Nishati™

Portable Rugged Effective Solar Power

Smart Energy Harvesting for Every Warfighter

Joint Service Power Expo 2017

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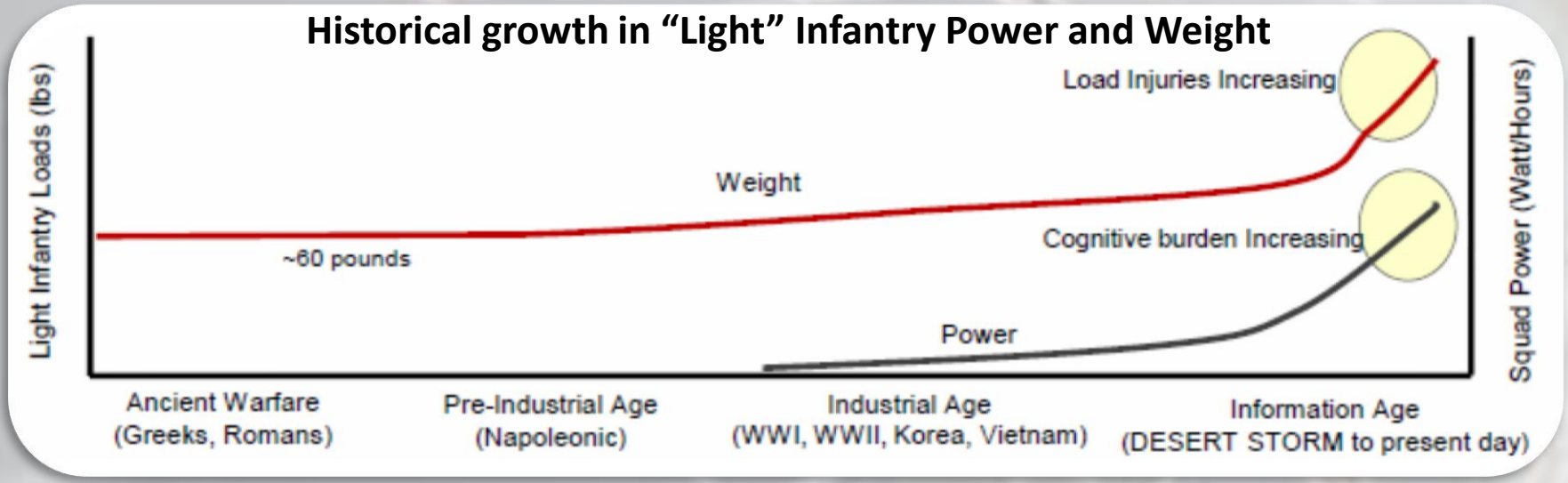
New Technology Increasing Power Needs for Individual Warfighters

- **Modern technology is enabling highly dispersed and lethal forces**
  - Enhanced individual optics, communications, surveillance and network-enabled capabilities are increasing battlefield awareness and operational autonomy
- **Digital voice, data, video communications capabilities proliferating**
  - From theater C2 down to the individual warfighter
  - Exponential increase in number and type of battery-operated and backed-up devices
  - Android-based devices beginning to field
- **Premium on reliable access to power for individuals and small units**

Tactical Power Demands Burden the Individual Warfighter

- **Dramatic growth of battery/energy-intensive capabilities over the past 15 years**
  - Battery-dependency for critical capabilities requires "energy reserve" to be carried
  - Device / hardware management potentially increases task-loading
- **Overburden growth is anticipated to continue due to trends in sensor and information technology-enabled capabilities and 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.

