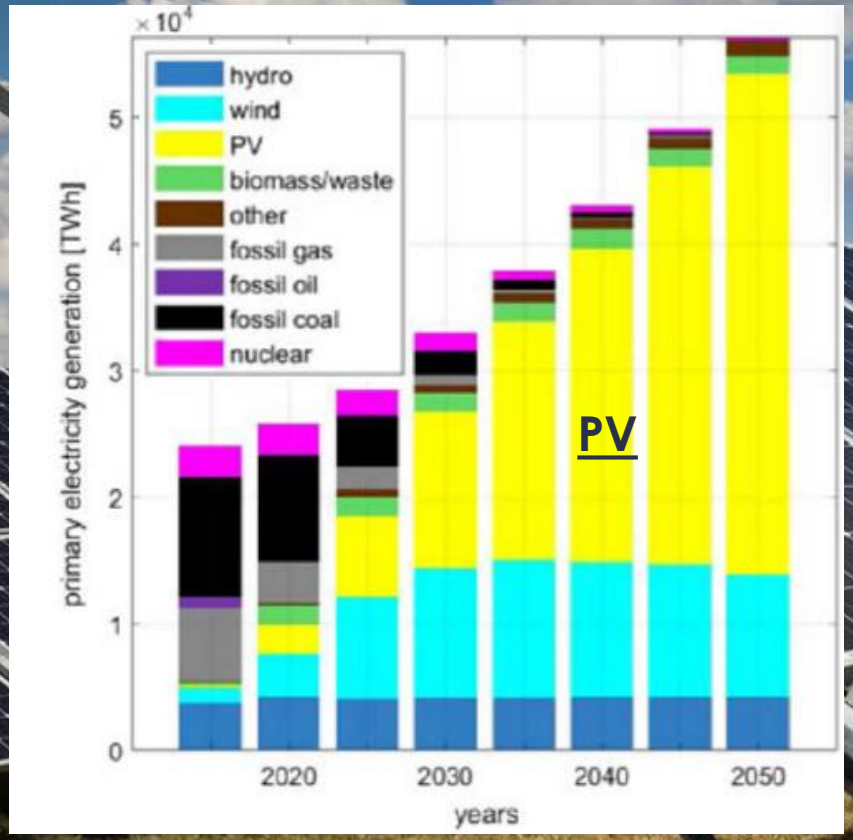
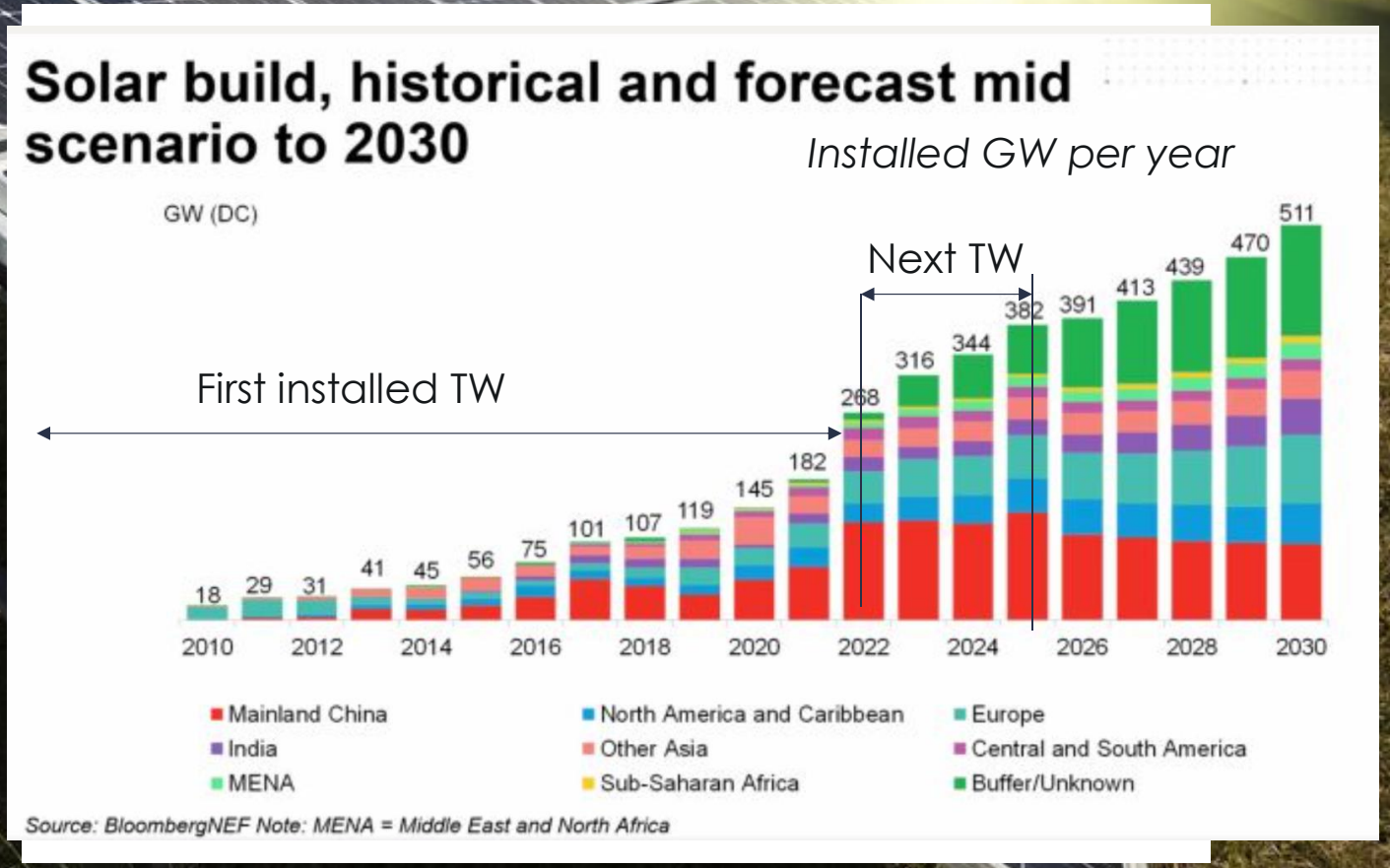
From new generation mainstream Photovoltaic technologies to optimized integration for buildings, agriculture and transport

Matthieu Despeisse / 01.12.2022

The PV ERA is just starting



https://ieeexplore.ieee.org/document/9837910



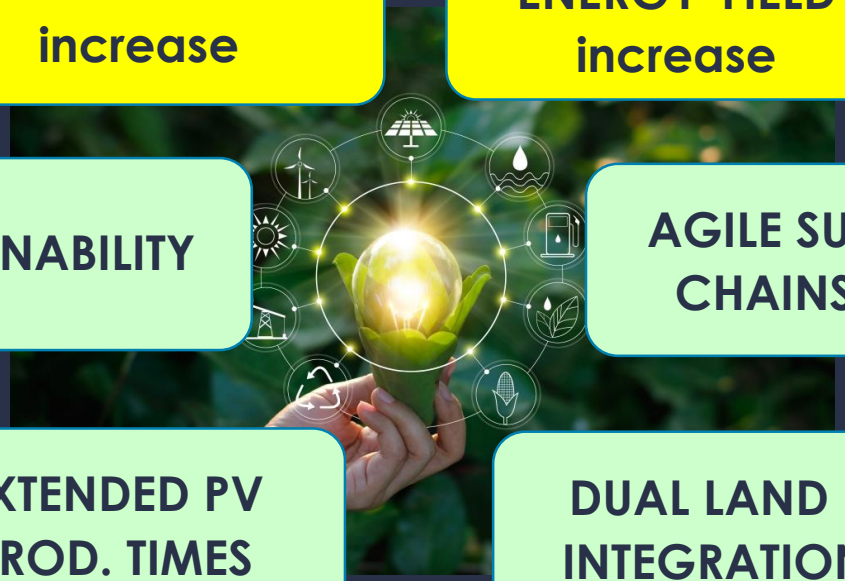
PV Module low cost + TW scale + large electricity contribution to global mix

