CAUSEWAYGT
The Power Beneath Us

[redacted]

17th February 2022

Dear Sir or Madam,

Please find enclosed Causeway Geothermal Limited response to the draft policy statement on Geothermal Energy for a Circular Economy. We greatly appreciate the effort involved in developing the draft to this point and we hope that our input can further the development of the policy. We support the approach of having a Geothermal Energy Advisory Group to support the process of developing the policy and regulatory framework. We believe Ireland has an opportunity to develop a leading geothermal policy in Europe that will encourage the adoption of geothermal in service of our climate goals.

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CAUSEWAYGT RESPONSE TO THE DRAFT POLICY STATEMENT ON "GEOTHERMAL ENERGY FOR A CIRCULAR ECONOMY"

Causeway Geothermal Ltd ("CausewayGT") is an Irish start-up focused on decarbonising heat in the large commercial and industrial sector with a core offering of geothermal energy. We are keenly motivated to support the Department of Energy, Climate & Communications (DECC) in the development of a best-in-class policy for geothermal utilisation. We believe that geothermal energy is a neglected climate technology and can substantially contribute to the targets and actions outlined in the 2021 Climate Action Plan. The main author and primary contact is Dr Niall McCormack, MD and Chief Executive of CausewayGT; he is also Chair of the Geothermal Association of Ireland, Vice Chair of the Industry Advisory Board of the SFI research centre iCRAG, sits on the Board of Renewable Energy Ireland, and the Geothermal Advisory Committee for Northern Ireland. The secondary author is Dr Simon Todd, MD and Chief Technologist of CausewayGT and Adjunct Professor to the School of Earth Sciences in University College Dublin. This response has been peer reviewed by a number of Irish and European industry, academic and policy experts.

Overall

We support the intent of a strong policy with associated regulatory body to oversee geothermal energy. We strongly support the approach of having a Geothermal Energy Advisory Group to aid the process of developing the policy and regulatory framework. Key elements where we believe the draft policy can be strengthened include the following:

- Clarify the objective of the policy.
- Three currently missing elements:
  - Clear numerical **targets** for geothermal adoption (different targets for Shallow and Deep) aligned to Ireland and EU targets for heating and cooling;
  - **Incentives** for adoption of geothermal (Shallow and Deep different); and
  - Clear policy statement on the building of **capabilities** to deliver policy targets.
- **Shallow** (<500m) and **Deep** (>500m) Geothermal should be separated as they have different characteristics that require different treatment in policy and regulation.
- Shallow Systems that have **low impact should be automatically Permitted**:
  - Propose a Net Energy Yield/Usage per Unit Area of property is a more appropriate classification than a maximum energy used (e.g. in kW/m^2 not a kW);
  - Below an appropriate kW/m^2 threshold Shallow systems be registed only (the permit is automatic). Over the threshold GSRO review possible project permits;
  - For systems with wells closer to (5m) or outside the property boundaries, a permit should be required from the proposed GSRO.
- Deep Geothermal should be licensed:
  - **licensing by area is appropriate**, however we would suggested modifications.
- All commercial and industrial systems should register their usage quarterly

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Detailed Commentary and Supporting References

Geothermal and Climate Action

The acknowledgement that geothermal can play a role in climate action in Ireland (page 4 of the draft policy document) is most welcome, particularly noting that decarbonising heat is the biggest opportunity for geothermal, and we believe that the policy should be focused on delivering that potential. So too is DECC's observation that the use of geothermal energy is more advanced in other countries in Europe. Nevertheless, the links of the policy to the European legislation and the Irish 2021 Climate Action Plan could be made more explicit. For example, according to the proposed Effort Sharing Regulation, Ireland is expected to reduce its emissions by over 40% - the question is *"how geothermal energy can contribute to the achievement of this goal?"*. Furthermore, it is important to outline the contributions of geothermal energy to meeting the renewables and energy efficiency targets, including the ones set for heating and cooling. Additionally, DECC should take into account the benefits of geothermal energy to improve energy performance of buildings in line with Directive EU 2018/844. That the extended (or "hidden") environmental costs are very low, indeed of the lowest of all energy sources[1] could be more emphasized.

There is also an opportunity to outline how the geothermal policy contributes towards meeting current EU requirements, such as the 1.1 percentage point annual increase in the volume of renewable heating and cooling (Article 23 of the Renewable Energy Directive 2018/2001/EU[2]). In July 2021, the European Commission proposed to make this a binding target on Ireland and all other Member States (COM(2021) 557 final[3]). Furthermore, it launched plans to introduce a carbon price on heating in buildings (COM(2021) 551 final – Chapter IVa) to further drive investment in renewable heating and cooling solutions to address the climate crisis as well as the geopolitical risks from imported energy dependence.

[1] Sovacoola, B. K., Kimb, J. & Yang, M.; The hidden costs of energy and mobility: A global meta-analysis and research synthesis of electricity and transport externalities; Energy Research & Social Science Volume 72, February 2021, 101885

[2] DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources. Official Journal of the European Union 21.12.2018 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=fr

[3] DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

The International Energy Agency's Renewable 2021[4] report found that geothermal heat pumps have the lowest levelised cost compared to fossil and other renewable heating solutions. This Policy should help realise the Circular, Security and Economic benefits for Ireland.