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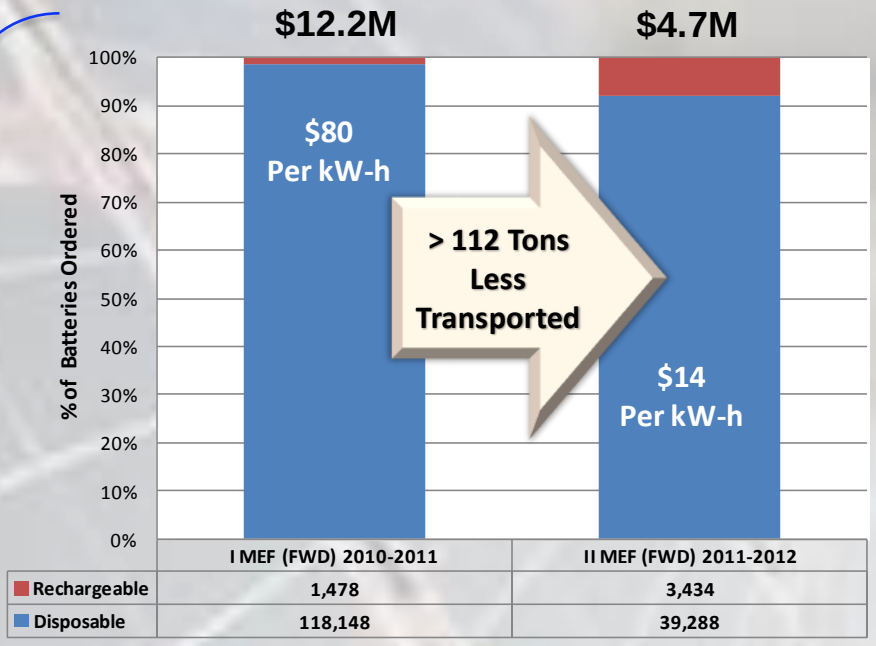
Fiscal and Logistical Benefits of Re-chargeable Battery Capabilities

- **~2008-2013: Re-charging devices rapidly increase on the battlefield; Dismounted warfighter SoS power solutions in R&D**
  - **2010**: First time majority of Army batteries purchased were rechargeable[1]
- **2012: The Marine Corps found an apparent increase in rechargeable battery use in Afghanistan having a notable logistical & fiscal impact**
- **2014: Army analysis indicated that the Small Unit Power initiative would save the Army $1.49 billion in batteries over 20 years[2]**



	I MEF (FWD) 2010-2011	II MEF (FWD) 2011-2012
Rechargeable	1,478	3,434
Disposable	118,148	39,288

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

Growth in Recharging Capabilities Driven by Small Unit Energy Demands

[1] 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, 7.
[2] Ibid, 13.

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Empowering Individuals and Small Units

- Value of solar recharging demonstrated by 1st generation portable solar systems
- Individual warfighters and small units empowered to manage energy as they do other precious commodities such as ammunition
- Increased supply "autonomy" enhances operational capabilities


