

**DOCKETED**

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# Title 24 2022 ACM: Heat Pump Baseline Analysis – Nonresidential Buildings

October 6, 2020

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# 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

# APPROACH

- 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

Current Baseline		Systems Analyzed
Small Office	Single Zone Rooftop – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Supplemental Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> <li>▪ Variable Refrigerant Flow + DOAS</li> </ul>
Medium Office	Packaged Variable Air Volume – Hot Water Heat with Gas Boiler	<ul style="list-style-type: none"> <li>▪ Packaged VAV – Electric Resistance Reheat</li> <li>▪ Packaged VAV – Electric Reheat &amp; Parallel Fan Boxes</li> <li>▪ Packaged VAV w/ Heat Pump Boiler</li> <li>▪ Variable Refrigerant Flow + DOAS</li> <li>▪ Water Source Heat Pump w/ Elec. Boiler + DOAS</li> </ul>
Large Office	Built-Up Variable Air Volume – Hot Water Heat with Gas Boiler	<ul style="list-style-type: none"> <li>▪ Variable Air Volume (VAV) w/ Elec. Reheat</li> <li>▪ VAV w/ Electric Reheat &amp; Parallel Fan Boxes</li> <li>▪ VAV w/ Heat Pump Boiler</li> <li>▪ Water Source Heat Pump w/ Elec. Boiler + DOAS</li> </ul>

# ALTERNATIVE SYSTEM OPTIONS

Current Baseline		Systems Analyzed
Small Retail	Single Zone and Single Zone Variable Air Volume (VAV) – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> </ul>
Medium Retail	Single Zone and Single Zone VAV – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> </ul>
Large Retail	Single Zone VAV – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> </ul>

