kensaheatpumps

Ground Source Heat Pumps for Social Housing

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Introduction

Ground source heat pumps are a compelling technology for social housing providers looking to develop or upgrade properties to meet more stringent regulatory requirements. However, systems, particularly the design of the ground arrays, need to be handled correctly and this requires some expertise even if the subsequent installation is very straightforward.

The purpose of this Information Booklet is to provide guidance covering the application of heat pump technology in social housing properties.

Without doubt, the market is currently confused by conflicting performance claims and, in some cases, an unfortunate inconsistency between the performance promised at the pre-order stage and subsequent real-life experiences. Whilst the Information Booklet concentrates on ground source technology, it also refers briefly to air source heat pumps if only to try and dispel some of the myths surrounding this technology.

Of course, upon request, Kensa would be happy to provide specific information for any new build or retro-fit project.

A Little About Kensa Heat Pumps

Kensa Engineering was established in 1999 and initially acted as an installation contractor gaining experience of many imported ground and air source heat pumps. Quickly, the company realized that not only were these appliances not suited to typical UK properties but they were also generally expensive and required a high level of installer expertise.

Recognizing the opportunity to develop its own range, Kensa launched its first Compact ground source heat pump and gradually introduced new products to ensure a solution for every residential application. Kensa now focuses on production and is the UK's only manufacturer of a full range of ground source heat pumps with outputs ranging from 4 - 150kW.

As a manufacturer, Kensa works alongside selected partners - borehole field designers, drilling contractors and installers - to deliver a complete package with each partner offering expertise in their specific area. This approach allows Kensa to offer a variety of fulfillment strategies to suit individual requirements, as described later in this document. It is this flexible approach that has reduced overall project costs for many clients.

The company now operates from a 20-acre site in Cornwall employing an ever-increasing workforce dedicated to delivering competitively priced, well-engineered and expertly applied heat pumps to the residential sector.

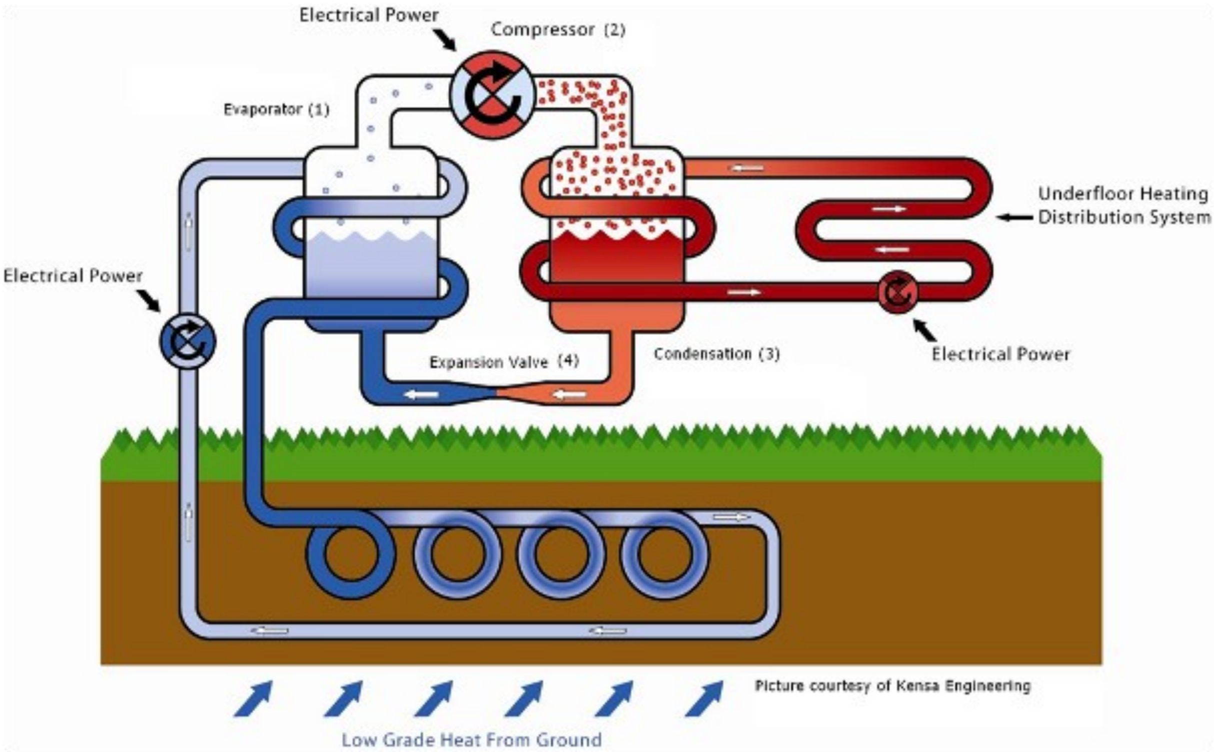
Kensa's success has been rewarded with numerous awards including UK Business of the Year (Ashden Awards, 2008), Product of the Year (Housing Excellence Awards, 2009) and Green Manufacturer of the Year Award 2009 (Corgi Live Awards)

