HeatInvest - Enhancing Cluster Development and Investment Readiness of the Heat-pumps and Geothermal Energy European Value Chain (I3 project)

HeatInvest - Funding opportunities for Heat-pumps in Hungary and the European Union

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Geosyn Geo-Cluster, 2nd MML Online Workshop
06.10.2026

Accelerating Geothermal and Thermal Energy Storage Deployment in Europe: Policy, Regulation and Market Readiness

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The presentation at a glance

- **Introduction to HeatInvest and the Hungarian status:** in a nutshell
- **Funding:** EU and Hungarian funding opportunities
- **HeatInvest:** webpage and ideas
- **Expert workshops:** Germany and Belgium

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Introduction to HeatInvest: Background

- EU-27 countries have adopted the objective to **decarbonise Heating and Cooling** (H&C) applications, responsible for almost half of total energy consumption, as a necessary condition for reaching **climate neutrality** by 2050.
- **Heat pumps** & **geothermal energy** technologies have been identified as **optimal clean alternatives** for H&C, combining significantly lower carbon emissions and a reduced need for energy imports. Large-scale uptake of these technologies is a necessary condition for the EU bloc to reach climate neutrality; this requires **a massive investment wave** but also constitutes a tremendous opportunity for the EU **heat pumps & geothermal value chains**, enhancing industrial competitiveness & employment, & reducing at the same time regional disparities.

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Introduction to HeatInvest: Background

HeatInvest

Region of Eastern Macedonia and Thrace

BUNDESVERBAND GEOTHERMIE

flux50 ENERGISING THE FUTURE

KLASTER ZRÓWNOWAŻONA INFRASTRUKTURA

equium SOUND ENERGY COOLERS

PROMEA

eae agencia extremeña de la energía (C)

STRIA

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Introduction to HeatInvest: Objectives

- The core **HeatInvest objective** is to build the capacities of innovation actors from regions that face substantial, chronic or structural obstacles to secure balanced participation in EU value chains and interregional innovation partnerships:

  1. **Strengthen the investment and business planning capacities of regional value chain actors**, accelerating ecosystem development and facilitating access to markets.

  2. **Improve regional policy frameworks** to create enabling environments for innovative investments, fostering collaborations among policy actors and stakeholders.

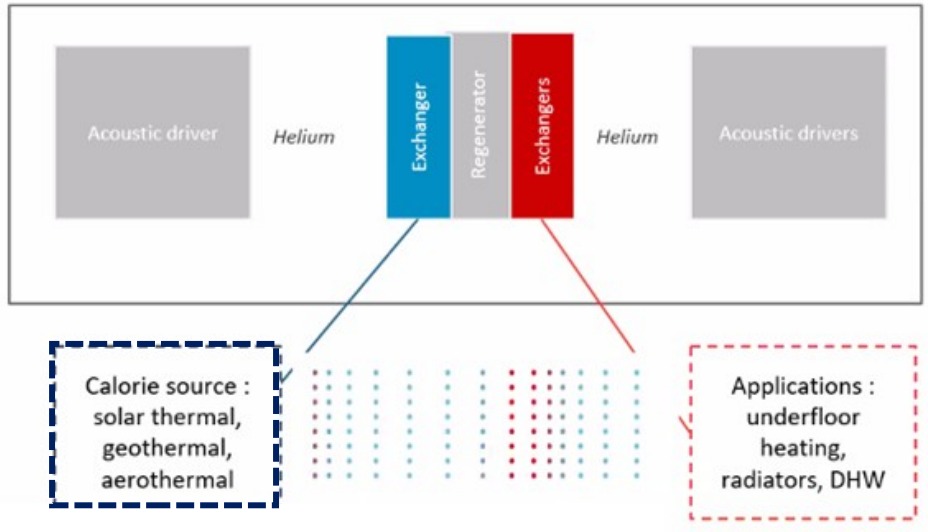
  3. **Scale-up research**, **investment** and **business synergies** within regional and interregional value chains.

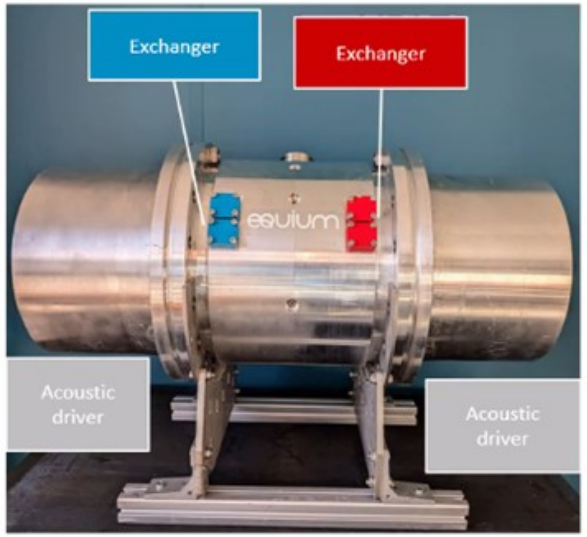
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Introduction to HeatInvest: Objectives

EQORE (the CORE SYSTEM OF OUR COMPRESSOR LESS HEAT PUMP) is a Stirling acoustic engine :

An acoustic driver converts electrical energy into sound waves, which create alternating compression and expansion, that enables heat transfer to generate heating or cooling without phase change.





EQORE Prototype 4 kW : 2023

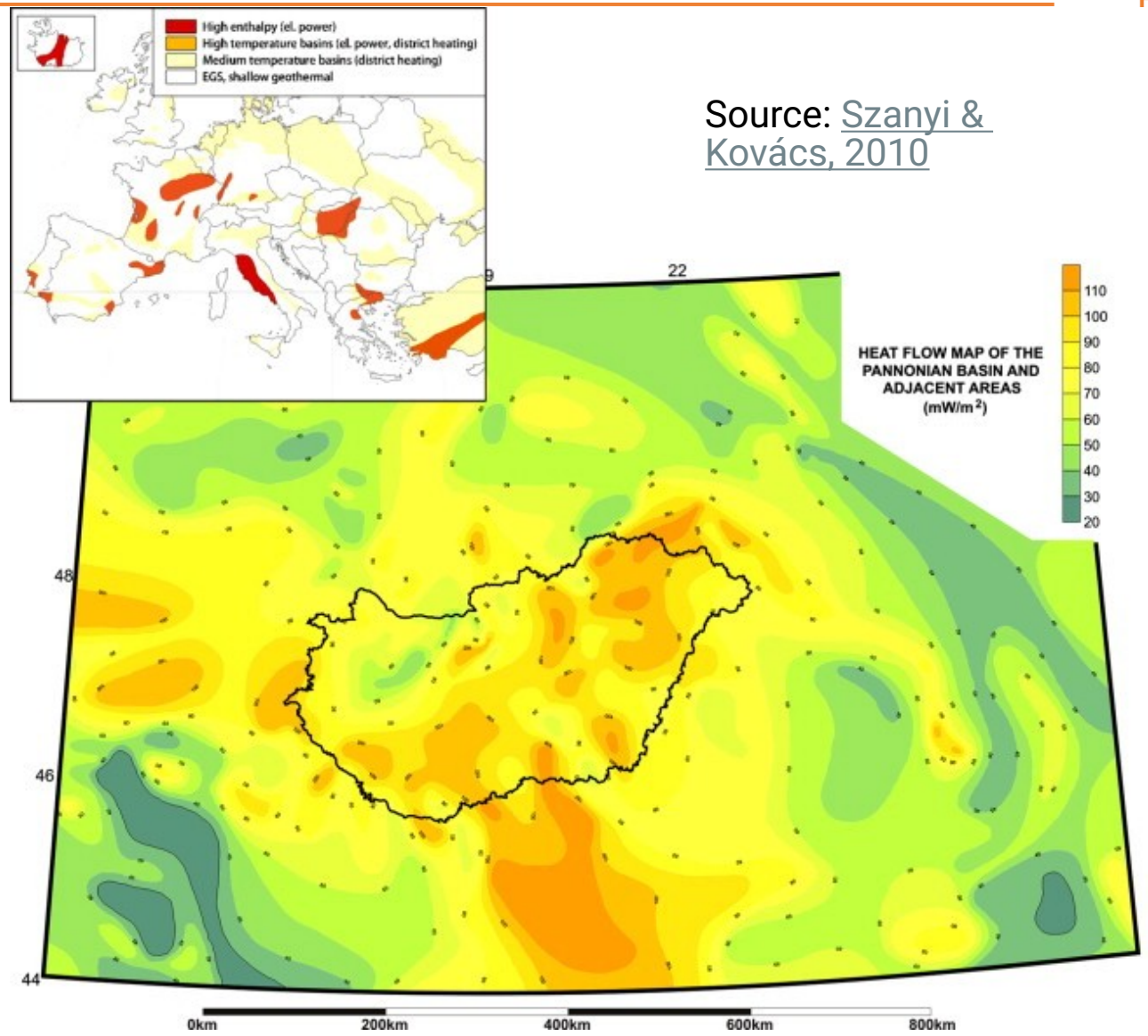


EQORE Prototype 2025 10 kW

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Introduction: Heatpump Deployment in Hungary - Market Status, Challenges and Scalable Opportunities

- Hungary remains heavily dependent on natural gas for residential and public-sector heating.
- Geothermal gradient: 60-70 °C/km.
- Heatflow: very advantageous – great potential

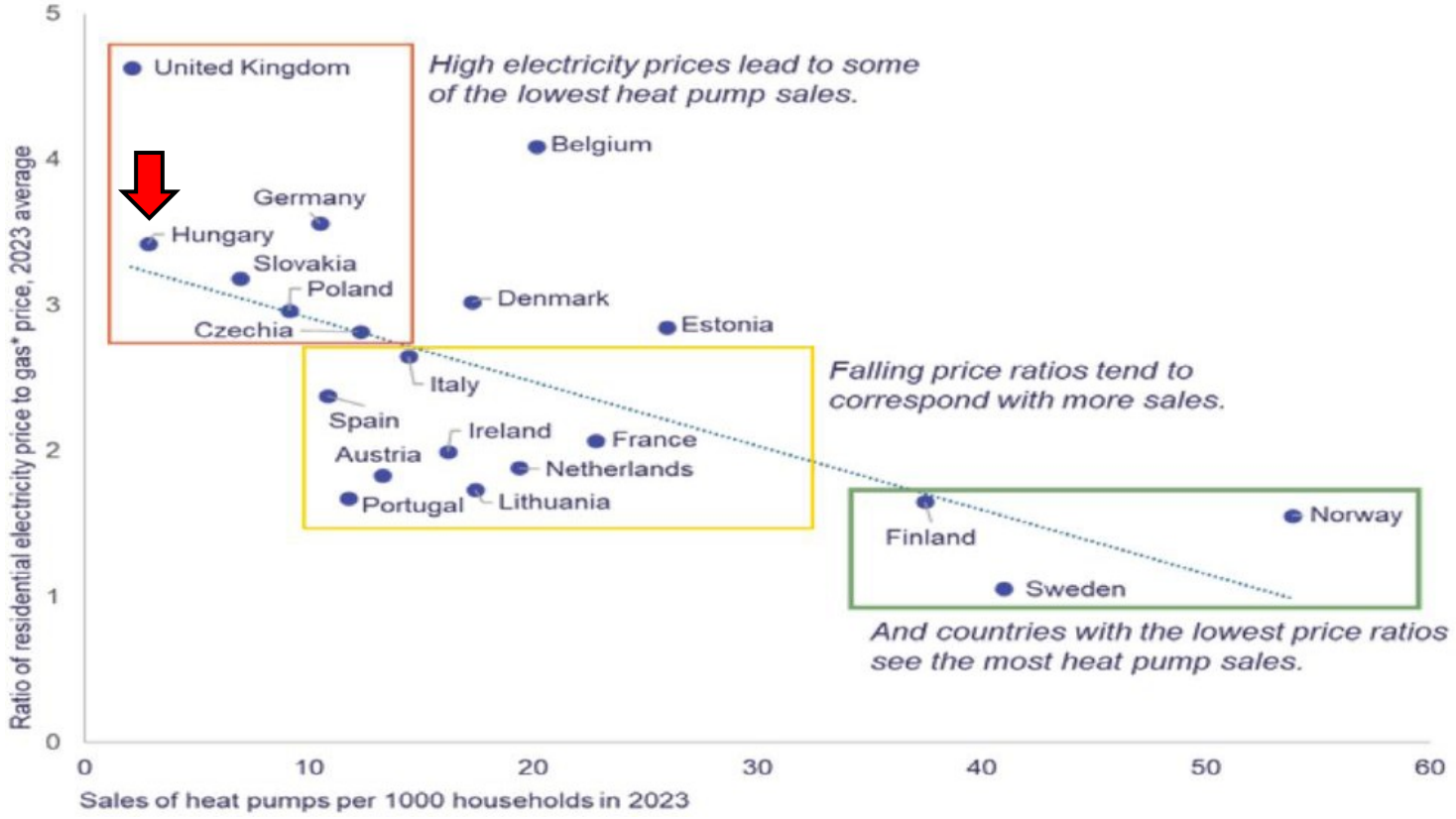


Source: Szanyi & Kovács, 2010

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Introduction: Heatpump Deployment in Hungary - Market Status, Challenges and Scalable Opportunities

- **Market Growth**
- The 2022–2023 energy crisis significantly increased public awareness.
- Demand for residential heat pumps increased rapidly.
- Market growth has continued despite a slowdown in construction activity.
- Increasing interest from:
  - municipalities, schools
  - healthcare facilities, industrial users
- **Market Drivers**
- Rising energy efficiency requirements
- EU climate objectives
- Building renovation programmes
- Integration with rooftop solar systems



Source: EHPA

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Introduction: Heatpump Deployment in Hungary - Market Status, Challenges and Scalable Opportunities

HeatInvest

- According to data collected by the Hungarian Energy and Public Utility Regulatory Authority (MEKH), nearly **1.4 million air-conditioning units (air-to-air heat pumps)** were sold to residential customers in Hungary between 2022 and 2025. During the same period, approximately **35,000 air-to-water heat pumps** were installed, primarily in newly constructed buildings.

- The commercial heat pump market remains relatively small, with only a few thousand units sold annually for offices, public buildings, retail facilities and industrial applications. The market for industrial heat pump systems is even more limited. Potential for growth!

- The strongest growth was observed in the air-to-air heat pump segment:
  2022: ~440,000 units sold (record year)
  2023: ~280,000 units sold
  2024: ~400,000 units sold
  2025: ~270,000 units sold (estimated)
- Market fluctuations were largely influenced by energy prices and weather conditions, including the 2022 energy crisis and increasingly frequent summer heat waves.
- As a result, Hungary is estimated to have **around 2 million heat pump units currently in operation**, making heat pumps an increasingly important component of the country's heating and cooling sector.

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Funding: T3.1 Funding opportunities to enhance interregional collaboration

Task 3.1 entails the **development of a funding opportunities database**, led by STRIA. More specifically:

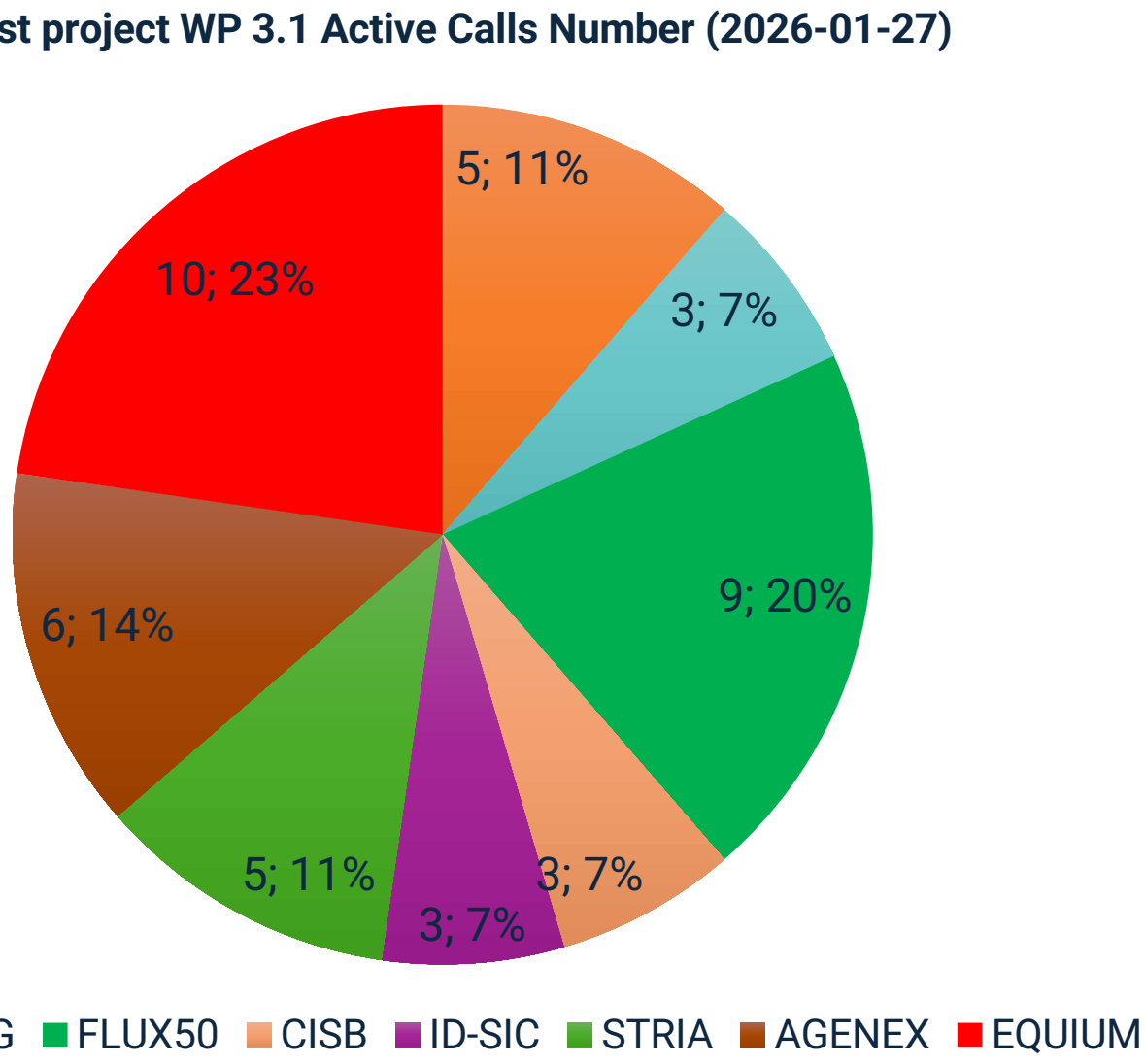
- The **HeatInvest Database** will include available **EU, national and regional funding sources**, to guide clusters and partnerships in identifying and securing financial support.

Subsequently the project partners will:

- **Conduct an online workshop**, organized, by ID-SIC that will inform a preparation of the project's exploitation plan, which will be developed by PROMEA.
- **Collaborate on how the consortium**, as well as their individual regional ecosystems, **will valorise EU funding sources**, especially ERDF, to finance further innovation activities and enhance the sustainability of project results.

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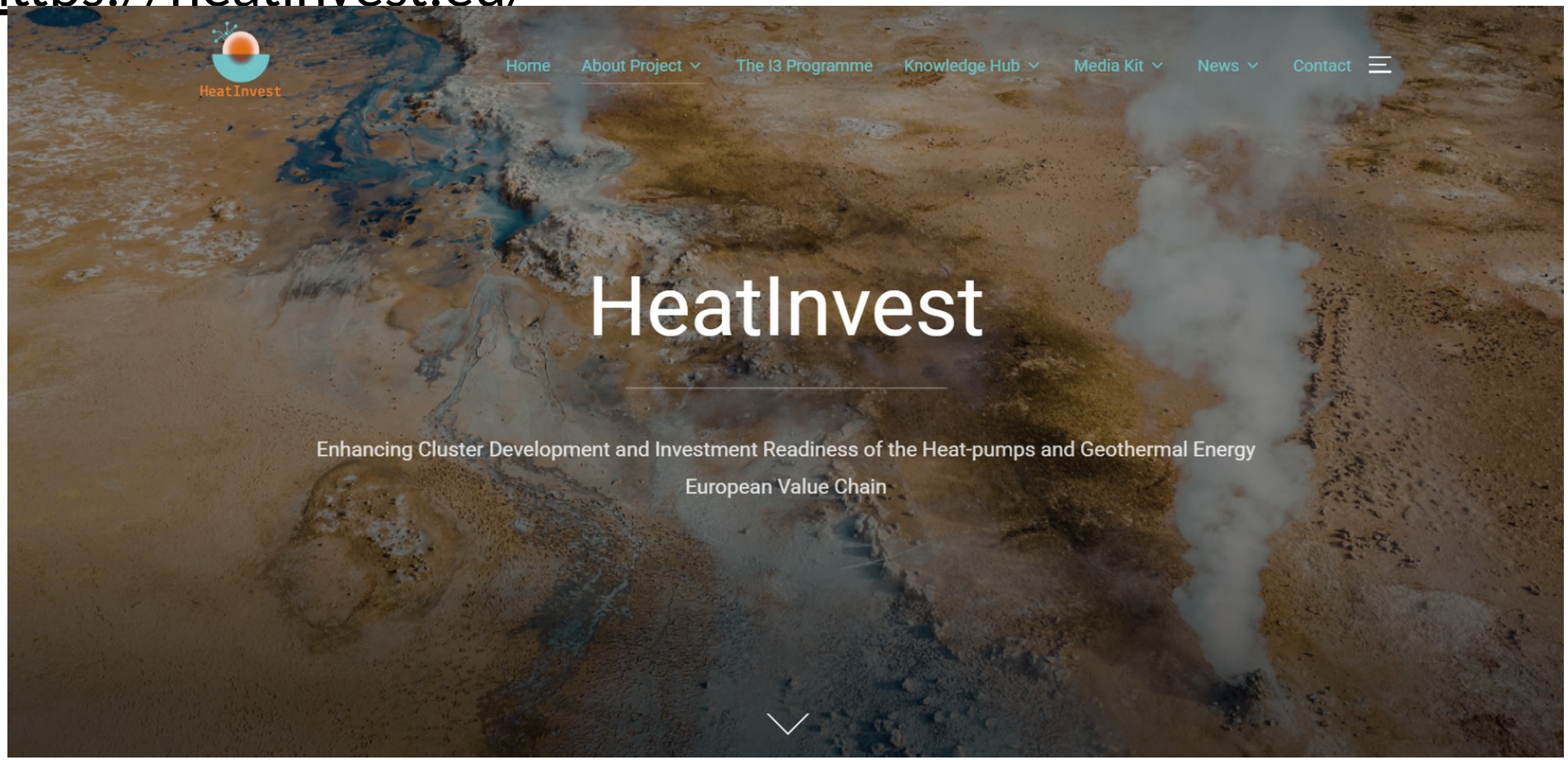
Funding: T3.1 Funding opportunities to enhance interregional collaboration



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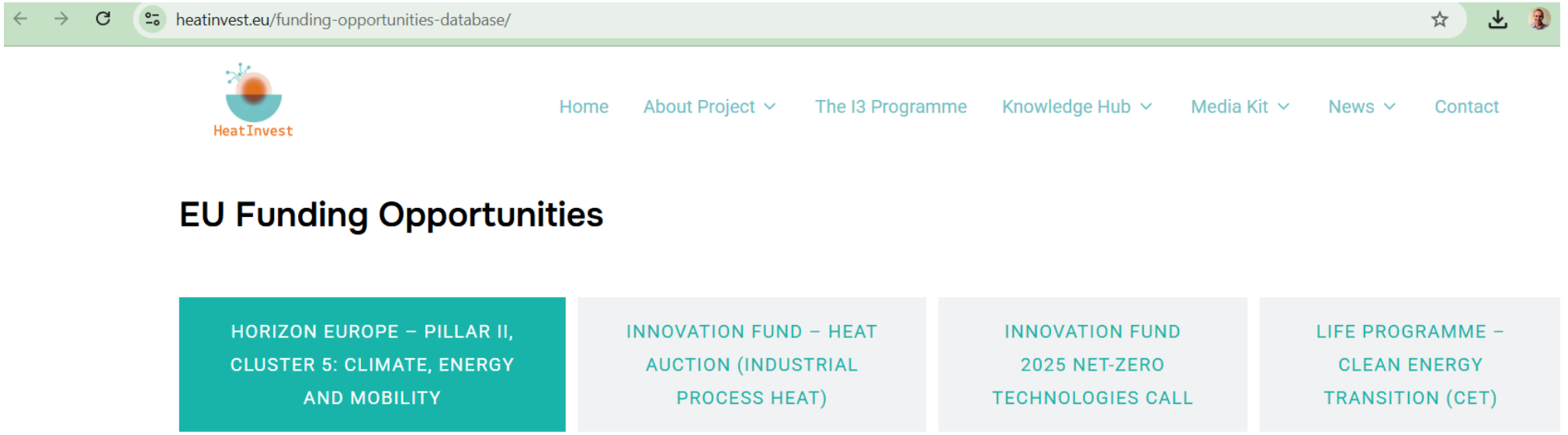
Webpage: Funding database

- https://heatinvest.eu/



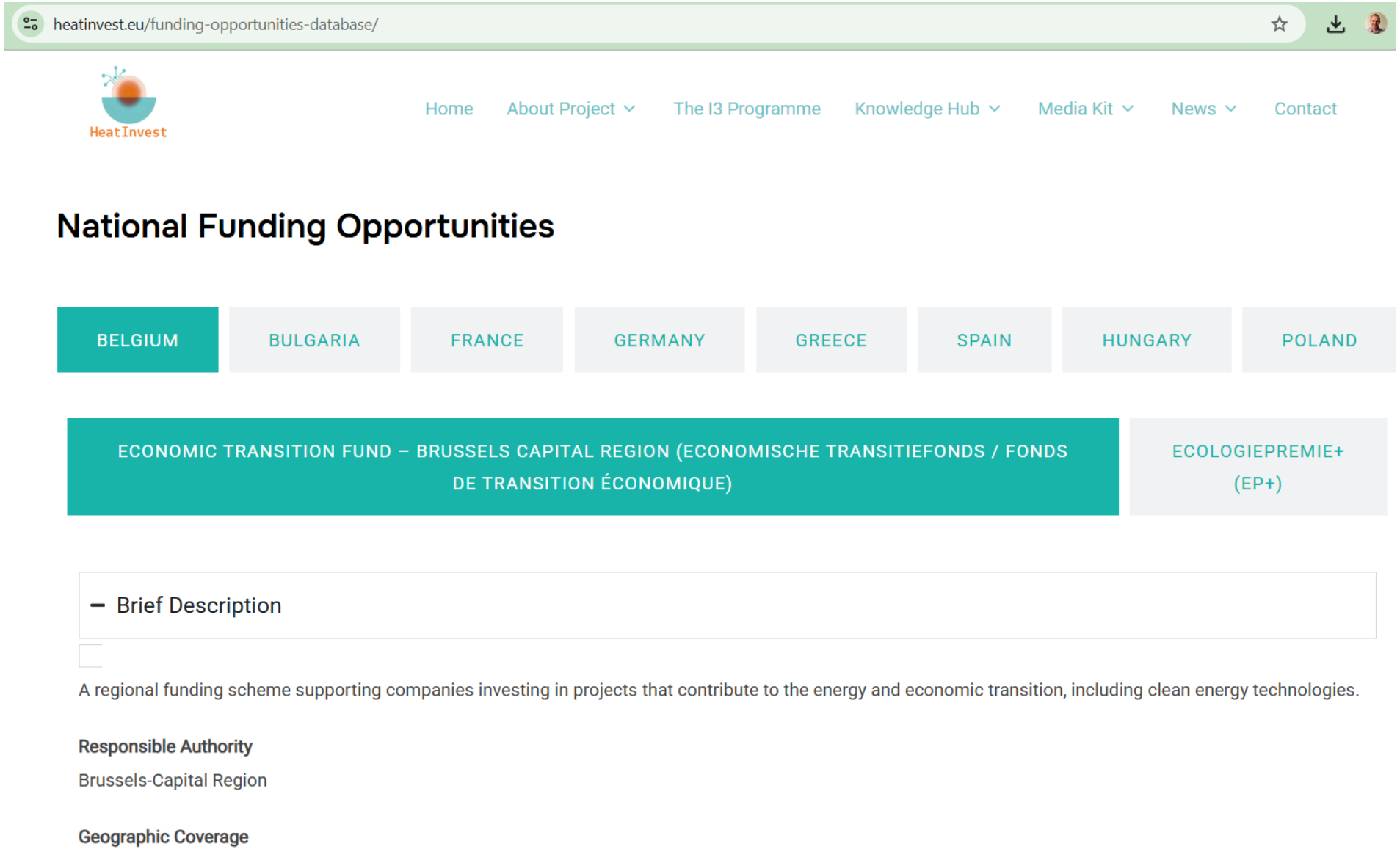
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Webpage: Funding database



