UEC's Tactical Edge Hybrid Power System

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Mobile Energy System – Current State

- USMC reports that since 2001, it has experienced a 250% increase in deployed radios and a 300% increase in deployed computers.
- As power requirements in the battle space grow, so does the war fighters' dependence on fossil fuels.
- Pushing fuel forward on the modern battlefield is expensive in human, capital equipment, and fuel cost.
- Convoys operate at high risk due to improvised explosive device incidents resulting in additional force protection costs.
- According to a USMC study:
  - 1:50 casualty vs. convoy
  - 1:17 IED incident vs. convoy
  - 60% of convoy payload is fuel and water
- Reducing the number of convoys provides undeniable benefits.
- Commanders need real-time consumption data to efficiently manage their power assets

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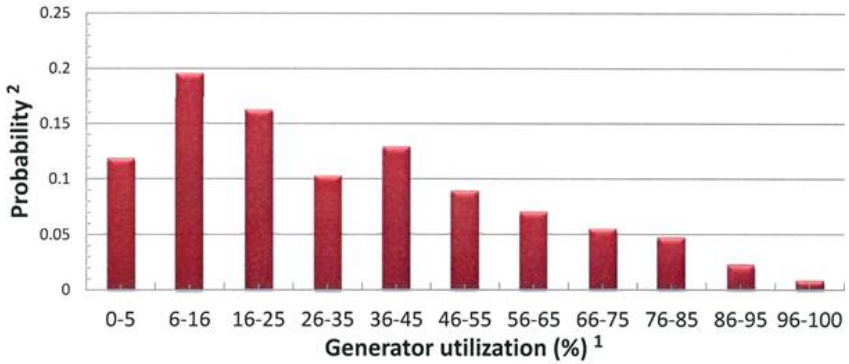
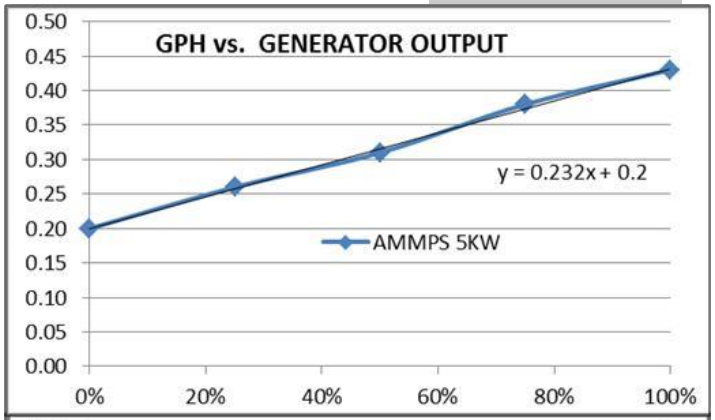
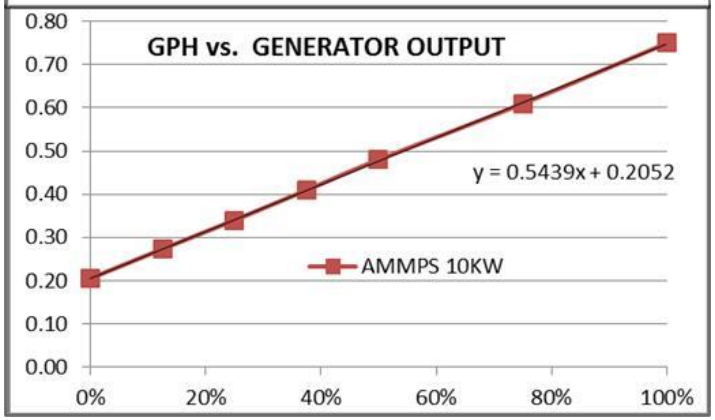
Mobile Energy Systems (Generators) – Current State

Forward operating bases consume an average of 300 gallons of fossil fuel per day. Currently deployed generators primarily operate at sub-optimal loads. A typical generator operates with a 50% or higher load only 30% of the time! (Source: USMC Brief)







5KW AMMPS @ 50% Load = ~8KW/GPH

5KW AMMPS @ 100% Load = ~11.6KW/GPH

*Potential 45% Gain in Efficiency

Harvest this Gain via Hybrid Systems

The US Marine Corps is out front with Renewable and Hybrid Energy Programs

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Renewable & Hybrid Energy Programs

