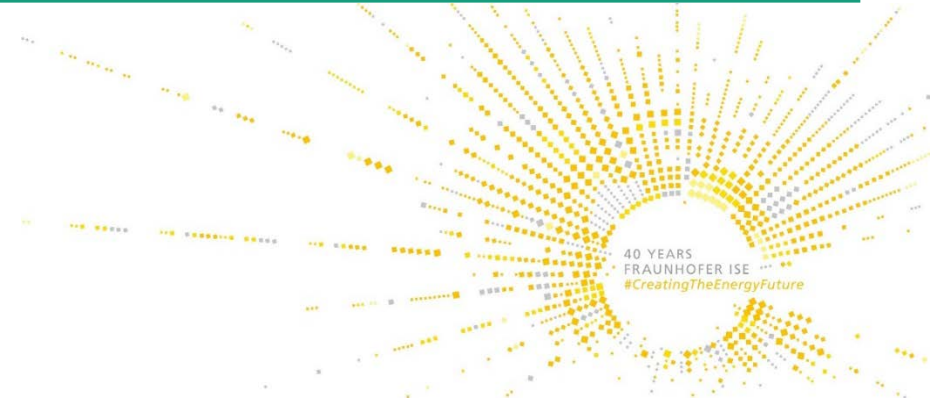


Materialinnovationen für die Solarenergie

Impulsvortrag

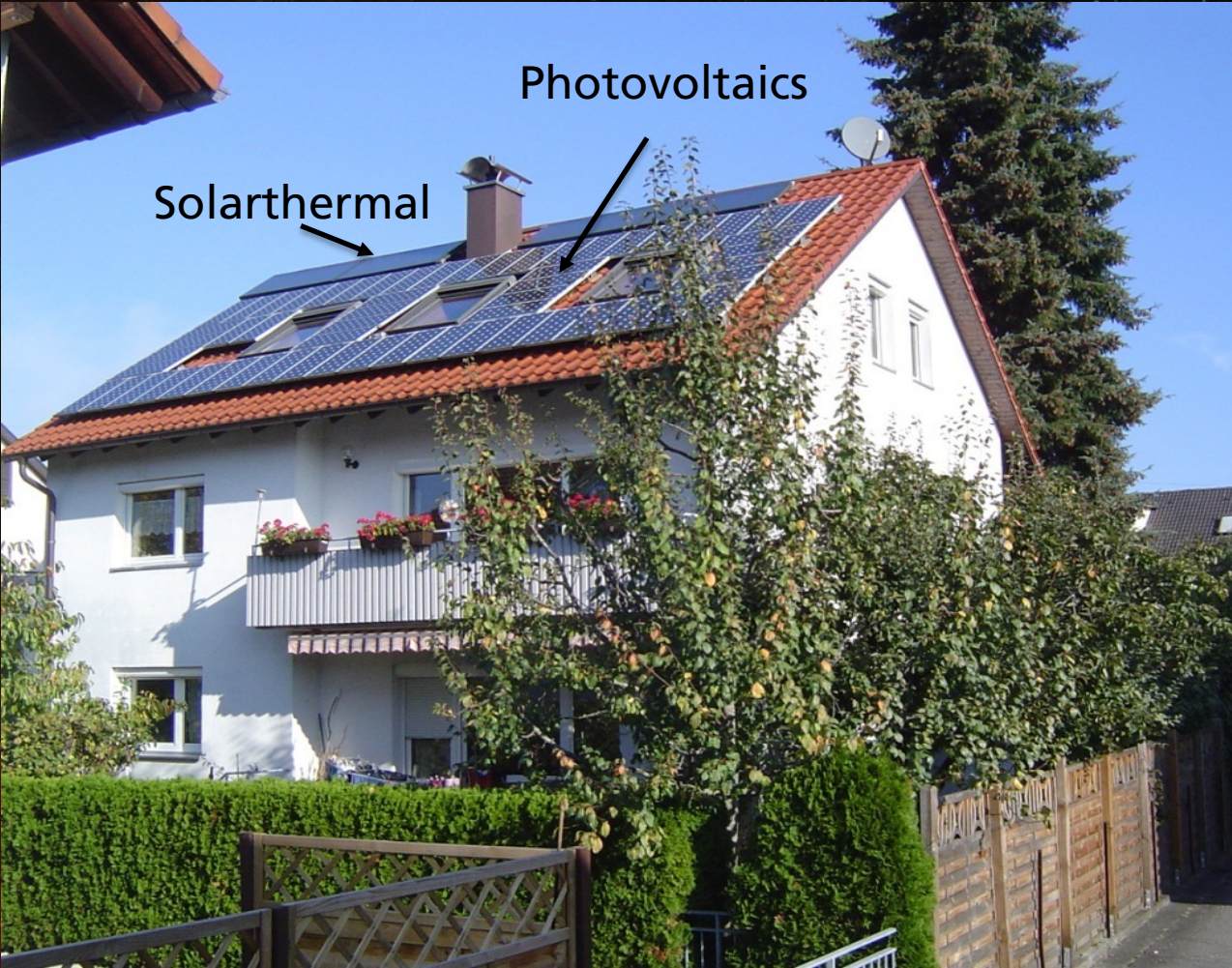
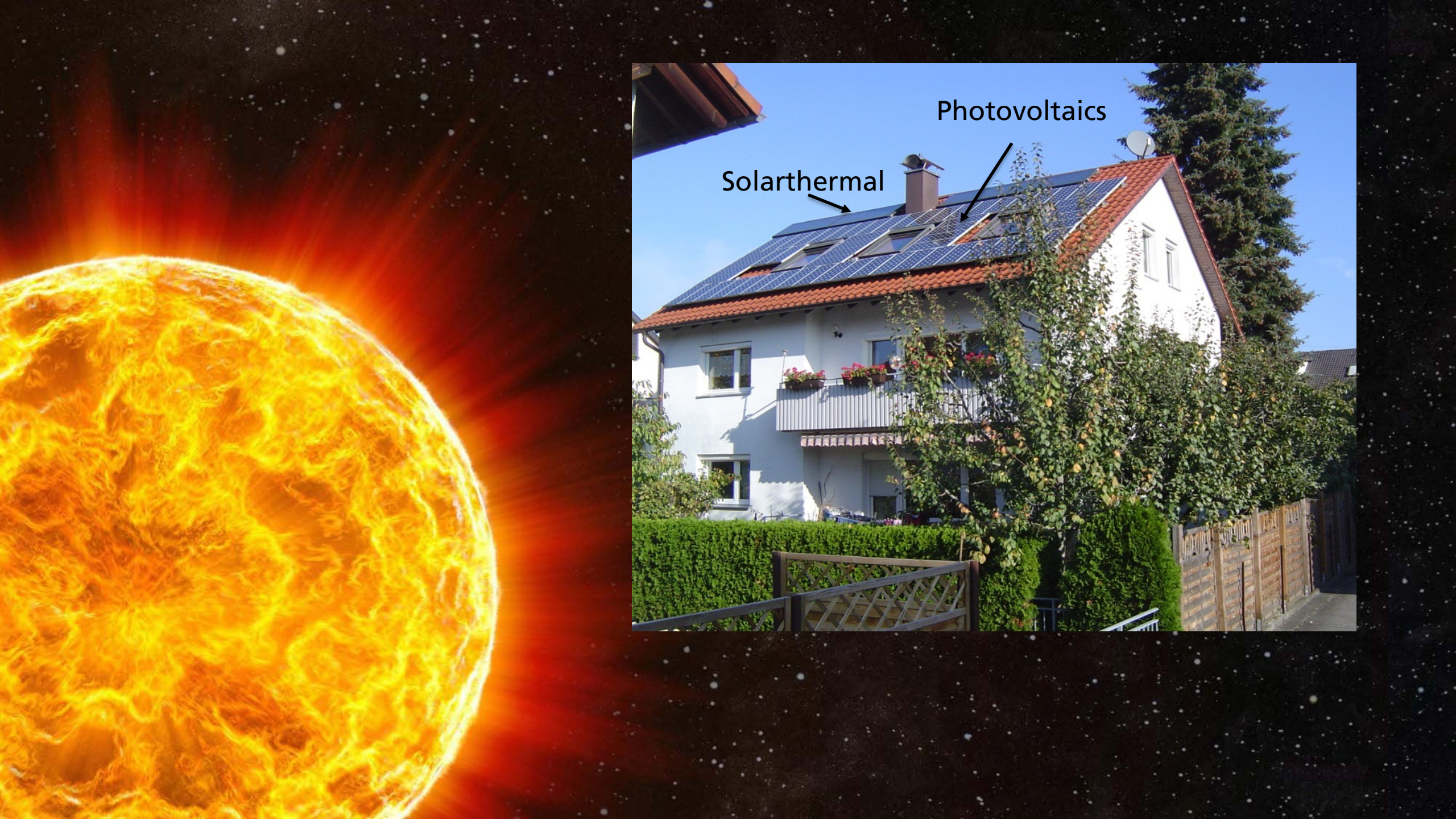


