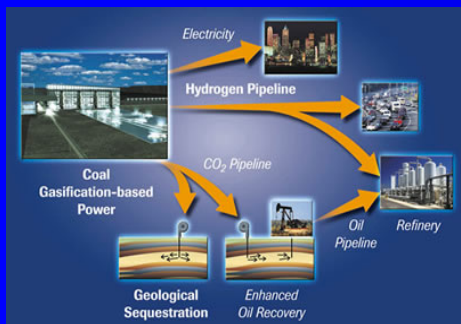




**Session 1**  
**Holcomb**

# DoD / Army Stationary Power Requirements

Secure, Reliable, Efficient Energy  
Home Station to Foxhole

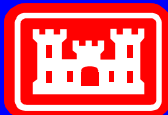


Franklin H. Holcomb  
Project Leader, Fuel Cell Team

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US Army Corps  
of Engineers

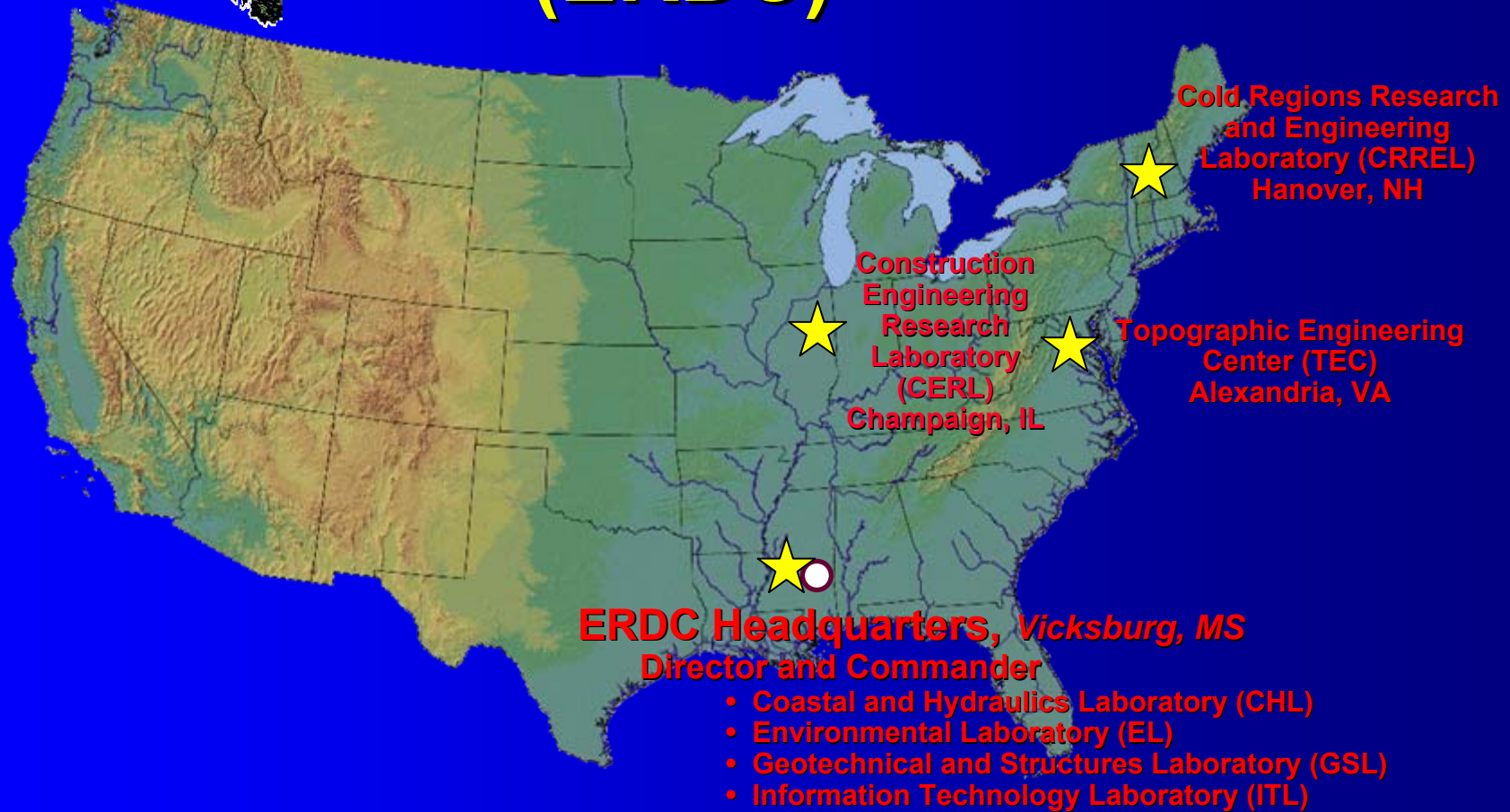
24 JAN 07

Engineer Research and Development Center

# Presentation Outline

- **Introduction**
- **Power & Energy Technology Requirements & Goals**
  - Installations
  - Warfighter
- **Selected Initiatives**