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Webpage: Funding database



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Latest expert workshop in: Berlin





Hospital heating-cooling project: - when is cold…

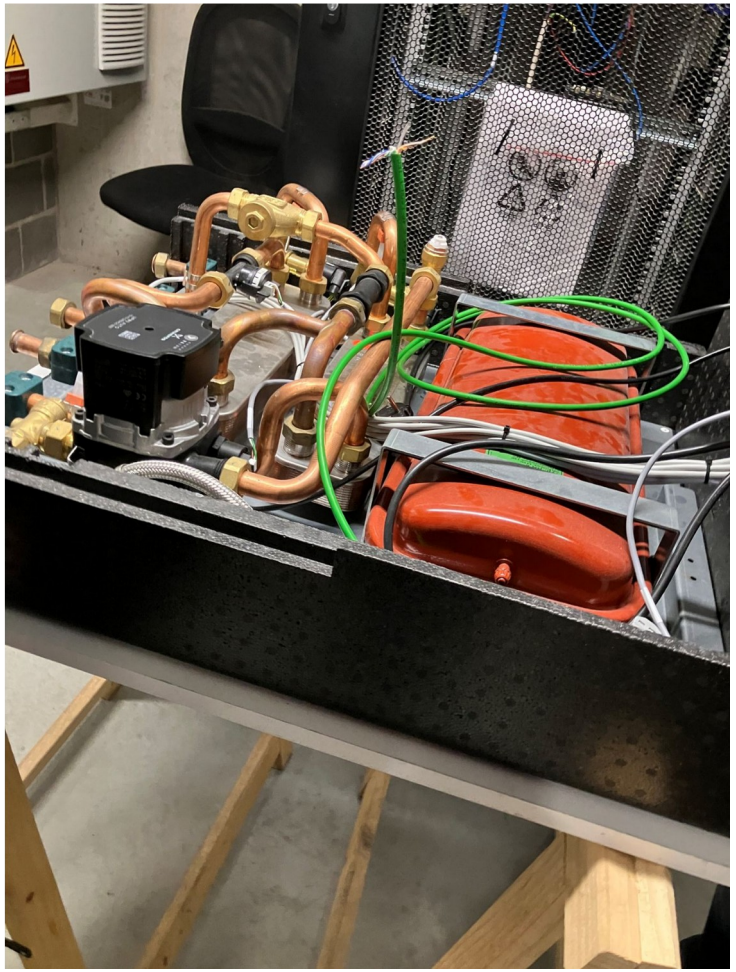
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Latest expert workshop in: Belgium



MuideMeulestede project: - when a fork could create a big problem…





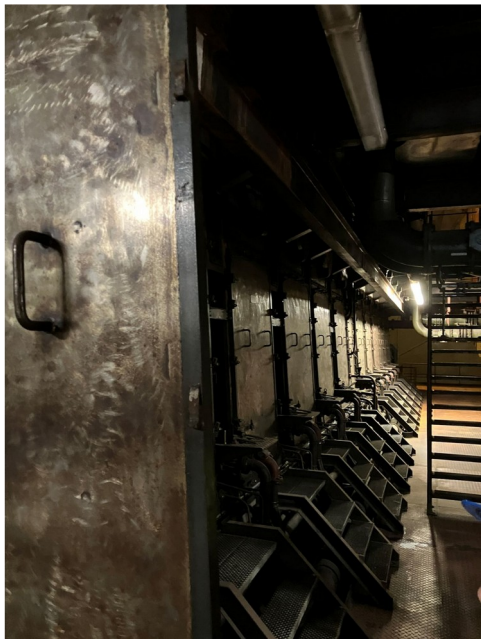
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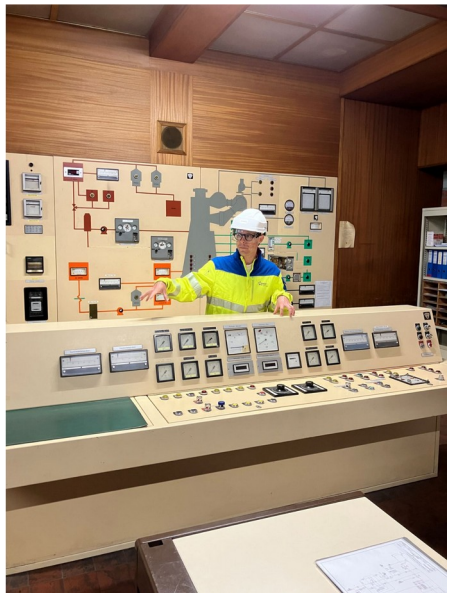
Latest expert workshop in: Belgium



Luminus project: - the oldest…











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Latest expert workshop in: Belgium

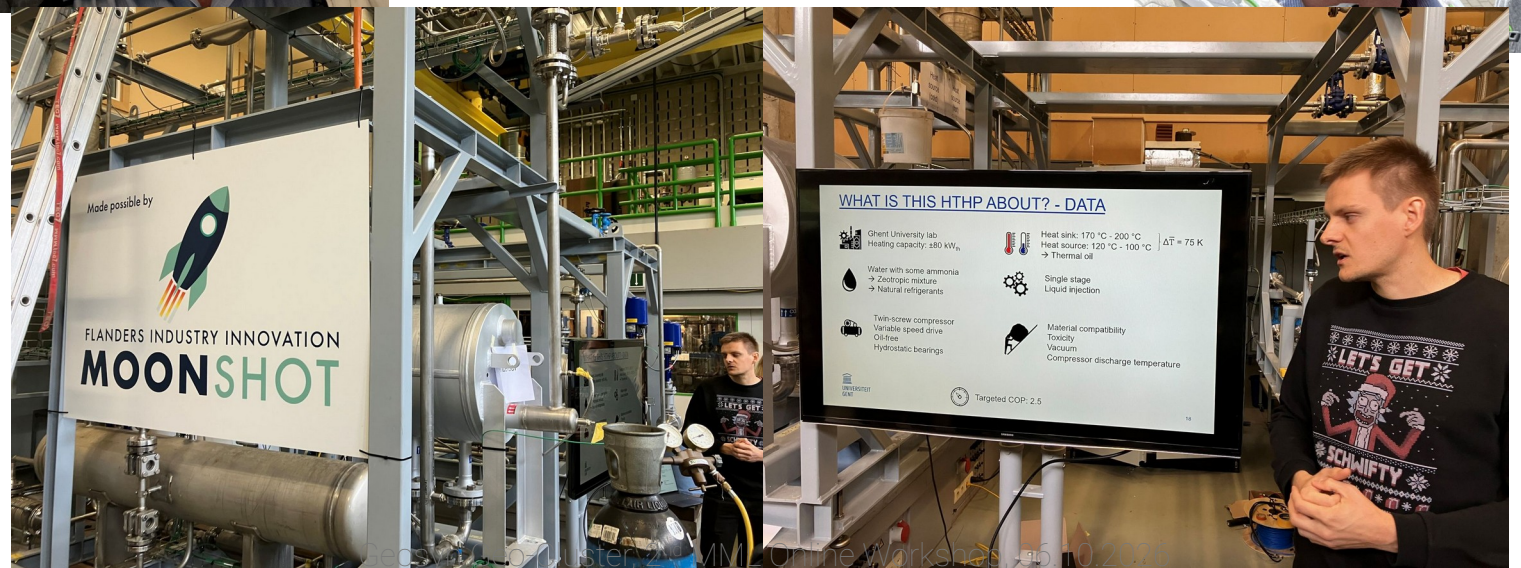


Daikin: - driving the innovation…

MoonShot: - G-tech heatpump…



Alpro: - visiting the biggest plant – 17 hectares…



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Enhancing Cluster Development and Investment Readiness of the Heat-pumps and Geothermal Energy European Value Chain

HeatInvest

Thank you!

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GeoS-TECHIS

Geothermal Source Thermal Energy for Cooling and Heating in Industries with Steam

2ND JOINT MOBILIZATION AND MUTUAL LEARNING ONLINE WORKSHOP

06 October 2026

Presentation: *Stakeholder perceptions, public acceptance and community engagement as enabling conditions for geothermal energy deployment*

Presenter: *Sarah Kaltenegger, Fraunhofer IAO*

GeoS-TECHIS Project - Grant Agreement 101172928

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Fraunhofer's Role in GeoS-TECHIS

Purpose of our work

- **Better understanding** of knowledge, attitudes, concerns, and information needs of the public and relevant industrial stakeholders
- Reducing non-technical barriers to industrial decarbonization
- Addressing **societal acceptance** and stakeholder involvement is **essential** for supporting the **successful deployment** of geothermal technologies

Why this matters

- **Low public knowledge** & persistent **concerns** about geothermal energy
- Evidence-based **information can reduce uncertainty** and misconceptions
- **Stakeholder** involvement **supports** informed decision-making and **acceptance**

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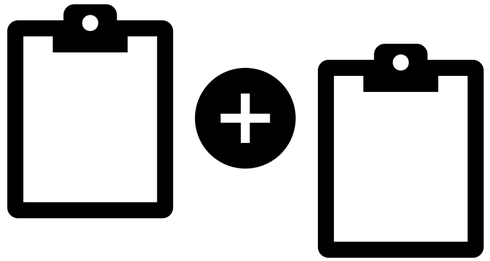
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Recap of our work

1. Literature research and analysis for the development of surveys and interview guides
2. Stakeholder workshop for input on related topics → Project Partners
3. Conduction of Public Survey → Galicia public
4. Conduction of Stakeholder Survey → Stakeholders from more than three different industries
5. Conduction of Interviews → Industries (projects with ongoing or planned geothermal initiatives)
6. Analysis of Survey and Interview Findings

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Public perception and stakeholder engagement



Public Survey

- 12-minute online survey
- Items measured on a 7-Point Likert Scale
- Conducted in February 2026
- 597 high-quality respondents (men and women over 18, living in pilot region in Spain, Galicia)

Stakeholder Survey

- 15-minute online survey
- Items measured on a 7-Point Likert Scale
- Conducted between November 25 and July 26
- 26 completed questionnaires
- Respondents from different industries

Stakeholder Interviews

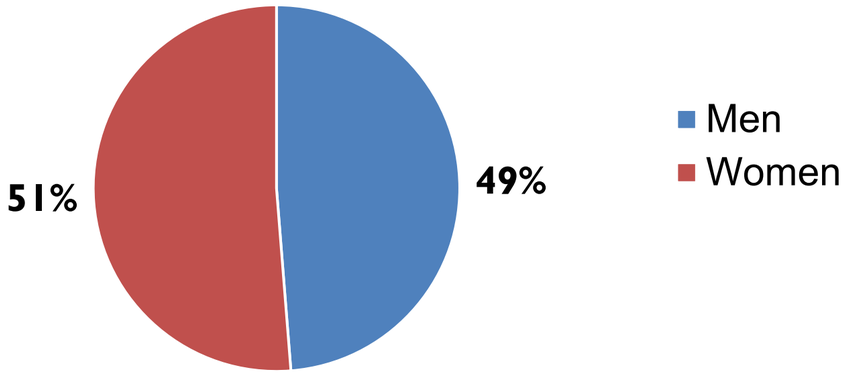
- Seven semi-structured interviews
- Conducted between April 26 and July 26
- Interviewees from different industries

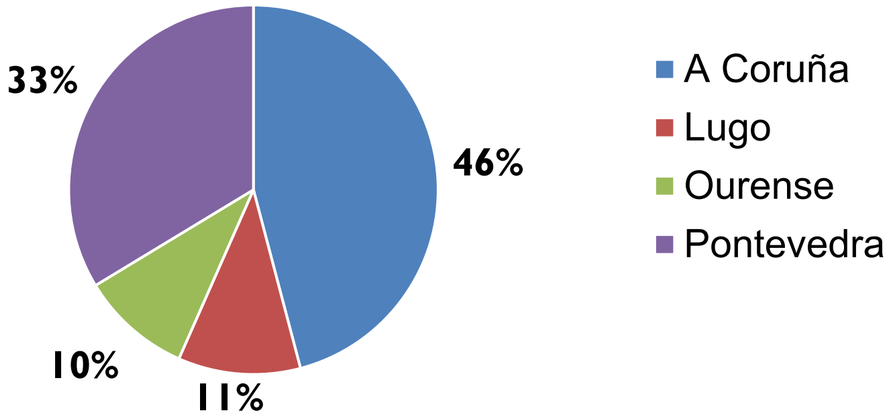
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Results of Public Survey

1) Sociodemographic information





2) Environmental and Climate Change Awareness

- Environmental issues affect both daily life and health
- CO_2 emissions have a significant impact on climate change
- Continuing current practices may lead to environmental catastrophe
- Climate change has significant impacts
- Science and technology alone will not solve climate change without changes in human behaviour

3) Knowledge about geothermal energy

- **Moderate knowledge** about geothermal energy
- Highest level of agreement for general knowledge of geothermal energy
- Moderate knowledge of familiarity with geothermal power generation methods

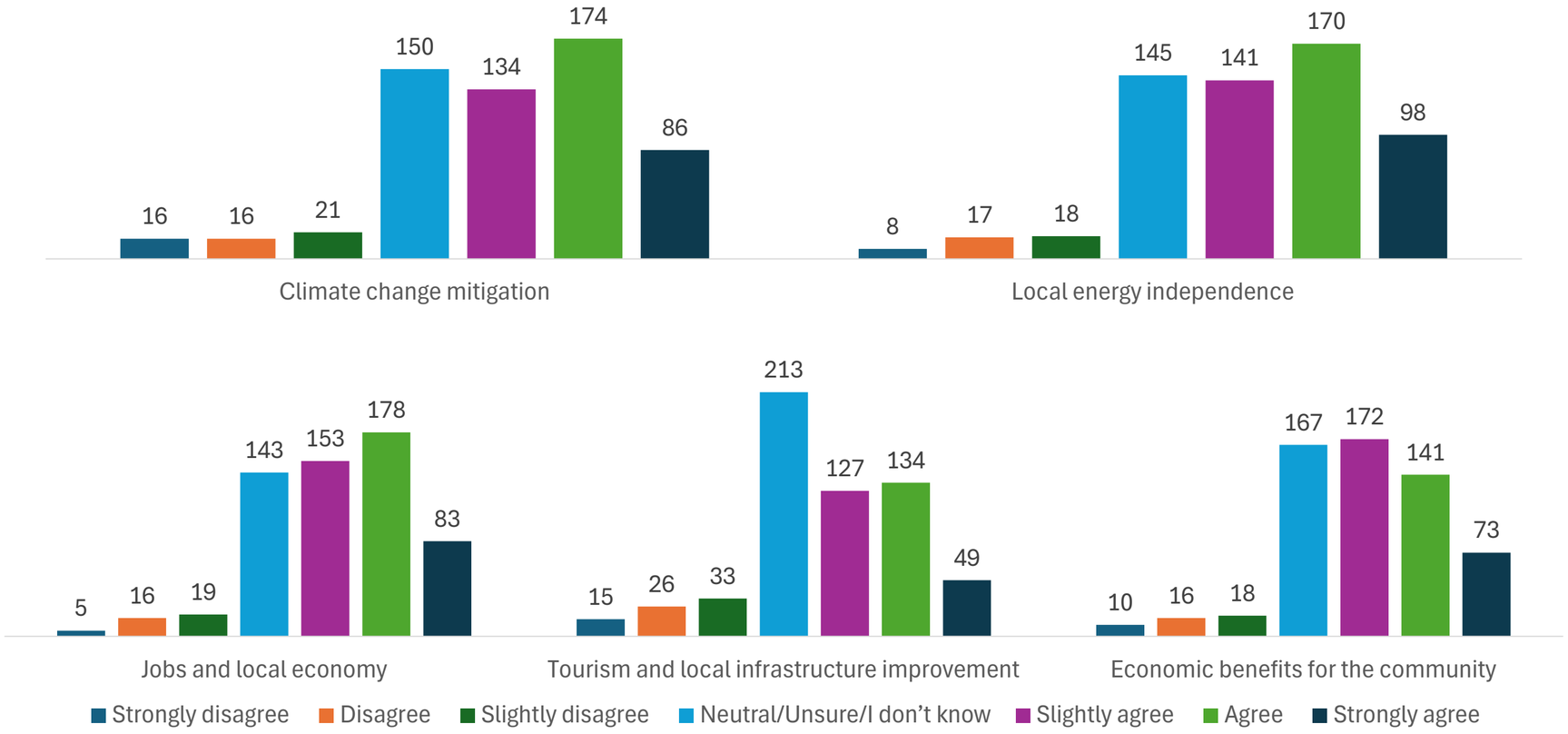
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Results of Public Survey

Perceptions of geothermal energy (Potential Benefits)

To what extent do you agree with the following statements?



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Results of Public Survey

Perceptions of geothermal energy (Concerns)

To what extent do you agree with the following statements?

Concerns

- Technical & regulatory concerns were moderate to high: time and effort required for implementation (M = 5.11), lack of qualified suppliers (M = 4.94), and bureaucratic barriers (M = 4.90)
- Environmental concerns (impacts on groundwater (M = 4.52); seismic activity (landslides or earthquakes) (M = 4.35); negative impacts on the local landscape and surroundings (M = 4.37)) perceived as less challenging than technical and regulatory issues

Support

- Support for geothermal energy in the region was moderate (M = 4.70)
- Support for its role in the future regional energy system was rather high (M = 5.18)
- Support would increase particularly through environmental protection, safety, job creation, community involvement, and local economic benefits

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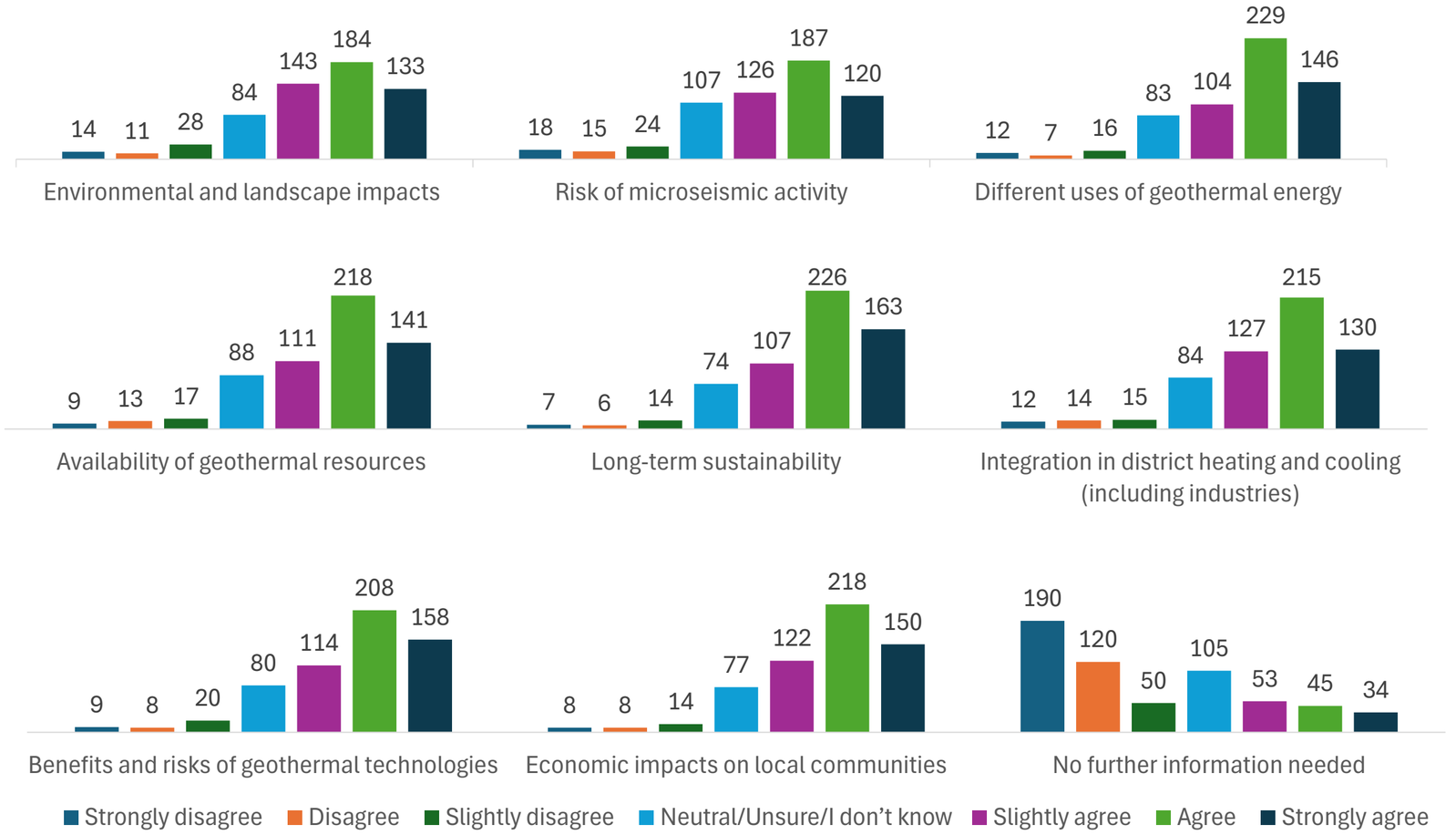
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Results of Public Survey

Knowledge Gaps

To what extent do you agree with the following statements?

***Note**: Statement about further information was reverse-coded.*



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Conclusion of Public Survey

- Generally **positive perception** & strong climate awareness
- **Moderate** technical knowledge
- High trust in **scientific institutions**
- **Key concerns:** safety, environmental impacts, implementation complexity & regulatory barriers
- **Quite high demand for information** (sustainability, risks, economic impacts, practical applications)



Transparent, scientifically grounded & targeted **communication is essential** to strengthen informed public **acceptance**

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Results of Stakeholder Survey

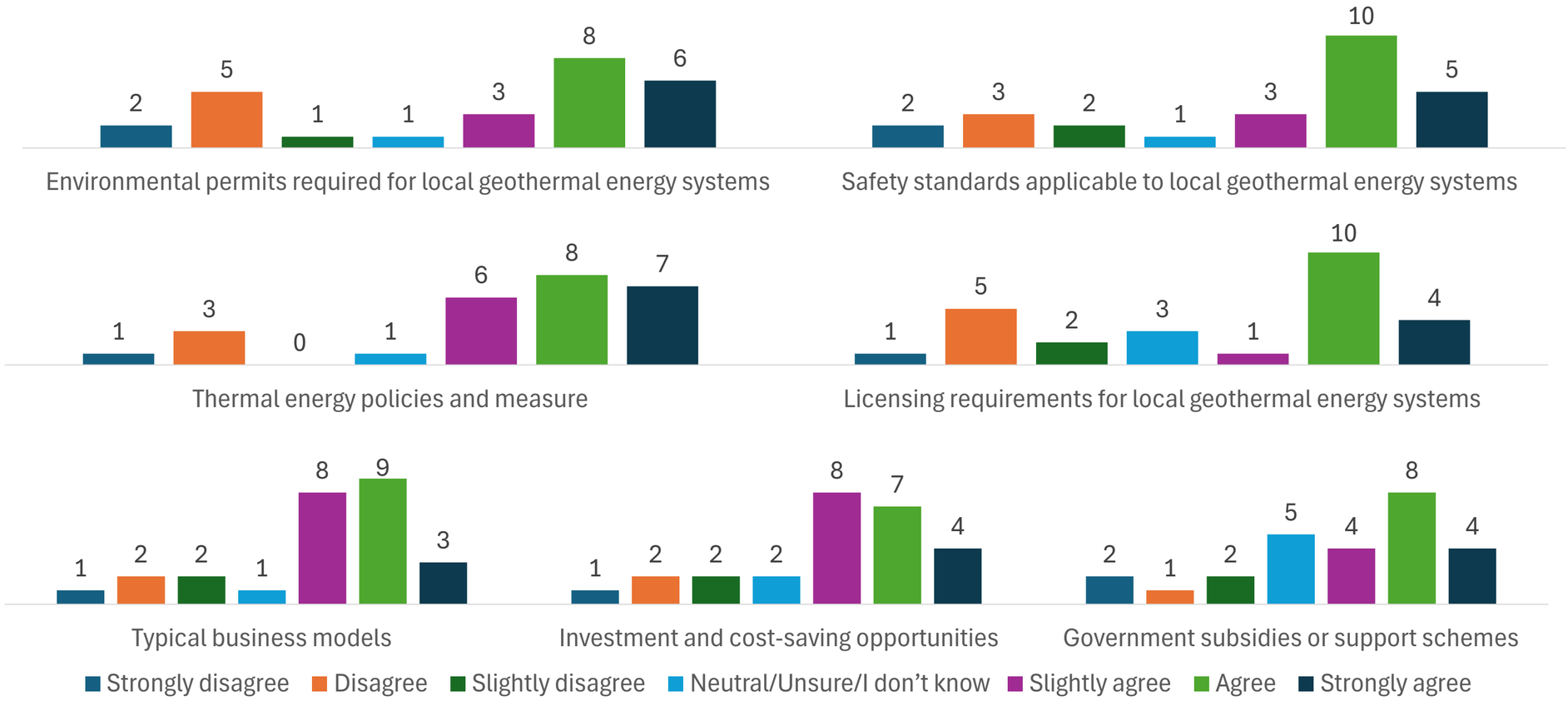
Stakeholder sample composition

- **Industry:** 76.9% classified as Other; mainly research & development, energy, local administration, non-profit associations and education
- **Company size:** Mainly small (46.2%) and medium-sized enterprises (38.5%)
- **Position:** Mainly technicians/engineers (34.6%) and researchers/scientists (30.8%)
- **Location:** 76.9% from Germany; remaining respondents from other European countries and the US, Canada and Bolivia

