GeoAtlantic: Boosting local ecosystems for the use of geothermal energy in the communities

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Analysis of the state of the art and successful practices (task 4.1)

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By Ana Palmero

Approved by/ To be approved by Armando Oliveira/all partners involved

UPORTO, Portugal

Partner responsible

Partner n.º 5 - Universidade do Porto - Partner

Partners involved

Partner n.º 1 - Concello de Ourense - Lead partner

Partner n.º 2 - Fundación Centro Tecnológico de Eficiencia y Sostenibilidad Energética - Partner

Partner n.º 3 - Instituto Tecnológico Y De Energías Renovables - Partner

Partner n.º 4 - Associação de Municipios da Cova da Beira - Partner

Partner n.º 5 - Universidade do Porto - Partner

Partner n.º 6 - Islay Energy Trust - Partner

Partner n.º 7 - Argyll, Lomond and the Islands Energy - Partner

Partner n.º 9 - Agence Locale de l'Energie et du Climat (ALEC) - Partner

Partner n.º 10 - Cork Institute of Technology (CIT) - Partner

Partner n.º 11 - European Heat Pump Association - Partner

Partner n.º 12 - Associação das Agências de Energia e Ambiente (Rede Nacional) - Associated partner

Partner n.º 13 - EDA RENOVÁVEIS, S.A. - Partner

Partner n.º 14 - Secretaria Regional da Energia, Ambiente e Turismo - Associated partner

Partner n.º 15 - Câmara Municipal da Ribeira Grande - Associated partner

Partner n.º 16 - Câmara Municipal da Povoação - Associated partnerAssociated partner

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1. Objectives

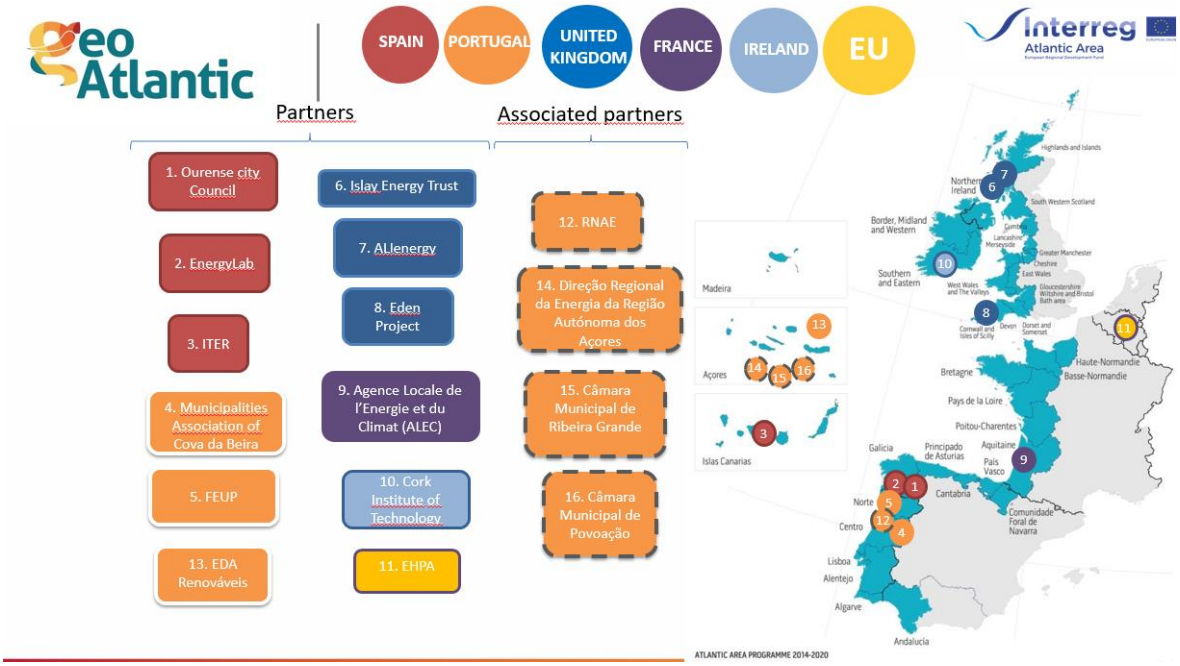
The main objective of this task (4.1) is compile the information about practices of local initiatives (buildings, districts, power plants, hot houses, etc.) that have led to a transformation in specific territories in the utilization of geothermal energy (heating/ cooling and electricity), both in the Atlantic Area (AA) or in other European regions.

Due to the extension of some documents created for this Task 4.1 by some partners and consulted by internet, they will be mentioned in this document and the files will be appended to this report. All attached files will be identified with the corresponding reference number.

2. Analysis of the state of the art and successful practices (task 4.1)

A first step for this WP4.1 is the knowledge about Geothermal Legislation in each region/country involved in the project (section 2.1).

2.1. Information about geothermal legislation in each country/region



All partners of the Geoatlantic project are located in the Figure 1.

Fig. 1 – Names and localization of the all partners, including the associated partners, in the Atlantic Area.

In this project, there are six regions from Atlantic Area (AA) involved in the tasks: Portugal, Spain, United Kingdom, France, Ireland and Belgium (represented by EHPA-European Heat Pump Association). After analyzed the legislation about the geothermal technologies of each region involved in the project, it was concluded that only few regions have legislation in this area. To know the situation of the legislation in AA, some questions were elaborated to the partners. These questions addressed the next issues: geothermal energy licensing system, related regulation and administrative procedures, geothermal energy licensing authority, geothermal resources inventory and statistics and financial incentives schemes.

