US ARMY CERDEC Fuel Cell Technology

Micro Nano Breakthrough Conference
July 28, 2004
Portland, OR

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Chief, Environmental Systems and Fuel Cell Branch
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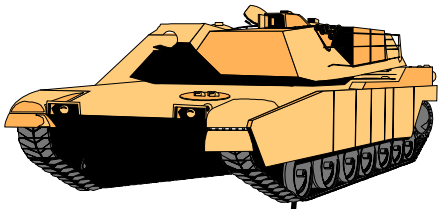
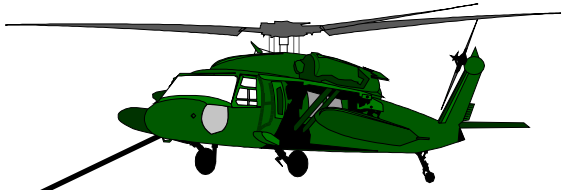
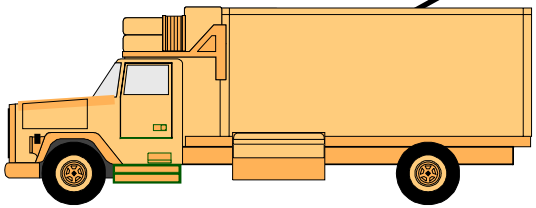
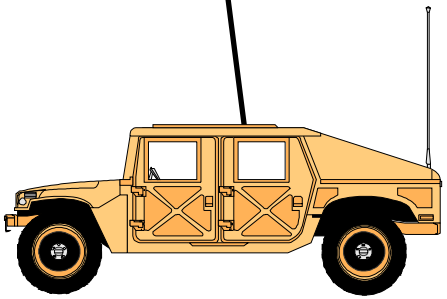
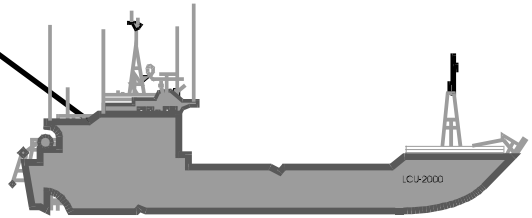
Military Needs in Power & Environmental Control











THE AMERICAN WARFIGHTER: ARMY'S #1 CUSTOMER

Copyright: Time Magazine, December 2003

The ARMY'S R&D programs are focused on developing critical, cutting edged equipment for the **AMERICAN WARFIGHTERS** so that they can accomplish their Mission quickly and effectively and return home safe.

The AMERICAN WARFIGHTERS are our BOTTOM LINE.

