



LONGi

LONGi × UNSW Technical Seminar 2026

Advancing Back-Contact Technology & Future Solar Innovation



Electrical Behaviour of Back-Contact Cells Under Partial Shading: Implications for Energy Yield Modelling and Reliability in an Australian Utility Context

LONGi Product Solution - Sang Bui

Introduction: Back-Contact cells don't just improve performance —the structural difference change electrical behaviour in the shade

1. The structural difference:

1. Conventional front-contact vs back-contact cells
2. Difference in electrical behaviour in the shade

2. “Anti-Hotspot”

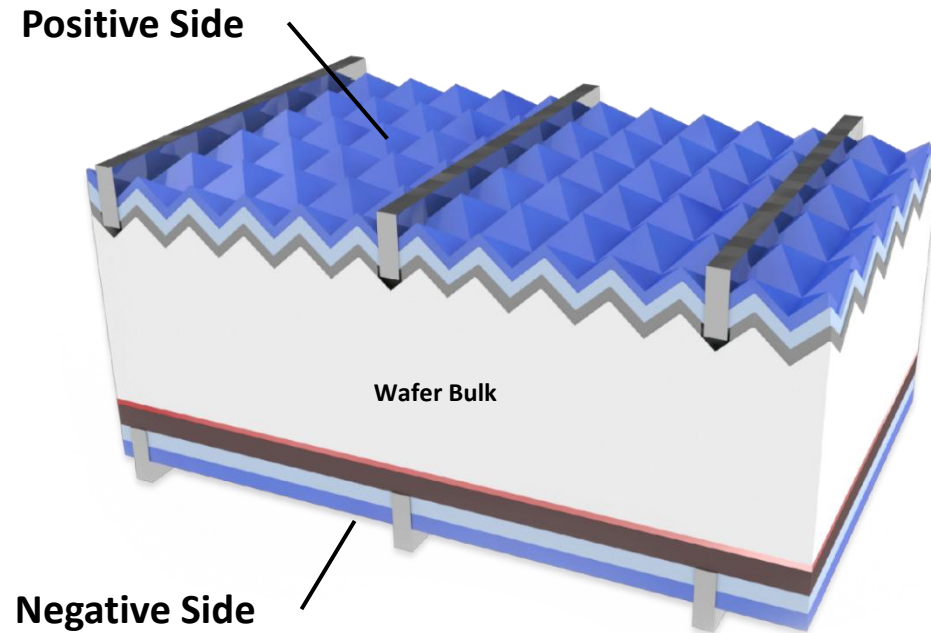
1. The need to address hotspot and the defects they create in conventional front-contact cells.
2. The difference in back-contact cells
3. How to apply this in PVSYST models, and the current challenges.

3. “Anti-Shade”

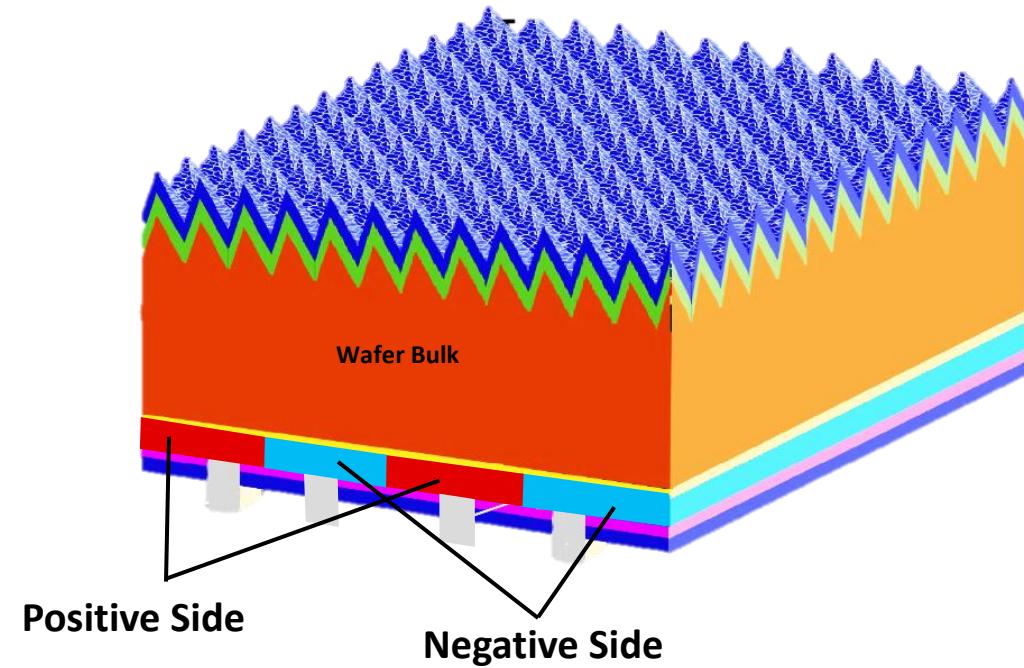
1. The problem with bypass diode protection on conventional front-contact modules.
2. The difference with back-contact cells
3. How to apply this in PVSYST models, and the current challenges.