USMC Programs of Record:

GREENS: Ground Renewable Expeditionary Energy System

MEHPS: Mobile Electric Hybrid Power Sources (aka MHEES)

Objectives:

* Go farther and stay longer on every gallon of fuel
* Liquid fuel only for mobility

GREENS - 3rd BN 7th Marines – COC Comms

GREENS - 2nd BN 11th Marines – G-BOSS

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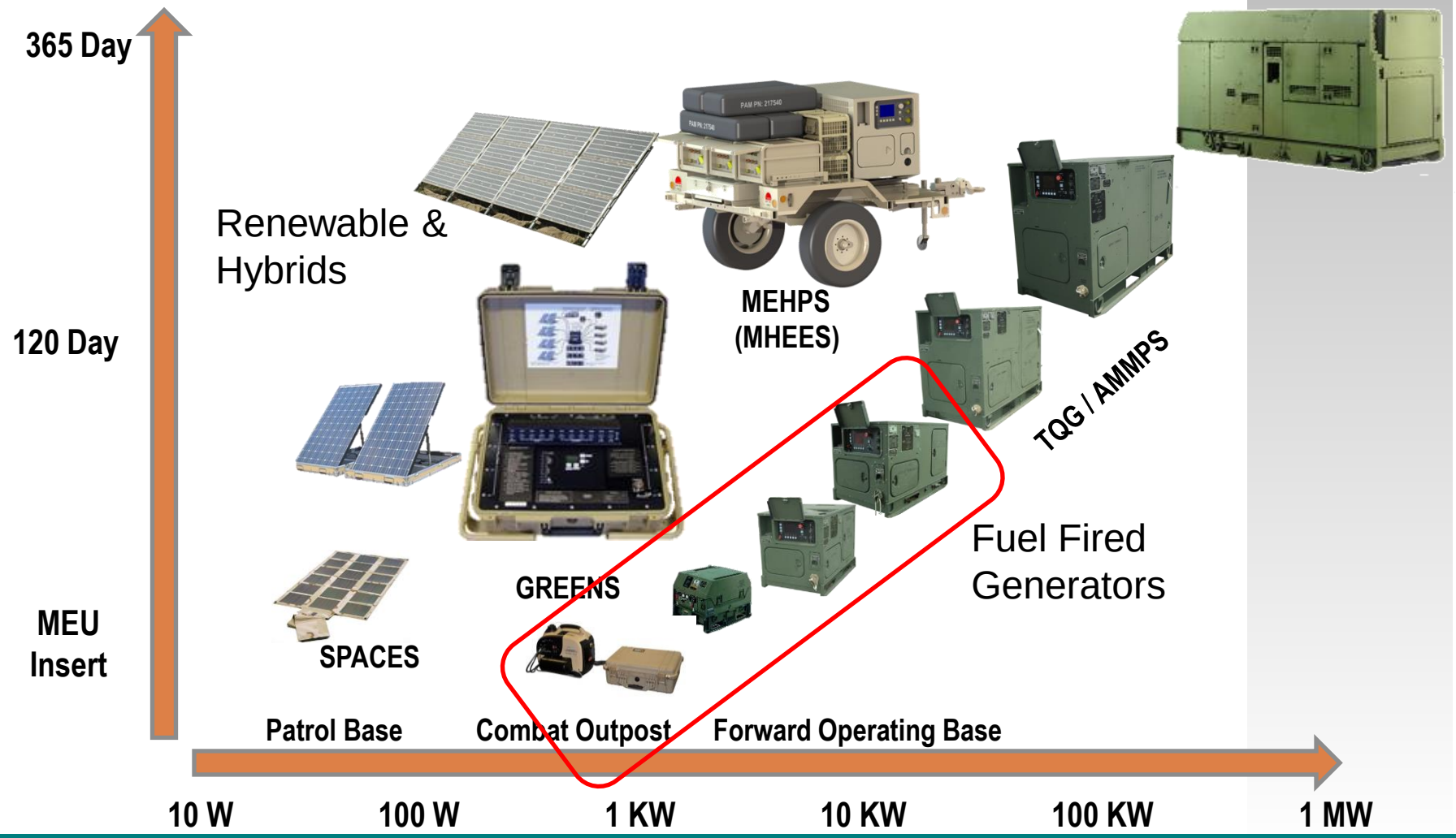
US Marine Corps “Sizing to Mission” Power Plan



