ENERGY SAVINGS
WHITEPAPER

An analysis of the unique 75F IoT Building Management System in U.S. small offices, 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. small offices, both retrofit and new construction. Studied 75F applications include Dynamic Airflow Balancing and Outside Air Optimization (OAO).

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 **23%** in retrofit small offices
- **Total building** energy savings of up to **26%** for new construction small offices
- Energy savings potential is **even across the U.S.**, with the **central and southwestern** 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 offices 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.

SMALL OFFICES

Small office building energy consumption is based on a one-story building with 5,500 square feet, an air-source heat pump for cooling and an air-source heat pump with gas furnace as backup for heating. Distribution and terminal units include single-zone, constant air volume air distribution, with one unit per occupied thermal zone.

RESULTS | **Small Offices, Retrofit**

RESULTS | **Small Offices, New Construction**

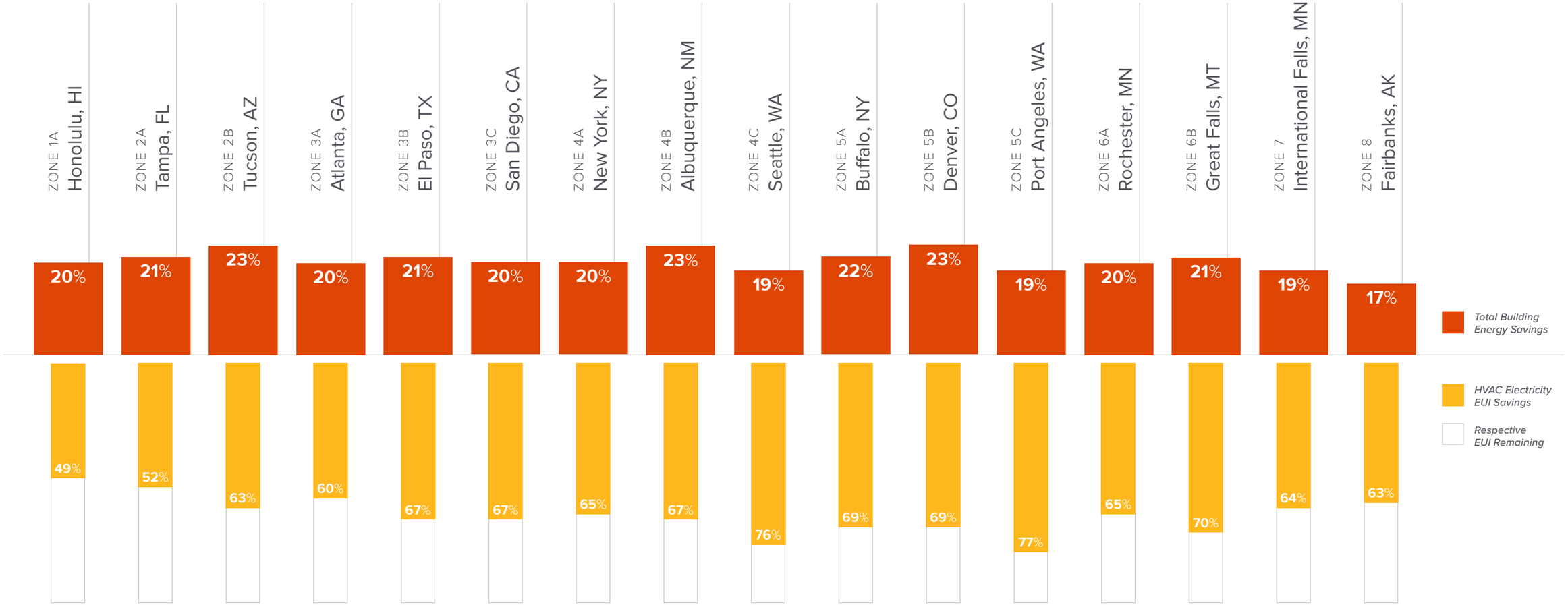
75F® Dynamic Airflow Balancing™

75F® Dynamic Airflow Balancing™ is a proactive zone control system that remotely monitors and controls conditions in individual spaces for superior comfort and efficiency. Predictive machine learning algorithms optimize heating and cooling capacity by redirecting conditioned air to the spaces that need it most, a strategy that multiple third-party, independent tests like the NREL study prove can lower utility cost significantly. Beyond efficiency, the Dynamic Airflow Balancing design is fine grained, so every space gets its own individual temperature control. With these tools, building engineers who implement 75F's Dynamic Airflow Balancing technology can expect vastly improved energy efficiency, occupant comfort, and productivity. These advantages are accessible to a wide variety of commercial buildings thanks to a full-stack solution that works out of the box, scalability across a range of central plant equipment and site footprins, and intuitive and user-friendly tuners like zone prioritization for hassle-free operation. 75F Dynamic Airflow Balancing is ideally suited for multizone airhandling units and packaged rooftop units where zone reheat is not available.

