Validating Innovative Renewable Energy Technologies: ESTCP Demonstrations at Two DoD Facilities

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14. ABSTRACT

With stated goals of 25% of energy consumed required to be from renewable energy by 2025, the DoD has set aggressive, yet achievable targets. With its array of land holdings facilities, and environments, the potential for renewable energy generation on DoD lands is great. Reaching these goals will require implementation of new technologies across the DoD. However many technologies have not undergone technical, economic, or environmental field validation. Wide spread implementation of such technologies may be hindered by the lack of credible information. Two current demonstration projects funded by the ESTCP program will be discussed. The first project utilizes technology provided by Vanir Energy and Power Partners?solar thermal panels to provide hot water to the domestic hot water system and an adsorption chiller, providing 80 tons of cooling capacity to a mess hall at MCRD Parris Island, SC. The second project implements a novel thermal oxidizer?microturbine technology provided by Flex Energy, that allows for the generation of electricity using low BTU waste gases that are typically flared or vented. In this application, the unit is utilizing low BTU methane from a landfill at Fort Benning to produce up to 250 kw of electricity. Information on system design, operation, and impacts?economic payback, emission reductions and renewable energy production will be provided. The applicability of the technologies throughout DoD will also be discussed?including the potential landfill sites throughout DoD where the turbine technology could be applied, and the primary solar energy resources available at DoD facilities.

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DEMONSTRATION OF TWO RENEWABLE ENERGY TECHNOLOGIES FOR DOD INSTALLATIONS – SOLAR CHILLING AND LANDFILL GAS-TO-ENERGY

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Information on system design, operation, and impacts—economic payback, emission reductions, and renewable energy production will be provided. The applicability of the technologies throughout DoD will also be discussed—including the potential landfill sites throughout DoD where the turbine technology could be applied, and the primary solar energy resources available at DoD facilities.

Acknowledgements

Lead Organization:

- Southern Research Institute

Co-Performers:

- U.S. EPA's Environmental Technology Verification (ETV) Program
- FlexEnergy (Microturbine Supplier)
- Vanir Energy (Solar Chiller System Supplier)
- Power Partners (Adsorption Chiller Supplier)

Host Sites:

- Fort Benning, GA – 1st Division Road Landfill
- MCRD Parris Island, SC – Mess Hall

Funding & Support:

- ESTCP – Projects EW-0823 and EW-0928

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ETV

FLEXENERGY

VANIR Energy Renewing the Future

POWER PARTNERS, INC.

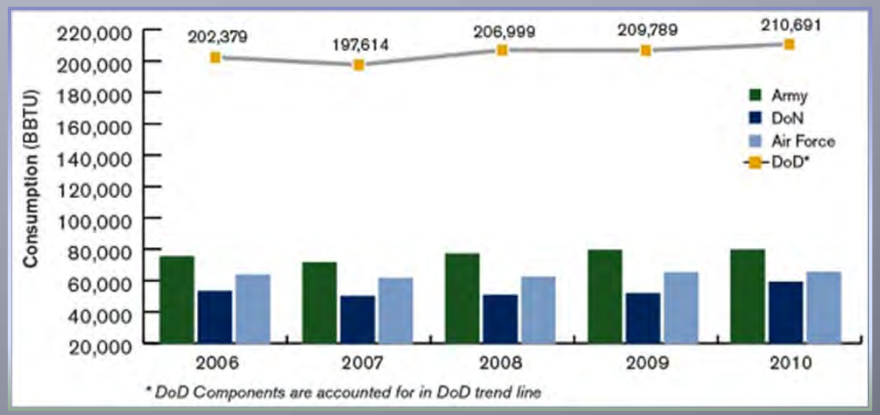
UNITED STATES MARINE CORPS

MANEUVER CENTER OF EXCELLENCE FORT BENNING

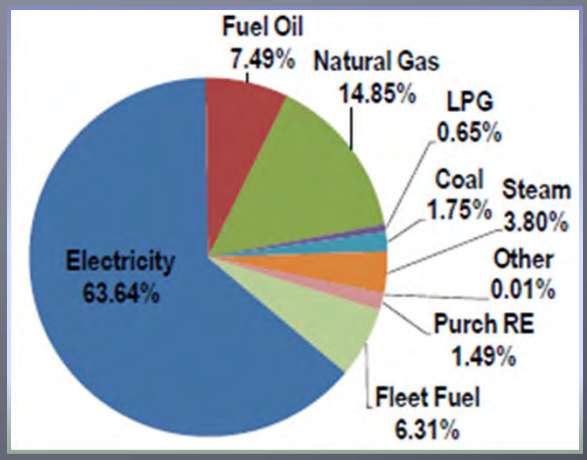
ESTCP

Defense Energy

- America's largest energy consumer
- Over 300,000 buildings at over 500 domestic installations
- ~$3.5 Billion/yr on facility energy (28% of DoD total)
- ~40% of DoD GHGs



