ENERGY SAVINGS
WHITEPAPER

An analysis of the unique 75F IoT Building Management System in U.S. primary schools, both new construction and retrofit.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

75F

INTRODUCTION

This report comprehensively quantifies the potential energy savings of the 75F IoT Building Management System (BMS) in U.S. primary schools, both retrofit and new construction. Studied 75F applications include Outside Air Optimization (OAO) and Smart VAV With Reheat.

The National Renewable Energy Lab (NREL) cultivated the data in this report by leveraging U.S. Department of Energy (DOE) building benchmarks and characteristics across multiple cities, annualized to capture total building energy savings as well as heating, ventilating, and air conditioning (HVAC) electricity and natural gas energy use intensity (EUI) reductions.

- **Total building** energy savings of up to **14%** in retrofit primary schools
- **Total building** energy savings of up to **12%** for new construction secondary schools
- Energy savings potential is **even across the U.S.**

METHODOLOGY

The U.S. Department of Energy (DOE) is responsible for conducting research about commercial building systems and energy efficiency in coordination with national laboratories, private industry, and universities, with a stated goal of developing more energy efficient buildings and eventually reaching zero energy buildings. This research relies heavily on standardized benchmarks developed and shared by Lawrence Berkeley National Laboratory (LBNL), Pacific Northwest National Laboratory (PNNL), and the National Renewable Energy Laboratory (NREL), the nation's primary laboratory for renewable energy and energy efficiency research and development.

CLIMATE ZONES

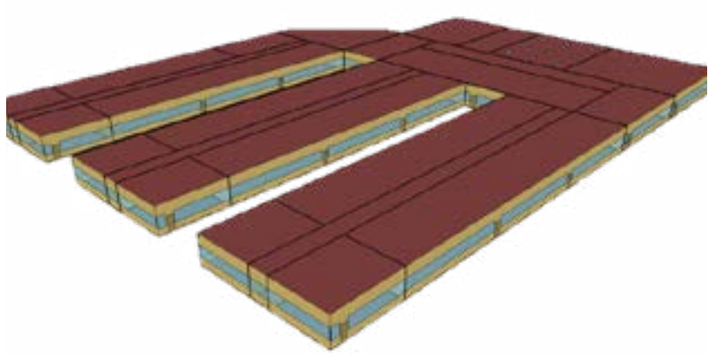
The education facilities analyzed in this report are in 16 cities representing all U.S. climate zones: Honolulu, HI; Tampa, FL; Tucson, AZ; Atlanta, GA; El Paso, TX; San Diego, CA; New York, NY; Albuquerque, NM; Seattle, WA; Buffalo, NY; Denver, CO; Port Angeles, WA; Rochester, MN; Great Falls, MT; International Falls, MN; and Fairbanks, AK. Efficiencies are based on the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 90.1-2016 for new construction buildings, and Standard 90.1-2004 for retrofit buildings. All buildings have varying schedules, occupancy, component efficiency, locations and orientation, lighting loads, plug loads, HVAC sequences and varying ventilation requirements based on zone use.

PRIMARY SCHOOLS

Primary school building energy consumption is based on a one-story building with 73,960 square feet, gas furnace inside packaged air conditioning unit and hot water from a gas boiler for heating, and packaged air conditioner unit for cooling. Distribution and terminal units include direct air from the packaged unit for the CAV system; VAV terminal box with damper and hot water reheating coil for the VAV system; and minimum supply air at 30% of the zone design peak supply air.

