

# Advanced RTU Specification:

## Overview of DOE National Laboratory System HVAC/R Competencies



**DOE Webinar**  
**1:00 to 3:00 PM, EST**  
**March 3, 2011**

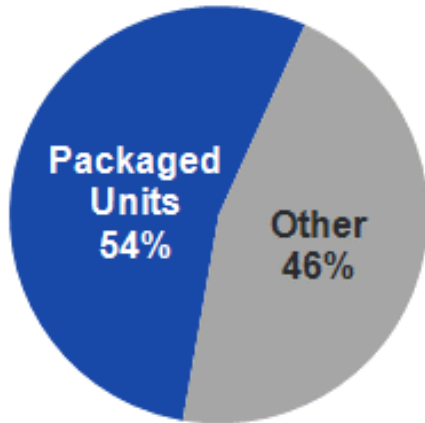
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## Initiative Purpose

- ❑ Challenge U.S. manufacturers to build and deliver innovative, competitively priced, energy-saving rooftop units that meet the *Commercial Building Energy Alliance (CBEA)*-driven requirements of a high-performance specification
- ❑ Realize large energy and cost savings for CBEA members and for the nation



## Cooling



**Fact:** Packaged (unitary) equipment uses > 50% space cooling energy in commercial buildings

## Drivers

- DOE wants to reduce energy use in commercial buildings
- Owners want to save energy and money
- Manufacturers want to develop and sell better equipment

**If companies only buy best in class Ten Ton RTUs, they**

- decrease energy needs by 50%**
- save about \$50 million a year in energy costs**
- mitigate the need for 5 power plants**

- An estimated 40,000 ten ton RTUs sold per year
- A typical 100,000 sq. ft. large box retail building contains 20 Ten Ton RTUs
- Units being purchased today do not fully integrate full set of technology options available on the market
- This specification describes as a minimum
  - ARI rated efficiency from the baseline 11.0 EER / 11.2 IEER to 18 IEER
  - Decrease air flow by specifying variable air volume rather than constant air volume
  - Increase fan efficiency from 45% efficient to premium<sub>4</sub> efficiency

## Primary features of specification:

- ❖ Guide for manufacturer's development of RTU
- ❖ High performance requirement (18 IEER) addresses part-load operation
- ❖ Performance testing
- ❖ Direct Digital Control based unit control system
- ❖ Diagnostics and wireless communication (to sustain high level of performance throughout equipment lifetime)

- DOE's laboratories & technology centers house world-class facilities where cutting-edge research is performed. The facilities, along with their more than 30,000 scientists and engineers, report to DOE Program offices.
- Government-owned contractor-operated facilities
- Four national labs principally support DOE's Building Technologies Program, including HVAC/R
  - Lawrence Berkeley National Laboratory
  - National Renewable Energy Laboratory
  - Oak Ridge National Laboratory
  - Pacific Northwest National Laboratory

1. R&D and design assistance with industry partners resulting in new products
2. Performance testing and evaluation facilities
3. Modeling and system simulations
4. Fault detection, controls and diagnostics
5. Field monitoring
6. Familiarity with test procedures and standards

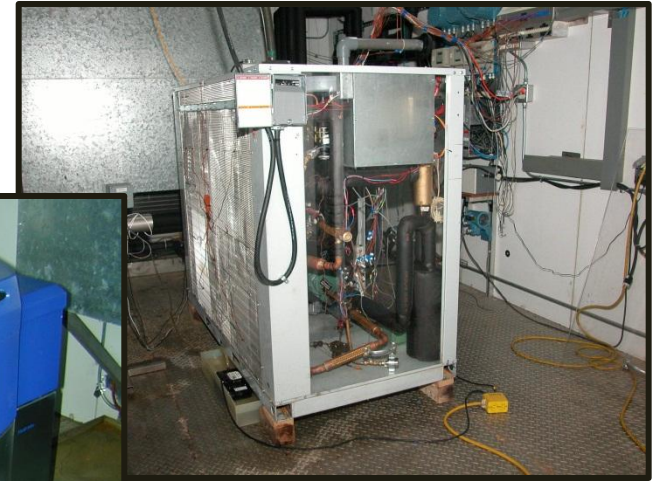
- Industry partnerships have resulted in new technologies under development and introduced to the market



