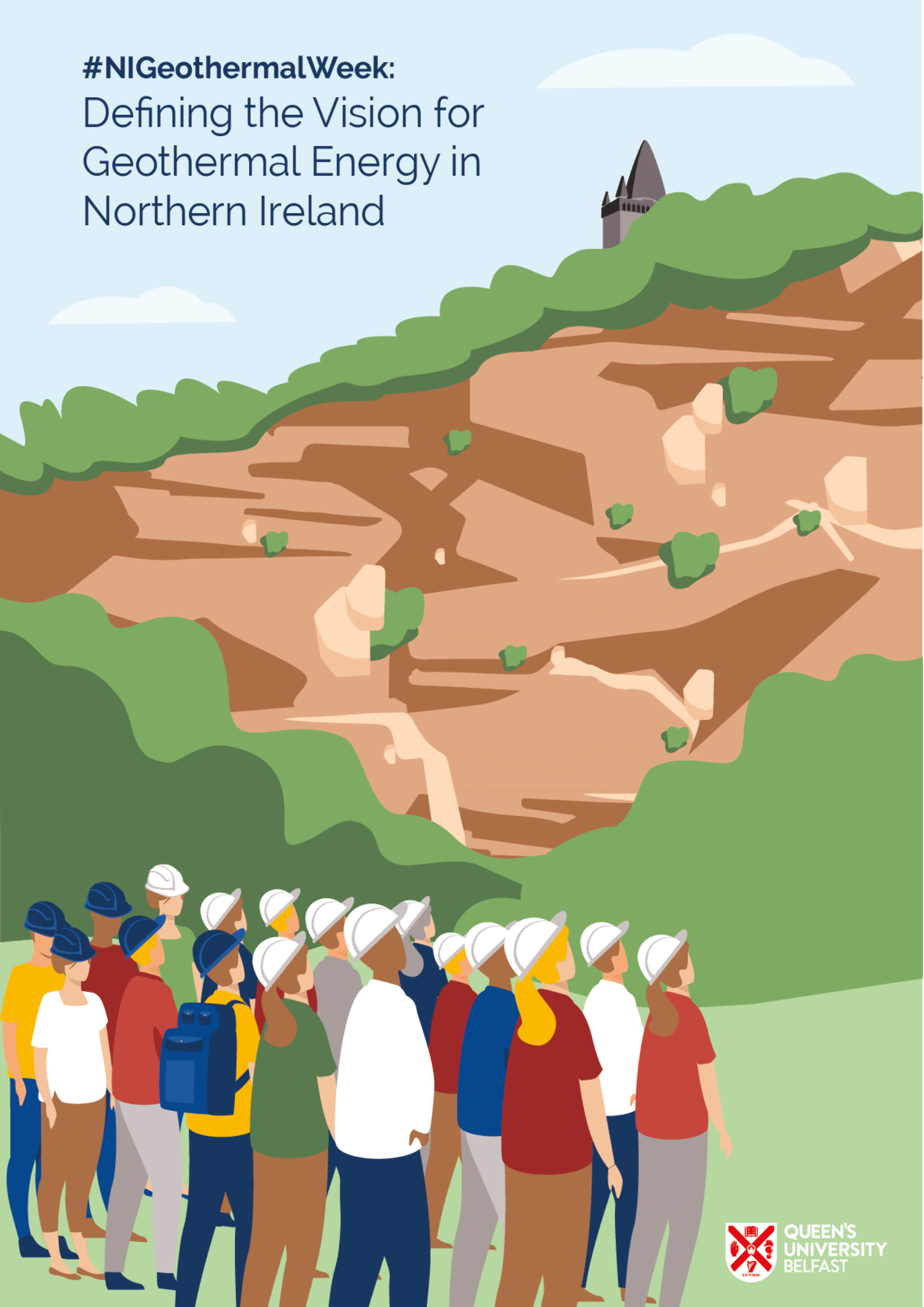
#NIGeothermalWeek:
Defining the Vision for Geothermal Energy in Northern Ireland



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This report has been prepared by Queen's University Belfast for the Department for the Economy and the Geothermal Advisory Committee. This report reflects the views of academics at Queen's University Belfast. Throughout the report the authors are referred to as 'we'.

The information contained in this publication is believed to be correct at the time of writing. Whilst care has been taken to ensure the information is accurate, Queen's University Belfast can accept no responsibility for any errors and omissions.

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REPORT SUMMARY

Northern Ireland Geothermal Energy Week (#NIGeothermalWeek) was held between June 13th – 17th 2022 at Riddel Hall, Queen's Management School, Queen's University Belfast. This inaugural event for the geothermal community in Northern Ireland could not have been more timely. The backcloth of geopolitical events – Northern Ireland Climate Act legislation mandating action on net zero targets, geopolitical conflict on the edge of the European Union leading to energy insecurity and strong inflationary pressures – has produced a window of opportunity for accelerating energy market transitions.

Northern Ireland Geothermal Energy Week inspired, energised and focused attention. Under the stewardship of the Department for the Economy (DfE) and the Geological Survey of Northern Ireland (GSNI), and in partnership with Queen's University Belfast, it provided policy makers, industry and research communities with the opportunity to come together, and create the conditions for defining the vision for the future of geothermal energy in Northern Ireland.

Underpinned by the themes of partnership and inclusion, NI Geothermal Energy Week elicited the international experiences and insights from the International Geothermal Trade Associations; International Geothermal Association (IGA) – International, European Geothermal Energy Council (EGEC) - European Union, and Geothermal Rising (formally Geothermal Resources Council, GRC) - USA. This dialogue took place on the opening stakeholder day. Further to this, an awareness-and understanding-building public webinar with an expert panel, sought to highlight how geothermal energy outcomes can deliver to all communities across Northern Ireland.

Working together across the week and agreeing the way forward yielded important insight for defining a vision for geothermal energy in Northern Ireland; revolving around communities, people, customers, environment, investment and operations. This cocreated vision aligns with the NI 10X economic vision, the World Energy Council's energy trilemma vision, local geology as well as geothermal energy sensory experiences for heating and cooling.

Northern Ireland Geothermal Energy Week was rich with information, social engagement and network encounter feedback. Taking stock, some things we learn from this inaugural event, not least with the survey feedback indicating perceptions of knowledge increasing, improving attitudes towards geothermal and reassuring points on the event organisation and a strong willingness to attend further geothermal sector events for organising and galvanising action. This report and reporting practice helps support industrial policy evaluation. It also showcases aesthetic innovation processes of sensory and evaluative forms of policymaking practice. Significantly too, this vision-making practice shifts the geological vocabulary towards a wider business sectoral understanding.

Looking forward, the challenge now is to commission, run and deliver demonstration geothermal projects, showcasing their results to the general public with a simple geothermal value proposition, while also cocreating a roadmap to deliver our future geothermal vision for Northern Ireland. We believe that this vision reflects an emerging shift towards a lingua franca for building the geothermal sector.

CONTENTS

1 INTRODUCTION TO NI GEOTHERMAL ENERGY WEEK

This report was commissioned by and compiled for the Department for the Economy (DfE), with support from the Geological Survey Northern Ireland (GSNI) and the Geothermal Advisory Committee (GAC) in Northern Ireland (NI). The focus of this report is the inaugural event called **Northern Ireland Geothermal Energy Week** – referred to digitally as the hash-tag **#NIGeothermalWeek**. We will use both descriptors throughout this report interchangeably to acknowledge social influence in both realms. This report summarises Northern Ireland Geothermal Week and has four main sections which are outlined below:

1. Background and rationale for NI Geothermal Energy Week.
2. An outline of the activities of NI Geothermal Energy Week.
3. Defining the NI Geothermal Vision.
4. NI Geothermal Energy Week Feedback.

Figure 1 - #NIGeothermalWeek field trip as illustrated on report front cover.

Before discussing **Northern Ireland Geothermal Week**, it is important to signpost new readers towards the multiple geoscience reports dating back as far as the 1970s and in the direction of the work of the Geological Survey of Northern Ireland (GSNI) more generally.[1] Overall, this body of research work concludes that Northern Ireland has favourable geological conditions for providing low-carbon alternative geothermal heating-and cooling-demand solutions. At this stage, it is also worthwhile providing a non-technical overview of geothermal energy, as exhibited in Box A (see overleaf), and setting the context for any new reader of this report. As noted elsewhere, geothermal is a heating or cooling energy source that naturally occurs from the earth's subsurface. That energy source can be connected directly to a home or business, but can also be designed across networks with multiple homes and businesses. There are various designs, depths and technologies deployed to accomplish a geothermal project. Initial desk top feasibility surveys followed by onsite exploration are typically undertaken to scope out and ascertain the subsurface potential and to match that assessment with the customer's heating and cooling requirements. The geothermal heat source can be designed as a standalone source, or alternatively as a complement to other energy sources. At the surface interface, ground source heat pumps can also be used as part and parcel of the everyday built environment mechanical, electrical and plumbing solutions.[2]

[1] Raine, R.J. and Reay, D.M., (2021), Geothermal energy potential in Northern Ireland: Summary and recommendations for the Geothermal Advisory Committee. GSNI Technical Report 2021/EM/01.
[2] Palmer, M., Ireland, J., Ofterdinger, U., Zhang, M. (2022), Net zero pathways: Building the geothermal energy sector in Northern Ireland. Department for the Economy. Technical Report, pp.1-137.

Box A: WHAT IS GEOTHERMAL ENERGY?

Geothermal is a heating or cooling energy source that naturally occurs in the earth's subsurface.

Geothermal energy is a single energy source that connects directly to one domestic home or industrial business.

Geothermal energy is an energy source that connects across networks with multiple homes, institutes and businesses.

There are different designs (closed loop, open loop), depths (shallow, deep) and technologies deployed to accomplish a geothermal project.

Exploration and feasibility surveys are typically used to scope out and ascertain the subsurface potential and to match with the customer's heating and cooling requirements.

For both domestic and business users, geothermal energy source 'flows' can be enabled with ground source heat pumps, or through direct use systems.

For larger network deployment across homes or businesses, the geothermal heat source can be configured and integrated with existing mechanical, electrical and plumbing solutions.

Box A – What is Geothermal Energy? Source: Palmer, Ireland, Ofterdinger & Zhang (2022), Abridged Report, p.3.

1.1 Background and Rationale for NI Geothermal Energy Week

Since the NI Department for the Economy (DfE) first published the *Energy Strategy – Call for Evidence on 17th December 2019*, interest in geothermal energy across Northern Ireland has been steadily increasing. This public consultation called for specific evidence or information on the opportunities for geothermal heat supply in Chapter 6: Heat, Q23 *'Can you provide any evidence or information on the opportunities for geothermal heat supply?'*[3]. This question led a series of activities and these are outlined in Appendix 1 and culminated with NI Geothermal Energy Week.

First discussed at the Department of the Economy's Geothermal Advisory Committee (thereafter GAC), the GAC minutes note conversations and discussions of the GAC members on the planning of NI Geothermal Energy Week.[4] The rationale for the proposed week of engagement activities was informed by feedback from the Build Back Better – Geothermal Energy for Northern Ireland virtual conference and the ongoing geothermal webinar series. The key rationale of NI Geothermal Energy Week was to cocreate the dialogue conditions for defining the vision for geothermal energy in Northern Ireland.

Therefore, guided by the NI Executive's Green Growth strategy transitional framework – referred to as the N.I. Diamond – #NIGeothermalWeek sought to work together with business, society and knowledge bases to deliver a market-focused approach (see Figure 2 overleaf). A GAC sub-committee formed to deliver the geothermal energy conference and it reported back to the monthly GAC meetings.

[3] https://www.economy-ni.gov.uk/energy-strategy-call-for-evidence
[4] GAC minutes on the 26th of November 2021. On the 28th January 2022, the GAC minutes and specifically agenda item 5 stated that a new GAC working group had *been* established to host a geothermal conference in 2022. Potential dates, stakeholders, location options and public engagement and the need for a media plan were discussed.

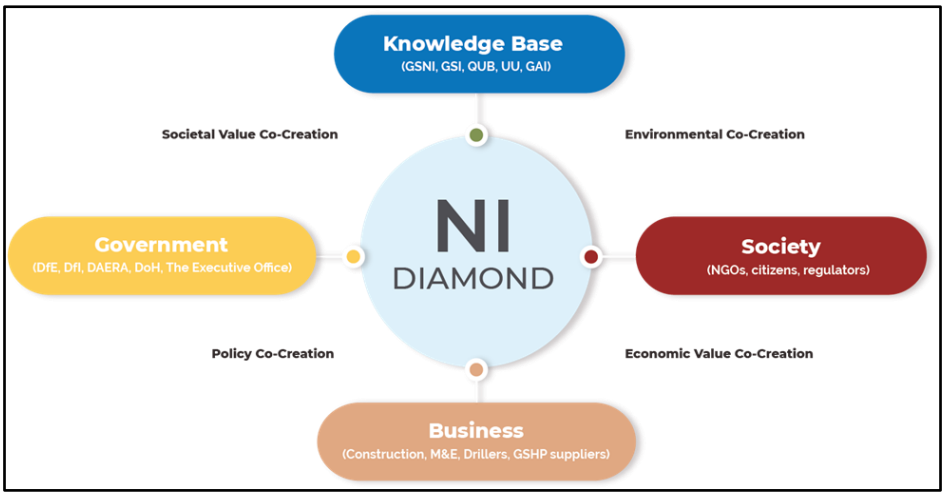


Figure 2 - Geothermal and the NI Diamond

Source: Adapted from Independent Strategic Review of NI Agri-Food – DAERA Report.

To provide further guidance on engagement activity in the codesign of #NIGeothermalWeek, a *Spectrum of Conversations* model was used. This dialogue-led approach is based on the ideas of relatedness, possibility, engagement, opportunity, action and completion, as shown in Figure 3 below. Taken together, both models provided counsel for collaborative decision-making, for making shared and inclusive, broadly considered decisions in the co-design of the plenary panel, round table dialogues, case demonstration, field trip and evening keynote panel webinar.

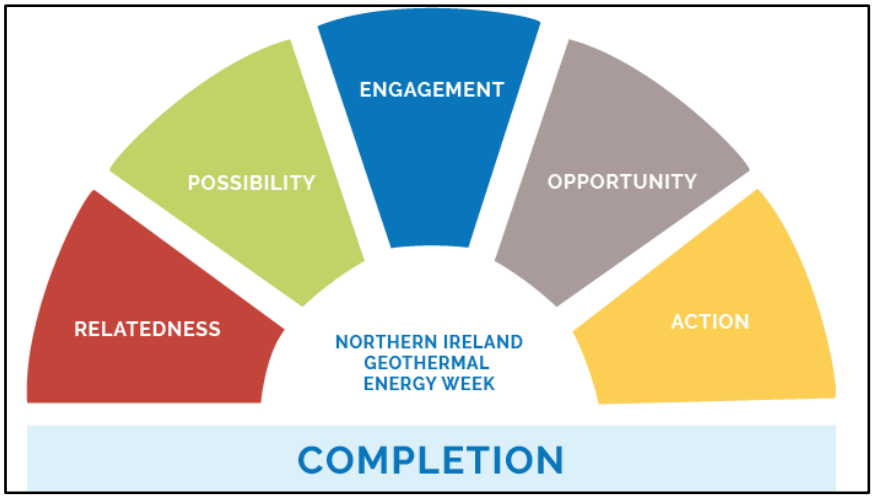


Figure 3 – Spectrum of dialogues used in codesign of #NIGeothermalWeek

Source: Adapted from JMW Consultants Spectrum of Conversations model, 2018

With this rationale in mind, we observe that Department of the Economy's Geothermal Advisory Committee, consulted widely and with stakeholder participation, working with Queen's University Belfast to ensure an inclusive, fair, balanced and equitable stakeholder approach.

1.2 Circular Policy Methodology

Policy necessitates perception and recognition of the issues 'on the ground' that require intervention – what should and should not be done. In consultation with academics from Queen's University Belfast, the Department for the Economy adopted a Circular Policy Methodology with #NIGeothermalWeek to support and steer and geothermal policy-making

practice and process (See Appendix 2 for further information on this methodology). Not only does this methodological approach benefit stakeholder engagement and involvement across multiple levels, but it enables consensus-building amongst stakeholders, or agreement on the causal beliefs held to be critical for building the geothermal sector.[5]

The Circular Policy Methodology rests on the assumption that people have an ingrained need to understand and control their environments and thus try to develop causal explanations. By creating event dialogue stimulus to influence explanations,[6] participants can attribute and find perspective on how *their* voice fits into decision-making, policy-making and actions 'on the ground'. This can enhance the institutional conditions for technology and policy acceptance as shown in Box B (see below).

Box B: Circular Policy Methodology and community acceptance

Orientation and process insight: If people understand the necessity of a policy decision and support the goals and means envisaged by this policy, they are more likely to accept it. Therefore, organising policy workshops can provide more transparent information about what issues they will face. Crucial elements are transparency about issue pros and cons and potential alternatives, as well as process.

Finding opportunity-risk balance: Acceptance is more likely when the planned consequences of the policy decision creates opportunity, and benefits oneself or related communities. This includes the perception of low or at least acceptable risks. In this context, the risk assessments of experts and those of laypersons are often not congruent, but with more familiarity and social interaction that gap can close.

Self-efficacy: Energy transition means the change of infrastructures and daily life environments. It is important to experience one's own impact and influence within this transformation process.

Identity-making and meaning-making: The more people can identify emotionally with a measure, the greater their willingness to accept it. This means that infrastructure measures must also be recognized emotionally as elements of one's own living environment where meaning is made. This is more likely to happen the more local stakeholders are included, listened to and involved.

