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Advancing Geothermal Energy Through Strategic Cooperation: The GEOTHERMICA Initiative

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ABSTRACT

The GEOTHERMICA Initiative demonstrates how coordinated public-sector cooperation can accelerate geothermal energy deployment across Europe and North America. Operating as a transnational funding and cooperation platform, GEOTHERMICA unites national funding agencies and public authorities to overcome market fragmentation, align research and innovation priorities, and facilitate strategic exchange on policy frameworks. Since 2017, the Initiative has mobilised over €90 million across three joint calls, funding 30+ transnational projects in 20 countries while establishing a sustained knowledge-exchange ecosystem.

This paper presents GEOTHERMICA's strategic framework, highlighting two complementary pillars: competitive joint calls for RD&I projects (TRL 4-8), and strategic cooperation between member states and with the sector through workshops, roundtables, and symposia. Emphasis is placed on the Initiative's Underground Thermal Energy Storage (UTES) Workshop and Symposium Series, developed in partnership with IEA Geothermal, which has positioned UTES as a cornerstone technology for flexible, decarbonised heating and cooling systems (European Commission, 2021).

GEOTHERMICA's governance model, built on shared decision-making, transparent coordination, and inclusive membership, provides a replicable blueprint for international clean energy cooperation. As the Initiative transitions beyond its Horizon 2020 Cofund phase, it invites new funding agencies and public authorities from Europe, North America, and beyond to join this expanding network. By aligning national resources with European climate goals, GEOTHERMICA accelerates the pathway toward carbon-neutral heating and cooling systems while strengthening energy security and industrial competitiveness.

1 INTRODUCTION

Geothermal energy remains underutilised for heating, cooling, and energy storage, even though it can provide reliable, dispatchable, and locally sourced renewable energy. Fragmented markets, inconsistent policy frameworks, and uncoordinated national research priorities have limited investment and slowed commercial deployment of geothermal technologies. To address these barriers, the GEOTHERMICA Initiative was launched as a coordinated transnational effort that aligns public-sector action around shared objectives for geothermal development.



Figure 1. Three pillars of the GEOTHERMICA Initiative.

Building on the Geothermal ERA-NET (2012–2016), GEOTHERMICA has evolved into a strategic cooperation platform built on three core pillars: joint calls for innovation projects, policy coordination among funding agencies, and stakeholder engagement through targeted knowledge-sharing activities (Figure 1). This integrated model links national and EU-level investments, helping research and demonstration projects progress toward deployment-ready solutions while supporting Europe's broader goals for renewable heating, cooling, and energy system integration.

The Initiative is governed through a General Assembly of participating funding and governmental agencies, a Cabinet that oversees strategic and operational decisions, and a dedicated Initiative Office jointly hosted by the Icelandic Environment and Energy Agency (UOS) and GEORG Geothermal Research Cluster (Figure 2). As GEOTHERMICA moved beyond its Horizon 2020 Cofund phase, it has entered a new stage focused on expanding membership, deepening international cooperation, and consolidating its role as a long-term platform for accelerating geothermal deployment. This paper presents GEOTHERMICA's evolution, core instruments, and main achievements, and outlines strategic priorities for the coming years to illustrate the value of this cooperation model for funding agencies and public authorities.

Figure 2. The GEOTHERMICA Initiative logo represents a coordinated transnational effort to advance geothermal energy research, innovation, and system integration through policy alignment, stakeholder cooperation, and joint funding programs.

2 MISSION AND OBJECTIVES

GEOTHERMICA's mission is to strengthen and accelerate geothermal sector development through coordinated public-sector action and strategic policy alignment. The Initiative pursues five interconnected objectives:

- Accelerate geothermal deployment by supporting RD&I activities across the entire value chain—from resource assessment and drilling to system integration and market uptake.
- Coordinate funding mechanisms at national and EU levels to improve efficiency, leverage investment, and reduce fragmentation.
- Strengthen transnational cooperation to ensure geothermal research aligns with regional, European, and international energy and climate frameworks (EU Green Deal, REPowerEU, European Geothermal Energy Strategy).
- Support energy system integration, positioning geothermal as a central component of sustainable district heating and cooling networks, with emphasis on Underground Thermal Energy Storage (UTES) as a critical enabler of system flexibility.
- Foster inclusive collaboration among public authorities, industry, and research organisations, addressing regulatory, technical, and financial barriers through shared learning and joint action.