- Next Generation Rooftop Unit (Fiscal Year 2012)
  - Develop high efficiency rooftop unit as a follow-on effort to the High Performance Rooftop Unit Challenge
  - Goal is a cost-effective RTU capable of achieving an IEER of 20
  - Strategy will be to utilize Modelica and heat pump design model to analyze various strategies and develop prototype system design
  - Main options to be investigated include:
    - Micro-channel heat exchangers
    - High efficiency fan motors and compressors
    - Evaporative pre-cooling
    - Strategies for improving part-load performance
    - Ground-coupled heat exchangers

- Integrated Heat Pump
  - Goal: multifunction electric heat pump for space heating, space cooling, water heating on demand, dehumidification on demand, ventilation air control
  - Conceptual designs for both air-source and ground-source versions
    - Single, variable speed compressor based; with variable speed fans and pumps (as appropriate)
    - Analyses show potential for ~50%→65% savings (depending on location)
  - Cooperative Research and Development Agreements in place with two major manufacturers to develop initial products
    - Ground-source version expected on market by late 2011 or early 2012
    - Air-source version by 2013/14
  - Current application focus is high-efficiency residential
    - CRADA efforts targeted at 2-ton nominal cooling capacity systems initially
  - Basic technology can also be applied to small commercial buildings

- Environmental chambers for testing performance of residential and commercial HVAC equipment at ORNL



- Heat exchanger test loops and compressor calorimeters allow for component testing
- Capabilities
  - Temperature range
    - -20°F – 150°F
  - Humidity control
    - Desiccant wheel installed to achieve extremely low dew point temperature
  - Variable airflow
    - 0 – 1600 CFM
  - Refrigerant flexibility
  - Compressor-less refrigerant circulation system
- Calorimeters capable of testing alternative working fluids including flammable refrigerants



## Advanced HVAC Test Lab at NREL

### Accuracy

State-of-the-Art instruments for the highest accuracy available for psychrometric and power measurements

### Speed

The unique configuration of the laboratory allows complete performance map evaluation in less than half the time it would take most labs. Changing the air flows from a cool/dry to a hot/humid condition typically takes about 20 minutes; whereas, this can take hours using the industry standard enthalpy chamber approach.

