# 2013 BBA Efficiency Forum
# Space Conditioning Breakout Sessions

# BBA Member Discussion – Current and New Projects

- Agenda
  - Duct Leakage Project
  - Advanced RTU Campaign
  - Brainstorm new ideas

# Duct Leakage Project – Why?

- Duct leakage can
  - Increase system airflow rates by 5% to 35%
  - Double fan energy and increase cooling energy by 40%
- Payback for sealing ducts can be 2-3 years
- Duct leakage has multiplying impacts
  - Increased fan, pump, and chiller/boiler energy consumption
  - Unbalanced air distribution and poor thermal comfort
  - Unable to meet ventilation requirements
  - Poor indoor air safety – spread of contaminants
  - Oversized equipment to make up for losses

# Duct Leakage Project

- Objective: Identify when duct leakage is a problem and correct it cost effectively
- Solutions to be explored to help building owners
  - Help facility managers recognize and quantify the problem
  - Provide case studies of the best solutions
  - Partner with Western Cooling Efficiency Center – Dr. Mark Modera
- Proposed Outputs
  - Best practices for measuring and estimating impacts of duct leakage, correcting problems, rebalancing HVAC systems
  - Owner's guide and procurement specification for duct leakage
  - Improved analysis tools
- Ask to BBA members
  - Is duct leakage a problem?
  - What would be most useful?
  - Review resources

# Advanced RTU Campaign (ARC)

- What:
  - Move the commercial building RTU market to greater adoption of high efficiency RTUs and RTU controls
  - Follow-on to RTU Challenge and Advanced RTU Controllers demonstrations
- Who: Campaign organizers, supporters, and DOE
  - Organizers: ASHRAE, RILA, and others to be announced
  - Supporters: Utility programs, efficiency organizations, and manufacturers
  - Participants: Building owners
  - Department of Energy provides technical support
- When: The project launches May 30, 2013 and runs through November 2014

# Eligible Technologies

- Control Retrofits
  - Variable speed fan, advanced economizer controls, demand controlled ventilation, fault detection and diagnostics
  - Preliminary results show reduced RTU energy consumption by up to 40% with a 2-4 year payback

- RTU Early Retirement and High-Efficiency Replacement and New Construction
  - CEE Tier 2 and above efficiency levels including the DOE RTU Challenge specification

# Advanced RTU Campaign (ARC) Participation

| | Evaluate | Replace or Retrofit | Start Saving | Be Recognized |
|---|---|---|---|---|
| Description | Evaluate the business case for high-efficiency RTU improvements | Commit to retrofitting or replacing at least one RTU | Share expected and actual energy savings and provide feedback | Recognition will be awarded to participants in a variety of categories |
| Resources | • Case studies<br>• Calculators<br>• Technical advisors | • RTU specifications<br>• Financing/ incentives list | • Calculators<br>• Technical advisors | Recognition and award program |
| Important Dates | Campaign launches May 30, 2013 | Limited technical assistance is available until July 2014 | Deadline to report savings claims is September 2014 | Awards announced November 2014 |

# Members Experiences with RTU Replacements

- Experience with RTU replacement/retrofits
  - Successes
  - Challenges and Solutions
- What resources are needed to help you be successful?
- Should other technologies be included in the Advanced RTU Campaign?
  - ERV
  - Evaporative pre-cooling

# Brainstorming New Projects

- What new technologies have you heard of?
- What promising existing technologies are underutilized?
- What are the technical and market sticking points?
- How can we gathering performance data and successes to help you?

## Current Projects Barriers and Opportunities

- Agenda
  - Introductions (5 min)
  - Duct leakage project (15 min)
  - RTU advanced controller demos – preliminary results (20 min)
  - Brainstorm ideas (45 min)

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  - Provide case studies of the best solutions
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# Manufacturer Solutions

