How your ventilation system can help with your air conditioning load

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On behalf of Hugh Crowther, P.Eng.
AGENDA

1. Cooling loads primer
2. Ventilation unit primer
3. Cooling with the ventilation unit
4. Energy Impact
5. Summary
6. Questions
COOLING LOADS PRIMER

PART 1

HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD
Passive House Cooling

- **Cooling load** – lower load, different use profile
- **Tight envelope** – lower portion of total cooling load, humidity loads more important
- **Ventilation air** - higher portion of total cooling load
- **Comfort** - air temperature and mean radiant temperature are closer than typical buildings – an opportunity!
- **Comfort** – load, temperature, humidity, room air velocity
Passive House Sensible Cooling

- Sensible heat sources
  - Envelope – much lower
  - Fenestration / Solar - lower
  - Plug loads - similar
  - Lighting - lower
  - People - similar

- Building type becomes important
  - Use: Office vs. multifamily
  - Compactness
  - Possible thermal zones
Sensible Cooling
• Low area loads challenge existing HVAC equipment
  • terminal units with good air distribution at low loads
  • Right-sizing
  • Risk of cycling
7 HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD

Cooling Loads & Compactness

• Commercial buildings are inherently bigger than single family dwellings
• As buildings get bigger, the surface to volume ratio drops
  • Envelope becomes less dominant
  • Surface-to-volume ratios
    • 2000 ft² home = 0.19
    • 20,000 ft² bldg= 0.078
    • 100,000 ft² bldg = 0.048
• 20,000 ft² building likely has a zone in cooling during winter
HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD

Cooling Loads & Climate

- Hot
- Cold
- Moist
- Dry
- Marine

Range of average minimum temperatures for each zone:

- Zone 1: Below -50°F
- Zone 2: 0°F to -40°F
- Zone 3: -40°F to -20°F
- Zone 4: -20°F to 0°F
- Zone 5: 0°F to 10°F
- Zone 6: 10°F to 20°F
- Zone 7: 20°F to 30°F
- Zone 8: 30°F to 40°F
- Zone 9: 40°F to 50°F
- Zone 10: 50°F to 60°F
- Zone 11: Above 60°F

Marine (C) - Dry (B) - Moist (A)

All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dillingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yakutat-Koyukuk.

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands.
Passive House Cooling Demand & Load limits

- $\leq1.8$-$8.9 \text{kBtu/ft}^2 \text{-hr Peak Cooling Load}$
- $\leq1.0$-$21.4 \text{kBtu/ft}^2\text{-yr Cooling Demand}$
- Climate specific
- Maintain thermal comfort
Annual Ventilation Loads

Vancouver

New York City
Internal Loads & Balance Point

Credit: Dan Nall, Syska Hennessy
Internal Loads & Balance Point

• Lower balance point leads to cooling at lower ambient temperature

• More free cooling hours
  • Air side economizer (ventilation unit)
  • Water side economizer (cooling tower)
  • Operable windows

• Fewer mechanical cooling hours – savings!
Cooling Load Reduction Measures

• Active and Passive shading

• Maximum Daylighting and LEDs
  • Width and orientation of building allows light to reach across the entire floor
PASSIVE HOUSE BUILDING
COOLING LOADS SUMMARY

Low Balance Point
Low balance point means buildings need cooling at lower outside air temperatures
Cooling is required more frequently
Mechanical cooling may be required less frequently
More available hours of free cooling

Ventilation is Higher Portion of Load
Maximize rejection of heat from outdoor air by maximizing energy recovery effectiveness
Minimize energy consumed ventilating. Pick HRV/ERV with low electrical consumption (W/CFM)

Buildings are Very Tight
Humidity control must be considered – air tight enclosures don’t permit moist air to flow out.
VENTILATION UNIT PRIMER

HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD
ENERGY RECOVERY VENTILATION UNITS

