Status of Crystalline Silicon PERC Solar Cells

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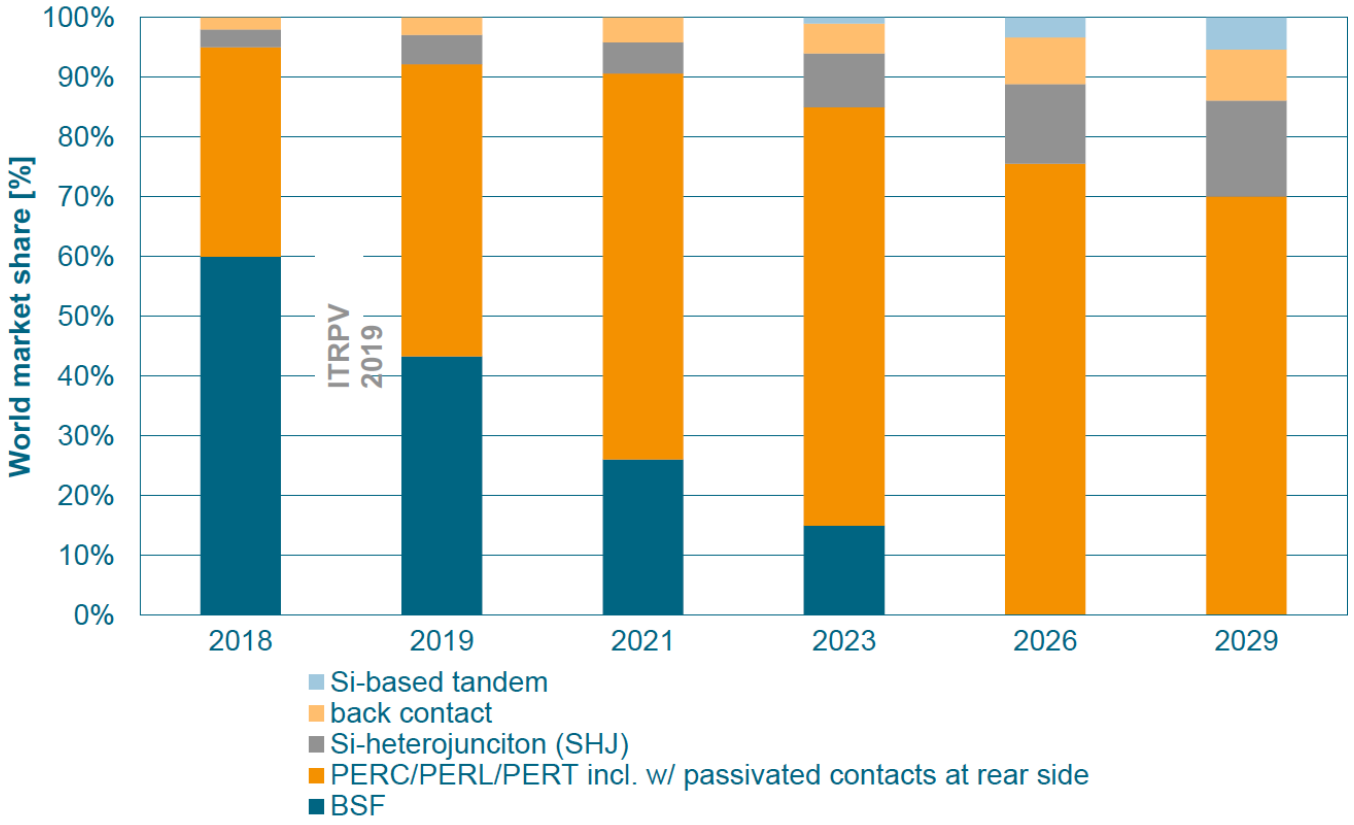
PERC Cell's Market Share



