Webinar
powered by
DSM Advanced Solar

24 September 2020

4 pm – 5 pm | CEST, Berlin
3 pm – 4 pm | BST, London
7 am – 8 am | PDT, Los Angeles
10 am – 11 am | EDT, New York

pv magazine webinars

Back-contact's move to the front

Mark Hutchins
Editor | pv magazine

Hugo Schoot
DSM Advanced Solar

Paolo Maccario
Silfab Solar

Radovan Kopecek
ISC Konstanz

Back-contact's move to the front

9/24/20 PV Magazine Webinar

Paolo Maccario

Outline

1) **Who is Silfab**
2) Why back-contact (the product)
3) Why back-contact (the process)
4) The results

Who is Silfab Solar Inc.

- Silfab is a leading North American manufacturer of solar modules with over 35+ years of global experience in the PV industry.
- Silfab is consistently one of the top 3 quoted residential brands* in the USA and sells to at least 10 of the top 15 residential solar installers and top distributors in US, Canada and Mexico.
- 2020 TOP PERFORMER PVEL DNV·GL PV MODULE RELIABILITY SCORECARD

*EnergySage

Silfab Solar Inc. – Timeline/Milestones

1981
Monocrystalline Cell Production

1986
Delphos PV Solar farm still producing 80% + output after 30+ years

1999
SOLARIS

2006
Helios technology enters the Kerself Group listed on Milan Stock exchange

2007
Silfab SPA $110M USD JV

2008
Equity Partnership

2010
Silfab Ontario, fully-automated PV manufacturer opens with 60 MW capacity

2011
30 years experience

Toronto facility expands to 90MW

2012
OEM Manufacturing contracts with

2013
114 MW / year capacity reached

Purchased ATS / Photowatt equipment

2014
Supplies **6 solar farms totaling over 65MW**

Delivery of **largest rooftop portfolio in Canada (18.1 MW)**

Return rate below 40 parts per million (PPM)

Name change to **Silfab Solar** and launching into the US Market

Purchased Flextronics Canada solar production line

2015
First Bifacial module

180 MW / year capacity reached

Silfab achieves AVL financing approval by

Silfab co-develops and produces first Lumos GSX modules for carports

2016
Exporter of the year award EDC

Silfab Bifacial installed on largest US rooftop project 16.9 MW

95% export volumes achieved

Silfab delivers solar modules for **Nike Headquarters**

2017
350 MW / year capacity

Silfab **receives OSEA manufacturer of the year award**

Silfab is recognized as #6 quoted solar brand in US by

Silfab achieves **AVL approval by Sun Run**

2018
Winner of **Bronze Stevie® Award** for Large Manufacturer / American Business Awards

Silfab COO, Paolo Maccario & Franco Traverso, awarded for environmental leadership by ICCO

Silfab supplies modules to **Puerto Rico**

Certification of **ISO9001:2015**

Extends **Product Warranty to 25 years** and **Performance Warranty to 30 years**

Silfab and **DSM** enter exclusive North American Alliance to develop and launch **Back-Contact PV Solar Module**

Silfab ranked number 30 on Canadian Business Growth 500 for **fastest growing companies**

Silfab jumps to 3rd most quoted solar brand in US by

Silfab purchases manufacturing facility in Bellingham, WA **becomes largest manufacturer in North America**

Silfab manufactures first **Made in America** modules

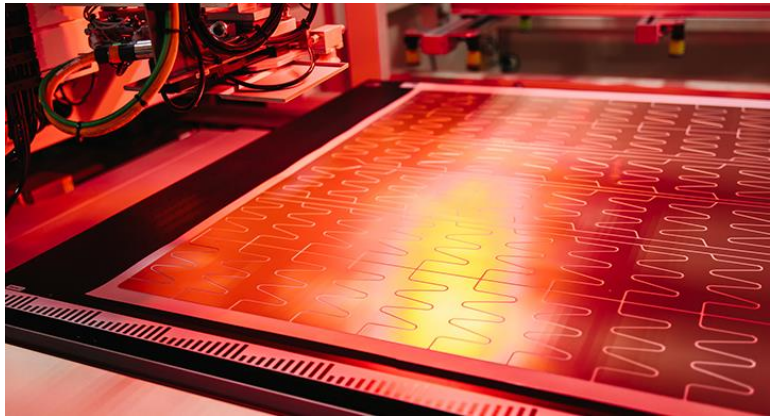
800MW /year capacity

2019
Silfab Solar and DSM Solar Launch First Generation Back-Contact MWT production line in Bellingham, WA using DSM's Conductive Backsheet (CBS)

