‘Ground Source Heat’ & ‘Shallow Geothermal Energy’

Homeowner Manual

Contents of the manual

The aim of this publication is to help readers with the decision to purchase and install a domestic ground source heat pump (GSHP) system for home heating. It is laid out as follows:

Note to users of this manual:

This document is not meant to be a "do-it-yourself" guide. Prospective buyers should seek out qualified advice and assistance to supplement the information provided here.

When considering the installation of a geothermal system, customers should contact utility and government agencies to ensure that their new system will comply with relevant codes and standards, as well as building, site and other regulations.

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Acknowledgements

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What is a ‘ground source heat’ or ‘shallow geothermal’ system?

A ‘ground source heat’ or ‘shallow geothermal’ system is a sustainable system of extracting renewable heat energy from the ground, concentrating it and using it to supply heat and domestic hot water. The same system can be used to cool a house by removing surplus heat energy and putting it into the ground. The most efficient systems carry out both functions.

Why use geothermal energy?

Geothermal energy is defined as the energy stored in the form of heat beneath the surface of the earth (RES Directive 2009/28/EC).

In many parts of the world, including Ireland, the surface of the earth acts as a very large collector of solar energy, where the energy radiated from the sun is stored below the earth’s surface. Similarly, heat from the core of the earth is also available beneath the earth’s surface. In Ireland, our climate is particularly well suited for harnessing this ‘shallow’ geothermal energy as soil and groundwater temperature are near constant for the majority of the year.

Ground Source Heat Pumps (GSHPs) are an efficient method of harnessing this renewable energy and are a tried-and-tested technology. These systems are increasingly popular for heating houses in Ireland as they provide significant cost savings compared to fossil fuel alternatives as well as providing environmental benefits.

The types of GSHPs discussed in this document are those which utilise ‘shallow’ geothermal energy from the ground and from water bodies. Heat pumps extracting energy from the ambient air known as Air Source heat pumps are not covered in this manual.

If you decide to further investigate the option of using a GSHP in your home, this manual will help your decision making. However, you should seek advice from a qualified professional. This person will advise you on the type of GSHP which is suitable for your home and on the different options available to you.

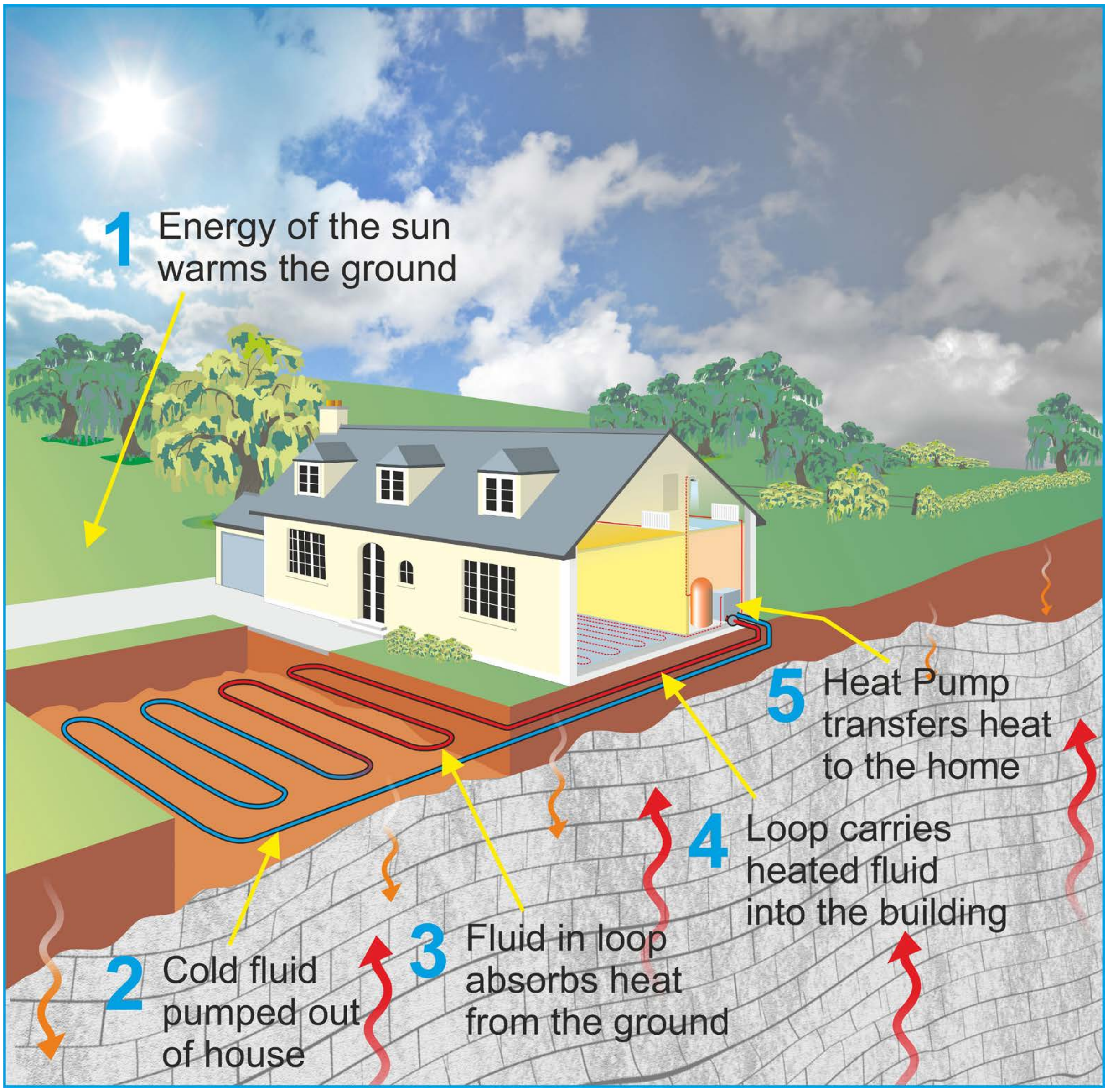
Where do I start?

This manual aims to answer some of the questions that a home owner might have with regard to ground source heat pump (GSHP) systems. It has been designed to guide you through the general considerations you need to make before choosing a GSHP, the different types of systems and their design, as well as providing an overview of the process of installing a system in your home. The initial information necessary to understand how a GSHP may be integrated into your home is outlined, and the key requirements that should be considered are given, for both new builds or retrofitting.

Here are some of the questions which you may have:

- *What is a ‘ground source heat’ or ‘shallow geothermal’ system?*
- *Why should I use geothermal energy?*
- *What is a ground source heat pump (GSHP) system made up of?*
- *What are the different types of GSHP collector systems?*
- *Why is Ireland a good place to install a GSHP?*
- *Is my home and garden suitable for a GSHP?*

- *What are typical system installation costs?*
- *How do GSHP compare to other heating systems?*
- *Can I use a GSHP in combination with another technology?*
- *What do I need to consider before installation begins?*
- *What is the installation process?*
- *Will the system need monitoring and maintenance in the future?*
- *Who is responsible for my system in the future?*



Choosing your system…

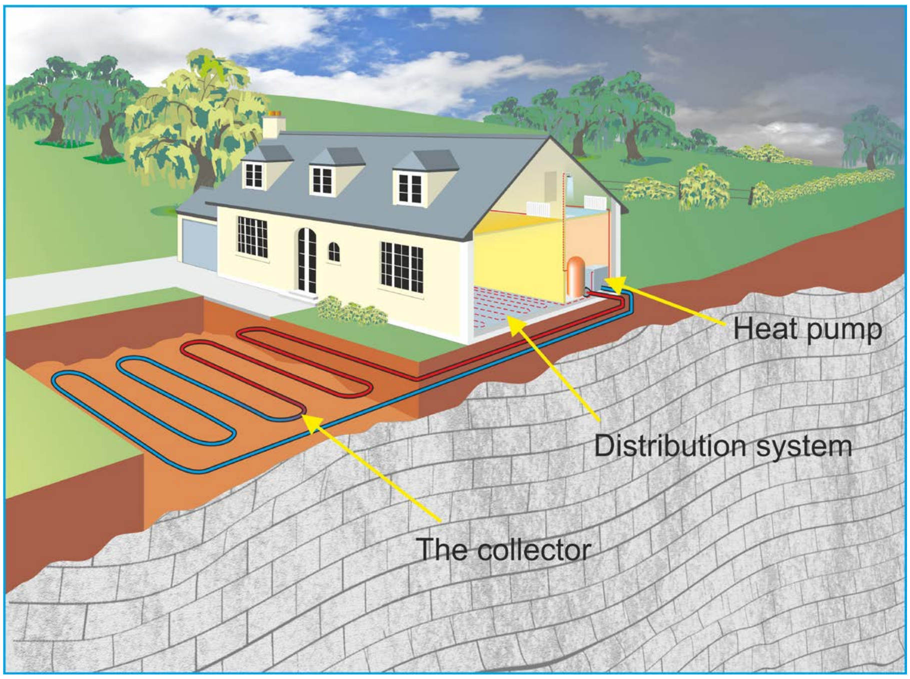
There are different types of GSHP systems and configurations that you can choose from. However, the choice of which type of system to install will depend on conditions specific to your home. The following sections provide basic background information on the different geothermal systems for Irish climatic and environmental conditions.

The systems dealt with in this booklet are 'shallow' ground source energy systems. These 'shallow' systems typically range from just below the earth's surface down to about 200m below ground level, although the final depth will be dependent on the specific conditions and requirements of your home.

What is a GSHP system made up of?

A GSHP is generally made up of three main components, as shown on the diagram below. These main components harness the energy in the ground and allow it to be used to heat or cool your home. They are:

1. the **collector (or loop)** - this extracts energy from the ground. There are several different types and layouts of collectors, and these are described later in this booklet;
2. the **heat pump** - converts the energy from the ground to usable energy in your home for heating or cooling
3. the **distribution system** - maintains your home at a constant temperature by providing heat or cooling through radiators or underfloor heating.

