

Enhancing Knowledge and Awareness about Geothermal Energy Through Art, Education and Engagement

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Keywords: education, dissemination, awareness, art, science

INTRODUCTION

Widespread knowledge and early engagement are crucial for the successful implementation of geothermal projects. A lack of awareness and understanding can hinder the development of this renewable resource, particularly in countries such as Italy where significant untapped potential exists. To address this gap, the Istituto Nazionale di Geofisica e Vulcanologia (INGV) has designed an integrated outreach strategy that merges science, art, and education to promote geothermal education. Three complementary tools have been developed: a scientific-art installation, i) PULSE (Power Under Land Source of Energy); ii) structured educational pathways for schools; and an iii) illustrated children's book. These initiatives aim to make geothermal concepts accessible, emotionally engaging, and pedagogically effective, fostering informed and receptive communities for future geothermal development.

1 BACKGROUND AND RATIONALE

Geothermal energy represents a clean and sustainable resource capable of supporting the energy transition and reducing greenhouse gas emissions. However, despite its advantages, public awareness of geothermal potential remains limited in many regions. Misconceptions about environmental impact, safety, and technical feasibility often obstruct acceptance and investment. Early and transparent engagement is therefore essential. Effective communication strategies can bridge the gap between complex geoscientific concepts and public perception, nurturing a shared understanding of geothermal resources and their benefits. In this context, educational and artistic approaches have proven powerful in transforming how audiences perceive science, inviting emotional connection, curiosity, and reflection. Within this framework, the INGV initiated a series of activities aimed at increasing geothermal awareness among diverse audiences, from children to adults, from schools to cultural spaces. The initiative, developed by a multidisciplinary team of scientists, communicators, educators, and artists, is structured around three main tools: i) the creation of a scientific-art installation named PULSE (Power Under Land Source of Energy), ii) the development of educational programs for schools, iii) the publication of an illustrated children's book. Public acceptance is a decisive factor for the success of geothermal projects. In several European countries, including Italy, opposition often arises from insufficient understanding rather than from technical or environmental issues. Therefore, fostering geothermal literacy, the ability to comprehend basic geothermal concepts and implications, is fundamental. Traditional outreach tools, such as lectures, reports, or websites, tend to reach only a limited audience. New strategies must stimulate curiosity and emotional resonance, enabling people to feel the Earth's energy rather than merely learn about it. Art and interactive education offer such pathways, allowing complex processes to be perceived through sensory, experiential, and creative dimensions. The rationale behind this work lies in the belief that science communication is not only about data transmission but about connection and participation. Engaging citizens from early ages and through diverse media can generate a cultural shift toward greater openness to renewable energy solutions.

2 METHODOLOGY AND DEVELOPMENT OF TOOLS

The outreach framework developed by INGV follows an iterative design combining scientific accuracy, pedagogical structure, and artistic creativity. Each tool was conceived to address a specific audience segment but to function synergistically within a unified narrative: the heat beneath our feet as a living, dynamic energy source.

2.1 PULSE – Power Under Land Source of Energy

PULSE (Power Under Land Source of Energy) is an immersive, transmedia scientific-art installation located at the headquarters of the *Istituto Nazionale di Geofisica e Vulcanologia* (INGV) in Rome, Italy. The installation, developed in collaboration with an artistic-union (LIMINAL-STATE), is accompanied by a set of multimedia contents designed to promote and explore geothermal energy, bridging the knowledge gap that often limits public understanding and support for geothermal resources. The installation is organized into two complementary sections: outdoor and indoor (figure 1).

