JOSH PARTEE

Redesigning Past for Future: Electrification and DOAS for Resiliency and Efficiency

The 2020–2022 renovation of the 1910 Portland Galleria building achieved LEED Platinum certification and presented a prime opportunity for Unico Properties to implement a decarbonization investment.

By Henry Odum, Associate Member ASHRAE; Shawn Oram, Associate Member ASHRAE.

Henry Odum is director of design & engineering for Ecotope in Seattle, Washington. Shawn Oram is principal of design and engineering for Ecotope in Seattle.

The project incorporates four stories of offices over ground floor retail as a tale of two parts. First is core & shell (C&S) renovation, focusing on historic preservation, embodied carbon savings and deep green energy conservation via elimination of fossil-gas and decentralized HVAC design. Second is a tenant improvement (TI) project to transform the 3,716 m^2 (40,000 ft^2) top floor into an example of an adaptable and resilient office space through dedicated outdoor air systems (DOAS) and advanced central controls.

ENERGY EFFICIENCY

For 2023, the billed electrical energy consumption for the entire building resulted in an EUI of just 26.3 kBtu/ft^2·yr (298.7 MJ/m^2 ·yr), which is 51% below the ASHRAE Standard 90.1-2016 baseline.

System measures include very high efficiency dedicated outdoor air systems (VHE-DOAS), variable refrigerant flow (VRF) heat pumps, added roof insulation, window inserts (existing single-pane windows protected by the National Register of Historic Places), LED lighting upgrades and heat pump water heating. These strategies were incorporated into a holistic approach to system integration, control and layout—by allowing systems to respond directly to occupancy via downsized ventilation fans with CO_2 controls and zonal fan coils to cycle on call from local thermostats with a broadened dead band.

INNOVATION

The first challenge in the C&S phase was to accommodate the existing retail tenant as they reduced their footprint from two floors to one while keeping the store running. This led to a decentralized HVAC approach that bisected two existing common shafts to provide 100% outdoor air supply and the incorporation of exhaust paths for each floor to provide Standard 62.1-2016 ventilation rates for office and retail occupancies. Four VHE-DOAS units with sensible heat recovery efficiencies over 85% were provided on each floor and set up to run on dedicated schedules.

The top floor TI uses central BMS controls and electronically commutated motors on the DOAS units to allow the office HVAC system to run in three different operating modes: *passive, active and IAQ*.

Passive mode is enabled when outdoor temperatures are moderate, 17.8°C–22°C (64°F–72°F), which occurs during 25% of annual occupied office hours in Portland. Comfort cooling and ventilation needs are met by natural ventilation as occupants open operable windows. Perimeter VRF zones use expanded dead band setpoints to allow heat/cool systems to remain off during these periods.

Active mode occurs when outdoor

temperatures are outside of the passive mode dead band. Operable windows are closed, VRF heat pumps operate to meet user-adjusted setpoints and DOAS systems operate in traditional demand-controlled ventilation schemes.

As shown in *Figure 1*, between the outdoor temperatures of 12.7°C–22°C (55°F–72°F), the building's HVAC systems are able to lower their energy use.

IAQ mode is an innovative control method for VHE-DOAS systems, targeted to provide a safe, resilient indoor environment for employees during the Pacific Northwest's recurring wildfire seasons. The outdoor weather station monitors $PM_{2.5}$ levels (a measure of wildfire smoke particulates) and the central BMS system triggers on booster fans to divert outdoor air through HEPA filters upstream of the DOAS units. The BMS system will alarm if any operable windows are open; meanwhile, the DOAS supply fan speeds are increased to positively pressurize the office to mitigate uncontrolled infiltration through the envelope.

INDOOR AIR QUALITY

The architectural firm kept a sharp focus on human-centered performance by creating a healthy, comfortable workplace to encourage employees to return. Pursuing WELL certification, nine indoor air quality (IAQ) sensors were installed, and a rooftop weather station was added to continuously monitor and report on key air quality parameters ($PM_{2.5}$, CO_2, VOCs, relative humidity and temperature).

Ongoing measurement and verification (M&V) data provided by the office's IAQ sensors has demonstrated the effectiveness of *IAQ mode*, keeping indoor $PM_{2.5}$ concentration levels below the World Health Organizations' human health limit of 5 µg/m^3. Portland's outdoor $PM_{2.5}$ readings exceeded 15 µg/m^3 several times in the summer of 2023, showing an 85% reduction of hazardous particulate pollution for the occupants.

COST EFFECTIVENESS

The C&S project secured a $500,000 grant, which was roughly 20% of the HVAC budget to support the renovation. Cost effectiveness of measures per the Energy Trust of Oregon (ETO) program were based off energy savings from a Standard 90.1-2016 baseline energy model. Utility cost savings of the operational EUI compared to the baseline energy model is roughly $150,000/year, which results in a simple payback of 17 years for the C&S HVAC measures.

As part of the study, the engineering firm analyzed the potential VRF equipment cost savings by pursuing a range of envelope performance measures. The top floor, with an uninsulated, high thermal mass roof, was calculated to require roughly 190 tons (668 kW) of cooling capacity. Load reduction calculations showed that installing R-20 above-deck roof insulation could allow that capacity to drop to 100 tons (352 kW), saving over $600,000 in VRF equipment costs and the required refrigerant charge of the system substantially.

In using a distributed HVAC system, Unico is able to save over $3,500/month per floor in HVAC utility costs alone, as tenant turnover occurs between leases. This continued operational savings from the C&S system design provides payback beyond the initial costs savings analysis of the renovation budgeting.

ENVIRONMENTAL IMPACT

By restoring this historic building, the embodied carbon savings for the project exceed 2,050 kgCO_2e/m^2. Energy efficiency through envelope measures, decoupled HVAC design using DOAS and heat pumps for space heating is paramount when decarbonizing existing building stock to reserve hydroelectric capacity in the Pacific Northwest's electric grid. ■

FIGURE 1 Temperature dependence on metered HVAC system energy consumption between active and passive modes.