GEOCLIMATE

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HEATING AND COOLING SYSTEMS

Geo Climate Systems

Assessing the Viability

Geoexchange systems have great flexibility and have been adopted in a wide range of applications. However, they are not a viable proposition for every project. The two main limitations with geoexchange systems are their land requirement for the loop field and the difficulties with retrofitting an appropriate heat distribution system within an existing Building.

The following information has been prepared to provide interested parties with an indication of what is required in order to install a geoexchange system. Factors to consider in assessing the viability of a geoexchange system for a particular project include the heat distribution system to be adopted, the size and location of the geothermal heat pump within the home and the type of loop field that can be installed. A summary of each factor is provided below to assist with assessing the viability of a geoexchange heating and cooling system for your project.

Selecting the Distribution System

Residential geoexchange systems can be operated either as air-ducted or hydronic (slab) heating systems. The type of system installed is determined by the requirements of the home and personal preferences of the owner. An air-ducted system utilises a water to air geothermal heat pump and can be used for both heating and cooling. Hydronic (slab) heating utilises a water to water geothermal heat pump and is typically only used for heating.

Retrofit projects should consider the viability of installing either ductwork or a hydronic pipe network. It may be worthwhile to discuss this with your builder or architect. Geoclimate Australia is pleased to assist where possible.

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The Geothermal Heat Pump

Geo Climate Systems is a distributor for WaterFurnace, the worlds leading supplier of geothermal heat pumps. WaterFurnace heat pumps have been incorporated into most Australian geoexchange installations.

Capacity

The capacity of the geothermal heat pump installed is directly related to the heating and cooling loads of the home. This is calculated by Geo Climate Systems and takes into account the size of the area to be heated, the location of the home and construction materials, including insulation, adopted.

As a general rule when calculating heat loads, Geo Climate Systems adopts a value of 120 watts per square metre for standard construction homes and 80 watts per square metre for a solar passive or similar environmentally friendly design. For example, a solar passive design home with 100 m2 to be air conditioned would require a 8000 W or 8 kW system while a standard construction home requiring 300 m2 to be heated would require a 36 000 W or 36 kW system. The size of the system required can be reduced by zoning the home or considering measures such as additional insulation or double glazed windows.

Physical Configuration

WaterFurnace manufacture both vertical and horizontal heat pumps, which is related to their physical configuration and not the type of loop field. Vertical units are typically located in a garage or a utility cupboard either within the home or on a covered verandah, while horizontal units are typically located within the roof space or beneath a bench or similar low feature. The physical configuration selected will depend on the location of the heat pump within the home. WaterFurnace also supply flexibility in the location of their air intakes and connections for ease of installation and access during any ongoing Maintenance.

Refrigerant Gas

WaterFurnace geothermal heat pumps supplied to the Australian market typically utilise ozone-safe R410A refrigerant. The exception is replacement units or special orders where R22 refrigerant gas may be utilised.

Power Supply

It is recommended that WaterFurnace geothermal heat pumps greater than approximately 7 kW are connected to a 3-phase 415 V power supply rather than the conventional single phase 240 V power supply. Most units greater than this capacity are only manufactured as 3-phase units. The reasoning is to limit drawdown on the local power supply at system start up. Depending on your location and upon consultation with your local power authority, it may be possible to install a single phase unit greater than 10 kW capacity.

Selecting a Loop Field/Heat Exchanger

The loop field may be vertical, horizontal, closed water or open water. An open water loop may utilise either a surface water body or a groundwater aquifer as its heat exchanger. Loop field selection is primarily based on availability of land and/or availability of a water body.

Material used to construct the loop field is typically High Density Polyethylene (HDPE) which is filled with a solution of water and an anti-freeze solution and then pressurised to ensure the integrity of all seals. Exceptions include the use of plate heat exchangers in water bodies and open water loops.

Vertical Loops

Vertical loop fields are selected when there is insufficient space for a horizontal loop and a suitable water body is not available. This is typical of many urban blocks. The loop field typically consists of 3-6 boreholes drilled to depths of between 80 and 100 m. The boreholes must be at least 5 m apart and as such even vertical loop fields can at times require more space than is available. The loop is installed within the borehole which is then grouted to seal the hole and ensure good thermal contact with the surrounding rock. A vertical loop field can be installed in almost any geological conditions. One of the frequent limitations on a vertical loop field for retrofit project is the work area available for a drill rig. For example, a home may have a backyard suitable for a vertical loop field but if the drill rig can not gain access or established landscaping is present that can not be damaged then the systems may not be viable.

Due to the drill rig requirements, vertical loop fields are more expensive than the other loop field options.

Horizontal Loops

Horizontal loops are installed in areas with additional land area but no suitable water body. The land area required must be sufficient to enable up to 300 m of trench to be excavated (for an 18 kW system). This may be in one long trench or a series of trench rows at least 3 m apart. Trenches are typically excavated to a depth of 2 m. Limitations on horizontal loops include shallow bedrock or rock outcrops and the presence of dry sand, which has poor thermal properties. There is good flexibility in the configuration of the trench and as such the occasional rock outcrop or tree is not of concern.

If a horizontal loop is difficult to fit on a site, it may be possible to utilise horizontal directional drilling to install the loop at greater depths. However, the cost of horizontal drilling increases the cost of loop field installation to that approaching a vertical loop. Otherwise, a horizontal loop field is almost half the cost of a vertical loop field.

