



ENERGY SAVINGS

WHITEPAPER

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



INTRODUCTION

This report comprehensively quantifies the potential energy savings of the 75F IoT Building Management System (BMS) in U.S. secondary education facilities, both retrofit and new construction. Studied 75F applications include Dynamic Chill Water Balancing (DCWB), 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 **17%** in retrofit secondary schools
- ▶ **Total building** energy savings of up to **13%** for new construction secondary schools
- ▶ Energy savings potential is **even across the U.S.**, with the **eastern, southern, and northern** portions of the country seeing the highest savings

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

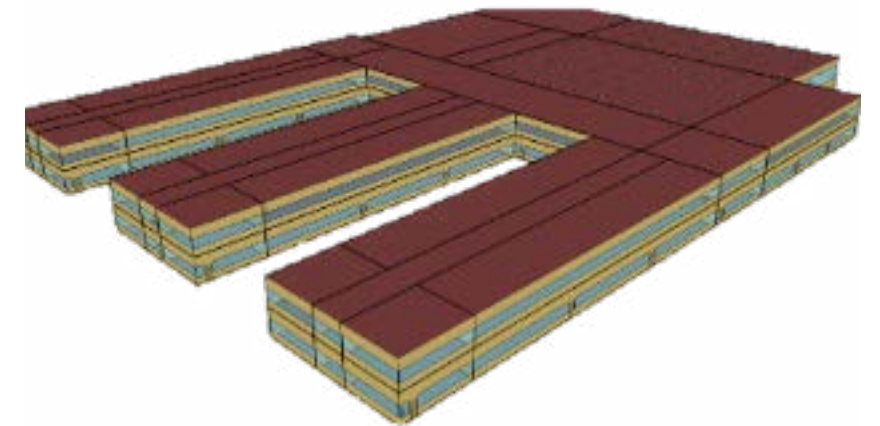
The education facilities analyzed in this report are in 16 cities representing all U.S. climate zones: Honolulu, HI; Tampa, FL; Tucson, AZ; Atlanta, GA; El Paso, TX; San Diego, CA; New York, NY; Albuquerque, NM; Seattle, WA; Buffalo, NY; Denver, CO; Port Angeles, WA; Rochester, MN; Great Falls, MT; International 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.

SECONDARY SCHOOLS

Secondary school building energy consumption is based on a two-story building with 210,900 square feet, gas furnaces inside packaged air conditioning units and a gas-fired boiler for heating, and packaged air conditioner and air-cooled chiller 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 | [Secondary Schools, Retrofit](#)

RESULTS | [Secondary Schools, New Construction](#)



APPLICATIONS

75F Dynamic Chilled Water Balancing is an end-to-end solution for chilled water systems. 75F sensors in each zone gather millions of data points daily and communicate these points via a 900 MHz wireless mesh network to the 75F® Central Control Unit™ — giving users the ability to monitor the inlet and outlet temperatures, chilled water flow rates, and BTU energy consumption across the line. 75F's system understands, analyzes, and optimizes the overall performance of the HVAC system under various conditions, thereby driving significant energy savings at an AHU level and at the chiller plant.

75F designs and manufactures the world's leading IoT-based Building Management System, an out-of-the-box, vertically integrated solution that is more affordable and easier to deploy than anything on the market today. The company leverages IoT, Cloud Computing and Machine Learning for data-driven, proactive building intelligence and controls for HVAC and lighting optimization. Investors include some of the biggest names in energy and technology. 75F's mission is to improve occupant productivity through enhanced comfort and indoor air quality — all while saving energy.

