



U.S. ARMY

ENERGY RESEARCH PLANS FOR THE ENGINEERING RESOURCES BRANCH

Energy Systems in Cold Region Climates

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Prepared for Ron Liston Seminar Series
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US Army Corps of Engineers



DISCOVER | DEVELOP | DELIVER

ABOUT ME...NOT YOUR TYPICAL ENGINEER

- Chemical Engineer
- JD (Energy), Masters Environmental Law and Policy



- U.S. Environmental Protection Agency
- U.S. Department of Energy
- U.S. Army Corps of Engineers – ERDC/CRREL



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WHAT DID I LEARN IN DC THAT HELPS AT CRREL?

- C.O.O.L acronyms that **C**reate **O**utstanding **O**ppportunistic **L**ingo!
- Don't abuse Power Point!
- Follow the Money!
 - Consumers, funders, appropriators...why they spend, what challenges they are trying to address



Enough said!

AT CRREL...ALL ABOUT ENERGY

Energy Needs Engineering Research, Yay!

*What kinds of
energy topics
are you
thinking about?*

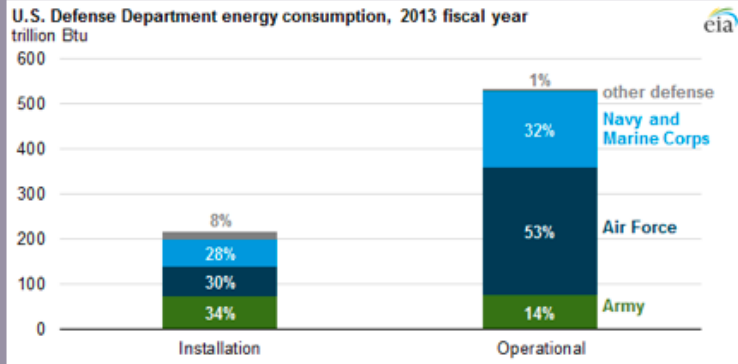
*All things
DoD/Army and
energy
(especially in the
cold)!*

- Learning what others are doing
- Identifying R&D opportunities
- Finding funding...and partners



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DoD & ENERGY

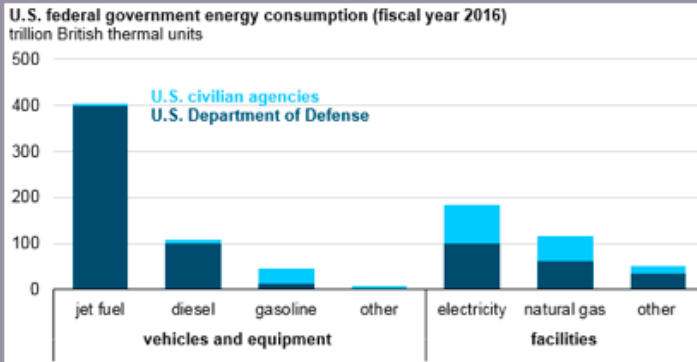
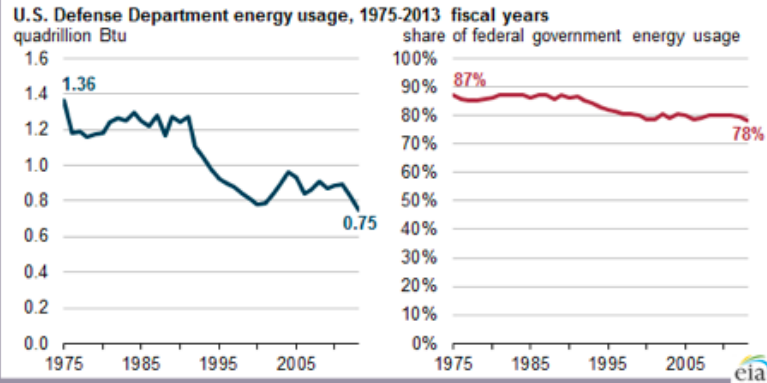


Installation energy is the energy required to run and operate military installations, which is mainly energy used in buildings but also energy used by vehicles not on combat missions.

Operational energy, which accounts for 70% of total DoD energy use, is the energy required for transporting, training, and sustaining personnel and weapons specifically for military operations.



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Figures from Energy Information Administration

WHY ENERGY NOW?

