Geothermal Perspective

“We’ve been interested in energy conservation since the early 1970s. We studied geothermal designs in the 1980s and actually began using a geothermal system on our own campus in the early 1990s." This is Dr. Lynn F. Stiles, Professor of Physics at The Richard Stockton College of New Jersey. He is describing the background behind the installation of one of the world’s largest single closed loop geothermal HVAC systems, totaling 1,741 tons of installed heating/cooling capacity. Stockton uses heat exchange wells and water source heat pumps (also known as geothermal heat pumps) to serve the needs of a growing campus.

Stockton is located on a rural campus that has been recognized for its harmonious fit with its pinelands surroundings.

The decision to consider geothermal technology arose from a number of circumstances. In 1990, the administration was interested in reducing energy costs. The College was planning replacement of its aging rooftop HVAC units, most of which dated to the school’s original construction in the early 1970s.

Time to Consider New Directions

Dr. Stiles had researched the merits of modern geothermal heat pump technology and urged the College to consider this innovative option. The Geothermal Project design featured 400 heat exchange wells located in boreholes 425 feet deep. These were installed in a 3.5 acre area that included the College’s Parking Lot 1 plus some adjacent open space. Grants totaling $5.1 million were provided by the New Jersey Departments of Environmental Protection and Higher Education, and a rebate was received from the Atlantic City Electric Company. The high-efficiency geothermal system was designed to serve most of the academic buildings on campus.

Research grants totaling almost $1 million were obtained in order to study the environmental and energy use impacts of the project.

Pine Barrens a Protected Area

Because of the protected environmental status of New Jersey's Pine Barrens, the College had to get special permits from the State's Pinelands Commission. Use of a parking lot reduced the disturbance of undeveloped land. The Commission was a concerned about three aquifers that would be penetrated by the wells. Construction plans demonstrated that ground water quality would be protected and the aquifers would be sealed from interchange with each other and with surface water. The College's decision to use only pure water (without anti-freeze) as the heat exchange medium also helped assuage the Commission's concerns.

Stockton College Parking Lot Plays a Major Part in System Design

Four feet of surface soil was removed from the well field area and stockpiled before starting to drill and trench. After completion, the area was returned to its use as a large parking lot. The wells are located on a grid and spaced roughly 15 feet apart.

Plastic Pipes Slide into Boreholes

Within each four inch borehole, the installers placed two 1.25 inch diameter high density polyethylene pipes with a U-shaped coupling at the bottom.

After the pipes were installed, the boreholes were backfilled with clay slurry to seal them and to enhance heat exchange. In total, the loop system includes 64 miles of heat exchange pipe. In addition, 18 observation wells were located in and around the well field for long-term observation of ground water conditions. The individual wells are connected to 20 four inch diameter lateral supply and return pipes. The laterals, in turn, run to a building at the edge of the field where they are combined into 16 inch primary supply and return lines. These lines are connected to the heat pumps which serve Stockton's buildings. In the heating mode, the loop serves as a heat source and, in the cooling mode, as a heat sink. The heat pumps range in size from 10 to 35 tons. All are equipped for with air economizers.

The equipment is controlled by a building management system using 3,500 data points. This allows the College to take advantage of energy saving options such as duty cycling, night setback and time of day scheduling. The building management system also identifies maintenance needs in the system.

The system changeover took place during the holiday period in the winter of 1993-1994. The system immediately demonstrated that it could carry the entire planned heating load. In the first few years of operation, the average temperature of the well field has drifted upward by several degrees. This occurred because the buildings use more air conditioning than heating.

Energy Savings Meet Estimates

According to Stiles, the original estimate was that the geothermal system would reduce the academic building's electric consumption by 25 percent and natural gas consumption by 70 percent. "Because of the constant changes to the system, and other energy conservation steps, it was difficult to verify energy savings exactly. Based on extensive monitoring, the predictions turned out to be quite accurate." Stiles says that the project has passed the economic payback point and that the unusual approach was more than justified. In addition to the dollar savings achieved with the geothermal system, significant environmental and energy conservation benefits have accrued.

Alice Gitchell from the College's Office of Facilities Planning & Construction is actively involved in studying this type of technology. She notes that the Project substantially contributed to a calculated 13 percent overall reduction in the college's CO_2 emissions during a period of significant growth on the campus.

Because of its size and design, the geothermal system has made the campus a destination for many visitors from around the world. Gitchell says, "We’ve had visitors from China, Japan, Korea, Sweden, Germany, France, England and other countries." College representatives have given numerous presentations to professional groups and geothermal conferences.

The geothermal system was built with some additional loop capacity to allow for campus expansion, and smaller geothermal installations now serve six other campus locations with a total capacity of 650 tons.

Advice Offered to Other Owners

Because of the extended history of the project, Professor Stiles is frequently asked for advice by others contemplating geothermal solutions. Sizing, well executed building shells and accurate heat loss and gain estimates are essential. Also, heat pumps and the water pumps must easily accessible. Incorporation of a cooling tower may have advantages. Finally, it is critically important to insure that the design engineer gets all the support needed to understand geothermal technology and design.