# Energy Strategy Call for Evidence

# Response Template

## How to Respond

This template replicates the questions asked in the Call for Evidence found at: https://www.economy-ni.gov.uk/energy-strategy-call-for-evidence

It is recommended that you should read the full consultation document before completing your response. Please note that the text boxes used throughout this template can be expanded to accommodate your response – there is no character limit.

For further information on how we handle your personal data please read our Privacy Notice

Early responses are encouraged but all responses should arrive no later than **5pm on 20 March 2020.**

Please send your response to:

**energystrategy@economy-ni.gov.uk**

Or alternatively by post to:

Energy Strategy
Department for the Economy
Netherleigh
Massey Avenue
Belfast
BT4 2JP

Quote the reference "**Energy Strategy Call for Evidence 2019**"

## 1. General Information

1. **Name (required)**

**Joseph Ireland** [redacted]

2. **Are you responding:**

   **X as an individual (please complete 3 to 5 below)**

   **☐ on behalf of an organisation / company (please complete 6 to 8 below)**

**If you are responding as an individual:**

3. **E-mail address**

[redacted]

4. **Address**

[redacted]

5. **If you are responding as an individual, please read the Privacy Notice and tick the statement below as applicable.**

   **X All responses will be published on the Department for the Economy website following completion of the Call for Evidence process. Please tick if you are content for your name to be published alongside your response.**

**If you are responding on behalf of an organisation / company:**

6. **Organisation / Company**

| |
|---|
| N/A |

7. **Position within Company / Organisation**

| |
|---|
| N/A |

8. **Contact details**

   a. **E-mail address**

| |
|---|
| N/A |

   b. **Address**

| |
|---|
| N/A |

## 2. Energy in Northern Ireland

Q1. What lessons can we learn from elsewhere in addressing energy within an overarching climate action framework?

Q2. What are the key considerations for decarbonising Northern Ireland's energy sector given existing linkages to other jurisdictions?

Q3. To what extent should Northern Ireland implement the key energy-related recommendations from the CCC 'Reducing Emissions in Northern Ireland' report?

Q4. Do you agree with the 30-year timeframe? If not, please state your preferred approach and reasons.

## 3. The Energy Transition in Northern Ireland

Q5. What are the unique characteristics of Northern Ireland that need to be considered in a net zero carbon energy transition?

Q6. Is your organisation undertaking or planning to undertake projects to support the energy transition? If so, please provide further details.

**Q5. Answer:** Northern Ireland has two unique characteristic's that can be integrated to aid in the Net Zero Carbon Transition. The first being Mother Earth is at temperatures above the normal, by that I mean that as you drill down the geothermal temperature gradient of the Earth is high at 29.0-42.7$^{o}$C/km (Pasquali, 2010). Lucky us! We have been Geologically gifted by Mother Earth herself to provide us with natural Geothermal Resources of energy to aid us in our energy transition. The presence of natural warm water reservoirs known as aquifers across the country at varying depths beneath the surface present an opportunity for public, private and third party sector Geothermal developments. Depending on aquifer depth and location there is an opportunity for both heating/ cooling and electricity generation. The warm aquifers are just waiting on us to sustainably investigate and subsequently ecologically develop. The time has come to harvest this energy, with a lot of the ground work already done through publication of multiple papers on this very topic.

The second unique characteristic is being from Northern Ireland. We are blessed with innovative, creative and intelligent Engineers. Who, in the past built the Titanic under Samson and Goliath and the Sky Scrapers in New York City. Why can't we once again become Innovative World Leaders/ Trend Setting Engineers? We have pushed the boundaries before, it is time to do it again.

The Northern Irish youth of today are ready for this historical change; in fact, they demand it. The youth have been vocalising this locally and globally through Climate Change strikes under Extinction Rebellion and the Greta Thunberg movement. It is time to put The Troubles behind us, unite as a people and show the world what gifts we have; they are beneath our feet and in our minds.

I personally have the experience of 7 years working offshore for oil and gas major BP as a Drilling Engineer in the North Sea, a job which I loved. Following a 'Climate Change Awakening" and subsequent period of personal development, I am no longer able to drill for oil, I resigned. I have returned to my home land to see how we can use our natural resources in a sustainable way. Geothermal Wells present us with a fantastic opportunity to do that. I am currently completing a PhD at Queen's looking at Shallow Geothermal Abstraction and Reinjection Systems in the hot Sherwood Sandstone Aquifer, which is substantially distributed across Northern Ireland beneath our feet. My passion for the Mother Earth's sub surface has been reunited in a sustainable and green way using the natural thermal gradient and hot aquifer kindly given to us.