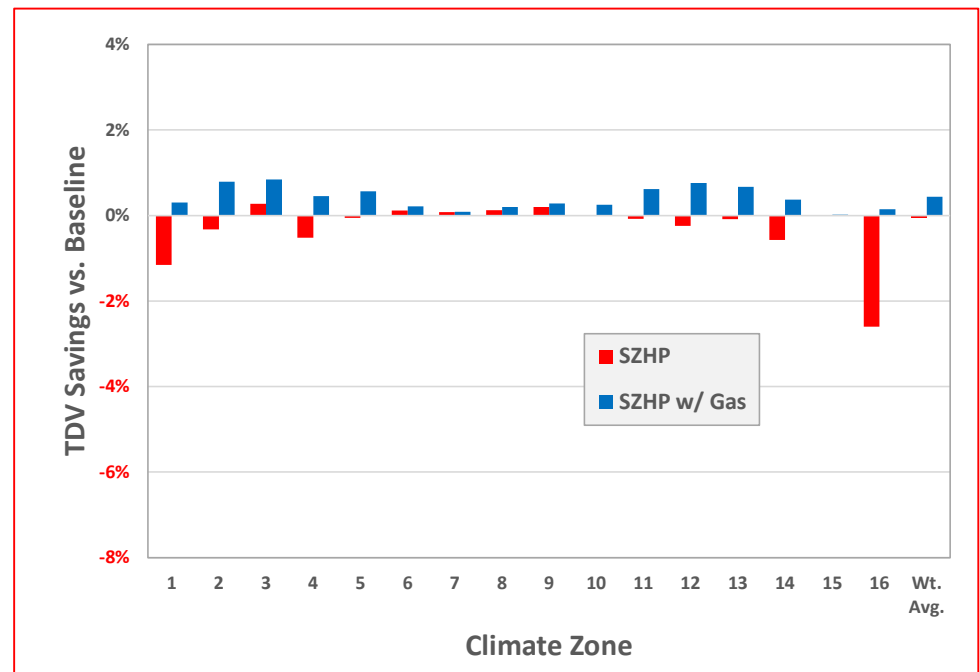
# ALTERNATIVE SYSTEM OPTIONS

Current Baseline		Systems Analyzed
Restaurant (Small)	Single Zone and Single Zone VAV – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> </ul>
School (Small)	Single Zone and Single Zone VAV – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> <li>▪ Packaged VAV – Electric Resistance Reheat</li> <li>▪ Packaged VAV – Electric Reheat &amp; Parallel Fan Boxes</li> <li>▪ Variable Refrigerant Flow</li> <li>▪ Water Source Heat Pump w/ Elec. Boiler + DOAS</li> </ul>
Warehouse	Single Zone VAV (Office), Heating Ventilating System (Storage) – Gas Furnace Heat	<ul style="list-style-type: none"> <li>▪ Single Zone Heat Pump</li> <li>▪ Single Zone Heat Pump with Gas Sup. Heat</li> <li>▪ Single Zone VAV Heat Pump</li> <li>▪ Single Zone VAV Heat Pump with Gas Sup. Heat</li> </ul>

