Interactions in value chain, risks of new technology Between-the-boxes challenge

10.05.2016 André Richter, Meyer Burger Technology AG

Historical PV

cost reduction through scaling and innovation

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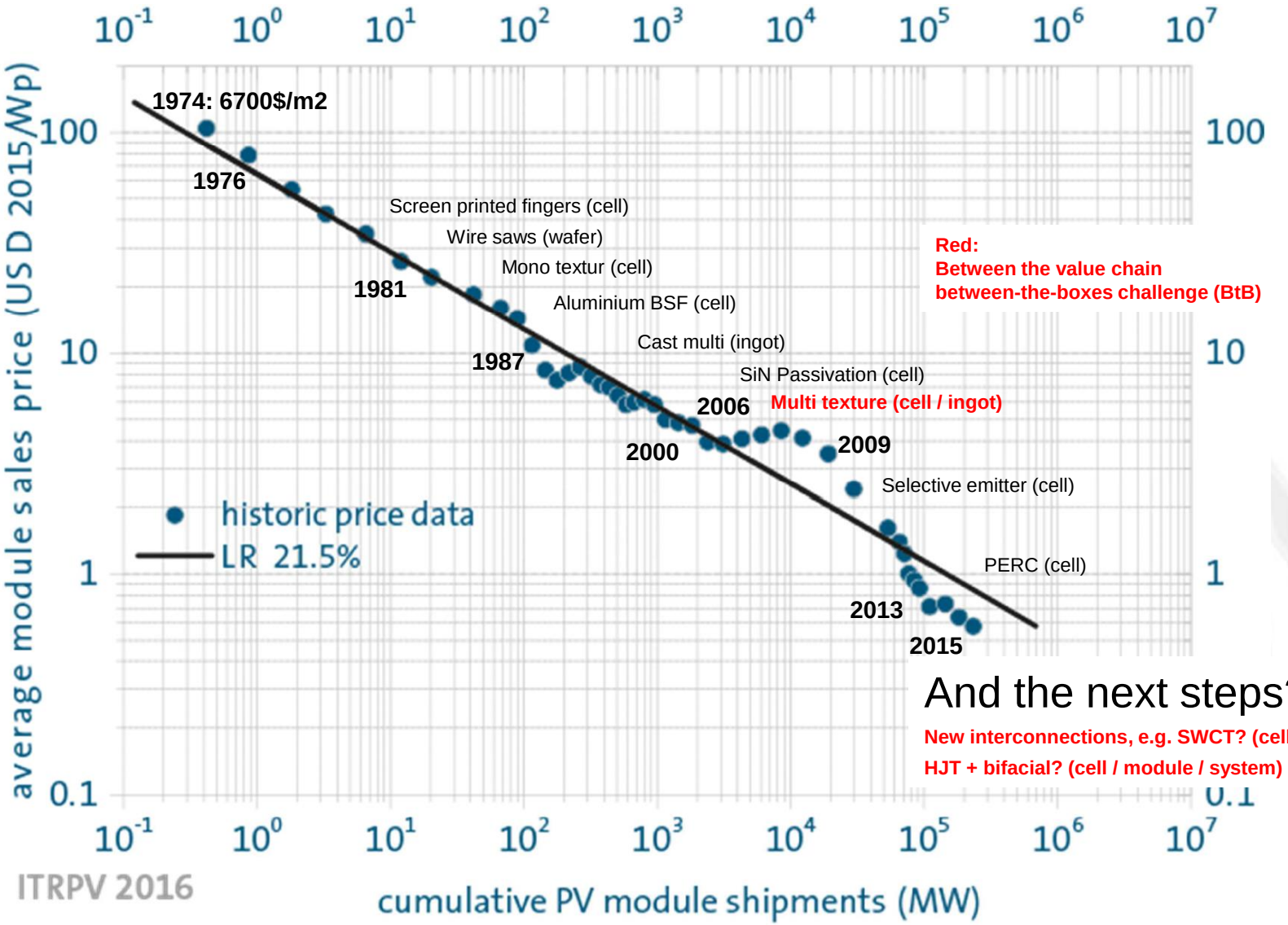


Red:
Between the value chain between-the-boxes challenge (BtB)

