

Turnkey
Services
Technologies



**COST REDUCTION OF PHOTOVOLTAIC ENERGY
BY HIGH EFFICIENT BIFACIAL MULTICRYSTALLINE P TYPE CELLS
IN INDUSTRIAL PILOT PRODUCTION**



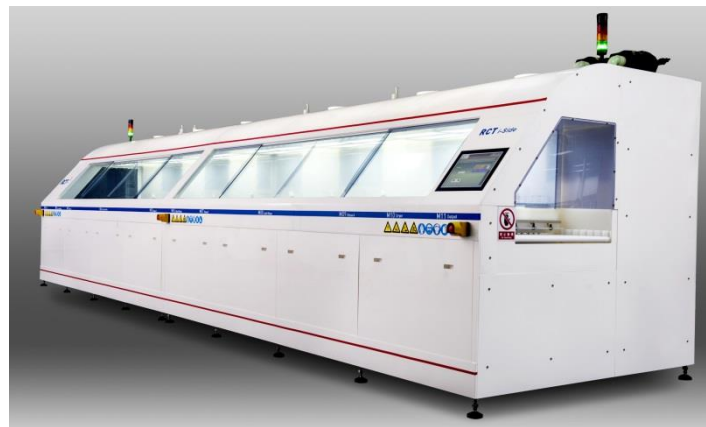
RCT Team since 2012

- ▶ Former engineers from centrotherm and RENA
- ▶ CEO Dr. Peter Fath

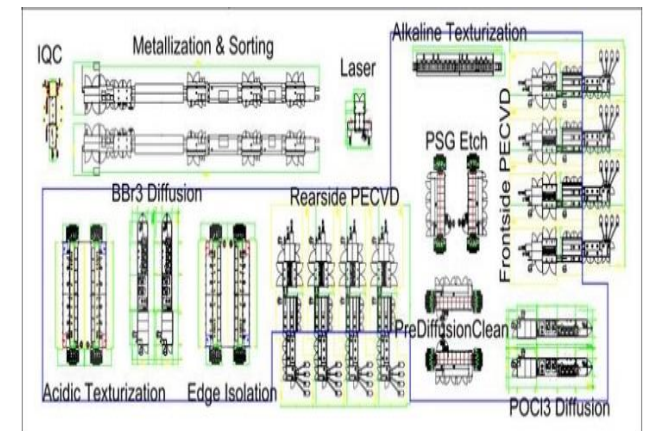
Cell technology development



Manufacturing of wet chemical equipment

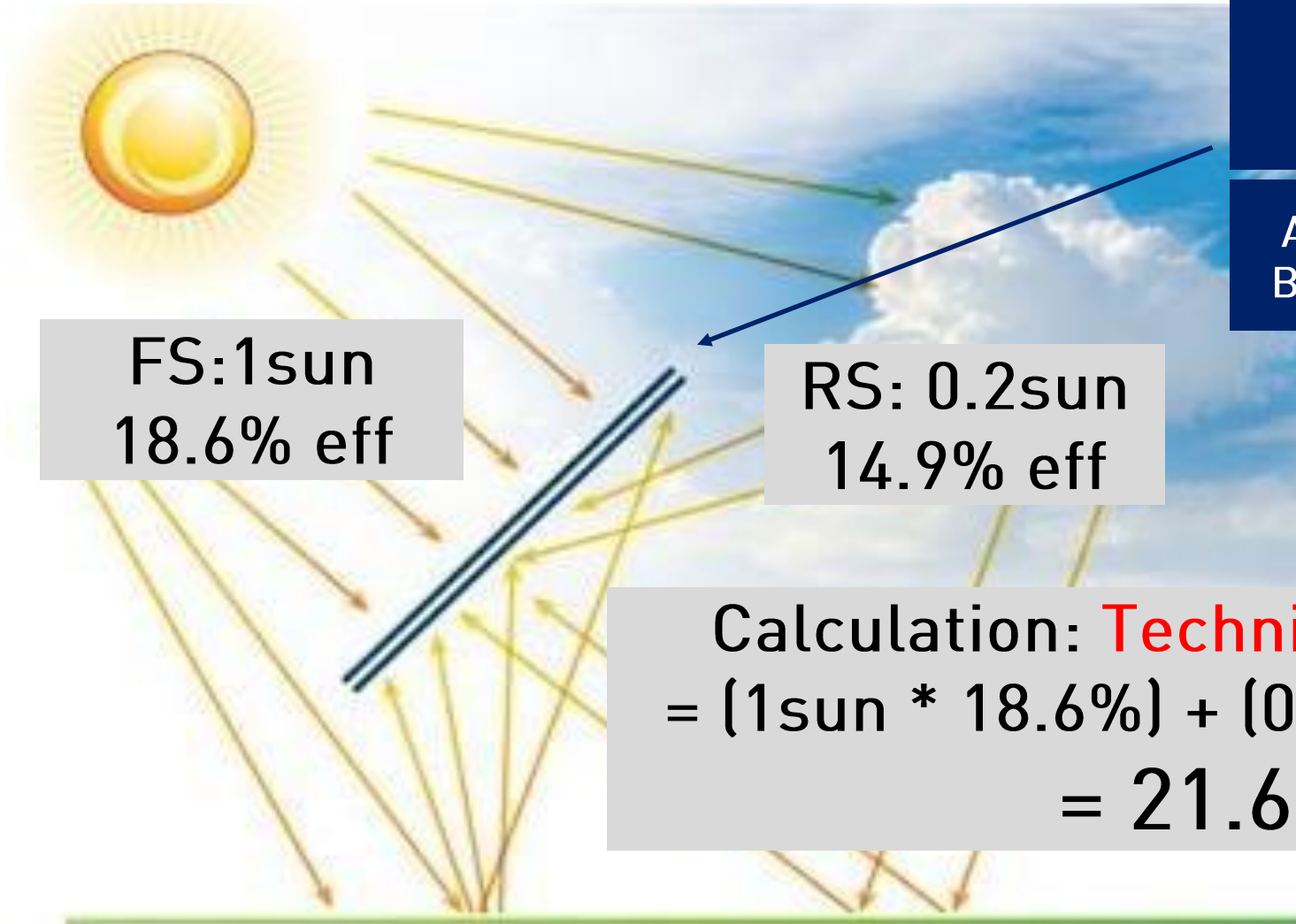


Production upgrade Ramp up Turnkey projects



Realise significant cost reduction for PV energy

- ▶ Increase light harvest by BIFACIAL cell structure
- ▶ Production of BIFACIAL solar cells on standard multi-crystalline p-type wafer (alternative p-Type Cz)
- ▶ Standard production equipment for BIFACIAL solar cell manufacturing



