



Navy Expeditionary Technology Transfer Program (NETTP)

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Brief Contents

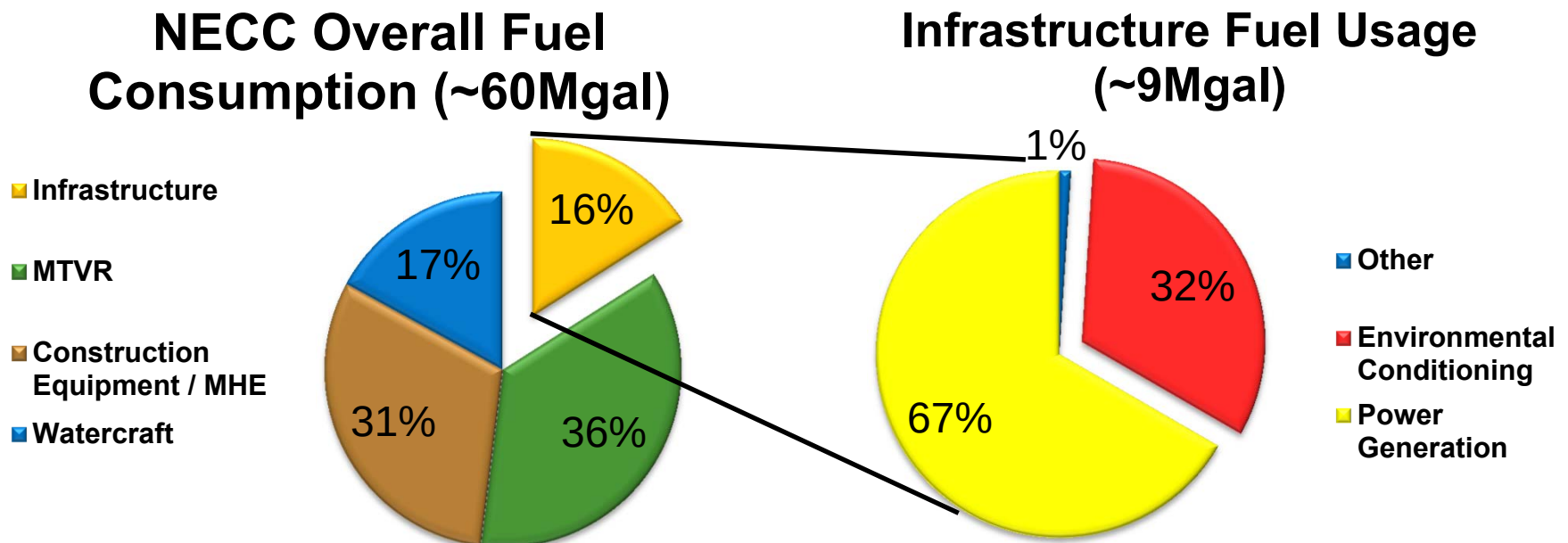


- **Expeditionary energy consumption problem**
- **Environmental Control Unit (ECU) goals**
- **Program structure**
- **Approach to solving the problem**
- **Candidate technologies**
- **Contact information**

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 soldier is killed or wounded for every 24 fuel convoys
- ECU operations cost ~ \$43 M/yr at a \$15/gal Fully Burdened Cost of Fuel



