GLOBAL RAIS®

Energy & Storage Solutions

Redundant **A**rrays of **I**ntegrated **S**olar

Global RAIS® provides modular, low voltage, kit-based solar PV solutions that are efficient, reliable, and cost-effective. Our ultra-safe and resilient systems can be adapted for small to mid-size off-grid and grid-tied installations and features a unique DC to DC storage capability.

The Key Messages

- RAIS® is fundamentally superior, for performance and for resilience. Installations show it, customers attest to it, and competitor trends prove
- Systems engineering based on safety and reliability design principles result in greater productivity and lowers the overall cost of energy
- Multiple aspects of RAIS® design are being mimicked across the industry as long-term performance and reliability issues are revealed
- Features and advantages align well with market growth, native storage integration; micro-grid architecture ideal for VPP and EaaS applications
- Platform can accelerate viability of emerging cell technology due to less thermo-mechanical stress-induced degradation mechanisms

RAIS®: Advancing Solar Energy Generation

Future Solar Demands

Bankability → PPA Fidelity

- Productivity, efficiency
- Safety, insurability
- Dependability, durability

Grid Integrity

- Interconnection stability
- Storage integrability
- Localized assurance

Extensible Technology

- Efficiency & productivity gains
- Expand applications and markets
- Accelerate R&D to market

RAIS® Platform Advantages

Systematically Better PV

- Maximum energy generation
- Fireproof, hurricane rated
- Reliable, resilient, robust

Microgrid System Model

- Predictable, stable power
- Direct storage capability
- Least risk, greatest flexibility

Advanced technology roadmap

- Ideal platform for new PV tech
- Extensible to flexible formats
- Compatible with concentration

The Global RAIS® Advantage

Our Solar PV systems offer a robust suite of differences over conventional solar at a competitive price:



Redundant Solar

No single point failures – unlike conventional solar PV, every element of our systems have multiple connections making the entire Global RAIS® system highly resilient.

Storage Ready Now

Global RAIS® modules can charge batteries directly from the module for true DC – DC storage.

Extremely Maintainable

With our smart low voltage design, maintaining a device is safe and easy by trained staff, eliminating the need for costly specialists.

Highly Robust and Resilient

The matrix topology and a proprietary aluminum back sheet with integrated module-level controllers offer robust real-world resiliency.

Global RAIS® Patented Technology

A Highly Distributed System

Parallel connection of multiple PV modules to groupings of redundant micro-inverters via a redundant low voltage bus

Grid Independency

Our systems are compatible with point of use without a grid connection and offer the command and control of array and inverters for microgrid and grid-connected systems

Low Voltage and Safe System

Less than 60V on the DC bus means no risk of arc flash or fire and is 2020 Rapid Shutdown compliant

A Safe and Easy to Install System

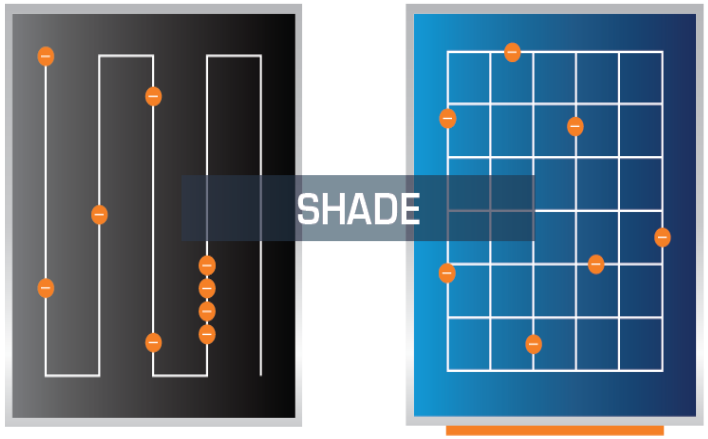
High-density self-supported wave-type non-penetrating racking offering access and offering robust integrated module electronics

A Highly Resilient and Reliable System

Active redundancy is built into all aspects of our systems via a parallel-series topology and a proprietary aluminum back sheet, integrated module-level controller



