# *FUEL CELLS for Deployed Forces*

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**Unclassified / Pre-Decisional**

# *Overview*

- Historical DoD support for fuel cells
  - Multi-service funding on past and present efforts
- Power demand categories for fuel cells
  - >60w, 100-1000W, 1-10 kW
  - Competition in each category
- Challenges
  - Single fuel on the battlefield (JP-8 – high sulfur)
  - Reliability/Ruggedization
  - Start up times / load following



Unclassified

# DOD Role in Hydrogen and Fuel Cell Programs

- Be an ***early adopter*** and ***principal demonstrator***
- Foster competition in the marketplace and provide a market demand
- Support improved Technology and Manufacturing Readiness Levels
  - Exercise the supply chain
  - Test under real world conditions
  - Provide feedback to manufacturers
- Improve fuel cell readiness by funding R&D efforts in areas that are near commercialization
- Support DOD-unique research to leverage other government and commercial R&D investments

Unclassified

# Small Power

RDECOM

## CERDEC Fuel Cell Team

CERDEC US ARMY–RDECOM

**Mission:** Rapidly develop and transition suitable fuel cell technologies to applications where they are most needed.

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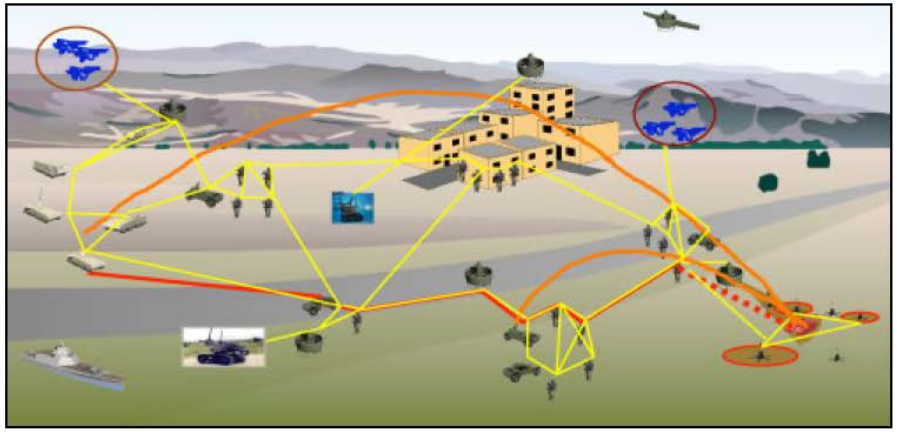
# Small Power

## Potential Benefit – Sensor and Soldier Power



- Longer runtimes than current batteries for comparable form factors
- Logistic advantages related to handling and lifecycle costs
- Cheaper than current batteries for comparable power needs

TECHNOLOGY DRIVEN. WA



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# Past Efforts

RDECOM

## Sensor and Soldier Power (100 mW – 55 W)

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| Fuel Technology | Current Efforts |
|---|---|
| Direct Methanol | SFC Smart Fuel Cell; Samsung; PolyFuel |
| Reformed Methanol | UltraCell High Power Micro Fuel Cells |
| Chemical Hydrides | General Atomics; jadoo Power |
| Propane | AMI Adaptive Materials Inc. |
| Bio Fuel | Akermin |

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# Past Efforts

RDECOM

## Man Portable Power (150 W – 500 W)

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| Fuel Technology | Current Efforts |
| --- | --- |
| Reformed Methanol | Protonex (The Next Generation of Portable Power™), IdaTech |
| Ammonia Borane | Spectrum Brands, Rayovac |
| Sodium Borohydride | Ultralife Batteries, Lynntech |

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# Army/ONR Efforts

## Low Signature Generators & APUs

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
BUILDING STRONG®

Regenerative Fuel Cell System for Silent Camp™ Operations

- Fuel cell – electrolyzer – diesel generator hybrid power system using hydrogen for energy storage
- High pressure Proton Energy electrolyzer coupled to 30 kW tactical diesel generator as the primary power source
- High pressure hydrogen stored and used in a 5kW Altergy PEM fuel cell for Silent Camp

3-10 kW

Solid Oxide Fuel Cell APU

Vehicle Based APU

Towable Power

- SOFC operating on desulfurized JP-8 and synthetic/biofuels fuels
- Provides quiet, low IR signature, low emissions mobile power generation
- Power Output: 10kW (threshold) 15kW (objective)
- Efficiency: >30%
- Total System Volume: 30 watts/liter
- Weight: 35 watts/kilogram

# Potential Benefit – Man Portable

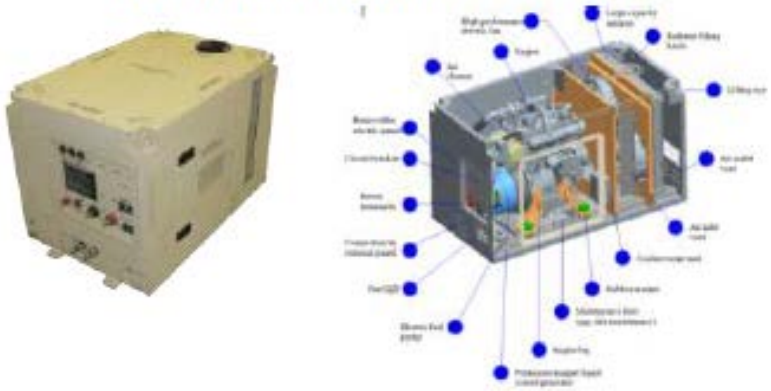
## Auxiliary Power/ Battery Charging

- Bridge power gap between batteries and generators
- Greater efficiencies than TQGs and vehicle power
- Reduced noise and heat signatures
- Enables remote, portable battery charging capability where other power sources are not practical
- Low emissions

# 1-10 kW Competition

3, 5, 10 kW Generators

Marvin Land Systems 5kW APU



Hybrid Systems

Unclassified

# Fuel Cell APU Challenges

**Sulfur Tolerance**

o 10 – 20% of system volume is consumed with sulfur removal technologies or devices

o Implement sulfur sensor technologies to optimize catalyst bed replacement schedules to avoid wasteful replacement of a useful device

o Implement sulfur sensor technologies to optimize control of regeneration cycles to reduce unnecessary cycling, which lowers capacity with each cycle

o Develop sulfur tolerant fuel cell stacks to reduce the amount of space dedicated to sulfur and gas cleanup

o Develop sulfur tolerant reformers to reduce the need for sulfur treatment

**Cost and Reliability**

o Reduce cost of fuel cell stacks through robust and reliable manufacturing

o Follow standard quality control practices to ensure fuel cell stacks have limited variations or defects to ensure predictable performance

o Decrease precious metal content

o Keep voltage degradation rates low for extended stack life