The Appeal of Ground Source Heat Pumps

Detailed information on how ground source heat pumps work can be found at www.kensaengineering.com. In brief, heat pumps utilize the free solar energy stored in the ground around any property.

There are three elements to a system:

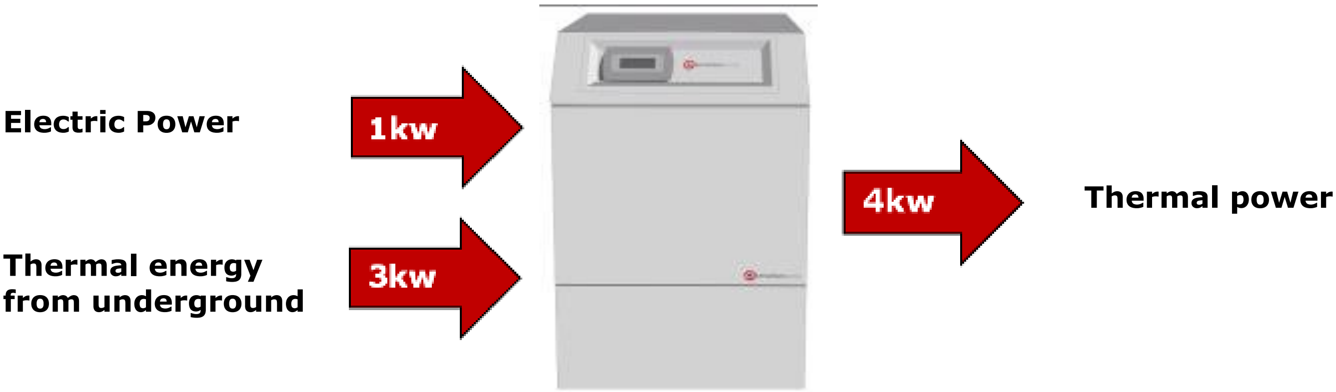
- The ground array, typically a borehole for social properties
- The heat pump
- The heat distribution (and domestic hot water) system



The heat pump circulates a cooled liquid, usually a water/anti-freeze mix, into the ground array using an electric pump. This liquid is heated by the earth, where temperatures remain relatively constant at 8-12C, and returns to the heat pump several degrees warmer.

The energy stored in the warmer liquid is transferred, via a heat exchanger, into a refrigerant which is stored in a sealed circuit within the heat pump. As the refrigerant absorbs the heat, it evaporates into a gas which is passed into an electrically-driven compressor. The compressor increases the pressure and temperature of the gas before feeding it into a second heat exchanger. Here the heat is transferred into the water circulating around the heat distribution system condensing the refrigerant into a liquid. The final stage sees the cooled refrigerant drop in pressure ready for the cycle to begin again.

The attractiveness of a heat pump is based upon its Coefficient of Performance (COP). For each kilowatt of energy used to power the electric compressor and circulation pumps, around four kilowatts of energy are produced. The precise COP will be dependent upon the ground temperature and the flow temperature required by the heat distribution/hot water system.



It can be seen that the tenants benefit from lower running costs and carbon emissions are significantly lower than any traditional heating system. More importantly, heat pumps are durable (they have an accepted life of 25 years plus) and require very little on-going maintenance, which means the lifetime cost of ownership for any Housing Association is very attractive. In addition, initial capital costs can be mitigated by significant levels of grant support.

As a consequence, there is considerable interest particularly for retro-fit programmes displacing solid fuel or direct electric heating systems as well as oil and LPG boilers. Once the cost savings are fully understood, it is expected that retrofit programme will also displace gas boilers, which typically have a life of less than ten years, thereby removing the considerable cost burden of annual servicing.