The Difference: A significant change in structure

Front Contact Cell Structure



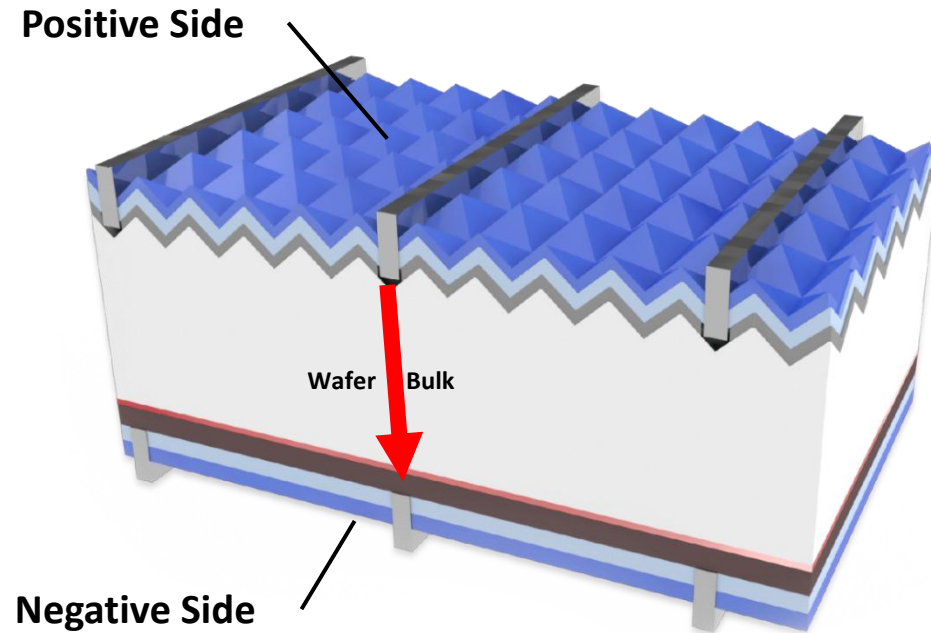
Back Contact Cell Structure



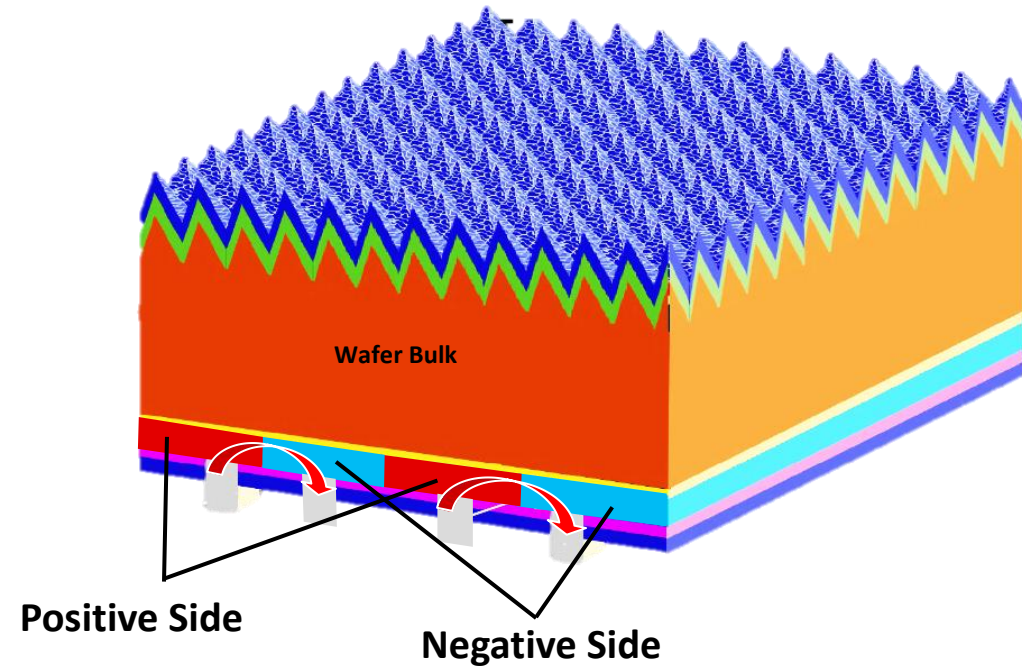
FRONT CONTACT VS BACK CONTACT

The Difference: Electrical behaviour without sunlight

Front Contact Cell Structure



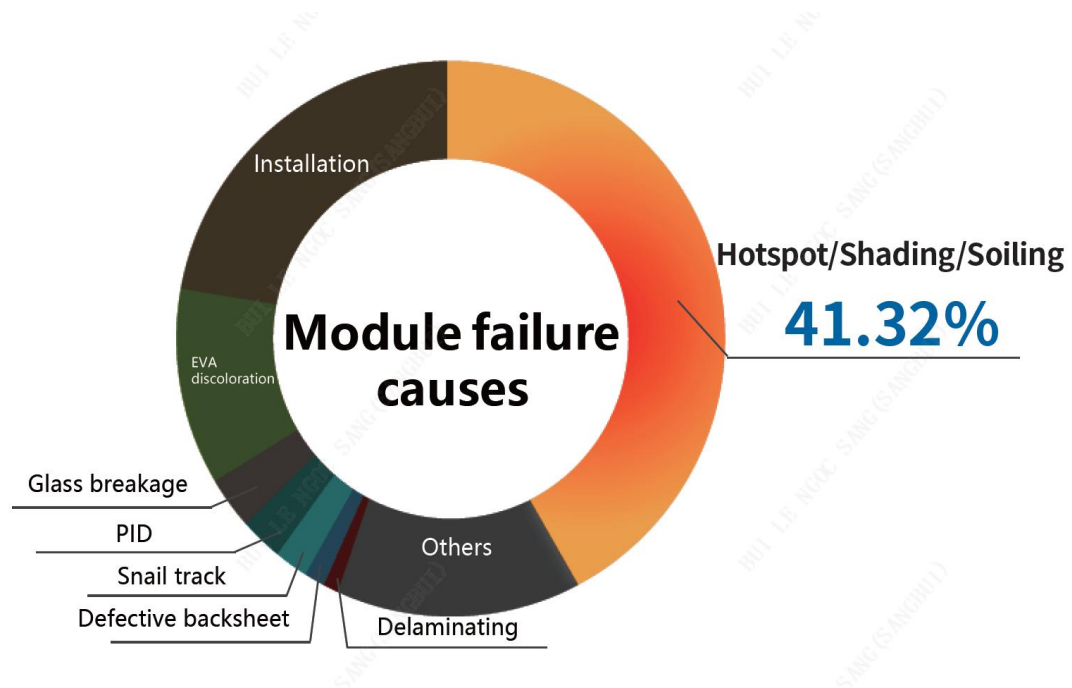
Back Contact Cell Structure



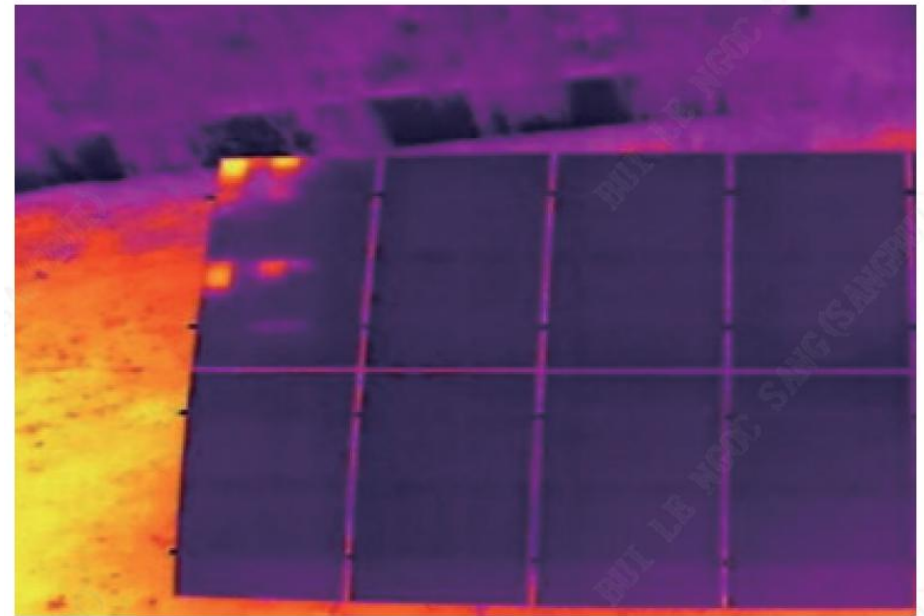
Red arrows shows path of current,
front contact lower dopant concentration and higher distances,
back contact higher dopant concentration and lower distances