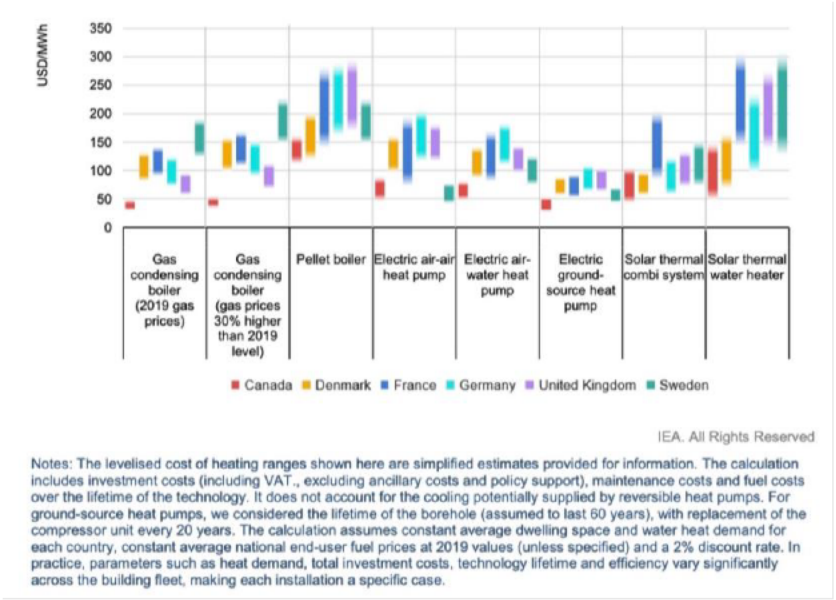

Figure 1 Overall cost-competitiveness of heating technologies: Levelised cost of heating for consumers, for space and water heating technologies and countries.[4]

Policy Objective

While there is a section in the Policy that discusses the "Purpose and Scope of this Paper" there is no clear objective stated, and no clear targets outlined. As the title of the policy is *"Draft Policy Statement on Geothermal Energy for a Circular Economy"* we believe that the purpose and scope of the document falls short. The title clearly indicates that this is a policy for ensuring that geothermal energy impacts the Circular Economy, and not just a policy to regulate how geothermal is harnessed. For the Policy to have impact on decarbonizing the heating/cooling sector it needs to clearly outline objectives that lead

[4] *Renewables 2021 Analysis and forecast to 2026;* International Energy Agency 2021

https://iea.blob.core.windows.net/assets/5ae32253-7409-4f9a-a91d-1493ffb9777a/Renewables2021-Analysisandforecastto2026.pdf

to the sustainable development of our geothermal resources, particularly in the matter of climate action and align with EU Renewable Energy Directives (RED)[5].

We propose the objective to be: *"the policy aims to promote the sustainable development of Ireland's geothermal resources such that they play a material role in decarbonizing heating and cooling for residential, public, commercial and industrial uses as a key element of fulfilling Ireland's climate and EU commitments"*.

The policy in its statements and in how it sets capacity levels is purely focused on heating when geothermal heating/cooling and storage of heat have the potential to play a material role in the Irish sector. As a proportion of energy use in Ireland, Heating/Cooling is the largest user (Figure 2) of energy with very little use of renewable sources. The lack of use of renewables in this heating/cooling is materially impacting Ireland's ability to meet its climate objectives. Without clear targets for sectors that can decarbonise this element of our energy sector that results is unlikely to change.

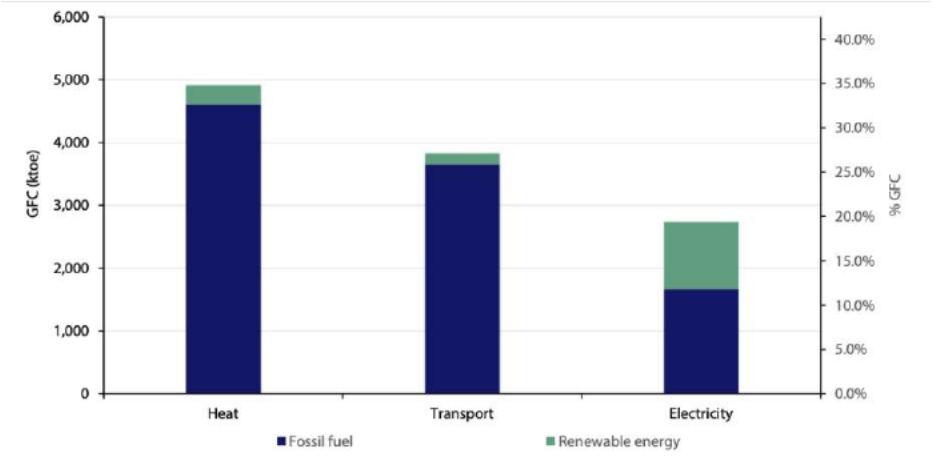

Figure 2 From SEAI's 2021 Energy summary Heat is they major element of Gross Final Consumption of Fossil Fuels