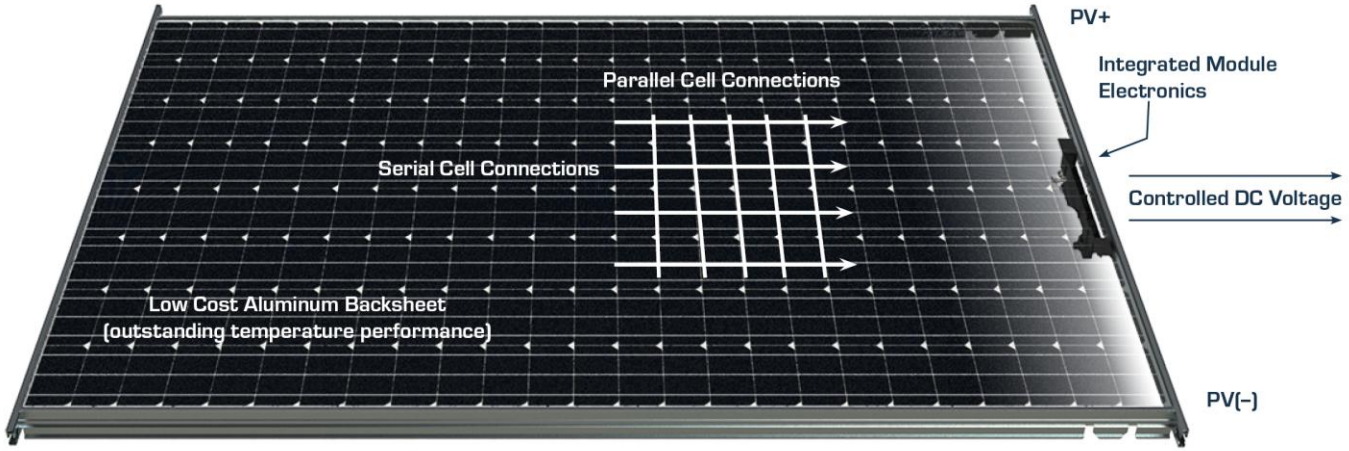
RAIS®: A Fundamentally Better PV System

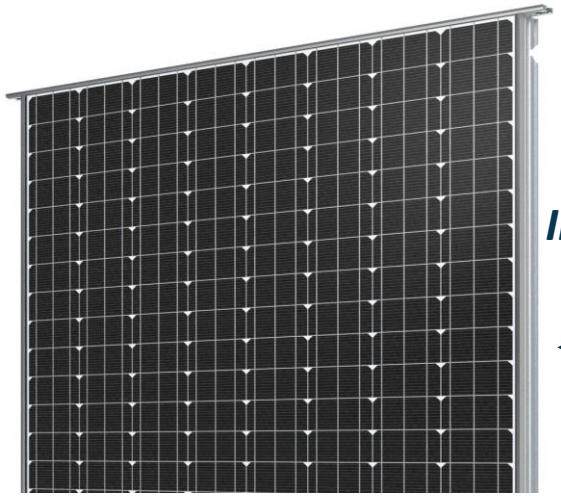


Yesterday's		Global RAIS®
Serial	Solar Cell Connections	Matrix
Poor	Partial Shade Performance	Excellent
String	Power Point Tracking	Within Module
High	Performance Degradation	Low

RAIS® modules are shading resilient and maximize every cell's output independent of insolation level and uniformity.

Built-in Intelligence Enables Cell Independent Performance





Frame Integrated Rack

Module Integrated Electronics

Cell-level MPPT + UL1741 charge controller
Regulated output independent of insolation variation

Aluminum Back sheet

Lighter than glass, >= moisture protection
Less thermomechanical stress on cells

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RAIS®: Smart, modular, bankable solar energy

The RAIS® Kit

Patented Low Voltage, Smart and Resilient Modules



RAIS® Systems are DC-DC Storage Ready

Highest Energy Density	*Orientation Agnostic*	*Low Weight*

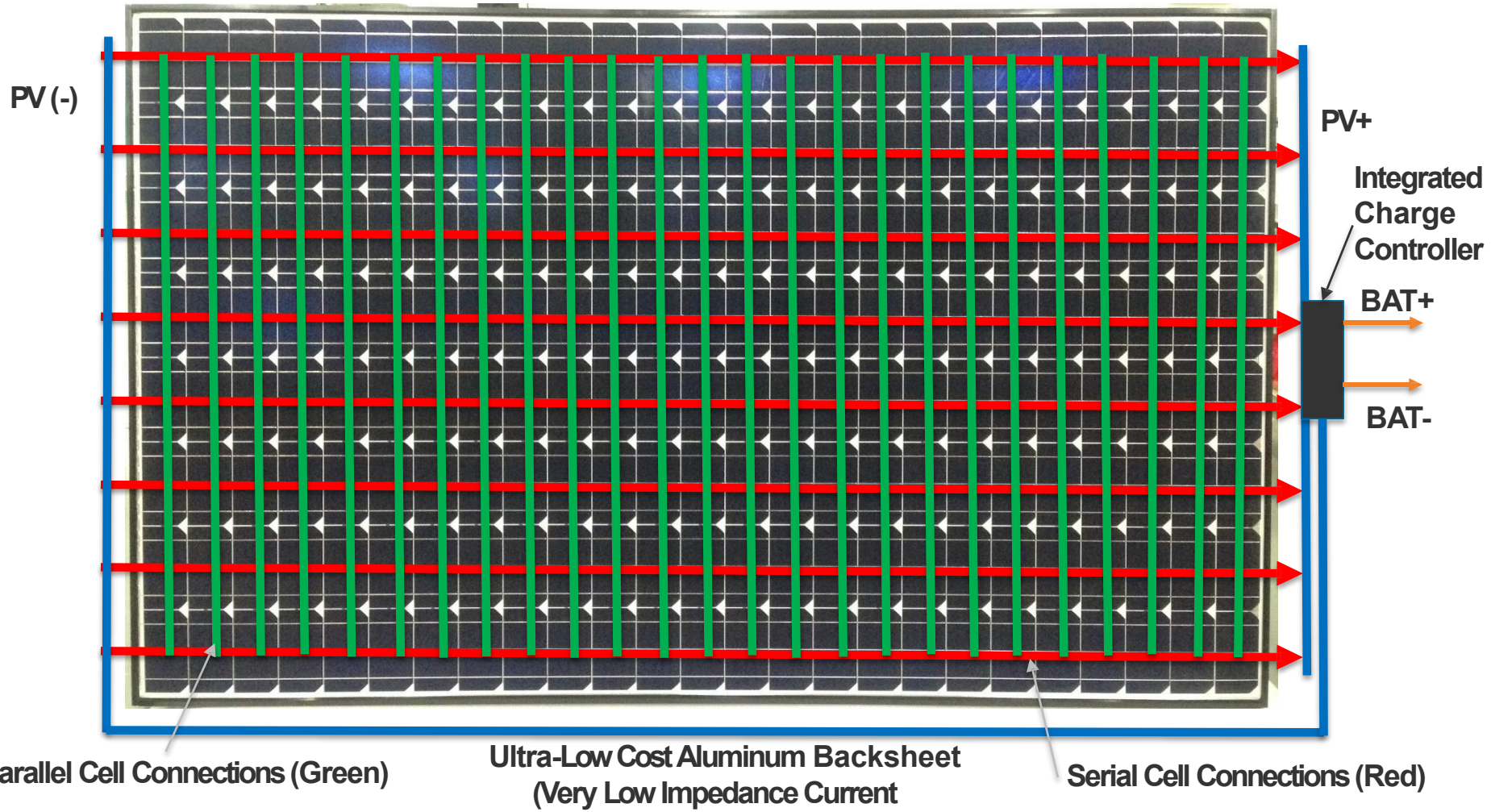


Integrated racking with co-planar frame extensions combined with our delta rail and tall peak creates a stiff structure that can pass loads deep into the array with little or no ballast required.



