Advanced, Energy Efficient Shelter Systems for Contingency Basing & Other Applications

Joint Committee On Tactical Shelters
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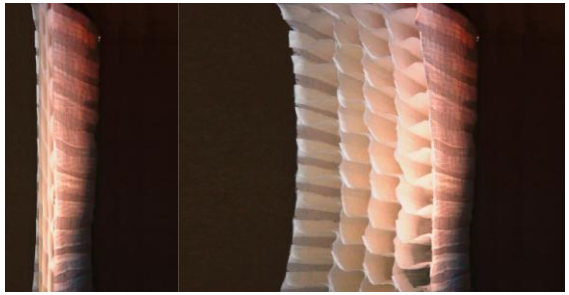
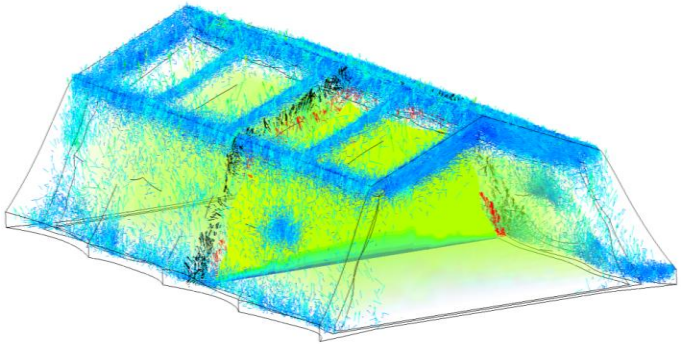
Discussion Topics

- Program Overview
- Key Stakeholders
- Program Management & Organization
- Schedule
- Technical Accomplishments
- Leveraged Efforts
- Technology Transition

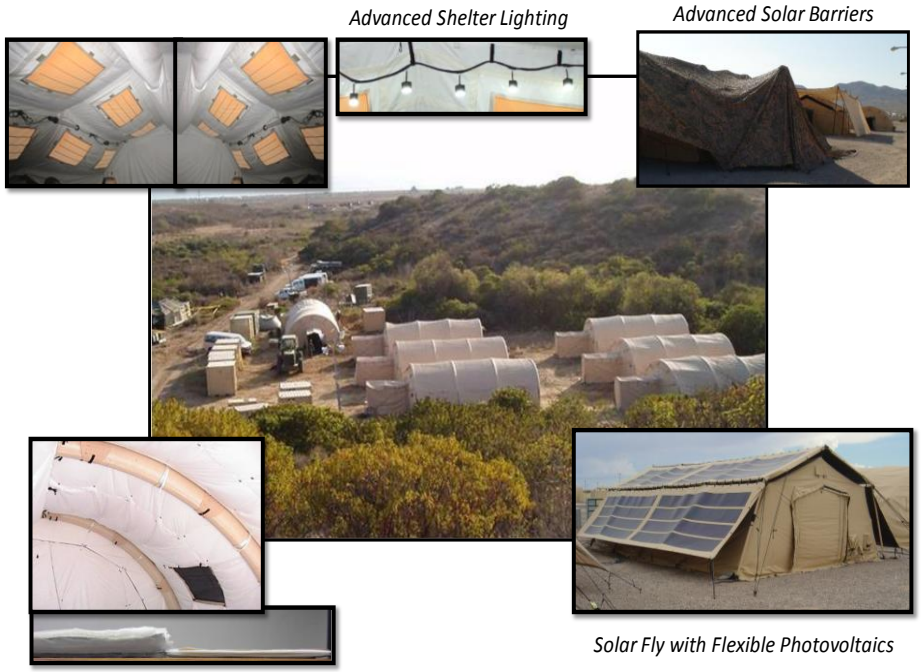




Advanced, Energy Efficient Shelter Systems for Contingency Basing & Other Applications

Operational Energy Capabilities Improvement Fund

- Joint Service, multi-organizational program to address inefficiencies with energy usage and fuel consumption of shelter systems
- Culmination of lessons learned will lead to optimized shelter systems to meet Joint Service needs



Program Provides:

• Initial Demonstrations – Operational evaluation of complete, state-of-the-art shelter systems when used by operators in the field

• Technology Development – Mature DOD and industry developed technologies to advance the state-of-the-art to reduce logistics/cost impact and further reduce fuel consumption on the battlefield

• Follow On Demonstrations – Leverage lessons learned in the Initial Demonstrations and Technology Development into optimized shelter systems and validate in the AOR

Warfighter Payoff:

• Energy efficient shelter systems that are optimized to reduce fuel consumption on the battlefield and manpower requirements for the Warfighter