# Engineer Research and Development Center (ERDC)



# ERDC-CERL Team & Collaborators

## ERDC-CERL Researchers



**Frank Holcomb**  
Elect. Engineer



**Roch Ducey**  
Elect. Engineer



**Tarek Abdallah**  
Elect. Engineer



**Dr. Chang Sohn**  
Mech. Engineer



**Joe Bush**  
Mech. Engineer



**Nicholas Josefik**  
Mech. Engineer

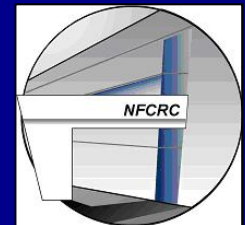


**Scott Lux**  
Elect. Engineer

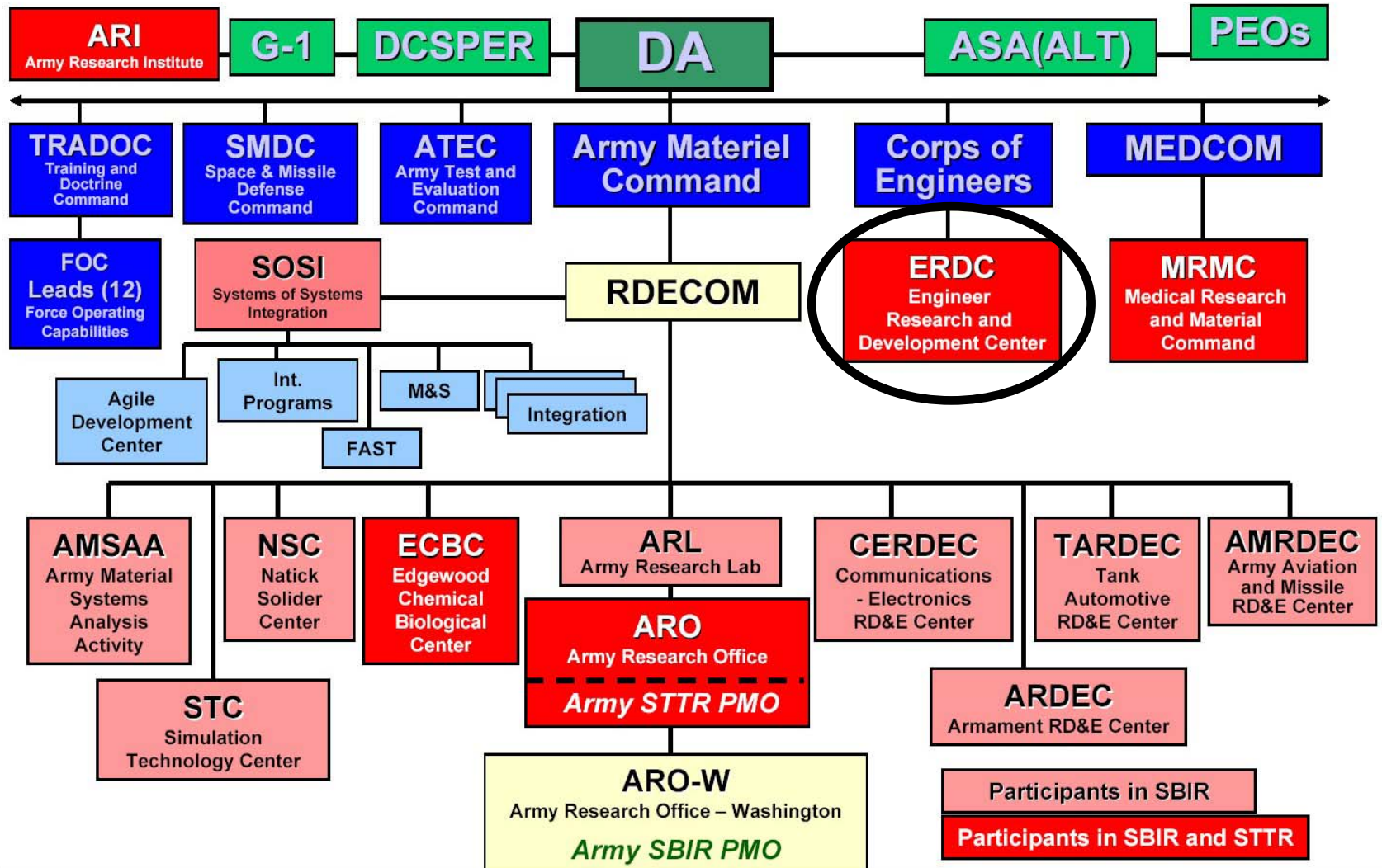


**Dr. Carl Feickert**  
Physicist

## Major Collaborators



# ARMY R&D Organizations



# Army Energy Strategy for Installations

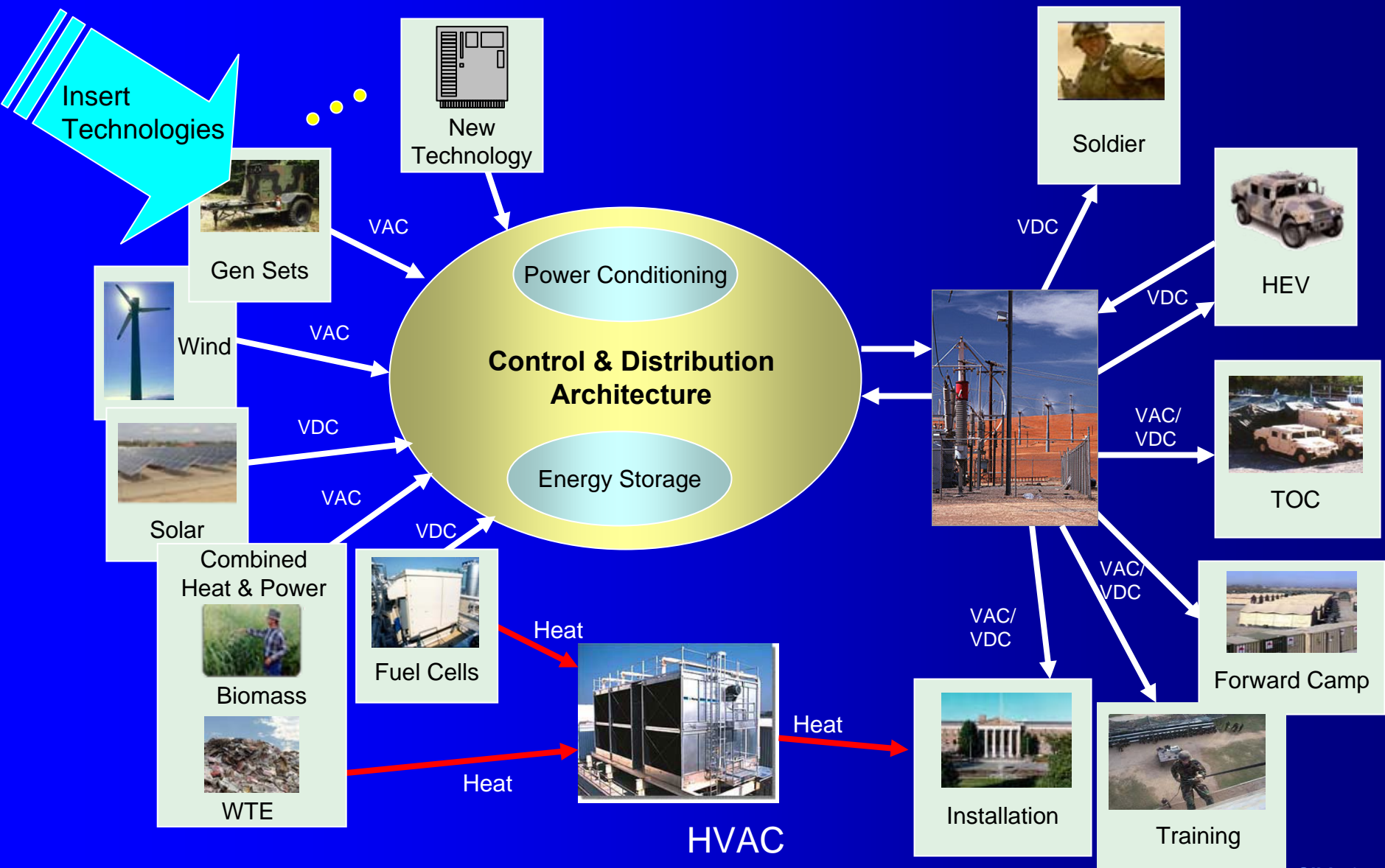
- The Strategy sets forth the Army's energy goals for 25 years and the Campaign Plan defines the intermediate actions, approaches, initiatives and funding over the 25 years to ensure the Army successfully achieves long-range energy and water management goals.
- The Strategy sets the general direction for the Army in five major initiatives:
  - Eliminate energy waste in existing facilities
  - Increase energy efficiency in new construction and renovations
  - **Reduce dependence on fossil fuels**
  - Conserve water resources
  - **Improve energy security**
- References
  - <http://hqda-energypolicy.pnl.gov/programs/plan.asp>
