European Technology And Innovation Platform On Deep Geothermal, A Presentation

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ABSTRACT

The European Technology & Innovation Platform on Deep Geothermal (ETIP-DG) is an open stakeholder group, endorsed by the European Commission under the Strategic Energy Technology Plan (SET-Plan), with the overarching objective to enable deep geothermal technology to proliferate and reach its full potential everywhere in Europe.

The Platform aims at bringing together all stakeholders representing deep geothermal technologies for power and/or heat from industry, research, and the public sector from all over Europe. Its mission is to provide a framework for stakeholders to define and implement a research and innovation strategy to increase the use of geothermal and to foster the growth and the market uptake of the relevant European industries.

To foster geothermal energy development in Europe, strategic documents are published: the Vision, the Strategic Research & Innovation Agenda (SRIA) and an Implementation Roadmap of Deep Geothermal Energy technologies.

1. INTRODUCTION

The European Technology and Innovation Platforms (ETIPs) have been recognised by the European Commission as a tool to strengthen cooperation with Stakeholders under the Strategic Energy Technology Plan (SET-Plan), as part of the H2020 programme. ETIPs focus on strategic issues where achieving Europe's future growth, competitiveness and sustainability relies upon major technological advances. They bring together industry and research stakeholders to define medium- to long-term research and technological development objectives and lay down markers to achieve them.

Deep geothermal energy is considered a key Renewable Energy Source (RES) to implement the EU 2020-2050 Strategy. It is recognised as a promising technology with large innovation potential in the European Commission's SET-Plan and its Integrated Roadmap.

The ETIP-DG aims at representing the entire deep geothermal energy sector at EU level, including companies, academia, research centres, and sectoral associations. It is thus uniquely placed to ensure that geothermal energy technologies can make a significant contribution to EU goals for decarbonisation, industrial development and technical innovation and excellence by 2020, 2030 and 2050. The Platform was launched in March 2016 during a Geothermal Forum of stakeholders, including large companies, SMEs, academia and research institutions. Terms of Reference (ToR) to establish the governance and procedures of the ETIP-DG were adopted in June 2016. The European Commission, DG RTD, officially recognised it as an ETIP in July 2016

2. MISSION AND ACTIVITIES OF THE ETIP-DG

The primary objective of the ETIP-DG is to foster overall cost reduction, including social, environmental, and technological costs. For this scope, the platform brings together representatives from industry, academia, research centres, and sectoral associations, covering the entire deep geothermal energy exploration, production, and utilization value chain.

Its activities focus on:

- The development of a long-term common Vision for deep geothermal for power and/or heat.
- The development of a European Strategic Research Agenda for deep geothermal for the next decade(s).
- Recommendations for the implementation of the strategic research agenda through a customized Technology Roadmap.
- Contribution to the European industry and research to maintain and consolidate its leading position in energy technologies for geothermal.

The definition of the needs of RD&I activities covers the development of all deep geothermal technologies.

2.1 Research and innovation policy

The European Union plays a key role in the promotion of renewable energy sources such as deep geothermal energy, notably thanks to its climate and energy policy framework.

The Renewable Energy Directive introduced key provisions for the development of deep geothermal RD&I. For geothermal for electricity production, priority of dispatch and priority access are instrumental to provide investor certainty at intermediate stages of technology readiness when supporting a demonstration project. The Renewable Directive also structured support schemes for renewable electricity at the European level, establishing feed-in tariffs or premiums that incentivise investments in new deep geothermal projects. The national binding target for minimum level of renewable energy in 2020 that included the Renewable Directive, as well as the requirement to provide some "National Renewable Energy Action Plans" were also instrumental for the development of deep geothermal by providing trajectories for each renewable source. The need to identify new resources to meet their target also led some Member States to initiate the development of deep geothermal in their territory or to relaunch it after long periods of stalled developments.

Geothermal RD&I is directly linked to the political support for climate mitigation, environmental protection (e.g. for air quality). 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.