# RESULTS

## 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

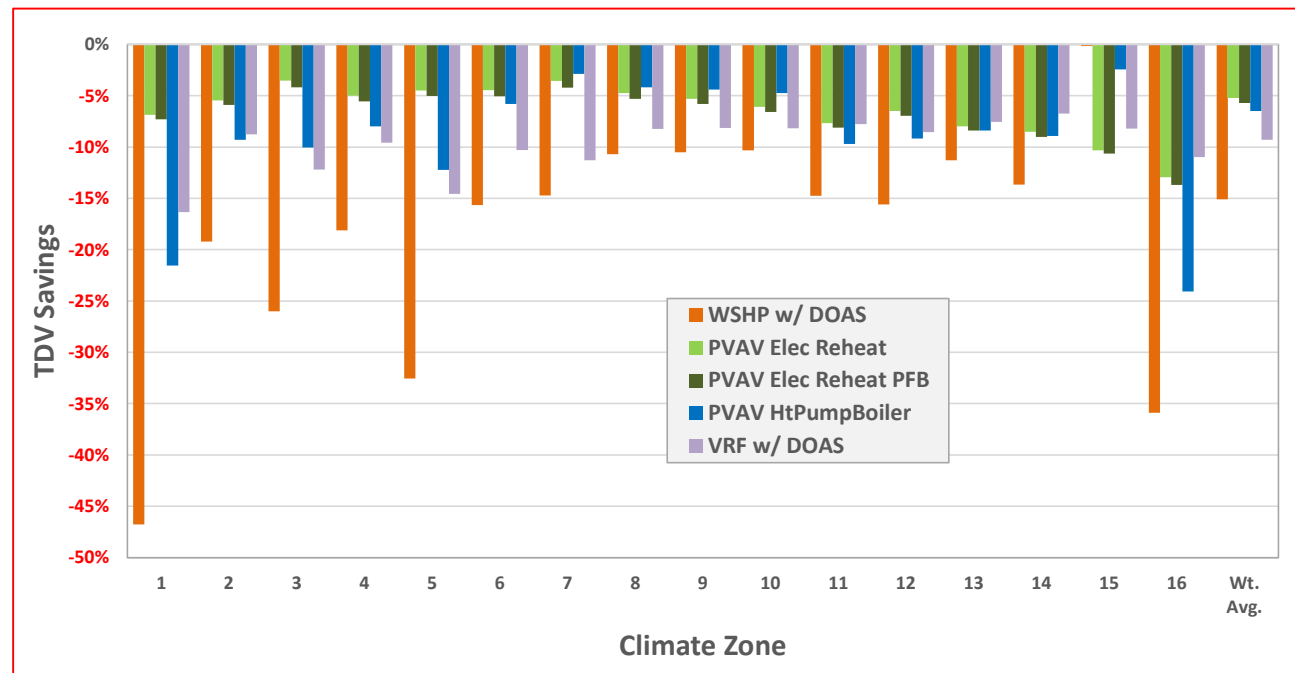




# RESULTS

## Medium Office

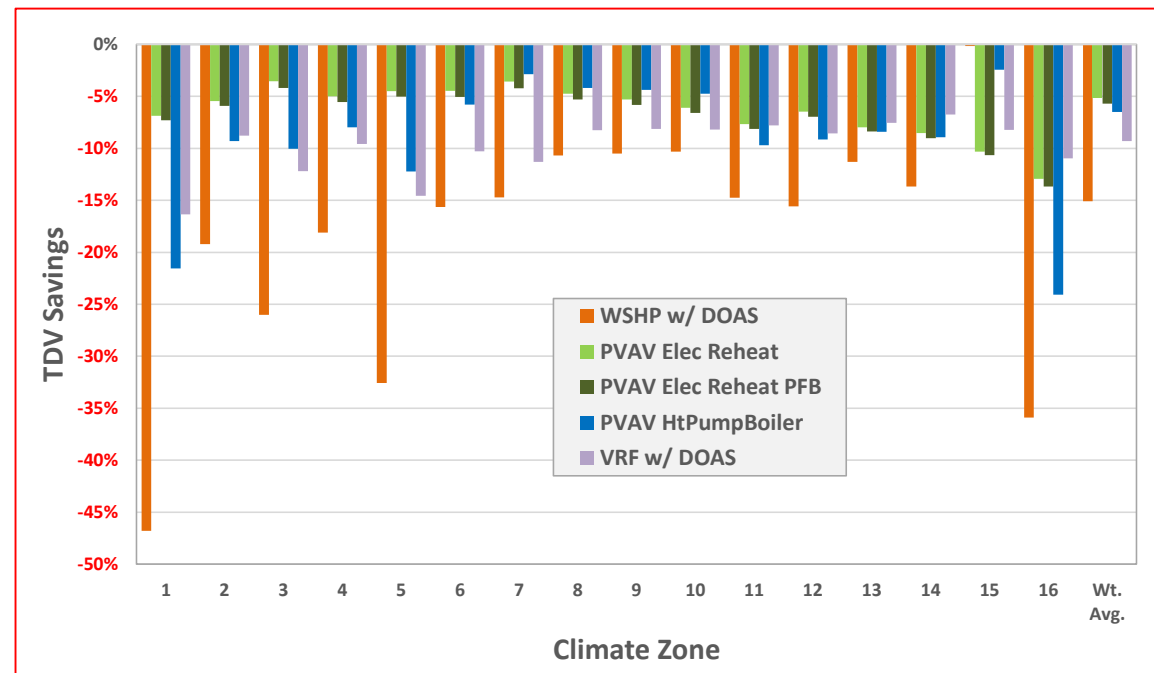
- Baseline is Packaged VAV with hot water reheat from a gas boiler
- Electric reheat options increase TDV
- Heat Pump Boiler and VRF models do not provide TDV savings