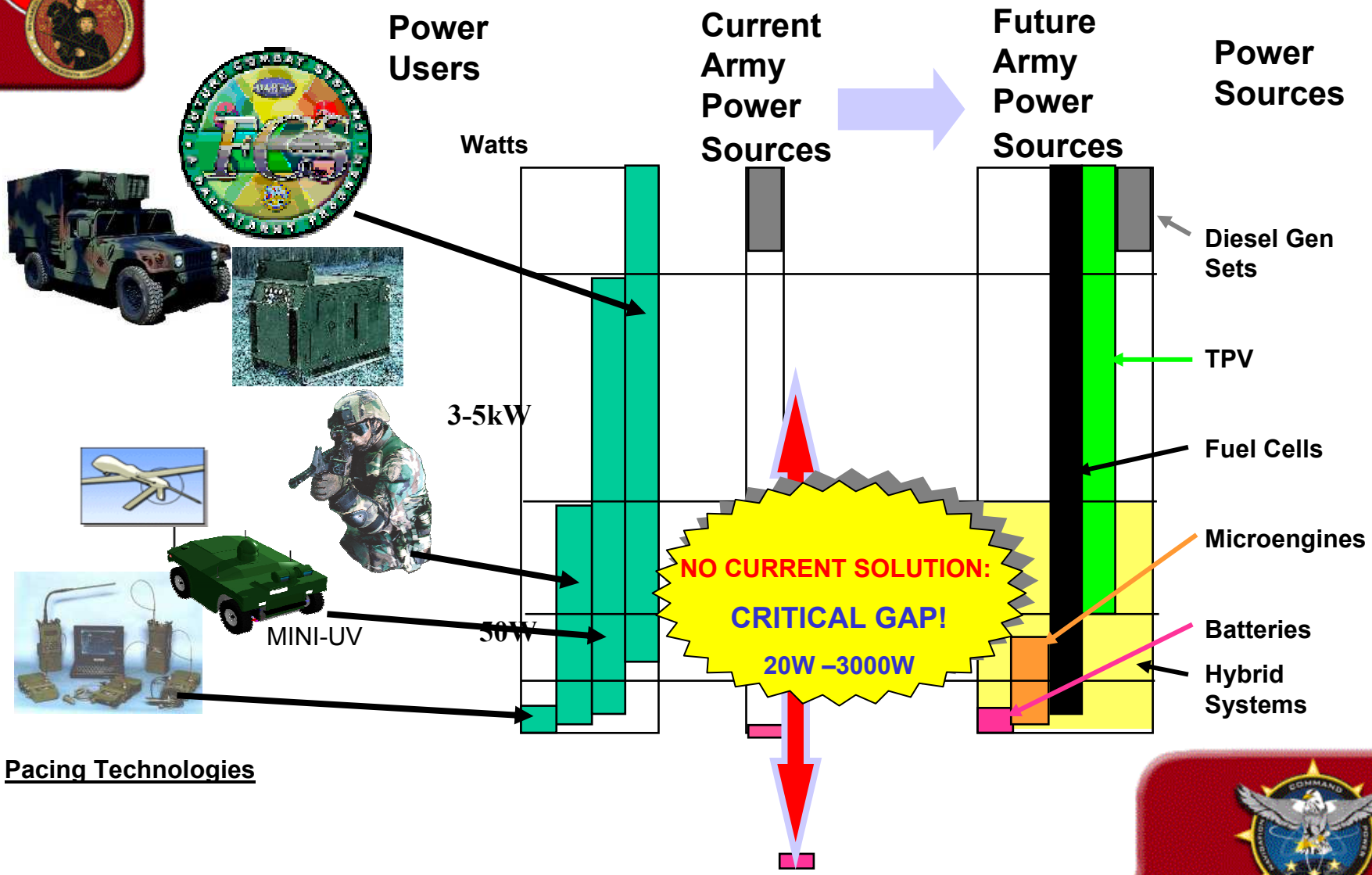
American Warfighters

For our American Warfighters

This is more than just a cartoon.

"We had extreme difficulty moving with all our weight. If our movement would have been to relieve a unit in contact or a time sensitive mission we would not have been able to move in a timely manner. It took us 8 hours to move 5 clicks. [that's less than 1 mph]"

Military Power Sources



Pacing Technologies

RDECOM

CER-11 Future Force Power

Status: Proposed New FY05

1. What is the problem?
Current power sources for the warfighter impose a huge logistics and cost burden and limit full application of C4ISR due to power & energy shortages. No integration of power and energy across the battlefield.

2. What are the barriers to solving this problem?
a. Small power sources are limited by commercially available scaling, system integration, and maturity of JP-8 external combustion
a. Ability to use waste heat limited by size of cooling components
b. Power management applied as "add-on", too late in design cycle
c. Lack of system integration, long recharge times limit hybrid use

3. How will you overcome those barriers?
a. Develop log fuel burners with high turn-down ratios for heat engines & innovative microchannel technology for small heat-driven cooling systems.
b. Power management applied at chip level and early in system design.
c. Integrate development of hi-risk meso components in hybrid fuel cell; improve battery materials and internal geometries for fast recharge

4. What is the capability you are developing and where is it described? This STO will produce critical battlefield power technologies for essential C4ISR equipment required by the Future Force. Power in this STO spans both mobile and soldier applications, and will lead to higher energy, lighter-weight, quieter fuel and cost efficient power sources, battery chargers, and power source management systems. FOCs supported: 11-04, FOC 11-01, & 11-07

