# IBC4EU - Bringing Solar Cell and Module Production Back to Europe

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Intersolar 2023

Munich

ISC research
for a sunny future

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No.101084259

# Motivation

- “We need to bring manufacturing back to Europe and the Commission is willing to do whatever it takes to make it happen. ” *Speech by Commissioner Simson at Solar Power Summit, 31.03.2022*

# Motivation

## N-TOPCon - Dual Process Route - Whole Line Equipment

| Step | Equipment | Process Flow | Application Cases |
|---|---|---|---|
| 1 | Batch-type Mono Texturing Equipment | Texturing & Cleaning | 90% clients below |
| 2 | LP Boron Diffusion Furnace | Front Boron Diffusion | Some clients below |
| 3 | Inline BSG Removal + Batch Rear Etch Polishing Equipment | Rear side wrap around deposition BSG removal + Rear side Etch Polishing | 90% clients below |
| 4 | LPCVD + LP Phosphorus Diffusion Furnace | Rear side Tunnel oxide $SiO_2$ | Jinko Solar (34GW), Jietai Solar(10GW), CHINT(2GW), DAS Solar(3GW), ZhongQing Photovoltaic (0.5GW), total 68.5GW (further expansion Jinko f5GW, Jietai Solar 13GW) |
| 5 | | Rear Poly-Si | |
| 6 | | Rear Phosphorus Diffusion | |
| 6 | PECVD (Three-in-one) | Tunnel Oxide $SiO_2$+Poly-Si+P-diffusion | Trina Solar (21.5GW), JA Solar (7.5GW), Canadian Solar (3GW),TONGWEI (9GW) Runergy (12.5GW), Solar Space (9GW) ,Mubang High-tech (10GW), GERI Solar (5GW),HeSheng (5GW), Anhui Daheng Energy(3GW), SUNTECH (1GW), Yingfa Group (1GW), BYD (1GW), Adani (4GW), Waaree (4GW), total 156GW( further expansion JA Solar 30 GW, Tongwei 36GW Runeregy 16GW) |
| 7 | Inline Single Side Cleaning Equipment + Batch RCA Cleaning Equipment | Front side wrap around deposition PSG removal | 90% clients above |
| 8 | | Front side Poly-Si removal | |
| 9 | | Front & Rear side BSG/PSG removal | |
| 10 | | Cleaning | |
| 11 | Horizontal PECVD (Two-in-one) | $SiO_2$ $AL_2O_3$ SiON SiN | 90% PECVD clients above |
| 12 | Horizontal PECVD | SiN | |
| 13 | Metallization, Firing | | Some clients above |

SC China

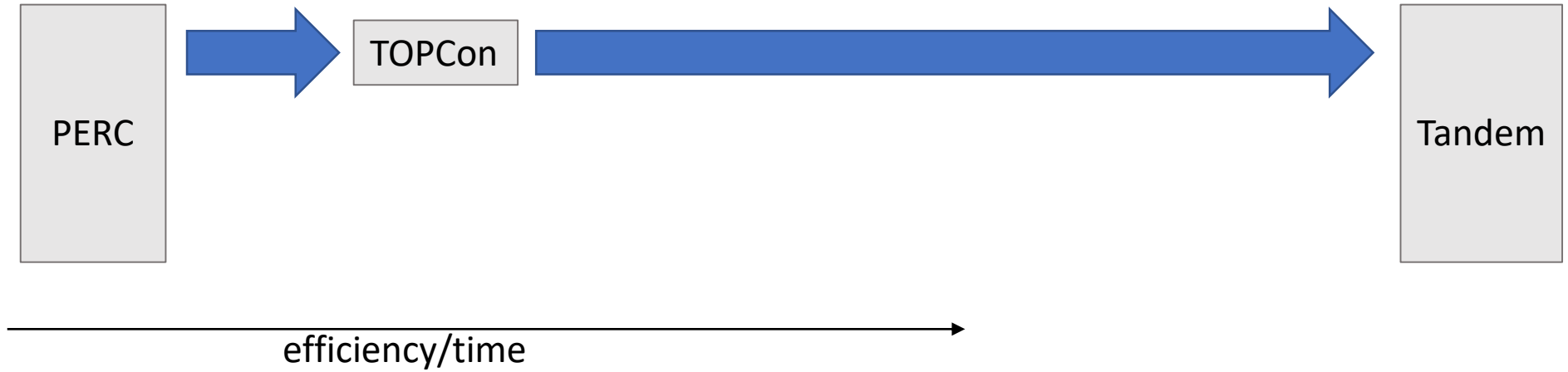
- Dynamic market
- TOPCon taking over

68 GW LPCVD

156 GW PECVD

# Motivation

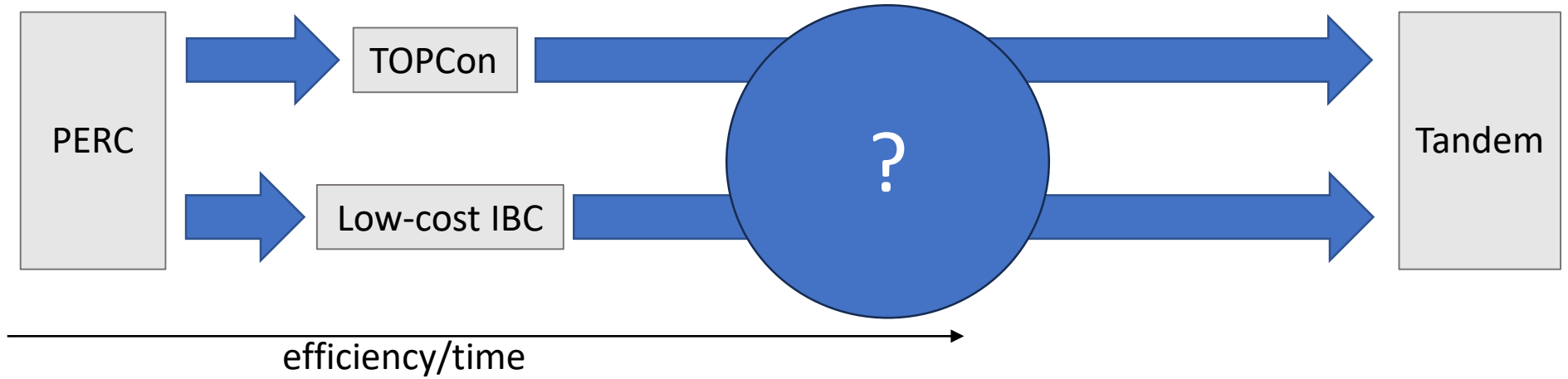
- Technology evolution ongoing




➲ How to close the gap until tandem becomes feasible?

