3rd Call 2021 (Joint with SES)

1. Galleries to Calories (G2C)

Galleries to Calories (G2C) demonstrates for the first time the use of legacy mine workings as recycled heat storage and transport networks to provide managed sustainable regional recharge of low enthalpy (< 40°C) geothermal heat present naturally in the subsurface, to make it available for regional heat pump extraction. G2C demonstrates the storage, transport, and recycling of waste industrial heat in extensive legacy mine workings southeast of Edinburgh, Scotland, and assesses its potential application in European and US coal and mineral mines.

A primary aim of G2C is to install a field test site where the hydraulic and heat transport characteristics of the legacy mine workings can be investigated in detail through the provision of both an injection and extraction borehole at two different locations within the mine workings, and the establishment of a demonstration of the technology. The project design is based around the need to provide a working prototype of up to 9 MW of cooling for a national computer facility. The heat geobattery concept is that the cooling is provided using mines water in a closed loop heat exchanger at the surface, and an open loop heat exchange in the mine workings. Once this heat is distributed and stored in the subsurface, various heat pump technologies in different surface geographical locations can be employed to recover it. The recycled heat will augment the natural geothermal heat present and sustainably replenish the natural heat extracted through the heat mining using heat pump technology.

Static heat storage in mine workings and various aquifer thermal storage schemes is currently state-of-the-art and either being investigated or trialled at a local scale in a number of countries (e.g., Verhoeven et al., 2014; Adams et al., 2019; Bao et al., 2019; Monaghan et al., 2021; Walls et al., 2021). Additionally, there are several examples of mine water discharge from legacy mine workings being used by community and small district-scale developments to heat 10s - 100s of properties. The fundamental issue is that although the amount of low-grade geothermal heat present in the subsurface is extensive, the resource is the result of thousands of years of heat conduction from deep within the earth and storage, influenced by the prevailing paleo-surface temperature conditions. The actual deeper subsurface heat recharge rate or outward heat flux is of the order of mW/m2.

G2C undertakes a full feasibility study of heat injection and subsurface transport, including in-depth geological, hydrogeological and geochemical site characterisation, quantitative assessment of the dynamic processes initiated by the widespread temperature changes to the subsurface, assessment of the sustainable thermal resource management for different development scenarios, determination of the best techniques for monitoring heat distribution, development of socially based economic models, investigation into the legal aspects of subsurface heat ownership as a basis for facilitating the establishment of equitable and sustainable business models and technical consideration of its wider application to European and US coal and mineral mines.

Project Coordinator: Prof. Dr Christopher McDermott, University of Edinburgh (UoE)

Partners: TownRock Energy (TRE), University of Strathclyde (UoS), Lawrence Berkeley National Laboratory (LBNL), Idaho National Laboratory (INL), Sandown Ltd (SNDWN), Scene Connect (SCENE).

Cooperation partners: British Geological Survey (BGS), Clyde Gateway (CG), Coal Authority (CA), Edinburgh Parallel Computing Centre EPCC, Midlothian Energy, Scottish Environmental Protection Agency (SEPA)

Start date September 1st 2022, 36 month duration

Total value of the project: €3,358,401

Total funding to Irish partners from GSI: €76,264

2nd Call 2020

1. Enhancing REServoirs in Urban deveLopmenT: smart wells and reservoir development (RESULT)

For clean cities (mission horizon Europe) geothermal reservoirs are prospected to be developed in many urban areas with the intent of replacing fossil fuel fired heating. In many urban areas the development of geothermal reservoirs is challenging - even if the subsurface reservoir conditions are relatively well known. The main objective is to demonstrate the potential for increased performance by 30-100% of major (marginal) reservoirs for heating in urban areas in the northern EU.
RESULT achieves this by deploying 1) optimization methods and drill and learn strategies, 2) reservoirs models and uncertainty assessments, 3) best in class well technology options, 4) Reservoir Development Optimization in different settings in Europe. The innovative procedure and techniques will be 5) used and demonstrated in asset development and drilling a geothermal doublet.