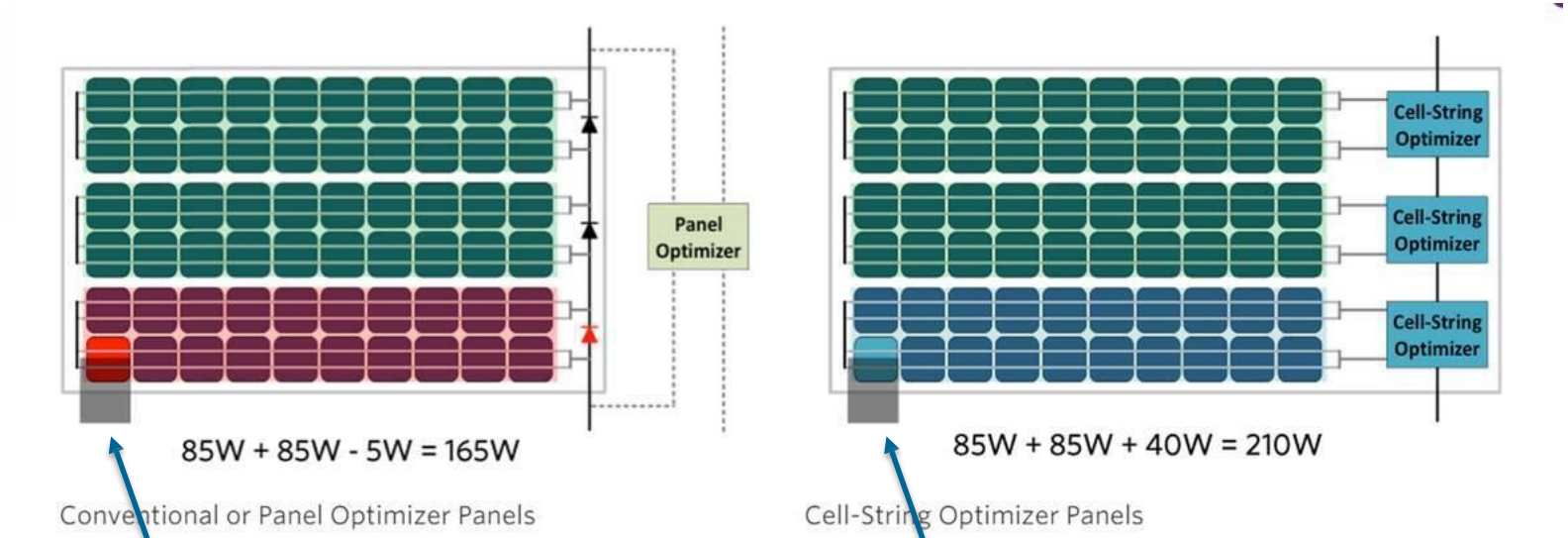
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Matrix + Al back architecture is more robust



GLOBAL RAIS
Energy & Storage Solutions

Conventional Response to Module Shading

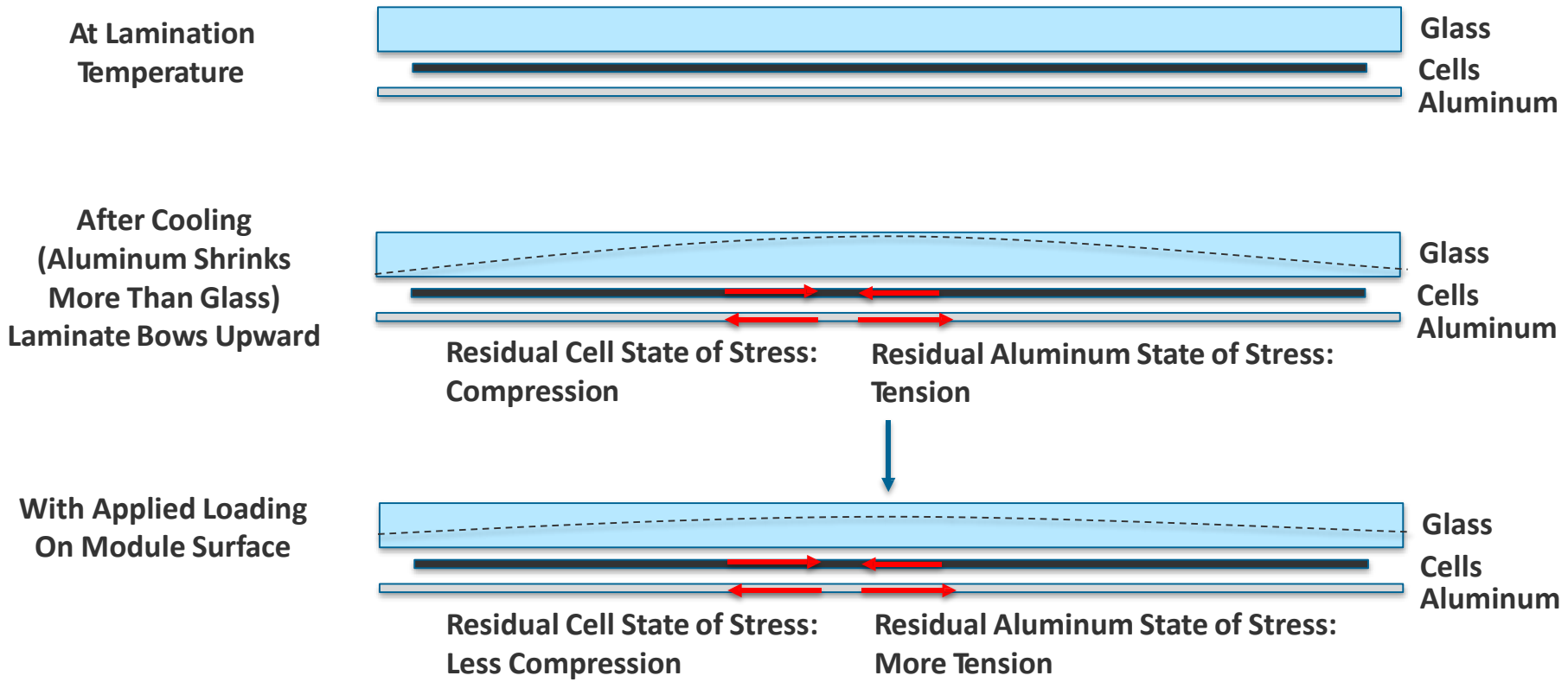


Shade 0.8% of Module, Drop 33% of the Power (Even With SolarEdge, Micro-Inverters, etc.)