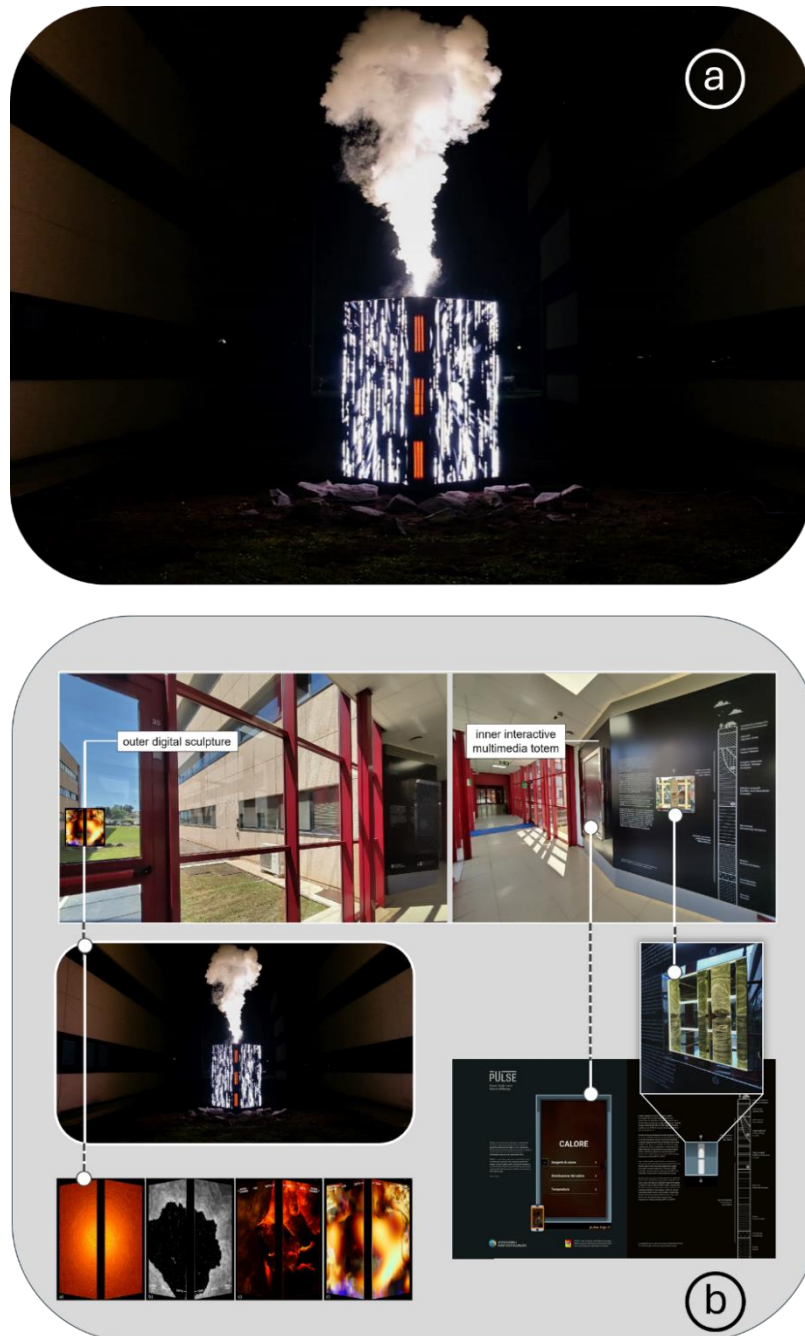


Figure 1. a) PULSE: external digital installation simulating a fumarole with infrared pulsating heating; b) internal 65" touchscreen and mirror box (quadrisfera) presenting, respectively: scientific concepts about geothermal energy, available on the web-platform pulse.ingv.it, and two core samples relative to the Larderello geothermal reservoirs. The cores are kindly provided by ENEL Green Power.

The outdoor component consists of a digital sculpture formed by two vertical LED walls, offering visitors a virtual journey into the Earth's interior through a combination of visuals and sound. The experience guides visitors through primordial heat generation, the accumulation of energy within geothermal reservoirs, and their surface manifestations. The narrative alternates between two main phases - a descent into the Earth

and an ascent toward an active geothermal system. Between these sequences, a simulation of a several-meter-high fumarole provides a vivid reminder of how the planet's heat naturally emerges at the surface. At the core of the sculpture, infrared pulsating heating lamps allow visitors to physically feel the Earth's heat. The projection sequence displayed on the LED walls presents a series of frames developed according to the rheological behavior of the planet moving from the Earth formation and primordial heat generation and solid metallic inner core to magmatic chamber and geothermal reservoir. For each element, indicative depths and temperature ranges are shown, anchoring the experience in solid geoscientific evidence. The indoor section complements the outdoor experience with a 65-inch touchscreen containing multimedia and educational content built on a WordPress-based architecture and accessible through the interactive web application *pulse.ingv.it*. This web-platform provides access to scientific and technical information on geothermal energy. The indoor area also features a “*quadrisfera*” mirror box, which displays rock core samples from the Larderello geothermal reservoirs for immersive 360° viewing, connecting the sensory experience to tangible geological evidence.