PV Module ASP Trend

Learning curve for module price as a function of cumulative shipments

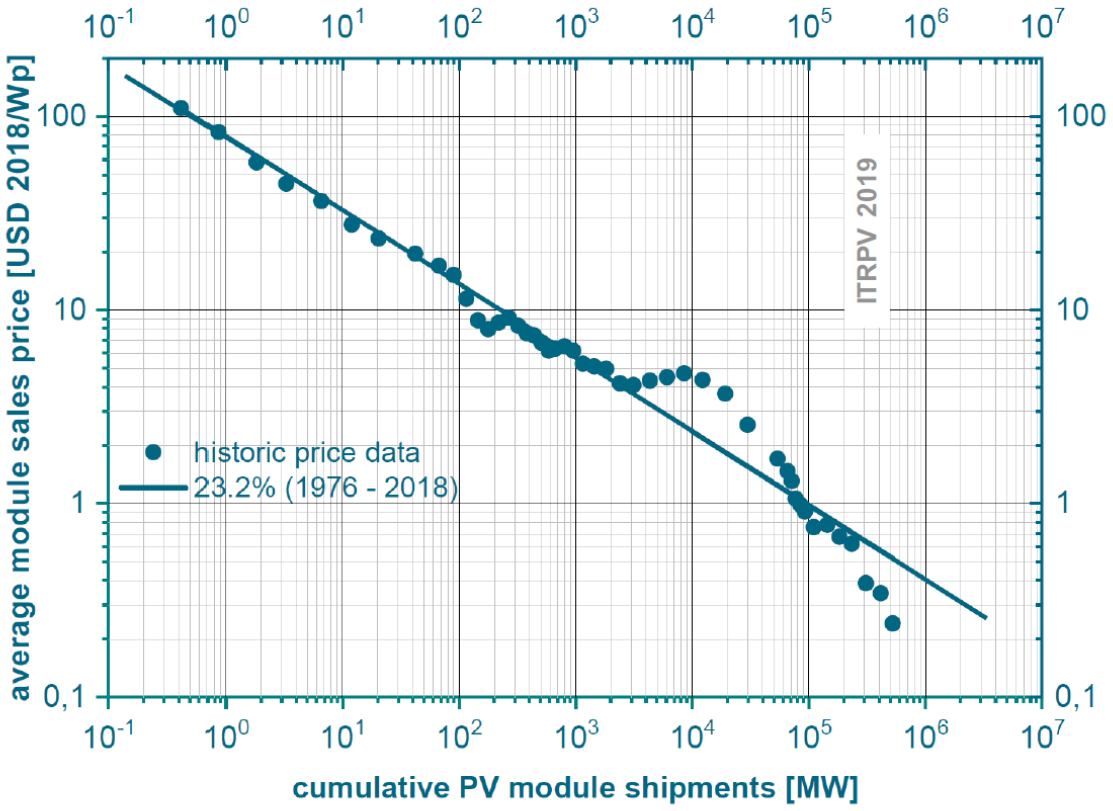
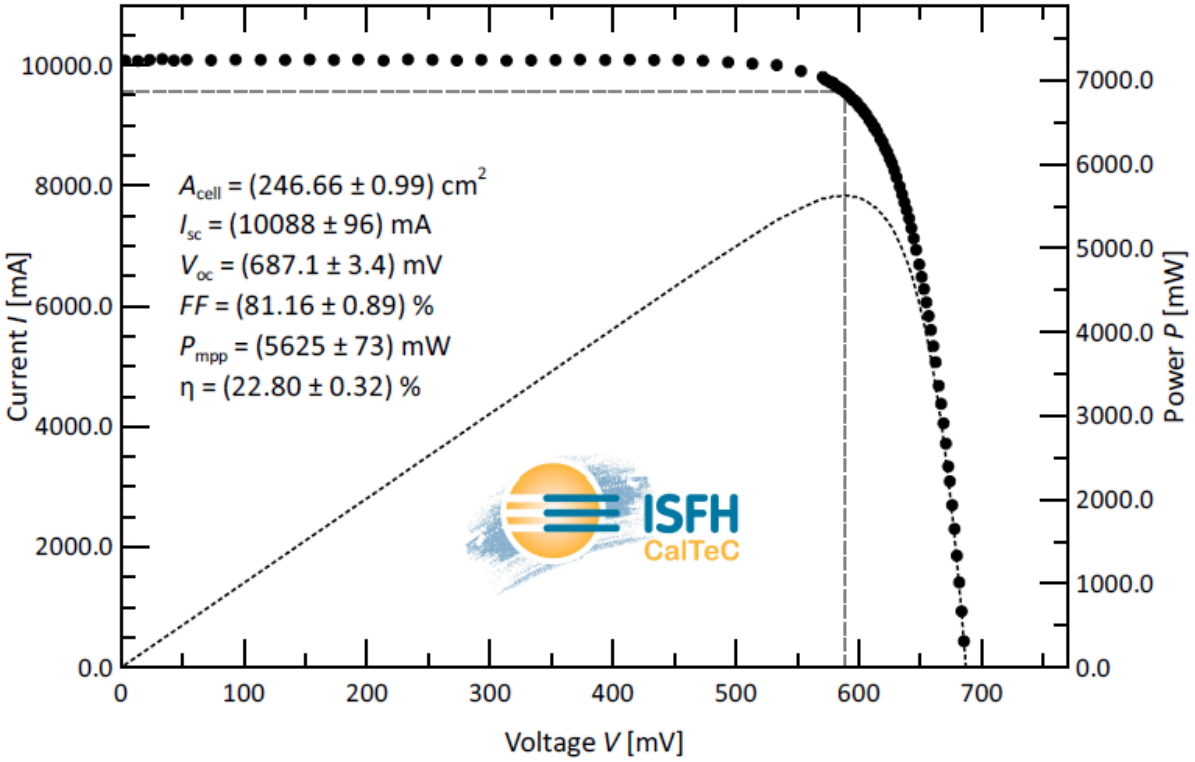


Fig. 1 : Learning curve for module spot market price as a function of cumulative PV module shipments.