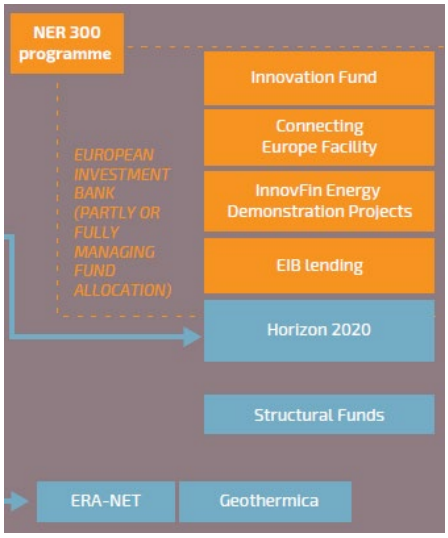

Figure 1: Overview of EU level instruments for direct support to RD&I in Deep geothermal (source: ETIP-DG).

EU level RD&I policies for deep geothermal focus on setting priorities for RD&I efforts in line with the priorities laid out by the EU's Climate and Energy Framework, which plays a crucial role in structuring the framework for deep geothermal innovation. For instance, the 2030 framework provides for specific support schemes provisions for innovative technologies, and specific rules for participation in the grid in the case of electricity projects.

At the national level, geothermal RD&I is also motivated by objectives of greenhouse gases reduction in many cases. It can also be motivated by other factors, such as 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 coal heating).

2.2 Financing research

Financing RD&I in deep geothermal rests on two dimensions: 1) public support to foster innovation; 2) financing mechanisms to best deliver financing to innovative projects with a high technology risk, and a likely long term pay back perspective.

At the European level, many instruments are structured to facilitate the emergence of innovative technologies. For financing projects, the Horizon 2020 programme is crucial in providing grants to fund deep geothermal RD&I. For more mature technologies, and notably for demonstration projects, the EIB is a crucial EU-level instrument, providing different types of funding (from lending to grants, including other types of financial instruments) to demonstration projects.

Nevertheless, for geothermal demonstration projects funding is mostly private, with either direct investments from the geothermal industry itself into innovation or, in some cases, through private equities and loans. At least in one case a crowdfunding platform was also involved. On the public side, structural funds and local governments provide the main financial support together with direct EU funding from H2020 projects.

There are many different types of support schemes that deliver funding to geothermal RD&I at the national level. In emerging markets such as Poland typically, RD&I means are used for 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 (as is the case in Germany for instance).

Moreover, the importance of risk mitigation, whatever the type of funding facility, appears crucial in enabling geothermal RD&I. It is for instance the case in France, the Netherlands and Flanders, where dedicated risk mitigation facilities are in place. 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).

3. THE VISION FOR DEEP GEOTHERMAL

The ETIP-DG released its "Vision for Deep Geothermal" in March 2018. The publication looks towards the future of deep geothermal energy development in the coming decades and highlights the great potential of untapped geothermal resources across Europe.

The Vision for Europe's R&I on Deep Geothermal is designed to trigger a debate about how best to achieve a future for geothermal energy in Europe that is secure, affordable, low carbon and which has the least impact on nature. To do so, it outlines the major potential of geothermal energy technologies to satisfy the European demand for heating and cooling and for electricity within the new 2030 climate and energy framework. It also highlights how the success of the energy transition entails designing optimal scenarios in terms of costs and affordability for the customers and the citizens, while guaranteeing energy comfort.

The "Vision" entails using geothermal energy to cover a significant part of the demand for domestic heat and much of the demand for electrical power in Europe. This includes fully exploiting the flexibility of the geothermal supply, providing large centralized as well as domestic and decentralized small scale options. It goes beyond the urban areas, by exploring the numerus applications already in operation producing heat for industrial and agricultural processes, for balneology and health spas.

It puts forward ten key messages:

- Resource potential: Geothermal is a widely available energy source, since underground heat is available everywhere;
- Fit for purpose: Geothermal has a large margin of progress in numerous applications and places;
- Stability & availability: Geothermal energy is available around the clock and has a predictable output;
- Growth: Geothermal resources are yet to be developed in most parts of the world and are ready to become a local economic development booster;
- Sustainability: Geothermal has a low environmental footprint;
- Cogeneration & hybridization: Geothermal can be combined with other energy sources and technologies to increase efficiency;
- Flexibility: Geothermal can be adapted to any type of energy demand, providing base load energy when needed;
- Optimization: Geothermal is a versatile source of energy, whose multiple-applications are optimized by cascade uses of heat;
- Cool & appealing: beside cooling the air of our houses, working spaces, malls, airport… geothermal is simply beautiful because it is essentially invisible;
- Market penetration & social dimension: Geothermal is a domestic and green resource, secure, stable, clean, and contributes to energy efficiency.