http://www.acq.osd.mil/ie/energy/DoD_AEMR_FY2010__July_2011[1][1].pdf



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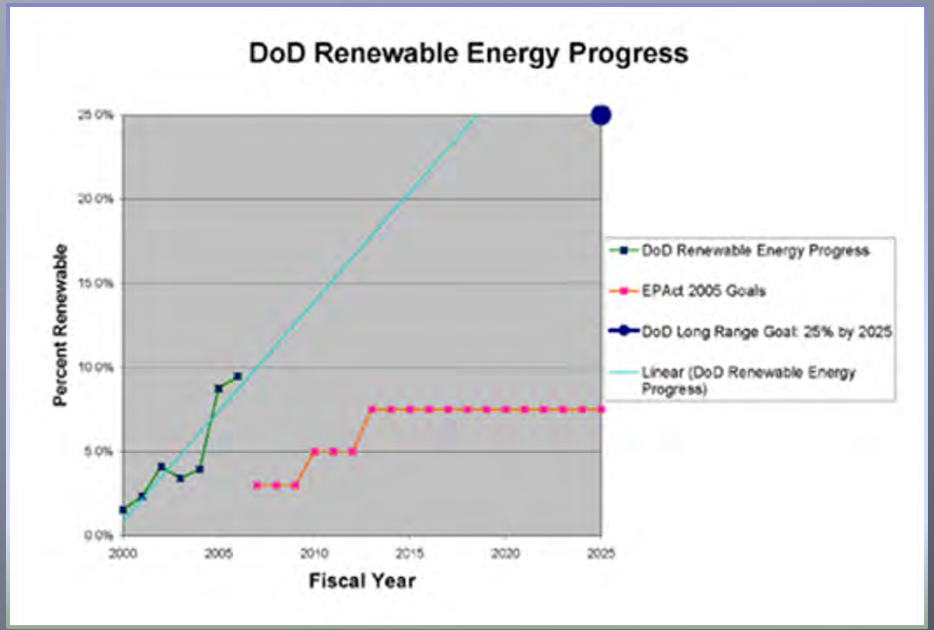
DoD Renewable Energy Goals

- Renewable Energy goals influenced or set by:
  - EPAct 2005
  - National Defense Strategy June 2008]
  - Executive Order 13423
  - National Defense Authorization Act 2007
  - 2007 EISA
- Progress made, but a long way to go



ESTCP Demonstration of Renewable Energy Technology

- Installation Energy Test Bed Initiative
- Prove out innovative systems via in field demonstration and validation:
  - Economics
  - Environmental
  - Operability (install, operate, maintain)
  - Regulatory, permitting, approvals
- Encourages adoption and more rapid commercialization and installation
- http://www.serdp-estcp.org/Featured-Initiatives/Installation-Energy.

Energy from Low Quality Landfill Gas

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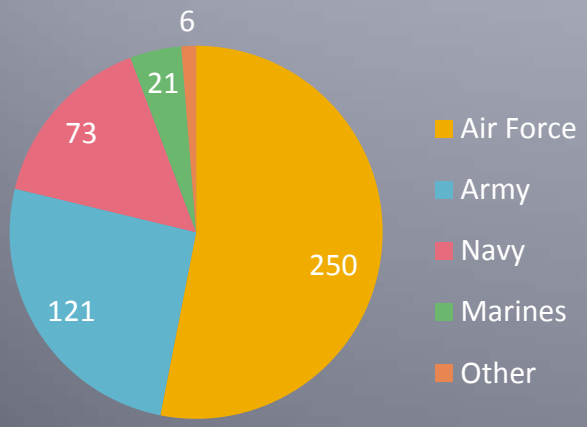
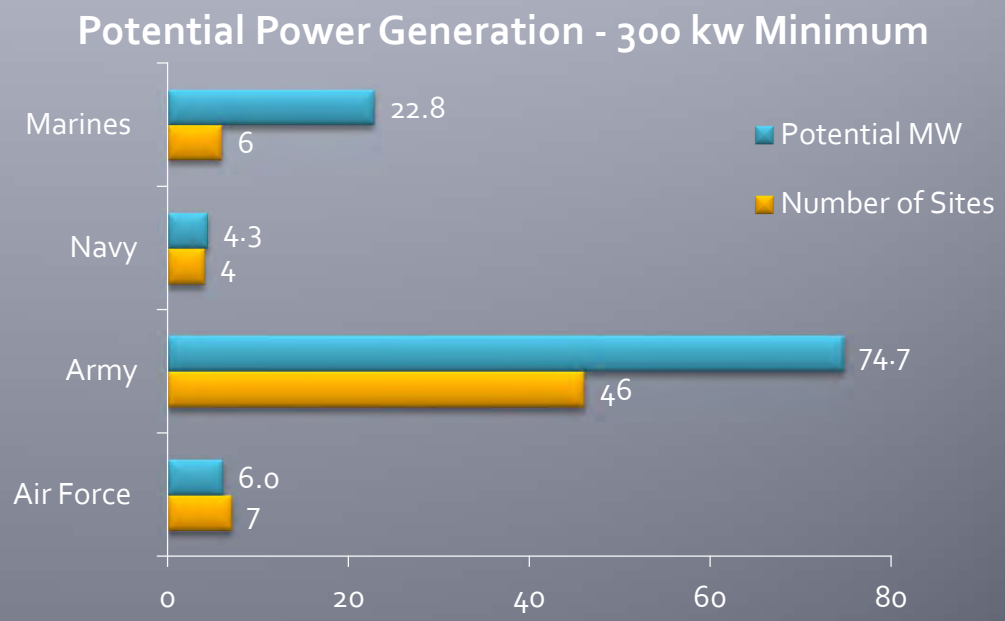
Energy in DoD Landfills





- Often vented or flared
- Many sites low quality gas
- No gas collection
- Environmental issues

- Baseload Renewable Power
- Reduce Emissions (GHG, other)
- Independent Energy Source
- Make $ Instead of Spending

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Potential Landfill Energy Solutions

Figure 1: Traditional Gas Turbine with Required Fuel Cleaning and External Combustion