Cast Mono Si PERC Record Cell

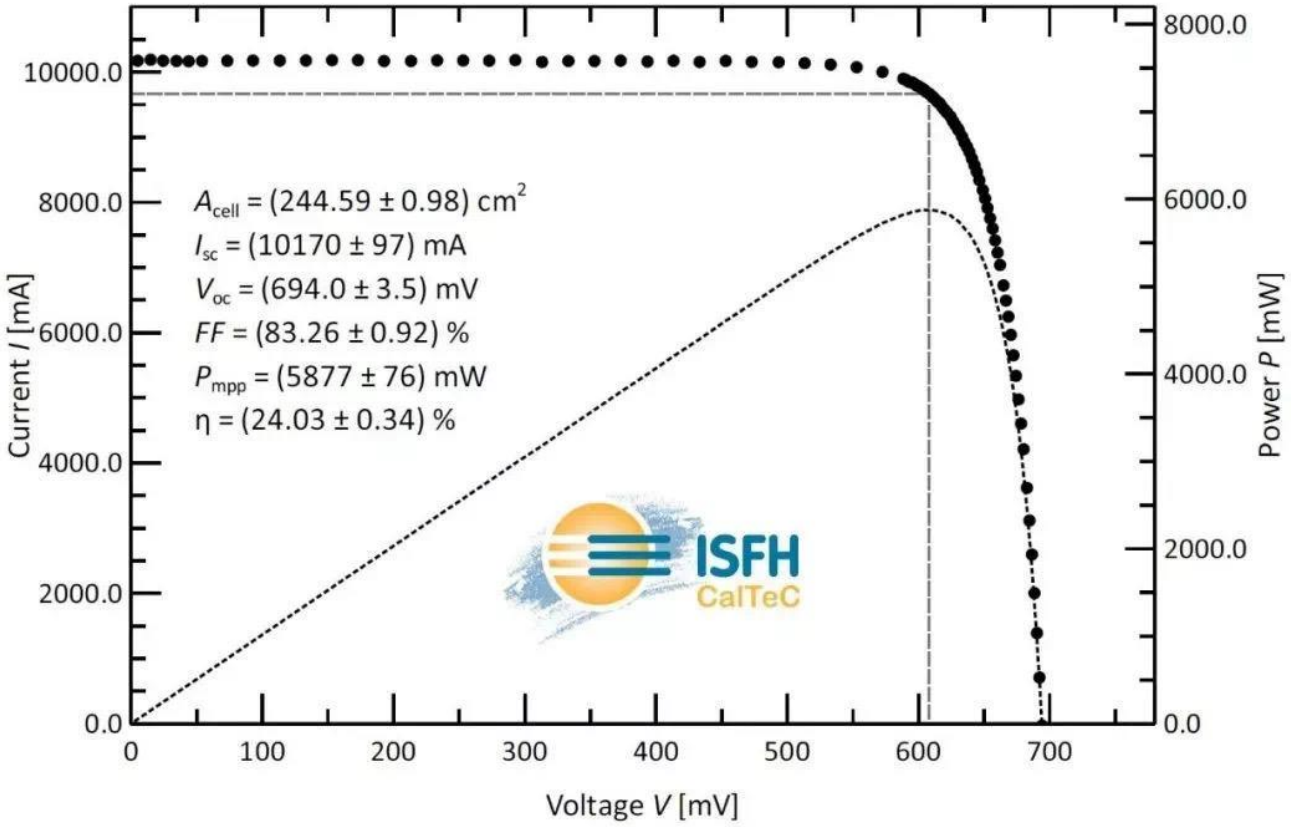
22.8%



From Canadian Solar. Inc

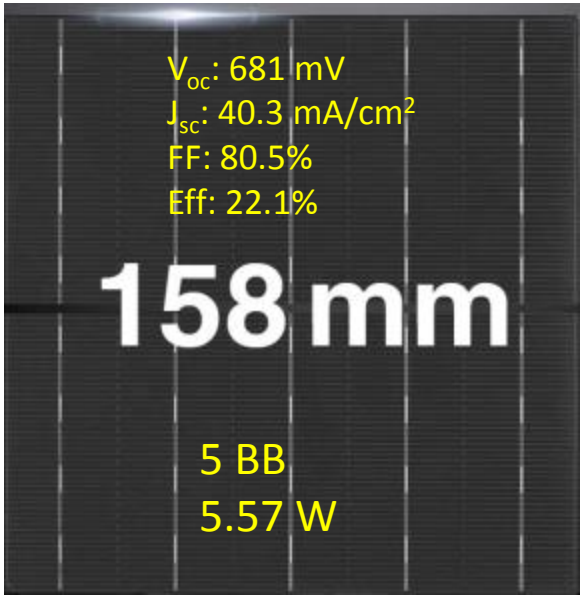
Mono Si PERC Record Cell

24.03%



From Longi

Typical *p*-PERC Cell Performance

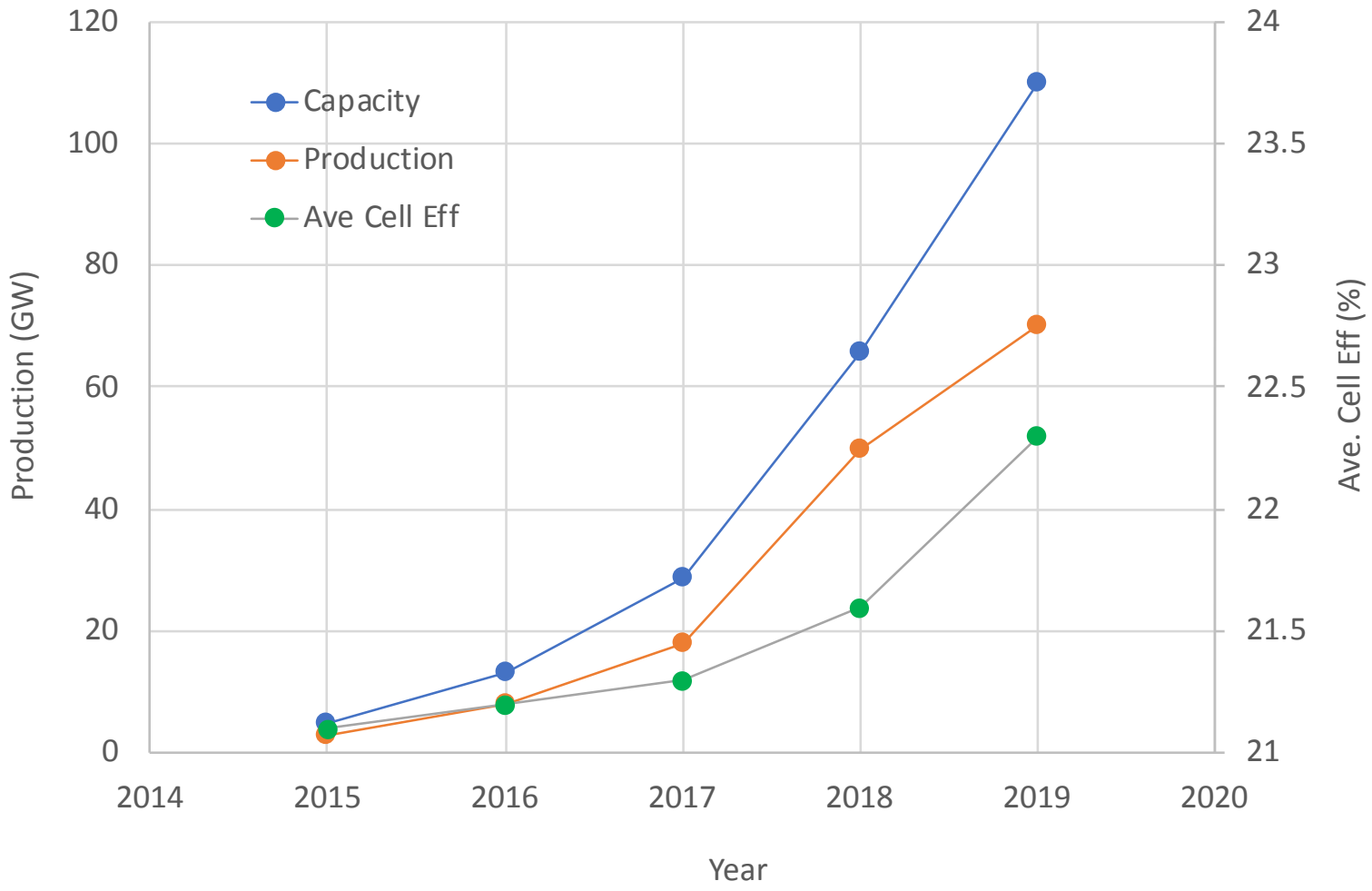


- Size : 158.75 x 158.75 mm^2
- Eff: 22.1%
- P_{max}: 5.57 W
- ASP: ¥1.01/W
  or ¥ 5.63/pc (11/2019)