“Anti-Hotspot”: Hotspot damage is a major failure mode in conventional modules

- It happens in real systems
- It's tied to reliability and lifetime



Hotspot is the primary cause of conventional module failure



Hotspot phenomenon under real application scenarios

“Anti-hotspot”: Hotspot formation on conventional front-contact cells risk thermal concentration

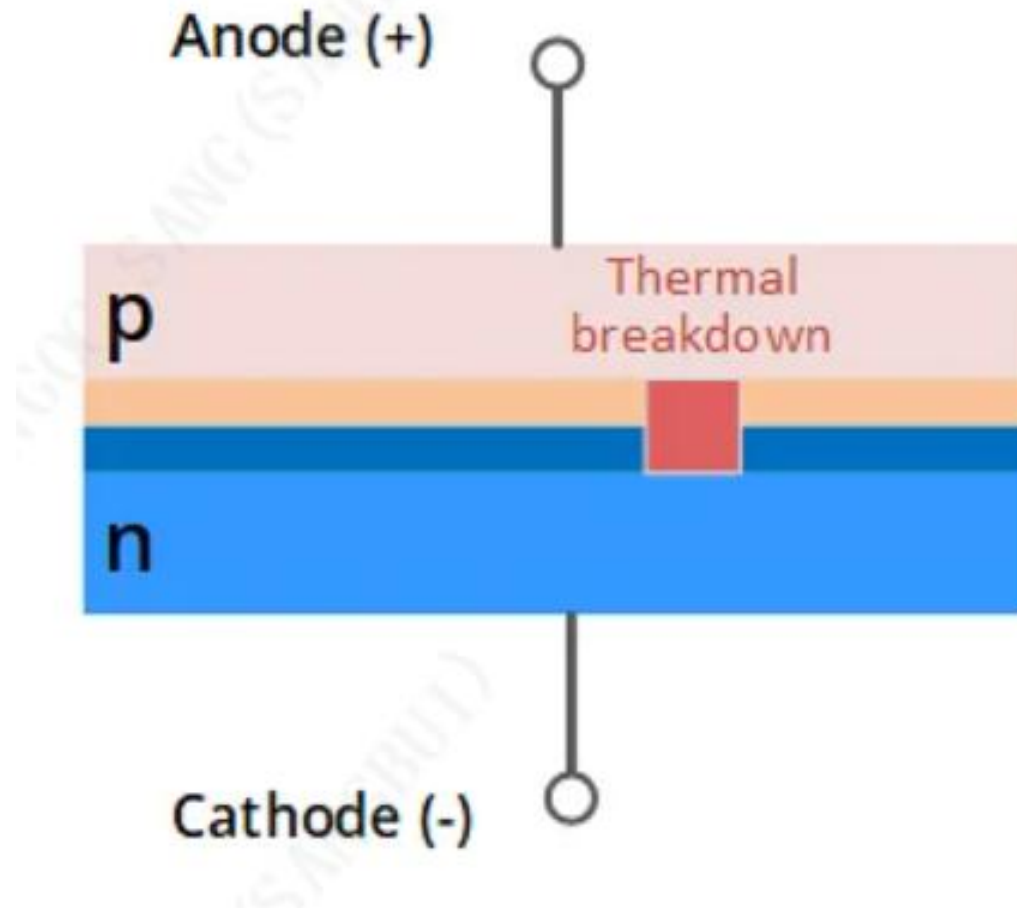
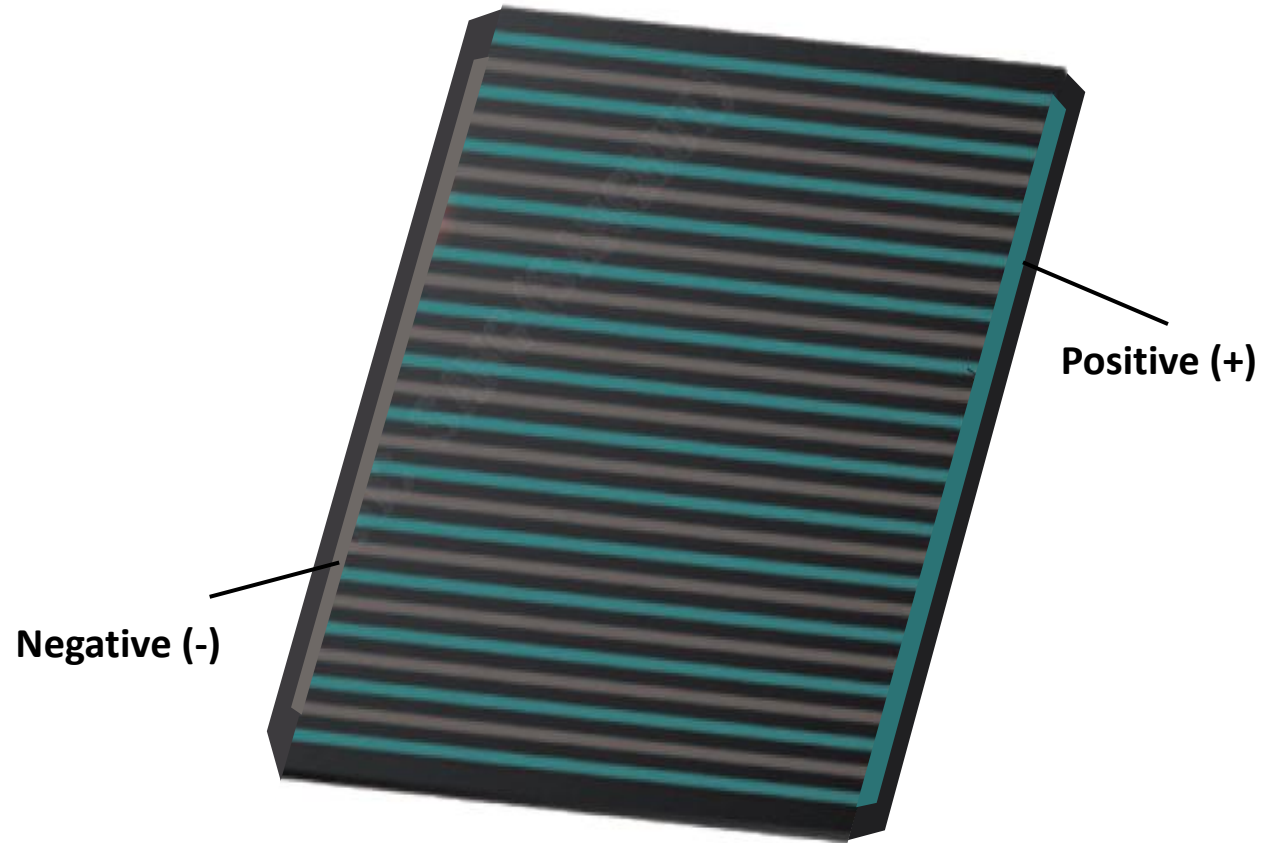