  - The Secretary of the Army and the Army Chief of Staff signed the Army Energy Strategy for Installations on 8 July 2005. [http://hqda-energypolicy.pnl.gov/docs/draft\\_strategy.pdf](http://hqda-energypolicy.pnl.gov/docs/draft_strategy.pdf)

# 2005 Energy Policy Act

- The Domenici-Barton Energy Policy Act of 2005 was signed by President Bush on 08 AUG 05. Army / DoD related guidance includes:
  - **Directs the federal government to use more renewable energy, with a goal of using 7.5 percent or more by 2013.**
  - Directs the federal government to meter or submeter all federal buildings by October 1, 2012.
  - Requires a 20 percent reduction in federal building energy use by 2015.
  - Provides funding for energy efficiency programs for public buildings, including schools and hospitals.
  - **Increases fuel efficiency requirements for federal vehicles.**
  - **Directs the DOE to fund selected demonstration projects that involve using hydrogen and related products at existing facilities or installations, such as existing office buildings, military bases, vehicle fleet centers, transit bus authorities, or units of the National Park System.**
  - Requires sustainable design principles to be applied to the siting, design, and construction of all new and replacement federal buildings.
  - Green procurement guidance.
- References
  - [http://energycommerce.house.gov/108/energy\\_pdfs\\_2.htm](http://energycommerce.house.gov/108/energy_pdfs_2.htm)