• 50% reduction in shelter system power consumption

• 36M gal/year fuel savings

• Savings to Investment Ratio (SIR) = 15.3:1

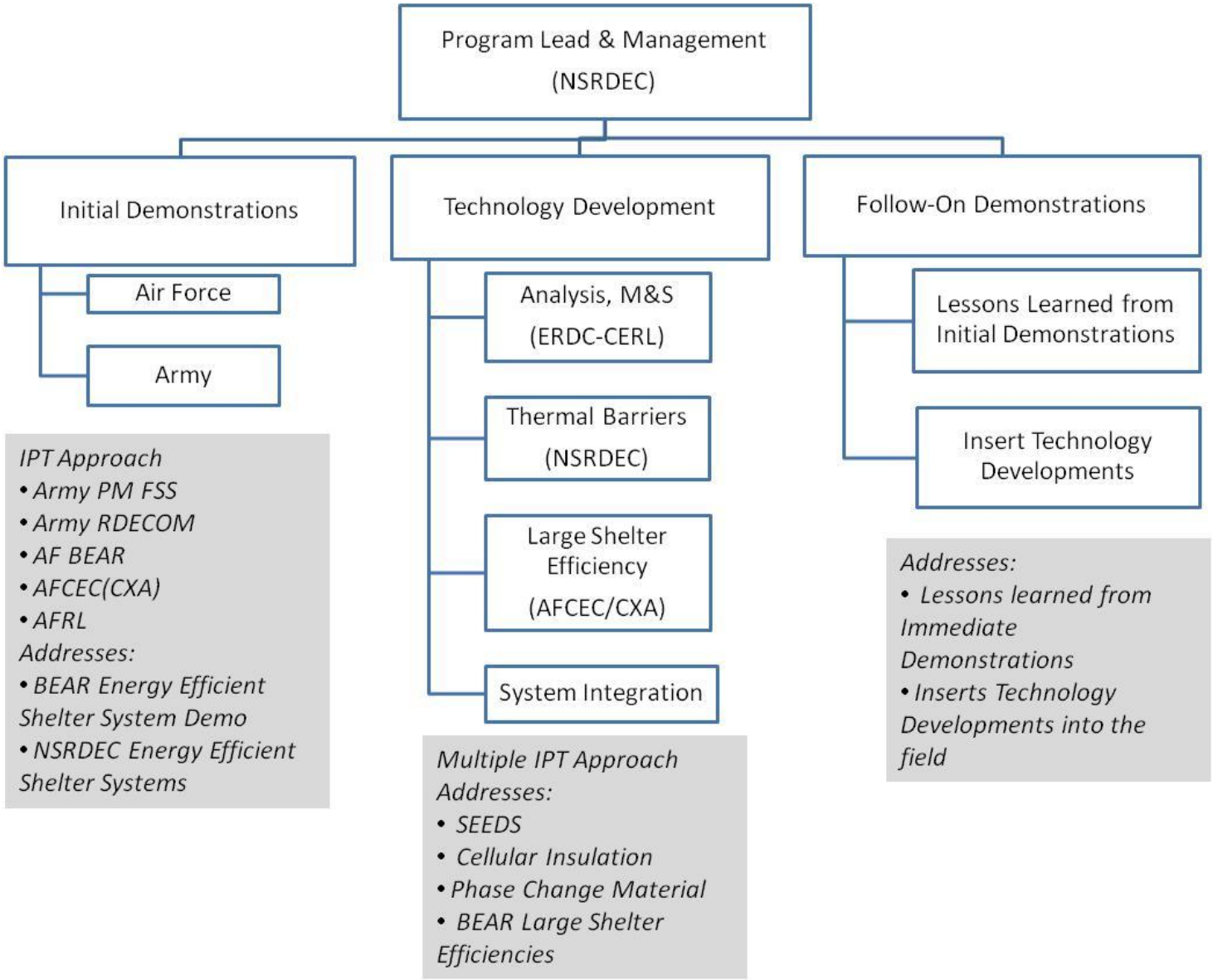
Key Partners & Stakeholders

Project Sponsor: OSD Operational Energy Plans & Programs Office

Overall Project Lead: Natick Soldier Research, Development & Engineering Center (NSRDEC)

