Wall Module

THE INTEGRATED FACADE

The convention in office building construction has long been to separate the structure and facade of the building perimeter into two distinct components, requiring two trades working on site and two steps in the construction process. For the OBF, the structure and facade is combined in the factory and delivered to the site as a complete single wall unit. As the perimeter columns and spandrel beams are being lowered into place, so also are the glazing, shading and facade systems—a clean, single-step process to erect a dried-in building. The columns and spandrel beam that make up each structural bay (30 feet x 13 floor) are precast as continuous frames that are then in-filled with the latest building fenestration technology—specifically fine-tuned to the site conditions and wall orientation. The building facade of the OBF is designed using high R-value materials, such as mullions made of pultruded fiber-reinforced polymer composites (FRP), which is fiberglass that has been formed into linear components to replace extruded aluminum, triple-pane glazing to minimize heating and cooling loads and translucent insulating panels using aerogel, interspersed to reduce loads. Solar radiation is blocked by large vertical shading devices and converted to electric energy with translucent amorphous silicon photovoltaic cells. In an effort to maximize the interior space planning, perimeter columns are shifted to the exterior of the wall—these external precast elements will be cast with integrated insulation to prevent thermal bridging to the interior.

01 High-Strength Precast Concrete Frame

02 Triple-Glazed High Efficiency Vision Zone

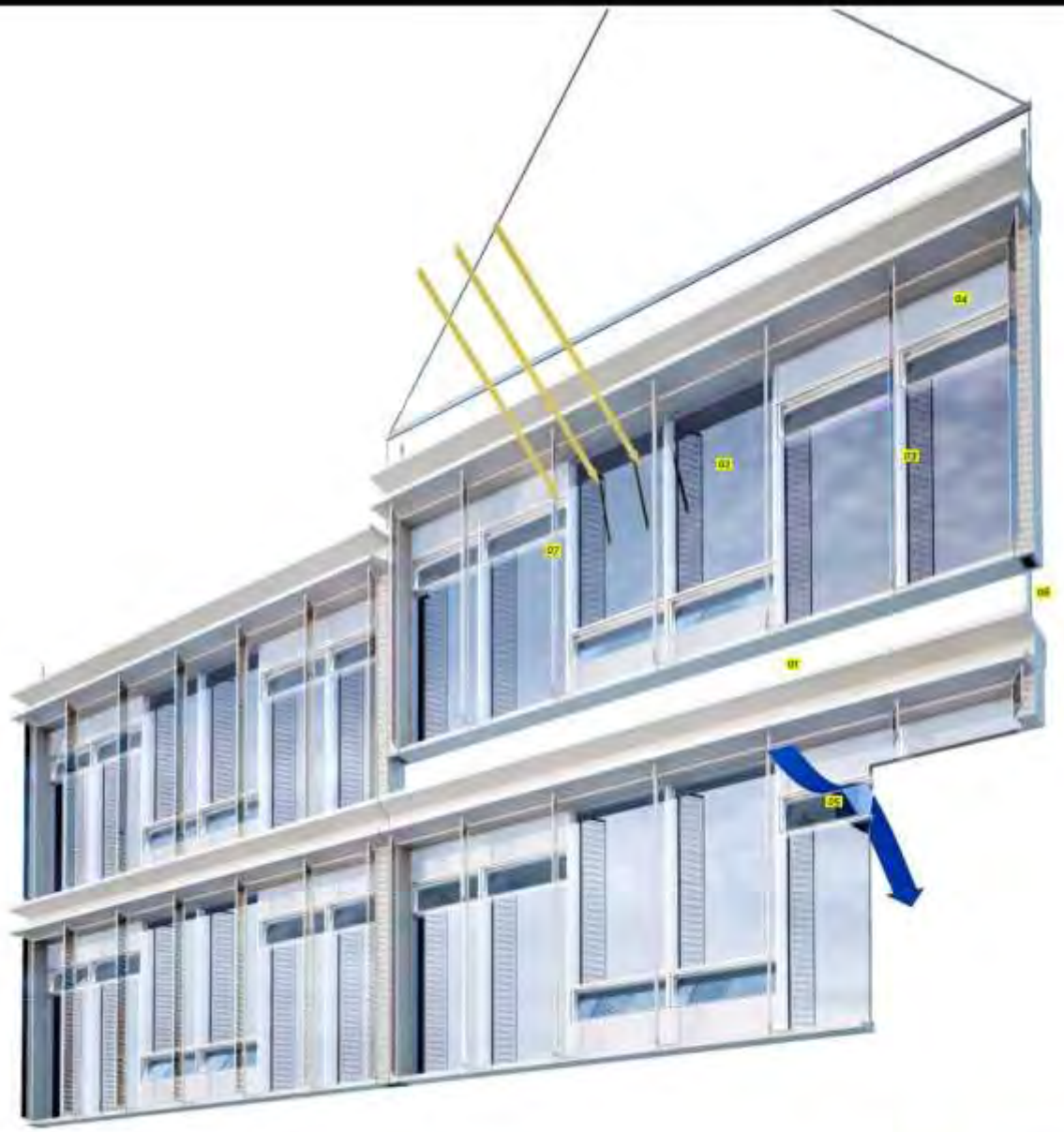
03 Pultruded Fiber-Reinforced Polymer Composite Mullion System

