



Navy (NAVFAC) Expeditionary Technology Transfer Program (NETTP)

presented to

Joint Committee on Tactical Shelters

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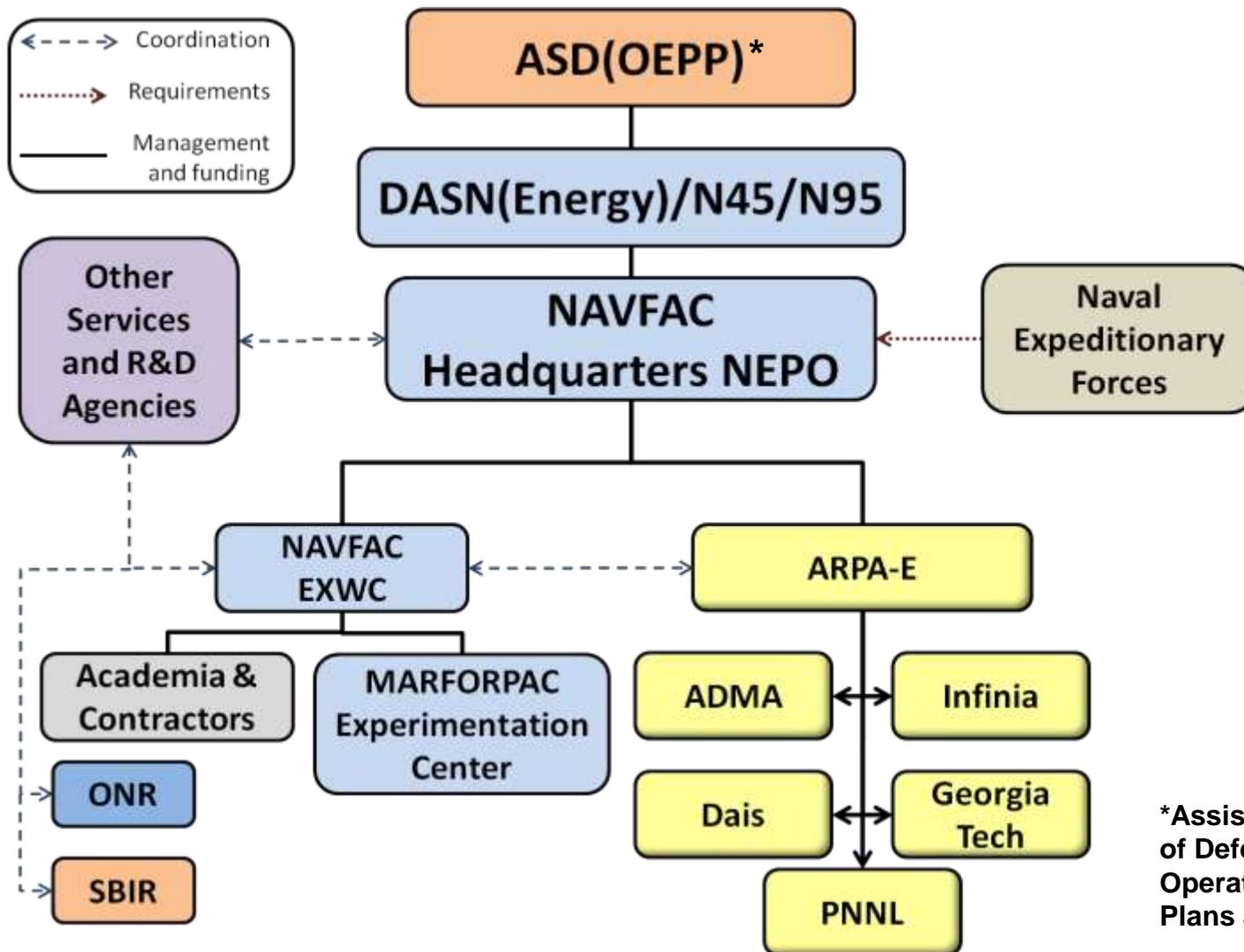
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Background and Funding

- **Navy Expeditionary Technology Transfer Program (NETTP)**
 - Conceived by Navy Energy Office, OPNAV N45E.
 - Developed in conjunction with NAVFAC (EXWC, NAVFAC Expeditionary Program Office (NEPO)) and ARPA-E.
 - ECUs identified as major consumer of fuel.
 - Partnering with Advanced Research Projects Agency – Energy (ARPA-E).
 - Leverage existing ARPA-E portfolio of revolutionary HVAC research.