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Results of Stakeholder Survey

Knowledge of Geothermal Energy (legal, regulatory and financial aspects)



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Results of Stakeholder Survey

Social and Sustainability Aspects

- Respect for **community rights and corruption prevention** (M = 6.38); accountable governance and community resource protection (M = 5.84)
- Safe and healthy conditions for residents and workers (M = 6.36)
- Fair salaries, good conditions for workers (M = 6.16)
- Supporting national/regional economic development (M = 6.25) and local employment (M = 5.96)
- Transparent communication with consumers (M = 6.21) and stakeholder engagement with local communities (M = 5.88)

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Results of Stakeholder Survey

External Challenges

Lack of governmental **funding opportunities** (M = 6.39)

Regulatory policy (M = 6.43)

Lack of **social awareness** (M = 5.74)

Environmental risks (M = 5.43)

Deficiencies in **technological innovation** (M = 3.87)

Talent and specialized **expert shortage** on complex operation (M = 4.65)

Internal Challenges

Competition from cheaper energy sources (M = 5.35)

Unstructured processes and **misalignment of strategies** (M = 5.43)

High **initial investment** (M = 6.04)

Long payback periods and **uncertain return on investments** (M = 5.52)

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Results of Stakeholder Survey

Knowledge Gaps

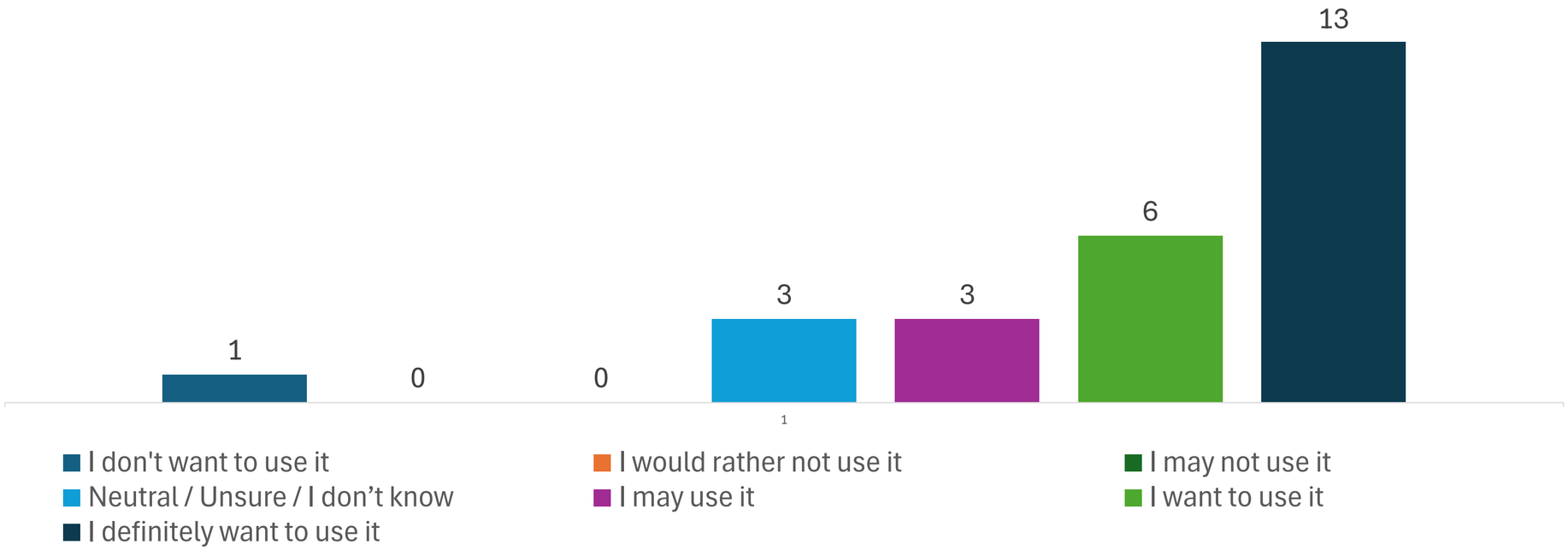
- **Successful geothermal projects** that share a similar context to their own company (M = 5.96)
- **Information on approved suppliers** (M = 5.65)
- **Management** of geothermal energy systems (M = 5.43)
- **Economic impact** of geothermal energy on their companies (M = 5.35)
- Information about **geothermal source availability** (M = 5.43)
- Information on **micro-seismic risks** related to geothermal energy (M = 5.30) and **environmental and landscape impacts** (M = 5.22)
- Information on **the functioning of geothermal systems**, such as heat pumps (M = 4.96)

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Results of Stakeholder Survey

Attitude Towards Future Usage

What do you think about the future use of geothermal energy systems in your specific context?



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Conclusion of Stakeholder Survey

- **Limited knowledge** of financing, business models, subsidies & regulation
- **Social & sustainability aspects:** employee safety, fair working conditions & community well-being
- **Key challenges:** high investment, long payback periods, regulatory barriers & limited government support
- **Information needs:** successful projects, business models, ROI, suppliers & technological applications
- **Positive attitude** towards usage of geothermal energy

Industry Stakeholders are broadly supportive
but **need practical information** on economic, regulatory and implementation aspects to enable informed decision-making

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„It is important to **involve people in decision-making** processes“

„Information is transparent, but it‘s not easy to find. Sometimes there are reports in local newspapers, but we should **increase communication** and **awareness** about the benefits for local communities“

“People are often not aware of the differences between the technologies, and **many would like to know more**”

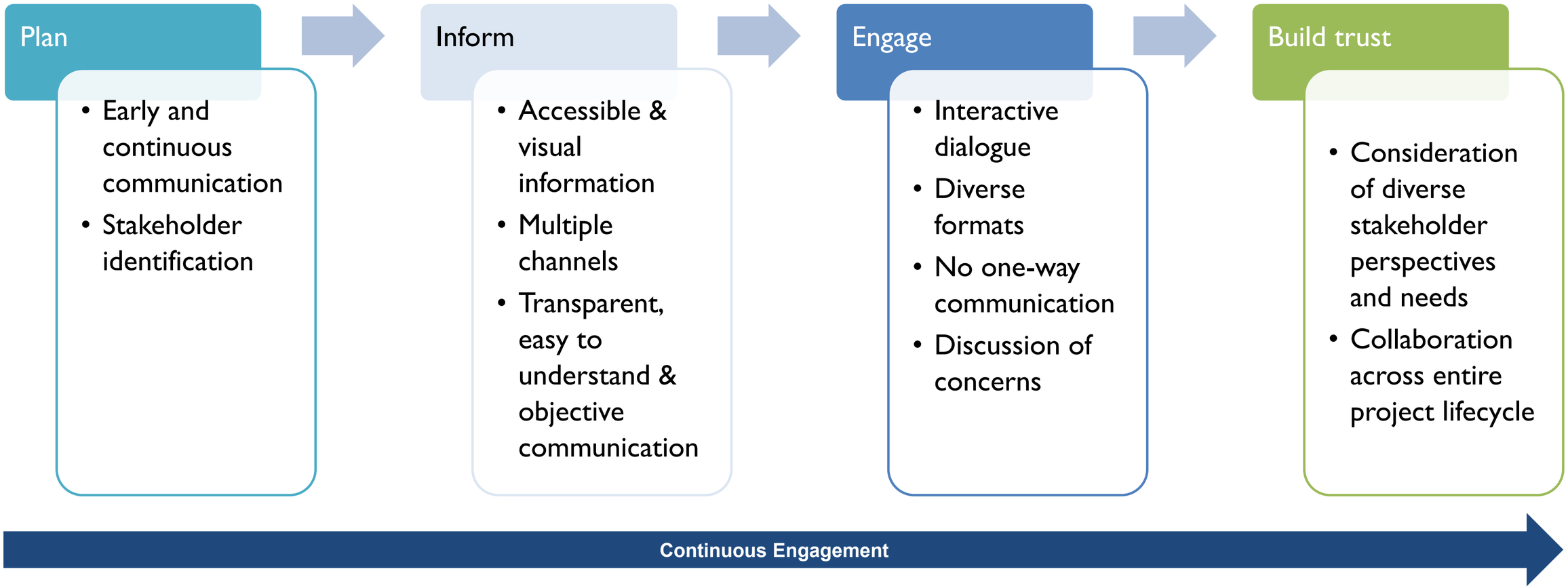
„Geothermal energy is **always available**, providing the same quality of energy every day and throughout the year, regardless of weather conditions. It is also **not vulnerable to sabotage**“

„Everything takes a little longer than you might have expected“ (Implementation Process)

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Stakeholder Engagement



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Thank You

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FlexGeo

Market framework conditions for flexible geoH&C and geoDHC: one size does not fit all

Giulia Conforto, Senior Researcher, e-think energy research | Project FlexGeo

2nd Geo-Cluster Joint Mobilisation and Mutual Learning Workshop, 6 October 2026

This project receives funding from the European Union's Horizon Europe research and innovation programme under grant agreement № 101147576.

Funded by the European Union

Where this work comes from

Scope: Feasibility of various flexible geothermal technologies

Demonstrator: 200 kWel reversible ORC / HP in a real DH network (Garching)

Geography: EU + Germany, Greece, Italy, Spain, Switzerland

Technical analysis TUM	**Market analysis** e-think	**Framework Report** Public, Dec 2025	**Update** Oct to Nov 2026	**Policy brief** 2027
Technical response: can flexible geoth. meet balancing requirements?	Regulation, policy, market structure, finance and business models	Joint report on technical and market framework conditions	Restructured by technology configuration, feeds WP4 modelling	Recommenda-tions co-developed with the external advisory board

Key finding: hybrid geothermal falls between silos

Electricity	Heat	Subsurface
Grid codes, balancing, feed-in, auctions	DH concessions, H&C plans, subsidies	Mining / water law, EIA thresholds

Heat + cold + power + storage + flexibility

1. **No technical standards**
   (case by case approval)
2. **Unclear support eligibility**
   heat, power, buildings or a mix?
3. **Balancing built for big plants**
   IT: only via UVAM until 2025 reform
4. **Negotiated heat network access**
   RED III access right barely enforced

No outdated rules to break, but no rules a bank can price.

Five countries, five different bottlenecks

	Germany	Greece	Italy	Spain	Switzerland
Standards for hybrid units	General rules only	No framework	No ORC specific rules	Not explicit	Cantonal variation
Heat network access	Largest DH market, bilateral connection deals	Few municipal grids (Kozani, Ptolemaida)	Integrated incumbents, low transparency	>50% public, small market	Municipal ownership, high trust
Permitting	3 to 12 months shallow, 24+ deep with EIA	GSHP ≤100 kW permit free since 2024	Months (GSHP) to 80+ (large)	3 to 18+ months, 17 regimes	6 to 24 months, 26 cantons
Support schemes	BEW 40% + HP opex aid, hybrid status unclear	Geothermal FIT phasing out to auctions	Conto Termico 3.0: 40 to 65%, building side	DHC grants, none for geothermal	Exploration grants, cogen. grey zone
Recent Developments	GeoBG in force, KfW drilling risk cover	Financing tool for municipalities in preparation	First FER 2 zero emission geoth. auction	Grid access decree repealed (Jul 2025)	Multi energy hubs gaining ground

Major barrier | Partial / uncertain | Enabling

Finance: money exists, rarely for hybrid or risky

Three instrument families

Feed in tariffs (power)
Long term price certainty, progressively being phased out

Premiums and auctions
Reward mature, cost competitive technologies

Investment grants, tax relief
Lower CAPEX, no revenue certainty

Four recurring gaps, first exceptions emerging

1. **Technology exclusion**
   Rarely names reversible ORC or hybrid units
2. **Short cycles**
   Mostly 2 to 3 year schemes vs 10 to 15 year paybacks
3. **Split infrastructure**
   Networks and plants funded apart (BEW is the exception)
4. **Risk cover for deep only**
   New in DE (2025) and CH, none for storage or closed loop

EU funds are open in principle, but 40%+ co financing (Innovation Fund) and long procedures penalise small, site specific projects.

- AccelerateEU (Apr 2026) announces EU derisking and insurance schemes. Will they fit more than deep hydrothermal?

Why we are restructuring the analysis

Before: hybrid, but generic

Heat	Cooling
Power	Storage
Flexibility	Shallow

No real technology does all of this.

After: 3 configurations + outlook

- **A** Rev. ORC/HTHP on deep hydrothermal
- **B** High temperature UTES (± HTHP)
- **C** 5GDHC with borehole storage
- **D** Closed loop systems (AGS), outlook

Each: own services, barriers, instruments.

Three configurations plus one outlook

A

Rev. ORC/HTHP on deep hydrothermal

Sells: Heat, power, grid flexibility

DE, CH, IT

B

High temperature UTES

Sells: Seasonal shift, peak shaving

DE, CH, IT

C

5GDHC + borehole storage

Sells: Heating and cooling, local balancing

ES, GR, DE / AT

D

Closed loop AGS (outlook)

Sells: Dispatchable heat (and power)

DE, CH, IT

Four products, four revenue logics, four different framework questions

Where each configuration gets stuck

	A Rev. ORC/HTHP	B HT-UTES ± HTHP	C 5GDHC + BTES	D AGS (outlook)
Subsurface permitting	Existing doublet, reinjection permit?	Water law caps injection temperature	Shallow and fast, many regional rules	Deep drilling under mining law
Classification	CHP? generator? heat pump?	Storage ≠ generation in support	Heat prosumers not recognised	New category (FER 2 names it)
Market access, revenue	Pooling OK, but heat duty + switch time	Value set by DH operator, gas, CO2	HP pools rarely prequalified	Needs long term offtake
Heat network access	Supply contract with operator	Mostly operator owned asset	New small networks to build	Access if independent
Finance and risk	First of a kind, no track record	No commercial HT-ATES yet	High pipe cost per customer	Drilling cost, thermal performance risk
Instrument that fits	**Paid flexibility, stacked support**	**Storage CAPEX grants, long HPAs**	**Bundled grants, community equity**	**CfD/FIT + performance cover**

Binding barrier | Relevant | Minor

Who made it to market, and what unlocked it

A Rev. ORC/HTHP

Not yet

Garching: first demo at commercial unit size

Missing: a price for flexibility

B HT-UTES

LT-ATES, NL: ~85% of >3,000 ATES worldwide

Unlocked by: general rules, 8-week permits

But the 25 °C cap blocks HT

C 5GDHC + BTES

Mijnwater (NL), ETH anergy grid (CH)

Unlocked by: one anchor owner, long horizon

D AGS (outlook)

Eavor, Geretsried (DE): grid power Dec 2025

Unlocked by: €91.6m Innovation Fund + EEG tariff

Markets opened where one rule or instrument removed the binding barrier

Implications for incentives and investment support

1	**Recognise hybrid and storage assets**	Explicit definitions, standards and eligibility, allow stacking of heat and power support	A B C
2	**Permitting proportionate to risk**	Shallow ≠ deep, closed ≠ open loop, one stop shops, binding deadlines	B C D
3	**Open flexibility markets**	Aggregated small units and heat pump pools in balancing and local flexibility markets	A C
4	**Rules for heat networks**	Enforce RED III access right, published tariffs, prosumer rights	A C D
5	**Match the instrument to the risk**	Insurance for subsurface risk, CAPEX for networks and storage, 10 to 15 year revenue certainty	A B C D

A Rev. ORC/HTHP **B** HT-UTES **C** 5GDHC + BTES **D** Closed loop (outlook)

FlexGeo

Thank you. Questions?

Giulia Conforto, Senior Researcher
e-think energy research
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This project receives funding from the European Union's Horizon Europe research and innovation programme under grant agreement № 101147576.

Funded by the European Union

Backup: business model archetypes

Self consumption

Industrial site with 24/7 heat and power demand

Illustrative payback 8 to 12 years

Fits: A, D

Third party supply

20 year heat purchase agreement with a municipal DH operator

Illustrative 70% debt, 8 to 10% equity return

Fits: A, B, D

Energy community

~150 households, €200k equity + €400k soft loan

Illustrative heat cost −25%

Fits: C

PPA / VPP aggregation

Pooling several units for wholesale and balancing markets

Unlocks 1 MW minimum bids

Fits: A, C

GEO-CLUSTER

GEOS-TECHIS

Geothermal Source Thermal Energy for Cooling and Heating in Industries with Steam

GEO SYN

2ND JOINT MOBILIZATION AND MUTUAL LEARNING ONLINE WORKSHOP

06 October 2026

Presentation: Unlocking Geothermal Decarbonisation through Policy Incentives and Support Mechanisms

Presenter: *Eloy Miñano, Daniel Checa (Leitat)*

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Content

- GeoS-TECHIS project
- Decarbonisation strategy:
  - Environmental Life Cycle Assessment
  - Social Life Cycle Assessment
- Results
- Conclusion

About GeoS-TECHIS

- EU-funded project:
  - 10/2024 to 9/2027
  - 9 European partners (+1 affiliated)
- Aim:
  - Integrated geothermal-based system for industrial heating and cooling.
- The project combines
  - Heat Pumping & Cooling
  - Thermal Storage Solutions
  - Digital Optimisation Tools
  - Environmental & Social Assessment



Methodology Overview

ELCA: Life Cycle Assessment for environmental impact





Life Cycle Assessment (LCA) is a robust tool for assessing environmental impacts across a product's life cycle, from raw material extraction to end-of-life.

LCA Robustness ⇆ *reliability, consistency, and credibility of its results under various assumptions and uncertainties*

Affected by

Methodology Overview

SLCA: Life Cycle Assessment for environmental impact

Goal & Scope

Assess potential social **risks** and **benefits.**
Geothermal implementation
Across **life cycle**

Methodological Framework

UNEP/SETAC S-LCA framework
PSILCA social hotspot database
Risk-hour based assessment
Sector and country-specific characterization

Application in GeoS-TECHIS

Economic Inventory data from:
- baseline
- pilot
- industrial-scale

To quantify **social impacts**

Life Cycle Inventory → Process Mapping → PSILCA Risk Characterisation → Stakeholder Categories Assessment → Interpretation & Scenario Comparison

Stakeholder categories assessed:
Workers, Local Community, Society, Value Chain Actors and Consumers.
Results are expressed as risk hours and used to compare the social performance of alternative geothermal deployment scenarios.



Methodology Overview

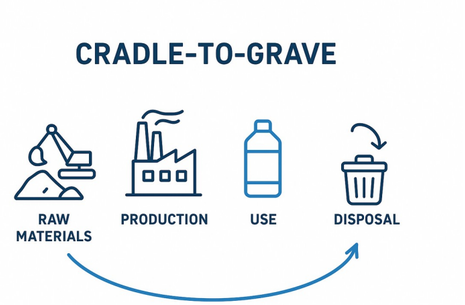
- Data collected across the supply chain

Kauman Factory

Related to energy

Cradle-to-grave

1 kWh of heat delivered to the user.
A geothermal system to provide 3250 MWh for the industrial production of conveyor belts over a minimum service life of 30 years.



- Data collected across the supply chain

Base-Line Scenario

Heating system **(Natural gas)**

Electricity

Cooling system

GeoS-TECHIS Scenario

Heating System **(Geothermal)**

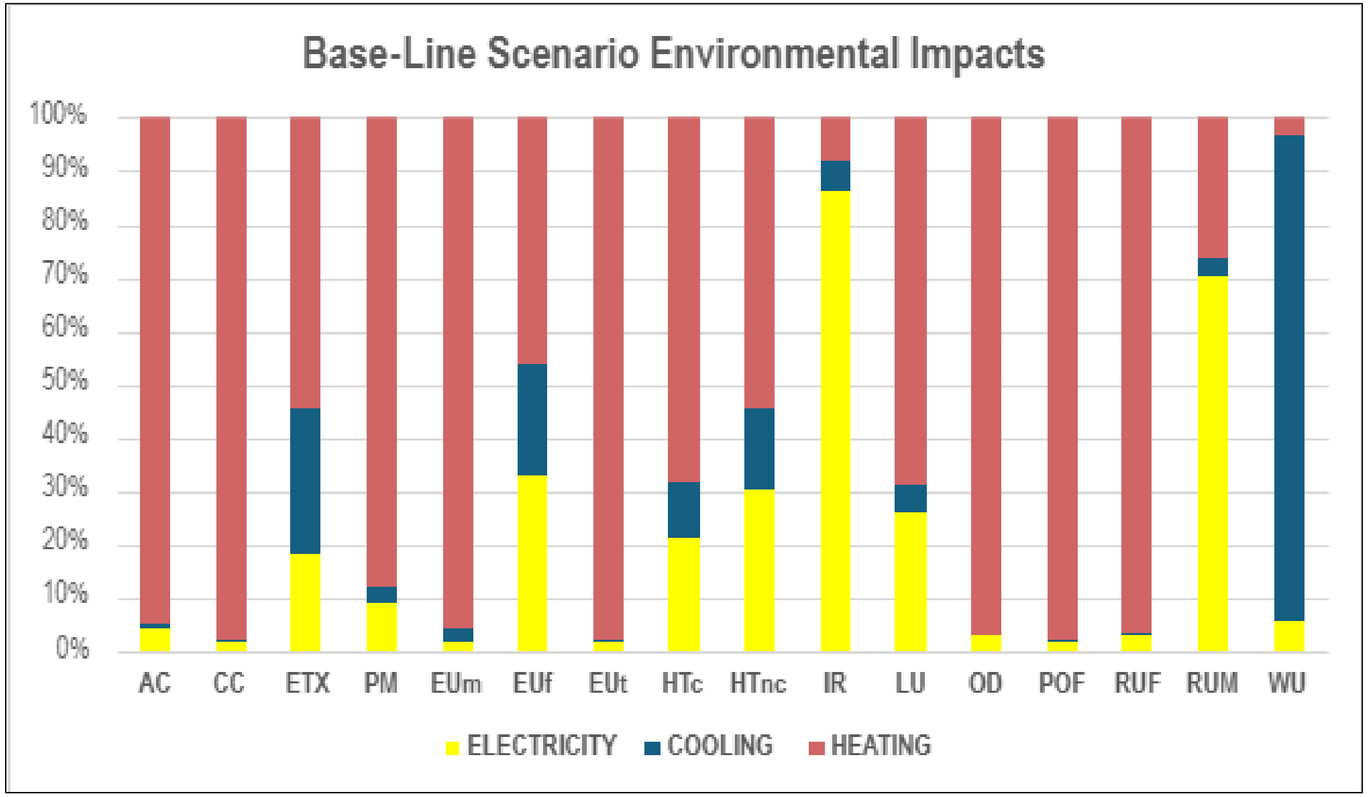
Electricity

Heat Pump

Cooling system

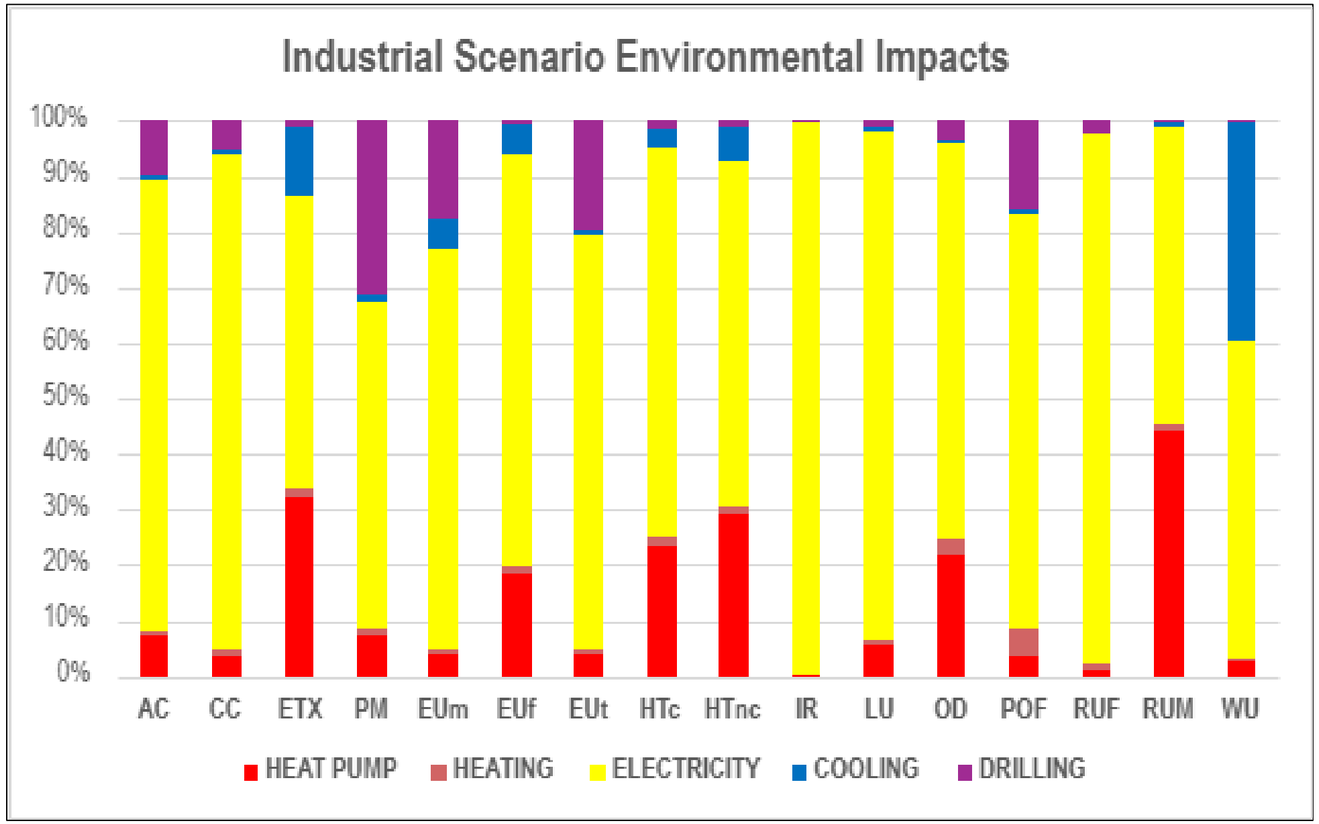
Drilling

Environmental LCA Results



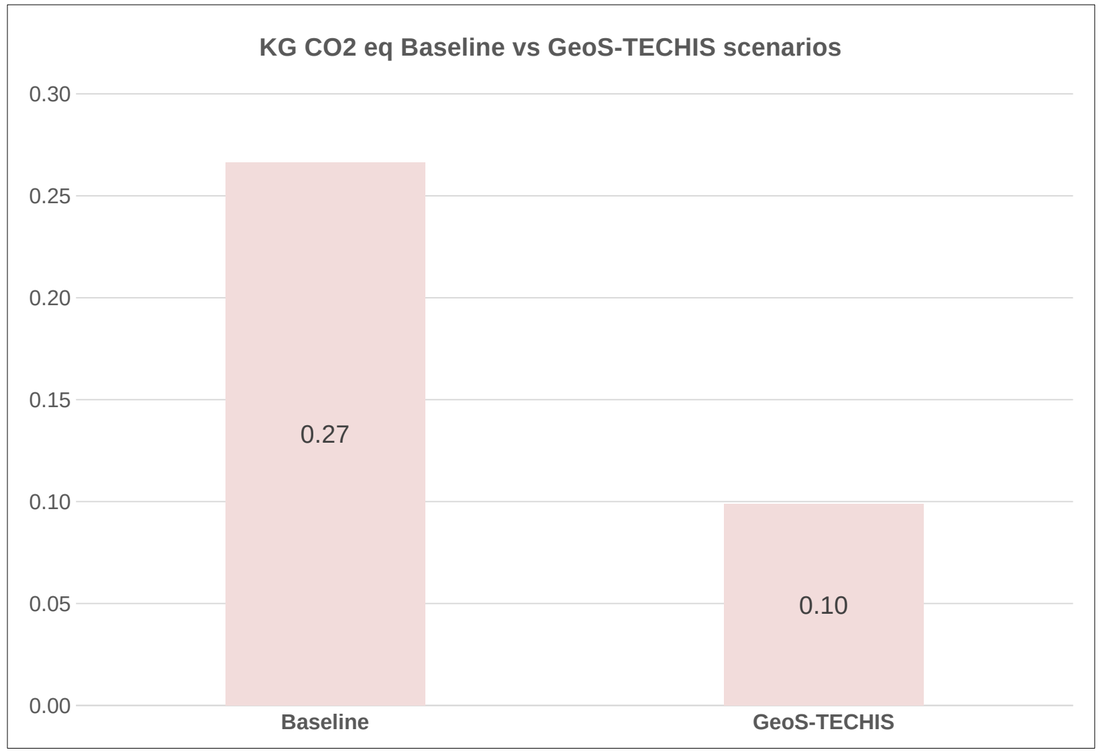
- Cooling system
  - Water
  - Infrastructure
- Electricity system
  - Electricity from solar panels
  - Spanish electricity mix
  - Solar panel infrastructure
- Heating system:
  - **Natural Gas** covers 3250 MWh heat demand
  - Infrastructure