Next, the information about the legislation for each country/region is explained.

2.1.1. European Union

The European Union (EU) aims to become the leader in the promotion and development of renewable energy, fight against climate change, encourage the shift to a low-carbon economy and stimulate high-potential economic growth. The next information about the situation of the EU legislation was summarized by EHPA (European Heat Pump Association).

Geothermal and Renewable Energy in Europe

The European Union (EU) aims to become the leader in the promotion and development of renewable energy, fight against climate change, encourage the shift to a low-carbon economy and stimulate high-potential economic growth.

According to the Article 194 of the Treaty on the Functioning of the European Union (EU)[1] the Union's energy policy shall aim, in a spirit of solidarity between Member States in the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment to:

a) ensure the functioning of the energy market
b) ensure security of energy supply in the Union

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012E%2FTXT

c) promote energy efficiency and energy saving and the development of new and renewable forms of energy

Such a provision entitles the EU to legislate on a number of issues which directly or indirectly affect both the shallow and deep geothermal energy sectors.[2]

The Renewable Energy (2009/28/EC), the Energy Performance of Buildings (2010/31/EU) Energy Efficiency (2012/27/EU) directives are key pieces of EU legislation for the promotion of geothermal energy in the EU. The content of these directives designs a framework which aims to help the EU to reach the Paris agreement targets, long-term targets of decarbonisation, overcome non-technical barriers and other market distortions.

The three directives were included in the 'Clean Energy for all Europeans' package, presented on 30 November 2016 by the Commission.[3] The aim of the package is to enable the European Union to be at the forefront of the clean energy transition and to pursue three main goals: putting energy efficiency first, achieving global leadership in renewable energies and providing a fair deal for consumers.

Considerable progresses were made in the legislative process for all the dossiers covering energy efficiency, renewable energy, governance rules for the Energy Union, clean energy innovation, the energy performance in buildings, security of supply and the electricity market design.

The European Commission estimated that the package would mobilise up to an additional 177 billion euro of public and private investment per year from 2021, thus generating up to 1% increase in GDP over the next decade and creating 900 000 new jobs. In addition, it would mean that on the average the carbon intensity of the EU's economy would be 43% lower in 2030 than now, with renewable electricity representing about half of the EU's electricity generation mix.[4]

Renewable Energy Directive

The 2009 Renewable Energy Directive established an overall policy for the production and promotion of energy from renewable sources in the EU. It required the EU to fulfil at least 20% of its total energy

[2] The EU Legal Framework for Geothermal Energy, Philippe Dumas and Luca Angelino, World Geothermal Congress 2015
[3] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans
[4] https://ec.europa.eu/energy/sites/ener/files/documents/com_860_final.pdf

needs with renewables by 2020 – to be achieved through the attainment of individual binding national targets. Member States set out how they plan to meet these targets and the general course of their renewable energy policy in national renewable energy action plans. Progress towards national targets is measured every two years when EU countries publish national renewable energy progress reports.[5]

The review of the Renewable Energy Directive was presented as part of the 2016 "Clean energy package", with the aim to reach an EU target of at least 27% share for renewable energy by 2030. Under the new proposal, new concepts were introduced such as 'ambient heat' (or ambient energy), encompassing aerothermal and hydrothermal as well as 'waste heat'. The proposal contained also a new sectoral target of yearly increase of renewable energy share in heating and cooling.

The agreement reached during the trialogues is to reach 32% of Renewable energy sources by 2030.[6]

An important aspect for geothermal energy is the new Article 23 of the Renewable Energy Directive, which aims to exploit the renewables potential in the heating and cooling sector, ensuring a cost-efficient contribution of the sector to target achievement, and to create a larger market for RES-H&C (Renewable Energy Source-Heating and Cooling) across the EU. The agreement achieved during the trialogues is to have a non-binding 1.3% per year of renewable heating and cooling target (waste heat could account max 40% of it). Table 1 shows important articles of the Directive for application in Geothermal Energy.

The directive also recognizes the importance of geothermal energy as local renewable energy source which has considerably lower emissions than fossil fuels and certain types of geothermal plants produce near-zero emission. The European Commission will make sure to facilitate the deployment of geothermal energy with low environmental impact and resulting in greenhouse gas saving compared to conventional sources.

In its 2017 report, the Commission highlighted that the EU as a whole achieved, in final energy consumption, a 16% share of renewable energy in 2014 and an estimated 16.4% in 2015, thus determining that the majority of Member States are on track to reach their RES binding targets.

[5] https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive
[6] http://europa.eu/rapid/press-release_STATEMENT-18-4155_en.htm

Although in terms of absolute renewable energy deployment heating and cooling remains the largest sector, the highest increase concerns the electricity sector, where the RES share grew by 1.4% per year between 2004 and 2014 (only 0.8% in the heating and cooling sector). The report recognizes the potential for an increase in the EU market of heat pumps and it also shows how the production from heat pumps increased from 1.8 Mtoe in 2004 to 9.7 Mtoe in 2015, thus continuing to exceed the indicative trajectory set in the NREAPs.[7]

Table 1 - Important articles of the Directive for application in Geothermal Energy

Article	**Provision**
Art. 2 b (bis)	Definition of Geothermal energy
Art. 3	Mandatory national targets
Art 7 and Annex VII	Calculation of renewable energy from heat pumps
Art 18 and Annex IV	Information and training
Article 20	Access to and operation of the grids
Article 23	Mainstreaming renewable energy in the heating and cooling installations