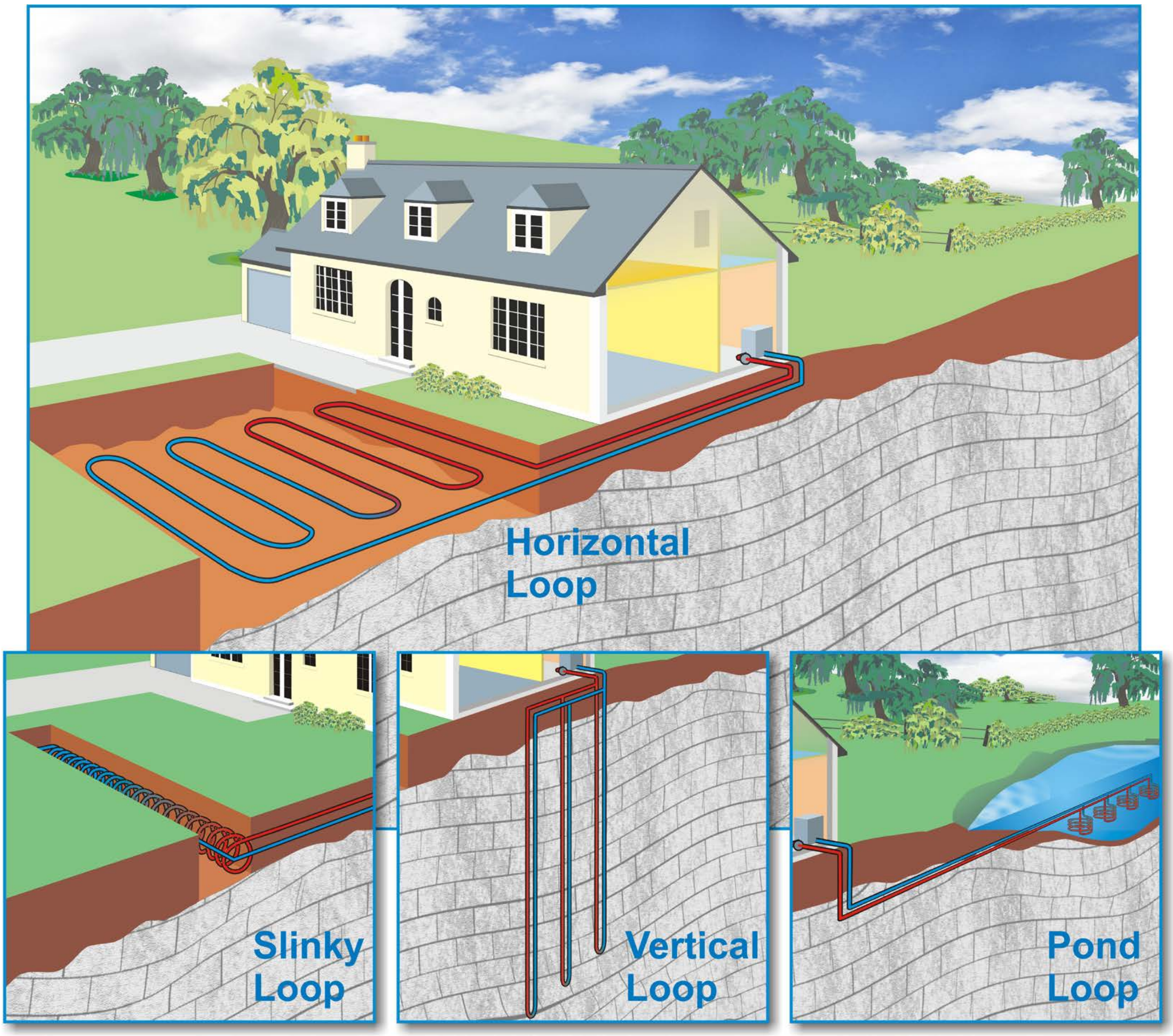


What are the different types of GSHP collector systems?

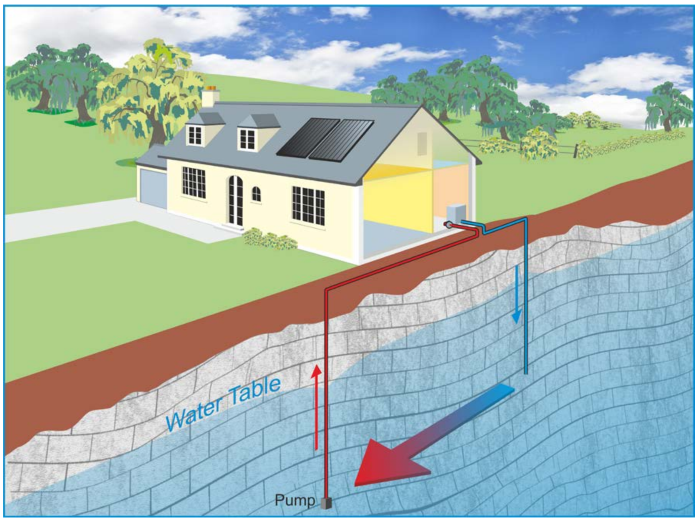
There are two main types of collector system (or loops) used to extract heat from the ground (or to release heat into the ground for cooling purposes), and these are known as 'open loop' or 'closed loop' collectors. These open or closed loop collectors are installed around your home in either a 'vertical' or 'horizontal' arrangement. Horizontal collectors are typically buried in shallow trenches, stripped ground or placed in ponds or rivers, while vertical collectors are installed in drilled boreholes or wells.

Closed loop systems have a closed pipe known as a loop buried in the ground which is filled with a fluid, known as a 'thermal transfer fluid'. As this fluid circulates around the loop, it absorbs heat from, or releases heat to, the ground in heating or cooling mode respectively.

As described on previous page, closed loop systems can be installed in your home in vertical or horizontal arrangements. The diagram below illustrates this.



An open loop collector obtains energy directly from the water by pumping it through a heat exchanger (in most cases there is a heat exchanger before the heat pump itself). These collectors are vertical systems where water is most commonly sourced by pumping groundwater from a borehole or a well. Once the heat energy has been extracted, the groundwater can then be either injected back into the ground using a re-injection well or discharged to a surface water body or a drain.



Discharging water to groundwater or surface water may have environmental impacts if the groundwater chemistry has been altered, or the heat pump has been used in cooling mode and the discharged water is warm. The relevant discharge permits should be sought from your Local Authority.

What are the considerations for using ground source heat?

When you are choosing between an open and a closed loop system, some considerations which may affect your decision are:

Open loop	Closed loop
• Requires the presence of a groundwater supply (an aquifer with sufficient yield)	• Can be used virtually anywhere
• Suitable groundwater chemistry required	• Adequate ground conditions need to be established at your dwelling
• Less space required in your garden	• Horizontal systems will require the most amount of space in your garden
• Higher heat extraction capacity per borehole	• Lower heat extraction capacity per borehole or trench[1]
• Maintenance of well(s) will be required	• Less maintenance than open loop systems
• Disposal of water needs to be arranged and may require a permit or licence	

Other considerations which would affect your decision to install a GSHP, such as the insulation level of your home will be discussed later.

Open or closed loops can also be placed in surface water bodies such as ponds, lakes or streams, to abstract the sun's energy from the water. However, these require the presence of a water course or large pond on your property. Also, surface water temperatures are more variable during the year than underground temperatures, with the lowest water temperatures (and heat energy stored) occurring in winter – at the time that heating demand is at its highest.

Why is Ireland a good place to install a GSHP?

Ireland has warm moist soils and a climate which is ideally suited for harnessing shallow geothermal energy year round. The soil type in Ireland allows this heat to be retained, while the frequent rainfall keeps the soil moist. This moisture within the ground is an excellent heat conductor, allowing heat to move towards your collector system. This favours the deployment of horizontal collector systems in many parts of Ireland

Vertical closed loop collectors can be installed in most underground geological settings in Ireland and where aquifers are present open loops are most favoured.

[1] To meet the heating and cooling needs of your home, more surface area is taken up by the installation of a closed loop collector system. Vertical systems require less surface area as the energy from the ground is collected vertically.

Information on subsoil, bedrock and aquifers

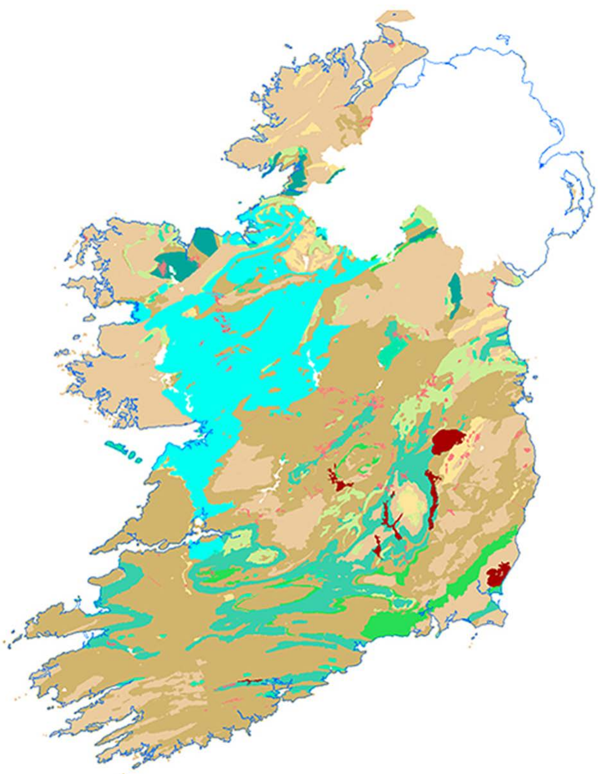
The Geological Survey of Ireland produces and holds maps for subsoil type, bedrock type, and groundwater availability (aquifers). These maps can be useful in making preliminary assessments about whether the ground conditions under your site would be favourable for closed loop systems, open loop systems or both.

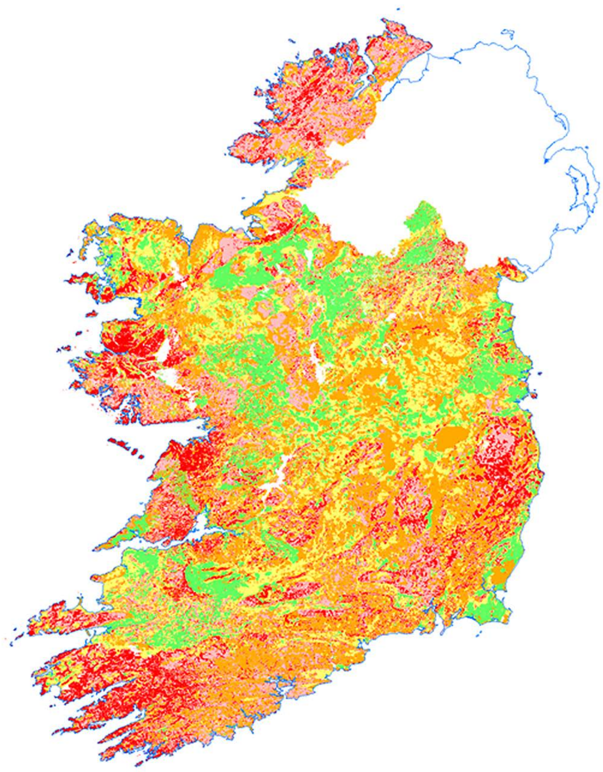
Groundwater Resource or Aquifer map *Delineates different volumes of bedrock or sand/gravel according to their groundwater resource potential.*

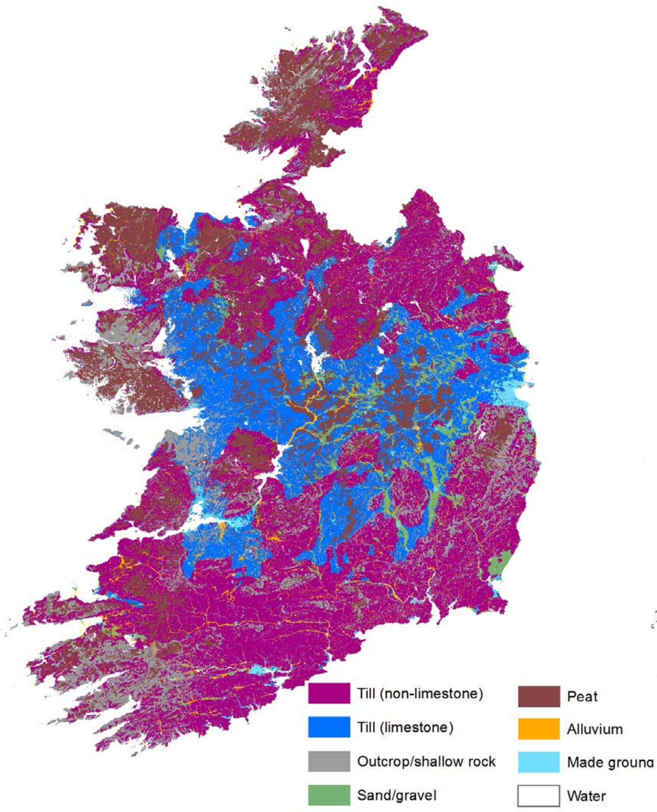
Aquifers are subsurface bedrock or sand/gravel deposits capable of storing and transmitting groundwater in useable quantities. Virtually all rock types are able to yield sufficient water for a domestic drinking water supply, but not all rock types are guaranteed to give sufficient water for an open loop GSHP, unless fracture zones are located. The better groundwater supplies can be found in karst limestone rocks (blue and aqua), well-fractured rock (green) and sands/gravels (maroon). The less productive bedrock aquifers are shown in brown and beige.