04 Translucent Fiberglass Panel With Aerogel Infill

05 Computer-Synchronized Operable Window For Airflow

06 Cast-In Structural Mounting Sleeve

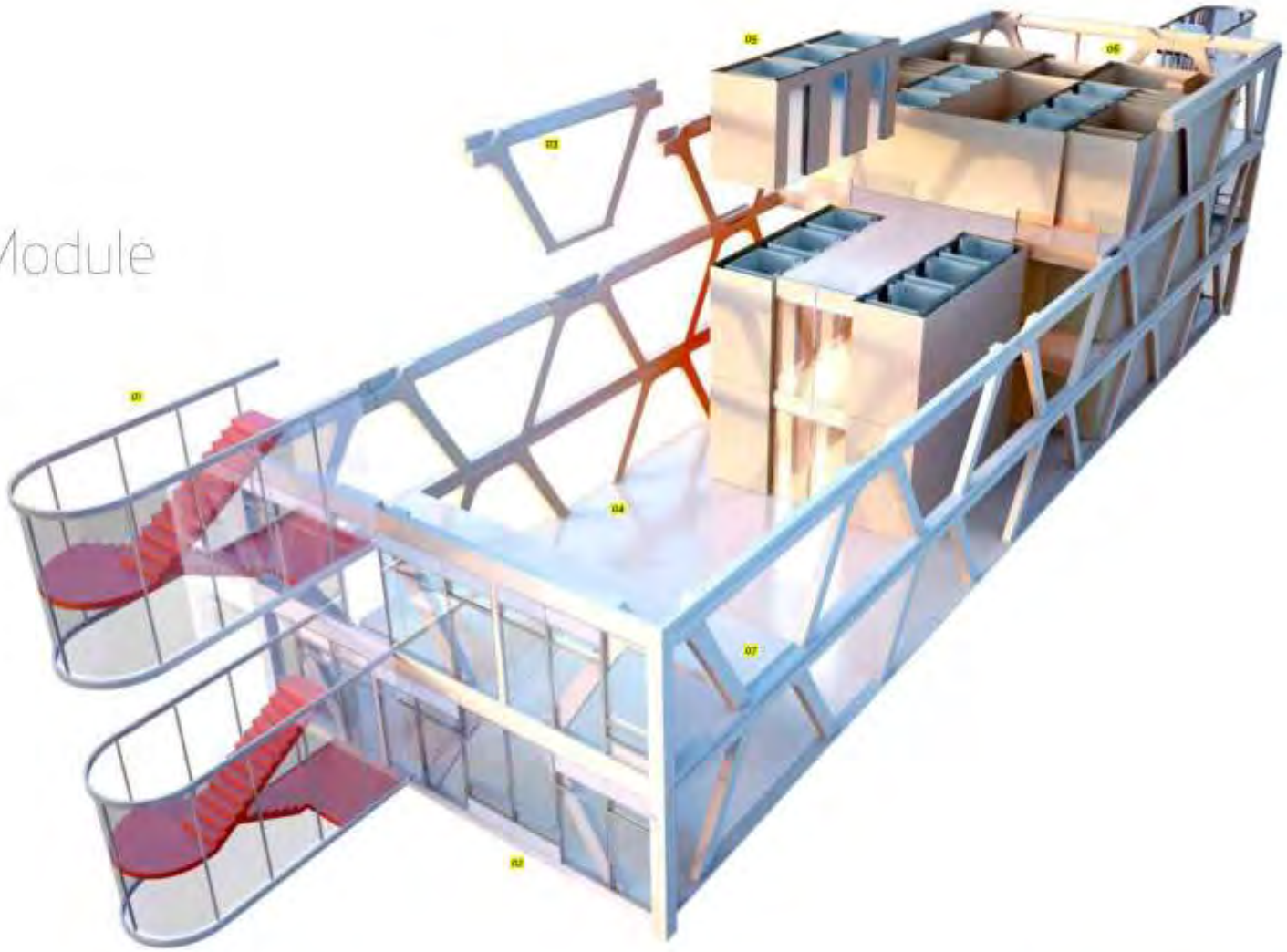
07 Photovoltaic-Integrated Vertical Sunshades