Energy performance of buildings

Buildings account for approximately 40% of the EU's overall energy consumption and for 36% of the EU's overall GHG emissions. With its efficient and renewable solutions, the heat pump industry can greatly contribute to the effort of reducing the energy consumption of buildings and to reaching the nZEBs (nearly Zero Energy Buildings) goals already foreseen by the previous directive.[8]

A revision of the Energy Performance of Buildings Directive (EPBD) was proposed in the 'Clean Energy' package, and already in December 2017 EU institutions managed to agree on a compromise text. The revised Directive aims to accelerate building renovation rates by reinforcing provisions on long-term building renovation strategies, with a view to decarbonising the building stock by mid-century. The text promotes the use of high-efficiency alternative systems in new buildings, when feasible, and

[7] https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports
[8] https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

foresees the creation of a Smart Readiness Indicator for Buildings, which should give recognition and incentivise the use of smarter building technologies and functionalities that enhance the energy efficiency of the building stock. The Directive is expected to come into force mid-2018 and will then have to be transposed into national law by Member States.

In addition, to unlock private financing for energy efficiency and renewable in buildings at a greater scale, the Commission launched also the 'Smart Finance for Smart Buildings' initiative. The creation of this new financial instrument, which was endorsed by the Board of the European Investment Bank (EIB), should unlock, together with other EU initiatives for smart buildings, a total of €10 billion in public and private funds until 2020 for energy efficiency projects.

With regards to energy efficiency, shallow geothermal technologies and geothermal district heating can undoubtedly be crucial technologies in meeting minimum requirements for energy performance which member states have to set in compliance with Directive 2010/31/EU on energy performance of buildings (EPBD)[9].

Energy labelling and Ecodesign

Heat pumps (including GSHP) are covered under both Ecodesign and energy labelling[10] legislation, which are two of the most effective policy tools in the area of energy efficiency. The energy label is an EU tool to help consumers choose energy efficient products. Ecodesign[11] aims to improve the energy and environmental performance of products throughout their life cycle, while energy labelling requirements aim to provide citizens with information about environmental performance of products and thereby incentive industry in the development of further improved products and innovations beyond minimum levels.

Research and Innovation

In terms of governance, R&I efforts to accelerate the deployment of cost-effective low carbon technologies have been organised under the so-called Strategic Energy Technology (SET) Plan, based

[9] The EU Legal Framework for Geothermal Energy, Philippe Dumas and Luca Angelino, World Geothermal Congress 2015
[10] https://eur-lex.europa.eu/eli/reg/2017/1369/oj
[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0125

on a structure with three pillars of implementation: a Steering Group, European Industrial Initiatives (EIIs) and the European Energy Research Alliance (EERA) and is supported by an information system (SETIS). Geothermal has been included in the SET- Plan through the geothermal panel of the European Technology and Innovation Platform (ETIP) on Renewable Heating and Cooling whose aim is to develop strategic research priorities and implementation roadmaps for the sector. The Energy Union strategy increased the focus on geothermal technology, with the launch of a dedicated ETIP on deep geothermal energy in 2016.[12]

2.1.2. Portugal

According to the Portuguese Decree-Law (D.L.) n.º90/90, of 16th March, geothermal resources are "the fluids and underground geological formations, of high temperature, whose heat can be susceptible of utilization". This definition is sufficient wide to cover all the modern utilizations of this energy. Furthermore, Decree-Law nº87/90 and nº90/90, of 16th March, determine that geothermal resources belong to the public domain, but private companies and municipalities can apply for the right of exploration and exploitation, on the basis of a concession granted by the Ministry of Economy, or in the Autonomous Region of Azores by the Regional Secretariat of Economy. As for the mining industry, the exploration and exploitation of geothermal resources have to be carried out under the supervision of a "Technical Director", generally a geologist or mining engineer, employed by the concessionaire and accepted by the Direcção Geral de Energia e Geologia (DGEG), the governmental agency in charge of all mining and oil development as well energy subjects in Portugal, or in The Azores by the regional authorities [1].

Figure 2 shows the scheme of the geothermal resource as defined in D.L. 90/90.