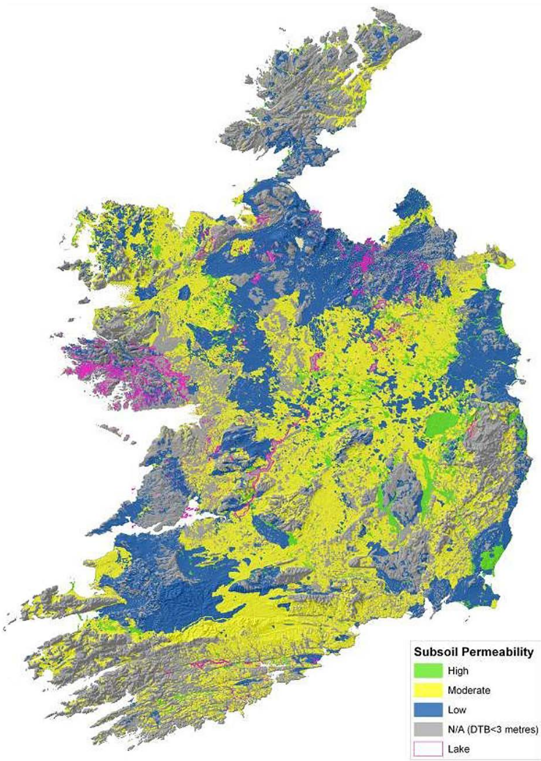
Groundwater Vulnerability map *Identifies different areas of the land surface according to how well they protect the groundwater resource beneath.*

Areas where the subsoil is <1m thick or rock is outcropping are shown in red and generally will not be suitable for horizontal closed loop systems, unless the site is enhanced by the provision of additional cover. Areas where the subsoil is up to 3 m thick are shown in pink and may or may not be suitable for horizontal loop systems. Areas shown in green comprise >10m of clay, and will be highly suitable for horizontal and vertical closed loop systems.









Subsoil type map *Identifies different subsoil types that occur between the base of the soil zone and above the top of the bedrock.*

Different subsoil types have different moisture contents and thermal properties. Tills can be silt- or clay-rich, with clays particularly favouring moisture retention. Peats have a very high moisture content. Sands/gravels, unless fully saturated with groundwater (i.e. below the water table), are generally poor at retaining moisture and, therefore, are poor at conducting heat through the ground.

Subsoil permeability map *Identifies areas of highly, moderately and poorly permeable subsoils.*

Different subsoil types have different moisture contents and thermal properties. Low and moderate permeability subsoils (shown in blue and yellow, respectively) are dominated by clay and silt, and have good moisture retention capacity, which is beneficial for transfer of heat from the underground to the heat collector pipes in closed loop systems. High permeability (shown in green) subsoils are dominated by sand and gravel. Where these are unsaturated (i.e. above the groundwater table), these subsoils are not good at transferring heat from the ground to the collector loop.

The GSI is producing a series of geothermal suitability maps which will be available to homeowners in the future. These maps will be a useful preliminary screening tool to assess whether a site may be suitable for an open or closed loop system. Separate maps will be produced for horizontal and vertical systems.

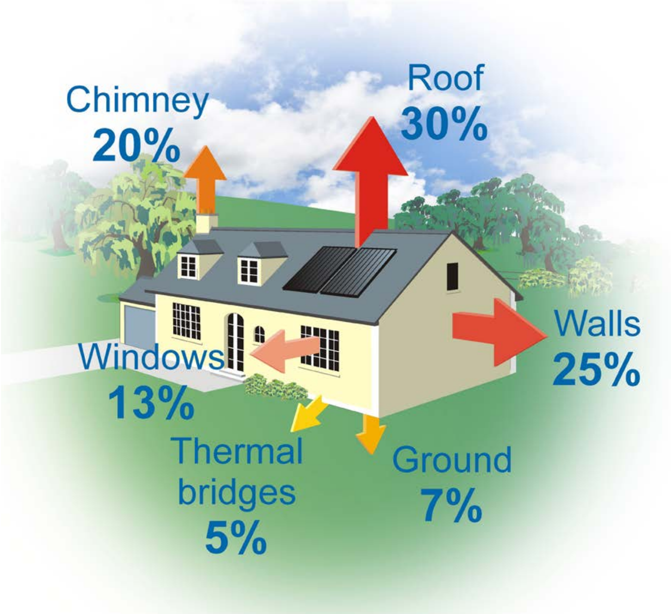
Is my home suitable for a GSHP?

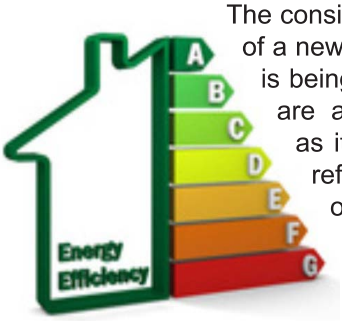
Most homes are suitable for installing a ground source heat pump system. Whether your home is a new build or you are retrofitting an existing home, the design and construction of your home is fundamental when considering whether to use shallow geothermal energy (ground source heat) or not.

There are a number of key factors that are required when considering the suitability of a ground source heat pump system to address the energy needs of your home. These factors are related to the construction specifications of your home and to the space and ground conditions present, and will have a direct effect on the type of ground source system that might be suitable, the cost associated with its installation as well as the operating efficiency of the system.

The key considerations for a home owner are summarised below:

- The design and insulation of your home is of critical importance for the operating efficiency of a GSHP. A poorly insulated property may not be suitable for installing a GSHP.
- The landscaping of your garden and the size of the area available for the collector loop will determine the type of system you can install.
- The internal layout of your home and the heat distribution system will determine the type of system you can install.





The considerations listed above are more easily taken into account during the design of a new home rather than when an existing home is being retrofitted. If your home is being retrofitted, you are encouraged to ensure the considerations listed above are addressed adequately before proceeding with a geothermal installation, as it the current requirement under part L of the Buildings regulations for any refurbishment works (you should consult the person responsible for the design of your system for more information on this). The professional giving advice on the design and installation should ensure that your home will be compliant with the current building regulations.

Coefficient of Performance

The performance of a GSHP system is expressed as the Coefficient of Performance (COP) which measures the amount of heat produced per one unit of electricity put into the system. The higher the COP of a system the more efficient it is. The COP is calculated by dividing the output of the heat pump by the electrical energy needed to run the heat pump at a specific temperature.

What are typical system installation costs?

This section aims to provide you with prices of the various elements of a GSHP installation. Several GSHP installers were approached in 2012 and provided pricing information. The prices summarised below are intended to act as a guide only and you should seek individual quotes from installers that take account of the requirements and characteristics of your home.

The installation guide price outlined below is for a 4 bedroom detached property with a BER of C1 and allows for 200 square metres (m^2) of underfloor heating. The costs include the cost of the heat pump and the groundworks for the installation of a loop.

		Cost Range (€)		
Description	**Details**	**Open loop**	**Closed loop: vertical**	**Closed loop: horizontal**
Heat Pump	8 to 12kW	7000	7000	7000
Groundworks	Open Loop (incl. Materials & Installation: Drilling)	3000		
	Closed Loop - Vertical (incl. Materials & Installation: Drilling)		3750	
	Closed Loop - Horizontal (incl. Materials & Installation: Excavation)			2500
System Maintenance	Annual Maintenance Cost	150	150	150
	Estimated Total (ex VAT)	**€10,150**	**€10,900**	**€9,650**

Assumptions

- 4 bedroom Detached House
- Building Energy Rating C1
- Heat Distribution System - 200m^2 Underfloor Heating

(source: average costs obtained from installer survey - 2012)

Additional costs to cover building system controls and the proposed heat distribution system for your home also need to be considered. These costs vary based on the type of heating system configurations which typically include underfloor heating in the case of new build homes. Low temperature radiators are also sometimes chosen for the delivering heat in a retrofit type setting. A further idea of the costs associated with these should be discussed with the person responsible for designing your system.

The running costs and payback times of installation costs are discussed in in the next section of this manual and compared to other heating systems.

How do GSHPs compare to other heating systems?

When considering the installation of a GSHP instead of other heating systems, the main criteria to compare are the system efficiencies, the environmental benefits and the capital investment and running costs.

Efficiency and environmental benefits

GSHPs are a renewable heating and cooling technology and their main environmental benefit is the reduction in the amount of primary energy required for space heating, hot water production and cooling.

A comparison for a 200m^2 house with an annual heating demand of 100 kWh/m^2 has been used to compare the efficiency of different systems, their installation costs, annual fuel and running costs as well as the CO_2 savings from the different systems.

Costs

The installation of a GHSP system requires an initial capital investment which is typically higher than other more conventional or fossil fuel based systems. However, significant savings can be made in the running costs of a GSHP compared to oil or gas based heating systems provided that the GSHP systems are adequately designed.

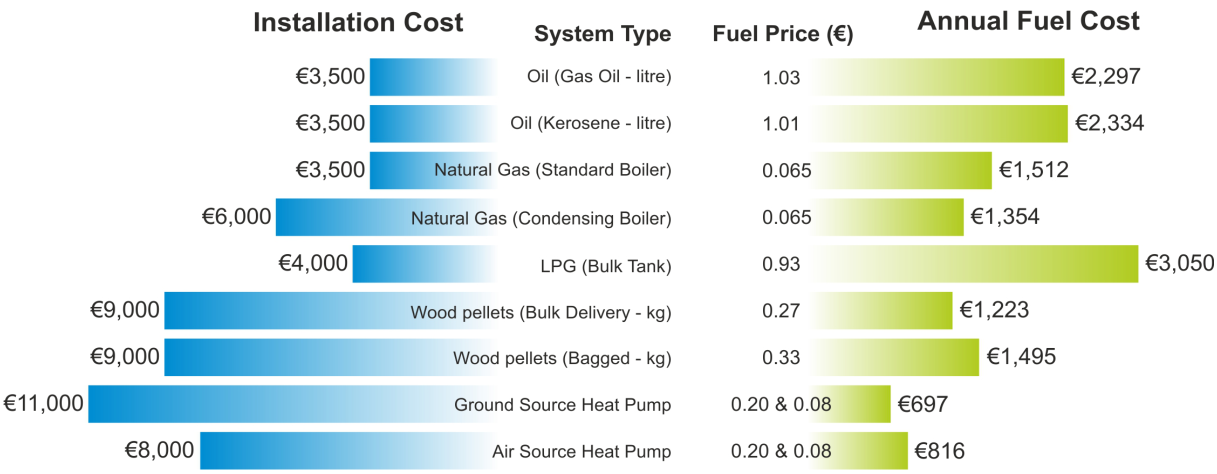
A comparison for a 200m^2 house with an annual heating demand of 100 kWh/m^2 has been used to compare the efficiency of different systems, their installation costs, annual fuel and running costs as well as the CO_2 savings from the different systems.