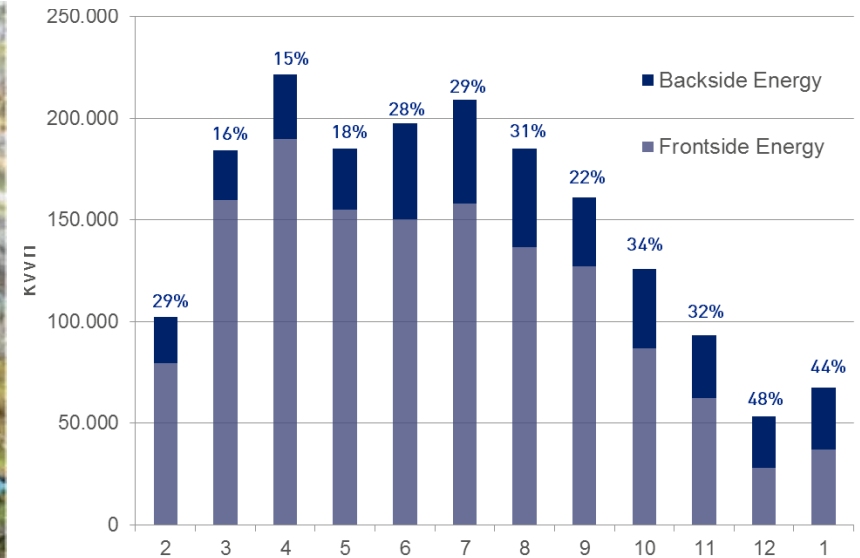
Multicrystalline
BIFACIAL cell

Additional light harvest by
BIFACIAL module rear side

FS: 1sun
18.6% eff

RS: 0.2sun
14.9% eff

Calculation: **Technical Efficiency**
= (1sun * 18.6%) + (0.2 sun * 14.9%)
= 21.6%

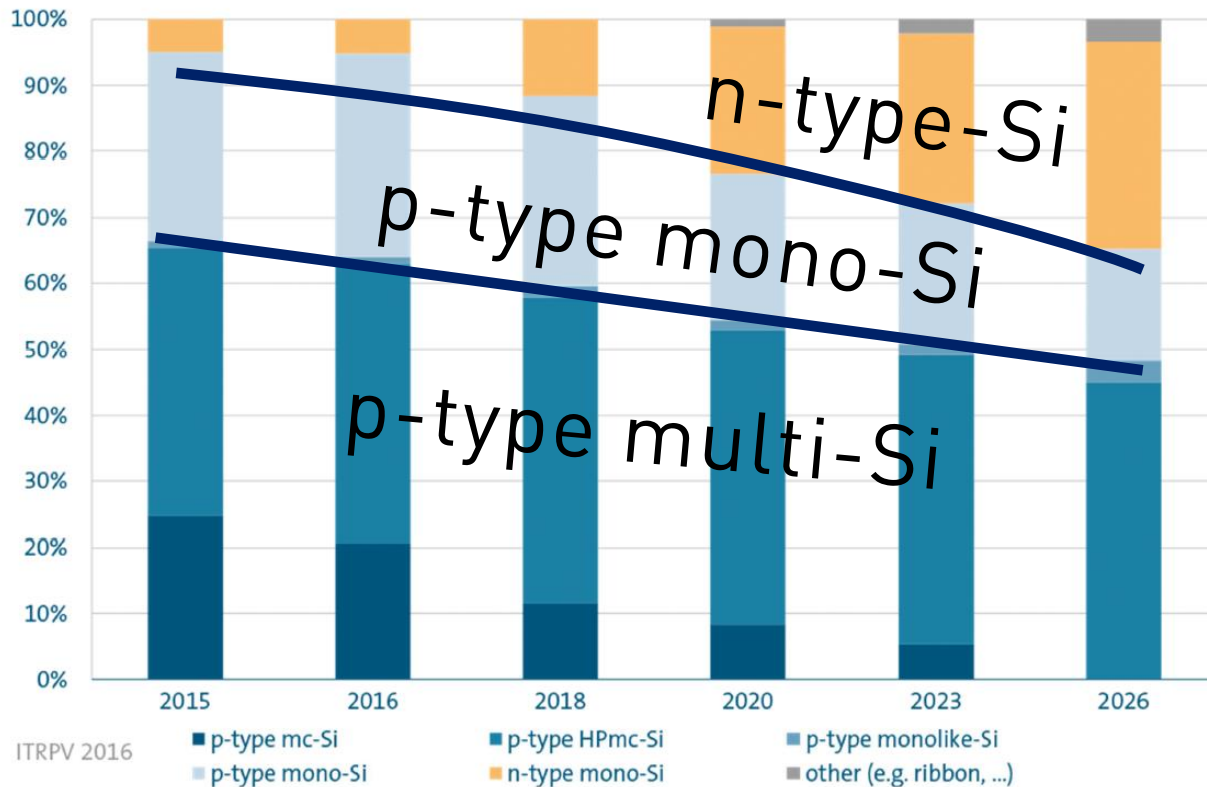


Source: Nishiyama Sakata Denki Co Ltd Annual Energy Performance Data

PVG Solutions

- Structure: EarthOn PERT
- Cell: n-type
- Location: Asahikawa, Japan
- Duration: Feb 2014 - Jan 2015