2.2 Educational pathways for schools

To strengthen geothermal literacy in formal education, INGV designed structured educational pathways tailored for primary, middle, and high schools. These pathways were co-developed with teachers to align with national curricula. Each level introduces geothermal energy through age-appropriate content, from simple games to technical lessons. The educational programme starts from the teachers, providing them the necessary knowledge and awareness to develop, in a second moment, specific and dedicated activities with their classrooms. The entire programme aimed to improve knowledge of geothermal resources (figure 2).

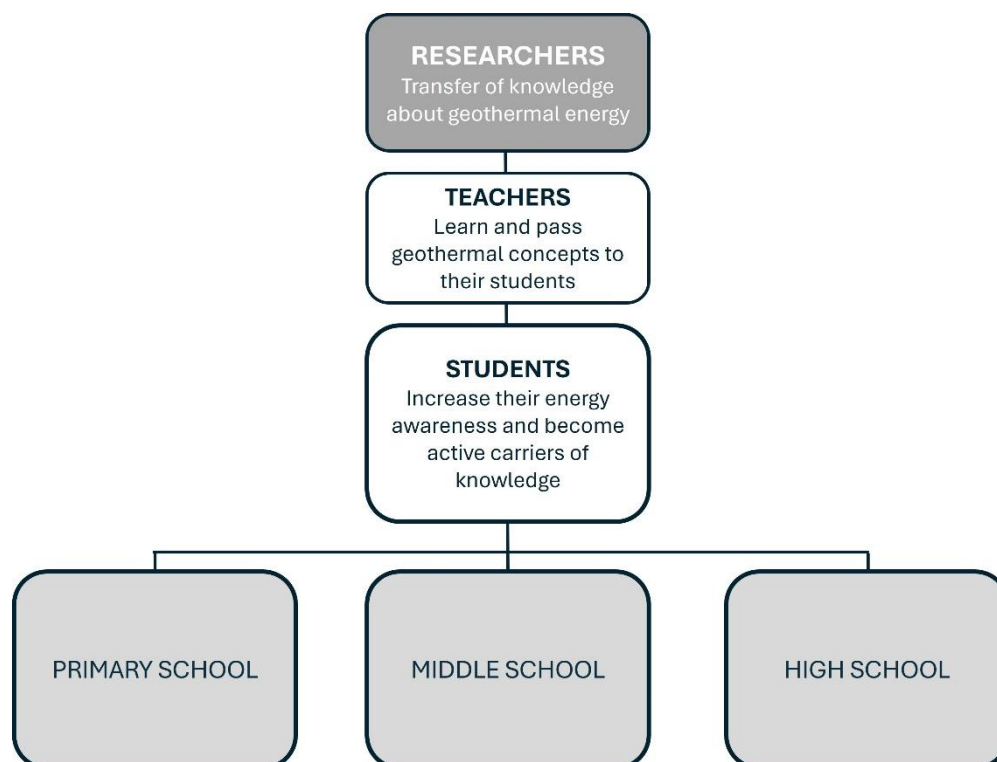


Figure 2. Workflow adopted for geothermal educational activities in the schools: researchers train teachers, who design geothermal activities that empower students across school levels.

