Capitol Hill House

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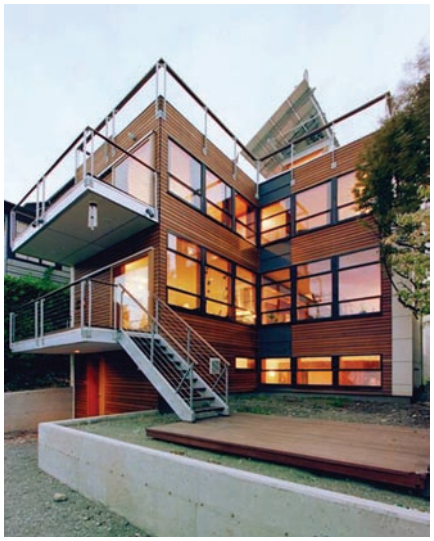
Green Home Case Study

Healthy homes for a healthy environment



About the project

Name: Capitol Hill House
Type: Single-family remodel/reconstruction
Square Feet: 4,200 existing, 80 new
Location: Seattle's Capitol Hill neighborhood
Completed: July 2002

Once a drab, boxy house with a flat roof, this home is now a bright, modern showcase of energy-efficiency and new technology. Although it was originally envisioned as a modest remodeling, the project expanded after the building team discovered flaws in the foundation and extensive rot within the ground floor. The house wound up as a hybrid of new and remodeled space. The basement is new, as is the ground floor, but the top floor was popped up on jacks and saved. The result is a fresh, integrated design within the same space, except for a new, tiny penthouse on the roof.

The small, glass-walled penthouse provides access to a new rooftop deck. Besides adding a stylish flourish to the look of the house, the penthouse also supports solar hot water and photovoltaic panels, and it helps illuminate the home. Light streams in through the penthouse and bounces down the stairs, which were moved to the center of the house and extend all the way from the basement to the roof.

The house incorporates numerous advanced building concepts and is wired to take advantage of current and future "smart house" technologies. The siding is installed over a rain screen — a waterproof drainage layer behind the siding that will keep any leaks from causing the sheathing or framing to rot. A device made of copper tubing extracts heat from shower drain water and uses it to pre-heat water going into the water heater. A 12,000-gallon rainwater collection system is set up to irrigate landscaping and refill toilets, but the system keeps the water clean enough that it could also supply household taps.

Goals/Challenges

Smart house technologies
One goal was to make this project a laboratory for sustainable construction and "smart house" technology, so wiring links all of the building's utility systems to a central computer.

Ratings & Awards

Remodeler Award,
2005 Built Green™
Design Competition

Built Green™ 4-Star
Certified Project
(452 points)

The Team

Architect

BLIP Design
(206) 501-8746
www.blipdesign.com

Builder

McGinnis Construction
(206) 227-9086

Structural Engineer

Swenson Say Fagét
(206) 443-6212
www.swensonsayfaget.com

Photovoltaics

Northwest Solar Center
(206) 396-8446
www.northwestsolarcenter.org

Radiant Floor/Solar Hot Water

Advanced Radiant Technology
(206) 783-4315
www.advancedradiant.com

Electrician/Solar Consultant

Sound Power
(206) 527-1390
www.soundpower.us

Smart house technology

Coast 2 Coast Technologies (206) 835-2077

Resources/Products

PowerPipe

Green Depot, Inc.
(360) 705-2868
www.greendepotinc.com

Cistern

Northwest Water Source
PO Box 2766
Friday Harbor, WA 98250
(360) 378-8900

Polyurethane foam insulation

Icynene
6747 Campobello Road
Mississauga ON, L5N 2L7 Canada
(905) 363-0102
www.icynene.com

Available locally from:
Progressive Insulation
2161 N Northlake Way, Seattle
(206) 547-8706
www.progressiveinsulation.com

Vacuum-tube solar system

Components include:
Viessmann stainless steel storage tank and heat exchanger
Thermomax vacuum tube panels
Thermomax SMT 400 controller

Available locally from:
Advanced Radiant Technology
8314 Greenwood Ave. N.
Seattle, WA 98103-4238
(206) 783-4315
www.advancedradiant.com

Photovoltaic system

Components include:
BP monocrystalline modules
SMA Sunny Boy inverter

Available locally from:
Sound Power Inc.
29931 NE 190th St.
Duvall, WA 98019
(425) 844-8748
www.soundpower.us

For More Info

Built Green™ – a residential green building program/rating system developed by the Master Builders Association of King and Snohomish Counties in partnership with Seattle. www.builtgreen.net