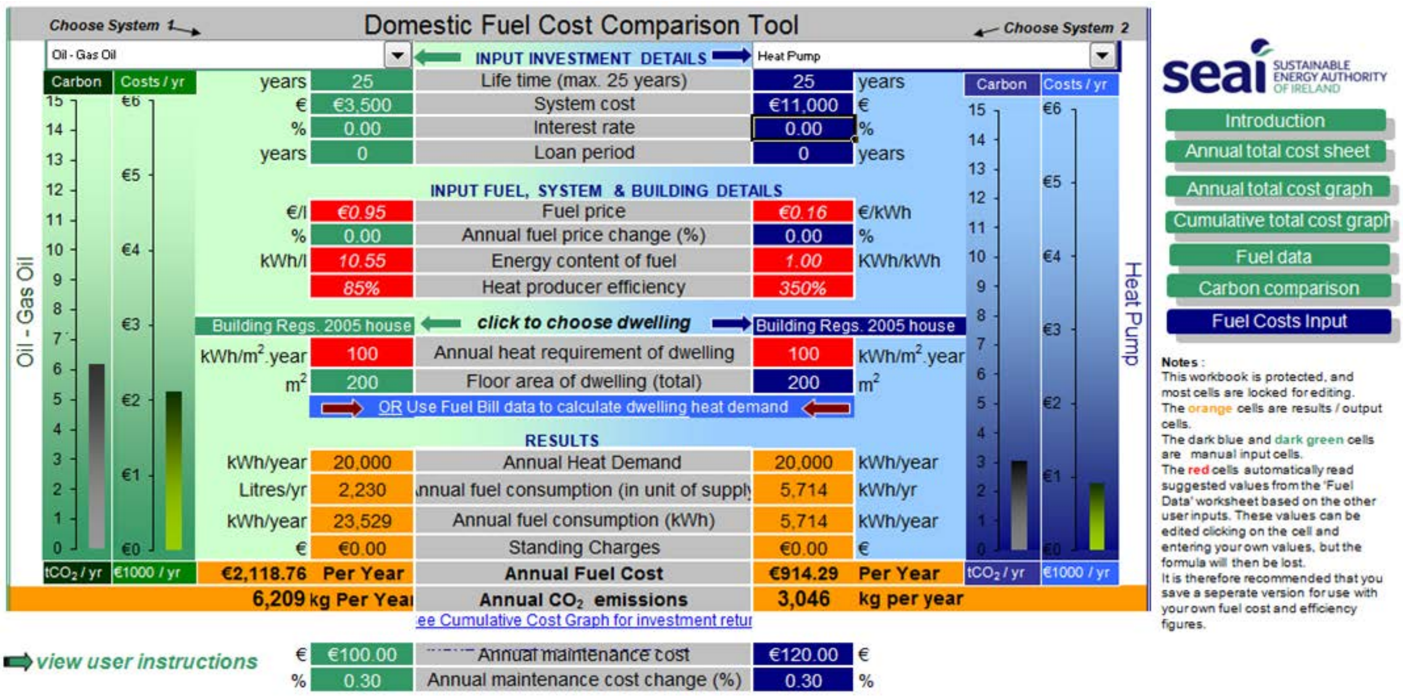
The Domestic Heating Cost Comparison Tool published by SEAI is a useful method for comparing the installation and running costs of different heating technologies. The examples quoted above in this manual are based on these figures. The SEAI tool can be found at: http://www.seai.ie/Publications/Statistics_Publications/Fuel_Cost_Comparison/Domestic_Heating_Cost_and_Carbon_Comparison_Tool_January_2012_xls.xls

Primary Energy Efficiency

Primary energy efficiency (provided as a percentage) is another way of expressing the efficiency of a heating system. This concept considers the amount of primary energy (energy from coal, oil, gas etc) used by a system versus the amount of energy the system produces. If a system has a primary energy efficiency of more than 100% it indicates that the system is producing more energy than it is using. By considering the amount of energy from primary sources such as oil and gas a system uses during heat production, it provides a measure of how environmentally friendly a system is.

Installation Costs and Estimated Annual Running costs (SEAI, 2012)





Running costs

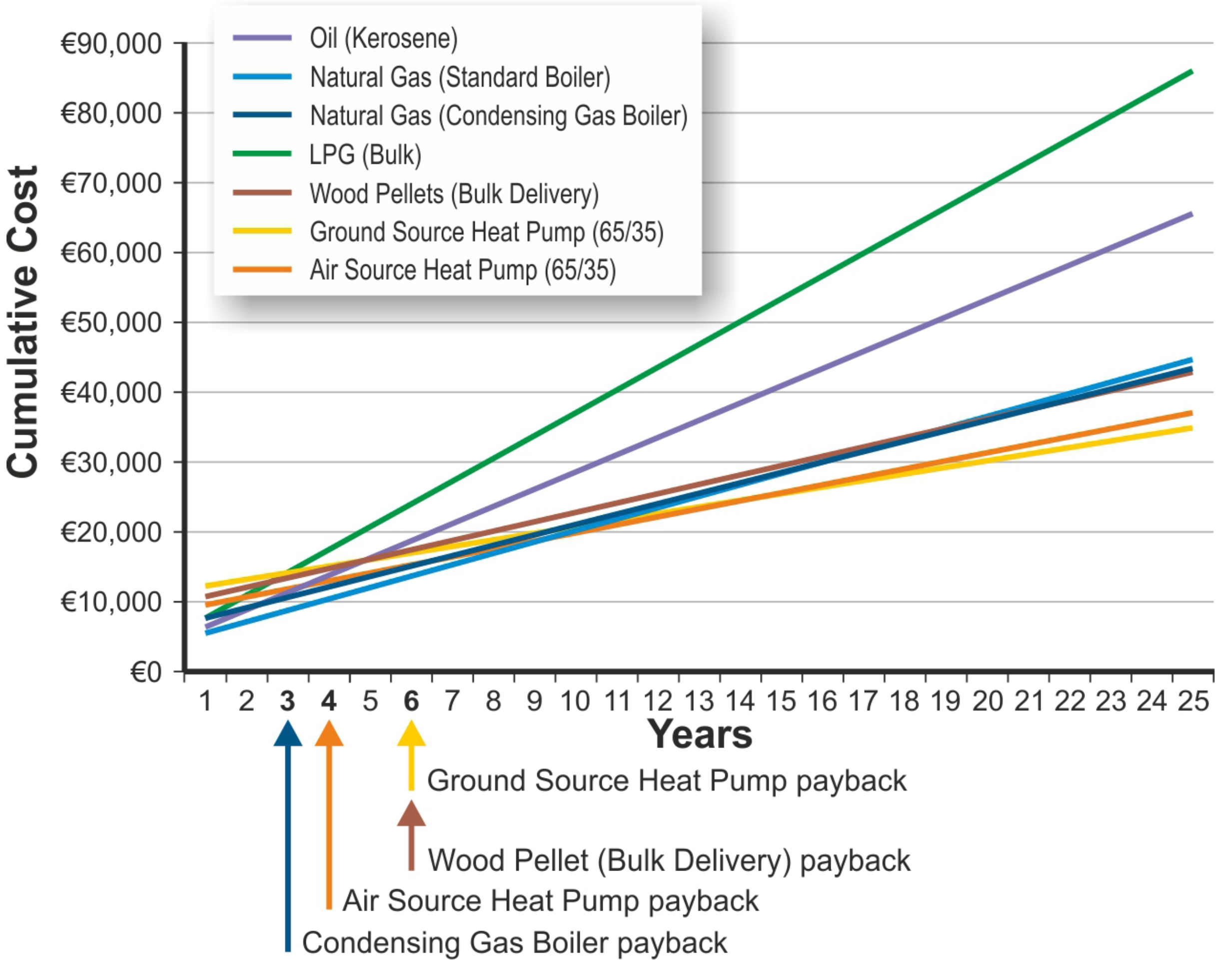
Over a 25 year period, the total cost of running the ground source heat pump 65% of the time on night rate electricity and 35% on Band DD electricity in the daytime, is approximately €34,500. This compares with an approximate cost of €36,700 for an air source heat pump running on the same electricity rates and with approximately €43,000 for running a condensing gas boiler over the same period (SEAI, Domestic Fuel Costs January 2013)

These figures demonstrate how GSHP systems are an efficient and environmentally friendly source of domestic heating, cooling and hot water production.

Payback

GSHPs have significantly lower running costs than those of more conventional systems, but the installation costs are higher. The SEAI tool allows the payback period for GSHP installation cost, including any loan required, to be calculated. The graph below illustrates that the payback time for the installation costs of our 4 bedroom example home is approximately 6 years.

Cumulative Total Heating Costs - Including initial investment cost & Operating Costs over 25 years



Once installed, a ground source heat pump requires very little maintenance, and anyone installing a heat pump should speak with their installer regarding a maintenance agreement. The life expectancy of the system is at least 25 years.

Energy efficiency and CO_2 emissions

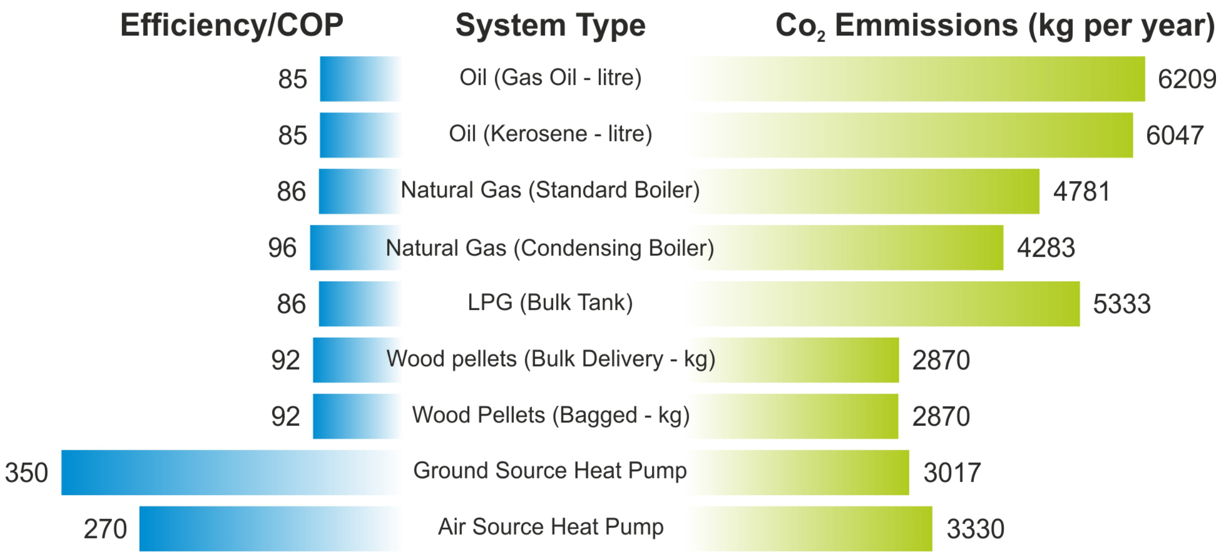
The graph below compares the primary energy efficiency and CO_2 emissions of different heating systems. The diagram shows that, for example, an oil fired boiler uses more energy than it produces while a geothermal system is the opposite.

The GSHP system is represented in different forms in this table based on the rate of electricity used. The data show that a GSHP is more efficient and consumes less energy than other types of systems such as oil or gas fired boilers.

For each unit of gas or oil burned in a conventional boiler, only 85 to 86% of that fuel is converted to heat energy used to heat your home (higher efficiencies are achieved used condensing boilers).

A GSHP running off electricity will produce more energy than it is using, typically for every unit of electricity you use, the ground source heat pump system will produce a minimum of 3.5 units of heat energy for a ground-water system (Annex VII to the Renewable Energy Directive 2009/28/EC - 2013/114/EU). In addition, by replacing your oil fired boiler with a GSHP, you will reduce your CO_2 emissions by at least 40%.