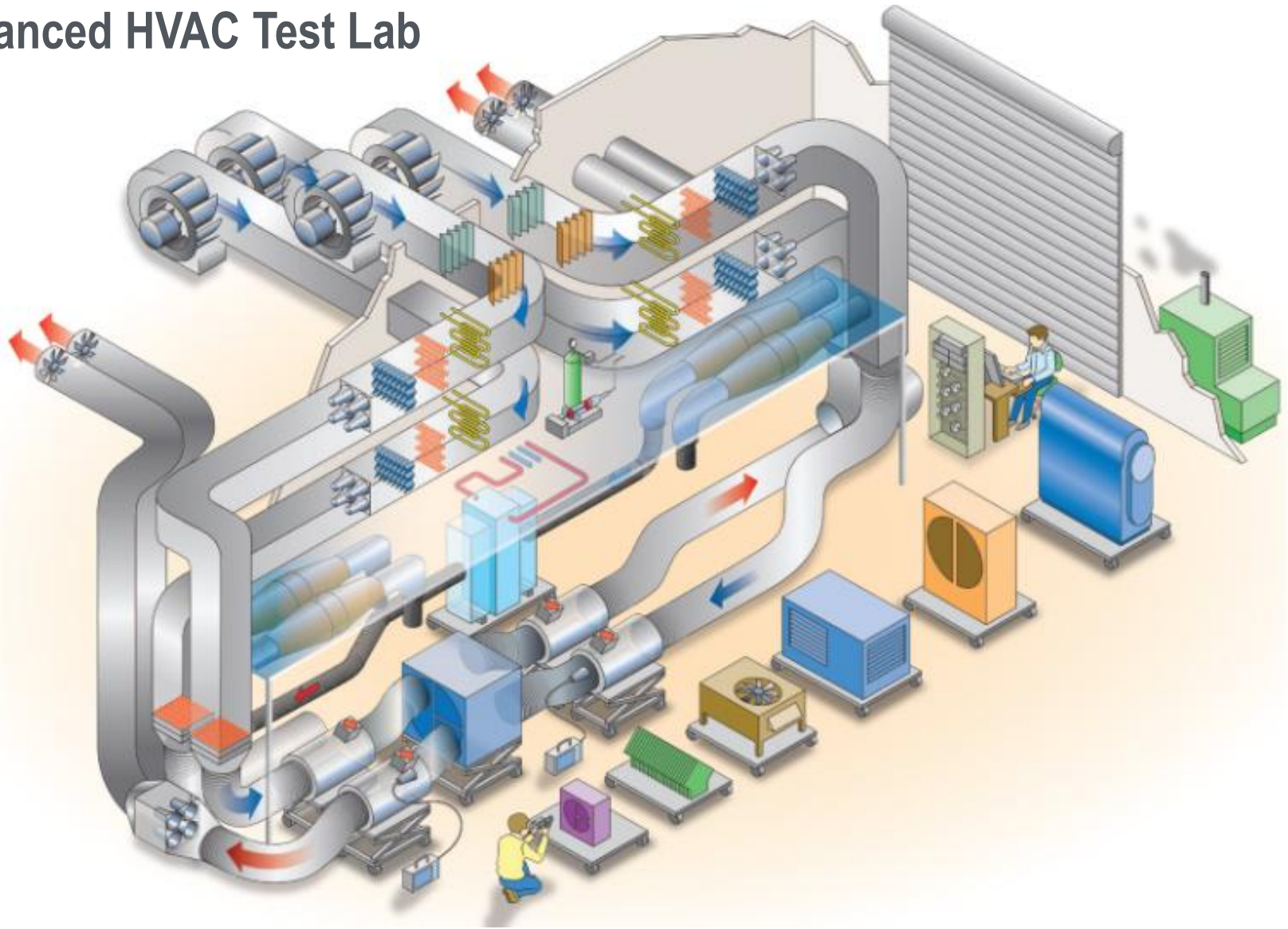
### Scale

Testing ranges from prototype scales, at less than 1 ton, up to standard sized 10 tons (Flow rates range from 50 to 20,000 cfm)

### Controllability

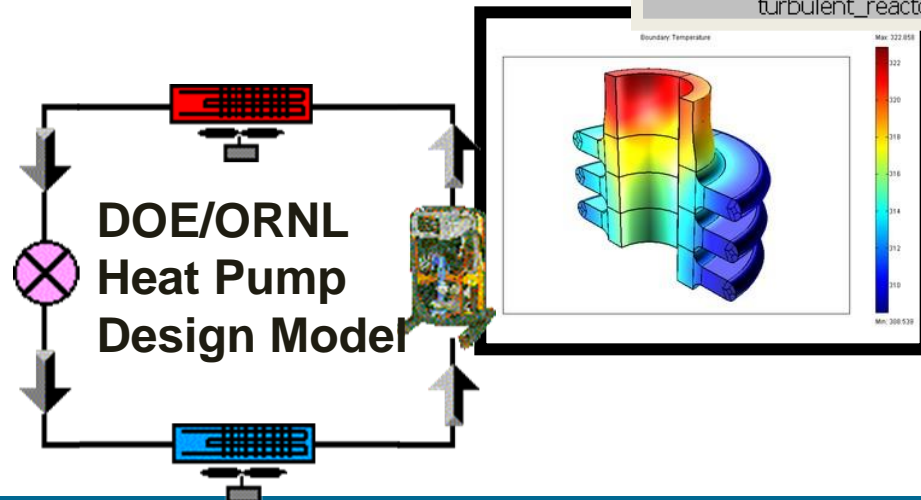
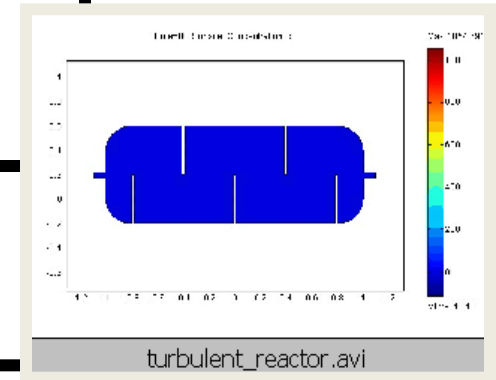
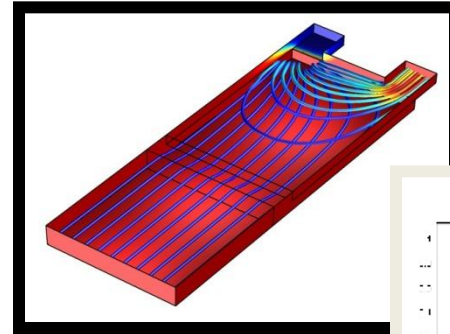
Capable to communicate via open protocols such as BACnet, LonWorks, and OPC/Modbus