- **Federal Statutes**
 - Title 10 U.S. Code: Operational Energy Activities; Energy Security; ... (*not really new*)
 - 2005 Energy Policy Act
 - 2007 Energy Independence and Security Act
 - 2018 National Defense Authorization Act set new energy policy that requires the secretary of defense to "ensure the readiness of the armed forces for their military missions by pursuing energy security and energy resilience"
- **Federal Policies and Guidance (e.g., OMB, Executive Orders)**
 - EO 13693, DOD Net Zero Goals
- **DoD Energy and Sustainability Policy**
 - DoD Energy Policy, DoD Directive 4180.01, (10 Aug 2017)
 - DOD Management of Energy Commodities: Overview, DOD Manual 4140.25, Volume 1 (1 Mar 2018)
- **Army Energy and Sustainability Policy**
 - Army Operational Energy Policy (30 Apr 2013)
 - Army Energy Security and Sustainability Strategy (ES2) (1 May 2015)
 - Installation Energy and Water Security Policy (Army Directive 2017-07) (23 Feb 2017)



For more information, see: <https://www.asaie.army.mil/Public/ES/policy.html>

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Not an exhaustive list.

ARMY'S MODERNIZATION PRIORITIES

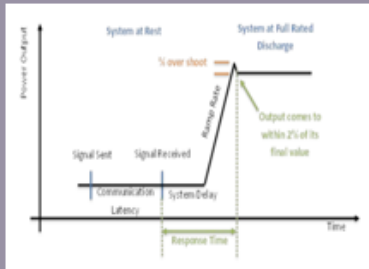
| | |
|---|--|
| Long-Range Precision Fires | |
| Next Generation Combat Vehicles | <ul style="list-style-type: none"> Directed Energy and Energetics- To leverage directed energy and energetics in lethal, non-lethal and protection applications that increases survivability and lethality. Power Generation and Management- To create the capability to service all platform energy needs via alternative energy means increasing operational range and reducing sustainment demands. |
| Future Vertical Lift | <ul style="list-style-type: none"> Future Vertical Lift will maintain an early and continuous focus on reliability and maintainability to create maintenance free operating periods and reduce forward logistics burdens, while also establishing an affordable life cycle of sustainment. |
| Army Network | <ul style="list-style-type: none"> Focused on integration, speed and precision to ensure the Army's capability development process is adaptable and flexible enough to keep pace with the rate of technology change |
| Air and Missile Defense Capabilities | |
| Soldier Lethality | <ul style="list-style-type: none"> Adaptive Soldier Architecture- This architecture will standardize data and power interfaces and connection points across the Soldier and squad and will standardize data, power interfaces and connection points across the Soldier and squad combat platform. |



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For more info, see <https://www.army.mil/standto/2018-06-06>.

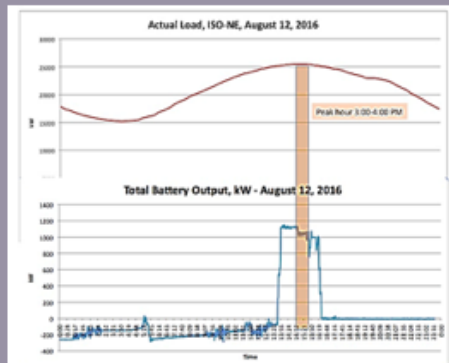
ENERGY PROJECTS – IMPACT TO THE ARMY



- Understanding the cost-benefit for different energy technologies informs prudent investment decisions
- Use of energy storage technologies can defray peak electricity costs (saving \$\$)
- Reduced risk w/r/t refueling missions



- Identify appropriate energy technologies to support more resilient installation operations
- Reduce negative implications of power interruptions and refueling
- Increase access to reliable power sources for remote applications