# RESULTS

## Medium Office

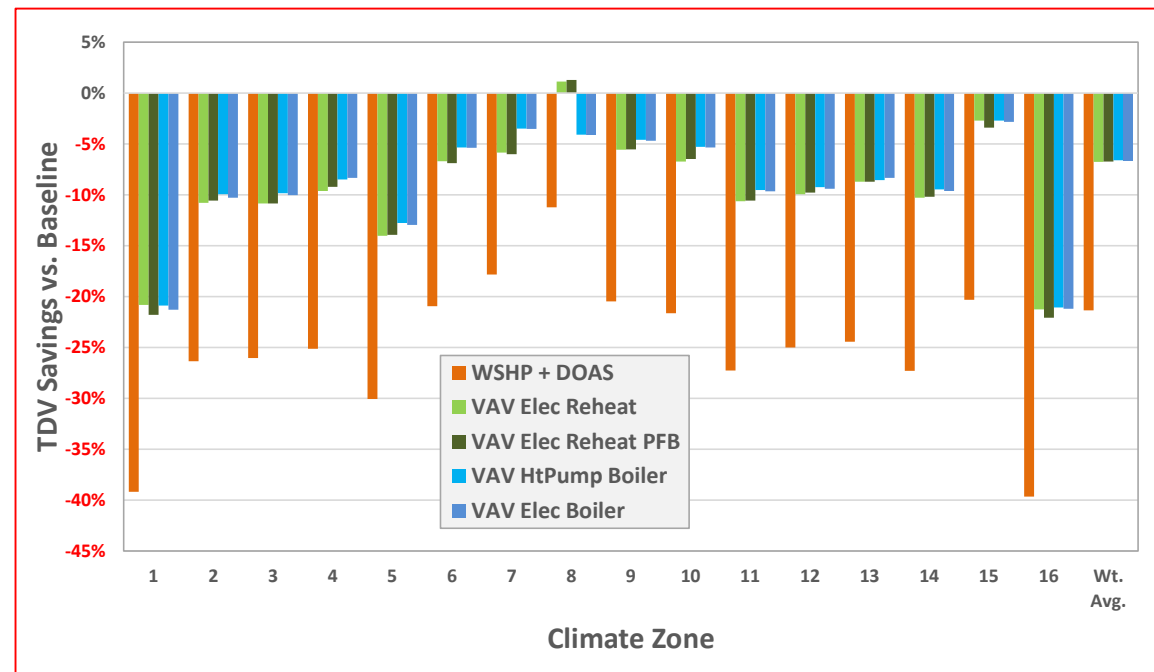
- Baseline is Packaged VAV with hot water reheat from a gas boiler
- WSHP shows much higher TDV consumption
- Electric reheat, heat pump boiler and VRF models do not provide TDV savings



# RESULTS

## Large Office

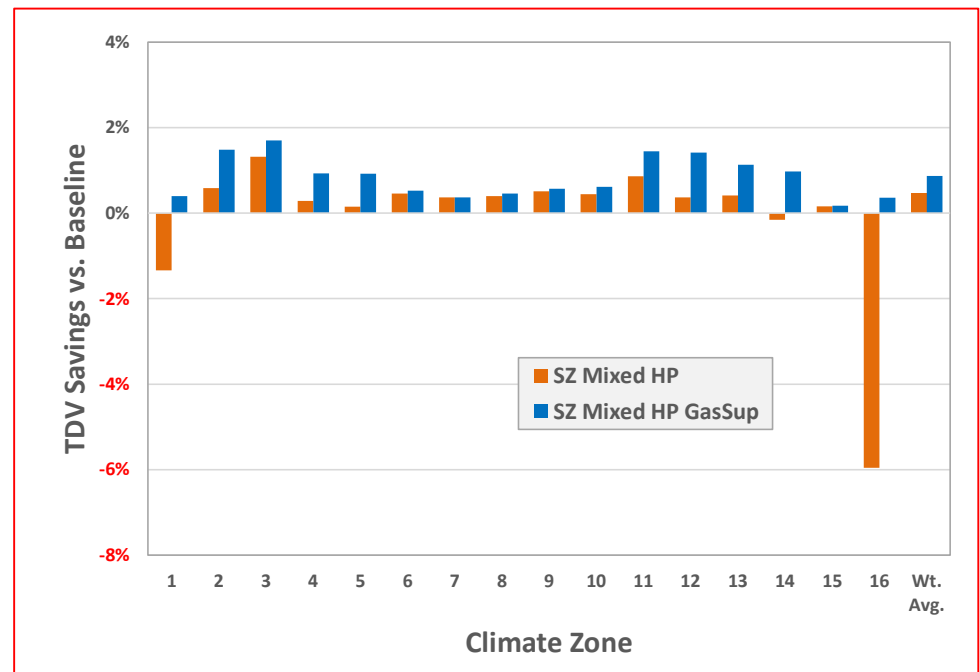
- Baseline is a Built-up VAV with chillers and hot water reheat from a gas boiler
- WSHP shows much higher TDV consumption
- Electric reheat options increase TDV except in CZ8
- Electric boiler options do not perform much better



