Final Scientific/Technical Report

DE-EE0004499

1. **Name of Recipient:** West Chester University
   Project Title: Design and Implementation of Geothermal Energy Systems at West Chester University
   Project Director/Principal Investigator: Greg Cuprak

2. **Patentable Information:** None. There is no restriction on the release of this information.

3. **Executive Summary:** West Chester University has launched a comprehensive transformation of its campus heating and cooling systems from traditional fossil fuels (coal, oil and natural gas) to geothermal. This change will significantly decrease the institution's carbon footprint and serve as a national model for green campus efforts. The institution has designed a phased series of projects to build a district geo-exchange system with shared well fields, central pumping station and distribution piping to provide the geo-exchange water to campus buildings as their internal building HVAC systems is changed to be able to use the geo-exchange water. This project addresses the US Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) goal to invest in clean energy technologies that strengthen the economy, protect the environment, and reduce dependence on foreign oil. In addition, this project advances EERE's efforts to establish geothermal energy as an economically competitive contributor to the US energy supply.

   For this grant, WCU will convert two classroom buildings to geo-exchange heating and cooling, build a central pump house and provide more wells. The two classroom buildings to be converted are Anderson Hall and Ruby Jones Hall. Anderson Hall is a 88,000 sqft building built in 1938. In 1993 it underwent a renovation and had water source heat pumps installed with steam to keep the water loop warm in winter and a cooling tower to remove heat from the loop in the summer. The existing 18 year old heat pumps will be replaced with new geo-exchange heat pumps, an energy recovery system and extra controls. The 23,000 sqft Ruby Jones was built in 1899 and last renovated in 1988. Its two pipe HVAC system which is currently heated with central steam in the winter and cooled with building chiller in the summer will be replaced with geo-exchange heat pumps, new water piping, energy recovery wheels and new makeup air ducts to the offices. A 4,200 sqft two level pump house will be constructed to move

water from the well fields throughout the campus. There will be one set of pumps to move water through the wells and another set of pumps to circulate water through campus. It will also contain water expansion tanks and a Spirovent to remove dirt and air from the water. A control system will be installed to provide just the right amount of circulation through these two systems. Finally, more wells will be drilled and added to a common well field system to support the extra load caused by adding two more buildings to this district system.

4. **Actual Accomplishments:** All goals and objectives of the Statement of Project Objectives were met. Anderson and Ruby Jones had their HVAC systems converted to a geo-exchange system in 2012. The Pump house was constructed and placed into operation at the end of 2012 and 88 more wells were drilled and added to the system by fall of 2013.

   The district geo-exchange system now has seven buildings connected together totaling 703,000 sqft. The University in addition is working several other projects which will add another six buildings and 450,000 sqft to the system over the next three years. Instrumentation has been installed so its operation and efficiency can be monitored.

   With the HVAC conversion of Ruby Jones and Anderson Halls, metering was installed to account for all the energy now being used by each of these buildings. This data is being recorded and will be uploaded on occasion to the DOE GDR.

5. **Summary of Project Activities:** The project was implemented by developing a good project plan which included developing a scope, timeline, list of milestones, and budget. The project was then divided into small parts being: 1) geoexchange conversion of Ruby Jones, 2) geoexchange conversion of Anderson Hall, 3) building of the Pump House, and 4) construction of eighty-eight more wells. Permits and approvals were obtained from appropriate state and local authorities for these various construction projects

   For the geoexchange conversion of Ruby Jones Hall, the winning mechanical and electrical contractors worked at night so as not to interfere with ongoing classes and installed fifty-three heat pumps, two energy recovery units, two variable speed pumps to circulate geothermal water through the building along with new temperature controls and controls on the geo-water circulating system.

   For the geoexchange conversion of Anderson Hall, the winning mechanical and electrical contractors worked during semester breaks and were able to get 3 classrooms at a time to install new geoexchange heat pumps and worked sequentially through the building. They installed eighty-three water to air heat pumps, four water to water heat pumps for

the makeup air and the existing perimeter heat systems, two variable speed pumps to circulate geothermal water through the building, four pumps for the perimeter heat loops and two pumps for the makeup air system along with new temperature controls and controls on the water circulating systems.