Shade 0.8% of Module, Drop 16% of the Power (Using "Special" Embedded Optimizer)

Compare to tenK, Shade 0.8% of Module, Drop 1% of the Power

Illustration of Effect of Rolled-Aluminum Backsheet



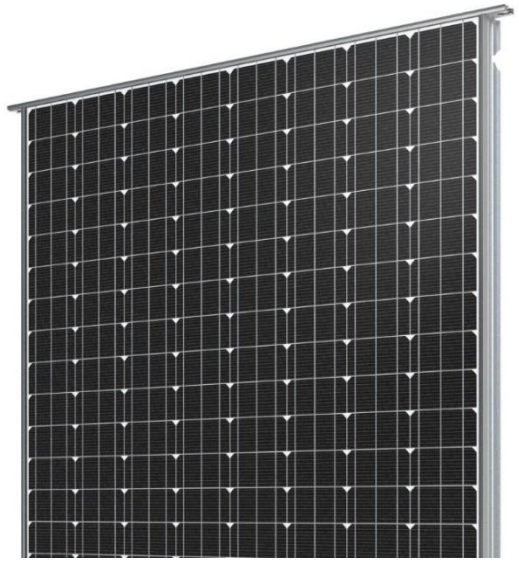
Aluminum Strength: 200 MPa Yield Strength
Plastic: <10 MPa Yield Strength

Complete System Safety

APEX Module

Type 1

UL 1703 Fire Rating



DUO PV System

Class A

UL 1703 Fire Rating



NFPA®

No

Arc Flash

No

Lethal Shock

GLOBAL RAIS™
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Low Weight and No Roof Penetrations Required



Integrated racking with co-planar frame extensions combined with our delta rail and tall peak creates a stiff structure that can pass loads deep into the array with little or no ballast required.

Global RAIS® DUO Array Structure



COMMERCIAL FLAT-ROOF

GROUND MOUNT

CARPORT

Highest Energy Density

Orientation Agnostic

Low Weight

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The Key Differences

Conventional Solar System

Standard Module



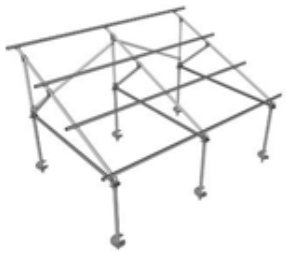
+

Inversion



+

Racking + BOS



Multiple vendors and no deliberate integration

Global RAIS® Kit

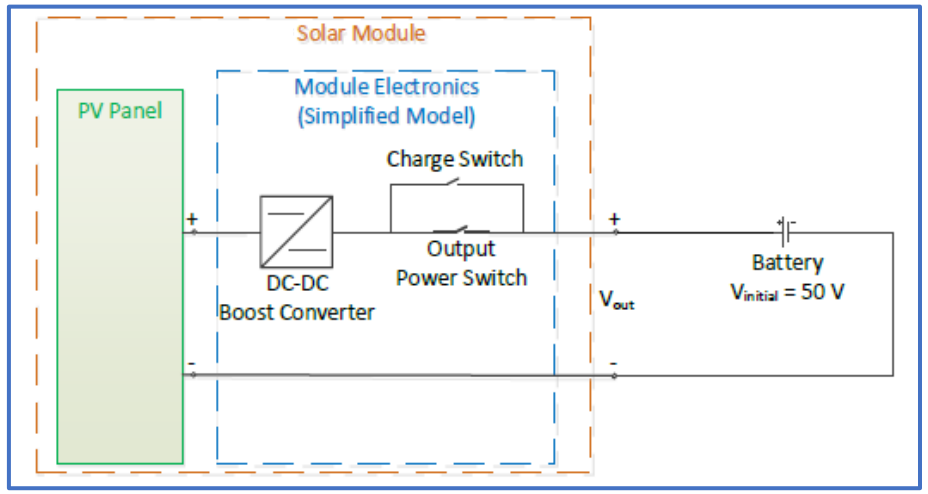
Patented Low Voltage, Smart and Resilient Modules



Storage Ready

Global RAIS® systems are DC-DC storage ready system

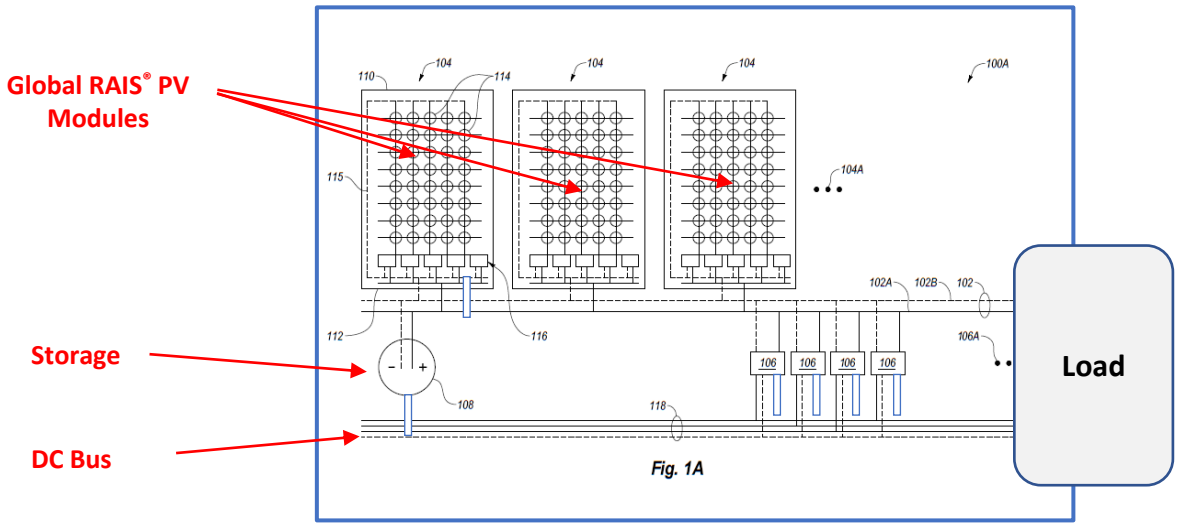
Direct DC – DC Storage, Dependable Grid Tie

