PASSIVE HOUSE ALLIANCE UNITED STATES

Glasswood Commercial PH Retrofit

Location:	Portland, OR
Climate Zone:	4
Size:	1,400 sq. ft.
Levels	Upper & adiabatic layer separating from Lower
Construction:	Commercial
Walls:	R-33 assembly. 2x4 service cavity, existing 2x4 wall cavity filled with high density cellulose, wrapped with 2” EPS foam, exterior gypsum, WRB, rain screen
Roof:	R-45 water-blown LDSPF with interior OSB air-tightness layer.
Floors	Adiabatic layer separates Passive House office space from restaurant below. Thermally connected, but air-sealed.
Mechanicals:	Zehnder 550 Confoair HRV controlled by on-demand CO2 sensor. Ductless minisplit. Heat pump water heater.
Windows:	Cascadia triple pane windows with insulated fiberglass frames and high solar heat gain.
Total Cost:	N/A
PH Upgrades:	$15/sq ft over standard
Savings/Yr.:	N/A
LifeCycle:	5 Year ReCoup

Overview:

Glasswood serves as a case study of the role Passive House can play in transforming the energy efficiency, occupant experience, and marketability of existing commercial spaces, all at affordable cost. Embedded in a walkable, transit-rich neighborhood, the project revolutionizes the performance of a 1916 building while contributing to the vitality of its urban surroundings. Designed by Scott | Edwards Architecture and built by Hammer & Hand, the project is the first Passive House commercial retrofit in the US.

Design Challenges:

How do we, in the 21st century, approach the renovation of historic but in-efficient buildings? The fuel burned to operate them speeds global climate change, but bull-dozing and rebuilding on any significant scale is not an option – too much architectural heritage and embodied energy wasted. The primary challenge at Glass-wood became how to transform the performance of the structure while preserving its architecture. The secondary challenge was how to retrofit to the Passive House standard on a building with an inherently energy-intensive commercial kitchen.

Project Website: http://hammerandhand.com/glasswood-passive-house-retrofit

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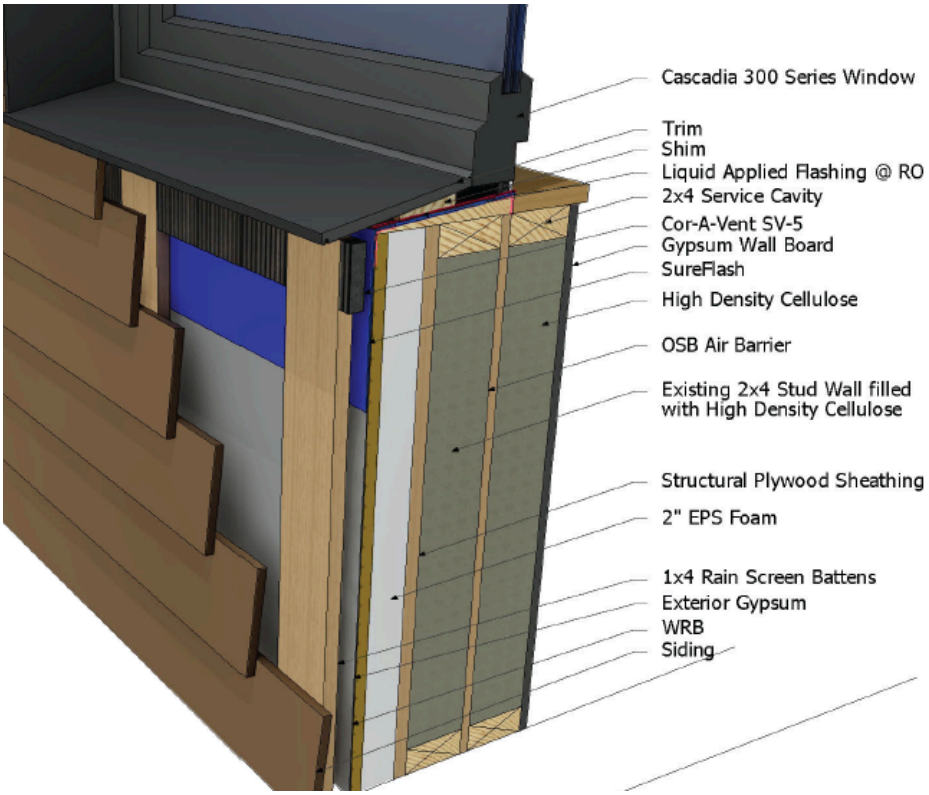
Design Solutions: Site

Given the challenge of incorporating a commercial kitchen into a Passive House structure, the critical site solution at the Glasswood retrofit is the adiabatic layer that separates the Passive House office space on the upper floor from the high-performance-but-not-Passive-House restaurant below. (Due to the intensive energy use and air change requirements of commercial kitchens, restaurants are usually not suitable for Passive House certification.) By treating the space between the office and restaurant as a partition wall, we isolated the office as its own self-contained unit. While thermally connected with the restaurant below, everything else about the building systems in the office is 100% separated, including air sealing, ventilation, heating and cooling, and domestic hot water. The adiabatic layer made Passive House possible for this structure.