One or Two Myths Explained

Whilst some companies might want you to believe their heat pump out-performs the market, the simple truth is that performance is remarkably consistent simply because many appliances share common components.

The most influential component is the compressor. The vast majority of ground source heat pumps sold in the UK feature a compressor sourced from one of just two suppliers. Consequently, performance will not be determined by the brand of the heat pump; instead, it will be dependent upon local ground conditions, the property's fabric insulation and air tightness specification and, most importantly, characteristics of the heat distribution and control system.

As a result, the property influences performance far more than the manufacturer's badge on the heat pump.

Both CERT and RHI grant programmes require the use of MCS-accredited products; all Kensa products are eligible for these funding streams.

Fortunately, in order to access the various grant programmes, manufacturers will have to obtain MCS (Microgeneration Certification Scheme) approval for their appliances. MCS certification involves testing to a consistent and robust performance standard (EN14511), which should help to reduce misleading performance claims.

It is also important to ensure the heat pump delivers the promised performance in each application. Sadly, many imported machines feature integral immersion heaters and some suppliers deliberately under-size the appliance, and its ground array, which means a greater reliance on direct electric heating. Whilst this approach may secure an initial commercial advantage, it will also result in far higher running costs for the tenant and the risk that eligibility for grant funding will be compromised. Thankfully, the proposed SAP2009 software, used to confirm compliance with Building Regulations and the Code for Sustainable Homes, will impose a modest penalty on this practice, which should improve the quality of the application engineering.

For the record, it is the view of the Heat Pump Association that heat pumps should be sized to handle the full space heating load and Kensa has adopted this design philosophy on all of its installations. Recently, a leading manufacturer conceded that this was the proper approach and amended their design practice and it is expected that further companies will follow suit if only to avoid complaints linked to excessive running costs.

Of course, Kensa maintains that, if required, heat pumps should also handle everyday domestic hot water requirements as well with the cylinder's immersion heater merely raising the stored temperature through 60°C on a weekly basis to combat the risk of Legionellas.

Clearly, handling the full load requires a higher capacity heat pump and a larger ground array, which, in most applications, means a deeper borehole.

Please refer to the section – 'Ground Array Design' for further information on borehole

Air Source Heat Pumps—The Issues

	Ground Source	Air Source
Unobtrusive	√	
Lower carbon emissions	√	
Lower ongoing maintenance costs	√	
Lower running costs	√	
Higher levels of grant support	√	
Permitted development rights	√	

Many air source heat pumps have been installed onto new build developments in the past year. Indeed, most contract builders have recognized their ability to help meet CSH Level Three in an inexpensive manner, so the technology certainly suits their purpose. Unfortunately, housing associations are inheriting properties that will demand far higher lifetime ownership costs and tenants are being disadvantaged since the day-to-day running costs associated with air source heat pumps can be significantly higher.

Interestingly, most major retrofit programmes have featured ground source heat pumps since housing associations appreciate the lower lifetime ownership costs. Further, Housing Associations are concerned by the potential noise issues associated with air source heat pumps.

Right now, planning permission is required for any air source heat pump installation. Sadly, this requirement is often glossed over or ignored by the suppliers which could have serious consequences. Whilst most renewable technologies have 'permitted development rights', permission has not been granted to micro wind turbines or air source heat pumps because of concerns over noise levels. Whilst certain models offer superior acoustic performance, the fact remains that no air source unit can be installed without planning permission and several existing installations have led to complaints and the subsequent removal of the appliances.

The greater lifetime ownership cost and the need for planning permission are not the only concerns linked to air source heat pumps. Their increased carbon emissions will compromise their ability to satisfy higher levels of the CSH and greater exposure to the technology will introduce Housing Associations to many other issues. For example, their aesthetic appeal is questionable, their external location exposes them to the risk of damage or vandalism, their ability to perform in the coldest conditions is compromised and they will require the user to brush away any snow cover, an unreasonable requirement during the middle of a cold night.

In the future, it is possible that product developments will mitigate some of these concerns but the current selection of air source heat pumps are more suited for private developers looking to comply with any planning conditions and market any development under a 'green' banner. They are certainly not as well-suited for social housing as ground source heat pumps.

