

CANADIAN SOLAR'S CUTTING EDGE SOLAR MODULES

July 2023

In 1920 Thomas Edison said:

“I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that. I wish I had more years left!”

Russell Ohl created the first photovoltaic cell in 1941.

Alexandre Edmond Becquerel discovered “the photovoltaic effect” in 1839, one year after an industry built the first coal-fired power plant. The PV effect is when an electrical current occurs in a conductor after the sun’s rays hit it.

You might be surprised to learn that the space industry adopted solar technology in the early 1950s to power spacecraft. For example, the Vanguard 1 was the first satellite to generate power through solar cells. It remains the oldest humanmade satellite that’s still in orbit, logging more than 6 billion miles to date. Today, various countries also use solar energy to power spacecraft when they send them on missions.

To power the whole earth with solar energy, it would require 191,000 square miles of solar panels.

**We're already very late to reverse climate change,
but perhaps it is not yet too late to save...**



POLAR BEAR



SNOW LEOPARD



GIANT PANDA



TIGER



**MONARCH
BUTTERFLY**



GREEN SEA TURTLE



AFRICAN ELEPHANT



MOUNTAIN GORILLA



ASIAN ELEPHANT



CHEETAH

Source: <https://www.worldwildlife.org/magazine/issues/fall-2015/articles/animals-affected-by-climate-change>

OUR MISSION

**Lead solar into every household;
create a better and cleaner earth for
future generations**

Canadian Solar Company Overview



Market leader in solar energy with a global footprint in project development and module manufacturing and sales



Strong presence in 25 countries:

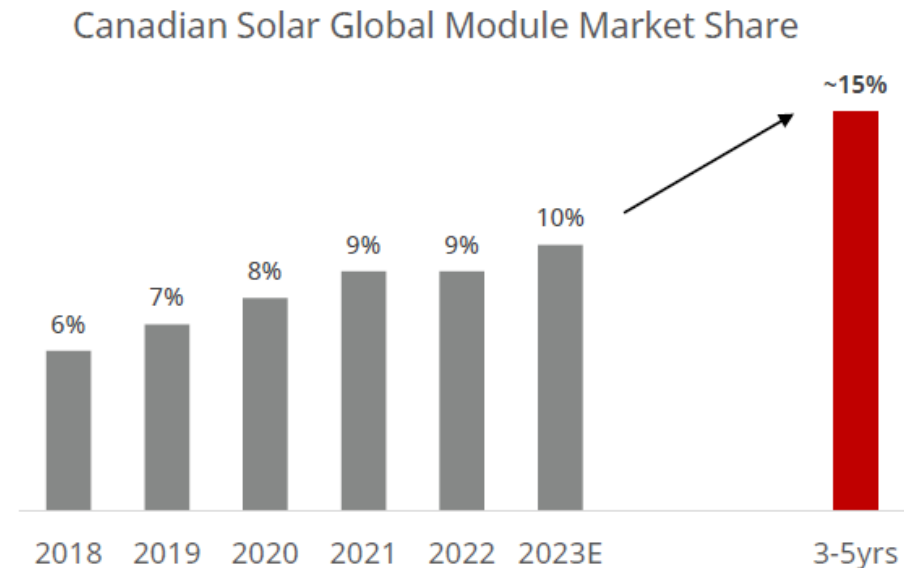
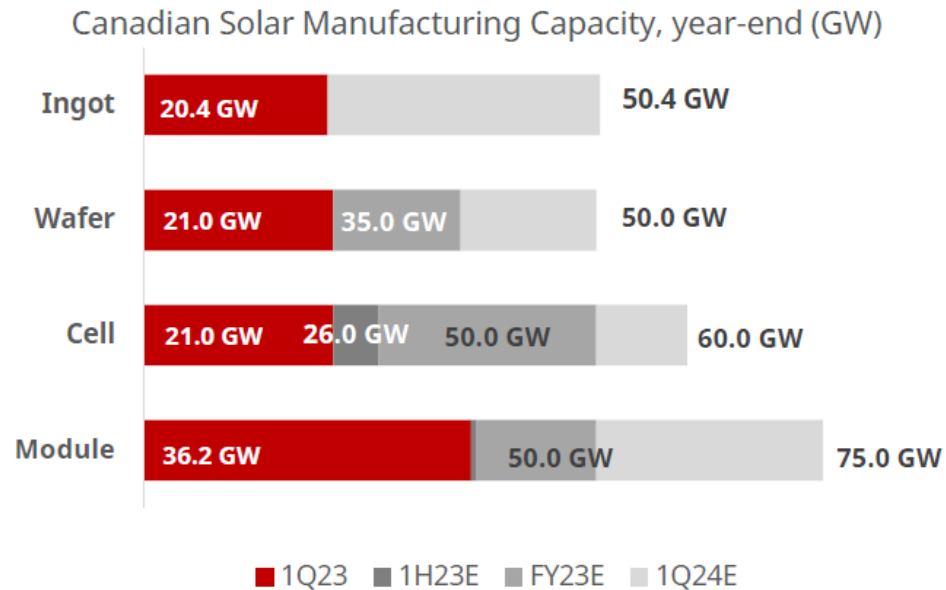
- **CSI Solar:** 19 countries
- **Energy Group:** 19 countries
- **17 factories + 1**

Production Facilities in: - Canada, Vietnam, Thailand, China. Currently in construction Texas facility.