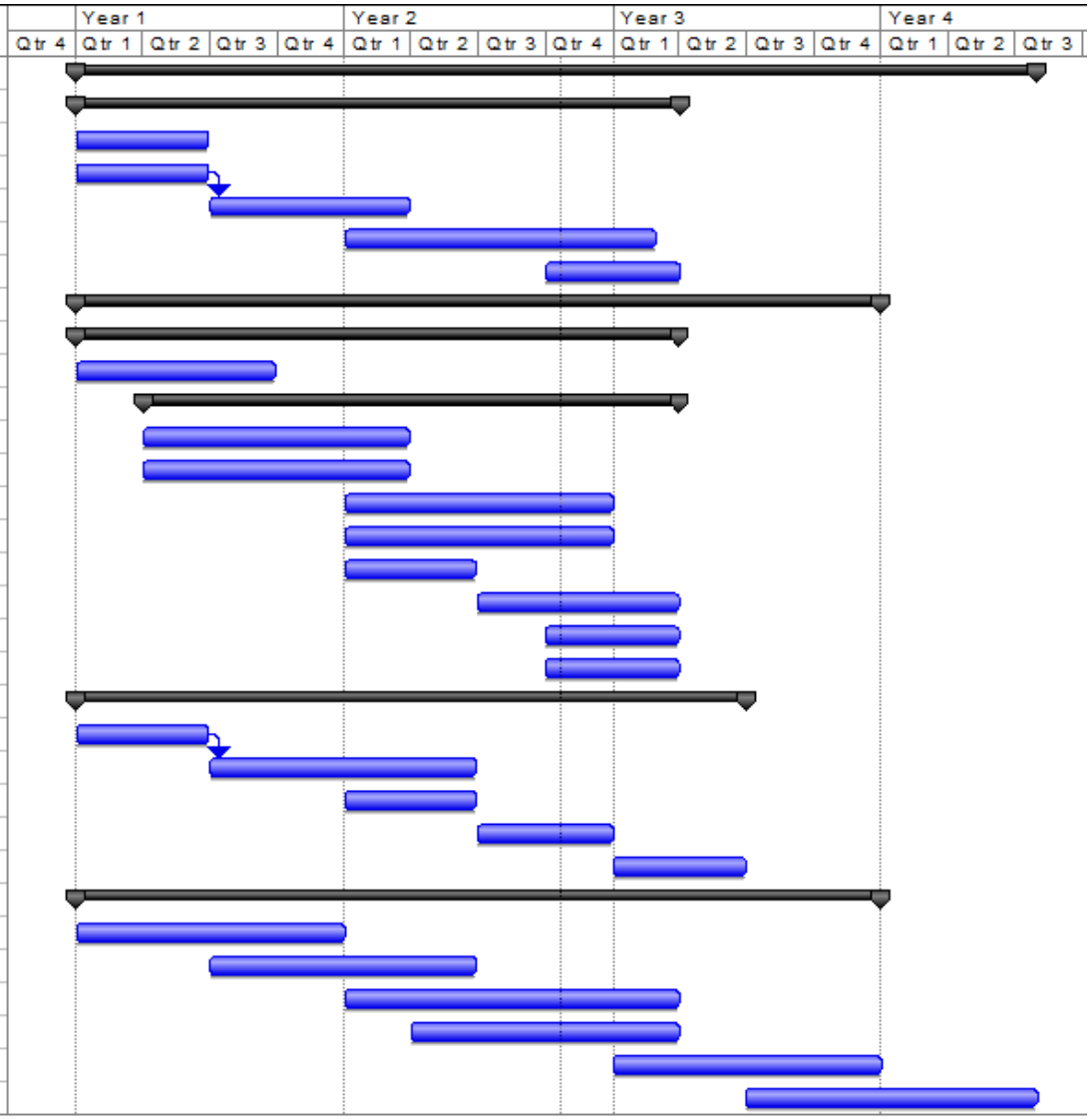
- Air Force Base Expeditionary Airfield Resources (BEAR) Global Management Office
- Air Force Civil Engineer Center (AFCEC/CXA)
- Army Corps of Engineers, Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL)
- Army Materiel Command - Product Manager Force Sustainment Systems (PdM-FSS)

Program Organization



Schedule

WBS	Task Name
1	ADVANCED, ENERGY EFFICIENT SHELTERS
1.1	INITIAL DEMONSTRATIONS
1.1.1	Identify Location(s)
1.1.2	Contracting
1.1.3	Procure Systems
1.1.4	Demonstration & Testing
1.1.5	Requirements & Reporting
1.2	TECHNOLOGY DEVELOPMENT
1.2.1	Analysis and M&S
1.2.1.1	Operational Performance Data Analysis
1.2.1.2	Technology Development
1.2.1.2.1	Shelter Performance Modeling
1.2.1.2.2	Improved Materials
1.2.1.2.3	Minimize Air Infiltration
1.2.1.2.4	Intelligence Occupancy Modeling
1.2.1.2.5	Integration
1.2.1.2.6	Test Plans & Assessment
1.2.1.2.7	Data Analysis
1.2.1.2.8	Economic Benefit Analysis
1.2.2	Advanced, High Performance Insulation
1.2.2.1	Assessment & Modeling
1.2.2.2	Component Validation
1.2.2.3	System Design
1.2.2.4	System Validation in Relevant Environment
1.2.2.5	Final Optimization & Manufacturing Capabilities
1.2.3	Large Shelter Efficiencies
1.2.3.1	Needs Study and Report
1.2.3.2	Near Term Demonstration
1.2.3.3	Innovative Design
1.2.3.4	Testing
1.2.3.5	Implementation
1.3	FOLLOW-ON DEMONSTRATIONS



Initial Demonstrations

Objective: Reduce energy consumption of shelter systems; demonstrate the energy savings that are achievable today in a relevant environment

- Leverage technologies developed and matured by the Services
- Address lessons learned through Net Zero Joint Capabilities Technology Demonstration
- Quantify the current state-of-the-art in a relevant environment

Technologies:

- Solar Shades
- Thermal Insulation
- Right-Sized Environmental Control Units
- Energy Efficient Lighting

Tasks:

- Build and field shelter systems
- Demonstration & Testing
    - Temperatures
    - Power Consumption
    - Technical Performance
- Enable commanders to see & assess technologies

Technical Challenge: Demonstrate fully integrated systems optimized for performance, energy efficiency, and minimized manpower requirements.