Image: Electrical concept cross section of a conventional front contact solar cell. Highlighting that in the shade, the concentration of current path leads to thermal break down at the weakest point.

"Anti-hotspot": BC cells distribute current across the entire cell under shade



Instead of concentrating thermal stress in one weak point,
back-contact cells spread current across the entire structure

"Anti-Hotspot": Improved Hotspot risk should reduce mismatch and dispersion

Front-Contact PVSYST

Ageing

Degradation values in simulations

Show which values will be used in the simulation for the chosen year, corresponding to these model parameters.

Simulation for year no

Modules degradation **5.9%**

Mismatch degradation **8.7%**

Global degradation 14.6%

Model

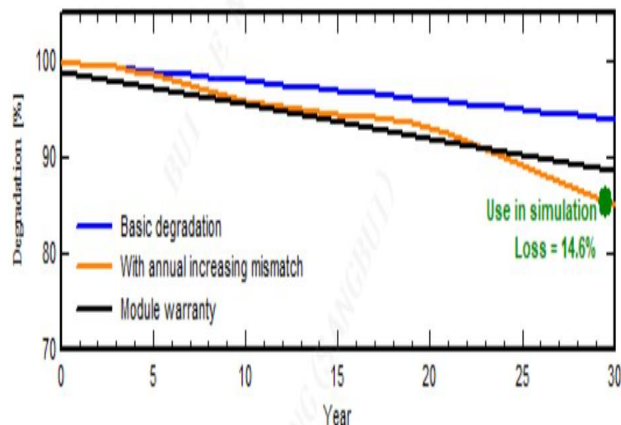
PV module ageing parameters

Aver. degradation factor ☐ %/year

Imp / Vmp contributions ☒ %

Imp RMS dispersion 0.40 ☒ %/year

Vmp RMS dispersion 0.40 ☒ %/year



Conventional Front Contact
PVSYST Dispersion Defaults in Blue Tick

Back-Contact PVSYST

Ageing

Degradation values in simulations

Show which values will be used in the simulation for the chosen year, corresponding to these model parameters.

Simulation for year no

Modules degradation **5.9%**

Mismatch degradation **3.1%**

Global degradation 9.0%

Model

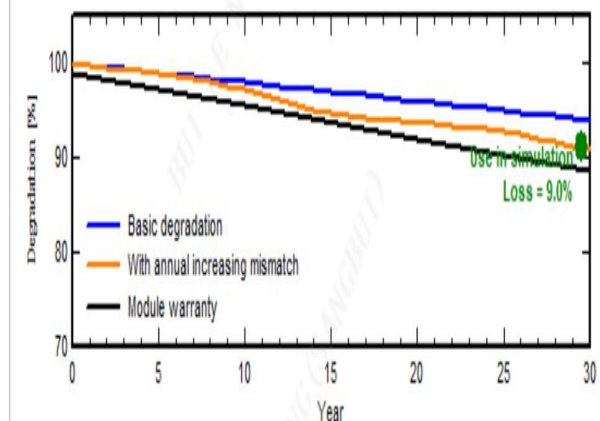
PV module ageing parameters

Aver. degradation factor ☐ %/year

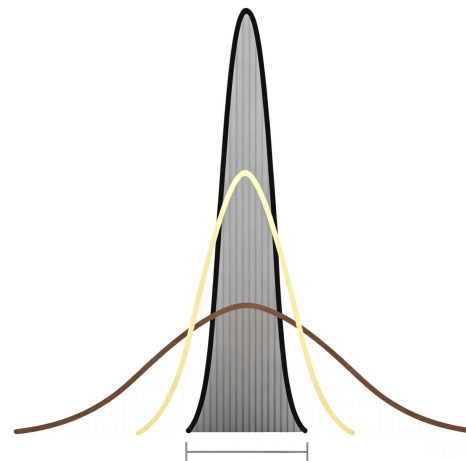
Imp / Vmp contributions ☒ %

Imp RMS dispersion 0.30 ☐ %/year

Vmp RMS dispersion 0.30 ☐ %/year



Back Contact
Better dispersion?



Same average,
But different dispersion?

