# RD&I Framework conditions with recommendations for non-members of the DG IWG

Focus on the key countries: Poland, Hungary, Bulgaria, Croatia, Greece, Finland and the United Kingdom

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Deep GEOTHERMAL IWG
SUPPORT UNIT

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# Contents

# 1. Executive Summary

The scope of this report is to provide a clear outline of the current and the upcoming framework conditions in order to have more RD&I in deep geothermal. It also determines a series of recommendations for improving these conditions for the SET Plan countries that are not yet members of the DG IWG, namely: Poland, Hungary, Bulgaria, Croatia, Greece, Finland and the United Kingdom. Deep geothermal energy requires a tailor made support framework due to the fact that it is a heavily regulated sector.

On a wider scale, the framework conditions for RD&I in geothermal are highly impacted by the EU's energy, climate, funding and research policies. Therefore, the recommendations for improvement of the framework conditions will be based on the above-mentioned policies.

In order to reach these objectives, a detailed mapping of relevant policy and regulatory issues impacting geothermal RD&I will be provided. In this way, it will set out the appropriate context for analysis. The goal is to highlight the main challenges for the RD&I in deep geothermal, in order to make sure that these RD&I priorities will be translated into clear and coherent policy recommendations, especially for those countries that are not members yet of the DG IWG.

The European RD&I policy framework contains a series of various interlinked regulations and policies that create a complex regulatory background. Following the adoption by the EU of a new framework for its climate and energy policy for 2030 and 2050, European countries are being encouraged to look to the best practices to achieve these new goals. In this context, deep geothermal energy is indeed, one of the most convenient renewable energy source that can provide baseload as well as flexible energy for electricity and heating and cooling.

However, geothermal remains an important but largely underdeveloped renewable sector in several European markets. As geothermal development is still new in many markets, deep geothermal projects usually rely on the EU policies to support research, development and innovation in this sector.

# 2. Mapping of the policy and regulatory framework impacting geothermal RD&I

## 2.1. METHODOLOGY

### Overview mapping: a tool for understanding the barriers

In order to understand the current challenges and barriers, an overview of the regulatory and policy framework that affects investments in RD&I in geothermal energy is needed. This part of the report will focus specifically on this task.

In this regard, there are two main EU policy and regulation areas that needs to be taken into account:

- Climate and energy
- Research, development and innovation

It is a well-known fact that geothermal is a local and reliable renewable source of energy. It is one of the core renewable energy sources that is offering a concrete solution to the climate crisis. In order to reach its full potential, there is a need not only for a feasible energy and regulatory framework, but also a need for a strong public financial support for geothermal RD&I developments.

In this respect, this report offers two overview mappings in order to present the comprehensive structure of policies and regulations in the EU for those two areas that have been identified as relevant. Climate, energy and RD&I European policies represent the accurate basis to define the policy and regulatory framework for geothermal RD&I. The main scope of the proposed overview mappings is to identify how the EU's general policy objectives could be translated into more specific RD&I funding regulations.

### Identifying case studies

For an easier understanding of the mapping, several case studies have been realised, assessing the specific framework for geothermal RD&I across different EU countries that are non-members of the DG IWG. These countries where chosen in order to reflect the diversity of framework and geothermal markets across Europe, starting with the mature to emerging.
This country overview includes Poland, Hungary, Bulgaria, Croatia, Greece, Finland and the United Kingdom.

Hungary, a traditional geothermal country in Eastern Europe, Finland being one of the most dynamic market for geothermal in Europe, Poland, Bulgaria and Croatia – currently emerging but promising markets for geothermal in Europe, and the United Kingdom, which

is an emerging market at early stages of development but which also brings its significant potential to the table. The case studies are not the most complex ones, but the aim here is to give a clear outline of the different types of frameworks for geothermal RD&I across Europe, for different geothermal market maturity.

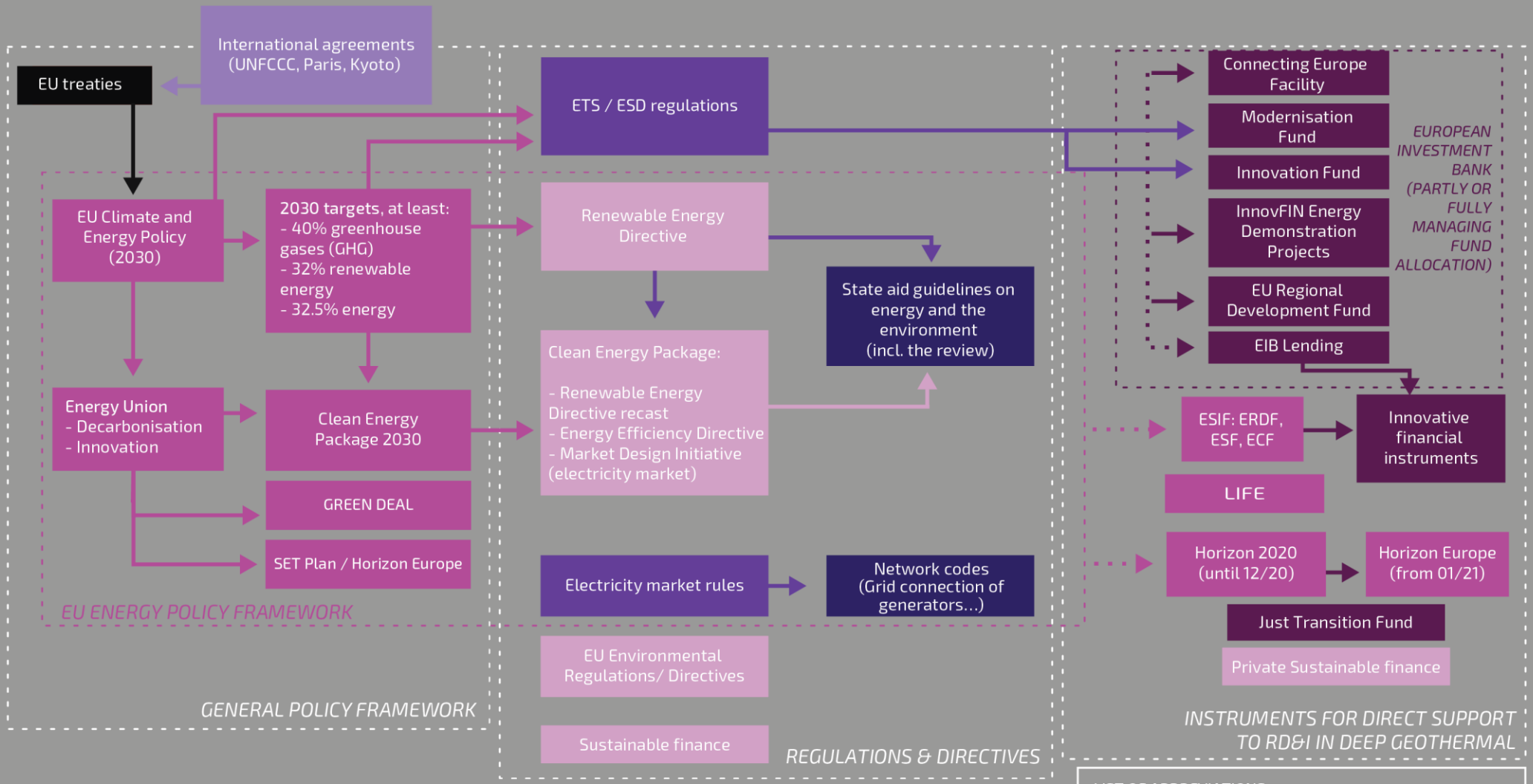
## 2.2 OVERVIEW OF THE EUROPEAN REGULATORY AND POLICY FRAMEWORK

The next 2 tables provide an overview of EU policies that are relevant to deep geothermal projects:

**on Climate and Energy for supporting deep geothermal**

**on Research, Development and Innovation relating to deep geothermal projects**

# OVERVIEW OF THE **EUROPEAN REGULATORY AND POLICY FRAMEWORK ON CLIMATE AND ENERGY** FOR SUPPORTING DEEP GEOTHERMAL



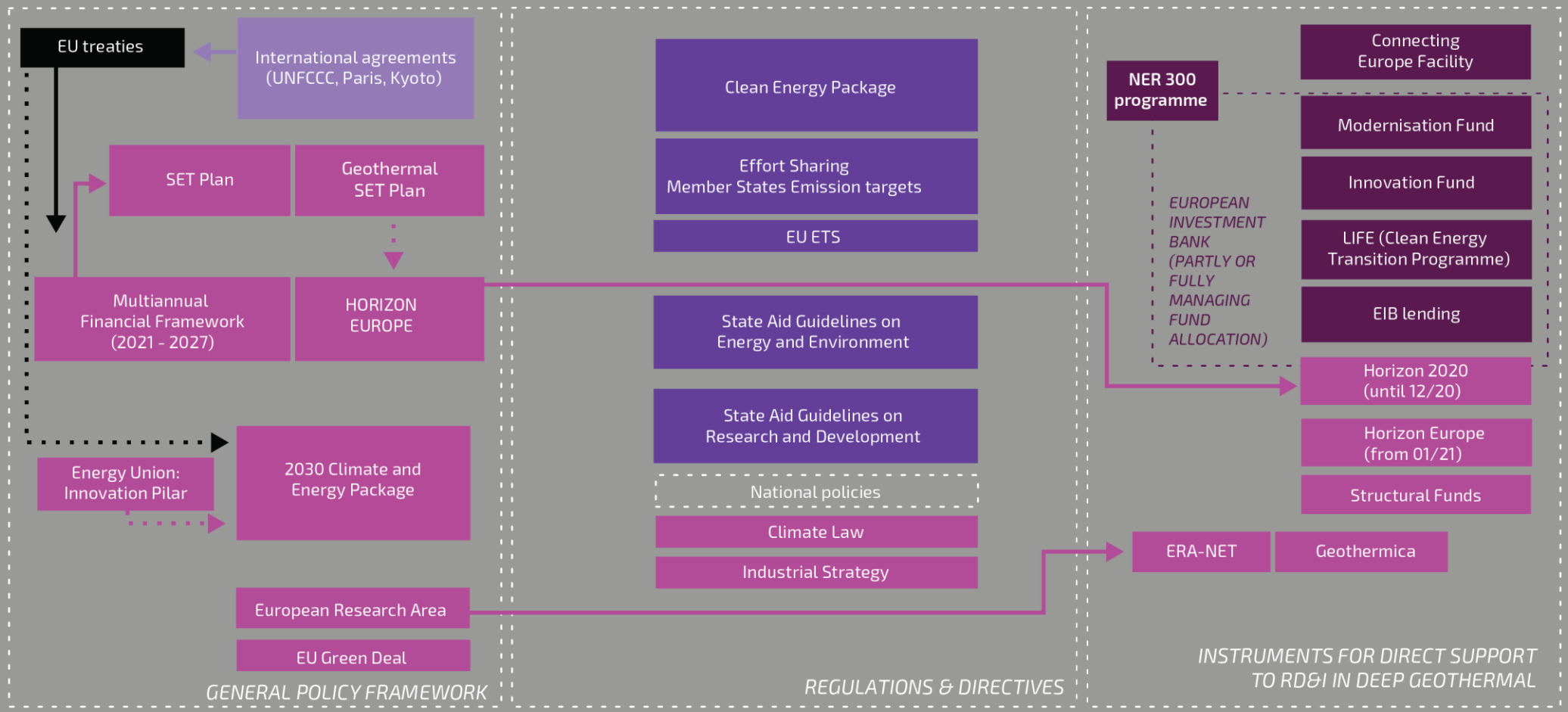

LEGEND

- Primary driver
- Partial driver
- European Commission as primary actor and enforcer
- EU laws
- EU Directives
- EU Regulations.: binding on Member States, although enforcement comes from the European Commission
- Guidelines: technical interpretation of Directives and Regulations by the EU Commission that shapes Member States application
- EIB managed financing
- International agreemetns

*LIST OF ABBREVIATIONS*

*EIB:* European Investment Bank
*ESD:* Effort Sharing Decision
*ESIF:* European Structural and Investment Fund
*ETS:* Emission Trading Scheme
*SET Plan:* Strategic Energy technology Plan
*UNFCCC:* United Nations Framework Convention on Climate Change

# OVERVIEW OF THE **EUROPEAN REGULATORY AND POLICY FRAMEWORK ON RESEARCH, DEVELOPMENT AND INNOVATION** RELATING TO DEEP GEOTHERMAL PROJECTS

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*EIB:* European Investment Bank
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*SET Plan:* Strategic Energy technology Plan
*UNFCCC:* United Nations Framework Convention on Climate Change

# 3. European policy and regulatory framework for deep geothermal energy

## 3.1 EUROPEAN CLIMATE AND ENERGY FRAMEWORK

### The 2030 package

The key 2030 targets are:

1) At least 40% cuts in greenhouse gas emissions (from 1990 levels) – might be up to 50-60% (currently under discussion);
2) At least 32% share for renewable energy;
3) At least 32.5% improvement in energy efficiency.

These are the EU-wide targets and policy objectives for the period from 2021 – 2030 that are included in the 2030 climate and energy framework that was adopted by the European Council in October 2014.

In order to translate the above-mentioned framework into regulations, a set of legislative packages were adopted:

1) The Emissions Trading System (ETS) that sets out the trading of GHG emissions in the European economy (-43% in 2030 compared to 2005);
2) The Effort Sharing Regulation (ESR) covering the sectors not covered by the ETS, aiming to reduce their emissions by 30% compared to 2005;
3) The National Energy and Climate Plans (NECPs), that Member States are obliged to adopt for the period 2021-2030 in order to reach the GHG emission targets (the first draft will need to be submitted by the end of 2019).

The Directive 2009/28/EC (RES Directive) is designed to ensure the achievement of the 2020 renewable energy targets. It addresses a number of key barriers for the deployment of geothermal such as lack of a widely accepted definition of geothermal energy, removal of administrative barriers, spatial planning, and certification of small-scale shallow geothermal installers. Moreover, it translates the EU target into legally binding national targets. In addition, the directive requires governments to submit national renewable energy action plans (NREAPs) including a qualitative analysis relating to the planned policy measures and a quantitative analysis showing sectorial targets and projections for each technology in electricity, heating and cooling, and transport.

Moreover, the recast Renewable Energy Directive (REDII) will enter into force in January 2020. The REDII sets a target of 32% renewable energy by 2030 at the European level. This forgoes the national binding target that are the rule until 2020. The targets are replaced by a governance system defined in a parallel regulation. It also defines a framework for supporting renewable energy project, where financing should be provided as a premium on

top of market price, and where Member States can choose to support specific technologies according to certain criteria (notably the need for diversification and to allow technologies with unachieved potential to emerge). In addition, the text allows the provision of specific support small-scale projects and to those for demonstrating innovative renewable technologies. It also prevents retroactive changes to a support schemes and requires that upcoming support scheme changes are announced at least 3 years in advance.