Technology Accomplishments: Initial Demonstrations

- 15 Shelter systems fabricated: varying configurations for comparison
  - A-frame and Quonset Hut shape shelters
  - Solar barriers and thermal insulation
  - Three different environmental control units
  - Three different lighting sets
  - Photovoltaics
  - Two shelters on one environmental control unit

- Form, fit, function at Tyndall AFB in August 2013
  - Power up and operate shelter systems
  - Validate data collection equipment operation
- Deployment to Kuwait September 2013
  - Coordinated with AFCENT
- Tear down and shipped out Dec 2013

Ali Al Salem, Kuwait Demo Site

Aerial Depiction of Site As Built

Shelters 1 & 2 – Air Force
Not to be Occupied
Gable Shelters
Fly
Cooled by 1 ECU

Shelters 3 & 4 – Air Force
Not to be Occupied
Gable Style Shelters
PV Flys
Cooled by 1 ECU

Shelters 5 & 6 – Air Force
Occupancy Allowed
Gable Style Shelters
PV Flys
Cooled by 1 ECU

Shelters 7 & 8 - - Air Force
Occupancy Allowed
Barrel Style Shelters
Fly
Cooled by 1 ECU

Shelter 9 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

Shelter 10 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

Shelter 11 – Army
Not to be Occupied
Gable Style Shelter
Fly
Cooled by 1 ECU

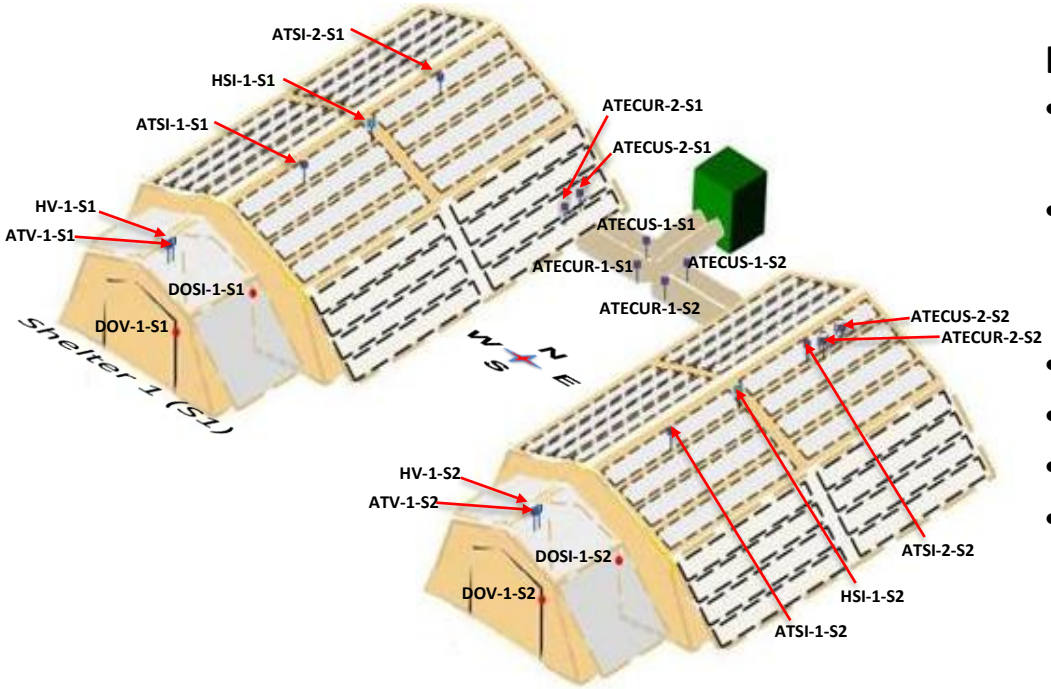
Shelter 12 – Army
Occupancy Allowed
Barrel Style AirBeam Shelter
Fly
Ground PV
Cooled by 1 ECU

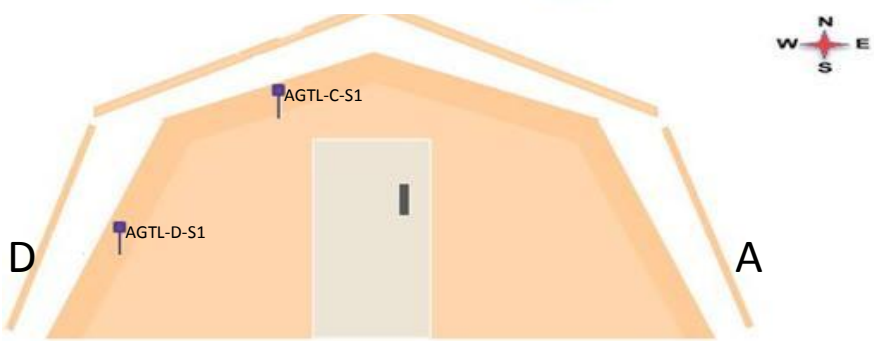
Shelter 13 – Army
Occupancy Allowed
Barrel Style AirBeam Shelter
Fly
Cooled by 1 ECU