**My Past below on the Byford Dolphin Drilling Rig getting her 5 yearly in Harland & Wolff. At this stage in my career with BP, I loved my job and was in line to become an oil rig Drilling Supervisor:**

[redacted]

**My future below in the car park at the David Kier Building testing on three Shallow wells (100m deep into the Sherwood Sandstone Aquifer). We plan to test these three wells to demonstrate the applicability and efficiency of shallow Geothermal Systems:**

**Our NI Engineering Past, famous around the world for our talents:**

**Our NI Engineering Future, the youth of today demand change and we have an opportunity to showcase that locally through our Energy Transition:**

**Q6. Answer:** I am currently completing a PhD at Queens having started on 1st October 2019. The PhD is fully funded for 4 years. Queen's and Aberdeen have joined up to form a Doctoral Training Programme (DTP) known as QUADRAT (https://www.quadrat.ac.uk/) . Together they have received funding from NERC to support 20 PhD students a year for the next 5 years. The project themes are Biodiversity, Earth Systems and Environmental Management. The aim of the joint DTP is for two Top UK Universities to collaborate and tackle the most significant Environmental and Social challenges that we now face as a human race on this planet.

My project falls into the category of Engineering/ Geoscience. The title of the PhD is *'The Impact of Thermal Plumes from Geothermal Systems on Aquifer Properties and Ground Water Quality*'.

The Geology of Northern Ireland presents positive Geothermal opportunities in a number of sedimentary basins across the country (Pasquali, 2010). Belfast is very suitable for Shallow Abstraction/ Re - injection Geothermal systems. The Lagan Valley contains a sandstone called the Sherwood Sandstone with thicknesses of up to 300m. The Sandstone is overlain by thick Mudstones, which act as insulation to the porous/ permeable Sherwood Sandstone aquifer beneath (Pasquali, 2010).

Essentially there is an underground water reservoir with an insulating top across the Lagan Valley. If you drill down approx 30m you will hit the top of the sandstone and can begin pumping water to surface from the aquifer. In the past the aquifer has been used by NIW to meet general water usage within Northern Ireland but a number of years ago they choose to move away from ground water resources to surface water resources. This has high cost implications of having to pump water over long distances from the Silent Valley to Belfast for example, but reduces maintenance associated with wells. Northern Ireland is the only country in Europe that doesn't use ground water resources to meet demand. Certain buildings in Belfast still use the Sherwood Sandstone aquifer for general building water consumption, e.g. DKB at Queens, Royal Victoria Hospital and Coca Cola factory to produce Coca Cola.

The temperature of the water in the Sherwood Sandstone aquifer remains quite static. Last week it was 13/14 $^{o}$C at 20m, which is quite warm considering air temperature was 8/9$^{o}$C . The availability of

this water resource presents an unique engineering opportunity for building heating/ cooling systems to incorporate.

**Commercial/ Public building Summer:**

Building Cooling in summer can be done directly from an abstraction well pump to a Plate Heat Exchanger in the HVAC system (Figure 1). There are no UK laws for working environment temperatures but guidance suggests above 23°C is not productive. The temperature profile shallow within the aquifer would be able to keep cool temperatures above this to desired levels.