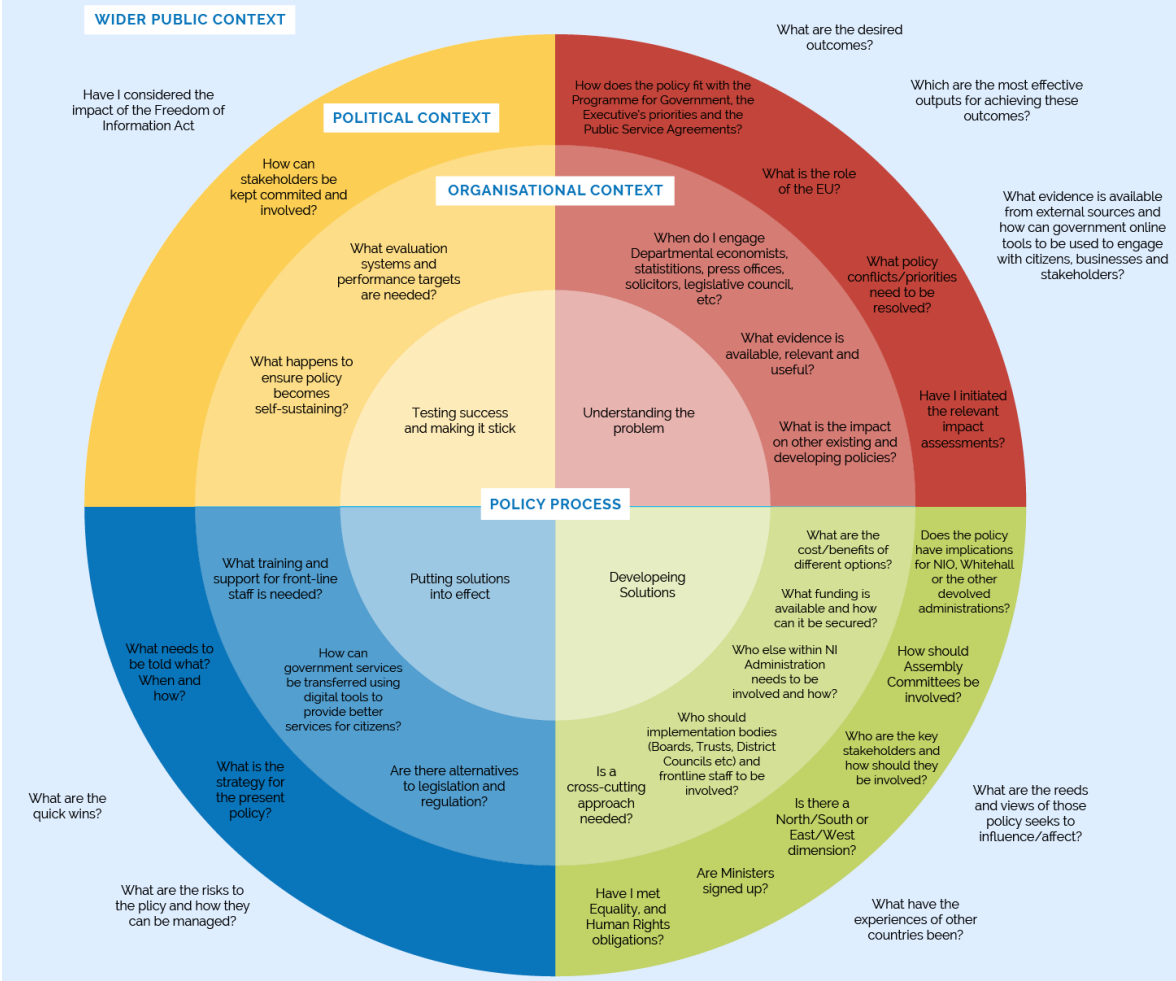
Box B - Circular Policy Methodology and community acceptance

Source: Hildebrand, Jahns, Klein (2022)[7]

NI Geothermal Energy Week afforded stakeholders the opportunity to engage, explore and articulate the geothermal opportunity and risk issues embedded at different community and project transitioning levels. Presently the NI Department for the Economy adopts a useful institutional policy question-led approach, as exhibited in Box C (see overleaf). When this practice is combined with an individual bottom-up approach, linking in with governance structures (i.e. Geothermal Advisory Committee), we believe that the circular nature of policy-making practice is enhanced. The bottom-up approach can feed into the policy screening questions, supporting dialogues, inclusion, peer experience sharing and review, and preparedness. We believe that this Circular Policy Methodology also institutionally safeguards against any individual arbitrage effects, gaps, or unintended market profiteering from when policy is imperfect in foreseeing externality problems.

[5] Carrington, D. J., Combe, I. A. & Mumford, M. D., (2019), Cognitive shifts within leader and follower teams: Where consensus develops in mental models during an organizational crisis, Leadership Quarterly. 30, p.335-350.
[6] Palmer, M. Medway, D. Warnaby, G. (2017), Theorising temporary spatial clusters and institutional boundary-work in industrial marketing, Industrial Marketing Management. 61, p.104–113.
[7] https://www.crowdthermalproject.eu/2022/06/10/webinar-how-to-evaluate-and-take-into-account-public-perception-in-geothermal-district-heating-and-cooling-projects Webinar 4/7/2022.

Box C: Policy process in context



Box C - Policy process in context

Source: NI Department for the Economy.

Regarding the Circular Policy Methodology practice, we observe exemplary foundational process policy innovation across #NIgeothermalWeek events. These activities are now, in turn, outlined in the next section of this report.

2 NI GEOTHERMAL ENERGY WEEK ENGAGEMENT ACTIVITIES

2.1 Opening plenary and panel discussion

Figure 4 – Opening day of #NIGeothermalWeek

The welcoming introduction of the NI Geothermal Energy Week proceedings were commenced by Dr Niall McCormack, Chair of the Geothermal Association of Ireland and Chief Executive and Managing Director of Causeway GT. Following on, the Vice Chancellor of Queen's University Belfast, Professor Ian Greer welcomed the audience and delivered a short speech to the delegates – excerpts of which are exhibited in Box D below. Figure 4 on the right shows, (from L-R), Professor Mark Palmer, Vice-Chancellor, Professor Ian Greer, Joseph Ireland, Minister for the Economy Gordon Lyons MLA, Dr. Niall McCormack and Dr. Marie Cowan outside Riddel Hall Management School prior to the opening plenary session of #NIGeothermalWeek.

Box D: Queen's University's Vice-Chancellor, Professor Ian Greer

Figure 5 – VC, Professor Ian Greer opening remarks

"Like all parts of the world, we in Northern Ireland face the challenge of tackling the Net Zero emission targets. We believe that challenge is faced with collaborative partnerships across related sectors. Aligns with our university ambition to work across disciplines and sectors in partnership with industry, government and communities."
"Queen's is currently developing the next stage of our carbon strategy - to achieve net zero emissions. Specifically for today, I note that our University has led out on geothermal technology within our estates, within the McClay Library for heating, within the School of Biological Sciences for the cooling of the laboratories and in the new Riddel Hall Management School building where 40 boreholes are awaiting connection to provide geothermal heating."

"Here at Queen's University we support the building of the geothermal sector with our geoscience research and skills agenda. Working in partnership with the Department for the Economy and other institutes, we have massive potential to develop further geothermal solutions in NI and for NI."

"…there are opportunities for linking geothermal R&D with BRCD through our Advanced Manufacturing Innovation Centre. And with Projects across the island of Ireland where already much collaboration in taking place. I know that today will bring much productive dialogue. Dialogue that will define the geothermal vision for Northern Ireland -that vision has never been so important to deliver than it is today."

Box D - Queen's University's Vice-Chancellor, Professor Ian Greer

Source: #NIGeothermalWeek opening plenary

This address was followed by the NI Economy Minister Gordon Lyons (see excerpts in Box E below). The Economy Minister emphasised in his speech the importance of a portfolio-driven approach to energy transitions, noting that geothermal heating and cooling had a role to play in achieving the vision of net zero carbon and affordable energy. Of significance, the Economy Minister announced £3.5 million for demonstrating a shallow (Stormont estates) and deep geothermal project (Antrim) in Northern Ireland (etender URL in footnote).[8] On foot of this announcement, the Department for the Economy initiated a procurement process to establish contract(s) to undertake the two geothermal feasibilities studies for the announced demonstrator projects. This pre-market engagement exercise aims to establish the following:

- Level of market interest in participating in the procurement process.
- Capacity of the market to complete the contract(s).
- Best practice to proceed with the contract(s).

Box E: Minister for the Economy Gordon Lyons MLA

"Geothermal is very much the 'Cinderella' of renewable technologies and I am pleased that my Department's Geological Survey of Northern Ireland has been working closely with Queen's School of Management to inform a roadmap, 'Building the Geothermal Energy Sector in Northern Ireland' to raise the profile of geothermal as a low carbon, renewable technology."

Figure 6 – Minister Gordon Lyons opening remarks

"My Department's Energy Strategy, The Path to Net Zero Energy, recognises that there is no single technological solution to decarbonising our energy mix and that, with its proven history globally, geothermal heating and cooling has a role to play in achieving our vision of net zero carbon and affordable energy."

"One of the guiding principles of my 10X economic vision is to support a greener, sustainable economy. With our globally recognised track record in advanced manufacturing and engineering, I am excited by the prospect of harnessing carbon-neutral energy sources such as geothermal energy."

Box E – Minister for the Economy Gordon Lyons MLA

Source: #NIGeothermalWeek opening plenary

Figure 7 – Dr Rob Raine delivering his presentation

Instrumental in undertaking much of the baseline geoscience research for understanding the geology across Northern Ireland, Dr Robert Raine (GSNI), then provided an informative presentation of the Northern Ireland geology and its implications for shallow and deep geothermal opportunities (see Figure 7). Alongside this presentation, a stalwart of the

[8] A link to the DfE pre-market engagement exercise is provided below for reference purposes: https://etendersni.gov.uk/epps/cft/prepareViewCfTWS.do?resourceId=4285247

geothermal sector building efforts and PhD research student at Queen's University Belfast, Mr Joseph Ireland, then provided an insightful personal journey narrative on building geothermal awareness in Northern Ireland. There is therefore much to learn through personal introspective account sharing, not least in understanding business sector emergence.

There is also much to learn through international sharing best practice and hosting international visitors with industrial experiences of leading out and building geothermal sectors. Northern Ireland Geothermal Energy Week did this, drawing upon this international industrial expertise of the world's leading Geothermal Trade Associations. The presenters comprised:

- Dr Marit Brommer, Director, International Geothermal Association.
- Dr Miklos Antics, President, European Geothermal Energy Council (Figure 8 below).
- Dr Will Pettitt, Executive Director, Geothermal Rising.

Figure 8 - Dr. Miklos Antics, President, EGEC

The International Trade Associations highlighted and showcased leading geothermal building examples that exist outside the UK and how those are developing. The presentations covered, amongst other issues, discussion on heat networks in the Paris suburban in France, use of horticulture glasshouses in the Netherlands and significant investments elsewhere in the west coast of the USA and in northern China. All of the main international Geothermal Trade Associations presented an overview of their activity, key developments and membership status. Each of the Geothermal Trade Associations also imparted advice on the strategic issues for developing the geothermal sector in Northern Ireland. We believe this is an exemplary way of bringing world leading expertise to Northern Ireland for enabling technology knowledge transfer and market breakthrough insights. Thanking all of the speakers, Dr Niall McCormack then provided a useful summary and key takeaways from the presentations for the audience.

Figure 9 – Opening panel discussion

Chairing and opening the panel discussion, Dr Marie Cowan, Director of the Geological Survey of Northern Ireland (GSNI), welcomed and invited the panel guests to be seated and introduced the guest panellists, which comprised the following senior executive decision-making members (note that Dr Will Pettitt was virtually attending from Montana in the United States of America as shown on the big screen in Figure 9 on the left):

- Richard Rodgers, Deputy Secretary, Head of Energy, NI Department for the Economy.
- Kevin Hegarty, Director of Green Growth and Climate Action, NI Department for Agriculture, Environment and Rural Affairs.
- Dr Marit Brommer, Director, International Geothermal Association.
- Dr Miklos Antics, President, European Geothermal Energy Council.
- Dr Will Pettitt, Executive Director, Geothermal Rising.

The audience were afforded the opportunity to ask questions in person and also anonymously using the application Slido[9] with an easy-access QR code[10] and the Chair read out a number of questions through this medium, addressing the panel members. There was a palpable interest from the audience with several questions and an open free flowing discussion (see Appendix 3 for additional collage of images of the opening plenary and panel discussion). The panel session was followed by a coffee break, during which GSNI demonstrated the hydrological properties of the Sherwood Sandstone using a desk top experiment (see Figure 10 above). The participants were then invited to the first of three round table dialogue discussions.

Figure 10 - Sherwood Sandstone demonstration

2.2 Round table organising

Geothermal energy has the capacity to influence every sector of the Northern Ireland economy for both heating and cooling solutions and, therefore, the representation of this diverse group of participants required much consideration. Organising engagement dialogues with communities, NGOs, institutions, businesses and other individuals is a well-accepted practice. However, it is not always possible to engage with all stakeholders in one week. With that in mind, the round table organising sought to get participants to define the vision for geothermal energy in Northern Ireland by;

- Engaging with envisioning NI geothermal sector practice,
- Exploring NI geothermal sector preparedness, needs and actions,
- Encouraging inclusive social networks and cross-sectoral exchange.

The stakeholder selection was led by Dr Marie Cowan, Director of the Geological Survey of Northern Ireland, and Chair of the GAC, working closely in consultation with the GAC members, the Department for the Economy's internal structures, along with Queen's University Belfast academics. Dr Marie Cowan engaged in an open stakeholder decision-making process and a full list was circulated to the GAC members seeking stakeholder recommendations.[11] In this process, we observed careful due consideration to ensure a balanced and equitable representation in the selection process at round tables (see Figure 11 & Figure 12 overleaf).

[9] https://www.slido.com/
[10] A QR barcode is a machine-readable optical label that can contain information or link directly to a website and permits audience members join an event by scanning it.
[11] Figure 11 and 12 are based on the feedback survey data which was distributed to all participants on the day. The original invitee list endeavoured to obtain a cross-sectional sample and the event attendance was voluntary, with attendance outside the Department for the Economy's control. We attained 48 completed questionnaires (n=48) with a response rate of 50 percent the response rate sample and all survey response rate caveats apply.

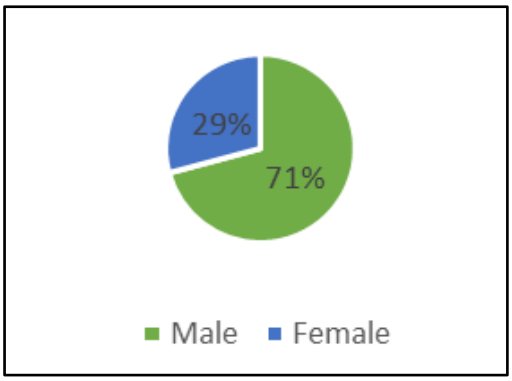


Figure 11 – Gender sample representation at #NIGeothermalWeek stakeholder day

Source: #NIGeothermalWeek questionnaire feedback

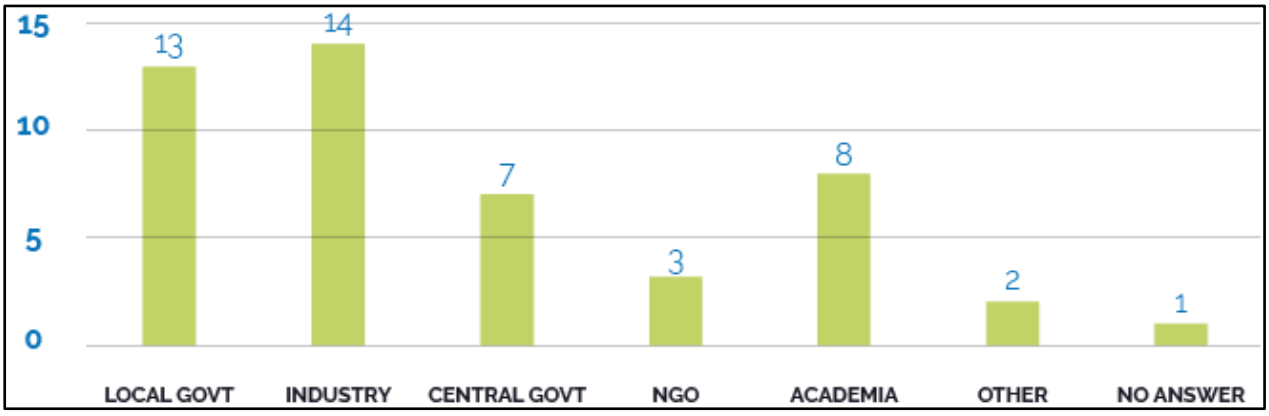


Figure 12 – Sample sector representation at #NIGeothermalWeek stakeholder day

Source: #NIGeothermalWeek questionnaire feedback

A challenge in co-designing this part of #NIGeothermalWeek that the GAC came across was how to effectively capture all of the participant stakeholders' voices and ensure 'social fluidity' at the round tables. Through pre-round table dialogue discussions with the GAC members, it was suggested that consideration of the World Café methodology might help support this activity and parts of that method were indeed adapted, along with others (see Appendix 2).

For each round table, the GAC chaperone (based on sector or experience) led out on the questions and with support from a host for each table (see Table 1 overleaf). Drawing on the expertise of the GAC members, this ensured the active participation of the Department for the Economy's GAC governance. Based on the overall volume of feedback voices (no=684, see Section 3.1), we believe that the round table discussions were successful in bringing together a range of people who may not always have had opportunities to talk and exchange ideas, and feedback suggested that participants valued this "interdisciplinary opportunity" (see Section 4.0 on respondent feedback).

Table No.	Table Chaperone	Table Host	Institute
1	Marie Cowan	Lucy Cotton	Geoscience Ltd
2	Corinna Abesser	Emer Caslin	iCRAG
3	Sharon Clements	Simon Todd	Causeway GT
4	Andy Frew	Sara Lynch & Aoife Foley	QUB
5	Ulrich Ofterdinger	Melanie Thrush	Arup
6	Rob Raine	Peter McConvey	Tetra Tech
7	Ric Pasquali	Mehdi Yusifov	bp
8	Niall McCormack	Sean Burke	BGS
9	Joy Hargie	Andrea Ellison	GSHPA
10	James Crawford	Justus Brokking	Transmark Renewables
11	Sikle Hartmann	Nick Vafaes	iCRAG/ GAI
12	Joseph Ireland	Helen Doran	Causeway GT

Source: GAC, June, 2022

Figure 13 – Round table dialogue

The round table sessions were Chaired by Professor Mark Palmer at Queen's University Belfast and he was supported by Dr Marie Cowan, Director of the GSNI (see Figure 13 on the left). Before the round table discussion began, the round table Chair briefly explained to the GAC members the table host role and invited any clarification questions. The hosts were given prompt cards for each dialogue, if needed. After that, the round table Chair explained the organisation of the round table dialogues to all of the participants within the room and introduced the specific questions which remained on display with the visual projector. The communication of this information was refined during the preparatory day with on-site visit on the 9th of June, 2022.

Professor Mark Palmer and Dr Marie Cowan both used the time to roam the floor and tables to assess how each of dialogues at the tables were being received by the participants and what information was being raised through the process. After approximately 30 minutes discussion, a further 15 minutes was provided for summarising the views. At the interval break, participants were invited to switch table if they desired. This approach allowed participants to actively network further into other conversations. Finally, after each discussion the GAC hosts populated the boards with the post-it notes and all participants were invited to look at the boards throughout the day. Appendix 4 provides an illustrative visual collage of the round table setting with the display boards and the post-it notes.

