Emerging Technologies Showcase
Commercial HVAC Webinar #2
April 14, 2015

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NOTE: Today’s presentation is being recorded and will be available at http://e3tnw.org/Webinars within 48 hours
Variable Capacity Heat Pumps (VCHP – VRF, VRV, DHP...)

Variable Refrigerant Flow Systems (VRF)
Variable Split System Heat Pumps

Jonathan Heller
Ecotope

April 14, 2015
Presentation Overview

Variable Refrigerant Flow Systems (VRF) and Variable Split System Heat Pumps

1. Present Range of VCHP Equipment
2. Present Features of VCHP that Enable Highly Efficient System Designs
3. Case Studies of Efficient and Inefficient Buildings
4. Make Case for Design-based Savings as Opposed to Widget-based Savings for VCHP Systems
Variable Capacity Heat Pumps (VCHP)

1. Outdoor Compressor Unit
2. Refrigerant distribution System
3. Indoor Heating/Cooling Dist. System

THREE PIPE VRF SYSTEM
Total individual control is possible with the ability to recover and recycle heat from one area to another
Outdoor Compressor Units
Refrigerant Distribution System

R-410a
Heat Recovery 2 vs. 3-pipe
Indoor Units

E3T Energy
Efficiency
Emerging Technologies
Fan Coil Energy Use

(Fan Watts for delivery of 8000 Btuh cooling)

<table>
<thead>
<tr>
<th>Fan Coil Type</th>
<th>Watts</th>
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<tr>
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<td>VRF Wall Cassette</td>
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<td>VRF Ceiling Cassette</td>
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<td>VRF Floor Cassette</td>
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<tr>
<td>VRF Medium Static Ducted</td>
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Variable Speed Split System Heat Pumps

The Components Of A Trane Home Comfort System.
1. Air Conditioner Or Heat Pump
2. Indoor Cooling Coil
3. Gas Furnace Or Air Handler
4. Air Cleaner

While an air conditioner, furnace and indoor cooling coil may be the most common configuration, your home comfort system may include a heat pump and air handler, or heat pump and gas furnace instead. An air cleaner works well with any system. Your Trane dealer can help you determine the best configuration for your particular home comfort needs.

A programmable thermostat with comfort control from Trane is reliable and can be as simple as set it and forget it. (Optional accessory, purchased separately.)
Residential Variable Capacity Heat Pump Field Study

Final Report

30 August 2013

A Report of BPA Energy Efficiency's Emerging Technologies Initiative
**Electric Heat and Duct Losses**

### Table 13. Modeled Equipment Efficiency

<table>
<thead>
<tr>
<th>Site</th>
<th>Electric Furnace, COP=1</th>
<th>Single Speed Heat Pump, HSPF=7.9</th>
<th>Variable Speed Heat Pump</th>
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**“Box Only” Efficiency**

- COP ~ 2.7 vs. 2.2
- 23% Improvement

### Table 15. Modeled Overall Efficiency

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<th>Site</th>
<th>Electric Furnace, COP=1</th>
<th>Single Speed Heat Pump, HSPF=7.9</th>
<th>Variable Speed Heat Pump</th>
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**“System” Efficiency**

- COP ~ 1.8 vs. 1.5
- 20% Improvement
R-410a: No Need for Back-up or Reheat
Move Away from Large Central HVAC Systems
Towards Smaller Zonal Systems
Move Away from All-In-One HVAC Systems
Towards Dedicated Ventilation Systems
Right-Size Mechanical Systems
Smaller Equipment
EUI of Seattle Fire Stations

Seattle Median (97)
Why are New Stations so Inefficient?

- Continuous ducted central fan systems
- Ventilation at 3x ASHRAE 62
- No heat recovery, electric heat on ventilation air
Rice Fergus Miller Office: Bremerton, WA

EUI = 21
Now What?
Load Reduction Measures

1. Insulation
2. Daylighting
3. VRF Heat Pumps
4. Heat recovery ventilation
5. Operable windows – Passive/Active
Non-Heat Recovery Heat Pump
Fan Energy Load Reduction: Ceiling Fans vs. Ducts to Move Air
End Use Reductions

- Cooling
- Heating
- Pumps
- Fans
- DHW
- Lights
- Ext Usage
- Plugs, Elev, Misc.

CBECs Avg. Office vs RFM
Smaller Mechanical Systems

Heating Load ~ 12 tons (1350 sf/ton)

Cooling Load ~ 22 Tons (850 sf/ton)
Construction Costs breakdown ($/sf)

- Fire Protection: $1.97
- Electrical: $17.11
- HVAC: $9.75
- Plumbing: $4.83
- Everything Else: $71.34
LEED Platinum

EUI = 21
King County Housing Authority: Tukwila, WA

EUI = 26
1980’s Level Envelope

- R-11 Walls
- R-20 Roof
- Uninsulated Slab
- U-0.4 Double Glaze
No Economizers
No Direct Digital Controls
High Efficiency Lights & Plugs
2-Pipe VRF with Heat Recovery

- 48 Tons
- 3 Outdoor Units
- 36 Ductless Units
- 14 Ducted Units
- 50 Zones Total
- 1.33 Ratio Indoor/Outdoor Units
DOAS via High Efficiency ERV

- VCHP Outdoor Condenser Unit
- Outside Air Intake Filterbox
- Louvered Penthouse
- New Skylight
- ECM Fans
- Crossflow Heat Recovery Core (Typ of 3)
- Bathrooms / Storage

E3T Energy Efficiency Emerging Technologies
High Performance, Low Cost

Energy End Use (EUI 26 kBtu/sf-yr)
- Lights: 32%
- Computers: 28%
- Misc.: 15%
- ERV Fans: 6%
- Heat: 12%
- Cool: 7%

KCHA Construction Budget ($95/sf)
- HVAC, $14
- Electric, $13
- Plumbing, $2
- Fire, $2
- Other, $64
Summary – Variable Speed Splits

- Energy Savings
- Non-Energy Benefits
- Technology Readiness
- Ease of Adoption
- Value
Summary – VRF

- Energy Savings
- Non-Energy Benefits
- Technology Readiness
- Ease of Adoption
- Value
Energy Savings

** Design-Based vs. Widget-Based Approach

- **2003 CBECs Avg. Office**: Energy Use Intensity (EUI) for Lights, Plugs, and Misc. is 35, and for HVAC is 23, totaling 58.
- **Seattle Avg. Office**: EUI for Lights, Plugs, and Misc. is 26, and for HVAC is 16, totaling 42.
- **KCHA**: EUI for Lights, Plugs, and Misc. is 7, and for HVAC is 12, totaling 19.
- **Rice Fergus Miller Office**: EUI for Lights, Plugs, and Misc. is 4, and for HVAC is 14, totaling 18.

E3T Energy Efficiency Emerging Technologies
Non-Energy Benefits

- Smaller equipment and distribution systems possible. Enables lower floor-to-floor heights and easier retrofit.
- Greater individual zone control possible
- Pre-manufactured systems allow for easier installation, coordination, commissioning
- Quiet
Technology Readiness
Ease of Adoption
Value
Questions?

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- Click on the hand icon when you want to ask a question
- Please use question pane to ask questions during Q & A or if you have any technical issues
1) How significant and reliable are the energy savings per unit?

2) How great are the non-energy advantages for the end user for adopting this technology?

3) How ready are the products(s) and providers to scale up for widespread use in the Pacific Northwest?

4) How easy is it for the end user to change to the proposed technology?

5) Considering all costs and all benefits, how good of a buy is this technology for the owner?