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UNLOCKING GEOTHERMAL POTENTIAL IN NORTHERN IRELAND

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ABSTRACT

Geothermal energy could play a pivotal role in the decarbonisation of the heat sector. Delays in its development will impede progress towards achieving Northern Ireland's Net Zero ambitions. Substantial geothermal energy potential exists across much of Ireland due to the availability of geothermal heat at accessible depths. This creates an opportunity to reduce greenhouse gas emissions, improve energy security and create new jobs in the renewable energy sector. To date, decarbonisation of the heat sector across the island has been slow. This paper focuses on the existing barriers to success for geothermal energy development in Northern Ireland and outlines the legislative changes required to unlock the sector.

Key words: geothermal energy, planning permission, ground source heat

INTRODUCTION

Geothermal energy is the heat derived from the ground, from depths of a few meters to multiple kilometers below the Earth's surface. Shallow geothermal energy is derived largely from solar radiation, whereas deeper geothermal energy is resultant of heat emanating from the Earth's core and the decay of mildly radioactive elements in some geological settings.

There are different grades of heat, from low-grade shallow subsurface heat (stored at depths of <200m) to intermediate and deep (kilometer range). Heat derived from depths of >500m has been defined by the UK government as 'deep geothermal energy' [1], albeit there is no clear legal definition. The Earth's increasing heat with depth, is a phenomenon described as the geothermal gradient.

Geothermal energy is a renewable, clean, and reliable source of energy that can help reduce greenhouse gas emissions and dependence on fossil fuels.

It is estimated that 68% of home heating in Northern Ireland is still fuelled by oil [2]. It is a similar picture in Ireland with approximately 70% of Irish homes still reliant on gas or oil in 2019 [3].

DECARBONISING THE HEAT SECTOR

In March 2023, The Intergovernmental Panel on Climate Change (IPCC), made up of the world's leading climate scientists, delivered a 'final warning' on the climate crisis, as rising greenhouse gas emissions push the world to the brink of irrevocable damage that only swift and drastic action can avert [4].

The decarbonisation of domestic building heat is arguably the biggest energy sector challenge we face over the next few decades and key to reducing greenhouse gas emissions. We as hydrogeologists have an opportunity to help with this green energy transition by supporting the development of a low carbon heat sector.

GEOTHERMAL POTENTIAL

Ireland has significant geothermal energy potential as documented by the Geological Survey of Northern Ireland (GSNI) and Geological Survey Ireland (GSI) [5] [6]. Geothermal heat is available at accessible depths across much of the island of Ireland. A small number of shallow schemes have already been developed and there is increasing interest in use of geothermal for new developments as well as building retrofit. Harnessing this geothermal energy has the potential to make a significant contribution to reducing our dependence on fossil fuels and help decarbonise our heat sector.

GOVERNMENT SUPPORT & NET ZERO TARGETS

Decarbonisation of the Irish heating sector has been slow to date, with Ireland falling well short of 2020 targets for renewable heat [7]. The Climate Action Plan envisages that this sector will be decarbonised by retrofitting 400,000 existing dwellings to a minimum B2 BER standard and installing 600,000 heat pumps in Irish homes by 2030 [8].

Northern Ireland Executive's Energy Strategy '*The Path to Net Zero Energy*' and associated Action Plan published in 2022 [9] [10], signals The Department for the Economy's (DfE's) intention to develop a better understanding of Northern Ireland's potential for geothermal energy. DfE hope to achieve this by commissioning geothermal demonstrator projects that will help educate, demystify and build the geothermal sector.

In February 2023 DfE commissioned two geothermal demonstrator projects in Northern Ireland. These comprise overarching communications and marketing initiatives and two technical feasibility studies: one which includes a shallow geothermal feasibility and exploratory investigation, on the Stormont Estate, Belfast and a second deep geothermal feasibility at Greenmount in County Antrim.

These projects will inform geothermal policy development across government as well as contributing to de-risking future private sector geothermal projects. The geothermal exploratory and feasibility studies will be used to better understand subsurface geothermal potential and to test planning and regulatory processes relevant to implementing geothermal schemes. At the Belfast site, boreholes will be installed and tested to understand site specific conditions. Extensive geophysical surveys and geological modelling will be undertaken at the Antrim site to identify an optimum location and design for a deep borehole source. The data and knowledge from these feasibility studies will be made available to the public and used to demonstrate that a viable geothermal heat resource is accessible at depth. It is hoped that this will encourage private investment and inform the development of a policy and regulatory framework that supports and promotes opportunities to unlock Northern Ireland's geothermal energy potential.

