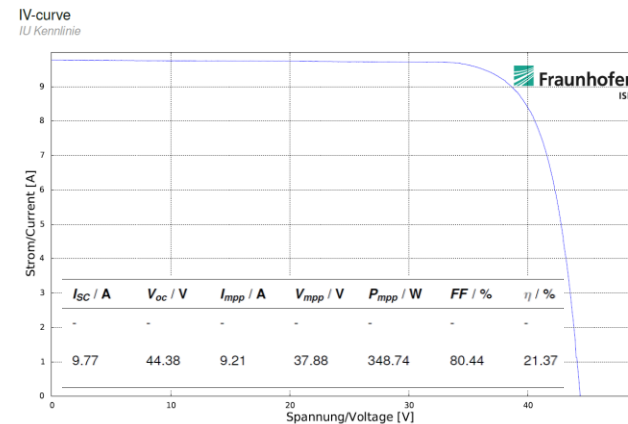
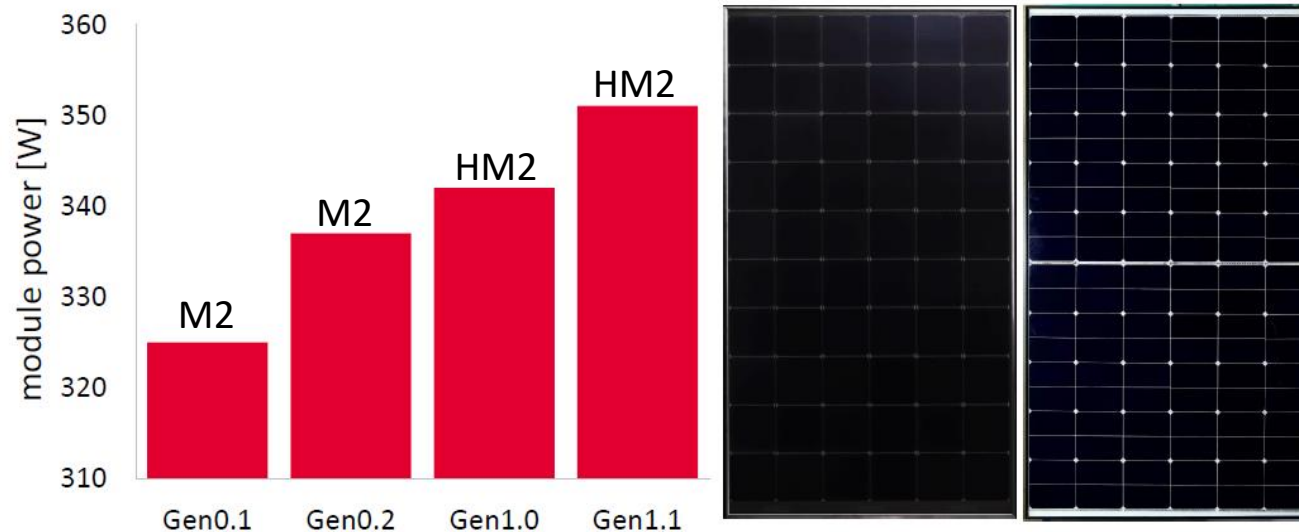
Silver consumption is the next big challenge for PV production with the 2mg/W target for sustainable manufacturing.

- Meyer Burger BusBar-less HJT technology not far from ~ PERC.
- Gen 2 Tunnel-IBC – **natively Indium free** - is already ahead (11.6mg/Wp)
- New metallization paste opens the possibility to **< 3mg/Wp** in the short-term without efficiency loss on tunnel IBC.
- **Tunnel IBC technology fulfills already today the conditions for a sustainable large scale PV manufacturing at competitive costs.**

[Zhang & al., RSC, 2021], M6 wafer, 2020 & 2031 prediction



SIRIUS: module line development



- Good performance progress during first year, from 327W to 349W.
- Module efficiency loss model established.
- 349W certified module by Fhg ISE
- HM2 cells at 24% average
- Equivalent to 391 W in HM6 configuration

IBC module monitoring outdoors

The two IBC mono-facial modules have been installed on the flat roof in Hauterive