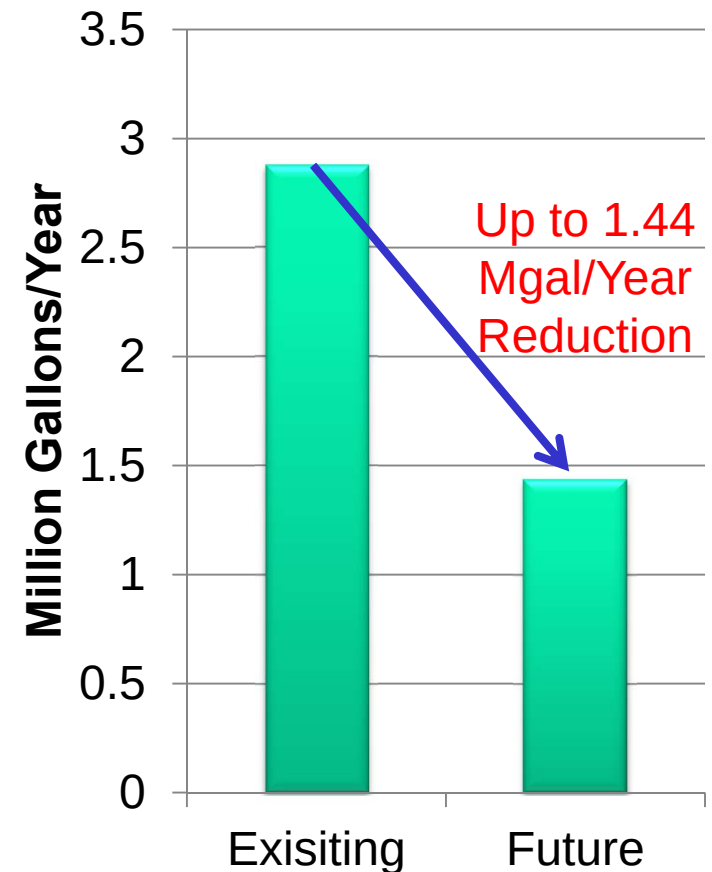
Expeditionary ECU Goals



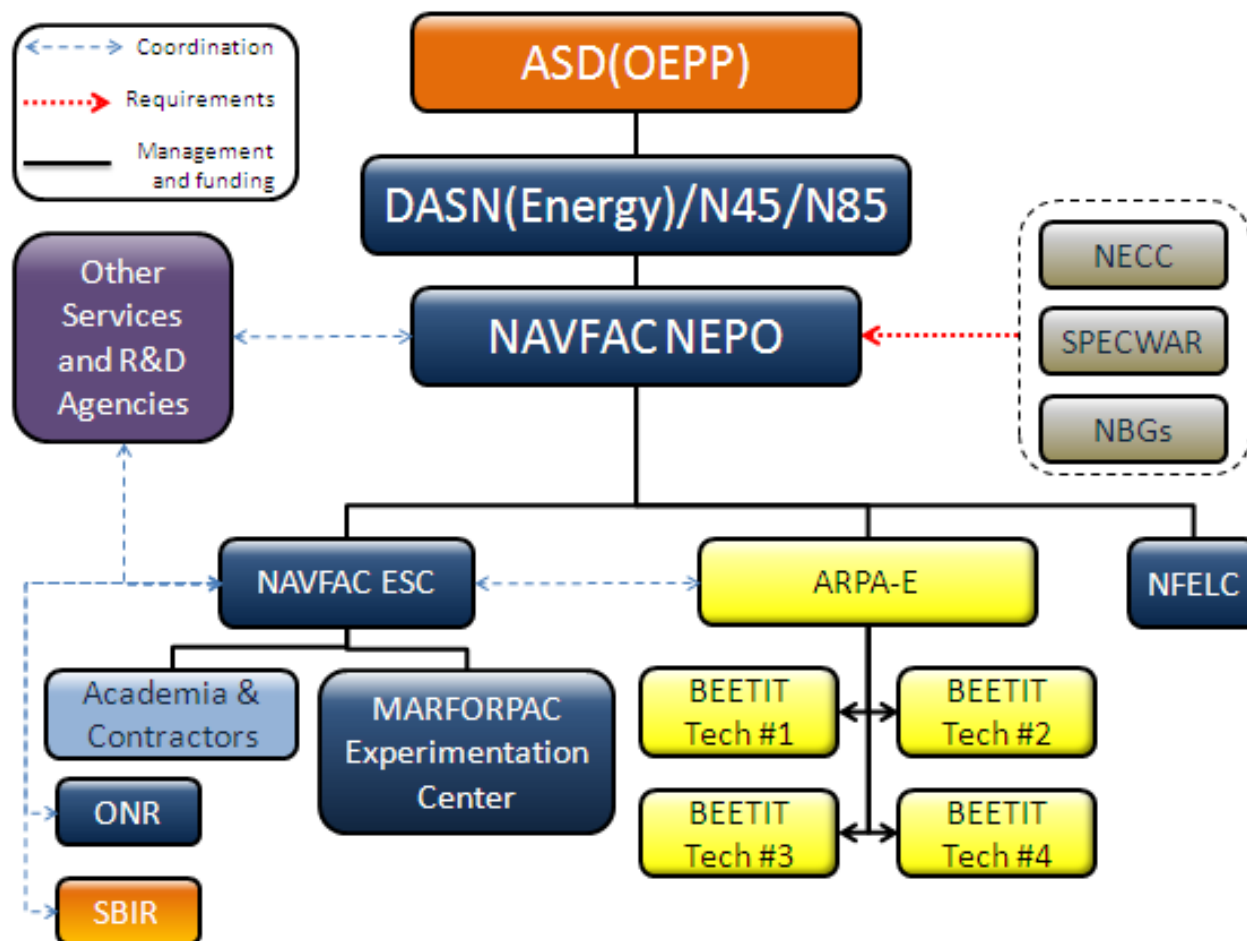
- **NETTP goal is to develop advanced ECUs**