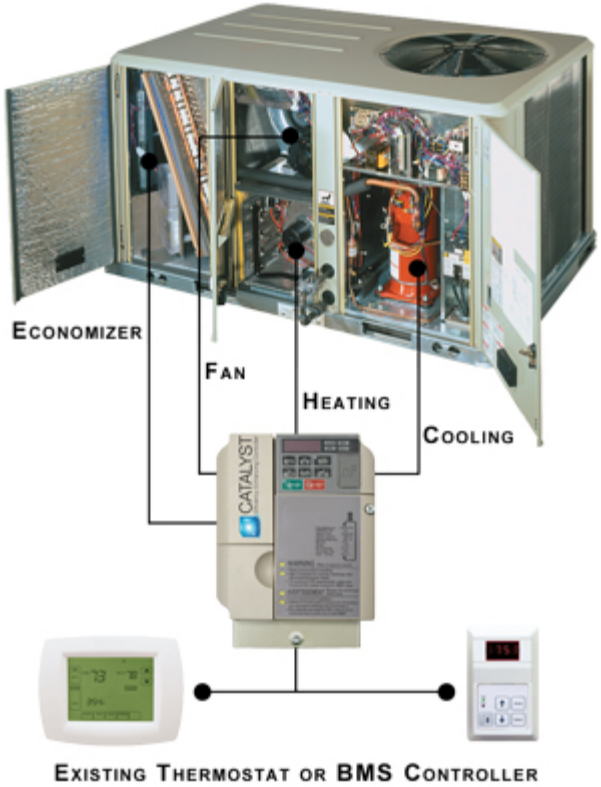
- What solutions are available for duct leakage?
  - Knowing when there is a problem
  - Quantifying the impact of the problem
  - Correcting the problem

# Advanced Packaged Rooftop Unit Controls: Results from Field Demonstrations

Srinivas Katipamula, Ph.D., Pacific Northwest National Laboratory

# Why is there a Need for an Advanced RTU Controller?

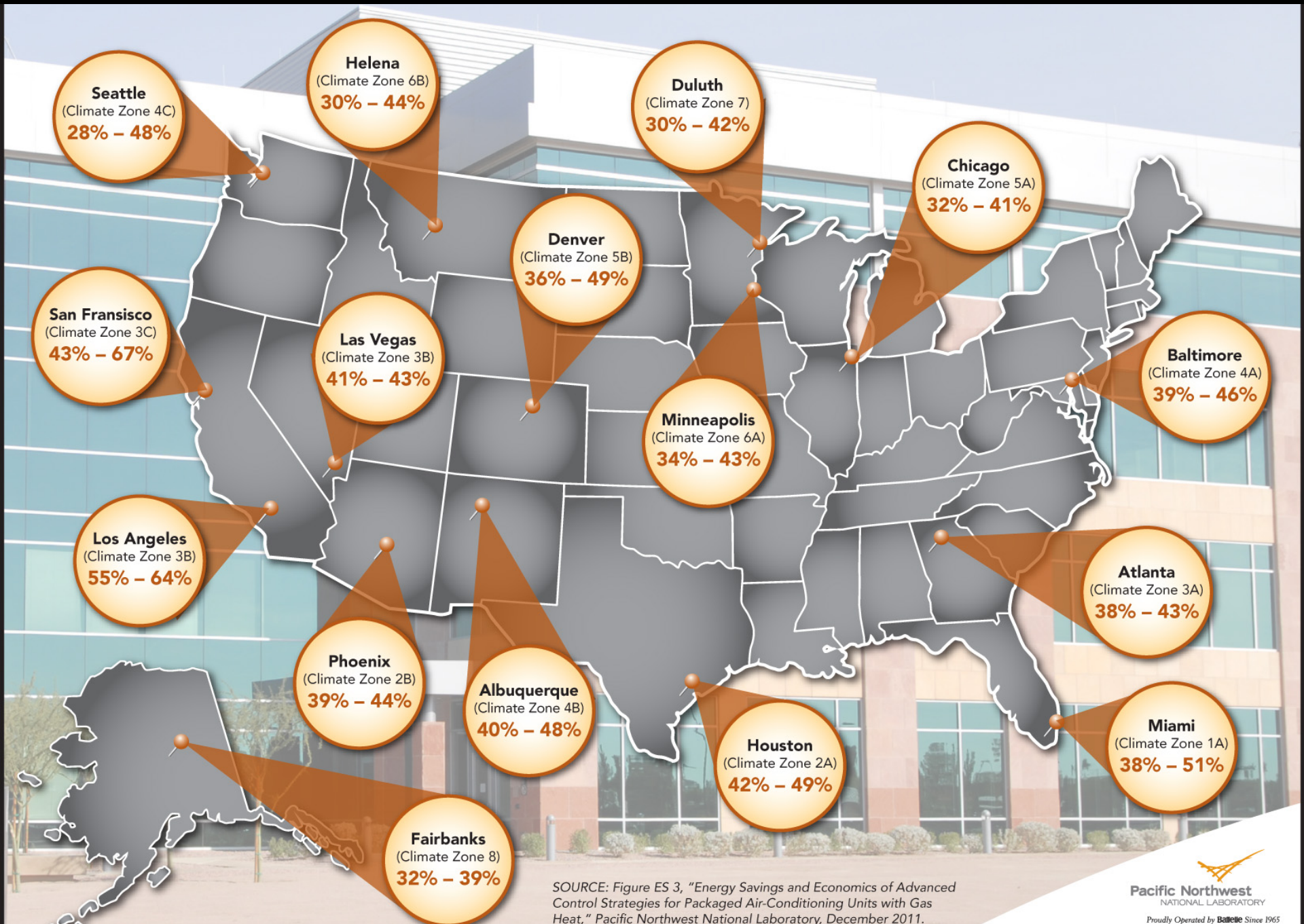
- Packaged air conditioners and heat pumps (RTUs) are used in about 58% of all cooled commercial buildings, serving about 69% of the cooled commercial building floor space (EIA 2003)
  - Packaged A/C uses 0.9 quads of electric cooling annually and 0.4 quads of heating (source)
- Most RTUs operate inefficiently
  - lack of advanced controls
    - constant supply speed fan and constant ventilation
  - lack of equipment maintenance
- Operating efficiency can be improved significantly with the use of advanced control strategies:
  - integrated economizers
  - variable or multiple speed supply fan control
  - demand controlled ventilation and
  - variable or multiple capacity control