APPLICATIONS

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

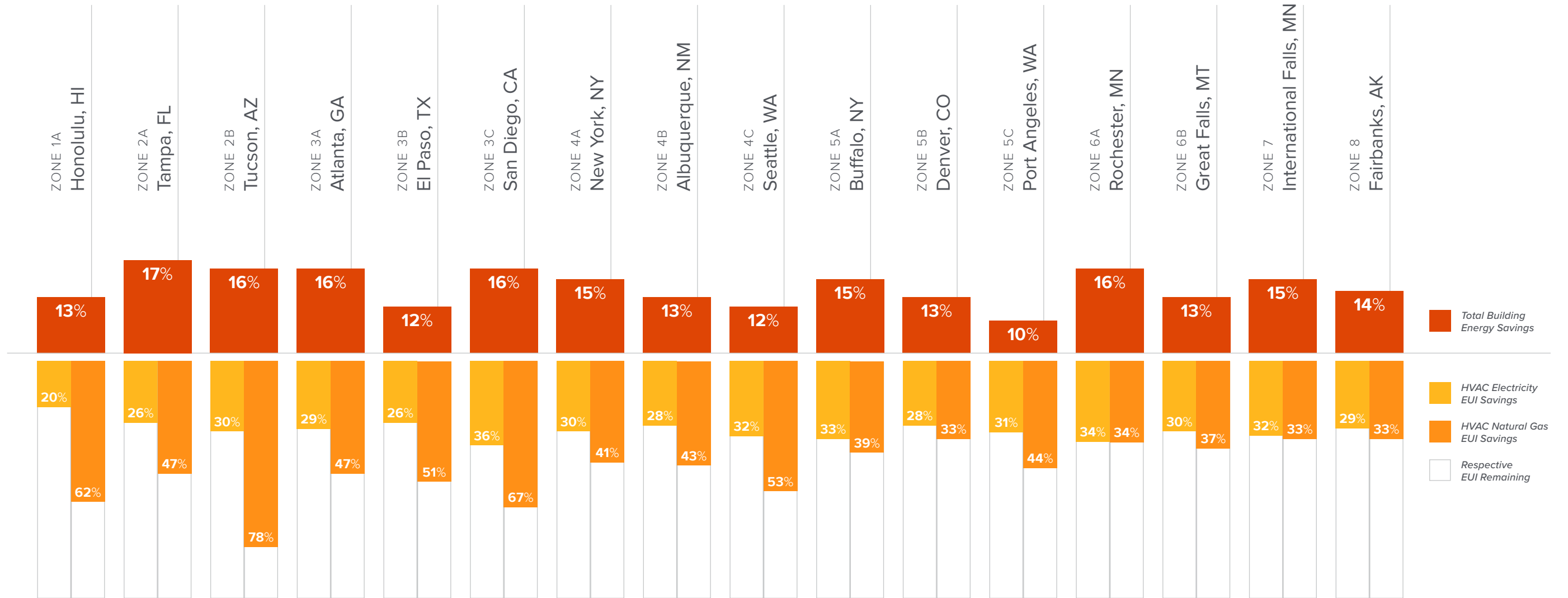
heating and interior cooling during winter months. Where common air handling equipment may serve these zones today, VAV with Reheat allows a central RTU or AHU to serve multiple zones. This way, one duct run can provide air for ventilation and cooling while reheat can be used for zones that need heating. 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.

APPLICATIONS

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.