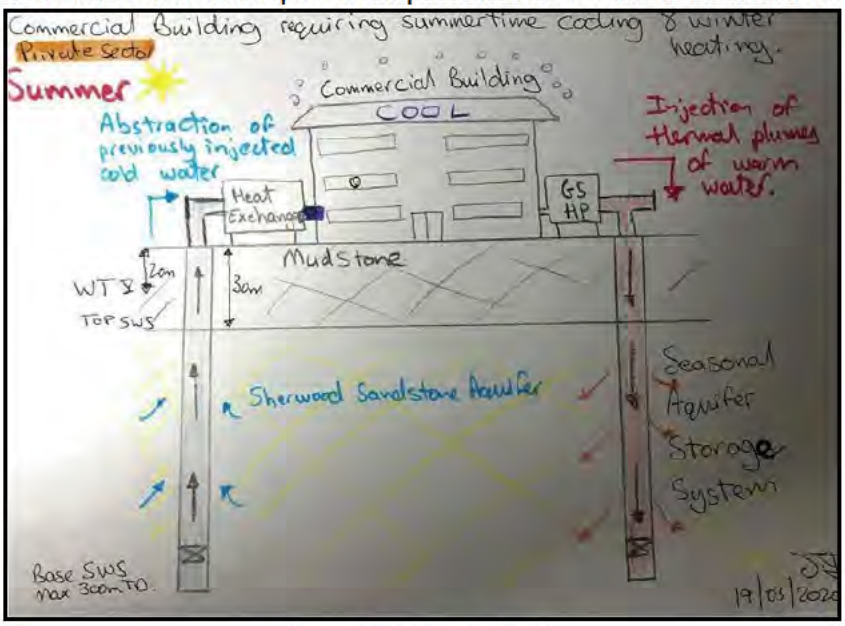


*Figure 1 - Cooling mode*

The water from the abstraction well will heat up as a result of the heat transfer in the HVAC Plate Heat Exchanger. This warm body of water, known as a thermal plume, will then be re-injected via the injection well back into the aquifer (Figure 1). The thermal plume will spread out into the aquifer over time and depending on the thermal properties of the rock will retain its heat for a period of time. The insulting mudstone on top in theory will also help thermal plume retain its heat. This seasonal "storage" of the warm water plume is known as Aquifer Thermal Energy Storage (ATES).

**Commercial/ Public building Winter:**

Building heating in winter can be done by reversing the cycle shown in Figure 1. The thermal plume is abstracted and then further heated via a Ground Source Heat Pump depending on building requirements before being distributed via the building HVAC (Figure 2). It is suggested temperatures above 16°C should be maintained (GOV.UK, 2020).

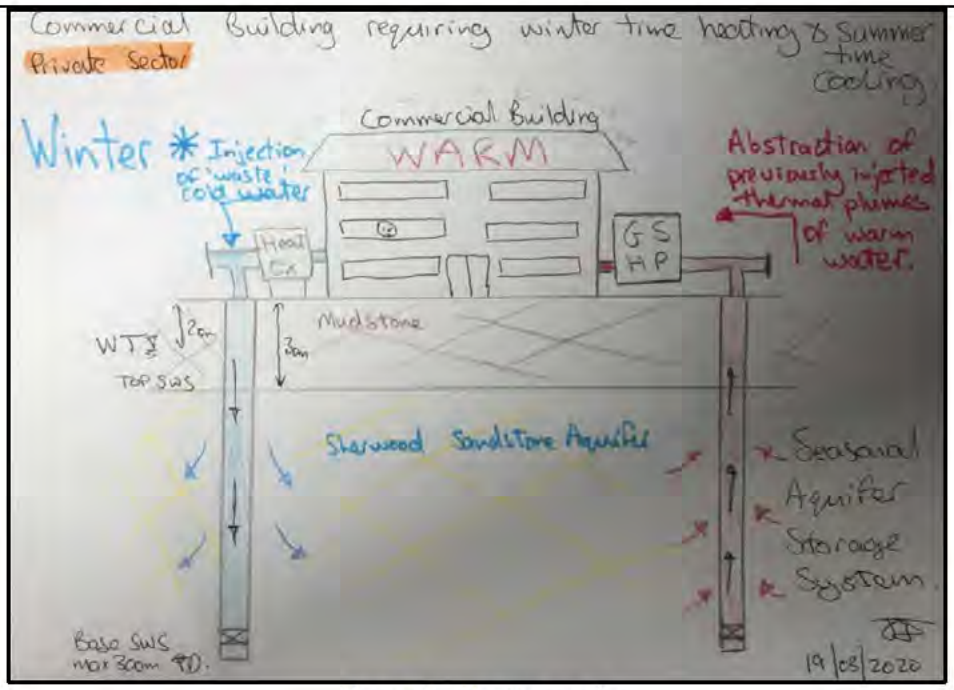


*Figure 2 - Heating cycle*

The warm water used for heating the building will cool as a result of the heat transfer process. This cold body of water will be re-injected into the aquifer (Figure 2). This water can then be re-abstracted when the cycle repeats itself during the Summer period (Figure 1).
**Note:** Sketches are only visual aids to illustrate the theory of Seasonal Aquifer Storage systems.