Sensible Energy Recovery “HRV” – hot humid days
- Rejects heat but not humidity
- Lowers Supply Air temperature
- Free cooling mode
- Plate, wheel, heat pipe, run around loops

Total / Enthalpy Energy Recovery “ERV” – hot humid days
- Rejects heat and humidity
- Lowers Supply Air temperature and humidity
- Free cooling mode
- Enthalpy plate, enthalpy wheel
Centralized Ventilation Units

- Indoors or outdoors
- Whole Building or multiple zone
Decentralized Ventilation Units

- Mainly Indoors
- Through-wall
- One per residence or zone
HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD
VENTILATION UNIT – WHEEL TYPE

Outside

Supply

Exhaust

Extract

0.1rpm

10.0%

Outside

Supply

Extract

Exhaust
VENTILATION UNIT – WHEEL TYPE

Extract
Outside
Supply
Exhaust

0.2rpm
20.0%

Extract
Exhaust
Outside
Supply
VENTILATION UNIT – WHEEL TYPE

0.34rpm

34.0%
VENTILATION UNIT – WHEEL TYPE

0.5rpm

50.0%
VENTILATION UNIT – WHEEL TYPE

1.0rpm 74.0%
VENTILATION UNIT – WHEEL TYPE

2.0rpm

82.0%
VENTILATION UNIT – WHEEL TYPE

How your ventilation system can help with your air conditioning load.

Extract

Outside

Supply

Exhaust

4.0rpm

83.7%

Extract

Exhaust

Outside

Supply
HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD

VENTILATION UNIT – WHEEL TYPE

Extract → Exhaust
Supply → Outside

6.0rpm

84.0%
VENTILATION UNIT – WHEEL TYPE

10.0rpm

84.0%
## Recovery Effectiveness

Different standards, different results

<table>
<thead>
<tr>
<th>AHRI</th>
<th>ASHRAE</th>
<th>PHI</th>
<th>PHIUS</th>
<th>HVI</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="AHRI Logo" /></td>
<td><img src="image2.jpg" alt="ASHRAE Logo" /></td>
<td><img src="image3.jpg" alt="PHI Logo" /></td>
<td><img src="image4.jpg" alt="PHIUS Logo" /></td>
<td><img src="image5.jpg" alt="HVI Logo" /></td>
</tr>
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</table>

**Different standards, different results**

\[
\varepsilon = \frac{\text{cfmsa}(Xo_a - Xsa)}{\text{cfmmin}(Xo_a - Xra)}
\]

\[
\varepsilon = \frac{(Xoa - Xea) + (Pel/m \cdot cp)/(Xra - Xoa)}{Xra - Xo_a}
\]

- Specify the project HRV/ERV modeling protocol
- Specify the reference HRV/ERV test method / standard use
- Possible penalties for relying on wrong standard
COOLING WITH THE VENTILATION UNIT
VENTILATION AIR AS LOAD

Summer – ventilation air must be delivered free of excess humidity and heat

- 55°F (12.8 °C) is typical target to achieve mechanical dehumidification
- After mechanical dehumidification, Supply Air temperature may be too cold
- Dehumidification via ERV avoids overcooling, saves energy
- Use ERV heat rejection as first stage of cooling
- Integrate supplemental cooling (DX, chilled water, etc.) to avoid conflicting sequence of operations
ASHRAE Standard 55 Comfort Zone

COOLING GOALS
• Traditional: Design for indoor conditions 75°F, 50% RH/65 gr/lb
• Bold New World: design to be in the ASHRAE 55 comfort range
• Either method requires a system of providing cooler, drier air than setpoint

<table>
<thead>
<tr>
<th>Outside Air</th>
<th>Temperature (_{drybulb})</th>
<th>Humidity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vancouver</td>
<td>77°F</td>
<td>75 gr/lb</td>
</tr>
<tr>
<td>New York</td>
<td>90°F</td>
<td>95 gr/lb</td>
</tr>
</tbody>
</table>