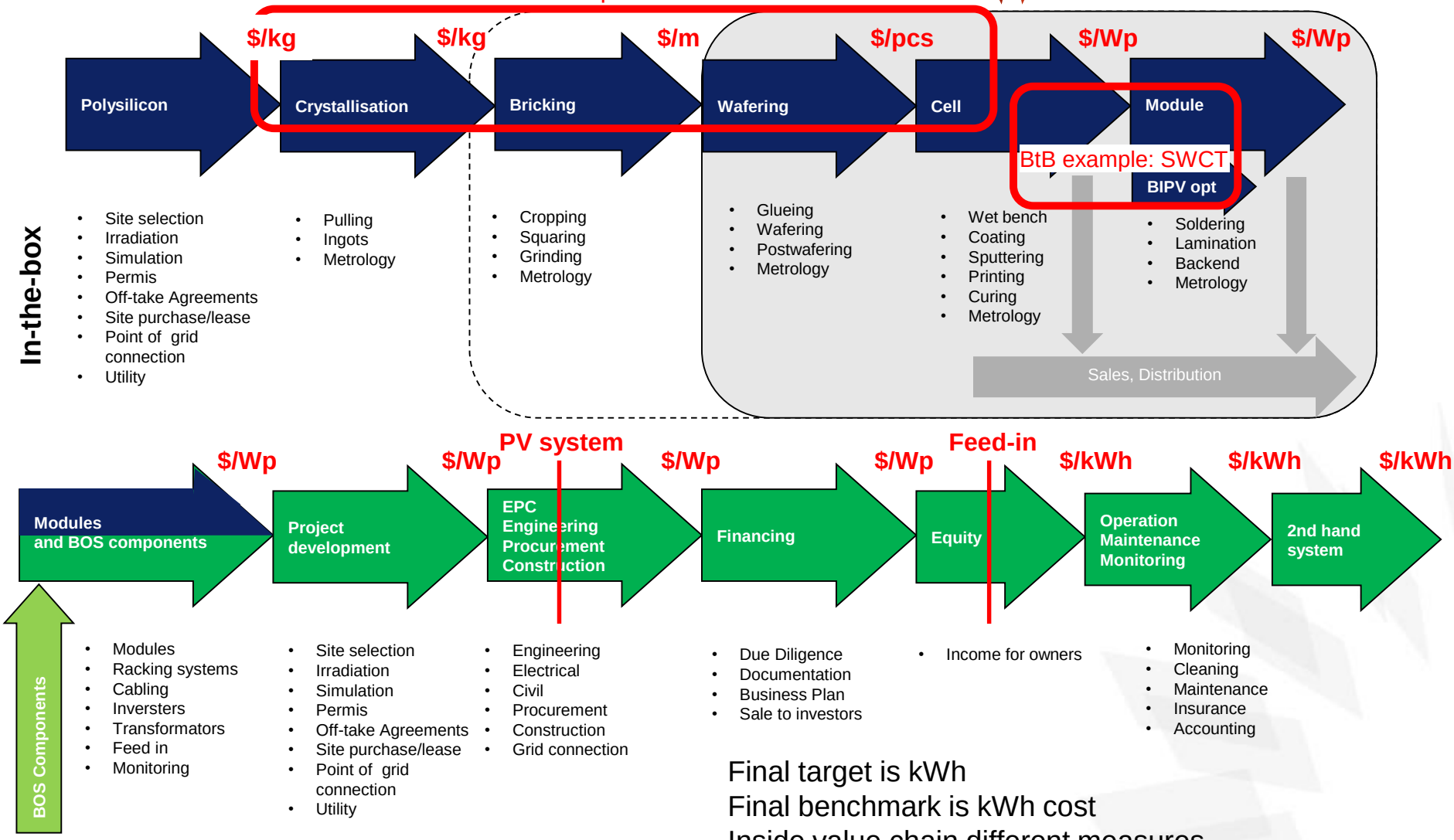
And the next steps?

New interconnections, e.g. SWCT? (cell / module)

HJT + bifacial? (cell / module / system)