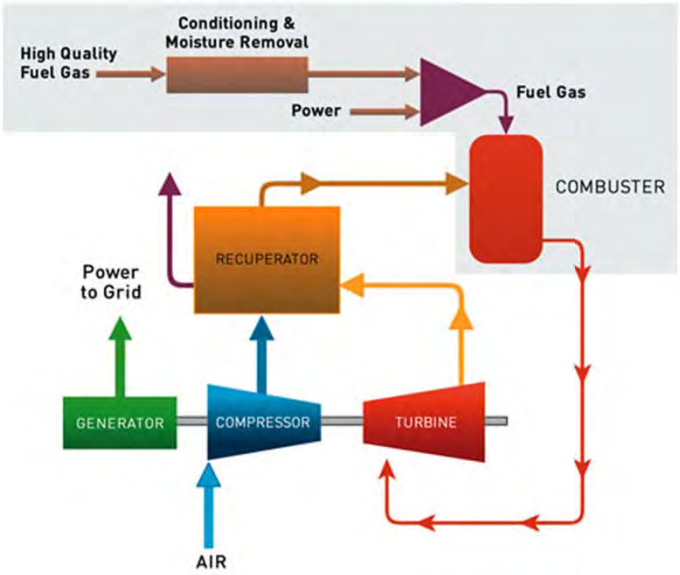
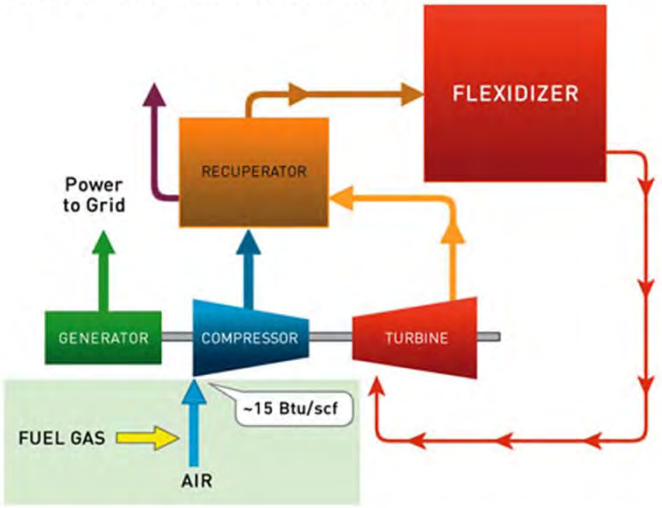


Figure 2: Flex Powerstation™ : Low Btu Gas Solution



- Traditional Systems (Engine or Turbine):
  - 350 BTU/scf
  - May not meet emission standards (CARB)
  - Complex gas conditioning and cleanup
- Flex Powerstation FP 250
  - 50 BTU/scf minimum
  - Very low NOx and CO
  - Minimal, simple gas cleanup
  - No fuel compressor

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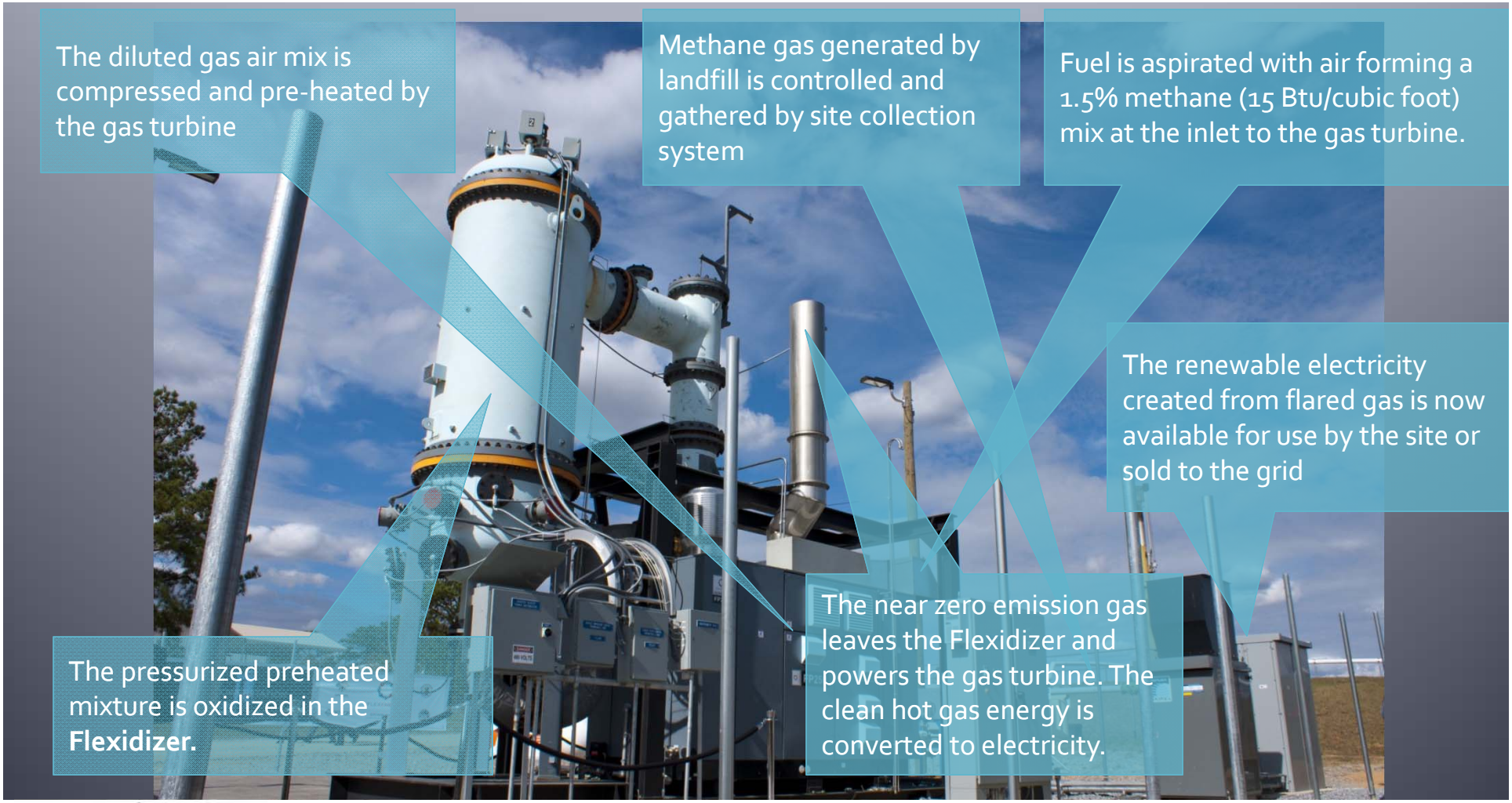
Flex Powerstation Specifications

