BALL STATE UNIVERSITY®

Ground Source Geothermal
District Heating and Cooling System

January 27, 2019

Background

Founded in 1918, Ball State University is a state-assisted institution of higher education located in Muncie, Indiana, approximately 55 miles northeast of Indianapolis. The University is home to seven academic colleges offering almost 300 degrees at the baccalaureate, masters and doctoral level to approximately 20,000 students. Ball State's main campus occupies 731 acres of land and includes more than 47 major buildings enclosing approximately 6.5 million square feet of space for academic classrooms, administrative offices, sports facilities, and residence halls.

Campus structures are heated and cooled by a so-called district energy system. Such a system provides steam and chilled water to numerous buildings from central energy plants. Ball State's steam plant was powered by four coal-fired boilers and three natural gas fired boilers. The four coal-fired boilers were originally placed into service in the 1940s and 1950s. These four coal boilers due to condition, capacity limitations and EPA emission requirements were shut down as of March, 2014.

Project Description

Ball State University's geothermal conversion project replaces the university's existing coal-fired boilers and chilled water equipment with the nation's largest ground-source geothermal district energy system. This system simultaneously produces hot water and chilled water.

In 2005, the Indiana General Assembly authorized Ball State University to replace or upgrade its aging coal-fired boilers and provided the university with the initial $44.8 million to begin the project. After exploring a number of alternatives, the university decided to replace its existing heating and cooling system with a geothermal ground source heat pump system. The earth's ability to maintain a constant temperature makes it a renewable energy source.

The University's board of trustees approved the plan on February 6, 2009. On May 9, 2009, Senator Richard Lugar joined university officials in Muncie to break ground on the project.

Major Features

The geothermal energy system is composed of the following major elements:

- District Energy Stations:

Two “district energy stations” have been built at opposite ends of the campus. The stations include large capacity heat pump chillers (4 x 2500 ton capacity), which can produce 150 degree Fahrenheit water for heating purposes and 42 degree Fahrenheit water for cooling purposes. The heat pump chillers in these two

buildings feed hot and cold water into the same distribution system that provided heating and cooling for all major buildings on campus.

- Boreholes:

Located in two separate fields totaling 25 acres, three thousand six hundred boreholes have been drilled to depths of 400 to 500 feet each. Inserted in each hole is a U-shaped piping that circulates water down to and up from the bottom of each borehole. After construction, borehole fields were restored to their previous use as parking lots and sports fields. A total of 1,800 boreholes have been completed on the north side of campus and serve the north district energy station. A total of 1,800 boreholes have been installed on the south side of campus and serve the south district energy station. The 3,600 borehole provide a heat transfer system that is composed of 1,100 miles of piping in contact with the ground.

It is important to note that the boreholes are not wells. No groundwater is used in any part of this "closed loop" geothermal system. Rather, water is introduced one time and re-circulates throughout the system on a continuous basis. This continuous flow of water supports a thermodynamic process whereby thermal energy is transferred into or out of the ground. Accordingly, the system does not draw from or pose an environmental threat to the underlying aquifer.

- Hot & Cold Water Distribution Network:

An extensive hot and cold water distribution loop has been constructed on campus to transport more than 20,000 gallons of water per minute between the geothermal fields, the district energy stations / heat pump chillers, and campus buildings. Nearly ten miles of new distribution loop has been installed.

- Building Interfaces:

Each building will require an interface connecting the building heating and cooling system with the distribution network. Those buildings that are currently heated with steam will be converted to hot water.

Benefits

The base project has been completed. Several buildings not currently converted will be converted to the geothermal system in the near future when they undergo full renovation. The university retired its use of coal as a fuel source, eliminating the following emissions annually: 85,000 tons of carbon dioxide, 240 tons of nitrogen oxide, 200 tons of particulate matter, 80 tons of carbon monoxide, and 1,400 tons of sulfur dioxide. The university's overall carbon footprint will eventually be reduced by nearly fifty percent when all building conversions are complete.

The project provided several hundred contractors and suppliers' employment and an opportunity for an estimated 2,300 direct and indirect jobs. Nearly all components of the project are American made.

Dramatic energy efficiency improvement is another major benefit of the project. The current stoker boiler system has a co-efficient of performance (COP) of .62. "COP" is the standard measure of heating/cooling efficiency - the higher the COP, the better. The current electric chiller system has a COP of 5.02. The weighted average of current systems is a 1.04 COP. With the geothermal installation, the combined COP will be 7.77 - a seven-fold increase in efficiency. In monetary terms, the university has begun to save $2 million annually in energy costs.

Additionally, the project has demonstrated that a large-scale deployment of geothermal heat pump technology is feasible. Through this demonstration, Ball State will stimulate broader application of this technology throughout the United States.

Ball State continues to share information with other entities that are evaluating the technology for their own use. We have also been visited or contacted by many universities inquiring about the geothermal system. The list is extensive and a few of the universities include: Hampton University; Stanford University; University of Notre Dame; Ohio State University; University of Iowa; Northern Kentucky University; Colorado College; Oakland University; Michigan University; Miami of Ohio University and Pratt Institute.

Funding

Funding was authorized by the 2005 Indiana General Assembly in the amount of $44.8 million, and in 2013 the Indiana General Assembly provide authorization in the amount of $33.1 million, and in 2009 a $5 million grant from the U.S. Department of Energy from the American Recovery and Reinvestment Act (ARRA) provided additional funding thereby totaling $82.9 million for the project. Because of the efficiency of the system, the university has been able to reduce our annual utilities bills by more than $2 million.

Milestones

The project began with the north borehole field construction in May, 2009.
The north campus geothermal building was placed into service in January, 2012.
Ball State shut down its coal fired boilers in March, 2014.
The final quantities of boreholes were complete on October 17, 2014.
The south campus geothermal building was placed into service in January, 2015.