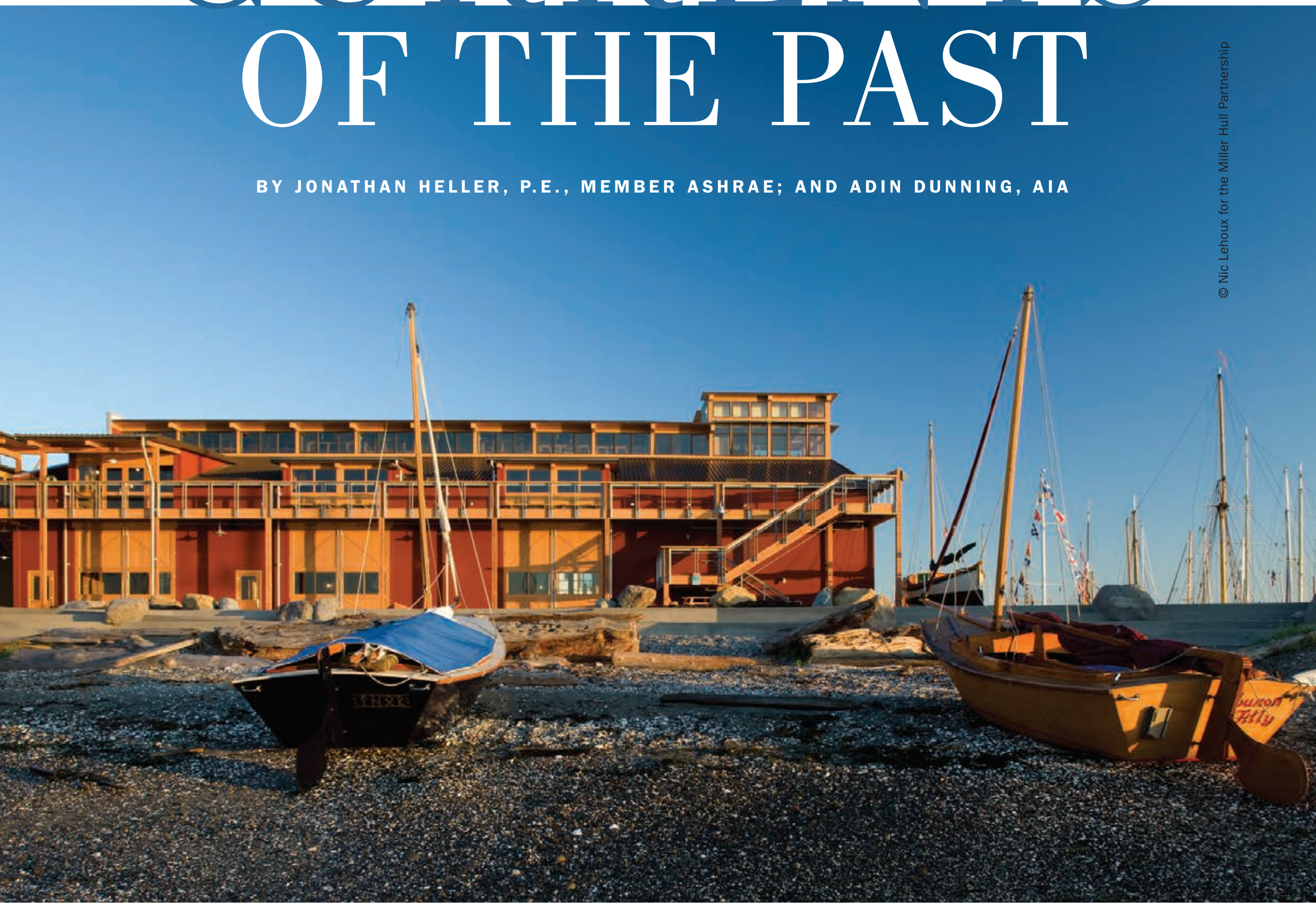
CURRENTS OF THE PAST

BY JONATHAN HELLER, P.E., MEMBER ASHRAE; AND ADIN DUNNING, AIA



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The Northwest Maritime Center (NWMC) project's primary goals are to protect, improve and restore the waters of Puget Sound. From energy use reduction to habitat restoration and material selection, all aspects of the project's impacts were considered by the client and the design team. Because the extensive community-based planning process was more than 10 years in the making, the project team focused on sound sustainability-focused planning decisions early on to ensure the design could effectively respond and adapt as technology evolved.