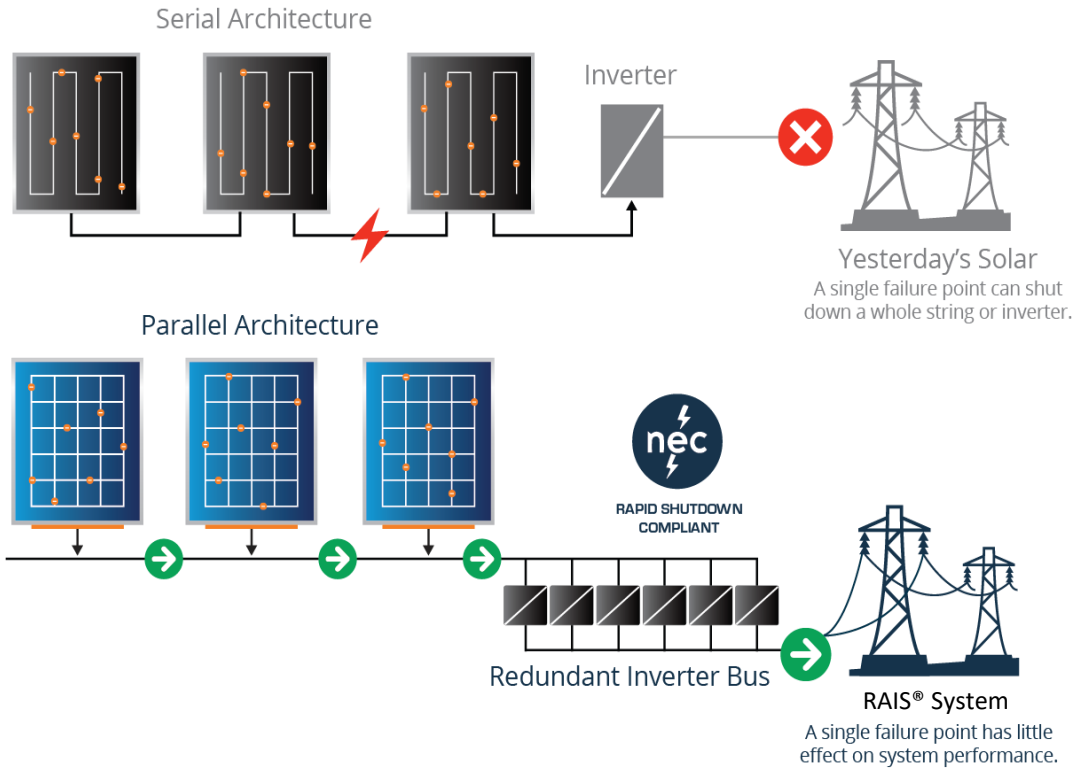


RAIS® PV modules behave similarly to current sources, operating at the line voltage.

Battery storage naturally integrates into low voltage DC array (< 60Vdc.)

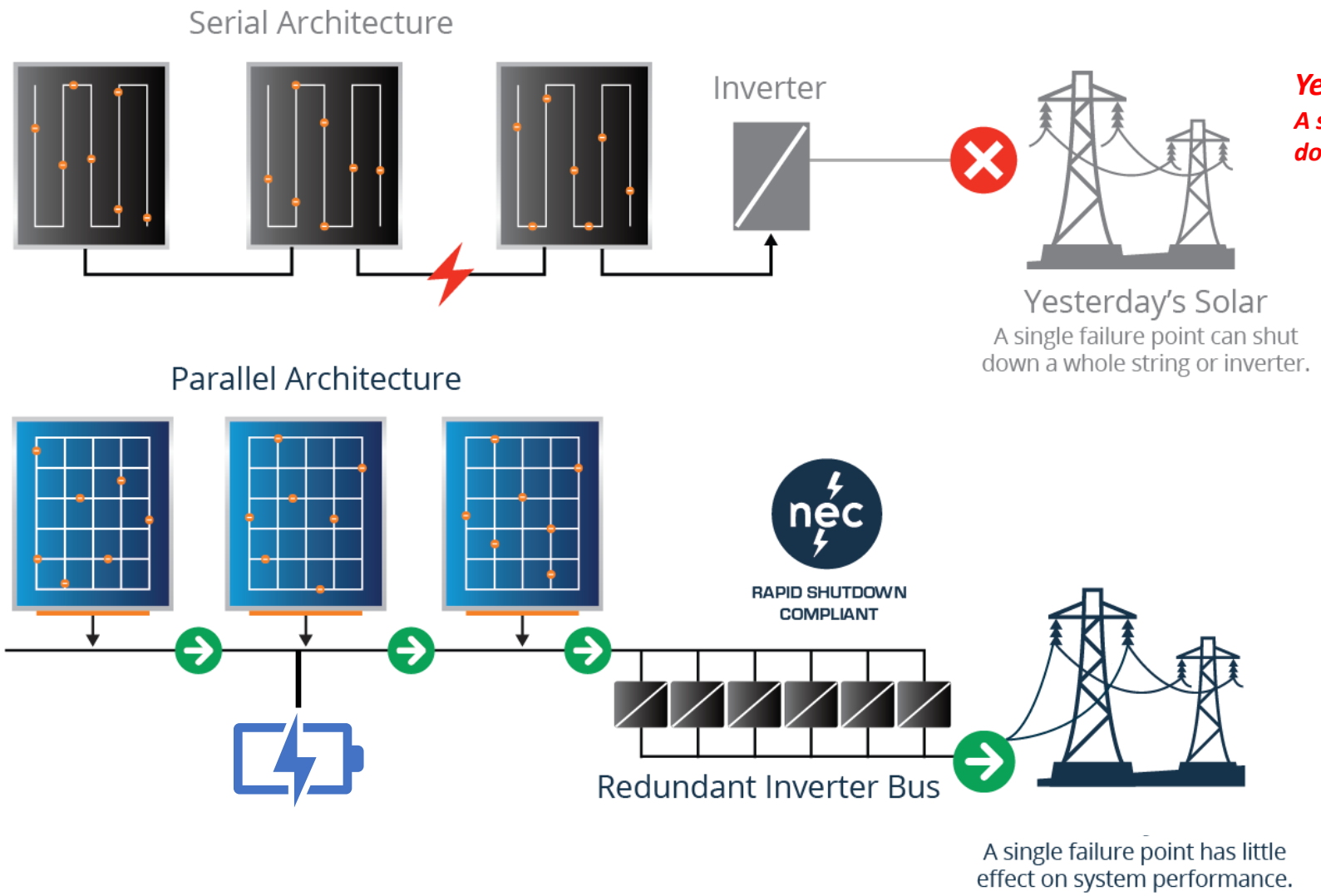
The storage device controls the line voltage as the panels deliver charging current in a preset voltage range.