Our success is driven by our global-local teams and our culture of diversity

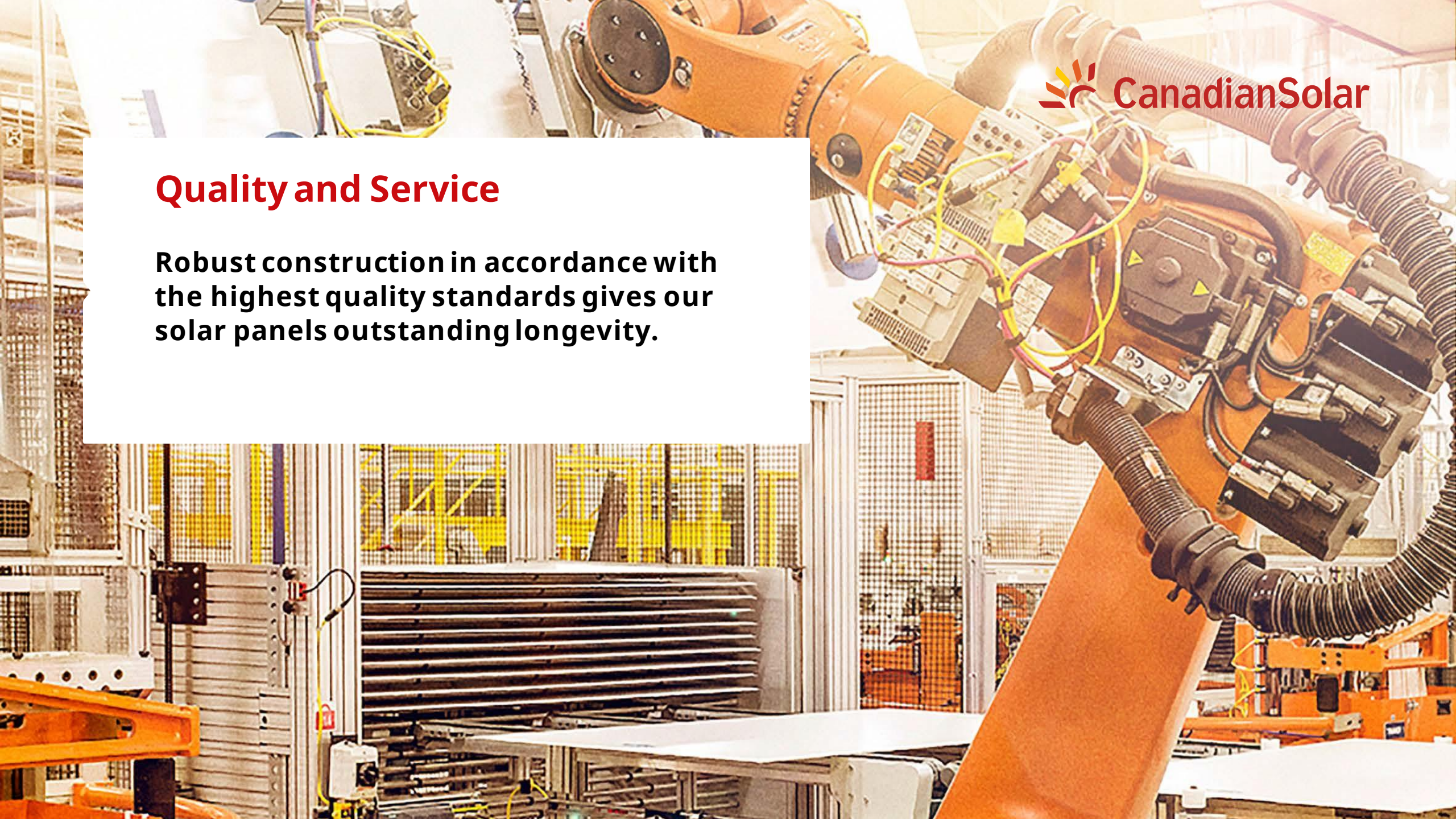
Gaining global market share through capacity expansion

- CSI Solar's strategy is to be a reliable module supplier through expanding its internal capacity and increasing the level of vertical integration, in order to ensure low cost for the customer and highest quality standards and in-house controls.
- CSI's global module shipments have grown 30% from 2013 with more than 55% of expansion growth expected in 2023.
- By the end of 2023 CSI's module capacity is expected to be fully supplied with in-house cell production.

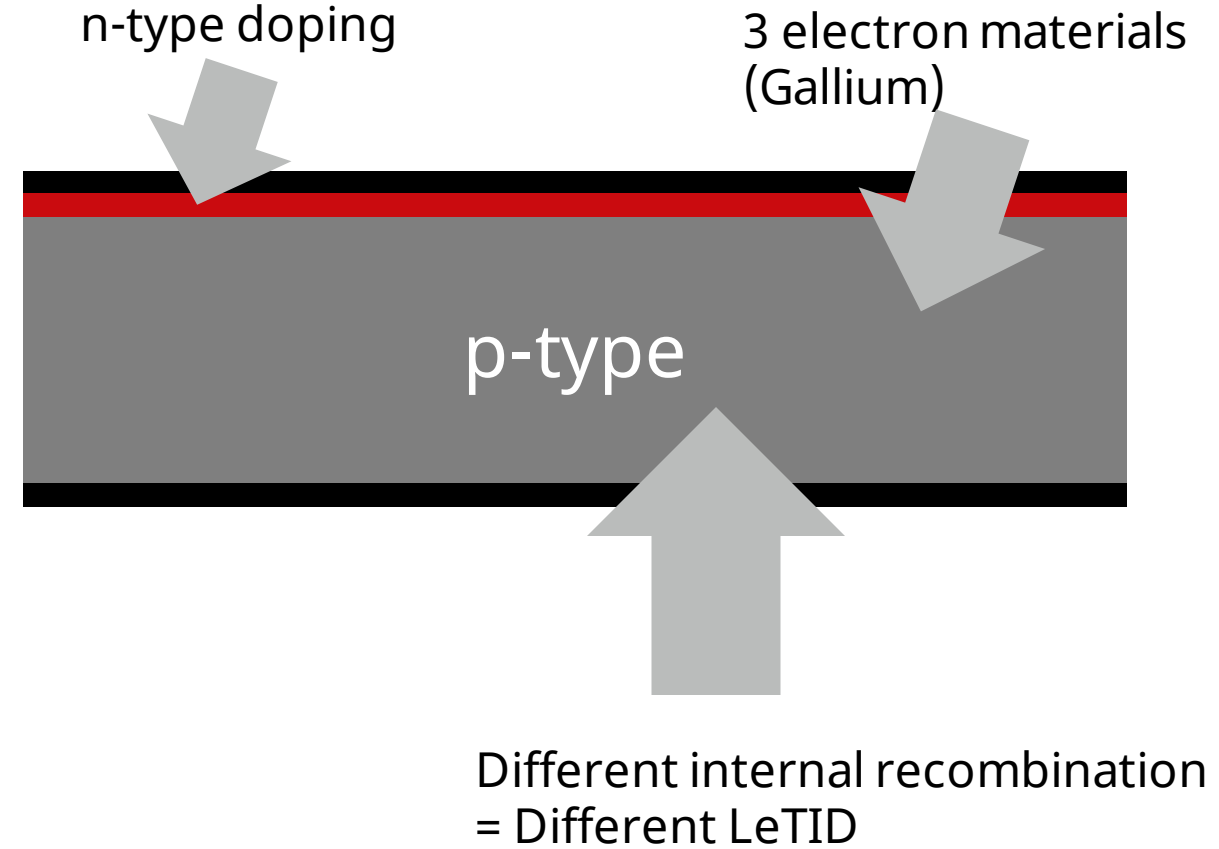
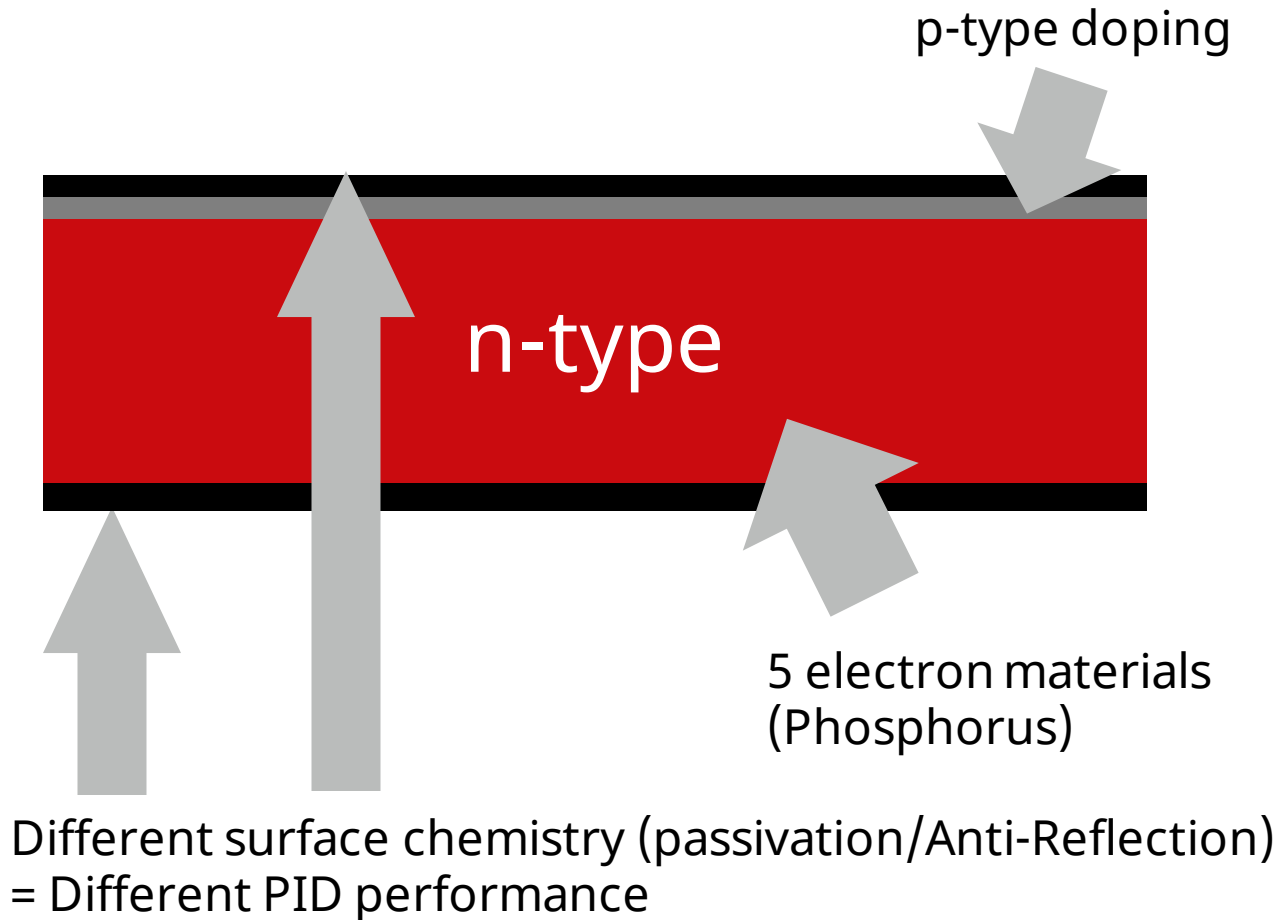