RESULTS | **Primary Schools, Retrofit**

RESULTS | **Primary Schools, New Construction**



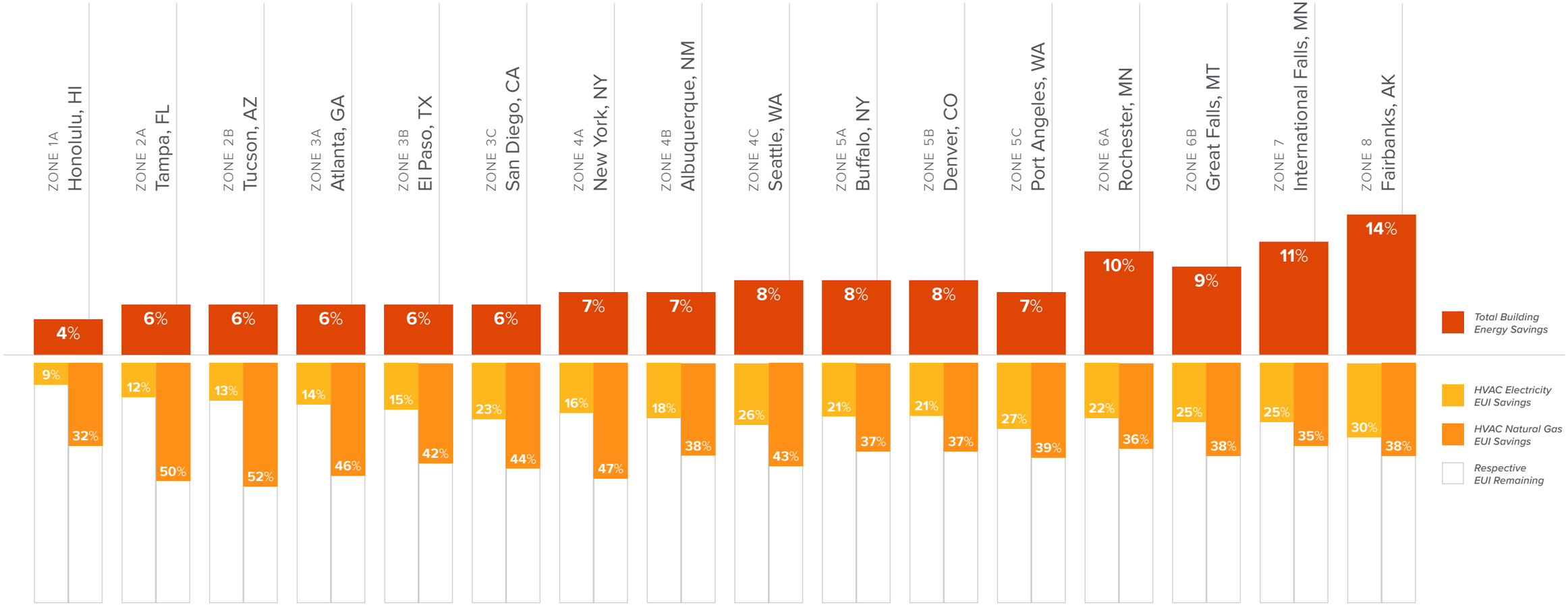
75F® Smart VAV With Reheat™

75F® Smart VAV with Reheat™ is a full-stack solution with components that include sensors connecting to 75F's AI for cloud analysis, a 75F® Central Control Unit™ (CCU) as a supervisor with built-in wall interface, 75F® Smart Node™ as terminal equipment controllers, third-party units with actuators or 75F Smart Dampers, and Facilisight, 75F's building intelligence suite of web and mobile apps for secure remote monitoring and control. VAV is an advantageous application for commercial buildings larger than 40,000 square feet with diverse loads or those that require simultaneous exterior heating and interior cooling during winter months. Where common air handling equipment may serve these zones today, VAV with Reheat allows a central RTU or AHU to serve multiple zones. This way, one duct run can provide air for ventilation and cooling while reheat can be used for zones that need heating. Where traditional VAV systems can be costly and inefficient, 75F has encapsulated newer ASHRAE-recommended advanced VAV control sequences. This application modernizes and acknowledges today's fully modulating RTUs and AHUs.