Andreas W. Bett

Fraunhofer Institute für Solare Energiesysteme ISE

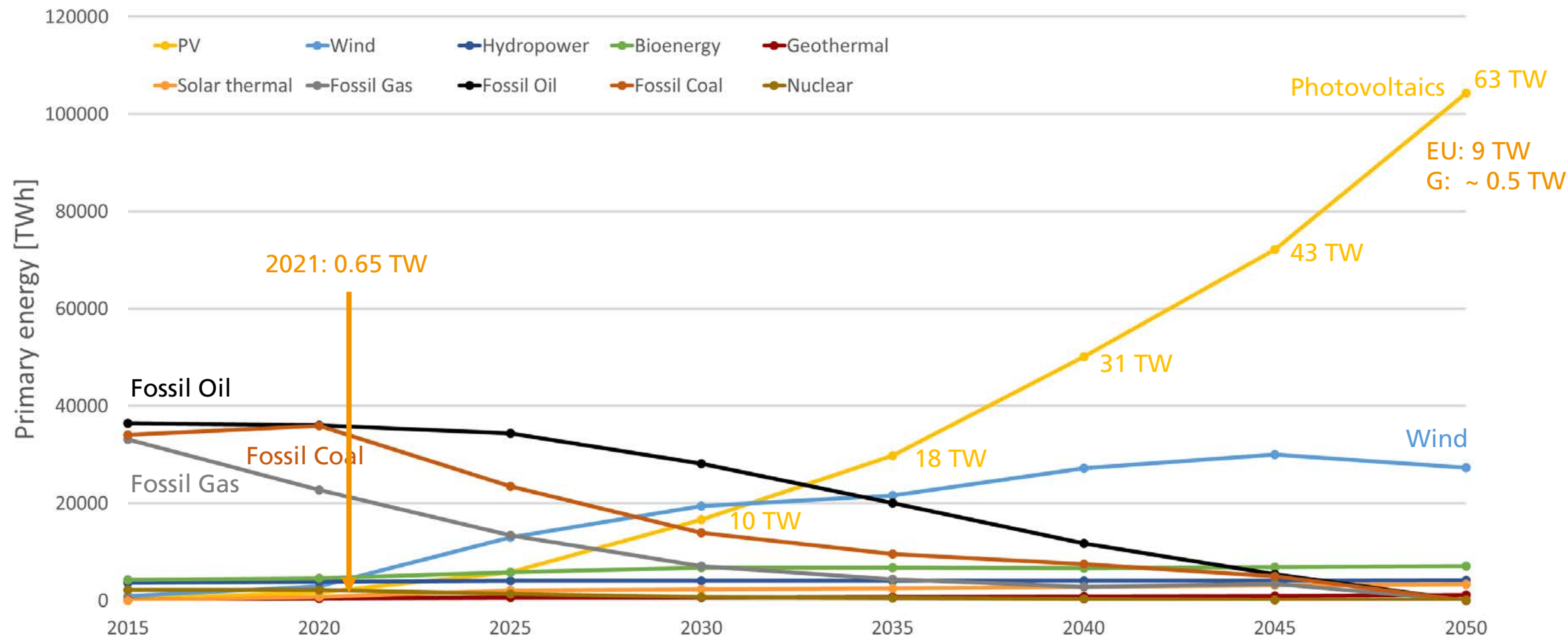
Materials for the European Green Deal
Online, 9. September 2021

www.ise.fraunhofer.de



Transformation of the Global Energy Supply to be CO₂-free in 2050

Market: Photovoltaic is Needed in Huge Quantities!



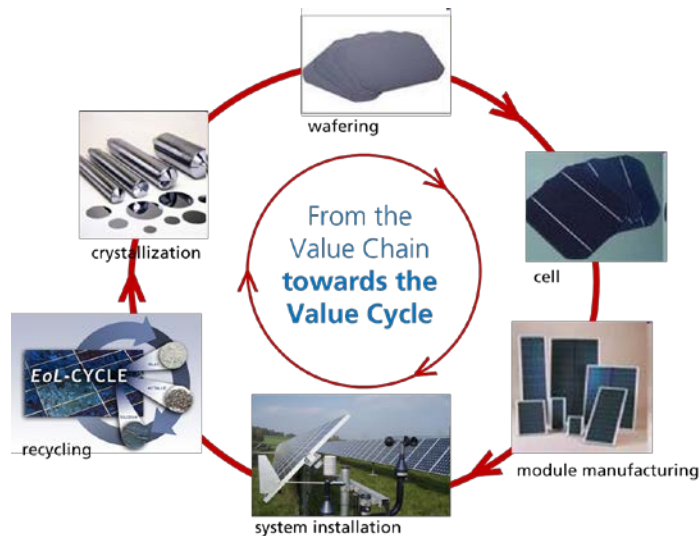
The Need of Huge Quantities Materials and Resources

Needs enormous resources:

~ 300.000 km² area

~ 3.000.000.000 metric tons material
(glass, silicon, silver, polymers...)

Circular Economy is mandatory!



High efficiency is mandatory!