New York

Vancouver
HEAT vs. TOTAL ENERGY RECOVERY

> Whether to use heat or total energy recovery for summer will depend on
  > the climate zone
  > The big picture summer vs winter vs shoulder

> Heat recovery devices (HRV) provide heat rejection only

> Total recovery devices (ERV) provide heat and moisture rejection

> Mechanical cooling will likely be required with either type
SENSIBLE ENERGY VENTILATION UNIT (HRV alone)
SUMMER OPERATION – Vancouver example

Certified values:
> 86% heat recovery (rejection) effectiveness
> 0.32 W/CFM electrical efficiency

Adding moisture to building
TOTAL ENERGY VENTILATION UNIT (ERV alone)
SUMMER OPERATION – Vancouver example

Certified values:
> 86% heat recovery (rejection) effectiveness
> 73% moisture recovery (rejection) effectiveness
> 0.32 W/CFM electrical efficiency

ERV provides 6x more cooling than HRV of same effectiveness

Adding heat and moisture to building

Outdoors $\Delta h = 2.7 \text{ Btu/lb}$ Indoors

77°F, 69 gr
Exhaust Air (EA)

77°F, 75 gr
Outside Air (OA)

75°F, 61 gr
Return Air (RA)

77°F, 64 gr
Supply Air (SA)

Exhaust Air Fan
Heat & Moisture Exchanger
Return Air Filter
Outside Air Filter
Supply Air Fan

Outside Air Filter

Outdoors $\Delta h = 2.7 \text{ Btu/lb}$ Indoors
SENSIBLE ENERGY VENTILATION UNIT (HRV alone)
SUMMER OPERATION – New York City example

Certified values
> 86% heat recovery (rejection) effectiveness
> 0.32 W/CFM electrical efficiency
TOTAL ENERGY VENTILATION UNIT (ERV alone)
SUMMER OPERATION - New York City example

Certified values
> 86% heat recovery (rejection) effectiveness
> 68% moisture recovery (rejection) effectiveness
> 0.32 W/CFM electrical efficiency

ERV provides 2.3x more cooling than HRV of same effectiveness

Adding heat and moisture to building

Outdoors $\Delta h = 7.4$ Btu/lb
Indoors

Outside Air (OA) $90^\circ F, 95$ gr/lb
Exhaust Air (EA) $88^\circ F, 83$ gr/lb
Supply Air (SA) $77^\circ F, 68$ gr/lb
Return Air (RA) $75^\circ F, 56$ gr/lb
Cooling Sources

Chilled water (CHW)
- High efficiency chillers
- Geothermal
- Central Plant
- Water side free cooling
- Best control range due to modulating valve

Variable refrigerant flow (VRF)
- Heat pump
- Heat recovery
- Integration requires more engineering
HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD

Cooling Sources

Self contained DX

- Stand alone unit
- Heatpump

Heat Pump (WSHP or GSHP)

- Tied to building or ground loop
- Heating and cooling
How Your Ventilation System Can Help With Your Air Conditioning Load

Cooling Distribution

Active Chilled Beam
- Cools zone with ventilation air and chilled water
- Requires chiller plant
- Heat recovery and water side free cooling
- Common in NZB

Fan Coil Unit
- Cools zone with ventilation air and chilled water
- Less efficient than chilled beams
- Rare in passive house buildings

Diffusers
- Cooled air direct to zone
- Vary airflow to control cooling
Example: ENERGY RECOVERY WITH SUPPLEMENTAL DX COOLING