2.3 Round table question-led dialogues

Figure 14 – Round table question -led dialogue #1

To assist with defining geothermal energy in Northern Ireland, the round table discussions rested on leading with 'three dialogues' following the Green Policy Platform approach (see Appendix 4 and Figure 14 as setting).[12] The 'three dialogues' were distilled from initial scoping research commissioned by the NI Department for the Economy entitled *"Net Zero Pathways: Building the Geothermal Energy Sector in Northern Ireland"*, which consulted widely with a range of geothermal sector experts in Northern Ireland and elsewhere in the UK, EU and the USA. That work provided the basis of each of the dialogues for discussion.

The first dialogue concerned leading questions on geothermal sector preparedness, needs and actions for **building** the NI geothermal sector. The second dialogue framed questions on **maintaining** the momentum and development of geothermal sector. Finally, the third dialogue sought to understand how to achieve inclusive geothermal energy **communities** and what might be done for embedding geothermal within the communities. Appendix 4 shows the questions for each dialogue and a collage of images from across the three dialogues.

The round table dialogues used a simple post-it note method to elicit the range of voices at each table.[13] This approach helps to include everybody. That is, rarely do the loudest voices at the round table discussions represent the majority and these 'dominant voices' can also speak at the extreme positions. Finding a way to be inclusive and invite the quieter voices into the dialogues and discussion was a key consideration for the GAC Chair and members. Essentially, not conflating stakeholder silence for disengagement. Moreover, individuals' use and inscription of post-it notes is shown to provide aesthetic properties and merits for engagement. GAC members on the 9th of June 2022 discussed the role of the posit-it notes when meeting at the premises and running through the host facility housekeeping arrangements.

[12] https://www.greengrowthknowledge.org/country/eu
[13] Research shows how aesthetics enhance engagement and the feeling of participation.

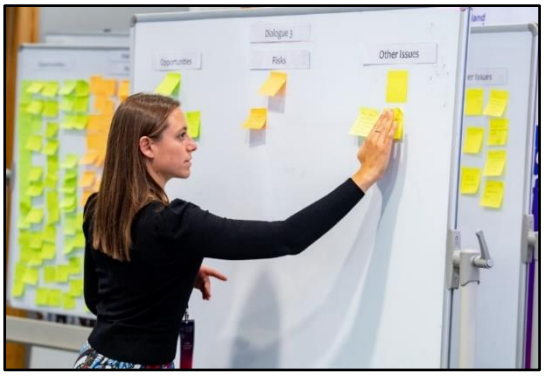


Figure 15 – Aesthetic post-it note engagement practice

The post-it notes were organised into opportunities (agreed as colour coded green), risks (agreed as colour coded orange), and other (agreed as colour coded yellow). The purpose of the 'other' category permitted leeway and flexibility outside the categories of opportunities and risks, something that the GAC members felt was important in preparatory open discussion. Flipcharts were also provided at each table for anyone wishing to communicate via that medium. The post-it notes therefore captured 'risk perceptions' as well as opportunity perceptions which allowed for positive effects to be shown (see Figure 15).

At the end of the third dialogue round table discussions, the Chair of GAC invited the round table floor for feedback on the process of the day (which is discussed in Section 2.3). This feedback was collected and presented at the GAC, along with the questionnaire feedback. Before closing the day's activities, the GAC Chair acknowledged with appreciation all of the stakeholders' contributions during the round table discussions. In addition, acknowledgement of outstanding institutional stalwart contributions were made with gifts, and the day ended with this jovial, mirth atmosphere.

2.4 Field trip Scrabo Quarry, Area of Special Scientific Interest (ASSI)

Geothermal energy week included a field trip by bus to Scrabo Quarry, Area of Special Scientific Interest (ASSI) on the afternoon of Wednesday 15th June 2022. It began with a meet and greet lunch at Riddel Hall at 1pm; with departure by bus to Scrabo Quarry at 2pm. Each participant was given a welcome pack that included a GSNI Field Trip Guide and a sample paper weight of the Sherwood Sandstone (see Appendix 5 for illustrative collage). Again, we observed careful due consideration by the GAC to ensure a balanced and equitable representation in the invitation and selection process.

At lunch, Dr Riccardo Pasquali of GeoServ and Vice-Chair of GAI gave an insightful presentation on installation practice of geothermal heating at the new build Queen's Management School building within the overall Riddel Hall site on the Stranmillis Road in south Belfast (see Appendix 5). The Management School has been expanding and the university developed plans to build a 6500 sq metre building. The Riddel Hall project adopted geothermal technology for heating the building and the geothermal installation comprised a shallow, closed-loop system, with 40 x 125m deep wells drilled. Dr Riccardo Pasquali discussed some of the design features and fielded questions from the participants.

Figure 16 – Scrabo Quarry, the face is 50m high

Upon arrival at Scrabo Quarry, Dr Mark Cooper provided the guided field tour along with his GSNI colleagues (Figure 16 on the left). A preparatory visit was made on Thursday 9th June and in advance of the field trip, the GSNI produced an informative booklet for the field trip (Appendix 5 for further collage illustration). Attendees included senior civil servants, policy-makers, senior council officials, Directors of environmental organisations and charities, researchers and CEOs of SMEs and the Utility Regulator. Upon arrival within the

Scrabo Tower car park, participants were given safety instructions and were also introduced to the Environment Officer with responsibility of Scrabo Quarry, Area of Special Scientific Interest (ASSI). Scrabo Quarry is at the foot of Scrabo Hill, while Scrabo Tower sits as a 135 feet (41 m) high 19th-century lookout tower at the mount of Scrabo Hill near Newtownards in County Down, Northern Ireland (a brief history was included on page 7 on the GSNI Field Trip Guide). Invited guests were guided by GSNI geologists and learned first-hand about the Sherwood Sandstone formation.

Figure 17 – Dr Mark Cooper (GSNI) explaining the geology

Developing knowledge of the Sherwood Sandstone resource, the field trip allowed decision-makers to learn in a practical way about this geology formation as a significant potential energy resource.[14] Undoubtedly, the subsurface presents some unique challenges in terms of visual aesthetics, sometimes making it difficult for decision-makers, regulators and policy-makers to comprehend from their office desks. However, by walking around the Sherwood Sandstone outcrop formation at Scrabo and also into the quarry, its physical scale (50m vertical surface exposed – see Figure 16), the visual aesthetics and the familiarity of the structural geology elements were more aptly demonstrated. When combined with the geological expertise of the GSNI, this helped the participants to situate the geography of the geology formation as well as its characterizing features for geothermal heating and cooling solutions. The links between this geology resource and the overall potential geothermal technological solution possibilities could be imaged and imagined (see Figure 17).[15] We commend that aesthetic policy process innovation and engagement work.[16] We also observed a subsequent Scrabo Quarry field trip organised by the GSNI, accommodating disability needs and further interest in this form of policy engagement. The return bus departed Scrabo Quarry and arrived back at Riddel Hall, Belfast at 5pm.

2.5 Public engagement panel discussion

The role of the general public is an important topic in energy transitions.[17] Previous research has highlighted that the challenge is as much a market behavioural breakthrough activity as it is a technological breakthrough activity. A significant challenge is one of building public confidence, shifting attitudes and engaging with public values and perceptions.[18] [19] Public perceptions vary across markets, however.[20] Therefore, panel discussions on the role that geothermal energy are required not only in building awareness of geothermal heating and cooling solutions, but in the co-creation of public values and ideas for public engagement. Both universities located in Northern Ireland – Ulster University and Queen's University Belfast – were represented in the panel engagement, along with the University of Liverpool.

[14] Raine, R.J. and Reay, D.M., (2021). Geothermal energy potential in Northern Ireland: Summary and recommendations for the Geothermal Advisory Committee. GSNI Technical Report 2021/EM/01.
[15] Research shows that aesthetic informs and animates people's internal conversations as they evaluate the arrangements they encounter and deliberate over how they should participate. See the research of Steven S. Taylor.
[16] An initial literature search on the QUB QCAT library database reveals no published work on this form of aesthetic policy engagement, highlighting the innovative approach taken by DfE and the GSNI in this respect.
[17] https://www.crowdthermalproject.eu/2022/06/10/webinar-how-to-evaluate-and-take-into-account-public-perception-in-geothermal-district-heating-and-cooling-projects/
[18] https://www.economy-ni.gov.uk/publications/net-zero-pathways-building-geothermal-energy-sector-northern-ireland
[19] https://www.plymouth.ac.uk/research/institutes/sustainable-earth/deep-geothermal
[20] https://www.emeraldgrouppublishing.com/journal/imr

Effectively, a regional approach for understanding local connection, emphasize the meaning of regional benefits and identification.

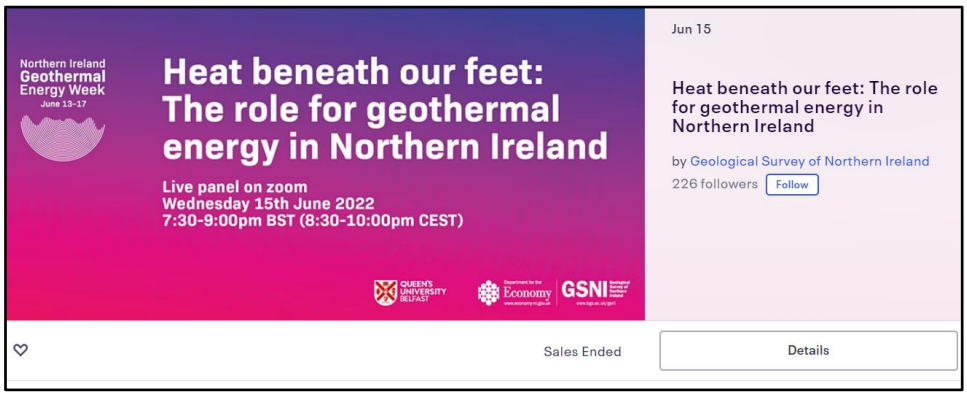


Figure 18 – The role for geothermal energy in Northern Ireland panel discussion

In total 120 people registered for the event via the Eventbrite registration page (see Figure 18 above and Appendix 6 for further details). Various sectors were represented at the event as shown in Figure 19 below.

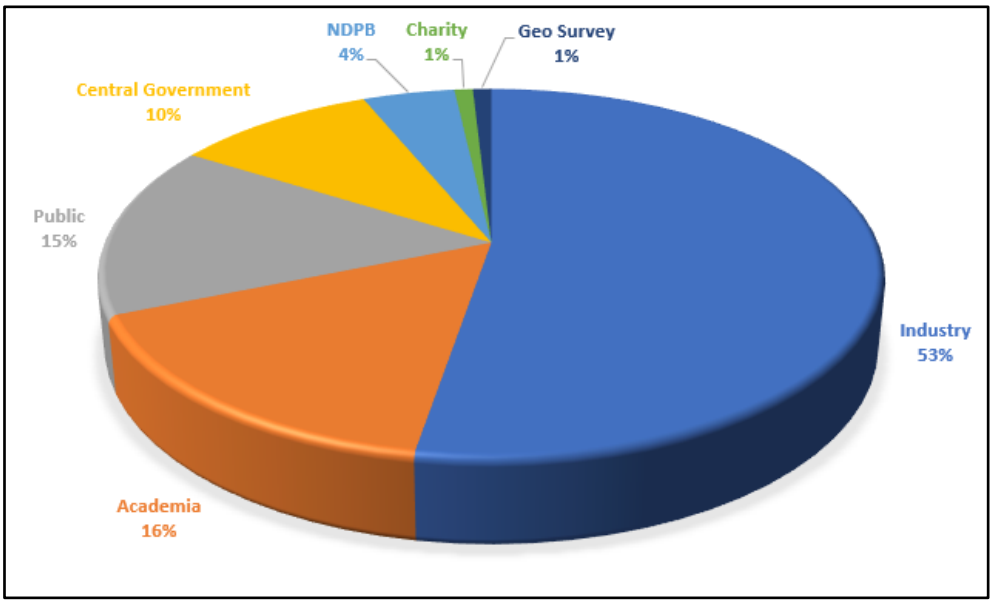


Figure 19 – Registrants sector breakdown

Interestingly, the international nature of the IP address profiles of attendees (for example, 28 countries including amongst others, the USA, India, New Zealand, Malaysia, Brazil, Turkey, China – see Figure 20 below) provides insight into the international interest of geothermal activity, while also perhaps suggesting that there is also still much to learn in hosting local community engagement. As shown in Figure 20, the majority of attendees are residents of the United Kingdom and Ireland. This data is a promising market signal for the future of geothermal sector-building locally.

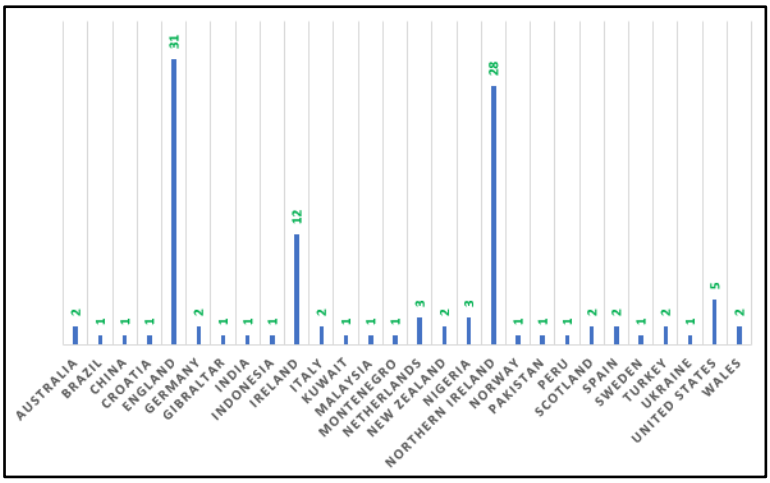


Figure 20 – Registrants location

The aim of this event was to invite members of the public to join a discussion in an engaging and interactive way on the role that geothermal energy can play in Northern Ireland. It drew upon the experiences of the expert Chair, Dr Silke Hartmann, Head of Integrated Catchment Planning Team at Northern Ireland Environment Agency. The online event started at 7:30pm and the Chair welcomed everybody in attendance and outlined the panellists including:

- Dr David McNamara, Lecturer Earth, Ocean and Ecological Science, University of Liverpool.
- David Banks, Director at Holymoor Consultancy Ltd.
- Professor Neil Hewitt, Head of School, Belfast School of Architecture and Built Environment at Ulster University.
- Kristina Hagström-Ilievska, Head of Marketing & Communications at Baseload Capital.

The panel discussion appeared to generate much public engagement, with online questions posed and this directed much of the panel discussion. Those questions ranged from:

- What exactly is geothermal energy?
- What can geothermal energy be used for?
- Do we have resources like Iceland/New Zealand?
- What geothermal potential does Northern Ireland have?
- What future role could geothermal play in our energy and decarbonisation needs?

Virtual polls were also incorporated to further involve the audience. Examples of the polls used are shown below:

- Vote for the renewable technology you are most familiar with (wind, solar, tidal, hydropower, geothermal)
- As you go deeper in the Earth's crust it gets hotter. In this region is it a.15degC/km, 30degC/km or 45degC/km?
- What do the highest levels of emissions come from heating or cooling?
- Did you know that there are geothermal systems operating in Belfast (yes/no)
- Underneath Belfast is an aquifer sandstone that can provide geothermal heating and cooling. How old is this rock unit? (10 Million years, 120 Million, 230 Million years).

The level of public participation and curiosity observed during this event was encouraging and there is much learning from the overall experience that can be taken forward for subsequent public engagement activities, including the ongoing webinar QUB, GSNI, GSI and GAI webinar series.

3 DEFINING THE GEOTHERMAL VISION FOR NI

Northern Ireland Geothermal Week (#NIGeothermalWeek) provided the conditions for participants to define the geothermal vision. In essence, a vision is summarized as a set of beliefs about how people should act, as well as interact, to attain some idealized future state for the geothermal sector.[21] Visions pivot and galvanize action, although that must begin with the elicitation and synthesis of stakeholder community voices and obtaining agreement on the way forward.[22] This section explains how that task process was undertaken during Northern Ireland Geothermal Week, along with its outcomes.

3.1 Synthesising round table vision feedback

The step between the round table discussion outputs and defining a geothermal vision was extremely important. The Circular Policy Methodology underpinning this task process is outlined in Appendix 2. This approach also needed to be flexible due to nascent nature of the geothermal sector and to allow leeway to capture the variety – heterogeneity – of issues raised from the stakeholders' round table dialogues. To do this work, the GAC members met over two days at Riddel Hall, Queen's University Belfast (14th and 16th of June) and began the task of organising the stakeholder voices from the round table dialogues (as seen in Figure 21). Below sets out a summary of the stages undertaken in defining the vision for the geothermal sector in Northern Ireland and also illustrative images from that work practice are exhibited in Appendix 7. As previously noted in this report, the post-it notes were extremely important for communicating feedback. We also used flip charts and white boards for transferring the dialogues from the round tables, thinking that aesthetic and visual would be the most effective way for GAC members to capture and discuss the round table feedback.

Figure 21 – Dialogue session populating post-it notes

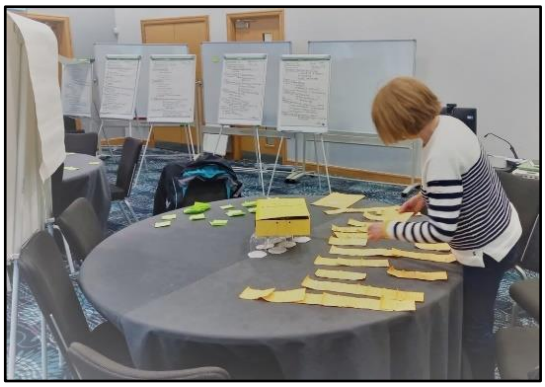


Figure 22 – Stage 1: Tallying post-it notes

Stage 1: Tallying post-it notes. This stage comprised creating a tally of the post-it notes and the various voices articulated during the round table dialogues (see Figure 22 above). Some 'cog notes' were shared and the GAC members immediately grasped what to do and lead out in organising the initial tally. The round table dialogues generated a large volume (no=684) of stakeholder voices vis-à-vis the post-it notes, as exhibited in Table 2 and Figure 23 overleaf.

[21] Mumford, M. D., & Strange, J. M. (2002). Vision and mental models: the case of charismatic and ideological leadership' in BJ Avolio and FJ Yammarino (eds) 2002 Transformational and Charismatic Leadership: the road ahead.
[22] More generally, the Earth Science Society under the leadership of President Mike Daly undertook a similar vision-making exercise as part of a Strategic Options Review (see Geoscientist 30 (7), 16-19, 2020) and that institutional vision was published in Spring (see Richard Hughes, Executive Secretary Geoscientist, 32 (1), p 5. 2022). https://geoscientist.online/wp-content/uploads/2022/03/GEO05_SPRING_2022_WEB.pdf

Table 1 - Tally of dialogues

Dialogues	Opportunities	Risks	Other issues	Total
Dialogue 1	116	114	60	290
Dialogue 2	102	65	24	191
Dialogue 3	111	51	41	203
Total	329	230	125	**684***

* Note that this post-it note tally excludes one digital feedback file and six pages of notes submitted.