Mobile & Fixed Renewable & Hybrid Energy Systems

Renewable and Hybrid Systems aren't only for the Military

- Remote Industry – Oil, Gas, Mining, Pumping, Cellular
- Regions in the Developing World
- Responding to Natural Disasters
- Humanitarian Crisis

Viable out on the edge where access to a reliable electrical grid is scarce and the fully burdened cost of fossil fuel justifies the investment in energy management, storage, and distribution

As the cost of energy storage decreases and the cost of fossil fuels increases, both $ and to the environment, hybridized power generation will move into commercial applications

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Tactical Edge Series
GREENS Product Line - Overview

- Energy Collection, Management, Storage, and Distribution System
- 2nd Generation Design – Combat Proven
- Man-Portable, Compact, Rugged, Submersible
- Six Primary Elements (Marine Corps Solution):
  - 1 – Power Distribution Control Unit (PDU-Controller)
  - 4 (8 Max) – High-Energy Density Batteries (HEDBS)
  - 1 – Power Distribution Kit (PDK)
  - 1 – Cable Interconnect Kit
  - 8 – Solar Panel Assemblies (Rigid or Flexible)
  - 1 – Output Power Adapter (OPA) – 5KW Gen II Option

5th BN 11th Marines – T-Battery

- 1KW 28Vdc Continuous Single System Configuration, up to 5KW in Parallel
- Wide range of auxiliary AC or DC input power with Auto-Start output
- Rapid Deployment - < 20 Minutes
- Modular architecture – Quickly adapt to other missions

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GREENS Gen II – Expeditionary Energy Network Top Level

1KW AC or DC Input

Over 5KWHr-10KWHr High Energy Density Lithium Battery Storage (Lead-Acid Alternate)

PDU - Controller

Cable Interconnect Kit

2KW Solar Input

Power Distribution Kit Including:
Two 500W 12V & 24V Protected Power Distribution Units
& Associated Peripheral Cables

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Power Distribution Kit (PDK) – Open Configuration

Marine Corps PDK Configuration

- PRC-117G/F
- PRC-148
- PRC-152
- PRC-153
- 1800W QP1800 Inverter
- 200W Sine-Wave Inverter
- BB-2590/U Battery Charger
- PRC–148/152 Battery Charger
- PRC-153 Battery Charger
- AA/AAA Battery Charger
- USB Power Ports

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Tactical Edge Series
MEHPS Product Line - Overview

MEHPS intelligently operates generators near full capacity to maximize efficiency. MEHPS stores excess generator and solar energy for future use. The stored energy powers the loads during nominal operations keeping the generator inactive until needed.

MEHPS – Lite: 3.5KVA (3KW Req)

MEHPS – Medium: 7KVA (5KW Req)

MEHPS – Medium: 10.5KVA (10KW Req)

Generators: 3KW TQG, 5KW TQG, 5KW AMMPS, 10KW AMMPS

Inputs: 120V 1P or 208V 3P, 28Vdc, Solar

Outputs: 120V 1P or 208V 3P, 28Vdc, Auto-Start, CAN, Ethernet

MCC-LTT - Trailer Mounted or Man-Portable Dismounted Operation – Rapid Deployment of Power

Ships in a single QUADCON

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Tactical Edge Series
MEHPS System Architecture

- Modular System Design – Power for the Mission
  - Controller Card
    - J1939 CAN Bus
  - 1KW Solar Smart Module
  - 1KW DC/DC Smart Module
  - 500W AC/DC Smart Module
  - 1.3KWh Smart Battery Increments

3.5KVA Controller

2.6KWh Battery Unit

- Scalable Solutions – Power for the Mission
  - 3x Parallel Control Units > 10KW of Power
    - 6x 20KW under development
  - 1KW-9KW of Solar Capacity
  - 1KW-9KW of regulated DC Output Capacity
  - Greater then 0.5C of Charge Capacity