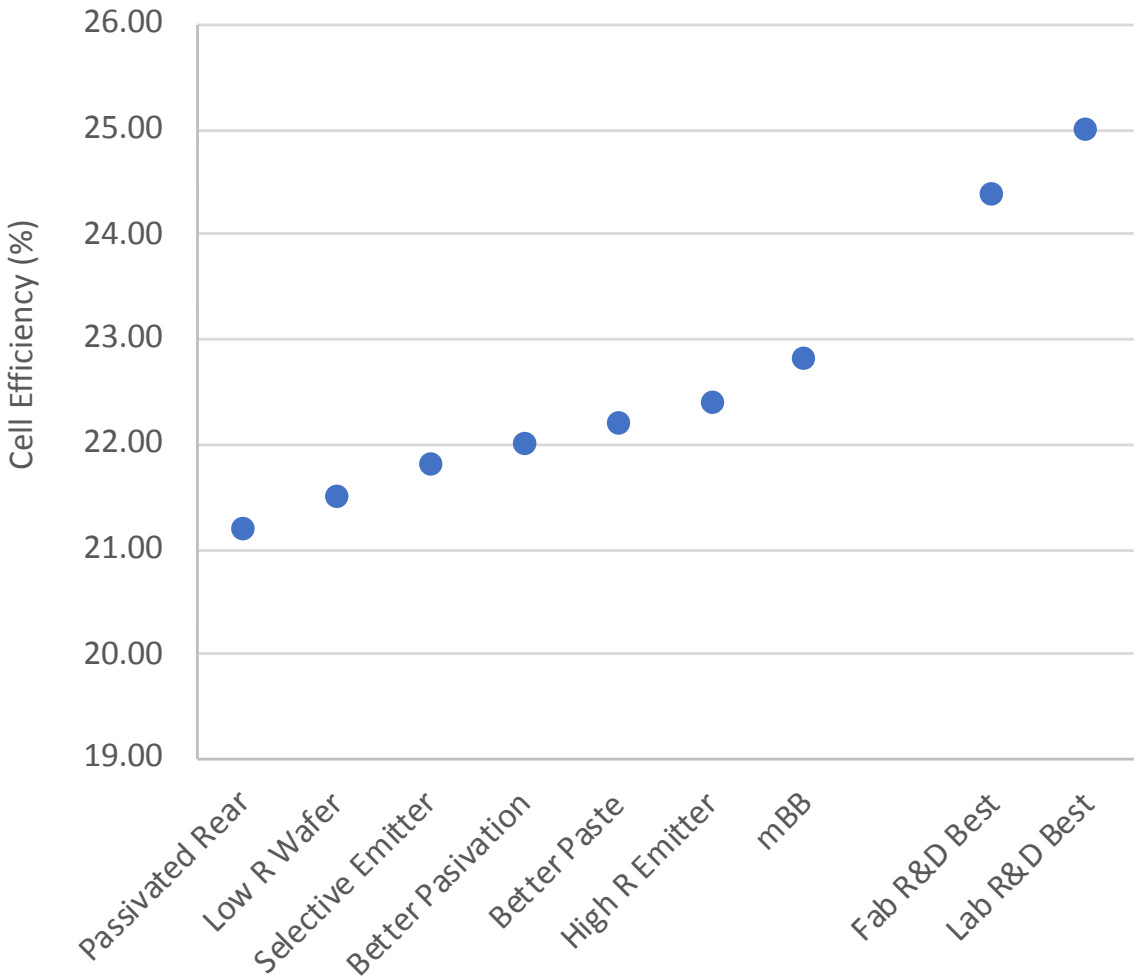
- Ag consumption (mg): <100

- LID, LeTID?
- > 22.5%?

PERC Cell Annual Production



Cell Improvements



Sweihan Project In Abu Dhabi 2016 - 2019

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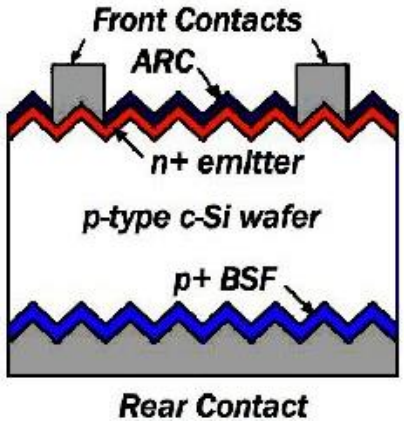
GLOBAL PROJECTS

Jinko Commissioned the World's Largest Solar Project in Abu Dhabi

The world's largest1 solar plant of 1,177MWp, which was jointly developed by the Jinko, Japan's Marubeni Corp. and Emirates Water and Electricity Company (EWEC), has recently started commercial operations as scheduled at Sweihan in Abu Dhabi. The AED3.2 billion project, which use all Jinko's high efficient mono panels, features another record at the time of bid submission attracting the world's most competitive tariff of 2.42 cents per kilowatt hour. In line with the Year of Tolerance in the UAE, the project - a venture between international companies, managed and constructed by a multi-national team - signifies the multi-cultural essence of the Company and its ability to integrate resource and top partners from around the world.

