The envelope is back!

- Insulation
- Glazing selection, assembly
- Air sealing
- Detailing of air barrier
Heat Pump Rooftop Units

• Packaged RTUs serve approximately 34% of US commercial building area
  – Office, retail, warehouse and education

• 95%+ of existing Midwest RTUs use natural gas for heating

• Electrification options
  – Heat Pump RTU
  – Dual Fuel RTU
# Heat Pump Rooftop Units

<table>
<thead>
<tr>
<th>Description</th>
<th>Dual Fuel RTU</th>
<th>Heat Pump RTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat pump for first-stage heating; natural gas-fired heat exchanger at low ambient conditions</td>
<td>Heat pump for all heating; potentially with electric resistance backup</td>
<td></td>
</tr>
<tr>
<td>First cost premium</td>
<td>20% premium</td>
<td>20-50% premium</td>
</tr>
<tr>
<td>Operating cost impact</td>
<td>Existing: 20-30% decrease New construction: <strong>15-20% increase</strong></td>
<td>Existing: 5-20% decrease New construction: <strong>35-40% increase</strong></td>
</tr>
<tr>
<td>Heating COP</td>
<td>8.0 - 8.5 HSPF</td>
<td>3.2 - 3.6 COP</td>
</tr>
<tr>
<td>Portion electrified</td>
<td>~50%</td>
<td>100%</td>
</tr>
<tr>
<td>Ancillary changes needed</td>
<td>Structural or electrical changes unlikely</td>
<td>Structural changes unlikely, electrical upgrades potentially</td>
</tr>
</tbody>
</table>
Variable Refrigerant Flow
The Rose
Affordable Housing
Minneapolis, MN
VRF + DOAS

SOURCE: Apartments.com
Variable Refrigerant Flow

Remaining issues

• Fully understanding field performance

• Value proposition: $30-35/ft$ system costs recorded, not accounting for 2022 jump in prices

• Refrigerant leakage
  – Shift to R-32
  – Leakage management practices
  – Hybrid systems?
Heat Pump Water Heaters

1. Residential-style and small-commercial
   - AO Smith 120-gallon model rated COP of 4.2.
   - Add tempering tanks, drain water heater recovery or point-of-use heaters to increase capacity
   - Examples of beneficial applications include food service, dentist offices, spas, gyms

2. Centralized
   - SanCO2 achieving 3.3 COP in Pacific Northwest
   - Mitsubishi Heat2O has CO\textsubscript{2} refrigerant
   - Increased availability of skid-mounted design
   - Larger applications

Source: AO Smith CHP-120
Heat Pump Water Heaters

SOURCE: Mitsubishi
Thank you for your time!

Scott Hackel
Slipstream
shackel@slipstreaminc.org
Electrification barriers in cold climates

- Lack of familiarity
- Capital Cost
- Utility Costs
- Equipment availability