Heating system efficiency and CO_2 emmissions generated from different heating systems (SEAI, 2012)



The cost savings that a GSHP (running 65% of the time on night rate electricity and 35% on Band DD electricity in the daytime) provides, compared with the installation of an oil fired system for the example 4-bed detached house used in this manual is given below[2]. The 4-bedroom 200m² house with a heat demand of 20,000 kWh will:

For the heat pump running 65% of the time on night rate electricity and 35% on Band DD electricity in the daytime:

- Have an annual fuel cost of €697 per year
- Have an annual CO_2 emission of 3,017 kg/year.

For the oil fired system:

- Have an annual fuel cost of €2,297 per year
- Have an annual CO_2 emission of 6,209 kg of CO_2

This illustrates that the heat pump is a cheaper and more efficient heating system. It also provides cooling for the home if required.

[2] The typical installation costs and the property details for both systems are entered into the spreadsheet. Based on this, the SEAI tool calculates the relative annual running cost and annual CO_2 emissions of each system.

Can I use a GSHP with conventional heating systems or other renewable energy technologies?

Yes! GSHP systems are frequently installed in combination with other systems. For example solar panels can be used for hot water supply while a GSHP system can be used for the underfloor heating.

A GSHP system can be designed to provide all the required heat for your home. However, because of the high capital costs of installing these systems it may be more cost effective to install them with another system. The GSHP system can be used in combination with a primary energy supply such as mains electricity or natural gas, or a renewable energy source such as a woodchip boiler, solar panels etc.

You should note that these are generally considered to be bespoke systems that are adapted to the specific building. These systems need to be designed according to the requirements and characteristics of your home. The specific design will have to be undertaken by a competent designer.

CO_2 emissions

The volume of carbon dioxide (CO_2) emitted from a system indicates how environmentally sound it is as reducing the CO_2 emissions from a property reduces its impact on the environment. Irish households emit over 10.5 million tonnes of CO_2 (a green house gas) in 2010 due to the combustion of fossil fuels for household heating and hot water production. Irish households represent 27% of total CO_2 emissions in Ireland in 2011 and are the second largest emitter after the transport sector (SEAI, 2013).

Installing your system

Now you have decided that a GSHP may be suitable for you, it would be wise to consider how and by whom the system will be designed and installed. This section will help you with those considerations and will also provide information on what is involved in the installation process, to give you an idea of what happens during GSHP installation.

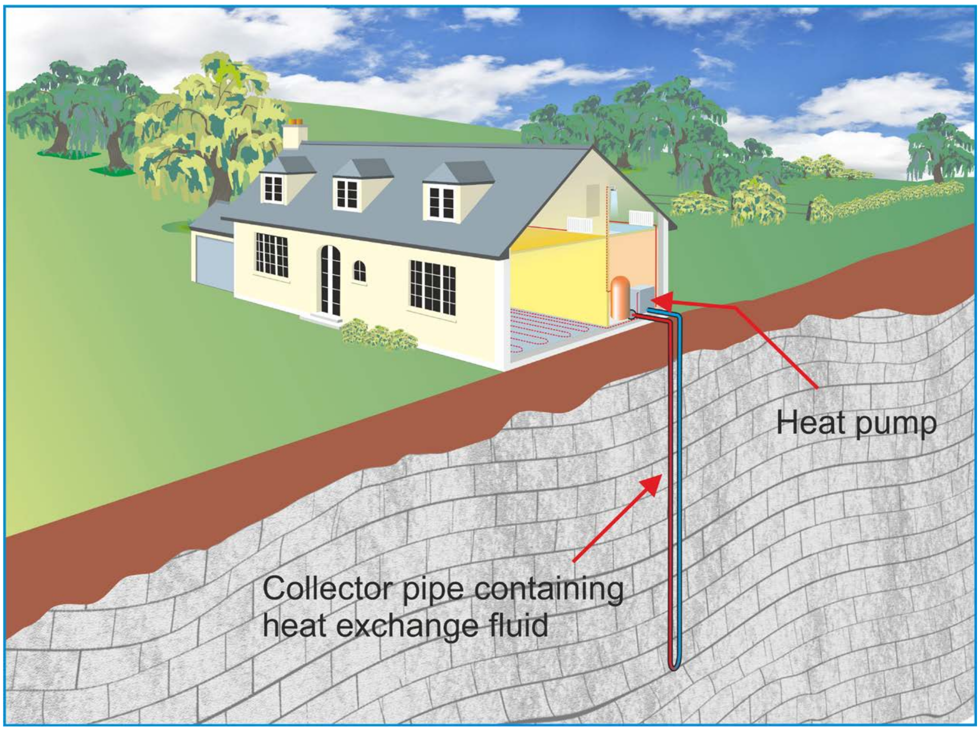
What do I need to consider before installation begins?

Once it has been established that your home is suitable for the installation of a GSHP system, the design of the system and the management of the installation should be considered.

As discussed earlier in this information booklet, the three main elements of a GSHP system are the collector (or loop), the heat pump, and the distribution system as shown on the diagram below. Each element has design requirements and considerations associated with it that apply to the system as a whole:

- **The heating/cooling demand of the building:** this will influence the size of the heat pump and collector required
- **Site size and space available for the collector:** the space available for the installation of the collector will be a key factor in establishing the type of system suitable for your home. This will determine whether it is possible to install a horizontal collector or whether a vertical collector is more appropriate.
- **Subsurface conditions:** the site-specific ground conditions and groundwater environment may also favour a specific type of collector.

Having considered the key factors that will help you determine what type of system you may choose as the most suitable for your home, there are design elements specific to the individual collector types that you may want to consider or understand before installing a GSHP system.



System type	Design element	Consideration	Why is this important?
System Choice (open loop or closed loop)	Site area	What space is available on the site?	• *Horizontal closed loop* systems require a large area (>0.2 ha or 0.5 acres) over which the collector loop will have to buried. • *Vertical* systems (*closed loop* or *open loop* systems) using boreholes occupy a much smaller area and can be installed on very small sites, or even within the building footprint.
	Type of geological material under the site	What are the soil, subsoil and bedrock types?	• Different geological layers underground, their thicknesses and water contents, and their thermal properties, are suited to different types of system. • The design of the collector needs to consider the specific properties that relate to the ground conditions at your home as these control the specifications of the collector to be installed.
		Why is the soil/ subsoil type and amount important?	• *Horizontal loop* systems generally need more than 1.5m of soil and subsoil to be efficiently installed. • Fine-grained soil/subsoils that hold onto moisture have good thermal conductivity properties. • Dry, coarse-grained sands and gravels are not suited to *closed loop* systems, as the heat cannot be transferred through the ground to the collector pipe efficiently. • Saturated sands and gravels (below the water table) are suitable for both *closed loop* and *open loop* systems.
		Why is the bedrock type important?	• Different types of rock have different heat transmitting and heat storage properties. This influences the length of *closed loop* collector pipe needed for a given building heat requirement. • Different types of rock have different abilities to transmit underground water. For *open loop* systems, a specific amount of water at a certain temperature is needed for a given building heat requirement.
	Availability of groundwater	Will there be enough groundwater to allow the operation of an open loop GSHP?	• The amount of water needed will depend on the heat demand of the building, and the temperature of the groundwater. • Saturated sand/gravel aquifers will reliably be able to provide sufficient water for an *open loop* system. • Most bedrock aquifers are capable of providing sufficient water for an *open loop* system, but this depends on being able to locate a productive fissure.
		Can the water be reinjected into the ground or a permit be granted to discharge to surface waters?	• The water that has circulated through an *open loop* system can be reinjected into the ground. There may be permitting requirements and the ability of the aquifer to take the water should be assessed. • Discharging the water to streams, rivers or mains drainage is likely to need a permit.
	Costs	Operating cost vs construction cost	• Where there is a choice of different system types, consideration should be given to the expected installation costs and the projected operating costs • These should be based on the design parameters for a heating system in your home.

System type	Design element	Consideration	Why is this important?
Closed loop		What space is available on the site?	• See ‘System choice’
		Are there any existing services (pipes, cables etc)?	• The presence of services should be identified before any excavation or drilling takes place. Horizontal systems require more space and are more likely to encounter services.
		How thick is the soil cover on the site?	• A *horizontal loop* system can require a trench approximately 1m deep to be excavated in order for the collector to be installed. • This will not be possible if the soil is not thick enough and/or rock is close to the surface unless the site is enhanced by the provision of additional suitable cover material brought onto the site.
		What determines the length of collector pipe required?	• The heating demand of the property determines the length of collector to be installed. The greater the heat demand, the greater the length of collector pipe will be required. • Adequate sizing will affect the system efficiency and installation cost. Therefore, a detailed design for this element is vital. • The two main factors determining the total length of collector pipe are: (1) The heat transmitting and heat storage properties of the soils, subsoils and rocks; (2) the heat demand of the building.
		How will the loop be laid out?	• *Horizontal loops* are laid out in trenches, usually as overlapping coils. The pipe is laid out to minimise the interference between the flow (cold) and return (warm) pipes of the collector. Adequate space should be left between the trenches in which the pipe is laid, or the rows of pipe on stripped ground. • *Vertical loops* go down to the bottom of the borehole in a ‘U’ shape. Adequate space should be left between boreholes if multiple boreholes are required as part of the collector system.
		Will a thermal response test be required?	• A thermal response test provides specific information on the thermal properties of the ground in which a *vertical loop* collector will be installed. • The information is used to design the most efficient heat collection system for the building’s heating demand, and to minimise drilling and installation costs. • These tests are not usually undertaken for domestic systems, but may be necessary for large systems with multiple boreholes.
	Collector pipe (‘loop’) material	What pipe material will be used?	• Typically HDPE pipe will be used for both horizontal and vertical closed loop collectors and in some cases for river or stream collectors. This pipe should be of PE100/PN16/SDR11 and CE certified
		Why is the pipe diameter important?	• Collector pipe diameters vary between 26.7 mm and 42.2 mm for closed and vertical loop collectors. A pipe size should be selected to maximise heat transfer efficiency between the pipe and the fluid as well as minimising the pumping energy required.

System type	Design element	Consideration	Why is this important?
Closed loop	Collector fluid	What is a circulating fluid and why is it necessary?	• The fluid that circulates in the collector pipe takes heat in from the ground, and brings it to the heat pump, where the heat energy is extracted before being transferred to the house distribution system.
		What circulating fluid will be used?	• The circulating fluid comprises a mixture of water antifreeze.
		Why is anti-freeze added?	• The operating temperature of the collector fluid can reach temperatures as low as -4°C to -5°C. A glycol (or anti-freeze) and water mixture is used in order to lower the freezing point of the fluid to below -10°C and ensure adequate operation even during the coldest seasons of the year.
		If there is a leakage of circulating fluid, can it harm the environment?	• Some circulating fluids can be harmful to the environment if they are in close proximity to sensitive ecosystems or drinking water supplies. The type of fluid used will determine how it should be handled on site and how the loop should be constructed and finished. • The owner of the system and property where it is installed, will be responsible for any environmental pollution from the site. Grouting (cementing) of vertical loops along the entire borehole length will prevent migration of any leaking fluids into the ground.
	Heat pump sizing	How does an installer determine the size of a heat pump?	• The heating demand of your home determines the size of the heat pump needed for your installation.
		Why are different GSHP manufacturers quoting me different sized pumps for my home?	• The efficiency of heat pumps can vary from one model to another. The internal mechanical parts of the heat pump and the working fluid contained within it are the principal factors that affect its efficiency. As these vary from one manufacturer to another, so the efficiency rating of the pumps can vary. (Note all heat pumps carry a CE and EN standard certification demonstrating their rated efficiency)
	Pressure testing	Why does the ground source heat collector pipework need to be pressure tested before it is used?	• Once the collector has been completed it should be tested before trenches are backfilled (*horizontal closed loop*) or grouted (*vertical closed loop*) to ensure that there are no leaks. • A certified contractor will perform a pressure test and a flow test before filling the collector with heat transfer fluid. • Any installation of a heat distribution system in your home will also be pressure tested in advance of completing the commissioning phase.
Open loop	Availability of groundwater	How much groundwater do I need to run my GSHP?	• See ‘System choice’
		How can I tell if I will have enough groundwater?	• See ‘System choice’ • In addition to information on the general aquifer type (e.g. sand/gravel, or bedrock and its productivity) from GSI maps, there may be information on the yield of nearby wells held by the GSI that can be used to indicate potential well yields at the site. • A groundwater specialist (hydrogeologist or groundwater engineer) can be consulted to help to determine the best location to site the boreholes. • A three-day abstraction test should be undertaken following the drilling of a borehole to ensure you have a sustainable supply of groundwater sufficient to provide heat to the heat pump system being installed.