To implement this mission and objectives, GEOTHERMICA has defined seven strategies that guide its joint calls, cooperation formats, and stakeholder engagement activities, as illustrated in Figure 3.



Figure 3. Strategies fitting the mission of the GEOTHERMICA Initiative

2.1 Strategic Priorities (2025–2027)

Between 2025 and 2027, GEOTHERMICA will focus on six strategic priorities that, together, accelerate geothermal deployment: decarbonising heating and cooling, integrating geothermal into urban and district energy systems, and scaling underground thermal energy storage as a flexibility asset. In parallel, the Initiative promotes cross-sector solutions with other renewables, develops opportunities for critical raw material and mineral recovery, and advances digitalisation through data, AI, and digital twins. These priorities steer joint actions, workstreams, workshops, and national updates, ensuring alignment with EU policy objectives, evolving member state needs, and annually agreed priorities of participating partners.

2.2 Operational model

GEOTHERMICA implements these priorities through a model:

- **Transnational cooperation** that aligns national funding agencies and public authorities around jointly designed RD&I activities, while financing remains based on national demands rather than external EU framework instruments.
- **Strategic knowledge exchange**, policy coordination, and foresight activities are shaping European and national geothermal strategies through workshops, roundtables, and symposia.

This model ensures that projects are embedded in a clear strategic and policy context, while research outcomes and stakeholder feedback continuously inform future cooperation formats, instruments, and workstreams.

3 JOINT CALLS: EVOLUTION AND IMPACT

The progression of GEOTHERMICA's joint calls illustrates the shift from singular technology validation to integrated, system-level innovation in geothermal energy deployment. Originally launched under the ERA-NET Co-fund framework within Horizon 2020 and transitioning into Horizon Europe, the calls drive the replication of projects and technologies, policy alignment and market integration, and support RD&I.

Since 2017, GEOTHERMICA has funded 30 collaborative projects engaging 200+ organizations, research institutions, SMEs, utilities, municipalities, and national agencies across 20 countries. These projects span TRL 4-8, advancing technologies from early development to commercial deployment (Table 1).

Collectively, the portfolio has mobilised over €110 million in combined public and private investment, enhanced subsurface characterization methods, demonstrated hybrid geothermal systems integrating renewable energy sources and storage, advanced digitalization of thermal grids through smart monitoring and control systems, and developed new business models for municipal and utility-scale geothermal deployment.

Table 1. GEOTHERMICA joint calls, focus areas, and project portfolios to date (2017–2021).

Call	Year	Focus	No. of Projects	Total Budget (€M)	Information
Joint Call 1	2017	Demonstration and Innovation	8	~50	Technology validation along the geothermal value chain
Joint Call 2	2019	Cross-sector integration	7	~30	Collaboration with CCS and energy systems.
Joint Call 3	2021	Heating & Cooling, UTES, and System Flexibility	15	~32	Hybrid systems, digitalisation, and storage; coordinated with JPP Smart Energy Systems

Full project information is available at **www.geothermica.eu**.

4 STRATEGIC COOPERATION

Low-temperature geothermal systems, covering direct-use applications, shallow geothermal, and underground storage, are emerging as one of Europe's most effective tools for decarbonizing heating and cooling networks. Recognising their strategic potential, the GEOTHERMICA Initiative has launched a Low-Temperature Workshop and Roundtable Series (2022–2025) to strengthen cooperation, identify barriers, and embed low-temperature geothermal into national and regional energy transition strategies. These activities align with Europe's Green Deal, REPowerEU, and the expected EU Geothermal Energy Strategy (2024), positioning geothermal energy as a reliable, local, and sustainable contributor to thermal decarbonization.