# Advanced RTU Controls: Accomplishments and Progress

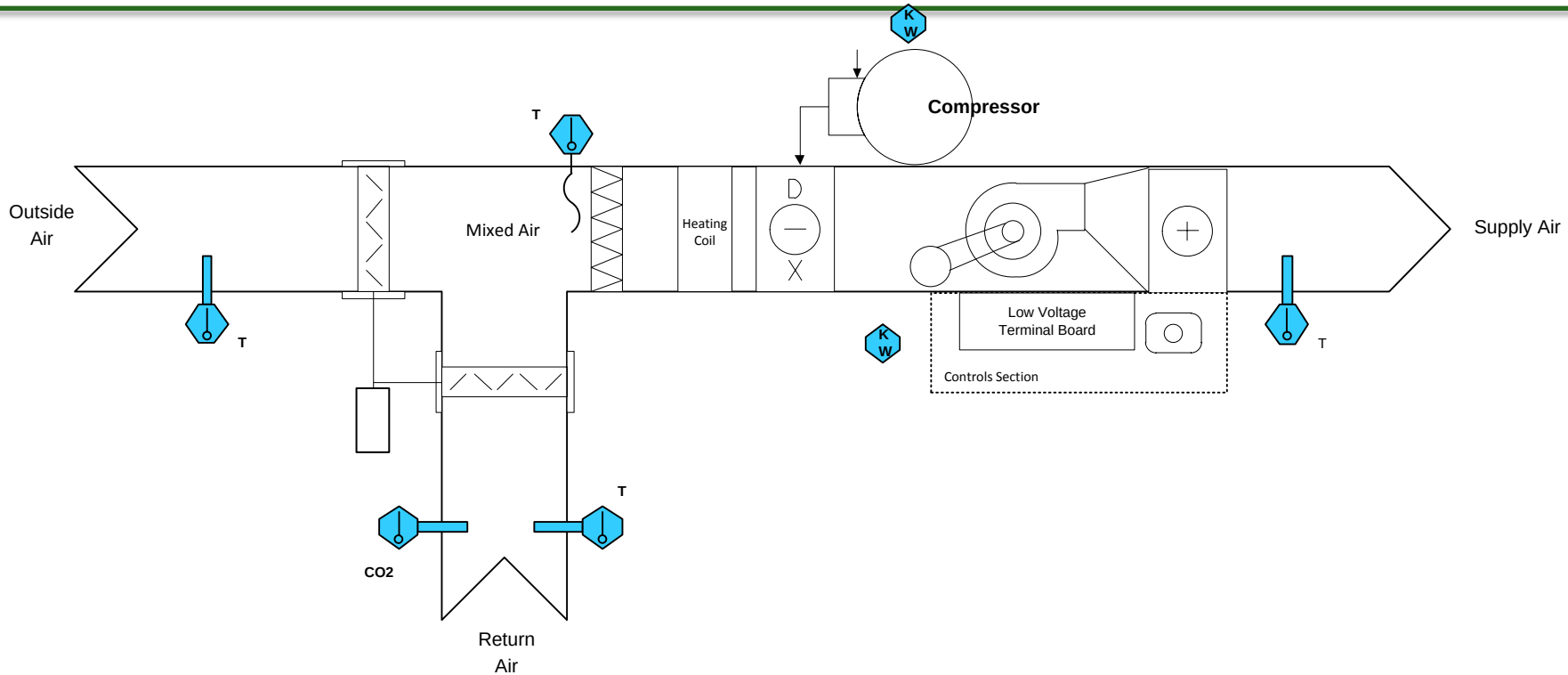
- Installation of all controllers for both DOE and BPA projects complete
- Continuing to monitor RTUs in the field
- Savings analysis underway and final report is being drafted, which will be released in August 2013 after BPA/DOE review
- Also coordinating work with Center for Energy and Environment in Minnesota, which is also evaluating advanced control products