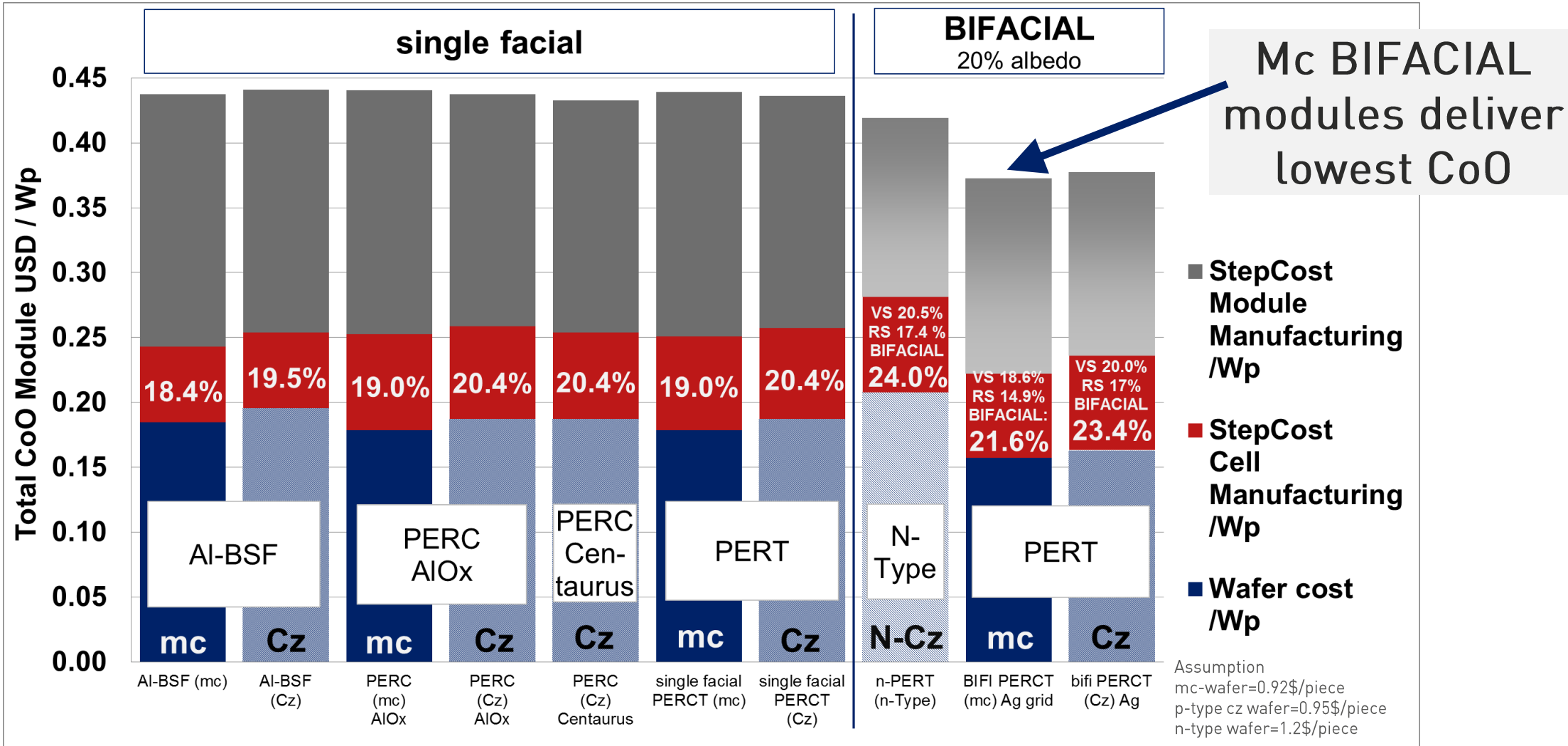
**Annual Bifacial
Energy Gain:
+ 21.9%**



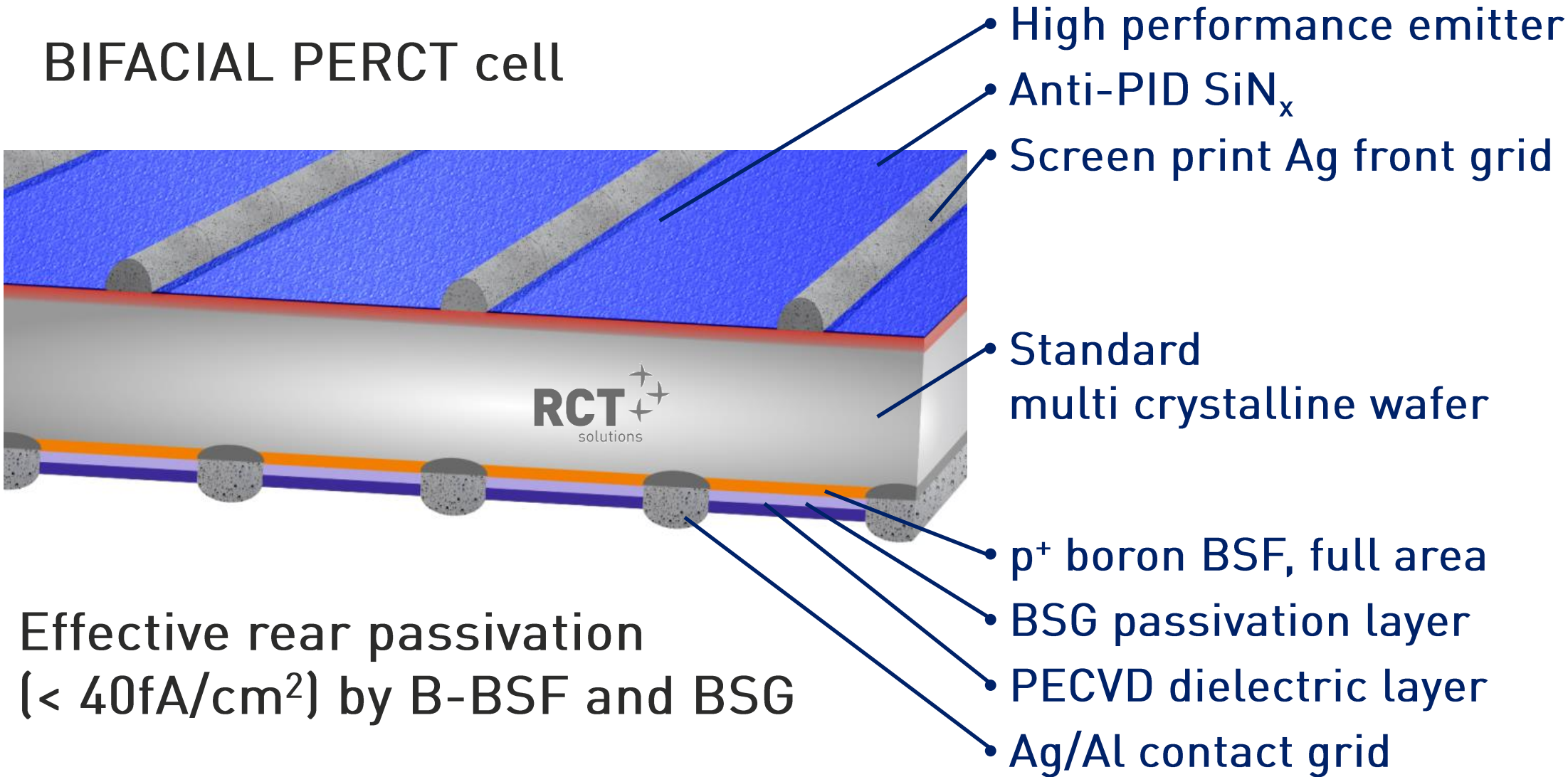
- ▶ High market share for p-type wafers until 2026
- ▶ p-type wafers and corresponding processes are well established