Quality and Service

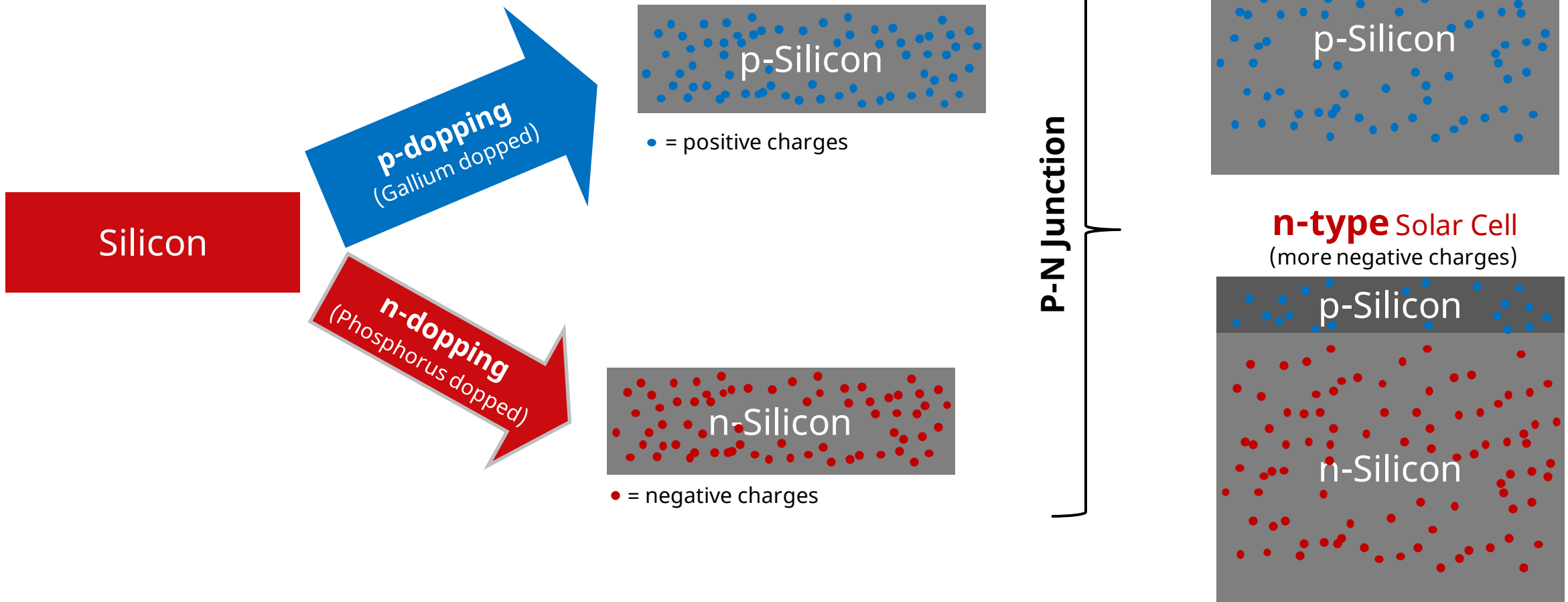
Robust construction in accordance with the highest quality standards gives our solar panels outstanding longevity.