The Summer system illustrated in Figure 1 is installed at the Queen's School of Biological Sciences for the purpose of cooling 14 laboratory rooms. The Lyric Theatre has a similar system to cool the auditoriums but the warm water plume is pumped into the Lagan instead of another well due to area constraints.

**Public District Heating year round:**
As stated previously in the Belfast area, the Sherwood Aquifer is up to 300m thick. This presents an opportunity to drill deeper wells and abstract the warmer water for a District Heating Scheme (Figure 3). This could not only be done in Belfast but in other areas across Northern Ireland where the water temperature within the aquifer is even higher (Pasquali, 2010).

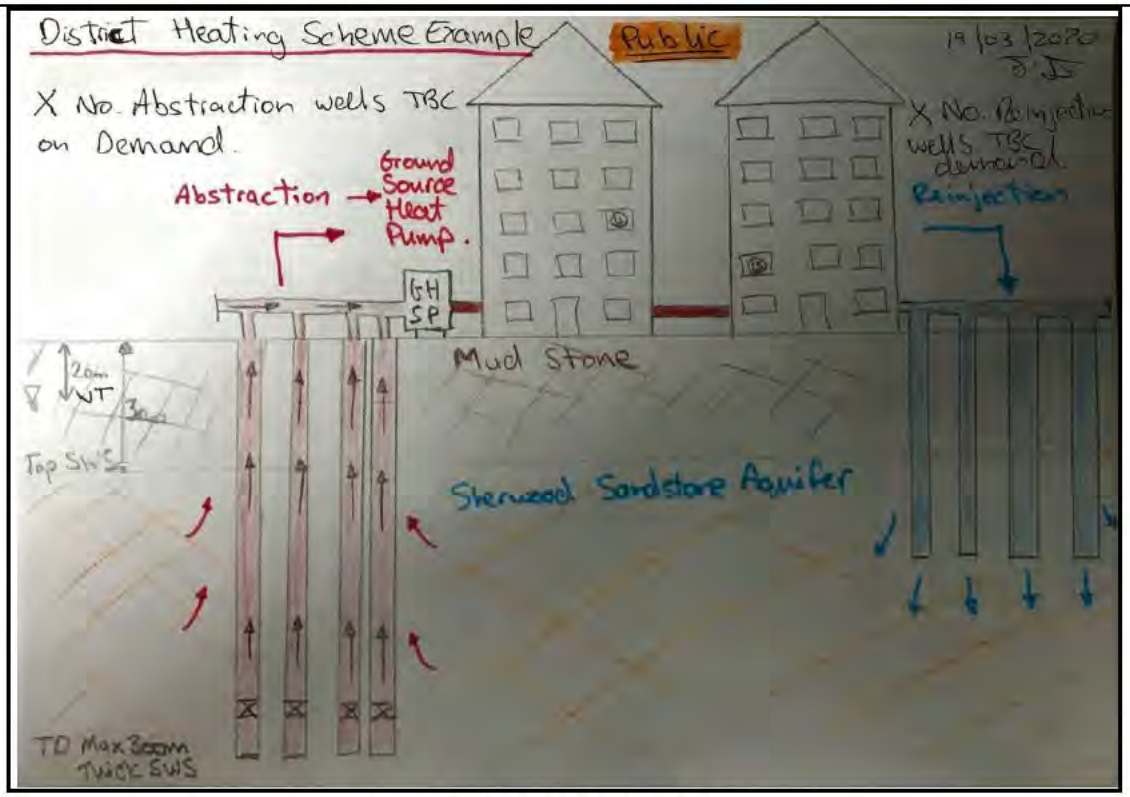


*Figure 3 - District Heating Scheme*

Multiple abstraction/ reinjection wells can be drilled depending on demand and the heating temperature requirement met via a Ground Source Heat pump (Figure 3).