Manufacturer of the Year in the WA manufacturing Awards by Seattle Business Magazine

Silfab Solar/DSM Joint Venture

- In 2019, Silfab Solar and DSM created a JV to develop, mass produce, market and sell PV solar modules. We were the first to bring this technology to North America.
- Today Silfab Solar operates one dedicated Eurotron line in Bellingham (WA) and sells to the US residential market.



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Why Does Back-contact Conductive Backsheet (CBS) Technology Exist?

PROS

- Highest power density of any module technology (even shingling!)
- Can be adapted to *any* kind of back-contact solar cell. IBC/n-type/EWT/MWT/etc.
- Highly-automated manufacturing (eliminates stringers and robotic lay-up operations)
- Highly customizable layout of electrical circuit
- Robust durability against thermo-mechanical stress (contacts are on the back).
- Low stress due to back contact can enable MFG with thinner cells. Individual small contact points, more robust than traditional back-contact module designs. No wire/ribbon at all!
- Better thermal performance (lower NOCT, 3rd party validated)
- Lower CTM losses
- Design of half-cell can easily be optimized for balanced high and low light performance

CONS

- Learning curve (any new manufacturing technology)
- Non-conventional supply chain
  - Rear Perforated Insulator (RPI)
  - Patterned CBS

Silfab SOLAR

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ITRPV Forecasts-Flexibility Is Essential

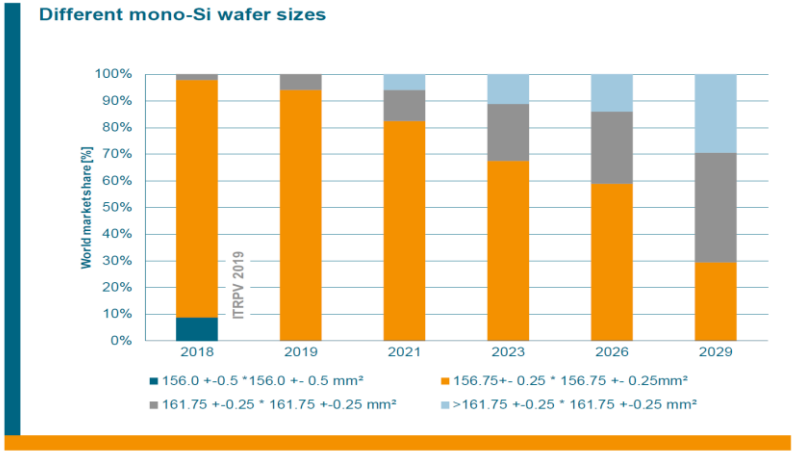


Fig. 40b: Expected trend of mono-Si wafer size in mass production.

ITRPV 2019

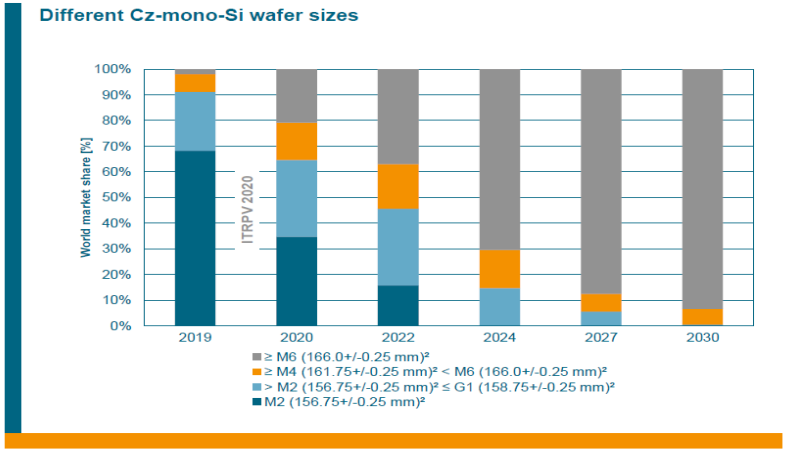


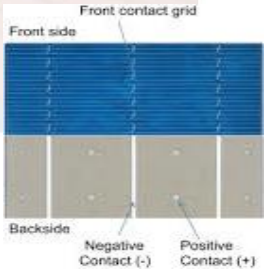
Fig. 16: Expected trend of Cz-mono-Si wafer size in mass production.