# Vision for Army Power Delivery Home Station-to-Foxhole



# Technology Advances Needed to Achieve Future National Power Delivery System (Ref)

- Smart power delivery system
- Advanced distribution automation
- Fast simulation and modeling
- Integrating distributed energy resources
- Distributed storage technologies
- Power system operation and control
- Reduce vulnerability to natural disaster & attack
- Improve power quality

**Army challenge    adapt national tech advancements to  
blend with & scale the power vision home station-to-foxhole**

Ref: *Power Delivery System and Electricity Markets of the Future*, EPRI, Palo Alto, CA: 2003. 1009102

# Power & Energy Technology Warfighter Goals

- Provide Warfighter Payoff!
- Meet Unique Operational Needs Of Each Service
- Compatibility With Diesel Fuel Logistics



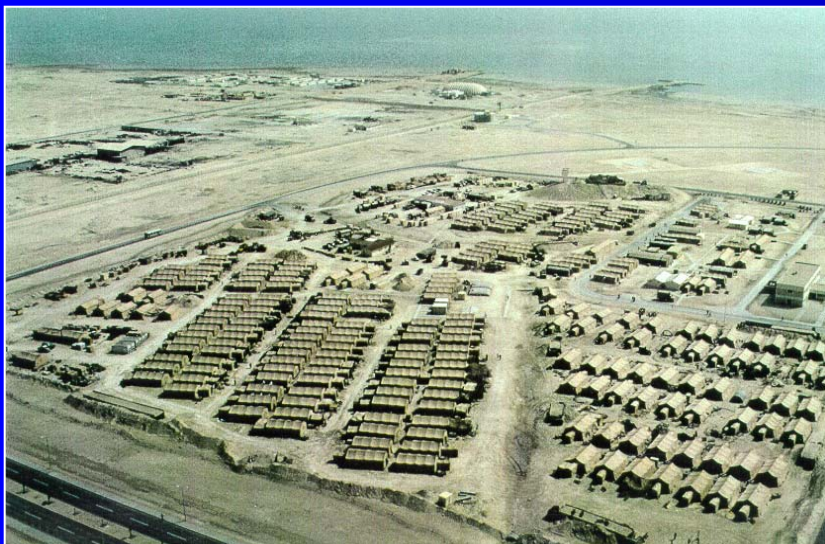
# TRADOC Pamphlet 525-66 (refers to Force Operating Capabilities (FOCs))

- **FOC-08-04: Installations as our Flagships**
  - Capstone Capabilities.
    - The role of installation is shifting to continuous support from **home station to foxhole**.
    - These capabilities apply to our permanent installations at home and abroad, as well as to those that support expeditionary and contingency activities.
  - In addition or adjunct to installation natural and built infrastructure needs inculcated into the other FOCs, the following encompasses those focused capabilities most critical to achieving required installation support for the Army:
    - **Provide Power Projection**
    - **Maintain Readiness**
    - **Maintain Quality of Life**
- **References**
  - <http://www.tradoc.army.mil/tpubs/pams/p525-66.htm>

# TRADOC Pamphlet 525-66

- **FOC-09-03: Power and Energy**
  - **Capstone Capabilities.**
    - Improve both strategic responsiveness and core warfighting abilities to effectively fight as an integral component of a joint, interdependent, full spectrum, mission-tailored force,
    - Optimize combat effectiveness via consumption reduction, alternative generation, management, and distribution of power and energy across the force, for all systems—automotive, electrical and soldier.
  - **(2) The use of a single fuel for both ground and aviation will simplify support operations. Efficiencies gained through improvements in the engineering and manufacturing processes will lessen fuel requirements for ground vehicles.**
    - Fuel cells and other in-place technologies will negate the need for storage of large quantities of bulk fuels for ground vehicles alone.
  - **(3) The use of alternatives to fossil fuel, including fuel cells, fusion, fission, hydrogen energy, renewable sources, biomass, and magnetohydrodynamic thrusters, must be pursued for significant advances in efficiency to be made.**
    - Systems of the future will look at power storage and distribution as two halves of the same whole, rather than as disparate systems.

# Forward Deployments



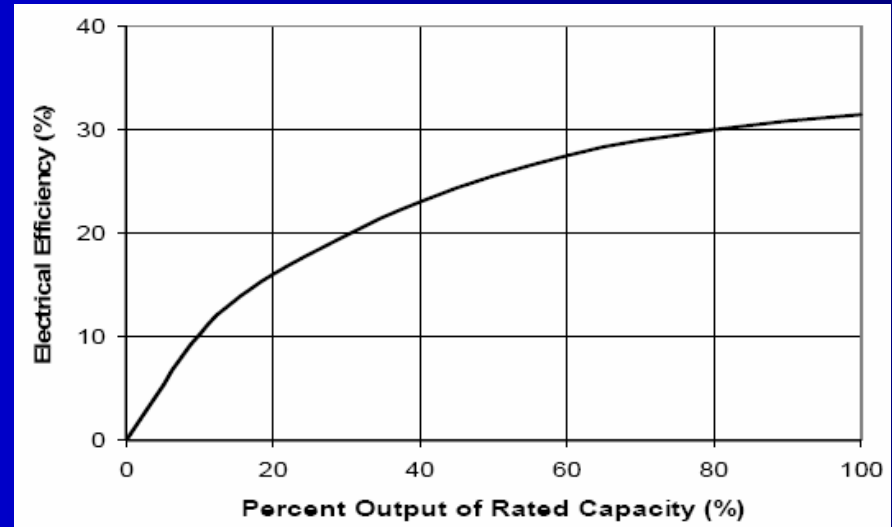
- **Base Camps**
- **Life Support Areas**
- **Advanced Operations Base**
- **Forward Operations Base**
- **Tactical Operations Center**
  