The provisions on support schemes are suitable to allow Member States to pursue the development of their national geothermal resources. A major new policy in this Directive is the addition of a provision on renewables in heating and cooling. Such provisions can serve as a further incentive to tap into the European geothermal energy potential:
- A national objective to increase by 1.3 percentage point annually the share of RES in the energy supplied for heating and cooling;
- Local and regional administrative bodies must include renewable heating and cooling in the planning of city infrastructure;
- Member States must provide adequate information to consumers regarding the renewable alternatives for heating and cooling.[1]

### The European Energy Union

In 2015, the European Commission has reorganised all the EU actions in the field in a framework strategy towards the establishment of a ‘resilient Energy Union with a forward-looking climate policy'. The strategy is being built around the following five dimensions:
1) Security, solidarity and trust: diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries;
2) A fully integrated internal energy market: enabling the free flow of energy across the EU through adequate infrastructure and without technical or regulatory barriers;
3) Energy efficiency: improved energy efficiency will reduce dependence on energy imports, lower emissions, and drive jobs and growth;
4) Decarbonising the economy: the EU is committed to a quick ratification of the Paris Agreement and to retaining its leadership in the area of renewable energy;
5) Research, innovation and competitiveness: supporting breakthroughs in low-carbon and clean energy technologies by prioritising research and innovation to drive the energy transition and improve competitiveness.

### Clean Energy for All European Package

This new dimension for the energy policies set the frame for having an energy system approach in the climate and energy package 2030 and in the Energy Roadmap 2050.

[1] Renewable Energy Directive, EGEC, https://www.egec.org/area/eu-climate-energy-framework/redii/

The Clean Energy for All European Package was presented by the European Commission in November 2016. Nearly two years later, after much debate, a final agreement was reached on the recast Renewable Energy Directive, the review of the Energy Efficiency Directive and on the Governance Regulation.
The agreement reached on the legislative texts for Renewables, Energy efficiency and Governance introduces key signals that, while not extremely ambitious or even aligned with the objective of the Paris Agreement on climate change, allow for the renewable energy industry to grow. It gives room for the greater emergence of geothermal energy with rules for support schemes that include the possibility to support differently different energy sources and to have specific schemes for innovative technologies.
In terms of ambition, the European Union is aiming for a share of renewable energy of at least 32% in 2030, alongside a 32.5% improvement in energy efficiency compared to a baseline. Altogether, these targets should put the EU on track to overshoot its 40% greenhouse gas emission reduction objective (compared to 1990).
Unlike the 2020 framework however, these EU targets do not translate into national ones. Member States will have to comply to the Governance framework that was also agreed upon, proposing National Energy and Climate Plans that lay out their national contributions to the EU objectives (which should amount to meeting the EU targets when all the Member States contributions are aggregated).

#### European Green Deal[2]

The European Green Deal provides a roadmap with actions to boost the efficient use of resources by moving to a clean, circular economy and stop climate change, revert biodiversity loss and cut pollution. It outlines investments needed and financing tools available, and explains how to ensure a just and inclusive transition.

The European Green Deal covers all sectors of the economy, including climate and energy. To set into legislation the political ambition of being the world's first climate neutral continent by 2050, the Commission will present within 100 days the **first 'European Climate Law'**. To reach our climate and environmental ambition, the Commission will also present the new **Industrial Strategy and Circular Economy Action Plan**, as well as other proposals for pollution-free Europe. Work will immediately start for upping Europe's 2030 emissions targets, setting a realistic path to the 2050 goal.

Meeting the objectives of the European Green Deal will require significant investment. Achieving the current 2030 climate and energy targets is estimated to require €260 billion

[2] European Commission, A European Green Deal, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

of additional annual investment, representing about 1.5% of 2018 GDP. This investment will need the mobilisation ofthe public and private sectors.[3]

The Commission will present in early 2020 a **Sustainable Europe Investment Plan** to help meet investment needs. At least 25% of the EU's long-term budget should be dedicated to climate action, and the European Investment Bank, Europe's climate bank, will provide further support. For the private sector to contribute to financing the green transition, the Commission will present a **Green Financing Strategy in 2020**.

Fighting climate change and environmental degradation is a common endeavour but not all regions and Member States start from the same point. **A Just Transition Mechanism** will support those regions that rely heavily on very carbon intensive activities. It will support the citizens most vulnerable to the transition, providing access to reskilling programmes and employment opportunities in new economic sectors.

Nonetheless, as part of the new EU Green Deal, the Commission will launch in March 2020 a **'Climate Pact'** to give citizens a voice and role in designing new actions, sharing information, launching grassroots activities and show-casing solutions that others can follow.

## 3.3 RESEARCH, DEVELOPMENT AND INNOVATION RELATING TO DEEP GEOTHERMAL PROJECTS

#### Emissions Trading Scheme, Effort Sharing Decision Modernisation and the Innovation Fund

The Emission Trading Scheme is the European carbon market for large facilities. The Effort Sharing Decision governs how “non-ETS” emissions reductions should be allocated among EU Member States. Within the Directives setting the ETS and the ESD, facilities to support the development of innovative renewable energy projects have been set up.

Among those, **the Innovation Fund** is one of the world’s largest funding programmes for demonstration of innovative low-carbon technologies. The Innovation Fund focuses on:

- Innovative low-carbon technologies and processes in energy intensive industries, including products substituting carbon intensive ones
- Carbon capture and utilisation (CCU)
- Construction and operation of carbon capture and storage (CCS)
- Innovative renewable energy generation

[3] The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind, EC Press Release, https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691

- Energy storage

The Innovation Fund is designed to take into account the lessons learned from its predecessor, the NER300 programme. It now includes:

- Open to projects from energy intensive industries
- More effectively tackles the risk component inherent to RD&I projects: up to 60% of the grant provided by the Innovation can be “milestone based” (e.g. completion of drilling) instead of performance based (i.e. delivery of CO2 emission reduction), which is crucial to geothermal projects due to the impact of geothermal resource risk on project finance.
- Provides support in more flexible way, following the cash flow needs of the project through pre-defined milestones
- Simpler selection process
- Stronger synergies with other EU funding programmes
- Streamlined governance and simplified decision-making

**The Modernisation Fund** is addressed at lower income European Member States for the modernisation of energy or industry facilities. It allocates 2% of the total ETS revenues. The Innovation fund meanwhile is expected to complement the Innovation Fund by providing financing to modernise the industrial equipment of Europe with a view to reduce emissions.

#### LIFE Programme

The LIFE programme, launched in 1992, is the only EU fund entirely dedicated to environmental and climate objectives. To date, it has co-financed, mainly through grants, over 4500 projects with total EU contribution amounting to about €5.9 billion. The present LIFE programme covers the period 2014 to 2020 and has a financial envelope of €3.5 billion. Today, it supports small scale projects aiming to share best practices, test small-scale technologies, and speed up the implementation of relevant EU legislation and policy. LIFE also acts as a catalyst for investment, notably trough integrated projects, and facilitates the implementation of large scale actions. In the light of this, the European Commission proposed on 1 June 2018 a regulation establishing a new LIFE programme for 2021-2027. The aim is to design an enhanced programme in order:

- to contribute to the shift towards a clean, circular, energy-efficient, low-carbon and climate-resilient economy, including through the transition to clean energy
- to protect and improve the quality of the environment
- to halt and reverse biodiversity loss, thereby contributing to sustainable development

To these ends, the Commission proposes €5.45 billion in current prices (0.43% of total EU spending) to be earmarked to the new programme which would contain two main portfolios, Environment and Climate Action, covering four sub-programmes:

- Nature and Biodiversity

- Circular Economy and Quality of Life
- Climate Change Mitigation and Adaptation
- Clean Energy Transition

To support the shift towards a clean energy, especially in regions that lag behind and have difficulty to absorb funding from the European structural and investment funds, the new programme would encourage investment and activities focusing in particular on energy efficiency and small-scale renewables.