5. What is the product of this STO? (Include M&S)
a. Quiet power sources,field chargers, Co-gen power & cooling b. Power management integrated into low power mission electronics [and TOC power distribution system]
c. Soldier hybrid systems, improved rechargeable batteries

6. Quantitative Metrics	Current	Program Obj. (TRL)	ORD Obj. (TRL)
a. Manportable field charger wt (kg)	none	<10 (6)	
a. 1-2kW noise @ 7 meters (dBA)	72	69 (6)	69 (6)
a. 5kW export + 18kBTUH cooling Fuel consumption (gal/hr)	1.0	0.5 (6)	0.5 (6)
b. Very low power soldier electronics		50% W (6)	
c. Soldier energy Wt lbs (72 hrs)	12	4 (6)	2 (6)

7. What is the Warfighter Payoff?: Increases Soldier mobility, sustainability, survivability and deployability by greatly reducing primary batteries/energy requirements. Provides significant fuel savings by reducing fuel required for power sources. Reduced signature and increased power/energy adds mission capability.

8. Transition Milestones: a. Quiet JP-8 fueled 1-2kW to PM-MEP STEP program in 08 a. Field chargers to LW Block III SDD in 06 a. Transition co-gen cooling-power to PM-MEP in 08 [b. TOC power management to PM-TOC 07] b. Power management software/methodologies to PSWAR 08
c. Transition Soldier hybrid power source to FFW ATD in 06, improved rechargeables to PM-SWAR in 07

9. Endorsements: CSSBL, 5/6/04, COL M. Ivy; FFW TPM, 5/17/04, Peter Wallace; PM-MEP, 4/29/04, James Cross; Pending DBBL, PEO-Soldier

10. Other STO Attributes:
- *Transition path for $50M DARPA Palm Power beginning in FY05*
- *Modeling and Simulation-Using existing mechanical/chemical design tool developed at Univ. of South Carolina to refine hybrid system*
- *Technology Protection Plan: Submitted 8 Apr 04*
- *International Program: Supports pending Project Arrangement under IEA-UK-A-A-98-1575*
- *Affordability Metrics*
  - *Energy cost for 72 hours is currently $1800 per soldier; hybrid system will reduce this to $30 per soldier*
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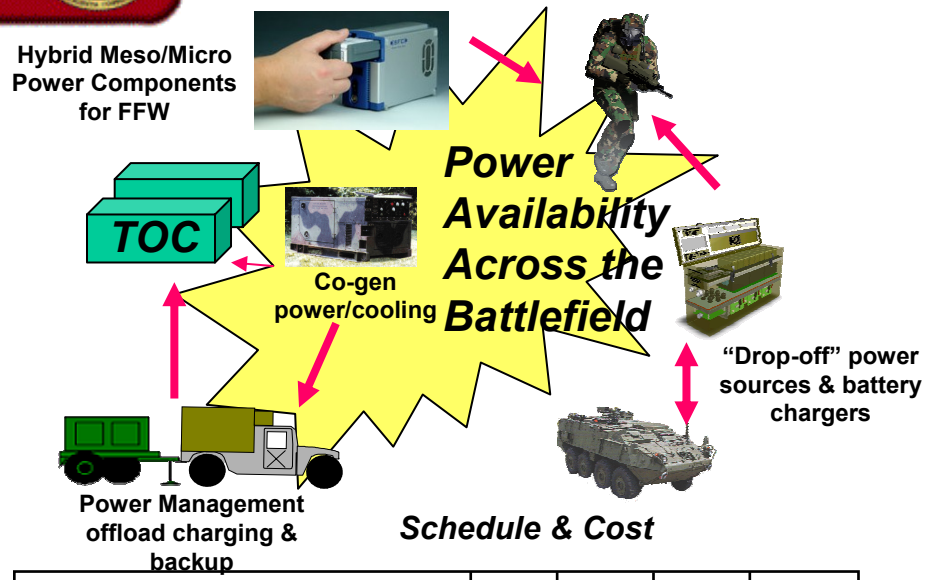
CER-11/Future Force Power



Purpose:

Develop component technologies into power systems providing

- *Dismounted soldiers increased mission duration and decreased logistics burden*
- *Optimized power for C4ISR equipment of Future Force mobile platforms*

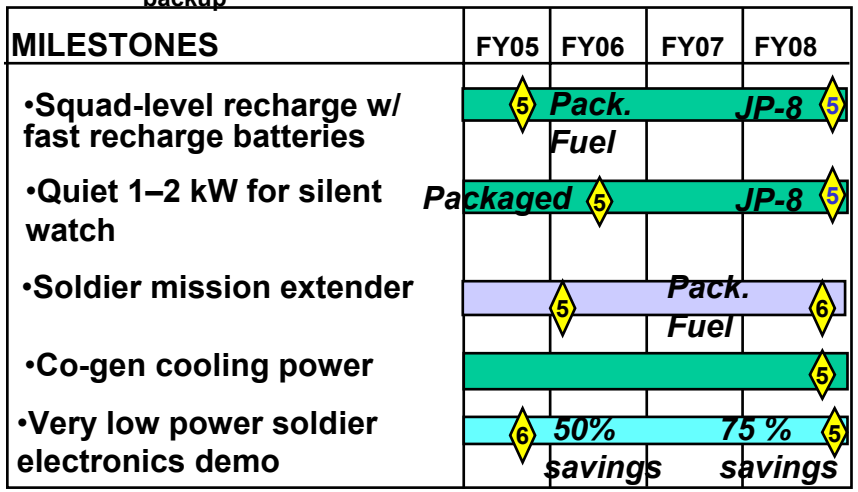
Products:

- ***Quiet log fuel 1-2kW to PM-MEP STEP program 08***
- ***Field chargers/batteries to LW Block III SDD in 06***
- ***Co-gen cooling-power to PM-MEP in 08***
- *Improved rechargeable batteries to PM-SWAR in 07, Power management software and methodologies in 08*
- ***Soldier hybrid power source to FFW ATD in 06***

Payoff:

- *Enhanced lethality and survivability through increased power/energy and reduced signature*
- *Enhanced mobility, sustainability, survivability and deployability by greatly reducing primary batteries/soldier energy resupply and C4ISR shelter support fuel consumption*
- *Specific Transitions plans*
  - *To FFW ATD in FY06*
  - *To PEO Soldier LW Block III in FY06 SDD*
  - *To PM-MEP STEP in FY08 SDD*

Schedule & Cost



CER-11 Future Force Power

FY05	FY06	FY07	FY08

FFW ATD LW Blk III

PM-MEP STEP

TRL= 5
2kW quiet power source
METRICS:
- <150 kgs, JP-8
- Noise 69 dBA

TRL=5
5 kW quiet power/cooling system
METRICS:
- JP-8; 50% fuel savings

TRL=5
250W Manportable field charger
METRICS:
- Liquid fuel
- <10kgs

TRL= 5
250W Manportable field charger
METRICS:
- JP-8
- <10kgs

TRL=6
Demo power mgnt at chip level
METRICS:
- soldier electronics at 50% savings over current power levels

TRL=5
20W Fuel Cell/rechargeable battery hybrid
METRICS:
- Methanol fuel
- 600whrs/kg @72 hrs
- 1.5 lbs "dry"

TRL=6
20W fueled hybrid power source
METRICS:
- Packaged fuel
- 700whrs/kg @72 hrs
- 1.5 lbs "dry"

TRL=6
Demo improved soldier suite processors
METRICS:
- soldier electronics at 75% savings over current power levels

Pacing Technologies:

• Meso-components	• Burner control/Heat-driven cooling	Power Management/Power integration