Source: ITRPV roadmap 2016

Module Cost for different Technologies

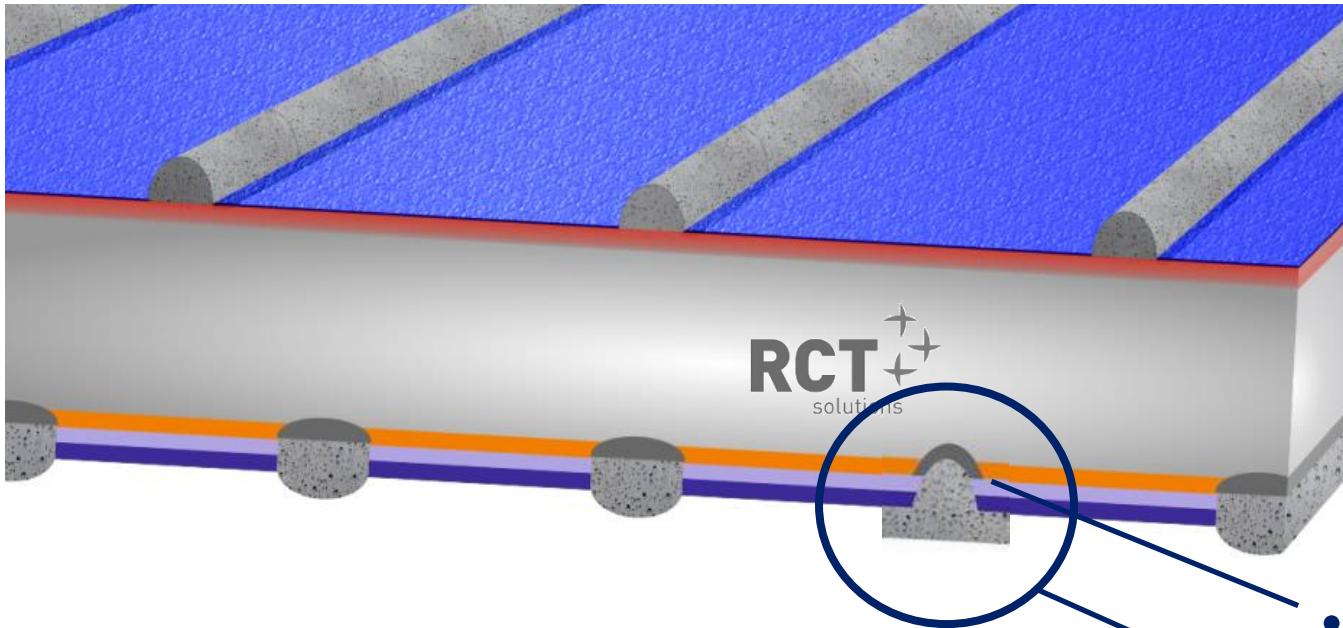


BIFACIAL PERCT cell



Effective rear passivation
($< 40\text{fA/cm}^2$) by B-BSF and BSG

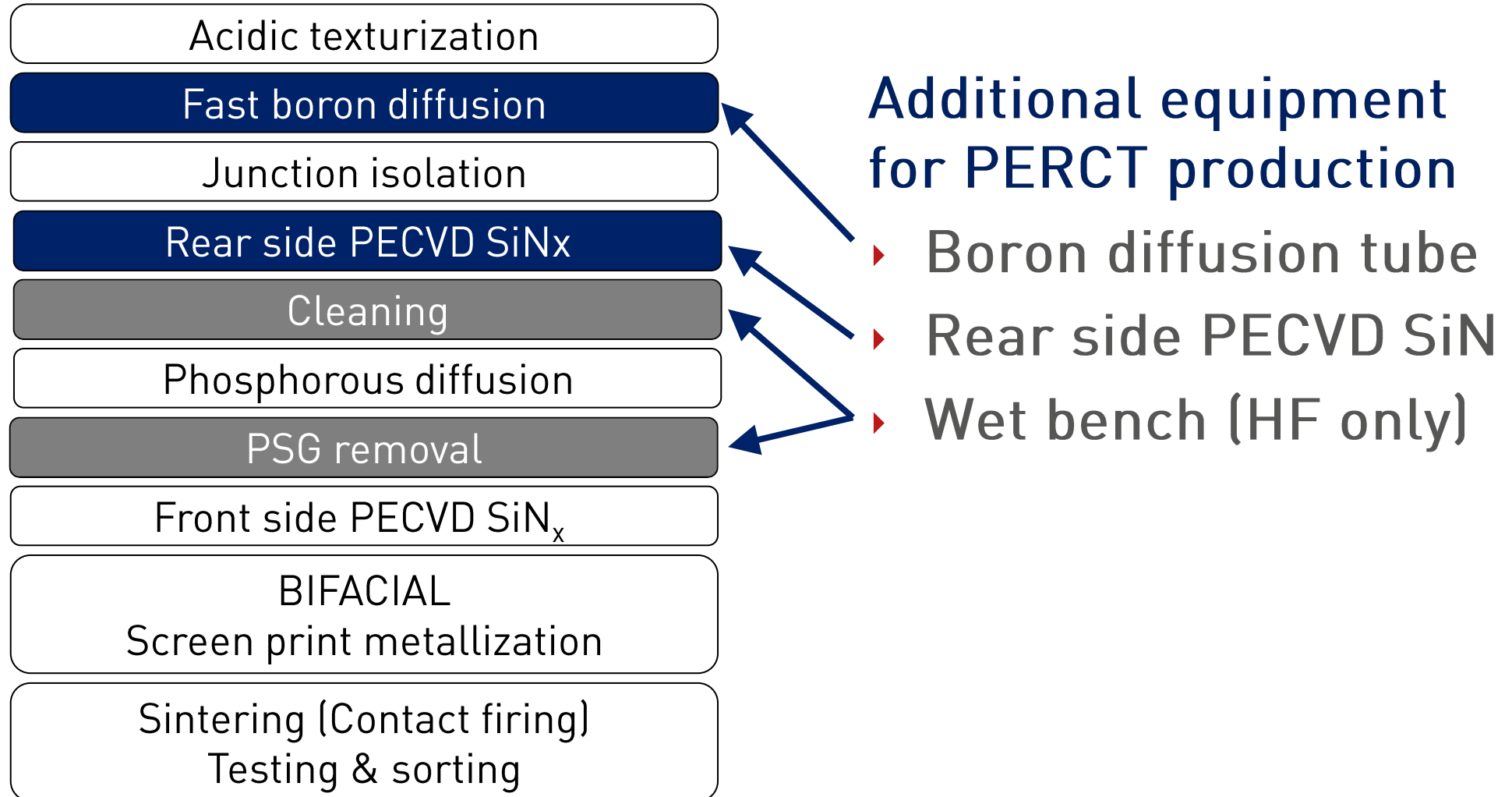
BIFACIAL PERCT cell

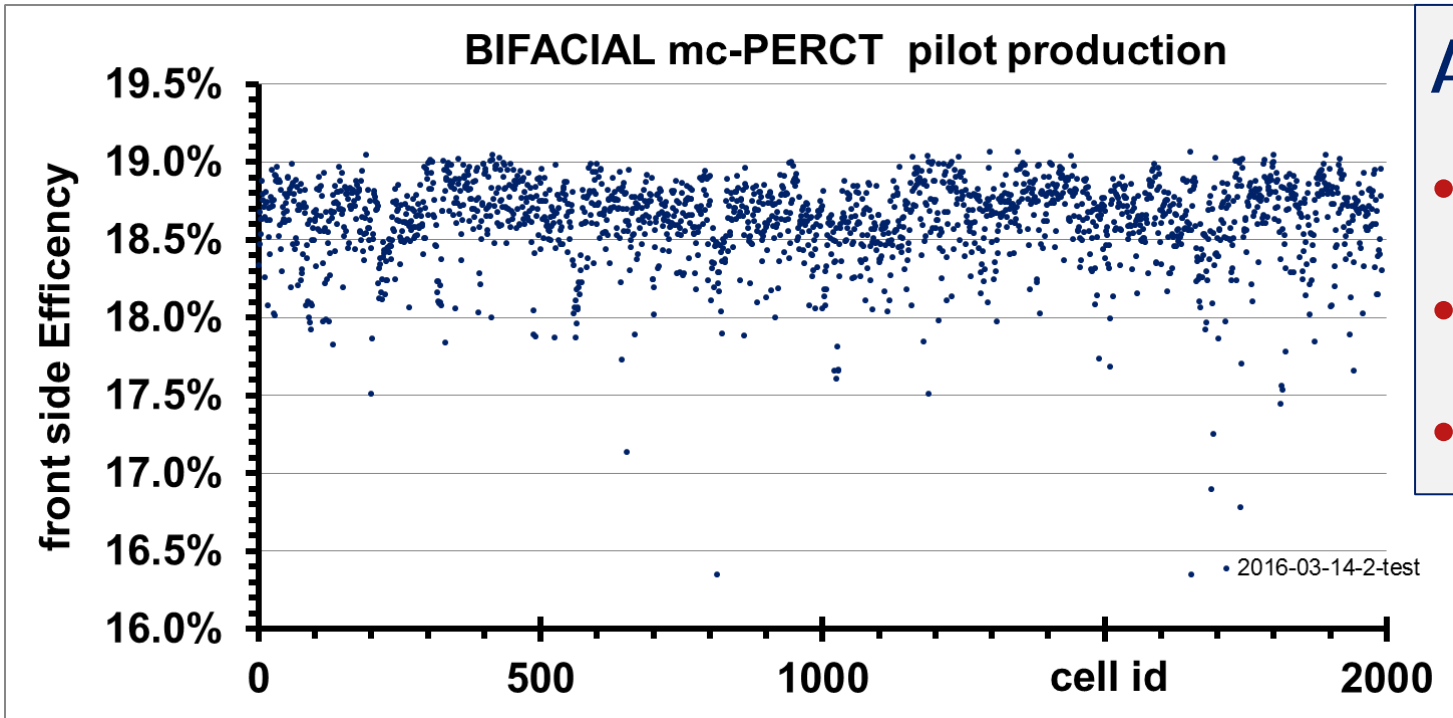