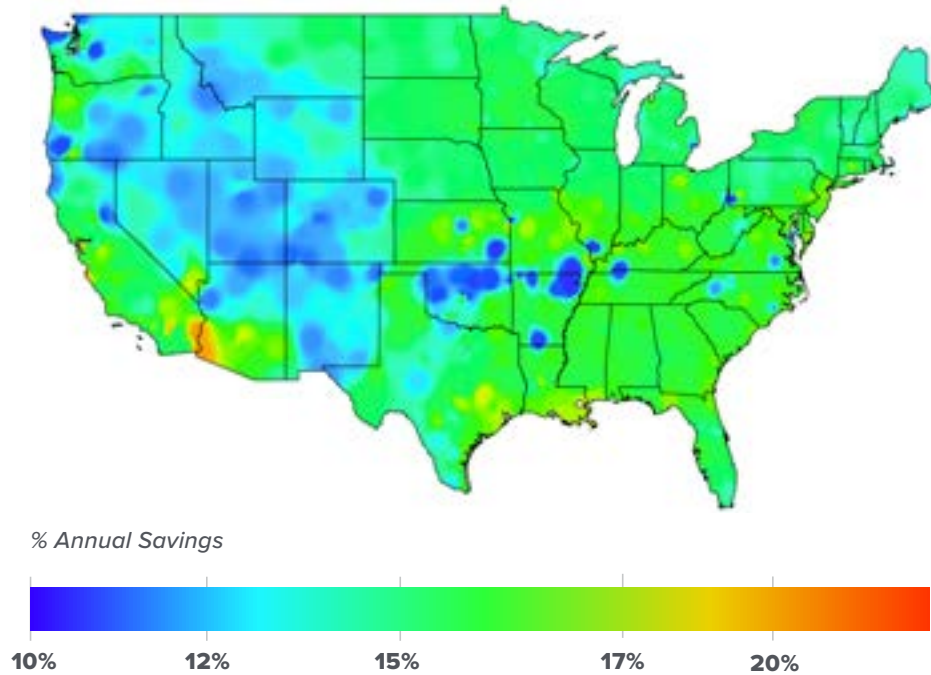
- ▶ **OAO** reduces the required ventilation of outdoor air leveraging additional sensors and optimized setpoints.
- ▶ **OAO IM** cycles the fan to maintain minimum outdoor air ventilation. Applied in any building with constant-speed fans in the HVAC equipment that provides ventilation to occupants.
- ▶ **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.