Energy Star – a government-backed program helping businesses and individuals protect the environment through superior energy efficiency. www.energystar.gov

King County Construction Works – provides free assistance and recognition to builders who recycle, reduce waste and use recycled-content building materials. www.metrokc.gov/dnrp/swd/greenbuilding

Seattle Sustainable Building Program – provides guidelines, incentives, and assistance to increase the environmental performance of buildings in Seattle. www.seattle.gov/dpd/sustainability

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To make it easy to track how power is used, the house has 32 electrical circuits—whenever possible, one for each appliance or system. Because lighting and security systems also link to the computer, the owners can make the components work in tandem. For example, lights go off when a room isn't occupied. The owners are also able to write protocols that adjust settings to realize the greatest energy efficiency. The pump that circulates hot water for the radiant heating system in the floors initially ran 16 hours a day, a typical setting. Now it runs for less than an hour a day because the owner, through the computer, told the pump to turn on water to a room only when it or an adjacent room is occupied. The security system ferrets out that information.

Individual switches can also communicate with each other by using FM signals transmitted over the house wiring system. The owner uses this function to fine-tune operation of fans in the three bathrooms and in the laundry room. In many new houses, a timer switches on one fan for a certain period each day to ensure that fresh air gets into the house. In this house, the owners can have each fan run for part of the time, which helps air circulate throughout the entire house, and they can change the settings easily to adjust for changes in how the house is used.

Extra insulation

Because the foundation needed to be replaced, the owners took the opportunity to excavate deeper under the house. This allowed them to turn what had been a creepy space with 6-foot-high ceilings into a pleasant basement with 8-foot-high walls. The space is comfortable because the concrete floor and walls are fully insulated. On the main floors, the builders used Icynene insulation, an open-cell polyurethane foam that expands about 100 times after it's sprayed into wall cavities. The foam seals all gaps, making the walls and ceiling essentially airtight. The company that tested the house for air leaks said this was the most airtight house they had ever found.

Solar chimney

Even though it is virtually airtight, the house has no ventilation system other than the bathroom and laundry room fans. Instead, ventilation depends on the passive "solar chimney" effect of the central stairwell and penthouse. Cool, fresh air flows in through a port in the basement server room. The computers warm the air, which then rises through the stairwell and pushes stale air up and out through a bathroom fan or open windows in the penthouse. If they want more ventilation, the residents open windows. Nearly all of the windows are operable.

Solar systems

The house has two solar systems: a vacuum-tube system for hot water and a photovoltaic system for electricity. The vacuum-tube system, also known as an evacuated-tube collector, is the most efficient type of solar water heater available today, although it's not always the most cost-effective. The system consists of rows of double-wall glass tubes with a vacuum between the layers. The inner tubes contain absorbers that take in the sun's heat and transfer the energy to a phase-changing material, which then heats the water. The vacuum keeps the heat from radiating back out into the sky, a crucial issue in a cool, windy climate like Seattle's. The evacuated-tube system is also very efficient at heating water even on cloudy days, another boon in our Northwest climate.

The photovoltaic system is grid-tied, meaning that electricity generated by the system flows out into the community's lines as the panels generate it. Residents can then get back the same amount of power when they need it, which eliminates the need for a costly battery storage system. The panels were designed to produce 3,250 kilowatt-hours of electricity a year, or about 75 percent of what the house needs in the summer and half of what it needs in the winter.

Wastewater heat recovery

In most houses, what goes down the drain isn't just dirty water; it's also heat. In this house, though, a device called a PowerPipe recovers more than 60 percent of the heat in shower water and uses it to pre-heat water flowing into the water heater. Because shower water is a huge percentage of the hot water used in most houses, the device cuts the overall energy needed to heat water in a typical house by more than 40 percent. The Department of Energy estimates this device may save 30-50% on shower hot water heating needs.

Lessons learned

Monitoring pays

The smart-house technology has given the residents invaluable insights into how their house operates and has allowed them to tweak many systems to make them more efficient. After the residents adjusted the radiant floor heat so that the pump runs less than an hour a day instead of 16, there was no noticeable difference in comfort, owner Ophir Ronen says. "It's made us realize how wasteful the typical house is."

Useable walls

The owners wanted as much natural light as possible, so windows in the front extend all the way to the floor. While this does provide abundant daylight, it also creates a dead area in front of the windows. Were they to do it over, the owners would end the windows about 3 feet up from the floor so that they'd have a partial wall where furniture and bookcases could go.