- 1.25-2x improved efficiency
- Rated for expeditionary environments
- Fit within the size and weight envelope of current systems
- Cause no increase in logistics support

FOB ECU Fuel Use



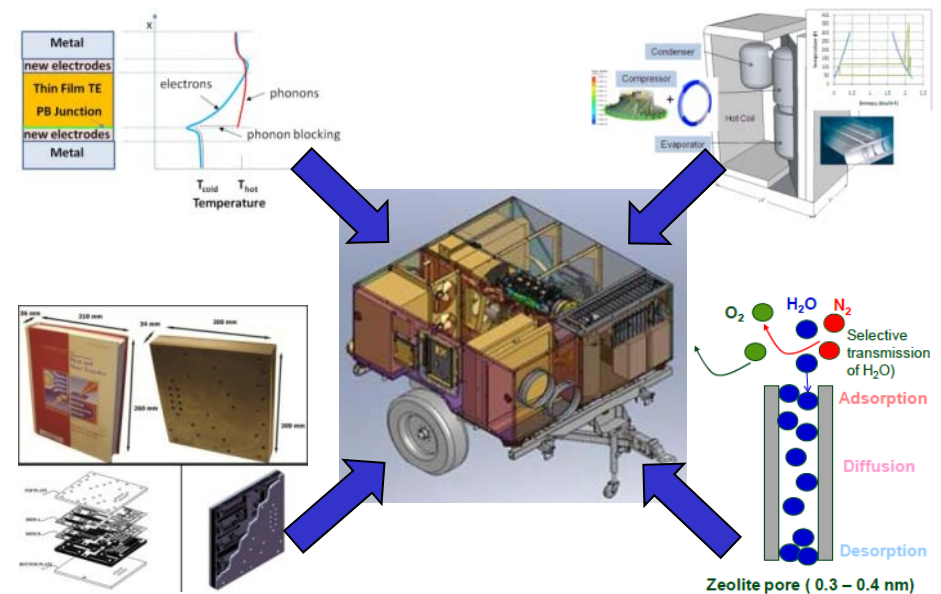
NETTP Program Structure



NETTP Approach



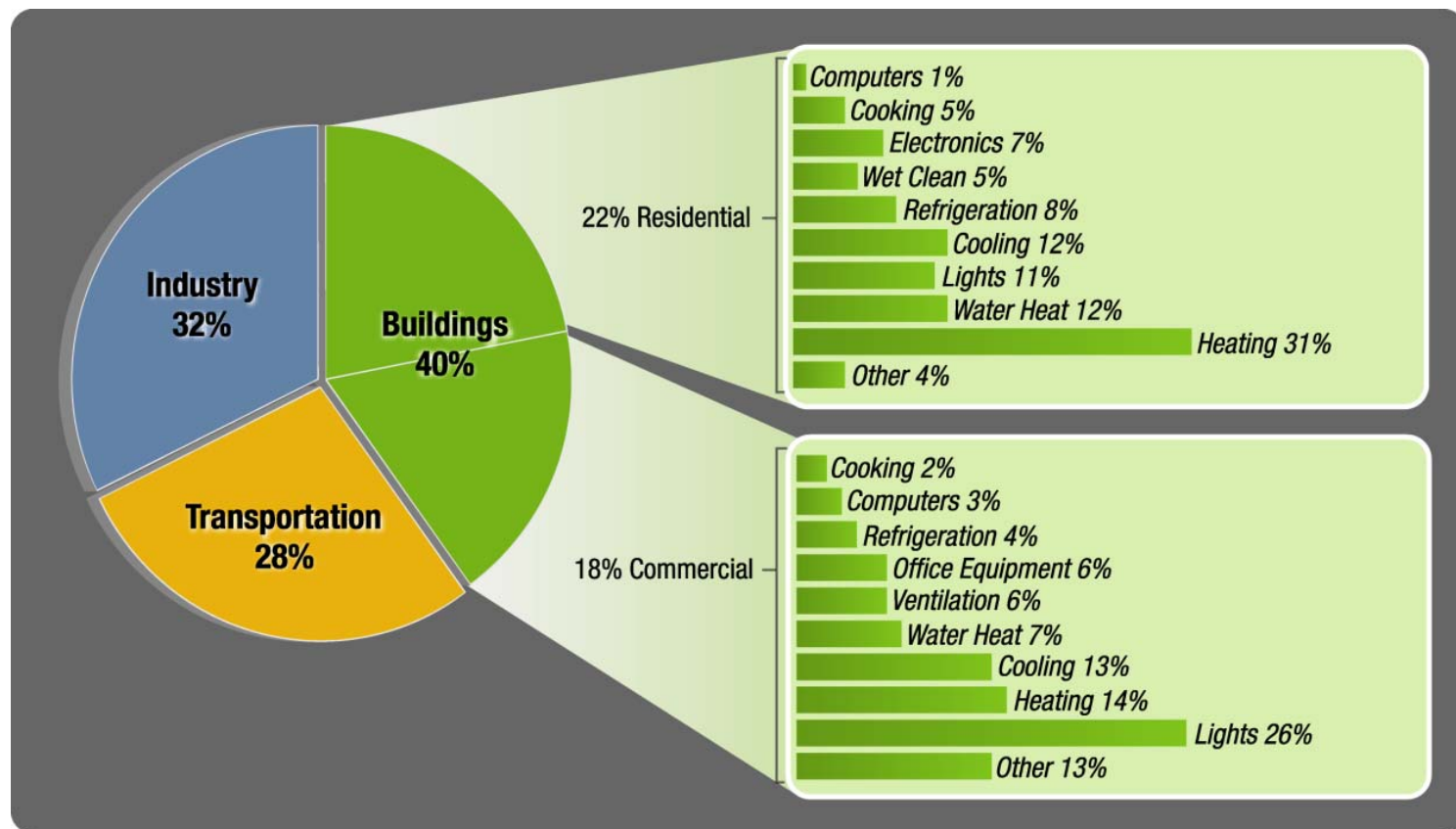
- Leverage the R&D efforts of the DOE Advanced Research Projects Agency–Energy (ARPA-E) in the area of efficient heating and cooling technologies
- NETTP will expand existing research efforts in the ARPA-E portfolio to focus on expeditionary ECUs
- Currently identified candidate technologies
 - Membrane Dehumidification
 - Absorption Cooling
 - Thermoelectric Cooling
 - Water-based HVAC