#### Horizon Europe

Horizon Europe is the EU's next Framework Programme for Research and Innovation that will replace Horizon 2020. It will run from 2021 to 2027 with a proposed budget of €100 billion. Set to launch in 2021, Horizon Europe will build on the achievements of Horizon 2020, bridging the past and the future of research and innovation in Europe. It has a different structure than its predecessor and a larger budget (the European Commission is proposing a total budget of €100 billion for 2021-2027).
Horizon Europe is divided into three main pillars:

- Excellent Science;
- Global Challenges and European Industrial Competitiveness;
- Innovative Europe, with a budget of €13.5 billion.

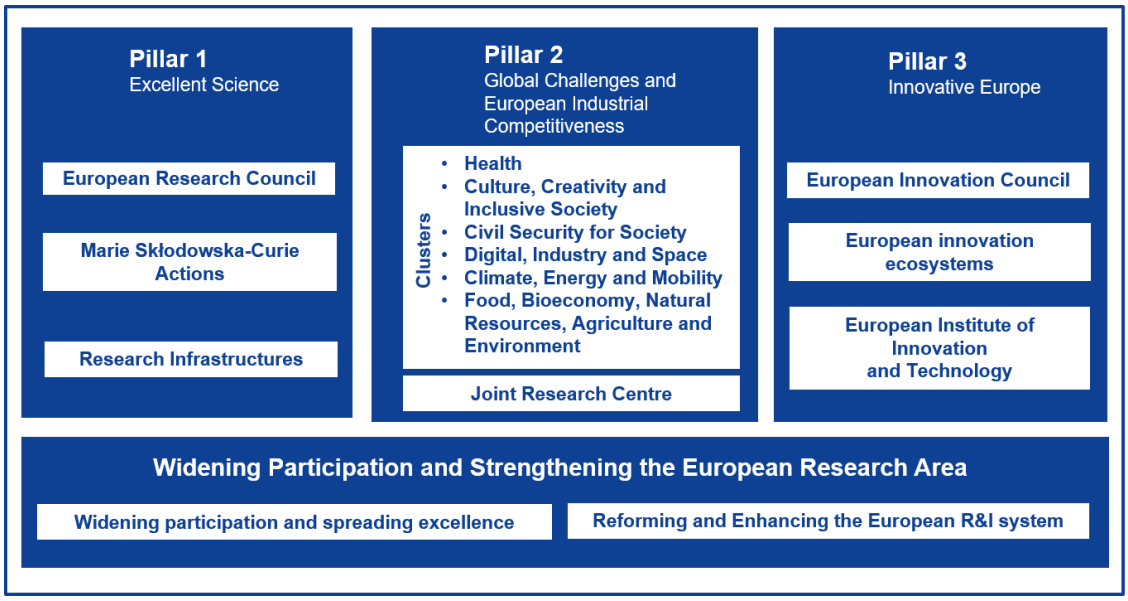
However, while Horizon 2020 was structured around seven main Societal Challenges, Horizon Europe identifies five overarching Global Challenges for action: Health, Inclusive and Secure Society, Digital and Industry, Climate, Energy, and Mobility and last but not least Food and Natural Resources.
The total funding dedicated to renewable energy projects, including geothermal energy, is not planned to increase as of 2019. The search for greater synergies between research priority areas may however lead to a greater inclusion of renewables across Horizon Europe projects (notably beyond the sole Climate, Energy and Mobility priority).

Horizon Europe will also introduce several new main features:

- A European Innovation Council (EIC) to help the EU become a frontrunner in market-creating innovation;
- New EU-wide research and innovation missions focusing on societal challenges and industrial competitiveness;
- Maximising the innovation potential across the EU;
- The principle of 'open science' that will require open access to publications and data;
- A new generation of European Partnerships and increased collaboration with other EU programmes.

The 2021-2027 programme will also five mission areas: adaptation to climate change including societal transformation, cancer, climate-neutral and smart cities, healthy oceans, seas, coastal and inland waters, soil health and food. Each mission will have a dedicated

mission board and assembly. Geothermal energy techologies are particularly poised to benefit from the funding aimed at addressing the “Climate Neutral and Smart Cities” mission.




*Preliminary structure of Horizon Europe, https://ec.europa.eu/info/horizon-europe-next-research-and-innovation-framework-programme_en*

### Connecting Europe Facility

The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone. Thus far, CEF financing in the energy sector has particularly benefited the deployment of gas infrastructure, and to a lesser extend transmission network for electricity. An upcoming challenge as the EC aims to increase the role of this facility in the energy sector, is for CEF to contribute to the necessary build up of renewable heating and cooling infrastructure in Europe, from which geothermal energy can dramatically benefit.

The CEF is divided into three sectors: CEF Energy, CEF Telecom, CEF Transport. A total budget of €5.35 billion is made available for energy projects for the 2014-2020 period, of which €4.6 in the form of grants managed by INEA.[4]

### European Investment Bank

The EIB is the European Union's bank. It is owned by the Member States and acts according to their policy priorities. The Bank works closely with other EU institutions to implement EU policy. It focuses on specific priorities including climate action and strategic infrastructure.

[4] CEF Energy, https://ec.europa.eu/inea/connecting-europe-facility/cef-energy

The EIB can intervene to support project through different channels such as:

- Loans: recipients range from large corporations to municipalities and small and medium-sized enterprises;
- Technical Assistance: which is provided by a team of experts (economists, engineers and sectoral specialists) to complement EIB financing facilities;
- Guarantees;
- Venture Capital: channeled through intermediaries.

In November 2019, the EIB decided that it would stop providing funding to fossil fuel projects from 2022 onwards. This development is a crucial step towards the redirection of financing to the energy transition. Being the largest public development bank, the EIB has an outsized impact on the allocation of financing to the energy sector, and as such it represents a model to follow for other financial institutions. The updated Energy Lending Policy constitute a template for other public and private financial institutions to also ban lending to fossil fuel projects.

# 4. Case studies of selected national frameworks

The objective is to have an understanding of national and EU RD&I regulations for deep geothermal in selected countries and to issue key policy recommendations for its improvement. Therefore, according to the Deliverable 6.4, this report targets the SET Plan countries that are not yet members of the DG IWG: Poland, Hungary, Bulgaria, Croatia, Greece, Finland and the United Kingdom.

These countries are considered to possess a significant potential for developing deep geothermal power and heat technologies. However, these technologies are not yet fully developed due to some continuous barriers and challenges. Each one of these countries has a different level of deep geothermal energy technologies deployment and market uptake that are listed below in more details.

## BULGARIA

### Highlights on the national situation

#### Overview of the deployment of geothermal energy

Bulgaria, as any other CEE market, has natural potential for renewable energy generation, including geothermal sources.

The installed thermal capacity increased by 19.6% from 83.10 MWt in 2014 to 99,37 MWt at the end of 2018; GSHP excluded. The renewable geothermal resources in the country have the potential for future direct use development. Currently only about 30% of the resources are being utilised.[5]

#### Stated objectives: policies and prospects

Bulgaria's energy objectives are defined on the national level by the Energy Act. This Act regulates the social relations associated with the activities of generation, import and export, transmission, transit transmission, distribution of electricity, heat and natural gas, oil and oil product transmission through pipelines, trade in electricity, heat and natural gas, as well as the powers of state bodies in formulating energy policy, regulation and control.