BARRIERS TO SUCCESS

Development of new policies and a regulatory framework that supports and promotes opportunities to unlock Northern Ireland's geothermal energy potential are vital if we are to meet our low carbon heat sector ambitions. In December 2022 the Department for Infrastructure (DfI) closed its public consultation on the suitability of permitted development rights in Northern Ireland. This consultation paper had a specific focus on Ground and Water Source Heat Pumps [11]. The consultation paper acknowledges the potential barriers to success when it comes to building the geothermal sector in Northern Ireland and provides an insight into what regulatory change is required.

Whilst not specifically referenced, the DfI consultation paper states that installing ground and water source heat pumps, within the curtilage of a dwelling, could fall within permitted development rights, subject to certain conditions being met. Class F of Part 2 of the

Schedule to the GPDO outlines these conditions, which are consistent with those set for the positioning of domestic oil storage tanks. The addition of clear wording giving ground and water source heat pumps permitted development rights would be beneficial.

The DfI paper also acknowledges that Northern Ireland is currently out of step with other jurisdictions in relation to ground and water source heat pumps. Permitted development rights currently exist in Scotland, England and Wales with no conditions or limitations. In the Republic of Ireland exempted development is provided for the installation on or within the curtilage of a house of a ground heat pump system (horizontal and vertical) subject to certain restrictions.

The consultation paper outlines DfI's intention to align the permitted development rights with Scotland, England and Wales and recommends permitted development rights for the provision of a ground or water source heat pump within the curtilage of a dwellinghouse with no conditions or limitations.

Whilst the above is a helpful start, the permitted development / exempted development rights don't address the sub surface elements of the installation. Specific reference to the collector system and whether this is considered part of the ground source heat pump (GSHP) system is required.

The Town and Country Planning (General Permitted Development) (England) Order 2015 [12] and The Town and Country Planning (General Permitted Development) (Non-Domestic Microgeneration) (Scotland) Amendment Order 2011 [13] provide a starting point for the sub-surface component of the system.

Schedule 1, Part 1B of the Scottish Amendment Order (2011) provides permitted development rights for the installation, alteration or replacement of such microgeneration equipment (including underground pipes) on or within the curtilage of non-domestic buildings, subject to certain limitations and conditions.

Class C and Class L of The Town and Country Planning GPDO (England) 2015, affords permitted development rights to the installation or alteration of water source heat pumps on domestic and non-domestic premises by permitting the installation, alteration or replacement of a microgeneration water source heat pump (including any pipes), subject to certain limitations and conditions.

The existing permitted development rights afforded to mineral exploration in Northern Ireland (through Schedule 2, Part 16 – Mineral Exploration – of The Planning (General Permitted Development) (Amendment) Order (Northern Ireland) 2020) [14] could be extended to geothermal exploration. The 2020 Order permits development on any land consisting of:

- a) the drilling of boreholes (other than for petroleum exploration);
- b) the carrying out of seismic surveys; or
- c) the making of other excavations, for the purposes of mineral exploration, and the provision or assembly on that land or on adjoining land of any structure required in connection with any of those operations.

Extending the above-mentioned development rights to the geothermal sector in Northern Ireland would be extremely beneficial.

NORTHERN IRELAND SPECIFIC BARRIERS TO SUCCESS

This section outlines some of the other planning related considerations that face geothermal **exploration** projects in Northern Ireland. Shallow geothermal schemes completed to date in Northern Ireland have typically been advanced as part of wider development proposals, and therefore planning permission has not been required specifically for this constituent part of the wider development.

Potential Barrier/Constraint #1: Permitted development rights for geothermal exploratory drilling and associated operations (surveys and testing etc.) remain unclear. In the absence of clear legislation drilling operations have, in some instances, been viewed as ‘engineering operations’ and in that context would be classed as ‘development’ under the terms of Section 23 of the Planning Act (Northern Ireland) 2011 [15]; thus, requiring planning permission.