“Anti-hotspot”: Summary

Conventional Front Contact Cells	Back-Contact Cells
Cell structure forces higher-voltage “breakdown” to conduct in shade	Cell structure enables low-voltage “tunnelling” to conduct in shade
Cell structure forces current through bulk → current looks for weak-points	Cell structure guides current through doped regions → more conductive paths
Concentrated avalanche breakdown at weak points	Distributed, low-stress conduction across the cell
Localised heating → hotspot formation	Distributed heating → hotspot risk reduced
Localised degradation → higher mismatch	Uniform behaviour → tighter module population
Hotspot formation remains an inherent, dominant risk in long-term reliability	Reduced hotspot conditions improve reliability and increase lifetime energy

“Anti-Shade”: Traditional protection (bypass diodes) sacrifices up to 30% power

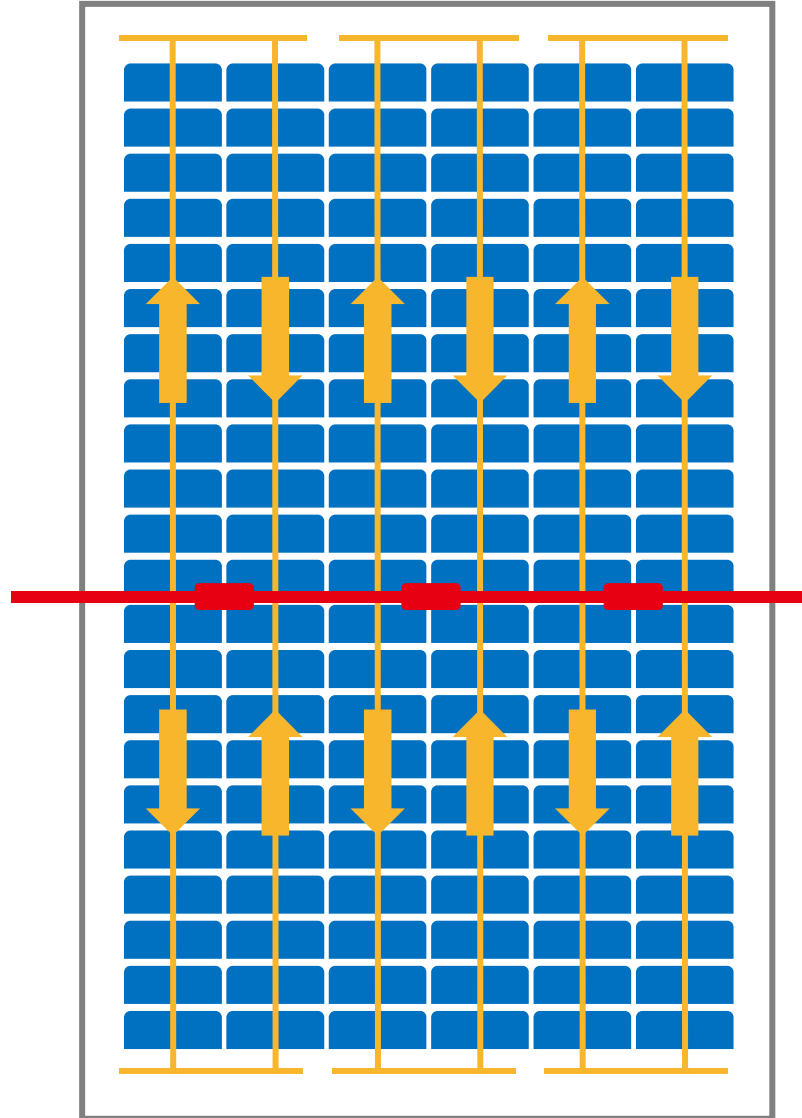
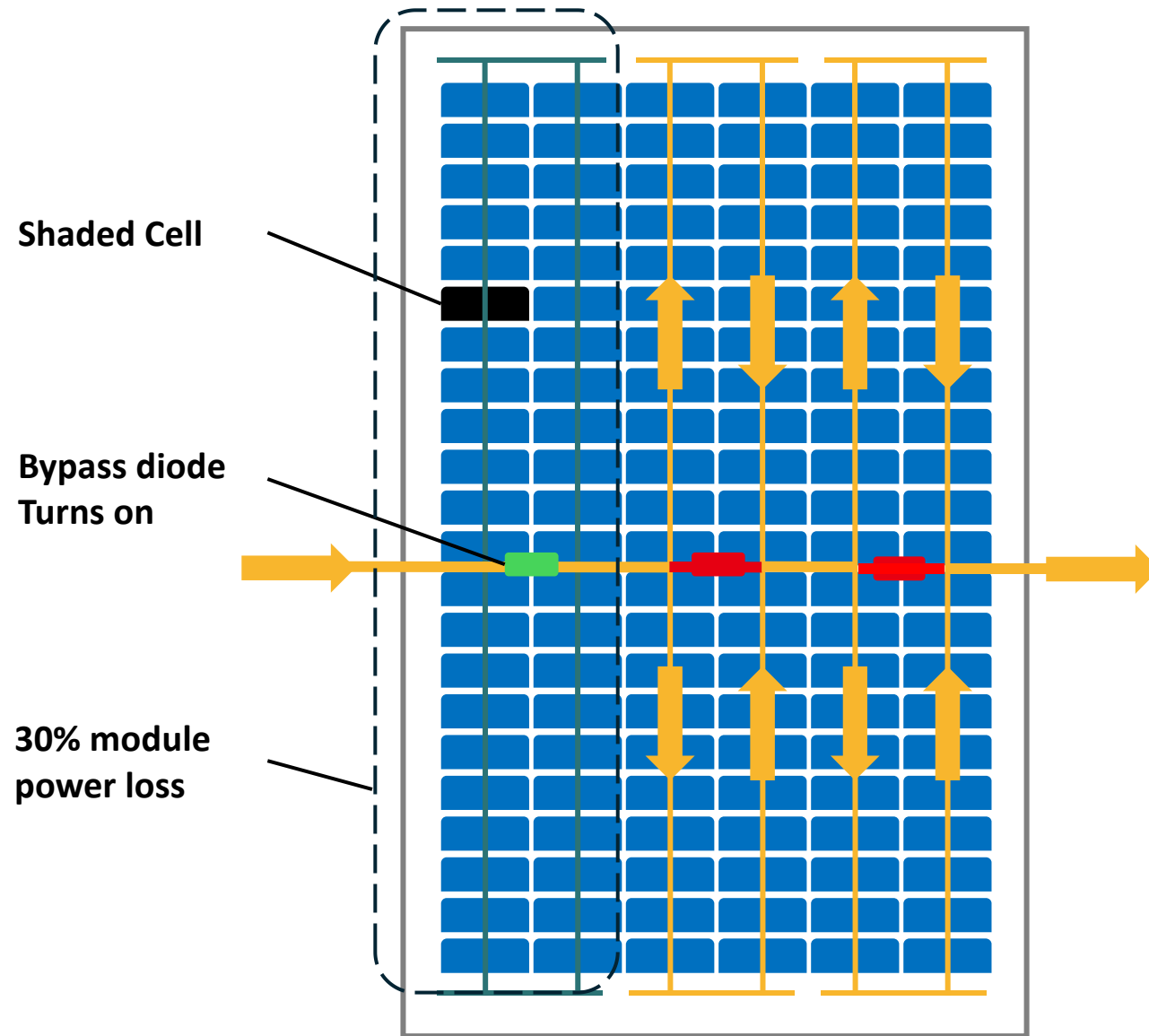


