DELTA: Delivering Efficient Local Thermal Amenities

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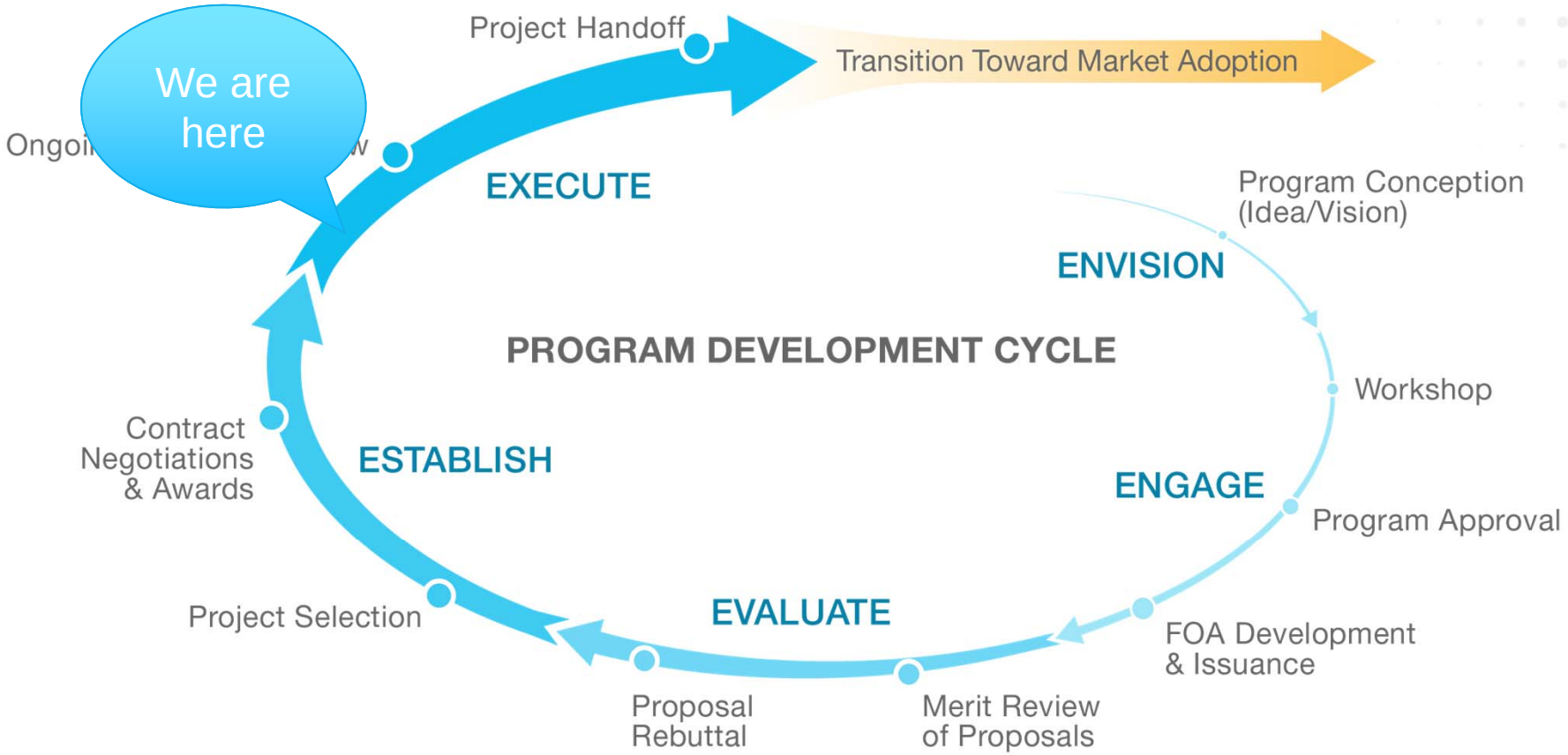
Welcome to Portland!

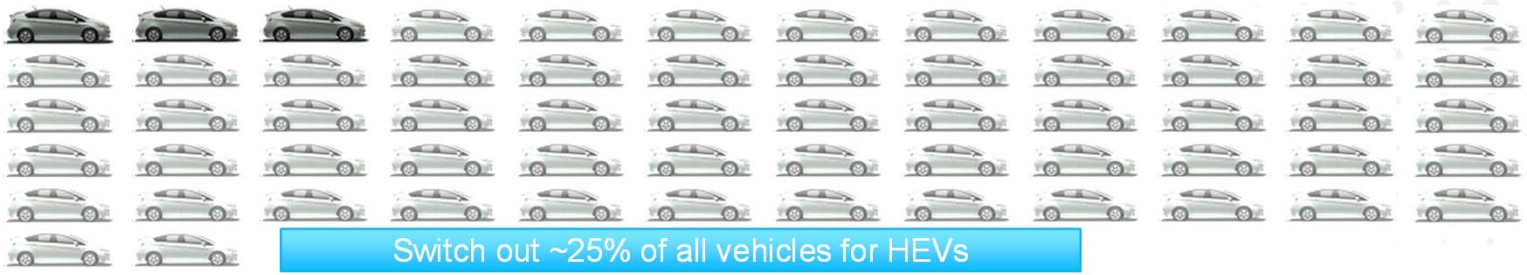
Thanks!