My PhD will focus on the impacts of thermal plumes generated from geothermal systems that re-inject the warm water plumes. We will be investigating the impact this has on aquifer properties and ground water quality, using the Sherwood Sandstone aquifer as a case study. The aquifer rock and ground water system will have never come into contact with warm water plumes before so we are very interested to know the results of this interaction.
Queen's have 3 shallow test boreholes drilled (100m) into the Sherwood Sandstone here in Belfast that I can use for active well testing. The thermal plumes are not only likely to reduce aquifer porosities & permeabilities by facilitating inorganic precipitation and secondary mineralisation but also by promoting microbial activity within the aquifer with the additional biomass adding to the reduction of aquifer porosities. This in turn will affect the overall efficiency and sustainability of the geothermal installation and reduce the sustainable yield of the groundwater body for water supplies. The study will combine the baseline characterisation of the aquifer system by completing a series of active borehole geophysical measurements, hydraulic tests, hydrochemical sampling and microbial profiling with the long-term monitoring of experimental thermal injection tests. Hydrochemical and microbial sampling & analysis will be supplemented with down hole temperature monitoring using fibre optic sensors and biogeophysical monitoring of microbial activity. Collected monitoring data will be integrated into numerical heat transport models to evaluate field-scale thermal properties of the aquifer and to better understand the impact of thermal plumes on aquifer properties. I am hoping for positive results by introducing the Seasonal Storage method so that the warm water plumes are only temporarily stored in the aquifer therefore limiting any long term affects.

Current PhD status:

1. Working with NIEA to gather info on existing geothermal systems installed into the Sherwood sandstone to get an idea of how functional they are. So far, I have found a limited number in N.I. This presents an opportunity for future growth in this sector.
2. Planning to re-log and categorise the 3no. test boreholes I have for testing. We have limited kit at Queen's but will categorise the properties with what equipment we have. This work is now on hold with the Coronavirus.
3. Designing the pumping testing and long term thermal injection tests. Having access to fibre optic well monitoring would be extremely beneficial to the project at this stage, so I am trying to get a DTS unit and some cable. BGS have a unit that I am hoping to borrow for this purpose.
4. Getting onto site here in N.I. where some water wells are being drilled to get a feel for the project on the ground and how we drill wells compared to offshore.

I believe this project could lead the way in future Public, Private and Third Party schemes in the coming years if a proper Geothermal Conference is held with all relevant personnel present to discuss what it would take to make Northern Ireland Geothermal a reality.

## 4. Consumers

Q7. How should we ensure that energy remains affordable for domestic consumers? What approach should be taken to eradicate fuel poverty?

Q8. What steps could be taken to improve the relative cost competitiveness of larger non-domestic consumers?

Q9. Is a strategic position of "enable and protect" the correct policy stance?

a) What policies or schemes are needed to enable active consumers?
b) What policies or schemes are needed to protect vulnerable consumers?

Q10. What types of advice and information are required by all consumers and what are the best mechanisms for facilitating this?

Q11. Are there examples of successful citizen energy projects in Northern Ireland and elsewhere that have delivered improved energy efficiency and/or clean energy to local communities?

Q12. What opportunities are there in both urban and rural areas for citizen energy communities in Northern Ireland? What role could government have in facilitating these?

Q13. What evidence can you provide that identifies the challenges and opportunities for NI energy consumers in decarbonising energy?

## 5. Energy Efficiency

Q14. What, if any, energy efficiency target or targets should be set for Northern Ireland?

Q15. How should we define, measure and monitor energy efficiency to optimise its potential in our homes, business, economy and environment?

Q16. What are the most important policy levers for government to ensure zero carbon in:

a) New domestic and commercial buildings by 2050?;

b) Existing domestic and commercial buildings by 2050?

Q17. What should the future of energy efficiency support look like and who should be the key delivery bodies?

## 6. Heat

Q18. What is the appropriate pathway and timeline for the decarbonisation of heat between now and 2030, and subsequently to 2050?

Q19. What are the appropriate ways to measure the progress of decarbonising heat?

Q20. What are the most cost-effective and sustainable steps that government might take to accelerate the reduction of the carbon intensity of heating fuels?

Q21. Is decarbonisation of the gas grid a viable option and what evidence can be provided on both the speed and affordability of decarbonising the gas grid?

Q22. What evidence can you provide on the opportunities for district heating schemes in Northern Ireland and where should responsibility lie for facilitating these?

Q23. Can you provide any evidence or information on the opportunities for geothermal heat supply?