RESULTS | SECONDARY SCHOOLS, RETROFIT



HIGHLIGHTS | SECONDARY SCHOOLS, RETROFIT

ANNUAL SAVINGS BY CLIMATE ZONE



ZONE 1A
Honolulu, HI

20% ■ **12.7%**
62% ■ Total Building Energy Savings

ZONE 2A
Tampa, FL

26% ■ **16.7%**
47% ■ Total Building Energy Savings

ZONE 2B
Tucson, AZ

30% ■ **16.4%**
78% ■ Total Building Energy Savings

ZONE 3A
Atlanta, GA

29% ■ **16.2%**
47% ■ Total Building Energy Savings

ZONE 3B
El Paso, TX

26% ■ **12.3%**
51% ■ Total Building Energy Savings

ZONE 3C
San Diego, CA

36% ■ **15.9%**
67% ■ Total Building Energy Savings

ZONE 4A
New York, NY

30% ■ **15.3%**
41% ■ Total Building Energy Savings

ZONE 4B
Albuquerque, NM

28% ■ **13.0%**
43% ■ Total Building Energy Savings

ZONE 4C
Seattle, WA

32% ■ **12.1%**
53% ■ Total Building Energy Savings

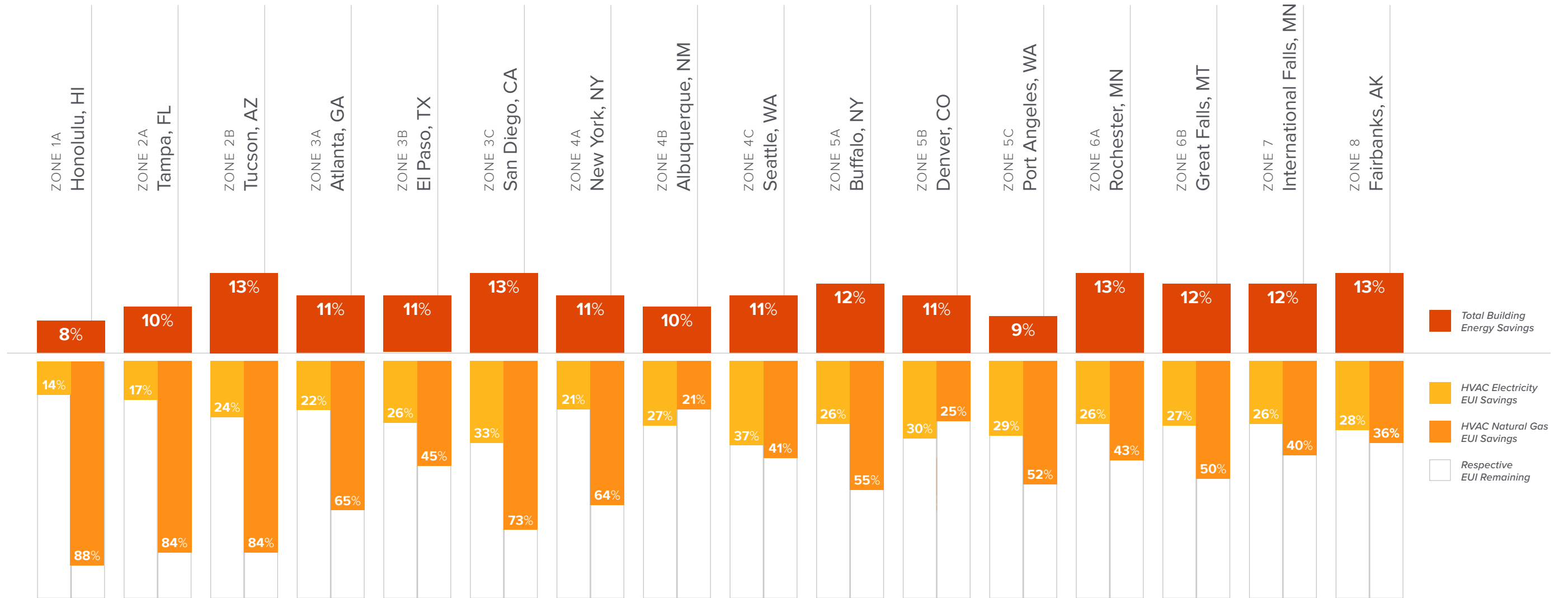
ZONE 5A
Buffalo, NY

33% ■ **15.0%**
39% ■ Total Building Energy Savings

ZONE 5B
Denver, CO

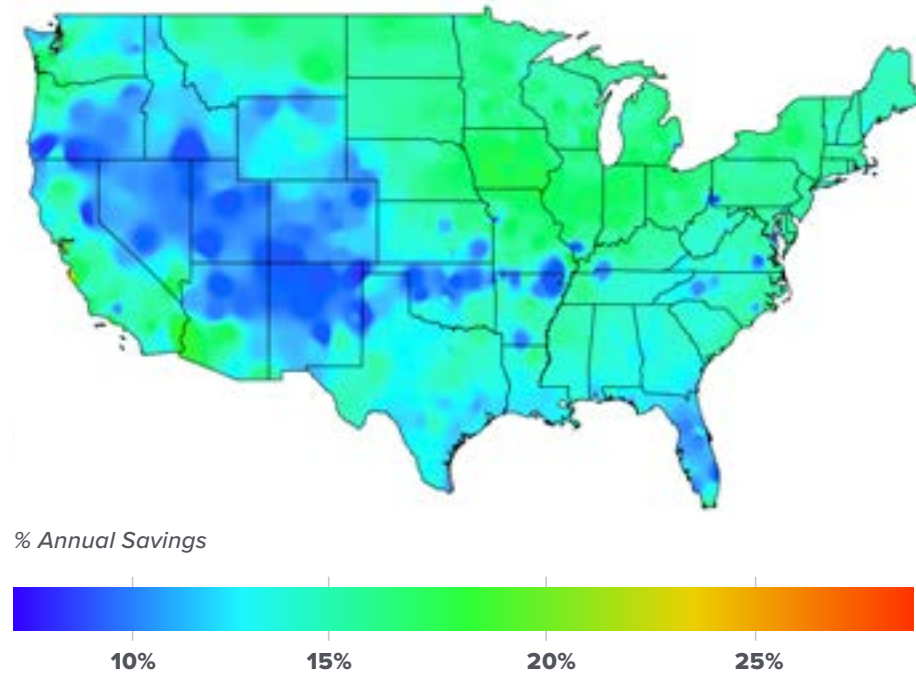
28% ■ **12.6%**
33% ■ Total Building Energy Savings