	FY12	FY13	FY14	FY15
OEClF NETTP Funding	3,190	1,220	3,340	1,570

NETTP Program Structure



NETTP Objectives



- **Develop advanced Environmental Control Systems (ECUs) which decrease the amount of fuel required for Heating, Ventilation, and Air Conditioning (HVAC) loads by 20-50%.**
- **These ECUs will**
 - **be rated for expeditionary operating environments.**
 - **fit within the size and weight envelope of currently deployed systems.**
 - **cause no increase in required logistics support.**
 - **have a procurement cost that is no more than 25% higher than currently deployed systems.**

NETTP Metrics/Needs

	Current ECU	NETTP Threshold	NETTP Objective
SEER¹ (BTU/W*hr)	7	9	14
Cooling Output (BTU/hr)	36,000	36,000	36,000
Electrical Input (kW)	5.1	4	2.6
COP² (W/W)	1.1	1.4	2.2
Cooling Output (BTU/hr)	36,000	36,000	36,000
Electrical Input (kW)	9.6	7.5	4.8
HSPF³ (BTU/W*hr)	3.4	3.4	6
Heating Output (BTU/hr)	28,000	28,000	28,000
Electrical Input (kW)	8.2	8.2	4.7
Weight for 9,000 BTU/hr ECU (lbs)	200	200	160
Weight for 36,000 BTU/hr ECU (lbs)	480	480	350
Heating Provided Down to (°F)	-25	-25	-50
Mean Time Between Failure (Hours)	2000	2000	3000
Cost/Unit for 36,000 BTU/hr ECU (\$)	15000	19000	15000

¹SEER: Seasonal Energy Efficiency Ratio ²COP: Coefficient of Performance

³HSPF: Heating Seasonal Performance Factor

NETTP Projects



- ARPA-E received 13 industry proposals. ARPA-E/NAVFAC selected 5 projects. Funding agreements completed and in place 4/13
- Two utilizing generator waste heat
 - Pacific Northwest National Laboratory- Genset Heat Recovery Adsorption Chiller.
 - Georgia Tech - Microscale Absorption Heat Pump ECUs.
- One Stirling Cycle
 - Infinia - Rugged Innovative Scalable ECU (RISE).
- Two Membrane Dehumidification (1 Year Feasibility Projects)
 - Dais Analytics - Compact Nanotechnology Membrane Chiller.
 - ADMA Products - Novel Membrane Dehumidifier-enabled Air Cooling.

NETTP Projects



- **The selections considered:**
 - Balance of technical, schedule, and cost risk.
 - Development Competition.
 - Manufacturability and retooling considerations.
 - Maturity to reach TRL 6 by FY15.
 - Higher risk/higher payoff concepts.
 - Technology’s potential for commercial applications.

- **Selection team comprised of representatives from NAVFAC, ARPA-E, Communications-Electronics Research, Development and Engineering Center (CERDEC), Office of Naval Research (ONR), and Marine Program Manager Mobile Electric Power (PMMEP) and Outside HVAC subject matter experts.**