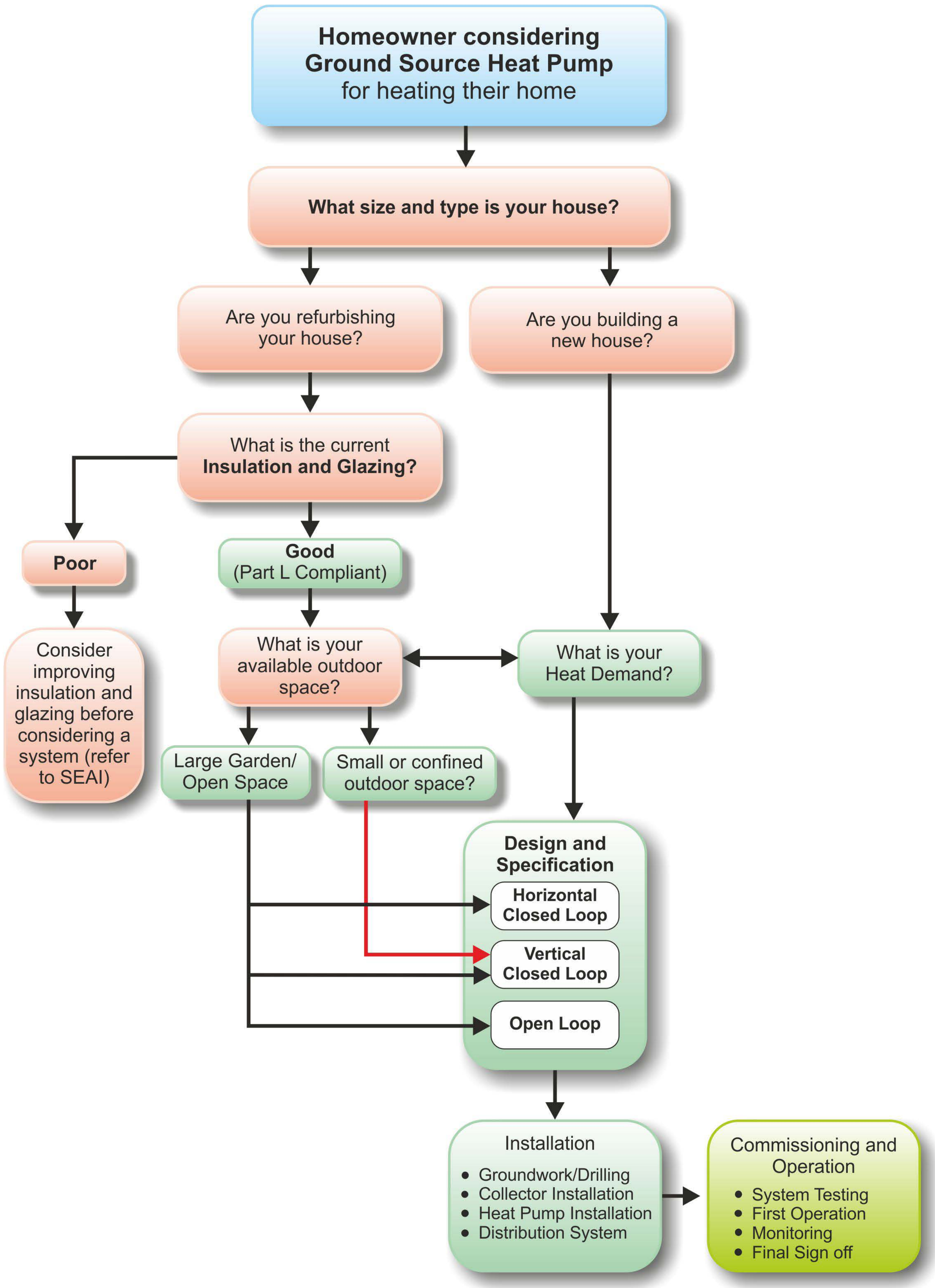
System type	Design element	Consideration	Why is this important?
Open loop	Availability of groundwater	What can I do if there isn’t enough groundwater from my borehole?	• If the borehole doesn’t provide a sufficient supply to meet the heat pump and building heating demands, you may need to drill an additional borehole to augment the supply, or you may consider another type of collector (i.e. a closed loop). • A groundwater specialist can be consulted to help to determine the best location to site the boreholes.
		What temperature is the groundwater?	• Groundwater temperatures vary very little in most areas of Ireland. Most Irish groundwaters have a nearly constant temperature of between 9-10^{o}C (north of Ireland) to 11-12^{o}C (south of the country). • In areas underlain by certain types of cavernous limestone (karst), groundwater temperatures may be more variable over the year. • In certain parts of Leinster and Munster, there are locations where slightly warmer waters upwell from deeper underground, and temperatures can be from 13-16^{o}C.
	General operation	Why is the groundwater temperature important?	• The higher the temperature of the water, the more heat energy it contains that can then be extracted using a heat pump. • The efficiency of your GSHP system can be increased if higher groundwater temperatures are available as the heat pump will require less electrical energy to deliver the required heat to your home.
		Is the groundwater quality important?	• The groundwater quality should be tested to ensure that it is not corrosive and that there are no dissolved natural substances in it that might block the GSHP system. • If the groundwater is found to be corrosive or scaling, this should be factored into the system design and maintenance programme.
		How should the used water be disposed of?	• The used water can be reinjected back into the ground, or discharged to a nearby stream or mains drainage. • If there is nowhere to dispose of the water, it is not advised to progress with an open loop system. • Re-injecting water to the aquifer requires a second borehole and can be difficult. The feasibility of this should be tested in advance of choosing this option.
		Will a discharge licence be required?	• If the proposed discharge is to any surface or groundwater body a discharge license is required from your Local Authority (ensure this can be secured before the system installation begins). In most cases discharge to stream surface water from a GSHP system operating in heating mode only is not usually a problem (subject to the water chemistry being tested). However GSHP systems used for cooling purposes will have to comply with maximum discharge temperature thresholds.

System type	Consideration	Why is this important?
Generic system questions (applies to open and closed loop)	Why should my system be tested before it is used?	• See ‘Closed loop’
	Will my system need maintenance in the future?	• All collector systems will require some level of maintenance. This is generally minimal for correctly completed systems. • *Open loop* collector boreholes should be periodically cleaned to guarantee efficient operation. • Temperature and flows of all *closed loop* collector systems should be regularly monitored. Many systems can use remote logging to achieve this and provide data in real time. • Periodic maintenance to circulating pumps and valves may be necessary.
	Should all contractors working on my property have insurance?	• All contractors should carry suitable levels of public liability and employer’s liability insurance to cover the scope of work that they are undertaking at your home. • If they are giving you professional advice or designing your system, they should also hold professional indemnity insurance. If you have employed someone to manage the whole installation (i.e. a “project manager”), ask them to obtain insurance details from all necessary parties before agreeing or entering into any contractual arrangement.
	Do Health and Safety legislative requirements apply to any site work being undertaken to install the GSHP?	• All contractors should be trained in Health and Safety (ask to see a valid Safe Passes) and companies should be able to provide you with a Health and Safety Statement demonstrating safe working practices in accordance with the *‘The Safety, Health and Welfare at Work Act, 2005’*.

Having outlined some of the different considerations and physical elements involved in the design of your system, you should be aware that adequate planning and design of your system needs to be undertaken and supervised at the installation phase. The flow chart (right) illustrates the order in which various design elements need to be considered, and summarises the tasks involved in the design and installation of a GSHP system.

You should appoint a qualified person or project manager who will advise on the design and manage the construction process on your behalf, as well as taking the responsibility for supervising the completion of the collector, the supply and installation of the heat pump and the distribution system (if necessary) to the standards specified. This person should be qualified and certified and should use competent/qualified sub-contractors.

This project manager may be the contractor, designer, installer, architect or an independent consultant. Similarly, it is vital that before construction begins you establish who will be responsible for the sign-off of the system (this person may be nominated by the project manager if one is appointed). This person should ensure that all the work undertaken on the project by their own staff, and also the work undertaken by other suppliers and sub-contractors, is completed according the necessary standards set out in the GSI Technical Guidelines for Ground Source Heat Pump Manual.



Homeowner considering Ground Source Heat Pump for heating their home
What size and type is your house?
Are you refurbishing your house?
Are you building a new house?
What is the current Insulation and Glazing?
Poor
Good (Part L Compliant)
Consider improving insulation and glazing before considering a system (refer to SEAI)
What is your available outdoor space?
What is your Heat Demand?
Large Garden/ Open Space
Small or confined outdoor space?
Design and Specification
Horizontal Closed Loop
Vertical Closed Loop
Open Loop
Installation
Groundwork/Drilling
Collector Installation
Heat Pump Installation
Distribution System
Commissioning and Operation
System Testing
First Operation
Monitoring
Final Sign off

It is important to establish which appropriately qualified professionals will taking responsibility for the different elements of the work involved. The professionals who may be qualified to undertake the various roles are summarised in the table below.

In all cases, you should ask the contractor to provide references for similar projects that he or she has undertaken in the past. Up to three quotes should be obtained for the proposed work.

In some cases different contractors or specialists may undertake one or more elements of the work. Similarly, a single company could undertake all of these tasks provided they are competent and certified to do so. The matrix below provides information on the contractor who may undertake each phase of the work.

FOR SOME INSTALLATIONS ONE PARTY MAY TAKE ON MORE THAN ONE ROLE	Driller/ Groundworks Contractors	Certified Installer	Designer	Engineer (M&E/HVAC)	Architect
General					
Heating/Cooling Requirements		●	●	●	●
Site Assessment (ground conditions and services)		●	●	●	
Project Manager		●	●	●	●
System Type Selection Design		●	●	●	
Contractor Selection (Experience and Insurance)		●	●	●	●
Open Loop					
Well and Collector Design			●		
Site Preparation and Clean Up	●				
Drilling and Borehole Completion - including Casing and Grouting	●				
Discharge Details and Licensing (to Aquifer or Surface Water)	●		●	●	(●)
Pump Test or other to ensure Enough Groundwater is available	●		●		
Loop construction & Supervision	●	●	●	●	
Closed Loop-Horizontal					
Ground Heat Exchanger Design		●	●		
Collector Type and Design - Excavation Detail and depths		●	●		
Collector Construction - Trenching and Excavation	●				
Collector Pipe Installation		●	●		
Backfilling and Landscaping of final collector area	●		●		
Closed Loop-Vertical					
System Design Calculations			●	●	
Ground Heat Exchanger Design			●	●	
Borehole Depth and Completion Specification including Grouting	●		●		
Site Preparation and Clean Up	●				
Drilling and Borehole Completion including Grouting	●				
Ground Heat Exchanger Installation and Supervision	●	●	●		
Thermal Response Testing (if necessary)			●		
Commissioning - Common to all systems					
Purging the Collector		●	●		
On-site Pressure and Flow Testing		●	●		
Collector Fluid Filling		●	●		
As-built Drawings supplied (Project Manager task)		●	●	●	●
System Sign-Off (Project Manager task)		●	●	●	
Post Installation - Common to all systems					
System Performance and Monitoring		●			
Collector and System Maintenance		●			

Following the installation process, the system should be pressure tested to ensure that there are no leaks and the system is working correctly. For a closed loop system, the ground loop should be pressure tested before it is installed in the ground, and again after installation.