[12] https://www.egec.org/research/

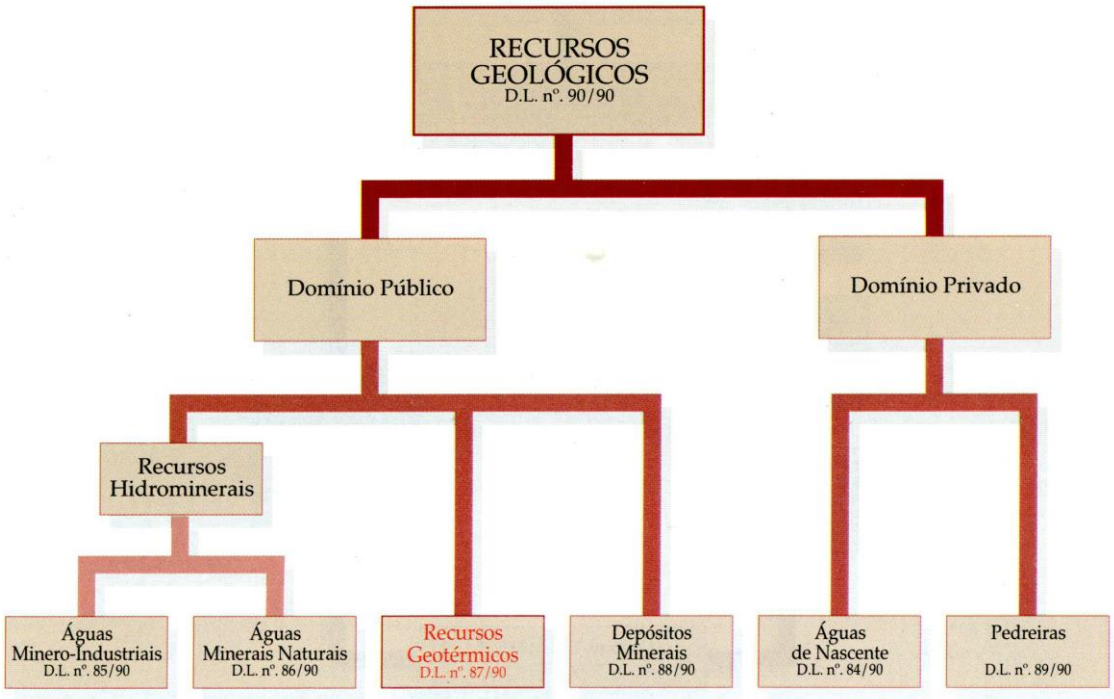


Fig. 2 – Scheme of Portuguese law D.L. nº 90/90 (Portuguese Legislation about geothermal resources) [2]

The last Portuguese Law about the geothermal resources is the law-decree number 54/2015 of 22 June 2015, which introduce the general principles for the development and exploration of the geothermal resources (in Portuguese: *Bases do regime jurídico da revelação e do aproveitamento dos recursos geológicos existentes no território nacional, incluindo os localizados no espaço marítimo nacional*).

The Article 29 of Law no.54/2015 establishes which it is an obligation of the dealers do the best use of resources. Then, DGEG consider that hydromineral resources, whose temperature is greater than 20 °C, are likely to be used in its component geothermal.

2.1.3. Spain

In the national legal field, the most relevant issue is the consideration of geothermal energy as a mining resource and its corresponding inclusion in mining legislation. Specifically, the geothermal

resources are defined in Law 54/1980, 5 of November, amending Law 22/1973, 21 of July, on Mines Law. This definition has not undergone any modification despite the fact that 30 years have passed since the enactment of the aforementioned law. This means that, as of today, such resources are subject to mining legislation and its authorizations. A summary about the Spanish legislations in different areas related with renewable energies is possible to find in [3]. The state of the art and successful practices in Spain are in the portfolio [4] (Spanish language).

One of the functions that the Spanish central government delegates to the autonomous communities that make up the country is the administrative management of authorizations for the exploitation of mining resources, so the granting of these permits will depend on the ministry of industry of each of the autonomous communities that make up Spain.

In the case of Galicia, as in the rest of the autonomous communities, there is no standardized procedure for the legalization of an installation related to geothermal use, even being different in each province within the autonomous community itself [4]. The procedure to be followed for the legalization of a geothermal installation in Galicia is not standardized and depending on the geothermal uses, i.e. if the installation is done in closed circuit or open circuit. All details about procedures for Galicia are summarized by Energy Lab and explained in [5].

2.1.4. France

About French legislation, the main resources are:

- Portail Ademe – BRGM dédié à la géothermie : http://www.geothermie-perspectives.fr/
- Outil d'aide à la décision en matière de géothermie très basse et basse énergie en région Aquitaine Atlas du potentiel géothermique des aquifères – BRGM - http://www.geothermie-perspectives.fr/sites/default/files/rp-59761-fr.pdf

Geothermal use is strictly regulated since exploiting heat or water from subsurface meet at the same time mining code, environmental code (law on water, ICPE-classified installations for environment protection), public health code and territorial authority general code. Concerning regulation, it is separated between high temperature (>150°C) and low temperature (<150°C).

In **Mining code**, it is possible consider the two types of temperatures:

- High temperature deposit fall within mining code as well as decree n°78-498 of June 2nd 2006 for request and attribution procedure.

- Low temperature site, more common in France have a specific regulation defined by art.98 to 103 of mining code as well as the decree n° 78-498 of march 28th 1978 for request and attribution procedure.

In **Environmental code**, geothermal use has to provide water resource preservation (decree n°93-743, Water Law).

About the financial incentives schemes, there are two schemes:

For private individuals

- Tax credit for some sustainable energy works in principal dwelling
- Regional subsidies
- Reduce VAT rate for works

For collective and tertiary operation

- Ademe's Fund for renewable heat for very low and low energy geothermal in Aquitaine
- Regional call for REN projects (not financed by heat funds)
- Call for interest for demonstrative project (eg energy storage)

More information on French legislation can be found in the document created by ALEC [6].

2.1.5. Ireland

Geothermal Legislation bill in Ireland was intended to be completed and approved in 2016. At present, it is not completed. Legislations regarding to the deep geothermal exploration are incorporate in Mineral development bill. Legislations for shallow geothermal exploration are incorporate in ground water resources bill. Irish legislator hopes to have Geothermal exploration bill completed by end of this year (2018). The documents associated with this matter, provided by CIT,

can be seen in the next references: the Irish groundwater regulation [7], Guideline values for the protection of groundwater in Ireland [8] and the Guidance on the Authorisation of Discharges to Groundwater [9].

On the other hand, the main barrier to the development of deep geothermal energy resources in Ireland remain the lack of specific legislation allowing developers to obtain licenses for resource exploration and development.

2.1.6 United Kingdom

General information about the situation in UK

All information summarized here, it is possible to find in [10].

The exploitation of geothermal resources in the UK continues to be minimal. There are no proven high temperature resources and limited development of low and medium enthalpy resources. However, in the reporting period 2007-2013, there has been a significant resurgence of interest in all aspects of geothermal energy in the UK.