ARPA-e Program Development



How difficult is it to save 1 Quad

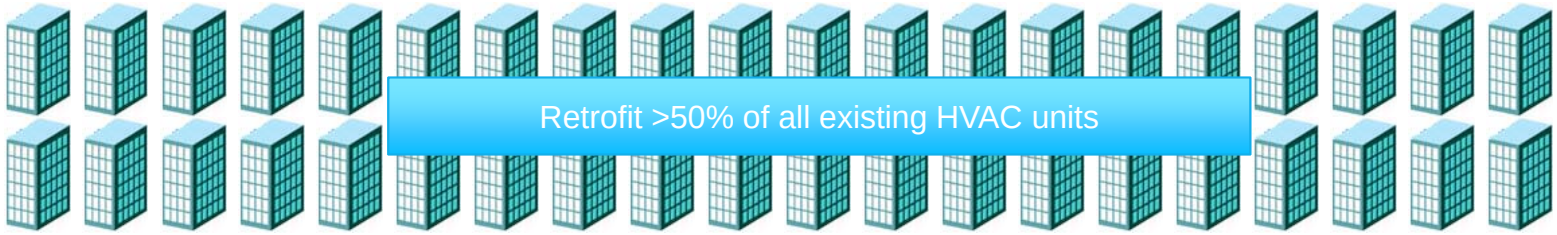
HEVs



EVs

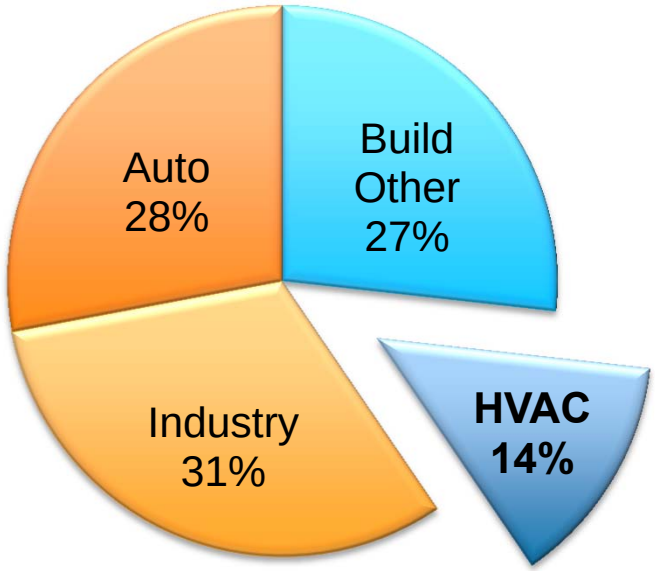
Homes

Commercial

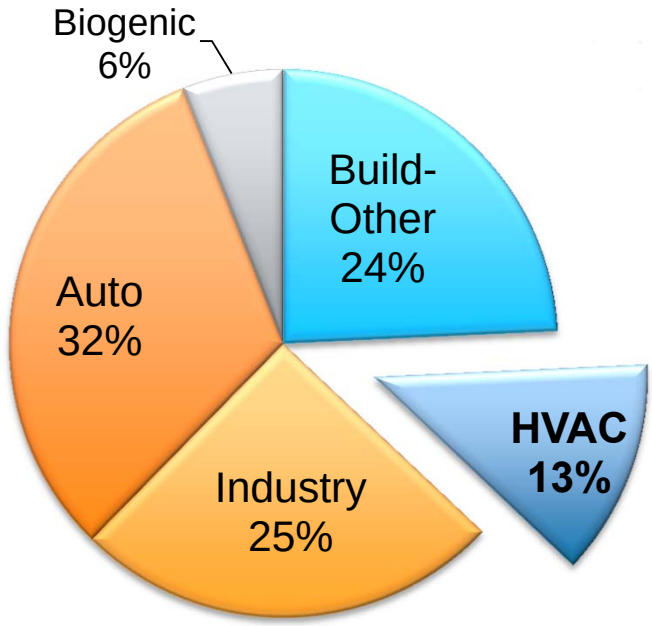


HVAC is a big piece of the pie

U.S. Energy Use



U.S. GHG Emissions



HVAC > 13% of energy use and emissions

Source: EIA 2011 data

Current Approaches and Challenges

- **Approaches**
  - HVAC system efficiency
  - Walls and windows insulation
  - Building sensing and control
- **Challenges**
  - Costly building retrofit (> 5 y payback, high capex, long-life)
  - “Split incentive” problem—building owner often not the user
  - Thermodynamically, most energy wasted

Building Component Life

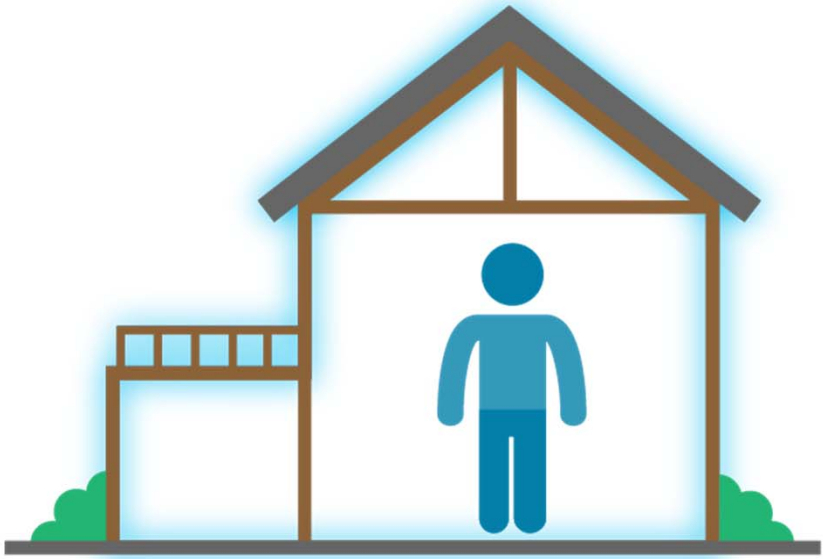
Component	Years
Incandescent Bulbs	0.5-1
Fluorescent Bulbs	5-10
Office Equipment	2-7
Consumer Electronics	3-15
Consumer Appliances	5-20
Residential Hot Water	5-20
Residential HVAC	10-30
Commercial HVAC	10-25
Building Envelope	20-50
Whole Building	40-120

Low-cost, easily deployable solutions needed

Program Vision

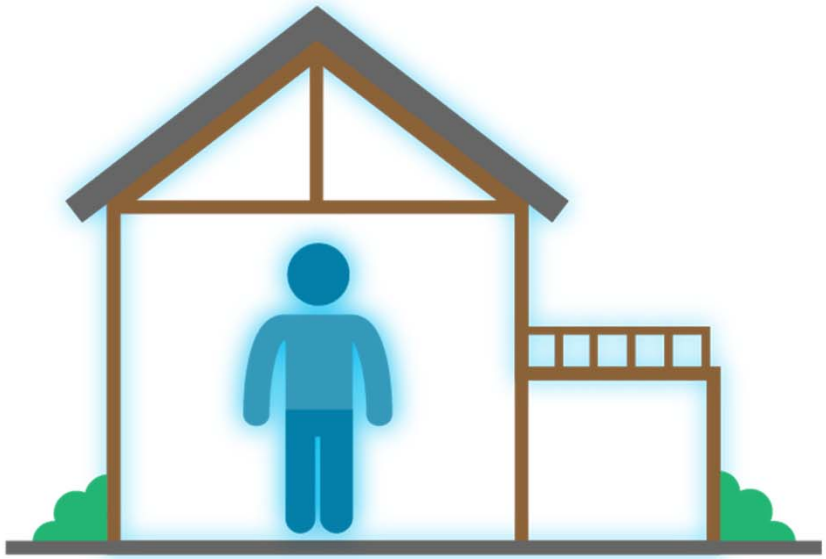
SAVE ENERGY by tailoring the thermal environment around the individual rather than over-heating or over-cooling unoccupied space within a building.