- **Fuel Related Casualties**
- **Waste Disposal also an Issue**



# Military GenSets & Efficiency

## Current DoD GenSet (2 kW – 60 kW) Inventory

Unit Rating (kW)	No. of Individual Units	Total Capacity (kW)
2	10,979	21,958
3	39,789	119,367
5	17,603	88,015
10	13,745	137,450
15	5,411	81,165
30	6,669	200,070
60	6,495	389,700
<b>Total</b>	<b>100,691</b>	<b>1,037,725</b>



**Partial Loading = Very Low Efficiency**



3 kW System



30 kW System



60 kW System

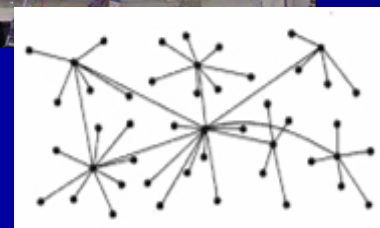
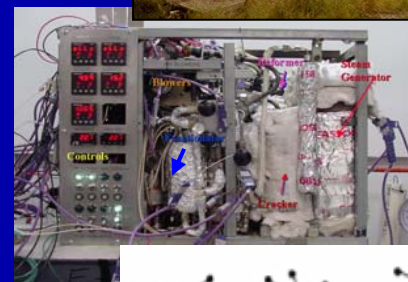
# Related Initiatives

- **Scalable and Dynamic Power Delivery Systems for Military Installations**
- **Congressional Projects**
  - Fuel Cell Demonstrations Tailored for Army Needs
  - Next Generation Fuel Cell Technology Development
- **DOE Interagency Agreement**
  - Energy Conversion, Energy Storage, Power Conditioning Support to FutureGen Project
- **National Military Command Center (NMCC) Support**
  - Designed, Installed, Tested Control Sys for Backup Switchgear
- **New Small Business Innovative Research (SBIR) Topics**
  - Intelligent Tactical Electric Grid Control
  - Hydrogen Reformation of Renewable Ethanol for Military Applications
- **Waste to Energy ECIP Project at Fort Stewart GA**
  - Co Production of Hydrogen, Heat, and Electricity via Fuel Cell



# Current Leveraging Initiatives

- **University of CA – Irvine / TARDEC → MOU**
  - “Silent Watch” Modeling and Simulation
- **249<sup>th</sup> Engineer Battalion / Mobile Electric Power**
  - “Silent Camp” Scoping
- **Fuels Reformation**
  - Logistic Fuels, Ethanol, Other Bio Fuels
- **Various CRADAs with Industry Partners**
- **Installation Electric Power Microgrid**
  - RDECOM P&E IPT, Sandia National Lab Energy Surety, SERDP Proposal
- **Army Energy Security Workshop**
  - NCA&T University Collaboration, DEC 2006



# Backup Slides

- Selected Publications & References
- FY07 Waste to Energy ECIP Project-Fort Stewart
- DoD PEM & PAFC Demonstrations
- “Silent Camp” Concept
- Stryker Vehicle Silent Watch Concept
- DoD Fuel Cell & H2 Initiatives Website

