Hitting the Performance BULL’S-EYE
With Measurement and Verification

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The Helen Sommers Building’s design honors tradition and history while expressing important values of its own time: openness and accessibility, performance and value, and environmental stewardship.

In March 2014, the State of Washington’s Department of Enterprise Services awarded the design-build team of ZGF Architects and Sellen Construction the contract for the new 225,000 square foot Helen Sommers Building in Olympia, Wash. While the $85.7 million project provides a beautiful, modern, collaborative workplace, its exceptional energy performance places it among the best high-performance buildings in the U.S.
It is the result of a guaranteed performance-oriented contract—a first for the State of Washington and an emerging industry trend—which withheld a portion of the contract funds and disbursed the funds over a five-year performance verification period.

The project was inspired by local U.S. government projects, namely Federal Center South (see HPB Magazine Fall 2014 issue) and driven by a need to create a new space for the Washington State Patrol, Legislative Agencies, Office of the State Treasurer, and the Office of Financial Management out of the existing Block 1063 building. The State of Washington used a tight timeline demanded by the appropriated funding.

Three teams participated in the four-month design-build competition, in which proposals were developed to a schematic design level to express design intent but also assessed cost, schedule and performance criteria. The selection process put a 30% weighting on the operations, maintenance, energy performance and

### BUILDING AT A GLANCE

- **Name**: Helen Sommers Building (1063 Block)
- **Location**: Olympia, Wash.
- **Owner**: State of Washington
- **Principal Use**: Governmental Office Building
- **Employees/Occupants**: 600
- **Expected (Design) Occupancy**: 780
- **Percent Occupied**: 77%
- **Gross Square Footage**: 225,000
- **Conditioned Space**: 215,000
- **Distinctions/Awards**: LEED Platinum

### FOR NEW CONSTRUCTION

- **Total Cost**: $85.7 million
- **Substantial Completion/Occupancy**: 2017

### KEY SUSTAINABLE FEATURES

- **Water Conservation**: Over 45% water savings against the baseline primarily through the use of low flow fixtures. The ground loop heat exchanger helps reduce cooling tower water consumption in the summer.
- **Daylighting**: Thinner floor plates and a central atrium enable ample daylight harvesting while advanced daylighting sensors and lighting controls allow for reduced lighting energy.
- **Individual Controls**: Operable windows coupled with an air-conditioning system that promotes the use of the windows by reducing heating and cooling in the zone during mild times of the year.
- **Carbon Reduction Strategies**: Ground loop, heat recovery chillers, heat recovery ventilators, 135 kW PV array

### OTHER MAJOR SUSTAINABLE FEATURES

- **Five-year performance guarantee on equipment as well as energy ensures that the building is continuously tuned**

### BUILDING TEAM

- **Building Owner/Representative**: Washington State Department of Enterprise Services
- **Architect**: ZGF Architects
- **General Contractor**: Sellen Construction
- **Mechanical Engineer**: WSP
- **Electrical Engineer**: Gerber Engineering
- **Energy Modeler**: WSP
- **Structural Engineer**: KPFF
- **Civil Engineer**: KPFF
- **Landscape Architect**: SiteWorkshop
- **Lighting Design**: Sydney Genette
- **LEED Consultant**: Sellen Construction
- **Commissioning Agent**: EEI

### ENERGY AT A GLANCE

- **Annual Energy Use Intensity (EUI) (Site)**: 25.24 kBtu/ft²
- **Electricity (Grid Purchase)**: 19.93 kBtu/ft²
- **Electricity (On-Site Solar or Wind Installation)**: 2.55 kBtu/ft²
- **Natural Gas**: 2.55 kBtu/ft²
- **Annual On-Site Renewable Energy Exported**: 0 kBtu/ft²
- **Annual Net Energy Use Intensity**: 22.69 kBtu/ft²
- **Annual Source (Primary) Energy**: 68.0 kBtu/ft²
- **Annual Energy Cost Index (ECI)**: $1.59/ft²
- **Annual Load Factor**: 35%
- **Savings vs. Standard 90.1-2007 Design Building**: 44.6%
- **Energy Star Rating**: 100
- **Carbon Footprint**: 0.14 lb CO₂e/ft²·yr
- **Power Represented by Renewable Energy Certificates**: 35%
- **Years Contracted to Purchase RECs**: 2 years
- **Percentage of Carbon Deferred by Purchasing Offsets**: 35%
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- **Heating Degree Days (Base 65°F)**: 5,655
- **Cooling Degree Days (Base 65°F)**: 1,558
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### WATER AT A GLANCE