The company or person signing-off the system should provide you with the following documentation:

- Certificate of completion and guarantee
- “As-built” drawings including a map of the collector layout and of all system components at the location where they have been installed
- Instructions on the operation of the system
- System sign-off documentation

What happens during the installation process?

The installation process of the GSHP will be highly dependent on the type of scheme that has been chosen to best suit your home. The pictures and diagrams below illustrate how the installation will proceed.

Closed loop: horizontal

A closed loop horizontal system will involve the excavation of trenches or stripping of ground in which a collector will be placed in order to allow it to abstract heat from the ground.

1. A survey of the garden should be undertaken to ensure there are no pipes or cables which may be encountered during excavation of the trench. This survey will not disturb the ground and will be carried out using a hand-held device to detect any cables. Existing plans showing the location of services should be consulted (these are available from the utility companies), and where the presence of plastic pipes are suspected, hand digging should be used to confirm the location of these before breaking ground.

2. A single large trench, multiple trenches or a back stripped area will be excavated into which the collector loop will be installed. A machine excavator (digger) will be used to dig this trench. The size of machine used will be dependent on the ground properties, the size of the trench planned, and the size of the site and any site access constraints. At this stage, an open trench will be present on the property and all relevant health and safety procedures should be followed to ensure that this does not pose a risk to the home-owner or construction workers. There will also be temporary heaps of

soil and subsoil around the property from the excavated trenches. (This material will be placed back into the trench or used to cover the excavated area once the loops have been installed). It may be necessary to place a layer of sand at the base of the trench before installing the collector.

3. The collector loop will now be installed in the trench and pressure tested to ensure there are no leaks.
4. Once it is confirmed that it is not leaking the loop will be placed in the ground. The method of installation will depend on the size of the loop and the type of excavation. In the case of stripped areas, long circular strands of collector pipe may be laid side by side or in the case of trenching, the pipe will be installed as a series of repeated short loops (see images below).





5. Once the pipe has been inserted into the ground, the trench will be backfilled using the excavator. The backfilled area is likely to be raised slightly higher than ground level to allow for settlement over time.
6. After the installation and backfilling, the collector loop will be pressure tested once more to ensure that it has not been damaged in the final installation steps and that it will not leak during the operation of the system.
7. After the backfilling, once the ground has been allowed to settle, the area can be landscaped to blend in with the surrounding environment. The picture (right) illustrates a field with a finished geothermal system.

Closed loop: vertical

A closed loop vertical system involves the drilling of a borehole, or possibly multiple boreholes, where the collector pipe will be installed. This will take heat from the heat exchange fluid circulating in the collector pipes.

1. Similarly to the horizontal collector, a survey will be undertaken to identify any unmapped services prior to drilling.
2. A drilling rig will be brought on site to drill a hole into which the vertical loop will be placed. The type and size of drilling rig used will depend on the properties of the well to be drilled, on the ground conditions, and on the size of the site and any site access constraints. The pictures below show different types of rigs being used to drill wells for closed loop systems.

3. During the drilling process, the area around the well may be disturbed. Mud and water will be used during the drilling process, which can potentially make the area around the drilling site quite messy. Mud and rock chippings will be disposed of appropriately once the drilling is completed.
4. The loop will be carefully inserted into the drilled borehole from a spool ensuring minimal damage to the plastic heat collector pipe as it is being installed.
5. Once a hole has been constructed and the pipe installed, the collector loop will be pressure tested to ensure that it is not leaking prior to commissioning. It is vital that a loop is tested, as a leaking loop in a borehole will lead to loss of the fluid. A leaking collector will not allow the heat to be transferred from the ground and may also potentially pollute the surrounding groundwater.
6. After installation and pressure testing, the collector pipe will be grouted into place in the borehole. This improves the operating efficiency of the system by improving the thermal contact between the subsoil/rock and the collector pipe. It also reduces the risk of environmental impact if the loop ever starts to leak in the future.
7. For very large domestic or commercial GSHP systems comprising multiple borehole collectors, a thermal response test could be undertaken on the first borehole once the loop has been installed. This will allow information to be collected for the thermal properties of the ground specifically at the site, which can then be used in the design of the GSHP system for your property to ensure it is as efficient as possible.
8. The finished well should be designed to allow it to blend in with the natural environment as shown in the picture (right).

Open loop:

An open loop system will involve drilling a water well and using the abstracted groundwater as the energy source.

1. As discussed at the start of the horizontal collector description, a survey will be undertaken to identify any unmapped services prior to drilling.
2. A drilling rig will be brought to your home to drill the groundwater borehole. The type and size of drilling rig used will depend on the depth and diameter of the well to be drilled, on the ground conditions, and on the size of the site and any site access constraints. The picture below shows a drilling rig being used to drill wells for open loop systems.

3. During the drilling process, the area around the well will be disturbed as shown in the pictures. Mud and water will be used or produced during the drilling process that will potentially make the area around the drill site quite messy. Mud and rock chippings will be disposed of appropriately following the completion of the drilling process. If artesian conditions are encountered, groundwater may rise up over the top of the well as shown in the pictures. Whilst additional parts are needed at the top of the borehole to ‘cap’ the artesian groundwater and prevent overflow during the lifetime of its use, artesian conditions are welcome since they reduce pumping costs.
4. The depth of the borehole will depend on the inflow zones encountered in the subsurface, and their ability to meet the required volume of groundwater. During drilling, short (10-20 minute) tests can be undertaken to ascertain an initial impression of the borehole yield using air from the drill-rig compressor to lift groundwater from the borehole. A longer test (several hours to days) should be undertaken to ensure that the yield indicated and required is sustainable over this time period.
5. Once the required depth has been reached during the drilling process, the designer will design the installation of the well to maximise the groundwater inflow to the well, protect the environment and to ensure the longevity of the well. In other cases where crumbling bedrock or sand/gravel aquifers are present, screened casing and gravel packs will be needed. Permanent casing through the subsoil and into the bedrock will be grouted in place. In most cases an open hole design in bedrock aquifers will be possible. It is imperative that the well head, area around the borehole and connected pipe work are designed in line with best practice to ensure that the well does not act as a pathway for contamination into the groundwater system.
6. When the well has been installed, a pumping test will be undertaken to determine the flow that can be achieved from the well and to ensure that that flow is sustainable. The water abstracted during this test will assess if there is enough groundwater to supply to the GSHP. The test water will have to be disposed of appropriately and this may require a discharge license may be required for this.

7. Once the well has been constructed, shallow trenches may need to be excavated to allow pipe-work to connect the borehole riser pipes to the heat pump. Depending on the heating demand of your house, it may be necessary to drill multiple wells (this is generally only the case in the event of insufficient groundwater in the first well of for very large homes, however).

8. At the end of the heat extraction process, the groundwater produced from an aquifer for use directly in the GSHP will have to be disposed of. This can be achieved by either re-injecting the water back in to the aquifer through a separate injection borehole, or by discharging to a surface water body. If re-injection to an aquifer is considered, the ability to re-inject the water into the aquifer will be tested using the abstraction borehole after it is completed. If the initial tests are successful, a second well for re-injection will then be drilled. A permit for discharging to ground may be required. Disposal of water to a river or lake will require a discharge license to be obtained from your local County Council. You should consider this at the early stages of development of an open loop collector.

9. The finished well should be designed to allow it to blend in with the natural environment as shown in the picture below:

Using your system…

Is the system easy to use?

How will I be able to control the operation of the heat pump system?

Once it is installed, the heating system should be as easy as any other modern heating system to control and operate.

Typically, a weather compensation system is used to control the heat pump. This includes both time and temperature controls for your house. The weather compensation system used to control the heat pump also includes an external temperature sensor, pipe temperature sensor and a central computer unit which controls all pumps and valves in the system. The central unit receives information from the sensors and programmable thermostats, and adapts the operation of your system based on the weather conditions and the heating requirements for your zones to ensure that heating and cooling are delivered efficiently throughout the year.

In line with all modern heating system designs, the system control ideally should include independent control of 'zones' or areas of your house . This zoning is controlled by a programmable temperature control that allows you to determine the heating requirements of individual areas of your house based on their use. An example of some of these zones includes:

1. living area
2. bedroom area
3. hot water (i.e. three main zones)

Will the system need monitoring or maintenance in the future?

Monitoring

How will I be able to monitor and control the operation of the heat pump system?

Many of the heating control systems have the ability to collect operational characteristic information from your system, and to store data on electricity consumption and heat delivery from your system throughout the year. These data are important in order to ensure that, once installed, your system is operating efficiently.

Even though the complexity of these systems varies considerably, GSI recommends that a monitoring system be included as part of any installation. Your installer will be able to advise you on the best system for you, but you should agree with your installer that they will visit and check that your system is operating adequately once the system has been running for several months.

Maintenance

As part of any GSHP installation, the GSI strongly recommends that a programme of maintenance is agreed with the installer once the system has been commissioned. Even though maintenance of these systems is not as onerous as for fossil fuel burning heating systems, it would be advisable to discuss what may be required with your installer as this may vary for different systems. Regular checks on the different parts of the system include:

- Operation of circulation pumps (all types of systems);
- Integrity of collector pipe (closed loop system);
- Well and pump cleaning (open loop collectors);
- Sediment and debris (river collectors).

The installation of river collectors is dependent on the characteristics of the water body, including low flow levels and the amount of debris in the river. These characteristics need to be carefully considered and may have to be installed in a trench box as shown in the figure (left).

Who is responsible for my system?

A shallow geothermal system constitutes one of the principal components of your home. As for any other equipment or part of your home that interact with the ground and the environment (e.g. your septic tank) you are responsible, as the homeowner, for the adequate operation and maintenance of your ground source heat pump system, and to ensure that it has no adverse impacts on the environment.

As discussed previously, the circulating fluid used in the ground heat exchanger may potentially be harmful to the environment. Should this fluid leak, you will be responsible for any arising environmental issue unless it is established that the system was not constructed and installed according to the Technical Guideline Standards in which case the installer may be responsible. The installer should also provide you with guarantee and/or warranty on the equipment and individual components of your system as well as the efficient long term operation and running efficiency of the system.

You should ensure that the installer provides full system sign off details, and that the system is constructed in line with best practice. The GSI Technical Guidelines for Shallow Geothermal Systems outlines best practice to be adopted by contractors installing shallow geothermal systems and to ensure environmental protection

Making the most of your system: Do’s and Don’ts

A series of do and don’ts have been outlined below to help you to ensure that you make the right decisions in the selection of your system.