In the summer of 2009, the LEED Gold certified Northwest Maritime Center opened to the public. The project is situated on a picturesque waterfront property in the seafaring community of Port Townsend, Wash, about 40 miles northwest of Seattle. The town's strategic location on the shipping channels leading into the west coast established the city as a thriving international boatbuilding seaport in the 1800s. Port Townsend served as the official port of entry for the entire Puget Sound for more than 50 years.

When the transcontinental railroad was completed in 1909 it terminated inland in Seattle. Port Townsend's importance to the region began to fade until a resurgence of traditional marine trades in the 1970s attracted a host of boatbuilders, sailmakers, riggers and others to the area. In 1976 the downtown commercial waterfront was designated a National Historic Landmark district. Today, Port Townsend is one of only three Victorian seaports listed in the National Register of Historic Places.

The NWMC serves as a center for education of traditional and contemporary maritime life. It is also home to the Wooden Boat Foundation, which organizes the oldest and largest annual wooden boat festival in North America.

In addition to its educational components, the project provides much needed public gathering spaces and access to the shoreline for visitors and residents of Port Townsend. The architecture reflects the Northwest marine building aesthetic, and sustainably harvested wood is used throughout the structure.

The project consists of two buildings with a combined area of 26,550 ft^2. The Education Building houses the educational programs including a large boat building and repair facility, classrooms, and a replica of a ship's pilot house. The red building is a nod to the town's historic brick

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Above The mission of the Northwest Maritime Center in Port Townsend, Wash., is to engage and educate people of all generations in traditional and contemporary maritime life, in a spirit of adventure and discovery. A large boat building and repair facility is one component of the center's educational programs.

Below A second-level deck connects the two buildings, surrounding the plaza and providing views of the Puget Sound and Cascade and Olympic Mountain Ranges.

Opposite Northwest Maritime Center deeded the new public plaza, boardwalk, and shoreline to the city to ensure public access to the waterfront in perpetuity. The project included clean up of a brownfield and the removal of more than 2,400 cubic yards of contaminated soil along the historic waterfront.

BUILDING AT A GLANCE

Name Northwest Maritime Center

Location Port Townsend, Wash. (40 miles NW of Seattle)

Owner Northwest Maritime Center and Wooden Boats Foundation

Principal Use
  Includes boat storage (livery), meeting rooms, commercial kitchen, chandlery (retail store), boat shop, craft auditorium, offices, classrooms, library, pilot house

Employees/Occupants 15 full-time employees, average of 35 visitors per day

Occupancy 90%

Gross Square Footage 26,550
  Conditioned Space 26,550

Distinctions/Awards 2012 ASHRAE Technology Award, New Commercial Building, Second Place Society Level, LEED Gold

Total Construction Cost $8.2 million

Total Project Cost $12 million
  Cost Per Square Foot $300

Substantial Completion/Occupancy September 2009

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The Northwest Maritime Center's on-the-water programs include team-building long boat crews, sailing lessons, Sea Scouts, youth and adult sailboat racing and the opportunity to take the helm of a historic schooner.

buildings as well as the traditional waterfront buildings.

The Resource Building promotes the rich maritime heritage of the community with a chandlery (retail space), small vessel rental and storage, exhibits and information gallery, community meeting rooms, and office spaces for maritime partner organizations. The warm yellow color of the building pays homage to the color of the traditional maritime buildings of this area.

The buildings surround a paved public plaza, which links the NWMC Education Pier, an adjacent public jetty and boardwalk and the buildings. The plaza also houses major community events and ensures public shoreline access in perpetuity. A second-level balcony rings the plaza and connects the two buildings while providing views of Port Townsend Bay and the Cascade and Olympic mountain ranges.

