U.S. Army Requirements-Driven Remote Power and Microgrid Opportunities

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08 APR 08

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Presentation Outline

• Introduction
• Background
• Goals and Requirements
  – Installation
  – Warfighter
• Army Funded Activities
• Acknowledgements
Engineer Research and Development Center (ERDC)

ERDC Headquarters, Vicksburg, MS
Director and Commander
- Coastal and Hydraulics Laboratory (CHL)
- Environmental Laboratory (EL)
- Geotechnical and Structures Laboratory (GSL)
- Information Technology Laboratory (ITL)

Cold Regions Research and Engineering Laboratory (CRREL) Hanover, NH
Topographic Engineering Center (TEC) Alexandria, VA

European Research Office

Map of the United States with locations of ERDC facilities marked.
Soldiers, Families, and Civilians

Home to the Force

Power Projection

Work & Training

... are our Customers!
Fuel Cell Demonstrations at Military Sites

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

- 30 Fuel Cells
- 30 Sites
- 1 Manufacturer

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

- 91 Fuel Cells
- 56 Sites
- 5 Manufacturers
FY05 DoD Energy Use
Total Site-delivered Energy (BTU)

Nation’s single largest energy user
(1% of total U.S. energy use & 78% of Federal energy use)

Commodity

Jet Fuel 71%
Electricity 18%
Fuel Oil 3%
Natural Gas 8%
Coal 1.6%
Diesel 2.3%
Auto Gas 0.7%
Steam 1%
Other 0.8%

Application

Vehicles 74%
Buildings 22%
Exempt 1%
Industrial 3%

$10.9B
919 Trillion BTU
The Army represents approximately:

- 19% of DoD Energy consumption
- 14% of DoD Fuel consumption
- 36% of DoD Utility consumption
Army Universe
Scope for Power and Energy Considerations
(FY06)

Installations
- IMCOM: 84
- Reserves: 4
- National Guard: 56
- AMC: 27
- Other: 5

Platforms
- Tactical (LTV/MTV/HTV): 235,000
- Combat (M1,M2/3, Stryker): 20,000
- Rotorcraft (Attack /Transport): 4,500
- Non Tactical Vehicles: 72,000
  (60,000 leased from GSA)

Forward Area Bases
- Support facility outside of CONUS
- Manned by U.S. military or host-nation nationals
- Capability determined by the forces and by the risks and costs of positioning specific capabilities at its location.

Environmental Clean-up
- Installation Restoration Program &
- Military Munitions Response Program
- Active Sites: 1,763
- BRAC Sites: 213
- Formerly Used Defense Sites: 2,153

Land Acreage
- United States: 15,174,634
- Europe: 162,174
- Asia: 51,291
- Other Overseas: 15,213

Buildings (million square feet)
- United States: 770
- Europe: 153
- Asia: 46
- Other: 7

Utilities
- Electric, gas, water and sewer - 47,803 miles

FY06 Army fuel and utility consumption:
- 412 M gallons of jet and multi-purpose mobility fuel at cost of $940 M
- 59 M gallons of diesel at cost of $123 M
- 20 M gallons of gasoline at cost of $45 M
- 330,000 gallons of biodiesel fuel at cost of $775 K
- $1.211 B annual utility cost for 77.3 BBtu

People
- Active: 482,400
- USAR: 205,000
- ARNG: 350,000
- Civilians: 229,000

as of 30 Sep 05
Ten largest U.S. Army installations ranked by the total number of on-base personnel (DOD 2005).