Electricity at $0.0242/kWh
1117 MW *p*-PERC Cell module

Standard Back Surface Field Cell

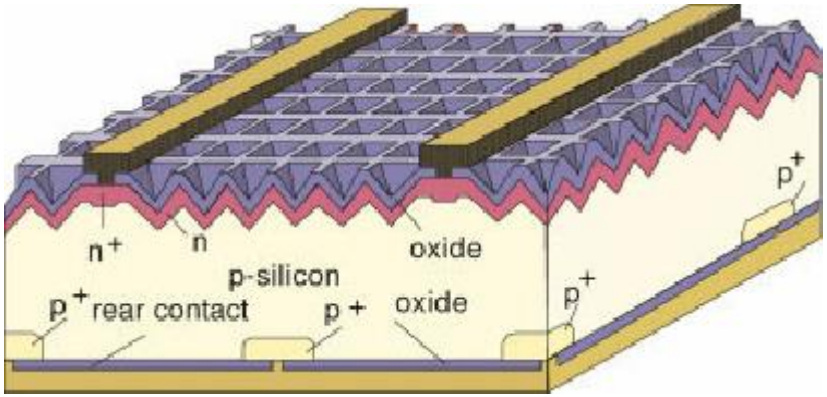


For p-type c-Si cell

~ 20%

Limited by rear J_0

The 25% UNSW PERC Cell



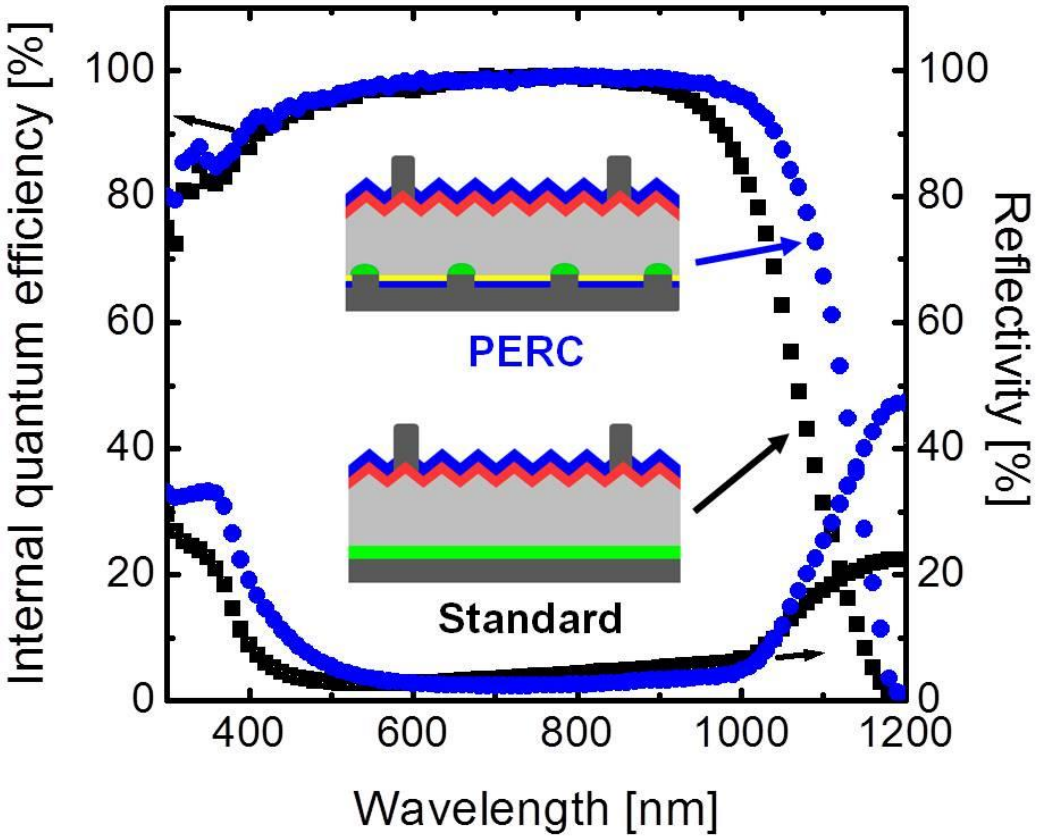
- Inverted pyramid
- Selective emitter
- Plated fingers
- Point contact