KEY SUSTAINABLE FEATURES

HVAC Water source heat pumps use the near constant ocean water temperatures as a heat source or sink;
Heat recovery ventilator provides tempered ventilation air to retail space

Daylighting Clerestories run the length of the buildings, daylight sensors
Individual controls: Separate thermostatic controls in private offices

Materials Forest Stewardship Council-certified glu-lam framing, dimensional lumber, plywood products, tongue and groove decking, and finish wall paneling, trim and cabinetry

Climate

Port Townsend sits on the protected waters of the Puget Sound and has a very mild climate tempered year-round by the proximity of the sea. The peak summer design temperature is only 81°F, and the peak winter design temperature is 22°F. Cooling is rarely ever needed if operable windows are provided for natural cooling.

Energy Efficiency Measures

Energy efficiency measures include natural ventilation during most of the year and, when natural ventilation isn't possible, heat recovery and demand control ventilation systems. However, the most significant source of the project's energy savings derives from the sea, which serves as a source of thermal energy.

Early in the design process, the project team recognized the energy savings potential of the site's most obvious resource: the temperate waters of the Puget Sound. Given the project's other strong connections to the sea, it was natural to embrace this opportunity by harnessing the near constant water temperature (~50°F) as an efficient heat source/sink for the high efficiency water source heat pumps located in each building.

The heat pumps are connected in a closed loop to titanium heat exchangers located in the deep waters below a new pier. The ocean-source geothermal system supplies all of the buildings' HVAC and domestic hot water heating needs at efficiencies more than 300% better than a similarly sized gas-fired or electric resistance system.

Each building is provided with space conditioning through a combination of ducted air systems, radiators, fan coils and radiant floor delivery systems. Pumping energy between the buildings' central closed water loop and the ocean heat exchanger is reduced through the use of variable speed pumps. The circulation pumps are set up to maintain a constant differential loop pressure, varying the pump speed up and down to maintain occupant comfort.

ENERGY AT A GLANCE

Annual Energy Use Intensity (Site)
30 kBtu/ft²
Electricity 30 kBtu/ft²

Annual Source Energy 100 kBtu/ft²*

Annual Energy Cost Index (ECI) $0.81/ft²

Savings vs. Standard 90.1-1999 Design Building 56%

Heating Degree Days
5,620 at base 65°F for 2011

Cooling Degree Days
4 at base 65°F for 2011

*National source ratio used. However, the ratio is high for Port Townsend because three-fourths of Washington State's electricity is generated from hydropower.

To reduce fan energy, radiant floor heating is provided in ground floor spaces, while radiator heating serves the upper floor office areas. Heat recovery ventilation is provided for the retail space and operable windows are relied upon for ventilation and natural cooling in the offices.

The Boat Shop is heated to only 60°F via a radiant floor since it is typically operated with the doors open during the swing season. Door switches turn off heating when doors are opened. Rooms with ducted systems are provided with heating and cooling and outside air economizer mixing boxes.

The classrooms in the Education Building are tied to door switches that disable the HVAC system when rooms are unoccupied (doors are open). The project also uses variable speed pumps, demand control ventilation (DCV), and natural ventilation for additional energy savings. The buildings' hybrid active/passive ventilation system

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Top Continuous bands of clerestories run the length of both buildings, providing even, natural light throughout the spaces. Controls monitor available daylight, and artificial lighting is seldom on throughout most of the buildings.

Above Boatbuilding functions spill out of the building into the right-of-way and onto the public plaza.

Left Designed as an extension of the public plaza, the sidewalks and drive-aisles of the adjacent street right-of-ways close to vehicles during events, serving as event space, and a "Bike Corral."

THE SECRETS ARE INSIDE: INNOVATION THAT OUTPERFORMS

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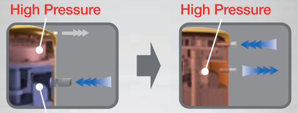

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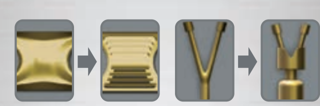

Wide Louver & Uniform Distributor
the heat transfer rate by creating air paths. The Uniform-Distributor optimizes heat exchanger path

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A replacement pier was lengthened to enhance the native eelgrass bed in Port Townsend Bay. The 215 ft pier was constructed for moorage of larger historic vessels, the ability to attract major events, educational opportunities for children through sailing programs, and other hands-on, on-the-water events.