Bifacial Aluminium
rear contact Grid

- Laser opening
- Aluminium contact grid

Mc-BIFACIAL PERCT process

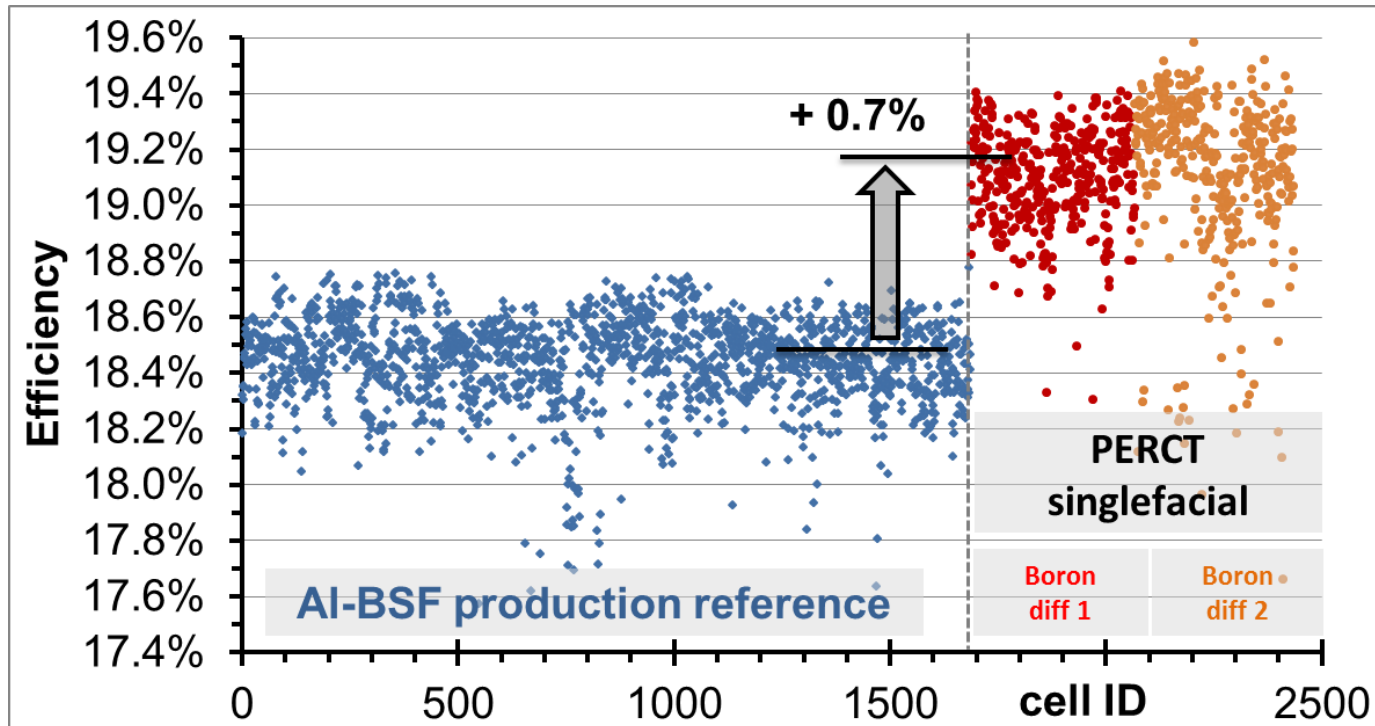




Average efficiency's

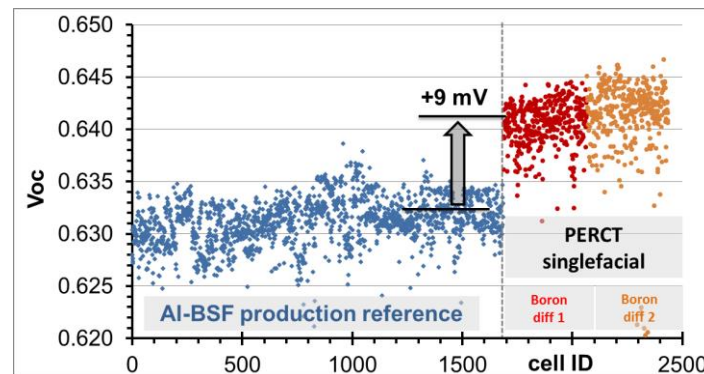
- Front side 18.6%
- Rear side 16.1%
- Bifaciality 86%