Shelter 14 & 15 – Army
Occupancy Allowed
Barrel Style AirBeam Super Shelter
Fly
Cooled by 1 ECU

Kuwait Evaluation Site

Technology Accomplishments: Initial Demonstrations

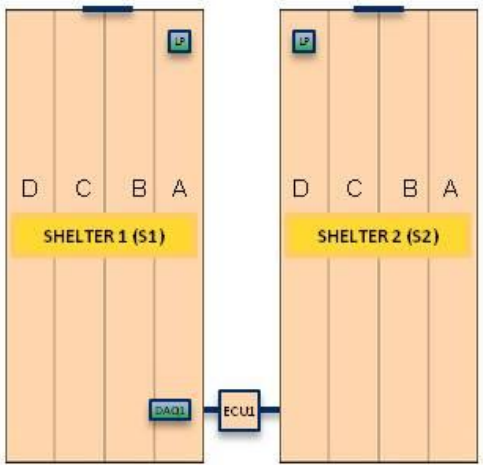




Shelter Air Gaps

Data Collection

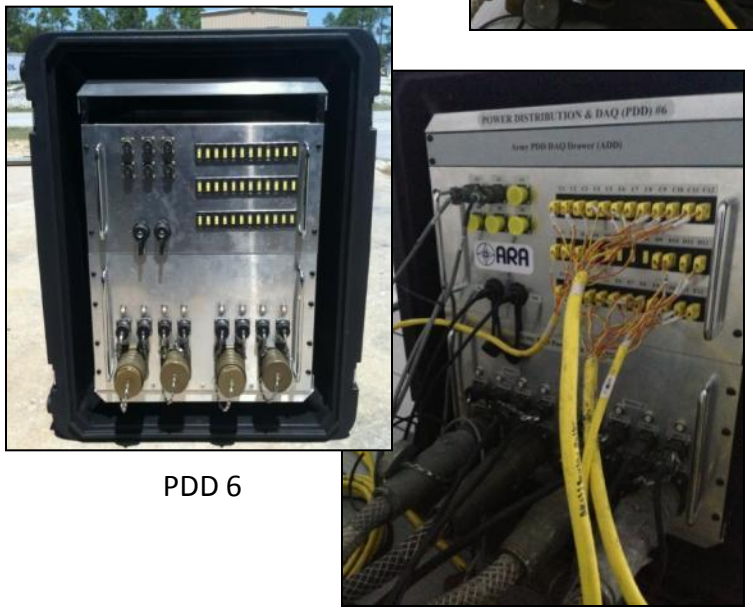
- Surface Temperatures
  - Solar barrier, shelter
- Air Temperatures
  - Internal, air gap, vestibule, ambient
  - ECU supply, return
- Humidity
- Incident solar radiation
- Shelter door
- Power demand
  - ECU, shelter, lights



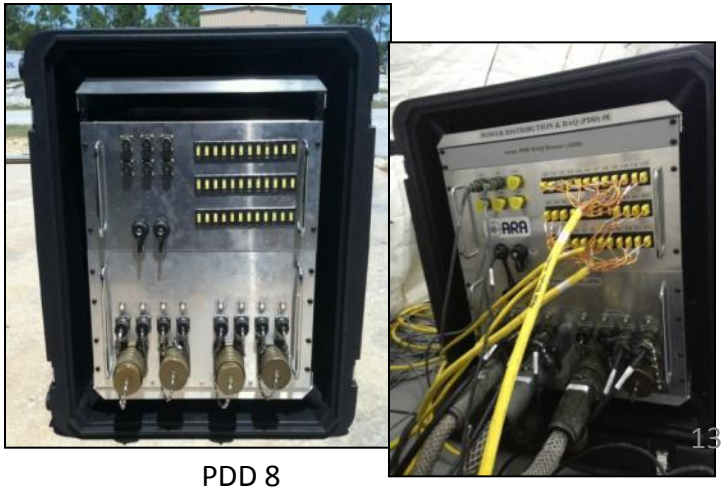
Technology Accomplishments: Initial Demonstrations

Master for Army Shelters PDD 5

Army Shelter with PV PDD 7



PDD 6



PDD 8

Initial Demonstration: USAF Guam Deployment

NSRDEC will be setting up 4 shelters in Aug for evaluation in Guam

- 1 TEMPER AS with 250 G Thinsulate liner, F100 ECU, New radiant solar shade
- 1 TEMPER AS with TempShield, F100 ECU, HDT solar shade
- 2 Base-X 305 shelters with TempShield liner.
  - 1 shelter will have HDT solar shade and one will not
- All shelters will have rigid floors, rigid doors, flexible LEDs

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Follow-On Demonstrations

Objective: Build on and leverage the lessons learned in the Initial Demonstrations by incorporating the Technology Development accomplishments into optimized shelter systems further reducing fuel consumption.