The "Vision" recognises that the ambitions outlined cannot be realized without a collective commitment. As we have learned in the last decades, energy transition is not only a matter of techno-scientific innovation, but also of cultural habits, social issues and political choices, which are strongly interconnected. To redesign the European energy systems towards a more sustainable future, the "Vision" calls for an interdisciplinary, open, 360 degrees approach, which cannot exclude the inexhaustible, renewable, and indigenous potential of geothermal energy.

Figure 2: The "City of the Future", as envisioned by the European Technology and Innovation Platform on Deep Geothermal (source: ETIP-DG)

4. THE STRATEGIC RESEARCH AND INNOVATION AGENDA

Following the SET Plan Declaration of intent on Strategic Targets, defined in the context of an Initiative for Global Leadership in Deep Geothermal Energy in 2016 and in its Implementation Plan adopted in 2018, the unlocking of the geothermal potential will be enabled by research and innovation focused on the improvement of technology and its incorporation into the energy system. These R&I actions must focus on achieving goals in terms of performance and cost-reductions.

Research and innovation will play a fundamental role in achieving these objectives. To helps us shaping a strategic R&I plan and to define R&I priorities, the ETIP-DG members compiled a Strategic Research & Innovation Agenda (SRIA). The SRIA reflects the 'Vision' of the ETIP-DG. This SRIA document recommends that action focuses on addressing the five main key challenges.

Three challenges are technological:

1) Prediction and assessment of geothermal resources:

A better understanding of complex and deep geological processes will enhance the predictability of underground conditions; deep exploration technologies will have high-resolution imaging capacity and data modelling will be fully integrated; geothermal resources beyond those already in development will be further characterized for optimizing their use and increase energy production. The overall objective of R&I in exploration is to reduce the costs of exploration technologies and increase probability to successfully characterize the geothermal resources prior to drill and during geothermal development.

2) Resource access and development:

Extraction of heat from the underground will be maximized by improved well designs, new drilling technologies, new sensors and monitoring techniques, and safe and sustainable flow enhancement. A reduction of drilling costs can be achieved by new or highly performant drilling techniques as well. Another basic challenge is to drill deeper and/or to reach very high temperature resources. There will be safe, rapid and automated technologies for accessing the underground.

Lifetime of boreholes and system components will be prolonged by using materials and pumps that are tailored for deep geothermal wells, real-time monitoring, and an in-depth understanding of reservoir and thermal loop processes. Underground energy storage will be efficient, fully integrated in the energy systems and responsive to demand.

Such R&I goals, to be also conjugated to environmental requirements, are of reference to the majority of European geothermal reservoirs, which often occur in densely populated areas and are characterized by low-to-medium temperature conditions.

3) Heat and electricity generation and system integration:

Energy conversion processes, surface systems of geothermal plants and the integration of geothermal heating, cooling and electricity supply into the energy system, the challenge is to maximise the generation at the lowest life-time cost. The net efficiency, performance and cost-effectiveness of production systems will be optimized, extending the temperature range of different applications of geothermal energy. Conversion of heat to electricity and to chill will be only constrained by physical laws and the production will be totally responsive to the demand and sustainable. Hybrid, multi-source and multipurpose high-efficiency systems embedding geothermal technology will become the European standard.

Two challenges are transversal:

4) From R&I to deployment (environmental, regulatory, market, policy, social, human deployments):

The aim is to develop regulatory, financial, political and social solutions that can be implemented for overcoming the barriers to the deployment of innovation in the sector, to the broad deployment of geothermal energy solutions and for increasing their uptake all over Europe. This must be done in parallel to the technological research described above, to enable geothermal energy to be one of the main contributors to the European climate and energy targets. It includes the support to establish a legislative framework that will sustain geothermal deployment, its penetration and profitability while guaranteeing that resources are properly managed, to provide low environmental impact technologies, to define economic evaluation criteria, including technical and economic risk assessment and finally to sustain partnerships between companies and consumers, by strengthening reciprocal trust through ethics and security.

5) Knowledge sharing (data harmonization and coordinated organization of data and information, shared research infrastructures):

Establishing an open-access policy to geothermal information (including standard exchange formats) will ensure open and easy access to data and information. This should be achieved through progressive harmonization of national data to facilitate data discovery and data mining. It is also vital to demonstrate throughout Europe capacity building, industrial technology transfer and science & academic partnerships via know-how, with the shared goal to develop high quality, competitive and sustainable geothermal energy projects.

