



Scalable Adaptable Solar Charging for Every Warfighter

NDIA Power Sources Committee Meeting

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Rick Schilke | Chief, U.S. Government Operations

rschilke@nishati-us.com, 01-571-999-3482

www.nishati-us.com

Nishati is Energy

- **Founded:** March 2014 in Colorado (SDB/WOSB)
- **U.S. HQ:** McLean, Virginia
- **Vision:** To improve lives and increase mission effectiveness for customers who live or operate beyond the reach of the electrical grid, where dependency on fossil fuel generators is unreliable or expensive, and in situations where grids fail.
- **Mission:** Manufacture, tailor and sell high performance photovoltaic solar modules, compact rugged solar racking systems that require no assembly, and complete solar energy systems for portable, semi-permanent, and fixed applications.



Fielded Innovations

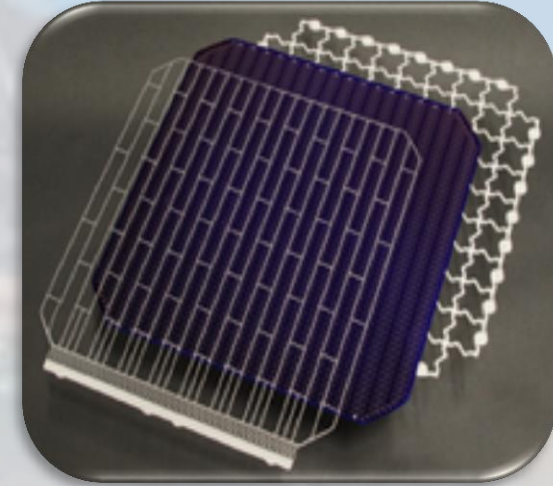
- Glass-free, High Efficiency Tri-Fold Solar Panels
- Lightweight Composite Roll-able Stand
- Rugged, Mil-Std rated solar panels, solar arrays, solar power systems
- Low Packaging Volume & High Power Density
 - Complete system in one rifle-size transport case
 - Can be taken as checked baggage on airlines



Mono-crystalline Silicon PV Cost & Performance in Thin-film-like Packaging

Introducing New Technology: Merlin[™] Interconnect

- 5X increase in tolerance to micro-cracking
- 10X improved Flex tolerance
- 100X increase in Fatigue resistance
- 3.5 - 5% more power output
= improved lifetime energy yield



- Superior thermal & electrical performance – Unique design results in lower electrical resistance, significantly improved fatigue life and inherent redundancy
- Mechanically robust – Solar cell sandwiched between two mechanically reinforcing grids; allows more flex than traditional c-Si cells
 - Passes stringent industry tests for dynamic loads and thermal cycling
- Reduced reflectivity/cell shading – Less metallization material on cell surface
- Increased internal reflection – Grid enhances light trapping geometry

Product Lines

Endurance

Portable Glass-free &
Tier 1 Glass Panels



Expedition

Integrated Portable Panel &
Assembly-free Rack Systems



Outpost

Family of Complete
Solar/Hybrid Systems



The Burden of Individual Battlefield Power

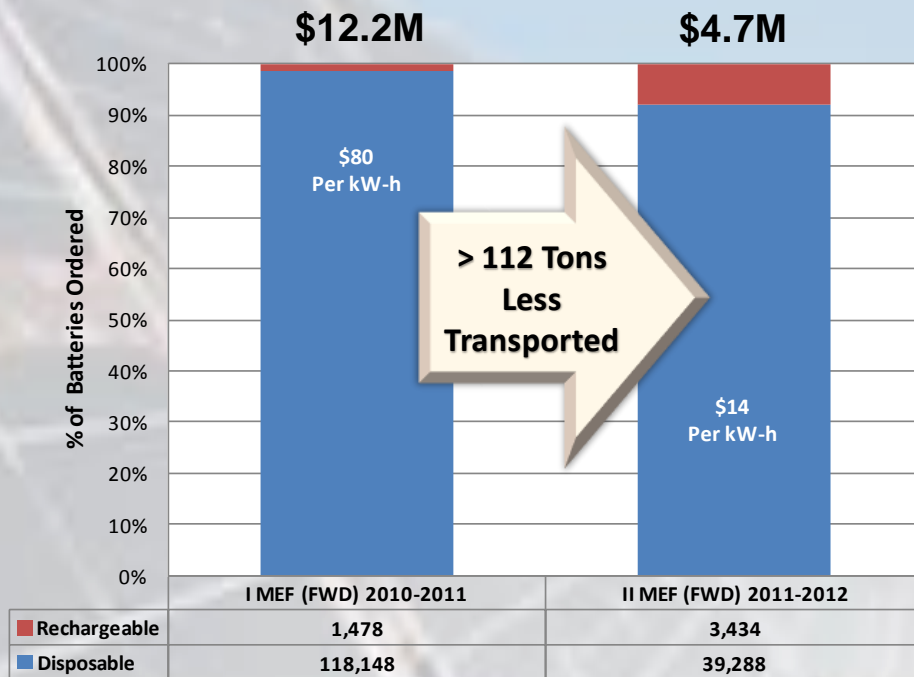
- Dramatic growth of battery/energy-intensive capabilities borne by the individual warfighter over the past 15 years = increased carried load and dependency on batteries for critical capabilities
- Overburden growth is anticipated to continue due to info-enabled operations



Source: A. Wahlman et al., Institute for Defense Analyses report: *An Assessment of the Challenges Associated with Individual Battlefield Power: Addressing the Power Budget Burdens of the Warfighter and Squad*, May 2014, 6.