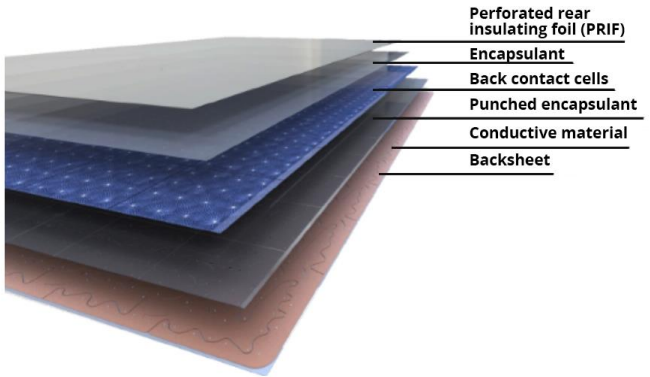
ITRPV 2020

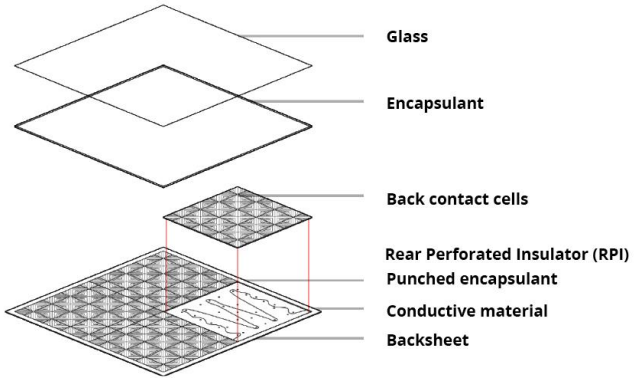
- ITRPV is quite conservative and may have temporarily lost its crystal ball in 2019..
- 2020-2022 predictions may also be quite conservative with only 35% anticipated wafer volumes in the >/= M6 (166mm) category.

Flexibility in Design

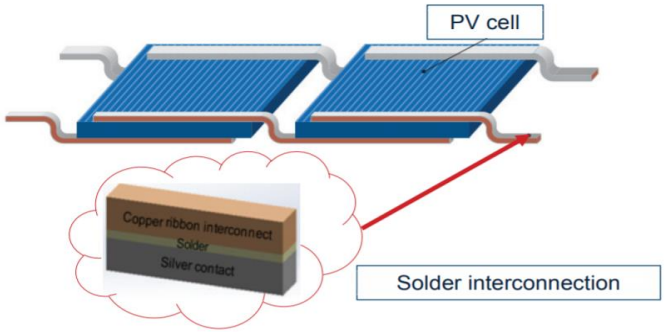
Examples of metal-wrap through back-contact solar cells based on p-type PERC technology

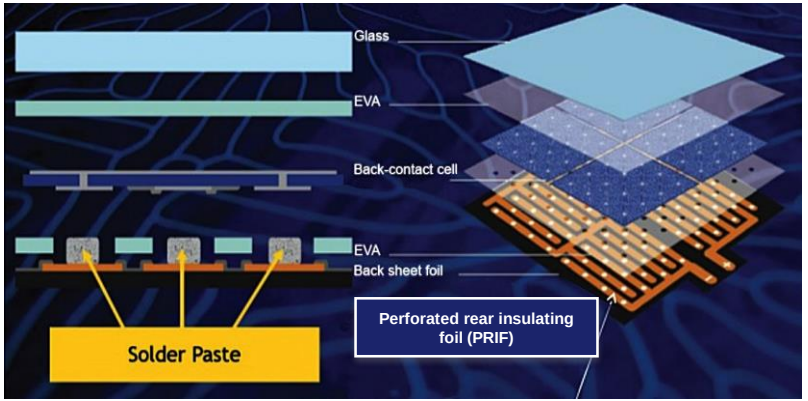






Durability Against Thermo-Mechanical Stress





Conventional PV cell interconnection
(copper/solder/silver pad/Si)