Do’s:

- Understand the benefits of installing a GSHP compared to your existing space and water heating system, and the operation of both of these for a long term period.
- Understand the local conditions of your house, the size and available space you have, and ensure the ground conditions at your site are checked and considered carefully before choosing the right GSHP system type for your house.
- Ensure that the designer and installer you choose to use is certified and insured to provide the services you will need (Refer to SEAI list of certified installers & members of the HPAI).
- Seek at least three quotes from different installers, and ask for references from previous clients for similar domestic systems.
- Appoint a project manager that has experience in installing the type of system you have chosen. If you are project managing the installation yourself, ensure you communicate regularly with the designer, installer and ground works/drilling contractor and have regular site meetings.
- Ensure that a detailed calculation of your heating demand and domestic hot water needs is made that takes into consideration: construction standards, insulation, glazing, occupancy and specific house layout. This should be undertaken before a system has been specified and a collector chosen for your home.
- Discuss the logistics of carrying out the ground works and drilling operations with your building contractor or driller, and ensure that you both understand all the aspects of the construction of the collector that has been chosen for you.
- When the construction of the collector is agreed, make sure that the work required for the re-instatement of your garden has been agreed in advance and is implemented at the end of the construction process.
- If you are choosing an open loop system, ensure you understand the importance of obtaining sufficient groundwater to supply heat to your home. You should seek advice regarding the likelihood of sufficient supply for your area (refer to the GSI Shallow Geothermal Collector Suitability Maps for

indicative information), and you should be aware that if insufficient groundwater is met after drilling you may have to consider closed loop collector. Speak to your designer and installer about this early on in the project.

- Consider the benefits of grouting vertical closed loop boreholes. Whilst specialised thermal grouts will add to the initial installation costs, the operational efficiency of the system and the costs will be lower in certain geological conditions (e.g. deep water table). Grouting is not currently mandatory in Ireland (as it is in other countries), but has environmental as well as economic benefits.
- A warranty or guarantee on the operation of the system should be discussed with the installer. If this is not offered up front, discuss possible options with your installer. Note that with most modern heat pump systems, performance can be monitored and accessed remotely by the installer, providing a cost effective way of providing support in the use of your new system.
- Ensure a monitoring system (even if it is very basic) is provided to you, and its operation is demonstrated by the installer. This will be a simple way of checking the performance of your system and ensure that it is operating efficiently.
- When the system is commissioned and handed over to you, ensure you get sign -off paper documentation, instructions on how you operate the system, drawings of the outdoor collector and system components installed in your house. A contact person and helpline to answer any future queries you may have should be clearly outlined.

Don’ts:

- Capital Investment costs of a GSHP system are higher than other conventional heating systems. Don’t directly compare installation costs to make your decision: you should consider the payback of the installation and the operating costs for a longer period of time.
- Ensure that the designer and installer have come to visit your home and the site in advance of specifying the type of system you may require. Don’t accept any recommendations or agree to any final designs and specifications if no one has visited your home.
- Lack of communication can lead to costly installation mistakes! When project managing the installation of a system yourself or when a project manager is appointed, ensure that all the parties involved are communicating the specifications and construction details of the project to each other.
- Rules of thumb used to either determine site ground conditions or the heating needs of your home should never be used to size and cost a GSHP system for your home.
- Cheaper is not necessarily best – ensure that you do not choose a system based only on a low price quotation alone. Drillers, installers and designers that can guarantee their work may be more expensive but will ultimately deliver you with a better quality system that will work more efficiently.

Glossary and list of Acronyms

Abstraction: Removal of water from groundwater or surface water, usually by pumping.

Antifreeze: A modifying agent added to water in a closed-loop system to lower the temperature at which the water freezes.

Aquifer: A subsurface layer or layers of rock, or other geological strata, of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater (Groundwater Regulations, 2010).

Artesian conditions: Where groundwater in a confined aquifer is at sufficient pressure to cause water to discharge at the ground surface without any pumping.

Closed loop: These schemes consist of a closed piping system buried in the ground (or in surface water, see water source) and filled with water and antifreeze. The liquid circulates in the collector pipe loops, absorbs heat from, or gives heat out to the ground (or surface water).

Coefficient of Performance (heating) (COPh): A measure of the efficiency of a heating appliance, calculated by dividing the heat output by the energy input.

Coefficient of Performance (cooling) (COPc): A measure of the efficiency of an air-conditioning appliance, calculated by dividing the cooling output by the energy input.

Collector: The part of the system through which energy is collected and transferred to the heat pump. These can be closed loop, horizontal or open loop. Refer to the relevant definitions in this glossary for each.

EGEC: European Geothermal Energy Council, is a non-profit organisation whose aim is to promote the use of geothermal energy in Europe.

EPA: Environmental Protection Agency, the State Agency responsible for ensuring and regulating environmental compliance within Ireland.

Fissure/fracture: A natural crack in rock which allows water movement along it.

GAI: Geothermal Association of Ireland, a society for those interested in shallow and deep geothermal energy, whose aim is to promote the development of geothermal resources in Ireland.

Groundwater: All water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil (Groundwater Regulations, 2010).

Groundwater Recharge: Two definitions: a) the process of rainwater or surface water infiltrating to the groundwater table; b) the volume (amount) of water added to a groundwater system.

Groundwater Resource: An aquifer capable of providing a groundwater supply of more than 10 m^3/d as an average or serving more than 50 persons.

GSHP: Ground Source Heat Pump – used to extract heat from, or dispose of heat to, the earth for space heating and cooling, as well as water heating. They operate on the fact that the earth beneath the ground surface remains at a constant temperature throughout the year, and that the ground acts as a heat source in winter and a heat sink in summer. They can be used in both residential and commercial or institutional buildings.

GSI: Geological Survey of Ireland, the State’s national geological mapping organisation.

Heat exchanger/heat pump: see GSHP.

High-density polyethylene (HDPE): A long-lasting synthetic material used as a ground heat exchange piping material.

HPAI: Heat Pump Association of Ireland – trade association of heat pump manufacturers and installers.

Horizontal Collector: A closed loop collector where pipes are buried horizontally at a depth of up to 3m below the ground surface.

Karst: A distinctive landform characterised by features such as surface collapses, sinking streams, swallow holes, caves, turloughs and dry valleys, and a distinctive groundwater flow regime where drainage is largely underground in solutionally enlarged fissures and conduits.

Karstification: The process whereby limestones are slowly dissolved by acidic waters moving through them. This results in the development of an uneven distribution of permeability with the enlargement of certain fissures at the expense of others and the concentration of water flow into these high permeability zones. Karstification results in the progressive development of distinctive karst landforms such as caves, swallow holes, sinking streams, turloughs and dry valleys, and a distinctive groundwater flow regime. It is an important feature of Irish hydrogeology.

Lake/Pond or River Collector: Closed loop collector making use of sealed HDPE or stainless steel pipes arranged in loops and submerged in a lake, pond or river, through which a heat transfer fluid is circulated to absorb or release heat from or into the water.

Loop: A heat exchanger used to transfer heat between the ground and heat pump. These collectors can be open loop, closed loop, horizontal, vertical or river/lake collectors. Please refer to the definitions in this glossary for further details.

Non hazardous pollutant: Any pollutant other than a hazardous substance.

Open loop: a system where water is abstracted for direct use in a heat pump, and then is discharged either back to ground, or to surface water.

Payback period: The period of time required for an investment to “repay” the cost of purchasing a heating system (including interest paid on money borrowed to purchase it) and the cost of energy used to operate it for the same period. The method is used to compare the economics of installing different heating system types considering different investment costs and operating costs.

Permeability: A measure of a soil or rock’s ability or capacity to transmit water under a potential hydraulic gradient (synonymous with hydraulic conductivity).

Pollution: The direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health, or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment (Groundwater Regulations, 2010).

Poorly Productive Aquifers (PPAs): Low-yielding bedrock aquifers that are generally not regarded as important sources of water for public water supply but that nonetheless may be important in terms of providing domestic and small community water supplies and of delivering water and associated pollutants to rivers and lakes via shallow groundwater pathways.

Recharge: The process by which water is added to groundwater (i.e. from a well discharging water into an aquifer from a GSHC scheme).

Risk: A combination of the probability (or frequency) of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

SEAI: Sustainable Energy Authority of Ireland, the State Agency responsible for promoting the use of renewable energy technologies within Ireland.

Subsoil: Uncemented geological material beneath the topsoil and above bedrock.

Surface Water: water on the land‘s surface such as a lake, reservoir, stream, river or canal. Can also be part of transitional or coastal waters. (Surface Waters Regulations, 2009.).

Till: Unsorted glacial Sediment deposited directly by the glacier. It is the most common Quaternary deposit in Ireland. Its components may vary from gravel, sands and clays.

Vertical Collector: A closed loop collector comprising HDPE pipe installed vertically in one or several boreholes through which heat transfer fluid is circulated.

Vulnerability: The intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities (DELG/EPA/GSI, 1999).

Water Table: The uppermost level of saturation in an aquifer at which the pressure is atmospheric.

Yield: the maximum safe yield of a well represents its dependable and continuous output during prolonged dry weather.

APPENDIX - Applicable Irish regulations

Building Regulations – Department of the Environment, Heritage & Local Government.

Part L - Conservation of Fuel and Energy - Dwellings (2011)

Part J - Heat Producing Appliances: (Reprint May 05) (pdf, 242kb)

SI 243 of 2012 EUROPEAN UNION (ENERGY PERFORMANCE OF BUILDINGS) REGULATIONS 2012

SI 229 of 2008 European Communities (Energy Performance of Buildings) (Amendment) Regulations 2008

SI 666 of 2006 (European Communities (Energy Performance of Buildings) Regulations

SI 115 of 2006 - (Part B) - Building Regulations (Amendment) Regulations 2006

SI 872 of 2005 (European Communities (Energy Performance of Buildings Regulations)

Groundwater & Discharge Licensing - Department of the Environment, Heritage & Local Government / Environmental Protection Agency

Local Government (Water Pollution) Act, 1977 to 1990

Protection of the Environment Act, 2003

Environmental Protection Agency Act, 1992- 2011

S.I. No. 9 of 2010 - Regulation 4 of the Groundwater Regulations

S.I. No 684 of 2007 Waste Water Discharge (Authorisation) Regulations 2007

S.I. No. 231 of 2010 – Waste Water Discharge Licence or Certificate of Authorisation - Amendment.

Health & Safety

Health and Safety at Welfare Act, 2005.

Safety, Health and Welfare at Work (Construction)(Amendment)(No. 2) Regulations 2012 (S.I. No. 481 of 2012)

Safety, Health and Welfare at Work (Construction)(Amendment) Regulations 2012 (S.I. No. 461 of 2012)

Safety, Health and Welfare at Work Act 2005 (Commencement) Order 2012 (S.I. No. 446 of 2012)

Safety Health and Welfare at Work (General Application) (Amendment) Regulations 2012 (S.I. No.445 of 2012)

Safety, Health and Welfare at Work (Construction)(Amendment) Regulations 2010 (S.I. No. 523 of 2010)

Safety, Health and Welfare at Work (General Application)(Amendment) Regulations 2010 (Artificial Optical | Radiation) (S.I. No. 176 of 2010)

Safety, Health and Welfare at Work (Construction)(Amendment) (No. 2) Regulations. (S.I. No. 423 of 2008)

Safety, Health and Welfare at Work (Construction)(Amendment) Regulations 2008 (S.I. No. 130 of 2008)

Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299 of 2007)

Safety, Health and Welfare at Work (Construction) Regulations 2006 (S.I. No. 504 of 2006)

Safety, Health and Welfare at Work (Control of Vibration at Work) Regulations 2006 (S.I. No. 370 of 2006)