1999 after new AM1.5 standard

Best Efficiency: 25.0%
FF: 82.8%
V_{oc}: 706 mV
J_{sc}: 42.7 mA/cm^2

1989: Passivated Emitter and Rear Cell (PERC)
Cell Efficiency: 22.8%

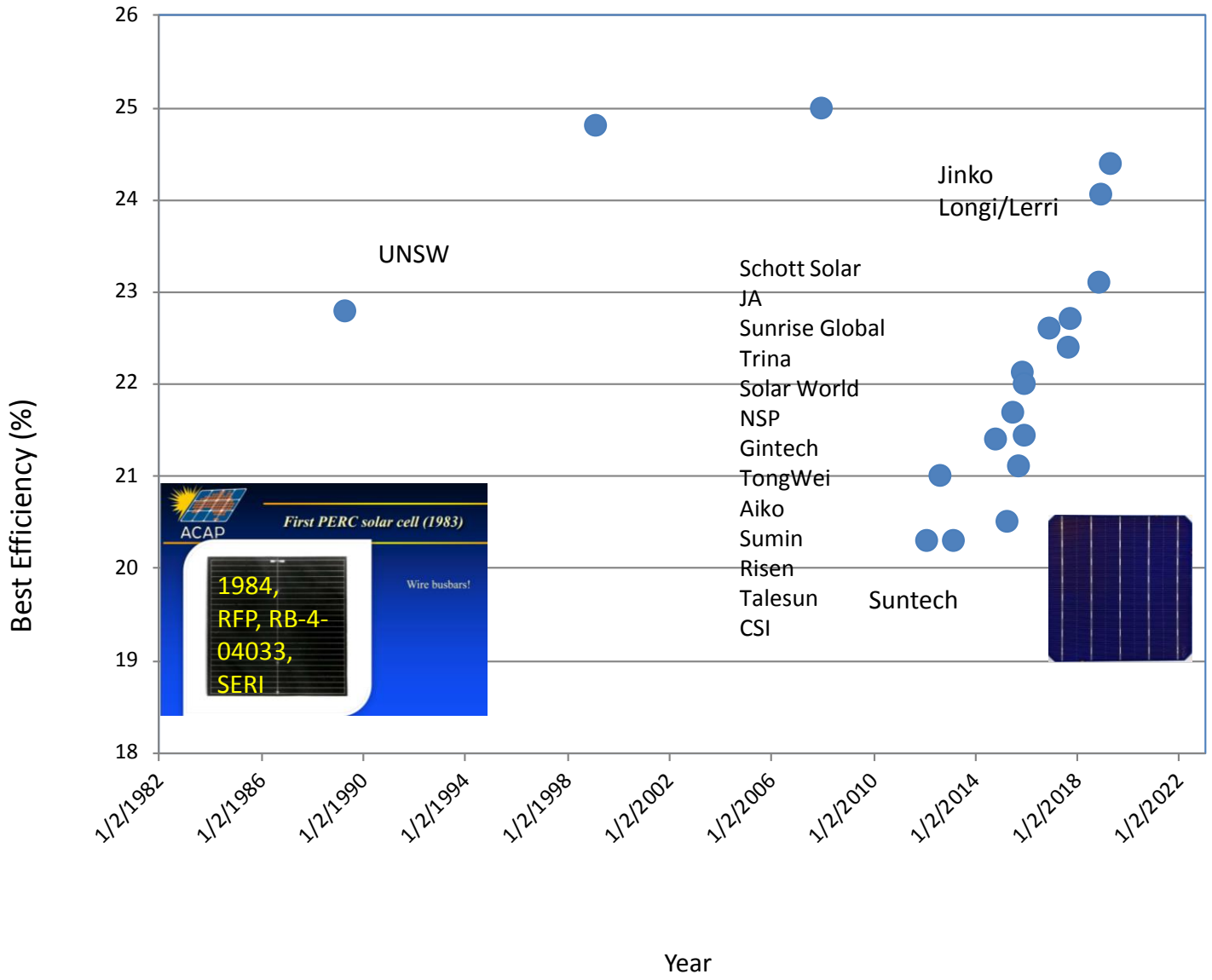
Advantages of PERC Cell



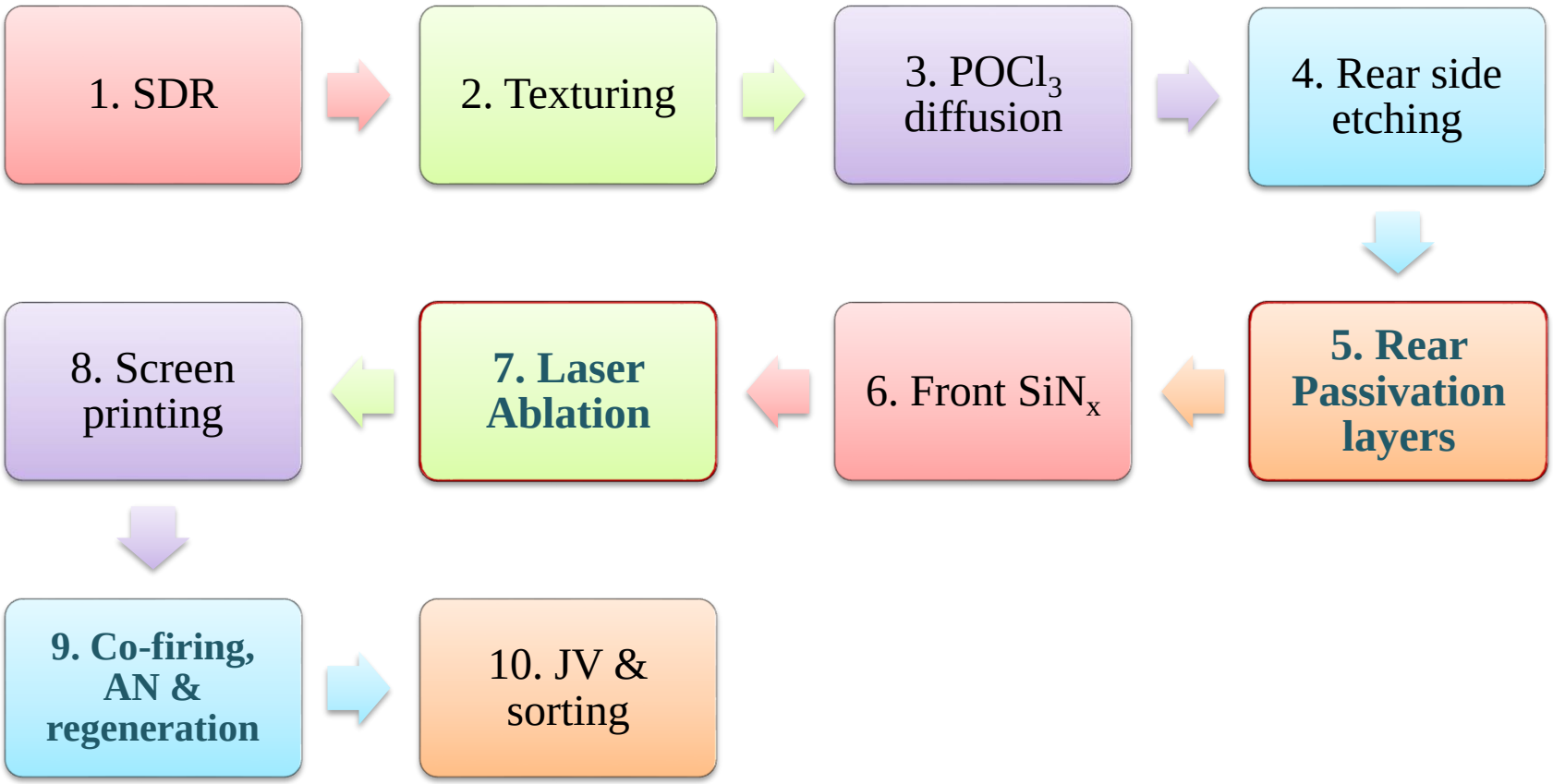
- Higher V_{oc}
- Better IR response

From ISFH

PERC Cell Performance Review



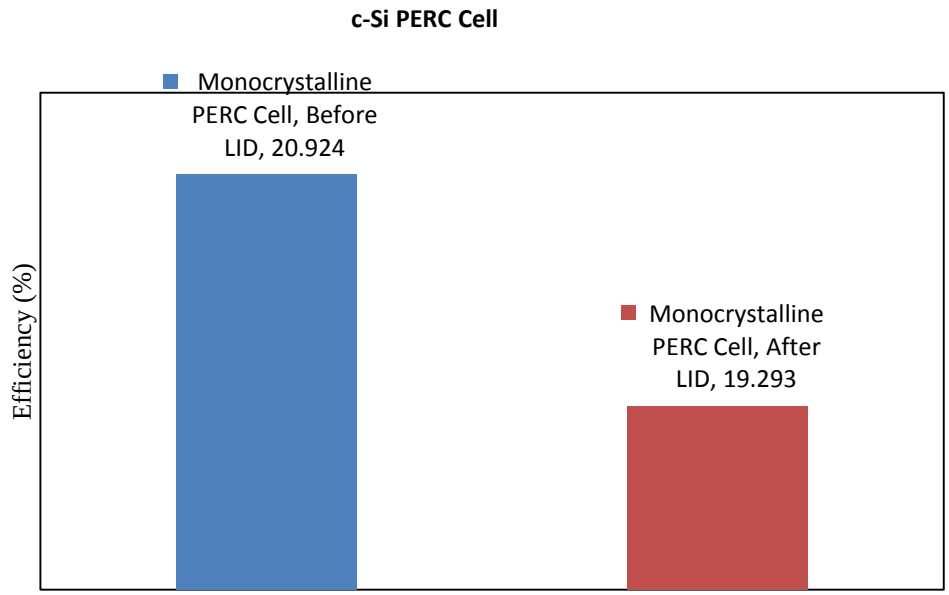
PERC Cell Process in Manufacturing



Factory Specs: *p*-type cell

Efficiency	%	>22
Throughput	wph	~ 6000
Capacity	MW/line	>250
Yield	%	>98
Cost of cell	$/W	0.035
CapEx	$*m*/GW	~ 40
Size		< M6, M12

Light Induced Degradation (LID)