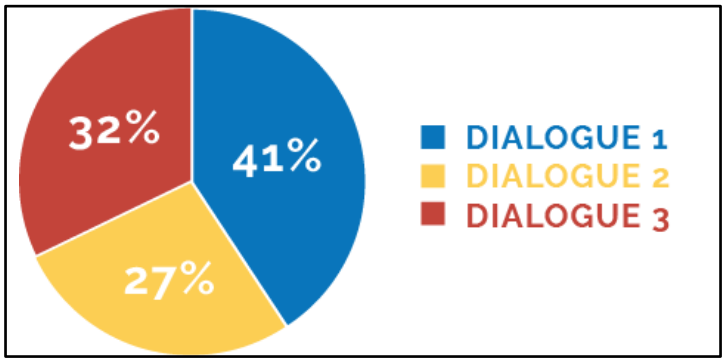


Figure 23 – Dialogue volume generated from stakeholder dialogues

A surprising finding from the tally was that that community was framed as an opportunity and tally had twice as many post-it notes than risks and stimulated and re-energised discussion.

Stage 2: (Re)reading and sorting. This stage comprised screening the post-it notes and identifying common segments of texts and organising the post-it notes accordingly on each of the tables. This stage was performed by the GAC members independently. This initial (re)reading simulated baseline issues and sub-themes. Also, in (re)reading the post-its, the GAC members informed themselves of the issues at hand 'on the ground' as written by the stakeholders in a local Northern Ireland context.

Stage 3: Organising questions and intra-coding. As previously outlined, posit-it notes were already coded in the colours and that assisted with this organising stage. This process was performed by GAC members at each table and in isolation to minimize 'group think interpretation' of the post-it notes and to better capture the heterogeneity in the stakeholder voices. The GAC members began organising the post-it notes across each of the dialogues and questions, and specifically around three colours – green denoted opportunities, orange denoted risks and yellow denoted other issues. The yellow post-it notes afforded the participants the leeway to raise other issues that did not fit within the opportunity or risk categories. The flip chart boards were colour-coded for each dialogue and all summary comments across all post-it notes were collated in a similar manner.

Stage 4: Building themes on flip charts. This reading and rereading analysis of the post-it notes provided overall sub-themes and that penultimate stage acted as the basis for creating and defining the number of spokes in the overall vision steering wheel (see Figure 24 on the right).

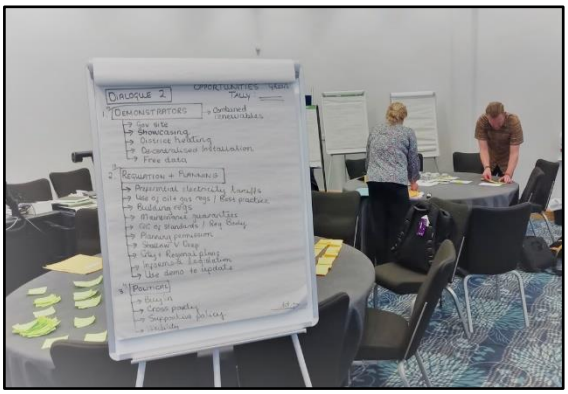


Figure 24 - Stage 4: Building themes on flip charts

Stage 5: White boarding and inter-group discussion. We then embarked on a process of bringing together and assembling all of individual themes identified at each of the tables. All of the flip charts were brought to the front of the room and a comparison of all of the themes was accomplished, resolving eventual inconsistencies between the theme coders (i.e. the GAC members). The final step involved was to deduce and distil the flip chart themes into a vision on the white board. This created a clear visualisation of where there was alignment across dialogues, and where perspectives differed (see Figure 25 below).

Figure 25 - Stage 5: White boarding and intergroup discussion

The vision was defined through the process of working in an interdisciplinary setting – geologists, policy practitioners, social scientists – each getting comfortable with new ways of thinking, new vocabularies, or new applications, as well as working together. In effect, finding the lingua franca for geothermal sector building. Despite the difficulties around this task, particularly the process and practice of vision-making articulation vis-à-vis statements, we observed a lively exchange, good humour and interaction, with all participants actively working on and contributing to the discussions based on post-it note dialogue evidence. There was a searching for active verbs to identify with the stakeholder feedback on possible vision futures, along with idioms in the grouping of words as having a meaning for defining the geothermal vision experience.[23] This vision-making task process lay the ground for its outcome, which is now discussed.

3.2 The Steering Wheel Vision for NI Geothermal Energy

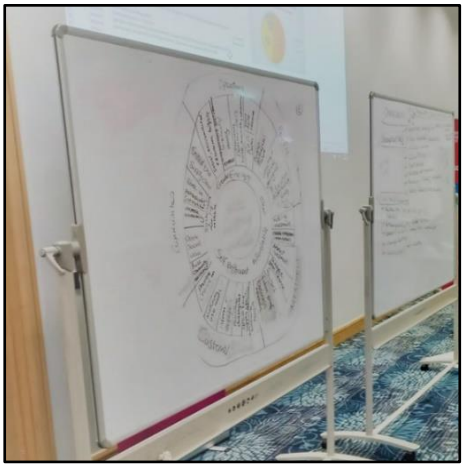


Figure 26 – NI Geothermal Steering Wheel Vision

From the rich array of views yielded by the post-it notes (no=684) and guided by previous research on workshop outcomes by Queen's University Belfast[24], the team of GAC members then articulated the vision for the geothermal energy in Northern Ireland. The vision also incorporated the international strategic take home messages yielded from the opening plenary and panel discussion, as outlined in Section 2.1.

[23]In addition to this, a further academic analysis will be undertaken on this corpus of data with thematic and semantic analysis with research software.
[24] Palmer, M. et al., (2015), Institutional maintenance work and power preservation in business exchanges: Insights into industrial supplier workshops, Industrial Marketing Management. 48. 214–225.

That articulated vision comprised: (i) a core experience, (ii) alignment dimensions (iii) six outer 'spoke dimensions' within a Steering Wheel Vision and statements. Each of the vision dimensions were deduced from the synthesis of the round table dialogue feedback. These statements were drafted and configured initially on the whiteboard within the round table room before further peer-review feedback at GAC meetings (see draft in Figure 26 on previous page and finalised in Figure 27 below).

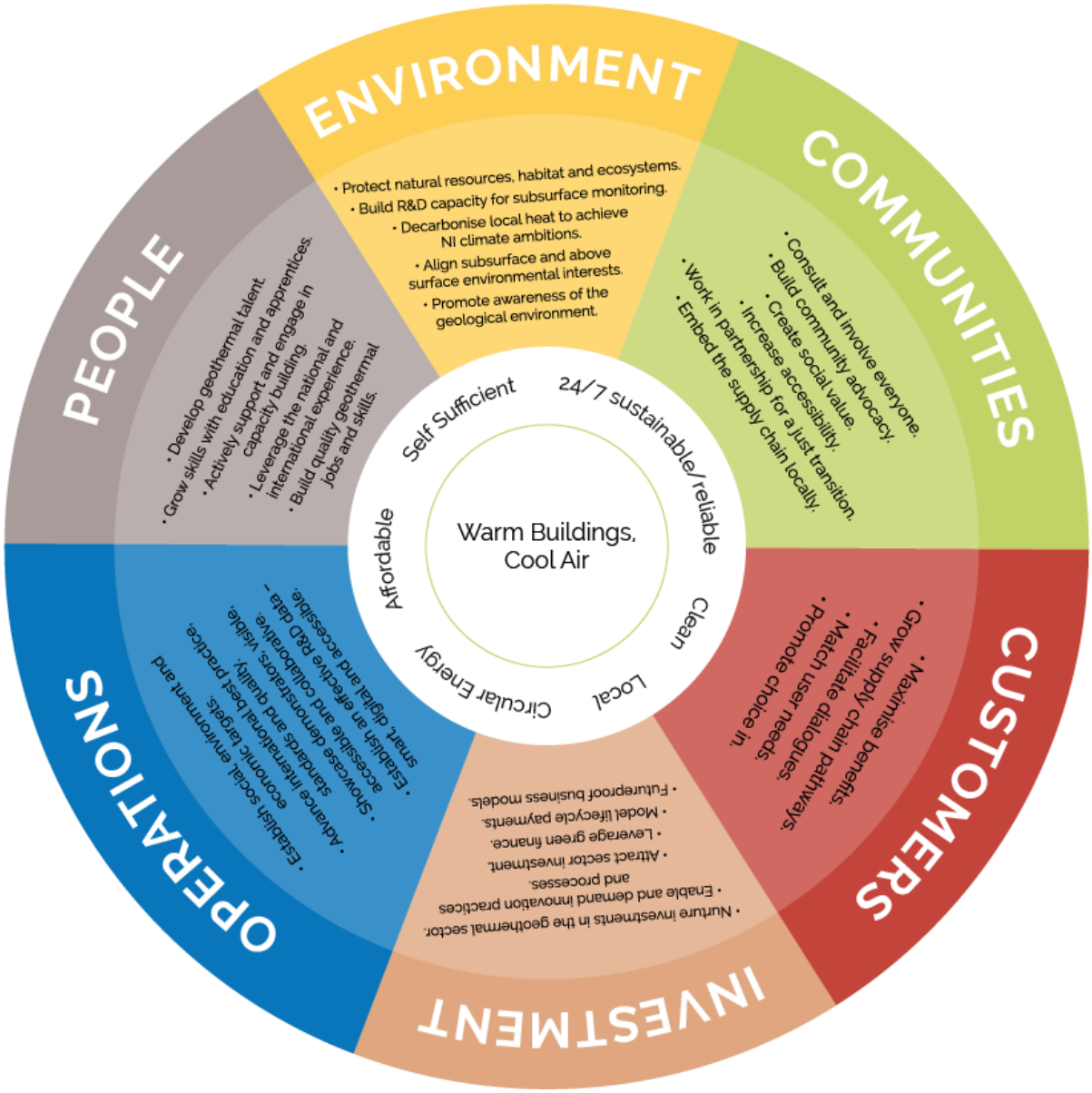


Figure 27 - The Steering Wheel Vision for NI Geothermal Energy

Source: Developed by members of the GAC, #NIGeothermalWeek, June 2022

We think this vision is bold and ambitious. [25] At the same time, the geothermal vision respects and builds on the longstanding NI built environment tradition of working with the Sherwood Sandstone formation[26] and also the NI bottled water tradition from the Sherwood

[25] Ready, D. A. and Conger J. A. (2008). 'Enabling bold visions', MIT Sloan Management Review, 49, pp. 70– 76.
[26] Natural stone database identifies 109 Sherwood Sandstone buildings across our built environment in Northern Ireland. See http://www.stonedatabase.com//building_search_results.cfm/k/0/btk/0/stc/205/ck/0

Sandstone groundwater, particularly evident in the early 20th century in Northern Ireland.[27] With NI tradition in mind, the team of GAC members sought to envision and repurpose the Sherwood Sandstone for heating-and cooling-solutions across Northern Ireland.

This long-term geothermal vision aims to create a step change in NI Green Growth Strategy, balancing climate, environment and the economy in Northern Ireland.[28] The realisation of this geothermal vision will ultimately see Northern Ireland deliver a just energy transition, providing a solid steering wheel framework for delivering on the decarbonisation of the built environment, while also strongly aligning with the 10X economic vision ambitions for the next decade for NI Department for the Economy. [29]We believe that this vision can situate NI as a climate-friendly landscape and amongst the elite small advanced economies in the world.

At the core of the geothermal vision for Northern Ireland is creating sensory experiential experiences of 'warm buildings and cool air experiences' for geothermal energy end users. [30] The premise of the core vision is simple: making user experiences your business drives community satisfaction.

The second circular sphere of the vision situates geothermal within the energy solution mix portfolio in Northern Ireland. This sphere of vision rests on the assumption that there is much more energy used for heating and cooling in buildings and industry, and a higher share of it is from coal, oil and gas.[31] A central vision is to put geothermal heating and cooling solutions in buildings which according to the recent UK Climate Change Commission progress report (June 2022) "continue to be well below the necessary level" across the UK in the delivery of net zero.[32] Geographic specificity is an important element of the geothermal vision, not least because geothermal activity is heavily influenced by the geology and also the location – the local – in which those activities take place. At the same time, the vision is also cognisant of the World Energy Council's energy trilemma of environmental sustainability, energy security and energy equity (accessibility and affordability)[33], alongside the characterizing features geothermal energy.

The large volume of round table dialogue feedback yielded important insight for delineating the six 'spoke dimensions'; revolving around communities, people, customers, environment, investment and operations.

Dr Marie Cowan (GSNI) along with Professor Mark Palmer (QUB) then co-presented and described the dimensions of the Steering Wheel Vision at the Geothermal Advisory Committee on final day of Geothermal Energy Week (17th of June, 2022). All GAC members were invited to provide initial peer-review feedback on the Steering Wheel Vision, having had the opportunity to view the Steering Wheel Vision on the evening prior to the GAC meeting. A further GAC meeting was later convened for the 24th of June, 2022 for further feedback and peer-review revision. In assembling this Steering Wheel Vision, a series of vision statements accompany this as exhibited in Box F overleaf.

Collectively, we believe the statements bring valuable focus, purpose, clarity on the vision building the NI geothermal sector seeks to achieve, and set out an engaging and bold vision

[27] See also more lately River Rock bottled water production outside Lisburn, Northern Ireland. https://www.coca-colahellenic.com/en/our-24-7-portfolio/hydration/deep-river-rock GSNI estimate that Sherwood Sandstone Aquifer in the Lagan Valley contains 20 times more water than the Silent Valley reservoir in the Mournes, Co.Down, NI.
[28] https://www.daera-ni.gov.uk/sites/default/files/consultations/daera/Green%20Growth_Brochure%20V8.pdf
[29] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/10x-economy-ni-decade-innovation.pdf
[30] Truong, Y. Simmons, G. and Palmer, M. (2012), "Reciprocal value propositions in practice: Constraints in digital markets," Industrial Marketing Management. 41. p. 197–206.
[31] International Energy Agency estimate over half of final total energy consumption is thermal (51%), transport (32%) and power (17%). https://www.iea.org
[32] file:///C:/Users/Mark%20Palmer/Downloads/Progress-in-reducing-emissions-2022-Report-to-Parliament.pdf p.20 and also see Table 1 (re: central column).
[33] https://trilemma.worldenergy.org

of a sustainability focused, inclusive, and vibrant future for all communities across Northern Ireland. The Steering Wheel Vision shifts the vocabulary from a geological one towards that which has wider business sectoral understanding. We believe that this transition is an obligatory passage point in finding a lingua franca for building the geothermal sector.

Box F: NI Geothermal Energy Vision Statements

To put geothermal heating and cooling solutions in place within the built environment and energy portfolio in Northern Ireland. This vision comprises six dimensions and these include;

Communities

To deliver geothermal energy to all communities. To achieve this, we will:

- Consult and involve everyone.
- Build community advocacy.
- Create social value.
- Increase accessibility.
- Work in partnership for a just transition.
- Embed the supply chain locally.

People

To build talent to drive geothermal excellence, capacity development and policy engagement. To achieve this we will:

- Develop geothermal talent.
- Grow skills with education and apprentices.
- Actively support and engage in capacity building.
- Leverage the national and international experience.
- Build quality geothermal jobs and skills.

Customers

To grow and facilitate geothermal customers in a sustainable way. To achieve this, we will:

- Maximise benefits.
- Grow supply chain pathways.
- Facilitate dialogues.
- Match user needs.
- Promote choice in.

Environment

To protect and preserve the environment for all communities. To achieve this, we will:

- Protect natural resources, habitat and ecosystems.
- Build R&D capacity for subsurface monitoring.
- Decarbonise local heat to achieve NI climate ambitions.
- Align subsurface and above surface environmental interests.
- Promote awareness of the geological environment.

Operations

To build administrative operational and policy support. To achieve this, we will:

- Establish social, environment and economic targets.
- Advance international best practice, standards and quality.
- Showcase demonstrators, visible, accessible and collaborative.
- Establish an effective R&D data – smart, digital and accessible.

Investment

To nurture, shield and protect sector investment funding. To achieve this, we will:

- Nurture investments in the geothermal sector.
- Enable and demand innovation practices and processes.
- Attract sector investment.
- Leverage green finance.
- Model lifecycle payments.
- Futureproof business models.

Box F – NI Geothermal Energy Vision Statements

Source: Developed from #NIGeothermalWeek and by members of the GAC.

4 GEOTHERMAL ENERGY WEEK FEEDBACK

Organising temporary sector clusters and specifically round table discussions inform and shape sector visions, roadmaps and policy-making. It is therefore important to reflect on these social practices with, and receive feedback from, participants following the events as this provides a vital analogue for future events.

4.1 On-the-day feedback

Towards the end of the round table dialogues, Dr Marie Cowan (GSNI) asked stakeholders participating at the round table discussions to reflect on their process experiences of the day. A summary of that very on-the-day feedback is included in a Word Cloud in Figure 28 overleaf.

4.2 Questionnaire feedback

A questionnaire was developed to be compact and short in length to encourage a high response rate and distributed to the participants NI Geothermal Energy Week towards the end of round table dialogue three. We attained 48 completed questionnaires (n=48) with a response rate of 50 percent[34], a summary of which is outlined in Appendix 8.

One of the highest forms of debate is about people making a discovery and shifting what they think. Round table dialogues can do that. The majority of the respondents' felt their individual knowledge (96%) and organisational knowledge (83%) of the geothermal sector has increased following this event. The respondents' job titles were placed into broad categories as displayed in Figure 12 in Section 2.2. These broad categories mirror and are aligned with the N.I. Diamond.

As shown in Appendix 8, respondents' attitude toward geothermal projects had improved following attendance at Geothermal Week, with 69 percent indicating a better attitude, 29 percent no change, while only 2 percent had a worse attitude. Ensuring participants feel heard is critical in stakeholder events. It is therefore reassuring that almost all of the survey respondents' felt that their voice had been heard and captured (98%) on building the geothermal sector vision in NI (with 2%, no answer).

Temporary sector clusters are important for building and maintaining sector momentum. The feedback survey asked respondents to indicate if they would attend or recommend another geothermal event or a similar-type event to a colleague. The overall responses are promising – all of the survey respondents (100%) show a willingness to attend or recommend another geothermal event or a similar-type event to a colleague.

