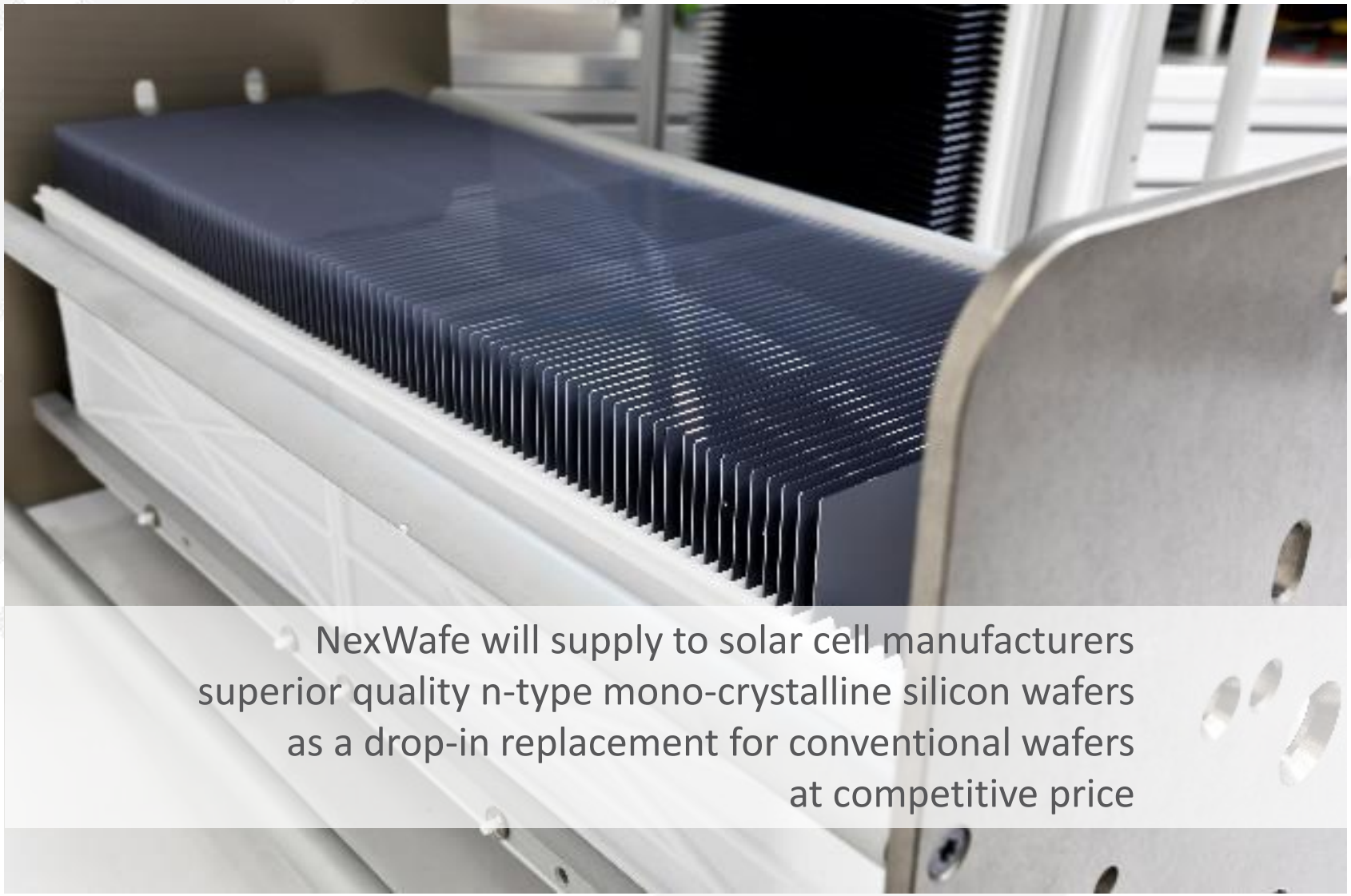
ETIP-PV Manufacturing Conference
Brussels, May 19th 2017

Epitaxial Wafers: A game-changing technology on its way to mass production

NEXWAFE
GROWING POWER

NexWafe: producer of high-quality silicon wafers



NexWafe will supply to solar cell manufacturers
superior quality n-type mono-crystalline silicon wafers
as a drop-in replacement for conventional wafers
at competitive price

Firm footing, strongly backed

- Founded in 2015 as a spin-off of Fraunhofer ISE
- Series A closed in March 2016
- Currently expanding pilot production for EpiWafers

Fraunhofer ISE

LYNWOOD Group

NEXWAFE GROWING POWER

Agenda

Epitaxial Wafers: A game-changing technology on its way to mass production

- Market needs
- EpiWafers – properties and advantages
- NexWafe's path to mass production