Atrex Energy SOFC using propane in cold temps

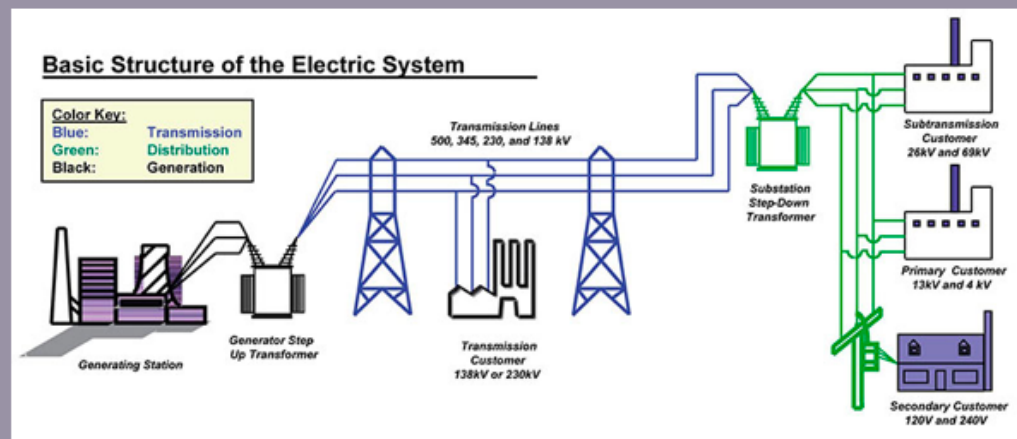


US Navy SOFC using solar/seawater

- Increased energy security and independence
- More flexibility for remote applications, in cold regions
- Ultimately, leverage more readily available energy resources
- Flexible test station to look at other design parameters to meet additional Army needs

WHAT'S THE PLAN?

- Understand Energy Systems
 - Providers
 - Community relationships
 - Applicable innovative technologies
- Understand DoD/Army Energy
 - ...in cold regions
 - ...in austere environments
 - ...for critical loads
 - ...for non-critical loads



- Support energy resilience for DoD/Army
 - Through improved situational awareness
 - Through thoughtful innovation
 - Through strategic energy management

SHORT TERM PLAN

DoD "ilities"



The operational and support requirements a program must address (e.g., availability, vulnerability, producibility, reliability, maintainability, logistics supportability).



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Technology Innovation

- Generation alternatives (e.g., solid oxide fuel cells)
- Waste heat utilization (e.g., stirling cycle engines)
- Energy storage (both thermal and electrical)

System Innovation

- Microgrid design
- System controls

Situational Awareness

- Improved data utilization
- Decision support tools

Fuel Diversity

- Diesel, propane, natural gas, JP8
- Solar, wind, geothermal, hydro

INSTALLATION RESILIENCE IN COLD REGIONS USING ENERGY STORAGE SYSTEMS

PROBLEM STATEMENT

- Army Installations in cold regions, especially remotely located require electricity to sustain operations
- Reliable and resilient electricity is especially necessary for critical infrastructure
- Energy storage technologies can, generally, provide on-site, readily deployable electricity supply to meet these needs

TECHNICAL OBJECTIVE

- Understand energy storage technologies capabilities
 - ...in cold regions
 - ...in remote locations
 - ...to meet critical Army installation electricity needs
- Document findings as guidance for acquisition/design decisions regarding deployment of energy storage on Army installations

Q: Which energy storage technologies are most suitable for cold region and remote applications to sustain critical installation infrastructure?



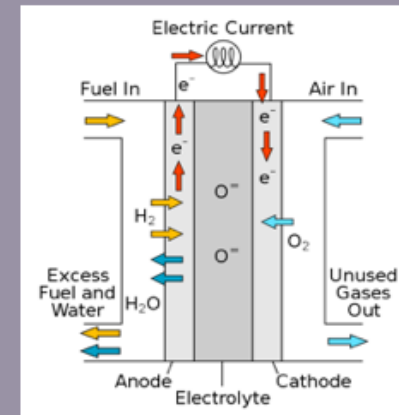
COLD REGION APPLICATION OF STATIONARY FUEL CELLS TO POWER CRITICAL INSTALLATION INFRASTRUCTURE

PROBLEM STATEMENT

- Army Installations in cold regions, and remotely-located, require electricity to sustain critical operations
- Independent back-up or primary power that can withstand power disruptions is needed
- Fuel cells are generally used to support infrastructure resilience as backup generation or remote power generation, mostly in temperate climates

TECHNICAL OBJECTIVE

- Understand commercial fuel cell capabilities
 - ...in cold regions
 - ...in remote locations
 - ...to meet critical Army installation electricity needs
- Document findings as guidance for acquisition/design decisions regarding deployment of fuel cells on Army installations for critical infrastructure (and broader application)



Q:

Can commercially available fuel cell technologies support critical installation infrastructure in cold region climates and remote locations?