Understanding how stakeholders imagine using geothermal thermal can help with sense-making (reading and interpreting) and sense-giving (thought leadership) within any environment.[35] Respondents were asked if they imagined using shallow heating geothermal technologies being used more regularly. Just over 77 percent stated that they were likely or extremely likely, or neutral, while 15 percent indicating extremely unlikely or unlikely, with 8 percent recording no answers.

As shown in Appendix 8, the vast majority of those who completed the survey reported that they would consider (likely or extremely likely, 90%) participating a multi-stakeholder deep geothermal feasibility project in the future where the geological conditions were right (no answer 2%, neutral 6% extremely unlikely 2%). This finding is interesting and understanding further this multi-stakeholder deep geothermal appeal might be informative. Geothermal

[34] This level of response rate is generally considered high for scientific surveys.
[35] Zhang, M., Hu, H., and Zhao, X., (2020), Developing product recall capability through supply chain quality management, International Journal of Production Economics, 229,107-795.

can be a stand-alone solution, but it is interesting respondents envisage working with geothermal technologies in combination with other energy sources and solutions, with 70 percent stating that they would find that likely and extremely likely. Overall, as previously indicated elsewhere in this report, the round table dialogues generated a large volume of comments (no=684) and each of those post-it notes will be followed up with academic-based semantic and also individual thematic study analysis.

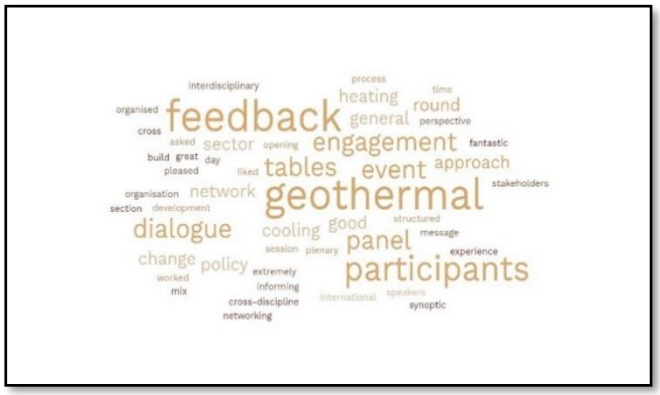


Figure 28 - Word cloud of round table process feedback

A Word Cloud of the feedback reveals that the principal ideas of Geothermal Energy Week helped to provide feedback on defining the vision and doing that with stakeholder participation, engagement and through dialogues (see Figure 28 on the left). There were several comments that recognised the role of interdisciplinary approaches and pointing to the scope to make further suggestions where other dialogues could happen with communities in the future. The Department for the Economy's GAC approach working together across epistemic disciplines is to be commended. The overall impression from the open-ended answers received is that there are a positive community opportunities offered by geothermal energy projects and these can be unlocked with multi-disciplinary teams working together. Box G below provides a summary of the feedback from the open-ended questionnaire survey feedback and also from GAC round table hosts.

Box G: Survey feedback and GAC round table host feedback
Location: Queen's Management School, Riddel Hall, Stranmillis, Belfast, NI.
Date: Monday 13th June 2022.
Feedback mode: Stakeholder Monitoring & Evaluation Questionnaire (Open ended question) and in person on-the-day.

Panel feedback:
Generally positive comments on opening plenary session and panel Q&A
Participants asked for more time for Q&As.

Round table feedback:
Participants were pleased with the organisation of the day –
"Extremely well organised event and included many stakeholders."
"Liked the approach/on message."

Participants highlighted the interdisciplinary perspective –
"Good to build a cross-discipline network." "Great cross section of experience."
"Good mix of participants."

Participants requested a synoptic view summarising the general views –
"Quick feedback after each panel to the floor."

Further engagement feedback opportunities:
"More engagement with the Mechanical, Electrical and Plumbing sector – the plumbers' voices."
"Perhaps a survey from the general public."

Box G – Survey feedback and GAC round table host feedback

Source: Questionnaire feedback at #NIGeothermalWeek, Monday 13th-Friday 17th June 2022

4.3 Social media feedback and media story outcomes

In terms of the policy evaluation, there is evidence of the halo effect generated by social media feedback[36] where participants monitored, amplified and generated sharing within networked community around NI Geothermal Energy Week. We find strong evidence of that halo effect generated from NI Geothermal Energy Week, particularly on the professional networking site Linked-In. An extremely important part of events such as NI Geothermal Energy Week are the online testimonials. A selection of this activity (sample =14 posts - see Appendix 9 for post details) had endorsed likes (n=545) and event comments (n=45) including, but not limited to:

- ***"A great week of insight, accomplishment and relationship – a wonderful foundation for the next phase."***
  Dr. Simon Todd – Director at Causeway Geothermal.
- ***"Inspirational talks on the huge potential of Geothermal Energy in Northern Ireland and really insightful discussions between a multi-sectoral group of stakeholders on how to enable it."***
  Emer Caslin – Business Development Manager at iCRAG, UCD, Dublin.
- ***"It was great to see such a positive statement from Minister Gordon Lyons, MLA, highlighting the role geothermal energy has to play as part of the Path to Net Zero Energy in Northern Ireland."***
  Andrew Foster – Senior Project Manager at Gavin & Doherty Geosolutions.

We also find that the coinciding announcement by the Economy Minster,[37] and the publication of the Department for the Economy's report 'Net Zero Pathways: Building the Geothermal Energy Sector in Northern Ireland' generated further coverage across multiple social media platforms. Queen's University Belfast also produced a short video which has been viewed over 1000 times.[38] The Economy Minister Gordon Lyons also produced a short video highlighting the role geothermal energy can play in achieving his vision of net zero carbon and affordable energy.[39]

The logo graphics, colours and promotion of the Geothermal Energy week were distinctive and visually striking. A further outcome noted at the GAC meeting at the end of the week was the event media coverage, both in the traditional print media (for example, Irish Independent, Farm Week, Belfast Telegraph) and also subsequent online coverage (for example, Syncni.com, Engineersireland.ie, Envirotecmagazine.com, Yourweather.co.uk, ThinkGeoEnergy.com) (See Appendix 10 for illustration).

4.4 GAC feedback and circular governance practice

At the end of Geothermal Energy Week, Dr Marie Cowan convened the GAC committee meeting (17th of June, 2022) to elicit feedback from all GAC members hosting each of the round table discussions to reflect on their experiences of how the round table conversations progressed. GAC members were given the opportunity to consider the round table discussions with their appreciation of the table dynamics and social flow, identify improvements and advise on enhancements. Overall, the feedback was very positive from the GAC members hosting at each of the round tables and there were some suggestions to improve Geothermal Energy Week.[40] A further GAC meeting was convened for the 24th of June, 2022. At that meeting, members identified further revisions to the Steering Wheel

[36] Pardo, C., Pagani, M., Savinien, J. (2022). The strategic role of social media in business-to-business contexts. Industrial Marketing Management, 101: p.82-97.
[37] https://www.belfasttelegraph.co.uk/news/northern-ireland/stormont-search-for-geothermal-energy-is-on-as-experts-study-estate-and-co-antrim-location-41768646.html
[38] https://www.youtube.com/watch?v=WJn1Ro-W44w
[39] https://www.linkedin.com/company/dept-for-economy-ni/videos/native/urn:li:ugcPost:6942102452858986496/
[40] This feedback is also noted and recorded in the GAC minutes in line best practice circular governance practice.

Vision, particularly in relation to the environment and subsurface spoke dimensions. The overall impression of the feedback on the process was very positive. Box H below provides a summary of the qualitative GAC Member feedback insights.

Box H: GAC round table host feedback
Location: Queen's Management School, Riddel Hall, Stranmillis, Belfast, NI.
Date: 17.6.2022
Feedback mode: Geothermal Advisory Meeting Hosts

Panel feedback
"Generally positive comments on opening plenary session and panel Q&A."

Round table feedback
"A structured, but simple approach to policy development that worked well."
"GAC and buddy system worked well at the tables."
"Employ note taking person to create more social fluidity."
"Create a way to rotate the table participation."

Field trip feedback
"Participants requested a synoptic view summarising the general views."
"Factor in contingency for traffic routes and delays."

Public panel feedback
"Consider more ways to build public awareness."

Feedback on other engagement opportunities
"More engagement with M&E sector and local representatives."
"More engagement with the Mechanical, Electrical and Plumbing sector."

Box H – GAC round table feedback Source: GAC meeting 17.6.2022

5 CONCLUSIONS

The geothermal energy transition in Northern Ireland has been brought into sharp focus amid a series of geopolitical events – Northern Ireland Climate Act legislation mandating action on net zero targets, geopolitical conflict on the edge of the European Union leading to energy insecurity and inflationary energy pressures. Against this backcloth, Northern Ireland Geothermal Energy Week (#NIGeothermalWeek) was held between June 13th – 17th 2022 at Riddel Hall, Queen's Management School, Queen's University Belfast. This inaugural event for the geothermal community in Northern Ireland therefore could not be more timely.

Northern Ireland has favourable natural geology resources for geothermal activity, particularly the Sherwood Sandstone Group, and unlocking that natural capital requires institutional work and support. Building on geoscience research work, this report captures an equally important aspect of market transitions – the sector organising vision, mobalisation, and the socio-techno practice needed, particularly for achieving market breakthroughs for net zero pathway transitions. We visualise the social practice of #NIGeothermalWeek not least because visuals are better at evoking emotions, capturing attention, creating involvement and bringing about complex market change.

Underpinned by the theme of working together, the inaugural Geothermal Energy Week aimed to define a vision for geothermal energy in Northern Ireland. #NIGeothermalWeek began with a blank canvas. Individual stakeholders had a blank canvas that they could populate as they see fit. The Department for the Economy and GSNI in partnership with Queen's University Belfast have used that canvas to define the geothermal vision in Northern Ireland. We demonstrate how this is achieved with the Circular Policy Methodology that allows stakeholders to gradually handle and get comfortable with the energy transition changes they face. This vision comprises foci or dimensions and these include; communities, people, customers, environment, operations and investment. This cocreated vision aligns with the NI 10X economic vision, while also being commensurate with the World Energy Council's energy trilemma, local geology, the built environment as well as geothermal energy sensory experiences for heating and cooling. Defining and articulating this vision is an important and necessary episodic step forward. Equally significant, the Steering Wheel Vision provides a compass directing the geological vector towards the wider business sectoral vocabulary. We believe that this vector shift is an obligatory passage point in finding a lingua franca for building the geothermal sector.

On the whole, as the many Q&As at the panel discussion, round table dialogues, field trip conversations and a public engagement panel, along with the feedback survey attest, stakeholders now have a wider and deeper appreciation of geothermal energy in Northern Ireland. Working together helps to find ways to address NI-specific geothermal sector issues, while integrating local knowledge with international experiences to collectively define the vision. Taking stock, some things we learn from this inaugural event, not least with the survey feedback. #NIGeothermalWeek produced exemplary best practice and process innovation adopted during the week.

Visions do things; critically they pivot, galvanise and cascade action. As such, our geothermal Steering Wheel Vision does not stop within the pages of this report, but should act to cascade action. Moving forward, the challenge now is to commission, run and deliver demonstration projects, showcasing their results to the general public with a simple geothermal value proposition, while also creating a roadmap to realise our geothermal vision for Northern Ireland.

6 NEXT STEPS

Following on from #NIGeothermalWeek and defining the geothermal vision, as outlined in Section 3 of this report, it is important that that momentum is harnessed by the Department for the Economy in the next steps. To this end, below sets out the next steps with timelines for consideration, both of which are underpinned with previous research report recommendations, [41] [42] and guided by the geothermal Steering Wheel Vision framework to ensure the geothermal policy impetus.

The first step towards enacting the NI Geothermal Vision is steering towards the operations vision sphere to **showcase demonstrators visibly, accessibly and collaboratively.** Commissioning, running and delivering both shallow and deep demonstrators must test the proof of concept model and generate the geothermal value proposition from R&D data. Site preparation work will trigger and bring public curiosity and questions from communities. Harnessing that curiosity can enhance community understanding of the geothermal vision and activity. We advise that demonstrator projects not only report on public engagement, but also visualize the steps throughout the project epoch for the purposes of building 'how-to' awareness of the geothermal project practice. Figure 29 overleaf outlines the steps of a standard bore well operation but also provides insight into the nature of the degree of showcasing potential of the demonstrators, so that others can observe the steps and learn from the government demonstrator at each step along the way. Doing this, prevents 'black boxing', but more importantly, it democratises the geothermal buildability process. The government demonstrators ultimately create the visible signposts and institutional pathways (path creation) for others to follow suit. This approach should apply to both shallow and deep geothermal projects, related milestones and illustrative workarounds for lessons learned to be drawn on both projects. Specifically on the deep drilling timeline, it would be judicious to factor in a scenario project management model to manage the external institutional process conditions e.g. planning, environmental monitoring and so on.

The second step towards enacting the NI Geothermal Vision is in **the articulation of the roadmap strategy** that defines key goals and policy action including the major steps or milestones needed to situate geothermal within the built environment and energy portfolio in Northern Ireland. Effectively, the geothermal policy journey began when the NI Department for the Economy (DfE) first published the Energy Strategy - Call for Evidence on 17th December 2019. We suggest that the Circular Policy Methodology, along with the real time feedback from the demonstrators, is used to shape the roadmap strategy. Step two will therefore be concurrent with step one. Consideration of the geothermal roadmap will be required and with a degree of urgency for the Department for the Economy as the timescales below suggest. This critical step also comprises geothermal regulations (instructing primary legislation on geothermal and heat networks), secondary legislation, supporting research and demonstration, along with wider enabling policy actions.

We believe that both steps are best proceeded with in parallel, although the first step invariably informs and feeds into the roadmapping work. Table 3 below sets out the steps with suggested timelines in a multi-phased approach. It is important that the impetus of Geothermal Energy Week is not lost but instead harnessed by the Department for the Economy and channelled into the next steps. We therefore advise that commensurate budgetary resource allocation supports the above steps and within the timelines detailed overleaf in Table 3.

[41] Raine, R.J. and Reay, D.M., (2021), Geothermal energy potential in Northern Ireland: Summary and recommendations for the Geothermal Advisory Committee. GSNI Technical Report 2021/EM/01.
[42] Palmer, M., Ireland, J., Ofterdinger, U., Zhang, M. (2022), Net zero pathways: Building the geothermal energy sector in Northern Ireland. Department for the Economy. Technical Report, pp.1-137

Table 3 - NI geothermal action step plan

Steps	Detail	Owner	Timelines of work, commencement and completion
Showcase demonstrators visibly, accessibly and collaboratively.	Initiate a procurement process for demonstrators. Showcase characterization of the site geology at the selected demonstrator sites. Showcase site feasibilities and environmental assessments. Undertake a standard bore well operation cycle, documenting steps for the purposes of building 'how-to' awareness of the geothermal project process. Organise, undertake and report on a series of public engagement activities to build awareness and understanding with the geothermal demonstration projects within the locale. Build a proof of concept model and simple geothermal value proposition.	DfE(with GSNI)	<u>Shallow project</u> Phase 1: Subsurface Quarter 2, 2022- Quarter 4 2023 Phase 2: Detailed system design Quarter 1, 2023- Quarter 3, 2023 Phase 3: Construction/ network Quarter 1 2024 <u>Deep project</u> Phase 1: Subsurface geophysics assessment, feasibility and institutional preparatory work Quarter 3, 2022- Quarter 2 2024 Phase 2 Drilling Quarter 3 2024- Quarter 3 2025
Develop NI geothermal sector roadmap.	Roadmap timeline for geothermal adoption in NI, including geothermal regulations (instructing primary legislation on geothermal and heat networks), secondary legislation, supporting research and demonstration, along with wider enabling policy actions.	DfE(with GSNI)	Call for Evidence Quarter 3 2019 NI Geothermal potential Quarter 1 2021 Sector research Quarter 1 2022- Quarter 3 2023 NI Geothermal Energy Week Quarter 2 2022 Geothermal Vision Quarter 2 2022 Roadmap Quarter 3 2022- Quarter 2 2023 Roadmap consultation Quarter 3 2024 Policy actions Quarter 4 2024 Instructing for primary legislation Quarter 3 2024 – Quarter 4 2024

Figure 29 – Enacting Sector Vision at Project Demonstrator Level (Source: Adapted from Oil and Gas Sector)

APPENDIX 1: TIMELINE OF BACKGROUND TO NI GEOTHERMAL ENERGY WEEK

- **8th January 2020:** New Decade New Approach agreement committing to; strategies to reduce carbon emissions in light of the Paris Climate Change Accord, a new Energy Strategy, a Climate Change Act, an Independent Environmental Protection Agency, an Economic Strategy to support the Green New Deal and a new incentive scheme to effectively cut carbon emissions.
- **3rd February 2020:** Announcement of a Climate Emergency by the NI Executive.
- **During February 2020:** DfE Call for Evidence workshops held across the month, which high-lighted that 50% of our total final energy consumption in 2017 was for heat generation.
- **3rd April 2020:** DfE Call for Evidence closed.
- **30th June 2020:** DfE Energy Strategy Call for Evidence Summary Report was published. In total, 73% of submissions replied to Chapter 6: Heat and over 22% of submissions replied specifically to Q23 relating to geothermal.
- **19th May 2020:** Energy Strategy Heat Working Group was formed by the Department for the Economy.
- **11th December 2020:** Build Back Better: Geothermal Energy for NI virtual conference, which was attended by approximately 320 people.
- **13th March 2021:** Geothermal for NI monthly webinar series launched. To date there has been 15 webinars with over 1500 attendees in total spanning four continents.
- **31st March 2021:** DfE Consultation on Policy Options for the new Energy Strategy for Northern Ireland was published.
- **2nd July 2021:** DfE Consultation on policy options closed.
- **8th July 2021:** Formation of the Geothermal Advisory Committee (GAC).
- **26th October 2021:** The Green Growth Strategy 10 commitments from the NI Executive launched.
- **26th November 2021:** Joseph Ireland brings a proposal for a 2-day geothermal conference for NI (#geothermalready) to GAC for consideration and approval granted.
- **16th December 2021:** Publication of the new DfE Energy Strategy for NI - the Path to Net Zero Energy which suggests running demonstrators to decarbonise heat using sources including geothermal.
- **13th January 2022:** GAC sub-committee meets to review geothermal conference proposal. Agreement reached on changing to a geothermal week consisting of between 2 & 2-1/2 days engagement across the week commencing 13th June 2022.
- **22nd January 2022:** The Energy Strategy 22-point action plan for delivery published on, point 16 of which commits to developing and commencing delivery of a geothermal demonstrator project.
- **28th January 2022:** First draft of #NIGeothermalWeek schedule reviewed by GAC (schedule based on JMW Spectrum of Conversations model see next section).
- **25th February 2022:** Stakeholder list and #NIGeothermalWeek event planner reviewed at GAC meeting. DfE commission Professor Mark Palmer, QUB, to complete a report on the development of the geothermal sector in NI.
- **9th March 2022:** Royal Assent for Climate Act (NI) with net zero delivery targets by 2050.
- **1ST April 2022:** Professor Mark Palmer presents part 1 preliminary report findings on the development of the geothermal sector in NI to the GAC. Stakeholder list for #NIGeothermalWeek agreed and field trip plan reviewed.
- **29th April 2022:**Professor Mark Palmer presents part 2 preliminary report findings on the development of the geothermal sector in NI to the GAC. Field trip attendees list reviewed and plans made to invite stakeholders for #NIGeothermalWeek.
- **27th May 2022:** Professor Mark Palmer submits report on the development of the geothermal sector in NI to the GAC for feedback. Joseph Ireland conducts virtual geothermal energy week conference walk through for final input.
- **13th – 17th June 2022:** #NIGeothermalWeek.