# RESULTS

## Small Retail

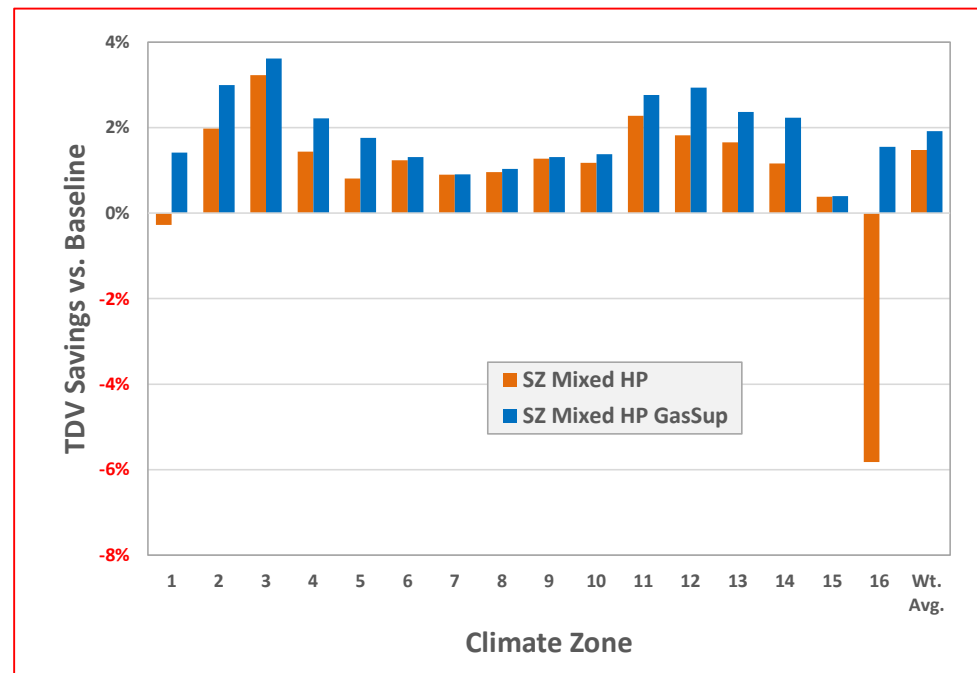
- Baseline is a mix of SZAC and single zone VAV air conditioners (SZVAVAC), all with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ



# RESULTS

## Medium Retail

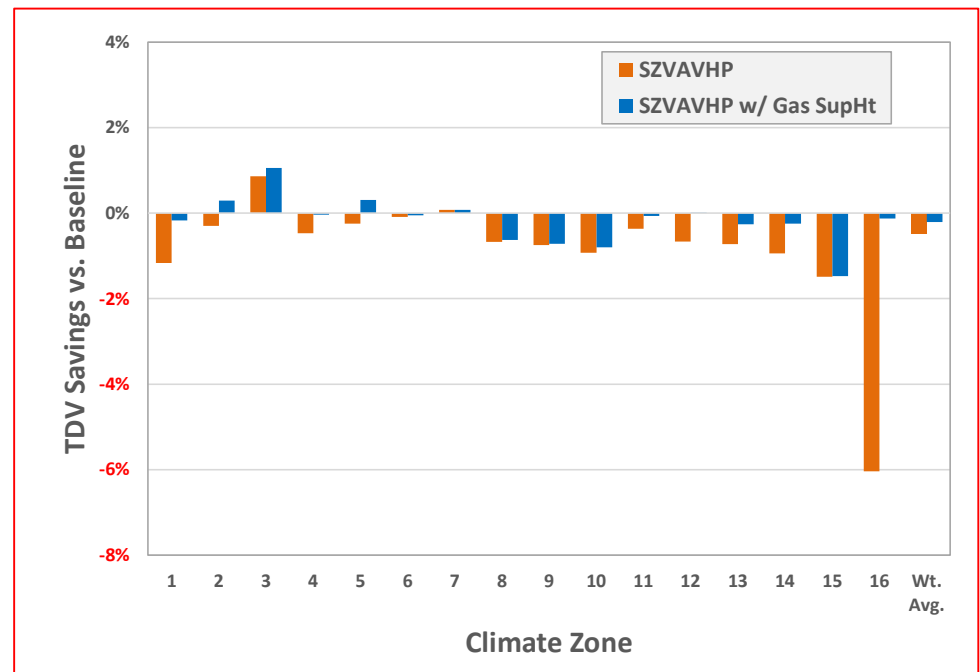
- Baseline is a mix of SZAC and SZVAVAC, with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ



# RESULTS

## Large Retail

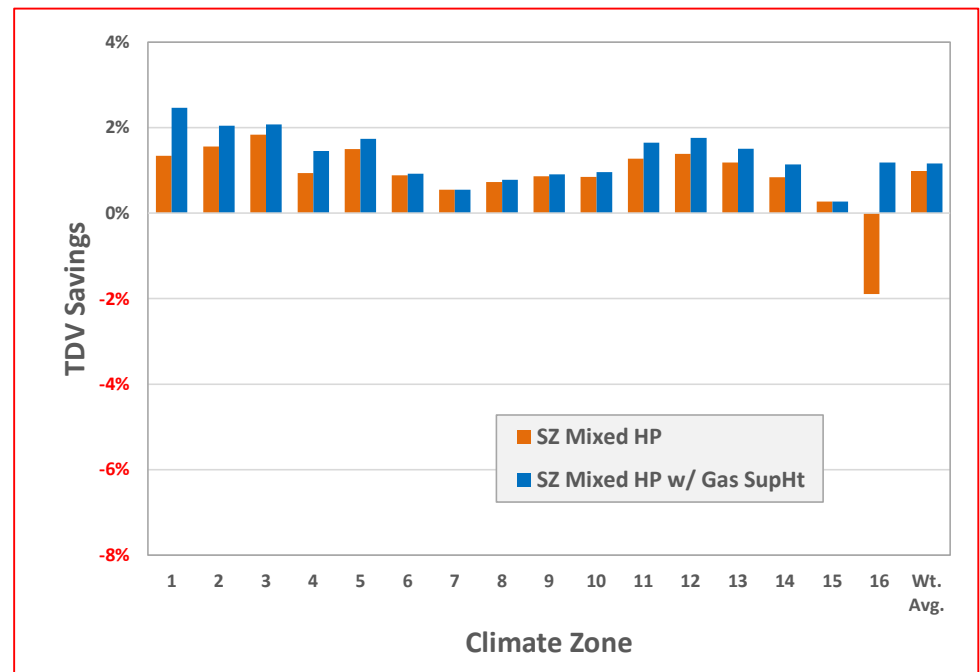
- Baseline is SZVAVAC with gas furnace heat.
- Changing furnace to heat pump heat - small reduction in TDV except in CZ1 and CZ16
- Changing supplemental heat to gas gives TDV savings in all CZ