PRESENT



HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) accounts for 13% of energy annually consumed in the U.S.

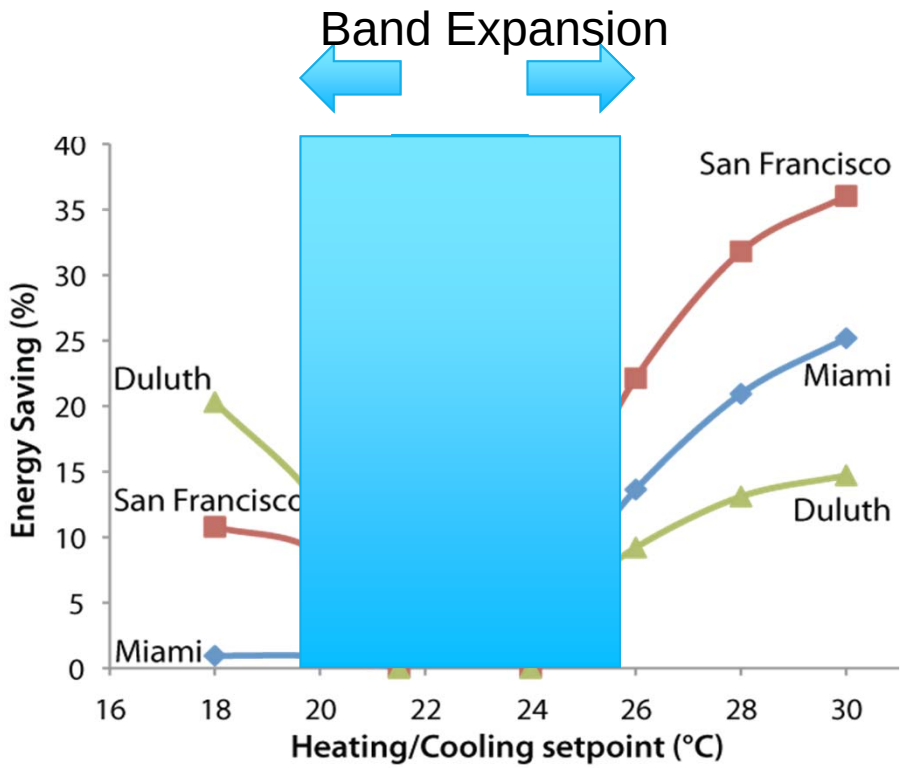
FUTURE



SAVE >15% of U.S. heating and cooling energy (~1.8 Qbtu)

DELTA Program Objective

- **Save 2% of US heating and cooling energy (1.8 Qd) by expanding temperature setpoints of buildings by 2.2°C in both directions**