**Q.22 Answer:** See Q.6 Answer for reference.

**Q23. Answer:** Evidence has been gathered since the 1970/80s encouraging Geothermal to be considered as a heat supply in Northern Ireland. Since the 2000s more detailed data has been produced through the publication of multiple reports. Developments since then in Geothermal well technology and a reduction in drilling costs, makes the concept of Geothermal more attractive than ever and could launch Northern Ireland back onto the map in terms of engineering ingenuity.

A 2005 study modelled data from previously drilled oil and gas exploration wells to develop temperature maps at varying depths across Northern Ireland, the results of the maps highlighted the presence of aquifers with above the normal geothermal gradient.

Another 2005 study completed for INTERREG by the CSA Group studied 19 deep boreholes across Northern Ireland and produced geothermal temperature maps. The report states that Shallow Geothermal systems in conjunction with a Ground Source Heat Pump are well suited, but that a process of education and promotion is required. More interestingly the report details that Deep Geothermal resources show significant potential at a number of 'hot spots' across the country, with Geothermal Gradients above the world average of 30$^{o}$C/km (Kelly, 2005). The Rathlin Basin is one of these 'hot spots' identified in the report, a detailed report completed by University of St. Andrews on the Rathlin basin also states that there is potential for Geothermal resource exploration in the basin, but further work is required. (Chambers, 2010)

The TELLUS aeromagnetic project in 2007 further improved the understanding of deep geological structures throughout Northern Ireland. The data identified specific targets for Deep Geothermal Development.

A 2007 report compiled by the CSA Group for Sustainable Energy Ireland, INTERREG and Action Renewables NI, investigated the status of Geothermal Resources across the Island of Ireland. In Northern Ireland temperature data was compiled from existing boreholes, with the following results (Jones, 2007):

- ✓ 500m = 30°C
- ✓ 1000m = 60°C
- ✓ 2500m = 95°C
- ✓ 5000m = 150°C

Shallow Geothermal Well systems (<150m & <30°C):
The CSA report recommends Shallow Geothermal Abstraction and Reinjection well schemes in conjunction with Ground Source Heat pumps for building heating and cooling on small, large or even district type schemes.
As discussed previously in Question, my PhD Project is specifically looking at these type of Geothermal Systems.
Also as discussed previously, this type of scheme was recently commissioned in the new Queen's University School of Biological Sciences Building to cool 14 lab rooms. The Lyric Theatre also uses a similar system to cool the auditoriums although the water down stream of the plate heat exchanger is pumped into the Lagan River and not into an injection well.

Dublin and Glasgow are now both in the process of designing Shallow Geothermal District Heating schemes:

- ✓ Dublin: GEO-URBAN Project (http://www.geothermica.eu/projects/geo-urban/)
- ✓ Glasgow: UK GEOS Site (https://www.ukgeos.ac.uk/observatories/glasgow)

Deep Geothermal Well systems:
The temperature results from deep wells detailed in the CSA report indicate "significant Geothermal resources with potential for commercial development" (Jones, 2007).

The 2008 assessment of Deep Geothermal in Northern Ireland by Action Renewables lists multiple locations across Northern Ireland where Deep Geothermal could address heating demands for future planned residential, commercial and industrial developments (Pasquali R. , 2008). The costings detailed in this assessment for drilling would be significantly reduced as in 2008 there was an oil boom, with Brent Crude at nearly $100 a barrel. In comparison to the recent crash in oil prices with Brent Crude at nearly $30 a barrel. The price is expected to reduce further as Saudi Arabia floods the market. Land drilling rigs (Kelly, 2005) will be warm stacked due to lack of activity and operational costs will fall considerably.

Further evidence for Deep Geothermal is highlighted in the GT Energy Paper 2010 stating "Deep Geothermal Energy should be considered as a suitable renewable energy alternative in Northern Ireland" and furthermore "Northern Ireland has an elevated Geothermal Gradient compared to other regions of Europe" (Pasquali R. , 2010).

Another option for Deep Geothermal in Northern Ireland is the Mourne Mountains, the naturally occurring radioactive granite reaches depths of 5 to 6km. The Mourne Mountains show the highest rate of heat production due to this radioactivity of all the Irish samples taken. Further work is however required to assess the true potential. (Ture, 2016)

Cornwall is in the process of using their higher temperature from radioactive granite for electricity generation through Deep Geothermal Wells:

- ✓ United Deep Downs Project (https://www.uniteddownsgeothermal.co.uk/)

**In Conclusion:**

There are a multitude of Geothermal Resources in Northern Ireland that Mother Earth has kindly provided to help us adjust in the Energy Transition and to show the world what we can do as a nation once again. The reduced costs associated with drilling and equipment at the very least warrant further exploration and testing.