Innovation: New Production Technology for Materials and Materials for Record Cell Efficiencies and

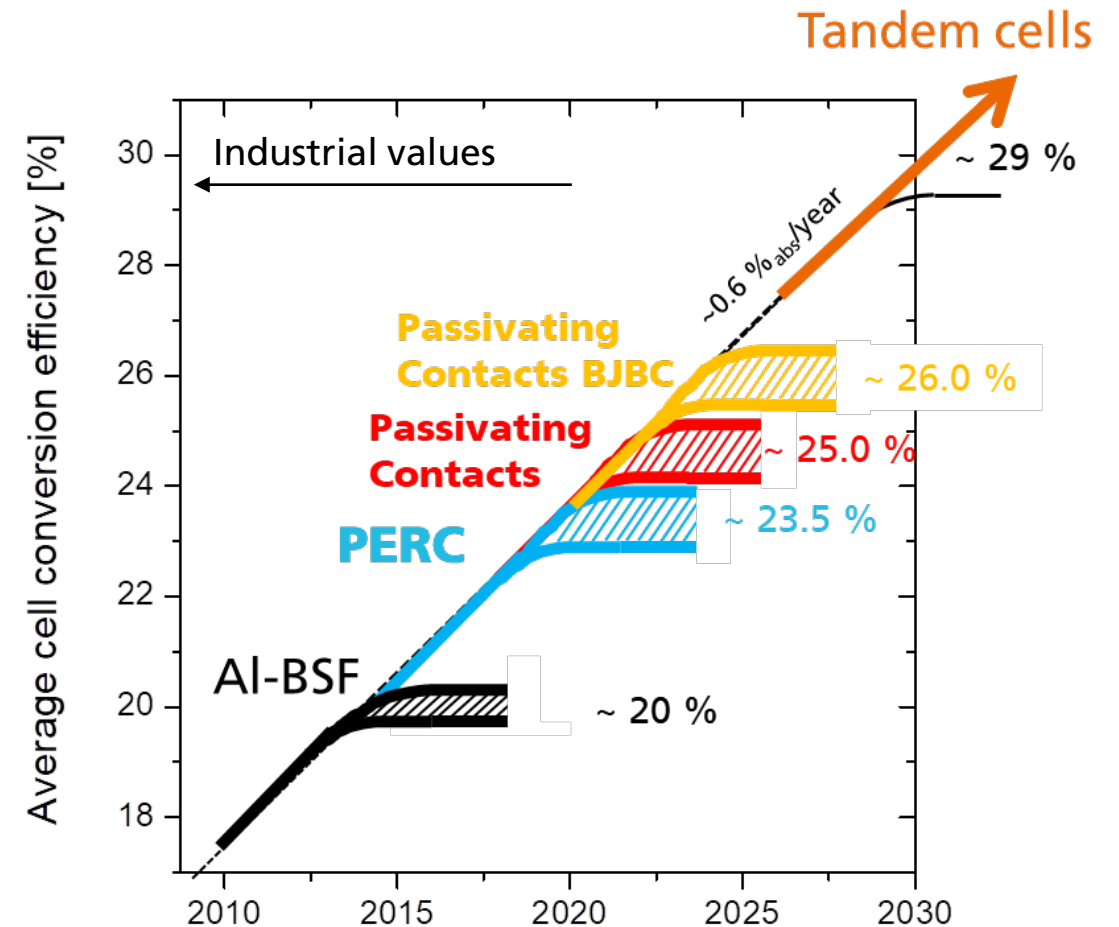
- Today: 80 % Passivated Emitter and Rear Cell (PERC) and 15 % Al-BSF solar cells in the world market; all made of Silicon material
- Recent **Laboratory** Records (tandems needs additional materials)

Si-TOPCon: 26.0 % (Europe)

BJ-HJT: 26.7% (Japan)

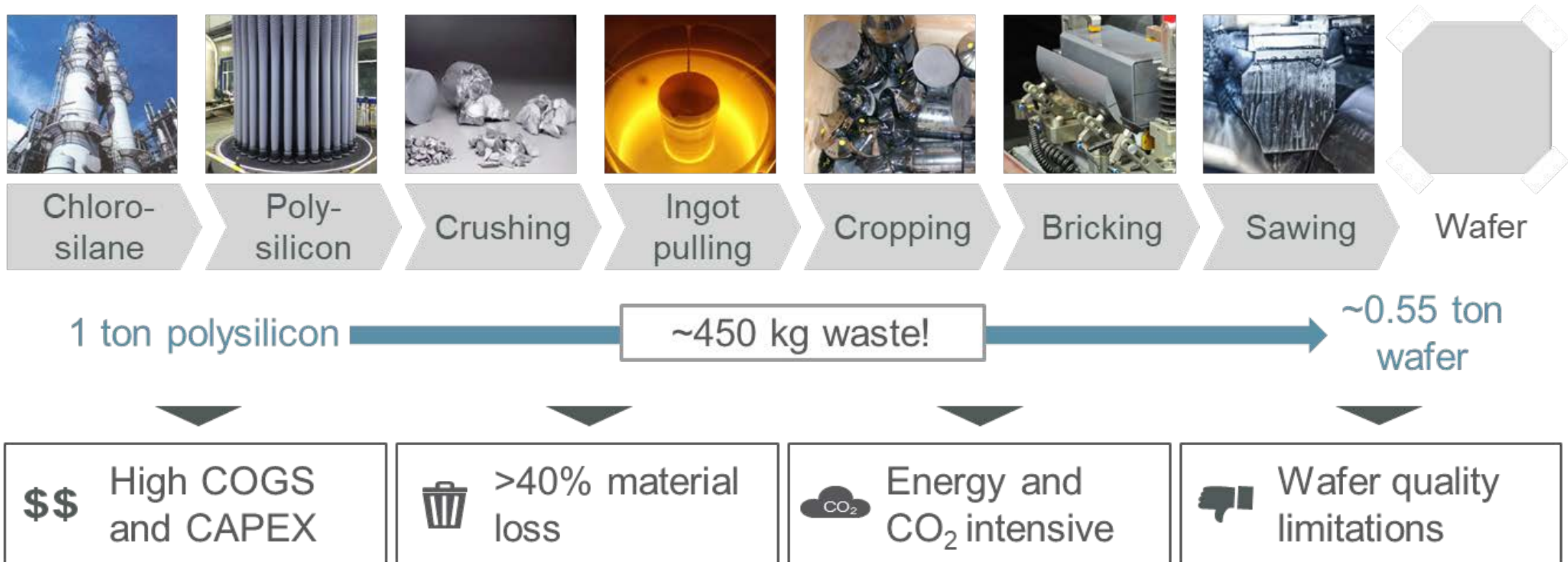
Pero/Si-Tandem: 29.5% (Europe)

III-V/Si-Tandem: 34.5% (Europe)