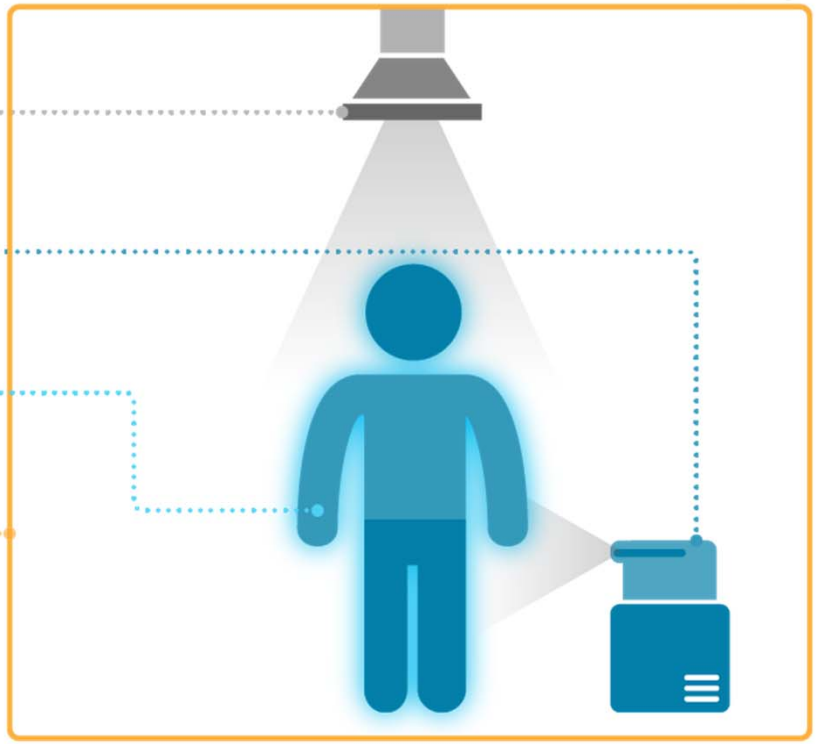


Credit: Arens et al, UC Berkeley

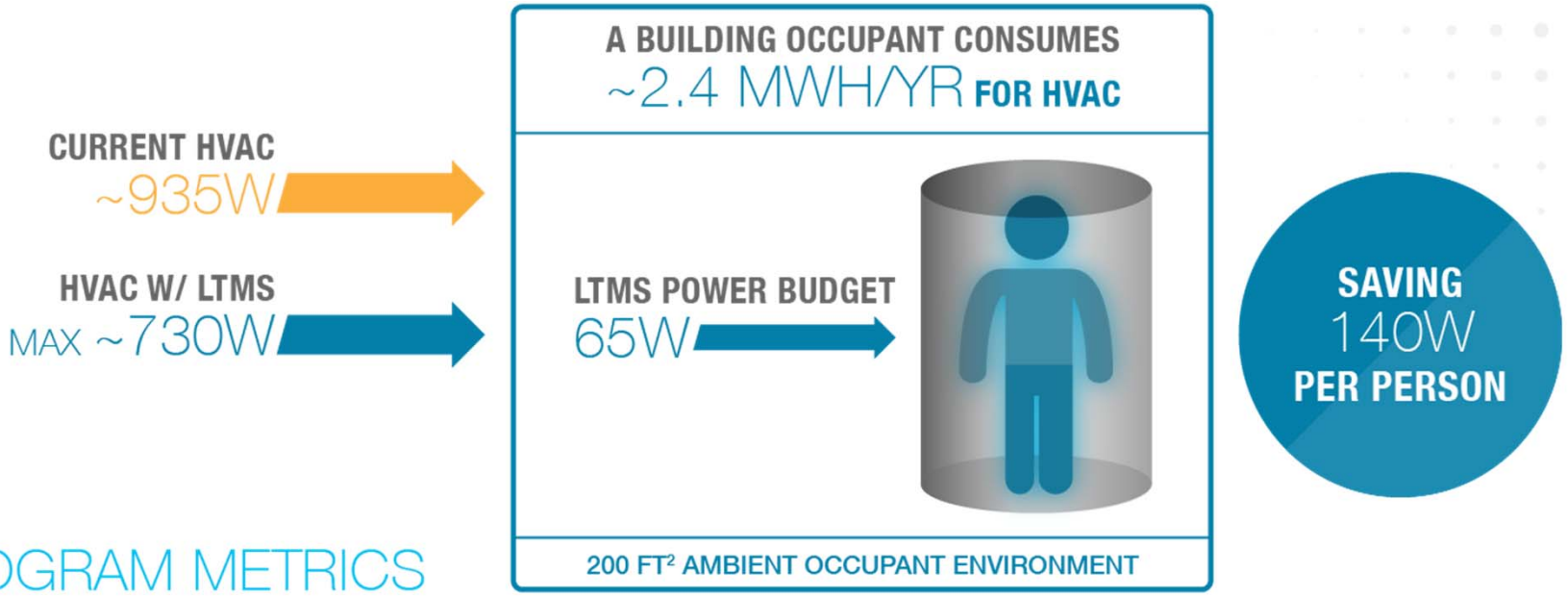
Technology Categories

Program considers
FOUR APPROACHES
to balance the risks and benefits of each.

1. **EXTENDED RANGE (>1M)**
   wireless, directed energy transfer
2. **CLOSE PROXIMITY (<1M)**
   wireless, directed energy transfer
3. **WEARABLE TECHNOLOGY**
   (e.g. adaptive insulation) to reduce energy consumption
4. **SYSTEM LEVEL SOLUTIONS**
   using combinations of approaches 1-3



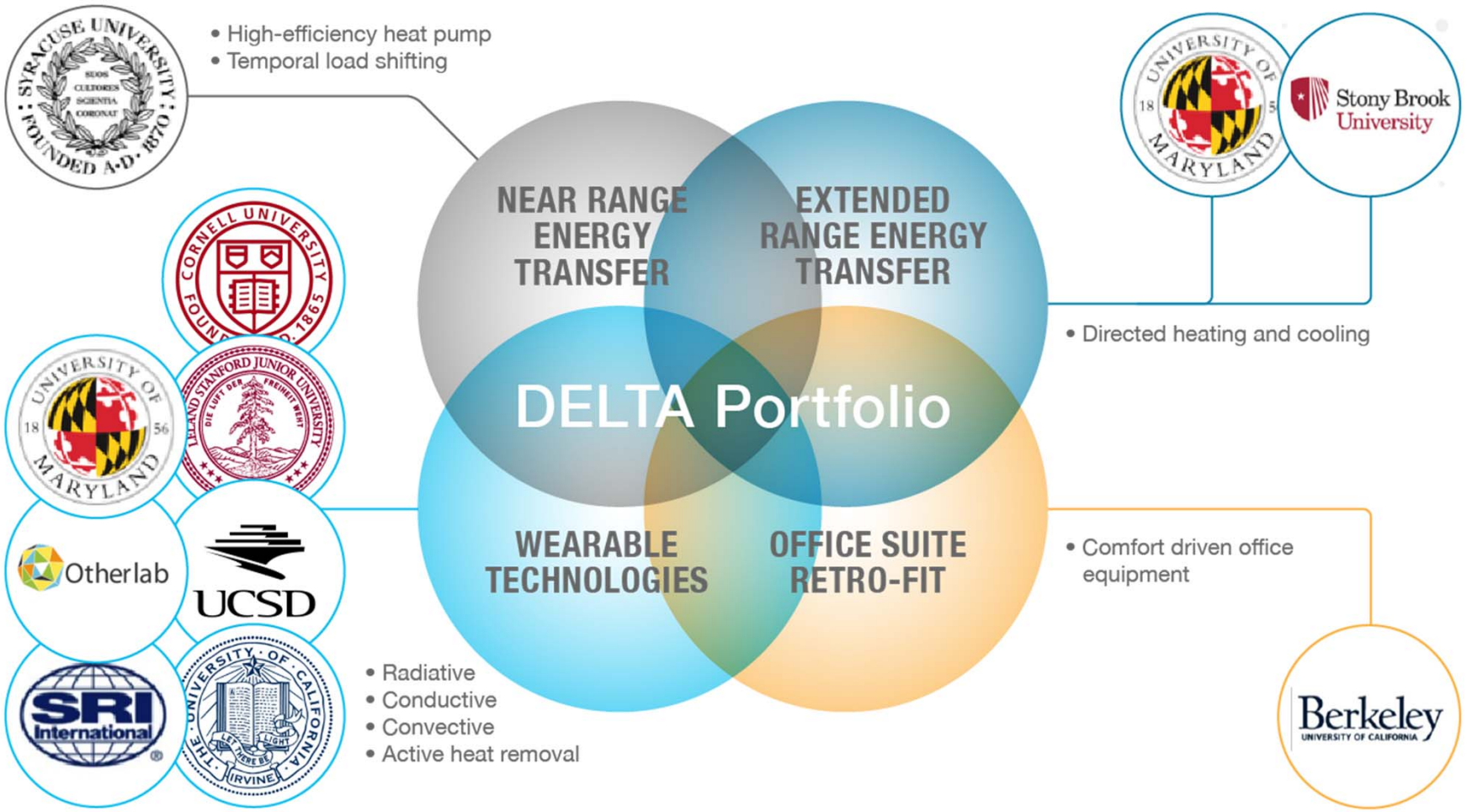
Primary Metrics, Enabling ≥ 15% Energy Savings



