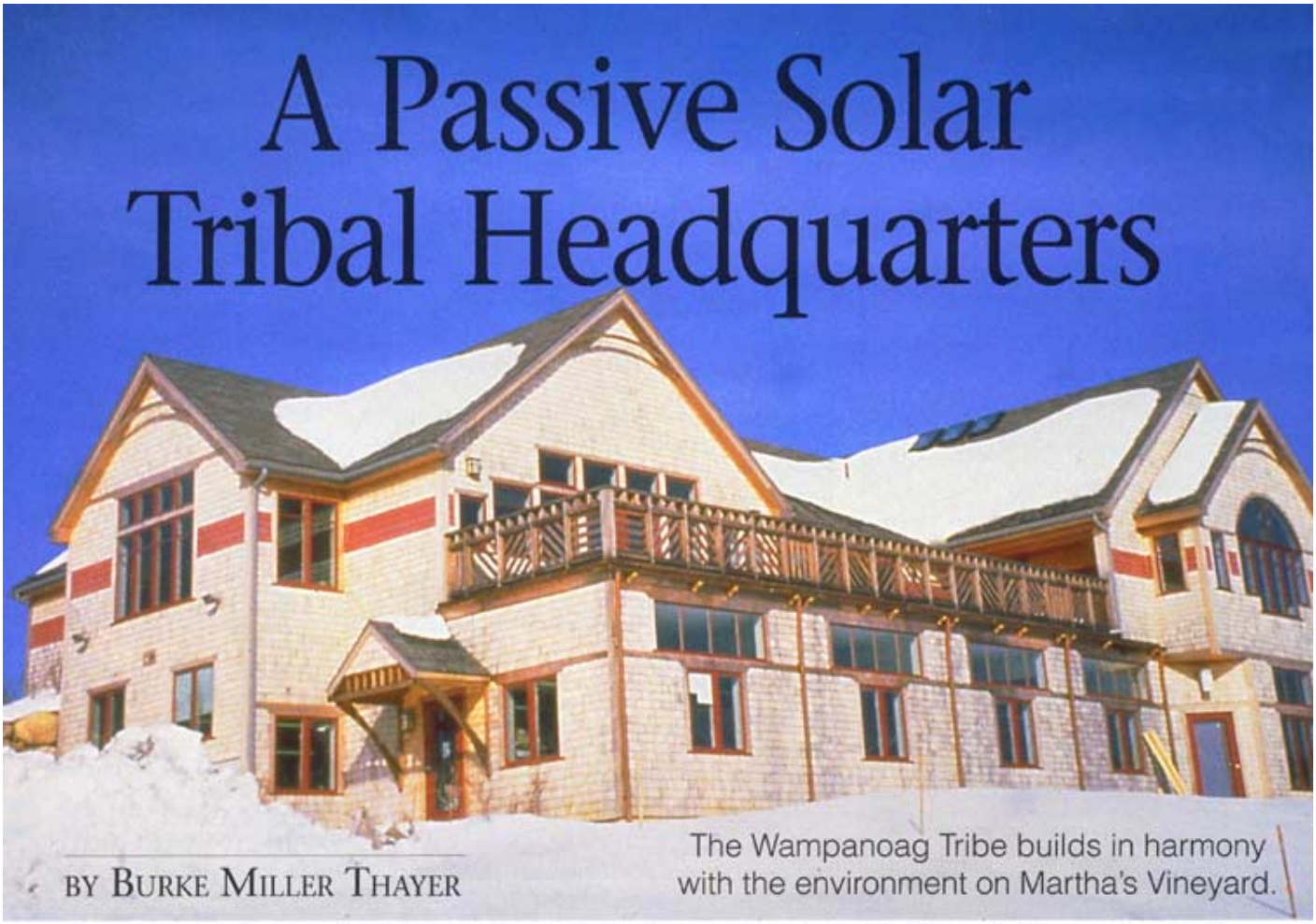
A Passive Solar Tribal Headquarters



The Wampanoag Tribe builds in harmony with the environment on Martha's Vineyard.

BY BURKE MILLER THAYER

The Wampanoag Headquarters reflects the tribe's traditions and values. The 2-story, 8,600 ft² (799 m²) building uses low impact, environmentally sustainable technologies to meet its energy and resource needs. It also saves the tribe $7600 on its annual energy bills.

Tribal members felt it was essential to honor what is to them a sacred and powerful site, and to use low impact, environmentally sustainable technologies.

This is the fifth in a series of six SOLAR TODAY articles describing successful sustainable energy buildings throughout the U.S. The series is part of the Buildings for a Sustainable America Education Campaign, co-sponsored by ASES and the Passive Solar Industries Council. This article was written for the Office of Building Energy Research, U.S. Department of Energy (DOE), through the National Renewable Energy Laboratory in Golden, Colorado, a DOE national laboratory.