In May 2019 the Bulgarian parliament approved amendments to the Bulgarian Energy Act, which include opening the free market to small power producers, removing power export charges and mandating smart meters for industry, that is bringing further liberalization to the nation's energy market.[6]

[5] Geothermal Energy Use, Country Update for Bulgaria (2014-2018), European Geothermal Congress 11-14 June 2019 http://europeangeothermalcongress.eu/wp-content/uploads/2019/07/CUR-05-Bulgaria.pdf

[6] KPMG, *Amendments to the Energy Act,* May 2019 https://home.kpmg/bg/en/home/insights/2019/05/amendments-to-the-energy-act.html

## Programmes on geothermal energy in Bulgaria

| NAME | MANAGED BY | OBJECTIVES | BUDGET |
|---|---|---|---|
| **Renewable Energy, Energy Efficiency and Energy Security Program (including geothermal)** | Bulgarian Ministry for Energy and by the European Economic Area (EEA) Financial Mechanism 2014-2021 | Financial support for several RES projects, including the new geothermal energy installation. | Total EUR 33 million |

Bulgaria has launched in May 2019 its Renewable Energy, Energy Efficiency and Energy Security Program, with an estimated EUR 33 million budget to finance street lighting, geothermal and hydropower utilization, energy efficiency in buildings, and other projects, the Ministry of Energy has said on its website.

The program is divided into four areas – developing small hydropower plants (HPPS) in water supply systems, new geothermal energy installations, improved energy efficiency in buildings, industry and municipalities, and competence building in the program relevant areas. Bulgaria's Renewable Energy, Energy Efficiency and Energy Security Program is funded by the European Economic Area (EEA) Financial Mechanism 2014-2021. The program has been successfully deployed in Bulgaria, and its budget has doubled over the current programming period, thanks to the ministry's strategic partnership with the Norwegian Water Resources and Energy Directorate and the National Energy Authority of Iceland, according to the Bulgarian ministry's website.[7]

The program budget coming from the EEA grants is EUR 28 million, representing 85% of the total budget, while the remaining 15% comes from Bulgaria's own funds, according to the Norwegian Water Resources and Energy Directorate. Projects can be awarded until 2021, and must be completed by 2024.

[7] Balkan Green Energy News, *Bulgaria to launch EUR 33 million renewables, energy efficiency, energy security program,* May 2019, https://balkangreenenergynews.com/bulgaria-to-launch-eur-33-million-renewables-energy-efficiency-energy-security-program/

# CROATIA

## Highlights on the national situation

### Overview of the deployment of geothermal energy

Croatia has several geothermal district heating systems as a consequence of oil exploration in the second half of the 20th century, so geothermal development is not news to Croatia. In the past decade, renewed interest has led to the commissioning of new geothermal heating and cooling systems for greenhouse installations. Meanwhile, in order to satisfy energy independence objectives and achieve its climate and energy goals, Croatia has been looking to geothermal as a resource that might also be exploited for electricity production.

### Stated objectives: policies and prospects

Croatia National Energy Strategy 2009 – 2020 set the main targets to increase the share of renewable energy to 20% in the annual gross energy consumption of the country by 2020, which are implemented according to the National Renewable Energy Action Plan's (NREAP). The strategy sets up a goal to maintain the level of 35% of a share of electricity generation from renewable energy sources in overall electricity consumption until 2020, while in Heating and cooling RES is expected to cover at least 20% of the demand. In this context, geothermal is expected to cover 1.3% of RES total energy consumption by 2020, mainly for tourist-recreational facilities, as well as for space heating, hot water, agricultural production, industrial manufacturing, fish farms, etc.
Specific goals for the future exploitation of geothermal energy are also mentioned regarding economically justified exploitation of existing geothermal bores, economically acceptable utilization of bores in order to use the geothermal energy, and exploitation of medium temperature basins for development.[8]

## Programmes on geothermal energy in Croatia

| Name | Managed by | Objectives | Budget |
|---|---|---|---|
| The 2016 Act on Renewable Energy Sources and High-efficiency Cogeneration | N/A | provides the comprehensive codification of provisions concerning the planning and the promotion of RES; introduces support scheme for RES- | N/A |

[8] EGEC Country Fische, https://www.egec.org/wp-content/uploads/2019/11/Country-Fiches-HR.pdf

| | | | |
|---|---|---|---|
| | | electricity producers, covering all technologies, in the form of a premium tariff and a guaranteed feed-in tariff (for installations smaller than 30 kW). | |

The 2016 Act on Renewable Energy Sources and High-efficiency Cogeneration provides the comprehensive codification of provisions concerning the planning and the promotion of renewable energy sources and introduce support scheme for RES-electricity producers, covering all technologies, in the form of a premium tariff and a guaranteed feed-in tariff (for installations smaller than 30 kW). Specific loans and incentives are also provided by the Croatian Bank for Reconstruction and Development (HBOR), in cooperation with commercial banks, and through the Environmental Protection and Energy Efficiency Fund (FZOEU) (interest-free loans, subsidies, financial assistance, donations). Geothermal energy is eligible for all measures.

In November 2019 Croatia's first geothermal power plant, the 16.5 MW Velika 1 in Ciglena near Bjelovar, has been officially unveiled. The Turkish company MB Holding owns the plant. Europe's biggest binary power plant was built in an investment of HRK 325 million (around EUR 43.7 million).

The Croatian Hydrocarbon Agency (CHA) has announced in September 2019 a public call to select the best bid for geothermal energy exploration in the Križevci exploration area, for the purpose of issuing an extraction license for energy use, the third such invitation issued in as many months. A drilling license shall be issued for a maximum of five years and can be renewed, but not more than two times, for periods of up to six months, according to the announcement.

In late August, the CHA announced a bidding procedure for geothermal exploration in exploration areas Babina Greda 1 and Babina Greda 2, also for the purpose of issuing an extraction license for energy use, while in June it invited bids for geothermal exploration for energy use in the Karlovac 1 area, according to the agency's website. Zagreb-based MB Geothermal, wholly-owned by Turkish MB Holding, signed a contract in 2019 on designing a geothermal ORC (Organic Rankine Cycle) power plant called Legrad, with an installed capacity of 19.9 MW. This will be MB Holding's second major geothermal project in Croatia, after its Velika Ciglena geothermal power plant was put in operation in late 2018. Geo Power Zagocha has announced plans to build a 20 MW geothermal ORC power plant Earlier this year, Croatian firm Geo Power Zagocha announced plans to build a 20 MW geothermal

ORC power plant in the Slatina 2 exploration area in the municipality of Čađavica, according to earlier reports.Tendering for geothermal energy exploration in exploration areas Slatina 1, Slatina 2, Slatina 3, and Slatina 4, located on the territory of the city of Slatina and in the Sopje, Čađavica, Crnac, and Nova Bukovica municipalities, was launched in July last year.[9]

Nonetheless, Croatia can also count on EU funding programmes to contribute to ongoing projects, notably through the NER300/Innovation Fund in the near future. Private investor activity is also crucial for the development of the country's geothermal energy capacity.

## GREECE

### Highlights on the national situation

#### Overview of the deployment of geothermal energy

In terms of resources, Greece is characterized by a good potential for geothermal electricity deployment, a particularly valuable resources in an electricity market dominated by lignite use. A major geothermal resource, where there is a lack of data availability regarding the installed stock, is shallow geothermal systems, which can provide renewable cooling and are a proven solution in other Southern European countries. Shallow geothermal systems can be deployed in most of the country.
However, notably as a result of economic difficulties, the past decade has been a lost one for geothermal energy developments in Greece.
As of 2018, deep geothermal for heating and cooling represents 13 MWth for two projects, and there are no geothermal electricity project operating.
The geothermal sector is on a positive dynamic in Greece, with two projects having been commissioned in the past 5 years, and a renewed interest for geothermal heating and cooling and for geothermal electricity production. The sector also attracts both smaller private operators looking to source geothermal heat (notably for agri-food processes), public authorities investing in district heating, and large private developers.
Although some of Greece's resources are well identified, notably in relation of neighbouring markets, deep geothermal resources identification still requires extensive exploration work on Greece.