- Solder joint formed at very high temperatures >220^{o}C
- Frontside busbar connection sandwiched between glass and cell.
- The bigger the CTE mismatch between the solder/Cu and solar cell/glass, the greater the damage induced by thermo-mechanical stress

Procedia Manufacturing, Volume 11, 2017, Pages 1145-1152. "Effect of Coefficient of Thermal Expansion (CTE) Mismatch of Solder Joint Materials in Photovoltaic (PV) Modules Operating in Elevated Temperature Climate on the Joint's Damage" ☆
Osarumen O.Ogbomo[a] Emeka H.Amalu[b] N.N.Ekere[a] P.O.Olagbegi[c]

Back-Contact/CBS PV cell interconnection
(copper foil/conductive paste/silver pad/Si)

- Contacts are formed at lower temperatures (~150^{o}C)
- All contacts are on the back, far away from the glass
- Contact points are 2-3mm in diameter. CTE mismatch between conductive paste + silicon results in minimal to no damage since contact is free to expand/contract.
- FLEXIBLE SUBSTRATE ALLOWS MOVEMENT. PROXIMITY TO GLASS, ON THE OTHER HAND, LIMITS MOVEMENT AND TRANSLATES STRESS TO CELL

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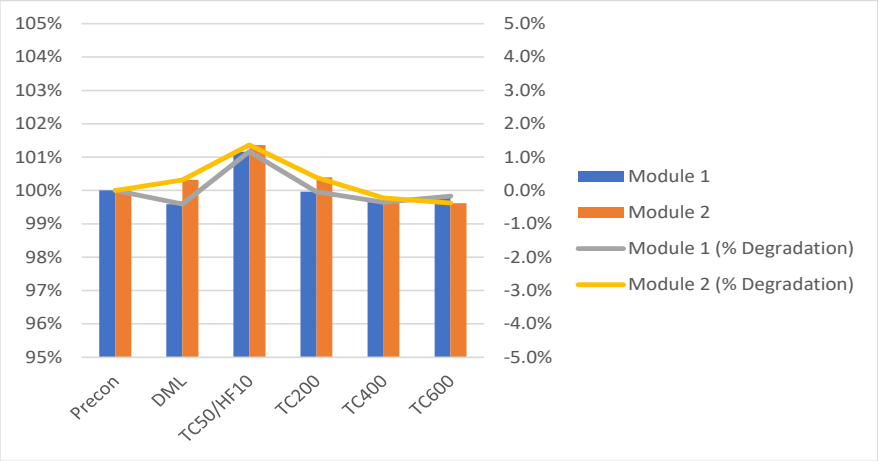
Testing & More Testing



