

Geothermal Heat Pump Systems and Federal Tax Incentives



turn to the expertsSM A stylized green leaf graphic positioned next to the "experts" text.

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Syracuse, New York**

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INTRODUCTION

A geothermal heat pump system provides heating and cooling while reducing both energy usage and costs. When government incentives for installation of geothermal systems are utilized to obtain tax credits and accelerated depreciation benefits, the system can realize a lower first cost as well as greater long-term savings. This paper will describe the types of geothermal heat pump system installations and the ways in which Carrier heat pumps can help property owners achieve a faster return on investment.

GEOTHERMAL HEAT PUMP SYSTEMS

Water source heat pump (WSHP) systems have become a popular choice for commercial buildings where multiple zones of control are desired. The relatively constant temperature of the ground or ground water below the surface is moderate compared to the temperature of the outdoor air, which changes dramatically from season to season. Geothermal heat pump systems use the earth's resources as a heat source and heat sink. A lake, river, well, or the ground itself is used to add or remove heat to maintain an operable water temperature.

Typical designs include vertical loops and horizontal loops. In some applications, water is piped from the ground or lake directly to the water source heat pump. Piping is limited to the amount of pipe required to get the water from the source to the unit.

Horizontal Ground Loop

This system is used when adequate land area is available and trenching can be accomplished easily. Parallel pipes are laid out in trenches 3 to 6 ft below the ground surface, and then back-filled. Depending on the design, one to six pipes are installed in each trench. Multiple pipe and coiled "spool" configurations are often used to conserve land requirements and reduce overall installed loop costs. See Figure 1.

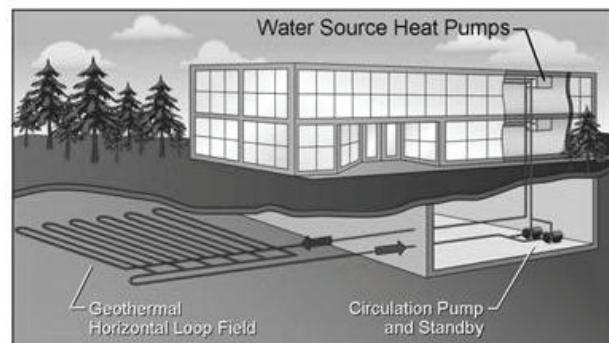


Figure 1 - Horizontal Closed-loop System,
Parallel Piped

The amount of pipe and the size of the ground loop field are based on ground conditions, heating and cooling requirements of the application, and system design. Trench lengths range from 100 to 400 ft per system ton. Pipes are spaced from 6 to 10 ft apart. The overall land area required ranges from about 750 to 1500 ft² per system ton.

Horizontal designs can use a series or parallel flow path. Series paths offer higher performance per pipe length, but a large pipe size must be used and the pressure drop can become too high.

Vertical Ground Loop

This design is well suited for retrofit applications when available land area is limited or where landscaping is already complete and minimum disruption of the site is desired. Vertical systems use piping installed in bore holes. Drilling equipment is used to bore small diameter vertical holes. Two pipes joined together with a U-Bend fitting are inserted into the vertical bore holes. The space around the pipe is filled with a grout material. This provides support and also promotes heat exchange between the pipe and the ground. The completed loop is concealed below ground. See Figure 2.

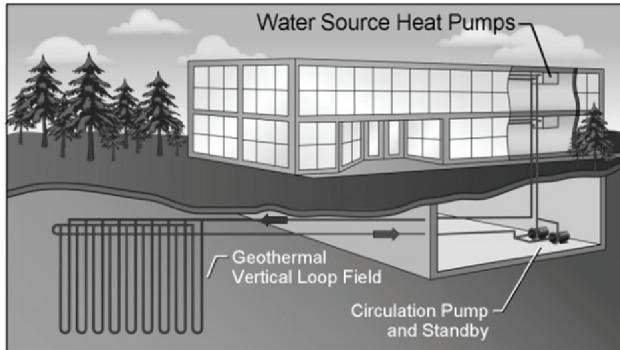


Figure 2 – Vertical Loop

Bore hole depth ranges from 100 to 300 ft per system ton. Bores should be spaced about 20 ft apart and properly grouted. The land space that is required ranges from 100 to 200 ft² per system ton. The number of loops required depends on ground conditions, depth of each hole, and load requirements.