An independent assessment of air source heat pumps, including a response from a leading supplier, can be found on the Building Sustainable Design Website — Click Here to visit this page.

Ground Array Design

It is critical to provide a well-designed ground array to ensure the system is sustainable. Quite simply, if insufficient plastic pipe is buried in the ground, the heat pump will either freeze the array or, if fitted, place an unacceptable reliance on the integral immersion heaters. Since Kensa heat pumps have never incorporated immersion heaters, Kensa has to ensure the ground array is sized appropriately.

This is not a straightforward task since it depends upon the thermal conductivity of the site, the efficiency of the heat pump and a precise understanding of the loads. It should be emphasized that any decision taken for the heat pump to handle domestic hot water will also require a deeper borehole.

Of course, the UK boasts very diverse geology which means that specialist thermo-geologists are typically employed to provide borehole specifications using sophisticated modelling software. If a reasonable number of boreholes are required in a single location, perhaps for a new build development, Kensa recommends a thermal response test to establish precise site conditions.

Kensa operates a rig which acquires the data (using a test borehole) that can be analysed by a consultant to provide specific performance figures and appropriate borehole specifications. If boreholes are required across an area, desk-based research is usually employed to develop the borehole specification, referencing borehole data from the British Geological Society database.

This specification will cover the diameter/depth of hole, the diameter of the ground probe and the type of thermal grout to be employed. Whilst questions about the heat pump's warranty are routinely raised during project negotiations, it is far more critical to understand the justification for the borehole design since an under-sized ground array cannot be remedied without incurring significant expense.

Domestic Hot Water

Whilst ground source heat pumps are an obvious choice for handling a property's space heating, there is a wider variety of options for domestic hot water. If the heat pump is asked to produce DHW, it is inevitable that the size of the ground array will need to be increased to a) handle the increased load and b) reflect the year round nature of DHW production (which compromises the ability of the ground array to recover temperature through the summer months).

Given the extra cost, there is sense in considering solar thermal panels on properties benefiting from the correct orientation particularly if the occupancy level suggests a significant hot water demand.

That said, the Kensa heat pump can provide hot water as well as any other appliance and the unique control system means that the maximum possible stored water temperature is always achieved. Rather than limit temperatures by the use of a cylinder thermostat, Kensa's design allows the heat pump to perform all its useful work before switching itself off when it recognises that it can have no further positive impact on the stored temperature.

Using the standard refrigerant (407C), a temperature of 50°C is possible with the immersion heaters in the cylinder lifting the temperature on a weekly basis to eliminate the risk of legionellas. This is the preferred solution for most social housing clients. In this configuration, the heat pump will handle all normal hot water requirements. Of course, compared to a traditional boiler, the cylinder replenishment times will be longer which means there may be a need to use the cylinder's immersion heater to expedite recovery, but only on occasions of exceptional hot water demand. Heat pumps with integral immersion heaters should be avoided since the tenant will not be able to control its use.

Kensa also offer a range of high temperature Compact models which utilise 134A refrigerant capable of providing stored water at 60°C. Whilst that might seem advantageous, this refrigerant 'de-rates' the heat pump's output, which means that larger and more expensive, compressors and heat exchangers are required. For this reason, they are not generally favoured for social housing applications.

In either case, to minimise running costs, efforts are usually made to secure a split rate electricity tariff (Economy Ten) and to ensure the heat pump's hot water production is focused during low cost periods. The government's recent decision, under its Low Carbon Transition Plan, to require the energy suppliers to introduce social tariffs should assist.

Finally, some clients choose to handle domestic hot water production, especially in smaller properties with modest demand, simply by using the immersion heaters in the cylinder. Although this stategy doesn't result in the lowest possible carbon emissions, it does provide a low-cost solution and running costs are reasonable especially if split rate tariffs are available.

Fulfilment Strategies

In any retrofit programme, a number of tasks must be handled. These are outlined in the table below.

The contractual 'bundling' of these tasks can vary on a project-by-project basis depending upon the requirements of each client, but a typical example is included in the table.