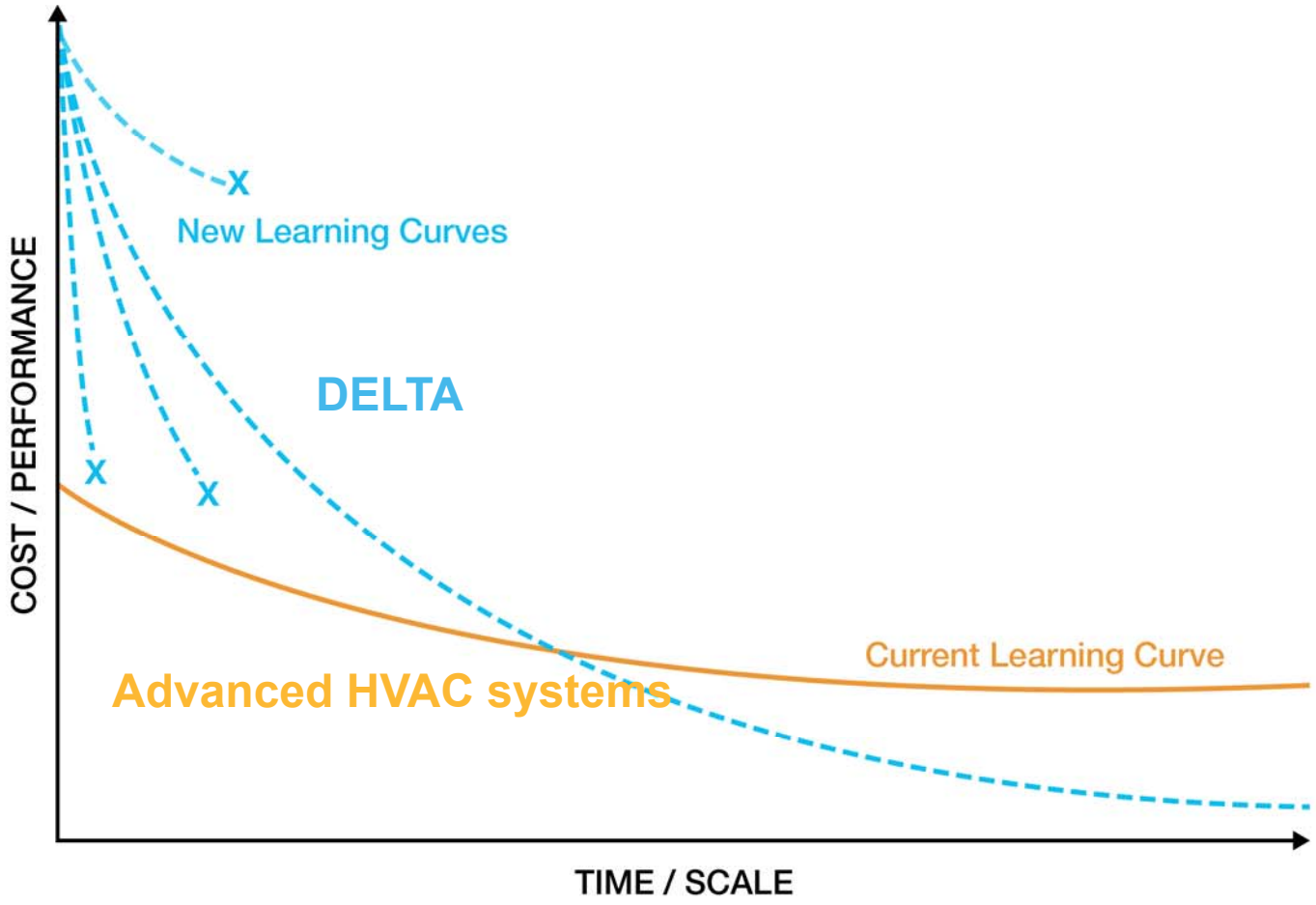
PROGRAM METRICS

1. **TECHNOLOGY MUST SUPPORT A TEMPERATURE SETPOINT ΔT OF ≥ 4°F WHILE MAINTAINING A CONSTANT SKIN TEMPERATURE**
2. **TECHNOLOGY MUST HAVE A COP TARGET OF >0.35**
   Systems can be passive or active w/ a max power consumption of 65 W/person
3. **ALL APPLICANTS MUST PRESENT A PATH TO PAYBACK WITHIN A 3 YEAR TIMETABLE**
   Payback allowance of $20/person/year @5.4¢/kWh for ΔT of 4°F in both directions

DELTA Portfolio by Category



Creating New Learning Curves



DELTA Is a Building Energy Program

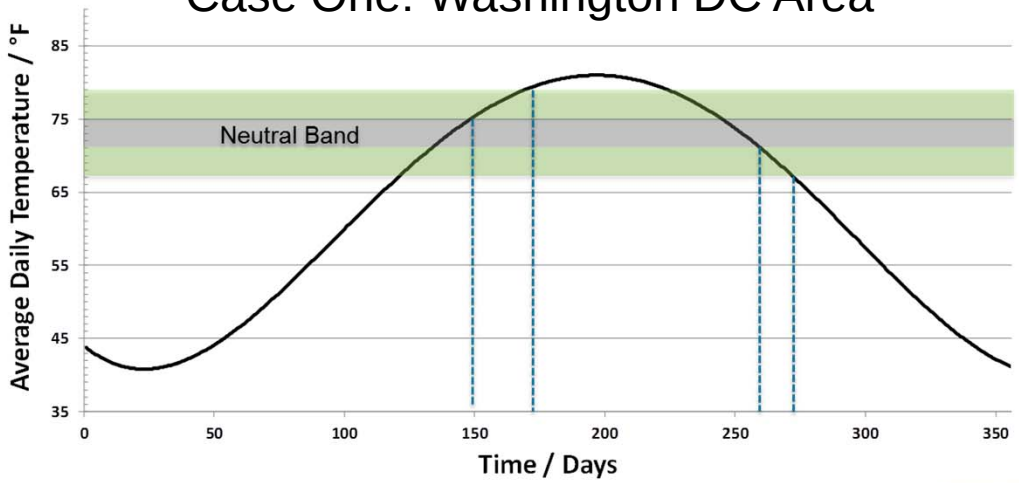
How to get to impact?

