Geothermal Consultation Response - BDP

Date: 05/02/2022

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DOCUMENT CONTROL SHEET

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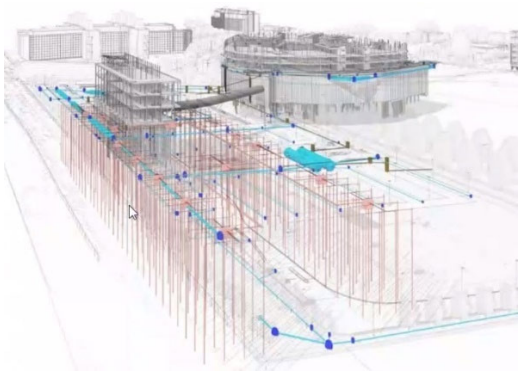
1. AREA OF EXPERTISE

BDP are experienced in the practical application of a wide range of heat pump systems to buildings. We have designed and monitored the following types of ground source heat pump systems:

- Vertical Closed Loop
- Horizontal Closed Loop
- Open Source with rejection to water sources
- Open Source with re-injection

Our experience of applying ground source heat pumps to buildings in Ireland spans over a 25 year period. Our engineers also have experience with large scale ground source systems in Europe including a 200 bore system for Roche Pharmaceuticals and the largest closed loop ground source system installed within Europe for AstraZeneca. Our Irish based engineers were involved in reviewing the designs of these systems.

Our expertise does not extend to a detailed knowledge of drilling or deep bore systems.



Images:
Roche HQ (200 bore hole system)
ESB HQ (32 bore hole system)
AstraZeneca (Europe's largest close loop system)

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2. OVERVIEW OF THE DRAFT POLICY STATEMENT

The review of ground source and geothermal potential in Ireland is welcomed. The proposed review of the legislative constraints to development would be especially beneficial from our perspective.

In particular, we support any developments that would make it easier to implement open source heat pumps in Ireland. Open source systems have the potential to be particularly cost and energy efficient but it can be difficult to achieve approval for such systems in Ireland due to a limited knowledge of the environmental impacts of such systems. The current legislative environment in Ireland has on occasion resulted in an inconsistent response to such proposals and a reluctance of some clients (including public bodes) to pursue such solutions.

A lack of knowledge of the environmental impacts of open source systems can result in the un-necessary rejection of proposals and any measures to provide a simplified application process with a consistent method of consideration is welcomed.

We believe that it is important that the policy document provides an accurate and transparent view on the financial and environmental benefits and challenges of ground source and geothermal systems. We have some concerns that the current draft in some areas demonstrates a financial optimism that could potentially lead to a sub optimal application of state support for schemes.

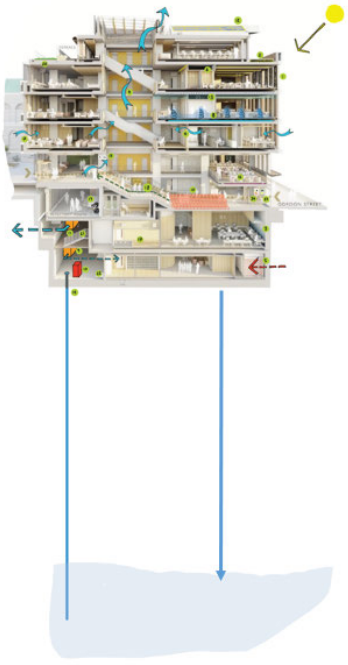

Image: UCL open loop system with re-injection where open source free cooling is used

Terminology

We note the term “Geothermal” is used to describe all forms of ground related energy within the policy document. In this response, for clarity we have used the term “ground source” to describe the gathering of heat from the ground which has ultimately come from solar energy and “Geothermal” to describe energy that has come from processes deep within the earth.

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3. HISTORIC PRECEDENT CONTEXT

The draft policy document refers to a number of historic precedents in making the case for further development.