The Planning (General Permitted Development) Order (Northern Ireland) 2015 (GPDO) [16] does not provide specific regulations for exploratory drilling for geothermal purposes and therefore presents a potential barrier to those who wish to investigate and or assess the underground heat potential at their site. Whilst the 2015 GPDO gives permitted development rights in respect of borehole drilling for mineral exploration projects, Planning Officers unfamiliar with geothermal investigation techniques are likely to air on the side of caution and determine that the works require planning permission.

Suggested Change #1: Permitted development rights such as those afforded to mineral exploration in Northern Ireland should be extended to shallow geothermal exploratory drilling. Other jurisdictions have sanctioned projects investigating geothermal resources under the relevant provisions (Part 17, Section K) of The Town and Country Planning (General Permitted Development) (England) Order 2015 [12].

Potential Barrier/Constraint #2: Geothermal Drilling does not fall neatly into any development classifications (Schedule 1 or Schedule 2) of The Planning Environmental Impact Assessment (EIA) Regulations (NI) 2017 [17]. Schedule 2, Category 2(d) of the regulations references ‘deep drillings’ including geothermal drilling. Although the Directive does not define “deep drillings”, in other jurisdictions the legal definition of deep geothermal uses a threshold of >500 meters [18]. The threshold and criteria in respect of this category of development triggers an EIA determination when “...drilling is to be undertaken within 100 metres of any waterway or water in underground strata”. The threshold appears onerous, as most hydrogeologists investigating shallow geothermal potential (<500m depth) in Ireland will almost certainly be drilling within 100 meters of water in underground strata. It is possible that the regulations were written with deep geothermal drilling or enhanced geothermal systems in mind, but the current wording has potential significant cost implications which could act as a significant barrier to investment.

Suggested Change #2: An update of The Planning Environmental Impact Assessment Regulations (NI) 2017 is required and a clear definition of geothermal drilling included as a minimum. Further consideration should be given to subdividing geothermal into sub-categories based on its potential environmental risk and or depth of exploration. Traditional shallow open and closed loop drilling risks can be managed in line with current industry guidelines such as the IGI Guidelines for drilling wells for private water supplies [19] and correct closed loop standards such as the Vertical Borehole Standard, March 2023 (Issue 3) [20]. These standards seek to maintain a high level of installation quality whilst protecting the water environment and ensure best practice.

The Department for Infrastructure (DfI) in Northern Ireland launched a consultation on 6th April 2023 on Review of Regional Strategic Planning Policy on Renewable and Low Carbon Energy [21]. Within this, geothermal energy is referenced under ‘emerging technologies’ with a recommended option to revise existing Strategic Planning Policy to better support, guide and facilitate new and emerging technologies. This represents a

further opportunity for geothermal stakeholders to input and shape future policy.

Potential Barrier/Constraint #3: With the absence of grant funding in Northern Ireland to support domestic scale geothermal exploration, it is likely that most of the near-term investment and development will have to come from the non-domestic market. Currently boreholes drilled for the purpose of investigating the geothermal potential at non-domestic sites could constitute a 'Major' Planning Application in Northern Ireland if the total development area exceeds 1 hectare.

Major planning applications are a special category of development under The Planning (Development Management) Regulations (Northern Ireland) 2015. There are several triggers for major development, including "sites of 1 hectare or greater". Major planning applications require the submission of a Proposal of Application Notice (PAN), indicating how you will carry out consultation, twelve weeks before submission of the formal planning application. Application fees are higher and Major applications typically take longer to determine.

Non-domestic scale heating and cooling schemes can comprise multiple abstraction and re-injection wells. Consider a four borehole well field, two abstraction and two re-injection boreholes, each 100m apart. Maximizing the separation distance between points of groundwater abstraction and re-injection increases the efficiency of ground source heat pump installation. This four-borehole system would theoretically trigger a major planning application as the drill sites and the area between would likely exceed 1 hectare when you consider the space required for the drilling compound, temporary material storage areas and access arrangements.

Suggested Change #3: Permitted development rights that recognise the likely scale of typical geothermal systems is required.

