This document is the slide presentation given by Noresco at the October 6 workshop on the topic of a nonresidential electric baseline in the Energy Code.
OBJECTIVES

- Identify heat pump based HVAC systems for consideration as 2022 ACM Baselines
- Evaluate performance relative to current ACM Baselines
  - All current baselines use gas heat
  - TDV expected to increase when switching to electric heat
- Identify systems that have lower TDV consumption, but result in a minimal increase in stringency
  - A new baseline with higher TDV consumption would decrease stringency for projects with electric heat
  - Systems with large differences from the baseline in TDV consumption are excluded from the results that will follow
- Use CEC prototypes
  - Office – Small, Medium and Large
  - Retail – Small, Medium and Large
  - Small Restaurant
  - Small School
  - Warehouse

- Service and Domestic Hot Water Systems – Electric Only

- Cooling parameters match baseline
  - Federal standards may impact this if baselines change in CBECC-Com

- Fan parameters also match baseline

- For similar system types, impacts are due to heating type only.
## ALTERNATIVE SYSTEM OPTIONS

<table>
<thead>
<tr>
<th>Current Baseline</th>
<th>Systems Analyzed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small Office</strong></td>
<td></td>
</tr>
</tbody>
</table>
▪ Single Zone Heat Pump with Gas Supplemental Heat  
▪ Single Zone VAV Heat Pump  
▪ Single Zone VAV Heat Pump with Gas Sup. Heat  
▪ Variable Refrigerant Flow + DOAS |
| **Medium Office** |                  |
| Packaged Variable Air Volume – Hot Water Heat with Gas Boiler | ▪ Packaged VAV – Electric Resistance Reheat  
▪ Packaged VAV – Electric Reheat & Parallel Fan Boxes  
▪ Packaged VAV w/ Heat Pump Boiler  
▪ Variable Refrigerant Flow + DOAS  
▪ Water Source Heat Pump w/ Elec. Boiler + DOAS |
| **Large Office**  |                  |
| Built-Up Variable Air Volume – Hot Water Heat with Gas Boiler | ▪ Variable Air Volume (VAV) w/ Elec. Reheat  
▪ VAV w/ Electric Reheat & Parallel Fan Boxes  
▪ VAV w/ Heat Pump Boiler  
▪ Water Source Heat Pump w/ Elec. Boiler + DOAS |
## ALTERNATIVE SYSTEM OPTIONS

<table>
<thead>
<tr>
<th>Current Baseline</th>
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</table>
| Small Retail     | - Single Zone Heat Pump  
                  | - Single Zone Heat Pump with Gas Sup. Heat  
                  | - Single Zone VAV Heat Pump  
                  | - Single Zone VAV Heat Pump with Gas Sup. Heat                                      |
| Medium Retail    | - Single Zone Heat Pump  
                  | - Single Zone Heat Pump with Gas Sup. Heat  
                  | - Single Zone VAV Heat Pump  
                  | - Single Zone VAV Heat Pump with Gas Sup. Heat                                      |
| Large Retail     | - Single Zone Heat Pump  
                  | - Single Zone Heat Pump with Gas Sup. Heat  
                  | - Single Zone VAV Heat Pump  
<pre><code>              | - Single Zone VAV Heat Pump with Gas Sup. Heat                                      |
</code></pre>
<table>
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| **Restaurant (Small)**  
Single Zone and Single Zone VAV – Gas Furnace Heat |  
- Single Zone Heat Pump  
- Single Zone Heat Pump with Gas Sup. Heat  
- Single Zone VAV Heat Pump  
- Single Zone VAV Heat Pump with Gas Sup. Heat |
| **School (Small)**  
Single Zone and Single Zone VAV – Gas Furnace Heat |  
- Single Zone Heat Pump  
- Single Zone Heat Pump with Gas Sup. Heat  
- Single Zone VAV Heat Pump  
- Single Zone VAV Heat Pump with Gas Sup. Heat  
- Packaged VAV – Electric Resistance Reheat  
- Packaged VAV – Electric Reheat & Parallel Fan Boxes  
- Variable Refrigerant Flow  
- Water Source Heat Pump w/ Elec. Boiler + DOAS |
| **Warehouse**  
Single Zone VAZ (Office), Heating Ventilating System (Storage) – Gas Furnace Heat |  
- Single Zone Heat Pump  
- Single Zone Heat Pump with Gas Sup. Heat  
- Single Zone VAV Heat Pump  
- Single Zone VAV Heat Pump with Gas Sup. Heat |
Small Office