Drivers of Technological improvements on going for PV Modules

EFFICIENCY increase

ENERGY YIELD increase

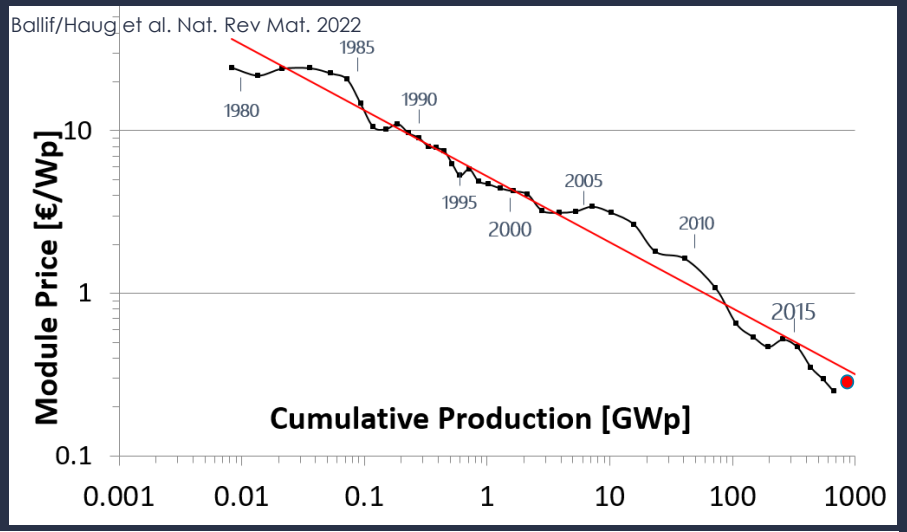
SUSTAINABILITY

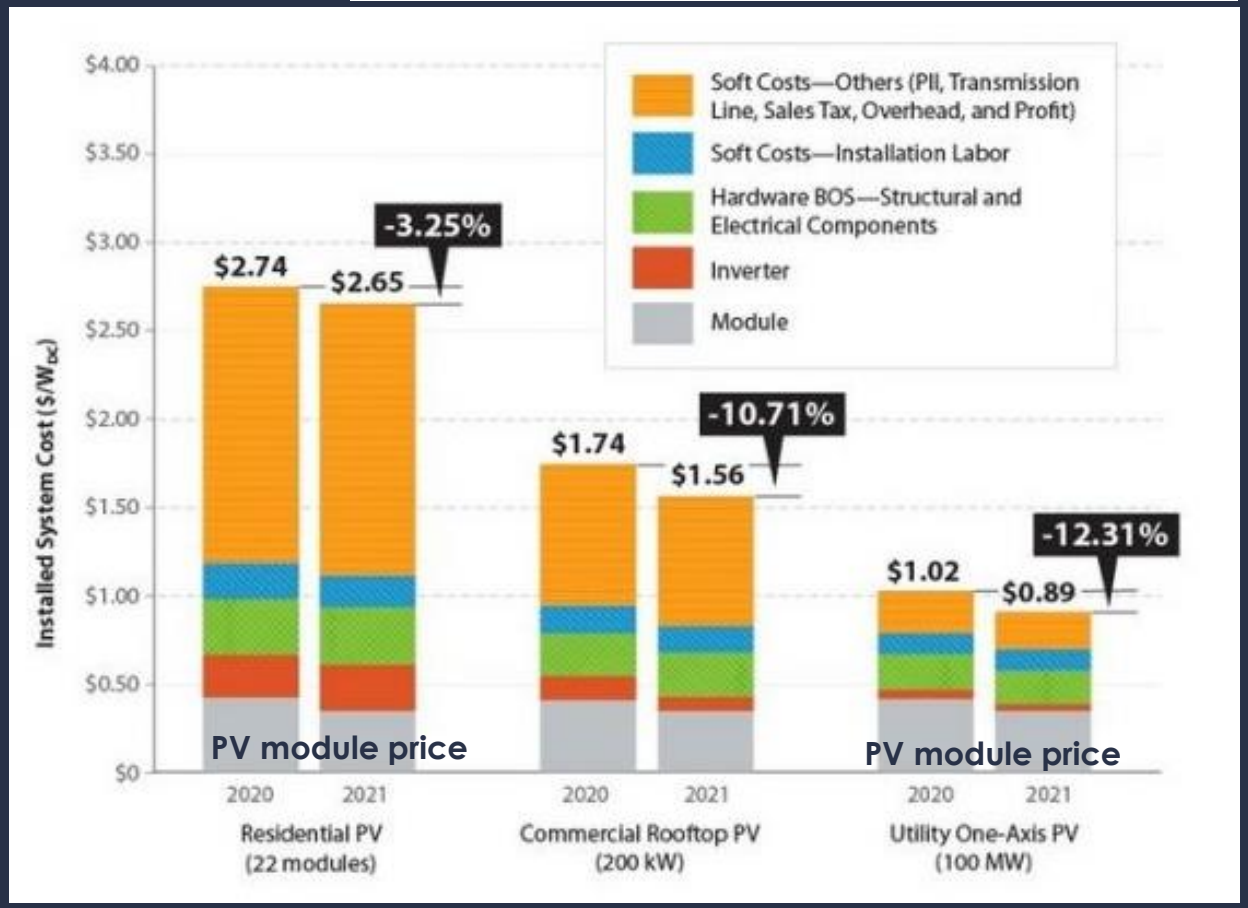


AGILE SUPPLY CHAINS PV

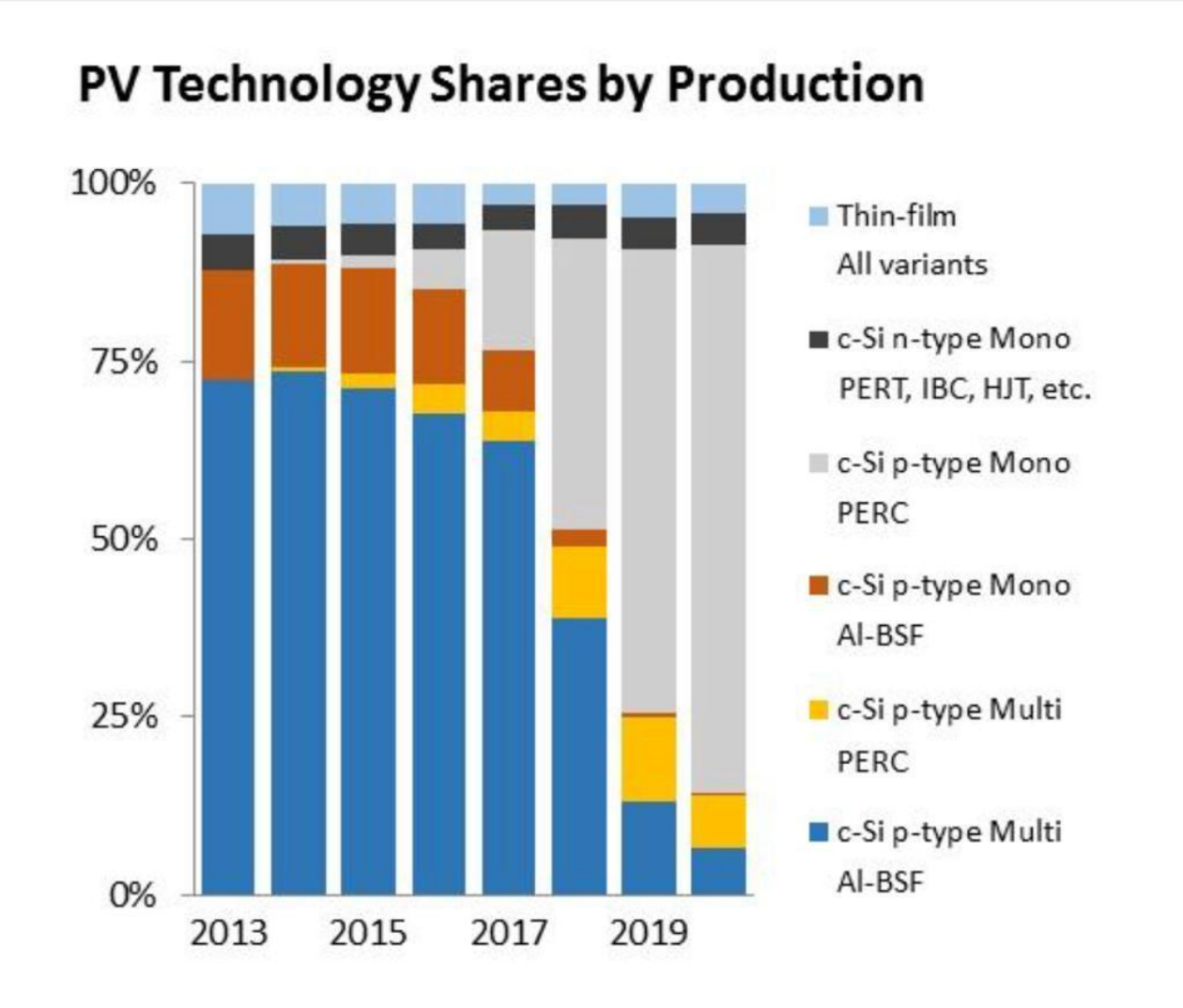
EXTENDED PV PROD. TIMES

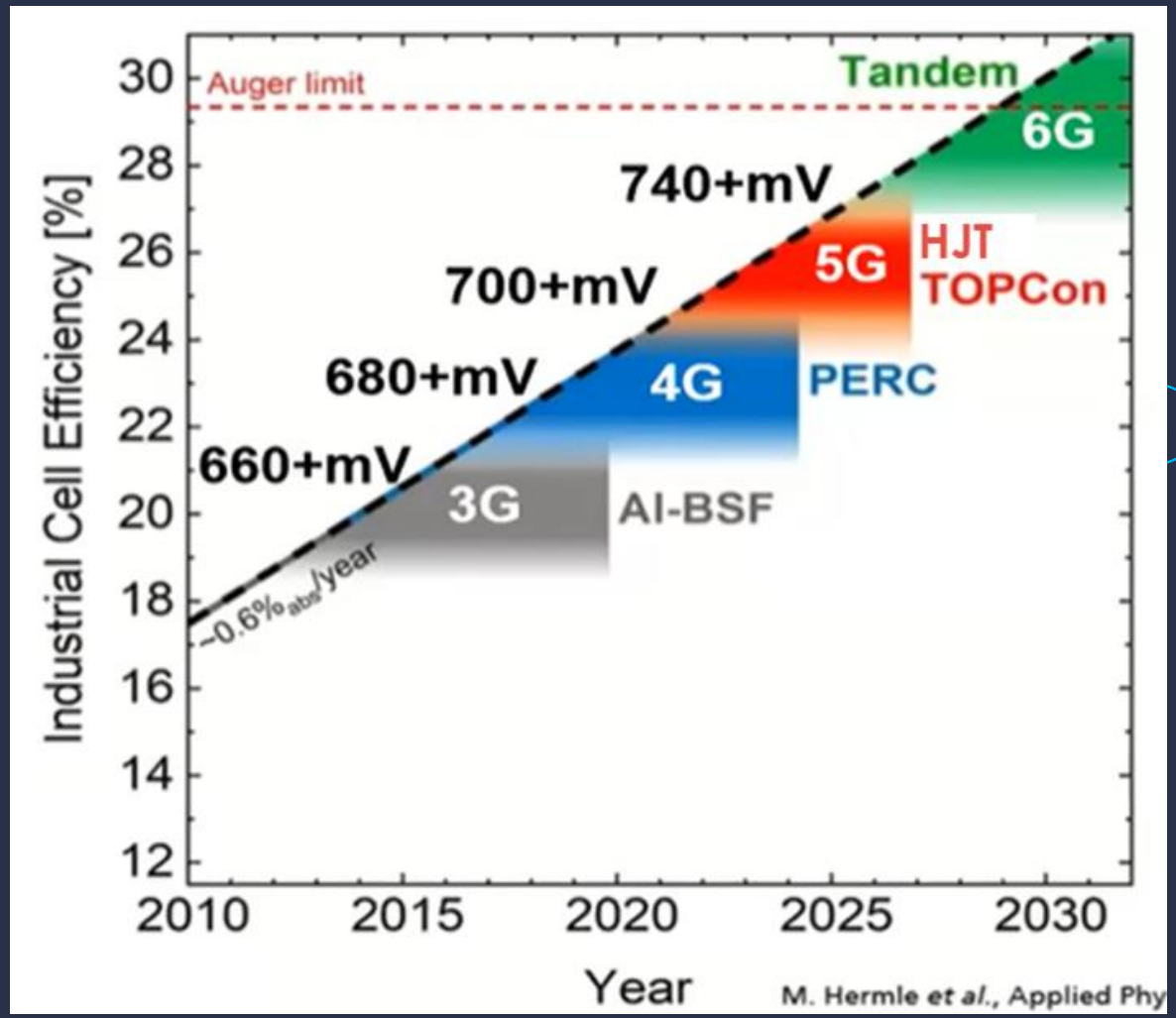
DUAL LAND - INTEGRATION





Change in the PV industry lead by need for higher efficiency



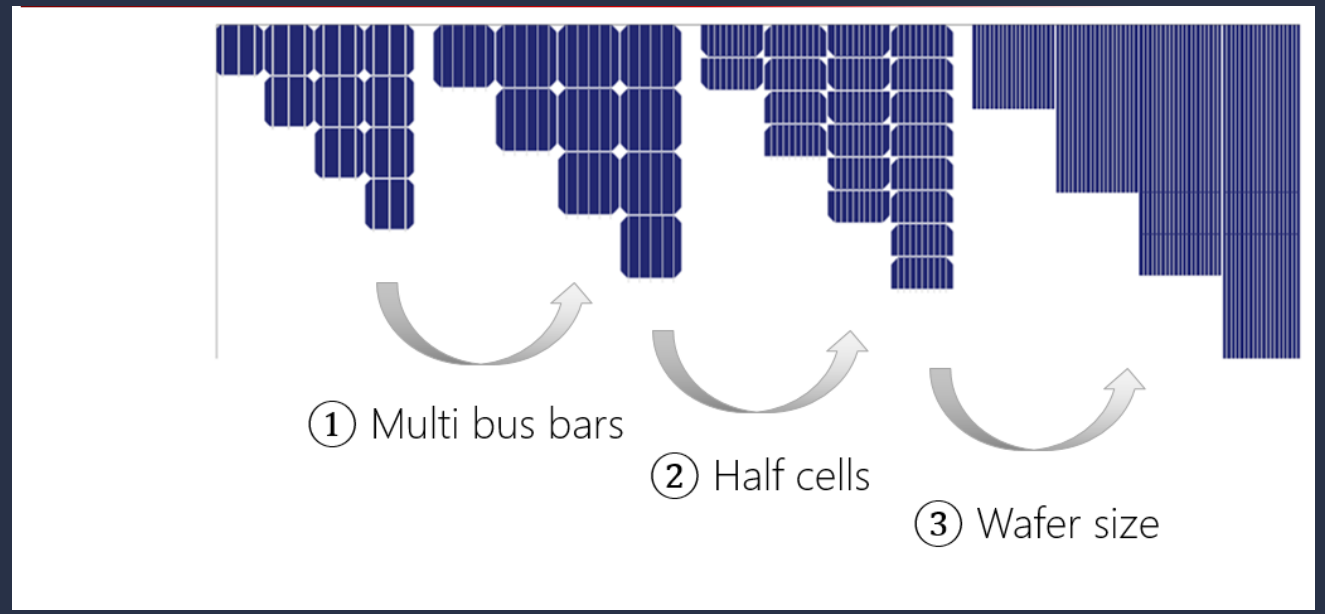


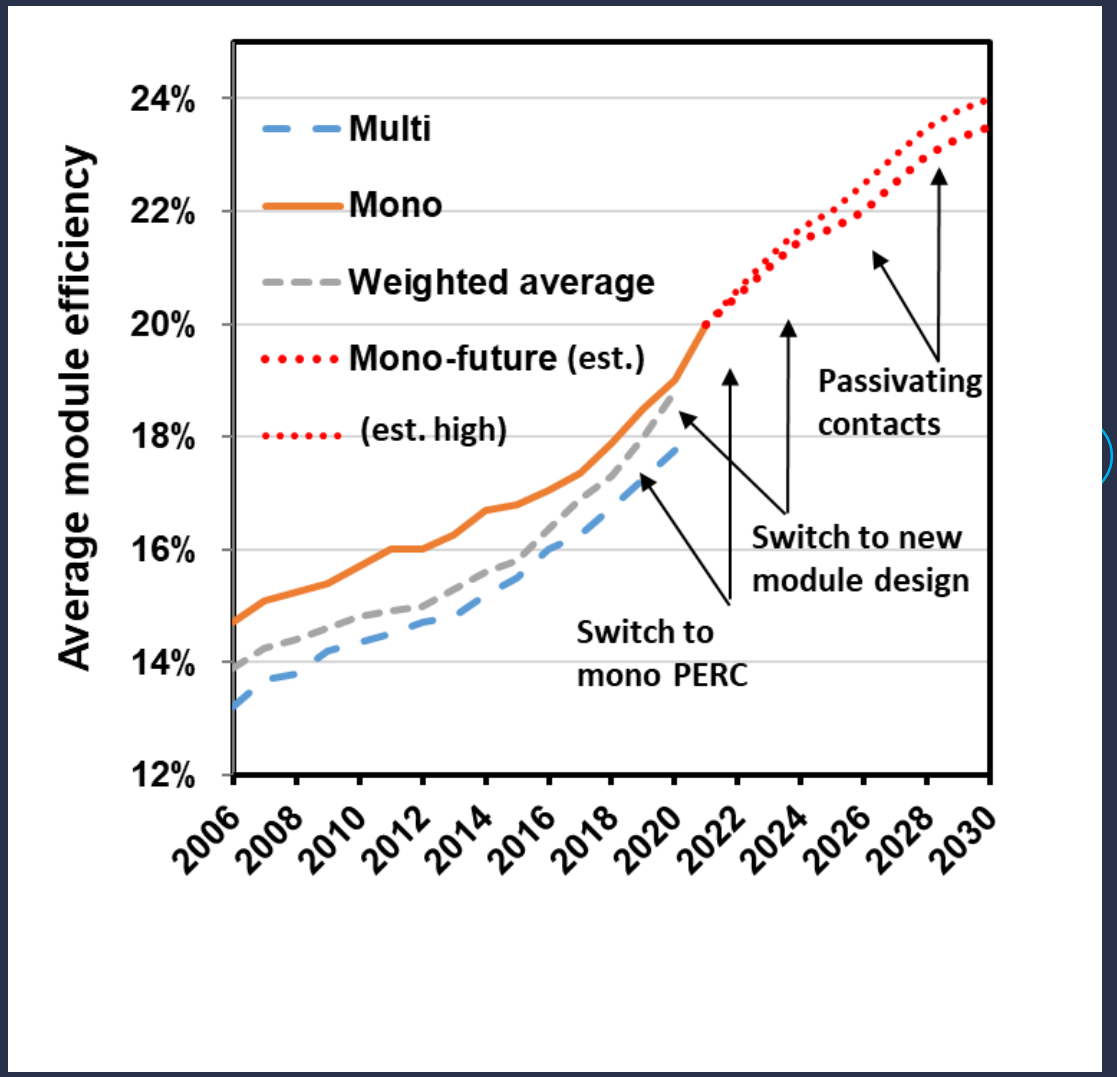
Source : PV tech