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Advanced System Architecture



Yesterday's Solar

A single failure point can shut down a whole string or inverter

1000V

Global RAIS® System

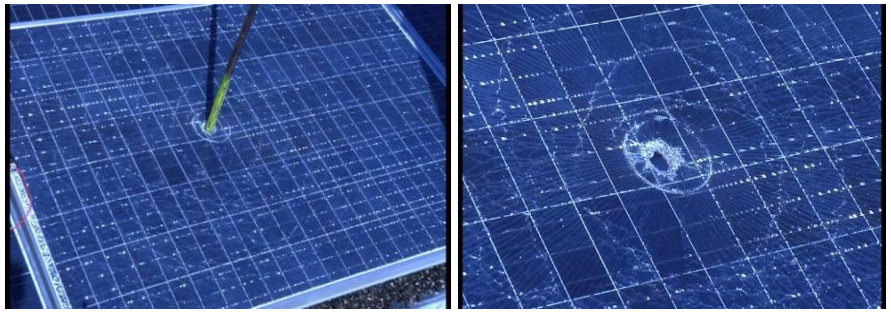
A single failure point has little effect on system performance

<60V

RAIS® Highly Resilient Module Architecture



Ballistic and Random Acts of Vandalism Comparison Test
Minimal Loss of AC System Power compared to conventional solar!

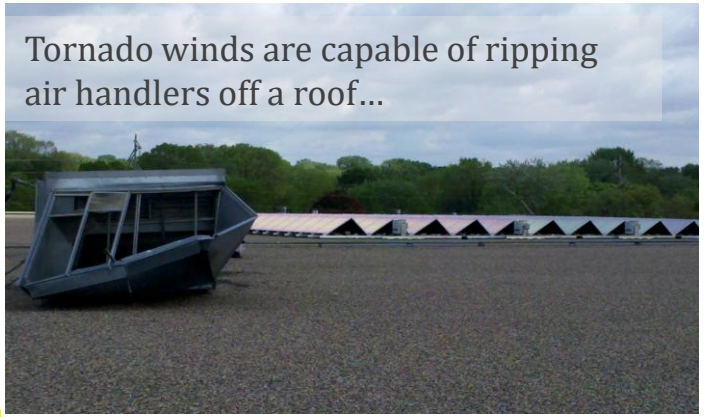


Metal Spike Piercing Through Module:
Only 1.3% Loss of AC System Power!

NFPA®

No
Arc Flash

No
Lethal Shock



Tornado Case Study
Four-Year-Old Ballasted System on a Midwest Rooftop – F-3 Tornado Direct Hit: Most Modules Shattered from gravel thrown about on the roof



Despite damage from >100mph flying roof gravel, our modules continued to make power and remain completely safe – *no high voltage arc risk!*

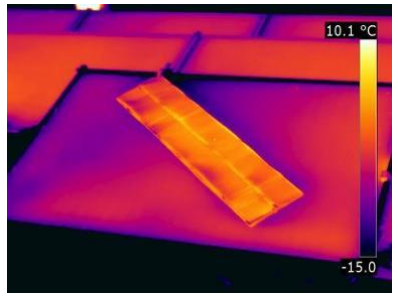
THE ARRAY STILL PRODUCED FULL AC POWER!!!

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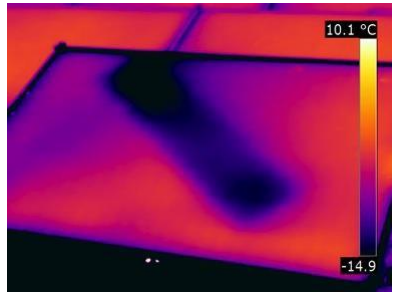
Why Parallel Connections for True Intelligence? (Allows Current to Easily Flow Around Constraints …)



Actual tenK module on roof in direct sun



Strip of cardboard applied to module
22% Area blockage, 25% Loss of power
Only 3% electrical loss w/ aggressive diagonal shade test