Army Vision for Military Fuel Cell Systems

Major Applications for Portable Power Technology

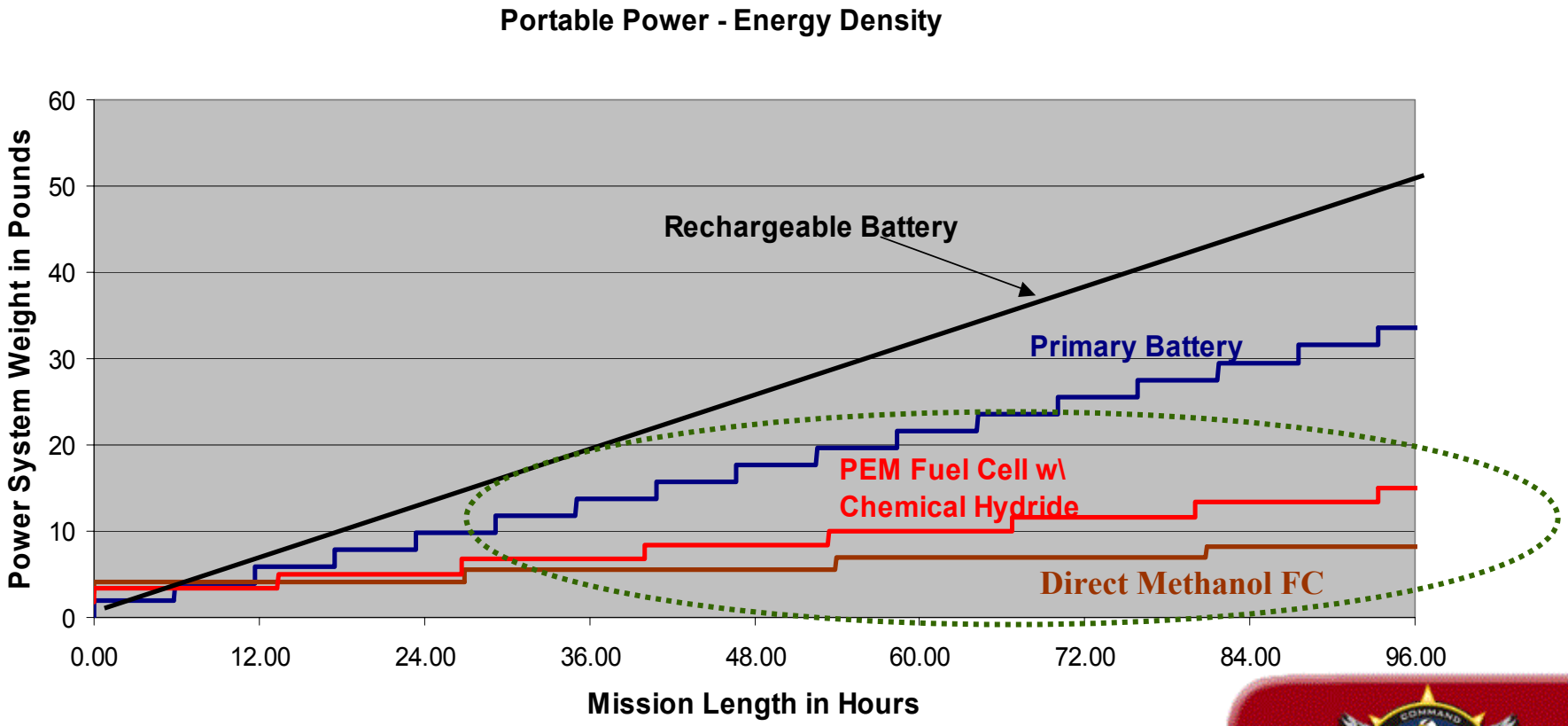
Soldier & Sensor Power (10-100W)

Auxiliary Power Units (500-3000W)