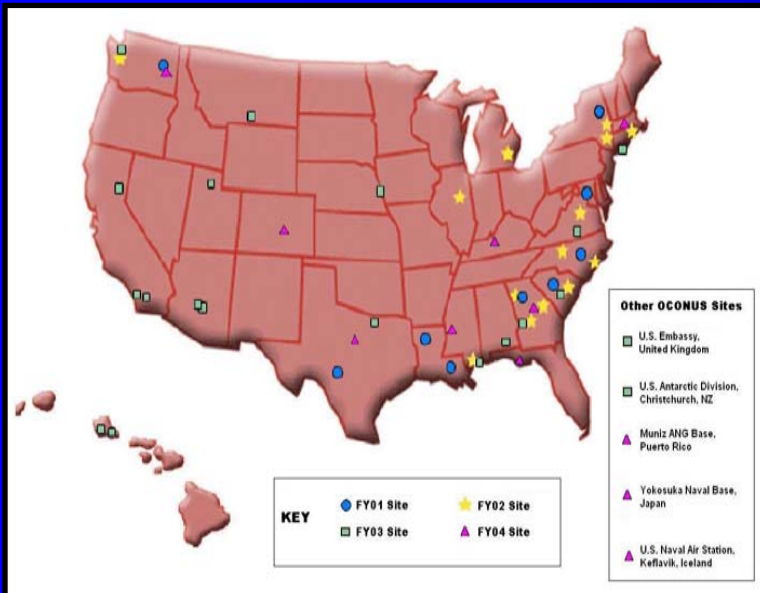
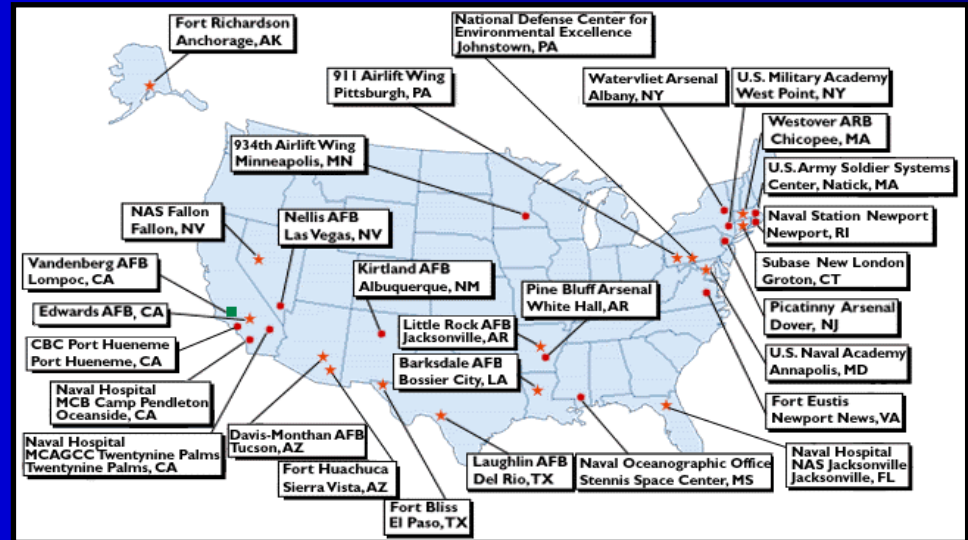
# Selected Publications & References

- Military Requirements of JP8 Reformers
  - [http://www.cecer.army.mil/techreports/Holcomb\\_JP8\\_Requirements\\_TR/Holcomb\\_JP8\\_Requirements\\_TR.pdf](http://www.cecer.army.mil/techreports/Holcomb_JP8_Requirements_TR/Holcomb_JP8_Requirements_TR.pdf)
- Control Dynamics of Adaptive and Scalable Power and Energy Systems for Military Micro Grids Report
  - [http://www.cecer.army.mil/techreports/ERDC-CERL\\_TR-06-35/ERDC-CERL\\_TR-06-35.pdf](http://www.cecer.army.mil/techreports/ERDC-CERL_TR-06-35/ERDC-CERL_TR-06-35.pdf)
- PEM Fuel Cell Demonstration Volume II Report
  - [http://www.cecer.army.mil/techreports/White\\_PEM\\_Vol2\\_TR/White\\_PEM\\_Vol2\\_TR.pdf](http://www.cecer.army.mil/techreports/White_PEM_Vol2_TR/White_PEM_Vol2_TR.pdf)
- Fort Stewart Waste to Energy (H2) Report
  - [http://www.cecer.army.mil/techreports/Holcomb\\_CERL\\_TR-06-07/Holcomb\\_CERL\\_TR-06-07.pdf](http://www.cecer.army.mil/techreports/Holcomb_CERL_TR-06-07/Holcomb_CERL_TR-06-07.pdf)

# FY93-FY94 Phosphoric Acid Fuel Cell (PAFC) Project Sites



90 Fuel Cells  
56 Sites  
5 Manufacturers



■ PC25A SITE  
● PC25B SITE  
★ PC25C SITE

30 Fuel Cells  
30 Sites  
1 Manufacturer

# FY01-FY04 Residential Proton Exchange Membrane Fuel Cell (PEMFC) Project Sites

# Stryker Vehicle With MREF-APU

## “Silent Watch” Capability

### HyPM 7

Generates power on-demand for silent watch mission use.