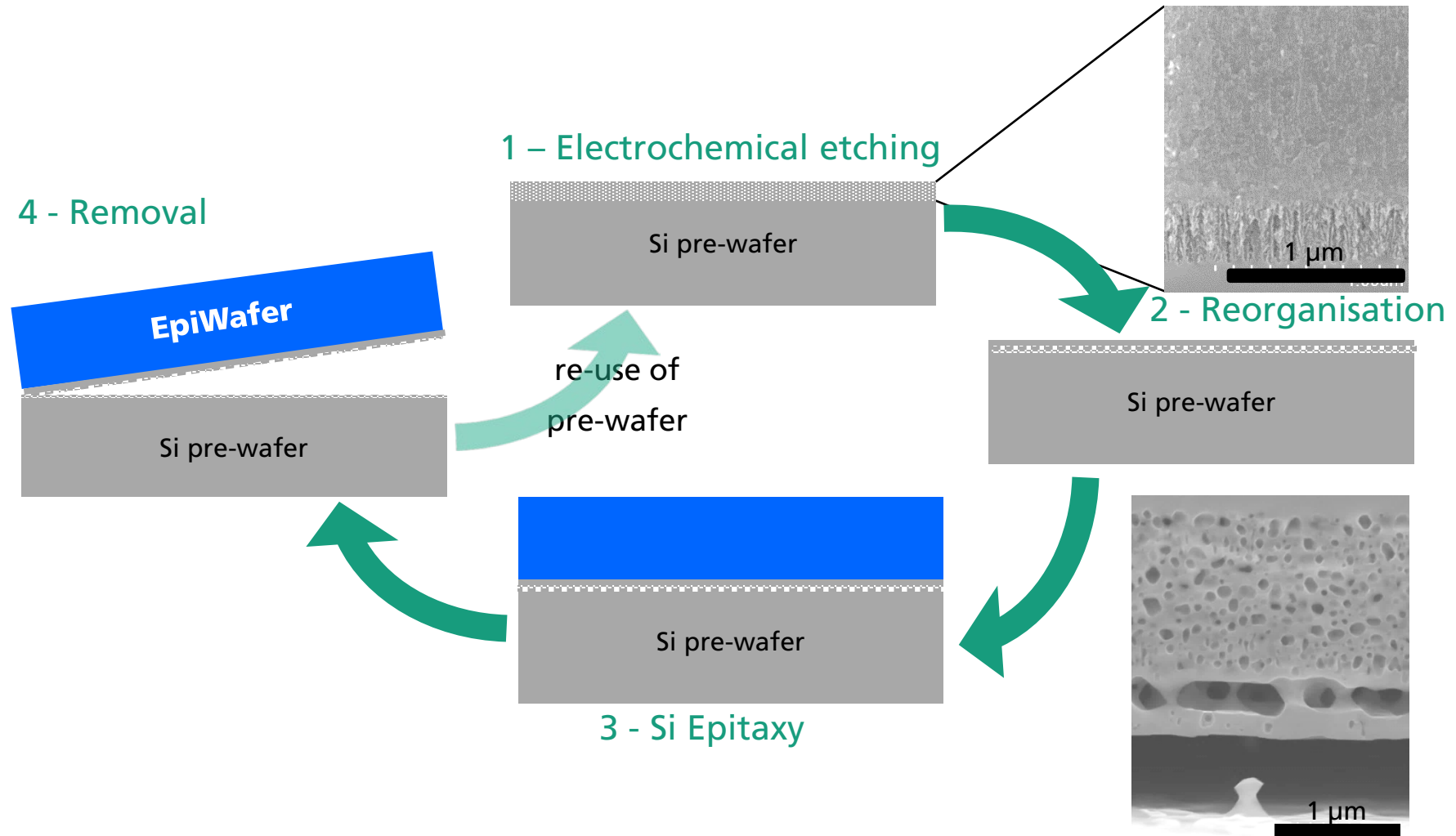
Innovation Material Production

Silicon Wafer – Today's Process



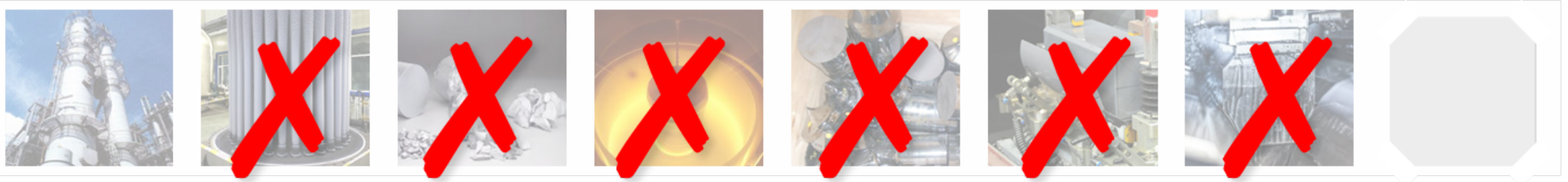
Innovation Material Production

Silicon Wafer – A New Process



Innovation Material Production

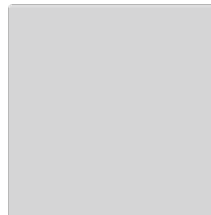
Silicon Wafer – New Process



Chloro-
silane



High-throughput
deposition



EpiNex®
wafer

Unique benefits

- ◆ 90% lower silicon losses
- ◆ 50% less energy and CO₂