Environmental LCA Results



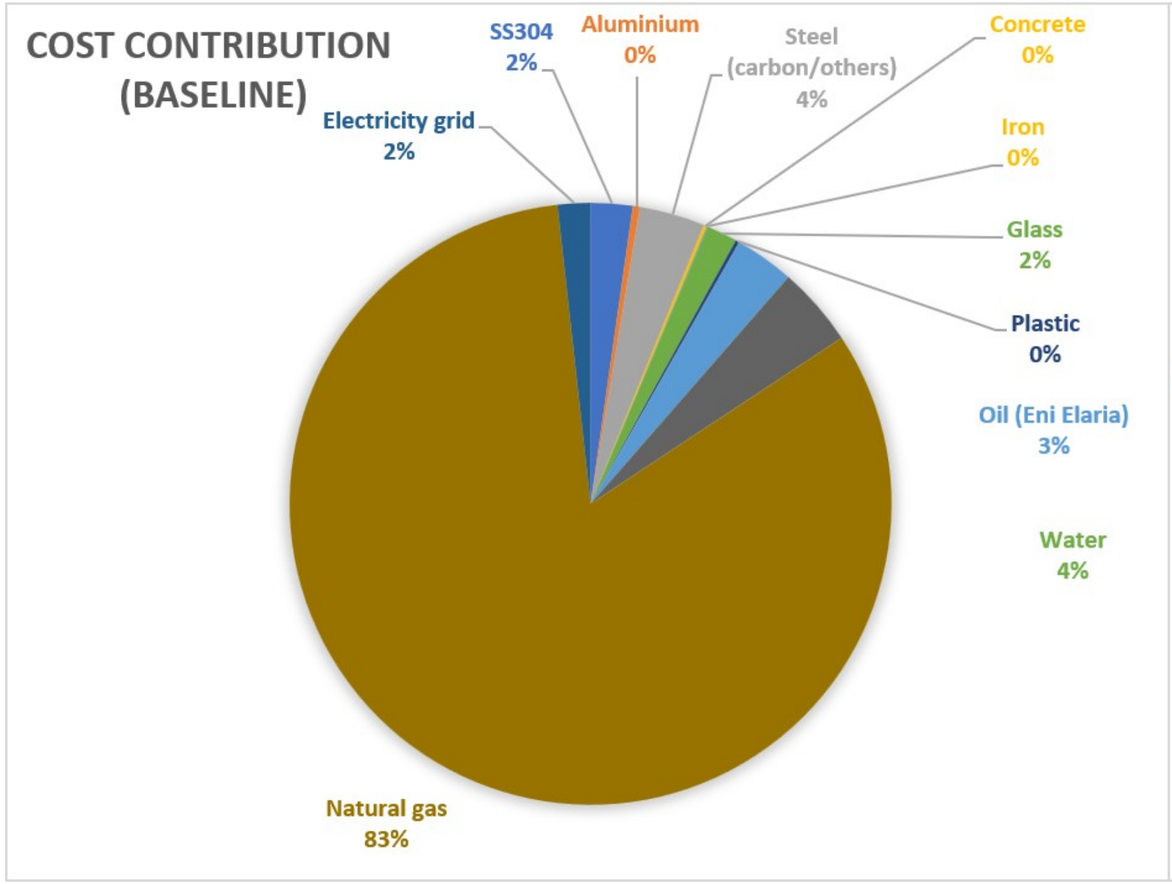
- Cooling system
  - Water
  - Infrastructure
- Electricity system
  - Electricity from Solar panels
  - Spanish electricity mix
  - Solar panel infrastructure
  - Heat pump electric demand
- Heating system
  - **Natural Gas** covers 0 MWh heat demand
  - Infrastructure
- Heat pump system
  - Heat transfer fluid
  - Infrastructure
- Drilling
  - Diesel consumption from machinery

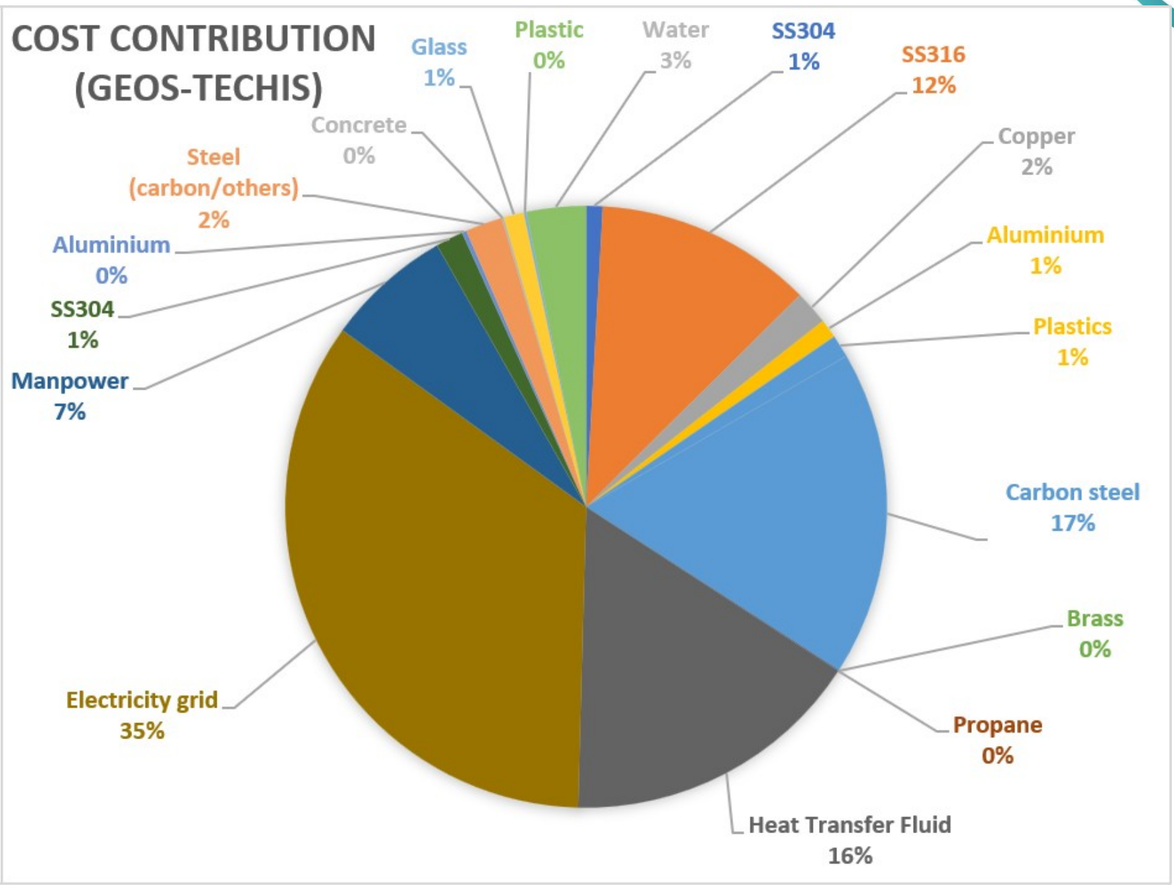
Environmental LCA Results



- Climate Change indicator
- 63% CO_2 reduction

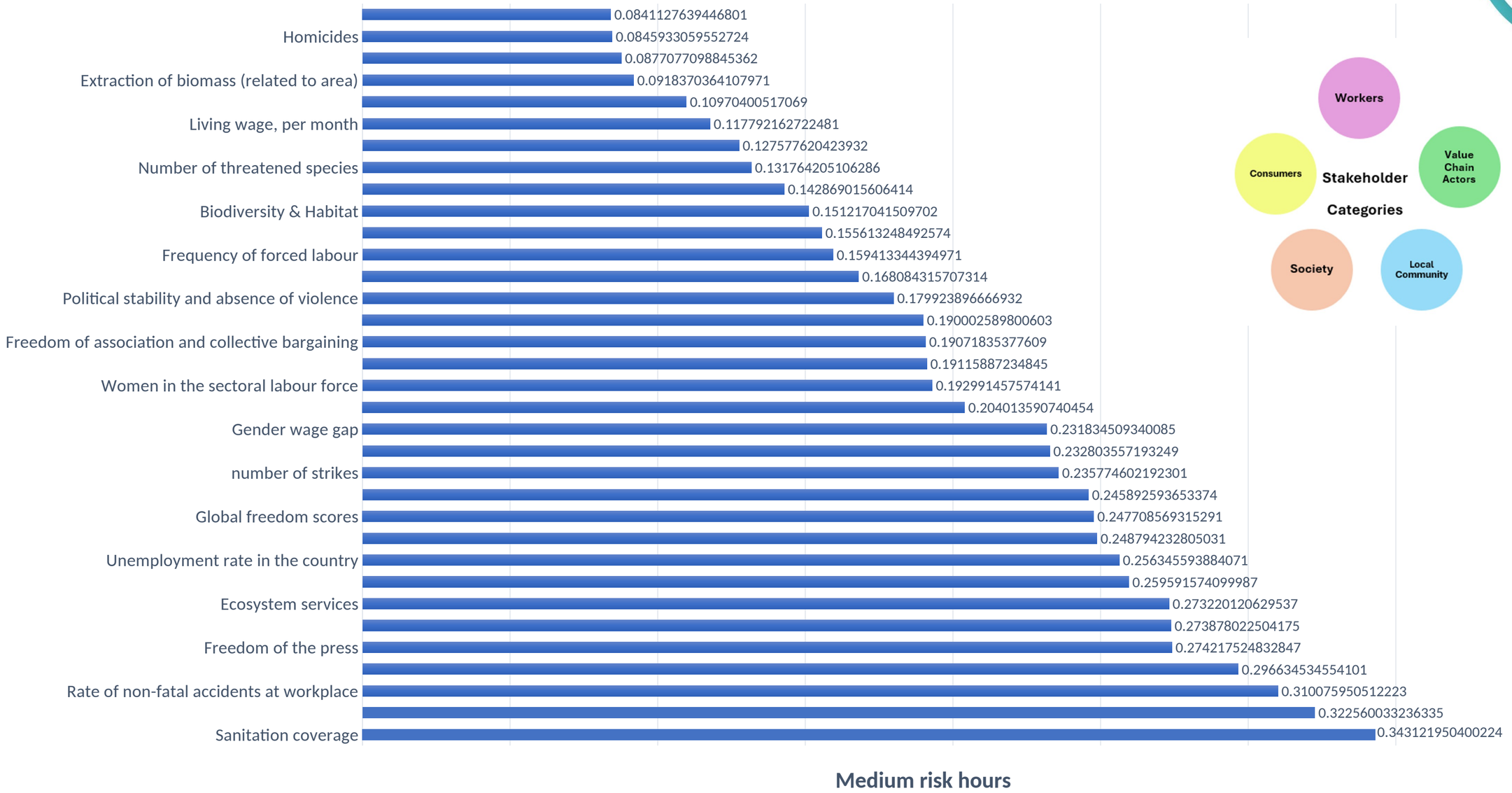
Social LCA Results



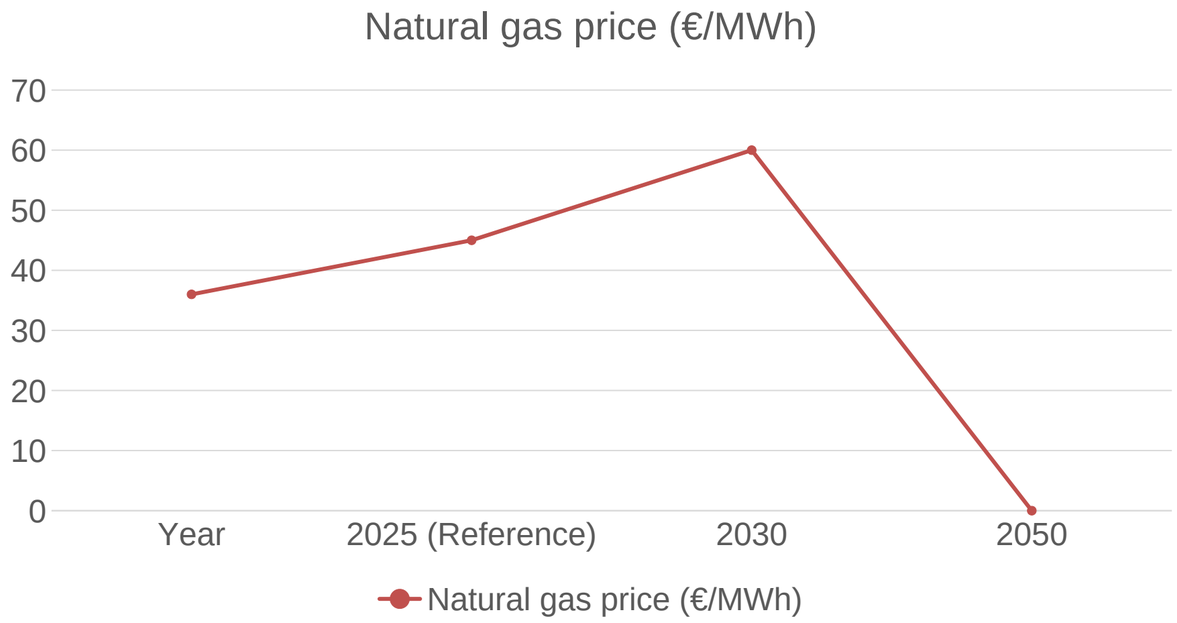


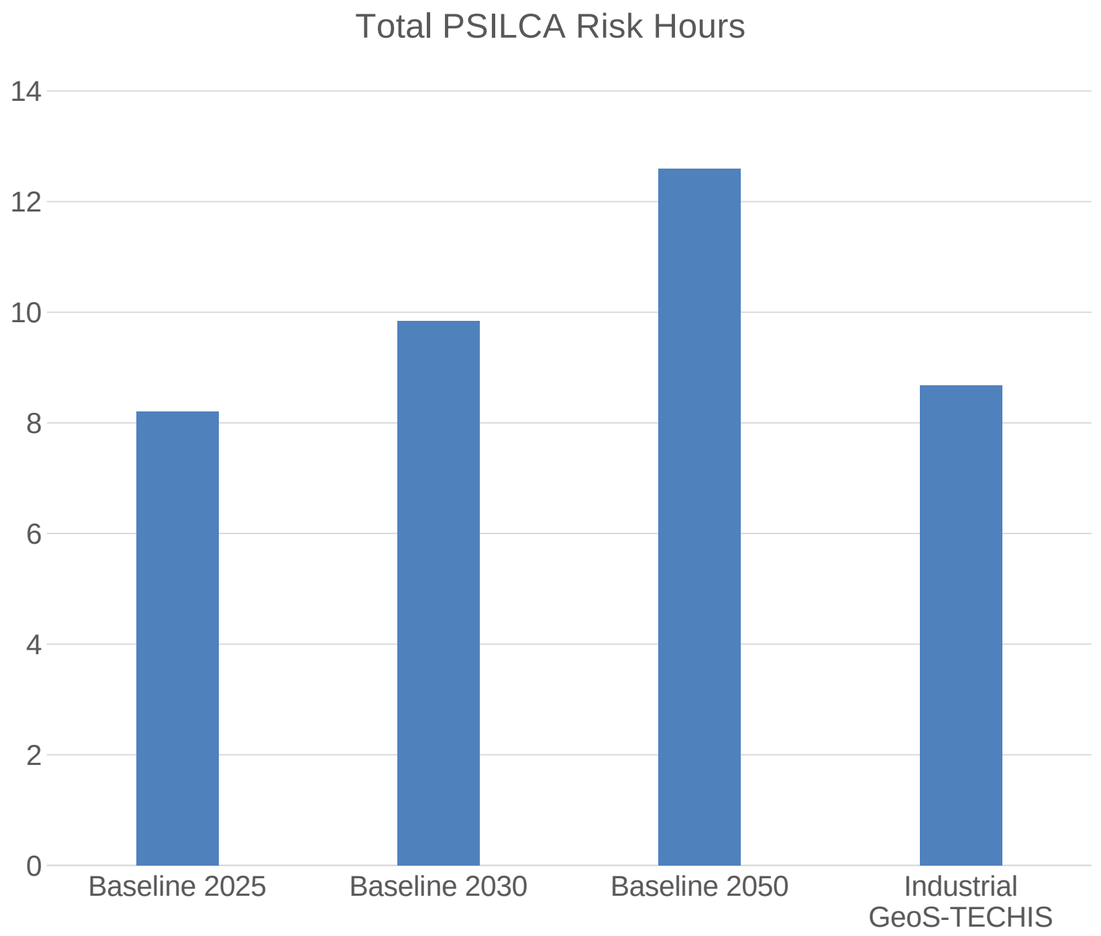
Scenario	Total Risk Hours	Scenario	Total Risk Hours
Baseline	8.21	**Industrial**	8.68

Social LCA Results



Prospective Social LCA Results





Scenario	Baseline 2025	Baseline 2030	Baseline 2050	Industrial GeoS-TECHIS
Total PSILCA Risk Hours	8,21	9,84	12,59	8,68

Conclusions

Environmental LCA: Life Cycle Assessment for environmental impact

- Natural gas ⟶ Geothermal
- Industrial scenario:
  - Significant reduction in CO2 emissions
  - Lower consumption of fossil resources
  - Reduced eutrophication potential
  - Higher impacts related to ionising radiation

Conclusions

Social LCA

- Supply chains are the main source of social risks across all assessed scenarios.
- Labour conditions and socio-economic indicators represent the most relevant social hotspots.
- Industrial deployment remains socially viable but requires attention to responsible sourcing practices.
- Prospective results indicate increasing social burdens associated with fossil fuel-based energy systems.
- The relative social sustainability benefits of geothermal energy are expected to strengthen over time.

Supporting Geothermal Deployment through Policy Instruments

Social and societal benefits identified

- Reduced dependence on fossil fuel supply chains
- Improved energy security and resilience
- Lower exposure to future energy market volatility
- Support for local economic development
- Contribution to sustainable industrial decarbonisation

Supporting Geothermal Deployment through Policy Instruments

Policy and support mechanisms

Regulatory Measures

- National geothermal development strategies
- Streamlined permitting procedures
- Integration into industrial decarbonisation policies

Financial Incentives

- Investment grants and innovation funding
- Risk-sharing instruments
- Green finance and sustainable investment programmes

Social Sustainability Measures

- Responsible sourcing requirements
- ESG criteria in procurement processes
- Supply-chain due diligence frameworks
- Stakeholder engagement and community participation

Funded by the European Union

Thank You
(Eloy Miñano & Daniel Checa)

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INTER STORES

International Innovation Network for the Development of
Cost- and Environmentally Efficient Seasonal Thermal Energy Storages

GEO-CLUSTER
Seasonal Thermal Energy Storage
From Demonstration Projects to Market Deployment in Europe

Geo-Cluster
GEOTHERMAL ENERGY PROJECTS
Funded by the European Union

GreenFlex

GREENFLEX, Anne-Charlotte Gripoix

OCTOBER 6th , 2026

Funded by the European Union

Project funded by
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

UKRI UK Research and Innovation

Seasonal Thermal Energy Storage

Why Europe Needs It Now ?

Why Underground Thermal Energy Storage Matters Now?

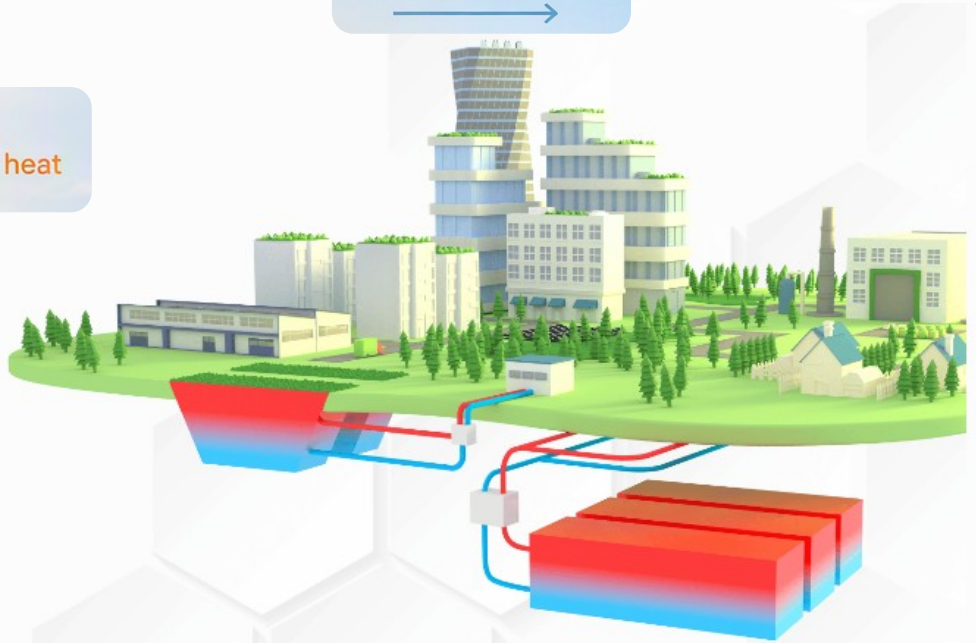
Turning today's renewable and waste heat into tomorrow's decarbonised industry and cities.

Europe does not lack renewable heat. It lacks the ability to store it when it is available and use it when it is needed.

INTER STORES

STORE TODAY FOR TOMORROW

SUMMER
Abundant renewable and waste heat



WINTER
Reliable, low-carbon heat for industry and cities

- Better use of renewable energy
- Lower emissions in industry and cities
- Greater energy security and resilience
- More affordable and sustainable heat for European citizens

Funded by the European Union

Project funded by
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

UK Research and Innovation

Seasonal Thermal Energy Storage:

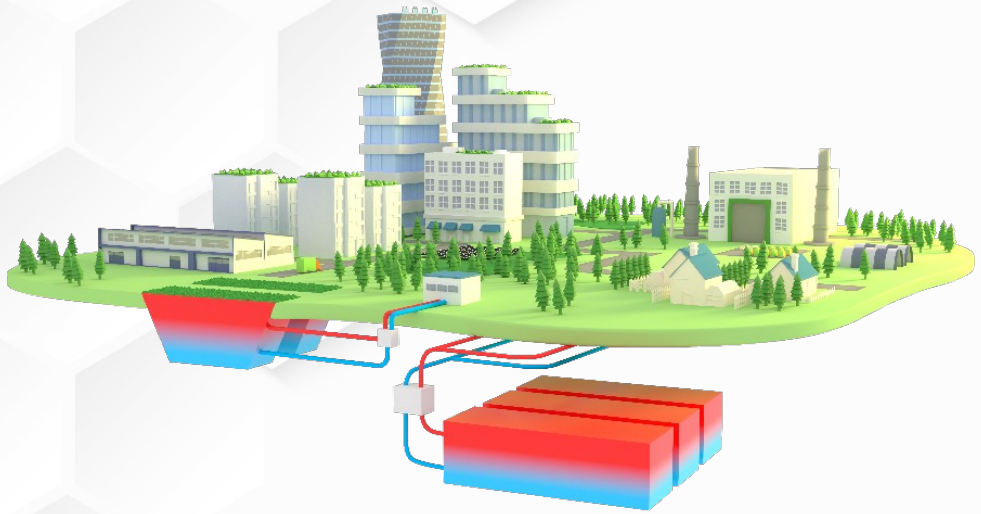
From Research Projects to Real Market Opportunities ?

INTERSTORES

Facts & Numbers

International Innovation Network for the Development of **Cost- and Environmentally Efficient Seasonal Thermal Energy Storages**

- **Granting authority –** CINEA
- **Type of action –** HORIZON Innovation Actions



Start date January 2024

Duration 48 months

Budget 11 million €



INTERSTORES

Demo Sites

International Innovation Network for the Development of **Cost- and Environmentally Efficient Seasonal Thermal Energy Storages**

incampus, Ingolshtadt, Germany

Open facility without a fence, a real campus – data centre, vehicle safety centre etc.

https://incampus.de/

Size: 18,000 m^3

TES type: WGTES, Reno-sTES

Insulation: Recycled material

Indirect charging/discharging




Reno – sTES – incampus January 2026


Reno – sTES – incampus June 2026


Reno – sTES – incampus September 2026

INTERSTORES

Demo Sites

International Innovation Network for the Development of **Cost- and Environmentally Efficient Seasonal Thermal Energy Storages**

Varanto, Vanta, Finland

will be the world's largest sTES facility in terms of size and capacity.