Empowering Individuals to Manage Energy Through Re-chargeables

- **~2008-2013:** Recharging enablers rapidly increase on the battlefield; Individual warfighter power solutions in R&D
 - **2010:** First time majority of Army batteries purchased were rechargeable¹
- **2012:** USMC assessment of battery use trends in OEF found an apparent shift toward rechargeable batteries having a notable logistical and fiscal impact
- **2014:** Army analysis indicated that the Small Unit Power (SUP) initiative would save the Army \$1.49 billion in batteries over 20 years¹



Source: R. Schilke, *USMC Disposable / Rechargeable Utility Battery Use Trends in OEF*, United States Marine Corps Expeditionary Energy Office, March 28, 2012, 8.

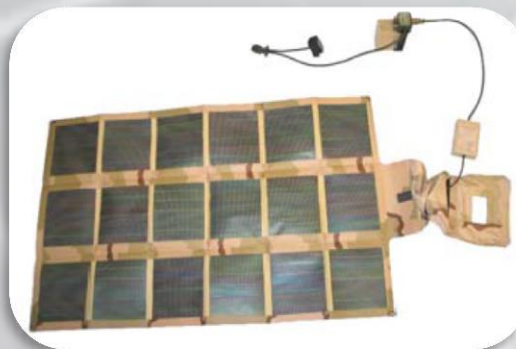
Rechargeables “complete the loop” and Require Active Energy Management

¹A. Wahlman et al., Institute for Defense Analyses report: *An Assessment of the Challenges Associated with Individual Battlefield Power: Addressing the Power Budget Burdens of the Warfighter and Squad*, May 2014, 6.

1st Gen Small Unit Solar Charging Lessons & Challenges

- Low module efficiency in real environment/deployed solar conditions
- Very sensitive to clouds/diffuse light and shading (power plummets to 0W)
- Difficult to employ at optimum angles and off the ground
 - Reduced harvest and heat-induced efficiency decrease
- Too bulky, heavy to be considered individual or dismounted warfighter system
- Separate components in basic system require cables
- Multiple components to make up a complete system must be spread loaded across multiple warfighters

Army REPPS



USMC SPACES



Endurance[™] 25 Multi-Voltage Solar Charging System*



- 25W+ Solar Charging for individual warfighters
- Glass-free, tri-fold design with Merlin Interconnect
- Man-packable / team- or squad-scalable
- Mono-crystalline silicon photovoltaic PV cells
- Multi-mode output with programmable electronics built in

- **Dimensions (LxWxD):**

- Folded Config.: 13.7" x 7.25" x 0.97" (panel + electronics)
- Deployed Config.: 22.0" x 13.7" x 0.72" (panel + electronics)

- **Weight: 1.9 lbs.**

- **Power:**

- Maximum System Voltage is 30V
- SAE 2-pin cable: 12.6-14.7VDC (Std Mode); 15-16.8V (VPM-402 Mode)
- 0-5A (Std Mode); 0.35-1.75A (VPM-402 Boost Mode)
- USB: 4.2 – 5.6VDC; 0 – 2.5A
- System Efficiency: 18.4-20.5% (mc-Si / mc-Si PERC PV cells)



ROI and Value Proposition

ROI

- Enhanced capability / combat effectiveness
- Individual, team, squad level requirements addressed in one system
- Mitigates tactical and replacement cost risk of current squad-level solar solutions

Value

- **Effective**- 18.4% module efficiency (***) maximizes solar harvest; enhanced performance in non-ideal solar conditions
- **Scalable**- Use alone or gang systems for more power; distributes warfighter load; provides tactical dispersion; reduces cost risk
- **Flexible and Adaptable**- Multiple voltage output options and programmable electronics allow tailoring to applications
- **Ruggedized**- Designed for Mil-Std 810G durability
- **Weatherproof**- IP 67
- **Compact**- <2 lbs; fits in or on and assault pack



***PERC cell upgrade available for 1.5-2% efficiency increase

Side by Side Comparison Rifle Squad BB-2590 Charging



1 per squad

1 per warfighter



SPACES		Endurance 25
124	Squad solar power (Watts)	351 (108W per fire team)
0	Individual solar power (Watts)	27
~0.5	BB-2590 charge capacity (batteries/hr)	~1.3
1	Simultaneous BB-2590 charging	3
Up to 2	Simultaneous power tasks	Up to 13
1.6	Avg weight per squad-member (lbs)	1.9 (2.1 lbs. w/external controller)
~\$4,223	Replacement Cost per system	~\$400
2	# of cables	No external cables; 1 paralleling adapter per 4 systems

Enhancing Individual through Squad Capabilities

Endurance 25

Development Status

- **Stage: Ready to Market**
- **TRL: 7-8**
- **Target users:**
 - Military (every warfighter + small remote sensors/comms)
 - Commercial (consumer electronics users)
- **DOD Interest**
 - Joint Infantry Company-Prototype – evaluation ongoing
 - USMC Infantry Equipping Challenge 2017 – selected participant
- **Manufacturing:**
 - U.S. and overseas manufacturing alternatives in place
- **Financing: Developed through v1.1 with Nishati internal R&D funds**
 - Relatively small DoD investment could have asymmetric impact

Opportunities to Develop/Enhance Endurance 25 for Military Use

- SMBus device/power manager compatibility
- SMBus battery direct charging interface
- Smart battery recognition and charging optimization
- Field programmability / user selectivity for power output parameters
- Camouflage cells / panel surface
- New device interfaces



QUESTIONS?