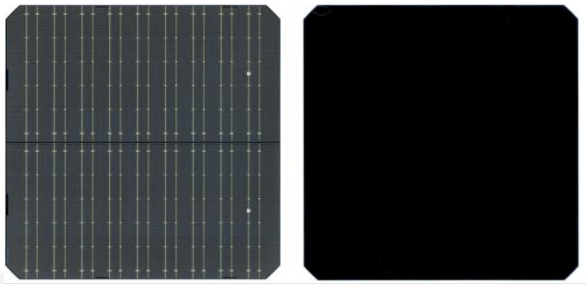
# Motivation

- Alternative approach




**ZEBRA cell**

- Half-cut, bifacial option
- Standard technology, screen printing
- Low costs



http://en.spicsolar.com/default/single/430.html

# IBC4EU - Bringing Solar Cell and Module Production Back to Europe?

To develop and demonstrate **at pilot line level** cost-competitive and sustainable industrial production of **IBC based PV products along the value chain**: from **ingots** and **wafers** to **solar cells** and **modules**.

# Project overview

Program: Horizon Europe

Coordination: ISC Konstanz

Duration: 36 months

Start date: 01.11.2022

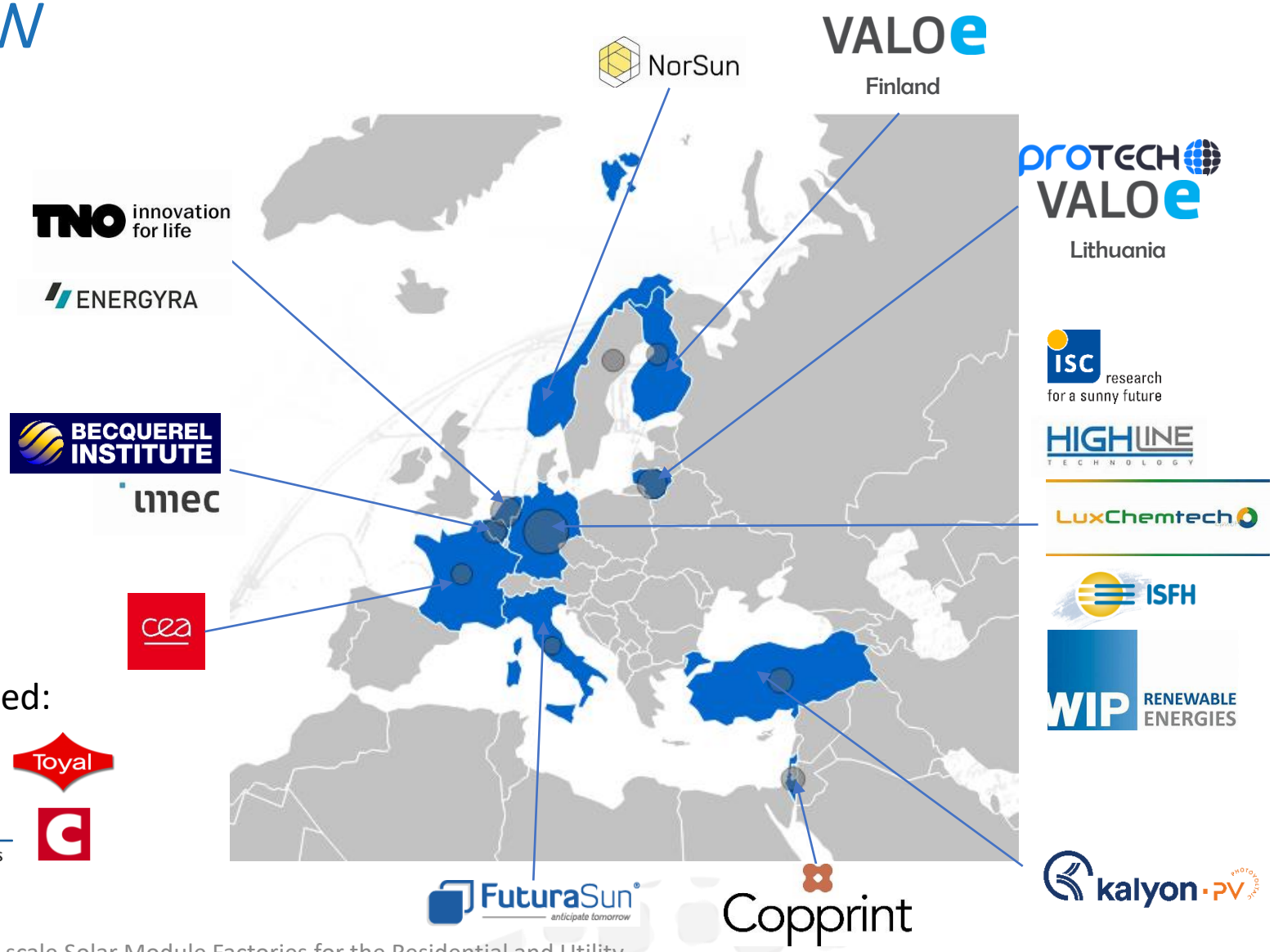
Funded partners: 17

Associated partners: 4

EU funding: ~14 mio €

Estimated budget: 17 mio €

EURECA




Associated:

R|E|N|A|. Toyal

LPKF Laser & Electronics

# Project overview

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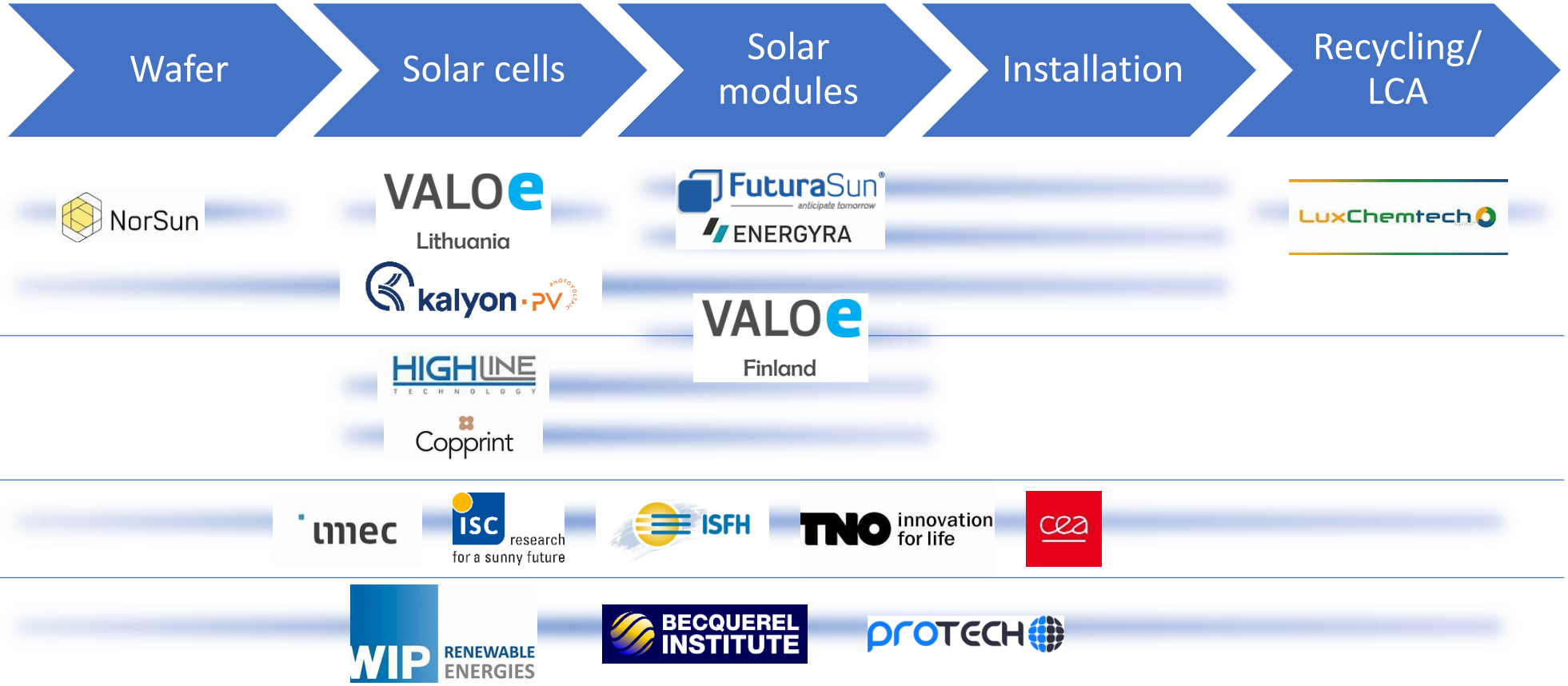
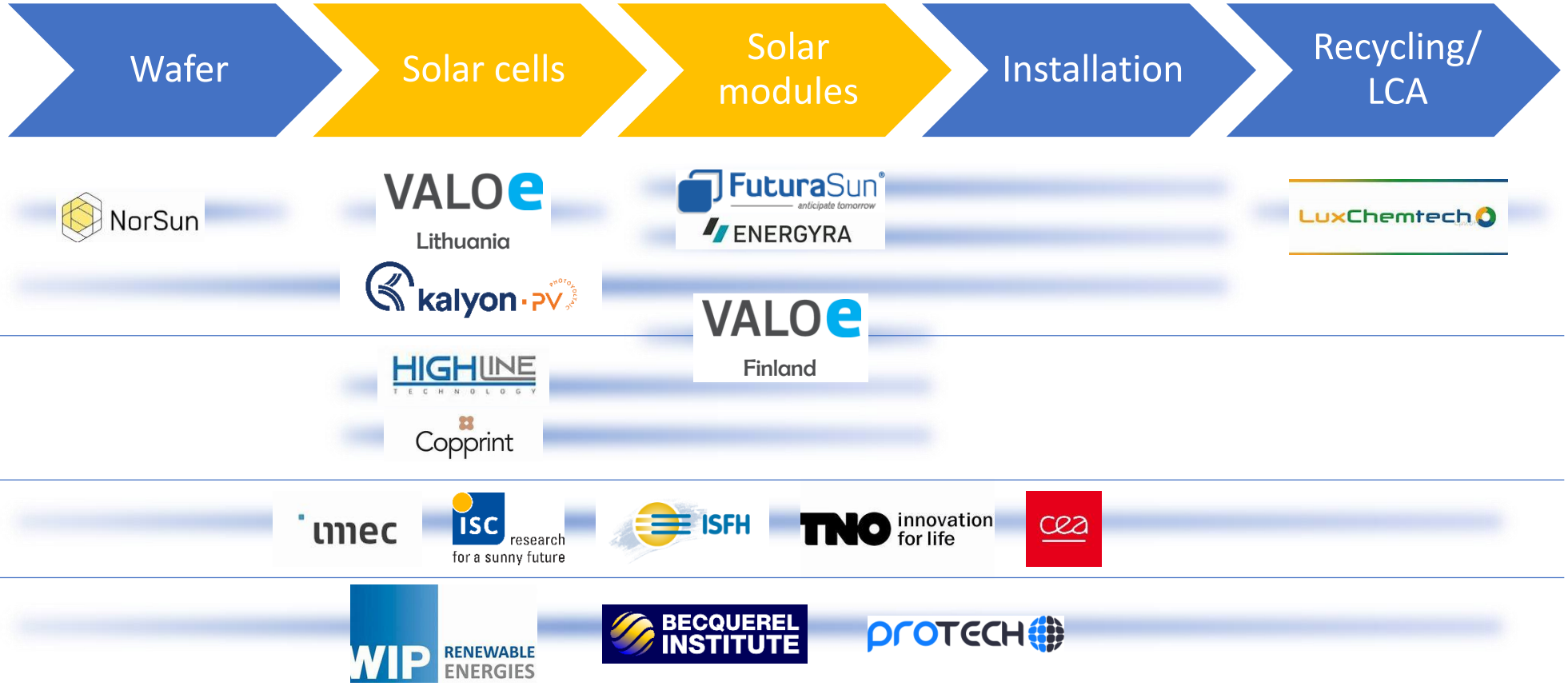
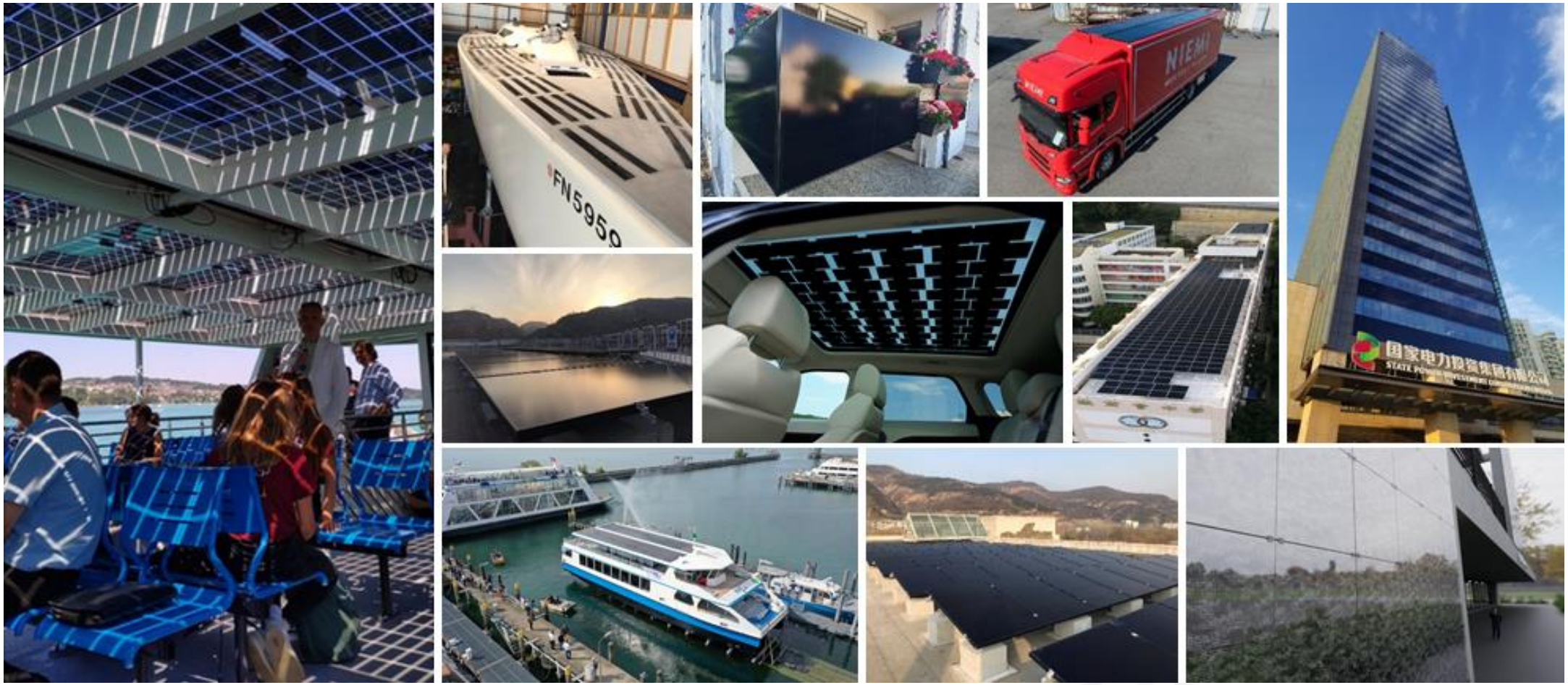