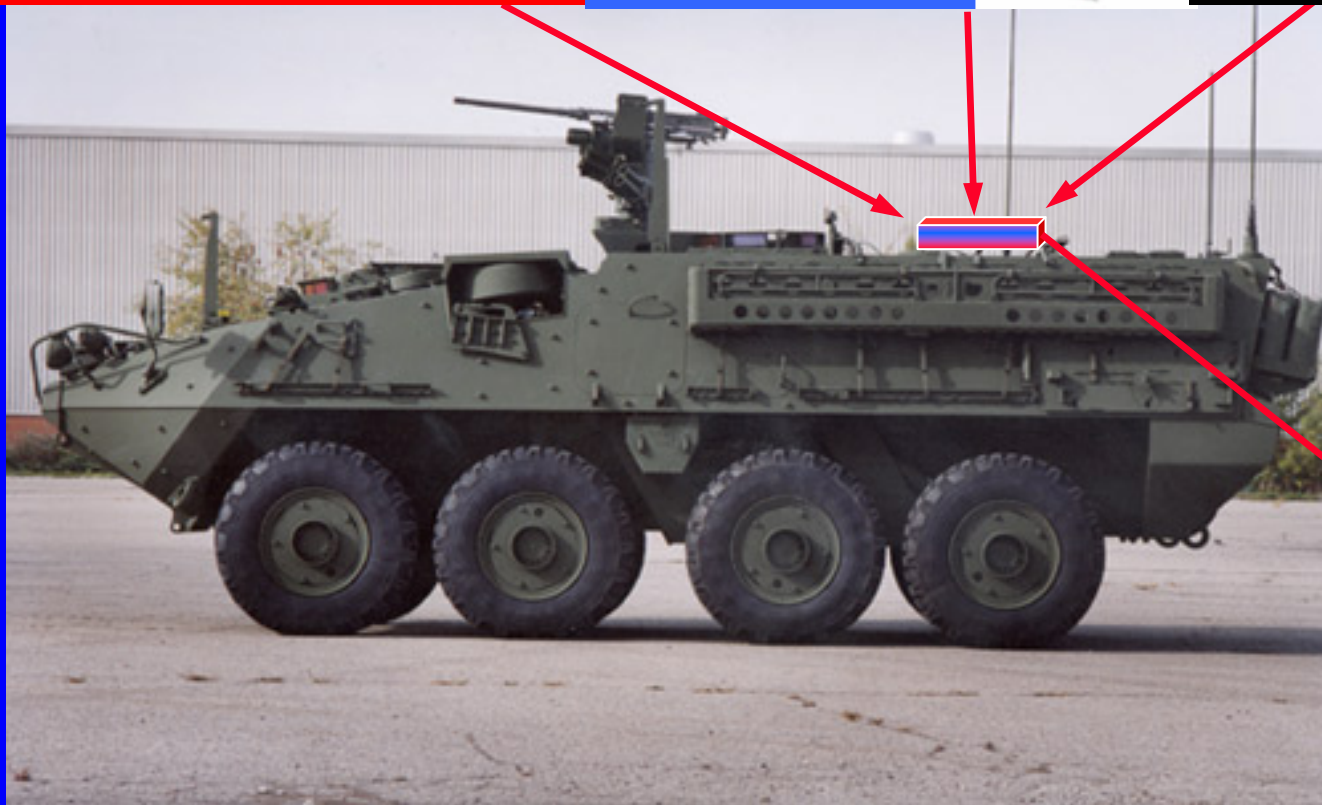
### HyLZER 2.0

Generates Hydrogen for storage and later use by HyPM 7



### Metal Hydride

Stores Hydrogen at low pressure for use on-demand by HyPM7 during power generation

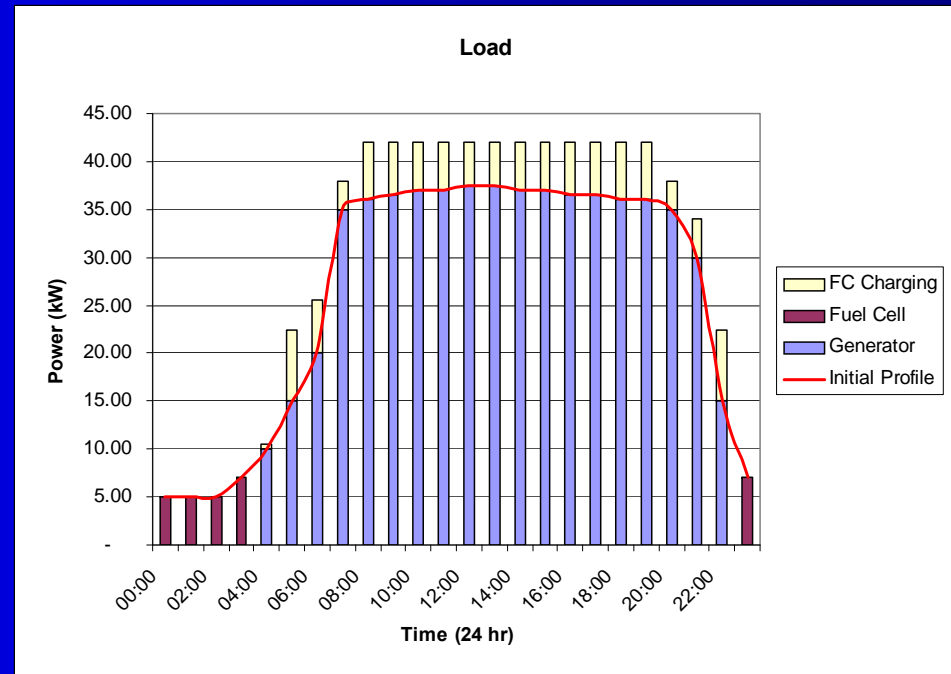
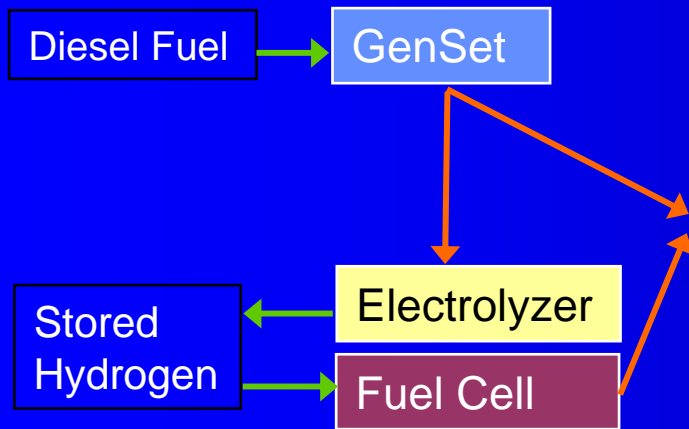


Current Prototype System is located behind turret and in front of the rear hatch ports of egress. System also includes on-board water storage vessel.