Cell Technology: n-type vs. p-type

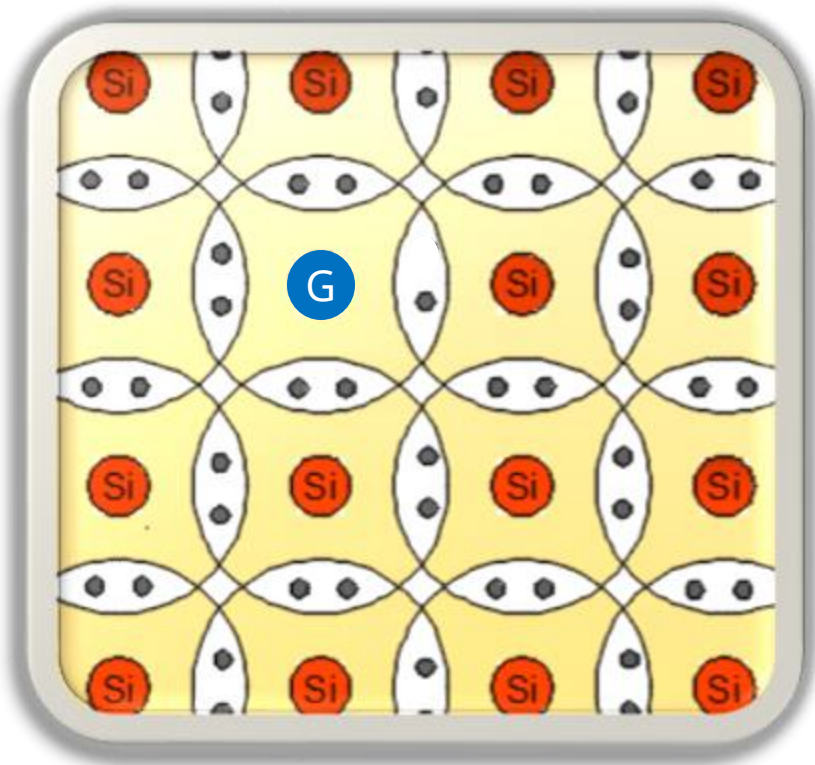


N-type or P-Type Definition

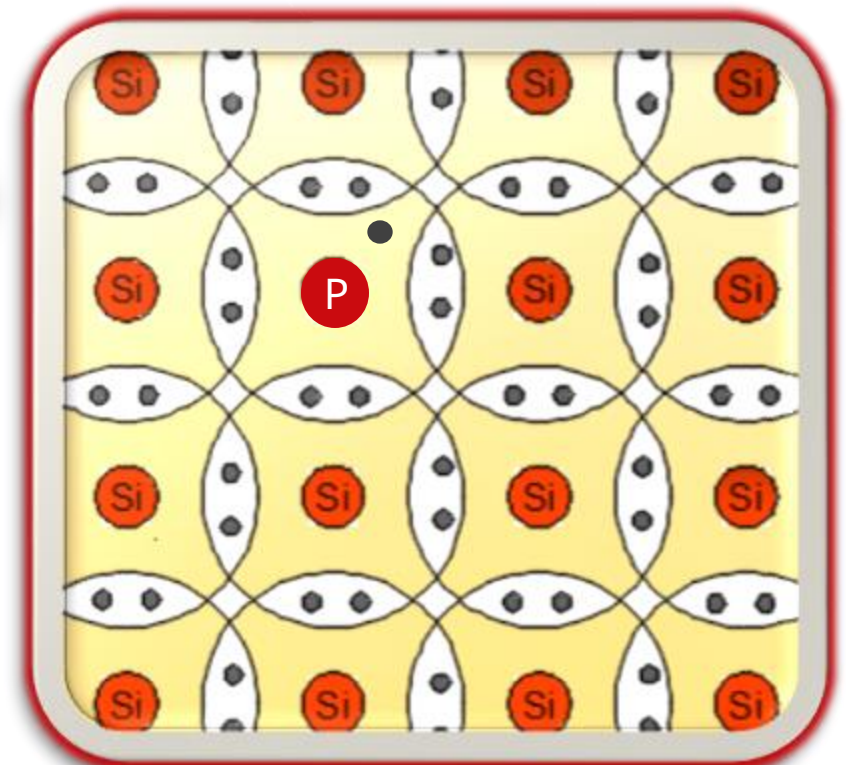


Longer minority carrier lifetime leads to higher efficiency

- P-type: Doped elements are 3-valent Ga atoms, majority carrier is hole, minority carrier is electron