Sources:
ITRPV 2016
Meyer Burger

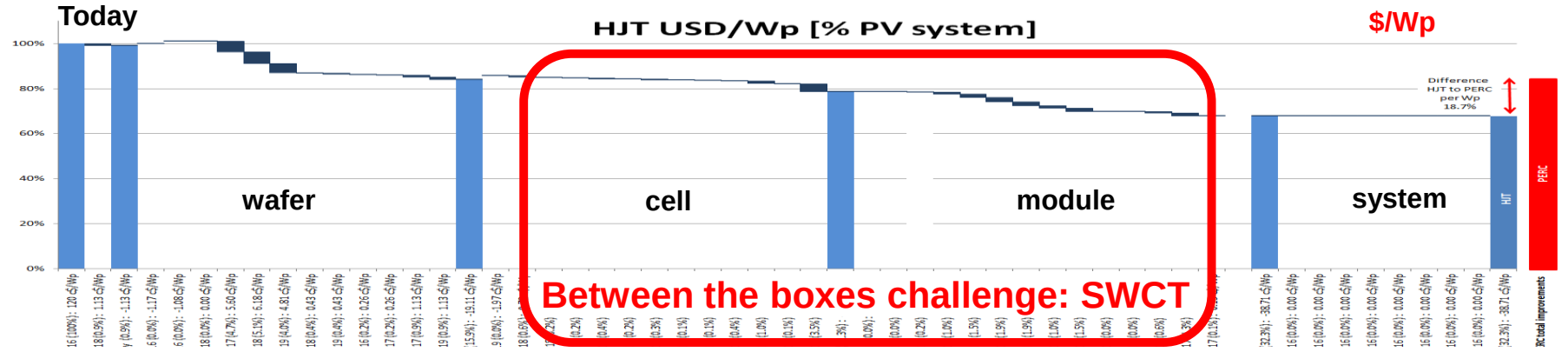
PV Value Chain

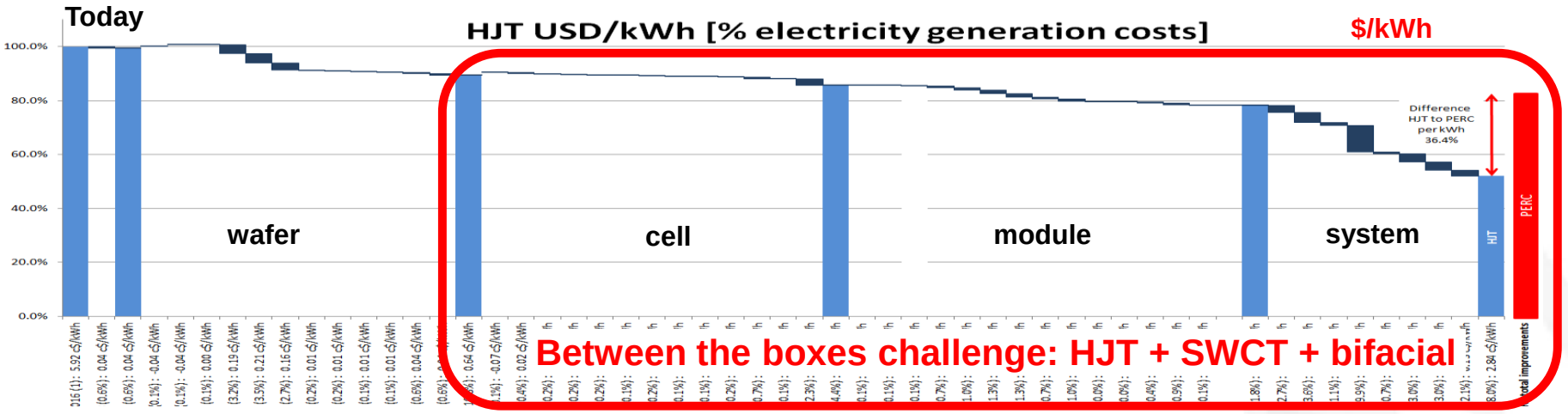


Final target is kWh
Final benchmark is kWh cost
Inside value chain different measures
Are all ways to achieve final target open?
Challenge for developments „between the boxes“

Example for not successful approach with BtB challenge:
UMG crystallization needs additional cell process adaptions

What next? Technology paths





Between the box challenge:

This diagram shows two possible paths for HJT and PERC until 2020.

The „new“ development has some effects in Wp, but very big effects in energy yield.

The value chain is challenging developments, because of different measures.

Risk assessment: Example 1

value optimizing in the box

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1a) Investigation for a new wire saw for a specific market:

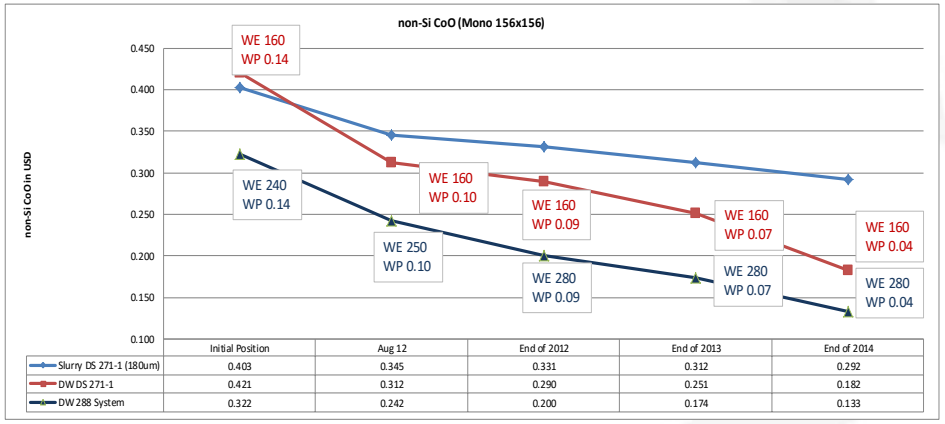
- Estimated costs R&D, proto type, tests: 6 mCHF
- Time needed for new development & qualification 24 months
- Estimated average total revenue: 6 mCHF
- Effect on PV value chain: > factor 5
- Decision to stop development, because high risk to lose money