The lack of clear targets is disappointing and inconsistent with other energy policies recently published by government. Many of our EU partners have demonstrated that geothermal can play a material role in heating/cooling across multiple sectors which significantly reduces greenhouse gas emissions in sectors where Ireland has failed to come anywhere close to meeting its targets. The renewable heat

[5] DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Brussels, 14.7.2021
COM(2021) 557 final 2021/0218 (COD)
https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf

target (RES-H target) was for 12% of energy used for heating and cooling to come from renewable sources in 2020. The actual RES-H achieved in 2020 was 6.3%, falling well short of the national target (Figure 3). This poor progress in RES-H was the main reason for failing to meet the overall RES target (SEAI 2021 report[6]). The RES targets are mandatory under EU Renewable Energy Directives[2,3,5].

Ireland is lagging peers in the decarbonisation of heat and in the use of **Shallow geothermal** in countries that have similar Shallow geothermal resources and population densities. In 2020, renewable energy accounted for 23% of the total energy used for heating and cooling in the EU, steadily increasing from 12% in 2004 and 22% in 2019. Renewable energy sources used for heating and cooling include solar thermal, geothermal energy, air and water ambient heat captured by heat pumps, solid, liquid and gaseous biofuels and the renewable part of waste[7].

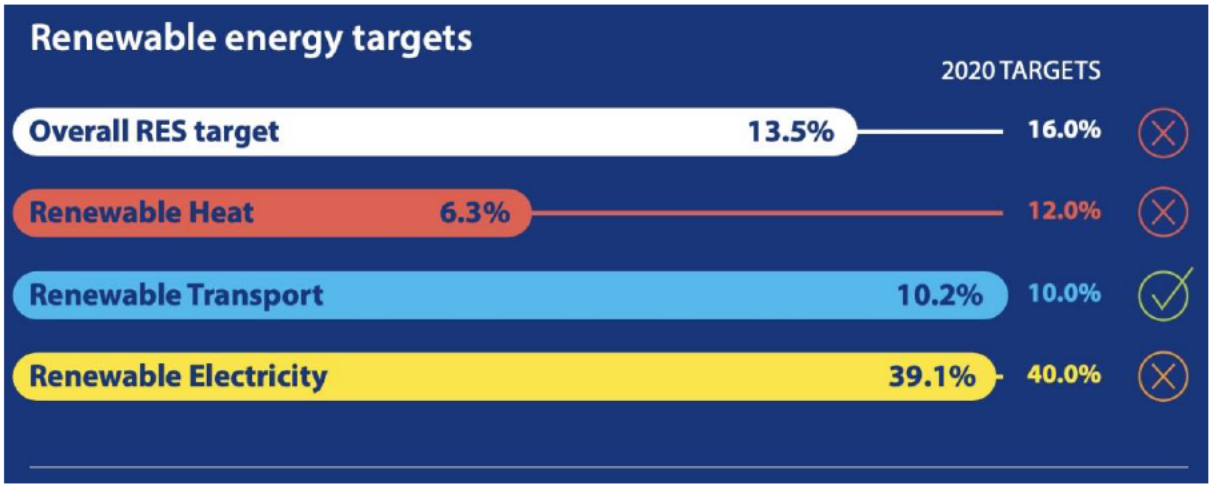

Figure 3 SEAI 2021 Annual Energy Report summary of Ireland's performance. Notably heat has materially failed to meet the targets.

Sweden and Ireland have similar shallow geothermal resources (low enthalpy). In 2019 the shallow geothermal energy systems provide approximately 23 TWh of heating and cooling in Sweden, of which around 17.5 TWh is renewable heat from the ground and approximately 1.1 TWh is a free-cooling from the ground. The total installed heating and cooling capacity in Sweden was approximately 6.8 GW[8].

[6] ENERGY IN IRELAND 2021 Report; December 2021 Sustainable Energy Authority of Ireland (SEAI)

https://www.seai.ie/data-and-insights/seai-statistics/key-publications/energy-in-ireland/

[7] European Commission, 2022; Renewables Steadily increasing in heating and cooling. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20220211-1

[8] Hanson, P 2019; *Geothermal Country Overview Sweden*; Geoenergy Marketing Services and references there-in

This compares to approximately 200 MW of installed capacity in Ireland in 2019[9]. This is circa 30 times less capacity in Ireland which has 50% of the population. In fact, Ireland has a higher population density than Sweden (75 versus 25 people per km^2)[10] and should be more suited geographically.