Elements of any retrofit programme	Responsible Company			
	Housing Association	Kensa	Drilling Contractor	Local M+E Contractor
Evaluation of property (provision of SAP report)				
Evaluation of site				
Appeal to tenants to accept technology				
Design of ground array				
Provision of ground array				
Specification and supply of heat pump				
Installation of heat pump				
Design of internals				
Supply and installation of internals				
Commissioning of heat pump				If MCS Certified
Education of user				
Maintenance contract				
Note:		Denotes Kensa's recommended approach		
		Denotes possible alternative approach		

As a manufacturer, Kensa seeks to partner with companies willing to offer a range of fulfillment solutions aimed at minimizing end user prices. Without doubt, the market for ground source heat pumps in the social housing sector is still evolving and some of the early market leaders are struggling to sustain their positions as new supply arrangements emerge.

Pioneering projects were typically installed by a heat pump installation specialist offering a turnkey package at premium prices with sub-contractor work, such as drilling, subject to significant mark-ups. As a consequence, the ground source technology often lost out to less expensive options. Air source heat pumps, in particular, gained market acceptance amongst contract builders, especially on new developments where they sought to satisfy planning conditions at the lowest build cost.

More recent projects have reflected a wider range of installation options with manufacturers and installers choosing to fragment the turnkey package into separate contracts.

This should not cause any concern. If a Housing Association was specifying gas boilers, a plumber would install the combi on the kitchen wall and a separate contractor would provide the gas connection to the property; the two elements would 'meet in the middle' and there would be no concerns about the separate responsibilities. In the case of heat pumps, the borehole is simply the equivalent of the gas infrastructure and need not be supplied by the same company responsible for installing the heat pump. This avoids any 'margin-on-margin' and reduces total costs. It should be remembered that most heat pump installation companies will have insufficient resource to handle the internal works (radiator replacement/DHW cylinder installation), so there is an inevitable split of project responsibilities elsewhere.

Heat Distribution System

Heat pumps work most efficiently when delivering water at the coolest possible temperature, which is why underfloor heating is generally mentioned as the preferred heat distribution system. Since the entire underfloor area acts as the heat emitter, it is argued that a lower flow temperature will still be sufficient to reach the required room temperature. Kensa certainly supports this recommendation if the underfloor heating pipes are installed within screed throughout the property; in this case, flow temperatures between 30-35°C are typical, depending upon the resistive value of the floor covering and the property's thermal insulation. (See Fig 1).

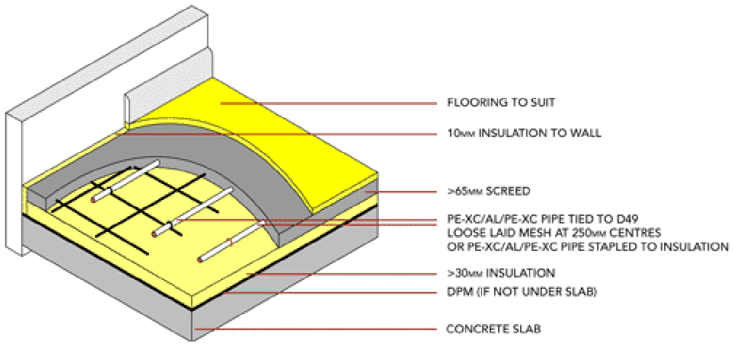


Fig 1

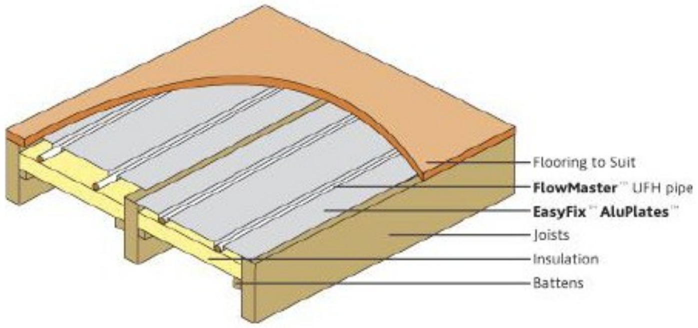


Fig 2

That said, many houses feature suspended timber upper floors where the provision of a screed layer, whilst possible, is generally awkward and expensive unless proprietary systems such as Finn Forest's Soundbar floor are specified. As a result, the heating pipes are often installed in the joist structure, typically embraced by a steel heat transfer plate (See Fig 2), although sometimes just placed in the void with an underlying reflective sheet. In these configurations, the flow temperature requirement is higher (40-50°C) to ensure sufficient heat is driven through the overlying chipboard and the floor covering (usually resistive underlays and carpet). Indeed, this flow temperature requirement is no different from that required by radiators so Kensa does not routinely suggest underfloor heating in standard two storey dwellings.