75F® Outside Air Optimization™

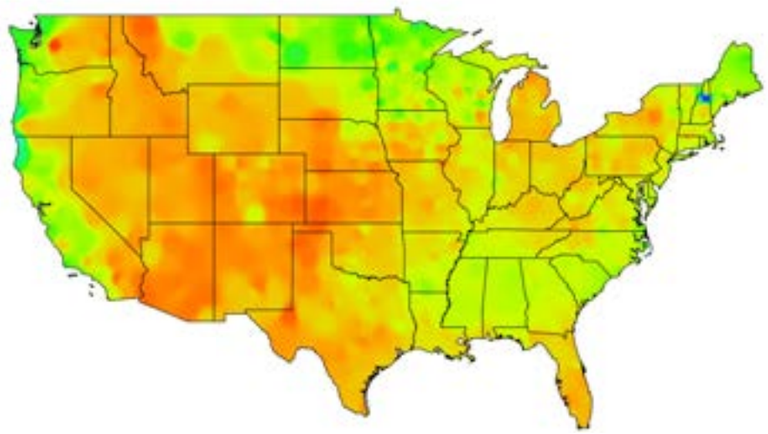
75F® Outside Air Optimization™ (OAO) is an application that combines hardware, software, and real-time weather data providing advanced sequences of operation from rooftop economizers to built-up air handlers in a wide range of commercial buildings. While OAO's three primary benefits are improved efficiency, 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 required ventilation of outdoor air leveraging additional sensors and optimized setpoints, and provides comparative enthalpy free cooling.
- **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.



*In this application, natural gas EUI increases due to cost efficiency over electricity.

ANNUAL SAVINGS BY CLIMATE ZONE



% Annual Savings

12% 16% 20%

HVAC Electricity EUI Savings

ZONE 1A
Honolulu, HI
49%
20.3% *Total Building Energy Savings*

ZONE 2A
Tampa, FL
52%
20.6% *Total Building Energy Savings*

ZONE 2B
Tucson, AZ
63%
22.5% *Total Building Energy Savings*

ZONE 3A
Atlanta, GA
60%
19.5% *Total Building Energy Savings*

ZONE 3B
El Paso, TX
67%
21.0% *Total Building Energy Savings*

ZONE 3C
San Diego, CA
67%
19.6% *Total Building Energy Savings*

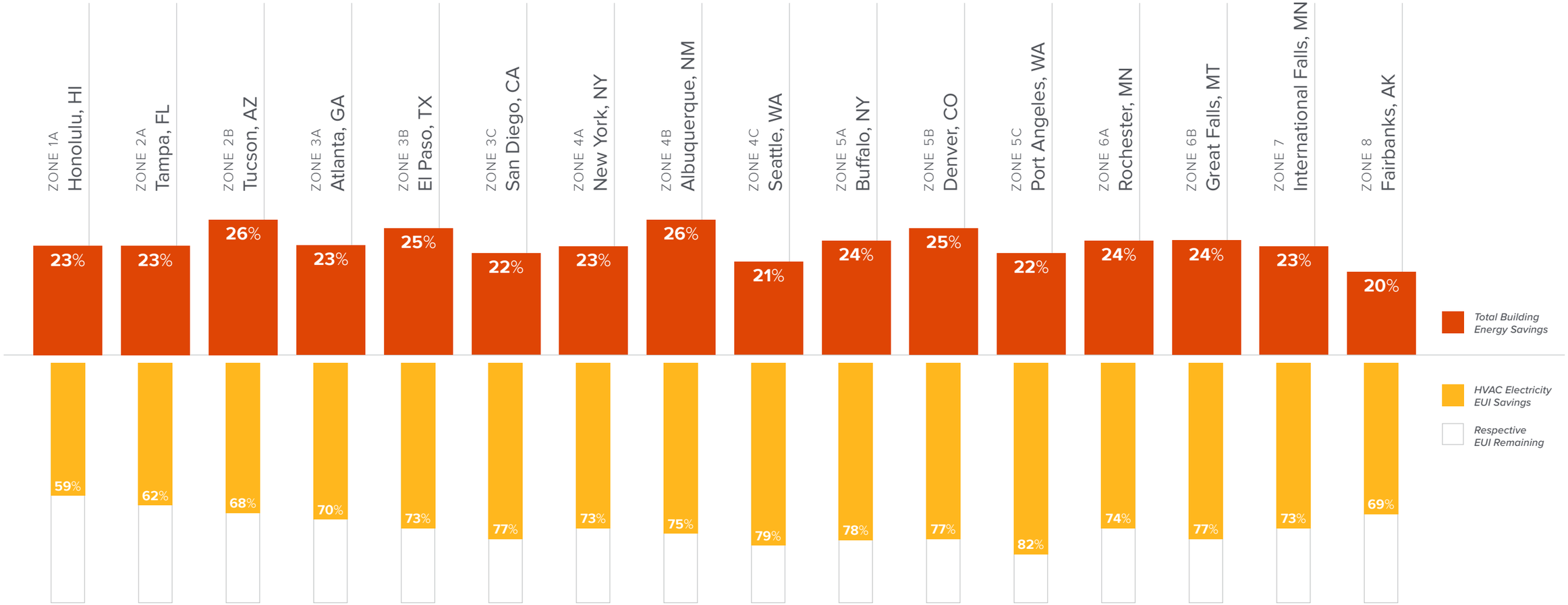
ZONE 4A
New York, NY
65%
20.1% *Total Building Energy Savings*