#### Stated objectives: policies and prospects

The 2010 national renewable energy action plan (NREAP) provides the basic framework for Greece renewable energy policy up to 2020 setting an overall target of 20% of energy generated from renewable sources in gross final energy consumption, with at least 20%

[9] Balkan Green Energy News, Croatia Issues Third Public Call This Summer For Geothermal Exploration, https://balkangreenenergynews.com/croatia-issues-third-public-call-this-summer-for-geothermal-exploration/

RES in heating and cooling and at least 40% in electricity. The plan makes only a passing reference to geothermal energy for potential future developments in industrial heat and the services sector. However, more measures are foreseen for the development of geothermal energy under the new National Energy and Climate Plan for 2030, currently under review by the European commission. Additionally, in 2003 the Greek Government adopted a law providing a specific regulatory framework for the "Exploitation of geothermal energy" (L.3175/2003), subsequently complemented in 2009 by 2 Ministerial Decisions laying down the conditions and procedures to lease out the right for geothermal energy exploration and management and the authorisations for the installation of space heating/cooling systems for own use.

### Programmes on geothermal energy in Greece

The 2010 national renewable energy action plan (NREAP) provides the basic framework for Greece renewable energy policy up to 2020 setting an overall target of 20% of energy generated from renewable sources in gross final energy consumption, with at least 20% RES in heating and cooling and at least 40% in electricity. The plan makes only a passing reference to geothermal energy for potential future developments in industrial heat and the services sector.

However, more measures are foreseen for the development of geothermal energy under the new National Energy and Climate Plan for 2030, currently under review by the European commission. Additionally, in 2003 the Greek Government adopted a law providing a specific regulatory framework for the "Exploitation of geothermal energy" (L.3175/2003), subsequently complemented in 2009 by 2 Ministerial Decisions laying down the conditions and procedures to lease out the right for geothermal energy exploration and management and the authorisations for the installation of space heating/cooling systems for own use.[10]

Greece is currently starting to develop its use of geothermal energy. Deep geothermal projects have started emerging in the past decade despite abundant resource. Looking forward to 2030, Greek national plans therefore need to set ambitious objectives based on resource, and aiming to scale up geothermal developments. These objectives should be accompanied with a sound policy, financial and regulatory framework that provides certainty to investors and attracts developers, notably developers with experience in other markets. To achieve a development of geothermal energy in Greece that is aligned with the country's resource, two key policies to be implemented include a robust scheme to mitigate the risk linked to geothermal resource uncertainty, and more generally improve the quality of knowledge of resources through exploration campaigns. The shallow geothermal sector,

[10] EGEC Country Fiche, https://www.egec.org/wp-content/uploads/2019/11/Country-Fiches-EL.pdf

which has a large potential to contribute to increasing penetration of renewable energy sources in the Greek heating and cooling sector, require a framework that acknowledges the specific characteristics of this technology compared to others.

# HUNGARY

## Highlights on the national situation

### Overview of the deployment of geothermal energy

Hungary has a tradition of using geothermal energy, notably in spa resorts. However, the country is also prominent is the use of its geothermal resource through district heating in Europe. There are over 254MWth of geothermal heat capacity in Hungary. The country is also investing in innovation, having inaugurated in 2017 its first geothermal combined heat and power in the Budapest area. Two additional combined geothermal heat and power plants are being developed, with planned capacities of 18 MWe for electricity and 34 MWth for heat.

### Stated objectives: policies and prospects

Hungary's first National Climate Change Strategy (NCCS) for 2008-25 was adopted by the parliament in 2008. It includes a greenhouse gas emissions reduction target of 16% to 25% for 2025 compared to 1990. The NCCS emphasized the government's obligation to create the necessary regulatory framework, to review and adjust subsidy systems and to raise awareness of sustainability in the society. The residential sector was given high priority. In 2011, Hungary issued a National Energy Strategy to 2030, including an objective for 25% renewables (notably geothermal) in heating and cooling, or to increase the use of geothermal for reducing agriculture's carbon footprint. The strategy estimates that geothermal could cover up to 5% of Hungary's energy needs on the long term.

## Programmes on geothermal energy in Hungary

| NAME | MANAGED BY | OBJECTIVES | BUDGET |
|---|---|---|---|
| **Environment and Energy Efficiency Operative Programme (EEEOP)** | National Development Agency and the National Environment and Energy Centre | The Environment and Energy Efficiency Operative Programme is one of the 15 operational programmes of New Hungary Development Plan; in the 5th priority axis, there is the increased energy efficiency and renewable energy application, specifically geothermal energy utilization. | EUR 3.7 billion (EUR 845 million for energy) |

The Environment and Energy Efficiency Operative Programme (KEHOP in Hungarian) is a EU co-funded programme that provides funding for the 2014-2020 period. It benefits from the Cohesion Fund (CF) and Regional Development Fund (ERDF). Energy efficiency

improvements, production of heat energy, especially in the building sector, using renewable energy sources including geothermal, support of renewable energy solutions and adaptation to climate change are among the priority areas of the programme.
In the framework of the EEA and Norway grants financial Mechanisms, the EEA FM-PA 6 Renewable energy programme area, there were two calls issued during the first quarter of 2014 and are currently under implementation:

- Increased renewable energy production: Implementation of Geothermal Based District Heating Systems – Replacing Existing Fossil Fuel Based District Heating;
- Increased awareness of and education in renewable energy solutions - Grant for Supporting Participation in Courses on the Utilization of Renewable Energy Solutions.

A new call for proposal was issued on January 2018[11] within the Regional Cooperation Fund for 2014-2020, and renewable energy, notably geothermal, is still among the priority axes. The budget for the Regional Cooperation is EUR 15 million.

## FINLAND

### Highlights on the national situation

#### Overview of the deployment of geothermal energy

Finland is a leading market for shallow geothermal in Europe. Thanks to a successful policy, regulatory and financial framework, coupled with favourable climate and geological conditions, the country consistently ranks among the top European countries in terms of installed stock and sales of shallow geothermal systems.
Finland does not however have any deep geothermal system currently operational, though some projects are under development for deep geothermal heating and cooling. Finland is particularly well suited for shallow geothermal developments, as its geology allows for more cost-effective drilling, and its climate justifies more easily the larger investments required by this heating and cooling technology.

11 Common Challenges – Shared Solutions – EEA and Norway Grants Fund for Regional Cooperation

Shallow geothermal systems can be deployed throughout the whole country. For deep geothermal, Finland does not have significant resources that are identified. However, as some ongoing projects for deep geothermal heating and cooling illustrate that there are deep geothermal resources available in the country, notably near the capital region of Helsinki. Ongoing projects demonstrating innovative technologies are a solution to prove deep geothermal resources in the country. Further exploration is however needed.

#### Stated objectives: policies and prospects

The 2016 National Energy and Climate Strategy for 2030 (MEAE), 2016 provides the main legislative framework for renewables and energy efficiency measures to achieve Finland's national targets of at least 50% of energy demand by renewable energy in 2030. Although it is not featured prominently, geothermal is considered among the new technologies that could bring additional potential for increasing the share of renewable energy sources in district heating production in the future. Emphasis is also put on the development of heat pumps for individual buildings and district heating.