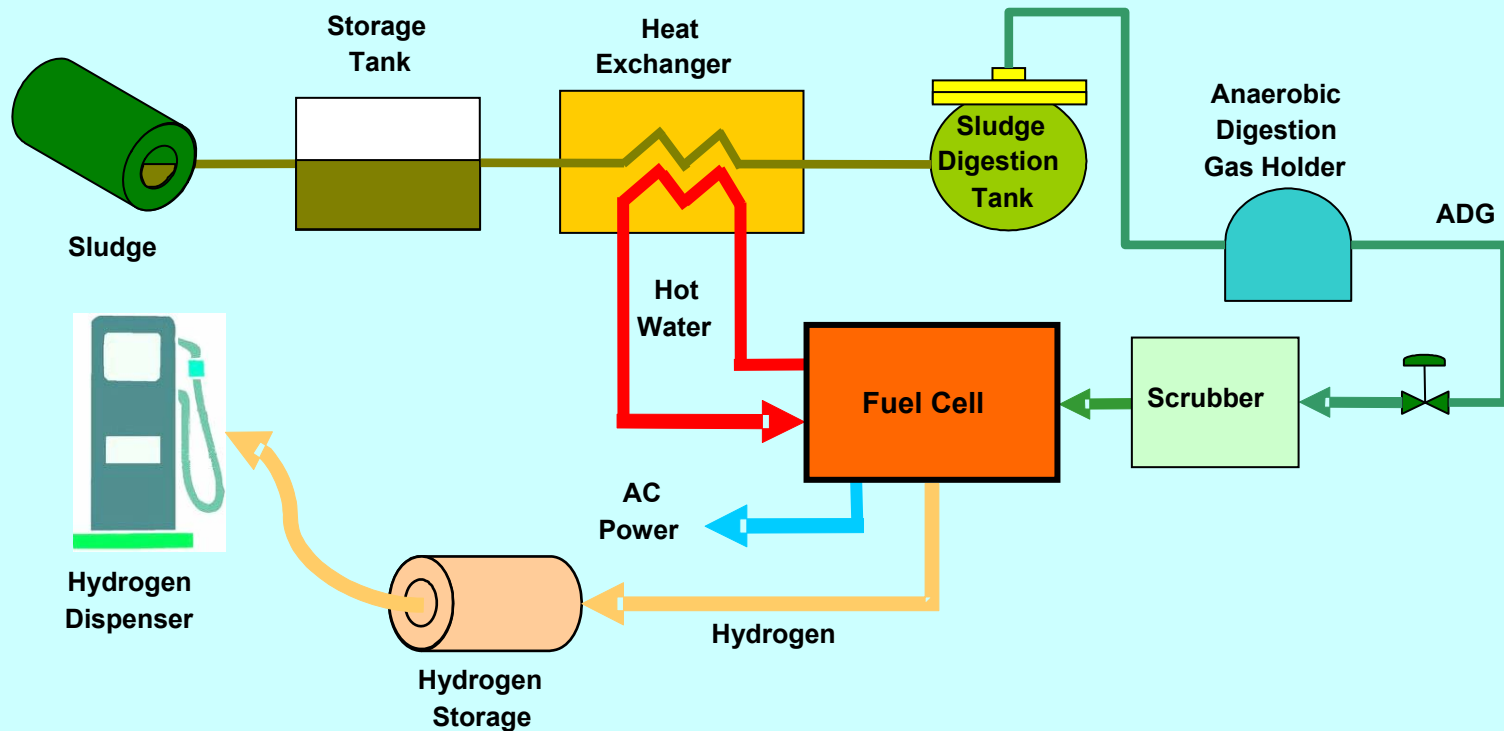
# Silent Camp Concept

- Increase GenSet Output to Electrolyze Water
- Store H<sub>2</sub> Produced from Electrolyzer
- Use Stored H<sub>2</sub> and Fuel Cell to Power Loads at Night
- Shut GenSet Off During Fuel Cell Operation
- Can Maximize Silent Camp Operation or Fuel Savings



24 Hour Load Profile

# FY07 Waste to Energy Energy Conservation Investment Program (ECIP) Project



DoDFuelCell ERDC/CERL Projects - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites Recycle Bin Mail Print Word Pad Notepad Internet Options

Address <http://dodfuelcell.cecer.army.mil/> Go

Google G Go 43 blocked Check Settings Links

# DoD FUEL CELL

## ERDC/CERL Projects

PAFC Demonstration | Climate Change Rebate Projects | DoD Hydrogen Initiatives  
Residential Demonstration | Research & Development | FC Test & Evaluation Center

- FUEL CELL APPLICATION GUIDE
- CALENDAR OF EVENTS
- WHAT'S NEW
- LIBRARY
- LINKS
- FEEDBACK FORM
- SEARCH
- SITE MAP



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Construction Engineering Research Laboratory.

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