It should be noted that the excellent thermal and air tightness specifications, now required on new build developments, means that the space heating load is very modest, often no more than 35 watts per square metre. This means that a three bedroom 85m² house has a peak space heating load of just 3kW. As a result, the heat requirement in individual rooms can be handled by a single standard-sized radiator even though the heat pump is only delivering water at 50°C. Of course, radiators are often used to dry laundry so are often favoured by tenants.

Finally, radiators are the sensible choice for retrofit schemes where oil or LPG-boilers are being displaced. In some cases, energy saving measures implemented after the existing radiators were originally installed means they will provide adequate outputs. In other instances, it is possible to install higher output radiators onto the existing tails, which certainly minimizes disruption. That said, in some cases, and all instances where microbore pipe has been used, it will be necessary to install a new radiator system. [To view our fact sheet for Heat Pumps with Radiators, CLICK HERE.]

Renewable Heat Incentive

The Renewable Heat Incentive (RHI) scheme is currently out for consultation hence the details here may change before the scheme is launched in April 2011, however the main points are not expected to change in any major way. In February, the Government produced a consultation document on the proposed Renewable Heat Incentive (RHI) scheme. This consultation sets out the Government's proposals on the design and operation of the Renewable Heat Incentive, with the aim of providing financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewable technologies and sources.

RHI payments to be claimed by, and paid to, the owner of the equipment. The RHI will be available to householders, local authorities and social landlords as well as the public, industrial and commercial sectors. All installations commissioned after 15th July 2009 will be seen as a "new installation" and will be eligible for the RHI.

Payments will be paid over the life of the equipment (for Ground Source 23 years) and will be inflation linked and guaranteed.

Example of the expected RHI returns:-

Semi-detached Property with 2 bedrooms and an annual space heating load of 8,998kWh/year and DHW load of 3,742kWh/year. The below figures are an estimate only.

Space Efficiency of GSHP (SAP)	DHW Efficiency of GSHP (SAP)	Tariff from RHI (£/kWh)	Annual contribution from RHI	Electrical Power absorbed by GSHP kWh/yr	Annual running cost based on 12p/kWh	Annual income from RHI		Life of GSHP (years)	Total income from RHI
320%	224%	0.07	£892	4,482	£538	£354		23	£8,142

Award Winners

As a UK-based manufacturer, Kensa Engineering can offer a wide range of approved ground source heat pumps including the Compact Range, the recipient of the 2009 Housing Excellence 'Product of the Year' award.

Kensa Engineering secured the prestigious 'Green Manufacturer of the Year' Award at the Corgi Live Awards 2009. This award reflects Kensa's reputation amongst installers and partners within the industry, not just for the standard of our product engineering but also for our commitment to an excellent level of service.

In 2009 Kensa won the prestigious Ashden Award for Sustainable Energy. As UK winners of the Energy Business category, Kensa gained recognition of their ground-breaking work in addressing fuel poverty, cutting carbon emissions and making renewable energy more accessible.

Case Study—New Linx Housing Trust

New Linx is the largest Registered Social Landlord in Lincolnshire, managing around 6000 homes. New Linx's Housing Trust developments across the county cater for all tenures and provide attractive, comfortable homes which are economical to run.

New Linx was looking to replace the solid fuel boilers installed in over 225 properties of their housing stock, throughout Lincolnshire. Naturally, New Linx was keen to finance the work on as many properties as possible which meant a requirement for significant levels of grant funding. Further, New Linx wanted to involve their own management resource to help reduce project costs.

In this case, Kensa introduced New Linx to Scottish and Southern Energy who committed over £1.25m of grant funding, via their CERT programme, to the project. Since solid fuel boilers emit significant levels of carbon, the grant amounts were generous; grant support averaged around £5000 per property.

To minimise New Linx's additional spend, Kensa suggested an innovative project approach with the drilling contractor working under separate contract. The drilling contractor provided and installed the ground probe and trenched the pipework back to the property. Reducing the costs further, the physical installation of the heat pump involved local mechanical and electrical contractors with an existing relationship with New Linx. Kensa provided a final check commissioning service.

To find out more about this case study, or to discuss a project with someone from Kensa Engineering, please do not hesitate to contact us.

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