Year 2011 was a significant year for the UK as it formally rejoined the IEA-GIA (International Energy Agency Geothermal Implementing Agreement) in September. The UK was a founder member of the IEA-GIA in 1997, but left in 2004. The contracting party is the UK Department for Energy and Climate Change (DECC). The UK is participating in three Annexes; Annex III- Enhanced Geothermal Systems, Annex VIII- Direct Use of Geothermal Energy and Annex X - Data collection and Information.

Two major legislative drivers are contributing towards increased interest in geothermal activity in the UK. The first is the European Union's RES Directive or 20/20/20 campaign – 20% Renewable Energy (electricity, heat and transport), and 20% CO2 reductions (below 1990 levels) by 2020. In practice, the UK has agreed a 15/20/20 commitment, which translates into 30% renewable electricity and 12% renewable heat by 2020. The second legislative driver is the 2008 UK Climate Change Bill that commits current and future UK governments to publicly declared CO2 reduction targets.

Legislation for deep geothermal development has been slow to catch up with the renewed level of interest in the sector. There is still no official licensing scheme for deep geothermal development in the UK. However, the Environment Agency, which regulates surface and aquifer water in the UK, has

introduced (2011/12) a scheme to cover deep geothermal aquifer systems. This provides some degree of resource protection to developers but has not addressed the fundamental issue of heat ownership. At the time of writing the report [10], 2013, the Department of Energy and Climate Change was revisiting this topic.

In 2014, the UK Guidance about Deep geothermal energy regulation was published and the information is available in https://www.gov.uk/guidance/deep-geothermal-energy-regulation.

Scotland

The information, obtained through Mr. George Dean from Islay energy Trust (Scotland), is explained below.

The regulation of geo-thermal energy is a matter devolved from the UK Government to the Scottish Government. The latter published a paper in 2013 which recommended a new regulation, but nothing has so far been published. Meanwhile the default position is that SEPA (Scottish Environment Protection Agency) acts as the body to consider applications for licences for deep geothermal. The UK Government regulation was published in 2014 and is reasonably straightforward, but applies only in England and Wales.

The UK has a scheme called the Renewable Heat Incentive (RHI), which is intended to support the installation of things like ground and air source heat pumps, biomass boilers and suchlike. This is UK-wide, and not devolved to Scotland, but the scheme has had some problems and is under review. There are two schemes, one for domestic properties, and one for businesses. Meanwhile SG are considering whether they should introduce some sort of local scheme. In Annex I it is possible to read the letter sent by Scottish Government with the information about the geothermal legislation in Scotland.

2.2 Successful practices on geothermal applications

The report created by EnergyLab in WP 6 – Action 6.1 (Identification of technologies with potential for AA) for the Geoatlantic project, analysed the current situation of geothermal energy in Europe and in the country of each project partner [11]. In addition, this report presented the more important systems installed in the partners' regions, with the geothermal application depending on the different factors.

In this state of the art, the classification of the geothermal systems regarding the different factors, is important to understand the information on the practices of local initiatives (buildings, districts, power plants, hot houses, etc.) in the use of geothermal energy (heating / cooling and electricity).

The geothermal systems are organized depending on temperature or on the depth of the sources. Regarding the **temperature** of the geothermal source, there are:

- Very low enthalpy: T<30°C
- Low enthalpy: 90>T>30 °C
- Medium enthalpy: 180>T>90 °C
- High enthalpy: T> 180°C

Regarding the **depth** of the geothermal source, there are:

- Shallow Geothermics : <150 m
- Deep Geothermics: >400 m

There are three main types of geothermal energy systems:

- Direct use and district heating systems (low or very low enthalpy; shallow geothermics)
- Electricity generation power plants or geothermal power (high enthalpy; deep geothermics)
- Geothermal heat pumps, to heat and cold building (low enthalpy; shallow geothermics)

- Direct use and district heating systems

Direct use and district heating systems use hot water from springs or reservoirs located near the surface of the earth. Ancient Roman, Chinese, and Native American cultures used hot mineral springs for bathing, cooking, and heating. Today, many hot springs are still used for bathing, and many people believe the hot, mineral-rich waters have natural healing powers.

Geothermal energy is also used to heat buildings through district heating systems. Hot water near the earth's surface is piped directly into buildings for heat. For example, a district heating system provides heat for most of the buildings in Reykjavik, Iceland.

Industrial applications of geothermal energy include food dehydration, gold mining, and milk pasteurizing. Dehydration, or the drying of vegetable and fruit products, is the most common industrial use of geothermal energy.

- Geothermal electricity generation or geothermal power

Based on the type of exploitation, geothermal systems can be divided into two categories: traditional geothermal (hydrothermal) systems and enhanced geothermal systems (EGSs). Conventional geothermal power systems have been developed for approximately 100 years; therefore, the power generation technology is mature. Compared to conventional geothermal energy developments, EGSs have the advantage of accessing more abundant heat by creating artificial fractures in the hot rocks and then injecting fluid into them, but disadvantages also due be considered. Currently, there are three EGS power plants in Europe: 1 in France (Soultz) and 2 in Germany (Landau and Insheim) [12].

Geothermal electricity generation requires water or steam at high temperatures (more than 180ºC). Traditional geothermal power plants are generally built where geothermal reservoirs are located, within a km or two of the earth's surface.

Geothermal energy contributes a significant share of electricity generation in several countries. For example, Azores Island (Portugal) has an amount of electricity generated with geothermal energy. Today´s total installed capacity in Azores approximately 30 MWe. The last one plant, new 4 MW geothermal power plant, has been inaugurated in 2017 on Terceira Island in the Azores, Portugal. The information of this plant is available in [13].