- ◆ 50% less CAPEX

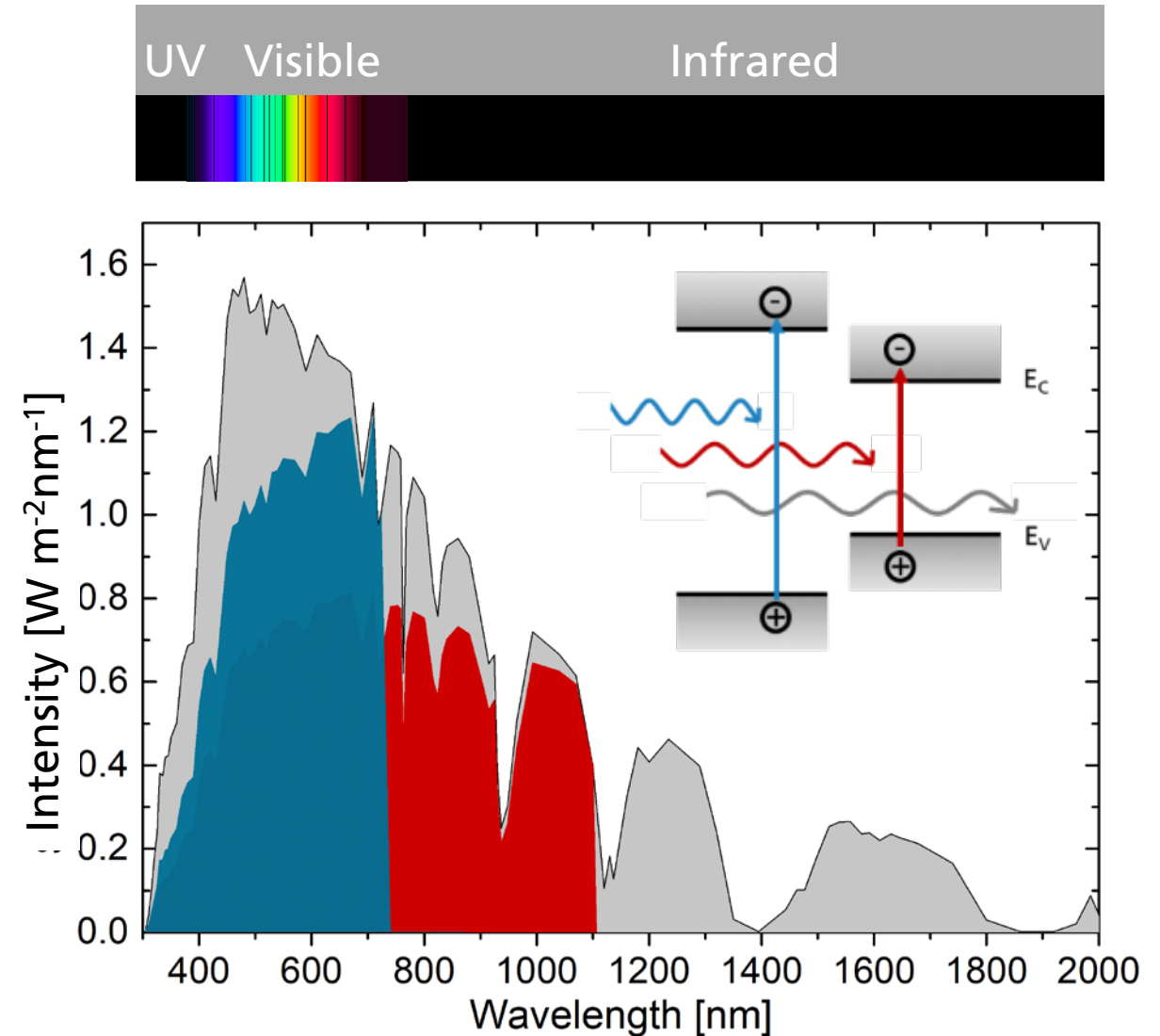
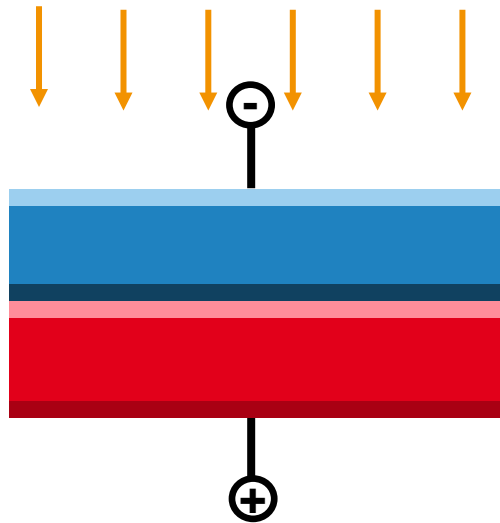
Disruptive wafer production by direct growth from chlorosilane gas

Innovation: Going Beyond the Limit Using one Material

Build a Tandem Solar Cell

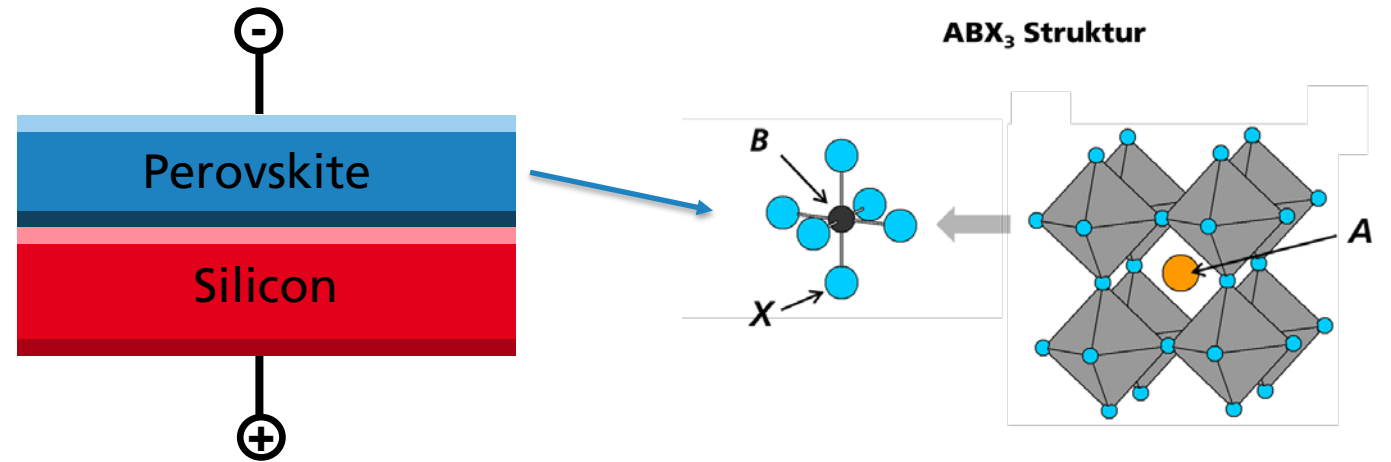
- The sun has a wide spectrum of colours / wavelengths
- Only one wavelength can be used efficiently by one solar cell type
- Two solar cell materials can split up the spectrum