Central Core Module

RETHINKING THE CENTER

In a conventional office building, the core is typically a tightly packed conglomeration of large structural members for lateral support and utilitarian programmatic spaces, such as egress stairs, mechanical rooms and restrooms. It is generally treated as a necessary yet mundane grouping of spaces relegated to the center of the floorplate and obscured from natural light. The OBF will define a new paradigm, one that embraces the core as the heart of the building, a unifying open space. Rather than group all of the lateral bracing into a massive, solid concrete cluster at the building corner, the OBF expands the bracing system into a large open tube of precast concrete latticework, surrounding light-filled centralized atria. Because lateral loads are more broadly distributed, the assemblage is more structurally efficient yet less material intensive. Stairs and elevator shafts are now independent of the structure and surrounded by natural light. Additionally, due to the system's inherent "plug & play" flexibility, it is intended that the independence of the structural core would allow for programmatic units such as mechanical rooms or elevators to be added or replaced at the discretion of the owner years after the completion of the initial project thereby allowing the building to be repurposed.



01 Modular Stair Section

02 Modular Wall Panel

03 Shear Wall Diagrid Module

04 Floor System (Shown in Atrium Condition)

05 Elevator Module

06 Bathroom Module

07 Atrium Bridge Connection

Putting It All Together

IMPLEMENTATION

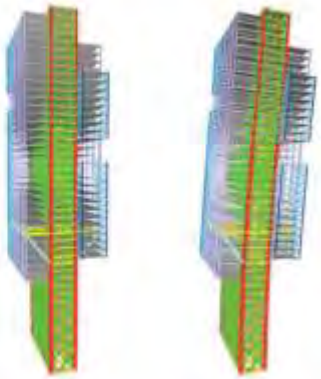
On-site assembly of the OBF will be a fast and exciting grand finale to a process that began, and largely took place, in a controlled factory environment. As modules are assembled to create dynamic spaces, and spaces assembled to form an elegant building, a new and futuristic icon will redefine the Seattle skyline.

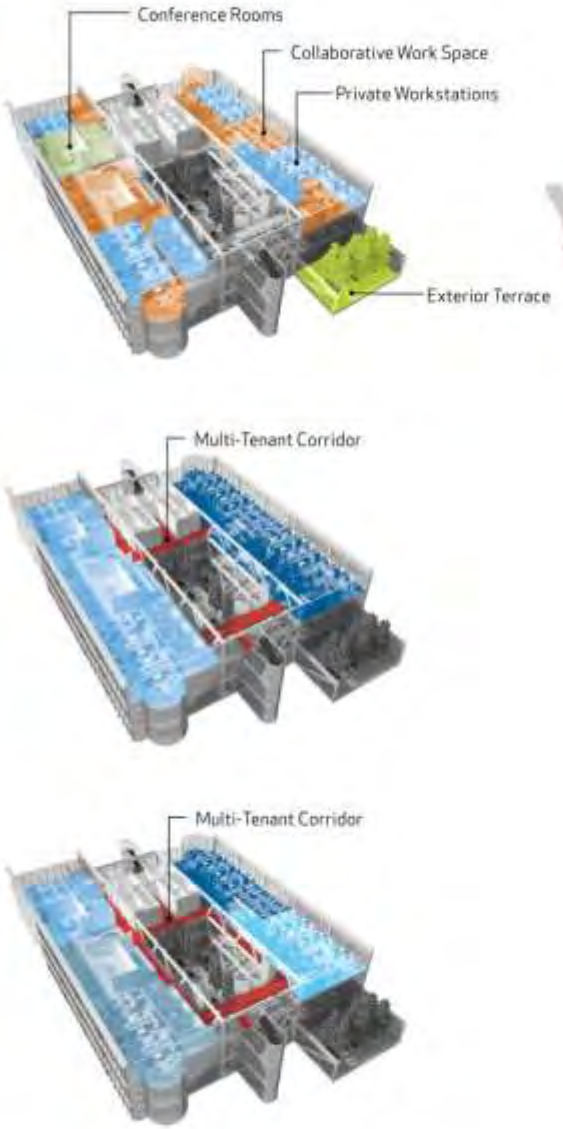
The OBF will represent healthier work environments for office inhabitants, responsible use of natural resources, and a secure financial investment for owners. The city will be proud of its new monument to progress. Tenants will readily lease space in a building that they know will promote employee productivity and well-being.