Surface Water System (Pond or Lake Loop)

This system, located near a lake or pond, is very economical to install since it requires minimum piping and excavation. The loop can be submerged beneath the water surface. The water serves as the source for absorption and rejection of heat. See Figure 3.

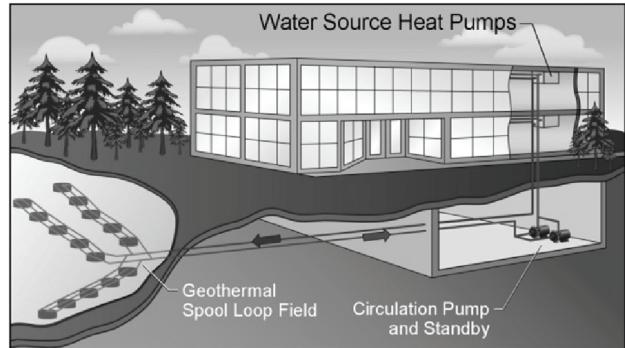


Figure 3 – Pond and Lake Loops

One popular design uses a spiral loop or “spool.” These designs require less area than straight pipe systems. A pond or lake is attractive as a heat sink because excavation costs are virtually eliminated. Coils or “spooled” mats of pipe can be placed in the pond or lake. A typical residence would require 1/4 to 1/2 acre of water surface at a depth of 8 to 10 ft. The coils should not rest on the bottom of the lake so heat transfer can occur on all sides of the coil.

Open Loop System

This system is used where good quality ground water is plentiful. In this application, ground water is pumped through supply piping from the well to the building. A well must have enough capacity to deliver a minimum of 1.5 gpm per ton. The water is then pumped back into the ground through a discharge well as it leaves the building. An additional heat exchanger is usually installed between the building water piping system and the ground water piping system. This design limits the amount of piping and excavation required. See Figure 4.

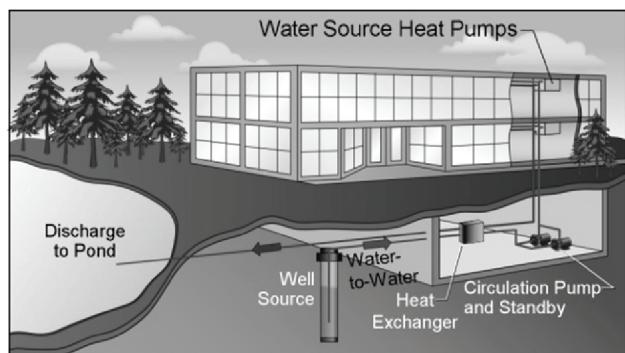


Figure 4 – Open Loop System

GOVERNMENT INCENTIVES ADD TO GEOTHERMAL HEAT PUMP SAVINGS

The renewable source of energy makes the geothermal heat pump system one of the most efficient HVAC systems available. Federal tax credit and depreciation deduction incentives increase the appeal of the cost-effective, flexible, geothermal heat pump system.

Federal Business Energy Investment Tax Credit

The Energy Improvement and Extension Act of 2008 (H.R. 1424), enacted in October 2008, expanded the Investment Tax Credit (ITC) to include geothermal heat pumps in the category of eligible energy properties and to extend the applicable period from October 3, 2008 through December 31, 2016. Under this resolution, a tax credit of 10% of dollars spent can be claimed for geothermal heat pump systems placed in service before the end of 2016.

There is no maximum limit on the credit, which includes cost of equipment and installation. The tax credit may be used to offset AMT tax. In addition, if the credit exceeds the tax liability, a loss can be carried forward for one year.