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**



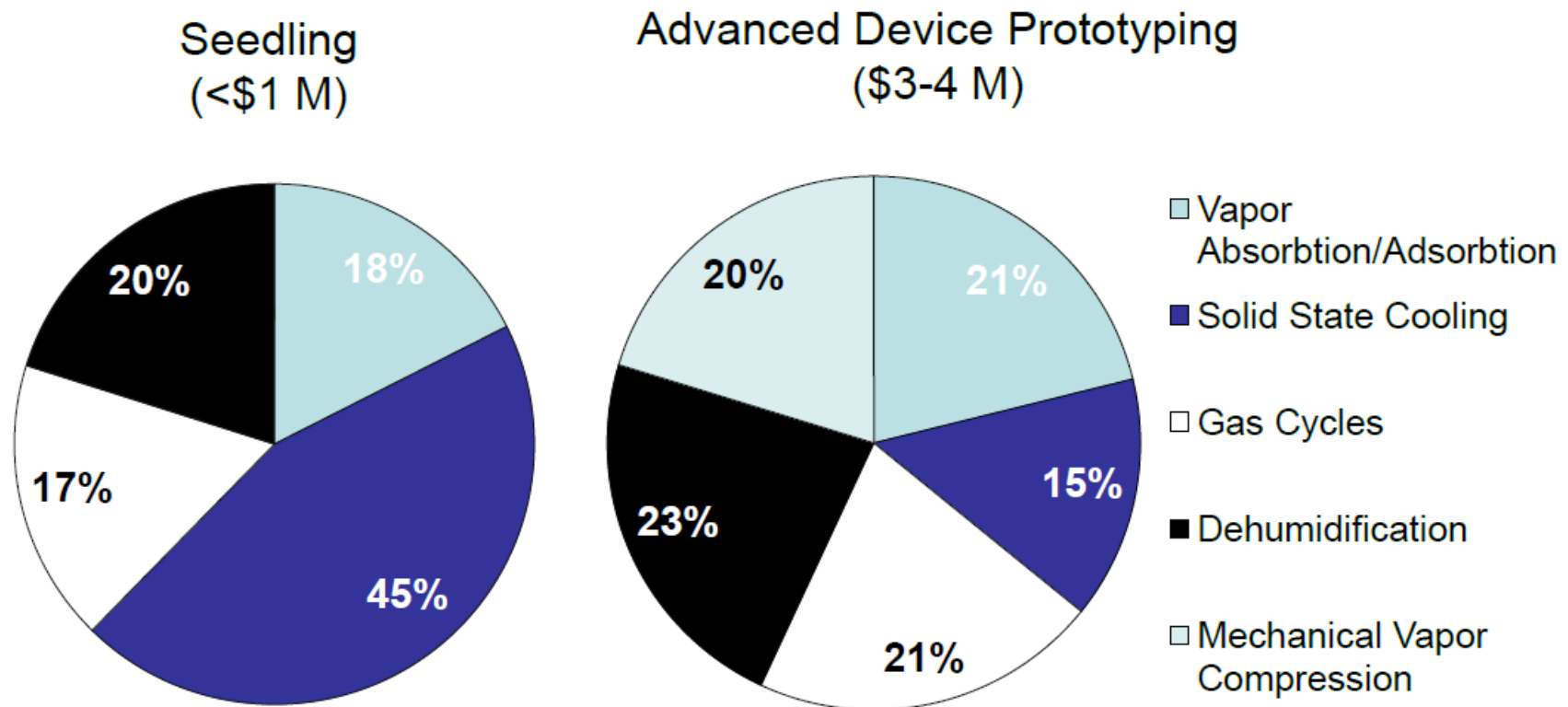
Source: LBNL Environmental Energy Technologies Division, 2009