- **Annual Water Use**: Unavailable

### BUILDING ENVELOPE

- **Roof**: Insulation above deck
  - **Overall R-value**: R-20
  - **Reflectivity**: 0.30
- **Walls**: Steel framed
  - **Overall R-value**: R-13 + R-7.5 CI, U-0.064
  - **Glazing Percentage**: 47%
- **Basement/Foundation**: Slab Edge Insulation R-value NA
- **Basement Wall Insulation R-value**: U-0.03
- **Windows**: Effective U-factor for Assembly: 0.34
- **Solar Heat Gain Coefficient (SHGC)**: 0.39
- **Visual Transmittance**: 70%
- **Location**: Latitude 47 N
The State of Washington specified a set of holistic sustainability performance criteria, including LEED Gold certification and support of the local state economy—for every dollar invested in the project, 75 cents would go back to Washington companies and workers. The project ultimately reached LEED Platinum and 88 cents for every dollar invested, totaling $68 million supporting the Washington state economy. The guaranteed energy performance target was set as part of the competition at an energy use intensity (EUI) of 30.1 kBtu/ft²-year before renewables and 28 kBtu/ft²-year once renewable energy generation was applied, placing it in the top 1% of office buildings. The final design achieved an EUI of 25.24 kBtu/ft²-year. Could the building maintain the target for five years straight?

It was a challenge in the four-month competition phase to develop a schematic design proposal that could meet the guaranteed budget and energy performance criteria, while developing a thoughtful design that could be clearly communicated and adequately express the complexity and unique user experience of the building.

Pushing the Design Envelope

Today, the Helen Sommers Building represents a new paradigm for civic workplaces by fostering flexibility and transparency in an open office environment. Located on the State of Washington’s Capitol Campus, the design provides daylit workspaces anchored by shared conference and open-meeting areas, bringing together multiple State agencies under one roof, in an active, collaborative environment.

The design acknowledges the prominence of the gateway site—between the historic State Capitol Campus and downtown Olympia—the history of ingenuity in Washington, and openness of government. The exterior is a modern reflection of the strong civic form of the Capitol Campus in proportion, color, and texture. Abundant glass elements integrated into the curtainwall, canopies, and sunshades contribute to the openness and transparency of the façade. The adjacent Olmsted Lawn carries a visual connection from the front porch and entrance of the building, through the central atrium and up to the public access roof terrace with views of Puget Sound and the Olympic Mountains.

### Sustainable Features

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<th>Feature</th>
<th>Description</th>
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<td>A 71% reduction in carbon dioxide equivalent emissions compared to the average office building. The impact of that is equal to removing 291 cars off the road for one year, or saving all electricity use in 204 homes for one year.</td>
<td>Concrete mixes used for the project reduced embodied greenhouse gas emissions compared to typical mix designs.</td>
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<td>Over 10% of the building’s energy comes from renewable solar power. This is equivalent to 166,447 kilowatt hours (kWh) per year—the same as reducing carbon dioxide emissions from 5,064 propane cylinders used for home BBQs, or enough energy to power 13 homes for one year.</td>
<td>Highly efficient LED lighting, controlled by daylight sensors, minimizes unnecessary energy use, saving carbon dioxide emissions equal to burning 141,988 pounds of coal each year. The energy saved from these LED fixtures is enough to power 19 homes for one year.</td>
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<td>A highly reflective roof, reducing the energy needed to cool the building.</td>
<td>75% of heating comes from heat recovery chillers and ground source heat exchangers that use geothermal energy from the earth. The system saves the equivalent greenhouse gas emissions of a vehicle traveling 318,082 miles per year.</td>
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<td>Operable windows and angled fins providing natural ventilation to the workspace.</td>
<td>Smart water systems that will save an estimated 828,310 gallons of water per year—enough to provide the water needs for a four-person household for 6.5 years.</td>
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<td>Expected to help the State avoid more than $100 million over the building’s lifetime compared to leasing space, according to 2015 life-cycle cost estimate by the Office of Financial Management.</td>
<td>Energy Star Rating: 100</td>
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<td>45.5% Potable Water Reduction</td>
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Figure 1 ENERGY CONSUMPTION, FIRST-YEAR OF OPERATION VS MODEL
One essential design challenge was balancing the needs of the individual tenants while enabling energy performance. To achieve the State’s ambitious performance goals, the design-build team worked closely with subcontractors to select sustainable materials—sourced locally where possible—reduce the carbon footprint by 71%, compared to the average office building, and incorporate renewable solar power.