- Most advanced and effective shelter system to include solar barrier, thermal insulation, environmental control unit and accessories
- Demonstrated and validated performance in a field environment

50% Reduction in Power Consumption
Improved Capabilities
Technology Transition

Follow on Demo Plans
US Army

- Winter FY15 (Ft Greely AK with CRTC)
  - Up to 8 shelters
  - 1 baseline TEMPER Air Supported with 250G lofted liner
  - Union Jack AirBeam shelter
  - V1.5 AirBeam shelter
  - 2 RDS 635 Frame shelter with cellular insulation
  - 1 RDS 635 Frame shelter with 250G lofted liner
  - 1 TEMPER Air Supported with cellular insulation
  - All shelters will use fuel fired heaters
    - Looking to leverage PdM-FSS effort on IASH Type II
- Summer FY15

  (Ft. Irwin NTC or Holloman AFB)
  - Up to 8 Shelters
  - 1 baseline TEMPER Air Supported with 250G lofted liner
  - V1.5 shelter
  - 2 RDS 635 Frame shelter with cellular insulation
  - 1 RDS 635 Frame shelter with 250G lofted liner
  - 1 TEMPER Air Supported with cellular insulation
  - Right Sized ECUs/two shelters off one ECU
  - Radiant barrier solar shade

Cellular Thermal Insulation Approach

Greatest technical challenges :durability and flame resistance

- Awarded four contracts to investigate different technical approaches
  - Alternative reinforced films, fibers
  - Samples and full scale prototype testing conducted
- Focus on manufacturability
- Concept Down selection

Measure	Current	Effort Objective	Army Objective	TRL or SRL
Weight	32 oz/sq yd (based off 2" lofted insulation)	12 oz/sq yd	As lightweight as possible. < Current System Weight (32 oz/sq yd)	Start 5 End 7
Deployment Time	2.5-3 hrs (untrained soldiers)	1-2 hrs	As quickly as possible.	Start 5 End 7
System Durability	N/A Testing not yet performed	Withstand 50 strike/erect cycles (TEMPER spec)	Withstand 50 strike/erect cycles	Start 5 End 7
Cost	~$42/sq yd ($6153/liner)	$15-25/sq yd ($2197.5 – $3662.5/liner)	As cheap as possible	Start 5 End 7

Technology Accomplishments: Cellular Thermal Insulation

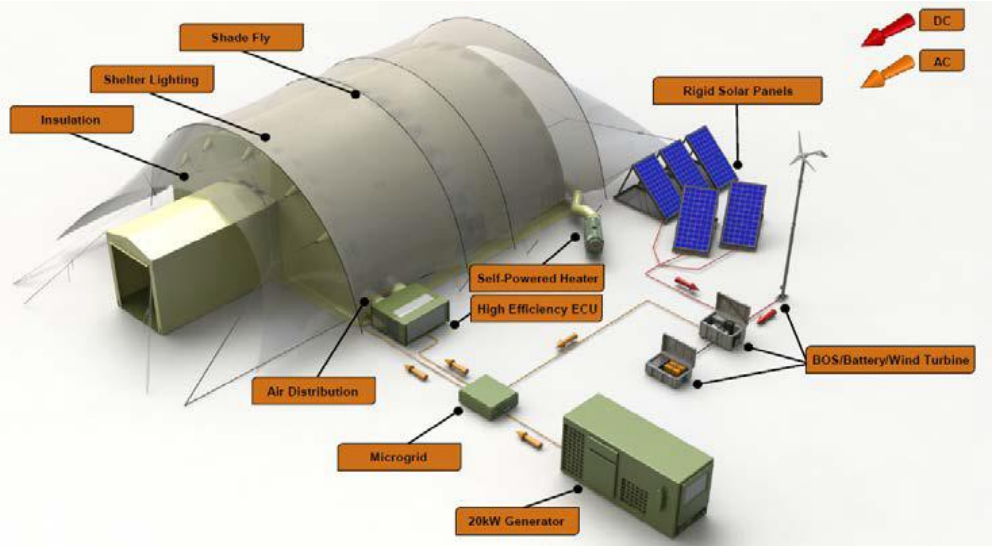
0.3” Collapsed

3.5” Deployed Provides R5 alone, >R6 installed

- Unique nonwoven material for reduced weight & high flame resistance
- Novel manufacturing technology to address peel failures
- Reinforced outer skins for increased durability
- September 2014 full-scale delivery of AirCell insulated TEMPER Air Supported and Johnson Outdoors RDS for winter testing

Technology Accomplishments: Leveraged Effort

Army Rapid Innovation Fund: Energy Efficiency Optimization of COP/PB Shelters to Reduce Fuel Consumption



Objectives: Develop optimized energy efficient solutions for austere shelter systems. Right-size the major energy-consuming components, harvest renewable energy, insulate the shelter, and significantly reduce fuel consumption. Scope includes radiant barriers, shade fly, microgrid, photovoltaics, convective heaters and LED lighting.