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BEETIT Portfolio Breakdown



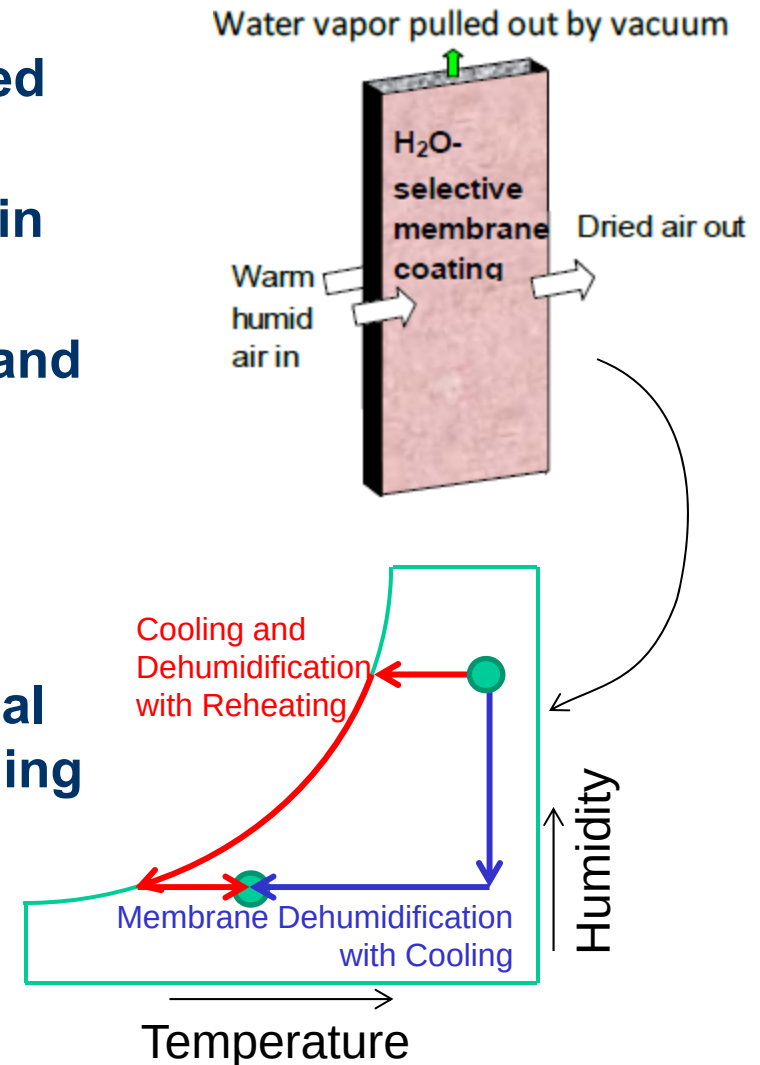
• \$30.3 M, 3 years, 16 projects



Membrane Dehumidification



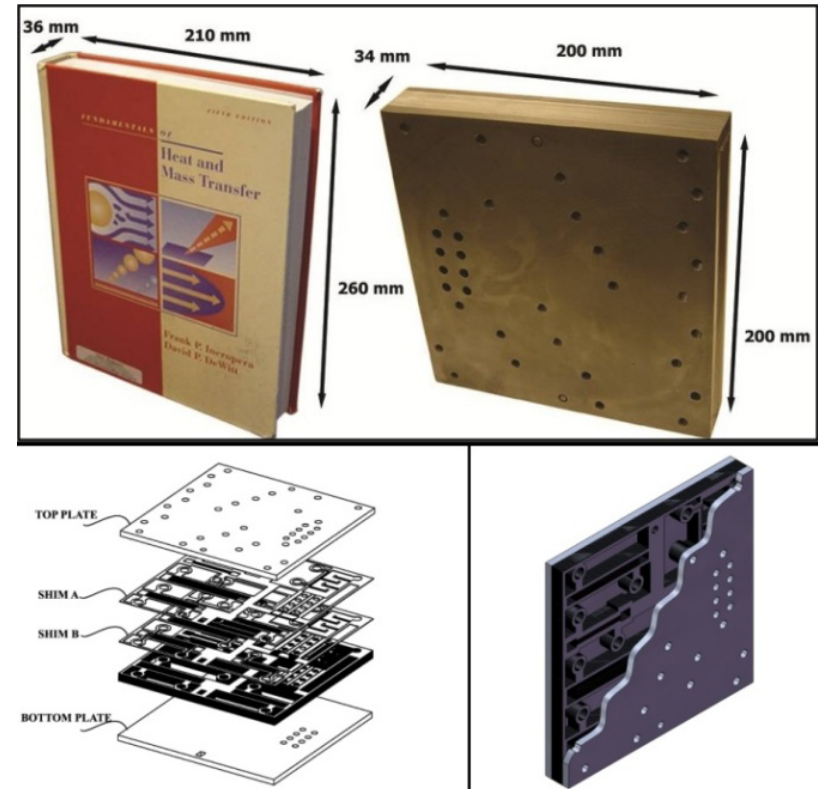
- Selective removal of water vapor from feed air using a zeolite membrane
- Temperature/Humidity levels can be met in warm, humid climates without reheating
- Allows higher cooling coil temperatures and a higher Coefficient of Performance
- Can be used as a drop-in solution for retrofitting\ of existing AC systems
- Possible to achieve $(COP)_{Th}$ of >1.12 for cooling of hot, humid air with conventional vapor compression AC systems by avoiding latent cooling duty with the membrane dehumidification