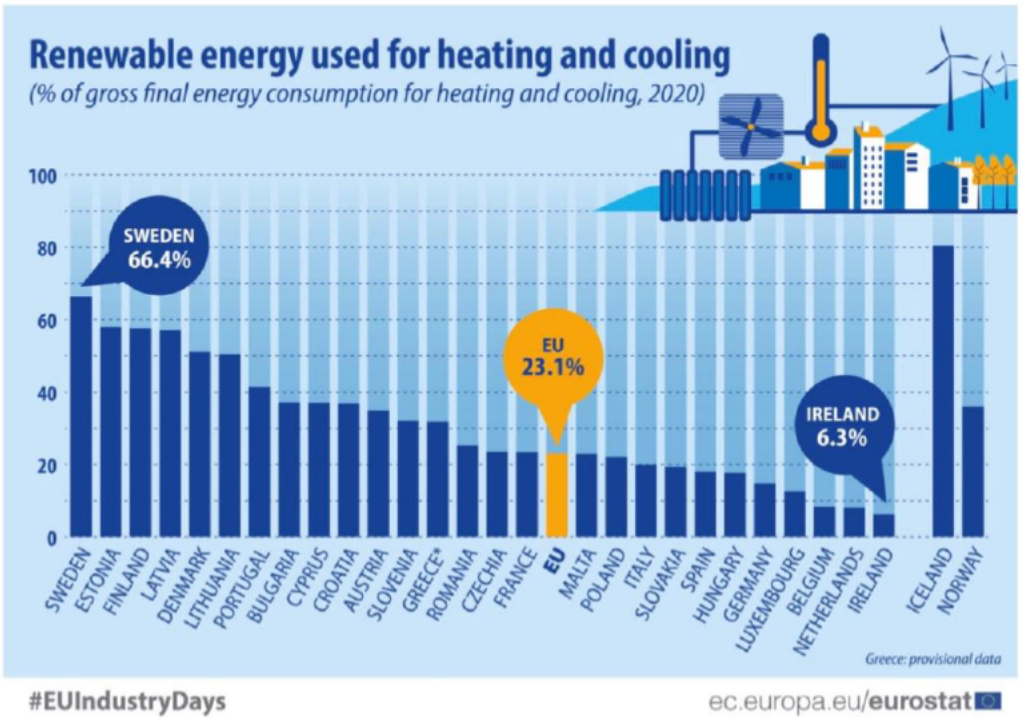

Figure 4 From Eurostats data and publication. Ireland has the lowest penetration of renewable energy in the heating and cooling sector of any EU member state. Many of these states, including the leader Sweden, have significant geothermal input into their renewable heat and cooling while having similar geothermal resources (low enthalpy).

One powerful action that the Policy could take is to state that **geothermal must be assessed for deployment in publicly funded buildings** that are new builds or where there is material change in the heating/cooling systems that considers the cost and carbon savings of geothermal. This would demonstrate government leadership in reducing their dependence on fossil fuels for heating and cooling of government sponsored buildings. Additionally, by inducing activity in the sector it would give the opportunity for more examples for other potential users to consider as they look at geothermal for decarbonising their heating and cooling.

[9] Pasquali, R., R., Hunter Williams, T., Blake, S. & McAteer, J. 2019; *Geothermal Energy Use, Country Update for Ireland*; European Geothermal Congress 2019 Den Haag, The Netherlands, 11-14 June 2019

[10] Data from https://eacea.ec.europa.eu/

Geothermal Energy and Climate Action

The policy states that geothermal here is the "heat radiating from the Earth's core, or stored heat from the Sun". With that, the policy is looking to cover all forms of geothermal development. However, in this section it appears to mix the shallow ground source resource – which is available everywhere in Ireland – with the deeper geothermal resource that is less evenly distributed (in some areas you need to go deeper to get the same heat).

Shallow geothermal resources that are ubiquitous and relatively evenly distributed, well understood in Ireland and can be developed with no risk as demonstrated by hundreds of thousands of deployments across Europe in similar geological regimes. There is approximately 7 **GW** of deployed shallow geothermal capacity in Sweden, the leading country for renewable heating/cooling in Europe (Figure 4). **Deeper Geothermal** is more variable, less well understood, significantly more expensive and less predictable geothermal resources, and has seen less deployment in areas that have significant renewable heat, for example Sweden has only 44 **MW** of deployed deep geothermal.

We recommend a simple divide of Shallow versus Deep (e.g. Germany's federal definition of 500 m would be our recommendation, another equally valid consideration would be 400 m[11]) which would enable a policy approach that will promote deployment in the very short term of Shallow geothermal systems which immediately have the ability to materially impact Ireland's greenhouse gas emissions and impact our 2030 targets. The appropriate regulations, targets and incentives for deep geothermal can then be developed which will enable deep geothermal to play its material role in Ireland's 2050 goals.

We **fully support** the intent of the policy to:

1. Give certainty regarding the ownership and use of geothermal energy;

2. Create a process for licencing the exploration for and harnessing of geothermal energy resources;

3. Create a system of reporting on geothermal projects;

4. Integrate with existing environmental, health and safety and planning regulatory frameworks;

[11] Haehnlein, S., Bayer, P. & Blum, P., 2010; *International legal status of the use of shallow geothermal energy*; Renewable and Sustainable Energy Reviews 14

For the policy to deliver on its title – "Geothermal Energy for the Circular Economy" we suggest that **added to this should** be:

5. Targets for geothermal usage aligned to Ireland and EU targets for renewable heating and cooling;

6. Incentives for adoption of geothermal, that should differ between shallow (e.g. heat purchasing agreement support) and deep (e.g. exploration risk mitigation);

7. Re-skilling and upskilling support for the workforce.

As stated, the lack of **targets** undermines the effectiveness of the policy. Additionally, the lack of any mention of any targets is inconsistent with how Ireland has approached other elements of the energy sector, for example Wind where clear targets have been set[12].