The Wampanoag tribal headquarters has a soul. People can feel it when they enter. The building seems to speak of home, of family and of harmony with the earth. It reflects the spirit that still lives in this small group of Native American people who have inhabited Martha's Vineyard for many hundreds of years.

Completed in 1994, this small commercial building has become the new hub of Wampanoag community life. An administrative, educational and social center for the tribe, it reflects Wampanoag traditions, values and newly rediscovered identity.

When the Wampanoags began discussing their community building, they knew they wanted it to have as little impact on the natural environment as possible. As tribal chairwoman Beverly Wright puts it, "As Native Americans, we have always been environmentally sensitive, and we wanted our tribal headquarters to reflect that." Tribal members felt it was essential to honor what is to them a sacred and powerful site, and to use low impact, environmentally sustainable technologies.

Large south-facing windows in the second story welcoming area provide direct solar gain and an expansive view of the Atlantic Ocean.

Design Objectives

The tribe hired ARC Design Group, an architectural, engineering and construction management firm, to help them translate their values into a well-conceived and well-constructed building. Several important design objectives emerged from the early discussions between ARC principals and tribal administrators. Their most significant two objectives in the context of sustainable building design were to build in harmony with the environment and to create an integrated design and construction process.

Both the designers and the owners wanted the new headquarters to have as little impact on the environment as possible over the course of its lifetime. Among other things, this meant conserving energy and making use of passive solar energy. This task was a significant challenge, given the cold, humid and often cloudy winter weather combined with hot, humid summers off the coast of Massachusetts.

Integrated Design/ Construction Process

The principals of ARC Design Group include architect Bruce Coldham, sustainable systems engineer Marc Rosenbaum and designer/builder John Abrams. For the Wampanoag project, they added a site designer and structural engineer to their team from the very beginning of the design process. As a member of the design team, each professional was responsible for considering the building as a whole system of integrated components. This approach is different from the way most commercial buildings are built. According to Coldham, "Most buildings are designed as a settlement between the various designers, each defending their own turf." In an integrated approach, everyone's decisions are made in full consultation with everyone else, so that nothing is "cast in stone" before it can be fully evaluated from all the different perspectives.

The integrated design approach required an integrated construction approach as well. So rather than hiring a general contractor, the Wampanoags hired a construction superintendent, Gino Mazzaferro, to oversee the entire construction process. Mazzaferro's early involvement as a team member in the design process helped the team to avoid mistakes and enabled him to ensure that the designers' intentions were faithfully implemented.

Solar and Energy-Efficient Design

The 8,600 ft² (799 m²) Wampanoag headquarters includes office space, a kitchen, large and small meeting rooms, health facilities, a library and display areas. It is 110 feet (33.3 meters) east to west and about 40 feet (12.1 m) north to south.

The siting of the building is a good example of how the integrated design process worked in practice. The owners and ARC initially assumed they would perch the building at the highest point on the site to take full advantage of the magnificent view of the Atlantic Ocean. Early input from the site designer, however, helped the team to see a better alternative before completing the schematic design. The alternative building design and siting resulted in a lower profile and a less obtrusive presence on the land.

With the north wall set into the south-facing hillside, one story is above grade on the north and two stories are above grade on the south. A large deck and strategically located second story windows allow the occupants to take in the ocean view. The siting and orientation shield the building from the harsh winter winds and cold and give it maximum exposure to the sun. Sixty-five percent of the window area faces south, which allows the sun to provide a significant portion of the building's heating needs.

The design/construction team paid careful attention to insulation levels and air infiltration. The R-22 walls are 2x6 construction with blown-in-blanket fiberglass, which does a more complete job of filling the wall cavities than traditional batts. The vaulted ceilings are insulated to an R-value of 40. Minimally insulated commercial buildings in this climate have R-11 walls and R-30 ceilings.

One of the benefits of the integrated design/construction approach was careful attention to detail. For example, Abrams, Coldham and the structural engineer collaborated on framing techniques that allowed parts of the building to be insulated that are often neglected in conventional construction. Mazzaferro then made sure that the framers followed through. Rosenbaum worked closely with Mazzaferro and the insulating contractor to achieve an extraordinarily airtight building. During the sealing and insulating process, Rosenbaum performed blower door tests to check air infiltration and identify places that required more attention. The final blower door test indicated less than one air change per hour (ACH) at 50 pascals of pressure, which is an exceptionally low leakage rate of less than 0.1 ACH at ambient air pressures.

Because electrical lighting is typically the largest energy load in an office building, the designers incorporated advanced daylighting techniques in tandem with state-of-the-art lighting controls. Interior light shelves combine with south-facing windows to reflect sunlight deep into the first-floor work spaces, which are open and

South-facing windows combined with light shelves provide daylighting for first-floor work spaces. The light shelves bounce light through interior clerestory glazing into north rooms more than 30 feet away.

expansive to make maximum use of the natural light. The ceilings on this level are almost 11 feet (3.3 m) high, which allows deeper light penetration and creates a more expansive feeling. Advanced lighting controls dim and raise lighting levels depending on the amount of daylight available.