Parameter	Specification
Nominal Electrical Output	250 kW
Minimum Fuel Strength	50 Btu/scf
Minimum Fuel Supply Pressure	2-5 psig
NOx , CO Concentration in Exhaust	<1 ppm
Gas Heat Rate	3,750,000 btu/hr
Exhaust Gas Temperature	450-500 F
System Weight	54,000 lbs
System Footprint	20 ft x 12 ft

Flex Powerstation Technology Description



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Ft. Benning 1st Division Road Landfill

- 48 acres – MSW and mixed waste
- 2.3 million cubic yards / 1 million tons waste
- Operated 1985 – 1998
- Methane migrating off site
- 39 collection wells
- Existing LFG flare

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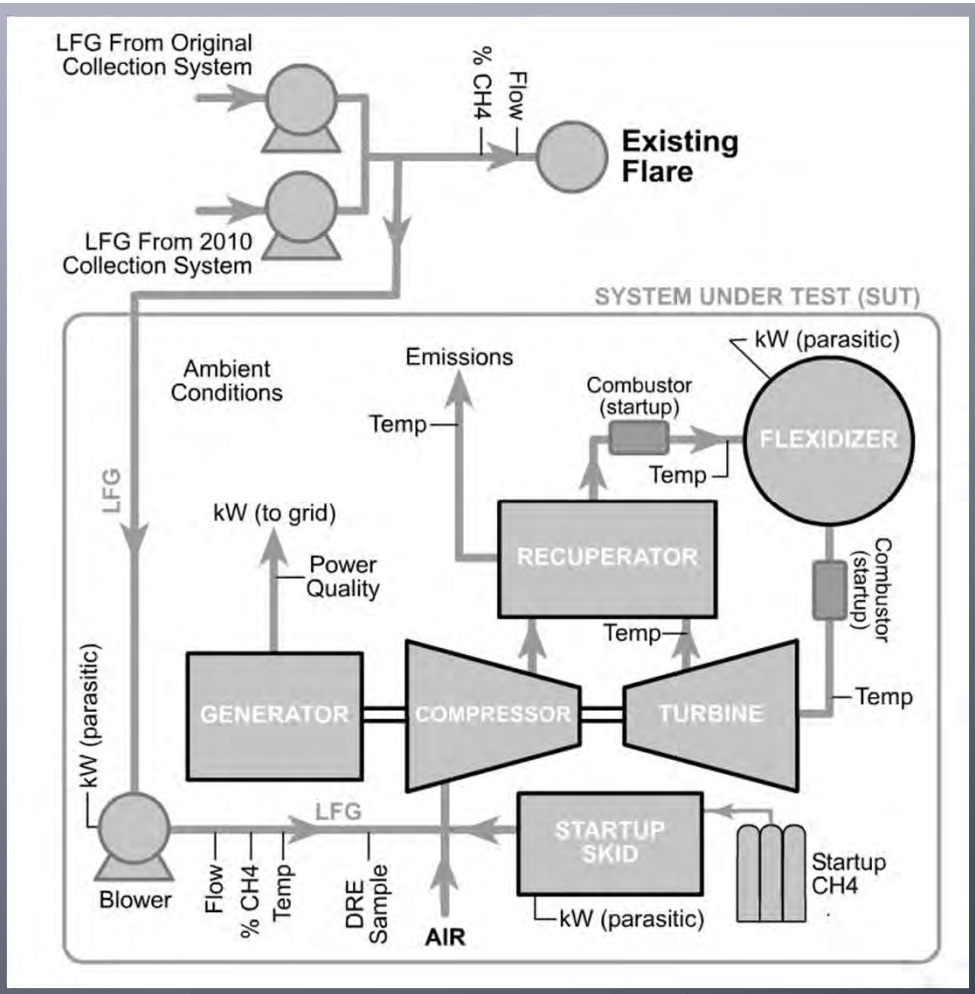
Flex FP250 Installation at Ft. Benning