Market needs

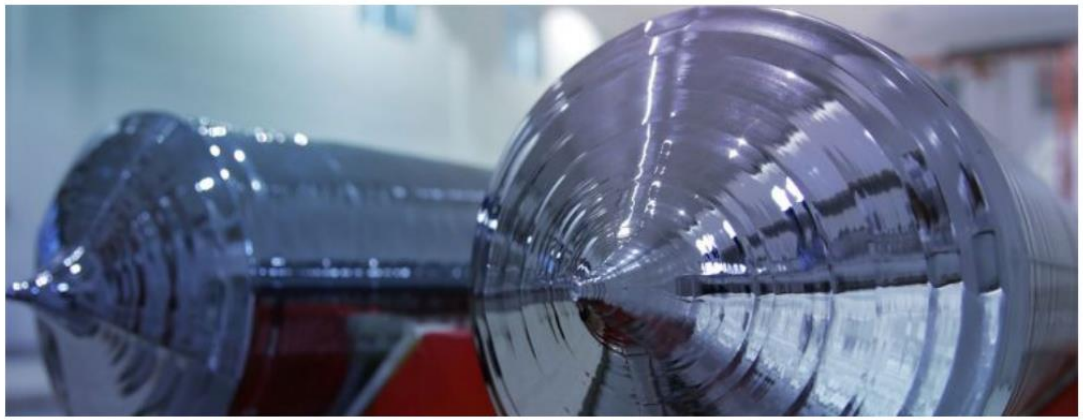
Mono and multi production 50:50 in 2018, but mono is the future

May 09, 2017 6:04 AM BST

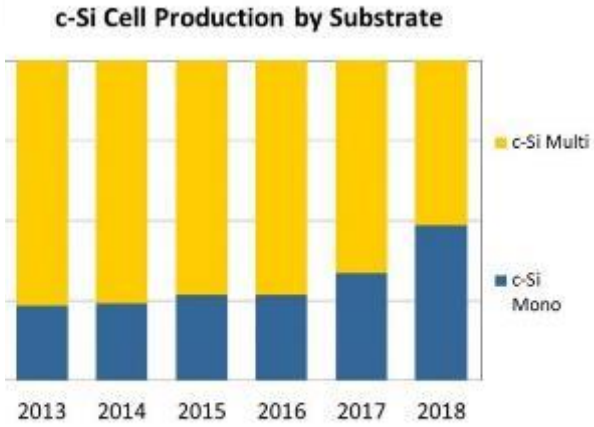
Share

By **Finlay Colville**, Head of Solar Intelligence, Solar Media

Finlay Colville joined Solar Media in June 2015 as head of the new Solar Intelligence activities. Until October 2014, he was vice president and head of solar at NPD Solarbuzz. Widely recognised as a leading authority on the solar PV industry, he has presented at almost every solar conference and event worldwide, and has authored hundreds of technical blogs and articles in the past few years. He holds a BSc in Physics and a PhD in nonlinear photonics.



Mono c-Si cell production is forecast to account for 49% of all c-Si cell production in 2018, and will become the dominant technology used in the PV industry by 2019, according to new research contained in the latest release of the PV Manufacturing & Technology Quarterly report, from the in-house research unit at PV-Tech's parent company Solar Media Ltd.