PV MODULE EFFICIENCY INCREASE : 0.4-0.5% gain per year, average 21.5-22.5% in 2025

Using high efficiency cells + switch to wire interconnect (less shadowing), reduced series resistance, less empty areas, larger modules

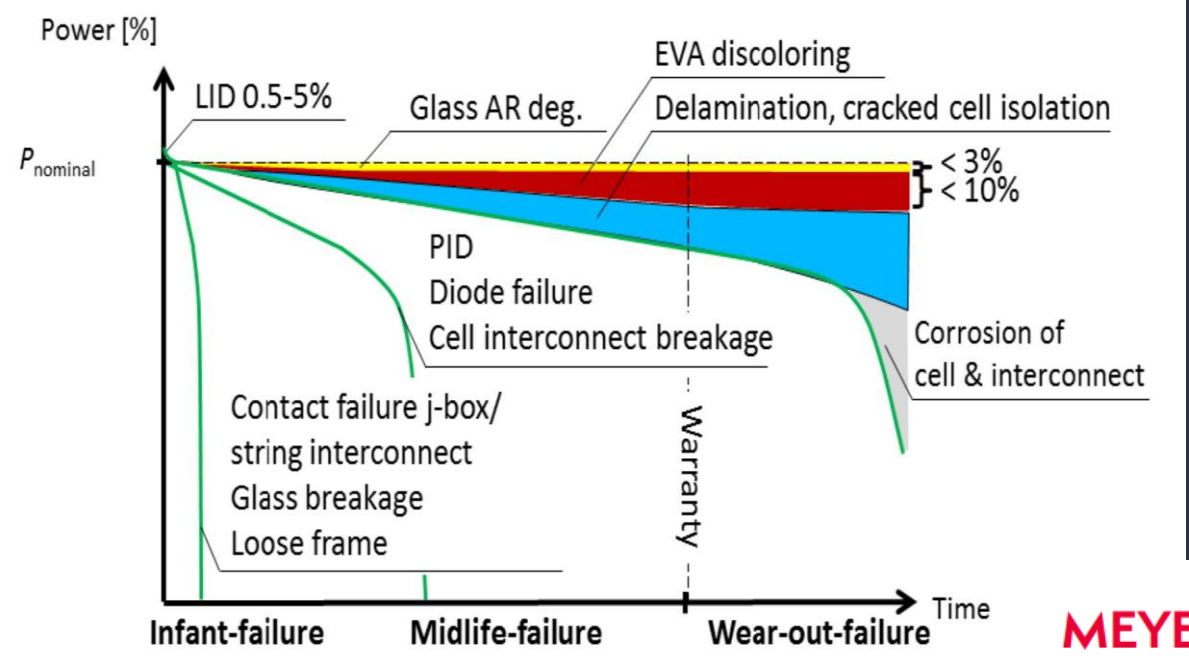
Practical limit at 24-25% for silicon modules

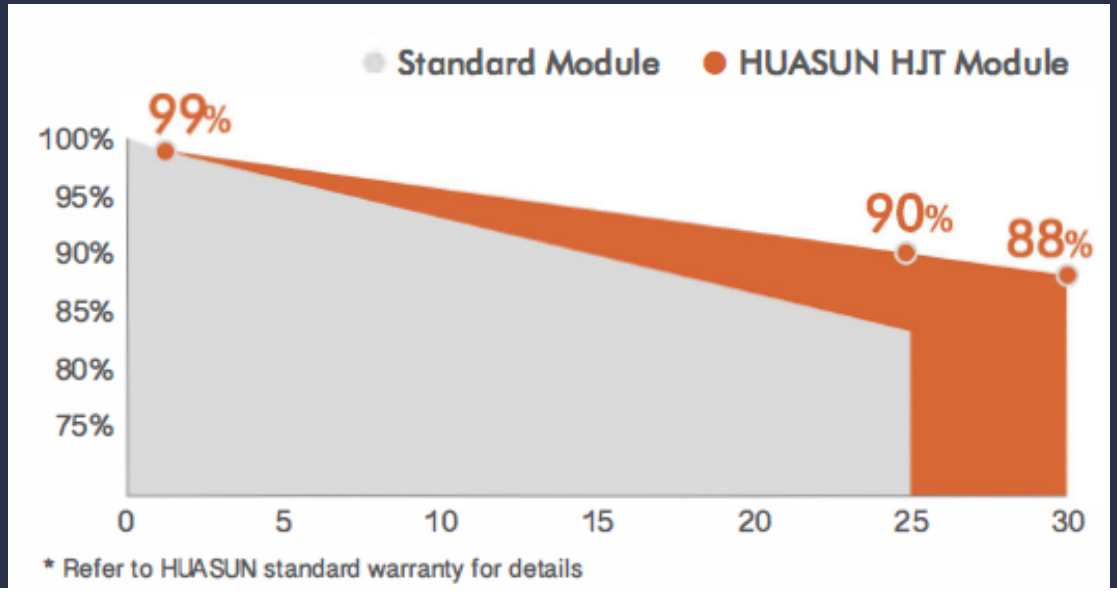




csem

TOWARDS HIGHER ENERGY YIELDS : minimized performance loss





MEYER BURGER WARRANTY

Product Warranty [y]	30
Power Warranty [y]	30
Power after 1 year	≥99% of nominal power
Annual Degradation [%/y]	0.20
Power after 30 years	≥93.2% of nominal power