Modular Thermal Hub



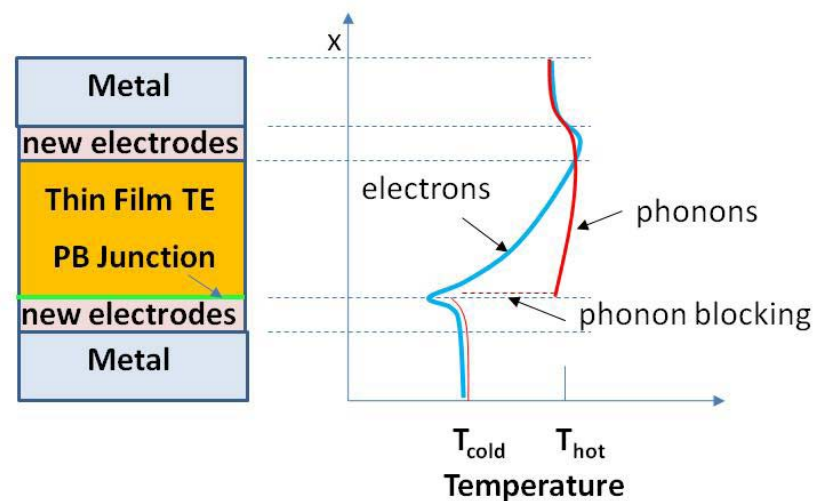
- Small, efficient absorption cooling
- Energy source: Combustion, low-grade waste heat, solar thermal energy
- Reversible operation enables space cooling and heating, and water heating
- Modular cooling and heating unit
- Monolithic packaging offers small fluid charge, flexible placement
- Working fluid with zero GWP
- Long-term equivalent electric COPs: 2.5–8.3



Non-Equilibrium Asymmetric Thermoelectrics



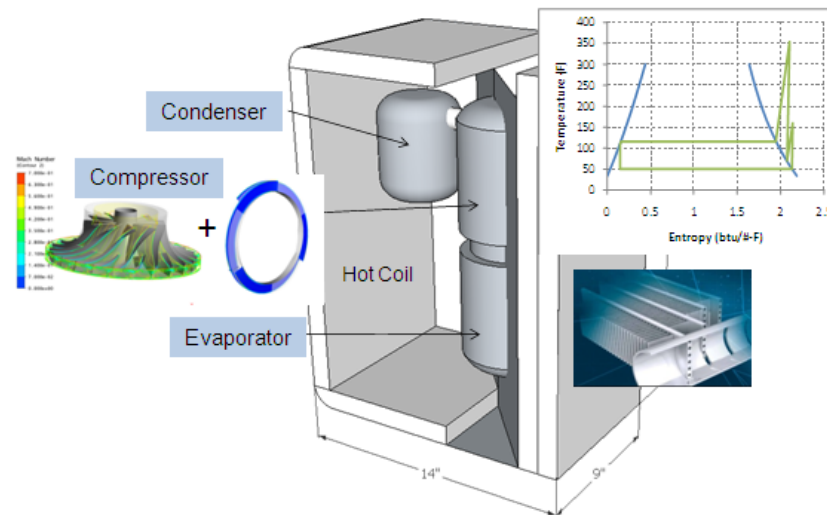
- NEAT will result in light, reliable, low-cost, green cooling engines with no moving parts
- NEAT may attain $COP > 4$ at $\Delta T = 22^\circ\text{C}$ (vs $COP < 2$ for current TE)
- Mitigation of interface losses in thin film coolers using novel electrodes
- Non-equilibrium effects utilized to decouple electron and phonon systems in thin films



Water based HVAC System



- Utilizes water as the refrigerant with a goal $COP > 4$
- Enables use of water as a cost-effective, zero global warming potential non-flammable and non-toxic option for air-conditioning and refrigeration devices
- Supersonic compression enables single-stage high compression



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