Project Coordinator: Prof. Stefan Wiemer, Netherlands Organisation for Applied Scientific Research
Partners: Bochum University of Applied Sciences, International Geothermal, Centre (GZB)
Iceland Geosurvey, Reykjavik Energy, Huisman, ENGIE, Gavin & Doherty Geosolutions, Rheinisch-Westfaelische, Technische Hochschule – GIA
Cooperation partners: RWE POWER AG
Start date Dec 1st 2020, 36 month duration
Total value of the project: €11,580,616
Total funding to Irish partners from GSI: €22,696

2. Innovation for De-Risking Enhanced Geothermal Energy Projects (DEEP)

The Nov. 2017 Mw 5.5 Pohang earthquake in South Korea induced during the reservoir creation phase of a deep geothermal energy project represents a major setback and tremendous challenge to future deep geothermal energy exploitation. Recent advancements in sensor technology, in combination with new machine learning based data analysis techniques, are opening up new horizons for the management of induced seismicity. The project DEEP aims to build and test the next generation of sensors and data analysis tools for induced seismicity monitoring, risk assessment and mitigation in real-time, with the final aim to to safely manage deep geothermal operations. We will demonstrate these new technologies and processing workflow at the Utah FORGE EGS site and transfer the technologies and software to other sites in Europe, for example to the Haute Sorne project in Switzerland

Project Coordinator: Prof. Stefan Wiemer, ETH-Zurich, Swiss Seismological Service
Partners: ETH-Zurich, Swiss Seismological Service, Lawrence Berkeley National Laboratory, University of Strasbourg, School and Observatory of Earth Sciences, Bochum University of Applied Sciences, International Geothermal Centre, University of Geneva, Institute, of Environmental Sciences, Dublin Institute of Advanced, Studies, GeoEnergieSuisse AG, University of Utah, Department of Geology & Geophysics, RWE Power AG
Start date Dec 1st 2020, 36 month duration
Total value of the project: €4,172,148
Total funding to Irish partners from GSI: €199,948

1st Call 2018

1. GEOURBAN

Identification and Assessment of Deep GEOthermal Heat Resources in Challenging URBAN Environments

The need to reduce greenhouse gas emissions is an important issue facing society at present. Appropriately designed, district-scale geothermal heating systems can satisfy society's "energy trilemma", by providing a secure energy supply that is economical and environmentally sustainable. The ability to use geothermal resources to generate heat in urban areas where the demand is greatest has the potential to significantly reduce our reliance on fossil fuels, and to support national and EU sustainable energy policies.

Potential deep geothermal resources in challenging, lower-enthalpy EU settings remain poorly understood and largely untapped. The GEO-URBAN project aims to explore the potential for low enthalpy geothermal energy in urban environments. The project will focus on two target locations – Dublin, Ireland and Vallès, Catalonia, Spain – and will provide a feasibility analysis for the commercial development of deep geothermal resources in these regions. Challenges to be overcome in these areas by GEO-URBAN include low- to medium-enthalpy geothermal settings, geological challenges due to the fractured nature of the bedrock in both regions (fractured limestone and metamorphic basement in Dublin, and fractured granite in Vallès), and logistical challenges for geothermal exploration due to the urban environment.

GEO-URBAN will evaluate novel geophysical exploration and modelling techniques for urban areas, which will be applied at both test locations. Geophysical data collected during GEO-URBAN will feed into a commercialisation strategy for the exploitation of deep geothermal resources in challenging urban environments, which will draw upon existing knowledge and experience from partners in Denmark, where the deep geothermal heat industry is more established. This knowledge transfer will be reciprocated by the cross-transfer of detailed geological and hydrological data on fractured limestone lithologies in Ireland, which are of interest as ultra-deep geothermal targets in Denmark and elsewhere in Europe.

Significant local stakeholder involvement will ensure that GEO-URBAN exploration activities align with local sustainable energy plans and district heating strategies. Furthermore, policy recommendations to assist the sustainable exploitation of deep geothermal energy resources in each region will be outlined.