PV-Tech & Solar Media Ltd, in. 2017

PVTECH PVCELLTECH CONFERENCE

Market needs

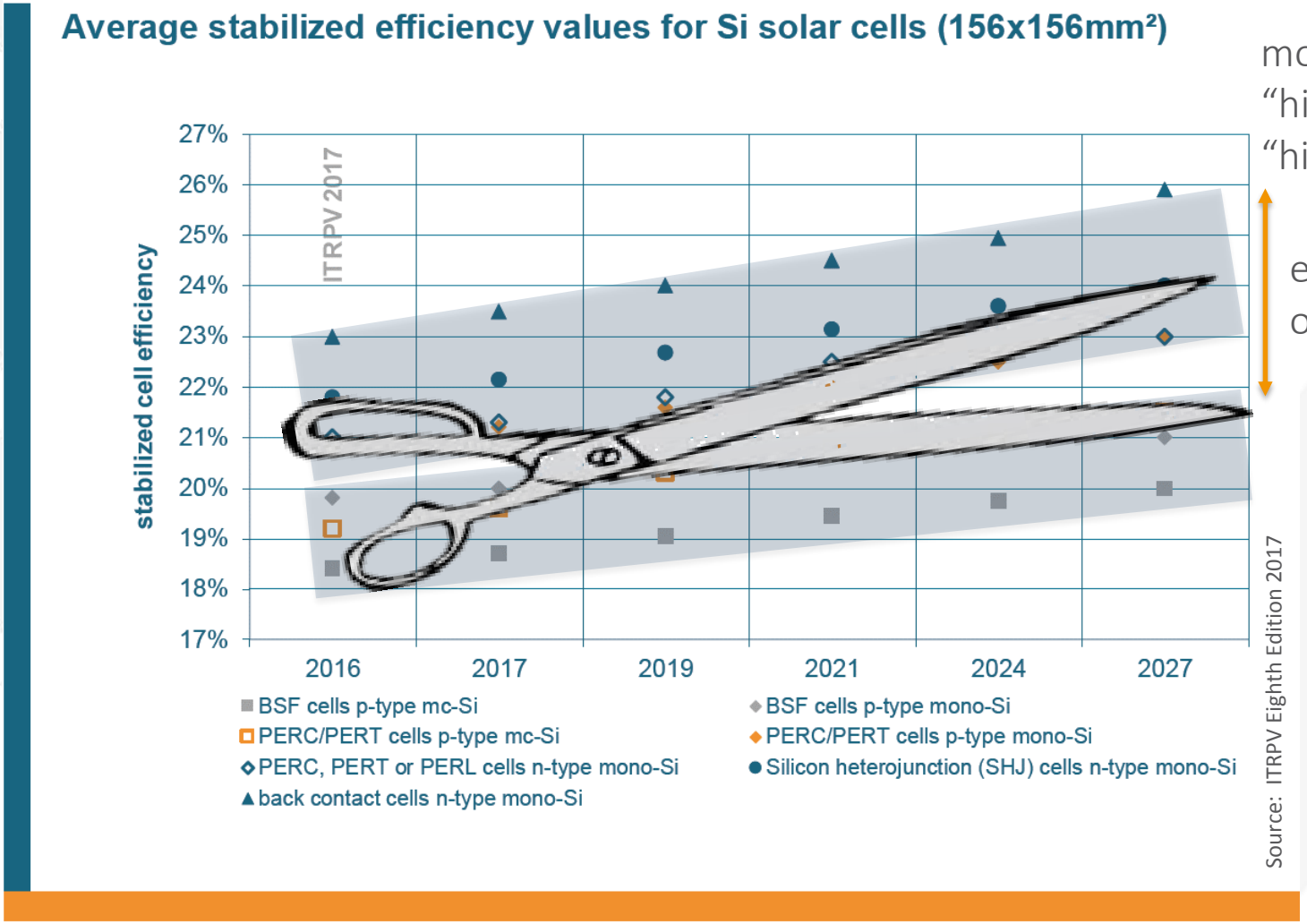
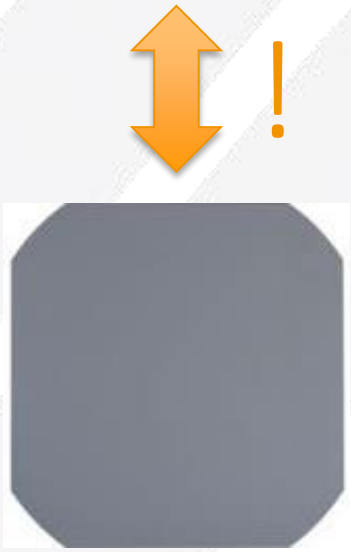


Fig. 39: Average stabilized efficiency values of c-Si solar cell in mass production (156 x 156 mm²).

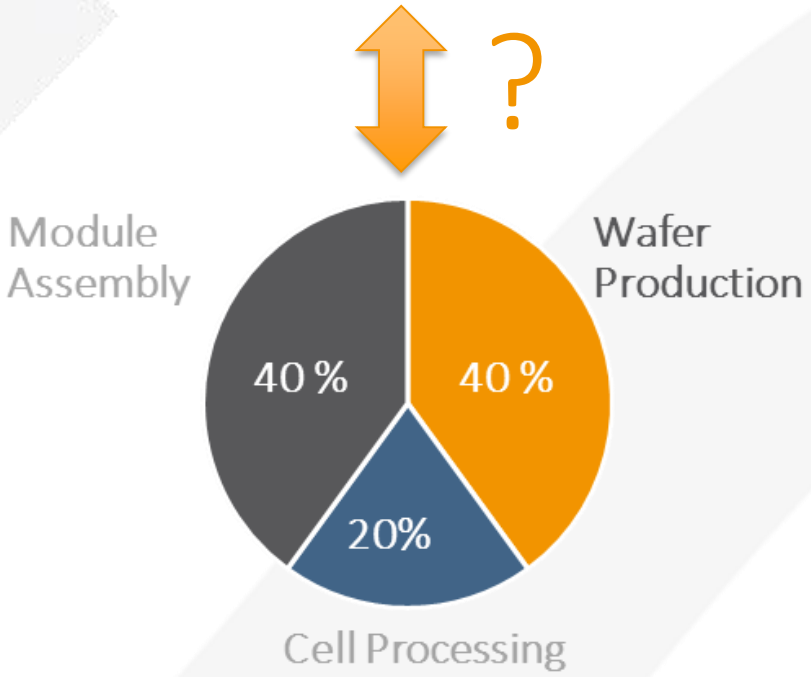
The PV-industry needs disruptive approaches to cut cost