„Lost“ for value chain of estimated 0.7ct$/Wp

Example illustration

1b) Roadmap of successful development: -10ct$/wfr

This benefit remains in-the-box: no BtB challenge



	Initial Position	Aug 12	End of 2012	End of 2013	End of 2014
Slurry DS 271-1 (180um)	0.403	0.345	0.331	0.312	0.292
DW DS 271-1	0.421	0.312	0.290	0.251	0.182
DW 288 System	0.322	0.242	0.200	0.174	0.133

Risk assessment: Example 2

risk reduction for investments in PV systems through faster payback, higher yield, higher declining balance but facing BtB challenge

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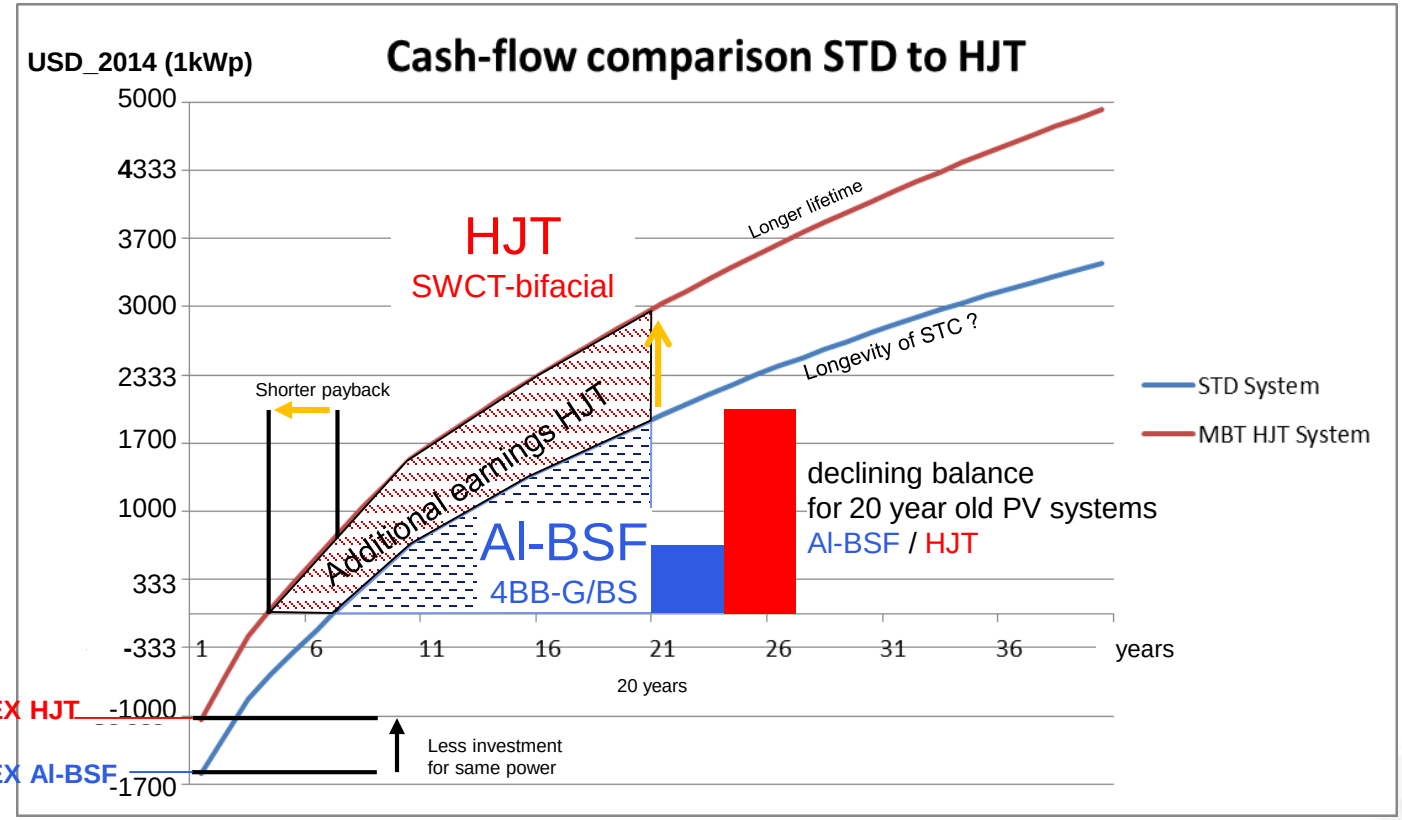