# RESULTS

## Small Restaurant

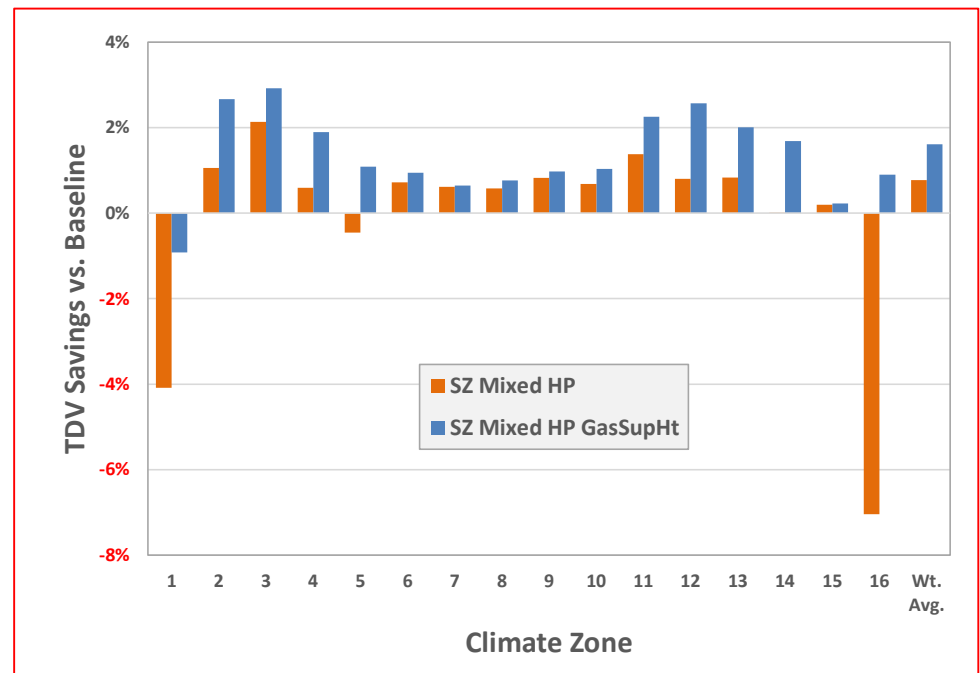
- Baseline is a mix of SZAC and SZVAVAC, both with gas furnace heat
- Switch to heat pump provides TDV savings in every climate zone except CZ16
- Gas supplemental heat gives TDV savings in CZ16 too



# RESULTS

## Small School

- Baseline is a mix of SZAC and SZVAVAC, 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

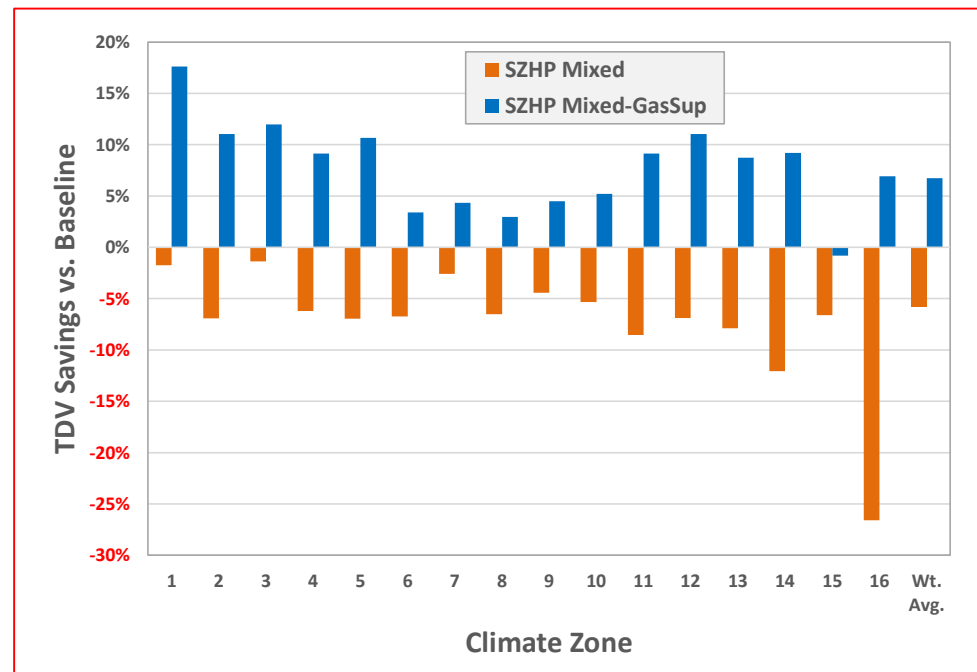




# RESULTS

## Warehouse

- Baseline is a SZVAVAC 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



# 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