<table>
<thead>
<tr>
<th>Rank</th>
<th>Facility</th>
<th>Military Personnel</th>
<th>Total Installation Personnel</th>
<th>Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fort Bragg, NC</td>
<td>43,890</td>
<td>52,367</td>
<td>152,922</td>
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<tr>
<td>2</td>
<td>Fort Hood, TX</td>
<td>42,391</td>
<td>50,215</td>
<td>214,778</td>
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<tr>
<td>3</td>
<td>Fort Campbell, KY</td>
<td>28,753</td>
<td>33,395</td>
<td>35,985</td>
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<tr>
<td>4</td>
<td>Fort Benning, GA</td>
<td>27,627</td>
<td>32,600</td>
<td>171,873</td>
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<tr>
<td>5</td>
<td>Fort Lewis, WA</td>
<td>21,893</td>
<td>27,932</td>
<td>86,041</td>
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<tr>
<td>6</td>
<td>Fort Leonard Wood, MO</td>
<td>21,873</td>
<td>26,247</td>
<td>62,911</td>
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<tr>
<td>7</td>
<td>Fort Jackson, SC</td>
<td>22,351</td>
<td>26,076</td>
<td>52,301</td>
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<tr>
<td>8</td>
<td>Fort Sill, OK</td>
<td>18,735</td>
<td>22,796</td>
<td>93,831</td>
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<tr>
<td>9</td>
<td>Fort Knox, KY</td>
<td>15,359</td>
<td>20,135</td>
<td>109,054</td>
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<tr>
<td>10</td>
<td>Fort Stewart, GA</td>
<td>13,628</td>
<td>19,317</td>
<td>279,271</td>
</tr>
<tr>
<td>Rank</td>
<td>Facility</td>
<td>Average Annual Demand</td>
<td>Summer Peak Electricity Demand</td>
<td>Minimum Demand</td>
</tr>
<tr>
<td>------</td>
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<td>----------------</td>
</tr>
<tr>
<td>1</td>
<td>Fort Bragg, NC</td>
<td></td>
<td>100-110 MW peak going to 150 MW</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fort Hood, TX</td>
<td></td>
<td>99 MW</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fort Campbell, KY</td>
<td>~30 MW</td>
<td>48-56 MW (32-38 MW winter peak)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Fort Benning, GA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Fort Lewis, WA</td>
<td>27 MW</td>
<td>36 MW</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fort Leonard Wood, MO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fort Jackson, SC</td>
<td>~ 20 MW</td>
<td>31 MW summer peak, 23 MW winter peak</td>
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<tr>
<td>8</td>
<td>Fort Sill, OK</td>
<td>19.4 MW</td>
<td>36 MW</td>
<td>8-10 MW winter night</td>
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<tr>
<td>9</td>
<td>Fort Knox, KY</td>
<td>22.36 MW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Fort Stewart, GA</td>
<td></td>
<td></td>
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**Averages**

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<tr>
<th></th>
<th>1.53</th>
<th>0.60</th>
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</thead>
</table>


Goals and Requirements

✓ 2005 Army Energy and Water Campaign Plan
✓ 2005 Energy Policy Act
• 2006 TRADOC Pamphlet 525-66,
  – FOC-09-03: Power & Energy
  – FOC-08-04: Installations as our Flagships
• 2007 Executive Order 13423
✓ 2007 SERDP SON for Scalable Power Grids
Army Energy Strategy for Installations

• The 2005 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*
What is Energy Security?
Utility Reliability?

- Energy security is the capacity to avoid adverse impact of energy disruptions caused either by natural, accidental or intentional events affecting energy and utility supply and distribution systems.
Energy Policy Act of 2005

• Effective on August 8, 2005

• Federal Facilities Provisions
  – Energy Reduction Goals - 20% by FY 2015
  – Energy Efficient Buildings - 30% better than ASHRAE standards
  – Renewable Energy – Purchase 7.5% or more in 2013 and beyond *(DoD Internal Policy is 25% by 2025)*
  – Energy Efficient Products – Install Energy Star or FEMP designated products
The Objective of this SON is to Provide DoD Installations with the Capability to Network Distributed Generation (DG) Technologies, Including Renewables, Especially at Mission Critical Facilities.

- Robust Network Topology Dynamics
- Dynamic Response of Distributed Control Strategies
- Mission-Based Load Shedding and Algorithms
- Conduct Simulation-Based Microgrid Experiments

• Released February 2008

• Recommendation #2: Reduce the Risk to Critical Missions at Fixed Installations from Loss of Commercial Power and Other Critical National Infrastructure.
  – Develop a plan to “Island Critical Missions from the Grid by December 2008
  – Require that all DoD Installations Meet a “Net Zero” Energy Standard by 2025
$ / Gallon of Delivered Fuel to Battlefield

$ 10 – Truck Convoy Driven from Kuwait
$ 40 – Cargo Ship from Overseas
$ 400 – Flown in Via Aircraft

$$ What Cost in Lives ??
How Do We Get There?
To be successful, the Army Campaign Objectives need a Full-Spectrum Power Architecture ... microgrid concept

VAC = AC voltage
VDC = DC
TOC = Tactical Ops Ctr
HEV = Hybrid Elec Veh

Power Conditioning
Control & Distribution Architecture
Energy Storage

HVAC

Forward Camp
Installation
Training

Batteries
Gen Sets
Wind
Solar
Combined Heat & Power
Biomass
Fuel Cells

Heat

HEV
TOC

VAC = AC voltage
VDC = DC

TOC = Tactical Ops Ctr
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