http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20955.pdf
http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-21944.pdf




*SOURCE: Figure ES 3, "Energy Savings and Economics of Advanced Control Strategies for Packaged Air-Conditioning Units with Gas Heat," Pacific Northwest National Laboratory, December 2011.*

# Advanced RTU Controller: Field Test Measurement Plan




- The following parameters will be measured: outdoor-air temperature, return-air temperature and $CO_2$, mixed-air temperature, supply-air temperature, outdoor-air damper signal, supply fan power and total unit power. Additional parameters from the RTU controller will also be recorded (fan, compressor, economizer status, etc.)

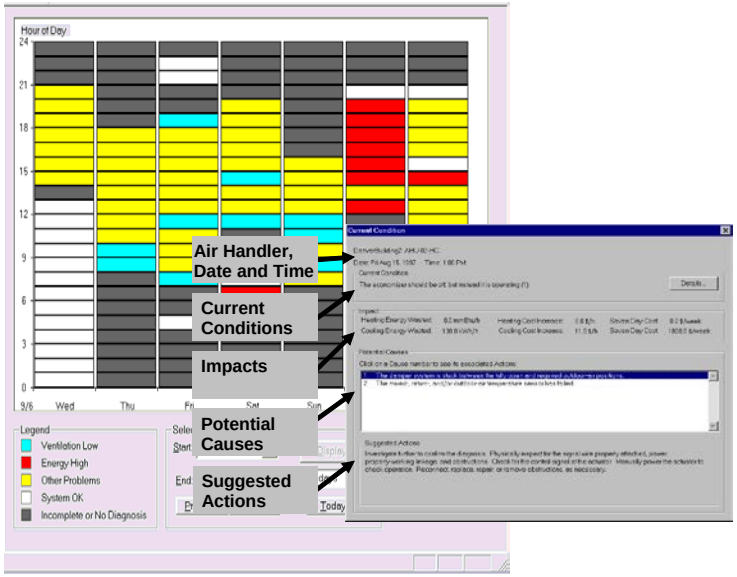
# Advanced RTU Controller: DCV and Fan Controls Verification