Warranty conditions apply

csem

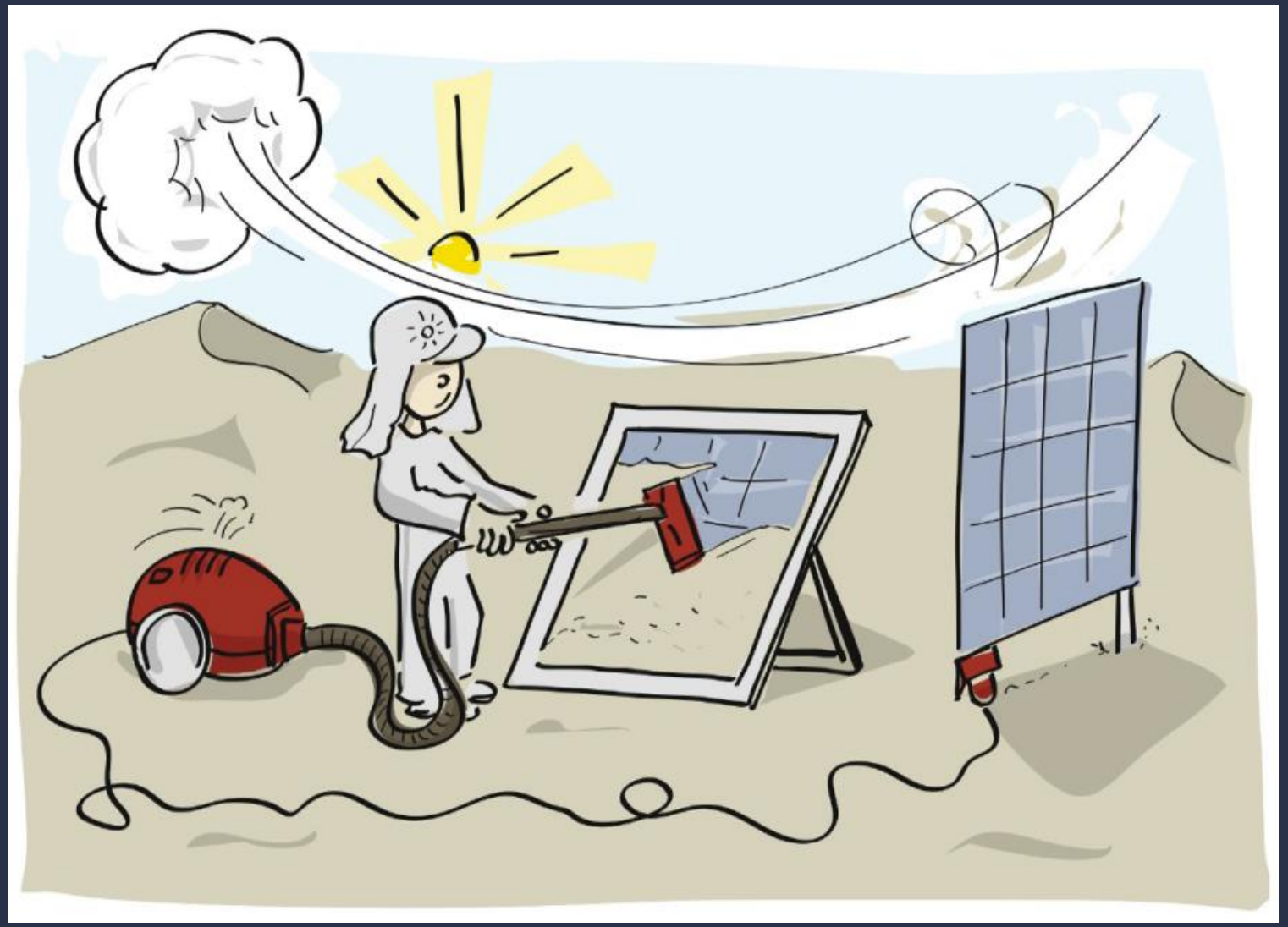
TOWARDS HIGHER ENERGY YIELDS

BIFACIALITY

THERMAL COEFFICIENT

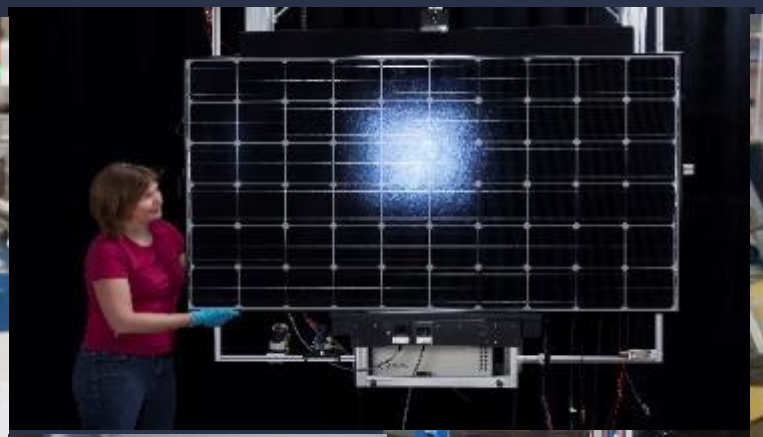
SOILING MANAGEMENT

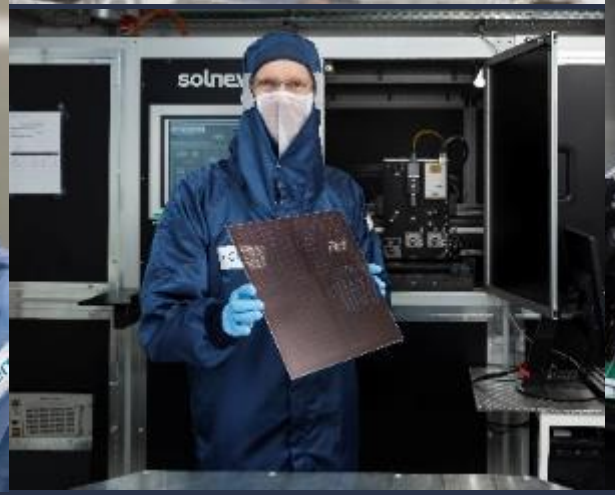
SHADOWING MANAGEMENT



CSEM PV-CENTER: 2'000 m2 research & piloting infrastructure / from R&D to pre-production

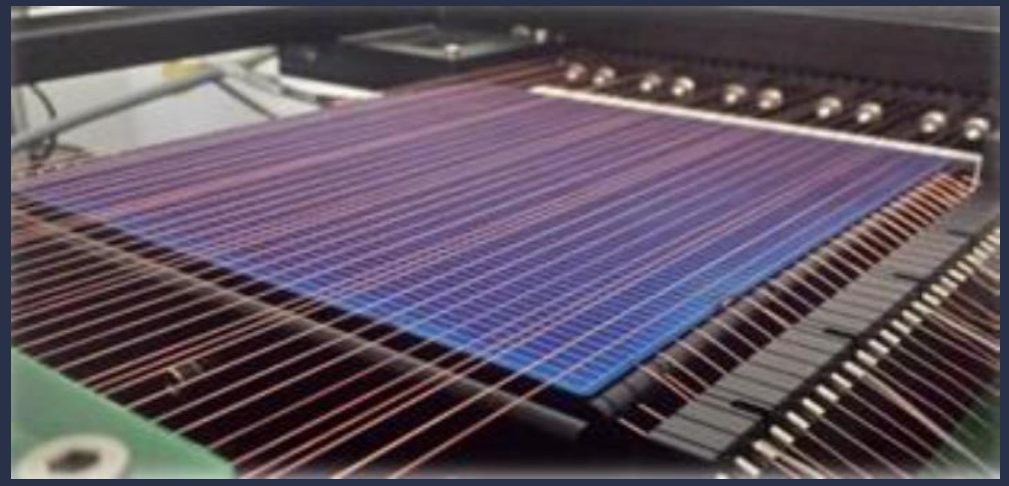
csem

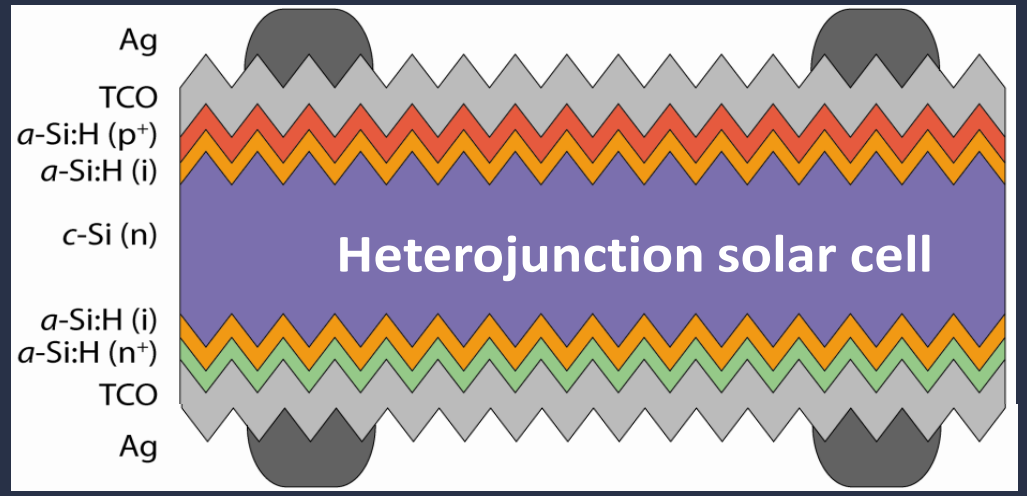




csem

CSEM PIONEER OF SILICON HETEROJUNCTION TECHNOLOGY





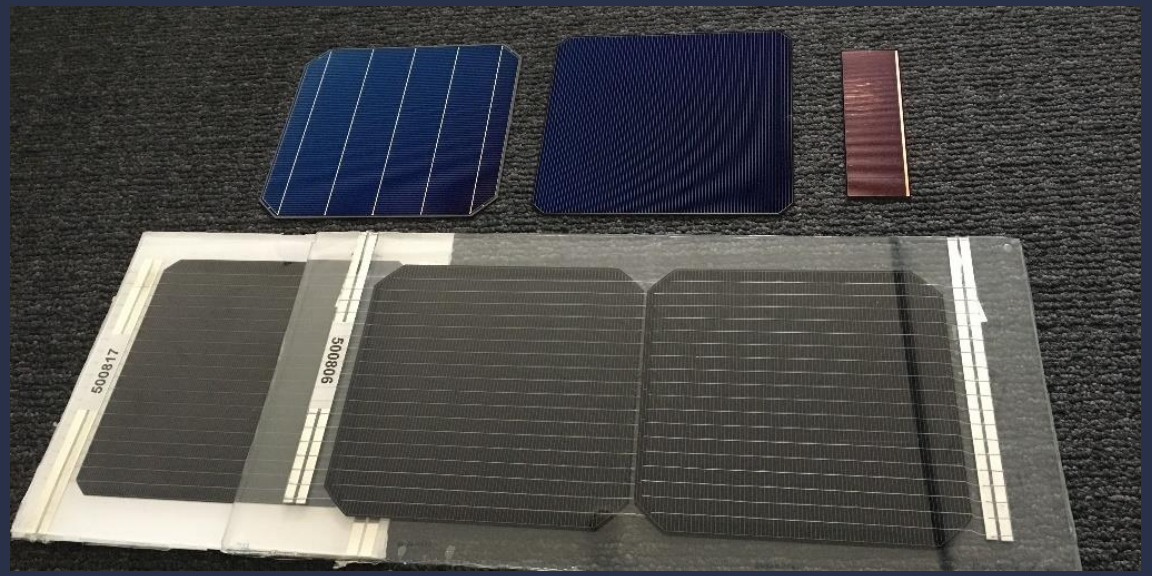
HJT development and transfer program initiated in 2008