LONG TERM PLAN...FOR COLD REGIONS AND BEYOND

AIR UNIVERSITY
AIR FORCE OFFICER PROFESSIONAL
EDUCATION CENTER
AIR FORCE FELLOWS



Department of Defense Energy Strategy *Teaching an Old Dog New Tricks*

Department of Defense
Energy Strategy
Teaching an Old Dog New Tricks

GREGORY J. LENGEL
Colonel, USAF

Walker Paper No. 10

Air University Press
Maxwell Air Force Base, Alabama 36112-5962

January 2008



COLD REGIONS
RESEARCH AND
ENGINEERING
LABORATORY

- Identify & Mitigate Vulnerability
- Increase Situational Awareness
- Improve Energy Security

Typical Bases – Planning Snapshot

| | Occupancy | Power | Water |
|--------------------|-------------------|-------------|-------------------|
| Large | ~5-25k+ personnel | 3-20+ MW | 65k-850k gal/day |
| Medium | 500-5000 | 250KW – 3MW | 6.5k-170k gal/day |
| Small | 10-500 | 2KW – 250KW | 130-17k gal/day |
| Per Soldier/Person | | 0.7kW | 13-34 gal/day |

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MICROGRIDS

Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) -- cybersecurity, physical disruptions, "fuel" diversity

Fort Custer Microgrid Model – replicable; designed to implement energy surety goals of "neighboring" bases

Marine Corps Air Station Miramar, San Diego -- natural-gas generators, diesel generators, landfill-to-gas, battery storage, 1.2 megawatts of solar PV

...

CRREL – FUTURE TEST BED for cold region microgrid design and energy system technology testing (just maybe!)

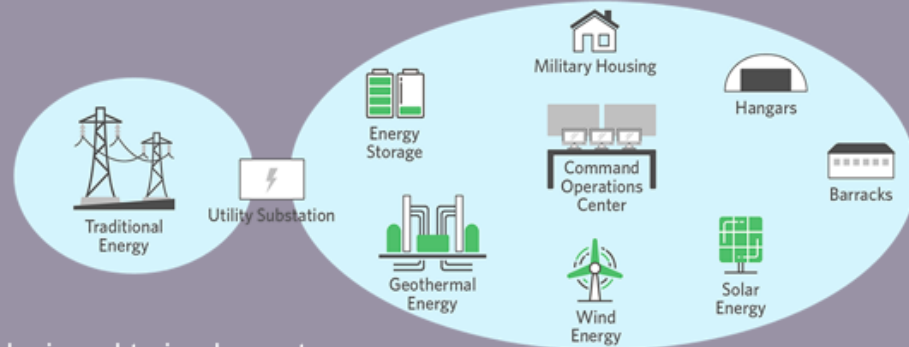
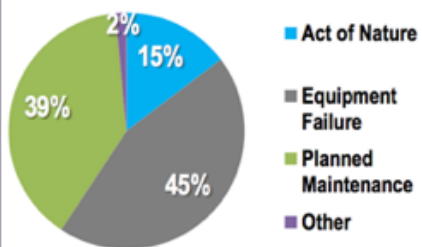


Image Source: Black & Veatch

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RESILIENCE

FY 2016 Utility Outages



- Utility disruption data is required under Title 10, 2925(a)
- Disruption data informs on-going metrics guidance

Details on OASD(EI&E) Energy Resilience Initiatives:
http://www.acq.osd.mil/eie/IE/FEP_Energy_Resilience.html



Department of Defense Resilient Energy Systems



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Map figure from: <https://www.greentechmedia.com/articles/read/for-the-u-s-military-energy-resilience-has-long-been-a-priority#gs.bv12gZd4>

Utility Outages Stats from: https://www.energy.gov/sites/prod/files/2017/06/f34/5_Storage%20and%20Microgrids%20Panel%20-%20Ariel%20Castillo%2C%20DoD.pdf

MORE COLLABORATORS...NEED AND KNOWLEDGE

Within the Federal Family

- DoD
 - Army – Installation Partners
 - ▶ ERDC labs
 - Within CRREL
- DOE
 - Energy Storage Program
 - Federal Energy Management Program
 - Microgrid expertise
 - ...other energy-related research programs
 - DOE National Labs

Beyond the Federal Family

- Industry collaborators
 - Work together to further existing technology for “cold region” applications
- NGOs
 - Leverage interests to identify R&D project opportunities, demos, etc.
- States/State Energy Offices
 - Lessons learned
 - Research agencies



UNIVERSITY COLLABORATIONS...TO ADDRESS BASE ENERGY CHALLENGES AND SIMILAR COMMUNITY CHALLENGES

In Alaska...

- Leverage CRREL's Permafrost Tunnel and Farmer's Loop Facilities as demo/test locations for energy technologies
- Work with DoD installations in Alaska to develop an "Energy Atlas" for DoD lands in Alaska (potential model for other DoD lands)

In New England...

- Leverage local understand of cold climate demands to develop "cold region resilient" energy systems for use locally and on cold region and remote DoD/Army installations
- Understand cold region implications on generation, system controls, storage, etc. and develop solutions where performance issues are identified



STAY TUNED FOR MORE PROJECT DETAILS AND PROGRESS...

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