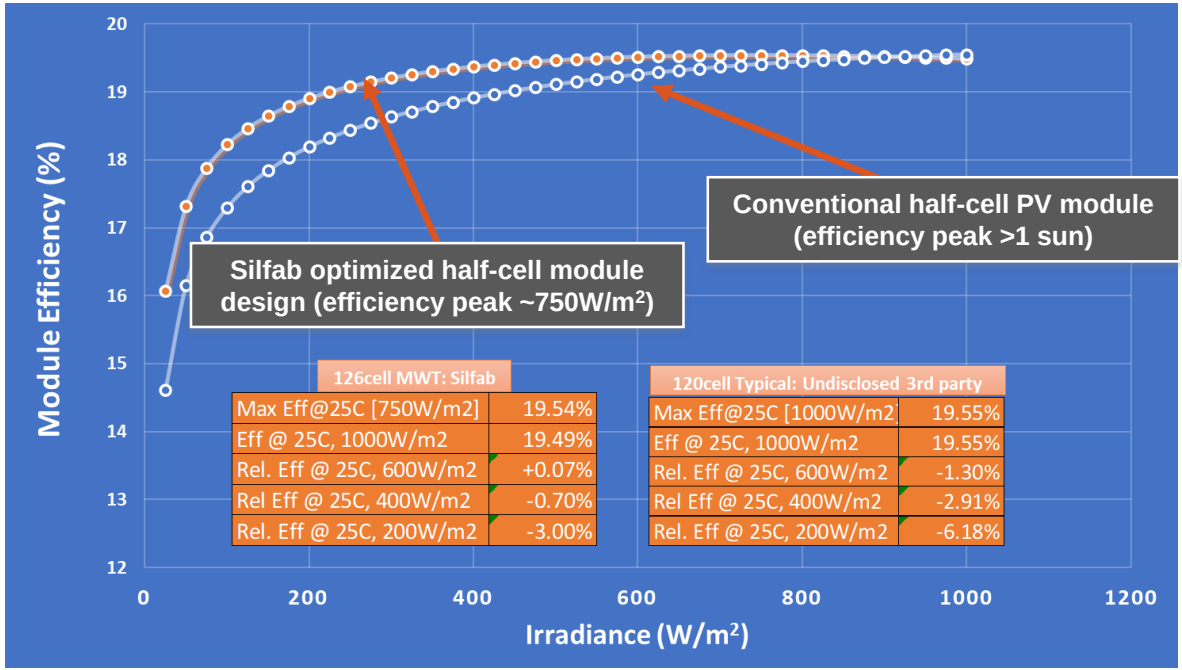
1) DML (dynamic mechanical load): 1000 cycles at +/- 1000Pa, 3 cycles/min at 25°C (IEC 62782)
2) TC50: 50 thermal cycles from -40°C to +85°C with current injection at Imp
3) HF10: 10 humidity freeze cycles from -40°C to +85°C at 85% R.H.
4) Then TC600.

- **Even after 4 different types of testing, the degradation was less than 0.5% relative to time zero.**

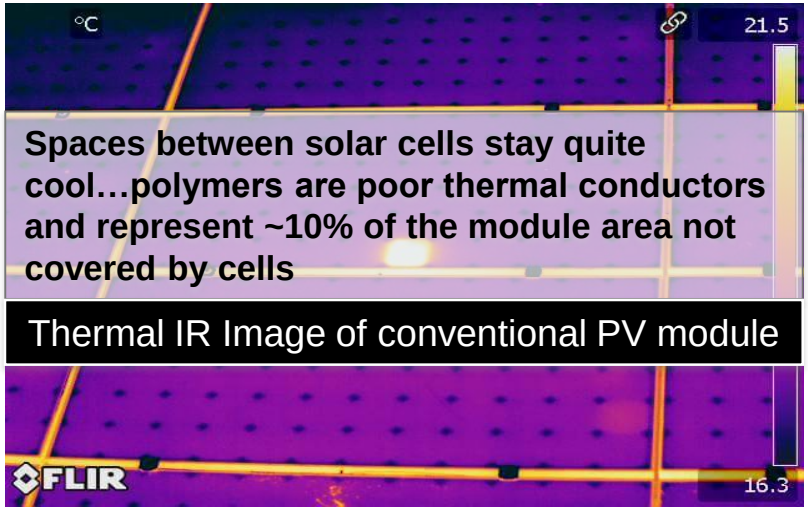
Not all PV modules generate the same amount of energy…

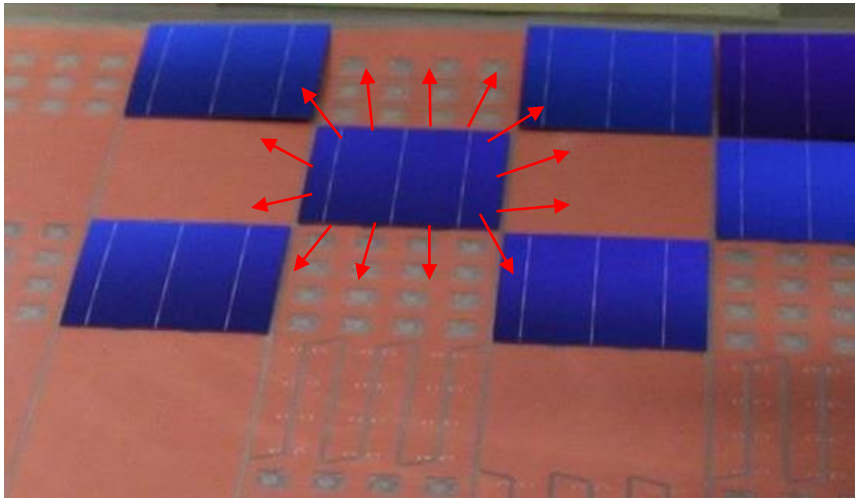
1) Low Light Performance

- 126cell (3rd party PAN file measurements) = 3.0% rel. loss @ 200W/m^2
- Typical half-cell on the market (3rd party) = 4.5% -7.0% loss @200W/m^2