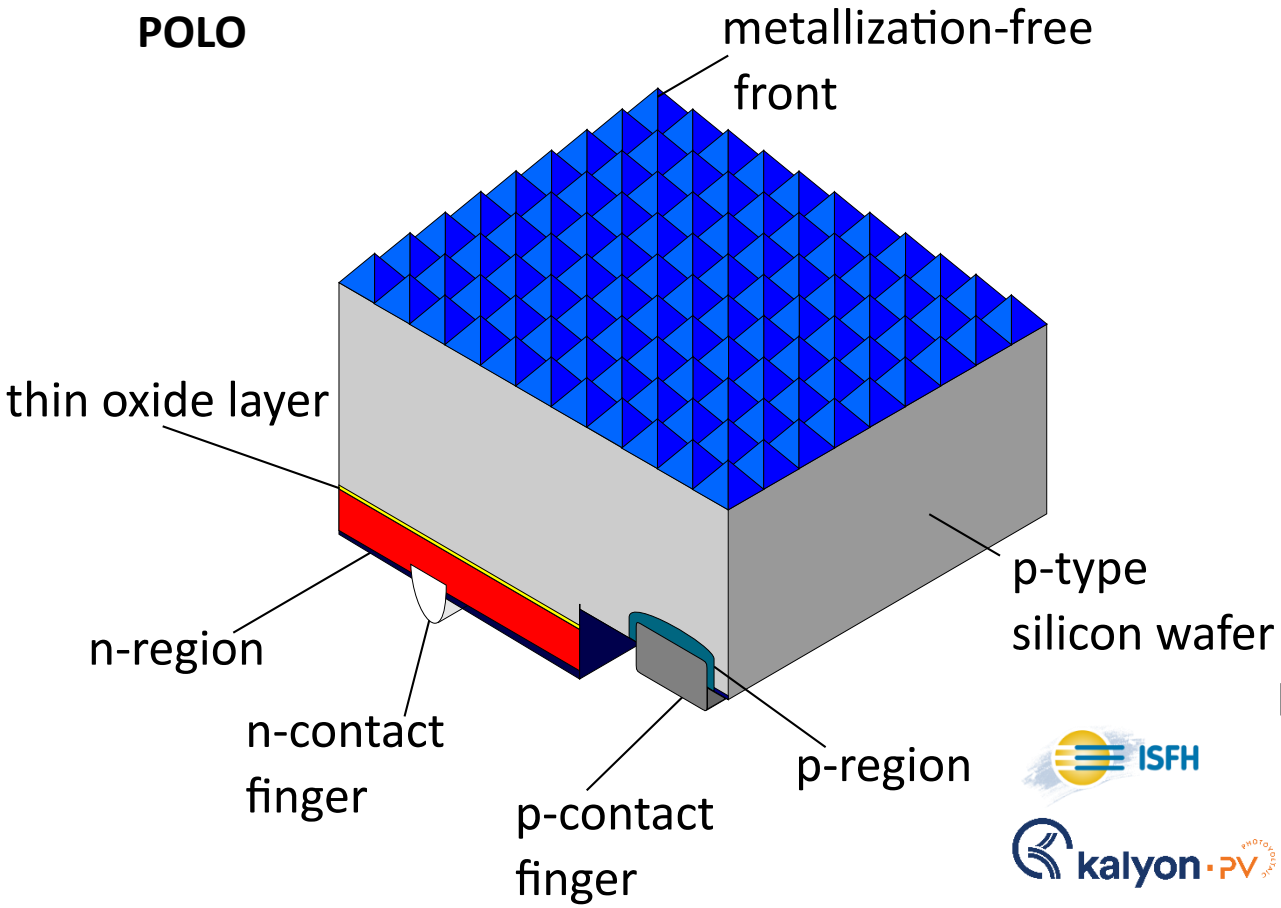
# Project overview

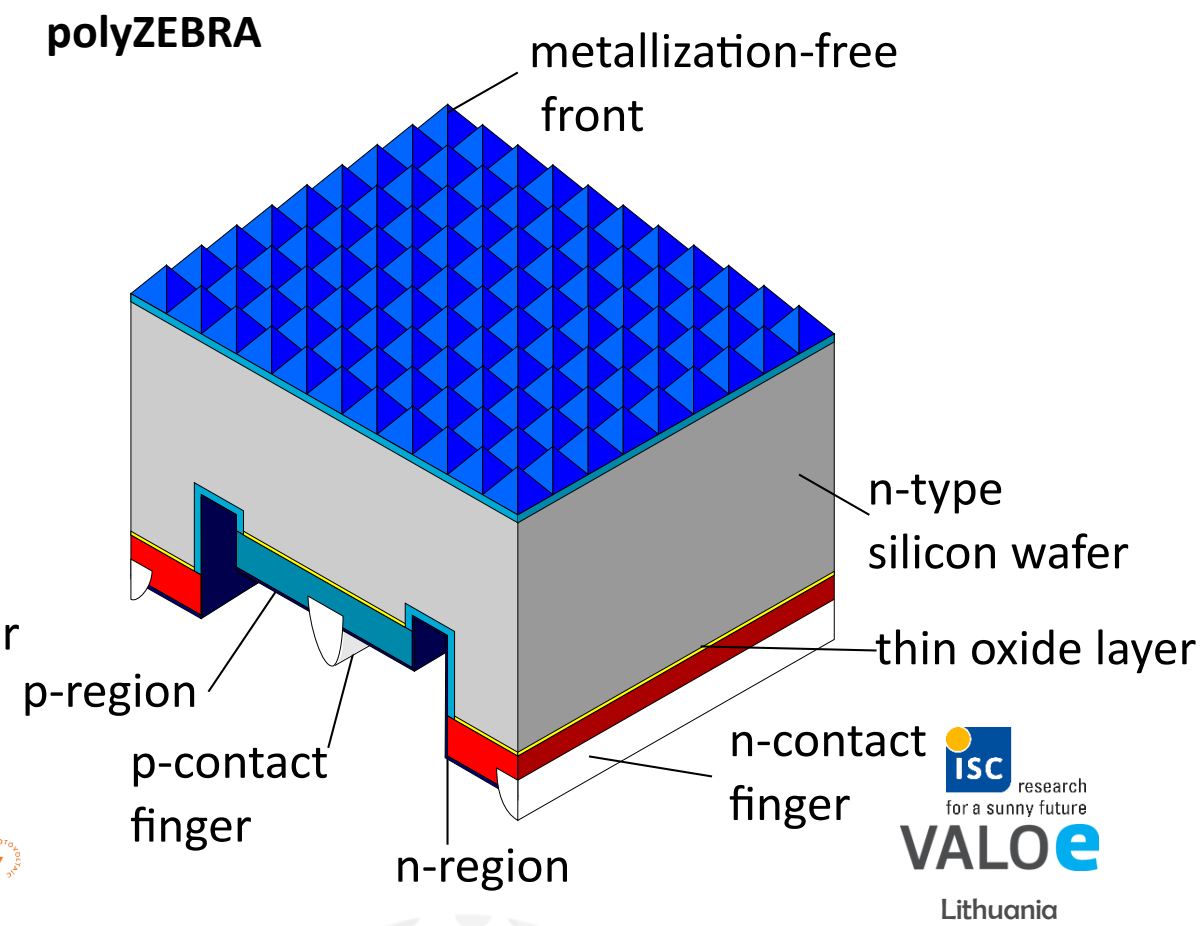


# Why IBC?



# Low-cost IBC upgrade (TOPCon (I)BC = TBC, hybrid pBC HPBC)



# Low-cost IBC upgrade

**POLO**

- Largely based on PERC+ production equipment
- Very lean process sequence
- Efficiency goal: 25%

**Innovations:**

- Local deposition of poly-Si by shadow mask PECVD
- Reduction of silver content

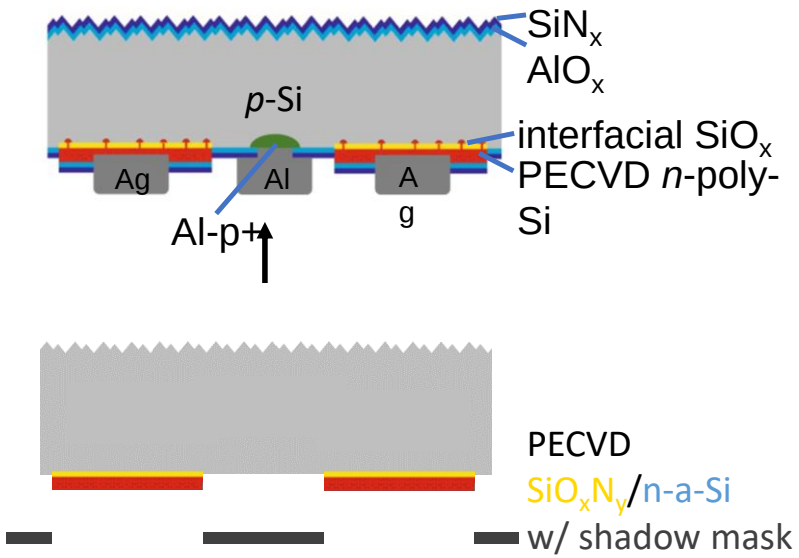
**polyZEBRA**

- Upgrade (100% compatible with ZEBRA back-end)
- Developed in Highlite (H2020)
- Efficiency potential: >25%
- IP secured

**Innovations**

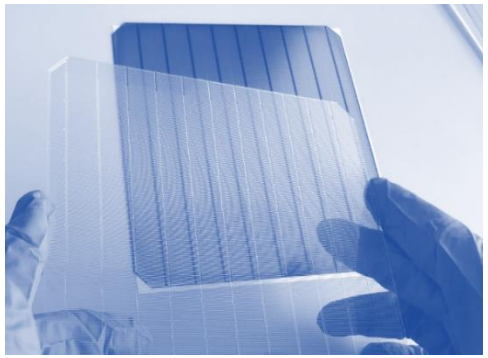