We wish to caution that the conclusions drawn from historic precedents requires a consideration of their context relative to that of future systems. From our experience in studying the real life performance of systems, we are aware that very little data is published on the actual performance of existing systems and that they often do not perform as effectively as the information published would imply.

We have on a number of occasions been called to review existing systems that were not performing as designed and have some insights into the practical limitations of such systems.

It is also important to consider that many precedents were initiated within a considerably different environment to that of future systems. In particular the following should be considered:

National Grid Carbon Intensity

The carbon intensity of the national grid in Ireland has roughly halved over the previous fifteen years. This provides a significantly different environment for decision making relative to that which existed when many existing precedents were designed.

The reduction in grid carbon intensity reduces the benefits of ground source heat pump solutions relative to alternatives. The argument for the use of ground source systems is primarily that they have a better efficiency than alternatives such as air source heat pumps. Taking an extreme scenario where the carbon intensity of the national grid approaches zero, there becomes no carbon benefit to the use of a method of reducing carbon emissions. This means that the carbon case for ground source applications is now half that which applied when many historic precedents were produced. The difference is in reality even more dramatic as the rate of reduction in carbon intensity of the national grid is accelerating. Renewable energy installed directly on buildings also accelerates the effect as it lowers the carbon impact of electricity delivered to heat pumps below that of the grid.

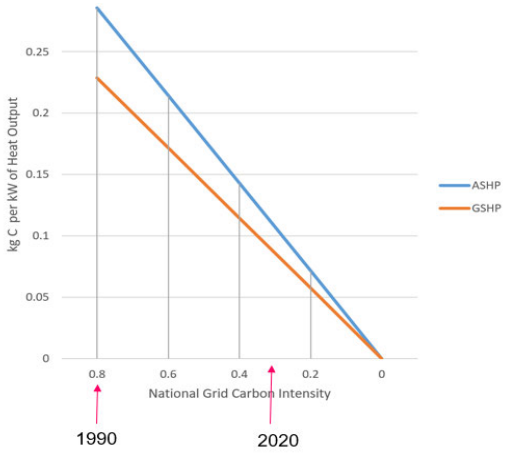

Image: Relative performance of ground and air source systems over time due to changes in grid carbon intensity.

Heat Loads

The heating demand of new buildings has reduced dramatically over a short period of time and is set to *approach* zero in future construction. There is also a significant move to retrofit existing buildings and reduce the heating loads in the process.

Domestic hot water loads in residential and commercial buildings are not reducing as dramatically and in some cases (particularly residential buildings) become the primary load.

This creates a very different context to that which was considered when designing historic precedents.

The shift towards domestic hot water lead loads is particularly important as air source heat pumps are demonstrated to offer a better efficiency than ground source heat pumps when serving domestic hot water loads in the Irish climate. This is because domestic hot water loads continue through the summer months when the air offers higher source temperatures (better efficiencies) than ground source systems.

The reality of loads shifting to domestic hot water affecting optimum heat pump selection holds for shallow ground source systems but may not apply to high temperature deep geothermal sources.

The overall reduction of heating loads however applies to deep source solutions and in particular district heating applications. Higher cost systems, such as district heating in particular have a better financial case where high density heat loads are provided.

For many commercial buildings there is now a net cooling load and a significant proportion of the heating load can be provided as a by product of cooling. This often leaves little or no heating load for ground systems to address. Closed loop ground systems can assist with cooling and energy storage but given the low external temperatures in Ireland it is often not a cost effective solution. Open source collectors are a different case and are particularly attractive and often cost effective for cooling applications.

Climate

Some precedents available both for the application of ground source heat pumps and district heating are within countries with notably colder climates than Ireland. Both technologies have a better financial case in such environments as air temperatures are colder. Colder temperatures shift the benefits towards ground source applications and heat loads are larger which assists in justifying the cost of district heating.