To build the 4,200 sqft pump house there were four contractors involved: a general, a mechanical, an electrical and the controls contractor. Once land development approval was received from the local township, construction started on the building. In the basement there are three 1000 gallon water expansion tanks, and a Spirovent separator to remove dirt and air from the geothermal distribution water. On the ground floor are 5 variable speed 150 hp campus distribution pumps and 5 variable speed 75 hp well field pumps along with an electrical distribution center to support the pumps and necessary controls and monitoring devices.

Eighty-eight more wells were drilled and connected to the pump house. The disturbed ground and paved areas were restored. There are now four hundred and thirty-eight 500 foot wells connected to the central pump house. Additional wells will be drilled in later projects and connected as more buildings are added to our district geoexchange system.

6. **Products Developed under Award:**
    a. **Publications:** There have been a number of articles about West Chester University transitioning to a district geo-exchange for its heating and cooling and about the various grants received from the Department of Energy to assist in the transition.
        - 2009 Vol. 6, No. 4 – Publication: GEO OUTLOOK – "West Chester, Converting to District Geothermal"
        - Summer 2010, WCU Magazine – "Geothermal Heating and Cooling Building Conversion: A Major Sustainability Initiative"
        - December 6, 2010, Philadelphia Inquirer Blog, - "$4.7 M U. S. Grant For Chesco Energy Field"
        - December 7, 2010, Philadelphia Business Journal – "West Chester U. gets $5M DOE grant"
        - December 9, 2010, Web Site: West Chester University News and Events – Public Relations and Marketing - "West Chester University Awarded $5 Million for Geothermal Project"
        - December 12, 2010 The Daily Local (dailylocal.com) – "Historic energy grant for WCU"
        - University News – "Largest WCU Grant Goes to Energy Project"
        - January 31,2011, Chronicle of Higher Education – "Energy Department Supports Project at 2 Climate – Commitment Signatories"
        - Winter 2011, WCU Signs of Excellence – "WCU Awarded $5 Million Energy Grant"

- January 15, 2013 - Pennsylvania Council of Professional Geologists Meeting - “West Chester University Well Field Performance” - presented by Dr. Martin Helmke
- January 25, 2013 - Pennsylvania Ground Water Association Meeting - “West Chester University Well Field Performance” - presented by Dr. Martin Helmke
- October 30, 2013 – Annual Geological Society of America meeting - “Performance of a large Geoexchange System in Fractural Gneiss of Southeast Pennsylvania” presented by Dr. Martin Helmke
- November 7, 2013 – Ball State Geothermal Conclave - “West Chester University Campus Geo-exchange System” by Greg Cuprak and Neal Babcock.

b. **Web Site:** This Grant supports one element of a much larger transition of West Chester University to a geo-exchange heated and cooled campus. The university website describes our efforts at this large transition: http://www.wcupa.edu/_INFORMATION/AFA/Facilities/Energy/default.asp

c. **Networks or collaborations fostered:** The University worked with two Engineering firms Buchart Horn (York, PA) and Alderson Engineering (Southampton, PA) for the geoexchange conversion of Ruby Jones and Anderson Halls. For Ruby Jones, Gaudelli Brothers (Millville, NJ) were the mechanical contractor and Cook’s Services (Avondale, PA) the electrical contractor. For Anderson Hall, Fluidics, Inc. (Philadelphia, PA) was the mechanical contractor with BSI Electrical (Montogomeryville, PA). Century Engineering, Inc (New Cumberland, PA) designed the pump house and well field. For the pump house the following contractors were involved Gordon H Baver (general – Pennsburg, PA), Gaudelli Brothers (mechanical – Millville, NJ), Yates Electrical Services (Quakertown, PA), and Radius Services (controls – Chadds Ford, PA). Jackson Geothermal (Morrisville, PA) drilled and connected the wells to the pump house.

Geologists at Ball State and West Chester University are starting to collaborate on joint studies of the geological impact of large well fields.

d. **Technologies/Techniques:** A challenging aspect of the project has been to reduce the noise of the well drilling machinery. We are drilling within 50 feet of residential neighbors for months at a time and the drilling rigs are very noisy. We have installed fencing with sound dampening material on which has helped to dampen some of the noise.

e. **Inventions/Patent Applications**: None

f. **Other products, data or databases**: None

7. **Computer Modeling:** No computer modeling was used.

8. **Acknowledgement:** This material is based upon work supported by the Department of Energy under Award Number EE0004499.

9. **Disclaimer:** This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.