Outdoor Air
90°F db
75°F wb
107 gr/lb

Supply Air
55°F db
54.5°F wb
62.4 g/lb

Return Air
75°F db
50% RH

After Wheel
80°F db
68°F wb

Condensing Unit
ENERGY RECOVERY WITH SUPPLEMENTAL COOLING

<table>
<thead>
<tr>
<th>Air Path</th>
<th>Temperature $\text{db}$</th>
<th>Humidity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Air</td>
<td>90°F</td>
<td>107 gr/lb</td>
</tr>
<tr>
<td>After ER wheel</td>
<td>90°F</td>
<td>84 gr/lb</td>
</tr>
<tr>
<td>After DX coil</td>
<td>54°F</td>
<td>62 gr/lb</td>
</tr>
<tr>
<td>At supply diffuser</td>
<td>~54-55°F</td>
<td>62 gr/lb</td>
</tr>
<tr>
<td>Room setpoint</td>
<td>75°F</td>
<td>65 gr/lb</td>
</tr>
</tbody>
</table>

54°F supply air
• can overcool, or
• results in occupant comfort, if:
  • Air outlets are applied with precision
  • Air is ducted to terminal device
  • Zone control devices provide variable air volume
**ENERGY RECOVERY WITH SUPPLEMENTAL COOLING AND REHEAT**

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<th>Air Path</th>
<th>Temperature $\text{db}$</th>
<th>Humidity Ratio</th>
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<tr>
<td>Outside Air</td>
<td>90°F</td>
<td>107 gr</td>
</tr>
<tr>
<td>After ER wheel</td>
<td>90°F</td>
<td>84 gr</td>
</tr>
<tr>
<td>After DX coil</td>
<td>54°F</td>
<td>62 gr</td>
</tr>
<tr>
<td><strong>After reheat coil</strong></td>
<td><strong>72°F</strong></td>
<td><strong>62 gr</strong></td>
</tr>
<tr>
<td>At supply diffuser</td>
<td>~72-73°F</td>
<td>62 gr</td>
</tr>
<tr>
<td>Room setpoint</td>
<td>75°F</td>
<td>65 gr</td>
</tr>
</tbody>
</table>

72°F supply air
- neutral
- results in occupant comfort, if:
  - Air outlets are applied with precision
  - Air is ducted to terminal device
- Auxiliary terminal devices provide extra cooling.
Use Controls to Get More Cooling

- **BOOST flow** to increase volume of cool air delivered
- **LOWER air temperature** is more efficient
  - When the indoor temperature is lower (Winter)

<table>
<thead>
<tr>
<th>Space Temp.</th>
<th>Supply Air Temp.</th>
<th>Airflow Rate</th>
<th>Sensible Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>75°F</td>
<td>55°F</td>
<td>0.11 cfm/ft²</td>
<td>2.4 Btu/h-ft²</td>
</tr>
<tr>
<td>75°F</td>
<td>55°F</td>
<td>0.165</td>
<td>3.6</td>
</tr>
<tr>
<td>75°F</td>
<td>50°F</td>
<td>0.11 cfm/ft²</td>
<td>3.0</td>
</tr>
<tr>
<td>75°F</td>
<td>50°F</td>
<td>0.165</td>
<td>4.5</td>
</tr>
<tr>
<td>75°F</td>
<td>45°F</td>
<td>0.11 cfm/ft²</td>
<td>3.6</td>
</tr>
<tr>
<td>75°F</td>
<td>45°F</td>
<td>0.165</td>
<td>5.4</td>
</tr>
<tr>
<td>78°F</td>
<td>55°F</td>
<td>0.11 cfm/ft²</td>
<td>2.7</td>
</tr>
<tr>
<td>78°F</td>
<td>55°F</td>
<td>0.165</td>
<td>4.1</td>
</tr>
<tr>
<td>78°F</td>
<td>50°F</td>
<td>0.11 cfm/ft²</td>
<td>3.3</td>
</tr>
<tr>
<td>78°F</td>
<td>50°F</td>
<td>0.165</td>
<td>5.0</td>
</tr>
<tr>
<td>78°F</td>
<td>45°F</td>
<td>0.11 cfm/ft²</td>
<td>3.9</td>
</tr>
<tr>
<td>78°F</td>
<td>45°F</td>
<td>0.165</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Real World: Unequal Use