Accelerated Depreciation

Heat pumps offer operation flexibility and engineering robustness. These characteristics result in a long life cycle for the typical heat pump, which may remain in service for over 20 years. This long life cycle means that the geothermal heat pump system provides a significant return on investment. The return on investment may be achieved sooner through the use of Modified Accelerated Cost-Recovery (MACR) depreciation.

Energy property is classified as 5-year depreciable property. Geothermal heat pump systems are eligible for 5-year MACR depreciation on the entire system. A bonus depreciation is available for the first year.

The combination of the tax credit and the accelerated depreciation enhances the ability of the energy-saving geothermal heat pump system to quickly pay for itself.

Eligibility

The geothermal energy property must be located in the U.S. and the equipment must use ground or ground water as an energy source for heating and cooling the building. The eligible property must be placed in service between October 3, 2008 and

December 31, 2016. The equipment must also meet any performance and quality standards in effect at the time the equipment is acquired.

For information on federal tax credits and additional state incentives, visit the Database for State Incentives for Renewables and Efficiency at www.dsireusa.org.

Claiming Tax Credits and Deductions

Tax credits and depreciation deductions can only be claimed by the owner of the building. The original use of the equipment must begin with the taxpayer, or the system must be constructed by the taxpayer. The energy property must be operational in the year in which the credit is first taken. Visit www.irs.gov to download tax form 3468.

Excluded Property

The credit cannot be claimed for spending on equipment used solely for a purpose other than heating or cooling a structure, on previously used equipment, or on equipment that is used by an entity not subject to U.S. income taxes. These entities include schools, government agencies, charities, and other tax-exempt organizations. This also precludes tax-exempt entities from leasing energy property. However, energy purchase contracts are a mechanism that has been used to provide financing to these groups by the solar industry.

Payback Analysis

Following are examples of 3 geothermal heat pump system applications that may be eligible for the federal tax incentives. The table on the next page shows the resulting savings.

NEW CONSTRUCTION — A business spends \$750,000 to install a geothermal heat pump system in their brand new office building, which they move into in the 4th quarter of the year.

RETROFIT — A business that has owned their building for five years installs a \$400,000 geothermal heat pump system, replacing boilers and putting in a ground loop, all of which become operational in the 1st quarter of the year.

REPLACEMENT — In the 3rd quarter of the year, a business with a 25-year old heat pump system spends \$200,000 to upgrade to a Carrier geothermal system.

RESULTS

FINANCIAL FACTS	APPLICATION		
	New Construction	Retrofit	Replacement
Original Cost	\$750,000	\$400,000	\$200,000
Corporate Tax Bracket	40%	40%	40%
Depreciable Tax Basis	\$712,500	\$380,000	\$190,000
CREDITS			
Investment Tax Credit	\$75,000	\$40,000	\$20,000
2010 MACRS Tax Benefits	\$14,250	\$53,200	\$11,400
2011 MACRS Tax Benefits	\$108,300	\$39,520	\$25,840
2012 MACRS Tax Benefits	\$64,838	\$23,560	\$15,580
2013 MACRS Tax Benefits	\$39,188	\$16,720	\$9,310
2014 MACRS Tax Benefits	\$31,350	\$16,720	\$8,550
2015 MACRS Tax Benefits	\$27,075	\$4,560	\$5,320
Total Tax Savings Over 5 Years	\$360,000	\$194,280	\$96,000

Additional Federal Tax Incentives for Geothermal Heat Pump Systems

GRANT IN LIEU OF TAX CREDITS — For certain energy properties on which construction was begun before the end of 2011, a grant of 10% of costs is available from the Treasury Department for payment in lieu of tax credits.

FEDERAL ENERGY-EFFICIENT COMMERCIAL BUILDINGS TAX DEDUCTION — The tax deduction for energy-efficient commercial buildings established by the Federal Energy Policy Act of 2005 has been extended to include buildings placed in service through 2013. This deduction is available to owners of new or existing buildings who install lighting, heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost. A reduction of \$1.80 per square foot may be claimed if the building total energy and power cost is reduced by 50% compared to a building that meets the minimum requirements of ASHRAE Standard 90.1-2001. A partial deduction of \$0.60 per square foot is available if an individual heating or cooling systems provides at least one third of the required 50% annual savings.