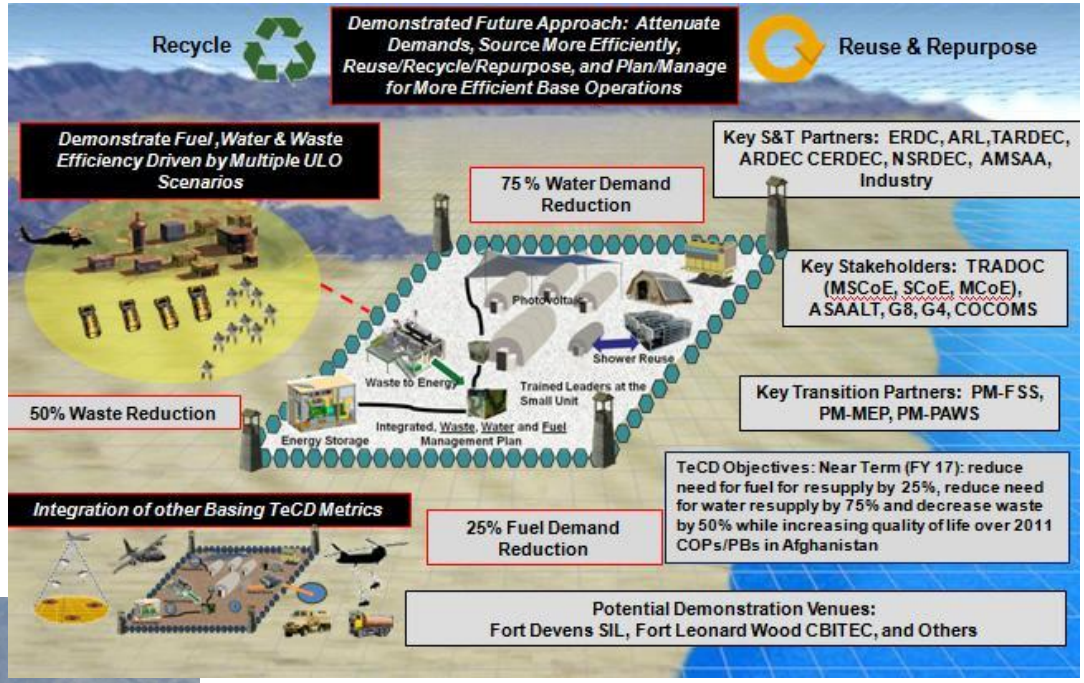
Have developed and prototyped:
- Microgrid Storage & Distribution Unit
- 42K BTU ECU with variable speed scroll compressor
  - 24K to 42K of cooling at 6.6kW
  - Electric resistive heater
  - Dehumidification
- Monitor and Control System

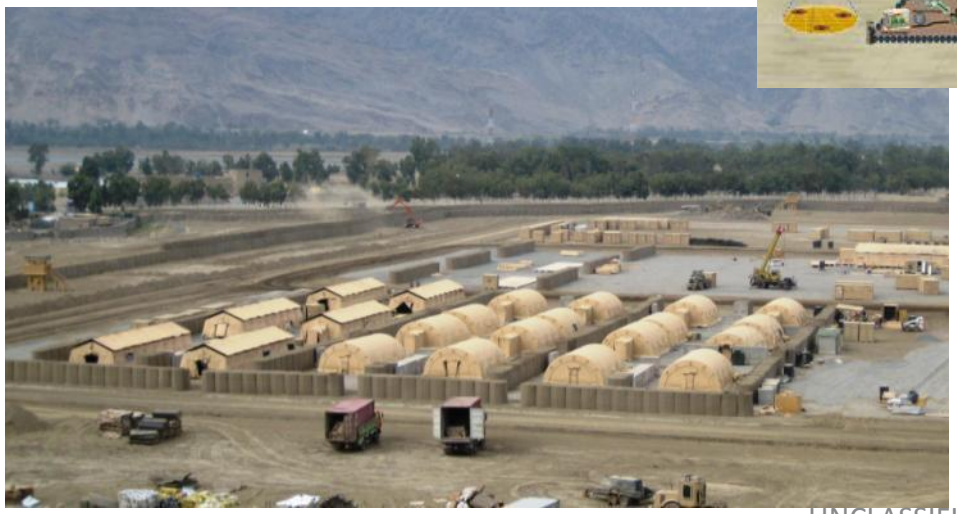
Deliverables:
- Technical reports
- Optimized energy efficient system including MicroGrid, PV, batteries, lighting, generator and ECUs

Metrics/Measures of Success: 25% reduction in fuel consumption

Technology Transition

- Additional technology maturation
- Technology-Enabled Capability Demonstration 4a: Basing Sustainment & Logistics
- PEO Combat Support & Combat Service Support
- Air Force BEAR