- *Make something people will buy*
- *If enough people buy it, make sure it will save energy*

How to Make Things People Will Buy

Impact: Adoption Leading To Energy Savings

Case One: Washington DC Area

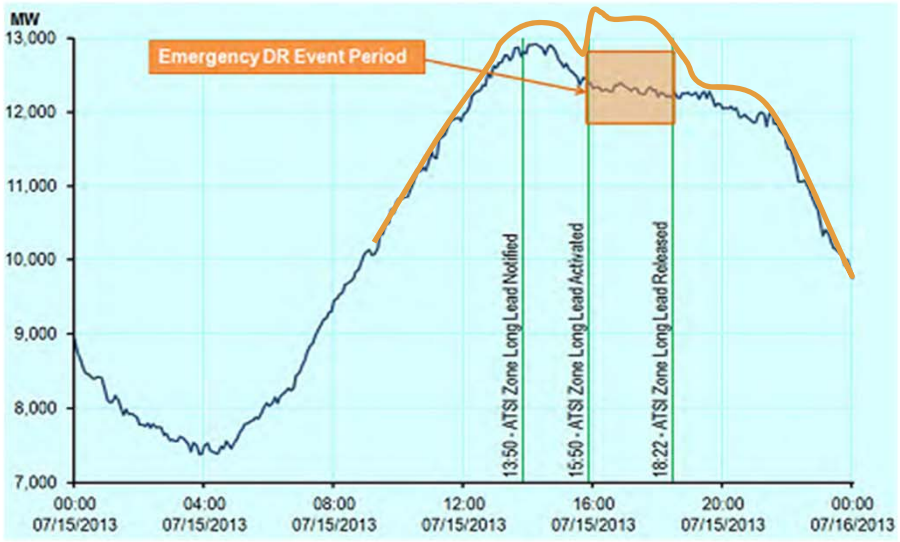


Residential

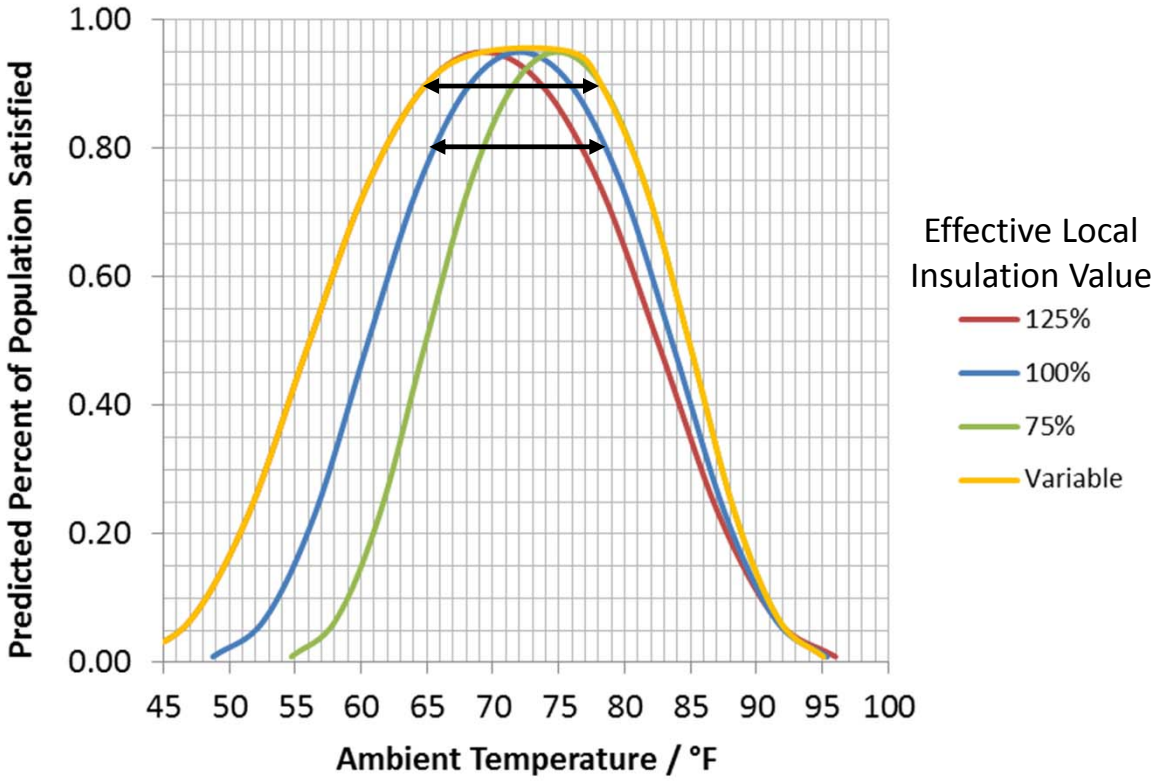
Delay cooling season by ~25 days
Delay heating season by ~10 days

Residential and Commercial

- PJM 900 MW Demand Response.
- 7% capacity was from HVAC turndown.
- Valued at a ~$0.08 per kWh credit.



