Smart Use of Geothermal Energy

Next Generation Flexible Trigeneration Geothermal ORC Plant

Innovating Geothermal Energy for a Carbon-Neutral Europe

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Project Overview

€5 million
Budget

48 months
Duration

6
Milestones

7
Partners

3
Key Technologies

Consortium Members

Fraunhofer

TECHNOVATIVE SOLUTIONS

ZORLUENERJI

GEOLORN IRELAND LIMITED

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LE GROUPE Naldeo

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Mission

Core Mission

To transform geothermal Organic Rankine Cycle (ORC) plants into flexible tri-generation systems that produce electricity, heating, and cooling, using an AI-integrated Energy Management System (EMS).

Energy Demand Focus

Heating and cooling account for 46% of EU energy cosumption, with only 18% met by renewables. nGEL targets the untapped potential of low-to-medium temperature geothermal resources to balance energy demands.

Scalability Potential

If applied across the EU, nGEL could meet about 4% of the EU’s current annual heat demand, equivalent to an economic saving of €9.6 billion annually through reduced natural gas imports.

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The Challenges

Energy Consumption Gaps: Heating and cooling represent 46% of the EU's energy use, but renewables only cover a fraction of this demand.

Reliance on Fossil Fuels: Natural gas is a primary source, creating economic and environmental vulnerabilities.

Grid Instability: Current renewables (e.g., solar, wind) are intermittent, challenging grid stability.

Low-Temperature Resources: Europe has abundant low-enthalpy geothermal fields, but they are underutilised, especially in binary ORC plants.

What is Needed

Flexible and Scalable Renewable Energy:
nGEL's tri-generation system provides flexibility for various energy demands.

Real-Time Demand Response:
An AI-driven EMS, integrated with cold and thermal energy storage, enhances grid compatibility and supports the day-ahead energy market.

Scalability Across the EU:
The technology targets sedimentary formations (e.g. Pannonian Basin and Upper Rhine Graben) and can be implemented widely with existing and new ORC infrastructure.

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Project Objectives

Design flexible geothermal ORC with trigeneration capabilities

Ensure environmental sustainability

Develop a control strategy for Demand Side Management (DSM)

Design and develop Cold Thermal Energy Storage (CTES)

Increase reliability of ORC against high ambient temperature

Integrate AI-driven Digital Twin for nGEL integrated ORC plant

Provide an Energy Management System (EMS) for the flexible ORC

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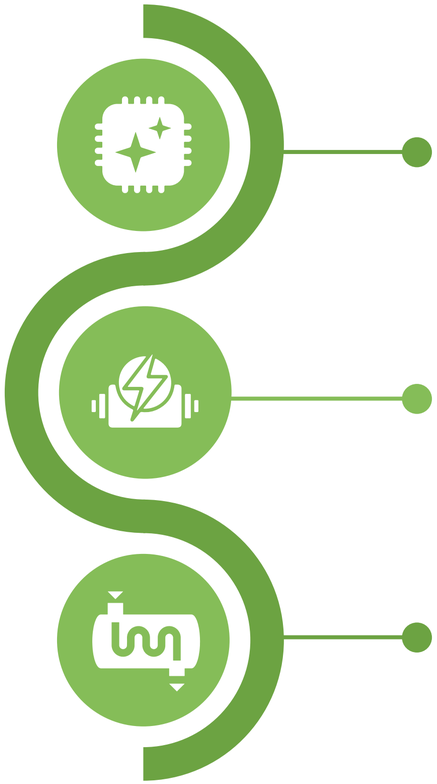
nGEL Project Solution



AI-Driven EMS

Schedules power, heat, and cooling output in real-time based on market and demand forecasts.

Cold Thermal Energy Storage (CTES) and Hot Thermal Energy Storage (HTES)

Storage solutions ensure energy availability during peak demand.

Absorption Chiller and Heat Exchangers

Enable cooling alongside power and heating, enhancing multi-functional use.

Expected Outcomes

Meets dynamic energy needs and contributes 4% to the EU's heating demand, with substantial reductions in reliance on imported natural gas.

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Key Innovations

Digital Twin of ORC Plant

AI-driven digital twin to monitor, predict, and optimise plant operations, ensuring peak performance.

Demand Side Management (DSM)

Adaptive control strategies to handle fluctuations in demand and grid needs.

Enhanced Resilience

Ensures operational reliability even in high ambient temperatures, essential for summer demandspikes.

Smart Control Integration

Optimises tri-generation flexibility by balancing output across power, heating, and cooling.

Concept and Methodology

Methodology

Digital Twin Integration

Uses AI-based simulation models to optimise ORC system performance.

Cold Thermal Energy Storage and Thermal Energy Storage Development

Designs and implements CTES and TES for enhanced grid resilience.

Demand Side Management

Creates a responsive energy solution by optimising energy output to match grid requirements.

Design Philosophy

Flexibility and environmental sustainability are at the core, with scalable solutions adaptable to various European regions.

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Pilot Region

Target Pilot Region

Selected EU location is the Kızıldere village of Sarayköy district in Denizli Province, southwestern Turkey.

Goals

Test scalability, optimise EMS configurations, and evaluate the environmental and economic impact.

Community Engagement

Partnering with local energy providers to adapt solutions to regional infrastructure needs.

Expected Outcomes

Cost Efficiency

Reduces capital, operational, and maintenance costs, making geothermal energy more competitive.

Environmental & Societal Benefits

Lower CO2 emissions and significant contributions to the EU's climate neutrality goals.

Increased ORC Competitiveness

Enhances geothermal ORC technology's role in Europe's renewable energy landscape.

Energy Security & Grid Resilience

Provides a reliable renewable energy source to stabilise grids, especially during intermittent renewable peaks.

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Expected Impact on EU Policy and Economy

Policy Influence

nGEL aims to shape future geothermal energy regulations and smart grid policies

Methodology

Potential to create jobs and lower energy costs, especially in pilot regions

Technical Tools

Supports local energy autonomy by diversifying renewable energy sources, reducing dependency on imports

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