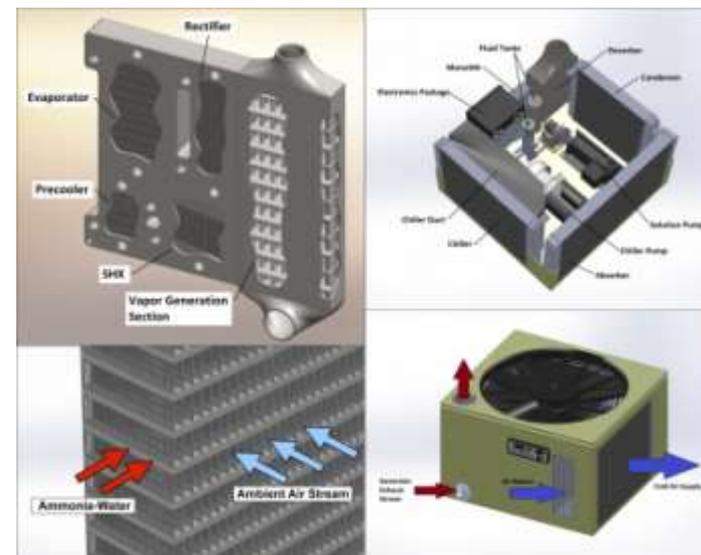
NETTP Projects

- **Genset Heat Recovery Adsorption Chiller for Navy Forward Operations Bases**
 - Adsorption air conditioner utilizing exhaust waste heat from a generator. Much smaller, lighter and more efficient than traditional adsorption coolers using a new Metal Organic Framework (MOF) adsorbent.
- **Can be combined with a generator as a generator/ECU.**
 - Can reduce fuel use by 42% for cooling, 100% for heating.*



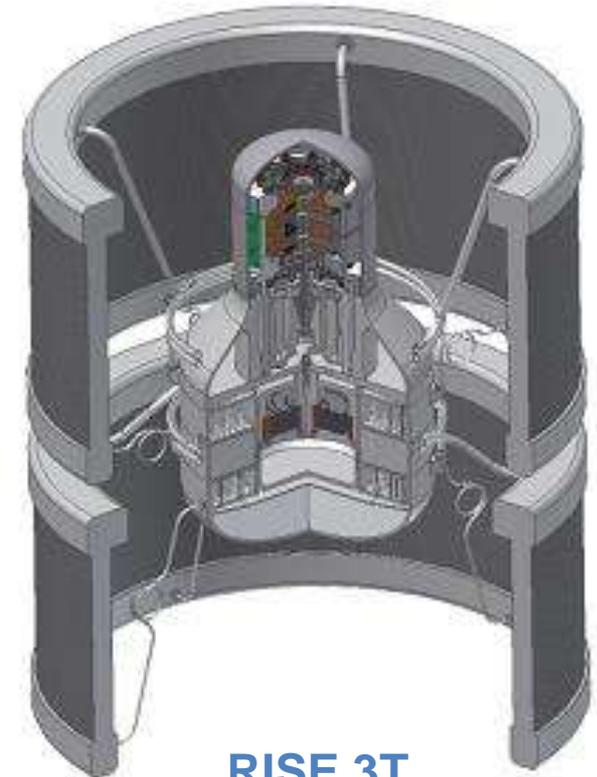
*Based on usage scenario from Field Exercise and preliminary performance estimates

- **Microscale Absorption Heat Pump**
 - Absorption heat pump utilizing exhaust waste heat from a generator. Can be mass produced at low cost and is much more compact than conventional absorption heat pumps by capitalizing on several-fold heat and mass transfer enhancements possible in microscale passages.
- Can be combined with a generator as a generator/ECU.
 - Can reduce fuel use for cooling by up to 32%, heating by 100%*.



*Based on usage scenario from Field Exercise and preliminary performance estimates

- **Rugged Innovative Scalable ECU (RISE)**
 - Compact heat pump that uses an unconventional, Stirling cycle system to produce cooling and heating more efficiently than conventional vapor compression systems. Utilizes a cost-effective thermosiphon 2-phase heat transport system to greatly reduce the temperature drops between internal Stirling cycle heat exchangers and air-side heat exchangers.
- **Direct replacement for existing vapor compression ECUs**
 - Can reduce fuel use up to 40% for cooling and 75% for heating.