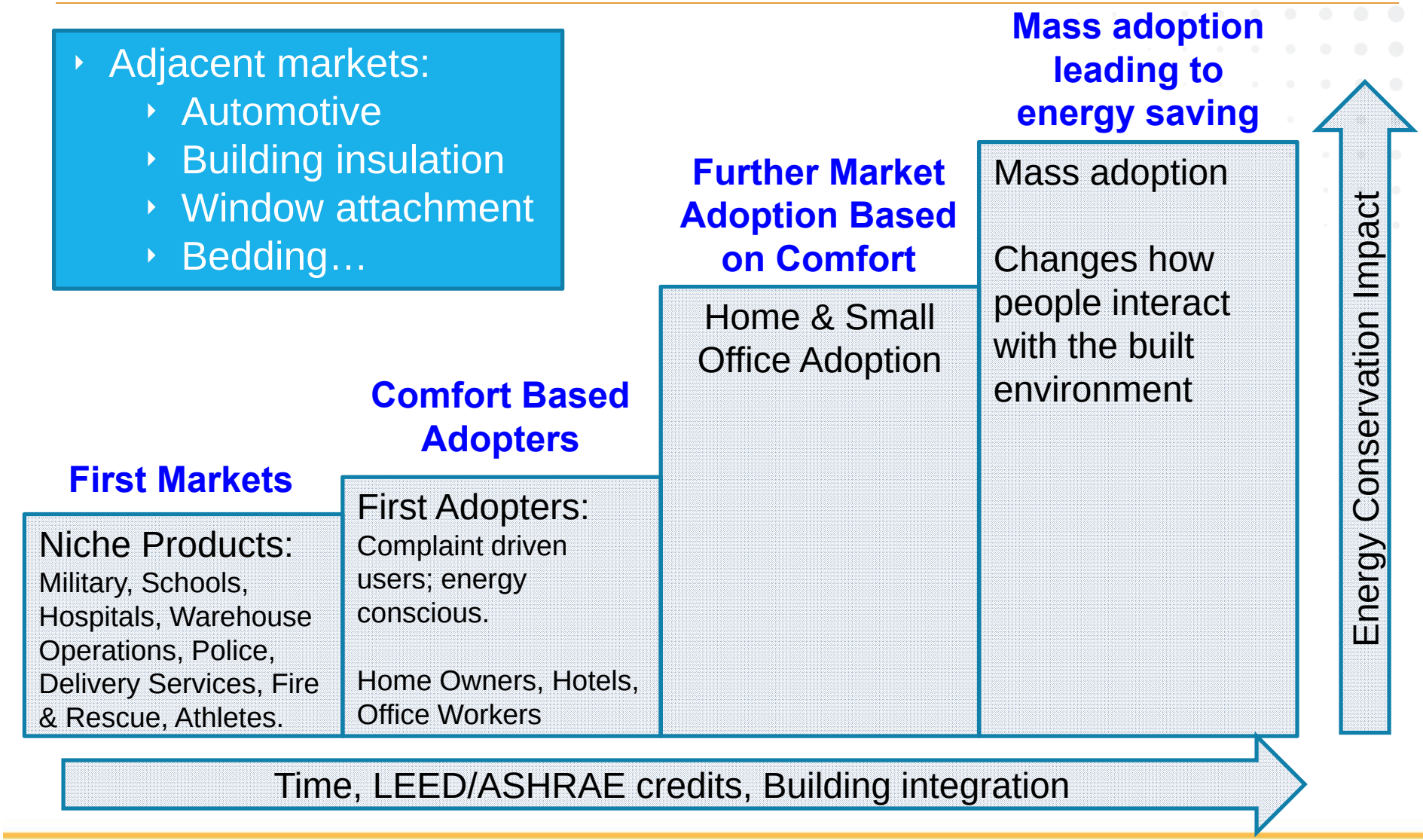
How Much Adoption Will Save Energy
-The Correlation Between Comfort and Energy



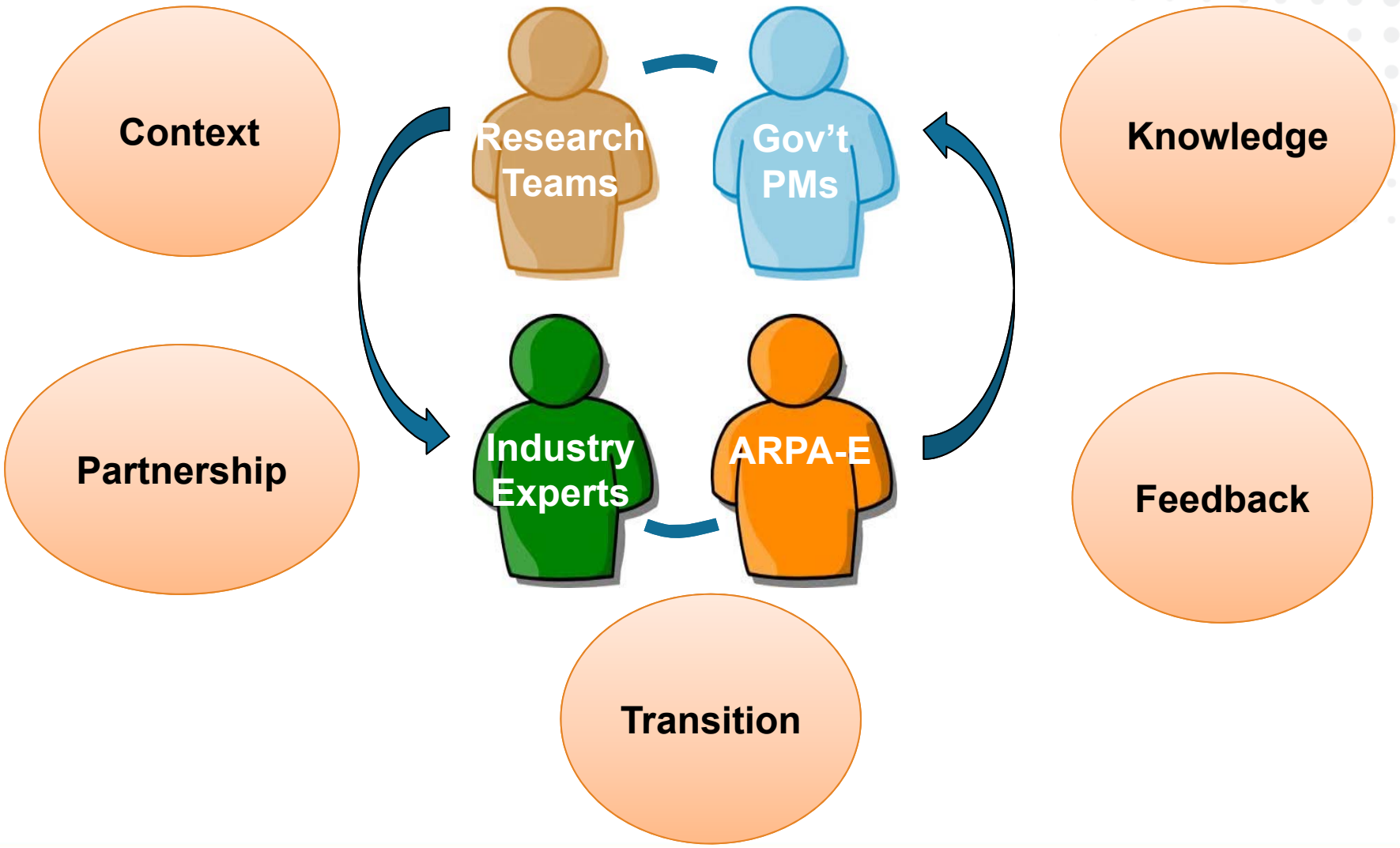
~ 10% targeted adoption results in 4ºF set point expansion but temperature adaptability is required