Geothermal energy can benefit from different grant-based subsidies for the promotion of renewable energies technologies: The energy aid grant, which promote the use or production of renewable energies, advance energy efficiency and reduce the environmental effects caused by energy production and use, and the Investment Aid for Renewable Energy and New Energy Technologies. In addition, geothermal is eligible for and investment support for farmers, which can be used for the construction of heating facilities working on renewable energies.[12]

## Programmes on geothermal energy in Finland

In September 2019, the final phase of drilling the world's deepest geothermal heat wells in has been launched in Otaniemi, Finland. It is a project run by the Finnish energy company St1. The first 6.4 kilometre-deep geothermal heat well was completed last year, and the second well to a depth of 3.3 kilometres awaiting the results of water stimulation modelling. The drilling plan for the remaining part of the second well has been determined according to modelling and the actual drilling will start in September. Once complete in 2020, the plant will be the world's deepest geothermal heat production plant, which will produce heat completely without emissions.[13]

[12]

[13] ThinkGeonergy, Final phase launched of drilling the world's deepest geothermal heat wells in Otaniemi, Finland, http://www.thinkgeoenergy.com/final-phase-launched-of-drilling-the-worlds-deepest-geothermal-heat-wells-in-otaniemi-finland/

The theoretical and basic research (theory for applications) in Finland is mostly run by GTK. It has very comprehensive geological and geophysical data bank collected during tens of years. All Finland has been covered by air borne geophysics. GTK has also two mobile TRT-vans/units for in-situ surveys (Fig. 5). Also resources are focused on research, especially to theoretical behaviour and modelling of an single energy well as well as multi hole storage systems, and for determining the thermal properties of bedrock from layer to layer using fiber optic thermometers combining TRT- method and called DTRT- test. Moreover large installations/hybrid systems including real-time monitoring and steering of energy uptake from a field are under active research. Some trials with bentonite grouting have been run. A new challenge for research and applications will come from the need to go deeper, to depths of 1000-2000 m.[14]

In the medium term, Finland's key challenge will be to consolidate its shallow geothermal sector, notably as it enters a cycle of replacement of part of the installed stock. The stability of the framework that allowed this technology uptake is therefore crucial. Regarding the deep geothermal sector, there is a limited potential for development at scale in the medium term and will require a better knowledge of the resource potential for deep geothermal in Finland. Finland may also tap into innovative technologies such as Underground Thermal Energy Storage to integrate more variable renewables in its networks and deal with seasonal demand swings due to winter heat demand, which reduces the cost of the energy transition. Geothermal electricity developments are unlikely in Finland except for some possible demonstration projects for innovative technologies.

## POLAND

### Highlights on the national situation

#### Overview of the deployment of geothermal energy

While geothermal energy remains a minor component of Poland's energy mix, with 64 MWth of capacity currently installed for district heating, it does possess valuable resources. Poland also has a long history of using thermal waters for balneotherapy.
Highlighting its emergence as a key market for geothermal developments in Europe, with 14 plants currently in development (compared to 6 existing facilities).

#### National objectives and policy projects

Poland has not traditionally been a major actor in the geothermal sector. It has long had a strong indigenous energy industry, which remains to this day, with large coal reserves and

[14] Geothermal Energy Use, Country Update for Finland, http://europeangeothermalcongress.eu/wp-content/uploads/2019/07/CUR-10-Finland.pdf

a significant exploitation of its oil and gas resources. Poland's energy policy is notably characterised by a drive for autonomy and the use of indigenous source.
Another driver for the development of geothermal energy in Poland, is the need for improving air quality in the country, which still relies heavily on coal for heating purposes (which dramatic impact on different types or air emissions).
The highly developed district heating infrastructure, though it remains in need of additional investment, is an opportunity for integrating geothermal heat at a lower cost.

## Programmes for geothermal energy in Poland

| NAME | MANAGED BY | OBJECTIVES | BUDGET |
|---|---|---|---|
| **Public support for geothermal energy generation uses** | Ministry of Environment | Programme destined to financing the development of geothermal energy by local authorities. | EUR 45 million (exploratory well drilling)<br>EUR 113 million (additional well drilling) |

The Ministry of Environment plays a key role for the development of geothermal energy in Poland. Funds for supporting geothermal heat or CHP in Poland are primarily channelled through the Polish National Fund for Environmental Protection[15], which redistributes part of the royalties paid by fossil energy extraction to the Polish government into environmental projects (including renewable energy deployment).
Geothermal energy in Poland can also benefit from the geological survey realised in the second half of the 20th Century for the purpose of oil and gas exploration. This resource is made freely available by the Government.
Moreover, several European funding channels, from the European Union such as the structural funds, or from other programmes such as EEA-Norway grant also contribute to the emergence of deep geothermal uses in Poland. For instance, the EEA facility contributed to financing the development of a plant in Poddembice. Within the GeoHeatPol project it also aimed at collecting best practices for scaling geothermal energy deployment in Poland.
Poland is also looking into the possibility to set up a risk guarantee mechanism for reducing investment costs in geothermal energy projects. The GeoHeatPol project contributed some inputs to these debate, which remains at its early states – much like the development of geothermal in Poland.

[15] https://www.nfosigw.gov.pl/en/

# UNITED KINGDOM

## Highlight on the national situation

### Overview of the deployment of geothermal energy

Geothermal energy use in the United Kingdom comes primarily from shallow geothermal systems for heating and cooling, where there are more than 31,500 systems operational. Indeed, a strong focus has been put on this technology solutions for the decarbonisation of a building stock characterised by a dominance of individual heating and cooling systems.
The UK does not have operational geothermal electricity at this date, and only one deep geothermal heating and cooling project has been commissioned thus far. Developments are however ongoing in both cases. The British deep geothermal sector is quite diverse, and current operators and ongoing projects have been undertaken by large energy companies, SMEs and public authorities alike.
This diversity of actors is revealing of the relevance of geothermal energy as a solution for the British heating and cooling sector and the potential for scaling up developments provided the right framework is in place.
Deep geothermal resources are spread throughout the United Kingdom, although unevenly. Notable areas with identified deep geothermal resources for heating and cooling include the South West and the South East of England, Northern Ireland and parts of Scotland. Identified areas with resources suitable for geothermal electricity production include Northern Ireland and Cornwall. In both cases, more exploration could allow to identify more resources. Moreover, the UK, which has a rich history of coal mining, also has a large potential exploit geothermal heat trapped in abandoned coal mines, as several ongoing projects are aiming to. Shallow geothermal projects meanwhile can be implemented throughout the country.

### National objectives and policy projects

The 2010 National Renewable Energy Action Plan set a target for the United Kingdom to achieve 15% of its total gross final energy consumption from renewable sources by 2020, with around 30% of electricity generation and 12% of heat demand expected from RES. According to the NREAP, the main contribution from geothermal is expected in the heating sector from ground heat pumps, which are estimated to provide 953 ktoe of final energy consumption by 2020 (from 433 kin 2016).

## Programmes for geothermal energy in the UK

The use of geothermal energy is set to increase in the United Kingdom, both for shallow geothermal technologies and for deep geothermal energy use. For shallow geothermal, the sizeable, though fairly small when considering the overall size of the UK heating and cooling market, has large prospects to increase, provided the right policy, regulatory and financing

framework is put in place, reflecting the specific benefits of this heating and cooling technology compared to others.

Shallow geothermal is also a well-suited solution in a market with a low penetration of heating and cooling infrastructures. For deep geothermal, there are keen prospects for an increased in use, with the coming online of geothermal electricity projects in the coming few years and of new deep geothermal projects for heating and cooling. This will however require that the framework allows for security of investments, minimizes technology risk and that energy planning allows for the development of heating and cooling infrastructure at a larger scale in the country.