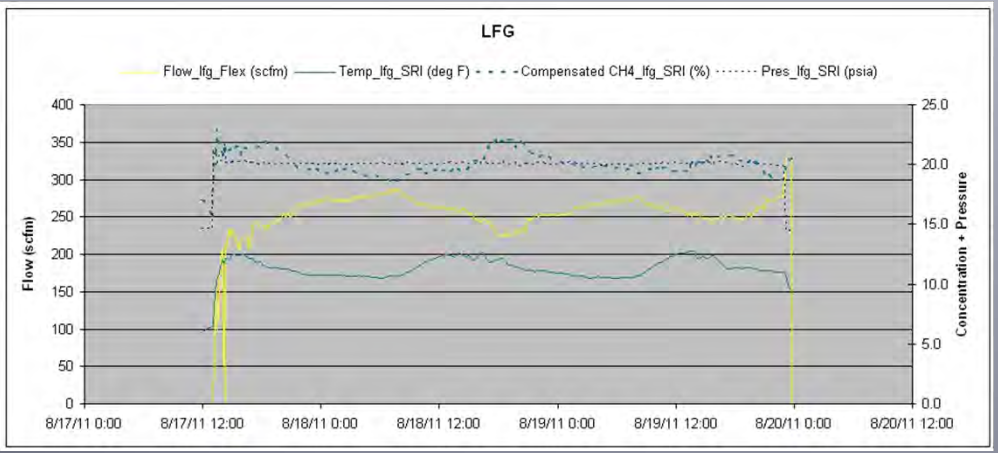
- Commissioned September 29, 2011
- Dedicated November 8, 2011

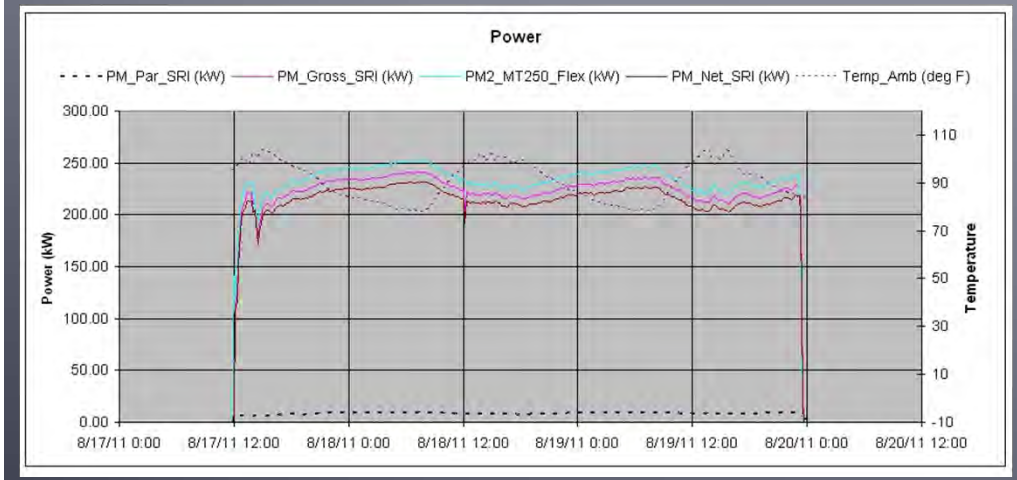
Demonstration Technical Approach

- Complete independent verification testing
  - Monitor for one year
  - Emissions and destruction efficiency evaluation
- ETV Generic Protocol for DG-CHP Verification as basis for monitoring, instrumentation, and data analysis



Preliminary Results – To Date





Parameter	Result to Date
Total Hours*	313
Total MWh (Gross)	85.4
Total MWh (Net)	80.7
Average Output	221 kW
Avoided CO_2e	18.6 tons
Electricity Savings	$1817 ($3326)
Projected Annual Savings	$113,861 ($196,502)
Projected CO2 Avoidance	1285 tpy CO_2e

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Future Plans

- Continued Operation and Monitoring
- Emissions Testing – early 2012
- Second installation – finalizing site selection



- Guidance Document development
- System improvements (Flex Energy)

Solar Cooling for DoD Buildings

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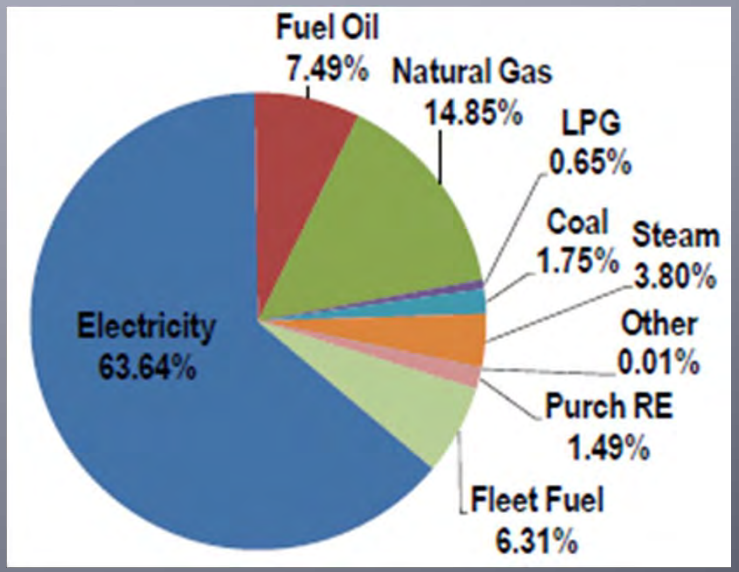
Building Energy Consumption

- Estimates show that 38% of building electricity use is related to cooling (LBNL)
- Many steam (nat. gas) driven chillers also
- Many opportunities for energy and cost savings to meet DoD goals



Solar Cooling Solution: Vanir Energy and Power Partners

- Use proven solar thermal to provide low grade heat (hot water)
- Use a*d*sorption chiller driven by low grade heat or steam to provide cooling
- Offsets electricity or natural gas usage of traditional systems
  - Reduces GHG emissions
  - Reduces operating costs
- Can also provide hot water or space heating for optimum efficiency