Incentives are highly dependent of the profiles of investment in geothermal, as is the approach to licensing. Our considerations on incentives are detailed later in our feedback to the consultation.

Circular Economy and Geothermal

We agree with the assessment that geothermal is consistent with the Circular Economy. We would go further and suggest that the use of geothermal energy for heating, cooling and storage may additionally be a way of managed electricity demand by using electricity at "off peak" times to store heat geothermally to be used for heating when electricity demand is high reducing electricity demand from heat pumps.

Environmental Protection and Geothermal Energy

We support the statements made. It is worth noting that the archetypes should play a role in the level of oversight required as they have different environmental footprints. Aligned with how we consider different forms of geothermal (shallow/deep, closed/open, big/small) we have proposed a different archetype approach in Exhibit A.

[12] Gov.ie 2021 *Facilitation of Offshore Renewable Energy by Commercial Ports in Ireland* https://www.gov.ie/en/policy-information/8f40e-policy-statement-on-the-facilitation-of-offshore-renewable-energy-by-commercial-ports-in-ireland/

Purpose and Scope of this paper

As the title of the policy is "Draft Policy Statement on Geothermal Energy for a Circular Economy" we believe that the purpose and scope of the document falls short. We would propose the overall objective, aligned with the title should read: *"the policy aims to promote the sustainable development of Ireland's geothermal resources such that they play a material role in decarbonizing heating and cooling for residential, public, commercial and industrial uses as a key element of fulfilling Ireland's climate and EU commitments"*.

Also aligned with the title we would believe that **added to the current intent should** be:

- **Targets** for geothermal usage aligned to Ireland and EU targets for renewable heating and cooling;
- **Incentives** for adoption of geothermal, that should differ between shallow (e.g. heat purchasing agreement support) and deep (e.g. exploration risk mitigation);
- **Re-skilling and upskilling** support for the workforce.

Engagement with the public in harnessing Ireland's geothermal resources

We support the intent of the engagement with public.

Geothermal Energy Advisory Group

We **support** the establishment of a **Geothermal Energy Advisory Group**. We consider the Geothermal Advisory Committee (GAC) in Northern Ireland to be best-in-class engagement with stakeholders as it pertains to how to develop policy. Even the GAC during its tenure has improved both its approach and re-consider the membership. The cross-functional discussions including Civil Servants from all key departments (Energy, Economy, Planning etc), academics (Built Environment, Engineering, Geoscience etc), industry (Geothermal Association of Ireland, Institute of Geologists of Ireland etc.) has enable a significantly more integrated and considered approach to the tradition send papers out for people to review approach. The addition of social science expertise has been of significant benefit and has brought the element of community into the discussions on policy.

Information Resources for the public

We support the elements of the work that look to inform all stakeholders. It should also ensure that it delivers the information the public needs to unambiguously demonstrate the low risk associated with geothermal energy and not only focus on the higher risk approaches to geothermal energy that are only

used in very specific circumstances and may be limited in their deployment in Ireland. This should be further reinforced with the proven cases of geothermal energy as one of the lowest impact (e.g. Shallow Closed-Loop etc), cleanest forms of energy available.

Access to Land

We agree that the policy needs to clearly articulate how this will be handled and that the Geothermal Energy Advisory Group should have the critical skill sets available to ensure that they can inform the policy. Under our recommended changes this would only be an issue for deep deployments. This is an additional reason to separate shallow deployment that are on the site of the user from licenses for deep that would likely cover multiple surface landowners.

Geothermal Energy Explained

We agree that the policy needs to clearly articulate how this will be handled and that the Geothermal Energy Advisory Group should have the critical skill sets available to ensure that they can inform the policy.

Geothermal Energy Resources

The use of shallow geothermal resources is neglected in this section. Globally shallow geothermal has been used since 1945[13]. Since the mid-1970s France has been installing on average over 10,000 units a year, peaking in the early 1980's at over 50,000. Shallow geothermal in low enthalpy environments has, and can have, a material impact on decarbonising heat. Ensuring that the **distinction between shallow** (ground source heat) and **deep** (earth source heat) is **essential for a balanced policy approach**.

There is also an important distinction between the geothermal resource that is available and the temperature that a process requires. The use of heat pumps with geothermal heat greatly reduces the required subsurface temperature needed to deliver heating/cooling for the user. 70 °C for a building can be delivered extremely efficiently from 14 °C water using heat pumps. Cooling should also be more prominent in the consideration. Again, with geothermal heat as an energy source for a heat pump, geothermal energy can and is used in Ireland and overseas for cooling.

[13] Burkhard Sanner, 2017 Ground Source Heat Pumps – history, development, current status, and future prospects. 12th IEA Heat Pump Conference.

