

## *A Successful Combined Heat and Power Project at the University of New Hampshire*

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### ABSTRACT

The University of New Hampshire (UNH) is in the midst of a major construction and renovation program. Construction of new buildings has exceeded the capacity of the central heating system. Equipment in the existing central heating plant is aging, with some of the boilers over 60 years old. UNH investigated options for utility system upgrades. Because of electric rate uncertainty, UNH focused on options that included self-generation of electricity. The CHP plant has one 7.9 MW dual fuel turbine with heat recovery steam generator and auxiliary duct-firing. The building was designed and constructed to drop-in two additional turbines as UNH adds buildings over the next 20 years. The initial CHP configuration will provide about 90 percent of UNH electric needs and all heating needs.

### THE ENVIRONMENT

The University of New Hampshire is one of the largest energy users in the state with total energy expenditures of over \$13 million in FY 2005. The campus has 12,500 full-time students and provides heating via a 300,000 pound/hr district steam facility and electricity from the local utility with a summer peak load of 13 megawatts. Loads have been growing on average at 1 to 2 %/year and there is significant impetus to add central cooling to existing and prospective facilities to increase summer campus utilization.

Currently, the University of New Hampshire is in the midst of a major construction and renovation program.

Planning estimates identify approximately \$10 million of additional capital spending for air conditioning capacity in existing buildings over the next twenty years, with nearly \$5 million needed over the next five years.

The New Hampshire legislature recently passed electricity deregulation laws that created significant uncertainty about future electricity rates. The existing special contract between UNH and its local electric utility company was approaching the expiration date. There was a potential for UNH to lose the significant discounts associated with that special contract.

There are major budget pressures at UNH for a number of reasons including:

- low state funding levels,
- increased benefits costs and,
- reduced investment income as a result of low interest rates.

As a result, a major campus-wide cost containment effort was initiated with the facilities division being asked to shoulder significant budget reductions.

## EVALUATING OPTIONS

To address the aging utility infrastructure and needs for increased heating and cooling capacity, UNH investigated options for utility system upgrades. Because of electric rate uncertainty, UNH focused on options that included self-generation of electricity.

To begin the process, UNH hired a local engineering firm with extensive utilities experience to conduct a broad-brush study of a new combined heat and power (CHP) plant on campus. The results of that study indicated significant economic benefits from a CHP plant. UNH then commissioned that engineering firm to conduct a detailed CHP study. That study demonstrated even greater economic benefits than the initial study. Based on those results, UNH decided to test the viability of a CHP solution in the private sector by soliciting qualified vendors.

UNH placed one advertisement in a national energy publication requesting qualifications from interested firms and received qualifications packages from over 50 companies across the US. After a comprehensive

review of those qualifications, six firms were selected as semi-finalists. After further review, three finalists were invited to prepare detailed proposals.

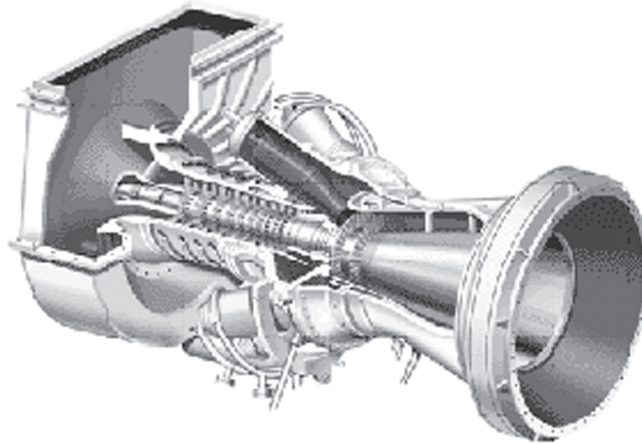
The RFP was purposely very open-ended, because UNH wanted the finalists to use their experience and creativity to develop the best solutions for UNH's utility infrastructure needs. To encourage a strong effort developing their proposals, UNH offered to pay each firm that met the RFP requirements \$100,000 upon signing a contract with one of the other firms.

One firm dropped out of the RFP process because of corporate restructuring and a decision to focus on other business activities. The other two finalists submitted detailed proposals. After a comprehensive review of the proposals, UNH selected EMCOR Energy and Technologies, Inc. (EE&T) as its partner to develop a long-term utility infrastructure solution.

#### THE SOLUTION

The project was based on a design-build contract with EMCOR and full commercial operations began a few months ago. The CHP plant design initially has one 7.9 MW dual fuel turbine with heat recovery steam generator and auxiliary duct firing. At the time of selection, there were two companies that offered turbines in the needed size. The two were Solar and Siemens, which the University selected the Siemens turbine based on its dual fuel capability and price. Figure 1 is a picture of the 7.9 MW Siemens "Tempest" turbine. The building to house the CHP was designed and constructed to drop-in two additional turbines as UNH adds buildings and their associated loads over the next 20 years. The plant was also designed to add several thousand tons of chilled water capacity as air conditioning is added to buildings in that area of campus. The initial CHP configuration will provide about 90% of UNH electric needs and all heating needs. The existing UNH district heating plant was left in place for redundancy and fuel arbitrage opportunities. The turbine can fire on liquid fuel or natural gas and the boilers can burn number 2, or 6 oil or natural gas.