- Streamlined process for pilot production
- PECVD-based poly-Si depositions
- Hybrid metallization based on Cu screen printing

# POLO



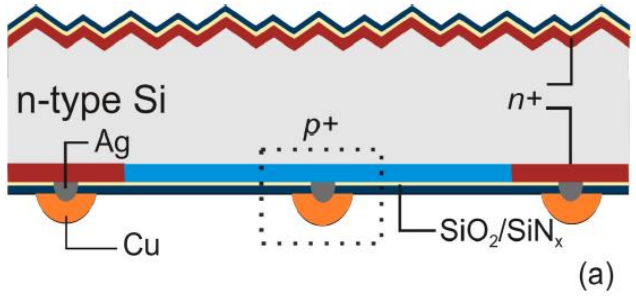

- Glass shadow masks for local PECVD SiON/n-poly-Si deposition enable a very cost-effective processing sequence
- Local PECVD process sucessfully transfered from lab-tool to industrial tool
- M2-sized POLO IBC solar cells using shadow masks in the industrial PECVD tool achieve $\eta$ = 23.8% with $V_{oc}$ = 720 mV[1]

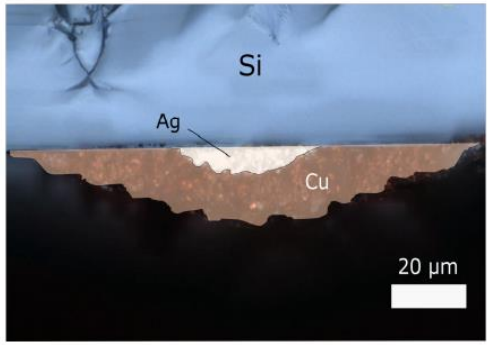
**Industrial tool:**
c.plasma tool from centrotherm