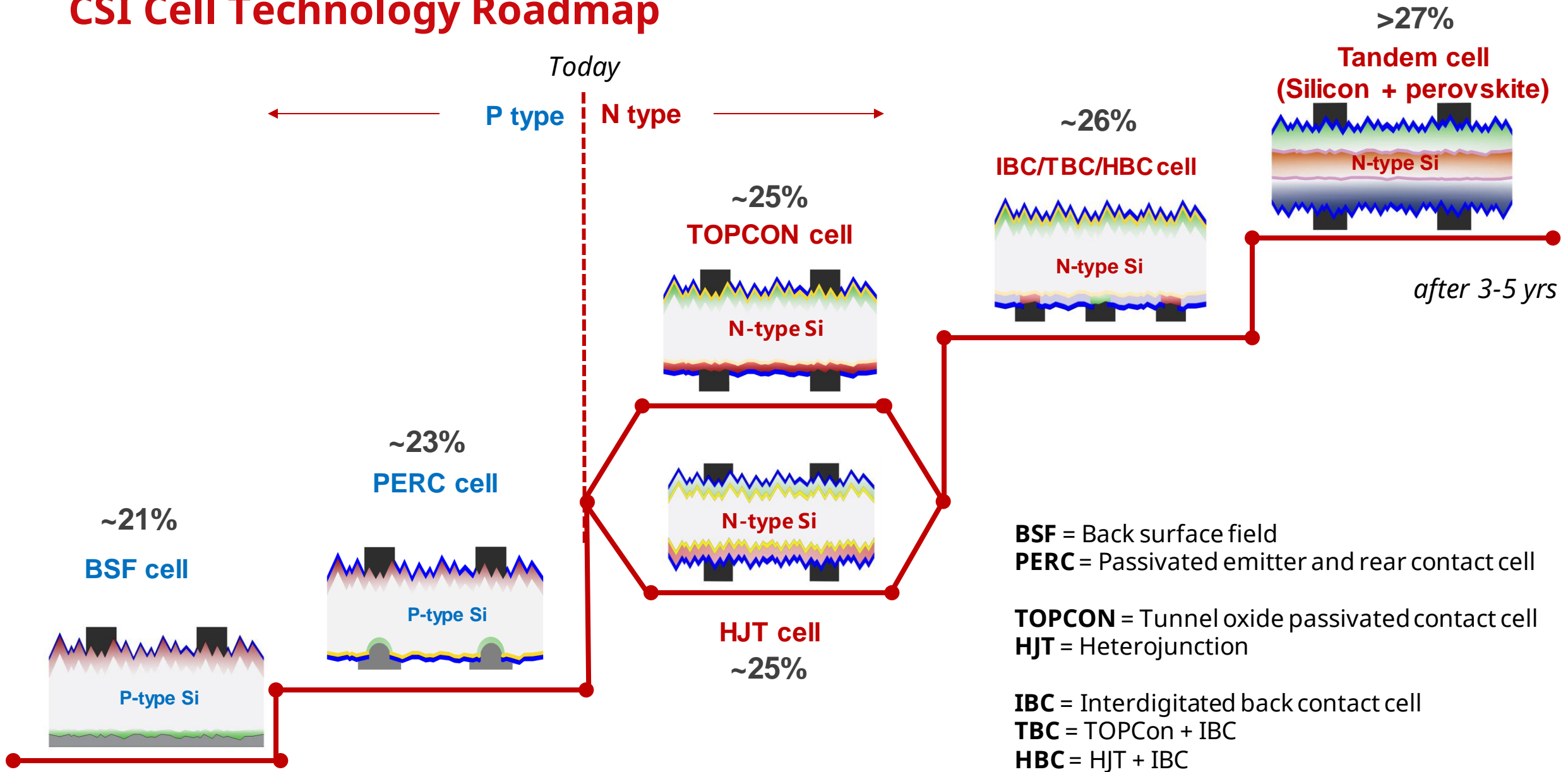


- N-type: The doped element is a 5-valent P atom, majority carrier is electron, minority carrier is hole



- **N-type module has longer lifetime of minority carrier than P-type module.** Minority carrier lifetime is one of the key indicators to judge the quality of wafer. Because impurities have a weaker ability to trap holes, N-type minority carrier lifetime is usually longer than P-type

CSI Cell Technology Roadmap



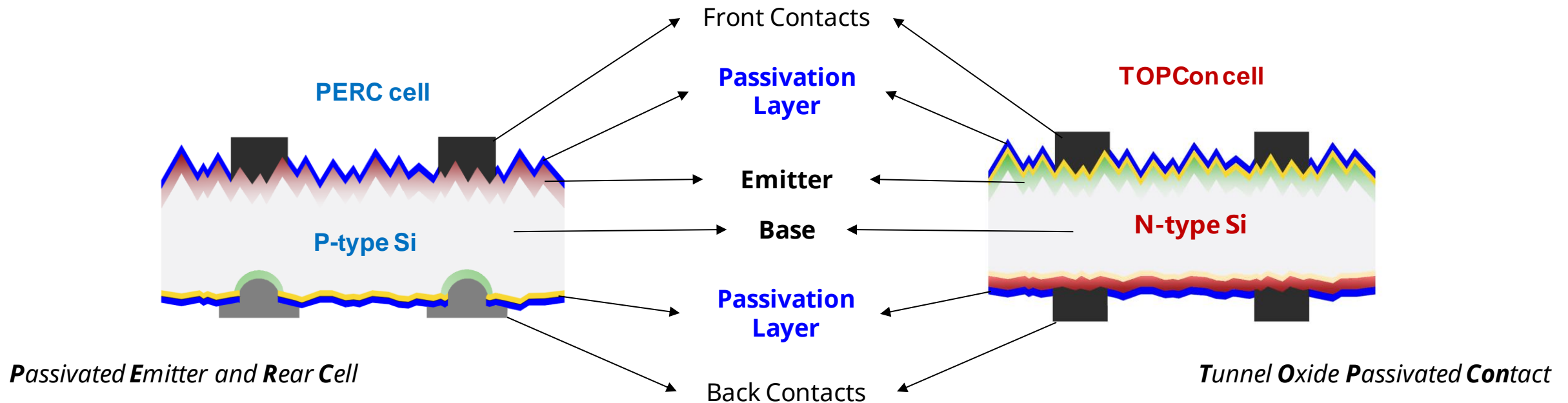
BSF = Back surface field
PERC = Passivated emitter and rear contact cell
TOPCON = Tunnel oxide passivated contact cell
HJT = Heterojunction
IBC = Interdigitated back contact cell
TBC = TOPCon + IBC
HBC = HJT + IBC

What is PERC? What is TOPCon?

Passivation technique to improve solar cell performance

TOPCon and **PERC** are advanced **passivated** cell architecture

- **Passivation** = “deactivation” of recombination sites (i.e. filter to separate the two charges) to reduce current losses
- PERC is mainly used with **p-type** cells
- TOPCon is currently widely used with **n-type** solar cells

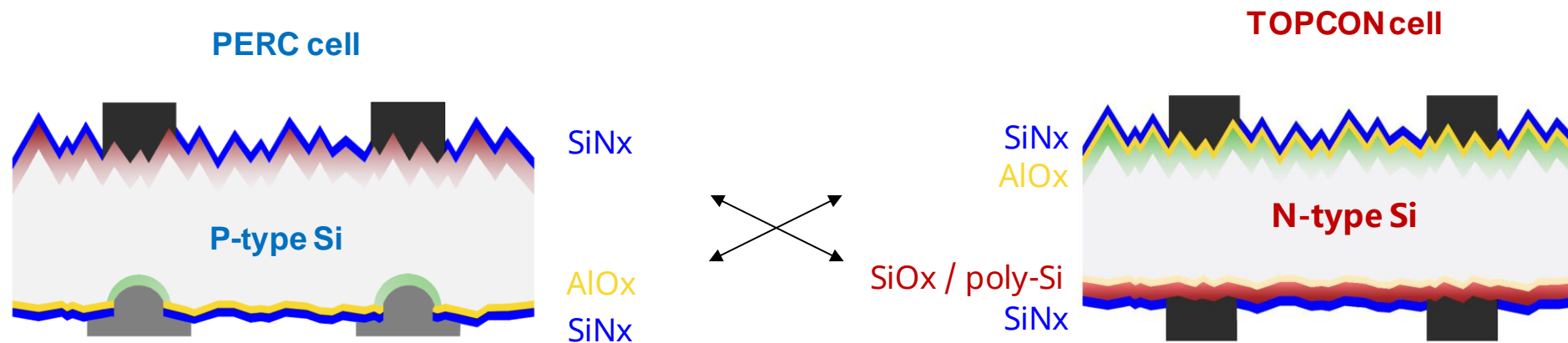


Why TOPCon is the next mainstream PV technology?