APPENDIX 2: ACKNOWLEDGEMENTS AND METHODOLOGY FOR NI GEOTHERMAL ENERGY WEEK

Acknowledgements

This report was commissioned by and compiled for the Northern Ireland Department for the Economy. To produce this report, we would like to thank Mrs Sharon Clements, Geothermal Policy Head, Department for the Economy, Dr Marie Cowan and Dr Robert Raine from the Geological Survey of Northern Ireland (GSNI), along with the other members of the Geothermal Advisory Committee that kindly provided peer-review feedback. We would like to also thank Alexander Donald at the British Geological Survey (BGS) and Ellen Green for their creative design contributions.

Circular Policy Methodology

Market confidence can be built in the 'journey-making' of policy practice. To that end, NI Geothermal Energy Week draws upon a range of theoretically informed approaches – some generate policy space (i.e. temporary spatial clusters), or direct and explore issues 'on the ground' (i.e. grounded approach), render and organise data (i.e. conversation mapping, casual mapping), some add verification and validation through peer-review (i.e. systems thinking and acceptance), as well as 'link in' across realms (i.e. expert panels, round tables, field trips, workshops, citizen participation, webinars) and enhance reporting through governance processes (i.e. clarification and vindication through committees). Undertaken prior to public policy consultation practice, this approach enables the iterative emergence of policy, with the cycling between peers, national and international comparisons, and a comparison of the feedback in a circular way. We refer to this combinatory approach as the Circular Policy Methodology (CPM). A synthesis of report research findings can also be used to generate the dialogues for the roundtable discussions. This can be supplemented with the Delphi Method to build consensus among a group of experts about a particular topic.[43] [44]We believe that the techniques contained within offer the potential to enhance the sharing, connecting, embedding, and co-creating between stakeholder communities as outlined in the N.I. Diamond framework. It provides, moreover, a mechanism for collaborative decision-making, for making shared, robustly defended, broadly considered decisions. This appendix now provides a brief overview of the techniques followed.

Temporary spatial clusters (TSC). The Circular Policy Methodology sought to create 'policy space'. Increasing stakeholder coordination through clustering events, such as NI Geothermal Energy Week, allows policymakers to explore not only information spaces for

[43] Turoff, M. (1970) The design of a policy Delphi. Technol. Forecast. Soc. Change, 2, 149–171.
[44] Bolger, F. and Wright, G. (2011) Improving the Delphi process: lessons from social psychological research. Technol Forecast. Soc Change, 78, 1500–1513.

fact finding (policy information space) but also searching for answers (policy solution space, best practice), needed for problem-solving tasks. [45] [46] TSCs as the basis of policy-making is not new but holistic reporting on this activity in practice is sparse.[47]

Strategy workshop design. The Circular Policy Methodology draws on the defining characteristic of strategy workshop design thinking – evident as an 'away-day' – that remove proceedings from everyday instituted routines. A common view is that feature frees up participants and policymakers from the habitual strictures – their institutions – that may hinder authentic strategic conversations on a raft of related issues such as visions, policy, projects, roadmapping etc. Research finds a positive association with neutral venues and also between the breadth of stakeholder involvement and improved interpersonal relations among workshop participants. NI Geothermal Energy Week's co-design supports the idea that building social cohesion among decision makers is an essential function of system-wide change transitions.[48]

Grounded approach. The Circular Policy Methodology is guided by a grounded approach, which allows for flexibility or leeway in the emergence of issues.[49] Rather than being committed to an existing template, or frame of reference, the circular policy methodology foregrounds open-ended questions, with latitude for exploring different policy issues, while structure is bracketed with the themes of 'opportunities', 'risks' and 'other issues'. This grounded 'bottom-up policy-making model' research mitigates against the 'blind spots' that can emerge in policy implementation and that can impede decision-making practice. The Circular Policy Methodology effectively integrates elements of both bottom up and top-down approaches. Further insight is then obtained by 'zooming out' with conversation mapping techniques and 'zooming in' with causal mapping between the conversation issues and through switching between the lenses.[50] [51] Conversation and casual mapping procedures exemplify techniques that can achieve stakeholder integration.

> **Conversation mapping.**[52] By eliciting the views within the workshop spaces, the circular policy methodology attempts to listen to and understand the diversity of stakeholder opinion generated from the round table discussions. Conversation

[45]Palmer, M. Medway, D. Warnaby, G. (2017), Theorising temporary spatial clusters and institutional boundary-work in industrial marketing, Industrial Marketing Management, 61, p.104–113.
[46] Shore, J. Bernstein, E. Lazer, D. (2015), Facts and Figuring: An Experimental Investigation of Network Structure and Performance in Information and Solution Spaces. Organization Science, 26, pp.1432-1446.
[47] Shaw, D. (2003), Mapping knowledge in groups. In: Edwards JS (ed). Proceedings of Knowledge Management Aston Conference. Operational Research Society: Birmingham, UK, pp 363–374.
[48] MacIntosh, R.,D. MacLean andD. Seidl (2010), 'Unpacking the effectivity paradox of strategy workshops: do strategy workshops produce strategic change?' In D. Golsorkhi, L. Rouleau, D. Seidl and E. Vaara (eds), The Cambridge Handbook of Strategy as Practice, pp. 291– 309. Cambridge: Cambridge University Press.
[49] Strauss, A.L., Corbin. J. (1990), Basics of qualitative research: Techniques and procedures for developing grounded theory. Thousand Oaks, CA: Sage.
[50] Huff, A. (1990), Mapping strategic thought. John Wiley and Sons. Chichester.
[51] Eden, C. (1992), On the nature of cognitive maps. Journal of Management Studies, 29, pp. 261–265.
[52] Harris, R.V., Dancer, J.M., Smith, D. and Campbell, S. (2009), The use of conversation mapping to frame key perceptual issues facing the general dental practice system in England. Community Dental Health, 26, pp. 84-91

mapping brings out a visual mapping and representation of the issues (i.e. whiteboards and flipcharts), particularly where variances are generated from that diversity as those can be root-cause of the core policy issues.[53]

Casual mapping.[54] It is also desirable to integrate stakeholders' own words to ensure grouping at the basic level – categorization. Casual mapping reveals the causal connections between entities on an issue.[55] Through identifying causality between the issues, the policy makers are able to learn more about the relationship between the issues to inform their decision making activities.[56] Similarities between categories reduce the number of categories and enables understanding of the main vision dimensions along which similarity exists.

Peer-review driven. A key part of the Circular Policy Methodology is providing a structured, managed, and collaborative practice of peer-review whereby reputable others are invited to feedback on ideas, proposals and practice. [57] Part of the 'journey making' involves peers having dialogues, committee link-in opportunities, policy spaces and sharing information whilst following a methodology.[58] We observe that the NI Department for the Economy Geothermal Advisory Committee members were invited to peer-review all of the inputs and outputs from NI Geothermal Energy Week. Internationally, the Director of the International Geothermal Association, the President of the European Geothermal Energy Council and the Executive Director, Geothermal Rising, USA were all in attendance at NI Geothermal Energy Week and were invited to provide peer round table feedback. Internationally, there are examples from Organisation for Economic Co-operation and Development (OECD) and Urban Development Network (UND) in terms stakeholder, peer and community engagement.

OECD peer review. OECD has developed its review approach to promote co-operation, development and economic growth.[59] The approach a four-stage process – (1) Plan and define the area of study, (2) Collect, structure and evaluate data, (3) Review and revaluate policy domains to identify effective approaches, (4) Report.[60]

[53] Root cause analysis (RCA) is a framework for structured investigations. Nicolini, D., Waring, J. and Mengis, J. (2011), The challenges of undertaking root cause analysis in health care: A qualitative study, Journal of Health Services Research & Policy, 16, pp. 34-41
[54] Markóczy, L., Goldberg, J. (1995), A method for eliciting and comparing causal maps. Journal of Management, 21, 305-333.
[55] Hodgkinson, G. P., & Sparrow, P. R. 2002. The competent organization: A psychological analysis of the strategic management process. Buckingham: Open University Press.
[56] Shaw D, Ackermann F and Eden C (2003), Approaches to sharing knowledge in group problem structuring. J Opl Res Soc 54, 936–948.
[57] Nicolini, D., Hartley, J., Stansfield, A. and Hurcombe, J. (2011), Through the eyes of others: Using developmental peer reviews to promote reflection and change in organizations, Journal of Organizational Change Management, 24 pp. 211-228.
[58] Edwards JS, Collier PM and Shaw D (2003), Making a journey in knowledge management strategy. Journal of Information Knowledge Management 2, pp. 135–152.
[59] Pagani, F. (2002), Peer Review as a Tool for Co-Operation and Change. African Security Review 11(4), 15–24.
[60] OCED (2003) Peer Review: An OECD Tool for Co-operation and Change. Paris: OECD Publishing.

Urban Development Network (UDN). UDN connects 500 EU cities responsible for *"implementing integrated actions based on Sustainable Urban Development strategies"* (European Commission). The UDN peer review approach promotes dialogue that addresses issues sustainable urban development, for example flood defence and control (See Figure 30).[61]

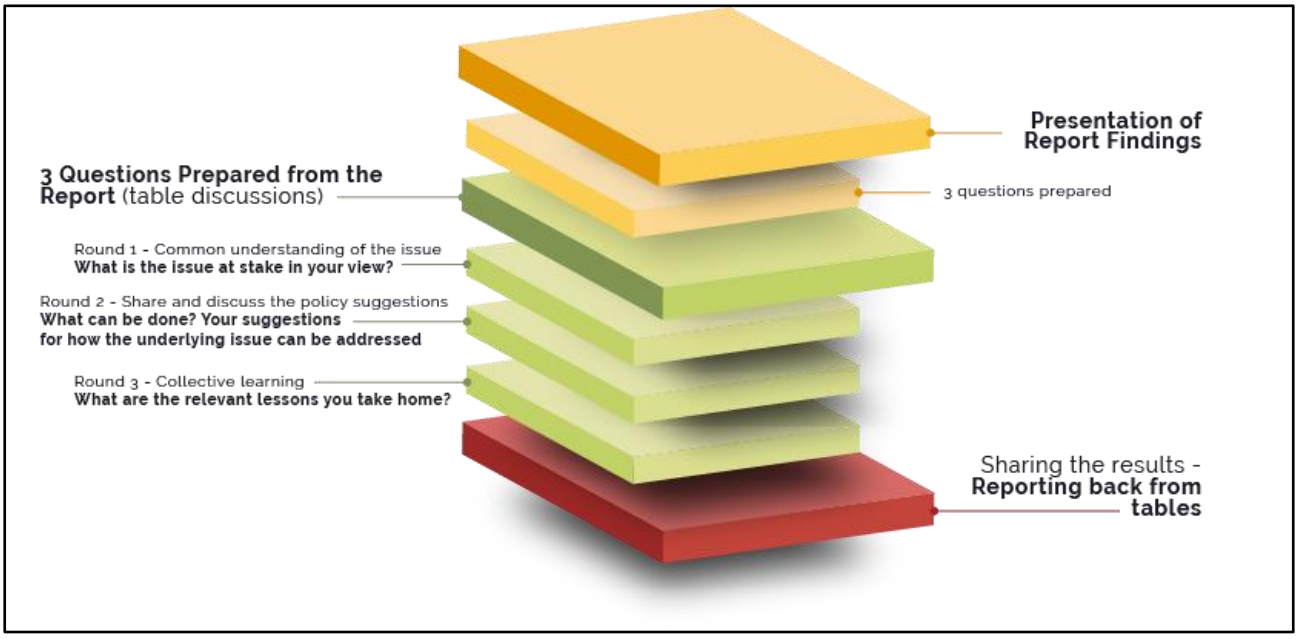


Figure 30 - UDN Illustration of question-led dialogues

Source: Adapted from Shaw et al. (2020)[62]

Reports, reporting and evaluation. Producing the report constitutes a critical step in the Circular Policy Methodology. The sharing of supplemental material in the report format provides insight into policy-making engagement practice. The latest development in reporting innovation is integrated reporting – the circular, a reporting approach that is supported internationally with a range of institutes, amongst others, the International Integrated, Reporting Committee (IIRC),[63] the Global Reporting Initiative (GRI),[64] The World Business Council for Sustainable Development,[65] The World Resources Institute,[66] and the Carbon Disclosure Project.[67] This reporting practice helps support industrial policy evaluation of NI Geothermal Energy Week: to establish its impact; to inform the allocation of funding to policy measures; to demonstrate value for money; to stimulate stakeholder debate about

[61] UNDRR (2018), European Cities Pioneer DRR Peer Review. Available at: https://www.unisdr.org/archive/60918 (Accessed: 20 July 2022).
[62] Shaw, D., Fattoum, A., Moreno Romero, J. & Bealt, J., Jun (2020) A structured methodology to peer review disaster risk reduction activities: The Viable System Review, International Journal of Disaster Risk Reduction. 46.
[63] https://www.integratedreporting.org
[64] https://www.globalreporting.org
[65]https://www.wbcsd.org
[66] https://www.wri.org
[67] https://www.cdp.net/en

forms of public intervention; and, to contribute to improvements in the design and administration of policy interventions. [68] Reporting in this way adds precision engagement evidence that only strengthens disclosure for those seeking background information and more depth on policy impact and engagement practice.

[68]Potter, J. & Storey, D. (2007), OECD Framework for the Evaluation of SME and Entrepreneurship Policy and Programmes. Paris OECD.

APPENDIX 3: OPENING PLENARY AND PANEL Q&A DISCUSSION

Northern Ireland Geothermal Energy Week
June 13–17

Defining the vision for geothermal energy in Northern Ireland

Programme

08:30 Registration and coffee.

Conference session
09:00 Welcome – Dr Niall McCormack, Chair, Geothermal Association of Ireland (GAI)
09:05 Opening Remarks – Prof. Ian Greer, Vice-Chancellor, Queen's University Belfast
09:10 Opening Remarks – Minister Gordon Lyons MLA, Department for the Economy
09:20 Dr Rob Raine, Energy Geologist, GSNI and Joseph Ireland, PhD researcher, QUB
09:35 Dr Marit Brommer, Director, International Geothermal Association (IGA)
09:50 Dr Miklos Antics, President, European Geothermal Energy Council (EGEC)
10:05 Dr Will Pettitt, Executive Director, Geothermal Rising (online)

Panel Discussion
10:20 Panel discussion chaired by Dr Marie Cowan, Director, GSNI

Panellists
· Richard Rodgers, Deputy Secretary, Head of Energy, Department for the Economy (DfE)
· Kevin Hegarty, Director of Green Growth and Climate Action, Department for Agriculture, Environment and Rural Affairs (DAERA)
· Dr Marit Brommer, IGA
· Dr Miklos Antics, EGEC
· Dr Will Pettitt, Geothermal Rising

11:00 Coffee/tea break

Roundtable Sessions
Each session includes 30 minutes roundtable discussions, 15 minutes break and 15 minutes feedback

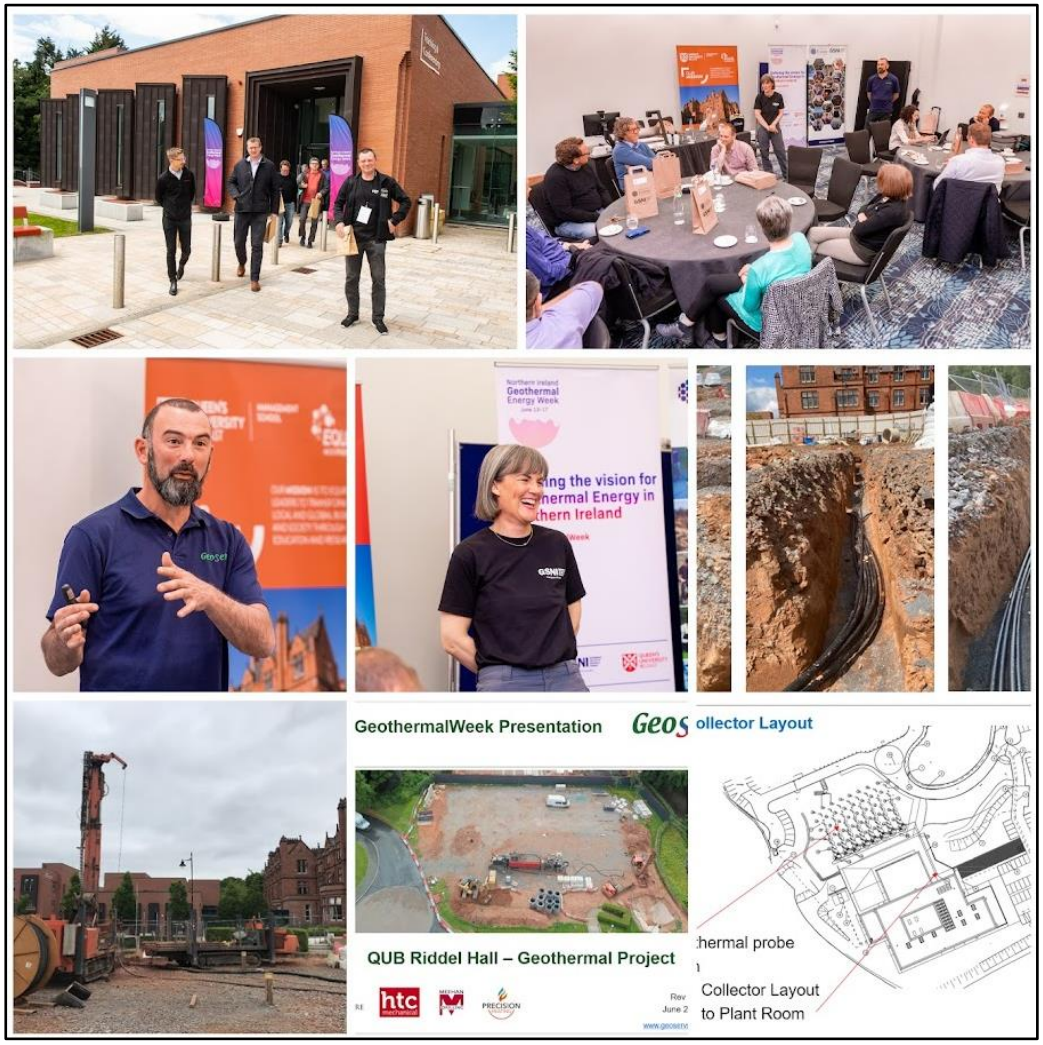
11:30 **Session 1: - Building the scaffolding for geothermal sector confidence.**
12:30 Networking Lunch
13:30 **Session 2: - Maintaining growth and momentum in the geothermal sector**
14:30 Coffee
15:00 **Session 3: - Sustaining industry via institutional carriers**
16:00 Plenary feedback, summary, and conference close