- Geothermal heat pumps (GHP)

Geothermal heat pumps use the constant temperatures near the surface of the earth to heat and cool buildings. Geothermal heat pumps transfer heat from the ground (or water) into buildings during the winter and reverse the process in the summer.

In Europe, there are some examples of geothermal heat pumps integrated in buildings. In the website of the European Heat Pump Association (EHPA, a partner of GeoAtlantic project) it is possible find useful information about heat pump [14] and example of GHP [15].

More details about the GHP can be seen in the section 4.9 of the report created by EnergyLab [11].

Summary of the successful practices in each region

As explained before, in the report [11] is possible find the geothermal applications and geothermal projects developed in each region of the AA.

In general, for each system installed in each region, can be interesting to know:

- the installed capacity (MWt) and energy use (TJ/year), for non-electric applications of geothermal energy;

- the installed geothermal electric capacity (kWe or MWe), for utilisation of geothermal energy to generate electricity.

Some partners sent information about the systems installed in their region with the general characteristics of each of them. In addition, other information was collected through the database and bibliography found in Internet.

2.2.1 European Union

Europe has a total installed generating capacity (electricity and thermal combined) of 29.9 GW, representing 35.9% of the world's geothermal capacity[13].

Geothermal heating and cooling uses for tertiary, agricultural, and industrial sectors [16]

The use of geothermal for heating is also increasing, supported by the construction of new district heating networks and the retrofitting of old ones, thanks to local and national planning identifying geothermal heat as a cost-efficient solution to meet heating needs. In 2017, 9 new plants were inaugurated, adding over 75 MWth across France, the Netherlands and Italy. Geothermal district heating accounts for over 4.9 GWth of capacity in Europe (1.7 GWth in the European Union), with 294 plants currently in operation. The number of new plants coming online each year is on an upward trend, with an average annual growth rate of 10% in recent years. The development of geothermal as a solution for heating and cooling is particularly dynamic in Germany, where 35 projects are planned or in developments, but many smaller or newer markets are also increasingly investing in geothermal energy, such as the Netherlands, Poland, and the UK.

Individual heating systems [16]

Looking at individual geothermal heating systems, the shallow geothermal market remains the largest segment of the sector in terms of number of installations, installed capacity and energy

[13] https://www.worldenergy.org/data/resources/region/europe/geothermal/

produced. Individual geothermal heating systems, or geothermal heat pumps, represent over 20 GWth of heating capacity in Europe, with nearly 2 million installed units. In Europe, annual sales average around 100,000 units. Germany, Sweden, Switzerland and France remain key markets. Poland, Belgium, and Estonia are emerging markets undergoing rapid development.

Geothermal power [16]

Installed geothermal electricity capacity in Europe amounts to 2.8 GWe (of which 1 GWe in the European Union), producing over 15 TWh per year. In Europe there are 117 plants, 16 of which were inaugurated in 2017 with an average capacity of 22 MWe. The new additions are quite significant, with 330 MWe of new geothermal electricity capacity coming online, mainly in Turkey. The Turkish market continues to be the most dynamic in terms of power production, but it is worth noting that the first Hungarian geothermal power plant came online in 2017. Around 30 projects are under construction in Turkey, France, Hungary, Germany, the UK, Iceland, Croatia and Belgium, while another 276 projects are under investigation.

2.2.2 Portugal

The limited geothermal resources in mainland Portugal have been developed for direct use, whereas geothermal occurrences in the Azores are utilised for the production of electricity as well as being used directly.

Low-temperature resources in Mainland Portugal are exploited for direct uses in balneotherapy and small heating systems and shallow geothermal with heat pumps is gaining increasing importance. At present, new regulations for shallow geothermal purposes are being prepared to regulate the new installations and to avoid bad practices. These regulations will also include the obligation to register all new GSHP's installations in order to get more realistic statistical data on the new installations.

Tables 2 and 3 present a characterization of the geothermal uses in Portugal as of 31 December 2014.

Table 2 – Utilization of geothermal energy for direct heat as of 31 December 2014 (other than heat pump) [17].

Locality	Type	Maximum Utilization					Capacity	Annual Utilization		
		Flow Rate	Temperature (°C)		Enthalpy (kJ/kg)			Ave. Flow	Energy	Capacity
		(kg/s)	Inlet	Outlet	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor
Monção	B+D	12,5	49,0	20,0			1,52	8,00	30,6	0,64
Chaves	B+D	15,0	74,0	20,0			3,39	10,00	71,2	0,66
Caldelas	B	7,5	30,3	20,0			0,32	4,50	6,1	0,60
Gerês	B	0,9	47,0	20,0			0,10	0,80	2,8	0,88
Taipas	B	2,0	29,0	20,0			0,08	2,00	2,4	0,99
Caldas da Saúde	B	4,0	30,0	20,0			0,17	3,00	4,0	0,75
Carlão	B	0,4	27,5	20,0			0,01	0,37	0,4	0,99
Aregos	B	4,0	63,0	20,0			0,72	4,00	22,7	0,99
Carvalhal	B	6,9	60,0	20,0			1,15	0,30	1,6	0,04
Cavaca	B	5,0	29,0	20,0			0,19	1,00	1,2	0,20
São Pedro do Sul	B+D+G	19,4	67,0	20,0			3,81	15,40	95,5	0,79
Alcafache	B+D	6,0	51,0	20,0			0,78	4,00	16,4	0,66
Sangemil	B	6,5	40,0	20,0			0,54	4,00	10,6	0,61
Felgueira	B	9,2	36,0	20,0			0,62	4,00	8,4	0,43
Luso	B	10,5	24,9	20,0			0,22	2,00	1,3	0,19
Manteigas	B	4,0	47,0	20,0			0,45	3,00	10,7	0,75
Unhais da Serra	B	7,2	37,0	20,0			0,51	5,00	11,2	0,69
Monfortinho	B	36,0	31,0	20,0			1,66	4,00	5,8	0,11
Vimeiro	B	29,0	24,5	20,0			0,55	2,00	1,2	0,07
Monchique	B	10,4	32,0	20,0			0,52	3,00	4,7	0,29
Longroiva	B+D	6,3	47,0	20,0			0,71	2,50	8,9	0,39
Azores Islands										
Caldeiras Rib. Grande	B	1,0	90,0	20,0			0,29	1,00	9,2	0,99
Carapacho (Graciosa)	B	2,5	37,6	20,0			0,18	2,50	5,8	0,99
Ferraria (S. Miguel)	B	10,0	62,1	20,0			1,76	10,00	55,5	0,99
TOTAL							**20,2**		**388,2**	**0,5**