High compatibility with current manufacturing lines

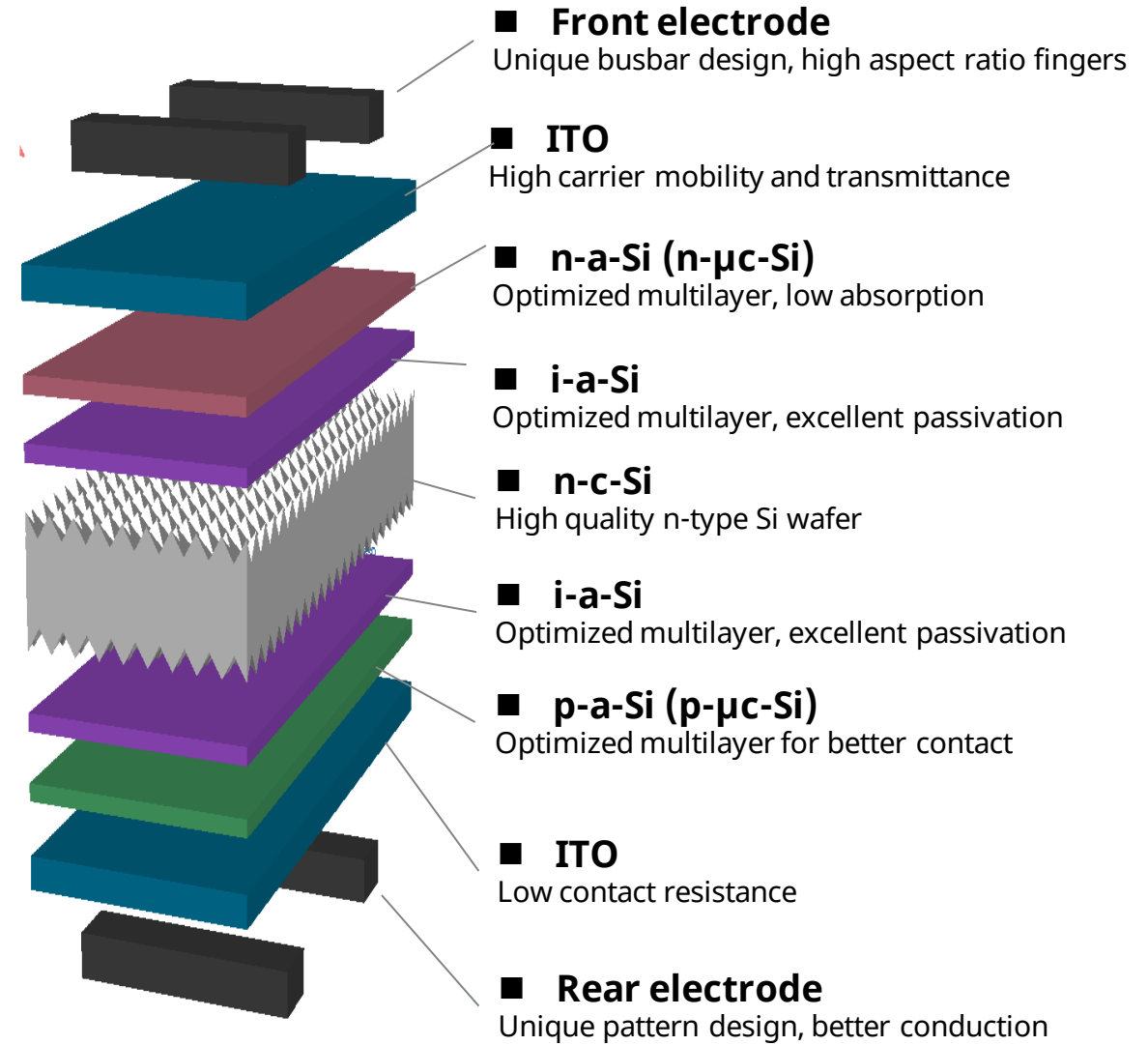
TOPCon is **compatible** with current PERC manufacturing lines, due to the **similar cell architecture** with PERC

- With 2 additional process steps, current PERC manufacturing lines can produce TOPCon
- HJT requires new manufacturing lines, and **higher CAPEX**



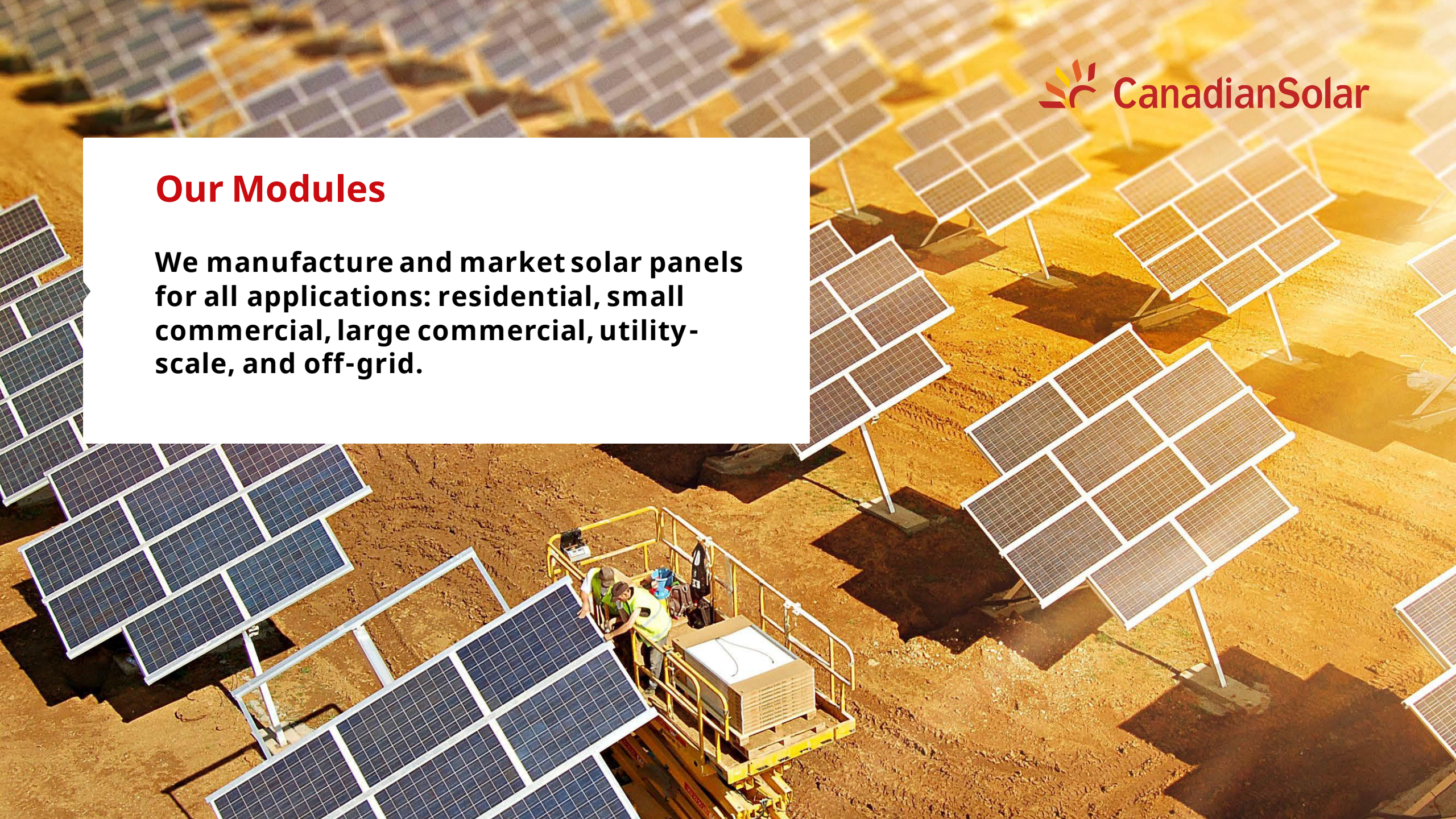
What is HJT ?