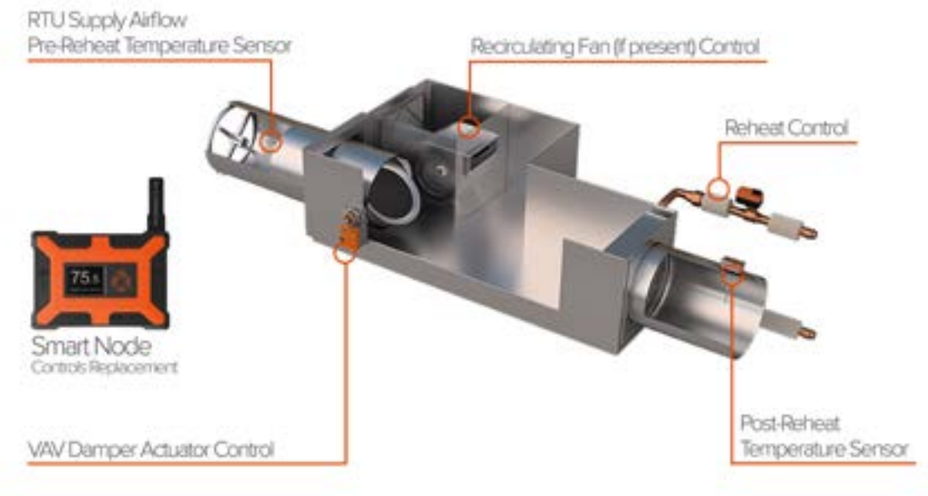
75F® Outside Air Optimization™

75F® Outside Air Optimization™ (OAO) is an application that combines hardware, software, and real-time weather data providing advanced sequences of operation from rooftop economizers to built-up air handlers in a wide range of commercial buildings. While OAO's three primary benefits are improved efficiency, comfort and indoor air quality, this report will focus on OAO's efficiency potential. NREL's study includes three OAO control strategies: OAO, OAO Interval Modulation (IM), and OAO Smart Demand Control Ventilation (DCV). This report focuses exclusively on OAO data, though specific control strategy descriptions are available for all three.

- **OAO** reduces the required ventilation of outdoor air leveraging additional sensors and optimized setpoints.
- **OAO IM** cycles the fan to maintain minimum outdoor air ventilation. Applied in any building with constant-speed fans in the HVAC equipment that provides ventilation to occupants.
- **OAO Smart DCV** uses CO2 sensors to detect occupancy and adjusts ventilation by room in VAV systems. Applied in buildings with central HVAC systems serving multiple zones leveraging traditional VAV terminal units.


ZONE 1A Honolulu, HI
4%
9%
32%
ZONE 2A Tampa, FL
6%
12%
50%
ZONE 2B Tucson, AZ
6%
13%
52%
ZONE 3A Atlanta, GA
6%
14%
46%
ZONE 3B El Paso, TX
6%
15%
42%
ZONE 3C San Diego, CA
6%
23%
44%
ZONE 4A New York, NY
7%
16%
47%
ZONE 4B Albuquerque, NM
7%
18%
38%
ZONE 4C Seattle, WA
8%
26%
43%
ZONE 5A Buffalo, NY
8%
21%
37%
ZONE 5B Denver, CO
8%
21%
37%
ZONE 5C Port Angeles, WA
7%
27%
39%
ZONE 6A Rochester, MN
10%
22%
36%
ZONE 6B Great Falls, MT
9%
25%
38%
ZONE 7 International Falls, MN
11%
25%
35%
ZONE 8 Fairbanks, AK
14%
30%
38%
Total Building Energy Savings
HVAC Electricity EUI Savings
HVAC Natural Gas EUI Savings
Respective EUI Remaining