The designers chose low-e, argon-filled glazings for all windows while optimizing them for different orientations. For the south windows, they used LOF's Energy Advantage™ glass, which transmits more solar radiation than most low-e glazings. For the other three sides, they specified Cardinal LoE2-171 glass, which reduces summertime heat gain while providing good visible light transmittance.

With low electric lighting usage, the heat load from internal sources is smaller than in most commercial buildings. This fact, combined with high insulation levels, low-e glazings and appropriate window placement and building orientation eliminated the need to install mechanical cooling except in the copier room, which needs dehumidification.

Mechanical Systems

The building's back-up space heating is provided by an oil-fired hydronic system, which automatically adjusts water temperature relative to the outdoor temperature to operate at maximum efficiency. A heat recovery system uses exhaust air from the composting toilet system to heat all domestic hot water.

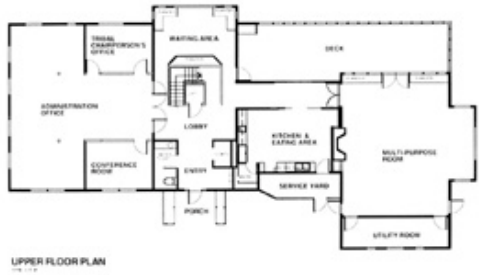
To maintain air quality in this very tightly constructed building, the designers incorporated a heat recovery ventilation system, which operates continuously so that each room is always getting fresh air. Because the building has no basement, crawl space or suspended ceilings, designing the ductwork for the ventilation system was a challenge. This was another area in which the team approach to design paid off. The architect, mechanical engineer and structural engineer worked together to make sure that the duct design fit flawlessly with the structural components. This meant that the installers could devote their full attention to performing a quality installation job instead of figuring out how to get around beams.

The Wampanoag headquarters uses about half the energy of a comparable building in the Martha's Vineyard climate.

Energy Performance

The Wampanoag headquarters uses about half the energy of a comparable building in the Martha's Vineyard climate. With future fine-tuning of the heating and electrical control systems, the designers expect it to use even less. All three members of the ARC Design Group have been back to the building several times to check on and make improvements in its operation, and they stress that this is a crucial and often overlooked part of the design and construction process.

The designers calculate that a comparable conventionally-designed building would have a combined heating and electrical load of about 64,000 Btu/ft²/yr (727 million joules/m²/yr), including domestic water heating. The new Wampanoag building requires 13,300 Btu/ft²/yr (151 million joules/m²/yr) for space heating and 16,900 Btu/ft²/yr (192 million joules/m²/yr) for lighting and other electrical loads, including the small amount needed to operate the composting toilet and domestic water heating systems. This is a 53 percent reduction in overall energy load compared to the reference case.



UPPER FLOOR PLAN

LOWER FLOOR PLAN

Dollars and Sense

The design and operation of the Wampanoag headquarters is not only better for the environment, but makes sense for the tribal pocketbook as well. The conservatively predicted energy bills for a reference case building would total about $13,200 per year for space and water heating, lighting, cooling and office equipment. The Wampanoags are spending about $5,600 (a savings of $7,600) for at least the same services. They actually use their building during more hours and for a broader range of purposes than what ARC Group assumed for the reference building. The solar/energy efficiency features added only about $39,000 to the cost of the million-dollar Wampanoag building, so the tribe is saving a minimum of $7,600 each year in return for their initial extra investment of $39,000. This gives them a simple payback time of a little over 5 years. Or, figured another way, their solar/efficiency energy-invested dollars are paying handsome annual dividends of 19%.

Green Building

In addition to low energy requirements, the Wampanoag building makes use of an extensive list of resource-efficient, salvaged and recycled materials such as tile made from recycled glass, carpet made from recycled plastic bottles, insulation made from recycled styrofoam containers and natural linoleum flooring. The designers also required low-toxicity paints and finishes and non-adhesive floor covering installation.

A waterless composting toilet and graywater system, which includes extensive plantings in deep-soil beds, converts all human waste and wastewater to resources used within the building. In addition, the building is equipped with a comprehensive solid waste recycling system.

The Key to Success

The integrated design/construction process was the key to the success of the Wampanoag headquarters. This process made it much easier than it would have otherwise been for the designers and subcontractors to initiate and follow through on innovative and environmentally sensible designs and practices. The flexibility of the process also allowed the tribe to spend approximately 40 percent of their construction budget with tribal-member-owned businesses and 95 percent within

the local island economy.