Photo by: U.S. Army CERDEC


Photo by: R.A. Schilke

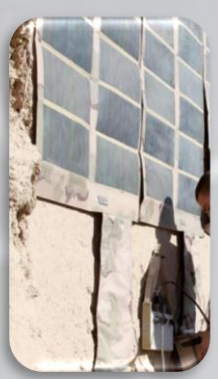


Photo by: GySgt William Price

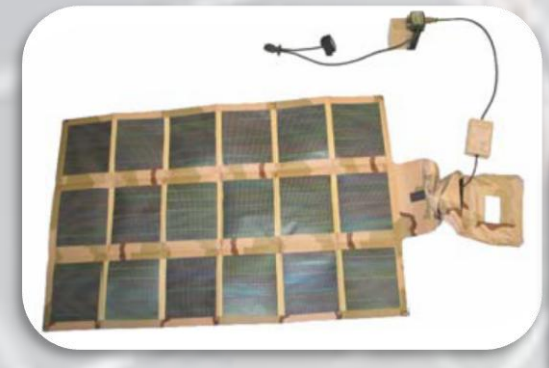

Photo by: schapman

Completing the Energy Loop for Small Units and Individual Warfighters

1st Gen Dismount/Small Unit Solar Charging Lessons & Challenges

- **Flexible solar panels employing thin-film amorphous silicon (a-Si) and Copper Indium Gallium Selenide (CIGS) photovoltaic (PV) solar cell chemistries initially fielded**
- **Low module (panel + electronics) efficiency in deployed solar conditions / scenarios:**
  - Very sensitive to clouds / diffuse and low-angle light, and shading -> power plummets
  - Difficult to employ at optimum angles and off the ground
  - Reduced harvest and heat-induced efficiency decrease
  - Large solar format reduces ability to harvest small areas of available light inside structures or within vegetation without shading-induced shutdowns
- **Multiple components in basic system**
  - Requires costly additional cables
  - More “pieces” & weight to manage
- **Bulk and weight**
  - Drives capability to be fragmented across multiple warfighters during maneuver / foot movement

Army REPPS



USMC SPACES

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Imperatives for a "Smart"-er Approach

Next Gen Small Unit Solar Harvesting

1) **Lightweight, compact, rugged, weatherproof, and low visibility**
   - *<2 lb with electronics & connections*
   - *Fits in or on an assault pack*
   - *Designed for Mil-Std 810G durability*
   - *IP67 dust-/water-proof*
   - *Mono-crystalline cells reinforced by state of the art gridded interconnect metallization*
   - *Glass-free, very low reflectivity (< 4% at 80^{o} angle of incidence)*

Leveraging State of the Art Advances in Portable, Rugged Solar

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Imperatives for a "Smart"-er Approach

Next Gen Small Unit Solar Harvesting

2) Improve power production & reliability

- *18.4% to >20%* module efficiency*
- *25W scalable to over 100W*
- *Solar cells/interconnects optimized for thermal/mechanical/electrical robustness*

3) Improve resilience to expeditionary environment & employment constraints

- *Size permits harvesting small areas of available light*
- *Performs in diffuse and low angle light*
- *Loss of one system doesn't negate the capability*
- *Loop and toggle system aids easy off-ground deployment*
- *Semi-rigidity permits tilt angle deployment*

Improved Performance and Expeditionary Resilience

*mc-Si PERC cell upgrade

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Imperatives for a "Smart"-er Approach

Next Gen Small Unit Solar Harvesting

4) **Maximize use cases & interoperability across applications**
   - *Stand-alone device or central-battery charger - provides each warfighter a charging capability*
   - *Gang multiple panels for more power/ faster charge*
   - *Multiple voltage outputs – including USB*
   - *Built-in programmable electronics for application tailoring*

Dismounted Warfighter and Remote C4ISR Energy Harvesting with One System

Imperatives for a "Smart"-er Approach

Next Gen Small Unit Solar Harvesting

5) Simplify device/configuration management

- *Compact, efficient integrated electronics and cables means fewer pieces in the basic kit*
- *Benefits the warfighter and the program manager*

6) Control procurement & sustainment costs

- *Use mainstream solar industry mono-crystalline silicon photovoltaic cells*
- *Reduced total procurement cost / Watt*
- *~70% cost reduction over current capability*

Dismounted Warfighter and Remote C4ISR Energy Harvesting with One System

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Illustrating a "Smart"-er Energy Harvesting Solution

1 per squad

1 solar system per warfighter

SPACES		Nishati Endurance 25
124	Rifle squad solar power (Watts)	325 (100W per fire team)
0	Individual solar power (Watts)	25
~0.5	BB-2590 charge capacity (batteries/hr)	~1.3
1	Simultaneous BB-2590 charging	3
Up to 2	Simultaneous squad power tasks	Up to 13
Panels: 3.0 ea / Controller: 2.6	Weight (lbs.)	1.9 (2.1 w/external controller) per person
~$4,223	Replacement Cost per system	~$400
2	# of cables	No external cables; 1 paralleling adapter per 4 systems

Enhancing Individual and Squad Power Capabilities

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Opportunities to Evolve the Smart Solar Harvesting Concept

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





Expanding the Art of the Possible

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Nishati is Energy

- **Founded**: March 2014 in Colorado (Woman-owned/Small Disadvantaged Business)
- **Headquarters**: 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.

Increasing Mission Effectiveness by Reducing Warfighter Power Burden