Image of a conventional 66 cell half-cut module showing internal current direction, locations of sub-modules and by-pass diodes

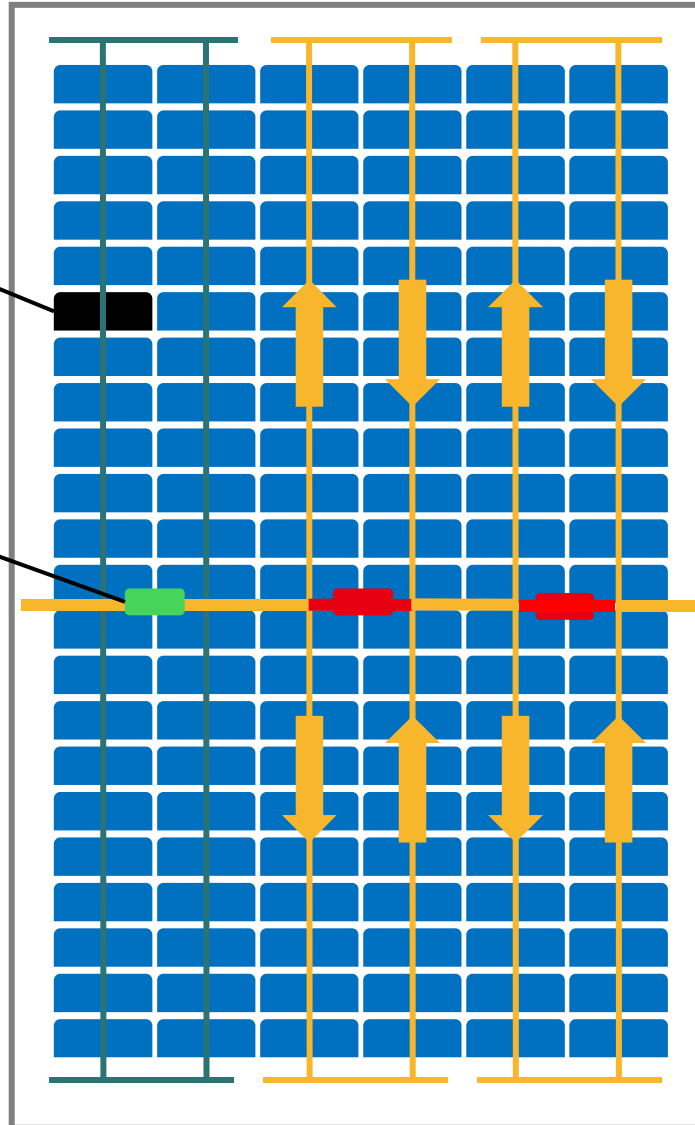
"Anti-shade": Traditional protection (bypass diodes) sacrifices up to 30% power



"Anti-shade" : BC modules reduce reliance on bypass diodes and preserve output

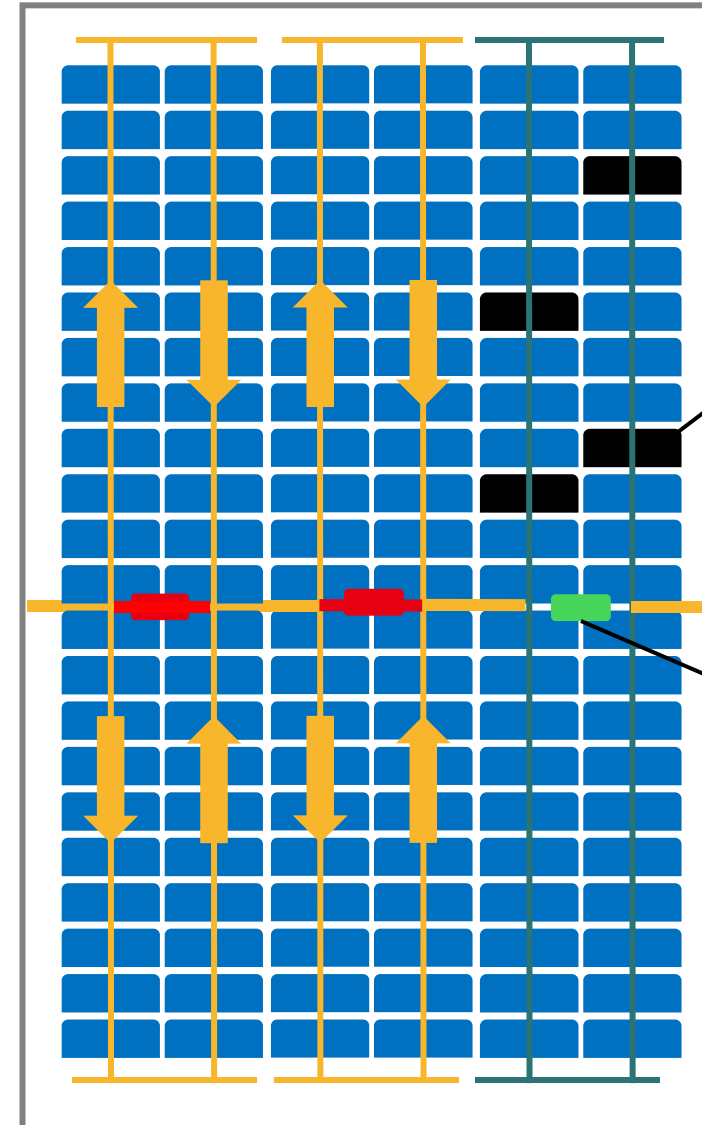
Conventional front-contact:
Just one shaded Cell
Activates the bypass diode