B = Bathing and swimming (including balneology); D = District heating (other than heat pumps); G = Greenhouse and soil heating

Table 3 – Utilization of geothermal energy for electric power generation as of 31 December 2014 [17].

Locality	Power Plant Name	Year Com-missioned	No. of Units	Status	Type of Unit	Total Installed Capacity (MWe*)	Total Running Capacity (MWe*)	Annual Energy Produced 2013 (GWh/yr)	Total Under Constr. or Planned (MWe)
Ribeira Grande	Ribeira Grande (Phase A)	1994	2		B	6	5		42,5
Ribeira Grande	Ribeira Grande (Phase B)	1998	2		B	9	5		42,5
Ribeira Grande	Pico Vermelho	2006	1		B	13,5	13		100
Total						**28,5**	**23**		

** Installed capacity is maximum gross output of the plant; running capacity is the actual gross being produced.*

More complete and current information about the geothermal uses and plants in Portugal, can be seen in the report created by DGEG (in Portuguese) and achieved through RNAE, associated partner in this project [18].

2.2.3 Spain

Research has shown that a low-enthalpy geothermal resource is widely distributed across the Spanish mainland. The main areas are in the northeast, southeast, northwest and the centre.

The geothermal resources evaluated in all these cases exhibit low temperatures, 50–90 ºC. The only area where high-temperature fluids might possibly exist at depth lies in the volcanic archipelago of the Canary Islands. Hot dry rock resources have been evaluated on the islands of Lanzarote and La Palma. On the island of Tenerife, the presence of high-temperature areas has been investigated, but no commercially viable geothermal reservoirs have been found[14].

The use of geothermal systems in Galicia, focuses solely and exclusively on heating/cooling installations. The document created by EnergyLab [5] shows the geothermal heating/cooling systems in Galicia. Also, some of the successful practices in Ourense, can be seen in the document created by Concello de Ourense [3].

2.2.4 France

Table 4 shows the information about practices of local initiatives in the utilization of geothermal energy (heating/ cooling) in each region of France. More detailed information about the geothermal system installed in France can be seen in the document available through ALIEC (in French) [19].

[14] https://www.worldenergy.org/data/resources/country/spain/geothermal/

Table 4 – Geothermal system (GHP) installed in buildings of France.

Region	Town	Building	Geothermal system	Installed capacity		Energy use
				Heating	Cooling	
				MWt	MWt	TJ/year
Bretagne	Saint-Malo	Cultural centre	Heat pump on vertical probes	0.21	0.17	
Aquitaine	Rochefort-sur-mer	Geriatrics centre	Heat pump on vertical probes	0.30		0.9
Normandie	Evreux	Hospital	Heat pump on aquifer	0.88		
Aquitaine	Bayonne	Social Security	Heat pump on aquifer	0.70		
Pays de loire	Saint-Gilles Croix de Vie	Head quarters	Heat pump on vertical probes	0.13	0.12	
Aquitaine	Bergerac	High school	Heat pump on vertical probes	0.19		
Normandie	Tourville-la-Rivière	Shopping centre	Heat pump on aquifer	1.26	0.70	
Bretagne	L'Hotel d'Air	Henhouse	Heat pump on aquifer	0.07		
Aquitaine	Pontet-Canet	Winerie (castle)	Heat pump on vertical probes	0.66	0.47	4.4

2.2.5 Ireland

Geothermal energy resources in Ireland are of low enthalpy in nature, with the main exploitation focussed on the use of ground source heat pumps, accounts for a total of 191 MWt installed capacity until 2015 [20], with a thermal energy produced for heating of 251.64 GWh and 10.29 GWh for cooling (Table 5).

Table 5 – Shallow geothermal energy, ground source heat pumps (GSHP) [20].

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2015 *		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2015 *	17,195	191	252	350 est	14 est	3
Projected total by 2018	18,250	225	270			

* If 2014 numbers need to be used, please identify such numbers using an asterisk

2.2.6 UK (Scotland)

The exploitation of geothermal resources in the UK continues to be minimal. There are no proven high temperature resources and limited development of low and medium enthalpy resources. However, between 2010 and 2015, there has been a significant resurgence of interest in all aspects of geothermal energy in the UK. Two EGS/HDR projects in Cornwall have sites and planning approval. In terms of real activity "in the ground" a new deep hole has been drilled in the centre of Newcastle, and ground source heat pump installations have continued. Compared to previous updates, there has been a significant awakening of geothermal interest in Scotland [21].

The report [11], in the section 5, explain the complete information about the geothermal projects and geothermal system currently used in Scotland.