NI CASE STUDY

Buildings on the Stormont Estate are currently heated using oil/gas fired boilers. Delivery of the Energy Strategy and Executive's climate change commitments mean that this source of heating will have to be phased out and replaced with a low carbon alternative. The Estate overlies a principal aquifer – the Sherwood Sandstone, which boasts a high thermal conductivity and supports high groundwater yields, that could be used to provide heating and cooling, when combined with a heat pump. This provides an opportunity to use a renewable source of energy that has the potential to deliver higher efficiencies than alternative solutions.

MAJOR PLANNING APPLICATION

In February 2023, DfE commissioned Tetra Tech to carry out two geothermal demonstrator projects in Northern Ireland. This paper focuses on the first of the two projects at Stormont Estate, Belfast. The project includes a shallow geothermal feasibility and exploratory investigation. As part of the Stormont Estate investigation Tetra Tech will identify the most suitable geothermal solution to provide heating and cooling at several pre-identified buildings; including identification of the optimum depth of the borewell(s) and recovery system based on the most efficient and cost-effective means of utilising the shallow subsurface environment. The proposed boreholes are investigatory only at this stage. The investigation findings will be needed before a decision is taken on how best to use the resource.

It is planned to drill four boreholes from Ground Level (GL) to a Total Depth (TD) of approximately 250 metres at 200 mm diameter and a cored borehole up to 500 m depth with a hole diameter of 96 mm. The Stormont Estate is large, and this creates an opportunity to spread the boreholes out across the site to minimise interaction between points of water abstraction and re-injection; thus increasing the efficiency of the system

(open loop). The trade-off is that the site area is greater than 1 hectare and therefore triggers a Major planning application.

The latest statistics [22] published by The Department for Infrastructure for April – September 2022 shows that the average processing time for major planning applications brought to a decision or withdrawal was 56.4 weeks across all Northern Ireland councils. This means that the drilling and testing of the five boreholes proposed at Stormont Estate will likely be delayed by over a year.

To avoid a major planning application, consideration was given to constraining the red line boundary around each of the drill sites in a manner consistent with the approach taken by many windfarm developments. Keeping a very tight red line boundary around the 5 no. compounds (each circa 25m x 50m) linked by a red line does result in a site area of approx. 0.7 – 0.8 hectare. The boundary also needs to encompass any mitigation measures required as part of the works (i.e. points of discharge or locations where water may be directed to as part of the works – i.e. a catch-pit). In order to give the project some flexibility and enable micro-siting of borehole positions following the completion of various technical assessments (i.e. ecology, archeology, noise, hydrological etc.), the decision has been taken to proceed with a major planning application. This means that the borehole positions can be moved within the redline boundary should this be required, without the need to re-start the planning process.

EIA DEVELOPMENT

The requirement for EIA arises from Directive 85/337/EEC as transposed by The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2017. On certain large-scale developments the Northern Ireland Environment Agency (NIEA) Development Management Team are asked by Planning Service to assess whether an EIA is required due to its environmental impact. This process is called screening. If Planning Service determines that an EIA is required NIEA will advise what types of surveys and other technical information will be needed to assess the environmental impact.

Because Schedule 2, Category 2(d) of The Planning Environmental Impact Assessment (EIA) Regulations (NI) 2017 [17] references “deep drillings, in particular – geothermal drilling” (see extract below), EIA screening is required. The absence of a clear definition for “deep drillings” means that some uncertainty exists for those having to apply this legislation.

The threshold and criteria used to determine whether the development constitutes EIA is also likely to be met when “...the area of the works exceeds 1 hectare” or “in relation to geothermal drilling.... Drilling is to be undertaken within 100 meters of any waterway or water in underground strata”. The depth to water within the target aquifer is expected to be approximately 25 – 30m at the Stormont site and groundwater is also likely to be encountered at shallower depths within the overlying superficial sand and gravel deposits. It is therefore difficult to see how the drilling of boreholes at the Stormont Estate would constitute anything other than EIA development.

Environmental Impact Assessments add significant time and cost to any development. In contrast, if a large industrial water user wanted to drill a 5 borehole well field for water supply, it is unlikely that this would constitute a major planning application, nor would it constitute EIA development in Northern Ireland.

The absence of permitted development poses a significant barrier to the investment and adoption of geothermal energy in Northern Ireland.