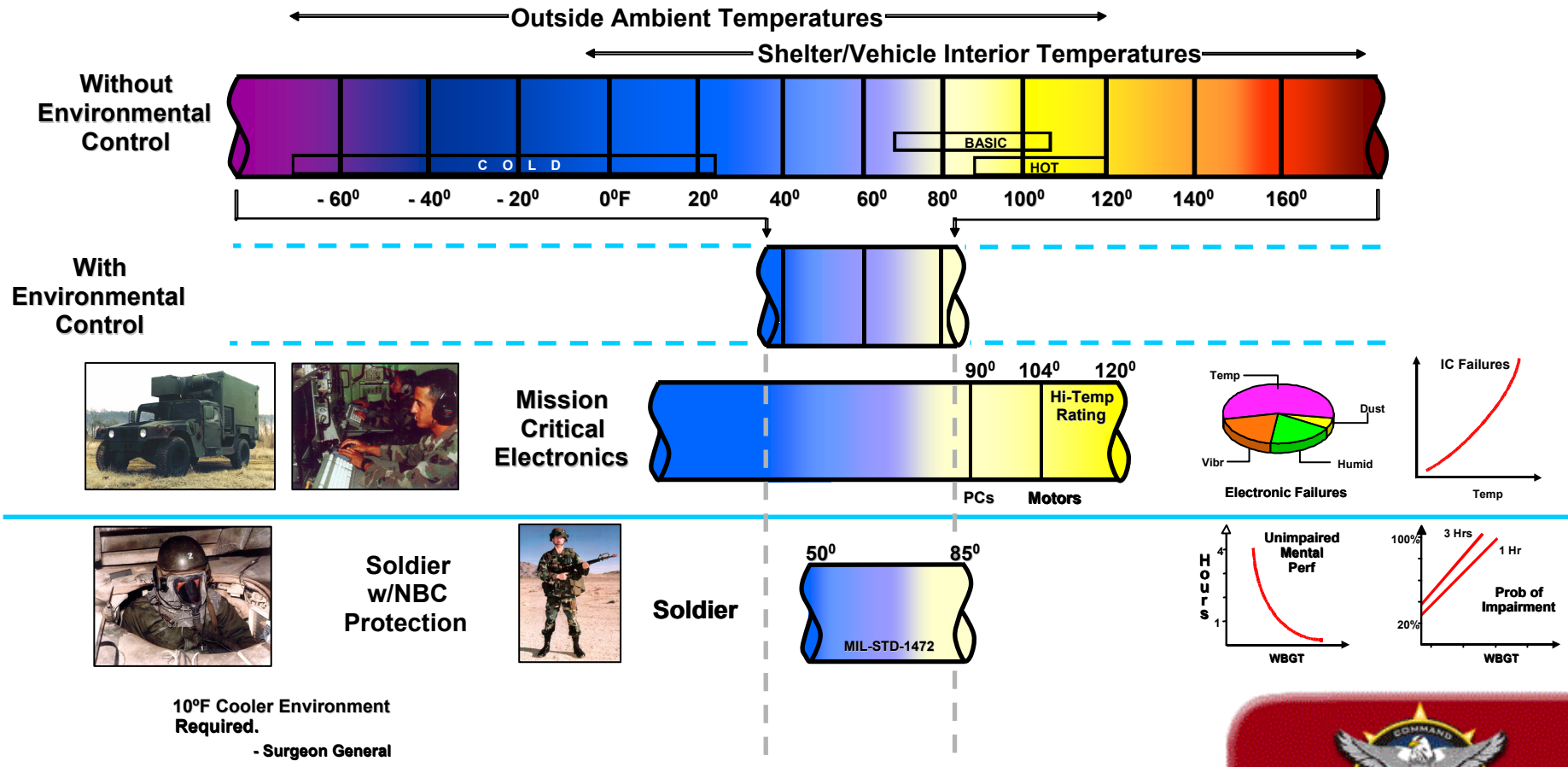
Combined Heat and Power (>3000W)

High Energy Dense Fuels

High energy dense fuels, such as methanol, favor low-power systems over batteries for longer missions (12+ hours)!



Environmental Control for the US Army



10ºF Cooler Environment Required.

- Surgeon General

RDECOM

Future Force Power STO Objective Proposal

Need for Individual Soldier Cooling

Extremes Temperatures → Physiological Strain → Mission-Limiting

- Wet Bulb Globe Temperature (WBGT) is commonly used as a guidance for environmental heat stress to prevent heat stroke during physical exercise or while at work.
- Available work decreases with increased ambient temperature. At high ambient:
  - Soldier can perform heavy work 10 min/hr
  - must intake 1 qt/hr water.
- Body Armor and Mop Gear further decrease work time available.
- Cooling of Soldier would increase work time and decrease water intake.
- Current vapor compression technology too heavy for soldier to carry.
- Develop lightweight environmental control system for soldier.