- Vacant zones
- Time of use difference
- Occupancy level
- Use Demand Control Ventilation and Zoning to avoid over-ventilating
Example: Commercial

- Parameters
  - Sample floor: 20,000 ft²
  - 145 ft by 145 ft
  - Passive House construction
  - Open floor plan

- Core and perimeter areas

- 45 °F outside air balance point
  - Above 45 °F, floor has net heat gain, cooling required
  - Perimeter zones may still need heat
Shoulder Season Strategy

• Supply Air: neutral or cooling?
  • neutral (75°F) SA requires mechanical cooling in core year round
  • cooling (55°F) SA requires reheat at perimeter

• Strongly consider HVAC with heat recovery (VRF, WSHP, fan coil with HR chillers)
Zoning Ventilation Air

> Use a central ERV to recover as much energy as possible

> Use decentralized heating/cooling sections to temper air as required
  > Core gets cooling air
  > Perimeter gets neutral air
  > Reset either zone based on time of year
COOLING with VENTILATION AIR SUMMARY

Ventilation air is a cooling load
Need to get ventilation air to a neutral condition. Enthalpy wheels become more important in cooling (dehumidification)

Ventilation Air can be used to provide some free cooling during shoulder weather
Low balance point means shoulder weather happens sooner. By adjusting room temperature, supply air temperature and supply airflow, you can double the cooling effect. In shoulder weather, the energy penalty is only the fan work

Control Zone load in shoulder weather makes ventilation cooling more complex
The core and perimeter zones will behave differently making the control sequence more complex. Consider decentralized supplemental heating and cooling based on control zone needs.
ENERGY MODELLING
ENERGY MODEL SETUP
HRV vs. ERV, NYC
MODEL SETUP -

Scenario 1- No Reheat

55°F SAT

Scenario 2- Hot Gas Reheat

70°F SAT
**ENERGY MODEL RESULTS**

New York City - 55°F Cooling

<table>
<thead>
<tr>
<th>Energy Recovery Savings</th>
<th>System 1 Name</th>
<th>Total Recovery</th>
<th>System 2 Name</th>
<th>Sensible Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Recovery Type</td>
<td>Enthalpy Wheel</td>
<td>Sensible Wheel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor Air Energy Load (kBtu)</td>
<td>907,940</td>
<td>908,327</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Recovered Energy (kBtu)</td>
<td>575,327</td>
<td>455,906</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remaining System Load (kBtu)</td>
<td>426,340</td>
<td>452,422</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASHRAE Std 90.1-2016 Compliant</td>
<td>Pass</td>
<td>Fail - Fan Power Limitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASHRAE Std 189.1 Compliant</td>
<td>Pass</td>
<td>Fail - Fan Power Limitation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit Energy Consumption</th>
<th>System 1 Name</th>
<th>Total Recovery</th>
<th>System 2 Name</th>
<th>Sensible Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Energy Usage (kWh)</td>
<td>55,184</td>
<td>55,114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotor Motor Energy Usage (kWh)</td>
<td>747</td>
<td>747</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Energy Usage (kWh)</td>
<td>27,479</td>
<td>30,456</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Energy Usage (kWh)</td>
<td>311</td>
<td>311</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidifier Energy Usage (kWh)</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Energy Usage (kWh)</td>
<td>83,721</td>
<td>86,629</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
New York

Case 1: SAT = 55 F, 5000 CFM

> Sensible wheel unit (HRV) consumes 10.8% more electricity for cooling annually than total energy unit (ERV)