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Geothermal Systems

The geological and technological characterisation of the different types of geothermal projects that *could* be delivered is a very useful framework for policy (page 20). We need to add a number of attributes to the framework to make these archetypes most distinct (see Exhibit A). Depth of geothermal resource, as well as the footprint of the developed subsurface resource relative to the surface user facility are critical. A depth threshold needs to be applied to distinguish shallow from deep geothermal resources, as the former can be deployed at pace and scale in the short term, whereas the latter is more reliant on exploration, resource delineation and technology development. We propose a depth threshold of 500 m similar to Germany, however there is no exact number that differentiates shallow v deep. The cut-off can reasonably range from 400m to 800m. An explicit characterisation of the archetypes will help link the necessary regulatory processes and controls. We also suggest that output temperature and the use of the energy (heat or electricity) are important distinguishing factors.

Shallow and Deep distinguishing characteristics

	Resource Uncertainty	**Investment scale**	**Operations Risk**
Shallow	Low	Low	Low
Deep	High	High	Medium

Why 500m?

Resource Uncertainty

On resource uncertainty, for example at 200 m a 20% difference in geothermal gradient from 3 °C/100m to 2.4 °C/100m would reduce the expected temperature from 16 °C to 14.8 °C, assuming a 10 °C surface temperature. This would have minor impact on the design of a geothermal system. At 3km the difference in geothermal gradient would result in either 100 °C or 82 °C, resulting in significant difference in system design.

Construction Costs

Well construction cost for less than 500 m are less than €100/m, while those for wells deeper than 1000 m are greater than €1,000/m.

Operational Considerations

The construction of deep wells, greater than 500 m have additional operation considerations, e.g. pore pressure, that involve additional regulation.

While there is no exact answer, 500 m enables a simple permitting model for the current shallow geothermal systems to deploy, enables appropriate licensing of deep geothermal to account for resource uncertainty and investment scale and distinguishes the resources so that appropriate incentivisation can be done.

An alternative would be 400 m, which has been used in other EU countries (Haehnlein *et al*[11]). We recognise that it may be expedient to align the depth cut-off with other regulations (e.g. water).

Closed and Open System considerations

	Resource density	**Water Impact**	**Operational Risk**
Closed	Low	Low	Low
Open	High	Moderate	Moderate

Closed systems are low risk, however, access the resource more slowly (conduction is slow relative to fluid flow) and they have low impact on water and low operational risks. Both styles of systems can be deployed at any depth. Open systems produce water from the ground and need to have the water production and any reinjection regulated.

Big v Small

Geothermal systems are energy systems. As previously stated, an approach that ensures that the resource is managed appropriately is a "net energy yield by area". A simple capacity threshold (70kW or otherwise) is inappropriate as it neglects (and may actively discourage) cooling and heat storage.

This is particularly important in high yield closed-loop systems where energy is extracted and stored through conduction and heat replenishment is crucial for long term sustainability. By not considering the potential for use of wells for thermal storage (e.g. solar or waste heat) the simple kW capacity approach also potentially enables excessive storage of heat in the subsurface. Without recognition of heat-input for the purpose of storage/cooling, coupled with a lack of consideration for the size of the affected area (100 hectares treated the same a 1 hectare), the Draft Statement does not appropriately reflect how geothermal, particularly shallow geothermal is currently being utilised in Ireland or in countries of similar geothermal resource where it is being used to materially decarbonise their heating and cooling.

A system of classification that acknowledges both the amount of energy used and the areal footprint of the system is more appropriate. There are different models for how this can be done, however what is important is that deployments that manage that use the resource appropriately and do not impact the resources in other area should be permitted with no addition requirements, other than registration and reporting for commercial and industrial deployments. Where above an appropriate energy threshold then the system should require additional scrutiny be the appropriate specialist authority (propose GSRO) before permitting.

For Shallow geothermal and with this in mind we propose that 0.1 kW/m^2 of net energy usage (heating as energy extraction and cooling/storage as energy input) be used as a standard measure of regulatory threshold. This would consider the impact of a 10 kW single shallow borehole (e.g. 150 metres deep) and scaled appropriately for the footprint of the property. Under such classifications, shallow systems would be automatically permitted if under the suggested threshold. If over this threshold, they would require a permit from the GSRO. All systems would be required to follow other appropriate regulations (e.g. water abstraction where appropriate). The GSRO would permit systems that impact beyond the boundaries of the landowner with consideration to the potential impact to neighbours (e.g. a well closer than 5 m in a closed system).

A few examples used to illustrate the impact of this on an installation:

1) A single house residence that sits on at least 80 m^2 of land area could deploy a 20kW capacity heat pump and use it seasonally and automatically receive a permit;
2) Using the IKEA Ballymun geothermal installation has 1.5MW[9] capacity as an example, based on a total of 158 drilled boreholes of ~120 metres depth each over an area of approximately 0.126 km^2, which represents less than 50% of the actual IKEA site. This system is also used seasonally so is not used at maximum capacity all the time. This system, while large capacity does not over deplete the resource or impact neighbours and would automatically receive a permit. It would however be obliged to report usage;
3) To construct and run a 2MW capacity extraction system 24/7 all year on 0.1 km^2 would require the operator to apply for a permit from the GSRO;
4) To store 2MW in 0.1 km2 area with wells less than 500 m would require the operator to apply for a permit from the GSRO;
5) Any system requiring wells that are deeper than 500m would require licensing under the proposed Geothermal Energy Exploration Licence (GEEL).