Bypass diode
Turns on



Back-Contact:
Up to 4 shaded cells
In one sub-string
activates the bypass diode

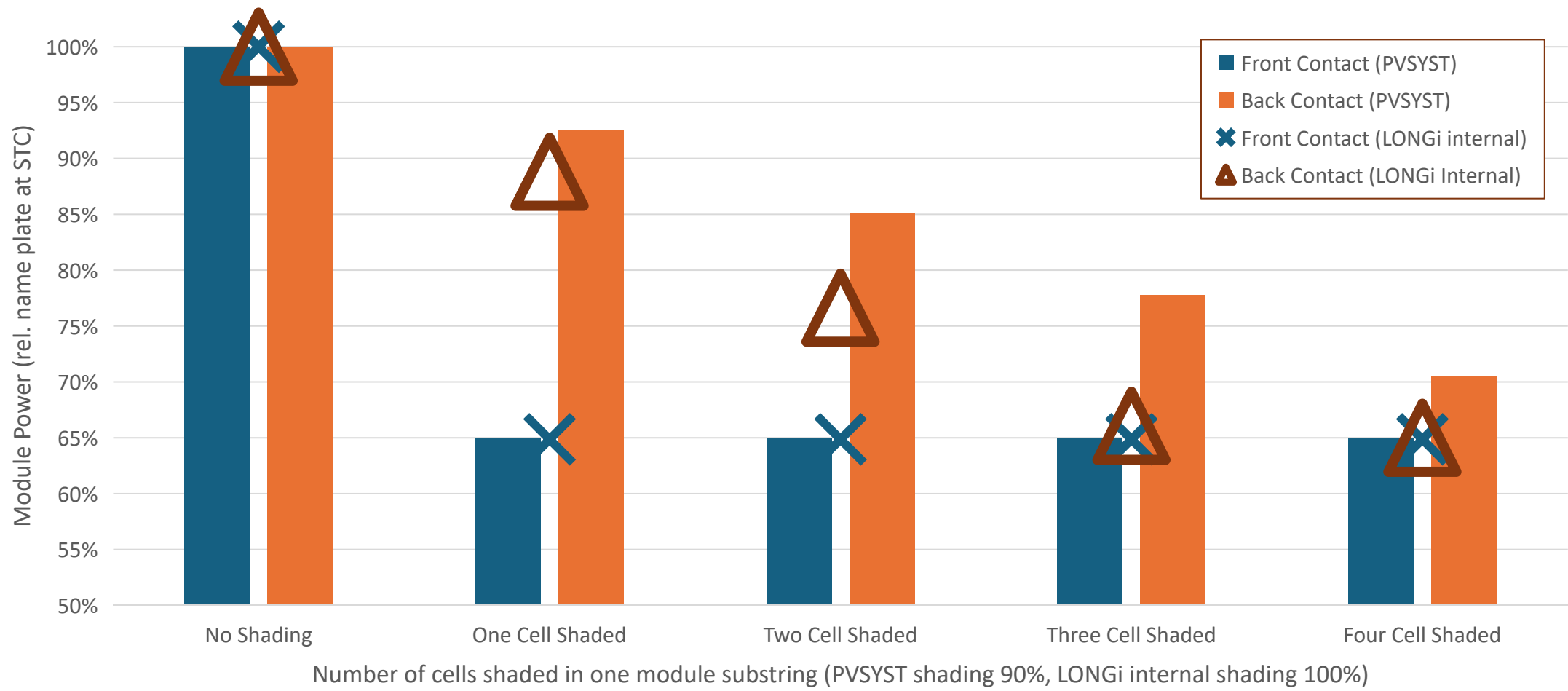
Bypass diode
Turns on



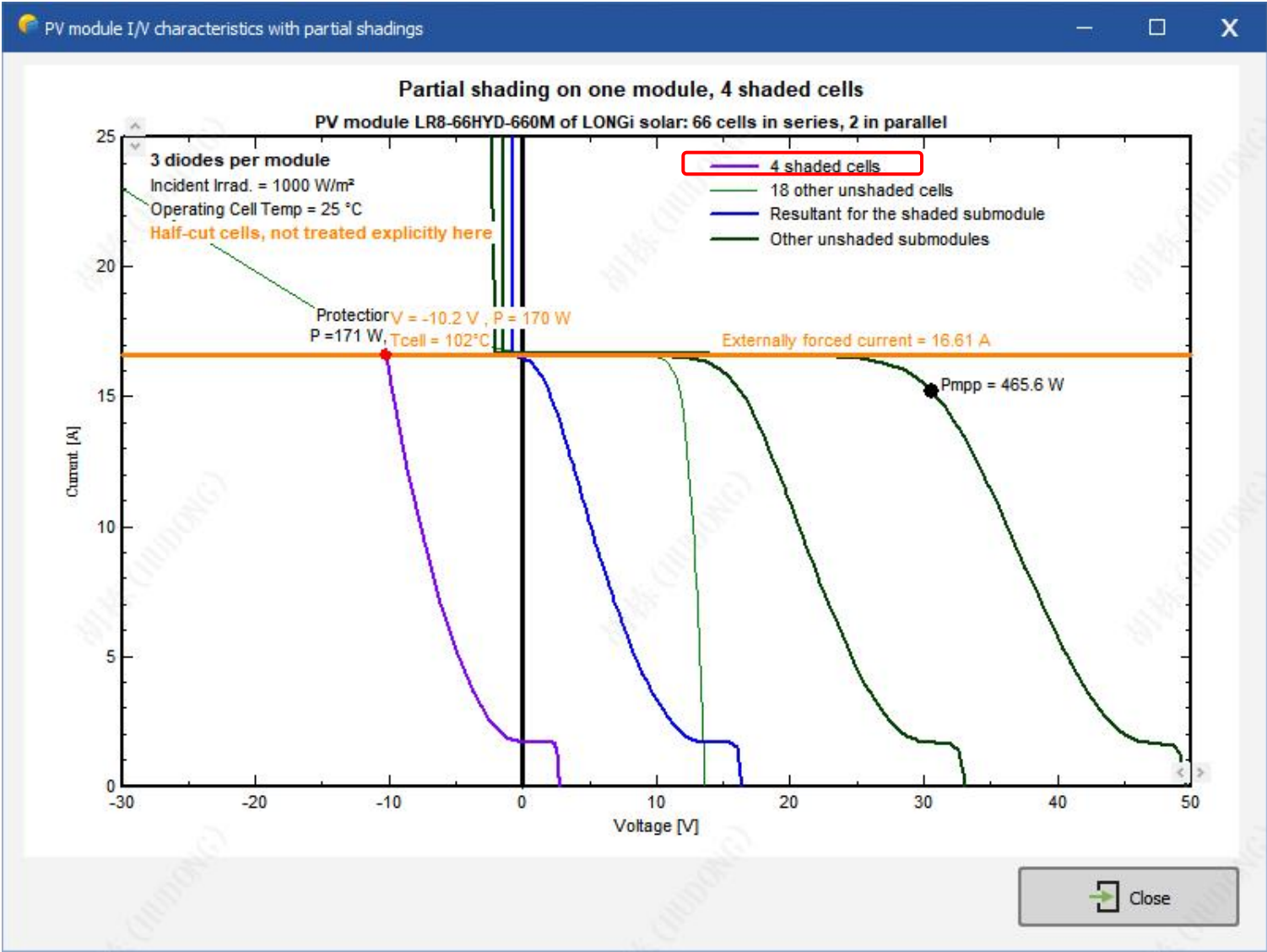
FRONT CONTACT VS BACK CONTACT

"Anti-shade": Back-Contact modules sustain higher energy production under shading

Back-Contact Power vs Front Contact Power
Against number of cells shaded. Simulation validated with internal test results



“Anti-Shade”: PVSYST’s Arev and PV module I/V characteristics tool, almost valuable.