4.1 Underground thermal energy storage (UTES)

Underground Thermal Energy Storage (UTES), also called Geothermal Storage, has emerged as a critical enabler of geothermal system integration, linking heat and cold supply with renewable generation and network flexibility. UTES technologies, including Aquifer Thermal Energy Storage (ATES), Borehole Thermal Energy Storage (BTES), Mine-Water Thermal Energy Storage (MTES), and Pit Thermal Energy Storage (PTES), provide seasonal load balancing and support smart thermal grids.

The UTES track within GEOTHERMICA addresses four strategic themes:

- Large-scale storage integration: Multiple technologies support seasonal load balancing and link geothermal heat to grid flexibility.
- Policy, regulation, and financing: Even countries with mature storage technologies face fragmented regulatory systems and complex funding schemes. Switzerland's risk-guarantee mechanism serves as an exemplary model.
- Business models and market readiness: UTES is becoming commercially relevant beyond pilot status, with utilities and banks developing financing mechanisms.
- Knowledge exchange and capacity building: Many regions lack practical UTES expertise; coordinated learning is required to scale deployment.

Recognising UTES as a cornerstone of Europe's heating and cooling transition, GEOTHERMICA has established a dedicated UTES Workshop and Symposium Series in partnership with IEA Geothermal and the IEA Energy Storage TCP. Flagship events in Hoorn (ATES workshop, 2023), Offenburg (UTES symposium, 2024), Vienna (UTES workshop, 2025), and Zürich (UTES symposium, 2025) have brought together policymakers, industry, and

researchers to share operational experience, showcase leading projects, and identify joint priorities for regulation, monitoring, and financing.

Insights from these activities can inform a European (or even global) UTES Research and Innovation agenda that could define research priorities, technology pathways, and policy measures for deployment beyond 2030. Such an agenda can inform upcoming Horizon Europe calls and the Clean Energy Transition Partnership, while future GEOTHERMICA events will continue to link pilot demonstrations, financing dialogues, and policy roundtables. By placing UTES at the centre of Europe's heating and cooling transition, GEOTHERMICA is helping transform geothermal from a standalone heat source into system-enabling infrastructure essential for achieving climate neutrality by 2050.

4.2 Low-temperature geothermal: Driving Heating and Cooling transition

Low-temperature geothermal systems for direct use, shallow geothermal, and underground storage are emerging as highly effective options for decarbonising heating and cooling networks across Europe. To accelerate their uptake, GEOTHERMICA launched a Low-Temperature Workshop and Roundtable Series (2022–2025) that combines technical exchange with policy dialogue and regional case studies.

Key activities include a Roundtable on Heat Transition and Geothermal Opportunities in Ptuj, Slovenia (2023), the Iceland–Romania Geothermal Bridge Initiative (2024–2025), and a Geothermal Synergy Study Visit in Iceland (2025), which together have fostered cross-border learning on district heating, cascading uses, regulation, and capacity building. Proceedings and materials made available via the GEOTHERMICA website provide ongoing guidance for policymakers and practitioners.

Across these events, several recurring barriers have been identified: fragmented regulatory and permitting frameworks, high upfront investment needs, particularly for smaller municipalities, limited visibility of low-temperature geothermal in national heating strategies, and capacity gaps among local authorities and utilities. By addressing these challenges through coordinated workshops, roundtables, and follow-up actions, GEOTHERMICA is positioning low-temperature geothermal as a scalable, replicable solution that can support Europe's 2050 carbon-neutrality objective in a wide range of geological and climatic settings.