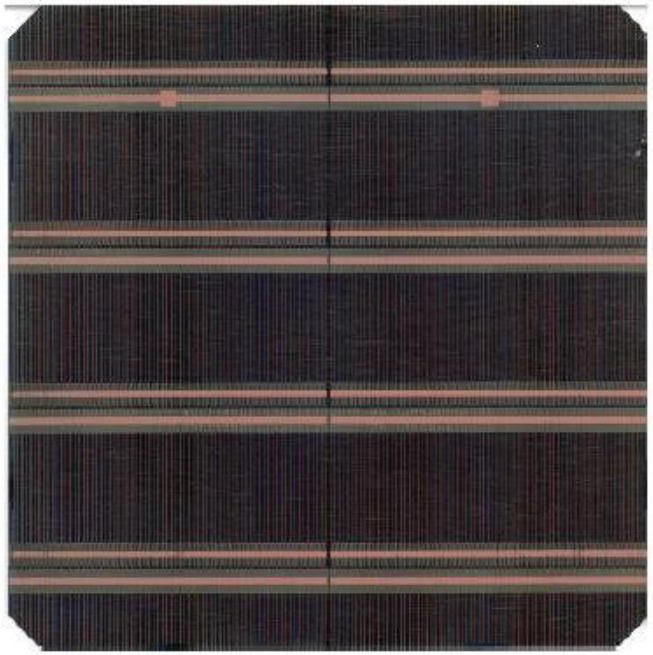


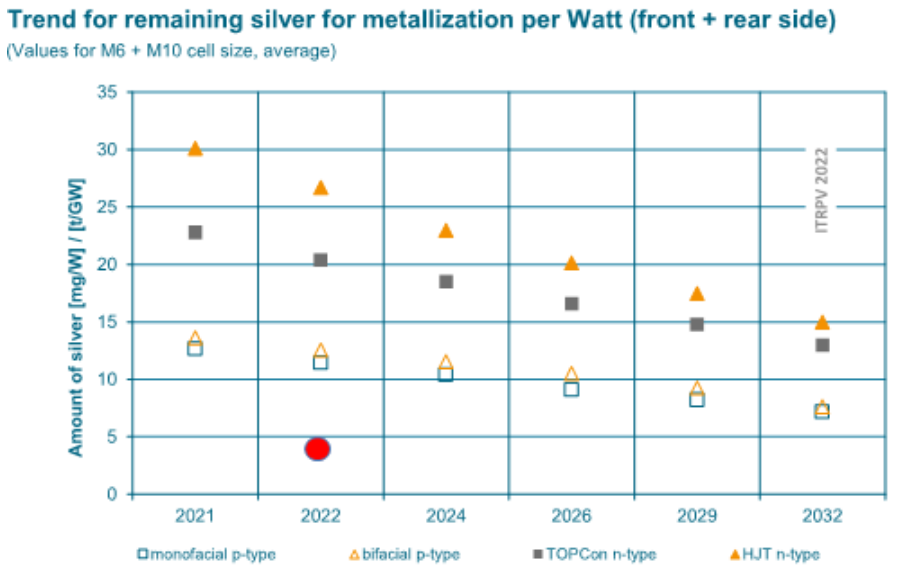
[1] *V. Mertens et al., EUPVSEC Conf. (2023), accepted as oral*

# Cu-ZEBRA




- All screen printing based
- Longterm stability has been demonstrated

N. Chen et al. Solar RRL 7.2 (2023):2200874
Buchholz, PVCellTech 2023
D. Rudolph, MIWS 2023

# Low cost bi-facial backsheet for Zebra IBC cells

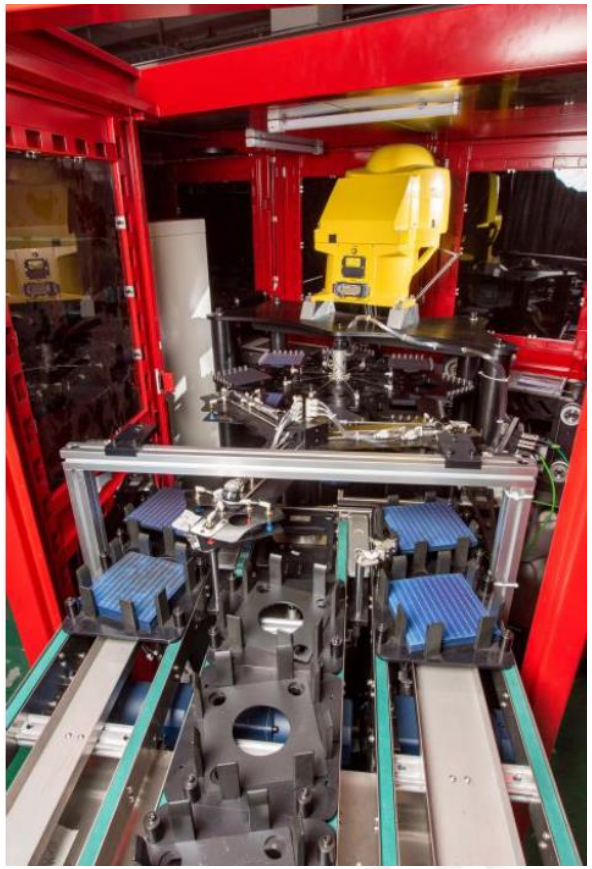
- High bi-faciality
- Cost similar to traditional stringing
- Both glass-glass and glass-foil construction possible
- Compatible with all back-contact assembly lines
- Easy change between different cell sizes, layouts, etc.

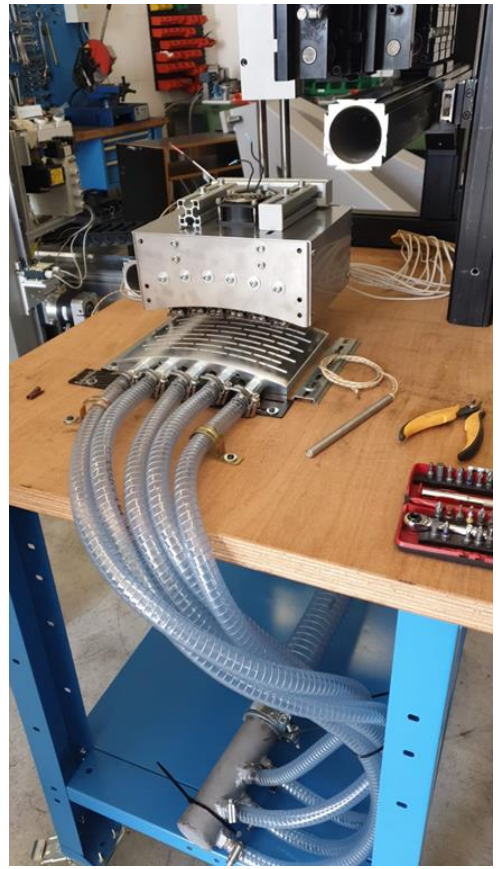
# Pilot scale manufacturing of back sheets