75F SMART VAV WITH REHEAT ILLUSTRATION



ZONE 1A
Honolulu, HI
9% | 32% | **4.1%** *Total Building Energy Savings*

ZONE 2A
Tampa, FL
12% | 50% | **5.7%** *Total Building Energy Savings*

ZONE 2B
Tucson, AZ
13% | 52% | **5.8%** *Total Building Energy Savings*

ZONE 3A
Atlanta, GA
14% | 46% | **5.8%** *Total Building Energy Savings*

ZONE 3B
El Paso, TX
15% | 42% | **5.7%** *Total Building Energy Savings*

ZONE 3C
San Diego, CA
23% | 44% | **5.6%** *Total Building Energy Savings*

ZONE 4A
New York, NY
16% | 47% | **7.2%** *Total Building Energy Savings*

ZONE 4B
Albuquerque, NM
18% | 38% | **6.8%** *Total Building Energy Savings*

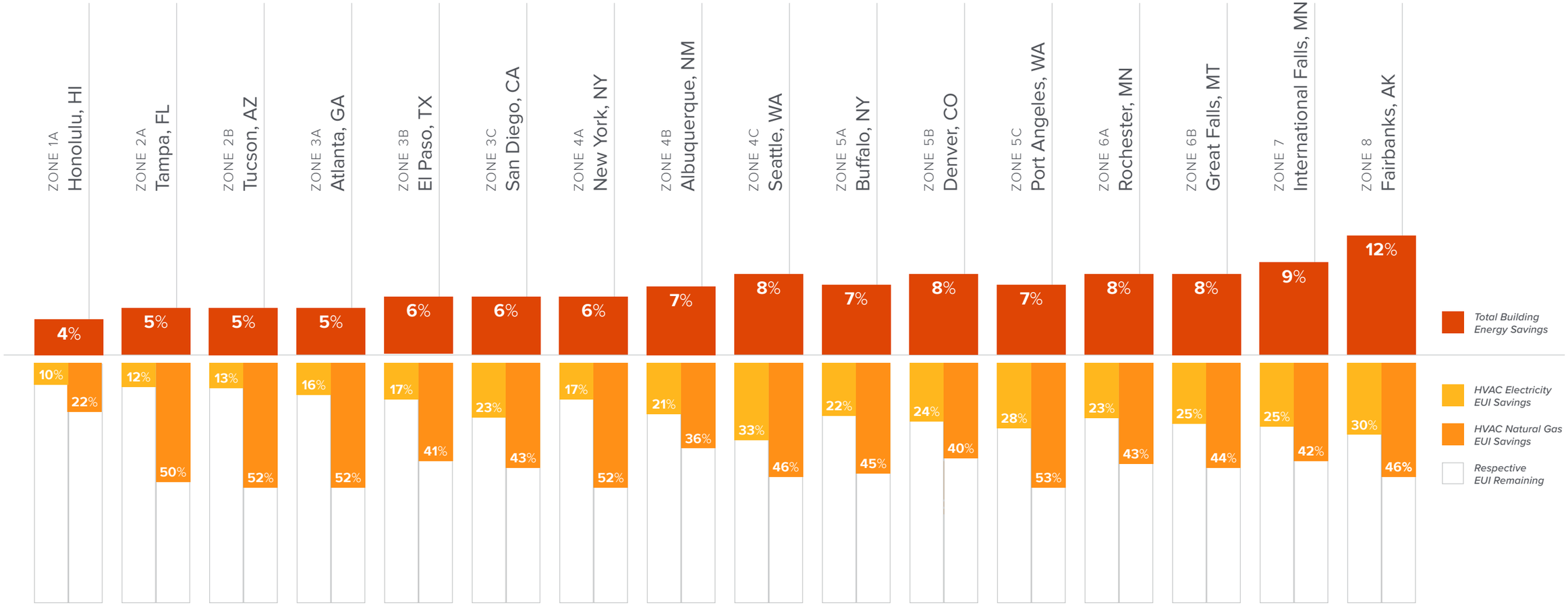
ZONE 4C
Seatlle, WA
26% | 43% | **7.7%** *Total Building Energy Savings*