- Supply fan controls vary by mode of operation
  - Automated database scripts are used to verify operation
- Demand control ventilation
  - $CO_2$ level is maintained below 1,000 ppm again automated scripts will be used to verify this operation
- 10 rules created to verify operations, which focus on:
  - Fan speeds in different RTU operating modes, such as ventilation and economizing
  - Outdoor air damper control depending on sensed $CO_2$ concentration
- For each operation, automated database scripts are used to identify exceptions to the rules
- Exceptions are further investigated

| Mode | Supply Fan Speed | |
|---|---|---|
| | Advanced (%) | Standard (%) |
| Economizer | 90 | 100 |
| 1st Stage Cooling | 75 | 100 |
| 2nd Stage Cooling | 90 | 100 |
| 1st or 2nd Stage Heating | 90 | 100 |
| Ventilation | 40 | 100 |

# Advanced RTU Controller: Field Test Economizer Controls Verification

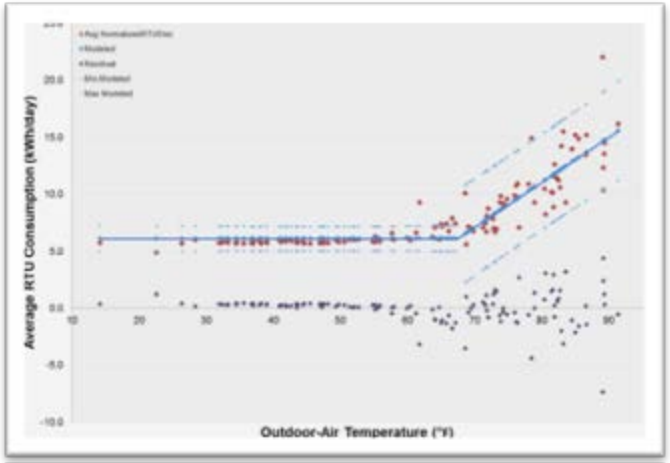
- To verify the economizer controls, the data collected from the RTU is processed with PNNL's Outdoor Air Economizer (OAE) Diagnostician
- OAE Diagnostician will identify problems with economizer controls and ventilation operations
- OAE originally funded by Building Technologies Office and enhanced using funding from California Energy Commission Public Interest Energy Research and the Washington State Project

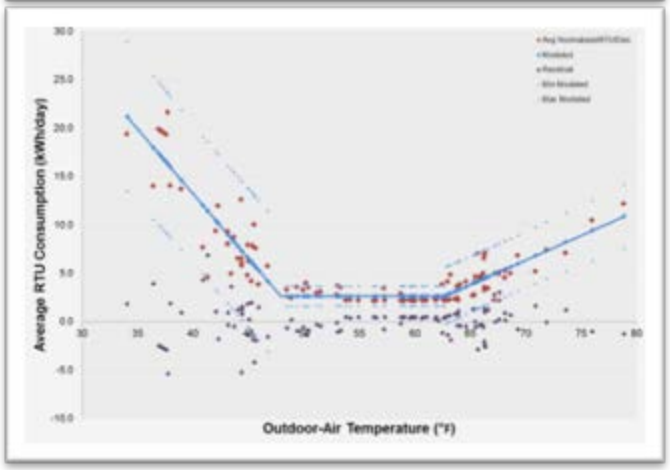


# Advanced RTU Controls: Energy Savings Estimation Tool

- PNNL is using Energy Charting and Metrics (ECAM) Tool to estimate energy savings
  - Semi-automated approach
  - PNNL has further automated the tool
  - Ability to normalize the savings to a typical year (e.g. TMY3)