RESULTS | SECONDARY SCHOOLS, NEW CONSTRUCTION

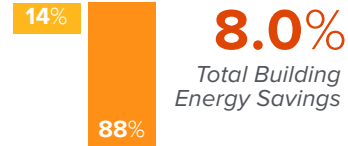


HIGHLIGHTS | SECONDARY SCHOOLS, NEW CONSTRUCTION

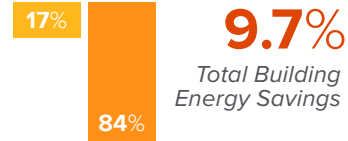
ANNUAL SAVINGS BY CLIMATE ZONE



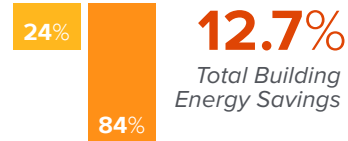
ZONE 1A
Honolulu, HI



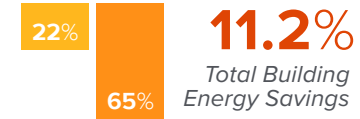
ZONE 2A
Tampa, FL



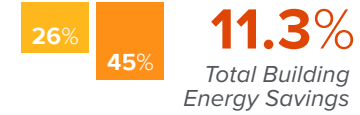
ZONE 2B
Tucson, AZ



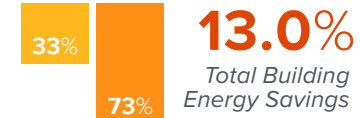
ZONE 3A
Atlanta, GA



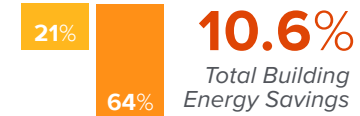
ZONE 3B
El Paso, TX



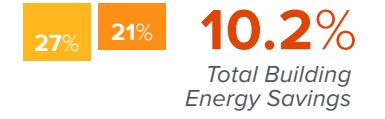
ZONE 3C
San Diego, CA



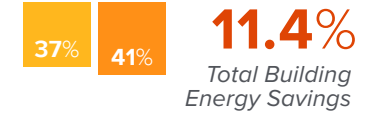
ZONE 4A
New York, NY



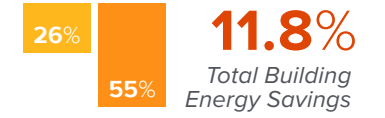
ZONE 4B
Albuquerque, NM



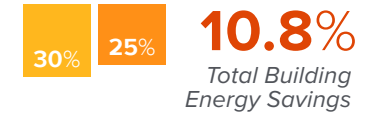
ZONE 4C
Seattle, WA



ZONE 5A
Buffalo, NY



ZONE 5B
Denver, CO



■ HVAC Electricity EUI Savings ■ HVAC Natural Gas EUI Savings

CONCLUSION

This analysis shows significant savings from combined applications Smart VAV With Reheat, Dynamic Chill Water Balancing, and Outside Air Optimization sequences in secondary education facilities, particularly in the midwest and eastern half of the U.S. for retrofit projects and the northern edge of the country for new construction. Retrofit secondary schools have the potential for greatest efficiency improvements

in this report with savings of up to 17% total building energy use in representative cities, though new construction buildings are a close second at 13%. While these high savings are typically located in the eastern and northern portions of the U.S., data in other areas of the country, such as the Rocky Mountains area, still hover between 10% and 12% savings in both vintages.