- Valoe will build 60MW pilot line in IBC4EU project
- The backsheet will be piloted by Valoe and other project partners
- Valoe will sell the manufacturing equipment and/or backsheet

# FuturaSun ZEBRA cell interconnection by stringing

- Patented stringing concept, optimize the system for multi busbar ZEBRA cells
- The soldered strings without mechanical tension → no problems in the module's lifecycle
- High throughput and ready for future technology evolvements

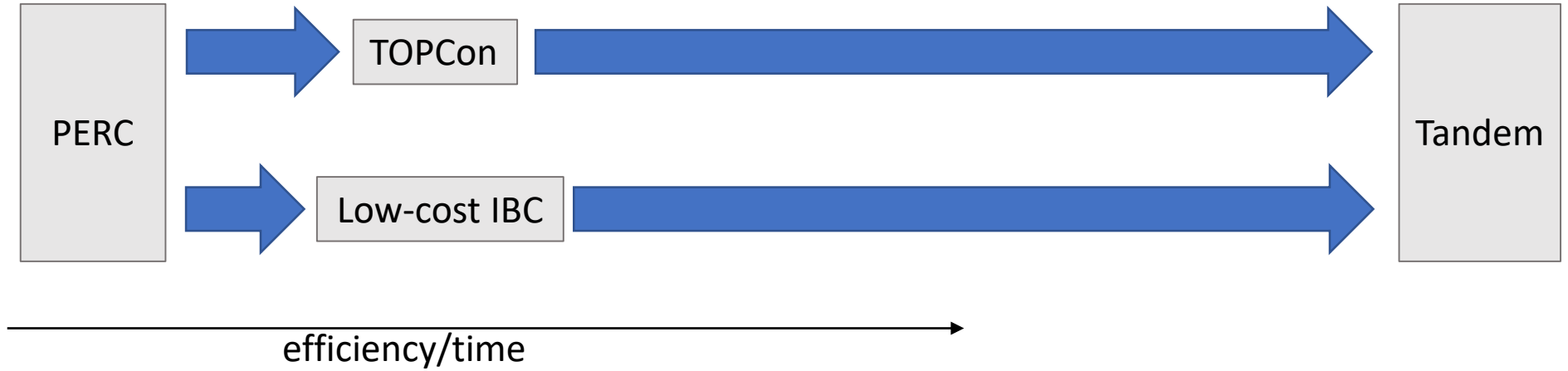




# Back contact module production

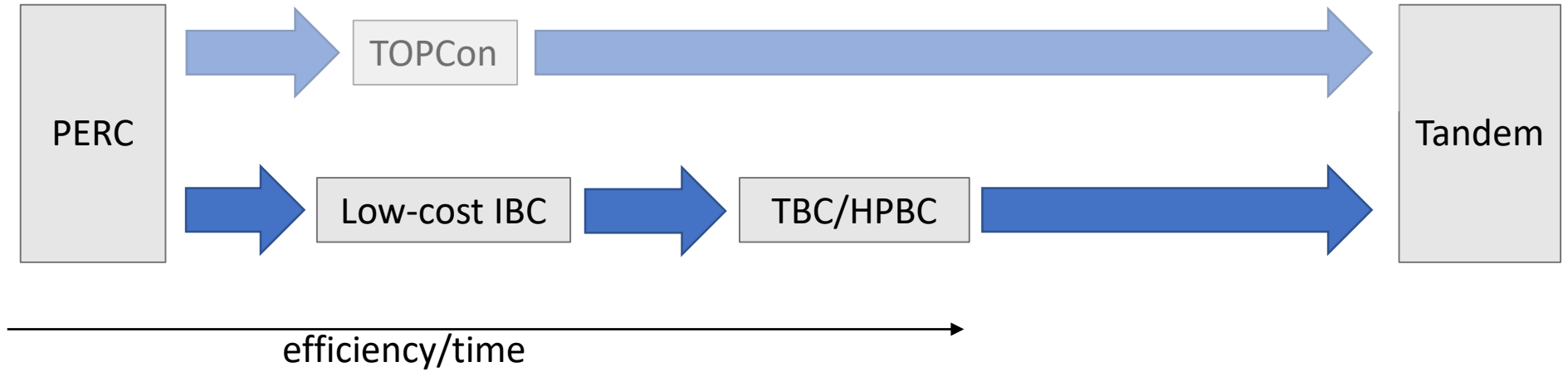
- Technology approach of Energyra is back-contact with copper foil interconnection.
- Production on Industry 4.0 scale 125 MWp and expanding to second production line in 2024
- Focus shifting towards lightweight glass-free PV (semi-finished) modules
- First results on IBC module production Q4-2022

# IBC4EU approach



# IBC4EU approach

Pilot production in Europe ☑



# IBC4EU approach

Pilot production in Europe ☑

- Highest performance
- Excellent aesthetics
- European equipment available
- Supply chain in Europe for most critical materials available

**NEXT:** Mass production (GW scale) **?!**

IBC4 EU

# Thank you!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## Project Partners

ISC, PROTECH, FuturaSun, NorSun, imec, ENERGYRA, cea, BECQUEREL INSTITUTE, WIP RENEWABLE ENERGIES, Copprint, LuxChemtech, TNO innovation for life, ISFH, HIGHLINE, VALOE Lithuania, VALOE Finland, kalyon PV

## Associated Partners

C, LPKF Laser & Electronics, Toyal, 東洋アルミ, RENA

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No.101084259