The Wampanoag building is an excellent example of how an integrated team approach and concern for the environment can translate into environmentally friendly, aesthetically uplifting and economically practical building design. ✪

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The ASES/PSIC Buildings for a Sustainable America Education Campaign is a nationwide effort to make policymakers, building professionals and consumers more aware of the benefits of applying sustainable energy principles to building design and construction. These benefits include increased affordability, more jobs, less environmental impact, reduced energy consumption and improved health.

Here's how the Wampanoag Tribal Headquarters stacks up:

Energy
53 percent overall reduction in total energy load

Environment
Combination of power plant emissions and oil-fired boiler emissions eliminated per year through savings in both electrical and heating load:
SO2 — 948 lbs (431 kg)
NOx — 351 lbs (160 kg)
CO2 — 115,698 lbs (52,590 kg)
In Massachusetts, a significant percentage of electrical energy is generated by nuclear power plants. This means that using less electricity reduces the environmental impacts of nuclear waste as well as fossil fuel extraction and combustion emissions. Using less oil for heating reduces the impacts of oil exploration, production and spills in addition to air pollution.

Affordability
$134/ft²—about average construction cost for commercial facilities of comparable size and quality in similar off-shore locations. The added cost of $39,000 is offset by energy savings of $7,600/yr. This translates to a simple payback of about 5 years or a 19 percent annual return on investment.

Jobs and Economy
The Wampanoags have $7,600 per year to spend in the local economy that they would otherwise be spending on energy. The net effect is more jobs and a healthier economy. They were also able to spend 40 percent of their construction budget with tribal-member-owned businesses and 95 percent within the local island economy.

Health and Productivity
By reducing emissions from fossil fuel combustion and wastes from nuclear plants, the Wampanoag building reduces health risks to the population as a whole (such as lung disease and cancer). By using daylighting, indoor trees and plants, and low-toxicity materials and by providing continuous ventilation, the building also enhances the physical and mental well-being of its occupants.

Wampanoag Tribal Headquarters Project Details

Project Description: Tribal Offices and Community Space
Owner: Wampanoag Tribe of Gay Head (Aquinnah)
Designers: ARC Design Group, Chilmark, Massachusetts; John Abrams, Marc Rosenbaum, P.E., Bruce Coldham, Principals.
Construction Supervisor: Gino Mazzaferro
Location: Gay Head, Martha's Vineyard, Massachusetts
Size: 2 story, 8600 ft² (799 m²)
Construction Cost: $1,150,000
Date Completed: January, 1994
Heating Degree Days: 5982
Cooling Degree Days: 450

ENERGY PERFORMANCE

	Reference (predicted)	Wampanoag TH (actual/predicted*)	Percent Reduction
Heating	22,700 Btu/ft²/yr (258 million joules/m²/yr)	13,300 Btu/ft²/yr (151 million joules/m²/yr)	41 %
Electrical (lighting, office equipment, ventilation and hot water)	41,300 Btu/ft²/yr (469 million joules/m²/yr)	16,900 Btu/ft²/yr (192 million joules/m²/yr)	59 %
Total	64,000 Btu/ft²/yr (727 million joules/m²/yr)	30,200 Btu/ft²/yr (343 million joules/m²/yr)	53 %

SOLAR FEATURES
- 765 ft² (71 m²) south-facing glass
- 4 foot (1.2 m) interior light shelf with dedicated daylighting glass above
- minimal east or west glazing

ENERGY EFFICIENCY FEATURES
- R-40 roof (BIBS fiberglass)
- R-22 walls (2x6 cavity with BIBS fiberglass), minimal thermal bridging
- Airtight construction (0.97 AC/H at 50 pascals, <0.1 AC/H at ambient pressure)
- Low-e, argon-filled glazing tuned to orientation
- Heat recovery ventilation
- High-efficiency lighting equipment and controls
- Heat recovery from compost toilet exhaust air heats all domestic hot water
- Water conserving plumbing fixtures and waterless toilets

ADDED COST OF SOLAR/EFFICIENCY FEATURES

Actual Cost of Wampanoag TH	$1,150,000
Predicted Cost of Reference Case	$1,111,000
Total Added Cost	$39,000

ENERGY BILLS	Reference (predicted)	Wampanoag TH (actual/predicted*)
Heating	$2,200/yr	$900/yr
Lighting/Electric	$11,000/yr	$4,700/yr
Total	$13,200/yr	$5,600/yr

ENVIRONMENTAL/HEALTH FEATURES
- Continuous ventilation system
- Daylighting
- Plantings in graywater treatment beds
- Non-adhesive installation of carpet and linoleum
- Low toxicity paints and finishes
- Extensive use of resource-efficient, salvaged and recycled materials
- Comprehensive solid waste recycling system
- Waterless composting toilet system
- Graywater filtered and treated in planters within the building

*prediction based on measured performance for first nine months of 1994