HJT SmartWire module solution program initiated in 2013

Demonstrated > 24 % on full area cell in 2017

Demonstrated ultra high reliability SmartWire 2019

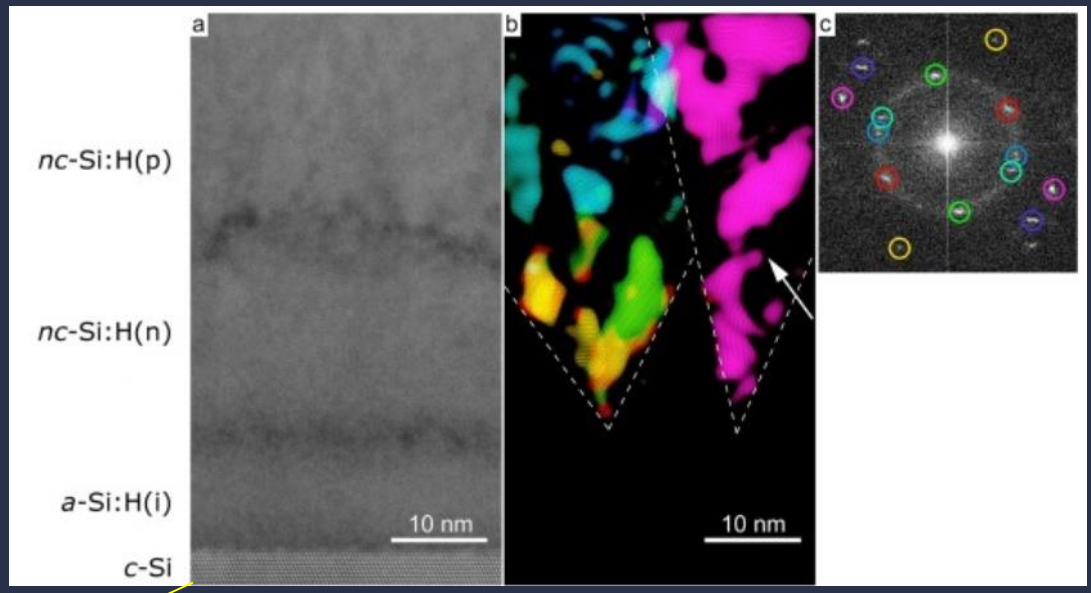
High efficiency, high bifaciality, low thermal coefficient, high reliability, high energy yield

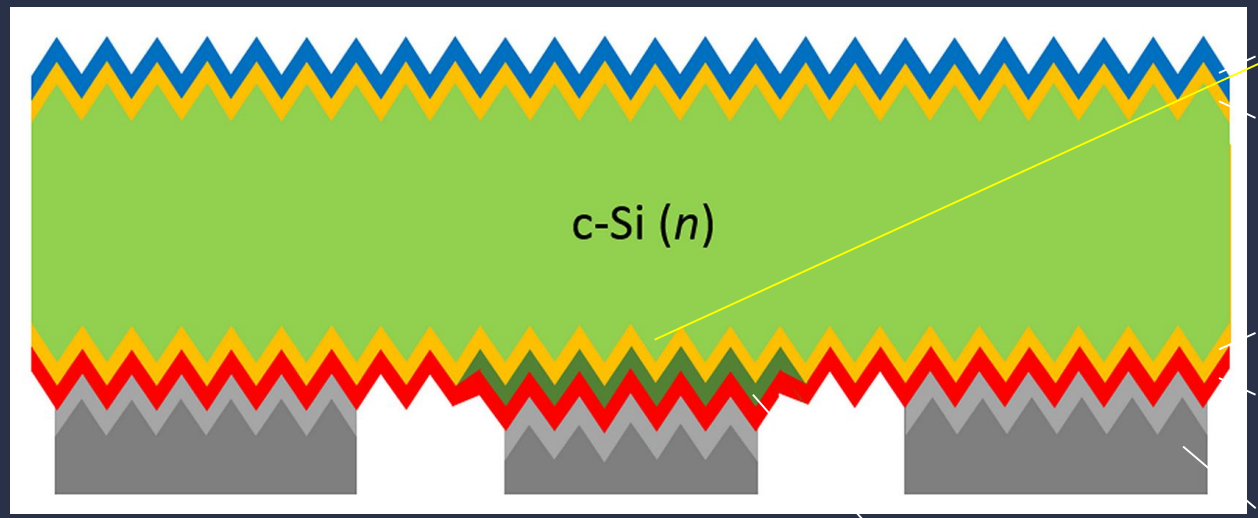


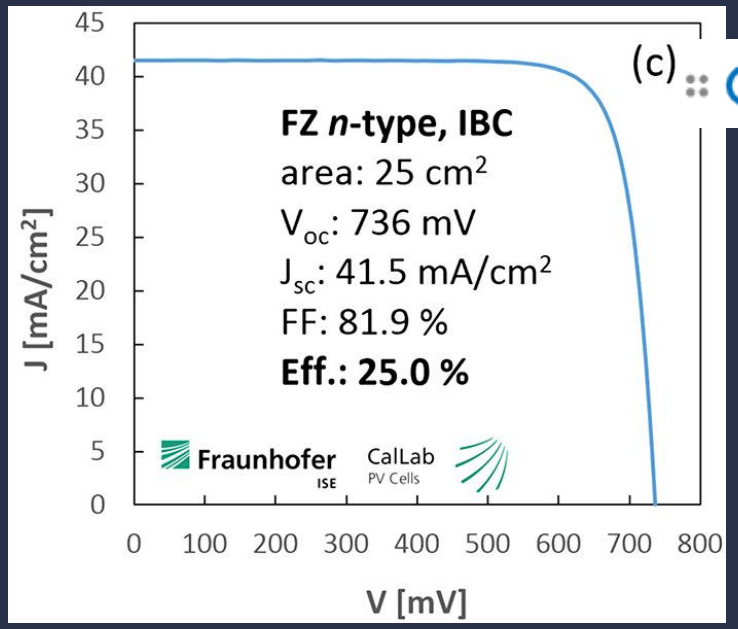
csem

Next step for Heterojunctions: All contacts at the back

- Tunnel (n+/p+ omic contact) heterojunction IBC with simple processing.
- 2 patterning steps, 1 alignment.







Tomasi et al., Nature Energy, 2017
Descoeudres et al., Prog. Photov. 2020

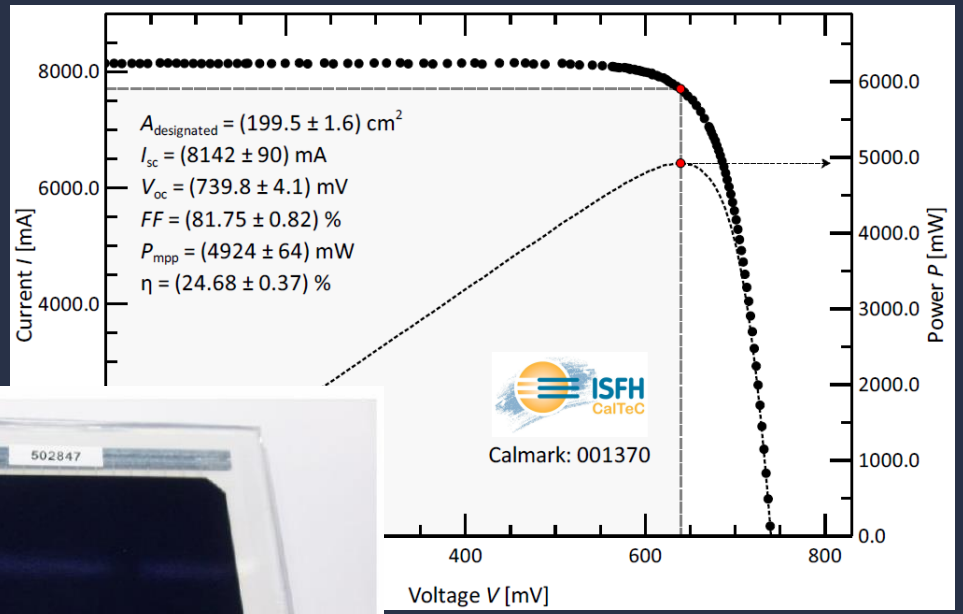
csem

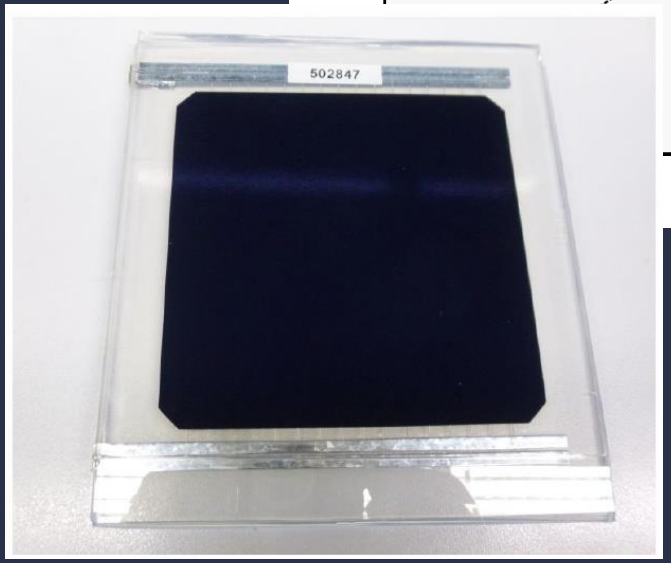
Some R&D activities in Neuchâtel

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Federal Office of Energy SFOE

- World record single-cell **laminate** with tunnel-IBC + SmartWires® :





✓ 24.7 % efficiency: world record for a laminate !

- First 60-cell tunnel-IBC module in glass/backsheet configuration:

Large EU pilot-line Project pilatus (Meyer Burger, EPFL, CSEM, kick-starts 1.10.2022

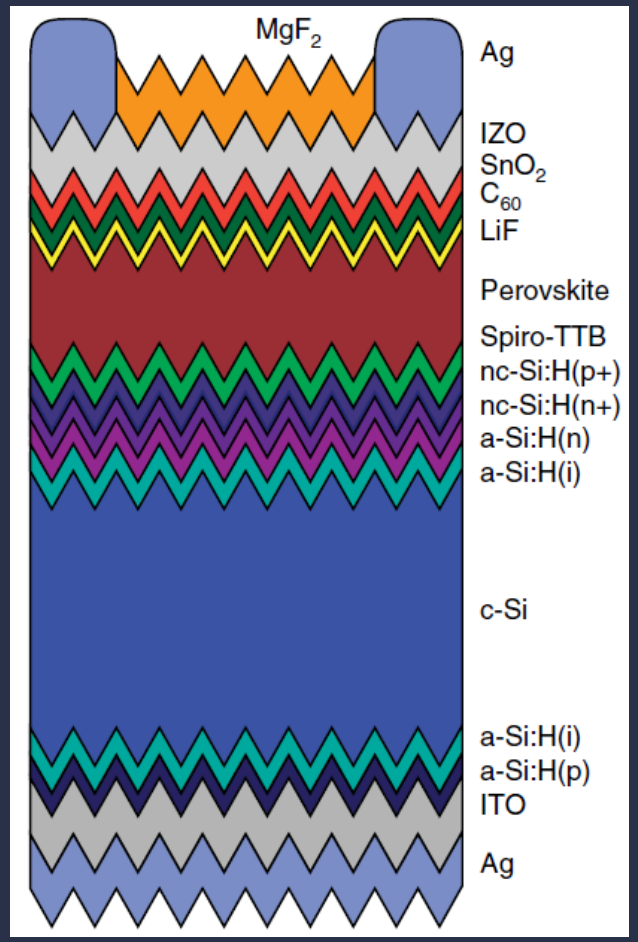
MEYER BURGER

csem

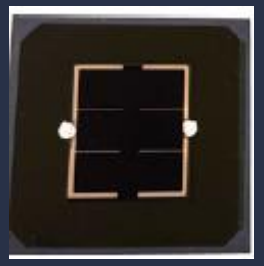
M. Despeisse, B. Paviet-Salomon, A. Faes, D. Lachenal et al.