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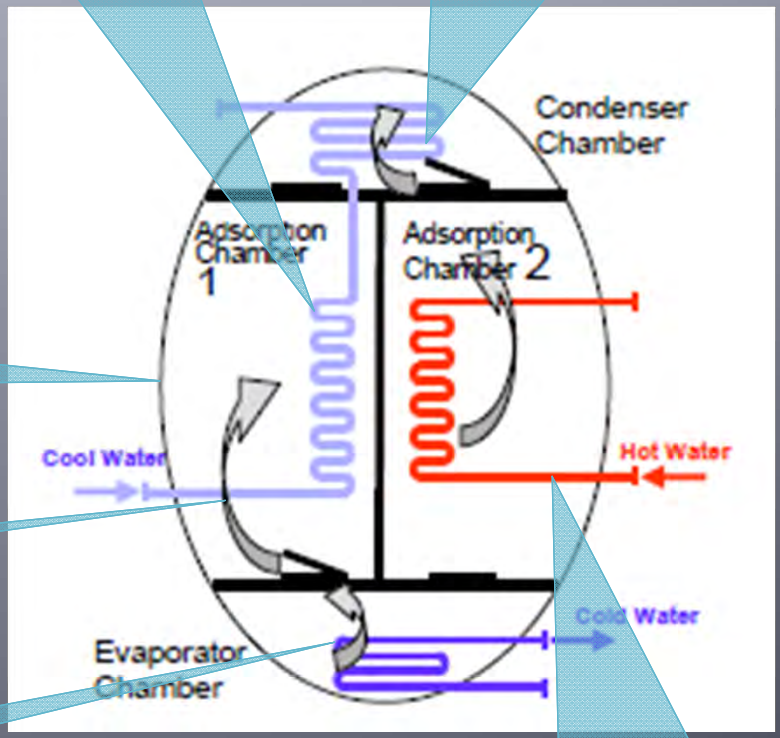
The Adsorption Chiller

- Use low grade or waste heat
- Driven by hot water
- Low energy consumption
- Low maintenance
- Water (refrigerant) and silica gel (dessicant)

▪Cool water removes heat

▪Vapor condensed and sent to evaporator



▪Operates at near full vacuum

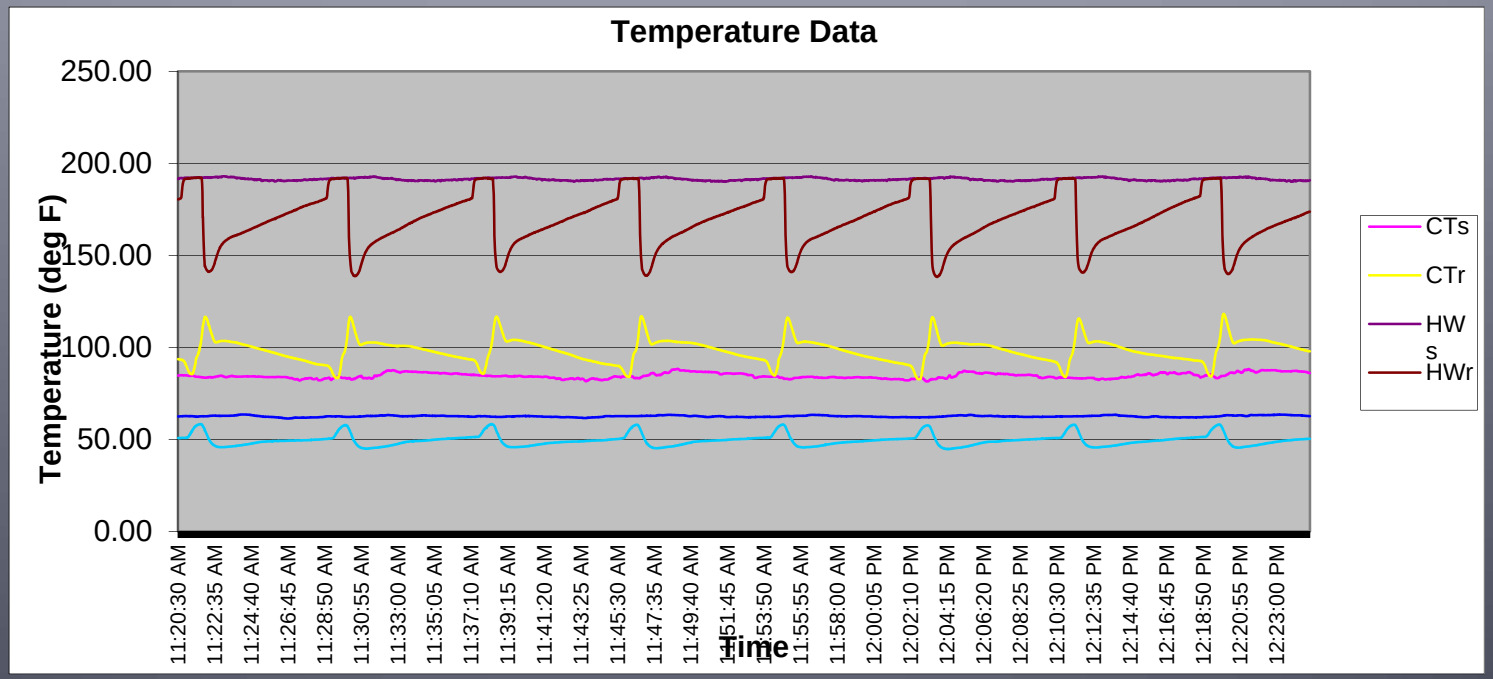
▪Water vapor adsorbed by silica gel

▪Evaporation creates cooling

▪Hot water evaporates adsorbed water

Ecomax Chiller Performance

- COP of 0.57; Average hot water =160 F
  - 76 RT capacity
  - Supply temp = 58F
  - Chilled Water Temp = 49 F (avg.)
- Max RT = 109 @ COP = 0.43