## Advanced HVAC Test Lab



- Modeling capabilities include:

- EnergyPlus
  - Use *and* development
- Modelica (HVAC component library)
- ORNL Heat Pump Design Model
- Purdue AC Model
- REFPROP
- TRNSYS
- FLUENT
- DYMOLA

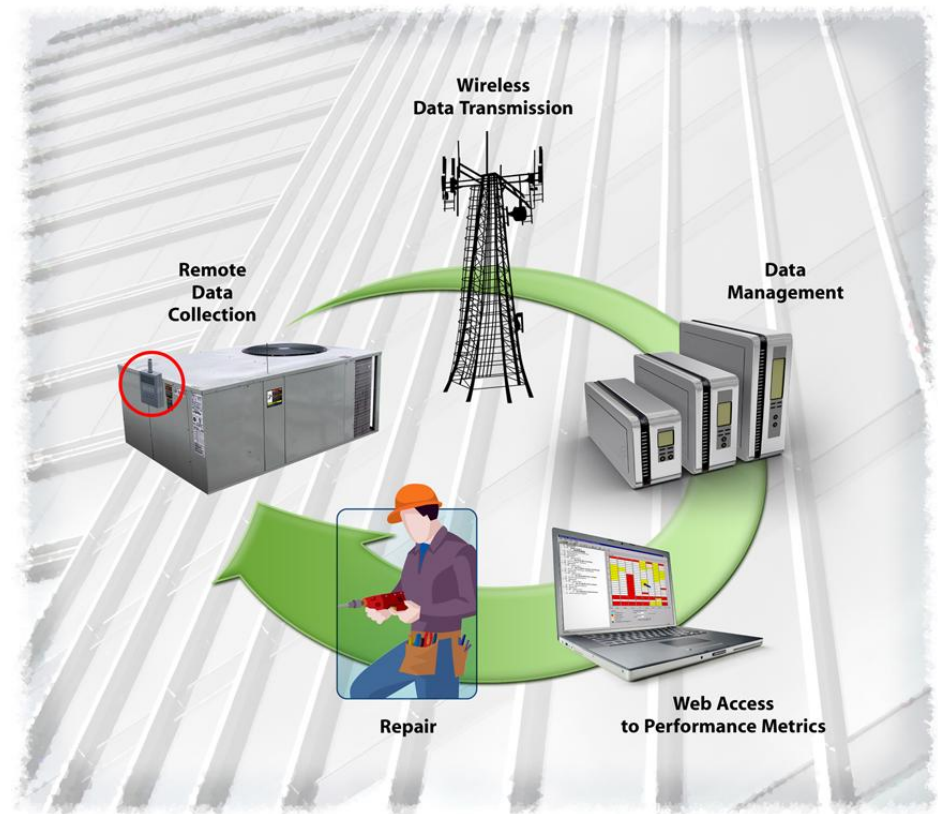


- Calculate performance across climates & building sectors
  - Integration of performance maps into simulation engines to model across all climates and building types to provide accurate estimates of space temp. & humidity control & energy/peak savings
- EnergyPlus
  - Capture steady state and transient behavior (particularly latent degradation due to compressor cycling) down to a sub one minute time resolution
  - Capture how different control strategies can affect performance and therefore be optimized based on system behavior, building type, and climate

## Smart Monitoring and Diagnostic System (SMDS)

- Monitors condition and performance of packaged rooftop air conditioners and heat pumps
- Detects and diagnoses faults with sensors, dampers/economizer, set points, control parameters and control logic
- Future – could implement refrigerant-side fault detection and diagnostics

## Smart Monitoring and Diagnostic System (SMDS)



## Self-Correcting HVAC Controls

- Control systems that automatically and in real time correct and optimally compensate for faults occurring in HVAC systems and their components
- These capabilities can be integrated with building control systems to ensure new and existing commercial buildings operate at or near peak efficiency

## Interested in Participating?

Sign up for updates as the Challenge progresses

[www.buildings.energy.gov/alliances/rooftop\\_specification.html](http://www.buildings.energy.gov/alliances/rooftop_specification.html)

DOE Contact for Equipment Questions

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## Questions