Drivers for future cost reduction

- High efficiency solar cells



- Minimized material consumption

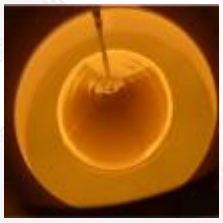


Module manufacturing cost

Reducing wafer cost is key

Standard wafer processing: low material usage, high cost





Chlorosilane → Poly silicon → Cz Ingot pulling → Cropping Squaring → Grinding → Wire sawing → Wafer

60% loss!

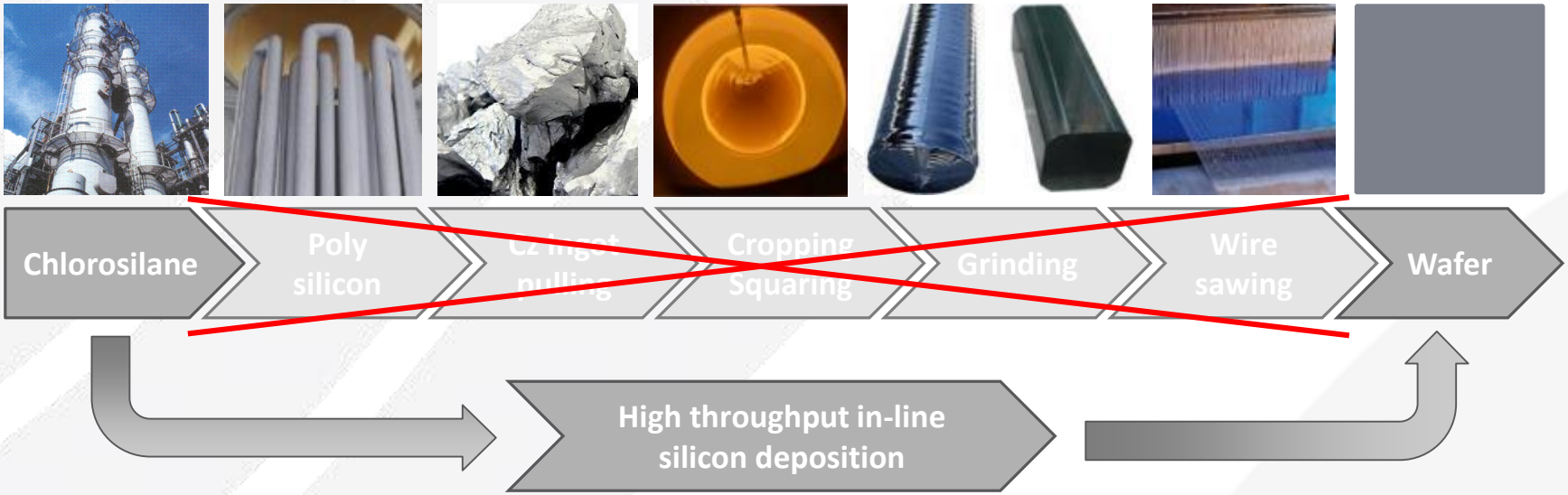
1 kg Si → 0.4 kg wafer

Severe silicon losses - High energy consumption - Capital intensive

High wafer cost

High losses limit cost reduction potential severely

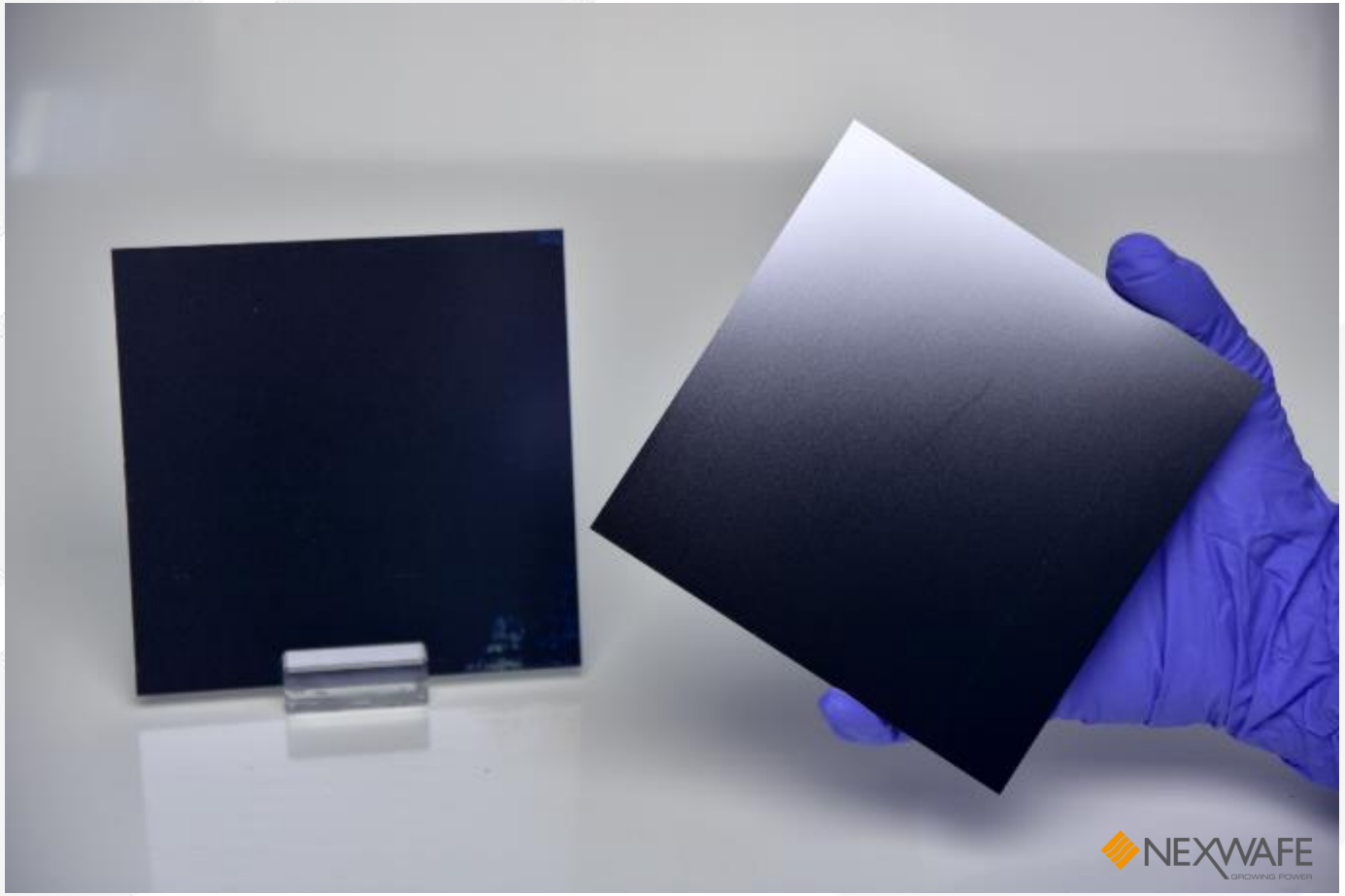
EpiWafers – smart and efficient value chain by kerfless wafering



Reduced silicon consumption
Dramatically less energy needed
Significantly less CAPEX