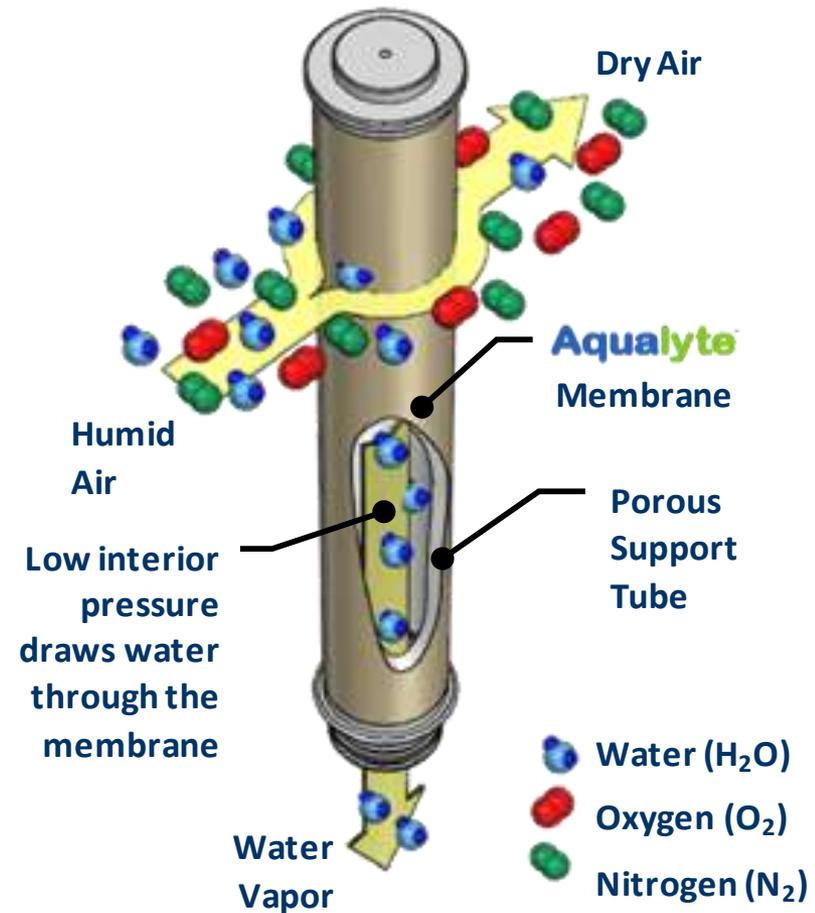


RISE 3T



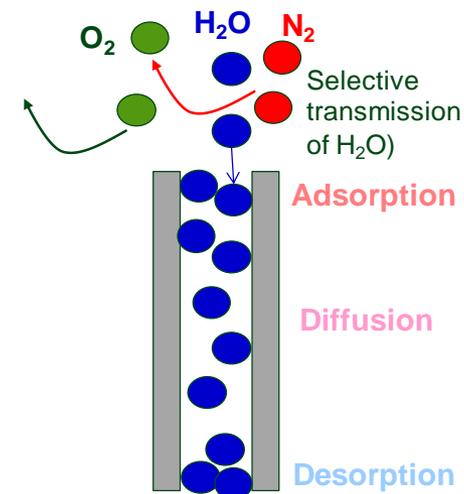
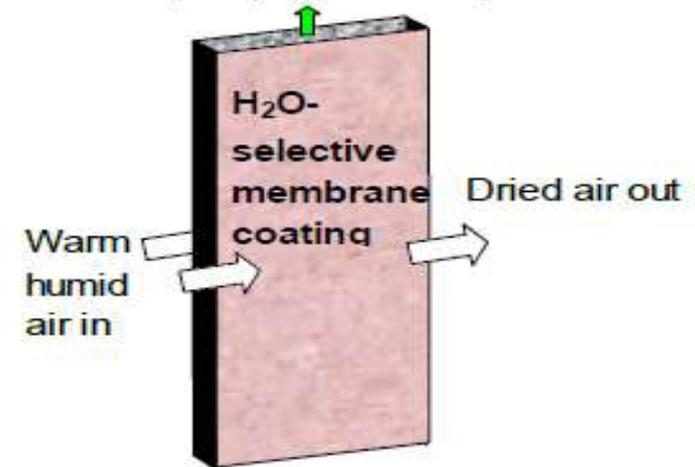
RISE 5T