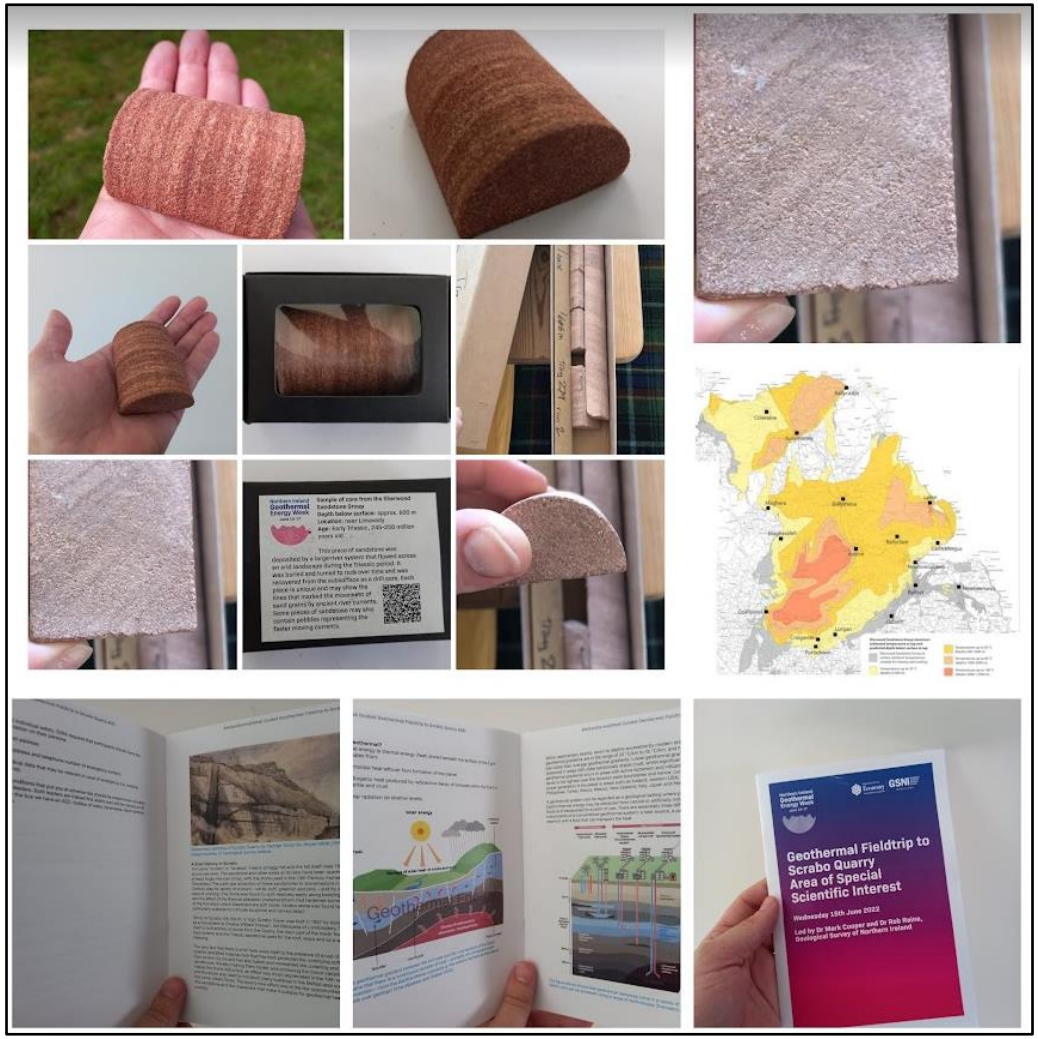
Department for the Economy | GSNI Geological Survey of Northern Ireland | Queen's University Belfast

Jointly organised by the Geological Survey of Northern Ireland (GSNI) and Queen's University, Belfast.

APPENDIX 4: ROUND-TABLE QUESTION-LED DIALOGUES WITH STAKEHOLDERS

APPENDIX 5: RIDDEL HALL PRESENTATION, SCRABO TOWER AND QUARRY ASSI FIELD TRIP

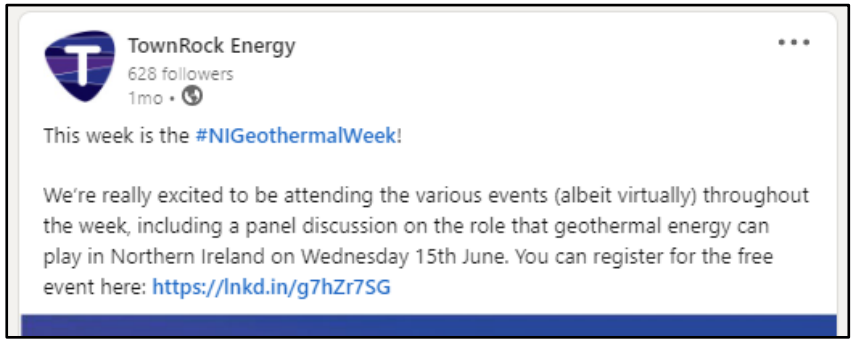


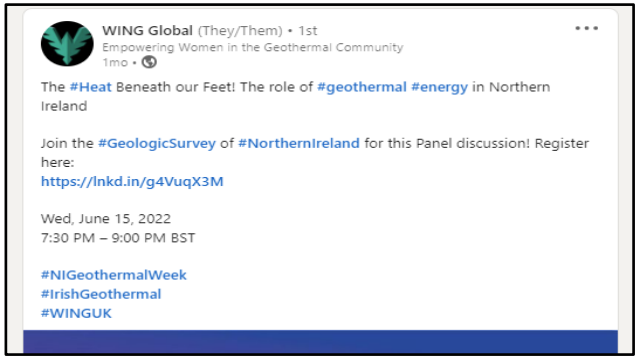



GSNI


McComb's

APPENDIX 6: LIVE VIRTUAL PANEL DISCUSSION

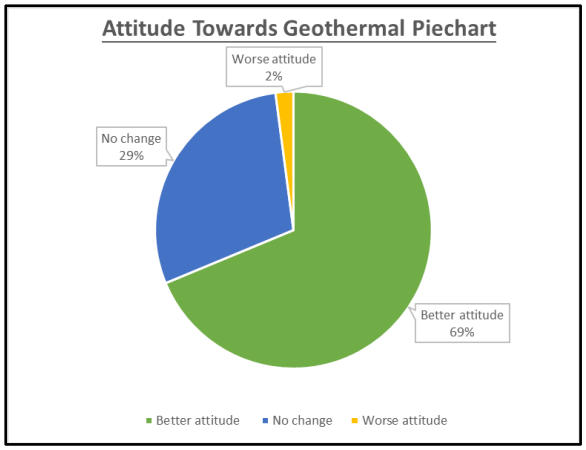


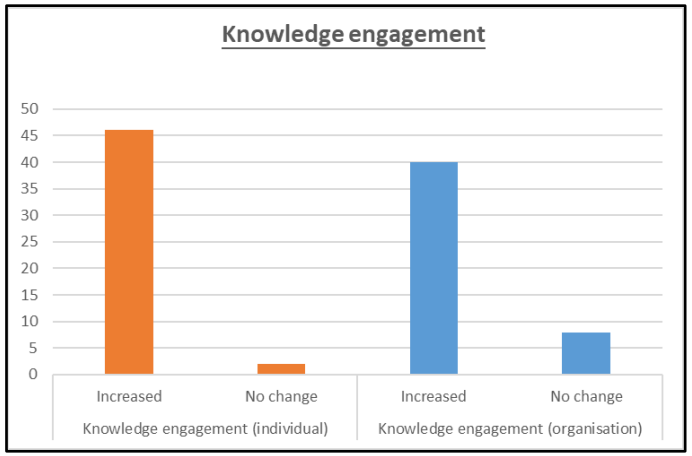


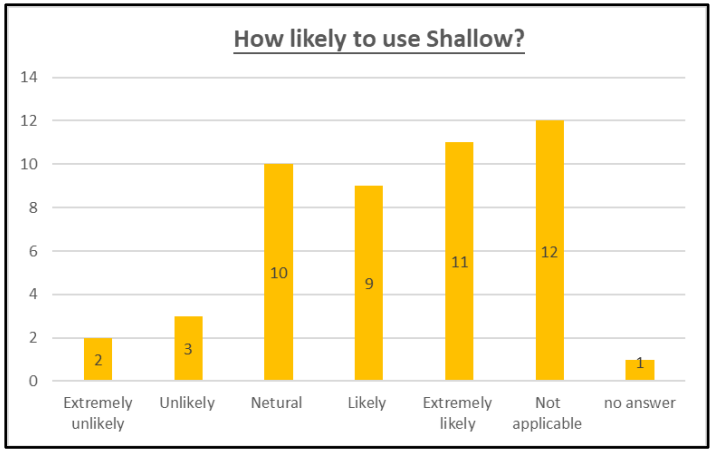
APPENDIX 7: DEFINING THE VISION FOR GEOTHERMAL IN NORTHERN IRELAND

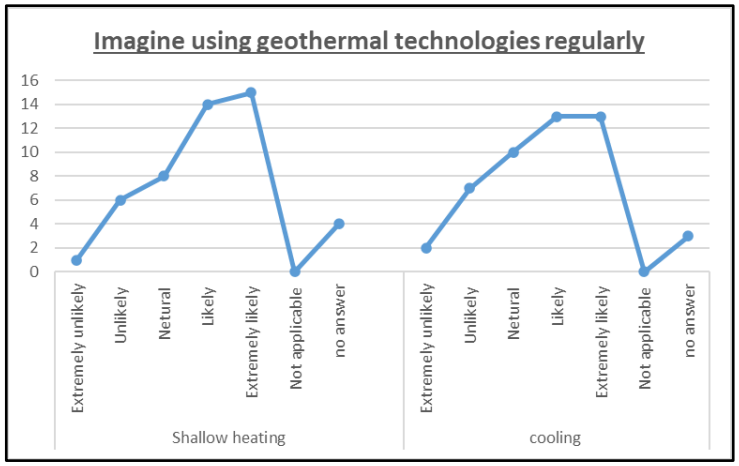
Collage of round table dialogue output synthesis process. Note: resolution deliberately lowered to keep input anonymous.

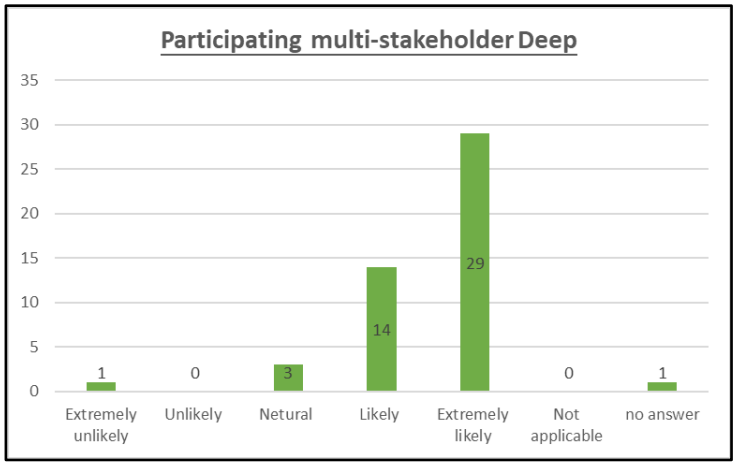
APPENDIX 8: QUESTIONNAIRE FEEDBACK FROM NI GEOTHERMAL ENERGY WEEK

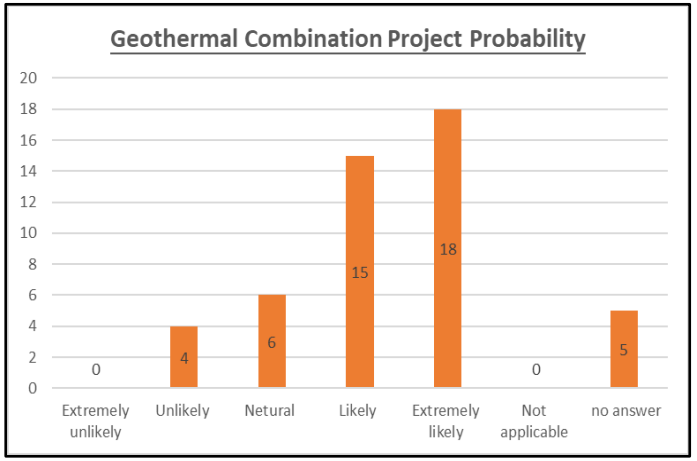




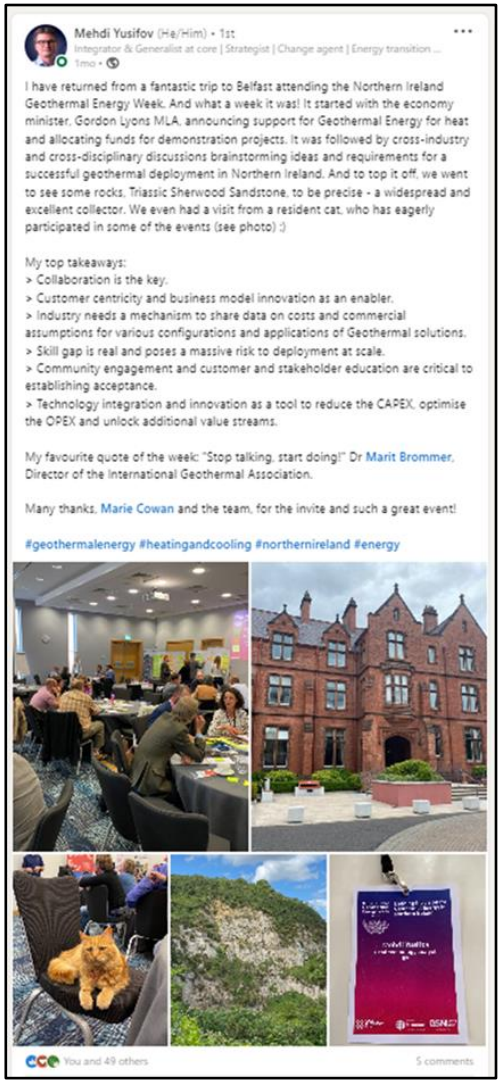


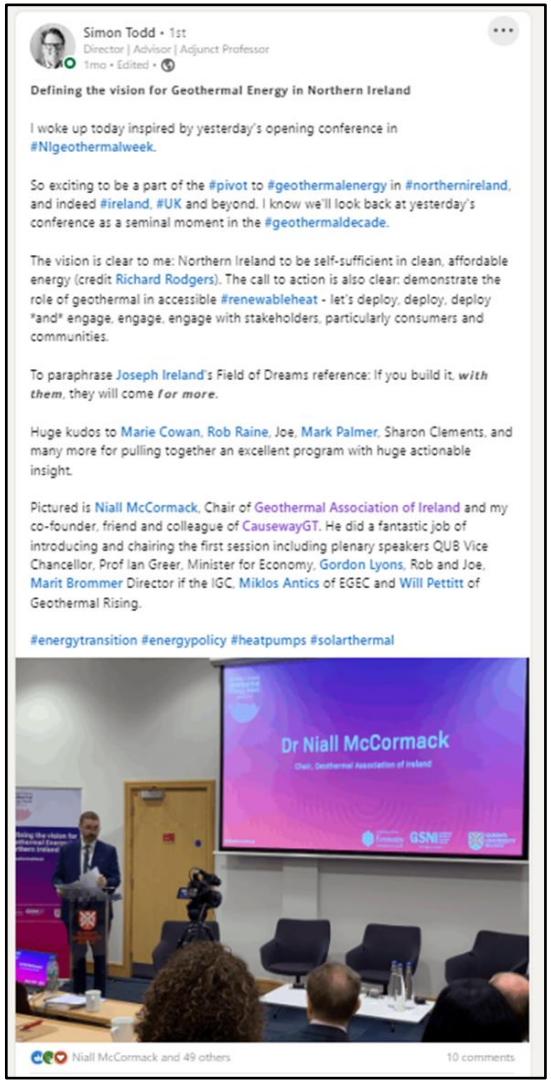


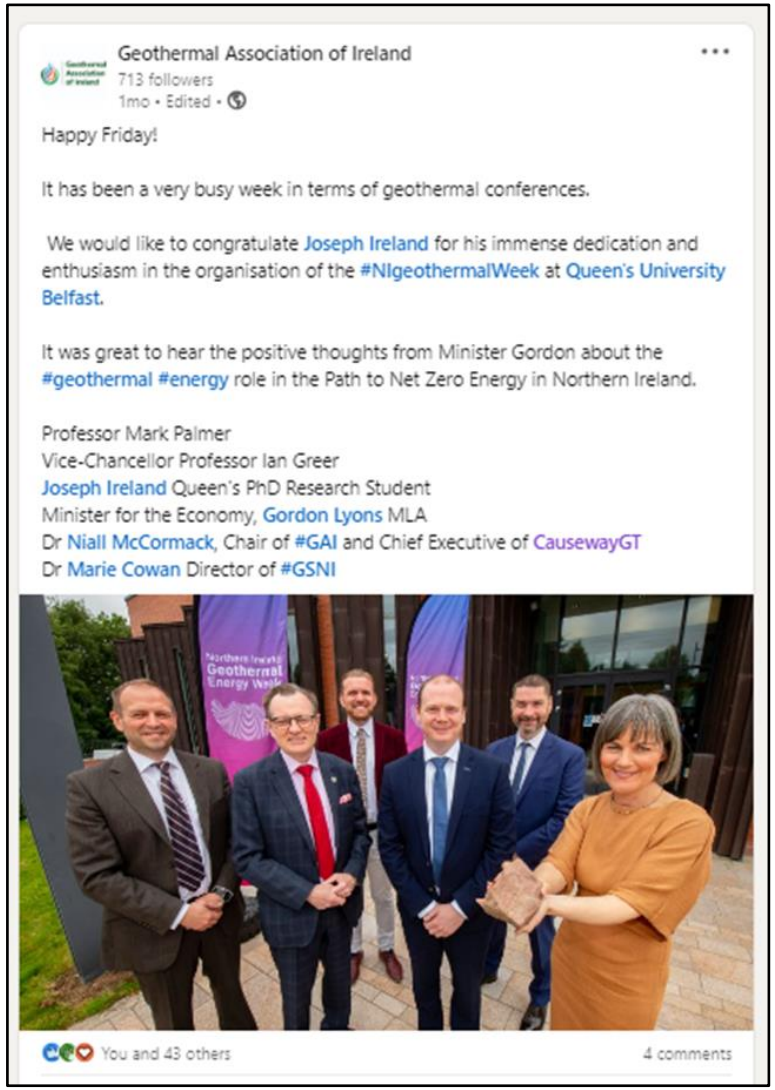




APPENDIX 9: ILLUSTRATIVE SOCIAL MEDIA LINKED-IN FEEDBACK FROM PARTICIPANTS







Illustrative examples of digital re-enactment of NI Geothermal Week

Gavin & Doherty Geosolutions (GDG)
6,388 followers
1mo • Edited •

Andrew Foster, Senior Project Manager at GDG, was invited to attend the kick off for #NIGeothermalWeek: Defining the vision for geothermal energy in Northern Ireland.