MEHPS-Med LTT Mounted

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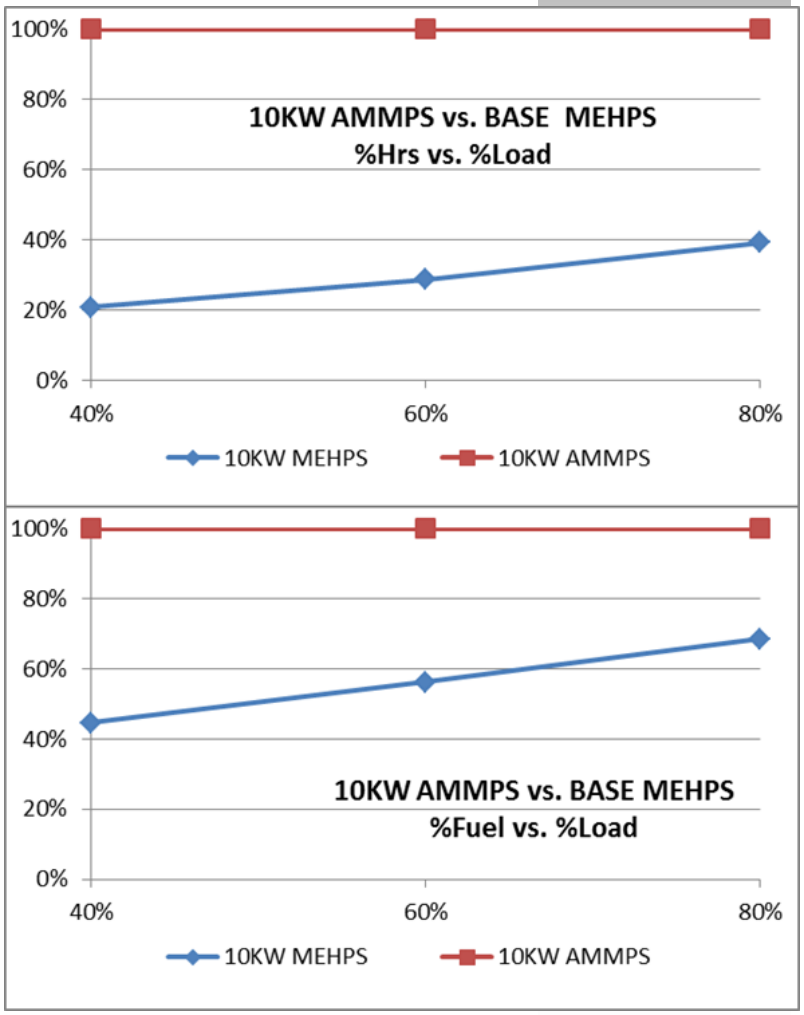
Tactical Edge Series
MEHPS Product Line – Engineering Results

Baseline Engineering Analysis Minimum MHEES/MEHPS Configuration

- 10KWh Energy Storage
- 1KW Solar Capacity

Initial simulation and testing indicates a 50% fuel and 70% maintenance savings over typically loaded 10KW AMMPS

MEHPS-Lite Engineering Demonstrator



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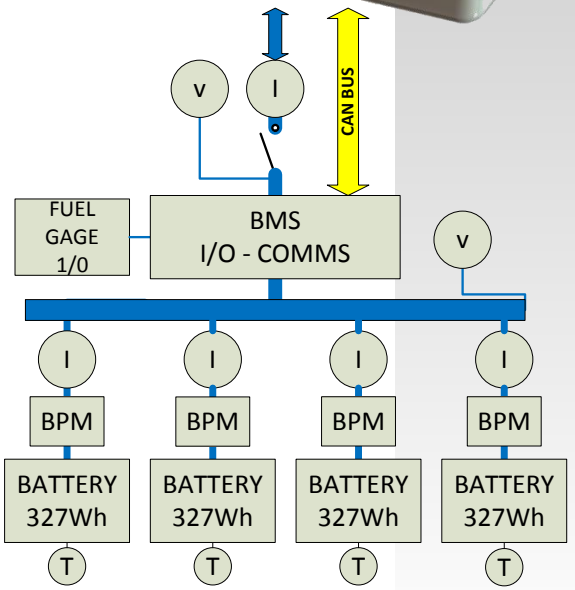
28V-1300 Wh High Energy Density Battery