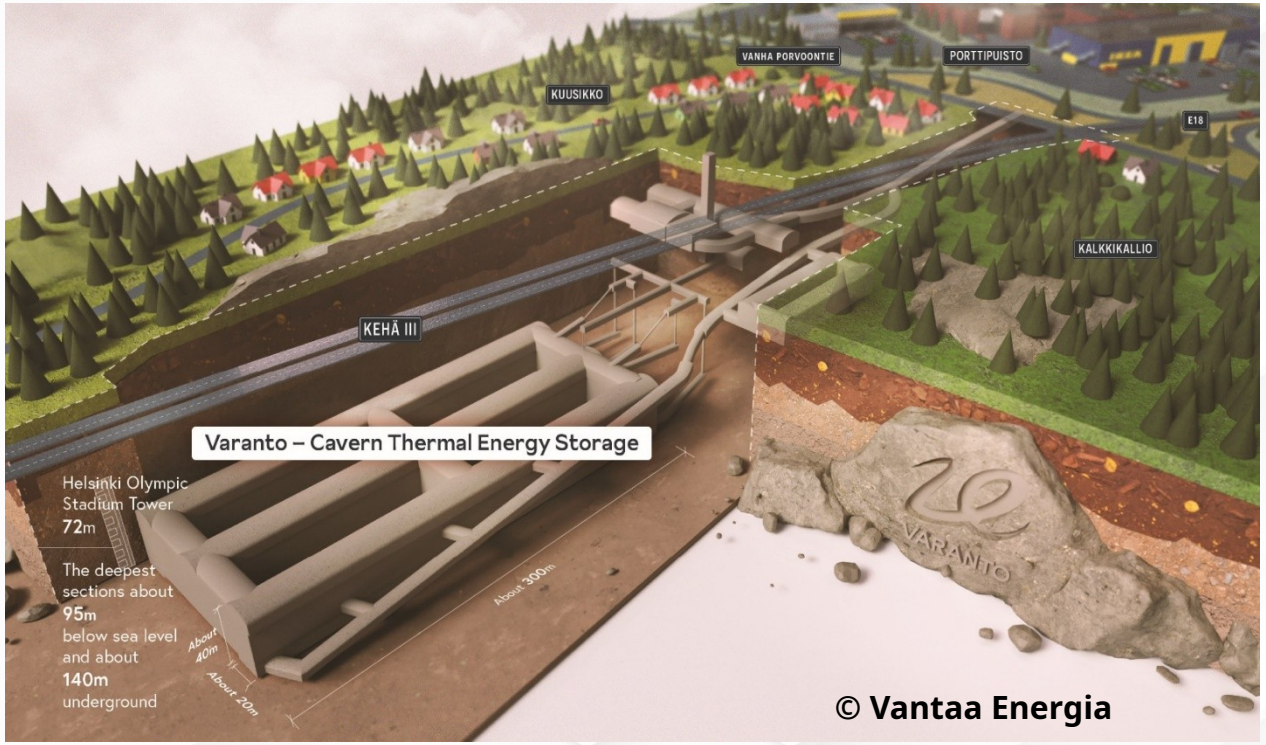
https://www.vantaanenergia.fi/en/projects/heatstorage/

Size: 1,000,000 m³

Capacity: 90 GWh

TES type: Giga-CTES

Storage medium: Pressurized water t>130°C



INTERSTORES

Transfer Sites

International Innovation Network for the Development of **Cost- and Environmentally Efficient Seasonal Thermal Energy Storages**

TRANSFER-SITE INDUSTRIAL INFO SHEET

EFFINGHAM ROAD GASHOLDER SITE - SHEFFIELD



Reno-sTES

CONCEPT | United Kingdom

Preliminary transfer-site info sheet | Sheffield, UK | Project stage: Concept | August 2026 [0579-INT-TS-015]

HEADLINE DATA

Storage type & capacity **Reno-sTES, TTES (P1); compact PTES + TTES (P2)**	Main heat source **Bernard road ERF, max. 45 MW**	Heat offtakers **Veolia Sheffield District Heating Network**	Assessment status **TTES assessed; PTES spatial concept only**
2025 heat supplied **93,449 MWh** *total network heat including oil and gas backup*	Current annual heat export **Up to 100,000 MWh/year**	Peak heat export **32 MW**	Network/route length **547 m** *CO_2 saving TBC from modelling*

CONCEPT AT A GLANCE

The Sheffield transfer site concept places water-based TES at the former Cadent gasholder site between Effingham Street and Sussex Street.
The proposed store would connect to the Sheffield District Energy Network and receive heat from the Bernard Road Energy Recovery facility, approx. 330m from the site (Heat offtakers - Veolia Sheffield District Heating Network).
The network supplied **93.45 GWh** of heat in 2025 and currently exports up to approximately **100 GWh annually**, with a peak heat export of **32 MW**. The initial concept is a **100 MWh tank** TES designed for daily peak shifting.
The site layout also safeguards space for a future compact pit thermal energy store with projected network growth eventually justifying multi-day or seasonal storage.

WHY IS THIS SITE RELEVANT?

- Repurposing the former gasholder site provides a **Reno-sTES** oriented brownfield application, examining how legacy energy infrastructure and land could support a new thermal-storage function.
- The phased concept explores a transition from a **100 MWh** daily balancing TTES to longer-duration PTES capacity as the DHN expands.
- This allows INTERSTORES to examine the technical, special, demand and economic conditions that would trigger progression **from short-duration balancing to seasonal storage.**
- The case is potentially replicable across European cities with redundant gas or industrial sites located close to existing or planned DHNs.
- Sheffield also broadens the INTERSTORES evidence base by adding a UK energy-from-waste network with constrained urban land and an active heat-network expansion context.



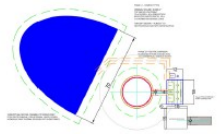


SHEFFIELD PHASED THERMAL STORAGE CONCEPT

TTES daily buffer + safeguarded PTES expansions

Storage concept and technical snapshot

a Phase 2 TTES/PTES spatial arrangement



PHASE 2 – COMPACT PTES
- Nominal volume: **approx. 30,000 m³**
- Indicative volume range: **25–36,000 m³**
- Top water footprint: **70 m chord × 60 m projection**
- Indicative water depth: **16 m**
- Perimeter service zone: **5 m**
- Gross capacity: **0.6–0.85 GWh$_{th}$** (ΔT=20 K)
- Future potential: **1.2–1.9 GWh$_{th}$** (ΔT 40–45 K)

b Phase 1 TTES general arrangement



c Phase 1 TTES vertical section



KEY PLAN PARAMETERS
- Useful storage: **100 MWh**
- Tank internal/external diameter: **20.8/21.5 m**
- Foundation raft: **Ø 24 m**
- Indicative service envelope: **Ø 36 m**
- Plan enclosure: **18 x 12 m**
- Hardstanding: **15 x 15 m**
- Access road width: **6 m**

Preliminary arrangement – not for construction

KEY PLAN PARAMETERS
- Useful storage: **100 MWh**
- Internal diameter: **20.8 m**
- Active water height: **31.2 m**
- Overall tank height: **approx. 35 m**
- Reference storage temperatures: **95/86°C**
- Atmospheric tank with low-pressure nitrogen blanket
- Upper and lower diffusers shown schematically

Preliminary arrangement – not for construction

Phase 1 comprises a 100 MWh stratified TTES designed around the networks average 103 ° C flow and 83 ° C return temperatures.
The store would charge from the ERF through an isolating heat exchanger during the 16 off-peak hours each day and discharge across the 06:01:00 and 6:00-21:00 demand peaks.
The identified 10MW daily shifting opportunity, leaving operational headroom within the store.
Phase 2 would add a 25,000-36,000 m³ PTES for multi-day and seasonal operation.
Its gross capacity would be approximately 0.6-0.85 GWh$_{th}$ at the current 20k operating range, potentially increasing to 1.2-1.9 GWh$_{th}$ if future network operation enables a 40-45 K range.
The PTES would charge during prolonged low-demand periods and discharge during sustained winter demand, while the TTES continued providing rapid daily balancing.

TECHNICAL DATA BY SYSTEM AREA

SYSTEM AREA	DATA SUMMARY	SOURCE/STATUS
Heat source	Bernard Road ERF; maximum output 45 MW; 81.27 GWh supplied by ERF in 2025.	Veolia data
Heat transfer	Direct charging through an isolated heat exchanger arrangement; no heat pump presently assumed.	Conceptual design - CEN
Heat demand/ offtake	93.45 GWh supplied in 2025; up to 100 GWh annual export; 32 MW peak.	Veolia data
Network Temperatures	Average flow/return of 103/83° C giving an average network ΔT of approx. 20 K. Winter flow temperature increases to approx. 110° C, although a corresponding winter return temperature has not been provided. During summer, flow temperature falls to approx. 92-93° C while return temperature is typically 86° C, producing a much narrower ΔT of approx. 6-7 K. This seasonal variation will influence the usable capacity and operating strategy of both storage phases.	Veolia; ΔT values derived
Phase 1 TTES	100 MWh; approx. 20.8 m internal diameter and 35 m high; equivalent to approx. 3.1 hours at current peak and export.	Concept design
Phase 2 PTES	Approximately 25,000-36,000 m³; 16 m indicative depth; 30-45° side slopes; approximately 0.6-0.85 GWh$_{th}$ at the current 20 K ΔT.	Conceptual spatial design
Operation	Up to 16 hours available for charging; discharge targeted at 06:00-09:00 and 16:00-21:00, additional benefit when targeted at maintenance shut down times to reduce backup oil and gas use.	Preliminary operating strategy

DELIVERY CONTEXT

Outcomes, stakeholders and risks

ENERGY/SYSTEM

Phase 1 would time shift available ERF heat from lower-demand periods into the morning and evening peaks. This could reduce short-duration operation of gas and oil-fired backup plant, improve utilization of available ERF capacity and provide additional operational flexibility and resilience.
Phase 2 is not assumed to be necessary under present network conditions. Instead, the PTES concept provides an expansion pathway if future network growth produces a recurring longer-duration or seasonal imbalance that cannot be managed by the 100 MWh TTES, as well as providing coverage over times of prolonged maintenance/ upgrades as seen in 2025.

ENVIRONMENTAL

Carbon savings would arise only where stored ERF heat demonstrably displaces fossil-fueled backup generation or enables additional low-carbon heat to be supplied to the network.

These savings have not yet been quantified and will depend on actual storage dispatch, marginal backup fuel and future heat-demand growth.

The concepts also supports productive reuse of a former gas-infrastructure site, potentially avoiding additional greenfield land take.

ECONOMIC/STRATEGIC

Preliminary modelling does not currently demonstrate a viable standalone investment case based on avoided peak backup fuel costs.

A stronger case would require multiple sources of value, potentially including additional heat sales, reduced fossil fuel use, improved resilience, carbon value and deferred generation or network reinforcement.

The phased approach limits initial investment to the storage presently supported by operational demand.

STAKEHOLDERS AND ROLES

ROLE	ORGANISATION	RELEVANCE/STATUS
Storage owner/ landowner	Cadent	Controls the proposed site. Confirmation required regarding site engagement, developable land, existing assets.
Heat source owner	Veolia Sheffield	Operates Bernard Road ERF and the district heating network.
Economics/ finance	Sheffield Count Council	Municipal authority and Veolia contract partner. Relevant to heat network expansion, heat network zoning, planning coordination and alignment with Sheffield's wider decarbonization strategy.
Heat offtakers	General publci Sheffield	Important for public perception and demand growth.

KEY RISKS AND UNCERTAINTIES

RISK AREA	ISSUE/IMPLICATION	STATUS
Demand growth & Phase 2 trigger	Longer-duration PTES would depend on sufficient network expansion, recurring seasonal heat imbalance and potentially a wider network temperature difference.	Phase 2 remains a future option rather than current requirement.
Land/geology	Structural condition of the former gasholder base, groundwater, excavation depth and location of retained Cadent assets may reduce available storage volume.	Major feasibility gate.
Economics/ finance	Site-specific CAPEX, OPEX, heat value and avoided backup costs are not yet confirmed. Preliminary modelling suggests that avoided peak fuel expenditure alone is unlikely to justify the 100 MWh TTES.	Concept is not yet investment-ready. Additional value streams and more detailed cost evidence required.

CURRENT STATUS

CONCEPT

The Sheffield case has progressed to conceptual and pre-feasibility assessment. Veolia has supplied network capacity, temperature and operational data; GIS analysis has identified indicative connection routes; and a **100 MWh TTES** has been modelled and developed into a preliminary CAD arrangement. A compact PTES option has also been defined as a future expansion phase.

The case is suitable for INTERSTORES transfer site comparison but does not represent an approved project or investment proposal. Results will be shared with Veolia before any publication.

Seasonal Thermal Energy Storage:

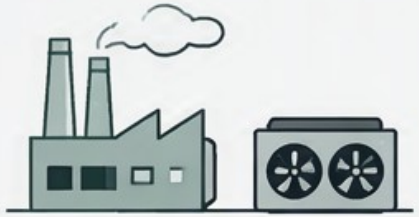
What creates value to inverstors?

WHERE DOES STES CREATE VALUE?

Unlock low-carbon heat when and where it's needed

5 KEY APPLICATION CONTEXTS

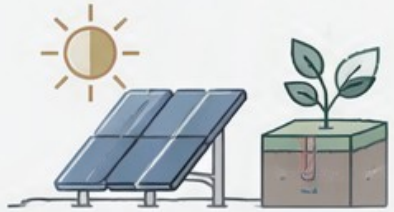
1 RECOVER WASTE HEAT



Industry • Data centres
Waste-to-energy plants

Value: Use heat that would otherwise be lost

2 INCREASE RENEWABLE HEAT UTILISATION



Solar thermal • Geothermal
Biomass • Other renewable heat

Value: Maximise renewable share and reduce curtailment

3 AVOID FUTURE GENERATION ASSETS



Expanding DH networks
Boiler or peak plant replacement

Value: Defer or avoid costly future investments

4 PROVIDE FLEXIBILITY TO HEAT SYSTEMS



District heating networks
Better resilience and balancing

Value: Improve system resilience and flexibility

5 SUPPORT INDUSTRIAL HEAT DEMAND



Industries with seasonal or variable heat demand

Value: Secure low-carbon heat supply for industry

Seasonal Thermal Energy Storage:

What Are the Main Barriers to Market Deployment?

EXECUTIVE SUMMARY

DEMONSTRATORS SHOW LIMITED PROFITABILITY TODAY, BUT STRONG POTENTIAL FOR REPLICATION & VALUE CREATION

INTER STORES

KEY FINDINGS

Limited profitability today

The two demonstration sites show payback periods of **25 and 38 years**. Sites are already decarbonized even without storage and current energy prices are relatively low. **CAPEX remains high** (136–280 €/m³).

Clear improvement potential

Several transfer sites show **better performance** than the demonstrators. Sensitivity analyses identify **market conditions** under which seasonal thermal storage becomes economically attractive.

High dependency on energy prices

Profitability depends on the price of the fossil energy replaced and on policy support (feed-in tariffs, subsidies). Solutions become attractive when **heat sales price > €120/MWh**.

Strong long-term outlook

Scaling up, cost reductions and improved policy frameworks can reduce CAPEX and shorten payback periods to **less than 10 years**.

PROFITABILITY ASSESSMENT BY TRANSFER SITE CATEGORY

TRANSFER SITE CATEGORY	ECONOMIC OUTLOOK (PAYBACK POTENTIAL)	KEY VALUE DRIVERS	SENSITIVITY (MARKET / PRICE)
Industrial waste heat (fossil-based DHN)	HIGH POTENTIAL (10–15 years) ●●●●○	Replace fossil heat Large volumes of waste heat	Attractive if heat price is high
Waste-to-Energy plants	HIGH POTENTIAL (10–18 years) ●●●●○	Better use of existing assets Strategic for DHN expansion	Stronger if plant already amortised
Large DHN with market flexibility	MEDIUM POTENTIAL (15–25 years) ●●●○○	Market arbitrage Additional revenues	Dependent on electricity prices
Data centres	MEDIUM POTENTIAL (15–25 years) ●●●○○	Stable, low-carbon heat source	Attractive with low electricity prices
Already decarbonised DHN	LOW POTENTIAL (> 25 years) ●○○○○	Resilience Flexibility	Limited direct economic gains

KEY TAKEAWAY

Seasonal thermal storage creates the highest value when it unlocks otherwise unused low-carbon heat and avoids future fossil-based investments, while CAPEX remains the main barrier.

Lower CAPEX + supportive policies = shorter payback & strong replication potential

Funded by the European Union

Building a replicable market for cost-effective seasonal thermal energy storage in Europe.

Project funded by Innosuisse – Switzerland

UK Research and Innovation

Key Insights from the STES Value & Barrier Workshop

A multi-partner workshop to understand value creation and barriers to STES deployment

INTER STORES

65+ ideas collected

Multi-partner workshop

Value drivers and **deployment barriers** assessed

Ideas by theme (number of ideas)





THE VALUE EQUATION

VALUE CREATION

- Surplus heat
- Flexibility
- Resilience
- Cost savings
- Decarbonisation

STES

BARRIERS

- Cheaper alternatives
- Geology
- Space constraints
- Integration challenges
- Regulations

KEY THEMES IDENTIFIED

- Economics
- Technical & geological constraints
- System integration
- Sustainability
- Strategic value



KEY TAKEAWAY

The workshop suggests that successful STES projects are primarily driven by **economic value** and local site conditions, while **technology maturity** is generally perceived as a secondary concern.

Funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
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Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER

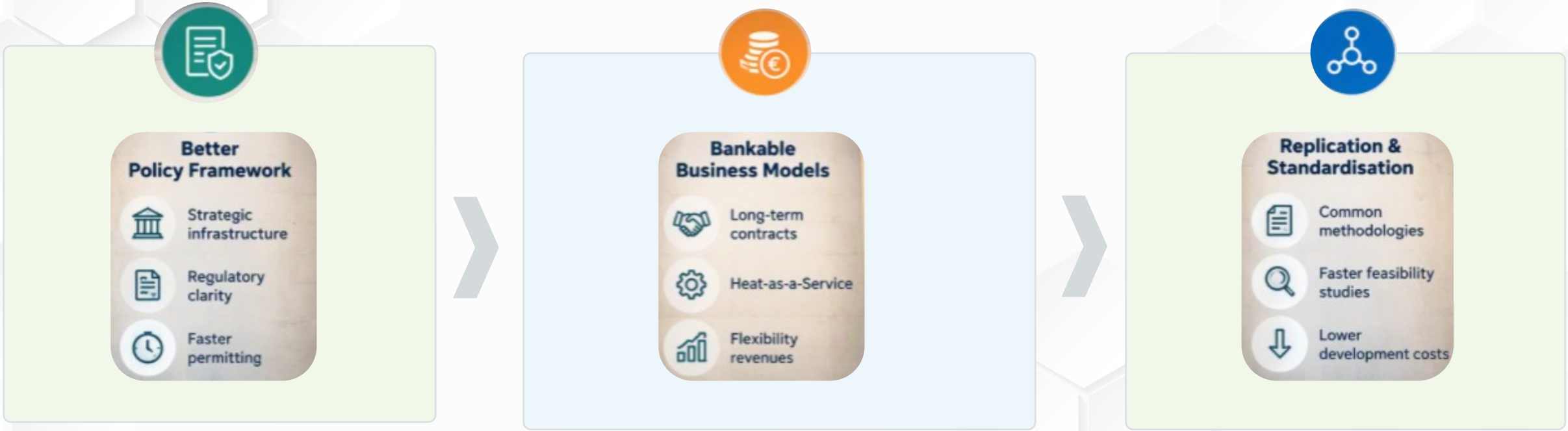
State Secretariat for Education, Research and Innovation SERI

UK Research and Innovation

Seasonal Thermal Energy Storage:

What Is Needed to Unlock Market Deployment?

What Is Needed to Unlock Market Deployment?



The challenge is no longer proving that Seasonal Thermal Energy Storage works.
The challenge is making it repeatable, investable and scalable

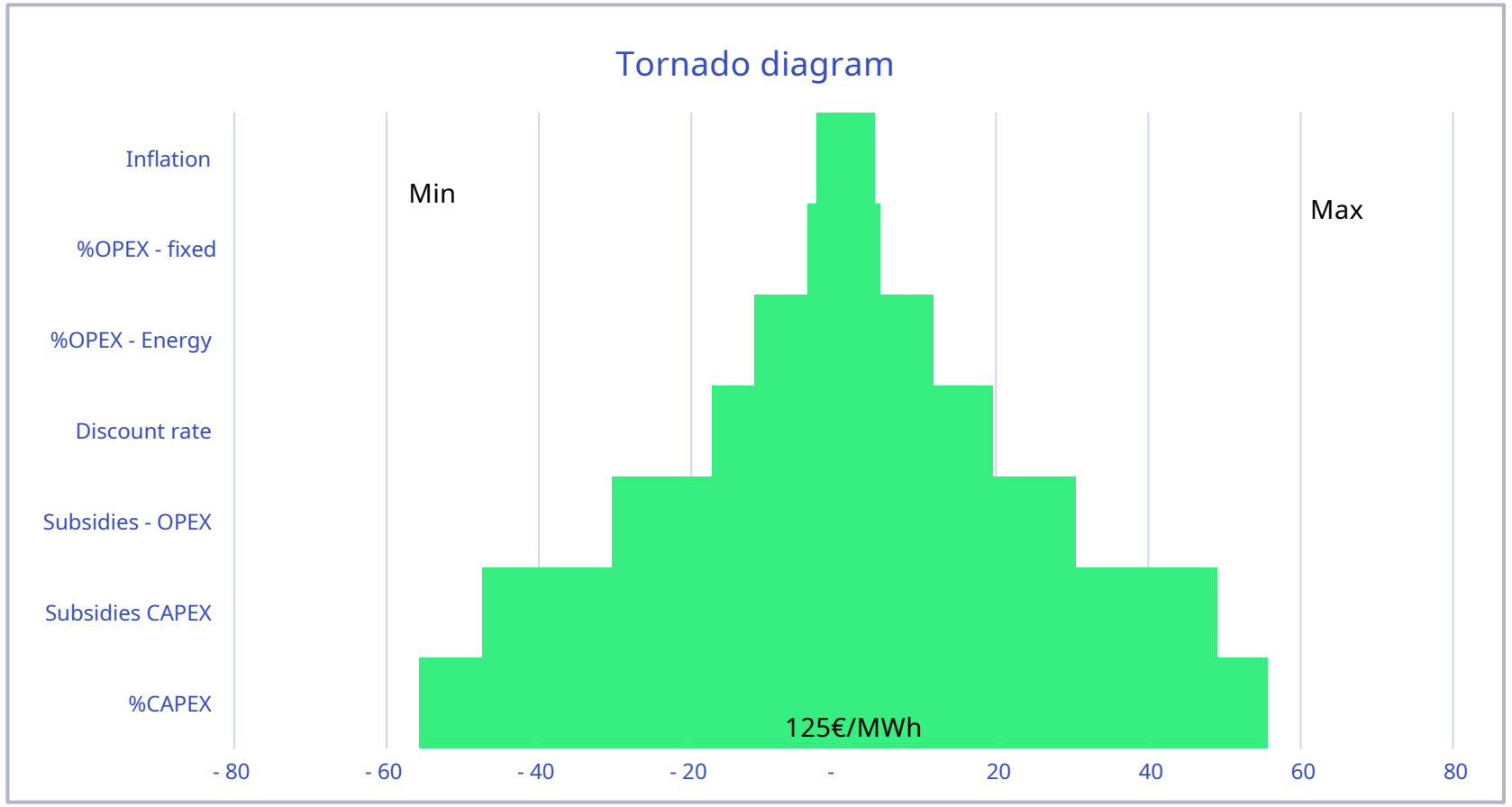
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UK Research and Innovation

MAIN CONCLUSIONS -

...THE TWO MAIN LEVERS TO REDUCE THE LCOH OF THE STORAGE SOLUTION ARE LOWERING CAPEX FOR A GIVEN DESIGN BASIS, AND SECURING STRONG POLICY SUPPORT, INCLUDING SUBSIDIES AND FEED-IN TARIFFS. A LCOH OF 70€/MWH CAN BE REACH FOR STORAGE



	LOW	AVERAGE	HIGH
Energy Price	-20%	Actual	+20%
CAPEX	-40%	Actual	+40%
Discount rate	6%	8%	10%
Inflation	0,5%	1,5%	2,5%
Subsidies CAPEX	100%	70%	40%
Feeding tariff	-50€/MWh	0	+50€/MWh

From Demonstrators to Replicable Projects

LESSON 1

Economics Drive Project Success

- Abundant waste heat availability
- Strong and stable heat demand
- Long-duration storage potential

LESSON 2

Early Screening Is Critical

Project viability depends on a few key parameters identified at an early stage:

- Heat source availability
- Demand profile
- Geological suitability
- Land availability

LESSON 3

Scaling Requires Standardisation

Accelerating deployment will require:

- Common methodologies
- Standardised pre-feasibility tools
- Knowledge sharing across Europe

From demonstration to deployment: the goal is to reduce development effort and accelerate replication.

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Project funded by
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INTER STORES

Thank You

for Your Attention



Funded by the European Union

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2nd Joint Mobilization and Mutual Learning Online Workshop

Accelerating Geothermal and Thermal Energy Storage Deployment in Europe: Policy, Regulation and Market Readiness

EVIDENCE-BASED TOOLS AND METHODOLOGIES TO INCREASE AWARENESS AND SUPPORT GEOTHERMAL H&C ADOPTION AND DEPLOYMENT IN INDUSTRY

Dario Bonciani

COSVIG – Consortium for the Development of Geothermal Areas

Funded by the European Union

Challenges for European Industry: Time for an Energy Revolution

European industries need vast amounts of energy for H&C processes

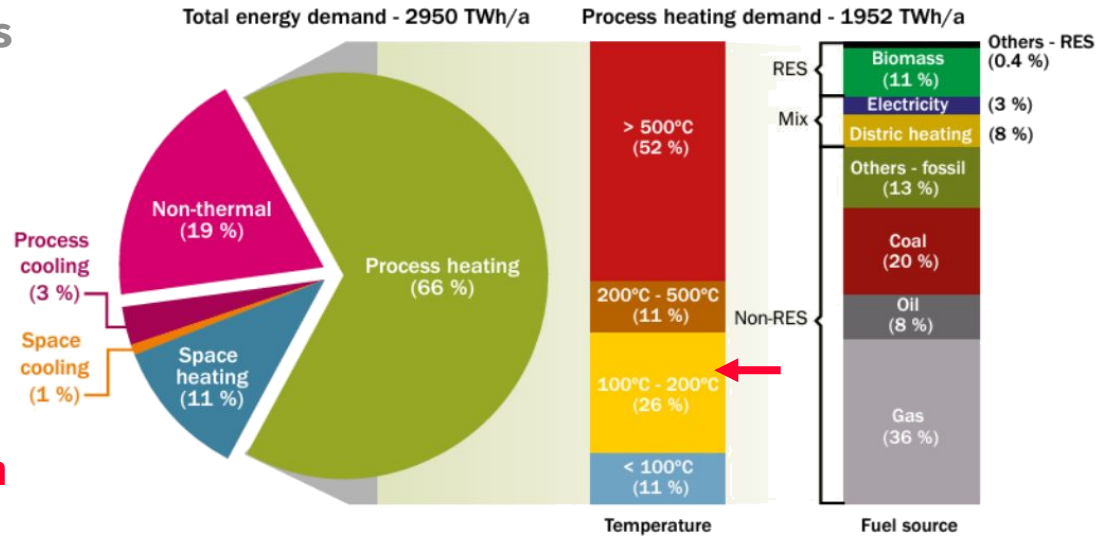
Energy intensive processes <200°C:

Pulp & Paper, Food & Beverages, chemistry, wood products, cement and textiles

Process cooling demand is >110 TWh

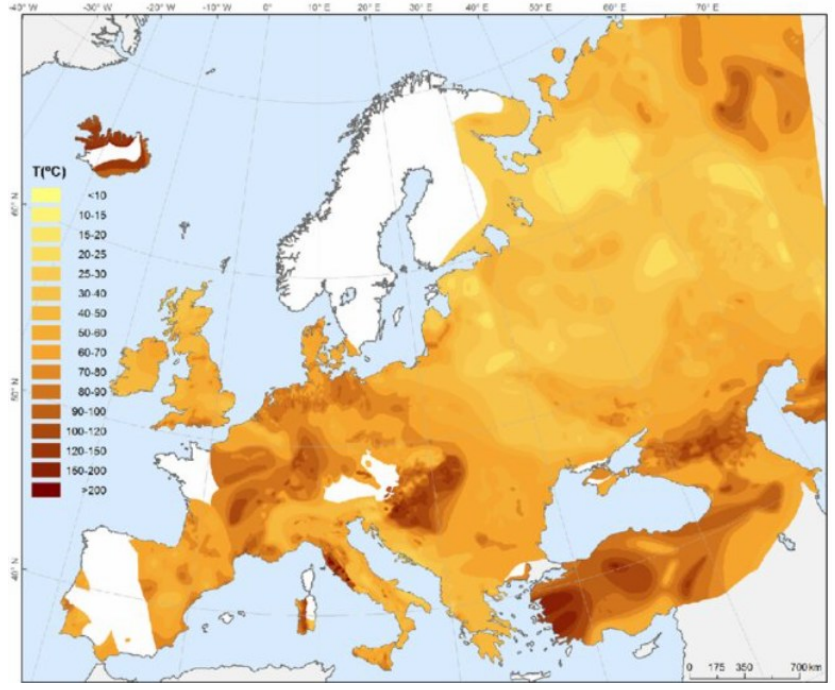
≈ 16% of EU industrial electricity consumption

Energy consumptions in European Industries [De Boer et al., 2020]



Industries struggle with energy security, in meeting decarbonisation targets and lose competitive advantage

- **Fossil fuel dependency** – The share of renewables is increasing but most industrial H&C still relies on fossil fuels
- **High carbon emissions** – Industry accounts for 25% of EU energy consumption
- **Rigid systems** – Lack of operational flexibility and integration



Untapped geothermal potential:

- 25% of cities and industries in Europe are in areas with suitable potential
- Geothermal could meet ≈ 5% of industry heat demand by 2050
- Non-technical gaps hampering H&C technology deployment

The GEOSYN Solution

GEOSYN connects industries directly to geothermal energy: the same heat source provides both flexible heating and cooling for industrial needs.