These activities are supported by SFOE in the frame of the project "SIRIUS" (2021-2024E)

Cells above 30% ? Perovskite/silicon tandem solar cell

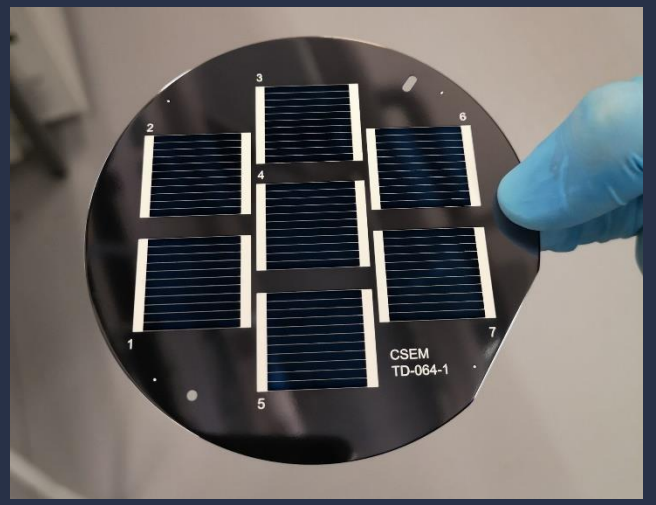


Sahli et al. Nature materials 2018



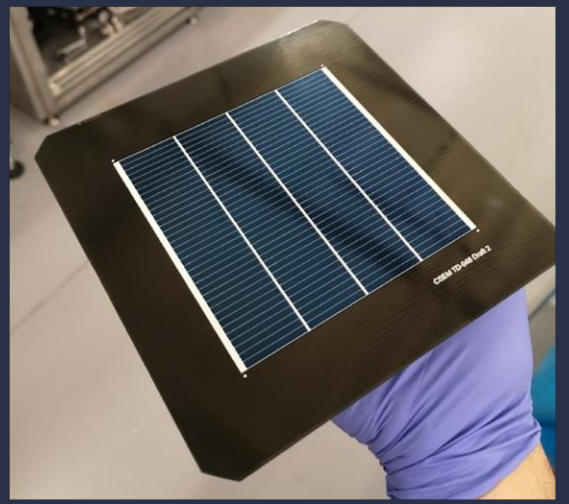
EPFL PV-lab:

Certified > **31.3 %***



CSEM : **29.5%** on 25 cm2

Upscaling ongoing…



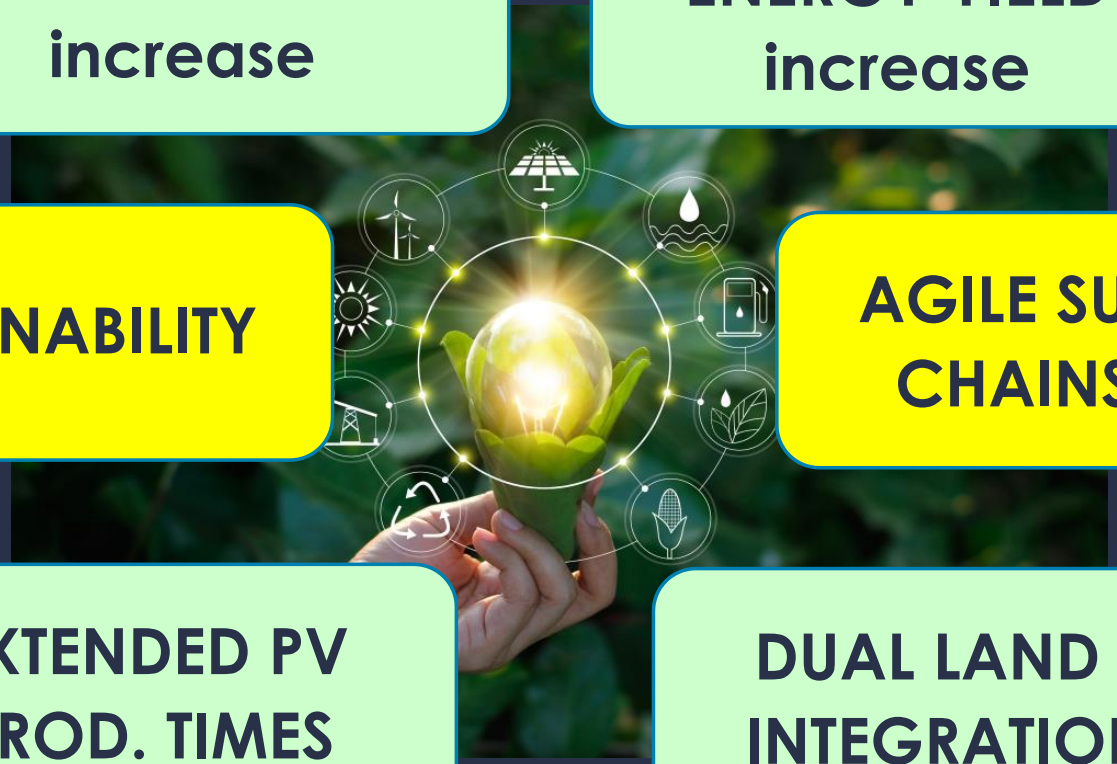
csem

Press release: Xin Yu Chin, Quentin Jeangros, Christian Wolf, A. Walter, B. Kamino et al.