I recommend a '**Geothermal for Northern Ireland Conference 2020'** to discuss a detailed plan for the future and associated activities/ costings. I suggest the following should attend:

- Geological Survey NI
- Northern Ireland Water
- NIE
- British Geological Society
- White Young Green
- Geological Survey Ireland
- European Geophysical
- Robertson Geo Logging
- Northern Innovation
- Michael Nugent M&E
- RPS
- Sola Sense
- NIEA
- UK GEOS
- United Downs
- Meehan Drilling
- Geo Drilling Solutions
- iCRAG
- Well SENSE
- Belfast City Council
- Belfast Climate Commission
- SIBNI
- Invest NI
- Action Renewables
- All Party Assembly Group on Climate Change
- Dr David Mc Namara

## 7. Power

Q24. What is the appropriate pathway for the decarbonisation of power from now to 2030, and subsequently to 2050?

Q25. What target for electricity consumption generated from renewable sources by 2030 is ambitious, achievable and affordable?

Q26. How can the new infrastructure necessary to meet a new renewable electricity target be delivered in a timely, affordable and acceptable way for consumers and society?

Q27. What innovations and solutions could contribute to meeting a new renewable electricity target?

Q28. What market incentives and support are necessary for investors to deliver the investment in renewable generation assets at a scale that will achieve a new renewable electricity target?

Q29. What steps need to be taken by Government to facilitate investment in offshore and marine renewables for NI?

## 8. Transport

Q30. What would be an appropriate pathway to decarbonised energy for transport to 2050?

Q31. What role should active travel have in the decarbonisation of the transport sector and what should government do to support this?

Q32. What energy infrastructure is needed to facilitate the uptake of electric vehicles in line with UK Government's 'Road to Zero' targets?

Q33. How will transport integrate with other energy uses (e.g. homes with solar generation, battery storage, EV charging) and what can government do to optimise the opportunities represented by this integration?

Q34. To what extent can alternative low carbon transport fuels contribute to decarbonisation of the transport sector?

Q35. Do you have any data/research to help inform and reduce the carbon intensity of our transport energy in order to achieve net zero carbon by 2050?

## 9. Other Issues:

### a. Security of Supply

Q36. What specific risks to security of energy supply are likely to emerge as a result of our changing energy mix, and what actions can be taken to mitigate these?

Q37. What measures or indicators could be adopted or developed to monitor energy security of supply?

### b. The Role of Data

Q38. What is the most cost-effective method of capturing consumer energy usage data in electricity and natural gas (where meters are in place)? In heating oil (where there is no metering obligation)?

Q39. What concerns need to be addressed regarding data privacy, security and/or ownership?

Q40. What are your views on applying the key recommendations of the Energy Data Taskforce for NI?

Q41. What organisations or businesses do you see as having a key role in optimising the value of data? How will they do this?

### c. Carbon Capture and Storage

Q42. What steps, if any, should NI policy-makers consider with regard to the development or implementation of CCUS in NI?

### d. Energy and the Economy

Q43. What specific economic opportunities will arise from the decarbonisation of energy?

Q44. What skills are needed to realise the potential economic benefits of energy in the future?

Q45. What are your views on the future of overall energy demand in NI and how can we ensure that any potential demand growth aligns with our net zero carbon target?

### e. Delivery Framework for an Energy Strategy

Q46. Do the existing division of responsibilities and powers across government enable the most effective approach to the overall aim of decarbonising energy? If not, what are your suggestions for improvement?

Q47. What are the opportunities for local government to contribute to the delivery of the net zero carbon target?

Q48. What are your views on how statutory duties and accompanying legislation and regulatory frameworks would need to change to facilitate the transition to net zero carbon by 2050?

Q49. Is there a need for a dedicated organisation to champion, lead and deliver sustainable energy interventions? If so, what should this look like?

## 10. Additional information

Q50. Is there anything else you would like to add in response to this Call for Evidence?