The exterior building materials include precast concrete, brick veneer, and limestone cladding. The raw materials of concrete were available locally, which helped minimize transportation emissions, but the greater challenge was to reduce the emissions associated with the cement content during concrete production. By redesigning the concrete mixes for this project and producing Environmental Product Declarations (EPDs) to measure their environmental impact, the project team reduced the overall embodied carbon in concrete by 27%, compared to similar mixes in the Pacific Northwest.

The Helen Sommers Building was the first publicly-funded project in Washington that required EPD data for concrete mixes, providing a clear and quantifiable picture of the project’s embodied greenhouse reduction amounts. Optimizing the 12,024 cubic yards of concrete placed in this project saved 1,386 metric tons of greenhouse gases, compared to the national average of similar strength mixes. This is the equivalent of not driving 3.4 million car miles.

Sometimes when you’re focused on what, you only care if it works; you no longer know why you’re doing it. Despite the lofty energy goals and the restrictive contractual guarantees, the design team’s heart was always with the users.

Many HVAC professionals say a building is successful when 80% of the people are satisfied. What they’re really saying is, that if you put 100 people in a space with set conditions—DB temperature of 72°F, no wind, minimal humidity, minimal direct sun, etc.—that 80 of them will be satisfied. How do we please more of the people, more of the time? And
how can we do this cost effectively and in a manner that uses minimal energy?

The Helen Sommers design team looked at traditional systems, highly advanced “active energy saving” systems, or “occupant-enabled” systems (that could perform on their own but engaging occupants would amplify performance). A system that would allow for a range of temperatures ultimately dictated by the occupants.

After extensive energy modeling and comparisons of the various system attributes the design team found the best performance balance (good for the user and good for energy) in a system that decouples the ventilation air from the zone air conditioning. This solution merges a well understood and easy to maintain system with innovative controls that engage occupants in a thoughtful way.

The engine behind this HVAC system is “typical” of high performance buildings in the Pacific Northwest. A high efficiency central plant that included magnetic bearing chillers for cooling and a ground loop heat exchanger for heating. Unlike many high-performance buildings that size the groundloop for the full heating load, the energy modeling showed a point of diminishing returns and the team decided to optimally size (50 tons) the ground loop to manage the majority of the heating loads and rely on a backup boiler for supplemental heating during the coldest time of the year.

Performance vs. Performance Contracts

The design team was experienced with measurement and verification contracts as the bulk of the team had finished the Federal Center South building in 2012 and carefully measured and verified that building during its first year of operation. One key lessoned learned is to clearly define accountability at the start of the performance period. An energy model is only as good as the inputs, so the design team clearly communicated what was assumed in the model.

![Figure 3 CAMPUS AND COMMUNITY CONTEXT](image1)

![Figure 4 SHADING STRATEGY EFFECTIVENESS—EAST, WEST FAÇADES](image2)
and who was responsible for each pot of energy during operation. For instance, a tenant may operate seven days a week while an energy model (the basis for the contracted performance target) may assume a five-day workweek. Not only is it important to communicate these assumptions, the analysis included the potential impact of variations in the assumptions and means and methods for correcting any discrepancies. This allowed the owner, the operator and the design team to understand and agree to the most important operating factors that impact energy and the 30.1 kBtu/ft²-yr target.

Measuring the performance of the building started in November 2017. The first few months of M&V required coordination between the designers, builders, controls contractor and building operator—the M&V team—to ensure that the building was being properly measured and that the measured data could provide information on how the building was running and how it could be improved.

The M&V process was completed using the building analytics software that interfaces with the building management system (BMS) and serves as a remotely accessible energy dashboard. Individual BMS points from ground loop
temperatures to central plant mode engagement were trended and stored throughout the M&V period. Each quarter the data was collated, tracked and reported to the team so that adjustments could be made to tune the building.

During the first quarter of operation, the M&V team corrected the building’s HVAC systems (which were running outside of building operating hours), tweaked thermal comfort in select spaces, improved acoustics and identified glare issues. The team also identified opportunities for the Washington State Patrol to reduce plug loads by shutting computers off at night, and by managing the server’s 24/7 loads.

The performance agreement for the 1063 Block Replacement Helen Sommers building allowed for a maximum EUI of 30.1 kBtu/ft². During the first full year of occupancy from November 2017 through the end of October 2018 the building operated with an EUI of 25.24 kBtu/ft², exceeding expectations by 17%.
An additional 2.55 kBtu/ft² of energy was produced by the solar PV array, for a net EUI of 22.69 kBtu/ft².