BUILDING STRUCTURE

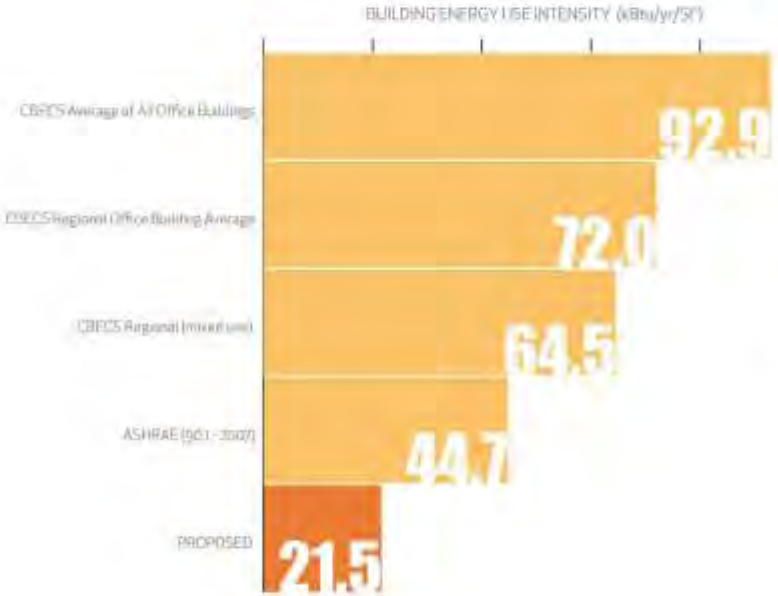
It is expected that the OBF will have a useful life spanning many decades into the future. Careful consideration has been given to ensure its durability and longevity through the trauma of potential natural disasters, particularly in a city with significant seismic activity. As the modules of the OBF are lowered into place, they are structurally fused together by weld points and NMB sleeves—a specially designed coupling system that effectively unites two abutting reinforcing bars from separate precast units into a continuous reinforced concrete member.

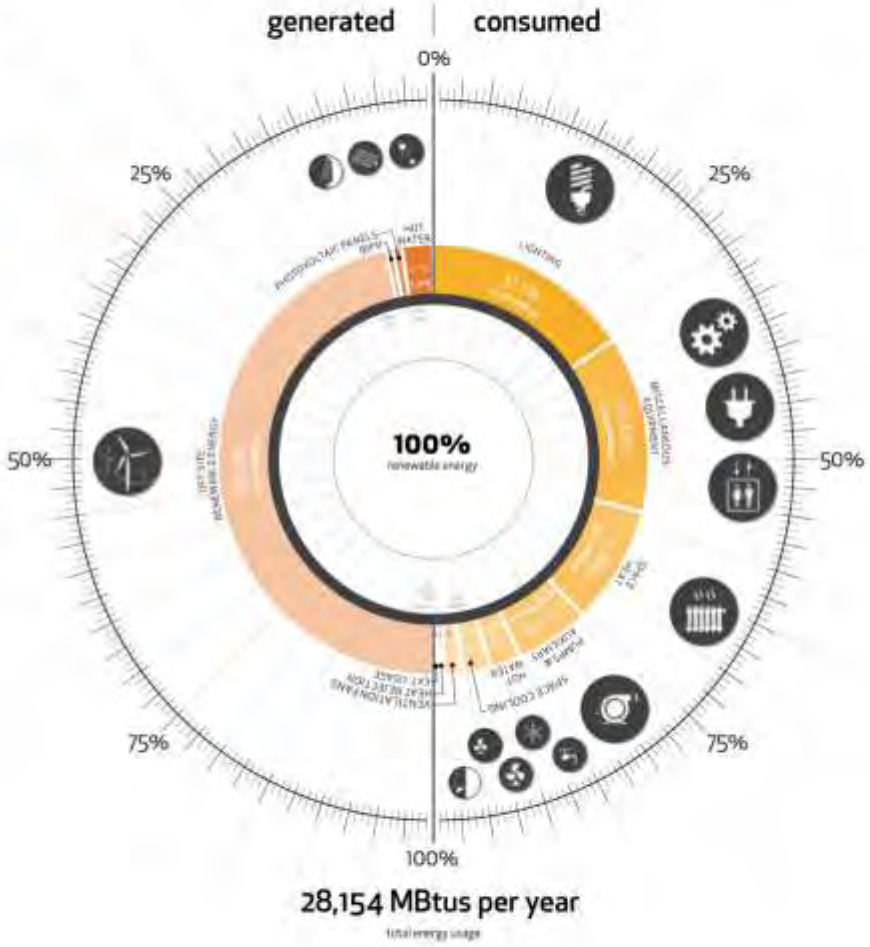
In the high-rise office tower, lateral loads will be resisted by a "core-only" approach, in which a central diagrid tube will resist both moment and shear forces. Structural analysis confirms that, through the modules' use of high-strength materials, this structural configuration is more than sufficient to keep tower deflection within acceptable limits. It is anticipated that in the near future, higher strength concrete and reinforcing steel will become more economical and widely available, therefore as less concrete and less steel were the assumed materials for the structural testing of the OBF. The core-only structural model of the tower is fully expressed in the building form, by transferring perimeter vertical loads to the core at the bottom of the office bars, and allowing the core to stand alone for the bottom third of the office building.




