betterbricks/

HVAC CASE STUDY

Portland Firm Engineers Thermal Comfort and HVAC Efficiency

Energy 350 turns up air quality and comfort with high-performance HVAC approach.

Originally built as a warehouse in 1943, the 11 Main Building in Portland, Oregon, was converted into an office space in 2014. Though its existing HVAC system was functional, its deficiencies created an uncomfortable indoor environment with occasionally poor indoor air quality. An energy engineering firm, Energy 350, occupies a large portion of the building's main floor along with second story space that includes a mezzanine and two private offices – 7,569 sq. ft. in total. Several months into the Covid-19 pandemic in summer 2020, Energy 350 management began to consider how they could provide the safest, healthiest and most comfortable indoor environment for employees who wanted to return to the office.

After considering a variety of HVAC system types, Energy 350 determined that a cutting-edge approach called very high efficiency dedicated outdoor air systems, or very high efficiency DOAS, would be the most advantageous upgrade. With very high efficiency DOAS, Energy 350 found a way to improve their building's safety and comfort, while also helping reduce their overall energy use and carbon emissions.

> "Before this project, our thermal comfort and ventilation were limited. We had no reliable control of our building's air changes, and thermal comfort was difficult to achieve universally due to our single-zone systems."
>
> *— Josh Weissert, Principal Engineer, Energy 350*

Project Overview

Building Type
Office

Project Floor Area
7,569 sq. ft.

Energy Utility/Program
Portland General Electric

Total Project Cost
$13.94 per sq. ft.[1]

Annual Reduction in GHG Emissions
59%

Reduction in Total Buildilng Energy Use
79%[2]

> **“This project increased confidence in our building safety with added air changes and controllability and improved occupant comfort by adding several zones. I’m most impressed at how much system capacity we were able to remove and still maintain comfort through a few unprecedented weather events.”**
>
> *— Josh Weissert, Principal Engineer, Energy 350*

Energy 350 embraces HVAC design pinnacle.

Very high efficiency DOAS is a high performance approach to HVAC that combines high-efficiency equipment with design best practices, including:

1/ Using an electric heat pump system that meets ENERGY STAR® performance

2/ Pairing the heating and cooling with a high-efficiency heat or energy recovery ventilator (HRV/ERV)

3/ Right-sizing the heating and cooling equipment

4/ Decoupling the HRV/ERV from the heating and cooling

Representing the next step in the ongoing evolution of HVAC design, this approach provides better temperature control and excellent indoor air quality for Energy 350’s employees, while reducing the building’s HVAC energy use by 84%, when compared to the pre-existing system.

With a variety of high-efficiency electric heating and cooling equipment options on the market, Energy 350’s engineers were afforded a great deal of flexibility when designing to their specific HVAC needs. And their high-efficiency HRV improved the system’s efficiency so much that they were able to downsize their primary cooling system from 20 tons to 10 tons – while still maintaining comfortable conditions in even the hottest weather.

All in all, the Energy 350 team’s upgraded approach to HVAC design benefits their employees and building management by providing:

- **Better indoor air quality** due to filtered 100% outside air being brought into the space at a higher ventilation rate – without the increase in the energy usage typically incurred by systems with similar ventilation rates
- **Increased occupant comfort** from significantly better zonal temperature control and thermal stability
- **Improved occupant productivity** by improving indoor air quality and comfort
- **Lower energy bills**

CONVERSION SUMMARY

Pre-Existing HVAC system:	2x 8.5-ton Carrier packaged rooftop units
New HVAC system:	1x 10-ton LG Multi V5 variable refrigerant flow (VRF) air-source heat pump with 7x ductless indoor units 2x Ventacity VS1000RTh HRVs

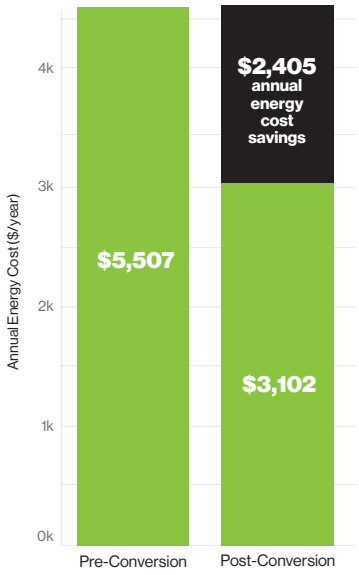
reduction in total HVAC energy use[2]

reduction in building energy use[2]

Healthy air means safety and peace of mind.

Since the installation in early 2021, the building occupants have been very satisfied with the increased zonal control of temperature and the improved indoor air quality – and the data backs up their experience. CO_2 and temperature data collected over 12 months demonstrate that the building's thermal comfort and indoor air quality are excellent, and the equipment has been operating reliably and efficiently since installation.

The CO_2 data shows that the office maintains levels consistently at or below 800 ppm, indicating that the new equipment is providing effective ventilation rates, and therefore may reduce harmful contaminant levels.[3] The system's avoidance of recirculated air helps to minimize the circulation and introduction of contaminated particles – an important way to minimize the spread of viruses like Covid-19 and other toxins inside the building. However, unlike competing high-ventilation HVAC systems, this approach does not increase energy costs despite providing 100% filtered outside air.



Results

Energy 350's employees were never more satisfied with the performance of the very high efficiency DOAS approach than during an unprecedented heat wave when outside air temperatures reached 112 F. Despite the record-breaking temperatures, very high efficiency DOAS kept the office within 2 degrees of the 75 F temperature setpoint – even though the system's cooling capacity had been reduced to 10 tons from 20 tons during the conversion. In addition to the cost savings and improved comfort, the project resulted in an 18 metric tons (59%) reduction in greenhouse gas emissions (GHG) annually[4]. Now almost one year after the conversion, the Energy 350 team remains very pleased with their HVAC system and confident that it will keep their building safe, healthy and comfortable.

> "Incredibly, our office stayed quite comfortable during the two hottest days in Portland's history. The temperature at most of the workstations was around 75–77 degrees, even though it was 112 degrees outside. Our new system helps us feel comfortable and healthy in pretty much any situation."
>
> *— Ola Miles, Office Manager, Energy 350*

[1] The project costs may be lower than typical due to Energy 350 performing much of the mechanical engineering design.

[2] Compared to a pre-conversion system with code-minimum equipment (gas-packaged rooftop units).

[3] According to ASHRAE 62.1 Addendum D, a ventilation rate of 15 cfm per person will result in a steady-state CO2 concentration of 700 ppm above outdoor levels (roughly 1100 ppm totals, as outdoor CO2 levels tend to be a little above 400 ppm). This level has been found to keep a substantial majority (80%) of people in a space satisfied with respect to body odor. However, CO2 alone is not a good indicator of IAQ.

[4] Reported GHG emissions reduction is based on the following assumptions: 1) 11.7 pounds of CO2 per therm of natural gas saved, 2) 0.91 pounds of CO2 per kWh avoided (Northwest Power and Conservation Council's latest report from 2018 on avoided CO2 rates in the Northwest). This HVAC conversion project is estimated to save 4,005 therms of natural gas and increase site electricity usage by 8,242 kWh annually resulting in an annual reduction of 39,361 lbs CO2. The EPA reported national average avoided electricity emissions rate is 1.56 lbs/kWh, so projects outside of the Northwest may have significantly different GHG reductions.

betterbricks/

To learn more about this and other efficient commercial HVAC solutions, visit BetterBricks at **betterbricks.com/solutions/hvac**.