Individual Soldier Cooling With Heat Actuated Cooling

Cooling load: 350 Watt

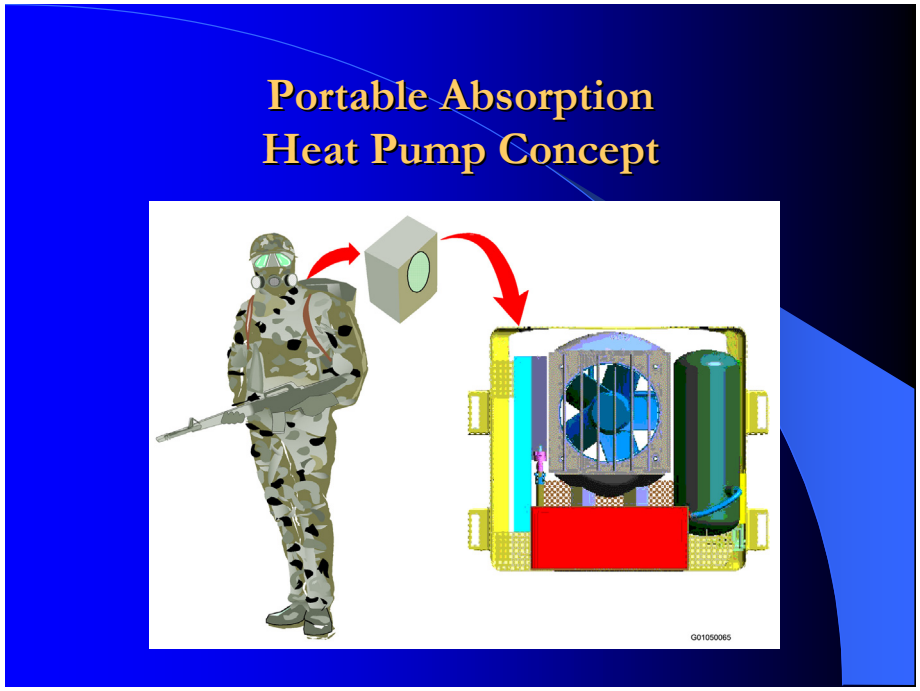
120°F ambient temperature

Weight: < 7.0 pounds

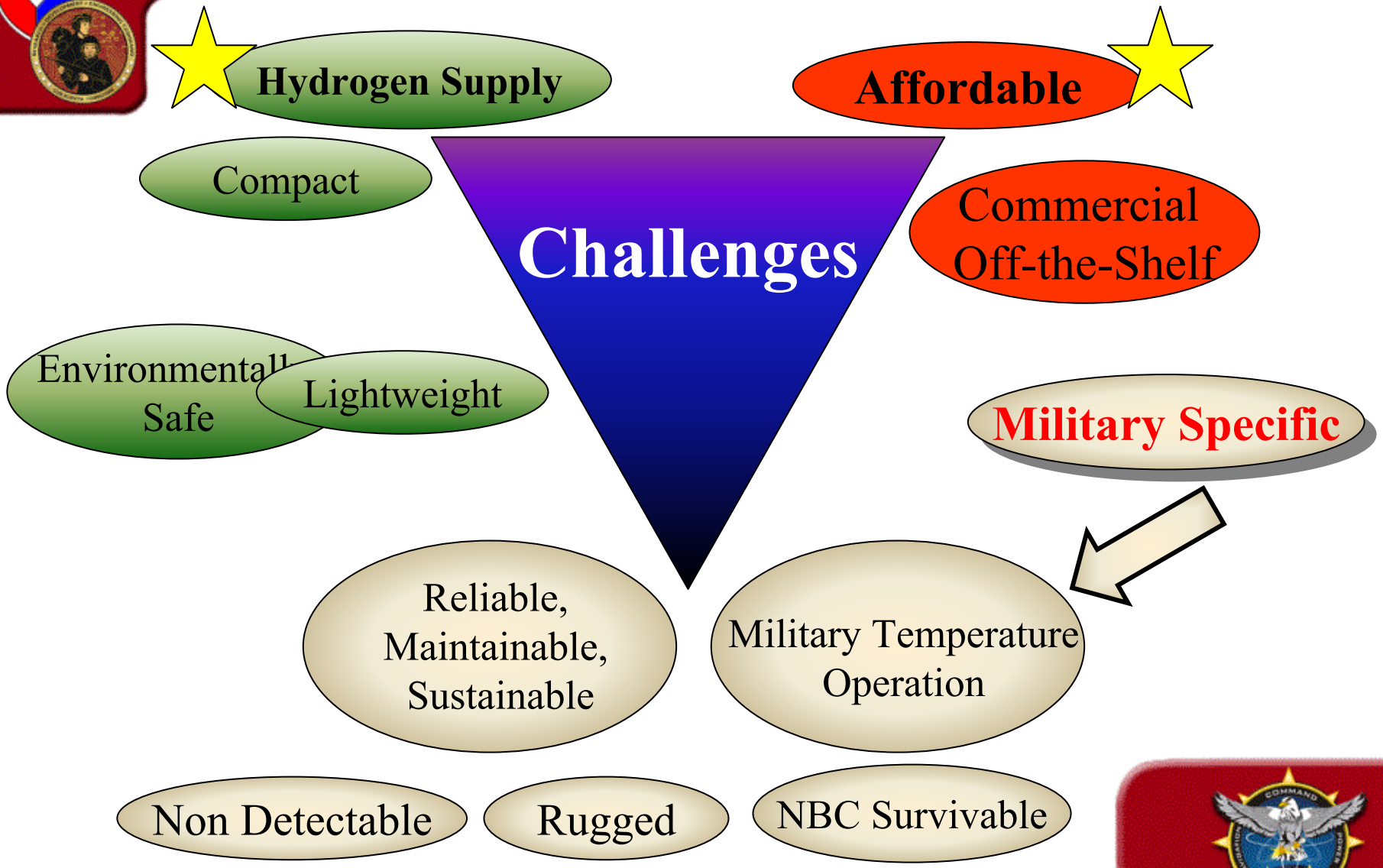
Fuel: Diesel

8 hours between resupply

< 225 cubic inches volume



Power & Cooling Technology Challenges



Broad Agency Announcement for Fuel Cell Technology

To be revised and updated this Fall

Basic and applied research, development, and demonstration of lightweight, robust fuel cell power sources, associated technology and components for use in various applications ranging from less than one watt to several kilowatts.

Current Efforts

Ruggedization of current fuel cell technology for rapid transition to the field.
Focus on Solider Power, Battery Charging, and Logistics Fuel Reforming

CERDEC 3 Power Areas for Portable Fuel Cell Technology

Soldier & Sensor Power (0-100W)	Battery Charging (100-500W)	Auxiliary Power Units (500W-5kW)

DAAB15-02-R-003, Fuel Cell Technology Broad Agency Announcement.

Listed under Contracting Officer, Patricia Davis on the Army Single Face to Industry Interactive Business Opportunities Page (https://abop.monmouth.army.mil/).

Broad Agency Announcement for Environmental Control

Basic and applied research, development, and demonstration of small, lightweight, efficient environmental control technology , associated technology and components for use in various applications ranging from less than one to one hundred twenty kBTUh.

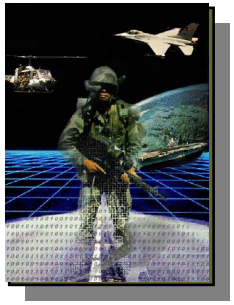
Current Efforts

The BAA is currently pending release and will focus on the following areas.

Combined power generation and air conditioning
Reduced size and weight
Increased efficiency and reduced fuel consumption

CERDEC 3 Areas for Portable Cooling Technology

Soldier Cooling (0- 1 kBTUh)	Shelter Cooling (6-36 kBTUh)	Tent Cooling (36-120 kBTUh)

Conclusions

Urgent need for Advanced Power Sources and Cooling.