This methodology has been strongly applied in the past by INGV in the framework of educational programmes aimed to increase the awareness respect to seismic and volcanic phenomena (Camassi et al., 2005; La Longa et al., 2012; Camassi et al., 2016; Crescimbeni et al., 2016; Musacchio et al., 2021). The educational pathways proposed to the teachers were structured around three core objectives: i) promoting the understanding of fundamental concepts related to geothermal energy and stimulating scientific curiosity; ii) supporting the development of critical thinking on the risks, benefits and sustainability of geothermal resources; iii) fostering active collaboration among teachers, students, families and the scientific community. A key methodological component was the active involvement of teachers, who, supported by INGV researchers, adapted scientific content to their class context. Teacher training thus became the backbone of

the entire pathway. The educational activities were carried out in November 2025 in the Aeolian Islands, engaging all three school institutes of the archipelago (*IC S. Lucia, IC Isole Eolie, Istituto Superiore I. Conti Eller Vainicher*). The Aeolian Archipelago was selected in connection with the ongoing IRGIE research project (Procesi et al., 2025), aimed at developing an inventory of geothermal resources on the islands, estimating their geothermal potential, and identifying suitable uses. Around 40 teachers, 50 classes and approximately 700 students from primary to upper secondary schools have been engaged. INGV researchers provided two multi-module training courses (8 hours each), delivered either online or in presence depending on school needs. The modules covered: (i) Earth structure and origin of terrestrial heat; (ii) geothermal energy and its technological uses; (iii) environmental impacts, risk communication and comparison with other energy sources; (iv) methodological guidelines for designing geothermal educational activities. After the training phase, teachers co-designed classroom activities with INGV support (from December 2025 to April 2026). This phase adopted a transdisciplinary approach integrating several school subjects. Experiential learning has been strongly encouraged: hands-on demonstrations, local case studies, field-based observations and creative outputs were used to reinforce scientific concepts. The educational pathway have included two final moments: a concluding workshop with teachers to evaluate impact, level of satisfaction, and pedagogical effectiveness; a public event involving students, families, local administrations and citizens, where classes present their work and discuss geothermal opportunities for the Aeolian Islands. All materials, such as presentations and texts, produced during the educational activities will contribute to a final set of educational resources, including a geothermal educational guide for teachers and students. The first implementation of the programme demonstrated high levels of engagement among teachers and students, confirming that structured educational interventions can substantially improve scientific literacy, especially in territories where geothermal resources are locally present but not well understood.

2.3 Illustrated Children's Book

To engage the youngest audiences, we have developed an illustrated book that presents geothermal energy through an accessible narrative. Specifically, the book is designed as a graphic novel following a day in the life of a young girl who chats with her grandfather. Through their conversation, the grandfather explains how the energy that powers homes can also come from the Earth's heat, introducing the concept of geothermal energy in a relatable way. This storyline is enriched with insights into the Earth's internal structure, the origins of the Earth's heat, and sustainable practices for using energy. By framing the science in a personal and visual story, the book fosters early awareness and curiosity about renewable energy. It helps children grasp where the warmth in their homes can originate and encourages a more sustainable mindset from a young age.



Figure 3. Mockup of the illustrated book “The Magical heat of the Earth”.

3 DISCUSSION AND CONCLUSIONS

The integrated outreach strategy developed within this project demonstrates that combining artistic installations, school-based educational programs, and child-oriented storytelling can significantly enhance public understanding of geothermal energy. By merging sensory experience, structured pedagogical pathways, and narrative-driven learning, the three tools - PULSE, the IRGIE educational program, and the illustrated children's book—address complementary segments of society and create a coherent and scalable model for geothermal literacy. The results highlight that early engagement, particularly through teachers and young students, strengthens the capacity of communities to critically assess energy options and fosters greater openness toward geothermal development. Likewise, immersive art-based communication effectively conveys invisible geoscientific processes, making them emotionally and conceptually accessible to wider audiences. Overall, this approach underscores the importance of multidimensional communication strategies in supporting the energy transition. Future efforts will focus on replicating and expanding these tools in other regions, evaluating long-term learning outcomes, and integrating additional digital resources to further strengthen the dialogue between scientific institutions and society.

Acknowledgements

The authors would like to thank the teachers who chose to participate in the educational programme, as well as all the students involved. Special thanks go to the Regional School Office of Sicily and to Isabella Munda for facilitating the implementation of the activities in the schools. We also thank *Regione Siciliana*, Department of Energy, for funding the IRGIE Project (2023-2026). All the dissemination tools presented in this extended abstract were developed with funding from the IRGIE Project and *Istituto Nazionale di Geofisica e Vulcanologia*.

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