Geothermal Projects and Regulation

CausewayGT fully supports the statement that "Geothermal energy projects will have to be delivered in full compliance with all environmental protection law, including the public's rights to information and participation in decision making processes in line with the Aarhus Convention."

The risk-based approach to the level of regulation required is the right approach and the examples provide (page 21) are resonant. As previously stated the distinction between closed and open loop and between shallow and deep are important. We offer further commentary to the Project Archetypes in the attached Exhibit A.

Appropriate licensing is essential for the development of Deep geothermal resources. This gives the developer of the resource security of tenure and enables investment. Today in Ireland over 99% of geothermal deployments are shallow (less than 500m) and are progressing with no permitting/licensing approach. The current proposed policy would shut down that industry for any scale today. The policy needs to support the local development of heating and cooling for the local buildings where they are using the heat close to surface (shallow systems), rather than use a model that is based in exploration for scarce resources (oil, metals). As stated there is a fundamental need to define "shallow" and "deep" as these classifications are generally linked to vastly differing levels of investment requirements. Countries with high enthalpy ranges at shallow depth, such as Italy, would require additional parameters in these definitions, however, Ireland is a low-mid enthalpy environment, with a largely homogenous shallow environment. As such, it is envisioned that Ireland's geothermal resources be subject to an 'Irish geological approach'. Therefore, defining a broad classification for shallow (<500 metres) and deep (>500 metres) resources would be suitable in this context. The following is proposed (and summarised in Exhibit A):

Shallow systems (using the German definition of less than 500m).

- All systems must be registered.
- Residential systems are only subject to planning regulation.
- Commercial and Industrial systems require registration and energy use reporting. In the case of open systems, the appropriate planning regulations and water usage regulations apply. The area is the area the land owner has, not just the area of the deployment.
- Energy use (not purely capacity) of >0.1 kw/m2 requires the project to be licensed by the new GSRO as outlined previously.

Deep Systems

For depths of over 500 metres, the licensing of acreage per an Exploration/Production approach may be more appropriate, as a greater footprint would encourage more activity for the development of the resource. What does need to be ensured is that the licensing process enables the operating company to have security of tenure, while also promoting activity in a timely manner. We would propose that the licensing approach is reviewed as it is not currently obvious how that will be achieved with the proposed model.

Outline Regulatory Framework

We agree that having a regulatory framework for both shallow and deep geothermal is useful in reducing uncertainty for developers. We would urge the DECC to appreciate that any process needs to be designed carefully and resourced properly in order to be beneficial to everyone. We strongly agree with the four points of content for regulatory framework (page 23), but propose that there needs to be a fifth on targets for geothermal use and a sixth under the broad topic of broad policy incentives and safeguards to provide support for developers taking resource and project risk and to help customers choose geothermal heat over fossil fuels. Additionally, skills development needs to be central in the policy. We recommend that these three elements are in the Policy and not left purely to legislation.

Ownership of Geothermal Energy

We understand why the Minister for DECC should be the office which has the authority regulate ownership (page 25), but the relationship to other departments and arms of government, such as SEAI needs to be mapped. Currently SEAI does not have any capacity or capability in geothermal[14] which is a significant gap for a material arm of government's sustainable energy policy. We see the development of this capability as an addition to the requirement for a GSRO.

For shallow geothermal systems, which have a narrow subsurface footprint typically not greater than the surface building and associated areas, we do not see the need for regulation of ownership through leasing. Only open loop systems may have sufficient risk profile to warrant additional controls, and this can be based on existing rules for water abstraction. For deep geothermal systems, licensing and

[14] https://www.seai.ie/technologies/

leasing may be appropriate, but should considered in terms of projects intending to use the resource, rather than similar to oil and gas exploration.

Heat volume guarantee, thresholds and lease terms

We believe that the heat volume guarantee (page 25) is not a workable solution – too difficult to predict, measure and assure. Similarly, the use of a KW threshold (page 26) is not workable except for distinguishing single domestic ground source heat pumps. We propose an energy use/unit area approach for the reasons stated above for shallow systems as stated above. For deep geothermal projects we would instead propose that an area and depth considerations be included the licensing and leasing of outlined projects with defined use of the energy perhaps with heads up indication of customer commitment. Signposting to committed projects, at least the intention, helps to avoid "gold rush" claimers taking exploration leases with the intention of holding facility owners and others to ransom on the resource (monopsony, page 26). In Exhibit A we have added some commentary to the risk characterization of the project archetypes to illustrate our viewpoint on when leases, licenses and associated process should apply.

Incentives and financial support

The draft policy is completely silent on incentives to accelerate the development of geothermal energy in Ireland. The experience with wind and solar demonstrates that geothermal will not reach its potential without government support to incentivize development and use. They also clearly point to the fact that this should be in the Policy and not just the legislation.