Conference Rooms
Collaborative Work Space
Private Workstations
Exterior Terrace
Multi-Tenant Corridor
Multi-Tenant Corridor
01
02
03
04
05
06
07

77% reduction





Strategies

ENERGY STRATEGIES

PASSIVE DESIGN STRATEGIES

- Atriums enhance stack effect
- Sun shades manage summer solar gain
- Thermal mass creates a thermal flywheel effect
- Night flushing cools the thermal mass
- Operable windows provide natural ventilation
- Daylight access reduces artificial lighting

HIGH PERFORMANCE ENVELOPE

- Triple-glazed low-e Krypton filled curtain wall glass: U-value as low as 0.12[1]
- Translucent Aerogel panels: U-value 0.05
- Fiberglass curtain wall framing: U-value 0.05[2] (vs. 0.85 for mechanically fastened aluminum curtain wall)[3]
- Continuous insulation avoids thermal breaks
- Green roof: cools by evapotranspiration and increases summer thermal resistance

HIGH EFFICIENCY HEATING & COOLING

- Radiant heating and cooling decouples conditioning from ventilation
- Geothermal exchange heating and cooling plant
- High efficiency magnetic bearing chillers
- High efficiency hot water condensing boiler plant; option to connect to Seattle Steam District Energy
- Cooling towers for one third of cooling (peak) load only

MIXED-MODE EFFICIENT VENTILATION

- Displacement ventilation with fresh air rising from floor
- Demand-control ventilation controls that supply fresh air when CO_2 is too high
- Energy recovery enthalpy wheels with dehumidification condition fresh air intake with heat from exhaust air

EFFICIENT LIGHTING

- Daylighting reduces need for artificial lighting
- Daylight sensors and dimming controls provide necessary light in varying light conditions
- Automatic interior roller shades provide glare control
- Efficient direct/indirect T5 fluorescent fixtures or LED fixtures