- Safe Stable LiFeP04 Lithium Cell Technology
  - 70 Wh/Kg Energy Density
  - 3 Levels of Safety Protection
- J1939 CAN Bus Communications
- Output Enable Switch
- Rugged, Submersible, Tamper Proof Packaging
- -20C to +60C Operation
  - -40C to +85C Upgrade Currently in Test
- Extensively Tested
  - UN/DOT Class 9
  - NAVSEA Technical Manual S9310-AQ-SAF-010



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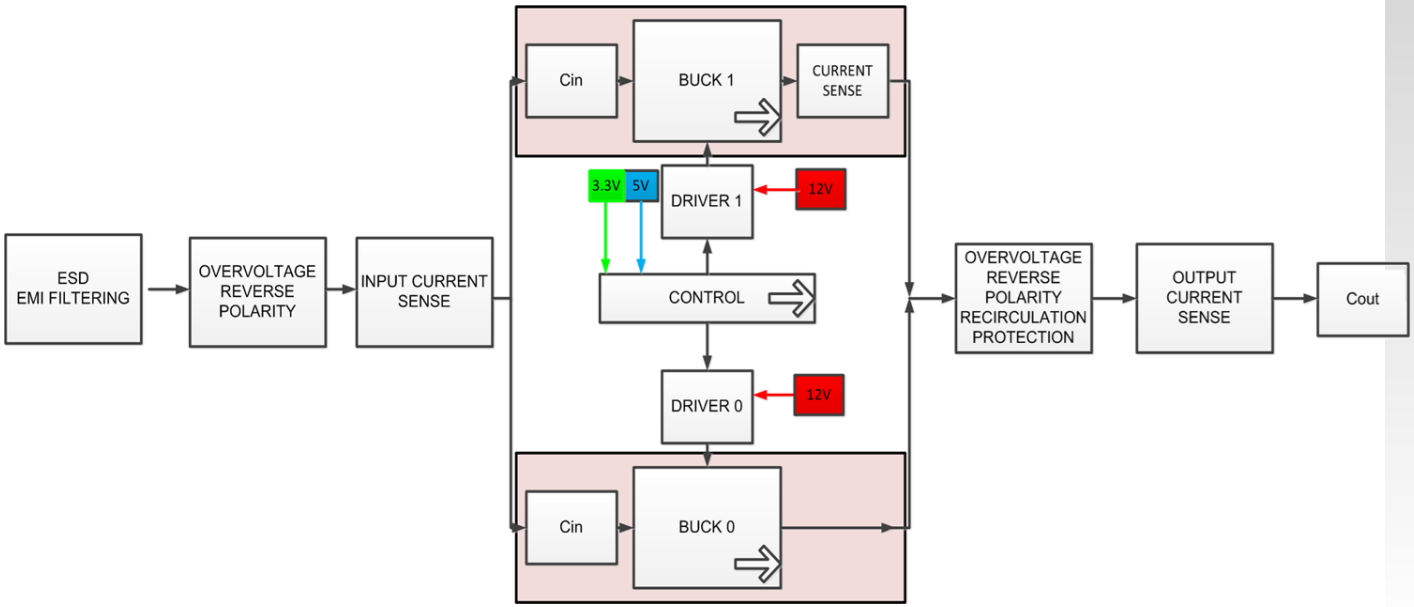
28V - 1KW Solar Architecture

- Modular “plug-n-play” Architecture & Packaging
- J1939 CAN Bus Communications
- Dual PI Voltage & Current Control MPPT Loops
- Phased Parallel Drivers for Low Ripple
- Incorporated “lessons learned” from GREENS 500W Gen I Solar Board



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Tactical Edge Series

Modular design allowed UEC to design and deploy a single-box 500W system in 6 weeks.

Powers a sensor suite for medical units preparing for humanitarian deployment in Africa

MEHPS–Lite 3.5KW Demonstrator Powering ECU at Quantico TSOA

Conclusion

- Hybrid Technology is a Force Multiplier*:
  - Time - More time to focus on the mission, less on sustainment
  - Money - More money to train, less on rising energy costs
  - Lives - More Marines in the fight, fewer hauling fuel

GREENS Powered Sensor Array

GREENS Training

* Marine Corps Communications Playbook – 9/5/2014

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