There are three main areas we ask DECC to consider for incentives are:

Shallow Geothermal and Potentially Deep: Project capital support

We strongly believe that at scale deployment of both household and larger shallow geothermal projects and, in due course, deeper geothermal projects will lead cost performance improvement in drilling and facility capex. However, for the development of initial projects, developers and consumers would benefit and will probably need support. This can take the form of tax breaks for installation costs, or in the case of larger projects capital loans at a lower cost of capital than commercial funds can provide because of perceived residual resource risk and project execution risk at the industry matures. Such industrial loans or other financial support can be dedicated to projects and scaled proportionately to balance both risk and reward.

All Geothermal: Fuel/electricity prices

For shallow geothermal heat projects at any scale, Irish developers and commercial customers may need support to offset higher electricity prices compared to natural gas and oil. For example, if the electricity price is 3 times greater than the equivalent fossil fuel cost, then the heat pump system needs to have a coefficient of performance of at least 3 to offset this price difference. In some European countries this imbalance has in part been due to social and environmental levies being disproportionately attributed to electricity. In order to enable heat pumps to be economic some of these countries have redistributed the levies or give credits to users consuming electricity in heat pumps. In Ireland (non-household pre-tax electricity/gas price ratio of 4.5[15]), electricity costs are high, even in pre-tax terms, because of relatively high infrastructure costs and the lack of a very cheap baseload such as Sweden (non-household pre-tax electricity:gas price ratio of 1.6) has for hydroelectric generation. Carbon pricing mechanisms or social/environmental levies on gas are options to level the playing field in Ireland.

Deep Geothermal: Exploration risk underwriting

As the draft policy acknowledges, drilling to reduce risk and uncertainty in resource presence and quality is expensive, particularly in a very immature drilling market like Ireland. Developers will need support in bringing the drilling supply chain up to speed and to support early data collection. In the Netherlands this cover takes the form of a government-backed insurance scheme. An alternative is the ability to have written off exploration capital as a tax deductible.

Skills and Capabilities

Industry knowledge, capability & competency and technology development

As rightly pointed out by the draft policy the industry will need support in both setting standards for competency and accreditation to these standards. But the industry, or rather technical colleges, universities, trade associations and other institutions will need support to put together educational and training plans to deliver these competencies. The collateral benefits are new jobs. The regulator itself will need a phased resource and capability plan so that any installed process is supported by competent people.

[15] Eurostat: Electricity prices for non-household consumers - bi-annual data (from 2007 onwards) https://ec.europa.eu/eurostat/databrowser/product/page/NRG_PC_205__custom_2039975

The draft policy also points to the need for a deliberate effort to improve our collective knowledge of the subsurface. We agree and encourage the DECC to take a holistic approach to this for example by:

- Matching resource mapping and further government drilling with heat demand analysis;
- Supporting developers in their exploration risk reduction efforts; and
- Putting equal bias to the support of engineering technology development to the role of heat networks in distributed energy solutions and the social sciences aspects of the energy transition.

Consultation process

We are pleased with the proposal of a Geothermal Energy Advisory Group to steward the consultation process as the final policy document evolves to be ready for presentation to government. We hope that the Group will be deliberately designed to have different disciplines, backgrounds, and perspectives involved to account for all technical, economic and social implications of geothermal development. It is particularly important for there to be representation by consumers, developers, academia, finance, SEAI as well as DECC. Northern Ireland had a similar body appointed last year last year and we suggest that the two groups should work closely together as while the two jurisdictions have different regulatory frameworks to be addressed, the technical and commercial issues as well as the climate action opportunities are common. Finally, Ireland is clearly behind other European countries (e.g. Sweden) in its utilisation of geothermal energy and we suggest that it would be worthwhile identifying and recruiting advisors to the Group that can help with international best practice and peer review.

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Exhibit A

	Type	Definition	System type	Use	Authority
Closed-loop **Shallow**	Residential – single or low density.	low-yield energy for residential heating & cooling	Small ground-sourced heat pumps	Heating and cooling (heat pumps)	Per Building requirements
	Low-mid Net Energy	<0.1 kW/m2 Net energy usage	- Large ground-sourced heat pumps.	Heating, Cooling and Storage Agriculture, Commercial, Districts, Public Service & Industry	Per Building requirements
	High Net Energy	>0.1 kW/m2 Net energy usage	Advanced Geothermal System	Heat and/or electricity power generation	Permit application which would be awarded by GSRO
Open-loop **Shallow**	Residential – single or low density.	low-yield energy for residential heating and cooling	Small ground-sourced heat pumps; Standing-column well	Heating and cooling (heat pumps)	Per Building requirements & water authority
	Low-mid Energy	<0.1 kW/m2 Net energy usage	-Ground-sourced heat pumps; Standing-column well -Hydrothermal - Direct Use; Large ground-source heat pump	Heating & Cooling in Agriculture, Commercial, Districts, Public Service and Industry	Local planning regulator & water authority
	High Energy	>0.1 kW/m2 Net energy usage	Hydrothermal electricity generation; Enhanced geothermal systems	Heat and/or electricity power generation	Permit application which would be awarded by GSRO
Deep System Open/Closed	Mid-High Energy	All net energy levels	Commercial and Industrial	Heating, Cooling, Storage and Electricity.	License for exploration and production