- Monolithic Tandem solar cells



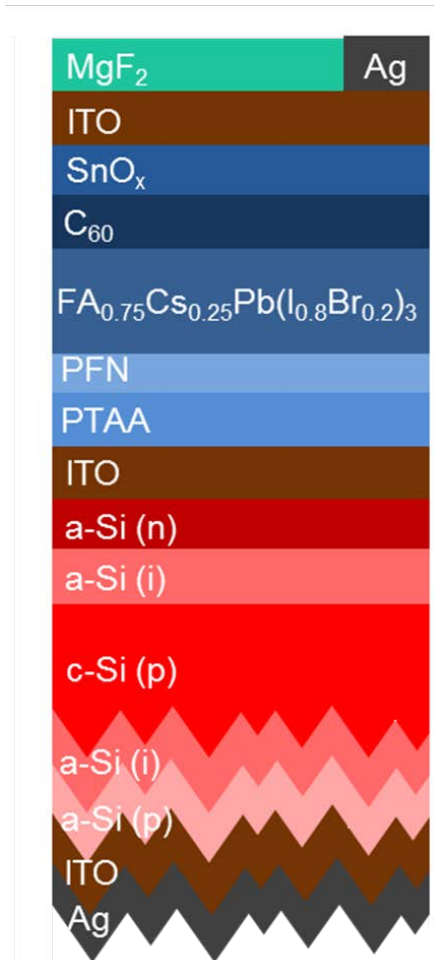
Tandem PV

Perovskites on Silicon



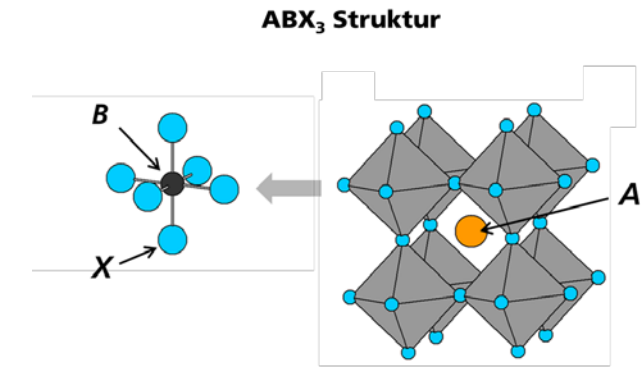
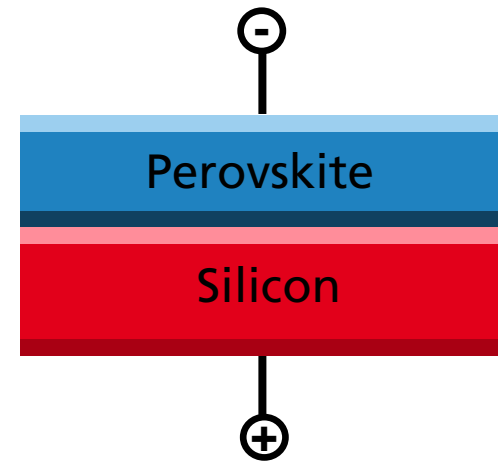
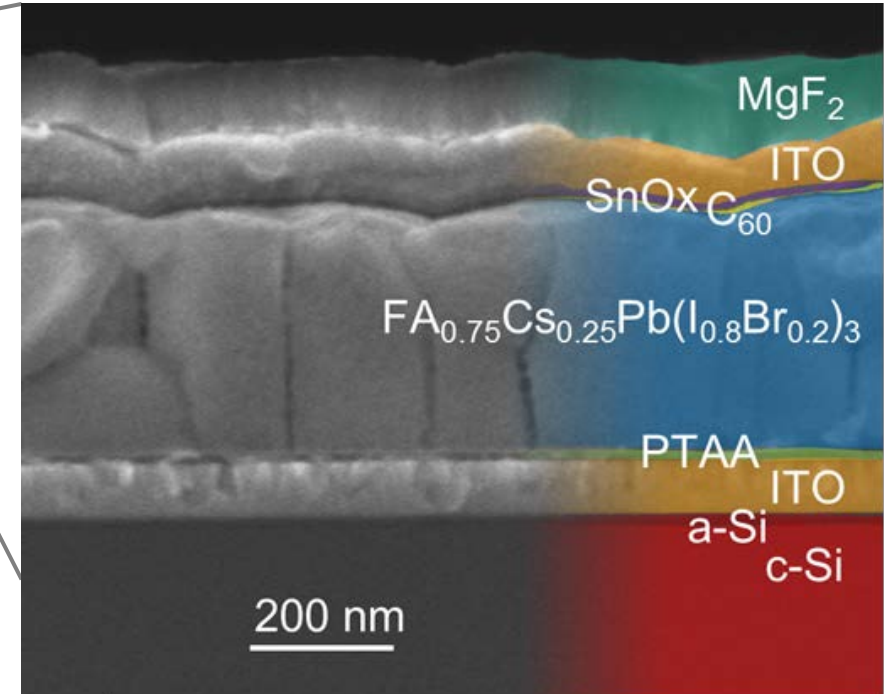
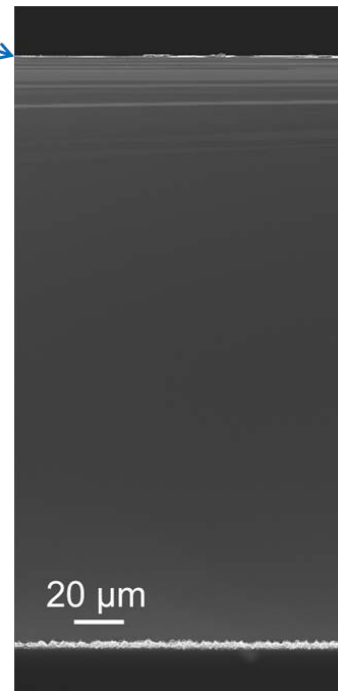
Tandem PV