Very high cost cutting potential

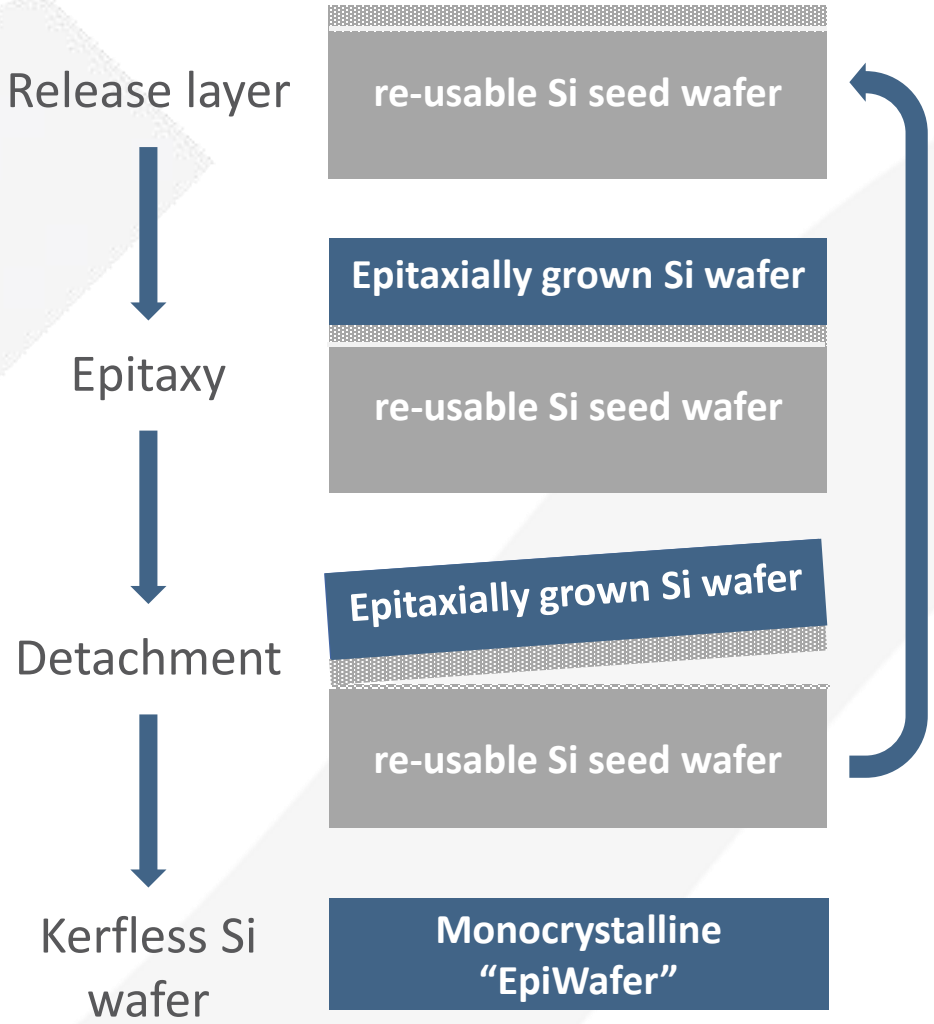
EpiWafer



Drop-in replacement of conventional wafers for high efficiency cells

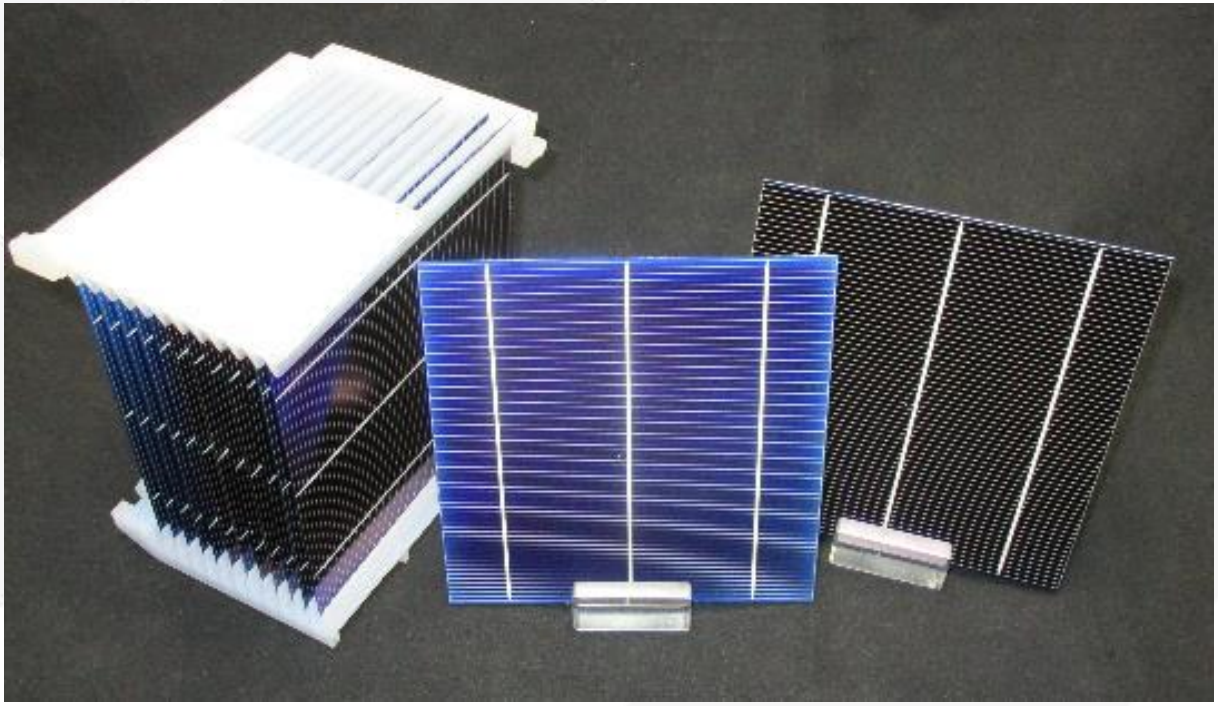
Kerfless EpiWafer process for mass production

- Idea: “Clone” a monocrystalline seed wafer
- Closed seed wafer loop and nearly no kerf allows for low production cost
- Wafer thickness: “standard” 180 µm or thinner – no problem to produce 80 µm thin wafers