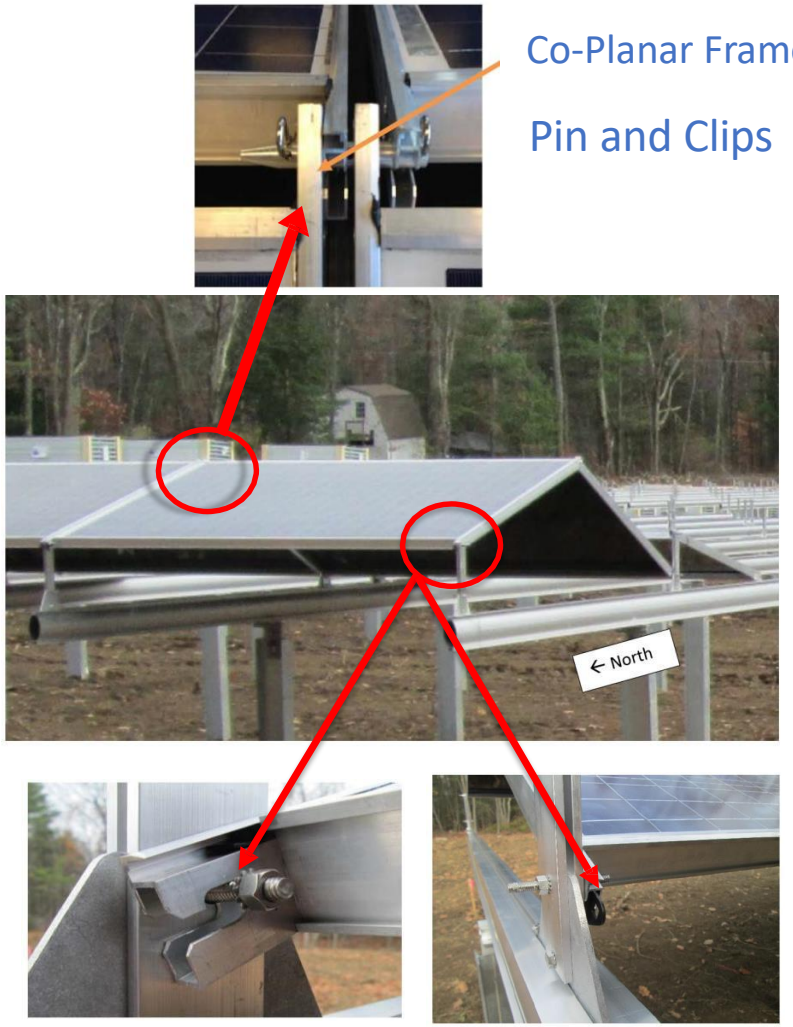


Cardboard removed, IR photo shows covered area is cool.
Energy loss is proportional to shade, no hot spot created

tenKsolar has reinvented the solar module using low-cost, off-the-shelf PV materials to achieve superior energy output and density

APEX DUO Integrated Racking

- APEX DUO modules have 3.2 mm glass and an aluminum back sheet (provides enhanced rigidity and serves as thermal heatsink)
- Unique Module Architecture using Shading Resistant Modules and Co-Planar Module Frame Extensions
- Module Directly attached to fins fitted into delta rail channel
- Simple Clip at Top to Form WAVE
- All Modules Listed as Self-Grounding



Key Patent-Protected Innovations

Protected Innovation	Patent Claim Description	Patent Status	International Coverage
Parallel-series module design with proprietary back sheet	Parallel-series topology + proprietary back sheet, integrated module-level controller	Multiple Granted (2029+)	✓
Wave geometry and racking construction	High-density self-supported wave-type racking with easy access, robust, integrated electronics	Multiple Granted (2029+)	✓
Redundant low voltage inverter bus with associated controls	Parallel connection of multiple PV modules to multiple redundant inverters via redundant low voltage bus	Multiple Granted (2032+)	✓
System integration for PV arrays in grid- connected and in microgrid applications, including BESS	Command and control of array, inverters for microgrid and grid-connected systems with simple robust controls; direct integration of storage into LV DC bus with simple control via inverters	Multiple Granted (2034+)	✓

Portfolio of 30 U.S. and foreign patents to protect differentiated technology

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Competitive Analysis

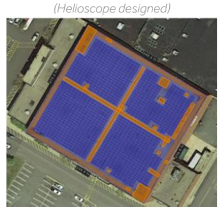
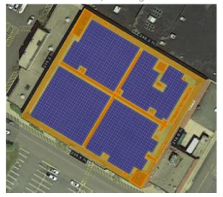
	Global RAIS®	SunPower® Maxeon USA/China	Hanwah Q-Cells South Korea Germany	Mission Solar USA
High Performance in Shaded Conditions				
Resilience to Micro-Cracks				
Direct DC-to-DC Storage Capability				
High Power Module (Increased Production with wavelets)				
Resilient, Aluminum-Backed Modules				
Completely Kitted System (w/easy install)				
Financial Resources				
Made in the USA				
Certified B-Corporation				

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Global RAIS Economic Advantages

Global RAIS Economic Advantages

GLOBAL RAIS® Energy & Storage Solutions

Conventional	Sunpower	Global Rais *DUO PV System*
400W + SE OP + 33kW Inv *(Helioscope designed)*	327W E Series *(Helioscope designed)*	500W APEX PV Module *(Global RAIS designed)*
		

Key System Details	Conventional	Sunpower Helix	Global Rais *DUO*
Year 1 kWh	426,195	682,587	702,563
20yr kWh	9,708,722	15,808,714	**16,636,691**
DC Size	453 KW	602 KW	596 KW
AC Size	301 KW	501 KW	391 KW
Module Quantity	1,134	1,842	**1,192**
Key Financial Metrics	**Conventional**	**Sunpower**	**Global Rais *DUO***
Kit Price	$0.70	$1.40	$1.35
EPC Price	$0.55	$0.49	$0.43
O&M Fee	$12/kW/yr	$11/kW/yr	$9/kW/yr
25 Year NPV	**$569,255**	**$955,790**	**$1,024,049**