3. Conclusions

In this report, the analysis of the state of the art and successful practices of the geothermal application in the Atlantic Area (AA) and other European regions were explained. The actual Geothermal Legislation in each region/country involved in the project and in European Union was also described. The main objectives of the WP 4.1 were achieved.

The collected information shown in this report is reached with the available documents referenced. The documents referenced without link by website, will be attached to this report.

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Annex I

Minister for Business, Innovation and Energy
Paul Wheelhouse MSP

Scottish Government
Riaghaltas na h-Alba
gov.scot

T: 0300 244 4000
E: scottish.ministers@gov.scot

Mr Michael Russell MSP
(by e-mail heather.wolfe@parliament.scot)
The Scottish Parliament
EDINBURGH
EH99 1SP

Our ref: 2017/0040540

25 November 2017

Dear Michael,

Thank you for your e-mail dated 6 November setting out a number of questions raised by one of your constituents about the Scottish Government's policy in respect of geothermal energy. I have addressed each question in turn in the following paragraphs.

Schedule 5 of the Scotland Act 1998, as amended, sets out those matters which are reserved. These matters do not include heat. Therefore, in general terms, policy relating to heat, including geothermal heat, is a devolved matter.

Moving on to the question about the current policy in respect of geothermal energy, since the publication in 2013 of the findings of the study into the potential of deep geothermal in Scotland, the Scottish Government has been working with stakeholders to build on these findings and help develop the industry in Scotland. The Scottish Government is committed to largely decarbonising Scotland's energy system by 2050. The Scottish Government's Heat Policy Statement and the draft Energy Strategy recognise that deep geothermal energy could be an environmentally viable renewable heat source for Scotland.

Below is a summary of how the Scottish Government has been working with key geothermal stakeholders over the past four years (more information is available on the Scottish Government website at http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/GeothermalEnergy :

- In 2014, the Geothermal Energy Expert Group was convened as a short life working group to provide advice on how to kickstart the geothermal industry in Scotland. The Group recommended that the Scottish Government provide financial support for feasibility studies to collect further data on the geothermal resource in Scotland and identify potential local markets for that resource.

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- In response to this recommendation, the Geothermal Energy Challenge Fund was launched in March 2015 and was run as part of the Low Carbon Infrastructure Transition Programme (LCITP). In 2015-16, almost £200,000 grant was made available under the LCITP to explore the technical feasibility, economic viability and environmental sustainability of the geothermal resource in sites in Fife, North Lanarkshire, Aberdeen, Aberdeenshire and Clackmannanshire. Further work at the Fife site received £37,000 grant from the LCITP.

- To help promote awareness amongst the industry of the regulatory framework for deep geothermal projects in Scotland, a guidance document was developed in liaison with relevant regulatory authorities, including SEPA.

- In 2016 the Scottish Government, in partnership with Scottish Development International, sponsored a learning journey to a large scale minewater geothermal and district heating project in the Netherlands to help understand the potential impact of a minewater geothermal project on the local landscape, environment and economy.

- During 2017, the Scottish Government has been working with the British Geological Survey, as it has developed proposals for the Glasgow Geothermal Energy Research Field Site in Clyde Gateway.

- In August 2017, the Cabinet Secretary for Economy, Jobs and Fair Work announced that up to £5.3 million is being made available to the HALO project in Kilmarnock. This includes £1.8 million from the LCITP for a deep geothermal district heating network to serve the development.

Finally, your constituent asks whether the Scottish Government has any plans to introduce any specific elements or modifications of the RHI Scheme for Scotland. In the 2015 Autumn Statement, the UK Government announced the continuation of the RHI Scheme for the 2016-21 spending review period with the introduction of budget caps and an overall increase in funding to £1.5 billion by 2020-2021.

The Scottish Government fully endorses and actively promotes the UK Government's RHI Scheme to encourage the uptake of renewable heat technologies to the benefit of householders and businesses across Scotland. We currently provide grant-funding to Resource Efficient Scotland and The Energy Savings Trust to promote and manage a range of bespoke services and loans to promote energy efficiency measures and renewable heat technologies to encourage uptake of the UK wide RHI Scheme. Scotland currently accounts for 20% of accreditations to the RHI Scheme in both the domestic and non-domestic market. This is well above pro-rata.

The continuation of the UK RHI Scheme (or an equivalent) beyond 2021 will be critical to encouraging investment in, and development of, renewable heat technologies to the benefit of householders and businesses across Scotland. My officials continue to liaise with colleagues from the Department for Business, Energy and Industrial Strategy at the UK Government to ascertain whether funding will likely continue beyond 2021. At present this has yet to be decided. Once there is clarity on whether the RHI Scheme will continue beyond 2021, we can then consider any requirement for modifications or alternatives to the RHI Scheme.

St Andrew's House, Regent Road, Edinburgh EH1 3DG
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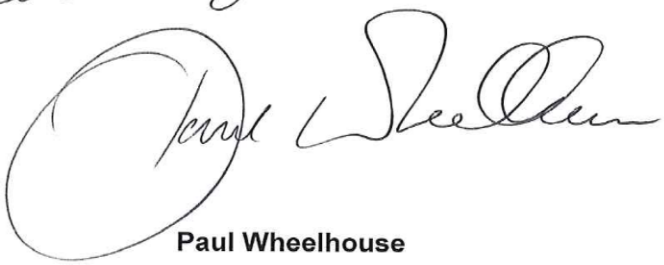
I hope this is helpful in summarising how the Scottish Government has been working with key stakeholders over the last few years to support the development of a deep geothermal industry in Scotland.

Kindest regards



Paul Wheelhouse

St Andrew's House, Regent Road, Edinburgh EH1 3DG
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