Perovskites on Silicon



Perovskite
Solar Cell

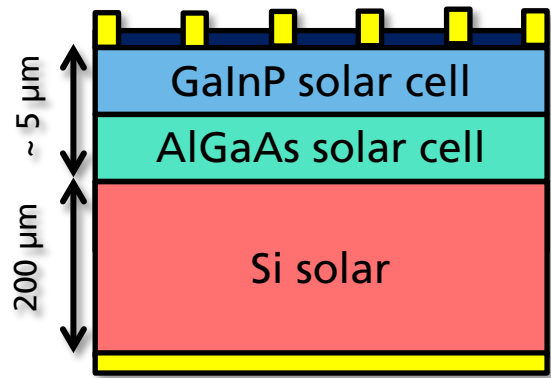
Silicon
Solar Cell



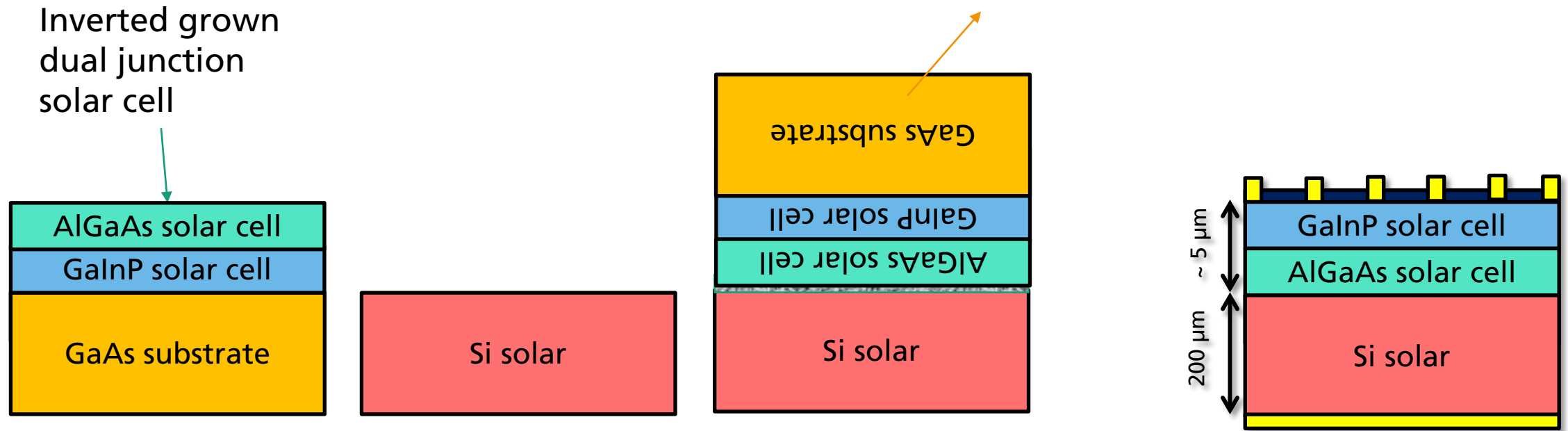
Tandem PV

III-V-Semiconductor on Silicon: Wafer-Bonded

- Three materials: GaInP, AlGaAs, Si
- Very high voltage > 3 V



Wafer-Bonded Solar Cell

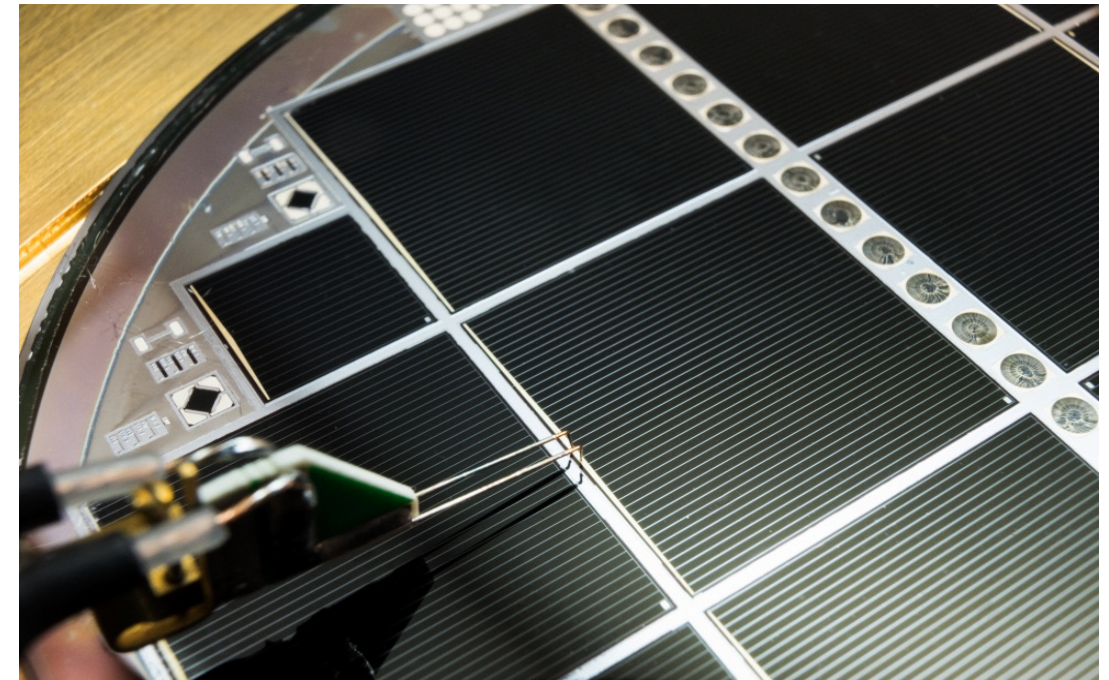
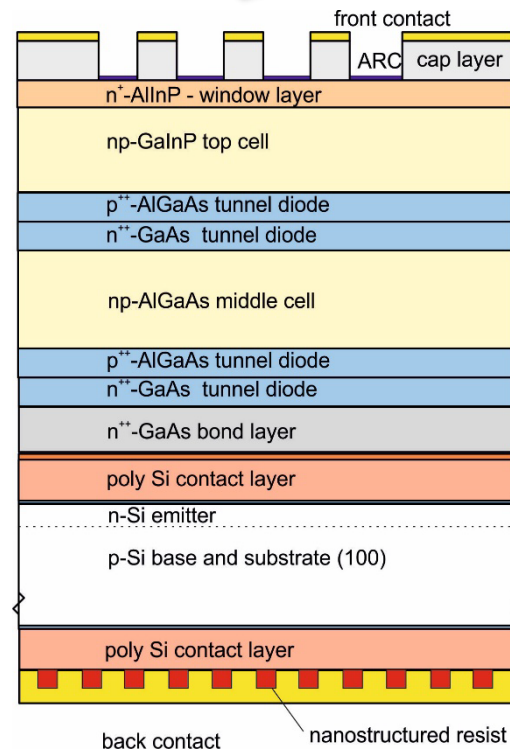
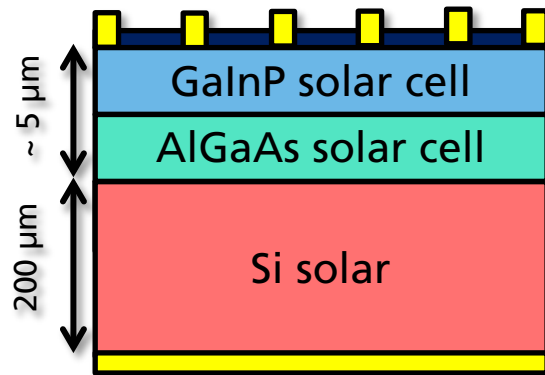
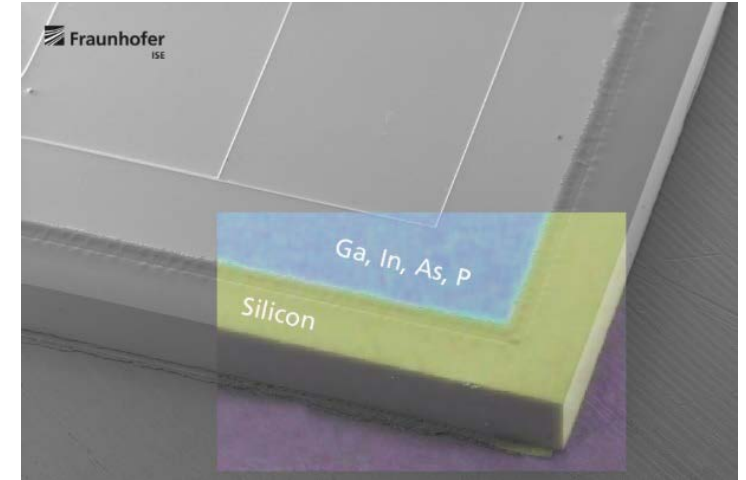