- Baseline is single zone air conditioners (SZAC) with gas furnace heat
- Changing furnace to heat pump heat - small reduction in TDV in some climate zones, small increase in others
- Changing supplemental heat to gas gives TDV savings in all CZ

RESULTS

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>SZHP</th>
<th>SZHP w/ Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT. Avg.</td>
<td>-8%</td>
<td>0%</td>
</tr>
</tbody>
</table>

TDV Savings vs. Baseline
Medium Office

- Baseline is Packaged VAV with hot water reheat from a gas boiler
- Electric reheat options increase TDV
- Heat Pump Boiler and VRF models do not provide TDV savings
Medium Office

- Baseline is Packaged VAV with hot water reheat from a gas boiler
- WSHP shows much higher TDV consumption
- Electric reheat, heat pump boiler and VRF models do not provide TDV savings
Large Office

- Baseline is a Built-up VAV with chillers and hot water reheat from a gas boiler
- WSHP shows much higher TDV consumption
- Electric reheat options increase TDV except in CZ8
- Electric boiler options do not perform much better
Small Retail

- Baseline is a mix of SZAC and single zone VAV air conditioners (SZVAVAC), all with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ

RESULTS

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<tr>
<th>Climate Zone</th>
<th>TDV Savings vs. Baseline</th>
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<tbody>
<tr>
<td></td>
<td>SZ Mixed HP</td>
</tr>
<tr>
<td></td>
<td>SZ Mixed HP GasSup</td>
</tr>
<tr>
<td>1-16 Wt. Avg</td>
<td>-8%</td>
</tr>
<tr>
<td>Avg.</td>
<td>0%</td>
</tr>
</tbody>
</table>

Graph showing TDV Savings vs. Baseline for SZ Mixed HP and SZ Mixed HP GasSup across different climate zones.
Medium Retail

- Baseline is a mix of SZAC and SZVAVAC, with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ

RESULTS

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<thead>
<tr>
<th>Climate Zone</th>
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<tbody>
<tr>
<td>1-8</td>
<td>-8%</td>
</tr>
<tr>
<td>9-16</td>
<td>-6%</td>
</tr>
<tr>
<td>17</td>
<td>-4%</td>
</tr>
<tr>
<td>18</td>
<td>-2%</td>
</tr>
<tr>
<td>19-21</td>
<td>0%</td>
</tr>
<tr>
<td>22-24</td>
<td>2%</td>
</tr>
<tr>
<td>25-27</td>
<td>4%</td>
</tr>
</tbody>
</table>

Graph showing TDV savings for Climate Zones 1-24 and the average (Avg.)
Large Retail

- Baseline is SZVAVAC with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ

**RESULTS**

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<tr>
<th>Climate Zone</th>
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<tbody>
<tr>
<td>SZVAVHP</td>
<td></td>
</tr>
<tr>
<td>SZVAVHP w/ Gas SupHt</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing TDV savings vs. baseline for different climate zones.](image-url)
Small Restaurant

- Baseline is a mix of SZAC and SZVAVAC, both with gas furnace heat
- Switch to heat pump provides TDV savings in every climate zone except CZ16
- Gas supplemental heat gives TDV savings in CZ16 too
Small School

- Baseline is a mix of SZAC and SZVAVC, all with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1, CZ5 and CZ16
- Changing supplemental heat to gas provides TDV savings except in CZ1
Warehouse

- Baseline is a SZAVAC serving the office and heating/ventilating units serving storage areas, all with gas furnace heat.
- No direct electric heat alternative to the H/V units
- Constant volume heat pumps show increased TDC
- Change to gas supplemental heat reduces TDV in all climate zones

RESULTS

-30%  -25%  -20%  -15%  -10%  -5%  0%  5%  10%  15%  20%

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<tr>
<th>Climate Zone</th>
<th>TDV Savings vs. Baseline</th>
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<tbody>
<tr>
<td>SZHP Mixed</td>
<td></td>
</tr>
<tr>
<td>SZHP Mixed-GasSup</td>
<td></td>
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</tbody>
</table>
CONCLUSIONS

- Switch of baseline from gas furnace to heat pump appears viable
  - Need to evaluate impact of Federal minimum cooling efficiencies
  - Need to investigate additional options to avoid baseline with higher TDV consumption
    - Envelope changes?
    - Climate zone specific additional measures?

- Electric alternatives to gas boilers problematic

- Need to evaluate Federal cooling efficiency minimums

- Will be looking at inclusion of DOAS options