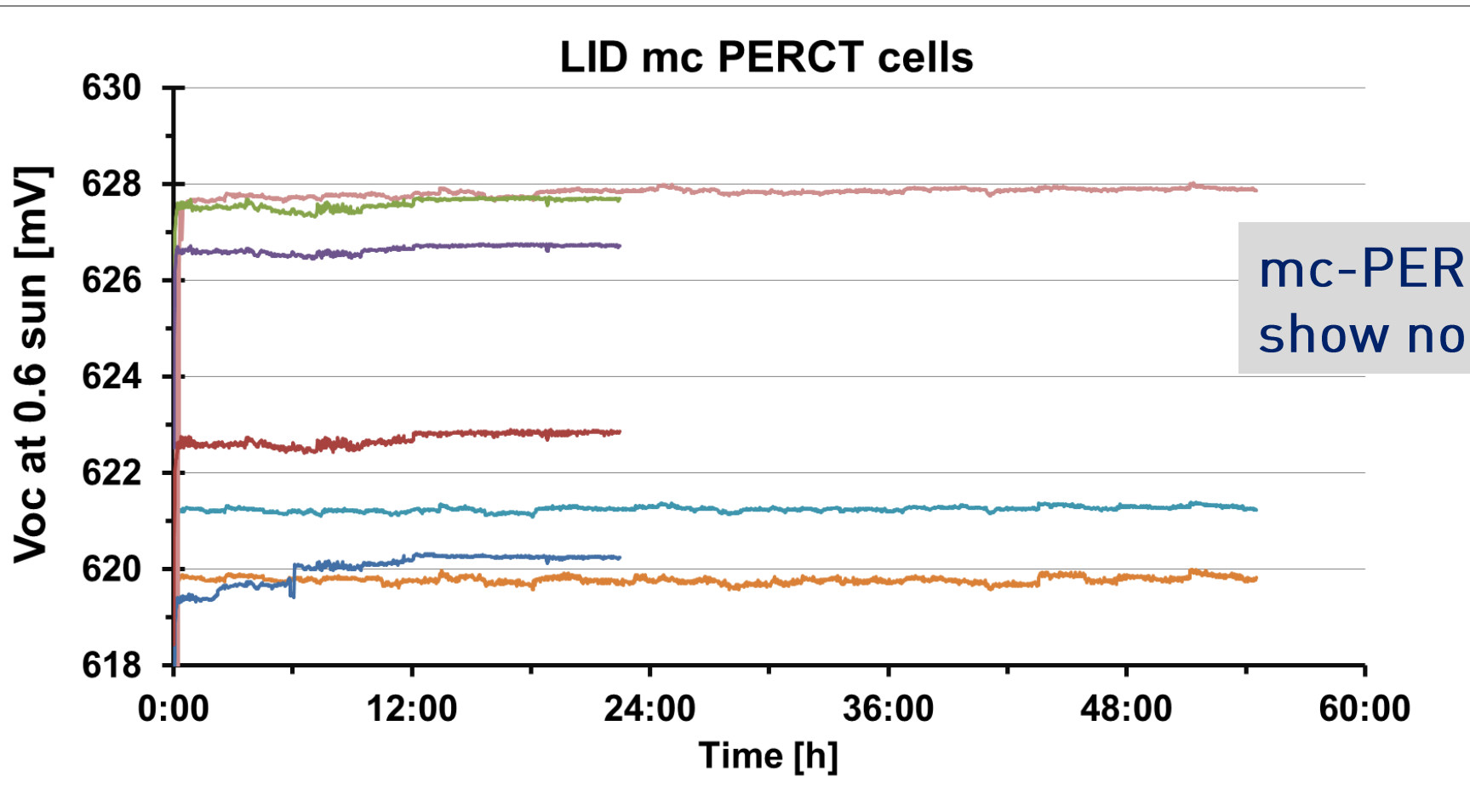
Module ID	average cell Eff.	back sheet	CTM loss	Module power front (1sun) [W]	Module power rear (1 sun) [W]	technical power 1.0 sun front + 0.2 sun rear [W]
P6016SY087	18.47	transparent	2.4%	265.8	167.5	299