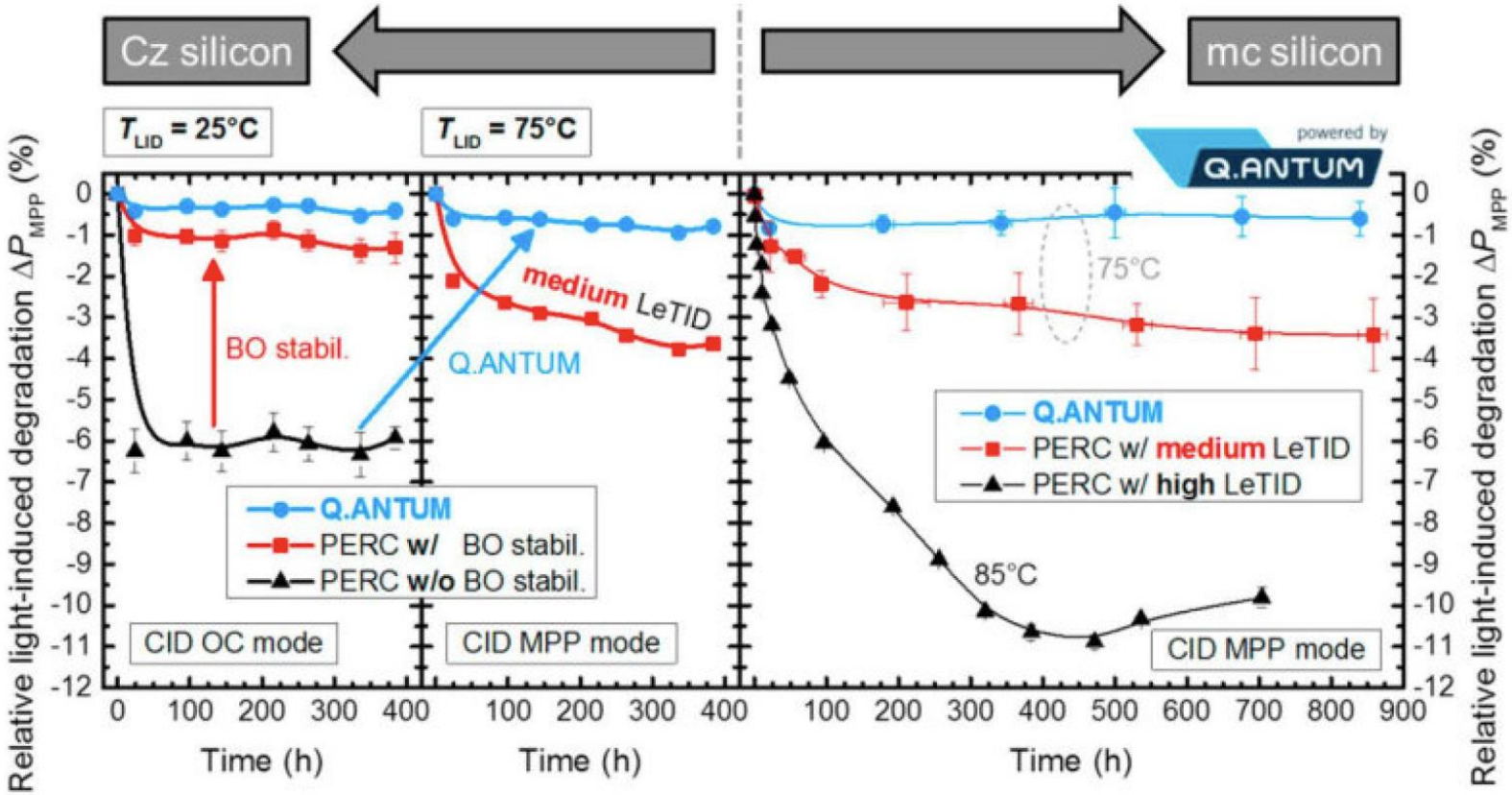


Testing Condition

- Illumination intensity at 900-1000W/m^2
- Cell temperature at 50-60℃
- Light Soaking for 5 hours

	c-Si PERC Cell
Before LID	20.92%
After LID	19.79%
Δ	5.42%

LeTID

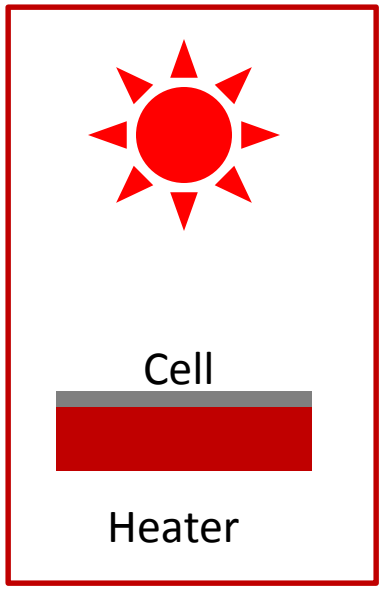


F. Fertig, et. al. Energy Procedia 124(2017)338-345

Q-Cell Report

Regeneration of Defects

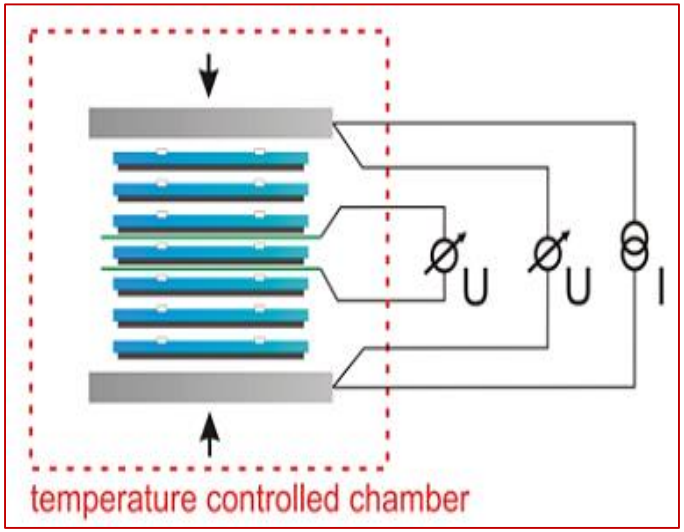
Photon injection



1 – 100 suns

LED/Laser

Carrier injection



Axel Herguth and Giso Hahn,
EU PVSEC 2013)