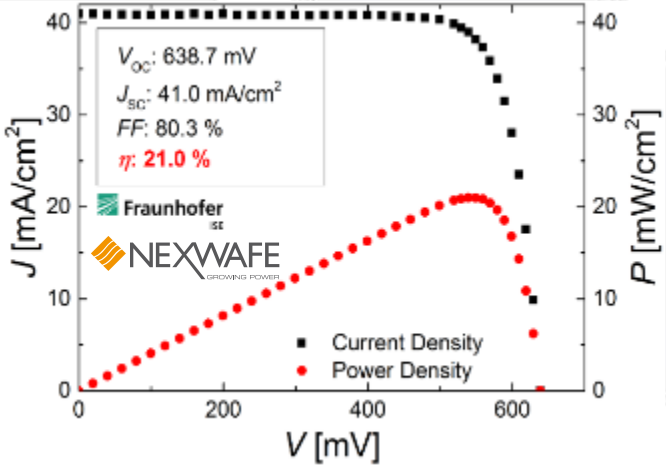


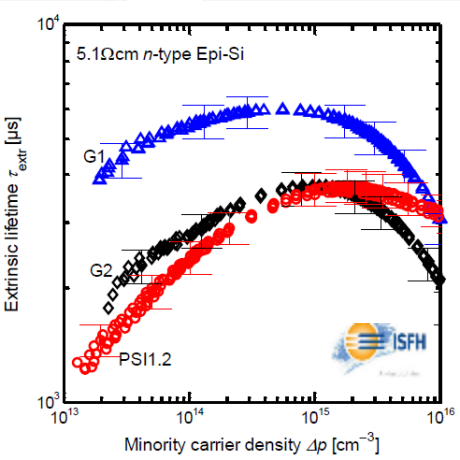
Optimizing customer value by specific product advantages

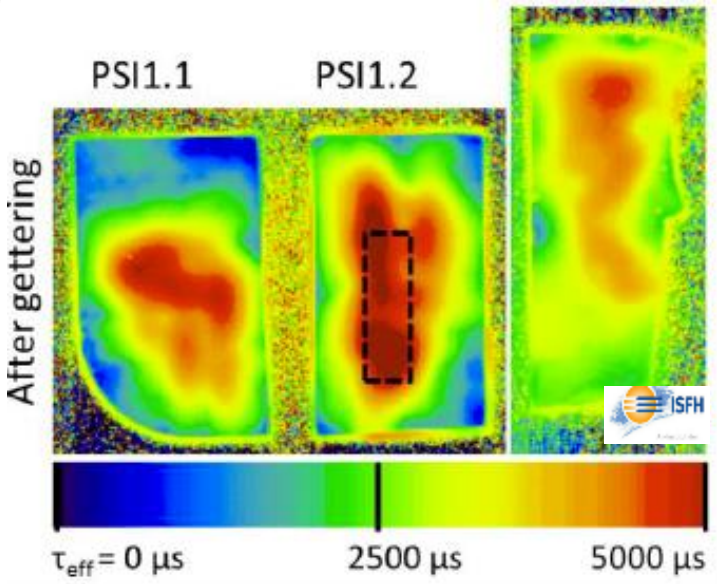
- Full-square wafer format: **Higher solar cell and module power**
- Better control of wafer parameters: **Narrower module efficiency distribution**
- Wafer thickness down to 80 µm: **Disruptive cost reduction and efficiency increase**
- In-situ growth of pn junction: **Cost savings on solar cell production**



EpiWafer achievements







C. Gemmel et al., Journal of Photovoltaics, 2016

Efficiencies > 20% and lifetimes in ms range proven

Quality can be perfect…

…but how can we produce billions of good EpiWafers??

Inline - the must-have for mass production

Mass production requires more than bulk lifetime!

- Very high throughput, modular scalable
  - 1000's of wafers per hour per machine
  - 10.000's of wafers per hour per factory
- High Yield > 95% (mechanical, electronic)
- High OEE > 80% (uptime, yield)
- Low production cost
  - Efficient BOM
  - Automation
  - Low CAPEX

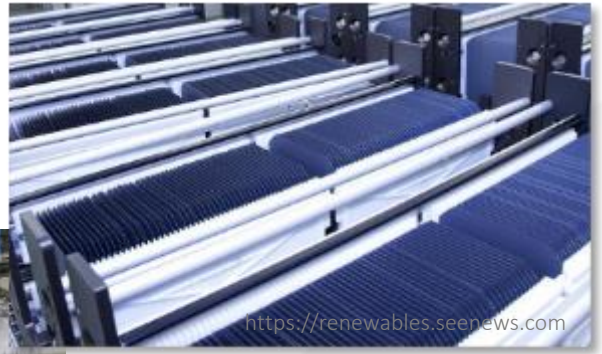
→ Not achievable with batch or single-wafer processing