A central chilled water plant with electric centrifugal chillers was also constructed at a different location on campus. That building was designed for about 2,400 tons of chilled water capacity with 1,200 tons installed initially.



**Figure 1. 7.9 MW Siemens Tempest Turbine.**

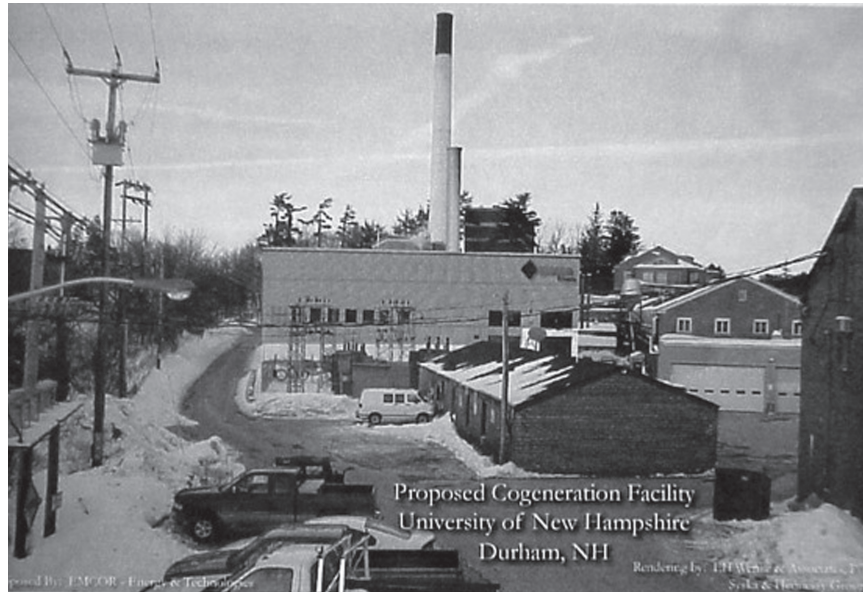
As part of the campus cost containment effort, UNH decided to privatize the facilities functions. In accordance with that decision, the utilities project will include EMCOR taking over operations and maintenance responsibilities for the new CHP plant, the existing heating plant, all campus chillers and the campus electrical distribution system. EMCOR offered positions to all of the existing heating plant staff.

The CHP project had the usual startup issues with interconnection, automation and general learning of the system by the staff. The local utility was not helpful throughout the project because they lost a significant load by the University choosing to self generate.

The construction budget, including contingency, was \$28 million. The annual O&M contract is expected to be in the range of \$1.5 to \$2.0 million. Depending upon variables such as fuel and utility electricity costs, the net present value (NPV) 20-year savings are expected to be in the range of \$30 to \$60 million. The CHP project will solve UNH's heating and cooling capacity challenges and provide significant cost reductions for the facilities division. Figure 2 shows the CHP plant on the University campus.

#### RENEWABLE FUEL PROJECT

The University of New Hampshire is about to use renewable landfill gas as an alternative to natural gas and liquid fuel, which will



**Figure 2. University of New Hampshire CHP Plant.**

improve the local and regional environment over the long term, while also helping the University deal with rising energy costs. The environmental improvements from burning landfill gas are substantial, and will begin when the project comes on line in late 2007.

Landfill gas is created when waste in a landfill decomposes. Landfill gas contains about half methane and half carbon dioxide, with small amounts of oxygen, nitrogen, and hydrogen, and trace amounts of hazardous air pollutants (less than 0.2%).

The project established a partnership between the University and Waste Management Incorporated. UNH will purchase landfill gas from Waste Management at their Turnkey landfill site in Rochester, New Hampshire. Currently, Waste Management directly flares 6000 standard cubic feet, which will grow to 12,000 SCF of the gas, into the atmosphere. The University will use that gas for almost all of its energy needs.

For the University to use the gas in the 7.9-MW turbine, the landfill gas must be significantly scrubbed to increase the heat content of the fuel. The refining of landfill gas to the limit the gas turbine requires does not have a long commercial history and no process has more than a few reference installations to examine. Yet, technology does exist for

each unit operation process that is required. The need is to remove as much of the sulfides, siloxanes and heavy organic compounds before beginning the separations of methane, CO<sub>2</sub> and nitrogen. Virtually all of the carbon dioxide will be removed during the processing of the gas.

To use the processed landfill gas on the UNH campus, a pipeline will be constructed between UNH and Waste Managements Turnkey landfill in Rochester, NH. This 12-mile long pipeline would run along a local turnpike, as well as along existing rail lines, and through some private property.

The successful CHP project described above will be enhanced both environmentally and financially with the new renewable fuel.

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#### ABOUT THE AUTHOR

**Allan E. Braun, Jr.** is President of Braun Consulting which specializes in finding new and innovative ways to increase efficiency and/or reduce expenses in higher education facility operations. He has over thirty-five years of facilities and operations experience. From 1996 until March 2006, Mr. Braun was the Assistant Vice President for Facilities at the University of New Hampshire. From 1994-1996, he was the Associate Vice Chancellor for Facilities Management at the University of Illinois at Chicago, IL. And, from 1987-1994, he was the Associate Vice President for Facilities at Yale University in New Haven, CT. Mr. Braun has had numerous other facility responsibilities dating back to the 1970's. He may be contacted at [AllanBraun@comcast.net](mailto:AllanBraun@comcast.net).