The overall objective of GEO-URBAN is to identify the geothermal resources available in two challenging urban locations and to demonstrate a commercialisation strategy that has the potential to be adapted in other similar locations, thus advancing geothermal energy from a TRL 5 to a TRL 7 in the target areas.

Project Coordinator: Dr Sarah Blake, Gavin and Doherty Geosolutions Ltd

Partners: Universitat de Barcelona, Dublin City Council, University College Dublin/iCRAG, Dublin Institute for Advanced Studies, Barcelona Supercomputing Center

Cooperation partners: Geothermal Association of Ireland, Spanish Geothermal Technology Platform, Institut Cartogràfic i Geològic de Catalunya

Start date May 1st 2018, 36 month duration

Total value of the project: €737,233

Total funding to Irish partners from GSI: €289,550

2. COSEISMIQ

COntrol SEISmicity and Manage Induced earthQuakes

Over the last decade induced seismicity has become an important topic of discussion, especially owing to the concern that industrial activities could cause damaging earthquakes. Large magnitude induced seismic events are a risk for the population and structures, as well as an obstacle for the development of new techniques for the exploitation of underground georesources. The problem of induced seismicity is particularly important for the future development of geothermal energy in Europe, in fact deep geothermal energy exploitation projects such as Basel (2006) and St Gallen (2013) have been aborted due to the felt induced earthquakes they created and an increasing risk aversion of the general population. Induced seismicity is thus an unwanted product of such industrial operations but, at the same time, induced earthquakes are also a required mechanism to increase the permeability of rocks, enhancing reservoir performances. Analysis of induced microseismicity allows to obtain the spatial distribution of fractures within the reservoir, which can help, not only to identify active faults that may trigger large induced seismic events, but also to optimize hydraulic stimulation operations and to locate the regions with higher permeability, enhancing energy production. The project COSEISMIQ integrates seismic monitoring and imaging techniques, geomechanical models and risk analysis methods with the ultimate goal of implementing innovative tools recently developed but yet untested. These adaptive, data driven approaches for reservoir optimization and for the control and management of induced seismicity represent a major contribution to safe and sustainable geothermal energy exploitation. Within the project COSEISMIQ, we will demonstrate the usefulness of what we call the Real-Time Induced Seismicity Controller (RISC) in a commercial scale application in Iceland.

The project is organized in four work packages (WPs): WP1 Demonstration Case; WP2 Microseismic Monitoring and Imaging; WP3 Geomechanical Modeling; WP3 Risk Assessment and Mitigation. The selected demonstration site for this project is the Hengill region in Iceland, where the two largest geothermal power plants of the country are in operation, the Nesjavellir power stations and the Hellisheidi power station, the third largest geothermal power plant in the world. This demonstration site is ideal to test and validate COSEISMIQ technologies (WP1) since there are many existing and commercially successful geothermal projects and induced seismicity is common, but it is much less of a risk governance challenge due to low population density and limited building fragility. The main activities of WP2 are the development of innovative full-waveform seismological methods for microseismicity analysis and reservoir characterization, needed to obtain a detailed knowledge of the geometry of active faults and on the ongoing fracturing process during stimulation operations. WP3 focuses on the real-time implementation of geomechanical modeling tools to simulate induced seismicity in relation to injections scenarios. The comparison of the observed seismicity with the forecasted one will be used validate and update in real-time the geomechanical model increasing the seismicity forecasting performance. Finally, WP4 merges the outputs of WP2 and WP3 in a tool for real-time control, decision support and management of induced seismicity. COSEIMIQ would give a substantial contribution to the European renewable energy roadmap aiming to increase the share of renewable energy. Understanding how to prevent or reduce large induced earthquakes plays a pivotal role in the development of future, innovative, and clean forms of natural deep underground energy resources.

Project Coordinator Prof. Stefan Wiemer, Swiss Seismological Service, ETH Zurich
Partners: Iceland GeoSurvey, GeoEnergie Suisse AG, Reykjavik Energie, Dublin Institute for Advanced Studies
Cooperation partners: GFZ German Research Centre for Geosciences
Start date May 1st 2018, 36 month duration
Total value of the project: €2,497,457
Total funding to Irish partners from GSI: €199,958