Monitoring Data

When system viability studies are carried out based on manufacturer's lab data, the results can be very misleading. This is why it is very important to consider the results of independent monitoring studies and other sources of data that does not derive from system manufacturers alone.

There are very few independent studies of ground source system performance but the 2017 UCL study of domestic heat pump systems provides some useful insights.

One of the key observations of relevance is that it detected only a 6% improvement in energy performance of ground source systems relative to lower cost air source systems. This is not statistically significant enough to confirm any benefit to the use of the ground source heat pumps studied. While this is not in keeping with some manufacturer advice, it is in consistent with what would be expected from a review of the thermodynamics involved.

When it is considered that the study was completed on housing with a lower ratio of domestic hot water load to heating than current new build, it becomes clear that if these systems were applied to **newly** built housing in Ireland the ground source solution would have produced higher carbon emissions than an air source solution. This is because air source is more efficient for domestic hot water heating as external average temperatures are notably higher than ground temperatures (see note below on ground temperatures).

We are not proposing that grant funding is not provided for ground source solutions but if grant funding were to be provided at a **higher** rate for ground source solutions than air source solutions there is a very real risk that the state would encourage the use of higher carbon emission solutions. There is precedent for this accidental effect as grant funding was historically made available for heat pumps at a time when their carbon performance was worse than that of gas boilers (This is no longer the case after the grid carbon intensity has dropped dramatically).

Ground Temperatures

When ground temperatures are quoted it is important to be aware that these temperatures change as soon as heat extract occurs. Where ground temperatures are quoted that intuitively seem attractive they can be misleading. For example where a deep geothermal temperature of 70^{o}C is quoted, this does not mean that a constant supply of heat is available at that temperature. Ground temperatures can provide a useful indication of potential but must be quoted with caution. If a ground temperature is higher than the average air temperature, this does not mean the use of the ground is inherently more efficient than an air source equivalent as the ground temperature typically drops below the air temperature as soon as heat is extracted.

Ground source solutions do retain improved heat exchange efficiencies relative to air source **for the same temperature**. This is related to the benefits of capitalising on the higher specific heat capacity of water. The reading of temperature alone can however be misleading.

Cost Effectiveness

Installation cost data for ground source systems that have been completed is often difficult to obtain. From our experience of a significant number of systems installed in both Ireland and the UK, there is almost never a recovery of costs for closed loop system. A number of commercial systems that are in operation currently have had

payback periods in the order of hundreds of years. We can provide some cost data that explains the economics of closed loop systems in practice on request.

Open loop systems on the other hand have shown significant cost benefits in real installations as the installation costs are notably lower.

The cost challenges of closed loop systems does not mean there is never an appropriate application for them and we have recommend and designed such systems for particular applications where there is an advantage but such cases are rare.

We have witnessed a number of clients that have been mislead as to the cost effectiveness of systems proposed who later discover the monitored performance and installation cost differ notably from that promised. Some of these clients have been influenced in their decisions to proceed with ground source systems by guidance provided which appears to be independent but is often inaccurate.

We have some concern that the current draft policy document in places makes statements about the financial benefits of systems that could be misleading if not backed by transparent calculations and the consideration of the results of independent monitoring.

4. SPECIFIC APPLICATION COMMENTS

4.1 Systems covered in the policy

The draft policy document covers a number of very different systems as follows:

- Closed loop shallow ground source
- Open loop shallow ground source
- Open loop water source
- Deep geothermal source
- District heating

4.2 Shallow Ground Source

It is important that any policies or guidance documentation takes into account the real life performance of systems and not the theoretical system characteristics. Independent monitoring studies and real, completed, verified system costs should be used to inform policy.

Performance claims should be transparent with costs and energy calculations clearly provided.

It is also important that any policies take into account the Irish context in terms of weather, building legislation and grid carbon intensity as described above.