Conditions:

- Al-BSF: cell 18.5%
- HJT: cell 22%

- Irradiation: 1200 kWh/kWp
- Total cost 1550 USD/kWp installed
- Inflation rate 2.25%
- WACC 0%

IRR 10 years:
Al-BSF: 7% pa.
HJT: 18% pa.

Return after 20 years
HJT: 3 Mio USD
Al-BSF: 2 Mio USD

Return after 36 years
HJT: 4,5 Mio USD
Al-BSF: theoretical
2,5 Mio USD

Advantages HJT:

- Capex in HJT-PV system red line: CAPEx is -5% to -30% (Wp / m2) lower due to higher cell efficiency which lowers BOS costs per Wp
- HJT leads to energy gain of 10% and more due to the very low temperature coefficient and due to gains of SWCT cell connection
- HJT shows no LID and PID degradation because of n-type material and low temp processing (no micro cracks).
- High longevity because of high quality module encapsulation

Example 2 (track record)

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Heterojunction (HJT):

- HJT >1GWp in market since 2004 (Sanyo/Panasonic)
- This modules are still known premium quality

SWCT:

- SWCT, former Day4 >250MWp in market since 2005
- Certified by banks for SWCT installations

HJT + SWCT:

- Several IEC certificates achieved in 2014, 2015, 2016
- Extended TC, DH up to 4x, 8x
- Company est. 1953 with reliable machines and big market share in PV since 2002
- Today: COO (ca. 500MW) on similar level than 1st tier companies (ca. 3GW)
- In future: COO will undercut xGW scaled technologies
- Energy production at 10% to 30% lower costs than best next technology, no LID or PID, PV system capex same or below actual system capex: This technology can help to follow the learning curve.

BtB challenge!
Is this technology (HJT + SWCT) bankable?

Thank you

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Meyer Burger´s way to follow learning curve: High efficiency, high energy yield, very low LCOE

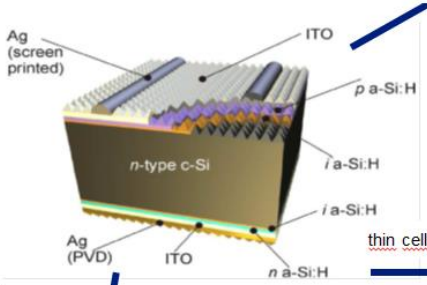
1 High efficiency cell
- lower system cost (BOS)
- Thin > high efficiency

Only 6 process steps
- low COO

Temperature coefficient
- higher energy yiel
- Bifacial -> higher energy Yield

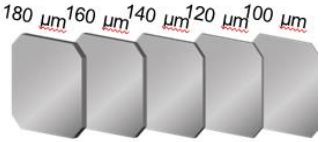
High upside potential
- In future technology will follows improvement path of PV

Texture
a-Si front/ rear side
TCO / metal rear contact
Print front Side
Print BS
Test & Sort



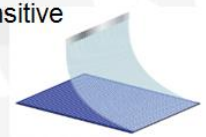
2 Diamond wire wafering
- thinner wafer -> lower costs

Mono wafers



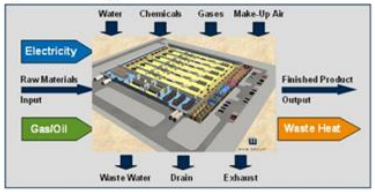
3 TCO layer and wafer thickness suitable for SmartWire
- 80% less silver,
- higher energy yield
- higher efficiency
- longevity
- microcrack resistent
- less sand / dust sensitive

thin cells (thin wafers)



Improved facility

6 Low energy consumption opens door for new facility concepts, layouts logistics



Quality & perfromance control

5 Material quality and Tracking, MES

High capacity, busbarless measurement

4 Adapted test metrology
- high cap cells
- BB0
- DragonBack
- PED (Chipping)