5 STRATEGIC STAKEHOLDER DIALOGUE

GEOTHERMICA's success relies not only on its coordinated funding mechanisms but also on stakeholder engagement, roundtable dialogues, and knowledge-sharing. The Initiative acts as a bridge between public authorities, industry, and research, with workstreams that are sometimes tailored to the needs of individual member states and sometimes to the wider geothermal community and sector. These processes ensure that outcomes from funded projects and policy discussions translate into actionable frameworks that support geothermal deployment, replication, and market integration of geothermal solutions.

GEOTHERMICA's approach is guided by three principles: co-creation, transparency, and replication. Early involvement of research institutions, funding agencies, utilities, and industry ensures that activities are scalable and policy-relevant, while open sharing of data, methods, and outcomes underpins evidence-based decision-making and accountability. Lessons learned are systematically captured and transformed into guidance and tools that inform national and European programmes, reinforcing impact beyond individual projects.

5.1 Knowledge Sharing Workshops

GEOTHERMICA organises knowledge-sharing workshops to facilitate project-level exchange, technical collaboration, and cross-sector learning. Recent workshops in Bern, Switzerland (September 2024), and Glasgow, United Kingdom (September 2025) brought together project coordinators, national agencies, and industry partners to review the outcomes of the Joint Call 2021 and explore innovation directions.

These events, organised in cooperation with CETPartnership, the Swiss Federal Office of Energy (SFOE), JPP Smart Energy Systems, and Scottish Enterprise, emphasise linking geothermal projects with district heating initiatives, digitalisation efforts, and energy storage networks to maximise system flexibility.

5.2 Communication and institutional partnerships

GEOTHERMICA operates a comprehensive outreach strategy that combines digital and in-person tools, including an online project database and dashboard, newsletters, policy briefs, webinars, and joint events with EGEC and ETIP Geothermal. Institutional partnerships with CETPartnership, the EERA Geothermal Joint

Programme, IEA Geothermal, and advocacy networks such as EGEC and ETIP Geothermal align geothermal priorities with broader energy-innovation agendas and policy processes. Coordination with the SET Plan Geothermal Implementation Working Group (IWG) ensures that GEOTHERMICA's activities contribute to Europe's 2050 vision for geothermal energy, including indicative targets for heating, cooling, power generation, and underground thermal energy storage, and support the revised Implementation Plan addressing non-technical barriers across the value chain. This participatory model has increased geothermal visibility in national strategies, strengthened research-policy alignment, and improved the prospects for replication across Europe.

6 IMPACT ON THE POLICY INTEGRATION OF GEOTHERMAL

GEOTHERMICA has achieved significant impact by transforming coordinated research frameworks into tangible innovation outcomes, strengthening policy coherence, and sustaining transnational collaboration. The Initiative aligns closely with the European Green Deal, the REPowerEU Plan, and the Clean Energy Transition Partnership (CETPartnership), positioning geothermal energy as a central pillar of Europe's decarbonization strategies. National funding and regulatory bodies have more firmly embedded geothermal development within their energy and climate agendas (see Table 2).

Table 2 National policy and regulatory impacts linked to GEOTHERMICA participation.

Country	Main policy or regulatory impact
Iceland (UOS, RANNÍS)	Geothermal confirmed as cornerstone of renewable strategy and sustainable resource management policy
Netherlands (RVO)	Geothermal recognised as a primary option for largescale heat decarbonisation, supported by dedicated schemes for district heating projects
Germany (PtJ)	Regulatory frameworks strengthened to streamline permitting, reduce investment risk, and expand roles for underground thermal storage
Switzerland (DETEC)	Risk guarantee mechanisms introduced to stimulate UTES deployment
Ireland (GSI)	Geothermal integrated into the 2024 National Policy Statement on Geothermal Energy, clarifying resource assessment and licensing rules
United States (DoE)	Participation in GEOTHERMICA used as a platform for regulatory dialogue, technology transfer, and investment de-risking in geothermal projects

Through this evolution, GEOTHERMICA has moved beyond a funding mechanism to become a platform for European alignment and strategic foresight, helping to shape the next generation of cooperation frameworks. Dedicated UTES workshops and symposia organised under the Initiative have raised the profile of storage-enabled geothermal solutions in European policy debates and informed discussions within the SET Plan Geothermal Implementation Working Group (IWG).