http://www.pnl.gov/buildingretuning/ecam.stm



# Advanced RTU Controller: Field Test Saving Analysis Approach

**Original Data Filtering**

**Identify and remove outlier data**

**Data Aggregation and Normalization**

**Generate daily RTU energy use and the average outdoor air temperature**

**Regression Model Development**

**ECAM Tool**

$$E_{cool} = C_0 + C_1 * (T - T_{CCP})_+$$

$$E_{heat} = H_0 + H_1 * (T_{HCP} - T)_+$$

**Measured Energy & Cost Savings**

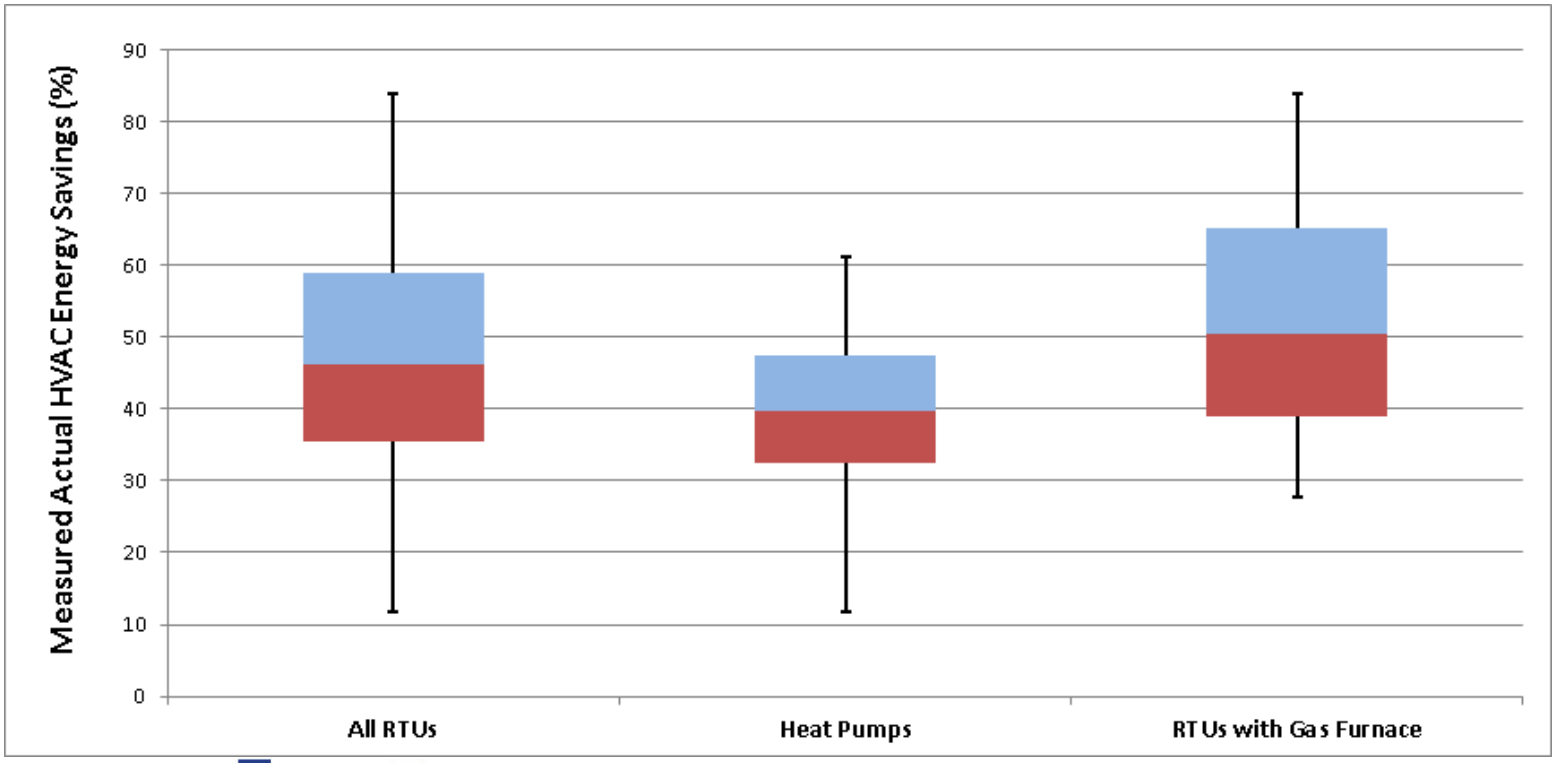
**Apply the pre-retrofit regression model to the post-retrofit period**