It was great to see such a positive statement from Minister Gordon Lyons, MLA, highlighting the role geothermal energy has to play as part of the Path to Net Zero Energy in Northern Ireland.

There was an informative expert panel discussion and an excellent selection of venue, as right outside Queen's University Belfast's Management School at Riddel Hall, there was ongoing construction of a shallow geothermal system.

#geothermal #geothermalenergy

Irene Pascual Perea and 14 others

Stephen Bielby • 1st
Operations Manager
1mo •

My last evening before I head back to the U.K. tomorrow. Had a great week being part of #NIGeothermalweek at Queen's University Belfast It's been a pleasure meeting and discussing the important role of Ground Source Heating.
#groundsourceheatpumps #energy #university #geothermal #gshp

You and 22 others 4 comments

Will Pettitt (He/Him) • 1st
Geothermal Discipline Lead, Baker Hughes
1mo •

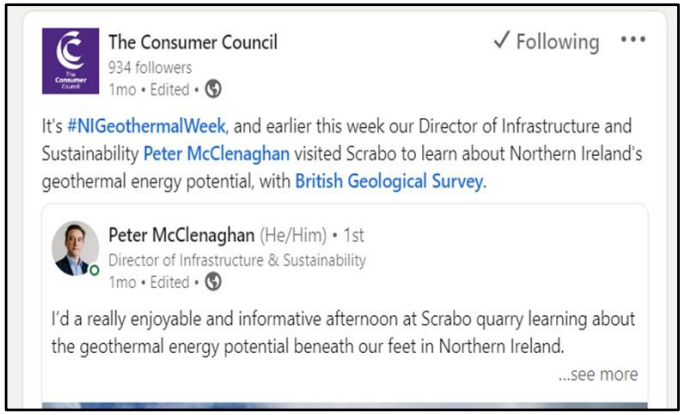
Recently had the great privilege to present on the use of Earth's Heat in the Energy Transition at the opening session of #NIGeothermalWeek. Here is the recording of the presentation. A successful transition over the coming decades needs all #geothermal technologies supplying 24/7 energy anywhere: power generation as we electrify; heat in industry and communities; heating and cooling in building efficiency; and long-term energy storage. Spoke on behalf of Geothermal Rising before moving to Baker Hughes.

Thanks so much to the organizers of the event, Mark Palmer, Joseph Ireland, Rob Raine, Marie Cowan, and Niall McCormack, and all the contributors to the presentation. Excited to see the evolution of geothermal energy use in Northern Ireland.

#UsetheEarthtoSavetheEarth #WeAreBakerHughes #energytransition

You and 42 others

Illustrative examples of digital re-enactment of NI Geothermal Week



Illustrative examples of digital re-enactment of NI Geothermal Week

Illustrative examples of digital re-enactment of NI Geothermal Week

APPENDIX 10: BUILDING GEOTHERMAL AWARENESS IN THE MEDIA CHANNELS

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Geothermal energy could be key to unlocking a greener economy

GEOTHERMAL energy could be the key to unlocking new energy sources to help meet net zero greenhouse gas emissions by 2050.

That's according to research from Queen's University Belfast where Professor Mark Palmer and Joseph Ireland have been working on a new landmark report for the Department for the Economy and the Northern Ireland Geothermal Advisory Committee.

The report, Net Zero Pathways: Building the Geothermal Energy Sector in Northern Ireland, highlights that building the geothermal energy sector can help transition Northern Ireland towards a low-carbon future and create an emerging market.

Future geothermal energy use is considered key in decarbonising Northern Ireland's heat sector as it is a clean and naturally occurring source of energy. It uses the natural subsurface as a source of heat and has the potential to provide cooling and seasonal storage of energy.

Launched as part of Northern Ireland Geothermal Energy Week, the Queen's University report offers detailed recommendations for the way forward and focuses on the confidence-building actions needed to unlock the opportunities for energy from geothermal heating and cooling.

> There is a real positive opportunity for portfolio-driven energy market-making here

Professor Palmer from Queen's Management School commented: "Despite over forty years of geological evidence gathering, which confirms that Northern Ireland has favourable geological conditions for geothermal activity, the findings of our report show an absence of awareness and visibility of the geothermal project activity on the ground. There is a real positive opportunity for portfolio-driven energy market-making here."

Economy Minister Gordon Lyons said: "One of the guiding principles of my 10X economic vision is to support a greener, sustainable economy. With our globally recognised track record in advanced manufacturing and engineering, I am excited by the prospect of harnessing carbon-neutral energy sources such as geothermal energy."

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Stormont search for geothermal energy is on as experts study estate and Co Antrim location

Parliament Buildings in Stormont, Belfast. Picture by Peter Morrison

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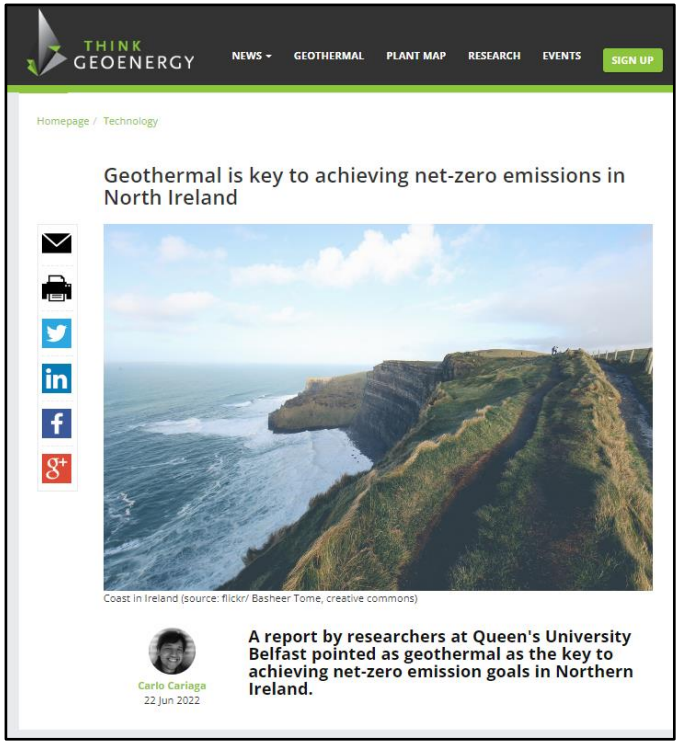
Geothermal energy could be "invisible key" to unlock new energy sources

23 June, 2022

Geothermal energy could be the "invisible key" to unlock new energy sources and help meet net zero greenhouse gas emissions by 2050, according to Queen's University Belfast researchers.

Pictured left to right: Professor Mark Palmer from Queen's Management School; Queen's University's Vice-Chancellor Professor Ian Greer; Mr Joseph Ireland from Queen's University's School of Natural and Built Environment and Queen's Management School; Economy Minister Gordon Lyons; Dr Niall McCormack, Chief Executive and Managing Director of Causeway GT and Chair of the Geothermal Association of Ireland and Dr Marie Cowan, Director of the Geological Survey of Northern Ireland (GSNI).



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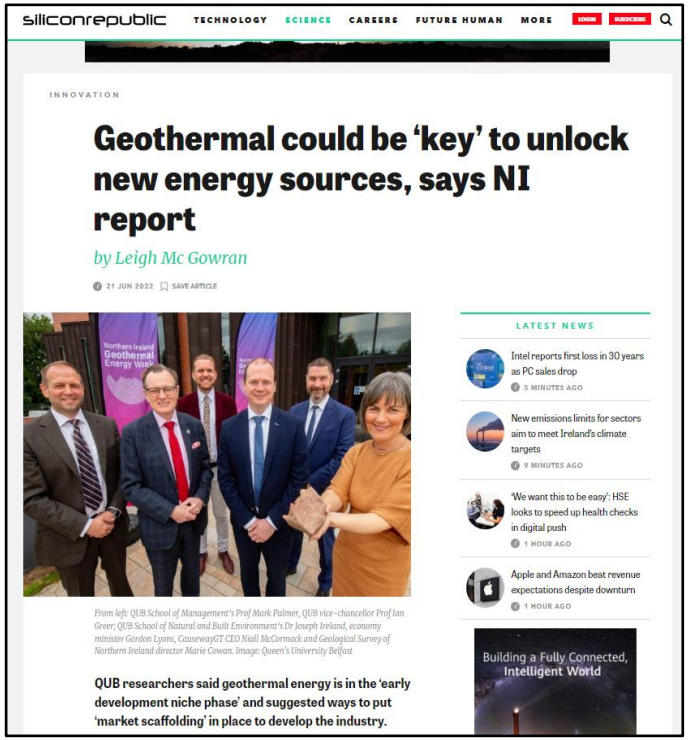
Geothermal is key to achieving net-zero emissions in North Ireland

Coast in Ireland (source: flickr/ Basheer Tome, creative commons)

Carlo Cariaga
22 Jun 2022

A report by researchers at Queen's University Belfast pointed as geothermal as the key to achieving net-zero emission goals in Northern Ireland.



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INNOVATION

Geothermal could be 'key' to unlock new energy sources, says NI report

by Leigh Mc Gowran

21 JUN 2022 SAVE ARTICLE

From left: QUB School of Management's Prof Mark Palmer, QUB vice-chancellor Prof Ian Greer; QUB School of Natural and Built Environment's Dr Joseph Ireland, economy minister Gordon Lyons, CausewayGT CEO Niall McCormack and Geological Survey of Northern Ireland director Marie Cowan. Image: Queen's University Belfast

QUB researchers said geothermal energy is in the 'early development niche phase' and suggested ways to put 'market scaffolding' in place to develop the industry.

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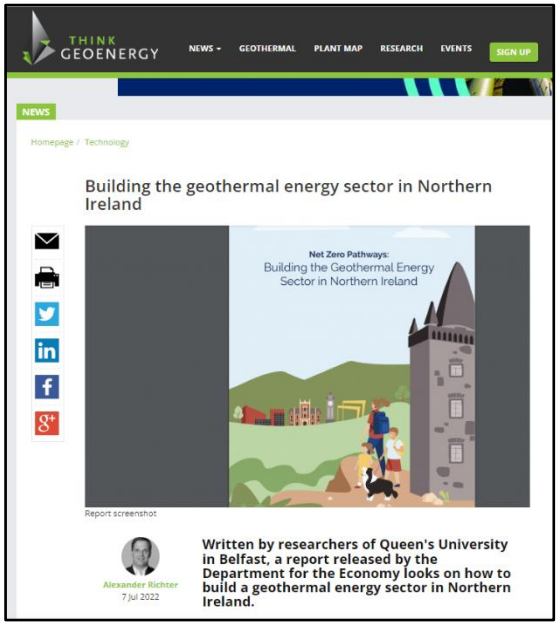
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Building the geothermal energy sector in Northern Ireland
Net Zero Pathways:
Building the Geothermal Energy Sector in Northern Ireland
Report screenshot
Alexander Richter
7 Jul 2022
Written by researchers of Queen's University in Belfast, a report released by the Department for the Economy looks on how to build a geothermal energy sector in Northern Ireland.


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Report details Northern Ireland geothermal opportunity and next steps
June, 2022
Krafla Power Plant in Iceland.
A new report for the Northern Ireland Geothermal Advisory Committee outlines the opportunities presented by geothermal energy for helping the country transition to net zero greenhouse gas emissions by 2050.
Prepared by researchers from Queen's University Belfast, the report offers detailed


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Geothermal energy could be 'invisible key' to unlock new power sources
By Steven Moore June 26, 2022
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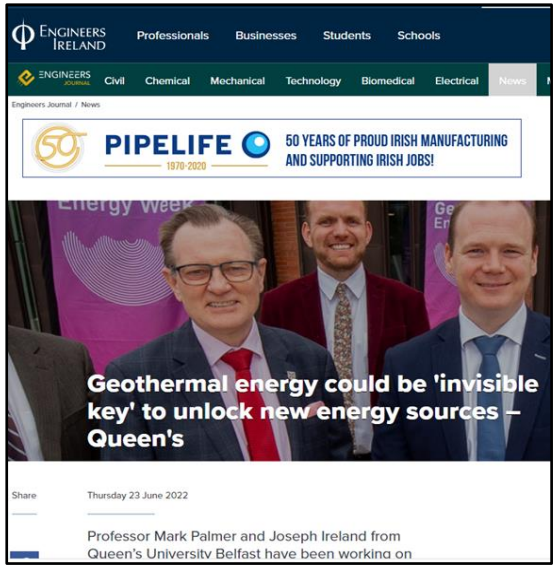
Geothermal energy could be the "invisible key" to unlock new energy sources and help meet net zero greenhouse gas emissions by 2050, according to Queen's University Belfast researchers.


Summer 2022 | Issue 6
2
Note from the Chair Continued
Also speaking at the kick-off of Geothermal Week was vice-chancellor Prof Ian Greer of Queen's University, who hosted the event. Queens and Trinity College in Dublin are leading the way with deployments in the new Business School at Ridell Hall and in the refurbishment of the Rubrics building respectively. These deployments demonstrate how geothermal can be effectively deployed in sensitive environments and deliver long term sustainable energy. Following Geothermal Week, a key report "Net zero pathways - building the geothermal energy sector in Northern Ireland" authored by Prof Mark Palmer, Joe Ireland, Dr Ulrich Ofterdinger and Min Zhang was publish.
Niall McCormack (Chair GAI), Ric Pasquali (Vice Chair GAI and the one actually working) & Joe Ireland (Secretary GAI) at Trinity College geothermal deployment.
Net Zero Pathways:
Building the Geothermal Energy Sector in Northern Ireland
The report concludes that the geothermal sector in Northern Ireland is presently in an early development niche phase and invites the geothermal shaper community to build a niche strategy, while putting in place the market scaffolding and also showcasing geothermal buildability. The authors highlight that creating the geothermal transition must be accessible, fair and without adverse effects on peoples' jobs and quality of life. The report puts forward several considerations for building the market scaffolding and outlines a holistic perspective for showcasing flagship geothermal projects.
You can access the short and long versions of the report at:
www.economy-ni.gov.uk/publications/net-zero-pathways-building-geothermal-energy-sector-northern-ireland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Geothermal energy could be 'invisible key' to unlock new energy sources – Queen's
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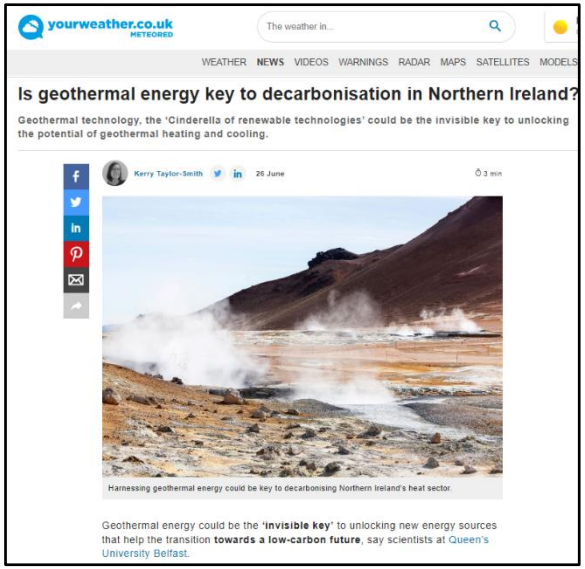
Thursday 23 June 2022
Professor Mark Palmer and Joseph Ireland from Queen's University Belfast have been working on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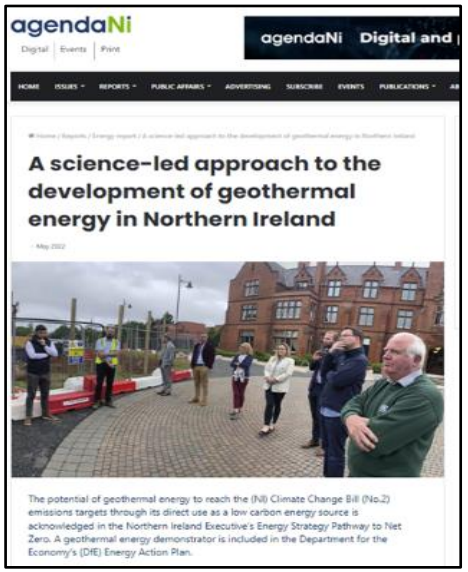
Is geothermal energy key to decarbonisation in Northern Ireland?
Geothermal technology, the 'Cinderella of renewable technologies' could be the invisible key to unlocking the potential of geothermal heating and cooling.
Kerry Taylor-Smith
26 June
3 min
Harnessing geothermal energy could be key to decarbonising Northern Ireland's heat sector.
Geothermal energy could be the 'invisible key' to unlocking new energy sources that help the transition towards a low-carbon future, say scientists at Queen's University Belfast.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A science-led approach to the development of geothermal energy in Northern Ireland
The potential of geothermal energy to reach the (NI) Climate Change Bill (No.2) emissions targets through its direct use as a low carbon energy source is acknowledged in the Northern Ireland Executive's Energy Strategy Pathway to Net Zero. A geothermal energy demonstrator is included in the Department for the Economy's (DfE) Energy Action Plan.

Department for the Economy
www.economy-ni.gov.uk

GSNI Geological Survey of Northern Ireland