VERTICAL TRANSPORTATION

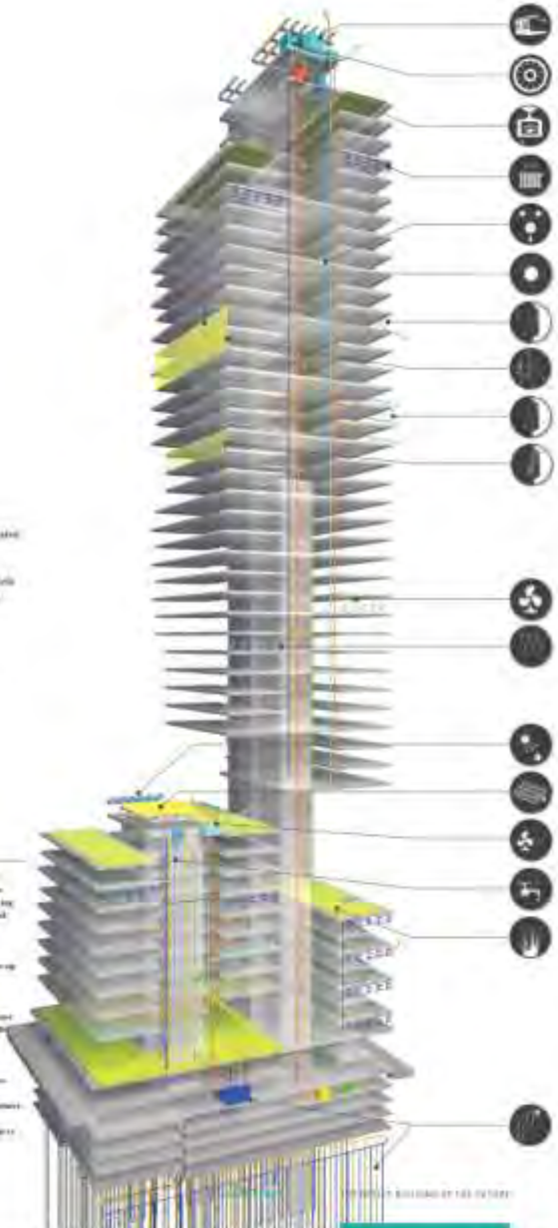
- Open stairs increase physical activity of occupants and reduce elevator demand
- Efficient new elevator belt technology can reduce energy by up to 50%, adding a regenerative drive that recaptures energy lost in braking can save an additional 25%[4]

OCCUPANT BEHAVIOR

- Tenant sub-metering incentivizes and encourages tenant efficiency
- Online building energy management systems provide real-time feedback to encourage better energy usage
- Tenant plug load reductions encourage more efficient equipment
- Task lighting encouraged to reduce general illumination

RENEWABLE ENERGY HARVEST

- Solar hot water (thermal) collectors are inexpensive and highly efficient
- Conventional monocrystalline photovoltaic panels with 20% conversion efficiency offer the highest production per square foot on roofs[5]
- Amorphous silicon building-integrated photovoltaics offer the most production in conditions with diffused lighting and vertical surfaces[6]



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3. Carbary, Lawrence, and Ellis [illegible] "A Thermal Modeling Comparison of Typical Curtainwall Glazing Systems." Glass Performance Days. Dow Corning. [illegible] Accessed [illegible] May 2013.
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5. Sunpower Corporation. "The Most Powerful Solar Panels for Your Business." [illegible] Accessed [illegible] May 2013.
6. [illegible] "Building Integrated Photovoltaics." [illegible] Page [illegible]

Strategies

WATER STRATEGIES

HIGH-EFFICIENCY WATER FIXTURES

- Watersense-approved faucets, showers and toilets assure quality and reduced consumption
- Motion-activated and auto shut-off fixtures reduce demand and waste

RAIN WATER COLLECTION & STORAGE

- Collection from all surfaces, including roofs, green roofs and site
- 1,300-cubic-foot cistern sized for cost-effectiveness

EFFICIENT LANDSCAPE IRRIGATION

- Efficient and effective drip irrigation method
- Drought-tolerant landscaping minimizes irrigation needs

MECHANICAL PROCESS WATER COLLECTION & STORAGE

- Reclamation of cooling tower blow-down and condensate water flows (these can account for 40% of a building's water demand)
- 13,800-cubic-foot cistern captures a large volume of water to vastly reduce demand and waste

WASTE WATER COLLECTION

- Managing grey water and black water flows together is more cost effective than managing separately

LIVING MACHINE

- A low-energy system for treating all waste water on site and includes the following:
  - Settling tank for equalizing flow and settling solids
  - Control system to manage flow and monitor performance and quality.
  - Wetlands installations located inside or outside for removal of nutrients and pollutants — this is the visible, odorless portion of the system.
  - Disinfection system to kill any remaining pathogens[1]

REVERSE-OSMOSIS PLANT

- For final purification of Living Machine output as well as collected effluents to produce potable water

REUSE OF COLLECTED & TREATED WATER

- System stores 80% of potable water needs
- Drastic reduction in city water and sewer services substantially reduces utility costs
- Tenants are charged for water services provided by the owner through on-site water collection and recycling services
- Payback on systems in as little as 5 years[2]

1. "Natural Water," "How It Works," Living Machine ®, www.livingmachines.com/about/how_it_works, (accessed 10 May 2011).
2. Eugene, Dave. "Water Efficiency Narrative," Wagonmaker Elementary Assessment.