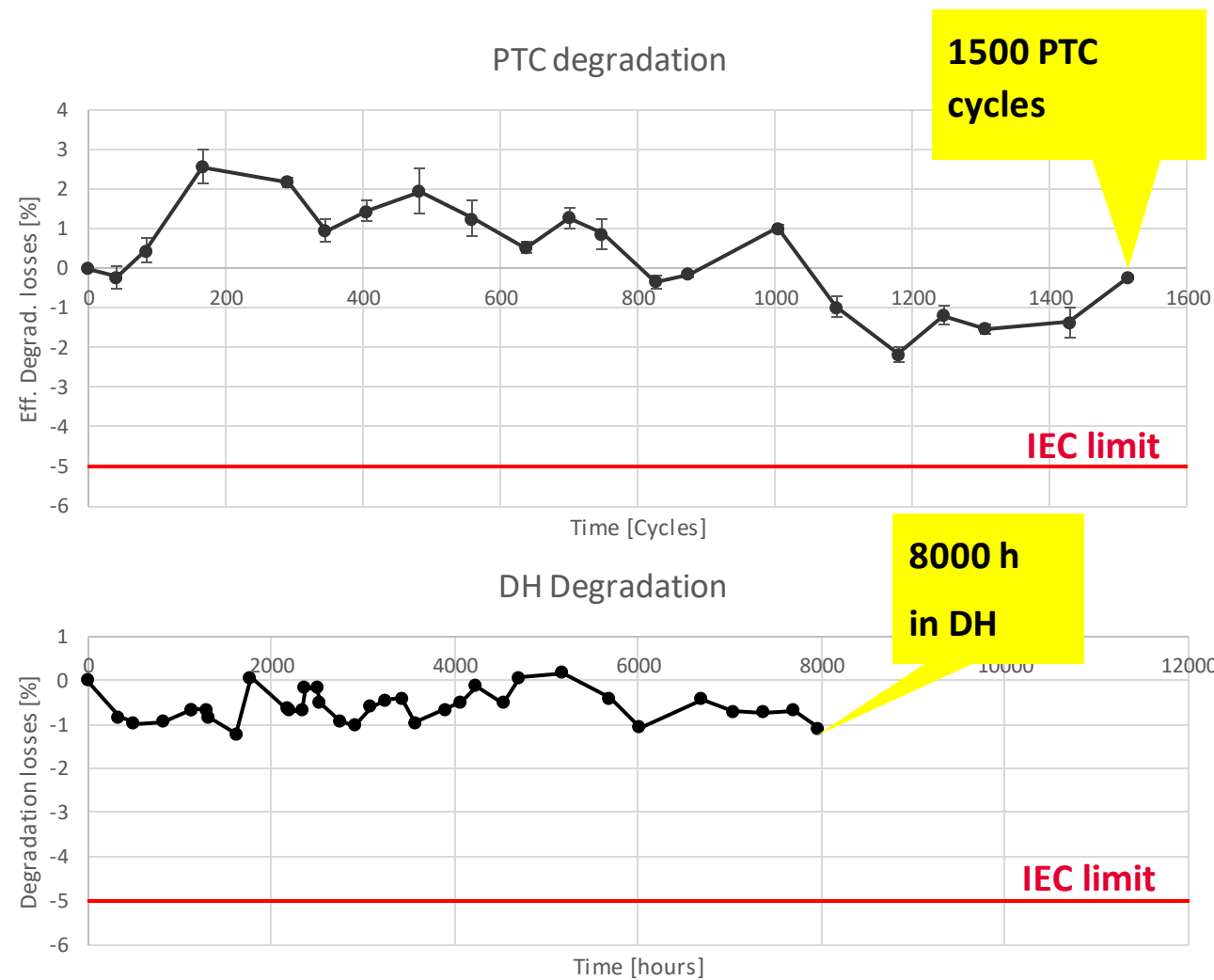
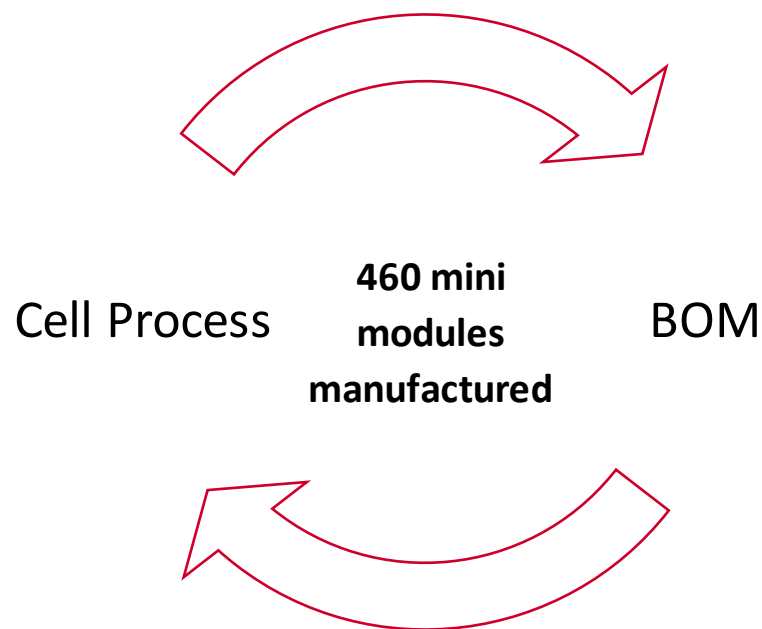
Module monitoring of R&D and various commercial modules during the SIRIUS project

First indicator of yield and reliability performance

Reliability monitoring indoors

Targeting 40 years module lifetime:

- Excellent PTC and DH behavior
- No module issue linked to Al:ZnO material



The next generation of heterojunction technology is in the works according to our announced R&D roadmap



Development on track:

- Ultra low Ag consumption
- Excellent reliability demonstrated
- First 60cells full size modules manufactured.
- PILATUS EU project : IBC pilot line of cells modules starting in 2023.



4

Solar Careers at Meyer Burger

For the EU to meet its energy security targets, in 2030 the continent must employ over 1 million solar workers, twice as much as in 2021.

EU Solar Jobs Report 2022

➤ jobs.meyerburger.com

Currently 62 vacant positions at MB!!!



With the right energy, anything is possible.