ZONE 5A
Buffalo, NY
21% | 37% | **8.3%** *Total Building Energy Savings*

ZONE 5B
Denver, CO
21% | 37% | **8.2%** *Total Building Energy Savings*

HVAC Electricity EUI Savings

HVAC Natural Gas EUI Savings


ZONE 1A Honolulu, HI
4%
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ZONE 3A Atlanta, GA
5%
16%
52%
ZONE 3B El Paso, TX
6%
17%
41%
ZONE 3C San Diego, CA
6%
23%
43%
ZONE 4A New York, NY
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17%
52%
ZONE 4B Albuquerque, NM
7%
21%
36%
ZONE 4C Seattle, WA
8%
33%
46%
ZONE 5A Buffalo, NY
7%
22%
45%
ZONE 5B Denver, CO
8%
24%
40%
ZONE 5C Port Angeles, WA
7%
28%
53%
ZONE 6A Rochester, MN
8%
23%
43%
ZONE 6B Great Falls, MT
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25%
44%
ZONE 7 International Falls, MN
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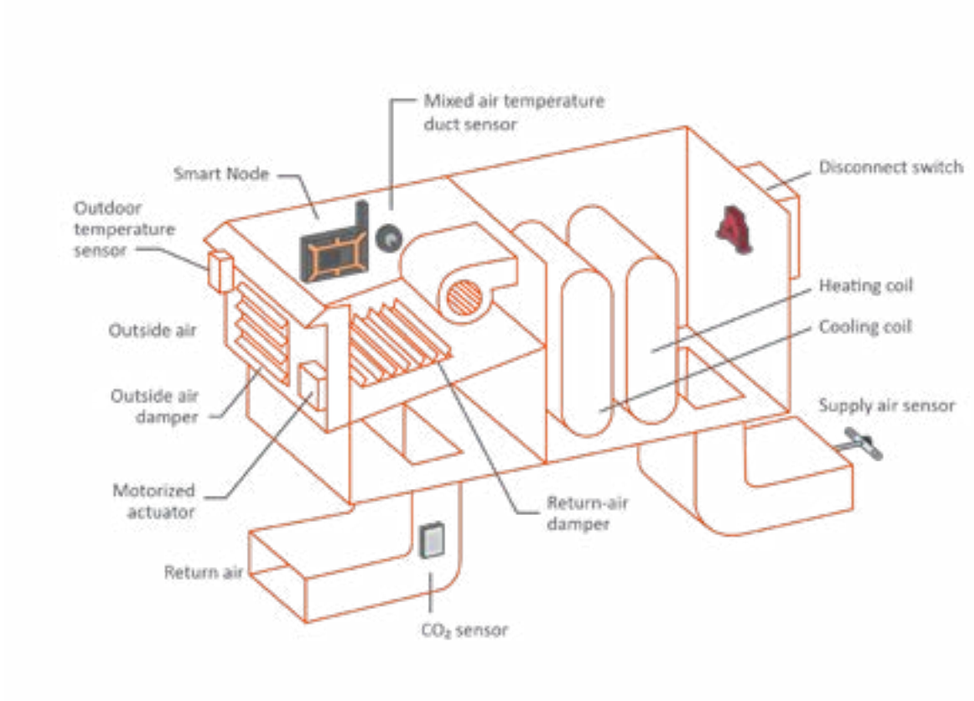
25%
42%
ZONE 8 Fairbanks, AK
12%
30%
46%
Total Building Energy Savings
HVAC Electricity EUI Savings
HVAC Natural Gas EUI Savings
Respective EUI Remaining

75F OUTSIDE AIR OPTIMIZATION ILLUSTRATION



ZONE 1A
Honolulu, HI

10% 22% **4.0%** *Total Building Energy Savings*

ZONE 2A
Tampa, FL

12% 50% **4.6%** *Total Building Energy Savings*

ZONE 2B
Tucson, AZ

13% 52% **5.0%** *Total Building Energy Savings*

ZONE 3A
Atlanta, GA

16% 52% **5.3%** *Total Building Energy Savings*

ZONE 3B
El Paso, TX

17% 41% **5.6%** *Total Building Energy Savings*

ZONE 3C
San Diego, CA

23% 43% **5.6%** *Total Building Energy Savings*

ZONE 4A
New York, NY

17% 52% **6.0%** *Total Building Energy Savings*

ZONE 4B
Albuquerque, NM

21% 36% **6.6%** *Total Building Energy Savings*

ZONE 4C
Seatlle, WA

33% 46% **7.6%** *Total Building Energy Savings*

ZONE 5A
Buffalo, NY

22% 45% **6.6%** *Total Building Energy Savings*

ZONE 5B
Denver, CO

24% 40% **8.2%** *Total Building Energy Savings*

HVAC Electricity EUI Savings

HVAC Natural Gas EUI Savings

CONCLUSION

This analysis shows significant savings from combined applications Smart VAV With Reheat and Outside Air Optimization sequences in primary education facilities, particularly in climates like those found in Colorado, Minnesota, Washington, and Alaska. Retrofit primary schools have the potential for greatest efficiency improvements in this report with savings of up to 14% total building energy use in representative cities, though new construction buildings are a close second at 12%. While these high savings are typically located in climates that are mountainous and prone to cold winters, data in other areas of the country, such as the southwestern portion, still hover between 5% and 7% total building energy savings in both vintages.

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