EFFICIENCY increase

ENERGY YIELD increase

SUSTAINABILITY

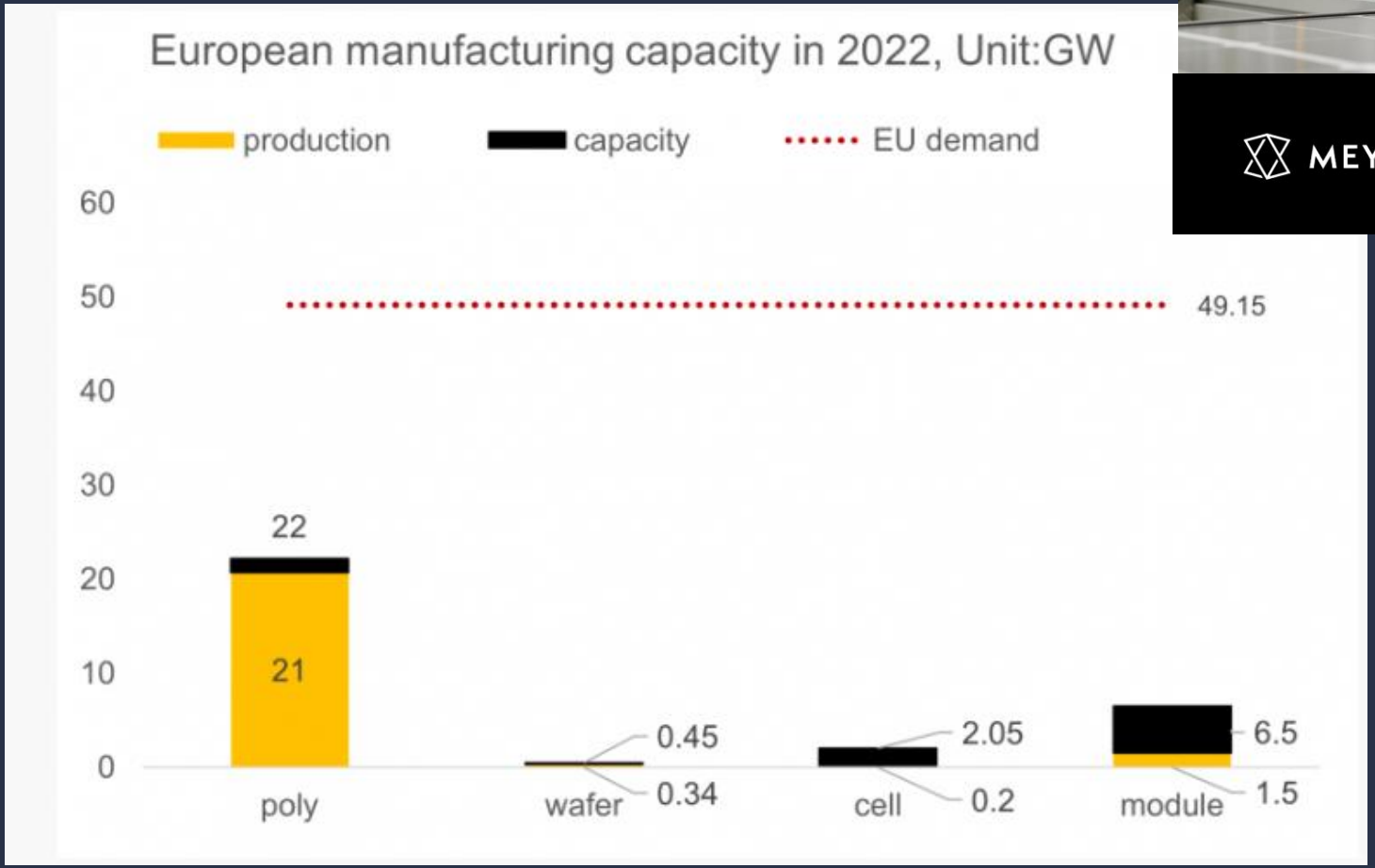


AGILE SUPPLY CHAINS PV

EXTENDED PV PROD. TIMES

DUAL LAND - INTEGRATION

RePower EU with Solar: The 1TW EU Solar Pathway for 2030



EFFICIENCY increase

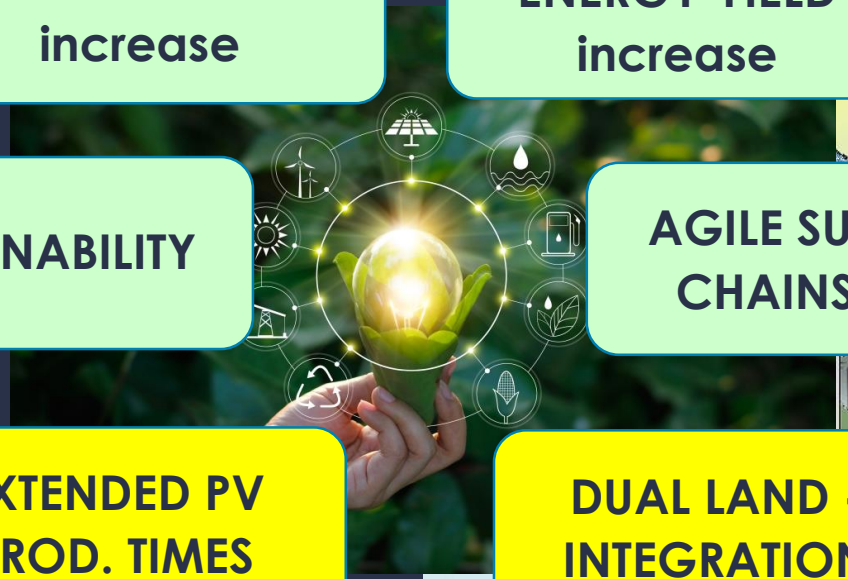
ENERGY YIELD increase

SUSTAINABILITY

AGILE SUPPLY CHAINS PV

EXTENDED PV PROD. TIMES

DUAL LAND - INTEGRATION

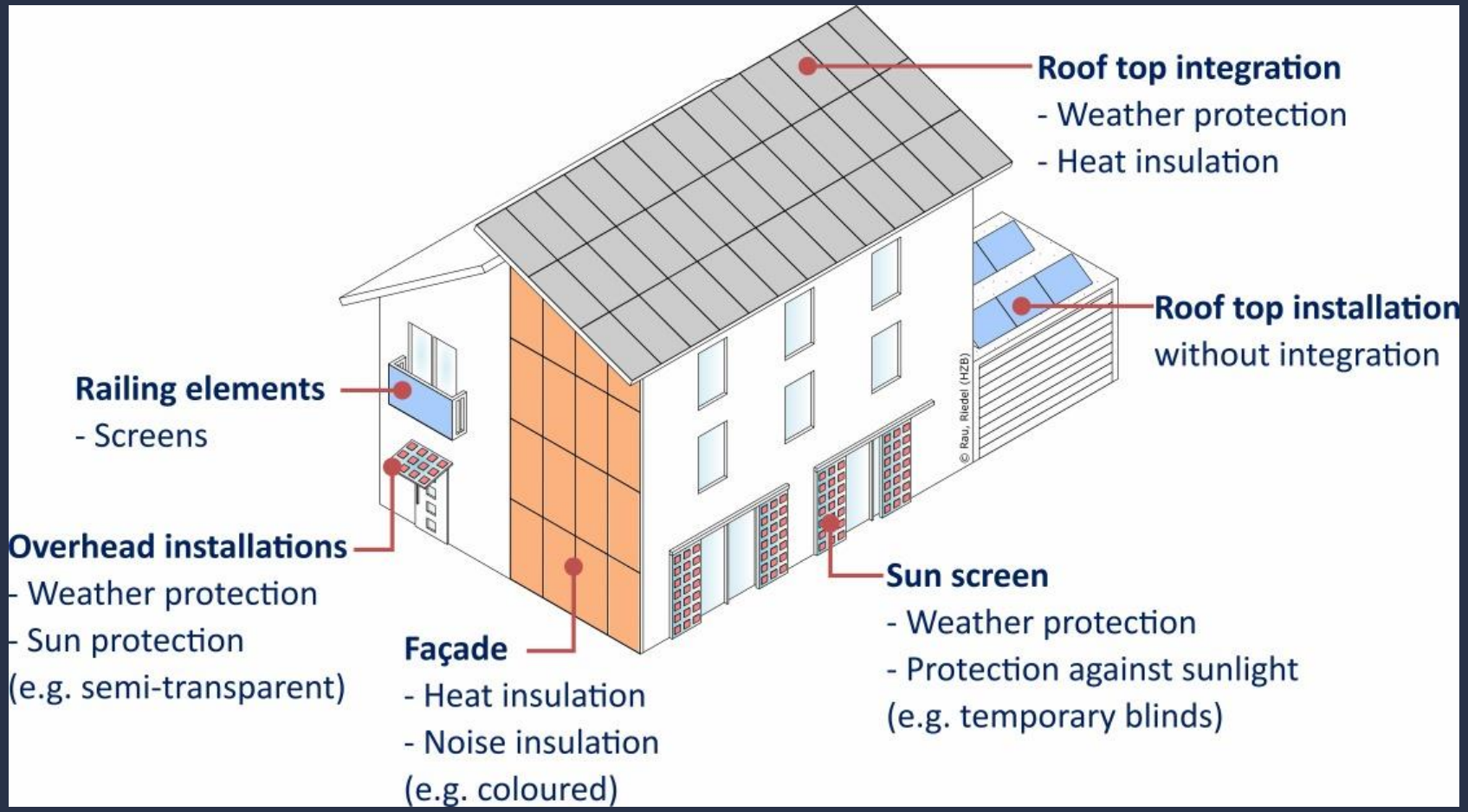


INTEGRATED PHOTOVOLTAICS

csem

Whatever scenario, we need to cover a large part of the buildings with PV in many countries