Solar Chiller Retrofit System

- 80 RT adsorption chiller
- 84 roof-mounted evacuated tube collectors
- Supports a max. 38 RT load on chiller
- Steam backup and peaking
- 1,000 gallon hot water storage tank
- Capability for full operation on steam
- New, larger capacity cooling tower
- Pumps, piping, instrumentation, controls
- Existing 60RT electric chiller
- Solar for hot water heating when not chilling

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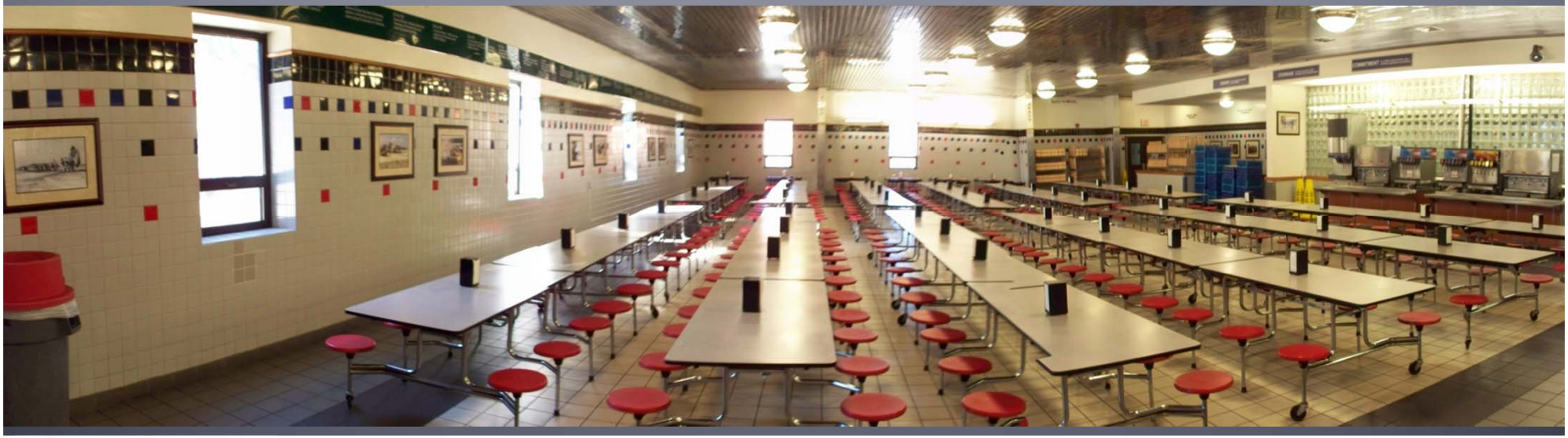
MCRD Parris Island, SC

- Building 590 – 1st Battalion Mess Hall
- Formerly steam for heat, cooling, and hot water
- Steam driven LiBr absorption chiller, supplemental electric compressor chiller
  - Trane Chiller with ~90 RT capacity & nameplate COP of 0.62
- Cool roof & rooftop solar panels reduce cooling requirement to <80 RT