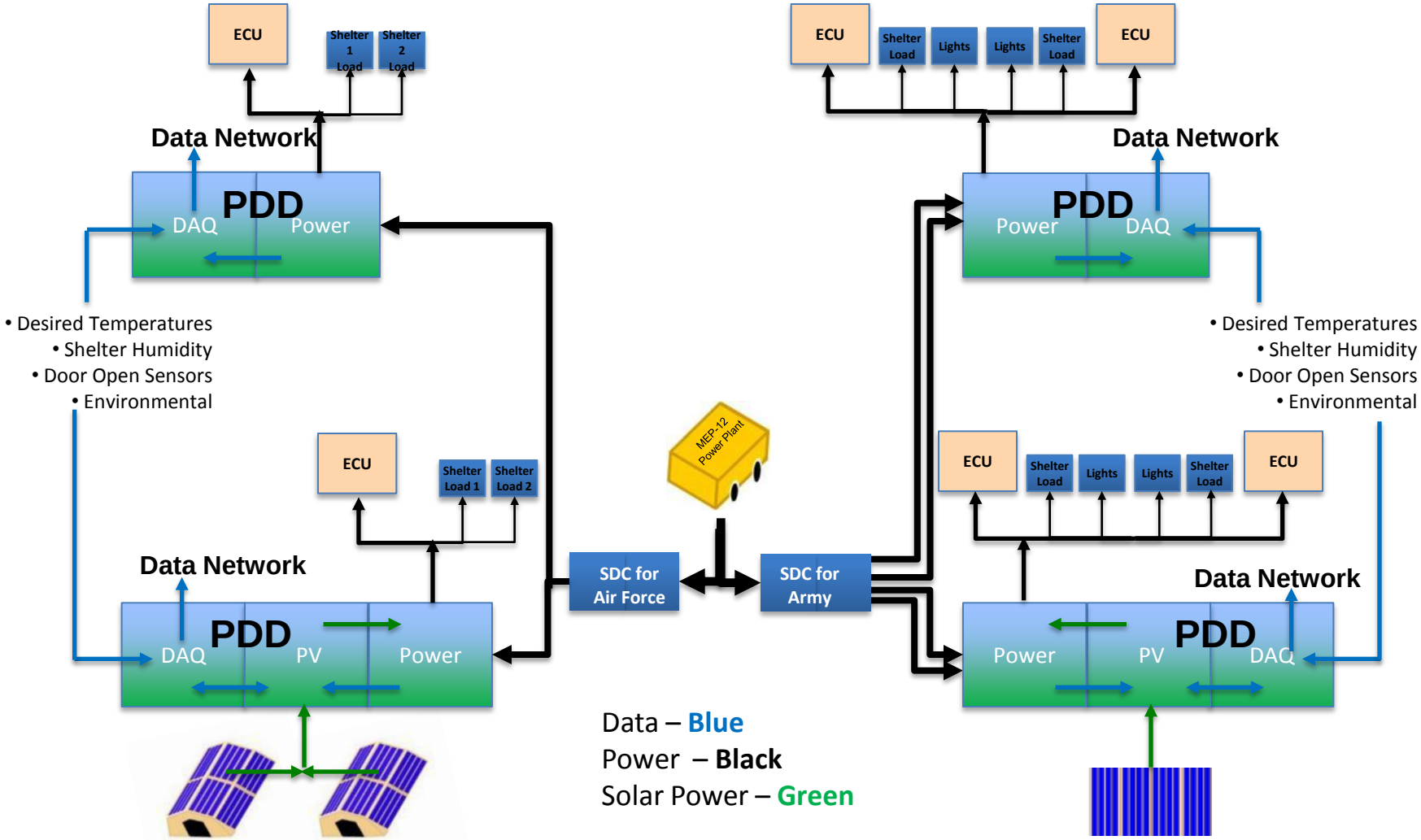


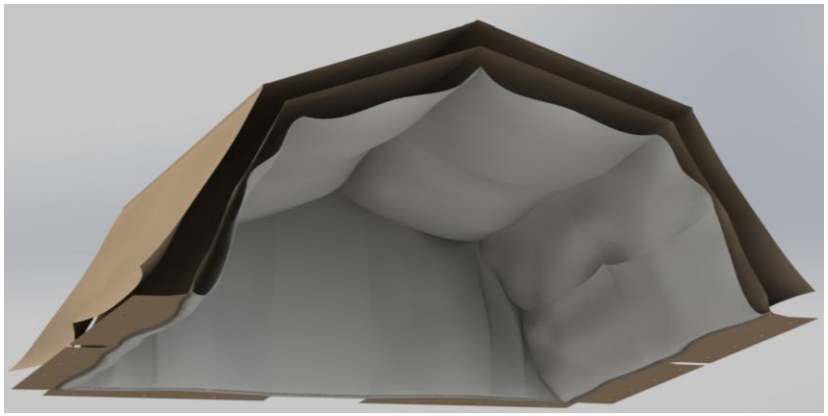


Questions & Discussion

Backup

Data Flow



Data – **Blue**
Power – **Black**
Solar Power – **Green**

Technology Accomplishments: Modeling & Simulation