The technology uses **water as refrigerant** and cascades energy efficiently through the system, maximising opportunities offered by geothermal heat.

Beyond technology, GEOSYN engages local communities, showcases industrial applications, demonstrates reliability and turns evidence into recommendations supporting wider deployment.

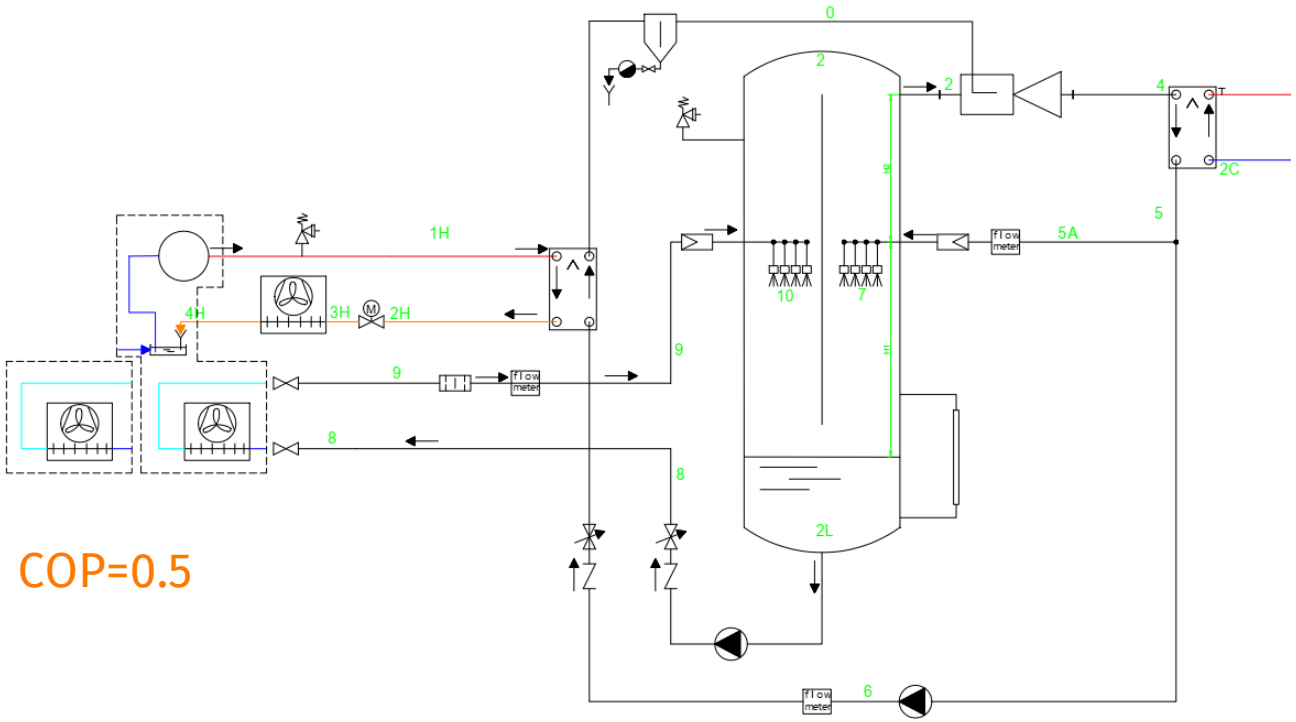


Project GEOSYN - GA nr. 101172812

Funded by the European Union

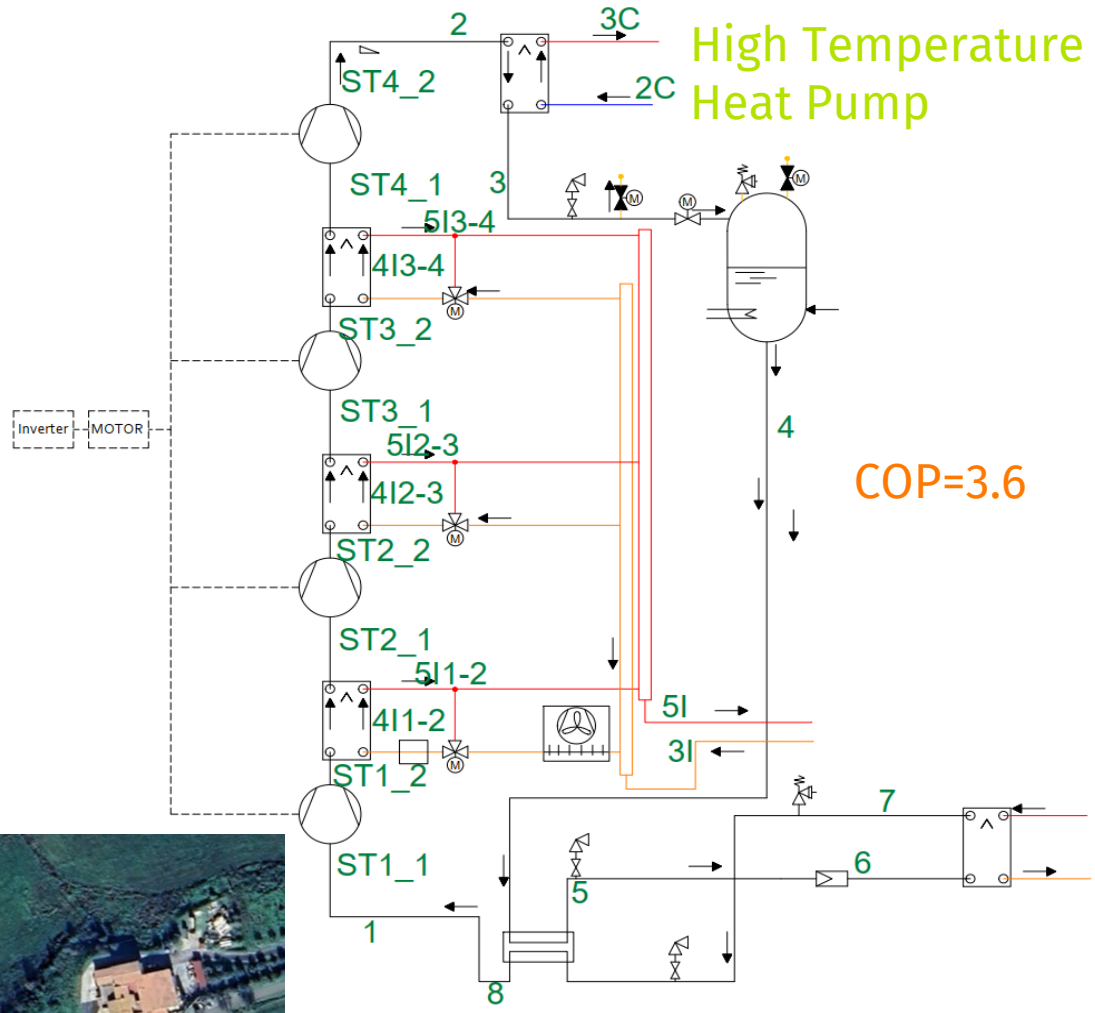
The technical solution

Heat Powered Refrigeration System



COP=0.5

High Temperature Heat Pump



COP=3.6



Project GEOSYN - GA nr. 101172812

Funded by the European Union

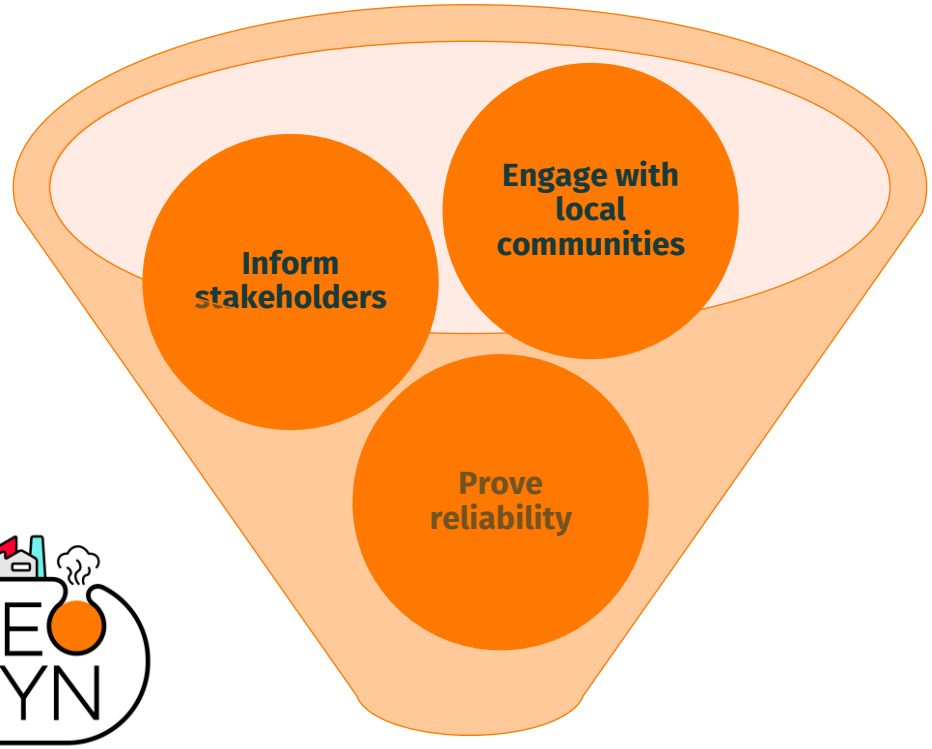
Bridging geothermal deployment gaps beyond technological innovation

Deployment gap: the distance between the technical potential of geothermal H&C technologies and their uptake by industrial users

Challenges to bridge deployment gaps

- Low social acceptance: it is usually the result of fragmented information, low public awareness of risks and benefits and lack of engagement.
- Limited industry awareness of proven applications
- Perceived investment risks and uncertainty about costs and benefits

The GEOSYN's Approach



Evidence-based information supports trust, market confidence and informed decision-making among industries, communities and policymakers

Project GEOSYN - GA nr. 101172812

Mapping existing experiences of heating and cooling integrations

Main achievements

94
mapped geothermal H&C examples

62
industrial production process cases

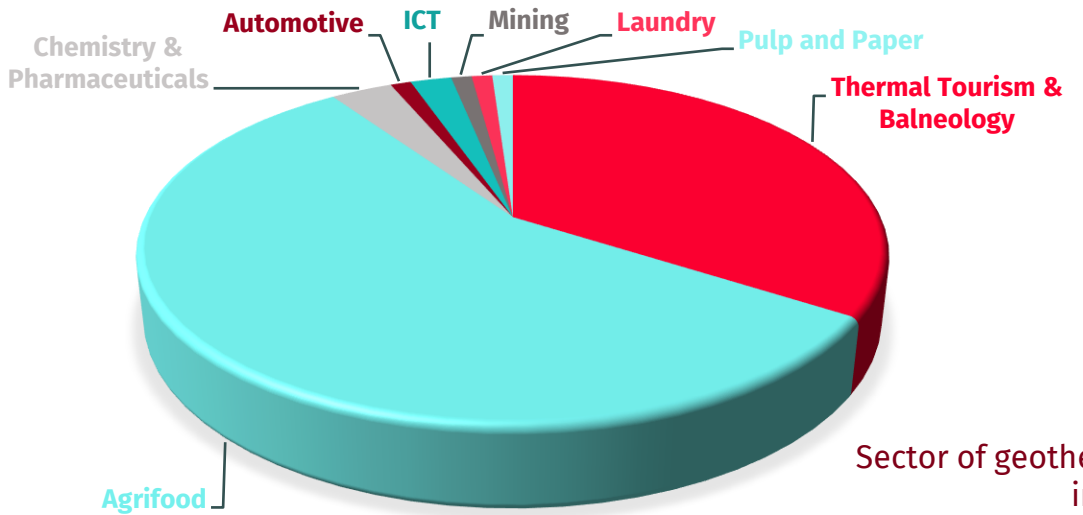
32
thermal tourism & balneology cases

86
examples located in Europe

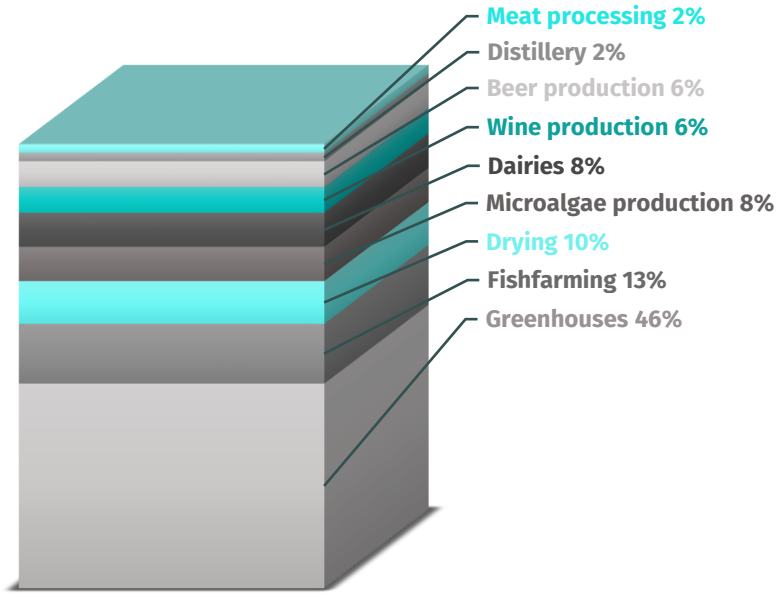
Geothermal H&C applied in 6 industrial sectors
All cases georeferenced and labelled by country, sector and kind of production

- The mapped applications span a broad range of sectors
- Evidences of the versatility and replicability of geothermal H&C technologies and their adaptability for different industrial H&C demands
- **Open Access WebMap** with existing examples
  - Showcases how geothermal H&C is integrated in industries
  - Reports energy-related data, technical description, economic, environmental and social aspects
  - Supports market uptake and boosts trust

https://geosynproject.eu/existing-applications/



Sector of geothermal H&C integration



Details of the agrifood productions integrating geothermal H&C

Mapping existing experiences of heating and

Main achievements

94
mapped geothermal H&C examples

62
industrial production process cases

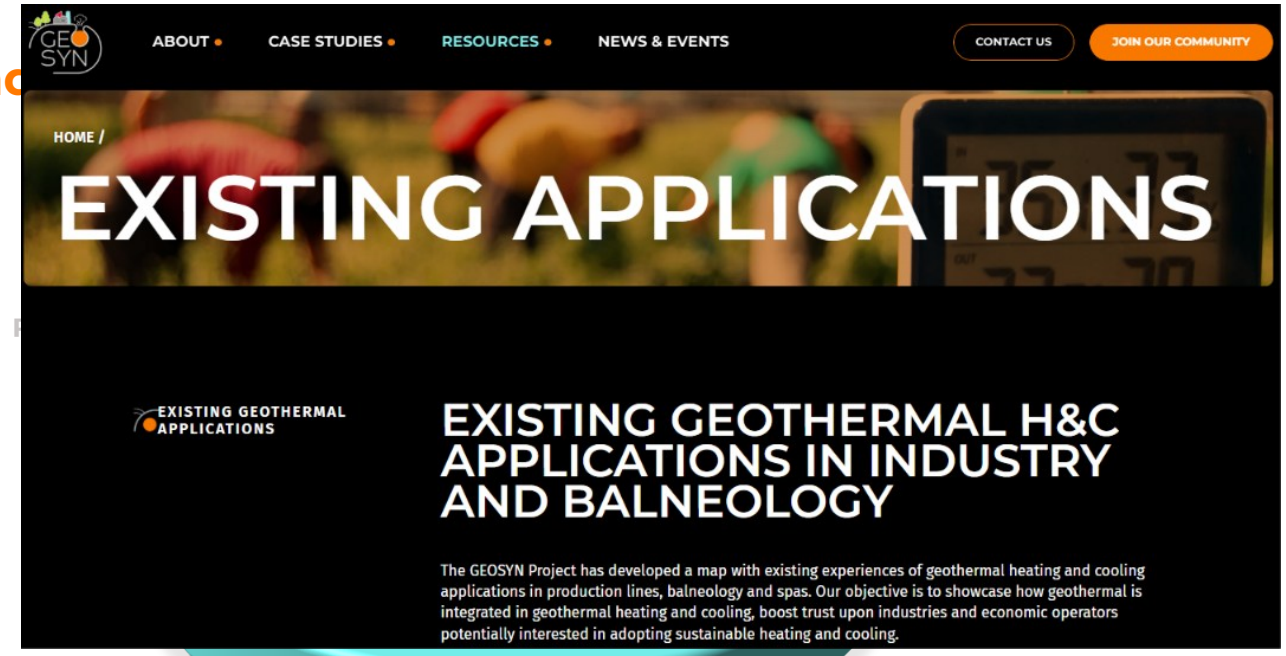
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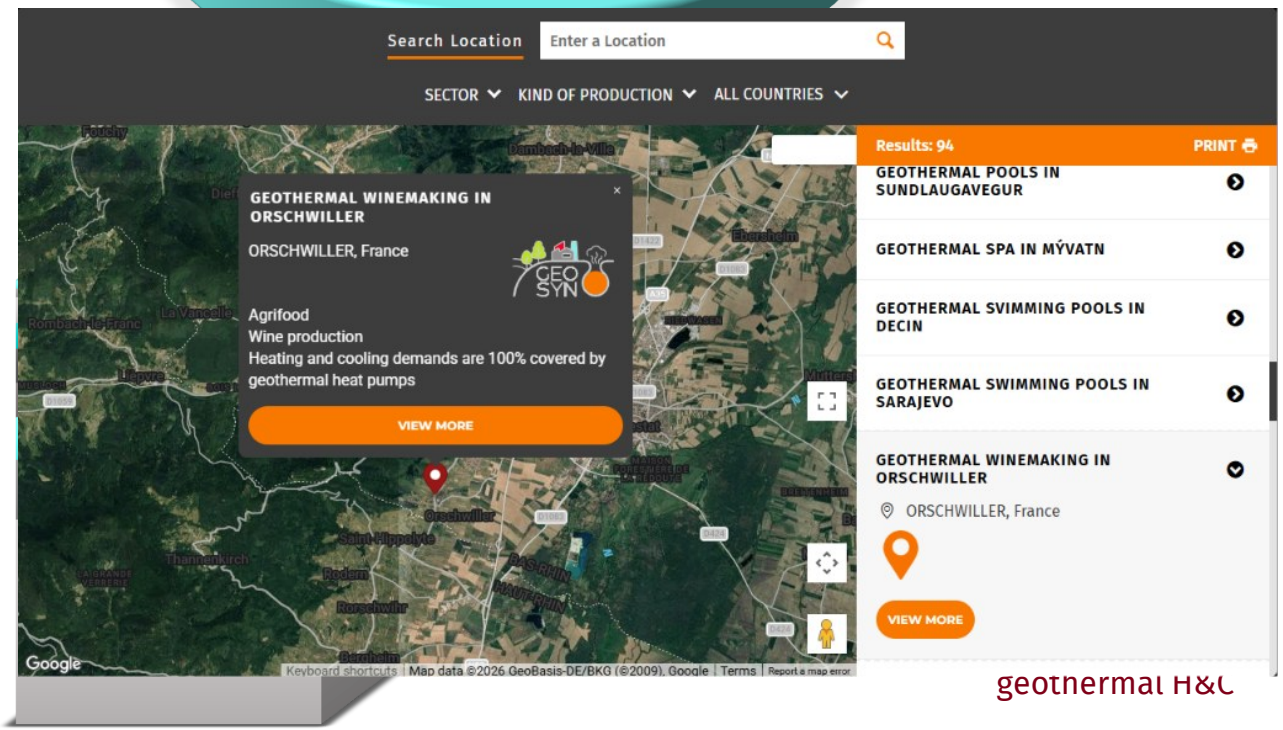
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Geothermal H&C applied in 6 industrial sectors
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https://geosynproject.eu/existing-applications/





Assessing the societal impacts of geothermal H&C technologies

Main achievements

2
focus countries
Italy + Ukraine

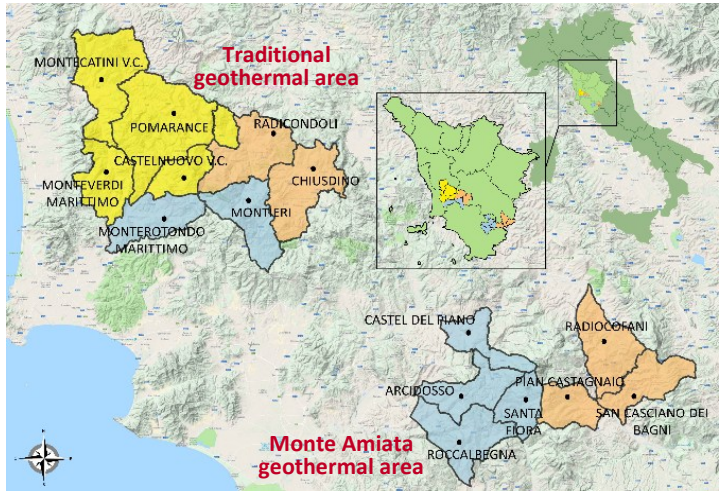
2
engagement
events

244
survey
responses

Promotion of inclusive dialogue with local communities

IT **63%** / UA **28%**
Associate geothermal to heat + power uses

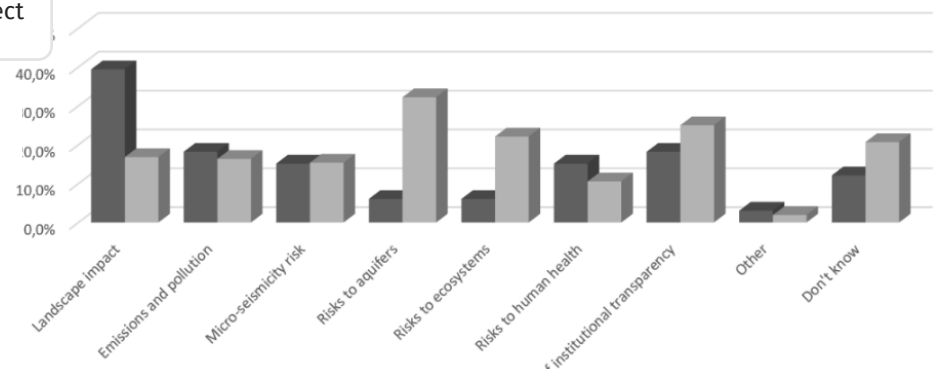
IT **74%** / UA **69%**
Willingness to support local geothermal project



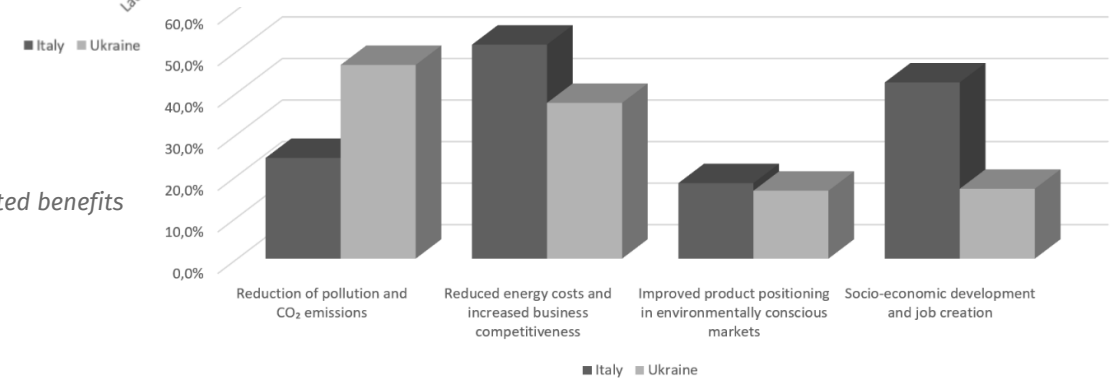


Survey results: Italy and Ukraine compared

Main concerns on geothermal energy



Main expected benefits



Feedback from survey and engagement workshops

Italy: Higher familiarity and trust; stakeholders prioritised lower heating costs, local jobs, transparent communication and environmental integration.

Ukraine: Lower initial awareness but strong interest in energy independence, resilience, knowledge building, local jobs, economic feasibility and national policy alignment.

Common gap: Cooling applications require clearer explanations and demonstrative examples.

Common features: support grows when tangible benefits, dialogue, transparency and inclusion accompany technological progress.