BUILDING ENVELOPE

Roof
Type Membrane roofing and standing-seam metal over polyiso insulation, vapor barrier on ½ in. plywood over 2 × 6 wood decking
Overall R-value R-30 (nominal), U-value=0.034 (overall assembly)

Walls
Type 2 x 6 wood frame @16 in. on center
Overall R-value R-21 Batts (nominal), U-value=0.057 (overall assembly)
Glazing Percentage 29%

Basement/Foundation
Slab Edge Insulation R-value 2 ft vertical R-10; Slab edge, F=0.54; Floor over livery: R-30, U-value=0.029
Under Slab (Radiant) Insulation R-value R-10

Windows
Wood Windows, Low-e2 Argon Glass
U-value 0.35 (overall including frame)
Solar Heat Gain Coefficient (SHGC) 0.45
Visual Transmittance 0.62

Location
Latitude 48°06'58" N
Orientation NE-SW

design reduces energy use while maintaining high levels of indoor air quality, comfort, and connection to the outdoors.

The project saves water and energy by using low-flow plumbing fixtures throughout.

Lighting

The design capitalizes on building orientation (northeast-southwest), with operable clerestory windows running continuously the lengths of both buildings, spilling daylight throughout the spaces and facilitating natural ventilation.

The buildings are programmed to put actively occupied spaces against outside walls to optimize daylighting. The upper level spaces are abundantly daylit due to their orientation and relationship with exterior walls and use of continuous clerestories. Ninety-four percent of regularly occupied spaces have outside views and have daylighting at levels that allow lights to be off during daylight hours.

To ensure even light distribution, meeting rooms and open offices have two running monitor bands. Daylighting controls are used throughout, adjusting artificial lighting as natural light permits.

As a cost-saving measure, daylight controls turn lights off by default. When an occupant enters a room, lights are turned on manually, and the controls self adjust the lighting level. Glare is controlled through overhangs and an automatic roller shade system

Energy Use

An ASHRAE Standard 90.1-1999 Appendix G energy model of the ocean-source geothermal system was provided for documentation of energy savings for utility incentives from Puget Sound Energy (PSE). The building was modeled using eQUEST version 3.56. Ecotope took the PSE incentive model and modified it to meet the requirements of LEED-NC v2.1 EAc1.

The project as modeled performed 56% better than the ASHRAE

Standard 90.1-1999 budget case building. The model predicted annual energy use of 226,340 kWh, or an EUI of 29.1 kBtu/ft^2 · yr. After two years of operation, the project had an average annual energy use at 233,633 kWh. The energy use intensity is 30 kBtu/ft^2 · yr; within 3% of the energy model prediction. (The model was not recalibrated to reflect actual operating conditions.)

Because the NWMC project includes many types of uses, a comparison to a "typical" building is not straightforward. *Table 1* illustrates a weighted average EUI for the types of space uses in the NWMC project compared to the 2003 CBECS averages.

With an EUI of 30 kBtu/ft^2 · yr, the Northwest Maritime Center ranks among the lowest energy use buildings in the country.

MONTHLY ENERGY USE, 2009–2012

TABLE 1 **ENERGY USE INTENSITY COMPARISON**

Primary Uses	Area (ft^2)	2003 CBECS EUI	2003 CBECS Category
Boat Storage (Livery)	2,850	77	Service (Vehicle Repair and Service, Postal Service)
Meeting Rooms, Commercial Kitchen	3,700	76	Education
Chandlery (Retail Store)	4,300	82	Retail
Boat Shop, Craft Auditorium	6,200	66	Public Assembly
Offices, Classrooms, Library, Pilot House	9,500	72	Office
Total Project	**26,550**	**73.3 kBtu/ft^2 · yr** (CBECS weighted average)	
NWMC Actual EUI		**30 kBtu/ft^2 · yr** (2009–2011)	

Environmental Impacts

The NWMC is located on the site of a former sawmill, a shipyard and deep draft dock, and most recently an oil terminal. The site was deemed an "intrusion" in the National Historic Landmark district, and was purchased by the citizens of Port Townsend for remediation into a community hub with public access to the shoreline. More than 2,400 tons of contaminated soil was removed to remediate the site prior to construction.