- **Compact Nanotechnology Membrane Chiller**
 - Compact dehumidification system utilizing a selectively permeable polymer membrane to adiabatically remove moisture from an air stream.
- **Add on to vapor compression ECU to remove humidity**
 - Reduce fuel use by an estimated 10% in humid environments.
- **Evaporative coolers that work in all climates**
 - Estimated fuel use reduction of 33-90%, depending on climate.



- **Novel Membrane Dehumidifier-enabled Air Cooling**
 - Energy-efficient, compact dehumidification system utilizing coated, porous metal membranes that selectively allow water vapor to pass, but not air.
- **Add on to vapor compression ECU to remove humidity**
 - Reduce fuel use by an estimated 10% in humid environments.
- **Evaporative coolers that work in all climates**
 - Estimated fuel use reduction of 33-90%, depending on climate.

Water vapor pulled out by vacuum



Zeolite pore (0.3 – 0.4 nm)

NETTP Thrust



- **Intent of these technology explorations**
 - Utilizing the fuel energy in exhaust waste heat, increase fuel energy utilization from 33% to 50%.
 - Stirling cycle based heat pumps which use 30% less energy.
 - Compact dehumidification systems that can improve ECU efficiency by 10% or allow evaporative cooling in all conditions.

Contact Information



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Backup Slides

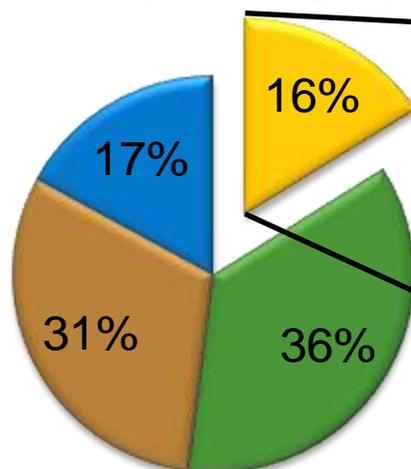


Backup - Expeditionary Energy Consumption

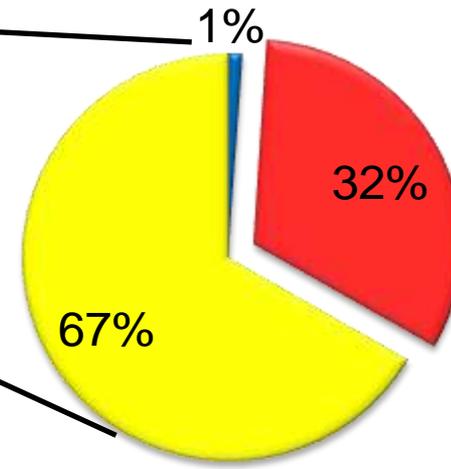
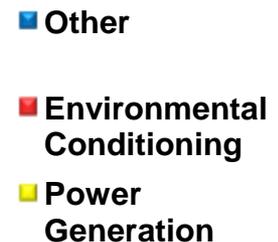


- Deployed Navy Expeditionary Forces use up to 9 Mgal/yr for infrastructure-related fuel usage
- Environmental Conditioning accounts for ~ 32% of FOB energy used
- Fuel accounts for ~ 50% of logistics convoy loads
- 1 warfighter killed or wounded for every 24 fuel convoys
- ECU operations cost ~ \$43 M/yr at a \$15/gal Fully Burdened Cost of Fuel

NECC Overall Fuel Consumption (~60Mgal)