Deductions may be taken in the year construction is completed and may be claimed by the building owner or, in the case of a government-owned building, by the system designer. The energy savings must be calculated using qualified software approved by the IRS.

CARRIER GEOTHERMAL WATER SOURCE HEAT PUMP (WSHP) SYSTEMS

Aquazone™ water source heat pump products are available in a flexible, efficient array of models, which can be used in all types of water loop, ground water, and ground loop type systems.

Application Guidelines

To utilize Aquazone units in ground water applications, extended range should be specified. This will provide factory-installed insulation on the coaxial coil to prevent condensate from dripping when entering water temperatures are below 60 F.

In some applications, maintaining proper water quality may require the use of higher corrosion protection for the water-to-refrigerant heat exchanger. Water quality varies from location to location and is unique for each job. Water characteristics such as pH value, alkalinity, hardness, and specific conductance are of importance when considering any WSHP application. Water typically includes impurities and hardness that must be removed.

The required treatment will depend on the water quality as well as type of system. Water problems fall into three main categories:

1. Scale formation caused by hard water reduces the heat transfer rate and increases the water pressure drop through the heat exchanger. As water is heated, minerals and salts are precipitated from a solution and deposited on the inside surface of the pipe or tube.
2. Corrosion is caused by absorption of gases from the air coupled with water on exposed metal. Corrosion is also common in salt-water areas.
3. Organic growths such as algae can reduce the heat transfer rate by forming an insulating coating on the inside tube surface. Algae can also promote corrosion by pitting.

Carrier WSHP Feature Summaries

AQUAZONE™ 50PS

Single-Stage Water Source Heat Pumps



- Sizes 006 ($\frac{1}{2}$ ton) through 070 (6 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Exceeds ASHRAE 90.1 efficiencies
- Galvanized steel construction with attractive matte black powder coat paint and silver accents
- Stainless steel drain pan
- Foil-backed insulation in air handler section
- Double isolation compressor mounting for quiet operation
- Insulated divider and separate compressor/air handler compartments
- Copeland scroll compressors (rotary for sizes 006 to 012)
- TXV metering device
- Extended range (20 to 110 F) operation
- Microprocessor controls standard (optional Deluxe D and/or DDC controls)
- LonWorks*, BACnet†, Modbus** and Johnson N2 compatibility options for DDC controls
- Factory-mounted hanger brackets for horizontal units
- Flush, securely mounted corner post water connections (no backup wrench required)
- Unit performance monitoring system
- Eight safeties standard
- Wide variety of options including factory-installed service disconnect (Engineered to Order – ETO)

AQUAZONE™ 50PT

Two-Stage Water Source Heat Pumps



- Sizes 026 (2 ton) through 072 (6 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Exceeds ASHRAE 90.1 efficiencies
- Galvanized steel construction with powder coat paint finish
- Stainless steel drain pan
- Foil-backed insulation in air handler section
- Double isolation compressor mounting for quiet operation
- Insulated divider and separate compressor/air handler compartments
- Two-stage unloading scroll compressors
- TXV metering device
- Extended range (20 to 120 F) operation
- Microprocessor controls standard (optional Deluxe D and/or DDC controls)
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Factory-mounted hanger brackets for horizontal units
- Flush, securely mounted corner post water connections (no backup wrench required)
- Unit performance monitoring system
- Eight safeties standard
- Wide variety of options including factory-installed service disconnect (Engineered to Order – ETO)