**Normalized Annual Energy & Cost Savings**

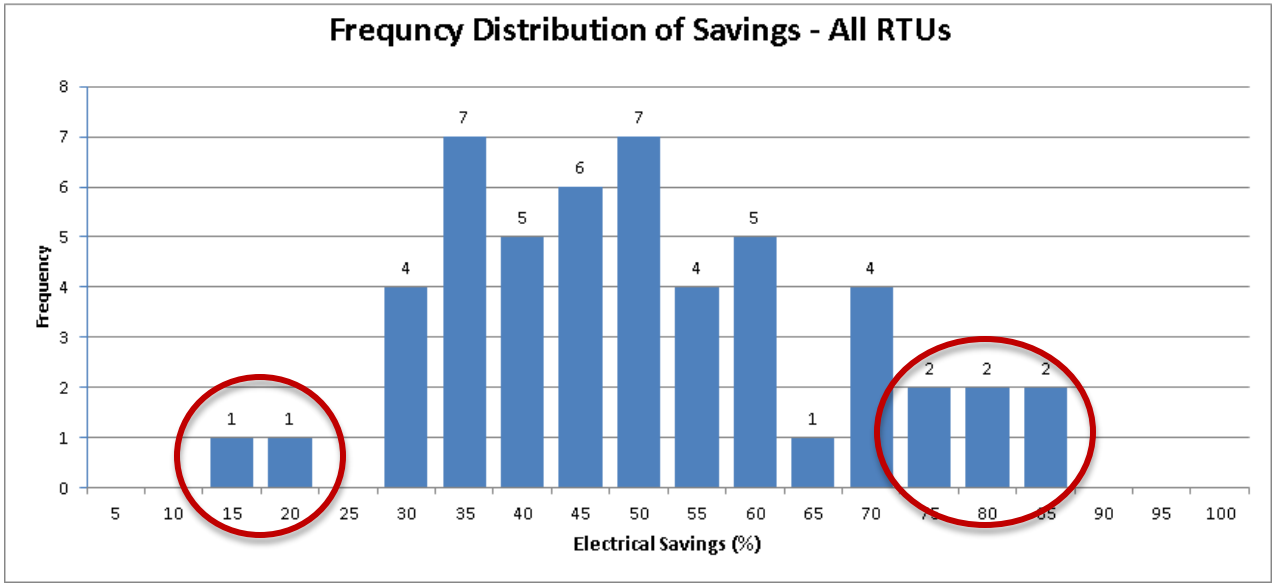
**Apply the pre- and post-retrofit regression models to TMY3 weather data**

# Advanced RTU Controls: Electricity Savings (%) from Field Measurements

- Electricity consumption from 51 RTUs were analyzed
  - 17 RTUs are heat pumps and the rest are air conditioners with gas furnaces



# Advanced RTU Controls: Distribution of Electricity Savings and Expected Payback




- Installed cost of advanced controls:
  - 1 to 3 hp motor (up to 15-ton capacity) is approximately $3,500 + $600-$800 (labor)
  - 5 to 7.5 hp motor (up to 25-ton capacity) is approximately $4,100 + $600-$800 (labor)
- Detailed economic analysis is not yet complete, but paybacks for units with 7.5 ton capacity and higher likely will be 3 or less with no utility incentives
  - Smaller units (<7.5 ton) will have slightly higher payback

# Advanced RTU Controls: Next Steps

- Develop a deployment and communication plan and help BTO/CBI (and BPA) promote the use of advanced controls for existing RTUs thru RTU replacement campaign initiated by BTO's Commercial Buildings Integration Program
- Develop web-based tool to help users estimate potential savings from use of advanced controls for their specific climate and building type

# Brainstorming New Projects

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## Manufacturer Solutions and Looking Forward

- Agenda
  - Introductions
  - Advanced RTU Campaign
  - Solutions and new ideas from manufacturers
  - Brainstorming and discussion of new ideas

# Advanced RTU Campaign (ARC) Quick Overview

- What:
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# Manufacturer Solutions

- What solutions do you have that support Advanced RTU Campaign?
  - Technical solutions (hardware, controls, etc.)
  - Market solutions
  - Other
- What other new space conditioning solutions do you have?

# Open Discussion, Brainstorming

- What barriers are preventing existing solutions from being implemented?
  - Technical
  - Market
  - Practical implementation
- What are the best new opportunities for energy efficiency or avoided energy consumption?