Life Cycle Inventory: an environmental evidence layer

Purpose:
Establish a robust quantitative basis for environmental assessment of GEOSYN H&C technologies, considering material and energy flows across construction, operation, maintenance and end-of-life

Main achievements

EJ
ejector cooling system LCI developed

2
GEOSYN technology configurations

HTHP
construction-phase LCI developed

Datasets for LCIA and environmental hot-spot identification

5
virtual case studies supported by processed data

LCI online
LCI and research data published online

LCI outputs

- HTHP inventory structured across condenser-side, intercooler, geothermal-side and four-stage heat pump circuits, including piping
- Ejector plant inventory structured across condenser-side, geothermal heat-exchanger and cold-production circuits, including piping

LCIA and interpretation will evaluate environmental impacts during subsequent project stages

Project GEOSYN - GA nr. 101172812

Funded by the European Union

From evidence to engagement: a replicable framework for geothermal H&C adoption

The GEOSYN replicable framework

Evidence base

Technical demonstrations
Existing applications / webGIS
Social acceptance findings
LCI datasets

Engagement and awareness

Accessible messages to industries
Citizens and communities
Geothermal stakeholders

Tailored communication

Editorial plan
Factsheets and web contents
Podcasts
Social media

Enabling outcomes

Geothermal literacy
Trust and transparency
Market confidence

Beyond the GEOSYN Project

This approach is a replicable pathway for territories and industrial sectors where adoption is constrained by limited visibility, practical examples or trust

THANK YOU FOR YOUR ATTENTION!

GEOSYN

"Geothermal Heating & Cooling for Industry

Dario Bonciani

COSVIG

d.bonciani@cosvig.it



www.geosynproject.eu

info@geosynproject.eu

#GEOSYNPROJECT

Funded by the European Union

USES4HEAT

DEMONSTRATION UTES PROJECTS

– from theory to practice

Dr. JOSE ACUNA, KTH

2nd GEO-CLUSTER Joint mobilization and mutual learning online workshop, 2026-10-06

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Practical lessons from USES4HEAT

USES4HEAT aims at demonstrating large scale UTES + key enabling technologies.

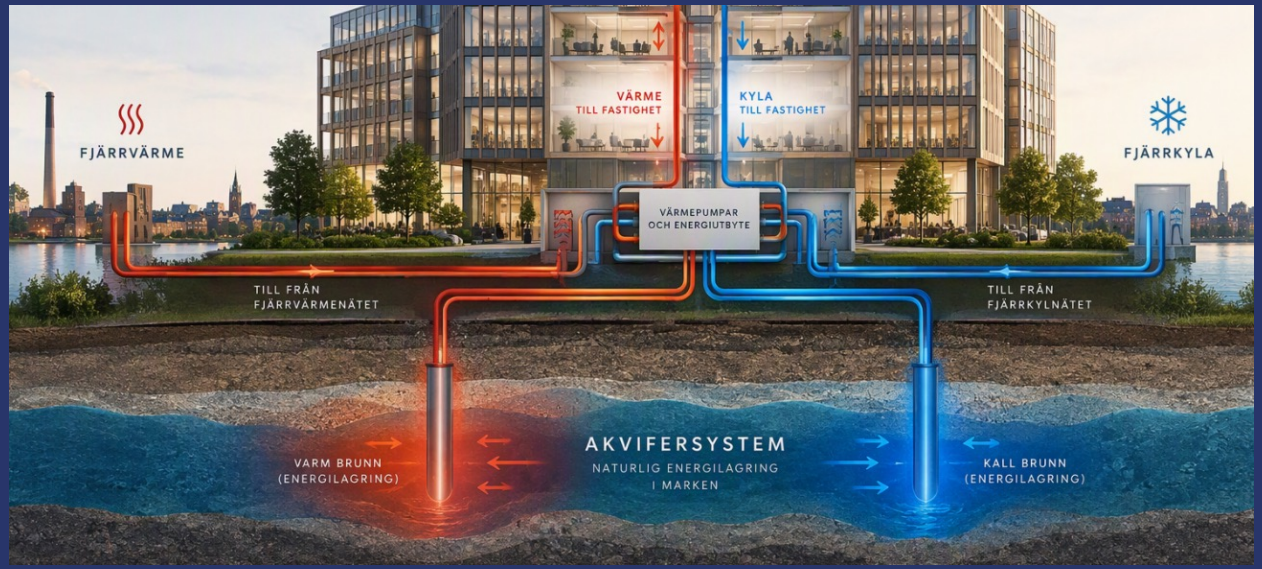
- from theory to practice: practical lessons learned on demonstration&replication sites

- **ATES demo sites**
  -> Riva del Carda, Italy —amendment-> Andel, Netherlands
- **BTES demo sites**
  -> Oslo, Norway —amendment-> Litomerice, Czech Republic
- **CTES replication site**
  -> Stockholm, Sweden

ATES

AQUIFER THERMAL ENERGY STORAGE

FROM RIVA DEL CARDA, ITALY -> TO ANDEL, NETHERLANDS



USES4HEAT

ATES site in Riva del Carda

- In spite of highly engaged and competent local team, the demo could not be materialized due to **drilling permission not being approved**





Date: 08 January 2026

To: EUROPEAN CLIMATE, INFRASTRUCTURE AND ENVIRONMENT EXECUTIVE AGENCY (CINEA)
From: GARDA CARTIERE S.P.A.
Subject: Opinion on Termination of Participation in GA 101136136 — USES4HEAT

To whom it may concern,

This letter serves as the formal opinion from GARDA CARTIERE S.P.A. regarding the termination of our participation as a beneficiary in the USES4HEAT project (Grant Agreement No. 101136136), effective 31/05/2025.

- **Organization:** GARDA CARTIERE S.P.A.
- **PIC:** 904834334
- **Address:** VIALE ROVERETO 15, 38066, RIVA DEL GARDA (TN) (IT)

We confirm our agreement with the termination, as per the requirements of Grant Agreement No. 101136136 Article 32. This termination is due to the main reason that the demo-site in Riva del Garda did not obtain the authorization and required permits from the local authorities. A detailed justification is provided in the justification for the amendment AMD-101136136-2.

We request that this notification triggers the necessary amendment procedures to formalize our exit and reallocate resources within the consortium.

We are available to discuss this matter further and provide any additional information required for smooth project transition.

Sincerely,

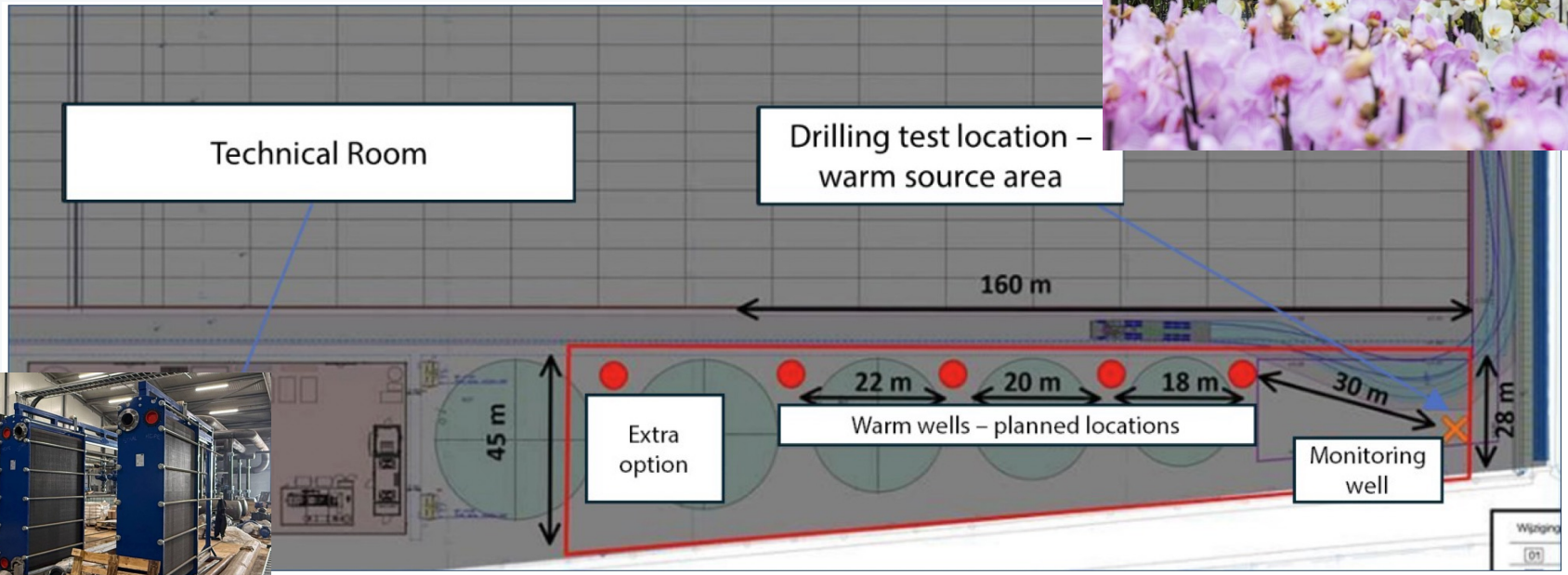
Antonio Di Blas
Amministratore Delegato

CARTIERE DEL GARDA S.p.A.
Viale Rovereto 15
38066 RIVA DEL GARDA (TN)

Plan B = ATES site in ANDEL

- Project execution decided before entering the EU project
- Under construction as the amendment is processed
- Engaged and knowledgeful end user and local team
- Several economical driving forces (electricity market, energy savings etc)
- Mature technology in hosting country





BTES

BOREHOLE THERMAL ENERGY STORAGE

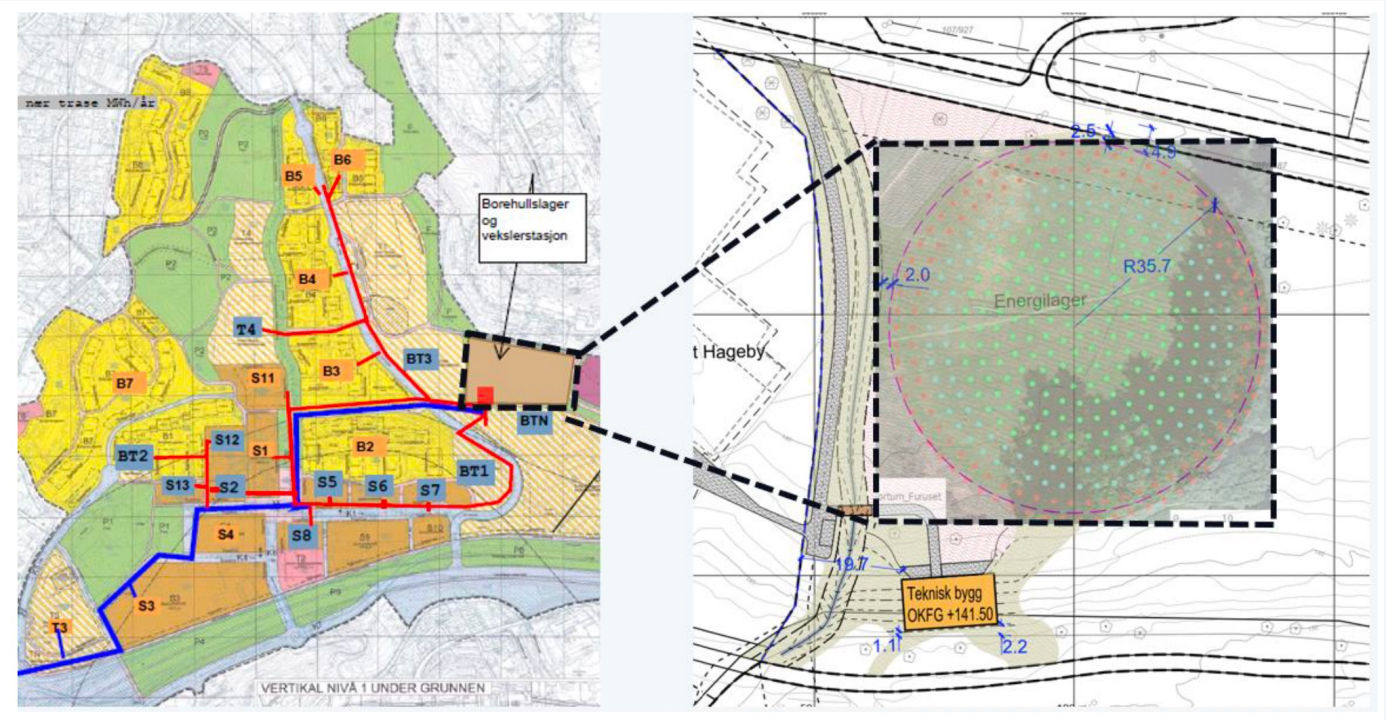
FROM OSLO, NORWAY -> TO LITOMERICE, CZECH REPUBLIC



USES4HEAT

HT-BTES site in Oslo

- Changes in the organisation of the demosite owner and other investments prioritized
- New LCC analyses carried out within the project = **unprofitable**
- Demosite not materialized

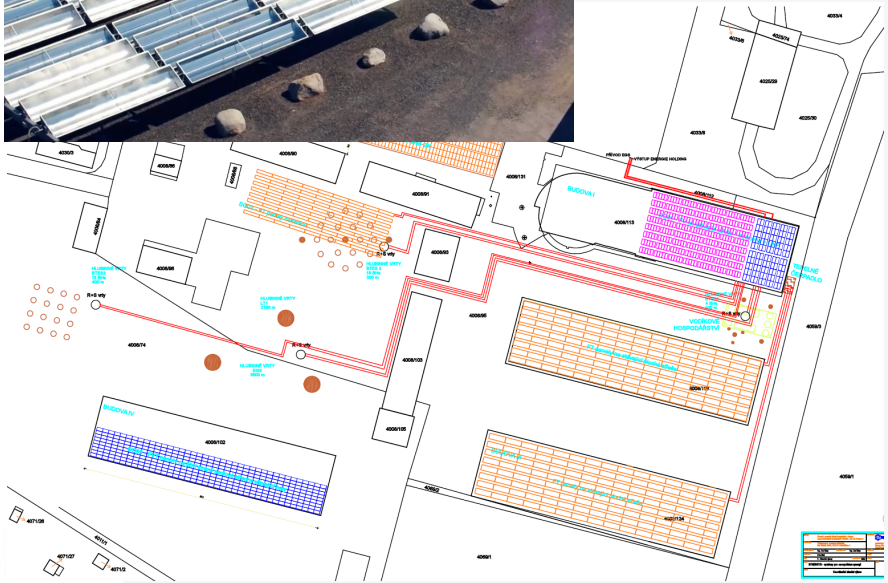


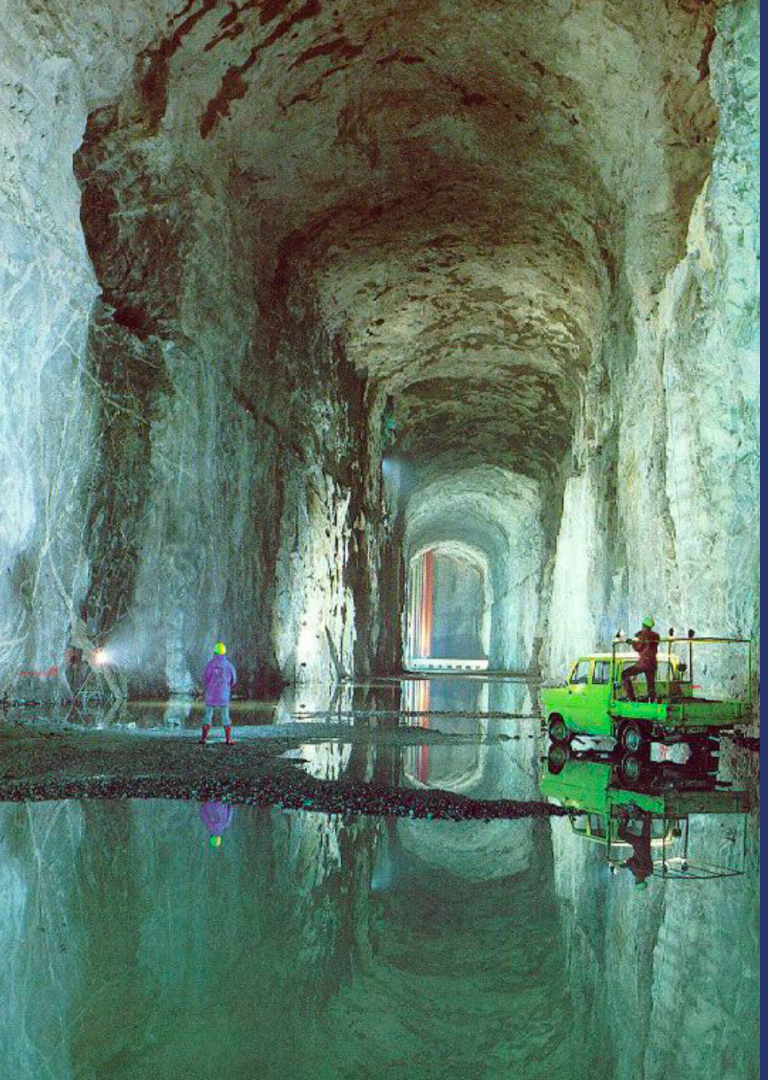
Plan B: HT-BTES at Litomerice

- Ongoing project -> **long procurement process**
- Contracting works start when the money is secured
- Delays in delivery of key enabling technology?
- Multiple funding sources







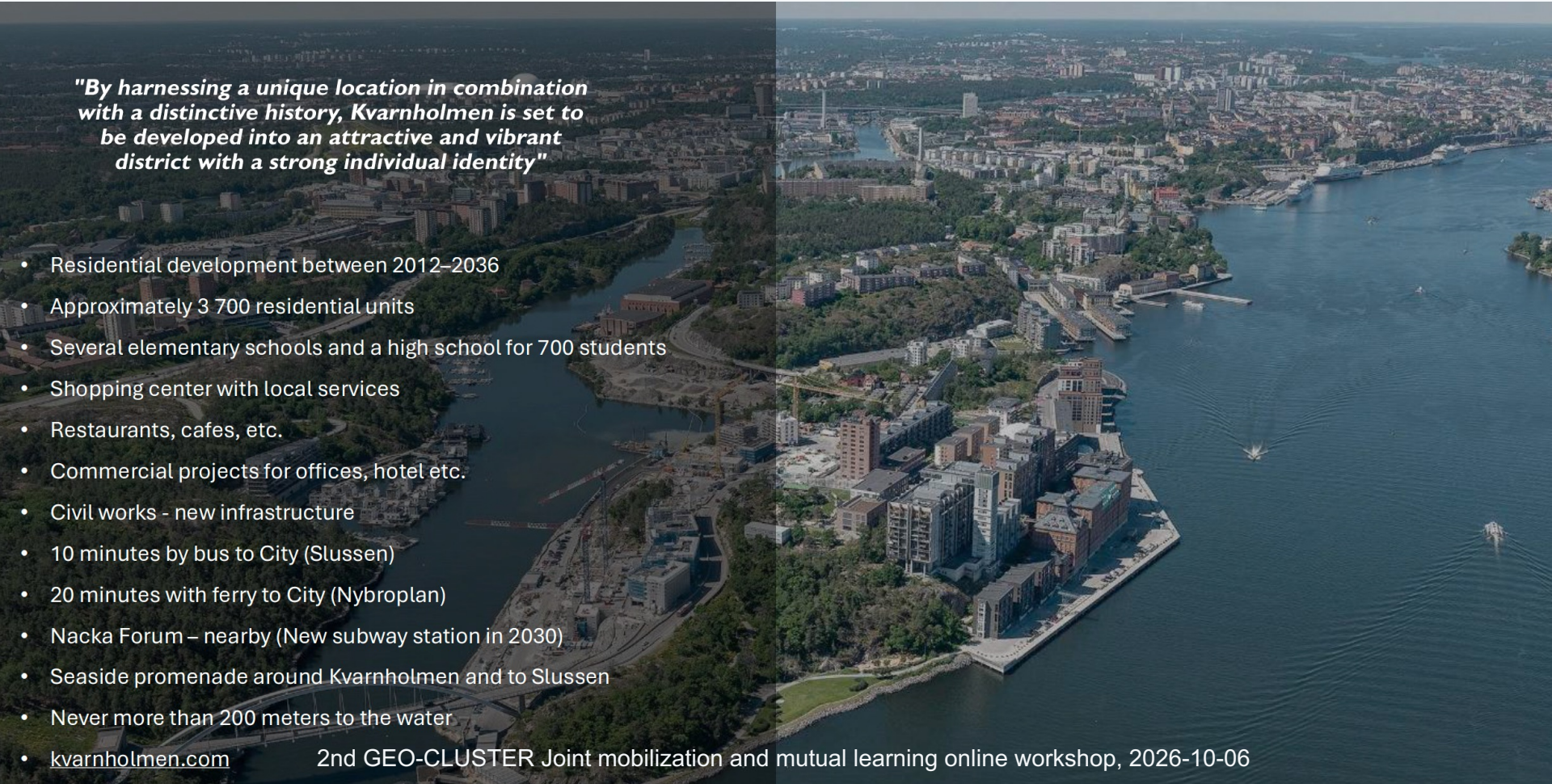


CTES

CAVERN THERMAL ENERGY STORAGE

KVARNHOLMEN, SWEDEN: BECOMING READY FOR DEMONSTRATION

USES4HEAT

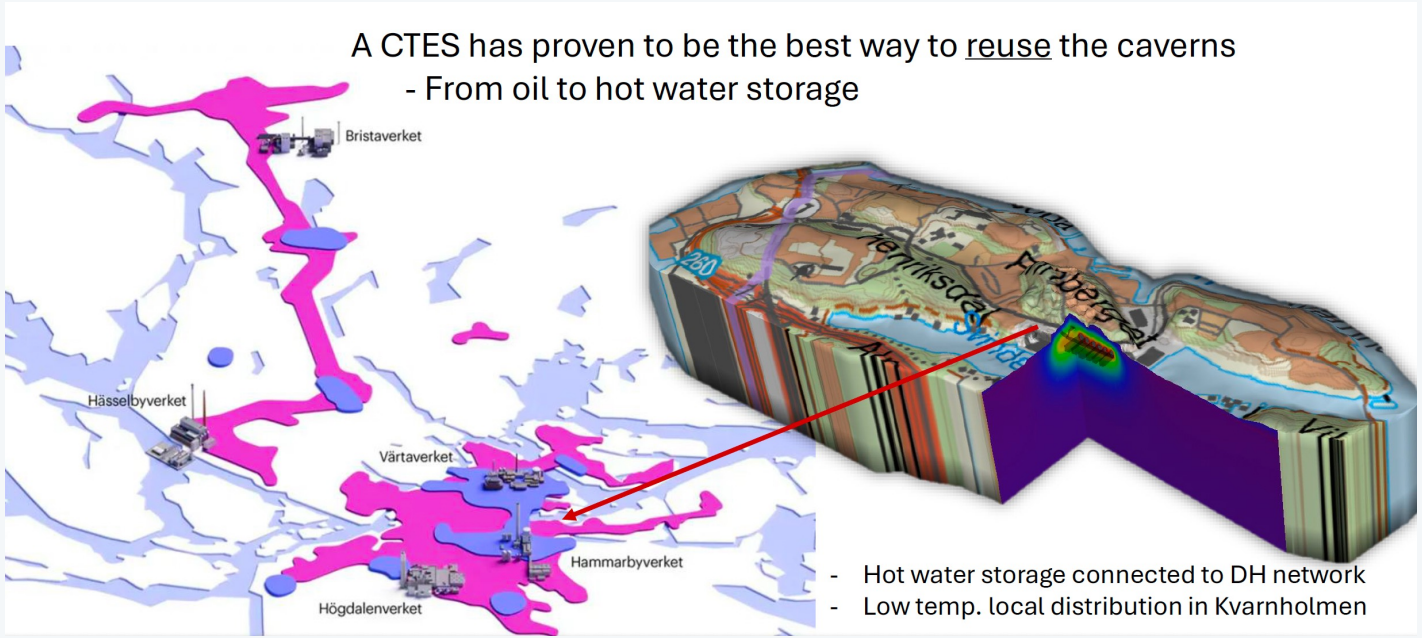


"By harnessing a unique location in combination with a distinctive history, Kvarnholmen is set to be developed into an attractive and vibrant district with a strong individual identity"

- Residential development between 2012–2036
- Approximately 3 700 residential units
- Several elementary schools and a high school for 700 students
- Shopping center with local services
- Restaurants, cafes, etc.
- Commercial projects for offices, hotel etc.
- Civil works - new infrastructure
- 10 minutes by bus to City (Slussen)
- 20 minutes with ferry to City (Nybroplan)
- Nacka Forum – nearby (New subway station in 2030)
- Seaside promenade around Kvarnholmen and to Slussen
- Never more than 200 meters to the water
- kvarnholmen.com

Approaching demo phase

- Ongoing collaboration with demosite owner and DH network operator
- Detailed LCC analyses, sensitivity analyses
- Study of environmental, economical, resilience and flexibility benefits
- Early engineering already carried out and preparation for permission process
- High attention, new funding initiatives

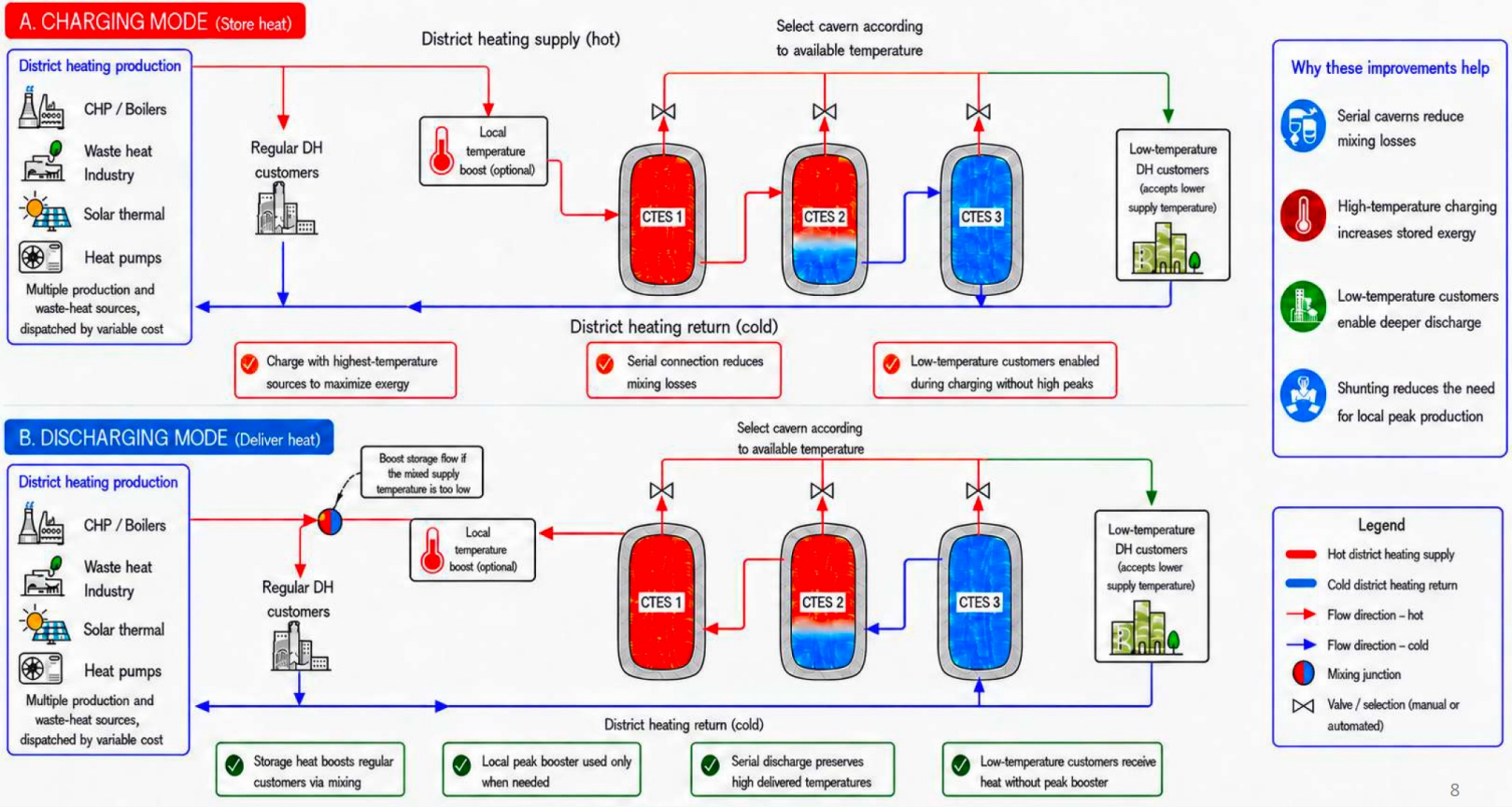


From replication to demonstration

USES4HEAT

Co-funded by the European Union

Source: Dalgren et al. 2026. 12th Int. Conf. on Smart Energy Systems



OTHER TIPS WHEN PLANNING DEMO PROJECTS

- Double check that the realisation of the project has been seriously evaluated before boarding a demonstration site
  - Financially (profitability analyses performed before demo project)
  - Practically (permission, implementability, engagement)

- Academia vs Industry:
  - Researchers have often limited understanding of the complexity of commercial projects and contracting works
  - Commercial stakeholders have often limited understanding of the complexity of R&D projects
  - Ambassadors and innovation angels are needed.