In addition to the project's energy efficiency measures, the design aimed at improving the shoreline habitat for juvenile salmon and other fish vulnerable to predators. Great care was taken in designing the new pier, which serves as the focal point of the center's on-the-water educational programs.

The new pier was constructed for moorage of larger historic vessels, the ability to attract major events, educational opportunities for children through sailing programs, and other hands-on/on-the-water events. Extending 215 ft into the bay and encompassing 4,900 ft^2, the pier provides a safe place to enjoy the area's natural beauty while learning about native flora and fauna.

The pier design minimizes shading of the eelgrass planted to restore over 3,000 ft^2 of shoreline habitat for the salmon fry. Eelgrass is a critical and sensitive habitat for fish (including threatened

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A mission of the Maritime Center is to inspire visitors to take better care of the Puget Sound. An deck provides views of the bay and Cascade and Olympic Mountains, providing the context for visitors to consider their impacts on the environment.

salmon), shellfish, waterfowl and other animals. Marine creatures can spend part or all of their life cycles in this delicate underwater grassy environment.

To alleviate shading from the pier, the underside of the structure is clad with stainless steel panels to reflect sunlight back into the water. The project's titanium heat exchange plates are located in deep water at the end of the pier, beyond the sensitive eelgrass habitat.

Indoor Air Quality

The project is designed to meet the ventilation requirements of ASHRAE Standard 62.1-2004. The Chandlery is served by a 100% outside air heat recovery ventilator system (OSA HRV) with a 76% sensible effectiveness. The HRV provides tempered ventilation air to the retail space. The meeting rooms are equipped with a demand controlled ventilation (DCV) system tied to CO_2 sensors to maintain high levels of ventilation during intermittent high occupancy in these spaces.

The offices are equipped with operable windows, which provide natural ventilation and cooling from breezes off the Puget Sound, complying with the 4% operable window area under the ASHRAE Standard 62.1-2001 (section 5.1.1). Ninety percent of regularly occupied spaces are within 15 ft of a window. Low VOC paints, carpets, and furnishings are used throughout the project to minimize indoor pollutants.

LESSONS LEARNED

Projects for non-profit organizations that must raise construction funds can be very challenging for the design team. This project was 10 years from beginning to end, which required multiple restarts and spanned changes in technology, CAD programs, and shifts in the various members of the design team and owner's decision makers. Every time the project starts and stops it takes time and money to get back up to speed, figure out what has changed, and make the necessary adjustments. Long projects such as this are assisted by very careful documentation and clear contracting language.

Don't be afraid to propose innovative ideas. The decision to go with the ocean heat pump system was pursued even though the design team initially thought that the various regulating bodies would find reason to block it. However, with careful explanation of the environmental impacts and advantages, all governing agencies were convinced that this was a great idea for this project.

Lessons from the Navy's experience with ocean heat exchangers were used in this project to locate the heat exchangers as deep as possible to reduce the amount of marine growth. The project team also learned that some growth is acceptable as the marine animals that tend to populate these surfaces are mostly filter feeders, so they are pushing water through their bodies; enhancing thermal heat transfer.

When working with a non-profit client, budget is often (always) a critical factor. Our team made decisions about sustainability that were tied to the mission and goals of the organization. Systems and decisions were intrinsic to the architecture, and this ensured that value-engineering did not compromise the sustainable goals for the project.

Finally, project teams should take into account the availability of local knowledge and service technicians when selecting building systems. Commissioning can be challenging in relatively remote areas (this project is a two-plus-hour trip by car and ferry). This building was lucky to find a local tradesman who was able to get the systems figured out, programmed, and operating correctly per the design specifications.

For example, the economizer and demand control ventilation controls weren't working properly. It was discovered that the wrong controls were installed (instead of heat pump controls, furnace controls were put in). Also, the circulation pumps were originally set to run at constant volume, but were switched to variable volume constant pressure per the spec. The commissioning agent also made sure temperature controls and scheduling were set per the basis of design.