4.3 Open Loop Systems

Open loop and re-injection systems appear to have a significant potential to produce environmental savings at a relatively low cost. There are a number of precedents in Ireland that have performed very well in terms of both environmental and cost performance.

It is however difficult to gain approval for such systems and the process for gaining approval is not always clear or consistent.

We are not aware of any re-injection systems installed in Ireland but we have used such systems very successfully in the UK. While we have proposed such solutions for buildings in Ireland; the proposals are typically met with a response that there is no clear and straight forward mechanism for achieving approval. There are also concerns that including such proposals in planning applications could result in the rejection of an application as a result of planners being unsure of how to address the proposals.

The clarification and simplification of the process would be beneficial. It would also be worth sponsoring a case study and environmental analysis of the impacts to provide better understand the knowledge of such systems.

4.4 Deep Geothermal

We have no direct experience with such systems but are familiar with the thermodynamics involved in heat extraction. We caution that where high temperatures are detected at depth, the recovery of energy from depth is complex.

A large number of deep bores can be required to generate a meaningful heat exchange area and a proportion of the heat gathered can be lost on the journey to the surface.

We believe it is beneficial to continue research into this form of energy but the expenditure and potential benefits should be transparent.

It seems unlikely that Ireland has the potential to significantly affect overall state carbon emissions through this technology, particularly in a context where policy exists to reduce heat demand of buildings (reducing the economic case for such solutions).

The study of the technology is however still of scientific interest as long as monitoring and cost data is transparently disseminated.

4.5 District Heating from Ground Source and Geothermal Systems

Traditionally district heating systems have only been considered as a potential option where heat loads are large and dense as costs of distribution can be significant.

Many precedents available are also within countries that have a very different environment to Ireland and were created in a different energy context. For example in Northern Finland district heating is used to deliver waste heat from a power station in a particular application. External temperatures are considerably lower than those found in Ireland (as the sun doesn't rise for several months of the year) and the power stations used are not as efficient as modern power stations meaning that waste heat is available at higher temperature (it is more efficient to recover heat within a power station where technically feasible than to deliver it as high temperature waste heat).

In Ireland, building policy aims to reduce heat loads from buildings to the point that the use of district heating for many (but not necessarily all) new building scenarios is very unlikely to be cost or energy effective. In a context where heat loads are low the losses from the system become significant and the cost relative to locally provided heat pumps is also a significant consideration.

Where new buildings primarily have a domestic hot water load the use of ground source heat pumps is also questionable as air source solutions are likely to offer a better efficiency due to the higher average air temperatures.

The use of ground source systems and district heating with existing housing or commercial stock has an improved potential but should be considered in the context of the overall policy to improve the performance of this stock and the relative costs of the provision of local heat pump solutions. The alternative economics and environmental performance of air source alternatives should also be considered.

4.6 District Heating From Non-Ground Sources

The discussion of district heating from surface waste energy processes such as incineration and data centres seems to be beyond of scope for the policy as it does not relate to ground sourced heat.

It is possible that the policy refers to these systems purely as examples of district heating systems that could apply to heat pump applications.

It is important that the full extent of grant funding provided for these projects is transparent and considered. As the systems are only financially viable with significant grant funding it is important to consider if greater environmental savings would have been provided by the application of the funding to alternative projects.

There is on occasion a logic to applying grant funding to projects that are not economically optimal where the supporting of the technology may lead to a reduction in installation costs for future projects but this does not seem to be the case for district heating as it is a well established technology in terms of the understanding of technical barriers to usage.

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5. CONCLUSIONS

The continued study and dissemination of information on all forms of heat production and usage is welcomed and the creation of a policy is fully supported.

We encourage the use of monitoring data and transparent economic plans to inform decisions on information provided to the public and the formation of any grant policies in relation to ground source and geothermal energy.

The development of policy on open source heat pump and free cooling solutions is very positive and we support any measures that would make it easier to apply such systems to projects.