- Amendments – Demosite owners are critical and their involvement needs to be carefully planned as a proposal for a demo project is submitted. An amendment process due to Demo-partner change can have large consequences for the project and consortium members.

- Technical:
  - Double check TRL level of key enabling technologies before including it in a DEMO project
  - More charging cycles = higher profitability.



USES4HEAT

THANK YOU!

Dr. JOSE ACUNA
KTH Energy Technology
josea@kth.se
+46762320008

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NON-MARKET BENEFITS OF LARGE THERMAL ENERGY STORAGE

Accelerating Geothermal and Thermal Energy Storage Development in Europe

06.10.2026

Anja Gahleitner
Simon Moser

Energieinstitut an der Johannes Kepler Universität Linz

TREASURE

This project has received funding from the European Union's Horizon Europe research and innovation programme under the grant agreement No 101136095.

TREASURE: Project context

Demonstrating Large Pit Thermal Energy Storages (PTES) and improving their components, processes, and procedures for an accelerated realization of 100 % sustainable district heating networks in Europe

- **TREASURE** consortium is coordinated by AEE INTEC and unites the multidisciplinary knowledge of 23 diverse organizations from 7 European countries
- Duration: January 2024 – December 2027
- funded by the European Union's Horizon Europe research and innovation programme (Grant Agreement No. 101136095)

TREASURE: Objectives

The TREASURE project aims to accelerate the implementation of large-scale underground thermal energy storage (PTES) systems to facilitate the transition to fully renewable district heating networks in Europe.

The main objectives are:

- Construction of 7 demonstration plants in 5 different countries
- Bridging the gap between research and practice to develop robust, safe, cost-effective, and sustainable solutions for PTES across Europe
- Development of safe, smart PTES integration concepts to optimize renewable

D6.3 – Evaluation of Non-Market Benefits

Research motivation & question

As part of **TREASURE**, we investigated the **non-market benefits of Large Thermal Energy Storage (LTES)**.

Starting point:
The economic value of a storage system does not capture all the benefits that matter to society and customers.

So, we wanted to answer three questions:
Do customers value non-market benefits of LTES?
Are they willing to pay for these additional benefits?
And how well is LTES accepted?

Conduction of the survey: End of 2025.

The full survey results are available here:

Why non-market benefits matter?

Large Thermal Energy Storage (LTES) play a crucial role in the transition to renewable and efficient heating.

Economic challenges:

- High investment costs
- Low number of annual charging cycles
- **Often critical cost-benefit ratio**
- Consider **additional benefits of LTES**

Key attributes of the survey

To assess the value customers place on LTES, the survey considered four key attributes:

- **CO_2 reduction**

  The reduction in greenhouse gas emissions enabled by LTES

- **Resilience**

  In this study: **greater stability of heating prices**

- **Visibility**

  Whether the **storage facility is visible** to customers

- **Cost**

  The additional **annual heating costs** associated with the storage

The combination of these attributes allowed us to estimate customers' willingness to pay for the non-market benefits of LTES.

Survey methodology

Survey

Survey Scope:

- Target: 3,000 potential district heating costumers
- 5 countries: Austria, Denmark, Germany, Sweden, Poland
- Structured online survey, online panel recruitment

	Initial Sample Size	Total Survey Responses	Final Sample (passed attention check)
Austria	500	504	464
Denmark	500	549	477
Germany	750	769	701
Poland	750	844	743
Sweden	500	533	488
	3,000	3,219	2,873

Questionnaire design:

- Clear, simple language, in **national languages**

Quality control measures:

- **Time-based screening**: exclude participants completing Discrete Choice Experiment unrealistically fast
- **Attention check** embedded in survey

Questionnaire structure

Thematic blocks

- Introduction & Consent
- Attitudinal and behavioural questions
- Infographic
- Discrete Choice Experiment
- Energy related questions & experience
- Socio demographic information

Introduction & Consent

- Project information & Purpose of the survey
- Data protection

Attitudinal and behavioural questions (views on topics related to the environment and energy)

- Environmentally friendly
- Development of renewable energy projects
- Fossil fuel
- „Attention Check“

Infographic

- Information on: What is a Large Thermal Energy Storage (LTES)?
- Attributes: Costs to build, saves CO_2 emissions, price stability/resilience of the system, visibility/type
- Graphic of visibility of the three design-types of LTES (Tank, PIT, Cavern)

Discrete Choice Experiment *(experiment simulated real-life decisions between alternatives)*

- Introduction into the experiment
- Aspects considered (4 attributes)
- Graphic of the three design-types
- Choice task: Selection between LTES system with a specified combination of the four attributes vs. no LTES system (current situation without storage)
- Respondents were asked to consider their actual life situation
- Each respondent completed a set of six choice tasks

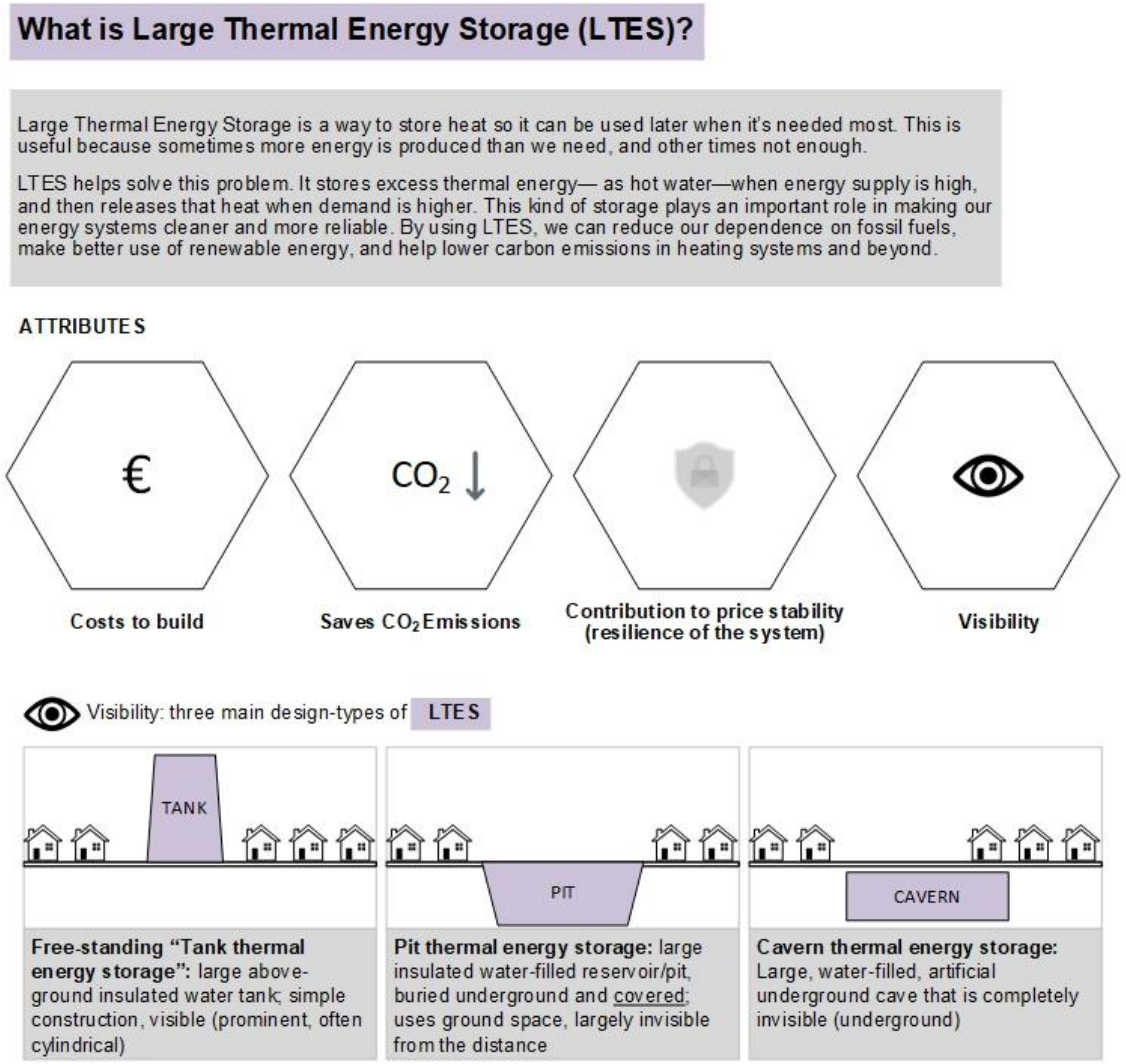
Energy-related questions & experience

- Heating system
- For non-district heating customers: do you know someone with district heating?
- Heating bill
- Heating failure experience
- Electricity supply tarrif
- Blackout (within the last 10 years)
- Battery storage system

Socia-demographic information

- Education
- Net income
- Ownership status (home)
- Gender
- Age

How LTES were presented to respondents



Objective

- Ensure that participants understood the concept of LTES

Therefore

- National language
- clear and easy-to-understand explanations
- 4 attributes of LTES
- 3 different design types of LTES and their visibility

Discrete Choice Experiment (DCE)

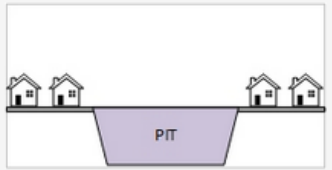
Choice: Building an LTES system vs. Not building an LTES system

Each choice included **four attributes**:

- Additional annual costs: 4 parameters
- Visibility/design of the storage system: 3 types
- CO_2 emission reductions: 3 parameters
- Contribution to price stability: 2 parameters

Each participant completed **6 choice tasks**.

When you answer, please consider your real-life situation, including your budget, values, and usual behavior.

	LTES	No LTES
Extra costs to your heating bill in Euro per year	50 Euro	0 Euro (no extra costs as no construction activity takes place)
Visibility/Type		
CO_2 savings	5%	0% (no CO_2 savings)
Contribution to price stability (resilience of the system)	50% protection against global price spikes (your heating bill stays rather stable)	0% protection (against global price spikes - your heating bill is likely to fluctuate with global price)
What would you choose?	○ LTES	○ No LTES

Overall results

High public support for LTES

2,873 usable responses

- **65–70%**
  of all choice observations selected LTES over the status quo
- **78.1%**
  approval when annual additional cost is only €10
- **53.2%**
  approval at €200 additional annual cost

Respondents show a clear baseline preference for investing in LTES, indicating broad public support when LTES is framed as a climate and energy security measure.

What drives acceptance?

- **CO_2 reduction** > Most highly valued attribute

  Strong increase in approval from 5% to 40% CO_2 reduction
- **Resilience** > Positive effect on acceptance

  Protection against **energy price volatility** is valued by respondents
- **Visibility / storage type** > Less visible solutions are preferred

  Compared with a tank:

  Cavern: +6.4 pp approval

  Pit: +2.9 pp approval
- **Cost** > **Strongest barrier to adoption**

  Higher annual heating-cost increase significantly reduces approval

Who supports LTES & implications

- **Socio-demographic variables have a limited effect**
- **Income** is the only socio-demographic variable consistently affecting adoption
- Gender, age, education and home ownership show **no significant effect**

What can increase acceptance?

- **Highlight climate benefits:** Frame LTES as a **climate mitigation measure**, not only as infrastructure.
- **Minimise visual impact.** Prioritise **underground / low-visibility solutions** where technically feasible.
- **Emphasise resilience.** Communicate LTES as a means of **protecting households against energy price volatility**.

There is a positive willingness to pay for LTES!

Thank You!

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SEEDS

Cost-effective and replicable RES-integrated electrified heating and cooling systems for improved energy efficiency and demand response

Funded by the European Union

GeoCluster workshop: stakeholder-based barriers and solutions in the SEEDS project

Natan Vandeginste

SEEDS WP7 Leader
Senior Project Leader at SWECO

6 October 2026



Objectives of the SEEDS project



- https://project-seeds.eu/
- The overall aim of SEEDS is to boost the **electrification of thermal systems** in buildings through an integrated approach leveraging **energy efficient renovation and smartification** of HVAC systems.
- *Keywords*: MPC, flexibility, multi-source HPs, district heating, replication
- This strategy is tested in six different demonstration pilots throughout Europe: 🇩🇰 🇧🇪 🇸🇮 🇬🇷 🇭🇺

2024	2025	2026	2027
Design, permission, tender	Construction, installation, algorithms	Measurements, testing	Implementation, upscaling

Objectives of WP7

WP7 "Decision making support framework for replication of thermal demand electrification and improved energy efficiency" has **3 objectives**:



Identify

Identify barriers for external replication of SEEDS innovations (and innovative HP solutions in general)



Support

Support decision makers to identify, plan, implement and run thermal system electrification projects.



Convince

Convince decision makers of the value of thermal system electrification.

Methodology of WP7

WP7 is divided into **4 tasks**:



Interviews

Interviews with decision makers:

- 3 groups were identified: local governments, project developers & property managers.
- **Semi-structured interviews**, distributed geographically and per decision maker group.



Problem

Problem statement definition:

- Definition of barriers based on the interviews and creation of user journeys.



Toolbox

Development, testing & deployment of a **publicly available digital support toolbox**:

- Combination of tools and frameworks established in other WPs.
- Tailored to each decision maker group.
- Dynamic behaviour with input parameters.



Storytelling

Visual storytelling to demonstrate pilot results and value to decision makers:

- ArcGIS StoryMaps (online platforms) integrated in project website

Barriers mentioned in interviews

In Slovenia, the replacement of oil boilers does not require prior permission to connect to the electricity grid. This results in uncoordinated load increases and thus **grid instability**, blackouts, and public complaints.

"Chicken-and-egg" problem: approximately 80% of end-user connections are required to ensure the **economic feasibility of heating networks**.

In Denmark, the strong **market position of district heating operators** limits the incentive to reduce operating temperatures

Respondents reported "**Pilot sickness**", or the difficulty to move from small pilot projects to broader, full-scale implementations.

Existing **support schemes** are often insufficient and primarily targeted at individual measures rather than collective solutions.

In Belgium, there is **ample underground space** due to existing utility infrastructure. Only the DSO can install pipes on the public domain, limiting the expansion of heating networks since they need to stay on private property.

User journeys – Project developer

PROJECT DEVELOPER



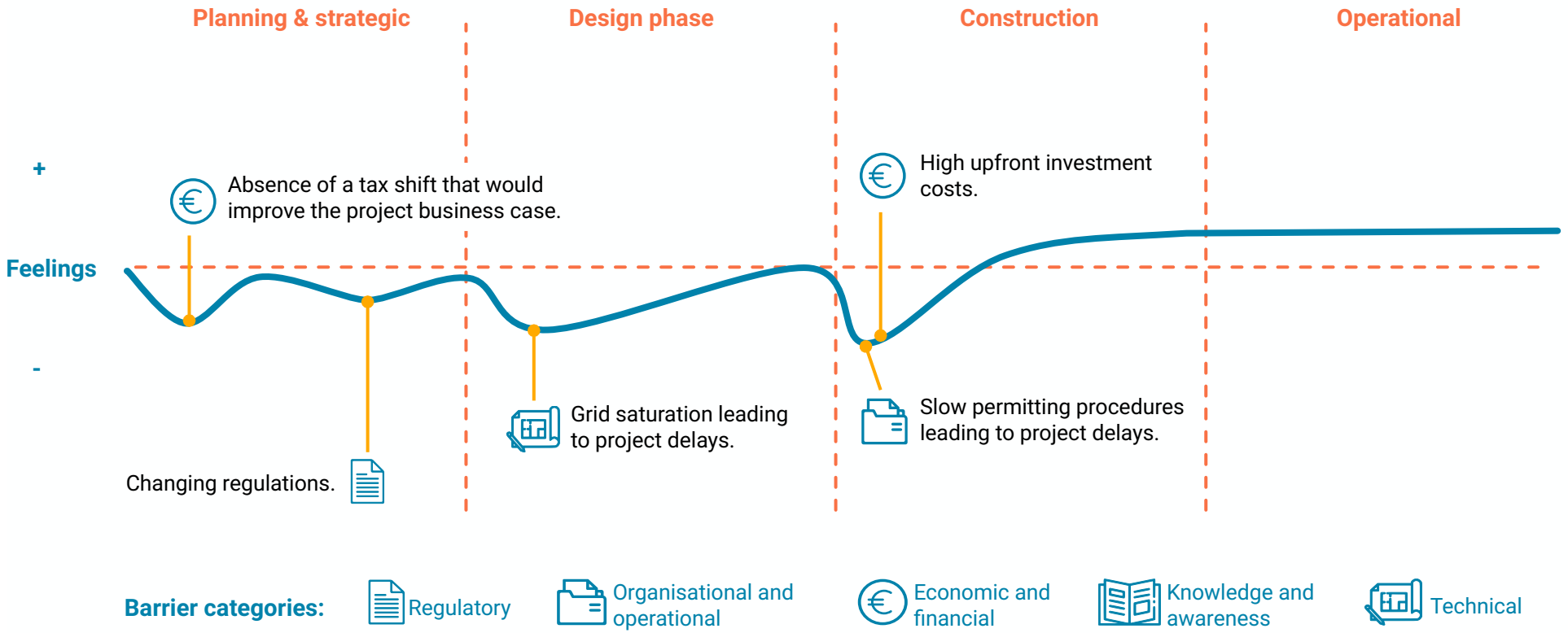
Role

The project developer is responsible for delivering profitable (sustainable) energy projects. The role involves developing and managing projects, where clear regulations, efficient permitting, access to technology and a viable business case are essential.

Responsibilities

- Deliver profitable (sustainable) energy projects.
- Assess and secure viable business cases.
- Manage projects from design to implementation.
- Ensure regulatory compliance and permitting.
- Coordinate with internal teams and external stakeholders.

Decision moments



User journeys – Facility manager

FACILITY MANAGER



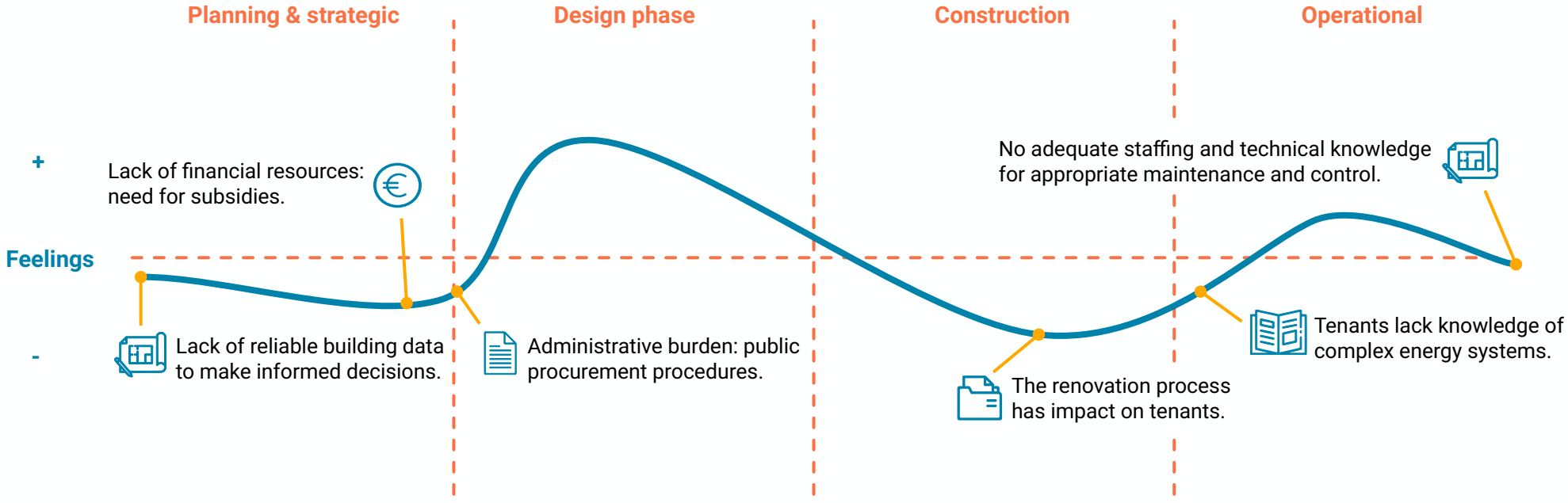
Role

The facility manager works within property management companies, including both commercial property managers and social housing providers.

Responsibilities

- Operate and maintain building energy systems
- Ensure tenant comfort and minimise disruption
- Comply with regulations
- Control costs or ensure financial viability

Decision moments



Barrier categories: Regulatory · Organisational and operational · Economic and financial · Knowledge and awareness · Technical

User journeys – Local government

LOCAL GOVERNMENT



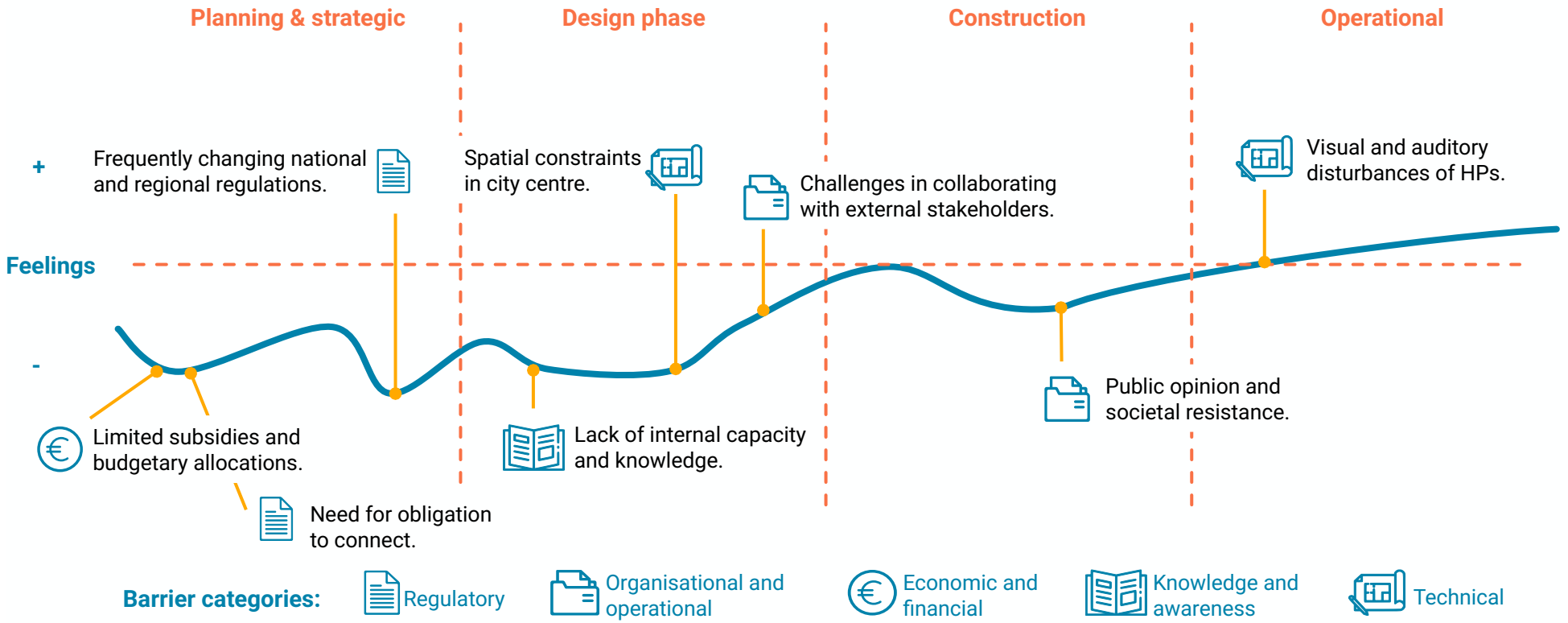
Role

A local government official is responsible for driving the governments energy transition and climate action. This person focuses on translating national and regional regulations into concrete local policies and projects, while aligning actions with political priorities.

Responsibilities

- Translate regulations into actions
- Develop energy and climate strategies
- Align policy measures with local political priorities
- Influencing implementation through subsidy schemes, and public initiatives.

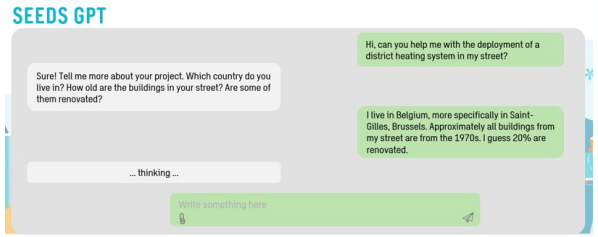
Decision moments



Development of a toolbox

Decision-maker support framework

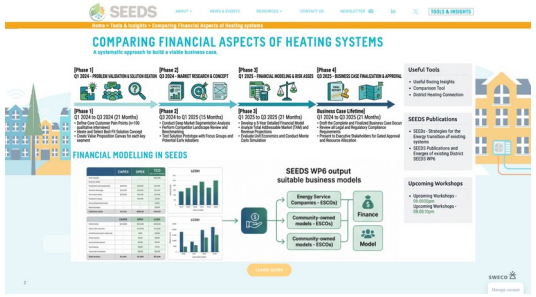
1. **Barrier-driven**: organise around barriers, not the tools
2. **Tailored**: address the particular case of the user
3. Navigate to **existing solutions**: up-to-date with low maintenance



Chat interface to determine use case of user



Recommendation engine with use case parameters



Insight pages with tools, acceleratores and ideas

Thank you !



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SEEDS

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