Why Structured Foils/MWT Run Cooler

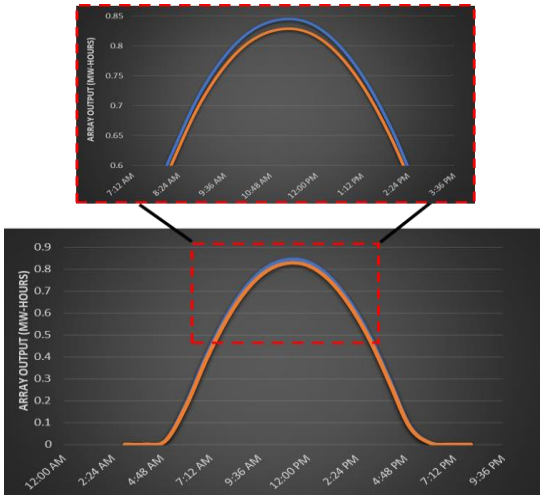




2) NOCT

- 3rd party measured (two different RTL's) = 40.6ºC (60cell), 43.5ºC (126cell)
- Typical black/black (BoB) module NOCT = 47-50ºC
- Temp Coeff for Pmax ~0.4%/ºC (That's 6ºC x -0.4% = 2.5% increase to instantaneous energy production!!)
- MWT/structure foil PV modules have ~10% more area to laterally spread heat for optimized heat transfer

PVSyst Simulations – Hot/High Irradiance in Las Vegas



Day of Interest

6,541.1 kWh – Daily Sum (Conventional 120 half-cell)

6,702.7 kWh – Daily Sum (Silfab MWT, 126cell)

2.54% more energy production

Annualized

Silfab MWT/126cell array = 1924kWh/kWp

Conventional 120cell array = 1873kWh/kWp

2.72% more AEP (annualized energy production)

Breakdown

- ❑ 1.5% attributable to lower operating temp.
- ❑ 1.2% attributable to performance at low irradiance

*Note, simulations done with PVSyst Version 7.0.0

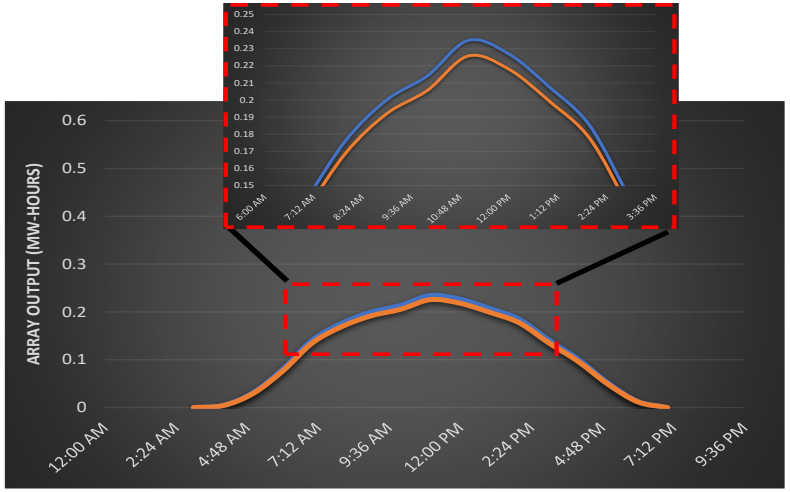
**PAN file for Silfab is based on fitting model data to measurements made by ISO 17025 accredited 3rd party lab according to IEC 61853-1,-2

***PAN file for conventional 120cell module was acquired from a 3rd party lab with ISO 17025 accreditation. Manufacturer was not disclosed, however data is representative of a typical 5BB half-cell module.