AQUAZONE™ 50HQP

Horizontal Large Capacity Water Source Heat Pumps



- Horizontal sizes 072 (6 ton) through 120 (10 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Unit configuration can be ordered with left or right return air and straight or back supply air discharge. Discharge is field convertible
- Field conversion uses all existing parts including panels and belts
- Electrical box is on right side and can be field converted to left side of unit
- Water can be connected to either side
- Copeland scroll compressors
- Dual refrigeration circuits (all sizes)
- Exceeds ASHRAE 90.1 efficiencies
- Galvanized steel construction with attractive matte black epoxy powder coat painted front access panel
- Insulated divider and separate compressor/air handler compartments
- TXV metering device
- Extended range (20 to 110 F) operation (may require optional extended range insulation)

AQUAZONE™ 50VQP

Vertical Large Capacity Water Source Heat Pumps



- Vertical sizes 084 (7 ton) through 300 (25 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Unit configuration can be ordered with, or converted to, top front, or back discharge. Return cannot be field converted. Return and supply cannot be on the same side
- Field conversion uses all existing parts including panels and belts
- Electrical box can be field converted to be on front or back of unit
- Electric power can enter from any side of unit
- Water and drain can be connected to either side
- Dual refrigeration circuits (sizes 168, 192, 240, 300)
- Exceeds ASHRAE 90.1 efficiencies
- TXV metering device
- Extended range (20 to 110 F) operation
- Microprocessor controls standard (optional Deluxe D and/or DDC controls)
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Unit performance monitoring system

*Registered trademark of Echelon Corporation.

†Sponsored by ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers).

**Registered trademark of Schneider Electric.

AQUAZONE™ 50PC/P1
Compact
Water Source Heat Pumps



AQUAZONE™ 50PSW
Water-to-Water
Water Source Heat Pumps



- Sizes 006 ($\frac{1}{2}$ ton) through 060 (5 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Galvanized steel construction with attractive matte black epoxy powder coat front access panel
- Epoxy powder painted galvanized steel drain pan
- Sound absorbing fiberglass insulation
- Double isolation compressor mounting for quiet operation
- Insulated divider and separate compressor/air handler compartments
- Scroll compressors (rotary for size 018 and below)
- TXV metering device
- Microprocessor controls standard (optional Deluxe D and/or DDC controls)
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Factory-mounted hanger brackets for horizontal units
- PSC three-speed fan motor
- Unit performance monitoring system
- Eight safeties standard
- Extended range (20 to 110 F) capable

AQUAZONE™ 50PEC
Console
Water Source Heat Pumps



- Sizes 09 ($\frac{3}{4}$ ton) through 18 (1 $\frac{1}{2}$ ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- High-efficiency rotary compressors
- Two-piece chassis/cabinet design
- Galvanized steel cabinet with durable “polar ice” powder coat finish and black matte finish on subbase
- Slope top/aluminum rigid bar supply air grille. Front or bottom return
- Unique double isolation compressor mounting for quiet operation (sizes 09 to 15)
- Extended range (20 to 110 F) capable
- Advanced digital auto or manual changeover unit-mounted controls with temperature display (°C or °F) and fault indication
- Remote-mounted controls available
- Microprocessor controls standard (optional Deluxe D and/or DDC controls)
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Right or left-hand piping arrangement
- Unit performance monitoring system
- Eight safeties standard
- Wide variety of options including coated air coil

- Sizes 036 (3 ton) through 360 (30 ton)
- Puron® non-ozone depleting refrigerant (R-410A)
- Copeland scroll compressors
- Dual independent refrigeration circuits (sizes 120 and 360)
- Exclusive single side service access (front of unit) allows multiple units to be installed side-by-side for large capacity installations
- Top water connections, staggered for ease of manifolding multiple units (sizes 180 and 360)
- Heavy gage galvanized steel construction with polyester powder coat paint and stainless steel front access panels
- Insulated compressor compartment
- Extended range (20 to 110 F) capable
- Microprocessor controls standard
- LonWorks, BACnet, Modbus and Johnson N2 compatibility options for DDC controls
- Compressor “run” and “fault” lights on the front of the cabinet (sizes 180 and 360)
- Seven safeties standard
- Options include sound attenuation package and cupro-nickel heat exchanger(s)



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