GEOTHERMICA also cultivates strategic partnerships with CETPartnership, the European Energy Research Alliance (EERA), the European Geothermal Energy Council (EGEC), the European Technology and Innovation Platform (ETIP) Geothermal, IEA Geothermal, and the SET Plan Geothermal IWG to coordinate research priorities and cross-sector efforts. Through these collaborations, the Initiative amplifies its impact, reinforces knowledge sharing, and supports policy alignment at European and global levels, underscoring geothermal energy's contribution to long-term decarbonisation objectives and inviting further engagement from funding agencies and public authorities.

7 LESSONS LEARNED AND STRATEGIC VISION

7.1 Key insights

GEOTHERMICA's experience offers several lessons applicable to transnational clean energy cooperation:

- Joint programming enhances efficiency and visibility: Aligning national and EU investments optimises the innovation value chain from research to market entry, reducing redundancies and leveraging comparative strengths among Member States.
- Early stakeholder engagement ensures relevance: Involving researchers, ministries, regulators, industry, and regional actors ensures project outcomes align with real policy challenges and market needs.
- UTES as a system enabler: Underground thermal storage unlocks the full potential of geothermal energy by providing flexibility, stability, and seasonal balancing capacity, essential for decarbonised thermal energy systems.
- Strategic differentiation creates new opportunities: Combining geothermal with storage, digitalisation, and district energy opens growth pathways that traditional energy markets have not captured—by creating new value spaces through innovation.

7.2 Future directions

GEOTHERMICA's future aligns with the expected European Union's Geothermal Energy Strategy (2024) and REPowerEU Plan. The Initiative will continue deepening integration with CETPartnership and contributing to SET Plan updates, ensuring geothermal innovation remains central to Europe's net-zero pathway. Future priorities include:

- Advancing research, innovation, and deployment of geothermal and geothermal storage (UTES).
- Strengthening international collaboration with IEA Geothermal, Mission Innovation, and national agencies.
- Extending the collaborative model to emerging geothermal markets.
- Exploring possibilities for transnational project funding through bilateral projects and/or possible multinational calls in the future.

By pursuing these future directions, GEOTHERMICA aims to evolve from a funding network into a strategic transformation platform that actively shapes value-chain optimisation and system integration pathways for geothermal energy. This evolution will help ensure that geothermal becomes a defining element of a competitive, sustainable, and climate-neutral energy system in Europe and in partner regions worldwide.

8 CONCLUSIONS

GEOTHERMICA has established a robust and scalable model for transnational cooperation, information sharing, financing coordination, and policy integration in geothermal energy. Since 2017, the Initiative has mobilised more than €90 million for over 30 projects across 20 countries, creating a lasting knowledge-exchange ecosystem that strengthens Europe’s capacity to deploy geothermal heating, cooling, and storage systems and positions UTES as a cornerstone technology for the energy transition. Its governance model is based on shared decision-making and transparent coordination and offers a replicable blueprint for international clean-energy cooperation.

As GEOTHERMICA enters its next phase, the Initiative aims to evolve from a funding network into a strategic transformation platform that designs and tests pathways for integrated geothermal solutions. By aligning national resources with European climate objectives and by advancing dedicated roadmaps for UTES and low-temperature geothermal, GEOTHERMICA can help partners accelerate deployment, enhance energy security, and support a resilient, carbon-neutral energy system in Europe and beyond.

Funding agencies and public authorities are invited to engage with GEOTHERMICA by joining its cooperation framework, contributing to future joint calls, and participating in workshops and strategic dialogues that shape research and innovation priorities. Interested organisations can find further information on ongoing activities, project portfolios, and partnership options at www.geothermica.eu or by contacting the GEOTHERMICA Initiative Office.

Visit www.geothermica.eu to learn more and join the Initiative.

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