Oversized custom wood and glass doors are opened throughout the shoulder seasons and summer, providing natural ventilation. FSC-certified wood was sourced for glu-lam framing, structural decking, wood paneling, millwork, casework, and finish deck. Wood materials were analyzed for cost and regional availability whenever possible.

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Additional source specific exhaust is provided for the boat building shop and the kitchen space. In both cases, variable speed exhaust fans and makeup air ducts are provided.

Operations and Maintenance

The titanium heat exchanger plates hold up significantly better than stainless steel in the salt water environment. Locating the plates in deep water 12–15 ft below the lowest tide line ensures minimal marine growth.

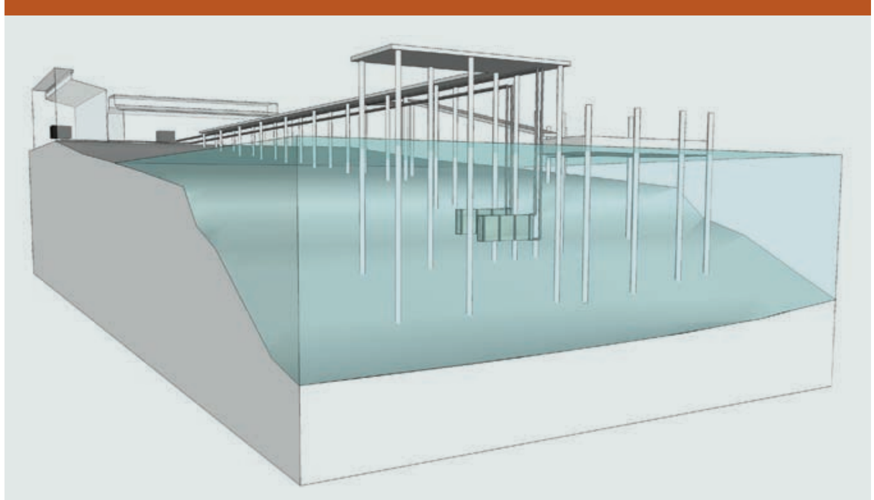
The heat exchanger plates are constructed with 2 ft spacing between the plates, allowing divers to remove any growth that may occur and clean the plates as necessary to maintain heat exchange efficiency. The indoor heat pumps are grouped together in mechanical mezzanine areas in each building for centralized maintenance access.

Since the non-profit NWMC organization does not have a full-time maintenance or operations person, simple thermostat controls are available to the building users to provide control of thermal comfort.

Cost Effectiveness

The NWMC building saves approximately $29,000/year in electric bills compared to the LEED base case building, and performs 59% better than an area-weighted average CBECS baseline. The project met Puget Sound Energy's (PSE) prescriptive incentive requirements for

REDUCING ENVIRONMENTAL IMPACT



To reduce impacts to one of the Puget Sound's endangered eelgrass beds, the new pier is designed to maximize light to the bay's floor by reducing the effective shadow width from the overwater structure and provide reflective panels under the solid sections. The project's titanium heat exchanger plates are located at the end of the pier, beyond the sensitive eelgrass habitat.

envelope and lighting measures, and qualified for additional incentives for the efficient ocean-source heat pump system. The project received nearly $130,000 in utility incentives and capital grants from PSE.

The HVAC system came in under $22/ft^2 installed, or 7.2% of the project's total construction costs. No natural gas is available in Port Townsend, so the heat pump system will provide long-term energy cost reductions for the non-profit building owner compared to the alternative heating energy of electric resistance or propane.

Conclusion

Through the use of natural resources, such as the ocean-source heat pumps, daylighting and natural ventilation, the NWMC minimizes its energy use and costs. The environment-friendly design of the pier demonstrates how building projects can minimize adverse effects on the natural environment. The end result provides indirect and direct community benefits, including reduced pollution, protection of natural habitat for fish and plants and a gathering place to celebrate and learn about the area's maritime culture. ●

BUILDING TEAM

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General Contractor Greg Parrish, Owner, Primo Construction

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Electrical Engineer, Lighting Design Edward J. David, Principal, J Omega

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