ZONE 4B
Albuquerque, NM
67%
22.6% *Total Building Energy Savings*

ZONE 4C
Seatlle, WA
76%
19.4% *Total Building Energy Savings*

ZONE 5A
Buffalo, NY
69%
21.7% *Total Building Energy Savings*

ZONE 5B
Denver, CO
69%
22.8% *Total Building Energy Savings*



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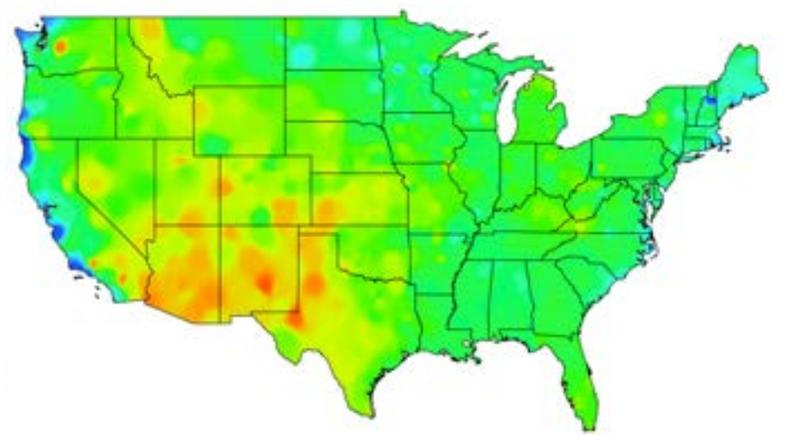
ANNUAL SAVINGS BY CLIMATE ZONE



HVAC Electricity EUI Savings

ZONE 1A
Honolulu, HI
59%
22.6% *Total Building Energy Savings*

ZONE 2A
Tampa, FL
62%
22.9% *Total Building Energy Savings*

ZONE 2B
Tucson, AZ
68%
25.8% *Total Building Energy Savings*

ZONE 3A
Atlanta, GA
70%
23.2% *Total Building Energy Savings*

ZONE 3B
El Paso, TX
73%
25.5% *Total Building Energy Savings*

ZONE 3C
San Diego, CA
77%
21.7% *Total Building Energy Savings*

ZONE 4A
New York, NY
73%
23.0% *Total Building Energy Savings*

ZONE 4B
Albuquerque, NM
75%
26.0% *Total Building Energy Savings*

ZONE 4C
Seatlle, WA
79%
20.7% *Total Building Energy Savings*

ZONE 5A
Buffalo, NY
78%
24.5% *Total Building Energy Savings*

ZONE 5B
Denver, CO
77%
25.5% *Total Building Energy Savings*

CONCLUSION

This analysis shows significant savings from combined applications Dynamic Airflow Balancing and Outside Air Optimization sequences in small offices, particularly in the central and western portions of the U.S. for retrofit projects and the southwest of the U.S. for new construction. New construction large offices have the potential for greatest efficiency improvements in this report with savings of up to 26% total building energy use in representative cities, though retrofit buildings are a close second at 23%. While the highest savings are typically located in the midwest and southwestern portions of the U.S., no particular climate zone demonstrates total building savings below an 18% range in new build scenarios and a 12% range for retrofits. Most circumstances lead to overall savings between 19% and 23%.

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