The data shown here is for all end uses. Collectively, the building met the annual energy target set forth in the performance agreement.

The building consumed less energy than the model in every single month of occupancy, demonstrating robust operations under a wide range of internal and external conditions. The largest end uses for most months were the chillers, plug loads, IT loads, and fans.

The first few months of operation were characterized by low occupancy and thereby low internal gains (people, lighting, plugs) which created larger than expected boiler

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**Figure 8** HIGH PERFORMANCE DESIGN | MECHANICAL SYSTEM OPTIONS

1 BASELINE SYSTEM DESCRIPTION
Overhead VAV—In cooling, the central AHUs deliver more air to handle the cooling loads. In heating, VAV boxes in the zone heat the supply air as necessary.

2 ACTIVE ENERGY SAVER SYSTEM DESCRIPTION
DOAS Coupled with In-Zone Active Chilled Beams—DOAS AHU are located on the roof. The ventilation air travels through small ductwork to the office zones. In-zone active chilled beams provided radiant heating and cooling as required.

3 OCCUPANT-ENABLED SYSTEM DESCRIPTION
DOAS Coupled with Parallel Fan Powered Terminal Units—Fan-powered terminal units (FPTU) with heating and cooling coils at each zone provide additional space conditioning as required. When loads are low and outside air temperatures right, the FPTUs are turned off, and occupants rely on operable windows.

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**Figure 9** CENTRAL PLANT HEATING LOADS ANALYSIS

The total daily heating loads were analyzed to help size the GLHX and estimate the contribution of a thermal storage tank. It was found that:

- A 50 ton GLHX handles 67% of the annual heating load
- An 800 kWh thermal storage tank does 6% of the total heating load (a phase change material based thermal storage tank would be about one-third of the size)
- The boilers handle the remaining 27%

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The mechanical system options comparison table is shown below.

| Option                          | Cost | Flexibility | Energy Performance | Occupant Control | Ongoing Comfort | Air Quality | Allows Active Cooling | Duct Size | Floor to Ceiling Height | And Control | Complexity of Operations | System Noise | Maintenance Simplicity | Optimization Through MV
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energy consumption. As the building became more occupied, the load balance improved causing the heat recovery chiller, operating with the group loop, to take over more of the heating and cooling demand and improve central plant efficiency.

Lighting and receptacle loads have stayed relatively low despite the building being mostly occupied. Only IT 24/7 loads have risen to levels higher than stipulated in the performance agreement, resulting in a small adjustment to the energy accounting.

Lessons Learned

HVAC

Fan energy continues to consume more energy than estimated in the energy model. A recent effort with the mechanical design team, owner, and controls contractor identified possible improvements to the in zone fan coil unit operation. The fans were installed as specified with ECM motors, and controls wiring to enable variable fan speed. However, they are currently operating near a constant volume, recirculating air with ventilation air when there is no heating or cooling load. The sequence of operations is being updated to allow the fans to ramp down minimum airflow when no load is present, saving a significant amount of fan energy.
Metering and M&V

The first few months of M&V during the performance period included significant coordination with the controls contractor, the M&V analyst, and the M&V building analytics software. This involved verifying a number of different BMS outputs to ensure that the analyst had useful, accurate data. Ideally, this process should begin before occupancy or at least prior to the performance period, so that things like hydronic flow rates and temperatures can be ready to go right away for early system tuning and analytics.

Renewable Energy

The building includes a 143 kW rooftop photovoltaic (PV) array. The PV system is anticipated to produce roughly 135,000 kWh of energy per year, offsetting 2.1 EUI (kBtu/ft²), or about 7% of building consumption. Since the building was occupied in November the PV array has produced a total of 166.7 MWh of energy. This translates to an EUI of 2.55 kBtu/ft²·yr, and just over 10% of the building’s total energy consumption during the same period. Therefore, the building has officially exceeded its target PV production during the first year. The actual system has produced over 19% more energy than anticipated.

Conclusion

The Helen Sommers Building represents a pivot on the part of the State to a new type of building and a new level of sustainability performance. In an era of constrained revenue, conservation of resources and dollars is the new revenue stream. Through high-efficiency building systems, LEED certification, measurement and verification during operations, and investing in responsible products and technology, the project is a blueprint for not only an optimized building but also one that delivers on the full definition of sustainability.

ABOUT THE AUTHORS

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