



Middlebury College

Middlebury, Vermont

*Steam Heats, Cools, Provides Electricity
at Pioneering Vermont College*

“**T**he College wanted to get the fullest possible use of its steam plant. Installing backpressure turbo-generators along with absorption chillers was a logical step.” In this way, Michael Moser, central heating plant manager at Middlebury College describes the College’s successful program for steam plant utilization. The College is located in Middlebury, Vermont, about 30 miles south of Burlington.

Middlebury College was founded in 1800 by Timothy Dwight, then President of Yale College. The school’s original purpose was to train young men from Vermont and neighboring states for the ministry and other learned professions of the early 19th century. In 1883, it became one of the first formerly all-male schools in New England to admit women. Today, it has an international reputation for its programs in the sciences, arts, and humanities. The College also has a reputation for innovative solutions—in its academic programs, and elsewhere.





All of the major building cooling on campus is done by Trane absorption equipment.

Pioneering Academic Programs

One of the College's best-known programs is its Bread Loaf School, a summer academic program offered since 1920 at a Green Mountain location away from the central campus. Among the long list of mentors at the Bread Loaf School was New England poet Robert Frost, who participated in the program for 42 years.

The College has an enrollment of 2,100 students, mostly residential, and offers both undergraduate and graduate degrees. The picturesque main campus on rolling hills in the Village of Middlebury features academic buildings, a chapel, and residence halls all constructed of gray stone and fitting into a harmonious overall appearance. The College has a close, historic relationship with the Middlebury village community.

Broad Campus Steam System

Currently 36 buildings comprise 1.6 million square feet on the 350-acre campus. All receive heating service from a campus steam system. The system supplies heating, domestic hot water, laundry, and steam for food service. Steam is produced by boilers at the Service Building in the central part of the campus. The boiler fuel is No. 6 oil.

The College's four steam boilers consist of a 1963 Babcock & Wilcox, a 1968 Cleaver-Brooks, a 1985 Zurn, and a 1999 Babcock & Wilcox. The two earlier boilers operate at 125 psig, and the two newer ones at 250 psig. The newest boiler was installed to meet the requirements of Bicentennial Hall, the science center that opened in 2000.

All of the major building cooling on campus is done by Trane absorption equipment. Because of the availability of surplus steam in the warm months, the College in 1976 installed its first Trane single-stage absorption chiller,



Trane single-stage absorption chiller in Bicentennial Hall.

serving the Johnson Art and Art History Building. The 150-ton machine is located in a basement mechanical room of the building. Because of the need for complete climate control for art materials, this chiller is held in readiness year-round.

A second 500-ton Trane absorption machine was installed to serve the Fine Arts Building when it was completed in 1991. In 2000, two more 500-ton single-stage Trane absorption chillers were installed in Bicentennial Hall, which was dedicated as the College celebrated its 200th anniversary. The operating season for these three machines is typically from early May through October.

These machines all supply 44°F (7°C) chilled water to air handlers that serve VAV boxes in the three buildings. According to George McPhail, who manages the HVAC system on campus, the College has been pleased with the comfort levels achieved with the absorbers and chilled water system. McPhail anticipates extension of building cooling systems in additional campus buildings.

Cleaver-Brooks Boiler





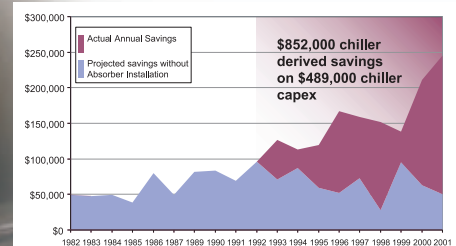
On-campus Electric Generation

The unusual aspect of the Middlebury College system is its use of backpressure steam turbine-generator sets in line with the boilers to reduce the steam pressure and to provide electric energy for campus use. According to Moser, "The College recognized the opportunity to extract useful energy from the steam in the process of reducing it to our application levels of 22 psig or lower. We use these systems rather than pressure-reducing valves, and receive a significant amount of electric energy year-round."

The three turbine-generator sets were designed to match the specific steam supply conditions on the campus. One unit, rated at 250 kW, receives steam at 125 psig and reduces it to 22 psig. The other two units, rated at 600 kW and 850 kW, receive steam at 250 psig and also reduce it to 22 psig. The largest and most recent unit was designed and installed in 2000 by the Turbosteam Corporation of Turners Falls, Massachusetts. The outlet steam from all of the units goes to a common campus steam supply.

Chilled water goes to air handlers, like this Trane Modular Climate Changer unit.

According to Moser, the first turbine-generator set was installed in 1980. He notes, "Over the years, these units have been really trouble-free." The generator output is at 480 VAC, which is stepped up to the campus distribution voltage of 12.5 kV. He estimates that the generators provide approximately 10 percent of the campus electric requirement, depending on the time of year. The power supplier is Central Vermont Public Service and the delivered energy cost is about 8.5 cents per kWh. The College uses 20 million kWh/year. The units are located next to the boilers in the Service Building.



Savings increase estimated based on comparison of each year's capacity factor to 1992 baseline, all at current electric rates. Chilling is assumed to be a campus necessity, and its cost of production is therefore not included in this calculation.

Growing Opportunity for Steam Systems

Sean Casten, chief executive officer at Turbosteam, indicates that Middlebury College has been a pioneer in a growing trend of colleges and other institutions using this type of equipment. "Middlebury College understood that the pressure reduction process was an opportunity to increase their energy security and reduce their annual operating costs."

Casten points out that rather than generate all of their energy at a distant power plant and have it pushed down the line to the College, they can meet some of their requirements right here on campus. "And the incremental cost is very minor—less than 2.0 cents per kWh versus the 8.5 cents per kWh cost from the utility." He notes that at this retail rate, the turbine-generators on campus are today providing electric energy valued at \$170,000.



One of the three backpressure turbine-generators.

Casten says that the College system is a very good example of the benefits of backpressure turbine-generators. "The College has demonstrated that sub-megawatt sizes of backpressure turbine-generator sets make economic sense. At Middlebury College we have seen a payback for the systems of less than two years. There are many other institutions out there that have discovered that they can do the same thing."

Synergies from Absorption Plant

In effect, the use of absorption chillers during the cooling season increases the potential output of the turbine-generators at times when the output of steam would otherwise be quite low. According to Casten, the savings achieved for the College over the past ten years with the turbine-generators combined with absorption cooling has totaled \$852,000, nearly double the amount achievable with the turbine-generators alone. These savings will grow even faster with the newer chiller and turbine-generator installations.

Emil Krieger from Trane Albany works with the College on a regular basis and notes that the electric generation system has no impact on the absorption chillers, except to make them an even more attractive comfort solution. "Single-stage absorbers like these need low-pressure steam. The College simply makes fuller use of the steam before it goes to the chillers. We'd recommend other steam users take a look at this option."

Middlebury College is growing, and plans are being made to extend steam lines and chilled water service to new campus buildings, including a dormitory and dining hall. Moser notes that with the greater level of steam use for new campus building, on-campus electric generation will increase proportionately. Just as Middlebury College has pioneered new ideas in education, with absorption cooling and turbine-generators it is also showing the way for many other energy users.



New facilities require more electric energy and more chilled water service.



Trane
A business of American Standard Companies
www.trane.com

For more information, contact your local district office or e-mail us at comfort@trane.com

Literature Order Number	CASE-SLX071-EN
Date	August 2002
Supersedes	New
Stocking Location	La Crosse

Trane has a policy of continuous product and product data improvement and reserves the right to change design and specifications without notice.