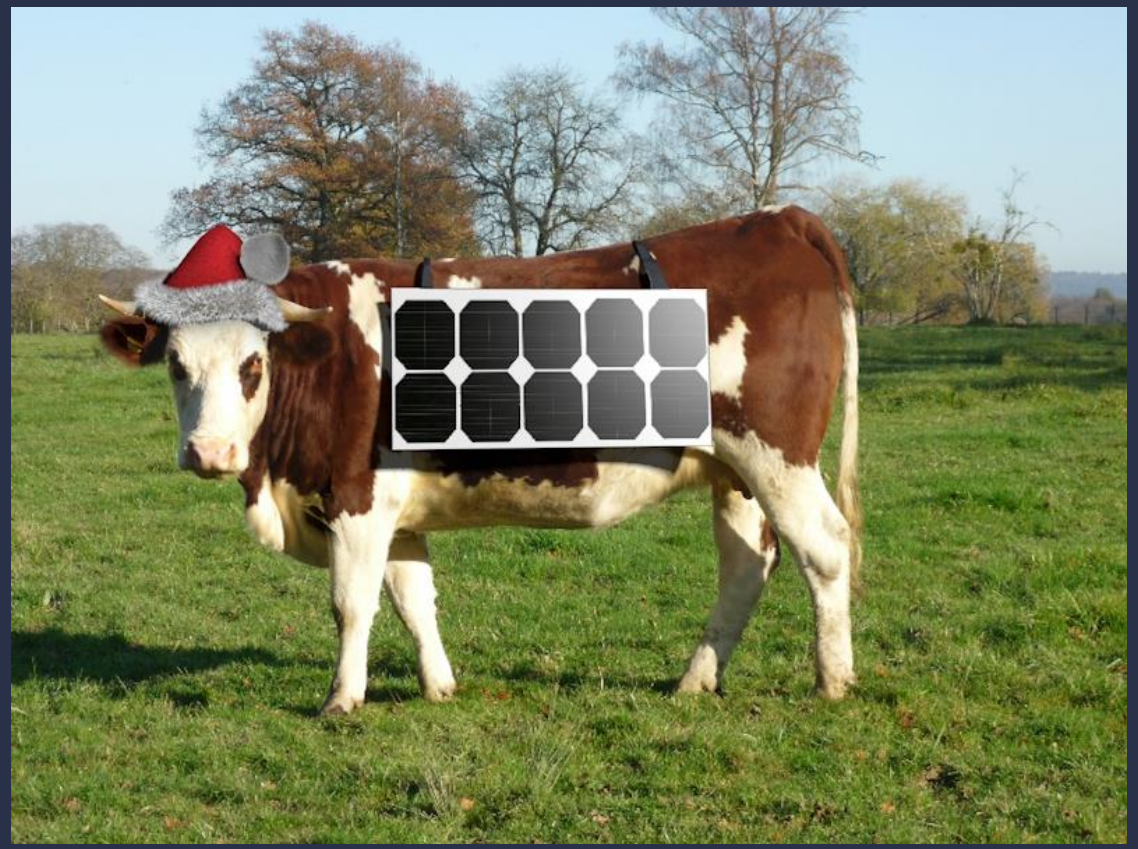
Massive solarisation of building



csem

Switzerland, sensitive to acceptance in Rural and Urban Environment

Sensitive to aesthetics



csem

csem
FACING THE CHALLENGES OF OUR TIME

SOLAXESS
WHITE & COLOR SOLAR TECHNOLOGY

SOLAXESS
white solar technology

3S Solar Plus

csem
FACING THE CHALLENGES OF OUR TIME

csem

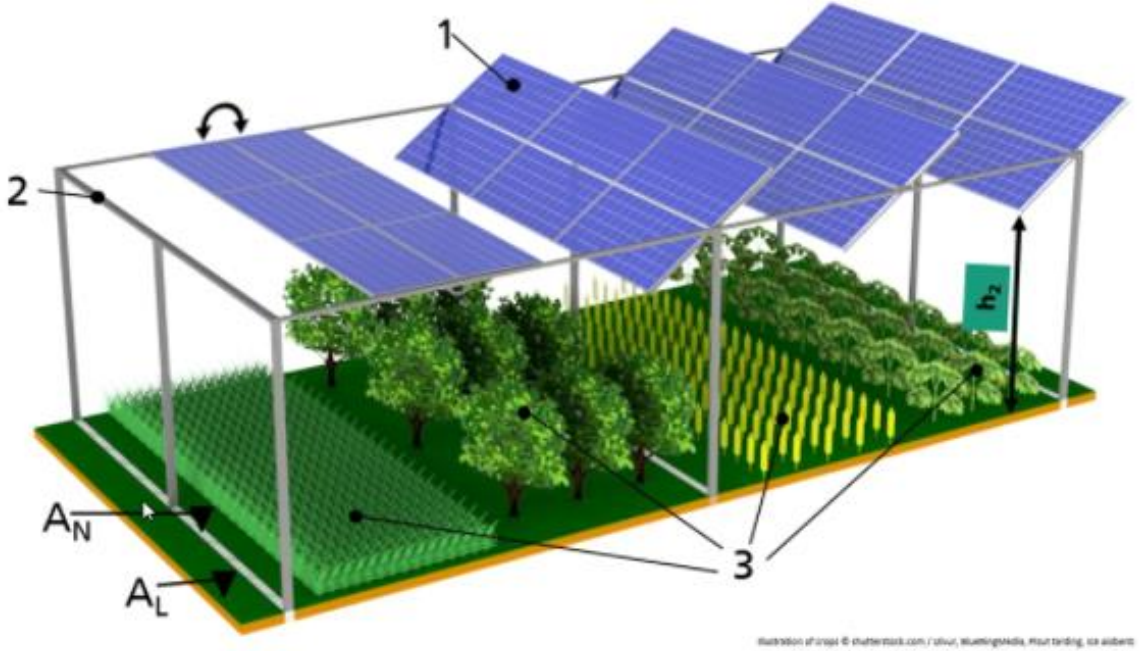
Elegance : a HIGHLIGHT

FREESUNS
SOLAR ROOFS

csem

DUAL LAND USE : Growth of AgriVoltaic projects

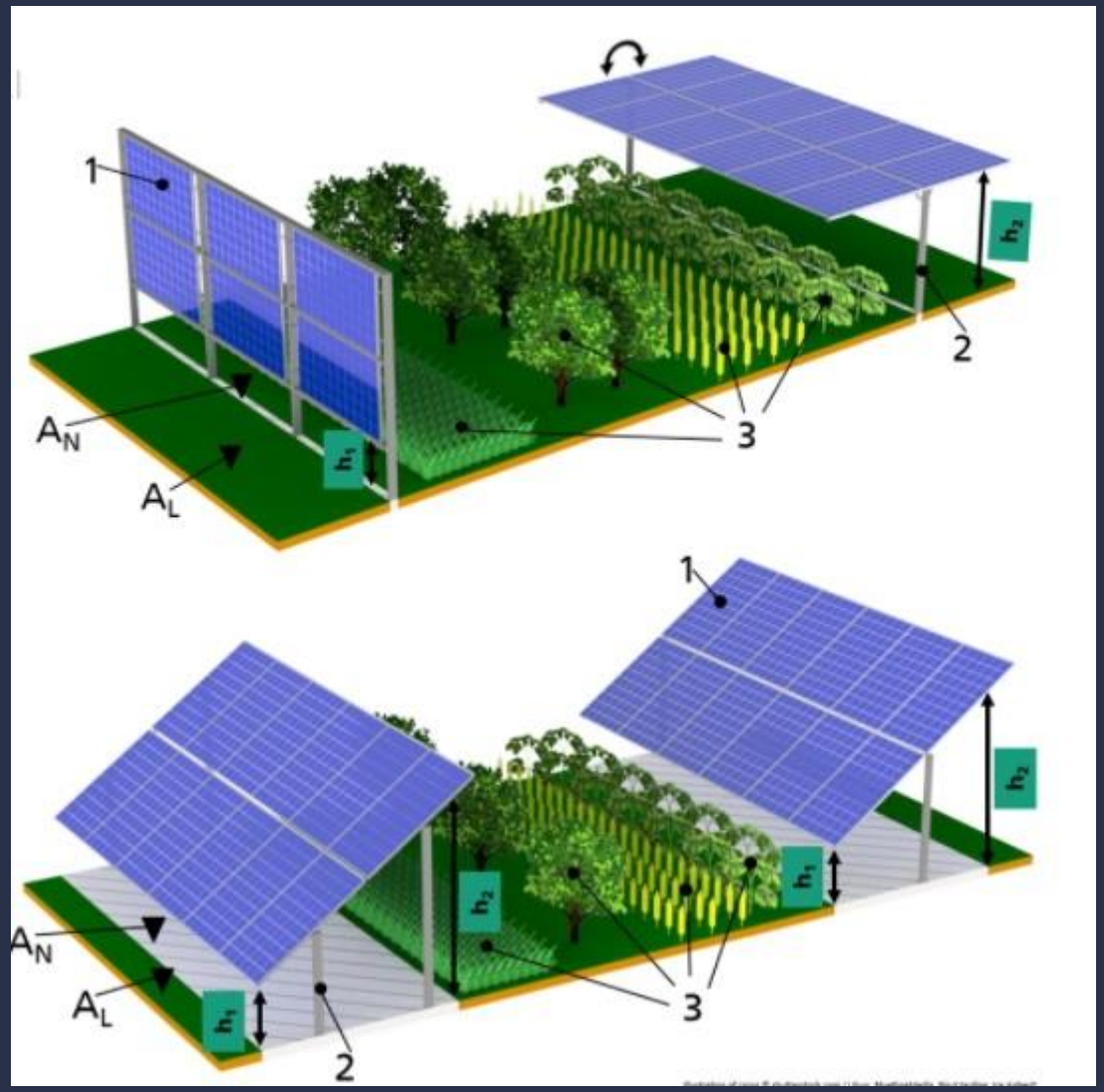
Category 1: Overhead PV



Legend:

A_L	Cultivatable agricultural areas	
A_N	Uncultivatable agricultural areas	
h_1	Clearance height below 2.10 m	
h_2	Clearance height above 2.10 m	
1	Examples of solar modules	
2	Mounting structure	
3	Examples of crops	

Category 2: Interspace PV



csem

DUAL LAND USE : Growth of AgriVoltaic projects

insolight

New dynamic system developed by INSOLIGHT

Minimal

Maximal

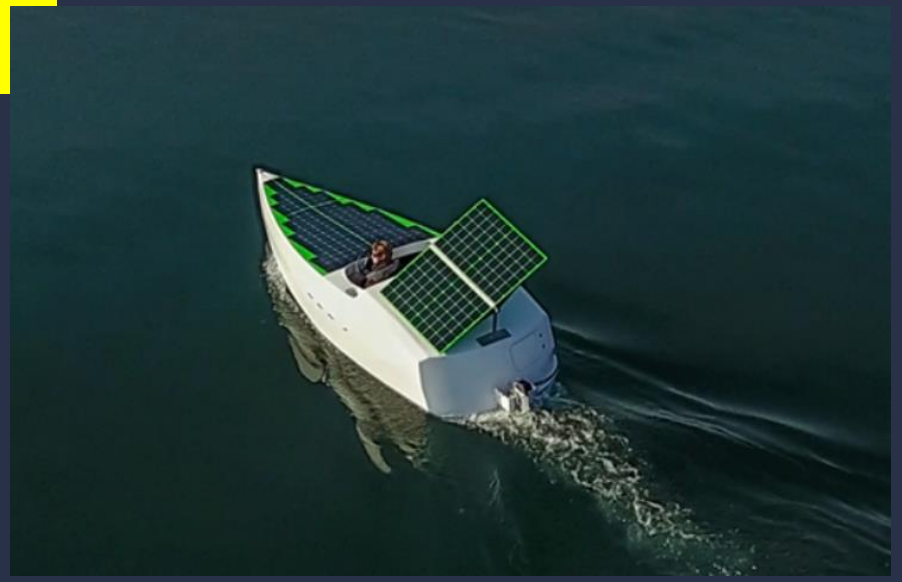
PV for transport

Electrical mobility with added PV powering

csem

PV everywhere

CSEM technologies for various shapes, self standing or applicable, lightweight PV

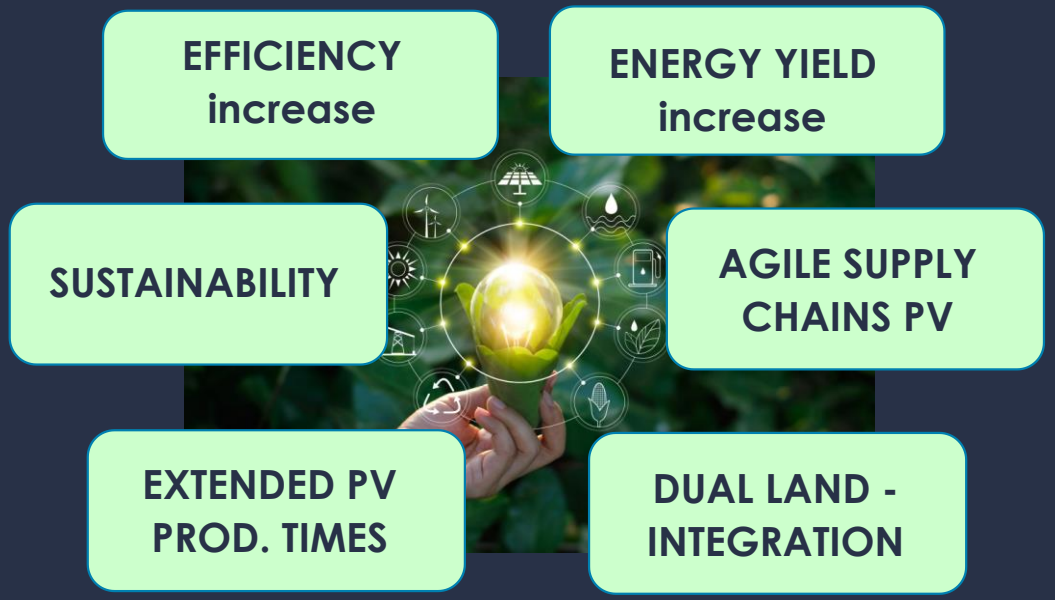


700 g/m2 !

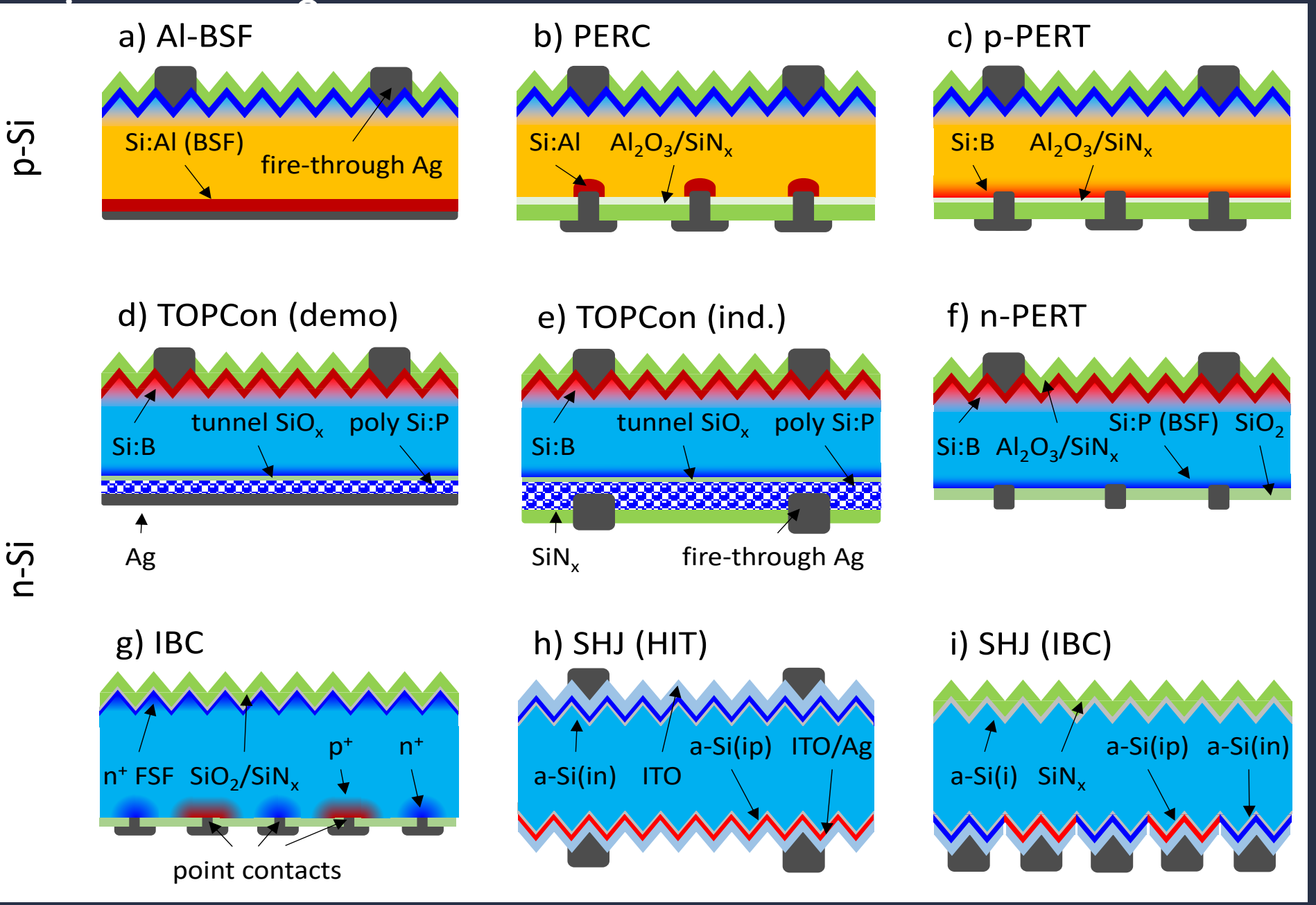
Thank You !!

Questions ??

Matthieu Despeisse / 01.12.2022



Why efficien



csem