Design Solutions – Envelope

In constructing the project's high performance envelope we maintained the shell's existing 2x4 wood framing and added layers inside and out. As part of the project's seismic retrofit we installed new structural exterior sheathing and taped all seams with vapor-permeable tape to create a wind-tightness layer. Working outwards from this sheath-ing, we layered on continuous EPS insulation followed by a layer each of Densglas, 30-minute paper, rain-screen and new cladding. Working inwards from the exterior sheathing, we filled the existing wall cavity with cellulose insulation, and then added a new layer of OSB with taped seams to create the air barrier. After confirming appropriate air-tightness with a blower door fan test, we installed a framed service cavity layer, insulated it with cellulose, and finished with layer of interior gypsum. In assembly the wall is R-33. The roof is an R-45 water-blown low density spray polyurethane (LDSPF) roof system with a sealed interior OSB air tightness layer.

The project employs high performance windows with insulated fiberglass frames and high solar heat gain, triple-pane glazing. We installed each window using liquid applied flashings. To create seamless air and water tightness, this liquid applied barrier goes into all penetrations and rough openings in the building envelope.



"The Glasswood project is not just about revolutionizing energy efficiency. It's about revolutionizing the experience of working inside,"

Sam Hagerman
co-owner Hammer & Hand

MEP Systems:

The MEP System at Glasswood is one of the simplest components of the project. The office is ventilated using a Zehnder 550 Comfoair, controlled by a carbon dioxide sensor that modulates the ventilation rate depending on occupancy. The project takes advantage of night flushing through the HRV for passive cooling (bypassing the heat recovery core).

Domestic hot water for the lavatory and kitchenette is provided by the heat pump hot water heater, programmed to run after-hours. As mentioned above, during summer months this unit partially offsets the space's cooling load by pulling heat from the interior air. During winter months the unit can be switched over to electric resistance heat to avoid cooling the space. Heating and cooling is provided by one ductless mini-split.

Enjoying the Design:

Glasswood is an airy, quiet, comfortable, fresh-air-infused space. An open floor plan coupled with a carefully planned daylighting scheme allows natural light to fill the office, even on grey Portland days. Although the structure overlooks busy Division Street in southeast Portland, the project's high performance windows and advanced building envelope shield the interior space from noise outside. And the freshness of interior air is palpable, exposing how accustomed we've become to conventional interior spaces that are stale and oxygen-poor. The space is a great place to be and work, and while we don't have numbers to prove it, there's no doubt that productivity is getting a major boost.

"The Glasswood project is not just about revolutionizing energy efficiency. It's about revolutionizing the experience of working inside," said Sam Hagerman, co-owner of Hammer & Hand and certified Passive House consultant for the project. "Passive House brings unprecedented levels of thermal comfort and indoor air quality – no drafts, lots of clean, fresh air.

Lessons Learned:

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While it is basically a given in Passive House construction, this project reminded us how effective it is to use structural sheathing as the air barrier and protect it behind a service cavity to prevent penetrations. We also felt lucky to have installed circuit-by-circuit monitoring in the office to help control plug loads. Though we didn't fully appreciate its importance at the beginning of the project, this approach has given us the detail necessary to zero-in on specific plug loads and manage office equipment energy consumption more effectively: vital in plug-load dominated office environments. On the comfort front, we have found that low-wattage portable desk fans can be an excellent way to accommodate a wide range of comfort requirements by building occupants.

In retrospect, we would have added motorized exterior shading with adjustable louvers for solar control. In the shoulder months solar heat gain is a bit higher than we'd like when coupled with the internal gains from office equipment and occupants.

Additional shading control would also allow occupants to manage glare on computer screens when necessary. During the heating season the temperatures are even across the building, but the space would benefit from additional mixing of cooling air provided by the single ductless mini-split head during the summer months. Installing an additional ductless head or using a fully ducted mini-split would provide tighter temperature control during the cooling season.

Finally, while the occupancy sensors in our lighting system work great, the photo cells for controlling the intensity of light – a central part of our daylighting scheme – have proven to be a challenge to fine tune and commission.

Cost benefit analysis

The upstairs Passive House portion of the project cost just $15 more per square foot than a conventional, built-to-code retrofit. Because it is a "buy and hold" project, this upfront investment promises to pay lasting dividends to the owner in the form of lower bills, higher rents, better marketability, and lower vacancy rate thanks to happier tenants. The utility savings alone will payoff the added construction cost within five years.

THE TEAM

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