> HRV requires 30% more VRF cooling capacity than ERV

> All required heating is provided by recovered heat

<table>
<thead>
<tr>
<th></th>
<th>Total cooling required (tons)</th>
<th>Energy recovery cooling (tons)</th>
<th>Mechanical cooling remaining (tons)</th>
<th>Annual cooling energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRV</td>
<td>31.8</td>
<td>7</td>
<td>24.8</td>
<td>30,456</td>
</tr>
<tr>
<td>ERV</td>
<td>31.8</td>
<td>12.6</td>
<td>19.2</td>
<td>27,479</td>
</tr>
</tbody>
</table>
### HOW YOUR VENTILATION SYSTEM CAN HELP WITH YOUR AIR CONDITIONING LOAD

#### New York City - SCENARIO 2- 55°F Cooling, Hot Gas Reheat

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<td><strong>Energy Recovery Type</strong></td>
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<td></td>
<td>Sensible Wheel</td>
<td></td>
</tr>
<tr>
<td><strong>Outdoor Air Energy Load</strong></td>
<td>kBtu</td>
<td>1,341,884</td>
<td></td>
<td>1,342,344</td>
</tr>
<tr>
<td><strong>Annual Recovered Energy</strong></td>
<td>kBtu</td>
<td>952,162</td>
<td></td>
<td>784,800</td>
</tr>
<tr>
<td><strong>Remaining System Load</strong></td>
<td>kBtu</td>
<td>532,116</td>
<td></td>
<td>557,544</td>
</tr>
<tr>
<td><strong>ASHRAE Std 90.1-2016 Compliant</strong></td>
<td>Pass</td>
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<tr>
<td><strong>Fan Energy Usage</strong></td>
<td>kWh</td>
<td>54,446</td>
<td></td>
<td>54,377</td>
</tr>
<tr>
<td><strong>Rotor Motor Energy Usage</strong></td>
<td>kWh</td>
<td>747</td>
<td></td>
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<td><strong>Cooling Energy Usage</strong></td>
<td>kWh</td>
<td>26,515</td>
<td></td>
<td>29,408</td>
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<tr>
<td><strong>Heating Energy Usage</strong></td>
<td>kWh</td>
<td>16,515</td>
<td></td>
<td>16,522</td>
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<tr>
<td><strong>Humidifier Energy Usage</strong></td>
<td>kWh</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Energy Usage</strong></td>
<td>kWh</td>
<td>98,224</td>
<td></td>
<td>101,054</td>
</tr>
</tbody>
</table>
**New York**

**Case 2: SAT = 70 F, 5000 CFM + hot gas reheat**

> Sensible unit (HRV) consumes 10.9% more electricity for cooling annually than total energy unit (ERV) (=case 1)

> HRV requires 30% more VRF cooling capacity than ERV (=case 1)

> Reheat coil adds 0.1” pressure drop but allows 70°F Supply air temperature for no additional energy cost

<table>
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<tr>
<th></th>
<th>Total cooling required (tons)</th>
<th>Energy recovery cooling (tons)</th>
<th>Mechanical cooling remaining (tons)</th>
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</tr>
</tbody>
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ENERGY MODELLING SUMMARY

Climate is Critical

ERV saves energy and requires less VRF cooling capacity in New York

ERV required to meet Std 90.1 in New York

ERV offers little benefit relative to HRV in Vancouver

Where Climate supports ERV use, savings may be substantial

In New York City, total energy recovery offers 4 times cooling savings over sensible cooling

Capital cost may be reduced due to smaller VRF condensing units
SUMMARY
SUMMARY

Passive House Envelope Performance provides extra savings opportunities

Low balance point in Passive House results in greater free cooling availability.

Leverage close coupled room and mean radiant temperatures to maximize energy savings by widening room temperature set point range.

Ventilation System Can help (or hurt) cooling design

Ventilation is a larger percentage load in PH projects. Make ventilation unit as efficient as possible.

Leverage ventilation system for free cooling. Optimize SAT to maximize energy savings summer and winter.

Always consider climate and the season

In New York City a total energy recovery system recovered 400% more cooling than a sensible system. In Vancouver, savings may be negligible.

Consider heating, cooling and shoulder season performance.
Thank you!