Figure Out the Root Cause of LeTID

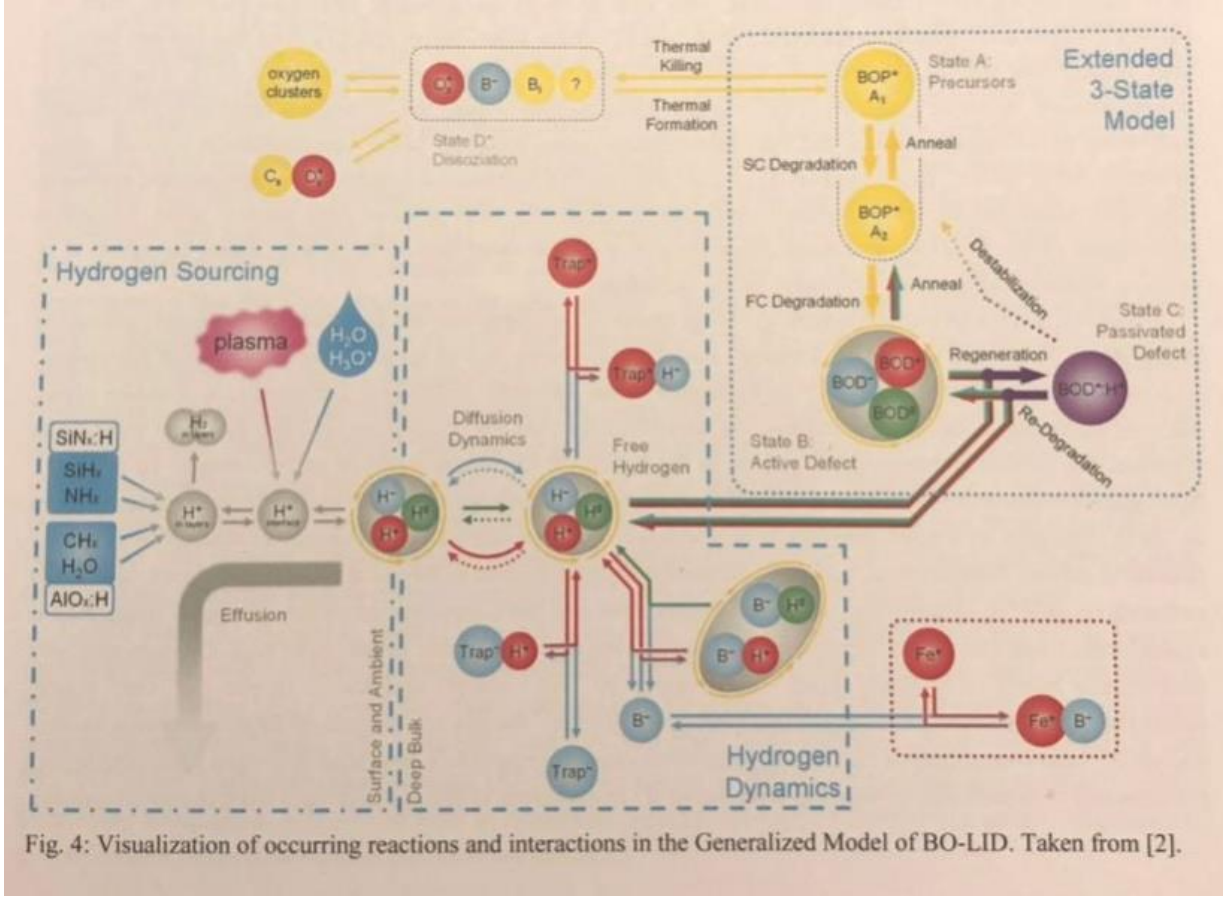


Fig. 4: Visualization of occurring reactions and interactions in the Generalized Model of BO-LID. Taken from [2].

Alex Herguth, and Brett Hallam, from: 28th Workshop on c-Si solar cells and Modules

Evolution of Cell Size and Design

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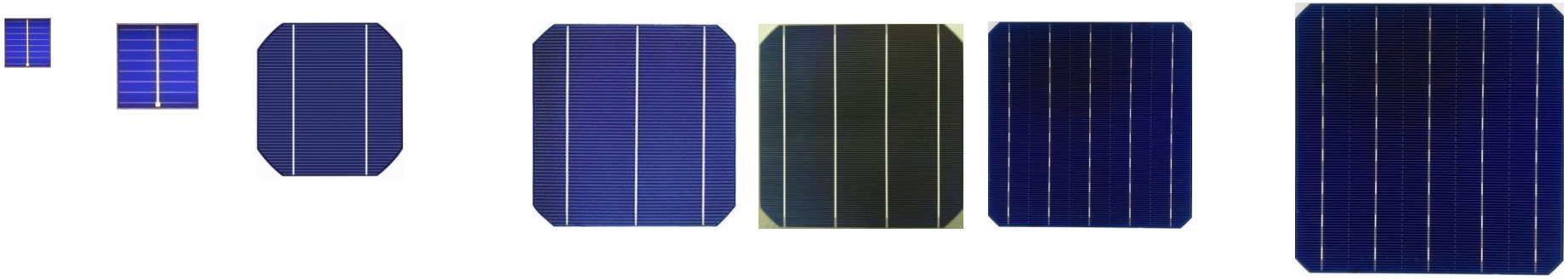
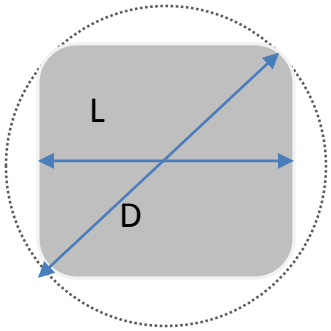
1 cm² 4 cm² 148 cm² ~ 240 cm² ~ 274 cm²



1/2 mBB Bifacial Shingle nBB

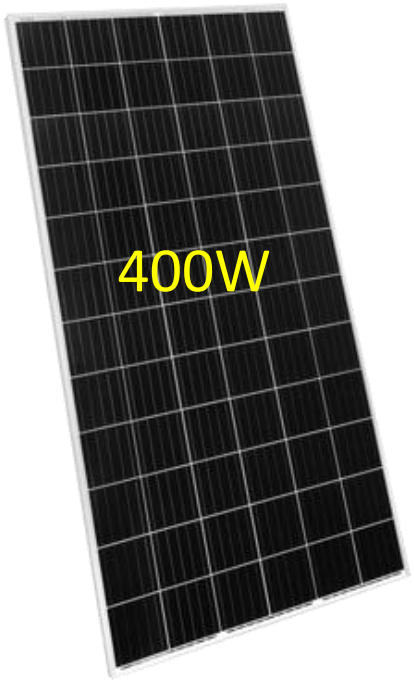
Cell Size Gets Larger



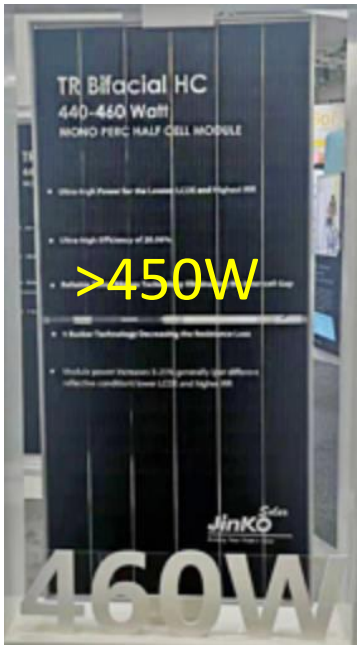
	Unit	M2	G1	M6	M12
Diameter	mm	211.0	223.0	223.0	304.8
Length	mm	156.75	158.75	166.00	210.00
Area	cm^2	244.31	252.01	274.16	441.00
Change	cm^2	0.00	7.70	29.85	196.69
Change	%	0	3	12	80
Change	%		0	9	75
Change	%			0	71

Module Trend

2018



2019



2020

Applications

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Highway sound barrier

Above water

Thank You!