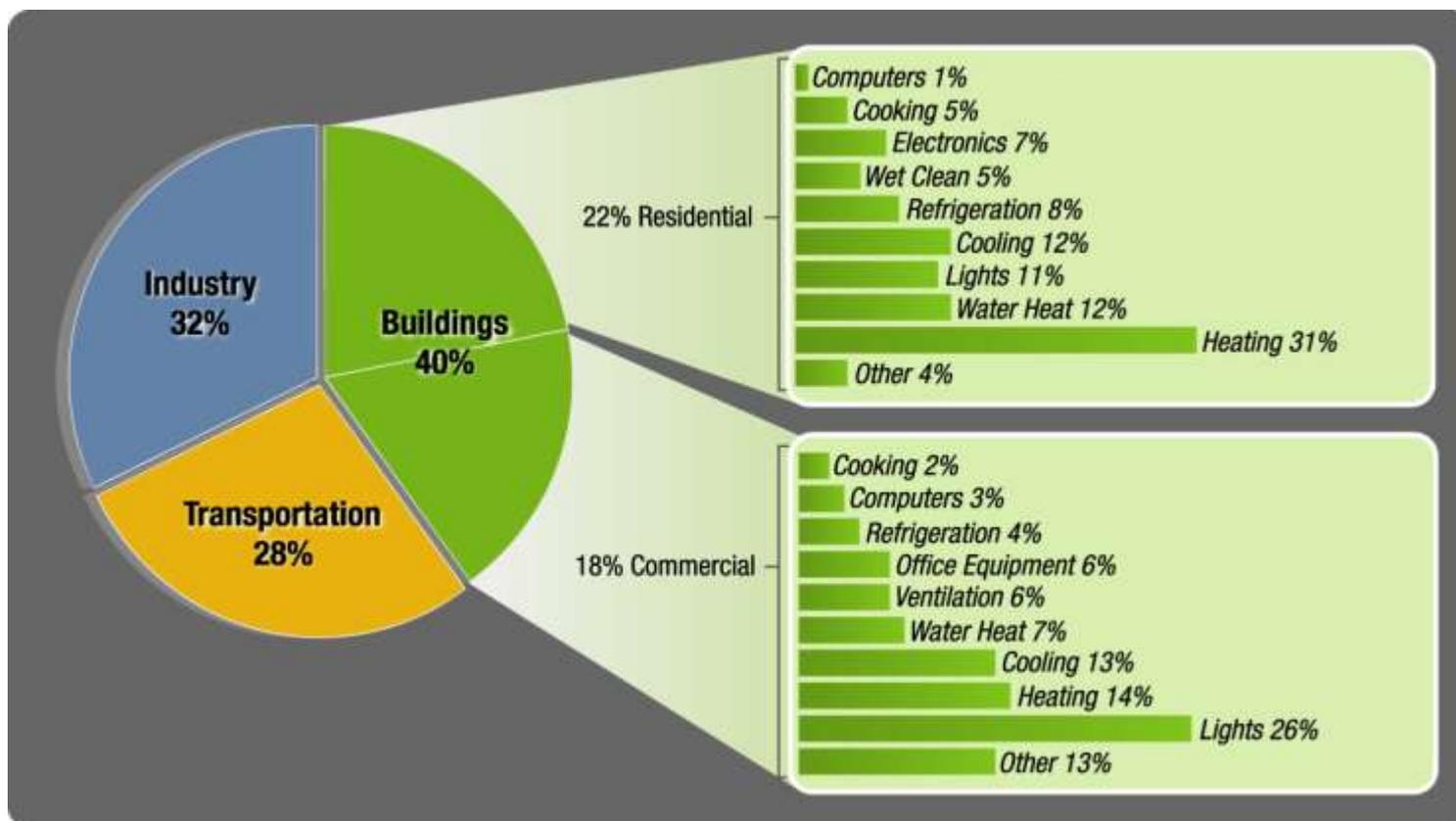
Infrastructure Fuel Usage (~9Mgal)



Backup - The ARPA-E BEETIT Program



- **BEETIT: Building Energy Efficiency Through Innovative Thermodevices**
- **Buildings use 72% of electricity and 55% of the natural gas in the U.S.**
- **Heating & cooling account for ~ 50% of energy consumption**



Source: LBNL Environmental Energy Technologies Division, 2009

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