Project Assumptions

Location:	Select rooftop in Northeastern United States
Space Constrained:	Maximum energy generation is desired
Degradation Rate:	Conventional- 0.5%, Sunpower- 0.4%, Global RAIS - 0.2%
Azimuth:	Conventional=210, Sunpower=121/301, Global RAIS =210/30
Financing	20 year term with 2% escalator
NPV:	7% discount rate
Utility Rate:	$0.14/kWh with 3% escalator
Ten K Solar Inclusions:	Module, Inverter, Racking, DC Balance of Systems
NEC 2020:	Value is assigned for compliance - SolarEdge 33kW + 400W Optimizers kitted with Helix product - GR meets all Rapid Shutdown requirements including NEC 2020
Additional Notes:	- Modeled energy is estimate only using identical weather file - Soiling, AC wiring and performance losses all assumed identical - All O&M numbers assume 25 year warranty coverage on inverters and electronics - EPC price includes all AC & DC labor, BOS equipment, design, permit and shipping - Inputs are project specific and based on customer input for this project

71% MORE ENERGY

Global RAIS produces nearly equivalent energy to Sunpower and produces 71% more than conventional.

+$450K

Global RAIS delivers an additional $450K of economic value vs. Conventional and beats Sunpower Helix on all.

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Conventional PV Project Comparison

GLOBAL RAIS® Energy & Storage Solutions

77 Rio Robles
San Jose, CA





	Conventional PV 400W Trina Module at 5°	Global RAIS DUO 500W APEX Module
DC Size	418 kW[1]	451 kW[2]
AC Size	336 kW	289 kW
Number of Modules	1,045	904 Modules
25 Year Production	11,818 MWh	15,511 MWh
Average Production Per ft²	87 kWh[3]	114 kWh[3]
Warranted Degradation	0.5%	0.2%[4]
25 Year Warranted Power	85.0%	92.2%
Standard Inversion Warranty	12-25 Years	25 Years
Shade Tolerance	String Level	Cell Level[5]
2020 Rapid Shutdown	with Additional DC Optimizer	Integrated
DC System Voltage	1,000V	60V[6]
Ballast Location	Distributed Throughout Array	Perimeter of Array[7]

[1] Conventional Trina System Performance Modeled with Helioscope™
[2] Global RAIS DUO System Modeled with NREL SAM/PVComplete™
[3] Average kWh/ft² based on 25 year output from 13,628 ft² rooftop
[4] Global RAIS Limited Warranty Terms v1.1 – globalrais.com/support/warranty
[5] Global RAIS Redundant Low Voltage Topology - globalrais.com/whitepapers/redundant-topology
[6] Global RAIS Integrated Module Electronics - globalrais.com/benefits/moduleelectronics
[7] Global RAIS Ballast Requirements - System Design Guide - globalrais.com/design/designguide

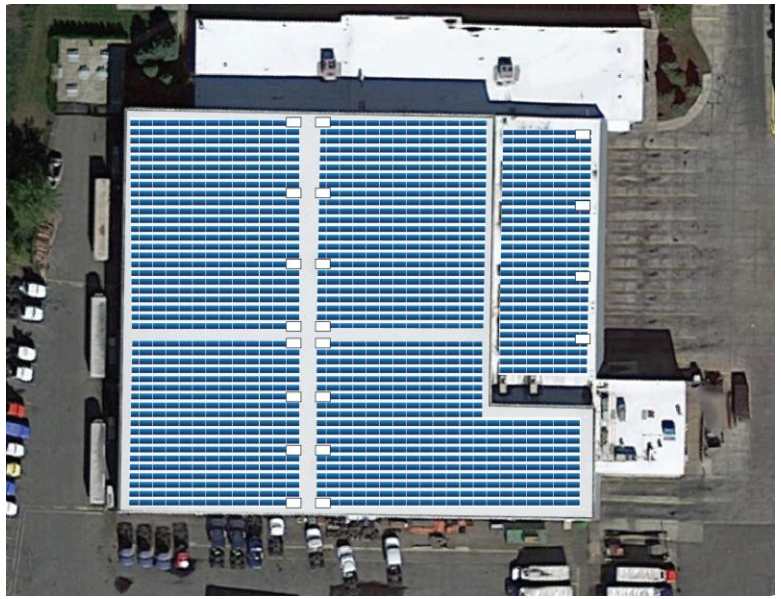
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Energy Density Advantage

Conventional 400 W *@10° South*

419 kW DC

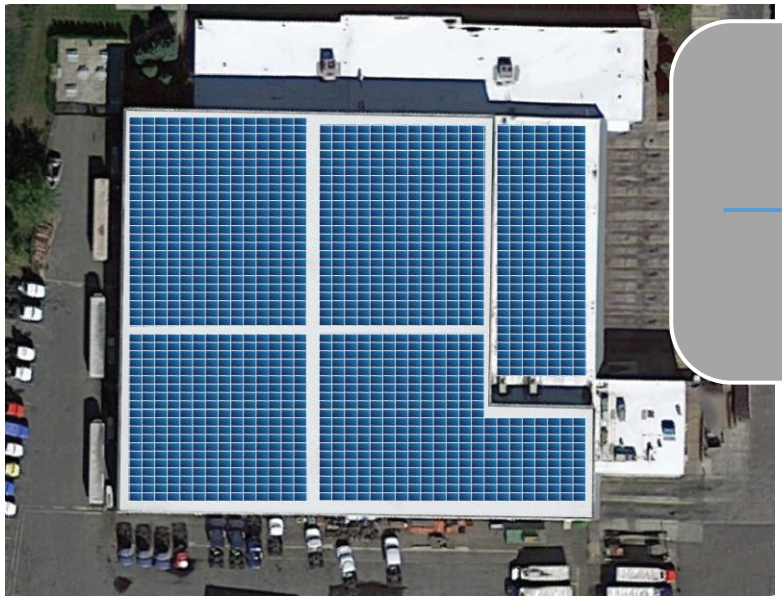
549,600 kW hrs



GR APEX *DUO 500 W*

790 kW DC

905,588 kW hrs



64%

MORE ENERGY

MORE ENERGY TODAY AND MORE ENERGY OVER TIME

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