Tandem PV

III-V-Semiconductor on Silicon

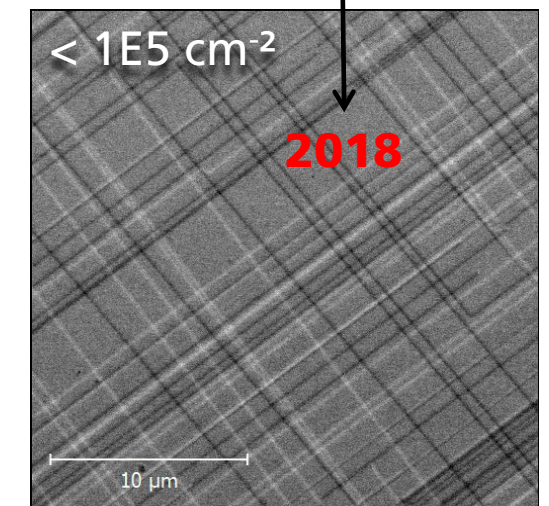
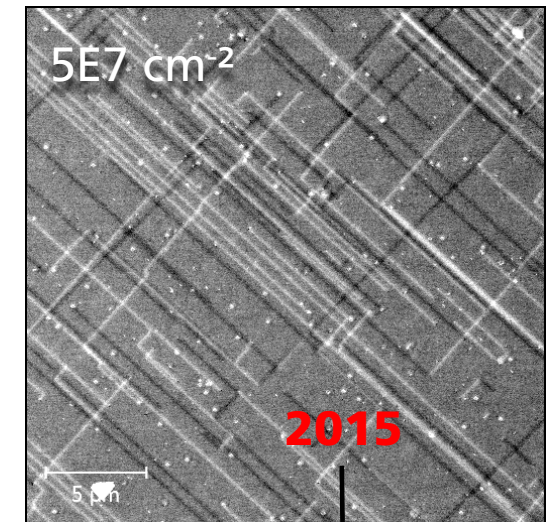
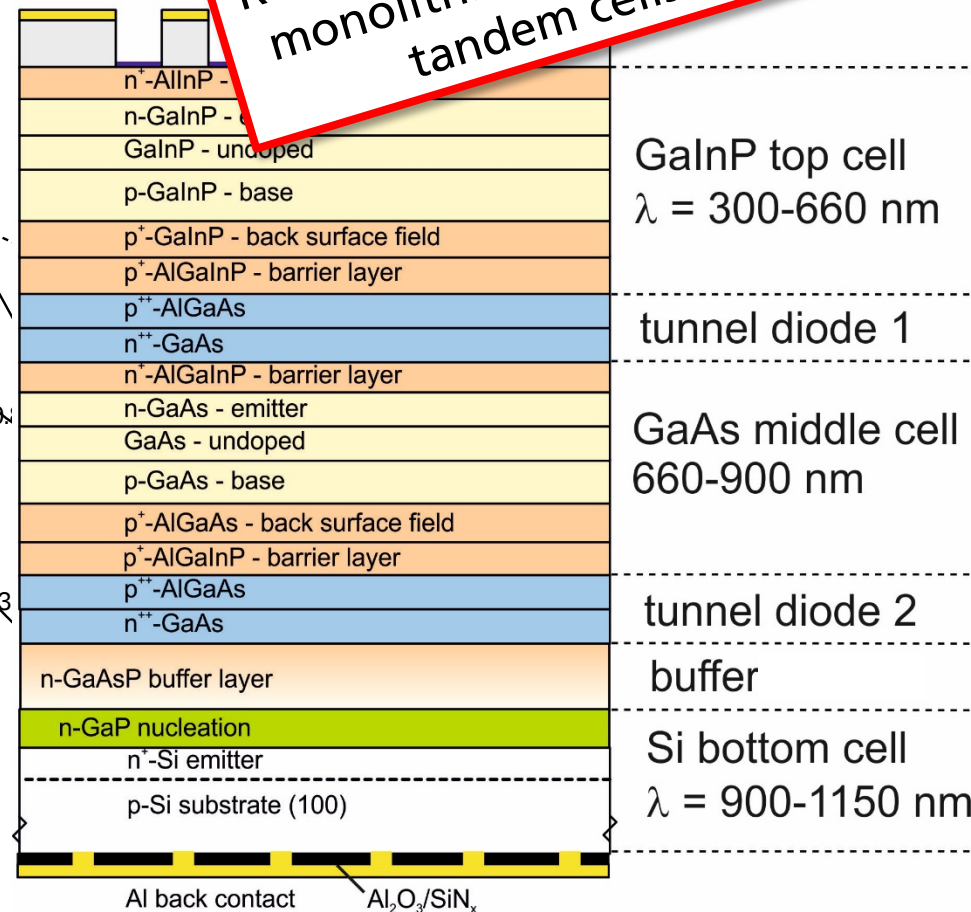
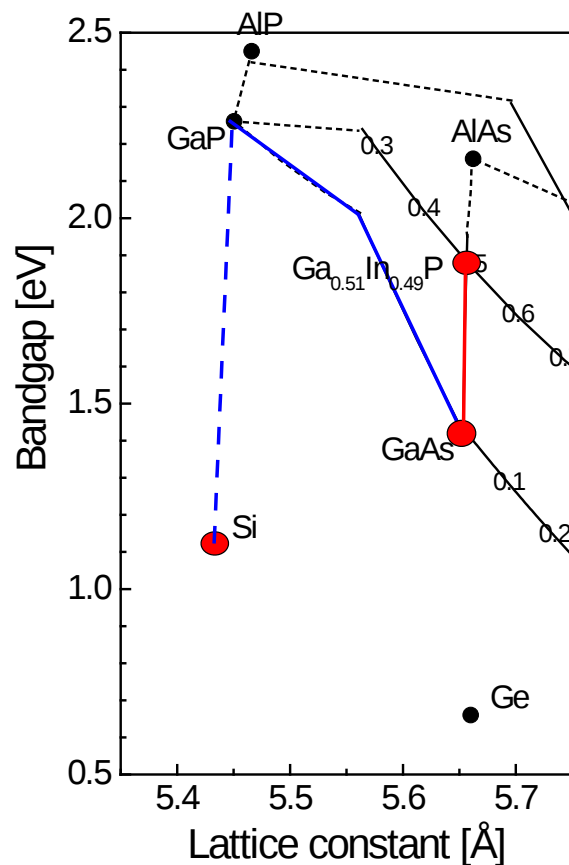
- Three materials: GaInP, AlGaAs, Si
- Very high voltage > 3 V

35.9% @ ISE
Record for monolithic
silicon-based tandem cells



Technology Status 2-Terminal III-V/Si Tandem Direct Epitaxy Growth on Silicon

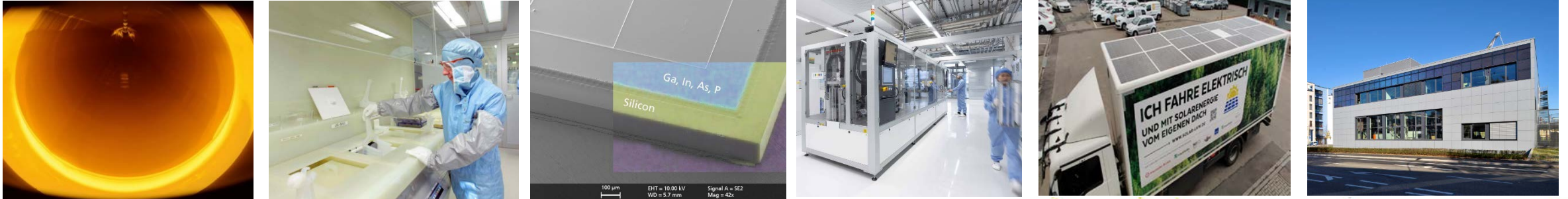
25.9% @ ISE
Record for directly grown
monolithic silicon-based
tandem cells



Conclusions

- Innovations in material science are of utmost importance for solar energy
 - Recyclability towards circular economy
 - Sustainability in respect to material availability and process flow
- Innovations on component and system level mandatory
 - Cell, module, inverter, installation.....

Thank You for Your Attention



Fraunhofer Institut for Solar Energy Systems ISE

Prof. Andreas W. Bett

www.ise.fraunhofer.de

andreas.bett@ise.fraunhofer.de