Roadmap to Realizing Technology Impact

- Adjacent markets:
  - Automotive
  - Building insulation
  - Window attachment
  - Bedding…



Kickoff Meeting Objectives



Founding a Technical Community

Outreach

- Opinion articles in technical journals
- Symposia at technical conferences

Inreach

- Web portal for project teams
- Other ideas welcome

Welcome


architectural applications
a2
ThermoAnalytics
Sandia National Laboratories
Stony Brook University
intel
electroZyme
United Technologies Research Center
NIKE
SPAWAR
adidas
vf
HermanMiller
HARWICH PARTNERS
NASA
SYRACUSE UNIVERSITY
SUOS CULTORES SCIENTIA CORONAT
FOUNDED A·D· 1870
Columbia Sportswear Company
DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA
WiTricity
University of Colorado Boulder
OAK RIDGE National Laboratory
WEEL TECHNOLOGIES
Ucla
DEFENSE THREAT REDUCTION AGENCY
UNITED STATES OF AMERICA
IDEO
Oregon State UNIVERSITY
UNDER ARMOUR
Stanford University
UCSD
Global Apparel Solutions
UNIVERSITY OF MARYLAND
POLARTEC
Berkeley UNIVERSITY OF CALIFORNIA
ATM
CORNELL UNIVERSITY
FOUNDED A.D. 1865
Nxeco
SRI International
Bush Technical
SA STRATEGIC ANALYSIS
UCIrvine UNIVERSITY OF CALIFORNIA, IRVINE
Otherlab
Shingebiss LLC
Booz | Allen | Hamilton

Agenda

Day #1

HVAC Energy Flow in Buildings

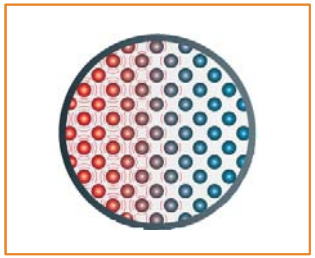
DELTA Projects Overview #1

DELTA Adoption Challenges Panel

DTRA

Day #2

DELTA Projects Overview #2



Thermal Engineering for DELTA

TT 105 - Intro to Textile Tech

DOE - BTO

We Are Here to Help

Ping Liu
Program Director

Chris Atkinson
Program Director

Dave Henshall
Tech-2- Market Advisor

Russel Ross
Technical SETA

Ashok Gidwani
Technical SETA

Heather Schmidt
Program SETA

A Bit About Onsite Reviews

- Every project is expected to be reviewed at least once every quarter either onsite or remotely.
- The main objective is to review project progress:
  - What has been done in the past quarter?
  - What do the results mean to the project critical path? If the path is threatened, what is the plan to address it?
- Preferred format:
  - Start with a high level overview (e.g., a Gant chart with critical milestones noted);
  - Show the *actual* milestone document and state whether milestones have been met;
  - Provide technical details to support claims of accomplishments;
  - Discuss next steps and voluntary corrective actions;
  - Explain what help you need from us.

A Word About Quarterly Reports

- **Be concise**: most important is to note progress on milestones; leave sensitive/proprietary information out if you like

Measuring ARPA-E/DELTA's Success

MOVING TECHNOLOGY TOWARD MARKET

- Partnerships with other government agencies
- New companies formed
- Follow-on funding
- Established company relationships and developed new communities
- Products in the marketplace

BREAKTHROUGH ACHIEVEMENTS

- Technology breakthroughs
- Patents
- Publications

OPERATIONAL EXCELLENCE

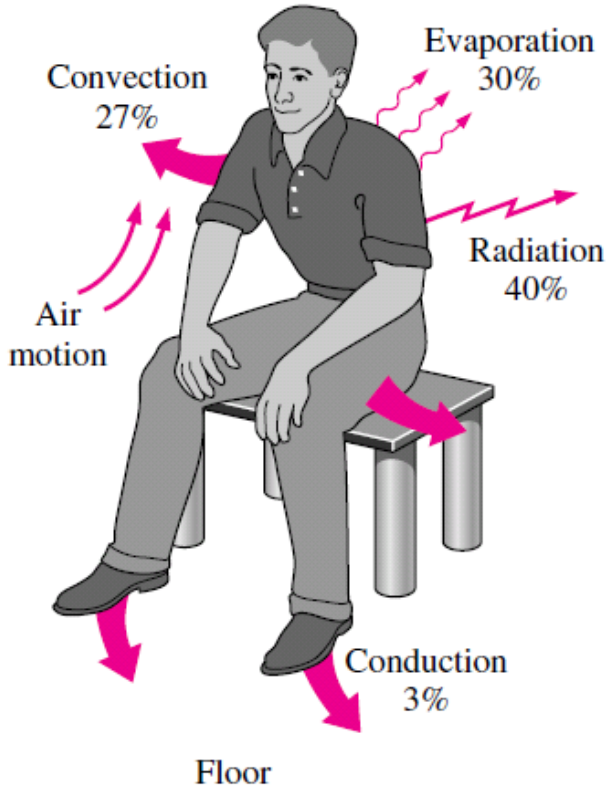
- Expedited program development and project selection
- Aggressive performance metrics

U.S. DEPARTMENT OF
ENERGY

www.arpa-e.energy.gov

Thermal Regulation in Indoor Environments

$$Q_{Body} = (Q_{Convection} + Q_{Radiation} + Q_{Latent})_{Skin}$$



Managing Thermal Flux, Q:

1) Alter materials for thermal transport

2) Alter ambient conditions

Requires Energy Input

*Typical Occupant Thermal Load : ~**105 W***