P6016SY088	18.47		2.0%	266.9	165.6	300
P6016SY089	18.57		2.5%	267.0	163.4	300
60 cell	18.5	transparent	2.3%	266.6	165.5	300

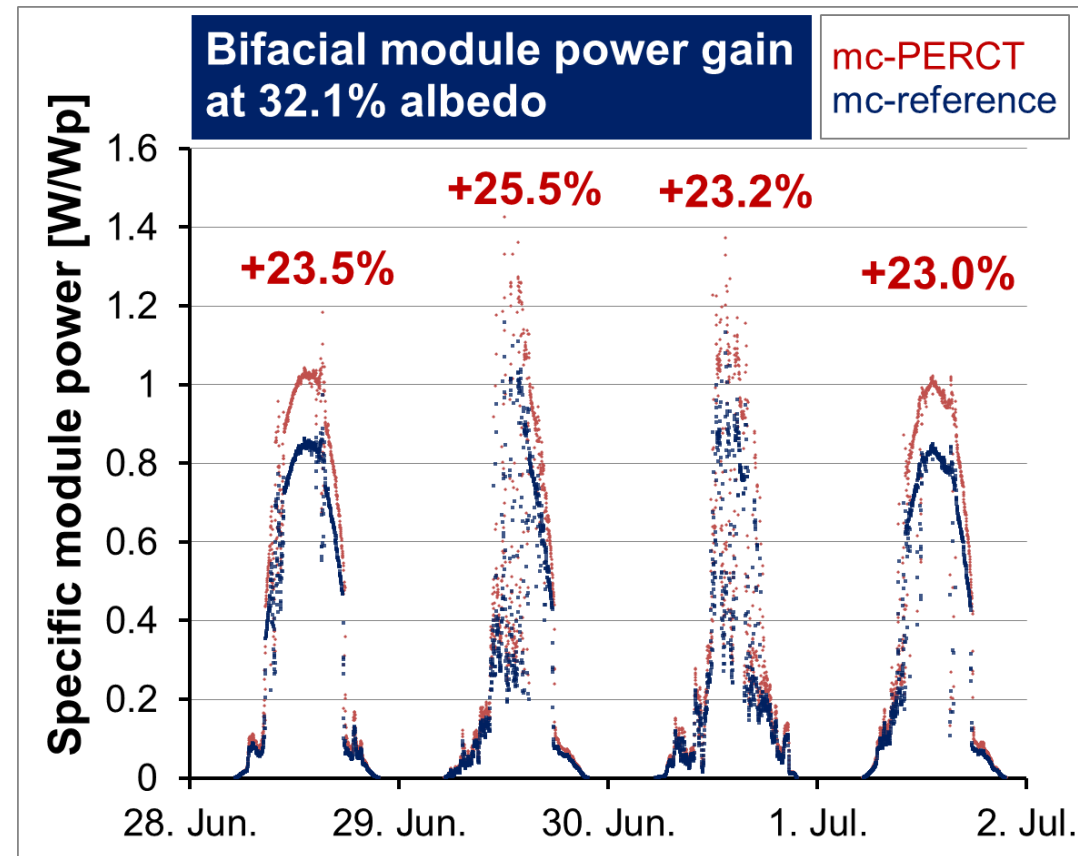
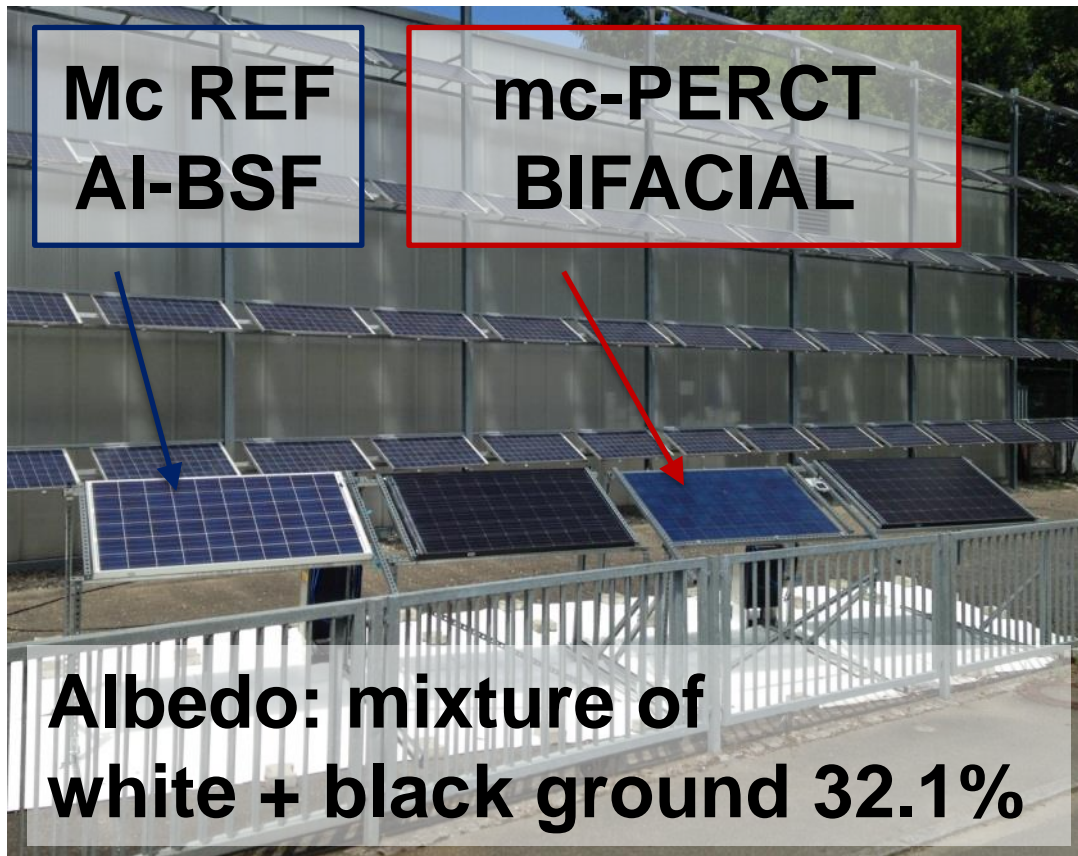