- ✓ High cell efficiency → 22.8% module efficiency with HiHero
- ✓ Simple process flow and superb yield.
- ✓ 100~150 μ m thin wafer possible → Lower production costs
- ✓ Low carbon footprint approach: Low temperature processing (~200°C).
- ✓ Suitable for future upgrade to HBC (HJT+IBC, >27%), Perovskite/Si tandem (>30%).



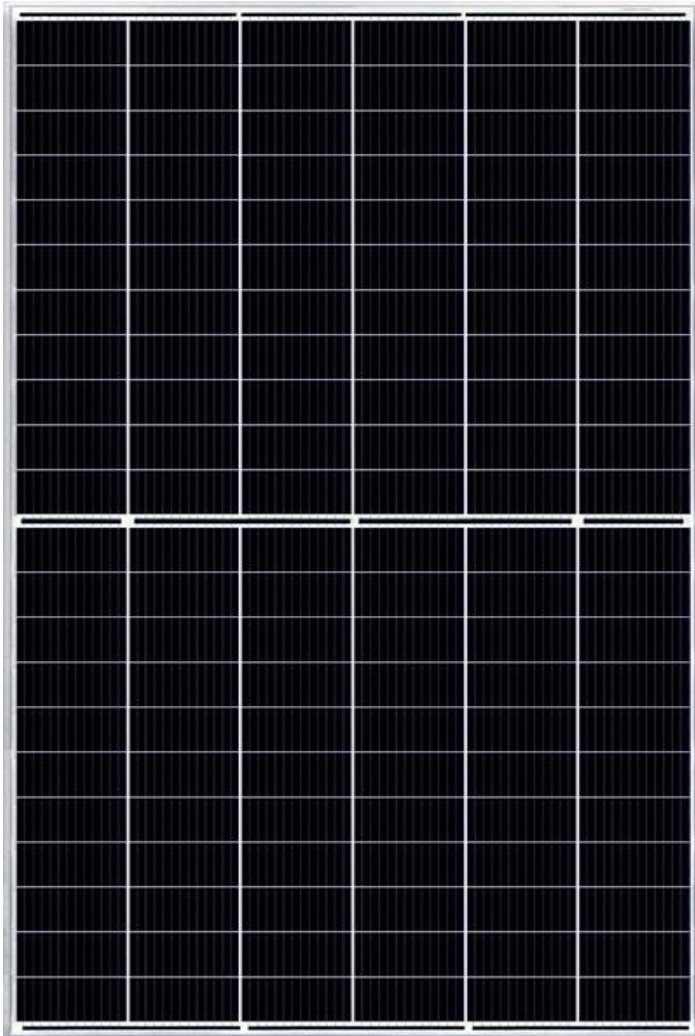
Our Modules

We manufacture and market solar panels for all applications: residential, small commercial, large commercial, utility-scale, and off-grid.



Superior performance of TOPCon

Significantly increased energy yield compared to mono-PERC modules



Higher efficiency

- **1% module efficiency** vs. PERC
- **+15 W** for 182mm modules, **+20 W** for 210mm modules

Lower temperature coefficient

- **-0.29 %/°C** (vs. -0.34 %/°C for PERC)

Higher bifaciality

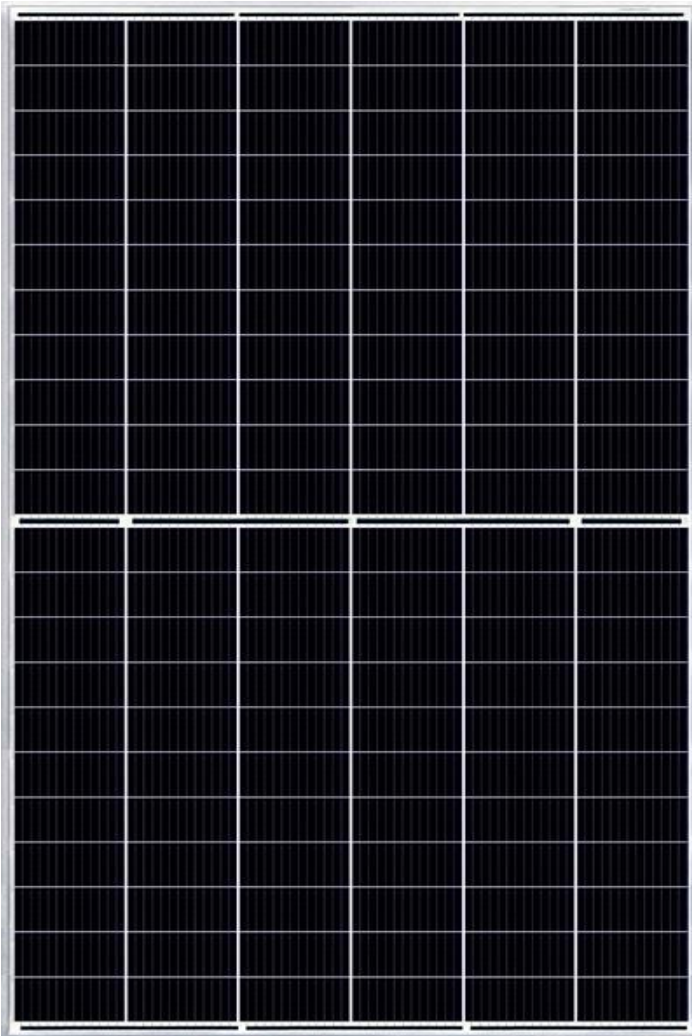
- **Up to 80 %** (vs. 70 % for PERC)