Selecting a Loop Field/Heat Exchanger cont'd

Closed Water Loops

A closed water loop requires a body of water with sufficient depth and surface area to accommodate the heat exchange requirements of the loop. This may include a farm dam, pond, river, bay, harbour or the ocean. One of the difficulties of this in the Australian context is during the late summer or drought conditions when many dams become low or even dry. This tends to occur when the greatest load is required on the system, resulting in a far from adequate cooling capacity. Any surface water body utilised to accommodate a closed water loop should be a minimum of 3 m deep at all times. The required surface area of the water body is based upon the heat load of the home and can be determined at the design stage. As a general rule, in an enclosed water body (ie dam or pond) 50 m2 of water surface is required per kilowatt of capacity.

The closed loop placed within the water body consists of either the same HDPE pipe used for vertical and horizontal loops or a plate heat exchanger constructed of stainless steel for reshwater applications or aluminum or titanium for sea water applications. Either construction method is less expensive than the earth-based loops.

Open Water Loops

Open water loops operate by flushing water through the heat pump and discharging it back into the environment. The water is not polluted in any way and as such does not cause a pollution concern. A suitable water source is a groundwater aquifer or surface water body. Use of an aquifer will require an extraction well and a reinjection well, while a surface water body would require an inlet and an outlet. Discharged water may be slightly warmer or cooler than the intake water and as such the inlet and outlet should be at least 6 m apart depending on the available water source. Another alternative is to use discharge water for a second application such as irrigation or general water supply. Such alternatives will depend upon local regulations on groundwater use. However, not all water bodies can be used for an open water loop. Water quality must meet minimum standards to ensure hat excessive corrosion and scaling does not occur to the heat pump.

An open water loop is typically the most cost effective method of installing a geoclimate system. However, operational costs may be slightly higher than other loop fields due to the requirement to operate a pump to collect water and a higher level of preventative maintenance on the heat pump.

Alternative Loops

Alternative heat exchangers include treated effluent or other liquid streams which may be present at a site. Such alternatives tend to be limited on residential projects and should only be attempted after consultation with an experienced design engineer. In order to be considered feasible, it would be necessary for the liquid stream to be constantly present and be of minimum volume and flow rate in order to function effectively as a heat exchanger.

Residential Pools and Spas

The water to water geothermal heat pumps used for hydronic heating can also be used to heat your pool or spa. A typical residential swimming pool requires a 17 kW unit while a spa may require up to a 30 kW unit. There is no difference with the loop field for a water heating unit.

One of the main considerations when designing your pool or spa is to realise that significant heat losses may occur overnight or if the water body is exposed to wind. It is therefore recommended that pool or spa covers be used overnight and when not in use.

Costs of a Geoexchange System

TInstallation costs for a geoclimate system are typically 3-4 times that of a conventional central air-conditioning system with approximately half the energy usage. However, this will vary greatly depending on the source of heat, use of the system and the type of loop field installed. For example, bottled LPG systems are much more expensive to operate than conventional electrical systems while a vertical loop field is more expensive than a horizontal loop field.

The table provided below outlines budget estimates for a range of geoclimate systems. However, please note that these are provided as indicative only and are subject to a range of factors as discussed above. Their purpose is to provide prospective purchasers an indication of the capital osts likely to be encountered and for most projects will be an upper estimate. Remember that a standard construction home requires approximately 120 W per square metre of conditioned area and a solar passive designed home requires approximately 80 W per square metre of conditioned area.

Capacity (KW)	Approx Budget Estimate Vertical Loop Field System	Approx Budget Est Horizontal Loop Field (trenching) System
10	$27 000	$16 000
15	$34 000	$22 000
20	$48 000	$30 000
25	$58 000	$34 000
30	$65 000	$38 000
35	$75 000	$46 000
40	$80 000	$50 000

Note 1: Costings provided are subject to detailed design and does not include the distribution system (ie hydronic piping or ducting).
Note 2: Costings for closed and open water loops not provided due to large discrepancies experienced for these projects. If you think that a water loop is suitable for your project please contact us and we can provide an estimate.

It should also be remembered that the value of geoexchange systems goes well beyond their capital cost. Geoexchange systems have a design life in excess of 25 years, are very quiet and offer superior comfort levels.

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Exploring Geoexchange Further

We hope that the above information has enabled you to better understand the geoexchange concept by undertaking a self assessment of the viability of a geoclimate system for your project. If there are any outstanding questions or points requiring further clarification please do not hesitate to contact us.

If you would like Geo Climate Systems to undertake a detailed design and costing for your project please forward us a copy of your building plans and a site plan as well as information on construction materials, insulation and local soil and geological conditions. Electronic submission in pdf form is suitable. Geo Climate Systems can also provide a cost comparison with your choice of alternative options which will compare both installation and operating costs.

Geo Climate Systems charges a non-refundable deposit of $350 + GST for this design work which is credited to the final project costs. The purpose of this charge is to cover the cost of design and calculations and to identify genuine enquiries. We hope that the above has been useful in providing you with additional information on whether geoexchange is a viable solution for your project. If you have any questions or would like to discuss geoclimate further please do not hesitate to contact Geo Climate Systems. We would be very happy to discuss with you how geoexchange can be incorporated into your project.

WaterFurnace
Smarter from the Ground Up

IGSHPA
Down to Earth Energy

MASTER PLUMBERS AND MECHANICAL SERVICES ASSOCIATION OF AUSTRALIA

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