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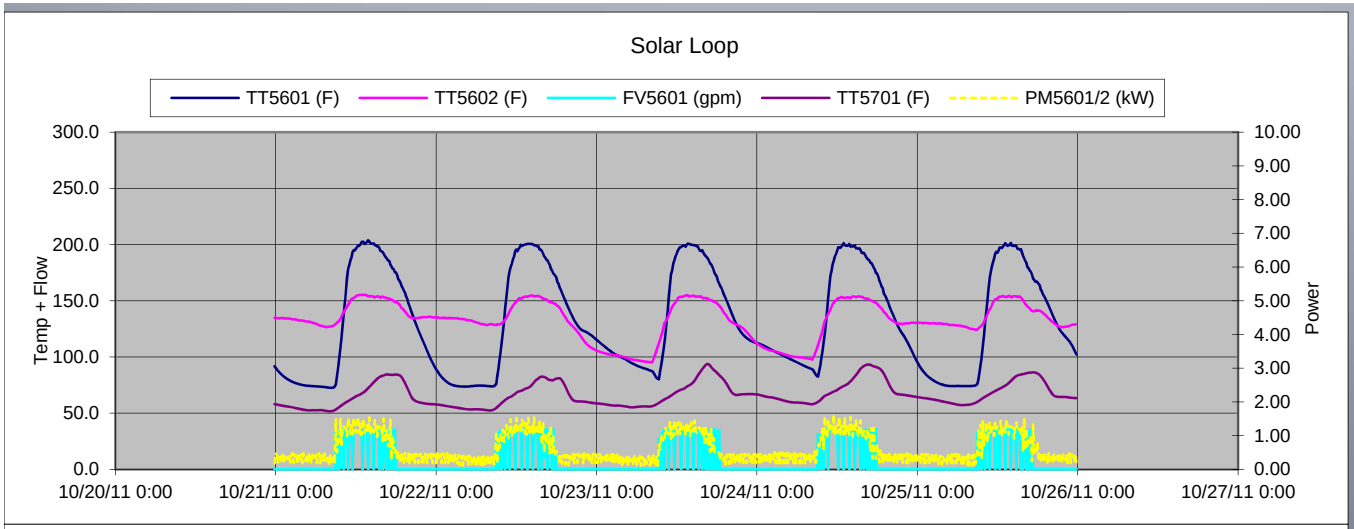
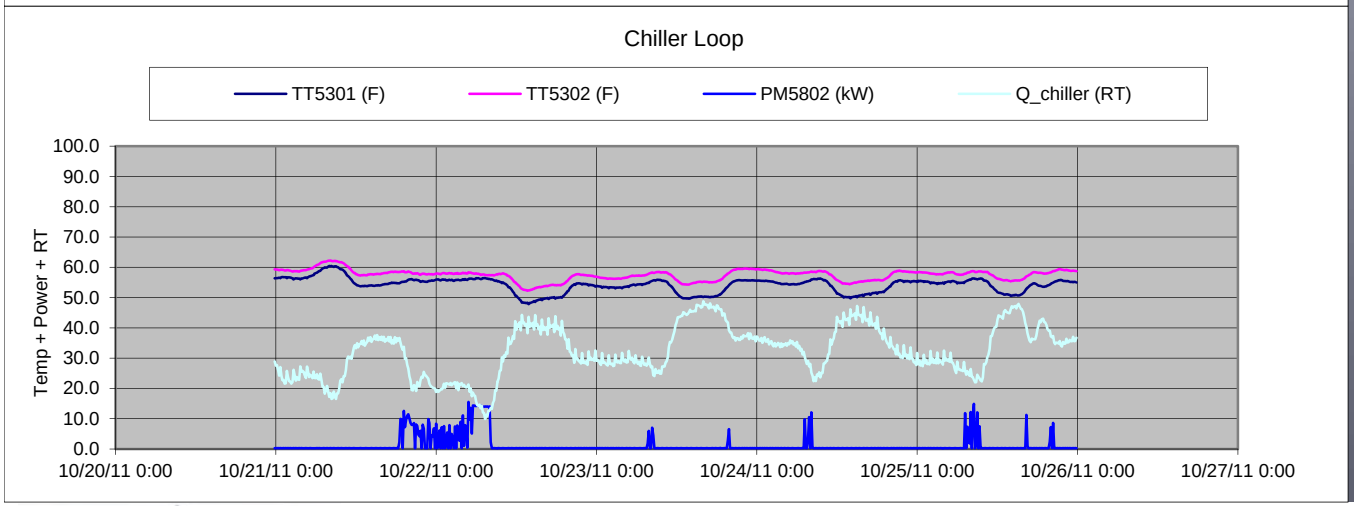
Current Installation

- Installation and commissioning near completion
- System, BOP, and control modifications / optimization being implemented
- To be completed by end of year

Preliminary Results





6-Day Run Analysis (Preliminary)		
Average Output	32	tons
Solar Fraction	17	%
COP	0.43	
Chiller Load Contribution	69	%
Cumulative Array Output	18.2	MMBtu
Cumulative Steam Use	91.1	MMBtu

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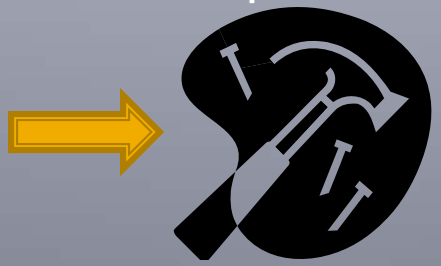
Preliminary Results - Benefits

- Areas with greater solar radiation will see a greater benefit and shorter payback periods.
- By avoiding the use of steam and electricity, progress is made toward GHG reduction and renewable energy goals
  - 203 tpy CO_2 offsets
  - 752 MWh renewable energy equivalent at 50% solar fraction
- Projections yield favorable economics (based on acceptance test)

Economic Benefits			
Solar Fraction	Annual Savings	Payback Period (yrs)	Net Present Value (20 yr life)
50%	$ 119,328	7.23	$ 1,160,527
40%	$ 95,462	9.20	$ 770,289
30%	$ 71,596	12.66	$ 380,051
17%	$ 40,571	24.87	$ (127,256)

Future Plans

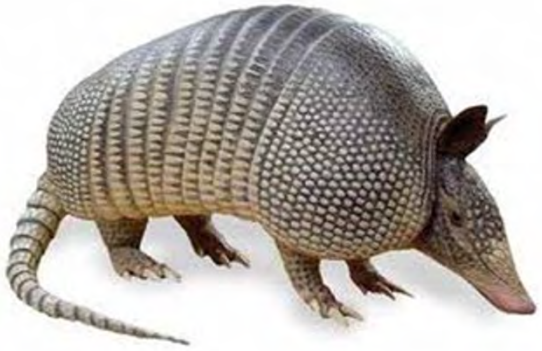
- Official one year monitoring period will begin upon completion of steam line replacement.



- Guidance document and tool for site feasibility evaluation
- Final performance analysis report (early 2013)
- Chiller manufacturer scaling up and down to meet diverse market (10-330RT)

Lessons Learned
aka 'This is why we do demos'

- Expect the unexpected
- Baselines are often difficult, and site specific
- Technologies can work well, but…
- Integration, retrofit, or balance of plant are key
- Existing equipment can have major impacts
- Approvals ? Permits?
- Theory or Lab ≠ Reality
- Short term ≠ long term
- Success can be site specific



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A few things to help…

- DoD Landfill Database and Report available
- Guidance documents being developed with feasibility assessment tools
- Final Reports late 2012
- Site Visits welcome

Questions?

- Contact:

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