Average efficiency

- Eff gain 0.7%
- Eff 19.1%
- +9mV





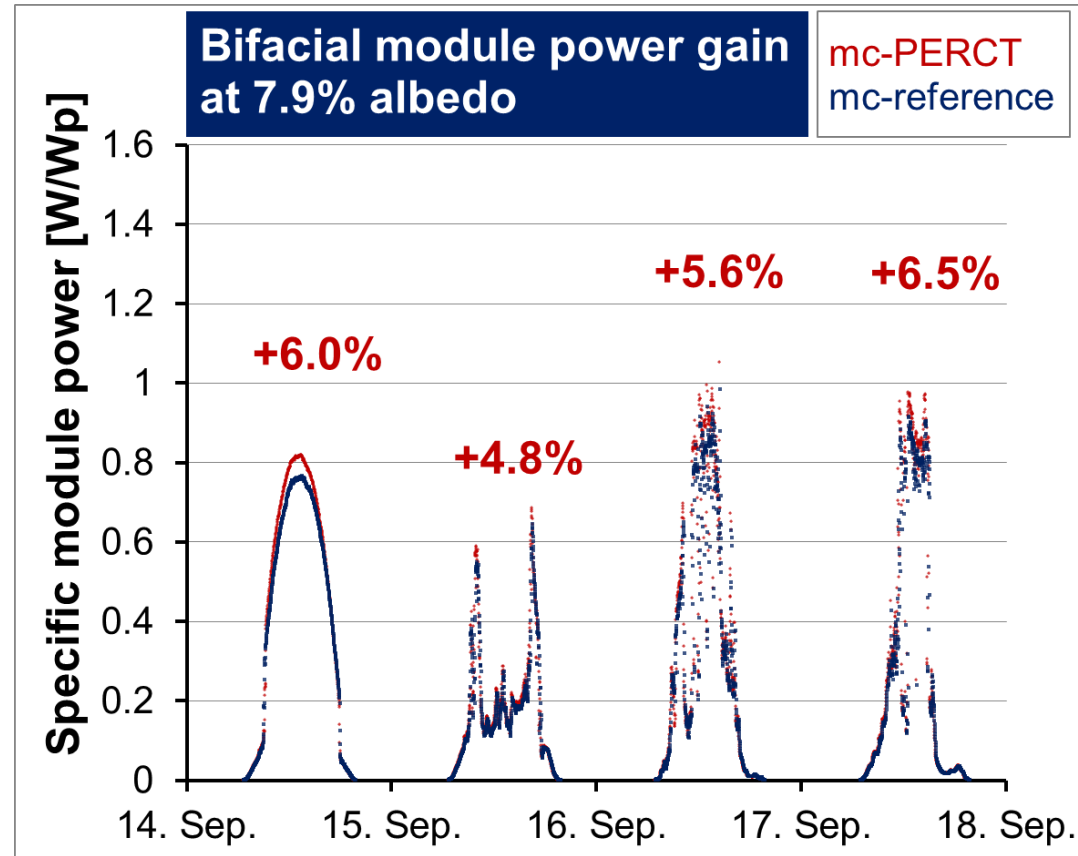


Estimation of bifacial gain

32.1% albedo * 80% bifaciality = 25.7%

Measure :

+23.0%...25.5%



Estimation of bifacial gain

7.9% albedo * 80% bifaciality = **6.3%**

Measure :

+(4.8) ... **5.6%** ... **6.6%**

mc-PERCT BIFACIAL

- ▶ Average front side eff + 18.6%, >85% bifacial factor
- ▶ 15% cost reduction on module level at 20% albedo
- ▶ No LID
- ▶ Albedo determine additional bifacial energy harvest
- ▶ Optional: Rear side aluminium grid metallization
- ▶ Next step: Set up of pilot PV plants

Thank you for your attention!