Table 1. *The Planning EIA Regulations (NI) 2017: Descriptions of development and applicable thresholds and criteria for the purposes of the definition of “Schedule 2 development”.*

Column 1 Description of development	Column 2 Applicable thresholds and criteria
The carrying out of development to provide any of the following—	
1. Agriculture and aquaculture	
(a) Projects for the use of uncultivated land or semi-natural areas for intensive agricultural purposes;	The area of the development exceeds 0.5 hectare.
(b) Water management projects for agriculture, including irrigation and land drainage projects;	The area of the works exceeds 1 hectare.
(c) Intensive livestock installations (unless included in Schedule 1);	The area of floorspace exceeds 500 square metres.
(d) Intensive fish farming;	The installation resulting from the development is designed to produce more than 10 tonnes of dead weight fish per year.
(e) Reclamation of land from the sea.	All development.
2. Extractive industry	
(a) Quarries, open-cast mining and peat extraction (unless included in Schedule 1);	All development (except the construction of buildings or other ancillary structures where the floorspace does not exceed 1,000 square metres).
(b) Underground mining;	
(c) Extraction of minerals by fluvial or marine dredging;	All development.
(d) Deep drillings, in particular— (i) geothermal drilling; (ii) drilling for the storage of nuclear waste material; (iii) drilling for water supplies; with the exception of drillings for investigating the stability of the soil;	(i) In relation to any type of drilling the area of the works exceeds 1 hectare; or (ii) in relation to geothermal drilling and drilling for the storage of nuclear waste material only, drilling is to be undertaken within 100 metres of any waterway or water in underground strata.

WIDER IMPLICATIONS FOR REPUBLIC OF IRELAND

There is a need to examine whether current planning legislation in the Republic of Ireland supports the installation of geothermal systems in a timely and cost effective manner if The Climate Action Plan targets are to be met.

CONCLUSIONS

The regulation of geothermal schemes is a matter for the devolved administrations in the UK. Northern Ireland lags behind in the development of bespoke planning rules, environmental regulation or licensing systems specific for the development and operation of geothermal schemes. The absence of bespoke regulations mean that geothermal developments are dealt with through existing regulation, which were initially developed with objectives other than geothermal energy production.

Currently, planning consent is required for the development of GSHP systems, and in some cases, an Environmental Impact Assessment (EIA) is also required.

Geothermal heating has an important role to play in the decarbonisation of the heat sector. Delays in its development could impede progress towards reducing greenhouse gas emissions, improved energy security and new job creation. Decarbonisation of the heat sector on the island of Ireland has been slow so far. This paper focuses on the existing barriers to success for geothermal energy development in Northern Ireland and provides suggested legislative changes which would help unlock the sector.

The need to secure planning permission to drill boreholes for shallow geothermal exploration and/or to implement a geothermal scheme could set a dangerous precedent and introduce red tape and unnecessary cost for geothermal development in Northern Ireland, particularly at a time when there is a need to grow the sector.

Thousands of boreholes are drilled for mineral exploration, groundwater abstraction and ground investigation in Northern Ireland annually, none of which require planning permission. Several geothermal schemes have successfully been delivered in Northern Ireland; without required standalone planning permission for the geothermal component of the works. Most have been progressed without planning or have passed through the planning process, often without mention, as part of wider development proposals.

This does not mean that such works should not be subject to some form of control. Existing checks and balances and regulatory controls are in place to deal with drilling works associated with borewells and mineral exploration. These controls include notifying the Geological Survey of Northern Ireland when drilling boreholes to depths of >15m. Consent from The Department of Agriculture, Environment and Rural Affairs (DAERA) is required for associated use of boreholes such as abstraction and discharge. All of which would apply to the Stormont Estate demonstrator project. In addition, promotion of industry developed good practice, potentially linking to financing/insurance, would also offer protection to the environment and customer.

A review and update of the planning and EIA regulatory framework surrounding geothermal exploration and development is required in Northern Ireland. Granting permitted development rights to shallow geothermal exploration including drilling, surveying and testing would streamline the regulatory process and encourage greater adoption of this technology at the domestic and non-domestic scale. Geothermal is an important part of the energy mix required to decarbonise our heat sector and meet our net zero ambitions.

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