Inline processing is a must-have to achieve low production cost

Out of the lab into production

- 5 MW production line in operation 2H 2017
- Start of mass production in 2018

2018
EpiWafer factory



2017
5 MW production

2012
ProConCVD

R&D at Fraunhofer ISE

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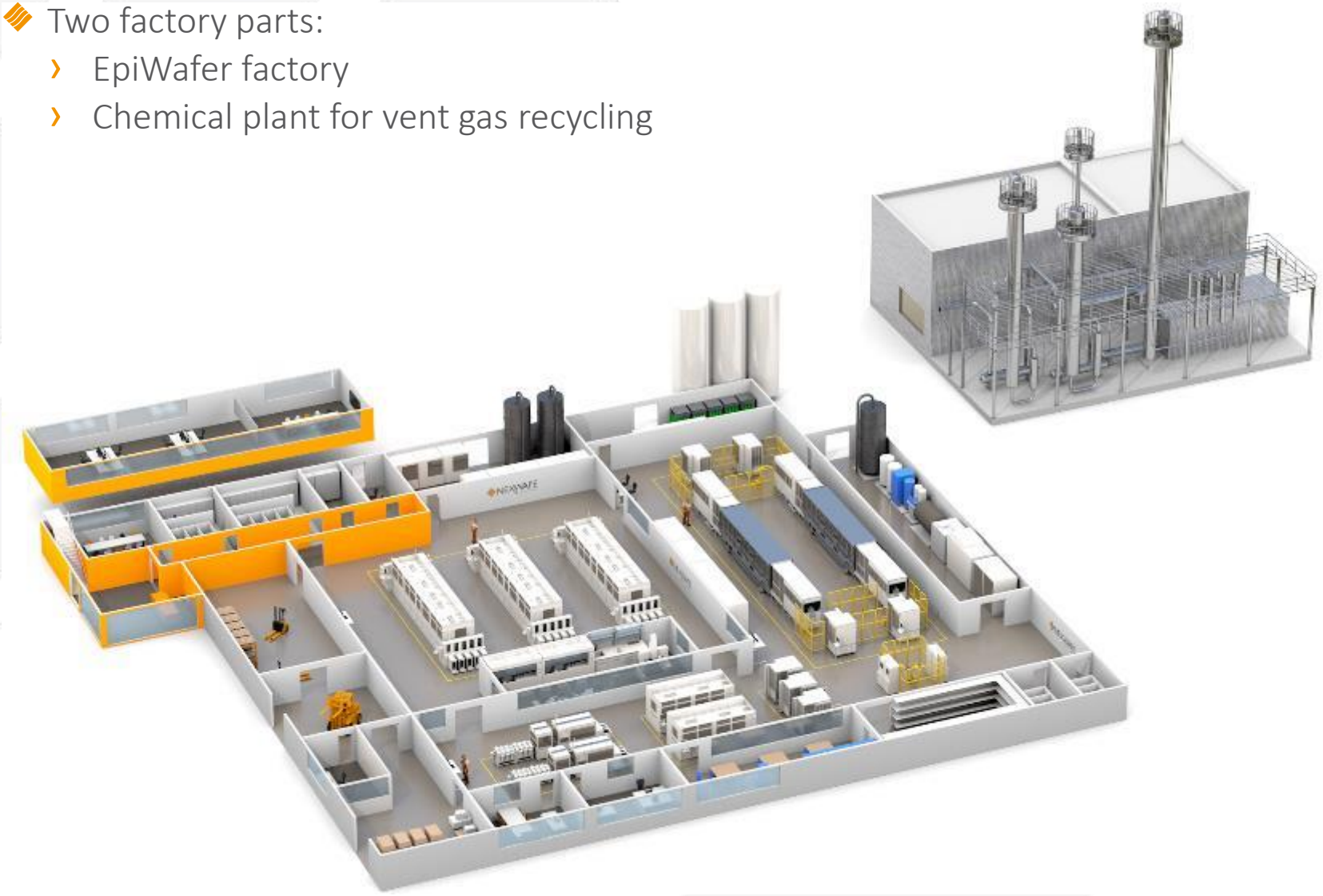
Production

Mass production based on a mature inline process
building on 20 years of R&D work at Fraunhofer ISE

Efficient and scalable 250 MW factory

- Two factory parts:
  - EpiWafer factory
  - Chemical plant for vent gas recycling



NexWafe's EpiWafers – innovation, growth and competitiveness

NexWafe brings solar wafer production back to Europe

- Most innovative, proprietary and patented PV technology fundamentally changing the process chain and the cost of the wafer industry
- We ensure long-term competitiveness in Europe by creating a scalable and highly profitable business
- We create jobs in R&D and manufacturing in Europe

LET'S BE AMBITIOUS!

Acknowledgements

NexWafe acknowledges funding by

German Federal Ministry of Economics and Foreign Affairs

and

EIT InnoEnergy

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