# 5. List of policy and regulatory issues

A geothermal energy system is developed in several phases. The figure below illustrates a simplified way to classify the different steps of a deep geothermal project:

a) exploration; b) resource development; c) construction; d) commissioning and operation.

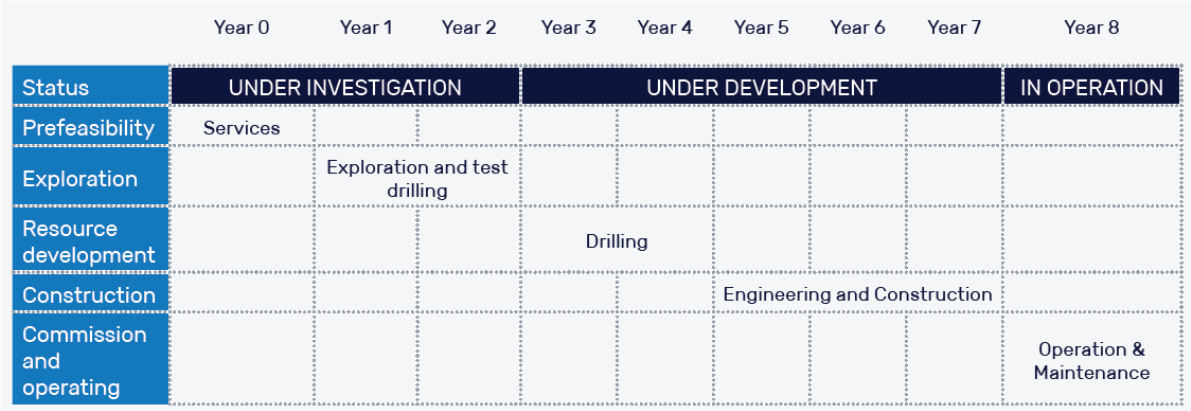



Figure 1. Phases of a deep geothermal project. Source EGEC Geothermal Market Report (2017: p. 44)

Each of these phases is subject to one or more permits and has to be compliant with a certain set of national and local rules. This whole set of rules should be transparent and balanced in order to guarantee a sustainable use of the resource, confidence in the technology, and investment security. The most relevant regulatory issues affecting the geothermal sector can be classified are the following:

### Definition, classification, and resource ownership

The definition, classification, and ownership of the geothermal resources affect many key aspects of regulation in this field.

In the EU, Directive 2009/28/EC (RES Directive) provides a legally binding definition according to which 'geothermal energy' means energy stored in the form of heat beneath the surface of solid earth (Art. 2).
A substantial legal issue is the definition of resource ownership. In this respect, in the EU three situations can be observed. The first one is when the geothermal resources belong to the state and its government that issues licenses and permits for its use. This is available for the majority of European countries that are having plants in operation and it seems to be the most desirable option in order to guarantee the security of investments for project developers. The second case, more typical for common law systems, is when the resource belongs to the owner of the surface area; this could lead to competition in the same area, where multiple owners are concerned. The third and the most problematic case is found in some juvenile markets where there is no clear definition of ownership. Traditionally, a first come - first served approach is in place, unless priority is given by law to a specific use.
The licensing procedures are coming from historical national regulations of the underground, in particular the mining code. European standards on resources classification could help geothermal market actors to report their resource to regulators and financial actors but the discussion has just started. Currently, an international debate is also taking place in order to define geothermal resources worldwide.

### Licensing and authorisations

The licensing or authorisation procedure is established by national, and sometimes regional, decision-makers. Within the geothermal sector, a license provides exclusive rights in a certain area and for a given period of time, thereby ensuring investment security. Additionally, a licensing regime tends to clarify issues such as who is eligible to obtain a permit, who are the licensing authorities, how many steps and the time the process involves, the exact time period for which a license can be obtained and extended, if royalties are required, and under what parameters.

### Financial risk management schemes

A Geothermal Risk Insurance Fund is seen as an appealing public support measure for overcoming the geological risk. As costs decrease and markets develop, the private sector will be able to manage project risks with, for example, private insurance schemes, and attract private funding.
With the notable exception of a few European market participants operating in well-developed geothermal regions, project developers have very little capability to manage the financial risk owing to the poor knowledge of the deep subsurface, lack of technological progress and high cost. In effect, the probability of success/failure weighted net present values of project cash flows tend to be overly negative, thus effectively shutting out private capital from investing in geothermal energy.
However, with technology development (increasing the probability of success of finding and developing geothermal reserves) coupled with experience and thus reductions in cost,

project developers will eventually be able to accept and, where appropriate, transfer project risks (technical, economical, commercial, organizational and political) in such manner that private funding will become available. Until then, a Geothermal Risk Insurance Fund is seen as an appealing public support measure for geothermal.

### Support schemes

Public support for geothermal energy involves the mobilisation of private financing in a difficult investment climate. The economic and financial crisis had a considerable impact on investments in clean energy. The picture already appears to be complicated. However, it should be mentioned that geothermal is a capital-intensive technology that takes some years to develop. Such a barrier can be tricky to overcome, especially with the European stock markets being still uncertain and with the banks looking exclusively for zero risk.
The European climate and energy policy framework is a major element driving financing to deep geothermal RD&I. The European Union in general has set up many facilities that direct financing to innovation in deep geothermal at every stage, from early research to the demonstration of deep geothermal energy project at scale. The identification and the assessment of the European policy and regulatory framework and the financing facilities is a starting point to estimating the needs of RD&I in deep geothermal.

# 6. Conclusions

Geothermal energy development is not a very recent exploration in Europe, but the market in this area remains underdeveloped. Even the current market conditions do not allow further development and a series of non-technical barriers still need to be removed. Moreover, a new generation of geothermal technologies is also needed for answering the challenges of the next decade for the European energy system.

Research and Innovation policies remain the key drivers and imperatives for the market uptake of deep geothermal energy. Innovation has already enabled an uptake of geothermal energy in areas where it was previoulsy undeveloped. It is therefore crucial for the regulatory framework of geothermal RD&I to be tailored to the needs of this sector, to foster innovation and bring innovative technologies to market.

Policy and regulation are keys to the growth of renewable energy. Therefore, it is necessary to understand the impact in the future to be able to come up with regulations or policies favoring energy production technologies that have relatively the least negative environmental impact.

An important aspect of geothermal RD&I is directly linked to the political support for climate mitigation and environmental protection. The shift towards geothermal energy is indeed a politically driven one, at least when it comes to supporting the development of new geothermal technologies to allow the development of more resources. To that end, the EU climate and energy objectives are a structuring policy for geothermal RD&I, as it is the bedrock for EU support to geothermal RD&I through such upcoming facilities as Horizon Europe, Innovation Fund, ERDF etc.

At the national level, geothermal RD&I is also promoted through the objectives of greenhouse gases reduction, energy security or environmental protection (notably the case in Poland where public support for geothermal is in large part motivated by the need to alleviate air emissions from the coal heating).

What comes out of the different case study that were laid out in this publication is the diversity in the support schemes that deliver funding to geothermal RD&I, which itself is a testament to the diverse meanings of geothermal RD&I. In emerging markets such as Poland or Bulgaria typically, RD&I means financing the first projects which give more information on geological conditions, increase the experience of the industry in the market, etc. In some markets that are more mature, geothermal RD&I may be the subject of research funding. Moreover, the importance of risk mitigation, whatever the type of funding facility, appears crucial in enabling geothermal RD&I. Grant based financing in earlier markets however do also amount to mitigating the various risk embedded in geothermal RD&I (from

the technology risk to the geological risk which happens when temperature and flow conditions of the reservoir are not aligned with an economic exploitation of the project).