Information, communication and analytics capabilities will be enabled on a large scale. Underground data will expand in number and type, will be globally organized and made easily accessible. Terms of reference for reporting and computing geothermal potential, production and capacity will be harmonized; data sharing will improve scalability and extrapolation of the information, improving the capacity to forecast techno-economic parameters and influencing energy planning.

Solving these challenges will give the geothermal sector enormous capability with regard to the key societal challenge of our energy future, and will add greatly to our ability to maintain the safety, security, wealth, and well-being of Europe. The overall Mission of the Research, and Innovation Agenda is to raise the Deep Geothermal sector to contribute to the Clean Cities and Communities of the Future, where a combination of renewable energy sources, including geothermal, for local electricity, transport and heating-and-cooling supply to buildings, tertiary and industry, with underground thermal storage facilities, and electric vehicle are integrated into the system.

5. THE UPCOMING DEEP GEOTHERMAL TECHNOLOGY ROADMAP

The ETIP-DG is now working on the implementation roadmap to plan research priorities and investigate ways of funding. It will also further define key performance indicators (KPIs) and major milestones. The Deep Geothermal Technology Roadmap is expected to be published in 2019. It follows the SET Plan Declaration of intent on Strategic Targets, defined in the context of an Initiative for Global Leadership in Deep Geothermal Energy in 2016. It will also participate to the execution of the SET-Plan Implementation Plan adopted in 2018, achieving goals in terms of performance and cost-reductions.

From 2020, the Deep Geothermal R&D plan will be implemented with research projects funded publicly by the upcoming European Programme Horizon Europe from 2021 to 2027, by the 2nd call of Geothermica (ERANET) and European level, and by national and regional public research programmes. The industry will also participate to the implementation through co-funding of R&D project and private investment in innovation.

In the framework of this implementation plan, first research results are expected by 2023. The ETIP-DG implementation plan 2020-2025-2030 will follow the timeline of the EU programme for R&I, and will present a plan for developing different research priorities and areas.

The implementation of the Deep Geothermal Technology Roadmap will be monitored by reviewing ongoing and recently achieved research projects and by assessing the impact of the first results on the key performance indicators. Future trends are also identified, by highlighting areas in which relevant projects are being developed, which could have an expected major impact on a given KPI. This analysis is performed by research area, as identified in the Deep Geothermal Technology Roadmap.

6. CONCLUSIONS

Deep geothermal energy is considered a key Renewable Energy Source (RES) to implement the EU 2020-2050 Strategy. It is recognised as a promising technology with large innovation potential in the European Commission's SET-Plan and its Integrated Roadmap.

In March 2016, the European Technology and Innovation Platform on Deep Geothermal (ETIP-DG) was launched as a tool to strengthen cooperation under the SET-Plan. The ETIP-DG is an open stakeholder group that brings together representatives from industry, academia, research centres, and sectoral associations, covering the entire deep geothermal value chain.

The ETIP-DG members sketched their view on the development of deep geothermal in the "Vision for Deep Geothermal". The Vision depicts that by 2050, large geothermal power plants that tap into ultra-hot, supercritical heat reservoirs supply a large part of Europe's baseload electricity would need to be developed. In places where the geothermal resources are of lower temperature, the electricity potential is boosted by combining geothermal with other renewable resources such as solar-thermal, salt-gradient power, photovoltaics or local biomass.

At the local level, geothermal Combined Heat and Power (CHP) plants are used for grid balancing services through voltage and frequency regulation and by supplying fast ramping, dispatchable energy. Additional flexibility is created by exploiting the vast thermal storage potential of 4th generation district heating and cooling (DH&C) networks, including low and high temperature underground thermal storage, tank and pit storage using advanced storage media, as well as storage in the building mass and the piping of the DH&C-network.

The 4th generation DH&C networks work in a temperature range of 55 – 25°C or lower. This allows utilization of low temperature residual heat derived from industrial processes and buildings and improves the efficiency of the connected RES. Intelligent supply-and-demand management based on predictive, self-learning control algorithms and fast data communication allows efficient utilization of the flexibility and ensures an optimal utilisation of all energy sources that are connected to the network. In this way, a hybrid energy infrastructure is created that connects DH&C networks with the electric grid, and other energy vectors through various coupling points.

REFERENCES

"Vision for deep geothermal", European Technology and Innovation Platform on Deep Geothermal (ETIP-DG), Brussels, (2018).

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