Better low-light performance

- **+0.2 % at 200 W/m²** compared to PERC

Enhanced Reliability of TOPCon

Combining CSI manufacturing expertise and TOPCon inherent features



Lower power degradation

- No Boron-oxygen related LID, excellent anti-LeTID & anti-PID performance
- **1 %** first year degradation + **0.40 %** annual degradation rate

CSI advanced manufacturing technology

- **Non-destructive cutting** to reduce cell crack risk
- Multiple point quality control throughout production

Minimizing impact of micro-cracks

- **16 BB** for 182mm modules
- **18 BB** for 210 mm modules

Overview – Monofacial Modules

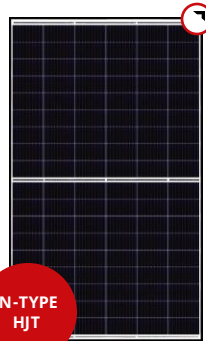
Residential

Commercial

Utility

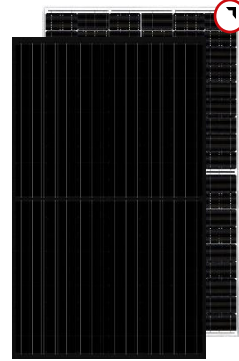
Also available with black frame

HiHero
CS6R-H-AG

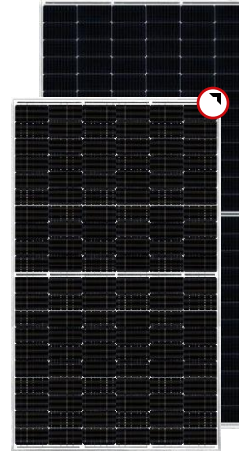


N-TYPE
HJT

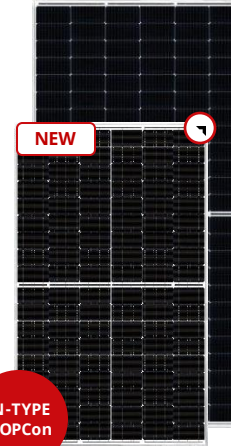
HiKu6
CS6R-MS All-Black
CS6R-MS



HiKu6
CS6L-MS
CS6W-MS



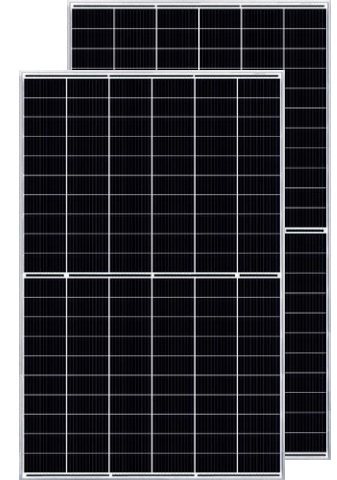
TOPHiKu6
CS6R-T***
CS6W-T



NEW

N-TYPE
TOPCon

HiKu7
CS7L-MS
CS7N-MS



Wattage:	420-445 W	6R-MS AB: 380-405 W 6R-MS: 395-420 W	6L-MS: 445-465 W 6W-MS: 535-555 W	6R-T: 420-435 W 6W-T: 560-580 W	7L-MS: 585-615 W 7N-MS: 645-675 W
Efficiency:	22.8 %	6R-MS AB: 20.7 % 6R-MS: 21.5 %	6L-MS: 21.5 % 6W-MS: 21.5 %	6R-T: 22.3 % 6W-T: 22.5 %	7L-MS: 21.7 % 7N-MS: 21.7 %
Cells:	182mm half-cut n-type HJT 10 Busbars	182mm half-cut mono-PERC 10 Busbars	182mm half-cut mono-PERC 10 Busbars	182mm half-cut n-type TOPCon 16 Busbars	210mm half-cut mono-PERC 12 Busbars
Dimensions:	1722 x 1134 x 30 mm	1722 x 1134 x 30 mm	6L-MS: 1903 x 1134 x 30 mm 6W-MS: 2278 x 1134 x 30 mm	6R-T: 1722 x 1134 x 30 mm 6W-T: 2278 x 1134 x 30 mm	7L-MS: 2172 x 1303 x 35 mm 7N-MS: 2384 x 1303 x 35 mm
Weight:	23.0 kg	21.3 kg	6L-MS: 24.2 kg 6W-MS: 27.6 kg	6R-T: 21.3 kg 6W-T: 27.6 kg	7L-MS: 31.0 kg 7N-MS: 34.4 kg
Per Pallet / Container:	35 / 910 pcs	35 / 910 pcs	6L-MS: 35 / 840 pcs 6W-MS: 35 / 700 pcs	6R-T: 35 / 910 pcs 6W-T: 35 / 700 pcs	31 / 558 pcs
Temperature coefficient (Pmax)	-0.26 % / °C	-0.34 % / °C	-0.34 % / °C	-0.29 % / °C	-0.34 % / °C
Warranties: Prod:	15 / 25* yrs	12 / 25** yrs	12 / 25** yrs	12 yrs	12 yrs
Output:	1 + 0.35 % (30 yrs)	2 + 0.55 % (25 yrs)	2 + 0.55 % (25 yrs)	1 + 0.4 % (30 yrs)	2 + 0.55 % (25 yrs)

Made for high reliability - highlights

HOTSPOTS

Lowest risk with: Only few cells per diode - 6 cell strings per module ensure the highest durability against shading & CSIR:
Canadian Solar Infrared Ray Testing

MECHANICAL LOAD

Superior high load reliability with CELL CUT: Low Damage Slicing

HIGH TEMPERATURE

Our modules are designed for the high temperature areas defined in IEC 63126 | Level 1

DEGRADATION

- Industry-leading control of initial degradation (LID & LeTID):
- Gallium Ingots
 - Degradation test for each batch





Storage – Coming soon

EP Cube*

Residential Energy Storage System

EP Cube is a flexible and intelligent home energy storage system intended for smart management of solar power generation and residential electricity consumption. It combines an aesthetic and compact design with a customisable storage capacity. It is easy and quick to install, and the operations are safe and reliable. Furthermore, you can control the device remotely.

Key Features:

-  Integrated hybrid inverter
Supports DC and AC input
-  Modular battery system
Easy to install and transport
-  Supports Wi-Fi and cellular communication
Remotely monitor generation and consumption
-  Multiple energy storage modes
Guarantees household power supply



* Please contact your sales representative for the availability in your region.

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THANK YOU!