PVSYST PHOTOVOLTAIC SOFTWARE

Silfab SOLAR

PVSyst Simulations – Cool, Cloudy/Low Irradiance in Boston



Day of Interest

1,924.9 kWh – Daily Sum (Conventional 120 half-cell)

2,008.4 kWh – Daily Sum (Silfab MWT, 126cell)

4.3% more energy production

Annualized

Silfab MWT/126cell array = 1408kWh/kWp

Conventional 120cell array = 1365kWh/kWp

3.15% more AEP (annualized energy production)

Breakdown

- ❑ 1.2% attributable to lower operating temp.
- ❑ 2.0% attributable to performance at low irradiance

*Note, simulations done with PVSyst Version 7.0.0

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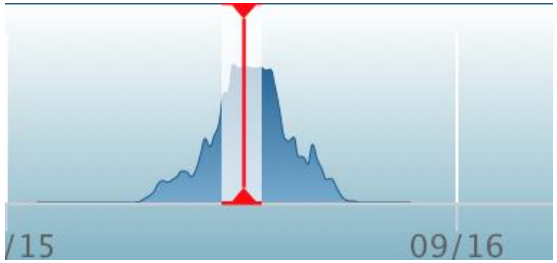
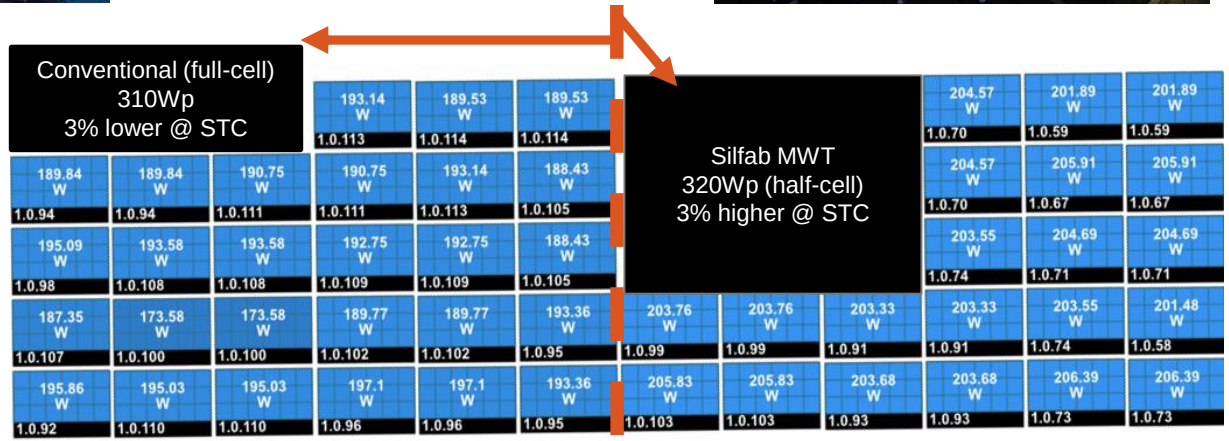
Sehome High School Project (Bellingham, WA)

100kW PV system donated by Silfab Solar



- Instantaneous AC Power = **7% higher (rel.)! for MWT 320Wp modules**. 4% due to better thermal management and 3% due to higher STC (320Wp vs. 310Wp)
- Total kWh so far from July to September 2020 = **6% higher than the conventional 310Wp modules**
- 3% is attributable to the higher relative STC rating, but **the remaining 3-4% increase is due to better thermal performance(rel.)**



Summary and Conclusions

- Silfab Solar/DSM Joint Venture was the first to bring back contact CBS PV modules to North America.
- Back contact /CBS PV Module Designs offer many advantages and are already seeing GW scale manufacturing volumes globally.
- Operationally, the level of simplicity in the design and automation are unparalleled which allows for lower CapEx/OpEx and an efficient use of manufacturing space.
- Durability of back contact/CBS PV modules against thermo-mechanical stress is intrinsic to the design. As validated by extensive accelerated stress testing.
- Performance of back contact/CBS PV modules is superior to conventional designs using p-type mono-PERC cells and rivals more expensive hetero-junction (HJT) cell-based modules. A combination of better thermal and low-irradiance performance.

TO LEARN MORE ABOUT

SILFAB SOLAR

CONTACT US: +1 905-255-2501
INFO@SILFABSOLAR.COM
WWW.SILFABSOLAR.COM