WESTERN PENNSYLVANIA SCHOOL FOR THE DEAF
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The Residence at WPSD – Sustainability and Efficiency

WPSD Geothermal Heating and Cooling

The Western Pennsylvania School for the Deaf (WPSD) is a regional asset with a history of being an early adopter of technology with regards to helping those with hearing disabilities rise to their full potential. WPSD also wants to be an institutional role model with regards to being a wise steward of its resources while promoting sustainable development. As such WPSD has chosen to build a new LEED certified residence hall on its Pittsburgh Campus and to use a geothermal system to provide heating and cooling.

The U.S. EPA has stated, ***"Ground Source Geothermal is the most energy-efficient, environmentally clean and cost effective space conditioning systems available today."*** Geothermal heating and cooling solutions also benefit electric utilities, such as West Penn Power, by promoting load balancing through the addition of customers during the heating season and reducing peak loads during the cooling season.

The Residence project at WPSD is a perfect candidate for employing clean and sustainable building design. There is no better opportunity to demonstrate our commitment to the future than in the design and construction of the living quarters of our future adults and decision-makers. What better time in their lives to be exposed to the benefits of a well designed space that utilizes energy in a very efficient manner while having very little impact on their environment?

Our proposed system involves no combustion fuels and is completely electrically driven. However, compared to utilizing 100% electric heat, ground source heating equipment utilizes about 40% of the power, lessening the burden on the power supplier and the power distribution network.

Background: Geothermal Heating and Cooling

Geothermal Heating and Cooling systems, also known as Geothermal Ground Source Heat Pumps, work on the basis that it takes less energy to operate a heat pump by transferring heat into or out of the earth's moderate year round temperature than into the air with its temperature extremes. Geothermal systems are proven technology and provide significant life-cycle benefits over conventional HVAC technologies (i.e. Air Source Heat Pump systems or stand-alone furnaces with air conditioners) in terms of energy efficiency, emissions & environmental impacts, performance, reliability safety, and costs.

Geothermal heating and cooling benefits electric utilities by promoting load balancing, through the addition of customers during the heating season, and reducing peak loading during the cooling season. The installed geothermal heating and cooling capacity worldwide exceeds 4.4 million tons (1 ton = 12,000 Btus). The US alone has more than 1,000,000 geothermal systems with an installed capacity exceeding 2.4 million tons.

Geothermal systems, unlike solar or wind, provide renewable energy savings on a 24/7/365 basis. Efficiency savings are often in the range of 30% to 60% of space-conditioning energy consumption,

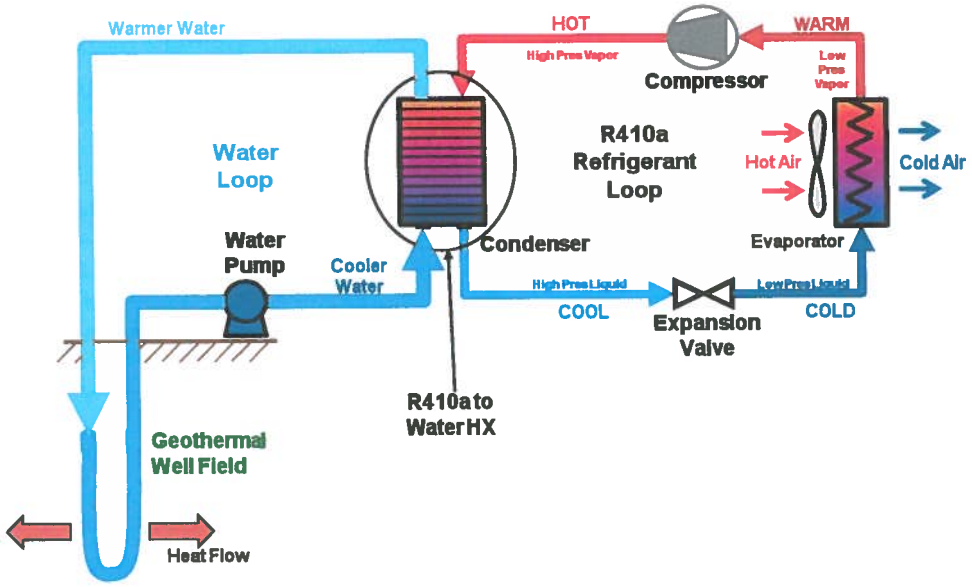
depending on system efficiency, technology replaced, climate, and application. If all technically U.S. applicable applications were converted to geothermal the annual national energy savings would approach 3.7 Quads. Additional geothermal benefits include that major system components are out of harm's way (i.e. buried and located indoors), provide for better space utilization, reduces heat signature, reduces noise and reduces local pollution.

However, despite the technology's maturity and many benefits the U.S. geothermal market is still only about 2% of the of the available HVAC U.S. market. Recent DOE studies have identified the major market barriers to rapid and widespread deployment of geothermal as: high installation costs and disruptions to the customer associated with installations.

How Geothermal Systems Work

Figure 1 diagrams the most common geothermal system operating in the cooling mode. This design has two cycles 1) Heat Pump Refrigerant Loop and 2) Water Loop. The heat pump cools the R410a refrigerant which is sent to an air side heat exchanger (evaporator) to cool the air. In this step, the refrigerant heats up and evaporates. The hot refrigerant travels to an R410a refrigerant to water heat exchanger where water is used to transfer the heat energy from the refrigerant into the geothermal well field where it is dissipated into the earth. This design is known as an "Indirect Exchange" geothermal well field design because it uses an R410a refrigerant to water heat exchanger to indirectly transfer heat removed from the air into the ground. To heat the air the cycle runs in reverse.

Figure 1: Indirect Exchange Water Geothermal System – Cooling Mode



Project Description

The WSPD Residence Hall project will house between 40 and 80 students. The 27,000 ft^2 facility is heating dominate with a peak heating load 384 MBH and a peak cooling load of 44.8 tons. The facility HVAC system was designed as a water-based indirect exchange geothermal system. Seventy, 0.5-1.5 ton water source heat pumps, are distributed throughout the facility and a 20 ton water source heat pump

system is used to condition fresh air. A 180 gpm water pump, housed in the mechanical room, moves water mixed with propylene glycol (30%) through a system of water pipes to the heat pumps distributed throughout the facility and into the geothermal well field to accept or reject heat energy into the ground. The propylene glycol serves to prevent the water from freezing. The distributed heat pumps heat and cool the both the building fresh air and return air, to provide year round comfort. Water is used to either accept or reject heat from the heat pumps. The water is then sent to the well field where the heat energy is transferred into the earth.

LEED Certification

A major part of attaining LEED 2009 NC certification involves reducing energy use relative to a baseline system which would comply with all mandated code requirements for equipment efficiency, control of HVAC systems, mechanical systems insulation, etc. Our HVAC design surpasses that benchmark by a conservatively calculated 17% due in large part to the efficiency obtained from utilizing the geothermal well field as a heat source and heat sink depending on the season and the building requirements.

An additional energy benefit results from the reduction of energy consumed by the domestic hot water system compared to current energy code mandates. The selected heaters for this project exceed the required efficiency by 20%. Also, water efficient fixtures reduce water consumption, both hot and cold, by 20% over the code required values.