3.9 Reverse current coefficients (Arev) test

Module Type	LR8-66HYD-655M	REFERENCE MODEL
Sample No.	3	6
Start / end date (dd/mm/yyyy)	17-09-2025	
Arev (mA/V)	1134.0	37.8

Basic data Sizes and Technology Model parameters Additional Data Measured Data Commercial Graphs

Description Longi Solar, LR9-66HYD-740M

Optional additional specifications available for this PV module

Secondary parameters Customized IAM Degradation

Specific losses or gains

LID loss (Crystalline Si-modules) N/A %

Light soaking gain (CIS modules) N/A %

Specified μVco on datasheets -0.199 i.e. -98 mV/°C

Reverse characteristics

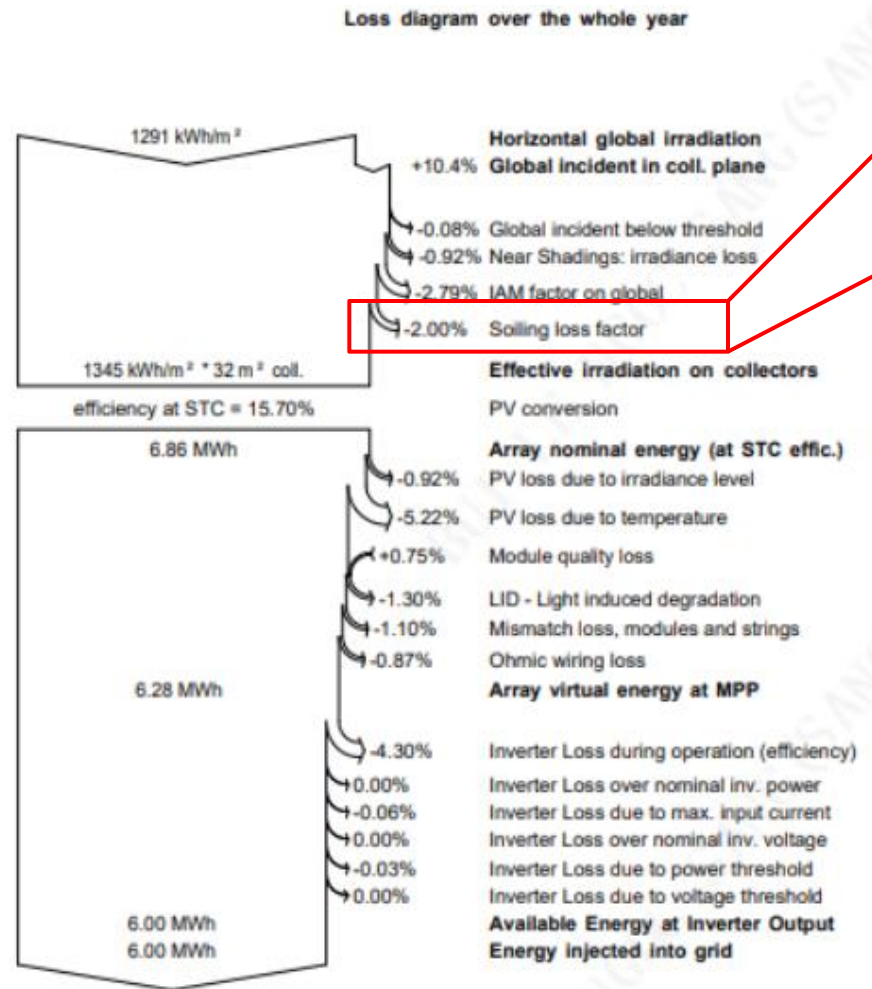
Single cell reverse characteristics (dark) Quadratic factor Arev 1134.0 mA/V²

NB: This reverse parameter is only used in the framework of the array behaviour special tools (partial shadings on modules). Its value is not essential and can be taken as the proposed default.

PVSYST’s AREV parameter provides a location to add this anti-shade characteristic, and the tool is useful to quantify when the diode turns on, but it’s limited.

And importantly, it doesn’t quantify the benefit for a Single-axis back-tracking solar farm yield analysis.

"Anti-Shade": PVSYST over simplifies soiling loss



Yearly soiling loss factor

Yearly loss factor % ☐ Default

Soiling loss in PVSYST is a simple user input percentage factor. Typically 1.5-2% for Australian Utility projects. The industry now has two module technology choices that behave differently under localised shade.

Image above is a typical Utility Scale solar farm arrow loss diagram

"Anti-Shade": Summary

Conventional Front Contact Cells	Back-Contact Cells
Relies on bypass diode activation under shading to self protect	Delays bypass diode activation through improved conduction structure
Low AREV (37.8mA/V) → diode activates with minimal shading (≈ 1 cell)	Higher AREV (1134mA/V) → diode activates under heavier shading (≈ 4 cells)
Early bypass → step-change power loss ($\sim 30\%$)	Sustains conduction → gradual power reduction
Low tolerance to shading → small shading causes large losses	Higher tolerance to shading → more shading before major loss
PVSYST soiling model's simple % loss is fine for conventional versus conventional comparisons	Applying the same soiling factors despite different electrical behaviour under estimates back-contact's performance in the shade

Closing: BC Technology is a change in cell structure, with real system value, but modellers still face challenges

- Fundamentally different cell architecture
 - Different current behaviour under non-ideal conditions
 - → Lower hotspot risk & better shade performance
- System Implications:
 - Improved reliability → more lifetime energy
 - Improved shading response → higher retained output
- **But current technology comparisons omit these from yield analysis**
 - Should this continue?
 - Should mismatch losses be assumed the same?
 - Should soiling losses be assumed the same?
- Application Engineering Challenge:
 - Technically validated at module level
 - Not yet fully reflected in system yield models
- Further research is needed help modellers quantify these effects in looks like PVSYST